ARIZONA DEPARTMENT OF TRANSPORTATION

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DEVELOPMENT OF NEW PAVEMENT DESIGN EQUIVALENT SINGLE AXLE LOAD (ESAL)

Final Report

Prepared by:
Sirous H. Alavi, Ph.D., P.E.
Kevin A. Senn, P.E.
Nichols Consulting Engineers, Chtd.
1885 South Arlington Avenue, Suite 111
Reno, NV 89509

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Arizona Department of Transportation
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Phoenix, Arizona 85007
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16. Abstract Establishing, maintaining, and enhancing the statewide network of roads are among the most important goals of any state highway agency. These require huge investments of both financial and human resources year in and year out. Accordingly, it makes good sense to apply sound engineering practices to ensure these resources are allocated wisely.

One of the fundamental and universally sought parameters that influence all new pavement and rehabilitation design decisions is *traffic*. For a given road segment, accurate estimates of current and projected traffic (in terms of Equivalent Single Axle Loads (ESALs)) can result in significant cost savings, either from the standpoint of initial construction cost or future maintenance and rehabilitation cost.

The primary objective of this project is to prepare a new ESAL design table for Arizona's highway network. This new table is based on analysis of current traffic data collection procedures, traffic forecasting methodology, and ESAL development procedures, including the assignment of traffic ESAL levels to the various highway segments. It is also based on new information such as provided by weigh-in-motion (WIM) systems. There are recommendations made for installing WIMs at a series of sites. System methodology for assessment of future needs for WIM and AVC installations is presented in this report focusing on technology installation, operation, and maintenance issues. The new ESAL table is provided to Arizona DOT in an electronic format on a CD ROM.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

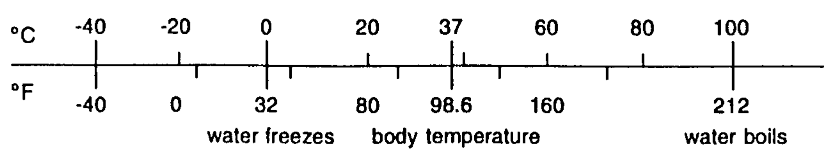
Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
ml	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
ft oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3

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

Symbol	When You Know	Multiply By	To Find	Symbol
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg

TEMPERATURE (exact)

Symbol	When You Know	Do The Following	To Find	Symbol
°F	Fahrenheit temperature	°F - 32 ÷ 1.8	Celcius temperature	°C



APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	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
m^2	meters squared	1.19	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		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	1.31	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T

TEMPERATURE (exact)

Symbol	When You Know	Do The Following	To Find	Symbol
°C	Celcius temperature	°C x 1.8 + 32	Fahrenheit temperature	°F

METER: a little longer than a yard (about 1.1 yards)
LITER: a little larger than a quart (about 1.06 quarts)
GRAM: a little more than the weight of a paper clip
MILLIMETER: diameter of a paper clip wire
KILOMETER: somewhat further than 1/2 mile (about 0.6 mile)

*SI is the symbol for the International System of Measurement

ACKNOWLEGEMENTS

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The NCE project team was led by Dr. Sirous Alavi, the principal investigator. Mr. Kevin Senn was the project manager, and the project engineers were Mr. Weston Ott, Mr. Joseph Mactutis and Mr. Tony Lorenzi. The project team received valuable assistance from two consultants: Dr. Tom Papagiannakis of Washington State University and Mr. Earl Laird of TP&R. Last but not least, Mrs. Carol Chiappetta and Mrs. Barbara Milliken provided administrative support.

LIST OF ABBREVIATIONS

AADT	Annual Average Daily Traffic
AAWDT	Annual Average Weekday Traffic
ADOT	Arizona Department of Transportation
ATR	Automated Traffic Recorder
AVC	Automatic Vehicle Classifier
CV	Coefficient of Variation
ESAL	Equivalent Single Axle Load
FHWA	Federal Highway Administration
GVW	Gross Vehicle Weight
KESAL	Thousand Equivalent Single Axle Loads
LDF	Lane Distribution Factor
LTPP	Long-Term Pavement Performance
NCE	Nichols Consulting Engineers
NRBA	No Recommendation by AASHTO
QC/QA	Quality Control/Quality Assurance
RV	Recreational Vehicle
SR	State Route
TPG	Traffic Planning Group
TWS	Truck Weight Study
TAC	Technical Advisory Committee
WIM	Weigh-in-motion

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CHAPTER 1: INTRODUCTION

PROBLEM STATEMENT

Establishing, maintaining, and enhancing the statewide network of roads are among the most important goals of any State highway agency. These require huge investments of both financial and human resources year in and year out. Accordingly, it makes good sense to apply sound engineering practices to ensure these resources are allocated wisely.

For designing the new roadways (or rehabilitating existing ones), there are alternative methodologies available to engineers (including those used by ADOT) which call for a number of inputs that can significantly affect the design output. One of the fundamental and universally sought parameters that influences all new pavement and rehabilitation design decisions is *traffic*. For a given road segment, accurate estimates of current and projected traffic (in terms of Equivalent Single Axle Loads (ESALs)) can result in significant cost savings, either from the standpoint of initial construction cost or future maintenance and rehabilitation cost. In other words, accurate ESAL estimates help produce better pavement thickness designs and/or more realistic determinations of the performance lives of newly-constructed (or rehabilitated) pavements.

ADOT currently has an ESAL design table developed in the mid-80s that, for a given road segment, uses average ESAL vehicle factors, traffic volume, and vehicle classification data to generate base year, 10-year and 20-year estimates of accumulated ESALs. Since that time, significant progress has been made in the automated collection of vehicle weight and classification data. ADOT currently has 14 weigh-in-motion (WIM) sites and nine automatic vehicle classifier (AVC) sites maintained as a part of the Long-Term Pavement Performance (LTPP) Program. The Traffic Planning Group (TPG) maintains an additional six WIM sites and two AVC sites.

Thus, research was needed to evaluate and then enhance the existing ESAL design table incorporating the new monitoring data that is now available. It was also important to determine whether existing monitoring systems are collecting quality data, and whether the existing systems satisfactorily cover the key highway segments in Arizona.

OBJECTIVE

The primary objective of the project was to prepare a new ESAL design table for Arizona's highway network. This new table is based on analysis of current traffic data collection procedures, traffic forecasting methodology, and ESAL development procedures including the assignment of traffic ESAL levels to the various highway segments. It is also based on new information such as those provided by WIM systems. Through the course of this project, a plan was developed and presented in this report for future review and update of the ESAL table on a routine (i.e., yearly) basis. There are recommendations made for installing 10 WIM sites. Also, a system methodology for assessment of future needs for WM and AVC sites is presented in this report focusing on technology, installation, operation, and maintenance issues.

SCOPE

As stated in the Objective, the primary focus of this project was to develop a new ESAL table for future pavement designs. This table was developed using the best available data provided by ADOT. No data was collected by the project team.

RESEARCH APPROACH (NEW ESAL TABLE)

There are three major types of data collected by ADOT, namely: vehicle counts, vehicle classification, and vehicle weights. The first two are collected either manually or automatically, while the latter is collected using WIM technology. The research team analyzed all types of available collected data and utilized the most representative data to produce the new ESAL table. The existing ESAL table consists of over 1,000 highway segments. These segments were not changed as a part of this study. Each segment has:

- An annual average daily traffic (AADT).
- The percent trucks based on the total traffic stream.
- The class breakdown of vehicle types based upon the Federal Highway's 13 class scheme.
- An annual growth factor and an ESAL value for both a flexible and a rigid pavement.

ADOT performs vehicle counts on all segments either annually (for high volume roads) or every 3 years (for all other roads). Classification data is collected either manually using 6-hour counts or automatically using 48-hour counts and also follows either an annual or a 3-year rotation. Given the costs of collecting classification data, a number of segments in the ESAL table are assigned to the most representative classification station. There are also a number of AVC/WIM systems that were installed primarily to support the LTPP program. The TPG does have four AVC/WIM sites that collect classification and weight data. The data from the WIM sites were utilized to determine the average ESAL factors for each Federal Highway Administration (FHWA) vehicle class 4-13. Final ESAL values were based upon the weighted average of the vehicles on each particular roadway segment. Sections that had a WIM representing its classification station used ESAL values based on measured data. Sections with no WIM systems representing their classification station used average ESAL factors based on a statewide average.

OVERVIEW OF REPORT

Accomplishment of this project required the following tasks.

Task A. Review the scope of work and work plan at a kick-off meeting between the ADOT project Technical Advisory Committee (TAC) and key members of the investigating team.

Task B. Review the current traffic data collection, analysis and forecasting procedures used by ADOT. This included WIM and AVC information as well as other manual and automated collection techniques.

Task C. Review ADOT's procedures for developing its existing ESAL design table. The information gathered under Task B was used extensively in this task and a thorough review of the existing design tables (as provided by ADOT) was performed.

Task D. Recommend changes to the current procedures which can be incorporated into ADOT's practice. Formulate a plan for updating these in future years. The future data should be utilized to improve the existing traffic distribution, growth factor estimates, weight distribution algorithms, and ESAL calculations.

Task E. Prepare a new ESAL design table for the ADOT highway network based upon the new procedures and the best available traffic data.

Task F. Undertake an assessment of WIM and AVC data needs with due consideration as to cost, towards optimizing the contribution of continuous automated data sites in the development of ESAL table. Recommend 10-12 core sites along with another list of key sites, making an estimate of installed cost (where applicable), operation and maintenance costs in both equipment and staff.

This report contains a separate chapter for each task, as well as a final chapter containing the conclusions and recommendations of the research team.

CHAPTER 2: KICK-OFF MEETING

Shortly after the awarding of the contract, a kick-off meeting was scheduled between the project team and the ADOT TAC. The purpose of this meeting was to discuss the key elements of the project, identifying the data sources that would be required and establishing key contact for providing the data.

MEETING OVERVIEW

The kick-off meeting between ADOT project TAC and key members of the NCE team took place on December 2, 1998. NCE's principal investigator, project engineer, and technical advisor participated in a 1-day meeting with the TAC to review the scope of work and work plan in detail. A draft agenda for this meeting was prepared by NCE and was circulated among the project team (ADOT and NCE) for their review and comment in advance of the meeting date. A final meeting agenda based on input from the ADOT TAC and NCE project team was prepared and circulated just prior to the meeting date.

The meeting lasted over 3 hours, during which the NCE team was able to become familiar with the ADOT groups (and points of contact) involved the in traffic data collection and analysis. The project objectives were discussed and the work plan was thoroughly reviewed. The topics that received significant attention were the importance of getting as much information as possible regarding the existing ADOT ESAL tables and the traffic growth rates. It was decided that NCE would generate growth information based on the best available data and forecasting methods currently used by ADOT and other relevant agencies (i.e., the Maricopa Association of Governments in the Greater Phoenix Area). In the latter part of the meeting, NCE presented a wish list for data that needed to be evaluated in this project. Contact persons were identified for each data element. Table 2.1 summarizes all the materials provided to the NCE team.

Table 2.1. Data provided by ADOT.

Data Type
Hardcopy and electronic version of existing ESAL table
ADT File from Traffic Planning Group--not known if it will be hardcopy or electronic
ADOT's adaptation of American Association of State Highway and Transportation Officials (AASHTO) ESAL Calculation (George Way and John Eisenberg)
"Interesting" trends in traffic data as identified by George Way (waywim.xls)
Data related to how growth factors are/were calculated
Data related to how growth factors are/were calculated
Vehicle volume and classification data
Transportation Planning Group WIM data--three WIM sites
Transportation Planning Group WIM data--fourth WIM site
List of weigh scales in Arizona
A1MRSNVJ.xls--Growth factors for key segments for 1997
A2USSNVJ.xls--Seasonal distributions for key segments for 1997
A3FTSNVJ.xls--Load factors by axle group for 1997

Table 2.1. Data provided by ADOT (continued).

Data Type
Transportation Planning Group traffic count data
Transportation Planning Group classification data--138 sites with classification data for 1997 (vcls9704.xls); manual classification surveys from 1996, 1997 and 1998
Relevant literature and reports from 1986 ESAL study
ADT Growth regression performed in 1990 (hardcopy)
Maricopa Association of Governments Conformity Analysis Appendices, Volume 2
Pima Association of Governments Regional Transportation Improvement Program Tucson)
Information regarding base year for ESAL table
Input files for TRAFPROG or TRAF18K (as applicable)
Description of WIM systems for TPG WIM systems
Locations of classification sites
Definition of percent trucks in "Traffic on the Arizona State Highway System 1997"
Information regarding which fields in "Traffic on the Arizona State Highway System 1997" are measured and which are calculated
Description of how growth factors are determined in the Excel file containing regional growth factors
Documentation describing the Axle Factors by Axle Factor Group Excel spreadsheet--Chaparral may have, ADOT does not
Conversion from FHWA classification scheme to ADOT ESAL table classification scheme
Information on how much data the ADOT ATR sites collect
Information on regional groups 8 and 99
1996 classification data

Following the meeting, NCE compiled the meeting notes and submitted a draft set to the project manager for review. Upon receiving feedback on those draft minutes, the official minutes were sent to all members of the TAC. The final minutes form this meeting are found in appendix A.

CHAPTER 3: REVIEW PROCEDURES FOR TRAFFIC DATA COLLECTION, ANALYSIS, AND FORECASTING

The State of Arizona has a roadway network comprised of interstates, primary and secondary roads. The roadway network maintained by ADOT has been divided up into segments, which represent roadway sections with unique traffic and/or geometric constraints. The traffic data used in this study was collected almost entirely by ADOT. Understanding this data was of utmost importance before any meaningful progress could be made. This chapter reviews the traffic data collection, analysis, and forecasting methodologies currently used by ADOT.

COLLECTED TRAFFIC DATA

The following is a brief description of each data type that is currently available for use in the new ESAL table. Each data group is important in either the determination of the number of vehicles passing a roadway segment or the type and weight of vehicles.

AVERAGE ANNUAL DAILY TRAFFIC COUNTS

The vast majority (over 90 percent) of traffic volume counts performed by ADOT consist of either 24-hour or 48-hour counts using pneumatic road tubes or inductive loops. These counts are collected on a rotational basis, with some high volume areas being counted annually, but most areas being collected every 3 years. These counts are expanded into AADT values using a series of factors that will be described later in the ADOT data analysis section of this report.

6-HOUR MANUAL TRAFFIC COUNTS FOR VEHICLE CLASSIFICATION

This data is collected by ADOT on a 3-year rotational basis. The 6-hour manual classifications are not factored in any way and are used primarily to provide ADOT with two sources of information. The first piece of information is axle correction factors for pneumatic tube-based traffic counts and the second is the percentage of the AADT that is generated by commercial vehicles. The collection process of manual data is very labor intensive and costly. Only 30 percent of the approximately 140 classification stations use manual counts.

48-HOUR COUNTS FOR VEHICLE CLASSIFICATION

Like the 6-hour manual counts, the 48-hour counts are collected on a 3-year rotational basis. The data is collected with portable programmable classification equipment. As with the manual counts, axle correction factors and percentage of commercial vehicles is determined. However, unlike the 6-hour counts, the 48-hour counts are also used to determine AADT for the section of roadway in which they are collecting data. Seventy percent of the classification stations use these machine counts.

AUTOMATED TRAFFIC RECORDER (ATR)

This data is collected by ADOT, and has passed all internal quality checks, for different time intervals throughout the year. This data was not supplied to NCE in raw form, but it is used by ADOT to develop growth, seasonal, and axle factors for AADT calculations. In discussions with ADOT, it was learned that there are approximately 80 ATR sites in Arizona that ideally would all be collecting data continuously. However, due to equipment maintenance requirements and manpower constraints, there are typically 50 ATR sites functioning at any one time.

LTPP AND ADOT TRAFFIC PLANNING GROUP (TPG) AVC/WIM COLLECTED DATA

As part of the LTPP program, there is a requirement to collect AVC and WIM data. ADOT currently has nine AVC sites and 16 WIM sites functioning as part of the LTPP program. Table 3.1 and figures 3.1 and 3.2 list these sites and show their locations. The TPG has four additional sites at which AVC/WIM data is collected. This data includes calculations of the yearly truck volumes by truck classification and trucks as a percent of total traffic.

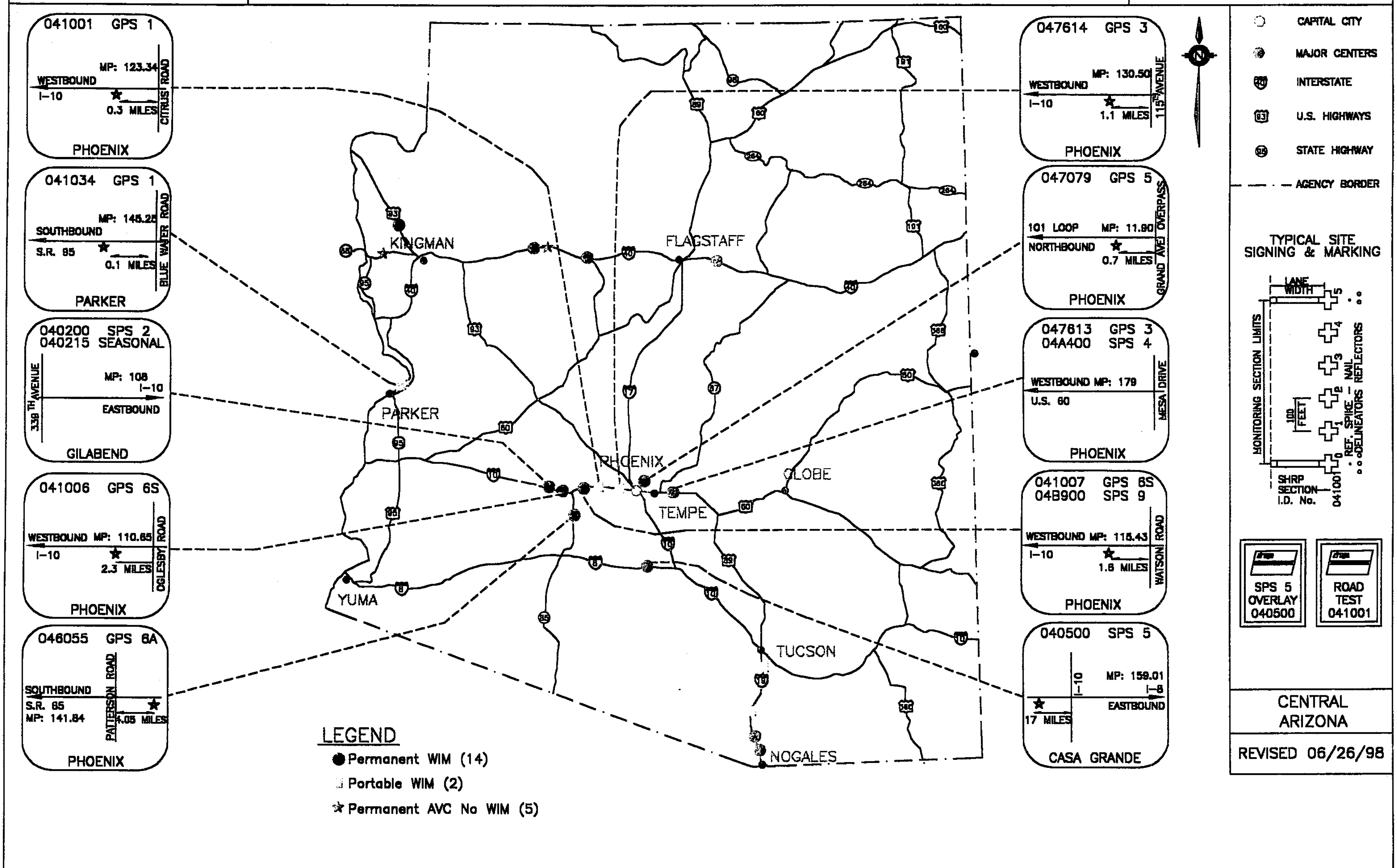
Table 3-1. LTPP Arizona WIM/AVC sites.

Arizona/ATRC Site # and Pavement Type	Site Location Route & MP (KIM)	SHRP ID	WIM/AVC		
			Status	Make	Sensor
025 RIGID	US-93 NB 052	0100	PERM WIM	PAT	BENDING PLATE
026 RIGID	I-10 EB 108	0200	PERM WIM	IRD	BENDING PLATE
009 FLEX	I-8 EB 159	0500	PERM WIM	PAT	PIEZO
202 RIGID	I-40 EB 202	0600	PERM WIM	PAT	BENDING PLATE
204 RIGID	I-40 WB 202	0600	PERM WIM	PAT	BENDING PLATE
020 FLEX	I-40 WB 145	1002	PERM WIM	PAT	PIEZO
012 FLEX	I-10 WB 110	1006	PERM WIM	PAT	PIEZO
011 FLEX	I-10 WB 115	1007	PERM WIM	PAT	PIEZO
005 FLEX	I-19 SB (029)	1015	PERM WIM	IRD	PIEZO
018 FLEX	I-40 EB 106	1024	PERM WIM	PAT	PIEZO
010 FLEX	SR-85 SB 141	6055	PERM WIM	PAT	PIEZO
006 FLEX	I-19 NB (023)	6060	PERM WIM	PAT	PIEZO
021 RIGID	SR-101 NB 011	7079	PERM WIM	PAT	PIEZO
024 RIGID	US-60 WB 179	7613	PERM WIM	PAT	PIEZO
019 FLEX	I-40 WB 113	1025	PERM AVC PORT WIM	PAT	PIEZO
015 FLEX	SR-68 EB 001	1037	PERM AVC PORT WIM	PAT	PIEZO
023 FLEX	I-10 WB 123	1001	PERM AVC NO WIM	PAT	PIEZO
007 FLEX	I-19 NB (054)	1017	PERM AVC NO WIM	PAT	PIEZO
013 FLEX	R-95 SB 145	1034	PERM AVC NO WIM	PAT	PIEZO
008 FLEX	I-19 SB (084)	6054	PERM AVC NO WIM	PAT	PIEZO
022 RIGID	I-10 WB 130	7614	PERM AVC NO WIM	PAT	PIEZO

SHRP-LTPP CENTRAL ARIZONA WIM & AVC SITE LOCATIONS

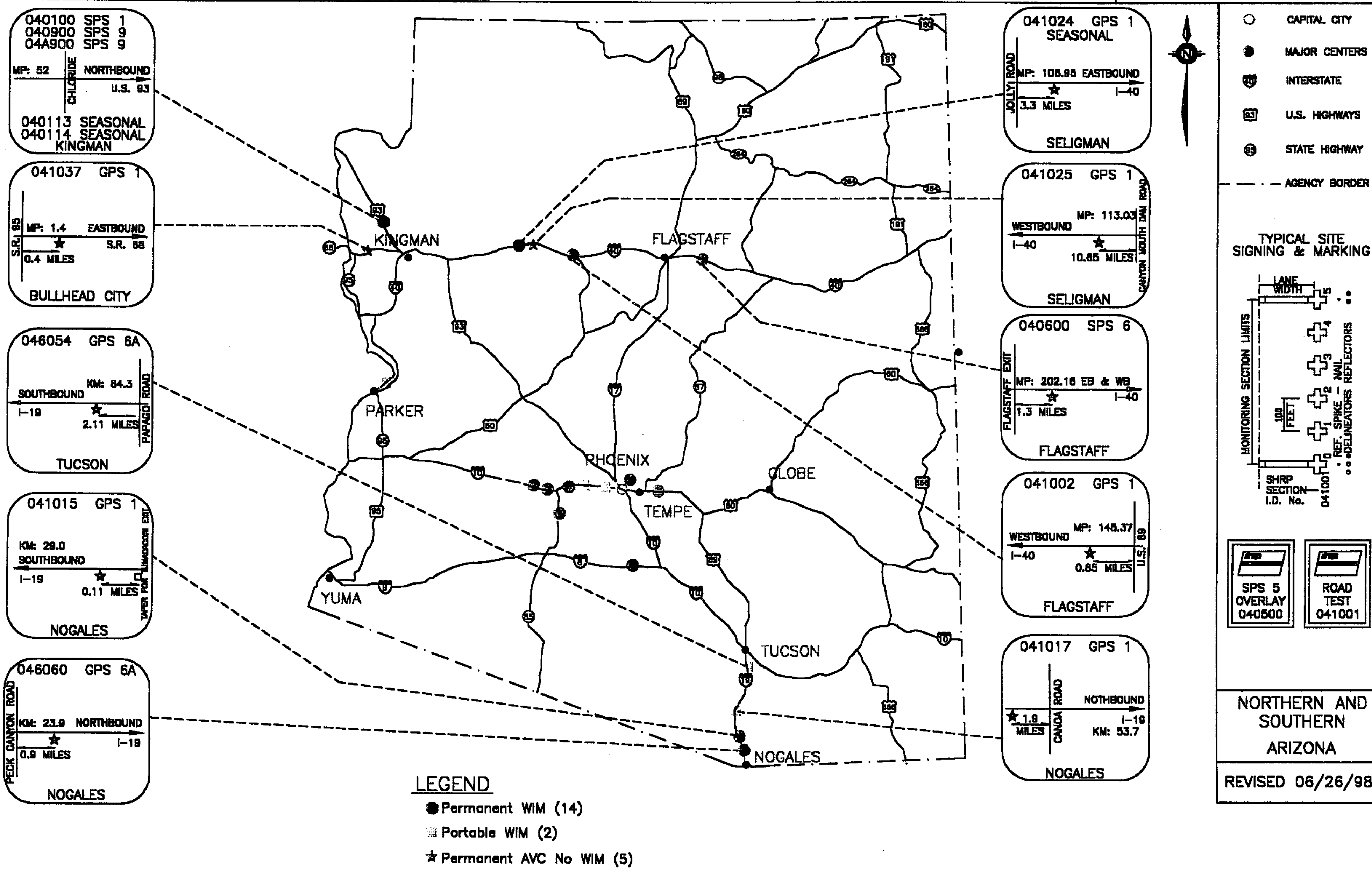
General Pavement Studies and Specific Pavement Studies

NICHOLS CONSULTING ENGINEERS, Chtd.



SHRP-LTPP NORTHERN AND SOUTHERN ARIZONA
WIM & AVC SITE LOCATIONS
General Pavement Studies and Specific Pavement Studies

NICHOLS CONSULTING ENGINEERS, Chtd.



NORTHERN AND SOUTHERN ARIZONA

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For the LTPP data, quality checks of the collected AVC/WIM data were performed following the LTPP traffic Quality Control/Quality Assurance (QC/QA) procedure. Once the data is processed using the LTPP traffic software, a LTPP regional traffic engineer reviews the data, and a summary of questionable data is flagged. The flagged data is then compiled for review by a senior traffic engineer familiar with AVC/WIM data.

After the data review by the LTPP regional contractor is complete, the flagged QC/QA packets are sent to the State DOT that collected the raw data. A State traffic engineer reviews the flag list and decides if the DOT agrees with the findings. Once the edited flag list is received from the DOT by the LTPP regional contractor, the data is edited and summarized for use in the LTPP project. The edited LTPP AVC/WIM data is then summarized for used by pavement researchers and designers. For the ADOT TPG WIM data, the flag list process was done internally at NCE.

Maricopa County Traffic Data

An investigation was conducted for incorporating the traffic information from Maricopa County into the ESAL tables. The information provided by Maricopa County consisted of a report entitled *Conformity Analysis for the Fiscal Year 1999-2003 MAG Transportation Improvement Program and the MAG Long Range Transportation Plan Summary and 1997 Update with 1998 Addendum.* The report provides more of a network summary of traffic information and is therefore not directly applicable to the segment specific ESAL table. It is important to mention, however, that the report states that "MAG (Maricopa Association of Governments) model estimates of 1997 VMT (vehicle miles of travel) are within one percent of the 1997 HPMS (Highway Performance Monitoring System) VMT that the Arizona Department of Transportation reported to the FHWA on July 16, 1998."(1) Assuming the HPMS VMT is calculated from the same ADOT traffic counts that the ESAL table is based on, it can be concluded that the ADOT data being incorporated into the ESAL table is sufficiently close to MAG data. Therefore, no special measures for incorporating MAG data into the ESAL table were taken.

Pima County Data

Traffic data provided by Pima County was evaluated for its applicability and possible incorporation into the ESAL tables. The information provided by Pima County consisted of a map entitled *Traffic Volumes in Metropolitan Tucson and Eastern Pima County 1997-1998*, and maps illustrating AADT estimates for the year 2020. The maps illustrate AADT values for various freeway and arterial segments within the City of Tucson and portions of Pima County. As a test, the 1997-1998 AADT values for all of the freeway segments illustrated on the map were compared with the AADT values provided by ADOT within its report *Traffic on the Arizona Highway System 1997.*(2) The AADT values matched exactly for all segments. As the map lists the Arizona Department of Transportation as a source of traffic count information, this is not surprising. As it was concluded that Pima County data was based upon ADOT traffic counts, no special measures for incorporating it into the ESAL table were taken. However, a comparison of the Pima County AADT estimates for 2020 with the new ESAL table forecasted AADT values is reported in chapter 5.

ADOT Data Analysis

As mentioned in the previous section, traffic volume counts are collected over a 24-hour or a 48-hour period. In order to convert these counts into annual values, it is necessary to apply a number of factors. The methodology followed in expanding the counts to AADT values is explained below.

Factor Groups

As explained by the TPG, Arizona is divided into sixteen factor groups, with one extra group for "weird sites." The groupings are based solely on geographical locations and do not account for the functional class of the road located within the group (i.e., interstate highway or state route), although there are factor groups named for I-8, I-10, I-15, I-17, I-19, and I-40. The "weird site" grouping contains very few sections and these are primarily segments that have relatively high percentages of recreational traffic where seasonal and daily variations are not observed. These factor groups contain at least two continuously operating automatic traffic recorders (ATRs) located within the group, except for group 6 (one ATR), group 8 (zero ATRs), group 16 (zero ATR) and group 99 Weird Sites (zero ATRs). Group 8 had an ATR that is currently out of service but there are plans to have it repaired.

There are three different factors applied to the factor groups, namely: growth, seasonal, and axle factors. For sections that have no data collected during the year for which the traffic tables are being completed, the previous year's data is adjusted based on the factor group factors. The factor groups were determined by the contractor that processes ADOT's traffic data, and this process has been approved by FHWA.

Growth Factors

This data was provided by the TPG and contains the growth factors by growth factor group for Arizona (table 3.2). The growth factors are calculated by comparing AADTs from 1996 to those from 1997 at the ATRs. The growth rates from multiple ATRs in a growth factor group are averaged to determine a single value for all sections within a growth factor group. As mentioned above, if a particular section has not had any measurements made in 1997, then the growth factor for the respective growth factor group will be applied to the 1996 AADT. This value is a moving average from year to year and therefore does not reflect any long-term trends. For growth factor groups that do not contain a functional ATR, a growth factor of one is assumed.

The factors listed in table 3.2 for determining average annual weekday traffic (AAWDT) and average annual weekend traffic (AAWET) values had no relevance to this study.

Table 3.2. Growth factors.

Growth Factor Group	Incl'd Sites 96-97	AADT Growth Factor	Incl'd Sites 1997	AAWDT Conversion Factor	AAWET Conversion Factor
0-Yuma Metro	2	1.2	2	0.99	0.95
1-I-8	1	1.17	2	0.92	1.06
2-I-10 West of PHX	1	1.17	2	0.95	1.03
3-Phoenix Metro	3	1.01	4	1.1	0.72
4-I-10 PHX-TUC	1	1.1	2	0.94	1.05
5-Tucson Metro	*	1.06	2	1.03	0.91
6-I-10 East of TUC	*	1	1	0.95	1.09
7-I-17	1	0.88	3	0.85	1.22
8-I-19	*	1	*	0.91	1.09
9-I-40 West of FLAG	1	0.99	2	0.96	1.07
10-I-40 East of FLAG	1	1.08	2	0.97	1.06
11-Southwest	1	1.19	3	0.93	1.06
12-West Central	4	1.04	9	0.96	1.01
13-East Central	7	1	14	0.95	1.01
14-North of I-40	3	0.91	6	0.99	0.97
15-Extreme SE Corner	4	1.03	5	0.99	0.99
16-I-15	*	1	*	1	1
99-Weird Sites	*	1	*	1	1

Note 1: AAWDT conversion factor = AAWDT/AADT. AAWDT includes Monday - Thursday.
Note 2: AAWET conversion factor = AAWET/AADT. AAWET includes Saturday - Sunday.
Note 3: Included sites must have at least one month of data.
Each month must have at least one day(s) of data for each day of week.
Note 4: * - Factor value was supplied by system operator.
Note 5: + - Factor value was supplied by system operator and replaced a value calculated from data.

Seasonal Factors

This data was provided by the TPG and contains the daily and seasonal adjustment factors by seasonal factor group for Arizona. These values are determined by comparing the AADT values by day of the week and by month of the year at each ATR in each growth factor group. In seasonal factor groups that have multiple ATRs, the values from each ATR are averaged. Each factor group has its own seasonal factor. Table 3.3 shows seasonal factor group 0.

For days of the month and months of the year for which no ATR data is available, these factors are estimated by the system operator.

Axle Factors

This data was provided by the TPG and contains monthly axle factors by axle factor group (table 3.4). Although monthly factors are shown, there is no variation from month-to-month for an axle factor within a particular axle factor group. The reason for this is that each value is determined based upon the vehicle classification data, and the classification data is only collected for a maximum of 48 hours at a particular site. If continuous classification data were to be collected, then this table could show variation from month-to-month.

These factors are only applied to data that was collected by road tubes (as opposed to the ATRs or inductive loops). When applying the axle factor, the value from the table should be doubled and then factored out to be a 24-hour count (if it was collected as a 48-hour sample) to obtain the adjusted raw volume.

FORECASTING

Very little information was provided discussing forecasting methodologies utilized by ADOT, and the information that was provided fits most appropriately in the next chapter, which discusses the existing ESAL table.

Table 3.3. Seasonal factors for seasonal factor group 0.

Seasonal Factor Group: 0-Yuma Metro																								
Factor	Jan	#	Feb	#	Mar	#	Apr	#	May	#	Jun	#	Jul	#	Aug	#	Sep	#	Oct	#	Nov	#	Dec	#
SAF	0.816	1	0.831	1	0.778	2	1.050	*	1.202	2	1.228	2	1.169	2	1.163	2	1.177	2	1.046	1	0.940	1	0.820	1
Sunday	1.170	1	1.057	1	1.162	2	1.118	*	1.084	2	1.086	2	1.005	2	1.054	2	1.132	2	1.029	1	1.079	1	1.282	1
Monday	1.009	1	0.952	1	0.990	2	0.962	*	1.011	2	1.017	2	1.024	2	1.020	2	0.930	2	1.333	1	1.090	1	0.951	1
Tuesday	0.979	1	1.084	1	1.019	2	1.035	*	1.052	2	1.031	2	1.079	2	1.074	2	0.998	2	1.032	1	1.139	1	0.913	1
Wednesday	1.041	1	1.042	1	1.011	2	0.984	*	1.065	2	1.010	2	1.056	2	1.054	2	1.022	2	0.990	1	0.855	1	0.942	1
Thursday	1.018	1	1.071	1	0.998	2	1.012	*	1.003	2	0.978	2	0.952	2	1.013	2	1.067	2	0.982	1	1.054	1	1.121	1
Friday	0.891	1	0.942	1	0.877	2	0.928	*	0.839	2	0.896	2	0.908	2	0.841	2	0.875	2	0.854	1	0.850	1	0.880	1
Saturday	0.937	1	0.887	1	0.998	2	0.982	*	1.007	2	1.008	2	1.005	2	0.988	2	1.046	2	0.901	1	1.015	1	1.017	1

Table 3.4. Axle factors.

Axle Factor Group	Jan	#	Feb	#	Mar	#	Apr	#	May	#	Jun	#	Jul	#	Aug	#	Sep	#	Oct	#	Nov	#	Dec	#
0-Yuma Metro	0.46	*	0.46	*	0.46	*	0.46	*	0.46	*	0.46	*	0.46	*	0.46	*	0.46	*	0.46	*	0.46	*	0.46	*
1-I-8	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*
2-I-10 West of PHX	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*
3-Phoenix Metro	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*
4-I-10 PHX-TUC	0.39	*	0.39	*	0.39	*	0.39	*	0.39	*	0.39	*	0.39	*	0.39	*	0.39	*	0.39	*	0.39	*	0.39	*
5-Tucson Metro	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*
6-I-10 East of TUC	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*
7-I-17	0.41	*	0.41	*	0.41	*	0.41	*	0.41	*	0.41	*	0.41	*	0.41	*	0.41	*	0.41	*	0.41	*	0.41	*
8-I-19	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*
9-I-40 West of FLAG	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*	0.34	*
10-I-40 East of FLAG	0.38	*	0.38	*	0.38	*	0.38	*	0.38	*	0.38	*	0.38	*	0.38	*	0.38	*	0.38	+	0.38	+	0.38	*
11-Southwest	0.44	*	0.44	*	0.44	*	0.44	*	0.44	*	0.44	*	0.44	*	0.44	*	0.44	*	0.44	*	0.44	*	0.44	*
12-West Central	0.44	*	0.44	*	0.44	*	0.44	*	0.44	*	0.44	*	0.44	*	0.44	*	0.44	*	0.44	*	0.44	*	0.44	*
13-East Central	0.45	*	0.45	*	0.45	*	0.45	+	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*	0.45	*
14-North of I-40	0.46	*	0.46	*	0.46	*	0.46	*	0.46	*	0.46	*	0.46	*	0.46	*	0.46	*	0.46	*	0.46	*	0.46	*
15-Extreme SE Corner	0.47	*	0.47	*	0.47	*	0.47	*	0.47	*	0.47	*	0.47	*	0.47	*	0.47	*	0.47	*	0.47	*	0.47	*
16-I-15	0.5	*	0.5	*	0.5	*	0.5	*	0.5	*	0.5	*	0.5	*	0.5	*	0.5	*	0.5	*	0.5	*	0.5	*
99-Weird Sites	0.5	*	0.5	*	0.5	*	0.5	*	0.5	*	0.5	*	0.5	*	0.5	*	0.5	*	0.5	*	0.5	*	0.5	*

Note 1: # - This column indicates number of vehicle classification count sites.

Note 2: * - Factor value was supplied by system operator.

Note 3: + - Factor value was supplied by system operator and replaced a value calculated from data.

CHAPTER 4: REVIEW PROCEDURES FOR DEVELOPING ESAL DESIGN TABLES

The focus of this chapter is to review the current ADOT ESAL table. This table was originally developed in 1986 and was most recently updated in 1997.

CURRENT ESAL TABLE

As referenced in table 2.1, the current ADOT ESAL table was received in electronic and hardcopy formats. This table has been examined to determine the number of highway segments and analysis methodologies included within the spreadsheet. The document explaining ADOT's current method for calculating ESALs has also been received and reviewed. Table 4.1 is a portion of the existing ESAL table.

There are 1,040 segments in the existing ESAL table. Each row in the table contains the same types of information. The first three columns, highway and milepost, give the location of the traffic section (column 4). The traffic section number is unique and is generally consecutive, although there are occasions when the traffic volume increases to the point where a section needs to be subdivided. In these instances, a new section number is introduced (such as section 1161 in between sections 6 and 7 in table 4.1).

In chapter 3, it was noted that there are approximately 140 classification stations located throughout Arizona. The traffic sections have classification data from the most representative station, as determined by ADOT, assigned to them (e.g., sections 1-5 use the classification data from station 42). Columns 10-16 contain the information collected at these classification stations. Column 10 is the percent of commercial traffic, which ranges from 20 percent to 69 percent with an average of 43 percent. Columns 11-15 are the percent of each truck classification within the percent commercial traffic identified in column 10. Table 4.2 shows the range and mean values for each classification. Column 16 contains information on bus traffic, which ranges from 0.1 percent to 1.6 percent with a mean of 0.4 percent.

Column 9 contains the 1997 percent annual growth factors. These factors have generally remained unchanged since 1991. Some factors were manually changed over time by experts from ADOT using their best judgement observing changing trends between 1991 and 1997. Column 6 contains the two way AADT as calculated in 1991 (this is a discrete value in the spreadsheet). Columns 7 and 8, however, contain equations that calculate the AADTs in 1997 and 2017, respectively. The basic equation is: 1991 AADT*(1+(Year X-1991)*(percent annual growth)), where Year X is 1997 or 2017.

Table 4.1. Sample from existing ESAL table.

