

**LIGHTED GUIDANCE TUBE  
EVALUATION**

**Final Report**

**Experimental Features #OR-00-02**



*Oregon Department of Transportation*

# **LIGHTED GUIDANCE TUBE EVALUATION**

## **Final Report**

### **Experimental Features #OR-00-02**

by

Andrew Griffith, P.E.

and

Eric Brooks, E.I.T.

for

Oregon Department of Transportation  
Research Group  
200 Hawthorne SE, Suite B-240  
Salem OR 97301-5192

and

Federal Highway Administration  
Washington, D.C.

**August 2000**



Report No. OR-EF-01-02	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle LIGHTED GUIDANCE TUBE EVALUATION		Report Date August 2000	
		Performing Organization Code	
7. Author(s) Andrew Griffith, P.E. and Eric Brooks, E.I.T. ,		8. Performing Organization Report No.	
9. Performing Organization Name and Address Oregon Department of Transportation Research Group 200 Hawthorne SE, Suite B-240 Salem, Oregon 97301-5192		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. Experimental Features OR-00-02	
12.Sponsoring Agency Name and Address Oregon Department of Transportation Research Group 200 Hawthorne SE, Suite B-240 Salem, Oregon 97301-5192		13. Type of Report and Period Covered Final Report 2000	
		14. Sponsoring Agency Code	
15. Supplementary Notes			
16. Abstract  This report summarizes the evaluation of the Lighted Guidance Tube (LGT), a 3M™ product used to delineate a temporary detour curve section on the Eddyville-Cline Hill Section construction project. The 3M™ LGT system can reduce accidents on highway curves or through construction work zones by providing motorists with continuous, positive guidance along the roadway.  The installation of the LGT proved to be more challenging than envisioned, primarily because the crew was unfamiliar with the device. The LGT was first installed in December 1999 but did not work as designed. This was because the tube portion of the LGT had been stored for two weeks outside at the job site. Dirt and water had accumulated on the interior of the tube, thus reducing its optical light transmission characteristics. When 3M was consulted, they provided additional tubing for replacement. The new tube was reinstalled in February 2000.  During its five months in service, the LGT was evaluated to observe its effect on vehicle speeds, accidents, and driver perceptions. The effect on vehicle speeds was inconclusive; no relationship between the presence of the LGT and vehicle speeds could be established. During the LGT's time in service, no accidents occurred at the site. In a survey of local residents, 86% of the drivers surveyed said the LGT helped them travel through the curve section. The majority of comments received from the survey respondents was very positive. Generally, remarks focused on how much the LGT helped drivers see the layout of the curve.  The LGT remained in service until June 2000 when it was dismantled to accommodate the completion of the new highway alignment. The LGT is available for reuse on future Oregon Department of Transportation projects.			
17.Key Words LIGHTED GUIDANCE TUBE, BARRIER DELINEATION, WORK ZONE SAFETY, OREGON		18.Distribution Statement Copies available from NTIS	
19.Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 25 + Appendices	22.Price

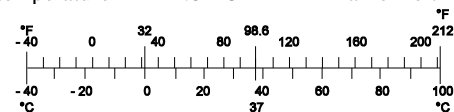
## SI\* (MODERN METRIC) CONVERSION FACTORS

### APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
<b><u>LENGTH</u></b>				
In	Inches	25.4	Millimeters	Mm
Ft	Feet	0.305	Meters	M
Yd	Yards	0.914	Meters	M
Mi	Miles	1.61	Kilometers	Km
<b><u>AREA</u></b>				
in <sup>2</sup>	Square inches	645.2	millimeters squared	mm <sup>2</sup>
ft <sup>2</sup>	Square feet	0.093	meters squared	M <sup>2</sup>
yd <sup>2</sup>	Square yards	0.836	meters squared	M <sup>2</sup>
Ac	Acres	0.405	Hectares	Ha
mi <sup>2</sup>	Square miles	2.59	kilometers squared	Km <sup>2</sup>
<b><u>VOLUME</u></b>				
fl oz	Fluid ounces	29.57	Milliliters	ML
Gal	Gallons	3.785	Liters	L
ft <sup>3</sup>	Cubic feet	0.028	meters cubed	m <sup>3</sup>
yd <sup>3</sup>	Cubic yards	0.765	meters cubed	m <sup>3</sup>
NOTE: Volumes greater than 1000 L shall be shown in m <sup>3</sup> .				
<b><u>MASS</u></b>				
Oz	Ounces	28.35	Grams	G
Lb	Pounds	0.454	Kilograms	Kg
T	Short tons (2000 lb)	0.907	Megagrams	Mg
<b><u>TEMPERATURE (exact)</u></b>				
°F	Fahrenheit temperature	5(F-32)/9	Celsius temperature	°C

### APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
<b><u>LENGTH</u></b>				
mm	Millimeters	0.039	inches	in
m	Meters	3.28	feet	ft
m	Meters	1.09	yards	yd
km	Kilometers	0.621	miles	mi
<b><u>AREA</u></b>				
mm <sup>2</sup>	millimeters squared	0.0016	square inches	in <sup>2</sup>
m <sup>2</sup>	meters squared	10.764	square feet	ft <sup>2</sup>
ha	Hectares	2.47	acres	ac
km <sup>2</sup>	kilometers squared	0.386	square miles	mi <sup>2</sup>
<b><u>VOLUME</u></b>				
mL	Milliliters	0.034	fluid ounces	fl oz
L	Liters	0.264	gallons	gal
m <sup>3</sup>	meters cubed	35.315	cubic feet	ft <sup>3</sup>
m <sup>3</sup>	meters cubed	1.308	cubic yards	yd <sup>3</sup>
<b><u>MASS</u></b>				
g	Grams	0.035	ounces	oz
kg	Kilograms	2.205	pounds	lb
Mg	Megagrams	1.102	short tons (2000 lb)	T
<b><u>TEMPERATURE (exact)</u></b>				
°C	Celsius temperature	1.8 + 32	Fahrenheit	°F



\* SI is the symbol for the International System of Measurement

## **ACKNOWLEDGEMENTS**

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

Barnie Jones, Oregon Department of Transportation Research Group  
Joni Reid, Oregon Department of Transportation Research Group  
Dave Horton, Oregon Department of Transportation Research Group  
Deborah Martinez, Oregon Department of Transportation Research Group  
Ed Venard, Oregon Department of Transportation Region 2  
Mike Bledsoe, Oregon Department of Transportation Region 2

## **DISCLAIMER**

This document is disseminated under the sponsorship of the Oregon Department of Transportation and the United States Department of Transportation in the interest of information exchange. The State of Oregon and the United States Government assume no liability of its contents or use thereof.

The contents of this report reflect the view of the authors who are solely responsible for the facts and accuracy of the material presented. The contents do not necessarily reflect the official views of the Oregon Department of Transportation or the United States Department of Transportation.

The State of Oregon and the United States Government do not endorse products of manufacturers. Trademarks or manufacturers' names appear herein only because they are considered essential to the object of this document.

This report does not constitute a standard, specification, or regulation.



# LIGHTED GUIDANCE TUBE EVALUATION FINAL REPORT

## TABLE OF CONTENTS

<b>1.0 INTRODUCTION.....</b>	<b>1</b>
1.1 PROBLEM STATEMENT.....	1
1.2 BACKGROUND .....	1
1.3 DESCRIPTION OF THE LGT.....	1
1.4 RESEARCH OBJECTIVES.....	3
<b>2.0 LITERATURE REVIEW.....</b>	<b>5</b>
<b>3.0 BACKGROUND INFORMATION OF TEST SITE.....</b>	<b>7</b>
3.1 SITE CHARACTERISTICS.....	7
3.2 ACCIDENT DATA .....	9
<b>4.0 INSTALLATION OF LGT .....</b>	<b>11</b>
4.1 INITIAL INSTALLATION.....	11
4.2 RE-INSTALLATION OF THE LGT .....	13
<b>5.0 IN-SERVICE MONITORING AND DATA COLLECTION.....</b>	<b>15</b>
5.1 SPEED DATA.....	15
5.2 WEATHER AND TRAFFIC VOLUME ANALYSIS .....	17
5.3 ACCIDENT RECORDS .....	18
<b>6.0 MOTORIST SURVEY .....</b>	<b>19</b>
<b>7.0 SUMMARY AND CONCLUSIONS.....</b>	<b>23</b>
<b>8.0 REFERENCES.....</b>	<b>25</b>

## APPENDICES

APPENDIX A: Speed Distribution Charts

APPENDIX B: Precipitation and Traffic Volume Data

APPENDIX C: Survey Questionnaire

APPENDIX D: Recorded Answers to the Question: “Can you provide any information on how the lighted tube helped you?”

APPENDIX E: Recorded Answers To The Question: “Why didn't the lighted tube help?”

APPENDIX F: Recorded Answers to the Question: “Do you have anything else you would like to add?”



## LIST OF TABLES

Table 5.1: Baseline Speeds for Westbound and Eastbound Lanes.....	15
Table 6.1: Survey Responses Indicating if the Lighted Guidance Tube Helped .....	19
Table 6.2: Survey Responses Assessing the Comfort Level Attributed to the Lighted Guidance Tube .....	20
Table 6.3: Cross Tabulation of Responses to the Help Question, with Responses to the Comfort Level Question ...	20

## LIST OF FIGURES

Figure 1.1: Lighted Guidance Tube Section.....	2
Figure 1.2: Light Injector at the End of a Section of Lighted Guidance Tube .....	2
Figure 3.1: Location of Project Site on U.S. Route 20; MP 28.0.....	7
Figure 3.2: Project Site Looking East (New Highway Alignment is at Right) .....	8
Figure 3.3: Project Site Looking West (New Highway Alignment is at Left).....	8
Figure 3.4: Project Site Looking West.....	9
Figure 4.1: Installing the Connection Cable to the Lighted Guidance Tube .....	11
Figure 4.2: Lighted Guidance Tube with Dead Spots Throughout its Length.....	12
Figure 4.3: Scotchlite™ Barrier Delineation Sheeting Developed by 3M™. .....	13
Figure 4.4: The Lighted Guidance Tube Operating as Designed .....	14
Figure 5.1: Westbound Speeds Recorded Prior to and After Lighted Guidance Tube Installation .....	16
Figure 5.2: Eastbound Speeds Recorded Prior to and After Lighted Guidance Tube Installation .....	17

# **1.0 INTRODUCTION**

## **1.1 PROBLEM STATEMENT**

Changing traffic flows, particularly through major construction projects with hard-to-follow and confusing curves, create hazards for night drivers. One potential way to improve safety at night for motorists trying to maneuver through work zones is the use of a lighted guidance tube. The 3M™ lighted guidance tube (LGT) has been used in 34 other states and 12 countries. A lighted guidance tube can improve the delineation of sharp turns and detour curves in construction work zones, thereby increasing safety and reducing accidents.

In 1999, the Oregon Department of Transportation (ODOT) decided to use the LGT on one of its highway construction projects, Eddyville - Cline Hill Section. Since it had not been used before by ODOT, the LGT was selected as an experimental feature for research, so it could be fully evaluated during the construction period.

## **1.2 BACKGROUND**

Safe and efficient traffic movements through work zones are a key concern for every construction project, particularly when space limitations require detours. Physical barriers are often used to guide traffic through the construction area, with warning signs to alert drivers to the changing traffic patterns.

At night or in poor weather, drivers have more difficulty anticipating and responding to changes indicated by the signs and barriers. The 3M™ LGT system is intended to reduce accidents on highway curves or through construction work zones by providing motorists with continuous, positive guidance along the roadway (*3M™ Product Bulletin 1994*). The system is all-weather and reusable. The tube comes in lengths of 6.1 m (20.0 ft) and can be connected to form multiple-tube lengths that can be configured as a single- or bi-directional system using yellow or white light.

## **1.3 DESCRIPTION OF THE LGT**

The LGT uses 3M™ Optical Lighting Film on the inside surfaces of a 100 mm polycarbonate tube that is flexible enough to conform to the curves in the road. The tube is installed atop concrete barriers using mounting brackets that are mechanically fastened to the top of the barrier (Figure 1.1). The tube is attached to the brackets with rubber straps, with the 6.1 m segments connected using flexible couplings. The LGT can also be attached to walls, guard rails, and other structures.



