OPERATIONS MANUAL

TUCSON METRO AREA

FEDERAL PROJECT NO. ITS-9904 (005)
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1.0 GENERAL INFORMATION

1.1 Background

Urban traffic congestion has become a fact of life across the U.S., and studies indicate that this problem will not get any better in the future. The number of registered vehicles is increasing rapidly and exceeds the growth of population. The migration of jobs from the cities to the suburbs has resulted in dramatic growth in travel, not only on freeways but also on urban arterials.

Congestion occurs when demand exceeds capacity (e.g., during peak hours, called recurring congestion) or when capacity is reduced (e.g., during incidents when lanes are blocked, called non-recurring congestion). The non-recurring (incident-related) congestion is a substantial part of overall congestion and its effects can be more serious and critical. It is estimated that by the year 2005, approximately 70 percent of the overall urban congestion will result from incidents and the resulting cost to the U.S. public will exceed $75 billion because of lost productivity. Therefore, it is beneficial that incident-related congestion be managed in an organized, comprehensive manner in order to increase safety, mobility, and economic vitality. These goals can be achieved through the implementation of a freeway management system (FMS).

1.2 Regional Freeway Management System Concept

The components of an FMS include field hardware (cameras, variable message signs, ramp meters, traffic interchange signals, vehicle detectors, and communications equipment), a traffic management center with associated hardware and software, the policies and procedures established to deal with transportation-related events, and the pertinent staff.

The objectives of the FMS are:

A. To reduce the impact and occurrence of recurring congestion on the freeway system;

B. To minimize the duration and effects of non-recurring congestion on the freeway system;

C. To maximize the operational safety and efficiency of the traveling public while using the freeway system;

D. To provide the facility users with information necessary to aid them in making effective use of the freeway facilities and to reduce their mental and physical stress; and

E. To provide a means of aiding users who have encountered problems (crashes, breakdowns, confusion, etc.) while traveling on the freeway system.

1.3 Tucson Freeway Management System

The long-term need for an FMS in the Tucson metro area was recognized in 1988 by the Arizona Department of Transportation (ADOT) as a result of an improvement study conducted for the I-10 corridor. The study identified the need for expanding the corridor capacity by increasing the number of traffic lanes on I-10 in Tucson, and the implementation of the FMS to maximize the utilization of future corridor capacity to meet demand beyond the year 2015.

The first phase of the Tucson Metro area FMS covers I-10 (Ina Road to 6th Avenue) and I-19 (Valencia Road to Irvington Road). This first phase features 12 closed circuit television (CCTV) cameras, 8 variable message signs (VMS), and a dedicated fiber optic communications system. The first phase will also enable the Tucson Traffic Control Center (TTCC) to communicate with the city 911 Center, Department of Public Safety (DPS) Dispatch Center, ADOT District Maintenance office on Grant Road, and the ADOT Traffic Operations Center (TOC) in Phoenix.

Future phases of the Tucson Metro area FMS will include additional features such as ramp metering and incident detection in order to provide real-time control capability of the system that adapts to real-time traffic movement.

In future phases of the Tucson FMS, freeway mainline detection system will comprise of sets of inductive loops in each traffic lane (or above the roadway, non-intrusive detection system) at a spacing of approximately one-third mile. Data from these detectors is used to electronically determine abnormalities in the system, which would indicate a potential incident. Once an incident is identified, CCTV cameras with pan, tilt, and zoom capabilities will be aimed at the potential incident location to enable the Control Center operators to confirm the incident and verify its type. Information to be communicated to the motorists will be displayed using VMS's, strategically located along I-10 and on I-19, where diversions may need to take place.

Traffic signals at the freeway interchanges and at intersections of the freeway frontage roads with cross-streets will be operated as part of the FMS. This function will provide efficient discharge of vehicles from freeway off-ramps and frontage roads during normal and incident conditions, and provide smooth progression along city cross-streets.

Several arterial interchange signals in the Tucson metro area are currently using video imaging detection devices, such as the Autoscope system. This video equipment also provides the TTCC real-time images of the freeway interchange ramps and traffic conditions at intersections.

1.3.1 Surveillance and Control System

The surveillance and control function is required to evaluate operational freeway traffic characteristics, and determine the appropriate operational control strategies. The components included under this function are:

A. Closed-Circuit Television (CCTV);

B. Variable Message Signs (VMS);

C. Route Diversion Plans;

D. Traveler Information (via the Internet); and

E. Metro Networks, Air/Ground Peak Hour Surveillance.

1.3.2 Incident Management System

Incident management provides an operational and safety benefit to the motoring public. An effective incident management program requires the cooperation and coordination of all the resources to restore the freeway or local roadway to full traffic capacity quickly and efficiently after an incident occurs.

The techniques and procedures used to deal with incident-related freeway congestion comprise several components, each of which can effectively solve a part of the problem. All of these components are then integrated into an overall comprehensive incident management system that will deal with the problem in its entirety.

Incident management involves six major phases, as listed below:

A. Detection;

B. Verification;

C. Response;

D. Removal;

E. Traffic Management; and,

F. Motorist Information.

Incident management can save lives, time, and money by minimizing the time that dangerous obstructions remain on the roadway.

1.3.3 Traveler Information System

Providing timely and accurate information to motorists is essential in order to enable them to make informed decisions on route choice. An added benefit is the reduction in secondary accidents as motorists become alerted to the existence of congested conditions. The following are several methods for providing information to motorists:

A. Variable Message Signs;

B. Commercial Radio;

C. Highway Advisory Radio Systems;

D. Print Media;

E. Cable TV;

F. Cellular Phones;

G. Alphanumeric Pagers; and

H. In-Vehicle Route Guidance Systems.

1.4 Regional Traffic Signal Control System

The control of traffic signals, including signals operated by local jurisdictions, is beneficial to managing traffic which is diverted to frontage roads or arterials as part of a route diversion plan during the occurrence of incidents on the freeways.

The development of a coordinated signal progression along the arterials allows motorists to travel with limited controlled stopping, thus reducing congestion. Coordination may occur among all signals in the system or control could be provided for an individual grouping of signals. The City of Tucson controls all of the traffic signals at City intersections and freeway interchanges and monitors the traffic flows within its jurisdiction. This monitoring is accomplished by using a computerized central traffic signal control system, operated from the Tucson Transportation Control Center.

Other participating agencies, such as ADOT, Pima County, City of South Tucson, Town of Marana and the Town of Oro Valley will have traffic signals connected to the regional system as a part of a comprehensive regional system strategy.

1.5 Regional Transit Management System

A transit management system includes the use of advanced navigation and information, Automated Vehicle Location (AVL), scheduling, and communications technologies to improve the operations of public transportation systems. The principal components are fleet management, mobility management, traveler information, and electronic fare payment. The principal objectives of the transit management system are to:

A. Increase the convenience of fare payment;

B. Improve safety and security;

C. Increase service reliability;

D. Minimize passenger travel times; and

E. Improve schedule adherence.

1.6 Regional Emergency Management System

The Regional Emergency Management System includes the following features:

A. Automated emergency vehicle notification upon verification of an incident;

B. Routing of emergency vehicles in conjunction with special priority given through a traffic management center; and

C. The initiation of emergency assistance requests with the subsequent response from emergency management personnel.

2.0 INTERNAL POLICIES AND PROCEDURES

2.1 Daily Responsibilities

- ***The Tucson Traffic Control Center will monitor the Tucson FMS during weekdays, 6:00 AM to 6:00 PM.***

- ***The ADOT TOC in Phoenix will monitor the Tucson FMS all other times.***

The ADOT TOC in Phoenix is responsible for monitoring the freeway management system in the Phoenix metropolitan area, and operates 24 hour per day, 7 days per week. As ADOT expands management facilities in other parts of the state, the TOC continues to serve as a management focal point, supporting these various systems from a central location.

The Tucson Traffic Control Center (TTCC) is responsible for monitoring the local arterial traffic signals for several agencies in the Tucson metropolitan area, and will have links to the Tucson freeway management system giving the TTCC the ability to monitor the Tucson FMS.

Between the weekday hours of 6:00 AM to 6:00 PM, the TTCC will provide monitoring assistance for the Tucson FMS. All other times, the ADOT TOC in Phoenix provides monitoring for the Tucson FMS. DPS will be in contact the ADOT TOC in Phoenix 24 hours per day, 7 days per week. Frequent communications between the ADOT TOC and the TTCC will occur during times when both centers are staffed, to coordinate traffic management activities.

Subsequent sections delineate specific agency roles in controlling traffic and responding to incidents, emergencies and routine system adjustments.

Timely and accurate information relayed to the appropriate responders and decision-makers is required. The proper use of the closed circuit television cameras (CCTV) and the variable message signs (VMS) is required to provide rapid and accurate incident warnings to motorists.

Table 2.1 - Responsibility Table

Function	***6 AM to 6 PM Mon-Fri***	***Other Times***
Identify Incident	911/DPS/Metro Networks	911/DPS
Notify DPS/Police	911/DPS/Metro Networks	911/DPS
Notify Other Authorities	DPS	DPS
Dispatch ADOT Forces	Phoenix TOC	Phoenix TOC
Request VMS for – DPS Action	DPS	DPS
- Non-DPS	TTCC	City Communications or 911
Post VMS Message	Phoenix TOC/Grant Road	Phoenix TOC
Enter HCRS	Phoenix TOC	Phoenix TOC
Enter/Revise ADOT Log	Phoenix TOC	Phoenix TOC
Enter/Revise Metro Network Log	Metro Network	N/A
Continued Coordination	DPS/TTCC/TOC	DPS/TOC
Traffic Signal Change - Advance	TTCC	N/A
Traffic Signal Change - Emergency	TTCC	City Communications or 911

2.2 CCTV Monitoring

- ***The DPS has the highest priority in controlling the CCTV cameras on the Tucson FMS.***

The Tucson FMS currently consists of twelve closed circuit television (CCTV) camera sites, listed in Table 2.2. Expansion plans call for addition of one more camera south of the I-10/I-19 interchange.

When monitoring and controlling the numerous CCTV cameras that are now incorporated into the Tucson FMS, an administrative protocol, detailed in a later section, is established to minimize or eliminate operational conflicts between agencies.

Table 2.2 - CCTV Locations

CCTV No.	*Highway*	*Location*	*Milepost*
CCTV-1	I-10 WB	North of Ina Rd.	248.70
CCTV-2	I-10 WB	North of Orange Grove Rd.	250.00
CCTV-3	I-10 WB	North of Sunset Rd.	251.20
CCTV-4	I-10 WB	South of Ruthrauff Rd.	252.59
CCTV-5	I-10 WB	North of Prince Rd.	253.40
CCTV-6	I-10 WB	South of Prince Rd.	254.50
CCTV-7	I-10 EB	North of Miracle Mile	255.20
CCTV-8	I-10 WB	North of Grant Rd.	256.18
CCTV-9	I-10 WB	South of Speedway Blvd.	257.38
CCTV-10	I-10 WB	South of Congress St.	258.40
CCTV-11	I-10 WB	North of Starr Pass Blvd.	259.40
CCTV-12	I-10 WB	I-19/I-10 Interchange (North)	260.10
FUTURE	I-19 SB	I-19/I-10 Interchange (South)	101.00

Each operational entity shown in Table 2.3 has the capability to control cameras. This capability, if used imprudently, can result in personnel as well as job conflicts. Examples of potential conflicts are:

A. Interruption of visual observations during incident management operations;

B. Interruption of preprogrammed camera movement by the authorized agency;

C. Interruption of routine or periodic traffic monitoring by traffic technicians;

D. Interruption of VCR recordings used for data gathering, training, etc.;

E. Interruption of traffic surveillance for media reports; and

F. Interruption of surveillance for law enforcement operations.

2.2.1 CCTV Control Protocol

The following camera control priority levels shall be in effect:

Table 2.3 - Camera Control Priority Levels

Priority Level	***Agency***
1	Department of Public Safety
2	ADOT TOC (Phoenix)
3	TTCC (Tucson)
4	911 Center
5	ADOT Grant Rd. (Tucson)

The following CCTV control protocol rules shall be in effect:

A. The DPS Area Operator shall have access to the CCTV controls at any time, and shall supersede any other requests and users.

