ITS Strategic Plan

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ACRONYM LIST

ADA	Americans with Disabilities Act
ADOT	Arizona Department of Transportation
AOI	Area of Influence
ARRA	American Recovery and Reinvestment Act
ASU	Arizona State University
ATCS	Adaptive Traffic Control System
ATMS	Advanced Traffic Management System
AVL	Automated Vehicle Location
AZ511	Arizona 511 Phone System
C2C	Center-to-Center
C2F	Center-to-Field
CAD	Computer Aided Dispatch
CCTV	Closed Circuit Television Camera
CIP	Capital Improvement Program
CMAQ	Congestion Mitigation and Air Quality Improvement Program
DMS	Dynamic Message Sign
DPS	Arizona Department of Public Safety
DTC	Downtown Tempe Community
FD	Fire Department
FMS	Freeway Management System
FTA	Federal Transit Administration
HAWK	High-intensity Activated crossWalK
HCRS	Highway Conditions Reporting System
IGA	Intergovernmental Agreement
IP	Internet Protocol
IT	Information Technology
ITS	Intelligent Transportation Systems
MAG	Maricopa Association of Governments
Mbps	Megabits Per Second
MCDOT	Maricopa County Department of Transportation
MOU	Memorandum of Understanding
NHI	National Highway Institute
NTOC	National Transportation Operations Coalition
PD	Police Department
PIO	Public Information Officer
PSAP	Public Safety Answering Point
PTZ	Pan, Tilt, Zoom
RADS	Regional Archived Data System
REACT	Regional Emergency Action Coordination Team
SMFO	Single Mode Fiber Optic Cable
STEP	Streetscape and Transportation Enhancement Manual
TIP	Transportation Improvement Program
TMC	Transportation Management Center
TOC	Traffic Operations Center
TSOP	Traffic Signal Optimization Program
USDOT	United States Department of Transportation
VID	Vehicle Image Detection
VLAN	Virtual Local Area Network

1. PLAN OVERVIEW

The *Tempe General Plan 2030* identifies an important strategy to "Integrate Intelligent Transportation Systems (ITS) technologies into the street network and traffic control system" to benefit motorists, pedestrians, bicyclists, and transit users. The City also has a Comprehensive Transportation Plan that presents a long range vision and definition of the transportation system. This ITS Plan then defines how technology can be used to optimize the operation of the system. Adding lanes or building new roads is expensive and not always practical in a built-out city such as Tempe. Creative and cost-effective strategies and options such as ITS technologies, can help address these problems and can help improve the quality of travel on the roads throughout the City.

The City of Tempe has developed an ITS Strategic Plan to map out strategies for implementing ITS technologies in the City. The goal is to better manage traffic and provide a safe travel experience for passenger vehicles, transit, and METRO Light Rail users, as well as bicyclists and pedestrians. An ITS Strategic Plan is needed to support future implementation of projects based on available funding or partnering opportunities. The Plan also provides solutions to meet needs that are focused on smart deployment of technologies which serve multiple purposes and create efficiencies in the services that Tempe provides to its residents and travelers.

The Tempe ITS Strategic Plan includes the following:

- *Background, Goals and Outreach* – These first sections set the stage for the plan's overall purpose, stakeholder involvement, and goals/objectives.
- *Needs Assessment* – This section identifies the needs in Tempe from various perspectives to ensure that this ITS Strategic Plan will encompass the broad goals and objectives of the City.
- *Infrastructure Assessment* – This section defines the existing systems, technologies, and planned infrastructure that need to be considered when planning for ITS deployments and integration.
- *Strategy Development and Telecommunications* – This section presents the infrastructure, strategies, and deployment support guidelines including telecommunications general criteria as well as recommendations for improvements/modifications to make the system more efficient and make use of private partnerships where feasible.
- *Functional Roles and ITS Operational Requirements* – This section includes the roles and responsibilities involved in applications and operations of the ITS network as well as the involvement of other departments.
- *Implementation, Maintenance, Training, and Funding* – This last section identifies the partnerships, funding, timeframes, and phasing plan that will support the growth and integration of the City's ITS Program.

2. WHAT IS ITS AND WHAT ARE THE BENEFITS?

2.1 ITS Definition

ITS refers to the application of computer, electronics, and communications technologies to improve the efficiency, mobility, and safety of the transportation system.

ITS management elements can be used effectively to manage traffic and reduce the effects of congestion on arterial roadways. It is important to be able to manage ITS infrastructure from a centralized location for efficiency, for faster response, and for collaboration.

There are three main uses of ITS:

1. Controlling Devices – this allows agencies to monitor and control roadside equipment in real-time and in response to actual conditions.
2. Disseminating Information – this provides valuable information to travelers about traffic and travel conditions.
3. Sharing Information – this allows agencies to share important information with each other (between City departments, between Cities, between City/State/County).

In a City such as Tempe that is bounded by neighboring jurisdictions and does not have opportunities to expand roadways to meet capacity demand, ITS becomes a very important traffic management tool to improve the efficiency, mobility, and safety of that transportation system.

According to the United States Department of Transportation (USDOT) ITS Joint Program Office, there are six categories of ITS devices/elements in arterial management systems and these are highlighted in **Figure 1**. They are:

- *Surveillance* – Includes traffic surveillance or infrastructure surveillance. Examples include sensors, Video Image Detectors (VID), and Closed Circuit Television cameras (CCTV) to monitor, in real-time, traffic on corridors and at key intersections.
- *Traffic Control* – To better balance traffic and keep traffic moving along corridors. Can be used for transit signal priority, emergency vehicle preemption enhancements, adaptive signal control, advanced signal systems, bicycle and pedestrian, or special events.
- *Lane Management* – Can be used for high-occupancy vehicle facilities, reversible flow lanes, pricing, lane control, variable speed limits, and emergency evacuation.
- *Parking Management* – Includes parking data collection and/or parking information dissemination.
- *Information Dissemination* – May use devices such as Dynamic Message Signs (DMS) or in-vehicle systems or may use services such as Internet-based or phone-based systems to provide real-time information about road conditions, incidents or closures.
- *Enforcement* – Can be used for speed enforcement or stop/yield enforcement.

There are a number of ITS applications that could be considered for the City of Tempe. Example ITS applications are shown in **Figure 1**.

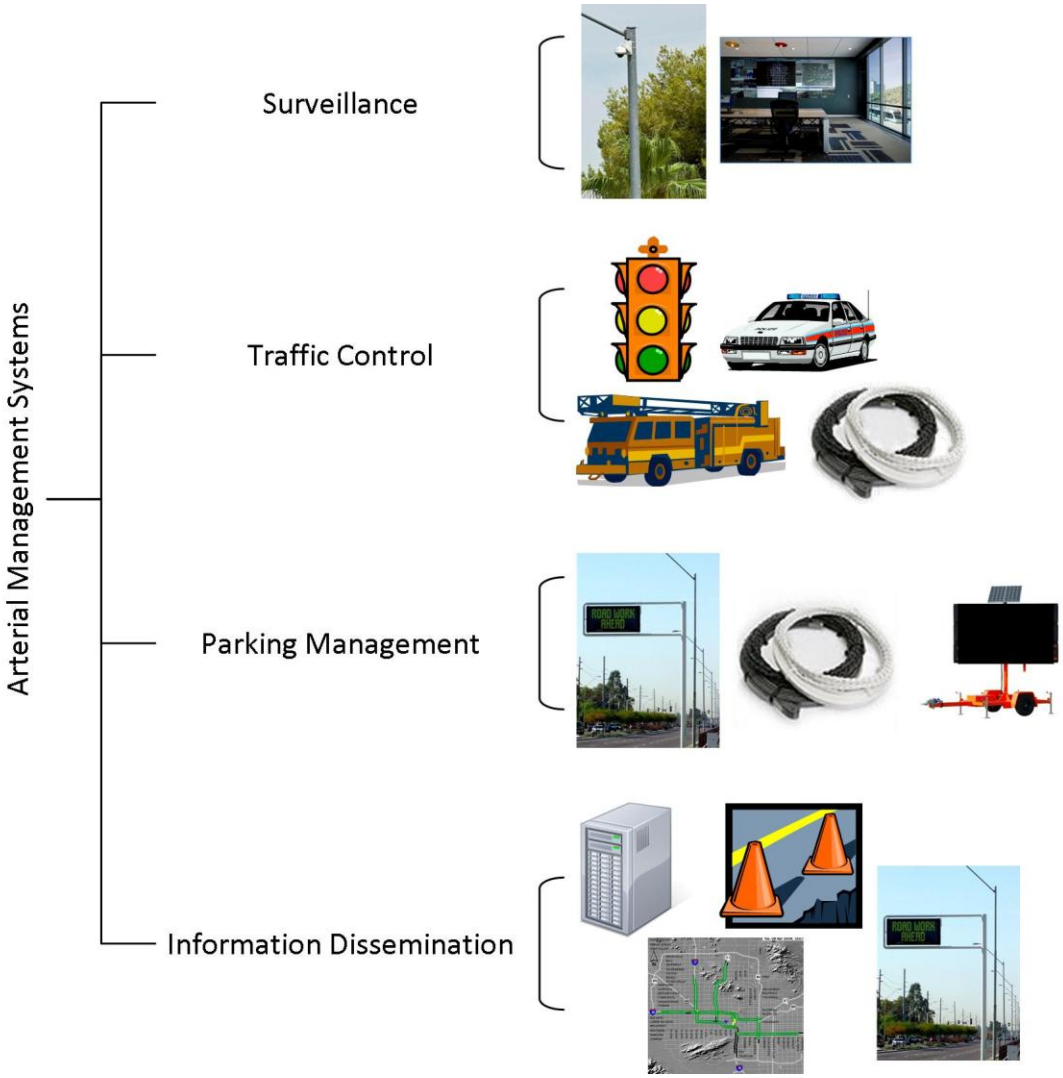


Figure 1 – Categories of Arterial ITS Elements

2.2 Benefits of ITS Elements

The benefits for ITS technologies include:

- Improving the safety of the roadway.
- Reducing incidents on the roadway.
- Improving or reducing the response time of emergency services.
- Providing the public with real-time and planned road conditions to help plan travel routes through traveler information services such as websites, information phone numbers, and dynamic message signs.
- Real-time monitoring and control of roadside systems from one centrally located operations center.
- Allowing operating centers to share information with each other.

Figure 2 shows the relative scale of the benefits of ITS applications. Actual benefit values are dependent on the type of ITS used and its integration within a broader ITS program. There is ample research that indicates ITS deployments can be beneficial to both travelers and transportation agencies, including the following:

- Signal coordination along Bell Road in the northwest Phoenix metropolitan area between Loop 303 and Loop 101 resulted in a cost savings for travelers of $7,000 per weekday ($1.8 million annually) and annual time savings of 160,000 hours.
- In Tucson, it was reported that adaptive signal control used in conjunction with transit signal priority decreased delay for travelers on main streets by up to 18.5% and on cross-streets by up to 28.4%.

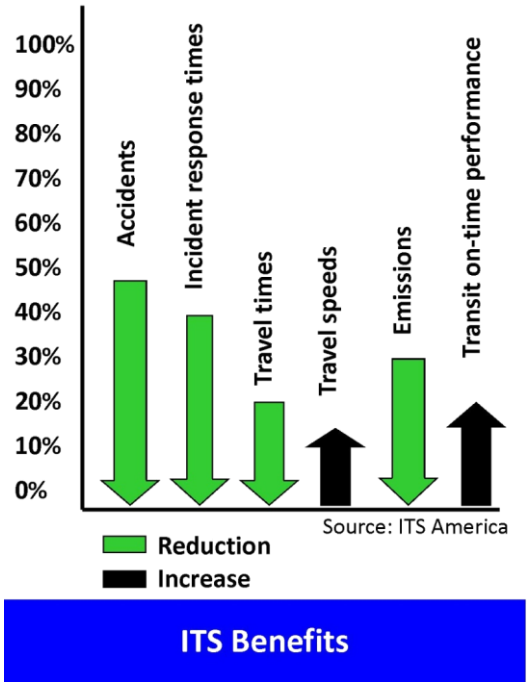


Figure 2 – ITS Benefits Graph

3. VISION, GOALS AND OBJECTIVES

The purpose of this plan is to accomplish the following objectives:

- Shape the vision of ITS in Tempe;
- Identify needs that ITS technologies can address;
- Establish goals, objectives, and priorities for ITS;
- Identify the infrastructure, funding opportunities, and partnerships necessary to support the City's ITS priorities;
- Identify roles and responsibilities for implementing these priorities; and
- Establish timeframes for implementing and integrating ITS into the City.

To provide direction and focus while developing the ITS Strategic Plan, the City of Tempe identified a clear vision and supporting goals and objectives for the future of ITS in the City. It is important to note that these goals are ongoing—there will need to be active partnering, deployment, and operation throughout the life of the City's ITS Program to keep these goals current and relevant to the direction of the program.

City ITS Vision –

"To effectively use technology to optimize Tempe's multi-modal transportation system."

ITS Goals –

- ***Safety*** – Improve safety and emergency response for all travelers.
- ***Integration*** – Innovation and integration across all modes of travel to meet the needs of the diverse users of Tempe's transportation network and implementation of smart tools in smart ways to maximize each tool's use.

- ***Partner*** – Maximize partnerships and resources to support programs and services to improve efficiency and quality of travel.
- ***Image*** – Incorporate ITS effectively into high quality aesthetics and livability of the City.
- ***Creativity*** – Implement tools in innovative ways to prepare the City for future citywide and regional multi-modal transportation needs.
- ***Sustainability*** – Introduce ITS that can be effectively operated, maintained, and shared to positively impact both environmental and economic sustainability.

4. CITY OVERVIEW

The City of Tempe is located in the Southeastern portion of Phoenix metropolitan area. As of 2010, the population was estimated at 162,000. Tempe is the most densely-populated city in the state. Arizona State University (ASU) enrolls more than 58,000 students each year at its Tempe campus. This means that the actual population impacting the transportation network is more than the reported population of the City, particularly in the downtown area of Tempe around the ASU campus. The City's transportation system includes the arterial street system, bus network, bike trails, and the METRO Light Rail line. In addition, Tempe is surrounded by the Arizona Department of Transportation (ADOT) freeway system.

The ADOT freeway system is instrumented with ITS infrastructure (CCTV cameras, DMS, fiber optic communications, and ramp meters). This freeway system experiences congestion during the AM peak and PM peak periods, as well as periodic non-recurrent congestion such as incidents on the freeways blocking traffic. Depending on the level of congestion on the freeway, travelers may seek alternate arterial routes through the City.

The Tempe Transportation Management Center (TMC) manages the current deployment of ITS technologies in the City, and will be managing future infrastructure as it is deployed and integrated on key corridors. The Tempe TMC is shown in **Figure 3**.

Figure 3 – Tempe Transportation Management Center

The 2000 Census data shows that 4% of Tempe residents commute primarily by walking to work and 3.4% of all commute trips are by bicycle, the largest proportion of bicycle commuters among all the cities in the Phoenix metropolitan region. There are over 150 miles of established bicycle paths in the City. There are pedestrian and bicycle crossings throughout the City to accommodate crossings of vehicular travel lanes.

Both the City of Tempe and Valley Metro provide fixed-route transit service within Tempe. Tempe's three transit transfer centers provide a high concentration of bus routes for passenger connections. Long-range plans for transit improvements in Tempe include increased peak-period service on all routes, extended hours on all routes, implementation of new routes, and bus pullouts where possible, additional transfer facilities where needed and continued planning and implementation of commuter rail and bus rapid transit.

The Tempe Police Department (PD) has a headquarters building and three substation locations in north, central, and southern Tempe. There are currently 154 officers and 245 total Police staff. During incidents, Tempe PD are able to access the traffic signal controllers to manually alter the signal timing or put the signal into flash mode to control traffic during the incident.

The Tempe Fire Department (FD) has six fire stations located throughout the City. There are an estimated 150 people on staff to support Fire operations. Fire vehicles are typically a first responder to all roadway crashes and incidents to clear vehicles from the travel lanes in Tempe. All signalized intersections are equipped with traffic signal preemption for fire vehicles, which allows FD personnel to travel through signalized intersections safely.

The City of Tempe is an event-hosting "hotspot" in the Phoenix metropolitan area with more than 150 special events throughout the City annually. There are a number of events that typically require road closures and support from police officers and fire department personnel and others to be able to manage the events. Events can require anywhere between 5 and 30 Tempe PD officers to manage traffic around the event.

Additional detail on the City of Tempe is provided in **Appendix A**.

5. STAKEHOLDERS AND OUTREACH

In order to understand the needs, issues, and opportunities for ITS in the City, several stakeholders were involved in the study process. A Focus Group meeting was held to gather the stakeholder group together to discuss project topics, and one-on-one meetings were held with specific representatives from departments to collect more detail on current processes and activities. Outcomes from the Focus Group formed the basis of the project implementation and phasing and the completion of the final Tempe ITS Strategic Plan.

Other important plans/studies that Tempe has conducted or are ongoing were referenced as well to obtain insights of potential ITS applications to improve the transportation network. These included the Tempe General Plan, Scottsdale/Tempe North/South Transit Corridor Study, Tempe South Corridor Study, and others.

An online survey was also developed in advance of the Focus Group meeting and was distributed to invited Tempe personnel in order to gain insight into Tempe's personnel needs, issues, and priority focus areas. A summary of the ten responses received, the summary of results from each question, and how those results were used in moving forward with the strategies development, is provided in **Appendix B**.

6. NEEDS ASSESSMENT

Based on the identified concerns, issues, and needs that the stakeholders provided, specific needs for the City have been documented to guide the focus for the ITS Strategic Plan. These needs have been categorized to provide a starting point for ITS services prioritization and the importance of integrating operations. The general and overarching needs can be applied in many of the categorized areas and are summarized in the following section.

General and Overarching Needs

- Recognize that funding for future projects is limited or non-existent – plan needs to provide a balance between processes and projects and demonstrate benefits of investing in certain strategies.

- Introduce new technologies to the City's infrastructure that will meet the needs of departments and partners and serve multiple purposes within City services (police monitoring, event management planning, transportation planning, etc.).
- Explore the potential for creating public/private partnerships to support parking, event management, etc.
- Recognize that resources for Traffic/ITS are limited – will need to focus on a future program that maximizes the use of automated processes, and streamlines current processes.
- Collect information about traffic and road conditions in real-time and provide pre-trip real-time conditions to travelers.
- Recognize that training and cross-training will become a necessity as new technologies are introduced that are to be operated and maintained by existing City resources.
- Streamline ITS into existing development – combining ITS projects with roadway / bicycle / pedestrian enhancement projects to implement technologies along key corridors, placing conduit with sewer/water projects and having Information Technology (IT) partner with TMC staff to utilize infrastructure.

Traffic Management Needs

- Maintain signal coordination along key corridors to be able to maximize traffic throughput, particularly during peak commute times.
- Use existing communications and facilities throughout the City as well as ADOT routes as a "backbone" system to tie Tempe infrastructure into a central system for operations.
- Maintain transit and METRO Light Rail infrastructure and communication connectivity to support broader traffic management goals.
- Utilize City IT tools and capabilities to support traffic management functions and operations.
- Provide the ability for traffic signal technicians to test equipment and communicate with field devices from a remote site such as the Tempe TMC.

Incident Management and Response Needs

- Provide the ability to modify the traffic signal timing plans in response to incidents and closures.
- Share Tempe PD CAD with transportation staff, Tempe Fire, and potentially transit services to broaden knowledge of incident details and response activities.
- Coordinate Tempe PD and TMC resources to be able to actively manage events using infrastructure once deployed.

Information Sharing and Dissemination Needs

- Provide information to Public Information Officer (PIO) for communications to the public.
- Integrate real-time information about incidents, events or congestion in Tempe into traveler information websites (City or AZ511).
- Implement tools, such as DMS, to provide real-time, en-route information to travelers.
- Provide real-time information to the public about incidents/events – most information provided to public currently is planned events/closures.

Multi-Modal Needs

- Provide range of alternatives to support bicycle and pedestrian crossing of roadways where traffic signal applications cannot or should not be applied.

Transit Management Needs

- Coordinate between transit services in Tempe and Police/Fire to alert of incidents and anticipated clearance information to better respond to alternate routing options.
- Obtain real-time location information from transit vehicles to support alternate routing, on-time schedule performance, and other dispatching functions.
- Disseminate better information about impacts and detours of transit routes to transit travelers.

Parking Management Needs

- Provide parking information to public, particularly during major events – need to coordinate with both City and privately-owned parking facilities.

Special Event Management Needs

- Use tools to monitor ingress/egress of traffic for future improvements in event plans.
- Partner with business community along key corridors as well as other neighboring cities for event planning activities.
- Improve navigation for travelers that are not attending special events.

7. CURRENT INFRASTRUCTURE ASSESSMENT

The purpose of conducting an inventory is to identify and document the existing and programmed ITS infrastructure in the City of Tempe. This inventory helped in identifying existing gaps related to infrastructure and communications. ITS infrastructure incorporates communication facilities (such as telephone lines, fiber, and wireless) and devices (such as CCTV, DMS, traffic signals, and emergency vehicle preemption). The relationship of the location of those devices to major corridors, fire or police stations, bicycle/pedestrian crossings, and the Tempe TMC is important to consider within the context of how to effectively utilize existing ITS as well as plan for future ITS.

7.1 Field Devices

The field devices are the most visible components of an ITS program. They are used for traffic monitoring, detection, control, management, and traveler information, among other uses. ITS infrastructure includes video image detection (VID), CCTV cameras, and traffic signal controllers. There has been some limited deployment of technologies on roadways in Tempe, but there are plans with near-term funding to implement infrastructure on key corridors.

7.1.1 Traffic Signals

The City currently operates 221 traffic signals on arterial and collector routes throughout the City as, shown in **Figure 4**. The City leases 47 circuits from Qwest to connect traffic signals to the TMC. The cost of these leased lines is $80,000 per year. Thirty-two Light Rail traffic signals are connected to the TMC via fiber optic cable.

An Intergovernmental Agreement (IGA) is in place with ADOT for Tempe to own, operate, and maintain the traffic signals at arterial intersections with the freeways. ADOT fiber cable along Loop 101, US-60, Loop 202, and I-10 connects interchange signals in the City of Tempe in a ring configuration as part of the ADOT Freeway Management System (FMS), as shown in **Figure 4**.

Each of the signalized intersections has detection for left turning movements at major intersections and the application varies at arterial/collector intersections. The City uses a combination of VID and loop detection. Thirty-nine of the City's traffic signals have VIDs on one or more directions of travel.

Most of the traffic signals in the City are operated from the Tempe TMC and are managed through the use of TransSuite software. This software provides Tempe with a control platform for updating signal timing plans, responding to status messages received from the controller, and a potential future method for controlling other ITS devices from the field.

Traffic signals are maintained by the Tempe Maintenance Department personnel. Preventative maintenance scheduling is planned for once per year per traffic signal. This scheduling was reduced from two times per year per traffic signal due to additional requirements to maintain street lights and blue staking for the City.

The City of Tempe received three projects from the Maricopa Association of Governments (MAG) Traffic Signal Optimization Program (TSOP) in 2011. One project was for signal synchronization along University Drive for 18 traffic signals for AM, PM and off-peak timing. This project optimized the traffic signals along University Drive to decrease delay, promote safety, and potentially decrease congestion along this multi-modal corridor. Another project was the updating of the City's Synchro network. The third project was for the Rural Road corridor from Curry to Baseline which examined options for improved signal synchronization as well as focused studies for operational improvements at Rural and University and Rural and Tyler/Terrace.

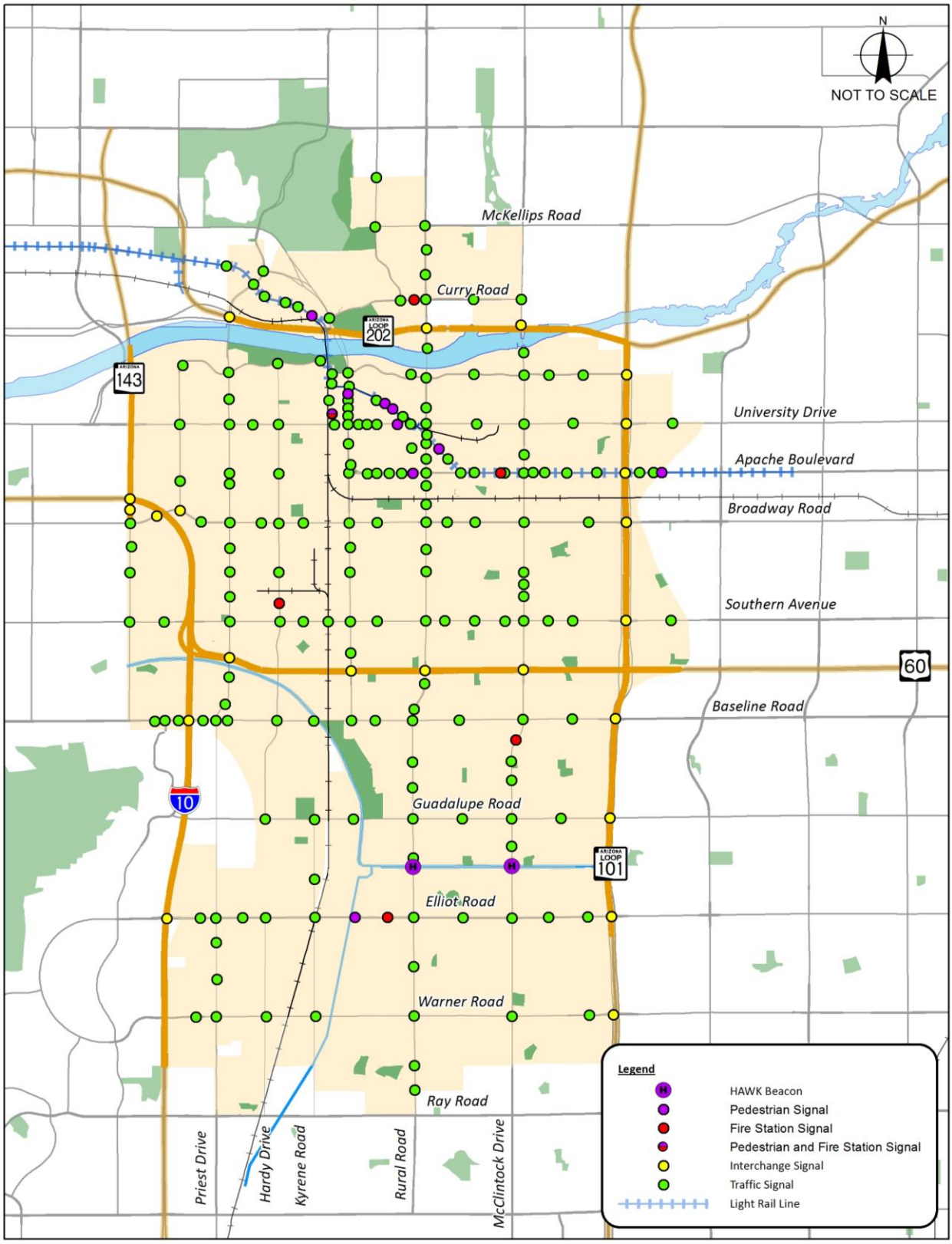


Figure 4 – Signal Locations

7.1.2 Surveillance

Tempe currently has six City-owned CCTV cameras deployed along the Light Rail alignment. Locations for these CCTV are:

- Veterans Parkway/6th Street
- Priest Drive/Washington
- Rural/Tyler
- University/Veterans
- McClintock/Apache
- Apache/Terrace

Additional CCTV infrastructure is programmed for implementation in the next four years as part of projects programmed in the MAG Transportation Improvement Program (TIP) utilizing Congestion Mitigation and Air Quality (CMAQ) federal funding. Also, the Tempe TMC has access to METRO Light Rail security surveillance cameras located at the Light Rail Stations and to ADOT freeway cameras located on Loop 202, Loop 101, I-10 and US-60.

Video Image Detectors (VIDs) have the capability to offer the Tempe TMC video images at the intersections where they are located; however, video images are not yet being received at the TMC. VIDs are generally fixed direction due to the detection zones established and therefore have a limited window of viewing capability. VIDs do not have the functionality (pan, tilt, and zoom [PTZ]) that CCTV cameras have for traffic monitoring purposes although they are still useful for video images if there is a communications network that can transmit that image back to the TMC.

ADOT has implemented full FMS components along the freeways surrounding Tempe, including CCTV cameras, DMS, fiber optic communications, and ramp meters. Locations for ADOT CCTV cameras and ADOT DMS are shown in **Figure 5**. Tempe is able to view ADOT CCTV camera images via a direct TMC fiber connectivity to the ADOT TOC.

Tempe is one of only a few local agencies in Maricopa County that have a direct fiber connection (100 Mbps) to the ADOT Traffic Operations Center (TOC), which offers them two fibers to view real-time images from four ADOT CCTV cameras at one time.

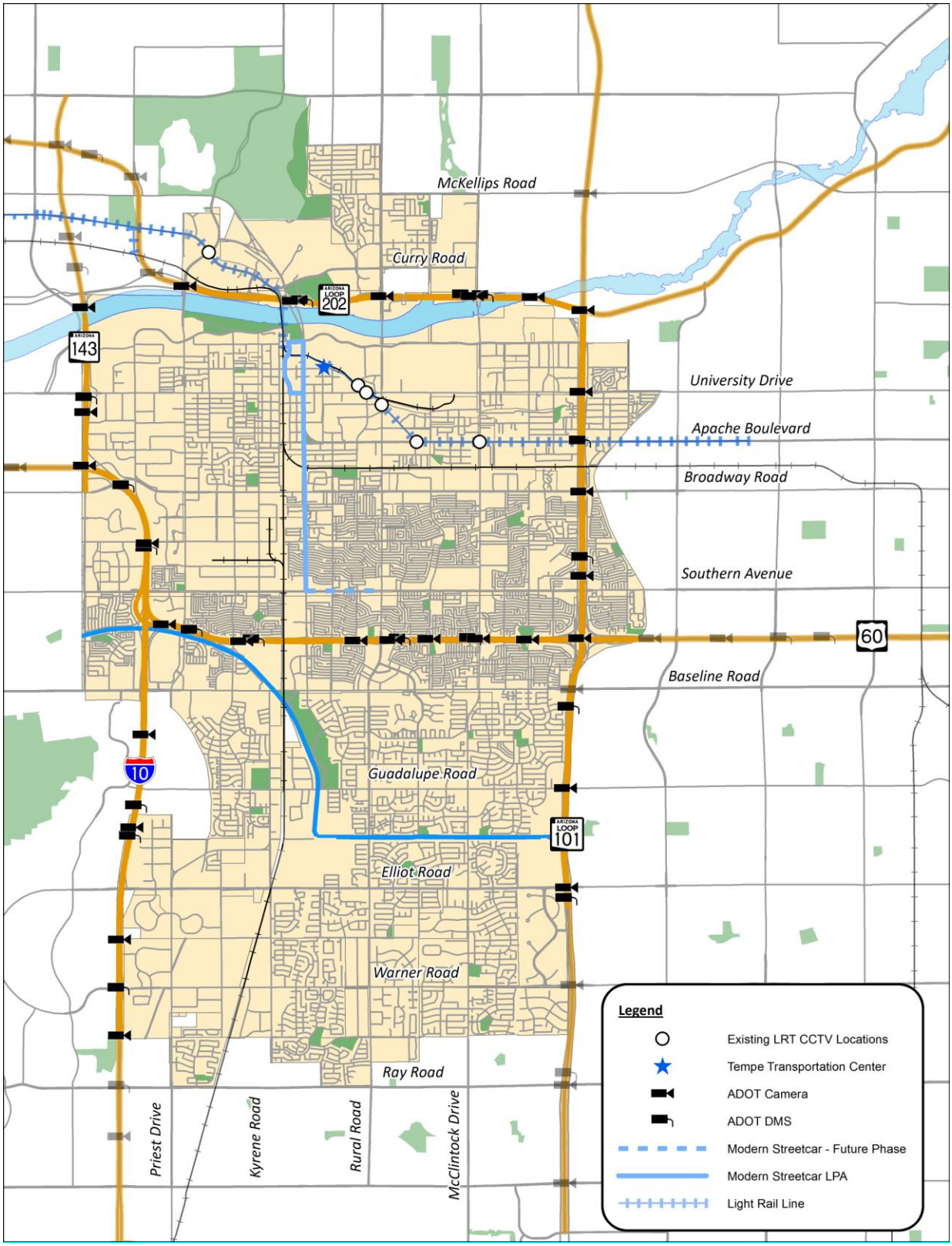


Figure 5 – Existing Infrastructure Locations

7.1.3 Traveler Information

Tempe currently does not have City-owned permanent or portable arterial DMS to utilize for traveler information. High volume corridors and key routes for event traffic offers opportunities for future DMS locations.

The City of Tempe public website has a well-established Traffic Closures and Restrictions online map available at www.tempe.gov/StreetClosures. This online tool is updated regularly with events and planned closures and is utilized by local media to stay current on road/lane closures.

There are a number of ADOT DMS within Tempe that offer travelers freeway incident/closure notifications as well as travel times. ADOT DMS have been used in the past to manage or route special event traffic to locations in Tempe. Tempe works with ADOT to provide floodgate messages on the 511 website and phone to alert the public of special events that are planned to host more than 30,000 people per day.

7.2 Alternative Modes and Parking

The City of Tempe has created a multi-modal environment where travelers have access to mass transit and bicycle/pedestrian facilities, while still maintaining adequate access to the standard vehicle.

Pedestrian signal indications are provided at all signalized intersections. Mid-block pedestrian signals are installed at 12 locations due to the increased pedestrian traffic in a specific area. The City requires all pedestrian access at intersections to be compliant with all Americans with Disabilities Act (ADA) guidance.

The City has installed two High-intensity Activated crossWalKs (HAWKs) between Elliot Road and Guadalupe Road at the intersections of Rural Road/Western Canal and McClintock Road/Western Canal (also shown previously in **Figure 4**). The HAWK beacon is designed without a green light and remains dark until a path user activates the signal. The crossings change to a "walk" indication after pressing the button and are designed to stop vehicles with a red indication.

There are 17 locations for parking facilities within the City of Tempe downtown area, two of which are City-owned parking facilities. The rest are privately-owned facilities managed by the Downtown Tempe Community, Inc. (DTC). ASU owns and operates six parking facilities/structures and 20,000 parking spaces total on the Tempe campus property only. Parking operations in downtown Tempe are separately managed by the City, DTC, and ASU.

METRO Light Rail provides high-capacity transit service through Tempe and to the west to Phoenix and to the east to Mesa. In Tempe, the Light Rail line has nine transit stops. All transit stops have video security surveillance devices that the Tempe TMC can access for monitoring activity as needed.

Alternative mode infrastructure and parking locations are represented in **Figure 6**.

