THE EFFECT OF LAW ENFORCEMENT DEPLOYMENT PATTERNS ON MOTORISTS' SPEEDS

Final Report

SPR 304-161

by

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December 2003

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-OR-DF-04-04		

4. Title and Subtitle	5. Report Date
The Effect of Law Enforcement Deployment Patterns on Motorists' Speeds	December 2003
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Kevin J. Haas, P.E., Barnie P. Jones, Ph.D. and Alan R. Kirk	

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Oregon Department of Transportation Research Unit 200 Hawthorne Ave. SE, Suite B-240 Salem, Oregon 97301-5192	11. Contract or Grant No. SPR 304 - 161

12. Sponsoring Agency Name and Address		13. Type of Report and Period Covered
Oregon Department of Transportation Research Unit 200 Hawthorne Ave. SE, Suite B-240 Salem, Oregon 97301-5192	and Federal Highway Administration 400 Seventh Street S.W. Washington, DC 20590	Final Report
		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The combination of increased demands on Oregon's transportation system and limited law enforcement resources has led the Oregon Department of Transportation (ODOT) to investigate whether a relationship exists between motorists' speeds and law enforcement levels. If an optimum level of law enforcement could be identified that reduces the number of motorists driving in an unsafe manner, the end result could be a more efficient deployment of scarce law enforcement resources.

This study deployed enhanced law enforcement patrols at six study sites in Oregon to evaluate the effects of law enforcement presence on vehicle speeds. Investigators first recorded baseline speeds for a two-month period prior to the commencement of enhanced enforcement. Enhanced patrols varied from 10 to 25 hours per week on either fixed or random schedules. Enforcement at each site was on an eight-week cycle: two weeks of enhanced patrols followed by six weeks of normal patrols.

The data analysis compared median and 85th percentile speeds in the baseline and enhanced enforcement conditions. Baseline and enhanced enforcement data were also compared for the percent of vehicles traveling over the posted speed at each site. The findings showed that enhanced patrols resulted in small but statistically significant reductions in speed at most of the test sites. Both median and 85th percentile speeds were significantly higher than posted speeds at all of the study sites in both the baseline and the enhanced enforcement conditions.

17. Key Words	18. Distribution Statement
speed limits, basic rule, police patrol, traffic law enforcement, field study, data collection, speeding, median speed, 85th percentile speed, optimum deployment	Copies available from NTIS, and online at http://www.odot.state.or.us/tddresearch

19. Security Classif. (of this report).	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	56	

Technical Report Form DOT F 1700.7 (8-72) Reproduction of completed page authorized Printed on recycled paper

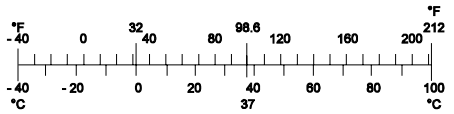
SI* (MODERN METRIC) CONVERSION FACTORS

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
Mi	Miles	1.61	Kilometers	Km
		AREA		
In^2	Square inches	645.2	millimeters	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		
Fl 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.				
		MASS		
Oz	Ounces	28.35	Grams	G
Lb	Pounds	0.454	Kilograms	Kg
T	Short tons (2000 lb)	0.907	Megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9	Celsius 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
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	1.308	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)		
°C	Celsius temperature	1.8C + 32	Fahrenheit	°F



* SI is the symbol for the International System of Measurement

(4-7-94 jbp)

ACKNOWLEDGEMENTS

The authors would like to thank the following for their assistance in the conduct of the research and the preparation of this report:

McGregor Lynde, Joni Reid and Deborah Martinez, Oregon Department of Transportation Research Unit

Jeremy Williams and Michelle Baldwin (Student Interns), Oregon Department of Transportation Research Unit

Larry Christianson, Oregon Department of Transportation Safety Division

Steve Vitolo, Oregon Department of Transportation Safety Division

Andrew Griffith, Texas Department of Transportation

DISCLAIMER

THE EFFECT OF LAW ENFORCEMENT DEPLOYMENT PATTERNS ON MOTORISTS' SPEEDS

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1.0 INTRODUCTION

1.1 PROBLEM STATEMENT

Both transportation and law enforcement agencies in Oregon face increasing challenges to maintain vehicular speeds at safe and legal levels. Vehicle Miles Traveled (VMT) in Oregon has consistently outpaced population growth in the state. Over the past 10 years, while population has been growing at an annual rate of 1.2 percent, VMT has increased at a rate of more than 2 percent annually (*ODOT 2002a*).

Reduced manpower and limited operating budgets further constrain transportation and law enforcement agencies as they attempt to provide traffic corridors that are safe for the traveling public. In 1980 the Oregon Department of State Police had 655 troopers assigned to patrol Oregon's highways (*Oregon Department of State Police 2002*). As of November 2003, that number had been reduced to 329 (*ODOT 2003a*).

The combination of increased demands on Oregon's transportation system and severely restricted resources in the law enforcement community has led the Oregon Department of Transportation (ODOT) to investigate whether a relationship exists between motorists' speeds and law enforcement levels. If an optimum level of law enforcement could be identified that reduces the number of motorists driving in an unsafe manner, the end result could be a more efficient deployment of scarce law enforcement resources.

1.2 OBJECTIVES AND RESEARCH METHODOLOGY

The overall objective of this study was to evaluate the effectiveness of different levels of law enforcement on Oregon's highways. The research would provide ODOT Safety Division staff with valuable information in determining which patrol patterns are most effective in reducing motorists' speeds. The goal was to optimize the perceived risk of apprehension relative to enforcement resources invested.

The following tasks were undertaken in order to accomplish the research objectives:

1. A literature search to determine the extent and applicability of previous research pertaining to the relationship between law enforcement patterns and motorists' speeds.

2. Identification of 6 test sites where enhanced law enforcement patrols would be implemented over an 18-month period.

3. Development of various law enforcement patterns to be implemented at the test sites.

4. Installation of monitoring equipment at all test sites to record speed and volume data for the duration of the project.

5. Establishment of a control test for collecting data at all test sites prior to the commencement of enhanced law enforcement patrols.

6. Implementation of enhanced law enforcement patrols and collection of data at all test sites.

7. Analysis of the data collected throughout the duration of the project.

The sections that follow will discuss each of these tasks and their outcomes. Section 2 discusses the literature review. Section 3 documents the site selection process. Section 4 covers the development of law enforcement patterns and the data collection methods. Section 5 presents the data analysis and findings. Sections 6 and 7 present the conclusions and recommendations from the study.

2.0 LITERATURE REVIEW

Previous documented research on the relationship between law enforcement patterns and motorists' speeds in the United States is limited. While much attention has been given to law enforcement in work zones and the effectiveness of reducing motorists' speeds when traveling through such zones, there is a significant lack of documentation focusing on the relationship between law enforcement patterns and motorists' speeds out on the open highway.

Baker (*1954*) was one of the first to identify how law enforcement patterns affect the behavior of motorists, who would otherwise travel at speeds greater than the law allows. Few would argue that the visible presence of law enforcement presents the immediate possibility of enforcement action on violators at a particular location. Baker surmised that if there is general belief amongst drivers that speed laws are enforced on a particular highway, this belief will act as a deterrent to drivers wanting to exceed legal speed limits, even if no law enforcement is known to be in the vicinity. Many law enforcement agencies still base their enforcement patterns around Baker's central theory that he put forth almost 50 years ago.

More recently, Sisiopiku and Patel (*1999*) evaluated the effectiveness of law enforcement presence on a rural highway where the speed limit for cars had recently been increased from 65 mph (105 km/h) to 70 mph (113 km/h). The field study focused on a 29-mile (45 km) segment of Interstate 96 in Ionia County, Michigan. One of the study's objectives was to determine the "halo" effects of law enforcement presence, i.e., the lasting effects when law enforcement is no longer present at a particular location. While the study failed to link motorists' speeds to specific patterns of law enforcement, one of the key findings showed that no "halo" effects were observed during the course of the study. While motorists' speeds showed some reduction upstream from a visible patrol car, as soon as vehicles passed the patrol car they accelerated to speeds higher than the average speed.

Internationally, the Monash University Accident Research Centre (MUARC) in Australia has published several reports focusing on speed enforcement. Diamantopoulou and Cameron (*2002*) examined the effects of overt and covert speed enforcement operations on rural Australian highways. The study found that a mix of covert and overt speed enforcement operations provided the greatest reduction in crashes and speeds over a two-year period from July 1995 to June 1997. A follow-up publication by Delaney, Diamantopoulou and Cameron (*2003*) provided a comprehensive review of MUARC speed enforcement research over the past several years. One of the principles outlined in the report suggests that the deterrence effects of speed enforcement could be maximized by employing low to medium intensity enforcement at multiple sites on the highway system.

3.0 SITE SELECTION

Six sites were selected for data collection and enhanced enforcement in cooperation with ODOT staff and local law enforcement agencies. Figure 3.1 shows a map of the site locations.

Figure 3.1: Test site locations

Two sites were located on the North Santiam Highway (Oregon Route 22) in Marion County. An additional two sites were located in Polk County, one on the Willamina-Salem Highway (Oregon Route 22) and the other on Pacific Highway West (Oregon Route 99W). Finally,

Benton and Lane Counties each had one site on the Alsea Highway (Oregon Route 34) and Florence-Eugene Highway (Oregon Route 126), respectively.

The sites represented a mix of expressways, state, region, and district highways according to the State Classification System (SCS) listed in the Oregon Highway Plan (*ODOT 1999*). Details about the sites selected for this research effort are provided in Table 3.1.

Table 3.1: Test site details

Site	County	Highway	Route	Milepost	Posted Speed	State Highway Classification	Lanes	Avg. Daily Traffic (ADT)
Aumsville	Marion	North Santiam	22	10	55 MPH (88 km/h)	Expressway	4	19,800
Gates	Marion	North Santiam	22	33.7	50 MPH (80 km/h)	State	2	4,800
Oak Knoll	Polk	Willamina-Salem	22	18.9	55 MPH (88 km/h)	Expressway	4	26,800
Monmouth	Polk	Pacific Highway West	99W	70.9	55 MPH (88 km/h)	Region	2	7,600
Alsea	Benton	Alsea	34	53.9	55 MPH (88 km/h)	District	2	2,200
Noti	Lane	Florence-Eugene	126	43.9	55 MPH (88 km/h)	State	2	6,200

All of the sites were located on highways with a posted speed of 55 mph (88 km/h) for all vehicles, with the exception of Gates which had a posted speed of 50 mph (80 km/h). Oregon differs from many other states in that posted speeds are not absolute. All travel on rural, non-interstate highways in Oregon is subject to the Basic Rule. The Basic Rule states that motorists must drive at speeds that are reasonable and prudent by considering other traffic, road, and weather conditions. The Basic Rule does not allow motorists to drive faster than the posted speed, nor does it set absolute speeds designated for all conditions. The Rule expects drivers to be responsible for their own actions (*ODOT 2003b*).

4.0 FIELD STUDY METHODS

4.1 DEVELOPMENT OF LAW ENFORCEMENT PATTERNS

The main objective of the project was to evaluate different levels of law enforcement to see if one particular pattern was more effective than others in controlling motorists' speeds. In order to accomplish this objective, a technical advisory committee for the project helped to develop a unique enforcement plan for each of the six sites. Levels of enforcement were divided into three different categories:

- Heavy – 25 hours of additional enforcement per week
- Medium – 15 hours of additional enforcement per week
- Light – 10 hours of additional enforcement per week

In addition, law enforcement personnel were placed on either a "Fixed" or "Random" schedule. A Fixed schedule specified certain hours of the day that the given level of additional enforcement would be applied, typically during morning or afternoon peak traffic times. A Random schedule allowed the given level of additional enforcement to be applied at any time during an enforcement shift. Thus only in the Fixed schedule was the actual presence of a patrol officer known at the specified times of day.

Patrols at each of the six sites were considered extra enforcement above and beyond the normal enforcement patterns of each law enforcement agency. The extra patrols were paid for by grants secured by the ODOT Safety Division, specifically for the purpose of this research effort. Patrol officers on overtime shifts and equipment were provided by the sheriff offices of each of the four counties involved in the study.

Patrols at each of the six sites were operated on a rotating schedule. Officers provided enhanced patrols over a two-week period at each site, followed by six-weeks with no enhanced patrols. This eight-week cycle was repeated over a period of 18 months for each site. To minimize the outlying effects of recreational and leisure travel associated with each site, all of the enhanced patrols were deployed on weekdays. Therefore, this study will focus only on data collected during weekdays for each of the sites. The details of each enforcement plan are provided in Table 4.1.

Table 4.1: Enforcement details

Site	County	Enforcement Level	Enforcement Schedule
Gates	Marion	Light	Random
Alsea	Benton	Light	Fixed
Monmouth	Polk	Medium	Random
Aumsville	Marion	Medium	Fixed
Oak Knoll	Polk	Heavy	Random
Noti	Lane	Heavy	Fixed

4.2 DATA COLLECTION

Speed and enforcement data were collected from July 2001 to January 2003. All of the sites had automated traffic recorders to collect speed data throughout the study. Each of the recorders was configured to count vehicles and record their speeds. The speed data was collected for each hour and stored in 10 speed bins, as shown in Table 4.2.

Table 4.2: Speed data recording bins

Bin	Speed Range
1	> 0 and ≤ 40 mph (>0 and ≤64 km/h)
2	> 40 and ≤ 45 mph (>64 and ≤72 km/h)
3	> 45 and ≤ 50 mph (>72 and ≤ 80 km/h)
4	> 50 and ≤ 55 mph (>80 and ≤ 88 km/h)
5	> 55 and ≤ 60 mph (>88 and ≤ 97 km/h)
6	> 60 and ≤ 65 mph (>97 and ≤ 105 km/h)
7	> 65 and ≤ 70 mph (>105 and ≤ 113 km/h)
8	> 70 and ≤ 75 mph (>113 and ≤ 121 km/h)
9	> 75 and ≤ 80 mph (121 and ≤ 129 km/h)
10	> 80 and ≤ 150 mph (129 and ≤ 241 km/h)

The bins were set up in increments of 5 mph (8 km/h) except for the first and last bins. The first bin stored all vehicle speeds from 0 - 40 mph (0 - 64 km/h) traveling in a particular hour. For instance, if a vehicle were traveling at 38 mph (61 km/h), it would be counted and stored in the first bin as a vehicle traveling between 0 and 40 mph (0 - 64 km/h). If a vehicle were traveling just over 55 mph (88 km/h), it would be stored in the next higher bin, i.e., > 55 and ≤ 60 mph (>88 and ≤ 97 km/h).

Traffic volume and speed data were collected at each site for a 2-month period prior to the deployment of enhanced enforcement, to establish a baseline condition.

During the periods of enhanced enforcement, patrols were instructed to stay within 1 mile (1,600 m) of the automated traffic recorder to ensure that the data collected was an accurate reflection of the conditions near the recorder when enhanced enforcement was present. The layout of a typical site is depicted in Figure 4.1.

