Research Report
KTC-93-13

WEIGH STATION BYPASSING

by

Herbert F. Southgate
Research Engineer

Joseph D. Crabtree
Research Engineer

Jerry G. Pigman
Research Engineer

and

Nikiforos Stamatiadis
Assistant Professor

Kentucky Transportation Center
College of Engineering
University of Kentucky
Lexington, Kentucky

in cooperation with

Kentucky Transportation Cabinet
Commonwealth of Kentucky

and

Federal Highway Administration
U.S. Department of Transportation

May 1993

COMMONWEALTH OF KENTUCKY
TRANSPORTATION CABINET
FRANKFORT, KENTUCKY 40622

DON C. KELLY, P.E.
SECRETARY OF TRANSPORTATION

JERRY D. ANGLIN
DEPUTY SECRETARY
AND
COMMISSIONER OF HIGHWAYS

BRERETON C. JONES
GOVERNOR

June 1, 1994

Mr. Paul E. Toussaint
Division Administrator
Federal Highway Administration
330 West Broadway
Frankfort, KY 40601

SUBJECT: IMPLEMENTATION STATEMENT
Research Study, "Weigh Station Bypassing: Causative Factors and Enforcement Costs," (KYHPR-91-136)

Dear Mr. Toussaint:

The subject study did not find significant numbers of trucks modifying their route choices in order to avoid enforcement activity. However, trucks on non-Interstate routes do have a much higher frequency of violations than trucks on Interstates. Therefore, three of the study's six recommendations deal directly with non-Interstate enforcement. These recommendations appear reasonable and will be undertaken (within the constraints of available manning).

The study also recommends pursuing innovative options for expediting weigh station operations, which could allow resources to be shifted to non-Interstate enforcement. Investigations of this type are currently being conducted through two Intelligent Vehicle Highway Systems (IVHS) projects on Interstates 65 and 75.

The fifth recommendation, dealing with the accuracy of statewide WIM data, is currently being addressed by another research study (KYHPR-94-159). The final recommendation, dealing with the use of WIM data to direct enforcement efforts, will be jointly explored by the Division of Planning and the Division of Motor Vehicle Enforcement.

Sincerely,

J.M. Yowell, P.E.
State Highway Engineer

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
KTC-93-13		

4. Title and Subtitle
Weigh Station Bypassing

5. Report Date
May 1993

6. Performing Organization Code

7. Author(s)
H.F. Southgate, J.D. Crabtree, J.G. Pigman, N. Stamatiadis

8. Performing Organization Report No.
KTC-93-13

9. Performing Organization Name and Address
Kentucky Transportation Center
College of Engineering
University of Kentucky
Lexington, KY 40506-0043

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
KYHPR-91-136

13. Type of Report and Period Covered
Final Report

12. Sponsoring Agency Name and Address
Kentucky Transportation Cabinet
State Office Building
Frankfort, KY 40622

14. Sponsoring Agency Code

15. Supplementary Notes
Prepared in cooperation with the Federal Highway Administration, US Department of Transportation.
Study Title: Weigh Station Bypassing: Causative Factors and Enforcement Costs

16. Abstract

A Study was initiated in May of 1990 to investigate the problem of trucks bypassing or avoiding weigh/enforcement stations in Kentucky. A literature review identified two major studies (Wisconsin and Florida) on the subject, both of which are summarized in this report. In addition, a 1989, limited-scope study of truck bypassing of weigh stations in Kentucky was reviewed and summarized.

The primary data collection effort for this study took place in the fall of 1990, centered around the Simpson County enforcement station on Interstate-65. Three potential bypass routes were identified. Automatic vehicle classification (AVC) and weigh-in-motion (WIM) equipment was installed on I-65 and on all three bypass routes. Data collection took place over a three-week period, with enforcement on the bypass routes during the second week.

Significant conclusions of the study include: 1) While weigh station bypassing does occur in Kentucky, there was no indication of significant numbers of trucks modifying their route choices due to enforcement activity on the bypass routes; 2) Average truck weights and the percentage of trucks overweight are higher on bypass routes than on Interstate routes, but this is not primarily a result of bypassing activity; 3) The majority of trucks on bypass routes have legitimate reasons (in terms of origin or destination) to be on those routes; 4) A high percentage of trucks on bypass routes have violations, regardlesss of whether the trucks have a local origin/destination along the route; 5) The most common inspection violations on bypass routes are safety-related equipment violations, followed by driver violations; 6) Temporary enforcement efforts on bypass routes can be effective and can be self-supporting through citation revenues; 7) Due to accuracy limitations, high speed WIM data may not be appropriate for certain uses.

The following recommendations were developed: 1) A statewide enforcement plan should be developed with increased emphasis on enforcement for non-Interstate routes; 2) Innovative options should be investigated to simplify or expedite weigh station operations; 3) Enforcement efforts on non-Interstate routes should be randomized and unpredictable and should include weighing of trucks; 4) Effectiveness measures should be developed and used to monitor non-Interstate enforcement efforts; 5) The accuracy of statewide WIM data should be assessed; 6) The potential for using statewide WIM data to identify problem areas and direct enforcement efforts should be explored, and a formal process should be established to foster this cooperative effort.

17. Key Words	18. Distribution Statement
Truck Bypassing Weight Enforcement Scale avoidance	Unlimited, with approval of the Kentucky Transportation Cabinet.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	48	

METRIC CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO METRIC UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in.	inches	25.40000	millimetres	mm
ft	feet	0.30480	metres	m
yd	yards	0.91440	metres	m
mi	miles	1.60934	kilometres	km
		AREA		
$in.^2$	square inches	645.16000	millimetres squared	mm^2
ft^2	square feet	0.09290	metres squared	m^2
yd^2	square yards	0.83613	metres squared	m^2
ac	acres	0.40469	hactares	ha
mi^2	square miles	2.58999	kilometres squared	km^2
		FORCE		
kip	pound-force	4.44822	kilonewton	kN
		VOLUME		
fl oz	fluid ounces	29.57353	millilitres	ml
gal.	gallons	3.78541	litres	l
ft^3	cubic feet	0.02832	metres cubed	m^3
yd^3	cubic yards	0.76455	metres cubed	m^3
		PRESSURE		
psi	pound-force per square inch	6.89476	kilopascal	kPa
		MASS		
oz	ounces	28.34952	grams	g
lb	pounds	0.45359	kilograms	kg
T	short tons (2000 lb)	0.90718	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9	Celsius temperature	°C

APPROXIMATE CONVERSIONS FROM METRIC UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimetres	0.03937	inches	in.
m	metres	3.28084	feet	ft
m	metres	1.09361	yards	yd
km	kilometres	0.62137	miles	mi
		AREA		
mm^2	millimetres squared	0.00155	square inches	$in.^2$
m^2	metres squared	10.76392	square feet	ft^2
m^2	metres squared	1.19599	square yards	yd^2
ha	hactares	2.47103	acres	ac
km^2	kilometres squared	0.38610	square miles	mi^2
		FORCE		
kN	kilonewton	0.22481	pound-force	kip
		VOLUME		
ml	millilitres	0.03381	fluid ounces	fl oz
l	litres	0.28417	gallons	gal.
m^3	metres cubed	35.31448	cubic feet	ft^3
m^3	metres cubed	1.30795	cubic yards	yd^3
		PRESSURE		
kPa	kilopascal	0.14504	pound-force per square inch	psi
		MASS		
g	grams	0.03527	ounces	oz
kg	kilograms	2.20462	pounds	lb
Mg	megagrams	1.10231	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius temperature	1.8C + 32	Fahrenheit temperature	°F

TABLE OF CONTENTS

EXECUTIVE SUMMARY

e the capability for state agencies to monitor trucks for proper operation with regard to weights, vehicle safety, registration, and other credentials. There is a concern that trucks may be avoiding enforcement stations by choosing alternate routes (called bypass routes), thus preventing detection of overweight conditions or other violations.

Two major studies of weigh station avoidance by trucks have been conducted in other states. A 1986 study in Wisconsin (1) found significant evidence of truck bypassing and determined that trucks on the bypass routes were much more likely to have violations (particularly safety and driver violations) than trucks on the mainline. A 1990 study in Florida (4) also found significant evidence of bypassing activity and determined that trucks on the bypass routes are more likely to be overweight (and by a greater amount) than trucks at the weigh station.

A limited study of weigh station avoidance in Kentucky was conducted during the summer of 1989 as part of the "Integrated Truck Monitoring System" study (5). That study concluded that the temporary opening of a weigh station is accompanied by an increase in the number of trucks on bypass routes and an increase in the percentage of trucks on bypass routes that are heavily laden.

The primary data collection for this study was conducted in September and October of 1990. The study area was centered around the Simpson County enforcement station on Interstate-65 near the Kentucky-Tennessee border. Data were collected using weigh-in-motion (WIM) and automatic vehicle classification (AVC) equipment, which was installed on Interstate-65 and on three potential bypass routes. The weigh station remained open throughout the three-week data collection period, and an intensive enforcement effort was carried out on the bypass routes during the second week.

The truck volume data collected by the AVC equipment were analyzed to determine if the heavy enforcement activity on the bypass routes caused a shift in route choice by truckers. The analysis did indicate a possible shift in truck traffic, but it was fairly small. This analysis did not generate any strong evidence for the existence of significant bypassing activity.

A fairly extensive analysis was conducted of the WIM data from the I-65 site and the three bypass routes. This analysis concentrated primarily on average weight per truck and percentage of trucks overweight. Looking at average weight per truck, the bypass route carrying the heaviest trucks in week 1 experienced a 1,000 pound reduction per truck in week 2. The other routes were virtually unchanged. The analysis of the percentage of trucks overweight was rather inconclusive, offering no strong indication that the overweight percentages were affected by the enforcement efforts.

Inspection and citation forms from the enforcement efforts on the bypass routes were analyzed, resulting in some interesting and significant findings. For the three bypass routes combined, about 60 percent of the trucks inspected were found to have at least one violation. Thirty percent had violations serious enough to be placed out of service. The most common violations noted during the inspections were safety-

related equipment violations, followed by driver violations. Based upon origin and destination information on the inspection sheets, it was determined that two-thirds of the trucks on the bypass routes had legitimate reasons for using those routes. In other words, most of the trucks on the bypass routes were there because they had local origins or destinations serviced by the selected route.

There was no apparent relationship between a truck's "legitimacy" for using the bypass route (based on origin/destination) and the likelihood or seriousness of violations. Trucks classified as "bypass" (based on origin/destination) were no more likely to have violations than those trucks classified as "legitimate". Of the citations written on the three bypass routes, the most common was failure to display a valid Kentucky identification card. The next three most common violations were related to licensing, registration, and identification.

A second data collection effort was conducted in October of 1991, centered around the Kenton County weigh station on southbound Interstate-75 in northern Kentucky. The analysis of these data yielded no significant conclusions.

The file of statewide WIM data, collected and maintained by the Division of Planning of the Kentucky Department of Highways, was analyzed to determine average truck weights and overweight percentages at various sites throughout the state. This analysis did not result in any significant findings.

The most significant conclusions of this study can be summarized as follows:

1. While it is generally accepted that weigh station bypassing does occur in Kentucky, there was no indication of significant numbers of trucks modifying their route choices based on enforcement activity on the selected bypass routes.

2. Average truck weights and percent of trucks overweight are higher on bypass routes than on Interstate routes, but this is not primarily a result of bypassing activity.

3. The majority of trucks on bypass routes have legitimate reasons (in terms of origin or destination) for being on those routes.

4. A high percentage of trucks on bypass routes have violations. This is true whether or not they have legitimate reasons for being on the routes.

5. The most common inspection violations on bypass routes are safety-related equipment violations. Driver violations are the next most common.

6. Temporary enforcement efforts on bypass routes may be extremely effective in identifying violations and issuing citations. Such efforts can be self-supporting through the revenue generated from citations.

7. Due to accuracy considerations and data "scatter," high-speed WIM data may not be appropriate for certain uses.

The following recommendations resulted from this study:

1. A statewide enforcement plan should be developed with increased emphasis on enforcement for non-Interstate routes. Enforcement agency manning should be adjusted to allow proper emphasis on non-Interstate enforcement.

2. Innovative options for simplifying or expediting weigh station enforcement operations should be investigated and, where appropriate, implemented. This would allow weigh station personnel to be shifted to non-Interstate enforcement.

3. Enforcement efforts on non-Interstate routes should be random and unpredictable, and should not remain at one location for more than 24 hours. Insofar as practical, all loaded trucks should be weighed.

4. Effectiveness measures should be developed for non-Interstate enforcement and should be used for ongoing monitoring of those enforcement efforts.

5. The accuracy of statewide WIM data should be assessed. Guidelines and limitations for proper use of the data should be developed and disseminated.

6. The potential for using statewide WIM data to identify problem areas and direct enforcement efforts should be explored. A formal process should be developed and implemented to foster ongoing cooperation in this effort between the Division of Planning and the Division of Motor Vehicle Enforcement.

ACKNOWLEDGEMENTS

This report was prepared in consultation with and under the guidance of the following members of the Study Advisory Committee:

Don Ecton	Division of Planning, Department of Highways
Rob Bostrom	Division of Planning, Department of Highways
Barry House	Division of Planning, Department of Highways
Fred Eckhart	Division of Planning, Department of Highways
Dan O'Dea	Division of Planning, Department of Highways
Bill Stutzenberger	Division of Planning, Department of Highways
Ben Elder	Kentucky State Police
Joe Breeze	Division of Motor Vehicle Enforcement, Department of Vehicle Regulation
John Robey	Division of Motor Vehicle Enforcement, Department of Vehicle Regulation
Steve Maffett	Division of Motor Vehicle Enforcement, Department of Vehicle Regulation
David Herald	Division of Motor Vehicle Enforcement, Department of Vehicle Regulation
Leon Walden	Federal Highway Administration
Glen Jilek	Federal Highway Administration

Others whose contributions to this study are also gratefully acknowledged include the following:

Steve Anders	Division of Motor Vehicle Enforcement, Department of Highways
Dan Inabnitt	Division of Planning, Department of Highways
Carla Crossfield	Kentucky Transportation Center
David Cain	Kentucky Transportation Center
JoAnn Browning	Kentucky Transportation Center
Susan Walden	Kentucky Transportation Center

INTRODUCTION

BACKGROUND

Weigh/enforcement stations provide the capability for state agencies to monitor trucks to determine if the vehicles are being properly operated in terms of weights, vehicle safety, registration, and other credentials. In addition, information collected at enforcement stations is used in tax assessment, which makes it an important factor in state revenue.

There is a concern that many trucks may be avoiding enforcement stations by taking alternate routes (also called bypass routes). Observations by enforcement personnel have reinforced that concern. If trucks are, in fact, avoiding enforcement stations, the consequences could be highly significant. Weight requirements could be violated without detection, resulting in pavement and structural damage. Safety requirements could also be violated without detection, resulting in accidents, injuries, and fatalities. Truck travel measurements for tax assessment could be understated, resulting in reduced revenue. These effects are amplified by the fact that the bypass routes are usually lower-class highways, with less capability to handle overloaded trucks and truck traffic in general. Trucks on these bypass routes may also have an adverse effect on the level of service of the route and the quality of life adjacent to the route.

To properly evaluate and respond to the truck avoidance problem, it is important to assess the extent and the significance of the problem. If the problem is determined to be significant, then alternative methods of enforcing truck regulations and monitoring truck activity need to be explored. These alternatives should be evaluated in terms of their potential effectiveness, benefits, and costs.

