COORDINATION OF COMMERCIAL VEHICLE DATA COLLECTED BY AUTOMATIC TRAFFIC COUNTER (ATC) AND WEIGH-IN-MOTION (WIM)

FINAL REPORT 526

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16. Abstract

The purpose of this report is to examine the current state of commercial vehicle data handling in an effort to identify ways in which the Arizona Department of Transportation's (AzDOT) practices can be improved. This is done through a three-fold approach that includes a literature review, survey of other states' practices, and an AzDOT needs assessment.

The literature review shows an absence of a best practices consensus relative to coordination of commercial vehicle data. Obstacles to developing an effective program appear to be lack of funding, data quality, timeliness of delivery, and incompatible data formats. Success is contingent on inter- and intra-agency cooperation among data collection units.

A survey of state practices showed data collection is typically centralized in one or two departments. Data collection is part of a permanent program using permanent data collection sites supplemented by portable equipment. No apparent method of operation led to an "effective" or "very effective" self-rating. Commercial vehicle data are primarily used to meet federal reporting requirements with limited use for size and weight enforcement.

The needs assessment showed the lack of commercial vehicle data for effective size and weight enforcement as the area where the current system falls short of user needs. This is due in part to the lack of coordination and communication between data collection units. Additionally, a large percentage of traffic count and classification equipment is in need of repair or replacement. Weigh-in-motion equipment is absent on critical interstate highways and truck bypass routes.

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SI (MODERN METRIC) CONVERSION FACTORS*

APPROXIMATE CONVERSIONS TO SI UNITS					APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	When You Know	Multiply By	To Find	Symbol	Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH					**LENGTH**			
in	inches	25.4	millimeters	mm	mm	millimeters	0.039	inches	in
ft	feet	0.305	meters	m	m	meters	3.28	feet	ft
yd	yards	0.914	meters	m	m	meters	1.09	yards	yd
mi	miles	1.61	kilometers	km	km	kilometers	0.621	miles	mi
	AREA					**AREA**			
in^2	square inches	645.2	square millimeters	mm^2	mm^2	Square millimeters	0.0016	square inches	in^2
ft^2	square feet	0.093	square meters	m^2	m^2	Square meters	10.764	square feet	ft^2
yd^2	square yards	0.836	square meters	m^2	m^2	Square meters	1.195	square yards	yd^2
ac	acres	0.405	hectares	ha	ha	hectares	2.47	acres	ac
mi^2	square miles	2.59	square kilometers	km^2	km^2	Square kilometers	0.386	square miles	mi^2
	VOLUME						**VOLUME**		
fl oz	fluid ounces	29.57	milliliters	mL	mL	milliliters	0.034	fluid ounces	fl oz
gal	gallons	3.785	liters	L	L	liters	0.264	gallons	gal
ft^3	cubic feet	0.028	cubic meters	m^3	m^3	Cubic meters	35.315	cubic feet	ft^3
yd^3	cubic yards	0.765	cubic meters	m^3	m^3	Cubic meters	1.308	cubic yards	yd^3
	NOTE: Volumes greater than 1000L shall be shown in m^3.								
	MASS					**MASS**			
oz	ounces	28.35	grams	g	g	grams	0.035	ounces	oz
lb	pounds	0.454	kilograms	kg	kg	kilograms	2.205	pounds	lb
T	short tons (2000lb)	0.907	megagrams (or "metric ton")	mg (or "t")	Mg	megagrams (or "metric ton")	1.102	short tons (2000lb)	T
		TEMPERATURE (exact)					**TEMPERATURE (exact)**		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celsius temperature	°C	°C	Celsius temperature	1.8C + 32	Fahrenheit temperature	°F
	ILLUMINATION						**ILLUMINATION**		
fc	foot candles	10.76	lux	lx	lx	lux	0.0929	foot-candles	fc
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2	cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
	FORCE AND PRESSURE OR STRESS					**FORCE AND PRESSURE OR STRESS**			
lbf	poundforce	4.45	newtons	N	N	newtons	0.225	poundforce	lbf
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa	kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

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GLOSSARY OF ACRONYMS

AASHTO	American Association of State Highway Transportation Officials
ADR	automatic data recorder
ASCII	American Standard Code for Information Interchange
ASTM	American Society for Testing and Materials
ATC	automatic traffic counter
ATMS	Advanced Traffic Management System
ATRC	Arizona Transportation Research Center
AVC	automatic vehicle classification
AzDOT	Arizona Department of Transportation
Caltrans	California Department of Transportation
CB	citizens' band
CD-ROM	compact disk-read only memory
CEO	Chief Executive Officer
CTR	Center for Transportation Research
CVISN	Commercial Vehicle Information Systems and Networks
DAW	Dynamic Axle Weighing
DMV	Department of Motor Vehicles
DOT	Department of Transportation
DPS	Department of Public Safety
ECM	Electronique Controle Mesure
FHWA	Federal Highway Administration
FMS	Freeway Management System
GIS	geographic information systems
GIS-T	Geographic Information Systems for Transportation
HPMS	Highway Performance Monitoring System
HURF	Highway User Revenue Fund
IRD	International Road Dynamics
ITC	International Traffic Corporation
ITE	Institute of Traffic Engineers
ITS	Intelligent transportation systems
ITS/CVO	Intelligent Transportation System/Commercial Vehicle Operations
LTPP	Long-Term Pavement Performance
MAG	Maricopa Association of Governments
MPO	metropolitan planning organization
MVD	Motor Vehicle Division
NCHRP	National Cooperative Highway Research Program
PAG	Pima Association of Governments
PAT	Pietzsch Automatisierungstechnik
PC	personal computer
POE	port-of-entry
SAS	SAS Institute Inc.
SHRP	Strategic Highway Research Program
TAS	Traffic Analysis Software
TCC	Traffic Counter and Classifier

TDP	Traffic Data Processor
TMA	transportation management area
TMC	Traffic Management Center
TMG	Traffic Monitoring Guide
TOC	Traffic Operations Center
TOPPS	Traffic Operating and Planning Software
TPD	Transportation Planning Division
TRA	Traffic Research & Analysis, Inc.
TRADAS	TRAffic DAta System
TRB	Transportation Research Board
TTI	Texas Transportation Institute
VMS	variable messaging system
VTRIS	Vehicle Travel Information System
WIM	weigh-in-motion
WIMAGE	weigh-in-motion image

EXECUTIVE SUMMARY

The Arizona Department of Transportation (AzDOT) is working to improve its system for handling commercial vehicle data collection and dissemination. The purpose of this research was to examine the current state of commercial vehicle data handling in an effort to identify ways in which AzDOT's practices can be improved.

Two primary factors drive the need for an effective program to handle commercial vehicle data. The first involves the impact of overweight vehicles on the state's roadways and the use of state funds to support aging highway infrastructure. It has been claimed that overweight commercial vehicles are the primary cause of state highways failing to meet their expected or designed life span. If this is true, millions of dollars in damage that must be funded from Arizona's Highway User Revenue Fund and other sources are being unnecessarily expended on replacement of existing highways prematurely aged by overweight vehicles.

The second factor involves the state's obligation to meet federal traffic data reporting requirements. The Federal Highway Administration (FHWA) mandates "requirements for development, establishment, implementation, and continued operation of a traffic monitoring system for highways and public transportation facilities and equipment in each State." As such, states are required to record traffic volumes, vehicle classification, and vehicle weight data as part of their traffic monitoring system.

This report is comprised of three sections. The first section includes a literature review to identify recent research, current trends, and best practices in the industry. The second section includes the results of a survey of other state programs, which is used to benchmark current practices. The last section is a needs assessment, used to identify areas within AzDOT at which resources should be targeted. The principal findings are listed below.

Literature Review:

- Enforcement of size and weight restrictions is essential to preserving highway infrastructure.
- There is an absence of best practices in the area of coordination of commercial vehicle data.
- Success is contingent of inter- and intra-agency cooperation among data collection groups.
- Obstacles appear to be lack of funding, data quality, timeliness of delivery, and incompatible data formats.
- Data partnering amongst state agencies, metropolitan planning organizations (MPOs), and local governments offers opportunities for cost sharing and resource conservation but will be contingent on effective use of data management systems.

- Department of transportation priorities have shifted toward intelligent transportation systems (ITS) and ATMS – neither of which are involving commercial vehicle data handling.

Survey of State Practices:

- Among those participating in the survey, data collection is centralized within one or two departments within an agency, typically the Planning Division and/or Traffic Engineering Unit.
- Commercial vehicle data are shared with three or more departments.
- Data collection is typically part of a permanent program using permanent data collection sites supplemented by portable equipment.
- No apparent method of operation consistently led to an "effective" or "very effective" self-rating.
- The primary use of commercial vehicle data is to meet federal reporting requirements with limited use of the data for size and weight enforcement.

AzDOT Needs Assessment:

- The lack of data for use in size and weight enforcement was identified as the primary obstacle that needed to be overcome.
- Data collection is decentralized with lack of coordination and communication between departments responsible for collecting the data.
- There is a lack of functional data collection equipment and a limited number of weigh-in-motion devices located strategically along state highways.
- There is lack of standardization of data formats and limited accessibility to data across departments.
- Absence of a comprehensive data management system for storage and retrieval of traffic data by all stakeholders in AzDOT limits system effectiveness.

As a result of these investigations, it is evident that action needs to be taken to improve AzDOT's current system for coordination of commercial vehicle data. Of initial importance is the absence of a long-range, agency-wide plan to address the situation. A first step would be to establish an intra-departmental task force to begin addressing the issues. Some areas to target include establishing consistent standards of practice relative to data collection, storage, and exchange. Unfortunately, the absence of a best practices consensus in the area of commercial vehicle data coordination leaves little to build on.

The biggest obstacle to modifying the current system will likely be lack of funds to support needed change. Formation of data partnerships may provide some cost savings and resource conservation. However, repair or replacement of non-functional traffic recorders and installation of additional weigh-in-motion devices will be a significant expense. Yet, this must be a priority, as no amount of procedural change will produce accurate data when recording equipment is faulty.

In summary, the magnitude of the financial impact that overweight vehicles have on our highways, in the long run, makes inaction more costly than allocating resources toward improving the system.

1.0 INTRODUCTION

1.1 PURPOSE

The Arizona Department of Transportation (AzDOT) is working to improve its system for handling commercial vehicle data collection and dissemination. Arizona has a number of sites, handled by different state entities, that gather data at strategic points to aid in the design of future highways, identify traffic trends, and determine daily traffic counts. A coordinated system of sharing the data gathered and extracting the information required by all sections of AzDOT is required to optimize the use of existing resources.

This paper examines the state of commercial vehicle traffic data collection and sharing practices in Arizona and other state departments of transportation (DOTs). A review of the literature was done to identify recent research, current trends, and best practices in the industry. In addition, an AzDOT data needs assessment was conducted to determine where the current system might be falling short of user needs. This report summarizes the information gathered and will be used to assist AzDOT with improving the efficiency and effectiveness of its current practices.

1.2 BACKGROUND

Two primary factors drive the need for effective handling of commercial vehicle data. The first involves the impact of overweight vehicles on the state's roadways and the use of state funds to support our aging highway infrastructure. The second factor involves the state's obligation to meet federal traffic data reporting requirements.

The state of Arizona taxes motor fuels and collects a variety of fees and charges relating to the registration and operation of motor vehicles on the public highways of the state. These collections include gasoline and use fuel taxes, motor carrier taxes, vehicle license taxes, motor vehicle registration fees, and other miscellaneous fees. These revenues are deposited in the Arizona Highway User Revenue Fund (HURF) and are then distributed to cities, towns, and counties and to the State Highway Fund. These taxes represent the primary source of revenues available to the state for highway construction and improvements and other related expenses.

It has been claimed that overweight commercial vehicles are the primary cause of state highways failing to meet their expected or designed life span. If this is true, millions of dollars in damage that must be funded from HURF and other sources is being unnecessarily expended on replacement of existing highways prematurely aged by overweight vehicles. The Arizona Department of Transportation has primary responsibility for enforcement of laws regulating commercial vehicle size and weight limits. Consequently, it is essential that AzDOT have an effective system for intra-agency sharing of the data that it collects at automatic traffic counter (ATC) and weigh-in-motion (WIM) sites throughout the state.

In addition to size and weight enforcement, the Federal-Aid Policy Guide established by the Federal Highway Administration (FHWA) mandates "requirements for development, establishment, implementation, and continued operation of a traffic monitoring system for highways and public transportation facilities and equipment in each State." Subchapter F of the *Federal-Aid Policy Guide* (http://www.fhwa.dot.gov/legsregs/directives/fapgtoc.htm) outlines general requirement for compliance with this policy. States must comply with these requirements when…

- Traffic data are used in support of studies or systems which are the responsibility of the U.S. Department of Transportation;
- Collection of traffic data is supported by the use of federal funds;
- Traffic data are used in the apportionment or allocation of federal funds;
- Traffic data are used in design or construction of an FHWA funded project; or
- Traffic data are required as part of a federally mandated program.

A state's traffic monitoring procedures also apply to the "activities of local governments and other public or private non-state government entities collecting highway traffic data within the state" if the data are used for any of the purposes described above. States are required to record traffic volumes, vehicle classification, and vehicle weight data as part of their traffic monitoring system. The collection of this data for selected areas of the state is delegated to public or private non-state government agencies outside of AzDOT. Therefore, the sharing of data between AzDOT and outside entities is crucial to AzDOT meeting obligations of the Federal Policy Guide.

In addition, Federal-Aid Policy Guide Subchapter G, Part 657, Certification of Size and Weight Enforcement, requires that "each State enforce vehicle size and weight laws to assure that violations are discouraged and that vehicles traversing the highway system do not exceed the limits specified by law. These size and weight limits are based upon design specifications and safety considerations, and enforcement shall be developed and maintained both to prevent premature deterioration of the highway pavement and structures that provide a safe driving environment." The purpose of the regulation is to "prescribe requirements for administering a program of vehicle size and weight enforcement on Federal Aid highways including the required annual certification by the State." The program shall describe the procedures, resources, and facilities which the State intends to devote to the enforcement of vehicle size and weight laws." Each State is required to submit its enforcement plan or an annual update by July 1 of each year. Failure to comply with these requirements can result in loss of Federal-Aid highway funds apportioned to the State for the next fiscal year.

Effective enforcement of laws regulating commercial vehicle size and weight limits is dependent on the availability as well as accuracy of ATC and WIM data from sites throughout the state. These data also are needed for meeting federal reporting requirements. Therefore, dissemination of accurate and reliable commercial vehicle count, class and weight data is an essential element to maintaining the integrity of the state's highway infrastructure.

1.3 PROJECT OVERVIEW

This report is comprised of three sections—a review of existing literature on coordination and sharing of commercial vehicle data collected by automatic traffic counters and weigh-in-motion devices, a survey of state departments of transportation, and a needs assessment of AzDOT's commercial vehicle data requirements. The first section contains information gathered through a review of books, journals, Internet websites, and interviews with traffic data collection professionals.

The second section contains the results of the Commercial Vehicle Data Handling Practices Survey sent to the fifty state DOTs. In some cases, the survey was sent to more than one individual in a state department of transportation if more than one department could be identified as being responsible for collecting commercial vehicle data. The results of the survey were compiled in a Microsoft Access database and summarized for this report. The survey is included as Appendix A. The results reported by each individual participant are included as Appendix B.

The last section of the report summarizes the current state of AzDOT's commercial vehicle ATC and weigh-in-motion data handling practices. Strategic data collection sites in the state are identified and individuals responsible for data collection and dissemination were interviewed. The needs of data users is assessed and summarized.

2.0 LITERATURE REVIEW

2.1 PURPOSE AND METHODS

The purpose of the literature review is to examine current trends in the coordination of commercial vehicle traffic data collected by automatic traffic counters and weigh-in-motion devices. This was done through an extensive search of books and journal articles as well as websites associated with the transportation industry. State and federal transportation agencies, professional associations, and manufacturers of traffic analysis software were included in the search.

As the goal of the review is to focus on innovative new practices that might be useful in improving AzDOT's current system for handling commercial vehicle data, this reviewer concentrated on information published during the past five years.

2.2 STATE DEPARTMENTS OF TRANSPORTATION

Each of the 50 state departments of transportation websites was canvassed for documentation on the state's commercial vehicle data collection practices and their size and weight enforcement plans. This seemed an important place to start, as data collection on state and federal highways is primarily the responsibility of the state's department of transportation. Despite this fact, there is disappointingly little descriptive information on who collects the data, how it is disseminated to users, or enforcement programs. The lack of information may be due to the need to keep data collection activities and enforcement plans unpredictable so as to minimize the opportunities for circumventing the system. Examining the 50 state DOT websites did not prove to be a beneficial mechanism for discovering innovative new practices in data coordination and sharing.

2.3 RELATED RESEARCH

No studies dealing exclusively with ***commercial vehicle*** data handling practices were identified in the literature. The search was subsequently expanded to include information on general traffic data handling practices in which truck classification and weight data are included.

Several studies addressing issues of general data handling in traffic monitoring programs were uncovered. The first of these reports is *An Overview of Traffic Monitoring Programs in Large Urban Areas* by Joseph Mergel with the Center for Transportation Information at the Volpe National Transportation Systems Center. The purpose of this 1997 study was to "get a sense, even if only on an anecdotal level, as to who was doing what, and how, and why in terms of data collection; and second to identify programs that might potentially serve as models for urban areas throughout the country." [1]

The report summarizes results of a literature review of traffic data collection programs and the author's interviews with urban traffic data handling professionals in select areas of the country. Some of the conclusions and comments relevant to statewide data collection programs and weigh-in-motion data are reproduced below directly from the report.

1. **There is a general lack of knowledge regarding which agencies collect what types of data and the manner in which it is collected within the states and within individual urban areas.**

   The author reports having difficulty identifying individuals at the local level responsible for traffic data collection. The FHWA division offices in states containing the urbanized areas of interest were contacted but in most cases were not familiar with any data collection efforts below the level of the state DOT. Individuals at the state DOTs could in most cases only refer study personnel to someone at an MPO (metropolitan planning organization). Ironically, the MPOs, while the agency level least involved in direct data collection, were the most knowledgeable about who was involved in data collection within their area.

   The largest non-response to study interviewers came from state DOTs. In many cases, they were unable to provide information on their data collection programs within a specified transportation management area (TMA), although they could readily provide information on their total statewide program. States reported they just did not have the numbers available on that basis or that they would have to contact their individual district or regional offices. In many cases, where the state DOT did provide data on their program at the TMA level, it was with what seemed to be a great deal of effort on their part. This may perhaps be an argument in favor of using geographic information systems (GIS) to track traffic data and data collection sites.

2. **There is no central source of information on the extent of use of new technology for either traffic management or traffic data collection within urban areas.**

3. **The quality of urban area traffic data collection efforts, and presumably of the resulting data, varies widely. Many programs would appear to meet currently accepted standards, many others would not, and in many cases there is no program.**

   Data reported in the MPO-conducted surveys showed that about half of the local agencies do not have a regular data collection program, i.e., either don't collect data or collect it as needed. It was not possible to judge the quality of the regular programs with the data available. Traffic volume counts were most prevalent with speed studies a distant second. Other types of data such as truck weight were hardly collected at all.