LT = LIGHT TRUCK MT = MEDIUM TRUCK TS = TRACTOR & SEMI-TRAILOR
TT = TRUCK & TRAILOR TST = TRACTOR & SEMI-TRAILOR

				TWO - WAY			1997 PERCENT	CLASSIFICATION PERCENTAGES							100% OF THE ONE-WAY ACCUMMULATED 18 KIP ESAL (THOUSANDS) THROUGH THE YEARS:											
HIGHWAY	MILEPOST	TRAF SEC	CLASS STA	1991 ADT	1997 ADT	2017 ADT	ANNUAL GROWTH	COM	LT	MT	TS	TT	TST	BUS	1997 FLEXIBLE	2007 FLEXIBLE	2017 FLEXIBLE	1997 RIGID	2007 RIGID	2017 RIGID	1997 FLEXIBLE	2007 FLEXIBLE	2017 FLEXIBLE	1997 RIGID	2007 RIGID	2017 RIGID
I 8	0.0 - 0.57	1	42	10172	12857	24172	4.4	44.7	66.8	13.2	16.4	2.1	1.5	0.3	488	6094	15113	546	6825	16927	488	6094	15113	546	6825	16927
I 8	0.57- 2.23	2	42	11915	14989	27880	4.3	44.7	66.8	13.2	16.4	2.1	1.5	0.3	568	7104	17619	637	7957	19733	568	7104	17619	637	7957	19733
I 8	2.23- 3.98	3	42	14553	18919	37838	5.0	44.7	66.8	13.2	16.4	2.1	1.5	0.3	717	8967	22238	803	10043	24906	717	8967	22238	803	10043	24906
I 8	3.98- 7.63	4	42	13083	17479	37055	5.6	44.7	66.8	13.2	16.4	2.1	1.5	0.3	663	8284	20545	742	9279	23011	663	8284	20545	742	9279	23011
I 8	7.63- 9.40	5	42**	13418	18248	40147	6.0	44.7	66.8	13.2	16.4	2.1	1.5	0.3	692	8649	21450	775	9687	24024	692	8649	21450	775	9687	24024
I 8	9.40- 12.21	6	41**	16589	21964	45685	5.4	45	71.2	12.5	13.2	1.7	1.4	0.2	727	9091	22546	815	10182	25251	727	9091	22546	815	10182	25251
I 8	12.21-14.24	1161	41	18000	23400	46800	5.0	45	71.2	12.5	13.2	1.7	1.4	0.2	775	9685	24020	868	10848	26902	775	9685	24020	868	10848	26902
I 8	12.21- 21.03	7	41	8821	9774	13292	1.8	45	71.2	12.5	13.2	1.7	1.4	0.2	324	4045	10033	362	4531	11237	324	4045	10033	362	4531	11237
I 8	21.03- 30.80	8	41	8322	9770	15437	2.9	45	71.2	12.5	13.2	1.7	1.4	0.2	324	4044	10029	362	4529	11232	324	4044	10029	362	4529	11232
I 8	30.80- 37.95	9	41	8789	10687	18382	3.6	45	71.2	12.5	13.2	1.7	1.4	0.2	354	4424	10971	396	4954	12287	354	4424	10971	396	4954	12287
I 8	37.95- 42.06	10	41	8443	10216	17367	3.5	45	71.2	12.5	13.2	1.7	1.4	0.2	338	4229	10487	379	4736	11745	338	4229	10487	379	4736	11745
I 8	42.06- 54.96	11	41	8277	10214	18181	3.9	45	71.2	12.5	13.2	1.7	1.4	0.2	338	4228	10484	379	4735	11743	338	4228	10484	379	4735	11743
I 8	54.96- 67.41	12	41	7226	8223	12006	2.3	45	71.2	12.5	13.2	1.7	1.4	0.2	272	3404	8441	305	3812	9454	272	3404	8441	305	3812	9454
I 8	67.41- 73.48	13	41	5655	5994	7193	1.0	45	71.2	12.5	13.2	1.7	1.4	0.2	198	2481	6153	222	2779	6892	198	2481	6153	222	2779	6892
I 8	73.48- 78.46	14	41	5416	5741	6889	1.0	45	71.2	12.5	13.2	1.7	1.4	0.2	190	2376	5893	213	2661	6600	190	2376	5893	213	2661	6600
I 8	78.46- 87.04	15	41	5838	6188	7426	1.0	45	71.2	12.5	13.2	1.7	1.4	0.2	205	2561	6352	230	2869	7115	205	2561	6352	230	2869	7115
I 8	87.04-102.23	16	41	6365	6938	9019	1.5	45	71.2	12.5	13.2	1.7	1.4	0.2	230	2872	7122	257	3216	7976	230	2872	7122	257	3216	7976
I 8	102.23-106.51	17	41	7520	9009	14955	3.3	45	71.2	12.5	13.2	1.7	1.4	0.2	298	3729	9248	334	4176	10357	298	3729	9248	334	4176	10357
I 8	106.51-111.42	18	41	7620	9266	15937	3.6	45	71.2	12.5	13.2	1.7	1.4	0.2	307	3835	9511	344	4295	10653	307	3835	9511	344	4295	10653
I 8	111.42-115.14	19	15	6696	7741	11766	2.6	45	36.2	18	39.1	3.2	3.5	0.3	568	7098	17602	636	7949	19714	568	7098	17602	636	7949	19714
I 8	115.14-115.62	20	15**	3844	4813	8855	4.2	45	36.2	18	39.1	3.2	3.5	0.3	353	4413	10944	395	4942	12257	353	4413	10944	395	4942	12257
I 8	115.62-119.42	21	15	3517	4002	5843	2.3	45	36.2	18	39.1	3.2	3.5	0.3	294	3670	9101	329	4110	10193	294	3670	9101	329	4110	10193
I 8	119.42-140.81	22	16**	5718	6061	7273	1.0	45	28.1	14.1	51	3.6	3.2	0.3	501	6263	15533	561	7015	17397	501	6263	15533	561	7015	17397
I 8	140.81-144.57	23	16	7941	9704	16885	3.7	45	28.1	14.1	51	3.6	3.2	0.3	802	10027	24868	898	11231	27852	802	10027	24868	898	11231	27852
I 8	144.57-151.68	24	16	7854	9550	16427	3.6	45	28.1	14.1	51	3.6	3.2	0.3	790	9869	24475	884	11053	27412	790	9869	24475	884	11053	27412
I 8	151.68-161.53	25	62	8310	9307	13030	2.0	45	31.2	11.3	50.8	3.9	2.8	0.2	736	9203	22823	825	10307	25562	736	9203	22823	825	10307	25562
I 8	161.53-167.53	26	62	5336	5720	7093	1.2	45	31.2	11.3	50.8	3.9	2.8	0.2	452	5656	14027	507	6335	15710	452	5656	14027	507	6335	15710

The table also includes two identical sets of ESAL values for 1997, 2007 and 2017. The first set (columns 17-22) are calculated by multiplying the value in each corresponding column (23-28) by 1 (e.g., column 23 multiplied by 1 equals column 17). The key value in columns 17-28 is found in column 23. This is the 1997 flexible ESAL value. This cell contains an equation that is found by taking the 1997 ADT (two-way) divided by two multiplied by percent commercial vehicles divided by 100 multiplied by 100 minus light trucks multiplied by 100 multiplied by 1.4 (or 1.7) multiplied by 365 divided by 1000 (i.e., (((((1997 ADT/2)*((% Com/100)))*((100-% LT)/100))*1.4 (or 1.7)*365)/1000)). The flexible 2007 (column 24) value takes the flexible 1997 value and multiplies it by 12.5, while the flexible 2017 ESAL value (column 25) multiplies the flexible 1997 ESAL value by 31. The corresponding rigid ESAL values (columns 26-28) are determined by multiplying the flexible ESAL value by 1.12.

Table 4.2. Range and mean values for Arizona truck classifications.

	Light Truck	Medium Truck	Tractor and Semi-Trailer	Truck and Trailer	Tractor and Semi-Trailer
Minimum (%)	28.1	3	0.3	0	0
Maximum (%)	95.2	36.6	53.8	5.3	5.6
Mean (%)	73	12.1	12.5	1.4	1.1

Discussions with ADOT personnel revealed that there have been a number of simplifying assumptions made that may not have been documented, but of which the ADOT materials group are well aware. The primary assumptions are that for 1997, the commercial vehicles (excluding the light truck category) contribute a factor of 1.4 ESALs per vehicle (except for the Interstate 40 and U.S. 93 corridors for which the factor is 1.7 ESALs per vehicle), the 10-year ESAL multiplier is 12.5, and the 20-year ESAL multiplier is 31. These numbers were determined to be defendable by the materials group and account for such factors as expected increases in tire pressures and vehicle weights over time.

CHAPTER 5: RECOMMEND CHANGES TO CURRENT PROCEDURES

There is significant overlap between items in chapter 5 and their subsequent application in chapter 6. This is due to the close tie between the NCE team's recommendations and their subsequent effect on the revised ESAL table. Ideally, every segment in Arizona would have its own continuous and calibrated AVC/WIM system. However, the cost of this instrumentation (not to mention the labor to maintain the systems and collect and process the data) is prohibitive. The recommendations in this chapter are believed to be implementable without significantly affecting the current expenditures for traffic data collection.

FHWA VEHICLE CLASSIFICATION SYSTEM

Vehicles traveling in the United States come in many shapes and axle configurations. This creates difficulties for State DOT personnel in the classification of vehicle types on roadway networks. The FHWA has developed two methods of vehicle classification that have been used in the Truck Weight Study (TWS). The two methods developed are the 6-digit classification system and the 13-bin classification system. The 13-bin system is currently the most accepted system and is the current FHWA required classification system (figure 5.1).

Prior to the 13-bin FHWA system; the USDOT used what is referred to as the 6-digit system. This system is extremely flexible; however, it produces many different vehicle types (i.e., more than 13). ADOT is currently using the 13-bin FHWA vehicle classification system.

The 13-bin system allows a better understanding of the vehicle types on the ADOT road network, and reflects the state-of-the-practice for State DOTs in the United States. Additionally, the 13-bin system can be easily reduced into the more general vehicle class system that has been used in the past (i.e., the LT, MT, TS, TT, TST scheme in the existing ESAL table) if necessary. Both the TPG and the LTPP data is reported in the 13-bin classification system, so no work will be required on behalf of ADOT to implement this classification scheme into the new ESAL table.

TRAFFIC FORECASTING METHODOLOGY

As mentioned in chapter 4, there is not currently a mechanism by which AADT forecasts are updated aside from manually updating growth factors. The existing growth factors were determined by applying a linear regression to AADT data that extended through 1991.

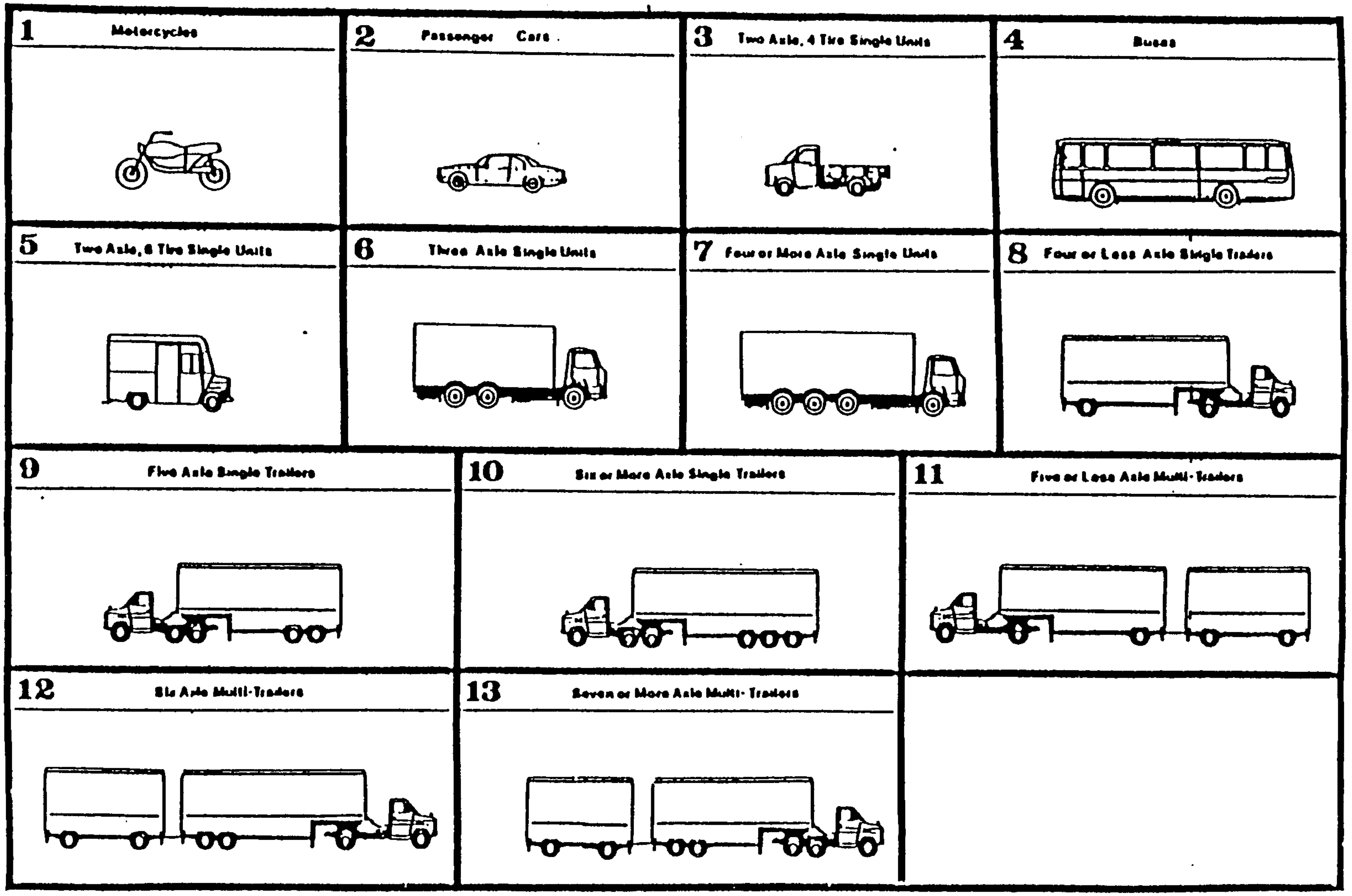


Figure 5.1. FHWA vehicle classification.

NCE APPROACH TO AADT FORECASTING

The forecasting of AADT is important in the understanding of traffic movements and for the calculation of ESALs in the ADOT ESAL table. ADOT has been collecting AADT data for 1,040 traffic segment locations since 1974. This has been accomplished by manual surveys, automated counting equipment, and more recently by AVC and WIM systems. Upon the recommendation of the TAC, only the last 6 years of data was to be used in any forecasting models.

The forecasting of AADT for all segments is critical in the revisions to the ADOT ESAL table. The difficulty with forecasting traffic data is that not all traffic segments have the same pattern of traffic growth. Additionally, traffic growth is triggered by many factors that can not be foreseen or modeled. The NCE team decided to initiate the growth factor analysis with the assumption that a linear trend in growth exists for most traffic segments. However, given the relatively small data set (as sites where traffic volumes were collected every three years would only have two measured data points and four points calculated using growth factors), only about 40 percent of the data showed a strong linear correlation (i.e., $R^2 > 0.6$).

It was then determined by the project team that the most reasonable method to determine the AADT growth factors was to average the average annual growth factors for each year between 1992 and 1997. For sections with low AADTs, this resulted in some extremely large growth factors, and there was some discussion whether to limit the maximum annual growth, but it was decided that this would be outside the scope of the project (since more familiarity with each specific site was required) and should be decided by ADOT personnel. Sections with annual growth factors over 15 percent are identified in the new ESAL table. In future years, as AADT values are added, it is expected that fewer segments will need to be flagged as having questionable growth factors.

NEGATIVE GROWTH

Another trend that was discovered in the AADT data during the analysis was that some sections exhibited negative growth trends. A negative trend in AADT will directly affect the trend in yearly and cumulative ESALs. After discussing this matter with the TAC, it was decided that the minimum growth factor for any section would be 2 percent, so sections with negative growth trends, or positive growth trends less than 2 percent, would be modified to have a growth factor of 2 percent.

COMPARISON OF 2020 AADT ESTIMATES (PIMA COUNTY VS. NEW ESAL TABLE DATA)

As a quality assurance check, the 2020 AADT estimates from the maps provided by Pima County were compared with 2020 estimates of AADT from the new ADOT ESAL table. Table 5.1 contains a listing of the 2020 AADT values provided by Pima County, the 2020 AADT values computed by the new ESAL table, the percentage difference between the two, for 26 ADOT segments in Pima County and the *theoretical capacity* (this will be defined in chapter 6) of each segment. The majority of the 2020 AADT values have a percent difference of less than 40 percent. These numbers compare even better when they are constrained by the maximum theoretical capacity for each roadway segment. While there would still be segments that differ significantly (segment 533 is the prime example), other segments (e.g., 245 and 246) would match almost exactly. Considering the fact that 20-year traffic estimates are difficult to closely estimate, the NCE team feels that this comparison confirms the AADT forecasting methodology.

Table 5.1. Comparison of Pima County and ESAL table 2020 AADT values.

ADOT Segment #	Pima County 2020 AADT	NEW ADOT 2020 AADT	% Diff.	Theoretical Capacity
100	129,000	159,029	-23.3	110,000
101	139,000	85,487	38.5	165,000
102	147,000	170,905	-16.3	165,000
103	139,000	106,395	23.5	165,000
104	152,000	110,589	27.2	165,000
105	172,000	156,098	9.2	165,000
106	173,000	184,629	-6.7	165,000
107	175,000	172,756	1.3	165,000
108	170,000	246,769	-45.2	165,000
110	176,000	235,846	-34.0	165,000
111	184,000	206,412	-12.2	165,000
115	82,000	93,363	-13.9	110,000
116	76,000	152,664	-100.9	110,000
117A	66,000	160,495	-143.2	110,000
117B	79,000	160,495	-103.2	110,000
244	85,000	92,074	-8.3	110,000
999	94,000	111,941	-19.1	110,000
245	110,000	139,949	-27.2	110,000
246	110,000	140,316	-27.6	110,000
988	12,000	68,927	-474.4	55,000
551	20,000	38,791	-94.0	55,000
552	54,000	139,277	-157.9	110,000
553	55,000	587,170	-967.6	110,000
554	57,000	45,260	20.6	110,000
555	66,000	106,676	-61.6	110,000
556	60,000	122,552	-104.3	110,000

ESAL DEVELOPMENT PROCEDURES

The new ESAL table was sorted according to traffic volumes as well as percent commercial vehicles. The segments in each area with the highest volumes or percent vehicles were selected for the purposes of determining whether FHWA class 1-3 vehicles (motorcycles, passenger cars and pick-up trucks) have a significant impact on the overall number of ESALs a segment will experience. It was found that these classes of vehicles may be ignored for the purpose of calculating ESALs. As an example, a 4,000-pound passenger car would generate 0.0004 ESALs. Therefore it would take over 6,000 passenger cars to equal the number of ESALs of one fully loaded FHWA class 9 tractor semi-trailer.

PROCESS FOR ESAL DISTRIBUTION

The data provided by the TPG and LTPP WIM sites provides the most consistent source of weight data for each vehicle classification. While there is no need to modify the classification sections set up by ADOT, it was important to incorporate the LTPP and TPG WIM sites into the existing classification sections. Tables 5.2 and 5.3 present this information.

Table 5.2. The location of LTPP WIM site relative to ADOT classification stations.

ADOT Classification Station	Corresponding LTPP WIM Sites
20	0214, 1001, 1003, 1006, 1007, 7614
21	1034
26	1037
29	0114
31	1024, 1025, 1062, 1065
32	1002
46	6053
53	1036
62	0501
75	6054
76	1015, 1016, 1017, 1018, 6060
127	6055
142	7079
148	7613
151	0601

Table 5.3. The location of ADOT TPG WIM sites relative to ADOT classification stations.

ADOT Classification Station	Corresponding ADOT TPG WIM Sites
5	9006
21	9003
22	9004
46	9001

The WIM data passing the QC/QA checks described in chapter 3 was summarized by site to yield yearly average load and percent vehicle truck data. The summaries included percent trucks, average ESALs per truck type, and axle load spectrum. For vehicle class 4-13, a reasonableness check was applied consisting of comparing the average ESALs per class for all years of data to the corresponding ESALs calculated using the maximum legal gross vehicle weights (GVWs) for each class. Table 5.4 summarizes this comparison for flexible pavements.

Table 5.4. ADOT network average ESALs by vehicle class for flexible pavement for all years.

Vehicle Class	ESALs from WIM Average	ESALs From Maximum GVW*	Standard Deviation of WIM Averages
4	0.81	2.3	0.397
5	0.20	1.9	0.122
6	0.66	1.5	0.354
7	0.53	2.3	0.288
8	0.59	3.2	0.439
9	1.29	2.4	0.532
10	1.25	1.8	0.707
11	1.76	6.1	1.083
12	0.96	5.7	0.644
13	3.06	5.4	1.334

*Note: ESAL table values are based on SN=4 and P_t=2.5, using the AASHTO[3] design procedure and 14 kip single unit front axle, 12 kip multiple unit front axle, 20 kip single axle, and 34 kip dual tandem axle weights.

As expected, the average ESALs per class from the WIM sites is less than the ESALs from the estimated maximum GVW. This is because some trucks are empty or carrying a light cargo that fills the truck before loading the truck to the maximum GVW. This is commonly observed and has been thoroughly studied by C. Dahlin of the Minnesota DOT.[4]

Similarly, the ESALs by vehicle class for rigid pavements were also determined (table 5.5). These values are similar to those in table 5.4, but are not exactly the same. The ESALs from maximum gross vehicle weight were not computed (although they would be very similar to those calculated in table 5.4). The pavement type of the LTPP site, not the pavement type in which the sensors themselves are housed, were used to determine whether the pavement was flexible or rigid.

Table 5.5. ADOT network average ESALs by vehicle class for rigid pavement for all years.

Vehicle Class	ESALs from WIM Average	Standard Deviation of WIM Averages	Two Standard Deviations of WIM Averages
4	0.89	0.213	0.426
5	0.15	0.080	0.161
6	1.07	0.464	0.929
7	2.25	1.095	2.191
8	0.73	0.537	1.073
9	2.13	0.634	1.268
10	1.68	0.607	1.213
11	1.77	0.832	1.664
12	0.92	0.369	0.739
13	4.75	1.455	2.910

An important distinction that needs to be made is that the standard deviation noted in tables 5.4 and 5.5 is the standard deviation of the average values of each WIM site. It is not the standard deviation of all data collected at the sites within the flexible or rigid pavement type groupings.

COMPARISON OF DATA FROM TWO ADJACENT LTPP WIM SITES

A study was undertaken to determine if similar traffic patterns existed between relatively close WIM sites on a major interstate in Arizona. Two LTPP WIM sites were selected: 041007 and 041006 on westbound I-10 west of Phoenix. The chosen sites were 5 miles apart and LTPP WIM data was collected for the truck lane at both sites.

The comparison results were very encouraging, as most heavy vehicle classes showed little percent difference between the two sites using daily and yearly comparisons. However, two vehicle classes did show differences that triggered further investigation. The vehicle classes of concern were 5 and 8 (see appendix B, daily comparisons). Figure 5.2 shows the comparison between vehicle types for the year 1996.

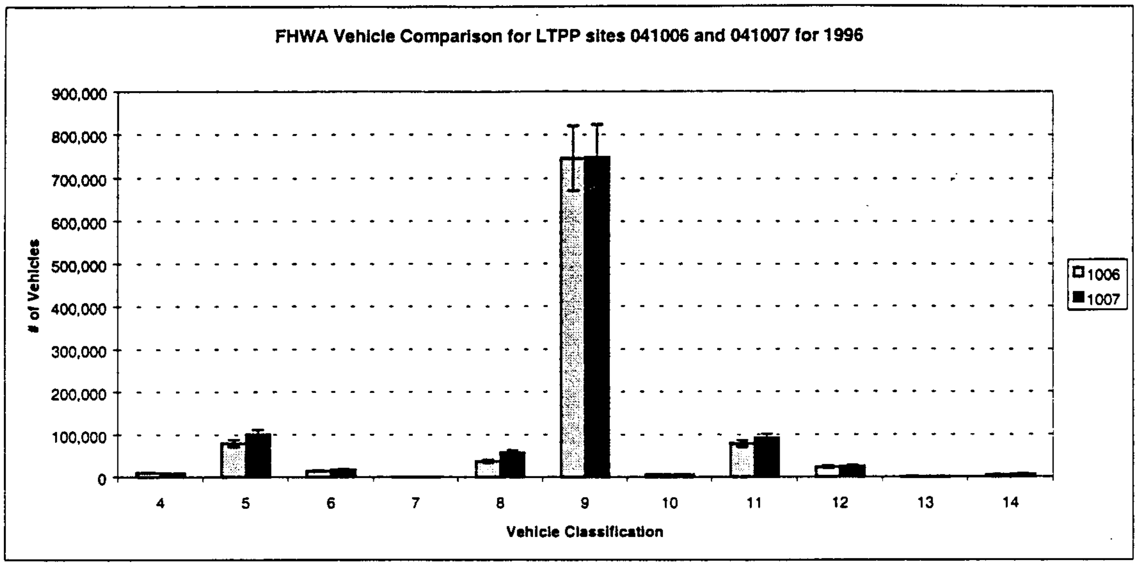


Figure 5.2. Annual comparison of FHWA class 4-13 vehicles between 041006 and 041007.

The experience NCE has gained through processing the Western Region WIM data caused the team to question if the difference was due to Recreational Vehicles (RVs). This suspicion was further fueled by the consistent trend of more vehicle classes 5 and 8 being observed at LTPP site 041007 as compared to site 041006. The team questioned if these vehicles were leaving I-10 and traveling south on SR85. This movement of vehicles was confirmed by ADOT personnel as SR85 is a route to a popular resort destination on the Gulf of Mexico. Further, it was verified by ADOT TPG that the actual number of class 5 and 8 vehicles is much less than what the data shows because the AVC equipment is misclassifying these vehicles based on axle spacing parameters. Other members of TAC stated that a significant number of class 9 vehicles also use the SR855 by-pass, but as can be seen in figure 5.2, this is not shown in the data provided to NCE.

COMPARITON OF LTPP AND TPG DATA FROM THE SAME CLASSIFICATION STATION

There were two classification stations that have LTPP and TPG AVC/WIM equipment installed: stations 21 and 46. The TPG data for station 21 did not pass the QC/QA analysis, but the data for station 46 did. Unfortunately, there was not any common year between the LTPP and TPG data, but it was possible to compare the annual trends. This comparison is shown in table 5.6. For most classes, the data compares quite well. However, almost 12 percent of the TPG vehicles fell in class 14 (unclassified). In 1998, almost 48 percent of the vehicles fell in class 14, which suggests that the TPG system is in need of calibration (not included in table 5.6).

Table 5.6. Comparison of LTPP and TPG AVC data in station 46.

	Vehicle Classification (% by Class)										
	4	5	6	7	8	9	10	11	12	13	14
1993 - LTPP	2	15.2	1.8	0.6	3.6	68	0.3	5.8	1.7	0.2	0.8
1994 - LTPP	1.7	13.3	1.8	0.6	6.7	67.3	0.4	5.5	1.6	0.4	0.6
1995 - LTPP	0.9	5.7	1.1	0	14.5	59.5	0.2	4.7	1.4	0.1	0.4
1996 - LTPP	1	14.6	1.2	0	14.9	61.1	0.3	4.9	1.3	0.2	0.4
1997 - TPG	1.1	14	1.7	0	3.3	64.3	0.3	2.3	0.9	0.1	11.9

COMPARISON OF TPG DATA WITH CONTINUOUS AVC/WIM DATA

Within classification station 151 is an LTPP WIM system where the sensors collect data in all lanes and both directions (typically, the sensors are only in the single lane that contains the LTPP test section). At sites with all lanes instrumented, it is possible to calculate the AADT and percent trucks (which otherwise is impossible without making assumptions about traffic distribution, see appendix B). Table 5.7 shows the results of the comparison between the continuous data collection and the TPG 6-hour manual count for classification and mechanical count for AADT.

Table 5.7. Comparison of AADT and percent trucks between TPG and LTPP data.

Year	TPG AADT	TPG % Trucks	LTPP AADT	LTPP % Trucks	% Difference AADT	% Difference Trucks
1994	14068	31.3	12122	41.8	16	25
1995	14304	36.4	14210	40.6	0.7	10
1996	24900	11.5	14590	42.3	71	73

Between 1995 and 1996, the TPG data changes drastically while there is no such fluctuation in the LTPP data. This highlights the variability inherent in expanding short periods of data collection into annual values.

GROWTH FACTORS FOR ESAL PER VEHICLE CLASS AND CHANGES IN MAKEUP OF TRUCK TRAFFIC

Observation of the LTPP WIM data has shown that the traffic makeup changes in many ways with time. Change in AADT with time has already been discussed. Two analyses were performed to look at other parameters that also change with time. Namely, the change in the ESAL factors associated with each vehicle class over time and the change in the makeup of the truck traffic over time.

The LTPP data revealed that the ESAL factors calculated from WIM data for each truck classification varies from year-to-year. An investigation was conducted to see if a general trend in the calculated ESAL factors could be established and consequently a recommendation be made on whether to incorporate the trend into the ESAL table. This investigation revealed that although calculated ESAL factors may increase or decrease over time for specific sites, in general, the ESAL factors appear to have remained relatively constant from 1993 through 1997. This is logical as the maximum allowable axle weights have not changed during that period. For this reason, the ESAL factors incorporated into the ESAL table have not been adjusted with time.

In addition, the makeup of the truck traffic also changes over time. It has been found that for the LTPP WIM sites for the years 1993 through 1997, the class 9 truck percentage relative to the total truck traffic has increased in increments of approximately 2.5 percent per year.

$$\% \text{ Class 9 Trucks}_{(n)} = \% \text{ Class 9 Trucks}_{(1993)} + 2.5\% * (\text{Year} - 1993)$$

Note: Percent class 9 trucks in the above equation is relative to the total truck traffic.

Relative to the entire traffic stream, class 9 trucks have increased in increments of approximately 0.8 percent per year.

$$\% \text{ Class 9 Trucks}_{(n)} = \% \text{ Class 9 Trucks}_{(1993)} + 0.8\% * (\text{Year} - 1993)$$

Note: Percent class 9 trucks in the above equation is relative to the total traffic stream.

This issue is worth revisiting in another 3 to 5 years to see if the trend in increasing percentages of class 9 vehicles in the traffic stream is continuing. If it is, consideration should be given to modifying the growth factor by vehicle class.

INVESTIGATION OF AVC AND WIM CALIBRATION

Current Practice

As discussed in chapter 3, the ADOT maintains a network of 14 permanent WIM sites, five AVC sites and two additional AVC sites equipped with portable WIM systems (i.e., the sensors are installed permanently, while the data acquisition system is portable). In addition, the Arizona TPG maintains another six WIM sites, plus two AVC sites. These WIM sites are equipped with either bending-plate or piezo-electric sensors and were supplied by either PAT or IRD. The AVC systems come from PAT and they are of the double loop plus axle sensor technology.

The on-site WIM calibration method used is a variation of the method prescribed by the LTPP directive TDP-11 (April 1998).[5] It involves successive passes of two 5-axle semi-trailer (3S-2) test trucks. Typically, these trucks have flat-bed trailers and similar suspension systems in their corresponding axles. The trucks are loaded near their maximum GVW of 80 kips and their axle loads are measured using a static weigh scale.

Initially, 10 runs are performed at a given speed, which is selected depending on the speed limit at a WIM site. For these runs, errors are calculated as the percent difference between the static load and the WIM measurements for each of the:

- Steering axle.
- First tandem axle .
- Second tandem axle.
- GVW.

The statistics calculated are the average and the standard deviation of the percent errors for each of these four groups of measurements. A WIM system must yield average errors lower than a prescribed level in each of these four groups of measurements in order to pass. These levels of average error are set at +-5 percent for the bending plate systems and at a slightly higher value for the piezo systems. If during this process, consistent trends emerge in the average errors, calibration adjustments are made to the WIM system. Once the calibration is completed and if the maximum average errors are not exceeded, additional runs are performed using the same two trucks running at various speeds, to verify that the average WIM errors remain within the prescribed range. Otherwise, the particular WIM site is "shut-down" and no further data is collected from it until it can be fixed. This calibration process takes about 2-3 hours per WIM site to complete.

The statewide WIM data is post-processed at the office for quality assurance using the methodology developed by Minnesota DOT (TRR 1364, 1994).[4] For this purpose, the consistent properties of the steering axle load of 3-S2 trucks is used, rather than the consistent properties in the distribution of their GVW. In addition, the WIM data collected for the LTPP sites is processed through the software package developed by Chaparral Inc, which encompasses a wider range of QA tests than the Minnesota DOT method.

The on-site calibration of AVC systems is done through visual inspection without a rigorous analysis of observed versus recorded vehicle classification data. No post-processing of the AVC data is carried out for QA purposes.

Recommended Improvements

A number of recommendations are made for improving and expediting the ADOT WIM and AVC calibration procedures. These include considering the effect of pavement roughness and vehicle speed on WIM error analysis and using a video recorder for AVC calibration, respectively.

Improved WIM Calibration Method

It is well documented that the variation in dynamic axle loads increases with speed and roughness, hence affecting the magnitude of the WIM errors observed at a given site. Experimental evidence (Papagiannakis et al., 1990)[6] has produced relationships that can be used to calculate the expected coefficient of variation (CV percent) of dynamic axle loads as a function of pavement roughness (R in terms of International Roughness Index (IRI) m/km)) and vehicle speed (V in m/km). These relationships are plotted on figures 5.3 through 5.5 in terms of the CV of dynamic load versus the vehicle speed for three levels of pavement roughness (i.e., smooth, medium and high roughness). The two suspension types referred to in these figures are a rubber-sprung walking beam and an independent air-ride, which represent extremes in dynamic behavior (i.e., a leaf spring would exhibit a dynamic load CV between the two shown). It should be evident that using test trucks with air-ride suspensions would reduce the dynamic load variation and expedite the calibration process.

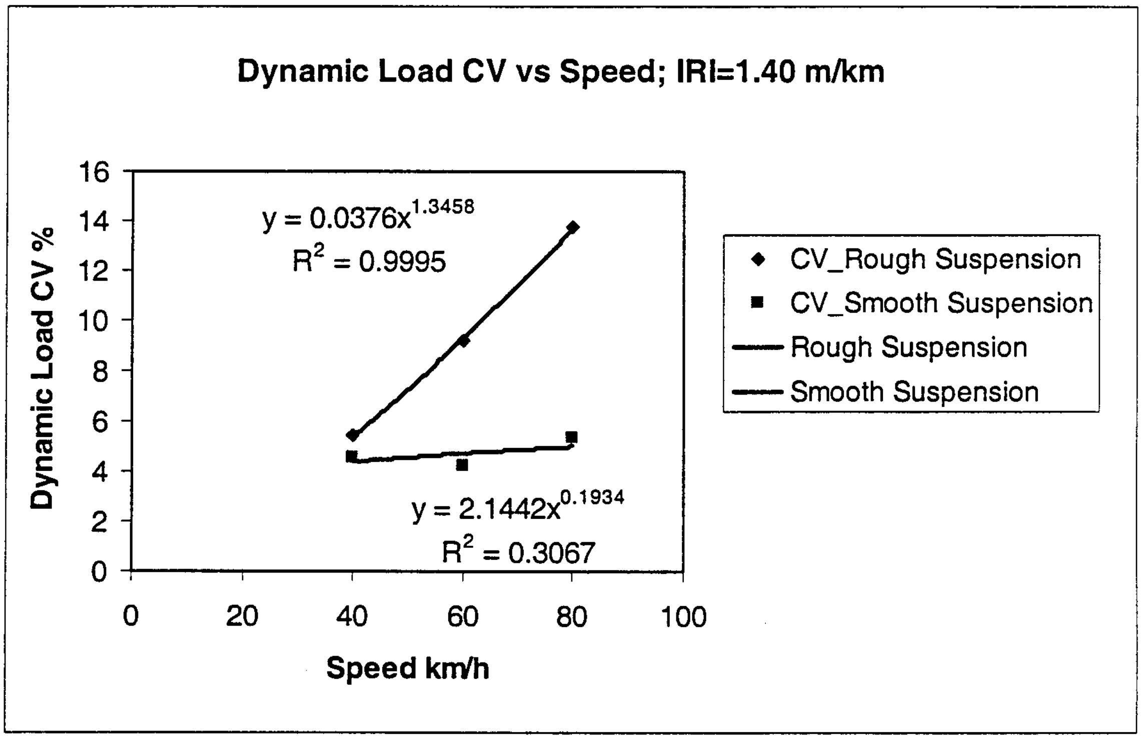


Figure 5.3. Dynamic load vs. vehicle speed; IRI=1.40 m/km.

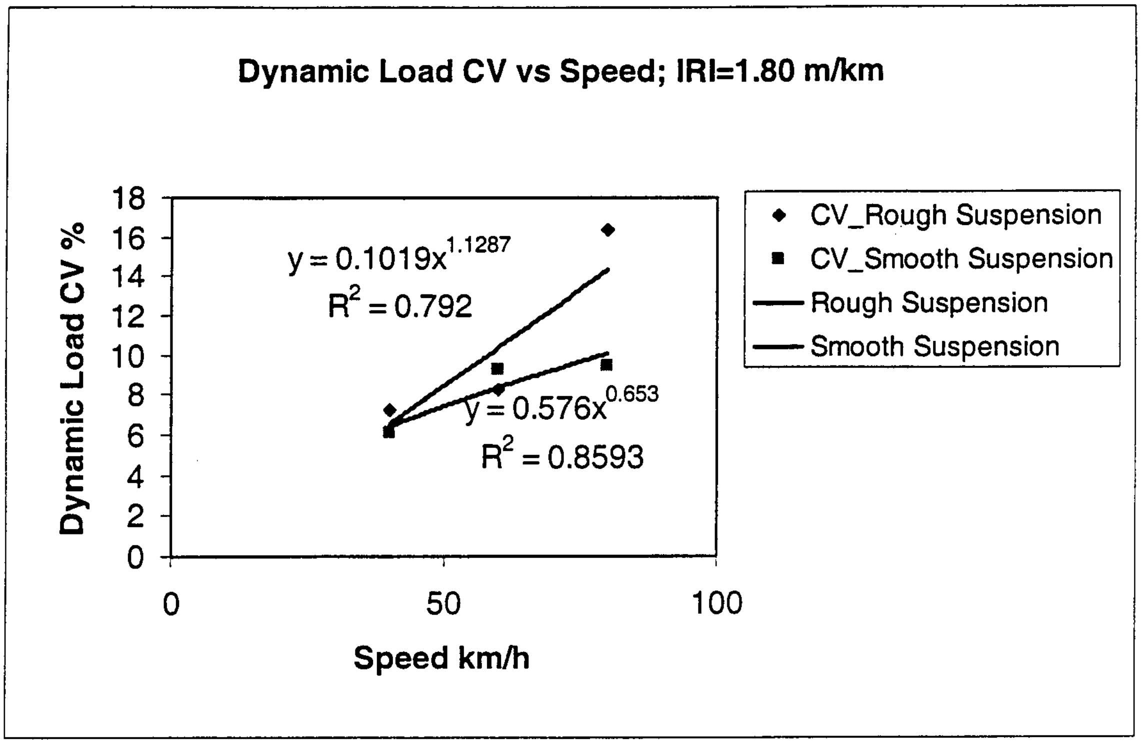


Figure 5.4. Dynamic load vs. vehicle speed; IRI=1.80 m/km.

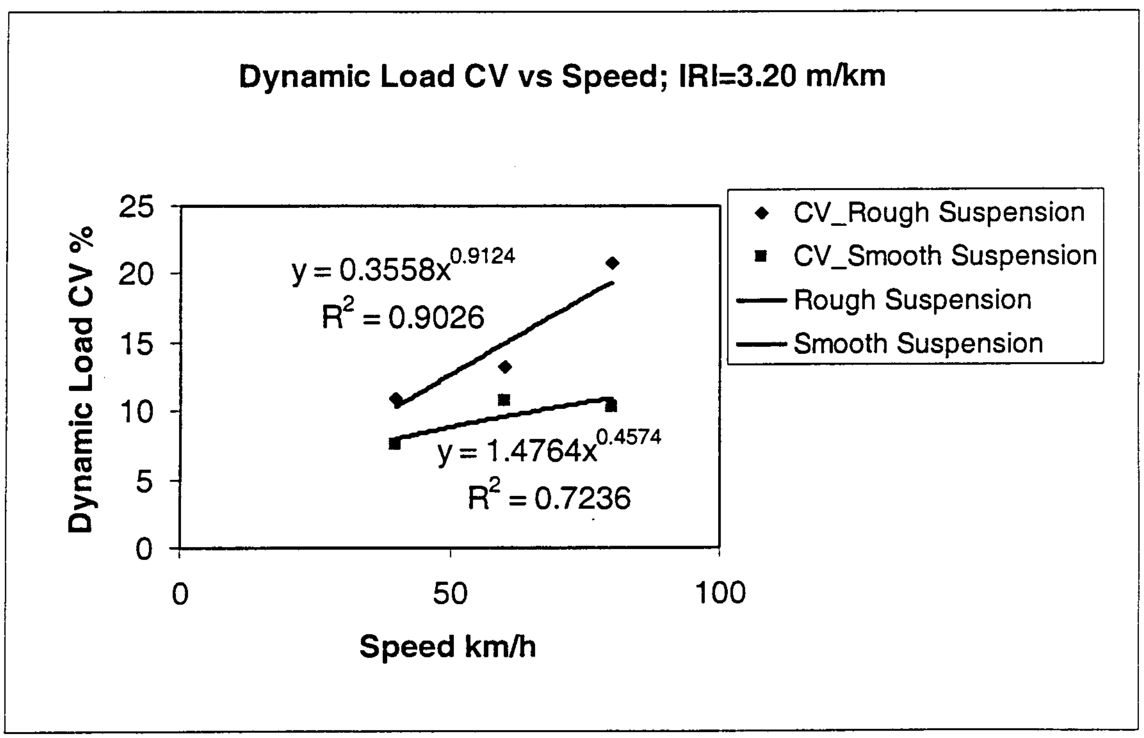


Figure 5.5. Dynamic load vs. vehicle speed; IRI=3.20 m/km.

Another experimental observation is that replicate test truck passes (i.e., same truck and speed) generate repetitive dynamic axle loads along the road. Hence, the magnitude of the dynamic axle loads applied on a WIM sensor from successive replicate truck passes are equal. This allows reducing the number of test truck passes for achieving an initial WIM calibration. To take advantage of this properties, it is suggested to carry out an initial analysis of the results by axle or axle group (i.e., tandems or triples) rather than by averaging the errors. This procedure is explained below.

These findings allow the following calibration approach (after Papagiannakis et. al, 1996).[7]

1. Calculate the anticipated range in the WIM measurements for each axle/axle group as the mean (i.e., static) load +- 2 standard deviations (i.e., calculated as the static load value multiplied by the CV obtained from figures 1 through 3 for the roughness at the site and the speeds of the test vehicles). This can be easily done at the office for all the speeds expected to of the test trucks at the site, given its IRI roughness.

2. Perform one run of each test truck and compare the WIM measurements of each axle/axle group and each vehicle to their anticipated range. There are four distinct possibilities:

    a. If all measurements fall outside the anticipated range and they are all either higher or lower than this range, adjust system calibration calculated as:

$$\textit{calibration factor adjustment} = \frac{\sum static_i}{\sum WIM_i}$$

    It would be desirable to carry out this adjustment prior to continuing with subsequent test runs.

    b. If all measurements fall outside the anticipated range and some are above, while other below, there are major problems with the WIM system, either software (e.g., integration algorithms of piezo signals) or hardware (e.g., damaged strain gauges of bending plates. These problems are not likely to be solved through calibration adjustments and will require a technician's intervention.

    c. If all measurements fall within their anticipated ranges, no calibration adjustments are necessary prior to carrying a subsequent test run by repeating step 2.

    d. If some measurements are outside their expected range, while others are inside, a judgement call must be made whether actions corresponding to either (a) or (c) are to be taken.

3. Once the desirable number of runs is carried out and condition (2c) is satisfied for all runs and all speeds, it should be ensured that the requirements of the TDP 11 Protocol are met, that is average WIM errors are lower than the prescribed value percent for each axle group (i.e., steering, first tandem and second tandem) for all test speeds.

In summary, this approach allows expedient (i.e., several test runs) determination of whether a WIM calibration problem exists and whether the problem can be solved via calibration factor adjustments or there is a hardware/software problem present.

Improved WIM Data QA Method for Non-LTPP Sites

In improving the WIM data QA for non-LTPP sites, it is advised to use the properties of the traffic stream to determine likely problems with the data. The simplest approach is to use the steering axle load of the three-S2 trucks as an indicator of WIM data quality. This is one of the tests used by the Minnesota DOT approach and does not take into account problems with the vehicle classifying algorithms of WIM systems. It has nevertheless been used successfully as a QA criterion (Ott et al., 1996)[8] and it is used by a number of WIM manufacturers as a means of auto-calibrating WIM systems. In establishing mean and standard deviation values for the steering axles of three-S2 trucks, it is advised to collect a small data sample at static weigh scales (e.g., 10-20 trucks per season). Suggested static load locations are the major ports of entry at the four boundaries of the State. It is understood that the ports of entry truck inspection stations run independently of ADOT. However, it would take a small effort to convince them to print and retain the small sample size required.

Improved AVC Calibration Method

As described next, AVC data collection should complement the WIM data collection for the purpose of predicting AADT volumes and accumulated ESALs. For this purpose, it is essential that AVCs are properly calibrated. It is recommended to use a video camera for recording the vehicle classification of the traffic stream, instead of relying on visual observations. This can be done using a household-grade video camera set on a tripod on the side of the road. The clock on the camera can be synchronized with the clock on the AVC system. Even recording over a short period of time (e.g., while visiting an AVC site) would allow a far more accurate calibration of the AVCs than as compared with visual observation. The data should be post-processed at the office by at least two observers and the manual classification procedure compared to the AVC to decide on its accuracy.

SURVEY OF OTHER AGENCIES

For comparative purposes, a number of State Highway Agencies were surveyed to determine how they calculated ESALs. The survey was submitted to 15 agencies and 11 responded. The following questions were included in the survey:

1. Does your State use ESAL computations for pavement design and rehabilitation?

Yes:____
No:_____

2. What type of types of data do you use to come up with the ESAL table values? (Will you fax us the first page of your ESAL table for an example?)

a.) Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location?

3. Do you break down ESALs by vehicle classification

4. Do you apply average ESAL factors to the vehicles in each classification? What are they?

5. Do you use growth factors to expand ESALs to design years?

6. Do you use WIM data? If not, what do you use for load data?

7. Are there links between Pavement Management System (PMS) data and the ESAL tables?

a.) Are your growth factors for PMS the same for ESAL growth factors?