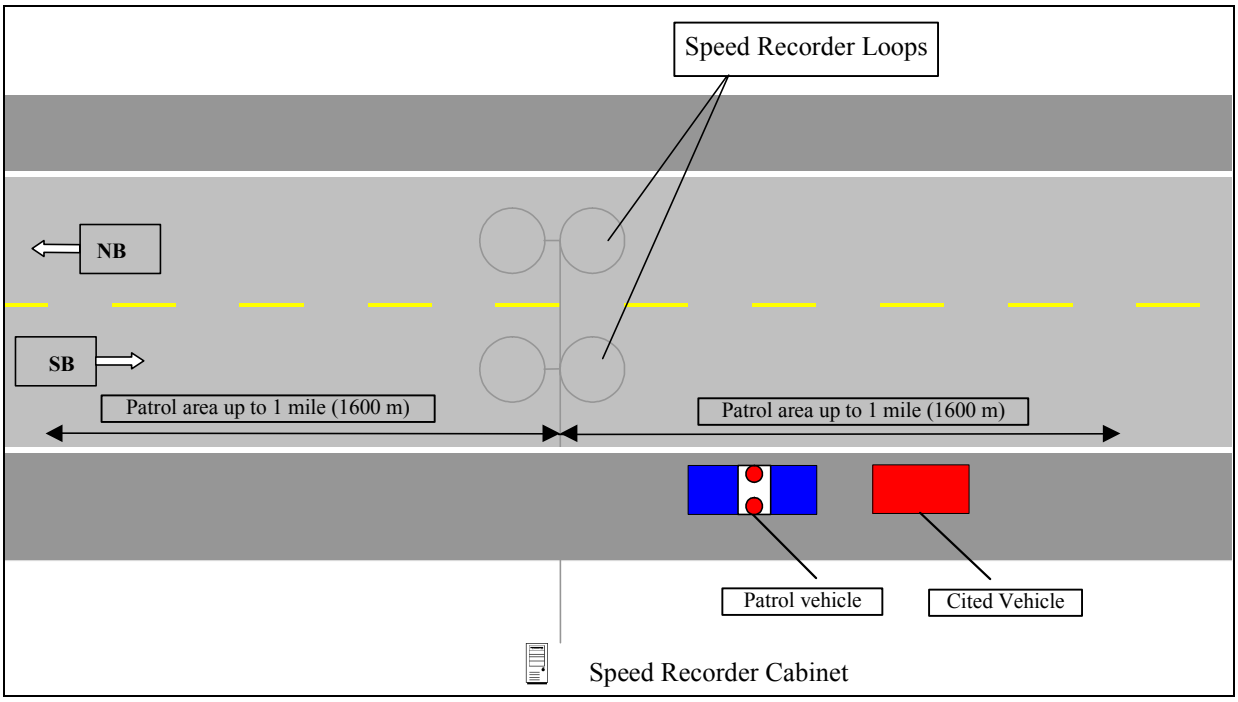

Figure 4.1: Typical site layout

4.3 SITE DATA

Field studies were commenced at each of the six sites and data was collected over a period of 18 months. During the 18 months of enhanced enforcement, traffic volume data and speeds were recorded with the automated traffic recorders. Data was divided into periods of "Normal Enforcement" and "Enhanced Enforcement." The following statistics were determined for each site:

- Median (50th percentile) speed;
- 85th percentile speed;
- Percent of vehicles traveling over the posted speed; and
- Percent of vehicles traveling 10 mph (16 km/h) or greater over the posted speed.

The results of the data collection efforts are presented in Section 5.

5.0 ANALYSIS OF RESULTS

5.1 ENHANCED ENFORCEMENT OVERVIEW

Across the six test sites, enhanced police enforcement totaled 1,210 hours over the 18-month period. A total of 1,331 citations were issued during these enforcement periods. Table 5.1 shows the enhanced enforcement activity and citations issued for each test site. Although the number of citations issued might be expected to be at least generally associated with the number of overtime hours logged, Table 5.1 shows that this was not the case. The number of citations issued per hour varied from 0.5 to 2.1.

Table 5.1: Summary of speed enforcement activity by site

Site	County	Enforcement	Overtime Hours	Citations	Average No. Citations per Hr
Gates	Marion	Light/Random	74.5	83	1.1
Alsea	Benton	Light/Fixed	96.0	53	0.6
Monmouth	Polk	Medium/Random	227.0	105	0.5
Aumsville	Marion	Medium/Fixed	119.0	229	1.9
Oak Knoll	Polk	Heavy/Random	305.5	142	0.5
Noti	Lane	Heavy/Fixed	388.0	719	2.1
		Total:	1,210.0	1,331	1.1

From the frequency distributions of the binned speed data, the following speed characteristics were examined:

- Median (50th percentile) speed;
- 85th percentile speed;
- Percent of vehicles over posted speed; and
- Percent of vehicles 10 mph (16 km/h) or greater over posted speed.

The binned speed data for all lanes (regardless of direction) were combined into one frequency distribution, and the hourly Baseline and enhanced enforcement speeds were compared. Graphs of these comparisons are included in Appendix A.

5.2 MEDIAN (50TH PERCENTILE) SPEEDS

The differences in median speeds varied greatly among the sites. The largest reduction from Baseline median speeds was observed at Noti with a decrease of 2.02 mph (3.25 km/h) between the hours of 0600 to 0700 during periods of enhanced enforcement. Conversely, several sites experienced increases in median speeds during periods of enhanced enforcement. The largest increase was 2.56 mph (4.12 km/h) during the hours of 1800 to 1900 at the Gates site. The reductions in median speeds appeared to occur more consistently during Fixed enforcement periods than during Random enforcement.

5.3 85TH PERCENTILE SPEEDS

At the 85th percentile speed, 85% of the vehicles in a particular hour are traveling at lower speeds. The remaining 15% are exceeding the 85th percentile speed.

The 85th percentile speeds exhibited similar patterns to the median speeds. The largest reduction from Baseline 85th percentile speeds was observed at Noti with a decrease of 2.32 mph (3.73 km/h) between the hours of 0800 to 0900 during periods of enhanced enforcement. Conversely, several sites experienced increases in 85th percentile speeds during periods of enhanced enforcement. The largest increase was 2.31 mph (3.72 km/h) during the hours of 1900 to 2000 at the Gates site. As with median speeds, the reductions in 85th percentile speeds appeared to occur more consistently during Fixed enforcement periods than during Random enforcement.

5.4 PERCENT OF VEHICLES TRAVELING OVER POSTED SPEED

In most cases, the percent of vehicles traveling over the posted speed during periods of enhanced enforcement was lower than during the corresponding Baseline conditions. However, significant differences in percentages were observed among the sites. The largest reduction from Baseline percentages was observed at Noti with a decrease of 16.3 percentage points between the hours of 0600 to 0700 during periods of enhanced enforcement. Conversely, the Gates site experienced an increase of 18.6 percentage points during the hours of 1900 to 2000 when enhanced enforcement was present. The reductions in the percent of vehicles traveling over the posted speed appeared to occur more consistently during Fixed enforcement periods than during Random enforcement.

5.5 PERCENT OF VEHICLES TRAVELING 10 MPH (16 KM/H) OR GREATER OVER THE POSTED SPEED

The percent of vehicles traveling 10 mph (16 km/h) or greater over the posted speed exhibited similar patterns to vehicles traveling over the posted speed. The largest reduction from Baseline conditions was observed at Aumsville with a decrease of 7.9 percentage points between the hours of 1700 to 1800 during periods of enhanced enforcement. Conversely, several sites experienced increases in number of vehicles traveling 10 mph or greater over the posted speed

during periods of enhanced enforcement. The largest increase was 6.6 percentage points during the hours of 2300 to 2400 at the Oak Knoll site.

5.6 STATISTICAL TESTING

To examine the statistical relationship between law enforcement patterns and speed, a chi-square test for independence was performed on the binned data from each test site. (The Baseline and Enhanced Enforcement speed data for all sites is included in Appendix B.) Speed data for a typical test site are shown in Table 5.2. Each row represents a one hour period for the prescribed conditions. Each of the 10 columns represents one of the 10 speed bins. Because enforcement was not present during all hours of the day, Baseline hours correspond to the prescribed enforcement conditions for each site. This ensures a valid statistical comparison between Baseline and enforcement data. For instance, at the Gates site enforcement was only present between the hours of 600 and 1800.

Table 5.2: Gates Baseline Speed Distribution

Start Hour	End Hour	<40 mph	41-45 mph	46-50 mph	51-55 mph	56-60 mph	61-65 mph	66-70 mph	71-75 mph	76-80 mph	>80 mph	Total
600	700	116	254	965	1491	752	264	59	10	6	1	3918
700	800	110	225	1091	2081	1335	514	133	23	7	0	5519
800	900	111	184	938	2201	1625	756	191	33	4	1	6044
900	1000	96	208	1222	2905	1879	714	211	38	5	2	7280
1000	1100	103	296	1537	3399	2271	879	197	24	4	2	8712
1100	1200	104	263	1684	3943	2384	913	188	30	7	4	9520
1200	1300	133	277	1820	4116	2728	975	222	39	3	1	10314
1300	1400	114	303	1865	4397	2853	1062	214	37	6	4	10855
1400	1500	186	437	1924	4626	3128	1085	232	35	8	1	11662
1500	1600	175	361	2005	4944	3390	1223	275	35	5	2	12415
1600	1700	179	476	2062	4376	2862	1066	262	41	4	2	11330
1700	1800	231	641	2396	3879	2023	756	154	28	5	1	10114
	Total	1658	3925	19509	42358	27230	10207	2338	373	64	21	107683

The data from the Baseline and the enforcement period tables were then compiled into a single speed distribution table used for chi-square testing, such as the one shown in Table 5.3.

Table 5.3: Gates Speed Distribution for Chi-square Testing

Enforcement Condition	<40 mph	41-45 mph	46-50 mph	51-55 mph	56-60 mph	61-65 mph	66-70 mph	71-75 mph	76-80 mph	>80 mph	Total
Baseline	1658	3925	19509	42358	27230	10207	2338	373	64	21	107683
Light/Random	224	560	3260	7307	5231	1912	453	68	17	5	19037
Total	1882	4485	22769	49665	32461	12119	2791	441	81	26	126720

A chi-square test for independence was run to look at the relationship between a particular level and pattern of enforcement and vehicle speed. If the two variables are independent, the frequency distribution of the binned speed data will not depend on levels of enforcement. Thus, the distribution of Baseline speed data will not be significantly different from the one for the enforcement level.

The chi-square statistic (χ^2) was computed for Baseline and enforcement conditions using the following formula:

$$\chi^2 = \sum \frac{(O_j - E_j)^2}{E_j} \quad \textbf{(5-1)}$$

where O_j is an observed cell frequency, and E_j is the expected cell frequency.

The calculated chi-square statistic is then compared with the theoretical value of chi-square determined from statistical tables, given an assumed significance level (α), which is set at 0.05. If the calculated χ^2 is greater than the theoretical value, it can be inferred (with a 5% probability of error) that a statistical relationship does exist.

5.6.1 Analysis of Gates speed data

Table 5.4 shows the Baseline and enforcement speed distributions of the Gates site. The differences between the observed and expected values in the Baseline data contributed very little to the total chi-square value. The differences between observed and expected in the Light/Random enforcement data resulted in a statistically significant difference. During this period, the median speed of 53.75 mph (86.50 km/h) and 85th percentile speed of 59.62 mph (95.95 km/h) was actually slightly higher than Baseline conditions where the median speed was 53.39 mph (85.92 km/h) and the 85th percentile speed was 59.42 mph (95.63 km/h). This leads to the question of why speeds would be higher when enforcement was present. One possible conclusion is that the combination of a Light enforcement schedule patrolling at random hours did not act as an effective deterrent to excessive speed at this location. Another contributing factor could have been the geometric design of the highway and location of data collection equipment at this site. This will be discussed further in Section 5.7.

Table 5.4: Speed distribution and chi-square analysis of Gates site

Enforcement Condition	<40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	>80	Total
Baseline	1658	3925	19509	42358	27230	10207	2338	373	64	21	107683
	1.54%	3.64%	18.12%	39.34%	25.29%	9.48%	2.17%	0.35%	0.06%	0.02%	100.00%
Light/Random	224	560	3260	7307	5231	1912	453	68	17	5	19037
	1.18%	2.94%	17.12%	38.38%	27.48%	10.04%	2.38%	0.36%	0.09%	0.03%	100.00%
Total	1882	4485	22769	49665	32461	12119	2791	441	81	26	126720
	1.49%	3.54%	17.97%	39.19%	25.62%	9.56%	2.20%	0.35%	0.06%	0.02%	100.00%

Chi-square = 91.15, degrees of freedom = 9, significant at .05

5.6.2 Analysis of Alsea speed data

The Baseline and enforcement speed distributions for the Alsea site are presented in Table 5.5. Both the Baseline and Light enforcement on a Fixed patrol schedule contributed to the calculated chi-square being significantly greater than the theoretical value. The median speed of 55.70 mph (89.64 km/h) and 85th percentile speed of 61.88 mph (99.59 km/h) during periods of enhanced enforcement were slightly lower than Baseline conditions where the median speed was 56.33 mph (90.65 km/h) and the 85th percentile speed was 62.40 mph (100.42 km/h). In contrast to the Gates site, it appears that the Fixed schedule of Light enforcement may be more effective than a Random patrol schedule in reducing speeds.

Table 5.5: Speed distribution and chi-square analysis of Alsea site

Enforcement Condition	<40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	>80	Total
Baseline	151	368	1852	8209	9479	4601	1163	257	54	62	26196
	0.58%	1.40%	7.07%	31.34%	36.18%	17.56%	4.44%	0.98%	0.21%	0.24%	100.00%
Light/Fixed	174	227	1112	4417	4487	1960	538	130	34	42	13121
	1.33%	1.73%	8.47%	33.66%	34.20%	14.94%	4.10%	0.99%	0.26%	0.32%	100.00%
Total	325	595	2964	12626	13966	6561	1701	387	88	104	39317
	0.83%	1.51%	7.54%	32.11%	35.52%	16.69%	4.33%	0.98%	0.22%	0.26%	100.00%

Chi-square = 154.77, degrees of freedom = 9, significant at .05

5.6.3 Analysis of Monmouth statistical data

The Baseline and enforcement data for the Monmouth site are presented in Table 5.6. The differences between the observed and expected values in the Baseline data contributed very little to the total chi-square value. The differences between observed and expected in the Medium/Random enforcement data resulted in a statistically significant difference. The data shows that the median speed of 56.92 mph (91.60 km/h) and 85th percentile speed of 62.35 mph (100.34 km/h) during periods of enhanced enforcement were slightly lower than Baseline conditions where the median speed was 57.06 mph (91.83 km/h) and the 85th percentile speed was 62.53 mph (100.63 km/h).

Table 5.6: Speed distribution and chi-square analysis of Monmouth site

Enforcement Condition	< 40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	> 80	Total
Baseline	2634	2789	13637	84505	133412	64152	13146	1959	406	386	317026
	0.83%	0.88%	4.30%	26.66%	42.08%	20.24%	4.15%	0.62%	0.13%	0.12%	100.00%
Medium/Random	625	530	3176	19357	29153	13742	2662	359	68	88	69760
	0.90%	0.76%	4.55%	27.75%	41.79%	19.70%	3.82%	0.51%	0.10%	0.13%	100.00%
Total	3259	3319	16813	103862	162565	77894	15808	2318	474	474	386786
	0.84%	0.86%	4.35%	26.85%	42.03%	20.14%	4.09%	0.60%	0.12%	0.12%	100.00%

Chi-square = 85.46, degrees of freedom = 9, significant at .05

5.6.4 Analysis of Aumsville statistical data

The Baseline and enforcement speed distributions for the Aumsville site are presented in Table 5.7. Based on the chi-square testing, both the Baseline data and Medium/Fixed schedule enforcement data contributed significantly to the calculated chi-square value. The data shows that the median speed of 61.60 mph (99.14 km/h) and 85th percentile speed of 67.58 mph (108.76 km/h) during periods of enhanced enforcement were slightly lower than Baseline conditions where the median speed was 61.96 mph (99.71 km/h) and the 85th percentile speed was 68.17 mph (109.70 km/h).

Table 5.7: Speed distribution and chi-square analysis of Aumsville site

Enforcement Condition	< 40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	> 80	Total
Baseline	650	296	2277	35786	202691	255887	133083	39419	11288	3150	684527
	0.17%	0.11%	0.40%	5.39%	29.95%	37.48%	19.06%	5.47%	1.53%	0.43%	100.00%
Medium/Fixed	973	715	1476	14787	78373	95827	45790	11919	3103	901	253864
	0.38%	0.28%	0.58%	5.82%	30.87%	37.75%	18.04%	4.70%	1.22%	0.35%	100.00%
Total	1623	1011	3753	50573	281064	351714	178873	51338	14391	4051	938391
	0.09%	0.04%	0.33%	5.23%	29.61%	37.38%	19.44%	5.76%	1.65%	0.46%	100.00%

Chi-square = 3222.94, degrees of freedom = 9, significant at .05

5.6.5 Analysis of Oak Knoll statistical data

The Baseline and enforcement speed distributions for the Oak Knoll site are presented in Table 5.8. Based on the chi-square testing, both the Baseline data and Heavy/Random schedule enforcement data contributed significantly to the calculated chi-square value. The data shows that the median speed of 60.21 mph (96.90 km/h) and 85th percentile speed of 66.51 mph (107.04 km/h) during periods of enhanced enforcement were slightly lower than Baseline conditions where the median speed was 60.70 mph (97.69 km/h) and the 85th percentile speed was 66.80 mph (107.50 km/h).