4. **Data within many urban areas would not appear to be collected in any kind of coordinated fashion. Most data exchange is informal.**

   The author reports that two things stand out regarding data exchange in the urban areas. The first is the preponderance of informal exchange over formal. For purposes of this study, informal exchange referred to situations where it is done, as needed, on a case-by-case basis, e.g., an individual in one agency calling an individual in another to see if they had any recent data on a certain intersection or road segment. Formal exchange involves the transfer of a comprehensive data set on a regular or routine basis, e.g., each year, an agency provides other agencies within the area with a copy of all the traffic data it collected during the past year.

   The second is that the formal exchange seems to be dominated by the flow of information to or from MPOs within urban areas. This should not be surprising. Since most "local" agencies do not have permanent data collection programs, they could not be expected to provide their data to others on anything other than an ad hoc basis. On the other hand, a major role of MPOs in most areas is to compile and distribute traffic data, either collected by themselves or others.

   The agencies responding to the survey did not have a problem with the current data sharing relationships. The problems most often indicated had to do with timeliness of data delivery, doubts about the quality of the data, and incompatible data formats. State agencies seemed to have the most complaints about data they received from local agencies.

   Additionally, state agencies tended to rely on permanent in house staff for data collection, while other agency types utilized permanent in house staff supplemented by temporary help during the data collection "season".

5. **Funding and staffing cutbacks have hurt data collection efforts in the recent past, and continue to pose a threat in the future.**

   An Institute of Traffic Engineers (ITE) survey found that funding for operations/ maintenance and capital improvements and staff shortages are expected to remain significant issues for local traffic engineering agencies over the next few years. The lack of adequate funding, both for operations/maintenance and capital improvements, is a significant issue to most agencies, regardless of jurisdiction size. While funding and staff levels were found to have increased on average, agencies felt that current funding and staff levels represented about 80% of what was needed to perform all of their functions effectively. More than half of the respondents felt that new requirements such as congestion management systems would result in increased workload, without increases in funding to deal with the potential impacts. This will tend to continue the trend of agencies having to do more with less.

6. **New technology would seem to hold promise as a solution to budget/staff reductions, but does not seem to have lived up to its full potential.**

   The new technology considered here involves that hardware and software connected with collecting traffic volume data from an Advanced Traffic Management System (ATMS)/Traffic Management Center (TMC)/computer-controlled traffic signal system.

An Overview of Traffic Monitoring Programs in Large Urban Areas was the first of two reports by Mr. Mergel. The companion report, entitled *Case Studies of Traffic Monitoring Programs in Large Urban Areas* [2], documents the in-depth review of the traffic monitoring programs in four urban areas—Philadelphia, Tampa-St. Petersburg, Minneapolis-St. Paul, and Portland. The major issue areas addressed in the second report were those points of interest identified by the first report. The author was interested in answering the following questions:

"Could ATMS be used to provide planning type data?"

"How were traffic data collection programs funded in those urban areas that managed to maintain viable programs, given that many agencies reported that traffic data collection programs had been eliminated or curtailed because of lack of funding?"

"What were the key ingredients needed to achieve a coordinated/cooperative data collection program within a given urban area and to provide all agencies in an area with the data they needed, in the proper form, and in a timely fashion?"

Findings of the case study report are reproduced directly from the report below [2].

1. **There are no unusual or innovative funding sources for traffic data collection in widespread use at the present time.**

   State agencies and MPOs were found to use standard federal program funds to pay for data collection. State and local agencies did not have a secure independent source of funding. Staff levels at state DOTs appear to be as much of a policy decision as a budget question. Decreased staff size as opposed to decreased budget levels appears to be more of a threat to maintaining viable data collection programs at the state DOT level.

2. **ATMS type systems can be used to collect planning data, but a well thought out ATMS implementation plan is necessary if ATMS is to provide useful planning type data.**

   Currently available hardware and software from traffic signal control systems and ramp-metering systems are being utilized by various agencies to collect traffic data. ATMS is seen as a solution to the problem of declining staff levels and increasing data needs, i.e., automation to increase productivity, and the safety of data collections. There also is a move toward automation of data collection in terms of increased use of permanent continuous count stations for increased productivity and safety.

3. **There is no magic ingredient in the success of coordinated data collection programs.**

   Successful programs were based on a spirit of cooperation and professionalism among all involved parties within a region. However, it appears to be helpful to have one agency take the lead in advocating and coordinating the program.

4. **While current programs generally provide the data that is needed, data quality and accessibility are major concerns.**

   Quality control of all aspects of data collection and processing is essential. This issue emerged during the course of the case study site visits. The loss of permanent staff devoted to data collection appears to have had an adverse impact on the quality of data. The reliability of equipment especially automatic vehicle classifier technology also surfaced as a concern. Another concern expressed was that of making data collected by all involved agencies available to all partners in a consistent format on a timely basis.

Two primary recommendations arose from the findings of the second report. They are as follows:

- All new ATMS systems should be designed and built with the capability of collecting traffic monitoring type data.

  Despite the fact that ATMS type systems in a number of areas now collect data for planning purposes, there are many other areas where this capability is not utilized. In an age of increasing data needs and declining data collection budgets and staff levels, this source of data should be utilized to its full potential.

- The concept of a central clearinghouse for the evaluation of data collection equipment, and the widespread dissemination of the resultant information to data collection agencies, including those below the state DOT level, should be vigorously pursued.

  Case study participants volunteered a number of concerns regarding the accuracy of available traffic data collection equipment, especially that used for vehicle classification and speed. Some of the local agencies had been forced to conduct their own tests on the equipment. The time and expense for each transportation agency to do their own testing is clearly wasteful and inefficient.

The state DOTs and FHWA, working through a pooled fund project, have attempted to establish a test center and clearinghouse for vehicle detector equipment. Observations from the site visits reinforced the crying need for such a facility, and more importantly the dissemination of results to all transportation agencies involved in data collection, especially those involved at the city, county, and MPO level.

Both reports by Mr. Mergel, *An Overview of Traffic Monitoring Programs in Large Urban Areas* and *Case Studies of Traffic Monitoring Programs in Large Urban Areas*, can be obtained at http://www.fhwa.dot.gov/ohim/tvtw/tvtwpage.htm.

In 1997 and 1998, the Federal Highway Administration undertook a reassessment of the Highway Performance Monitoring System (HPMS). This was done in cooperation with state and MPO partners and many HPMS users in the transportation and research communities. The system was streamlined but consensus was that the system's full potential is not being realized. The recommendation arising from this reassessment was that successful instances of data sharing and data partnerships within the HPMS process be identified and documented.

Kevin E. Heanue, consultant for National Cooperative Highway Research Program, prepared *Data Sharing and Data Partnerships for Highways NCHRP Synthesis 288* to accomplish this task. He acquired information for the report through a survey of state DOTs and MPOs, literature review, and discussions with federal, state, and local officials. Some of the findings of his inquiries relevant to this paper taken directly from the report are listed below. [3]

- Currently there are only limited instances of data sharing or data partnering within the HPMS process.

- The practice in those states and metropolitan areas where data sharing occurs indicates significant opportunities for saving in data collection costs within HPMS data collection programs. These saving would occur primarily through the more efficient collection and use of traffic volume data. These savings are over and above the savings that will be achieved by the revisions associated with the implementation of the HPMS reassessment.

- Data partnering in HPMS programs, whenever and wherever practiced, has created advantageous situations for all participants in the partnering. The greatest benefit occurs through multiple use of the data collected. An additional benefit is improved data quality, brought about by the greater care and attention paid by partners in the HPMS process.

- True data partnering in the collection of data from the HPMS sample sections only occurs in three states: California, Michigan, and Pennsylvania. In these states, MPOs have a major role in the collection process.

- There is a limited amount of partnering in HPMS data collection in an additional 16 to 18 states through MPO and/or local government involvement in the collection of data on HPMS sample sections not on the state highway system.

- Approximately 30 states undertake all HPMS data collection with their own staffs or, in a few instances, with the involvement of state consultants.

- Financial arrangements within the HPMS data collection system vary considerably. One of the three states noted as involved in true data partnering make "extra" funds available to MPOs for HPMS-associated expenses.

- Data partnering is much more apt to occur when a state has a comprehensive data management system designed to be accessed from throughout the agency. State data management systems make it much easier to expand access to other partners.

Despite the fact that truck classification and weight data represent a unique subset of the HPMS required data elements, the data sharing practices identified through the reassessment remain applicable. Some of the practices that were recognized as best examples of partnering within the HPMS process are listed below:

- Establishment of state and MPO data coordinating committees with representation from states, MPOs, and major local jurisdictions.

- Incorporation of HPMS data into broader data management systems by states and MPOs.

- Provision by states of highway system performance data to MPOs and local jurisdiction on either a real-time or annual basis.

- Recognition of state, MPO, and local agency roles and costs for HPMS data collection through formalized financial arrangements.

- Provisions by the FHWA of analytical software to states and MPOs to permit them to undertake HPMS-based performance and needs analysis.

- States permitting MPO access to Intelligent Transportation System (ITS) loop detectors and other traffic monitoring devices within an MPO's jurisdiction.

- California Department of Transportation/Southern California Association of Government's establishment of a data coordinating committee, which is overseeing their pioneering look at data sharing between the state, MPO, and major local jurisdictions.

  Caltrans (California Department of Transportation) has a very ambitious program to facilitate the collection of HPMS data using MPOs as partners wherever possible. They have an excellent state HPMS program, which provides for frequent adjustment of HPMS samples in order to maintain statistical validity as traffic conditions change. The degree to which the MPOs accept the role of partners in the process varies throughout the state.

- The Kalamazoo, Michigan, MPO's use of the unified planning work program as a basis for allocating HPMS data collection responsibility and for crediting local data collection costs against the local share of MPO costs.

  Michigan Department of Transportation, although requiring MPO involvement in HPMS data collection, has a flexible policy on the nature of that involvement. The competencies of the individual MPOs are recognized and in individual instances local agencies are credited for their role in the process to a greater degree than observed elsewhere in this synthesis.

The limited number of true data sharing activities identified by *NCHRP Synthesis 288* is disheartening but points out the tremendous opportunities for cost sharing and resource conservation that may be possible. This report can be purchased online at http://www.nationalacademies.org/trb/bookstore/.

In early 2000, the Transportation Research Board (TRB) published a series of papers under the heading Transportation in the New Millennium: State of the Art and Future Directions, Perspectives from the Transportation Research Board Standing Committees. Several of the papers touch on the subject of data sharing; however, not in any depth. The Transportation Research Board Committee on Urban Transportation Data and Information Systems presented the report, *Future of Urban Transportation Data*, as part of the series. The report takes a brief look at several topics, one of which is the use of ITS data for transportation planning.[4]

The authors suggest that continuous data collection systems such as those involved in traffic monitoring programs "will eventually supplement or replace traditional traffic data sampling programs." Traffic volume and classification data from ITS systems could replace short-term counts in urban areas. The authors also point out the potential for significant improvements in data quality by eliminating transcription errors through use of automated data collection technologies associated with ITS applications. The sharing of ITS data among different transportation entities has the potential to provide significant cost saving as well as yield large volumes of data for analysis. [4]

Additionally, the authors note that sharing of data by multiple users has its problems. Some of the challenges identified in the report include:

- Formulating information use and sharing policies;
- Addressing data use and management issues inherent in sharing and analyzing extremely large databases in a distributed data user environment;
- Developing analytical tools and procedures that can be used to explore and analyze trends and relationships in large, complex transportation databases; and

- Developing and incorporating automated quality control procedure into data archiving practices to ensure that end users have data of sufficient quality and accuracy.

Unfortunately, no suggestions are made in the article on how to address these challenges so as to promote data sharing activities within and across transportation agencies.

A second paper, entitled *Highway Traffic Monitoring* and presented by the Committee on Highway Traffic Monitoring, takes a brief look at the state of the art and future directions. Mark Gardner, the author, notes that the "basic practice of highway traffic monitoring has not changed dramatically since its beginnings early this century" *(referring to the 20th century)*. In his description of the "state of the practice" he makes no mention of data sharing practices among transportation professionals. However, in looking into the future, he identifies integration of highway traffic monitoring with ITS as the "highest need and most likely development of the new millennium." Gardner points out that the needs of traffic monitoring and traffic management complement each other but he does not give suggestions on how implement integration of the two systems. [5]

A third paper presented by the Committee on Statewide Transportation Data and Information Systems, entitled *Data, Data, Data—Where's the Data?*, emphasizes the need for a new transportation strategy as we enter the new millennium. The requirement for a new strategy arises out the need to accommodate growth in already heavily populated urban areas. The changing demographics of our society have put new and different demands on the transportation system. Additionally, there is an increased use of our highway infrastructure for transporting goods across the country. The authors believe "accurate, reliable and readily available data is the essential tool for making the new strategy a reality." [6]

The authors also report that currently most "agencies don't have the money to sustain the needed data programs" and that "most programs do a bad job of justifying the need for data expenditures." [6] If this is the case, sharing of data as well as intra- and inter-agency coordination of data collection activities will be essential. Surprisingly, the report makes no mention of this point.

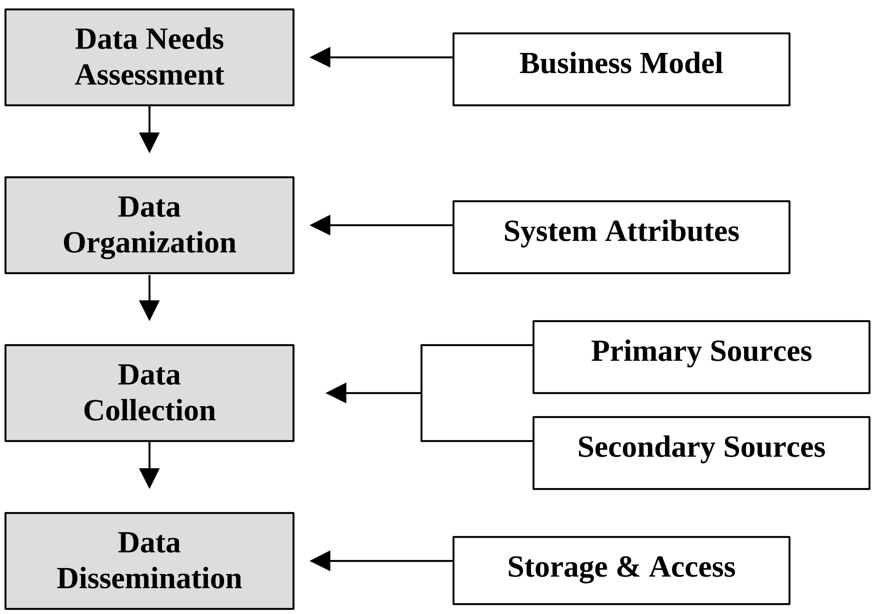
All three papers from the Transportation in the New Millennium Series can be found at http://www4.trb.org/trb/onlinepubs.nsf/web/millennium_papers.

The only document outlining the logistics of implementing an agency-wide data coordination strategy was found in the 1997 report, *Guidance Manual for Managing Transportation Planning Data, NCHRP Report 401*. This report addresses the primary issues, requirements, and obstacles involved with developing an integrated strategy for handling transportation data.

The authors begin by emphasizing the need to establish a data task force to be led by the state DOT. The task force should include representatives from state DOT functional offices, MPOs, other transportation data user groups such as air quality planning agencies, and other public and private stakeholders. The report suggests the mission of this task force should be as follows:

> ***"To ensure coordination and collaboration in the assessment of data needs and in the organization, collection, and dissemination of data across all user groups within the state."*** [7]

The data program proposed in the manual is targeted toward a comprehensive data collection program but the development process can be applied on a smaller scale to collection of any transportation data subset. The format of the program is shown below.



[Source: 7]

Figure 1. Suggested Data Program

The strategy for implementing such a program is based on four primary components: data needs assessment, data organization, data collection, and data dissemination. The first stage involves the application of a strategic planning platform to assess data needs. The authors recommend use of the Business Model in defining overall needs.

The Business Model is outlined in the article as a six-step process including the following actions:

1. Define the mission;
2. Define goals and objectives;
3. Develop strategies to meet goals and objectives;
4. Map strategies to functions;

5. Assess information needs; and
6. Define data and develop processes.

The second stage of the implementation process involves defining a standardized data system. The potentially large volume of data collected demands an efficient organization that will allow timely access to information needed for decision-making. [7]

The third stage involves examining the economics of the data collection process. "Today we have too much data and too little analysis related to its usefulness and cost-effectiveness in supplying the information needed for transportation planning. It is easier (but perhaps more expensive) to collect lots of data with the intent that it can be used somehow than it is to analyze carefully the salient needs and to design efficient ways to collect data to fill specific needs. Moreover, much of the available data are not tailored to specific needs and are often redundant. Having too much data not well organized and not directly useful makes it more difficult to identify the useful data and it wastes resources that could be allocated to improving more directly usable data." A primary responsibility of the interagency data task force is to assign data collection responsibilities to ensure the efficient use of available resources. [7]

The last of the four stages targets data integration, consistency, and sharing. The authors cite the two primary reasons for implementing a data integration strategy as time and money—factors that impact all traffic data professionals. The need for integration is not a new concept; however, there has been little movement toward achieving this objective. The manual identifies three strategies for achieving integration:

- A centralized approach where one department or division acts as the gatekeeper for all planning data;
- A decentralized method utilizing a bottom-up approach that recognizes the need for autonomy by the user but provides a mechanized centralization; or
- A technological approach such as Geographic Information Systems for Transportation (GIS-T) that relies on the concept of location as a basis for the structuring of information systems.

Each of these approaches is discussed in the manual as well as the institutional constraints on moving toward integration as a mechanism for taking advantage of the cost-effectiveness and productivity benefits of sharing data and reducing redundancy. The authors also look to the evolution of GIS to ignite further activity in the arena of data integration in the transportation industry. [7]

2.4 CONCLUSIONS

The FHWA's May 2001 *Traffic Monitoring Guide* (http://www.fhwa.dot.gov/ohim/tmguide/tmg1.htm), reports that truck weight data is the most costly and difficult to collect of the required HPMS data elements. Yet, it is one of the most important. "Traffic loading is a primary factor in determining the depth of pavement sections. It is used as a primary determinant in the selection of pavement maintenance treatments. The total tonnage moved on roads is used to estimate the value of freight traveling on the roadway system and is a major input into calculations for determining the costs of congestion and benefits to be gained from new construction and operating strategies. Truck classification and weight information is also a key component in studies that determine the relative cost responsibility of different road users."

The absence of best practice case scenarios in the area of coordination of commercial vehicle data handling implies that, despite its importance, it has not been a priority issue among state DOTs. As mentioned previously, the recent focus of the transportation community has been in the area of ITS and ATMS. But, ITS is not reaching its full potential if it does not integrate more aspects of the effort to manage our highway infrastructure [8].

Mergel's [1,2] studies testify to the lack of coordination in the area of data collection in large urban areas. Issues of data quality, timeliness of data delivery, and incompatible data formats are of concern. Funding and staff cutbacks further compromise a state's data collection efforts. Consequently, information is inconsistently available or totally absent for decision-making in the area of size and weight enforcement, pavement management, and roadway design. The limited number of data sharing best practices identified following the HPMS reassessment further documents the lack of activity in this area.