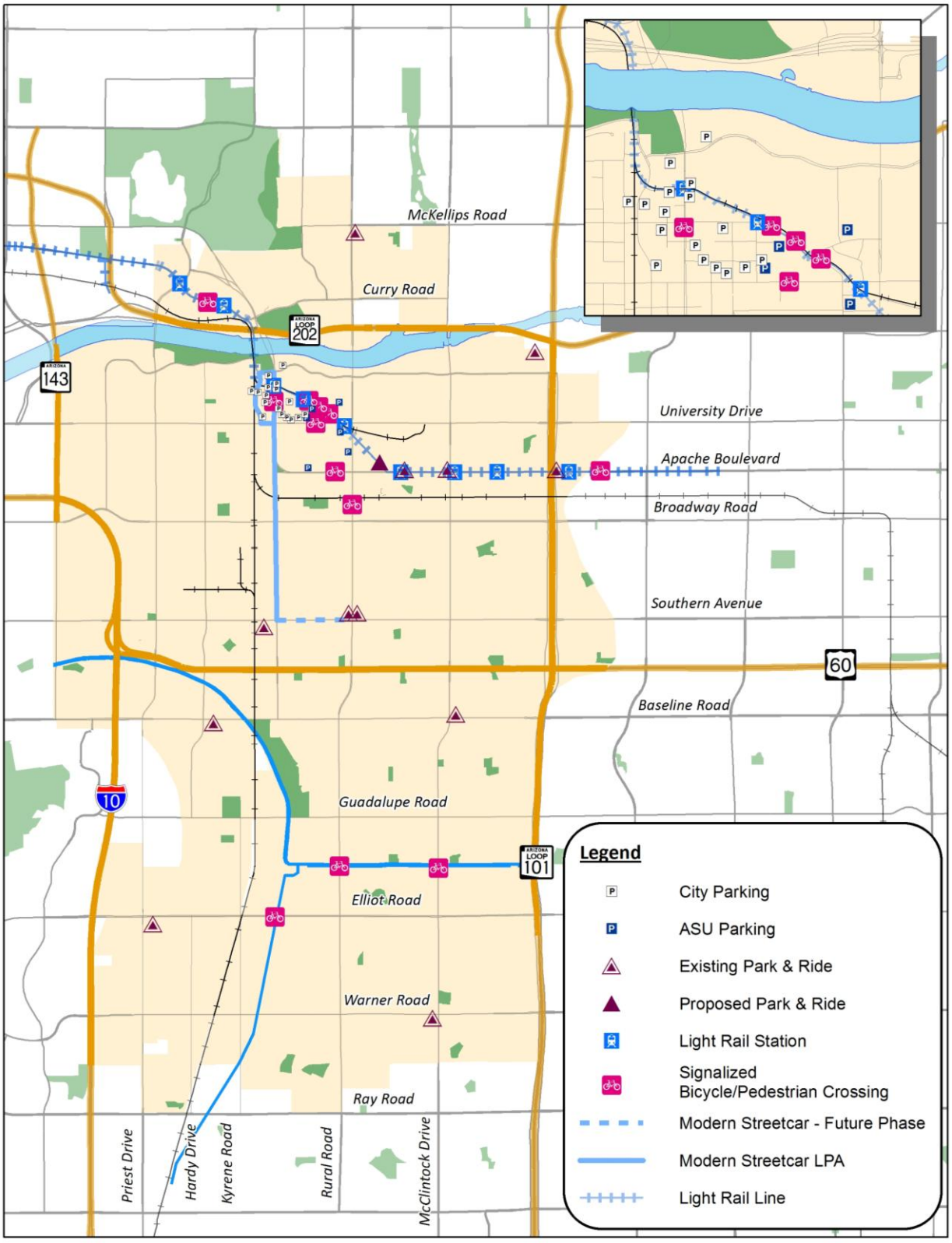


Figure 6 – Alternative Modes and Parking Infrastructure

7.3 Transportation Management Center

The City has a state-of-the-art TMC located in the Tempe Transportation Center at 200 East 5th Street. The Tempe Transportation Center provides connections between Light Rail and more than a dozen bus routes as well as passenger amenities, ticketing and bicycle parking.

The TMC consists of a conference room, three offices, an operation room with spaces for three operators, and server equipment room with space for a device testing lab. The video wall is an Activu rear projection video wall that consists of eight separately controlled video cubes arranged in a 2x4 configuration. The equipment room houses the traffic control system server, communications equipment and other operational equipment.

The City of Tempe TMC currently:

- Manages existing traffic signals through the use of TransSuite software;
- Manages existing CCTV cameras through the use of Camera Cameleon software;
- Monitors the Phoenix Fire CAD data feed for incidents;
- Monitors the ADOT freeway congestion map;
- Views ADOT cameras on the freeways throughout Tempe;
- Monitors METRO Light Rail stations via video security surveillance devices; and
- Leases communications paths to most traffic signals.

7.4 Communications Network

Tempe has an existing network of fiber cable and conduit throughout the City as shown in **Figure 7**. This communication infrastructure is owned and managed by various entities including City transportation, City IT, and numerous private agencies. All City departments have high-speed connections to IT. Some City facilities are connected by microwave.

There is fiber cable along the entire Light Rail path through Tempe that is utilized to connect the six existing CCTV along the Light Rail and is available for future City purposes. The Light Rail Traffic Signal System uses a 144 strand single-mode fiber optic (SMFO) cable installed within the Light Rail duct bank. Tempe is currently using 10 strands for traffic circuits, 2 strands for CCTV and 2 strands each for mid-level switches. Tempe can access Light Rail fiber at two locations: the Police substation and the Fire substation along the Light Rail path. The City of Tempe IT also has a general purpose 72-strand SMFO cable with 12 strands reserved for transportation applications.

ADOT fiber cable along Loop 101, US-60, Loop 202, and I-10 connects interchange signals in the City of Tempe in a ring configuration as part of the ADOT FMS. Tempe utilizes the ADOT fiber network to connect the TMC to interchange traffic signals. Currently, this use of ADOT fiber is in a string pattern.

The fiber and conduit paths of private sector telecommunications companies that have existing agreements with Tempe or other neighboring jurisdictions for shared use of these fiber or conduit paths are shown in **Figure 8**.

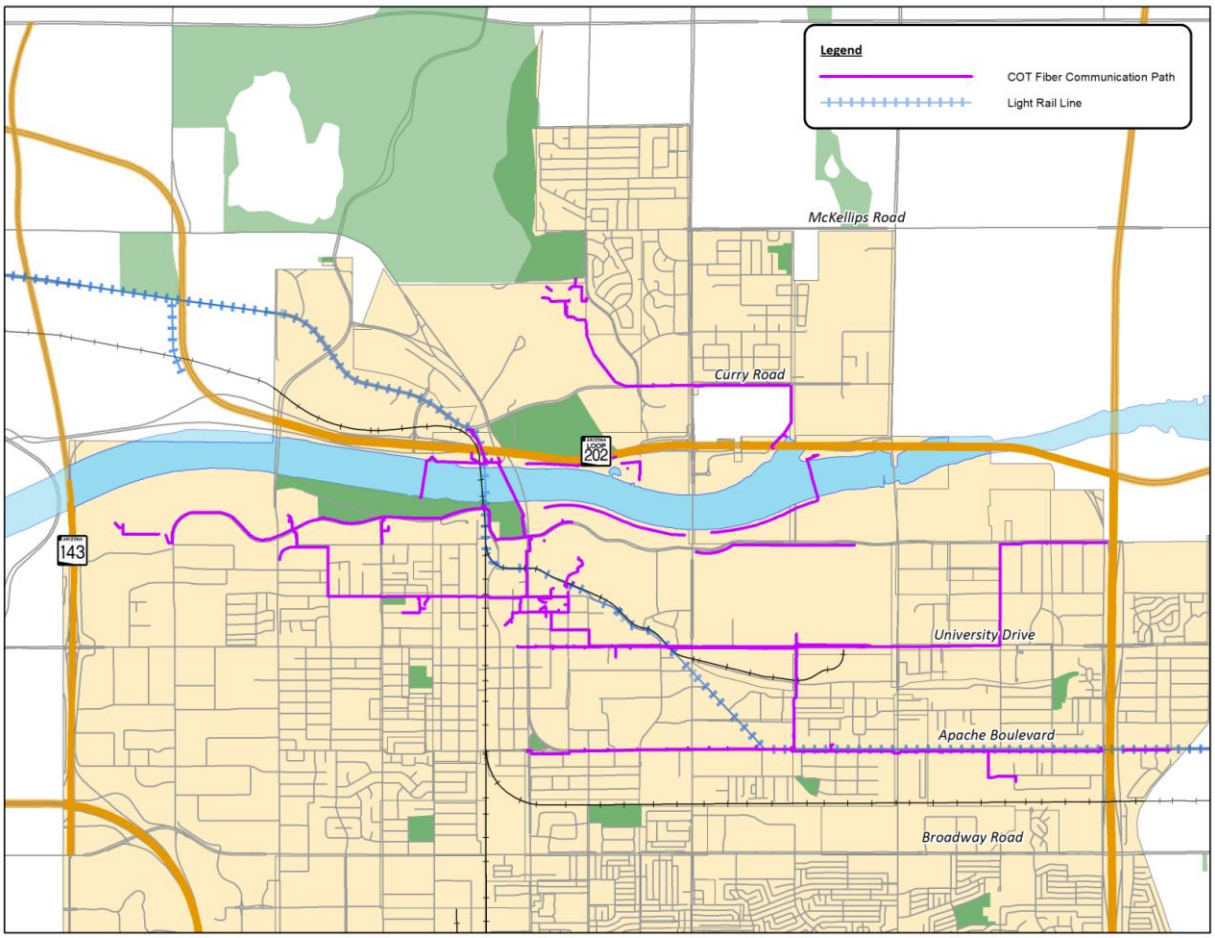


Figure 7 – City of Tempe Fiber Communication Paths

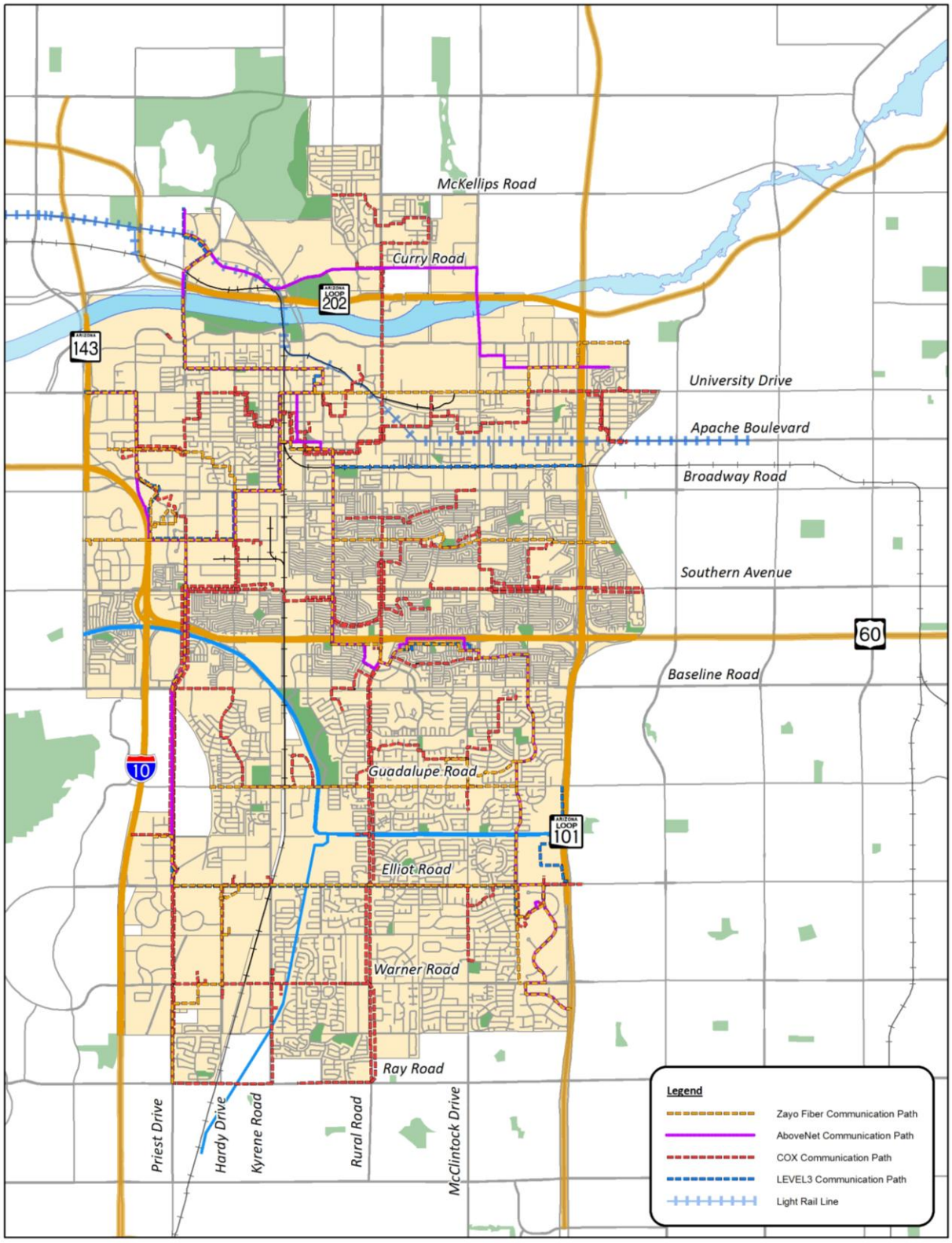


Figure 8 – Existing Communications Network – Private Companies

Not all private companies are represented in this map – only those who have existing Tempe agreements for shared use of fiber/conduit or those who have partnered with other neighboring jurisdictions for sharing agreements are shown.

8. PLANNED INFRASTRUCTURE ASSESSMENT

8.1 Planned ITS Infrastructure

The ITS infrastructure assessment reviewed the programmed locations for future ITS devices, and programmed projects through the City Capital Improvement Program (CIP), MAG TIP, and transit enhancements. Tempe has programmed CCTV projects through the MAG TIP including:

- 2011 CCTV, VID, and wireless interconnection.
- Light Rail monitoring station locations in 2012.
- CCTV locations in 2012 to be installed throughout City and connected on the new wireless radio system backhauled on fiber to the TMC.
- Fiber project in 2012 to install fiber along University (Mill to Rural), Apache (Mill to Gary), and Mill (Rio Salado to Apache).
- CCTV locations in 2014 to be installed and connected through new Tempe fiber backhauled on ADOT fiber.

Figure 9 depicts the locations of the programmed CCTV cameras as well as the fiscal year timeframe for their installation. ITS infrastructure such as CCTV cameras can help the City better fulfill incident management responsibilities. **Figure 9** also shows the locations of the PD and FD stations throughout the City to emphasize the opportunities for CCTV camera image sharing to support incident response along arterial corridors.

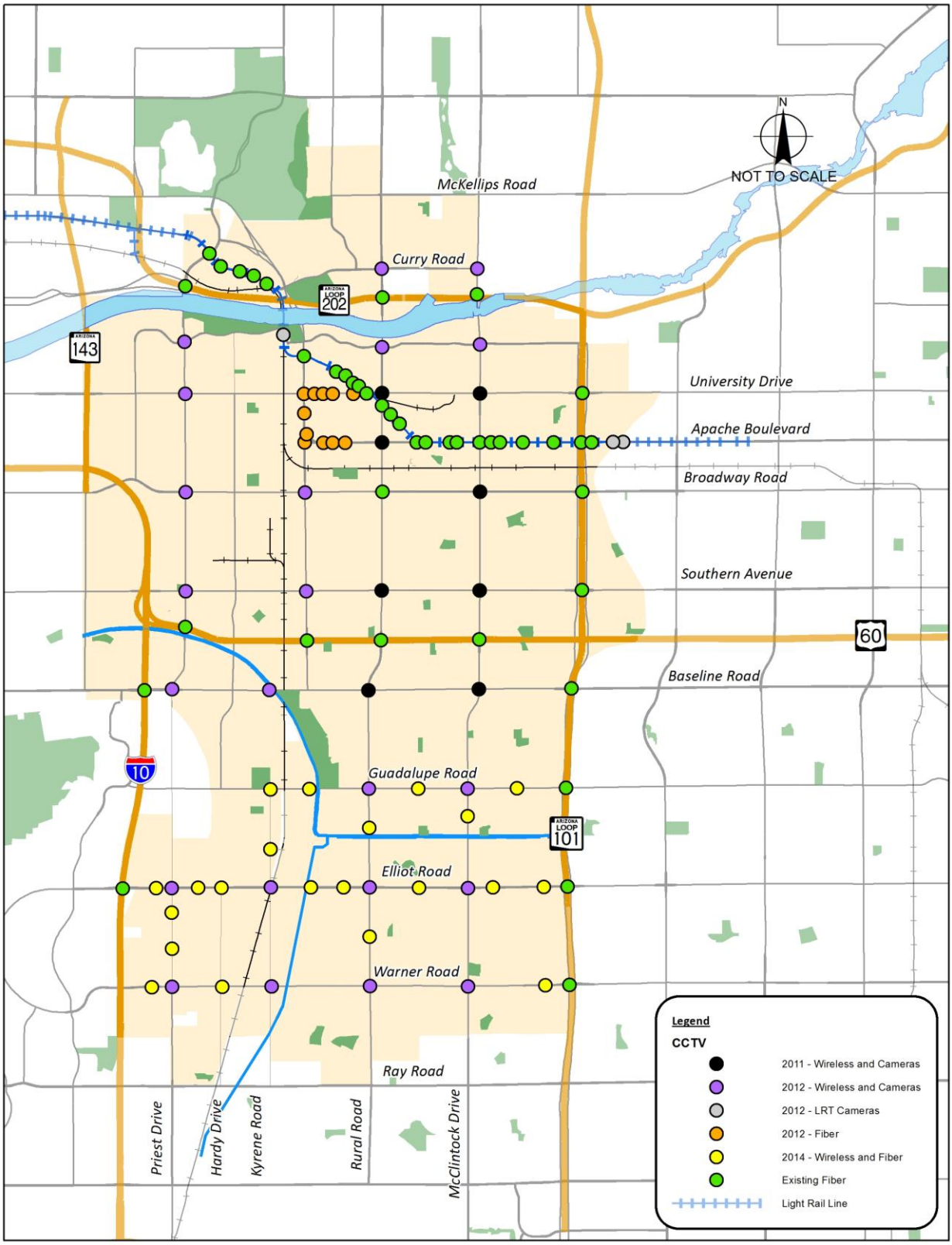


Figure 9 – Planned CCTV Locations

8.2 Planned Development

Planned development is important to consider when introducing new infrastructure. Population centers and traffic generators such as large acreage multi-use developments create needs for the movement of traffic that previously were not present. Coordinating with planned development is an important component of optimizing new infrastructure components to support future ITS such as communications conduit and traffic signal locations.

There are existing and planned retail, industrial, and office developments throughout Tempe that already do contribute or are expected in the future to contribute to traffic congestion and patterns in the City. Key development areas in Tempe include:

- Mill Avenue District/Tempe Town Lake – 5,000 new condos built, 10,000 new residents expected within 5 years.
- Papago Park Center (Loop 202 and Priest Drive) – 522 acres of mixed-use office/research park.
- ASU Research Park (Loop 101 and Warner Road) – 320-acres research park for professional business development.
- Fountainhead Corporate Park (I-10 and Broadway Road) – 170-acre business park with 40 acres of improved land ready for development.
- Emerald Center (I-10 and Warner Road) – Large acreage of home furnishing stores with more than 20 remaining acres of prime freeway-frontage for development with more retail and commercial space and hotel sites planned.

Existing and planned housing developments also significantly influence current and projected traffic congestion and patterns.

The ITS Strategic Plan needs to factor in the timeframes for significant development activities as well as key capital improvements. Timeframes could potentially help to prioritize near-term ITS and technology investments as well as identify opportunities to integrate ITS with programmed or planned capital roadway enhancements.

Planned infrastructure and deployment projects from the City of Tempe CIP, MAG TIP, and other planned arterial and multimodal enhancements in Tempe are provided in **Table 1** by year for the next five years. The City's CIP is approved on an annual basis so projects in later years of the CIP are only tentative.

Table 1 – Planned Development and CIP/TIP Projects

Project #	Year	Project Name	Project Description	Cost	Source of Funds
ANNUAL PROJECTS (WITH DIFFERENT FUNDING EACH YEAR) – OPPORTUNITIES TO LEVERAGE FOR ITS PURPOSES					
67-00489	Ongoing	Downtown Public Parking	Provides funding for operations and lease payments on private parking facilities that the City has leased or purchased parking rights for use as public parking in the downtown.	$200,000 typical per year	Transfer from Other Funds
67-946555	Ongoing	Digital Infrastructure	Provides funding to upgrade and enhance the telecommunications network infrastructure for IT purposes and covers conduit, fiber optic cable, wireless, and other alternative telecommunication infrastructure enhancements.	$225,000 typical per year	Other Revenue
69-999859	Ongoing	Utility Undergrounding	Provides for the undergrounding of overhead utility lines.	$350,000 typical per year	HURF Fund Balance GO Bonds
6999869	Ongoing	Streetlight Upgrades / New Installs	Provides for the installation of new street lights at various locations as well as the upgrading of streetlights. A typical year's program would include installation of 200 new arterial street lights, 50 mid-block residential lights, and five alley lights.	$300,000 typical per year	HURF Fund Balance GO Bonds
6904350 (TMP11-108)	Ongoing	Pedestrian ITS Devices	Provides for converting existing or installing new accessible pedestrian push buttons at traffic signal controlled intersections. It is planned that 10 intersections will be converted to ADA pedestrian push buttons per year.	$25,000 typical per year	General Obligation Bonds
TMP11-105	2011	Citywide	Intersection Reconstruction	$425,250	Local Funds
TMP11-106	2011	Citywide	Arterial Street Reconstruction and Improvements	$561,643	Local Funds
TMP12-117	2012	Various Locations	Install new/upgrade modular traffic signals	$600,000 typical per year	Local Funds

Table 1 – Planned Development and CIP/TIP Projects (continued)

Project #	Year	Project Name	Project Description	Cost	Source of Funds
MAG TIP PROJECTS – RELATED TO ITS					
TMP11-703	2011	CCTV and Wireless	Install wireless communications and CCTV monitoring at 26 intersections	$312,000	CMAQ Funds Local Funds
TMP12-118	2012	Various Locations	Install video traffic detection, CCTV and wireless communications at eight intersections	$425,000	CMAQ Funds Local Funds
TMP12-804 (696950 from CIP)	2012	Citywide	Design and construct fiber optic cable installations – Install fiber optic communications to signalized intersections along University Drive from Mill Avenue to McClintock Drive utilizing existing conduit	$361,171	CMAQ Funds
TMP12-806 (6004360 from CIP)	2012	Light Rail Transit Corridor in Tempe	Install CCTV monitoring stations at 25 Light Rail signalized intersections	$425,099	CMAQ Funds Local Funds
TMP13-126	2013	Citywide	Design and install fiber optic communications	$350,000	Local Funds
TMP13-902 (Identified in CIP)	2013	Traffic Control Cabinets and Hardware Replacement	Procure and install traffic control cabinets and hardware – Phase 1 of 3 – Procure equipment needed to upgrade and rehabilitate 70 of the city's traffic signal control cabinets	$770,000	CMAQ Funds Local Funds
TMP14-102 (Identified in CIP)	2014	Corridors of Elliot / Guadalupe / Warner	Construct/install fiber optic communication to the signals along Elliot and install wireless radios with CCTV monitors along Guadalupe and Warner	$547,619	CMAQ Funds Local Funds
MAG TIP PROJECTS – LEVERAGE FOR ITS PURPOSES					
TMP10-620	2011	Broadway Road: Rural Road to Mill Avenue	Acquire right-of-way and construct pedestrian and bicycle facilities improvements	$5,143,560	CMAQ Funds Local Funds
TMP11-701	2011	University Drive: Priest Drive to UPRR	Improve bicycle and pedestrian facilities	$6,525,080	CMAQ Funds Local Funds
TMP12-114	2012	Citywide	Arterial Street Reconstruction and Improvements	$668,125	Local Funds
TMP13-123	2013	Citywide	Arterial Street Reconstruction and Improvements	$1,069,000	Local Funds
TMP13-124	2013	Citywide	Arterial Street Reconstruction and Improvements	$1,069,000	Local Funds
TMP14-134	2014	Citywide	Arterial Street Reconstruction and Improvements	$1,175,900	Local Funds
TMP15-142	2015	Citywide	Arterial Street Reconstruction and Improvements	$668,125	Local Funds

9. STRATEGY DEVELOPMENT

This section identifies specific strategies for technology, communications, and coordination solutions to transportation challenges within the City. Partnering opportunities also played a key factor in strategy development with both internal departments as well as external neighboring jurisdictions.

The strategies identified focus on implementation opportunities for the near-term, mid-term, and long-term for deploying and integrating ITS. The process to develop project recommendations took into account stakeholder needs and priorities and major anticipated efforts and developments within the City.

Recommended strategies in this ITS Strategic Plan represent different types of implementation processes. Some strategies will have a design and construction process and others will identify the need to establish a standard protocol or modify an existing system.

The purpose of defining strategies is to support:

- Infrastructure deployment;
- Operations and sharing in real-time; and
- ITS integration into planning and program development/operations.

The strategies defined in this document are developed as an action list that incrementally builds out the City's ITS program. This methodology provides flexibility to allow Tempe to complete what can be implemented based on available resources. Each action may be accomplished in a different timeframe than represented in the table. ***The tables provide a checklist view to "check off" when each action has been accomplished, as shown in Appendix A.***

9.1 Strategy Development Assumptions

Assumptions used in developing strategies include:

- Strategies incorporate programmed CIP projects that could be leveraged to support the ITS program.
- Not all strategies have the same level of effort for implementation – many are smaller action items that could be completed relatively quickly.
- Strategies can be adjusted to another timeframe depending on feasibility of implementation.
- Strategies initiated by departments other than ITS/Traffic assumes strong partner support (~50%) in implementation or management of the strategies.
- Some strategies initiated by ITS/Traffic could ultimately be transferred to others to be completed.

9.2 Timeframes

The timeframes referenced within the Strategic Plan generally correspond to:

Near-Term Timeframe (0-2 Years) Actions:

Characteristics: involves coordination with other departments, could result in fast implementation, are generally less effort to complete, and generally require no new funding to be identified.

Requirements: could require stretching or modifying existing resources or job responsibilities to accomplish short term effort that results in a longer term goal. These actions do not involve any new capital projects that are not already programmed.

Mid-Term Timeframe (2-5 Years) Actions:

Characteristics: involves coordination with other departments, could be implemented with little or no funding, may have more effort involved in implementation, and results in larger impact strategy.

Requirements: could require funding support through TIP or CIP application or shift in City funding or staffing to implement.

Long-Term Timeframe (5-10 Years) Actions:

Characteristics: involves implementing new programs, upgrades, and communications.

Requirements: requires long-term funding through TIP or CIP application and/or potentially ongoing dedicated City funding or staffing.

9.3 Strategy Information

Strategy categories have been identified that will group different types of actions that address common needs and goals. This section provides an overview of the types of information that are contained within the individual strategy tables. An overall strategy summary table that lists all categories by near-, mid-, and long-term timeframes is provided in the next section. Strategy categories are grouped based on the types of devices, systems, and processes to be deployed as well as the lead or partner department that is anticipated to be involved. Strategy categories are:

- CCTV Deployment;
- DMS;
- Traffic Signals;
- Communications;
- Transportation Management Center;
- Program Management;
- Traveler Information;
- Incident Management;
- Special Event Management;
- Bicycle/Pedestrian ITS; and
- Transit ITS.

The following information is defined for each individual action for each functional strategy:

- Project name;
- Brief project description; and
- Roles and responsibilities (involving other departments or agencies as applicable).

Supporting information is identified for the strategy categories including:

- Benefits as related to City's ITS goals and priorities; and
- Needs addressed.

9.4 Summary of Strategies for Tempe

Table 2 provides a summary of ITS implementation strategies in the near-, mid- and long-term timeframes. Specific details on the considerations in pursuing each strategy are defined in further detail in **Appendix C**.

Figure 10 provides a citywide arterial CCTV deployment plan that shows existing, programmed, and recommended CCTV locations. Additional locations will likely be added over time.

Figure 11 provides a citywide arterial DMS deployment plan. Phased implementation of these DMS are recommended in **Appendix C**.

Table 2 – Strategy Summary Table

NEAR-TERM	MID-TERM	LONG-TERM
CCTV (SEE FIGURE 10)		
TMP10-803 Video Traffic Detection and 8 CCTV (CIP Local) (CCTV Deployment – Phase I) TMP11-703 CCTV Monitoring at 22 Intersections (TIP CMAQ) (CCTV Deployment – Phase II) TMP12-806 CCTV Monitoring at Light Rail Stations (TIP CMAQ) (CCTV Deployment – Phase III)	CCTV Deployment – Phase IV Complete After-Hours CCTV Usage Agreement Establish After-Hours CCTV Communication Link	CCTV Deployment – Phase V
DMS (SEE FIGURE 11)		
	Special Event DMS – Phase I	Freeway Approach DMS – Phase II Corridor Focused DMS – Phase III
TRAFFIC SIGNALS		
Corridor Traffic Signal Timing – Phase I Develop Special Event Timing Plans New/Upgrade Modular Traffic Signals (CIP Local) – Phase I	Corridor Traffic Signal Timing – Phase II New/Upgrade Modular Traffic Signals (CIP Local) – Phase II Adaptive Corridors Testing and Implementation – Phase I	Corridor Traffic Signal Timing – Phase III Adaptive Corridors Implementation – Phase II Adaptive Corridors Implementation – Phase III
COMMUNICATIONS (SEE FIGURE 12 AND 13)		
Establish Conduit Connections TMP12-804 Citywide Fiber Optic Cable Installations (TIP CMAQ) (Communications – Phase I) ITS/IT Agreement for Private Telecom Use Complete Private Telecom Agreements – Extension I	TMP14-102 ITS Installations on Elliot/Guadalupe/ Warner (TIP CMAQ) (Communications – Phase III) Citywide Communications – Phase IV Tempe Fiber Management Tool Complete Private Telecom Agreements – Extension II Coordination with Water CIP Projects – 2014-2016	Citywide Communications – Phase V Coordination with Water CIP Projects – 2017-2021
TRANSPORTATION MANAGEMENT CENTER		
Establish TMC Firewall TMC Maintenance Plan Establish Quarterly ITS/IT Meetings HCRS Area of Influence (AOI) Police Radio Scanner at TMC Establish Process to Provide City HCRS Inputs Establish Automated Traffic Data Archive TMC/TOC Agreement for Notification Technology Training for Devices	Hire TMC Operator Continue Quarterly ITS/IT Meetings Establish Standard City ITS Details Provide Input to Roadway Planning Establish Real-Time Corridor Data Technology Training for Devices	TMC Upgrades/Maintenance Continue Quarterly ITS/IT Meetings Expand Real-Time Corridor Data Establish Regional Community Network (RCN) Connection Technology Training for Devices
PROGRAM MANAGEMENT		
	Establish Report Card Develop Operations Plan and Standard Operating Procedures Prepare ITS Study and ITS Data Analysis	Update Operations Plan and Standard Operating Procedures

Table 2 – Strategy Summary Table (continued)

NEAR-TERM	MID-TERM	LONG-TERM
TRAVELER INFORMATION		
PIO Coordination	Incident Distribution List Real-Time Enhancements to City Website	Ongoing Enhancements to City Website Arterial Travel Times on DMS Mobile Parking Application Evaluation of Dynamic Pricing for On-Street Parking
INCIDENT MANAGEMENT		
Assist with CAD to Transit Weblink Info Police Connection to Public Safety Video Distribution System	Police/Fire Automated Vehicle Location (AVL) to TMC Intranet Enhancement - TMC to Public Safety and Other Tempe Depts Investigate Use of REACT in Tempe Incident Detour Plans	Establish Tempe Regional Emergency Action Coordination Team (REACT)
SPECIAL EVENT MANAGEMENT		
Special Event Website Links	Special Event Response Support Plan	
BICYCLE/PEDESTRIAN ITS		
ITS Guidelines for Bikes/Peds Crossing Treatments Policy Review of Safe Routes to School Program	Bike/Ped ITS Deployment – Phase I Crossing Treatment Locations – Phase I Review of Safe Routes to School Program	Bike/Ped ITS Deployment – Phase II Crossing Treatment Locations – Phase II Prepare Bike/Ped ITS Study Review of Safe Routes to School Program
TRANSIT ITS		
Streetcar ITS Design Input	Streetcar ITS Construction Intranet Enhancement – TMC to Transit Real-Time Transit Data Transit Signal Priority	Streetcar ITS Operations

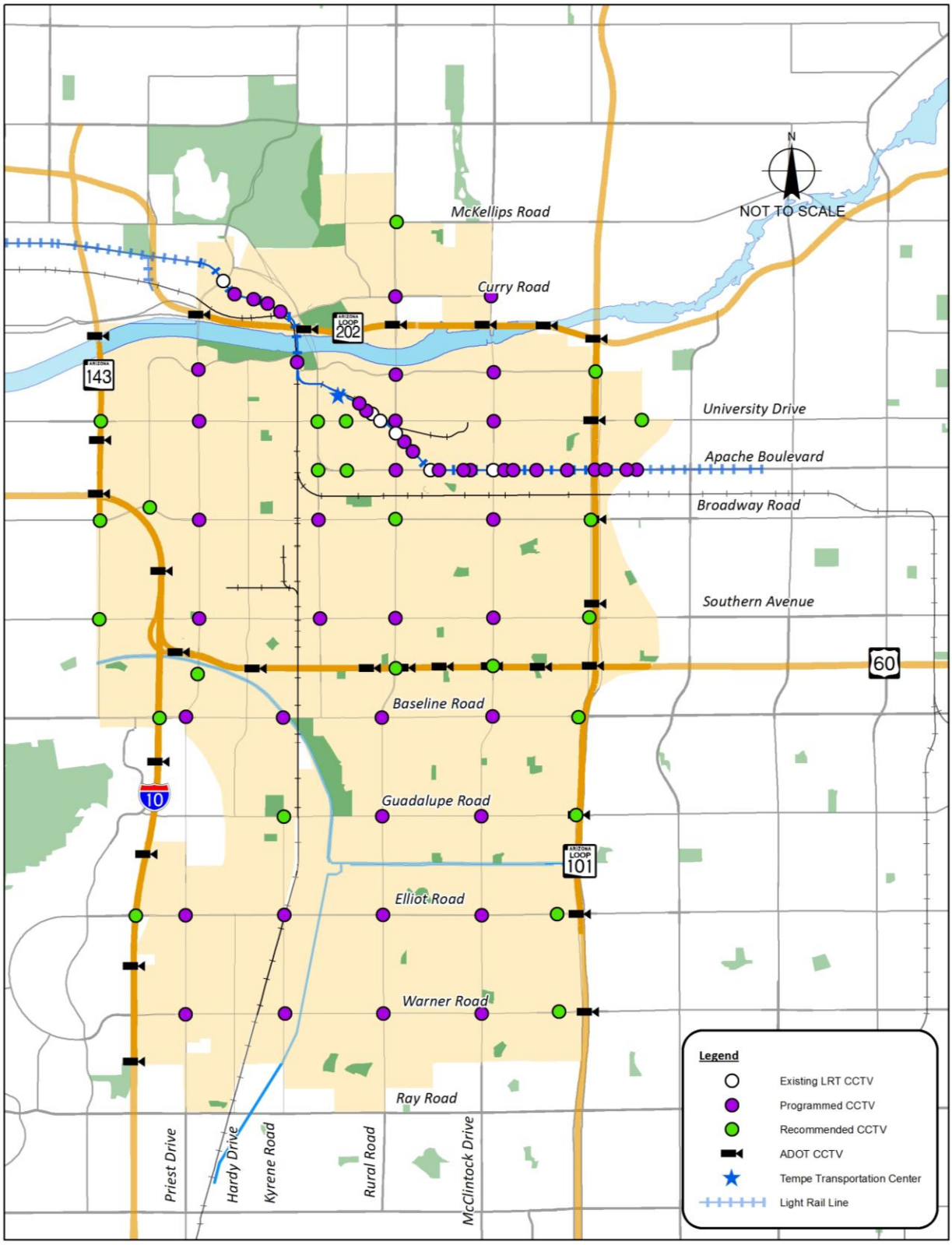


Figure 10 – Recommended CCTV Devices

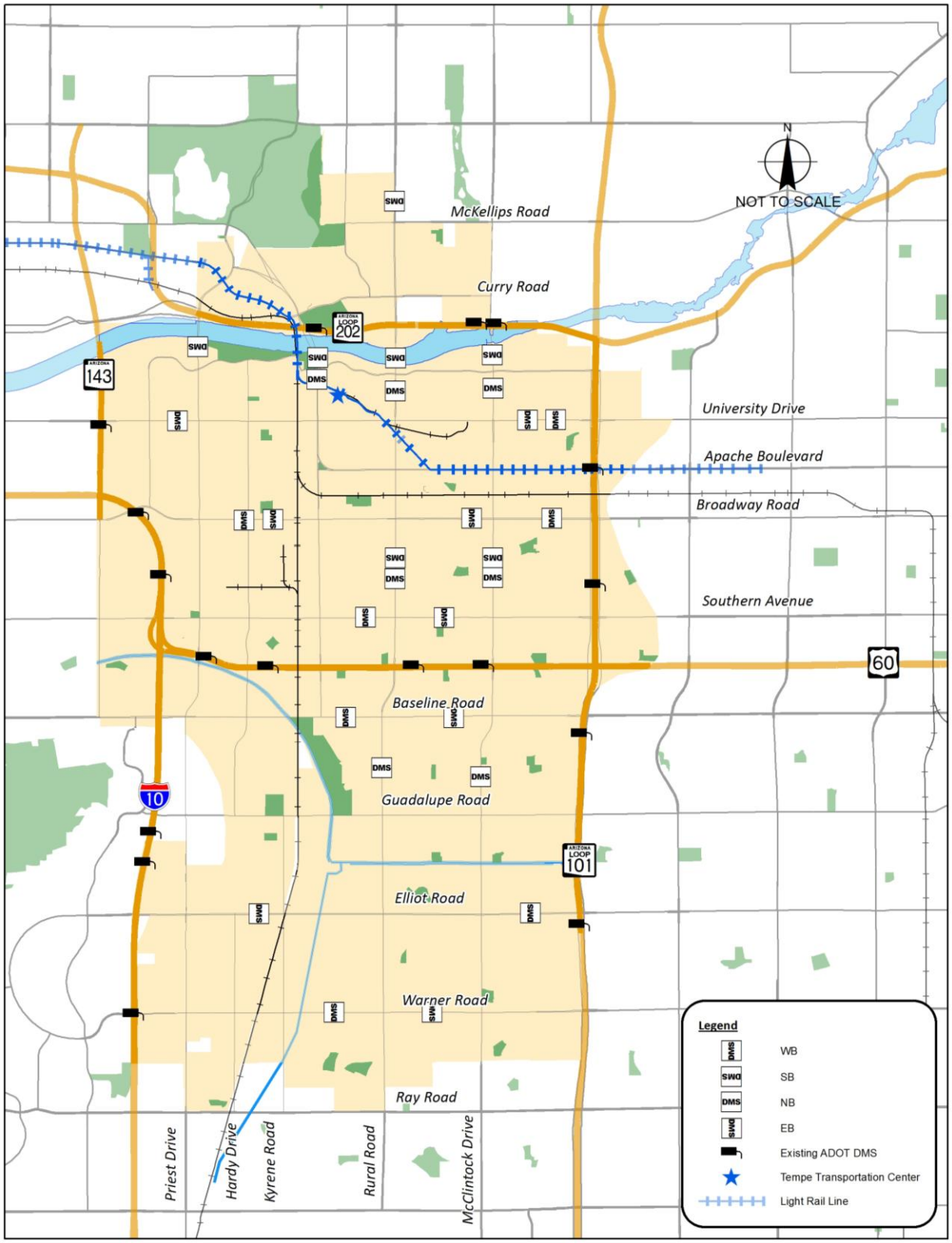


Figure 11 – Recommended DMS Devices

10. TELECOMMUNICATIONS

This section provides the recommended telecommunications network considerations for the build-out of the Tempe ITS program. Current communications media alternatives in the City of Tempe is a hybrid system including fiber optic communications, wireless communications, and leased line communications (to be ultimately phased out).