Figure 1.1: Lighted Guidance Tube Section

The light source for the tube is a light injector (lamp assembly) which is inserted on one end of the tube (Figure 1.2). The light injector consists of a 50 watt halogen lamp and a 48VDC to 12VDC power supply converter. According to specifications from 3M™, a maximum of five segments of 6.1 m tube can be illuminated by one lamp. The tubes are designed to be optically directional, with two lamps per 30.5 m of tube required if the tube is to be seen by both directions of traffic. To be bi-directional, the lamps are attached at the opposite ends of the 30.5 m section, configured so the lights shine towards each other.



Figure 1.2: Light Injector at the End of a Section of Lighted Guidance Tube

A system power supply converts 240VAC to 48VDC, and provides power for up to 20 light injectors. The 48VDC power is delivered by flexible connecting cables that can be run along the top of the barrier to connect each light injector to the system power supply.

## **1.4 RESEARCH OBJECTIVES**

This project was undertaken to evaluate the effectiveness of the LGT in reducing the potential for work zone accidents. There were five tasks in the evaluation:

1. Literature review
2. Baseline data collection, including:
  - Analysis of the work zone site, noting traffic volumes, sight distances, weather patterns;
  - Compilation of accident data; and
  - Collection of speed data using temporary recorders placed in the work zone.
3. Installation of the LGT. This involved documenting the assembly the LGT including level of effort required (# of people, specialized equipment, etc.), ease of installation, traffic control needs and difficulties encountered with putting the system in place.
4. In-service monitoring and data collection. This performance monitoring included:
  - Compilation of accident data;
  - Collection of speed data using temporary recorders placed three to four times during the LGT's period of service; and
  - A survey of motorists regarding their perceptions about the LGT's effectiveness and safety.
5. Summary and Recommendations



## 2.0 LITERATURE REVIEW

Although there has been widespread use of the LGT in the United States and other countries, limited studies documenting in-service performance have been conducted.

Pfeifer and others (1994) evaluated the crash safety performance of the LGT mounted on a longitudinal barrier system. The assessment involved static tests on two 6.1 m (20.0 ft) sections coupled together and attached to a concrete floor. The configuration of the LGT duplicated an installation on top of a concrete barrier. A load was applied perpendicular to one end of the tube to simulate the forces of an automobile striking the tube during a lateral impact. The tests showed that a relatively low load will deflect the barrier. The researchers concluded that when the LGT is placed on a median barrier, and if it is struck by and deflected by a vehicle in one direction of traffic, "it is possible for it to project into the windshields of oncoming traffic" (Pfeifer *et al.* 1994).

Bernhard and Wade (1995) reviewed performance records of the LGT used in other states and countries. They summarized observations made by various transportation agencies. In citing an analysis done for Germany's "Committee on Traffic Control Devices", they identified six attributes that the LGT offers including:

- Optimum optical guidance, especially when visibility is poor;
- Advance notice to allow for timely adjustment of speeds when approaching dangerous curves;
- A suitable technique for providing protection against wrong-way drivers by means of a bi-directional LGT;
- Comparatively low energy consumption; and
- Favorable cost-benefit ratio.



### 3.0 BACKGROUND INFORMATION OF TEST SITE

#### 3.1 SITE CHARACTERISTICS

The test site is located at MP 28.0 on U.S. Route 20, approximately 8 km east of Eddyville, Oregon (Figure 3.1). The site is within the limits of the Eddyville-Cline Hill Section highway construction project.

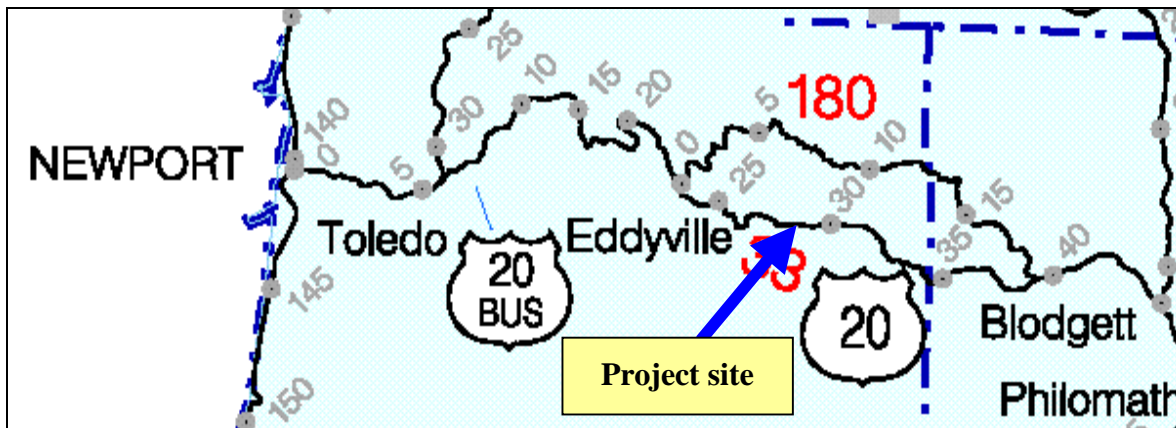


Figure 3.1: Location of Project Site on U.S. Route 20; MP 28.0

The average daily traffic on this section is approximately 4,500 vehicles per day. Construction on the Eddyville - Cline Hill Section project started in the summer of 1998. To accommodate the construction of a new bridge over Little Elk Creek, the highway alignment was shifted to the north in November 1998.

At this detour, U.S. Route 20 consists of two lanes with limited shoulders. The outside edge of the eastbound lane is protected with approximately 100 m of concrete barrier (Figure 3.2). Traffic approaching the project site on the eastbound lane transitions through a reverse curve before reaching the curve at the project site (Figure 3.3). The posted speed limit is 30 mph through both curves. Additionally, there are three sets of rumble strips in the eastbound lane alerting motorists of the changes in alignment prior to the curves.

The westbound lane approaching the project site transitions through a long tangent section before reaching the project site. The speed limit at the beginning of the tangent section is 55 mph, reducing to 45 mph as traffic enters the construction work zone. Approximately 250 m from the project site, the speed limit is again reduced to 30 mph prior to reaching the curve. There are a series of three rumble strips in the westbound lane prior the curves to alert drivers of the change in alignment.





Figure 3.2: Project Site Looking East (New Highway Alignment is at Right)



Figure 3.3: Project Site Looking West (New Highway Alignment is at Left)



Figure 3.4: Project Site Looking West

## 3.2 ACCIDENT DATA

Between November 1998 and prior to the installation of the LGT, there had been two reported accidents at this location. Each of them involved vehicles that were traveling too fast (the posted speed limit in both directions is 30 mph). One of the accidents involved two fatalities, when a truck traveling westbound lane crossed the centerline and crashed into an eastbound traveling automobile. The driver and a passenger were killed in the automobile. The other accident involved a single car traveling eastbound, and resulted in property damage only.



## 4.0 INSTALLATION OF LGT

### 4.1 INITIAL INSTALLATION

On November 16, 1999, the LGT was first installed on the concrete barrier according to the instructions provided by 3M™. The installation was completed in one day by a crew of four ODOT employees, two from the Project Manager's office and two from ODOT's Research Group. The following describes the general installation sequence.

Mounting brackets were attached to the top of the concrete barrier with 9.5 mm anchor bolts and inserts. They were spaced evenly, approximately 1.2 m apart. After the brackets were fixed to the barrier, the tube was positioned on the brackets and attached using the rubber straps. Each 6.1 m tube segment was connected to the next using rubber tube couplings. There were 16 tube segments mounted to the top of the barrier, making a 97.6 m tube length along the curve.

One light fixture was installed to illuminate each five-tube section. The light fixtures were slipped onto one end of each five-section assembly. Three of the lights were oriented towards the east and two faced towards the west. After the lights and tube assemblies were in place, the light fixtures were connected to the power supply using 8-gauge connecting cable, which came in 30 m lengths. Figure 4.1 shows the light tube with the connecting cable running underneath the light tube on top of the concrete barrier.



Figure 4.1: Installing the Connection Cable to the Lighted Guidance Tube

After the tube was installed, a night inspection was conducted. The light tube did not appear to be working as designed. Although each fixture was working, there were "dead spots" where very little light was being projected. Some of these dead spots were 6 to 12 m in length. Figure 4.2 shows the noticeable dark spots in the light tube, looking to the west.



Figure 4.2: Lighted Guidance Tube with Dead Spots Throughout its Length

A 3M™ representative was contacted about the problems with the LGT. Harry Anderson of 3M™ determined there were two reasons why the tube was not working effectively. The first reason was attributed to dirt and water inside the tube. Prior to the LGT's installation, the tubes had been stored on-site, outside next to the concrete barrier. Some of the plastic covers had come off the tube ends, and over several weeks, dirt and water had accumulated on the inside. Although there didn't appear to be a lot of dirt or water film in the tube when it was installed, it was enough to inhibit light transmission on the optical film.

The second reason why the lighted guidance tube was not working properly was because of the configuration of the light fixtures. As explained in Sections 1.2 and 1.3, the LGT is optically directional. It can be configured to be seen in only one direction of traffic or in both directions. For this project, the tube was supposed to be seen in both directions of traffic, but in its current configuration, each section was one-directional. Mr Anderson explained that to be seen in both directions of traffic, two light injectors were required for each five-segment section of tube, configured at each end of the 30.5 m section so the lamps illuminated towards each other. Since this was the first use of the LGT, the crew who installed the tube was not aware of how the tube should be configured for a bi-directional system.

Mr. Anderson recommended two courses of action.

- Replace the LGT with new tube. Mr. Anderson noted that there was no way to remove the dirt from the inside of the tube, and therefore, replacement was the best option. The replacement tube would be provided by 3M™ at no cost to ODOT.
- Reconfigure the lights in the LGT to make it a bi-directional system.



During conversations with Mr. Anderson, he indicated that 3M™ was no longer manufacturing the LGT. The replacement tube was provided from remaining stock. Mr. Anderson noted that 3M™ had developed a reflective sheeting that can be applied to concrete barriers to make them more visible to motorists. Their product, Scotchlite™ barrier delineation sheeting (Figure 4.3), is a continuous strip of retroreflective material that is affixed to the side of the concrete barrier (3M™ 1999).



Figure 4.3: Scotchlite™ Barrier Delineation Sheeting Developed by 3M™.

## 4.2 RE-INSTALLATION OF THE LGT

The new tube was shipped by 3M™ in January 2000 and arrived on-site later that month. Due to emergency repairs on two major coastal highway landslides in January 2000, the new tube was not installed until February. On February 7, the LGT was reinstalled and configured to operate bi-directionally. To ensure adequate illumination, the number of tube sections for each group of two light injectors (one on each end) was decreased from five segments of 6.1 m light tube, to three light tube segments. The LGT was reconfigured so that the total length mounted on the concrete barrier consisted of five sections, with each section consisting of:

- Three, 6.1 m light tube segments (making an 18.3 m length); and
- Two light injectors placed at each end of the section, illuminating towards each other.

The LGT was tested and worked as designed for several days. On February 11, the LGT was inspected at night and only one of the five sections was illuminated. Mr. Anderson at 3M™ was contacted again for technical assistance. He theorized that the source of the problem may be a malfunctioning power supply. The power supply was replaced with an extra one that had been stored on the project site. With the new power supply, the light injectors illuminated in all five sections, and the LGT was functioning as designed. Figure 4.4 shows a fully operational LGT. The small breaks in the illumination are caused by the light injectors positioned in the tube.



Figure 4.4: The Lighted Guidance Tube Operating as Designed

The LGT remained in service until June 28, 2000. At that time, construction staging required removal of the concrete barrier and LGT to accommodate completion of the new highway alignment. The LGT was dismantled, transported to Salem, Oregon and stored inside so that it could be reused on future projects.

The next section of the report describes the in-service monitoring of the LGT from February to June 2000.