Fortunately, there are some cities and states that are moving forward on developing integrated systems. In addition to providing a streamlined approach to tackling the issues of data sharing and integration, the *Guidance Manual for Managing Transportation Planning Data* lists several short case studies of states making progress in this area. New Mexico has taken action to standardize the methods by which data are collected and organized. This is an essential first step in the integration process. The Bay Area Partnership in California formed a Data Integration Task Force to examine issues regarding data collected and used for planning and managing transportation. The manual also lists several states—Michigan, Vermont, Wisconsin—that incorporated GIS into their transportation management systems at the state DOT level. [7]

Progress has been slow considering how long this issue has been on the table. The savings of time and money that could come from a coordinated system for handling transportation data should be motivation enough to get things moving. What may prove to be the biggest obstacles toward data sharing and integration are institutional barriers and conflicting priorities that interfere with the ability to move forward. As Mergel identified, "There is no magic ingredient in the success of coordinated data collection programs. Successful programs were based on a spirit of cooperation and professionalism among all involved parties within a region." [1]

3.0 COMMERCIAL VEHICLE DATA HANDLING PRACTICES SURVEY

3.1 PURPOSE

One of the goals of the AzDOT commercial vehicle weight and classification program is to protect the state's highway infrastructure while, at the same time, streamlining and reducing delays to the trucking industry [9]. In an effort to achieve this goal, AzDOT is examining its data handling practices, which are an essential part of ensuring the timely dissemination of accurate and useful data to both internal and external users and stakeholders.

The AzDOT Data Handling Practices Survey was conducted to ascertain how other state departments of transportation gather and process commercial vehicle data. In addition, each agency was asked to assess the effectiveness of their current data handling practices. The results were examined to determine if a correlation exists between who collects the data, the method of data storage and sharing, how it is analyzed, and the level of effectiveness of the system as rated by the individual user. This information will be used to assist in improving the efficiency and effectiveness of AzDOT current practices.

3.2 METHODOLOGY

A two-page survey was sent to the fifty state DOTs on February 22, 2002. Prior to distribution of the survey each agency was contacted to obtain the name and address of an individual responsible for commercial vehicle data collection. In some cases, there was more than one person identified in different areas of the agency so some states received more than one survey. Participants were given three weeks to respond.

All fifty states returned survey results. The data were entered in a Microsoft Access database and summarized for this report. Following review of the results, individuals responsible for completing the survey were contacted to obtain additional or missing information and to clarify ambiguous responses. A list of each agency and the sixty individuals completing the survey follows:

Table 1. Survey Participants

Department of Transportation	Web Site	Contact
Alabama Department of Transportation	www.dot.state.al.us	Charles W. Turney
Alaska Department of Transportation	www.dot.state.ak.us	MaryAnn Dierckman
Arizona Department of Transportation	www.dot.state.az.us	Joe Flaherty, Estomih Kombe, Steve Abney
Arkansas Highway & Transport. Department	www.ahtd.state.ar.us	Ed Flanagan
California Department of Transportation	www.dot.ca.gov	Mohammad Fatemi
Colorado Department of Transportation	www.dot.state.co.us	Colette Negretti
Connecticut Department of Transportation	www.dot.state.ct.us	David N. McCorkle

Department of Transportation	Web Site	Contact
Delaware Department of Transportation	www.deldot.net	Jim Ho
Florida Department of Transportation	www.dot.state.fl.us/planning/	Harshad Desai
Georgia Department of Transportation	www.dot.state.ga.us	Michelle Young
Hawaii Department of Transportation	www.hawaii.gov/dot	Goro Sulijoadikusumo, Larry Oshiro
Idaho Transportation Department	www2.state.id.us/itd	Scott Fugit
Illinois Department of Transportation	www.dot.state.il.us	Rob Robinson
Indiana Department of Transportation	www.state.in.us/dot	Scott MacArthur
Iowa Department of Transportation	www.dot.state.ia.us	Ronald Bunting
Kansas Department of Transportation	www.ink.org/public/kdot	Steve Zimmerman, Bill Hughes
Kentucky Transportation Cabinet	www.kytc.state.ky.us	Dan Inabnitt
Louisiana Department of Transportation and Development	www.dotd.state.la.us	Robert Smith
Maine Department of Transportation	www.state.me.us/mdot	Ron Cote, Pete Pelletier
Maryland State Highway Administration	www.sha.state.md.us	Barry Balzanna
Massachusetts Highway Department	www.state.ma.us/mhd	Stephen R. Greene, William Mitchell
Michigan Department of Transportation	www.mdot.state.mi.us	Dave Schade, Bob Brenner
Minnesota Department of Transportation	www.dot.state.mn.us	Curtis Dahlin
Mississippi Department of Transportation	www.mdot.state.ms.us	Susannah Seal
Missouri Department of Transportation	www.modot.state.mo.us	Allan Heckman
Montana Department of Transportation	www.mdt.state.mt.us	Dan Bisom
Nebraska Department of Roads	www.dor.state.ne.us	Rick Ernstmeyer
Nevada Department of Transportation	www.nevadadot.com	Steve Davis
New Hampshire Department of Transportation	www.state.nh.us/dot	Robert Lyford
New Jersey Department of Transportation	www.state.nj.us/transportation	Louis C. Whitely
New Mexico State Highway Department	www.nmshtd.state.nm.us	Billy Larranaga
New York State Department of Transportation	www.dot.state.ny.us	Todd Westhuis
North Carolina Department of Transportation	www.dot.state.nc.us	Michael Ashbrook
North Dakota Department of Transportation	www.state.nd.us/dot	Bob Speckmann
Ohio Department of Transportation	www.dot.state.oh.us	Dave Gardner
Oklahoma Department of Transportation	www.okladot.state.ok.us	Lester Harragarra
Oregon Department of Transportation	www.odot.state.or.us/tddtrandata	Randal Thomas
Pennsylvania Department of Transportation	www.dot.state.pa.us	Gaye F. Liddick
Rhode Island Department of Transportation	www.dot.state.ri.us	Michael Sprague
South Carolina Department of Transportation	www.dot.state.sc.us	David Settle
South Dakota Department of Transportation	www.sddot.com	Kenneth E. Marks
Tennessee Department of Transportation	www.tdot.state.tn.us	Steve Allen, Ray Barton
Texas Department of Transportation	www.dot.state.tx.us	Carolyn A. Markert
Utah Department of Transportation	www.sr.ex.state.ut.us	Richard Ollerton
Vermont Agency of Transportation	www.aot.state.vt.us	Amy Gamble
Virginia Department of Transportation	www.virginiadot.org	C.T. Wicker
Washington Department of Transportation	www.wsdot.wa.gov	Tim Erickson, John Rosen, Capt. Fred Fakkema
West Virginia Department of Transportation	www.wvdot.com	Jerry L. Legg
Wisconsin Department of Transportation	www.dot.wisconsin.gov	Paul Stein, Lt. Jeffrey Lorentz
Wyoming Department of Transportation	www.dot.state.wy.us	Kevin Messman, Sherm Wiseman

3.3 SURVEY INSTRUMENT

The AzDOT Commercial Vehicle Data Handling Practices Survey included ten multiple-choice questions. The questions are shown below. The complete survey is included as Appendix A.

1. What type of data do you collect on commercial vehicles in your state?
2. Who is responsible for collection of commercial vehicle data in your state?
3. With what other departments/agencies do you share the data you collect?
4. How are commercial vehicle data collected? If permanent stations are used, are the commercial vehicle data collected via telemetry?
5. Is collection of commercial vehicle data part of a permanent data collection program or collected on an "as needed" basis?
6. What is your primary method of commercial vehicle data storage?
7. How is commercial vehicle data shared with other departments/offices?
8. What type of software do you use to analyze your commercial vehicle data?
9. How effective is your current system for handling commercial vehicle data?
10. For what purpose(s) is your commercial vehicle data being used?

3.4 SURVEY DATA

3.4.1 Question 1

All sixty participants responded to question 1. The question asked participants to indicate the types of commercial vehicle data collected by their department or unit within the state. Participants were required to put a check in the box preceding the appropriate response(s). Individual results reported by each state are listed in Appendix B. A summary of all results is provided in Table 2 below.

Table 2. Type of Data Collected

	Weight	Count	Classification FHWA Scheme F	Classification Non-FHWA	Speed	Delay/Travel Time	Other
Number of Responses	55	53	53	9	32	3	5
%	91.7	88.3	88.3	15.0	53.3	5.0	8.3

According to these data, most states collect commercial vehicle weight, count, and classification data. Of the nine respondents using a non-FHWA classification scheme, five indicated they use this in addition to the standard FHWA Scheme F and four indicated this was the only method used. The only requirements outlined in the Highway Performance Monitoring System (HPMS) are that there be "sufficient classification categories to represent vehicles with two to seven axles." [10] Speed data is gathered by approximately half the respondents with several indicating it is collected only as a consequence of automatically being reported by the equipment used to gather other required data.

The “other” types of data collected all referred to classification schemes and include: 1) the number of unspecified vehicles; 2) length scheme for manual classification; 3) state algorithm “axle classification code”; 4) three classification categories by length; and 5) the Texas six scheme.

3.4.2 Question 2

The second survey question asked participants to indicate whom in their state is responsible for collection of commercial vehicle data. Respondents were instructed to place a check in the box preceding the appropriate response(s). All sixty participants responded to the question. Individual results reported by each state are listed in Appendix B. A summary of all results is shown in Table 3 below.

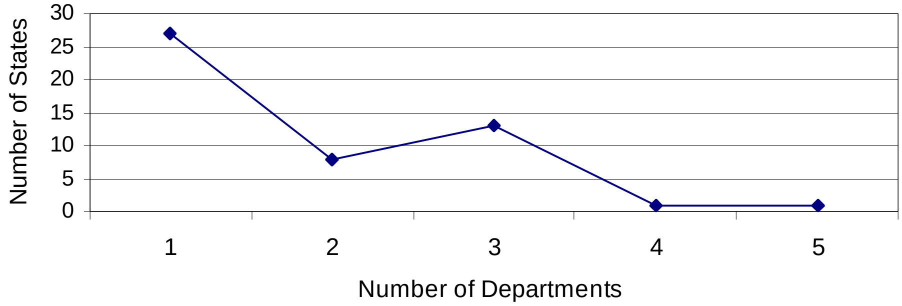
Table 3. Data Collection Units

	Planning Division	Motor Vehicle Enforcement	LTPP Program	Traffic Unit	Public Safety	Research Department	Cities, Counties, MPO	Other
Number of Responses	39	19	13	10	8	4	3	3
%	65.0	31.7	21.7	16.7	13.3	6.7	5.0	5.0

Thirty-six respondents (60.0%) indicated that only one department or agency within their state is responsible for collecting commercial vehicle data. The results from some states that submitted more than one survey were confusing. Theoretically, all departments within a state should have responded the same to this question. The lack of uniformity seems to indicate the lack of coordination and/or communication between departments within the traffic data collection units of these states.

If the results from states submitting more than one response are combined, the findings show fifty-four percent of all states centralize data collection within one department. Either way the results are analyzed, centralization of data collection seems to be the norm. The distribution of responses is shown in Figure 2 on the following page.

Figure 2. Number of Departments Collecting Commercial Vehicle Data



Regarding where the data is collected, the results show the Planning Division to be the most common unit gathering commercial vehicle data within each state. Following this came Motor Vehicle Enforcement, Long Term Pavement Performance Program, Traffic Unit, and Public Safety, in decreasing order of frequency.

The category of "Traffic Engineering Unit" was not included on the original survey as one of the multiple-choice responses; however, it was added during summarization of the data due to the large number of individuals writing a similar response in the "other" category. "Cities, Counties, MPOs" and "Research Department" were reported by three respondents each and in all cases were checked in addition to one or more other departments.

Of the 27 states where there is consensus that only one department is responsible for data collection, all but two indicated the Planning Division or Traffic Engineering Unit. After further investigation of individual responses, it was noted that some traffic engineering or traffic data units within a DOT fall under the domain of the Planning Division and some do not. So, some states marking both responses would have been accurate but redundant and somewhat misleading.

Conversations with some participants in the survey showed that the particular department reporting data collects *all* traffic data for the state not just commercial vehicle data. This was common for Planning Divisions and Traffic Units. On the other hand, the Motor Vehicle Division was never indicated as solely responsible for commercial vehicle data collection but rather an adjunct to another section of the state department of transportation.

3.4.3 Question 3

The third survey question asked participants with what other departments or agencies they shared their data. Respondents were instructed to place a check in the box preceding the appropriate response(s). All sixty participants reported results for this question. Individual results reported by each state are listed in Appendix B. A summary of all results is shown in Table 4 below.

Table 4. Data Sharing

	LTPP Program	Planning Division	Motor Vehicle Enforce-ment	Research	Department of Public Safety	Cities, Counties, MPOs	FHWA	Data is not shared	Other
Number of Responses	38	33	32	29	20	20	9	3	18
%	63.3	55.0	53.3	48.3	33.3	33.3	15.0	5.0	30.0

The information gathered for this question may be somewhat misleading as some respondents indicated their own department as well as *others* with which they share data. In particular, the number of Planning Division responses listed is over represented. As it was not possible to determine in all cases where this may have occurred the results are shown as they were reported on the surveys. This should be kept in mind when attempting to interpret these data.

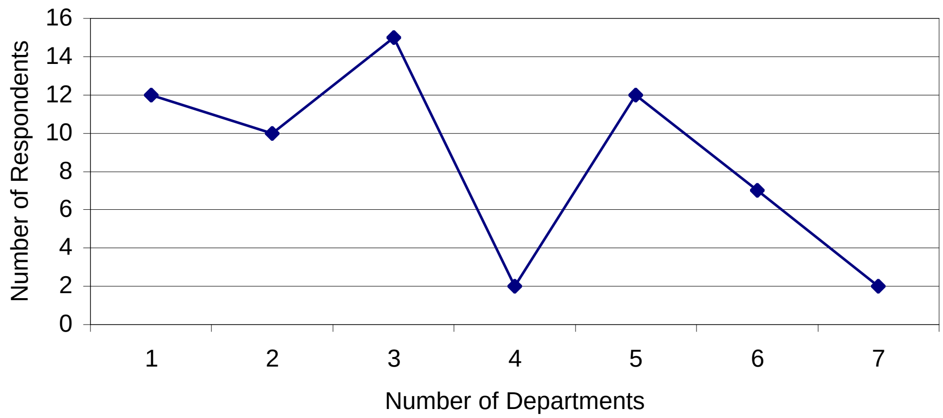
The Federal Highway Administration was not listed as a response on the survey; however, this response was listed nine times in the "other" category so it was added to the summary of results in Table 4. The additional departments/agencies listed under the "other" category included the following:

Table 5. "Others" Receiving Data

"Other" Responses	Number of Responses
General Public	4
Materials	2
Federal Motor Carrier Safety Administration	2
State Department of Transportation	2
Private Consultants	2
Border Patrol	1
U.S. Department of Transportation	1
Legislative Assembly	1
Engineering Division	1
Trucker's Association	1
State Highway Patrol	1

The majority of states (80%) reported sharing commercial vehicle data with two or more other departments or agencies. Although centralization of data collection appears to be the norm, the data that is collected is shared with many different entities including federal, state, and local stakeholders. Figure 3 shows a summary of the number of departments receiving commercial vehicle data collected by survey participants.

Figure 3. Number of Departments Receiving Commercial Vehicle Data



3.4.4 Question 4

Question 4 was broken into two parts, 4A and 4B. The first part asked participants how the commercial vehicle data is collected and offered three response choices: manually, portable classifiers and weighing devices, and permanent traffic monitoring stations. The second part of the question asked whether or not those using *permanent* monitoring stations retrieved the data using telemetry. All sixty participants responded to question 4A and fifty-nine participants responded to question 4B. Individual results reported by each state are listed in Appendix B. A summary of all responses is shown in Table 6 below.

Table 6. Data Collection Stations

	Manually	Portable (short-term) classifiers and weighing devices	Permanent monitoring stations	Other	Telemetry Used	Telemetry Not Used
Number of Responses	27	43	54	4	51	16
%	45.0	71.7	90.0	6.7	86.4	27.1

The results show the majority of respondents use permanent monitoring stations. Ten of these users (16.7%) report permanent monitoring stations as the only manner in which they collect commercial vehicle data. In addition, all ten of these respondents reported the data are retrieved via telemetry. Those reporting that data are collected manually did so in addition to using either permanent stations or portable devices. In only one instance, was “manually” reported as the sole method of data collection. This was reported by a state in which more than one unit collects commercial vehicle data.

It is apparent from looking at the results that some individuals incorrectly responded to question 4B. The question asked, “if permanent stations are used…” so that no more than 54 individuals should have responded. However, all but one respondent (i.e., 59 individuals) answered this question. If the results for those not using permanent stations are eliminated, 53 results remain. Forty-six of the permanent station users (94.3%) reported retrieving the data via telemetry, three (5.6 %) reported they did not use telemetry, and four reported that some stations used telemetry and some did not.

The four responses under “other” ways that commercial vehicle data are collected included: PrePass, CVISN sites (Commercial Vehicle Information Systems and Networks), video camera, and semi-permanent stations. PrePass is an Intelligent Transportation System/Commercial Vehicle Operations (ITS/CVO) application that involves placing a transponder in a commercial vehicle to allow electronic communication with a weigh station for the purpose of expediting the truck processing. As the truck approaches the weigh station, it is identified and weighed. A computer at the weigh station verifies the truck’s credentials. If the credentials are in order and the weight is within state guidelines, the truck bypasses the weigh station. If the weight is in excess of state limits or the credentials cannot be verified, the truck is directed via a variable messaging system (VMS) to pull into the weigh station. This type of application is typically at a permanent weigh station.

CVISN, developed by the U.S. Department of Transportation, is an information system and communication network that supports commercial vehicle operations through collection and dissemination of information related to safety, commercial vehicle credentials and tax administration, freight and fleet management, and vehicle operation. Whereas PrePass functions on the state level, CVISN’s goal is to develop a nationwide information network into which all states will input data. States can use the CVISN information network as part of a roadside-screening program, incorporating both weigh-in-motion (WIM) and automatic vehicle classification (AVC).

The “other” responses of video camera and semi-permanent stations as mechanisms for collecting commercial vehicle data require no further explanation.

3.4.5 Question 5

The fifth survey question asked participants whether collection of commercial vehicle data is part of a permanent data collection program or collected on an “as needed” basis. Participants could select more than one response. Individual responses reported by each participant are listed in Appendix B. A summary of all responses is shown in Table 7 on the following page.

Table 7. Data Collection Program

	Permanent Program	Special Studies (as needed)
Number of Responses	56	19
%	93.3	31.7

Of the sixty participants responding to this question, all but four indicated they have a permanent program for commercial vehicle data collection. Fifteen of the 56 participants reporting they have a permanent program also indicated they collect the data for purposes of special studies. Four participants in the survey indicated they only collect the commercial vehicle data for "special studies." Of these four participants, one is a long-term pavement performance program and the other three are Planning Division personnel. The consensus is clearly that commercial vehicle data should be part of a permanent data collection program.

3.4.6 Question 6

The sixth question on the survey asked, "What is your primary method of commercial vehicle data storage?" Respondents were instructed to place a check in the box preceding the appropriate response(s). Fifty-nine of the 60 participants responded to question 6. Individual responses are listed in Appendix B. A summary of all responses is shown in Table 8 below.