8. How much confidence do you have in the values you use for pavement design and rehab?

Survey States comments if any:

The complete responses to these surveys can be found in appendix C, but the results have been summarized in table 5.8.

Every agency that responded said that they did use ESAL computations. However, in reviewing table 5.8, that is about the only thing they all had in common. On the whole, most States use WIM data as a method of determining or confirming ESAL values for different vehicle types, and use different ESAL values for different locations. The level of confidence in the resulting values ranged from fair to high. The project team found the methodology employed by Kentucky of particular interest. As mentioned previously, the detailed response from each agency can be found in appendix C.

Table 5.8. Summary of agency responses to ESAL survey.

	Washington	Kansas	Oklahoma	Idaho	Oregon	South Dakota	Montana	Wyoming	Utah	Nebraska	Kentucky
Question 1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Question 2	*	*	*	*	*	*	Static scale data	*	Axle weights from WIM	*	*
Question 2a	Different	Different	*	Different	Same	Different	Same	Same	Different	Different	Different
Question 3	Y	Y	N	N	Y	Y	Y	Y	Y	Y	N
Question 4	Y	Y	Y	N	Y	N	Y	Y	Y	Y	Y
Question 5	Y	N	N	Y	Y	Y	Y	Y	N (for volumes, not ESALs)	Y	Y
Question 6	Y and N	Y	N	Y	N	Y	N (but will be changing)	Y	Y	Y	Y
Question 7	Y	N	N	*	Y	N	N	Y	Y	*	N
Question 7a	Y	*	N	*	Y	*	*	N	*	*	*
Question 8	High--ESAL (60-75%--traffic)	Fairly good	High	Good	Fairly good	Depends on proximity to WIM site	Average to high	Fair	High on major routes, lower on other routes	Good	High

*No comments provided.

CHAPTER 6: PREPARE NEW ESAL DESIGN TABLES

This chapter describes the format of the new ESAL tables, including the relevant analyses. A complete Users Manual can be found in appendix D.

DATA INPUTS

Three electronic files provided by the Arizona TPG were implemented into the ESAL design tables. Information from these files was supplemented by data collected at the LTPP and TPG AVC and WIM sites. The first file was *TR9397C.xls.*, which contains detailed segment location information, the number of lanes for each segment and the AADT and percent commercial vehicle values for each segment from 1993 through 1997. The second file was *Vcls9704.xls*, which contains classification station location data and the break down of the percent of each vehicle class 1-13 for each station to be applied to the 1997 data. The third file was *trfc7497.xls*, which contains the segment location information and the AADT value for each segment dating back to 1974.

The LTPP WIM data was extracted from the Western Regional Information Management System (RIMS) for all years through 1997. A number of investigations into this data were performed as described in chapter 5, including: comparing WIM data from adjacent systems near Phoenix; determining average ESAL factors per vehicle, per segment, and per pavement type; and calculating growth factors for ESALs.

Data was submitted from the four TPG functional WIM sites in Arizona for the years of 1997 and 1998 (except for site 9003, S.R. 95 MP 115EB, for which only 1998 data is available). All four sites are equipped with IRD piezo cable systems. This data was processed using the traffic software developed in the LTPP Program following the same methodologies used to process the data collected at LTPP sites.

As the WIM sensors were in the LTPP test lane, the above data only applied to the test lane. Truck classification as a percentage of total trucks was calculated and then, truck type as a percentage of total traffic was calculated for the test lane using the provided data.

As previously discussed, tables 5.3 and 5.4 show the AVC/WIM systems that were contained in each classification station. In instances where the relationship was 1:1, the TPG values for percent trucks in vehicle classes 4-13 (from *Vcls9704.xls*) were replaced with the values from the AVC/WIM systems. For the classification stations within which multiple AVC/WIM systems were located, the AVC/WIM data was averaged and then replaced the data from *Vcls9704.xls*.

ESAL values for each station were determined in similar fashion. Stations within which WIM systems were located had either the average values of all systems or the distinct values from the one system applied to determine the ESALs per vehicle class 4-

13. For classification stations in which no WIM systems were located, the average values for flexible and rigid pavements (tables 5.5 and 5.6) were utilized.

A table was developed listing the types of data collected at the various segments designated in the existing ESAL table. Particular attention was paid to those segments that contained a WIM system. The factor group for each segment containing a WIM system was determined.

KEY ASSUMPTIONS

The goal in the development of the ADOT ESAL tables is to report the most accurate forecast of the traffic and axle loading on the ADOT roadway network. There are, however, limitations due to the type of traffic data collection and limited traffic data collection locations. The following are assumptions that the NCE team made during the development of the new ADOT ESAL tables.

Directional Split

An assumption concerning ADOT traffic data is the directional split of traffic. The assumption is that there is a 50/50 split in traffic (i.e., that the same number of vehicles are traveling in one direction as the other). If this is not the case, then an alteration to the ESAL table spreadsheet can be made to accommodate site-specific information. However, no data that could be used to determine the directional split was provided to the NCE team.

Necessary Pavement Structure Assumptions

The LTPP WIM data utilizes the site-specific pavement structure for calculating the average ESALs per vehicle type. The ESAL values can vary depending on differences in the pavement type and structural section of each ADOT segment. This difference can be observed for the same axle weight but for different pavement types, (i.e., flexible and rigid pavement) and terminal serviceabilities, as shown in figure 6.1.

It is clear from figure 6.1 that the thickness of the pavement structure has a small effect on the ESAL calculation regardless of pavement type, and using a terminal serviceability of 3.0 instead of 2.5 has a similarly small effect. However, pavement type (portland cement concrete (PCC) or asphalt concrete (AC)) has a significant impact on ESAL calculation. The new ESAL table provides ESAL values for both PCC and AC pavements based on the average ESAL per vehicle class calculated using the 1993 through 1997 LTPP WIM data. In the new ESAL table, ESAL values for both AC and PCC type pavements are provided for each segment based on the recommendation of the TAC.

The TAC requested that the project team investigate the impact of a condition of terminal serviceability of 3.0 instead of 2.5. This was performed and it was determined that at the legal load limits, there is very little difference. As loading increases past the legal limit, the ESALs are slightly less for the calculation based on 3.0 for both rigid and flexible pavements. The relationship is not linear and increases with load (see figures 6.2 and 6.3).

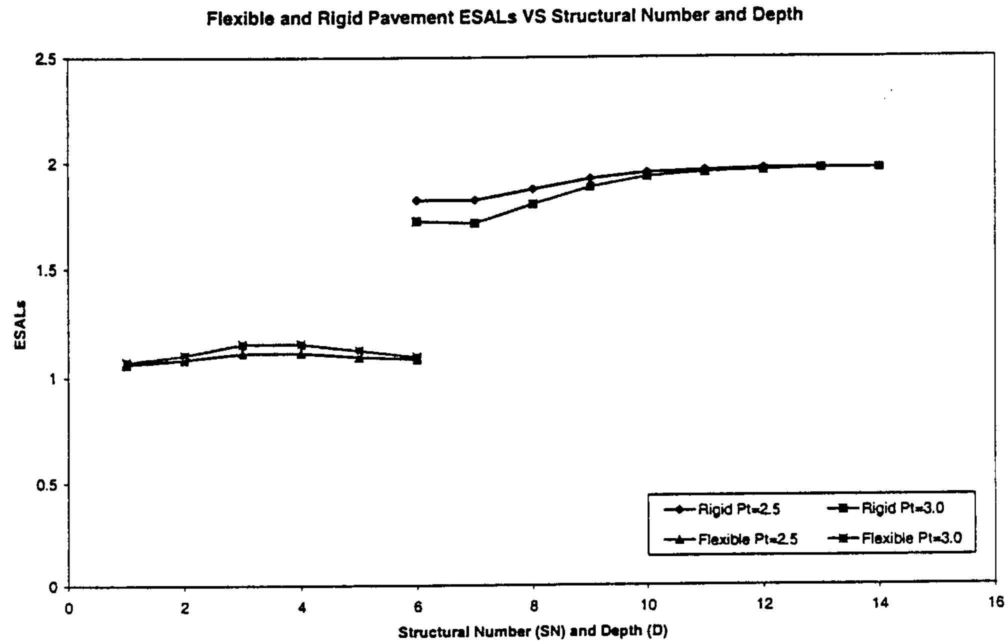


Figure 6.1

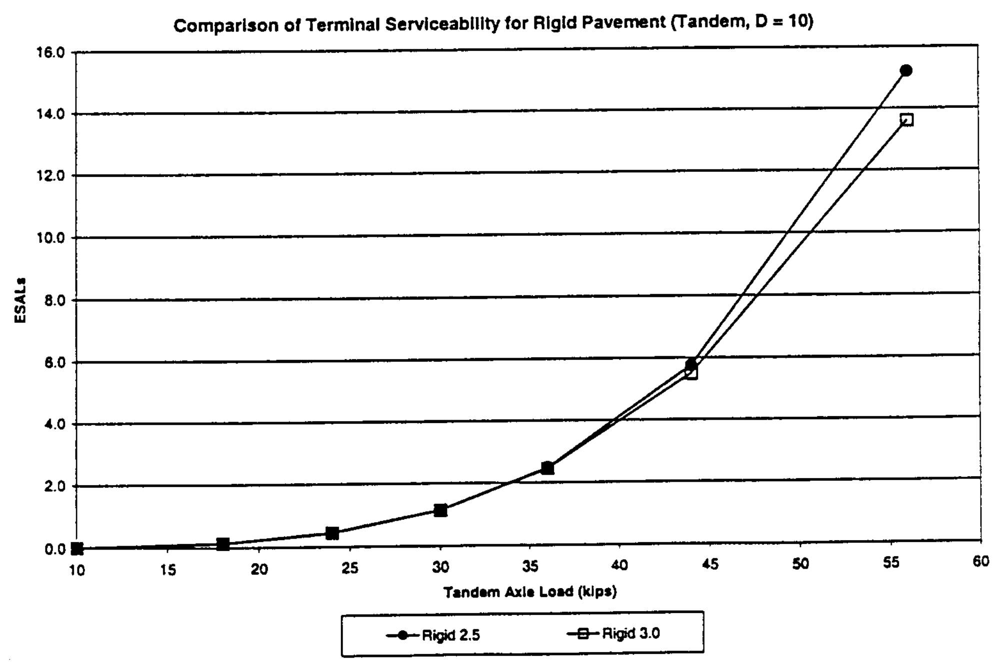


Figure 6.2

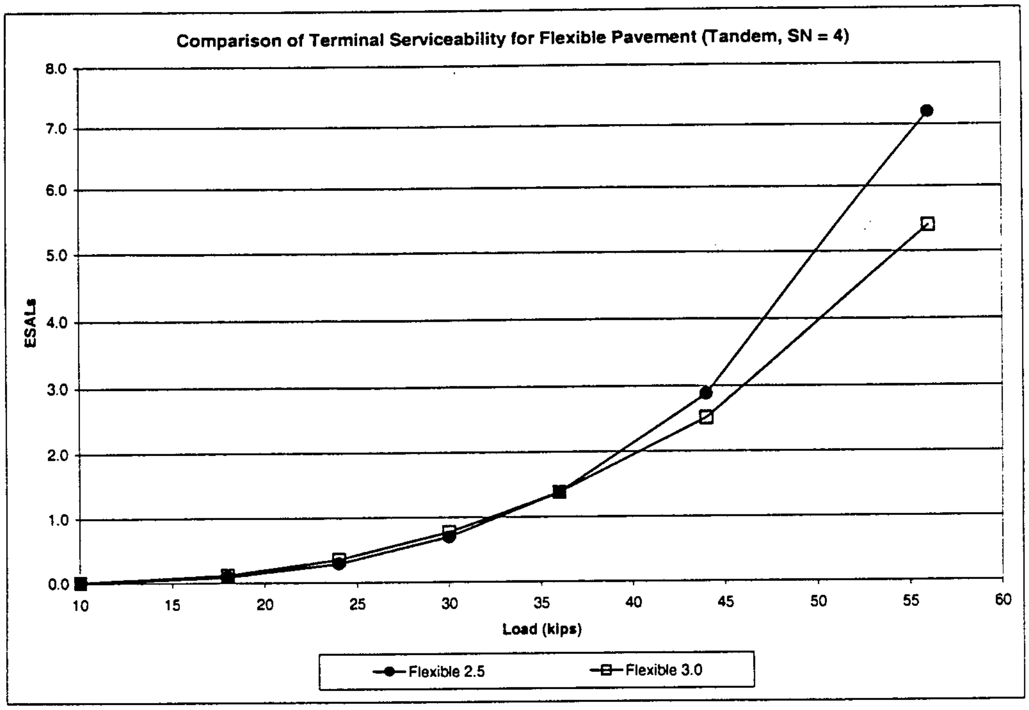


Figure 6.3.

ESAL TABLES

Proposed Format for the New ADOT ESAL Tables

Three independent tables were developed for use by ADOT. The new ESAL tables each contain 14 sub-tables in total. The only difference between each table is the set of values used for the ESAL per vehicle class.

- *Average_ESAL_Table.xls* uses either the measured or the averaged ESAL values for classes 4-13 as described in the Data Inputs section.
- *ESAL_Table_One_Std_Dev.xls* uses the measured or averaged values, plus one standard deviation of the averages for each vehicle class.
- *ESAL_Table_Two_Std_Dev.xls* uses the measured or averaged values, plus two standard deviations of the averages for each vehicle class.

Some tables represent calculations and others represent the input location of ADOT TPG and WIM data. This format of table interaction will allow the ESAL tables to be used for years to come, and allow easy access of information necessary for traffic engineering, traffic planning, and pavement design. Appendix F contains a stand-alone document that should be used to navigate through the spreadsheets. The following is a brief description of important elements in the new ESAL table.

Site Information

This data (primarily taken from *TR9397C.xls*) contains the segment by segment location, AADT and percent commercial vehicle information.

Cumulative One-way Flexible KESALs

This worksheet contains the cumulative thousands of ESALs (KESALs) for each segment assuming that the pavement is flexible. These values are determined by adding the previous year's KESAL total to the KESAL data for a particular year. Cumulative values are calculated through the year 2020. This worksheet is different for the three tables.

Cumulative One-way Rigid KESALs

This worksheet contains the cumulative thousands of ESALs (KESALs) for each segment assuming that the pavement is rigid. These values are determined by adding the previous year's KESAL total to the KESAL data for a particular year. Cumulative values are calculated through the year 2020. This worksheet is different for the three tables.

AADT 1974-2020

This worksheet contains the AADT values provided by the TPG from 1974 through 1997 (from *trfc7497.xls*). The average percent growth factor is calculated using the methodology described in chapter 5, and in instances where the percent growth is less than 2 percent, it is adjusted to be 2 percent. Using this growth factor, the AADTs from 1998 to 2020 for each segment are calculated. No limit as to maximum growth factor was utilized.

Capacity

This worksheet contains a simple logic check as to whether each segment has reached its capacity based on the following assumptions:

Using the 1994 Highway Capacity Manual, the capacity for each segment was calculated. Because capacity is primarily an issue in urban areas, the assumptions were based on urban conditions. Following the equation:

capacity = 2200 vehicles per lane per hour/.08 = 27,500 vehicles per lane per day

As the number of lanes for each segment is known, the capacity was determined for each segment for each year through 2020 (this is contained in the worksheet Total Theoretical Capacity). If a segment is under capacity for a given year, the capacity worksheet will contain the word "pass." If it is at or over capacity, it will contain the word "fail." After discussing the issue of capacity with the TAC, this method was adopted so that capacity issues could be identified but future calculations are based on the assumption that additional lanes will be constructed to handle the additional traffic.

Rigid KESAL One-way

This worksheet contains the calculation of rigid KESALs for each segment for each year beginning with 1997. This calculation is described below.

Rigid ESALs

This worksheet contains the ESAL factors for vehicle classes 4-13 for each segment, assuming that the pavement is rigid.

Flexible KESAL One-way

This worksheet contains the calculation of flexible KESALs for each year beginning with 1997. This calculation is described below, and includes, as instructed by the TAC, a multiplier of 1.1 for the ESALs per vehicle for classes 9-13. This multiplier is a safety factor to account for potential increases in tire pressure and vehicle weights.

Flexible ESALs

This worksheet contains the ESAL factors for vehicle classes 4-13 for each segment, assuming that the pavement is flexible.

Standard Deviation of ESALs per Class

This worksheet contains the average, plus one and plus two standard deviation values for flexible and rigid pavements. These values are the same as given in tables 5.5 and 5.6.

AADT Percent Growth for All Years

This worksheet contains the percent growth from year-to-year for each segment beginning in 1974 and continuing through 2020.

Number of Lanes

This worksheet contains the number of lanes in each segment. This value is given for each year between 1997 and 2020 to allow ADOT to evaluate the construction of additional lanes in future years.

Percent of Each Vehicle Type

This worksheet contains the percentage of each vehicle class 4-13 for each segment as determined in the most recent year this data was measured (1997).

ESAL Calculation

The site specific AADT is the basis or calculating ESALs for the ADOT ESAL table. To this, the nearest classification site/WIM site data available is applied to calculate yearly ESALs. The calculation of the values for rigid ESALs reported in the ESAL tables are done in the following manner using equation 1.

(equation 1)

$$\text{Yearly } ESAL_{seg} = 0.5 * (AADT_{seg}) * (365) * (\%\ Trucks)*[(\%\ VC4)*(ESAL4) + (\%VC5) * (ESAL5) + \ldots\ldots + (\%\ VC13) * (ESAL13)]$$

The definitions of the variables for equation 1 are as follows:

$ESAL_{seg}$: Total yearly one-way ESALs for all lanes for a network segment.
$AADT_{seg}$: Average Annual Daily Traffic collected by ADOT for the total two-way traffic for all lanes for a single network segment.
% Trucks: Percentage of trucks in the traffic system.
%VC(#): This is the percent of vehicle class (4-13) in the truck lane determined from collected WIM data.
ESAL(#): This is the average ESAL of vehicle class (4-13) in the truck lane determined from collected WIM data.

In order to calculate the flexible ESAL values, an additional factor of 1.1 is used as a multiplier within the brackets for vehicle classes 9-13 as shown in equation 2. This 1.1 multiplier was suggested by ADOT TAC as a safety factor to account for potential increases in tire pressure and vehicle weights. The KESAL values are determined by dividing the $ESAL_{seg}$ value by 1000.

(equation 2)

$$\text{Yearly } ESAL_{seg} = 0.5 * (AADT_{seg}) * (365) * (\%\ Trucks)*[(\%\ VC4)*(ESAL4) + (\%VC5) * (ESAL5) + \ldots\ldots + 1.1 * (\%\ VC9) * (ESAL9) + 1.1 * (\%\ VC10) * (ESAL10) + \ldots\ldots + 1.1 *(\%\ VC13) * (ESAL13)]$$

COMPARISON OF CURRENT AND NEW ESAL TABLES

As a test of the new ESAL table, the 1997 and 2017 AADT values and cumulative ESALs were compared with the same values from the existing ADOT ESAL table. This comparison was carried out for 20 segments, the 10 with the highest AADT values and the 10 with the lowest AADT values. Table 6.1 contains the results of the AADT comparison and tables 6.2 and 6.3 contain the results of the cumulative ESAL comparison for flexible and rigid pavements, respectively.

Table 6.1. AADT comparison between current and new ESAL tables.

Order	Segment	Existing ESAL Table AADT, 1997	New ESAL Table AADT, 1997	Existing ESAL Table AADT, 2017	New ESAL Table AADT, 2017	% Difference in Reported 1997 AADT	% Difference in Reported 2017 AADT
1L	719	264	74	317	104	72.0	67.2
2L	873	166	95	226	717	42.8	-217.3
3L	874	188	105	256	2575	44.1	-905.9
4L	1160	212	125	254	980	41.0	-285.8
5L	528	139	129	167	190	7.2	-13.8
6L	882	160	161	218	225	-0.6	-3.2
7L	762	186	172	223	430	7.5	-92.8
8L	819	260	175	426	245	32.7	42.5
9L	799	254	227	305	344	10.6	-12.8
10L	798	223	246	267	318	-10.3	-19.1
1H	68	205186	208643	400000	292100	-1.7	27.0
2H	72	153672	209066	276610	589642	-36.0	-113.2
3H	66	192487	209166	400000	367014	-8.7	8.2
4H	76	212000	210332	381600	294465	0.8	22.8
5H	73	189426	214944	340967	426763	-13.5	-25.2
6H	74	192197	217255	345955	430377	-13.0	-24.4
7H	67	192487	218411	400000	455807	-13.5	-14.0
8H	1004	189384	221336	340891	540334	-16.9	-58.5
9H	75	195396	223033	351713	441675	-14.1	-25.6
10H	69	202260	231123	400000	984575	-14.3	-146.1

Table 6.2. Cumulative ESAL comparison between current and new ESAL tables for flexible pavements.

Order	Segment	New ESAL Flex Average + 2 StDev ESAL, 2017	% Diff. in Reported 1997 Flexible ESALs	% Diff. in Forecasted 1997 Average + 1 StDev Flexible ESALs	% Diff. in Forecasted 1997 Average + 2 StDev Flexible ESALs	% Diff. in Forecasted 2017 Average Flexible ESALs	% Diff. in Forecasted 2017 Average + 1 StDev Flexible ESALs	% Differ. in Forecasted 2017 Average + 2 StDev Flexible ESALs
1L	719	15	99.1	98.3	95.7	99.2	98.5	97.9
2L	873	485	60.0	20.0	0.0	-23.5	-104.7	-185.3
3L	874	1600	50.0	33.3	0.0	-261.5	-497.4	-733.3
4L	1160	428	71.4	57.1	28.6	14.2	-43.9	-101.9
5L	528	68	50.0	0.0	-50.0	60.6	32.4	4.2
6L	882	231	0.0	-75.0	-125.0	8.3	-51.4	-111.9
7L	762	663	-133.3	-333.3	-500.0	-174.7	-372.7	-569.7
8L	819	89	80.0	40.0	20.0	76.6	60.1	43.7
9L	799	325	-50.0	-125.0	-225.0	-2.9	-70.1	-137.2
10L	798	352	-50.0	-150.0	-250.0	-27.5	-110.8	-193.3
1H	68	191815	24.8	-26.1	-76.9	38.9	-2.5	-43.8
2H	72	305953	-0.6	-68.6	-136.6	-30.2	-118.2	-206.3
3H	66	220712	19.6	-34.7	-89.0	25.0	-25.7	-76.4
4H	76	193368	26.6	-23.0	-72.6	40.3	0.0	-40.3
5H	73	245812	16.1	-40.7	-97.4	15.1	-42.2	-99.6
6H	74	248028	16.4	-40.1	-96.6	15.6	-41.5	-98.5
7H	67	258266	16.1	-40.6	-97.4	12.2	-47.1	-106.4
8H	1004	291765	13.5	-44.9	-103.3	-0.8	-68.9	-137.0
9H	75	254623	15.6	-41.5	-98.6	14.8	-42.8	-100.4
10H	69	465686	15.5	-41.7	-98.8	-50.6	-152.4	-254.2

Table 6.3. Cumulative ESAL comparison between current and new ESAL tables for rigid pavements.

Order	Segment	Existing ESAL Rigid ESAL, 1997	New ESAL Rigid Average ESAL, 1997	New ESAL Rigid Average + 1 StDev ESAL, 1997	New ESAL Rigid Average + 2 StDev ESAL, 1997	Existing ESAL Rigid ESAL, 2017	New ESAL Rigid Average ESAL, 2017	New ESAL Rigid Average + 1 StDev ESAL, 2017	New ESAL Rigid Average + 2 StDev ESAL, 2017	% Diff. in Reported 1997 Rigid ESALs	% Diff. in Forecasted 1997 Average + 1 StDev Rigid ESALs	% Diff. in Forecasted 1997 Average + 2 StDev Rigid ESALs	% Diff. in Forecasted 2017 Average Rigid ESALs	% Diff. in Forecasted 2017 Average + 1 StDev Rigid ESALs	% Diff. in Forecasted 2017 Average + 2 StDev Rigid ESALs
1L	719	26	0.3	0.4	1	798	8	11	15	98.8	98.5	96.2	99.0	98.6	98.1
2L	873	6	3	4	5	190	270	369	467	50.0	33.3	16.7	-42.1	-94.2	-145.8
3L	874	7	3	5	6	215	893	1217	1540	57.1	28.6	14.3	-315.3	-466.0	-616.3
4L	1160	8	3	3	4	238	232	317	402	62.5	62.5	50.0	2.5	-33.2	-68.9
5L	528	3	1	2	2	80	34	48	63	66.7	33.3	33.3	57.5	40.0	21.3
6L	882	4	5	7	9	122	129	175	222	-25.0	-75.0	-125.0	-5.7	-43.4	-82.0
7L	762	4	9	13	17	111	334	479	623	-125.0	-225.0	-325.0	-200.9	-331.5	-461.3
8L	819	6	2	3	3	177	45	64	82	66.7	50.0	50.0	74.6	63.8	53.7
9L	799	5	7	10	12	153	181	247	313	-40.0	-100.0	-140.0	-18.3	-61.4	-104.6
10L	798	4	8	11	13	134	197	268	339	-100.0	-175.0	-225.0	-47.0	-100.0	-153.0
1H	68	4819	4176	5766	7357	149400	105231	145316	185400	13.3	-19.7	-52.7	29.6	2.7	-24.1
2H	72	3609	4184	5778	7372	111892	167848	231785	295722	-15.9	-60.1	-104.3	-50.0	-107.2	-164.3
3H	66	4521	4186	5781	7376	140154	121084	167208	213331	7.4	-27.9	-63.1	13.6	-19.3	-52.2
4H	76	4979	4210	5813	7417	154361	106083	146492	186901	15.4	-16.8	-49.0	31.3	5.1	-21.1
5H	73	4449	4302	5941	7579	137925	134854	186223	237592	3.3	-33.5	-70.4	2.2	-35.0	-72.3
6H	74	4514	4348	6005	7661	139942	136100	187943	239786	3.7	-33.0	-69.7	2.7	-34.3	-71.3
7H	67	4521	4371	6036	7702	140154	141687	195658	249630	3.3	-33.5	-70.4	-1.1	-39.6	-78.1
8H	1004	4448	4430	6117	7805	137894	160065	221037	282009	0.4	-37.5	-75.5	-16.1	-60.3	-104.5
9H	75	4589	4464	6164	7865	142272	139688	192898	246109	2.7	-34.3	-71.4	1.8	-35.6	-73.0
10H	69	4751	4626	6388	8150	147269	255478	352796	450113	2.6	-34.5	-71.5	-73.5	-139.6	-205.6

As shown in table 6.1, there is a noticeable difference in the 1997 AADT values for the existing ADOT ESAL table and the new ESAL table. This can be attributed to the fact that the existing and new ESAL tables use two different sources of AADT data. The existing ESAL table's 1997 AADT values are forecasted based on 1991 (or earlier) AADT values and growth rates. The AADT values for the new ESAL table are from an electronic version of the *Traffic on the Arizona State Highway System 1997* provided by the Arizona Department of Transportation. This difference is substantial and is amplified further when projecting values for the 2017 comparison. As expected, values are much more similar at high AADT values than at low AADT values. As mentioned previously, the forecasted AADTs are not limited by capacity and there is no maximum growth rate. Segment 874, for example, has a growth rate of 117.6 percent with a very low AADT. High variability in year-to-year growth rate for segments with very low AADT is expected.

As shown in tables 6.2 and 6.3, the cumulative ESALs comparison results mirror that of the AADT comparison. It is important to note that the values are quite similar at higher ESALs for the average ESAL table and that adding plus one and plus two standard deviations adds to the final ESAL values an additional 38 percent and 76 percent, respectively. For the low volume roads, even when the table is off by 300 percent, that only works out to be 600 ESALs (or 30 ESALs/year), which is not a significant difference.

Based upon this investigation, it is the opinion of the NCE team that the approach outlined for the new ESAL table is a valid one and does not go against the experience and engineering judgement used in the development of the current ESAL table. This comparison; however, brings out the importance of more frequent update of the ESAL table in the future to incorporate new gathered data as it becomes available.

DEVELOPMENT OF ONE VALUE FOR ALL VEHICLES

At the request of the TAC, the project team was asked to provide a single ESAL value for all trucks. Some city or county agencies (that only have the capability to collect volume counts) come to ADOT asking for a single ESAL factor. To calculate this value, the average ESALs per vehicle class 4-13 was determined based on all WIM data collected in Arizona. Then, the average vehicle percentages per class was determined. These two values were multiplied together and then summed as shown in table 6.4.

The resulting value of 1.08 is the average ESALs per commercial vehicle. As discussed in chapter 4, in the existing ESAL table a value of 1.4 was used, which included some safety factors for increases in tire pressure and vehicle weights. It is up to ADOT to determine what value they would give to any agency, but the project team recommends using a value of 1.2, which will provide a 10 percent safety factor.

Table 6.4. Determination of a single ESAL value.

Vehicle Class	Average ESAL per Class	Average % Class	ESALS x Average % Class
4	0.87	4.8	0.04
5	0.21	21.8	0.04
6	0.82	10.4	0.09
7	1.64	2.4	0.04
8	0.61	16.1	0.10
9	1.71	36.1	0.62
10	1.31	2.0	0.03
11	1.86	5.1	0.09
12	0.97	0.6	0.01
13	3.73	0.5	0.02
		100	1.08

CHAPTER 7: ASSESSMENT OF WIM AND AVC DATA NEEDS

EXISTING SYSTEMS

The current WIM and AVC systems installed in Arizona have been described in chapter 3 and chapter 5 (see figures 3.1 and 3.2).

EQUIPMENT COST

The following estimated costs for the purchase, installation and maintenance of AVC and WIM equipment are for one travel lane. Installation costs are based upon a contracted bid for a turn-key operation. These estimated costs do not take into consideration associated factors such as roadway maintenance, repair, and traffic delays.

There are many variables that may effect the cost of installing, maintaining and calibrating AVC and/or WIM system. Probably the biggest variable will be the cost of obtaining power and telephone service to the site. The estimated costs for these services are based upon power and telephone service being within 20 feet of the site with an estimated total cost of $14,000. Other variables that affect costs are; site selection, site location, drainage, soil conditions, pavement conditions, in-roadway equipment configuration, full freeway limits, contractor installation costs, traffic control requirements, power and telephone line locations availability, equipment calibration, available manpower usage and construction equipment usage. The actual costs will very for each specific application, so these estimated costs should be used for relative comparisons only.

These estimated costs are based upon information provided by California DOT, Colorado DOT, Nevada DOT and from a presentation of WIM Technology – Economics and Performance presented at NATMEC 1998 by Andrew J. Pratt (see the estimated cost worksheets presented later in this section).

Estimated single lane installation and maintenance cost for AVC and WIM:

Permanent Automatic Vehicle Classifiers (AVC) type 2 Piezoelectric installation cost per lane is $18,280, in addition:

- Telephone and power costs are estimated at $14,000.
- Per year maintenance cost for permanent AVC per lane is $2,000.
- Life expectancy for in-roadway sensor is estimated at 4 years.

Permanent WIM type 1 Piezoelectric installation cost per lane is $25,750, in addition:

- Telephone and Power costs are estimated at $14,000.
- Per year maintenance cost for permanent Piezoelectric WIM per lane is $5,600.
- Life expectancy for in-roadway sensor is estimated at 4 years.

Permanent WIM, Bending Plate, constructed in a concrete pad installation cost per lane is $87,730, in addition:

- Per year maintenance cost for permanent Bending Plate WIM per lane is $5,600.
- Life expectancy for in-roadway Bending Plate WIM installation is estimated at 10 years.

Cost Worksheets

1) AVC Piezoelectric:

These estimated installation costs for AVC are for two inductive loops and one type 2 piezoelectric sensor in one lane of travel for both directions with roadside pull boxes and conduit connection to a roadside control cabinet with power and phone line connections and AVC classification equipment. No portable roadway or AVC classification equipment were considered for this estimate. Permanent AVC equipment can be removed from the cabinet and used at different locations where permanent in-roadway equipment exists for short period classification and a portable operation. The estimated maintenance costs do not include traffic data computations.

	Equipment and Installation By Private Contract
a. Control cabinets and mounts	$3,300
b. Pull boxes	710
c. Detector loops	2,100
d. Power service	7,000
e. Telephone service	7,000
f. Mobilization	3,400
g. Traffic control	2,900
h. Conduit	3,350
i. Piezo type 2 cable	3,400
j. AVC equipment	3,400

Two-lane estimated costs = $36,860. The estimate costs for one lane is $18,430.

Estimated maintenance costs per year per lane = $2,000. The life expectancy of AVC in-roadway equipment is estimated at 4 years.

2) WIM Cost Estimates:

Estimated costs are for in-roadway sensors: A. Piezoelectric, B. Bending Plate WIM. No portable WIM on-roadway or WIM portable equipment were considered for this estimate.

A. Piezoelectric WIM:

The Piezoelectric WIM was assumed to consist of two class 1 piezoelectric sensors, two inductive loops and one temperature sensor for one lane of traffic being monitored for both direction with roadside pull boxes and conduit connection to a roadside control cabinet with power and phone line connections.

	Equipment and Installation By Private Contract
a. Control cabinets and mounts	$6,500
b. Pull boxes	1,100
c. Detector loops	2,100
d. Power service	7,000
e. Telephone service	7,000
f. Mobilization	3,400
g. Traffic control	2,900
h. Conduit	3,400
i. Piezo type 1 cable	8,100
j. WIM equipment	10,000 (Includes calibration acceptance testing).

Estimated costs for two lanes = $51,500. The estimate for Piezoelectric for one lane is $25,750.

Estimated maintenance cost per year per lane is $5,600 (includes one calibration session). The life expectancy of WIM piezoelectric in-roadway equipment is estimated at 4 years.

B. Bending Plate:

The Bending Plate WIM sensors was assumed to be installed in a construction 100- by 12- by 1-ft concrete pad in a asphalt roadway. The in-roadway sensor was assumed to consist of one bending plate frame with two bending plates with sensors, two inductive loops, and one off scale sensor installed in one lane of traffic. Also, roadside pull boxes and conduit connection to a roadside control cabinet with power and phone line connections were assumed to be available.

One lane installation costs estimates:

	Equipment and Installation By Private Contract
a. Control cabinets and mounts	$6,500
b. Pull boxes	1,100
c. Detector loops	2,100
d. Power service	7,000
e. Telephone service	7,000
f. Mobilization	3,400
g. Traffic control	6,000
h. Conduit	3,500
i. Bending plate frame and plates	14,100
j. WIM equipment	15,000 (Includes calibration acceptance testing).
k. Construction concrete pad	21,900

Estimated costs per lane = $87,600. For two lanes, installation is $175,200.

Estimated yearly maintenance cost per lane is $5,600 (includes one calibration session). The life expectancy for the Bending Plate installed in a concrete pad is estimated at 10 years.

Recommendations

In deciding future investment in WIM/AVC operation, there are two considerations :

- Maintaining the WIM/AVC sites available.
- Adding additional WIM/AVC sites to the ones already operating.

To address the first consideration, the operational condition (i.e., calibration status) of the available WIM/AVC sites needs to be evaluated.

For the WIM systems at LTPP sites, the calibration status is routinely ascertained through the QA process implemented by the Chaparral software. The WIM systems at LTPP sites are very close together, especially on I-10 and I-19, for the purpose of yielding network-wide traffic data samples. Furthermore, it may possible to obtain national funding for rehabilitating some of these sites. As a result, it is recommended not to expend State funding towards rehabilitating any of the WIM systems at the LTPP sites.

For the WIM systems at other than LTPP sites, a simpler method can be followed for ascertaining calibration status. This can be done by testing the mean values of the steering axle load of three-S2 trucks against the range established from either static weigh data as already suggested under "WIM System Calibration" or, from WIM data, provided that it is obtained from an independently calibrated WIM system (e.g., WIM system at LTPP site).

For the AVC systems, at LTTP or other sites, there is a need to improve the "visual" calibration method currently used. For this purpose it is recommended to use video technology as the ground truth. Currently there are no video systems capable of classifying traffic based on the FHWA 13-bin classification scheme. However, this can have the simple form of a household-grade video-camera on the side of the road followed by manual counts from several independent observers. The advantage of a video system is that it is portable and can be moved between AVC locations to cover the entire State.

To address the second consideration, an evaluation of the truck traffic levels across the State needs was undertaken. Operating on the assumption that the greatest need is in areas of the highest AADTs where there is currently no AVC/WIM equipment the list compiled in table 7.1 was developed. In addition to the AADT factor, the other major factor was selecting classification sites that currently have no AVC/WIM systems located in their limits.

Some substitute locations for classification sites located above are: segment 76, for classification site 136; segment 102, for classification site 64; segment 79, for classification site 69.

In discussions with the TPG, seven ATRs were purchased and installed that had the capacity to collect classification data, but due to equipment and software problems (not to mention the constant pounding of thousands of vehicles per day) there is only one (on I-10 near Benson) that is currently capable of collecting vehicle classification information. ADOT should investigate the cost of getting these ATRs to collect classification data as was originally intended, and if there is a need to replace existing ATRs, ADOT should do so with equipment that can collect classification data.

Table 7.1. Recommended locations for AVC/WIM installations.

Classification	Traffic Segment	Route	1997 AADT
136	1184*	I-10	218,881
148	833	U-60	156,008
74	107*	I-10	108,332
143	1104	SL-202	124,060
64	97*	I-10	37,495
69	1001	I-10	102,850
144	610*	S-77	46,000
68	569	S-87	49,624
39	628	S-89	37,696
107	419	SB-40	34,000

*Existing ATR within this segment.

Before acting on these recommended installations, ADOT should revisit the assignment of particular traffic segments to the various classification sites. Additional weight should be given to sites containing AVC/WIM systems. If these assignments (segmentation) are revised, perhaps there would not be as strong a need for some of the installations (for example, recommendations for four installations in I-10 are in table 6.4, when there are already five existing systems on I-10 related to the LTPP program).

CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS

Arizona DOT does a fine job collecting as much traffic information as their budget allows. As funding becomes available, the following recommendations would be worth pursuing:

- Increase the frequency with which classification counts are taken (annually would be ideal).
- Increase the duration of the classification counts.
- Have all counts be collected with automated equipment and use manual classification (in association with video cameras) as a method of calibration.
- Install new AVC/WIM equipment at key locations.
- Instrument all lanes at AVC/WIM locations to allow accurate counts of percent trucks and AADT.
- Convert the ESAL tables from Excel spreadsheets to an interactive database.

Other issues that should not wait for increased funding are:

- Revisit the traffic segments assigned to classification sites to place more segments in classification sites with AVC/WIM systems.
- Calibrate of the TPG AVC/WIM equipment.

SUMMARY

This study resulted in the development of ESAL design tables that:

- Calculate annual ESALs for flexible and rigid pavements.
- Predict annual growth and assesses the reasonableness of the prediction.
- Are interactive so that a manual change of one parameter will cause the final ESAL calculation for that segment to be revised.
- Provide information regarding the capacity of each segment, with the ability to update these values in the future if additional lanes are constructed.
- Update ESAL values based on WIM data collected throughout Arizona.
- Provide a safety factor of +1 and +2 standard deviations for these ESAL values.

In addition, the following information is also provided:

- Insight into the types of data collected by ADOT.
- Formal documentation of how AADT values are calculated.
- Recommendations on AVC/WIM calibration.

- Recommendations on additional AVC/WIM installations.
- Determination of a single ESAL value for all trucks to provide other agencies in Arizona.
- Information from 11 State highway agencies on how they determine and utilize ESALs.
- Cost information on installation and maintenance of different types of AC and WIM systems.

The electronic files containing the three Excel spreadsheets (for three different ESAL calculation methodologies) is provided to ADOT on a compact disk.

REFERENCES

1. Conformity Analysis for the Fiscal Year 1999-2003 MAG Transportation Improvement Program and the MAG Long Range Transportation Plan Summary and 1997 Update with 1998 Addendum, Maricopa Association of Governments, September 1998.

2. ADOT, Traffic on the Arizona State Highway System 1997, Arizona Department of Transportation, Data Collection Team.

3. AASHTO, Guide for the Design of Pavement Structures, 1993.

4. Dahlin, C., "Proposed Method for Calibration Weigh-in-Motion Systems and for Monitoring that Calibration Over Time," TRB Research Record 1364, 1992.

5. Protocol for Calibrating Traffic Data Collection Equipment, LTPP Directive TDP-11, United States Department of Transportation, April 1998.

6. A.T. Papagiannakis, J.H.F. Woodrooffe, R.C.G. Haas and P. LeBlanc (1990), "Impact of Roughness-Induced Dynamic Load on Flexible Pavement Performance," ASTM Special Technical Publication, No. 1031, American Society of Testing of Materials, Philadelphia, PA.

7. A.T.Papagiannakis, K.Senn, and H.Hong (1996), "Two Alternative Methods for WIM System Evaluation/Calibration," Transportation Research Record, No. 536 pp. 1-11. Washington, D.C.

8. Ott, W. and A.T.Papagiannakis (1996), "A WIM QA Method Based on Analysis of the Variation of Three-S2 Steering Axle Loads," Transportation Research Record, No.1536 pp., 12-18, Washington, D.C.

APPENDIX A: MINUTES FROM KICK-OFF MEETING

APPENDIX A: MINUTES FROM KICK-OFF MEETING

KICK-OFF MEETING MINUTES

Arizona Department of Transportation
Development of New Pavement Design Equivalent Single Axle Load (ESAL)
Contract No.: T9813A0003

Note: Italicized items involve submission of data from ADOT to NCE; tasks from the work plan are referred to by number in these minutes.

December 2, 1998

Meeting called to order by Estomih Kombe at 1:15 p.m.

The meeting agenda is included as attachment 1.

Those attending the meeting are listed in attachment 2.

Following the introductions, the project objectives were briefly discussed.

Next, a discussion of the work plan was begun.

Opening remarks (Sirous Alavi):

- Discussion of ESAL table
  - The ESAL table is one of the key deliverables and we need as much information as possible on the existing table used by ADOT.
  - *George Way will send both a hardcopy and electronic version of the existing ADOT ESAL table.*
  - *Bob Pike will send the ADT file his group creates (uncertain whether it is an electronic file or hardcopy).*
  - George Way asked NCE to investigate how other agencies do things.

Task A

1. No discussion
2. No discussion

Task B

- *John Eisenberg and George Way adapted the AASHTO ESAL calculation method for ADOT, George Way to provide this documentation.*

1. *Bob Pike will work with us to provide and explain this information.*
2. ADOT collects the FHWA 13 classes on manual and automated surveys and then places them into the appropriate bins on the ESAL table.

- George Way expressed the opinion that we should be focusing on how to make WIM data work.

3. The planning group has only two AVC units and neither has produced any usable data; planning group WIM data was briefly discussed as well (more in task D).

   - *George Way has looked at a lot of the data provided by NCE in 1997 and will provide us with the "interesting" trends (and questionable trends) he has noticed in some of the traffic data.*
   - *Estomih Kombe will help to investigate issues arising from WIM data submitted to us:*
     - Questionable data will be investigated by us.
     - Nonsensical data will be ignored.

4. No seasonal effects currently used in percent trucks estimations.

   - Truck information is tied to ADT (i.e., number of trucks increases as ADT increases, but the percentage remains constant).