## 5.0 IN-SERVICE MONITORING AND DATA COLLECTION

### 5.1 SPEED DATA

Prior to the LGT installation, and on four separate occasions after the LGT was reinstalled in February, 2000, speed data was collected for both directions of traffic. Baseline speed data was collected in November (2-7); after the installation, data was collected in February (10-16), March (15-21), April (19-25) and May (23-30). TrafiCOMP III, Model 241 traffic and speed recorders were used. Speeds were recorded in both lanes by placing two road tubes at each approach to the project site and connecting them to the traffic recorder. As traffic traveled over the tubes, the recorder measured the speed and stored the data in bins (ranges). The data storage bins included 0-30 mph, 31-40 mph, 41-50 mph, 51-60 mph and 61-70 mph.

Speeds were measured for 24-hour periods for three to seven days in each period. For comparative purposes, average speeds were calculated for nighttime hours and daytime hours. Since sunrise and sunset times varied throughout the evaluation period, only the speeds recorded in “core” nighttime hours (9:00 p.m. until 6:00 a.m.) and for “core” daytime hours (7:00 a.m. to 5:00 p.m.) were used to determine averages. Table 5.1 summarizes the traffic volume, average speed, and the percentage going over 40 mph for each direction of travel. Speed distribution data can be seen in Appendix A. The average speeds are displayed graphically in Figure 5.1 for the westbound direction, and Figure 5.2 shows the average speeds in the eastbound direction.

**Table 5.1: Baseline Speeds for Westbound and Eastbound Lanes**

	WESTBOUND DAY			WESTBOUND NIGHTTIME		
	VOLUME	AVERAGE SPEED	% OVER 40 mph	VOLUME	AVERAGE SPEED	% OVER 40 mph
BASELINE (Nov 99)	3239	34.32	16.33	1115	36.84	26.91
Feb-00	8665	33.74	14.13	1562	35.22	21.19
Mar-00	9671	32.20	9.79	1440	34.67	18.33
Apr-00	7949	34.61	19.11	1459	36.32	25.91
May-00	10254	32.78	12.15	1961	34.19	16.32
	EASTBOUND DAY			EASTBOUND NIGHTTIME		
	VOLUME	AVERAGE SPEED	% OVER 40 mph	VOLUME	AVERAGE SPEED	% OVER 40 mph
BASELINE (Nov 99)	2219	28.34	0.50	263	28.39	0.38
Feb-00	9405	34.46	5.19	1190	30.96	3.45
Mar-00	8719	33.66	4.22	1102	28.30	3.18
Apr-00	8762	33.42	2.69	1156	30.67	4.15
May-00	5544	33.47	5.32	1066	30.47	3.85



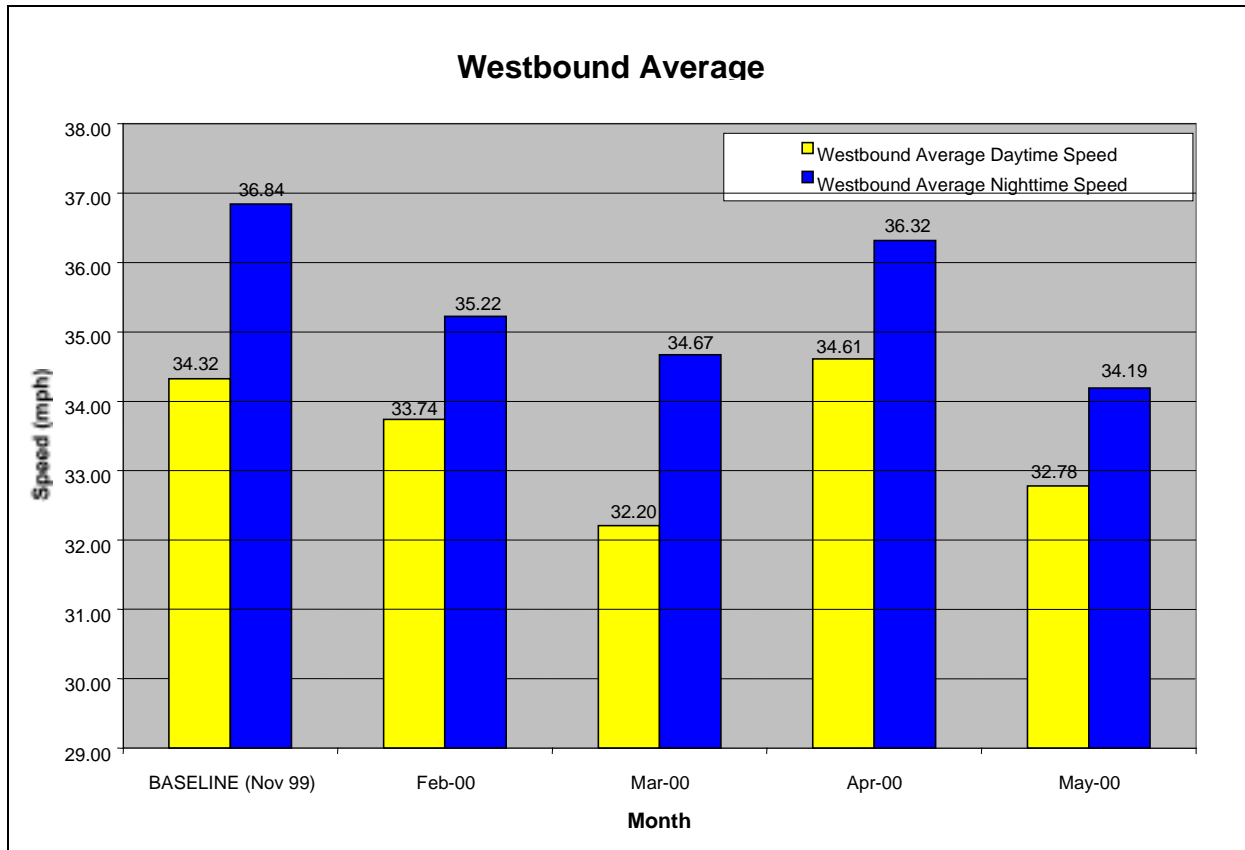


Figure 5.1: Westbound Speeds Recorded Prior to and After Lighted Guidance Tube Installation

As mentioned earlier in the report, the westbound lane, approaching the project site, transitions through a long tangent section before reaching the curve section. Even though the posted speed limit is 30 mph prior to the curve, the average speeds observed in the baseline condition were between 4.3 mph (daytime) and 6.8 mph (nighttime) higher than the posted speed limit. Thus, a desired outcome in using the LGT, was a lowering of speeds at nighttime in the westbound direction because drivers would be alerted earlier of the upcoming curve.

In Figure 5.1, it can be seen that for each of the four recording periods after the LGT installation, the average nighttime speeds were less than baseline. In fact, except for April, the trend shows a lowering in average nighttime speeds. This could suggest that the decrease in speeds may be attributed to the LGT. However, the same pattern was also observed for daytime speeds. Except for the April recordings, the daytime average speeds were lower than baseline. Since the nighttime speed pattern mirrors the daytime pattern, it appears that the LGT had no effect on reducing speeds at night in the westbound direction.

As also seen in Figure 5.1, the nighttime speeds in each period are higher than daytime speed. Intuitively, one might expect the opposite to be true. One possible explanation for the higher nighttime speeds might be due to lower traffic volumes at night. During daytime hours, more traffic is on the highway, and oftentimes vehicle queuing occurs where the speed of a group of closely spaced vehicles is governed by the speed of the vehicle at the front of the queue.

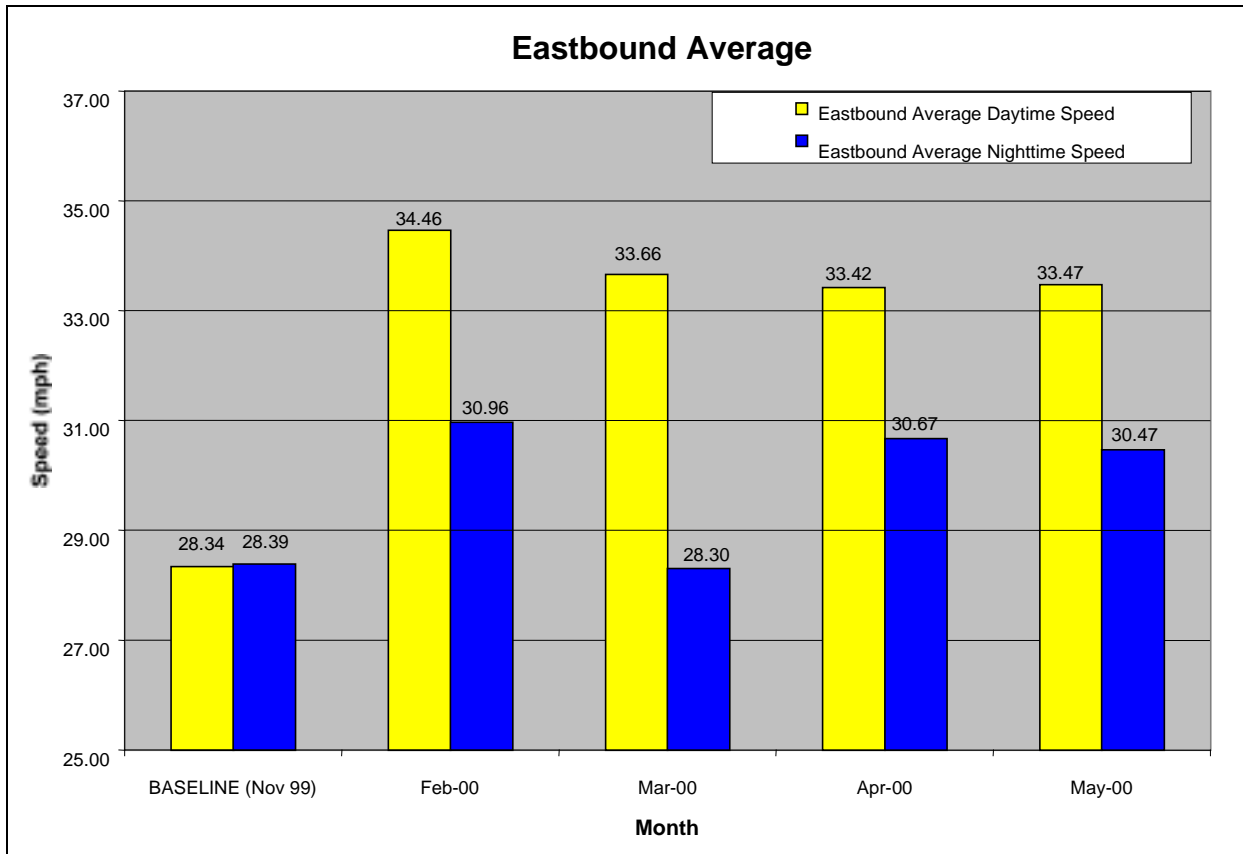


Figure 5.2: Eastbound Speeds Recorded Prior to and After Lighted Guidance Tube Installation

In the eastbound lane (Figure 5.2), the baseline nighttime and daytime speeds were much lower than the posted speed limit of 30 mph. As noted earlier in the report, the highway alignment approaching the curve for eastbound traffic limits speeds to a great extent.

After the LGT installation, the average daytime and nighttime speeds were higher than baseline for every period except for the average nighttime speed recorded in March, which was slightly lower than baseline. Although this overall pattern of speeds seems unexpected, it is interesting to note that after the LGT was installed, the nighttime eastbound average speeds were from 3 to 5 mph less than the daytime speeds. This was opposite of what occurred in the westbound direction. Again, the reason could be the effect of the highway alignment approaching the curve. The reductions might also be attributed to better delineation of the curve provided by the LGT, or to other possible factors.

## 5.2 WEATHER AND TRAFFIC VOLUME ANALYSIS

Weather data was reviewed to see if there was any relationship with the recorded speeds. The rainfall amounts recorded at the Corvallis, Newport, and Alsea Weather Stations are provided in Appendix B. Traffic volume was also considered to be a possible factor. As noted earlier, when traffic volumes increase, more vehicle queuing occurs, impacting travel speeds. Traffic volume data for east- and westbound traffic can also be found in Appendix B.

Regression analysis was used to further examine the effect of traffic volume, rainfall and the LGT on speeds in each direction. The results were inconclusive and cannot be used to adequately characterize a relationship between speed and one or more of the three variables (traffic volume, rainfall and usage of the LGT) examined in the analysis.