Table 5.8: Speed distribution and chi-square analysis of Oak Knoll site

Enforcement Condition	< 40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	> 80	Total
Baseline	1626	2828	9713	59727	189966	200126	89770	25083	4025	1001	583865
	0.28%	0.48%	1.66%	10.23%	32.54%	34.28%	15.38%	4.30%	0.69%	0.17%	100.00%
Heavy/Random	3140	2671	6122	23237	65402	66235	29515	8502	1505	424	206753
	1.52%	1.29%	2.96%	11.24%	31.63%	32.04%	14.28%	4.11%	0.73%	0.21%	100.00%
Total	4766	5499	15835	82964	255368	266361	119285	33585	5530	1425	790618
	0.60%	0.70%	2.00%	10.49%	32.30%	33.69%	15.09%	4.25%	0.70%	0.18%	100.00%

Chi-square = 7172.37, degrees of freedom = 9, significant at .05

5.6.6 Analysis of Noti statistical data

The Baseline and enforcement speed distributions for the Noti site are presented in Table 5.9. Based on the chi-square testing, both the Baseline data and Heavy/Fixed schedule enforcement data contributed significantly to the calculated chi-square value. The data shows that the median speed of 56.62 mph (91.12) km/h and 85th percentile speed of 61.96 mph (99.71 km/h) during periods of enhanced enforcement were significantly lower than Baseline conditions where the median speed was 58.10 mph (93.50 km/h) and the 85th percentile speed was 63.77 mph (102.63 km/h). The Noti site had by far the greatest reduction in speeds from Baseline conditions of all 6 sites included in this study.

Table 5.9: Speed distribution and chi-square analysis of Noti site

Enforcement Condition	< 40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	> 80	Total
Baseline	626	224	1384	16369	33182	19647	5346	1053	242	284	78357
	0.80%	0.29%	1.77%	20.89%	42.35%	25.07%	6.82%	1.34%	0.31%	0.36%	100.00%
Heavy/Fixed	1244	732	4455	38089	51371	20319	4622	898	249	339	122318
	1.02%	0.60%	3.64%	31.14%	42.00%	16.61%	3.78%	0.73%	0.20%	0.28%	100.00%
Total	1870	956	5839	54458	84553	39966	9968	1951	491	623	200675
	0.93%	0.48%	2.91%	27.14%	42.13%	19.92%	4.97%	0.97%	0.24%	0.31%	100.00%

Chi-square = 5373.65, degrees of freedom = 9, significant at .05

5.6.7 Chi-square analysis summary

The results of the chi-square tests, comparing the Baseline and the prescribed enforcement conditions at each test site are presented in Table 5.10. While the chi-square statistic was significant at the .05 level at all sites, it is readily apparent that the magnitude of the statistic is much greater at the Medium/Fixed enforcement site and at both Heavy enforcement sites. At the Light and Medium enforcement levels the magnitude of the statistic was greater at the Fixed schedule sites than at the Random schedule sites.

Table 5.10: Chi-square analysis of each test site

Test Site	Enforcement Condition	Theoretical Chi-square	Calculated Chi-square	Enforcement-Speed Statistical Relationship
Gates	Light - Random	16.92	91.15	Yes
Alsea	Light - Fixed	16.92	154.77	Yes
Monmouth	Medium - Random	16.92	85.46	Yes
Aumsville	Medium - Fixed	16.92	3222.94	Yes
Oak Knoll	Heavy - Random	16.92	7172.37	Yes
Noti	Heavy - Fixed	16.92	5373.65	Yes

5.7 DISCUSSION OF FIELD DATA

The field trials demonstrated that vehicles reduced their speeds at five of the six sites when enforcement was present. The lone exception was the Gates site where speeds actually increased during periods of enhanced enforcement. Several factors may have contributed to the increase in speeds at the Gates site. This is the only site where the posted speed was lower than 55 mph (88 km/h). In addition, this site lacked the rural, open highway characteristics of the other five sites. The traffic recorder was located on the eastern edge of the city limits of Gates and was in an area where the posted speed transitioned from 45 mph (72 km/h) to 50 mph (80 km/h) at milepost 33.24 and from 50 mph (80 km/h) to 55 mph (88 km/h) at milepost 33.68. It is likely that vehicles did not maintain a constant speed while approaching the traffic recorder site, since the recorder was located in an area where posted speed transitioned from 45 mph (72 km/h) to 55 mph (80 km/h) in less than ½ mile. The traffic recorder was also located between a series of horizontal curves that severely restricted the visible presence of law enforcement at the site.

For the other five sites, chi-square test for independence showed that there was a significant relationship (albeit small in magnitude) between speed and levels of enforcement. With the presence of statistically significant differences, one can infer that all enforcement levels resulted in vehicles slightly reducing speeds when enhanced patrols were present. The effectiveness of such patrols, however, varied noticeably among sites.

In reviewing the enhanced enforcement and Baseline data for each of the sites, it is apparent that the Heavy enforcement on a Fixed schedule resulted in the greatest reduction in motorists' speeds. Table 5.11 summarizes the speed data at the six sites, and shows the actual speed reduction resulting from differences between the enhanced enforcement and Baseline conditions.

Table 5.11: Summary of speed data for all sites

Site	Median (50th Percentile) Speed						85th Percentile Speed					
	Enforcement		Baseline		Difference		Enforcement		Baseline		Difference	
	mph	km/h	mph	km/h	Mph	km/h	mph	km/h	mph	km/h	mph	km/h
Gates	53.75	86.50	53.39	85.93	0.35	0.57	59.62	95.94	59.42	95.63	0.20	0.31
Alsea	55.70	89.64	56.33	90.65	-0.63	-1.01	61.88	99.58	62.40	100.42	-0.52	-0.84
Monmouth	56.92	91.60	57.06	91.83	-0.14	-0.22	62.35	100.34	62.53	100.64	-0.18	-0.30
Aumsville	61.60	99.13	61.96	99.72	-0.37	-0.59	67.58	108.76	68.17	109.70	-0.59	-0.94
Oak Knoll	60.21	96.90	60.70	97.69	-0.49	-0.79	66.51	107.04	66.80	107.50	-0.29	-0.46
Noti	56.62	91.12	58.10	93.50	-1.48	-2.38	61.99	99.76	63.77	102.63	-1.78	-2.87

The greatest reductions in median speeds were observed at the following sites: Noti (Heavy patrol/Fixed schedule); Alsea (Light patrol/Fixed schedule, and Oak Knoll (Heavy patrol/Random schedule). The greatest reductions in motorists' 85th percentile speeds were observed at the three sites with Fixed enforcement schedules: Noti (Heavy patrol); Aumsville (Medium patrol); and Alsea (Light patrol). As a general rule, most sites saw statistically significant reductions at both the median and 85th percentile speeds.

Comparing the 50th percentile and the 85th percentile speed reductions, the Oak Knoll and Alsea sites are of particular interest. Oak Knoll employed a Heavy level of enforcement on a Random schedule. While the median speed was reduced by 0.49 mph during times of enforcement, the 85th percentile speed saw only a marginal reduction of 0.29 mph. Similarly, Alsea which employed a Light level of enforcement on a Fixed schedule saw a slightly lower reduction in 85th percentile speed when compared to the median speed. The data for these sites are unique in that they run contrary to findings at three other sites. Aumsville, Monmouth, and Noti saw greater reductions in 85th percentile speeds during periods of enforcement when compared to median speeds at the same site. This will be discussed in further detail along with conclusions from the study in the next section.

Given the wide variation in the number of citations issued per hour, independent of the designated level of patrol (Table 5.1), one might hypothesize that the observed speed reductions were more due to the issuance of citations than to the patrol schedule. Table 5.12 shows the overtime hours, average number of citations issued per hour, and the reductions in the 85th percentile speeds for each site. Considering the five sites that showed reductions in speed, Figure 5.1 shows scatter plots of the average number of citations issued per hour by the observed speed reduction, and the number of overtime hours by the observed speed reduction.

Table 5.12: Overtime, average citations per hour and 85th percentile speed reductions

Site	Overtime Hours	Average No. Citations per Hr.	Average Difference in 85th Percentile Speeds (mph)
Gates	74.5	1.1	0.2
Alsea	96.0	0.6	-0.52
Monmouth	227.0	0.5	-0.18
Aumsville	119.0	1.9	-0.59
Oak Knoll	305.5	0.5	-0.29
Noti	388.0	2.1	-1.78

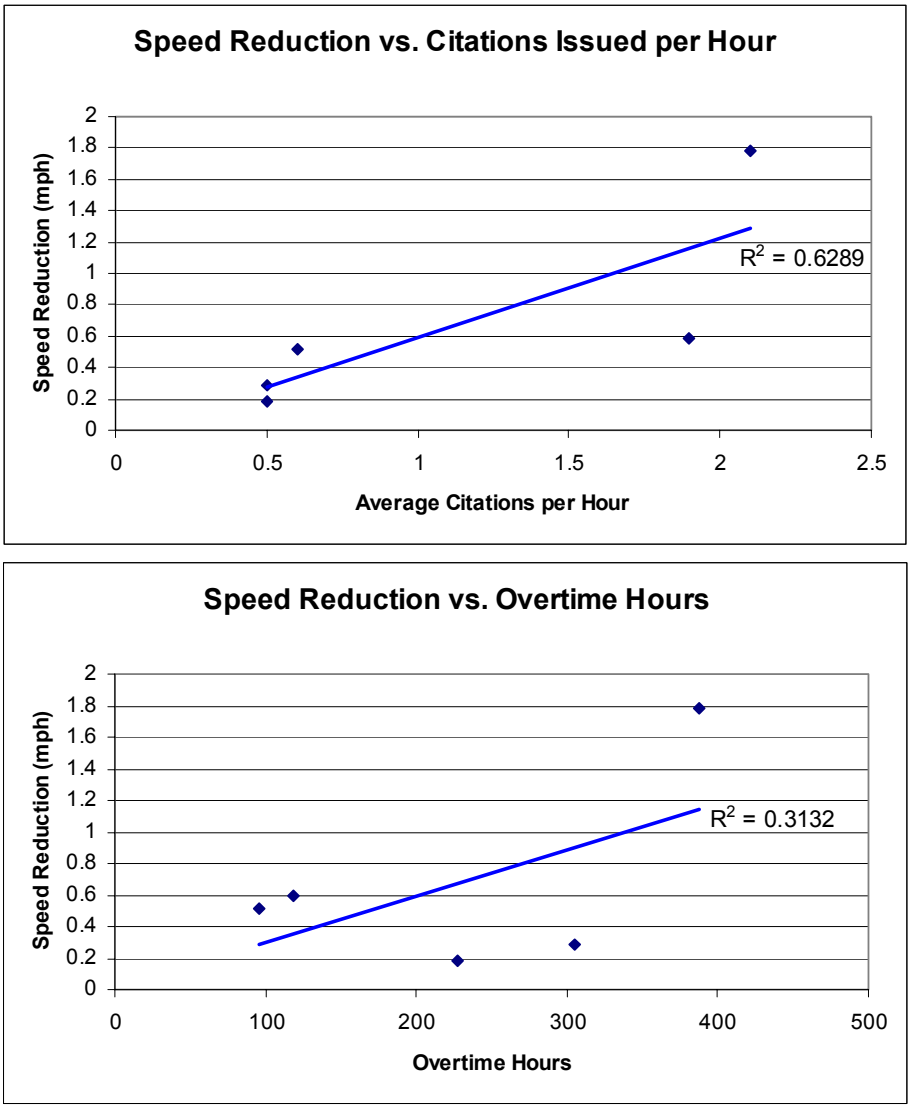

Figure 5.1: Speed reduction versus citations issued per hour and overtime hours

Although the data are limited, the regression coefficients in the scatter plots suggest that the differences in speed reduction may be more closely associated with the citations issued than with the overtime hours (i.e. level of patrol). This evidence that the vigorousness of enforcement activities (as measured by number of citations per hour) may play a role in speed reduction is not remarkable in and of itself. It does suggest that increased visibility of police patrols may have limited effects on speeds if these patrols are not accompanied by vigorous enforcement activities. This will be discussed in further detail in the next section.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The field trials at the six sites provided noteworthy results. Median and 85th percentile speeds decreased from the Baseline speeds for five of the six sites when enhanced enforcement was present. Chi-square testing for independence showed that there was a statistical relationship between the Baseline and enhanced enforcement conditions at all of the six sites.

In comparing the enforcement data to the Baseline conditions, the greatest reductions in median and 85th percentile speeds occurred at the Noti site where a Heavy enforcement pattern on a Fixed schedule was employed. Not lagging far behind was the Alsea site which saw slightly lower speed reductions while employing a Light enforcement pattern on a Fixed schedule. Overall, the field trials demonstrated that Fixed enforcement schedules produced greater speed reductions than Random enforcement schedules. However, identifying an optimum level of enforcement proved difficult. As noted earlier, both the Noti and Alsea sites saw similar results while employing vastly different levels of enforcement.

At face value, one might conclude that a Light enforcement pattern with a Fixed schedule would represent the optimum deployment of scarce law enforcement resources in Oregon. However, two important variables must be factored into the results of this study, Oregon's speed laws and the public perceptions of enforcement in Oregon.

As mentioned in Section 3, Oregon is known as a "basic rule" state. Posted speeds on rural, non-interstate highways do not represent an absolute limit, but rather a safe and reasonable speed under normal driving conditions. This is important because most citations issued by police in Oregon for excessive speed are categorized as violations of the basic rule. In these cases, law enforcement must provide evidence that the driver was traveling at a speed that was unreasonable for the conditions. These conditions include congestion, highway width, intersection hazards, weather, and visibility. Needless to say, this leaves a significant amount of room for interpretation as to what a safe and reasonable speed is for a particular section of highway in relation to the posted speed on that highway. Consequently, law enforcement personnel have been reluctant to cite drivers for minor violations of the basic rule. This point is illustrated by recent findings in a report that looked into drivers' perceptions of speed enforcement in Oregon.

A 2002 ODOT study surveyed 651 Oregon adult drivers on general speeding attitudes and behavior. The study found that a majority of drivers believe there is some "flexibility" in posted speeds, and that they can exceed the posted speed by up to 5 mph (8 km/h) without being cited. More than a third of the drivers surveyed believed they could exceed posted speeds by more than 5 mph (8 km/h) without being cited (*Jones, et al. 2002*). The results of the survey are consistent

with perceptions in Oregon that law enforcement personnel are reluctant to cite drivers for minor violations of the basic rule. This can only lead to the conclusion that the presence of law enforcement in and of itself does not necessarily act as an effective deterrent for drivers exceeding the posted speed in Oregon.

It should be noted that at all six test sites, median and 85th percentile speeds exceeded the posted speed. Furthermore, at both the Oak Knoll and Aumsville sites, the 85th percentile speed (traditionally used as a guideline for setting speed limits) exceeded the posted speed by more than 10 mph (16 km/h).

The effectiveness of law enforcement in reducing the percentage of vehicles traveling over the posted speed is as much a function of their presence as it is their diligence in issuing citations to drivers who violate the basic rule. Jones, et al. (*2002*) found that 83% of respondents in the 2002 survey reported the primary reason for obeying speed limits was due to the risk of receiving a citation from law enforcement personnel. Therefore, since the median and 85th percentile speeds exceed the posted speeds at all test sites, we can hypothesize that most drivers in Oregon do not significantly alter their driving behavior in the presence of law enforcement even when traveling up to 5 mph (8 km/h) over posted speeds.

This makes it difficult at best to reach a conclusion as to the optimum deployment of law enforcement resources in Oregon based on our test site data. While Fixed enforcement schedules at the Alsea and Noti sites proved to be the most effective in reducing speeds, these results may have had as much to do with the diligence of law enforcement agencies in issuing citations as it did with whether or not a speeding problem existed at the site. The combination of Oregon drivers' perceptions of law enforcement and existing Oregon speed laws lead one to conclude that most Oregon drivers will drive at a speed that **they believe** is reasonable for the conditions outlined in the basic rule, regardless of law enforcement presence or posted speed.

6.2 RECOMMENDATIONS

One of the most important findings contained in this report is the disconnect between existing Oregon speed laws and enforcement of the basic rule in Oregon. Several bills have been introduced in recent sessions of the Oregon Legislative Assembly to revise speed laws by giving the Oregon Department of Transportation authority to establish maximum speed limits on rural, non-interstate highways. As of the publication of this report, none of these legislative efforts has succeeded in becoming law. Revising Oregon speed laws, however, represents just one component of a comprehensive strategy to provide effective speed enforcement on Oregon highways.

