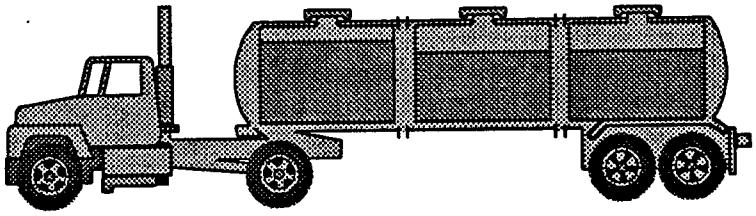
ARIZONA DEPARTMENT OF TRANSPORTATION



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LTPP TRAFFIC DATA COLLECTION AND MONITORING

PB98-143944

Final Report

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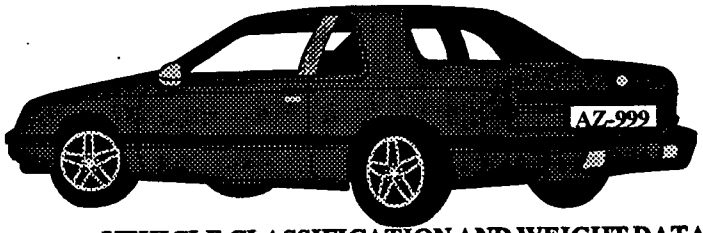
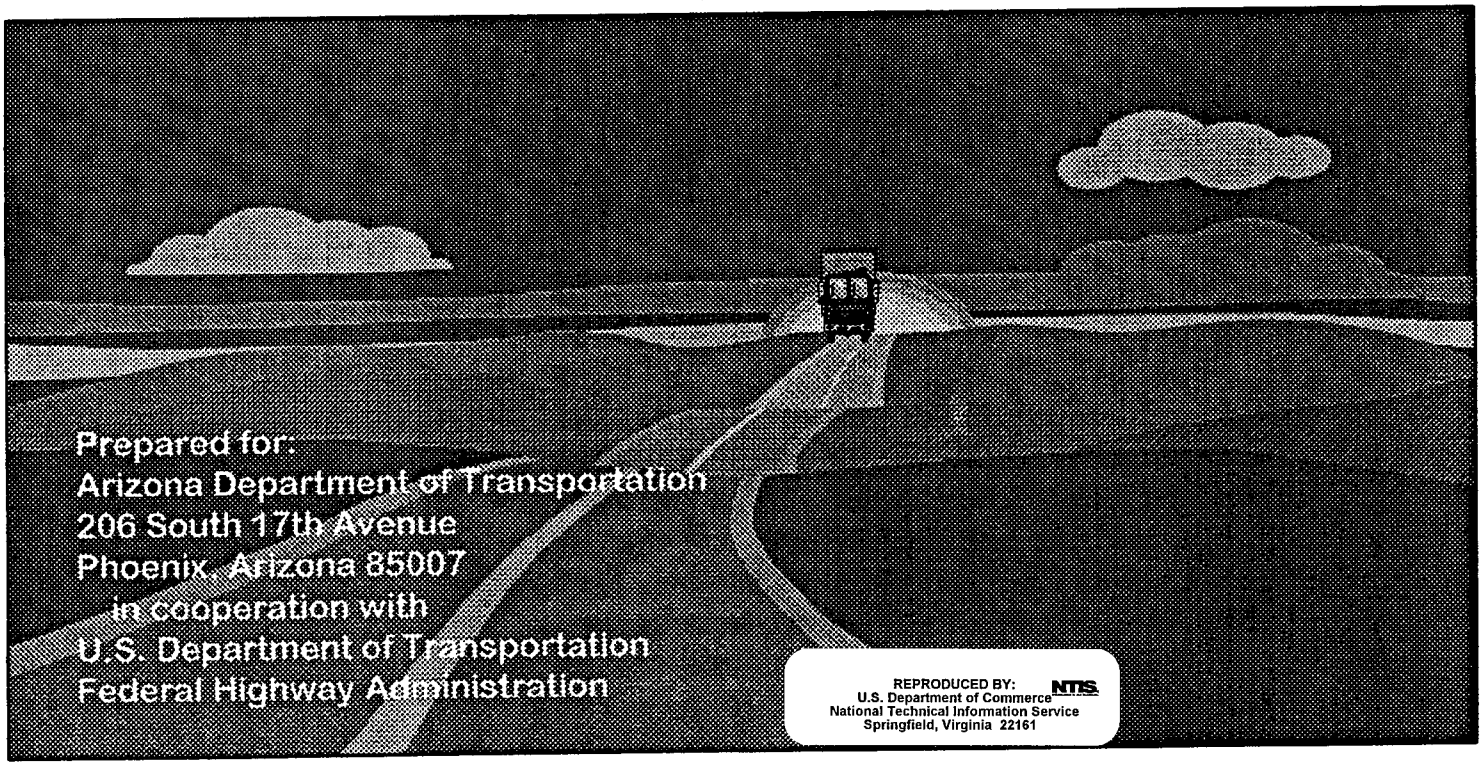


VEHICLE CLASSIFICATION AND WEIGHT DATA

May 1998



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16. Abstract

Traffic data collection is a vital part of the Strategic Highway Research Program's Long Term Pavement Performance Project. The Arizona Department of Transportation is an active participant in this program. The accurate monitoring and evaluation of traffic data, particularly along test sections (Specific Pavement Studies and General Pavement Studies) ensures that these studies are based on reliable traffic characteristics. This is an important parameter for the validity of study results and conclusions.

According to the 'Framework for Traffic Data Collection for the General Pavement Studies Test Sections' released by the Strategic Highway Research Program in January 1989, the Long Term Pavement Performance Program has six specific objectives, which are: (1). Evaluate existing design methods (2). Develop improved design methodologies and strategies for the rehabilitation of existing pavements. (3). Develop improved design equations for new and reconstructed pavements. (4). Determine the effects of loading, environment, material properties and variability, construction quality, and maintenance levels on pavement distress and performance. (5). Determine the effects of specific design features on pavement performance. (6). Establish a long term national data base to support SHRP's objectives and future needs.

This report presents a summary of vehicle count, classification, and weight data collection and monitoring effort at the initial 27 program sites around the state of Arizona, most of which were installed in October/November 1992. It highlights procedures taken to identify performance shifts, calibration of equipment, and on-going efforts to upgrade and expand the data collection program.

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METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	2.54	centimeters	cm
ft	feet	0.3048	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	6.452	centimeters squared	cm^2
ft^2	square feet	0.0929	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
mi^2	square miles	2.59	kilometers squared	km^2
ac	acres	0.395	hectares	ha
		MASS (weight)		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.0328	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

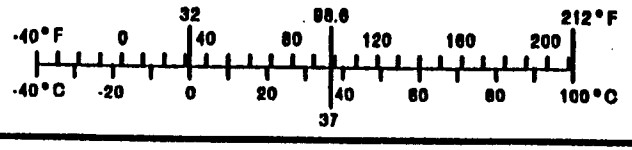
Note: Volumes greater than 1000 L shall be shown in m^3.

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
yd	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
yd^2	kilometers squared	0.39	square miles	mi^2
ha	hectares (10,000 m^2)	2.53	acres	ac
		MASS (weight)		
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1000 kg)	1.103	short tons	T
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

These factors conform to the requirement of FHWA Order 5190.1A

*SI is the symbol for the International System of Measurements



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I. INTRODUCTION

BACKGROUND

Traffic data collection is a vital part of the Strategic Highway Research Program's (SHRP) Long Term Pavement Performance Project (LTPP), of which the Arizona Department of Transportation is an active participant. The accurate monitoring and evaluation of traffic data, particularly along test sections (Specific Pavement Studies - SPS, and General Pavement Studies - GPS) ensures that these studies are based on reliable traffic characteristics. This is an important parameter for the validity of study results and conclusions. This report presents a summary of traffic count and weight data collection and monitoring effort at twenty seven sites around the state of Arizona, most of which were installed in October/November 1992.

SHRP AND THE LTPP PROGRAM

According to the 'Framework for Traffic Data Collection for the General Pavement Studies Test Sections' released by the Strategic Highway Research Program (SHRP) in January 1989, the Long Term Pavement Performance (LTPP) Program has six specific objectives, which are:

- Evaluate existing design methods.
- Develop improved design methodologies and strategies for the rehabilitation of existing pavements.
- Develop improved design equations for new and reconstructed pavements.
- Determine the effects of (1) loading, (2) environment, (3) material properties and variability, (4) construction quality, and (5) maintenance levels on pavement distress and performance.
- Determine the effects of specific design features on pavement performance.
- Establish a long term national data base to support SHRP's objectives and future needs.

The General Pavement Studies (GPS) experiment, one component of the LTPP study, involves the observation and monitoring of selected in-service pavement test sections over a period of upto 20 years. The primary goal of the GPS experiment is to

develop a national database that will provide the data to meet the objectives of the LTPP study. Valid traffic data representing each specific section is vital in accomplishing these objectives. Traffic is one of the most important primary variables in a study of pavement performance. The quality of the traffic data has a direct influence on the ultimate results that can be achieved.

Traffic data collection under the LTPP program constitutes a sizable proportion of all classification and weigh-in-motion data collection by the department. The locations of the LTPP traffic data sites however, were aimed at satisfying the needs of that program, which in some cases may not necessarily be ideal locations for statewide traffic data collection. The Data Team, within the Transportation Planning Group, is the primary traffic data collection and publishing arm for the department. In addition to six permanent WIM sites and two vehicle classification sites, they operate 38 Automated Traffic Recorders (ATR), and perform manual vehicle classifications at 125 locations around the state. Additionally, this group performs manual counts at 1000 or more locations annually. This data is available in their regular publication - Traffic on the Arizona State Highway System.

EXECUTIVE SUMMARY

Traffic data collection for the LTPP program started in Arizona with the installation of a permanent 4 lane WIM system on I-40 East of Flagstaff in 1989. Some data was collected at this site in 1990, 1991, and continuous data from 1993 onwards. In October and November, 1992 a major step was realized with the installation of 22 permanent one lane classification sites around the state. These sites were set up such that they could be hooked up to portable WIM modules for collecting weight data. Three such modules were in use for the 22 sites. In subsequent years more permanent 2 lane WIM systems would be added to the program. A major rehabilitation plan was put in place in 1996 and completed in 1997. This included the replacement of sensors and loops, upgrade of seven of the classification sites to two lane WIM systems, upgrade of five sites to two lane classification, and two new classification sites. As a result the program now has 14 two lane WIM sites, seven 2-lane classification sites, and two single lane classification sites.

While LTPP traffic data collection is geared toward generating data for the federal LTPP program, it is also an important traffic data source for the state of Arizona. In order to maintain the flow of data from these sites and support further evaluation of highway traffic volume and loading patterns, spending for site calibrations, sensor replacements, and equipment maintenance is necessary. It is thus strongly recommended that the department provide for an annual maintenance budget to support this program in the coming years so it can be streamlined and strengthened to serve the needs of the department even more effectively.

In its 1996 report to the department titled "Assessment of Arizona's Motor Carrier Enforcement Efforts", the consulting firm of JHK & Associates (now Transcore) had this to say about Arizona's Truck Data Surveillance Infrastructure.

> "Better and more timely information on truck usage of state highways is needed for enforcement deployment, for truck vehicle miles of travel analyses, for use fuel and motor carrier tax evaluations, for pavement design, and for other planning uses. Therefore, improving current truck data collection systems is a high priority." (12)

An initial step towards the improvement of truck data collection systems as called for above would be the department's commitment in funds to maintain existing ATRC and TPG data collection sites in good operational condition in the coming years.

All existing permanent installations for WIM and AVC data in the department ought to be maintained and calibrated at least annually so that they continue to provide the department with a good set of data and traffic trends in the coming years. This year for instance, a new project - SPR 455: Development of New Pavement Design ESAL, awaits WIM site calibrations so that it can proceed. ATRC and TPG WIM sites are crucial sources of loading data for this project. When completed, SPR 455 will make available a new set of ESAL tables for Pavement Design for the entire state highway system. A few checks of current estimates against WIM loading data strongly supports the need for the development of a new set of ESAL tables and for revisiting the process. While it can not be expected that WIM systems will cover the whole highway system, a good number of WIMs - properly located, will greatly supplement and strengthen current data collection efforts. This may mean adding to the existing set of WIM installations but it is worth the investment, providing needed input to the core task of the department, effective design, construction and maintenance of the state's highway system.

As the project in its present form is considered completed with the publication of this final report, the program can be continued at the ATRC with the establishment of a series 100 project to take its place. This will allow for a year by year allocation of funds to maintain the project and continue research of highway volume and loading characteristics while at the same time making much needed data to the department for among other things, much needed pavement design and planning activities.

II. LTPP TRAFFIC DATA COLLECTION SITES IN ARIZONA

Between 1990 and 1996, Arizona has operated a total of 27 sites under the LTPP program. These sites are located over interstate and state routes around the state, with the most sites on the three interstate highways I-10, I-19, and I-40 which combined for a total of 18 sites.

Table 1 Site Locations and Status: 1992-1997

Arizona /ATRC Site # & PAVEMENT TYPE	*Site Location Route & MP (KM)*	*SHRP ID*	1992 Status	1994 Status	1995 Status	1997 Status
026 RIGID	I-10 EB 108	0200	=	WIM(2)	>>	>>
002 FLEX	I-10 EB 292	6053	AVC(1)			deleted
012 FLEX	I-10 WB 110	1006	=	=	WIM(2)	>>
011 FLEX	I-10 WB 115	1007	AVC(1)	>>	WIM(2)	
023 FLEX	I-10 WB 123	1001	AVC(1)	>>	>>	AVC(2)
022 RIGID	I-10 WB 130	7614	AVC(1)	>>	>>	AVC(2)
006 FLEX	I-19 NB (023)	6060	AVC(1)	>>	>>	WIM(2)
007 FLEX	I-19 NB (054)	1017	AVC(1)	>>	>>	WIM(2)
005 FLEX	I-19 SB (029)	1015	AVC(1)	>>	>>	WIM(2)
004 FLEX	I-19 SB (038)	1016	AVC(1)	>>	>>	deleted
003 FLEX	I-19 SB (058)	1018	AVC(1)	>>	>>	deleted
008 FLEX	I-19 SB (084)	6054	AVC(1)	>>	>>	AVC(2)
017 FLEX	I-40 EB 098	1065	AVC(1)	>>	>>	deleted
018 FLEX	I-40 EB 106	1024	AVC(1)	>>	>>	WIM(2)
202 RIGID	I-40 EB 202	0600	WIM(2)	>>	>>	>>
016 FLEX	I-40 WB 092	1062	AVC(1)	>>	>>	deleted
019 FLEX	I-40 WB 113	1025	AVC(1)	>>	>>	>>
020 FLEX	I-40 WB 145	1002	AVC(1)	>>	>>	WIM(2)
204 RIGID	I-40 WB 202	0600	WIM(2)	>>	>>	>>
009 FLEX	I-8 EB 159	5000	AVC(1)	>>	>>	WIM(2)
021 RIGID	SR-101 NB 011	7079	AVC(1)	>>	>>	WIM(2)
015 FLEX	SR-68 EB 001	1037	AVC(1)	>>	>>	>>
010 FLEX	SR-85 SB 141	6055	AVC(1)	>>	>>	WIM(2)
013 FLEX	SR-85 SB 145	1034	AVC(1)	>>	>>	AVC(2)
024 RIGID	US-60 WB 179	7613	AVC(1)	>>	>>	WIM(2)
014 FLEX	US-93 NB 026	1036	AVC(1)	>>	>>	deleted
025 RIGID	US-93 NB 052	0100	=	WIM(2)	>>	>>

Table 1 lists the sites with their Arizona site numbers, a three digit number in the first column, and the location route and Mile Post (or KM) in the second column. The applicable SHRP site identification number, a 4 digit number is in the third column and the rest of the columns are for the system status, that is either permanent Weigh-in-Motion (WIM) site or an Automatic Vehicle Classification (AVC) site. The total number of monitored lanes is shown in brackets. The symbol ">>" is used to represent no status change, or a continuation of previous status, while '==' stands for no equipment in place. The site locations and operational status in 1996 are also shown on maps in Figure 1 and Figure 2, while the resulting status after the 96/97 upgrade is depicted in Figure 3.

One notes from Figure 1 that in some instances, particularly on the interstate routes, we have a number of data collection sites in close proximity of one another. While in these case this may not be the ideal site mix for purposes of state data collection efforts, the sites were located to satisfy the needs of the Long Term Pavement Performance program (LTPP) which has test sections at these locations. As the test sections under the LTPP are taken out of study and the program focuses more on statewide traffic data needs, the locations of these sites will be redistributed accordingly, for an more effective traffic data effort. In fact, a currently scheduled project has as part of its key tasks, the re-assessment of statewide traffic data collection site needs and locations.

To illustrate the extent of traffic data collection from the permanent WIM and AVC sites under the LTPP program, Table 2 and Table 3 present month by month data availability from these sites. Table 2 shows the months for which data was available from the permanent sites (either WIM or AVC) fro the period July 1993 to June 1996. Data was available where checked 'x'. Table 3 shows a data availability grid for WIM data from the use of portable WIM modules at the AVC sites. As stated earlier in the introduction, the classification site installations allowed for WIM data to be collected alongside the classification data when these modules were attached.

Pavement type, shown as RIGID or FLEX alongside the Arizona site number in Column 1 of table 1 stands for the type of pavement in which the sensors are installed. It is not necessarily an indication of the pavement type for the rest of the freeway section. Except for freeways in the Phoenix metropolitan area (includes sites 021, 022, and 024), the other 'concrete pavement' sites only have concrete for the length of the test section. All bending plate WIM systems were installed in concrete for longer life and improved performance.

SUMMARY OF CURRENT STATUS

By the end of 1997 a total of 14 two lane WIM sites and 9 AVC sites are operated by the research center as part of the LTPP program. Four of the WIM sites are bending-plate sites and the remainder are piezo sites (initially single lane AVC sites upgraded to two lane WIM operation). The bending plate WIM system on I-40 collects continuous weight and classification data for all lanes in all directions (4 lanes, treated as 2 sites by direction) while the other WIM sites collect continuous weight data for two lanes in the direction of travel as indicated for the

site. The rest of the sites, initially had automatic vehicle classification equipment installed in a single lane (driving lane). To obtain weight data at a classification site, one of three portable WIM units was attached to the AVC. The portable WIM units were rotated among the classification sites such that each site that is in good condition for the WIM unit collected weight data for at least one continuous 30 day period during the year. During the 1996/97 year seven of the AVC sites were upgraded to two lane WIM sites to bring the total to 14. In the same period five AVC sites were upgraded from single lane to two lanes, two lane classification sites were installed at two new locations while six of the original single lane classification sites were discontinued. The piezo WIM sites utilize three 6' long piezo-electric sensors and one loop per lane to perform both the weight and classification functions, while the new AVC sites utilize one 6' long piezo and two loops in each lane. The piezo WIM sites are calibrated to within 10% of static weight while the bending plate sites are calibrated to within 5% of static weight.

In 1998 a new initiative will be underway to inspect, rehabilitate, and calibrate all automated traffic data collection sites in the department. Apart from the systems described above, there are seven WIM systems and two AVC systems operated by the Data Team of the Transportation Planning Group, some of which may require a complete re-installation. This effort will improve the department's traffic data collection status while providing needed input for a statewide equivalent single axle load (ESAL) evaluation.

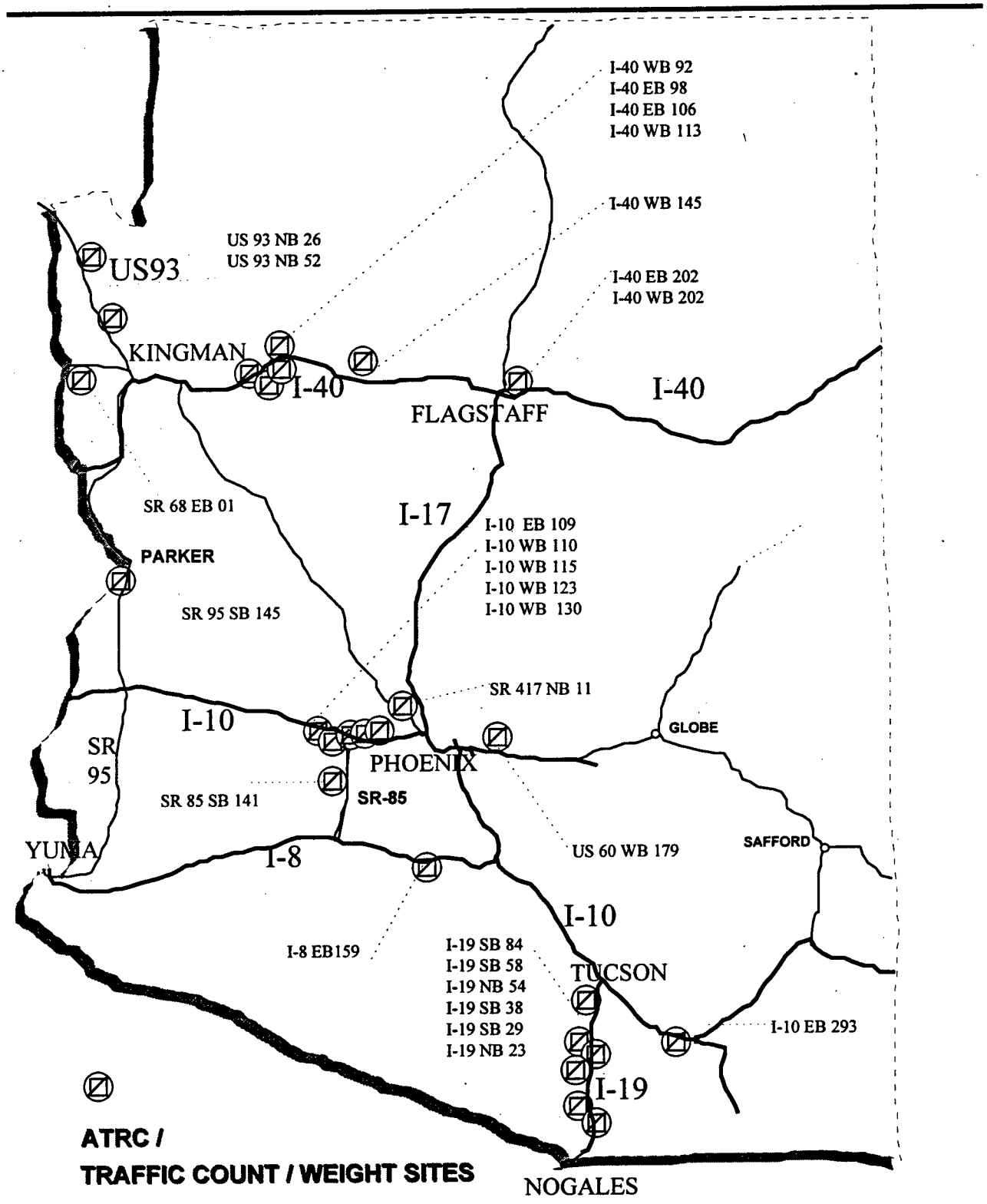

Figure 1 Arizona LTPP Traffic Data Collection Sites as of June, 1996

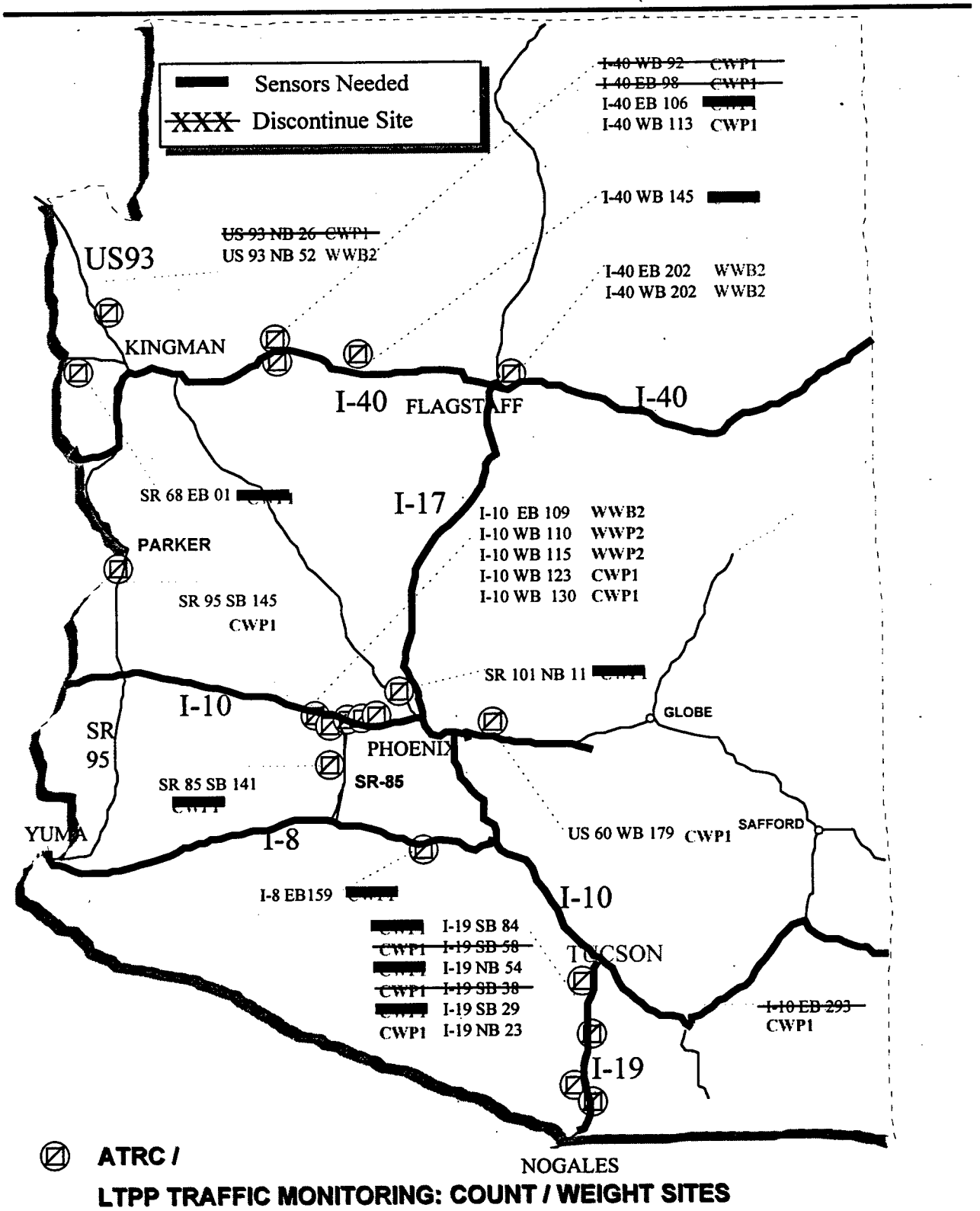

Figure 2 Status of Arizona LTPP Traffic Data Collection Sites as of June, 1996

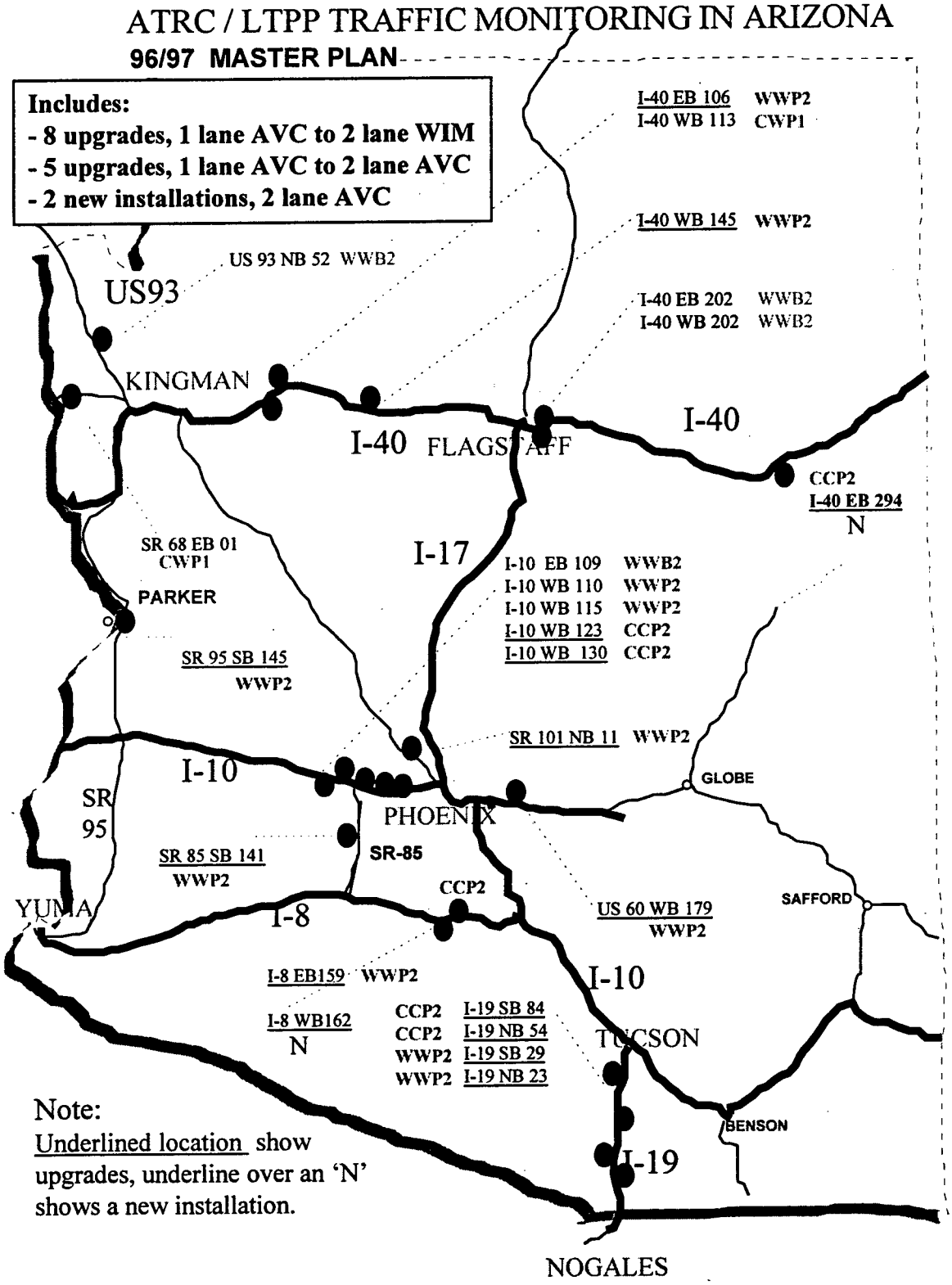

Figure 3 A Master Plan for Rehabilitation and Upgrade of Arizona's LTPP Traffic Data Collection Sites: 1996/97

Table 2 Data Availability for Permanent Systems: 1993-1996

YEAR / MONTH

	9306	9307	9308	9309	9310	9311	9312	9401	9402	9403	9404	9405	9406	9407	9408	9409	9410	9411	9412	9501	9502	9503	9504	9505	9506	9507	9508	9509	9510	9511	9512	9601	9602	9603	9604	9605	9606
I-10 EB 108											x	x	x	x	x	x													x	x	x	x	x	x	x	
I-10 EB 292				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x						x		x		x	x		x	
I-10 WB 110																										x	x	x	x	x	x	x	x	x		x	x
I-10 WB 115		x	x	x	x	x							x	x		x	x	x								x	x	x	x	x	x	x	x	x	x	x	x
I-10 WB 123		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
I-10 WB 130		x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
I-19 NB 023		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
I-19 NB 054		x		x									x	x		x	x	x	x		x	x		x	x	x	x	x			x			x	x	x	
I-19 SB 029		x	x	x	x	x	x	x	x	x	x	x	x	x																							
I-19 SB 038		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
I-19 SB 058		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x		x	x	x	x	x
I-19 SB 084		x	x		x	x	x	x		x	x		x	x		x	x	x	x		x																
I-40 EB 098				x	x	x		x	x	x	x	x																									
I-40 EB 106		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x	x	x	x		x	
I-40 EB 202		x	x	x	x	x	x	x	x	x		x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
I-40 WB 092		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x			x	x	x															
I-40 WB 113			x	x	x	x	x	x	x	x	x	x	x	x	x	x				x	x	x	x	x		x	x	x	x	x	x		x	x	x	x	x
I-40 WB 145			x	x								x	x	x	x	x	x			x	x	x	x	x													
I-40 WB 202		x	x	x	x	x	x	x	x	x		x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
I-8 EB 159		x	x	x	x	x	x	x	x	x						x	x	x	x	x	x	x															
SR-417 NB 011		x	x	x	x	x	x			x	x	x	x			x	x	x		x	x	x	x	x	x												
SR-68 EB 001		x	x		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
SR-85 SB 141		x	x														x	x		x	x						x	x					x	x		x	x
SR-95 SB 145		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
US-60 WB 179		x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x	x	x	x	x	
US-93 NB 026				x	x	x	x					x	x																								
US-93 NB 052									x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Notes: Data available for months indicated with 'x'.