5. There has been an historical under-estimation on traffic data for urban routes.

   - Linear regression was used to determine growth factors on the current ESAL table.
   - *Bob Pike and George Way to give us data concerning how growth factors are/were calculated.*
   - A system-wide forecast may be available for the greater Phoenix area from the Maricopa Association of Governments (MAG)--*Bob Pike to provide us with a contact.*
   - There was a significant discussion related to unrestricted traffic growth vs. restricted (i.e., sections reaching capacity) traffic growth.
     - Sirous Alavi stated that we would not be generating new growth rates from scratch but would investigate the methods currently used by ADOT and other forecasting methods in place in Arizona to propose the most appropriate methods for forecasting traffic growth.
     - Sirous Alavi identified three major sources of information wherein data exists that would aid in this effort.
       - *ADOT--George Way, Bob Pike and Estomih Kombe to provide.*
       - *Other Arizona traffic studies--Bob Pike to investigate potential sources and provide contacts or information as it is found.*
       - LTPP data--we have.
     - Larry Scofield questioned our methods for developing growth information, but upon further discussion it was determined that we were talking about the same thing and the confusion was in the semantics (growth rates would be developed but that they would be reliant upon the best available data and not on "new" forecasting models).

- It was determined that an additional column be added to the table to show a segment that has reached capacity and this capacity value would be used to determine the ESALs for that segment.
- ~~*Bob Pike to provide information regarding ADT capacity values.*~~
- It was determined that the vast majority of ADOT's highway network is not operating at capacity currently and will most likely not reach capacity in the next 20 years.
- George Way spoke of how part of this task is to develop methodology to allow for a more "continuous" updating of the ESAL tables in the future--we agree with the understanding that "continuous" doesn't imply daily, weekly or even monthly, but rather whenever dependable annual ADT values can be provided.

Task C

1. This task was discussed thoroughly as part of the Task B discussion

Task D

1. Estomih Kombe and Bob Pike stated that the planning group WIM data could easily be converted into the file format that would enable processing using the LTPP software.
2. No discussion
3. *Bob Pike to provide vehicle volume and classification data.*
4. It was learned that weigh stations in Arizona are not collecting weight or classification data. The possibility of collecting this type of information at key weigh stations was discussed, but no request for this information was made.
5. As previously mentioned, Bob Pike stated that seasonal effects are not currently assigned to truck percentages anywhere in Arizona (ADT values have seasonality).
6. The planning group's AVC on I-40 is gone and the one on I-8 is down with no plans to get working any time soon; all working WIM systems were calibrated.
   - Three systems calibrated fine and one had questionable values (the other two systems are down at this time).
   - *Estomih Kombe will be providing data from three WIM sites soon and from the one remaining site following his trip.*

Task E

1. No discussion

Task F

1. *Estomih Kombe and/or Bob Pike to prodcue a list of weigh scales within Arizona*
   - Potential classification data collection from weigh stations was again discussed but not requested.

2. No discussion

Task G

1. No discussion.

Task H

1. No discussion.

Task I

1. No discussion.

The NCE wish/question list was reviewed. This list is included in the attached agenda and the following list shows the persons responsible for the numbered items and whether the question was resolved during the meeting. Please note that there is some overlap between information requested on this list and information requested in the work plan discussion above.

1. Estomih Kombe provided the TAC list.
2. *Bob Pike to provide planning group traffic count data.*
3. *Bob Pike to provide planning group classification data.*
4. *Bob Pike and Estomih Kombe to provide planning group WIM data .*
5. *Estomih Kombe, Bob Pike and George Way to provide other appropriate data (i.e., WIM studies, AASHTO ESAL modification, corridor forecasts, etc.).*
6. Estomih Kombe provided a current list of WIM and AVC sites (*there still is a need to know whether any are located in pavements that will be requiring major rehabilitations in the near future*).
7. *Estomih Kombe, George Way and Bob Pike to provide information regarding current data collection, analysis and forecasting procedures.*
8. *Estomih Kombe, Bob Pike, George Way and Larry Scofield to provide available traffic forecasting models utilized by ADOT or commonly used in Arizona.*
9. *Estomih Kombe, Bob Pike, George Way and Larry Scofield to provide any supplemental sources of data (i.e., weigh scale data, Research Notes, etc.).*
10. *Bob Pike and George Way to provide current procedures for developing the ESAL design table.*
11. *George Way to provide all relevant literature and reports from the 1986 ADOT ESAL study (and related work based on the study).*
12. Estomih Kombe answered questions regarding ADOT's reporting requirements and stated that monthly reports should be brief summaries of work performed by task and should be sent to himself only (the quarterly reports will be sent to all TAC members).
13. Estomih Kombe gave ADOT's consent for ADOT LTPP data to be used in the study. The completed consent form will be sent to the LTPP TSSC.

14. The need to set up a meeting to discuss work completed through Task D and previous to beginning Task E was reviewed. It was decided that the TAC will review the work completed on Tasks B, C and D and a meeting will only take place if the project manager and the TAC deem it necessary.
15. NCE asked for a one-month no cost extension (letter requesting extension to be Fed-Ex'd to Estomih Kombe on 12/3/98).

ADOT did not have any major requests or questions that were not addressed during the course of the meeting.

The meeting was adjourned at 4:30 p.m.

APPENDIX B: ANALYSES FOR ESAL TABLE

APPENDIX B: ANALYSES FOR ESAL TABLE

CONVERTING ONE LANE CLASSIFICATION DATA TO ALL LANES

An area that was investigated was the distribution of ESALs across traffic lanes. This is the result of heavy vehicles traveling on the innermost lanes unless otherwise directed to travel in the left-hand lanes. Furthermore, it is difficult to determine what percentage of heavy vehicles will travel in each lane. Therefore, the recommendations from the 1993 AASHTO Guide were followed. The percent of design ESALs for the design lane are found in table b.1 below.

Table B.1. Percent of total ESALs in the design lane (AASHTO 1993).

Total No. of Lanes	No. of Lanes in Each Direction	Percent of 18-kip ESALs in Design Lane	Percent of 18-kip ESALs in Design Lane
2	1	100	100
3	1/2	NRBA	100*
4	2	80 - 100	80
6	3	60 - 80	60
7	3/4	NRBA	60*
8	4	50 - 75	50
9	4/5	NRBA	50*
10	5	NRBA	50*

Note: NRBA is the abbreviation for No Recommendation By AASHTO.
*Represents values recommended by the NCE team.

From the above table for the percent of total ESALs in the design lane, the percent of ESALs in the adjoining lanes will be 100 percent minus the percent of ESALs in the design lane (truck lane).

The term AADT represents the average annual daily traffic for all lanes and directions of a traffic segment. It was decided by the NCE team to report ESALs in the same manner. (i.e., total applied ESALs for all lanes and directions.) However, the LTPP WIM data is generally only gathered for the truck lane in one direction of travel. The collected WIM data must then be expanded to represent all lanes.

The ESAL data is expanded based upon the information in table B.2. This is accomplished by determining the cumulative recommend percentage distribution of ESALs across multilane traffic segments. To achieve the number of ESALs for a traffic segment, the AADT is multiplied by 365 (days in a year) then by the percent trucks in the truck lane from collected data and finally by a factor referred to as the Lane Distribution Factors (LDF). The LDF is used to account for the percent of vehicles in lane(s) adjacent to the truck lane. The following table contains the LDFs for different lane configurations.

Table B.2. Lane distribution factors for ADOT ESAL table.

No. of Lanes in Each Direction	Total No. of Lanes	Lane Distribution Factor (LDF)
1	2	1.000
1/2	3	1.000
2	4	0.625
3	6	0.555
3/4	7	0.476
4	8	0.500
4/5	9	0.444
5	10	0.400

The LDF factor will be used for each segment based upon the number of lanes in the segment. The LDF's use is further explained in the following section concerning the ESAL calculation.

ESAL CALCULATION

In order to account for lane distribution factor, the ESAL calculation would be as shown below.

Yearly $ESAL_{seg}$ = (0.5) * ($AADT_{seg}$)* (365) * (% Trucks)*(LDF) * [(% VC4)*(ESAL4) +

(%VC5) * (ESAL5) + ... + (% VC13) * (ESAL13)]

The definitions of the variables for equation 1 are as follows:

$ESAL_{seg}$: Total yearly one-way ESALs for all lanes for a network segment.

$AADT_{seg}$: Average Annual Daily Traffic collected by ADOT for the total two-way traffic for all lanes for a single network segment.

% Trucks: Percentage of trucks in the truck lane for one direction, or the average of the truck lane percentage for both directions.

LDF: Lane Distribution Factor (LDF) is the cumulative distribution of ESALs across all lanes in one direction.

%VC(#): This is the percent of vehicle class (4-13) in the truck lane determined from collected WIM data.

ESAL(#): This is the average ESAL of vehicle class (4-13) in the truck lane determined from collected WIM data.

However, the project team was not confident in this methodology (based on resulting outcome) and decided to use the percent commercial vehicles values provided by the Traffic Planning Group instead of using the lane distribution factor.

Figure B.1. FHWA Vehicle Classifications for LTPP sites 041006 and 041007 on 2/25/96.

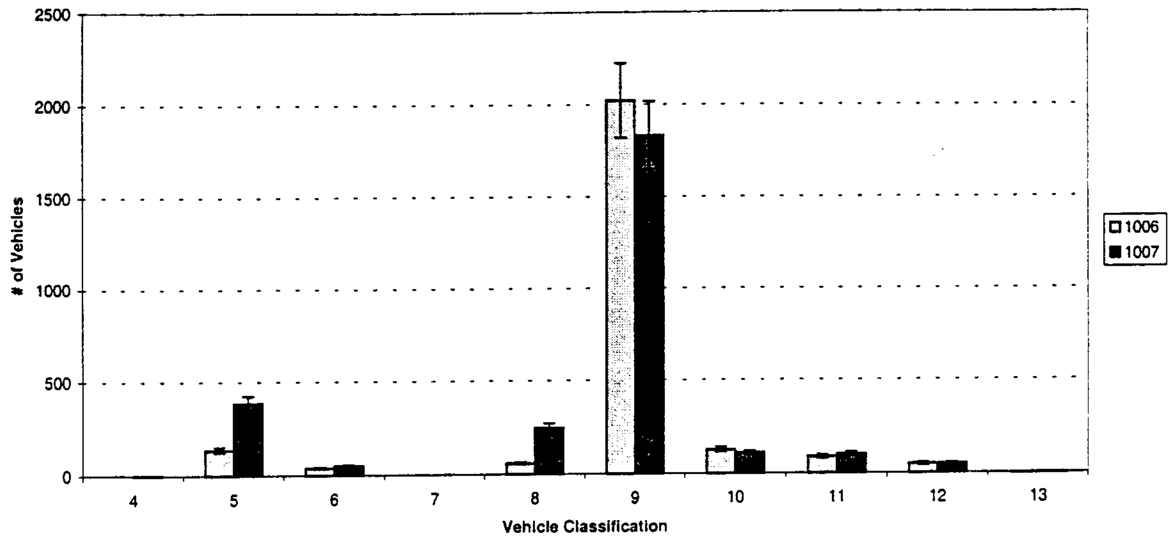


Figure B.2. FHWA Vehicle Classifications for LTPP sites 041006 and 041007 on 3/14/96.

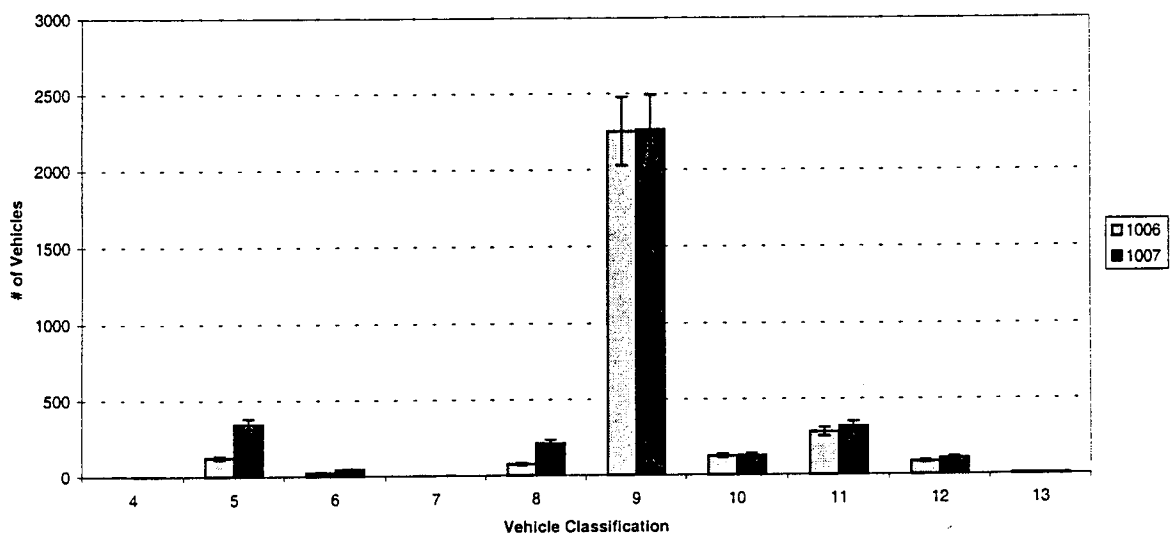


Figure B.3. FHWA Vehicle Classifications for LTPP sites 041006 and 041007 on 7/5/96.

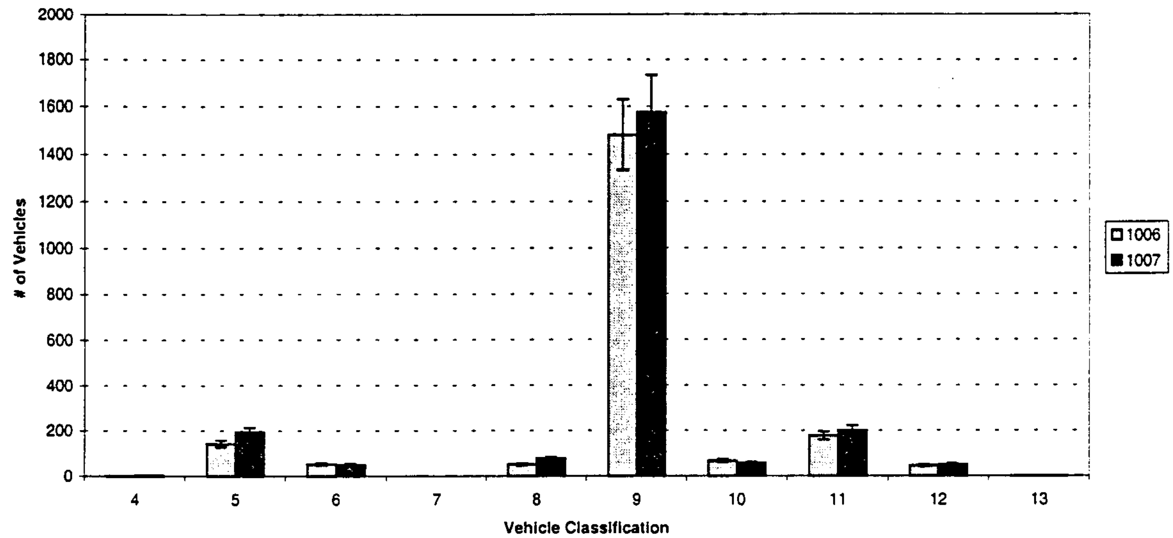


Figure B.4. FHWA Vehicle Classifications for LTPP sites 041006 and 041007 on 7/20/96.

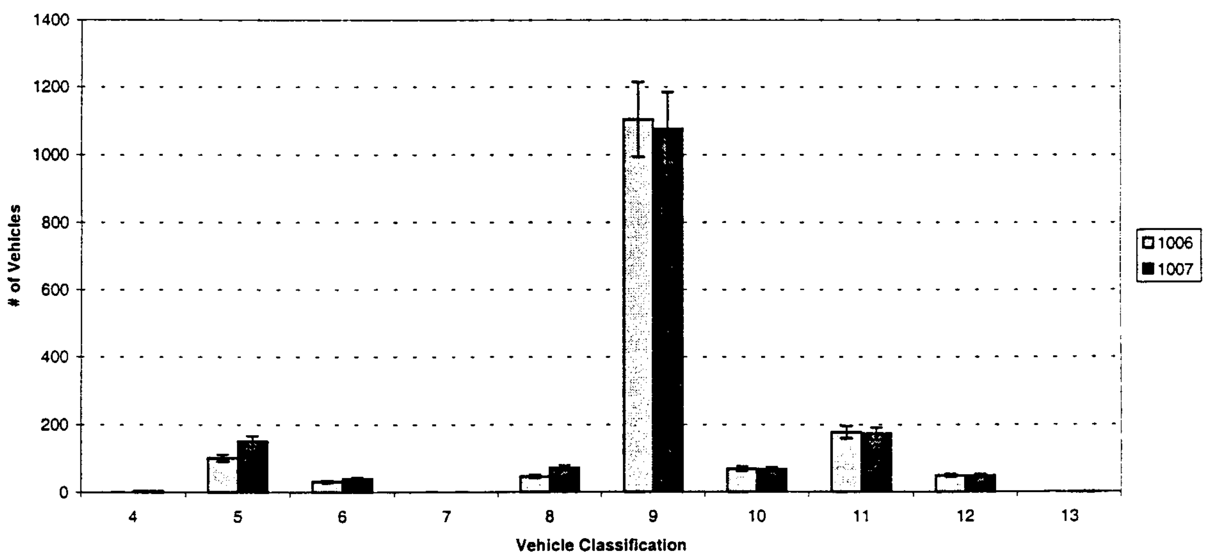
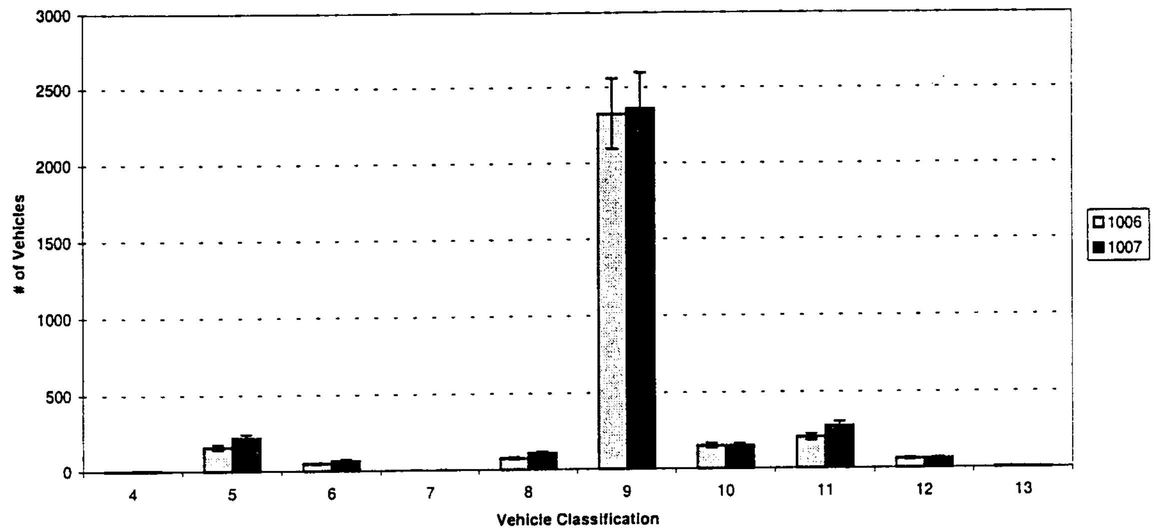


Figure B.5. FHWA Vehicle Classifications for LTPP sites 041006 and 041007 on 8/5/96.



APPENDIX C: RESPONSES TO AGENCY SURVEYS

KENTUCKY
TRANSPORTATION CABINET

FAX TRANSMITTAL

KYTC
DIVISION OF MULTIMODAL PROGRAMS
3RD FLOOR, NEW STATE OFFICE BLDG.
125 HOLMES STREET
FRANKFORT, KENTUCKY 40622
TELEPHONE NO. (502) 564-7686

DATE: 3/25/99	TOTAL PAGES TRANSMITTED: 7 *(Including this cover sheet)*
TIME:	
TO: Earl Laird	FROM: Rob Bostrom
FAX TRANSMITTAL NO:	
775-882-4565	
	FAX PHONE: (502) 564-4422

If total number of pages indicated are not received, please contact 3rd Floor *(FAX Operator)* at (502) 564-7686 *(Telephone Number)*.

MESSAGE:

Earl,

(1) Response to survey emailed. ✓
(2) Requested examples / tables:
A. Default ESAL table
B. Standard ESAL worksheet w/ methodology.
C. Simplified ESAL output
[uses default source data, default growth rates]

Rev. 10-12-94

Rob Bostrom

KENTUCKY RESPONSE TO NCE QUESTIONNAIRES

Survey Response
ESALs Used in Pavement Design

Our state can be identified in respect to answers on this survey.

1. Yes.
2. We have one ESAL value for all trucks. Two examples will be faxed. Note that we have a more complex (standard) methodology for Pavement Design that involves additional data collection, data smoothing and a high level of effort. We also have a simplified computer program that is used for determining ESALs when calculating Superpave mix design parameters.
   a. We use different ESAL values based on load information when the load information is available. Usually we use unit EAL values and the vehicle classification information (axles/truck) is different from site to site. We are faxing our default ESAL tables that contain data for six aggregated Classes.
3. We do not break down ESALs by vehicle classification.
4. We do apply average ESAL factors when site specific information is not available.
5. We use growth factors for all of the key prediction parameters separately. We use growth factors for volume, truck percentages, axles per truck and ESALs per axle.
6. We do use WIM data. The WIM data is preprocessed when our annual ESAL tables are produced by the Kentucky Transportation Center (the Cabinet's research partner). These ESAL values are then used when computing site specific ESAL forecasts for design purposes.
7. There are no links between the HPMS data and the ESAL tables. The growth factors for HPMS at this time are generic functional class factors while our ESAL growth factors are computed on a site specific basis (except when using the simplified method).
8. We have a high level of confidence in our pavement design/rehab ESAL values. We have invested a lot of research resources in developing/refining our ESAL prediction process and we think it does a good job. We also have a good traffic data collection program that supports the traffic forecasting function. The one deficiency that we have is that we would like to have more vehicle classification data. We currently have classification data at less than 7% of all state highway segments.

Subj: **RE: Survey ESAL Used in Pavement Design**
Date: 3/26/99 12:33:00 PM Pacific Standard Time
From: RBOSTROM@mail.kytc.state.ky.us (Bostrom, Rob (KYTC))
To: ETLAIRD@aol.com
CC: JROSS@mail.kytc.state.ky.us (Ross, Jerry (KYTC))

File: Survey Response.doc (34816 bytes)
DL Time (32000 bps): < 1 minute

Earl,

I enjoyed chatting with you the other day. In response to your survey, answers are listed on the attached document. I am faxing a copy of:

* Default 1997 ESAL values by functional class
* A sample ESAL calculation from an actual project using our standard methods that we use for pavement design.
* A sample ESAL calculation using a simplified method that we are using for Superpave mix designs.

<<Survey Response.doc>>

If you have any questions or need additional documentation, don't hestitate to call or e-mail.

Rob Bostrom
Transportation Engineering Specialist
Division of Multimodal Programs
Kentucky Transportation Cabinet
125 Holmes Street
Frankfort, KY 40622
Ph: 502-564-7686
> ———
> From: ETLAIRD@aol.com[SMTP:ETLAIRD@aol.com]
> Sent: Wednesday, March 24, 1999 12:20 PM
> To: RBOSTROM@mail.kytc.state.ky.us
> Subject: Survey ESAL Used in Pavement Design
>
> EARL T. LAIRD
> T P & R CONSULTANT
> Transportation Planning and Research
> 529 Bonanza Dr., Carson City, NV. 89706
> (775)882-4755 Fax (775)882-4565
> E-mail: etlaird@aol.com
>
> March 24, 1999
>
> Survey of States using ESALS for pavement design and rehabilitation. ESAL
> Data information being collected for an ESAL Research Contract between
> Arizona
> DOT and Nichols Consulting Engineers in Reno, Nevada:
>
> Survey State of: Kentucky; Mr. Rob Bostrom;
> Transportation Engineering Specialist; (502) 564-7183
>
> Please check One: Surveyed State (Does __) or (Does Not __) wish to be
> identified on how the state answered any of the survey questions. Only
> identify the state as a participant in the survey.

>
> Question No. 1: Does your state use ESAL computations for
> pavement design and rehabilitation?
> Yes:___
> No:___ If No what do you use?
>
> Q No. 2: What type or types of data do you use to come up with
>
> the ESAL table values (i.e.; one ESAL value for all trucks; ESAL
> values per truck class; etc.)? Will you fax us the first
> page of your
> ESAL table for an
> example.
>
> a. Do you use a single ESAL table for all design locations within your
> state
> or is a different ESAL value computed for different locations based upon
> load
> information for that location?
>
> Q NO. 3: Do you break down ESALS by vehicle classification?
>
> Q No. 4: Do you apply average ESAL factors to the vehicles in
> each classification? What are they?
>
> Q No. 5: Do you use Growth factors to expand ESAL's to design
> years?
>
> Q No. 6: Do you use WIM data? If No what do you use for load
> data?
>
> Q No. 7: Are there links between HPMS data and the ESAL tables?
> a. Are your growth factors for HPMS the same for ESAL
> growth factors?
>
> Q No. 8: How much confidence do you have in the values you use
> for pavement design and rehab?
>
> Survey States comments if any:
>
> Thank you for participating in this ESAL pavement design and
> rehabilitation
> survey. If you have any questions on this survey you may contact Earl
> Laird
> at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D.,
> P.E.;
> Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No.
> (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe;
> Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az
>
> Thank you again for your anticipated help.
>
> Earl T. Laird.
>

A

Aggregated 1997 ESALs - Three-year Averages with Smoothed Growth Rates

6-26-98/nrb

Agg. class	FCs	T%	GR	A/T	GR	EALs/A	GR	A/CT	GR	EALs/CA	GR
I	1	28.653	1.000	4.493	0.092	0.217	1.000	4.778	0.000	0.880	1.989
II	2,6	11.635	1.000	3.490	0.535	0.251	1.000	4.956	0.000	2.639	2.000
III	7,8,9	7.770	1.000	2.936	0.983	0.219	0.000	4.595	0.000	1.235	0.000
IV	11	13.406	1.000	4.076	1	0.183	0.000				
V	12,14	6.262	1.000	3.042	0.398	0.209	0.556	4.590	0.000	1.048	0.000
VI	16,17,19	5.238	1.000	2.772	0.946	0.171	0.000	4.083	0.000	0.594	0.000

Note: Negative growth rates were rounded to 0%, a maximum growth rate of 1% was used for T% and A/T, and a maximum growth rate of 2% was used for EALs/A.

B

FORECAST OF EQUIVALENT SINGLE AXLE LOAD ACCUMULATIONS

ROUTE ID:

County	Boone
Road Name	KY 536
Functional Class	16 - Urban Minor Arterial
Project Numbers	
Project Limits	East of US 25
Segment Limits	Same as Project Limits

Date	3/26/99
Name	R. Bostrom

TC 10-1 No.	61653
Route No.	KY 536
Item No.	6-101.00
Beg. MP	
End MP	
T.F. No.	98.227
Number of Lanes	2
1 or 2 way	2

REFERENCES:

Previous Forecasts	
Volume	OKI TMs
Truck Percent	Estimate by Dennis Merrill
ESAL Information	State Default

Present Year	1998
Construction Year	2002
Median Year	2012
Design Year	2022

TRAFFIC PARAMETERS:

	Present Year	Annual Change	Construction Year	Median Year	Design Year
Volume (AADT)	5560	1.68%	5940	7020	8300
Percent Trucks (%T)	10.00%	1.00%	10.4%	11.5%	12.7%
Percent Trucks Hauling Coal (%CT)	0.00%	0.00%	0.00%	0.00%	0.00%
Non-Coal Trucks:					
Axles/Truck (A/T)	2.772	1.00%	2.885	3.186	3.520
ESALs/Axle (ESAL/A)	0.171	0.00%	0.171	0.171	0.171
Coal Trucks:					
Axles/Truck (A/CT)	0	0.00%	0.000	0.000	0.000
ESALs/Axle (ESAL/CA)	0	0.00%	0.000	0.000	0.000

ESAL CALCULATIONS:

Total Median Year Daily ESALs

(AADT x (1-%T) x .005)+(AADT x %T x (A/T) x (ESAL/A))+(AADT x (%T) x (%CT) x (A/CT) x (ESAL/CA)) = 470.733

Design ESALs in Critical Lane

Median Daily ESALs x 365 x 20 x Lane Adj. = 1,718,000

Version 1.2, 7/22/97

KY536_ESALs.XLS

CALCULATIONS

ESAL Calculations:

4-Tired Vehicles =	7020	x	88.5%	x	0.005				=	31.065
Non-Coal Trucks =	7020	x	11.5%	x	3.186	x	0.171		=	439.668
Coal Trucks =	7020	x	11.5%	x	0.00%	x	0.000	x 0.000	=	0
Median Year Daily ESALs =	31.065	+	439.668	+	0				=	470.733
Design ESALs =	470.733	x	365	x	20	x	0.500		=	1,718,000

Lane Distribution Factors:

1 lane, 1 way	1.000
2 or 3 lane, 2 way	0.500
4 or 5 lane, 2 way	0.483
4 lane, 1 way	0.350
5 lane, 1 way	0.300
6 lane, 2 way	0.413
6 lane, 1 way	0.250
> 6 lane, 2 way	0.351
> 6 lane, 1 way	0.600

Segment: Same as Project Limits

TRAFFIC FORECAST METHODOLOGY

FORECAST INFORMATION

Forecast Number: 98.227 Forecaster: R. Bostrom

County: Boone Route: KY 536

Description: East of US 25

Item #: 6-101.00 Project #:

Requester: District 6 Priority: High Date: 11/9/98

Construction Year: 2002 Design Year: 2022

Data Requested: [X] ADTs [X] DHVs [X] PHFs [X] T% [X] EALs [X] TMs

BACKGROUND INFORMATION

Previous Forecasts:

Volume Source: OKI TMs

Classification Source: State Default

Coal Truck Source: DNA

Special Counts-
Date Requested: 12/4/98
Date Received: 12/28/98
Number Requested:

General Comments: None

Special Methods Used: [ ] Turns [ ] Manual Gravity [ ] Traffic Model [ ] Field Trip

Version 1.2, 7/22/97

KY536_ESALs.XLS

METHODOLOGY - GROWTH RATE & K FACTOR

Growth Rate: **1.68%** Source: OKI TMs

County Area: Entire Source: KY State Data Center

YEAR	TYPE	POPULATION	ANNUAL GROWTH RATE
1990	Census	43438	-
1995	Moderate Growth Est.	45939	1.13%
1995	High Growth Est.	48092	2.06%
2020	Moderate Growth Est.	53114	0.67%
2020	High Growth Est.	60670	1.12%

TLA GROWTH:

Station	Growth Rate	Notes
7	1.58%	
52	1.70%	
Average:	1.64%	

Growth From Previous Forecast: None Forecast #: DNA

Are any new developments planned or special conditions present in this area? ☐ Yes ☐ No

Source of this information: Field Trip

Describe development / special conditions: Wal-Mart

Land Use in Area: Mostly farm land

Comments: None

K Factor: **8.50%** Source: OKI TMs

Related ATR: None Location: DNA K Factor: DNA

Peak Hour Factor: **0.9** Source:

Version 1.2, 7/22/97 KY536_ESALs.XLS

Forecasted ESALs

Data type

A = actual data E = estimated data I = insufficient data

County Kenton

County	Station	Rt. Prefix	Rt. #	Rt. Suffix	Milepoints Start	Milepoints End	AADT	%T	Data type	A/T	Data type	ESAL/A	FC	Lanes	Daily # of coal trucks	Data type	A/CT	Data type	ESAL/CA	Lane Dist.	Years	Forecasted ESALs
59	59086	KY	536	na	0	0.268	2020	7.770	E	2.936	E	0.219	7	2	0	E	4.595	E	1.235	0.500	20	588,051
59	59L22	KY	536	na	0	1.895	5810	5.238	E	2.772	E	0.171	16	2	0	E	4.083	E	0.594	0.500	20	900,762
59	59L23	KY	536	na	1.895	3.305	4200	5.238	E	2.772	E	0.171	16	2	0	E	4.083	E	0.594	0.500	20	651,153
59	59L23	KY	536	na	3.305	4.476	3720	5.238	E	2.772	E	0.171	16	2	0	E	4.083	E	0.594	0.500	20	576,736
59	59L26	KY	536	na	4.476	6.092	2890	5.238	E	2.772	E	0.171	16	2	0	E	4.083	E	0.594	0.500	20	448,055
59	59065	KY	536	na	6.092	7.386	1550	7.770	E	2.936	E	0.219	7	2	0	E	4.595	E	1.235	0.500	20	451,227
59	59257	KY	536	na	7.386	9.284	1110	7.770	E	2.936	E	0.219	7	2	0	E	4.595	E	1.235	0.500	20	323,137
59	59250	KY	536	na	9.284	10.249	1330	7.770	E	2.936	E	0.219	7	2	0	E	4.595	E	1.235	0.500	20	387,182
59	59086	KY	536	na	10.249	10.474	2020	7.770	E	2.936	E	0.219	7	2	0	E	4.595	E	1.235	0.500	20	588,051

Subj: **Survey ESAL Used in Pavement Design**
Date: 3/24/99
To: [redacted]

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March 24, 1999

Survey of States using ESALS for pavement design and rehabilitation. ESAL Data information being collected for an ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: [redacted]
Transportation Engineering Specialist; (502) 564-7183

Please check One: Surveyed State (Does __) or (Does Not __) wish to be identified on how the state answered any of the survey questions. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?
Yes:___
No:___ If No what do you use?

Q No. 2: What type or types of data do you use to come up with the ESAL table values (i.e.; one ESAL value for all trucks; ESAL values per truck class; etc.)? Will you fax us the first page of your ESAL table for an example.

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location?

Q NO. 3: Do you break down ESALS by vehicle classification?

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? What are they?

Q No. 5: Do you use Growth factors to expand ESAL's to design years?

Q No. 6: Do you use WIM data? If No what do you use for load data?

Q No. 7: Are there links between HPMS data and the ESAL tables?
a. Are your growth factors for HPMS the same for ESAL growth factors?

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab?

Survey States comments if any:

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe;

Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

Thank you again for your anticipated help.

Earl T. Laird.

Hi Rob Bostrom,

Thank you for the quick and very informative reply to the questionnaire on ESAL use in pavement design. Of the 10 states I have received back questionnaires, I must tell you that your state and Kansas, thus far (and you know this is not a contest), has the most aggressive ESAL tables. You have ESAL for trucks, growth factors for future years, use vehicle class data at design sites, etc.. Very, very nice ESAL reporting tables. This old traffic guy like to see traffic reports tables that show the user we know how to collect traffic data and how to report same. Very good reporting.

Thanks again for your states input.

Earl T. (:>))

NEBRASKA DOT

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March 16, 1999

Survey of States using ESALS for pavement design and rehabilitation. EASL Data information being collected for a ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: Nebraska DOT; Mr. Jerome Miller ; Asst. Transportation Planning Engineer; (402) 479-4670 Fax: (402) 479-3884

Please check One: Surveyed State (Does X) or (Does Not __) wish to be identified on how the state answered any of the survey questions. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?
Yes: X
No: __ If No what do you use?

Q No. 2: What type or types of data do you use to come up with the ESAL table values? (Will you fax us the first page of your ESAL table for an example.)

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location? DIFFERENT

Q NO. 3: Do you break down ESALS by vehicle classification? YES

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? What are they? SEE ATTACHED SHEET

Q No. 5: Do you use Growth factors to expand ESAL's to design years? YES

Q No. 6: Do you use WIM data? If No what do you use for load data? YES

Q No. 7: Are there links between PMS data and the ESAL tables?
a. Are your growth factors for PMS the same for ESAL growth factors?

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab? GOOD CONFIDENCE

Survey States comments if any:

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

Thank you again,
Earl T. Laird.

DATE : 06/16/98
STATE : NE
PERIOD : 1997

NEBRASKA DEPARTMENT OF ROADS
TRANSPORTATION PLANNING DIVISION

W-4 TABLE
EQUIVALENCY FACTORS
By Direction

FUNCTIONAL CLASS(ES) : 02
AVERAGING METHOD : Hour of Day
AXLE GROUPING METHOD: Vehicle Size & Weight
STATION CODE(S) : 31030 (31030), 31070 (31070), 31110 (31110), 31150 (31150), 35650 (35650)

SUMMARY ESAL DESIGN FACTORS	3 SU 2-AX 4-TR	4 BUS	5 SU 2-AX 6-TR	6 SU 3-AX	7 SU 4-AX OR MORE	8 STT 4-AX OR LESS	9 STT 5-AX	10 STT 6-AX OR MORE	11 MTT 5-AX OR LESS	12 MTT 6-AX	13 MTT 7-AX OR MORE
RIGID PAVEMENT P= 2.50 *D=* 228 mm											
ESALSs PER VEHICLE	0.0000	0.3217	0.1593	0.3918	0.8451	0.9096	1.6278	1.8730	2.0122	3.1856	0.0000
PERCENT DISTRIBUTION USING AVERAGE DAILY COUNT	0.00	0.23	2.70	1.86	0.54	5.53	77.86	10.50	0.52	0.22	0.00
FLEXIBLE PAVEMENT P= 2.50 *SN=* 127 mm											
ESALSs PER VEHICLE	0.0000	0.2687	0.1605	0.2351	0.6965	0.7347	0.9872	1.1111	2.0317	2.7270	0.0000
PERCENT DISTRIBUTION USING AVERAGE DAILY COUNT	0.00	0.31	4.31	1.76	0.70	7.07	74.79	9.86	0.84	0.30	0.00
TRAFFIC VOLUME											
AVERAGE VEHICLES WEIGHED	0	3	51	17	1	13	165	18	1	-	0
AVERAGE VEHICLES COUNTED	457	3	72	20	3	26	201	24	1	-	0
PERCENT DISTRIBUTION OF AVERAGE DAILY COUNT BY TRUCK TYPE			20.66	5.78	0.78	7.40	58.16	6.82	0.32	0.09	0.00

20 YEAR ESAL ESTIMATES
ADT = 1000
Values in millions

FLEXIBLE PAVEMENTS GROWTH RATES

PERCENT TRUCKS	0	2	4	6	8	10
2	0.11	0.14	0.17	0.19	0.23	0.29
4	0.22	0.27	0.33	0.38	0.46	0.57
6	0.34	0.41	0.50	0.57	0.69	0.86
8	0.45	0.54	0.67	0.76	0.93	1.14
10	0.56	0.68	0.83	0.94	1.16	1.43
15	0.84	1.02	1.25	1.42	1.74	2.14
20	1.12	1.36	1.66	1.89	2.32	2.86
25	1.40	1.70	2.08	2.36	2.90	3.57
30	1.68	2.04	2.50	2.83	3.47	4.29
35	1.96	2.38	2.91	3.30	4.05	5.00
40	2.24	2.72	3.33	3.78	4.63	5.72
45	2.51	3.06	3.74	4.25	5.21	6.43
50	2.79	3.39	4.16	4.72	5.79	7.15

RIGID PAVEMENTS GROWTH RATES

PERCENT TRUCKS	0	2	4	6	8	10
2	0.18	0.22	0.26	0.30	0.37	0.45
4	0.35	0.43	0.53	0.60	0.73	0.91
6	0.53	0.65	0.79	0.90	1.10	1.36
8	0.71	0.86	1.06	1.20	1.47	1.81
10	0.89	1.08	1.32	1.50	1.84	2.27
15	1.33	1.61	1.98	2.24	2.75	3.40
20	1.77	2.15	2.64	2.99	3.67	4.53
25	2.21	2.69	3.30	3.74	4.59	5.66
30	2.66	3.23	3.96	4.49	5.51	6.80
35	3.10	3.77	4.62	5.24	6.42	7.93
40	3.54	4.30	5.27	5.99	7.34	9.06
45	3.99	4.84	5.93	6.73	8.26	10.19
50	4.43	5.38	6.59	7.48	9.18	11.33

97F

FUNCTIONAL CLASSIFICATION 02 (1997)
FLEXIBLE

Project No.:	F-1-1(111)
Control No.:	12345
Location:	Widget City
Date:	36238

	%	EQV	12330 ADT	12 % HT	ESAL
Single Unit Trucks					
2 axle, 6-tire	20.66	0.1605	12330	12	49.06
3 axle	5.78	0.2351	12330	12	20.11
4 axle, or more	0.78	0.6965	12330	12	8.04
Single Trailer Trucks					
4 axle, or less	7.4	0.7347	12330	12	80.44
5 axle	58.16	0.9872	12330	12	849.52
6 axle, or more	6.82	1.1111	12330	12	112.12
Multi-Trailer Trucks					
5 axle, or less	0.32	2.0317	12330	12	9.62
6 axle	0.09	2.727	12330	12	3.63
7 axle, or more	0	0	12330	12	0.00
					========
				Total	1132.54
			Total x 365		413377.24

1993 Total EASL	391507	using 1993 Esal Info
1994 Total EASL	376198	" 1994 " "
1995 Total EASL	358767	" 1995 " "
1996 Total EASL	411481	" 1996 " "
1997 Total EASL	413377	" 1997 " "
Average EASL	390266	USING 5-YR AVG OF ESAL INFO

~~future ADT 0~~ ~~present ADT 0~~ ~~years between 0~~ ~~growth factor #DIV/0!~~ ~~18-kip ESAL #DIV/0!~~

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775) 882-4755 Fax (775) 882-4565
E-mail: ETLAIRD@AOL.COM

FAX COVER SHEET
Number of pages including this cover sheet 2

TO: Jerome Miller FAX NUMBER: (402) 479-3884
Asst. Transportation Planning Engineer

FROM: Earl Laird FAX NUMBER: (775) 882-4565

DATE: March 18, 1999 TIME: 8:15 AM

SUBJECT: State Survey of ESAL Use For Pavement Design and Rehabilitation

REMARKS:
Hello Mr. Miller:

Per our phone conservation this A.M., attached is the small questionnaire dealing with your state's use of ESALS data in the design and rehabilitation of pavements. As I explained to you, the ESAL survey is part of a contract Nichols Consulting Engineers of Reno has with Arizona DOT dealing with ESAL design and its use in pavement design and rehab.

If you have any questions please call me at (775) 882-4755.

You may fax your answers to me at Fax No. (775) 882-4565.

Thanks for your anticipated help.
1
Earl T. Laird (:>))

FACSIMILE COVER SHEET
NEBRASKA DEPARTMENT OF ROADS

TRANSMIT TO

DATE 4-1-99
FAX # (775) 882-4565
NAME EARL T. LAIRD
COMPANY T.P. & R. CONSULTANT
DIVISION
SECTION
ROOM
CITY
STATE
PHONE (___) ___-____
PAGES SENT 5 (INCLUDING THIS PAGE)

TRANSMITTED FROM

FAX # (402)-479-3884
[redacted] J.C. MILLER
[redacted] ASST. PLN ENGR.
TRANSPORTATION PLANNING DIVISION
LINCOLN, NEBRASKA
(402) 479-[redacted] 4670
DOR5005@VMHOST.CDP.STATE.NE.US

NOTE:

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March 16, 1999

Survey of States using ESALS for pavement design and rehabilitation. EASL Data information being collected for a ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: Nebraska DOT; Mr. Jerome Miller; Asst. Transportation Planning Engineer; (402) 479-4670 Fax: (402) 479-3884

Please check One: Surveyed State (Does __) or (Does Not __) wish to be identified on how the state answered any of the survey questions. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?
Yes:___
No:___ If No what do you use?

Q No. 2: What type or types of data do you use to come up with the ESAL table values? (Will you fax us the first page of your ESAL table for an example.)

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location?

Q NO. 3: Do you break down ESALS by vehicle classification?

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? What are they?

Q No. 5: Do you use Growth factors to expand ESAL's to design years?

Q No. 6: Do you use WIM data? If No what do you use for load data?

Q No. 7: Are there links between PMS data and the ESAL tables?
a. Are your growth factors for PMS the same for ESAL growth factors?

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab?

Survey States comments if any:

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

Thank you again,
Earl T. Laird.