As law enforcement resources become increasingly scarce across the state, it is key for patrols to focus on areas where there are both speeding and safety concerns based on crash histories. The results of this study indicated that both Fixed and Random enforcement patterns had only small impacts on reducing speeds at most of the test sites. It could be argued that there were not serious safety concerns related to speeding at any of the test sites based on crash history data. All of the sites had crash rates below the statewide average (*ODOT 2002b*). It should be noted that the site with the highest crash rate, Alsea (1.39 crashes per million vehicle miles), saw a

significant reduction in median and 85th percentile speeds with a Light enforcement pattern on a Fixed schedule. This provides some evidence that focusing patrols on highways with significant crash histories and speeding problems can lead to reduced speeds and increased safety for motorists.

It should also be noted, however, that the lingering effects of such enforcement soon dissipate after patrols move on to a new location. All of the sites saw speeds return to Baseline levels almost immediately after the enhanced patrols were discontinued. This was not only true for the hours immediately after enforcement was present, but also for the days and weeks that followed the enhanced patrols at each site.

This report provides limited evidence that enhanced patrols yield some reduction in median and 85th percentile speeds. Enhanced patrols alone, however, may not be an effective deterrent to speeding in Oregon. Given that median and 85th percentile speeds at the test sites in this study were well in excess of posted speeds, it is reasonable to hypothesize that this is the case on open highways throughout the state highway system. The combination of current Oregon speed laws, public perception of enforcement in Oregon, and lack of resources available within the law enforcement community are likely contributors to this situation. Further analysis of speeds elsewhere in the state would be a first step toward fuller documentation of the situation.

Where speeds are found to be excessive, especially in areas with high crash rates, enhanced enforcement is recommended. Given the evidence of Oregon drivers' perceptions of speed enforcement, however, it may take considerable effort for enhanced enforcement to be effective. Until revisions are made to Oregon speed laws allowing the establishment of enforceable maximum speeds on non-interstate rural highways, the effectiveness of enhanced enforcement may be compromised.

Although this research effort focused on enforcement on non-interstate highways, recent legislation was passed by the Oregon Legislative Assembly in 2003, allowing ODOT to increase posted speeds on interstate highways up to a maximum of 70 mph (65 mph for trucks and buses) (*Oregon Legislative Assembly 2003*). Since posted speeds on Oregon's interstate highway system represent an absolute maximum (as opposed to rural, non-interstate highways), it is recommended that further research be conducted on the interstate system where ODOT is considering increases in posted speeds. This would be similar to the research that Sisiopiku and Patel (1999) performed in Michigan where posted speeds were increased from 65 mph to 70 mph. By building upon on the results of the Michigan study, ODOT could examine different levels and patterns of enforcement to find an optimum level of law enforcement deployment on the interstate system, an objective that was not accomplished in the current research effort. The application of results from such research to non-interstate highways in Oregon, however, would still be subject to interpretation due to the differences in speed laws and enforcement for interstate versus non-interstate highways.

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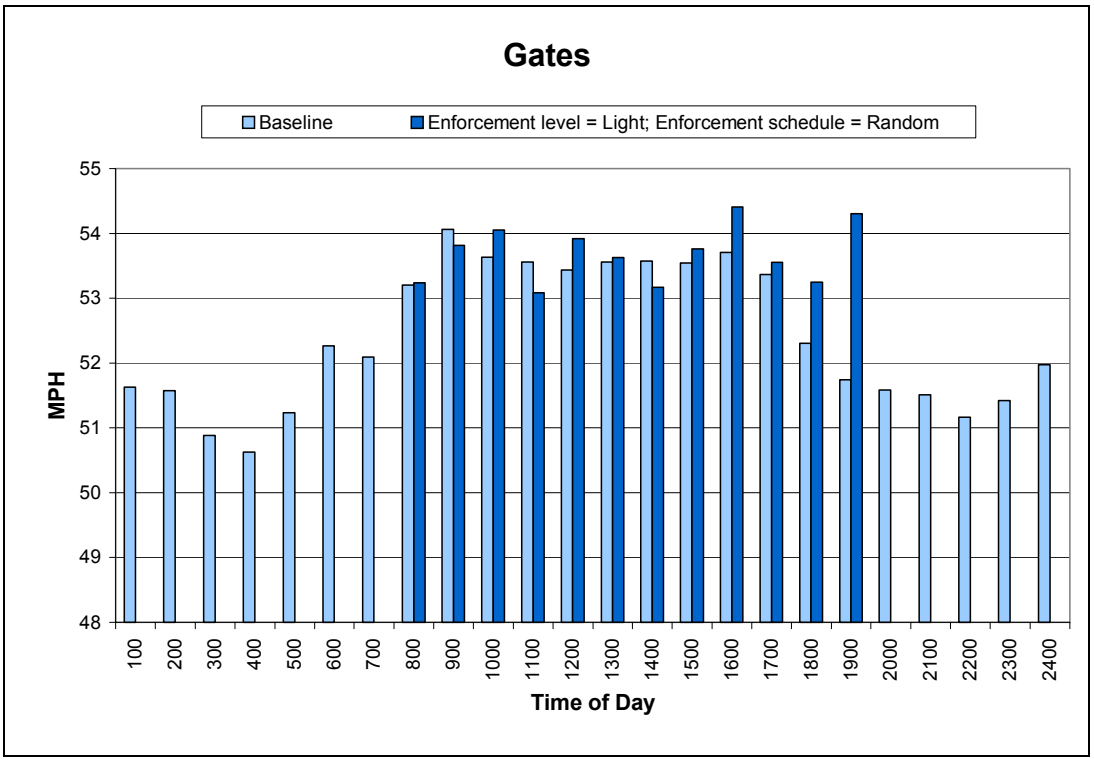
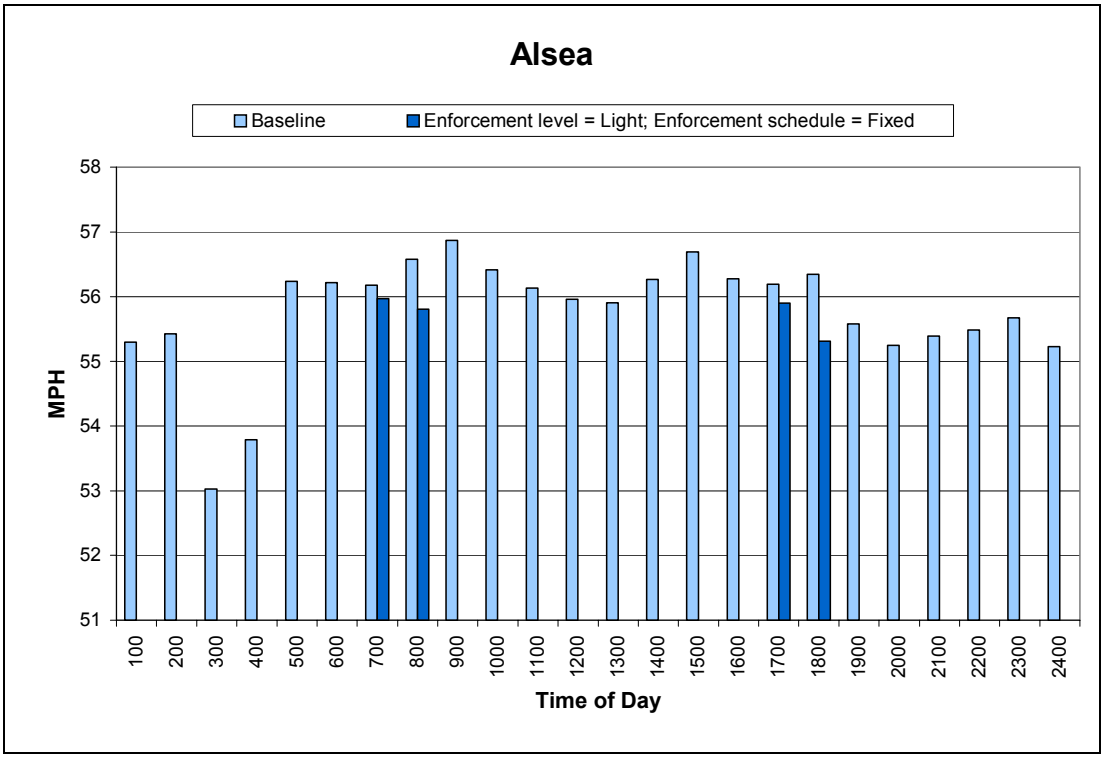
APPENDIX A: BASELINE AND ENHANCED ENFORCEMENT SPEED COMPARISONS

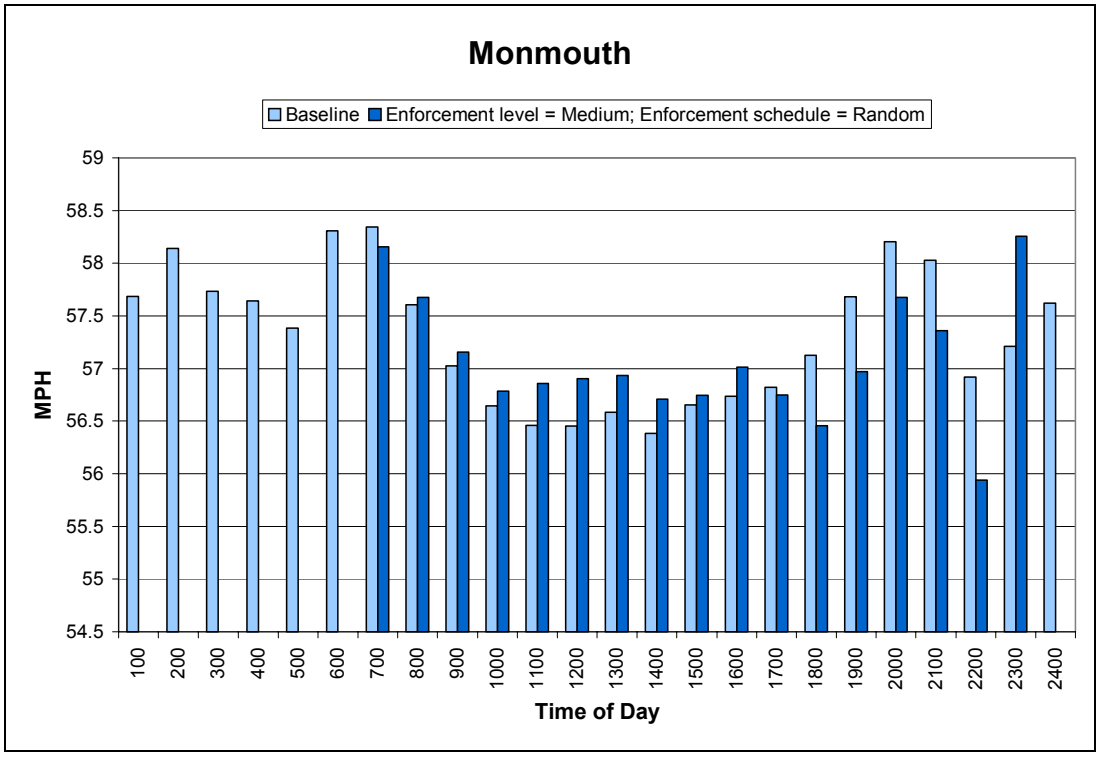
Median (50th Percentile) Speeds



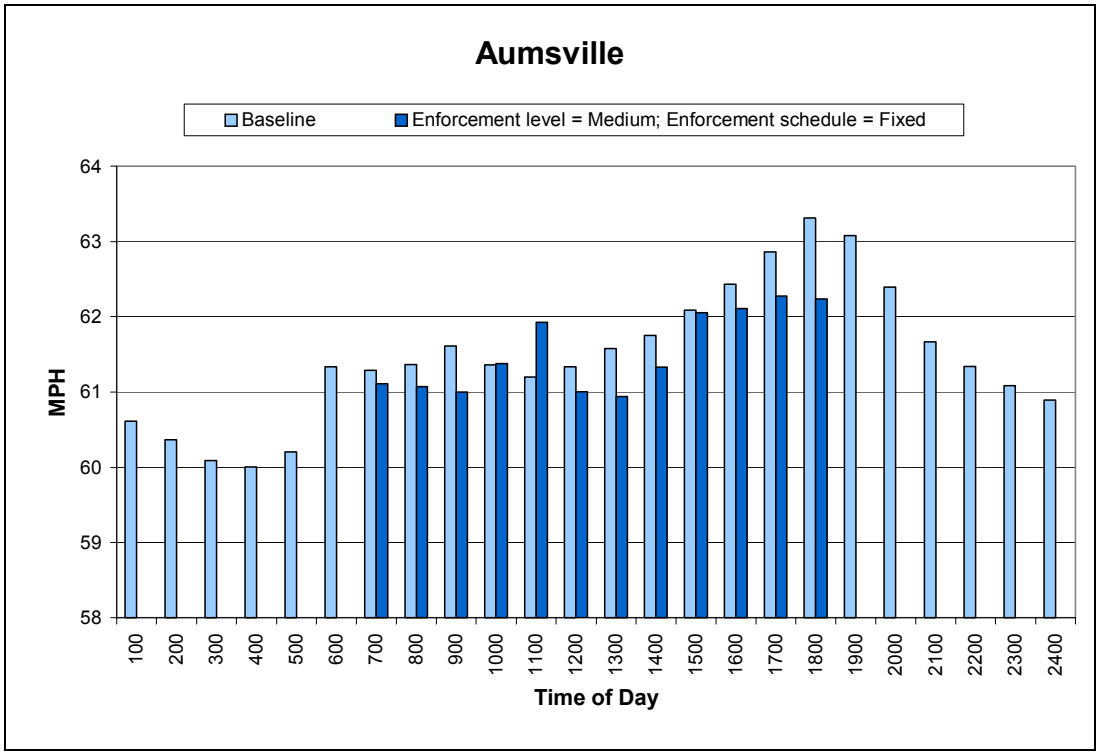
Median speeds on OR Route 22 – Gates (MP 33.7)



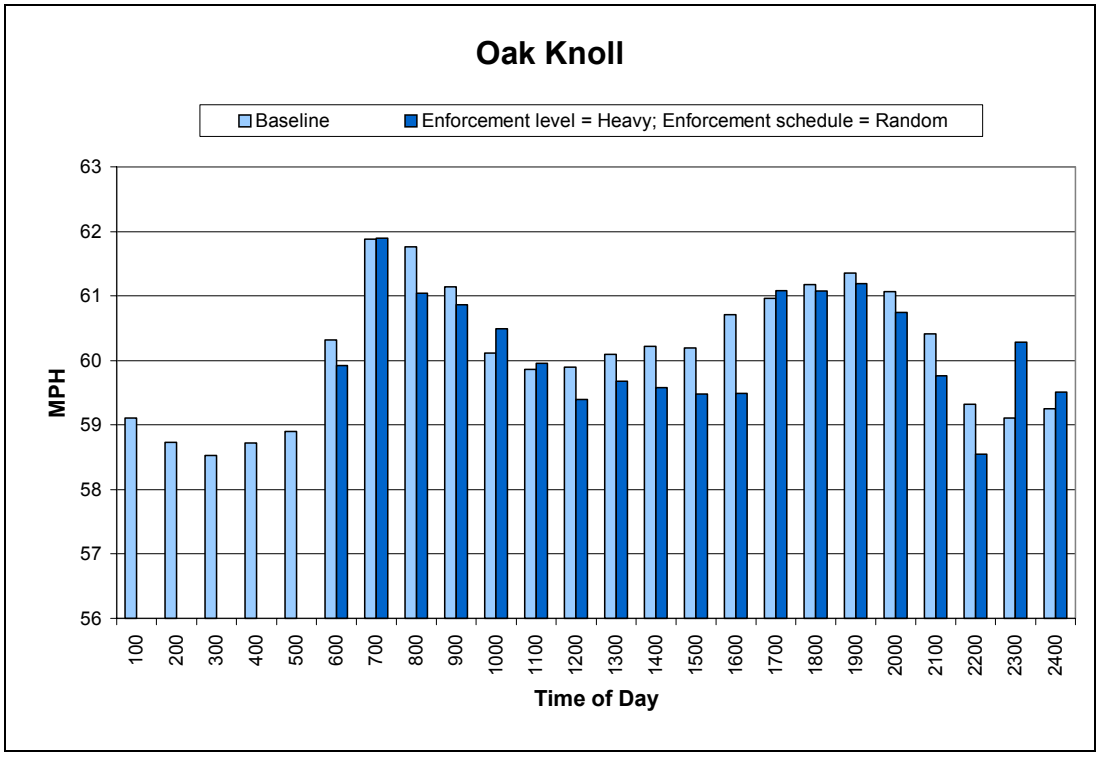
Median speeds on OR Route 34 – Alsea (MP 53.9)