Table 3 WIM Data Availability Using Portable WIM Units for the Period 1993 to 1996

YEAR/MONTH

SITE	9301	9302	9303	9304	9305	9306	9307	9308	9309	9310	9311	9312	9401	9402	9403	9404	9405	9406	9407	9408	9409	9410	9411	9412	9501	9502	9503	9504	9505	9506	9507	9508	9509	9510	9511	9512	9601	9602	9603	9604	9605	9606	9607
I-10 EB 292															x	x						x	x																				
I-10 WB 115																																											
I-10 WB 123											x	x	x	x	x																x	x	x			x	x						
I-10 WB 130																						x			x	x	x	x	x	x													
I-19 NB 023						x									x	x							x	x	x											x	x	x	x	x	x	x	x
I-19 NB 054		x				x																x																					
I-19 SB 029																																											
I-19 SB 038												x									x								x	x	x												
I-19 SB 058				x																x																							
I-19 SB 084				x							x																																
I-40 EB 098										x																																	
I-40 EB 106				x						x								x	x																								
I-40 WB 092																				x																							
I-40 WB 113																	x		x																	x			x	x			
I-40 WB 145																																											
I-8 EB 159																	x											x															
SR-417 NB 011										x		x	x	x	x																												
SR-68 EB 001															x	x																											
SR-85 SB 141						x																																	x	x				
SR-95 SB 145																	x												x	x										x	x	x
US-60 WB 179											x	x									x								x	x										x	x	x
US-93 NB 026																																											

Note: Data available where checked with 'x'

DATA COLLECTION PROCEDURES

There are two procedures that can be used to interrogate and retrieve data from the classification and weight sites, depending on whether or not the sites are equipped for remote communication.

1. Direct connection to the system hardware by portable computer: The system hardware includes a 25-pin port for data retrieval. The necessary data collection software (the main program for this package is named CC200) should be loaded on the portable computer prior to use at the site. The connection cable (9 pin female to the computer side and 25-pin male to the data collection system hardware) is not standard cable. Standard cable will not work with the PAT systems. A schematic of the pin connections is available for use in making /ordering these cables.

   Having connected the computer to the system, the software is run on the computer to establish a communication link with the data collection system. In addition to data down-load, a host of other parameter checks and changes can be made as necessary while the computer is connected to the system. Details on the use of this software and the possible manipulations are contained in the respective manuals, which are listed in the references (in particular #2, #4, and #5).

2. Remote data downloading via modem: Another way that data collection can be accomplished is by the use of communication modems. One modem is attached to the office computer and the other to the data collection system, the two are set properly for communication so that the office computer can be linked to the individual data collection units. By so doing, the different functions that were performed through a direct connection at the site can be performed from the office computer. In addition to the capability to call the site and proceed to down load data from the units, it is also possible to set the software for unattended operation at preset times. At the preset time(s), the system will call the sites in the order in which the lists are maintained. Three attempts are made to connect to each of the sites and retrieve data from the units. If successful, all data in the units that has not been retrieved before is downloaded. Unattended operation is useful for data download at night when phone rates are low, and for time consuming downloads that would otherwise tie down the computer during the day when it is needed for 'normal' use.

Issues and Problems of Data Collection Without Remote Capability

Data communication modems were not part of the Arizona LTPP data collection system until towards the end of 1994, except for three sites where modems were installed three to nine months earlier. At this time the data collection effort involved someone driving around the state at least once a month to visit each of these sites. While at the site they would download all data into a laptop computer. At the office the data is transferred to the office computer with the use of software especially developed for such applications ('Laplink' software is one such communications package). Visiting sites each month was not only time consuming it was also deficient for some of the weight sites. At one of the

sites in particular, the system has storage capacity for only a little more than 2 Megabytes of data while the size of daily files a this site is about 500 Kbytes. Thus only 4-5 days of data can be held at the site before it starts to erase 'old' datafiles to make space for newer files. To avoid losing data at this site one would need to visit the site with regularity at least six times a month! No doubt much data was lost as the site was visited only once or twice a month.

Data Collection with Remote Cellular Capability

Because many of LTPP traffic data sites are located in remote areas on the interstate freeways, installation of regular telephone lines would be costly and difficult. Cellular telephone lines are therefore used at all sites in conjunction with high quality modems capable of reliable cellular communication. Like the data collection systems, the modems are powered off of 12 Volt rechargeable batteries connected to solar panels.

III. HARDWARE AND DATA PROCESSING SOFTWARE FOR WIM & AVC

WIM AND AVC CONFIGURATIONS AND HARDWARE

Only two equipment manufacturers have so far supplied traffic monitoring equipment for the LTPP project in Arizona. These are International Road Dynamics (IRD) of Saskatoon - Canada, and PAT Traffic Control Corporation (PAT) of Chambersburg, PA. IRD installed a two-lane bending plate WIM system on Interstate 10 EB 108 towards the end of 1993 and a two lane piezo cable WIM system at KM 29 SB of Interstate 19 in 1996. PAT installed the rest of the systems on the remaining 26 sites (as of 1996), most of them in a combined installation project in October/November of 1992. As mentioned in the preceding chapter, Arizona's LTPP classification sites were installed with the capability to collect weight data when a portable hardware module was attached. For the initial 3- 1/2 years of the program, three portable modules were moved around 22 classification sites for short term weight data collection at these sites. Long term plans call for the increase of permanent weigh-in-motion sites, the elimination of some of the classification sites, and the establishment of some 'classification only' sites. Table 4 summarizes the type of monitoring equipment at LTPP sites. Figure 4 and Figure 5 illustrate the possible AVC and WIM sensor and loop configurations.

Table 4 Summary of Traffic Monitoring Equipment at WIM/AVC Sites (1997)

Manufacturer	Capability	Model	Sensors	No. of Sites	Remarks
PAT	WIM	DAW200	Bending Plate	2	Single 4 lane system considered 2-sites by direction of travel
IRD	WIM	--	Bending Plate	1	2 lane system
IRD	WIM	--	Piezo Cable	1	2 lane system (12/96)
PAT	WIM	DAW100	Bending Plate	1	2-lane system
PAT	WIM	DAW100	Piezo Cable	9	2 lane systems

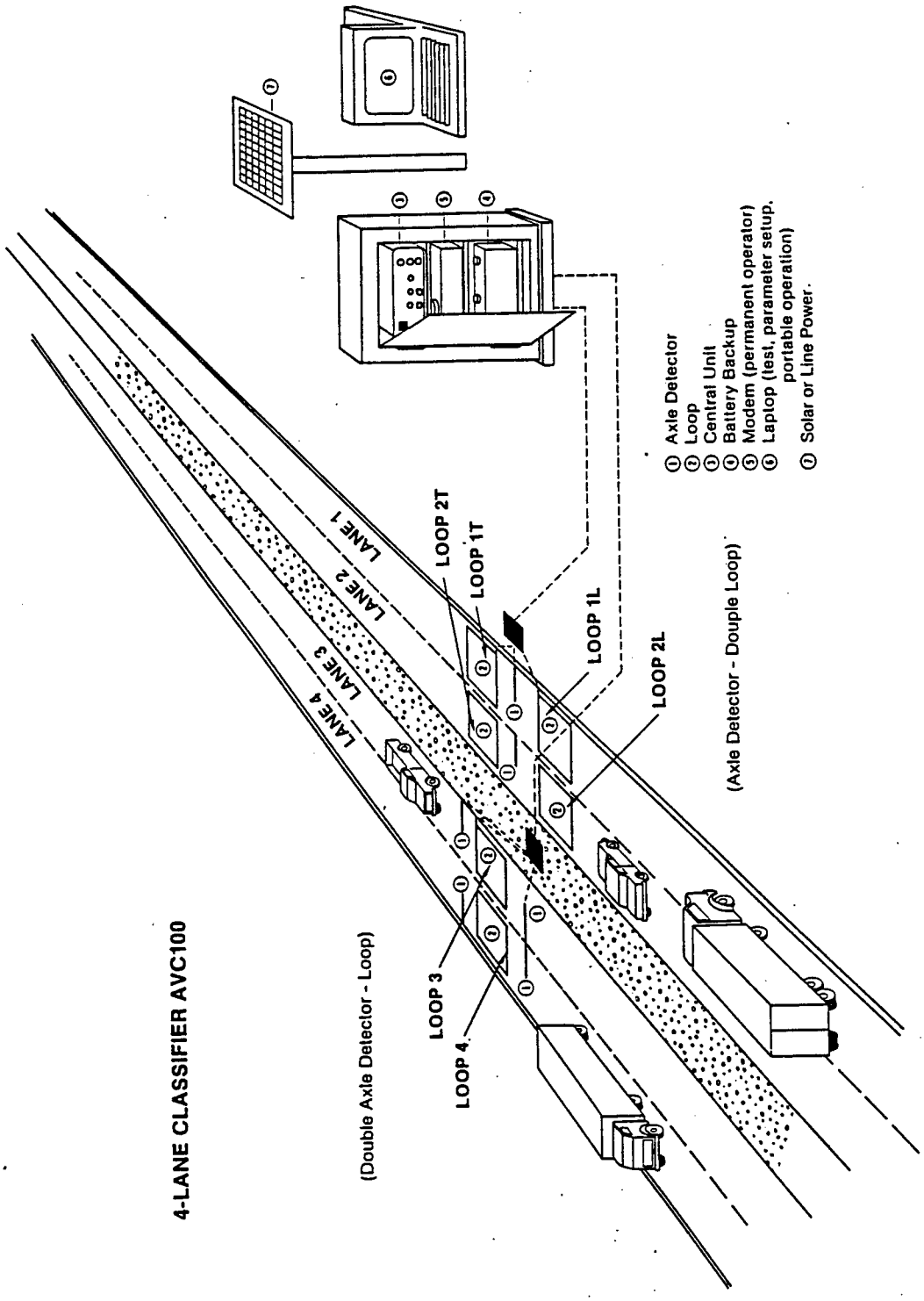

Figure 4 Typical AVC Axle Detector and Loop Configurations

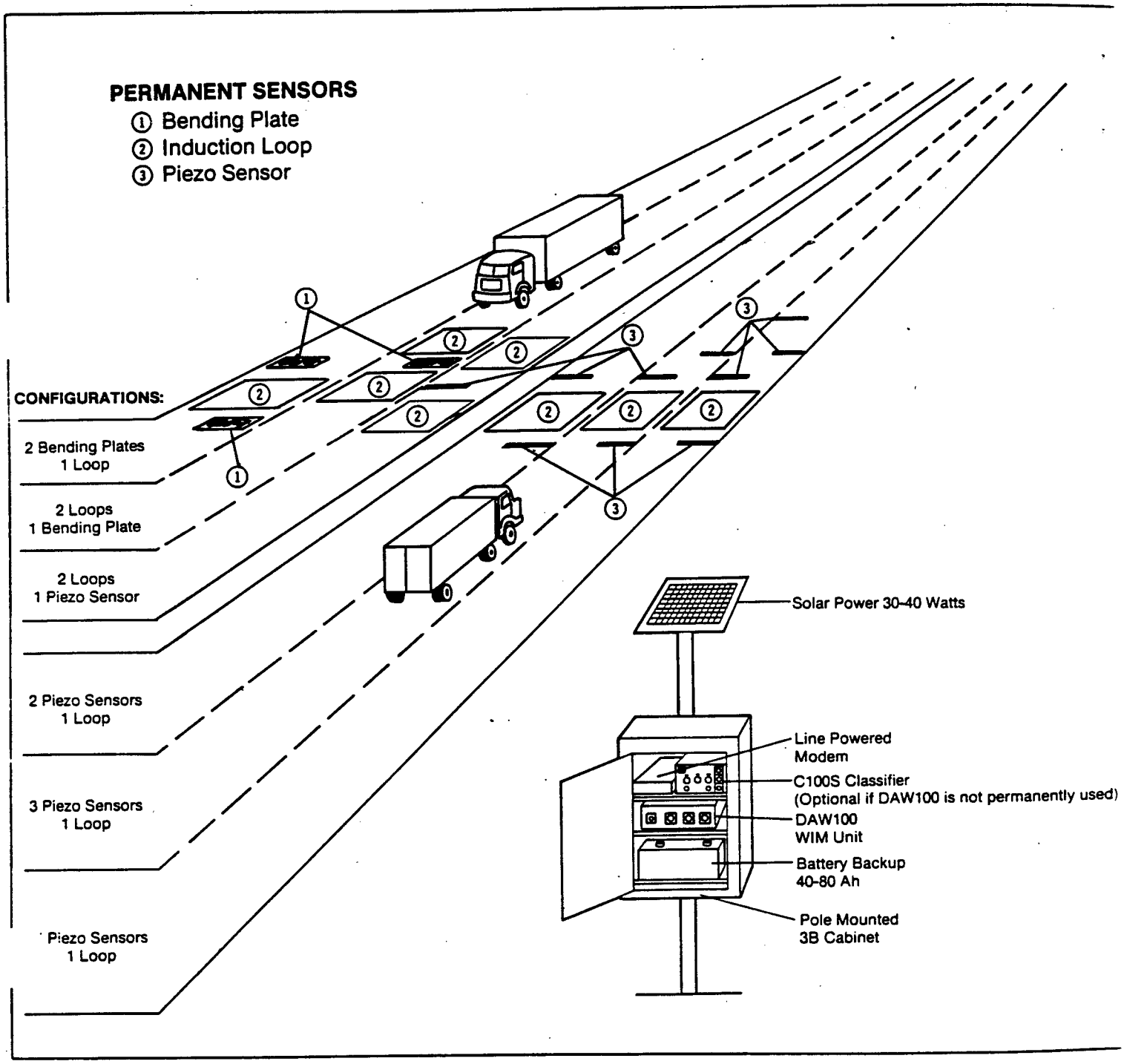

Figure 5 Typical WIM Axle Detector and Loop Configurations

Trends in Traffic Monitoring Technology

An inspection of the 1996 draft of 'Traffic Detection Technologies' compiled by the Federal Highway Administration (FHWA) shows that the industry is growing and that more devices are becoming available for both WIM and classification applications. While this compilation is by no means exhaustive, it clearly paints a picture of an industry on the move. Some of the main players in the industry have ten, twenty or even more years of involvement. Others are new comers with only a few years of serious participation. Research organizations are working hard to overcome existing deficiencies in traffic monitoring technologies by improving on these or developing new technologies that may eventually replace the existing ones.

Presentations at the 1996 - National Traffic Data Acquisition Conference in Albuquerque, New Mexico included a session on sensors that featured the following topics;

- Polymer Axle Sensors
- Ceramic Traffic Sensors
- Quartz WIM Sensors
- Geophones for Traffic Monitoring
- Micro-bend Fiber Optic Traffic Sensors

The first two, Ceramic and Polymer sensors are currently available commercially and have been for sometime now. The last three, quartz, geophones, and fiber optic sensors are either still in experimental stage or just entering the marked at this time. Some of these, like the quartz WIM sensors in particular, appear to hold the possibility of very good weight calibration characteristics. This would seem to suggest that the future of WIM may be in very good hands.

DATA PROCESSING SOFTWARE FOR WIM AND AVC

The two equipment manufacturers that have supplied traffic data collection equipment to ADOT's LTPP program (PAT Traffic Control Corporation [PAT] and International Road Dynamics [IRD]) supply custom software for processing data from their respective systems. In each case the raw data is in binary format, thus it needs to be processed before the data can be viewed. The final results of the data processing are similar in some ways and different in others. Each of the two systems generates a number of basic tables relating to vehicle counts, classification, speed, axle weights, and axle spacing as applicable. Each can also generate ASCII truck files with detail

information on individual trucks (classes 4 to 13 as per FHWA scheme) weighed at the sites, and TMG format ASCII files for vehicle volume, classification, and weight. The formats of these tables and ASCII files will be elaborated in subsequent sections of the report where the two systems are presented. As indicated earlier, PAT systems are installed in all but two of the sites in this program. This presentation will thus emphasize data processing for the PAT systems while noting the significant differences with IRD system software. Table 5 lists the different summaries that can be generated using PAT's software package 'REPORTER'. An intermediate processing stage is involved in which the raw files are first split into classification and weight files prior to the generation of the summary tables.

Table 5 Tables Generated by REPORTER Software

Classification/Speed Summary Reports Menu	1. Distribution of vehicle classification by hour of day
	2. Distribution of speeds by vehicle classification
	3. Distribution of vehicle speeds by hour of the day
	4. Distribution of vehicle counts by lane.
Weight Summary Reports Menu	1. Weight violations and invalid measurements
	2. Weight violations by hour of the days for truck classes
	3. Overweight vehicles by hour of the day for truck classes
	4. Distribution of gross weights for truck classes
	5. Distribution of truck volumes by class by lane
	6. Distribution of 18-KIP ESALS by class by hour

The first four tables (classification/speed summary reports) are available for both classification and weight sites, while the second set of tables (weight summary reports) are only available for weight sites. Before the software can be used to generate these tables, two files are needed that feed the software with necessary information to accomplish the task. These files (see Table 6 and Table 7 on the next pages) are normally supplied with the software but have to be customized to provide site specific information and the types of tables sought to be generated. Any number of files for different sites can be processed as a batch, provided that they are located in the same directory and the same type of system or equipment model was used in collecting the data. The software command for processing the data specifies the equipment model, thus data from different systems can not be processed in one batch. The IRD system requires only one such file for the generation of the FHWA TMG files. However, with IRD software, individual sites are described in a specific software routine, with data processing preceded by the

selection of an individual site to be processed. A newer version of PAT's software generates two additional tables.

Table 6 PAT's System File "Restat.lst" for Individual Site Data

```
12345678911234567892123456789312345678941234567895123456789612345678971234567898123456789912345678901234
YN ST FC SIT STN ID ROUTE  CNTY HPMS-----INFO YR TYPE AADT  NO LANES DIRECT-- ESAL LOCATION--------
N  04 01 002 046053 100010 019          93 1422 017000 1 CXXXXX  3 300000 F 05  I-10 MP292.9 EB
N  04 01 003 041018 100019 019          93 1422 012000 1 CXXXXX  5 500000 F 05  I-19 KM58.8 SB
N  04 01 004 041016 100019 023          93 1422 012000 1 CXXXXX  5 500000 F 05  I-19 KM38 SB
N  04 01 005 041015 100019 023          93 1422 013000 1 CXXXXX  5 500000 F 05  I-19 KM29.6 SB
N  04 01 006 046060 100019 023          93 1422 011000 1 CXXXXX  1 100000 F 05  I-19 KM23.9 NB
N  04 01 007 041017 100019 019          93 1422 012000 1 CXXXXX  1 100000 F 05  I-19 KM54.7 NB
N  04 01 008 046054 100019 019          93 1422 017000 1 CXXXXX  5 500000 F 05  I-19 KM84.3 SB
N  04 01 009 045000 100008 021          93 1422 003300 1 CXXXXX  3 300000 F 05  I-8 MP159.5EB
N  04 02 010 046055 300085 013          93 1422 006700 1 CXXXXX  5 500000 F 05  SR-85 MP141.9 SB
N  04 02 013 041034 300095 012          93 1422 010000 1 CXXXXX  5 500000 F 05  SR-95 MP145.1 SB
N  04 01 014 041036 200093 015          93 1422 006200 1 CXXXXX  1 100000 F 05  US-93 MP26.5 NB
N  04 02 015 041037 300068 015          93 1422 029000 1 CXXXXX  3 300000 F 05  SR-68 MP1.3 EB
N  04 01 016 041062 100040 015          93 1422 010000 1 CXXXXX  7 700000 F 05  I-40 MP92.9 WB
N  04 01 017 041065 100040 025          93 1422 009200 1 CXXXXX  3 300000 F 05  I-40 MP98.1 EB
N  04 01 018 041024 100040 025          93 1422 009100 1 CXXXXX  3 300000 F 05  I-40 MP106.8 EB
N  04 01 019 041025 100040 025          93 1422 008700 1 CXXXXX  7 700000 F 05  I-40 MP113.2 WB
N  04 01 020 041002 100040 025          93 1422 011000 1 CXXXXX  7 700000 F 05  I-40 MP145.5 WB
N  04 12 021 047079 300417 013          93 1422 000000 1 CXXXXX  1 100000 R 09  SR-417 MP11.9 NB
N  04 01 022 047614 100010 013          93 1422 043000 1 CXXXXX  7 700000 R 09  I-10 MP130.4 WB
N  04 01 023 041001 100010 013          93 1422 023000 1 CXXXXX  7 700000 F 05  I-10 MP123.4 WB
N  04 12 024 047613 200060 013          93 1422 125000 1 CXXXXX  7 700000 R 09  US-60 MP179 WB
```

Steps Prior to Data Processing for the PAT System

Before using the system files for data processing relevant entries need to be inserted. First, edit the file "restat.lst" (Table 6) that comes with the software package, inserting one row for every PAT site that is installed. For information on the necessary entries for this file refer to pages 3-6 of reference #3. Each one of the entries for this file must be entered in the file correctly to ensure that subsequent use of this file draws from valid values. When tables, and some special files like the Traffic Monitoring Guide (TMG) reports are generated, this file is used to supply the software with key information about the sites, which is in turn included in the tables and reports. As many as fifty lines representing fifty individual sites can be included in "restat.lst". This file resides on the same directory from which the main program file "reporter.exe" is launched. The IRD system calls for the use of a file to be named 'FHWA.xyz', used for generating TMG reports - where xyz is a three letter code for that site. Otherwise basic information about sites is entered in this system during an installation procedure that is necessary for each site before a site's data can be processed by the system. The three letter code for the site that was mentioned above with regard to the "fhwa.xyz" file must be the same as the code that is used during this installation procedure. The IRD system requires that each site

have a separate file for this purpose with the appropriate extension. Details are presented in section 8, pages 12-16 of reference #6.

Second, edit the file "retables.lst" (Table 7) that comes with the software package. Change the directory that will hold the data files (and consequently the generated files), and checking 'yes' or 'no' for each table listed to indicate whether or not the table is to be generated when automatic report generation is requested. Prior to each data processing session this file needs to be updated if a different set of tables is desired. Refer to page 6-7 of reference #3 for additional details.

Table 7 PAT's System File "Retables.lst" for Automatic Table Generation

```
12345678911234567892123456789312345678941234567895123456789612345678971234567 89
DEFAULT  DATA SUBDIRECTORY : C:\PAT\DATA
        TABLE NO.           DESCRIPTION
y            1               DIST. OF CLASSIFICATION BY HOUR OF DAY
y            2               DIST. OF SPEEDS BY CLASSIFICATION
y            3               DIST. OF SPEED BY HOUR OF DAY
y            4               DIST. OF VOLUME BY LANE
y            5               DIST. OF CLASSIFICATION AND SPEEDS BY LANE
y            6               WT. VIOLATIONS FOR CLASSES 4-15
y            7               WT. VIOLATIONS BY HOUR OF DAY
y            8               OVERWEIGHT VEHICLES BY HOUR OF DAY
y            9               GROSS WEIGHTS FOR CLASSES 4-15
y           10               18-KIP  ESAL  REPORT
y           11               DIST. OF TRUCK COUNTS BY CLASS BY LANE
y           12               1995 TMG METRIC FILE FORMATS
```

Place all data files to be processed in the data directory specified in file 'retables.lst'. In this case the data directory is "PAT\DATA" whereas the main directory, on which the execution program and system files reside is "C:\PAT". Because data files collected by different equipment systems do not necessarily have the same data format, the software treats them differently. Data for different sites can be combined only when the equipment models at the sites are the same. At the moment, Arizona has three different data collection systems from PAT, that is the AVC100, the DAW100, and the DAW200. Depending on which one of these is to be processed, the data for those sites with identical systems is placed in the data directory. Data files start with the letter 'd', while the first stage of data processing generates files with the letter 'b' (for AVC data) or two files with the letters 'c' and 'w' (for WIM data) depending on whether classification of weight files are involved. One needs to avoid having any other files in this directory that start with these four letters because the software will interpret these as either raw data files or processed data files, which may cause the process to be aborted when the software fails to handle those files. A good data organization structure will make the task much easier while preventing accidental data losses. In the structure shown in Table 8, the directory DAPP is where all incoming data is placed. Files to be processed are copied to the directory DATA, which summary files and others produced during processing are kept in the directory DATT. As long as no deletion of files in the directory DAPP is done, all files from sites will stay intact. Once the data is no longer current and all essential

summaries have been tabulated, these files can be transferred to storage media for safe keeping. A sample of each of the ten tables is included in Appendix A.

Table 8 Data Organization Structure: Files & Directories

```
Volume Serial Number is 1F6F-5AFA

 Directory of C:\PAT

REPORTER EXE       161,760 01-18-94   3:54p
AVC      LST         3,012 06-08-95   3:28p
RESTAT   LST         3,547 11-22-95   5:28p
RETABLES LST           783 03-27-96  11:23a
WIM      LST         3,547 11-22-95   5:28p
RESTAT   NEW         6,811 08-22-94  11:41a
RETABLES NEW           903 07-17-96  10:13a
DIR696   XLS        28,160 07-03-96   7:41a
.             <DIR>          10-04-95  12:53p
..            <DIR>          10-04-95  12:53p
AU6           <DIR>          07-29-96   1:38p
DAPP          <DIR>          06-20-96   7:05a
DATA          <DIR>          07-29-96   1:38p
DATT          <DIR>          07-09-96   3:13p
JN6           <DIR>          06-04-96   7:09a
17 file(s)        208,523 bytes
                  251,772,928 bytes free
```

Running the Data Processing Program [REPORTER.EXE]

To distinguish between data files originating from different systems, the command to execute the data processing program is of the form: 'REPORTER A M', where A is a single digit number for the system and M signifies that the generation of monthly summaries is sought. When M is omitted, the default monthly report mode is OFF. The value of "A" entered determines which program section is executed in accordance with the respective data collection system. The program expects values of A as follows;

- AVC100 system data >> [1]
- DAW200 system data >> [2]
- DAW400 system data >> [4]
- DAW100 system data >> [5]

Before any tables can be generated, the original files are processed into classification and weight record files. The menu for doing this is presented on the screen following program execution. During this process the original file(s) are split into classification and weight summary files, in the case of WIM data (DAW100 and DAW200 in Arizona). A new table just added to the new version of the software, distribution of vehicle classification and speed by lane, should also prove quite useful. The following reports are routinely generated for the compilation of summaries used for in-house data evaluation and validation as well as for the maintenance of an in-house database for classification and weight data. Other tables are generated only as needed in data checks.

- Distribution of classification by hour of the day
- Distribution of Volume by lane
- Weight violations for classes 4-15
- Gross Weights for classes 4-15
- 18-KIP ESALS Report.

In order to provide extra storage space for vehicle classification data at classification sites, the collection of speed statistics at these sites was omitted for most of the data collection period. This is not the case with upgraded or newer classification units that come with more storage capacity. The sites are capable of collecting hourly classification statistics for a period of 35 days when speed statistics is not included. Beyond this period the sites will then start to erase old data files. WIM sites collect classification statistics for all vehicles in addition to individual truck weight, axle spacing, and other detail.

Two PAT-WIM systems exist in Arizona's LTPP Traffic data collection Program. As late as 1996, permanent DAW100 equipment was installed at 3 sites while DAW200 units are installed at 2 sites (actually a single 4-lane system split into two sites by traffic direction). In addition 3 portable DAW100 units were used at the classification sites to collect short term weight data. In any one month therefore, as many as 6 sites could have DAW100's in place while 2 had the DAW200. Seven additional DAW100 units are currently in place after a 96/97 upgrade effort. Data processing for the DAW100 files can be accomplished as one batch. However, when the files for these sites are compiled at the same time (upto 6 sites), the tables generated are placed in a single file. This file may become quite big depending on the truck volume at those routes and the total number of days of data involved. Noting that this file is subsequently manipulated for instance with a spreadsheet to extract monthly summaries, it is important to keep the file to a manageable size. Current practice has thus been to handle data processing, one WIM site at a time.