### **5.3 ACCIDENT RECORDS**

During the five months for which the LGT was in service, there were no reported motor vehicle accidents. It seems plausible to conclude a direct causal relationship between the LGT and improved highway safety. However, because the time period was so short, more information was needed to achieve a better understanding of how the LGT improved highway safety. Therefore, to assess what motorists' perceptions about the LGT's effectiveness, a survey was conducted. Chapter 6 describes the results of the survey.

## 6.0 MOTORIST SURVEY

In order to qualitatively evaluate the effectiveness of the LGT, a motorist survey was developed. Motorists who had driven through the project site at night were surveyed by telephone to find out their opinions about the LGT's effectiveness in helping them safely travel through the curve section. A copy of the survey questionnaire is located in Appendix C.

The Oregon Survey Research Laboratory (ORSL) at the University of Oregon conducted the survey in March 2000. The sample size of 210 respondents was based on the population of 10,000 people who lived along U.S. Route 20 between Blodgett, Oregon and the east city limits of Newport, Oregon. The sample size was determined using a 95% confidence interval and a +/- 6.7% precision level. Each of the respondents had traveled through the project site at night and had noticed the LGT.

The results of the survey indicate that the LGT had a positive effect. Most of the motorists that were surveyed said they liked the lighted tube. As shown in Table 6.1, an overwhelming majority (87%) of the respondents answered "yes" when asked if the LGT actually helped them travel safely around the curve.

**Table 6.1: Survey Responses Indicating if the Lighted Guidance Tube Helped**

Frequency of Trips at Night	Did the lighted tube actually help guide you safely around the curve?			Grand Total
	Yes	No	Didn't Answer	
1-2 times	51	6	1	58
3-4 times	39	3		42
5-8 times	34	6	1	41
9-16 times	25	3		28
17-32 times	28	3	2	33
> 32 times	5	3		8
Grand Total	182	24	4	210

Another question asked motorists about the effect of the LGT on their comfort level when as they were driving through the curve. Two-thirds of the respondents felt their level of comfort was higher because of the LGT, as seen in Table 6.2. It is interesting to note that for people who drove through the project site one or two times, the percentage of respondents who said the tube made their comfort level higher was not as great as for the respondents who traveled in the project site more frequently. For instance, 31 out of 42 people (74%) who traveled though the project site three to four times said that the LGT provided them with a higher comfort level. Of those who traveled one to two times, only 33 out of 58 (57%) said the LGT gave them a higher sense of comfort. Familiarity with the light tube may explain this difference; since the LGT had

not been used before, people were unfamiliar with its operation. There may have been some confusion felt by drivers the first or second time they saw the LGT operating. As motorists drive through the site more often, they become familiar with the LGT and understand its purpose.

**Table 6.2: Survey Responses Assessing the Comfort Level Attributed to the Lighted Guidance Tube**

	<b>Did the lighted tube make your comfort level higher, about the same, or lower when driving through the curve section?</b>				
<b>Frequency of Trips at Night</b>	Higher	About the Same	Lower	Didn't Answer	Grand Total
1-2 times	33	18	7		58
3-4 times	31	6	5		42
5-8 times	28	9	3	1	41
9-16 times	19	6	2	1	28
17-32 times	24	7	2		33
> 32 times	5	1	2		8
Grand Total	140	47	21	2	210

Table 6.3 cross-tabulates the answers to the question about whether the lighted tube helped, with the responses about the comfort level for motorists. For instance, 7 respondents out of the 24 who answered “no” to: “Did the lighted tube actually help guide you safely around the curve?”, said the lighted tube made their comfort level higher when driving through the curve section. Alternatively, 40 respondents who said their level of comfort was about the same with the LGT, answered “yes” to: Did the lighted tube actually help guide you safely around the curve?”

**Table 6.3: Cross Tabulation of Responses to the Help Question, with Responses to the Comfort Level Question**

	<b>Did the lighted tube make your comfort level higher, about the same, or lower when driving through the curve section?</b>				
<b>Did the lighted tube actually help guide you safely around the curve?</b>	Higher	About the Same	Lower	Didn't Answer	Grand Total
Yes	131	40	11		182
No	7	7	9	1	24
Didn't Answer	2		1	1	4
Grand Total	140	47	21	2	210

Motorists who found the LGT helpful were asked to provide information on how the lighted tube helped them. The full text of their responses is located in Appendix D. Generally, their comments focused on how the LGT helped drivers see the curve. The tube gave them a better indication of where the curve was and its degree of curvature. Some commented that the LGT was an attention-grabber, causing them to slow down. About 10% of the respondents said they

initially thought the LGT was the headlights of another car as they approached the curve. However, as is evident from the comments, once people determined the light was delineating the curve, they felt the LGT helped guide drivers through the site.

As Table 6.1 shows, 24 motorists (13% of the total) answered “no” to the question: “Did the lighted tube actually help guide you safely around the curve?” They were also asked provide reasons why; the full text of their comments is located in Appendix E. Generally, people didn’t think it helped for either of two reasons:

- The LGT gave the impression of oncoming traffic; or
- Motorists who frequently drive that section of highway were already familiar with the alignment of the curve.

At the end of the survey, all survey respondents were asked if they had any additional comments. Most of the comments concerned the highway construction. These comments are contained in Appendix F.



## 7.0 SUMMARY AND CONCLUSIONS

In its five month service period, the LGT proved to be effective in guiding motorists through a difficult curve section on the Eddyville - Cline Hill Section construction project. During its time in service, the LGT was evaluated to observe its effect on vehicle speeds, accidents, and driver perceptions.

The effect on vehicle speeds is inconclusive. In the eastbound lane, speeds in both daytime and at night increased after the LGT was installed. However, speeds at night were less than the daytime speeds. Westbound traffic registered nighttime speeds higher than the daytime speeds for each recording period, including the baseline period. After the LGT was installed, the average daytime and nighttime westbound lane speeds were lower than the baseline speeds. Regression analysis did not demonstrate a correlation between nighttime speeds and the presence of the LGT.

During the LGT's time in service, no accidents occurred at the site. In a motorist survey, 86% of the drivers surveyed said the LGT helped them travel through the curve section. The majority of comments from the survey respondents was very positive. Generally, their remarks focused on how much the lighted tube helped them see the layout of the curve. The LGT alerted drivers and provided most of them with a greater level of comfort in traveling through that portion of the work zone.

The installation of the LGT proved to be more challenging than envisioned, primarily because workers were unfamiliar with the device. Users need to be aware of the requirement to keep the tube portion of the LGT free from dirt and water. The tube segments should not be stored outside prior to the installation. They should be stored inside with the ends covered to prevent dust or moisture from accumulating on the inside. When ready for installation, the tube segments should be transported to the job site and installed the same day.

The LGT is available for reuse on future ODOT projects. Installation requirements are minimal, and two people can easily install the LGT. It does however, require a power source. Additionally, inserts for anchors must be drilled into the top of the concrete barrier to attach the brackets to the barrier. Although 3M™ is no longer marketing the product, ODOT still retains over 300 m of tube sections that can be reused on a future project.

As noted earlier in the report, the research by Pfeifer and others (1994) demonstrated a possible hazard with the LGT being deflected into the oncoming traffic in the opposite direction of travel when impacted by a vehicle. If the LGT is to be used again on other ODOT projects, this potential hazard should be considered before using the LGT on median barriers.

Another alternative for median barrier delineation is the Scotchlite™ barrier delineation sheeting developed by 3M™. As discussed earlier in the report, the sheeting is retroreflective and can



enhance visibility for drivers to better estimate and adjust to changes in roadway alignment. It is recommended that the Scotchlite™ barrier delineation sheeting, or a similar proprietary product be tried in a future construction project, and evaluated by ODOT's Research Group as an experimental feature.

## 8.0 REFERENCES

Bernhard, Michael A. R. and Michael Wade. *Summary Report on the 3M™ Lighted Guidance Tube*. Human Factors Research Laboratory, University of Minnesota, April 1995.

Pfeifer Brian G., Barry T. Rosson and Dean L. Sicking. *Safety Evaluation of 3M Lighted Guidance Tubes*. Transportation Research Studies Research Report No. TRP-03-42-94. Midwest Roadside Safety Facility Center for Infrastructure Research, Department of Civil Engineering, University of Nebraska-Lincoln, January 1994.

3M™ Product Bulletin. *3M™ Lighted Guidance Tube*. 3M™ Traffic Control Materials Division, St. Paul, Minnesota, July 1994.

3M™ Product Bulletin 7500. *3M™ Scotchlite™ Barrier Delineation Sheeting*. 3M™ Traffic Control Materials Division, St. Paul, Minnesota, November 1999.