During the summer of 1989, a limited analysis of weigh station bypassing in Kentucky was conducted by the Kentucky Transportation Center as part of the "Integrated Truck Monitoring System" study. The results of that limited analysis are described briefly in the "Literature Review" section of this report. The results of that limited analysis prompted a desire for a more in-depth analysis.

OBJECTIVES

This study was initiated in May of 1990 to investigate the problem of trucks bypassing or avoiding weigh/enforcement stations in Kentucky. The objectives of the study were defined as:

1. To determine the extent of trucks bypassing weigh/enforcement stations.

2. To review bypass studies in other states to determine if patterns exist on a national level that may be of interest when addressing bypass activity in Kentucky.

3. To use data from the study to determine if changes are necessary in the

current enforcement programs to more effectively deal with the issue of bypassing.

4. To evaluate the cost effectiveness of increased enforcement to improve safety and revenue collection efficiency.

To accomplish these objectives, a work plan was devised which included the following tasks:

1. A review of literature to determine if information from studies conducted by other agencies can be applied to Kentucky.

2. A review of Kentucky's current enforcement program to gain a thorough understanding of current enforcement procedures. This was a prerequisite to evaluating current procedures and recommending any changes that may be needed.

3. Data collection and analysis to determine the extent of trucks using bypass routes to avoid enforcement stations.

4. Development of recommendations. This will include an evaluation of the potential for using advanced electronic data collection systems, such as automatic vehicle classification (AVC) equipment and weigh-in-motion (WIM) equipment, to ensure greater conformity with weight, safety, credentials, and revenue requirements.

5. Preparation of report.

LITERATURE REVIEW

The literature review revealed two major studies dealing with truck avoidance of weigh stations. One of the studies was conducted in Wisconsin in October of 1986. That study generated three reports, one from an enforcement perspective (1), one from a planning perspective (2), and one from a combined perspective (3). The other study, for which a draft version of the final report was obtained, was conducted in Florida in February through April of 1990 (4). Both of these studies were excellent sources of information, and they provided valuable input for this study.

In addition to the studies in Wisconsin and Florida, a limited study was conducted in Kentucky as part of the "Integrated Truck Monitoring System" study by the Kentucky Transportation Center (5). That study was conducted during the summer of 1989.

Anyone having a strong interest in truck avoidance of weigh stations should obtain copies of the referenced reports. For those who do not plan to seek out those reports, brief summaries have been prepared for inclusion in this report. As in any effort to summarize the work of others, omissions or misinterpretations may have

been made. Therefore, these summaries are intended only as general overviews for background information.

WISCONSIN STUDY

The stated objectives of the Wisconsin study were:

1. Quantify the extent of scale avoidance (by truck volume, by overweight trucks, and by equivalent single axle loads (ESALs)).

2. Illustrate the use of WIM truck avoidance data for pavement design.

3. Test the application of WIM technology in truck weight enforcement and recommend modifications to future enforcement activity.

4. Test the accuracy, reliability, utility, practicality, and limitations of WIM equipment.

5. Conduct a model scale avoidance study for use by other states.

The location selected for the study was the Rusk scale on westbound Interstate-94 in northwestern Wisconsin. 60,000 trucks were monitored over 248 study hours during October 1986. Monitoring took place from 9AM Tuesday to 9AM Friday (72 hours) on three consecutive weeks and from 9AM Tuesday to 5PM Wednesday (32 hours) on the fourth week. Each week represented a different phase of data collection, as described below:

Phase 1: Scale closed, no enforcement (baseline).
Phase 2: Scale open, no enforcement on bypass routes.
Phase 3: Scale open, wing enforcement on major bypass route.
Phase 4: Scale open, wing enforcement on major and secondary bypass routes.

The data collection was accomplished using portable, high-speed WIM equipment on the major bypass route and on the mainline one mile before the scale. Counter/classifiers were used on the secondary bypass routes. Low speed WIM was used at the scale itself. There was already a high-speed bridge WIM installation 27 miles downstream of the scale on I-94.

Results:

When the scales were opened in Phase 2, the following changes were noted in the truck traffic:

1. Mainline truck traffic dropped by 15%.

2. Truck traffic on the major bypass route increased 32%.
3. Downstream I-94 (bridge WIM) showed no drop in truck traffic; i.e., trucks were returning to the mainline after bypassing.
4. Diversion was more pronounced for 3S2 trucks and during evening hours.
5. The percentage of trucks overweight on the major bypass jumped from 4% (phase 1) to 18% (3S2's only). The mainline overweight percentage dropped from 14% to 13%.
6. Mainline ESALs (total) dropped 16%, while total ESALs on the major bypass more than tripled.

For phase 3, as compared with the baseline of phase 1:

1. Mainline truck traffic was down 18%.
2. Truck traffic on the major bypass route was up 18%, significantly less than phase 2.
3. Downstream I-94 showed a 9% drop in truck traffic, indicating wider diversion. Truck traffic on I-90 (the most distant bypass route monitored) was up 18%.
4. Time avoidance was higher than in phase 2.
5. The percentage of trucks overweight on the major bypass was 7%, much less than phase 2. The mainline overweight percentage dropped to 10%.
6. Mainline ESALs were down 23%.

For phase 4, as compared with the baseline of phase 1:

1. Mainline truck traffic was down 17%.
2. Truck traffic on the major bypass route was down 51%.
3. Truck volumes on all secondary bypasses were up.
4. Very little time avoidance was observed.

Key Findings:

1. Scale avoidance ranged from 15% to 18% by volume, from 6% to 34% by overweight trucks, and from 14% to 26% by ESALs.

2. As enforcement levels changed, total ESALs on the mainline decreased, but ESALs per truck was essentially unchanged.

3. 1987 ESAL factors used by Wisconsin pavement design engineers since 1987 are adequate.

4. Enforcement is necessary on mainlines, but more portable weighing on bypass routes should be coordinated with scale operation.

5. Geographic avoidance increases and becomes more remote as

enforcement increases.

6. Diversion to the major bypass route was by far the highest under phase 2, and predominantly during evening hours.

7. Pad WIM equipment did not stand up well to prolonged continuous operation. Bridge WIM equipment is inherently limiting and tends to malfunction.

8. The effects of scale avoidance were estimated as a two-year reduction in the pavement life of the major bypass route, a one year extension in the life of the mainline, and unknown effects on the secondary bypass routes.

9. Of the trucks diverting to the bypass routes:
   51% had safety violations
   24% had driver violations
   8% had weight violations
   4% had registration violations
   13% had no violations

10. During scale operations, trucks on the bypass routes (as compared to trucks on the mainline):
   - were 8 times more likely to have weight violations.
   - were 65% more likely to have driver violations.
   - were 14% more likely to have safety violations.
   - were only 1/3 as likely to have no violations.

FLORIDA STUDY

The stated objective of the Florida study was to assess the magnitude, expressed in equivalent single axle loads (ESALs), of the overweight truck weigh station avoidance problem. Additional consideration was given to determining whether the bypassing traffic was local, regional, or inter-regional in nature. The Interstate-95 corridor in the northeast corner of Florida was selected as the study area. Two permanent weigh stations and four bypass routes were used as traffic monitoring sites.

Data were collected under four enforcement strategies:

Strategy A: Scales open with no overweight citations issued.
Strategy B: Scales open with no enforcement teams patrolling the bypass routes. Citations were issued at the weigh scales.
Strategy C: Scales open with some enforcement teams patrolling the bypass routes (normal patrolling).

Strategy D: Scales open with maximum possible enforcement on bypasses and at selected rest areas (intensive enforcement).

Weight information was collected continuously at all sites throughout all four enforcement strategies, using mat WIM systems or static scales. Truck classification was accomplished by the WIM software, or by AVC equipment at the permanent weigh stations. Determination of proportions of trucks attributable to local, intrastate, and interstate traffic was accomplished by observation for one-hour periods within each strategy for each site.

Key findings:

1. The percentage of trucks in the entire corridor exceeding gross weight limits decreased markedly as the level of enforcement was increased. A similar decrease was found for tandem axle weights.

2. The average number of ESALs per truck decreased over the study period at each site.

3. In general, with regard to citations issued during the study, the violations at the permanent weigh stations were minor while those on the bypass routes were much more severe.

4. Most of the violators on the bypass routes were local and seriously overweight. Most of the violators at the permanent weigh stations were interstate truckers who were less than five percent overweight.

5. With increasing enforcement, the truck volumes decreased at the permanent weigh station on I-95.

6. The average number of ESALs per truck for the corridor was 1.8 for Strategy A, 1.6 for Strategy B, and 1.2 for Strategies C and D.

7. During Strategies A and B, approximately 90 percent of the corridor ESALs (from type 3S2 trucks) passed through the permanent weigh stations. That percentage dropped to 85 percent under Strategy C and 80 percent under Strategy D.

8. During the intensive enforcement of Strategy D, approximately 60 percent of the citations were issued at the weigh stations, while 40 percent were issued on the bypass routes. Eight percent of the trucks were overweight at the weigh stations, compared to 19 percent on the bypass routes. Trucks cited on the bypass routes weighed an average of 1,000 pounds more than those cited at the weigh stations.

Conclusions:

1. Trucks evade enforcement stations to a greater degree than assumed by Florida enforcement personnel.

2. WIM equipment is effective in identifying overweight trucks on bypass routes.

3. Portable weighmat WIM systems are not suitable for extended data collection sessions.

4. The overweight truck problem is dynamic and is difficult to quantify in the absence of permanent data collection equipment.

Recommendations:

1. Define the "area of influence" of each weigh station. Develop patrol schedules to address violation problems. (Patrol tactics should be randomized or use frequent concerted efforts similar to Strategy D.) For each area of influence, establish an enforcement data collection cordon to record enforcement data and to document enforcement efforts on bypass routes.

2. Consider a reporting requirement for Title 23 compliance in the area of weigh station bypass enforcement.

3. Install permanent WIM equipment on three or more bypass routes to monitor traffic. Use the resulting data to develop strategic enforcement activities.

4. Carry out a "Strategy D" enforcement operation for a long enough time period to identify the point of diminishing returns.

5. Assign additional positions to weigh stations and increase the level of patrol on bypass routes.

LIMITED KENTUCKY STUDY

The Kentucky study of weigh station avoidance was conducted within a larger study entitled "Integrated Truck Monitoring System". The objective of that limited study was to ascertain whether active inspection at permanent weigh stations affected route choice by operators of large trucks. Three permanent stations were included in the study; Interstate-75 in Scott County, Interstate-75 in Laurel County, and Interstate-64 in Shelby County.

Data collection was conducted on the mainline and on bypass routes with the

weigh stations open and with them closed. The data collection included manual classification counts, AVC data, and WIM data. (However, no AVC or WIM data were collected on the mainline during open operations). The data were used to test the following four hypotheses:

1. On bypass routes, the number of large trucks is greater when the mainline inspection station is open than when it is closed. (Large trucks were defined as those having three or more axles.)
2. On bypass routes, the proportion of all vehicles that are classified as large trucks is greater when the mainline inspection station is open than when it is closed.
3. On bypass routes, the proportion of all large trucks that are heavily laden is greater when the mainline inspection station is open than when it is closed. (Heavily laden was defined as exceeding bridge formula limits.)
4. The proportion of large trucks, in a corridor, that use bypass routes is greater when the mainline inspection station is open than when it is closed.

Altogether, 14 comparisons were made between open and closed operations. In 9 of the 14 comparisons, there was a statistically significant shift toward larger and/or heavier trucks on the bypass routes during open operations. The greatest increase was observed in Shelby County, where opening the weigh station resulted in approximately four more large trucks per hour on the bypass route, while the percentage of trucks that were heavily laden increased from 11 to 45 percent.

The study concluded that the temporary opening of a weigh station is accompanied by an increase in the number of trucks on bypass routes and an increase in the percentage of trucks on bypass routes that are heavily laden.

REVIEW OF KENTUCKY'S CURRENT ENFORCEMENT PROGRAM

There are 11 permanent weight enforcement station locations in Kentucky, all of which, at the time of data collection for this study, operated 24 hours a day, seven days a week[1]. Five of these are dual-direction stations and six are single-direction. In addition, there are two "port-of-entry" inspection stations in Western Kentucky, which operate 24 hours a day, five days a week. The port-of-entry stations do not have installed scales, but portable scales are available to use when a weight violation is suspected. Table 1 lists all of Kentucky's enforcement stations. The locations of the stations are shown in Figure 1.

Enforcement of laws and regulations regarding truck travel in Kentucky is carried out by the Division of Motor Vehicle Enforcement, which is a part of the Department of Vehicle Regulation of the Kentucky Transportation Cabinet. The

[1]Due to manpower shortages, some weigh stations now close one day each weekend.

Division of Motor Vehicle Enforcement is divided into nine regions, as shown in Figure 2. There is a Captain in charge of each region, with manning assigned as appropriate for the region's responsibilities. Table 2 describes the responsibilities, organization, and manning of each region (as of May 1992). Each region has responsibility for one or more enforcement stations. In addition, four of the regions have patrol units specifically assigned to roadside, or "roving" work.

The majority of the manning in the regions is assigned to the weigh/enforcement stations. Looking specifically at the assignment of Captains, Lieutenants, Officers, and Inspectors, only 16 out of 196 are assigned to patrols or "roving" enforcement. The remaining 180 are assigned to the enforcement stations. The manning of the enforcement stations is sufficient to support around-the-clock operation of the stations, but does not provide extra personnel to accomplish enforcement on potential bypass routes. Therefore, most enforcement on non-Interstate routes is accomplished using officers on overtime. This is especially true in those five regions which have no patrol units.

Enforcement of a bypass route is normally conducted using a moving patrol of one or two officers. When the route can be controlled from one stationary point where trucks can safely be flagged in, the officers may spend most of their time at that checkpoint. Each region schedules its own bypass coverage (when overtime is available) with loose oversight from central headquarters.

DESCRIPTION OF DATA COLLECTION

The primary data collection effort for this project took place in September and October of 1990. The enforcement station selected for the study was on Interstate-65 northbound in Simpson County. The study area is shown in Figure 3. The scale location is three miles from the Tennessee state line in south-central Kentucky. It is a significant corridor for truck traffic coming out of or through Nashville and heading toward Louisville, Lexington, Indianapolis, Cincinnati, Chicago, or other northern destinations. An attractive feature of this study location was that there were relatively few convenient bypass routes. Three routes were selected for monitoring: US 31W, US 31E, and US 431.

It is significant to note that there is another weigh station for northbound trucks just 5 miles south of the Simpson County station. That station is in Tennessee and, at the time of data collection, was being operated 24 hours a day, seven days a week. There is also another weigh station on Interstate-65 in Hardin County, 87 miles north of the Simpson County station. The presence of these other stations, particularly the Tennessee station, would affect the route choice of trucks wishing to bypass.

The Simpson County station is one of the most modern weigh stations in the United States. It uses WIM equipment to sort the trucks as they travel up the ramp to the station. The ramp then splits, and trucks are directed, using a variable message sign, to pass by the station at low speed or to go to the fixed scales. As a truck passes by the station or is positioned on the fixed scales, its identification number (KYU number) is read and entered into the weigh station computer. The

KYU number is instantaneously checked against the central database in Frankfort to ensure that the trucks credentials are valid. If a problem is detected with the truck's weight or KYU number, the truck is directed to a parking area and stopped. Otherwise, it will be directed back to the mainline. Some trucks are selected for inspection, based either on suspicion of a problem or random selection.

