

5. STUDY FINDINGS - SURVEILLANCE AND DATA COLLECTION SYSTEMS

The Group A ITI (Surveillance and Data Collection Systems) include the following:

1. **Road Weather Information Systems (RWIS)** are a combination of field equipment, communications links, and central computer equipment that enables automatic recording, transmittal and storage of weather data. As currently configured, RWIS stations include weather sensors, PAD traffic counters, remote cameras, and visibility sensors. RWIS will be deployed statewide.
2. **Passive Acoustic Detectors (PADs)** are field devices that generate traffic data by “listening” to noise produced by traffic. Thus far, PADs have been implemented in rural Arizona only as a component of RWIS stations. PADs will be deployed statewide.
3. **Remote Cameras** are fixed (no pan-tilt-zoom capability) still-frame units. Remote cameras have been deployed in at least three types of installations: at RWIS stations; on overhead VMS; and instrumented truck escape ramps. Remote cameras will be deployed statewide. This section addresses only remote cameras installed at RWIS stations and on overhead VMS; images from these cameras are available via remote polling on a timed or on-demand basis. The Kingman District’s instrumented truck escape ramps, including the camera component, are discussed in Chapter 8.



Figure 5: RWIS Sensor Assembly

4. **Speed Detection/Warning Devices** are radar-equipped VMS that are programmed to provide speed warning messages on detecting a speeding vehicle. ADOT currently has permanent (overhead), semi-permanent (shoulder-mounted) and portable (trailer-mounted) VMS devices that could be considered speed detection/warning devices. This section addresses only the permanent type; the shoulder-mounted and portable trailer-mounted VMS are discussed in the Chapter 6. Thus far, these devices have been deployed only on a local level.

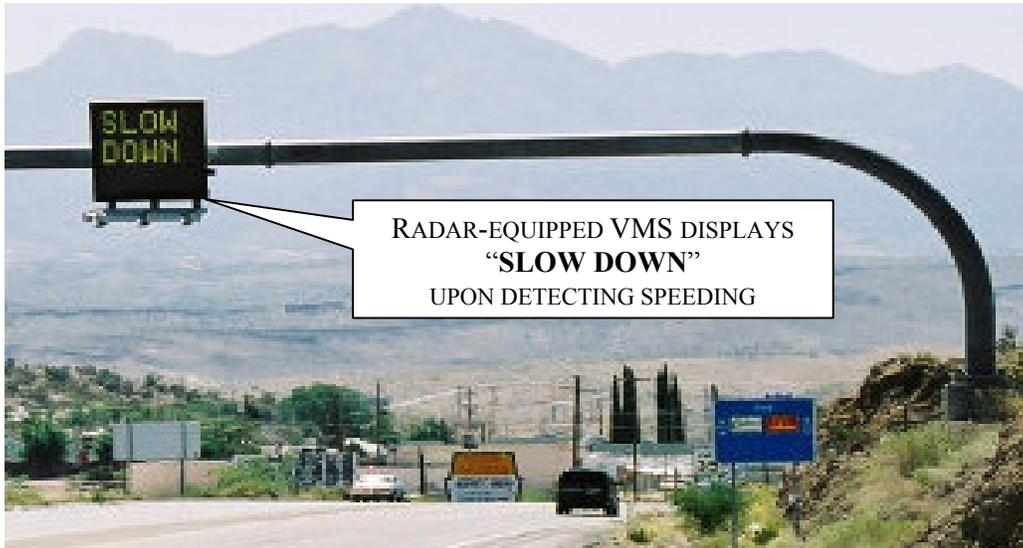


Figure 6: Overhead Mounted Speed Detection and Feedback Sign

5. **License Plate Readers** at the basic level are camera-based systems that capture license plate images and process the images using character recognition. One application of license plate readers is to estimate travel time by matching license plate numbers from two readers and calculating elapsed time between vehicle passage at the two locations. This particular setup is the system referred to in this section as a "license plate reader;" a more accurate description is "camera-based travel time estimation system." Thus far, this system has been deployed only on a local level.



Figure 7: Roadside License Plate Readers

Table 6 summarizes typical installation components and system functions/outputs associated with ADOT’s surveillance and data collection systems.