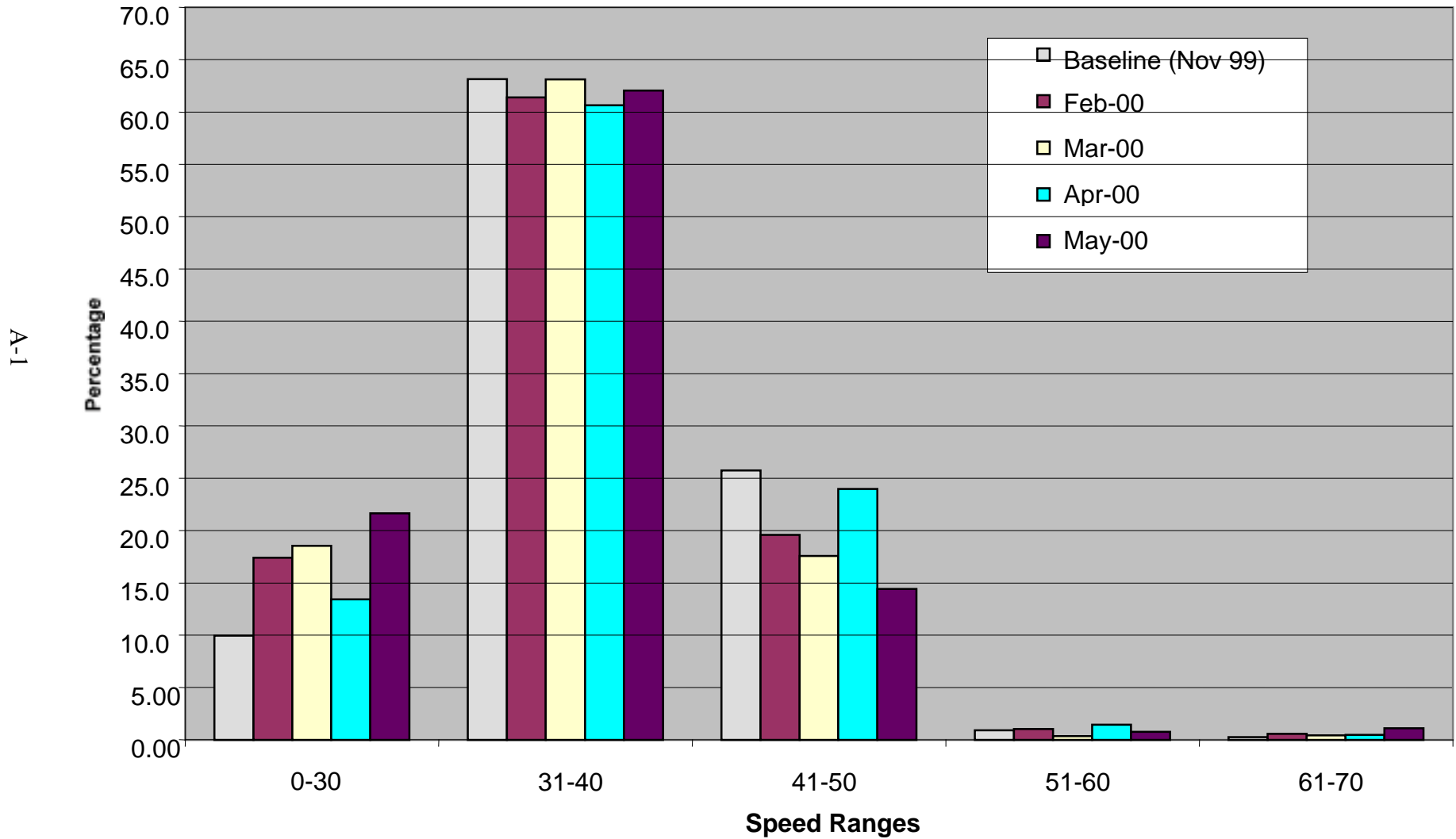


## **APPENDIX A**

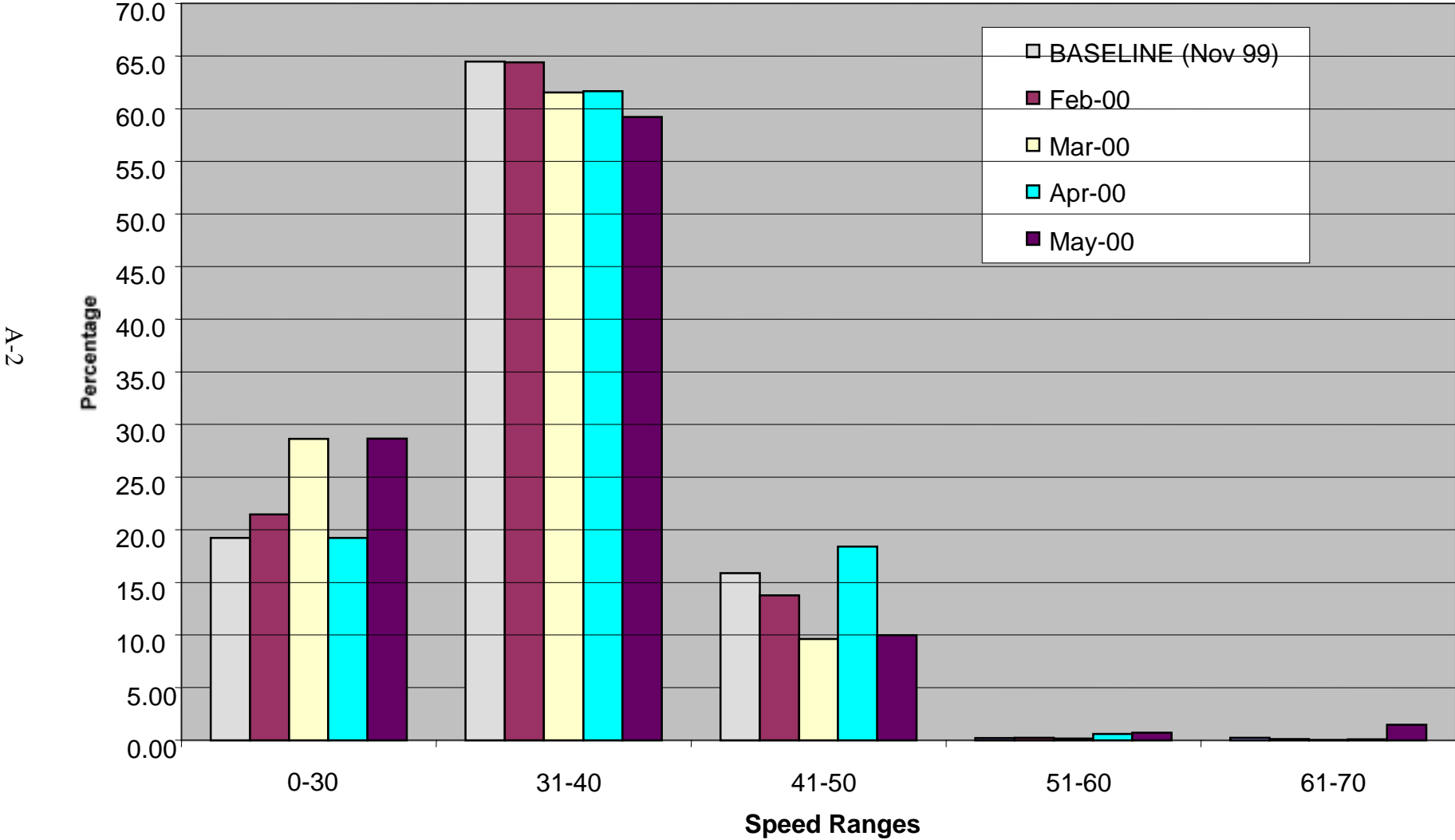
### **Speed Distribution Charts**



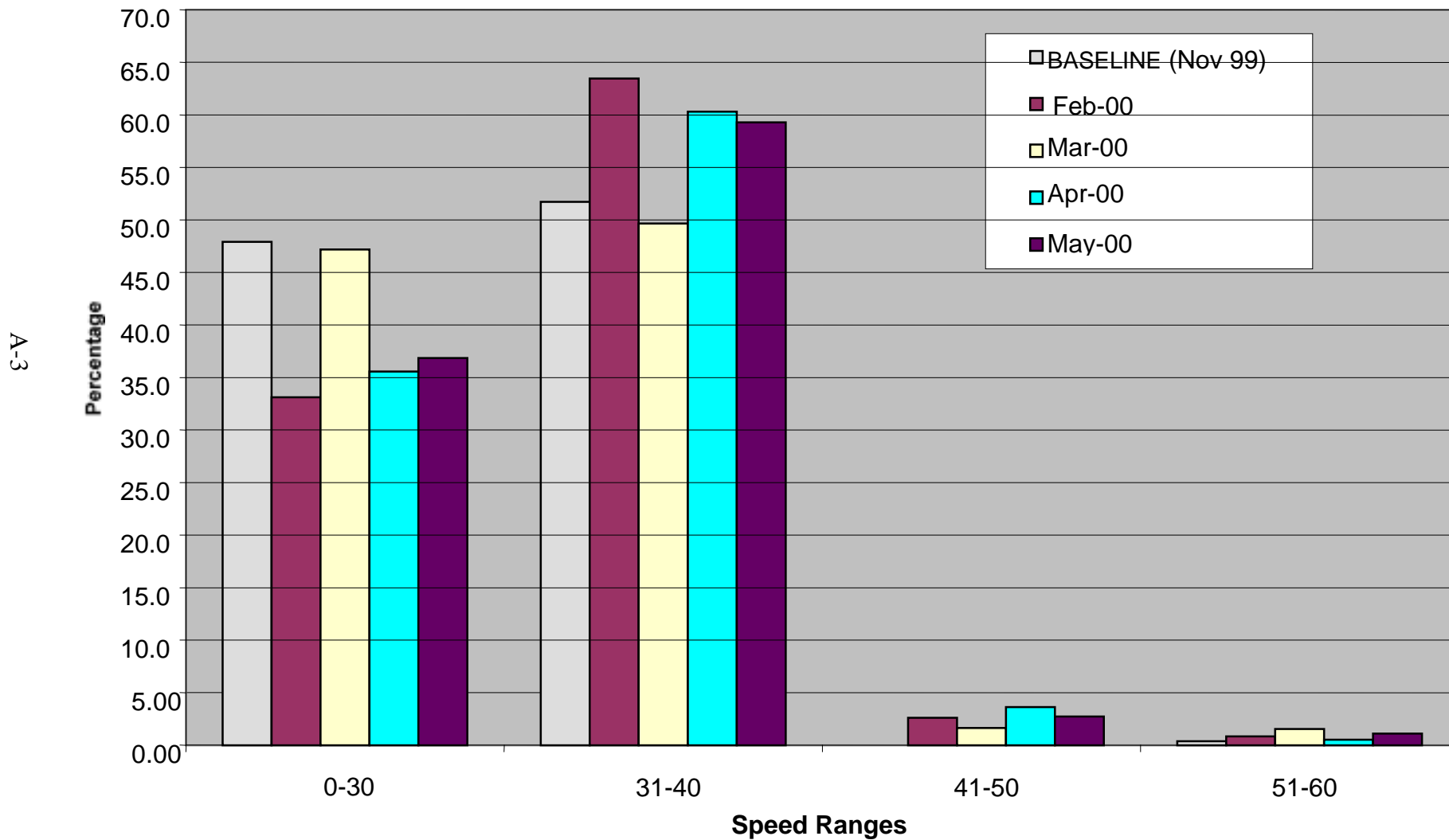
# Westbound Nighttime Speed Distributions