Table 8. Method of Data Storage

	Hard Copy	CD-ROM Diskette	Zip, Jaz Drive	Tape Drive	Laptop	Local PC	Dedicated Server	Computer Network
Number of Responses	15	18	7	1	5	24	20	24
%	25.4	30.5	11.9	1.7	8.5	40.7	33.9	40.7

The majority of respondents (52 or 88.1%) indicated their commercial vehicle data is stored on a local personal computer, dedicated server, or computer network (shared server). Sixteen of the 52 marked more than one computerized method. The remaining seven respondents (11.9%) reported using paper, CD-ROM, or a Zip drive as the primary method of data storage. One of the seven reported they were in the process of moving data storage to a dedicated server.

The four responses under "other, specify" were as follows: mainframe application (2), Oracle database (1), and shared server (1).

3.4.7 Question 7

The seventh survey question asked participants to indicate how they shared the commercial vehicle data they collect. Respondents were instructed to place a check in the box preceding the appropriate response(s). All sixty participants responded to this question. Individual responses are listed in Appendix B. A summary of all responses is shown in Table 9 below.

Table 9. Method of Data Sharing

	Hard Copy	CD-ROM Diskette	Network File Sharing	Intranet	Internet, E-mail	Modem Transmission (FTP)	The data is not shared
Number of Responses	44	17	17	18	5	7	3
%	73.3	28.3	28.3	30.0	8.3	11.7	5.0

Thirty-three respondents (55.0%) indicated using some form of electronic data sharing. Eight of the thirty-three reported using more than one method of electronic data sharing. Network file sharing and intranet were the most frequently reported responses. Internet and e-mail were not listed as responses on the survey; however, several participants wrote this under "other" so it was added to the summary of results.

It is not surprising that 73.3 % of the respondents reported sharing data in a "hard copy" format. Most agencies distribute traffic data as reports, publications, maps, and books. However, it is surprising that eighteen participants (30.0%) indicate this is their *only* method of data sharing. Looking at these eighteen participants, twelve indicated in question 2 that only one department within their state collects data. With the majority of states centralizing the data collection process, it would seem that more efficient mechanisms of sharing the data would be utilized. In addition, three other agencies reported not sharing the data they collect with any other departments or agencies.

3.4.8 Question 8

The eighth question asked survey participants what type of software they use to analyze their commercial vehicle data. Participants were asked to place a check in the box preceding the appropriate response(s) and write the name of the software vendor in the space provided. Fifty-nine out of 60 participants responded to this question.

Of the 59 individuals responding to the survey, four indicated that analysis is either not done in-house or is handled by a human individual rather than by software. The remaining 55 participants indicated one or more types of software—31 reporting a single method and 24 reporting two or more methods. Individual responses are listed in Appendix B. A summary of all responses is shown in Table 10 on the following page.

Table 10. Data Analysis Software

	Commercially Available Traffic Analysis Software	Custom Designed Software	In-House Designed System	Microsoft Product	Other, specify
Number of Responses	31	9	23	25	4
%	52.5	15.2	38.9	42.4	6.8

The use of commercially available traffic analysis software was the most common response. Ten out of 59 participants used Peek Traffic *(www.peek-traffic.com)*. This manufacturer offers the Traffic Data Processor (TDP) software to complement their vehicle counting, classification, and weighing devices—pneumatic rubber tubes, inductive loops, and piezo-electric sensors. The software manufacturers are shown below by frequency of use, as reported by participants in the survey.

Table 11. Commercial Software Manufacturers

Manufacturer	Number of Responses
Peek Traffic	10
Federal Highway Administration - VTRIS	9
Chaparral Systems Corporation	8
International Road Dynamics (IRD, Inc.)	7
Electronique Controle Mesure (ECM, Inc.)	3
Diamond Traffic	2
JAMAR Technologies, Inc.	1
ITC/Pat America	1
Not specified	2

In addition to commercial manufacturers, software developers are available to customize commercial software packages to meet the end user's needs. One such company is Diamond Edge Technology, LLC in Eugene, Oregon *(www.detllc.com)*. The organization provides custom hardware and software services for companies such as Diamond Traffic and International Road Dynamics. A system was developed for New York DOT to support polling and data export requirements. Diamond Edge Technology added extensive customization to the TrafMan and Telecom software packages for the New York DOT to allow handling of more than 100 existing Peek 241 and ADR counter sites, as well as IRD TCC-540 sites. [11]

The second most frequent response to question eight was the Vehicle Travel Information System (VTRIS) distributed by the Federal Highway Administration.

VTRIS is a Windows-based computer data base management system that can be used to handle automatic vehicle classifiers (AVC) and weigh-in-motion (WIM) systems in accordance with procedures outlined in the Traffic Monitoring Guide. In addition to data management, VTRIS validates and summarizes AVC and WIM data. [12] There are also a variety of printed reports available. The software is distributed to states for operation on their own PC and operating system. Both the software and user manual can be downloaded from the following site: http://www.fhwa.dot.gov/ohim/ohimvtis.htm.

Chaparral Systems Corporation, located in Santa Fe, New Mexico, was the third most popular software. The product used is most likely their TRADAS (TRAffic DAta System) software. "This is a software system for collecting, editing, summarizing, and reporting a wide range of traffic data." [13] A complete description of the software's capabilities can be found at the following site: http://www.chapsys.com/tradas.html.

International Road Dynamics, *(www.irdinc.com)*, was the fourth most popular software. This company offers a variety of weigh-in-motion systems. According to President and Chief Executive Officer (CEO) Terry Bergan, the company has an "extensive track record of providing effective solutions to a growing number of local and state transportation authorities."

Electronic Controle Mesure *(www.ecm-france.com)* was reported by three participants. The company offers the SATIA software to accompany their HESTIA weigh-in-motion and traffic analysis system. Diamond Traffic *(www.diamondtraffic.com)*, reported by two participants, is the manufacturer of the popular TrafMan software; however, it does not currently accommodate WIM data. The company is currently planning for WIM compatibility in the first quarter of 2003. The remaining manufacturers—JAMAR Technologies (www.jamartech.com), International Traffic Corporation (ITC)/Pat America *(www.patamerica.com)*—were each reported by one participant.

The use of in-house designed software programs and Microsoft products was about the same—23 and 25 participants, respectively. The in-house programming languages identified in order of prevalence were COBOL, Visual Basic, C, Fox Pro, Java, SAS Institute Inc. , and Perl. Five respondents did not specify a programming language. Three indicated new systems are under development.

Of the twenty-five participants using Microsoft products, ten indicated Microsoft as the only software they use to analyze commercial vehicle data. This seems somewhat surprising but may be due to the ease and flexibility of these programs in manipulating information in a database. It also may be due to the relatively routine nature of the analyses performed. There also seemed to be no correlation between the size and complexity of the agency and the sole use of Microsoft products. Larger states such as Illinois and Texas as well as smaller states of Hawaii and West Virginia all report Microsoft products as the only software in use. The number of areas collecting data in these states also ranged from a single department to as many as three.

Custom-designed software was the least frequently reported, with only nine out of 56 participants choosing this approach. This may be related to the development expense and time commitment involved with custom-designed software. In addition, the standardized nature of commercial vehicle data analysis may not warrant the investment in time or money. The more recent focus on Intelligent Transportation Systems (ITS) and Advanced Traffic Management Systems (ATMS) may be targeting already limited resources in areas were there is greater anticipated return on investment.

However, custom-designed software may be required to integrate complex systems of data gathering and sharing among multiple users. States using custom-designed software include Alaska, California, Idaho, Kentucky, Louisiana, Montana, New York, Vermont, and Virginia.

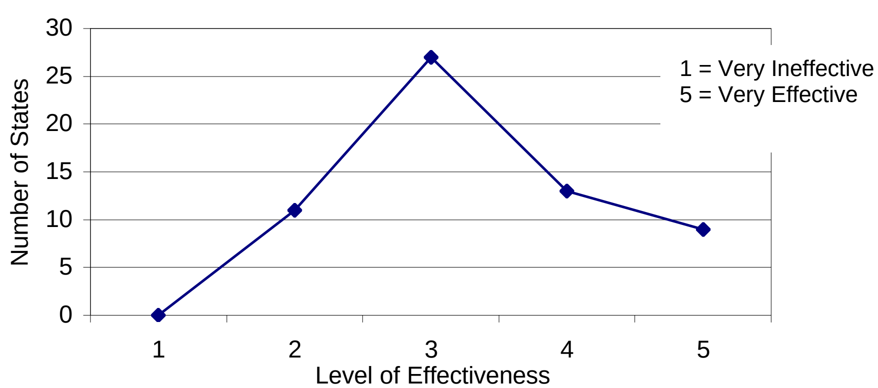
3.4.9 Question 9

Question nine asked participants to rate the effectiveness of their current system for handling commercial vehicle data. Participants could select a response from 1 to 5, with 1 being “very ineffective” and 5 being “very effective.” All sixty participants responded to this question. Individual responses are listed in Appendix B. A summary of all responses is shown in Table 12 below.

Table 12. System Effectiveness

	1 Very Ineffective	2	3	4	5 Very Effective
Number of Responses	0	11	27	13	9
%	0.0	18.3	45.0	21.7	15.0

Figure 4: System Effectiveness



Only 22 out of 60 (36.7%) participants reported the effectiveness of their current system for handling commercial vehicle data as either 4 – “effective” or 5 – “very effective.” This is a lower than expected response considering the importance of commercial vehicle data to transportation planning, congestion management, assessment of pavement performance, and infrastructure preservation through enforcement of vehicle weight restrictions.

In reviewing the responses of the participants reporting system effectiveness as “very effective,” all reported that data collection is centralized in one department within the DOT. There were no commonalities among other parameters such as method of data sharing, collection, or storage, size of the state or type of software used to analyze the data. Initially, this seemed significant until the thirteen participants reporting their system effectiveness as 4 – “effective” were examined. The characteristic of centralized data collection did not hold true for this group. Rather, the average number of departments collecting commercial vehicle data was 4.5, which is at the other end of the spectrum. The states classifying their data collection systems as “very effective” are Illinois, Maine, Michigan, Montana, Nevada, North Dakota, Rhode Island, Washington, and Wisconsin.

Looking back at the responses to question 3, many different departments within a state use commercial vehicle data presumably for decision-making purposes. Consequently, any data collection program reported as less than “effective” should be investigated to determine the cause of the perceived ineffectiveness and how it might be corrected.

3.4.10 Question 10

The last survey question asked participants to indicate how their commercial vehicle data are being used. Participants were required to put a check in the box preceding the appropriate response(s). All sixty participants responded to the question. Individual responses are listed in Appendix B. A summary of all responses is shown in Table 13 below.

Table 13. Data Usage

How is data being used?	Number of Responses	Percent
To meet federal data collection requirements (HPMS, etc.)	53	88.3
Highway planning and design	49	81.7
Pavement design	49	81.7
Development of axle correction factors for raw traffic counts	38	63.3
Research	35	58.3
Enforcement of vehicle size and weight laws	22	36.7
Allocation of maintenance funds	17	28.3
Data not being used for decision making	2	3.3

Not surprisingly, the most frequently reported use was "to meet federal data collection requirements (HPMS, etc.)." All fifty states reported using commercial vehicle data to meet federal requirements. The federal Highway Performance Monitoring System (HPMS) was developed in 1978 as a national highway transportation system database. "The major purpose of the HPMS is to provide data that reflects the extent, condition, performance, use, and operating characteristics of the Nation's highways. The HPMS data form the basis of the analyses that support the biennial Condition and Performance Reports to Congress." [14] As such, states are required to report vehicle classification data that represent daily, weekly, and seasonal variations in traffic flow on both rural and urban roadways throughout their state.

The use of commercial vehicle data for enforcement of size and weight restrictions was reported by only 22 of 60 (36.7%) of respondents. Overweight vehicles can cause significant damage to a state's highway infrastructure and have a negative financial impact through the excess consumption of highway maintenance funds. An increase in loading means exponential increases in acceleration of road wear. Ten percent overload increases pavement damage by 40%. There are also safety issues related to increased accident potential from worn, rutted, and potholed pavement. Additionally, lack of enforcement of weight restrictions acts as an incentive to overload trucks. This gives offending trucking firms an unfair competitive advantage against those who comply with the laws. [15] Consequently, all 50 states should have reported enforcement of size and weight restrictions as a primary use for their commercial vehicle data.

The responses supplied under the "other" category included financial analysis, General Assembly, private developers, consultants, and advocacy. Single participants reported each response. All represent important uses of commercial vehicle data.

3.5 CONCLUSIONS

Sixty individuals, representing all fifty states, participated in the Commercial Vehicle Data Handling Practices Survey. The summary of results shows the following practices to be common among the majority of states:

- The data collection program includes weight, count, and classification (FHWA Scheme F).
- When a single department collects commercial vehicle data, it is the Planning Department and/or Traffic Engineering Unit, which may be one and the same.
- If multiple departments collect data, Motor Vehicle Enforcement and Long-Term Pavement Performance (LTPP) Programs are the most common adjuncts.
- Commercial vehicle data are shared with three or more other departments or agencies.
- Collection of commercial vehicle data is part of a permanent data collection program and is done at permanent monitoring stations with information retrieval via telemetry.

- Data are stored on a local personal computer (PC), dedicated server, or computer network.
- Most data exchange is done electronically; however, thirty percent use “hard copy” as their only method of data sharing.
- Data analysis is conducted in-house using commercially-available, traffic analysis software or Microsoft products.
- Thirty-seven percent of participants report their systems as either “effective” or “very effective.”
- The major uses for commercial vehicle data are to meet federal reporting requirements (HPMS, VTRIS) and highway and pavement planning. Only thirty-seven percent report using the data for vehicle size and weight enforcement.

The most surprising finding of this survey was that vehicle size and weight enforcement are not a primary use for commercial vehicle data. Thirty-five out of fifty (70%) states report that the Motor Vehicle Enforcement Division either collects or receives commercial vehicle data. Fifteen of these states did not report using the data for enforcement purposes. This may be an aberration of the survey process but may warrant further investigation. With adherence to vehicle size and weight limits being such a critical component of maintaining our highway infrastructure, all states should have reported using commercial vehicle data for enforcement purposes.

4.0 COMMERCIAL VEHICLE DATA NEEDS ASSESSMENT

4.1 PURPOSE AND METHODS

The purpose of this needs assessment is to identify ways in which the Arizona Department of Transportation's system for coordination and sharing of commercial vehicle data can be enhanced to maximize the usefulness of the data collection effort. Of primary importance is the use of data collected throughout the state for enforcement of laws governing vehicle size and weight limits. Overweight vehicles are the primary cause of state highways failing to meet their expected or designed life span. Consequently, a reduction in the number of overweight vehicles on Arizona highways through improved enforcement should lessen the negative impact these vehicles have on our aging highway infrastructure.

The assessment consists of three primary components—conducting interviews with individuals responsible for data collection and dissemination; identifying data collection sites and types of data collected; and evaluating the law enforcement potential of existing data. In addition, various options for changes to the system are explored. These options were identified through examination of relevant literature, other state practices, and transportation technology.

4.2 INTERVIEWS

A series of interviews were conducted with individuals in each agency and/or department to gather information on current practices. The individuals interviewed along with the questions asked of each follow.

Arizona Department of Transportation
- Motor Vehicle Division, Motor Vehicle Enforcement Services
  - *Steve Abney, Southern Region Manager*
- Transportation Planning Division, Data Section
  - *Joe Flaherty, Senior Transportation Planner*
  - *Denis Duman, Information Technology Specialist IV*
- Arizona Transportation Research Center
  - *Estomih Kombe, Transportation Engineer II*
- Materials Section
  - *George Way, Chief Pavement Design Engineer*
- Freeway Management System, Transportation Technology Group
  - *Glenn Jonas, Senior Systems Engineering Specialist*

Pima Association of Governments
- *Nancy Ellis, Research Analyst*

Maricopa Association of Governments
- *Qing Xia, Transportation Engineer*

Traffic Research & Analysis, Inc.
Robert Medland, Vice President
Nichols Consulting Engineers
Kevin Senn, LTPP Western Region Agency Coordinator

Interview questions:

- What types of data are collected?
- How often and when are the data collected?
- Where are the data collection sites located?
- What type of equipment is used to collect the data?
- In what format is the data retrieved and stored?
- With whom are the data shared?
- Are you aware of other departments, divisions, or offices that collect similar data?

The responses to these questions and additional information gathered from the interviews are the basis for the summary of current practices and existing data collection sites.

4.3 DATA COLLECTION

There are several entities throughout the state responsible for gathering traffic data. These data are collected for a variety of reasons. Of primary importance is the need to meet federal reporting requirements established by the Federal Highway Administration. The Arizona Department of Transportation has overall responsibility for ensuring federal reporting requirements are met for the entire state. However, actual data collection for certain sectors of highway is delegated to local metropolitan planning organizations (MPOs). As in other states, traffic data also are gathered for purposes of research, pavement design and management, air quality monitoring, vehicle size and weight enforcement, and meeting information requests from public and private stakeholders and state government.

Data collection throughout Arizona is highly decentralized with each agency or department maintaining their own data collection sites with the exception of the MPOs. Both Maricopa Association of Governments (MAG) and Pima Association of Governments (PAG) utilize a private consultant, Traffic Research & Analysis, Inc. (TRA), for data collection. In these instances, TRA utilizes some existing AzDOT permanent traffic data collection sites as well as their own portable equipment to gather data. The types of data gathered include vehicle count, speed, class, and weight. For purposes of this report, only commercial vehicle data from automatic traffic counter (ATC) and weigh-in-motion (WIM) devices are considered.

4.3.1 AzDOT Transportation Planning Division Data Section

The AzDOT Transportation Planning Division (TPD) Data Section maintains 65 automatic traffic recorders and six WIM sites. A list of the sites is included in Appendix C. All 65 ATR sites are International Road Dynamics, Inc. (IRD) TCC530 recorders running 6 foot by 6 foot, 3 turn inductive loops spaced 18' apart, leading edge to leading edge. All travel lanes, in both directions, are covered. Of the 65 sites, only 26 are functional as the remaining sites either need reconstruction or are out of service due to recorder malfunction. The traffic data collected from these sites includes count, speed, and length. The length data are not classifiable into the FHWA 13-vehicle format due to the sensor type and configuration. Five of the 26 sites provide counts only as one or more of the loops are damaged and need to be replaced. None of the six WIM sites are functional. [16]

Of the 26 functioning sites, 13 can be polled remotely via landline modem or cell data modem. The data are downloaded nightly at 1 a.m. Those that cannot be polled remotely are retrieved manually with a laptop computer every two weeks. All data are retrieved in the IRD binary/ASCII text format. In both situations, the data are transferred to the Chaparral Systems TRADAS software for analysis. All data are stored in an Oracle database and are accessible through the AzDOT intranet. [16]

AzDOT is in the process of upgrading the traffic data recorders for all sites with Peek Traffic Inc. ADR 2000 recorders. The first 30 devices should be in place, two devices per site, by January 2003. A translation program written by Chaparral Systems will convert the Peek ADR 2000 data into the TRADAS software format for use by the TPD Data Section. [16] The TRADAS software meets the data processing requirements of the American Association of State Highway Transportation Officials' (AASHTO) *Guidelines for Traffic Data Programs* and the American Society for Testing and Materials (ASTM) Standard E 1442, *Standard Practice for Highway-Traffic Monitoring* [13].

Some vehicle classification data collection also is done manually at select locations throughout the state. Classification is based on a limited number of length categories. The sites chosen are dictated by HPMS data reporting requirements.