Figure 12 provides a citywide communications deployment plan in the form of fiber and wireless implementation. This figure highlights the programmed and recommended fiber for the City as well as programmed wireless hubs. **Figure 13** provides a citywide communications build-out plan for fiber corridors and wireless areas. Detailed wireless design for backhaul distribution switches is to be completed as the wireless network is implemented.

This section reviews the recommendations for the connectivity of Tempe's ITS devices to the Tempe TMC. Telecommunications principles such as logical versus physical separation and ring network topology methodology are provided in **Appendix D**.

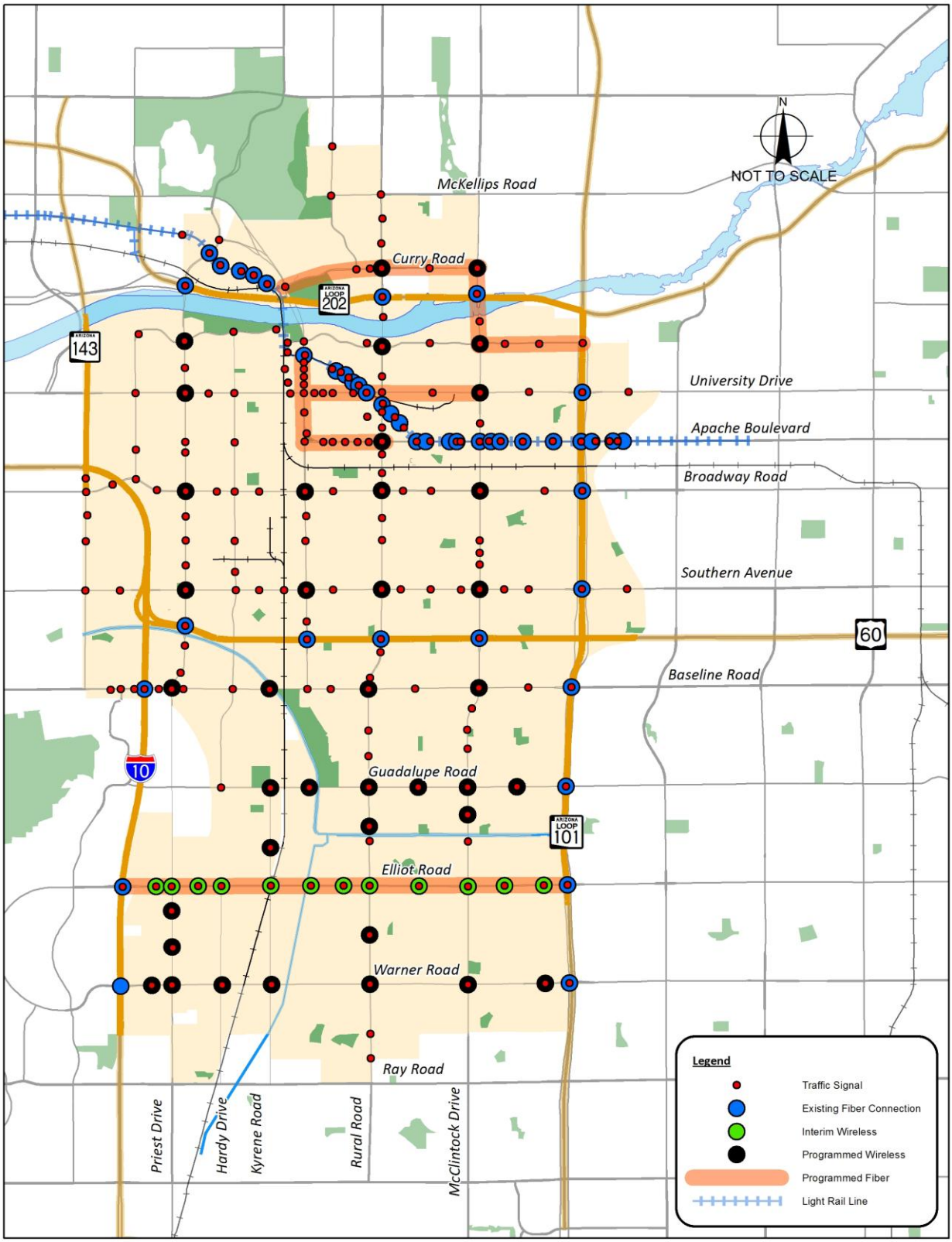


Figure 12 – Communications Phasing

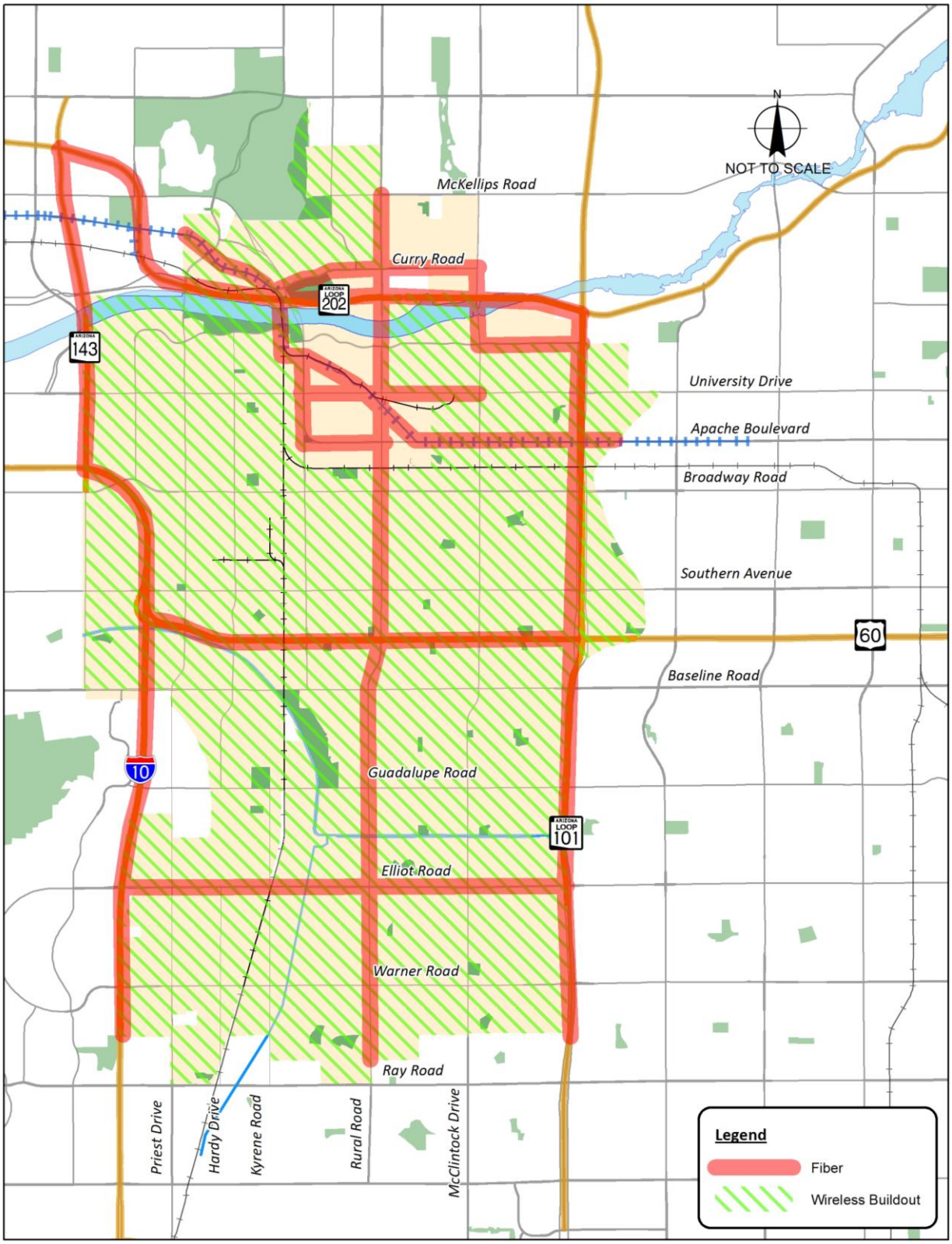


Figure 13 – Communication Types Build-Out

Figure 14 provides a diagram for network communications throughout the City including redundant paths for device information.

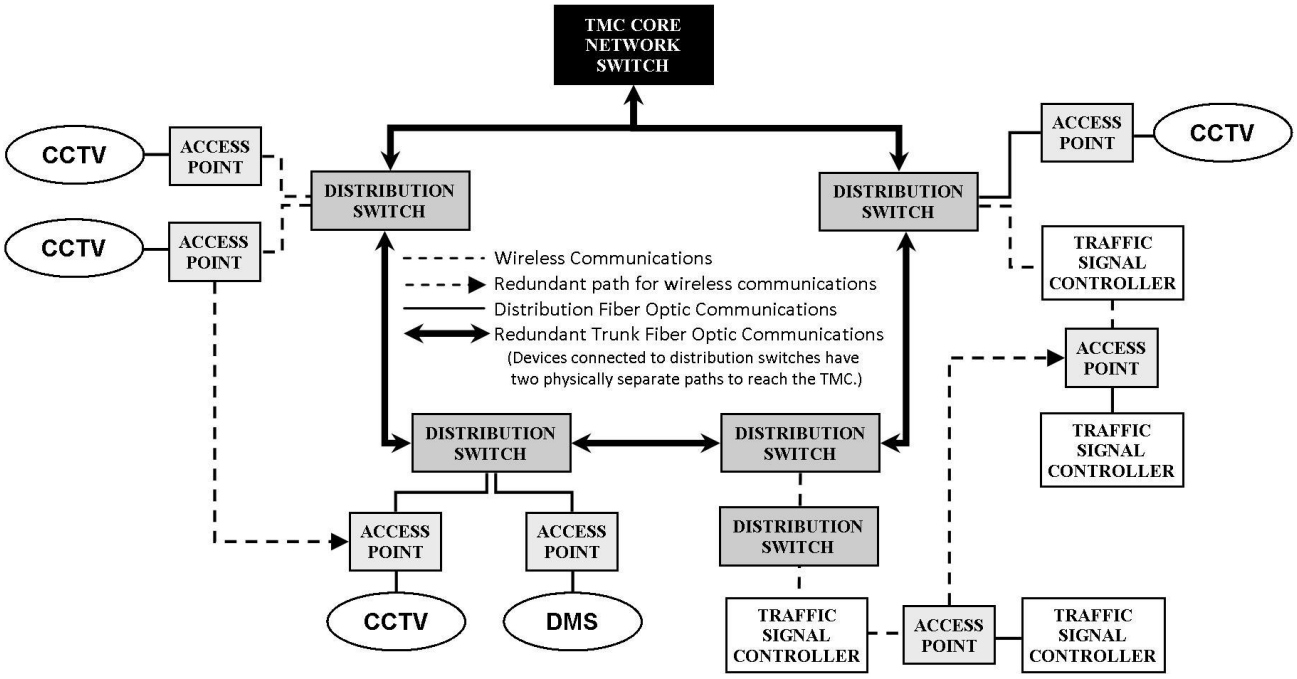


Figure 14 – Network Communications Diagram

The following is a summary list of telecommunications recommendations for the City of Tempe:

General:

- ☐ Develop a fiber master plan to map out the planned splice paths for fiber corridors and the wireless network throughout Tempe.
- ☐ Establish a standard that all roadway and traffic signal projects install a duct bank of conduits (2-2" and 2-1") for use by the City for ITS infrastructure.

Network Physical Separation:

- ☐ Physical separation should be achieved with wireless infrastructure and through some leased services offered by telecommunications service providers.
- ☐ Physically separate fiber paths for all Traffic/ITS applications from other City uses such as IT or Center-to-Center (C2C) with other agencies.
- ☐ Provide path diversity and network security within the Center-to-Field (C2F) network for the City.
- ☐ The Tempe TMC should have a Core Network Switch that is connected to all of the Distribution Switches in the City to receive all information from the ITS network.
- ☐ Implement redundant (duplicate) telecommunications equipment at the Tempe TMC.
- ☐ A three-ring fiber network topology is recommended for the ITS C2F network backbone. Recommended rings include one northwest ring, one southwest ring, and one east ring encompassing the area between Rural Road and Loop 101 within City limits (see **Figure 13** for reference).
- ☐ Establish multiple communications rings that can distribute the bandwidth needs across the multiple rings and provide added redundancy to the network

- ☐ It is required that each ring support device communications from all of the other rings.
- ☐ For all new fiber installed, it is recommended that the fiber cable be 96 strands or higher.
- ☐ Provide a minimum of two fibers for traveling two separate routes for network redundancy.
- ☐ A total of four strands of fiber cable dedicated for Tempe ITS is recommended.
- ☐ 1 Gigabit fiber connector paths are recommended to connect the wireless distribution switches to one of the fiber backbone rings.

Network Logical Separation:

- ☐ A Gigabit Ethernet system is recommended for the City of Tempe ITS backbone system.
- ☐ Logical separation with measures such as firewalls and permissions level access is recommended where physical separation cannot occur.
- ☐ Use subnets and Virtual Local Area Networks (VLANs) to separate network traffic for maintenance and management of the network.
- ☐ Create a C2C network for Tempe to be able to share information with other agencies. This C2C network should be secured logically from the C2F and IT networks at a minimum with preferred physical separation.

Network Security and Firewall:

- ☐ Develop a policy to restrict telnet, which allows remote users to login to a system, would be a good policy to enforce via a firewall.
- ☐ If Tempe plans to share device control and operation of their ITS devices with any other agencies, or vice versa, security policies will need to be developed between Tempe and that sharing agency to outline the level of cooperation.
- ☐ All outside traffic within the C2F network should be routed through a firewall.

Devices

- ☐ Tie all ITS devices to the TMC via an Internet Protocol (IP)-based method.
- ☐ All ITS devices that are located along fiber paths should be connected directly to the fiber and all traffic signals and other ITS devices away from the fiber path should be connected via wireless.
- ☐ Two physically separate paths (different street paths for the fiber, different conduits, or different fiber strands within the cable) are recommended when connecting all devices and facilities.
- ☐ All devices should have an Access Point or Distribution Switch (as needed) locally at its controller.
- ☐ Wireless Access Points should be used in areas where fiber is not cost effective to deploy.
- ☐ Traffic/ITS, IT, other agencies, and RCN should all have independent fibers strands that could potentially reside on the same fiber optic cable.
- ☐ All Wireless Access Points should be fiber or wirelessly connected to one or a maximum of two backhaul Distribution Switches for transmission back to the Tempe TMC.
- ☐ All devices (CCTVs, traffic signals, and DMS) are required at a minimum to be separated logically from one another.
- ☐ Limit the number of devices on any given distribution ring to 10 devices.
- ☐ The ADOT fiber network connectivity to traffic signals is recommended to be reconfigured within the Tempe ring topology in order to provide redundant paths back to the TMC to prevent single points of failure.

11. DEPLOYMENT SUPPORT GUIDELINES

While specific treatment decisions are based on stakeholder input, there are general thresholds for device applications that were considered for each type of corridor. This section provides guidance for recommended ITS applications and ITS component costs in 2011 dollars.

11.1 Guidelines for ITS Applications

Table 3 provides guidance for recommended ITS treatment options that could be applied when warranted by specific roadway characteristics, congestion, incident history, or other factors.

Table 3 – Guidelines for ITS Applications

Strategy	Typically Applied When	Application Guidelines
Adaptive Traffic Signals Technology	Adaptive is effective where variability and unpredictability in traffic demand results in excessive delay and stops that cannot be reasonably accommodated by updating coordinated signal timing parameters on a frequency consistent with agency traffic signal operations objectives. Under-saturated corridors provide the best opportunity and best benefits from the use of adaptive technology application. Adaptive is sometimes applied when the reduction in costs to retime signals every 3 to 5 years pays for the adaptive system installation.	Detection must be present or implemented to detect approaches to the intersection. Signals must be able to communicate with each other either via fiber or wireless communications. City should prepare for increased maintenance requirements for adaptive signals due to the intelligent infrastructure and interfaces with other equipment/systems. Adaptive Traffic Control System (ATCS) costs an average of $65,000 per intersection, which does not include the potential need for the replacement of local intersection hardware and software (depending on the type of system chosen). These additional costs should be factored into the decision on what adaptive strategy would be most cost-effective for the City to implement. Adaptive systems require less money than conventional traffic signals for their physical maintenance when their shares in overall budget and overall operations are compared. FHWA has prepared a Decision Tool to support agencies in making decisions on which adaptive system is the most effective for the agency-specific needs. It is recommended that prior to pursuing an adaptive strategy in Tempe, the local FHWA Every Day Counts Coordinator should be contacted to discuss acquiring this Decision Tool. The Coordinator at the time that adaptive will be pursued can be identified at http://www.fhwa.dot.gov/everydaycounts/contact/. Additional description of adaptive systems is provided in **Appendix E**.
Arterial Travel Times	Collecting real-time traffic data from deployed vehicle detection, Bluetooth technology, vehicle probes, or a third-party data supplier is available.	Need viable detection locations specifically for travel time calculation purposes. Define a target audience to help determine travel time destinations and messaging format. Accommodate difficulties in accurately estimating travel times by displaying travel time messages in ranges. Draw from multiple data sources when calculating travel times. Automate system operations to create smoother data management processes and less manual requirements of personnel. Regularly assess travel time data accuracy during initial implementation. Utilize DMS prior to key decision points where commuters can decide to take alternate routes. Solicit driver feedback to determine what information is most desired.

Table 3 – Guidelines for ITS Applications (continued)

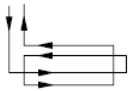
Strategy	Typically Applied When	Application Guidelines
Detection – Bicycle	Locations where cyclist volumes are heavy – such as University Drive, College Avenue and Mill Avenue. Locations where there are marked and signed routes for bicyclists.	Utilize existing Tempe Standard Detail T-576 for Bicycle Loop Detector which details a wiring diagram, as shown below, for specific bicycle purposes. A stencil of a bicycle should be used one foot back from the stop bar of the intersection, which is a line indicating where the bicyclists should position themselves over the loop – this is not currently shown in the Standard Detail T-576.  Utilize existing Tempe Standard Detail T-577 Bicycle Push Button and Pole which details pole location and push button signage specifically for bicycle purposes. Video detection applications can be expensive for bicycle detection only and therefore modifications to existing video image detectors to be able to detect bicycles should be considered. Bicycle-sensitive detectors are generally preferred over a signalized button specifically designed for bicyclists due to no footprint after installation and benefits of integration with main traffic signal controller. If bike lanes do not exist, traffic loop detectors can be used to detect bicycles if sensitivity is adjusted appropriately. When loop detectors are installed, traffic signalization should be set to accommodate bicycle speeds.
Detection – Pedestrian	Manual of Uniform Traffic Control Devices and Department of Justice Accessibility Guidelines need to be met. Locations where buttons can be positioned so that they are easily activated and near crosswalks. Signalized intersections where pedestrians are not anticipated to arrive during every cycle. Midblock locations where pedestrians frequently need to cross.	Pedestrian detection can be infrared, push buttons, or VID. Locally infrared technology is not commonly used because high temperatures have been known to cause complications with infrared detection. Push buttons are recommended. Where possible push button detectors should be placed in locations where they are unobstructed and accessible to disabled pedestrians. Push button detectors should be placed in locations where it is apparent which button is associated with each crosswalk.

Table 3 – Guidelines for ITS Applications (continued)

Strategy	Typically Applied When	Application Guidelines
Detection – Vehicle	At signalized intersections to detect vehicle demand and identify gaps to determine when phases need to be served or terminated. Locations where count and/or speed data is needed. Locations where adaptive signal timing is used. In parking spaces to track parking availability.	Beneficial if linked to other technology treatments to use in real-time (such as parking or adaptive signal systems). Can be combined with existing signal controllers, power, communications, etc. Intrusive detection is typically in the form of saw-cut loops or microloop tubes. Magnetometers are a less intrusive form of vehicle detection that are becoming more commonly used because of the minimal impact on the roadway and minimal required infrastructure. Two magnetometers per lane at the detection zone and one pole mounted access point per intersection or midblock detection site are required. For larger intersections or where advance detection is used, a repeater may also be required. Non-intrusive detection (i.e., video, infrared, microwave) can be pole or mast arm mounted. Infrared is not commonly used locally because high pavement temperatures have been known to cause complications. The most common form of non-intrusive detection locally is VID. VID requires one camera for each approach.
Dynamic Message Signs – Permanent Arterial	In order of priority for Tempe implementation: 1. To direct event traffic for ingress/egress near major traffic generators along high volume corridors – e.g., Tempe Town Lake or Stadium for Rural Road, University Drive, and Mill Avenue 2. Approaching freeways alerting travelers of congestion impacting major corridors or freeway access or freeway congestion 3. Providing paired DMS locations for those that have been implemented prior – e.g., if NB corridor DMS has been provided, implement SB corridor DMS in this priority level 4. Other considerations as noted in the application guidelines	Strategic locations prioritized for high volume corridors, in advance of population center or event generator, and in advance of freeway entrance decision points. Arterial fixed DMS sign structures need to be stand-alone and must include a sign, structure, foundation, controller, pole mounted cabinet, communications, and power. Develop standard message library as well as basic message design standard operating procedures for use to display on signs: problem, location of problem, and (if warranted) recommended driver action. Other considerations for implementing DMS: • To inform travelers of traffic or weather conditions, particularly in areas where unanticipated events occur regularly that delay traffic. • To indicate parking availability. • At locations where traffic control changes with conditions or by time of day. • To provide arterial travel time data.

Table 3 – Guidelines for ITS Applications (continued)

Strategy	Typically Applied When	Application Guidelines
Dynamic Message Signs – Portable	At entrance and exit points of planned event. To inform traffic of upcoming construction activities or to reroute traffic around active construction. To inform travelers of changes in traffic control.	Would require mobilization with appropriate vehicles to deploy at specific locations. Training and security requirements for posting and updating messages. Develop standard message library as well as basic message design standard operating procedures for use to display on signs: problem, location of problem, and (if warranted) recommended driver action. Portable dynamic message signs could be purchased or rented, depending on the anticipated frequency of use.
Fiber Optic Communications	High bandwidth communications are needed to support data transfer. Existing infrastructure may be present that could potentially be utilized: conduit, pull boxes, City-owned fiber cable, private telecommunications company owned fiber cable.	Look to use available fibers through other agencies, other City departments or private sector. Build out and connectivity of devices is key to a citywide traffic management strategy.
Parking ITS	Locations where parking is frequently at or near capacity and travelers must circle the block to wait for spaces to open up. Locations where similar parking alternatives are nearby where travelers could be redirected.	City parking facilities near special event venues where access is from main roads moving adjacent to special event venues. When choosing a technology, consider whether the facility is new construction or a retrofit, whether the facility is subject to frequent repaving, and whether or not the parking configuration will change over the long term. Research the availability of communications lines and power supplies thoroughly and get the permit process going early; check availability in the field before committing to a design. Partnership with ASU or private parking facilities can support personnel to monitor and maintain the system. Incorporate visual monitoring of systems to help ensure system reliability. On-site or management personnel may need to adjust the system manually in order for the system to continue to be reliable. Identify long-term maintenance needs and costs up front.
Traffic Signal Synchronization	Locations where signals are closely spaced, when traffic volumes are heavy, and when pedestrian traffic is not favored.	Establish formal or informal agreements with neighboring jurisdictions for traffic signal coordination along key corridors. Signals must be connected to some form of communications or must have GPS clocks to ensure they are properly synchronized.

Table 3 – Guidelines for ITS Applications (continued)

Strategy	Typically Applied When	Application Guidelines
Transit ITS	Signal priority for buses or Light Rail can be used to reduce delay. It is typically applied at locations where transit progression is favored over other traffic or where transit traffic is frequent and ridership is high.	Signal priority requires transit vehicle mounted transponders and mast arm mounted sensors and may involve transit signal heads. Signal priority systems can be used with existing signal controllers, power, communications, etc.
Video Monitoring Technology	Locations/intersections that experience high crash rates per City Police records. Locations where signal timing may need to be changed frequently based on traffic or weather related conditions. Locations where unplanned events frequently occur which have negative impacts on progression and cause severe delays.	CCTV requires camera enclosure, cabling, pole/mounting, foundation, power, and communications. CCTV location should be chosen so that all approaches to the intersection can be seen with pan, tilt, zoom capability. In some cases, a bucket truck survey may be beneficial to check sight distance and visibility. Mounting can happen on a traffic signal pole or on a stand-alone pole.
Wireless Communications	Fiber optic cable is not feasible financially or physically to reach device that needs connecting to the City's network. Radio interference is minimal or manageable to be able to allow for a specific bandwidth to be identified for City use – licensed or non-licensed.	Define the following: • Type of data to be transmitted • Amount of data to be transmitted • What types of radios/antennas are needed (separate antenna and radio or combined approach) • Profile of terrain • Urban or rural application • Reliability/redundancy needs of system • Type of network that can be used • Specifications for wireless deployment must be clear to avoid challenges

11.2 Cost Estimations for ITS Components

Table 4 provides guidance for estimating the cost of ITS projects based on components that can be introduced into existing projects or used in determining budgets for new projects. These costs are based on 2011 values and are to be used as a reference for the scale of value for each ITS component. These are general recommendations for the capital cost and included labor of each ITS component and should not be used as final estimates. Up-to-date cost estimation is required for all ITS projects and components when they are implemented based on that year's estimated values.

Table 4 – Cost Estimations for ITS Components

ITS COMPONENT	UNIT	ESTIMATE
CONDUIT INFRASTRUCTURE		
2 Inch Fiber Optic Conduit (Trench)	L.F.	$10.00
2 Inch Fiber Optic Conduit (Jack/Drill)	L.F.	$15.00
2.5 Inch Fiber Optic Conduit (Trench)	L.F.	$13.00
3 Inch Fiber Optic Conduit (Trench)	L.F.	$13.00
3 Inch Fiber Optic Conduit (Jack/Drill)	L.F.	$18.00
4 Inch Fiber Optic Conduit (Trench)	L.F.	$15.00
4 Inch Fiber Optic Conduit (Jack/Drill)	L.F.	$20.00
4 Inch Rigid Metal Fiber Optic Conduit	L.F.	$50.00
Cable Innerduct (1")	L.F.	$1.25
ITS No. 7 Pull Box	EACH	$500.00
ITS No. 7 Pull Box w/Extension	EACH	$650.00
ITS No. 9 Pull Box	EACH	$2,500.00
COMMUNICATIONS INFRASTRUCTURE		
Fiber Optic Cable (Single Mode 12)	L.F.	$2.50
Fiber Optic Cable (Single Mode 96)	L.F.	$2.75
Fiber Optic Cable (Single Mode 144)	L.F.	$3.00
Fiber Optic Splice Closure (Splice Tray/Closure)	EACH	$2,500.00
Modify Existing Fiber Optic Splice	EACH	$1,000.00
Field Hardened Ethernet Distribution Switch	EACH	$2,000.00
Field Hardened Ethernet Backbone Switch	EACH	$6,000.00
Wireless Field Equipment	EACH	$3,000.00
Core Network Switch	EACH	$14,000.00
TMC Server	EACH	$2,600.00
TRANSIT INFRASTRUCTURE		
Transit Signal Priority (Each Intersection)	EACH	$12,000.00
Transit Transponders (Each Bus)	EACH	$75.00
CCTV INFRASTRUCTURE		
CCTV 55' Pole	EACH	$5,500.00
CCTV Pole Foundation	EACH	$1,100.00
CCTV Camera Field Equipment (with pole mounted cabinet)	EACH	$9,000.00
CCTV Camera Field Equipment (without pole mounted cabinet)	EACH	$7,000.00
Video Codec	EACH	$3,000.00
Meter Pedestal, Foundation and Power Service	EACH	$6,000.00

Table 4 – Cost Estimations for ITS Components (continued)

ITS COMPONENT	UNIT	ESTIMATE
DMS FIELD EQUIPMENT		
DMS Controller and Pole Mounted Cabinet	EACH	$3,000.00
DMS Structure Foundation	EACH	$10,000.00
DMS Sign	EACH	$60,000.00
DMS Sign Structure	EACH	$20,000.00
Meter Pedestal, Foundation and Power Service	EACH	$6,000.00
Portable DMS Field Equipment	EACH	$15,000.00
VEHICLE DETECTION		
Inductive Loop Detector at Intersection (6'x40' Quad)	EACH	$1,000.00
Inductive Loop Detector at Mid-Block (6'x6')	EACH	$800.00
Loop Detector (Traffic Counter System)	EACH	$10,000.00
Detector Cards	EACH	$150.00
Loop Lead In Cable	L.F.	$1.00
Video Detection System (4-Camera)	EACH	$30,000.00
Magnetometer	EACH	$650.00
Access Point	EACH	$6,000.00
Repeater	EACH	$1,800.00
PARKING ITS		
Entrance/Exit Parking Ramp Meter Detection	EACH	$2,000.00
FUTURE POTENTIAL APPLICATIONS		
Fixed Lane Signals	EACH	$3,000.00
Variable Speed Display Sign	EACH	$3,000.00

11.3 Future Potential Applications

Future potential applications not considered within the timeframe of this Strategic Plan but that could be incorporated into the ITS program along key corridors in the future include:

- Lane Control Signs – To allow the temporary closure of lanes, supported by surveillance and detection technologies.
- Parking Management Data Collection System – Monitors the availability of parking and shares that information with travelers via DMS, website, mobile application, or other method. Requires coordination with privately owned parking facilities and DTC to determine ITS components that will be deployed to support this automated system (ingress/egress detection, space detection, additional DMS, etc.).
- Variable Speed Limits – This type of a system, which provides a dynamic display that can be changed by the TMC in response to congestion, incidents, or special events, would be applicable on highly congested corridors in the vicinity of the downtown area, the ASU campus perimeter corridors, or other major mile interval corridors.

12. FUNCTIONAL ROLES AND ITS OPERATIONAL REQUIREMENTS FOR THE ITS PROGRAM

This section discusses the various functional roles for each stakeholder department in Tempe's ITS program as wells as cross-jurisdictional coordination examples that neighboring jurisdictions are already employing that could streamline implementation of key ITS components on the arterials.