B. The TTCC may NOT take control of a camera when that camera is in the control of the DPS unless a participating agency has requested CCTV control from the TTCC, DPS is notified (refer to Contact List in Appendix) and approves, and the request is documented.

C. Cameras shall not be focused toward private property when not in use.

2.2.2 Non-Staffed Hours

The only traffic control center operating on a 24-hour-per-day/7-day-per-week basis is the ADOT TOC in Phoenix.

Tucson DPS personnel will maintain control of the CCTV at all times. In some instances, the DPS will not be available to receive and send messages via e-mail.

2.2.3 Policy

Video monitors in the TTCC and the DPS Control Center allow the operators to visually verify traffic incidents. CCTV cameras must be properly operated at all times to maintain agency performance and credibility. Still-frame images and video feeds to the media and Internet may be being viewed on a regular basis by the public. The following procedures shall be adhered to unless specific approval is granted by the Operations Supervisor to alter procedures.

All live video feeds shall display the ADOT logo.

Monitoring Incident Sites:

When incidents have been verified via the monitors or when a report of an incident has been received, the DPS will determine what initial response is needed. After initial evaluation of the scene, the cameras will be used to monitor incident related congestion. DPS may continue to control the cameras during the incident and it may be necessary to zoom into the scene for more specific evaluation.

Monitoring Law Enforcement Actions:

Police activities such as foot pursuits and vehicle chases may occur within the area covered by cameras. Phoenix TOC and TTCC operators may also monitor and track these activities, at the request of a law enforcement agency. Officers may come to the DPS or TTCC to view camera images during police actions.

The DPS will be the lead law enforcement agency in such actions. The DPS will use the cameras to assist in monitoring their specific needs, as appropriate. The requirements of the DPS during these types of incidents will supersede all other requests.

2.2.4 Video Recording Requests

Video images shall normally not be recorded, and no tapes shall be maintained. Video images may only be recorded for internal use by an agency, and shall solely be the responsibility of that agency.

2.3 Variable Message Sign (VMS) Operations

- ***ADOT shall be solely responsible for posting messages on VMS.***

2.3.1 Introduction

The Tucson Freeway Management System currently consists of eight Variable Message Signs (VMS) listed in the table below. Expansion plans for two additional VMS, as shown.

Table 2.4 - VMS Locations

VMS No.	*Highway*	*Location*	*Milepost*
VMS-1	I-10 EB	North of Grier Rd.	237.00
VMS-2	I-10 WB	North of Cortaro Farms Rd.	244.70
VMS-3	I-10 EB	South of Vail Rd.	280.78
VMS-4	I-10 WB	North of Kolb Rd.	269.95
VMS-5	I-19 NB	North of San Xavier Rd.	57.85
VMS-6	I-19 SB	North of Drexel Rd.	60.13
VMS-7	I-10 EB	North of Prince Rd.	253.50
VMS-8	I-10 WB	South of Speedway Blvd.	257.40
FUTURE	I-10 EB	South of Speedway Blvd.	257.41
FUTURE	I-10 WB	East of Country Club Rd.	263.91

These guidelines describe desired practices for using VMS in connection with traffic management, incident management, construction zone safety, and special operations. The intent of this document is to promote consistency on the part of the participating agencies in using VMS so the public will come to recognize these devices as a reliable source of traffic information.

The VMS is an integral part of the day-to-day operations of traffic operations centers. The VMS provides information related to highway and/or traffic conditions:

A. VMS is used in highway construction to advise motorists of road restrictions and detours.

B. VMS is used to advise of accidents, congestion, delays, and closures during normal traffic flow.

C. Weather conditions affecting traffic flow, such as snow, ice, and blowing dust, are transmitted to drivers via a VMS.

Messages deployed on a VMS can specify conditions at a specific location and provide alternative routing or actions to take to minimize negative impacts on traffic. Messages are deployed on VMS boards that are located sufficiently far enough away to allow for ample recognition and decision time for the motorist to understand the message and to react to the message. Messages can be deployed several miles from an incident.

Unless noted otherwise, the guidelines contained in this document apply to both fixed overhead and portable VMS boards used on the freeway and frontage road system.

2.3.2 VMS Guidelines

Portable VMS use is recommended for long-term events with expected closures of two or more hours resulting in motorist delays of one hour or more. The requests for these signs will be forwarded to the ADOT maintenance supervisors who are responding to, or are aware of the closures in the area.

Portable VMS may be requested for special events by event sponsors, DPS, or other participating agencies. The request shall be forwarded to the ADOT TOC in Phoenix to coordinate the process with ADOT maintenance, the event sponsor, and the appropriate government agencies. Some events may benefit from the use of portable VMS on non-ADOT maintained roadways, depending on agency ability and availability of such devices.

The following is a set of policy guidelines for VMS message and sign use. It outlines numerous issues related to message creation and verbiage rules, message placement, and other VMS operational issues. This is provided as a resource for the incident management program in the Tucson area to help train operators in the use of the VMS in the Tucson area.

The following standard for message sizing has been assumed for the purposes of this section:

- Freeway VMSs are 3-line, 18-character per line in size, and are permanently mounted over the roadway on support structures. Messages are tailored to be displayed in a single panel, whenever possible.
- Portable VMS are 3-line, 10-character per line in size. Messages are tailored to be displayed in two panels, whenever possible.

The amount of detail to be considered in these applications is substantial. However, the effectiveness of VMS in a traffic environment requires the sign operator to understand what needs to be communicated and how to present it in a concise manner.

A key issue of VMS is that they should only be used in conjunction with incident advisory and warning signs. VMS are not valid for use as regulatory signs because their use for regulatory messages is not recognized or standardized in the Manual on Uniform Traffic Control Devices (MUTCD) or the Federal Highway Administration "Traffic Control Device Handbook". Likewise, VMS have no legal status with respect to enforcement of any information that may be displayed.

The primary function for any VMS is to provide real-time information, in an advisory (advise motorists of conditions) or warning (warn motorists of conditions) capacity, on current traveling conditions. The effectiveness of VMS is therefore dependent on providing information which is timely, accurate, and reliable.

2.3.3 Typical Applications

Typical applications of VMS are detailed in the following table.

Table 2.5 – Typical VMS Applications

Application	***Condition***
Traffic Management	• Congestion • Construction • Maintenance • Special Events
Incident Management	• Collisions • Debris on the road • Hazardous Materials Spills
Environmental Conditions	• Adverse Weather • Fog • Dust Storms

Traffic Management:
This application deals with using VMS to manage traffic congestion where demand exceeds capacity for temporary periods. This category also includes traffic diversion, which may entail "active" or "passive" route guidance.

Active route guidance implies giving specific information to drivers concerning exact alternate routes to be followed to avoid a particular traffic condition. Active route guidance should not be used unless the recommended alternate route or detour is signed as such from end-to-end, and conditions on that route are actively monitored.

With passive route guidance, information is displayed indicating that a condition exists on the present route. It becomes the driver's choice whether they wish to divert and, if so, onto which alternate route.

Traffic management applications for VMS also include traffic conditions associated with special events (e.g. ball games, downtown events, parades) and scheduled events such as construction, temporary roadwork and routine maintenance. The VMS system can be an effective supplement to construction traffic control, but should not be used in lieu of adequate traffic control planning. Anticipated VMS use for construction and maintenance should be included in project traffic control plans, and scheduled in advance. The VMS system should be used when construction activities require drivers to perform complex maneuvers, for construction activities with major traffic impact, or in cases where traditional signing methods are impractical.

Incident Management:
This area of application includes incidents on freeways caused by random and unpredictable incidents such as traffic accidents, temporary lane blockages and hazardous material spills. Typically, VMS are used under these circumstances to inform drivers that an incident has occurred, the incident's geographic location relative to the VMS (e.g. "At Speedway"), and the impact (e.g. "Rt Ln Closed"). The use of the VMS messages for incident information requires monitoring by DPS, TOC or TTCC personnel. VMS shall not be left in operation after the condition it is addressing has expired, as public credibility will become damaged.

The use of a VMS system for incident information has the greatest potential for increasing or decreasing VMS credibility. If VMS messages are accurate and timely, they increase traffic management credibility.

Environmental Conditions:
This category applies to using VMS to alert drivers of the impact due to adverse weather conditions, such as rain, dust storms, ice and wind. In this capacity, VMS can be used to advise drivers that conditions warrant caution on their part to maintain levels of safety in keeping with current road conditions. Under this application, messages may also state a cautionary speed which drivers could choose to follow.

2.3.4 Freeway VMS

The freeway VMSs used in the Tucson Area are designed to support urban freeway operations. These signs are located at fixed strategic points around the network to provide drivers with information concerning incidents, roadwork, road conditions, and route information.

The purpose of Interstate VMS is to provide real-time traffic advisory and route guidance information to travelers on the freeway, in advance of an incident or traffic-impacting event, to give drivers the chance to react as they deem appropriate. The specific information conveyed may relate to accidents, roadwork, lane closures, status of connections to other routes, debris on the road, freeway closures, weather/environmental conditions as they relate to road conditions, and information regarding traffic conditions due to special events.

Freeway VMS should be available for use at all times (24 hours/day, 7 days/week) and should be used in coordination with adjacent VMS to provide information on an area-wide basis depending on the severity and impact of an incident. For example, if two VMS are available upstream from an incident, the sign farthest from the incident would be used to provide advance warning allowing drivers the time to divert from the route. Meanwhile, the sign closer to the incident would be used to control traffic flow nearer the incident. The strategic placement of these signs will support such coordinated use.

Freeway VMS have been strategically located in advance of major freeway-to-freeway interchanges or major surface-street interchanges along the I-10 corridor, to provide information to motorists prior to their reaching these route-decision points. The location of VMS sites in the Tucson region is shown in Table 2.4.

2.3.5 Message Elements and Characteristics

Unlike other traveler information devices, motorists must be able to read, assimilate and react to sign messages within a very short time frame. In the case of the freeway VMS, which generally have a minimum of 900 feet of visibility, this equates to 8.8 seconds of viewing time for motorists traveling at 70 mph, or 11 seconds at 55 mph.

2.3.6 Message Structure

To ensure messages are presented in a clear, concise, and consistent format, the following elements should be included in a message:

1. State the **PROBLEM** being addressed (accident, maintenance, construction, lane blockage);

2. Describe the problem **LOCATION** (cross street name, exit number, distance from sign);

3. Define the recommended motorist **ACTION** or **EFFECT** (Use Alternate, Prepare To Stop, Long Delay, Shoulder Closed).

Many agencies purport to follow these guidelines, but often fail to be strict in the element order or description. It is often tempting to overemphasize a particular element, with the end result being other elements are neglected, or messages become too long and complex. However, by adhering to the above structure, the composer is more likely to generate a message that is clear and succinct. Additionally, consistency in style and order allows the motorist to anticipate the message and allows them to focus on the element line that is of most importance to them.

