# EVALUATION OF REVISED LEFT TURN SIGNALIZATION

## Final Report
## #FHWA-OR-RD-98-07

by

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16. Abstract

Modified left turn signals had shown cost savings over the old style of traffic signals in initial installation and maintenance. This evaluation was conducted to determine whether those savings would be justified by no increase in the accident rates at the intersections where the new signals were installed. Eighteen intersections were selected for the evaluation and their accident rates before and after the new signal installation were compared. The results were statistically inconclusive, but since there was no indication of a significant rise overall in the accident rates, the evaluation committee determined that the savings already demonstrated would justify continuing to install the new signals.

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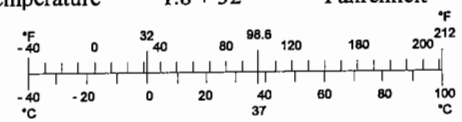
# SI* (MODERN METRIC) CONVERSION FACTORS

## APPROXIMATE CONVERSIONS TO SI UNITS

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| | | **LENGTH** | | |
| in | inches | 25.4 | millimeters | mm |
| ft | feet | 0.305 | meters | m |
| yd | yards | 0.914 | meters | m |
| mi | miles | 1.61 | kilometers | km |
| | | **AREA** | | |
| $in^2$ | square inches | 645.2 | millimeters squared | $mm^2$ |
| $ft^2$ | square feet | 0.093 | meters squared | $m^2$ |
| $yd^2$ | square yards | 0.836 | meters squared | $m^2$ |
| ac | acres | 0.405 | hectares | ha |
| $mi^2$ | square miles | 2.59 | kilometers squared | $km^2$ |
| | | **VOLUME** | | |
| 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 | 1.8 + 32 | Fahrenheit | °F |




* SI is the symbol for the International System of Measurement

(4-7-94 jbp)

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# 1.0 INTRODUCTION

The Oregon Transportation Commission approved a change in policy for the signalization of exclusive left turn lanes in January 1992. The new policy follows federal guidelines using all arrow indications in a standard vehicle signal head without any supplemental signing. Previous policy used an optically programmed signal head with only the green indication having an arrow. The programmed head was supplemented with a "LEFT TURN SIGNAL" interior illuminated sign. There was a definite initial installation and maintenance cost benefit to ODOT with the new policy, but there was some concern that intersections constructed or retrofitted to the new policy may have experienced an increase in accidents. A comparison of intersections utilizing the old policy and those same intersections after having been retrofitted was conducted to compare accident rates.

# 2.0 METHODOLOGY

Eighteen intersections in western Oregon were chosen for evaluation, based on the fact that each had been recently retrofitted with a revised left turn signal, and on the fact that no additional modification of the intersection was anticipated for the three years following the retrofit. For each of the eighteen intersections, two sets of accident history data were obtained from the Oregon Department of Transportation's Accident Data Unit. One set of data was a history of accidents at a given intersection covering the three years prior to its signal retrofit. The second set covered the available history of accidents up to three years following the retrofit. Some of the intersections did not have three years of "after" data available, due to the recent dates of retrofit.

The number of "before" and "after" accidents for each of the eighteen intersections was recorded and an accident rate per million entering vehicles (PMEV) was calculated (see Appendix A) for each time period using the following formula:

$$[(\text{number of accidents}) \times 10^6] \div [(\text{EV}) \times (\text{number of days})] = \text{Rate(PMEV)} \quad \textbf{(2-1)}$$

OR

$$[(\text{number of accidents}) \times 10^6] \div [(\text{EV}) \times (\text{years}) \times (365)] = \text{Rate(PMEV)} \quad \textbf{(2-2)}$$

Where: EV = number of Entering Vehicles per day, and years are indicated by a decimal.

The paired Student's T-Test was then applied to the resulting accident rates (see Appendix B).

# 3.0 FINDINGS AND CONCLUSIONS

Our results show a 4% decrease in the overall accident rate, but we can only say this with a 15% level of confidence. Even if no modifications had been made to any of the signal heads in the evaluation, we could expect this 4% change as part of a normal, random fluctuation. Although the evaluation of the accident rates has proved inconclusive, the original objective of the study has been met. The new signal heads are known to have an initial installation and maintenance cost benefit over the old, and our evaluation indicates that no adverse change in the overall accident rates has compromised this cost benefit.

# APPENDIX A

# ACCIDENT RATE TABLES

## CRATER LAKE HWY. @ FRED MEYER ENTRANCE (Medford)
### Hwy. 22, Route 62

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 70 | 33673 | 1096 | 1.90 | 20 | 35394 | 931 | 0.61 | -68% |

## CRATER LAKE HWY., BIDDLE RD. @ I-5 NB OFF-RAMP (Medford)
### Hwy. 22, Route 62

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 21 | 25539 | 1096 | 0.75 | 9 | 30837 | 872 | 0.33 | -55% |



## CRATER LAKE HWY. @ POPLAR DRIVE (Medford)
### Hwy. 22, Route 62

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 65 | 37964 | 1096 | 1.56 | 22 | 45686 | 750 | 0.64 | -59% |