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775) 882-4755 Fax (775) 882-4565
E-mail: ETLAIRD@AOL.COM

FAX COVER SHEET
Number of pages including this cover sheet 2

TO: Jerome Miller FAX NUMBER: (402) 479-3884
Asst. Transportation Planning Engineer

FROM: Earl Laird ETL FAX NUMBER: (775) 882-4565

DATE: March 18, 1999 TIME: 8:15 AM

SUBJECT: State Survey of ESAL Use For Pavement Design and Rehabilitation

==

REMARKS:
Hello Mr. Miller:

Per our phone conservation this A.M., attached is the small questionnaire dealing with your state's use of ESALS data in the design and rehabilitation of pavements. As I explained to you, the ESAL survey is part of a contract Nichols Consulting Engineers of Reno has with Arizona DOT dealing with ESAL design and its use in pavement design and rehab.

If you have any questions please call me at (775) 882-4755.

You may fax your answers to me at Fax No. (775) 882-4565.

Thanks for your anticipated help,
1
Earl T. Laird (:>)) Earl T. Laird

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775) 882-4755 Fax (775) 882-4565
E-mail: ETLAIRD@AOL.COM

FAX COVER SHEET
Number of pages including this cover sheet 2

TO: Jerome Miller FAX NUMBER: (402) 479-3884
Asst. Planning Engineer

FROM: Earl Laird FAX NUMBER: (775) 882-4565

DATE: April 1, 1999 TIME: 11:05 AM

SUBJECT: Thanks For State Survey of ESAL Use In Design and Rehabilitation

==

REMARKS:
Hi J.C. Miller:

Thank you for your prompt and very comprehensive answer to the survey of Nebraska's use of ESAL's in pavement design and rehabilitation.

I, an old retired planning traffic person, was very pleased to see that your division is collecting traffic classification and weight data and using individual truck and bus class data in developing ESAL for site specific design locations. I respect traffic personnel who collect site specific or site related traffic data and take the time to present this data to the user in a comprehensive report form that will answers site specific design questions that the designer may have. If the design administrator uses or does not use the data, it is there for their decision making needs. Of 11 states (15 states surveyed) three states, and your state is one, are using classification and weight data that are site specific or site related to the site location under design. The other 8 states are using a combination of: 1. An all truck statewide average ESAL; 2. A 3 bin truck (single, semi, and truck and trailer) statewide ESAL average; 3. A four bin truck (same as #2 only busses added) statewide ESAL value; or 4. Class 4 through 13 vehicle class statewide average ESAL value and applying these statewide ESAL values to vehicle classification of: 1. A state average; 2. Highway functional class; or 3. Site specific or related vehicle classification count.

Which of the above works? This is what the Arizona DOT research project is trying to answer. What way is best?

My personal view of this average one table, less computation, basic approach is: it's the easy way out. There are exceptions to all rules and I feel, without knowledge being gained from this research project, one should take the time to assure the ESAL values fit the location under design. Roadway construction and maintenance is very expensive and during the design stage of the project is not the time to take the easy way out. Knowing what traffic loads are there now is easy, to a degree, projecting these loads into the future is the hard part and needs lots of crystal ball work. I have provided a lot of design traffic data over the years and had the privilege of seeing my 20 and 30 year projections come true and some that were a long ways off. Most of those that were a long way off are in areas of unexpected fast traffic growth, unexpected land use changes, and truck commodity carrying changes. Win some lose some.

In a couple states, the design divisions are using statewide ESAL values developed, and supposedly verified with WIM data, from old loadometer static weight W-Tables and applied to new vehicle classification data. I am from the old loadometer days and moved my state (Nevada) into WIM data collection in the late 70's. I know that many trucks never came into our loadometer sites for weighing thus our ESAL values were low. Sadly, I see by the average ESAL values being used by the above states, the ESAL values appear to me to be low and when compared to your and other state ESAL values are low.

You are doing what appears to this old planning traffic guy, one good job. If you take this to your boss, you will get a pay raise. Yah, right! APRIL FOOL!

Thanks again for your help.

Earl T. Laird (:>))

From: <ETLAIRD@aol.com>
To: <GKUHL@dot.state.ut.us>
Date: Tue, Mar 23, 1999 8:58 AM
Subject: Survey ESAL Use For Design

UTAH DOT

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March 22, 1999

Survey of States using ESALS for pavement design and rehabilitation. ESAL Data information being collected for an ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: Utah DOT; Mr. Gary Kuhl; Planning Division Engineer; (801) 964-4552

Please check One: Surveyed State (Does X) or (Does Not __) wish to be identified on how the state answered any of the survey questions. Only identify the state as a participant in the survey. that's fine

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?
Yes: X
No:___ If No what do you use?

Q No. 2: What type or types of data do you use to come up with the ESAL table values? (Will you fax us the first page of your ESAL table for an example.) Axle weights from W.I.M. equipment

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location? varies by functional class

Q NO. 3: Do you break down ESALS by vehicle classification? yes

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? What are they? yes

Q No. 5: Do you use Growth factors to expand ESAL's to design years? for volumes, not factors

Q No. 6: Do you use WIM data? If No what do you use for load data? yes

Q No. 7: Are there links between HPMS data and the ESAL tables? yes - for vehicle class breakdown
a. Are your growth factors for HPMS the same for ESAL growth factors?

Q No. 8: How much confidence do you have in the values you use
higher on major routes with good truck data
lower on other routes with limited data

Project Traffic Report

PROJECT DESCRIPTION: So. of Silver Creek Interchange (North bd. traffic)

STATE ROUTE: S.R.- 40

BEG. M.P.: 0.50 **END M.P.:** 1.00 **LENGTH:**

PROJECT SCOPE: Reconstruction **REGION:** 2

Rigid or Flexible: Rigid **DIRECTIONAL FACTOR:** 1.00

CONSTRUCTION YEAR: 2000 **FUNCTIONAL CLASS** 2

DESIGN PERIOD: 20 yrs *D* = 9.00

DESIGN HOUR VOLUME %: 13 **NUMBER OF LANES:** 2

BASE YEAR AADT = 12,000
FINAL YEAR AADT = 17,440

ESAL's RATE CLASS 5-7 = 0.01 ESAL'S/VEH-YR
ESAL's RATE CLASS 8-13 = 0.03 ESAL'S/VEH-YR

F = 1.00

VEHICLE CLASS	BASE YEAR AADT	FINAL YEAR AADT	ANNUAL GROWTH RATE %	TRUCK FACTOR ESALS/VE	% OF LOAD	DESIGN ESAL'S X 1,000
1&2 MT. CYC. & CARS	8,620	12,360	1.8	0.0002	0.1	15.0
3 2 AXLE/4 TIRE VEH.	2,280	3,320	1.9	0.0300	2.9	600.4
4 BUSES	60	110	3.1	0.8800	2.5	521.9
SINGLE UNIT TRUCKS						
5 2 AXLE/6 TIRES	160	245	2.5	0.2065	2.1	427.9
6 3 AXLES	75	120	2.4	0.5211	2.1	429.0
7 4 AXLES (OR MORE)	35	60	2.7	0.0414	0.2	47.2
SINGLE TRAILER TRUCKS						
8 4 AXLE (OR LESS)	45	75	2.6	0.4847	1.6	332.1
9 5 AXLE (3S2)	400	660	2.5	2.9648	58.7	12219.7
10 6 AXLE (OR MORE)	65	105	2.4	1.4470	5.0	1051.0
MULTI-TRAILER TRUCKS						
11 5 AXLE (OR LESS)	65	90	1.6	1.3290	4.4	906.1
12 6 AXLE	25	35	1.7	1.0085	1.4	281.5
13 7 AXLE (OR MORE)	180	260	1.9	2.2342	19.2	3987.8
TOTAL (TRUCKS):	1,100	1,760			100.0	20,820
PERCENT TRUCKS:	9.17%	10.09%				
WEIGHTED TRUCK FACTOR:	1.7635	1.7575				
TOTAL (CARS/PICKUPS):	10,900	15,680				
PERCENT CARS/PICKUPS:	90.83%	89.91%				
WEIGHTED CAR/PICKUP FACTOR:	0.0064	0.0065				

SAMPLE REPORT

DESIGN LANE ESAL'S = 20,819,864

DESIGN LANE ESAL'S/DAY = 2,852

VEHICLE DATA SOURCES: Counts made in area
DATA COLLECTION DATES: 1996
ESAL FUNCTIONAL CLASS:
ESAL COLLECTION DATES: 1997-98

23-Mar-99

Functional Class

Axle Class	1 Rigid	1 Flex	2 Rigid	2 Flex	6 Rigid	6 Flex	7 Rigid	7 Flex	8 Rigid	8 Flex	9 Rigid	9 Flex
3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.5973	0.4315	0.4825	0.3327	0.0156	0.0186	0.0489	0.0520	0.0000	0.0000	0.0000	0.0000
5	0.5084	0.4718	0.2065	0.1996	0.3061	0.2898	0.3103	0.2798	0.0000	0.0000	0.0000	0.0000
6	0.8061	0.5250	0.5211	0.3465	0.4437	0.3172	0.6928	0.5204	0.0000	0.0000	0.0000	0.0000
7	0.0368	0.0306	0.0414	0.0431	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.9873	0.7838	0.4847	0.3808	0.5591	0.5018	0.9547	0.8276	0.0000	0.0000	0.0000	0.0000
9	4.8749	2.8744	2.9648	1.7798	2.7212	1.6410	1.6930	1.0079	0.0000	0.0000	0.0000	0.0000
10	3.6364	2.1457	1.4470	0.8289	0.0342	0.0350	0.0238	0.0185	0.0000	0.0000	0.0000	0.0000
11	4.0869	3.3987	1.3290	1.2482	1.4394	1.2700	0.7015	0.7197	0.0000	0.0000	0.0000	0.0000
12	3.5131	2.7883	1.0085	0.8695	0.1690	0.1813	0.0145	0.0150	0.0000	0.0000	0.0000	0.0000
13	5.2436	3.6942	2.2342	1.3596	2.6832	1.7199	0.8221	0.6400	0.0000	0.0000	0.0000	0.0000

Axle Class	11 Rigid	11 Flex	12 Rigid	12 Flex	14 Rigid	14 Flex	16 Rigid	16 Flex	17 Rigid	17 Flex	19 Rigid	19 Fl[illegible]
3	0.0026	0.0026	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	[illegible]
4	0.6822	0.5021	0.0000	0.0000	0.1850	0.1604	0.5403	0.4424	0.0000	0.0000	0.0000	[illegible]
5	0.3827	0.3529	0.0000	0.0000	0.1993	0.1812	0.8035	0.7393	0.0000	0.0000	0.0000	[illegible]
6	1.4318	1.0389	0.0000	0.0000	1.6884	1.0722	1.5896	1.1136	0.0000	0.0000	0.0000	[illegible]
7	0.7128	0.4919	0.0000	0.0000	0.8384	0.6205	0.5828	0.3465	0.0000	0.0000	0.0000	[illegible]
8	0.9871	0.6323	0.0000	0.0000	0.6136	0.4834	1.6810	1.3867	0.0000	0.0000	0.0000	[illegible]
9	2.8934	1.6884	0.0000	0.0000	3.0104	1.8133	4.2478	2.6026	0.0000	0.0000	0.0000	[illegible]
10	2.9179	1.6844	0.0000	0.0000	1.7633	1.2264	3.4718	2.1155	0.0000	0.0000	0.0000	[illegible]
11	2.3295	1.9882	0.0000	0.0000	2.4675	2.2975	0.3105	0.3074	0.0000	0.0000	0.0000	[illegible]
12	2.2456	1.8715	0.0000	0.0000	1.6821	1.5490	0.2632	0.2760	0.0000	0.0000	0.0000	[illegible]
13	3.6506	2.5203	0.0000	0.0000	3.1270	1.9288	5.2762	3.3584	0.0000	0.0000	0.0000	[illegible]

ESAL FACTOR TABLE

23-Mar-99

Subj: **Survey ESAL Use For Design**
Date: 3/23/99
To: GKUHL@dot.state.ut.us

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March ~~22~~ 23, 1999

Survey of States using ESALS for pavement design and rehabilitation. ESAL Data information being collected for an ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: Utah DOT; Mr. Gary Kuhl; Planning Division Engineer;
(801) 964-4552

Please check One: Surveyed State (Does __) or (Does Not __) wish to be identified on how the state answered any of the survey questions. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?
Yes:___
No:___ If No what do you use?

Q No. 2: What type or types of data do you use to come up with the ESAL table values? (Will you fax us the first page of your ESAL table for an example.)

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location?

Q NO. 3: Do you break down ESALS by vehicle classification?

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? What are they?

Q No. 5: Do you use Growth factors to expand ESAL's to design years?

Q No. 6: Do you use WIM data? If No what do you use for load data?

Q No. 7: Are there links between HPMS data and the ESAL tables?
a. Are your growth factors for HPMS the same for ESAL growth factors?

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab?

Survey States comments if any:

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

Thank you again,

Earl T. Laird.

[redacted]

UTAH

Yes, thank you, I did receive you faxed ESAL data tables.

After the Arizona ESAL research study is completed (in approximately 9 months), it is planned that the accumulated answers provided by the participating states, in how ESAL data is used in pavement design, will be distributed to all participating states (approximately 15 States).

Thank you for the prompt and very informative ESAL information.

Earl T. (:>))

Subj: **Re: Survey ESAL Use For Design**
Date: 3/24/99 6:49:35 AM Pacific Standard Time
From: srcopo1.gkuhl@dot.state.ut.us (Gary Kuhl)
To: ETLAIRD@aol.com

I faxed you some info yesterday. Could you let me kow if you didn't get it.

Also, can I get a copy of your study when you get it put together. I'd like to see what others are using for their ESAL factors.

——————— Headers ———————
Return-Path: <srcopo1.gkuhl@dot.state.ut.us>
Received: from rly-yd01.mx.aol.com (rly-yd01.mail.aol.com [172.18.150.1]) by air-yd05.mx.aol.com (v58.13) with SMTP; Wed, 24 Mar 1999 09:49:35 -0500
Received: from email.state.ut.us (email.state.ut.us [168.180.96.41])
by rly-yd01.mx.aol.com (8.8.8/8.8.5/AOL-4.0.0)
with SMTP id JAA27912 for <ETLAIRD@aol.com>;
Wed, 24 Mar 1999 09:49:33 -0500 (EST)
Received: from STATE-DOMAIN-Message_Server by email.state.ut.us
with Novell_GroupWise; Wed, 24 Mar 1999 07:44:02 -0700
Message-Id: <s6f897c2.020@email.state.ut.us>
X-Mailer: Novell GroupWise 5.5
X-GWFix: Yes
Date: Wed, 24 Mar 1999 07:46:33 -0700
From: "Gary Kuhl" <srcopo1.gkuhl@dot.state.ut.us>
To: <ETLAIRD@aol.com>
Subject: Re: Survey ESAL Use For Design
Mime-Version: 1.0
Content-Type: text/plain; charset=US-ASCII
Content-Transfer-Encoding: quoted-printable
Content-Disposition: inline

Survey of States using ESALS for pavement design and rehabilitation. ESAL Data information being collected for a ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: **Wyoming DOT; Ms. Vicki Bonds; Materials Engineer; (307) 777-4359**

Please check One: Surveyed State (Does X) or (Does Not __) wish to be identified on how the state answered any of the survey questioned. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?

Yes: **X**

No:___ If No what do you use?

Q No. 2: What type or types of data do you use to come up with the ESAL table values? (Will you fax us the first page of your ESAL table for an example.) **Faxed**

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location? **Single ESAL table for statewide.**

Q NO. 3: Do you break down ESALS by vehicle classification? **Yes**

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? What are they? **Yes, 13 FHWA class.**

Q No. 5: Do you use Growth factors to expand ESAL's to design years? **Yes. We update ESAL's yearly and project future.**

Q No. 6: Do you use WIM data? If No what do you use for load data? **Yes**

Q No. 7: Are there links between PMS data and the ESAL tables? **Yes, updated annually.**

a. Are your growth factors for PMS the same for ESAL growth factors? **No**

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab? **A fair amount of confidence, however WYDOT is considering incorporating the AASHTO recommendations.**

Survey States comments if any: **We would appreciate a copy of the resultant report.**

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

Thank you again,

Earl T. Laird.

NATURE SAVER™ FAX MEMO 01616

To Earl Laird	Date 3-23-99 · # of pages ▶
	From Dave Bigge
Co./Dept. TP & R	Co. WYDOT
Phone # 775-882-4755	Phone # 307-777-4490
Fax # 775-882-4565	Fax # 307-777-3857

WYOMING DOT

HIRED SURVEY BACK

STATEWIDE FACTORS
FLEXIBLE P=2.5 SN=5.0

1994

	# TRUCKS	ESAL	94FACTOR
PU	532	2.9588	0.00556185
BUSSES	815	361.0378	0.44299117
2D-6	2902	578.4832	0.19933949
3AXSUT	1294	436.9886	0.33770371
4AXSUT	5	2.5853	0.51706
CAT-08	2296	1015.993	0.44250566
CAT-09	88805	112823.7	1.27046563
CAT-10	2536	2025.123	0.79855008
CAT-11	8264	15238.27	1.84393393
CAT-12	300	266.6518	0.88883933
CAT-13	4434	4021.163	0.90689287
TOTAL	112183	136772.955	1.21919502

1995

	# TRUCKS	ESAL	95FACTOR
PU	637	35.0201	0.05497661
BUSSES	1145	542.8636	0.47411668
2D-6	7955	1000.1029	0.12572004
3AXSUT	2180	948.5803	0.43512858
4AXSUT	12	13.3779	1.114825
CAT-08	2677	1261.4318	0.47121098
CAT-09	105940	143146.673	1.35120703
CAT-10	3428	3321.672	0.9689825
CAT-11	8118	15423.5847	1.89992421
CAT-12	556	567.7007	1.02104442
CAT-13	5600	5505.8295	0.98318384
TOTAL	138248	171767.037	1.24245585

1996

	# TRUCKS	ESAL	96FACTOR
PU	674	25.2295	0.03743249
BUSSES	1364	703.0242	0.51541364
2D-6	9461	1428.632	0.15100222
3AXSUT	2722	1107.31	0.40680015
4AXSUT	42	84.414	2.00985714
CAT-08	3820	1497.316	0.39196754
CAT-09	124841	158512.759	1.26971715
CAT-10	5009	4830.658	0.96439569
CAT-11	6622	11583.81	1.74929175
CAT-12	831	672.8226	0.80965415
CAT-13	6614	7114.7584	1.07571186
TOTAL	162000	187560.734	1.15778231

16 YEAR ACCUM. 78,80-94

	# TRUCKS	ESAL	FACTOR
PU	21043	100.3878	0.0047706
BUSSES	2005	891.3819	0.4445795
2D-6	29016	8106.7933	0.27939045
3AXSUT	11616	7371.0266	0.63455808
4AXSUT	228	887.5601	3.89280746
CAT-08	11923	5141.0072	0.43118403
CAT-09	271278	344142.317	1.26859649
CAT-10	8478	13159.3732	1.55217896
CAT-11	23980	44754.4987	1.86632605
CAT-12	1915	1680.8863	0.87775264
CAT-13	13603	16039.7409	1.17913261
TOTAL	395085	442274.983	1.11944261

17 YEAR ACCUM. 78,80-95

	# TRUCKS	ESAL	FACTOR
PU	21680	135.4079	0.00624575
BUSSES	3150	1434.2455	0.45531603
2D-6	36971	9106.8962	0.2463254
3AXSUT	13796	8319.6069	0.60304486
4AXSUT	240	900.938	3.75390833
CAT-08	14600	6402.439	0.43852322
CAT-09	377218	487289.19	1.29179729
CAT-10	11906	16481.0452	1.38426383
CAT-11	32098	60178.0834	1.87482348
CAT-12	2471	2248.597	0.90999474
CAT-13	19203	21545.5704	1.12198981
TOTAL	533333	614042.02	1.15132951

18 YEAR ACCUM. 78,80-96

	# TRUCKS	ESAL	FACTOR
PU	22354	160.6374	0.00718607
BUSSES	4514	2137.2697	0.47347579
2D-6	46432	10535.6282	0.22690231
3AXSUT	16518	9426.9169	0.57070571
4AXSUT	282	985.352	3.49415603
CAT-08	18420	7899.755	0.42886835
CAT-09	502059	645801.95	1.28630689
CAT-10	16915	21311.7032	1.25992926
CAT-11	38720	71761.8934	1.85335468
CAT-12	3302	2921.4196	0.88474246
CAT-13	25817	28660.3288	1.11013397
TOTAL	695333	801602.754	1.15283289

STATEWIDE FACTORS
FLEXIBLE P=2.5 SN=5.0

1997

	# TRUCKS	ESAL	97FACTOR
PU	1381	11.0286	0.00798596
BUSSES	1631	707.5186	0.4337943
2D-6	6858	1484.2546	0.21642674
3AXSUT	3357	1186.5053	0.35344215
4AXSUT	40	40.2348	1.00587
CAT-08	3547	1437.673	0.40532083
CAT-09	120771	142633.166	1.18102165
CAT-10	4481	4244.9726	0.94732707
CAT-11	5481	8679.1072	1.58348973
CAT-12	1004	959.2201	0.95539851
CAT-13	8295	8906.7876	1.07375378
TOTAL	156846	170290.468	1.08571764

19 YEAR ACCUM. 78,80-97

	# TRUCKS	ESAL	FACTOR
PU	23735	171.666	0.00723261
BUSSES	6145	2844.7882	0.46294356
2D-6	53290	12019.7828	0.22555419
3AXSUT	19875	10613.4222	0.53400866
4AXSUT	322	1025.5868	3.18505217
CAT-08	21967	9337.428	0.42506614
CAT-09	622830	788435.116	1.26589136
CAT-10	21396	25556.6758	1.19446045
CAT-11	44201	80441.0006	1.81989097
CAT-12	4306	3880.6397	0.90121684
CAT-13	34112	37567.1164	1.10128742
TOTAL	852179	971893.222	1.14048014

Subj: **ESAL's Use For Pavement Design**
Date: 3/18/99
To: vbonds@missc.state.wy.us

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March 16, 1999

Survey of States using ESALS for pavement design and rehabilitation. EASL Data information being collected for a ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: Wyoming DOT; Ms. Vicky Bonds; Materials Engineer;
(307) 777-4070

Please check One: Surveyed State (Does __) or (Does Not __) wish to be identified on how the state answered any of the survey questioned. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?
Yes:___
No:___ If No what do you use?

Q No. 2: What type or types of data do you use to come up with the ESAL table values? (Will you fax us the first page of your ESAL table for an example.)

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location?

Q NO. 3: Do you break down ESALS by vehicle classification?

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? What are they?

Q No. 5: Do you use Growth factors to expand ESAL's to design years?

Q No. 6: Do you use WIM data? If No what do you use for load data?

Q No. 7: Are there links between PMS data and the ESAL tables?
a. Are your growth factors for PMS the same for ESAL growth factors?

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab?

Survey States comments if any:

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

Thank you again,

Earl T. Laird.

Subj: [redacted]
Date: 3/25/99
To: VBONDS@missc.state.wy.us

Hi Vicki Bonds:

Thank you for the return of the ESAL questionnaire and the information you provided on the use of ESAL's' in pavement design by Wyoming DOT. Dave Berge did fax to me, earlier, the ESAL tables used by Wyoming DOT. Please thank Dave for his help and again thank you for your prompt attention to the questionnaire.

Thanks again for the help.

Earl T. Laird (:>))

Tompkins, James

From: ETLAIRD@aol.com
Sent: Thursday, March 18, 1999 3:47 PM
To: jtompkins@state.mt.us
Subject: Survey ESAL Use In Pavement Design

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March 16, 1999

Survey of States using ESALS for pavement design and rehabilitation. EASL Data information being collected for a ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: Montana DOT; Mr. James Tompkins; Surface Design Engineer; (406) 444-6295 Fax: (406) 444-6204

Please check One: Surveyed State (Does __) or (Does Not __) wish to be identified on how the state answered any of the survey questioned. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?
Yes: X
No:___ If No what do you use?

Q No. 2: What type or types of data do you use to come up with the ESAL table values? (Will you fax us the first page of your ESAL table for an example.) Static Scale data - Near future will use WIM

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location? Single ESAL Table

Q NO. 3: Do you break down ESALS by vehicle classification? yes

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? What are they? yes

Q No. 5: Do you use Growth factors to expand ESAL's to design years? yes

Q No. 6: Do you use WIM data? If No what do you use for load data? Static Scale Will use WIM in the Near future

Q No. 7: Are there links between PMS data and the ESAL tables? NO
a. Are your growth factors for PMS the same for ESAL growth factors?

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab? AVERAGE TO HIGH

Survey States comments if any:

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

RIGID PAVEMENT

18 KIP EALs
Equivalent Load Factors

INTERSTATE

N = sample size

Type	1986	N	1987	N	1988	N	1989	N	1990	N	1991	N	1992	N	1993	N	1994	N	1995	N	1996	N	1997	N	AVG.	Total N
2A-6T	0.324	860	0.298	1031	0.258	861	0.269	1074	0.203	1180	0.239	968	0.229	1010	0.320	637	0.431	376	0.394	414	0.825	492	0.448	248	0.311	9151
3A-SU	0.458	554	0.536	351	0.609	363	0.615	392	0.529	446	0.598	328	0.564	443	0.724	319	0.709	261	0.542	271	0.776	348	0.742	194	0.600	4270
4A-SU	2.143	21	2.412	17	1.870	23	1.667	27	1.654	26	1.909	22	2.920	25	1.741	27	1.565	23	1.160	25	3.063	16	1.939	33	1.954	285
2-S-1	0.742	124	0.695	203	0.603	151	0.850	133	0.555	155	0.455	156	0.554	130	0.777	94	0.975	40	0.673	52	0.487	76	0.822	45	0.653	1359
2-S-2	0.871	263	0.589	353	0.732	250	0.554	258	0.475	261	0.515	235	0.513	234	0.625	176	0.551	89	0.894	94	1.462	119	0.981	53	0.670	2385
3-S-2	2.372	7898	2.335	10058	2.319	8046	2.314	8967	2.294	9626	2.283	10076	2.211	10350	2.360	9974	2.325	5914	2.238	7542	2.238	9223	2.194	4148	2.293	101822
3-S-3	2.150	240	1.743	257	2.215	205	2.205	215	2.279	244	1.929	323	1.902	338	1.992	361	2.020	353	2.053	473	2.090	667	1.541	444	1.989	4120
2-1	0.143	7	0.214	14	0.222	18	0.143	7	0.348	23	0.182	22	0.100	20	0.154	13	0.000	6	0.700	10	0.286	7	0.800	5	0.250	152
2-2	0.348	26	0.310	42	0.417	24	0.282	71	0.313	67	0.265	49	0.300	50	0.279	43	0.683	41	0.289	38	0.229	48	0.136	22	0.319	521
3-2	1.939	132	1.619	118	1.509	116	1.237	93	1.350	103	0.933	119	0.983	115	1.091	88	1.844	77	1.469	96	1.230	87	1.302	53	1.383	1197
3-3	2.053	38	1.548	31	0.864	22	1.167	18	1.870	23	1.176	17	1.708	24	1.667	21	0.375	8	1.929	14	1.526	19	1.356	45	1.518	280
2-S-1-2	2.345	542	2.088	628	1.988	402	2.020	512	2.022	538	2.031	582	1.978	541	1.960	376	1.990	205	1.341	135	2.182	88	1.547	53	2.033	4002
3-S-1-2	1.500	126	1.589	151	1.426	148	1.148	164	1.224	134	1.217	217	1.230	235	1.329	164	2.000	93	1.071	126	1.601	138	1.127	63	1.351	1759
3-S-2-2	2.274	503	2.305	574	2.527	545	2.360	583	2.327	727	2.333	664	2.573	726	2.616	554	2.791	388	2.397	365	2.590	536	2.611	239	2.459	6404
3-S-2-3	1.939	198	2.121	208	2.392	189	2.221	240	2.075	295	2.281	281	2.480	306	2.157	344	2.086	198	2.286	203	3.204	235	2.452	84	2.302	2779
7 AX. TRIP.	ERR	0	2.942	88	2.733	131	2.879	141	2.737	179	2.631	198	2.699	188	2.872	133	2.485	68	1.754	61	2.340	53	0.946	37	2.629	1273

Class 1 & 2 = 0.001
Class 3 = 0.007
Class 4 = 0.257

02/04/98 FILE NAME = EAL_R_I.WK4

RIGID PAVEMENT

18 KIP EALs
Equivalent Load Factors

INTERSTATE

N = sample size

Type	1986	N	1987	N	1988	N	1989	N	1990	N	1991	N	1992	N	1993	N	1994	N	1995	N	1996	N	1997	N	AVG	Total N
5	0.324	860	0.298	1031	0.258	861	0.269	1074	0.203	1180	0.239	968	0.229	1010	0.320	637	0.431	376	0.394	414	0.825	492	0.448	248	0.311	9151
6	0.458	554	0.536	351	0.609	363	0.615	392	0.529	446	0.598	328	0.564	443	0.724	319	0.709	261	0.542	271	0.776	348	0.742	194	0.600	4270
7	2.143	21	2.412	17	1.870	23	1.667	27	1.654	26	1.909	22	2.920	25	1.741	27	1.565	23	1.160	25	3.063	16	1.939	33	1.954	285
8	0.788	420	0.596	612	0.650	443	0.591	469	0.472	506	0.452	462	0.482	434	0.604	328	0.659	176	0.706	194	0.896	250	0.768	125	0.609	4417
9	2.365	8030	2.327	10176	2.308	8162	2.303	9060	2.284	9729	2.267	10195	2.198	10465	2.349	10062	2.319	5991	2.228	7638	2.229	9310	2.182	4201	2.283	103019
10	2.137	278	1.722	288	2.084	227	2.124	233	2.243	267	1.891	340	1.890	362	1.974	382	1.983	361	2.049	487	2.074	686	1.524	489	1.959	4400
11	2.345	542	2.088	628	1.988	402	2.020	512	2.022	538	2.031	582	1.978	541	1.960	376	1.990	205	1.341	135	2.182	88	1.547	53	2.033	4602
12	1.500	126	1.589	151	1.426	148	1.148	164	1.224	134	1.217	217	1.230	235	1.329	164	2.000	93	1.071	126	1.601	138	1.127	63	1.351	1759
13	2.180	701	2.324	866	2.528	865	2.401	964	2.326	1201	2.372	1143	2.569	1218	2.496	1031	2.548	654	2.299	629	2.749	824	2.403	360	2.438	10456

Class 1 & 2 = 0.001
Class 3 = 0.007
Class 4 = 0 257

02/04/98

FLEXIBLE PAVEMENT

18 KIP EALs
Equivalent Load Factors

INTERSTATE

N = sample size

	1986	N	1987	N	1988	N	1989	N	1990	N	1991	N	1992	N	1993	N	1994	N	1995	N	1996	N	1997	N	AVG.	Total N
2A-6T	0.337	860	0.316	1031	0.281	861	0.284	1074	0.225	1180	0.263	968	0.252	1010	0.336	637	0.452	376	0.413	414	0.803	492	0.464	248	0.328	9151
3A-SU	0.356	554	0.405	351	0.457	363	0.462	392	0.404	446	0.451	328	0.433	443	0.561	319	0.548	261	0.417	271	0.601	348	0.572	194	0.459	4270
4A-SU	1.571	21	1.882	17	1.348	23	1.407	27	1.192	26	1.455	22	2.000	25	1.407	27	1.391	23	1.080	25	2.313	16	1.667	33	1.530	285
2-S-1	0.766	124	0.714	203	0.662	151	0.665	133	0.619	155	0.455	156	0.615	130	0.619	94	0.975	40	0.731	52	0.553	76	0.867	45	0.689	1359
2-S-2	0.829	263	0.578	353	0.716	250	0.523	258	0.467	261	0.506	235	0.517	234	0.614	176	0.528	89	0.819	94	1.303	119	0.925	53	0.643	2385
3-S-2	1.494	7898	1.476	10058	1.461	8046	1.463	8967	1.458	9626	1.459	10076	1.419	10350	1.497	9974	1.480	5914	1.429	7542	1.453	9223	1.403	4148	1.460	101822
3-S-3	1.483	240	1.230	257	1.537	205	1.535	215	1.582	244	1.362	323	1.364	338	1.427	361	1.433	353	1.469	473	1.520	667	1.110	444	1.414	4120
2-1	0.143	7	0.357	14	0.222	18	0.143	7	0.348	23	0.227	22	0.150	20	0.231	13	0.000	6	0.600	10	0.429	7	0.800	5	0.283	152
2-2	0.308	26	0.333	42	0.417	24	0.282	71	0.299	67	0.245	49	0.280	50	0.256	43	0.585	41	0.263	38	0.208	48	0.136	22	0.299	521
3-2	1.652	132	1.381	118	1.293	116	1.086	93	1.155	103	0.824	119	0.861	115	1.023	88	1.571	77	1.240	96	1.046	87	1.094	53	1.192	1197
3-3	1.658	38	1.129	31	0.682	22	0.833	18	1.261	23	0.882	17	1.208	24	1.143	21	0.375	8	1.286	14	1.158	19	1.067	45	1.129	280
2-S-1-2	2.424	542	2.194	628	2.092	402	2.129	512	2.132	538	2.148	582	2.098	541	2.088	376	2.117	205	1.474	135	2.239	88	1.660	53	2.142	4602
3-S-1-2	1.444	126	1.556	151	1.372	148	1.140	164	1.209	134	1.212	217	1.234	235	1.305	164	1.903	93	1.087	126	1.558	138	1.143	63	1.329	1759
3-S-2-2	1.716	503	1.730	574	1.884	545	1.765	583	1.761	727	1.759	664	1.927	726	1.960	554	2.134	388	1.819	365	1.993	536	1.996	239	1.856	6404
3-S-2-3	1.323	198	1.451	206	1.651	189	1.529	240	1.427	295	1.584	281	1.699	306	1.494	344	1.465	198	1.591	203	2.213	235	1.690	84	1.589	2779
7 AX. TRIP.	ERR	0	3.116	86	2.916	131	3.050	141	2.899	179	2.803	198	2.882	186	2.955	133	2.691	68	1.738	61	2.528	53	1.054	37	2.765	1273

Class 1 & 2 = 0.001
Class 3 = 0.007
Class 4 = 0.257

02/06/98 FILE NAME = EAL_F_I.WK4

FLEXIBLE PAVEMENT

18 KIP EALs
Equivalent Load Factors

INTERSTATE

N = sample size

Type	1986	N	1987	N	1988	N	1989	N	1990	N	1991	N	1992	N	1993	N	1994	N	1995	N	1996	N	1997	N	AVG.	Total N
5	0.337	860	0.316	1031	0.281	861	0.284	1074	0.225	1180	0.263	968	0.252	1010	0.336	637	0.452	376	0.413	414	0.803	492	0.464	248	0.328	9151
6	0.356	554	0.405	351	0.457	363	0.462	392	0.404	446	0.451	328	0.433	443	0.561	319	0.548	261	0.417	271	0.601	348	0.572	194	0.459	4270
7	1.571	21	1.882	17	1.348	23	1.407	27	1.192	26	1.455	22	2.000	25	1.407	27	1.391	23	1.080	25	2.313	16	1.667	33	1.530	285
8	0.767	420	0.601	612	0.661	443	0.578	469	0.486	506	0.448	462	0.502	434	0.610	326	0.625	176	0.675	194	0.840	250	0.760	125	0.604	4417
9	1.497	8030	1.475	10176	1.459	8162	1.459	9060	1.455	9729	1.452	10195	1.413	10465	1.493	10062	1.481	5991	1.427	7638	1.449	9310	1.399	4201	1.456	103019
10	1.507	278	1.219	288	1.454	227	1.481	233	1.554	267	1.338	340	1.354	362	1.411	382	1.410	361	1.464	487	1.510	686	1.106	489	1.396	4400
11	2.424	542	2.194	628	2.092	402	2.129	512	2.132	538	2.148	582	2.098	541	2.088	376	2.117	205	1.474	135	2.239	88	1.660	53	2.142	4602
12	1.444	126	1.556	151	1.372	148	1.140	164	1.209	134	1.212	217	1.234	235	1.305	164	1.903	93	1.087	126	1.558	138	1.143	63	1.329	1759
13	1.606	701	1.801	866	1.990	865	1.894	964	1.848	1201	1.897	1143	2.016	1218	1.933	1031	1.989	654	1.738	629	2.090	824	1.828	360	1.898	10456

Class 1 & 2 = 0.001
Class 3 = 0.007
Class 4 = 0.257

02/06/98

RIGID PAVEMENT

18 KIP EALs
Equivalent Load Factors

PRIMARY

N = sample size

	1986	N	1987	N	1988	N	1989	N	1990	N	1991	N	1992	N	1993	N	1994	N	1995	N	1996	N	1997	N	AVG.	Total N
2A-6T	0.374	745	0.335	1405	0.354	1247	0.360	892	0.358	1135	0.307	1663	0.316	1533	0.346	1254	0.433	725	0.416	735	0.384	1095	0.479	721	0.360	13150
3A-SU	1.024	291	0.710	639	0.754	686	0.861	459	1.043	601	0.400	743	0.744	731	0.886	535	0.733	329	0.750	332	0.890	500	0.680	334	0.772	6180
4A-SU	1.714	21	1.875	16	1.273	22	5.500	10	1.182	22	2.205	39	1.800	50	2.116	43	1.067	45	1.821	39	1.670	115	1.900	50	1.797	472
2-S-1	0.790	62	0.695	95	0.546	97	0.500	66	0.476	82	0.508	130	0.407	123	0.446	92	0.429	63	0.357	84	0.378	119	0.355	76	0.483	1089
2-S-2	1.354	79	0.570	165	0.445	146	0.266	94	0.390	123	0.349	149	0.397	151	0.763	139	0.481	106	0.333	63	0.542	72	0.479	48	0.518	1335
3-S-2	2.731	2516	2.420	3619	2.291	3184	2.378	2588	2.458	3236	2.264	4272	2.134	3622	2.061	2757	2.015	2322	1.942	2427	2.119	3348	1.988	2370	2.242	36259
3-S-3	2.924	314	2.390	344	2.574	230	2.478	253	2.723	300	2.297	374	1.963	294	1.810	179	2.124	218	1.908	239	1.832	417	2.018	272	2.262	3434
2-1	0.500	6	0.826	23	0.684	19	0.462	13	0.286	14	0.138	29	0.114	35	0.261	23	0.071	14	0.091	11	0.250	12	0.474	19	0.335	218
2-2	0.067	15	0.370	46	0.277	47	0.209	43	0.308	39	0.298	94	0.211	114	0.169	65	0.106	123	0.115	87	0.321	84	0.296	54	0.223	811
3-2	2.360	189	2.633	422	3.314	563	3.311	489	3.191	351	2.894	622	3.168	679	2.803	320	1.394	104	3.320	322	2.921	354	1.753	154	2.961	4569
3-3	2.897	29	2.250	24	2.421	19	1.182	11	2.500	18	1.725	51	1.083	24	1.783	23	0.917	12	1.214	14	1.063	16	0.550	20	1.736	261
2-S-1-2	1.120	25	1.120	50	1.174	23	1.818	11	1.045	22	1.156	64	1.481	54	1.244	41	0.867	15	1.500	14	1.111	18	0.563	16	1.195	353
3-S-1-2	1.714	21	2.175	40	1.278	36	1.560	25	1.958	24	1.396	53	1.500	50	1.507	69	0.703	37	0.731	26	1.889	27	0.750	16	1.453	424
3-S-2-2	2.524	164	2.129	348	2.833	509	2.491	222	2.413	269	2.259	665	2.310	432	2.378	384	2.000	285	2.348	293	2.423	456	2.404	371	2.380	4398
3-S-2-3	2.359	39	2.465	99	2.038	105	2.805	82	2.211	114	2.288	220	2.475	198	2.954	151	2.232	151	2.483	118	2.755	159	2.215	93	2.449	1529

Class 1 & 2 = 0.001
Class 3 = 0.007
Class 4 = 0.257

02/04/98 FILE NAME = EAL_R_P.WK4

RIGID PAVEMENT

18 KIP EALs
Equivalent Load Factors

PRIMARY

N = sample size

Type	1986	N	1987	N	1988	N	1989	N	1990	N	1991	N	1992	N	1993	N	1994	N	1995	N	1996	N	1997	N	AVG.	Total N
5	0.374	745	0.335	1405	0.354	1247	0.360	892	0.358	1135	0.307	1663	0.316	1533	0.346	1254	0.433	725	0.416	735	0.384	1095	0.479	721	0.360	13150
6	1.024	291	0.710	639	0.754	686	0.861	459	1.043	601	0.400	743	0.744	731	0.886	535	0.733	329	0.750	332	0.890	500	0.680	334	0.772	6180
7	1.714	21	1.875	16	1.273	22	5.500	10	1.182	22	2.205	39	1.800	50	2.116	43	1.067	45	1.821	39	1.670	115	1.900	50	1.797	472
8	0.988	162	0.596	329	0.466	309	0.338	216	0.399	258	0.373	402	0.326	423	0.514	319	0.301	306	0.253	245	0.397	287	0.381	197	0.426	3453
9	2.705	2705	2.442	4041	2.445	3747	2.525	3075	2.530	3587	2.344	4894	2.297	4301	2.138	3077	1.988	2426	2.104	2749	2.196	3702	1.973	2524	2.323	40828
10	2.921	343	2.380	368	2.562	249	2.424	264	2.711	318	2.228	425	1.896	318	1.807	202	2.061	230	1.870	253	1.804	433	1.918	292	2.225	3695
11	1.120	25	1.120	50	1.174	23	1.818	11	1.045	22	1.156	64	1.481	54	1.244	41	0.867	15	1.500	14	1.111	18	0.563	16	1.195	353
12	1.714	21	2.175	40	1.278	36	1.560	25	1.958	24	1.396	53	1.500	50	1.507	69	0.703	37	0.731	26	1.889	27	0.750	16	1.453	424
13	2.493	203	2.204	447	2.697	614	2.576	304	2.352	383	2.266	885	2.362	630	2.540	535	2.080	436	2.387	411	2.509	615	2.366	464	2.398	5927

Class 1 & 2 = 0.001
Class 3 = 0.007
Class 4 = 0.257

02/04/98

FLEXIBLE PAVEMENT

18 KIP EALs
Equivalent Load Factors

PRIMARY

N = sample size

	1986	N	1987	N	1988	N	1989	N	1990	N	1991	N	1992	N	1993	N	1994	N	1995	N	1996	N	1997	N	AVG.	Total N
2A-6T	0.393	745	0.351	1405	0.373	1247	0.379	892	0.382	1135	0.331	1663	0.336	1533	0.385	1254	0.446	725	0.435	735	0.405	1095	0.491	721	0.379	13150
3A-SU	0.735	291	0.527	639	0.560	686	0.636	459	0.757	601	0.655	743	0.550	731	0.637	535	0.562	329	0.551	332	0.664	500	0.515	334	0.612	6180
4A-SU	1.429	21	1.313	16	1.045	22	4.200	10	1.000	22	1.564	39	1.400	50	1.674	43	0.956	.45	1.410	39	1.365	115	1.520	50	1.424	472
2-S-1	0.790	62	0.716	95	0.596	97	0.530	66	0.524	82	0.562	130	0.480	123	0.500	92	0.476	63	0.417	84	0.437	110	0.406	76	0.532	1069
2-S-2	1.241	79	0.545	165	0.445	146	0.255	94	0.390	123	0.342	149	0.377	151	0.669	139	0.453	106	0.317	63	0.514	72	0.479	46	0.490	1335
3-S-2	1.679	2516	1.504	3619	1.434	3184	1.486	2586	1.535	3236	1.424	4272	1.359	3622	1.333	2757	1.297	2322	1.256	2427	1.347	3348	1.296	2370	1.417	36259
3-S-3	1.968	314	1.640	344	1.752	230	1.688	253	1.873	300	1.586	374	1.398	294	1.313	179	1.541	218	1.427	239	1.333	417	1.463	272	1.565	3434
2-1	0.500	6	0.826	23	0.684	19	0.462	13	0.429	14	0.138	29	0.143	35	0.261	23	0.143	14	0.182	11	0.333	12	0.421	19	0.358	216
2-2	0.133	15	0.348	46	0.255	47	0.186	43	0.308	39	0.277	94	0.219	114	0.169	65	0.098	123	0.103	87	0.310	84	0.278	54	0.215	811
3-2	1.910	189	2.102	422	2.622	563	2.626	489	2.527	351	2.314	622	2.521	679	2.253	320	1.183	104	2.640	322	2.328	354	1.455	154	2.361	4569
3-3	1.966	29	1.708	24	2.000	19	0.909	11	1.667	18	1.255	51	0.875	24	1.261	23	0.667	12	0.857	14	0.750	16	0.450	20	1.268	261
2-S-1-2	1.240	25	1.220	50	1.217	23	1.818	11	1.182	22	1.281	64	1.593	54	1.415	41	0.867	15	1.643	14	1.222	18	0.688	16	1.306	353
3-S-1-2	1.619	21	1.975	40	1.194	36	1.440	25	1.833	24	1.302	53	1.400	50	1.449	69	0.730	37	0.692	26	1.852	27	0.688	16	1.370	424
3-S-2-2	1.835	164	1.618	348	2.187	509	1.842	222	1.803	269	1.770	665	1.734	432	1.773	384	1.502	265	1.741	293	1.607	456	1.790	371	1.797	4398
3-S-2-3	1.615	39	1.636	99	1.410	105	1.951	62	1.518	114	1.591	220	1.687	198	1.974	151	1.523	151	1.695	118	1.849	159	1.495	93	1.668	1529

Class 1 & 2 = 0.001
Class 3 = 0.007
Class 4 = 0.257

02/04/98 FILE NAME = EAL_F_P.WK4

FLEXIBLE PAVEMENT

18 KIP EALs
Equivalent Load Factors

PRIMARY

N = sample size

Type	1986	N	1987	N	1988	N	1989	N	1990	N	1991	N	1992	N	1993	N	1994	N	1995	N	1996	N	1997	N	AVG.	Total N
5	0.393	745	0.351	1405	0.373	1247	0.379	892	0.382	1135	0.331	1663	0.336	1533	0.385	1254	0.446	725	0.435	735	0.405	1095	0.491	721	0.379	13150
6	0.735	291	0.527	639	0.560	686	0.636	459	0.757	601	0.655	743	0.550	731	0.637	535	0.562	329	0.551	332	0.664	500	0.515	334	0.612	6180
7	1.429	21	1.313	16	1.045	.22	4.200	10	1.000	22	1.564	39	1.400	50	1.674	43	0.956	45	1.410	39	1.365	115	1.520	50	1.424	472
8	0.938	162	0.587	329	0.479	309	0.338	216	0.422	258	0.383	402	0.345	423	0.489	319	0.301	306	0.269	245	0.415	287	0.391	197	0.430	3453
9	1.695	2705	1.566	4041	1.612	3747	1.667	3075	1.632	3587	1.537	4894	1.542	4301	1.429	3077	1.292	2426	1.418	2749	1.441	3702	1.305	2524	1.522	40628
10	1.968	343	1.644	368	1.771	249	1.655	264	1.662	318	1.548	425	1.358	318	1.307	202	1.496	230	1.395	253	1.312	433	1.394	292	1.563	3605
11	1.240	25	1.220	50	1.217	23	1.818	11	1.182	22	1.281	64	1.593	54	1.415	41	0.867	15	1.643	14	1.222	18	0.688	16	1.306	353
12	1.619	21	1.975	40	1.194	36	1.440	25	1.833	24	1.302	53	1.400	50	1.449	69	0.730	37	0.692	26	1.852	27	0.688	16	1.370	424
13	1.793	203	1.622	447	2.054	614	1.872	304	1.716	383	1.725	885	1.719	630	1.830	535	1.509	436	1.727	411	1.818	615	1.731	464	1.764	5927

Class 1 & 2 = 0.001
Class 3 = 0.007
Class 4 = 0.257

02/04/98

Subj: **RE: Survey ESAL Use In Pavement Design**
Date: 3/19/99 12:32:24 PM Pacific Standard Time
From: jtompkins@state.mt.us (Tompkins, James)
To: ETLAIRD@aol.com ('ETLAIRD@aol.com')

MONTANA REPLY
3/19/99
ETL

Jim

-----Original Message-----
From: ETLAIRD@aol.com [mailto:ETLAIRD@aol.com]
Sent: Thursday, March 18, 1999 3:47 PM
To: jtompkins@state.mt.us
Subject: Survey ESAL Use In Pavement Design

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March 16, 1999

Survey of States using ESALS for pavement design and rehabilitation. EASL
Data information being collected for a ESAL Research Contract between
Arizona
DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: Montana DOT; Mr. James Tompkins; Surface Design Engineer;
(406) 444-6295 Fax: (406) 444-6204

Please check One: Surveyed State (Does X) or (Does Not __) wish to be identified on how the state answered any of the survey questioned. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for
pavement design and rehabilitation?
Yes:X
No:___ If No what do you use?