Table 6: Group A ITI – Components and Functions

| ITI | Typical Installation Components | System Functions / Outputs |
|---|---|--|
| A1. Road Weather Information Systems (RWIS) | A typical ADOT RWIS station is comprised of a weather pod, a road surface sensor (“puck”), a subsurface sensor, a traffic sensor, a camera, a remote processing unit (RPU), a cabinet on a concrete pad, and internal power and data connections, and power and communications equipment. Two different mounting structures have been used: a hinged three-sided truss tower and a pole. | The system provides the following reports: <ul style="list-style-type: none"> - Weather Conditions - Precipitation Information - Road Surface Conditions - Road Subsurface Conditions - Traffic Conditions - RPU Status |
| A2. Passive Acoustic Detectors (PAD) | A typical PAD (installed at an RWIS station) requires the PAD detector unit itself and internal power and data connections. | The PAD units provide traffic volume, speed and occupancy data. |
| A3. Remote Cameras (Fixed, Still-Frame) | RWIS station cameras: A typical RWIS station camera installation requires just two cameras (one per direction) and internal power and data connections. VMS cameras: A typical VMS camera installation requires two cameras (one per direction), internal power and data connections, and an RPU. The installation takes advantage of existing power and communications equipment, cabinet and concrete pad at the VMS site. | Both camera types provide fixed, still-frame bi-directional roadway images (i.e., the camera view can’t be adjusted). The images are available via remote polling on a timed or on-demand basis. |
| A4. Speed Detection / Warning Devices | A typical permanent speed detection/warning device is a radar-equipped VMS mounted on an overhead structure; other components include internal power and data connections, cabinet and controller, concrete pad, and power and communications equipment. | As a default, the device displays a speed limit message; on detection of a speeding vehicle, a speed warning (“SLOW DOWN”) messages is displayed. |
| A5. License Plate Readers | A license plate reader system consists of the following: cameras; triggering systems; Central Processing Unit (CPU) to handle data reporting, image manipulation and control functions; Character Recognition Engine; data storage/transmission system; and lights. | The system output is estimated travel time, based on a rolling average of individual vehicle travel times attained from matching license plate numbers at two readers. |

Table 7 summarizes the quantity of deployed ITI, deployment plans and maintenance arrangements associated with ADOT’s surveillance and data collection systems.

Table 7: Group A ITI – Quantity Deployed/Planned and Maintenance Arrangements

| ITI | Quantity Deployed/Planned | Maintenance Arrangements |
|---|---|--|
| A1. Road Weather Information Systems (RWIS) | 14 sites deployed; 50 new sites planned | ADOT currently has contracted with a consultant to provide RWIS maintenance statewide. The previous maintenance arrangement with the RTEOs had shortcomings, as these Regional offices were not funded for this activity, and viewed it as a low priority. |
| A2. Passive Acoustic Detectors (PAD) | 14 sites deployed; 50 new sites planned | See above. The contracted consultant also provides rural PAD maintenance statewide. |
| A3. Remote Cameras (Fixed, Still-Frame) | RWIS station cameras: 28 cameras at 14 sites deployed; 100 cameras at 50 new sites planned VMS cameras: Eight cameras / four sites deployed; 222 cameras / 111 new sites planned | See above. The contracted consultant provides remote camera maintenance statewide for both types of installations. |
| A4. Speed Detection/Warning Devices | One site deployed; no new sites planned | ADOT directly contacts the equipment vendor in the event of maintenance needs. |
| A5. License Plate Readers | Previously deployed for one project/construction zone (four cameras at two bi-directional sites); no new deployments planned | The Contractor was responsible for system maintenance. |

See Appendix H for maps of deployed and planned ITI in Group A.

Table 8 summarizes planned system enhancements and integration and standardization attributes or issues associated with ADOT’s surveillance and data collection systems.