As Tempe builds infrastructure with additional cameras, detection, traveler information and supporting telecommunications, there will be an enhanced operational capability from the Tempe TMC. With the planned coordination and information sharing envisioned to occur between the Tempe TMC and other city agencies (including Police and Fire), there will need to be some operational parameters put in place. In the longer term, this coordination could extend to neighboring jurisdictions. This section addresses recommended operations plans, device permissions as well as operational agreements that are recommended to be put in to place to govern the usage of Tempe's ITS equipment by others.

12.1 Operational Roles

Operational concepts show how various components, devices, and systems will work together to perform specific functions. There are five specific operational concepts described in this section that summarize the types of activities and events that are feasible to occur using a fully implemented ITS program (including CCTV, arterial DMS, traffic signal central control, and connections to other Tempe departments for sharing of systems):

- *Traffic Management* – daily monitoring, and control of devices throughout City, daily operations/communication between City departments and also between Tempe and neighboring jurisdictions.
- *Incident Management/Response* – coordination with incident/emergency response, maintenance, and other jurisdictions on shared corridors.
- *Work Zone Management* – tools to use for traffic control through work zones including DMS, signal control, video detection, and Police coordination.
- *Event Management* – coordination during events, managing ingress and egress traffic, and incident response during events.
- *Traveler Information* – disseminating information about construction/road closures, events, and incidents as well as information for 511 and az511.

In order to provide the various functions as outlined above, departments will need to share information with one another and work together to manage incidents and events. Information sharing and coordination serves to give each department the tools necessary to complete their roles and responsibilities efficiently. Using the roles and responsibilities outlined in **Table 5** and identifying the necessary coordination will help establish project recommendations and key priorities for Tempe.

Table 5 – Operational Roles Matrix

City Group	Traffic Management	Incident Management	Work Zone Management	Event Management	Traveler Information
Tempe TMC	Monitor traffic signals and timing plans, and intersection/corridor detection View real-time CCTV video feeds on Tempe roads, adjacent major corridors, and ADOT freeways Adjust traffic signal timing plans based on actual conditions Implement preplanned timing plans Notify motorists via DMS of construction, closures, incidents, events Monitor police radio Share CCTV video feeds with others as designated Archive traffic conditions data (volumes, speeds, etc.) Share corridor detector/intersection data such as volumes and speeds with neighboring agencies Receive incident alerts from Phoenix Fire CAD Receive incident alerts from ADOT AOI system	Monitor incidents via CCTV video images Monitor CAD feed from Phoenix Fire for incidents that impact Tempe arterials Coordination between Police and Fire to dispatch response Coordinate with Tempe REACT Team (if established) Coordinate with the Tempe Police Department on incident monitoring via field devices Adjust timing around incidents – may require coordination with neighboring jurisdictions Monitor the incident clearance process via CCTV video images where instrumented Send out emails/texts to distribution list for incident notification as well as all-clear when notified Post messages on permanent arterial DMS where instrumented Adjust signal timing plans back to normal conditions after clearance of incident Receive incident alerts from ADOT HCRS Area of Influence system Provide information to Public Information Officer for distribution to media Coordinate with Transit services on closure location and length	Input planned road closure information into ADOT Highway Conditions Reporting System (HCRS) Have access to portable equipment through work zone corridors deployed by contractors as needed Deploy and monitor portable and permanent equipment on detours and adjacent routes as needed Post messages on portable and permanent DMS Share real-time CCTV monitoring view with Police and neighboring jurisdictions Adjust timing plans on work zone corridor – also on adjacent corridors and detour routes Provide updates to Tempe website regarding construction projects, affected corridors, closures, detours – coordinate this information with Public Information Officer	Receive notification of an event Coordinate with Police for incident monitoring and management strategies during event Coordinate with local TMCs and ADOT for event traffic management and monitoring support Implement preset signal traffic timing plans for event traffic Monitor event conditions via CCTV video images, detection, and media Archive traffic conditions information (volumes, speeds, etc.) during an event Implement incident management strategy when incidents occur during an event Adjust pre-set traffic signal timing plans accordingly close to time of event ingress and egress Use DMS for messages for event ingress and egress Monitor egress from event back to normal traffic operating conditions	Post messages on portable and permanent DMS Post information on the Tempe website including CCTV screen shots for public view, CCTV streaming video for City intranet view, planned lane closure locations on website map Share traveler information with PIO to disseminate to media via established procedures

Table 5 – Operational Roles Matrix (continued)

City Group	Traffic Management	Incident Management	Work Zone Management	Event Management	Traveler Information
Tempe Transportation	Share planned work zone and permitting information with Tempe Maintenance		Share traffic condition and work zone status with partners on Tempe corridors and adjacent corridors – ADOT HCRS, Scottsdale, Mesa, Chandler, Phoenix, and media		Share information with media via Public Information Officer – radio, TV, newspaper, newsletter about incident information, work zone/construction updates, and event plan/detour routes
Tempe Maintenance		Dispatch Maintenance staff and vehicles – establish barricades, portable DMS, signing, support detour and incident clearance	Deploy portable equipment – Work Zone DMS, speed monitoring, CCTV at work zone and on key alternate routes/detours established by the City Monitor portable equipment through work zone corridors and on detour and adjacent routes	Deploy portable equipment – DMS, speed monitoring, CCTV at work zone and on key alternate routes/detours established by the City Remove portable devices and traffic control equipment initially deployed for event when event is over	
Tempe IT	Support Tempe TMC with network system maintenance/warranty management Share potential personnel as IT support	Work with Tempe TMC to enhance City Intranet use of shared TMC functionality	Work with Tempe TMC to enhance City Intranet use of shared TMC functionality	Work with Tempe TMC to enhance City Intranet use of shared TMC functionality	Work with Tempe Transportation and TMC to enhance City website
Tempe Public Information Officer		Prepare and send media alerts out based on information received from other Tempe departments	Provide updates to Tempe web site regarding construction projects, affected corridors, closures, detours – coordinate this information with TMC	Notify city departments, event location, affected neighboring jurisdictions of event management plan activities, roles, and responsibilities Notify media of event management plan activities, routes, detours, parking, etc. Provide event information to ADOT	Prepare and send media alerts out based on information received from other Tempe departments

Table 5 – Operational Roles Matrix (continued)

City Group	Traffic Management	Incident Management	Work Zone Management	Event Management	Traveler Information
Tempe Police Department	View CCTV video feeds Control capability of CCTV after TMC operating hours	Dispatch REACT/coordinate with REACT (existing – MCDOT, future if established – local) Establish detours for traffic to be routed around incident efficiently TMC and Police Department coordinate on incident monitoring	View real-time CCTV monitoring of work zone Police personnel to monitor work zone – provide feedback to TMC about observed operations	Coordinate with TMC for incident monitoring and management strategies Monitor event day conditions via CCTV video images, portable CCTV, media Monitor egress from the event back to normal traffic operating conditions	Publish incident notification information for media through PIO Police PIO to coordinate with Tempe PIO regarding message to provide via traveler information methods
Tempe Community Development	Coordinate with Tempe TMC and Transportation during development of Safe Routes to School Program and roadway applications for corridor modernization (future)				
Neighboring Jurisdiction TMC	Share CCTV video feeds on adjacent corridors in respective jurisdictions with Tempe TMC (future)	Detect/identify incidents via CCTV video images/traffic detection Coordinate to adjust timing on detour routes as needed	View real-time CCTV of work zones on shared corridors in respective jurisdictions with Tempe TMC Share traffic condition and work zone status for work zones in respective jurisdictions with Tempe TMC Exchange information on planned work zone/construction in respective jurisdictions with Tempe TMC	Coordinate with local TMCs and ADOT for event day traffic management and monitoring support	Share work zone information and incident information on shared corridors in respective jurisdictions with Tempe TMC
ADOT TOC	Share ADOT CCTV with Tempe TMC via direct fiber connection Keep HCRS and AOI system up-to-date related to incidents and planned closures on freeways impacting Tempe	Detect/identify incidents via CCTV video images/traffic detection	View real-time CCTV of work zones on shared corridors Keep HCRS and AOI system up-to-date related to incidents and planned closures on freeways impacting Tempe	Post messages on freeway DMS for special event traffic management	Include Tempe local information in AZ511 phone and web services

12.2 Coordinating Entities for Tempe's ITS Program

There are other departments that may be involved in the process of the ITS program. Examples include involving Information Technology to support TMC equipment/warranty maintenance, informing Community Relations of available information and data that may be shared via the City's web site or PD/FD that may be interested in accessing the City's ITS equipment to better support incident management. Coordination among these entities will be essential. **Figure 15** provides a summary of the different entities within the City of Tempe and their anticipated role or involvement with Tempe's ITS program and system operations.

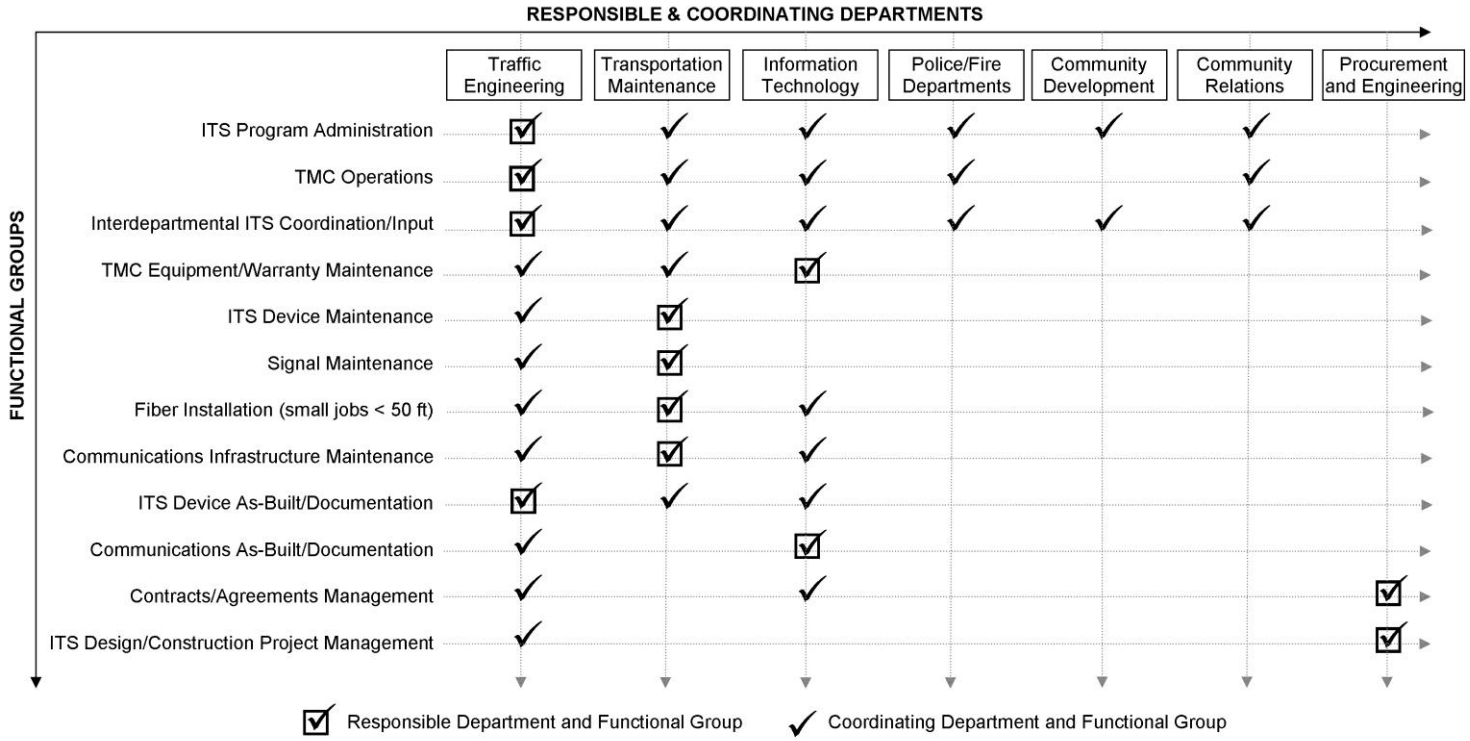


Figure 15 – Responsible and Coordinating Departments in Tempe

12.3 Recommended Operations Plans

With the new tools and capabilities envisioned to come on line in the City of Tempe TMC, it is recommended that the TMC develop standard operating procedures and guidelines to establish proper use and operations of the ITS investments. This will support existing TMC operations, integration or training of new staff (including future TMC staff and cross-training of other staff), as well as establish operational parameters for use of and/or access to images or data by other Tempe departments.

Table 6 summarizes recommended operating procedures to be developed or collected to support TMC and system operations.

Table 6 - Recommended Operations Plans

Recommended Document	Purpose and Content
Standard Operating Procedures • Processes for central system operations (software) • Central system troubleshooting • Operator workstation functions • Video wall functions • Device and communications operations and troubleshooting • Internal and external partner coordination • Ongoing maintenance • Emergency maintenance requests • Operating instructions for regional systems (including Camera Cameleon, ADOT HCRS, others when available)	Capture steps and processes for the operational activities at the TMC. Can aggregate existing software/system manuals and supplement with additional processes. To serve as a reference and training tool for those staff resources assigned to the TMC.
Traveler Information Strategy • DMS message guidelines and message sets • Email alert notification system and protocols • Provision of traveler information to Tempe's web site	Develop processes and a strategy for how information will be shared with other Tempe departments (e.g., PIO) and with the public.
Performance Monitoring Plan • Establish performance goals and how they will be measured • Data from system to support analysis (weekly, monthly, annual, as needed) • Process for analyzing and comparing data to previous years • Device reliability/status reports for tracking maintenance needs and issues • Outputs to regional performance monitoring activities	Establish a strategy to capture performance data from the system and the network. This will help identify where additional focus is needed or where benefits are being achieved.

To support Tempe in establishing its operating guidelines and processes, there are three regional guidelines that have been prepared by AZTech™. These primarily address interagency coordination and shared viewing and/or operations. This functionality is not a near-term priority for the City of Tempe, but may be considered in the future. These are:

- ***AZTech™ Regional Center-to-Center Dynamic Message Sign Guidelines*** – discusses permissions for agencies to post messages on another agency's sign, such as during afterhours or emergency conditions. May be applicable if Tempe permits ADOT to post messages on Tempe arterial DMS in close proximity to a freeway interchange in an after-hours scenario.
- ***AZTech™ Regional Center-to-Center Video Feed and Camera Control Guidelines*** – discusses the concept of sharing video feeds among agencies in the region, and states that the owning agency is responsible for establishing permissions for others to access video from their cameras.

- ***AZTech™ Regional Center-to-Center Traffic Management System Guidelines*** – outlines a regional agreement for sharing traffic signal timing plan information via the Regional Archived Data Server.

12.4 Tempe ITS Device Recommended Control and Permissions

During the Strategic Plan development process, stakeholders discussed the potential for shared operations or access to video and data generated by the ITS devices. It is not uncommon in most jurisdictions to have some level of shared permissions to view, or in some limited instances, to allow other entities to control ITS devices such as CCTV cameras.

Recommendations for primary, secondary, and view-only capabilities are provided in **Table 7** below to guide the implementation and shared use of the information that ITS devices are capable of collecting. The permissions provided to other Tempe departments should be documented in an agreement.

- ***Primary Control*** is defined as the day-to-day operational responsibilities carried out by the TMC. The Tempe TMC will have full control over equipment (including CCTV pan-tilt-zoom, DMS message placement, establishing pre-sets, etc.), will manage equipment and devices from the TMC, and will have authority to define what information is released to other entities.
- ***Secondary Control*** is given to the other departments based on permission from the Tempe TMC. Secondary Control may include full or limited permissions to maneuver CCTV from pre-sets, post a DMS message, or other capability granted by the TMC.
- ***View Only*** is defined as having no control or modifications of equipment, but the ability to view images or data released by the TMC.

Table 7 – Recommended Control Permissions for Tempe ITS Equipment

Department	Traffic Signals	CCTV	Permanent DMS	Wireless Communications
Tempe TMC	Primary	Primary	Primary	Primary
Tempe Maintenance	Secondary	Secondary	Secondary	-
Tempe IT	-	-	-	Secondary
Tempe Public Information Officer	-	View Only	View Only	-
Tempe Police Department	View Only	Secondary	Secondary	-
Tempe Community Development	-	-	-	-
Tempe Transit	-	Secondary	-	-
Neighboring Jurisdiction TMC	View Only	Secondary	View Only	-
ADOT TOC	-	Secondary	Secondary *	-

**This would only apply to DMS in proximity of freeway interchanges, and only if there is an urgent message to be placed that occurs outside of the Tempe TMC operating hours.*

12.5 Recommended Staffing for TMC

The level of ITS devices warrants an analysis of staff that should be dedicated to TMC operations.

Table 8 presents a sample of how a traffic operations center may be staffed. This table is based on information contained in the *ITE Traffic Control Systems Operation: Installation, Management, and Maintenance.* A level of service categorization is used to define the different staffing needs of different levels of operation. This table provides insight on how staffing levels can grow as traffic conditions change and responsibilities increase.

The categorical designations of small, medium, and large are based on the number of (1) general ITS equipment, (2) total traffic signals, (3) types of traffic signal control and (4) traffic signal detection capabilities within each agency's control.

Table 8 – Sample Staffing Levels

Agency Category	Level of Service	Center Manager	Supervisor	System Operator	Computer / Network Support (IT)	Public Safety Liaison	Total
Small	Special Event, Incident Response	-	-	0.5	-	0.5	1
Medium	Peak Period Coverage (Business Hours) (8 hrs/5 days)	0.5	1	1	0.5	1	4
Large	Short Weekday (12 hrs/5 days)	1	1	2	1	2	7
Regional	Continuous (24 hrs/7 days)	1	2	5	2	3	13

Source: ITE Traffic Control Systems Operation: Installation, Management, and Maintenance

The current status of the Tempe TMC managing the traffic signals and existing cameras is categorized as generally between "small" and "medium" in **Table 8** and therefore the TMC should be operated and managed by personnel totaling between one (1) and four (4) persons. It is important to note that the one person designated as the 'Public Safety Liaison' represents one person at Tempe PD that is able to view Tempe TMC video feeds rather than a person physically being in the Tempe TMC. This reduces the "medium" agency category recommended staffing level to three (3) persons. **Table 9** summarizes the recommended TMC staffing based on the current and planned ITS inventory for Tempe and the sample staffing levels for TMC operations.

Table 9 – Recommended TOC Staffing Guidelines Summary

Target Year	Level of Service	Supervisor	System Operator	Information Technology	Public Safety Liaison	Total
Current	Business Hours	1	0.5	0	0	1.5
2011-2012	Business Hours	1	1	0.5	0.5	3
2013-2015	Business Hours (more devices)	1	2	0.5	0.5	4
2015-Beyond	Short Weekday (12 hrs/5 days)	1	2	1	1	5

Near-Term Recommendation **–** Based on the table, it is recommended for Tempe to have at least one full-time System Operator (or two part time) dedicated to Tempe TMC operations in the 2011-2012 timeframe. In the near-term timeframe it is recommended to identify an IT staff person currently working in IT at Tempe to support TMC operations as needed. This will total effectively two (2) persons dedicated to the TMC and one half-time (0.5) IT person supporting the TMC. Implementing the PD video feed and control capability will effectively provide another half-time (0.5) public safety liaison to TMC operations, bringing the total TMC operations to three (3) personnel.

Mid-Term Recommendation **–** In the mid-term timeframe once more ITS devices have been implemented, there will need to be an additional full-time System Operator dedicated to the Tempe TMC. A dedicated IT person will only need to be hired if the Tempe TMC expands their operational hours. Until such time, one person within the existing staff of IT shall be designated as support for Tempe TMC operations. This lists three (3) persons dedicated to the TMC, one half-time (0.5) IT person supporting the TMC without extended TMC operational hours, and one half-time (0.5) public safety dispatch person to support TMC operations, bringing the total TMC operations to four (4) personnel.

As ITS infrastructure is added and fiber cable and wireless communications are implemented around the city, the Tempe TMC may need to increase personnel to be able to manage a larger network.

12.6 Agreements to Support Operations

Agreements should be developed between the TMC and other entities that would like access to video and data, or that the TMC has identified as having some level of permissive control. For internal entities such as PD and FD, these are likely to be informal agreements; for entities external to the TMC, there may need to be more formal agreements put in place. Agreements provide several benefits:

- They acknowledge the working relationship between the Tempe TMC and agency requesting permissive access;
- They acknowledge the purpose of the access (e.g., after hours viewing capability, after-hours control capability, data only, etc.);
- They incorporate relevant operational requirements or restrictions; and
- They acknowledge the responsibility of both entities (TMC and requesting entity).

Formal agreements that have currently been identified by the City of Tempe include agreements with private telecommunications companies for sharing conduit or fiber.

For the most part, any future internal agreements would be zero cost, but some agreements may require a financial commitment from agencies in the City depending on the service described in the agreement. Potential future agreements for the City of Tempe to consider are shown in **Table 10**.

Table 10 – Agreements for Future Consideration

Agreement Parties	Description of Agreement	Cost Considerations
Tempe TMC and Tempe Police and Tempe Fire	Formal agreement governing usage of Tempe arterial CCTV by Tempe PD Dispatch and Tempe FD Dispatch. Purpose would be to enable Police and Fire Dispatch to monitor specific arterials or incidents. May include pan-tilt-zoom capability at the discretion of Tempe TMC. Requirements for usage (zoom, recording, etc.) would be included. Tempe TMC may explore opportunity for Police or Fire to provide special event coverage and after-hours viewing. Addresses transfer of legality in terms of archiving video or other use by department other than for TMC purposes.	Look at intranet-based connection to limit cost requirements. May be additional user license with Tempe camera control software. Cost to be shared by Traffic, Police and Fire.
Tempe TMC and Local Media	View only capability to allow local media to broadcast full motion CCTV during traffic reports. At present, media has access to ADOT freeway cameras. Tempe TMC would have authority over which video streams are released. Media would be required to source information (display Tempe logo on video broadcast).	Current arrangement with ADOT is a direct connection to the ADOT TOC. Media may be able to obtain video through web-based connection.
Tempe TMC and Tempe Transit and Phoenix Public Transit	Future agreement to potentially share real-time video images on Tempe arterials that could impact transit operations. Explore a mutual data sharing agreement where the TMC and Tempe Transit could share vehicle location data and incident/closure notification information.	This kind of data connection could have a cost component for initial development. Look to potentially use the Regional Archived Data System (RADS) as a common platform to limit costs for developing specific interfaces.

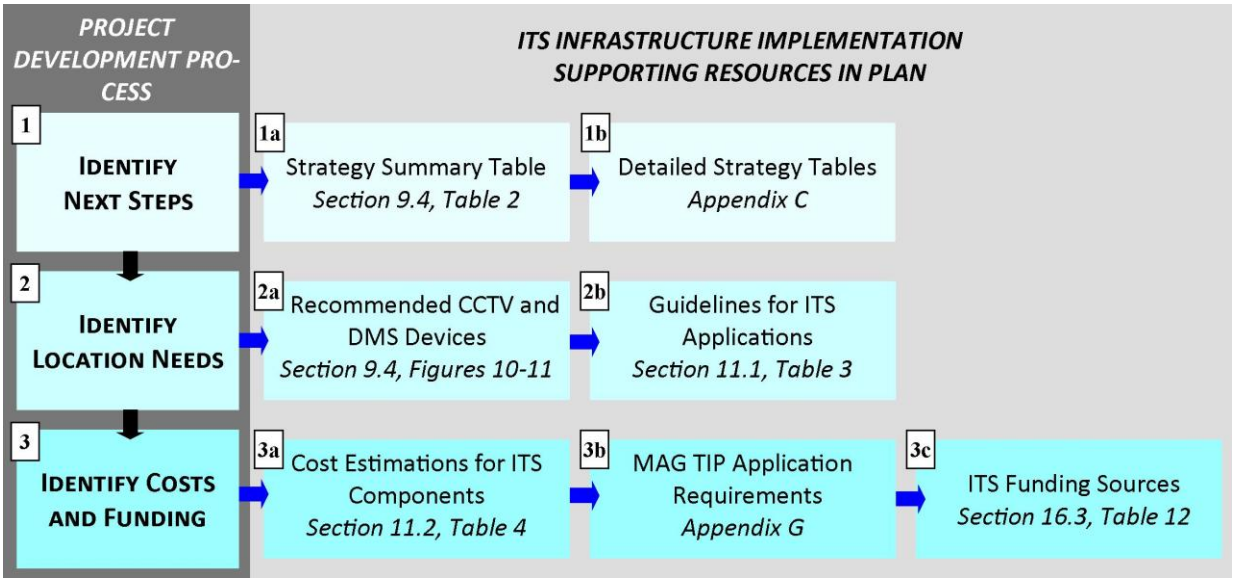
13. STRATEGY IMPLEMENTATION AND PHASING

This section is intended to provide the City of Tempe with a summary of resources, guidelines and recommended timeframes for phased implementation and expansion of devices and operational capabilities. The phasing and guidelines complement the strategy recommendations, and focus on the administrative, operational and funding requirements to support the deployment and integration recommendations. This section will serve as a reference for the City of Tempe as it continues to deploy and integrate desired ITS equipment and functionality.

The ITS strategy recommendations identify project and functional priorities for the City of Tempe in order to achieve the goals established as part of this strategic planning process. These recommendations are intended to serve as a guide for the next 10 years as the City of Tempe builds and integrates ITS devices. It is important to note that there are variables that could impact this deployment and integration, and as a result, the timeframes identified within the strategy development section have flexibility.

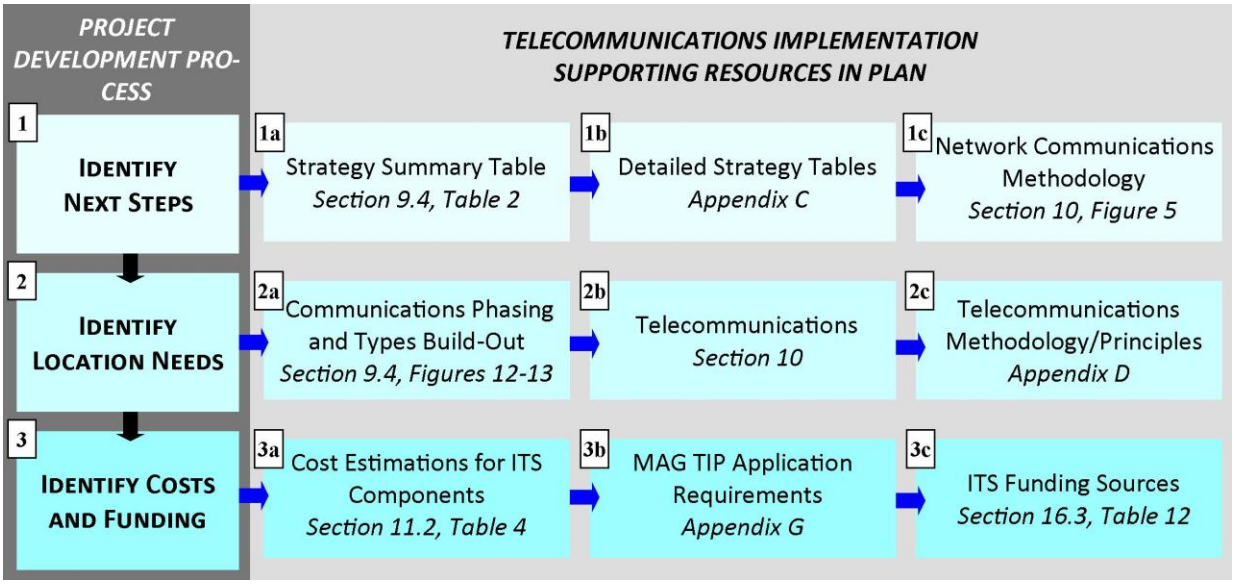
13.1 How to Use Plan for ITS Infrastructure Preparation for Implementation

As implementation of ITS infrastructure occurs, the following diagram identifies the supporting resources in this plan that can help with the procurement and preparation for implementation:



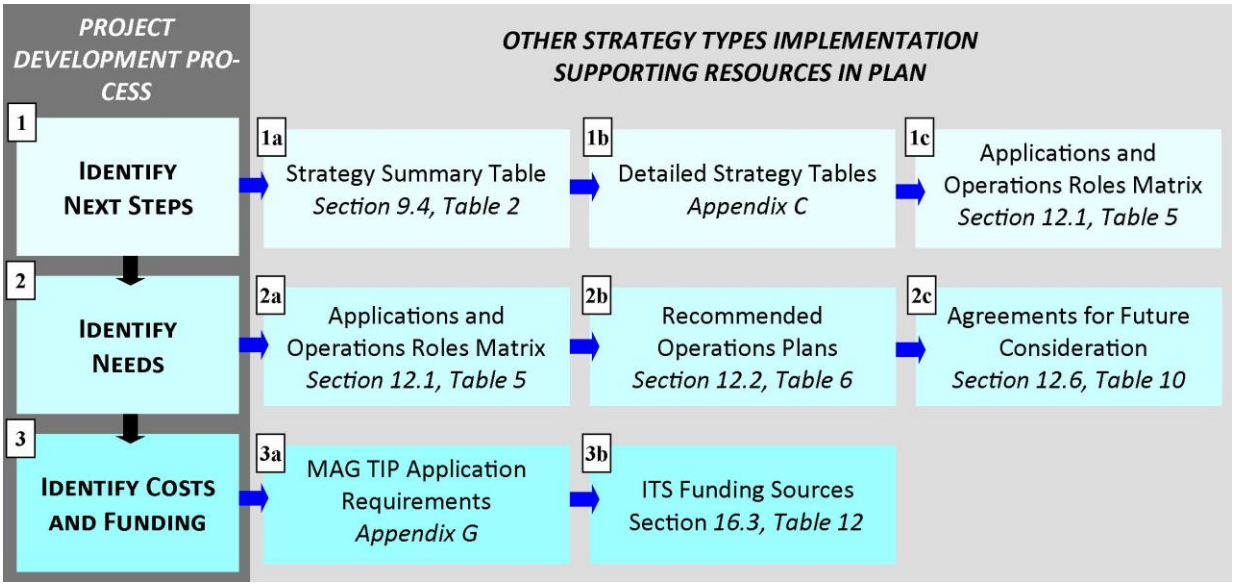
13.2 How to Use Plan for Telecommunications Preparation for Implementation

As implementation of telecommunications occurs, the following diagram identifies the supporting resources in this plan that can help with the procurement and preparation for implementation:



13.3 How to Use Plan for Other Strategy Types Preparation for Implementation

As implementation of other types of agreements, partnerships, or sharing strategies occur, the following diagram identifies the supporting resources in this plan that can help with the procurement and preparation for implementation:



13.4 ITS Program Dependencies

There are several considerations that could impact the deployment and integration recommendations:

- Available funding is perhaps the largest dependency and includes regional TIP funding through MAG, as well as local funding within the City of Tempe for staff, maintenance and operations. With federal funding uncertainty, MAG has currently deferred 2015 and future years programming; this could shift mid-term deployment and integration recommendations within the City.
- Available resources to operate and maintain the ITS program is a concern for many agencies in the region. The City of Tempe ITS group will need to consider availability of resources to support operations, and in particular maintenance, because maintenance resources will need to come from local funding. Similarly, IT resource needs should be forecasted to ensure adequate technical and network support for Tempe's ITS systems. Section 14 identifies the need to plan for maintenance requirements to be able to identify what level of ongoing maintenance support will be needed.

13.5 Coordination with Other Capital Projects and Programs

There will likely be corridor or intersection enhancement opportunities over time. This can provide an excellent opportunity to integrate ITS installations or upgrades along with the planned roadway or intersection enhancement. This kind of mainstreaming saves time, money, and minimizes impacts to motorists by accomplishing planned ITS enhancements while other reconstruction or improvement projects are underway.

The City of Tempe ITS personnel should be involved in reviewing upcoming corridor and intersection enhancements to identify opportunities for upgrading or replacing ITS equipment (including traffic signals, implementing detection or implementing communications) so that ITS program elements can be considered during the capital project design phase. Another focus is coordination with telecommunications company projects as well as establishing public/private agreements where they would be beneficial to support the ITS program.

This level of coordination is not limited strictly to roadway improvements. Coordination with the Water CIP projects can provide a good opportunity for ITS infrastructure installations or upgrades, in particular telecommunications. As major waterline replacement projects are planned and initiated, the City of Tempe ITS program manager should be involved in identifying if there are opportunities to integrate planned fiber installations along with these waterline replacements.

Tempe's ITS recommendations were established with a focus on how partnerships with neighboring agencies could create new and beneficial links to create a more transparent traffic management and incident response network. Future planned ITS infrastructure in Tempe should continue to coordinate with its neighbors' planned deployments to foster the greatest coverage and cooperation capabilities between the cities and the state. Tempe's neighboring jurisdictions coordinate with each other for fiber sharing, traffic signal coordination, participation in planning meetings, and in other ways as described in **Appendix F**.

As Tempe expands their ITS program, the following are items that can be incorporated within capital development projects to further the expansion in advance of separate ITS projects:

- Signalized Intersection – in addition to the standard signalized intersection equipment, the following is required:

- Detection;
- Ethernet switch and communications – wireless equipment or fiber equipment;
- CCTV;

- DMS; and
- Stand-Alone CCTV.

14. ITS DEVICE AND SYSTEM MAINTENANCE

Tempe's strategy for device maintenance is to utilize existing technicians within the City; they will be responsible for maintenance activities on traffic signals, detectors, CCTV, arterial DMS, communications, crossing technologies, and other field components of the ITS system.

This section provides general guidance for the City for ITS device maintenance considerations. Field devices (with the exception of traffic signals and some detection) will not likely require any major maintenance for several years; however, it will be important for Tempe to integrate sound preventive maintenance practices into its overall system operations and management program.

14.1 Equipment Lifecycle Considerations

Within the next five years, there are not anticipated to be significant maintenance requirements on newly deployed devices (namely CCTV and communications) outside of recommended preventive maintenance checks. DMS are not planned to be deployed for several years.

It is important for Tempe to consider equipment lifecycle when looking at the overall operations and management of the City's ITS program. **Table 11** below identifies typical device lifecycles for the equipment that Tempe plans to deploy. Tempe will not need to consider device replacement, other than traffic signal systems, for at least 5 years for detection, 10 years for switches, and likely 10 years for CCTV that are planned within the next few years.

Table 11 – Recommended Maintenance Requirements and Lifecycles for ITS Devices

Technology / Device	Recommended Maintenance Activities	Typical Lifecycle/Warranty
CCTV	Preventive maintenance check – twice yearly (pole level and cabinet). Emergency repair as needed.	10 years / 2 years
Loop Detection	Annual preventive maintenance check. Repair or replace as needed.	5 years / 1 year
Spot Detection	Annual preventive maintenance check. Repair or replace as needed.	5 years / 1 year
VID	Preventive maintenance check – twice yearly (pole level and cabinet). Emergency repair as needed.	10 years / 2 years
Traffic Signal	Annual preventive maintenance check. Cabinet equipment check twice per year. LED Lamp Replacement 5-6 years.	20 years / 2 years
Arterial DMS (permanent)	Preventive maintenance check – annually for sign; twice yearly for cabinet. Emergency repair as needed. Emergency repair is expected to be minimal with current sign technology and annual preventive checks.	7 – 10 years / 2 years
Portable DMS	Preventive maintenance check on all components – twice annually Emergency repair as needed,	7 – 10 years / 2 years
Wireless Radios	Annual preventative maintenance check. Repair, upgrade, or replace as needed. Communication check quarterly.	5 – 10 years / 1 year
Field Hardened Ethernet Switches	Preventative maintenance check – twice yearly. Troubleshooting quarterly.	10 years / 1 year

14.2 ITS Maintenance Strategies

The following are recommended strategies for the City of Tempe to integrate into its overall ITS maintenance program. They represent recommended practices, and emphasize preventive maintenance to keep devices operational and reliable.