2.3.7 Composition Guidelines

After the message has been developed, the composer or another person should always review it with the following in mind:

Word Economy:

The wording used in VMS messages can often be made more succinct through the use of alternate wording, word ordering, or appropriate abbreviations. Avoiding superfluous or implied words, such as the name of the road,[1] is the most effective method for reducing message length. Typically such words are implied statements that are useful in verbal conversations, but are unnecessary additions to a written sign message. The following example demonstrates the difference between a verbose or undesirable message (excess words) and a concise appropriate message (no excess words):

Verbose	*Concise*
GAME TRAFFIC **EXIT SPEEDWAY** **OR EXIT CONGRESS**	**EVENT TRAFFIC** **USE SPEEDWAY** **OR CONGRESS**

Message Phasing & Duration:
The key issue with phasing concerns display duration, which depends on message length. If a message requires more than one panel, it is an important consideration that there be ample time for the motorist to read it. Consideration should also be given to whether a long message can be shortened so that a single panel message will suffice.

If possible, multi-panel messages should always be avoided, both to mitigate message overload and to reduce the risk of confusing the driver. However, if a multiple panel message is warranted, and assuming the physical and atmospheric conditions at the site are sufficient to accommodate the maximum sight distance, the rule of thumb should be to provide a minimum exposure time of at least two seconds for each line and display transition.

For example, a three-line freeway VMS requires a minimum of six seconds (2 seconds per line) for the average motorist to read and comprehend. An additional two seconds are required to accommodate the dead time which occurs in alternating between displays, followed by an additional six seconds to read the second panel. This equates to a minimum exposure time of 14 seconds, or, at 70 mph, a viewing distance of nearly 1,440 feet. This is 60% more than the legibility distance generally required (of 900 feet) for a typical freeway VMS. This also fails to accommodate those drivers who began viewing the sign mid panel, which means they will need to see it cycle again which adds an additional 8 seconds (2 for the transition between panels, and 6 to fully read the first panel again) to this message exposure time.

The above example brings out two key factors associated with message phasing and display duration, namely travel speed of the driver and reading time necessary to comprehend a message. When multi-panel messages are required, both of these factors must be considered because they pose constraints on what can be accomplished in communicating with drivers via VMS.

The use of multi-panel messages also interjects the potential that a message may be misinterpreted if the panels are read out of sequence, or if one of the panels is missed altogether. Consider for example a message viewed on a portable VMS, the intended presentation being as follows:

Panel I	***Panel II***
I-10 EB **RAMP** **CLOSED**	**TONIGHT** **AT** **7 PM**

Under freeway conditions where, even in a construction zone, speeds may be as high as 55 mph, it is almost assured that at least one of these panels will be missed. For drivers who happened to miss the first panel, this message becomes completely meaningless and would probably leave the driver confused and dissatisfied with the efforts of those responsible for that sign. Likewise, if the second panel is missed, an entirely different and inaccurate meaning is conveyed. This may cause a lack of trust or disregard for other VMS as well.

Multipanel messages are generally inappropriate for high-speed freeway traffic, and instead should be used when traffic is either moving slower, or by restricting the alternating panel to fewer message statements. A safeguard and tool for operators is to provide them with a table defining the minimum read and sight distance times for each sign location. This table should be expressed for different speed ranges.

Table 2.6 addresses the issues of sight distance, travel speed and message phasing. The primary variable in reading a VMS is travel speed. The duration that a message is displayed may also be variable, however studies by Upchurch[1] have shown that a minimum read time of two seconds per line allows adequate time for the majority of drivers to read signs having up to 25 characters per line. When multiple panels are used to present a message, additional time must be included to allow for transition from one panel to the next.

Table 2.6 is to be read such that, for a sight distance of 900 feet and speeds of 75 mph or below, a single panel message of up to three lines may be displayed. Under these conditions, drivers will be able to have adequate time to read the message in its entirety.

For the same sight distance, at speeds of 55 mph and below, a four line message may be displayed. In this case the message will consist of two panels with the fourth line being displayed in the second panel, or the message may be distributed between the two panels with two lines per panel.

[1] Evaluation of Variable Message Signs: Target Value, Legibility, and Viewing Comfort; Upchurch, Baaj, Armstrong & Thomas; Presented at TRB; January 1992.

Table 2.6 - VMS Phasing and Display Time vs. Travel Speed

Sight Distance: 900 Feet — **3 Line VMS (Freeway)**

Number of Message Lines to be Displayed		1	2	3	4	5	6	7	8	9
Required Read Time in Seconds		2	4	6	10	12	14	18	20	22
Single Panel Message	≤ 75 mph	X	X	X						
Two Panel Message	≤ 55 mph	X	X	X	X					
	≤ 45 mph	X	X	X	X	X				
	≤ 40 mph	X	X	X	X	X	X			
Three Panel Message	≤ 25 mph	X	X	X	X	X	X	X		
	≤ 20 mph	X	X	X	X	X	X	X	X	
	< 15 mph	X	X	X	X	X	X	X	X	X

Sight Distance: 600 Feet — **3 Line VMS (Portable)**

Number of Message Lines to be Displayed		1	2	3	4	5	6	7	8	9
Required Read Time in Seconds		2	4	6	10	12	14	18	20	22
Single Panel Message	≤ 75 mph	X	X							
	≤ 70 mph	X	X	X						
Two Panel Message	≤ 40 mph	X	X	X	X					
	≤ 35 mph	X	X	X	X	X				
	≤ 30 mph	X	X	X	X	X	X			
Three Panel Message	≤ 15 mph	X	X	X	X	X	X	X	X	X

(The travel speeds listed are actual speeds observed and not posted speeds)

Under the same sight distance conditions, at speeds of 45 mph or below, a five line, two panel message may be displayed; at speeds of 40 mph or below, a six line, two panel message may be effectively displayed and so on as shown in the table for the sight distance of 900 feet. The first section of Table 2.6 relates to freeway VMS because they are specified to have a sight distance of 900 feet under all visibility conditions. The second table relates to portable VMS, which is designed to have a minimum sight distance of 600 feet.

Driver Comprehension:
Operators responsible for posting VMS messages must constantly have in mind the following question: "Is this message going to be as clear, concise, and relevant to the motorist (who only has a few seconds to read and comprehend the content) as it is to the composer who has additional background information and ample time to read it?"

It is vital that whenever a message is composed, the author considers the message from the drivers' point of view (i.e. be mindful of the VMS location and the fact that a driver will be traveling at a given rate of speed and distractions may be present). The minimum amount of text necessary to convey the message should always be used.

Word Usage & Meaning:
The importance of using the best word in a message cannot be overstated. A single word when used properly can convey a lot of information, while a word used improperly will create a lot of confusion.

Table 2.7 - Recommended VMS Word Abbreviations

Words	***Abbreviation***	***Words***	***Abbreviation***
Accident	ACC	Mile	MI
Alternate	ALT	Northbound	NORTH
Boulevard	BLVD	Parking	PKING
Center	CNTR	Right	RT
Closed	CLSD	Road	RD
Congestion	CONGEST	Roadway	RDWY
Construction	CONST	Roadwork	RDWRK
Eastbound	EAST	Route	RTE
Emergency	EMER	Service	SERV
Entrance, Enter	ENT	Shoulder	SHLDR
Expressway	EXPWY	Slippery	SLIP
Freeway	FRWY, FWY	Southbound	SOUTH
High Occupancy Vehicle	HOV	Speed	SPD
Highway	HWY	Traffic	TRAF
Information	INFO	Travelrs	TRVLRS
Lane	LN	Warning	WARN
Left	LFT, LT	Vehicle	VEH
Maintenance	MAINT	Westbound	WEST
Normal	NORM		

1. If the cause of an incident is unknown, describe the problem in general terms (e.g., "DELAY" or "CONGESTION").

2. Preferably use “ACCIDENT”. With the many international travelers, this is closer to Spanish. Or use “COLLISION” as a more professional term. Crash or Wreck appears unprofessional.

3. Avoid specifics or reasons when describing a problem. For example, “ACCIDENT” is a better term than "MULTI-CAR PILEUP" or "CAR FIRE."

4. Abbreviations for direction of travel should always be stated as “NORTH” for “Northbound”; “SOUTH” for “Southbound”; “WEST” for “Westbound”; and “EAST” for “Eastbound”.

5. Use "ROADWORK" in place of the word "CONSTRUCTION" for consistency with MUTCD requirements on advance warning signs.

6. Behavioral directives such as "REDUCE SPEED," should be used only when specifically requested by police or an emergency condition exists which warrants this usage.

7. Do not direct motorists to another route unless conditions on this route are known. If no good alternates are known, but a particular location should be avoided, use the more general statement "USE ALT" or "AVOID AREA."

8. Attempt to influence diversions by adjusting the message strength. For example, "CLOSED" is more powerful and will cause more diversion than "BLOCKED.” Other words which may be used with varying degrees of impact are "JAMMED," "MAJOR," "LONG DELAYS," and "CONGESTED." The impact these words have on the network will be affected by many factors, including location and availability of alternative routes.

9. Do not overuse the word "CAUTION." It should be reserved for hazardous situations only.

10. Do not flash, scroll, or in any other way attempt to attract attention with artistic message displays. The VMSs are not advertising gimmicks, and it is essential that the motorist be exposed to the message content for as long as possible. Exceptions to this might be flashing the action statement (e.g., "CAUTION") to highlight some special urgency in the situation, or scrolling an arrow to depict a lane change.

11. Avoid excessive use of numbers, which can be confusing. This is particularly challenging when there is a need to use one or more freeway identifiers with the time. Spelling out a number (e.g., "NOON") can alleviate some of these problems. Avoid using references to 12 AM or 12 PM.

12. Unless automated and updated by the control system, avoid details that can be measured or are overly precise such as duration of time (i.e., “15 MINUTE DELAY”). Motorists will compare the results and fault the system if there is a discrepancy.

13. Capitalized letters should be used for all letters in every message. A single character font should be used when presenting a message.

14. As a general policy, signs should not be displaying messages all the time (i.e., ads, public service announcements, etc.), as this will desensitize the public to them and reduce their effectiveness in the event of a traffic incident.

2.3.8 VMS Operations

Operation of VMS involves three system aspects, which are interdependent;

1. Warrants, which define conditions for which VMS are to be used;

2. VMS operational control, and

3. Approved messages.

Details on these system aspects are provided in the following sections.

Warrant Criteria For Displaying Messages:

Because variable message signs are high profile devices specifically designed to attract drivers’ attention, it is recommended that they be used to display messages only when traffic conditions warrant, otherwise the signs should remain blank. Also, VMS should not be used to display the same message day in and day out. If this becomes the case, use of a static sign should be considered. This will help promote driver confidence that if the signs are displaying a message, then the information warrants drivers’ attention regarding traffic conditions.

The warrants stated in this section identify specific traffic conditions for which VMS may be used to communicate information to drivers. The traffic conditions identified in the warrants represent thresholds for which it is recommended, not mandated, that action be taken in form using the VMS to provide drivers with information concerning the traffic conditions.

To maintain credibility and message accuracy, traffic conditions should always be verified prior to the display of a message. Verification confirms that warrants have been satisfied and that conditions exist which require the use of VMS. Verification may be provided using CCTV cameras, DPS officers, incident management personnel or other EMS personnel.

Alternatively, when to remove a message is equally important to effective VMS operation. The point is to always have messages maintain their relevance to the intended audience. In this way messages don't become dated, stale, or inaccurate. The goal is to have drivers implicitly trust the messages they read and actively seek out and react appropriately to the information presented.