Step by Step Procedure for Generating Summary Data Tables

1. Execute the program from the directory it is in, [PAT\>]

```
1.  FILE HANDLING UTILITIES
2.  CLASS/SPEED SUMMARY REPORTS MENU
4.  AUTOMATIC REPORT PROCESSING
5.  SET/CHANGE DATA PATH
6.  GENERATE MONTHLY REPORT
        X.  QUIT
            ENTER A SELECTION CODE :
```

2. Select: File Handling Utilities, option number 1

```
FILE HANDLING UTILITIES
      1.  GENERATE STATISTICAL AND TRUCK RECORD FILE[S]
      2.  GENERATE ASCII TRUCK FILE[S]
      3.  GENERATE ASCII CLASSIFICATION RECORD FILE[S]
      4.  GENERATE TRUCK RECORD BATCH PRINT
      5.  GENERATE TMG FORMAT OUTPUT FILE[S]
      6.  GENERATE ASCII SPEED BY LANE FILE[S]
      X.  RETURN TO PREVIOUS MENU

            ENTER A SELECTION CODE :
```

3. Select Option #1: Generate Statistical and truck Record File(s)
4. Respond to the subsequent prompts to have the program generate the appropriate files

```
      Volume in drive C is E_KOMBE
      Volume Serial Number is 1F6F-5AFA
      Directory of C:\PAT\DATA2

C5250410.98   C5250411.98   C5250412.98   C5250413.98   C5250414.98
C5250415.98   C5250416.98   C5250417.98   C5250418.98   C5250419.98
C5250420.98   D5250410.98   D5250411.98   D5250412.98   D5250413.98
D5250414.98   D5250415.98   D5250416.98   D5250417.98   D5250418.98
D5250419.98   D5250420.98   W5250410.98   W5250411.98   W5250412.98
W5250413.98   W5250414.98   W5250415.98   W5250416.98   W5250417.98
W5250418.98   W5250419.98   W5250420.98
       35 file(s)      2,036,224 bytes
                      39,354,368 bytes free
```

5. Ensure that tables to be generated are selected in the "retables.lst" file. If necessary edit the file from DOS to select only those tables that are needed for the different systems to be processed. Tables that are not available for a particular system can remain selected with no ill consequences for the process as the system will ignore any such selections.

```
12345678911234567892123456789312345678941234567895123456789612345678971234567
DEFAULT  DATA SUBDIRECTORY : c:\pat\datt\
         TABLE NO.           DESCRIPTION
y           1                DIST. OF CLASSIFICATION BY HOUR OF DAY
N           2                DIST. OF SPEEDS BY CLASSIFICATION
N           3                DIST. OF SPEED BY HOUR OF DAY
y           4                DIST. OF VOLUME BY LANE
y           5                WT. VIOLATIONS FOR CLASSES 4-15
n           6                WT. VIOLATIONS BY HOUR OF DAY
n           7                OVERWEIGHT VEHICLES BY HOUR OF DAY
y           8                GROSS WEIGHTS FOR CLASSES 4-15
y           9                18-KIP  ESAL  REPORT
n          10                DIST. OF TRUCK COUNTS BY CLASS BY LANE
```

6. Go (back) to the main menu and select: Automatic Report Processing, [option number 4 on the menu]. A number of prompts will appear for specifying such things as the files to be processed, lanes to process, output device (to screen, printer, or file), and filename if applicable. After all these queries have been answered, the program will start the generation of tables. When completed problem free, the menu will be displayed. At this point one is ready to do something else or quit the program.

The initial program execution command "***reporter A M***" described earlier should always be executed with the M at the end of the command line to indicate that monthly summary updates are sought during the generation of tables. If the M is omitted, these summaries will not be generated/updated. Samples of different tables generated by the software are shown in appendix A and a sample of monthly count and weight summaries is included in appendix B. The tables generated at this stage are on an hourly basis with daily summaries at the end of each 24-hour period. Additional manipulation is necessary with the aid of other applications to condense these tables into more usable weekly or monthly figures.

When generating summary tables for the IRD system, all parameters are set from within the program menus themselves prior to the request to generate the tables. As mentioned earlier, this system handles data processing one site at a time. The specification of the site is part of the necessary program input preceding the generation of the tables. When the tables are generated under this system, they are by default placed in special pre-defined system files. When this process is completed, and before another report is generated, these files can be 'transferred' into a user defined file by selecting the transfer option from the menu.

Traffic Monitoring Guide (TMG) Files for SHRP

The Federal Highway Administration (FHWA) through the Strategic Highway Research Program (SHRP) compiles a national LTPP database. Data submitted to SHRP for this

program needs to be in TMG format with standardized file names. To generate TMG files for AVC data, the original data files as down loaded from the sites can be used. Run the program for AVC100 (reporter 1 M), and select option number 1 followed by option number 5. Three types of files are generated for each day of data for each site that have file names which start with the numerals 2, 3, and 4. The first set of files with the '2' are station identification files. Since station descriptions would normally be forwarded as hard copy on standard forms designed for this purpose, these files are discarded. The second set of files with a '3' are traffic volume files, while the last set of files consists of vehicle classification information. Each set of files for a site for any one month (card 3 - volume and card 4 - classification files) can be combined into a single file and named appropriately for submission to SHRP. For information on data collection guide and file name structure, see reference #10, in particular pages 4.37 to 4.49.

For DAW100 and DAW200 data, TMG files can only be generated after splitting the original data into classification and weight files. Run the program for DAW100 or DAW200 as the case may be, then select option number 1 on the main menu, followed by option number 1 on the following menu, to generate statistical and truck weight record files. If this has already been done while compiling summary reports and these files are still in the data directory, skip this step and proceed to the next one. When the second menu reappears after generating the 'C' and 'W' files, select option 5 for TMG format output files. Four types of files are generated for each of the original data files (i.e. per day per site). In addition to the site description, traffic volume, and vehicle classification files ('2', '3', and '4') described for AVC data, a weight file is also generated. The weight files (referred to as 7-card files) are assigned names starting with '7'. Again, the station description files are discarded. The other files are combined for the month and named accordingly. The best way to combine and rename the files at the same time is to construct the filenames for the monthly data files and use a batch program to combine the files for each site into the appropriate new files as in the following examples;

- copy 3SITMO??.96 to V_NewFileName
- copy 4SITMO??.96 to C_NewFileName
- copy 7SITMO??.96 to W_NewFileName

  where:

  SIT = three character site code for the site as used in file 'restat.lst'

  MO = two digits for the month (July = 07)

  V/C/W-NewFileName = the appropriate filenames for the combined volume, classification, or weight data files according to reference #10 as cited earlier.

If one is doing this simultaneously for multiple sites, include the corresponding three lines in the batch file for each of those sites. As an example, the command line copy 3SITMO??.96 'to' V_NewFileName will copy all files in the directory that have "3" as the first character in the filename, the three site specific characters "SIT", and the month in question "MO" to the new file specified. The new filename starts with the character

"V" and has nine more characters which conform to set guidelines for SHRP site description, state, start date of data, month of data, and year of data.

Separating 4-lane data into 2-lane summaries by traffic direction

The DAW200 summaries for the 4-lane site are generated separately so that one can distinguish between the two traffic directions. Lanes are numbered Outer East-bound to Outer West-bound. Thus lanes 1 and 2 are Eastbound traffic lanes while lanes 3 and 4 are Westbound traffic lanes. The generation of statistical and truck weight record files proceeds without regard to traffic direction. Procedures following this one are the ones that require separating the two directions. When generating summary tables/reports select to process first lanes 1 and 2, after which you repeat the procedure to process lanes 3 and 4. The same procedure can be used where two lanes are equipped, with one lane in each direction of travel, to generate summaries by direction. When generating the TMG files, one need not separate the files by direction since truck records include lane number in the detail. Software that is used by SHRP in processing these files will identify and summarize data by lane and direction accordingly.

IV. DATA EVALUATION AND PRELIMINARY VALIDATION PROCEDURES

MAJOR STEPS IN DATA EVALUATION

The following list describes the major steps in data evaluation for both Classification and WIM data. The original files retrieved from the data collection systems comprise daily files in an unreadable (non-ASCII) format. These files must undergo some form of processing before they are of any use to someone in the office.

1. Convert daily data files into classification ('b') files for AVC data, classification and weight files ('c' and 'w') for WIM data.

2. Generate summary tables as applicable for the system in question. The different types of tables available for AVC and WIM data were presented in the previous section. The users manual for the REPORTER program covers these options. As long as one is dealing with the same data collection equipment, multiple sites can be processed simultaneously. The only requirement is that each of the sites be included in the file "restat.lst" which is used by the program for site specific information. Each line in the file contains site specific information the details of which are described in the manual.

3. Combine classification data from AVC and WIM equipment into a single file, preferably on a spreadsheet (Microsoft Excel is currently used for this). This file is convenient for performing initial data checks to try spot any irregularities in the data. In particular, the percentage of daily class 1 for each site is inspected as is the percentage of unclassified vehicles. The other class percentages are compared to the characteristic figures in previous months to see any major shifts that may signal possible errors in classification thus calling for further scrutiny of the data and maybe a site visit for further verification. Appendix D shows count trends by site.

4. Make necessary adjustments to classification data from step number 3) above for purposes of exporting this data to a vehicle count/ classification table in a database. For the most part the adjustments needed here are additions of columns for the site number, the year and month of the data, and the day of the data (Mon[1] - Sun[7]). The first two plus the date of the data which is already part of the classification data constitute the unique identifier for the day's data in the database.

5. Generate lane distribution figures for multiple lane sites using the Excel spreadsheet and a macro written for this purpose. The macro locates the lane summary figures in the table and accumulates these figures for the monthly totals for each lane.

6. Manipulate WIM summaries using a spreadsheet to create monthly data for gross weight distribution by vehicle class, monthly ESALS by vehicle class, and weight violations by vehicle class. Excel macros have been written to automate this process. An inspection of the monthly summaries generated in this step is a useful way of identifying obvious weight calibration problems, or problem WIM sites. These summaries are then modified for export into the database. Appendix E shows site ESAL trends by month for the period 1993-96 for a few sites while Appendix F compares ESAL values over a 4-month period with available estimates at the time.

7. Generate other useful charts and summaries for Microsoft Excel and Microsoft Access database for vehicle counts and classifications, gross weights, ESALS, and weight violations. A set of these charts and summaries is already established in these two applications. As the need arises, new ones will be developed to show other patterns that are deemed useful.

8. Generate TMG-format datafiles for classification and WIM data for transmission to SHRP. The files are generated from the set of files following the first data conversion, which are 'b' files for AVC data, or 'c' and 'w' files for WIM data. Having obtained the TMG files, they are combined into monthly files by site and named according to a naming procedure developed by SHRP and spelled out in its "Data Collection guide for LTPP Studies" reference number 10.

9. Perform other procedures for such patterns as month by month data trends, long term ratios etc. Compare observed patterns for prior periods to current month's data and determine if any major discrepancies exist. Among the trends monitored are total counts and percent of totals by classification. Others are total ESALS and class 9 truck ESALS.

The conversion of the original data files into classification and weight files (step 1) and the generation of summary tables (step 2) was covered in the chapter on data processing software. System files for the reporter software need to be set-up correctly to identify where data is located, what tables are to be generated, what the individual sites are with respect to the data files, and site specific detail such as traffic lanes and direction, location etc.

The process of generating summary tables for the month creates classification files for each site for each month. These files are of the form "**mc**sitmo.yr", as shown in Table 9. The first two characters in the filename are always 'mc'. The rest of the characters in the file name (with number of characters in brackets) represent the site number(3), month(2), and year(2). To obtain a classification file for all sites for the month, these individual files are combined. To satisfy the requirements of the database, additional fields are needed for the site number, the year and month, and the day of data (Mon-Sun). These fields are added to the files prior to combining them (step 3 above).

Table 9 Monthly Classification Summary Files

```
C:\PAT\DATT>dir mc*.*

 Volume in drive C is E_KOMBE
 Volume Serial Number is 1F6F-5AFA
 Directory of C:\PAT\DATT

MC01010   96          3,627 11-07-96   5:05p
MC01310   96          3,627 11-07-96   5:05p
MC01810   96          2,457 11-07-96   5:04p
MC02210   96          3,627 11-07-96   5:05p
MC02310   96          2,925 11-07-96   5:05p
MC02410   96          3,627 11-07-96   5:05p
MC20210W  96          3,627 11-07-96   4:20p
MC20210E  96          3,627 11-07-96   4:16p
MC51910   96          3,627 11-07-96   4:46p
MC52510   96          3,627 11-07-96   4:41p
```

Step 4 requires opening the files in Microsoft Excel for Windows as text files, with the option test separated by tab characters. Open also two blank spreadsheets making sure one of those is named "book2". Use macro number 1 after selecting the data in the first column of the file. This macro will align the data in columns, and create three new columns for the additional fields.

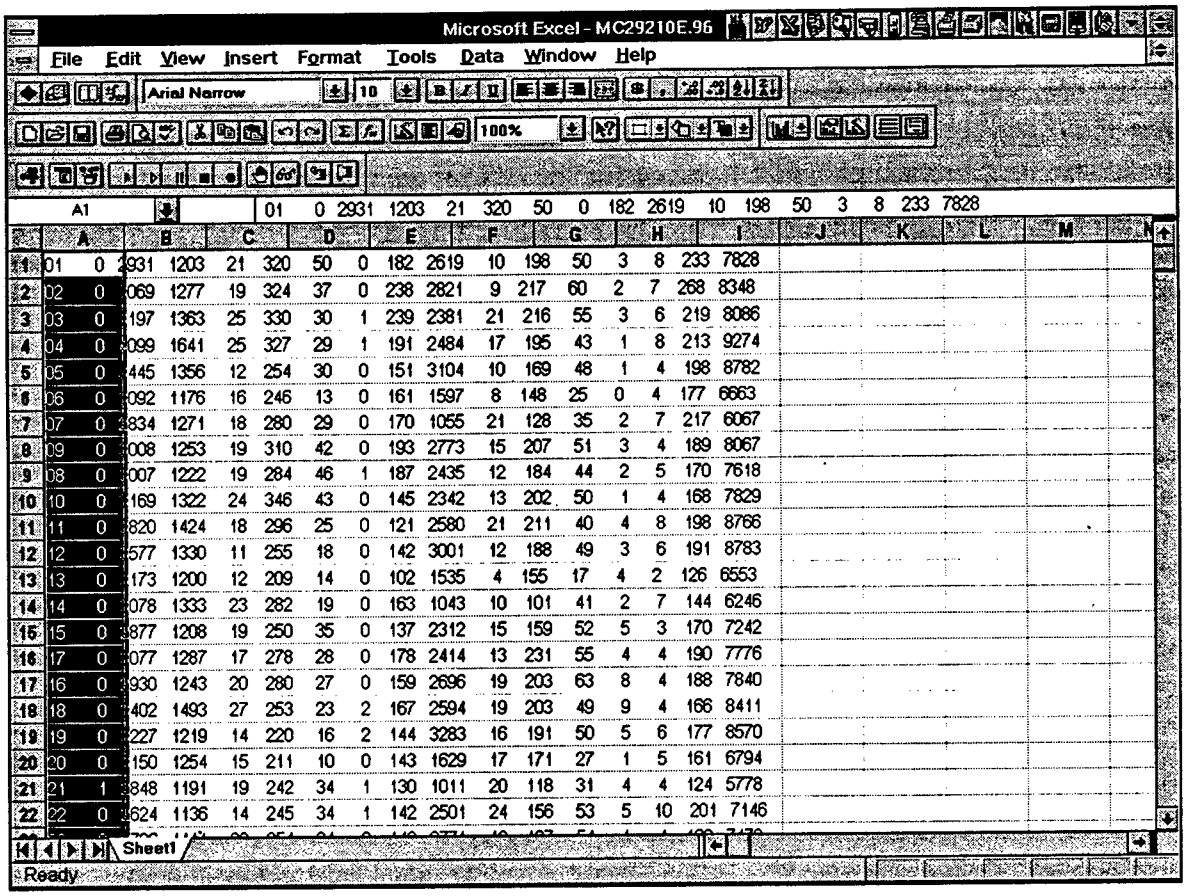

Figure 6 Data Manipulation for Traffic Database

Macro number 1 is the button at the top most left corner in **Figure 6** (with the diamond shape above the 'new file' button). The next three macros to the right of this one will subsequently be identified as macro number 2, 3, and 4 respectively. The source file for these macros is names 'macro1.xlm' and is located in the directory for Microsoft Excel templates and start-up files. After entering the day of the week fields (1-7 for Mon -Sat), the site number (e.g. 202), and the year/month field (e.g. 9609 for September 1996), having made sure 'book2' is open, select the rows in the file and use macro number 2 to copy and paste the data in the 'book2' worksheet. Repeat the procedure for all data files to create one file with all classification data ready for export into the traffic database. Once this is completed, the file can be renamed and saved accordingly. The data in the file is copied to the database table "class" to be used as part of the Microsoft Access traffic database.

The generation of lane distribution figures for multiple lane sites (step 5 above) is accomplished using macro number 3 and a file named "lanes.xls" which should be open before this macro is initiated. In the lanes.xls file, make a selection in a cell at the end of the file where the lane data is to be placed. Open the tables file for the site to be handled (always open these files as delimited files with the option for 'tabs' as delimiters. Place

the selection at the top of the file if it is not already there, and initiate macro number 3, the third macro button at the top of the screen from the left. Each time this button is clicked, the application located a daily lane summary which is "paste-added" to the lanes.xls file at the point of the selection to this file. Continued clicking on the macro files as many time as there are days of data in the file or until you come to the end of the classification data on the summary file. At this point the file 'lanes.xls' will have the number of vehicles in the month that used lane number 1, 2, to 6 as applicable. This gives the lane distribution for this site for the applicable month.

The process of creating monthly data for gross weights, truck ESALS, and weight violations (step 6) is very similar to the lane distribution summaries outlined above. Using the WIM summary tables file created with the 'reporter' software, macro number 4 is used as many times as necessary after the files 'esals.xls', gross.xls', and 'viol.xls' are opened and selections made at the end of the files where new summaries should go. Note that it is very important to ensure that the selection in the three files above or in the 'lanes.xls' file is in the a blank cell at the end of the file clearly separated from the rest of the data, to avoid overriding existing data.

INSPECTION OF COUNT AND CLASSIFICATION FIGURES

The best way to investigate classification counts for individual sites is to express these as a percentage of the total counts for a site for the day, week, or month. Over time, sites will show patterns indicative of the 'normal' percentages for individual classes, allowing for usual variations. Having a good feel for the expected magnitudes for class percentages and possibly the seasonal variations, allows for the identification of abnormalities in count data. In the count data presented in Table 9 for instance, class 1 percentages are 0.25% and lower except for site number 001. The majority of sites in fact have class 1 values between 0% and 0.1%. Whether or not the values for site number 001 are 'normal' depends on historical values for this site. If a site that has historically had class 1 percentages no higher than 0.1% is seen to have a figure of say 2% for the month, this would be an indicator of possible problems with the classification, unless one has reason for the sudden rise in the number of two wheelers.

Apart from the class 1 counts, other classifications can also be useful for purposes of identifying classification irregularities. Class 15 vehicles, which are the unclassified vehicles under the PAT system used by Arizona, indicate how well the system is able to classify vehicles into the 14 existing categories. While it is true that there exists vehicles on the road that do not fit into any of these categories, these are a small proportion of the total vehicles on the road.

Table 10 Monthly Classification Data by Vehicle Class by Site

001=US60..179 005=I19..029 009=I8..159 013=SR95..145 017=I40..098 021=SR417..011
002=I10..292 006=I19..023 010=SR85..141 014=US93..026 018=I40..106 022=I10..130
003=I19..058 007=I19..054 011=I10..115 015=SR68..001 019=I40..113 023=I10..123
004=I19..038 008=I19..084 012=I10..110 016=I40..092 020=I40..145 025=US93..052

SITE #	YR_MON	days :	Class1 %	Class2 %	Class3 %	Class4 %	Class5 %	Class6 %	Class7 %	Class8 %	Class9 %	Class10 %	Class11 %	Class12 %	Class13 %	Class14 %
001	9601	19	0.54	81.17	11.38	0.33	4.09	0.33	0.02	0.52	0.66	0.01	0.02	0.00	0.02	0.03
001	9602	29	2.04	83.03	3.26	1.09	8.31	0.25	0.02	0.38	0.09	0.00	0.00	0.00	0.00	0.01
001	9603	24	2.06	82.08	3.35	1.16	9.01	0.28	0.01	0.42	0.10	0.00	0.00	0.00	0.00	0.01
001	9604	22	1.75	85.03	2.57	0.91	7.58	0.19	0.01	0.25	0.06	0.00	0.00	0.00	0.00	0.00
001	9605	18	1.15	91.95	2.04	0.42	2.52	0.11	0.01	0.14	0.02	0.00	0.00	0.00	0.03	0.00
002	9602	29	0.07	47.69	15.30	0.25	4.99	0.44	0.01	6.82	20.19	0.10	1.55	0.45	0.05	0.13
002	9603	11	0.07	49.33	15.34	0.27	4.90	0.42	0.01	6.56	18.94	0.09	1.43	0.40	0.05	0.14
002	9605	17	0.06	51.68	15.64	0.31	4.62	0.40	0.01	3.54	20.01	0.12	1.62	0.45	0.08	0.16
003	9602	29	0.01	69.12	15.53	0.10	3.52	0.45	0.10	0.87	5.35	0.09	0.24	0.02	1.30	0.05
003	9603	25	0.00	70.14	15.08	0.08	3.16	0.49	0.13	0.69	4.57	0.09	0.20	0.02	1.47	0.03
003	9604	30	0.01	69.54	15.06	0.10	2.91	0.61	0.13	0.62	5.17	0.11	0.20	0.06	1.63	0.05
003	9605	29	0.03	73.34	14.58	0.12	2.78	0.52	0.07	0.63	4.77	0.09	0.20	0.06	0.77	0.07
003	9606	24	0.04	75.18	15.03	0.15	2.65	0.58	0.02	0.69	4.54	0.02	0.23	0.01	0.04	0.11
004	9601	31	0.06	71.32	13.22	0.19	2.73	0.49	0.01	1.08	9.76	0.02	0.31	0.02	0.03	0.07
004	9602	29	0.24	88.04	2.95	0.11	2.03	0.36	0.02	3.12	1.62	0.00	0.06	0.00	0.01	0.01
004	9603	25	0.22	90.77	1.77	0.12	1.72	0.27	0.01	2.82	0.75	0.00	0.02	0.00	0.00	0.00
004	9604	30	0.46	88.13	2.92	0.16	2.09	0.43	0.01	2.43	1.40	0.01	0.02	0.00	0.00	0.01
004	9605	16	0.80	88.87	3.69	0.17	1.57	0.60	0.01	1.05	1.06	0.00	0.02	0.00	0.00	0.02
006	9601	31	0.01	69.44	13.62	0.19	3.06	0.63	0.02	0.64	10.48	0.33	0.40	0.03	0.24	0.07
006	9602	29	0.01	67.27	13.80	0.21	3.35	0.67	0.02	0.87	11.76	0.36	0.43	0.02	0.40	0.07
006	9603	25	0.02	68.87	13.02	0.21	3.02	0.57	0.02	0.88	10.78	0.34	0.35	0.04	0.96	0.07
006	9604	30	1.08	65.93	12.43	0.24	1.65	0.67	0.02	0.57	13.25	0.04	0.42	0.03	0.02	0.08
006	9605	17	0.02	70.90	12.36	0.15	2.55	0.64	0.04	0.53	5.72	0.35	0.33	0.04	4.33	0.04
006	9606	17	1.08	69.77	13.66	0.26	1.66	0.61	0.01	0.54	7.79	0.06	0.30	0.02	0.03	0.13
007	9603	25	0.04	87.09	6.18	0.08	1.38	0.19	0.00	1.66	2.86	0.01	0.11	0.01	0.01	0.03
007	9604	30	0.02	94.46	2.72	0.04	0.55	0.13	0.00	0.65	1.16	0.00	0.06	0.00	0.01	0.02
007	9605	16	0.04	88.30	6.06	0.08	1.29	0.22	0.00	1.46	2.03	0.00	0.13	0.01	0.00	0.01
010	9602	24	0.19	57.51	14.22	0.36	5.26	0.57	0.01	4.64	12.04	0.09	1.71	0.39	0.04	0.14
010	9603	25	0.21	61.05	14.06	0.36	4.72	0.56	0.01	3.44	10.67	0.06	1.82	0.38	0.05	0.15
010	9605	29	0.16	63.86	12.85	0.29	3.63	0.43	0.01	2.63	11.35	0.06	2.02	0.34	0.04	0.24
010	9606	14	0.16	62.43	13.20	0.29	3.55	0.49	0.01	2.53	12.67	0.09	2.16	0.31	0.03	0.19
011	9601	19	0.03	49.70	12.18	0.26	3.20	0.44	0.01	1.76	22.78	0.20	2.79	1.22	0.20	0.24
011	9602	16	0.03	51.07	12.00	0.21	3.38	0.50	0.01	2.09	21.40	0.18	2.59	1.15	0.19	0.21
011	9603	14	0.03	53.48	11.86	0.24	3.03	0.50	0.02	1.89	20.03	0.20	2.53	1.13	0.21	0.20
011	9604	21	0.03	54.46	12.21	0.23	2.68	0.46	0.01	1.51	19.72	0.19	2.48	1.16	0.21	0.21
011	9605	18	0.02	52.04	12.38	0.28	2.43	0.50	0.01	1.36	22.33	0.20	2.80	1.23	0.18	0.26
011	9606	20	0.03	51.81	12.87	0.29	2.33	0.44	0.01	1.21	22.84	0.22	2.67	1.13	0.21	0.26
012	9601	22	0.01	49.87	10.76	0.46	2.73	0.56	0.01	1.50	23.84	0.20	2.48	0.76	0.04	0.18
012	9602	22	0.02	45.37	11.60	0.29	2.77	0.52	0.01	1.44	27.00	0.20	2.97	0.91	0.05	0.20
012	9603	14	0.03	52.47	9.31	0.24	2.58	0.48	0.02	1.44	22.08	0.18	2.52	0.79	0.04	0.17
012	9605	18	0.08	48.81	10.77	0.39	1.84	0.53	0.01	0.99	27.02	0.24	3.07	1.32	0.31	0.27
012	9606	10	0.03	45.85	12.55	0.40	2.05	0.43	0.01	1.04	28.43	0.28	3.09	1.36	0.33	0.29
013	9601	31	0.05	58.28	24.69	0.10	11.26	0.36	0.07	3.23	1.13	0.01	0.21	0.01	0.02	0.06
013	9602	29	0.04	62.95	21.83	0.10	10.50	0.35	0.06	2.30	1.07	0.01	0.22	0.01	0.01	0.08
013	9603	25	0.08	65.10	20.98	0.10	9.51	0.38	0.08	1.80	1.14	0.02	0.22	0.01	0.02	0.09

High figures for class 15 would thus indicate a possible failure by the system to classify vehicles that should belong to one of the 14 types. Class 7 is a rare vehicle type, thus whenever significant percentages show up for this class it should be cause for concern. The percentages of class 9 trucks, the most common long haul truck on the road, can also be used for site patterns, except one has to keep in mind any seasonal patterns that cause variations in truck traffic will cause this figure to vary accordingly. Routes that have high recreational traffic will show high counts for class 5 truck which include a good proportion of recreational vehicles. These patterns can be used during this inspection to get some idea of whether the counts for individual vehicle classes are within 'expected' range or not.

IMPORTANT HINTS FOR TRAFFIC DATA PROCESSING:

Data organization is important to minimize errors and omissions. For example, create subdirectories for data retrieval, for data processing, for month by month data, and other special needs like TMG data. Due to the volume of data involved it is very easy to be swamped with data and create a mess if data locations are not properly organized.

As seen in this example from the current PAT directory on the office computer, there are four subdirectories, OC6 and SE6 for those month's data, DAPP for data retrieved from the sites (current data), and DATT for placing data waiting to be processed as well as for files created during data processing. Ordinarily three to four months of data would be held on the office computer before it is put away on backup media.

```
Volume Serial Number is 1F6F-5AFA
 Directory of C:\PAT

REPORTER EXE       161,760 01-18-94   3:54p
AVC      LST         3,012 06-08-95   3:28p
RESTAT   LST         3,012 06-08-95   3:28p
RETABLES LST           783 09-18-96   5:11p
WIM      LST         3,547 09-18-96   5:10p
RESTAT   NEW         6,811 08-22-94  11:41a
RETABLES NEW           903 07-17-96  10:13a
DIR696   XLS        28,160 07-03-96   7:41a
.            <DIR>          10-04-95  12:53p
..           <DIR>          10-04-95  12:53p
DAPP         <DIR>          10-23-96  11:17a
DATT         <DIR>          10-23-96  11:17a
OC6          <DIR>          09-26-96   4:47p
SE6          <DIR>          09-09-96   8:43a
       14 file(s)        207,988 bytes
                     327,974,912 bytes free

C:\PAT>
```

Data originating from the different types of collection systems is processed separately since the processing software needs to treat these differently. Thus data from DAW200 files and DAW100 files for instance, can not be processed together. One needs to know which files originate from which systems since the filenames look the same. In addition, it is advisable to process one WIM site at a time. Doing so will avoid confusion in summarizing monthly WIM data from the tables. If data files for two or more WIM sites are processed together all the tables for these sites will be lumped in one big file which may be too big to manipulate. For the AVC sites, since we are dealing with fewer tables and most data is available in the individual site summaries created by the software at processing time, it is all right to process multiple sites together. So far the practice has been to either process all AVC sites together or in two batches.

The different macros that are used with the Excel spreadsheets are designed to work with the generated files when loaded without data columns. In most cases the macro will reformat the data in columns before doing the data manipulation. When these files are loaded into Excel the options that seek to load the file as "delimited" text, and text separated by 'tabs' should be chosen. This way the macros will work as intended. It should further be noted that none of the macros will loop or repeat the necessary tasks to the end of the file. To complete the compilations (particularly with the WIM data summaries) one needs to click on the macro as many times as is necessary to get to the end of the file, which is the same as the number of days in that month's data.

MICROSOFT ACCESS DATABASE FOR TRAFFIC DATA

Available Data

Upon processing the data from the sites using software supplied by the manufacturers, the systems are designed to provide the following count summaries.

1. Distribution of classification by hour of the day
2. Distribution of speed by classification (currently off for AVC sites)
3. Distribution of speed by hour of the day (currently off for AVC sites)
4. Distribution of volume by lane

Presently speed is not a major concern of study for the LTPP program Noting that the AVC100 is incapable of lane distribution and speed by classification data, only the first set of tables, distribution of classification by hour of the day is regularly handled for AVC site summaries.