- ***Log and track preventive maintenance activities.*** This will assist in identifying any significant issues or trends.
- ***Develop a budget and identify resource requirements for annual maintenance needs for ITS devices.*** Tempe will be utilizing existing signal technicians to support preventive maintenance and emergency repairs. Establishing an annual estimate of number of devices that will need preventive checks as well as approximate timeframes will help with communicating resource needs to technical staff.
- ***Integrate processes for multi-level checks to better identify the source of the malfunction***. A device malfunction might not always be the equipment at the intersection or location. The City should develop processes to perform tests to determine if it is a software issue, communications issue or device failure prior to placing a maintenance request.

The maintenance of ITS infrastructure is managed out of the Transportation Division Maintenance Group; therefore, a brief summary of the recommended maintenance technician staffing guidelines per the International Municipal Signals Association recommendations include:

- 30 traffic signals per one technician;

- 100 ITS devices (CCTV, DMS, VID, other) per a second technician; and
- 200 miles of fiber per a third technician.

The values above shown per technician can be used to calculate, based on ITS infrastructure implementation and maintenance needs, and how many technicians are needed for ITS-specific purposes.

It is recommended that a biannual review of inventory/maintenance resource needs is performed and coordinated with the Maintenance Group to support.

There are no major device lifecycle replacements anticipated for at least 10 years as new infrastructure is being implemented currently. There will be more emphasis on TMC network equipment upgrades within the 10 year timeframe.

15. TRAINING AND CAPACITY BUILDING

ITS training and capacity building for transportation professionals is one of the key elements to ensure the success of ITS and transportation system design and operations. This section includes recommended areas for training and capacity building and sources for training.

Based on the City of Tempe's ITS priorities identified in the Deployment and Integration Recommendations, the following are technical training considerations or needs for this ITS program:

- Cameras and video technologies – troubleshooting, maintenance and repair
- Telecommunications (wireless and fiber) – troubleshooting, testing, repair, installation
- Emerging technologies – Bluetooth, mobile applications and other data collection strategies
- Traffic Signal Timing (including Synchro)

In addition to device or technology specific training, there are other program elements that also will benefit from increased awareness and capacity building. The following are better suited for program managers:

- **Systems Engineering** – Systems Engineering is a required process to apply for ITS projects using federal funds, as well as for MAG TIP funding applications. See **Appendix G** for additional detail on Tempe's ITS program applicability to the MAG Regional ITS Architecture to support MAG TIP funding applications.
- **Performance Monitoring/Management –**The City of Tempe could benefit from training on how to use the data and metrics that will be generated from its ITS devices and systems to support corridor and citywide analyses of the effectiveness of its system operations.
- **New Approaches to Operations** – Strategies such as transit signal priority or adaptive traffic signal operations strategies represent new or different approaches to system operations that are not yet widely used in this region. Additional training on best practices would be beneficial as Tempe looks to potentially implement these operational strategies.

A decade ago, training was primarily offered in a classroom environment, which required a significant time commitment and potential travel. While classroom style training is still common, there are also other training vehicles that make necessary training and information sharing much more accessible.

- ***Webinars and web-based training opportunities*** are offered through ITE, FHWA, the Transportation Research Board and a host of others on timely topics such as new technologies, new operational approaches, system evaluations, among others.

- ***ITS Arizona, ITE Arizona, and IMSA Arizona Chapters*** are active in providing technical training opportunities for their members. Recent topics have included BlueTooth technologies, traffic signal controllers and telecommunications networking. Some of these sessions might have a fee associated with them.
- ***AZTech™ Operations Working Group*** offers periodic training on systems that are regionally relevant or used by several local agencies within the region. Camera Cameleon was a recent training opportunity in 2011.
- The ***National Transportation Operations Coalition (NTOC)*** offers periodic webinars on various topics of interest. These are offered at no charge. NTOC webinars are typically program level discussions suitable for Tempe TMC Manager/Supervisor, and they do not typically address detailed technical issues.
- The ***National Highway Institute (NHI)*** offers a range of courses, but these come at a fee of $350 - $400 per attendee, and may require travel. Also, NHI courses may be more applicable to freeway/highway operations than municipal arterial operations.

16. FUNDING THE ITS PROGRAM IN TEMPE

Funding needs for ongoing implementation, upgrades, operations and maintenance is a critical part of Tempe's overall ITS program. There are three categories of funding that will need to be factored in:

- Capital funds – design, implementation, integration, construction, equipment/infrastructure
- Operations funds – ongoing system operations, staffing, training
- Maintenance funds – routine maintenance, equipment upgrades and equipment replacement (emergency replacement as well as lifecycle replacement)

As the City of Tempe ITS infrastructure is deployed, the funding needs will shift from design and implementation to operations and maintenance. This represents a very different funding strategy in that operations and maintenance are not covered by federal funding (such as CMAQ). This is a challenge for many agencies, as maintenance budgets rarely increase to keep pace with deployment and level of infrastructure in the field. To help address this known and upcoming need, this plan needs to factor in the shift in funding needs over the next decade. This will help the City of Tempe:

- Identify what federal funding is needed and can be used to support the City's ITS program, including new infrastructure, equipment purchases, equipment and infrastructure upgrades and communications; and
- Identify what City funds and resources need to be in place to adequately support the operations, management and maintenance needs of the City's ITS program.

This section describes the City of Tempe ITS program funding needs, different funding sources and approaches for planning for ongoing funding of Tempe's ITS program elements.

16.1 Current ITS Program Funding

Tempe has approximately $3 million programmed through the MAG TIP through 2014 specifically for ITS-related projects. Another $19.1 million is programmed in the MAG TIP for Tempe projects that can be used for inclusion of ITS components (traffic signal upgrades, bike/ped improvements, etc.). For many of the near-term infrastructure and equipment-based strategies, currently programmed funds within the MAG TIP were an important consideration.

In fact, much of the ITS infrastructure, including communications, CCTV cameras and signal upgrades for Tempe in the near-term are funded through the MAG TIP with a local City match (per CMAQ and MAG funding requirements).

16.2 Projected ITS Program Capital Funding

The following outlines the estimated range of ITS Program funding requirements in a general order of magnitude within each timeframe identified in this plan.

- Near-Term
  - *Number of years in timeframe:* 2
  - *Major components within timeframe:* Additional CCTV, wireless network, and IT action list for smaller collaborative tasks
  - *Total funding requirement anticipated in timeframe:* $3 million (already programmed)
  - *Specific infrastructure included in timeframe (in addition to non-infrastructure enhancements):* 50 CCTV cameras, 2 miles of fiber, 20+ signals synchronized along one corridor, 26 wireless connections to traffic signals
- Mid-Term
  - *Number of years in timeframe:* 3
  - *Major components within timeframe:* Traffic signal coordination, DMS, additional CCTV, additional communications (wireless), communications (fiber), TMC personnel, tools for enhanced TMC functionality and asset/system management, real-time corridor data
  - *Total funding anticipated in timeframe:* $5-7 million
  - *Specific infrastructure included in timeframe (in addition to non-infrastructure enhancements):* 10 CCTV cameras, 6 DMS, 15 miles of fiber, 50+ signals synchronized along three corridors, 40 wireless connections to traffic signals, 10 miles of real-time corridor data, 3 bike/ped crossing treatments
- Long-Term
  - *Number of years in timeframe:* 5
  - *Major components within timeframe:* Traffic signal coordination, additional DMS, additional CCTV, additional communications (both fiber and wireless), ITS studies/analyses, enhance real-time corridor data
  - *Total funding anticipated in timeframe:* $6-8 million
  - *Specific infrastructure included in timeframe (in addition to non-infrastructure enhancements):* 10 CCTV cameras, 23 DMS, 8.5 miles of fiber, 75+ signals synchronized along five corridors, 55 wireless connections to traffic signals, 10 miles of real-time corridor data, 5 bike/ped crossing treatments

It is important to note the following assumptions that apply to the anticipated funding needed in each timeframe noted above:

- Near-term programmed funding is identified – although this funding is not guaranteed beyond the current fiscal cycle;
- Total values calculated using general costs for ITS components as identified in Table 4 applied to strategy details;
- Costs for each component may change over the course of the next ten years;

- There are local funding match requirements for federal projects that use TIP funding which may range from 0% to 30% depending on the federal amount requested for the project; and
- Action lists that are identified in **Appendix C** for Program Management or the Transportation Management Center may or may not be outsourced, which will impact total funding requirements for each timeframe.

16.3 Types of Funding Sources

There are a variety of funding sources and types to support ongoing implementation, deployment and operations and maintenance of Tempe's ITS program. It is assumed that funding will consist primarily of a combination of City funds and Federal funds to support the majority of the ITS strategy recommendations. The following **Table 12** provides some details, benefits and limitations of the different types of funding.

Table 12 – ITS Funding Sources

Funding Type	Description	Application Process
Congestion Mitigation Air Quality(CMAQ)	Federal funding, applied through MAG TIP programming process on an annual basis (most years) CMAQ is suited for capital/infrastructure projects (ITS field equipment, traffic signals, telecommunications to connect signals/equipment, traffic management centers) and activities that will show a demonstrable positive impact on reducing delay, improving progression and reducing environmental impacts. Not typically applicable for operations and maintenance, although equipment upgrades and replacements would be covered.	The regional ITS programming budget is typically between $6M and $7M per year, and this is spread across a variety of ITS projects in the region. With uncertainty of future federal funding, MAG has not yet programmed beyond 2014.
MAG Traffic Signal Optimization Program (TSOP)	MAG programs funding to help support traffic signal timing activities on arterials. Typically funded on an annual basis within the TIP, and usually in the range of $300-$400K per year. Agencies can respond to a call for TSOP projects through MAG, and projects are selected from the applications and assigned to a MAG On-Call Consultant. Historically, projects have averaged $25-$30K.	MAG encourages collaborative projects between agencies for cross-jurisdictional corridors. The strategy recommendations (**Appendix C**) identify key arterials within the City of Tempe that would serve as good candidates for TSOP funds.
City of Tempe Capital, Operating and Maintenance Funds	Local funding from the City of Tempe will be required to support operations and maintenance of the ITS program. Local funding would also cover staff resources, including those within the Tempe ITS and Traffic Engineering Section (maintenance).	The City of Tempe has established processes for how departments need to submit requests for annual CIP and other budgets.
Federal Grant Funding	Grant funding through USDOT/FHWA has been very competitive in recent years. With the continuing extensions of the SAFETEA-LU Federal Transportation Funding Bill, and with the shifting focus toward accelerating large-scale construction projects with stimulus funds, grant funding specifically for ITS has been somewhat limited. The Stimulus/American Recovery and Reinvestment Act (ARRA) focused on large infrastructure programs (such as highways, bridges, rail and transit), and maintenance/preservation activities. USDOT has issued two rounds of competitive TIGER discretionary grant cycles (Transportation Investment Generating Economic Recovery) to help support local agency projects. The FY11 budget recently passed by Congress (April 15, 2011) included $528M for another installment of the TIGER program. TIGER III has recently closed. The continuation of any ARRA or TIGER funding is not certain.	While a stand-alone ITS project may not be competitive among the hundreds of applications USDOT will receive, if the City of Tempe (alone or in partnership) is submitting an application, including ITS and operational enhancements within a larger grant application would be a key recommendation. There is a 20 percent local match requirement with the TIGER discretionary grant program, and historically, recipients have shown a much higher local match percentage. Consider inter-jurisdictional corridor telecom, infrastructure, or equipment upgrades that show benefit to all agencies involved.

Table 12 – ITS Funding Sources (continued)

Funding Type	Description	Application Process
MAG Safety Program Funds/Highway Safety Improvement Program	MAG administers the Highway Safety Improvement Program (HSIP) funds for each fiscal year totaling $1 million per year. MAG issues a call for HSIP project applications for "systematic" and "spot" road safety improvements. Member agencies coordinate with ADOT Local Government's Traffic Safety Section in carrying out all required steps for implementing HSIP projects. They include: completion of all required environmental/right-of-way/utility clearances and development of Intergovernmental Agreements with ADOT.	This is not traditionally a funding source for ITS projects, but Tempe could look to safety program for applications such as pedestrian crossing technologies, highway/rail (Light Rail) safety improvements, or intersection upgrades at high-crash locations.
Cost Sharing	ITS and operations provides a unique opportunity for public-private partnerships, as well as cost sharing with other capital projects. Tempe ITS has successfully partnered with Valley Metro, ADOT, and other City of Tempe departments. Examples include: - Combining conduit installation/construction as part of other roadway capital projects to minimize disruption to right-of-way. - Partnering with private telecommunications companies for shared use of conduit for telecommunications networks (already a practice in Tempe). - Integrating equipment upgrades into other intersection or corridor enhancements	This strategy emphasizes partnerships among City agencies and with the private sector; as a result, it will require some advanced planning, particularly to work through any potential policies, agreements or schedule coordination.

For some of the near-term strategies, currently programmed funds within the MAG TIP were an important consideration. For other strategies, Tempe can use the information in **Appendix G** to apply for MAG TIP funding in subsequent years for specific strategies. With the uncertainty of future federal funding, MAG currently has deferred future programming. The Federal funding process requires that each project is reviewed by ADOT which adds submittal and review time to each project. Timeframes shown for each strategy reflects when initiation should occur and may not reflect the actual time to design, construct or implement the strategy.

The fiscal years in which each project is recommended to be implemented were specifically not included in the strategy details because of the opportunity to allocate funding in advance of the planned year for the project. Due to the changing nature of funding, project prioritization was used rather than the specific years in which to implement the project.

17. ITS STRATEGIC PLAN UPDATING PROCESS

The Tempe ITS Strategic Plan is a dynamic plan that focuses on documenting current and future ITS infrastructure and plans throughout the city as well as relationships with other agencies. To be consistent with changing needs and evolving technologies, this plan requires periodic updating and review as the ITS program grows in Tempe. This maintenance plan documents the procedures for updating the components of the Tempe ITS Strategic Plan that will likely change over time.

It is anticipated that the Tempe Traffic Engineering Section (or more specifically the TMC Manager and supporting TMC personnel) will have primary maintenance responsibility for the ITS Strategic Plan.

17.1 Manual, Review, and Update Process

Semi-Annual Updates

It is recommended that this plan be updated as the ITS program and strategies are implemented on an ongoing basis. The following Sections, Tables, and Figures are recommended to be updated on at least a semi-annual basis (if not sooner) to keep the document up-to-date:

- Section 9.4, Table 2 – Strategy Summary Table
- Section 9.4, Figures 10-13 – Recommended CCTV Devices, Recommended DMS Devices, Communications Phasing, and Communication Types Build-Out
- Section 11.2, Table 4 – Cost Estimations for ITS Components (if costs significantly change with new fiscal years)
- Section 12.2, Table 6 – Recommended Operations Plans
- Section 12.6, Table 10 – Agreements for Future Consideration
- Appendix C – Detailed Strategy Tables

Full Plan Review

It is recommended that the Tempe ITS Strategic Plan be red-lined annually following completion of the MAG TIP project application process. This will ensure that the most recent additions to the ITS system are included. This will also ensure that new or adjusted projects outlined in the MAG TIP and City's CIP are included in the detailed strategy tables in **Appendix C** for consideration for immediate federal funding.

Full Plan Update

It is recommended that in the 3-5 year timeframe, this entire document be updated to reflect the changes that have occurred. The Sections that support the Tables and Figures listed above are of upmost importance to update as they will have the most changes.

17.2 Version Control

A version control system for the ITS Strategic Plan needs to be implemented to identify the "working" or "live" version of the document.

The version control system for the Tempe ITS Strategic Plan should include a date next to each set of updates manually written in the plan OR a brief summary sheet of updates that is inserted in the plan.

Tempe will maintain version control of all updates to the ITS Strategic Plan.

APPENDIX A – CITY OVERVIEW

A1. Geographic Overview

Tempe is located in the East Valley section of the Phoenix metropolitan area, as shown in **Figure A1**. The City is bordered by Phoenix to the west, Scottsdale to the north, Mesa to the east, and Chandler to the south. Tempe's downtown area is the location of the ASU main campus.

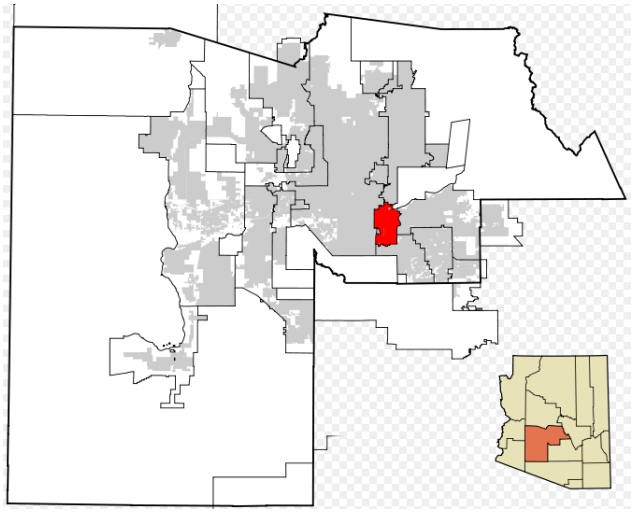


Figure A1 – Tempe Location within Maricopa

Between 2000 and 2010, the population has grown between 0.7% and 1.9% per year. As of 2006, the population was estimated at 170,000. Approximately 41% of the population in 2006 were of college age which describes the large student base and potential for fluxes in traffic conditions based on school session periods. Tempe is the most densely-populated city in the state. ASU enrolls more than 58,000 students each year at its Tempe campus. This means that the actual population of Tempe impacting the transportation network is more than the reported population of the City, particularly in the downtown area of Tempe around the ASU campus.

A2. Transportation

The City of Tempe is surrounded by the ADOT freeway system, as shown in **Figure A2**, that is instrumented with ITS infrastructure (CCTV cameras, DMS, fiber optic communications, and ramp meters). This freeway system is well-established and experiences congestion during the AM peak and PM peak periods, as well as periodic non-recurrent congestion such as incidents on the freeways blocking traffic. Depending on the level of congestion due to an incident, travelers may seek arterial alternate routes such as Southern Avenue, Broadway Road, or Baseline Road to bypass the congestion. The Phoenix metropolitan area's grid system offers travelers easy-to-access alternate opportunities for travel; however, this transition of congestion from the freeways to the arterials creates concerns from a local traffic management and incident management perspective. ADOT freeways, arterials, multi-modal options, and a major State University which are centered near the downtown area create many opportunities for incorporating technology.

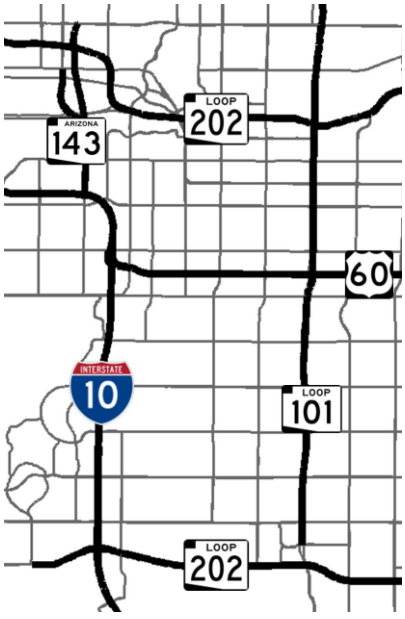


Figure A2 – ADOT Instrumented Freeways

Coordination between the freeway management of congestion and the arterial impacts of that freeway congestion was an important consideration for this plan. The congestion experienced on arterial routes due to unanticipated volumes causes challenges for transit services throughout the City as well. By

improving the coordination and collaboration between freeway traffic management and arterial management, the overall system performance would be improved.

The City of Tempe TMC currently manages the limited deployment of technologies in the City, and will be managing future infrastructure as it is deployed and integrated on key corridors. The Tempe TMC is shown in **Figure A3**. The TMC monitors the filtered Phoenix Fire CAD for incidents that impact roads in Tempe, monitors the ADOT congestion map, and views ADOT cameras on the freeways throughout Tempe. Currently, the City leases communications paths to most traffic signals and manages those signals through the use of TransSuite software from their TMC. There is an existing network of fiber cable and conduit owned and managed by various entities: City transportation, City IT, and numerous private agencies.

Figure A3 – Tempe Transportation Management Center

The City owns and maintains a fleet of maintenance vehicles. For incidents, Transportation Maintenance responds to any event that is utilizing their emergency vehicle/crash truck. For special events, the traffic operations team will set up and break down traffic control or the event sponsor hires a traffic barricading company.

The proximity to major arterials and the existing and planned infrastructure in neighboring jurisdictions are important factors in prioritizing ITS deployments for the City of Tempe. There are opportunities for coordinated operations with neighboring agencies along Rural/Scottsdale, McClintock/Hayden, and some of the major east-west corridors such as Baseline and Apache/Main.

Based on a records analysis performed by the Tempe Police Department for the last six months of 2010, these ten intersections have experienced the most number of accidents and are recommended to be priority focus areas for the recommendations in this ITS Strategic Plan:

- Rural Road and University Drive (60 collisions)
- Rural Road and Southern Avenue (54 collisions)
- 5000 S Arizona Mills Circle (47 collisions)

- McClintock Drive and University Drive (46 collisions)
- Mill Avenue and Southern Avenue (44 collisions)
- Baseline Road and I-10 Freeway (43 collisions)
- Apache Blvd and Rural Road (38 collisions)
- Broadway Road and McClintock Drive (37 collisions)
- Baseline Road and Rural Road (36 collisions)
- 48th Street and Southern Avenue (35 collisions)

Developing a plan for deploying and integrating ITS services should focus around the highest incident and traffic volume corridors throughout the City. **Figure A4** shows the blue highlighted corridors that experience more than 30,000 vehicles on an average weekday (based on MAG 2007 average weekday traffic counts map – 24 hour, two-way) within the City of Tempe boundaries. Also shown in the figure are the high incident locations identified by the Tempe PD for the last six months of 2010 (see red dots on figure). The overlaps of incident locations and high volume corridors will be key focus areas for ITS applications moving forward.

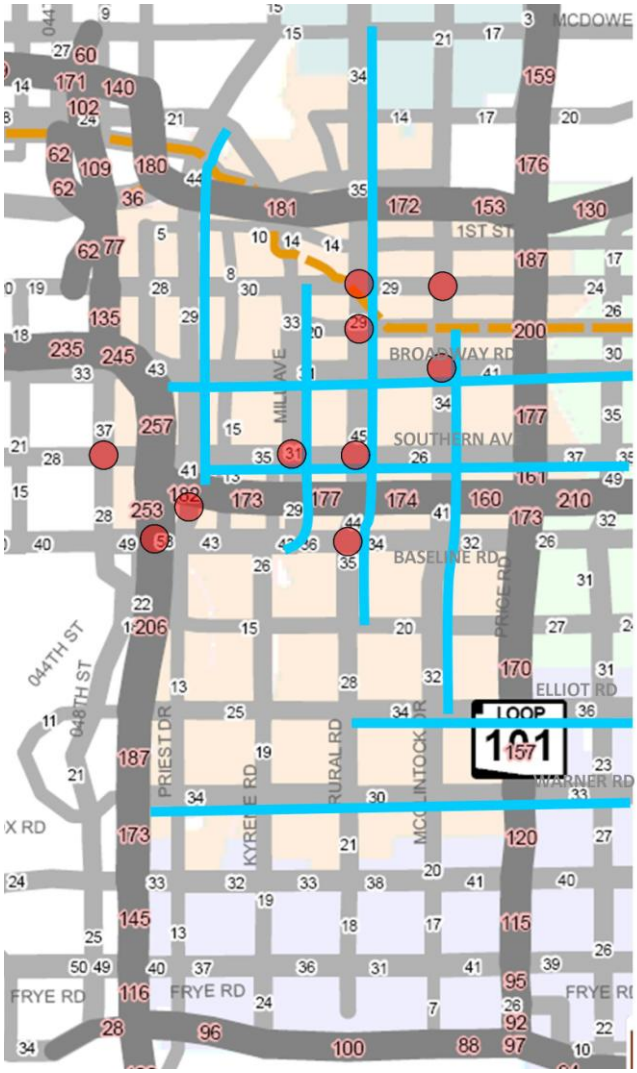


Figure A4 – High Incident and Traffic Volume Locations

A2.1 Bicycle/Pedestrian

The 2000 Census data shows that 4% of Tempe residents commute primarily by walking to work and 3.4% of all commute trips are by bicycle, the largest proportion of bicycle commuters among all the cities in the Phoenix metropolitan region. There are over 150 miles of established bicycle paths in the City. There are pedestrian and bicycle crossings throughout the City to accommodate roadway crossings.

The Streetscape and Transportation Enhancement (STEP) Manual was developed for the City of Tempe in order to outline a process that the City can use to prioritize projects and the steps necessary for initiation and implementation by residents and neighborhood groups. The STEP process involves both small and large scale traffic calming alternatives. A small scale traffic calming project is one that can be implemented within the budgetary authority of the Public Works Manager, while one that requires City Council action for budgeting would be considered a large scale project. Businesses sometimes have a specific role in requesting

locations for crosswalks and other bicycle/pedestrian facilities particularly if their location warrants an application. The City has been able to introduce bicycle and pedestrian enhancements through the use of federal grant funding. Enhancements are typically a result of specific community needs/issues. The Western Canal path and other key bicycle/pedestrian paths are planned facilities. The ASU area of the City is generally the focus of implementing bicycle and pedestrian technologies and applications.

The City installed HAWK (High-Intensity Activated Cross Walk) beacons at two locations along the Western Canal as part of the Western Canal Multi-Use Path Project: Rural Road and McClintock Drive. These locations are between major corridor signalized intersections and are focused on preserving canal bicycle path movements across major corridors. From a bicyclist or pedestrian standpoint, the crossings change to a "walk" indication after pressing the button, and are designed to force vehicles to slow down and stop whenever someone needs to cross the street. At other times, vehicles pass through freely when the beacon is dark. The City's HAWK signals are maintained by the City Transportation Division.

A2.2 Transit

Both the City of Tempe and Valley Metro provide fixed-route transit service within Tempe. Tempe's three transit transfer centers provide a high concentration of bus routes for passenger connections. Transit information is available to the public via the Valley Metro main website (www.valleymetro.org) and at all transit centers in the City. All Tempe transit vehicles are equipped with automated vehicle location devices. This information is collected and managed by Phoenix Public Transit. **Table A1** provides descriptions of each of the transit services operating in Tempe currently, as well as the future Modern Streetcar proposed for the downtown district.

Long-range plans for transit improvements in Tempe include increased peak-period service on all routes, extended hours on all routes, implementation of new routes, and bus pullouts where possible. Additional transfer facilities where needed and continued planning and implementation of light rail, commuter rail and bus rapid transit are also identified.

Table A1 – Transit Services Operating in Tempe

SERVICE	DESCRIPTION
Tempe in Motion	The City of Tempe operates routes that supplement regional bus service and provide bus access to Scottsdale, Phoenix, Chandler, Gilbert, and Mesa. Tempe also provides a bike-on-bus program with bike racks on buses, as well as lockers and racks located in areas served by transit. Transit bus drivers currently provide incident information to their dispatch centers and alert Police/Fire if no response is present yet at the incident location.
Valley Metro	Valley Metro provides regional fixed-route transit service along routes that link Tempe to activity centers throughout the region. Valley Metro coordinates a system of publicly and privately owned park and ride lots throughout the metropolitan area.
Polytechnic Shuttle	ASU provides campus shuttles between the main campus in Tempe and the east and west campuses in Mesa and Phoenix, as well as to Mesa Community College. Special event transit service is provided from designated park-and-ride lots in Tempe.
Neighborhood Circulators	The City of Tempe operates a free neighborhood circulator service called Orbit involving five free shuttle routes near ASU (called Earth, Jupiter, Mars, Mercury, and Venus) that operate on a regular basis seven days per week. Tempe also provides free high-frequency bus circulator service (FLASH Forward, FLASH Back, and FLAST McAllister), serving downtown Tempe, ASU, and neighborhoods east and west of these destinations. Tempe funds regionally-oriented Dial-a-Ride service for senior citizens and people with disabilities.
METRO Light Rail	The METRO Light Rail connects north Phoenix, downtown Phoenix, ASU's downtown Phoenix campus, Papago Park Center, Tempe Town Lake, downtown Tempe, ASU, Apache Boulevard, and the East Valley Institute of Technology. Nine light rail stations support the alignment of the transit service. The Phoenix Sky Harbor International Airport is accessible by a people-mover connection at the 44th Street/Washington Street METRO Light Rail station.
Tempe Modern Streetcar	The Tempe South High Capacity Transit Study has evaluated a range of transit technologies and potential north-south alignments for a Modern Streetcar. The locally preferred alternative is an alignment in a Mill/Ash Avenue one-way loop which is 2.6 miles and has the ability to increase transit ridership in the corridor, connect neighborhoods, encourage development and redevelopment and strengthen the Valley's urban core. The alternative will be submitted to the Federal Transit Administration in an application for federal grant dollars. This Modern Streetcar will link with the METRO Light Rail alignment at the Mill Avenue/3rd Street Station. See **Figure A5**.

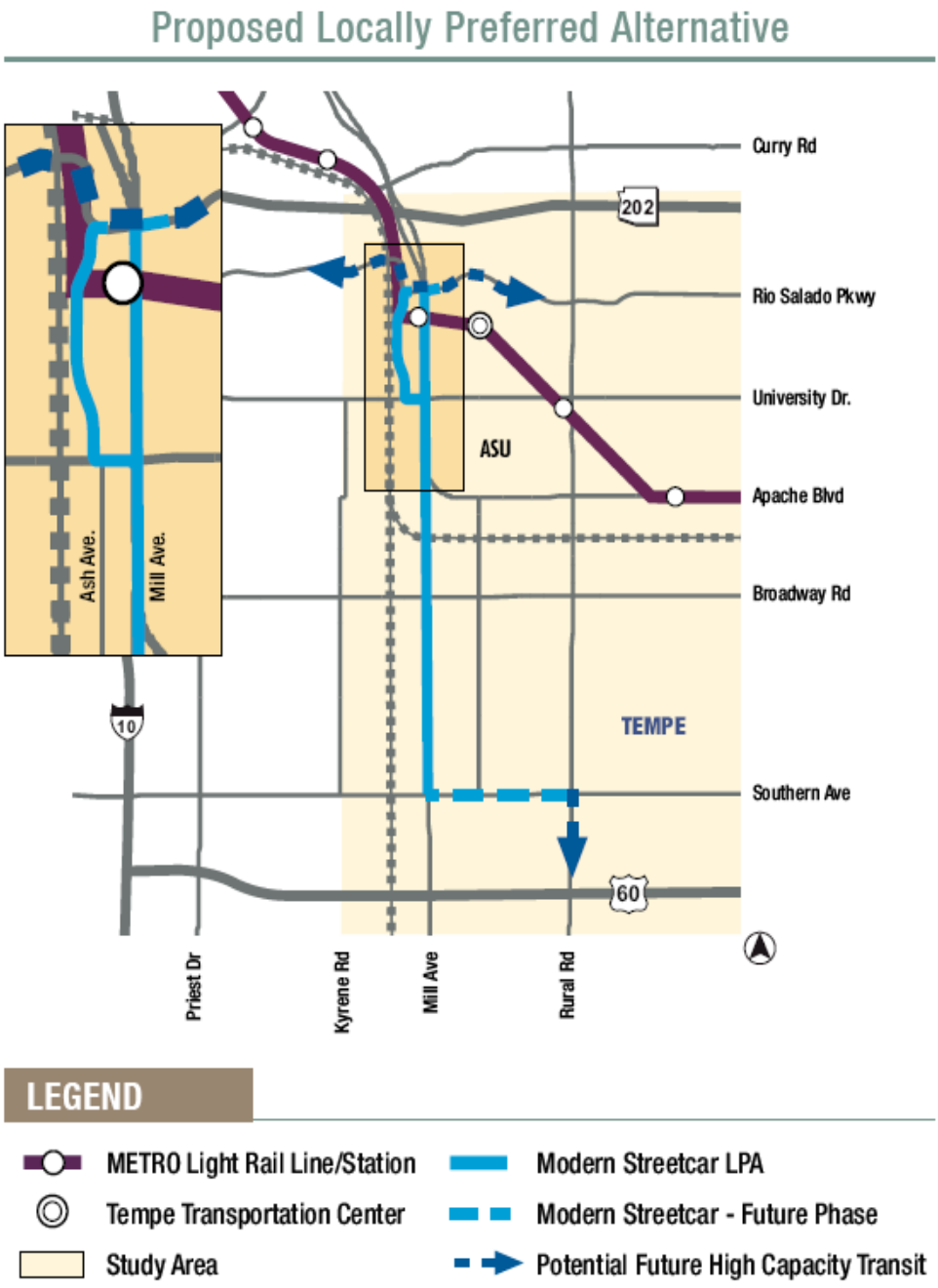


Figure A5 – Tempe Modern Streetcar Locally Preferred Alternative
Source: Tempe Streetcar Web Page on City of Tempe Website – Project Update

A3. Tempe Police Department

The Tempe PD has a headquarters building and three substation locations in north, central, and south Tempe. There are currently 154 officers, and 245 total Police staff.

The Tempe PD utilizes a CAD system that is accessible by all in-field officers and is updated by substation location dispatchers. The older Public Safety System Inc. (PSSI System) had been in use for over 17 years and was recently replaced in June 2011 with a new CAD system. The new

CAD system provides a mapping view of all vehicle locations and status so when an incident location is input into the system, dispatchers can immediately dispatch the closest vehicles to the scene. In-vehicle laptops, called mobile data terminals, were also updated with the CAD system which shows the same mapping display of the incident and their position relative to other vehicles and the incident location. The updated CAD system is the completion of Phase II of a three-phase effort; Phase III is planned to include each patrol becoming a wireless access point with Wi-Fi devices in each trunk to be able to access and share large quantities of data remotely.

Detailed information from a 911 call or non-emergency phone call is input into the CAD system and is sent to a police dispatcher who assigns the call to an officer. At least three dispatchers are assigned to work a police radio channel on each shift: one assigned to each half of the city (divided at Broadway) and the other on an information radio channel. Tempe PD utilizes police bike units, the mounted unit, and officers on foot during weekends and events.

During incidents, Tempe PD are able to access the traffic signal controllers to manually alter the signal timing or put the signal into flash mode to control traffic during the incident. Tempe PD typically have an on-scene Public Information Officer (PIO) to handle information dissemination to the media and other agencies. Tempe PD provides media with information during incidents and also lets neighboring agency Police Departments know about incident information.

Tempe PD is the Public Safety Answering Point (PSAP) for the City's 911 calls. For Fire dispatching needed, the call is forwarded to Phoenix Fire Dispatch to be able to dispatch Tempe FD vehicles. Tempe PD coordinates with neighboring agency Police departments during incidents.