2.3.9 VMS System Priorities

Real-time VMS operations can become very fast paced and the operating environment can be quite dynamic. The variability of conditions on the road opens up the potential for conflict in terms of which situations will be handled in which order. This potential for conflict requires that priorities be established concerning which types of events should be handled first in a situation where several incidents and/or traffic conditions are occurring simultaneously. Prioritizing which types of events are to be dealt with, and in what order, helps to eliminate confusion and loss of time in critical situations. For this reason the following order of priority has been developed as a guide for operators who will be responsible for using the VMS system.

Event Priorities (Listed in order of importance):

1. ***Safety Related*** - Safety is the first priority. This means that any messages that are directly related to safety of the traveling public are given first priority for display. Notable examples of this are emergency situations where highway closures are required due to hazardous materials spills that pose clear threat to life and property.

2. ***Incidents*** - Primarily accidents where injuries have occurred and/or lanes are blocked. This also includes incidents where the potential for injuries exists due to occupied vehicles becoming disabled and blocking traffic lanes that should otherwise be open for travel.

3. ***Traffic Management*** - This includes major congestion delays, road, lane, or ramp closures regardless of the reason for the closure because these types of closures directly impact the route a driver would take. Road conditions related to weather are also included here.

4. ***Minor Traffic Impacts*** - Minor traffic impacts include construction lane closures, maintenance activities that slow traffic, and delay information.

5. ***Test Messages*** - Usually the timing for display of this type of message is discretionary and may be done at a time when distraction to drivers can be minimized.

6. ***Public Service Announcements*** - Messages related to driving safety, air quality warnings or other public service type messages.

2.3.10 VMS Operations Control

Operational control for all VMS that are a part of the Tucson FMS along the I-10/I-19 corridor will be under the sole authority of ADOT.

Using VMS Message Libraries:

VMS message libraries allow operators to maintain consistency in the text and presentation of VMS messages to the public, such that over time, drivers will become familiar with specific text and its meaning. Likewise, approved library messages reduce the likelihood that errors in message spelling or length may be input by operators.

VMS message libraries for the Tucson FMS shall be pre-approved by ADOT. Any permanent additions or changes to the VMS message libraries should be made by submitting requested changes or additions to the libraries, to ADOT for their consideration and approval. Such requests should be made by any participating agency if they contend that the local driving population would respond more effectively to a specific message, or that a recurring event or activity warrants the establishment of a specific message not already in the message library.

Using Messages Not Contained In A VMS Library:

The VMS message libraries shown here provide examples of message structure and abbreviation usage for use by agency personnel in creating messages required to meet their operational needs; these tables are not intended to be comprehensive in scope. As unique situations arise, requiring new message creation, it will be required that an individual in charge, or an appointed position, be responsible for reviewing such messages and authorizing them prior to displaying them on a VMS.

Message Authorization:

Participating agencies may request posting of messages through ADOT, and if ADOT concurs, will post the message. Special event messages shall be requested in advance to the Phoenix TOC.

2.3.11 VMS Message Examples

Table 2.8 – Traffic Management Messages

VMS Type	*Situation*	*Example Message*	
Permanent Freeway VMS	Freeway speeds fallen below 45 mph for more than 15 minutes or across two or more consecutive traffic monitoring stations, resulting in congestion	CONGESTION NEXT 2 MILES EXPECT DELAY	
	Any time freeway speeds fall below 30 mph for a period of 5 minutes	CONGESTION NEXT 2 MILES EXPECT DELAY	
	Construction or maintenance activities which reduce the capacity of the freeway	ROADWORK NEXT 5 MILES RT LANE CLOSED	
	The existence of work zones on the freeway, which require work vehicles to merge in and/or out of freeway speed lanes	TRUCKS MERGING 1 MILE USE CAUTION	
	Geometric changes requiring traffic channeling, merging or weaving patterns that are temporary and different from the normal alignment	RT 2 LANES CLOSED NEXT 2 MILES MERGE LEFT	
	When anticipated demand exceeds capacity in localized areas due to traffic destined for high impact special events	EVENT PARKING USE SPEEDWAY OR CONGRESS	
Portable VMS	Construction or maintenance activities present which reduce freeway or surface street capacity	RIGHT LANE CLOSED	XX MILES
	Geometric changes requiring traffic channeling, merging or weaving patterns that are temporary and different from the normal alignment	LANES SHIFT LEFT	XX MILES

	Special event traffic volumes creating excessive demand on surface street capacity based on circulating traffic looking for parking	EVENT PARKING	1 MILE AHEAD

Table 2.9 – Incident Management Messages

VMS Type	*Situation*	*Example Message*	
Permanent Freeway VMS	Incident which reduces the capacity of the freeway	RT LANE CLOSED 2 MILES MERGE LEFT	
	Event adjacent to the freeway which threatens the health and/or safety of drivers on the freeway	ROAD CLOSED 2 MILES EXIT SPEEDWAY BLVD	
	Disabled vehicle on either shoulder of the freeway, causing queuing and/or reduction of speeds below 55 mph to occur upstream	CONGESTION NEXT 2 MILES EXPECT DELAY	
	Debris on any portion of the travel lanes of the freeway	DEBRIS LEFT LANE	
	Civil defense emergency	FREEWAY CLOSED 2 MILES EXIT SPEEDWAY BLVD	
Portable VMS	Incident which reduces the capacity of the freeway and is projected by an Incident Management Team member to last for a duration exceeding 2 hours	LEFT LANES CLOSED	MERGE RIGHT
	Event adjacent to the freeway which threatens the health and/or safety of drivers on the freeway projected to last for a duration exceeding 2 hours	I-10 EB CLOSED	EXIT AT SPEEDWAY

Table 2.10 – Environmental Conditions Messages

VMS Type	*Situation*	*Example Message*
Permanent Freeway VMS	Reduction in visibility to 1,000 feet or less (dust, fog, etc.)	SEVERE DUST NEXT 1 MILE REDUCE SPEED
	Icy pavement conditions	BLACK ICE POSSIBLE USE CAUTION
	High winds	HIGH WINDS NEXT 2 MILES USE CAUTION

2.4 Telephone Contact

- ***Citizen requests/questions are received at the TTCC on a publicly published telephone number.***

- ***Participating agencies contact the TTCC on a separate number, reserved solely for the purpose of agency coordination.***

Distribution of the TTCC direct numbers should be limited to sources the TTCC desires to have direct access. Public distribution of a direct number to the TTCC makes for positive public relations, but will result in frequent disruptions during emergencies and other times when TTCC personnel need to direct their attention to management functions.

One direct number should be dedicated solely for the purpose of interagency access to the Phoenix TOC from the other participating agencies.

Citizen requests and questions should be received by the TTCC on a publicly published telephone number, and will be directed to the appropriate agency. Each agency will follow established procedures in dealing with citizen requests. Emergency calls will be directed to the 911 Center.

2.5 News Media Communication

- ***Operators shall be extremely cautious in what information is provided to the media.***

Metro Networks Access to TTCC:
Metro Networks has entered into a public-private contractual agreement with the City of Tucson to have Metro staff members assigned to the TTCC. They will provide information to their network on traffic conditions throughout the area. Metro staff shall adhere to the applicable policies in this manual (Security, etc.) while working in the facility.

Media Procedures:
When the media seeks further information on events, the TTCC operators will refer them to the appropriate office for information. When the media inquires about closures due to police activities or investigations, they shall be referred to the appropriate law enforcement agency. There shall be no access without the written approval of the appropriate emergency service provider.

OPERATORS MAY PROVIDE DELAY OR DETOUR INFORMATION BUT SHALL NOT COMMENT ON CAUSE OR GIVE ESTIMATED TIME OF CLEARANCE.

Inquiries about ADOT will be referred to the ADOT Public Information Office. Inquiries about potential claims of negligence or possible employee misconduct will be referred to the participating agency.

If an ADOT or other participating agency employee is involved in an accident or is the victim of an accident or crime, all media inquiries shall be referred to the agency conducting the investigation. In all cases, the TTCC Supervisor and affected participating agency shall be notified as soon as possible of media inquiries.

2.6 Public Relations

Requests for tours or individual access to the TTCC for observation purposes shall be referred to the City Traffic Engineer or his designee for further consideration, approval and arrangement. Typically, tours should not be conducted during peak traffic periods, emergencies or scheduled major events so as to not detract TTCC staff attention from the traffic management function.

2.7 Control Center Security

- ***The TTCC is a secure facility and must be maintained as such by all staff at all times.***

The TTCC shall be viewed as a secure facility, and not available for random public access. The operator workstation area shall be secured with locked doors

As the TTCC operation grows and staff and other legitimate participants have a need for access, the use of security access cards may be appropriate as a means of controlling access while minimizing TTCC staff involvement in the access process.

Participating agencies shall formulate a listing of legitimate TTCC visitors who shall be approved for access without question, such as technicians or Traffic Engineers directly involved in traffic operations. Law enforcement agencies and Metro Networks may do the same. However, it is prudent to limit the list of “full access” individuals who have full reign of access, and to further define hours and days access should be allowed for each.

Participating agencies shall be responsible for notifying TTCC staff of changes in agency staff that imply a change in access level of listing. If an employee is terminated or has a scheduled resignation, immediate access controls shall be implemented.

Personal visitors such as family members or co-workers who otherwise have no job related purpose in the TTCC shall be obligated to follow the security rules noted herein.

Building maintenance staff and cleaning personnel shall not be given free access to the TTCC. All facility maintenance, such as changing of light bulbs, cleaning, etc. shall be performed at times when the TTCC is occupied by staff. This policy may be relaxed on an experimental basis if additional security measures, such as security cameras or card access are in place and TTCC management approves alternative policies.

Approval of the list of personnel allowed direct access, by day of week and hour of day, shall be approved by the City Traffic Engineer or his designee. Being an employee of a participating agency does not give an individual an inherent right to access to the TTCC.

2.8 Budgeting, Staffing, Equipment & Spare Parts

- ***The participating agencies must dedicate sufficient resources to support the various elements of the traffic management operation.***

Budgeting:
Budgeting, staffing, equipment and spare parts are the responsibility of each participating agency.

Any monetary exchange between public agencies in support of daily system operations may result from additional intergovernmental agreements (IGA's), but currently are not in place. Existing IGAs specify who is responsible for various tasks, with the assumption that each agency will develop a mechanism for paying for such tasks internally.

ADOT, Pima County and the other participating agencies fund their activities from general operating funds. No special funding or pool funds are currently used for regional operations.

Staffing:
Each agency is responsible for maintaining and training adequate staff to fulfill their own needs. For traffic signals, this generally implies that the City of Tucson and its designee will accommodate the TTCC operations staff and each agency will have a mechanism by which they can maintain their own controllers and cabinets in the field with agency personnel or via contracted agent.

Needs to increase staffing as a result of increased numbers of signals results in individual agencies requiring to commit sufficient resources to support such infrastructure successfully. Over time, it may be possible for agencies to pool resources to fulfill that commitment.

Equipment & Spare Parts:
ADOT is responsible for maintaining the FMS field equipment and making sure sufficient supply of spare parts is available. In the event of a need for maintenance or parts relative to FMS field equipment, the Grant Road Maintenance facility shall be notified.

The City of Tucson is responsible for maintaining the TTCC FMS equipment as agreed upon in the FMS Intergovernmental Agreement (IGA) with ADOT.