4.3.2 Arizona Transportation Research Center

The Arizona Transportation Research Center (ATRC) Long Term Pavement Performance (LTPP) Program maintains 18 stations. A listing of the sites is included in Appendix D. Ten of the stations are weigh-in-motion sites and the remaining eight are AVCs. All of the sites are piezo-electric sensors imbedded in either asphalt or concrete with the exception of three sites that are bending plates in concrete. The piezo sites are attached to AVC 100 recorders and the bending plates to Dynamic Axle Weighing (DAW) 100 recorders both from PAT America. Data from the sites are retrieved monthly. A couple of high truck volume lanes/sites are retrieved twice monthly. If remote access is functional, data are retrieved weekly. The data are stored in the Traffic

Monitoring Guide text file data format on the zip or hard drive of a personal computer. The count, class, and weight data also can be loaded into Microsoft Access for analysis. [17]

4.3.3 AzDOT Freeway Management System

A third group collecting traffic data is the AzDOT Freeway Management System (FMS). This ITS application is a key element in Arizona’s plan to optimize freeway operations. It allows more efficient utilization of the existing freeway capacity, improves driver information and safety, and reduces delays and fuel consumption. The FMS is comprised of a series of inductive loop sensors which detect traffic flow patterns, video monitoring for incident confirmation, variable message signs to inform motorists of freeway conditions, entrance ramp meters, traffic intersection signal control, and remote monitoring. A network of computers and communication systems located at the Traffic Operations Center (TOC) control the system. [18]

The FMS routinely collects count, speed, and some limited classification data from the inductive loop sensors that are placed roughly 1/3 mile apart along the freeway corridor. The truck counts are limited to two categories (trucks 35’ to <55’, trucks >55’) and are not very consistent. Accurate calculation of truck length depends on precise loop placement. A large number of the loops were installed in the original pavement sub-grade and can be up to 18” below the surface. The deeply buried loops behave as though they are spaced further apart than the 18’ center-to-center installation requirements so truck volumes are classified poorly. There are a small number of detector locations where truck data is reasonably accurate. The Freeway Management System’s main function is to optimize freeway operations; it was not designed to gather accurate and detailed traffic data. Consequently, the data is of limited use for size and weight enforcement. [19]

4.3.4 AzDOT Motor Vehicle Division

The AzDOT Motor Vehicle Division (MVD) works closely with federal and state agencies to ensure the safe movement of commercial vehicle traffic on Arizona's highways. In this capacity, MVD has responsibility for commercial vehicle size and weight enforcement services throughout the state. There are thirteen port-of-entry facilities that collect commercial vehicle data in support of this effort. A list of the site locations is included as Appendix E.

Six of the 13 ports-of-entry are equipped with WIM as part of the PrePass program used to pre-clear trucks through the weigh stations. In these instances, data collection is done on a continuous basis gathering count, speed, gross and axle weight, and classification data. The remaining seven ports-of-entry gather truck data manually through the use of static and/or portable scales. The information is recorded on a daily basis and then reported to management on a monthly and yearly basis for statistical reviews. Additionally, there are mobile crews that gather data on a random, unpredictable basis in an effort to apprehend trucks that are out of compliance with size and weight limits. Although responsible for size and weight enforcement throughout the entire state, MVD has no permanent data collection sites on highways within the interior of the state. [20]

4.3.5 Metropolitan Planning Organizations

The last groups responsible for collecting traffic data are the metropolitan planning organizations. Collection of traffic counts for certain highways is delegated to the MPOs in Maricopa and Pima counties. For both organizations, a consulting firm, Traffic Research and Analysis, Inc. (TRA), does all of the data collection. Traffic counts are done to meet federal-reporting requirements with no differentiation made between vehicle types. Any additional traffic data collection such as vehicle classification is done for special studies only.

Traffic Research and Analysis, Inc. also collects data as needed for AzDOT. Existing TPD Data Section ATC sites or portable pneumatic rubber tubes are used for count and classification data. TRA does not maintain any permanent data collection sites. The extent of vehicle classification depends of the equipment utilized. No weight data are currently being collected by TRA for either the MPOs or AzDOT; however, TRA has the capability to perform this function through use of bending plates or piezoelectric sensors. The traffic data collected by TRA are provided to the contracting agencies via hard copy, dBASE file transfer, or linear referencing format. [21]

4.3.6 Summary of Data Characteristics

The utility of the traffic data collected is dependent on a number of factors such as type of data, format, access, and availability. Table 14 below lists each group directly involved in data collection, the types of data collected, and the equipment utilized to collect the data.

Table 14. Type of Data Collected

Data Collection Group	Commercial Vehicle Data Type		
	Count	**Class**	**Weight**
AzDOT Transportation Planning Division – Data Section	Permanent ATC	Manual, ATC (length only)	Equipment not functional
Arizona Transportation Research Center – LTPP Program	ATC, WIM	ATC*, WIM*	WIM
AzDOT Freeway Management System	ATC	ATC (2 truck classes only)	None
AzDOT Motor Vehicle Division	WIM	WIM*	WIM, portable and static scales
Traffic Research & Analysis, Inc. – Consultant	Permanent AzDOT sites and portable equipment	Permanent AzDOT sites and portable equipment	None

* FHWA 13 classes

Table 15 shows a summary of the data available through existing sources that could be of use for size and weight enforcement. The accuracy of the data, frequency with which it is collected, and accessibility of the data to users is included. The only group collecting exclusively commercial vehicle data is AzDOT Motor Vehicle Division.

Table 15. Data Availability

	Type of Data	Remote Access	Frequency of Retrieval	Accuracy	Format
AzDOT TPD – Data Section	Count, Speed, Length	Yes	Daily	Good	TRADAS
		No	Every 2 weeks	Good	
ATRC – LTPP	Count, Speed, Class, WIM	Yes	Weekly	Good	TMG format text file
		No	Monthly	Good	
AzDOT MVD	Count, Speed, Class, WIM	Yes	Daily	Good	Excel database

4.4 ATC AND WIM SITE MAPS

Data collection sites also play an important role in the utility of the data collected. Maps displaying the location of ATC and WIM sites are shown on the next two pages. The maps show the state highway system including federal, state, and interstate routes along with county boundaries. Figure 5 shows the ATC and WIM sites color-coded to indicate the AzDOT division responsible for data collection at the site. Detailed listings of the sites, their exact locations, equipment type, and data collected are shown in Appendices C, D, and E. Figure 6 shows the same site map; however, the highways also are color-coded to indicate the percent of commercial vehicles using each route.

Key data collection sites are those where WIM are on high volume highways or on key bypass and secondary routes. Ideally, real-time WIM data would be used to target specific overweight vehicles. If not real-time, the classification and weight data could be used retrospectively to identify when and where illegal trucks are running.

As the maps show, Transportation Planning Division ATR and WIM sites are strategically dispersed throughout the state. The sites are located across high volume interstate routes I40 and I10, from New Mexico to California. Additionally, there are sites on secondary and bypass routes. Unfortunately, none of these sites have functional WIM devices.

The new ADR 2000 data recorders being installed at 15 of the sites (2 recorders per site) have the capability to handle WIM data if they are fitted with a WIM board. It may be advisable to also install piezoelectric or quartz sensors to allow for collection of much needed vehicle weight information. Site selection for placement of the new recorders and any WIM technology should be done in conjunction with MVD

Figure 5

2002 ATC and WIM Sites

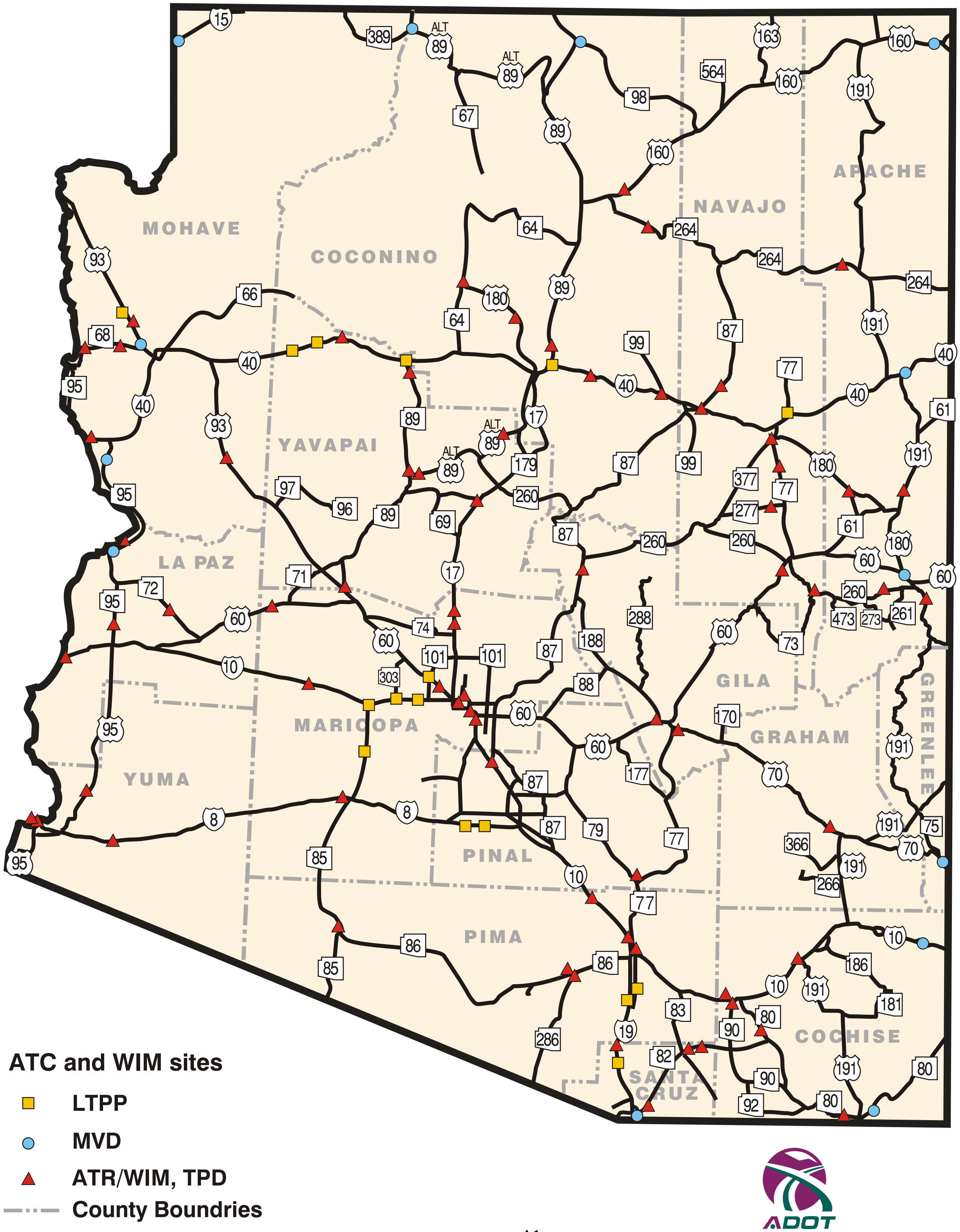
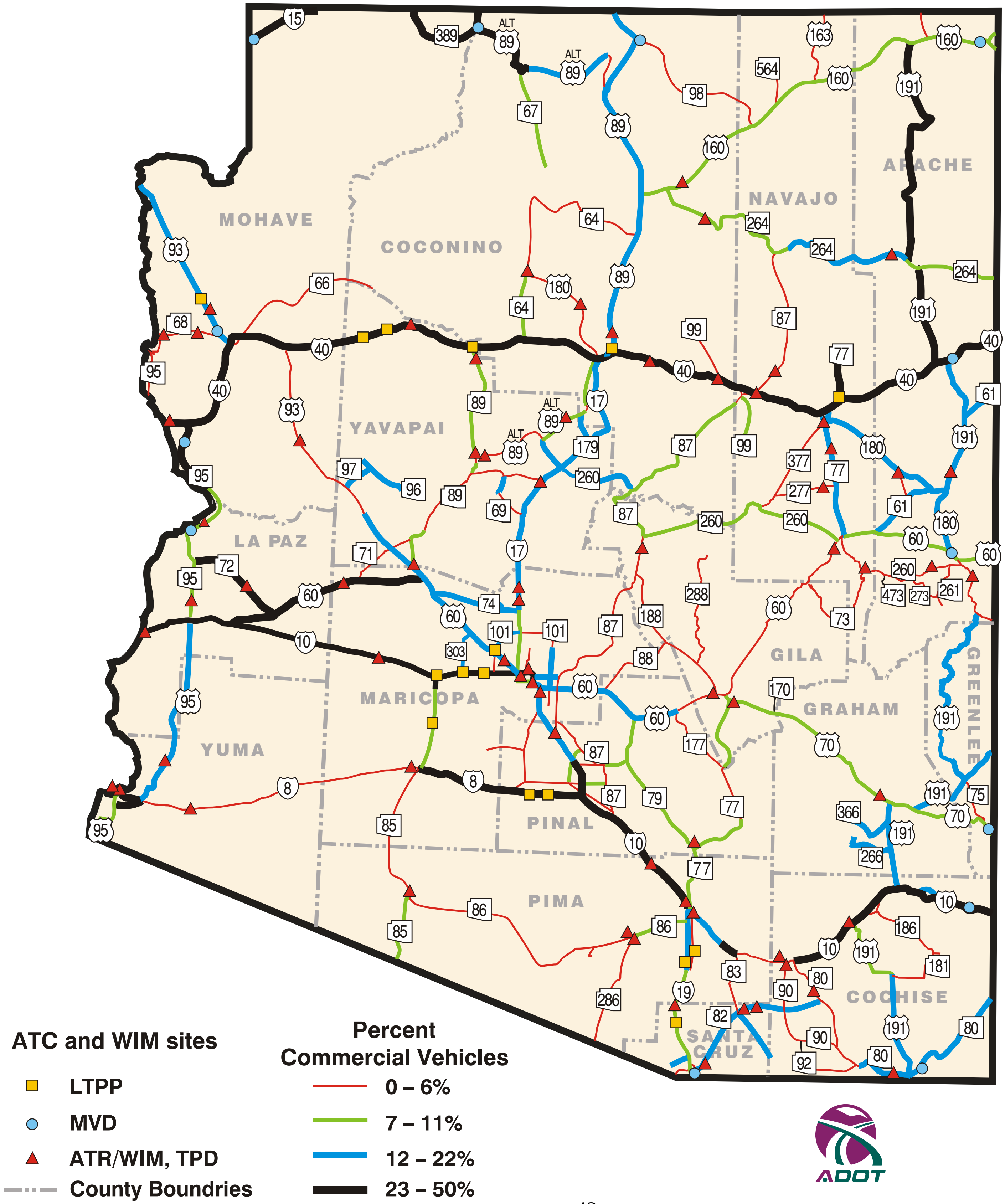


Figure 6

2002 ATC and WIM Sites and Percent Commercial Vehicles Using State Highways



enforcement personnel. This will ensure optimal placement for meeting HPMS reporting requirements and planning needs as well as size and weight enforcement needs.

4.5 DATA FLOW AND USAGE

The mechanism for data sharing between data collection groups is currently difficult as the data are stored in different formats and not easily accessible to all users. The TPD Data Section is the primary recipient of data collected throughout the state. As the Data Section is responsible for ensuring HPMS reporting requirements are met on a timely basis, the department needs to have access to traffic count, class, and weight data for highways throughout Arizona.

As identified in Figure 7 on the next page, the primary uses of Arizona commercial vehicle ATC and WIM data are to meet the following needs:

- Highway performance monitoring system;
- Long term pavement performance monitoring;
- Pavement design and management;
- Vehicle size and weight enforcement; and
- Special requests from public and private stakeholders.

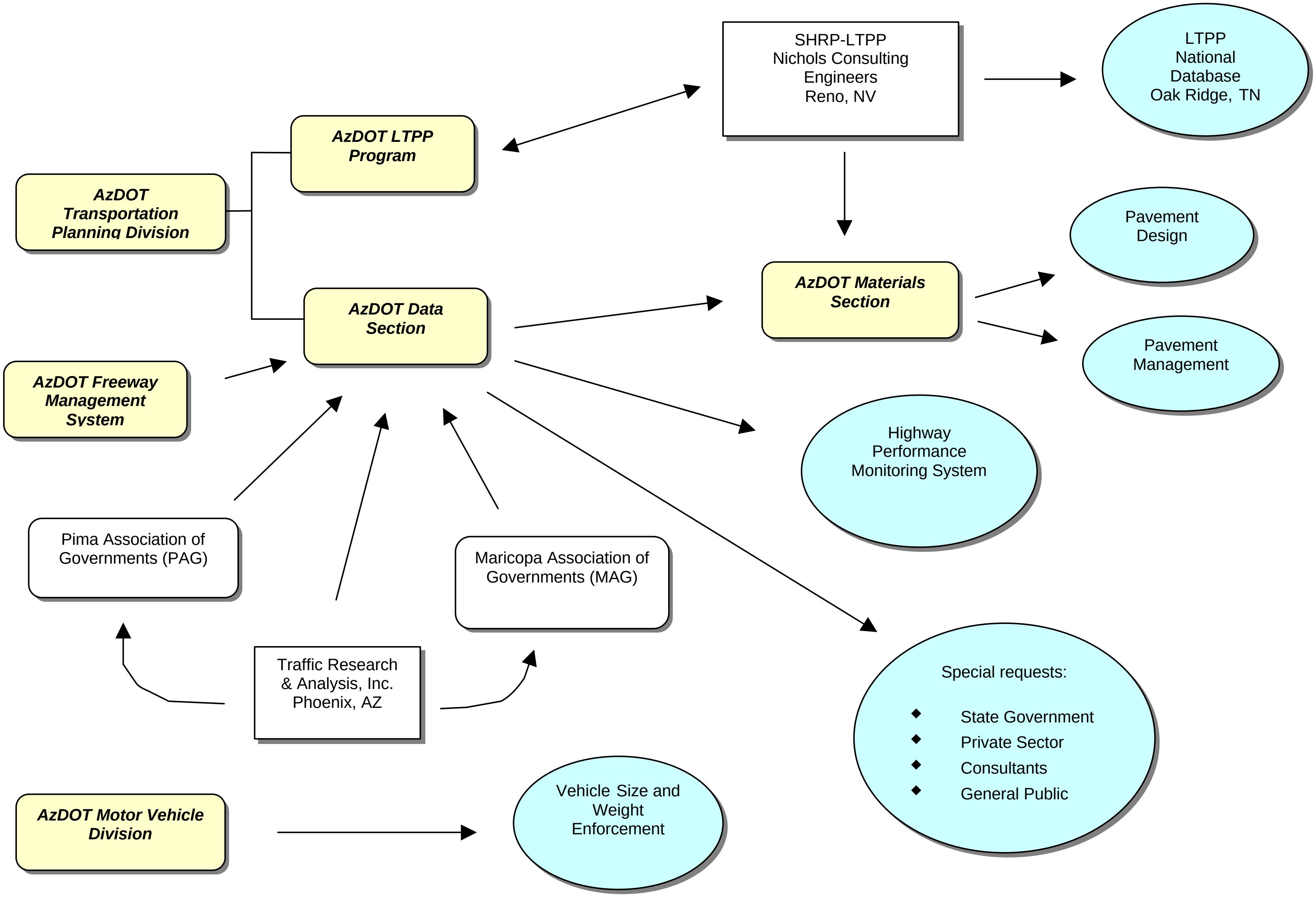
The parties responsible for meeting each of these needs also are shown in Figure 7. In three of the four cases, under current conditions, the group collecting the data is also the primary user of the data. In these situations, the accuracy and availability of the data is under the control of the users. This is not the case for the Materials Section, which is responsible for pavement design and management. The data required by the Materials Section comes from TPD Data Section and/or the Strategic Highway Research Program (SHRP).