Table 8: Group A ITI – Enhancements, Integration and Standardization

| ITI | Planned Enhancements / Integration / Standardization |
|---|--|
| A1. Road Weather Information Systems (RWIS) | The remote processing units (RPU) are polled periodically by a central RWIS server that resides at the Flagstaff District office. ADOT Districts are able to run RWIS reports based on polled data over the ADOT Intranet. ADOT captures images and data from the RWIS server and makes the information available on the Internet via the “Roadway Conditions – Closures & Restrictions”” links of the az511.com website. |
| A2. Passive Acoustic Detectors (PAD) | Currently, the only PAD units installed in rural locations are located at ADOT RWIS stations. The unit is mounted on the RWIS station’s tower or pole and interfaces with the station’s RPU. |
| A3. Remote Cameras (Fixed, Still-Frame) | The central RWIS server at Flagstaff periodically polls the RWIS and VMS RPU, thereby transferring camera image data. |
| A4. Speed Detection/Warning Devices | A permanent speed detection/warning device operates as a standalone system. |
| A5. License Plate Readers | A license plate reader system operated as a stand-alone system for travel time estimation in a particular area. Internal system integration was required to gather license plate data from different areas. Initial plans to disseminate estimated travel times to the public via integrated VMS were scratched due to liability concerns. |

Table 9 summarizes stakeholder awareness and usage of ADOT’s surveillance and data collection systems.

Table 9: Group A ITI – Stakeholder Awareness and Usage

| ITI | Awareness | Usage |
|---|---|--|
| A1. Road Weather Information Systems (RWIS) | Most ADOT personnel are aware of RWIS. Public awareness of RWIS data availability at the az511.com website seems to be growing. | ADOT personnel in the Flagstaff, Holbrook, Kingman and Safford Districts make use of RWIS information. |
| A2. Passive Acoustic Detectors (PAD) | PAD data is not available to the public via az511.com . ADOT personnel have some awareness of PAD data availability via RWIS. | Currently, there appears to be very little ADOT or partner usage of PAD data. |
| A3. Remote Cameras (Fixed, Still-Frame) | ADOT personnel have some awareness of remote camera image availability. Public awareness of remote camera image availability at az511.com seems to be growing. | ADOT personnel in the Flagstaff, Holbrook, Kingman and Safford Districts make use of remote camera images; some consider images the most useful data provided by RWIS. |
| A4. Speed Detection/Warning Devices | ADOT personnel have some awareness of the device. | The Kingman District operates the device continuously. |
| A5. License Plate Readers | ADOT personnel have some awareness of this system. | No known current usage, and little interest expressed by ADOT. |

Table 10 summarizes the costs and perceived and reported benefits associated with ADOT’s surveillance and data collection systems.

Table 10: Group A ITI – Costs and Benefits

| ITI | Costs | Perceived and Reported Benefits |
|---|--|---|
| A1. Road Weather Information Systems (RWIS) | \$137,200 to \$145,200 capital costs; \$170/yr to operate; \$3,328/yr to maintain | <ul style="list-style-type: none"> - Manage plowing & deicing operations - Dust storm prediction/warning - Share data with the National Weather Service (NWS) - Improved traveler safety via public access to data at the az511.com website |
| A2. Passive Acoustic Detectors (PAD) | Integral part of RWIS installation (see above) | <ul style="list-style-type: none"> - Supplement automatic traffic recorder data - Non-intrusive technology simplifies maintenance and improves personnel safety |
| A3. Remote Cameras (Fixed, Still-Frame) | <p>RWIS station cameras: Integral part of RWIS installation (see above)</p> <p>Variable Message Sign cameras: Cost to retrofit at existing overhead VMS: \$20,000 per site (two cameras)</p> | <ul style="list-style-type: none"> - Remotely verify pavement and weather conditions - Improved traveler safety via public access to images at az511.com website |
| A4. Speed Detection/Warning Devices | \$48,820 capital costs | <ul style="list-style-type: none"> - Speed study observed speed reduction - Perceived safety and repair costs improvements |
| A5. License Plate Readers | Incentive to maintain travel time was less than 1% of total project cost | ADOT - improved level of service through construction zone; Contractor - received 96% of incentive; public - less delay, frustration, and need for detours |

Table 11 summarizes the key issues and operational status and element-specific performance measures associated with ADOT’s surveillance and data collection systems.