Each participating agency is responsible for their own equipment and spare parts for the traffic signal controllers and cabinets. Variations may arise as a result of annexations, IGA's or route turn-backs to local agencies – all of which shall be fully documented with agency responsibilities spelled out.

2.9 Documentation and Information Update

All incidents reported to the TTCC will be referred to the appropriate agency where it will be logged and dealt with according to that agencies standard operating procedures. Each agency shall be responsible for keeping their own logs/records per their current policies. Detailed information including times of response, clearance, and each transaction should be recorded as they occur.

2.10 Education and Training

- ***Training should be an ongoing commitment in order for the system to be operated at its highest efficiency.***

Initial system training for the *iCons* traffic signal system is provided as a part of the initial system integration by the system vendor to TTCC staff. TTCC staff shall train other users as they come on-line. Initial system training for the FMS components is provided through the construction contractor as a part of the FMS Phase I implementation.

Periodic training sessions for the purpose of refresher training and to respond to curiosities and questions developed through system usage for both the signal and FMS

systems should be offered to workstation operators on an annual basis. New operators should participate in those sessions.

It is suggested that the initial training as well as each refresher training session be videotaped and made available as a part of the training for new operators for both the TTCC and participating agency workstation users. TTCC staff should be the maintainers of training videotapes, arranging and coordinating all future training as the lead agency for operations of these systems.

All workstation operators from each participating agency shall have sufficient training prior to being allowed access to the system beyond a read-only mode. The TTCC Supervisor shall assign the access level for all traffic signal system workstation users, complying with the access level guidelines set forth herein. Changes in access levels or disputes regarding access level assignments shall be mediated between the City Traffic Engineer and the participating agency's supervisor. The ADOT Phoenix TOC shall be responsible for assigning FMS user rights.

As system operations issues arise within any participating agency, issues related to the traffic signal system should be documented and transmitted to the TTCC for compilation. Issues related to the FMS should be transmitted to the ADOT TOC in Phoenix. Subsequent annual training should then take into account the compiled list of issues and address how to deal with each. If an identified issue with the signal system, by nature of its importance or impact on daily operations, is deemed significant enough for immediate action, the TTCC shall initiate contact with the appropriate vendor or party to seek out whatever information is needed to resolve or respond to the issue. The ADOT Phoenix TOC will be responsible for contacting vendors with issues related to the FMS.

2.11 Computer Software and Hardware

Computer software and hardware (CCTV control system, VMS system, traffic signal system) was supplied as part of the initial system implementation for the FMS and the regional traffic signal system. Maintenance of equipment is the responsibility of the agency in which the equipment resides. The TTCC staff may offer advisory assistance upon request, but current financial arrangements do not provide a pool of funds for mutual use for TTCC or agency workstation hardware and software maintenance or equipment replacement.

If a piece of hardware fails, the participating agency in which the hardware resides should evaluate whether they are capable of determining the source of the problem and are able to mitigate the problem or if an outside vendor needs to be called.

Agencies are suggested to check the status of warranties on hardware prior to conducting self-repair efforts. Warranty information for initial system implementation

should be the responsibility of ADOT staff, who may, in turn, transfer information relative to specific equipment to the agency in which that equipment is assigned, making that agency responsible from that point.

Software issues shall be directed to Phoenix TOC to determine if the issue is based in the host systems or at the workstation. Host system issues (CCTV controllers, some CCTV switches, VMS message controller software) should be bought to the attention of Phoenix TOC staff for action. Phoenix TOC staff shall determine problem symptoms, determine a course of corrective action, and initiate action if related to any software elements residing at the Phoenix TOC or TTCC. If the software issue affects participating agencies, Phoenix TOC staff shall issue an informational message to all affected agencies stating the problem, resulting system operations limitations, course of corrective action, anticipated time frame for resolution and a contact person at the ADOT Phoenix TOC for further information. Agencies shall follow a similar procedure with the iCons system except the TTCC will be the contact agency.

Local software issues shall be initially evaluated by the participating agency, or their agent. In some cases, the ADOT Phoenix TOC or TTCC staff may assist in this evaluation.

The cost of resolving local hardware and software issues falls upon the participating agency if no warranty coverage otherwise exists for the specific issue.

2.12 Highway Condition Reporting System

The Highway Condition Reporting System (HCRS) is a Windows based, real time information system designed to collect statewide roadway information from a variety of sources. The information includes:

- Current and planned road closures and alternate routes;
- Current restrictions, such as closed lanes and speed reductions;
- Incident or accident location and status;
- Current roadway conditions, including weather information;

The HCRS is operated by the Arizona Department of Transportation, although a number of other organizations enter information into the system via workstations, as authorized clients. Information entered into the HCRS is accessible via the Arizona Department of Transportation's Internet Web site, "www.azfms.com," which also includes real-time CCTV camera views of freeways in the Phoenix metropolitan area.

Information on Tucson area traffic conditions is entered into the HCRS, either directly by the ADOT Tucson District Maintenance Supervisor or by the ADOT Phoenix TOC, based on information provided by the Tucson Maintenance Supervisor. DPS Communications also enters traffic conditions directly into the HCRS.

2.13 Regional Traffic Signal Control

- ***Traffic signal timing is the responsibility of the owning agency.***

- ***Emergency situations allow reasonable variations in the public interest.***

The Tucson area has the advantage of a regional traffic signal control system, independent of the freeway management system, based on the *iCons*[tm] software platform. All traffic signals will eventually be connected, and all regional agencies that own traffic signals will participate. Geographic coverage extends from Marana and Oro Valley to the north, to Green Valley and Sahuarita to the south, including all Pima County signals in the unincorporated areas in between.

iCons allows the TTCC to monitor and modify traffic signal operational parameters from the TTCC. The system maintains all of the data for every connected traffic signal, and allows upload and download of data.

2.13.1 Agency Responsibilities

The following agencies have Intergovernmental Agreements (IGA's) that support the maintenance and operation of traffic signals:

- Arizona Department of Transportation
- City of Tucson
- Pima County
- Town of Marana
- City of South Tucson
- Town of Oro Valley

There are multiple IGA's on the subject of installation, operation and maintenance between the various organizations, and these are contained in the Appendix. As new agreements are formulated, they should be added to this document.

Agency traffic management staff is warned that when interpreting the IGA's, that the language used in each IGA implies that each stands alone, and does not necessarily supercede or supplement the preceding agreement.

There is an identified need to consolidate, update and refine the language of the interagency IGA's into a set of agreements that provides more specific language regarding specific responsibilities as Tucson implements a regional traffic control strategy. For example, the use, installation and maintenance of RCU units as a traffic signal interface is specified in the exiting IGA's, but would not be applicable under the new system architecture. Other examples of IGA needs include revisions to the responsibility for traffic signal timing under normal conditions and emergency conditions. New IGA's will be formulated with language to provide each participating agency with a hierarchy of secure traffic signal data under the new regional control system.

As IGA's are updated, or new IGA's come available, they should be posted in the Appendix of this Manual for quick reference.

Arizona Department of Transportation:
Owns, operates and maintains all traffic signals on State routes outside of the City of Tucson city limits.

Owns, operates and maintains the following traffic signals within the City limits:

- I-19/Ajo Way
- 16th Avenue/Ajo Way
- Benson Highway (B-10)/Palo Verde Road
- I-10/Alvernon
- I-10/29th Street
- I-10/Valencia
- I-10/Hotel Circle
- I-10/Palo Verde

The above locations are currently owned, operated and maintained by ADOT, but may eventually transition to City responsibility under a future IGA due to recent annexation of the areas in which these signals are located.

Under the regional traffic control system, ADOT has access to all regional traffic signals via a workstation at the Grant Road Maintenance Yard that allows data control to ADOT signals, and read-only access to all others.

City of Tucson:
Owns, operates and maintains all traffic signals within the city limits. By IGA with the State, the city operates and maintains ADOT signals within the city limits except those listed above.

Under the regional traffic control system, the City of Tucson has access to all regional traffic signals via the TTCC, and is the System Administrator – allowing full data control to all participating signals.

Pima County:
Owns, operates and maintains all traffic signals within Pima County not otherwise maintained by ADOT or a municipality (City of Tucson, Town of Marana, City of South Tucson). This includes rural traffic signals in unincorporated areas, Sahuarita, and non-ADOT signals in Green Valley.

Under the regional traffic control system, Pima County has access to all regional traffic signals via three workstations at the Mission Road Traffic Signal Maintenance Shop that allow data control to Pima County signals, and read-only access to all others.

Town of Marana:
Owns, operates and maintains non-ADOT traffic signals within the incorporated Town limits of Marana. (The signals at I-10/Orange Grove and I-10/Ina Road will become the responsibility of the Town of Marana under a future IGA.)

Under the regional traffic control system, the Town of Marana will have access in the future to all regional traffic signals via a workstation located at Orange Grove Development Center that allows data control to Town of Marana signals, and read-only access to all others.

City of South Tucson:
Owns the traffic signals within the one mile square City limits. The City of South Tucson contracts with the Town of Marana on an on-call basis for traffic signal maintenance and operations.

Under the regional traffic control system, the City of South Tucson is not anticipated to have a workstation, as long as the Town of Marana continues to maintain the South Tucson traffic signals.

Town of Oro Valley:
Owns the traffic signals within Town limits. The Town of Oro Valley contracts with the Phoenix Highway Products for traffic signal maintenance and operations.

Under the regional traffic control system, the Town of Oro Valley will have a workstation, location not yet determined.

Pima Association of Governments (PAG):
Regional planning agency responsible for planning, financing and implementation for a variety of transportation facilities, including ITS and traffic signals. Does not own or control any traffic signals. PAG leads the Tucson ITS Working Group, which is the group that discusses traffic signal operations and policies, among other issues.

2.13.2 Traffic Signal Timing
The development of traffic signal timing is the responsibility of the owning agency, except in cases where they have handed over that responsibility to a maintaining agent – such as the City of South Tucson contracting with the Town of Marana.

Use of the workstations at each participating agency will be supported by training offered by the City of Tucson. Future year training for new operators and new users should continue to be provided on a periodic basis, as the need manifests itself. Agencies should make such requests to TTCC staff as needed.

2.13.3 Daily Operations
The City of Tucson's Traffic Control Center (TTCC) monitors all connected traffic signals of the various agencies on a normal weekday basis (except holidays), from 6:00 AM to 6:00 PM.

The current operation does not offer manual coverage 24 hours per day on a 7 day per week basis. However, the regional control system has the capability to issue digital pages to participating agencies. Agencies should contact the TTCC to arrange programming of specific pager telephone numbers and specific field conditions under which the automated pager system should be activated. Participating agencies should be prudent in selection of activation alarms.

Future regional system enhancements should consider improving of communications between agencies by implementing a second layer of notification, possibly via radio system. Under the current system, the entire communications process depends on land line and cellular telephone. In a major emergency, some media may be overly congested or inoperable, causing additional confusion at a time when coordinated efforts need to be in effect.

2.13.4 Emergency Traffic Signal Operations

Traffic signal operators shall recognize that some of the procedures in this section are not currently addressed in existing IGA's. The following have been formulated, reviewed and agreed to by the participating agencies until formalization via IGA occurs. The intent of these procedures is to provide guidance where none otherwise exists – but within the realm of common sense and interagency courtesy.

Some emergency conditions will occur while the TTCC is staffed. During such times, the type of emergency will be evaluated by TTCC staff, contact and coordination with affected agencies will be initiated and action plans formulated. Action plans for traffic signals will likely call for temporary modifications of traffic signal timings, and possible omission of phases. Such changes, made in the general interest of regional traffic control, shall be formulated by TTCC staff and approved by the owning agency. In the event the owning agency does not agree with the traffic signal action plan, the owning agency shall be responsible for an alternate plan.