Q No. 2: What type or types of data do you use to come up with

the ESAL table values? (Will you fax us the first page
of your ESAL table for an example.)Static scale data, in the
near future we will use WIM.

a. Do you use a single ESAL table for all design locations within your state
or is a different ESAL value computed for different locations based upon
load
information for that location? Simple Esal table.

Q NO. 3: Do you break down ESALS by vehicle classification? Yes

Q No. 4: Do you apply average ESAL factors to the vehicles in
each classification? What are they? Yes

Q No. 5: Do you use Growth factors to expand ESAL's to design years? Yes

Q No. 6: Do you use WIM data? If No what do you use for load data? Will use WIM in the near future. Presently use static scale.

Q No. 7: Are there links between PMS data and the ESAL tables?
a. Are your growth factors for PMS the same for ESAL growth factors? NO.

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab? Average to High.

Survey States comments if any: Earl, I am mailing some Esal charts that Dan Bisom furnished, as I had his section answer some of the questions that pertained to them.

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

Thank you again,

Earl T. Laird.

———— Headers ————
Return-Path: <jtompkins@state.mt.us>
Received: from rly-yd02.mx.aol.com (rly-yd02.mail.aol.com [172.18.150.2]) by air-yd01.mail.aol.com (v58.13) with SMTP; Fri, 19 Mar 1999 15:32:24 -0500
Received: from doaisd01001.state.mt.us (doaisd01001.state.mt.us [161.7.104.182])
by rly-yd02.mx.aol.com (8.8.8/8.8.5/AOL-4.0.0)
with ESMTP id PAA02670 for <ETLAIRD@aol.com>;
Fri, 19 Mar 1999 15:32:23 -0500 (EST)
Received: by doaisd01001.state.mt.us with Internet Mail Service (5.5.2407.0)
id <HB7DYAFD>; Fri, 19 Mar 1999 13:32:22 -0700
Message-ID: <018C4C169A5CD211B84808002BB29C64BB2BE4@doaisd02003.mdt.state.mt.us>
From: "Tompkins, James" <jtompkins@state.mt.us>
To: "'ETLAIRD@aol.com'" <ETLAIRD@aol.com>
Subject: RE: Survey ESAL Use In Pavement Design
Date: Fri, 19 Mar 1999 13:32:17 -0700
MIME-Version: 1.0
X-Mailer: Internet Mail Service (5.5.2407.0)
Content-Type: text/plain;
charset="iso-8859-1"

Subj: **Survey ESAL Use In Pavement Design**
Date: 3/18/99
To: jtompkins@state.mt.us

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March 16, 1999

Survey of States using ESALS for pavement design and rehabilitation. EASL Data information being collected for a ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: Montana DOT; MT James Tompkins; Surface Design Engineer;
(406) 444-6295 Fax: (406) 444-6204

Please check One: Surveyed State (Does __) or (Does Not __) wish to be identified on how the state answered any of the survey questioned. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?
Yes:___
No:___ If No what do you use?

Q No. 2: What type or types of data do you use to come up with the ESAL table values? (Will you fax us the first page of your ESAL table for an example.)

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location?

Q NO. 3: Do you break down ESALS by vehicle classification?

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? What are they?

Q No. 5: Do you use Growth factors to expand ESAL's to design years?

Q No. 6: Do you use WIM data? If No what do you use for load data?

Q No. 7: Are there links between PMS data and the ESAL tables?
a. Are your growth factors for PMS the same for ESAL growth factors?

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab?

Survey States comments if any:

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

Thank you again,

Earl T. Laird.

MONTANA

Subj: **Re: Thanks For Survey Reply**
Date: 3/24/99
To: jtompkins@state.mt.us

Hi Jim,

Thank you for the prompt and informative reply to the Arizona ESAL research questionnaire. You informed me that you would mail the sample ESAL table you received from Dan Bison and I am looking for it in the mail.

Thanks again,

Earl T. (:>))

Subj: **Re: Thanks for Mailing Survey ESAL**
Date: 3/29/99
To: jtompkins@state.mt.us

MONTANA

Hi Jim,

I received the ESAL tables and Survey in the mail on Saturday. Thank you for mailing them.

Thanks again and have a nice bright summer.

Earl T. (:>))

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

SOUTH DAKOTA'S REPLY

March 23, 1999

Survey of States using ESALS for pavement design and rehabilitation. ESAL Data information being collected for an ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: South Dakota: Mr. David Huff; Planning Traffic Division; (605) 773-3358 Fax: (605) 773-4713

Please check One: Surveyed State (Does __) or (Does Not __) Wish to be identified on how the state answered any of the survey questions. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?
Yes: X
No: __ If No what do you use?

Q No. 2: What type or types of data do you use to come up with the ESAL table values? (Will you fax us the first page of your ESAL table for an example.) WIM data (SEE ATTACHS FAX)

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location? Different for locations

Q NO. 3: Do you break down ESALS by vehicle classification? Average ESAL/ 13 vehicle classes

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? What are they? NO - based on WIM

Q No. 5: Do you use Growth factors to expand ESAL's to design years? Yes

Q No. 6: Do you use WIM data? If No what do you use for load data? Yes

Q No. 7: Are there links between HPMS data and the ESAL tables? Not necessarily
a. Are your growth factors for HPMS the same for ESAL growth factors?

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab? It depends how close location is to WIM installation

Survey States comments if any:

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

Thank you again,

Earl T. Laird.

South Dakota

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775) 882-4755 Fax (775) 882-4565
E-mail: ETLAIRD@AOL.COM

FAX COVER SHEET
Number of pages including this cover sheet 2

TO: David Huff FAX NUMBER: (605) 773-4713
Planning Traffic Division

FROM: Earl Laird FAX NUMBER: (775) 882-4565

DATE: March 23, 1999 TIME: 7:45 PM

SUBJECT: Thank You For State Survey of ESAL Use For Design

REMARKS:
Hello David ~~Huff~~: Huft

Thank you for the quick fax response and very informative reply to the questionnaire on the use of ESAL's in pavement design.

Would you have an example of an ESAL table that you would send to your design or material divisions that provides the ESAL values they may need for pavement design? This would be very helpful in showing Arizona DOT how ESAL data are reported to interested divisions needing the data. My fax number is (775) 882-5465.

Thanks again for the help,

Earl T. Laird (:>))

Earl - ESAL values are computed upon request of Materials & Surfacing to our Data Inventory Office. No "tables" are reported. Instead, Data Inventory estimates the total number of ESALs that are expected to be applied to a highway pavement during its design period. Rigid and flexible estimates are provided.

If I'm missing something in your request, please call me at 605/773-3358. I think it might be more productive to speak in person. Dave

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March 23, 1999

Survey of States using ESALS for pavement design and rehabilitation. ESAL Data information being collected for an ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: South Dakota; Mr. David Huff; Planning Traffic Division; (605) 773-3358 Fax: (605) 773-4713

Please check One: Surveyed State (Does __) or (Does Not __) wish to be identified on how the state answered any of the survey questions. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?
Yes:___
No:___ If No what do you use?

Q No. 2: What type or types of data do you use to come up with the ESAL table values? (Will you fax us the first page of your ESAL table for an example.)

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location?

Q NO. 3: Do you break down ESALS by vehicle classification?

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? What are they?

Q No. 5: Do you use Growth factors to expand ESAL's to design years?

Q No. 6: Do you use WIM data? If No what do you use for load data?

Q No. 7: Are there links between HPMS data and the ESAL tables?
a. Are your growth factors for HPMS the same for ESAL growth factors?

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab?

Survey States comments if any:

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

Thank you again,

Earl T. Laird.

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775) 882-4755 Fax (775) 882-4565
E-mail: ETLAIRD@AOL.COM

FAX COVER SHEET
Number of pages including this cover sheet 2

TO: David Huff FAX NUMBER: (605) 773-4713
Planning Traffic Division

FROM: Earl Laird ETL FAX NUMBER: (775) 882-4565

DATE: March 23, 1999 TIME: 7:45 PM

SUBJECT: State Survey of ESAL Use For Pavement Design and Rehabilitation

---

REMARKS:
Hello David Huff:

Per my phone message, attached is the small questionnaire dealing with South Dakota's use of ESAL data in the design and rehabilitation of pavements. As I explained to you, the ESAL survey is part of a contract Nichols Consulting Engineers of Reno, Nevada has with Arizona DOT dealing with ESAL design and its use in pavement design and rehab.

If you have any questions please call me at (775) 882-4755.

You may fax your answers to me at Fax No. (775) 882-4565, or e-mail to the above e-mail address.

Thanks for your anticipated help.

Earl T. Laird (:>)) Earl T. Laird

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775) 882-4755 Fax (775) 882-4565
E-mail: ETLAIRD@AOL.COM

FAX COVER SHEET
Number of pages including this cover sheet 2

TO: David Huff FAX NUMBER: (605) 773-4713
Planning Traffic Division

FROM: Earl Laird FAX NUMBER: (775) 882-4565

DATE: March 23, 1999 TIME: 7:45 PM

SUBJECT: Thank You For State Survey of ESAL Use For Design

REMARKS:
Hello David Huff:

Thank you for the quick fax response and very informative reply to the questionnaire on the use of ESAL's in pavement design.

Would you have an example of an ESAL table that you would send to your design or material divisions that provides the ESAL values they may need for pavement design? This would be very helpful in showing Arizona DOT how ESAL data are reported to interested divisions needing the data. My fax number is (775) 882-5465.

Thanks again for the help.

Earl T. Laird (:>))

WASHINGTON STATE DOT
REPLY TO SURVEY.

Subj: **FW: ESAL Use Survey**
Date: 3/15/99 4:37:16 PM Pacific Standard Time
From: PIERCEL@WSDOT.WA.GOV (Pierce, Linda M)
To: ETLAIRD@aol.com ('ETLAIRD@aol.com')

See comments in text below.

>———
>From: ETLAIRD@aol.com[SMTP:ETLAIRD@aol.com]
>Sent: Monday, March 15, 1999 3:50 PM
>To: Pierce, Linda M
>Cc: sirous@nce.reno.nv.us
>Subject: ESAL Use Survey
>
>EARL T. LAIRD
>T P & R CONSULTANT
>Transportation Planning and Research
>529 Bonanza Dr., Carson City, NV. 89706
>(775)882-4755 Fax (775)882-4565
>E-mail: etlaird@aol.com
>
>March 15, 1999
>
>Survey of States using ESALS for pavement design and rehabilitation. ESAL
>Data information being collected for a ESAL Research Contract between Arizona
>DOT and Nichols Consulting Engineers in Reno, Nevada:
>
>Survey State of: Washington DOT; Ms. Linda Pierce; Material and Testing
>(360)709-5470
>
>Please check One: Surveyed State (Does X) or (Does Not __) wish to be
>identified on how the state answered any of the survey questioned. Only
>identify the state as a participant in the survey.
>
>Question No. 1: Does your state use ESAL computations for
> pavement design and rehabilitation?
> Yes: X
> No:___ If No what do you use?
>
>Q No. 2: What type or types of data do you use to come up with
> the ESAL table values? (Will you fax us the first page
of your ESAL table for an example.) WSDOT has determined
ESAL/truck factors. The original factors were developed based on
Washington loadometer tables and later verified using WIM. ESAL table
>is not available.
>
>a. Do you use a single ESAL table for all design locations within your state
>or is a different ESAL value computed for different locations based upon load
information for that location? ESAL factors developed based on type of
>truck.
>
Q NO. 3: Do you break down ESALS by vehicle classification? Yes,
FHWA vehicle class 4, 5, 6, 7 - 0.40 ESAL/vehicle
FHWA vehicle class 8, 9, 10 - 1.00 ESAL/vehicle
>FHWA vehicle class 11, 12, 13 - 1.75 ESAL/vehicle
>
>Q No. 4: Do you apply average ESAL factors to the vehicles in
> each classification? What are they? See above.

>
>Q No. 5: Do you use Growth factors to expand ESAL's to design
years? Yes, we apply a 1.6 percent growth factor to our ESAL
>calculation.
>
>Q No. 6: Do you use WIM data? If No what do you use for load
> data? See answer to No. 2 above.
>
>Q No. 7: Are there links between PMS data and the ESAL tables?
> a. Are your growth factors for PMS the same for ESAL
growth factors? Our PMS contains the ESAL calculations for
>each section of state highway. The growth factors are the same.
>
>Q No. 8: How much confidence do you have in the values you use
for pavement design and rehab? Complete confidence in the
ESAL/vehicle values, I have about 60 - 75 percent confidence in the
>actual traffic counts that are supplied to us.
>
>Survey States comments if any:
>
>Thank you for participating in this ESAL pavement design and rehabilitation
>survey. If you have any questions on this survey you may contact Earl Laird
>at above telephone or e-mail. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal
>Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or
>e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT;
>telephone (602)407-3435; e-mail ekombe@dot.state.az
>
>Thank you again,
>
>Earl T. Laird.
>

------------ Headers ------------
Return-Path: <PIERCEL@WSDOT.WA.GOV>
Received: from rly-yd02.mx.aol.com (rly-yd02.mail.aol.com [172.18.150.2]) by air-yd01.mail.aol.com (v56.26) with SMTP; Mon, 15 Mar 1999 19:37:16 1900
Received: from mail1.wsdot.wa.gov (mail1.wsdot.wa.gov [164.110.100.178])
by rly-yd02.mx.aol.com (8.8.8/8.8.5/AOL-4.0.0)
with ESMTP id TAA21806 for <ETLAIRD@aol.com>;
Mon, 15 Mar 1999 19:37:15 -0500 (EST)
Received: from magnolia.WSDOT.WA.GOV (magnolia.wsdot.wa.gov [164.110.102.213]) by mail1.wsdot.wa.gov (8.7.5/8.7.5.96328) with SMTP id RAA01348 for <ETLAIRD@aol.com>; Mon, 15 Mar 1999 17:00:59 -0800 (PST)
Received: by magnolia.WSDOT.WA.GOV with SMTP (Microsoft Exchange Server Internet Mail Connector Version 4.0.996.39)
id <01BE6F02.1E1C6E30@magnolia.WSDOT.WA.GOV>; Mon, 15 Mar 1999 16:37:29 -0800
Message-ID: <c=US%a=_%p=WA.GOV%l=CEDAR-990316003712Z-54210@magnolia.WSDOT.WA.GOV>
From: "Pierce, Linda M" <PIERCEL@WSDOT.WA.GOV>
To: "'ETLAIRD@aol.com'" <ETLAIRD@aol.com>
Subject: FW: ESAL Use Survey
Date: Mon, 15 Mar 1999 16:37:12 -0800
X-Mailer: Microsoft Exchange Server Internet Mail Connector Version 4.0.996.39
MIME-Version: 1.0
Content-Type: text/plain; charset="us-ascii"
Content-Transfer-Encoding: 7bit

KANSAS
ESAL DATA

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March 19, 1999

Survey of States using ESALS for pavement design and rehabilitation. EASL Data information being collected for a ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: Kansas DOT; Mr. Garrett Olson ; Field Data Collection Engineer; (785) 296-~~6351~~ 6357 Fax: (785) 296-8168 OR Alan Spicer (785) 296-3470

Please check One: Surveyed State (Does X) or (Does Not __) wish to be identified on how the state answered any of the survey questions. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?
Yes: X
No: __ If No what do you use?

Q No. 2: What type or types of data do you use to come up with the ESAL table values? (Will you fax us the first page of your ESAL table for an example.) See next 2 pages — truck weight data by vehicle classification

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location? See sample from traffic forecast

Q NO. 3: Do you break down ESALS by vehicle classification? Yes (modified to 7 groups)

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? Yes What are they? Grouped by Functional Classification

Q No. 5: Do you use Growth factors to expand ESAL's to design years? No

Q No. 6: Do you use WIM data? Yes If No what do you use for load data? Yes 30 sites per year

Q No. 7: Are there links between PMS data and the ESAL tables? NO
a. Are your growth factors for PMS the same for ESAL growth factors?

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab? Fairly confident.

Survey States comments if any: We have been collecting all truck data since 1995 in metric - we do not have "metric esal tables" to use

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

Thank you again,
Earl T. Laird.

English Units

08/17/95

STATE OF KANSAS
EIGHTEEN KIP EQUIVALENTS RATE PER 1000 VEHICLES OF VEHICLES WEIGHED DURING THE YEARS 1992, 93, 94,

number of sites → (15) RURAL PRINCIPAL ARTERIAL - INTERSTATE

RIGID PAVEMENT - P=2.0

	Single Unit Trucks: 2 Axle 4 Tire	Single Unit Trucks: 2 Axle 6 Tire	Single Unit Trucks: 3 Axle or More	Single Trailer Trucks: 4 Axle or Less	Single Trailer Trucks: 5 Axle or More	Multi-Trailer Trucks: 5 Axle or Less	Multi-Trailer Trucks: 6 Axle or More
D= 6"	2	140	681	614	1891	1611	1839
D= 7"	2	136	671	605	1878	1590	1818
D= 8"	2	135	675	631	1897	1575	1809
D= 9"	2	135	682	600	1904	1574	1807
D=10"	2	135	689	600	1915	1573	1807
D=11"	2	135	693	630	1921	1574	1898

RIGID PAVEMENT - P=2.5

	Single Unit Trucks: 2 Axle 4 Tire	Single Unit Trucks: 2 Axle 6 Tire	Single Unit Trucks: 3 Axle or More	Single Trailer Trucks: 4 Axle or Less	Single Trailer Trucks: 5 Axle or More	Multi-Trailer Trucks: 5 Axle or Less	Multi-Trailer Trucks: 6 Axle or More
D= 6"	2	144	665	633	1853	1659	1884
D= 7"	2	136	643	612	1825	1611	1834
D= 8"	2	133	648	602	1848	1582	1810
D= 9"	2	132	664	599	1860	1572	1805
D=10"	2	133	678	599	1901	1570	1806
D=11"	2	133	687	600	1914	1571	1807

FLEXIBLE PAVEMENT - P=2.0

	Single Unit Trucks: 2 Axle 4 Tire	Single Unit Trucks: 2 Axle 6 Tire	Single Unit Trucks: 3 Axle or More	Single Trailer Trucks: 4 Axle or Less	Single Trailer Trucks: 5 Axle or More	Multi-Trailer Trucks: 5 Axle or Less	Multi-Trailer Trucks: 6 Axle or More
SN=1	2	138	437	530	1101	1527	1396
SN=2	2	143	444	549	1128	1576	1454
SN=3	2	143	446	560	1149	1607	1495
SN=4	2	137	436	547	1134	1583	1468
SN=5	2	133	431	536	1116	1555	1433
SN=6	2	132	430	530	1105	1541	1413

FLEXIBLE PAVEMENT - P=2.5

	Single Unit Trucks: 2 Axle 4 Tire	Single Unit Trucks: 2 Axle 6 Tire	Single Unit Trucks: 3 Axle or More	Single Trailer Trucks: 4 Axle or Less	Single Trailer Trucks: 5 Axle or More	Multi-Trailer Trucks: 5 Axle or Less	Multi-Trailer Trucks: 6 Axle or More
SN=1	3	141	439	538	1109	1549	1418
SN=2	4	155	463	585	1177	1645	1546
SN=3	3	157	470	614	1234	1725	1652
SN=4	2	142	446	581	1195	1666	1582
SN=5	2	131	431	550	1145	1593	1490
SN=6	2	128	447	558	1167	1556	1509

15 RURAL PRINCIPAL ARTERIAL - OTHER

RIGID PAVEMENT - P=2.0

	Single Unit Trucks: 2 Axle 4 Tire	Single Unit Trucks: 2 Axle 6 Tire	Single Unit Trucks: 3 Axle or More	Single Trailer Trucks: 4 Axle or Less	Single Trailer Trucks: 5 Axle or More	Multi-Trailer Trucks: 5 Axle or Less	Multi-Trailer Trucks: 6 Axle or More
D= 6"	3	183	834	1161	2469	2068	2756
D= 7"	3	180	816	1142	2441	2053	2728
D= 8"	3	180	816	1142	2459	2048	2734
D= 9"	3	181	827	1154	2490	2049	2753
D=10"	3	182	839	1166	2515	2050	2772
D=11"	3	183	849	1175	2532	2052	2789

RIGID PAVEMENT - P=2.5

	Single Unit Trucks: 2 Axle 4 Tire	Single Unit Trucks: 2 Axle 6 Tire	Single Unit Trucks: 3 Axle or More	Single Trailer Trucks: 4 Axle or Less	Single Trailer Trucks: 5 Axle or More	Multi-Trailer Trucks: 5 Axle or Less	Multi-Trailer Trucks: 6 Axle or More
D= 6"	3	183	800	1135	2375	2094	2696
D= 7"	3	177	763	1093	2317	2058	2636
D= 8"	3	176	763	1093	2352	2046	2648
D= 9"	3	178	783	1116	2418	2046	2686
D=10"	3	180	838	1141	2471	2048	2726
D=11"	3	182	829	1161	2566	2051	2758

FLEXIBLE PAVEMENT - P=2.0

	Single Unit Trucks: 2 Axle 4 Tire	Single Unit Trucks: 2 Axle 6 Tire	Single Unit Trucks: 3 Axle or More	Single Trailer Trucks: 4 Axle or Less	Single Trailer Trucks: 5 Axle or More	Multi-Trailer Trucks: 5 Axle or Less	Multi-Trailer Trucks: 6 Axle or More
SN=1	3	186	588	1066	1490	2031	2433
SN=2	3	189	587	1068	1503	2067	2432
SN=3	3	186	574	1044	1504	2081	2398
SN=4	3	180	555	1010	1481	2057	2350
SN=5	2	178	551	1005	1471	2041	2351
SN=6	2	179	557	1018	1471	2037	2375

FLEXIBLE PAVEMENT - P=2.5

	Single Unit Trucks: 2 Axle 4 Tire	Single Unit Trucks: 2 Axle 6 Tire	Single Unit Trucks: 3 Axle or More	Single Trailer Trucks: 4 Axle or Less	Single Trailer Trucks: 5 Axle or More	Multi-Trailer Trucks: 5 Axle or Less	Multi-Trailer Trucks: 6 Axle or More
SN=1	3	189	586	1069	1493	2052	2438
SN=2	5	197	595	1078	1533	2115	2449
SN=3	4	192	574	1035	1545	2152	2381
SN=4	3	178	532	963	1493	2096	2277
SN=5	3	172	520	946	1461	2051	2268
SN=6	2	174	542	980	1488	2037	2348

08/17/95

STATE OF KANSAS
EIGHTEEN KIP EQUIVALENTS RATE PER 1000 VEHICLES
OF VEHICLES WEIGHED DURING THE YEARS 1992, 93, 94.

01 RURAL MINOR COLLECTOR

RIGID PAVEMENT - P=2.0

	Single Unit Trucks: 2 Axle 4 Tire	Single Unit Trucks: 2 Axle 6 Tire	Single Unit Trucks: 3 Axle or More	Single Trailer Trucks: 4 Axle or Less	Single Trailer Trucks: 5 Axle or More	Multi-Trailer Trucks: 5 Axle or Less	Multi-Trailer Trucks: 6 Axle or More
D= 6"	36	649	1036				
D= 7"	34	636	997				
D= 8"	33	639	993				
D= 9"	33	650	994				
D=10"	33	659	994				
D=11"	33	665	993				

RIGID PAVEMENT - P=2.5

	Single Unit Trucks: 2 Axle 4 Tire	Single Unit Trucks: 2 Axle 6 Tire	Single Unit Trucks: 3 Axle or More	Single Trailer Trucks: 4 Axle or Less	Single Trailer Trucks: 5 Axle or More	Multi-Trailer Trucks: 5 Axle or Less	Multi-Trailer Trucks: 6 Axle or More
D= 6"	40	624	1020				
D= 7"	36	597	1000				
D= 8"	34	602	993				
D= 9"	33	624	993				
D=10"	33	644	994				
D=11"	33	656	994				

FLEXIBLE PAVEMENT - P=2.0

	Single Unit Trucks: 2 Axle 4 Tire	Single Unit Trucks: 2 Axle 6 Tire	Single Unit Trucks: 3 Axle or More	Single Trailer Trucks: 4 Axle or Less	Single Trailer Trucks: 5 Axle or More	Multi-Trailer Trucks: 5 Axle or Less	Multi-Trailer Trucks: 6 Axle or More
SN=1	31	684	773				
SN=2	36	679	795				
SN=3	37	650	806				
SN=4	34	620	789				
SN=5	31	622	776				
SN=6	30	639	772				

FLEXIBLE PAVEMENT - P=2.5

	Single Unit Trucks: 2 Axle 4 Tire	Single Unit Trucks: 2 Axle 6 Tire	Single Unit Trucks: 3 Axle or More	Single Trailer Trucks: 4 Axle or Less	Single Trailer Trucks: 5 Axle or More	Multi-Trailer Trucks: 5 Axle or Less	Multi-Trailer Trucks: 6 Axle or More
SN=1	33	687	781				
SN=2	45	679	834				
SN=3	52	618	871				
SN=4	42	557	825				
SN=5	35	555	788				
SN=6	32	670	774				

15 URBAN PRINCIPAL ARTERIAL - INTERSTATE

RIGID PAVEMENT - P=2.0

	Single Unit Trucks: 2 Axle 4 Tire	Single Unit Trucks: 2 Axle 6 Tire	Single Unit Trucks: 3 Axle or More	Single Trailer Trucks: 4 Axle or Less	Single Trailer Trucks: 5 Axle or More	Multi-Trailer Trucks: 5 Axle or Less	Multi-Trailer Trucks: 6 Axle or More
D= 6"	2	207	1209	732	2252	2317	3036
D= 7"	2	203	1192	722	2231	2300	3013
D= 8"	2	202	1198	718	2249	2297	3020
D= 9"	2	202	1211	719	2273	2300	3033
D=10"	2	203	1223	719	2292	2303	3044
D=11"	2	203	1231	726	2303	2306	3051

RIGID PAVEMENT - P=2.5

	Single Unit Trucks: 2 Axle 4 Tire	Single Unit Trucks: 2 Axle 6 Tire	Single Unit Trucks: 3 Axle or More	Single Trailer Trucks: 4 Axle or Less	Single Trailer Trucks: 5 Axle or More	Multi-Trailer Trucks: 5 Axle or Less	Multi-Trailer Trucks: 6 Axle or More
D= 6"	3	212	1172	742	2181	2336	3017
D= 7"	2	204	1137	725	2139	2296	2966
D= 8"	2	201	1147	716	2172	2288	2976
D= 9"	2	201	1175	716	2226	2293	3005
D=10"	2	202	1200	718	2265	2300	3028
D=11"	2	203	1217	719	2288	2303	3042

FLEXIBLE PAVEMENT - P=2.0

	Single Unit Trucks: 2 Axle 4 Tire	Single Unit Trucks: 2 Axle 6 Tire	Single Unit Trucks: 3 Axle or More	Single Trailer Trucks: 4 Axle or Less	Single Trailer Trucks: 5 Axle or More	Multi-Trailer Trucks: 5 Axle or Less	Multi-Trailer Trucks: 6 Axle or More
SN=1	2	201	768	647	1325	2291	2375
SN=2	2	209	779	667	1346	2323	2415
SN=3	2	210	780	676	1357	2332	2436
SN=4	2	204	765	662	1339	2303	2404
SN=5	2	200	758	650	1325	2288	2380
SN=6	2	199	757	646	1319	2289	2373

FLEXIBLE PAVEMENT - P=2.5

	Single Unit Trucks: 2 Axle 4 Tire	Single Unit Trucks: 2 Axle 6 Tire	Single Unit Trucks: 3 Axle or More	Single Trailer Trucks: 4 Axle or Less	Single Trailer Trucks: 5 Axle or More	Multi-Trailer Trucks: 5 Axle or Less	Multi-Trailer Trucks: 6 Axle or More
SN=1	3	205	772	655	1330	2310	2392
SN=2	4	223	800	703	1386	2369	2480
SN=3	3	228	809	730	1422	2395	2539
SN=4	2	212	774	692	1377	2328	2462
SN=5	2	201	753	661	1337	2286	2397
SN=6	2	198	770	666	1370	2280	2399

EQUIVALENT SINGLE AXLE LOADS (ESAL) ANALYSIS

K-4 Oakland Expressway Just North of US-40

4-89 K-7316-01

Sample of ESAL traffic forecast

		% DIST.	18 KIP ADL ON RIGID PVMNT.*		18 KIP ADL ON FLEX. PVMNT.*	
YR 2000 TRAFFIC =	12700	7.0% TRUCKS	D=260mm (10in.)	D=280mm (11in.)	SN=5	SN=6
AUTO	8852	69.7	2.66	2.66	2.66	2.66
LT. TRUCK	2959	23.3	5.92	5.92	5.92	5.92
2 AXLE-6 TIRE	114	0.9	21.15	21.37	20.23	20.35
3 AXLE TANDEM	38	0.3	30.18	30.78	19.16	20.00
4 AXLE 1 TRAILER	241	1.9	176.15	177.11	156.36	159.74
5 AXLE 1 TRAILER	495	3.9	1022.30	1031.71	611.70	623.58
5 AXLE 2 TRAILER	0	0.0	0.00	0.00	0.00	0.00
6 AXLE 2 TRAILER	0	0.0	0.00	0.00	0.00	0.00
TOTALS	12700	100.0	1258.34	1269.56	816.03	832.24

		% DIST.	18 KIP ADL ON RIGID PVMNT.*		18 KIP ADL ON FLEX. PVMNT.*	
YR 2010 TRAFFIC =	16800	7.0% TRUCKS	D=260mm (10in.)	D=280mm (11in.)	SN=5	SN=6
AUTO	11710	69.7	3.51	3.51	3.51	3.51
LT. TRUCK	3914	23.3	7.83	7.83	7.83	7.83
2 AXLE-6 TIRE	151	0.9	27.97	28.27	26.76	26.91
3 AXLE TANDEM	50	0.3	39.92	40.72	25.35	26.46
4 AXLE 1 TRAILER	319	1.9	233.02	234.29	206.84	211.31
5 AXLE 1 TRAILER	655	3.9	1352.33	1364.78	809.17	824.90
5 AXLE 2 TRAILER	0	0.0	0.00	0.00	0.00	0.00
6 AXLE 2 TRAILER	0	0.0	0.00	0.00	0.00	0.00
TOTALS	16800	100.0	1664.58	1679.41	1079.47	1100.92

10 YEAR ACCUMULATED ESAL'S

RIGID PAVEMENT:
D=260mm: 5,334,333
D=280mm: 5,381,871

FLEXIBLE PAVEMENT:
SN=5 : 3,459,280
SN=6 : 3,528,031

		% DIST.	18 KIP ADL ON RIGID PVMNT.*		18 KIP ADL ON FLEX. PVMNT.*	
YR 2020 TRAFFIC =	20900	7.0% TRUCKS	D=260mm (10in.)	D=280mm (11in.)	SN=5	SN=6
AUTO	14567	69.7	4.37	4.37	4.37	4.37
LT. TRUCK	4870	23.3	9.74	9.74	9.74	9.74
2 AXLE-6 TIRE	188	0.9	34.80	35.17	33.28	33.48
3 AXLE TANDEM	63	0.3	49.68	50.66	31.54	32.92
4 AXLE 1 TRAILER	397	1.9	289.88	291.47	257.32	262.88
5 AXLE 1 TRAILER	815	3.9	1682.37	1697.85	1006.65	1026.21
5 AXLE 2 TRAILER	0	0.0	0.00	0.00	0.00	0.00
6 AXLE 2 TRAILER	0	0.0	0.00	0.00	0.00	0.00
TOTALS	20900	100.0	2070.82	2089.27	1342.91	1369.60

20 YEAR ACCUMULATED ESAL'S

RIGID PAVEMENT:
D=260mm: 12,151,[illegible]
D=280mm: 12,259,720

FLEXIBLE PAVEMENT:
SN=5 : 7,880,123
SN=6 : 8,036,734

* USING TERMINAL SERVICEABILITY OF 2.5 / FACILITY TYPE RURAL
USING 1992, 1993, & 1994 KANSAS TRUCK WEIGHT DATA

03-Mar-99

Kansas Department of Transportation

KDOT

Bureau of Transportation Planning,
Docking State Office Building, Room 830
915 Harrison
Topeka, Kansas 66612-1568

FAX

Date: 3-22-99
Number of pages including cover sheet: 5

To: EARL LAIRD
TP&R CONSULTANT
Phone: (775) 882-4755
Fax phone: (775) 882-4565
CC:

From: ALAN SPICER
TRAFFIC AND FIELD OPERATIONS ENGINEER
KANSAS DOT
Phone: 785-296-3470
Fax phone: 785-296-8168
spicer@ksdot.org

REMARKS: ☐ Urgent ☐ For your review ☐ Reply ASAP ☐ Please comment

Earl -
If you have questions about our answers or our data - feel free to give Garry or me a call. Good-luck
- Alan

If assistance is needed, please contact Phyllis Bailey or Rachel Quinlan at (785) 296-3841

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March 19, 1999

Survey of States using ESALS for pavement design and rehabilitation. EASL Data information being collected for a ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: Kansas DOT; Mr. Garrett Olson ;
Field Data Collection Engineer;
(785) 296-6351 Fax: (785) 296-8168

Please check One: Surveyed State (Does __) or (Does Not __) wish to be identified on how the state answered any of the survey questions. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?
Yes:___
No:___ If No what do you use?

Q No. 2: What type or types of data do you use to come up with the ESAL table values? (Will you fax us the first page of your ESAL table for an example.)

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location?

Q NO. 3: Do you break down ESALS by vehicle classification?

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? What are they?

Q No. 5: Do you use Growth factors to expand ESAL's to design years?

Q No. 6: Do you use WIM data? If No what do you use for load data?

Q No. 7: Are there links between PMS data and the ESAL tables?
a. Are your growth factors for PMS the same for ESAL growth factors?

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab?

Survey States comments if any:

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

Thank you again,
Earl T. Laird.

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775) 882-4755 Fax (775) 882-4565
E-mail: ETLAIRD@AOL.COM

FAX COVER SHEET
Number of pages including this cover sheet 2

TO: Garrett Olson FAX NUMBER: (785) 296-8168
Field Data Collection Engineer

FROM: Earl Laird FAX NUMBER: (775) 882-4565

DATE: March 19, 1999 TIME: 8:30 AM

SUBJECT: State Survey of ESAL Use For Pavement Design and Rehabilitation

==

REMARKS:
Hello Garrett Olson:

Per our phone conservation this A.M., attached is the small questionnaire dealing with your state's use of ESALS data in the design and rehabilitation of pavements. As I explained to you, the ESAL survey is part of a contract Nichols Consulting Engineers of Reno has with Arizona DOT dealing with ESAL design and its use in pavement design and rehab.

If you have any questions please call me at (775) 882-4755.

You may fax your answers to me at Fax No. (775) 882-4565.

Thanks for your anticipated help.
1
Earl T. Laird (:>))

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March 16, 1999

Survey of States using ESALS for pavement design and rehabilitation. EASL Data information being collected for a ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: Oklahoma DOT; Mr. Daryl Johnson; Traffic Analyst; (405) 521-2575 Fax: (405) 521-6917

Please check One: Surveyed State (Does __) or (Does Not __) wish to be identified on how the state answered any of the survey questions. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?
Yes: ✓
No: __ If No what do you use?

Q No. 2: What type or types of data do you use to come up with the ESAL table values? (Will you fax us the first page of your ESAL table for an example.) LEGAL LIMIT TYPE 9 (80K)

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location?

Q NO. 3: Do you break down ESALS by vehicle classification? NO

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? What are they? → RIGID - 4.066 ESAL/T9 FLEX - 2.378

Q No. 5: Do you use Growth factors to expand ESAL's to design years? NO

Q No. 6: Do you use WIM data? If No what do you use for load data? NO

Q No. 7: Are there links between PMS data and the ESAL tables?
a. Are your growth factors for PMS the same for ESAL growth factors? NO, NO ESTIMATE TRAFFIC GROWTH, ASSUME ESAL/T9 SAME

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab? HIGH, CONSERVATIVE APPLICATION (SAFETY #1)

Survey States comments if any:

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

Thank you again,

Earl T. Laird.

03/19/99 FRI 10:02 [TX/RX NO 7333]

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March 16, 1999

Survey of States using ESALS for pavement design and rehabilitation. EASL Data information being collected for a ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: Oklahoma DOT; Mr. Daryl Johnson; Traffic Analyst; (405) 521-2575 Fax: (405) 521-6917

Please check One: Surveyed State (Does __) or (Does Not __) wish to be identified on how the state answered any of the survey questions. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?
Yes:___
No:___ If No what do you use?

Q No. 2: What type or types of data do you use to come up with the ESAL table values? (Will you fax us the first page of your ESAL table for an example.)

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location?

Q NO. 3: Do you break down ESALS by vehicle classification?

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? What are they?

Q No. 5: Do you use Growth factors to expand ESAL's to design years?

Q No. 6: Do you use WIM data? If No what do you use for load data?

Q No. 7: Are there links between PMS data and the ESAL tables?
a. Are your growth factors for PMS the same for ESAL growth factors?

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab?

Survey States comments if any:

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

Thank you again,

Earl T. Laird.

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775) 882-4755 Fax (775) 882-4565
E-mail: ETLAIRD@AOL.COM

FAX COVER SHEET
Number of pages including this cover sheet 2

TO: Daryl Johnson FAX NUMBER: (405) 521-6917
Planning Traffic Analyst

FROM: Earl Laird ETL FAX NUMBER: (775) 882-4565

DATE: March 18, 1999 TIME: 8:00 AM

SUBJECT: State Survey of ESAL Use For Pavement Design and Rehabilitation

==

REMARKS:
Hello Daryl Johnson:

Per our phone conservation this A.M., attached is the small questionnaire dealing with your state's use of ESALS data in the design and rehabilitation of pavements. As I explained to you, the ESAL survey is part of a contract Nichols Consulting Engineers of Reno has with Arizona DOT dealing with ESAL design and its use in pavement design and rehab.

If you have any questions please call me at (775) 882-4755.

You may fax your answers to me at Fax No. (775) 882-4565.