## BELTLINE HWY. @ ROYAL AVE. (Eugene)
### Hwy. 69

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 15 | 21134 | 1096 | 0.65 | 10 | 23018 | 876 | 0.50 | -23% |

## BELTLINE HWY. @ ROOSEVELT AVE. (Eugene)
### Hwy. 69

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 4 | 12484 | 1096 | 0.29 | 1 | 14646 | 876 | 0.08 | -73% |

**BELTLINE HWY. @ BARGER RD. (Eugene)**
**Hwy. 69**

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 29 | 28808 | 1096 | 0.92 | 13 | 31086 | 876 | 0.48 | -48% |

**HILLSBORO-SILVERTON HWY. @ SETTLEMEIR AVE. & BOONES FERRY RD. (Woodburn)**
**Hwy. 140, Route 214**

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 12 | 24187 | 1096 | 0.45 | 11 | 28349 | 901 | 0.43 | -5% |

**OREGON COAST HWY. @ S.E. NEPTUNE DR. (FRED MEYER ENTRANCE) (Warrenton)**
**Hwy. 9, Route 101**

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 3 | 13077 | 1096 | 0.21 | 3 | 17872 | 844 | 0.20 | -5% |

**CORVALLIS-NEWPORT HWY. @ 15th ST. (AVERY PARK ENTRANCE) (Corvallis)**
**Hwy. 33, Route 20**

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 6 | 15770 | 1096 | 0.35 | 10 | 19301 | 870 | 0.60 | 72% |

**SALEM HWY. @ 25th ST. (Salem)**
**Hwy. 72, Route 22**

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 42 | 50190 | 1096 | 0.76 | 72 | 68281 | 821 | 1.28 | 68% |

## SALEM HWY. @ AIRPORT RD. (Salem)
### Hwy. 72, Route 22

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 22 | 47223 | 1424 | 0.33 | 9 | 59084 | 935 | 0.16 | -50% |

## OREGON COAST HWY. @ N. 20th (Newport)
### Hwy. 9, Route 101

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 12 | 29584 | 1096 | 0.37 | 17 | 33469 | 900 | 0.56 | 52% |

## ROGUE VALLEY HWY. @ PINE ST. (Central Point)
### Hwy. 63, Route 99

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 6 | 19303 | 1096 | 0.28 | 12 | 22477 | 606 | 0.88 | 211% |

## EUGENE-SPRINGFIELD HWY. @ 52nd ST. (Springfield)
### Hwy. 227, Route 126

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 14 | 23473 | 1096 | 0.54 | 17 | 29998 | 1024 | 0.55 | 2% |

## GREEN SPRINGS HWY. @ ROGUE VALLEY HWY. (Ashland)
### Hwy. 21, Route 66

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 12 | 23653 | 1096 | 0.46 | 12 | 22723 | 596 | 0.89 | 91% |

**CRATER LAKE HWY. @ DELTA WATERS RD. (Medford)**
**Hwy. 22, Route 62**

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 8 | 28248 | 1096 | 0.26 | 10 | 37674 | 241 | 1.10 | 326% |

**REDWOOD HWY. SPUR @ AGNESS AVE. (Grants Pass)**
**Hwy. 25**

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 10 | 15686 | 1096 | 0.58 | 4 | 22275 | 630 | 0.29 | -51% |

**OREGON COAST HWY. @ RHODODENDRON DR. (Florence)**
**Hwy. 9, Route 101**

| BEFORE | | | | AFTER | | | | RATE CHANGE |
|---|---|---|---|---|---|---|---|---|
| No. of Accidents | EV | No. of Days | Rate (PMEV) | No. of Accidents | EV | No. of Days | Rate (PMEV) | |
| 4 | 22889 | 1096 | 0.16 | 7 | 17974 | 488 | 0.80 | 401% |

# APPENDIX B

# PAIRED STUDENT'S T-TEST

| Accident Rates | | | | | |
|---|---|---|---|---|---|
| Before | After | | t-Test: Paired Two Sample for Means | | |
| 1.90 | 0.61 | | | | |
| 0.75 | 0.33 | | | *Before* | *After* |
| 1.56 | 0.64 | | Mean | 0.601 | 0.577 |
| 0.65 | 0.50 | | Variance | 0.215 | 0.103 |
| 0.29 | 0.08 | | Observations | 18 | 18 |
| 0.92 | 0.48 | | Pearson Correlation | 0.066 | |
| 0.45 | 0.43 | | Hypothesized Mean Difference | 0 | |
| 0.21 | 0.20 | | df | 17 | |
| 0.35 | 0.60 | | t Stat | 0.190 | |
| 0.76 | 1.28 | | P(T<=t) one-tail | 0.426 | |
| 0.33 | 0.16 | | t Critical one-tail | 1.740 | |
| 0.37 | 0.56 | | P(T<=t) two-tail (complement of 0.148) | 0.852 | |
| 0.28 | 0.88 | | t Critical two-tail | 2.110 | |
| 0.54 | 0.55 | | | | |
| 0.46 | 0.89 | | | | |
| 0.26 | 1.10 | | | | |
| 0.58 | 0.29 | | | | |
| 0.16 | 0.80 | | | | |