# Westbound Daytime Speed Distributions

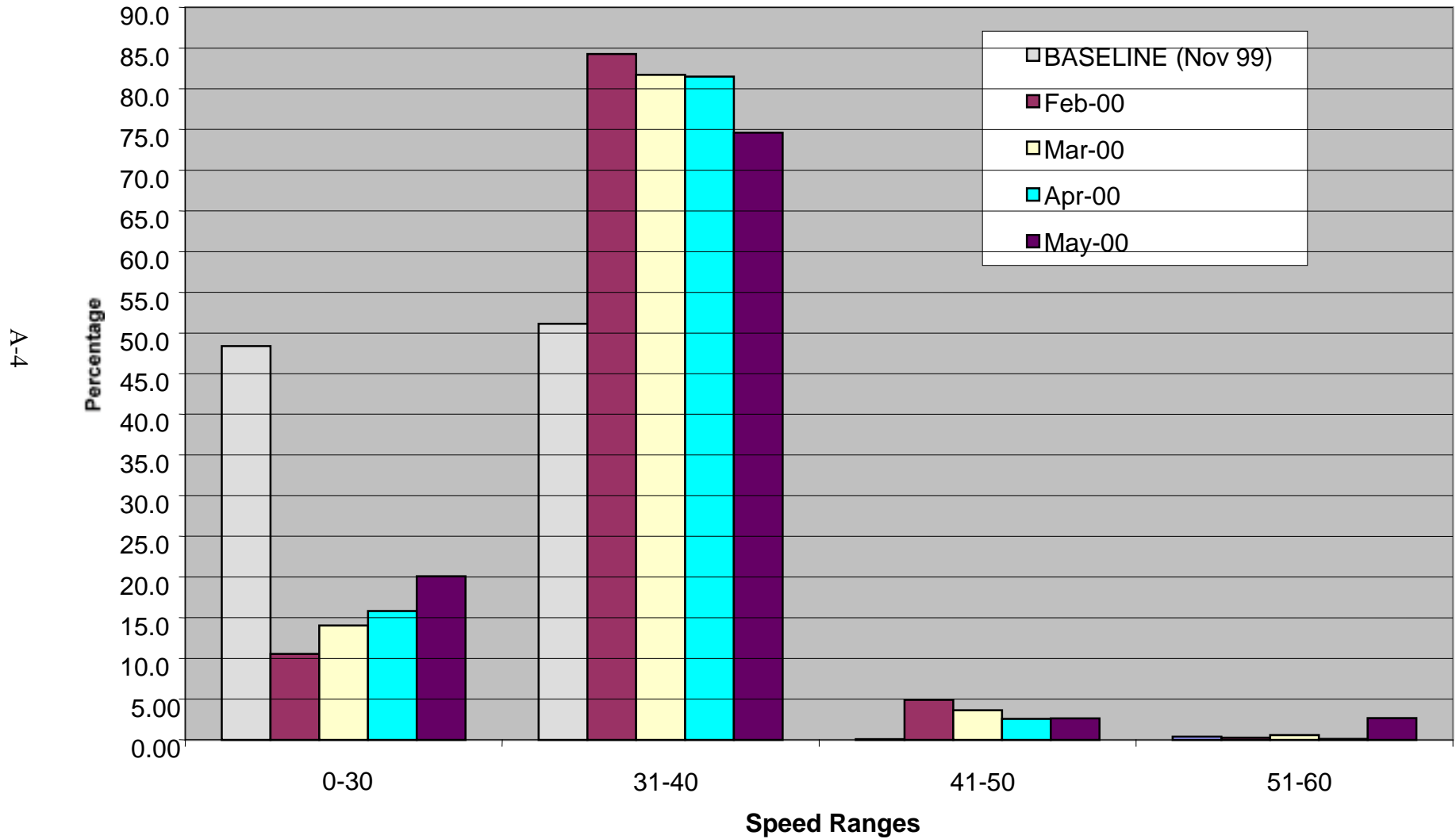


# Eastbound Nighttime Speed Distributions





# Eastbound Daytime Speed Distributions



## **APPENDIX B**

### **Precipitation and Traffic Volume Data**



<b>Precipitation Data</b>				
<b>Date</b>	<b>Corvallis (in.)</b>	<b>Alesea (in.)</b>	<b>Newport (in.)</b>	<b>Average (in.)</b>
11/02/99	0.00	0.00	0.00	0.00
11/03/99	0.00	0.00	0.03	0.01
11/04/99	0.03	0.23	0.00	0.09
11/05/99	0.00	0.00	0.58	0.19
11/06/99	0.88	1.56	0.00	0.81
11/07/99	0.01	0.00	0.69	0.23
02/09/00	0.12	0.19	0.02	0.11
02/10/00	0.01	0.04	0.06	0.04
02/11/00	0.24	0.70	0.62	0.52
02/12/00	0.64	0.70	0.73	0.69
02/13/00	0.08	0.30	0.49	0.29
02/14/00	0.63	0.80	0.69	0.71
02/15/00	0.28	0.54	0.01	0.28
02/16/00	0.01	0.04	0.01	0.02
03/15/00	0.00	0.04	0.06	0.03
03/16/00	0.36	0.30	0.42	0.36
03/17/00	0.07	0.30	0.05	0.14
03/18/00	0.03	0.30	0.44	0.26
03/19/00	0.19	0.60	0.15	0.31
03/20/00	0.27	0.12	0.00	0.13
03/21/00	0.00	0.00	0.00	0.00
04/19/00	0.00	0.00	0.01	0.00
04/20/00	0.00	0.00	0.00	0.00
04/21/00	0.00	0.15	0.19	0.11
04/22/00	0.08	0.13	0.04	0.08
04/23/00	0.03	0.30	0.24	0.19
04/24/00	0.18	0.24	0.01	0.14
04/25/00	0.11	0.09	0.34	0.18
05/23/00	0.00	0.00	0.03	0.01
05/24/00	0.00	0.00	0.00	0.00
05/25/00	0.00	0.00	0.00	0.00
05/26/00	0.01	0.12	0.13	0.09
05/27/00	0.07	0.25	0.24	0.19
05/28/00	0.09	0.30	0.13	0.17
05/29/00	0.05	0.04	0.02	0.04
05/30/00	0.03	0.00	0.13	0.05
05/31/00	0.06	0.00	0.08	0.05

<b>EASTBOUND TRAFFIC VOLUME SUMMARY DATA</b>						
<b>Date</b>	<b>Nighttime Volume</b>	<b>Nighttime Average Speed</b>	<b>Nighttime Percent over 40 mph</b>	<b>Daytime Volume</b>	<b>Daytime Average Speed</b>	<b>Daytime Percent over 40 mph</b>
2-Nov-99	68	29.84	1.47	448	29.40	0.45
3-Nov-99	118	28.25	0.00	1154	28.23	0.26
4-Nov-99	77	27.32	0.00	617	27.77	0.97
9-Feb-00	73	33.86	8.22	515	34.49	7.57
10-Feb-00	141	33.59	4.96	1235	33.81	5.10
11-Feb-00	182	30.39	5.49	1443	34.59	5.68
12-Feb-00	184	31.07	1.63	1232	35.12	5.68
13-Feb-00	139	31.54	1.44	1912	34.73	2.98
14-Feb-00	213	29.75	3.29	1147	33.98	3.84
15-Feb-00	192	29.33	2.60	1090	34.74	8.07
16-Feb-00	66	30.88	1.52	831	33.92	5.42
15-Mar-00	97	30.04	2.06	597	33.72	4.19
16-Mar-00	172	30.44	5.23	1347	34.25	6.01
17-Mar-00	162	30.35	4.94	1374	33.74	5.68
18-Mar-00	208	26.97	1.44	1351	33.93	3.18
19-Mar-00	170	25.85	0.59	1736	33.93	2.42
20-Mar-00	220	28.82	2.73	1374	33.70	4.66
21-Mar-00	73	33.31	8.22	940	33.68	3.72
19-Apr-00	62	31.15	4.84	674	33.17	3.71
20-Apr-00	202	31.47	6.44	1286	34.22	4.67
21-Apr-00	204	31.46	3.92	1505	32.87	1.99
22-Apr-00	206	27.78	1.46	1367	33.58	1.46
23-Apr-00	158	28.73	2.53	1648	33.97	2.37
24-Apr-00	207	31.93	5.31	1212	32.21	1.57
25-Apr-00	117	32.81	5.13	581	33.37	3.10
26-May-00	70	31.50	4.29	343	33.53	9.33
27-May-00	309	29.92	3.88	1017	33.62	5.80
28-May-00	313	29.67	1.60	1237	33.54	4.28
29-May-00	274	30.83	4.74	2172	33.06	3.22
30-May-00	74	32.66	6.76	301	33.12	10.63

<b>WESTBOUND TRAFFIC VOLUME SUMMARY DATA</b>						
<b>Date</b>	<b>Nighttime Volume</b>	<b>Nighttime Average Speed</b>	<b>Nighttime Percent over 40 mph</b>	<b>Daytime Volume</b>	<b>Daytime Average Speed</b>	<b>Daytime Percent over 40 mph</b>
5-Nov-99	440	34.83	15.91	1151	31.82	7.82
6-Nov-99	400	38.35	34.25	1179	35.65	20.70
7-Nov-99	275	37.86	33.82	909	35.78	21.45
9-Feb-00	120	36.92	26.67	479	34.93	18.16
10-Feb-00	221	35.18	21.27	1164	33.48	13.23
11-Feb-00	380	33.83	12.63	1510	32.88	10.53
12-Feb-00	228	37.14	31.14	1682	33.90	14.27
13-Feb-00	191	35.76	23.56	927	34.19	15.75
14-Feb-00	106	34.56	16.98	1062	32.17	9.51
15-Feb-00	189	35.55	23.28	990	34.45	17.47
16-Feb-00	74	33.00	17.57	851	35.29	19.27
15-Mar-00	122	33.57	12.30	648	33.25	15.59
16-Mar-00	225	34.57	21.33	1295	32.03	8.65
17-Mar-00	357	35.14	19.89	1548	32.41	9.04
18-Mar-00	231	35.07	19.05	1838	31.25	7.40
19-Mar-00	201	33.41	10.45	1407	32.94	11.58
20-Mar-00	217	34.62	18.89	1566	33.13	12.77
21-Mar-00	87	36.53	27.59	1369	31.11	6.94
19-Apr-00	110	35.73	27.27	710	34.53	21.13
20-Apr-00	268	37.57	33.58	1227	35.29	21.60
21-Apr-00	344	34.98	18.60	1640	33.66	15.43
22-Apr-00	246	36.01	22.76	1536	35.04	19.40
23-Apr-00	167	37.18	27.54	1089	35.87	24.24
24-Apr-00	214	37.21	28.50	1228	34.25	18.57
25-Apr-00	110	35.68	28.18	519	33.03	11.75
23-May-00	131	33.94	17.56	906	30.98	9.49
24-May-00	220	34.52	18.64	1157	32.11	11.67
25-May-00	282	34.45	18.44	1255	32.19	11.47
26-May-00	467	33.86	13.70	1614	32.15	11.52
27-May-00	333	32.92	12.01	2008	32.91	10.81
28-May-00	238	35.14	18.49	1529	34.21	13.28
29-May-00	195	35.27	19.49	1477	33.60	15.03



## **APPENDIX C**

### **Survey Questionnaire**





## Motorist Survey

### Hwy 20 East Of Eddyville

Hello. My name is \_\_\_\_\_ and I am calling from the Oregon Survey Research Laboratory. The Oregon Department of Transportation (ODOT) has asked us to call and interview drivers age 18 and older who live near Highway 20 between Newport and Blodgett, to provide ODOT with information about the effectiveness of a new type of lighting that they are using on one of the curve sections in the highway construction zone east of Eddyville. I want to assure you I am not selling a thing and that this survey is completely voluntary and anonymous. The interview will only take about 5 minutes. Do you have any questions about the interview before we begin?

- 1) Have you driven through the Highway 20 construction area east of Eddyville in the last 2 months?
  1. YES (GO TO 2)
  2. NO (GO TO END)
  
- 2) Have you driven through the Highway 20 construction area east of Eddyville after dusk or at night in the last two months?
  1. YES (GO TO 3)
  2. NO (GO TO END)
  
- 3) Approximately how many times have you driven through the highway construction area in east of Eddyville after dusk or at night in the last two months?

OPEN-ENDED

- 4) Did you notice the *long lighted tube* attached to the top of a concrete barrier in one of the curve sections?
  1. YES (GO TO 5)
  2. NO GO TO END)
  
- 5) Did the lighted tube make your comfort level higher, about the same, or lower when driving through the lighted curve section?
  1. HIGHER
  2. ABOUT THE SAME
  3. LOWER

6) Did the lighted tube actually help guide you safely around the curve?

1. YES (GO TO 7)
2. NO (GO TO 8)

7). Can you provide any information on how the lighted tube helped you?

OPEN-ENDED; GO TO END

8) Why didn't it help?

OPEN-ENDED; GO TO END

END: Thank you very much for taking the time to answer these important questions about safety improvements on Highway 20. Your comments have been valuable. Do you have anything else to add?

## **APPENDIX D**

### **RECORDED ANSWERS TO THE QUESTION:**

**“Can you provide any information on how the lighted tube helped you?”**



## Can you provide any information on how the lighted tube helped you?

It was quite bright and made me pay attention.

Well, it does outline the cement barrier so we can see the outline of it better.

It helped guide that the curve was there and in fact it was ...and exactly where it was.  
Can see better.

Well, it caused more caution, because whenever I see that thing I think of cars coming the other direction, because it appears from what we are used to because it is like his lights are hitting a reflective area and you expect a car to come from the other direction. When I get there I realize, wow, I've been tricked.

Um, it just shows me where the curve was and help the people who don't drive there a lot like me know where the curve was.

Um, yes because before we got to where the light was, we had gone through some curves and when we got to the section with the lighting we thought it was really great. There was a guy behind us driving kind of crazy, and he passed us. I don't know if it had any effect on him or not, but he must have seen it. I think it must have caught his attention, maybe kept him alive. It would have kept him from going over the embankment. And it was dark and rainy, so we thought it was really great and commented on it.

Well, it just...you know which way to go...it guided you good.

Um, it just made it more aware that there was a wall there and there was a sharp corner. It almost looked like head lights reflecting off the guardrail.

Before you knew it was there, but you didn't know how long that concrete barrier was, so the lighting helped.

Well for me, I know this curve is coming up because I live here, but it is a sharp curve and you have to obey the speed. It changes, gives you perception as for the curvature of the road. Family came down and missed my place, going west, at 35 miles an hour, and missed my place.

Saw it way before I would have seen the original corner. It's awesome, I really like it. Those tubes are awesome. You should put more of them around.

Just make you know that the curve was coming up faster. See that curve a lot further way. We spent time looking at it, whether it is a light or a reflector.

Because you knew where the curve is, you are aware of it. Nope, that's fine.

Oh, it was just easier to see, it was better than other types.

Just helped make me go around the curve easier.

## Can you provide any information on how the lighted tube helped you?

---

Well, it was like being closer to the city where there was more light, easier to see that it was coming, it make me feel safer.

Um, I guess it makes you know that the corners are sharp. I have driven through it so much that I got used to it. I drive through it 6 days a week, going there in the morning and coming back at night.

Um, it helps you see.

Well, it shows you the curve...I would say that the curiosity made me paid attention too much....it was distracting me...it would be dangerous for that because I just kept looking what it was, it's distracting me.

Um, just we knew where the wall was. At first we thought it was another car.

Just making me...it was well lit, so I was more aware of and faster. If I didn't know the curb, it made me more aware because it was brighter than reflectors, but I know that curb real well so I always know it's there. I can drive that road with my eyes blindfolded.

It made it easier to see that it was a curve. If you have never seen it before and come upon it, it can be distracting, until you've seen it once.

Well at first when you come into it, the first time I drove through, I didn't know what it was. I thought it was a car coming at me so I was being real cautious, but when I got up to the tubes I saw they were tubes. I think it helps, it's kind of a fog light out there, helps you around the corner.

At least I was able to see how far away I was from the construction.

I guess it makes you aware of the curve.