A4. Tempe Fire Department

Tempe FD has six fire stations located throughout the City. There are an estimated 150 people on staff to support Fire operations. In 1997, the Tempe FD was the first agency in the world granted international accredited agency status by the Commission on Fire Accreditation International.

Currently, the average emergency response time is 5 minutes and 32 seconds (from dispatch to arrival) according to the Tempe FD city website. Fire vehicles are typically a first responder to all roadway crashes and incidents in Tempe. Nearly all signalized intersections are equipped with traffic signal preemption for fire vehicles, which allows Tempe FD personnel to travel through signalized intersections safely during travel to incident locations. There are Global Positioning System (GPS) units on-board all Fire vehicles that allows dispatching of the closest unit to an incident. Tempe FD utilizes an 800MHz system for radio communications between dispatchers and vehicles.

A5. Events

The City of Tempe is an event-hosting "hotspot" in the Phoenix metropolitan area with more than 150 special events throughout the City annually. There are a number of events that occur in the City of Tempe that typically require road closures and support from police officers and fire department personnel and others to be able to manage the events. Larger events, some of which include complete closures of major arterials and create parking challenges, include (general attendance levels are included where applicable):

- Spring Festival of the Arts – 225,000 attendees
- Fiesta Bowl Block Party (New Year's Eve) – 100,000 attendees
- Insight Bowl Game – 55,000 attendees

- American Cancer Society Heart Walk and Breast Cancer Walk
- Anaheim Angels Spring Training Games
- Oktoberfest – 125,000 attendees
- P.F. Chang's Rock 'n' Roll Marathon – 40,000 attendees
- Ironman Arizona Triathlon – 2,500 participants and 20,000 spectators
- Fourth of July Fireworks – 100,000+ attendees
- ASU Stadium football games and events/Wells Fargo Arena events

Events can require anywhere between 5 and 30 Tempe PD officers to support the safety at the event and to manage the traffic around the event. Tempe FD has provided emergency services to a growing number of community events in the City each year. Due to the high attendance and/or the nature of the events, it is often necessary to require or recommend support from PD/FD staffing to deliver the necessary emergency services to the event. By staffing special events, the PD/FD are meeting the needs of the City without adversely impacting normal emergency service delivery to Tempe citizens. Staffing is accomplished by placing types and numbers of teams into service at events using the most effective means to provide the service. This may be accomplished through the use of tents, bikes, medic carts, walking teams, special event truck, and/or Fire apparatus. Fire personnel are coordinated out of Fire Station 6 on Ash Avenue.

Tempe has a well-established Traffic Closures and Restrictions online map available on the City website (www.tempe.gov/StreetClosures). This online tool is updated regularly with events and planned closures and is utilized by local media to stay current on road/lane closures. This helps the media make informed decisions on suggesting potential alternate routing options away from incidents to the travelers that are watching/listening the media report.

The City of Tempe works with ADOT to provide floodgate messages on the 511 website and phone to alert the public of special events that are planned to host more than 30,000 people per day.

APPENDIX B – STAKEHOLDERS AND OUTREACH

B1. Meetings

In order to understand the needs, issues, and opportunities for ITS in the City, it was necessary to meet with a range of stakeholders through various methods. One primary Focus Group meeting was held to gather the stakeholder group together to discuss project topics, and one-on-one meetings were held with specific representatives from departments to collect more detail on current processes and activities.

Representatives from various departments participated in an initial Focus Group meeting to collaborate on the development of the ITS Strategic Plan. The purpose of the first meeting was to gather input on ITS services and technologies that are currently in use and those services and technologies that might be of use in their operations. Stakeholders were asked to discuss their departments' challenges, issues, needs, and objectives that ITS could address. The Focus Group meeting was held in March 2011, and interviews with stakeholders that were not present were completed in the weeks following.

Outcomes from the Focus Group meeting formed the basis for project implementation and phasing. Stakeholders included in the ITS Strategic Plan outreach were:

- Tempe Transportation Division (Transit, Transportation Maintenance, and Traffic Engineering);
- Tempe Fire Department;
- Tempe Police Department;
- Arizona State University – parking/police/architecture;
- Tempe Information Technology;
- Tempe Public Information/Communications;
- Tempe Transportation Commission;
- Tempe Community Development;
- Special Events Task Force;
- Federal Highway Administration;
- Arizona Department of Transportation;
- Maricopa Association of Governments; and
- Valley Metro.

B2. Coordination with Others

Other important plans/studies that Tempe has conducted or are ongoing were referenced as well which provided insights for potential ITS applications to improve the transportation network. These are listed in **Table B1**.

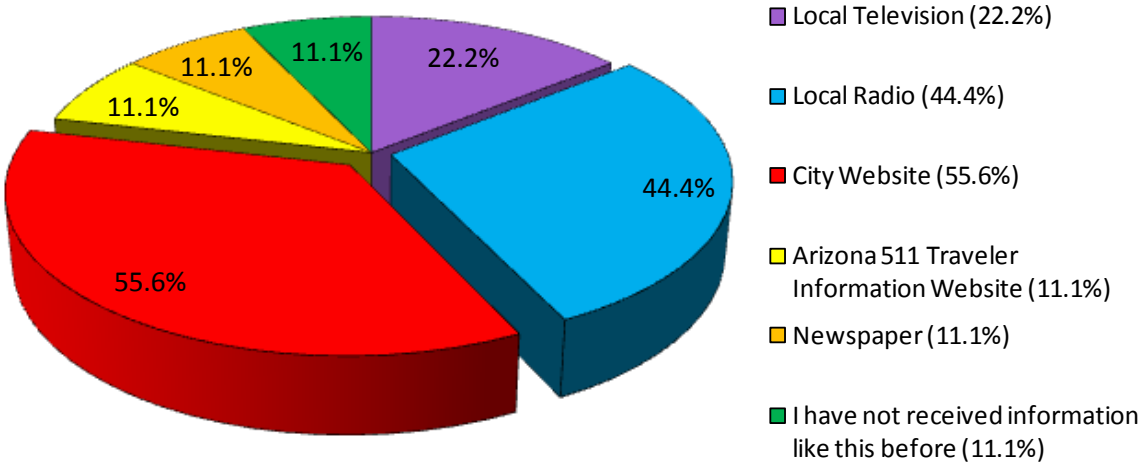
Table B1 – Additional Coordination Efforts

TITLE	DESCRIPTION
Tempe General Plan	The Tempe General Plan was adopted by the Tempe City Council in December 2003. The transportation chapter is designed to guide the further development of a citywide multi-modal transportation system integrated with the City's land use plans. The transit section of the transportation chapter has goals of increasing available transit modes and services and to facilitate connections among transportation modes. In the Tempe General Plan 2030 (with sources from the City Comprehensive Transportation Plan), it states that a guiding principle of the City is to accommodate additional demand through new technology, such as ITS and Travel Demand Management (TDM) strategies. It also states that a strategy for transit in Tempe will to be to integrate ITS technologies into transit system plans and services and to continually investigate new and emerging transportation technologies for use in the design and operation of streets and transit. The overall objectives in the Tempe General Plan 2030 that ITS can look to address are: - Discourage the use of single occupant vehicles; - Encourage the use of alternate modes of transportation; - Provide incentives to increase the number of transit trips; - Promote and provide incentives to potential attendees of special events to use alternate modes of transportation (transit, bike and/or walk); and - Establish a strong visual identity and aesthetic image for Tempe, its gateway entrances, and its neighborhoods.
Downtown Tempe Community	The DTC is a private, non-profit organization established in 1993 that works in partnership with the City of Tempe to increase the value of the Mill Avenue District through enhanced management and promotional services on behalf of DTC members (local business and property owners) and other downtown stakeholders.
Scottsdale/Tempe North/South Transit Corridor Study (2003)	This was a Transit Major Investment study that recommended Scottsdale Road as the preferred high capacity transit corridor. There are numerous north/south routes within the City of Scottsdale which connect to and are operated by the City of Tempe. The Scottsdale City Council approved Scottsdale Road as the corridor and recommended that bus rapid transit, light rail transit, and modern streetcar be evaluated in future studies. Given the anticipated travel demand on the Loop 101 Freeway and limited opportunities to expand the existing roadway system, transit options represented the most feasible method to serve the traveling public and increase person capacity in these corridors.
Tempe South Corridor Study	METRO, in cooperation with the Federal Transit Administration (FTA), is nearing completion of a 24-month study to analyze potential high capacity transit improvements in the cities of Tempe and Chandler. The project will provide a connection to the current 20-mile METRO Light Rail. Transit ridership in Tempe has quadrupled in the past decade while the population has only moderately increased showing an increasing demand for public transit. The Tempe South Corridor study will focus on public transit alternatives to help alleviate congestion on Tempe and Chandler streets.
Regional Community Network (RCN)	This is a bidirectional fiber optic video sharing link between the ADOT TOC and the City of Tempe TMC. This link allows concurrent viewing of up to two of Tempe's CCTV images and camera control from the ADOT TOC and the MCDOT TMC via a 100Mbps connection.

B3. Online Survey

An online survey was developed in advance of the Focus Group meeting and was distributed to invited Tempe personnel in order to gain insight into Tempe's personnel needs, issues, and priority focus areas. The following is a summary of the ten responses received based on questions asked, the summary of results from each question, and how those results were used moving forward in the ITS Strategic Plan development. For each question below, a summary of the total respondent selections and inputs to the survey are provided. Questions that offered specific selections for the responses are shown first and followed by results that asked for individualized responses.

QUESTION: How do you get information about road closures/events in Tempe?

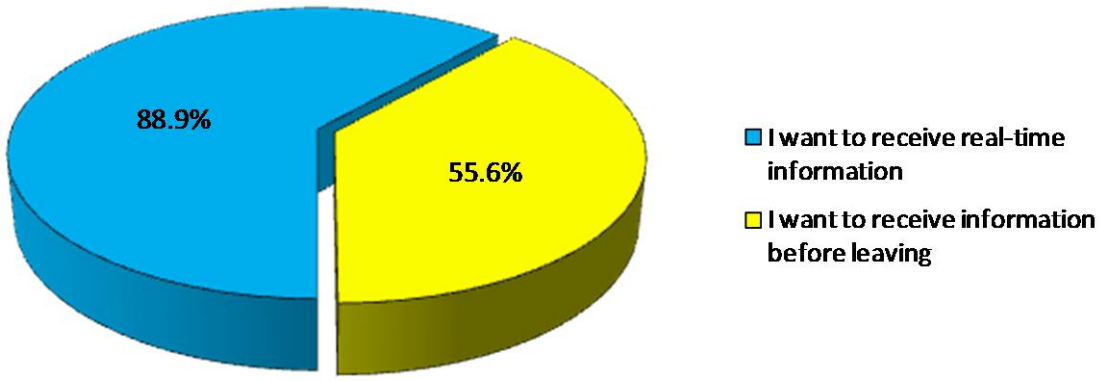


Respondents indicated that they receive this type of information from more than one location. The graph above indicates the total percentage of respondents that accessed each specific tool.

A majority of road closure/event information is provided via the City's website and local radio. Media overall provided a majority of the respondents with road closure/event information, which highlights the need to cooperate with the media outlets (radio, television, public information officers) to make sure the messages are not only consistent to travelers, but that information is accessible to travelers. The City website is where more than half of the respondents go to for road closures/events. That City website may be key in getting information out to the public more effectively to support more real-time and closure/restriction/event information.

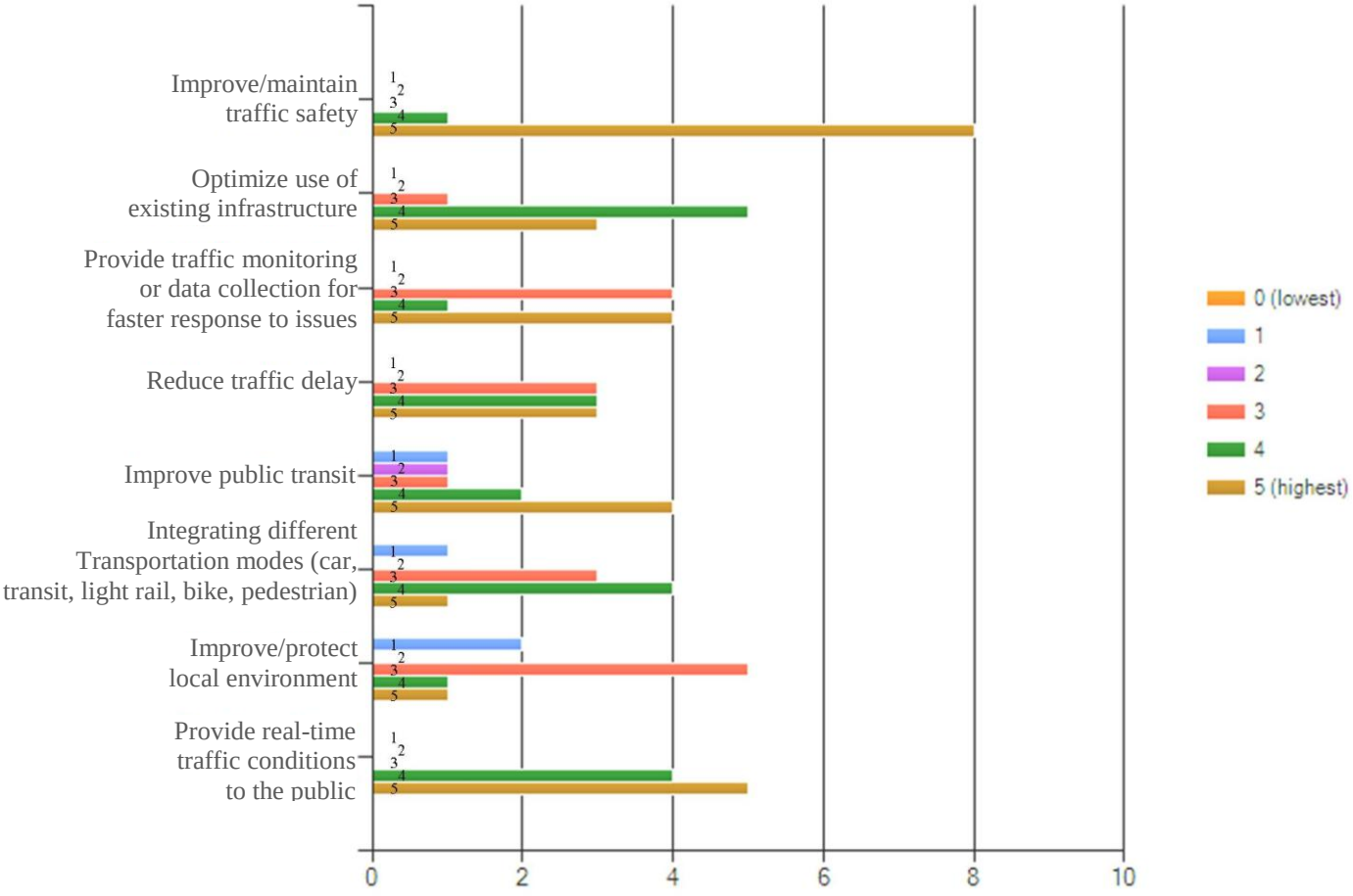
Options on the survey that were not selected as being used to get this type of information were the Arizona 511 phone number and traffic applications on mobile devices – this is most likely due to the limited arterial information for both of those options.

QUESTION: How would you like to be able to get information about traffic and road conditions?



Respondents generally desired receiving information in both real-time and before leaving for their trip. A priority emerged of receiving information real-time with 88.9% of respondents selecting this option and only 55.6% of respondents selecting that they would like to receive information before leaving. It will be important to leverage the City website and media for receiving information prior to the traveler leaving their computer or television – however, this graph indicates that an emphasis needs to be placed in Tempe for providing real-time information in a number of different methods that are available to the public (mobile application, transit center broadcasts, message signs, other options).

QUESTION: How would you rank each of the following in terms of what should be the focus for this planning effort?

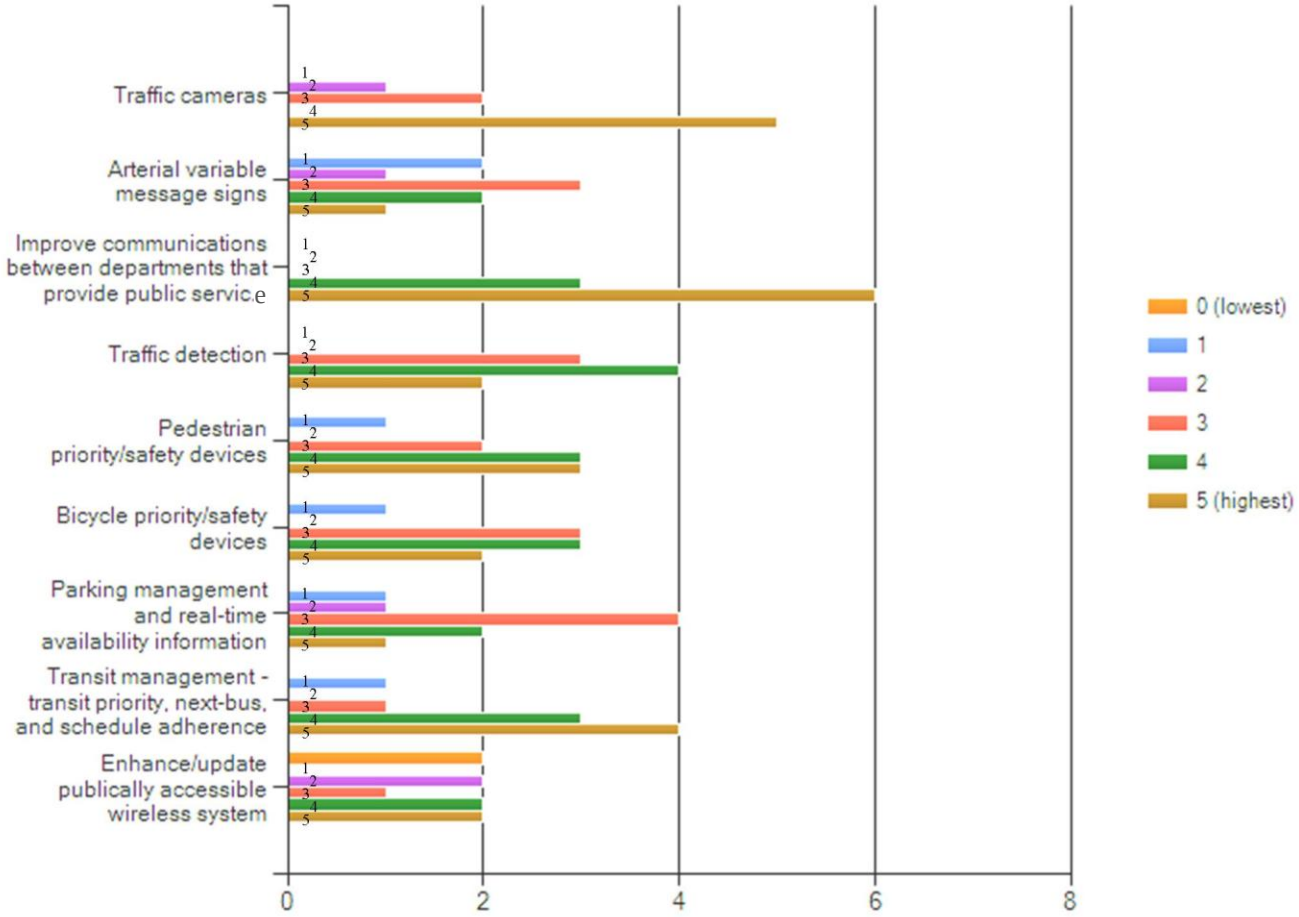


The top five highest priority focus areas in order include (with average ranking):

1. Improve/maintain traffic safety (4.89)
2. Provide real-time traffic conditions to the public (4.56)
3. Optimize use of existing infrastructure (4.22)
4. Integrating different transportation modes (4.00)
5. Reduce traffic delay (4.00)

These primary focus areas will be brought forward in developing recommendations and implementation phasing.

QUESTION: Rank the following technologies in order of priority to be implemented in the City.

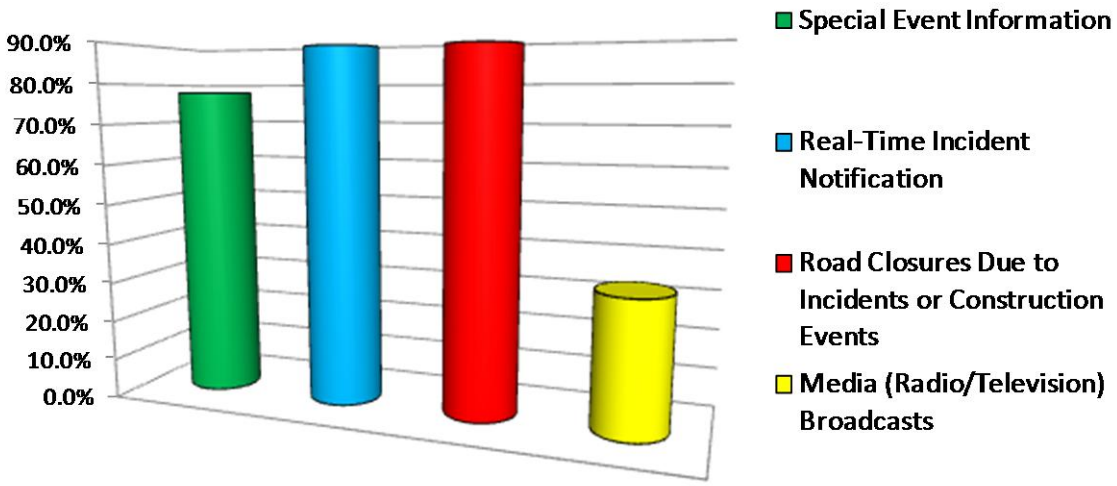


The top five highest priority technologies that respondents view as valuable to a Tempe ITS Program are listed in order below (with average ranking). These high priority technologies that respondents are interested in pursuing as part of the Tempe ITS Program will be brought forward in developing recommendations and implementation phasing.

1. Improve communications between departments that provide public service for the City (4.67)
2. Transit management – transit priority, next-bus, and schedule adherence (4.00)
3. Traffic detection (3.89)
4. Pedestrian priority/safety devices (3.78)
5. Traffic cameras (3.67)

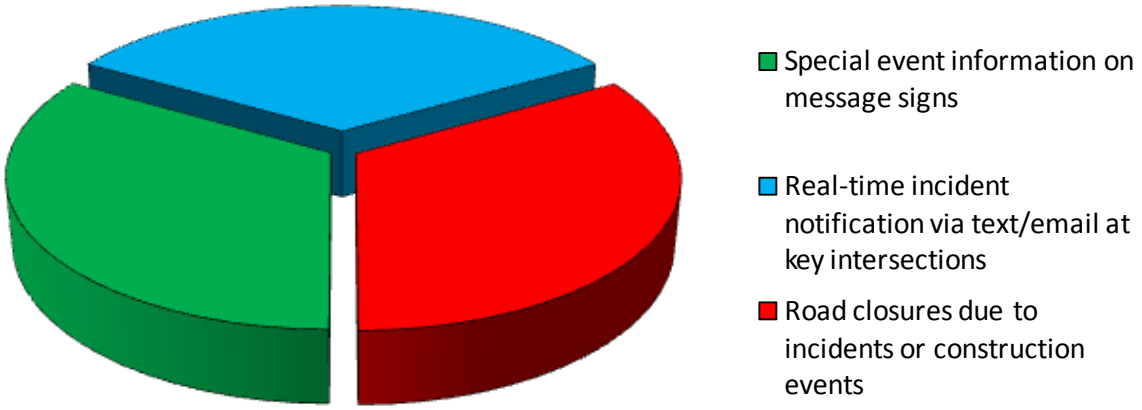
In previous survey questions, 88.9% of respondents indicated a preference to receive real-time information and the second highest priority focus areas is for the City to provide that real-time information. This is somewhat contradictory to the rankings shown as part of this question which did not prioritize some key real-time tools and opportunities such as message signs, parking real-time information, and enhancing/updating the publically accessible wireless system. This comparison serves to focus the application of technologies to the needs of the City.

QUESTION: What type of traveler information would be beneficial to distribute to internal agency personnel via email?



Road closure and real-time incident notification information were the highest priority type of traveler information that could help support agency response. Incidents require real-time information to be able to respond the most efficiently from all departments within the City. Special event information is important for the impacts that the special event will have on the roadways, on enforcement capabilities, and on potential resource needs (public safety, maintenance, traffic monitoring/management).

QUESTION: What types of traveler information would be beneficial to support your drive/walk/bike in the City as a public traveler?



All of these types of information were recommended for distribution to the public across the various transportation modes avaiable in the City.

APPENDIX C – DETAILED STRATEGY TABLES

STRATEGY TABLE GUIDANCE:

- Strategy tables provide timeframes (without years) of individual actions along with action descriptions and roles and responsibilities that apply to each action.
- All near-, mid-, and long-term timeframe actions are provided within one table to be able to view the larger picture of the ITS program.
- Individual actions are provided "check boxes" to offer the opportunity to "check off" completed items as a living reference of the build-out of the ITS program.
- Individual recommended roles and responsibilities are provided as guidance to defining an action to be completed, involving key departments/personnel in the development of that action.
- Listings for locations of ITS devices provides full build-out recommendations to allow Tempe to "check off" or "date" what has been completed. Near-, mid-, and long-term actions may all have the same list which allows Tempe to update the lists as needed when moving from year-to-year. This allows the opportunity to fast-track one location of a device over another for example because of a different project offering to incorporate that device location into its project.
- At the bottom of each strategy table is supplemental information to support the link back to the goals and needs of the ITS Strategic Plan as well as MAG TIP application support which generally applies to most of the actions listed in each strategy table.

Strategy: CCTV DEPLOYMENT

Recommendations	Description	Considerations
	NEAR-TERM	
☐ **TMP10-803 Video Traffic Detection and 8 CCTV (CIP Local) (CCTV Deployment – Phase I)**	☐ TMP10-803 project to purchase and install Video Traffic Detection ($425,000 in 2011-2012 will be connected on the new wireless radio system then connected to existing fiber backbone)	☐ Coordinate for access to facilities during design and construction
☐ **TMP11-703 CCTV Monitoring at 22 Intersections (TIP CMAQ) (CCTV Deployment – Phase II)**	☐ TMP11-703 project to install wireless communications and CCTV monitoring at 22 intersections ($312,000 in 2011-2012 will be connected on the new wireless radio system then connected to existing fiber backbone)	☐ Coordinate for access to facilities during design and construction
☐ **TMP12-806 CCTV Monitoring at Light Rail Stations (TIP CMAQ) (CCTV Deployment – Phase III)**	☐ TMP12-806 (project # 6004360) project to install CCTV monitoring stations at 25 Light Rail signalized intersections ($425,099 in 2011-2012 and will connect to Light Rail fiber)	☐ Coordinate with METRO Light Rail for access to facilities during design and construction
	MID-TERM	
☐ **CCTV Deployment – Phase IV**	☐ Prepare bid package for the installation of CCTV locations as defined in **Figure 10** (approximate budget $200,000) and communications if possible (as defined in communications project "Citywide Communications – Phase IV") – focus on recommended locations near downtown area first and additional locations once those have been implemented	☐ ITS to identify CCTV locations that can be completed via TIP application or local funding ☐ For Mill Avenue recommended CCTV – identify locations that will be least impacted by Modern Streetcar improvements in the future ☐ Coordinate for access to facilities during design and construction
☐ **Complete After-Hours CCTV Usage Agreement**	☐ Develop memorandum of understanding (MOU) agreement between ITS and Tempe Police for special event and after-hours monitoring control and support, data sharing, access to Traffic infrastructure and systems by Police	☐ Traffic to partner with Police to coordinate what level of control and support is needed ☐ Traffic to establish MOU agreement and have all parties sign
☐ **Establish After-Hours CCTV Communication Link**	☐ Establish direct connection between ITS and Tempe Police for special event and after-hours control of CCTV – utilize IT infrastructure and systems management to coordinate this connection for control.	☐ Traffic to partner with Police to identify system connection for CCTV control ☐ IT to configure communications link
	LONG-TERM	
☐ **CCTV Deployment – Phase V**	☐ Prepare bid package for the installation of CCTV locations as defined in **Figure 10** (approximate budget $200,000) and communications if possible (as defined in communications project "Citywide Communications – Phase V") – focus on recommended locations in North Tempe first and additional locations once those have been implemented	☐ ITS to identify CCTV locations that can be completed via TIP application or local funding ☐ Coordinate for access to facilities during design and construction

SUPPORTING INFORMATION	
Related ITS Goal/s	• Integration • Image • Creativity • Sustainability
Needs Addressed	• Introduce new technologies to the City's infrastructure that will meet the needs of departments and partners and serve multiple purposes within City services. • Use tools to monitor ingress/egress of traffic for future improvements in event plans. • Collect information about traffic and road conditions in real-time and provide pre-trip real-time conditions to travelers. • Coordinate Tempe PD and TMC resources to be able to actively manage events using infrastructure once deployed. • Integrate real-time information about incidents, events or congestion in Tempe into traveler information website (City or AZ511).
MAG TIP APPLICATION SUPPORT	
Recommendations Relationship to MAG RIA Market Packages	• ***CCTV Management***: ATMS01 – Network Surveillance • ***CCTV Sharing***: ATMS06 – Traffic Information Dissemination
User Services	• 1.6 Traffic Control • 1.7 Incident Management
Subsystems	• Roadway • Traffic Management • Emergency Management

Strategy: DMS

Recommendations	Description	Considerations
	MID-TERM	
☐ **Special Event DMS – Phase I**	☐ Recommend combining 6-8 locations into one TIP project application for permanent arterial DMS (and incorporate mid-block detection location as outlined in **Figure 11** if funding allows). The following are recommended Special Event DMS locations to implement in this timeframe: • SB Mill North of Rio Salado • SB Rural North of Rio Salado • SB McClintock North of Rio Salado • SB Priest North of Rio Salado • EB University East of SR-143 • WB University West of Loop 101 • NB Rural South of Broadway • NB McClintock South of Broadway • WB Broadway West of Loop 101 • EB Broadway East of Priest/56th	☐ ITS to identify DMS that can be completed via TIP application or local funding ☐ ITS to identify priority locations for DMS implementation – in this initial phase, focus on locations surrounding special event venues and typical ingress/egress routes to those special events ☐ ITS to determine if Mid-Term Communications project budgets will allow addition of DMS based on locations of DMS recommended in **Figure 11** ☐ Coordinate for access to facilities during design and construction
	LONG-TERM	
☐ **Freeway Approach DMS – Phase II** ☐ **Corridor Focused DMS – Phase III**	☐ Recommend combining 6-8 locations into one TIP project application for permanent arterial DMS (and incorporate mid-block detection location as outlined in **Figure 11** if funding allows) – reference full recommended DMS list in near-term timeframe. The following are recommended Freeway Approach DMS locations to implement in this timeframe: • SB Rural North of McKellips • NB Mill South of Rio Salado • NB Rural South of Rio Salado • NB McClintock South of Rio Salado • EB University East of McClintock • EB Broadway West of McClintock • WB Broadway West of Priest/56th • SB Rural North of Southern • SB McClintock North of Southern • NB Rural South of Baseline • NB McClintock South of Baseline • WB Warner West of Rural • EB Warner East of Rural The following are recommended Corridor Focused DMS location to implement in this timeframe: • WB Southern West of Rural • EB Southern West of McClintock • WB Baseline West of Rural • EB Baseline West of McClintock • WB Elliot West of Loop 101 • EB Elliot West of Kyrene	☐ ITS to first define dates of previously implemented DMS ☐ ITS to identify additional DMS that can be completed via TIP application or local funding. In the second phase, focus on locations for freeway approaches. In the third phase, focus on locations that complete corridor routes through the City. ☐ ITS to identify priority locations for DMS implementation ☐ ITS to determine if Long -Term Communications project budgets will allow addition of DMS based on locations of DMS recommended in **Figure 11** ☐ Coordinate for access to facilities during design and construction

SUPPORTING INFORMATION	
Related ITS Goals	• Integration • Image • Creativity • Sustainability
Needs Addressed	• Implement tools, such as arterial dynamic message signs, to provide real-time, en-route information to travelers. • Provide real-time information to the public about incidents/events – most information provided to public currently is planned events/closures. • Coordinate Tempe PD and TMC resources to be able to actively manage events using infrastructure once deployed. • Use tools to monitor ingress/egress of traffic for future improvements in event plans. • Improve navigation for travelers not attending events during special events.
MAG TIP APPLICATION SUPPORT	
Recommendations Relationship to MAG RIA Market Packages	• ***DMS Management***: ATMS06 – Traffic Information Dissemination
User Services	• 1.2 En-Route Driver Information • 1.6 Traffic Control • 1.7 Incident Management
Subsystems	• Roadway • Traffic Management

Strategy: TRAFFIC SIGNALS

Recommendations	Description	Considerations
	NEAR-TERM	
☐ **Corridor Traffic Signal Timing – Phase I**	☐ Signal synchronization projects to be completed with TSOP funding (if TSOP funds are not available, then use local funds). Priority for next selections are: 1. Corridors that have not yet been completed 2. Earliest completion date Corridors in order of priority are recommended in this near-term timeframe as follows: o Broadway Road o McClintock Drive (coordinate with City of Scottsdale and City of Chandler for collaborative TSOP project along McClintock Dr/Hayden Rd across multiple jurisdictions) o Southern Avenue (coordinate with City of Mesa and City of Phoenix for collaborative TSOP project along Southern Ave across multiple jurisdictions) o Priest Drive	☐ ITS to identify corridors that can be completed through TSOP application or within City funding limits ☐ ITS to initiate TSOP application for traffic signal synchronization corridor/s or funding identification if using City funds ☐ Coordinate for access to facilities during design and integration ☐ Coordinate with neighboring jurisdictions for TSOP applications when possible
☐ **Develop Special Event Timing Plans**	☐ Develop "special event timing plans" for Rural, University, Broadway, and Mill for specific events that meet the following criteria in order of priority: 1. Large attendance – over 75,000 attendees 2. Entire road closure requirements 3. Lane closure requirements 4. Multiple event days Events that only fit into the multiple event days category or are centrally located at the Tempe Beach Park may not be suitable for special event timing plans, although may be considered as determined by ITS.	☐ ITS to identify appropriate special events that would benefit from special event timing plans ☐ ITS initiate and develop special event timing plans ☐ Coordinate with Police to provide brief training on special event timing plans as notification of how traffic signals will plan to function during event
☐ **New/Upgrade Modular Traffic Signals (CIP Local) – Phase I**	Existing projects to install new or upgrade modular traffic signals – incorporate wireless radio installation and configuration with new or upgraded signals. →Consider including the purchase of CCTV integration components for the signal controller (video switch and decoder) to be procured when a future CCTV is installed at the intersection (where applicable identified in **Figure 11** or to be held for installation at different location in future). ☐ TMP12-117 ☐ TMP13-128	☐ Traffic to incorporate updated language into projects ☐ Traffic to lead and manage project ☐ Coordinate to store equipment for future installations that can be acquired by the project