4.6 END-USER DATA REQUIREMENTS

Each of the primary data users were queried for the type and extent of the data they would consider ideal for their use.

The Materials Section does not collect any ATC or WIM data. When asked, George Way, Chief Pavement Design Engineer, reports that the ideal truck weight information would be classification, axle type (single, dual, tri or quad), and axle weight (in pounds). He also reports being satisfied with the availability and timelines of the data the Materials Section currently receives from the TPD Data Section and SHRP. Yet, two issues were identified as concerns—the reliability of the data collection equipment and the quality of the data obtained from the TPD recording devices. Mr. Way also noted that it would be of interest to have access to WIM data collected by MVD. [22]

Figure 7. ATC and WIM Data Flow



The Motor Vehicle Division collects commercial vehicle data at the port-of-entry facilities and with their mobile enforcement units. These data are not shared with other departments. It is collected strictly for monitoring trucks for compliance with the state's size and weight restrictions. However, in order to effectively enforce these restrictions throughout the *entire* state, more data are needed. The goal of MVD, according to Captain Steve Abney, is to take the data collected from every ATC and WIM site in Arizona and use it to determine when and where illegal trucks are running. This would allow for more effective deployment of expensive mobile operations. Currently, the division is relying on personal observations, calls from engineers or local authorities, and just plain luck to be in the right place at the right time. The commercial vehicle data needed for effective enforcement on the state's highways includes the number of vehicles, type, day of the week, and time of day. Weight data (illegal versus legal) also is essential but typically less available. [20]

The third primary data user is the Transportation Planning Division Data Section. When asked the type and extent of data the Section would consider ideal, Mr. Joe Flaherty reported they would have adequate data to meet HPMS reporting requirements and special requests if all of the equipment at existing sites were functional. As this is not the case, the availability of accurate and timely data is compromised.

The fourth primary data user is the State Highway Research Program – Long Term Pavement Performance Program. Mr. Kevin Senn, LTPP Western Region Agency Coordinator, reported having access to all data necessary to meet program requirements.

As a result of the interviews conducted, the use of commercial vehicle data for weight enforcement was identified as the primary area where the current system is falling short of user needs relative to data sharing/handling practices. The Motor Vehicle Division does not have ready access to commercial vehicle data collected by other groups throughout the state for use in size and weight enforcement.

4.7 WEIGHT ENFORCEMENT POTENTIAL

With the lack of data for effective weight enforcement identified as the primary area of need, the weight enforcement potential of existing transportation data was examined. Of the four areas collecting some form of classification and/or weight data, only three AzDOT departments are viable sources of enforcement information—MVD, TPD Data Section, and ATRC LTPP Program. Data from the fourth area, AzDOT Freeway Management System, lacks the accuracy necessary for weight enforcement.

The AzDOT Motor Vehicle Division has access to the data they collect at the ports-of-entry and with mobile units. MVD would like to have access to TPD Data Section and LTPP Program commercial vehicle data. The TPD Data Section collects classifications in a limited number of categories that may be of use but the condition of the equipment is poor. Currently, only 26 of the 71 sites are functional. None of the WIM sites are operational. With replacement of the traffic data recorders, the availability of data will be improved. It will be important to ensure the data gathered with the new recorders is in a format that can be used by both TPD and MVD. The classification data collected with the new recorders can be used to understand commercial vehicle traffic flow patterns on secondary and bypass routes.

The ATRC LTPP Program has fewer sites but the vehicle class and weight data could be useful if it were collected on a more frequent basis. But, unless there is AVI equipment associated with the WIM sites, it would be difficult to target the overweight vehicles detected by the equipment. Additionally, the fact that it is currently collected only weekly or monthly negates it usefulness in real time enforcement efforts. The LTPP classification data may be of use in trending traffic flow patterns on a few of the interior highways in the state.

The weight enforcement potential of existing transportation data is somewhat limited. In addition, obstacles exist that make sharing data difficult. As Table 15 on page 39 shows, each of the three sections maintains the data in a different format. Consequently, conversion to a usable format by the collector or user would be required to make the information of use to MVD.

Several areas were investigated for potential solutions to improving current enforcement practices within the state in light of the lack of adequate ATC and WIM data. This included looking at other state programs and considering technology applications that may improve the effectiveness of the enforcement process.

4.8 STATE PRACTICES

Each of the fifty state departments of transportation websites were queried for information on the use of ATC and WIM data for enforcement purposes. The majority of states provided no information or only a brief description of their size and weight enforcement programs. One thing was evident in reviewing the websites: data collection and enforcement characteristically fall under the domain of different divisions or departments within state government. Data collection falls under the Planning Division or Traffic Engineering Unit and enforcement typically falls under Public Safety or the Motor Vehicle Division, which may or may not be a part of the Department of Transportation. Consequently, goals, objectives, and priorities between divisions and departments differ. Additionally, weight data, which are so important to size and weight enforcement, are one of the most difficult and costly to collect further compounding the effort to develop an effective enforcement unit.

Size and weight enforcement is of particular concern in Arizona as the number of commercial vehicles traveling throughout the state continues to increase. According to the U.S. Census Bureau, the population of Arizona increased 40.0% from 1990 to 2000 as compared to the overall population of the United States, which grew only 13.1%. The state's net gain over the past three decades ranks as the 6^{th} largest in the country. By the year 2025, Arizona is projected to be the 17th most populous state with 6.4 million people. As the economy grows by virtue of our increasing numbers, so does the number of commercial vehicles transporting goods throughout the state. Our increasing population will mean an increasing size and weight enforcement burden on the Motor Vehicle Division if highway infrastructure is to be preserved.

4.8.1 Oregon Department of Transportation

In looking at the activities of other states, a few have documented recent activity in the area of truck weight enforcement efforts. Oregon underwent an audit by its Secretary of State that identified five areas of concern that need attention in order to strengthen the Oregon DOT's Motor Carrier Transportation Division enforcement program (www.odot.state.or.us/trucking/). [24] These included:

- Enforcement activities are concentrated at a limited number of fixed-location scales, mostly at ports-of-entry.
- Although ports-of-entry are open much more than other sites, they share the same low violation rate. This result suggests essentially no gains in compliance for the additional resources invested at the ports.
- The hours of operation for Oregon's truck scales tend to be highly predictable, with scales open more frequently during midday and less often at night and during the early morning.
- Compared to the in-bound ports-of-entry, a driver of an illegally overweight truck faces a lower risk of apprehension on secondary highways, in metropolitan areas, and on outbound lanes of interstate highways.
- The location of truck scales are well known and, through the use of CB radios, truckers are able to determine whether scales are open or closed.

The issues identified in Oregon are not unique. They are reproduced here, as they are issues identified as common to many states. The recommendations given by the Oregon Secretary of State to address these concerns follow.

- Review approaches to truck weight enforcement using available department and division data in developing cost-effective staff deployment strategies;
- Consider introducing more variability in the opening and closing times of ports-of-entry;
- Consider adopting additional outcome goals and measures that have been validated in other states to provide outcome-based results aligned with enforcement objectives – deterring illegally overweight truck operations and minimizing pavement and bridge wear;
- Enhance research tools to identify bypass routes, and develop enforcement strategies based upon truck travel data; and
- Continue working with the State Police and county and city officials to improve truck weight enforcement for state highways in metropolitan areas.

Another obvious recommendation would be to increase the number of weigh-in-motion sites along state highways. This may not have been addressed in this instance as

Oregon’s 1998 site inventory showed 6 ports-of-entry, 52 weigh stations, 20 portable scale sites, and 26 mobile enforcement sites. However, budget adjustments have resulted in a 32% reduction in the number of enforcement officers (from 142 to 96) over the past 12 years that may have reduced their effectiveness despite the number of available weighing sites. [24]

4.8.2 Minnesota Department of Transportation

The Minnesota Department of Transportation (MnDOT) implements weight enforcement policy through their office of Transportation Data and Analysis in conjunction with the State Patrol. The office develops vehicle weight information to help guide enforcement with the joint goals of safety and infrastructure preservation. The office is focusing on long-range planning for more effective weight enforcement. [25]

As part of this effort, an informal e-mail survey was conducted by MnDOT asking state DOTs about their long-range efforts in the area of weight enforcement. Twenty-two responses were received. Of those, ten reported having no long-range plan, three reported that enforcement was not handled through the DOT; the remainder sent their annual certification plan or indicated they are working on a plan. All but one of the states indicating some action in the area of weight enforcement reported either adding WIM sites or utilizing existing WIM sites more effectively. [26]

Some areas being pursued by those states responding to the survey include:

- Look at weight data for insights to guide enforcement;
- Work with enforcement personnel on WIM placement and use as enforcement screening;
- Move toward single person patrols as technology permits;
- Install high-speed mainline WIM;
- Put greater emphasis on mobile units and less on interior weigh stations;
- Use in-pavement WIM with dial-in laptop access to screen trucks;
- Consider use of portable automatic vehicle identification (AVI) in conjunction with WIM;
- Improve communications from a database access perspective;
- Promote cooperation with other state agencies; and
- Monitor technology for new developments.

Minnesota DOT is developing an interagency vision that includes goals and objectives along with recommendations on how their long range planning efforts should proceed. The plan targets the following six areas—permanent enforcement sites, mobile enforcement, civil weight law, education and information, data analysis, and resources. Their preliminary recommendations are consistent with the actions being taken by other states. A final plan has not yet been published but is in the works. [26]

4.8.3 Virginia Department of Transportation

Size and weight enforcement in Virginia is handled through the Department of Motor Vehicles (DMV) in conjunction with the Department of State Police. The program functions through a statewide network of 13 permanent Motor Carrier Service Centers and 12 mobile crews placed strategically throughout the state. The Department of Motor Vehicles uses its mobile crews to deter bypassing of permanent scales and to conduct special operations. One unique characteristic of the Virginia program is their mobile operations unit nicknamed “Nomad.” The unit is “housed in a custom manufactured van that allows mobile crews to set up at a turn out and weigh vehicles similar to a small weigh station. It has weigh-in-motion capabilities, static scale equipment, and signs to direct trucks to “Pull In” or “Bypass” the weighing site. This unit also has the capability of making intelligent motor carrier evaluations in a dynamic environment. Motor carriers with a transponder will be able to be tracked for safety, assessment and payment of taxes and appropriate credentials in a more effective way that allows non-compliant carriers to be more easily detected.” [27]

4.8.4 Kentucky Transportation Cabinet

Size and weight enforcement in Kentucky is handled through the Transportation Cabinet Division of Motor Carriers. In June 2002, the University of Kentucky University Transportation Center and Kentucky Transportation Cabinet in conjunction with Computer Recognition Systems, Inc., announced signing of a contract for development of a virtual weigh station. “This new system will automate weigh-in-motion, vehicle identification, and remote enforcement and monitoring. It also provides a platform to incorporate other sensors for cargo security. The goal is to develop a relatively low cost system that can be widely deployed as an alternative to traditional weigh stations.” [28]

4.8.5 Texas Department of Public Safety

The Texas Department of Public Safety has primary responsibility for enforcement of state laws and federal regulations governing operation of commercial vehicles in Texas. “In 1999, as a result of the continued increase in commercial vehicle use of Texas roads, the Texas legislature directed DPS to inventory facilities and equipment, provide an overview of enforcement activity related to commercial vehicles, and report staffing levels and operating hours. The legislature also requested recommendations of infrastructure improvements for handling projected trucking increases. The Department of Public Safety called on the Texas Transportation Institute (TTI) and the University of Texas Center for Transportation Research (CTR) to partner in creating a comprehensive report of DPS enforcement activities.” [29]

“The project determined that DPS is significantly under-equipped and understaffed.” [29] “The current system of weighing suspicious trucks on roadside scales is inefficient and labor intensive.” The anticipated increase in truck traffic necessitates the need to create more efficient and effective enforcement methods. DPS officers need a more effective way of targeting violators. TTI pilot-tested a system using weigh-in-motion in combination with other ITS technologies to improve truck weight enforcement. The new system, known as WIMAGE (weigh-in-motion image), combines WIM sensors with a camera system to identify vehicles exceeding weight limits. The system then sends a picture of the vehicle to an enforcement vehicle. The novelty of the system is that the enforcement vehicle is not required to stay at the site or remain stationary. Tests of the new system showed that WIMAGE could receive and store data on approximate truck length, axle weight and spacing, and transmit it to a mobile enforcement vehicle. The stored data also can be used to indicate patterns in truck volumes. [30]

4.9 TECHNOLOGY

The consensus of the websites visited and current literature on the subject seems to be that strategically placed WIM technology offers the best means of identifying overweight/oversize vehicles on main highways and bypass routes. The objective is to record truck weight in a manner that does not disrupt truck traffic flow or result in over-enforcement. Several different types of WIM technology exist to target violators—piezo-electric sensors, quartz sensors, bending plates, and single load cell weigh pads. Financial considerations will most likely dictate which of these options are most feasible. Table 16 below shows the four primary types of WIM devices listed in order of increasing cost.

Table 16. WIM Technology

Technology	Description
Piezoelectric Sensors	Consists of a piezoelectric element, encapsulated in an extruded aluminum housing. The sensors are easily installed with epoxy in a small slot in existing or new asphalt or concrete pavement.
Quartz Sensors	Utilizes quartz crystal force sensing technology. The sensors consist of an aluminum alloy profile in the middle of which quartz disks are fitted under pre-load. The sensor is isolated from side forces by a special elastic material. These sensors are easily installed with epoxy flush with the surface of any existing or new asphalt or concrete pavement surface.
Bending Plate Scales	Utilizes strain gauge weighing elements to determine and weigh wheel/axle loads in each of two low profile scales installed in a lane. The system consists of two steel frames (per lane) that are installed into existing or new asphalt or concrete pavement, and the weigh pads that are bolted to the installation frame.
Single Load Cell Weigh Pads	Single load cell weigh pads utilize a self-contained weighing unit, with the weighing element consisting of a single load cell. The scale mechanism incorporates patent load transfer torque tubes that effectively transfer all loading on the weighing surface to the load cell, which is mounted centrally in the scale. The system consists of two steel frames (per lane) that are installed into existing or new asphalt or concrete pavement, and weigh pads that are bolted to the installation frame.

Source: International Road Dynamics [31]

"The positive economic benefits of WIM far outweigh the costs. WIM systems help to protect hundreds of miles of roads at less than 1% of total maintenance costs for those hundreds of miles of road. The cost for operating and installing a deluxe weigh-in-motion (WIM) system is under $75,000 per year over a ten-year period. In comparison, the cost to maintain five hundred miles of four-lane interstate is $8 to 10 million per year. WIM costs less than 1% of total maintenance costs! This insubstantial investment will have a tremendous impact on reducing maintenance costs and preserving hundreds of miles of interstate from premature wear." [32]

The integration of video imaging and WIM was the only "new" technology identified. This intelligent transportation system application is helping to optimize the use of enforcement personnel by allowing them to remain mobile and target only trucks screened by WIM as being overweight. When set-up on bypass and secondary roads, these systems can identify trucks attempting to avoid weigh stations. These unmanned "virtual" weigh stations may be a viable solution to staff reductions and budget cuts.

In addition to WIM technology, standard automatic traffic counting devices can be used to pinpoint when and where trucks are running throughout the state. Ideally, existing ATCs being used to meet other data reporting requirements can be used to locate where vehicles are traveling in the state. If not, new equipment may be in order. A discussion of the different types of counting and classification equipment can be found in the publication *"State-of-the-Art" Report on Non-Traditional Traffic Counting Methods* available through the Arizona Transportation Research Center at the following website: www.dot.state.az.us/ABOUT/atrc/index.htm.

4.10 CONCLUSIONS

The Arizona Department of Transportation has five different groups—Planning Division, Motor Vehicle Division, Arizona Transportation Research Center, Freeway Management System, and Traffic Research and Analysis, Inc.—collecting ATC and/or WIM data throughout the state. Maximizing the efficiency and effectiveness of the data collection process demands a coordinated effort among these groups to ensure data is available to meet the requirements of all stakeholders. The five primary uses of the ATC and WIM data in Arizona must meet to following needs:

- Highway performance monitoring system reporting requirements;
- Long term pavement performance monitoring;
- Pavement design and management;
- Vehicle size and weight enforcement; and
- Special requests from public and private stakeholders.

After thorough review of the current system for providing this data, the lack of adequate vehicle classification and weight data for effective size and weight enforcement was identified as the primary deficiency in the system. The AzDOT system for coordination of commercial vehicle data collected by ATC and WIM lacks several important elements necessary to support this important goal. The principal shortcomings include:

- Lack of common intra-departmental goals and objectives regarding the collection and dissemination of commercial vehicle data;
- Lack of communication and coordination between data collection units;
- Decentralized ATC and WIM data collection;
- Inconsistent data format across data collection units;
- Lack of a comprehensive database management system for storage and retrieval of traffic data designed to be accessed from throughout AzDOT;
- Faulty or nonfunctional traffic counting/classification equipment;
- Weight monitoring is limited to port-of-entry facilities supplemented with some random mobile enforcement operations; and
- Absence of WIM equipment along interior highways for real-time weight enforcement.

These deficiencies are not unique to Arizona; they were found to be present in other state departments of transportation as well. The lack of established “best practices” and the apparent lack of long-range planning efforts seems to indicate that having a coordinated, agency-wide size and weight enforcement program has not been a priority. Considering the significant impact that overweight vehicles have on our highways, more resources need be designated to improving current commercial vehicle data collection and sharing practices.

5.0 CONCLUSIONS AND RECOMMENDATIONS

This project was designed to look at commercial vehicle data handling procedures in an effort to identify practices that could be used to improve the Arizona Department of Transportation's system for collection and dissemination of commercial vehicle data. A literature review and survey of other state programs was used to benchmark current practices. A needs assessment was done to identify areas at which resources should be targeted within AzDOT. The principal findings are listed below.

Literature Review:

- Enforcement of size and weight restrictions is essential to preserving highway infrastructure.
- There is an absence of consensus on best practices in the area of coordination of commercial vehicle data.
- Success is contingent on inter- and intra-agency cooperation among data collection groups.
- Obstacles appear to be lack of funding, data quality, timeliness of delivery, and incompatible data formats.
- Data partnering amongst state agencies, MPOs, and local governments offers opportunities for cost sharing and resource conservation but will be contingent on effective use of data management systems.
- Department of transportation priorities have shifted toward Intelligent Transportation Systems and Advanced Traffic Monitoring Systems – neither of which involve commercial vehicle data handling.

Survey of State Practices:

- Among those participating in the survey, data collection is centralized within one or two departments within an agency, typically the Planning Division and/or Traffic Engineering Unit.
- Commercial vehicle data are shared with three or more departments.
- Data collection is typically part of a permanent program using permanent data collection sites supplemented by portable equipment.
- No apparent method of operation consistently led to an "effective" or "very effective" self-rating.
- The primary use of commercial vehicle data is to meet federal reporting requirements with limited use of the data for size and weight enforcement.