Weigh-In-Motion (WIM) Sites

In addition to the above four reports, normally tabulated by the system for each 24 hour period, 6 other reports (numbered 5 to 10 below) are available on the WIM systems (DAW100 and DAW200) as follows;

5. Weight violations for classes 4-15

6. Weight violations by hour of the day

7. Overweight vehicles by hour of the day

8. Gross weights (distributions) for classes 4-15

9. 18-KIP ESALS for vehicle classes 4-15

10. Distribution of truck counts by class by lane

Monthly summary reports

Based on the PAT system software, a one page classification summary for each site can be compiled showing the number of vehicles for each vehicle class by day. This is available for the classification sites as well as the WIM sites. In addition, for WIM data a second page summary is available for "distribution of weighed vehicles by day of the month for vehicle classes 4-15". This summary shows, amongst other things, total vehicles with invalid measurements and total vehicles with weight violations.

ASCII truck files

For WIM data, an ASCII file can be generated when desired, showing individual truck information (for classes 4-15). These records include lane number, date, time, vehicle number, vehicle class, gross weight, vehicle length, speed, axle spacing and individual axle weights.

One notes therefore that depending on the aspects being investigated, there is a large amount of data that can be generated. This data needs screening and summarizing for use in a database. The question is what data is needed in the database and what format it should be in. The first part, what data, will be based on the relevance of the

data items as well as realistic expectations in terms of the extraction and storage requirements. The second part, what format, will be based on the nature of anticipated queries for information and data summaries from the database.

User input on this is very useful in determining the kind of data, its format, and the corresponding design of database tables and queries to accomplish that objective. Time is taken to think about what one would like to get from the database - one year, two years, five, or more years from now.

Tables: The following tables are included in the database (names used not exactly the same);

1. **sites** - site classification summary
2. **class** - classification data by site by month
3. **summary_class counts** - monthly class summaries prior months
4. **wmg** - monthly gross weight summaries by truck class
5. **wmv** - weight violations and truck ESALS, monthly summaries
6. **wms** - monthly data (WIM) availability information
7. **month descr** - Descriptions for month-year entries [9605=May 96]

A description of the contents of the different tables follows;

Sites: This database table (shown as Table 11 below) has individual site numbers, locations and other site specific information. It provides general information about the sites.

Table 11 Structure of "Sites" Table in Database

AZ SITE #	SHRP SITE-ID	2-WAY LANES	EQPT LANES	ROUTE & LOCN	PAVEMENT TYPE	RECNT AADT 2-WAY
001	7613	6	1	US-60 MP 179 WB	RIGID	125000
002	6053	4	1	I-10 MP 292 EB	FLEX	17000
003	1018	4	1	I-19 KM 58.8 SB	FLEX	12000
004	1016	4	1	I-19 KM 38 SB	FLEX	12000
005	1015	4	1	I-19 KM 29.6 SB	FLEX	13000

Class: This database table, shown as Table 12 below, contains the daily vehicle classification counts for all sites. Each data row is identified by site number, year & month, and date. A column for day of the week is included for possible "day-trend" investigations.

Table 12 Structure of the "Class" Table in the Database

SITE	YR	DAT	DAY	CL1	CL2	CL3	CL4	CL5	CL6	CL7	CL8	CL9	C10	C11	C12	C13	C14	C15	ALL
001	9405	1	7	1	5093	341	8	8	2	1	16	1	0	0	0	2	1	32	5516
001	9405	2	1	0	5272	576	5	39	27	3	62	135	5	5	1	30	2	149	6311
001	9405	3	2	0	5499	608	1	44	16	5	49	109	3	4	0	32	4	141	6525
001	9405	4	3	4	5318	696	1	42	24	3	62	127	6	4	2	27	3	167	6496

Wmg: This database table has truck gross weight distributions for WIM sites for each month. It is illustrated in Table 13 below, where the first three columns together are unique for each data set, giving the site number, year & month, and gross weight interval (lower end of 5 KIP range).

Table 13 Structure of the Gross Weight Table "WMG" in the Database

site #	yr & mo	wt_kip	class4	class5	class6	class7	class8	class9	class10	class11	class12	class13	class14	class00	all_clas
009	9405	030	3	0	1	0	15	68	1	2	0	0	3	3	96
009	9405	035	1	0	2	0	9	64	1	3	1	0	4	2	87
009	9405	040	1	0	0	0	6	114	2	2	0	0	0	3	128
009	9405	045	0	0	0	0	2	142	0	2	5	0	0	1	152
009	9405	050	0	0	0	0	0	171	2	8	0	0	0	3	184
009	9405	055	0	0	0	0	1	236	0	16	2	0	0	2	257
009	9405	060	0	0	0	0	0	321	2	24	4	0	0	2	353

Wmv: Illustrated in Table 14 below, this database table has monthly summaries of vehicles weighed, violations and ESALS counts.

Table 14 Structure of the Weight Violations and Truck ESALS Table "WMV" in the Database

site #	yr & mo	veh_clas	counted	invalid	weighed	viols_#	esals_tot	single_vi	tandem	gross_vio	bridge_vi
009	9405	04	30	23	7	0	4	0	0	0	0
009	9405	05	193	111	82	0	14	0	0	0	0
009	9405	06	23	8	15	0	3	0	0	0	0
009	9405	07	1	1	0	0	0	0	0	0	0
009	9405	08	135	60	75	1	23	0	0	0	1

Wms: As shown under Table 15, this database table contains WIM site notes like number of days data was collected, portable WIM unit number, and other remarks on a month by month basis.

Table 15 Structure of the WIM Data Collection Summary "WMS' in the Database

site #	yr & mo	unit # wim	# days	remarks
019	9405	99	45	ok
019	9407	99	22	July1 to 22
025	9405	p	31	ok
025	9406	p	30	ok
025	9407	p	30	OK. 1-30
202	9405	p	18	first month of
202	9406	p	30	smooth cellular

month descr: The purpose of this table is to provide convenient year & month labels particularly for reports, based on the values in the yr. & mo. columns of the other tables. This makes it possible for a '9405' report to be labeled "May - 1994" without having to do this manually every time the report changes. Additional information fields may be added to this table if it is specific to a data collection period, which is the key attribute for this table. It is illustrated in Table 16.

Table 16 Structure of the Month Description Table in the Database

year & mon	year - month
9402	FEBRUARY 1994
9403	MARCH 1994
9404	APRIL 1994
9405	MAY 1994
9406	JUNE 1994
9407	JULY 1994

summary_class counts: This is a temporary table, when sufficient data has been accumulated it will not be necessary. The table contains the monthly classification summaries going back twelve months. These summaries are needed for the compilation of month by month trends and running averages for the counts for specific vehicle classes. This database table is illustrated in Table 17.

Table 17 Structure of the Summary Class Counts Table in the Database

SITE #	YR_MON	label	no. of	CL1	CL2	CL3	CL4	CL5	CL6	CL7	CL8
001	9307	JL93	22	974	381711	99626	240	4611	2164	265	11059
001	9308	AU93	26	844	375527	99436	235	4474	2076	396	11128
001	9309	SE93	27	1065	378891	99951	879	4842	1795	411	11261
001	9310	OC93	30	974	382340	102027	1490	5079	1494	327	11408
001	9311	NO93	30	603	363305	96938	639	4381	1899	93	10188
001	9312	DE93	5	600	361008	108180	816	5328	2100	210	11814

CL9	CL10	CL11	CL12	CL13	CL14	CL15	CLALL
4512	99	244	58	428	464	38992	545445
4556	140	240	48	486	527	39758	539869
4198	147	270	40	596	349	39830	544525
3590	115	247	47	527	314	43298	553276
4329	86	253	29	232	322	39167	522464
3870	132	222	72	468	264	46884	541968

The range of queries that can be developed from the above database tables include the following;

- classification counts by site by month
- classification totals by site for a given period
- classification totals by site by day of the week for a given period
- Violations by truck class by site
- ESALS totals by truck class by site
- average ESALS by truck class by site

- Percent weight violations by truck class by site
- Weight violations by type of violation by truck class by site
- Invalid measurements by truck class by site
- Gross weight distribution by truck class by site
- Any combination of the above

The list of possible queries is by no means exhaustive, any particular manipulation of the data in the database can yield a different query. However, only when the data is part of the database, and in the necessary format for the query, will the query design be possible. This is why input is normally sought from potential users to make the final database design even more useful.

V. PERFORMANCE EVALUATION AND CALIBRATION OF WIM AND AVC SITES

INTRODUCTION

The biggest challenge in operating almost any system is dealing with problems associated with the failure of the system to perform as intended. Such failures in the case of WIM and AVC equipment can take a number of variations including the following;

- The system is inoperative, not running at all
- The system is running but it does not recognize the presence of vehicle axles at all (no counts)
- The system is running, it recognizes and reports vehicle presence (it counts) but does not weigh
- Everything looks fine except data inspection reveals that the classification and weighing of vehicle axles is in error.

In situations where there is an obvious indication of problems, the process towards a solution is clearer and outcomes more predictable. However, the case where everything looks fine on the surface except the system is giving us figures that are not a good representation of the relevant traffic stream requires a continuous effort to track and understand the nature of the data that is collected over time. To be able to inspect data sets and spot problem data there must be sets of patterns that form a basis of what is considered "expected" data patterns. Incoming data (preferably site specific) is inspected against the expected patterns for conformity. Such patterns could be developed based on existing physical expectations, like 'normal' axle spacing for a particular truck type, or they can be based on site specific observations like trucks running empty on a particular stretch of freeway because they are normally on the return trip.

The types of patterns that are used during data inspection and evaluation range from simple rules of thumb to ones involving control charts for individual truck classes or total counts/loading. This report will touch on the more basic patterns. SHRP's quality assurance procedures offer a cross section of procedures for further scrutiny of the data. These procedures are applied to data that is forwarded to SHRP by the state agencies as a routine procedure prior to acceptance of the data for the national traffic database. State agencies on the other hand, do their own evaluations as well as reviewing the quality assurance results. Many of the parameters in Appendix C can be adjusted as necessary. Among patterns that can be used for preliminary data inspection are the following;

Count and Classification Data	Class 1 counts (percent)
	Class 15 counts (percent)
	Class 9 pattern
	Class 13 counts (percent)
Weight Data	Gross Weight Distribution for Class 9 Trucks
	Front Axle Weights for Class 9 Trucks

The significance of class 1 counts lies in the fact that particularly for sites along freeways, there are very few motorcycles. For most of the Arizona LTPP sites this class accounts for less than 0.2 percent of the total count. When there is a sensor problem or a calibration problem it may cause this figure to go up, sometimes to 1% or 2% or even more. Class 15 for the Arizona system is reserved for unclassified vehicles. When the system is working properly a very small percentage of vehicles go unclassified. For AVC data this figure is about 2%, while it is just slightly higher for WIM data. The difference is a result of WIM systems classifications incorporating axle weight limits while AVC classifications are based on axle spacing alone. Class 13 counts, like class 1 counts are normally very low because there are very few of these combinations on the road. When class 7 percentages are reported high it is normally because class 8 trucks or some other combination trucks are wrongly classified as class 7. Patterns for class 9 trucks, the most common long distance combination, depend on route and site but over time clear patterns start to emerge. As far as weight data is concerned, front axle weights for class 9 trucks have been shown to stay in the same range of magnitude with little if any variation with gross weight. The typical front axle weight distribution as shown in Table 18 is used as a basis for identifying possible calibration shifts. The distribution of gross weights for class 9 trucks can be tracked for site specific patterns, such as shown in Table 19. This distribution normally (not always) shows two distinct peaks, one for the unloaded trucks and a second one corresponding to the loaded trucks. For the most part the existing fleet of class 9 trucks has unloaded peaks in the range 28-32 KIP, with small variations depending on route and cargo hauled. Assuming that the majority of trucks on the road are within the legal weight limit, the loaded peak should represent the dynamic weight for the legal 80 KIP weight. Static weights at ports of entry attest to the validity of this assumption. Depending on the inherent error in the measurements however, this peak will shift accordingly.

EXAMPLES OF TYPICAL DATA SETS

Table 18 Class 9 Front Axle Weights as Registered at a WIM Site over a 4-day period

Weight Range			Total Trucks
0 to 2.5	0	0	0
2.5 to 5	0	0	10
5 to 7.5	0	0	58
7.5 to 10	0	0	1715
10 to 12.5	0	0	**6500**
12.5 to 15	0	0	670

Table 19 Gross Weight Distribution for Truck Classes 4-15 & All Classes:

025	9609	000	0	0	0	0	0	0	0	0	0	0	0	0	0
025	9609	005	0	801	0	0	0	0	0	0	0	0	0	111	912
025	9609	010	0	1232	8	0	109	3	0	0	0	0	0	287	1639
025	9609	015	6	604	99	0	278	17	0	1	0	0	0	412	1417
025	9609	020	14	293	91	0	310	195	0	1	0	0	25	207	1136
025	9609	025	13	124	13	0	207	646	0	9	0	0	167	146	1325
025	9609	030	48	38	32	0	168	764	2	63	8	0	22	59	1204
025	9609	035	130	10	108	0	144	766	8	90	6	1	9	32	1304
025	9609	040	146	3	139	0	107	861	13	125	19	4	3	13	1433
025	9609	045	68	0	42	0	51	1065	8	145	17	9	3	6	1414
025	9609	050	4	0	6	0	45	1045	12	111	19	0	8	6	1256
025	9609	055	0	1	0	2	21	1077	3	150	31	0	1	4	1290
025	9609	060	0	1	0	2	3	1094	6	169	41	2	1	3	1322
025	9609	065	1	0	2	0	1	1310	8	151	53	0	6	2	1534
025	9609	070	0	0	1	0	0	1621	18	103	24	0	26	2	1795
025	9609	075	0	0	0	0	0	**2566**	17	127	16	1	75	3	2805
025	9609	080	0	0	0	0	0	882	16	82	7	1	67	0	1055
025	9609	085	0	0	0	0	0	44	12	7	1	1	7	1	73
025	9609	090	0	0	0	0	0	8	7	1	0	1	1	1	19
025	9609	095	0	0	0	0	0	2	5	0	0	3	0	0	10
025	9609	100	0	0	0	0	0	0	2	0	0	1	0	0	3
025	9609	105	0	0	0	0	0	1	5	0	0	1	0	0	7
025	9609	110	0	0	0	0	0	1	0	0	0	1	0	0	2
025	9609	115	0	0	0	0	0	0	1	0	0	1	0	1	3
025	9609	120	0	0	0	0	0	0	0	0	0	0	0	1	1

In the gross weight data given in Table 19, one notes that the loaded peak is in the 75-80 KIP weight interval, where it should be. This set of data does not have the second weight peak for the class 9 trucks. The second peak was said to be expected around the 28-32 KIP interval corresponding to empty class 9 trucks. With long haul routes the percent empty trucks is low. Beyond the legal weight limit the gross weight distribution drops sharply, as would be expected. Problem sites will sometimes show an elaborate tail in the 90-120 KIP region. Sometimes the last interval which represents any weight higher than 120 KIP will show a peak of its own! Situations like these signify a system out of calibration or moving in that direction.

Table 20 Vehicle Count Percentages by Class for Site 202 from Jan '95 to July '96

site	yr/mo	days	cls1	cls2	cls3	cls4	cls5	cls6	cls7	cls8	cls9	cls10	cls11	cls12	cls13	cls14	cls15	30all-cls
202	9501	28	0.00	40.55	16.62	0.33	3.25	0.48	0.00	2.69	30.65	0.15	3.52	0.86	0.03	0.06	0.82	124650
202	9502	28	0.00	42.22	16.16	0.27	3.34	0.34	0.00	3.19	29.22	0.12	3.21	0.86	0.02	0.06	0.98	171347
202	9503	29	0.00	44.29	15.95	0.27	3.53	0.34	0.00	4.02	26.81	0.14	2.76	0.73	0.02	0.05	1.08	202059
202	9504	26	0.00	44.91	16.01	0.26	3.62	0.35	0.00	4.07	26.28	0.13	2.51	0.65	0.03	0.06	1.10	216998
202	9505	21	0.00	46.59	16.43	0.24	3.49	0.30	0.00	2.92	24.95	0.13	2.48	0.58	0.02	0.09	1.78	221054
202	9506	30	0.00	46.80	18.05	0.20	3.37	0.32	0.00	2.00	23.99	0.09	2.28	0.54	0.02	0.08	2.27	254049
202	9507	31	0.00	47.92	18.55	0.18	3.23	0.28	0.00	1.70	23.12	0.10	2.15	0.52	0.02	0.10	2.13	254168
202	9508	30	0.00	45.59	17.33	0.23	3.07	0.33	0.00	1.70	26.31	0.11	2.48	0.61	0.02	0.10	2.13	234256
202	9509	30	0.00	43.79	17.12	0.26	3.11	0.33	0.00	1.90	27.87	0.12	2.46	0.63	0.02	0.06	2.33	222794
202	9510	29	0.00	42.05	17.03	0.28	3.21	0.35	0.00	2.11	29.18	0.12	2.57	0.64	0.01	0.06	2.38	216874
202	9511	29	0.00	41.47	17.21	0.26	2.81	0.32	0.00	1.59	30.68	0.14	2.59	0.73	0.02	0.07	2.10	199946
202	9512	28	0.00	44.44	17.90	0.26	2.50	0.33	0.00	1.33	28.22	0.14	2.40	0.64	0.03	0.05	1.76	182894
202	9601	29	0.00	42.67	17.49	0.30	2.80	0.34	0.00	1.48	29.36	0.16	2.68	0.77	0.02	0.06	1.88	165232
202	9602	21	0.00	42.01	17.10	0.30	2.97	0.30	0.00	1.83	29.68	0.15	2.71	0.73	0.02	0.08	2.11	176630
202	9603	25	0.00	44.23	16.96	0.24	3.19	0.31	0.00	2.20	26.98	0.15	2.46	0.70	0.02	0.08	2.48	208843
202	9604	30	0.00	43.67	16.98	0.25	3.37	0.37	0.00	2.54	26.87	0.14	2.32	0.64	0.02	0.08	2.73	222626
202	9605	27	0.00	45.08	16.66	0.22	3.43	0.40	0.00	2.11	26.64	0.12	2.20	0.61	0.03	0.10	2.41	229349
202	9606	24	0.00	45.48	17.43	0.18	3.30	0.35	0.00	1.89	26.00	0.14	2.21	0.54	0.02	0.08	2.38	245503
202	9607	29	0.00	45.76	18.35	0.20	3.27	0.32	0.00	1.67	25.34	0.12	2.09	0.53	0.02	0.06	2.28	252932

Vehicle count data given in Table 20 for site number 202 includes 19 columns from left as follows; site number, year and month of data in row, total days data collected this period, count percent class 1 through class 15, and 30 day equivalent total count for the month. This particular site is one of the best performers in the program. The counts by vehicle class show a high level of consistency throughout the period. When problem sites are presented this way, the patterns show irregularities where problems existed.

EXAMPLES OF PROBLEM DATA SETS

Table 21 Vehicle Count % by Class for Site Number 10

site	yr/mo	days	cls1	cls2	cls3	cls4	cls5	cls6	cls7	cls8	cls9	cl10	cl11	cl12	cl13	cl14	cl15	30_all
010	9501	29	0.20	55.53	17.58	0.51	1.87	0.53	0.00	5.90	12.22	0.05	2.11	0.27	0.06	0.13	3.03	76235
010	9502	16	1.35	64.73	13.59	0.27	1.62	1.65	0.00	4.68	7.20	0.03	1.29	0.15	0.18	0.14	3.11	122276
010	9508	15	3.04	56.76	15.63	0.53	2.67	0.23	0.00	4.14	9.45	0.14	0.93	0.13	0.05	0.18	6.14	68118
010	9509	30	2.64	57.10	14.33	0.54	4.58	0.37	0.01	4.56	8.72	0.15	1.09	0.16	0.09	0.17	5.50	72695
010	9602	24	0.19	57.51	14.22	0.36	5.26	0.57	0.01	4.64	12.04	0.09	1.71	0.39	0.04	0.14	2.82	92388
010	9603	25	0.21	61.05	14.06	0.36	4.72	0.56	0.01	3.44	10.67	0.06	1.82	0.38	0.05	0.15	2.46	98800
010	9605	29	0.16	63.86	12.85	0.29	3.63	0.43	0.01	2.63	11.35	0.06	2.02	0.34	0.04	0.24	2.10	92482
010	9606	14	0.16	62.43	13.20	0.29	3.55	0.49	0.01	2.53	12.67	0.09	2.16	0.31	0.03	0.19	1.90	86220
010	9607	29	0.17	66.14	13.27	0.37	3.44	0.40	0.01	1.84	10.47	0.06	1.80	0.22	0.05	0.12	1.63	89296

For site number 10 which is depicted in Table 21, some of the data sets (in particular during the months of February, August, and September 1995) show indications that vehicle classification may have been a problem. Class 1 percentages for these months are all 1.3 and above while those percentages are 0.2 and lower for the rest of the months. Class 9 percent is 9.5 and lower for these months, mostly 11 and higher for the other months. Two of these months have 5.5 and 6 % unclassified vehicles while the general trend for unclassified vehicles based on the remaining months is of magnitude 3 and lower. The data for February through July 1996 shows a much higher level of agreement, suggesting that the problem was corrected.

In the above inspections data for periods of 10-18 months were used to show the trends in the data. This was a convenient way to show how such patterns can serve to identify shifts in calibration. However, one does not want to have to accumulate data for long periods before identifying and acting on such shifts. Normally, the most current data is processed and the resulting data characteristics are compared to what has been observed over time for the site at hand. If some of these patterns stick out as calling for further scrutiny, one begins the process of determining whether this is a false alarm. Where the problem appears real, it is pursued further until resolved.

Site Calibration for Vehicle Classification and Weight Measurement

In order to maintain the data collection sites in good working condition, the equipment is calibrated regularly for classification and weight. The goal is to have calibrations at least once a year, and when possible on a six month schedule. According to SHRP recommended practice, the former is acceptable while the latter is preferred. So far it has only been possible to sustain an annual calibration of all sites.

Table 22 Section of a Spreadsheet used for Weight Calibration

Truck #	1		10/16/92	Site	#3 I-19	KM 58.0		
Run #	Gross	Single	Axle 2	Axle 3	Tandem 1	Axle 4	Axle 5	Tandem 2
1	72.1	8.5	13.0	13.0	26.0	18.9	18.5	37.4
2	78.6	10.9	15.4	15.0	30.4	18.9	18.2	37.1
3	81.6	11.3	16.0	15.6	31.6	19.6	18.0	37.6
4	76.7	10.6	17.1	12.3	29.4	18.3	18.3	36.6
5	78.1	10.4	14.2	15.6	29.8	19.2	18.5	37.7
6	81.9	11.0	16.7	14.7	31.4	19.8	19.6	39.4
7	77.5	10.5	15.3	13.7	29.0	19.5	18.4	37.9
8	85.4	11.3	16.4	15.6	32.0	21.2	20.9	42.1
9	80.5	10.8	15.0	15.7	30.7	19.0	19.7	38.7
10	82.4	8.5	16.8	16.9	33.7	19.9	20.1	40.0
11	77.2	9.7	12.4	16.1	28.5	18.2	20.6	38.8
12	72.6	7.8	14.3	13.1	27.4	18.0	19.2	37.2
13	81.6	10.8	16.1	16.8	32.9	17.9	19.8	37.7
14	72.3	8.6	13.8	11.8	25.6	17.7	20.3	38.0
15	73.6	10.2	14.6	11.4	26.0	17.4	19.8	37.2
16	72.9	10.7	13.2	11.2	24.4	17.6	20.0	37.6
17	74.4	10.5	14.4	13.7	28.1	18.2	17.5	35.7
18	78.9	8.5	17.0	14.2	31.2	18.3	20.7	39.0
19	81.1	8.9	18.2	15.1	33.3	18.4	20.3	38.7
20	74.7	8.8	15.2	12.4	27.6	17.9	20.2	38.1
Average	77.71	9.92			29.45			38.13
St. Dev.	3.87	1.10			2.65			1.33
Static	75.08	10.14			29.42			35.5
Avg. %	3.50	2.22			0.10			7.39
St. Dev. %	5.15	10.84			8.99			3.74
Truck #	2	Date	10/16/92	Site	#3 I-19	KM 58.0		
Run #	Gross	Single	Axle 2	Axle 3	Tandem 1	Axle 4	Axle 5	Tandem 2
1	72.1	10.6	14.6	14.3	28.9	16.9	15.6	32.5
2	73.1	10.7	15.0	13.6	28.6	17.6	15.9	33.5
3	66.4	9.2	12.6	13.6	26.2	15.6	15.4	31.0
17	72.9	10.5	15.3	14.0	29.3	16.8	16.0	32.8
18	75.3	10.6	15.9	14.9	30.8	18.8	14.9	33.7
19	75.4	11.1	14.8	14.2	29.0	18.4	16.7	35.1
20	77.4	11.1	15.9	14.4	30.3	16.6	19.1	35.7
Average	75.20	10.77			30.04			34.03
St. Dev.	3.03	0.85			1.62			1.37
Static	70.5	10.28			28.3			31.94
Avg. %	6.67	4.72			6.13			6.54
St. Dev. %	4.30	8.25			5.73			4.30
P. Avg %	5.08	3.47			3.12			6.97
P. Sd. %	4.73	9.55			7.36			4.02
Results	PASS	PASS			PASS			PASS

In addition to the regular schedule, calibration is also performed as a corrective measure when data inspection for a site indicates calibration problems. Vehicle classification with the AVC systems are based on axle configurations and spacing as detected on system loops, cables, bending plates, or a combination of these. Vehicle speed is determined from the time it takes an axle to travel from one sensor to another, whose separation is entered in the system. Axle spacings are based on the vehicle speed and the time between a sensor picking the axles. If the sensor separation is entered in the system correctly and the sensors are identifying axle presence properly, the AVC system will perform vehicle classification according to the classification algorithms for the different vehicle classes.

WIM systems calibration requirements are more demanding in that the magnitude of the signal caused by the weight of the axle must be determined and translated into equivalent dynamic weight. Since the magnitude of this signal is influenced by factors other than the actual pressure from the weight of the axle, there is more room for calibration shifts. When this happens, the quality of weight data from a site diminishes and so does the quality of associated classification data depending on the magnitude of the calibration shift, since WIM systems incorporate weight limits in classification specifications.

Weight calibration involves the use of 2 semi-trailer trucks (class 9) twenty times across the sensors following initial trial runs and calibration adjustments. Using the known axle spacings and weights for the two trucks, calibration parameters are adjusted until one is satisfied that the system registers the best values possible. Twenty runs are then made for each set of sensors (i.e. each lane). The data obtained is evaluated using a spreadsheet, shown in Table 22, developed for this purpose to ascertain that deviations from the static weights are within the allowable margins for the applicable system.

VI. LONG TERM MASTER PLAN AND GENERAL RECOMMENDATIONS

The previous chapter dealt to some length on the calibration of sites. Regular calibration of the sites is undertaken to ensure the highest quality of data. If sites are not monitored carefully and calibrated on a regular basis, the systems could be pilling up useless data for months. Resources would be wasted at the same time that data would be unavailable in that period.

While Site calibration and monitoring is crucial for ensuring quality data, on its own it will not keep the sites running indefinitely. Sensors in the pavement will reach the end of their useful life and fail. When this happens, sensors must be replaced in order for the site to be running again. For many of Arizona's LTPP traffic monitoring sites, two or more sensors have failed causing the sites to be shut down pending replacement of the sensors and in some cases upgrade to 2-lane WIM for weight data or 2-lane AVC. Chapter 2 included summaries on the site situation and what is planned for each of the site locations.

In 1995 upgrade work was initiated on three traffic collection sites, two of which had been single lane classification sites and the other a site which had the cabinet erected but which was otherwise never installed. Upgrades for the three sites were earmarked to provide two-lane weigh-in-motion service using piezo cable sensors. Two of these sites (located on interstate 10 WB MP 110 and MP 115) were completed in June 1995 and started providing traffic data in July of that year. Work on the other site (located at I-19 MP 29 SB), which was part of a pavement preservation project, faced several delays after which it was completed December of 1996 including weight calibration.

In accordance with the 1996/97 master plan, a total of 14 sites have been rehabilitated or relocated in 1997. Of these, seven sites were rehabilitated and upgraded to 2-lane WIM operation. Five other sites underwent rehabilitation and upgrade to 2-lane AVC operation. Two new AVC sites were installed for two lane operation using relocated equipment. A planned WIM at an arrestor bed site was shelved after that project was closed. Completion of this work is expected to bring the program back in good standing while providing needed weight and classification data for the LTPP program.

The Importance of Continuous WIM and AVC Sites

As the responsibility of operating the traffic data collection sites shifts to the state following the initial role of the Strategic Highway Research Program of the FHWA, the department finds itself in a position of increased financial demands for the maintenance, general operation, replacement and even additions to these sites. Based in part on figures derived from the just complete system upgrade, we now estimate that sensor replacements for the piezo systems are needed every three years. At going prices,

assuming in-house installation work, this translates to about $9000 for two lane WIM and about $7000 for two lane AVC for sensor and loop replacements alone. Annual weight calibration cost for the WIM sites are estimated at $2700 for a two lane system. The calibration cost estimate includes the rental of a loaded 5 axle tractor trailer which is ideal for this as it represents the typical loaded truck on our freeways.

Put together, these figures represent a significant budget even for the department of transportation. More important however, is the fact that these sites make available very useful data that can not be obtained otherwise. The design of new pavement and the maintenance and replacement of existing pavement on the state's highway system can be done most effectively with reliable loading data. Short term data collected with non continuous systems is prone to a lot of seasonal and chance events that can greatly reduce the usefulness of the data for long term projections and patterns. At the same time, the nature of short term data collection is such that the possibility of interference with the normal flow itself is quite real, which can cause the data thus collected to be unrepresentative of the true truck population. Truckers are known to change routes, brake or accelerate at scales, all of which distorts the data. The 'silent' nature of permanent high speed installations avoids all these shortcomings.

All existing permanent installations for WIM and AVC data in the department ought to be maintained and calibrated at least annually so that they continue to provide the department with a good set of data and traffic trends in the coming years. This year for instance, a new project - SPR 455: Development of New Pavement Design ESAL, awaits WIM site calibrations so that it can proceed. ATRC and TPG WIM sites are crucial sources of loading data for this project. When completed, SPR 455 will make available a new set of ESAL tables for Pavement Design for the entire state highway system. A few checks of current estimates against WIM loading data strongly supports the need for the development of a new set of ESAL tables and for revisiting the process. While it can not be expected that WIM systems will cover the whole highway system, a good number of WIMs - properly located, will greatly supplement and strengthen current data collection efforts. This may mean adding to the existing set of WIM installations but it is worth the investment, providing needed input to the core task of the department, effective design, construction and maintenance of the state's highway system.