MID-TERM		
☐ **Corridor Traffic Signal Timing – Phase II**	☐ Signal synchronization projects to be completed with TSOP funding (if TSOP funds are not available, then use local funds). Corridors in order of priority are recommended in this near-term timeframe as shown in **Figure 3** are as follows: o Warner Road (coordinate with City of Chandler for collaborative TSOP project along Warner Rd across multiple jurisdictions) o Elliot Road o Guadalupe Road o Baseline Road (coordinate with City of Mesa and City of Phoenix for collaborative TSOP project along Baseline Rd across multiple jurisdictions) o Rio Salado Parkway (coordinate with City of Mesa for collaborative TSOP project along Rio Salado Pkwy/8th Street across multiple jurisdictions)	☐ ITS to identify corridors that can be completed through TSOP application or within City funding limits ☐ ITS to initiate TSOP application for traffic signal synchronization corridor/s or funding identification if using City funds ☐ Coordinate for access to facilities during design and integration ☐ Coordinate with neighboring jurisdictions for TSOP applications when possible
☐ **New/Upgrade Modular Traffic Signals (CIP Local) – Phase II**	Existing projects to install new or upgrade modular traffic signals – incorporate wireless radio installation and configuration with new or upgraded. →Consider including the purchase of CCTV integration components for the signal controller (video switch and decoder) to be procured when a future CCTV is installed at the intersection (where applicable identified in **Figure 10** or to be held for installation at different location in future). ☐ TMP14-137 ☐ TMP15-145	☐ Traffic to incorporate updated language into projects ☐ Traffic to lead and manage project ☐ Coordination to store equipment for future installations that can be acquired by the project
☐ **Adaptive Corridors Testing and Implementation – Phase I**	☐ Adaptive testing in Tempe on Mill Avenue between Southern Avenue and Rio Salado Parkway. Incorporate this adaptive corridor into the Tempe Streetcar project design and construction. ☐ Once adaptive is successfully implemented along Mill Avenue showing an improvement in traffic throughput and reduced traffic stopping time, implement an adaptive strategy on the following corridors as recommended below: o Ash Avenue from Rio Salado to University Drive o Rio Salado Parkway from Loop 101 to McClintock Drive	☐ ITS to partner with the Tempe Streetcar project to incorporate an adaptive strategy at all traffic signals along Mill Avenue and the Streetcar alignment ☐ Solicit proposals for adaptive deployment on specified corridors for each adaptive strategy that is feasible to deploy within Tempe based on existing detection and configuration/capabilities of the traffic signal system ☐ ITS to identify detector capabilities within additional specified corridors ☐ Leverage existing traffic signal controller upgrades or capital improvement projects in area to upgrade detection if needed

LONG-TERM		
☐ **Corridor Traffic Signal Timing – Phase III**	☐ Signal synchronization projects to be completed with TSOP funding (if TSOP funds are not available, then use local funds). Corridors in order of priority are recommended in this near-term timeframe are as follows: o University Drive o Rural Road (coordinate with City of Scottsdale and City of Chandler for collaborative TSOP project along Rural Rd/Scottsdale Rd across multiple jurisdictions) o Mill Avenue	☐ ITS to identify corridors that can be completed through TSOP application or within City funding limits ☐ ITS to initiate TSOP application for traffic signal synchronization corridor/s or funding identification if using City funds ☐ Coordinate for access to facilities during design and integration ☐ Coordinate with neighboring jurisdictions for TSOP applications when possible
☐ **Adaptive Corridors Implementation – Phase II** ☐ **Adaptive Corridors Implementation – Phase III**	☐ Adaptive implementation in Tempe – recommendations as defined below: o University Drive (near Loop 101) o McClintock Drive (near Tempe Marketplace) ☐ Second phase of adaptive testing in long-term timeframe – recommendations as defined below: o Baseline Road (near Arizona Mills Mall) o Priest Drive (near Arizona Mills Mall)	☐ ITS to identify detector capabilities within specified corridors ☐ Leverage existing traffic signal controller upgrades or capital improvement projects in area to upgrade detection if needed ☐ Implement adaptive to new corridors based on strategy chosen in mid-term timeframe
SUPPORTING INFORMATION		
Related ITS Goals	• Integration • Image • Creativity • Sustainability	
Needs Addressed	• Maintain signal coordination along key corridors to be able to maximize traffic throughput, particularly during peak commute. • Leverage existing communications and facilities throughout the City as well as ADOT routes to tie Tempe infrastructure into a central system for operations. • Leverage transit and METRO Light Rail infrastructure and communication connectivity to support broader traffic management goals. • Utilize City IT tools and capabilities to support traffic management functions and operations systems. • Ability for traffic signal technicians to test equipment and communicate with field devices from a remote site such as the Tempe TMC. • Ability to modify the traffic signal timing plans in response to incidents and closures for more active traffic management of Tempe's roads. • Integrate real-time information about incidents, events or congestion in Tempe into traveler information website (City or AZ511).	
MAG TIP APPLICATION SUPPORT		
Recommendations Relationship to MAG RIA Market Packages	• ***Collecting Detector Data***: ATMS01 – Network Surveillance • ***Traffic Signal Management***: ATMS03 – Surface Street Control • ***Traffic Signal Plan Sharing***: ATMS06 – Traffic Information Dissemination and ATMS07 – Regional Traffic Management	
User Services	• 1.6 Traffic Control • 1.7 Incident Management	
Subsystems	• Roadway • Traffic Management	

Strategy: COMMUNICATIONS

Recommendations	Description	Considerations
	NEAR-TERM	
☐ **Establish Conduit Connections**	☐ Install conduit connections less than 500 feet in length (SR 143 project will install some conduit connections)	☐ Coordinate to identify funding for connections
☐ **TMP12-804 Citywide Fiber Optic Cable Installations (TIP CMAQ) (Communications – Phase I)**	☐ TMP12-804 project to design and construct fiber optic cable installations citywide ($361,171 in 2012) to provide signal interconnect along University from Mill to Rural, Mill from Rio to 13th, Apache from the curve to Terrace using existing fiber conduits, as shown in **Figure 12 (Programmed Fiber – Orange Circle Identifiers)**	☐ Coordination with IT for access to facilities during design and integration
☐ **ITS/IT Agreement for Private Telecom Use**	☐ Develop formal agreement between IT and ITS to use identified private company conduit that IT already has access to for new fiber projects – defines physical and/or logical network separation of IT and ITS functions utilizing same fiber cable or strands through different corridors of City	☐ IT to lead agreement development based on what IT infrastructure can be used for ITS purposes
☐ **Complete Private Telecom Agreements – Extension I**	☐ Develop agreements with additional private telecommunications providers to utilize conduits or dark fibers for City use – to include verification of dB loss, verification of connectivity and vault locations, label usable fiber cables for City use, and develop maintenance agreement for City used fibers	☐ IT to lead effort in developing agreement and partner with City Attorney to develop agreement ☐ ITS to partner with IT to begin negotiations with private company for use of conduit or fibers for City use
	MID-TERM	
☐ **TMP14-102 ITS Installations on Elliot, Guadalupe and Warner (TIP CMAQ) (Communications – Phase III)**	☐ TMP14-102 project to construct/install fiber optic communications to the signals and install wireless radios with CCTV monitors on the corridors of Elliot, Guadalupe, and Warner for a total of 11 miles ($547,619) as indicated in **Figure 12 (Programmed Fiber – Orange Color Band Identifier)**. This project will use an existing conduit along Elliot for fiber optic communication to the Elliot signals and wireless radios will be used to provide communication to signals along Guadalupe and Warner. 13 CCTVs will be placed at major intersections in the area for traffic monitoring.	☐ Coordination with IT for access to facilities during design and integration
☐ **Citywide Communications – Phase IV**	☐ Install remaining fiber communications (what was not able to be installed during the Near-Term timeframe) to connect traffic signals to fiber optic cable communications along Rural Road, as indicated in **Figure 12 (Recommended Fiber – Green Colored Band Identifier)** – identify TIP project for remaining corridor fiber miles ☐ Install wireless communications to connect additional traffic signals to high speed communications, as indicated in the interim in **Figure 12** and ultimate build out in **Figure 13**, prioritizing signals within one mile of an accessible Tempe fiber path	☐ ITS to identify local funding for remaining Rural Road fiber corridor, develop TIP application for project, or coordinate with private telecommunications company for use of fiber ITS to lead and manage project ☐ Coordination with IT for access to facilities during design and integration

☐ **Tempe Fiber Management Tool**	☐ Develop a Fiber Management Tool to map out the planned fiber splice paths for particular corridors and wireless network throughout Tempe as communications are implemented	☐ IT to lead project ☐ Coordinate with ITS to define network separation needed for fiber/wireless communications
☐ **Complete Private Telecom Agreements – Extension II**	☐ Develop agreements with additional private telecommunications providers to utilize conduits or dark fibers for City use – to include verification of dB loss, verification of connectivity and vault locations, label usable fiber cables for City use, and develop maintenance agreement for City used fibers	☐ IT to lead effort and partner with City Attorney to develop agreement ☐ ITS to partner with IT to begin negotiations with private company for use of conduit or fibers for City use
☐ **Coordination with Water CIP Projects – 2014-2016**	☐ Coordinate with CIP 3299989 Water Line Replacement and Repair project to try to install conduit/fiber -– 2011/12 ☐ Coordinate with CIP 3299969 Sewer Line Replacement and Repair project for 2011-2012 to potentially install conduit/fiber	☐ Work with IT and Water to revisit if this is a potential option ☐ Reference Water Utility Department Integrated Master Plan to identify priority lines that need to be replaced
LONG-TERM		
☐ **Citywide Communications – Phase V**	☐ Install remaining fiber communications (if any) to connect traffic signals to fiber optic cable communications along Rural Road, as indicated in **Figure 12 (Recommended Fiber – Green Colored Band Identifier)** – identify TIP project for remaining corridor fiber miles (if any) ☐ Install wireless communications to connect additional traffic signals to high speed communications, as indicated in the interim in **Figure 12** and ultimate build out in **Figure 13**, prioritizing signals within one mile of an accessible Tempe fiber path	☐ ITS to identify local funding for remaining Rural Road fiber corridor, develop TIP application for project, or coordinate with private telecommunications company for use of fiber (if corridor has not completed to date) ☐ Coordination with IT for access to facilities during design and integration
☐ **Coordination with Water CIP Projects – 2017-2021**	☐ Coordinate with CIP Water Line Replacement and Repair projects to try to install conduit/fiber ☐ Coordinate with CIP Sewer Line Replacement and Repair projects to try to install conduit/fiber	☐ Work with IT and Water Services to revisit if this is a potential option ☐ Reference Water Utility Department Integrated Master Plan to identify priority lines that need to be replaced
SUPPORTING INFORMATION		
Related ITS Goals	• Integration • Partner • Creativity • Sustainability	
Needs Addressed	• Leverage existing communications and facilities throughout the City as well as ADOT routes to tie Tempe infrastructure into a central system. • Utilize City IT tools and capabilities to support traffic management functions and operations systems. • Introduce new technologies to the City's infrastructure that will meet the needs of departments and partners and serve multiple purposes within City services (police monitoring, event management planning, transportation planning, etc.).	
MAG TIP APPLICATION SUPPORT		
Recommendations Relationship to MAG RIA	• ***Traffic Signal Management***: ATMS03 – Surface Street Control • ***Connection with Neighboring Jurisdictions:*** ATMS07 – Regional Traffic Management	
User Services	• 1.6 Traffic Control	
Subsystems	• Roadway • Traffic Management • Other Traffic Management	

Strategy: TRANSPORTATION MANAGEMENT CENTER

Recommendations	Description	Considerations
	NEAR-TERM	
☐ **Establish TMC Firewall**	☐ Establish TMC firewall to protect Tempe infrastructure and systems from external influence	☐ IT to lead effort ☐ Coordinate with ITS for access to TMC, network room, and systems for configuration
☐ **TMC Maintenance Plan**	☐ Create a TMC Preventative and Replacement Maintenance Plan to maximize the useful life of the facility – document TMC equipment, establish hardware/software maintenance manager for TMC, etc. Include in the plan to update the asset management list of TMC components. This information would accurately document the beginning of all manufacturers' warranty and would help in defining the anticipated life cycle replacement month/year.	☐ Coordinate with IT to determine maintenance support needs and resources and identify existing documentation such as TMC equipment lists, lifecycles, and warranty information ☐ Update list to include the purchase date of all components, the installation date, and the anticipated month/year of replacement using the life cycle range
☐ **Establish Quarterly ITS/IT Meetings**	☐ Ongoing task to meet with IT on a quarterly basis to discuss infrastructure, Intranet, maintenance, communications schema, support resources from each side, upcoming projects or enhancements, etc.	☐ ITS to coordinate with IT to establish quarterly meeting time/location and confirm participation each meeting
☐ **HCRS Area of Influence (AOI)**	☐ Establish TMC AOI through ADOT HCRS to include boundary identified by McDowell Rd/Loop 101, Loop 101/Loop 202 Santan, I-10/Loop 202, and Loop 202/32nd Street – for automated email notification of incidents, closures, and permitted work zones that will affect the freeways identified in Tempe's established AOI. This AOI system will supplement and verify the TMC/TOC Agreement for Notification identified in a recommendation above.	☐ ITS to work with ADOT TOC personnel to establish AOI account and boundary
☐ **Police Radio Scanner at TMC**	☐ Coordinate with Police to provide TMC a Police radio scanner through the ongoing radio system replacement project	☐ Police to provide Radio Scanner to TMC ☐ Potentially leverage City Regional Radio System Maintenance and Replacement project (# 5501989) to provide radio scanner
☐ **Establish Process to Provide City HCRS Inputs**	☐ Initiate TMC inputs to ADOT HCRS about Tempe arterial road conditions and planned closures so that information can be included in the ADOT 511 traveler information services	☐ ITS to access system and input planned construction projects into HCRS system ☐ ITS to coordinate with IT to potentially develop an automated connection to updating HCRS
☐ **Establish Automated Traffic Data Archive**	☐ Archive ITS data on City servers for central archive of all data for information to support before/after ITS application justification studies – potential data to file under specific categories within the archive include volumes, turning movement counts, traffic signal maintenance requests, traffic signal timing change logs, special event specific usage statistics, ASU statistics on bike/ped movements, etc.	☐ Traffic to coordinate with IT related to ongoing upgrades identified in CIP for Enterprise Network File Storage and Archival to determine relation to traffic data archive location/storage requirements ☐ Traffic to establish what data will be archived and frequency of archiving ☐ ITS to verify archival by querying specific information as test

☐ **TMC/TOC Agreement for Notification**	☐ Establish formal agreement with ADOT TOC for TOC operators to notify Tempe TMC operator/personnel directly regarding incidents/impacts on freeway routes that may affect the City's arterials – recommended along US-60, I-10, Loop 101, and Loop 202 Red Mountain within Tempe	☐ Coordinate with ADOT TOC to formalize agreement
☐ **Technology Training for New Devices**	☐ Technician training for signal technicians on how to maintain new devices – potentially leverage regional resources when available	☐ Maintenance to identify training needed on specific ITS devices/components (additional to training provided as part of project delivery)
MID-TERM		
☐ **Hire TMC Operator**	☐ Hire full-time TMC operator	☐ ITS to work with Traffic to search for qualified applicant – job posting or internally
☐ **Continue Quarterly ITS/IT Meetings**	☐ Ongoing task to meet with IT on a quarterly basis to discuss infrastructure, Intranet, maintenance, communications schema, support resources from each side, etc.	☐ ITS to coordinate with IT to establish quarterly meeting time/location and confirm participation each meeting – adjust time/location and invited attendees as needed
☐ **Standard City ITS Details**	☐ Develop standard City details for installing pull boxes, conduit, fiber communications, wireless communications, additional conduits, etc.	☐ ITS to work with Traffic to establish details or contract out effort to develop details ☐ ITS to work with Traffic to incorporate details into City Standard Details
☐ **Provide Input to Roadway Planning**	☐ Provide input to support corridor revitalization projects to add bike lanes, sidewalks, traffic calming measures – define thresholds for applying different ITS applications based on the needs of the users as well as recommendations for planning roadway improvements to appropriately prepare for future ITS implementation	☐ Traffic to coordinate with Community Development to develop thresholds for applying specific ITS applications ☐ Community Development to incorporate process for checking thresholds prior to implementing specific solutions – include on City intranet for access
☐ **Establish Real-Time Corridor Data**	☐ Leverage regional data and/or deploy detection (Bluetooth, ITIP, other private sector) to support real-time corridor travel time speeds. Detection should be placed at one-third mile increments where existing detection is not present. Priority corridors for this type of additional real-time detection are reserved for freeway alternates and high volume corridors. For this mid-term timeframe, it is recommended to focus on the corridors of: o Rural Road o McClintock Drive	☐ Prepare scope of detection needed for each corridor – identify locations that can be completed via TIP application ☐ Establish connections to devices for enhanced detection system ☐ Define archive location for real-time data ☐ Designate operational use of real-time data via video wall, operator decision-making, device control/usage, etc. ☐ Incorporate new corridor detection into ITS Program
☐ **Technology Training for Devices**	☐ Technician training for signal technicians on how to maintain existing and new devices – potentially leverage regional resources when available	☐ Maintenance to identify training needed on specific ITS devices/components (additional to training provided as part of project delivery)

LONG-TERM		
☐ **TMC Upgrades / Maintenance**	☐ Enhancements to TMC based on recommendations from TMC Maintenance Plan	☐ ITS to coordinate with IT as defined by plan ☐ Prepare scope of upgrades/maintenance needed for TMC –incorporate into TIP application
☐ **Continue Quarterly ITS/IT Meetings**	☐ Ongoing task to meet with IT on a quarterly basis to discuss infrastructure, Intranet, maintenance, communications schema, support resources from each side, etc.	☐ ITS to coordinate with IT to establish quarterly meeting time/location and confirm participation each meeting – adjust time/location and invited attendees as needed
☐ **Expand Real-Time Corridor Data**	☐ Expand use of regional data and/or deploy detection (Bluetooth, ITIP, other private sector) to support real-time corridor travel time speeds. Detection should be placed at one-third mile increments where existing detection is not present. For this mid-term timeframe, it is recommended to focus on the corridors of: o Baseline Road o Southern Avenue	☐ Prepare scope of detection needed for each corridor – identify locations that can be completed via TIP application ☐ Identify communications connection to each traffic signal for centralized collection of real-time data ☐ Incorporate new corridor detection into ITS Program
☐ **RCN Connection**	☐ Establish RCN connection through future phase of RCN program – establish/maintain involvement in RCN Working Group	☐ Ensure TMC firewall is in place prior to RCN connection ☐ ITS to coordinate with ADOT and MAG for network connection into RCN via ADOT to MAG's Network Manager system
☐ **Technology Training for Devices**	☐ Technician training for signal technicians on how to maintain existing and new devices – potentially leverage regional resources when available	☐ Maintenance to identify training needed on specific ITS devices/components (additional to training provided as part of project delivery)
SUPPORTING INFORMATION		
Related ITS Goals	• Safety • Integration • Partner	
Needs Addressed	• Resources for Traffic/ITS are limited – will need to focus on a future program that does not require additional staff, maximizes the use of automated processes, and streamlines current processes. • Leverage existing communications and facilities throughout the City as well as ADOT routes to tie Tempe infrastructure into a central system for operations. • Ability for traffic signal technicians to test equipment and communicate with field devices from a remote site such as the Tempe TMC. • Training and cross-training will become a necessity as new technologies are introduced to be operated and maintained by existing City resources. • Coordinate Tempe PD and TMC resources to be able to actively manage events using infrastructure once deployed.	

MAG TIP APPLICATION SUPPORT	
Recommendations Relationship to MAG RIA Market Packages	• ***Traffic Data Archive***: AD1 – ITS Data Mart • ***Collecting Detector Data***: ATMS01 – Network Surveillance • ***ITS Device/Data Sharing***: ATMS06 – Traffic Information Dissemination • ***RCN Connection for Sharing Information with Other Agencies***: ATMS07 – Regional Traffic Management
User Services	• 1.6 Traffic Control • 1.7 Incident Management • 7.1 Archived Data
Subsystems	• Archived Data Management • Emergency Management • Traffic Management

Strategy: PROGRAM MANAGEMENT

Recommendations	Description	Considerations
MID-TERM		
☐ **Establish Report Card**	☐ Utilize existing data and regional data to support performance measures to justify deployments and ITS investments	☐ Traffic to lead effort and incorporate into Citywide performance measure reporting ☐ Coordinate to collect archived information needed for effort
☐ **Develop Operations Plan and Standard Operating Procedures**	☐ Development of a concept of operations for integrating tools into daily operations of TMC, police, fire, special events, partner agencies, etc. including roles and responsibilities with using new infrastructure and monitoring capabilities that can better utilize technology to support traffic management, incident management, event management. As part of this strategy, also establish Standard Operating Procedures for use of devices, data, systems, etc.	☐ Coordinate with Police and IT to determine roles and responsibilities of their departments in relation to ITS tools ☐ Develop Operations Plan and Standard Operating Procedures
☐ **Prepare ITS Study and ITS Data Analysis**	☐ Using archive of data to support before/after study for ITS application/s – Tempe has the opportunity to create the first example of quantitative justification of ITS in the region ☐ Use ITS to provide analysis of where transit/traffic issues exist (right-of-way limitations) – timing, signals, recurring special events	☐ ITS to initiate effort on a project by project basis based on data collected by corridor throughout the City ☐ Prepare scope of work –consider incorporating into TIP application ☐ Offer study opportunity to Arizona Transportation Research Center, ASU, or MAG for completion
LONG-TERM		
☐ **Update Operations Plan and Standard Operating Procedures**	☐ Update Operations Plan and Standard Operating Procedures - once ITS system has been used for a few years	☐ Coordinate with Police and IT to determine any updates to roles and responsibilities of their departments in relation to using ITS tools
SUPPORTING INFORMATION		
Related ITS Goals	• Sustainability	
Needs Addressed	• Resources for Traffic/ITS are limited – will need to focus on a future program that does not require additional staff, maximizes the use of automated processes, and streamlines current processes.	
MAG TIP APPLICATION SUPPORT		
Recommendations Relationship to MAG RIA Market Packages	• ***Traffic Data Archive***: AD1 – ITS Data Mart • ***Using Regional Archived Data***: ATMS01 – Network Surveillance	
User Services	• 7.1 Archived Data • 1.6 Traffic Control	
Subsystems	• Archived Data Management • Roadway • Traffic Management	

Strategy: TRAVELER INFORMATION

Recommendations	Description	Considerations
	NEAR-TERM	
☐ **PIO Coordination**	☐ Coordinate PIO communications to get all PIOs on all lists – transportation, police, special event; make PIOs aware of what info TMC can provide	☐ Coordinate with PIOs from various departments to establish what is shared and with whom ☐ Establish ITS information that can be provided to PIOs to support reports
	MID-TERM	
☐ **Incident Distribution List**	☐ Incident status/response contact distribution lists – set up different thresholds for who is notified during an incident.	☐ ITS to initiate effort and partner with departments that could benefit from real-time incident information ☐ Coordinate with transit to set up list to provide incident notification as well as all-clear signs ☐ Coordinate with neighboring City Police Departments and TMCs, Maintenance (as needed based on incident thresholds)
☐ **Real-Time Enhancements to City Website**	☐ Enhance City website with automated real-time data when available (CCTV snapshots, special event restriction information, potentially parking restriction information in Tempe or on key corridors in neighboring jurisdictions) and link to ADOT AZ511.gov information	☐ IT to lead project and establish what information needs to be shared with AZ511.gov and in what format ☐ Coordinate with ITS for access to information location to automate updates to City website
	LONG-TERM	
☐ **Ongoing Enhancements to City Website**	☐ Ongoing enhancements and maintenance of City traffic information on website	☐ IT to lead updates as needed
☐ **Arterial Travel Times on DMS**	☐ Discuss lessons learned with City of Chandler regarding the implementation of their travel time system using Bluetooth sensor technology and uniquely-created algorithm for calculation of travel times ☐ Evaluate additional technologies (such as probes) ☐ Consider strategic locations that are prone to peak-period congestion adjacent to freeways mid-City feeders to freeways such as: Baseline Road, Southern Avenue, Elliot Road, and Warner Road	☐ Identify applicable corridors based on use of existing DMS along corridor to support travel times ☐ Prepare scope of work –consider incorporating into TIP application ☐ Identify detection necessary to calculate travel times to post to DMS – existing loop detectors, new Bluetooth sensors, etc.
☐ **Mobile Parking Application**	☐ Mobile parking application development to communicate information about parking availability and current status information regarding stadium, City lots, private lots, ASU lots	☐ ITS to potentially partner with City of Glendale and City of Scottsdale to pursue this opportunity ☐ ITS to solicit third party vendor interest in developing a mobile application – no cost to Tempe, benefit is advertising opportunity on Tempe website to company to download application and public response to use application

☐ **Evaluation of Dynamic Pricing for On-Street Parking**	☐ Investigate how dynamic pricing for on-street parking would be implemented and if it is feasible to consider in Tempe to encourage healthy usage and turnover of parking as well as more effective pricing strategies during particular times of each day to maximize benefit	☐ Partner with the Downtown Tempe Community Inc. to determine feasibility of dynamic pricing for on-street parking ☐ Reference recommended parking policies in the 2010 Downtown Tempe Community Parking Policy Assessment / Review of Parking & Economic Development Best Practices document
SUPPORTING INFORMATION		
Related ITS Goals	• Safety • Partner • Sustainability	
Needs Addressed	• Collect information about traffic and road conditions in real-time and provide pre-trip real-time conditions to travelers. • Coordinate PIO communications to the public between City departments/services. • Integrate real-time information about incidents, events or congestion in Tempe into traveler information website (City or AZ511). • Implement tools, such as arterial dynamic message signs, to provide real-time, en-route information to travelers. • Provide real-time information to the public about incidents/events – most information provided to public currently is planned events/closures.	
MAG TIP APPLICATION SUPPORT		
Recommendations Relationship to MAG RIA Market Packages	• ***Local PIO Coordination***: ATIS01 – Broadcast Traveler Information • ***ITS Device/Data Sharing***: ATMS06 – Traffic Information Dissemination	
User Services	• 1.2 En-Route Driver Information • 1.7 Incident Management	
Subsystems	• Emergency Management • Information Service Provider • Media • Roadway • Traffic Management	

Strategy: INCIDENT MANAGEMENT

Recommendations	Description	Considerations
NEAR-TERM		
☐ **Assist with CAD to Transit Weblink Info**	☐ Establish Tempe Fire CAD link to transit	☐ IT to lead effort and coordinate with Transit to implement
☐ **Police Connection to Public Safety Video Distribution System**	☐ ITS to support Tempe Police to establish connectivity to the Video Distribution System to initially view real-time ADOT CCTV images and ultimately view real-time Tempe CCTV images	☐ ITS to initiate effort with MCDOT to get Police access to VDS system
MID-TERM		
☐ **Police/Fire AVL to TMC**	☐ Share Police/Fire AVL mapping capability with TMC	☐ IT to lead effort in sharing mapping capability from CAD system with TMC ☐ Coordinate with Police and ITS to implement
☐ **Intranet Enhancement - TMC to Public Safety and Other Tempe Depts**	☐ Establish Intranet connection between TMC and public safety agencies (Tempe Police and Tempe Fire) as well as other Tempe departments to provide live video feeds and means for instant communication on response status	☐ IT to lead effort to establish Intranet location for Police/Fire/Tempe Depts/TMC connection and to configure CCTV system to be able to share on Intranet service
☐ **Investigate Use of REACT in Tempe**	☐ Developing up concept of operations for how a Tempe REACT team would integrate with current incident response strategies	☐ ITS to initiate information collection to develop concept of operations for a potential Tempe REACT team ☐ Coordinate with MCDOT regarding support for collection of information ☐ Leverage information from other Cities in the Phoenix Valley that have had their own REACT teams ☐ Identify potential funding source for REACT team and work with MCDOT to support with funding requirements for a City team
☐ **Incident Detour Plans**	☐ Prepare Incident Detour Plans that focus on smaller scale incidents that occur along major arterial corridors through Tempe or on adjacent freeways that cause traffic to off-ramp onto Tempe arterials	☐ ITS to develop scoping for project or internal effort to complete
LONG-TERM		
☐ **Establish Tempe REACT Team**	☐ Establish a Tempe REACT Team to support incident response in the City	☐ ITS to initiate funding prioritization for a Tempe REACT Team – partner with neighboring jurisdiction to implement joint REACT Team via TIP application ☐ Partner with Police for REACT contacts and training on REACT Team activities for support ☐ Coordinate with MCDOT regarding agreement development

SUPPORTING INFORMATION	
Related ITS Goals	• Safety • Integration • Partner
Needs Addressed	• Introduce new technologies to the City's infrastructure that will meet the needs of departments and partners and serve multiple purposes within City services (police monitoring, event management planning, transportation planning, etc.). • Resources for Traffic/ITS are limited – will need to focus on a future program that does not require additional staff, maximizes the use of automated processes, and streamlines current processes. • Ability to modify the traffic signal timing plans in response to incidents and closures for more active traffic management of Tempe's roads. • Share Tempe PD CAD with transportation, other neighboring police dispatch centers, Tempe FD, and potentially transit services to broaden knowledge of incident details and response activities. • Coordinate Tempe PD and TMC resources to be able to actively manage events using infrastructure once deployed. • Provide real-time information to the public about incidents/events – most information provided to public currently is planned events/closures.
MAG TIP APPLICATION SUPPORT	
Recommendations Relationship to MAG RIA Market Packages	• ***ITS Device/Data Sharing***: ATMS06 – Traffic Information Dissemination • ***Access to Video Distribution System***: EM01 – Emergency Call-Taking and Dispatch • ***Tempe REACT Team***: EM01 – Call-Taking and Dispatch
User Services	• 5.2 Emergency Vehicle Management
Subsystems	• Emergency Management • Emergency Vehicle • Traffic Management

Strategy: SPECIAL EVENT MANAGEMENT

Recommendations	Description	Considerations
NEAR-TERM		
☐ **Special Event Website Links**	☐ Link Tempe special events website with event promoter websites	☐ Community Services to lead effort in providing event promoter website link on City website ☐ Update event promoter website links as needed
MID-TERM		
☐ **Special Event Response Support Plan**	☐ Determines appropriate resources for TMC presence during incidents and how that will relate to field/dispatch resources and documents roles and responsibilities during specific events between TMC, Police, and other departments	☐ Coordinate with Police to develop roles in special event response as well as define new personnel as primary contact for TMC during special events
SUPPORTING INFORMATION		
Related ITS Goals	• Safety • Integration • Partner	
Needs Addressed	• Use tools to monitor ingress/egress of traffic for future improvements in event plans. • Partner with business community along key corridors as well as other neighboring cities for event planning activities. • Improve navigation for travelers not attending events during special events. • Integrate real-time information about incidents, events or congestion in Tempe into traveler information website (City or AZ511). • Provide real-time information to the public about incidents/events – most information provided to public currently is planned events/closures.	
MAG TIP APPLICATION SUPPORT		
Recommendations Relationship to MAG RIA Market Packages	• ***ITS Device/Data Sharing***: ATMS06 – Traffic Information Dissemination • ***Dynamic Pricing for On-Street Parking (would require an update to the MAG RIA):*** ATMS16 – Parking Facility Management	
User Services	• 1.1 Pre-Trip Travel Information • 1.2 En-Route Driver Information • 3.1 Electronic Payment Services	
Subsystems	• Roadway • Traffic Management • Other Roadway	

Strategy: BICYCLE/PEDESTRIAN ITS

Recommendations	Description	Considerations
NEAR-TERM		
☐ **ITS Guidelines for Bikes/Peds**	☐ Develop ITS guidelines for bicycle/pedestrian detection applications where recommended	☐ ITS to initiate guideline development
☐ **Crossing Treatments Policy**	☐ Crossing Treatments Policy development – for implementing consistency throughout the City	☐ ITS to support policy development incorporating infrastructure recommended thresholds for application
☐ **Upgrade Pedestrian Timing**	☐ Upgrade pedestrian signal timing to published 2009 MUTCD standards	☐ ITS to lead effort
☐ **Review of Safe Routes to School Program**	☐ Safe Routes to School program every year – involve ITS in review to identify future locations for crossing applications and input on safety concerns that ITS could potentially help to address	☐ ITS to provide feedback as warranted on developed program
MID-TERM		
☐ **Bike/Ped ITS Deployment – Phase I**	☐ Leverage Pedestrian ITS Devices project (CIP #6904350 – $25,000 per year) to incorporate into the scope the design of bicycle/pedestrian detection applications. Recommended locations along existing bicycle paths/routes approaches to signalized intersections could include: o East and West along University Drive o North and South along College Avenue o East and West along Apache Boulevard o North and South along Hardy Drive o East and West along Alameda Drive o All directions at intersections along Guadalupe Road o East and West along Warner Road o North and South along McClintock Drive between Guadalupe Road and Warner Road o North and South along Kyrene Road between Guadalupe Road and Warner Road o North and South along Mill Avenue at major mile intersections	☐ ITS to incorporate bicycle/pedestrian detection opportunities into ongoing conversion of pedestrian devices in CIP ☐ Utilize existing Tempe Standard Detail T-576 for Bicycle Loop Detector and T-577 Bicycle Push Button and Pole
☐ **Crossing Treatment Locations – Phase I**	☐ Implement crossing treatments at locations as warranted – could include pedestrian activated crosswalks, HAWKs, or other applications	☐ Prepare scope of work –consider incorporating into TIP application ☐ ITS to support implementation
☐ **Review of Safe Routes to School Program**	☐ Safe Routes to School program every year - involve ITS in review to identify future locations for crossing applications and input on safety concerns that ITS could potentially help to address	☐ ITS to provide feedback as warranted on developed program

LONG-TERM		
☐ **Bike/Ped ITS Deployment – Phase II**	☐ Leverage Pedestrian ITS Devices project (CIP #6904350 – $25,000 per year) to incorporate into the scope the design of bicycle/pedestrian detection applications where recommended – see full recommended list in mid-term to include those that have not been implemented yet into this timeframe	☐ ITS to incorporate bicycle/pedestrian detection opportunities into ongoing conversion of pedestrian devices in CIP
☐ **Crossing Treatment Locations – Phase II**	☐ Implement crossing treatments at all locations of street/rail intersections near downtown Tempe – 1st Street, 5th Street, University Drive, 9th Street, 10th Street, 13th Street between Farmer Avenue and Ash Avenue – could include pedestrian activated crosswalks, HAWKs, or other applications	☐ Prepare scope of work –consider incorporating into TIP application ☐ ITS to support implementation
☐ **Prepare Bike/Ped ITS Study**	☐ Using archive of data to support before/after study for bicycle/pedestrian ITS application/s - Tempe has the opportunity to create the first example of quantitative justification of the use of bicycle/pedestrian ITS in the region ☐ Using archive of data to support before/after study for ITS application/s – Tempe has the opportunity to create the first example of quantitative justification of ITS in the region	☐ ITS to initiate effort on a project by project basis based on data collected by corridor throughout the City ☐ Partner with Arizona Transportation Research Center, ASU, or MAG for completion
☐ **Review of Safe Routes to School Program**	☐ Safe Routes to School program every year - involve ITS in review to identify future locations for crossing applications and input on safety concerns that ITS could potentially help to address	☐ Community Development to solicit ITS involvement in review of Safe Routes to School program development ☐ ITS to provide feedback as warranted on developed program
SUPPORTING INFORMATION		
Related ITS Goals	• Safety • Integration • Partner • Image • Creativity • Sustainability	
Needs Addressed	• Maintain safety for bicycle and pedestrian paths throughout the City, particularly where the paths cross streets or rail lines. • Provide range of alternatives to support bicycle and pedestrian crossing of roadways where traffic signal applications cannot or should not be applied. • Provide parking information to public, particularly during major events – need to coordinate with both City and privately-owned parking facilities.	
MAG TIP APPLICATION SUPPORT		
Recommendations Relationship to MAG RIA Market Packages	• ***Railroad Crossing Coordination***: ATMS13 – Standard Railroad Crossing • ***Bicycle/Pedestrian ITS Applications***: ATMS01 – Network Surveillance	
User Services		
Subsystems	• Roadway • Traffic Management • Other Roadway	

Strategy: TRANSIT ITS

Recommendations	Description	Considerations
	NEAR-TERM	
☐ **Streetcar ITS Design Input**	☐ Incorporate new technologies in with design of Streetcar and roadway to support Streetcar travel – potentially CCTV, DMS, adaptive signal timing, mid-block detection, pedestrian-activated crossings ☐ Identify information up front that will be required to be shared with other agencies (AVL, passenger counting, etc.)	☐ Coordinate with Streetcar design and development to identify key technology and infrastructure additions that could support the Streetcar's implementation and streamline the install of ITS equipment for the ITS Program
	MID-TERM	
☐ **Streetcar ITS Construction**	☐ Leverage data from Streetcar (priority control/bus rapid transit) and identify ITS technologies to supplement existing equipment such as intelligent monitoring, data collection, and performance management	☐ Coordinate with Streetcar implementation to define access to transit data and use of data
☐ **Intranet Enhancement - TMC to Transit**	☐ Establish Intranet connection between TMC and transit agencies to share incident/event status information	☐ IT to lead effort
☐ **Real-Time Transit Data**	☐ Obtain real-time transit data to support schedule adherence information disseminated to Rural/University, Tempe Transit Centers, others	☐ Coordinate with Tempe Transit, Phoenix Public Transit, and Valley Metro
☐ **Transit Signal Priority**	☐ Implement transit signal priority devices along Rural Road between Warner and Rio Salado to support multiple transit routes serving that corridor	☐ Transit to lead and coordinate with ITS for infrastructure implementation and traffic signal controller communications
	LONG-TERM	
☐ **Streetcar ITS Operations**	☐ Implement and verify operations of new technologies introduced during Streetcar ITS – Phase I and Phase II ☐ Refine technology usage and outputs as needed	☐ Coordinate to verify operations of ITS technologies ☐ Determine additional technologies needed or data that can be collected based on what was implemented
	SUPPORTING INFORMATION	
Related ITS Goals	• Safety • Integration • Partner • Image • Creativity • Sustainability	
Needs Addressed	• Coordination between transit services in Tempe and Police/Fire to alert of incidents and anticipated clearance information to better respond to alternate routing options. • Obtain real-time location information from transit vehicles to support alternate routing, on-time schedule performance, and other dispatching functions. • Disseminate better information about impacts and detours of transit routes to travelers using transit services.	

