

R22-1



W21-19



W21-20

# *Act 229 Evaluation Report*

Prepared for



Prepared by





---

## Table of Contents

<b>1. Documentation Page</b>	<b>3</b>
<b>2. Executive Summary</b>	<b>4</b>
2.1. Purpose	4
2.2. Evaluation Results	4
<b>3. Background</b>	<b>4</b>
<b>4. Approach</b>	<b>8</b>
4.3. Speed	8
4.4. Compliance	9
4.5. Contractor Perception	10
4.6. Motorist Perception	11
<b>5. Locations Evaluated</b>	<b>12</b>
<b>6. Results</b>	<b>13</b>
6.1. Speed Comparison	13
6.2. Headlight Compliance	15
6.3. Work Zone Crash Data	16
6.4. Driver Survey	17
6.5. Contractor Interviews	23
<b>7. Conclusion</b>	<b>27</b>



**I. Documentation Page**

<b>1. Report No.</b> FHWA-PA-2006-038-E00228-WO7		<b>2. Government Accession No.</b>		<b>3. Recipient's Catalog No.</b>	
<b>4. Title and Subtitle</b> Act 229 Evaluation Report			<b>5. Report Date</b> January 2007		
			<b>6. Performing Organization Code</b>		
<b>7. Author(s)</b> Richard Sesny (PennDOT), Larry Lentz (PennDOT), Eric Rensel (Gannett Fleming)			<b>8. Performing Organization Report No.</b>		
<b>9. Performing Organization Name and Address</b> Gannett Fleming, Inc 207 Senate Ave Camp Hill, PA 17011-2316			<b>10. Work Unit No. (TR AIS)</b>		
			<b>11. Contract or Grant No.</b> E00228		
<b>12. Sponsoring Agency Name and Address</b> The Pennsylvania Department of Transportation Bureau of Planning and Research 400 North Street, 6 <sup>th</sup> Floor East Harrisburg, PA 17120			<b>13. Type of Report and Period Covered</b> Final Report		
			<b>14. Sponsoring Agency Code</b>		
<b>15. Supplementary Notes</b>					
<b>16. Abstract</b>  In December 2002, the Pennsylvania Legislature adopted Act 229. The act was intended to improve highway safety in highway work zones by requiring drivers to illuminate their vehicles' headlights; and by delineating those active work zones where motorists are exposed to increased penalties for moving violations due to the presence of workers. The signs and light were intended to supplement work zone traffic control devices already required by Title 67.					
<b>17. Key Words</b> White Light, Work Zone, Safety			<b>18. Distribution Statement</b> No restrictions. This document is available from the National Technical Information Service, Springfield, VA 22161		
<b>19. Security Classif. (of this report)</b> Unclassified	<b>20. Security Classif. (of this page)</b> Unclassified	<b>21. No. of Pages</b> 28	<b>22. Price</b>		

Form DOT F 1700.7

(8-72)

Reproduction of completed page authorized

## 2. Executive Summary

### 2.1. Purpose

The purpose of this study was to evaluate the effectiveness of the Act 229 signs. Five measures of effectiveness were analyzed:

- ✓ Speed Reduction
- ✓ Headlight Compliance
- ✓ Contractor Perception
- ✓ Work Zone Crash Data
- ✓ Motorist Perception

Nine locations distributed within the Commonwealth were selected to evaluate the before and after situations. The test locations were chosen from PennDOT Districts 2-0, 3-0, 4-0, 11-0 and 12-0. Among the test sites, three types of roadways were evaluated:

- ✓ Urban freeway
- ✓ Rural freeway
- ✓ Major arterial

### 2.2. Evaluation Results

When Act 229 signs were implemented in the work zone a minimal impact was witnessed. Average increase of vehicles with headlights on entering work zone was only 8.1 percent. The average speed reduction through the work zone was 2.1 mph. When comparing the growth rates of traffic (1.6%) and work zone related accidents (1.2%) on Pennsylvania's roadways, work zone related accidents have decreased by 0.4 percent. Both contractor and public perception express ineffectiveness in the ability of the Act 229 signs to reduce speeding and increase safety within work zones.