Table 11: Group A ITI – Key Issues and Operational Status

| ITI | Key Issues | Operational Status / Element-Specific Performance Measures |
|---|---|--|
| A1. Road Weather Information Systems (RWIS) | <ul style="list-style-type: none"> - Road surface sensor inaccuracy/short lifetime - Software problems - Maintenance arrangement - Unreliable communications - Truss tower with hinge simplifies maintenance but is susceptible to vandalism; pole mount requires bucket truck for access - Polling frequency and high telephone bills | <p>Percent RWIS deficiency (tracked by TTG on a monthly basis) varies between 29% and 100% (data from Nov. 2003-August 2004). Both communications (cellular and wireline) and software reported by ADOT as contributing factors to deficiency.</p> |
| A2. Passive Acoustic Detectors (PAD) | <ul style="list-style-type: none"> - Low installation, maintenance and data archival costs - Low data demand - VMS-mounted PADs did not function well - Other in-pavement and non-intrusive detector options exist, including portable - See RWIS issues | <p>PAD, located as they are at RWIS, are subject to RWIS communications failures (see above).</p> |
| A3. Remote Cameras (Fixed, Still-Frame) | <ul style="list-style-type: none"> - Frequently updated camera images valuable for both ADOT and the public, but communications bandwidth and costs limit ability to provide desired update frequency (camera image is large part of total data flow during polling) - See RWIS issues | <p>Remote cameras located at RWIS and Variable Message Signs (VMS) are subject to RWIS communications failures (see above). Statewide camera deficiency: 0% to 79% (data from Jul. 2003-Aug. 2004; includes 12 Tucson closed-circuit television (CCTV) cameras</p> |
| A4. Speed Detection/Warning Devices | <ul style="list-style-type: none"> - This device can alleviate a chronic spot speed problem even if root causes of problem (such as geometrics) continue - Flashing “SLOW DOWN” message more effective than showing drivers’ actual speed | <p>The permanent speed detection/warning device is generally reliable. Reduced 85th percentile speed 18% from 51 to 42 mph (comparing speed studies from Jan. 2002 and Aug. 2003).</p> |
| A5. License Plate Readers | <ul style="list-style-type: none"> - Camera mounting deterred vandalism - Public privacy concerns resolved - Lack of communications resolved via microwave link - Provide for penalty or alternative time estimation method during system downtime - Lighting angle affects image clarity - Criteria for application: important corridor location, high business impact, lengthy detour, high road user costs | <p>Some problems with system downtime were experienced. System matched 11% of vehicle license plates (considered adequate for travel time estimation).</p> |

Appendix I presents scores assigned to the 18 key ITI on the basis of universal performance measures, or performance measures that apply to all key ITI. The scores, varying from 1 for “least impact” to 5 for “most impact,” were somewhat subjective but were an attempt to gauge the strength with which the various ITI contribute to system goals, using stakeholder feedback as a primary basis.

To better gauge the overall effectiveness of individual ITI in contributing to the four evaluation goal areas (improve safety, improve mobility, reduce costs, and improve system reliability/usefulness), composite goal area scores and an overall composite score were calculated based on the universal performance measure scores.

First, raw composite goal area scores were calculated by adding individual scores for each applicable goal within each goal area. Then, since not every goal applied to each ITI, the maximum composite goal area score for each ITI was determined. The composite goal area scores were calculated as the ratio of the raw composite score to the maximum composite score. Since the initial scores varied from 1 to 5, the composite goal area scores vary from a minimum of 20 (when all individual goal scores are 1) to a maximum of 100 (when all individual goal scores are 5). The overall composite score, taken by adding the four composite goal area scores, can vary from 80 to 400.

The key ITI were ranked on the basis of the overall composite score, both among all ITI and among the ITI within their group. Table 12 summarizes the performance evaluation of ADOT’s surveillance and data collection systems, based on these universal performance measure composite scores.

Table 12: Group A ITI – Evaluation Based on Universal Performance Measures

| ITI | Composite Goal Area Scores | | | | Composite Overall Score (Overall/Group Rankings) |
|---|----------------------------|----------|-------|----------------------------|---|
| | Safety | Mobility | Costs | Reliability/ Usefulness | |
| A1. Road Weather Information Systems (RWIS) | 40 | 40 | 52 | 56 | 188 (16 of 18 / 3 of 5) |
| A2. Passive Acoustic Detectors (PAD) | 20 | 20 | 24 | 32 | 96 (18 of 18 / 5 of 5) |
| A3. Remote Cameras (Fixed, Still-Frame) | 40 | 40 | 60 | 56 | 196 (15 of 18 / 2 of 5) |
| A4. Speed Detection/Warning Devices | 100 | 60 | 76 | 52 | 288 (8 of 18 / 1 of 5) |
| A5. License Plate Readers | 40 | 40 | 52 | 32 | 164 (17 of 18 / 4 of 5) |