To collect data for the study, AVC and WIM equipment was installed on I-65 and on all three bypass routes. Figure 3 shows the locations where the equipment was installed. Unfortunately, the site selected on I-65 was not the best location. Because of the short distance between the interchange at milepoint 2 and the weigh station, the equipment was installed between the state line and the interchange. This means that some trucks recorded by the I-65 AVC and WIM equipment could exit at milepoint 2 and be detected again on US 31W. This would appear to be a major concern, because exiting at milepoint 2 provides the shortest bypass around the Simpson County weigh station. However, any truck seeking to bypass the Simpson County weigh station would also be expected to bypass the Tennessee weigh station (both are 24-hour-a-day operations). This makes it highly unlikely that a large number of bypassing trucks would exit at milepoint 2.

The AVC and WIM equipment was activated early in the week of September 24 and was allowed to collect data over a three-week period. The weigh station remained open throughout the three weeks of data collection. During the first week, no enforcement activities were conducted on the bypass routes. Thus, the first week of data represents a normal, baseline condition for comparison. During the second week, temporary inspection stations were set up on all three bypass routes. These temporary stations operated continuously throughout the second week, stopping trucks for inspection, checking of credentials, and completion of a survey form designed for this study. The safety inspection form and survey form are shown in Figures 4 and 5, respectively. Due to the volumes of truck traffic and the amount of time required to conduct an inspection, only a small fraction of the trucks (5 to 10 percent) could be inspected. Portable scales were available at each temporary enforcement station, but they were only used when an overweight condition was suspected. Because of the resources required for the bypass enforcement effort, the weigh station operated on a skeleton crew throughout the second week. Basically, the only activity that took place at the weigh station during that week was the recording of KYU numbers (and checking of credentials through the central database).

The all-out enforcement effort was stopped at the end of the second week, and the third week of data collection was conducted with no enforcement on the bypass routes (as in the first week).

A second data collection effort was conducted in October of 1991. That effort centered around the Interstate-75 corridor, southbound, in northern Kentucky. The study area is shown in Figure 6. The enforcement station is located in Kenton County about 5 miles south of the interchange with Interstate-71. This corridor is a major truck route from Cincinnati (and points north) to Lexington, Knoxville, Chattanooga, Atlanta, and other southern destinations.

The data collection took place over a two-week period, using AVC equipment at some locations and WIM equipment at others. Potential bypass routes monitored were US 25, US 27, KY 17, KY 467, and KY 491. Unfortunately, due to a combination of factors (number of potential bypass routes, shortages of enforcement personnel, and poor communications), the data collection was not coordinated with bypass enforcement efforts. This severely limited the usefulness of the data.

DATA ANALYSIS

SIMPSON COUNTY I-65

AVC Data

Using the data collected for the Interstate-65 corridor, the first analysis dealt with truck volume data collected by the AVC equipment. The volume data were used to test the assumption that truckers were choosing to use bypass routes to avoid being weighed and/or inspected at the mainline weigh station. If truckers were making route selections based upon the desire to avoid inspection, then the second-week enforcement efforts should be reflected in a shift of truck traffic, either back to the mainline or onto other, less-convenient bypass routes.

There was a concern that gaps in the data, caused by equipment malfunctions and staggered start-up times, would affect the validity of week-to-week and route-to-route comparisons. In order to strengthen confidence in those comparisons, a decision was made to limit the analysis to weekday data (from 7 AM Monday until 7 AM Saturday). In addition, a 48-hour period was identified (11 AM Wednesday through 11 AM Friday) for which there was uninterrupted data for every route in every week. All analyses performed on the full set of weekday data were also performed on the common 48-hour period. Results were compared for the two time periods, and any significant differences were noted in the text. Unless otherwise indicated, the results presented in the tables include all weekday data.

The results of the analysis are shown in Tables 3 through 5. Table 3 presents the truck volume, expressed in trucks per hour, for each of the routes during each week. Tables 4 and 5 present the same information in different ways, looking at the breakdown of total corridor traffic (Table 4) and the percentage changes in traffic from baseline values (Table 5). Comparing week 2 to week 1, the truck volumes on two of the bypass routes were lower in week 2, and the third route was unchanged. Overall, the truck volume on the bypass routes was reduced by 2.6%, a difference of less than one truck per hour. Meanwhile, the truck traffic on the Interstate decreased by 5.6%, or seven trucks per hour. As a result, total corridor truck traffic was reduced by 5%. If the analysis is limited to the 48-hour common time period, the bypass routes showed a 7.5% reduction from week 1 to week 2, while the Interstate truck volume dropped by only 3.3%. The resulting drop in total corridor truck traffic was 4.1%.

The volume shifts from week 1 to week 2 are difficult to explain and interpret. It appears that the bypass enforcement efforts may have caused some truckers to

divert to other, more distant routes. However, the shift is very small and could be the result of random fluctuations or other factors. It is also possible that the extensive enforcement efforts caused some truckers to avoid the corridor altogether, which could explain the drop in I-65 truck traffic. It is interesting to note, as shown in Table 4, that the bypass routes carried a greater proportion of the total corridor truck traffic in week 2 than in week 1. This does not support the theory that significant numbers of trucks are using the bypass routes to avoid inspections.

Some additional analyses of the volume data were conducted to provide general information on truck travel characteristics of the corridor. Results of these analyses are depicted in Figures 7 through 12. Figure 7 shows the variation in truck volumes on Interstate-65 over the course of a 24-hour weekday (averaged over the 15 weekdays of data collection). Figure 8 shows the same information for each of the bypass routes. Figure 9 shows the variation in truck volume by day of the week for Interstate-65, while Figure 10 shows the same information for the bypass routes. Figure 11 shows the breakdown of trucks by classification on Interstate-65, while Figure 12 shows the same breakdown for the bypass routes. Figure 13 shows the classification breakdown for each individual bypass route. The classifications used in Figures 11-13 are as follows:

Class 5	Straight Truck, 2 axles
Class 6	Straight Truck, 3 axles
Class 8	Tractor-semitrailer, 4 axles
Class 9	Tractor-semitrailer, 5 axles

WIM Data

An analysis of the WIM data collected on I-65 and the three bypass routes showed a 23-hour time slot (10 AM Thursday through 9 AM Friday) for which there was uninterrupted data from every route in every week. As with the AVC data, all analyses of WIM data were performed using the full set of weekday data, and were then repeated using the 23-hour common time period. The analyses were carefully compared, and any significant differences were noted. All tables, unless otherwise indicated, show results for the full set of weekday data.

Late in the first week of data collection, a problem was discovered in the setup of the WIM equipment on Interstate-65. The problem was immediately corrected, but later analysis revealed that the first week of data contained inaccuracies. Therefore, the first week of data from I-65 had to be discarded.

Two primary measures were used in evaluating the WIM data: average weight per truck and percentage of trucks overweight. All WIM weights were corrected to static equivalent weights (using a program developed for that purpose by the Kentucky Transportation Center) before being used in calculations.

The assumption to be tested was that operators of overweight trucks were using bypass routes to avoid being weighed at the weigh stations. If that assumption was true, then drivers of those trucks would be expected to choose other routes during the enforcement efforts of the second week. That, in turn, would cause a reduction in the average weight per truck and the percentage of trucks overweight

on the bypass routes.

Average Weight per Truck:

The summary of average weights per truck is presented in Table 6. Although the first-week average for the Interstate is missing (as discussed previously), it is reasonable to assume that it would be in the range of 41,000 to 42,000 pounds per truck, as it was for the other two weeks. Thus, for the baseline condition, US 31E had a significantly higher average truck weight than the Interstate, while the other bypass routes were very similar to the Interstate. The average weight per truck decreased slightly for US 31E from week 1 to week 2, while the other two bypass routes were virtually unchanged. The reduction in truck weights on US 31E, amounting to about 1,000 pounds per truck, was still only a 2% reduction. It is interesting to note that the route carrying the heaviest trucks experienced the most noticeable reduction.

From week 2 to week 3, the Interstate truck weights remained virtually unchanged, as did those on US 31E and US 31W. US 431 experienced a dramatic jump in average truck weight (12%), which is difficult to explain and may be related to an equipment malfunction. A failure of the WIM equipment on US 431 resulted in a gap of over 50 hours during the middle of the third week. Restricting the analysis to the 23-hour common time period does not eliminate the increase in truck weights on US 431, but it does reduce the magnitude of the increase (8% rather than 12%). In the absence of any logical explanation for truck weights increasing dramatically, we can only speculate that the WIM equipment may have experienced accuracy problems either before the failure or after it was corrected.

Percentage of Trucks Overweight:

The percentage of trucks overweight was calculated for each route during each week, using four different definitions of overweight. The first calculation identified those trucks overweight by gross weight, i.e., greater than 80,000 pounds. The second calculation looked at axle weight limits, i.e., 20,000 pounds for a single axle, 34,000 pounds for a tandem, and 50,000 pounds for a tridem. The third calculation identified those trucks in violation of the federal Bridge Formula. The fourth and final calculation identified those trucks that were overweight by any of the previous three definitions.

The results of these analyses are shown in Tables 7-10. Table 7 shows the percent overweight by gross vehicle weight. It is immediately obvious that the percent overweight on the bypass routes is much greater than on the Interstate. It is also interesting that the percent overweight is lower on US 31W than on the other two routes. US 31W is the closest route to the Interstate and provides the shortest, most convenient route for bypassing the Tennessee station and the Simpson County station. Looking at the changes from week 1 to week 2, there was a slight reduction in the overweight percentage on US 31E and US 31W. However, the percent overweight on US 431 actually increased in week 2. From week 2 to week 3, the overweight percentage went up on one route, down on another, and remained

constant for the third. It is certainly not evident from these numbers that the enforcement efforts had any significant effects on the overweight percentages on the bypass routes. Tables 8-10 are equally inconclusive.

By looking at Tables 7, 8, and 9, it may be seen that more trucks violate axle weights than any other weight limits. This is particularly true on the Interstate, where axle weight limits are violated four times as frequently as the Bridge Formula and eight times as frequently as gross weight limits. The differences are not so extreme on the bypass routes, where only a two-to-one ratio exists between axle-weight and gross-weight violations.

Truck Inspection Data

During the second week of data collection, enforcement personnel conducted over 400 truck inspections on the three bypass routes. Each inspection was documented on an inspection form (Figure 4). Copies of the completed inspection forms were requested by the Kentucky Transportation Center. Most, but not all, of the forms were obtained. Upon review, some of the inspection forms were found to be for southbound trucks, and others had discrepancies which prevented a clear determination of their direction. These inspections were excluded from the analysis, leaving a total of 240 to be analyzed. The results of that analysis are presented in Tables 11-16.

Table 11 shows a basic summary of the inspection results. For the three routes combined, about sixty percent of the trucks inspected were found to have at least one violation. Thirty percent had serious violations that resulted in the truck being placed out of service (OOS). The percentages varied somewhat from route to route, with US 31E having the highest rates of violations and OOS, and US 431 having the lowest. It is perhaps significant to note that nearly three times as many inspections were performed on US 31E as on either of the other routes. This was not due to higher truck volumes, as was shown in Table 3. Instead, it appears to have resulted from a more aggressive enforcement effort at the US 31E site[2].

Table 12 shows that some violations could have gone undetected, because not all inspections were "level one" (full inspections). Some were "level two", which does not include an inspection of brake condition, and some were "level three", which only checks paperwork and credentials. Again, the more aggressive effort on US31E is evident, as nearly 90 percent of the inspections on that route were level one or two (compared to 53 percent and 36 percent on the other two routes).

Table 13 shows a breakdown of the types of violations noted during the inspections. For the 148 trucks with violations, a total of 295 violations were observed, which is two violations per truck. The most common violations were safety-related, with brakes, tires, and lighting or signal violations occurring most frequently. Driver violations were the next most common, with logbook violations being most often observed. The only other violations observed were related to vehicle registration, identification, and other paperwork. It is significant to note that there

[2]This aggressive enforcement could explain why US 31E experienced the largest decrease in average truck weights from week 1 to week 2, as previously noted.

were no weight violations documented on the inspection sheets. Trucks were not weighed during the inspections unless the inspector observed something to indicate an overweight condition. (However, five citations were written for overweight trucks on the bypass routes, as discussed in the following analysis of citation data.)

Table 14 shows that the most frequent reason for declaring a truck OOS was a vehicle safety violation. Driver violations also were a significant contributor to OOS decisions.

If enforcement activity on the bypass routes affected the route choice of truckers, the percentage of trucks having violations might be expected to drop off after the first few hours of bypass enforcement (as truckers became aware of the enforcement activity). To determine if this occurred, an additional analysis was performed to assess the percentage of trucks with violations as a function of time. Table 15 shows the results of that analysis. As shown in the table, The percentage of trucks with violations remained fairly constant through the first three days and then dropped off somewhat for the remainder of the week. The percentage placed OOS did appear to decrease after the first day (although this is of questionable significance due to the small sample size on the first day), but the percentage then remained fairly high through the week.

One particularly useful piece of information on the inspection sheets was the truck's origin and destination. This information was used to classify each truck as legitimate, questionable, or bypass, depending on whether its origin and destination explained why it was on the bypass route. This was obviously a subjective exercise, so each truck was classified by two independent observers. Whenever a discrepancy existed between the two observers (which was not often), a third observer was used to reconcile the difference. Table 16 presents the results of this analysis. Overall, 65% of the trucks inspected on the bypass routes were classified as "legitimate", while 25% were classified as "bypass". This means that approximately two-thirds of the trucks on the bypass routes had local origins or destinations which were served by their selected route.

If the trucks classified as "bypass" were on the bypass routes to avoid being weighed or inspected at the weigh station, one might expect to see a higher level of violations or OOS conditions for the "bypass" trucks, as compared to the "legitimate" trucks. Table 17 shows the violation and OOS percentages for "legitimate" trucks as compared to "questionable/bypass" (Q/B) trucks. For the three bypass routes combined, the Q/B trucks did have a higher percentage with violations (65% to 59%) and percentage OOS (32% to 29%), but the differences were fairly small. There was significant variation among the routes. US 31W was the only route for which the Q/B trucks had a higher percentage of both violations and OOS. Based on this analysis, no firm conclusions could be drawn about the relationship between origin/destination and the likelihood or seriousness of violations.

Truck Citation Data

A total of 285 citations were written in the study area over the three-week data-collection period. These citations documented 369 individual violations.

Computer-generated copies of the citation forms were provided by the Division of Motor Vehicle Enforcement for this analysis. The results of the analysis are shown in Tables 18-19.

Table 18 presents a summary of the citation data for the study area. The highest number of citations written in any single week was 89 on US 31E (during the second week). That location also had the highest number of violations per citation. For the three bypass routes combined, there were 140 citations written, documenting 193 violations. Despite the fact that the weigh station on I-65 was manned with a skeleton crew during the second week, they still issued 35 citations, which was about 60% of their first week total.

Table 19 shows the types of violations that were cited during the study period. By far, the most common violation cited was the failure to display a valid Kentucky identification card. This was true on both the Interstate and the bypass routes. The next three most common violations in the corridor were related to licensing, registration, and identification.

For the most part, the breakdown of violation types on the bypass routes was similar to that on the Interstate. However, there were also some interesting differences. Only 5 overweight violations were cited on the bypass routes, compared to 15 on the Interstate. As was stated previously, trucks on the bypass routes were not weighed unless there was some reason to suspect an overweight condition. Driver hours-of-service violations were cited 15 times on the bypass routes, compared to only once on the Interstate. Other violations that were more common on the bypass routes included vehicle oversize (6 to 0) and vehicle safety deficiencies (4 to 0). Failure to maintain insurance was cited 9 times on the Interstate, but was not cited on the bypass routes.