Thanks for your anticipated help.
1
Earl T. Laird (:>))

OKLAHOMA DEPARTMENT OF TRANSPORTATION

Date: 3-19-99

To: MR. EARL T. LAIRD

Fax #: 775 882 — 4565

From: DARYL JOHNSON

Fax #: (405) 521-6917

Subject: ESAL QUESTIONAIRE

Number of Pages Including Cover Sheet: 2

STOP THE KNOCK

Please remind drivers to:

- Not drink and drive
- Watch speed limits
- Wear passenger restraints

Subj: **RE: Survey ESAL Use In Pavement Design**
Date: 3/22/99 10:16:47 AM Pacific Standard Time
From: SFugit@itd.state.id.us (Scott Fugit)
To: ETLAIRD@aol.com ('ETLAIRD@aol.com')

IDAHO DOT RESPONSES WITH FAX ESAL TABLE

Earl
Here's Idaho's responses. I hope this helps. Let me know if you have any other questions. I will have the ESAL report fax going out to you sometime today. I would appreciate a copy of your results when your done. Thanks Earl. Good luck.

Scott W. Fugit
Traffic Survey and Analysis Section
Idaho Transportation Department
ph: 208-334-8207
fx: 208-334-4432
email: sfugit@itd.state.id.us

Question #1. Yes

Question #2. We use volume, some basic classification breakdown (commercial versus non-commercial) and WIM data to establish and update ESAL tables. Yes, I would be glad to fax you a sample of the ESAL table used by ITD.

Question #3. No. The ADT estimates are shown for passenger cars and commercial vehicles on the ESAL Report, but all of the actual ESAL numbers are combined for all vehicles.

Question #4. ESAL's are not specified for separate vehicle classifications.

Question #5. Yes. We use a straight 20 year design life linear growth estimate for ESALs.

Question #6. Yes. WIM data is used to do periodic updates of the ESAL tables on which estimates are based.

Question #7. I am assuming by PMS your referring to HPMS. With that in mind the answer is no, not directly. Some of the same classification data used for HPMS submissions are also used to contribute to figuring the commercial/non-commercial breakdown on the ESAL report, but there is no direct connection. The HPMS and ESAL growth factors are different.

Question #8. We have good confidence that our ESAL report provides our clients with good ESAL estimates – but they could be even better. We are attempting to update the ESAL table more often to provide more detailed ESAL information based on the most recent data available.

-----Original Message-----
From: ETLAIRD@aol.com [mailto:ETLAIRD@aol.com]
Sent: Thursday, March 18, 1999 10:58 AM
To: SFUGIT@itd.state.id.us
Subject: Survey ESAL Use In Pavement Design

EARL T. LAIRD
T P & R CONSULTANT

·Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March 16, 1999

Survey of States using ESALS for pavement design and rehabilitation. EASL Data information being collected for a ESAL Research Contract between Arizona
DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: Idaho Dept. of Highways; Mr. Scott W. Fugit; Traffic Survey;
(406) 444-6295 Fax: (208) 334-8207

Please check One: Surveyed State (Does __) or (Does Not __) wish to be identified on how the state answered any of the survey questioned. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?
Yes:___
No:___ If No what do you use?

Q No. 2: What type or types of data do you use to come up with

the ESAL table values? (Will you fax us the first page of your ESAL table for an example.)

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load
information for that location?

Q NO. 3: Do you break down ESALS by vehicle classification?

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? What are they?

Q No. 5: Do you use Growth factors to expand ESAL's to design years?

Q No. 6: Do you use WIM data? If No what do you use for load data?

Q No. 7: Are there links between PMS data and the ESAL tables?
a. Are your growth factors for PMS the same for ESAL

growth factors?

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab?

Survey States comments if any:

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

Thank you again,

Earl T. Laird.

———————— Headers ————————
Return-Path: <SFugit@itd.state.id.us>
Received: from rly-zb01.mx.aol.com (rly-zb01.mail.aol.com [172.31.41.1]) by air-zb02.mail.aol.com (v58.13) with SMTP; Mon, 22 Mar 1999 13:16:46 -0500
Received: from hqissv09.itd.state.id.us (hqissv09.itd.state.id.us [164.165.237.9])
by rly-zb01.mx.aol.com (8.8.8/8.8.5/AOL-4.0.0)
with ESMTP id NAA16658 for <ETLAIRD@aol.com>;
Mon, 22 Mar 1999 13:16:43 -0500 (EST)
Received: by HQISSV09 with Internet Mail Service (5.5.2232.9)
id <FZCHKF0P>; Mon, 22 Mar 1999 11:16:29 -0700
Message-ID: <7C3F7CD4E21FD1119F73006097DBB254E9F377@HQISSV10.itd.state.id.us>
From: Scott Fugit <SFugit@itd.state.id.us>
To: "'ETLAIRD@aol.com'" <ETLAIRD@aol.com>
Subject: RE: Survey ESAL Use In Pavement Design
Date: Mon, 22 Mar 1999 11:16:25 -0700
MIME-Version: 1.0
X-Mailer: Internet Mail Service (5.5.2232.9)
Content-Type: text/plain;
charset="iso-8859-1"

PROJECTED COMMERCIAL AND 18,000 EQUIVALENT SINGLE AXLE LOADINGS (ESALS) 1
10:08 MONDAY, MARCH 15, 1999

ROUTE NUMBER : SH 75 SEGMENT CODE : 002230 BEGINNING MILEPOINT : 202.439 ENDING MILEPOINT : 202.476
TRUCK DENSITY = 1 : LIGHT LAST YEAR WITH DATA : 1997 CUMULATING ESALS UP TO 2020 STARTING TO CUMULATE IN 2000

YEAR	PASSENGER CAR ADT	PICKUP ADT	COMMERCIAL ADT	----- RIGID PAVEMENT ESAL (IN THOUSANDS) ----- ESALS:BOTH DIRECTIONS YEAR VALUE	CUMULATIVE	50% DIRECTION OF TRAVEL YEAR VALUE	CUMULATIVE	---- FLEXIBLE PAVEMENT ESAL (IN THOUSANDS) --- ESALS:BOTH DIRECTIONS YEAR VALUE	CUMULATIVE	50% DIRECTION OF TRAVEL YEAR VALUE	CUMULATIVE
1997	620	0	80								
2000	650	0	90	13	13	7	7	10	10	5	5
2001	660	0	90	14	27	7	13	10	20	5	10
2002	670	0	90	14	41	7	20	11	31	5	15
2003	680	0	90	14	55	7	27	11	42	5	21
2004	690	0	90	14	69	7	35	11	53	6	26
2005	690	0	100	15	84	7	42	11	64	6	32
2006	700	0	100	15	99	8	50	11	76	6	38
2007	710	0	100	15	114	8	57	12	87	6	44
2008	720	0	100	16	130	8	65	12	99	6	50
2009	730	0	100	16	146	8	73	12	111	6	56
2010	740	0	110	16	162	8	81	12	124	6	62
2011	750	0	110	17	179	8	90	13	137	6	68
2012	760	0	110	17	196	8	98	13	149	6	75
2013	770	0	110	17	213	9	107	13	163	7	81
2014	780	0	110	18	231	9	115	13	176	7	88
2015	790	0	120	18	249	9	124	14	190	7	95
2016	800	0	120	18	267	9	133	14	203	7	102
2017	810	0	120	18	285	9	143	14	218	7	109
2018	820	0	120	19	304	9	152	14	232	7	116
2019	820	0	120	19	323	10	162	15	246	7	123
2020	830	0	130	19	342	10	171	15	261	7	131

IDAHO

FAX

From The Idaho Transportation Department
Traffic Survey and Analysis Section

To: Earl Laird
Of: TP&R Consulting
Phone: 775-882-4755
Fax: 775-882-4565
Number of pages: 2 including cover page

From: Scott Fugit
Ph: (208)334-8207
Fax: (208)334-4432
Date: 22 March, 1999
Email: sfugit@itd.state.id.us

Subject: ITD's Projected ESAL Loadings Report

Earl

In conjunction with question #2 on your ESAL survey, attached please find a copy of ITD's Projected ESAL Loadings Report. If you have any questions, or I can be of any further service, please don't hesitate to contact me. Good luck.

Scott

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March 16, 1999

Survey of States using ESALS for pavement design and rehabilitation. EASL Data information being collected for a ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: Idaho Dept. of Highways; Mr. Scott W. Fugit; Traffic Survey;
(406) 444-6295 Fax: (208) 334-8207

Please check One: Surveyed State (Does __) or (Does Not __) wish to be identified on how the state answered any of the survey questioned. Only identify the state as a participant in the survey.

Question No. 1: Does your state use ESAL computations for pavement design and rehabilitation?
Yes:___
No:___ If No what do you use?

Q No. 2: What type or types of data do you use to come up with the ESAL table values? (Will you fax us the first page of your ESAL table for an example.)

a. Do you use a single ESAL table for all design locations within your state or is a different ESAL value computed for different locations based upon load information for that location?

Q NO. 3: Do you break down ESALS by vehicle classification?

Q No. 4: Do you apply average ESAL factors to the vehicles in each classification? What are they?

Q No. 5: Do you use Growth factors to expand ESAL's to design years?

Q No. 6: Do you use WIM data? If No what do you use for load data?

Q No. 7: Are there links between PMS data and the ESAL tables?
a. Are your growth factors for PMS the same for ESAL growth factors?

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab?

Survey States comments if any:

Thank you for participating in this ESAL pavement design and rehabilitation survey. If you have any questions on this survey you may contact Earl Laird at above telephone, e-mail or Fax Number. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955 or e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT; telephone (602)407-3435; e-mail ekombe@dot.state.az

Thank you again,

Earl T. Laird.

OREGON DOT
REPLY

HIGHLITE IN YELLOW

Subj: **RE: Survey ESAL Use For Design**
Date: 3/16/99 7:04:19 AM Pacific Standard Time
From: Jeffrey.L.GOWER@odot.state.or.us
To: ETLAIRD@aol.com

My response to your questionnaire is below, my comments **are in bold print** to help you identify them. Hope this information is helpful.

> -----Original Message-----
> From: ETLAIRD@aol.com [SMTP:ETLAIRD@aol.com]
> Sent: Monday, March 15, 1999 5:04 PM
> To: GOWER Jeffrey L
> Subject: Survey ESAL Use For Design
>
> EARL T. LAIRD
> T P & R CONSULTANT
> Transportation Planning and Research
> 529 Bonanza Dr., Carson City, NV. 89706
> (775)882-4755 Fax (775)882-4565
> E-mail: etlaird@aol.com
>
> March 15, 1999
>
> Survey of States using ESALS for pavement design and rehabilitation. EASL
> Data information being collected for a ESAL Research Contract between
> Arizona
> DOT and Nichols Consulting Engineers in Reno, Nevada:
>
> Survey State of: **Oregon DOT; Mr. Jeffrey L. Gower; Pavement Design;**
> **(503)986-3123**
>
> Please check One: Surveyed State (**Does _X_**) or (Does Not __) wish to be
> identified on how the state answered any of the survey questioned. Only
> identify the state as a participant in the survey.
>
> Question No. 1: Does your state use ESAL computations for
> pavement design and rehabilitation?
> Yes:_X__
> No:___ If No what do you use?
>
> Q No. 2: What type or types of data do you use to come up with
>
> the ESAL table values? (Will you fax us the first page
> of your ESAL table for an example.)
>
> a. Do you use a single ESAL table for all design locations within your
> state
> or is a different ESAL value computed for different locations based upon
> load
> information for that location?**Single table**
>
> Q NO. 3: Do you break down ESALS by vehicle classification?**Yes**
>
> Q No. 4: Do you apply average ESAL factors to the vehicles in
> each classification? What are they?**Yes, See table at end.**
>
> Q No. 5: Do you use Growth factors to expand ESAL's to design
> years?**YES**

>
> Q No. 6: Do you use WIM data? If No what do you use for load
> data?Only for vehicle counts.
>
> Q No. 7: Are there links between PMS data and the ESAL tables?Yes
> a. Are your growth factors for PMS the same for ESAL
> growth factors?Yes
>
> Q No. 8: How much confidence do you have in the values you use
> for pavement design and rehab?They are only as reasonable as the
> vehicle count information. Average axle weight information is probably
> conservative if anything.
>
> Survey States comments if any:
>
> Truck ESAL Table
>
> Two Axle Truck: 0.27 ESALS per Truck
> Three Axle Truck: 0.60 ESALS per Truck
> Four Axle Truck: 0.88 ESALS per Truck
> Five or more Axles: 1.78 ESALS per Truck
> Buses: 1.98 ESALS per Truck
>
> Thank you for participating in this ESAL pavement design and
> rehabilitation
> survey. If you have any questions on this survey you may contact Earl
> Laird
> at above telephone or e-mail. Or: Dr. Sirous Alavi, Ph.D., P.E.; Principal
> Investigator; Nichols Consulting Engineers, Chtd., Phone No. (775)329-4955
> or
> e-mail sirous@nce.reno.nv.us; or, Dr. Estomih M. Kombe; Arizona DOT;
> telephone (602)407-3435; e-mail ekombe@dot.state.az
>
> Thank you again,
>
> Earl T. Laird.

———————— Headers ————————

Return-Path: <Jeffrey.L.GOWER@odot.state.or.us>
Received: from rly-zb01.mx.aol.com (rly-zb01.mail.aol.com [172.31.41.1]) by air-zb02.mail.aol.com (v56.26) with SMTP; Tue, 16 Mar 1999 10:04:18 -0500
Received: from odot.state.or.us (goofy.odot.state.or.us [167.131.11.233] (may be forged))
by rly-zb01.mx.aol.com (8.8.8/8.8.5/AOL-4.0.0)
with ESMTP id KAA04513 for <ETLAIRD@aol.com>;
Tue, 16 Mar 1999 10:04:16 -0500 (EST)
From: Jeffrey.L.GOWER@odot.state.or.us
Received: by exsalem1.isb.odot.state.or.us with Internet Mail Service (5.5.2232.9)
id <HBS3PVTJ>; Tue, 16 Mar 1999 07:04:16 -0800
Message-ID: <BF03ED27D2C2D111AEA500A0C95DC7900141072B@EXSALEM3.highway.odot.state.or.us>
To: ETLAIRD@aol.com
Subject: RE: Survey ESAL Use For Design
Date: Tue, 16 Mar 1999 07:04:14 -0800
MIME-Version: 1.0
X-Mailer: Internet Mail Service (5.5.2232.9)
Content-Type: text/plain

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775)882-4755 Fax (775)882-4565
E-mail: etlaird@aol.com

March 15, 1999

Survey of States using ESALS for pavement design and rehabilitation. EASL Data information being collected for a ESAL Research Contract between Arizona DOT and Nichols Consulting Engineers in Reno, Nevada:

Survey State of: Oregon DOT; Mr. Jeffrey L. Gower; Pavement Design;
(503)986-3123

Please check One: Surveyed State (Does __) or (Does Not __) wish to be identified on how the state answered any of the survey questioned. Only identify the state as a participant in the survey.

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Q No. 6: Do you use WIM data? If No what do you use for load data?

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a. Are your growth factors for PMS the same for ESAL growth factors?

Q No. 8: How much confidence do you have in the values you use for pavement design and rehab?

Survey States comments if any:

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Thank you again,

Earl T. Laird.

KANSAS THANKS

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775) 882-4755 Fax (775) 882-4565
E-mail: ETLAIRD@AOL.COM

FAX COVER SHEET

Number of pages including this cover sheet 2

TO: Garrett Olson **FAX NUMBER:** (785) 296-8168
Field Data Collection Engineer

FROM: Earl Laird **FAX NUMBER:** (775) 882-4565

DATE: March 24, 1999 **TIME:** 4:50 PM

SUBJECT: State Survey of ESAL Use For Pavement Design and Rehabilitation

REMARKS:

Hello Garrett Olson:

Thank you for the quick and very informative reply to the questionnaire on ESAL use in pavement design. Of the 8 states I have received back questionnaires, I must tell you that your state, thus far and I know this is not a contest, has the most aggressive ESAL tables. You have ESAL by truck class, by functional class, by pavement depth and future years, etc.. Very, very nice ESAL reporting. This old traffic guy like to see traffic reports that show the user we know how to collect traffic data and how to report same. Very good reporting. Why collect the data unless you are going to put it in a report form that the user can and should use. Thanks for showing it can be done.

Thanks again for your states input.

Earl T. (:>))

OKLAHOMA
THANKS

EARL T. LAIRD
T P & R CONSULTANT
Transportation Planning and Research
529 Bonanza Dr., Carson City, NV. 89706
(775) 882-4755 Fax (775) 882-4565
E-mail: ETLAIRD@AOL.COM

FAX COVER SHEET

Number of pages including this cover sheet 2

TO: Daryl Johnson **FAX NUMBER:** (405) 521-6917
Planning Traffic Analyst

FROM: Earl Laird ETL **FAX NUMBER:** (775) 882-4565

DATE: March 24, 1999 **TIME:** 4:30 PM

SUBJECT: Thanks for State Survey of ESAL Use For Pavement Design and Rehabilitation

---

REMARKS:

Hello Daryl Johnson:

Thank you for the quick and very informative reply to the questionnaire on the use of ESAL's in pavement design.

Thanks again,

Earl T. (:>)) ETL

APPENDIX D: NEW ESAL TABLE USER'S MANUAL

APPENDIX D: NEW ESAL TABLE USER'S MANUAL

The following serves as reference documentation for all of the electronic files included in the new ADOT ESAL Tables. Electronic copies of three files are included, as listed below:

- Average_ESAL_Table.xls
- OneStdDev_ESAL_Table.xls
- TwoStdDev_ESAL_Table.xls

There are 14 worksheets in each of the three Microsoft Excel spreadsheets. These worksheets are defined on the following pages. The definitions follow a consistent format of identifying the worksheet name at the top of each table, and then describing the contents of each column within the worksheet. Ten worksheets are the same for all three files. The only difference between each file is the value used in the ESAL calculation. The Average_ESAL_Table file uses either the measured or the system average values for ESALs per vehicle class, while the OneStdDev_ESAL_Table and TwoStdDev_ESAL_Table files use the measured or average ESAL values plus one and plus two standard deviations, respectively. These standard deviations are calculated using the differences in average ESALs per each vehicle class for all WIM systems.

All three files are over 20 Megabytes in size as they contain a large amount of information and they are also set up to recalculate the final KESAL values based on changes made to any of the worksheets. The following is a list of activities that a user may want to perform (referenced by **worksheet name** and *column name*):

- Create a new segment.
  - **All worksheets** (except **Stdev ESALs per Class**), *SEGMENT* (or *SECTID*): if additional traffic sections are created, the site information would need to be created in **Site Info** and then the *SEGMENT* (or *SECTID*), as well as *ATR* and *class* columns would need to be updated in the other worksheets. For worksheets where equations are present, simply paste the equation from an adjacent row into the new segment's row.

- Reset KESALs to Zero following a reconstruction or overlay.
  - **Cum.One-way Flex + 10 percent, Cum One-way Rigid**, *KESAL Yr*: in each of the two spreadsheets, enter "0" for the year in which the reconstruction or overlay took place for the segment. The KESAL values will remain cumulative from that point on.

- Modify a segment's percent growth.
  - **AADT 1974-2020**, *Forecasting Percent Growth*: if the user would like to modify the growth factor for any segment, enter the revised factor in this column. The forecasted AADT values will automatically be recalculated as will the KESAL values.

- Limit the maximum AADT for a segment
  - **AADT 1974-2020,** *AADT Yr*: if the user would like to limit the maximum AADT for a particular segment, enter the value into the year in which maximum capacity will be reached and then copy that value for future years. Each file contains the worksheet **Capacity** that indicates--by pass or fail--whether a section is under capacity for each year. Each file also has the worksheet **Total Theoretical Capacity** that contains the actual AADT value that is assumed to be the maximum capacity.

- Adjust the maximum AADT for a segment.
  - **Number of Lanes,** *# Lanes Yr*: if there is going to be additional lanes constructed for a segment, enter the new number of lanes in the year where construction will be completed and then copy that value into future years.
  - **Total Theoretical Capacity,** *Year Yr*: these values are all calculated based on the assumption that 27,500 vehicles per lane per day is the maximum capacity and multiplying this value by the number of lanes. If the user wishes to modify the maximum capacity per lane, then the equation should be modified and copied to all related cells. Another method would be to replace the equation with a new value (i.e., replace the calculated 110,000 vehicles per day with 125,000).

- Adjust the ESALs per vehicle class.
  - **Rigid ESALs, Flexible ESALs,** *ESALcls**: the user can replace the value for either rigid or flexible pavements (or both) for any segment. The final KESAL values will be recalculated automatically.

- Adjust the percentage of each vehicle class.
  - **Percent Vehicle Type Table,** percent *Cls* *: the user can replace the percentage of any vehicle class for any segment (note: there is no check to confirm the percentages add up to 100 percent). The final KESAL values will be recalculated automatically.

These instructions were provided assuming the user was using the Average_ESAL_Table File. They can be applied to the other two files by changing the following: **Cum.One-way Flex +10 percent** to **Cum 1way Flex 10 percent 1 stdev** or **Cum 1way Flex 10 percent 2 stdev, Cum One-Way Rigid** to **Cum One-Way Rigid 1 stdev** or **Cum One-Way Rigid 2 stdev**. All other referenced tables are the same for all three files.

Worksheets in Average_ESAL_Table

Site Info (ADOT % Trucks)--from *TR9397C.xls*	
Column	Description
SECTID	The segment number as designated by ADOT (ADOT uses segment and SECTID interchangeably)
RTE_L	The route type (i.e., I = interstate, U = U.S. highway, S = state highway)
RTE_N	The route number
BMP	The beginning milepost of the segment
STARTING	A description of the beginning location of the segment in terms of nearest exit/interchange
EMP	The ending milepost of the segment
ENDING	A description of the ending location of the segment in terms of nearest exit/interchange
ORDER	A counting function that begins with 1 and increases by 1 for each segment
SEC_LEN	The length of the segment (in miles)
ATR	The Automatic Traffic Recorder assosicated with each segment
CLASS	The classification station associated with each segment
SECTION	The segment number as designated by ADOT
LANES	The total number of lanes (in both directions) within the segment
AADT93	The AADT for each segment as reported by ADOT for 1993
PCCV93	The percent commercial vehciles for each segment as reported by ADOT for 1993
AADT94	The AADT for each segment as reported by ADOT for 1994
PCCV94	The percent commercial vehciles for each segment as reported by ADOT for 1994
AADT95	The AADT for each segment as reported by ADOT for 1995
PCCV95	The percent commercial vehciles for each segment as reported by ADOT for 1995
AADT96	The AADT for each segment as reported by ADOT for 1996
PCCV96	The percent commercial vehciles for each segment as reported by ADOT for 1996
AADT97	The AADT for each segment as reported by ADOT for 1997
PCCV97	The percent commercial vehciles for each segment as reported by ADOT for 1997
EST_DATE	The year the traffic segment was established
CNTFRQ	The frequency with which traffic counts are performed at each segment
STATUS	The status of the most recent traffic count for each segment
LASTCNT	The year of the last traffic count for each segment
NEXTCNT	The year of the next traffic count for each segment
MISSCNT	Whether the traffic count was successfully collected (FALSE) or not (TRUE) at each segment
REMARKS	Comments by ADOT regarding each segment

Worksheets in Average_ESAL_Table

Cum.One-way Flex + 10%	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
KESAL 1997	The total one-way KESALs for each segment in 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 1998	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 1999	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2000	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2001	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2002	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2003	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2004	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2005	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2006	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2007	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2008	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2009	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2010	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2011	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2012	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2013	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2014	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2015	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2016	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2017	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2018	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2019	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13
KESAL 2020	The total one-way KESALs for each segment since 1997 assuming a flexible pavement and adding a 10% factor of safety for vechicle classes 9-13

Worksheets in Average_ESAL_Table

Cum One-way Rigid	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
KESAL 1997	Total one-way KESALs for each segment based on a rigid pavement for 1997
KESAL 1998	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 1999	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2000	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2001	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2002	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2003	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2004	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2005	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2006	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2007	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2008	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2009	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2010	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2011	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2012	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2013	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2014	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2015	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2016	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2017	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2018	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2019	Total one-way KESALs for each segment based on a rigid pavement since 1997
KESAL 2020	Total one-way KESALs for each segment based on a rigid pavement since 1997

Worksheets in Average_ESAL_Table

AADT 1974-2020--1974-1997 data from *trfc7497.xls*	
Column	Description
ORDER	A counting function that begins with 1 and increases by 1 for each segment
Segment	The segment number as designated by ADOT
RTE_L	The route type (i.e., I = interstate, U = U.S. highway, S = state highway)
RTE_N	The route number
BMP	The beginning milepost of the segment
EMP	The ending milepost of the segment
SEC_LEN	The length of the segment (in miles)
ATR	The Automatic Traffic Recorder assosicated with each segment
CLASS	The classification station associated with each segment
Segment	The segment number as designated by ADOT
PCCV97	The percent commercial vehicles for each segment as reported by ADOT in 1997
1974	The measured AADT for each segment for 1974
1975	The measured AADT for each segment for 1975
1976	The measured AADT for each segment for 1976
1977	The measured AADT for each segment for 1977
1978	The measured AADT for each segment for 1978
1979	The measured AADT for each segment for 1979
1980	The measured AADT for each segment for 1980
1981	The measured AADT for each segment for 1981
1982	The measured AADT for each segment for 1982
1983	The measured AADT for each segment for 1983
1984	The measured AADT for each segment for 1984
1985	The measured AADT for each segment for 1985
1986	The measured AADT for each segment for 1986
1987	The measured AADT for each segment for 1987
1988	The measured AADT for each segment for 1988
1989	The measured AADT for each segment for 1989
1990	The measured AADT for each segment for 1990
1991	The measured AADT for each segment for 1991
1992	The measured AADT for each segment for 1992
1993	The measured AADT for each segment for 1993
1994	The measured AADT for each segment for 1994
1995	The measured AADT for each segment for 1995
1996	The measured AADT for each segment for 1996
1997	The measured AADT for each segment for 1997
Avg. % Growth	The average % growth for each segment based on the average of the annual growth factors from 1992 to 1997; this value is calculated using Macro 1
Forecasting % Growth	The % growth used in projecting AADT for future years; this differs from the Avg. % Growth where the Avg. % Growth is less than 2% (Forecasting % Growth is never less than 2%)
1996	The measured AADT for each segment for 1996; this value is repeated but not counted twice
1997	The measured AADT for each segment for 1997; this value is repeated but not counted twice
1998	The forecasted AADT for each segment for 1998
1999	The forecasted AADT for each segment for 1999
2000	The forecasted AADT for each segment for 2000
2001	The forecasted AADT for each segment for 2001
2002	The forecasted AADT for each segment for 2002
2003	The forecasted AADT for each segment for 2003
2004	The forecasted AADT for each segment for 2004

Worksheets in Average_ESAL_Table

2005	The forecasted AADT for each segment for 2005
2006	The forecasted AADT for each segment for 2006
2007	The forecasted AADT for each segment for 2007
2008	The forecasted AADT for each segment for 2008
2009	The forecasted AADT for each segment for 2009
2010	The forecasted AADT for each segment for 2010
2011	The forecasted AADT for each segment for 2011
2012	The forecasted AADT for each segment for 2012
2013	The forecasted AADT for each segment for 2013
2014	The forecasted AADT for each segment for 2014
2015	The forecasted AADT for each segment for 2015
2016	The forecasted AADT for each segment for 2016
2017	The forecasted AADT for each segment for 2017
2018	The forecasted AADT for each segment for 2018
2019	The forecasted AADT for each segment for 2019
2020	The forecasted AADT for each segment for 2020

Worksheets in Average_ESAL_Table

Capacity	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
Year 1997	Indication of whether each segment exceeds capacity in 1997 ("Pass" means under capacity, "Fail" means over capacity)
Year 1998	Indication of whether each segment exceeds capacity in 1998 ("Pass" means under capacity, "Fail" means over capacity)
Year 1999	Indication of whether each segment exceeds capacity in 1999 ("Pass" means under capacity, "Fail" means over capacity)
Year 2000	Indication of whether each segment exceeds capacity in 2000 ("Pass" means under capacity, "Fail" means over capacity)
Year 2001	Indication of whether each segment exceeds capacity in 2001 ("Pass" means under capacity, "Fail" means over capacity)
Year 2002	Indication of whether each segment exceeds capacity in 2002 ("Pass" means under capacity, "Fail" means over capacity)
Year 2003	Indication of whether each segment exceeds capacity in 2003 ("Pass" means under capacity, "Fail" means over capacity)
Year 2004	Indication of whether each segment exceeds capacity in 2004 ("Pass" means under capacity, "Fail" means over capacity)
Year 2005	Indication of whether each segment exceeds capacity in 2005 ("Pass" means under capacity, "Fail" means over capacity)
Year 2006	Indication of whether each segment exceeds capacity in 2006 ("Pass" means under capacity, "Fail" means over capacity)
Year 2007	Indication of whether each segment exceeds capacity in 2007 ("Pass" means under capacity, "Fail" means over capacity)
Year 2008	Indication of whether each segment exceeds capacity in 2008 ("Pass" means under capacity, "Fail" means over capacity)
Year 2009	Indication of whether each segment exceeds capacity in 2009 ("Pass" means under capacity, "Fail" means over capacity)
Year 2010	Indication of whether each segment exceeds capacity in 2010 ("Pass" means under capacity, "Fail" means over capacity)
Year 2011	Indication of whether each segment exceeds capacity in 2011 ("Pass" means under capacity, "Fail" means over capacity)
Year 2012	Indication of whether each segment exceeds capacity in 2012 ("Pass" means under capacity, "Fail" means over capacity)
Year 2013	Indication of whether each segment exceeds capacity in 2013 ("Pass" means under capacity, "Fail" means over capacity)
Year 2014	Indication of whether each segment exceeds capacity in 2014 ("Pass" means under capacity, "Fail" means over capacity)
Year 2015	Indication of whether each segment exceeds capacity in 2015 ("Pass" means under capacity, "Fail" means over capacity)
Year 2016	Indication of whether each segment exceeds capacity in 2016 ("Pass" means under capacity, "Fail" means over capacity)
Year 2017	Indication of whether each segment exceeds capacity in 2017 ("Pass" means under capacity, "Fail" means over capacity)
Year 2018	Indication of whether each segment exceeds capacity in 2018 ("Pass" means under capacity, "Fail" means over capacity)
Year 2019	Indication of whether each segment exceeds capacity in 2019 ("Pass" means under capacity, "Fail" means over capacity)
Year 2020	Indication of whether each segment exceeds capacity in 2020 ("Pass" means under capacity, "Fail" means over capacity)

Worksheets in Average_ESAL_Table

Rigid KESAL One-Way	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
KESAL 1997	One-way KESALs assuming a rigid pavement for 1997
KESAL 1998	One-way KESALs assuming a rigid pavement for 1998
KESAL 1999	One-way KESALs assuming a rigid pavement for 1999
KESAL 2000	One-way KESALs assuming a rigid pavement for 2000
KESAL 2001	One-way KESALs assuming a rigid pavement for 2001
KESAL 2002	One-way KESALs assuming a rigid pavement for 2002
KESAL 2003	One-way KESALs assuming a rigid pavement for 2003
KESAL 2004	One-way KESALs assuming a rigid pavement for 2004
KESAL 2005	One-way KESALs assuming a rigid pavement for 2005
KESAL 2006	One-way KESALs assuming a rigid pavement for 2006
KESAL 2007	One-way KESALs assuming a rigid pavement for 2007
KESAL 2008	One-way KESALs assuming a rigid pavement for 2008
KESAL 2009	One-way KESALs assuming a rigid pavement for 2009
KESAL 2010	One-way KESALs assuming a rigid pavement for 2010
KESAL 2011	One-way KESALs assuming a rigid pavement for 2011
KESAL 2012	One-way KESALs assuming a rigid pavement for 2012
KESAL 2013	One-way KESALs assuming a rigid pavement for 2013
KESAL 2014	One-way KESALs assuming a rigid pavement for 2014
KESAL 2015	One-way KESALs assuming a rigid pavement for 2015
KESAL 2016	One-way KESALs assuming a rigid pavement for 2016
KESAL 2017	One-way KESALs assuming a rigid pavement for 2017
KESAL 2018	One-way KESALs assuming a rigid pavement for 2018
KESAL 2019	One-way KESALs assuming a rigid pavement for 2019
KESAL 2020	One-way KESALs assuming a rigid pavement for 2020

Worksheets in Average_ESAL_Table

Rigid ESALs	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
Class	The classification station number associated with each segment
ESALcls4	The rigid ESALs per vehicle class 4 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 4 vehicles is applied.
ESALcls5	The rigid ESALs per vehicle class 5 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 5 vehicles is applied.
ESALcls6	The rigid ESALs per vehicle class 6 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 6 vehicles is applied.
ESALcls7	The rigid ESALs per vehicle class 7 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 7 vehicles is applied.
ESALcls8	The rigid ESALs per vehicle class 8 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 8 vehicles is applied.
ESALcls9	The rigid ESALs per vehicle class 9 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 9 vehicles is applied.
ESALcls10	The rigid ESALs per vehicle class 10 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 10 vehicles is applied.
ESALcls11	The rigid ESALs per vehicle class 11 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 11 vehicles is applied.
ESALcls12	The rigid ESALs per vehicle class 12 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 12 vehicles is applied.
ESALcls13	The rigid ESALs per vehicle class 13 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 13 vehicles is applied.

Worksheets in Average_ESAL_Table

10% added Flex. KESAL One-Way	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
KESAL 1997	Total one-way KESALs for each segment for 1997 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 1998	Total one-way KESALs for each segment for 1998 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 1999	Total one-way KESALs for each segment for 1999 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2000	Total one-way KESALs for each segment for 2000 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2001	Total one-way KESALs for each segment for 2001 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2002	Total one-way KESALs for each segment for 2002 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2003	Total one-way KESALs for each segment for 2003 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2004	Total one-way KESALs for each segment for 2004 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2005	Total one-way KESALs for each segment for 2005 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2006	Total one-way KESALs for each segment for 2006 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2007	Total one-way KESALs for each segment for 2007 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2008	Total one-way KESALs for each segment for 2008 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2009	Total one-way KESALs for each segment for 2009 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2010	Total one-way KESALs for each segment for 2010 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2011	Total one-way KESALs for each segment for 2011 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2012	Total one-way KESALs for each segment for 2012 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2013	Total one-way KESALs for each segment for 2013 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2014	Total one-way KESALs for each segment for 2014 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2015	Total one-way KESALs for each segment for 2015 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2016	Total one-way KESALs for each segment for 2016 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2017	Total one-way KESALs for each segment for 2017 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2018	Total one-way KESALs for each segment for 2018 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2019	Total one-way KESALs for each segment for 2019 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.
KESAL 2020	Total one-way KESALs for each segment for 2020 based on a flexible pavement and including a 10% factor of safety for vehicle classes 9-13.

Worksheets in Average_ESAL_Table

Flexible ESALs	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
Class	The classification station number associated with each segment
ESALcls4	The flexible ESALs per vehicle class 4 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 4 vehicles is applied.
ESALcls5	The flexible ESALs per vehicle class 5 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 5 vehicles is applied.
ESALcls6	The flexible ESALs per vehicle class 6 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 6 vehicles is applied.
ESALcls7	The flexible ESALs per vehicle class 7 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 7 vehicles is applied.
ESALcls8	The flexible ESALs per vehicle class 8 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 8 vehicles is applied.
ESALcls9	The flexible ESALs per vehicle class 9 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 9 vehicles is applied.
ESALcls10	The flexible ESALs per vehicle class 10 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 10 vehicles is applied.
ESALcls11	The flexible ESALs per vehicle class 11 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 11 vehicles is applied.
ESALcls12	The flexible ESALs per vehicle class 12 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 12 vehicles is applied.
ESALcls13	The flexible ESALs per vehicle class 13 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 13 vehicles is applied.

Stdev ESALs per Cls	
Column	Description
Column 1	This table contains the mean, plus one standard deviation and plus two standard deviations for ESALs per vehicle class for both rigid and flexible pavements
Class 4	These values for vechilce class 4
Class 5	These values for vechilce class 5
Class 6	These values for vechilce class 6
Class 7	These values for vechilce class 7
Class 8	These values for vechilce class 8
Class 9	These values for vechilce class 9
Class 10	These values for vechilce class 10
Class 11	These values for vechilce class 11
Class 12	These values for vechilce class 12
Class 13	These values for vechilce class 13

AADT Percent Growth All Years	
Column	Description
Segment	The segment number as designated by ADOT
% Growth 1974	The percent growth in AADT for each segment for 1974
% Growth 1975	The percent growth in AADT for each segment for 1975
% Growth 1976	The percent growth in AADT for each segment for 1976
% Growth 1977	The percent growth in AADT for each segment for 1977
% Growth 1978	The percent growth in AADT for each segment for 1978
% Growth 1979	The percent growth in AADT for each segment for 1979
% Growth 1980	The percent growth in AADT for each segment for 1980
% Growth 1981	The percent growth in AADT for each segment for 1981
% Growth 1982	The percent growth in AADT for each segment for 1982
% Growth 1983	The percent growth in AADT for each segment for 1983
% Growth 1984	The percent growth in AADT for each segment for 1984
% Growth 1985	The percent growth in AADT for each segment for 1985
% Growth 1986	The percent growth in AADT for each segment for 1986
% Growth 1987	The percent growth in AADT for each segment for 1987
% Growth 1988	The percent growth in AADT for each segment for 1988
% Growth 1989	The percent growth in AADT for each segment for 1989
% Growth 1990	The percent growth in AADT for each segment for 1990
% Growth 1991	The percent growth in AADT for each segment for 1991
% Growth 1992	The percent growth in AADT for each segment for 1992
% Growth 1993	The percent growth in AADT for each segment for 1993
% Growth 1994	The percent growth in AADT for each segment for 1994
% Growth 1995	The percent growth in AADT for each segment for 1995
% Growth 1996	The percent growth in AADT for each segment for 1996
% Growth 1997	The percent growth in AADT for each segment for 1997
% Growth 1998	The percent growth in AADT for each segment for 1998
% Growth 1999	The percent growth in AADT for each segment for 1999
% Growth 2000	The percent growth in AADT for each segment for 2000
% Growth 2001	The percent growth in AADT for each segment for 2001
% Growth 2002	The percent growth in AADT for each segment for 2002
% Growth 2003	The percent growth in AADT for each segment for 2003
% Growth 2004	The percent growth in AADT for each segment for 2004
% Growth 2005	The percent growth in AADT for each segment for 2005
% Growth 2006	The percent growth in AADT for each segment for 2006
% Growth 2007	The percent growth in AADT for each segment for 2007
% Growth 2008	The percent growth in AADT for each segment for 2008
% Growth 2009	The percent growth in AADT for each segment for 2009
% Growth 2010	The percent growth in AADT for each segment for 2010
% Growth 2011	The percent growth in AADT for each segment for 2011
% Growth 2012	The percent growth in AADT for each segment for 2012
% Growth 2013	The percent growth in AADT for each segment for 2013
% Growth 2014	The percent growth in AADT for each segment for 2014
% Growth 2015	The percent growth in AADT for each segment for 2015
% Growth 2016	The percent growth in AADT for each segment for 2016
% Growth 2017	The percent growth in AADT for each segment for 2017
% Growth 2018	The percent growth in AADT for each segment for 2018
% Growth 2019	The percent growth in AADT for each segment for 2019
% Growth 2020	The percent growth in AADT for each segment for 2020

Worksheets in Average_ESAL_Table

Number of Lanes	
Column	Description
SECTID	The segment number as designated by ADOT (ADOT uses segment and SECTID interchangeably)
LANES	Value taken from *TR9397C.xls*
# Lanes 1993	The number of lanes for each segment in 1993
# Lanes 1994	The number of lanes for each segment in 1994
# Lanes 1995	The number of lanes for each segment in 1995
# Lanes 1996	The number of lanes for each segment in 1996
# Lanes 1997	The number of lanes for each segment in 1997
# Lanes 1998	The number of lanes for each segment in 1998
# Lanes 1999	The number of lanes for each segment in 1999
# Lanes 2000	The number of lanes for each segment in 2000
# Lanes 2001	The number of lanes for each segment in 2001
# Lanes 2002	The number of lanes for each segment in 2002
# Lanes 2003	The number of lanes for each segment in 2003
# Lanes 2004	The number of lanes for each segment in 2004
# Lanes 2005	The number of lanes for each segment in 2005
# Lanes 2006	The number of lanes for each segment in 2006
# Lanes 2007	The number of lanes for each segment in 2007
# Lanes 2008	The number of lanes for each segment in 2008
# Lanes 2009	The number of lanes for each segment in 2009
# Lanes 2010	The number of lanes for each segment in 2010
# Lanes 2011	The number of lanes for each segment in 2011
# Lanes 2012	The number of lanes for each segment in 2012
# Lanes 2013	The number of lanes for each segment in 2013
# Lanes 2014	The number of lanes for each segment in 2014
# Lanes 2015	The number of lanes for each segment in 2015
# Lanes 2016	The number of lanes for each segment in 2016
# Lanes 2017	The number of lanes for each segment in 2017
# Lanes 2018	The number of lanes for each segment in 2018
# Lanes 2019	The number of lanes for each segment in 2019
# Lanes 2020	The number of lanes for each segment in 2020

Worksheets in Average_ESAL_Table

Total Theoretical Capacity	
Column	Description
SECTID	The segment number as designated by ADOT (ADOT uses segment and SECTID interchangeably)
Year 1997	The total theoretical capacity for all lanes for each segment for 1997
Year 1998	The total theoretical capacity for all lanes for each segment for 1998
Year 1999	The total theoretical capacity for all lanes for each segment for 1999
Year 2000	The total theoretical capacity for all lanes for each segment for 2000
Year 2001	The total theoretical capacity for all lanes for each segment for 2001
Year 2002	The total theoretical capacity for all lanes for each segment for 2002
Year 2003	The total theoretical capacity for all lanes for each segment for 2003
Year 2004	The total theoretical capacity for all lanes for each segment for 2004
Year 2005	The total theoretical capacity for all lanes for each segment for 2005
Year 2006	The total theoretical capacity for all lanes for each segment for 2006
Year 2007	The total theoretical capacity for all lanes for each segment for 2007
Year 2008	The total theoretical capacity for all lanes for each segment for 2008
Year 2009	The total theoretical capacity for all lanes for each segment for 2009
Year 2010	The total theoretical capacity for all lanes for each segment for 2010
Year 2011	The total theoretical capacity for all lanes for each segment for 2011
Year 2012	The total theoretical capacity for all lanes for each segment for 2012
Year 2013	The total theoretical capacity for all lanes for each segment for 2013
Year 2014	The total theoretical capacity for all lanes for each segment for 2014
Year 2015	The total theoretical capacity for all lanes for each segment for 2015
Year 2016	The total theoretical capacity for all lanes for each segment for 2016
Year 2017	The total theoretical capacity for all lanes for each segment for 2017
Year 2018	The total theoretical capacity for all lanes for each segment for 2018
Year 2019	The total theoretical capacity for all lanes for each segment for 2019
Year 2020	The total theoretical capacity for all lanes for each segment for 2020

% Vehicle Type Table	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
% Cls 4	The percentage of FHWA class 4 vehicles for each segment
% Cls 5	The percentage of FHWA class 5 vehicles for each segment
% Cls 6	The percentage of FHWA class 6 vehicles for each segment
% Cls 7	The percentage of FHWA class 7 vehicles for each segment
% Cls 8	The percentage of FHWA class 8 vehicles for each segment
% Cls 9	The percentage of FHWA class 9 vehicles for each segment
% Cls 10	The percentage of FHWA class 10 vehicles for each segment
% Cls 11	The percentage of FHWA class 11 vehicles for each segment
% Cls 12	The percentage of FHWA class 12 vehicles for each segment
% Cls 13	The percentage of FHWA class 13 vehicles for each segment
Year	Year when calculations of vehicle class percentages was performed for each segment