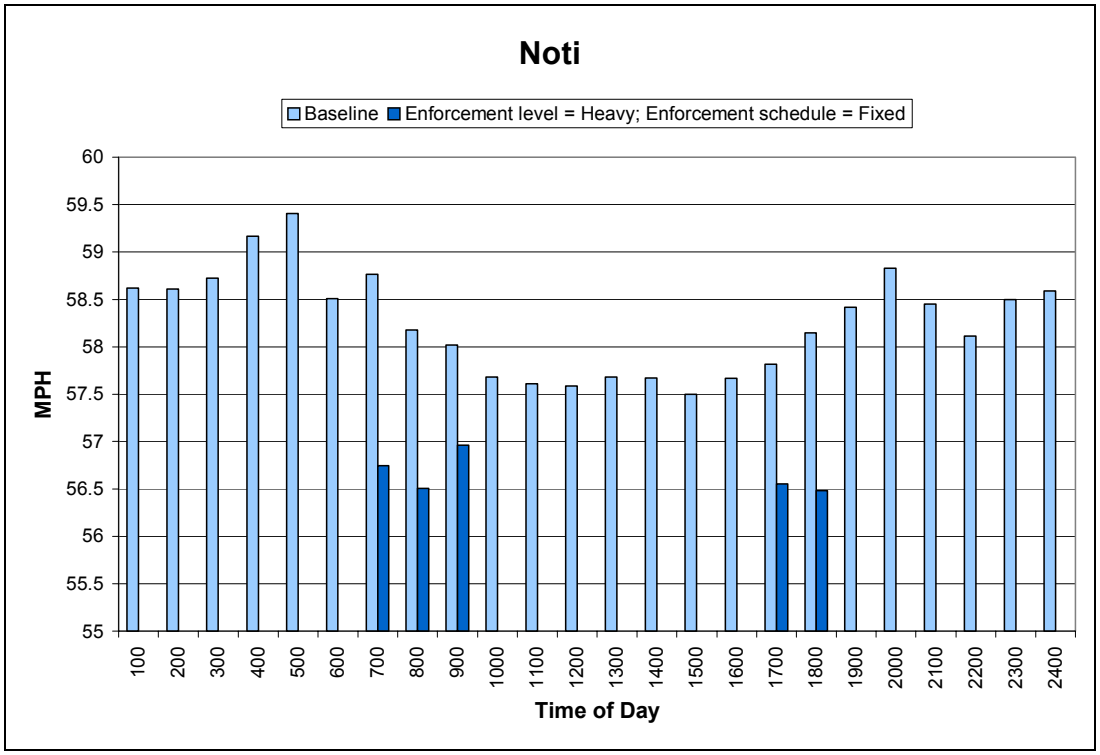
Median speeds on OR Route 99W – Monmouth (MP 70.9)



Median speeds on OR Route 22 – Aumsville (MP 10.0)

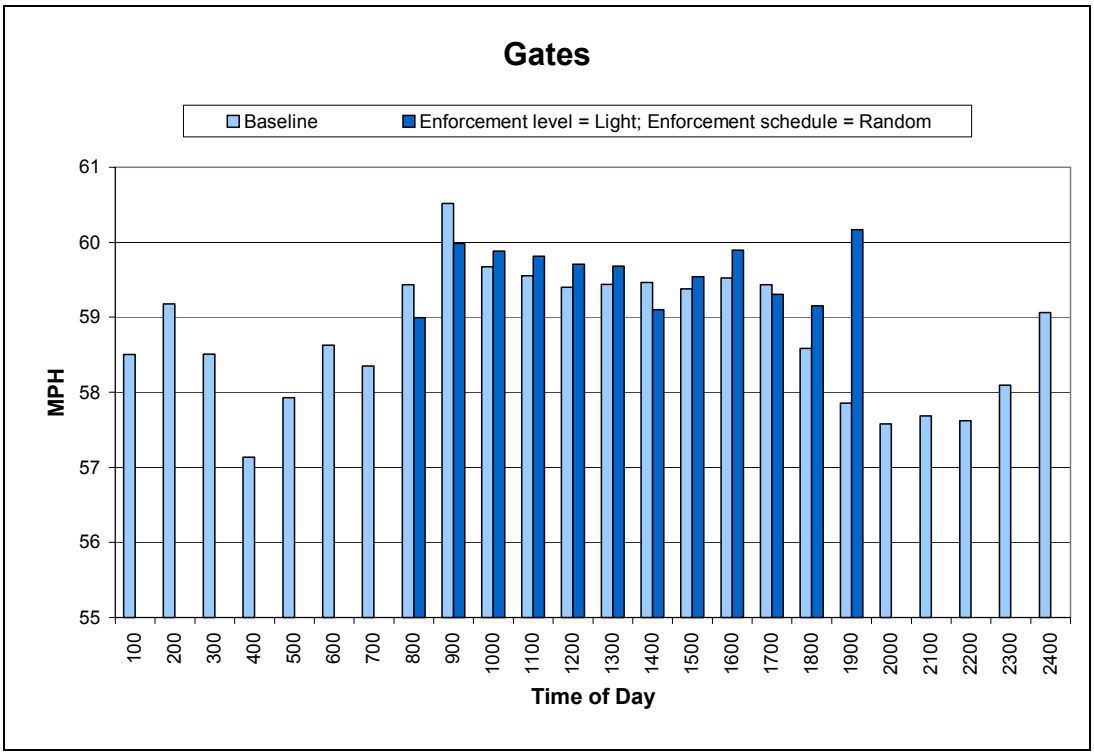


Median speeds on OR Route 22 – Oak Knoll (MP 18.9)

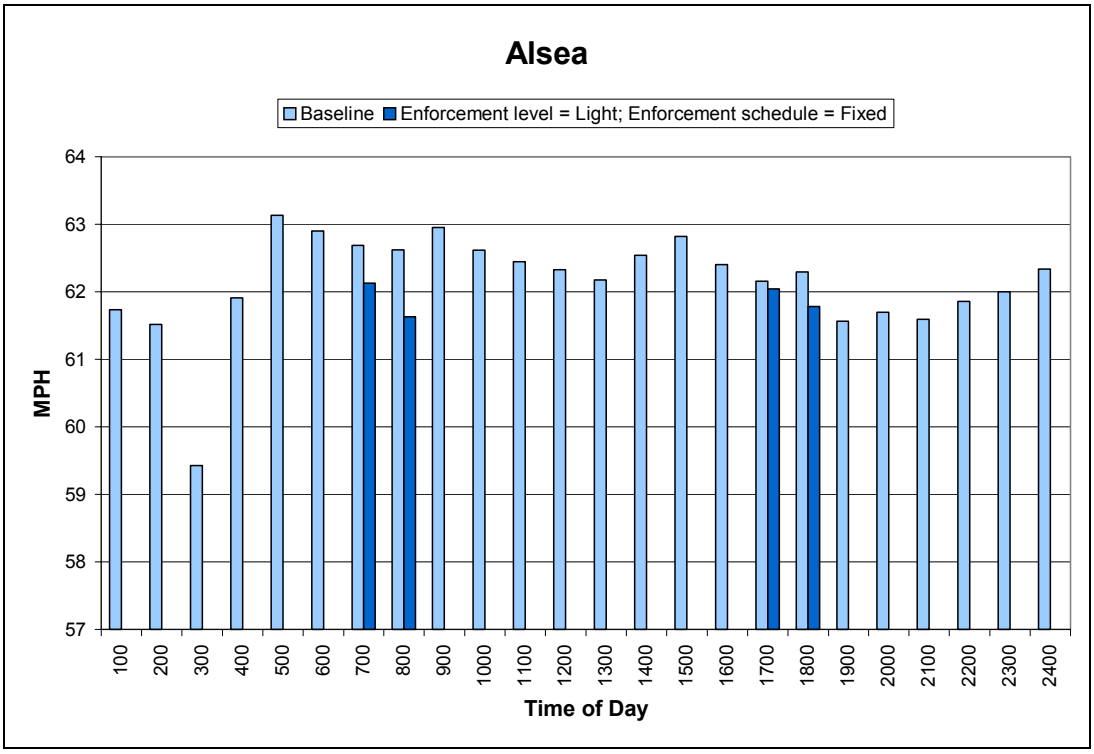


Median speeds on OR Route 126 – Noti (MP 43.9)

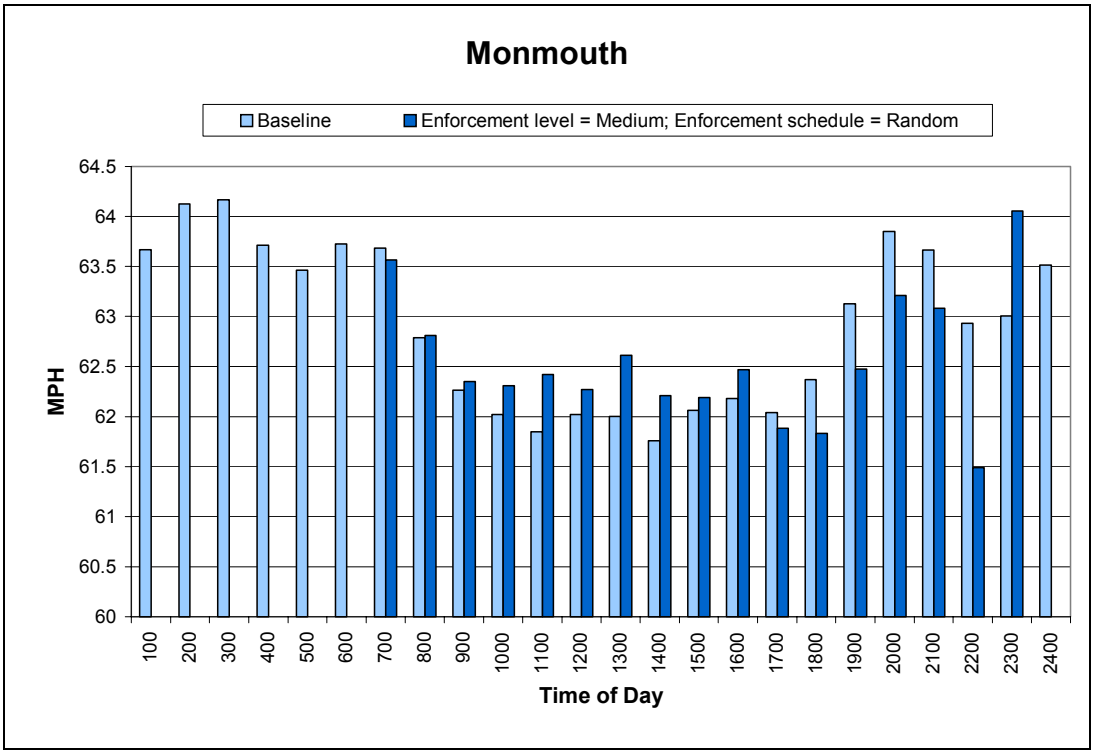
85th Percentile Speeds



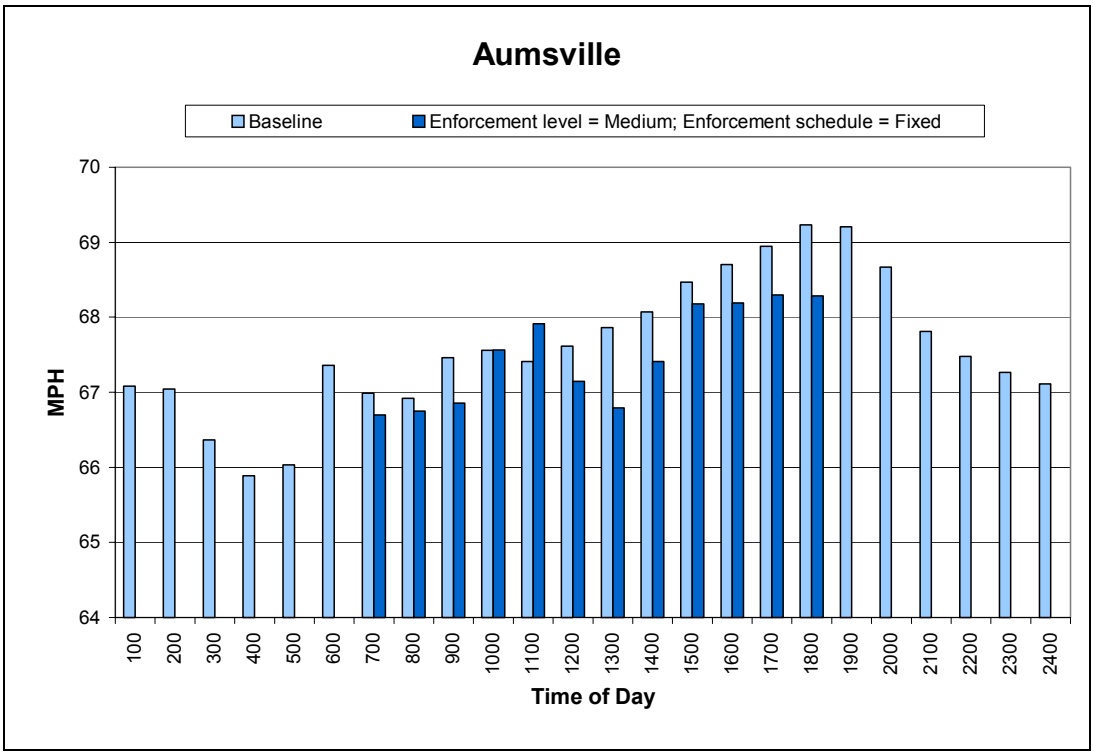
85th Percentile speeds on OR Route 22 – Gates (MP 33.7)



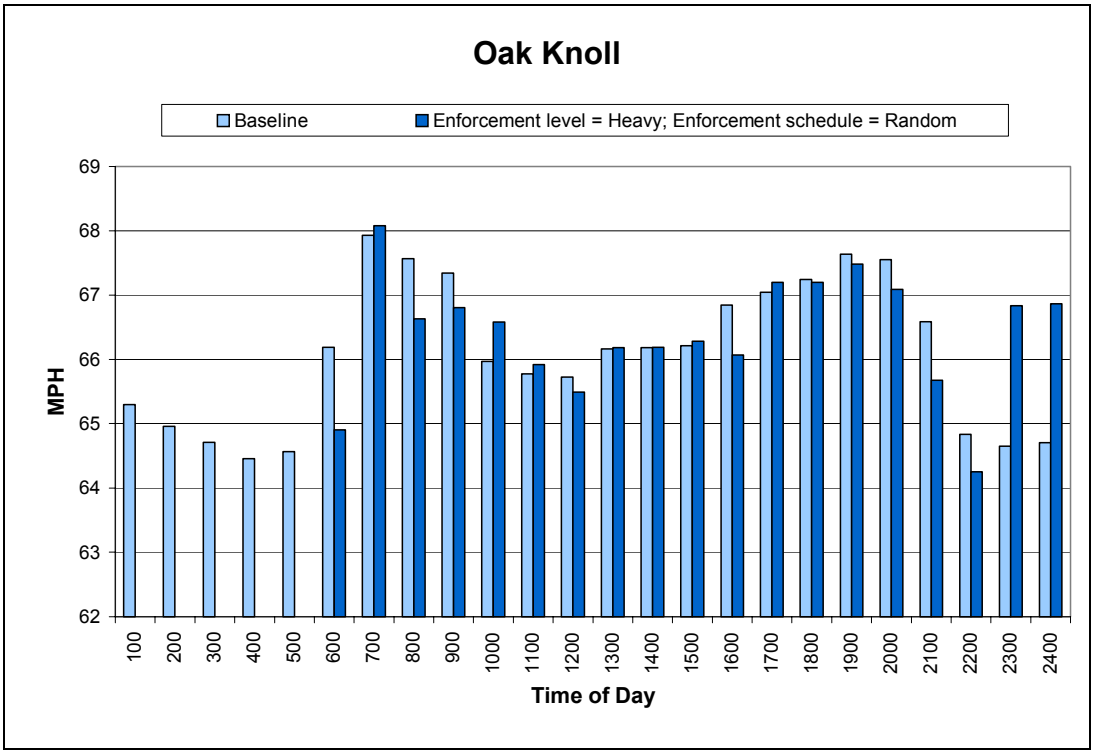
85th Percentile speeds on OR Route 34 – Alsea (MP 53.9)