The fact that only five overweight citations were issued on the bypass routes is significant, particularly in light of the WIM data discussed earlier. The WIM data showed that over 10 percent of the trucks on the bypass routes exceeded gross weight and/or axle weight limits during the second week (Tables 7 and 8). Using an average of 30 trucks per hour on the bypass routes (Table 3), there were about 5,000 trucks that travelled the bypass routes during the second week. Assuming that 500 of these trucks were overweight, only one percent of these were cited for weight violations. This calls into question the assumption that the enforcement effort would cause overweight trucks to divert to other routes. If truckers knew that the probability of being weighed and cited was low, they may have continued to use the bypass routes in spite of the enforcement activity.

As was done with the inspection data, the citation data were further analyzed to see if the frequency of citations dropped off markedly after the first few hours of enforcement. No appreciable dropoff could be observed.

KENTON COUNTY I-75

As described previously, the second data collection effort was centered around

Interstate-75 in Northern Kentucky. The data from this effort proved to be of very limited usefulness. As stated earlier, there was no coordination of the data collection with any enforcement activities. Therefore, no conclusions could be drawn regarding the effects of varying enforcement on the choice of routes. When WIM data were analyzed and used to compare truck weights at different sites, another problem became obvious. That problem is illustrated in the following discussion.

The data from I-75 offered what appeared to be a splendid opportunity to gain insight into the bypassing of weigh stations. One of the WIM data collection sites was on I-75, in Grant County, at milepoint 153. That site is approximately 15 miles south of the weigh station, with three interchanges between the weigh station and the site. Truck weight data were available from the weigh station ramp WIM equipment for the same time period that data were collected at the Grant County site. By comparing truck weights at the weigh station with truck weights at the Grant County site, it was felt that insight could be gained into the magnitude (or existence) of bypassing activity. Specifically, if overweight southbound trucks were bypassing the weigh station and getting back onto the Interstate just south of the weigh station, higher truck weights (and a higher percentage overweight) could be expected at the Grant County site when compared to the weigh station.

At first glance, the analysis appeared to confirm the suspicion of bypassing activity. As shown in Table 20, the average truck at the Grant County site was 1,300 pounds heavier than at the weigh station. The percentage of trucks overweight (exceeding any weight limit) was 18% at the Grant County site compared to only 2% at the weigh station. However, a look at the distribution of truck weights (Figure 14) forced a reexamination of the accuracy of the data in Table 20. The difference in the distributions of truck weights at the two sites appeared to reflect a difference in the characteristics of the measuring equipment more than it reflected a true difference in weights. This is reasonable to expect, because the data were collected by low-speed, permanent, in-pavement equipment at the weigh station, and by high-speed, temporary, mat equipment at the Grant County site. A fairly detailed analysis of the data was performed, but failed to result in any significant conclusions.

STATEWIDE WIM DATA

Significant amounts of weigh-in-motion (WIM) data are collected each year by the Division of Planning of the Kentucky Department of Highways. Most data collection sites are monitored for 48 hours every three years. Other sites have seven-day counts which are repeated every year. There are also some continuous data stations. As a result, there is a great deal of WIM data available for routes across the state. This data file offered an opportunity for further exploration of the problem of trucks bypassing weigh stations.

The analysis of the statewide WIM data involved two parts. First of all, WIM sites on non-Interstate routes were identified and classified according to their attractiveness as potential bypass routes. Secondly, WIM sites on Interstate routes were identified and classified according to their proximity to a weigh station. WIM data files from 1988 to 1991 were combined for the analysis.

For the first analysis, 11 sites were identified which were on rural, AAA highways (80,000 pound weight limit) which were not part of the Extended Weight Coal-Haul Road System. Using a state map showing these sites and the locations of all enforcement stations, each site was classified as either high, medium, low, or none, reflecting its attractiveness as a potential bypass route. This was admittedly a subjective exercise, so two independent observers rated the 11 sites. There was excellent agreement between the two observers.

The purpose of this analysis was to determine if a relationship could be observed between the attractiveness of the route as a bypass route and the truck traffic characteristics on the route. Specifically, the truck traffic characteristics chosen as possible indicators of bypass activity were average truck weight and percentage overweight. A summary of the analysis is presented in Table 21. It is not obvious by looking at the data whether a relationship exists or not. Therefore, a regression analysis was performed to test the relationship. The analysis was performed using the Statistical Package for the Social Sciences (SPSS) Personal Computer (PC) version. The correlation matrix indicated that there was a relationship between the attractiveness of a route as a bypass route and the percentage of trucks exceeding weight limits (R^2=0.68).

For the analysis of Interstate routes, eight sites were identified, and the distance to the nearest enforcement station was determined for each site. The sites were then classified as "near" (0-3 miles from enforcement station) and "far" (10 or more miles from weigh station). The analysis focused on investigating the relationship between the proximity to an enforcement station and the truck traffic characteristics, specifically the average truck weight and the percent overweight.

The results of this analysis are presented in Table 22. The relationship observed was exactly opposite of what was expected. Those sites within three miles of an enforcement station had higher average truck weights and overweight percentages than the sites ten or more miles from enforcement stations. These results definitely call into question the validity of using the statewide WIM data for this type of analysis. According to the data, there are sites on Interstate routes, less than three miles from weigh stations, where nearly half of all trucks are overweight. This is not reasonable, and it points to a need to investigate the accuracy of statewide WIM data. For the purposes of this study, it was apparent that no meaningful conclusions could be drawn from the analysis of statewide WIM data.

COST EFFECTIVENESS OF BYPASS ENFORCEMENT

The analysis of inspection and citation data from the I-65 study area showed that a large percentage of trucks on bypass routes (or non-Interstate routes in general) have violations and that many of these violations are serious enough to place the truck out of service (OOS). It is therefore appropriate to give some consideration to increasing the level of enforcement on non-interstate routes. Determining if increased enforcement is justified (and if so, how much) requires some knowledge of the associated costs and benefits.

The cost to put an enforcement officer in the field to conduct bypass

enforcement is $10.28 per hour on straight time, or $15.42 on overtime. Usually, two officers work together to conduct such enforcement. Therefore, the cost to conduct enforcement at a selected site for an eight-hour shift is $164.48 on straight time, or $246.72 on overtime. Currently, nearly all such enforcement is conducted on overtime.

Although revenue from citations is not the primary purpose of enforcement, it is significant when considering financial implications. The following analysis attempts to develop a conservative estimate of the revenue that might be generated from each eight-hour enforcement effort on a non-Interstate route. A typical two-man enforcement team can be expected to weigh and inspect three trucks per hour, or 24 trucks over an eight-hour shift. If 50 percent of these trucks have violations (conservative estimate based on Table 11), that will result in 12 citations being issued. If the average fine for a violation is $30[3], and the average number of violations per citation is 1.37 (see Table 18), then the total potential revenue from fines is approximately $495. The percentage of these fines that will actually be paid is unknown (reliable estimates are not readily available), but 50 percent should be a conservative estimate. This would yield revenue of approximately $250 from an eight-hour enforcement effort.

From this simple example, it appears that the cost of bypass enforcement can be offset by the revenue that they generate. If manning is adjusted to allow them to be conducted on straight time rather than overtime, then the revenue generated could significantly exceed the cost.

Obviously, the benefits of increased enforcement on non-interstate routes go far beyond increased revenue from fines. In addition to issuing citations, the enforcement officers would place OOS those trucks with serious safety, weight, registration, or tax deficiencies. Using the above example and assuming that 25 percent of trucks have OOS violations (based on Table 11), it can be estimated that six trucks would be placed OOS during each eight-hour shift. Returning these trucks to operation would require correcting the safety problem, offloading the excess weight, obtaining proper credentials, or correcting the tax deficiency. In each case, there is substantial benefit from identifying the offending truck and requiring the problem to be corrected.

The final benefit of non-Interstate enforcement, and perhaps the most important, is the deterrent effect that an effective enforcement program can have. When there is an increase in the probability (perceived or real) that a truck will be inspected on non-Interstate routes, there is a corresponding increase in the likelihood that truckers on those routes will choose to comply with regulations.

[3]Most fines are in the range of $20 to $25 (plus $47.50 court costs). Overweight violations range from a minimum of $60 to a maximum of $500 (plus court costs).

CONCLUSIONS

1. While it is generally accepted that weigh station bypassing does occur in Kentucky, there was no indication that significant numbers of trucks are modifying their route choices based on the presence or absence of enforcement activity on the bypass routes.

2. Average truck weights on bypass routes are somewhat higher than on Interstate routes (in the vicinity of a weigh station). The percentage of trucks exceeding weight limits is much higher on bypass routes than on Interstate routes (in the vicinity of a weigh station). However, the difference between truck weights on Interstates and on bypass routes does not appear to be primarily a result of bypassing activity. It is instead a reflection of the fact that the percentage of overweight trucks will vary inversely with the perceived probability of being weighed. Trucks travelling on non-Interstate routes (either for bypass purposes or for legitimate purposes) are unlikely to be weighed and are thus more likely to exceed weight limits.

3. The majority of trucks on bypass routes have legitimate reasons (in terms of origin or destination) to be on those routes. Thus, it is improper to assume that all (or even most) trucks on a bypass route are using that route to avoid a weigh station.

4. When trucks on bypass routes are inspected, a high percentage will have violations. This is true for trucks which are legitimately on the route (i.e., trucks having a local origin or destination) and for trucks which are apparently using the route as a bypass route. There is no indication that "bypassing" trucks (i.e., no local origin or destination) have a higher incidence rate of safety, weight, or other violations, as compared to "legitimate" trucks (i.e., local origin or destination) on the bypass routes.

5. The most common inspection violations occurring on bypass routes are safety-related (i.e., brakes, tires, lighting, and signals). Driver violations are the next most common.

6. Temporary enforcement efforts on bypass routes may be extremely effective in identifying violations and issuing citations. Such efforts can be self-supporting through the revenue generated from citations.

7. Because of accuracy considerations and data "scatter," there are some uses which are appropriate for high-speed portable WIM data and others which are not. For example, WIM data may yield highly accurate estimates for average weight but inflated values for percentage overweight. Care must be exercised when using portable WIM data to draw conclusions about truck weight distributions.

RECOMMENDATIONS

1. A statewide enforcement plan should be developed which incorporates increased emphasis on enforcement for non-Interstate routes. The manning of the Division of Motor Vehicle Enforcement should be adjusted as necessary to ensure proper emphasis on non-Interstate enforcement. The cost-effectiveness of non-Interstate enforcement efforts should be reevaluated annually, and manning levels should be adjusted as appropriate.

2. Innovative options[4] should be considered and investigated to simplify or expedite enforcement efforts at weigh stations. This could allow existing weigh station personnel to be shifted to non-Interstate enforcement.

3. Enforcement efforts on non-Interstate routes should be randomized and unpredictable, and generally should not remain at the same location for more than 24 hours. More frequent movement can be used to maximize the element of surprise. All enforcement efforts should include weighing capability, and, insofar as practical, all loaded trucks should be weighed.

4. Effectiveness measures for non-Interstate enforcement should be developed and used for ongoing monitoring of those enforcement efforts. Such monitoring will make it possible to determine the optimum level of enforcement for various regions of the state and the optimum duration of enforcement efforts at a single location.

5. The accuracy of statewide WIM data should be assessed. Guidelines and limitations for proper use of the data should be developed and disseminated.

6. The potential for using statewide WIM data to identify problem areas and direct enforcement efforts should be explored. A formal process should be developed and implemented to foster ongoing cooperation in this effort between the Division of Planning and the Division of Motor Vehicle Enforcement.

---

[4]Innovative options would include Automatic Vehicle Identification (AVI), mainline WIM, "premier carrier" programs, preclearance, automated roadside safety inspections, on-board safety monitoring, or any other concept with the potential to streamline the weigh station process.

REFERENCES

1. Wisconsin Department of Transportation, Division of State Patrol, Bureau of District Operations, Bureau of Support Services, "Do Truckers Avoid Enforcement Scales?", September 1988.

2. Wisconsin Department of Transportation, Division of Planning and Budget, "Truck Avoidance of Enforcement Scales: Description and Results of a Field Study," September 1988.

3. Wisconsin Department of Transportation, Divisions of Planning and Budget & State Patrol, "Truck Avoidance of Enforcement Scales: Field Study Results from a Combined Enforcement/Planning Perspective," April 1989.

4. Florida Department of Transportation, "Weigh Station Evasion by Trucks," DRAFT Report, March 1992.

5. Pigman, J.G. and Deacon, J.A., "Integrated Truck Monitoring System," Interim Report, Research Report KTC-89-60, Kentucky Transportation Center, University of Kentucky, December 1989.

TABLE 1. ENFORCEMENT STATIONS IN KENTUCKY

WEIGH STATIONS		
LYON COUNTY	I-24 EB/WB	MP 36
SIMPSON COUNTY	I-65 NB	MP 3
HARDIN COUNTY	I-65 NB/SB	MP 90
SHELBY COUNTY	I-64 EB/WB	MP 38
ROWAN COUNTY	I-64 EB/WB	MP 148
LAUREL COUNTY	I-75 NB/SB	MP 43
SCOTT COUNTY	I-75 NB	MP 130
KENTON COUNTY	I-75 SB	MP 167
HENRY COUNTY	I-71 NB	MP 35
BOONE COUNTY	I-71 SB	MP 77
HENDERSON COUNTY	US41 SB	MP 18
INSPECTION STATIONS (PORTS-OF-ENTRY)		
FULTON COUNTY	US45W/US51 NB	MP 0
BALLARD COUNTY	US51/US60 SB	MP 5

TABLE 2. PERSONNEL BREAKDOWN -- DIVISION OF MOTOR VEHICLE ENFORCEMENT (as of May 1992)

REGION		CAPT	LT	OFFCR	INSPCTR	TRAINEE	CLERK
1	Lyon Co. Scale	1	2	12	8	1	10
	Fulton P.O.E.		1	3	1	1	4
	Wickliffe P.O.E.			4	1	0	5
2	Simpson Co. Scale	1	2	8	3	2	4
3	Hardin Co. Scale	1	2	11	3	1	10
4	Shelby Co. Scale	1	2	12	2	0	10
	Jefferson Co. Detail		1	5	0	0	0
5	Scott Co. Scale	1	1	9	2	0	5
6	Rowan Co. Scale	1	1	16	6	0	10
	NE Kentucky Patrol		1	4	0	0	0
7	Laurel Co. Scale	1	1	14	4	2	10
	SE Kentucky Patrol		1	3	0	0	0
8	Henderson Co. Scale	1	1	5	4	2	5
	Western KY Patrol			1	0	0	0
9	Boone Co. Scale	1	1	3	6	1	5
	Henry Co. Scale		1	4	4	1	5
	Kenton Co. Scale		1	3	7	1	5

Note: Personnel assigned to headquarters total 28, including 1 Colonel, 1 Lt. Colonel, 2 Majors, 1 Captain, 4 Auditors, and 18 support personnel.

Note: Ten additional personnel have been authorized for patrol functions; 4 for Northeast KY, 4 for Southeast KY, and 2 for Northern KY.