As far as the ATRC is concerned, there is also the question of how to treat the LTPP traffic data collection program. On the one hand, this program can still be considered a research project in that we are still trying to understand the nature of classification and loading patterns and supporting related research projects such as SPR 455. On the other hand, as the initial role of the FHWA under SHRP diminishes, and without a clear end date for closing out this project, one can argue for designating the project as an ongoing 'research support' task as with a 100 series number. The research council may want to offer direction on this as part of a long term commitment to support and guide the department's future position as regards traffic data collection utilizing permanent automated equipment.

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APPENDIX

Appendix A: Daily Classification and Weight Tables 1-10

DISTRIBUTION OF VEHICLE CLASSIFICATIONS BY HOUR OF DAY

SITE NO : 202 Location : I-40 MP 202 EB / WB Lane(s) : 1 2 3 4
DATE : 11/01/96 County : 005 State-ID : 04 Direction : 3 3 7 7

HOURLY SUMMARY — VEHICLE COUNTS

HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	TOTALS
0- 1	0	41	11	2	4	0	0	6	123	1	18	1	0	0	5	212
1- 2	0	37	23	0	3	0	0	1	104	1	11	2	0	0	2	184
2- 3	0	39	14	0	4	3	0	2	96	1	16	2	0	0	7	184
3- 4	0	44	16	1	4	3	0	3	111	0	9	4	0	1	3	199
4- 5	0	42	18	1	6	8	0	2	119	0	14	1	0	0	6	217
5- 6	0	81	36	1	6	2	0	4	115	0	18	2	0	2	5	272
QTR TOTALS	0	284	118	5	27	16	0	18	668	3	86	12	0	3	28	1268
6- 7	0	180	78	2	14	2	0	8	141	1	16	4	0	2	5	453
7- 8	0	297	136	5	17	5	0	9	182	0	9	1	1	2	11	675
8- 9	0	320	129	2	23	1	0	14	184	3	11	4	0	0	33	724
9-10	0	377	120	1	27	3	0	17	189	1	14	2	0	2	20	773
10-11	0	414	134	2	22	2	1	20	220	5	18	7	0	0	21	866
11-12	0	387	168	3	45	3	0	19	208	7	15	4	3	1	34	897
QTR TOTALS	0	1975	765	15	148	16	1	87	1124	17	83	22	4	7	124	4388
12-13	0	387	185	2	41	5	0	26	218	1	16	5	1	1	27	915
13-14	0	432	191	4	39	5	0	22	217	3	15	3	6	0	36	973
14-15	0	501	200	3	48	6	0	17	202	1	16	4	0	0	25	1023
15-16	0	506	196	1	39	1	0	22	178	6	14	4	0	1	26	994
16-17	0	527	181	1	27	4	0	12	217	2	24	4	0	1	24	1024
17-18	0	554	183	1	45	4	0	23	212	2	16	7	0	0	24	1071
QTR TOTALS	0	2907	1136	12	239	25	0	122	1244	15	101	27	7	3	162	6000
18-19	0	414	158	1	20	0	0	4	162	0	14	6	0	1	11	791
19-20	0	264	111	1	22	1	0	10	146	0	8	3	0	0	20	586
20-21	0	228	98	1	14	1	0	7	180	1	15	2	0	0	9	556
21-22	0	209	93	0	10	0	0	11	162	0	11	3	0	0	8	507
22-23	0	132	69	1	10	1	0	5	144	0	17	4	0	0	2	385
23-24	0	97	32	1	6	0	0	3	125	1	12	5	0	1	6	289
QTR TOTALS	0	1344	561	5	82	3	0	40	919	2	77	23	0	2	56	3114

DAILY SUMMARY — VEHICLE COUNTS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	TOTALS
TOTAL	0	6510	2580	37	496	60	1	267	3955	37	347	84	11	15	370	14770
PERCENT	0.0	44.1	17.5	0.3	3.4	0.4	0.0	1.8	26.8	0.3	2.3	0.6	0.1	0.1	2.5	100.0

DISTRIBUTION OF SPEEDS BY VEHICLE CLASSIFICATION

SITE NO : 202 Location : I-40 MP 202 EB / WB Lane(s) : 1 2 3 4
DATE : 11/01/96 County : 005 State-ID : 04 Direction : 3 3 7 7

VEHICLE COUNTS

SPEED (Mph)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	TOTALS
1- 5	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1	4
6- 10	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3
11- 15	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
16- 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21- 25	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
26- 30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31- 35	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
36- 40	0	3	0	0	1	0	0	0	0	0	0	0	0	0	1	5
41- 45	0	14	4	0	2	1	0	3	1	0	0	0	0	0	7	32
46- 50	0	37	24	2	12	0	0	9	11	0	3	2	0	0	36	136
51- 55	0	222	82	8	52	2	0	45	85	2	27	3	1	2	56	587
56- 60	0	748	266	1	100	10	0	73	463	7	163	13	4	3	96	1947
61- 65	0	1794	631	6	167	26	1	73	1347	14	122	29	2	5	84	4301
66- 70	0	2151	937	16	105	14	0	42	1512	12	29	29	2	4	48	4901
71- 75	0	1072	465	3	42	6	0	18	454	1	3	8	2	1	19	2094
76- 80	0	338	134	0	6	1	0	3	72	1	0	0	0	0	3	558
81- 85	0	88	27	0	0	0	0	0	10	0	0	0	0	0	2	127
86- 90	0	11	7	0	0	0	0	0	0	0	0	0	0	0	0	18
91- 95	0	5	2	0	1	0	0	0	0	0	0	0	0	0	1	9
96-100	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2
> 100	0	18	0	1	8	0	0	0	0	0	0	0	0	0	16	43
TOTALS	0	6510	2580	37	496	60	1	267	3955	37	347	84	11	15	370	14770
AVG. SPEED	0	66	67	64	63	64	63	61	66	64	60	64	63	63	61	66

DAILY SPEED SUMMARY

TOTAL VEHICLES : 14770
AVERAGE SPEED : 65.7
MEDIAN SPEED : 68.0
85th PERCENTILE : 73.0

TOTAL VEHICLES > 55 Mph -- 14000
TOTAL VEHICLES > 60 Mph -- 12053
TOTAL VEHICLES > 65 Mph -- 7752
TOTAL VEHICLES > 70 Mph -- 2851

PERCENTAGE OF VEHICLES > 55 Mph -- 94.8
PERCENTAGE OF VEHICLES > 60 Mph -- 81.6
PERCENTAGE OF VEHICLES > 65 Mph -- 52.5
PERCENTAGE OF VEHICLES > 70 Mph -- 19.3

DISTRIBUTION OF VEHICLE SPEEDS BY HOUR OF DAY

SITE NO : 202 Location : I-40 MP 202 EB / WB Lane(s) : 1 2 3 4
DATE : 11/01/96 County : 005 State-ID : 04 Direction : 3 3 7 7

SPEED RANGE, (Mph)

HOUR	00-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	> 80	TOTALS
0- 1	1	0	0	1	3	6	35	68	70	23	5	0	212
1- 2	0	0	0	3	2	6	26	68	53	19	5	2	184
2- 3	0	0	0	2	2	14	32	54	51	17	10	2	184
3- 4	0	0	1	1	1	10	22	62	71	24	4	3	199
4- 5	0	0	0	0	4	7	30	68	71	31	6	0	217
5- 6	0	0	0	0	2	11	38	93	77	37	10	4	272
QTR TOTALS	1	0	1	7	14	54	183	413	393	151	40	11	1268
6- 7	0	0	0	2	4	13	58	135	163	63	11	4	453
7- 8	0	0	1	2	1	30	65	183	246	112	26	9	675
8- 9	1	0	0	3	6	27	92	197	246	112	31	9	724
9-10	0	0	0	3	9	28	114	247	250	93	22	7	773
10-11	1	0	0	2	8	30	104	265	273	143	29	11	866
11-12	0	1	0	1	6	34	125	239	305	139	37	10	897
QTR TOTALS	2	1	1	13	34	162	558	1266	1483	662	156	50	4388
12-13	2	0	0	2	7	37	104	242	287	175	41	18	915
13-14	2	0	0	1	7	42	106	263	355	142	37	18	973
14-15	1	0	1	2	15	42	139	282	326	162	35	18	1023
15-16	0	0	1	2	8	42	143	272	342	127	41	16	994
16-17	1	0	0	0	7	32	127	330	336	142	39	10	1024
17-18	0	0	1	2	13	27	134	326	330	166	45	27	1071
QTR TOTALS	6	0	3	9	57	222	753	1715	1976	914	238	107	6000
18-19	0	0	0	0	7	33	121	256	252	87	27	8	791
19-20	0	0	0	0	7	37	78	177	191	70	20	6	586
20-21	0	0	0	0	3	24	86	157	191	65	24	6	556
21-22	0	0	0	1	7	30	63	130	174	75	24	3	507
22-23	0	0	0	1	5	12	55	109	140	43	17	3	385
23-24	0	0	0	1	2	13	50	78	101	27	12	5	289
QTR TOTALS	0	0	0	3	31	149	453	907	1049	367	124	31	3114

DAILY SPEED SUMMARY

TOTAL VEHICLES	: 14770	TOTAL VEHICLES > 55 Mph -- 14000		PERCENTAGE OF VEHICLES > 55 Mph --	94.8
AVERAGE SPEED	: 65.7	TOTAL VEHICLES > 60 Mph -- 12053		PERCENTAGE OF VEHICLES > 60 Mph --	81.6
MEDIAN SPEED	: 68.0	TOTAL VEHICLES > 65 Mph -- 7752		PERCENTAGE OF VEHICLES > 65 Mph --	52.5
85th PERCENTILE	: 73.0	TOTAL VEHICLES > 70 Mph -- 2851		PERCENTAGE OF VEHICLES > 70 Mph --	19.3

DISTRIBUTION OF VEHICLE COUNTS BY HOUR OF DAY BY LANE

SITE NO : 202 Location : I-40 MP 202 EB / WB Lane(s) : 1 2 3 4
DATE : 11/01/96 County : 005 State-ID : 04 Direction : 3 3 7 7

HOURLY SUMMARY	VEHICLE COUNTS						
HOUR	L1	L2	L3	L4	L5	L6	TOTALS
0- 1	91	10	13	98	0	0	212
1- 2	92	15	8	69	0	0	184
2- 3	89	17	8	70	0	0	184
3- 4	90	11	12	86	0	0	199
4- 5	105	8	12	92	0	0	217
5- 6	129	11	14	118	0	0	272
QTR TOTALS	596	72	67	533	0	0	1268
6- 7	174	29	38	212	0	0	453
7- 8	244	56	79	296	0	0	675
8- 9	275	60	68	321	0	0	724
9-10	324	64	79	306	0	0	773
10-11	339	85	83	359	0	0	866
11-12	358	104	81	354	0	0	897
QTR TOTALS	1714	398	428	1848	0	0	4388
12-13	376	105	88	346	0	0	915
13-14	380	115	97	381	0	0	973
14-15	387	124	112	400	0	0	1023
15-16	383	116	97	398	0	0	994
16-17	388	135	96	405	0	0	1024
17-18	431	170	113	357	0	0	1071
QTR TOTALS	2345	765	603	2287	0	0	6000
18-19	311	86	70	324	0	0	791
19-20	250	57	37	242	0	0	586
20-21	246	64	39	207	0	0	556
21-22	257	60	29	161	0	0	507
22-23	207	33	18	127	0	0	385
23-24	153	31	12	93	0	0	289
QTR TOTALS	1424	331	205	1154	0	0	3114

DAILY SUMMARY	VEHICLE COUNTS						
	L1	L2	L3	L4	L5	L6	TOTALS
TOTAL	6079	1566	1303	5822	0	0	14770
PERCENT	41.2	10.6	8.8	39.4	0.0	0.0	100.0

DISTRIBUTION OF WEIGHT VIOLATIONS AND INVALID MEASUREMENTS FOR VEHICLES CLASSES 4-15

SITE NO : 202 Location : I-40 MP 202 EB / WB Lane(s) : 1 2 3 4
DATE : 11/01/96 County : 005 State-ID : 04 Direction : 3 3 7 7

CLASSIFICATION	TOTAL VEHICLE COUNTED	VEHICLES WITH INVALID MEASURE	TOTAL VEHICLES WEIGHED	TOTAL VEHICLES OVERWT.	PERCENT VEHICLES OVERWT.	NUMBER OF WEIGHT VIOLATIONS			
						******** AXLE	TANDEM	GROSS	********** BRIDGE
4	37	11	26	0	0	0	0	0	0
5	444	111	333	6	2	6	0	0	0
6	58	27	31	3	10	0	3	0	3
7	1	0	1	1	100	0	1	0	1
8	242	75	167	7	4	1	6	0	6
9	3953	1399	2554	800	31	7	777	463	800
10	37	16	21	9	43	0	9	8	8
11	347	165	182	24	13	18	1	14	14
12	84	35	49	2	4	0	0	2	2
13	11	8	3	3	100	0	3	3	3
14	15	5	10	7	70	4	4	6	7
15	273	110	163	8	5	2	5	3	6
TOTALS	5502	1962	3540	870	25	38	809	499	850

NUMBER OF VEHICLES WITH DATA ERRORS : 14
SPEED : 12 WEIGHT : 2

PERCENT VEHICLES NOT CLASSFIED (CLASS 15) : 5.0

PERCENT VEHICLES WITH INVALID MEASUREMENTS : 35.7

DISTRIBUTION OF WEIGHT VIOLATIONS BY HOUR OF DAY FOR VEHICLE CLASSIFICATIONS 4 THROUGH 15

SITE NO : 202 Location : I-40 MP 202 EB / WB Lane(s) : 1 2 3 4
DATE : 11/01/96 County : 005 State-ID : 04 Direction : 3 3 7 7

HOURLY SUMMARY

HOUR	TOTAL VEHICLES WEIGHED	TOTAL VEHICLES OVERWEIGHT	PERCENT VEHICLES OVERWEIGHT	NUMBER OF WEIGHT VIOLATIONS AXLE	TANDEM	GROSS	BRIDGE
0- 1	94	19	20	0	18	10	19
1- 2	73	15	21	0	15	6	15
2- 3	81	23	28	1	20	12	22
3- 4	91	28	31	1	27	14	27
4- 5	94	19	20	1	18	9	18
5- 6	96	19	20	1	17	7	19
QTR TOTALS	529	123	23	4	115	58	120
6- 7	114	20	18	1	18	6	20
7- 8	155	43	28	0	43	25	43
8- 9	171	43	25	2	41	27	41
9-10	178	46	26	4	40	22	43
10-11	207	50	24	2	45	32	49
11-12	216	62	29	1	59	48	60
QTR TOTALS	1041	264	25	10	246	160	256
12-13	209	46	22	3	43	25	46
13-14	205	46	22	4	43	31	44
14-15	207	56	27	3	53	31	55
15-16	180	49	27	4	44	31	46
16-17	188	53	28	4	49	30	53
17-18	204	41	20	1	36	23	41
QTR TOTALS	1193	291	24	19	268	171	285
18-19	146	41	28	1	39	25	40
19-20	127	34	27	0	32	20	34
20-21	146	42	29	0	41	25	42
21-22	126	27	21	1	25	15	26
22-23	126	24	19	2	20	9	23
23-24	106	24	23	1	23	16	24
QTR TOTALS	777	192	25	5	180	110	189

DAILY SUMMARY

TOTAL	TOTAL VEHICLES WEIGHED	TOTAL VEHICLES OVERWEIGHT	PERCENT VEHICLES OVERWEIGHT	NUMBER OF WEIGHT VIOLATIONS AXLE	TANDEM	GROSS	BRIDGE
	3540	870	25	38	809	499	850

DISTRIBUTION OF OVERWEIGHT VEHICLES BY HOUR OF DAY FOR VEHICLE CLASSIFICATIONS 4 THROUGH 15

SITE NO : 202 Location : I-40 MP 202 EB / WB Lane(s) : 1 2 3 4
DATE : 11/01/96 County : 005 State-ID : 04 Direction : 3 3 7 7

HOURLY SUMMARY

HOUR	TOTAL VEH"S WEIGHED	TOTAL VEH"S OVERWT	PERCENT VEH"S OVERWT	NUMBER OVERWEIGHT VEHICLES 4	5	6	7	8	9	10	11	12	13	14	15
0- 1	94	19	20	0	0	0	0	0	18	1	0	0	0	0	0
1- 2	73	15	21	0	0	0	0	0	15	0	0	0	0	0	0
2- 3	81	23	28	0	0	0	0	0	19	0	3	0	0	0	1
3- 4	91	28	31	0	0	0	0	1	26	0	1	0	0	0	0
4- 5	94	19	20	0	0	0	0	0	18	0	1	0	0	0	0
5- 6	96	19	20	0	0	0	0	1	16	0	1	0	0	1	0
QTR TOTALS	529	123	23	0	0	0	0	2	112	1	6	0	0	1	1
6- 7	114	20	18	0	0	0	0	0	18	0	1	0	0	1	0
7- 8	155	43	28	0	0	2	0	1	38	0	0	0	1	1	0
8- 9	171	43	25	0	1	0	0	0	39	1	0	0	0	0	2
9-10	178	46	26	0	2	0	0	2	39	1	1	0	0	1	0
10-11	207	50	24	0	0	0	1	0	47	0	2	0	0	0	0
11-12	216	62	29	0	1	0	0	0	55	3	1	0	1	0	1
QTR TOTALS	1041	264	25	0	4	2	1	3	236	5	5	0	2	3	3
12-13	209	46	22	0	0	0	0	0	44	0	0	1	0	1	0
13-14	205	46	22	0	1	0	0	0	39	2	2	0	1	0	1
14-15	207	56	27	0	0	1	0	1	50	0	2	0	0	0	2
15-16	180	49	27	0	0	0	0	1	43	0	3	0	0	1	1
16-17	188	53	28	0	0	0	0	0	52	0	0	0	0	1	0
17-18	204	41	20	0	0	0	0	0	40	0	1	0	0	0	0
QTR TOTALS	1193	291	24	0	1	1	0	2	268	2	8	1	1	3	4
18-19	146	41	28	0	0	0	0	0	39	0	1	1	0	0	0
19-20	127	34	27	0	0	0	0	0	34	0	0	0	0	0	0
20-21	146	42	29	0	0	0	0	0	41	1	0	0	0	0	0
21-22	126	27	21	0	0	0	0	0	26	0	1	0	0	0	0
22-23	126	24	19	0	1	0	0	0	21	0	2	0	0	0	0
23-24	106	24	23	0	0	0	0	0	23	0	1	0	0	0	0
QTR TOTALS	777	192	25	0	1	0	0	0	184	1	5	1	0	0	0

DAILY SUMMARY

HOUR	TOTAL VEH"S WEIGHED	TOTAL VEH"S OVERWT	PERCENT VEH"S OVERWT	NUMBER OVERWEIGHT VEHICLES 4	5	6	7	8	9	10	11	12	13	14	15
TOTAL	3540	870	25	0	6	3	1	7	800	9	24	2	3	7	8

DISTRIBUTION OF GROSS WEIGHTS FOR VEHICLE CLASSIFICATIONS 4 THROUGH 15

SITE NO : 202 Location : I-40 MP 202 EB / WB Lane(s) : 1 2 3 4
DATE : 11/01/96 County : 005 State-ID : 04 Direction : 3 3 7 7

VEHICLE COUNTS

GROSS WT (KIPS)	X	X	X	4	5	6	7	8	9	10	11	12	13	14	15	TOTALS
0- 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5- 10	0	0	0	0	90	0	0	0	0	0	0	0	0	0	4	94
10- 15	0	0	0	0	111	1	0	17	0	0	0	0	0	0	18	147
15- 20	0	0	0	0	47	5	0	48	0	0	0	0	0	0	42	142
20- 25	0	0	0	9	48	3	0	36	6	0	0	0	0	0	31	133
25- 30	0	0	0	1	29	10	0	27	11	1	1	0	0	1	19	100
30- 35	0	0	0	3	8	2	0	22	25	0	3	0	0	0	13	76
35- 40	0	0	0	7	0	3	0	8	46	1	2	0	0	0	8	75
40- 45	0	0	0	5	0	4	0	0	71	1	2	3	0	0	2	88
45- 50	0	0	0	1	0	1	0	4	120	0	1	0	0	0	6	133
50- 55	0	0	0	0	0	1	1	4	175	0	5	0	0	1	3	190
55- 60	0	0	0	0	0	1	0	1	208	1	15	2	0	0	2	230
60- 65	0	0	0	0	0	0	0	0	246	3	28	5	0	0	2	284
65- 70	0	0	0	0	0	0	0	0	273	0	49	22	0	0	4	348
70- 75	0	0	0	0	0	0	0	0	372	3	39	11	0	0	2	427
75- 80	0	0	0	0	0	0	0	0	535	3	23	4	0	2	4	571
80- 85	0	0	0	0	0	0	0	0	427	3	13	2	0	4	1	450
85- 90	0	0	0	0	0	0	0	0	35	0	1	0	1	0	1	38
90- 95	0	0	0	0	0	0	0	0	2	0	0	0	0	1	1	4
95-100	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	3
100-105	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
105-110	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
110-115	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	2
115-120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
> 120	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	2
TOTALS	0	0	0	26	333	31	1	167	2554	21	182	49	3	10	163	3540

DISTRIBUTION OF 18 KIP ESALS BY HOUR OF DAY FOR VEHICLE CLASSIFICATIONS 4 - 15

SITE NO : 202 Location : I-40 MP 202 EB / WB Lane(s) : 1 2 3 4
DATE : 11/01/96 County : 005 State-ID : 04 Direction : 3 3 7 7

FOR : RIGID PAVEMENT / DEPTH = 9 VEH STATUS : ALL

HOURLY SUMMARY			ESALS BY HOUR BY CLASS											
HOUR	TOTAL VEH'S WEIGHED	TOTAL ESALS	4	5	6	7	8	9	10	11	12	13	14	15
0- 1	94	182.0	1.5	0.1	0.0	0.0	0.8	164.5	2.7	10.6	0.8	0.0	0.0	0.9
1- 2	73	143.8	0.0	0.2	0.0	0.0	0.3	134.2	0.0	9.0	0.0	0.0	0.0	0.2
2- 3	81	198.4	0.0	0.1	0.2	0.0	0.6	168.7	0.0	23.5	1.7	0.0	0.0	3.6
3- 4	91	213.1	0.8	0.9	0.8	0.0	2.1	197.4	0.0	5.1	3.9	0.0	0.0	2.0
4- 5	94	191.4	0.0	1.1	2.7	0.0	0.9	171.8	0.0	11.1	1.0	0.0	0.0	2.7
5- 6	96	196.9	1.2	0.7	0.0	0.0	4.7	157.9	0.0	22.4	1.6	0.0	8.0	0.4
QTR TOTALS	529	1125.7	3.6	3.1	3.7	0.0	9.4	994.6	2.7	81.8	9.0	0.0	8.0	9.9
6- 7	114	227.1	1.2	0.4	0.1	0.0	1.0	197.7	0.0	19.1	2.8	0.0	4.8	0.0
7- 8	155	327.1	1.3	1.2	10.9	0.0	4.3	285.9	0.0	11.6	0.0	7.4	4.4	0.2
8- 9	171	334.1	1.6	5.4	0.3	0.0	1.5	303.4	2.7	7.7	0.0	0.0	0.0	11.6
9-10	178	358.6	0.0	6.5	0.2	0.0	8.3	313.3	8.6	13.8	1.2	0.0	3.4	3.3
10-11	207	429.3	1.7	2.4	0.2	1.3	3.3	380.8	3.7	26.1	3.6	0.0	0.0	6.3
11-12	216	438.7	0.7	7.9	0.2	0.0	3.5	374.2	17.3	19.0	1.1	2.8	0.0	12.1
QTR TOTALS	1041	2115.0	6.5	23.8	11.8	1.3	21.8	1855.3	32.3	97.2	8.7	10.1	12.6	33.5
12-13	209	379.9	0.0	5.8	0.7	0.0	2.9	342.2	2.5	11.1	5.1	0.0	8.9	0.8
13-14	205	477.2	3.4	6.4	1.0	0.0	3.4	410.0	15.1	16.9	2.0	9.9	0.0	9.1
14-15	207	407.6	1.0	8.4	3.6	0.0	6.7	350.4	2.0	23.2	1.6	0.0	0.0	10.7
15-16	180	377.9	0.4	6.0	0.6	0.0	7.0	323.2	1.9	24.7	3.2	0.0	4.2	6.6
16-17	188	415.8	0.0	1.0	0.0	0.0	2.0	379.5	0.0	22.2	1.1	0.0	7.1	2.9
17-18	204	349.0	0.0	5.7	0.1	0.0	2.1	313.5	0.0	16.6	3.6	0.0	0.0	7.4
QTR TOTALS	1193	2407.4	4.8	33.3	6.1	0.0	24.1	2118.7	21.6	114.7	16.6	9.9	20.3	37.3
18-19	146	323.0	1.7	1.1	0.0	0.0	0.4	287.4	0.0	22.7	4.6	0.0	0.8	4.2
19-20	127	257.1	0.0	2.3	0.0	0.0	0.9	242.4	0.0	3.1	2.6	0.0	0.0	5.9
20-21	146	355.3	0.5	1.0	0.0	0.0	3.6	316.4	10.9	18.6	2.1	0.0	0.0	2.2
21-22	126	253.4	0.0	3.0	0.0	0.0	1.1	239.2	0.0	7.1	2.0	0.0	0.0	1.1
22-23	126	249.4	0.6	2.1	0.2	0.0	0.6	217.9	0.0	23.4	4.4	0.0	0.0	0.1
23-24	106	232.7	1.0	0.4	0.0	0.0	1.7	210.2	0.7	16.3	2.5	0.0	0.0	0.0
QTR TOTALS	777	1670.9	3.8	9.8	0.2	0.0	8.2	1513.5	11.7	91.2	18.1	0.0	0.8	13.6

DAILY SUMMARY	TOTALS	4	5	6	7	8	9	10	11	12	13	14	15
VEH'S WEIGHED	3540	26	333	31	1	167	2554	21	182	49	3	10	163
18 KIP ESALS	7319.0	18.6	70.0	21.8	1.3	63.5	6482.1	68.3	384.9	52.5	20.0	41.7	94.3
AVERAGE ESALS	2.07	0.72	0.21	0.70	1.25	0.38	2.54	3.25	2.12	1.07	6.68	4.17	0.58

DISTRIBUTION OF TRUCK RECORD DATA BY LANE

SITE NO : 202 Location : I-40 MP 202 EB / WB Lane(s) : 1 2 3 4
DATE : 11/01/96 County : 005 State-ID : 04 Direction : 3 3 7 7

	LANE NUMBER													
CLASS	L1		L2		L3		L4		L5		L6		ALL LANES	
	COUNT	%	COUNT	%	COUNT	%	COUNT	%	COUNT	%	COUNT	%	COUNT	%
1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	7	0.2	1	0.2	0	0.0	0	0.0	0	0.0	0	0.0	8	0.1
3	165	5.6	37	6.8	26	10.3	147	7.0	0	0.0	0	0.0	375	6.4
4	18	0.6	3	0.5	1	0.4	15	0.7	0	0.0	0	0.0	37	0.6
5	189	6.4	33	6.0	16	6.3	206	9.8	0	0.0	0	0.0	444	7.5
6	11	0.4	3	0.5	5	2.0	39	1.8	0	0.0	0	0.0	58	1.0
7	1	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0
8	122	4.1	10	1.8	8	3.2	102	4.8	0	0.0	0	0.0	242	4.1
9	2116	71.2	422	77.0	172	68.0	1243	58.9	0	0.0	0	0.0	3953	67.2
10	20	0.7	4	0.7	2	0.8	11	0.5	0	0.0	0	0.0	37	0.6
11	168	5.7	7	1.3	8	3.2	164	7.8	0	0.0	0	0.0	347	5.9
12	32	1.1	2	0.4	8	3.2	42	2.0	0	0.0	0	0.0	84	1.4
13	6	0.2	3	0.5	0	0.0	2	0.1	0	0.0	0	0.0	11	0.2
14	9	0.3	1	0.2	0	0.0	5	0.2	0	0.0	0	0.0	15	0.3
15	108	3.6	22	4.0	7	2.8	136	6.4	0	0.0	0	0.0	273	4.6
TOTAL	2972	100.0	548	100.0	253	100.0	2112	100.0	0	0.0	0	0.0	5885	100.0

	LANE NUMBER													
STATUS	L1		L2		L3		L4		L5		L6		ALL LANES	
	COUNT	%	COUNT	%	COUNT	%	COUNT	%	COUNT	%	COUNT	%	COUNT	%
LEGAL	1476	49.7	324	59.1	178	70.4	994	47.1	0	0.0	0	0.0	2972	50.5
OVERWT	628	21.1	26	4.7	6	2.4	210	9.9	0	0.0	0	0.0	870	14.8
INVALID	868	29.2	198	36.1	69	27.3	908	43.0	0	0.0	0	0.0	2043	34.7
TOTAL	2972	50.5	548	9.3	253	4.3	2112	35.9	0	0.0	0	0.0	5885	100.0

Appendix B: System Monthly Data Summaries

I. Monthly Summaries for Site Classification Counts

II. Monthly Weight Summaries for Weighed Vehicles and Weight Violations

DISTRIBUTION OF VEHICLE CLASSIFICATIONS BY DAY OF MONTH

SITE NO : 202 Location : I-40 MP 202 EB / WB Lane(s) : 1 2 3 4
DATE : 9/96 County : 005 State-ID : 04 Direction : 3 3 7 7

DAILY SUMMARY DAY	VEHICLE COUNTS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	TOTALS
1 SUN	0	3231	1264	7	210	21	0	141	1848	13	139	24	1	2	184	7085
2 MON	0	3490	1359	12	171	12	0	130	776	4	129	22	0	0	158	6263
3 TUE	0	2886	1178	23	254	38	0	153	1036	9	123	26	5	7	180	5918
4 WED	0	2840	1147	29	281	28	0	155	2558	7	180	56	2	10	206	7499
5 THU	0	2993	1266	23	278	39	0	168	2625	10	184	38	10	11	226	7871
6 FRI	0	3554	1416	21	292	38	1	142	2634	13	189	37	2	6	195	8540
7 SAT	0	3302	1281	10	254	18	0	127	3092	16	159	55	1	3	197	8515
DAILY AVG	0	3185	1273	18	249	28	0	145	2081	10	158	37	3	6	192	7384
8 SUN	0	2798	1049	10	181	8	0	112	1723	6	159	27	1	2	143	6219
9 MON	0	2831	1180	18	238	32	0	149	1066	13	120	37	2	12	159	5857
10 TUE	0	2866	1096	27	223	34	1	169	2427	14	151	48	5	8	170	7239
11 WED	0	2891	1156	20	241	35	0	188	2794	12	191	57	4	13	212	7814
12 THU	0	3094	1256	18	280	32	0	135	2233	13	203	57	1	11	177	7510
13 FRI	0	3581	1500	24	244	29	1	134	2560	22	224	40	3	9	188	8559
14 SAT	0	3428	1354	14	203	33	0	109	3052	14	183	53	2	1	210	8656
DAILY AVG	0	3070	1227	19	230	29	0	142	2265	13	176	46	3	8	180	7408
15 SUN	0	3032	1164	6	213	26	0	120	1654	16	177	30	8	2	166	6614
16 MON	0	2851	1201	16	264	31	0	147	1025	19	130	41	17	6	170	5918
17 TUE	0	2850	1234	17	247	42	1	153	2375	20	150	50	3	5	171	7318
18 WED	0	3030	1185	35	257	39	0	161	2780	14	194	55	2	9	201	7962
19 THU	0	3072	1296	24	270	45	1	161	2267	16	211	52	8	6	201	7630
20 FRI	0	3717	1464	19	254	42	0	146	2478	18	211	39	10	6	194	8598
21 SAT	0	3409	1362	9	229	27	0	118	3048	21	187	44	2	2	195	8653
DAILY AVG	0	3137	1272	18	248	36	0	144	2232	18	180	44	7	5	185	7528
22 SUN	0	3258	1204	11	213	15	0	118	1526	13	153	24	2	4	155	6696
23 MON	0	3207	1285	31	302	32	1	157	1083	13	125	36	5	7	165	6449
24 TUE	0	3085	1304	22	321	44	0	169	2464	14	174	58	4	2	210	7871
25 WED	0	2992	1305	21	250	39	1	184	2688	20	200	58	3	6	203	7970
26 THU	0	3454	1460	16	302	43	0	167	2296	14	194	39	6	7	204	8202
27 FRI	0	3786	1616	17	257	31	0	142	2580	19	198	53	2	6	186	8893
28 SAT	0	3412	1336	12	242	28	0	153	3221	14	192	44	2	4	197	8857
DAILY AVG	0	3313	1359	19	270	33	0	156	2265	15	177	45	3	5	189	7848
29 SUN	0	3147	1193	20	254	16	1	141	1706	11	149	18	0	0	149	6805
30 MON	0	2931	1277	18	251	26	0	206	1041	15	150	33	2	3	181	6134
DAILY AVG	0	3039	1235	19	253	21	1	174	1373	13	150	25	1	2	165	6469

MONTHLY SUMMARY	VEHICLE COUNTS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	TOTALS
TOTAL	0	95018	38388	550	7476	923	8	4455	64656	423	5129	1251	115	170	5553	224115
PERCENT	0.0	42.4	17.1	0.2	3.3	0.4	0.0	2.0	28.8	0.2	2.3	0.6	0.1	0.1	2.5	100.0
DAILY AVG	0	3167	1280	18	249	31	0	149	2155	14	171	42	4	6	185	7471

MONTHLY SUMMARY FOR VEHICLE CLASSIIFICATION COUNTS.