AzDOT Needs Assessment:

- The lack of data for use in size and weight enforcement was identified as the primary need.
- Data collection is decentralized and lacks coordination and communication between departments responsible for collecting the data.

- There is a lack of functional data collection equipment and a limited number of weigh-in-motion devices located strategically along state highways.
- There is lack of standardization of data formats and limited accessibility to data across departments.
- Absence of a comprehensive data management system for storage and retrieval of traffic data by all stakeholders in AzDOT limits system effectiveness.

Recommendations to remedy the situation are two-fold, calling for both procedural change and the allocation of funding to support the change. Of primary importance is the need for long-range planning that will ensure commercial vehicle data collection and dissemination is a priority across AzDOT departments. An intra-agency task force that includes representatives from each of the stakeholder groups can be used to re-think current practices. Policies and procedures should be established so as to address the requirements of each department as well as meet AzDOT's federal and state data reporting commitments. Some issues to target include establishing consistent standards of practice relative to data collection, storage, and exchange.

Accomplishing goals and objectives established through long-range planning will require funding. Formation of data partnerships may provide some cost savings and resource conservation. Repair and/or replacement of non-functional traffic recorders and installation of additional weigh-in-motion devices will be a significant expense. However, this must be a priority, as no amount of procedural change will produce accurate data when recording equipment is faulty. The initial outlay of funds for new WIM devices may be costly but will support better enforcement of size and weight restrictions. This in turn will reduce expenditures for highway maintenance and diminish premature wear of state highways.

The state of Arizona cannot afford to postpone development of a multifaceted commercial vehicle data-handling program, as it is likely the consequences of inaction will outweigh the cost of implementing such a program.

REFERENCES

1. Mergel, J. *An Overview of Traffic Monitoring Programs in Large Urban Areas.* Center for Transportation Information, Volpe National Transportation Systems Center, US Department of Transportation, Washington, DC, July 1997.

2. Mergel, J. *Case Studies of Traffic Monitoring Programs in Large Urban Areas.* Center for Transportation Information, Volpe National Transportation Systems Center, US Department of Transportation, Washington, DC, July 1997.

3. Heanue, K. *Data Sharing and Data Partnerships for Highways – A Synthesis of Highway Practice #288.* Transportation Research Board – National Research Council, National Academy Press, Washington, DC, 2000.

4. Limoges, E., Purvis, C., Turner, S., Wigan, M., and Wolf, J. *Future of Urban Transportation Data.* Transportation in the New Millennium, Transportation Research Board – National Research Council, National Academy Press, Washington, DC, 1999.

5. Gardner, M. *Highway Traffic Monitoring.* Transportation in the New Millennium, Transportation Research Board – National Research Council, National Academy Press, Washington, DC, 1999.

6. Tate-Glass, M., Bostrum, R., and Witt, G. *Data, Data, Data – Where's the Data?* Transportation in the New Millennium, Transportation Research Board – National Research Council, National Academy Press, Washington, DC, 1999.

7. Faucett, J. *Guidance Manual for Managing Transportation Data.* National Cooperative Highway Research Program Report 401. Transportation Research Board – National Research Council, National Academy Press, Washington, DC, 1997.

8. Papiernik, D., Nanda, D., Cassada, R., and Morris, W. *Data Warehouse Strategy to Enable Performance Analysis.* In: Transportation Data, Statistics, and Information Technology. Transportation Research Record 1719. Journal of the Transportation Research Board – National Research Council, Washington, DC, 2000.

9. Abney, S. "IRD Receives $1 Million Contract To Upgrade Arizona Weighstations." *ITS News*, ITS America, July 2001.

10. HPMS Field Manual, Appendix F, Federal Highway Administration, December, 2000.

11. Diamond Edge Technology website, http://www.detllc.com, Eugene, Oregon, 2002.

12. Gillmann, R. *Policy – Vehicle Travel Information System Data Base Released to States*. Research & Technology Transporter, Turner-Fairbank Highway Research Center, November 1996.

13. Chaparral Systems website, http://www.chapsys.com, Santa Fe, New Mexico, October 2002.

14. Federal Highway Administration website, http://www.fhwa.dot.gov, June 2002.

15. Kishore, A., and Klashinsky, R. *Prevention of Highway Infrastructure Damage Through Commercial Vehicle Weight Enforcement.* International Road Dynamics, Saskatoon, Saskatchewan, November 2000.

16. Interview: Denis Duman, Information Technician Specialist IV, Arizona Department of Transportation. November 2002.

17. Interview: Estomih Kombe, Transportation Engineer II, Arizona Department of Transportation. October-November 2002.

18. Arizona Department of Transportation Intelligent Transportation Systems website, http://www.azfms.com, November 2002.

19. Interview: Glenn Jonas, Senior Systems Engineering Specialist, Arizona Department of Transportation, November 2002.

20. Interview: Steve Abney, Southern Region Manager, Motor Vehicle Enforcement Services, Arizona Department of Transportation, November 2002.

21. Interview: Robert Medland, Vice President, Traffic Research & Associates, Inc., November 2002.

22. Interview: George Way, Chief Pavement Design Engineer, Arizona Department of Transportation, November 2002.

23. United States Census Bureau, United States Department of Commerce, http://www.census.gov, November 2002.

24. Oregon Department of Transportation, Motor Carrier Transportation Division website, http://odot.state.or.us/trucking/, November 2002.

25. Minnesota Department of Transportation, Office of Transportation Data and Analysis website, http://www.dot.state.mn.us/tda/index.html, November 2002.

26. Written documentation provided by Charles Sanft, Director, Weight Data and Enforcement Policy, Minnesota Department of Transportation, November 2002.

27. Virginia Department of Motor Vehicles, Motor Carrier Services website, http://www.dmv.state.va.us/webdoc/commercial/mcs/index.asp, November 2002.

28. *Computer Recognition Systems, Inc. Receives Contract For Virtual Weigh Station*. ITS News, ITS America, June 2002.

29. Middleton, D. *Enforcement Efforts Gear Up for Increased Truck Traffic*. Texas Transportation Institute, Texas Transportation Researcher, Volume 38, Number 1, 2002.

30. Middleton, D. *Keeping Overweight Trucks From Getting A-Weigh.* Texas Transportation Institute, Texas Transportation Researcher, Volume 35, Number 3, 1999.

31. International Road Dynamics Intelligent Transportation Systems website, http://www.irdinc.com, November 2002.

32. Bergan, A., Lindgren, N., Berthelot, C., and Woytowich, B. *Preserving Highway Infrastructure Using Weigh-In-Motion (WIM).* International Road Dynamics, Saskatoon, SK, Canada, November 1998.

APPENDIX A: SURVEY INSTRUMENT

Arizona Department of Transportation
Survey of Commercial Vehicle Data Handling Practices

The *Arizona Department of Transportation* (AzDOT) is working to improve its system for handling commercial vehicle data collection and dissemination. As part of this process, we are interested in learning how other states gather and share commercial vehicle data within their respective states.

We would appreciate your response to the following questions. This information will be used to assist AzDOT in improving the efficiency and effectiveness of its current practices.

Person completing this survey: ___________________________ State __________________

Department _________________ Telephone ______________ E-mail ___________________

1. What type of data do you collect on ***commercial vehicles*** in your state? *(check all that apply)*

- ❑ Weight
- ❑ Count
- ❑ Speed
- ❑ Delay/Travel Time
- ❑ Classification (Non-FHWA "Scheme F")
- ❑ Classification (FHWA "Scheme F" 13 classes)
- ❑ Other, specify: _____________________________

2. Who is responsible for collection of ***commercial vehicle*** data in your state? *(check all that apply)*

- ❑ Department of ***Public Safety***
- ❑ Motor Vehicle ***Enforcement*** Division
- ❑ ***Planning*** Division
- ❑ ***Research*** Department
- ❑ Long Term Pavement Performance ***(LTPP)*** Program
- ❑ Cities, Counties, Metropolitan Planning Organizations
- ❑ Other, specify: __________________________

3. With what other departments/agencies do you share the data you collect? *(check all that apply)*

- ❑ Department of ***Public Safety***
- ❑ Motor Vehicle ***Enforcement*** Division
- ❑ ***Planning*** Division
- ❑ ***Research*** Department
- ❑ Long Term Pavement Performance ***(LTPP)*** Program
- ❑ Cities, Counties, Metropolitan Planning Organizations
- ❑ The data is not shared with other departments or agencies
- ❑ Other, specify: _____________________________________

4A. How are ***commercial vehicle*** data collected? *(check all that apply)*

- ❑ Manually
- ❑ Portable (short-term) traffic classifiers and weighing devices
- ❑ Permanent traffic monitoring stations
- ❑ Other, specify: ______________________

4B. If permanent stations are used, are the ***commercial vehicle*** data collected via telemetry?

- ❑ Yes
- ❑ No

4. Is collection of commercial vehicle data part of a permanent data collection program or collected on an "as needed" basis?

- ❑ Permanent Program
- ❑ Special Studies (as needed)
- ❑ Other, specify: _________________________

5. What is your primary method of ***commercial vehicle*** data storage? *(check all that apply)*

- ❑ Hard Copy (Paper, Microfiche)
- ❑ CD-ROM
- ❑ Zip Drive
- ❑ Tape Drive
- ❑ Laptop Computer
- ❑ Local PC
- ❑ Dedicated Server
- ❑ Computer Network
- ❑ Other, specify: __________________________

6. How is ***commercial vehicle*** data shared with other departments/offices (such as Motor Vehicle Division, Department of Public Safety, etc.)? *(check all that apply)*

- ❑ Hard Copy (Paper)
- ❑ CD-ROM, Diskette
- ❑ Network File Sharing
- ❑ Modem Transmission (FTP)
- ❑ Intranet
- ❑ Data is not shared with other departments
- ❑ Other, specify: ______________

7. What type of software do you use to analyze your ***commercial vehicle*** data?

- ❑ Commercially Available Traffic Analysis Software
  Specify manufacturer: ____________________________

- ❑ Custom Designed Software through an outside Consultant
  Specify programming language: _________________________
  Name of Consultant: __________________________________

- ❑ In-House Designed System
  Specify programming language: _________________________

- ❑ Microsoft Product (Access, Excel, etc)
- ❑ Other, specify: _________________________________

8. How effective is your current system for handling ***commercial vehicle*** data? *(circle your response)*

Very Effective				Very Ineffective
5	4	3	2	1

9. For what purpose(s) is your ***commercial vehicle*** data being used? *(check all that apply)*

- ❑ Allocation of maintenance funds
- ❑ Highway planning and design
- ❑ Pavement design
- ❑ Development of axle correction factors for raw traffic counts taken with road tubes
- ❑ Enforcement of vehicle size and weight laws
- ❑ Research
- ❑ To meet federal data collection requirements (HPMS, etc.)
- ❑ Not being used for decision making
- ❑ Other, specify: __________________________________

APPENDIX B: COMMERCIAL VEHICLE DATA HANDLING PRACTICES SURVEY RESULTS

Question 1. What type of data do you collect on ***commercial vehicles*** in your state?

Table B1. Type of Data Collected

State	Weight	Count	Speed	Delay/Travel Time	Class non-FHWA	Class FHWA Scheme F	Other
AK	X	X		X		X	X
AL	X	X				X	
AR	X	X	X			X	
AZ1			X			X	X
AZ2	X	X	X			X	
AZ3	X	X					
CA	X	X	X		X	X	
CO	X	X	X			X	
CT	X	X				X	
DE	X	X	X			X	
FL	X	X	X			X	
GA	X	X	X			X	
HI1	X	X	X			X	
HI2	X	X					
IA	X	X	X			X	
ID	X	X	X			X	X
IL		X			X		X
IN	X	X				X	
KS1	X	X				X	
KS2	X	X				X	
KY	X	X	X			X	
LA	X	X				X	
MA1						X	
MA2						X	
MD	X					X	
ME1	X	X				X	
ME2						X	
MI	X	X			X	X	
MN	X	X			X		
MO	X				X		
MS	X	X	X			X	
MT	X	X				X	
NC	X	X				X	
ND	X	X	X			X	
NE	X	X				X	
NH	X	X	X			X	
NJ	X	X	X			X	
NM	X	X				X	

State	Weight	Count	Speed	Delay/Travel Time	Class non-FHWA	Class FHWA Scheme F	Other
NV	X	X			X	X	
NY	X	X	X			X	
OH	X	X				X	
OK	X	X	X			X	
OR	X	X				X	
PA	X	X	X			X	
RI	X	X				X	
SC	X	X	X			X	
SD	X	X	X			X	
TN	X	X	X			X	
TX	X	X	X	X	X	X	X
UT	X	X	X		X	X	
VA	X	X	X			X	
VT	X	X	X			X	X
WA1	X	X	X			X	
WA2	X	X	X	X		X	
WA3	X		X				
WI1	X	X	X			X	
WI2	X	X	X		X		
WV	X	X				X	
WY1	X	X				X	
WY2	X	X	X			X	
Total	52	32	2	9	52	5	52
%	90.0	86.7	53.3	3.3	15.0	86.7	8.3

Question 2. Who is responsible for collection of ***commercial vehicle*** data in your state?

Table B2. Data Collection Departments

State	Public Safety	Motor Vehicle Enforce-ment	Planning Division	Research Department	LTPP Program	Cities, Counties, MPO	Traffic Unit	Other	Total
AK	X	X	X						3
AL			X		X				2
AR			X						1
AZ1		X							1
AZ2			X						1
AZ3			X	X	X				3
CA		X			X	X			3
CO		X					X		2
CT	X	X	X	X	X				5
DE							X		1
FL		X	X						2
GA			X						1
HI1		X	X						2
HI2		X	X						2
IA			X		X				2
ID		X	X						2
IL			X						1
IN			X						1
KS1			X						1
KS2		X	X		X				3
KY			X						1
LA			X						1
MA1									0
MA2			X						1
MD	X	X	X	X					4
ME1							X		1
ME2							X		1
MI			X						1
MN	X	X						X	3
MO			X						1
MS			X						1
MT			X						1
NC							X		1
ND			X						1
NE			X						1
NH			X						1
NJ	X	X					X		3
NM			X		X	X			3
NV							X		1
NY		X			X	X			3
OH			X						1
OK	X								1

State	Public Safety	Motor Vehicle Enforce-ment	Planning Division	Research Department	LTPP Program	Cities, Counties, MPO	Traffic Unit	Other	Total
OR		X	X						2
PA			X						1
RI							X		1
SC							X		1
SD								X	1
TN			X						1
TX			X		X	X			3
UT	X		X		X				3
VA	X	X		X					3
VT							X		1
WA1		X	X		X				3
WA2								X	1
WA3		X							1
WI1		X							1
WI2			X						1
WV			X		X				2
WY1			X						1
WY2		X	X		X				3
Total	8	20	39	4	13	3	10	3	
%	13.0	33.3	65.0	6.7	21.7	5.0	16.7	5.0	

Question 3. With what other departments/agencies do you share the data you collect?

Table B3. Data Sharing

State	DPS	Motor Vehicle Enforce-ment	Planning Division	Research Department	LTPP Program	Cities, Counties, MPOs	Data is not shared	FHWA	Other	Total
AK	X	X	X							3
AL				X	X					2
AR	X		X	X	X	X				5
AZ1		X							X	2
AZ2			X	X	X					3
AZ3							X	X		2
CA									X	1
CO			X	X	X	X			X	5
CT	X	X	X	X	X					5
DE	X		X		X					3
FL	X	X	X	X	X	X				6
GA			X	X						2
HI1					X					1
HI2		X	X					X		3
IA		X	X	X	X	X				5
ID	X	X	X	X	X	X				6
IL				X	X					2
IN		X		X	X	X				4
KS		X								1
KS1		X								1
KY				X	X					2
LA			X	X		X				3
MA1							X			1
MA2			X	X	X					3
MD					X					1
ME1		X	X		X					3
ME2		X	X							2
MI		X			X					2
MN	X									1
MO		X								1
MS		X		X	X					3
MT	X	X	X	X	X					5
NC			X	X	X	X		X		5
ND		X		X	X	X				4
NE			X	X	X					3
NH							X			1
NJ	X	X	X	X	X				X	6
NM	X		X		X	X			X	5
NV		X	X	X	X	X			X	6
NY		X				X			X	3
OH	X	X	X		X	X				5
OK			X	X	X					3
OR	X	X	X	X				X	X	6
PA								X		1
RI	X	X							X	3
SC	X	X	X	X	X	X				6
SD		X	X	X	X	X				5
TN								X		1
TX	X	X	X		X	X				5
UT	X		X	X	X	X		X	X	7
VA	X	X		X		X			X	5
VT		X			X				X	3

State	DPS	Motor Vehicle Enforce-ment	Planning Division	Research Department	LTPP Program	Cities, Counties, MPOs	Data is not shared	FHWA	Other	Total
WA1			X		X				X	3
WA2	X				X					2
WA3									X	1
WI1		X							X	2
WI2	X	X	X	X	X	X			X	7
WV		X	X		X			X	X	5
WY1			X		X			X		3
WY2	X	X	X	X	X	X				6
Total	20	32	33	29	38	20	3	9	17	
%	33.3	53.3	55.0	48.3	63.3	33.3	5.0	15.0	28.3	

Question 4A. How are ***commercial vehicle*** data collected?

Table B4. Collection Devices

State	Manually	Portable (short-term) classifiers and weighing devices	Permanent monitoring stations	Other
AK	X	X	X	
AL		X	X	
AR			X	
AZ1	X		X	
AZ2	X		X	
AZ3	X			
CA			X	
CO		X	X	
CT		X	X	
DE		X	X	
FL		X	X	
GA		X		
HI1			X	
HI2	X			
IA	X	X	X	
ID	X	X	X	
IL		X	X	
IN		X	X	
KS1		X		
KS2	X	X	X	
KY	X	X	X	
LA		X	X	
MA1		X		
MA2		X		
MD			X	
ME1	X	X	X	
ME2			X	
MI	X	X	X	
MN	X		X	
MO		X	X	
MS		X	X	
MT	X	X	X	X
NC			X	
ND		X	X	
NE	X	X	X	
NH	X		X	
NJ	X	X	X	
NM	X	X	X	
NV	X	X	X	X
NY	X	X	X	
OH		X	X	
OK			X	

State	Manually	Portable (short-term) classifiers and weighing devices	Permanent monitoring stations	Other
OR	X		X	
PA			X	
RI			X	X
SC		X	X	
SD		X	X	
TN		X	X	
TX	X	X	X	
UT	X	X	X	
VA	X	X	X	
VT	X	X	X	
WA1			X	
WA2		X	X	X
WA3	X	X	X	
WI1		X	X	
WI2		X	X	
WV	X	X	X	
WY1		X	X	
WY2	X	X	X	
Total	27	43	54	4
%	45.0	71.7	90.0	6.7

Question 4B. If permanent stations are used, are the ***commercial vehicle*** data collected via telemetry?