TABLE 3. TRUCK TRAFFIC VOLUMES FOR I-65 CORRIDOR

Average Trucks per Hour								
	I-65 Rt Lane	I-65 Lt Lane	I-65 Total	US31E	US31W	US431	Non-Interstate Total	Corridor Total
Week 1	112.1	17.3	129.4	11.5	12.1	7.4	31.0	160.4
Week 2	106.2	16.0	122.2	11.1	11.7	7.4	30.2	152.4
Week 3	105.9	16.0	121.9	11.3	12.5	6.4	30.2	152.1

TABLE 4. TRUCK TRAFFIC ANALYSIS FOR I-65 CORRIDOR

Percentage of Total Corridor Truck Traffic			
	I-65	Non-Interstate Routes	Total
Week 1	80.7%	19.3%	100.0%
Week 2	80.2%	19.8%	100.0%
Week 3	80.1%	19.9%	100.0%

TABLE 5. CHANGES IN TRUCK TRAFFIC VOLUMES FROM WEEK TO WEEK

Truck Traffic Expressed as a Percentage of Baseline (Week 1) Traffic			
	I-65	Non-Interstate Routes	Total
Week 1	100.0%	100.0%	100.0%
Week 2	94.4%	97.4%	95.0%
Week 3	94.2%	97.4%	94.8%

TABLE 6. AVERAGE WEIGHTS PER TRUCK FOR I-65 STUDY AREA

Average Weight Per Truck (Lbs)						
	I-65	US31E	US31W	US431	Non-Interstate Average	Corridor Average
Week 1	---	50738	41991	42979	45419	---
Week 2	41743	49796	41896	42827	45421	42488
Week 3	41595	50120	41971	48000	46425	42456
Number of Trucks Included in Average						
	I-65	US31E	US31W	US431	Non-Int. Total	Corridor Total
Week 1	---	820	838	610	2268	---
Week 2	11226	1201	1039	614	2854	14080
Week 3	13335	1274	1203	414	2891	16226

TABLE 7. PERCENT OF TRUCKS OVERWEIGHT -- GROSS VEHICLE WEIGHT

	I-65	US31E	US31W	US431	Non-Interstate Average	Corridor Average
Week 1	---	6.83%	2.98%	7.70%	5.64%	---
Week 2	0.03%	6.58%	2.89%	10.59%	6.10%	1.26%
Week 3	0.02%	6.59%	2.49%	13.77%	5.91%	1.07%

TABLE 8. PERCENT OF TRUCKS OVERWEIGHT -- AXLE WEIGHTS

	I-65	US31E	US31W	US431	Non-Interstate Average	Corridor Average
Week 1	---	12.56%	8.35%	14.43%	11.51%	---
Week 2	0.23%	13.16%	8.66%	17.75%	12.51%	2.72%
Week 3	0.21%	12.87%	7.32%	18.12%	11.31%	2.19%

TABLE 9. PERCENT OF TRUCKS OVERWEIGHT -- BRIDGE FORMULA

	I-65	US31E	US31W	US431	Non-Interstate Average	Corridor Average
Week 1	---	10.61%	5.85%	10.00%	8.69%	---
Week 2	0.06%	8.91%	8.66%	15.47%	10.23%	2.12%
Week 3	0.05%	9.97%	5.57%	16.43%	9.06%	1.66%

TABLE 10. PERCENT OF TRUCKS OVERWEIGHT -- BROAD DEFINITION

	I-65	US31E	US31W	US431	Non-Interstate Average	Corridor Average
Week 1	---	13.90%	10.26%	14.75%	12.79%	---
Week 2	0.27%	13.82%	11.36%	20.68%	14.40%	3.13%
Week 3	0.24%	13.58%	9.23%	21.50%	12.90%	2.50%

TABLE 11. SUMMARY OF TRUCK INSPECTION DATA FOR I-65 STUDY AREA

	US31E	US31W	US431	TOTAL
No. of Trucks Inspected	144	49	47	240
No. of Trucks with Violations	100	29	19	148
No. of Trucks Placed OOS	51	13	8	72
% of Trucks with Violations	69.4%	59.2%	40.4%	61.7%
% of Trucks Placed OOS	35.4%	26.5%	17.0%	30.0%

TABLE 12. BREAKDOWN OF TRUCK INSPECTIONS BY LEVEL OF INSPECTION

	US31E	US31W	US431	TOTAL
Level One Inspections	38	21	11	70
Level Two Inspections	90	5	6	101
Level Three Inspections	16	23	30	69
Total Inspections	144	49	47	240

Note:
Level One: Full Inspection
Level Two: Brakes Not Inspected
Level Three: No Physical Inspection of Truck -- Paperwork and Credentials Only

TABLE 13. TYPES OF VIOLATIONS NOTED DURING TRUCK INSPECTIONS

	Number of Occurrences			
	US31E	US31W	US431	TOTAL
Brake Violations	27	28	6	61
Tire Violations	43	5	0	48
Lighting or Signal Violations	40	5	7	52
Other Safety Violations	40	8	8	56
Driver Logbook Violations	30	5	7	42
Other Driver Violations	13	5	0	18
Vehicle Registration/Paperwork	11	1	6	18
Vehicle Weight	0	0	0	0
Total Violations	204	57	34	295

TABLE 14. VIOLATIONS RESULTING IN "OUT OF SERVICE"

	Number of Occurrences			
	US31E	US31W	US431	TOTAL
Safety Violations	43	20	5	68
Driver Violations	18	5	4	27
Registration Violations	5	0	0	5
Weight Violations	0	0	0	0
Other Violations	0	0	0	0
Total Violations	66	25	9	100

TABLE 15. TRUCK INSPECTION RESULTS BY DAY OF WEEK (for Three Bypass Routes Combined)

	Number of Trucks Inspected	Percent with Violations	Percent Placed OOS
Monday, 10/1/90	10[a]	70	50
Tuesday	45	71	38
Wednesday	50	68	36
Thursday	40	58	20
Friday	38	63	37
Saturday	20	55	15
Sunday	23	39	26
Monday, 10/8/90	13	54	8

[a]Inspections began in late afternoon of 10/1/90.

TABLE 16. SUMMARY OF ORIGIN/DESTINATION INFORMATION

Origin/Destination Code		US31E	US31W	US431	TOTAL
"Legitimate"	Number	87	30	39	156
	Percent	60%	61%	83%	65%
"Questionable"	Number	11	5	4	20
	Percent	8%	10%	9%	8%
"Bypass"	Number	44	13	4	61
	Percent	31%	27%	9%	25%
"Insufficient Information"	Number	2	1	0	3
	Percent	1%	2%	0%	1%
TOTAL	Number	144	49	47	240
	Percent	100%	100%	100%	100%

TABLE 17. EFFECT OF ORIGIN/DESTINATION CODE ON VIOLATIONS AND "OUT OF SERVICE"

	US31E	US31W	US431	TOTAL
Origin/Destination Code "L" (Legitimate)				
Percent with Violations	70%	53%	38%	59%
Percent "Out of Service"	37%	20%	18%	29%
Origin/Destination Code "Q" (Questionable) or "B" (Bypass)				
Percent with Violations	67%	67%	50%	65%
Percent "Out of Service"	33%	39%	13%	32%

TABLE 18. SUMMARY OF CITATION DATA FOR I-65 STUDY AREA

	I-65	US31E	US31W	US431	Non-Int. Total
Total Citations	145	89	21	30	140
Total Violations	176	131	26	36	193
Violations per Citation	1.21	1.47	1.24	1.20	1.37
Note: Breakdown of I-65 Citations by Week is 60, 35, and 42.					

TABLE 19. TYPES OF VIOLATIONS CITED FOR I-65 STUDY AREA

	Number of Occurrences					
	I-65	US31E	US31W	US431	Total Non-Int.	Total Corridor
Failure to Display Valid KY ID Card	82	42	8	16	66	148
KY Motor Fuel License (KYU) - None, Inactive, or Cancelled	23	18	5	5	28	51
Violation of Int'l Registration Plan	14	19	2	0	21	35
Improper Exterior ID	15	5	2	2	9	24
Overweight	15	2	1	2	5	20
Driver Hours of Service	1	11	4	0	15	16
No Interstate Authorized Authority (or Exempted Commodity Authority)	4	9	0	2	11	15
Other Registration Violations	2	4	3	3	10	12
Failure to Maintain Insurance	9	0	0	0	0	9
No Other State Registration	3	3	0	2	5	8
No Valid Operator's License	2	3	1	1	5	7
Oversize (width, height)	0	5	0	1	6	6
Vehicle Safety Deficiency	0	3	0	1	4	4
No or Improper Bill of Lading	1	3	0	0	3	4
No Special Permit (or Violation of Permit)	0	4	0	0	4	4
Running Scale or Disregarding Traffic Control Device	3	0	0	0	0	3
No Lease Agreement	1	0	0	1	1	2
DUI -- Alcohol	1	0	0	0	0	1
TOTAL	176	131	26	36	193	369

TABLE 20. SUMMARY OF TRUCK WEIGHT DATA ON I-75

	Location	
	Weigh Station MP 167	Grant County MP 153
Average Weight per Truck (Lbs)	55,041	56,367
Percent of Trucks Exceeding Gross Weight Limit	0.25%	10.43%
Percent of Trucks Exceeding Any Weight Limit	2.51%	18.33%

TABLE 21. SUMMARY OF ANALYSIS OF STATEWIDE WIM DATA FOR NON-INTERSTATE ROUTES

Station Number	County	Route	Route Class *	ADT	Bypass Potential	Avg. Truck Weight	% Overweight	
							Gross Weight	Any Limit
028	Trimble	US42	M.C.	831	High	34,261	5.00	14.62%
073	Allen	US31E	M.C.	4090	Medium	45,302	12.74	24.86%
792	Owen	US127	M.C.	2530	Medium	29,936	4.49	10.26%
010	Graves	US45	M.C.	1950	Low	29,540	1.22	7.54%
047	Fayette	KY922	M.C.	6150	Low	23,167	0.73	6.58%
029	Menifee	US460	M.A.	4955	Low	23,167	0.72	6.12%
043	Anderson	US127	P.A.	8580	Low	34,114	2.64	10.39%
505	Jessamine	US27	P.A.	10300	Low	33,007	2.27	10.23%
108	Grayson	US62	M.C.	1570	None	32,911	4.24	11.94%
046	Fulton	US51	M.A.	2280	None	50,269	7.08	14.15%
599	Barren	Pkwy	P.A.	5160	None	44,381	4.04	9.50%

* M.C. = Major Collector
M.A. = Minor Arterial
P.A. = Principal Arterial

TABLE 22. SUMMARY OF STATEWIDE WIM DATA FOR INTERSTATE ROUTES

Station Number	County	Route	Proximity to Weigh Station	Avg. Truck Weight	% Overweight	
					Gross Wt.	Any Limit
059	Henry	I-71	Close	61,398	27.34%	45.79%
158	Rowan	I-64	Close	49,321	13.13%	32.60%
285	Simpson	I-65	Close	54,073	10.20%	16.81%
257	Whitley	I-75	Far	51,354	8.31%	15.38%
319	Christian	I-24	Far	50,086	2.46%	4.56%
365	Fayette	I-75	Far	44,166	1.76%	3.64%
751	Clark	I-64	Far	51,961	17.79%	33.12%
831	Barren	I-65	Far	53,632	4.24%	8.07%