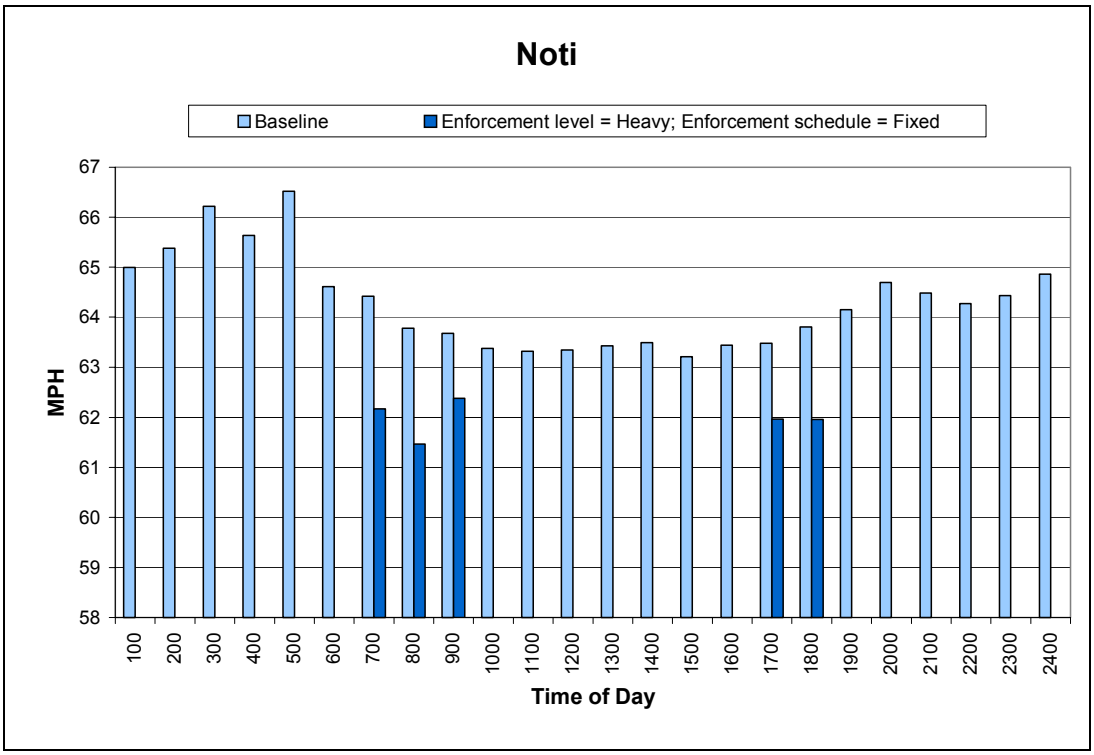
85th Percentile speeds on OR Route 99W – Monmouth (MP 70.9)



85th percentile Speeds on OR Route 22 – Aumsville (MP 10.0)

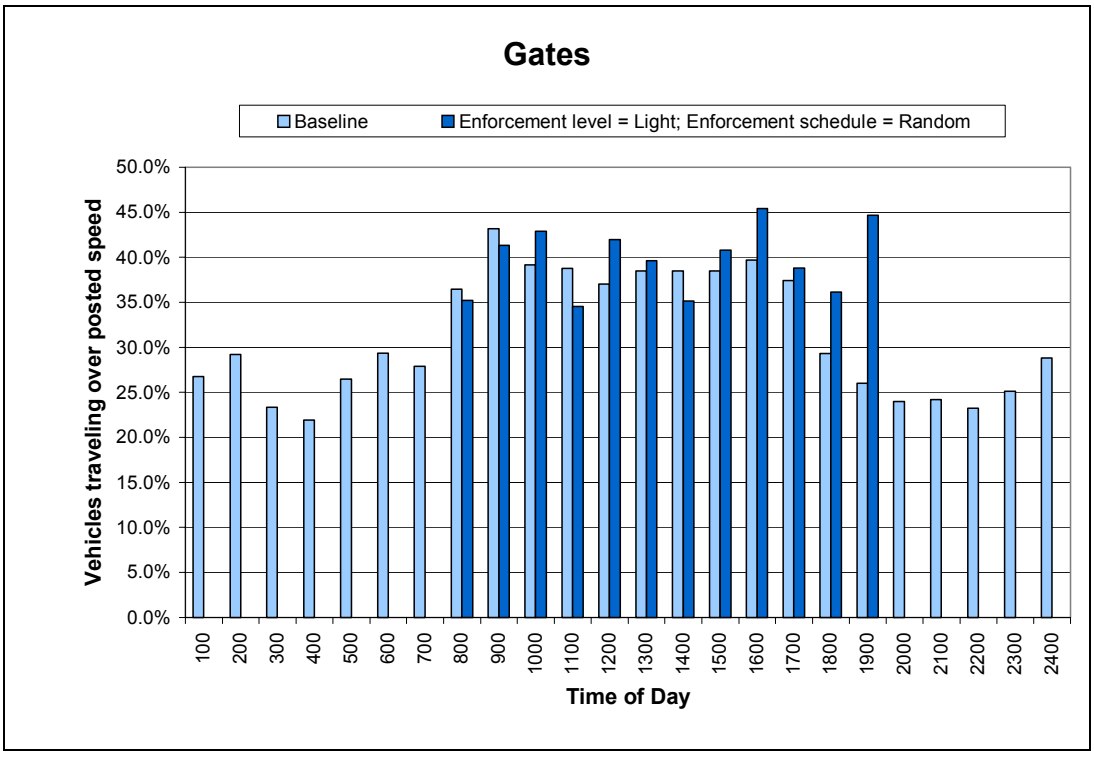


85th Percentile speeds on OR Route 22 – Oak Knoll (MP 18.9)

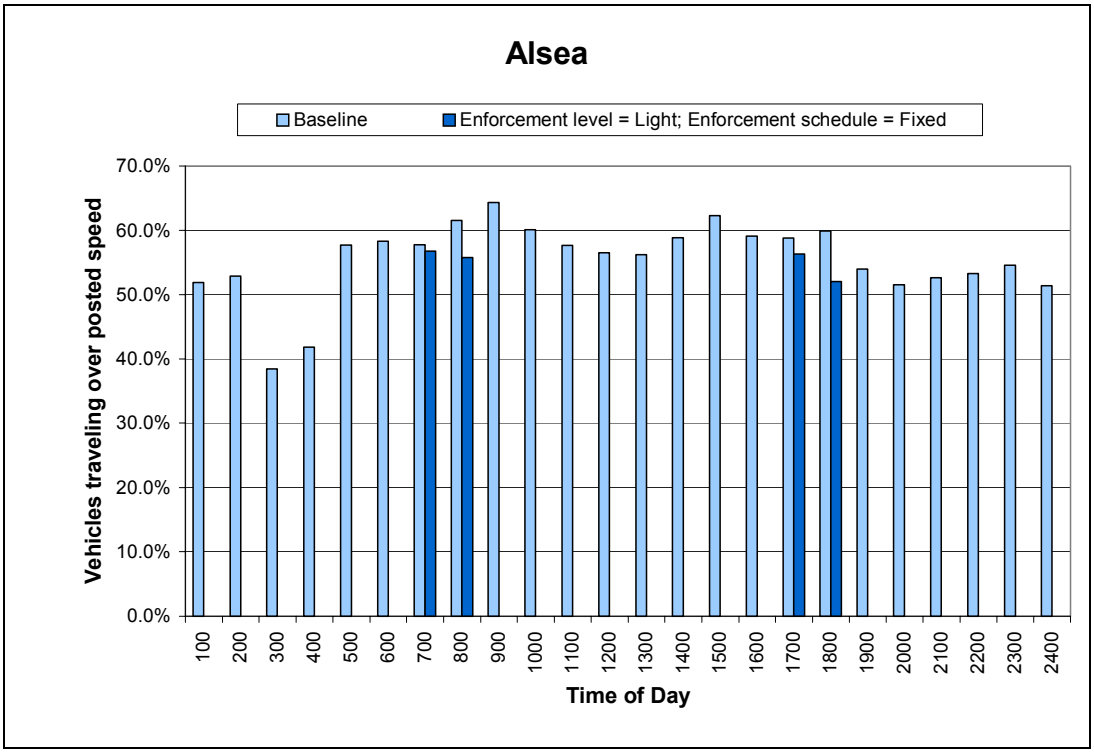


85th Percentile speeds on OR Route 126 – Noti (MP 43.9)

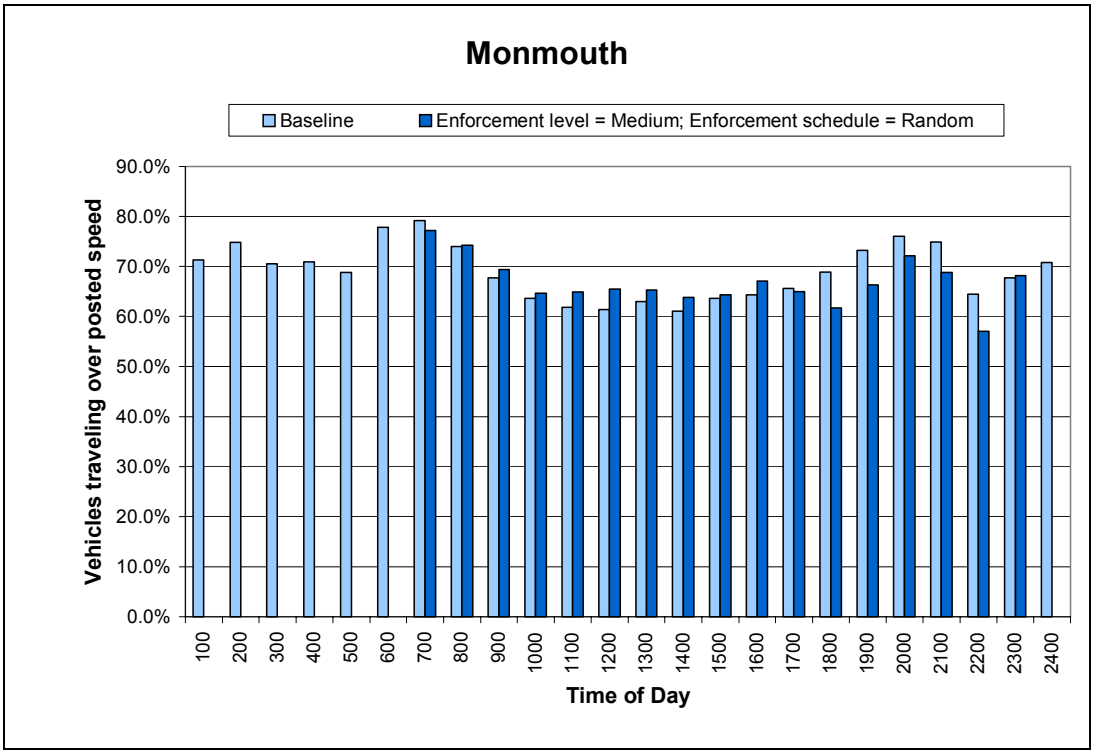
Percent of Vehicles Traveling over Posted Speed



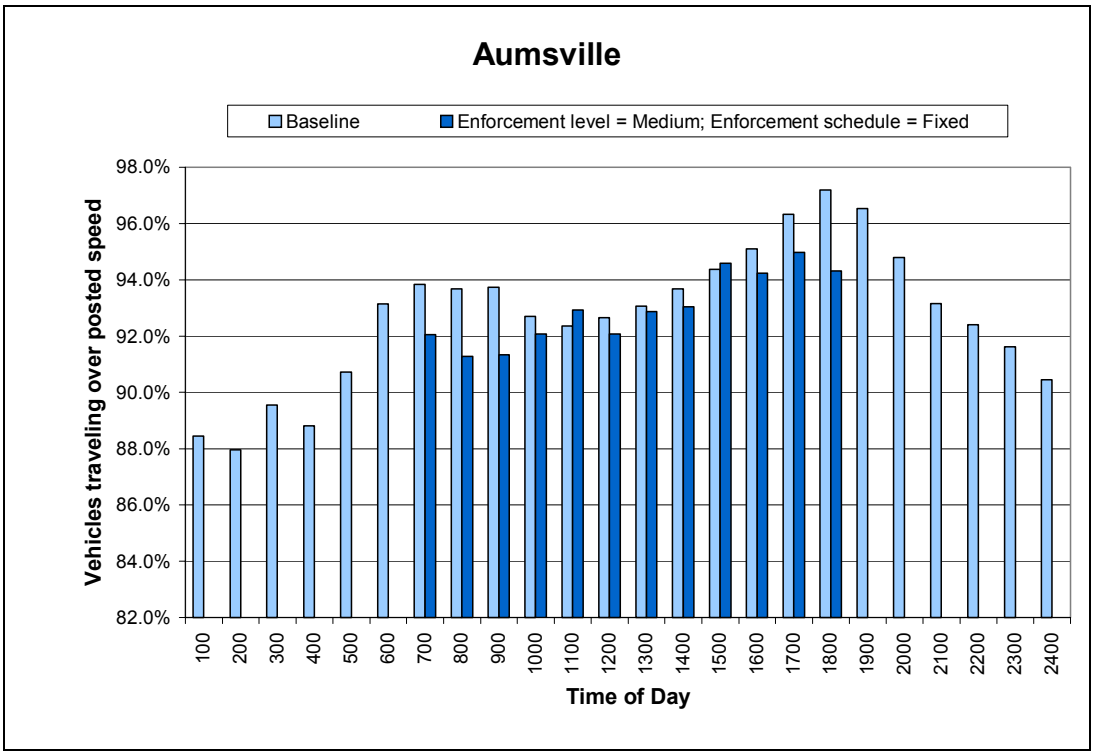
Percent vehicles traveling over posted speed on OR Route 22 – Gates (MP 33.7)



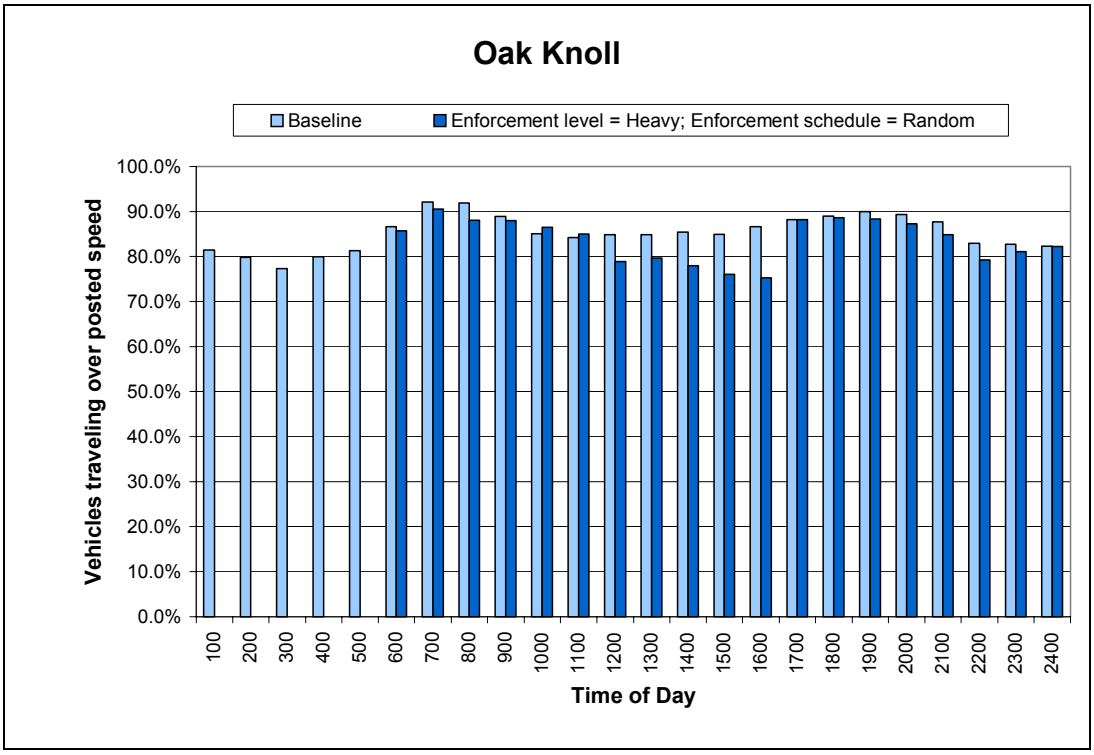
Percent vehicles traveling over posted speed on OR Route 34 – Alsea (MP 53.9)