MONTHLY SUMMARY - WEIGHED VEHICLES

DISTRIBUTION OF WEIGHED VEHICLES BY DAY OF MONTH FOR VEHICLE CLASSIFICATIONS 4 THROUGH 15

SITE NO : 202 Location : I-40 MP 202 EB / WB Lane(s) : 1 2 3 4
DATE : 9/96 County : 005 State-ID : 04 Direction : 3 3 7 7

DAILY SUMMARY

DAY	TOTAL VEH*S CNTD	TOTAL VEH*S WGHD	TOTAL VEH*S OVWT	PCT VEH*S OVWT	COUNTED VEHICLES 4	5	6	7	8	9	10	11	12	13	14	15
1 SUN	2399	584	24	7	174	20	0	118	1783	13	136	24	0	2	122	3
2 MON	1307	192	15	12	147	11	0	115	764	4	124	22	0	0	108	4
3 TUE	1674	293	18	22	207	37	0	127	1011	9	122	26	2	7	104	2
4 WED	3290	722	22	26	233	26	0	136	2490	6	177	55	2	10	129	5
5 THU	3343	758	23	23	228	36	0	145	2547	10	180	38	9	11	116	6
6 FRI	3331	726	22	21	241	34	1	123	2555	12	185	37	1	6	115	7
7 SAT	3691	853	23	10	204	12	0	102	3023	16	155	53	1	3	112	8
8 SUN	2215	572	26	10	153	8	0	98	1673	6	153	26	1	2	85	9
9 MON	1690	274	16	18	185	32	0	136	1044	13	120	36	1	12	93	10
10 TUE	3093	680	22	27	192	31	1	149	2366	14	147	47	4	8	107	11
11 WED	3525	745	21	20	208	30	0	165	2715	11	187	57	4	13	115	12
12 THU	2942	636	22	18	237	30	0	114	2168	12	198	55	1	11	98	13
13 FRI	3274	674	21	24	204	26	1	121	2494	21	218	39	3	9	114	14
14 SAT	3629	723	20	12	163	32	0	85	2974	14	180	51	2	1	115	15
15 SUN	2236	545	24	6	174	25	0	102	1598	16	171	30	7	2	105	16
16 MON	1692	267	16	16	208	29	0	132	1001	19	126	39	15	6	101	17
17 TUE	2992	587	20	16	193	39	1	134	2291	20	148	45	3	5	97	18
18 WED	3543	755	21	35	219	35	0	144	2720	14	190	55	1	9	121	19
19 THU	3032	571	19	22	229	41	1	134	2198	16	208	50	5	6	122	24
20 FRI	3193	661	21	19	194	38	0	130	2420	17	211	38	10	6	110	21
21 SAT	3659	801	22	9	186	21	0	111	2971	20	178	43	2	2	116	22
22 SUN	2074	434	21	11	168	14	0	105	1480	13	150	24	2	4	103	23
23 MON	1791	262	15	30	252	32	1	138	1066	13	118	33	5	7	96	25
24 TUE	3243	632	19	22	272	40	0	150	2397	12	169	57	4	2	118	20
25 WED	3436	754	22	21	211	37	1	153	2618	18	197	56	2	6	116	26
26 THU	3065	655	21	16	254	40	0	152	2234	14	188	38	5	7	117	27
27 FRI	3287	703	21	17	206	30	0	127	2518	19	194	52	2	6	116	28
28 SAT	3908	808	21	12	201	24	0	135	3146	13	192	43	2	4	136	29
29 SUN	2298	457	20	20	209	16	1	120	1664	11	145	18	0	0	94	30
30 MON	1782	260	15	18	217	23	0	181	1025	13	149	32	2	3	119	0

MONTHLY SUMMARY

DAY	TOTAL VEH*S CNTD	TOTAL VEH*S WGHD	TOTAL VEH*S OVWT	PCT VEH*S OVWT	COUNTED VEHICLES 4	5	6	7	8	9	10	11	12	13	14	15
TOTALS	84634	17584	613	3.5	6169	849	8	3882	62954	409	5016	1219	98	170	3320	464
PERCENT	100.0				7.3	1.0	0.0	4.6	74.4	0.5	5.9	1.4	0.1	0.2	3.9	0.5

Appendix C: Sample Office to Site Communication: Remote Interrogation of a WIM System, Showing Calibration Parameters

INTERROGATING A WIM SYSTEM AT MP 52 ON US-93 NB.

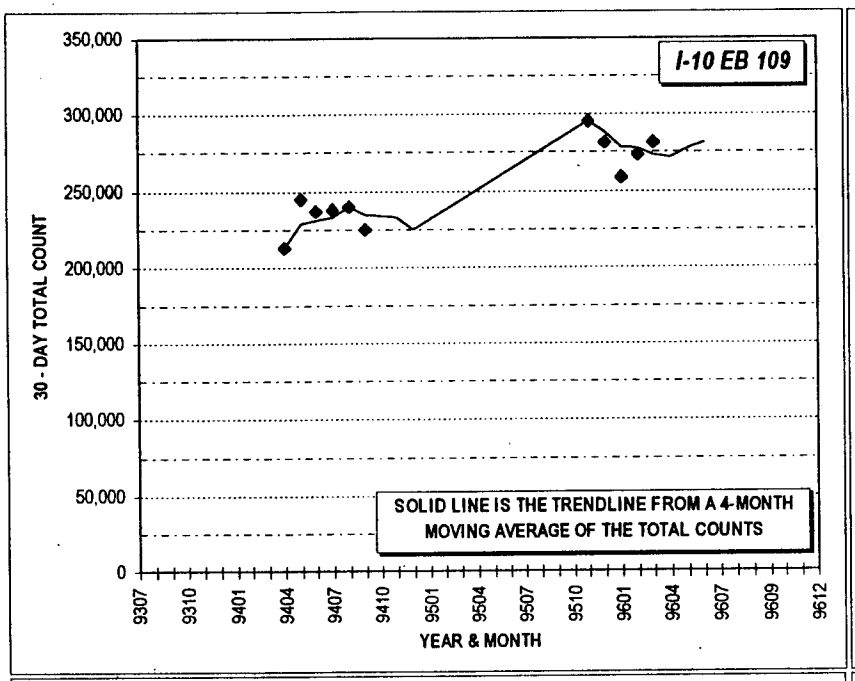
```
Disk logging on

Mode:
Mode:          CHECKING  SYSTEM  PARAMETERS
Mode:
Mode:0

Lane 1
Sensiti. leading  weigh pad:  1032
Sensiti. trailing weigh pad:  1031
Sensitivity  :  2090
Corr.-Fact. 1:  1000
Corr.-Fact. 2:  1000
Corr.-Fact. 3:  1000
Speed-Point 1:  4000
Speed-Point 2:  5000
Speed-Point 3:  6000
Peak limit   :    10

Lane 2
Sensiti. leading  weigh pad:  1017
Sensiti. trailing weigh pad:   983
Sensitivity  :  2250
Corr.-Fact. 1:  1000
Corr.-Fact. 2:  1000
Corr.-Fact. 3:  1010
Speed-Point 1:  4000
Speed-Point 2:  5000
Speed-Point 3:  6000
Peak limit   :    10
Mode:
Mode:
Mode:1
Weight select: 0 lbs
Length select:  feet
Speed  select:  mph

Number of Lanes: 2
Station code:   525
Distance weigh pads 1-2 (cm) lane 1:   495
Distance weigh pads 1-2 (cm) lane 2:   495
Mode:
Mode:
Mode:2
Weight select: 0 lbs
Length select:  feet
Speed  select:  mph
```

```
Weight lim. front  axle:   2000
Weight lim. single axle:   2000
Weight lim. tandem axle:   3400
Weight lim. triple axle:   3400
Bridge Formula:
Weight lim. front  axle:   6000
Weight lim. single axle:   6000
Distinct. single - multiple axles,
   upper distance:    800
   lower distance:    333

Reg. of overloaded vehicles.
Overload threshold :          0
Reg. Vehicle, lim. front axle:   350
Speed max.:  9999
Delay for WIM   Loop switch off [in %]:    15
Delay for CLASS Loop switch off [in %]:    15
Axle timeout based on 60 mph            :    700
Mode:
Mode:
Mode:
Mode:
Mode:3

No. of axles   :2

Type              :    1
Dist. axle low    :   10
Dist. axle high   :  600
Total weight low  :   10
Total weight high :  300
Lim. total weight : 8000

Type              :    2
Dist. axle low    :  610
Dist. axle high   :  999
Total weight low  :  100
Total weight high :  799
Lim. total weight : 8000

Type              :    3
Dist. axle low    : 1000
Dist. axle high   : 1450
Total weight low  :    0
Total weight high :  799
Lim. total weight : 8000

Type              :    4
Dist. axle low    : 2310
Dist. axle high   : 4000
```

```
Total weight low  : 1200
Total weight high :    0
Lim. total weight : 8000

Type              :    5
Dist. axle low    :  880
Dist. axle high   : 2309
Total weight low  :  800
Total weight high :    0
Lim. total weight : 8000

Type              :   15
Dist. axle low    :    0
Dist. axle high   :    0
Total weight low  :    0
Total weight high :    0
Lim. total weight :    0

Type              :   15
Dist. axle low    :    0
Dist. axle high   :    0
Total weight low  :    0
Total weight high :    0
Lim. total weight :    0

Type              :   15
Dist. axle low    :    0
Dist. axle high   :    0
Total weight low  :    0
Total weight high :    0
Lim. total weight :    0

Mode:
Mode:
Mode:
Mode:4

No. of axles   :2
Dist. axle low    :    3
Weight            : 3400
Dist. axle high   :   10
Weight            : 4000
Weight            :    4   3400
Weight            :    5   3400
Weight            :    6   3400
Weight            :    7   3400
Weight            :    8   3800
Weight            :    9   3900

No. of axles   :
```

```
Mode:
Mode:
Mode:
Mode:
Mode:5
 DAW 200   Version: 8.54  [12-Apr-93]
 No. Storage:    64
 Features : Self Calibration    AVI  Temperature
Compensation
  258  1000   268  1000   273  1000   278  1000   283  1000


Lane configuration (W = WIM, C = Class.): WWWW

Weight in kg   ? (Y/N):
Length in  m   ? (Y/N):
Speed in  km/h ? (Y/N):
Mode:
Mode:
Mode:
Mode:
Mode:6
```

Appendix D: Vehicle Count Trends for the Period January 1993 to June 1996


I-10 EB 109
30 - DAY TOTAL COUNT
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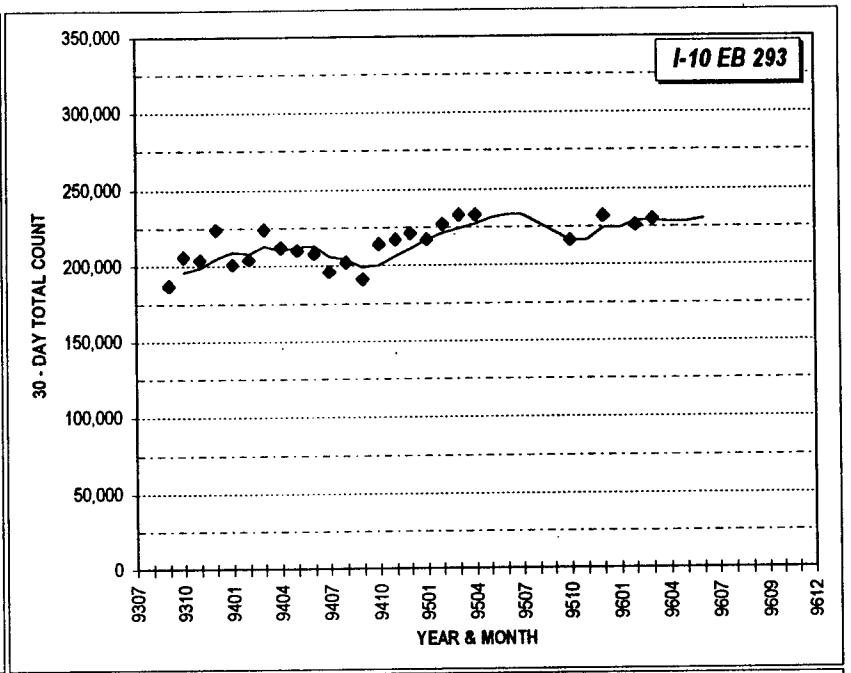
300,000
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH
SOLID LINE IS THE TRENDLINE FROM A 4-MONTH MOVING AVERAGE OF THE TOTAL COUNTS


I-10 EB 293
30 - DAY TOTAL COUNT
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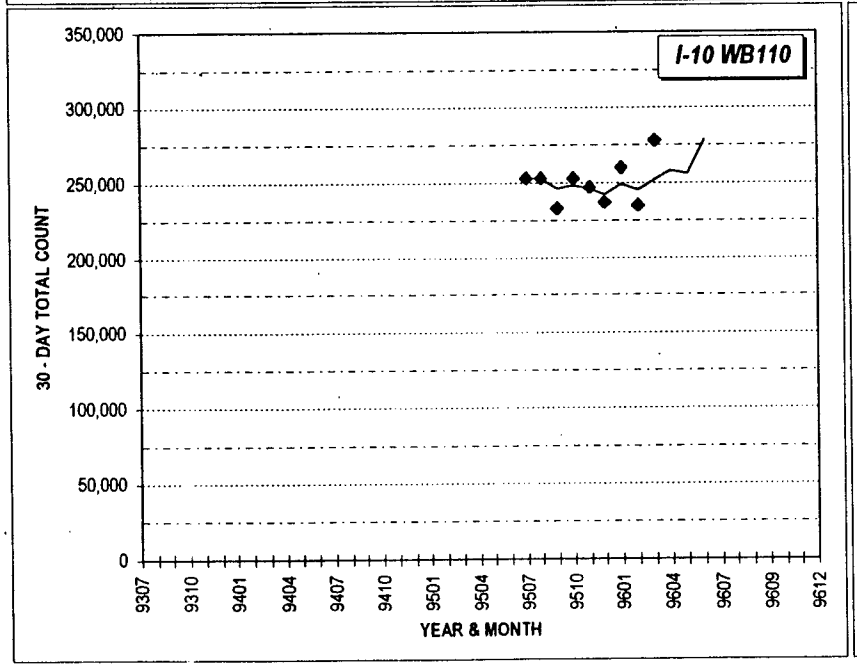
300,000
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH


I-10 WB110
30 - DAY TOTAL COUNT
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300,000
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
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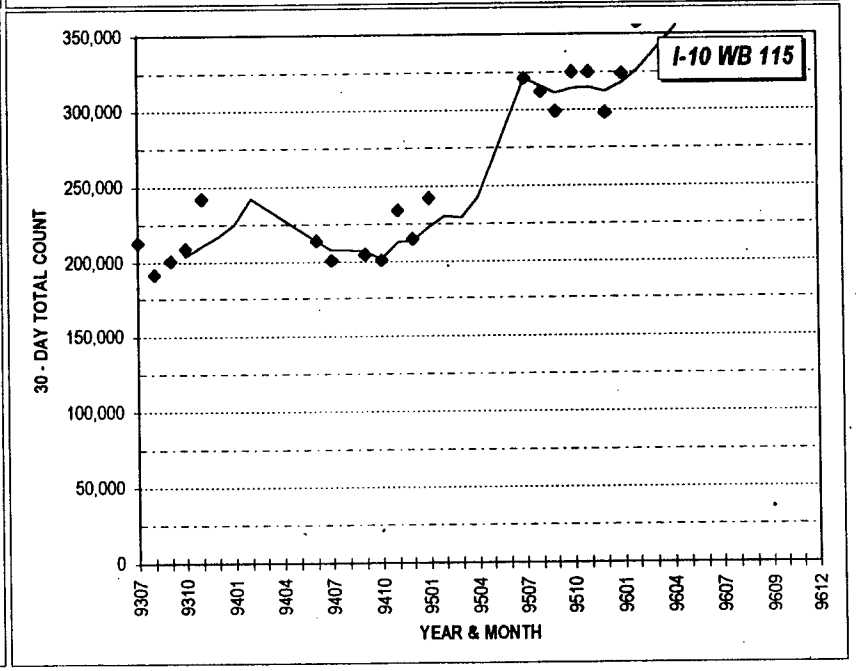
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH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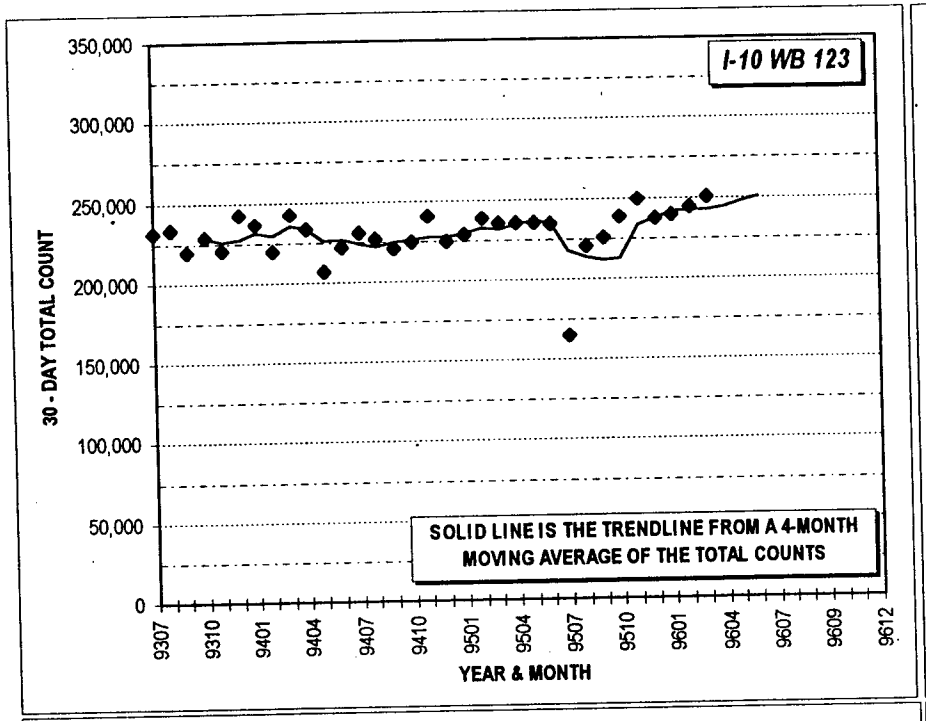
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH


I-10 WB 123
30 - DAY TOTAL COUNT
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250,000
200,000
150,000
100,000
50,000
0
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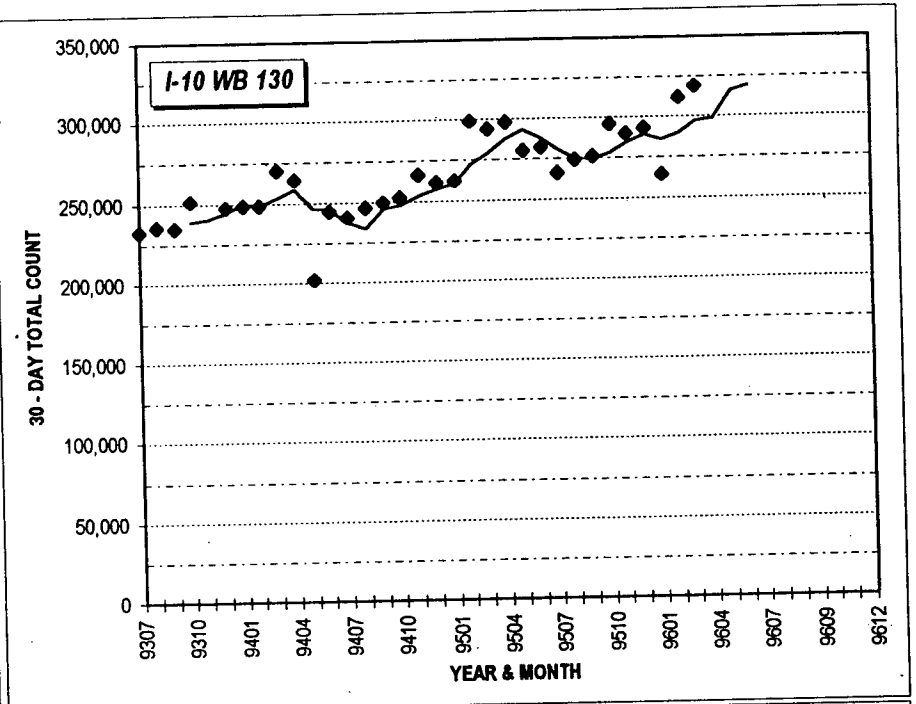
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH
SOLID LINE IS THE TRENDLINE FROM A 4-MONTH MOVING AVERAGE OF THE TOTAL COUNTS


I-10 WB 130
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200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
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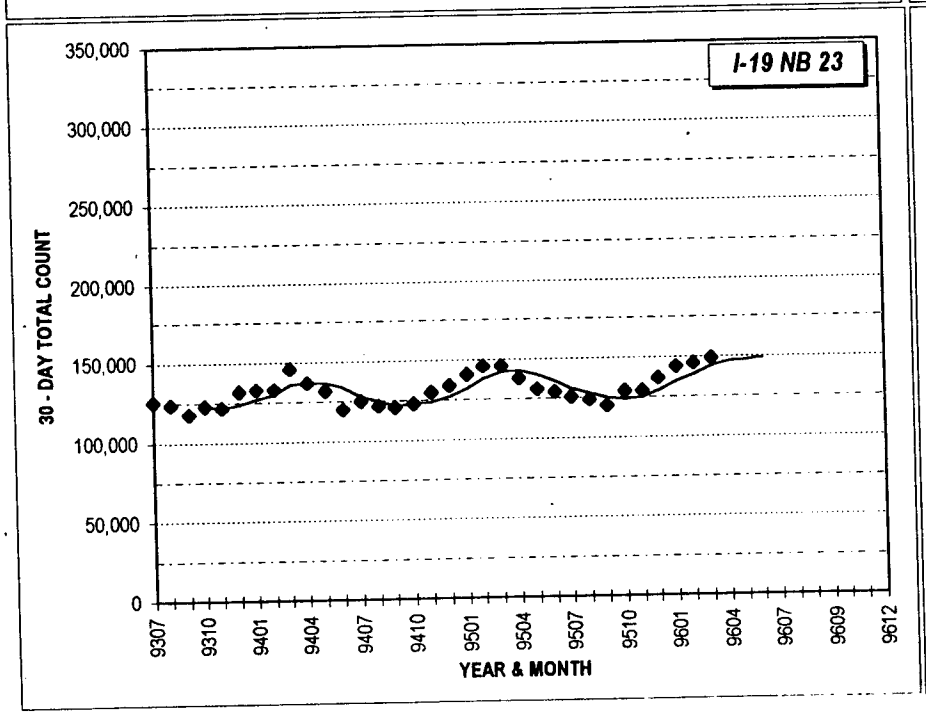
9510
9601
9604
9607
9609
9612
YEAR & MONTH


I-19 NB 23
30 - DAY TOTAL COUNT
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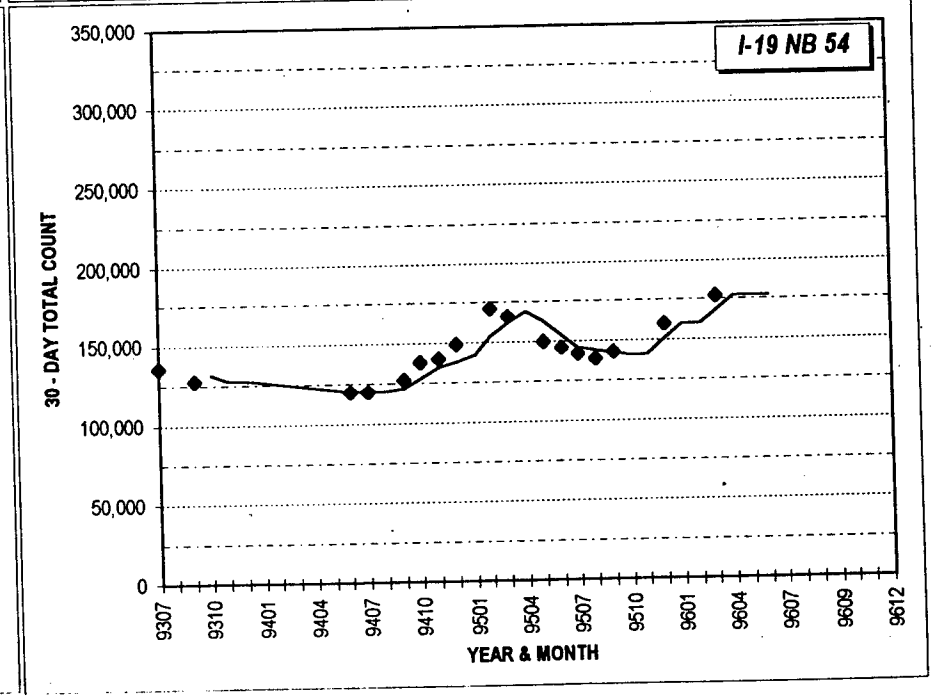
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH


I-19 NB 54
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250,000
200,000
150,000
100,000
50,000
0
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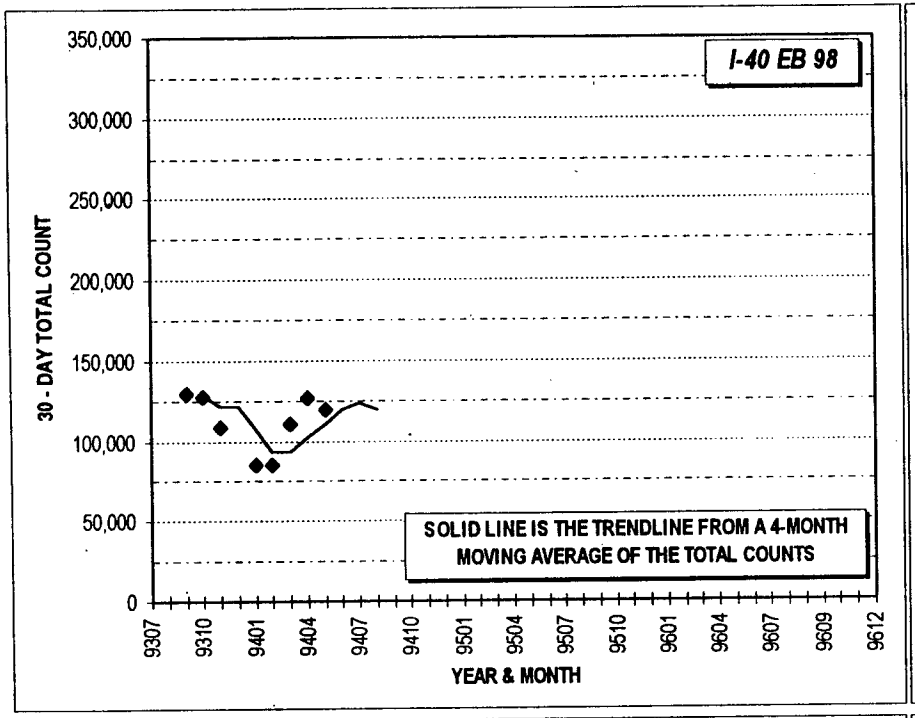
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH


I-40 EB 98
30 - DAY TOTAL COUNT
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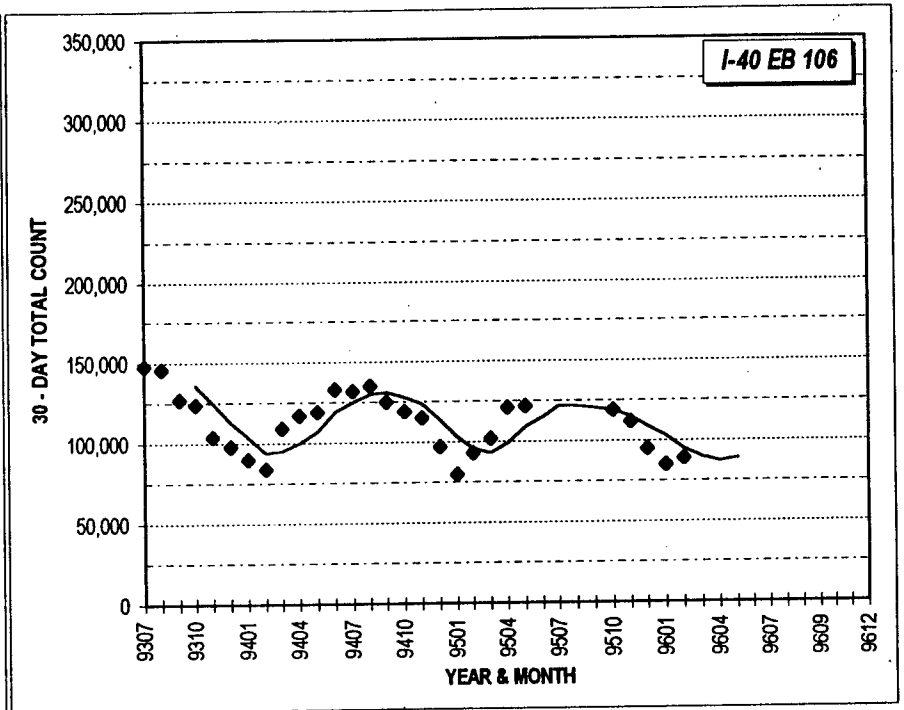
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH
SOLID LINE IS THE TRENDLINE FROM A 4-MONTH MOVING AVERAGE OF THE TOTAL COUNTS


I-40 EB 106
30 - DAY TOTAL COUNT
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250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
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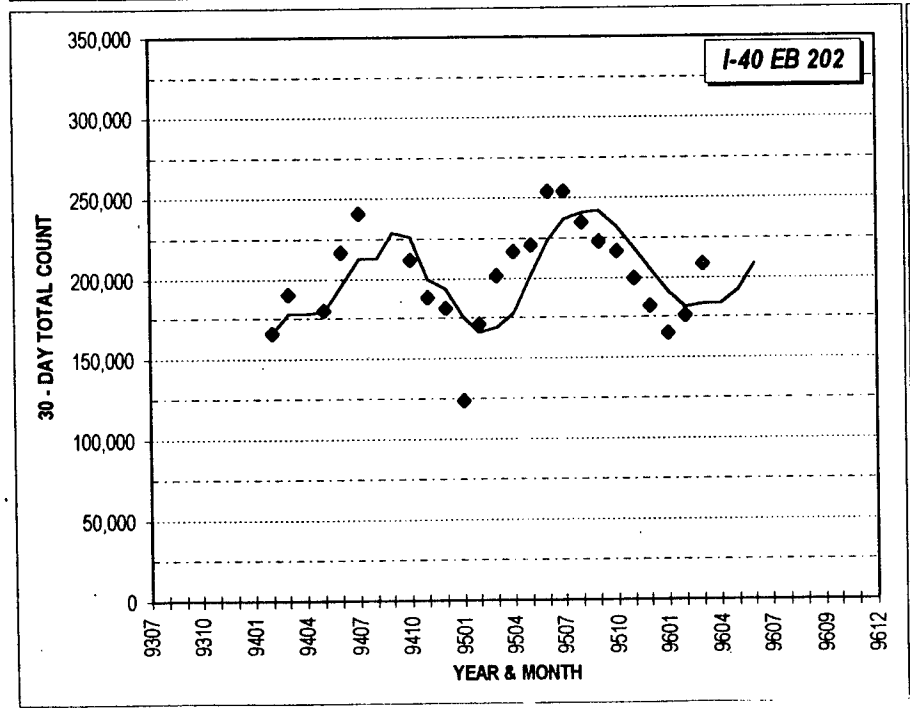
9510
9601
9604
9607
9609
9612
YEAR & MONTH


I-40 EB 202
30 - DAY TOTAL COUNT
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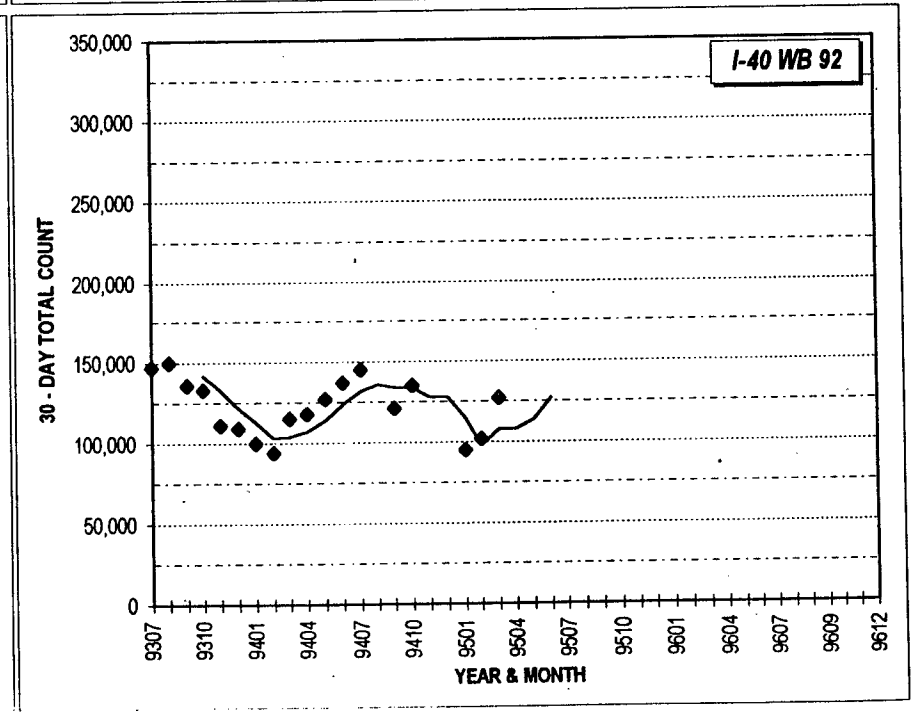
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH


I-40 WB 92
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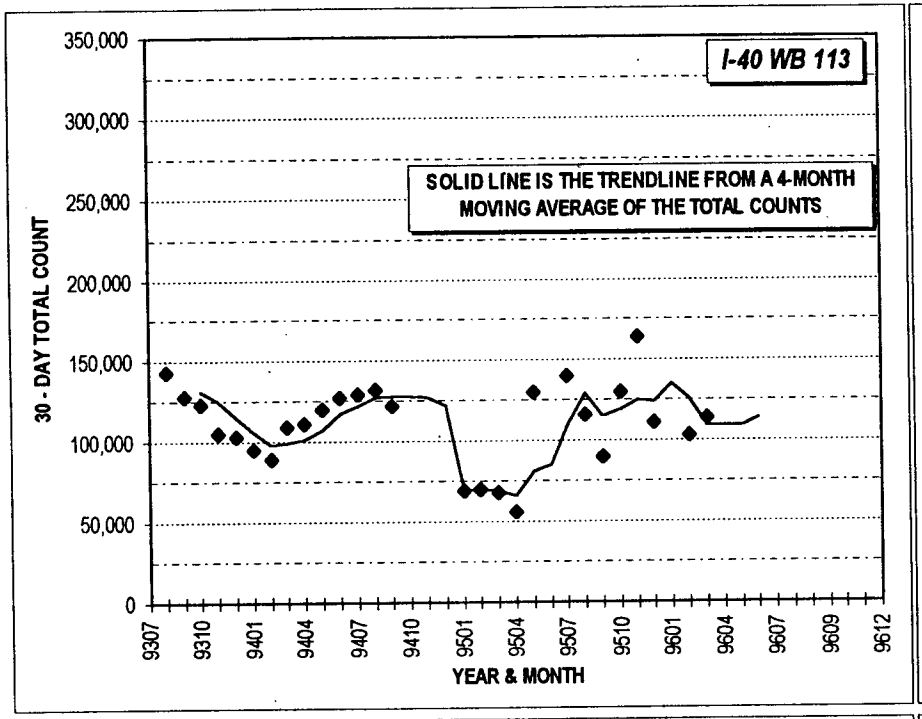
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH


I-40 WB 113
SOLID LINE IS THE TRENDLINE FROM A 4-MONTH MOVING AVERAGE OF THE TOTAL COUNTS
30 - DAY TOTAL COUNT
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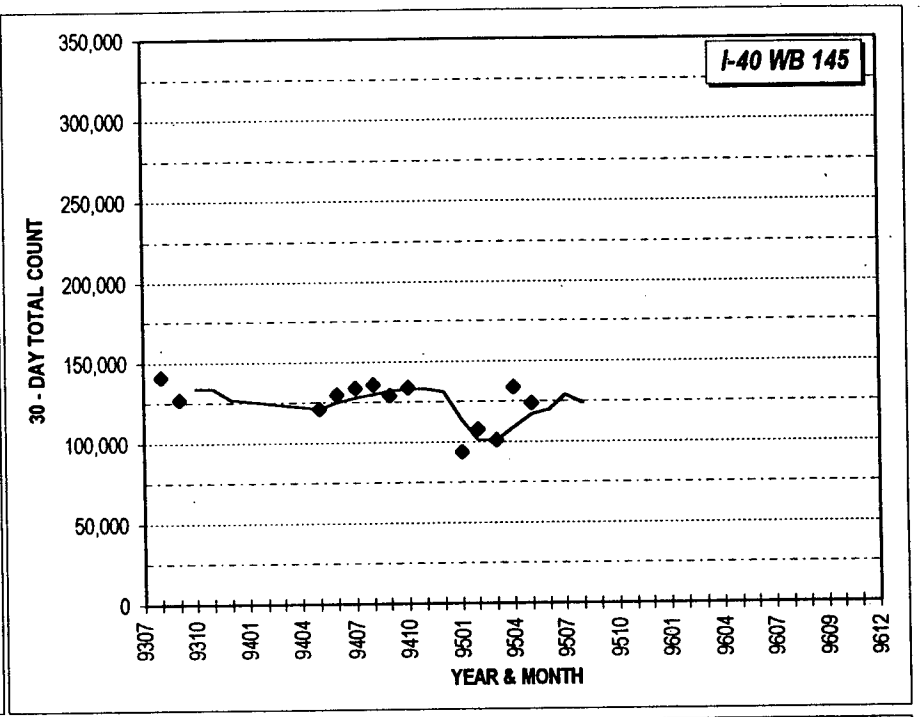
300,000
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH


I-40 WB 145
30 - DAY TOTAL COUNT
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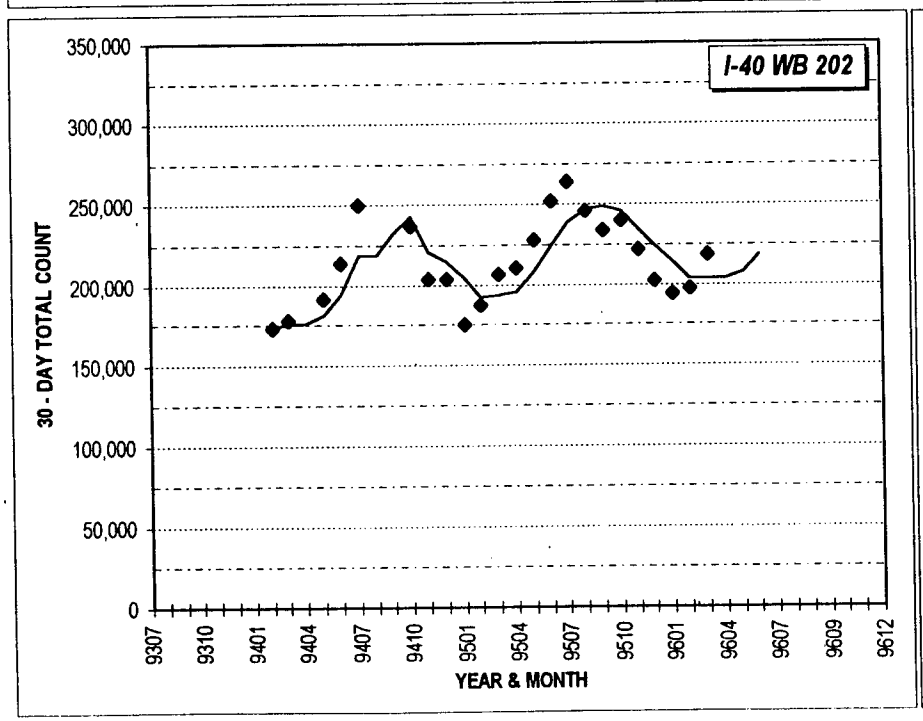
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH


I-40 WB 202
30 - DAY TOTAL COUNT
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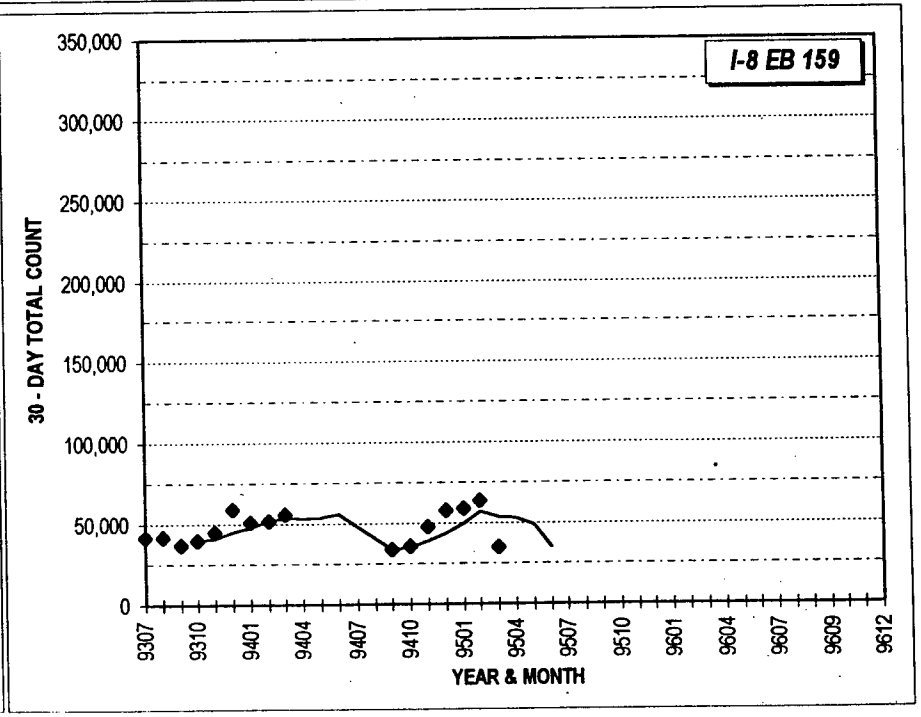
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH


I-8 EB 159
30 - DAY TOTAL COUNT
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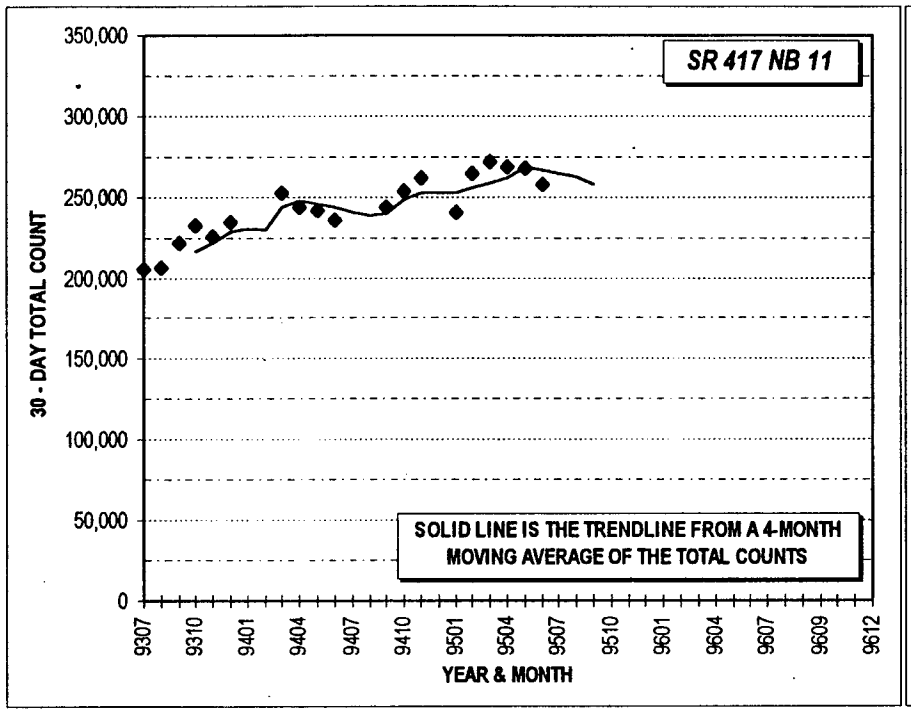
300,000
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH


SR 417 NB 11
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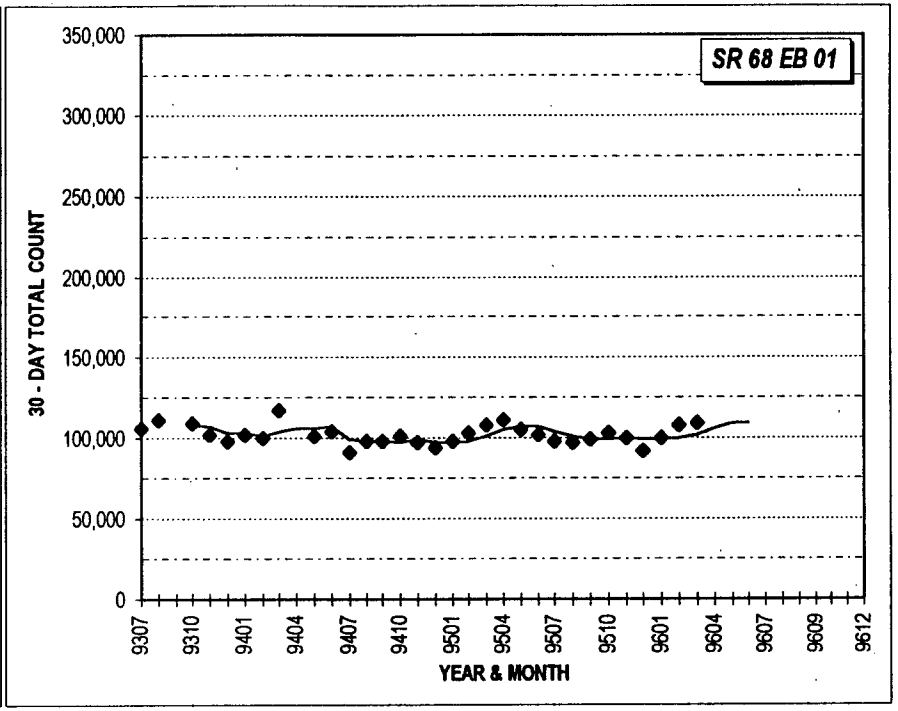
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH
SOLID LINE IS THE TRENDLINE FROM A 4-MONTH MOVING AVERAGE OF THE TOTAL COUNTS


SR 68 EB 01
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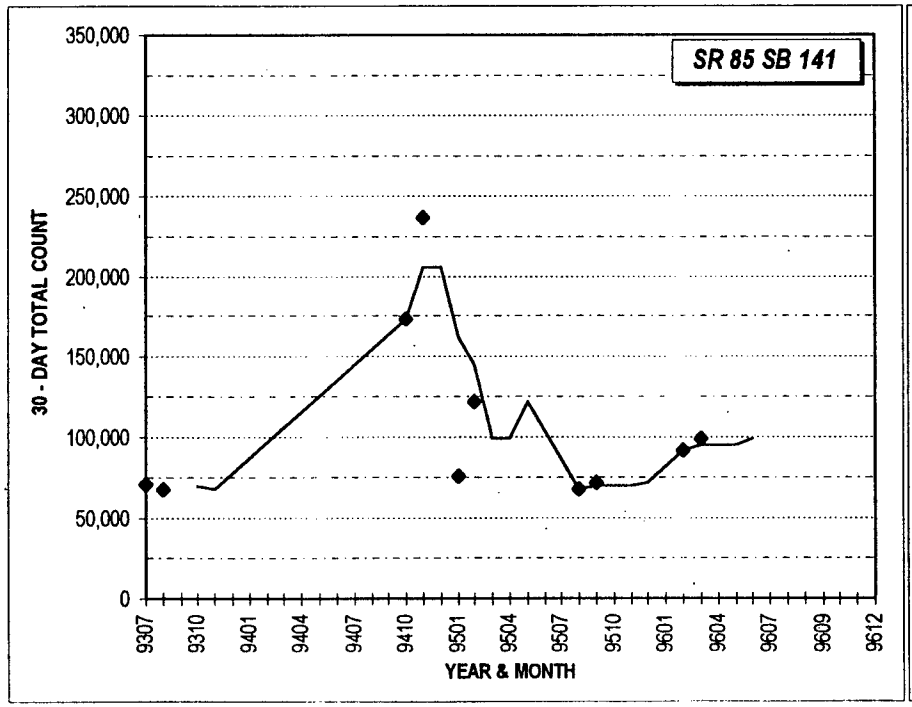
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH


SR 85 SB 141
30 - DAY TOTAL COUNT
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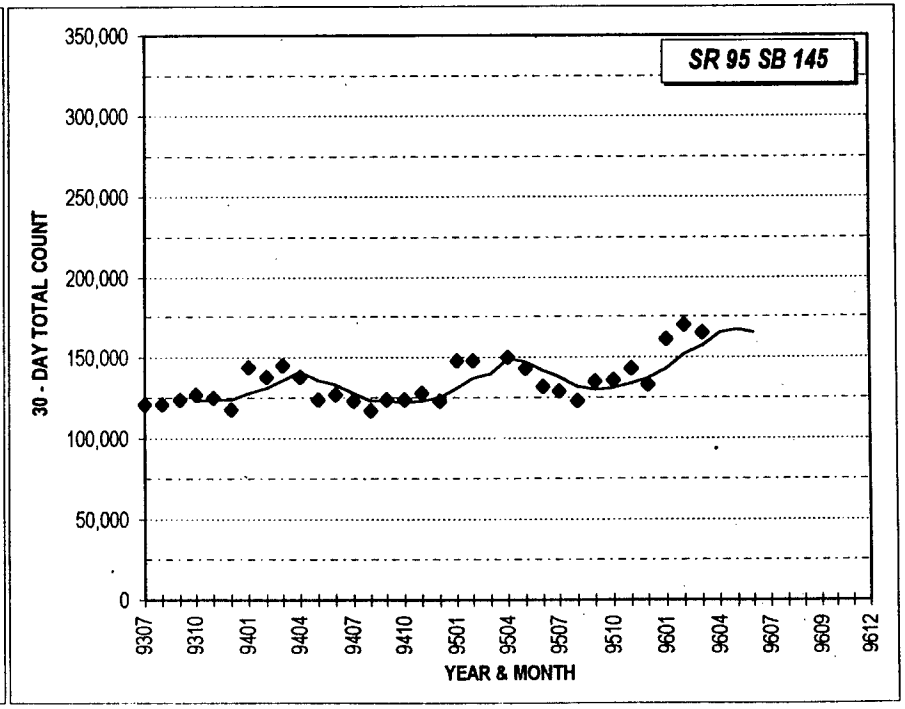
300,000
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH


SR 95 SB 145
30 - DAY TOTAL COUNT
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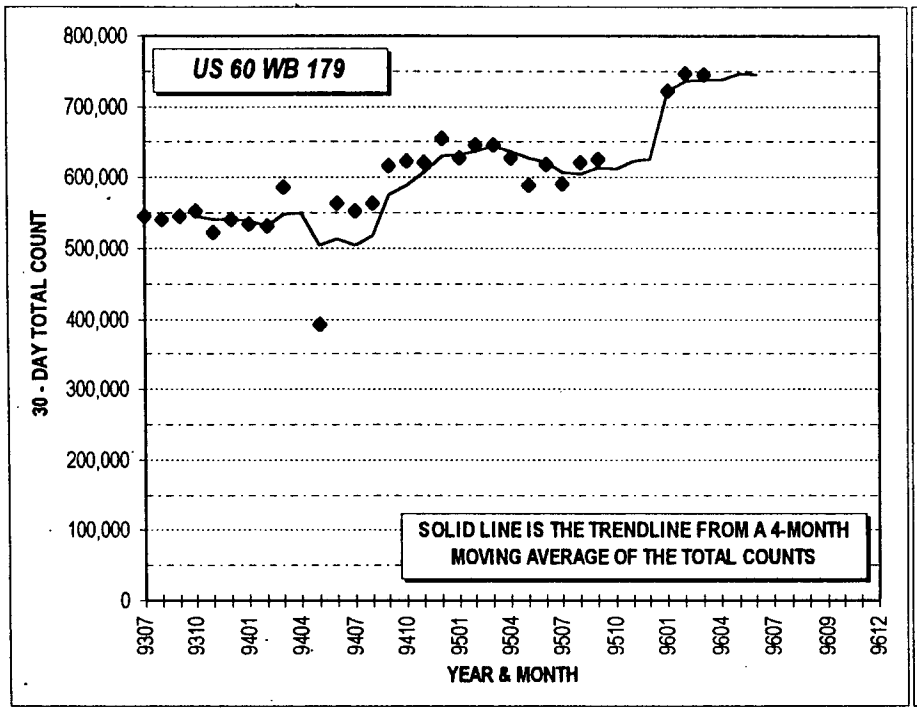
300,000
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH


US 60 WB 179
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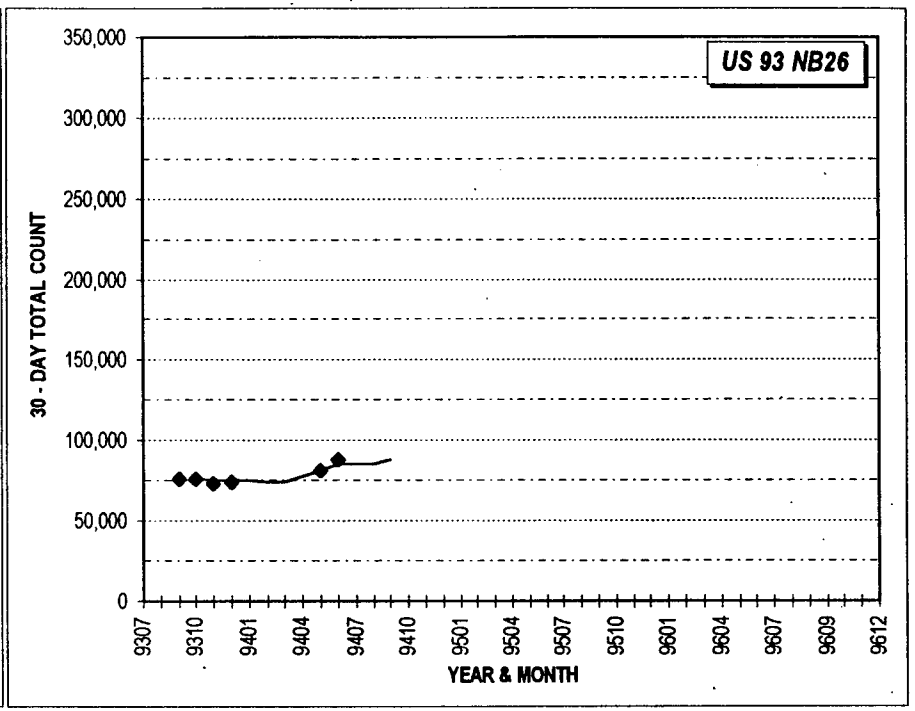
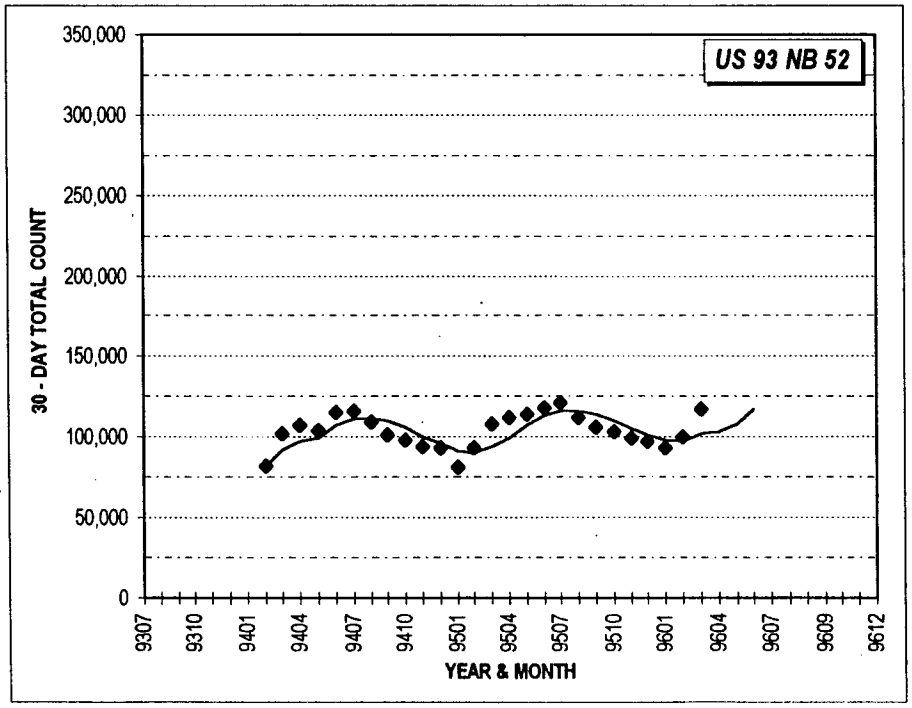
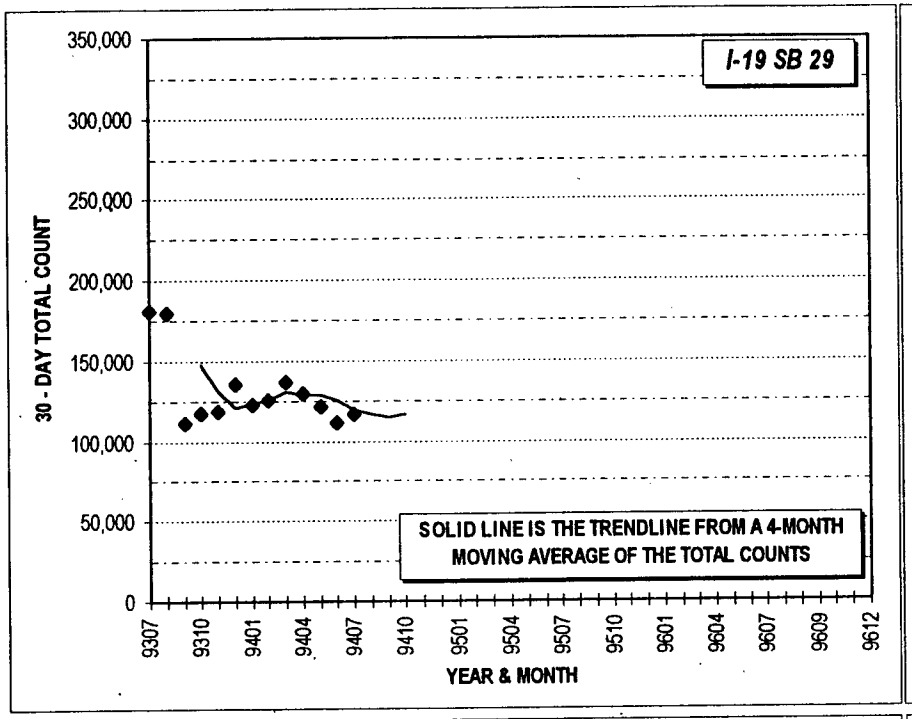
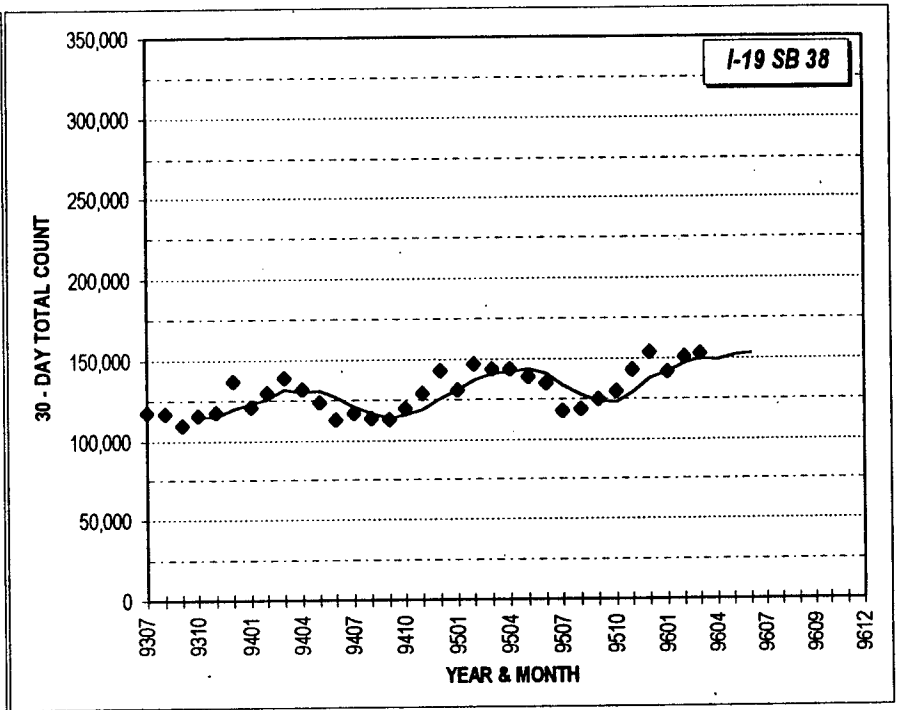
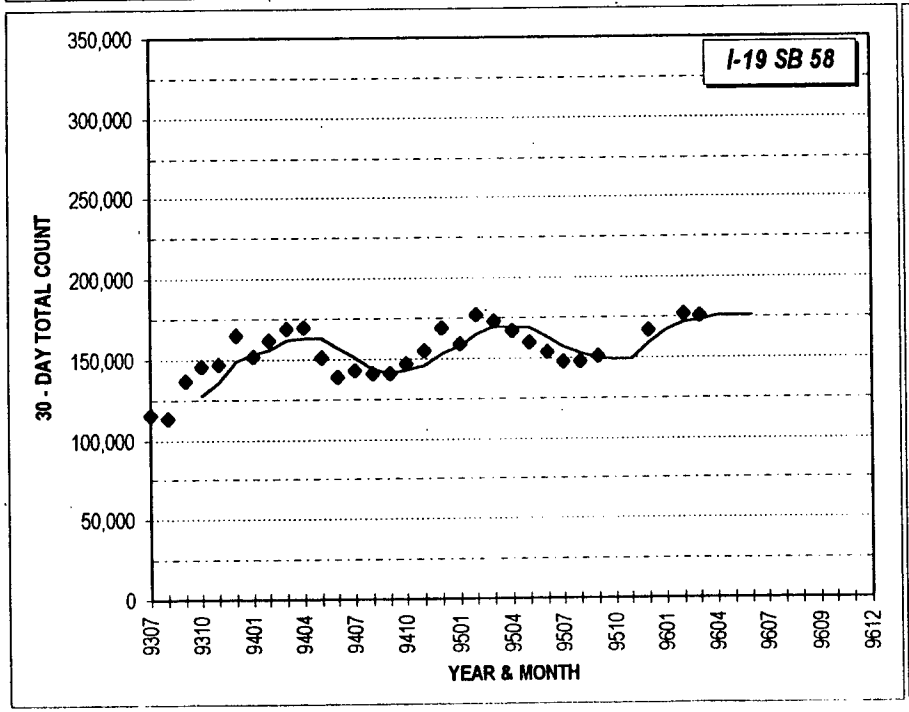
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
30 - DAY TOTAL COUNT
SOLID LINE IS THE TRENDLINE FROM A 4-MONTH MOVING AVERAGE OF THE TOTAL COUNTS
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH

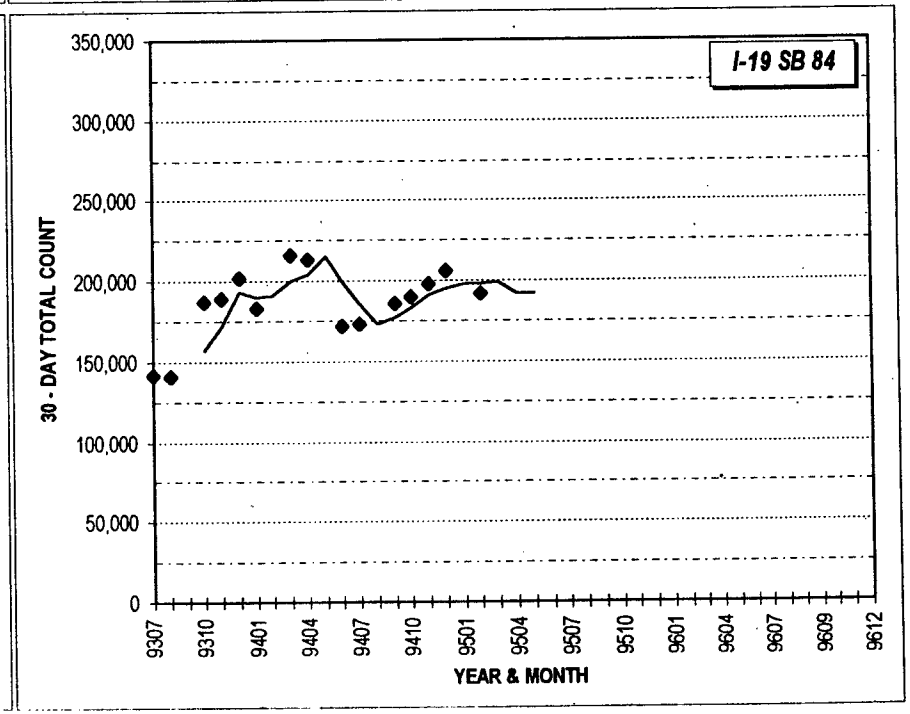

US 93 NB26
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
30 - DAY TOTAL COUNT
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH


US 93 NB 52
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
30 - DAY TOTAL COUNT
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH

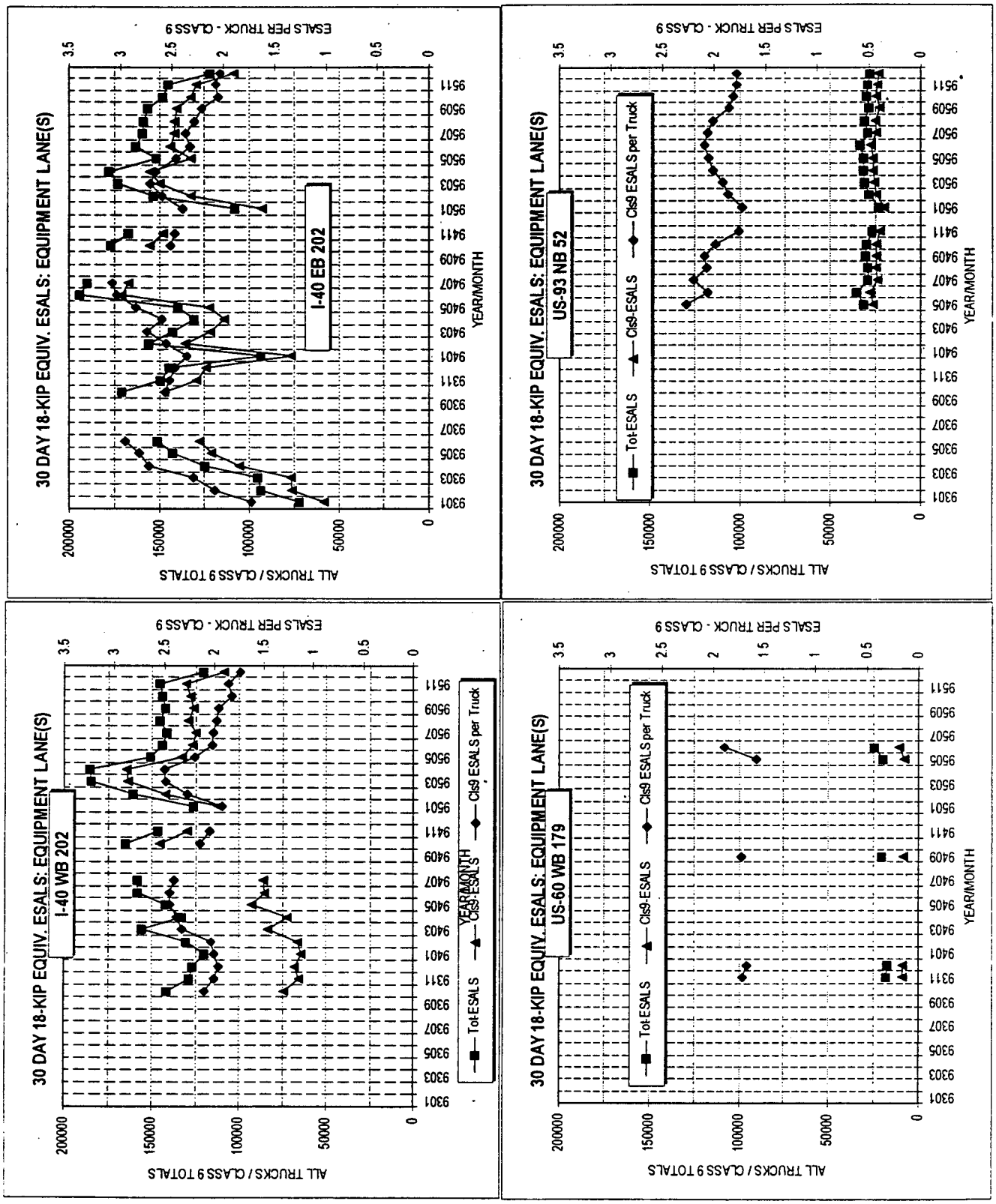

I-19 SB 29
30 - DAY TOTAL COUNT
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH
SOLID LINE IS THE TRENDLINE FROM A 4-MONTH MOVING AVERAGE OF THE TOTAL COUNTS


I-19 SB 38
30 - DAY TOTAL COUNT
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH

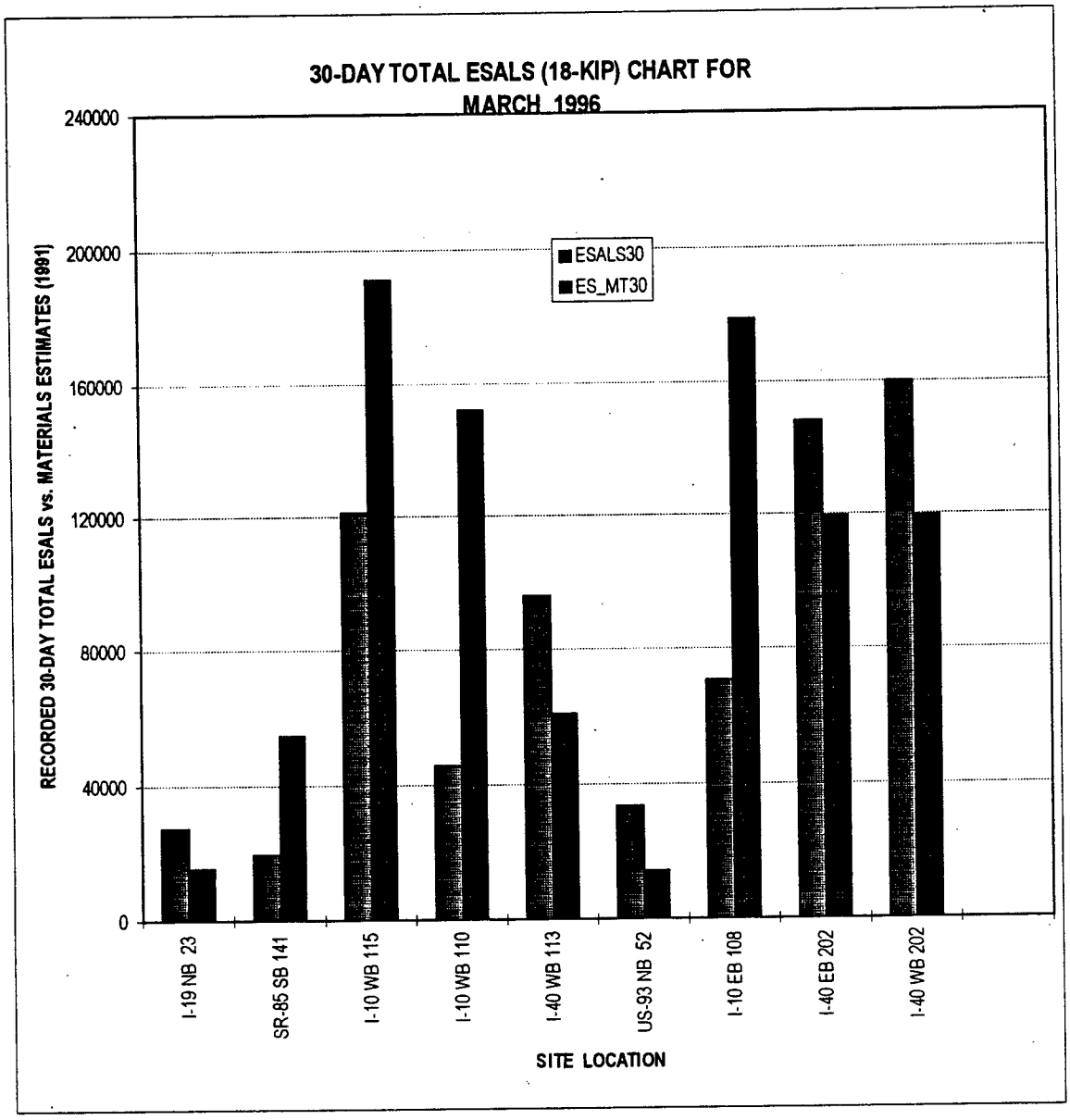

I-19 SB 58
30 - DAY TOTAL COUNT
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH

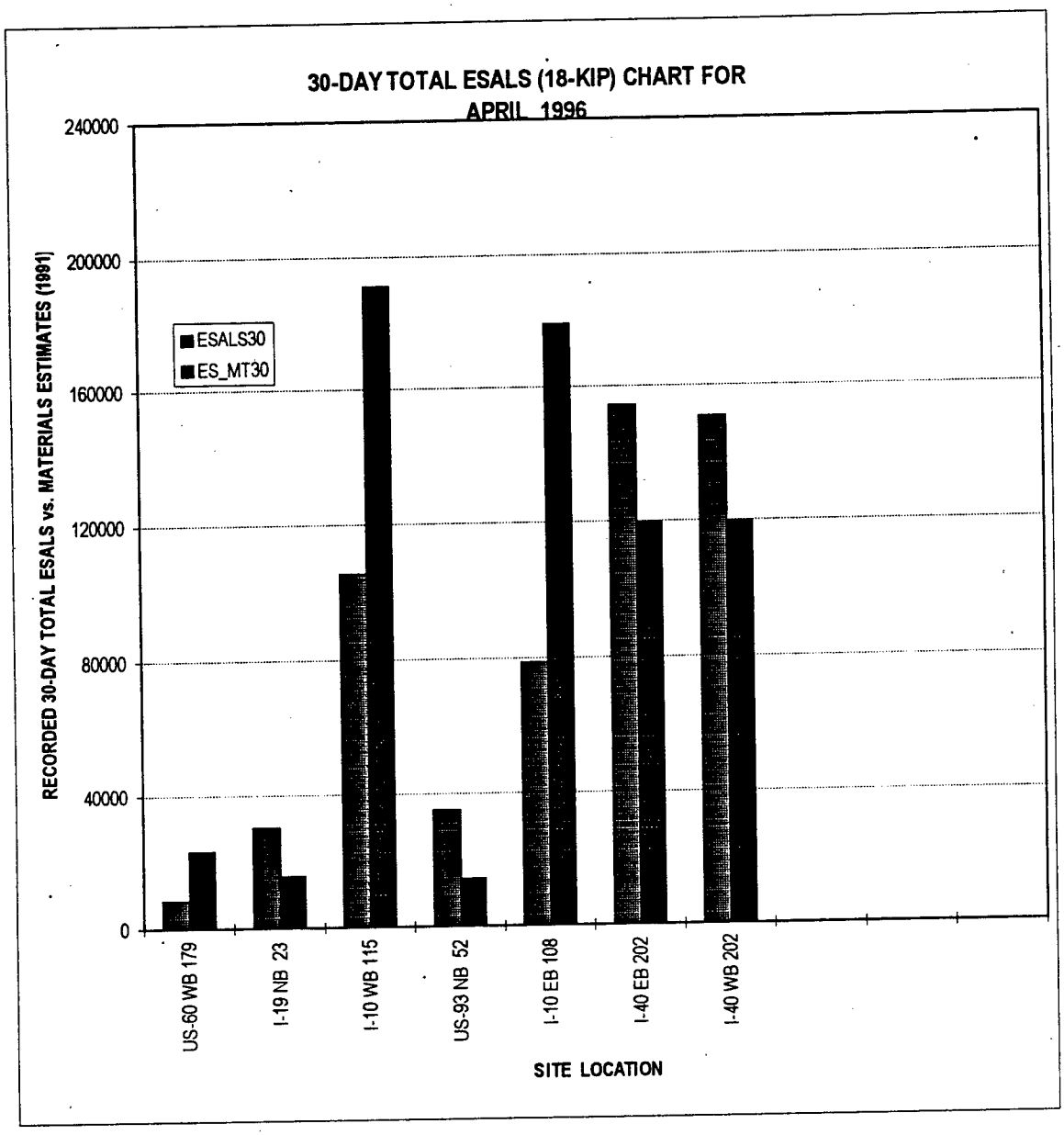

I-19 SB 84
30 - DAY TOTAL COUNT
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
9307
9310
9401
9404
9407
9410
9501
9504
9507
9510
9601
9604
9607
9609
9612
YEAR & MONTH

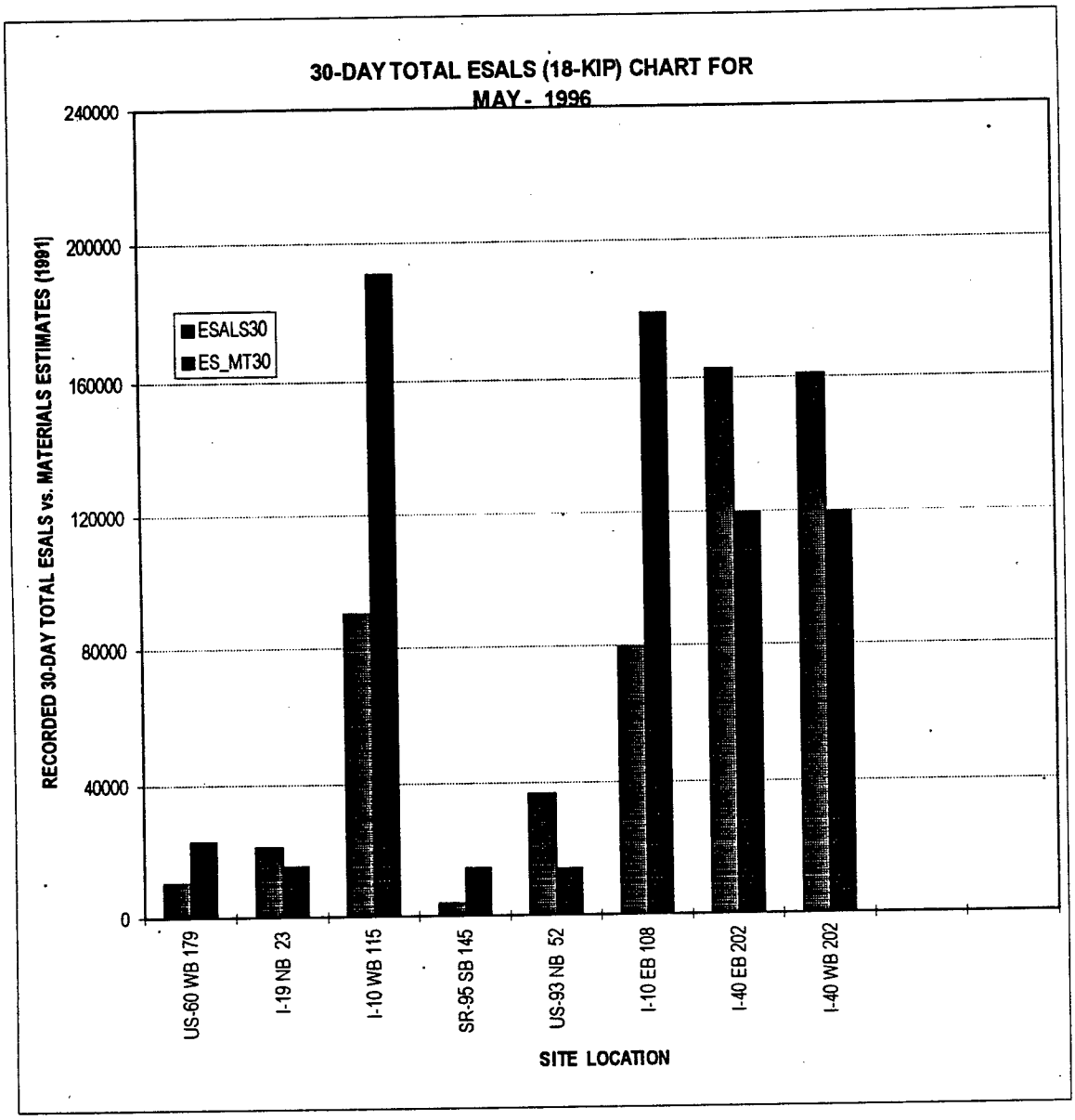
Appendix E: Truck '30 day ESALS' for a few WIM Sites over the Period January 1993 to June 1996

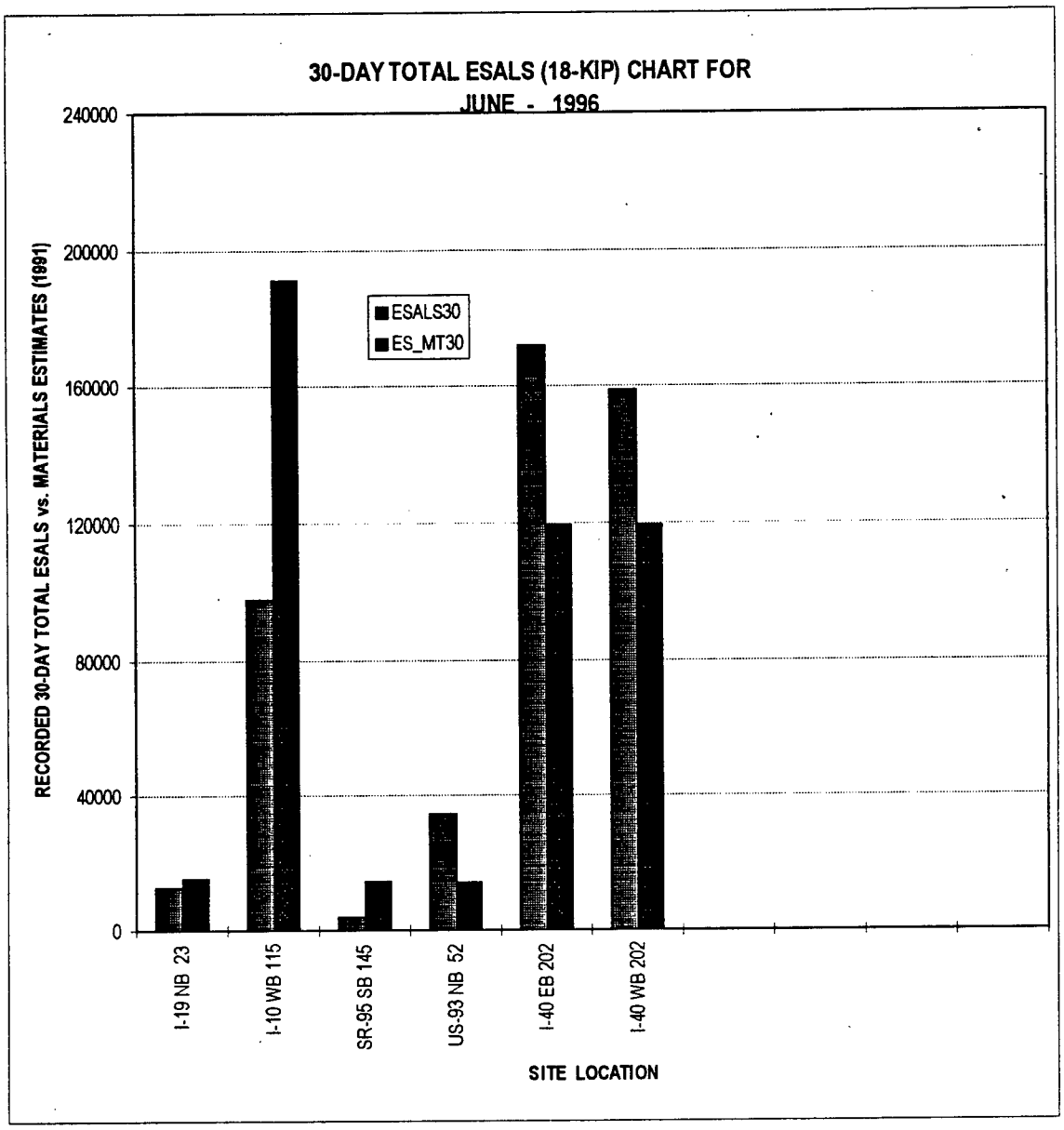

30 DAY 18-KIP EQUIV. ESALS: EQUIPMENT LANE(S)
I-40 EB 202
ALL TRUCKS / CLASS 9 TOTALS
ESALS PER TRUCK - CLASS 9
YEAR/MONTH
30 DAY 18-KIP EQUIV. ESALS: EQUIPMENT LANE(S)
US-93 NB 52
Tot-ESALS
Cls9-ESALS
Cls9 ESALS per Truck
30 DAY 18-KIP EQUIV. ESALS: EQUIPMENT LANE(S)
I-40 WB 202
30 DAY 18-KIP EQUIV. ESALS: EQUIPMENT LANE(S)
US-60 WB 179

Appendix F: Monthly ('30 day') Truck ESALS for WIM Sites During the Months March to June 1996


30-DAY TOTAL ESALS (18-KIP) CHART FOR MARCH 1996
RECORDED 30-DAY TOTAL ESALS vs. MATERIALS ESTIMATES (1991)
240000
200000
160000
120000
80000
40000
0
ESALS30
ES_MT30
I-19 NB 23
SR-85 SB 141
I-10 WB 115
I-10 WB 110
I-40 WB 113
US-93 NB 52
I-10 EB 108
I-40 EB 202
I-40 WB 202
SITE LOCATION


30-DAY TOTAL ESALS (18-KIP) CHART FOR
APRIL 1996
RECORDED 30-DAY TOTAL ESALS vs. MATERIALS ESTIMATES (1991)
240000
200000
160000
120000
80000
40000
0
ESALS30
ES_MT30
US-60 WB 179
I-19 NB 23
I-10 WB 115
US-93 NB 52
I-10 EB 108
I-40 EB 202
I-40 WB 202
SITE LOCATION


30-DAY TOTAL ESALS (18-KIP) CHART FOR
MAY - 1996
RECORDED 30-DAY TOTAL ESALS vs. MATERIALS ESTIMATES (1991)
240000
200000
160000
120000
80000
40000
0
ESALS30
ES_MT30
US-60 WB 179
I-19 NB 23
I-10 WB 115
SR-95 SB 145
US-93 NB 52
I-10 EB 108
I-40 EB 202
I-40 WB 202
SITE LOCATION


30-DAY TOTAL ESALS (18-KIP) CHART FOR
JUNE - 1996
RECORDED 30-DAY TOTAL ESALS vs. MATERIALS ESTIMATES (1991)
240000
200000
160000
120000
80000
40000
0
ESALS30
ES_MT30
I-19 NB 23
I-10 WB 115
SR-95 SB 145
US-93 NB 52
I-40 EB 202
I-40 WB 202
SITE LOCATION