Figure 1. Permanent Enforcement Stations in Kentucky

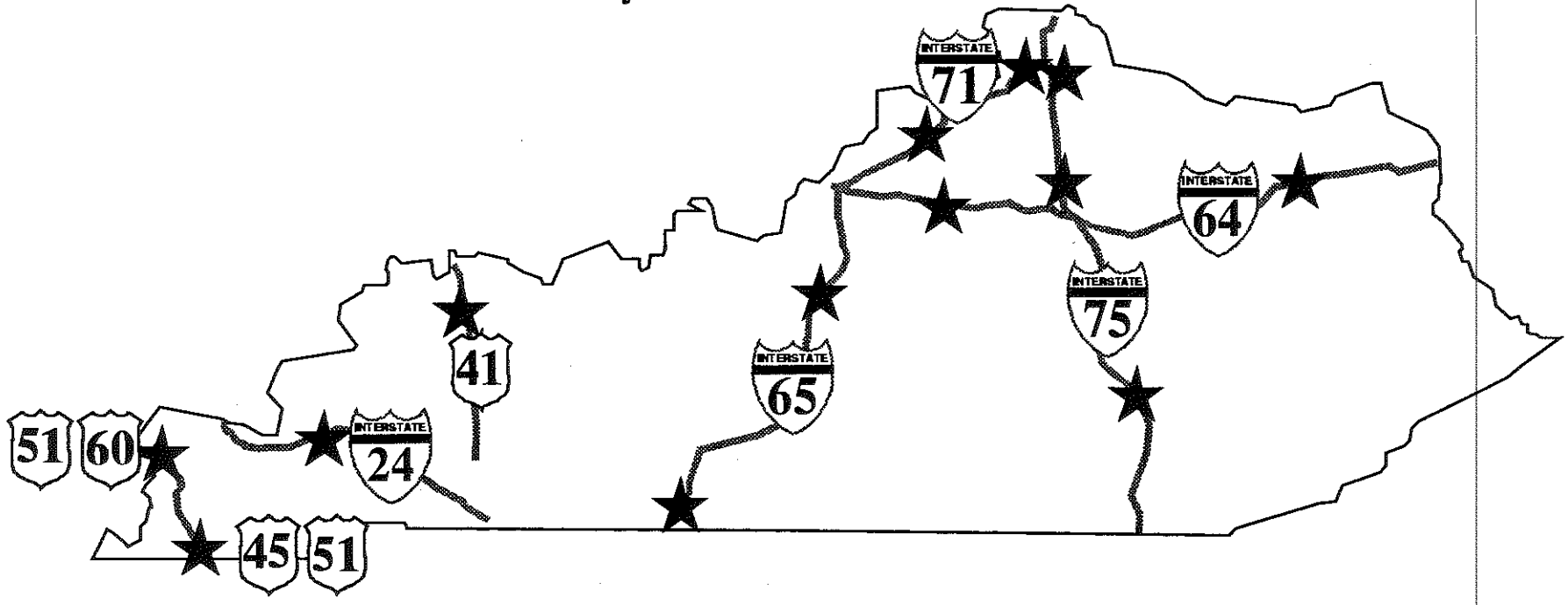


Figure 2. Motor Vehicle Enforcement Regions

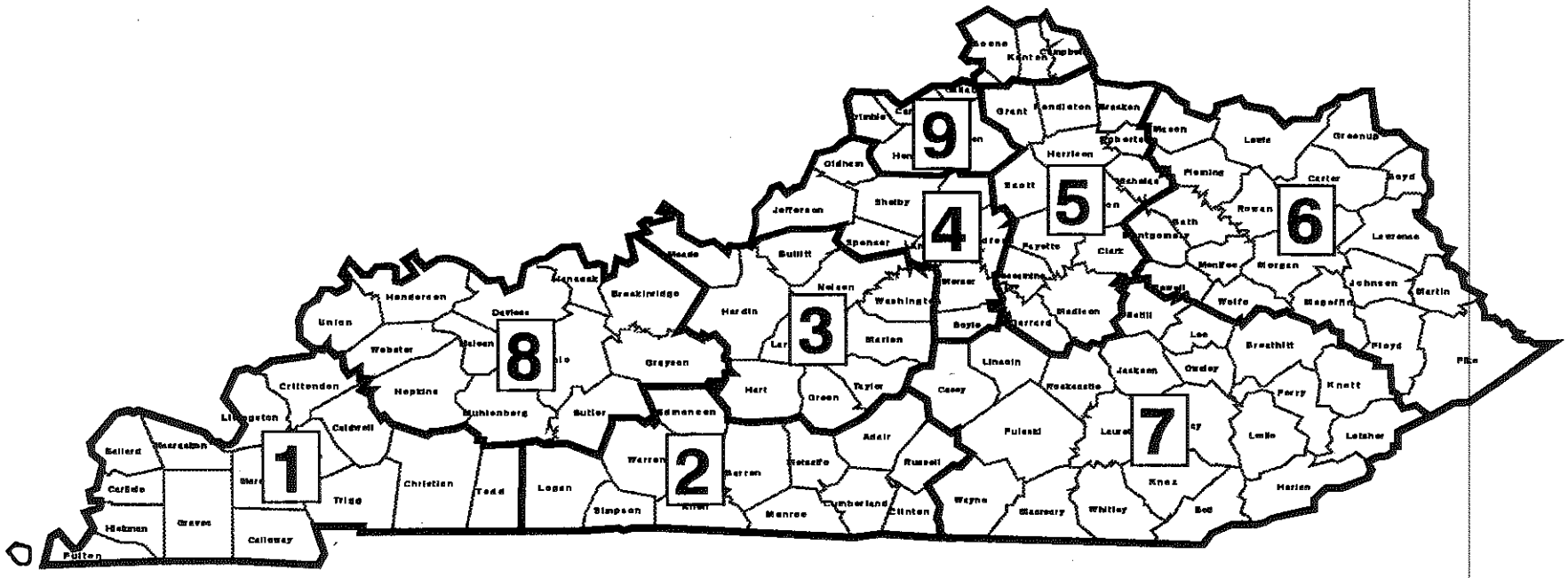


Figure 3. I-65 Study Area

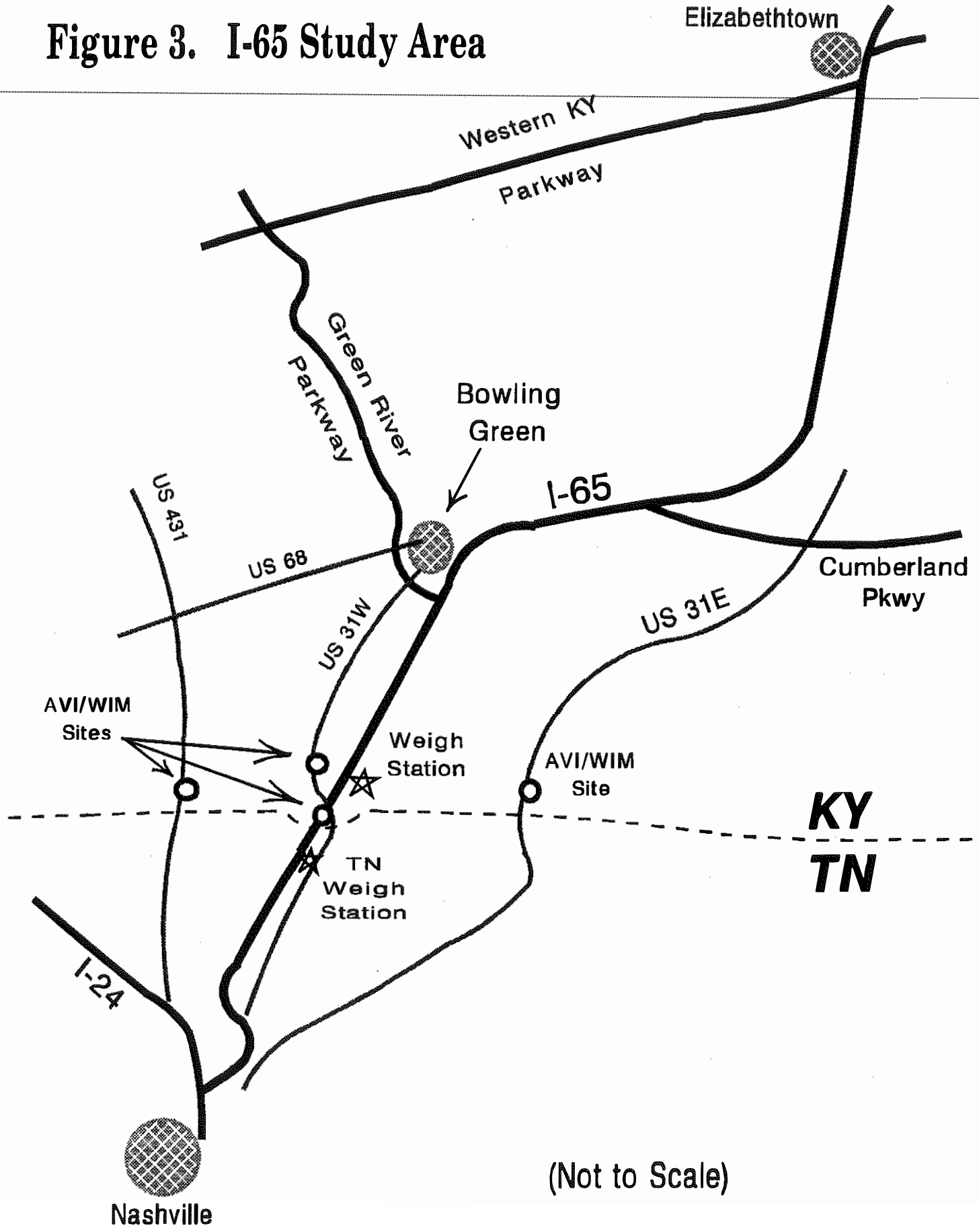
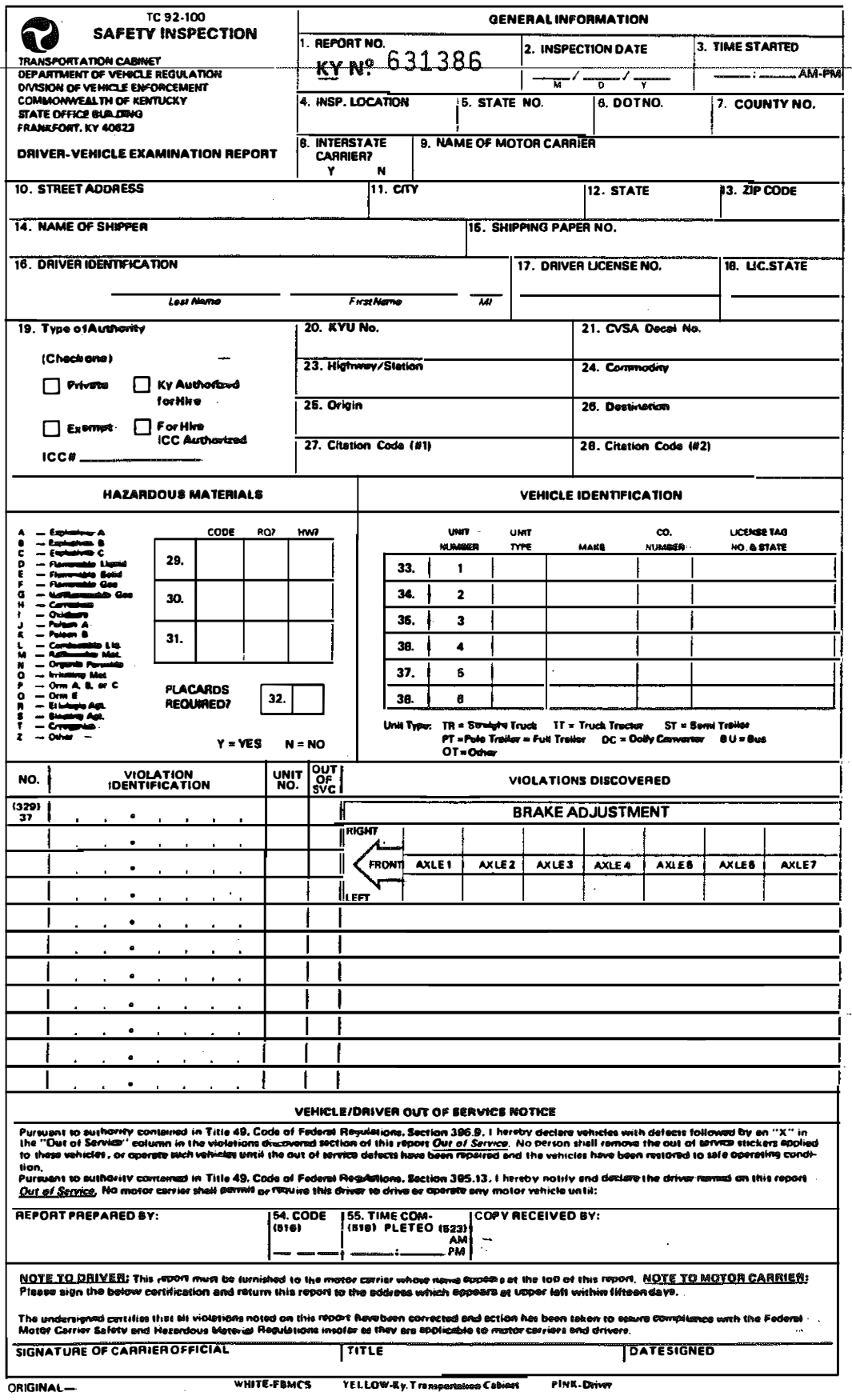


Figure 4. Safety Inspection Form



TC 92-100
SAFETY INSPECTION

TRANSPORTATION CABINET
DEPARTMENT OF VEHICLE REGULATION
DIVISION OF VEHICLE ENFORCEMENT
COMMONWEALTH OF KENTUCKY
STATE OFFICE BUILDING
FRANKFORT, KY 40622

DRIVER-VEHICLE EXAMINATION REPORT

GENERAL INFORMATION

1. REPORT NO. KY Nº 631386
2. INSPECTION DATE — / — / — (M / D / Y)
3. TIME STARTED — : — AM-PM
4. INSP. LOCATION
5. STATE NO.
6. DOT NO.
7. COUNTY NO.
8. INTERSTATE CARRIER? Y N
9. NAME OF MOTOR CARRIER
10. STREET ADDRESS
11. CITY
12. STATE
13. ZIP CODE
14. NAME OF SHIPPER
15. SHIPPING PAPER NO.
16. DRIVER IDENTIFICATION — Last Name / First Name / MI
17. DRIVER LICENSE NO.
18. LIC. STATE
19. Type of Authority (Check one) — Private; Ky Authorized for Hire; Exempt; For Hire ICC Authorized; ICC# _____
20. KYU No.
21. CVSA Decal No.
23. Highway/Station
24. Commodity
25. Origin
26. Destination
27. Citation Code (#1)
28. Citation Code (#2)

HAZARDOUS MATERIALS

A — Explosives A
B — Explosives B
C — Explosives C
D — Flammable Liquid
E — Flammable Solid
F — Flammable Gas
G — Nonflammable Gas
H — Corrosives
I — Oxidizers
J — Poison A
K — Poison B
L — Combustible Liq.
M — Radioactive Mat.
N — Organic Peroxide
O — Irritating Mat.
P — Orm A, B, or C
Q — Orm E
R — Etiologic Agt.
S — Blasting Agt.
T — Cryogenics
Z — Other

	CODE	RQ?	HW?
29.			
30.			
31.			

PLACARDS REQUIRED? 32. ☐

Y = YES N = NO

VEHICLE IDENTIFICATION

	UNIT NUMBER	UNIT TYPE	MAKE	CO. NUMBER	LICENSE TAG NO. & STATE
33.	1				
34.	2				
35.	3				
36.	4				
37.	5				
38.	6				

Unit Type: TR = Straight Truck TT = Truck Tractor ST = Semi Trailer PT = Pole Trailer = Full Trailer DC = Dolly Converter BU = Bus OT = Other

NO.	VIOLATION IDENTIFICATION	UNIT NO.	OUT OF SVC
(329) 37			

VIOLATIONS DISCOVERED

BRAKE ADJUSTMENT

RIGHT / FRONT / LEFT

AXLE 1	AXLE 2	AXLE 3	AXLE 4	AXLE 5	AXLE 6	AXLE 7

VEHICLE/DRIVER OUT OF SERVICE NOTICE

Pursuant to authority contained in Title 49, Code of Federal Regulations, Section 396.9, I hereby declare vehicles with defects followed by an "X" in the "Out of Service" column in the violations discovered section of this report *Out of Service*. No person shall remove the out of service stickers applied to these vehicles, or operate such vehicles until the out of service defects have been repaired and the vehicles have been restored to safe operating condition.

Pursuant to authority contained in Title 49, Code of Federal Regulations, Section 395.13, I hereby notify and declare the driver named on this report *Out of Service*. No motor carrier shall permit or require this driver to drive or operate any motor vehicle until:

REPORT PREPARED BY:

54. CODE (516) — —

55. TIME COMPLETED (523) — : — AM PM

COPY RECEIVED BY:

NOTE TO DRIVER: This report must be furnished to the motor carrier whose name appears at the top of this report. NOTE TO MOTOR CARRIER: Please sign the below certification and return this report to the address which appears at upper left within fifteen days.

The undersigned certifies that all violations noted on this report have been corrected and action has been taken to assure compliance with the Federal Motor Carrier Safety and Hazardous Material Regulations insofar as they are applicable to motor carriers and drivers.

SIGNATURE OF CARRIER OFFICIAL | TITLE | DATE SIGNED

ORIGINAL — WHITE-FBMCS YELLOW-Ky. Transportation Cabinet PINK-Driver

Figure 5. Survey Form

KYU	ICC	USDOT

ROUTE: __I65 __US31E __US31W __US431

SHIFT: __0-8 __8-16 __16-24

DATE / /

DESTINATION _____

VIOLATION–I65 SCALE (CHECK)
- __IMPROPER PAPERWORK
- __NO FUEL TAX PERMIT
- __NO REQUIRED SPECIAL PERMIT
- __OTHER

VIOLATION–ANY SITE (CHECK)
- __DRIVER LOG
- __OVERLOADED–ANY AXLE(S)
- __OTHER

REASON FOR USING BYPASS (CHECK)
- __BY COMPANY INSTRUCTIONS
- __AVOID TIME DELAY AT SCALE
- __AVOID SAFETY INSPECTION
- __OTHER

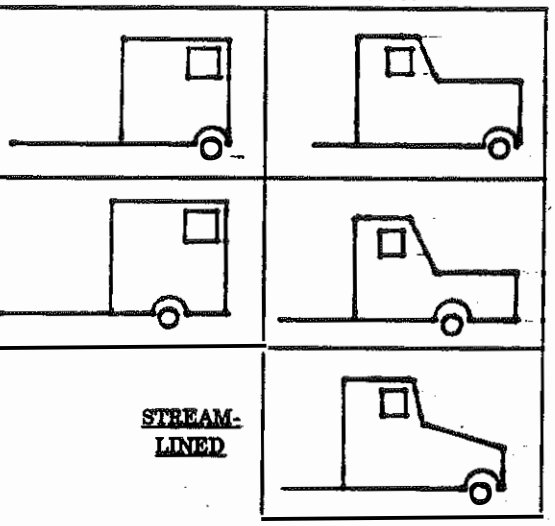
CITATION ISSUED: __YES __NO (CHECK)
- _____CODE NUMBER
- _____SAFETY INSPECTION NO.
- _____CITATION NUMBER

ORIGINAL

NEW SET-BACK

VEHICLE CLASSIFICATION NO.: _____

CAB-OVER | CONVENTIONAL



STREAM-LINED

SUSPENSION SYSTEMS: (CHECK)

	DRIVE AXLES	TRAILER AXLES
AIR BAG	____	____
"W"LEAF SPRINGS	____	____
"Y" SPRINGS	____	____
WALKING BEAM	____	____
TORSION BAR	____	____
OTHER	____	____

TRAILER OR BODY TYPE:
- __EQUIPMENT OR LOWBOY
- __BOX
- __FLAT BED
- __DUMP
- __TANKER
- __OTHER

FIFTH WHEEL LOCATION: NO. OF NOTCHES

FORWARD	CENTER	BEHIND
____	____	____

DRIVE SHAFT TO: (CHECK)
__LEAD AXLE __LAST AXLE

			STEERING	DRIVE	TRAILER
TIRE TYPE: (NO.)		RADIAL	____	____	____
		BIAS	____	____	____
TIRE BODY: (NO.)		NEW	____	____	____
		RETREAD	____	____	____
TREAD CONDITION (NO.)	GOOD	OVER 8/32"	____	OVER 4/32" ____	____
	FAIR	4/32 TO 8/32"	____	2/32-4/32" ____	____
	SLICK	3/32" OR LESS	____	2/32" MAX ____	____