It just made me aware it was real sharp there.

Well, yeah, you can see better. I know that highway well, so it doesn't make much difference for me, but it did make it more visible.

It was easier when there was oncoming cars, because you have to shut off your brights, it definitely made visibility and you weren't as nervous as to how much space you had.

It just makes you think someone's coming so then you slow down, but you can also see where the curb thingy is I guess.

Um, give me a better indication of what the curve was, the actual degree of the curve.

It made me more aware of my surroundings. You can see it before you get to it, you can see it for quite a ways. Something doesn't look quite right.

## Can you provide any information on how the lighted tube helped you?

---

Well, other than the first time I went through -- it was quite a shock -- it is a good idea, a good improvement. The biggest thing is that I go through all the time so I know the road, but a stranger would be able to see the curve of road. I was impressed. I like the idea.

Kind of surprised me the first time. It surprised me, then I guess it slows you down a bit.

At first it looked like another vehicle. It helps, it sort of illuminates the curve.

You can see the corner coming up ahead, that's probably the best part of it. You can see it as you approach the corner, you can see where the corner is, as opposed to just depending on your headlights. It makes me feel safer that other people see it coming around the other direction.

It made you more aware of the barrier first of all, and I know everything going on there, it just makes you more aware of the problem that was there.

Um, it lit up the area and it shows that it's a curved area, however, it is distracting at the height it is at. Because it looks like the lights of an oncoming car.

It just helped me know where the road was better.

It just lets you know basically what's there.

Oh, actually it made it look like there was another car coming on so it made me slow down, be more cautious. That's what it looked like to me anyway.

Everything is so black any light is better. It helped you knew exactly where the curve is.

I've lived here for years and I know what's there and I just watch out for it. Probably someone who wasn't familiar with the route and traveled it lately, it would probably be a help to them. I've traveled that route for fifty some years.

Well I have a problem at dusk seeing anyway. By having that tube there I could know I wasn't going off the edge. It kept me knowing exactly where I was.

Well, light is better.

Actually it was unique enough to draw attention to a situation and I guess my natural response was to slow down, because of the uniqueness of the lighting.

Just by illuminating the concrete wall there where construction is being worked on and letting people know there is curves.

As long as I know it's there I watch for it now. You always have to be cautious there anyway.

You can see better, and it's more lighted and it looks safer. Basically, it seems a lot safer than it was before.



## **Can you provide any information on how the lighted tube helped you?**

It was more obvious where the wall was, I guess not really.

You could see definitely where the road turned and how wide it was in that area, and you could see it ahead of time as you were coming up on the curve.

Uh, it gave a little more advance view of how long the curve was.

Yes, as you approached, much easier. I just drive the road quite frequently and know the area and that you have to take care around the curves, especially that one right now, because of all the accidents, and it is quite a tight corner and you watch out for the trucks when you meet them. I am sure it's quite helpful for the tourists and others especially at night for those who aren't familiar or don't go through the valley quite frequently.

Actually gave it, it imaged it a little better for me at night, I guess, made it show up well. No, that's about it, really.

It just looked like there were lights there, it was light and easier to see; safer.

It defined where the curve was, sometimes it kind of gets lost in the dark and it helped define it. The first time it kind of scared me because I didn't know what it was.

Well, it just helped you negotiate, especially when it gets a little foggy in the area, also you can see better when going around the curve, it just illuminates better.

I actually noticed it right away and it made me feel much more comfortable, and actually we discussed it when we noticed it and thought it was a great idea. I was surprised that somebody didn't think of it sooner.

It looked like an oncoming car because it's extra bright it catches your attention.

It just made it more visible from a little bit of a distance, instead of coming upon it so fast, you could see how tight the curve is.

Um, see that's a tough one and I've grown up on that highway and I know it like the back of my hand. It makes me more comfortable that tourist will see it and know it is there. Because they don't know the road necessarily and that curve will sneak up on you.

Prior to getting to the curve it made me think that there was another car coming around the corner, so that made me slow down before I got to the curve. Plus it lights up the area better.

It was brighter, clearer, it just shows up more, it brings it out more, noticeable.

You could actually see the bank better and lights from on-coming cars reflected off of them.

At first I thought it was reflections from on-coming cars and the next time I realized they were lit. They're really neat.

## **Can you provide any information on how the lighted tube helped you?**

---

I was apprehensive at first until I actually seen what it was. It will probably make it easier to travel through the construction zone. Some type of sign could warn people what they are about to come up upon them. It isn't something you are used to seeing. A sign could be valuable.

It might prevent wrecks.

It made me feel like I could feel where the road was going.

It just made it easier to see the middle line and the sides of the road.

It's easier to see the barrier all the way through.

It's kind of hard to tell there is a curve, so the tube kind of tells you that.

It stands out so much you can see the whole corner.

It just shows up so bright before you get there. You follow it around the curve.

I just, I think maybe it made me slow down sooner.

With the reflective surface it disappears, with lighting it shows the curve.

Just that it slowed me down to go around that corner and to drive cautiously.

It made it clear that there is a curve. If you went into the curve too fast it may not help, speed is the problem.

It made me more aware of the circumstances and the situation.

It helped you get around the sharp corners.

Well, it makes you aware that the corner is coming up. It lighted the corner up, you can tell from the distance away that the corner is there.

Just I noticed it, and I am sure the other drivers who are not familiar with the way know that the sharp corner is coming up.

Just made me more aware. Even during the daytime when I've been through.

It directs you well, but it is distracting to the lights then to then, it should be intermittent.

Well, it's at that corner that you could go straight; well, it doesn't go straight, so it does help you go around the corner.

It hindered, but helped when you realized it was not another car and that it was a lighted tube. Going down was probably more helpful.

## **Can you provide any information on how the lighted tube helped you?**

It just helped me see all the way around.

Well, they provide different lighting than you're normally used to. It helps break the monotony. It helps you concentrate. It is not too bright at night that your eyes avoid it.

Helped me see better.

It just made it so that you could see the curve. It's effective.

It actually makes you have the feeling that there's ongoing or coming cars or trucks.

It told you where the corner is.

Yes, it brings your attention to that you're going into a tight corner -- do posted speed, that is, 30 minutes. It slows you down. I was there the night the two people were killed -- and that's because someone went into that corner too fast.

It helped me to see that I'm going around the curve.

It made me feel safer about other drivers.

It was interesting, it really did not help.

Makes you see the guard rail.

It sets off a glare.

Made you know there was a curve and if went straight you'd run into a curve.

It gave you a sense of the corner. You knew where the road was.

It increased visibility.

Well first of all I was confused when I saw it but now that I know what it is, it reminds me that there's a sharp curve there and I have to be cautious.

It helped a lot because that corner is a bad corner.

My husband knows that road [he is a logging truck driver] very well and he doesn't need the lights, but he thinks it is a good idea for the tourists that are driving to the coast. He is more excited about the construction being done more than anything else. He wishes it would be done all the way to Toledo, to Pioneer Mountain, because there are still a lot of bad corners from Pioneer Mountain to Eddyville.

It would be like driving in the city with lights, you could have had your headlights off, you could see without them.

## **Can you provide any information on how the lighted tube helped you?**

It helped because it lighted up and makes you more cautious because you think another car's coming. It looks like reflecting tape and another car is around the corner, so it makes you really cautious about that corner.

Well I knew it was there anyway, but I noticed it because it lighted the whole rail way. It's a bad corner, I know what you're talking about. It just illuminated very well.

It just gave me a line to track on, like a margin line does on the outside.

It kind of makes us blind at times and makes it seem like another car is coming around the curves. And it is actually kind of scary.

Um, well I think because, it makes you more aware of the degree of the curve, because it is a little sharp there. It just helps you get around it. It makes you slow down. We find that we slow down even more than the recommended speed there. It makes it looked like a car is coming from the other direction. It didn't make that much difference as far as driving goes, but the first few time I was through there, I dimmed my lights, but that's not such a bad thing. as soon as I saw it was lighted, I put my brights on again.

I think, when I first saw it I was thinking a space ship landed down on the corner, but after I got into it, I realized it was there for a beneficial reason. I travel the road enough to know when to slow down, but I think for the cars ahead of me it was beneficial because they were out of state. To them it was beneficial and all the curb signs and cuts in the roads are beneficial. To me I drive the roads a lot so I'm a pretty good traveler.

Basically, it helped show where the corner was, how steep the corner was, and kept you in the proper lane. We actually need more law enforcement out there. Basically because I've been getting passed in the construction area by impatient drivers.

It's more additional alert that a curve's coming.

Its definitely a nice little thing on that corner there. It just helped me see the corner better.

Um, it does, it let me know that the corner was sharp as it was.

I think it makes people slow down...the lighted tube tells you to go careful.

It's easier to see from long distance.

You can see where the curve was.

It looked lit up, it looked like the other cars coming on the corner, so naturally you take a little bit more careful.

It helped so that we see it better.

## **Can you provide any information on how the lighted tube helped you?**

Well, I noticed it right away. Actually it looked like it was reflection of the oncoming car, but obviously it wasn't. It was very helpful.

It made me feel better. Those corners always scare me coming home in the evening. Anything that would make you more aware of the road would be an improvement.

Um, not really ...just it was different. You can see it from further away.

Um...just increase visibility. That's it.

Only that it was easier to see coming through than the regular street signs.

Um, not right now...(P). It helped me see that the corner was coming.

No, not really. I just was very cautious going through the construction area. I was going too slowly than necessary.

It makes it look like someone's coming toward you so you drive slower.

Well I wasn't driving but I could see the road better, I was surprised. I had never seen anything like it. I really liked it.

My relatives were killed on that corner and the light has made a big difference.

Well it's a good thing. It's needed. It points the thing out. We were the first ones through after a truck overturned and its wheels were still spinning. We didn't have a cell phone and could not call.

I felt like I was safe.

It helped me see the contour of the curve.

It's kind of a distraction at first.

It just made it easier to see where the concrete barrier was. It's quite narrow there and it gave me a better perception.

It just made it more visible. You could see the edge of the road better.

The corner angle was easier to see. The concrete barriers were easier to see. A couple of times it was raining, and it made it easier.

I just think that it kind of guides you around the curve. Well, I've been driving that same road for twenty-two years and I know the road well, but if I didn't know it well, then I still think it would help. It's really quite obvious. Well, the first time I went through I wondered if it was reflecting the headlights but it's more of a florescent...tubes.

## Can you provide any information on how the lighted tube helped you?

---

It's a pretty sharp curve in that section and it helps see the curve better.

It made it a lot easier to see. You could see everything better

Well it just. That you see it before you get to it. It helps going around the curve. I've never seen anything like it.

Well, lets see, it provides...a lot of people don't know the road and that helps dramatically for people when the road is under construction. I've been driving that for as long as they've been doing the construction, it doesn't worry me but the other drivers -- you get a lot of tourists and their reactions to the sudden sharp corner worries me. And that may help the other drivers a lot and it gives me more confidence that they're not going to suddenly swerve into my lane.

I think that it probably helped, yes. Well, it's just that when you approach that corner it makes it really clear, it helps define the arch of the turn, clearly define how it turns at this point and it also gets your attention because it's very different.

The tube I don't think makes that much difference, but if anything it probably helps. I know that area by heart.

It was better than reflectors. (laughter) It caught my attention and it looked like a car coming so it made me wary. But the next time through it was better.

It makes you more aware. Makes you think someone is coming and it keeps your attention on it.

Rivets in road are good to wake up people. Other than able to see the corner better.

It made it clear it was a big concrete wall there. Wasn't sure what it was at first because I was tired and had a long day. It makes you slow down. For those who are familiar with the area, they go faster and it makes you aware of them.

Well you know its weird, every time I go through it I think it is another car coming towards me, as a reflection of their light. It makes you slow down and it really lights up the curve.

At first it didn't help but now that I'm used to it, it does help

Um, it helped show that it was coming up, but I know the road anyways. For people who don't know the road I would think it would help. Just letting me know it was coming up.

Make you aware that there is danger there. It makes you aware that visibility is better and you can see the curvy parts and makes others slow down.

It was like a fog line being lit up -- easier to see.

It made it more visible.

## **Can you provide any information on how the lighted tube helped you?**

You could see better.