Inevitably, there will be emergencies during times when the TTCC is not staffed. Major emergencies may require on-call TTCC staff to initiate a staffed condition, making the TTCC the focal point for the traffic management effort. Contact names and numbers are listed in the Appendix of this document.

Recognizing that traffic management is the ultimate goal, and that a major emergency demands that all agencies transcend agency boundaries for the public welfare, in the event TTCC staff is not yet available, and no contact can be made by phone or radio, the owning agency may implement an action plan, but should then review and seek concurrence of these actions with TTCC staff immediately upon TTCC staff availability.

In some cases, the most immediate response may be to consider placing signals in a "free" mode or "flash" mode – both of which may be done remotely through the iCons system.

Participating agencies will have the ability to control traffic signals under their ownership when the TTCC is unmanned, but during times when the TTCC is reacting to emergencies, TTCC shall coordinate any activities that affect any participating agency with that agency, as well as broadcast to all participants the nature of the event and action plans being implemented. Operators should keep in mind that some events can grow, action plans can have unexpected results and the geographic impact can enlarge beyond what may have been originally anticipated – causing additional action and participation.

Typical chain of events for a traffic signal emergency event shall be:

On Freeway (Affecting Ramp Terminal Signals):

1. Emergency event occurs and is identified by citizen, law enforcement or CCTV.

2. DPS becomes aware of event and notifies the ADOT TOC.

3. ADOT TOC notifies Grant Road Maintenance.

4. Grant Road Maintenance acknowledges and notifies TTCC for traffic signal action plan, passing on any action plans (traffic signals, VMS, diversions, etc.) already in place on site by DPS or others.

5. TTCC verifies that Metro Networks is aware of the emergency event.

6. TTCC monitors event until control can return to normal.

7. TTCC advises participants and agencies when normal control is in place and the event is completed.

8. Event is documented and actions reviewed. Future action plans for similar events may be developed, including agency meetings to insure any modified action plans are shared with affected parties.

Note: Law enforcement officials may place a signal into the flashing mode as an immediate response to an emergency. The iCons system will identify that this has been done, allowing TTCC staff to consider that action in formulating a responsive action plan.

Off Freeway:

1. Emergency event occurs and is identified by citizen, law enforcement or CCTV.

2. Police or Sheriff agency become aware of event and notifies TTCC.

3. TTCC considers any action plans already in place on site by law enforcement or others, and modifies accordingly, notifying all affected agencies and participants.

4. TTCC verifies that Metro Networks is aware of the emergency event.

5. TTCC monitors event until control can return to normal.

6. TTCC advises participants and agencies when normal control is in place and the event is completed.

7. Event is documented and actions reviewed. Future action plans for similar events may be developed, including agency meetings to insure any modified action plans are shared with affected parties.

Note: Law enforcement officials may place a signal into the flashing mode as an immediate response to an emergency. The iCons system will identify that this has been done, allowing TTCC staff to consider that action in formulating a responsive action plan.

Typical emergencies may be weather related, affecting a large geographic area and causing a limited ability to react in the field. Other emergencies may be more localized, such as accidents, and allow specific traffic management techniques to be implemented. Operators shall familiarize themselves with the Incident Management procedures found elsewhere in this manual for a comprehensive understanding of all of the tools available for general traffic management, and specific agency roles and responsibilities.

Jurisdictions should document the event causing deviation from typical operations, evaluate the success of the procedures used and determine if alternatives exist that should be considered for future emergencies of similar nature. A separate three-ring binder, organized by emergency type, should be maintained for quick TTCC staff access. Making this documentation available on the TTCC network as PDF files will allow other participant access to the information and allow refinement and use by other participants as needed.

3.0 EXTERNAL POLICES & PROCEDURES

3.1 Interagency Communication Contact Points

Interagency Coordination:
Incidents, construction, or maintenance activities can alter traffic patterns significantly. Cities and Counties with adjacent roadways are often impacted by these activities. The TTCC staff will contact the appropriate police organization whenever traffic volumes caused by incidents, construction, or maintenance activities create congestion on adjacent roadways. The call will be made as soon as possible to allow for signal timing adjustments.

City and County agencies will be encouraged to advise the TTCC when they have activities that may impact traffic flows on freeways. They may also enter this information in the Roadway Closure and Reporting System (RCRS). DPS will continue to make notifications directly to Phoenix TOC and/or enter the information directly into the HCRS.

Cameras will be used to check the adjacent arterial and ramp areas to keep police departments and traffic information outlets apprised of any changes in conditions.

3.2 Agency Resource Allocation

Callout Procedures:
Call outs will come from DPS dispatcher for incidents requiring ADOT response. They will be directed to Phoenix TOC 24/hrs per day. Phoenix TOC will make the determination how those units will be notified according to current protocols. The DPS dispatch currently supplies report numbers to Phoenix TOC when necessary.

Risk Management Notification:
The Risk Management Investigator (RMI) will be notified by page whenever there is a confirmed traffic fatality on a state route or when requested by DPS or an ADOT supervisor. If the RMI will not respond until the next day, the operator will also obtain the location of any deceased or injured persons, location and a description of the vehicles, and the Tow Company that removed them from the collision site. The name, badge, and telephone number of the Primary Investigator will also be forwarded to the RMI. However, DPS will continue to make notification of fatalities via FAX, per current policy.

3.3 Transview

Transview (www.transview.org) is the City of Tucson's Internet site for all transportation-related information. In accordance with the City of Tucson's agreement with Metro Networks, no real-time traffic condition information will be made available to the public through Transview. In the future, a version of Transview that would include real-time traffic condition information, including CCTV camera views, may be made available to certain public agencies, including transit operators.

APPENDIX

List of Traffic Signals

Field 1, Intersection Number
Field 2, Intersection Name
Field 3, Jurisdiction
Field 4, City signal only - arrows, directions, comments.
Field 5, (*) Video detection
Field 6, (&) Railroad pre-empt
Field 7, (?) Not on system

?		1st Ave. & Oro Valley Retail Center	Oro Valley
?	5	Oracle Rd. & Pinto Lane	ADOT
?	6	Oracle Rd. & Golder Ranch Rd.	ADOT
?	7	Oracle Rd. & Wilds Rd.	ADOT
?	8	Oracle Rd. & Rancho Vistoso Rd.	ADOT
?	19	First Av. & Tangerine Rd.	Oro Valley
?	20	Oracle Rd. & Tangerine Rd.	ADOT
?	24	Naranja Dr. & La Canada Dr.	Oro Valley
?	26	Naranja Dr. & First Av.	Oro Valley
?	28	First Av. & Lambert Lane	Oro Valley
?	31	Oracle Rd. & First Av.	ADOT
?	37	Lambert Lane & La Canada Dr.	Oro Valley
?	38	Oracle Rd. & Pusch View Ln.	ADOT
?	39	Oracle Rd. & Conquistador Way	ADOT
?	43	Linda Vista & Thornydale Rd.	Pima County
?	44	Oracle Rd. & Linda Vista	ADOT
?	45	Overton Rd. & Thornydale Rd.	Pima County
?	49	Oracle Rd. & Calle Concordia	ADOT
?	52	Hardy Rd. & Thornydale Rd.	Pima County
?	54	Overton Rd. & Hardy Rd.	Pima County
?	56	Oracle Rd. & Hardy Rd.	ADOT
?	57	Silverbell & Coach Line	Marana
	58	Cortaro Farms & Az Pavilions	Marana
?	59	Cortaro Farms & I-10	ADOT
?	60	Cortaro Farms & Cerius Strav.	Pima County
?	61	Cortaro Farms & Camino de Oeste	Pima County
?	62	Cortaro Farms & Oldfather Rd.	Pima County
?	63	Thornydale Rd. & Cortaro Farms	Pima County
?	64	Cortaro Farms & Shannon Rd.	Pima County
?	66	Magee Rd. (north) & La Cholla Blvd.	Pima County
?	67	Magee Rd. & La Canada Dr.	Pima County
	69	Oracle Rd. & Magee Rd.	ADOT
	71	Silverbell & Cortaro Farms	Marana
?	72	Magee Rd. & Tuscany Dr.	Pima County
?	73	Magee Rd. (south) & La Cholla Blvd.	Pima County
	82	Ina Rd. & I-10	ADOT
	85	Ina Rd. & Oldfather Rd.	Marana
	86	Ina Rd. & Thornydale	Marana
	87	Ina Rd. & Meredith Pl.	Marana
	88	Ina Rd. & Camino De La Tierra	Pima County
	89	Ina Rd. & Shannon Rd.	Pima County
	90	Ina Rd. & Mona Lisa Rd.	Pima County
	91	Ina Rd. & La Cholla Blvd.	Pima County
	92	Ina Rd. & La Canada Dr.	Pima County
	93	Ina Rd. & Via Assisi	Pima County
	94	Oracle Rd. & Ina Rd.	ADOT
	95	Ina Rd. & Westward Look Dr.	Pima County
	96	Ina Rd. & Christie Dr.	Pima County
	97	Skyline Dr. & Pima Canyon Dr.	Pima County

99		Thornydale & Horizon Hills	Marana
100		Thornydale & Costco	Marana
?102		Orange Grove & I-10	ADOT
104		Orange Grove & Thornydale	Marana
?105		Orange Grove & Camino de La Tierra	Pima County
?106		Orange Grove & Shannon Rd.	Pima County
?108		Orange Grove & La Cholla Blvd.	Pima County
?110		Orange Grove & La Canada Dr.	Pima County
112		Oracle Rd. & Orange Grove Rd.	ADOT
?113		Orange Grove & First Av.	Pima County
115		Skyline Dr. & Orange Grove Rd.	Pima County
116		Skyline Dr. & Campbell Ave.	Pima County
126		Oracle Rd. & Rudasill Rd.	ADOT
136		Sunrise Dr. & Via Palomita	Pima County
137		Sunrise Dr. & Pontatoc Rd.	Pima County
138		Sunrise Dr. & C. Del Marques	Pima County
139		Sunrise Dr. & Swan Rd.	Pima County
141		Sunrise Dr. & Suncrest Pl.	Pima County
142		Sunrise Dr. & Craycroft Rd.	Pima County
143		Sunrise Dr. & Kolb Rd.	Pima County
?145		Craycroft Rd. & Territory Dr.	Pima County
?146		River Rd. & Shannon Rd.	Pima County
?147		River Rd. & La Cholla Blvd.	Pima County
148		La Canada Dr. & River Rd.	Pima County
150		Oracle Rd. & River Rd.	COT, all
152		River Rd. & Stone Ave.	COT
154		First Ave. & River Rd.	COT, all
?156		La Cholla Blvd. & Curtis Rd.	Pima County
158		Silverbell & Camino Del Cerro	COT
160	&	Ruthrauff Rd. & I-10 West	COT, e/w lead
161		Ruthrauff Rd. & I-10 East	COT, e -> nb lag, n/s lead
162		Ruthrauff Rd. & Davis Ave.	Pima County
163		La Cholla Blvd & Ruthrauff Rd.	Pima County
?169		Sabino Canyon & Snyder Rd.	Pima County
177		Oracle Rd. & Auto Mall Dr.	COT, n/s
178		Stone Ave. & Tucson Mall Dr.	COT, n -> wb lead
?180		River Rd. & Via Entrada	Pima County
181		Campbell Ave. & River Rd.	COT, all
?188		Wetmore Rd. & Romero Rd.	Pima County
190		Flowing Wells Rd & Wetmore Rd	Pima County
192		Wetmore Rd. & Fairview Ave.	COT
193		Oracle Rd. & Wetmore Rd.	COT, all
195		Wetmore Rd. & Stone Ave.	COT, n/s
197		First Ave. & Wetmore Rd.	COT, n/s
201		Oracle Rd. & Limberlost Rd.	COT
202		Stone Ave. & Limberlost Rd.	COT
203		First Ave. & Limberlost Rd.	COT, n/s
209		Romero Rd. & Roger Rd.	COT
210		Flowing Wells Rd. & Roger Rd.	COT, n/s
212		Oracle Rd. & Roger Rd.	COT, n/s
213		Stone Ave. & Roger Rd.	COT
214		First Ave. & Roger Rd.	COT, n/s
216		Campbell Ave. & Roger Rd.	COT
220		Campbell Ave. & Allen Rd.	COT
?223		River Rd. & Dodge Blvd.	Pima County
226		Swan Rd. & River Rd.	Pima County
229		Craycroft Rd. & River Rd.	Pima County