Figure 6. I-75 Study Area

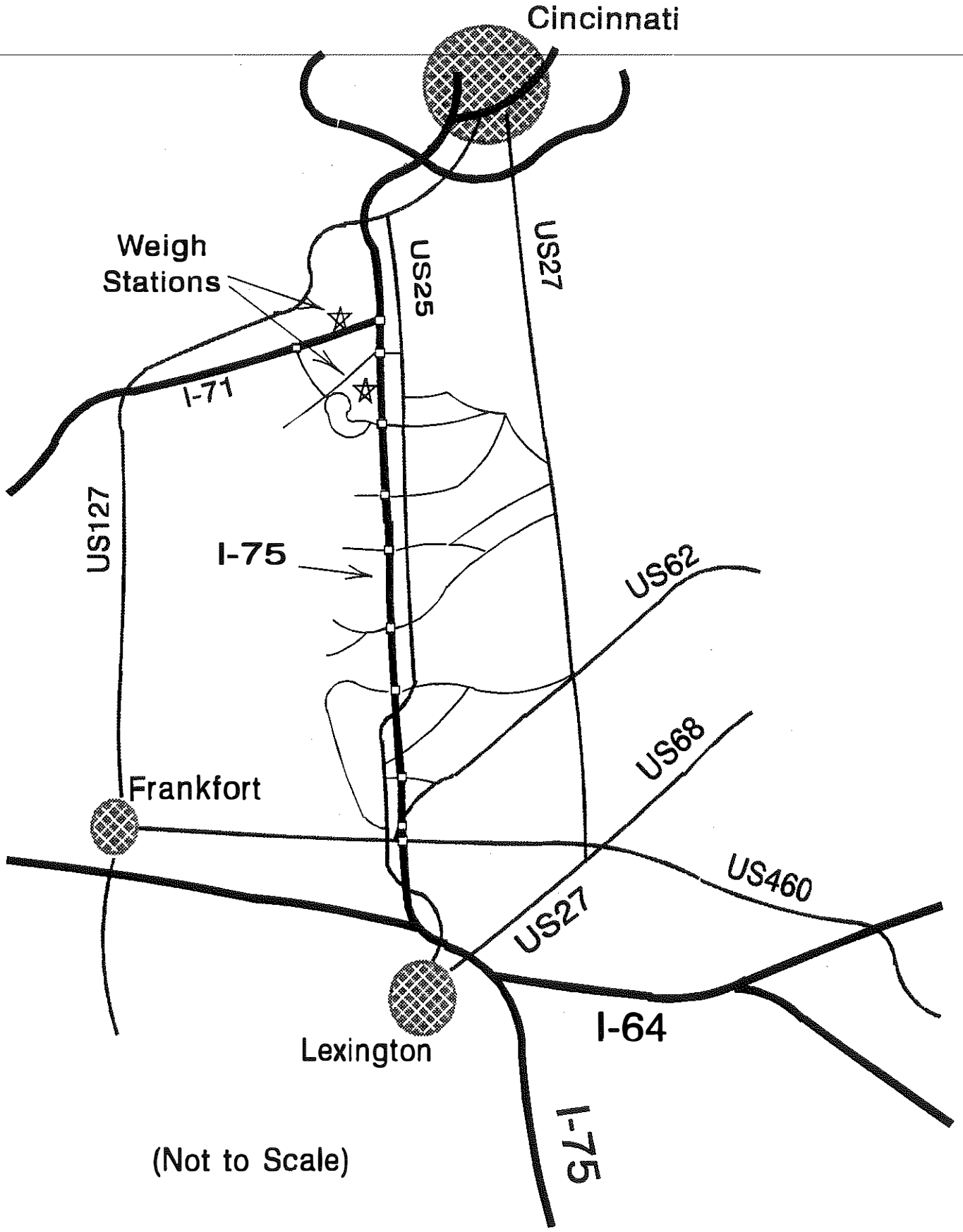


Figure 7. Truck Volume on Interstate 65 by Time of Day

(Average of All Weekdays)

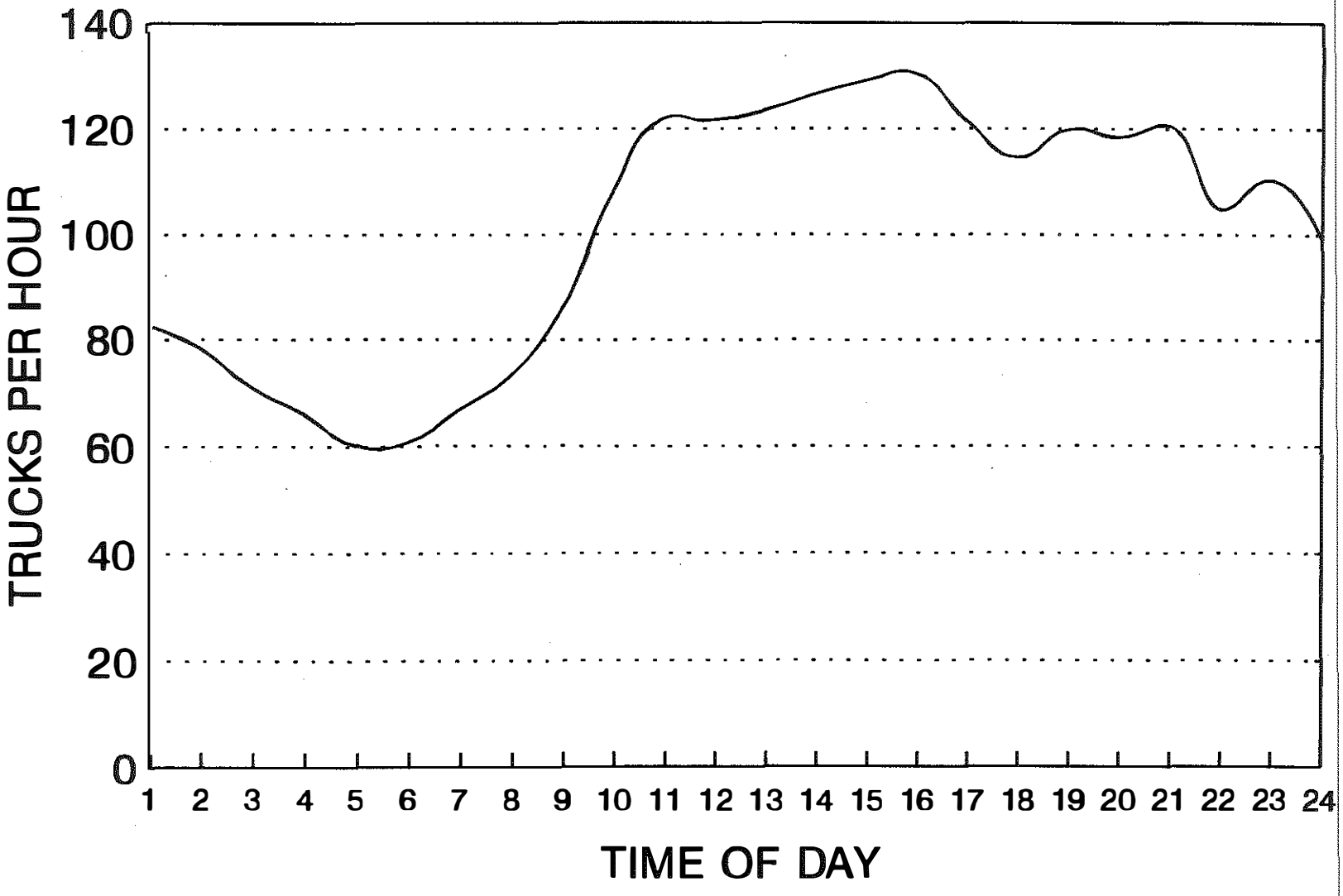


Figure 8. Truck Volume on Bypass Routes by Time of Day

(Average of All Weekdays)