MAG TIP APPLICATION SUPPORT	
Recommendations Relationship to MAG RIA Market Packages	• ***Local Dial-A-Ride Transit Dispatch***: APTS01 – Transit Vehicle Tracking, APTS03 Demand Response Transit Operations, APTS05 – Transit Security, APTS06 – Transit Maintenance, APTS07 – Multi-Modal Coordination • ***Tempe Transit Dispatch***: APTS02 – Transit Fixed-Route Operations • ***RPTA/Valley Metro Transit Dispatch***: APTS05 – Transit Security for Valley Metro • ***METRO Light Rail Operations Through Tempe***: APTS02 – Transit Fixed-Route Operations, APTS05 – Transit Security, APTS07 Multi-Modal Coordination, APTS09 – Transit Signal Priority
User Services	• 1.6 Traffic Control • 2.1 Public Transportation Management • 2.2 En-Route Transit Information
Subsystems	• Roadway • Traffic Management • Transit Management

APPENDIX D – TELECOMMUNICATIONS METHODOLOGY AND PRINCIPLES

This section provides the recommended telecommunications network considerations for the build out of the Tempe ITS program through the use of fiber cable and wireless technologies.

Communications media alternatives in the City of Tempe are a hybrid approach including fiber optic communications, wireless communications, and leased line communications (to be ultimately phased out). This section reviews the methodology of telecommunications, telecommunications principles, and recommendations for the connectivity of Tempe's ITS devices to the Tempe TMC.

D1. Overview and Outline of Methodology

The most opportune way to ensure growth and expansion of the ITS C2F network is to provide convenient and flexible options for each location/device to obtain interconnection. Each intersection and corridor in Tempe is unique in its existing infrastructure and plans for development.

Very few traffic signals in the City have available empty conduit that allows for a future direct fiber connection to the controller at the intersection. This means that in order to connect that signal to the network, a communication method such as wireless, will be utilized.

The City has the flexibility to choose the appropriate level of interconnection based on existing standard industry interfaces that are readily available and the ability of the network equipment and interfaces to support a variety of communications methods.

Various levels of network security are required for the C2F and C2C networks to support different application needs for each of the networks. The following section describes telecommunications principles in helping to shape the ITS network for Tempe. The recommendations section provides concise applications for the City to consider when implementing ITS devices and network equipment to support the City ITS program.

D2. Telecommunications Principles

D2.1 What is Physical Separation?

Both network separation and path diversity will play an integral part in the interconnection of facilities and field devices to the C2F network.

Network Separation

Physical separation of network usage will provide the highest level of security by making it physically impossible for someone connected to one distinct network to "hack" into another distinct network. For example, two networks would be physically separate if they were on separate fibers in separate conduits using separate network equipment where the network equipment is not physically connected to another network. This would be the extreme case and is not recommended from a cost perspective of developing separate paths and separate equipment for all needs.

Device Communications Redundancy

One of the most important design techniques to building reliability into a communications network for Tempe is redundancy – when referring to communications redundancy, this is typically called "path diversity". This means that if one part of the system fails (e.g., one communications path), there is an alternate success path that can act as a backup communications path. Redundancy significantly increases system reliability through the use of multiple paths to critical devices or facilities such as the Tempe TMC.

Security policies and network equipment that is based on standards can significantly improve network reliability. However, path diversity to protect from single points of failure will provide the greatest improvement in reducing system down time. Network equipment is expected to have some level of downtime due to communication system problems or planned outages for network upgrade activities. The only way to make these inevitable occurrences invisible to the users of the system is to have an alternate path for the network traffic to use while the outage is occurring.

Two paths housed within the same side of the roadway and the same conduit configuration with less than 12' of separation are susceptible to losing complete communications to devices/facilities upstream along the fiber. When providing redundant paths, two distinct conduit paths entering a given location with a minimum of 12' of separation is recommended. This separation of fiber will provide the facility redundancy of the fiber backbone network.

D2.2 What is Logical Separation?

Logical separation is the most economical type of network separation because the concept allows the use of sharing fibers and equipment without disrupting each of the networks using that equipment. However, a determined "hacker" on a shared network that is logically separate can break into the network traffic path of other logically separate networks.

Logical separation is a primary level of security for all ITS components. For example, CCTVs, traffic signals, and DMS would all be separated logically onto different VLANs but could potentially share the same physical fibers. In order to do this, subnets and VLAN will be required to separate the ITS components on the network.

In typical networks, the IP addresses are designated as one of the "private" IP address subnets. Most large networks typically use the subnet 10.X.X.X. A router on that network would also have a private address such as 10.0.0.1. The use of subnets to separate network traffic is essential for maintenance and management of the network.

Logical separation of networks through the use of firewalls is a higher level of protection. Firewalls exclude almost all content and then only include permissible applications thereby creating a network architecture that is much easier to operate, manage, and troubleshoot. The use of firewalls also reduces the likelihood of attacks generated from other systems or users from remote locations that do not possess the same level of security for the City's internal network. Firewalls cannot protect against network usage that does not go through the firewall.

D2.3 Device Communications Back to Tempe TMC

General guidelines for developing an ultimate communications network for ITS devices include:

- All devices should have an Access Point or Distribution Switch (as needed) locally.
- All Access Points should be fiber or wirelessly connected to one or a maximum of two backhaul Distribution Switches for transmission back to the Tempe TMC.
- The Tempe TMC should have a Core Network Switch that is connected to all of the Distribution Switches in the City to receive all information from the ITS network.

Fiber should be provided to the traffic signals that have the greatest benefit to supplying a connection to the other ITS devices within a corridor. A distribution switch is required at all traffic signal cabinets that will be connected to the fiber backbone and will function as the wireless backhaul locations for other ITS devices not on the fiber backbone paths.

The remaining traffic signals within wireless range of the fiber will need to have a wireless communications link between the access point at the signal controller and the distribution switch that is connected to the fiber. In some cases, the distribution switches will need to be placed where there is no existing fiber but may have a wireless connection to another distribution switch that is connected to fiber.

Leased lines:

1. Are the least reliable of the communications media options;
2. Have ongoing costs for their use;
3. Are being phased out of most agency uses; and
4. Have low bandwidth.

D2.4 Bandwidth Requirements

Bandwidth is a term used to describe the maximum capacity of traffic or data that can be transmitted across a network at any given time. Bandwidth is primarily a function of two key parameters: the speed of transmission and the volume/density of data.

Any given link has a limited amount of bandwidth it can support. Factors that affect the available bandwidth of a network include:

- The amount of traffic on the network (packet density);
- The number of users (routing delay); and
- Collisions between sets of data (contention).

Different network services require various amounts of bandwidth. Typical bandwidth requirements are shown in **Table D1**.

Table D1 – High-Level Bandwidth Requirements

ITS Component	Bandwidth Requirements (Mbps)
CCTV Camera Video w/ PTZ	3 Mbps
DMS	56 Kbps
Traffic Signal Controller	19.2 Kbps
Video Image Detection (each direction)	1.5 Mbps

The number of devices on each fiber optic ring path back to the Tempe TMC and the bandwidth requirements of the total number of those devices determine the size of the Ethernet system needed to maintain communications to those devices.

The following are two typical intersection bandwidth calculations that could be supported by up to a 100 Megabytes per second (Mbps) wireless distribution switch. Due to network protocol limitations (Rapid Spanning Tree Protocol and Spanning Tree Protocol), the limit on any given distribution ring is 10 devices. Establishing the areas of coverage for these distribution rings to connect to the main fiber backbone rings at two points for redundancy is important for designing the system.

Full VID at Intersection	***CCTV at Intersection***
4 VID @ 1.5 Mbps each	1 CCTV @ 3 Mbps
10 Traffic Signal Controllers @ 19.2 Kbps	1 VID @ 1.5 Mbps
= 6.192 Mbps	10 Traffic Signal Controllers Wirelessly Connected @ 19.2 Kbps
	= 4.692 Mbps

This calculation demonstrates that the wireless network will be adequate based on the number of large bandwidth devices with video required for each wireless connection. The typical one mile spacing of CCTV that Tempe has begun deploying throughout the City should limit the number of CCTV and/or VID images that need to use an individual wireless link to reach a distribution switch that is connected to a backhaul fiber path.

A 100 Mbps Ethernet system would be able to adequately support the network capacity needed for the ITS devices planned for Tempe's ITS network. A Gigabit Ethernet system provides a worst case scenario of bandwidth usage if all devices were to have to reside on one path back to the Tempe TMC. This system is a worst-case scenario system and accounts for the largest bandwidth Ethernet system needed for Tempe.

D2.5 Ring Topology

The physical topology of a network refers to the physical configuration of the fiber backbone network. There are several network topologies that have been evaluated for the build out the Tempe ITS C2F network. These topologies include point-to-point, star, daisy-chain, ring, mesh, and passive optical network.

Mesh and passive optical network topologies have been ruled out of the recommendations. Mesh networks require that every node in the wireless network is connected to every other

node in the network which can be cost prohibitive. Passive optical network requires an increased cost for TMC equipment because each location must transmit all the way back to the TMC. Network topologies such as point-to-point, star, daisy-chain, and ring can all be deployed in some form together as Tempe creates the City's ITS C2F network.

The Tempe TMC has access to two strands of fiber cable within the ADOT fiber cable buffer tubes. Two more strands of fiber cable (for a total of four strands) would provide ample path diversity and redundancy for the ITS network. A minimum of two fibers is needed for traveling two separate routes for network redundancy.

The main fiber backbone cable should be configured to provide separation of the two paths that will bring communications from a single device or facility back to the Tempe TMC. Fiber backbone "rings" establish this separation of two paths by providing a backbone cable for devices and facilities to connect to along priority corridors in a ring shape that then reaches the Tempe TMC from two physically separate paths. While it is accepted practice to establish a minimal number of rings to be able to connect a majority of the devices/facilities in the City, the paths of each ring may need to overlap with one another, providing multiple connection points to bring communications back to the Tempe TMC.

A three-ring fiber network topology is recommended for the ITS C2F network backbone. The primary and most important sections of the fiber ring are Elliot Road and Rural Road. Elliot Road fiber is already programmed for installation in the near-term. Rural Road fiber will need to be the primary focus for Tempe. Recommended distribution switch locations are along the fiber paths and at locations that have line of sight to the wireless traffic signal locations that are not planned to be connected to fiber. The three-ring topology with distribution switch locations provides redundant fiber paths and the opportunity for Tempe to connect all ITS devices and traffic signals to the ITS fiber network.

Tempe is currently using the ADOT fibers allocated for the City to connect traffic signals within City limits. This connection is essentially a daisy chain configuration where each signal is successively connected to the next forming one long string of connectivity. If this string of connectivity were to be broken, Tempe would lose connectivity to the signals past the breaking point along the string. Therefore, the ADOT fiber network connectivity to traffic signals is recommended to be reconfigured within the ring topology in order to provide redundant paths back to the TMC to prevent single points of failure.

D2.6 Wireless Network

Deploying a wireless network to connect traffic signals, CCTV, DMS, and other ITS devices is a feasible alternative to deploying direct fiber connectivity to all device locations. Wireless generally has 54 Mbps of speed capacity for point-to-point wireless radio and 300 Mbps of speed capacity for point-to-multi-point wireless radio speed capacity, whereas fiber cable has Gigabits of speed capacity – so there are limitations with a wireless network that require careful design and consideration. System reliability and redundancy for a wireless network should be designed. Unclear specifications for system implementation can cause wireless network failure.

The types of information that need to be specified for a wireless design include:

- Type of data to be transmitted over the network;
- Amount of data;
- What type of radios/antennas can be used;

- Profile of terrain;
- Location (urban/rural) interference;
- Reliability/redundancy needs;
- Type of network needs; and
- Can use unlicensed frequency or need licensed frequency.

The proper locations for wireless radios and backhaul locations to connect the wireless signal back into the fiber backbone will be individually designed by the wireless contractor. It is likely that in the initial stages of deploying the wireless network that radios and backhaul locations will or may be moved to accommodate new wireless infrastructure.

In order to complete a wireless design in Tempe, the following should be considered during each phase of implementation:

- All existing wireless network devices deployed require proper surveying and documenting to accommodate new wireless devices planned to be installed.
- May need to make software adjustments to accommodate various wireless network topologies.
- Determine existing interference (trees, buildings, signs, other wireless systems) through site survey.
- May require stronger radios in more dense locations of buildings to bypass the existing interference.
- Requires a wireless network manager to be installed on City server for proper management of the wireless signal throughout the network.
- Combination of radios will be a key decision point – mounting radios in the traffic signal controller cabinet with a separate antenna or purchasing a radio/antenna combined radio. Use dual radios if loss of bandwidth over multiple hops is a concern.
- I/O radios (on/off switch) could be used for applications such as emergency priority, dust warning systems, and bicycle/pedestrian crossings.
- Frequencies can range from 900 MHz to 5.8 GHz.

APPENDIX E – ADAPTIVE SYSTEM DECISION SUPPORT

Table E1, extracted from the *NCHRP Synthesis 403: Adaptive Traffic Control Systems: Domestic and Foreign State of Practice* (link to publication located at URL: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_403.pdf), shows how each of the ten major Adaptive Traffic Control Systems (ATCS) considered in this study are categorized for each of the ten principles. The information provided here is based on a comprehensive literature review and does not necessarily reflect how vendors and developers of ATCSs see their systems.

Table E1 – Adaptive System Characteristics Summary

ATCS	ACS Lite	BALANCE	InSync	LA ATCS	MOTION	OPAC	RHODES	SCATS	SCOOT	UTOPIA
Detection	SL, MB/ US	NSL	NSL	SL & US	NSL	MB & SL	MB & SL	SL, NSL, MB	US & SL	US & SL
Action	P & R	P & R	P & R	P & R	P & R	P	P	R	P & R	P
Adjustment	DCO	TCO	DCO	RA, TCO, DCO	TCO	TCO	TCO	RA	DCO	TCO
Time Frame	5–10 min	5 min	Phase/ Cycle/ 15 min	Cycle	5–15 min	Phase/ Cycle/ 5 min	Sec by sec	Cycle	Cycle/ 5 min	3 sec — Cycle
Level	C/L	C/L	C/L	C/L	C/L	C/L	C/L	C/L	C/L	C/L
Model	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Timings	S, O	S, Cl, O, PS	S, Cl, O, PS	S, Cl, O	S, Cl, O, PS	S, Cl, O	S	S, Cl, O	S, Cl, O, PS	S, PS
Flexi Region	No	No	Yes	Yes	No	No	No	Yes	Yes	Yes
Vehicle Actuated	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes	Yes
TSP	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Detection: SL = stop-line; NSL = near-stop-line; MB = mid-block; US = upstream.
Action: P = proactive; R = reactive.
Adjustment: RA = rule-based adjustment; DCO = domain-constrained optimization; TCO = time-constrained optimization.
Level: L = local; C = central.
Timings: S = splits; Cl = cycle length; O = offset; PS = phase sequencing.

Source: NCHRP Synthesis 403: Adaptive Traffic Control Systems: Domestic and Foreign State of Practice

The various adaptive strategies available for use have constraints and challenges associated with them that may limit their application in the future in Tempe. **Table E2** provides some considerations when choosing an appropriate adaptive strategy for Tempe application:

Table E2 – Adaptive System Descriptions and Considerations for Use

Type	High-Level Description	Considerations for Use
SCATS	Uses detector data at the intersection stopline to measure the degree of saturation (volume/capacity ratio) to adjust online the background fixed-time plans.	Requires specific detector types (tactical stopline and strategic upstream detectors) that few agencies have deployed at all intersections. Detectors are optimal at between the lengths of 12-14 feet.
SCOOT	Uses data from detectors located at the upstream end of each approach to estimate the size and shape of traffic platoons for each signal cycle and adjusts the timings to minimize the delays and stops. Integrated with EPAC and 2070 controllers.	Requires upstream detectors at adaptive intersections located at least 7 seconds of travel time upstream and can be located in the vicinity of the previous upstream intersection to reduce costs.
ACS Lite	Uses the existing coordinated timing plans and makes incremental adjustments to split and offset parameters as often as every 5 to 10 minutes. Compatible with all NEMA controllers and uses NTCIP standards-based communications protocol for its interface. Compatible with typical layouts used for intersections under fully actuated control. Incorporates detector processing to be flexible with size, location and capability of detectors.	The use of existing controllers and detectors reduces the cost of deploying this adaptive strategy. Logical detector processing reduces the need to resize or relocate existing detectors.
Kadence	Uses the existing coordinated timing plans and makes incremental adjustments to split, cycle, phase sequence, and offset parameters as often as every cycle. Offers cycle, TOD, and phase sequence tuning as well as compatible with any controller supporting NTCIP, AB3418E or QuickComm. Additionally, an optional component exists to analyze each incremental adjustment for safety. If an unsafe condition is determined to exist with the adjustment, the adjustment is not made. Compatible with typical layouts used for intersections under fully actuated control. Incorporates detector processing to be flexible with size, location and capability of detectors.	The use of existing controllers and detectors reduces the cost of deploying this adaptive strategy. Logical detector processing reduces the need to resize or relocate existing detectors.
InSync	Within a subset of 16 possible sequences of phase pairs (states) at any quad intersection, this adaptive system uses real-time traffic movements to select and input to the controller the optimal state. Plug-in system connects to existing traffic signal controllers using new detector cards.	Requires IP digital video detection cameras at all adaptive intersections and potential upgrade to controller detector cards. Requires the use of a proprietary I/O board within the processor and associated detector cards.
LA ATCS	Applies heuristic formulas based on extensive operational experience and adjusts offsets, splits and green time accordingly. Interfaces with Type 170 or 2070 controllers.	Requires at least one detector per lane for each phase upstream (200-300 ft) of the intersection.
RHODES	Proactively responds to stochastic variations in traffic flow by setting phase durations explicitly rather than adjusting timing parameters of an existing signal plan.	Processing and memory requirements are such that the native processors on existing traffic controllers are incapable of supporting its operation. May require added detection at locations where detection is inadequate to support system.

APPENDIX F – NEIGHBORING JURISDICTIONS COORDINATION EXAMPLES

One of the primary benefits of ITS systems is to allow agencies to connect to one another and coordinate better when traffic is most affected. Although the day-to-day operation of traffic management for the City is important, working together during major special events or coordinating operations during incidents that create traffic delays extending into neighboring jurisdictions is necessary. Tempe's neighboring jurisdictions coordinate with each other for fiber sharing, traffic signal coordination, participation in planning meetings, and in other ways described in **Table F1**.

Tempe's ITS recommendations were established with a focus on how partnerships with neighboring agencies could create new and beneficial links to create a more transparent traffic management and incident response network. Future planned ITS infrastructure in Tempe should continue to coordinate with its neighbors' planned deployments to foster the greatest coverage and cooperation capabilities between the cities and the state.

Table F1 – Other Jurisdiction Coordination Examples

Agency	Infrastructure	Agency-to-Other Agency Coordination Examples
ADOT	TOC, CCTV, DMS, Fiber, Local TMC Coordination	CCTV viewing by public safety through MCDOT Video Distribution System (VDS) system Partnership with Cities for use of conduit and fiber in ADOT right-of-way ADOT has established an agreement with Mesa to alert of incidents on freeways in Mesa
City of Mesa	TMC, Traffic Signals, CCTV, DMS, Fiber, Bus Rapid Transit	Traffic signal synchronization across jurisdictional boundaries with MCDOT along Power Road ADOT has established an agreement with Mesa to alert of incidents on freeways in Mesa Participation in the East Valley Signal Group to work with neighboring agencies to establish consistency and collaboration with traffic signals across jurisdictional boundaries (Tempe is involved in this Group) Established Bus Rapid Transit route for the Valley Metro LINK service through Mesa as an extension of the Light Rail line – could be looking to update the alignment of this line when the extension of Light Rail into downtown Mesa in 2012 begins construction
City of Phoenix	TMC, Traffic Signals, CCTV, DMS, Fiber	Coordinates with ADOT as part of Downtown Event Management to provide messages on DMS to support event traffic Coordinates with ADOT for signal management at freeway interchanges (Tempe does this as well) Worked with the City of Chandler and ADOT for coordination of traffic signals along I-10 corridor as part of MAG TSOP program in 2003-2004 (Tempe has coordinated with Chandler)
City of Scottsdale	TMC, Traffic Signals, CCTV, DMS, Fiber	Along the Scottsdale/Rural Road corridor, Tempe and Scottsdale coordinated to provide similar background cycle lengths to help achieve smooth progression along the corridor Coordination with Scottsdale Police personnel located in TMC during specific high-attendance events Coordination with DPS via police radio to provide updates on traffic conditions that impact incident response safety Programmed in near-term to establish a Scottsdale REACT Team to support incident response traffic control efforts within City limits
City of Chandler	TMC, Traffic Signals, CCTV, DMS, Fiber	Traffic signal synchronization across jurisdictional boundaries with Town of Gilbert and City of Mesa Participation in the East Valley Signal Group to work with neighboring agencies to establish consistency and collaboration with traffic signals across jurisdictional boundaries

APPENDIX G – MAG TIP APPLICATION REQUIREMENTS

G1. MAG TIP Application Process

The MAG TIP is a five-year schedule of specific projects to be constructed across the MAG Region. The *"Guide to Transportation Programming"* for MAG (developed in October 2007 for fiscal year 2008) provides MAG member agencies background information, instructions, and deadlines on the different transportation programs and requirements for the MAG TIP for each fiscal year. The typical MAG TIP process is outlined in **Table G1** as summarized by the timeline table published in each TIP. The important dates for agencies to be aware of are bolded in the table: initial project recommendations from agencies are due in August and the final MAG TIP is not typically approved until the next year.

The TIP application process could vary (including timelines) and agencies should periodically check with MAG to determine the application deadlines for the next TIP update cycle. With the uncertainty of future federal funding, MAG has deferred future programming. Tempe is very active with the MAG ITS Committee, and any TIP application information is shared through that Committee's communications.

For ITS projects, MAG allocates a specific amount per year (historically $6-$7M), and agencies in the region apply for funding for specific ITS projects. Applications are reviewed and consolidated by MAG, and then presented to the MAG ITS Committee for review and discussion. In many cases, funding requests exceed available funding, and it is up to the MAG ITS Committee to agree on an appropriate strategy, which could include reducing federal funding for some or all projects to be able to fund the majority of projects, or even eliminating some projects from consideration.

There have been opportunities for close-out funding through MAG, whereby there is a surplus of funds available after all projects have been funded. This is not the case for every year, and should not be viewed as a consistent funding source. Often, with such short turn-around for the close-out process, projects that are funded are typically smaller in nature, do not require any design, or have designs complete and just need funding for implementation.

Table G1 – MAG TIP Process

Transportation Improvement Program - Fiscal Year	
Year 1	
August	• **Member agencies develop project requests for MAG Federal funds** • **Stakeholders meeting/workshop on applying for MAG Federal funds**
September	• 1st Week - Member agencies submit project requests for MAG Federal funds • 3rd Week - Transportation Review Committee (TRC) review/recommend/approve draft list of MAG Federal Fund project requests
October	• Modal Transportation Advisory Committees (TACs) first review of requests for MAG Federal funds
November	• Modal TACs second review and rank modal projects
November/December	• TIP Data Entry System available to member agencies for project updates
December	• First Week - TRC review/recommend/approve second draft of MAG federally funded program
Year 2	
January	• 1st Week - Member agencies submit privately and locally funded projects for inclusion in TIP for an Air Quality Conformity Analysis (AQCA) • Managers, TPC, and RC review/recommend/approve second draft of MAG federally funded program
February	• Draft MAG TIP (Listing of Projects) produced • TRC recommends Draft TIP Project Listings for AQCA
February/March	• Draft TIP Project Listings for TAC and public review
April	• Managers, TPC and RC review/recommend/approve Draft TIP for an AQCA
April/May	• TIP undergoes AQCA
June	• AQTAC recommends approval of the AQCA • TRC review/recommend/approve TIP
July	• Managers, TPC and RC review/recommend/approve TIP
August	• Governor's designee approves TIP
August/September	• **First Four Years of the TIP included in the Arizona STIP**

G2. Specific Requirements for ITS Project Applications

For ITS project applications to the TIP, MAG includes two federal requirements that agencies must demonstrate compliance. These are requirements through SAFETEA-LU; it is not yet known if these requirements will remain with the new federal transportation legislation, or if there will be new requirements with that legislation. Any new requirements will be communicated to the City of Tempe and other local agencies by MAG. Current requirements are:

- Demonstrate compliance with the MAG RIA
- Demonstrate compliance with the Systems Engineering Process

This section provides Tempe with guidance on how to comply with these existing requirements.

G2.1 MAG ITS Architecture Mapping

An important goal of the MAG RIA development was to make the RIA a valuable resource to member agencies to support agency ITS project planning and development, ITS

integration, and required systems engineering processes. Systems Engineering is a requirement for the FHWA Final Rule 23 CFR 940 for ITS projects to be able to receive federal funding for construction/implementation. ***An agency that intends to develop an ITS project in their jurisdiction or in partnership with other agencies and will be applying for MAG TIP funding will be required to use the MAG RIA in the following ways:***

- To identify where in the MAG RIA the project is represented – this shows the pre-planning done in support of that project development.
- Agencies may be required to complete a systems engineering analysis – for documentation of the project development process that is using federal funds.
- Agency requirements for projects to be mapped to the architecture for compliance with the MAG TIP application process includes:
    - *Associated Market Packages* – Listing of the market packages from the MAG RIA that are supported by this project. This defines the system/s that will be created or impacted by the project.
    - *User Services* – Listing of the user services from the MAG RIA that are supported by this project. This defines the functionality that will be implemented.
    - *Subsystems* – Listing of the subsystems from the MAG RIA that are supported by this project. This defines the interfaces that will be added or updated.
- Market packages collect together the centers and devices that must work together to deliver a desired transportation service. Market packages depict current and future information transfer between ITS devices, management centers, and people. The market packages selected from the National ITS Architecture as part of the MAG RIA were chosen based on the existing and planned ITS infrastructure in Tempe at the time collected.

Refer to the MAG RIA website and click on the link for *"How to Use the Architecture – For Agency Project Development"* for support in the development of a Systems Engineering Analysis if required to do so for a specific ITS project. The current ITS projects in the MAG TIP have been included on the website, which also links to applicable agency-specific market packages.

G2.2 Project Type Mapping to MAG RIA

Table G2 is a consolidation from the MAG RIA Table 20 of the *Final Report*, which summarizes the location of information on the website for agencies to use to develop various types of ITS projects. When Tempe is reviewing the architecture website for TIP project applicability, selecting the appropriate inventory item will identify the market packages and equipment packages that would apply to that project. The "Market Package by Functional Area" link on the website could be helpful for Tempe where there is not a specific market package defined for the project/program planned for implementation.

Table G2 – Example Project Type Mapping to MAG RIA

Project Type	ITS Inventory	Example Subsystems	Example Associated Market Package	Example Equipment Packages	Example User Services
Installation of new CCTV cameras / expansion of existing camera system and integrating the cameras to be operational from a control center	CCTV, TMC	Roadway Subsystem, Traffic Management	ATMS01 - Network Surveillance	Roadway Basic Surveillance	1.6 Traffic Control 1.7 Incident Management
Installation of new DMS and integrating DMS to be operational from a control center	DMS, TMC	Roadway Subsystem, Traffic Management	ATMS06 - Traffic Information Dissemination	Roadway Traffic Information Dissemination	1.2 En-Route Driver Information
Synchronization of traffic signals along key corridor and integrating system to be operational from a control center	Traffic Signals, TMC	Roadway Subsystem, Traffic Management	ATMS03 - Surface Street Control	Roadway Signal Controls	1.6 Traffic Control
Deployment of traffic detection for use at mid-block locations and intersections	Vehicle Detectors, TMC	Roadway Subsystem, Traffic Management	ATMS01 - Network Surveillance	Roadway Basic Surveillance	1.6 Traffic Control
TMC to TMC communications installation to facilitate interagency coordination	TMC	Traffic Management	ATMS07 - Regional Traffic Management	TMC Regional Traffic Management	1.6 Traffic Control 1.7 Incident Management
Implement a project to archive data and send applicable information to a regional server for dissemination via 511 or another traveler information service.	Local City and Municipal Archived Data	Archived Data Management Subsystem	AD1 - ITS Data Mart AD2 - ITS Data Warehouse	ITS Data Repository	7.1 Archived Data

G2.3 Tempe Project Applicability to MAG RIA

The MAG TIP Application requires agencies to map project elements to the National ITS Architecture elements, subsystems, and user services. Specific strategies developed for Tempe are linked back to the market packages from the MAG RIA as shown in **Table G3** to help guide the Tempe TIP application process. This table will help with applying for funding for projects that use the various types of ITS infrastructure and communications. Each ITS component type that is marked with an 'X' is included or associated with that market package listed at the left. ITS components that are marked 'X-Central' identify the primary element for which the majority of information flows and coordination occurs as part of that market package. This table is flexible to the expanding ITS system and can be used to support the application of the MAG RIA to ITS components and functionality Tempe chooses to implement in the future.

Table G3 – ITS Components Applicability to MAG RIA

Market Package	TMC	CCTV	Permanent DMS	Portable ITS Equipment	Traffic Signal	Detection	Transit ITS	General ITS Comm.	Comm. Connecting Departments
AD1 – ITS Data Mart	X		X	X	X	X		X	X
AD2 – ITS Data Warehouse	X		X	X	X	X		X	X
APTS01 – Transit Vehicle Tracking							X		
APTS 02 – Transit Fixed-Route Operations							X		
APTS03 – Demand Response Transit Operations							X		
APTS05 – Transit Security		X					X		
APTS06 – Transit Fleet Management							X		
APTS07 – Multi-modal Coordination	X	X			X		X		
APTS09 – Transit Signal Priority	X				X		X		
ATIS01 – Broadcast Traveler Information	X		X	X				X	
ATMS01 – Network Surveillance	X	X		X				X	
ATMS03 – Surface Street Control	X				X	X		X	
ATMS06 – Traffic Information Dissemination	X		X	X					X
ATMS07 – Regional Traffic Management	X				X	X			X
ATMS08 – Traffic Incident Management System	X	X	X	X	X	X	X	X	X

Table G3 – ITS Components Applicability to MAG RIA (continued)

Market Package	TMC	CCTV	Permanent DMS	Portable ITS Equipment	Traffic Signal	Detection	Transit ITS	General ITS Comm.	Comm. Connecting Departments
ATMS13 – Standard Railroad Grade Crossing	X				X	X			
ATMS19 – Speed Monitoring	X					X			
EM01 – Emergency Call-Taking and Dispatch								X	X
EM02 – Emergency Routing								X	X
EM06 – Wide-Area Alert	X							X	X
EM07 – Early Warning System	X							X	X
MC04 – Weather Information Processing and Distribution	X		X	X	X	X		X	
MC10 – Maintenance and Construction Activity Coordination	X		X	X	X	X		X	
Other Market Packages That May Apply to Tempe in the Future									
ATMS17 – Regional Parking Management	X			X					
APTS04 – Transit Fare Collection Management							X		
APTS08 – Transit Traveler Information							X		
APTS10 – Transit Passenger Counting							X		

G2.4 ADOT Systems Engineering Checklist

ADOT, FHWA and MAG have developed a Systems Engineering Checklist that must be submitted to ADOT for review as part of the federal authorization process. The Systems Engineering Checklist needs to be completed prior to authorization of federal funds (not as part of the TIP application process). This checklist incorporates many of the ITS architecture mapping requirements, as well as requires identifying what documentation has already been prepared, such as a Feasibility Study, Concept of Operations, Alternatives Analysis, etc. The City of Tempe will be able to utilize the information in **Appendix G** regarding the MAG RIA to support many of the required elements of this checklist, including:

- User Service Bundles
- Market Packages to be implemented (or modified)
- ITS Standards to be used

A copy of the current checklist is available at.

http://www.azmag.gov/Documents/ITS_2010-11-22_ITS-Systems-Engineering-and-Architecture-Compliance-Checklist.pdf