Worksheets in OneStdDev_ESAL_Table

Site Info (ADOT % Trucks)--from *TR9397C.xls*	
Column	Description
SECTID	The segment number as designated by ADOT (ADOT uses segment and SECTID interchangeably)
RTE_L	The route type (i.e., I = interstate, U = U.S. highway, S = state highway)
RTE_N	The route number
BMP	The beginning milepost of the segment
STARTING	A description of the beginning location of the segment in terms of nearest exit/interchange
EMP	The ending milepost of the segment
ENDING	A description of the ending location of the segment in terms of nearest exit/interchange
ORDER	A counting function that begins with 1 and increases by 1 for each segment
SEC_LEN	The length of the segment (in miles)
ATR	The Automatic Traffic Recorder assosicated with each segment
CLASS	The classification station associated with each segment
SECTION	The segment number as designated by ADOT
LANES	The total number of lanes (in both directions) within the segment
AADT93	The AADT for each segment as reported by ADOT for 1993
PCCV93	The percent commercial vehciles for each segment as reported by ADOT for 1993
AADT94	The AADT for each segment as reported by ADOT for 1994
PCCV94	The percent commercial vehciles for each segment as reported by ADOT for 1994
AADT95	The AADT for each segment as reported by ADOT for 1995
PCCV95	The percent commercial vehciles for each segment as reported by ADOT for 1995
AADT96	The AADT for each segment as reported by ADOT for 1996
PCCV96	The percent commercial vehciles for each segment as reported by ADOT for 1996
AADT97	The AADT for each segment as reported by ADOT for 1997
PCCV97	The percent commercial vehciles for each segment as reported by ADOT for 1997
EST_DATE	The year the traffic segment was established
CNTFRQ	The frequency with which traffic counts are performed at each segment
STATUS	The status of the most recent traffic count for each segment
LASTCNT	The year of the last traffic count for each segment
NEXTCNT	The year of the next traffic count for each segment
MISSCNT	Whether the traffic count was successfully collected (FALSE) or not (TRUE) at each segment
REMARKS	Comments by ADOT regarding each segment

Worksheets in OneStdDev_ESAL_Table

Cum 1way Flex 10% 1 stdev	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
KESAL 1997	The total number of one-way KESALs for each segment for 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 1998	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 1999	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2000	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2001	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2002	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2003	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2004	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2005	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2006	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2007	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2008	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2009	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2010	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2011	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2012	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation

Worksheets in OneStdDev_ESAL_Table

KESAL 2013	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2014	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2015	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2016	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2017	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2018	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2019	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2020	The total number of KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by one standard deviation

Worksheets in OneStdDev_ESAL_Table

Cum One-way Rigid 1 stdev	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
KESAL 1997	Total one-way KESALs for 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 1998	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 1999	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2000	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2001	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2002	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2003	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2004	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2005	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2006	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2007	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2008	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2009	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2010	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2011	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2012	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2013	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2014	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2015	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2016	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2017	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2018	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2019	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2020	Total one-way KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation

Worksheets in OneStdDev_ESAL_Table

AADT 1974-2020--1974-1997 data from *trfc7497.xls*	
Column	Description
ORDER	A counting function that begins with 1 and increases by 1 for each segment
Segment	The segment number as designated by ADOT
RTE_L	The route type (i.e., I = interstate, U = U.S. highway, S = state highway)
RTE_N	The route number
BMP	The beginning milepost of the segment
EMP	The ending milepost of the segment
SEC_LEN	The length of the segment (in miles)
ATR	The Automatic Traffic Recorder assosicated with each segment
CLASS	The classification station associated with each segment
Segment	The segment number as designated by ADOT
PCCV97	The percent commercial vehicles for each segment as reported by ADOT in 1997
1974	The measured AADT for each segment for 1974
1975	The measured AADT for each segment for 1975
1976	The measured AADT for each segment for 1976
1977	The measured AADT for each segment for 1977
1978	The measured AADT for each segment for 1978
1979	The measured AADT for each segment for 1979
1980	The measured AADT for each segment for 1980
1981	The measured AADT for each segment for 1981
1982	The measured AADT for each segment for 1982
1983	The measured AADT for each segment for 1983
1984	The measured AADT for each segment for 1984
1985	The measured AADT for each segment for 1985
1986	The measured AADT for each segment for 1986
1987	The measured AADT for each segment for 1987
1988	The measured AADT for each segment for 1988
1989	The measured AADT for each segment for 1989
1990	The measured AADT for each segment for 1990
1991	The measured AADT for each segment for 1991
1992	The measured AADT for each segment for 1992
1993	The measured AADT for each segment for 1993
1994	The measured AADT for each segment for 1994
1995	The measured AADT for each segment for 1995
1996	The measured AADT for each segment for 1996
1997	The measured AADT for each segment for 1997
Avg. % Growth	The average % growth for each segment based on the average of the annual growth factors from 1992 to 1997; this value is calculated using Macro 1
Forecasting % Growth	The % growth used in projecting AADT for future years; this differs from the Avg. % Growth where the Avg. % Growth is less than 2% (Forecasting % Growth is never less than 2%)
1996	The measured AADT for each segment for 1996; this value is repeated but not counted twice
1997	The measured AADT for each segment for 1997; this value is repeated but not counted twice
1998	The forecasted AADT for each segment for 1998
1999	The forecasted AADT for each segment for 1999
2000	The forecasted AADT for each segment for 2000
2001	The forecasted AADT for each segment for 2001
2002	The forecasted AADT for each segment for 2002
2003	The forecasted AADT for each segment for 2003
2004	The forecasted AADT for each segment for 2004

Worksheets in OneStdDev_ESAL_Table

2005	The forecasted AADT for each segment for 2005
2006	The forecasted AADT for each segment for 2006
2007	The forecasted AADT for each segment for 2007
2008	The forecasted AADT for each segment for 2008
2009	The forecasted AADT for each segment for 2009
2010	The forecasted AADT for each segment for 2010
2011	The forecasted AADT for each segment for 2011
2012	The forecasted AADT for each segment for 2012
2013	The forecasted AADT for each segment for 2013
2014	The forecasted AADT for each segment for 2014
2015	The forecasted AADT for each segment for 2015
2016	The forecasted AADT for each segment for 2016
2017	The forecasted AADT for each segment for 2017
2018	The forecasted AADT for each segment for 2018
2019	The forecasted AADT for each segment for 2019
2020	The forecasted AADT for each segment for 2020

Worksheets in OneStdDev_ESAL_Table

Capacity	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
Year 1997	Indication of whether each segment exceeds capacity in 1997 ("Pass" means under capacity, "Fail" means over capacity)
Year 1998	Indication of whether each segment exceeds capacity in 1998 ("Pass" means under capacity, "Fail" means over capacity)
Year 1999	Indication of whether each segment exceeds capacity in 1999 ("Pass" means under capacity, "Fail" means over capacity)
Year 2000	Indication of whether each segment exceeds capacity in 2000 ("Pass" means under capacity, "Fail" means over capacity)
Year 2001	Indication of whether each segment exceeds capacity in 2001 ("Pass" means under capacity, "Fail" means over capacity)
Year 2002	Indication of whether each segment exceeds capacity in 2002 ("Pass" means under capacity, "Fail" means over capacity)
Year 2003	Indication of whether each segment exceeds capacity in 2003 ("Pass" means under capacity, "Fail" means over capacity)
Year 2004	Indication of whether each segment exceeds capacity in 2004 ("Pass" means under capacity, "Fail" means over capacity)
Year 2005	Indication of whether each segment exceeds capacity in 2005 ("Pass" means under capacity, "Fail" means over capacity)
Year 2006	Indication of whether each segment exceeds capacity in 2006 ("Pass" means under capacity, "Fail" means over capacity)
Year 2007	Indication of whether each segment exceeds capacity in 2007 ("Pass" means under capacity, "Fail" means over capacity)
Year 2008	Indication of whether each segment exceeds capacity in 2008 ("Pass" means under capacity, "Fail" means over capacity)
Year 2009	Indication of whether each segment exceeds capacity in 2009 ("Pass" means under capacity, "Fail" means over capacity)
Year 2010	Indication of whether each segment exceeds capacity in 2010 ("Pass" means under capacity, "Fail" means over capacity)
Year 2011	Indication of whether each segment exceeds capacity in 2011 ("Pass" means under capacity, "Fail" means over capacity)
Year 2012	Indication of whether each segment exceeds capacity in 2012 ("Pass" means under capacity, "Fail" means over capacity)
Year 2013	Indication of whether each segment exceeds capacity in 2013 ("Pass" means under capacity, "Fail" means over capacity)
Year 2014	Indication of whether each segment exceeds capacity in 2014 ("Pass" means under capacity, "Fail" means over capacity)
Year 2015	Indication of whether each segment exceeds capacity in 2015 ("Pass" means under capacity, "Fail" means over capacity)
Year 2016	Indication of whether each segment exceeds capacity in 2016 ("Pass" means under capacity, "Fail" means over capacity)
Year 2017	Indication of whether each segment exceeds capacity in 2017 ("Pass" means under capacity, "Fail" means over capacity)
Year 2018	Indication of whether each segment exceeds capacity in 2018 ("Pass" means under capacity, "Fail" means over capacity)
Year 2019	Indication of whether each segment exceeds capacity in 2019 ("Pass" means under capacity, "Fail" means over capacity)
Year 2020	Indication of whether each segment exceeds capacity in 2020 ("Pass" means under capacity, "Fail" means over capacity)

Worksheets in OneStdDev_ESAL_Table

Rigid 1 stdev	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
KESAL 1997	Total KESALs for 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 1998	Total KESALs for 1998 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 1999	Total KESALs for 1999 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2000	Total KESALs for 2000 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2001	Total KESALs for 2001 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2002	Total KESALs for 2002 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2003	Total KESALs for 2003 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2004	Total KESALs for 2004 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2005	Total KESALs for 2005 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2006	Total KESALs for 2006 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2007	Total KESALs for 2007 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2008	Total KESALs for 2008 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2009	Total KESALs for 2009 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2010	Total KESALs for 2010 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2011	Total KESALs for 2011 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2012	Total KESALs for 2012 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2013	Total KESALs for 2013 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2014	Total KESALs for 2014 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2015	Total KESALs for 2015 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2016	Total KESALs for 2016 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2017	Total KESALs for 2017 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2018	Total KESALs for 2018 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2019	Total KESALs for 2019 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation
KESAL 2020	Total KESALs for 2020 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by one standard deviation

Worksheets in OneStdDev_ESAL_Table

Rigid ESALs	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
Class	The classification station number associated with each segment
ESALcls4	The rigid ESALs per vehicle class 4 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 4 vehicles is applied.
ESALcls5	The rigid ESALs per vehicle class 5 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 5 vehicles is applied.
ESALcls6	The rigid ESALs per vehicle class 6 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 6 vehicles is applied.
ESALcls7	The rigid ESALs per vehicle class 7 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 7 vehicles is applied.
ESALcls8	The rigid ESALs per vehicle class 8 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 8 vehicles is applied.
ESALcls9	The rigid ESALs per vehicle class 9 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 9 vehicles is applied.
ESALcls10	The rigid ESALs per vehicle class 10 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 10 vehicles is applied.
ESALcls11	The rigid ESALs per vehicle class 11 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 11 vehicles is applied.
ESALcls12	The rigid ESALs per vehicle class 12 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 12 vehicles is applied.
ESALcls13	The rigid ESALs per vehicle class 13 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 13 vehicles is applied.

Worksheets in OneStdDev_ESAL_Table

Flex 1 stdev 10%	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
KESAL 1997	The total KESALs for each segment for 1997 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 1998	The total KESALs for each segment for 1998 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 1999	The total KESALs for each segment for 1999 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2000	The total KESALs for each segment for 2000 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2001	The total KESALs for each segment for 2001 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2002	The total KESALs for each segment for 2002 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2003	The total KESALs for each segment for 2003 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2004	The total KESALs for each segment for 2004 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2005	The total KESALs for each segment for 2005 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2006	The total KESALs for each segment for 2006 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2007	The total KESALs for each segment for 2007 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2008	The total KESALs for each segment for 2008 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2009	The total KESALs for each segment for 2009 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2010	The total KESALs for each segment for 2010 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2011	The total KESALs for each segment for 2011 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2012	The total KESALs for each segment for 2012 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation

Worksheets in OneStdDev_ESAL_Table

KESAL 2013	The total KESALs for each segment for 2013 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2014	The total KESALs for each segment for 2014 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2015	The total KESALs for each segment for 2015 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2016	The total KESALs for each segment for 2016 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2017	The total KESALs for each segment for 2017 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2018	The total KESALs for each segment for 2018 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2019	The total KESALs for each segment for 2019 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation
KESAL 2020	The total KESALs for each segment for 2020 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by one standard deviation

Worksheets in OneStdDev_ESAL_Table

Flexible ESALs	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
Class	The classification station number associated with each segment
ESALcls4	The flexible ESALs per vehicle class 4 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 4 vehicles is applied.
ESALcls5	The flexible ESALs per vehicle class 5 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 5 vehicles is applied.
ESALcls6	The flexible ESALs per vehicle class 6 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 6 vehicles is applied.
ESALcls7	The flexible ESALs per vehicle class 7 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 7 vehicles is applied.
ESALcls8	The flexible ESALs per vehicle class 8 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 8 vehicles is applied.
ESALcls9	The flexible ESALs per vehicle class 9 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 9 vehicles is applied.
ESALcls10	The flexible ESALs per vehicle class 10 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 10 vehicles is applied.
ESALcls11	The flexible ESALs per vehicle class 11 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 11 vehicles is applied.
ESALcls12	The flexible ESALs per vehicle class 12 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 12 vehicles is applied.
ESALcls13	The flexible ESALs per vehicle class 13 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 13 vehicles is applied.

Stdev ESALs per Cls	
Column	Description
Column 1	This table contains the mean, plus one standard deviation and plus two standard deviations for ESALs per vehicle class for both rigid and flexible pavements
Class 4	These values for vechilce class 4
Class 5	These values for vechilce class 5
Class 6	These values for vechilce class 6
Class 7	These values for vechilce class 7
Class 8	These values for vechilce class 8
Class 9	These values for vechilce class 9
Class 10	These values for vechilce class 10
Class 11	These values for vechilce class 11
Class 12	These values for vechilce class 12
Class 13	These values for vechilce class 13

Worksheets in OneStdDev_ESAL_Table

AADT Percent Growth All Years	
Column	Description
Segment	The segment number as designated by ADOT
% Growth 1974	The percent growth in AADT for each segment for 1974
% Growth 1975	The percent growth in AADT for each segment for 1975
% Growth 1976	The percent growth in AADT for each segment for 1976
% Growth 1977	The percent growth in AADT for each segment for 1977
% Growth 1978	The percent growth in AADT for each segment for 1978
% Growth 1979	The percent growth in AADT for each segment for 1979
% Growth 1980	The percent growth in AADT for each segment for 1980
% Growth 1981	The percent growth in AADT for each segment for 1981
% Growth 1982	The percent growth in AADT for each segment for 1982
% Growth 1983	The percent growth in AADT for each segment for 1983
% Growth 1984	The percent growth in AADT for each segment for 1984
% Growth 1985	The percent growth in AADT for each segment for 1985
% Growth 1986	The percent growth in AADT for each segment for 1986
% Growth 1987	The percent growth in AADT for each segment for 1987
% Growth 1988	The percent growth in AADT for each segment for 1988
% Growth 1989	The percent growth in AADT for each segment for 1989
% Growth 1990	The percent growth in AADT for each segment for 1990
% Growth 1991	The percent growth in AADT for each segment for 1991
% Growth 1992	The percent growth in AADT for each segment for 1992
% Growth 1993	The percent growth in AADT for each segment for 1993
% Growth 1994	The percent growth in AADT for each segment for 1994
% Growth 1995	The percent growth in AADT for each segment for 1995
% Growth 1996	The percent growth in AADT for each segment for 1996
% Growth 1997	The percent growth in AADT for each segment for 1997
% Growth 1998	The percent growth in AADT for each segment for 1998
% Growth 1999	The percent growth in AADT for each segment for 1999
% Growth 2000	The percent growth in AADT for each segment for 2000
% Growth 2001	The percent growth in AADT for each segment for 2001
% Growth 2002	The percent growth in AADT for each segment for 2002
% Growth 2003	The percent growth in AADT for each segment for 2003
% Growth 2004	The percent growth in AADT for each segment for 2004
% Growth 2005	The percent growth in AADT for each segment for 2005
% Growth 2006	The percent growth in AADT for each segment for 2006
% Growth 2007	The percent growth in AADT for each segment for 2007
% Growth 2008	The percent growth in AADT for each segment for 2008
% Growth 2009	The percent growth in AADT for each segment for 2009
% Growth 2010	The percent growth in AADT for each segment for 2010
% Growth 2011	The percent growth in AADT for each segment for 2011
% Growth 2012	The percent growth in AADT for each segment for 2012
% Growth 2013	The percent growth in AADT for each segment for 2013
% Growth 2014	The percent growth in AADT for each segment for 2014
% Growth 2015	The percent growth in AADT for each segment for 2015
% Growth 2016	The percent growth in AADT for each segment for 2016
% Growth 2017	The percent growth in AADT for each segment for 2017
% Growth 2018	The percent growth in AADT for each segment for 2018
% Growth 2019	The percent growth in AADT for each segment for 2019
% Growth 2020	The percent growth in AADT for each segment for 2020

Worksheets in OneStdDev_ESAL_Table

Number of Lanes	
Column	Description
SECTID	The segment number as designated by ADOT (ADOT uses segment and SECTID interchangeably)
LANES	Value taken from *TR9397C.xls*
# Lanes 1993	The number of lanes for each segment in 1993
# Lanes 1994	The number of lanes for each segment in 1994
# Lanes 1995	The number of lanes for each segment in 1995
# Lanes 1996	The number of lanes for each segment in 1996
# Lanes 1997	The number of lanes for each segment in 1997
# Lanes 1998	The number of lanes for each segment in 1998
# Lanes 1999	The number of lanes for each segment in 1999
# Lanes 2000	The number of lanes for each segment in 2000
# Lanes 2001	The number of lanes for each segment in 2001
# Lanes 2002	The number of lanes for each segment in 2002
# Lanes 2003	The number of lanes for each segment in 2003
# Lanes 2004	The number of lanes for each segment in 2004
# Lanes 2005	The number of lanes for each segment in 2005
# Lanes 2006	The number of lanes for each segment in 2006
# Lanes 2007	The number of lanes for each segment in 2007
# Lanes 2008	The number of lanes for each segment in 2008
# Lanes 2009	The number of lanes for each segment in 2009
# Lanes 2010	The number of lanes for each segment in 2010
# Lanes 2011	The number of lanes for each segment in 2011
# Lanes 2012	The number of lanes for each segment in 2012
# Lanes 2013	The number of lanes for each segment in 2013
# Lanes 2014	The number of lanes for each segment in 2014
# Lanes 2015	The number of lanes for each segment in 2015
# Lanes 2016	The number of lanes for each segment in 2016
# Lanes 2017	The number of lanes for each segment in 2017
# Lanes 2018	The number of lanes for each segment in 2018
# Lanes 2019	The number of lanes for each segment in 2019
# Lanes 2020	The number of lanes for each segment in 2020

Worksheets in OneStdDev_ESAL_Table

Total Theoretical Capacity	
Column	Description
SECTID	The segment number as designated by ADOT (ADOT uses segment and SECTID interchangeably)
Year 1997	The total theoretical capacity for all lanes for each segment for 1997
Year 1998	The total theoretical capacity for all lanes for each segment for 1998
Year 1999	The total theoretical capacity for all lanes for each segment for 1999
Year 2000	The total theoretical capacity for all lanes for each segment for 2000
Year 2001	The total theoretical capacity for all lanes for each segment for 2001
Year 2002	The total theoretical capacity for all lanes for each segment for 2002
Year 2003	The total theoretical capacity for all lanes for each segment for 2003
Year 2004	The total theoretical capacity for all lanes for each segment for 2004
Year 2005	The total theoretical capacity for all lanes for each segment for 2005
Year 2006	The total theoretical capacity for all lanes for each segment for 2006
Year 2007	The total theoretical capacity for all lanes for each segment for 2007
Year 2008	The total theoretical capacity for all lanes for each segment for 2008
Year 2009	The total theoretical capacity for all lanes for each segment for 2009
Year 2010	The total theoretical capacity for all lanes for each segment for 2010
Year 2011	The total theoretical capacity for all lanes for each segment for 2011
Year 2012	The total theoretical capacity for all lanes for each segment for 2012
Year 2013	The total theoretical capacity for all lanes for each segment for 2013
Year 2014	The total theoretical capacity for all lanes for each segment for 2014
Year 2015	The total theoretical capacity for all lanes for each segment for 2015
Year 2016	The total theoretical capacity for all lanes for each segment for 2016
Year 2017	The total theoretical capacity for all lanes for each segment for 2017
Year 2018	The total theoretical capacity for all lanes for each segment for 2018
Year 2019	The total theoretical capacity for all lanes for each segment for 2019
Year 2020	The total theoretical capacity for all lanes for each segment for 2020

% Vehicle Type Table	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
% Cls 4	The percentage of FHWA class 4 vehicles for each segment
% Cls 5	The percentage of FHWA class 5 vehicles for each segment
% Cls 6	The percentage of FHWA class 6 vehicles for each segment
% Cls 7	The percentage of FHWA class 7 vehicles for each segment
% Cls 8	The percentage of FHWA class 8 vehicles for each segment
% Cls 9	The percentage of FHWA class 9 vehicles for each segment
% Cls 10	The percentage of FHWA class 10 vehicles for each segment
% Cls 11	The percentage of FHWA class 11 vehicles for each segment
% Cls 12	The percentage of FHWA class 12 vehicles for each segment
% Cls 13	The percentage of FHWA class 13 vehicles for each segment
Year	Year when calculations of vehicle class percentages was performed for each segment

Worksheets in TwoStdDev_ESAL_Table

Site Info (ADOT % Trucks)--from *TR9397C.xls*	
Column	Description
SECTID	The segment number as designated by ADOT (ADOT uses segment and SECTID interchangeably)
RTE_L	The route type (i.e., I = interstate, U = U.S. highway, S = state highway)
RTE_N	The route number
BMP	The beginning milepost of the segment
STARTING	A description of the beginning location of the segment in terms of nearest exit/interchange
EMP	The ending milepost of the segment
ENDING	A description of the ending location of the segment in terms of nearest exit/interchange
ORDER	A counting function that begins with 1 and increases by 1 for each segment
SEC_LEN	The length of the segment (in miles)
ATR	The Automatic Traffic Recorder assosicated with each segment
CLASS	The classification station associated with each segment
SECTION	The segment number as designated by ADOT
LANES	The total number of lanes (in both directions) within the segment
AADT93	The AADT for each segment as reported by ADOT for 1993
PCCV93	The percent commercial vehciles for each segment as reported by ADOT for 1993
AADT94	The AADT for each segment as reported by ADOT for 1994
PCCV94	The percent commercial vehciles for each segment as reported by ADOT for 1994
AADT95	The AADT for each segment as reported by ADOT for 1995
PCCV95	The percent commercial vehciles for each segment as reported by ADOT for 1995
AADT96	The AADT for each segment as reported by ADOT for 1996
PCCV96	The percent commercial vehciles for each segment as reported by ADOT for 1996
AADT97	The AADT for each segment as reported by ADOT for 1997
PCCV97	The percent commercial vehciles for each segment as reported by ADOT for 1997
EST_DATE	The year the traffic segment was established
CNTFRQ	The frequency with which traffic counts are performed at each segment
STATUS	The status of the most recent traffic count for each segment
LASTCNT	The year of the last traffic count for each segment
NEXTCNT	The year of the next traffic count for each segment
MISSCNT	Whether the traffic count was successfully collected (FALSE) or not (TRUE) at each segment
REMARKS	Comments by ADOT regarding each segment

Worksheets in TwoStdDev_ESAL_Table

Cum 1way Flex 10% 2 stdev	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
KESAL 1997	The total number of one-way KESALs for each segment for 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 1998	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 1999	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2000	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2001	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2002	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2003	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2004	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2005	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2006	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2007	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2008	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2009	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2010	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2011	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2012	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations

Worksheets in TwoStdDev_ESAL_Table

KESAL 2013	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2014	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2015	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2016	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2017	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2018	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2019	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2020	The total number of one-way KESALs for each segment since 1997 assuming a flexible pavement and adjusting the ESALs per vehicle class upwards by two standard deviations

Worksheets in TwoStdDev_ESAL_Table

Cum One-way Rigid 2 stdev	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
KESAL 1997	Total KESALs for 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 1998	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 1999	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2000	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2001	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2002	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2003	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2004	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2005	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2006	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2007	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2008	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2009	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2010	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2011	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2012	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2013	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2014	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2015	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2016	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2017	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2018	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2019	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2020	Total KESALs since 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations

Worksheets in TwoStdDev_ESAL_Table

AADT 1974-2020--1974-1997 data from *trfc7497.xls*	
Column	Description
ORDER	A counting function that begins with 1 and increases by 1 for each segment
Segment	The segment number as designated by ADOT
RTE_L	The route type (i.e., I = interstate, U = U.S. highway, S = state highway)
RTE_N	The route number
BMP	The beginning milepost of the segment
EMP	The ending milepost of the segment
SEC_LEN	The length of the segment (in miles)
ATR	The Automatic Traffic Recorder assosicated with each segment
CLASS	The classification station associated with each segment
Segment	The segment number as designated by ADOT
PCCV97	The percent commercial vehicles for each segment as reported by ADOT in 1997
1974	The measured AADT for each segment for 1974
1975	The measured AADT for each segment for 1975
1976	The measured AADT for each segment for 1976
1977	The measured AADT for each segment for 1977
1978	The measured AADT for each segment for 1978
1979	The measured AADT for each segment for 1979
1980	The measured AADT for each segment for 1980
1981	The measured AADT for each segment for 1981
1982	The measured AADT for each segment for 1982
1983	The measured AADT for each segment for 1983
1984	The measured AADT for each segment for 1984
1985	The measured AADT for each segment for 1985
1986	The measured AADT for each segment for 1986
1987	The measured AADT for each segment for 1987
1988	The measured AADT for each segment for 1988
1989	The measured AADT for each segment for 1989
1990	The measured AADT for each segment for 1990
1991	The measured AADT for each segment for 1991
1992	The measured AADT for each segment for 1992
1993	The measured AADT for each segment for 1993
1994	The measured AADT for each segment for 1994
1995	The measured AADT for each segment for 1995
1996	The measured AADT for each segment for 1996
1997	The measured AADT for each segment for 1997
Avg. % Growth	The average % growth for each segment based on the average of the annual growth factors from 1992 to 1997; this value is calculated using Macro 1
Forecasting % Growth	The % growth used in projecting AADT for future years; this differs from the Avg. % Growth where the Avg. % Growth is less than 2% (Forecasting % Growth is never less than 2%)
1996	The measured AADT for each segment for 1996; this value is repeated but not counted twice
1997	The measured AADT for each segment for 1997; this value is repeated but not counted twice
1998	The forecasted AADT for each segment for 1998
1999	The forecasted AADT for each segment for 1999
2000	The forecasted AADT for each segment for 2000
2001	The forecasted AADT for each segment for 2001
2002	The forecasted AADT for each segment for 2002
2003	The forecasted AADT for each segment for 2003
2004	The forecasted AADT for each segment for 2004

Worksheets in TwoStdDev_ESAL_Table

2005	The forecasted AADT for each segment for 2005
2006	The forecasted AADT for each segment for 2006
2007	The forecasted AADT for each segment for 2007
2008	The forecasted AADT for each segment for 2008
2009	The forecasted AADT for each segment for 2009
2010	The forecasted AADT for each segment for 2010
2011	The forecasted AADT for each segment for 2011
2012	The forecasted AADT for each segment for 2012
2013	The forecasted AADT for each segment for 2013
2014	The forecasted AADT for each segment for 2014
2015	The forecasted AADT for each segment for 2015
2016	The forecasted AADT for each segment for 2016
2017	The forecasted AADT for each segment for 2017
2018	The forecasted AADT for each segment for 2018
2019	The forecasted AADT for each segment for 2019
2020	The forecasted AADT for each segment for 2020

Worksheets in TwoStdDev_ESAL_Table

Capacity	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
Year 1997	Indication of whether each segment exceeds capacity in 1997 ("Pass" means under capacity, "Fail" means over capacity)
Year 1998	Indication of whether each segment exceeds capacity in 1998 ("Pass" means under capacity, "Fail" means over capacity)
Year 1999	Indication of whether each segment exceeds capacity in 1999 ("Pass" means under capacity, "Fail" means over capacity)
Year 2000	Indication of whether each segment exceeds capacity in 2000 ("Pass" means under capacity, "Fail" means over capacity)
Year 2001	Indication of whether each segment exceeds capacity in 2001 ("Pass" means under capacity, "Fail" means over capacity)
Year 2002	Indication of whether each segment exceeds capacity in 2002 ("Pass" means under capacity, "Fail" means over capacity)
Year 2003	Indication of whether each segment exceeds capacity in 2003 ("Pass" means under capacity, "Fail" means over capacity)
Year 2004	Indication of whether each segment exceeds capacity in 2004 ("Pass" means under capacity, "Fail" means over capacity)
Year 2005	Indication of whether each segment exceeds capacity in 2005 ("Pass" means under capacity, "Fail" means over capacity)
Year 2006	Indication of whether each segment exceeds capacity in 2006 ("Pass" means under capacity, "Fail" means over capacity)
Year 2007	Indication of whether each segment exceeds capacity in 2007 ("Pass" means under capacity, "Fail" means over capacity)
Year 2008	Indication of whether each segment exceeds capacity in 2008 ("Pass" means under capacity, "Fail" means over capacity)
Year 2009	Indication of whether each segment exceeds capacity in 2009 ("Pass" means under capacity, "Fail" means over capacity)
Year 2010	Indication of whether each segment exceeds capacity in 2010 ("Pass" means under capacity, "Fail" means over capacity)
Year 2011	Indication of whether each segment exceeds capacity in 2011 ("Pass" means under capacity, "Fail" means over capacity)
Year 2012	Indication of whether each segment exceeds capacity in 2012 ("Pass" means under capacity, "Fail" means over capacity)
Year 2013	Indication of whether each segment exceeds capacity in 2013 ("Pass" means under capacity, "Fail" means over capacity)
Year 2014	Indication of whether each segment exceeds capacity in 2014 ("Pass" means under capacity, "Fail" means over capacity)
Year 2015	Indication of whether each segment exceeds capacity in 2015 ("Pass" means under capacity, "Fail" means over capacity)
Year 2016	Indication of whether each segment exceeds capacity in 2016 ("Pass" means under capacity, "Fail" means over capacity)
Year 2017	Indication of whether each segment exceeds capacity in 2017 ("Pass" means under capacity, "Fail" means over capacity)
Year 2018	Indication of whether each segment exceeds capacity in 2018 ("Pass" means under capacity, "Fail" means over capacity)
Year 2019	Indication of whether each segment exceeds capacity in 2019 ("Pass" means under capacity, "Fail" means over capacity)
Year 2020	Indication of whether each segment exceeds capacity in 2020 ("Pass" means under capacity, "Fail" means over capacity)

Worksheets in TwoStdDev_ESAL_Table

Rigid 2 stdev	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
KESAL 1997	Total KESALs for 1997 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 1998	Total KESALs for 1998 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 1999	Total KESALs for 1999 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2000	Total KESALs for 2000 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2001	Total KESALs for 2001 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2002	Total KESALs for 2002 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2003	Total KESALs for 2003 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2004	Total KESALs for 2004 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2005	Total KESALs for 2005 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2006	Total KESALs for 2006 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2007	Total KESALs for 2007 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2008	Total KESALs for 2008 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2009	Total KESALs for 2009 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2010	Total KESALs for 2010 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2011	Total KESALs for 2011 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2012	Total KESALs for 2012 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2013	Total KESALs for 2013 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2014	Total KESALs for 2014 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2015	Total KESALs for 2015 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2016	Total KESALs for 2016 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2017	Total KESALs for 2017 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2018	Total KESALs for 2018 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2019	Total KESALs for 2019 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations
KESAL 2020	Total KESALs for 2020 for each segment based on a rigid pavement and adjusting the ESALs per vehicle class upwards by two standard deviations

Worksheets in TwoStdDev_ESAL_Table

Rigid ESALs	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
Class	The classification station number associated with each segment
ESALcls4	The rigid ESALs per vehicle class 4 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 4 vehicles is applied.
ESALcls5	The rigid ESALs per vehicle class 5 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 5 vehicles is applied.
ESALcls6	The rigid ESALs per vehicle class 6 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 6 vehicles is applied.
ESALcls7	The rigid ESALs per vehicle class 7 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 7 vehicles is applied.
ESALcls8	The rigid ESALs per vehicle class 8 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 8 vehicles is applied.
ESALcls9	The rigid ESALs per vehicle class 9 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 9 vehicles is applied.
ESALcls10	The rigid ESALs per vehicle class 10 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 10 vehicles is applied.
ESALcls11	The rigid ESALs per vehicle class 11 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 11 vehicles is applied.
ESALcls12	The rigid ESALs per vehicle class 12 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 12 vehicles is applied.
ESALcls13	The rigid ESALs per vehicle class 13 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 13 vehicles is applied.

Worksheets in TwoStdDev_ESAL_Table

Flex 2 stdev 10%	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
KESAL 1997	The total KESALs for each segment for 1997 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 1998	The total KESALs for each segment for 1998 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 1999	The total KESALs for each segment for 1999 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2000	The total KESALs for each segment for 2000 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2001	The total KESALs for each segment for 2001 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2002	The total KESALs for each segment for 2002 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2003	The total KESALs for each segment for 2003 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2004	The total KESALs for each segment for 2004 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2005	The total KESALs for each segment for 2005 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2006	The total KESALs for each segment for 2006 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2007	The total KESALs for each segment for 2007 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2008	The total KESALs for each segment for 2008 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2009	The total KESALs for each segment for 2009 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2010	The total KESALs for each segment for 2010 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2011	The total KESALs for each segment for 2011 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2012	The total KESALs for each segment for 2012 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations

Worksheets in TwoStdDev_ESAL_Table

KESAL 2013	The total KESALs for each segment for 2013 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2014	The total KESALs for each segment for 2014 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2015	The total KESALs for each segment for 2015 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2016	The total KESALs for each segment for 2016 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2017	The total KESALs for each segment for 2017 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2018	The total KESALs for each segment for 2018 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2019	The total KESALs for each segment for 2019 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations
KESAL 2020	The total KESALs for each segment for 2020 assuming a flexible pavement, adding a 10% factor of safety for vechicle classes 9-13 and adjusting the ESALs per vehcile class upwards by two standard deviations

Worksheets in TwoStdDev_ESAL_Table

Flexible ESALs	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
Class	The classification station number associated with each segment
ESALcls4	The flexible ESALs per vehicle class 4 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 4 vehicles is applied.
ESALcls5	The flexible ESALs per vehicle class 5 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 5 vehicles is applied.
ESALcls6	The flexible ESALs per vehicle class 6 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 6 vehicles is applied.
ESALcls7	The flexible ESALs per vehicle class 7 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 7 vehicles is applied.
ESALcls8	The flexible ESALs per vehicle class 8 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 8 vehicles is applied.
ESALcls9	The flexible ESALs per vehicle class 9 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 9 vehicles is applied.
ESALcls10	The flexible ESALs per vehicle class 10 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 10 vehicles is applied.
ESALcls11	The flexible ESALs per vehicle class 11 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 11 vehicles is applied.
ESALcls12	The flexible ESALs per vehicle class 12 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 12 vehicles is applied.
ESALcls13	The flexible ESALs per vehicle class 13 for each segment. Segments that have a WIM located within their class station have the measured value applied. Otherwise the average value for ADOT WIM systems for class 13 vehicles is applied.

Stdev ESALs per Cls	
Column	Description
Column 1	This table contains the mean, plus one standard deviation and plus two standard deviations for ESALs per vehicle class for both rigid and flexible pavements
Class 4	These values for vechilce class 4
Class 5	These values for vechilce class 5
Class 6	These values for vechilce class 6
Class 7	These values for vechilce class 7
Class 8	These values for vechilce class 8
Class 9	These values for vechilce class 9
Class 10	These values for vechilce class 10
Class 11	These values for vechilce class 11
Class 12	These values for vechilce class 12
Class 13	These values for vechilce class 13

AADT Percent Growth All Years	
Column	Description
Segment	The segment number as designated by ADOT
% Growth 1974	The percent growth in AADT for each segment for 1974
% Growth 1975	The percent growth in AADT for each segment for 1975
% Growth 1976	The percent growth in AADT for each segment for 1976
% Growth 1977	The percent growth in AADT for each segment for 1977
% Growth 1978	The percent growth in AADT for each segment for 1978
% Growth 1979	The percent growth in AADT for each segment for 1979
% Growth 1980	The percent growth in AADT for each segment for 1980
% Growth 1981	The percent growth in AADT for each segment for 1981
% Growth 1982	The percent growth in AADT for each segment for 1982
% Growth 1983	The percent growth in AADT for each segment for 1983
% Growth 1984	The percent growth in AADT for each segment for 1984
% Growth 1985	The percent growth in AADT for each segment for 1985
% Growth 1986	The percent growth in AADT for each segment for 1986
% Growth 1987	The percent growth in AADT for each segment for 1987
% Growth 1988	The percent growth in AADT for each segment for 1988
% Growth 1989	The percent growth in AADT for each segment for 1989
% Growth 1990	The percent growth in AADT for each segment for 1990
% Growth 1991	The percent growth in AADT for each segment for 1991
% Growth 1992	The percent growth in AADT for each segment for 1992
% Growth 1993	The percent growth in AADT for each segment for 1993
% Growth 1994	The percent growth in AADT for each segment for 1994
% Growth 1995	The percent growth in AADT for each segment for 1995
% Growth 1996	The percent growth in AADT for each segment for 1996
% Growth 1997	The percent growth in AADT for each segment for 1997
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% Growth 1999	The percent growth in AADT for each segment for 1999
% Growth 2000	The percent growth in AADT for each segment for 2000
% Growth 2001	The percent growth in AADT for each segment for 2001
% Growth 2002	The percent growth in AADT for each segment for 2002
% Growth 2003	The percent growth in AADT for each segment for 2003
% Growth 2004	The percent growth in AADT for each segment for 2004
% Growth 2005	The percent growth in AADT for each segment for 2005
% Growth 2006	The percent growth in AADT for each segment for 2006
% Growth 2007	The percent growth in AADT for each segment for 2007
% Growth 2008	The percent growth in AADT for each segment for 2008
% Growth 2009	The percent growth in AADT for each segment for 2009
% Growth 2010	The percent growth in AADT for each segment for 2010
% Growth 2011	The percent growth in AADT for each segment for 2011
% Growth 2012	The percent growth in AADT for each segment for 2012
% Growth 2013	The percent growth in AADT for each segment for 2013
% Growth 2014	The percent growth in AADT for each segment for 2014
% Growth 2015	The percent growth in AADT for each segment for 2015
% Growth 2016	The percent growth in AADT for each segment for 2016
% Growth 2017	The percent growth in AADT for each segment for 2017
% Growth 2018	The percent growth in AADT for each segment for 2018
% Growth 2019	The percent growth in AADT for each segment for 2019
% Growth 2020	The percent growth in AADT for each segment for 2020

Worksheets in TwoStdDev_ESAL_Table

Number of Lanes	
Column	Description
SECTID	The segment number as designated by ADOT (ADOT uses segment and SECTID interchangeably)
LANES	Value taken from *TR9397C.xls*
# Lanes 1993	The number of lanes for each segment in 1993
# Lanes 1994	The number of lanes for each segment in 1994
# Lanes 1995	The number of lanes for each segment in 1995
# Lanes 1996	The number of lanes for each segment in 1996
# Lanes 1997	The number of lanes for each segment in 1997
# Lanes 1998	The number of lanes for each segment in 1998
# Lanes 1999	The number of lanes for each segment in 1999
# Lanes 2000	The number of lanes for each segment in 2000
# Lanes 2001	The number of lanes for each segment in 2001
# Lanes 2002	The number of lanes for each segment in 2002
# Lanes 2003	The number of lanes for each segment in 2003
# Lanes 2004	The number of lanes for each segment in 2004
# Lanes 2005	The number of lanes for each segment in 2005
# Lanes 2006	The number of lanes for each segment in 2006
# Lanes 2007	The number of lanes for each segment in 2007
# Lanes 2008	The number of lanes for each segment in 2008
# Lanes 2009	The number of lanes for each segment in 2009
# Lanes 2010	The number of lanes for each segment in 2010
# Lanes 2011	The number of lanes for each segment in 2011
# Lanes 2012	The number of lanes for each segment in 2012
# Lanes 2013	The number of lanes for each segment in 2013
# Lanes 2014	The number of lanes for each segment in 2014
# Lanes 2015	The number of lanes for each segment in 2015
# Lanes 2016	The number of lanes for each segment in 2016
# Lanes 2017	The number of lanes for each segment in 2017
# Lanes 2018	The number of lanes for each segment in 2018
# Lanes 2019	The number of lanes for each segment in 2019
# Lanes 2020	The number of lanes for each segment in 2020

Worksheets in TwoStdDev_ESAL_Table

Total Theoretical Capacity	
Column	Description
SECTID	The segment number as designated by ADOT (ADOT uses segment and SECTID interchangeably)
Year 1997	The total theoretical capacity for all lanes for each segment for 1997
Year 1998	The total theoretical capacity for all lanes for each segment for 1998
Year 1999	The total theoretical capacity for all lanes for each segment for 1999
Year 2000	The total theoretical capacity for all lanes for each segment for 2000
Year 2001	The total theoretical capacity for all lanes for each segment for 2001
Year 2002	The total theoretical capacity for all lanes for each segment for 2002
Year 2003	The total theoretical capacity for all lanes for each segment for 2003
Year 2004	The total theoretical capacity for all lanes for each segment for 2004
Year 2005	The total theoretical capacity for all lanes for each segment for 2005
Year 2006	The total theoretical capacity for all lanes for each segment for 2006
Year 2007	The total theoretical capacity for all lanes for each segment for 2007
Year 2008	The total theoretical capacity for all lanes for each segment for 2008
Year 2009	The total theoretical capacity for all lanes for each segment for 2009
Year 2010	The total theoretical capacity for all lanes for each segment for 2010
Year 2011	The total theoretical capacity for all lanes for each segment for 2011
Year 2012	The total theoretical capacity for all lanes for each segment for 2012
Year 2013	The total theoretical capacity for all lanes for each segment for 2013
Year 2014	The total theoretical capacity for all lanes for each segment for 2014
Year 2015	The total theoretical capacity for all lanes for each segment for 2015
Year 2016	The total theoretical capacity for all lanes for each segment for 2016
Year 2017	The total theoretical capacity for all lanes for each segment for 2017
Year 2018	The total theoretical capacity for all lanes for each segment for 2018
Year 2019	The total theoretical capacity for all lanes for each segment for 2019
Year 2020	The total theoretical capacity for all lanes for each segment for 2020

% Vehicle Type Table	
Column	Description
SEGMENT	The segment number as designated by ADOT
ATR	The Automatic Traffic Recorder number associated with each segment
CLASS	The classification station number associated with each segment
% Cls 4	The percentage of FHWA class 4 vehicles for each segment
% Cls 5	The percentage of FHWA class 5 vehicles for each segment
% Cls 6	The percentage of FHWA class 6 vehicles for each segment
% Cls 7	The percentage of FHWA class 7 vehicles for each segment
% Cls 8	The percentage of FHWA class 8 vehicles for each segment
% Cls 9	The percentage of FHWA class 9 vehicles for each segment
% Cls 10	The percentage of FHWA class 10 vehicles for each segment
% Cls 11	The percentage of FHWA class 11 vehicles for each segment
% Cls 12	The percentage of FHWA class 12 vehicles for each segment
% Cls 13	The percentage of FHWA class 13 vehicles for each segment
Year	Year when calculations of vehicle class percentages was performed for each segment