I could see the barrier there.

Seemed brighter and you could see the light reflections better.

It let you know the curve was coming so you can prepare for it and that's what gets you around the curve.

To be honest with you, I could increase my speed, but I also know the road.

Well it just shows, the direction of the road and stuff, it's a bad area until it's finished.

You can, when you're coming up to the corner, you can see the corner lit up right a ways away instead of it coming right up on top of you. This way you can see it coming and negotiate the corner better, so it does help quite a bit.

Well it just made you more alert, and ah, feel more safe.

It just makes you aware of the corner.

Well, it lights up the road so you can see but at the same time it's distracting it looks like another car coming.

At night it provides a kind of lighted sign to let you know there is a corner there.

You can see the curve better.

It offered a warning that you were approaching it.

It was more light, you could see the actual curve.

Upon first glance it looks like headlights so it definitely grabs your attention and makes you concentrate on the corner.

Made me a little more aware of the turn.

Just seeing better on the ground, rather than having the lights up so high, and it's pretty common sense. You just follow the light and there you are. Sometimes it does get foggy around there, so it helped out a lot.

It is always better to see than not.

It just woke me up to the fact that there's a curve.

That's hard I guess it wakes you up.

**Can you provide any information on how the lighted tube helped you?**

---

At first I thought it was like headlights, just to know that was there and how sharp the curve was.

It made it light the whole section which is kind of treacherous.

No, other than it's just a continual guide through the corners.

It lights up the road. It helps because you can't see the lines at night.

Just by it illuminating the things better than what a reflector would, kind of shortening the angle of it.

It shows how sharp the corner is.





## **APPENDIX E**

**RECORDED ANSWERS TO THE QUESTION:  
“Why didn't the lighted tube help?”**



## **Why didn't the lighted tube help?**

---

It's distracted me. It is worse. It doesn't help me at all.

I think it worked more, it almost works as a warning that there's oncoming traffic.

Because you think there is an oncoming vehicle. Why didn't they put in regular lights like they normally do? Why don't they get it done and get the hell outta here?

Like I just explained, it gave the impression that there was oncoming traffic coming and I dimmed my lights instinctively and therefore I couldn't see as well.

Because I have driven that curve so many times.

Well, as we going through the construction area we thought there was oncoming traffic and it made it confusing.

I was on the other side, but it made me comfortable knowing that other drivers was good.

It was daylight.

I didn't notice it until I was about half way around curve.

Well, like I said, we've been through there so much that it didn't make a difference really.

It looked like a barrier across the road, I've been driving that highway for more years than I want to say, that corner's weird enough and they put that there.

Because I already knew the road as I drive through it all the time. At first it looked like a line of cars coming at you. I didn't like that.

Because I drive straight through and I'm aware that the corner is there. Isn't that terrible? That thing has caught my attention, so I imagine it would be good for someone not from the area.

Because I know the road. The one thing it does is that it gives the same effect of oncoming traffic, I think it is a good thing. Especially when we get into foggy weather, it will be a good thing.

Well, it takes away from the depth perception at night. The headlights become pretty much worthless, it's a distraction. At night you can't see the headlights of the oncoming cars. Really no difference in the amount of light of the oncoming cars and lighted tubes. You can't tell if there is a car coming around the corner or not. The most dangerous part of that road, most of us local here in Newport know that the construction signs were all wrong -- backwards. The detour pointed opposite of the corner was wrong, the right sign was knocked out.

It just, you know, the curve is there already, it's a matter of going around it.

It made it a little more difficult in one way but it was better in another way.

## **Why didn't the lighted tube help?**

---

It's so unusual, it could cause an accident for someone who does not know the highway. When you are heading east, you can't tell if it's reflective or if it's an actual light, going west looks like cars coming around the curve. It's deceptive.

Because when I first saw it, it was kind of disorienting.

I didn't use it as a guide, but as warning that it was a very sharp curve.

It creates a type of atmosphere the problem is the lighting is too high. the light bounces off of the hood and so on, way too much light all over everything.

It makes it look like cars are oncoming when there isn't.

Because it made it seem that there were other cars oncoming. It was distracting.

Well I already knew it was there, it didn't seem to make a difference.

The company that did that curve did a terrible job. The lights are adequate but the tube does not help. The warnings are too far back.

It just seemed more like there was oncoming traffic when there was not - it decreased visibility.

## **APPENDIX F**

**RECORDED ANSWERS TO THE QUESTION:  
“Do you have anything else you would like to add?”**



## **Do you have anything else you would like to add?**

---

I'm just anxious for it to get through construction because it looks like we are going to have a good road.

Keep on changing things. You keep on putting in the new pumps, lights...they are more distractive and worse.

I think the construction outfit has done very good job as far as making it easier to get through the site.

No. When they are they going to finish it?

Yeah, I wish they'd start work on that thing again. Yesterday it was so nice and they're still working. It would be nice to have it done by summer. Like my brother-in-law says, "they should have had this done a year ago."

No, we live on Highway 20 on Philomath, so I'd be glad for any kinds of improvements on Highway 20 since it goes right through our town.

No...When are they going to finish it? I'll be glad when it is done.

How long will those concrete barriers be there? [gave her Mr. Griffith's phone #]

Just that I think there should be more police watching the trucks going around the curves. They take over and could squish the cars.

I hope you put more of them.

What it's about, how long they are going to do that.

No sir, but I wish they'd hurry up and finish it.

Well, I have one, the local papers and radio told us that there is no more construction until summer and yet the sign was there, even though there is no construction...and the police were just watching the speed limits and ...just make speed low, to 20 to 25. I think it is almost like entrapment.

When are they going to get done?

No, well, something like that. Just inform the public.

It makes it appear that a car is coming from the opposite direction.

Tell ODOT to put reflectors on the curves west of Eddyville, on the old section (not under construction). I can't believe they won't do that, or haven't done that.

Yeah, I'd like to add that I am glad that they are improving the highway around there, there have been quite a few accidents there. And also I think the 45-mile speed limit is a good idea.



## **Do you have anything else you would like to add?**

---

I wish they would get it over with.

I really, everything has been good. When will the construction start again?

I'd like to see more of the improvements faster.

No, not at all. The first couple time it was confusing because it looked like the lights of an oncoming car.

Whenever they get a chance I'd like to see them fix my driveway. I think that's their responsibility, I've been waiting for a couple of years now.

They ruined our driveways, our water system. They need to just get their things done and then get lost.

It would be nice if those lights were permanent. If they had more like that, it was very helpful.

I just hope they can continue on to Toledo with it, Pioneer Mountain or whatever, and finish the job, with the construction.

Uh, the only thing is they need to be clearer on the speed limits. Some aren't well posted 45 or 35.

Looking forward to the next phase of the project.

Talking about safety, you ought to put in a stoplight at highway 229 and 20, instead of just a caution.

No, I think that it will be wonderful when it is finished, that is a pretty creepy drive.

Just wish they'd hurry up and get it open.

No, are they going to keep them there? I think that it is a good idea for any construction area.

I don't like the little speed holes that they dug.

Well, they need to do something with the paint on the main road. Not just around the corner, but the whole road needs to be painted, re-stripped. They are not bright enough to see around where they are doing the construction, the length of the construction.

I'll be glad when the entire project is complete.

No, I work for the road department and it looked great.

If you see something you're not used to, you are apprehensive at first.

Yeah, my number is new and supposed to be unlisted.

## **Do you have anything else you would like to add?**

---

Because we do have such foggy wet weather, I think we need the reflectors in the road all the way from Philomath to Newport.

No, but I'm glad they are making these improvements during construction.

I think were disappointed that it was not open last fall.

Just that the... it was disconcerting the first few times through. It took some getting used to.

It was kind of distracting. I was a passenger and could feel the brakes and us slowing down because it was unexpected, but we knew the road. Some of the drivers may not be familiar with the road, could be sleepy and this could help them out.

Oh, I think everywhere should have long lighted tubes when they have sharp corners.

No, hope they hurry up and get it done, because the old road is terrible, we can't drive at night.

ODOT did every thing they could do, I think, in my opinion, to make it more safe in that area of construction.

Yes, I guess at the very beginning from the Blodgett end, where it starts at 45 mph -- it doesn't seem like it should be 45 mph. It should be the speed limit, that is, 55, until after you get into the curve. Because it's a long distance that you have to drive 45 -- and there's a cop that's watching.

I hope they hurry up and get it done.

How do those lights work? Are they florescent?

No. I like those tubes.

I'm glad they fixed that corner and can't wait until they do the rest of it.

Yeah, I don't think doubles (two trailer trucks) should be allowed on Highway 20. I wish there were more pull outs. Also, what I notice, when ODOT paints the highway for summer -- by winter a lot of that paint is gone. I'd like to see more white reflectors.

ODOT sent out a questionnaire. I live in Toledo. If it's dark or raining I can't see the yellow or white line. You have to drive slow. If they had those reflectors on the center line between Toledo and Newport I'd even help pay for them. They are really a big help. I'm 73 but even my daughter, who is 39, wants to see the reflectors there.

I know there is going to be lots of accidents when it opens up because of a lot of people speeding. People don't want to slow down and I wish they would.

That corner is bad.

## **Do you have anything else you would like to add?**

---

The project looks real good.

I'd be happy to see that new section open and be happy to see more funding for the highway between Eddyville and Toledo but you support Measure 82 (5 cents a gallon tax that lets truckers off the weight/mile). Rumble strips or grooves across the road have been an excellent safety addition.

One thing I've noticed driving at night is a lot of the highway signs are reflective, it's very disconcerting, you don't know if you're looking at deer eyes or what, so highway reflections at night are I think not very good.

I think the new construction is really going to be nice. It may make people drive faster, which isn't a good idea, but it is going to be better. It is going to increase traffic and speed, and then the people will get into the bad sections again, the curvey part of the road. They will be getting speed up on the nice sections and be going too fast when they hit the curves and it will bottleneck the traffic and people get impatient. And driving through Eddyville is a nightmare because of the railroad track and the curve right before it.

Um, no. Just that we'll be glad when its all done; its a just a very dangerous section of road. We would like to know why they did the section east of Eddyville before they did the Pioneer Mountain section because we have lived here a long time and it seems there have been a lot more accidents on that section of the road.

Well, I wish the project was getting done a little bit faster.

Put a light at the junction of Toledo on Hwy 20.

That corner needs to be changed and there will be more wrecks.

No, just that I hope they hurry up and finish the construction.

I think one of biggest problems is the detour ahead sign and it isn't a detour. It is a distraction. It does make people slow down. The silhouettes of trucks is backwards of what it should be, a strange truck driver might have a problem. The ripple bars are great.

Just, I am really glad that they're doing it and it'll make travel much safer.

Well, I just wonder when they will get through with all the bridges.

Um...I drove down that part thousand miles now, the signs were backwards and detour was not correct. I hope they could strengthen things out.

Wish they would make the new section 4 lane instead of two. Too much traffic. Not enough room.

No, it's nice to have a survey about something I care about.

## **Do you have anything else you would like to add?**

---

Um, they go through and put a Band-aid on it and call it a safety corridor, and it doesn't do a damned thing. There's lines of traffic coming from both ways and the whole thing is a sham calling it a safety corridor.

Let's fix the next section between Eddyville and Pioneer Mountain. Let's not wait, let's start, it's dangerous.

It probably helps drivers from out of town. It makes you think a car is coming from the other way. But all in all, I think it's a good idea. I haven't heard of any accidents there for a while so it might be helping.

The curves should not be so sharp. They have speed bumps there but cars don't slow down.

The biggest problem is there should be more reflective material in the center of the roadway.

No, but I use that road a lot and its nice to have something like that there.

I think people drive too fast through there.

The only thing about that turn is that you don't see the sign that's posted 45 miles an hour, it's deceiving because you get on the straight-away and you believe it's 55 not 45.

No, unless you can tell me where they're going to put the rest of the road (laughs).

No, just that they'd hurry up and finish it.

I think those lights are a good idea though, I really do. There are other ways they could use them. They are a good use of technology and that is a bad road.

No, I'll just be glad when it's all finished.

We don't see any work going on and wonder what is going on. We were supposed to be driving that by last Thanksgiving.