234	&	Prince Rd. & I-10	COT, e -> nb lead & w -> sb lag
237		Prince Rd. & Romero Rd.	COT
239		Prince Rd. & Flowing Wells Rd.	COT, all
241		Prince Rd. & Fairview Ave.	COT
242		Oracle Rd. & Prince Rd.	COT, all
243		Prince Rd. & Stone Ave.	COT
245		First Ave. & Prince Rd.	COT, all
246		Prince Rd. & Mountain Ave.	COT
248		Campbell Ave. & Prince Rd.	COT, all
250		Prince Rd. & Tucson Blvd.	COT
?258		Sabino Canyon & River Rd.	Pima County
?263		Sabino Canyon & Cloud Rd.	Pima County
267		Stone Ave. & Yavapai Rd.	COT, n -> wb lead
274		Oracle Rd. & Fort Lowell Rd.	COT, n/s
275		Fort Lowell Rd. & Stone Ave.	COT
277		First Ave. & Fort Lowell Rd.	COT, all
278		Ft. Lowell Rd. & Mountain Ave.	COT
279		Campbell Ave. & Ft. Lowell Rd.	COT, all
281		Fort Lowell Rd. & Tucson Blvd.	COT
282		Fort Lowell & Country Club	COT, n/s
284		Fort Lowell Rd. & Dodge Blvd.	COT, e/w
285		Fort Lowell Rd. & Alvernon Way	COT
286		Fort Lowell & Columbus Blvd.	COT
289		Craycroft Rd. & St. Gregory's	COT, n -> wb lead
291		Miracle Mile & I-10	COT, e -> nb lag
293		Miracle Mile & Flowing Wells	COT, all
294		Miracle Mile & Fairview Ave.	COT
295		Oracle Rd. & Miracle Mile	COT, n -> wb lead
300		Swan Rd. & Fort Lowell Rd.	COT
308		Oracle Rd. & Glenn St.	COT
309		Stone Ave. & Glenn St.	COT
311		First Ave. & Glenn St.	COT
313		Campbell Ave. & Glenn St.	COT
314		Tucson Blvd. & Glenn St.	COT
315		Country Club Rd. & Glenn St.	COT
318		Alvernon Way & Glenn St.	COT
320		Swan Rd. & Glenn St.	COT
322		Craycroft Rd. & Glenn St.	COT
328		Tanque Verde & Bear Canyon	COT, e/w (wb protected)
329		Tanque Verde & Catalina Hwy	COT, e -> nb lead
338		Grant Rd. & Silverbell Rd.	COT, all
341		Grant Rd. & Forbes Blvd.	COT, w -> sb lead
342	*	Grant Rd. & I-10	COT, e -> nb lag & w -> sb lead
345		Grant Rd. & Fairview Ave.	COT
346		Grant Rd. & Oracle Rd.	COT, all
347		Grant Rd. & Stone Ave.	COT, all
348		Grant Rd. & Sixth Ave.	COT
349		Grant Rd. & First Ave.	COT, all
350		Grant Rd. & Park Ave.	COT
351		Grant Rd. & Mountain Ave.	COT
352		Grant Rd. & Campbell Ave.	COT, all
353		Grant Rd. & Tucson Blvd.	COT
355		Grant Rd. & Country Club Rd.	COT, all
357		Grant Rd. & Dodge Blvd.	COT
358		Grant Rd. & Alvernon Way	COT, all
360		Grant Rd. & Columbus Blvd.	COT
362		Grant Rd. & Swan Rd.	COT, all

364	*	Grant Rd. & Rosemont Blvd.	COT
365		Grant Rd. & Beverly Ave.	COT
366		Grant Rd. & Craycroft Rd.	COT, all
369		Grant Rd. & Wilmot Rd.	COT, e/w
371	*	Tanque Verde & Sabino Canyon	COT, e/w lead, n/s split phase
373		Tanque Verde & Dos Hombres	COT, e/w
375		Wrightstown Rd. & Pantano Rd.	COT, n/s
?378		Tanque Verde Rd. & Houghton Rd.	Pima County
391		Tanque Verde & C. Principal	COT, e/w
392		Tanque Verde Rd. & Grant/Kolb	COT, all
398		Campbell Ave. & Elm St.	COT
399		Tucson Blvd. & Elm St.	COT
400		Country Club Rd. & Pima St.	COT
402		Pima St. & Dodge Blvd.	COT
403		Alvernon Way & Pima St.	COT
404		Pima St. & Columbus Blvd.	COT
405		Swan Rd. & Pima St.	COT
407		Pima St. & Rosemont Blvd.	COT
408		Craycroft Rd. & Pima St.	COT, all
412		Tanque Verde Rd. & Pima St.	COT, n/s (sb protected)
418		Oracle Rd. & Lee St. (SB)	COT
419		Oracle Rd. & Lee St. (NB)	COT
420		Stone Ave. & Drachman St.	COT, n -> wb lead
421		Campbell Ave. & Adams St. (SB)	COT
422		Campbell Ave. & Adams St. (NB)	COT
424		Wilmot Rd. & Fairmont St.	COT
429		Speedway & Greasewood	COT
431		Speedway & Silverbell	COT
432	*	Speedway & Riverview	COT
433		Speedway Blvd. & Grande Ave.	COT, w -> sb lead
435	*	Speedway Blvd. & I-10	COT, w -> sb lag & e -> nb lead
437		Speedway Blvd. & Main Ave.	COT, e/w
438		Speedway Blvd. & Stone Ave.	COT, all
439		Speedway Blvd. & Sixth Ave.	COT
440		Speedway Blvd. & Fourth Ave.	COT
441	*	Speedway Blvd. & Euclid Ave.	COT, all
442	*	Speedway Blvd. & Park Ave.	COT
443	*	Speedway Blvd. & Mountain Ave.	COT, w -> sb lead
444	*	Speedway Blvd. & Cherry Ave.	COT
445	*	Speedway Blvd. & Campbell Ave.	COT, all
447	*	Speedway Blvd. & Tucson Blvd.	COT, e/w
449	*	Speedway Blvd. & Country Club	COT, all
450		Speedway Blvd. & El Rancho-EB	COT
451		Speedway Blvd. & El Rancho-WB	COT
453	*	Speedway Blvd. & Alvernon Way	COT, all
455		Speedway Blvd & Columbus Blvd	COT, e/w
456		Speedway Blvd. & Swan Rd.	COT, all
458		Speedway Blvd & Rosemont Blvd	COT
460		Speedway Blvd. & Craycroft Rd.	COT, all
462	*	Speedway Blvd. & Wilmot Rd.	COT, all
464	*	Speedway Blvd. & Kolb Rd.	COT, all
466		Speedway Blvd. & Pantano Rd.	COT, all
468		Speedway Blvd. & Camino Seco	COT, n/s
470		Speedway Blvd. & Harrison Rd.	COT
?472		Houghton Rd. & Speedway Blvd.	Pima County
485		Euclid Ave. & University Blvd.	COT
487		Campbell Ave & University Blvd	COT

488	*	Country Club Rd. & Third St.	COT
492		Anklam Rd. & Greasewood Rd.	COT
494		St. Mary's & Silverbell Rd.	COT, all
495		St. Mary's Rd. & Grande Ave.	COT, e/w
496		St. Mary's Rd. & I-10	COT, w -> sb lag & e -> nb lead
498		St. Mary's Rd. & Granada Ave.	COT
500	&	Stone Ave. & Sixth St.	COT, e/w
501		Sixth St. & Sixth Ave.	COT
502		Sixth St. & Fourth Ave.	COT
503		Sixth St. & Euclid Ave.	COT
505		Sixth St. & Fremont Ave.	COT
506		Sixth St. & Highland Ave.	COT, n/s split phase
507		Sixth St. & Cherry Ave.	COT
508		Sixth St. & Campbell Ave.	COT, all
510		Sixth St. & Tucson Blvd.	COT
512		Fifth St. & Country Club Rd.	COT, all
514		Fifth St. & Dodge Blvd.	COT, w -> sb lead
515		Alvernon Way & Fifth St.	COT, all
516		Fifth St. & Columbus Blvd.	COT
517		Swan Rd. & Fifth St.	COT, all
519		Fifth St. & Rosemont Blvd.	COT
520		Craycroft Rd. & Fifth St.	COT, all
522		Wilmot Rd. & Fifth St.	COT, n/s
524		Pantano Rd. & Fifth St.	COT
535		Stone Ave. & Toole Ave.	COT, e/w
539		Granada Ave. & Alameda St.	COT
540		Church Ave. & Alameda St.	COT, e/w split phase
541		Stone Ave. & Alameda St.	COT
542		Sixth Ave. & Toole Ave.	COT
544		Church Ave. & Pennington St.	COT
545		Stone Ave. & Pennington St.	COT
546		Sixth Ave. & Pennington St.	COT
547		Toole Ave. & Pennington St.	COT
552		Wilmot Rd. & Corondolet Dr.	COT, n/s
556		Congress St. & Grande Ave.	COT
557	*	Congress St. & I-10	COT, w -> sb lag & e -> nb lead
559		Congress St. & Granada Ave.	COT, all
560		Congress St. & Church Ave.	COT, n -> wb lag
561		Congress St. & Stone Ave.	COT
562		Congress St. & Scott Ave.	COT
563		Congress St. & Sixth Ave.	COT
564		Congress St. & Fifth Ave.	COT
566		Broadway Blvd. & Church Ave.	COT, s -> eb lead
567		Broadway Blvd. & Stone Ave.	COT
568		Broadway Blvd. & Scott Ave.	COT
569		Broadway Blvd. & Sixth Ave.	COT
570		Broadway Blvd. & Fifth Ave.	COT
571		Broadway Blvd. & Fourth Ave.	COT
572		Broadway Blvd. & Aviation Hwy.	COT, w -> sb lag
573		Broadway Blvd. & Euclid Ave.	COT, all
575		Broadway Blvd. & Highland Ave.	COT
577		Broadway Blvd. & Kino/Campbell	COT, all
578		Broadway Blvd. & Plumer Ave.	COT
579		Broadway Blvd. & Tucson Blvd.	COT
581		Broadway Blvd. & Country Club	COT, all
582		Broadway Blvd. & Randolph Way	COT, e/w
583		Broadway Blvd. & Dodge Blvd.	COT, e -> nb lag