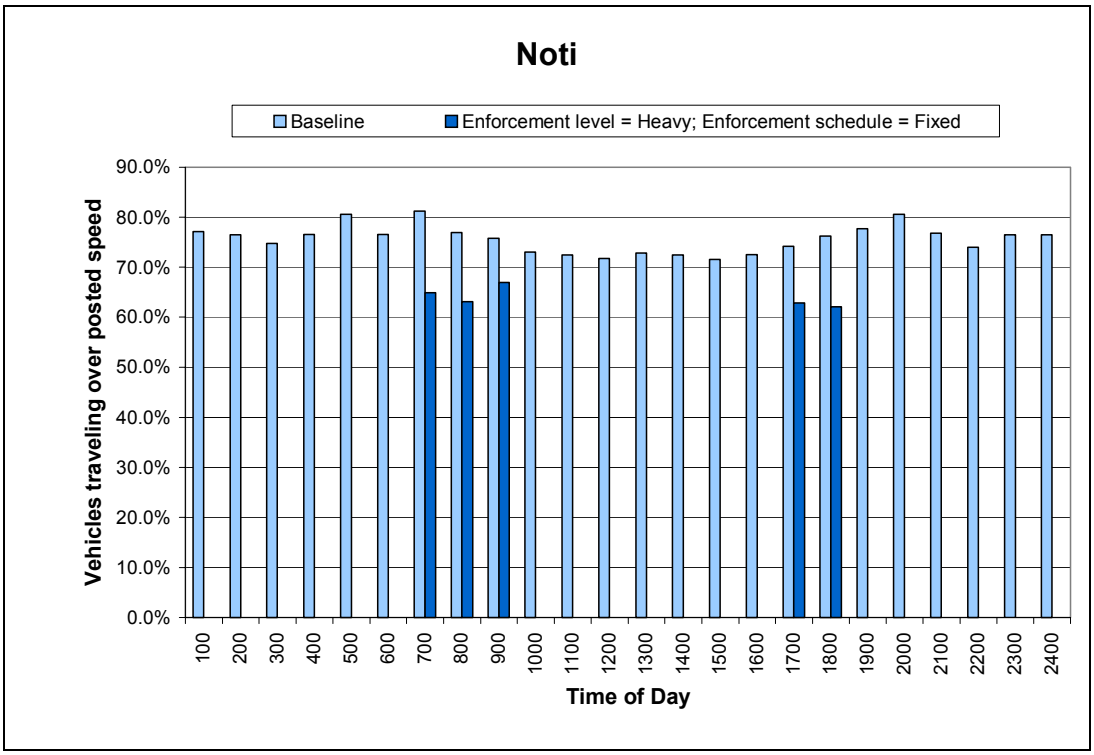
Percent vehicles traveling over posted speed on OR Route 99W – Monmouth (MP 70.9)



Percent vehicles traveling over posted speed on OR Route 22 – Aumsville (MP 10.0)

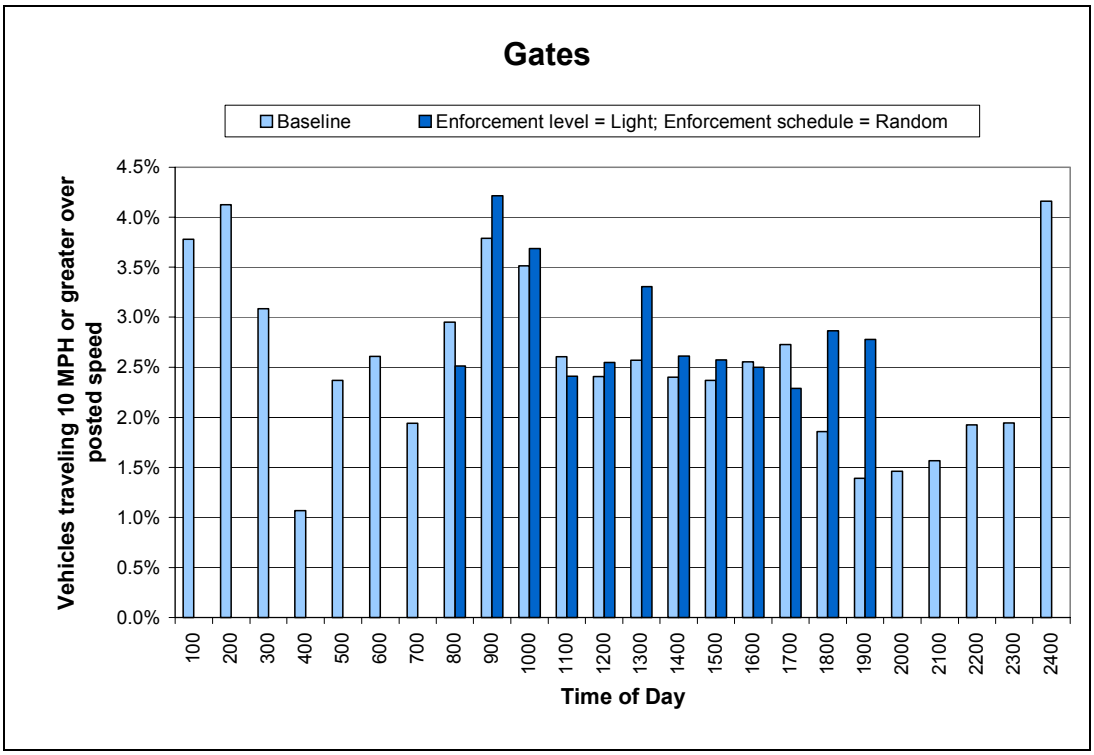


Percent vehicles traveling over posted speed on OR Route 22 – Oak Knoll (MP 18.9)

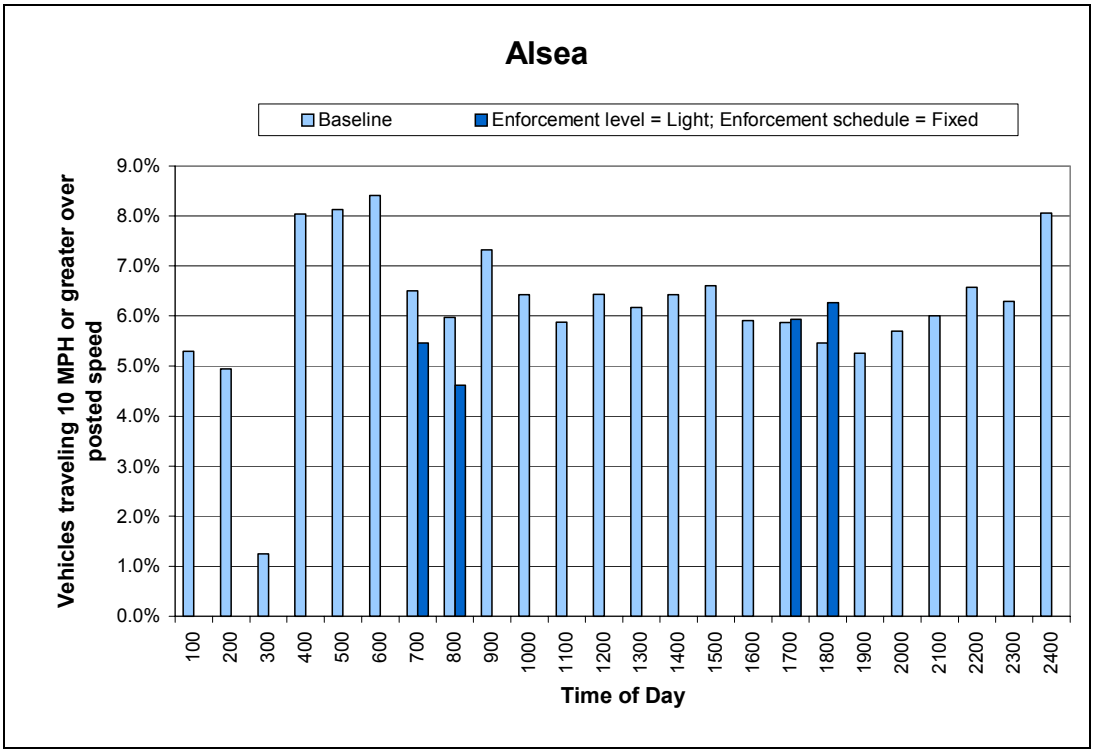


Percent vehicles traveling over posted speed on OR Route 126 – Noti (MP 43.9)

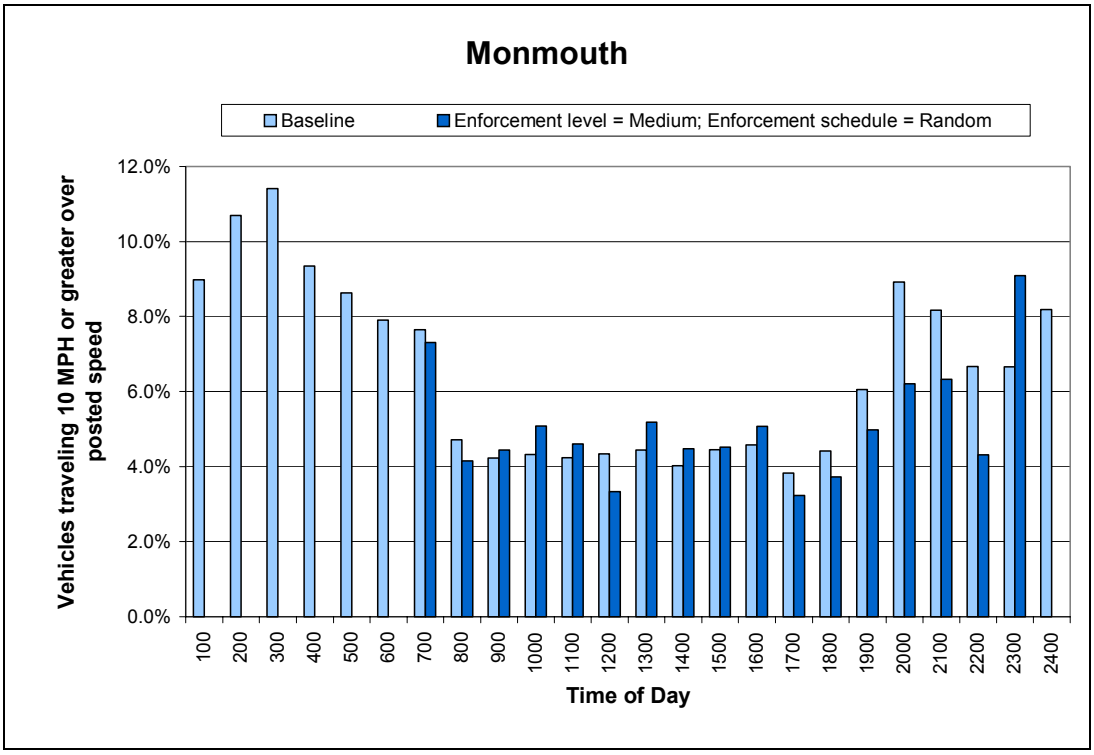
Percent of Vehicles Traveling 10+ mph (16 km/h) over Posted Speed



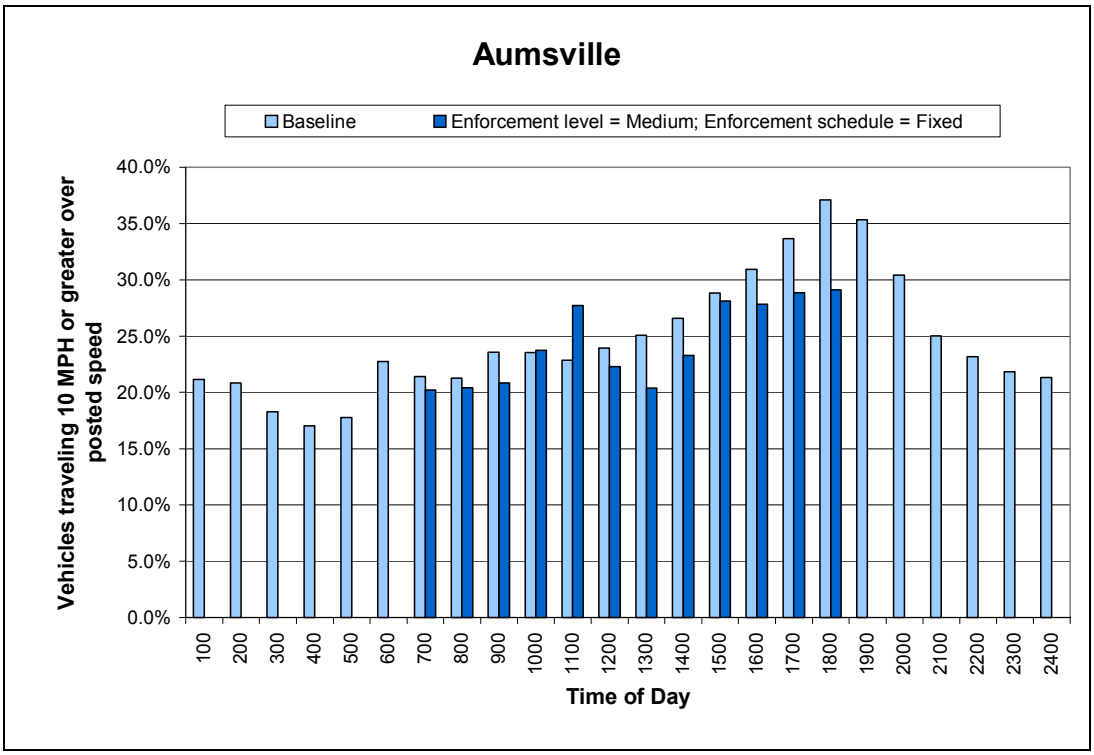
Percent vehicles traveling 10+ mph over posted speed on OR Route 22 – Gates (MP 33.7)



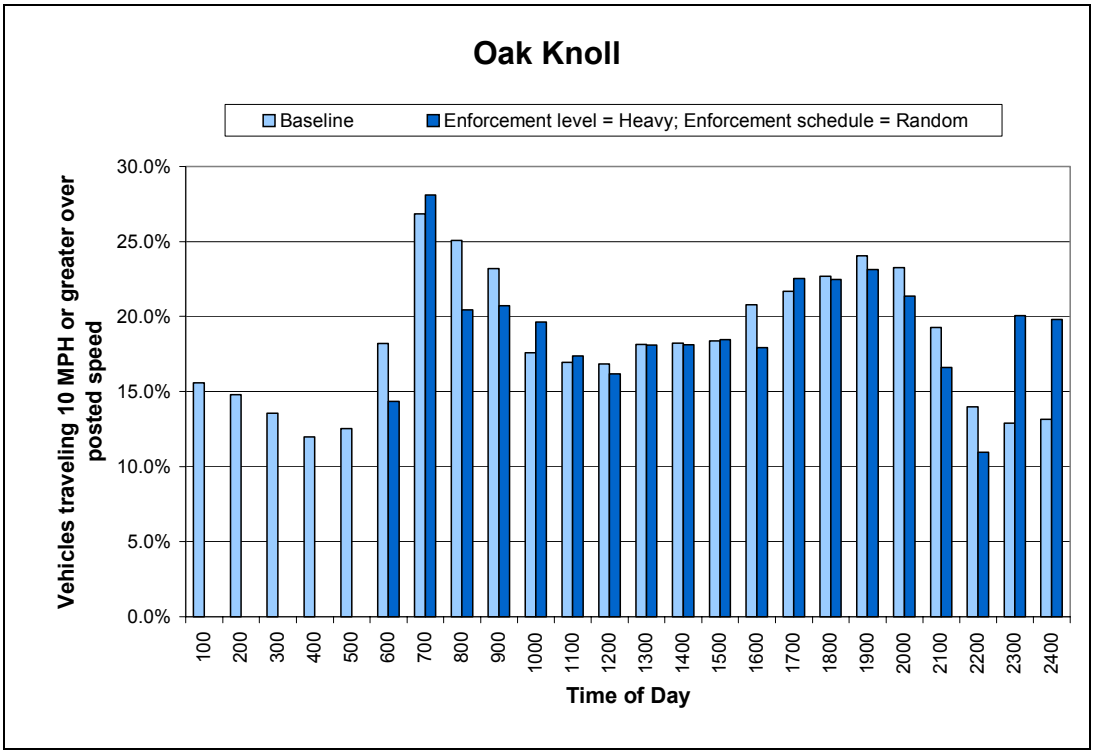
Percent vehicles traveling 10+ mph over posted speed on OR Route 34 – Alsea (MP 53.9)