Table B5. Data Retrieval

State	Yes	No
AK	X	
AL	X	
AR	X	
AZ1	X	X
AZ2		X
AZ3		X
CA	X	
CO	X	
CT		X
DE	X	
FL	X	
GA		X
HI1	X	
HI2		X
IA	X	
ID	X	
IL	X	
IN	X	
KS1	X	
KS2	X	
KY	X	
LA	X	
MA1		X
MA2		X
MD	X	
ME1	X	
ME2	X	
MI	X	
MN	X	
MO	X	
MS	X	
MT	X	
NC	X	
ND	X	
NE	X	
NH	X	
NJ	X	
NM	X	
NV	X	X
NY	X	
OH	X	X
OK	X	
OR		
PA	X	
RI	X	
SC	X	
SD	X	
TN	X	
TX	X	
UT	X	
VA	X	
VT	X	
WA1	X	
WA2		X
WA3	X	
WI1	X	
WI2	X	X
WV	X	
WY1	X	
WY2	X	
Total	51	12
%	86.4	20.3

Question 5. Is collection of ***commercial vehicle*** data part of a permanent data collection program or collected on an "as needed" basis?

Table B6. Type of Data Collection Program

State	Permanent Program	Special Studies (as needed)
AK	X	
AL	X	X
AR	X	
AZ1		X
AZ2		X
AZ3	X	
CA	X	
CO	X	
CT	X	
DE	X	X
FL	X	
GA	X	X
HI1	X	
HI2	X	
IA	X	
ID	X	
IL	X	
IN	X	
KS1	X	
KS2	X	
KY	X	X
LA	X	X
MA1		X
MA2		X
MD	X	
ME1	X	
ME2	X	
MI	X	
MN	X	
MO	X	
MS	X	
MT	X	X

State	Permanent Program	Special Studies (as needed)
NC	X	
ND	X	X
NE	X	X
NH	X	
NJ	X	
NM	X	X
NV	X	
NY	X	X
OH	X	
OK	X	
OR	X	
PA	X	
RI	X	
SC	X	X
SD	X	
TN	X	
TX	X	
UT	X	X
VA	X	
VT	X	
WA1	X	
WA2	X	
WA3	X	X
WI1	X	X
WI2	X	
WV	X	X
WY1	X	
WY2	X	
Total	56	19
%	93.3	31.7

Question 6. What is your primary method of ***commercial vehicle*** data storage?

Table B7. Method of Data Storage

State	Hard Copy	CD-ROM Diskette	Zip Drive	Tape Drive	Laptop	Local PC	Dedicated Server	Computer Network	Other, specify
AK		X					In progress		
AL						X	X		
AR		X							
AZ1									
AZ2			X			X			
AZ3	X								
CA	X	X	X				X		
CO	X	X				X		X	
CT	X	X			X	X			
DE	X	X							
FL							X		
GA						X			
HI1						X			
HI2	X								
IA		X				X		X	
ID		X				X	X		
IL								X	
IN							X		
KS1								X	
KS2								X	
KY		X	X		X	X			
LA						X			
MA1						X			
MA2								X	
MD							X		
ME1		X				X	X		
ME2						X			
MI								X	Oracle DB
MN			X						
MO							X	X	
MS		X					X		
MT							X		
NC	X	X				X			
ND					X		X		
NE	X					X		X	
NH						X		X	
NJ		X					X		
NM							X		
NV	X					X		X	Jaz Drive
NY							X	X	
OK	X	X						X	
OH							X	X	Mainframe application moving to client-server environment

State	Hard Copy	CD-ROM Diskette	Zip Drive	Tape Drive	Laptop	Local PC	Dedicated Server	Computer Network	Other, specify
OR				X				X	
PA								X	
RI		X	X			X			Shared server
SC						X		X	
SD							X		
TN	X								
TX		X	X		X	X		X	
UT					X	X		X	
VA	X					X	X		
VT								X	
WA1								X	Mainframe application
WA2							X		
WA3	X						X	X	
WI1	X					X			
WI2							X		
WV	X	X				X			
WY1		X						X	
WY2								X	
Total	15	18	6	1	5	24	20	24	5
%	25.4	30.5	10.2	1.7	8.5	40.7	33.9	40.7	8.5

Question 7. How is commercial vehicle data shared with other departments or offices?

Table B8. Method of Data Sharing

State	Hard Copy	CD-ROM Diskette	Network File Sharing	Modem Transmission (FTP)	Intranet	The data is not shared	Other, Specify
AK			X		X		
AL	X	X	X				
AR		X					
AZ1					X		Internet
AZ2		X					
AZ3	X						
CA	X	X			X		
CO	X	X			X		
CT	X	X					
DE	X	X					
FL	X						
GA	X			X			
HI1	X						Excel spreadsheet
HI2	X	X					
IA	X	X			X		
ID	X		X				
IL							Publications
IN	X	X	X	X	X		
KS1	X						
KS2	X						
KY					X		
LA	X						
MA1	X						
MA2				X			
MD		X					
ME1	X	X		X	X		
ME2			X				
MI	X		X		X		
MN	X						
MO	X						
MS	X	X		X			
MT			X				
NC	X	X					E-mail
ND	X						Reports
NE	X						Maps, Books
NH						X	
NJ	X				X		
NM	X				X		
NV	X		X		X		
NY	X		X				Internet website
OH			X				E-mail
OK						X	
OR			X		X		

State	Hard Copy	CD-ROM Diskette	Network File Sharing	Modem Transmission (FTP)	Intranet	The data is not shared	Other, Specify
PA						X	
RI	X						
SC	X						E-mail
SD	X				X		
TN	X						
TX	X		X		X		
UT	X	X	X	X	X		
VA	X		X				
VT	X		X				Dial-in access to WIM site
WA1	X	X					
WA2					X		
WA3	X		X				
WI1	X				X		
WI2	X						Direct database access
WV	X						
WY1		X	X				
WY2	X			X			
Total	43	17	17	7	18	3	11
%	71.7	28.3	28.3	11.7	30.0	5.0	18.3

Question 8. What type of software do you use to analyze your ***commercial vehicle*** data?

Table B9. Data Analysis Software

State	Commercial	Manufacturer	Custom	Language	Consultant	In-house Design	Language	Microsoft	Other, specify
AK	X	IRD	X	Not specified	Westman & Associates, Inc. and IRD			X	
AL	X	Diamond, Peek, ECM				X	COBOL	X	
AR	X	Peek, ITC/Pat America				X	Not specified	X	
AZ1	X	TRADAS-Chaparral							
AZ2									Regional coordinator
AZ3								X	
CA			X	C	Carl McMillin			X	
CO	X	Vendor Software						X	
CT									Analyzed by staff not software
DE	X	Chaparral							
FL						X	C		
GA									
HI1								X	
HI2								X	
IA	X	Peek TDP, VTRIS				X	Not specified		
ID			X	C	Pathfinder Development	X	SAS Institute Inc. , C		
IL								X	
IN	X	IRD, TRADAS-Chaparral							
KS1	X	VTRIS				X	C, Perl	X	
KS2	X	VTRIS				X	C		
KY			X	Fortran	Not specified	X	Not specified	X	
LA	X	Not specified	X	Not specified	Not specified				
MA1	X	Peek 241							
MA2	X	Peek 261/TDP							

State	Commercial	Manufacturer	Custom	Language	Consultant	In-house Design	Language	Microsoft	Other, specify
MD									Not done in-house
ME1	X	ECM						X	
ME2								X	
MI						X	FoxPro, Power builder (Oracle DB)		
MN	X	IRD							
MO	X	TRADAS-Chaparral						X	
MS								X	
MT	X	Chaparral	X	Oracle	Wesco				
NC	X	FHWA, Peek				X	under development in Oracle	X	
ND						X	under development	X	
NE						X	Visual Basic, Easytrieve Plus, Cobol 2		
NH	X	ECM						X	
NJ	X	TRADAS 2-Chaparral, VTRIS (WIM data)				X	Fortran		
NM	X	TRADAS-Chaparral							
NV						X	FoxPro for Win 2.6 DBF		
NY	X	TrafMan, Peek TDP	X	Oracle DB	CGI	X	Macro driven spreadsheets		
OH						X	Under development in Java		
OK	X	IRD							
OR						X	Not specified		
PA						X	Visual Basic		
RI	X	VTRIS, WIM vendors software							
SC	X	Peek TOPPS				X	C		
SD								X	
TN	X	Peek							

State	Commercial	Manufacturer	Custom	Language	Consultant	In-house Design	Language	Microsoft	Other, specify
TX								X	
UT	X	IRD, Peek, VTRIS							
VA			X	Unknown	IRD	X	Visual Basic		
VT	X	WIM=IRD, Class=TAS Plus	X	Oracle DB w/Power builder interface	GIS/TRANS, New Eng Traffic Monitoring System NETMS			X	
WA1	X	SAS (FHWA), VTRIS, IRD				X	TRIPS (Cobol & Natural)		
WA2						X	SQL 7		
WA3									Safetynet, CVISN
WI1						X	COBOL mainframe	X	
WI2	X	TRADAS-Chaparral							
WV								X	
WY1	X	VTRIS						X	
WY2								X	
Total	31		9			23		25	4
%	52.5		15.2			38.9		42.4	6.8

Question 9. How effective is your current system for handling ***commercial vehicle*** data?

Table B10. Data Handling System Effectiveness

State	5	4	3	2	1
AK				X	
AL			X		
AR		X			
AZ1			X		
AZ2			X		
AZ3				X	
CA			X		
CO			X		
CT		X			
DE			X		
FL		X			
GA			X		
HI1				X	
HI2		X			
IA		X			
ID		X			
IL	X				
IN			X		
KS1				X	
KS2			X		
KY			X		
LA				X	
MA1			X		
MA2			X		
MD			X		
ME1		X			
ME2	X				
MI	X				
MN				X	
MO			X		
MS				X	
MT	X				

State	5	4	3	2	1
NC		X			
ND	X				
NE		X			
NH				X	
NJ			X		
NM			X		
NV	X				
NY			X		
OH				X	
OK			X		
OR		X			
PA			X		
RI	X				
SC			X		
SD		X			
TN			X		
TX		X			
UT				X	
VA			X		
VT			X		
WA1			X		
WA2	X				
WA3		X			
WI1			X		
WI2	X				
WV				X	
WY1			X		
WY2			X		
Total	9	13	27	11	0
%	15.0	21.7	45.0	18.3	0.0

Question 10. For what purpose(s) is your ***commercial vehicle*** data being used?

Table B11. Commercial Vehicle Data Usage

State	Allocation of maintenance funds	Highway planning and design	Pavement design	Development of axle correction factors	Enforcement of size and weight laws	Research	To meet federal requirements HPMS	Not used for decision making	Other
AK		X	X	X			X		
AL		X	X	X		X	X		
AR		X	X	X		X	X		
AZ1		X	X	X			X		
AZ2						X			
AZ3					X		X		
CA		X	X			X	X		
CO		X	X			X	X		
CT	X	X	X	X			X		
DE		X	X	X			X		
FL	X	X	X	X	X	X	X		
GA	X	X	X	X			X		
HI1			X				X		
HI2	X	X			X	X	X		
IA		X	X	X		X	X		
ID		X	X		X	X	X		
IL		X	X			X	X		
IN	X	X	X	X		X	X		
KS1		X	X	X			X		
KS2		X	X	X	X	X	X		
KY	X	X	X	X		X	X		
LA		X	X	X			X		
MA1								X	
MA2		X	X	X		X	X		
MD						X		X	
ME1	X	X	X	X					
ME2		X	X		X		X		
MI		X	X	X		X	X		Financial Analysis

State	Allocation of maintenance funds	Highway planning and design	Pavement design	Development of axle correction factors	Enforcement of size and weight laws	Research	To meet federal requirements HPMS	Not used for decision making	Other
MN		X	X				X		
MO		X	X	X			X		
MS		X	X		X	X			
MT		X	X	X	X	X	X		
NC		X				X	X		
ND		X	X	X		X	X		
NE		X	X	X		X	X		
NH		X	X	X			X		
NJ		X	X	X			X		
NM	X	X	X	X		X	X		
NV	X	X	X	X	X	X	X		
NY	X	X	X	X	X	X	X		
OH	X	X	X	X	X		X		
OK		X	X	X			X		
OR		X	X		X	X	X		
PA							X		
RI			X	X			X		
SC		X	X	X	X	X	X		
SD		X	X	X	X	X	X		
TN		X	X	X			X		
TX	X	X	X		X	X	X		
UT	X	X	X	X	X	X	X		
VA					X	X			General Assembly
VT		X	X	X	X	X	X		
WA1		X	X	X		X	X		
WA2					X	X	X		
WA3	X				X	X	X		
WI1					X				

State	Allocation of maintenance funds	Highway planning and design	Pavement design	Development of axle correction factors	Enforcement of size and weight laws	Research	To meet federal requirements HPMS	Not used for decision making	Other
WI2	X	X	X	X	X	X	X		Private developers, consultants, advocacy
WV	X	X	X	X			X		
WY1		X	X				X		
WY2	X	X	X	X		X	X		
Total	17	49	49	38	22	36	53	2	4
%	81.7	81.7	63.3	36.7	60.0	88.3	3.3	81.7	6.7

APPENDIX C: TRANSPORTATION PLANNING DIVISION - DATA SECTION ATC AND WIM SITES

Highway	Milepost	Equipment Type	Capability
I 008	1.7	inductive loop	length, speed
I 008	37.0	inductive loop	length, speed
I 008	112.8	inductive loop	length, speed
I 010	2.5	inductive loop	length, speed
I 010	94.8	inductive loop	length, speed
I 010	145.1	Inductive loop	length, speed
I 010	154.1	inductive loop	length, speed
I 010	177.5	inductive loop	length, speed
I 010	237.4	inductive loop	count
I 010	256.5	inductive loop	length, speed
I 010	300.1	WIM	weight, count, class
I 010	330.0	inductive loop	length, speed
I 017	227.1	WIM	weight, count, class
I 017	232.5	inductive loop	length, speed
I 017	279.2	inductive loop	length, speed
I 019	29.4	inductive loop	length, speed
I 019	62.5	inductive loop	length, speed
I 040	3.5	inductive loop	length, speed
I 040	122.8	inductive loop	length, speed
I 040	215.0	inductive loop	length, speed
I 040	260.0	inductive loop	count
S 051	2.2	inductive loop	count
S 064	213.9	inductive loop	length, speed
S 068	5.6	inductive loop	length, speed
S 068	17.5	inductive loop	length, speed
S 072	35.0	inductive loop	length, speed
S 077	370.6	inductive loop	length, speed
S 079	94.0	inductive loop	length, speed
S 080	304.9	inductive loop	length, speed
S 080	359.5	inductive loop	length, speed
S 082	4.9	inductive loop	length, speed
S 082	30.9	inductive loop	length, speed
S 083	29.4	inductive loop	length, speed
S 085 1	52.5	inductive loop	length, speed
S 086	148.3	inductive loop	length, speed
S 087	248.7	inductive loop	length, speed
S 087	355.0	inductive loop	length, speed
S 089	319.3	inductive loop	length, speed

Note: ATC and WIM sites are in both directions**.**

APPENDIX C (CONT'D)
TRANSPORTATION PLANNING DIVISION - DATA SECTION
ATC AND WIM SITES

Highway	Milepost	Equipment Type	Capability
S 089	359.0	Inductive loop	length, speed
S 090	292.5	WIM	weight, count, class
S 095	115.4	WIM	weight, count, class
S 095	147.1	Inductive loop	length, speed
S 099	54.6	Inductive loop	length, speed
S 260	309.0	Inductive loop	length, speed
S 260	357.0	Inductive loop	length, speed
S 260	388.7	Inductive loop	length, speed
S 264	343.0	Inductive loop	length, speed
S 264	438.0	Inductive loop	length, speed
S 277	330.0	Inductive loop	length, speed
S 286	44.0	Inductive loop	length, speed
S 377	30.0	Inductive loop	length, speed
SA089	320.9	Inductive loop	length, speed
SA089	367.6	Inductive loop	length, speed
SB008 1	0.1	Inductive loop	length, speed
U 060	82.6	Inductive loop	length, speed
U 060	156.7	Inductive loop	length, speed
U 060	172.9	Inductive loop	count
U 060	252.0	Inductive loop	count
U 060	337.2	Inductive loop	length, speed
U 070	258.6	WIM	weight, count, class
U 070	337.2	Inductive loop	length, speed
U 089	422.0	Inductive loop	length, speed
U 093	57.1	Inductive loop	length, speed
U 093	130.6	Inductive loop	length, speed
U 093	194.1	Inductive loop	length, speed
U 095	50.0	WIM	weight, count, class
U 160	327.0	Inductive loop	length, speed
U 180	240.9	Inductive loop	length, speed
U 180	345.5	Inductive loop	length, speed
U 180	411.0	Inductive loop	length, speed
U 191	322.0	Inductive loop	length, speed

Note: ATC and WIM sites are in both directions.

APPENDIX D: LONG TERM PAVEMENT PERFORMANCE ATC AND WIM SITES

Highway	Direction	Milepost	Equipment Type	Capability
I 008	EB	159.0	piezo in asphalt	weight, count, class
I 008	WB	162.0	piezo in asphalt	weight, count, class
I 010	WB	115.0	piezo in asphalt	weight, count, class
I 010	WB	123.0	piezo in asphalt	weight, count, class
I 010	WB	130.0	piezo in concrete	weight, count, class
I 019	NB	23.0	piezo in asphalt	weight, count, class
I 019	NB	54.0	piezo in asphalt	weight, count, class
I 019	SB	84.0	piezo in asphalt	weight, count, class
I 040	EB	106.0	piezo in asphalt	weight, count, class
I 040	WB	113.0	piezo in asphalt	weight, count, class
I 040	WB	148.0	piezo in asphalt	weight, count, class
I 040	EB	202.0	bending plates in concrete	weight, count, class
I 040	WB	202.0	bending plates in concrete	weight, count, class
I 040	EB	294.0	piezo in asphalt	weight, count, class
S 085	SB	141.0	piezo in asphalt	weight, count, class
S 095	SB	145.0	piezo in asphalt	weight, count, class
S 101	NB	11.0	piezo in concrete	weight, count, class
U 093	NB	52.0	bending plates in concrete	weight, count, class

APPENDIX E: AZDOT MOTOR VEHICLE DIVISION WEIGH STATIONS

Highway	Direction	Milepost	Name	Equipment Type	Capability
I 008	NB	1.0	Yuma POE	static scales, PrePass (no WIM)	weight
I 010	EB	3.8	Ehrenberg POE	static scales, WIM, PrePass	weight, class, count
I 010	WB	383.3	San Simon POE	static scales, WIM, PrePass	weight, class, count
I 015	SB	1.0	St. George POE	static scales, WIM, PrePass, portable for enforcement details	weight, class, count
I 019	NB	1.0	Nogales POE	static scales, WIM	weight, class, count
I 040	EB	3.8	Topock POE	portable scales, static scales, WIM, PrePass	weight, class, count
I 040	EB	340.0	Sanders POE	portable ramp scales, static scales, WIM, PrePass	weight, class, count
S 095	NB	1.0	San Luis POE	portable ramp scales	weight
S 095	SB	144.0	Parker POE	static scales	weight
U 060	EB	386.3	Springerville POE	no scales	count only
U 070	WB	384.0	Duncan POE	static scales - single axle, tandem or single	weight
U 080	EB	370.4	Douglas State POE	portable scales, WIM	weight, class, count
U 089	SB	551.0	Page POE	static scales	weight
U 093	SB	67.0	Kingman POE	static scales, WIM, PrePass	weight, class, count
U 160	WB	465.2	Teec Nos Pos POE	portable scales	weight
UA089	SB	610.0	Fredonia POE	portable ramp scales	weight