584		Broadway Blvd. & Alvernon Way	COT, all
585		Broadway Blvd & Columbus Blvd	COT, e/w
586		Broadway Blvd. & Swan Rd.	COT, all
588		Broadway Blvd & Rosemont Blvd	COT, e/w
589		Broadway Blvd & Williams Blvd	COT
590	*	Broadway Blvd. & Craycroft Rd.	COT, all
592		Broadway Blvd. & Indian House	COT, e/w
594		Broadway Blvd. & Wilmot Rd.	COT, all
596		Broadway Blvd. & Jessica Ave.	COT
597	*	Broadway Blvd. & Kolb Rd.	COT, all
599		Broadway Blvd. & Prudence Rd.	COT, e/w
600		Broadway Blvd. & Pantano Rd.	COT, all
602		Broadway Blvd. & Sarnoff Dr.	COT, e/w
604		Broadway Blvd. & Camino Seco	COT, all
608		Broadway Blvd. & Harrison Rd.	COT
612		Broadway Blvd. & Houghton Rd.	COT
623		Camino Seco & Old Spanish Trl	COT
627		Kino Blvd. & Winsett St.	COT
632		Pantano Rd. & Kenyon Dr.	COT
637		Sixth Ave. & Eighteenth St.	COT
638		Kino Blvd. & Aviation Hwy.	COT, n/s protected
644		Starr Pass & Greasewood Rd.	COT
647		Mission Rd. & Ramp C	COT
651	*	22nd St. & I-10	COT, w -> sb lag & e -> nb lead
653		22nd St. & Tenth Ave.	COT
654		22nd St. & Sixth Ave.	COT, all
655		22nd St. & Fourth Ave.	COT
657	*	22nd St. & Park Ave.	COT, all
659		22nd St. & Kino Blvd.	COT, all
660		22nd St. & Cherry Ave.	COT
661		Aviation Hwy. & 22nd St.	COT, e -> nb lag
662		22nd St. & Tucson Blvd.	COT, e/w
664		22nd St. & Country Club Rd.	COT, e/w
667		22nd St. & Alvernon Way	COT, all
669		22nd St. & Columbus Blvd.	COT, e/w
671		22nd St. & Swan Rd.	COT, all
674		22nd St. & Craycroft Rd.	COT, all
677		22nd St. & Wilmot Rd.	COT, all
679	*	22nd St. & Kolb Rd.	COT, all
681		22nd St. & Prudence Rd.	COT, e/w
682		22nd St. & New Pantano Rd.	COT, w -> sb lead
683		22nd St. & Pantano Pkwy.	COT, all
685		22nd St. & Sarnoff Dr.	COT
686		22nd St. & Camino Seco (WEST)	COT, w -> sb lag
687		22nd St. & Camino Seco (EAST)	COT, e -> nb lag
688		22nd St. & Oak Park Dr.	COT
690		22nd St. & Harrison Rd.	COT
694		Houghton Rd. & 22nd St.	COT
702		Aviation Hwy. & Country Club	COT, e -> nb lag
707		Mission Rd. & Silverlake Rd.	COT
?708		Silverlake & I-10	ADOT
710		29th St. & Tenth Ave.	South Tucson
712		Sixth Ave. & 29th St.	South Tucson
713		Fourth Ave. & 29th St.	South Tucson
714	*	Park Ave. & Silverlake Rd.	COT
715		Kino Blvd. & Silverlake Rd.	COT
717		Alvernon Way & 29th St.	COT, n/s, e/w split phase

718		29th St. & Columbus Blvd.	COT
719		29th St. & Swan Rd.	COT, all
721		Craycroft Rd. & 29th St.	COT, n/s
723		Wilmot Rd. & 29th St.	COT
724		Kolb Rd. & 29th St.	COT
729		Aviation Hwy. & 34th St.	COT
730		Houghton Rd. & Old Spanish Trl	COT
?732		Kinney Rd. & Western Way	Pima County
734		Mission Rd. & 36th St.	COT, n -> wb lead
737		Sixth Ave. & 36th St.	South Tucson
739	*	Park Ave. & Thirty-Sixth St.	COT
740		Kino Blvd. & 36th St.	COT
744		Aviation Hwy. & Richey Blvd.	COT
746		Alvernon Way & Aviation Hwy.	COT, all (n/s protected)
749		Golf Links Rd. & Swan Rd.	COT, all (wb protected)
750		Golf Links Rd. & Craycroft Rd.	COT, all
752		Golf Links Rd. & Wilmot Rd.	COT, all
753		Golf Links Rd. & Mann Ave.	COT
754		Kolb Rd. & Golf Links Rd.	COT, all
755		Golf Links Rd. & Prudence Rd.	COT
756		Golf Links Rd. & Pantano Rd.	COT, all
758		Golf Links Rd. & Camino Seco	COT, w -> sb lead
759		Golf Links Rd. & Pantano Pkwy.	COT, e/w (wb protected)
761		Golf Links Rd. & Hearthstone	COT
763		Golf Links Rd. & Harrison Rd.	COT
767		Houghton Rd. & Golf Links Rd.	COT, n -> wb lead
772		Sixth Ave. & I-10	COT, n -> wb lag & s -> eb lead
774	*	Sixth Ave. & 44th St.	COT
778		Kolb Rd. & Stella Rd.	COT
780		Pantano Rd. & Stella Rd.	COT
787	*	Sixth Ave. & Veterans Blvd.	COT
788		Park Ave. & I-10	COT, n -> wb lag & s -> eb lead
790		Park Ave. & Benson Hwy.	COT
791		Palo Verde Rd. & Broadmont Dr.	Pima County
?793		Ajo Way & Kinney Rd.	ADOT
794		Ajo Way & La Cholla Blvd.	COT
795		Ajo Way & Mission Rd.	COT, all
796		Ajo Way & Holiday Isle	COT
797		Ajo Way & I-19 West	ADOT
798		Ajo Way & I-19 East	ADOT
799		Ajo Way & 16th Ave.	ADOT
800		Ajo Way & Twelfth Ave.	COT, all
802	*	Ajo Way & Sixth Ave.	COT, all
804	*	Ajo Way & Park Ave.	COT, all
805		Ajo Way & Benson Hwy.	COT
806		Kino Blvd. & Ajo Connect	COT, s -> eb lag
807		Ajo Way & Kino Connect	COT, all
809		Ajo Way & Forgeus Ave.	COT
810		Ajo Way & Country Club Rd.	COT, e/w
811		Ajo Way & Palo Verde Rd.	Pima County
812		Alvernon Way & Ajo Way	Pima County
814		Kolb Rd. & Escalante Rd.	COT, n/s
817		Pantano Rd. & Escalante Rd.	COT
831		Park Ave. & Fair St.	COT
833		Kino/Campbell & Benson Hwy.	COT, all
835		Mission Rd. & Irvington Rd.	COT, all
836		Irvington Rd. & Midvale Rd.	COT, w -> sb lead

837	*	Irvington Rd. & Santa Cruz	COT, w -> sb lead
838		Irvington Rd. & I-19	COT, w -> sb lag & e -> nb lead
840		Irvington Rd. & 16th Ave.	COT
841		Irvington Rd. & Twelfth Ave.	COT, all
843	*	Irvington Rd. & Sixth Ave.	COT, all
844		Irvington Rd. & Park Ave.	COT, all
845		Campbell Ave. & Irvington Rd.	COT, all
846		Irvington Rd. & Benson/Tucson	COT, all
847		Irvington Rd. & Benson Hwy.	COT
849		Irvington Rd. & Country Club	COT
850		Irvington Rd. & Palo Verde Rd.	ADOT
851		Irvington Rd. & Hotel Circle	ADOT
852		Alvernon Way & Irvington Rd.	Pima County
856		Kolb Rd. & Irvington Rd.	COT, all
869		Twelfth Ave. & Nebraska St.	COT
874		Benson Hwy. & Country Club	COT
875		Benson Hwy. & Palo Verde Rd.	ADOT
?879		Mission Rd. & Drexel Rd.	Pima County
884		Twelfth Ave. & Drexel Rd.	COT
886	&	Nogales Hwy. & Drexel Rd.	COT
887		Park Ave. & Drexel Rd.	COT
888		Campbell Ave. & Drexel Rd.	COT
889		Tucson Blvd. & Drexel Rd.	COT
893		Alvernon Way & Drexel Rd.	COT, n/s
894		Alvernon Way & Benson Hwy.	ADOT
900	&	Twelfth Ave. & Bilby Rd.	COT
902		Nogales Hwy. & Bilby Rd.	COT
903		Park Ave. & Bilby Rd.	COT
904	*	Campbell Ave. & Bilby Rd.	COT
?910		Valencia Rd. & Cardinal Av.	Pima County
?911		Valencia Rd. & Mission Rd.	Pima County
913		Valencia Rd. & Midvale Rd.	COT, e/w
915		Valencia Rd. & I-19	COT, e -> nb lead
916		Valencia Rd. & Santa Clara	COT, e/w
917		Valencia Rd. & Twelfth Ave.	COT, all
919		Valencia Rd. & Sixth Ave.	COT
920	&	Valencia Rd. & Nogales Hwy.	COT, all
921		Valencia Rd. & Park Ave.	COT, e -> nb lead
922		Valencia Rd. & Air Guard	COT, w -> sb lead
923		Valencia Rd. & Campbell Ave.	COT, e -> nb lead
924		Valencia Rd. & Tucson Blvd.	COT, all
925		Valencia Rd. & Country Club	COT, e/w
926		Valencia Rd. & Palo Verde	COT, e/w (wb protected)
927		Valencia Rd. & Alvernon Way	Pima County
930		Valencia Rd. & I-10	ADOT
?934		Valencia Rd. & Kolb Rd.	Pima County
946		Nogales Hwy. & Los Reales Rd.	COT
971		Valencia Rd. & Nexus Rd.	COT
--- GREEN VALLEY			
?		La Canada Dr. & Duval Mine Rd.	Pima County
?		Esperanza & La Canada Dr.	Pima County
?		Continental & Continental Plaza	Pima County
?		Continental & La Canada Dr.	Pima County
?		Desert Bell Dr. & La Canada Dr.	Pima County
?		Abrego & Esperanza	Pima County
?		Camino del Sol & Camino Encanto	Pima County

Rev: 2/27/0

CONTACT LIST

Revised: February 25, 2002

Agency	*Contact Name*	*Telephone*	*Fax*	*E-Mail*
ADOT Grant Rd.	Paul Sykes After Hours Cell Phone	(520) 628-5658 (520) 349-4819	(520) 628-5657	psykes@dot.state.az.us
ADOT TOC		(800) 379-3701		
DPS Dispatch		(520) 746-4500		
Tucson TTCC	Bob Hunt Ray Svec General Number Emergencies **ONLY** Signal Shop After Hours	(520) 791-4259 (520) 791-4086 (520) 791-4086 (520) 791-5983 (520) 791-3191 (520) 791-4144	(520) 791-5526 (520) 791-5526 (520) 791-5526	rhunt1@ci.tucson.az.us rsvec1@ci.tucson.az.us
Pima County	Don Pittenger Al Letzkus	(520) 740-5887 (520) 740-2601	(520) 740-2677 (520) 740-2823	dpittenger@mission.co.pima.az.us aletzkus@mission.co.pima.az.us
Metro Media		(520) 573-0713		
911 Center		911		
Town of Marana South Tucson	Pete Petrotta Dennis Dolan	(520) 297-2920	(520) 297-3930	ppetrotta@aol.com
Town of Oro Valley	John Brannan (Phoenix Highway Products)	(602) 434-1141	(602) 434-4197	jsbranaz@aol.com