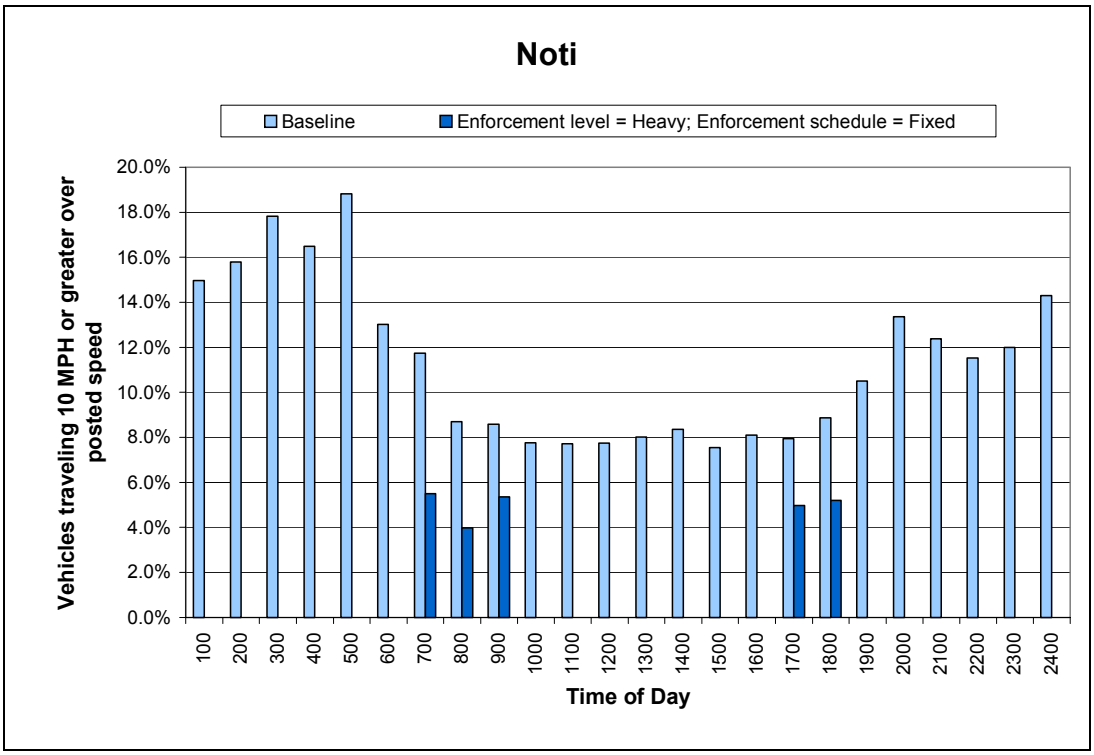
Percent vehicles traveling 10+ mph over posted speed on OR Route 99W – Monmouth (MP 70.9)



Percent vehicles traveling 10+ mph over posted speed on OR Route 22 – Aumsville (MP 10.0)



Percent vehicles traveling 10+ mph over posted speed on OR Route 22 – Oak Knoll (MP 18.9)



Percent vehicles traveling 10+ mph over posted speed on OR Route 126 – Noti (MP 43.9)

APPENDIX B: BASELINE AND ENHANCED ENFORCEMENT SPEED DATA

Gates Baseline Speed Distribution

Start Hour	End Hour	<40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	>80	Total
600	700	116	254	965	1491	752	264	59	10	6	1	3918
700	800	110	225	1091	2081	1335	514	133	23	7	0	5519
800	900	111	184	938	2201	1625	756	191	33	4	1	6044
900	1000	96	208	1222	2905	1879	714	211	38	5	2	7280
1000	1100	103	296	1537	3399	2271	879	197	24	4	2	8712
1100	1200	104	263	1684	3943	2384	913	188	30	7	4	9520
1200	1300	133	277	1820	4116	2728	975	222	39	3	1	10314
1300	1400	114	303	1865	4397	2853	1062	214	37	6	4	10855
1400	1500	186	437	1924	4626	3128	1085	232	35	8	1	11662
1500	1600	175	361	2005	4944	3390	1223	275	35	5	2	12415
1600	1700	179	476	2062	4376	2862	1066	262	41	4	2	11330
1700	1800	231	641	2396	3879	2023	756	154	28	5	1	10114
Total		1658	3925	19509	42358	27230	10207	2338	373	64	21	107683

Gates Light/Random Enforcement Speed Distribution

Start Hour	End Hour	<40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	>80	Total
600	700	2	30	131	301	181	53	14	2	2	0	716
700	800	13	47	222	470	338	137	38	9	6	1	1281
800	900	22	44	256	607	465	173	52	6	2	0	1627
900	1000	9	22	94	201	101	59	12	0	0	0	498
1000	1100	13	43	295	629	483	182	36	5	1	1	1688
1100	1200	14	63	365	745	517	197	58	5	0	2	1966
1200	1300	14	54	415	808	488	159	41	9	1	1	1990
1300	1400	57	104	498	1111	850	293	64	11	2	0	2990
1400	1500	30	43	305	909	733	280	48	11	0	0	2359
1500	1600	16	38	270	559	399	128	25	8	0	0	1443
1600	1700	27	51	236	511	329	101	35	0	2	0	1292
1700	1800	7	21	173	456	347	150	30	2	1	0	1187
Total		224	560	3260	7307	5231	1912	453	68	17	5	19037

Alsea Baseline Speed Distribution

Start Hour	End Hour	<40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	>80	Total
600	700	36	101	336	1183	1290	720	196	36	10	13	3921
700	800	33	83	404	1819	2224	1154	274	68	11	10	6080
1600	1700	43	86	550	2677	3000	1309	360	81	17	20	8143
1700	1800	39	98	562	2530	2965	1418	333	72	16	19	8052
Total		151	368	1852	8209	9479	4601	1163	257	54	62	26196

Alsea Light/Fixed Enforcement Speed Distribution

Start Hour	End Hour	<40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	>80	Total
600	700	23	41	148	525	591	283	65	16	8	4	1704
700	800	29	51	272	1028	1115	481	103	24	4	13	3120
1600	1700	71	71	305	1277	1382	605	178	35	11	10	3945
1700	1800	51	64	387	1587	1399	591	192	55	11	15	4352
Total		174	227	1112	4417	4487	1960	538	130	34	42	13121

Monmouth Baseline Speed Distribution

Start Hour	End Hour	< 40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	> 80	Total
600	700	61	56	283	2626	6324	4051	925	135	29	21	14511
700	800	160	124	574	5796	11792	5946	1020	129	33	26	25600
800	900	231	171	894	5543	9281	4176	765	95	22	14	21192
900	1000	194	215	936	5226	7482	3240	655	85	17	24	18074
1000	1100	191	226	1018	5456	7319	3085	627	103	16	19	18060
1100	1200	179	216	1066	5580	7134	3260	653	95	20	23	18226
1200	1300	213	228	1120	5405	7699	3311	677	108	27	25	18813
1300	1400	274	323	1223	5901	7972	3361	662	91	21	25	19853
1400	1500	247	291	1180	5988	8732	3803	791	116	12	24	21184
1500	1600	220	218	1145	7174	10134	4539	926	122	35	41	24554
1600	1700	163	181	1234	8105	12089	5323	899	126	17	34	28171
1700	1800	134	152	979	8109	13329	6053	1139	131	33	26	30085
1800	1900	84	102	607	4512	8578	4731	1004	144	30	20	19812
1900	2000	47	50	310	2665	5194	3395	926	160	34	22	12803
2000	2100	48	55	322	2225	4350	2702	666	157	21	19	10565
2100	2200	117	119	467	2534	3423	1833	478	97	16	16	9100
2200	2300	71	62	279	1660	2580	1343	333	65	23	7	6423
Total		2634	2789	13637	84505	133412	64152	13146	1959	406	386	317026

Monmouth Medium/Random Enforcement Speed Distribution

Start Hour	End Hour	< 40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	> 80	Total
600	700	5	2	19	230	483	300	62	16	3	1	1121
700	800	29	17	95	832	1715	936	142	6	5	4	3781
800	900	50	39	238	1907	3293	1453	288	30	4	3	7305
900	1000	50	41	248	1445	2084	931	209	34	7	7	5056
1000	1100	25	25	146	962	1326	665	132	13	3	4	3301
1100	1200	7	3	27	221	306	160	20	4	1	0	749
1200	1300	38	25	145	721	1060	550	118	15	3	3	2678
1300	1400	91	71	443	2435	3402	1585	299	54	4	19	8403
1400	1500	106	76	419	2176	3214	1453	284	45	10	13	7796
1500	1600	47	50	288	2148	3267	1508	347	33	5	6	7699
1600	1700	33	72	321	1741	2653	1168	162	27	4	7	6188
1700	1800	80	54	398	2272	2946	1302	236	28	2	7	7325
1800	1900	43	28	251	1446	2184	1042	213	30	9	10	5256
1900	2000	7	7	37	268	473	281	58	9	3	1	1144
2000	2100	7	5	42	306	460	261	58	10	3	2	1154
2100	2200	7	14	54	204	244	99	23	2	2	1	650
2200	2300	0	1	5	43	43	48	11	3	0	0	154
Total		625	530	3176	19357	29153	13742	2662	359	68	88	69760

Aumsville Baseline Speed Distribution

Start Hour	End Hour	< 40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	> 80	Total
600	700	40	14	152	2738	16183	18398	7677	1766	527	242	47737
700	800	61	29	228	3855	21680	26104	10717	2480	639	175	65968
800	900	73	23	170	2756	15028	18774	8380	2181	599	190	48174
900	1000	63	34	209	2906	14432	16012	7330	2186	610	226	44008
1000	1100	40	42	226	3213	15556	16453	7477	2154	664	222	46047
1100	1200	54	27	227	3276	16166	17358	8310	2446	711	198	48773
1200	1300	54	35	238	3127	15714	18133	8749	2689	790	256	49785
1300	1400	56	25	205	3110	16671	19371	10107	3011	921	230	53707
1400	1500	58	26	207	3178	17998	22387	12282	3928	1223	330	61617
1500	1600	57	19	187	3149	18777	25871	14946	4793	1410	363	69572
1600	1700	49	13	145	2471	17881	27831	17238	5461	1511	349	72949
1700	1800	45	9	83	2007	16605	29195	19870	6324	1683	369	76190
Total		650	296	2277	35786	202691	255887	133083	39419	11288	3150	684527

Aumsville Medium/Fixed Enforcement Speed Distribution

Start Hour	End Hour	< 40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	> 80	Total
600	700	231	218	282	2155	12162	13889	5559	1281	363	127	36267
700	800	492	260	359	3258	16644	18861	7757	1907	432	137	50107
800	900	146	193	368	2808	13807	14783	6386	1544	399	126	40560
900	1000	3	3	11	146	660	745	350	107	25	6	2056
1000	1100	0	0	3	58	250	312	188	40	10	1	862
1100	1200	1	3	6	219	1013	1003	488	116	33	6	2888
1200	1300	0	1	7	162	859	870	358	90	29	9	2385
1300	1400	3	2	11	152	805	877	415	105	35	7	2412
1400	1500	3	2	12	188	1113	1406	781	200	67	17	3789
1500	1600	43	11	125	1863	9944	13561	7120	1999	582	150	35398
1600	1700	29	12	134	1713	10244	14578	7876	2220	566	159	37531
1700	1800	22	10	158	2065	10872	14942	8512	2310	562	156	39609
Total		973	715	1476	14787	78373	95827	45790	11919	3103	901	253864

Oak Knoll Baseline Speed Distribution

Start Hour	End Hour	< 40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	> 80	Total
500	600	79	53	280	1629	5256	5181	2068	552	125	34	15257
600	700	52	78	307	2504	10533	13857	7541	2122	302	65	37361
700	800	131	186	519	3658	15682	21270	10875	2629	321	44	55315
800	900	185	192	467	3264	11472	12868	6468	1794	278	48	37036
900	1000	157	217	631	3844	11160	10793	4356	1150	182	37	32527
1000	1100	107	189	679	4225	11647	10592	4203	1157	196	48	33043
1100	1200	133	206	680	4075	11894	10864	4210	1210	172	44	33488
1200	1300	90	195	704	4282	11897	11274	4679	1336	235	53	34745
1300	1400	109	218	705	4283	12359	12085	4956	1392	216	67	36390
1400	1500	99	208	831	4651	12944	12639	5373	1434	221	43	38443
1500	1600	109	216	761	4520	13298	14235	6570	1807	246	83	41845
1600	1700	93	206	723	4066	13520	15115	7061	1916	293	72	43065
1700	1800	85	217	671	3803	13176	15445	7394	2027	294	78	43190
1800	1900	51	108	412	2347	8902	10431	5028	1633	298	89	29299
1900	2000	48	95	312	1703	6515	6890	3280	1133	226	76	20278
2000	2100	24	75	264	1701	5884	5633	2267	743	179	53	16823
2100	2200	20	66	331	2161	5762	4661	1537	448	95	32	15113
2200	2300	24	60	263	1753	4833	3641	1101	359	83	23	12140
2300	2400	30	43	173	1258	3232	2652	803	241	63	12	8507
Total		1626	2828	9713	59727	189966	200126	89770	25083	4025	1001	583865

Oak Knoll Heavy/Random Enforcement Speed Distribution

Start Hour	End Hour	< 40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	> 80	Total
500	600	4	2	7	36	124	120	37	8	3	1	342
600	700	1	2	6	66	213	278	167	43	10	1	787
700	800	8	12	42	353	1047	1292	577	118	12	1	3462
800	900	45	48	178	1265	4047	4504	2015	536	74	12	12724
900	1000	56	67	216	1316	4099	4148	1802	507	88	21	12320
1000	1100	39	50	237	1422	4133	3775	1505	436	75	14	11686
1100	1200	548	405	848	2710	7035	6378	2524	759	132	40	21379
1200	1300	604	476	939	2848	7598	7152	3148	944	202	42	23953
1300	1400	557	416	787	1884	5038	4842	2172	670	120	31	16517
1400	1500	558	392	787	1881	4375	4302	2029	600	110	44	15078
1500	1600	583	474	850	1972	4427	4583	2134	572	78	29	15702
1600	1700	31	68	230	1466	4654	5331	2609	678	109	31	15207
1700	1800	42	94	302	1819	6169	6976	3375	898	155	36	19866
1800	1900	31	70	257	1375	4418	5211	2429	784	150	59	14784
1900	2000	20	55	183	1141	3551	3705	1672	536	108	34	11005
2000	2100	11	27	146	1112	3128	2705	1017	320	64	19	8549
2100	2200	2	11	83	498	1176	773	231	64	14	4	2856
2200	2300	0	1	19	43	98	106	46	18	0	3	334
2300	2400	0	1	5	30	72	54	26	11	1	2	202
Total		3140	2671	6122	23237	65402	66235	29515	8502	1505	424	206753

Noti Baseline Speed Distribution

Start Hour	End Hour	< 40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	> 80	Total
600	700	67	13	133	1395	3544	2395	778	153	40	33	8551
700	800	181	43	191	2680	5711	3468	913	176	38	42	13443
800	900	87	41	228	2943	5846	3338	891	193	36	50	13653
1600	1700	152	63	471	5033	9507	5164	1372	240	65	83	22150
1700	1800	139	64	361	4318	8574	5282	1392	291	63	76	20560
Total		626	224	1384	16369	33182	19647	5346	1053	242	284	78357

Noti Heavy/Fixed Enforcement Speed Distribution

Start Hour	End Hour	< 40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	> 80	Total
600	700	147	53	443	4008	5643	2224	553	110	33	32	13246
700	800	221	110	639	6304	8605	3072	569	130	34	52	19736
800	900	182	87	553	6027	8947	3810	859	162	39	49	20715
1600	1700	385	231	1528	11298	14951	5985	1355	258	70	113	36174
1700	1800	309	251	1292	10452	13225	5228	1286	238	73	93	32447
Total		1244	732	4455	38089	51371	20319	4622	898	249	339	122318