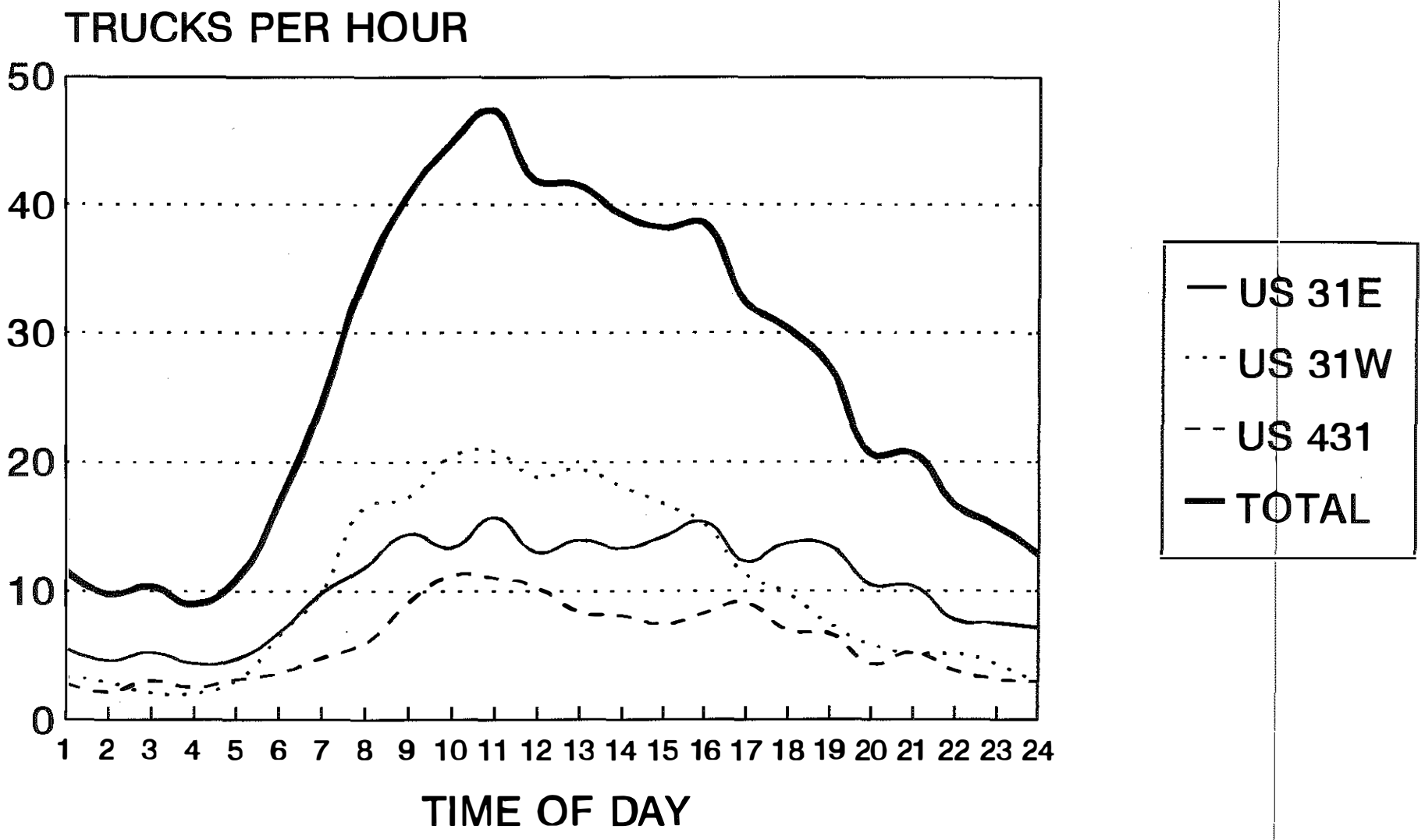


Figure 9. Truck Volume on Interstate 65 by Day of Week

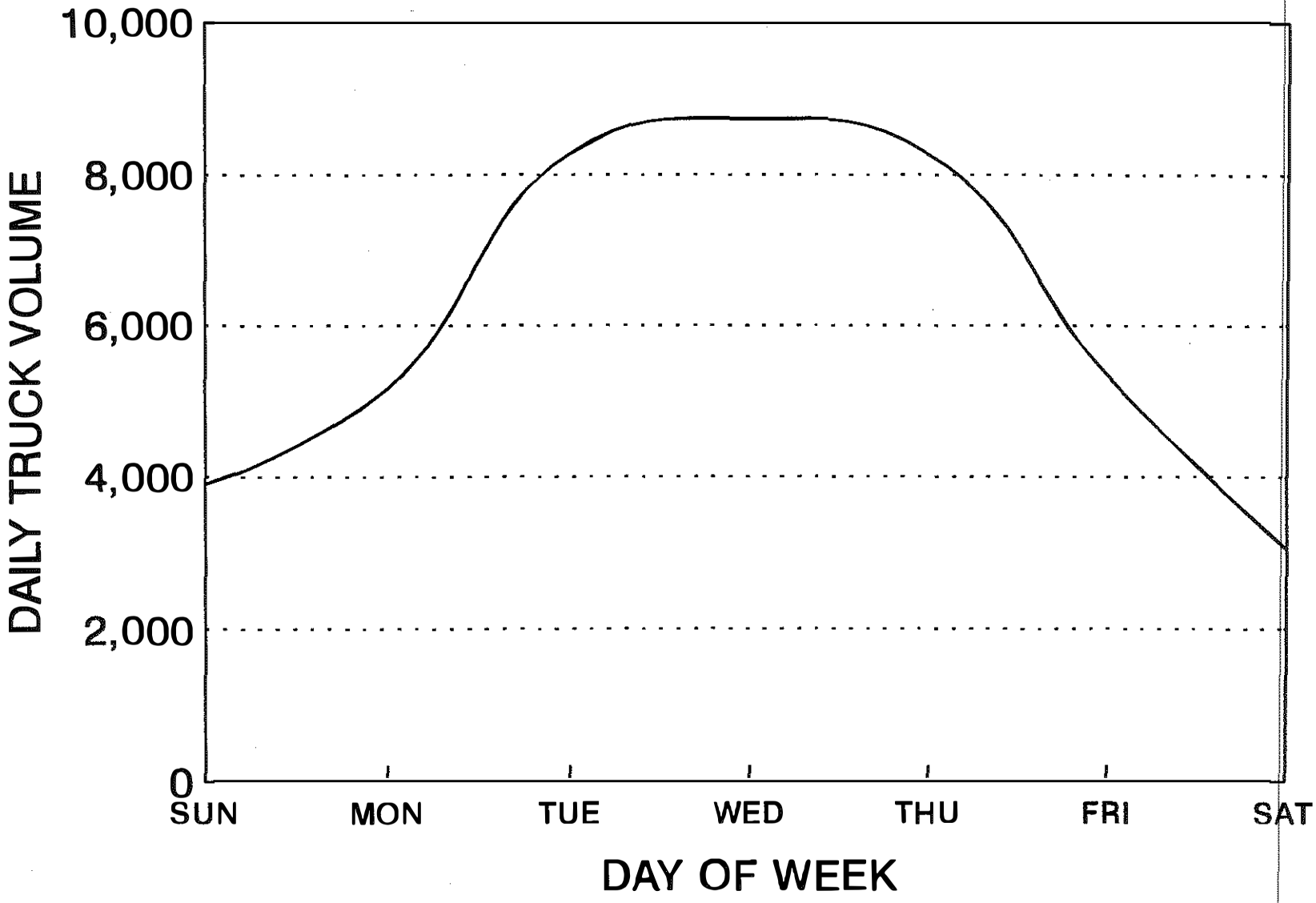


Figure 10. Truck Volume on Bypass Routes by Day of Week

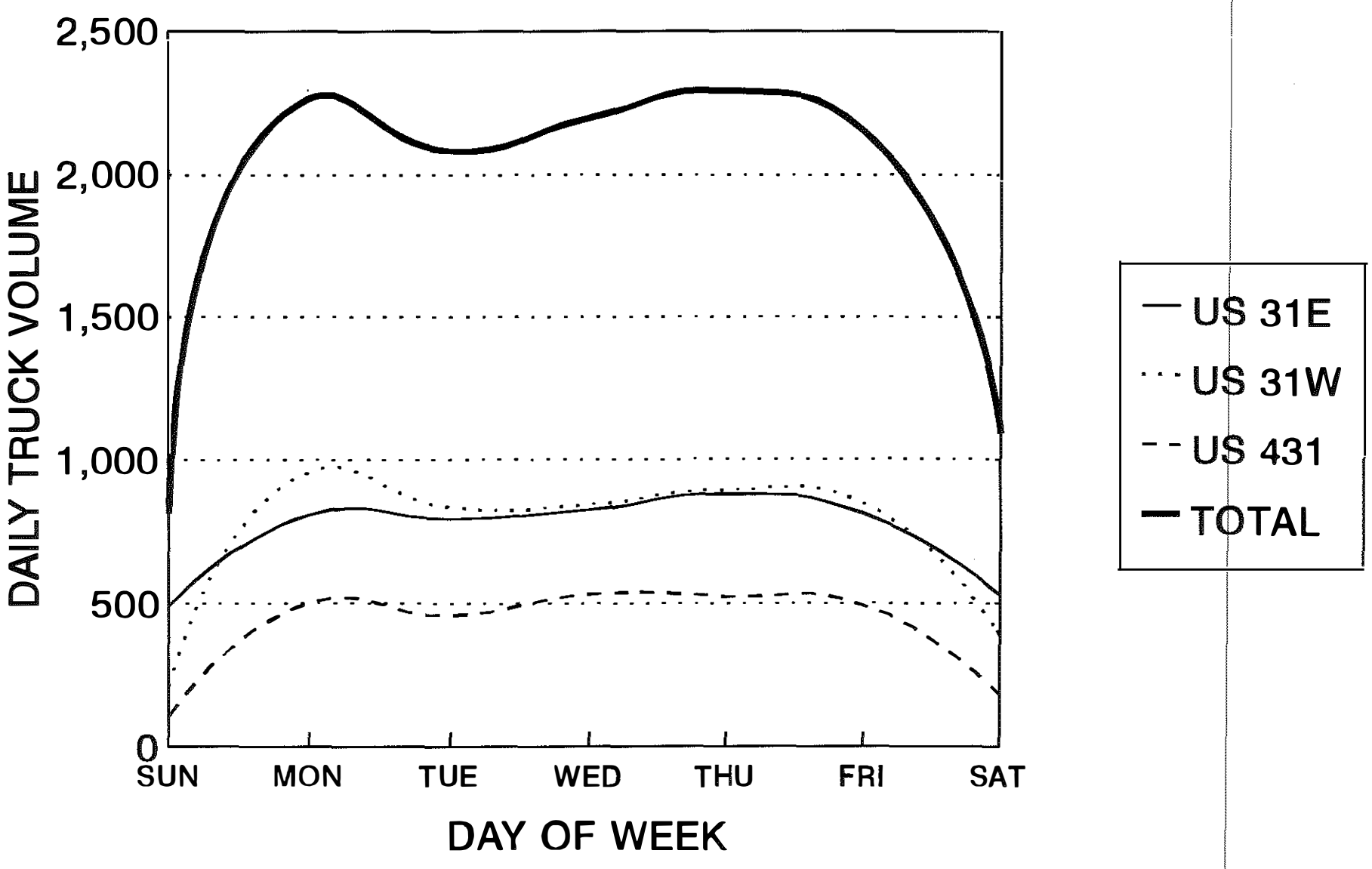


Figure 11. Classification of Trucks on Interstate 65

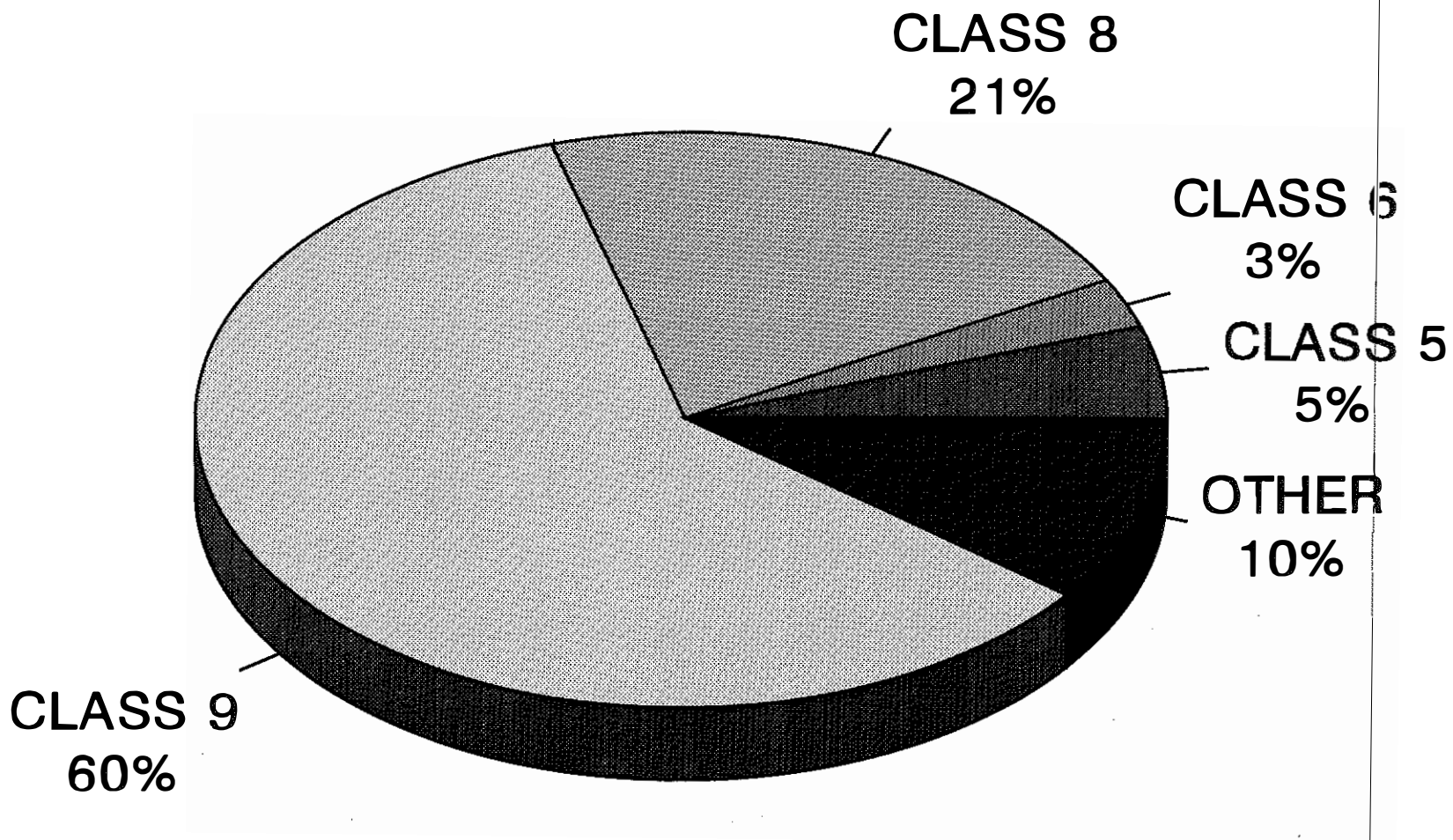


Figure 12. Classification of Trucks on Bypass Routes

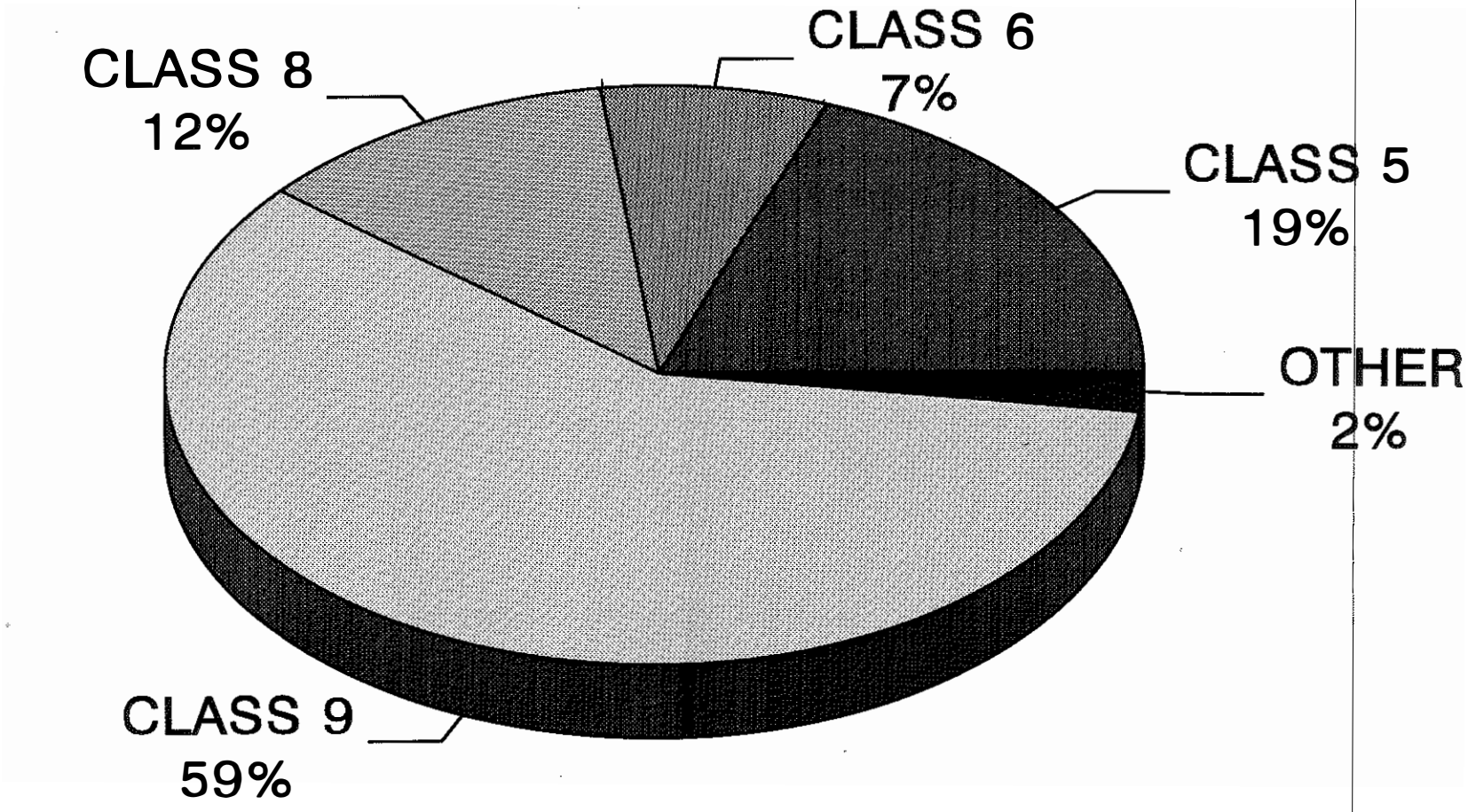


Figure 13. Classification of Trucks on Bypass Routes

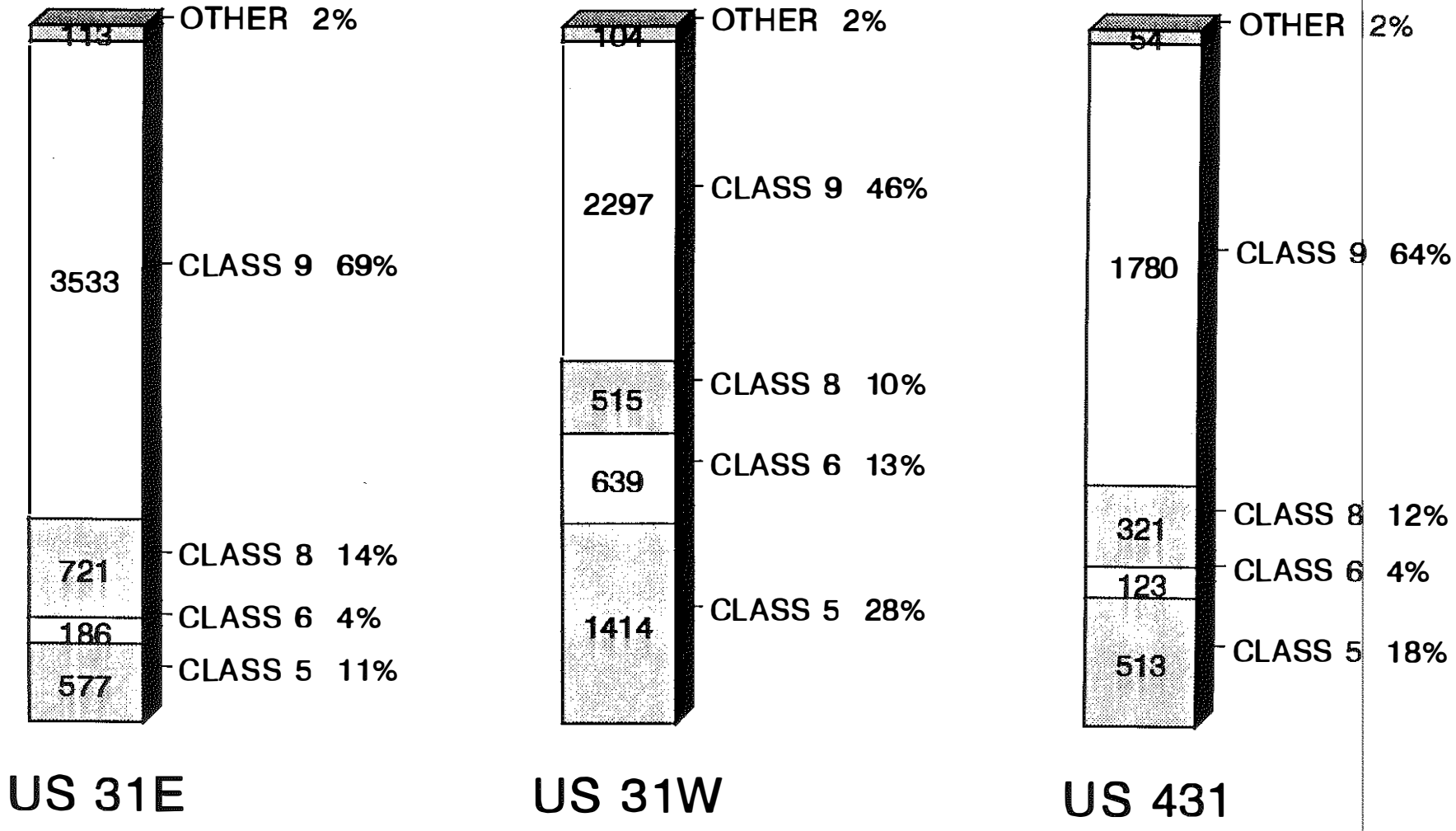


Figure 14. Weight Distribution for I-75 WIM Sites

CLASS 9

1200 10/21/91 TO 1100 10/28/91