## 3. Background

In December 2002, the Pennsylvania Legislature adopted Act 229. The act was intended to improve highway safety in highway work zones by requiring drivers to illuminate their vehicles' headlights; and by delineating



W21-19

those active work zones where motorists are exposed to increased penalties for moving violations due to the presence of workers. The signs and light were intended to supplement work zone traffic control devices already required by Title 67.

The Department began installing these traffic control devices in June 2003. This evaluation was conducted to determine if the traffic control devices reduce speeds and increase safety in active work zones. To test this hypothesis, PennDOT conducted data collection, field observations and analysis of the before situation (no Act 229 signing erected) and the after situation (Act 229 signing erected).

When the Act was adopted, it was recognized that in certain situations installing these traffic control devices would be difficult and other times it would be counterproductive from a safety and operational perspective. Current requirements of these signs are outlined in *Publication 212: Official Traffic Control Devices section 212.419. Special controls in work zones* and *Publication 213: Work Zone Traffic Control Guidelines*

#### Publication 212.419.a (General)

Special signing required in 75 Pa.C.S. 3326, 3365, 4309, 6123 and 6123.1 will be in addition to the traffic-control devices required by the MUTCD and shall be installed in accordance with this section.

#### Publication 212.419.b (Application)

Signing under this section is discretionary in the following work zones:

- ✓ Short duration work, where the operation will be completed in 1 hour.
- ✓ Mobile operations, where the work moves intermittently or continuously.
- ✓ Stationary work where the daily duration of the construction, maintenance or utility operation is less than 12 hours and all traffic-control devices are removed from the highway at the completion of the daily operation, including all advance warning signs.
- ✓ Work along highways other than expressways or freeways where the normal speed limit is 45 miles per hour or less.

Publication 212.419.c (Work Zone – Turn on Headlights Sign (R22-1))

The Work Zone – Turn on Headlights Sign (R22-1) shall be erected as the first sign on each primary approach to the work zone, generally a distance of 250 to 1000 feet prior to the first warning sign. On high-speed approaches including all expressways and freeways, the larger advance distances should be used. If work begins at or near the border of the Commonwealth, the R22-1 signs should be installed within the Commonwealth.



Arterial installation of the R22-1

Publication 212.419.d (Active Work Zone When Flashing (W21-19))

The Active Work Zone When Flashing (W21-19) shall be erected as close as practical to the beginning of the active work zone.

- ✓ The sign should not be erected within a transition or at a location where workers are put at risk when they may need to turn the light on and off.
- ✓ When a construction, maintenance or utility project has more than one active work zone and the active work zones are separated by a distance of more than 1 mile, signs for each active work zone shall be erected.



Arterial installation of the W21-19

- ✓ The W21-19 signs shall be installed on temporary sign posts on Type III barricades, and a white Type B high-intensity flashing light must be attached to the upper portion of each W21-19 sign. The light shall be activated only when workers are present, and deactivated when workers are not anticipated during the next 60 minutes.



W21-20

Publication 212.419.e (End Active Work Zone Sign (W21-20))

The End Active Work Zone Sign (W21-20) shall be erected immediately at the end of each active work zone, except this sign is not needed if either the End Road Work Sign (G20-2a) or End Work Area Sign (G20-3) is installed at the end of the active work zone.

Publication 212.419.f (Work zones on expressways of freeways)

When work is on an expressway or freeway, appropriate signs and lights identified in subsections (c), (d) and (e) at on-ramp approaches shall be installed.

Publication 212.419.g (Portable changeable message sign)

A portable changeable message sign (PCMS) may be used in lieu of the R22-1, W21-19 or W21-20 signs.

Publication 212.419.h (Speed display sign)

In Interstate highway work zones with a project cost exceeding \$300,000, a speed display sign shall be installed on each mainline approach to the work zone to inform motorists of their speed.

- ✓ The speed display sign must display the motorist's speed in miles per hour in numerals at least 18 inches in height.
- ✓ As an alternative, a portable changeable message sign (PCMS) may be equipped with radar and programmed to display vehicle speeds.
- ✓ PCMSs may also flash appropriate messages such as "YOU ARE SPEEDING" or "SLOW DOWN." The signs shall be placed ½ to 1 mile in advance of the physical work zone.

## 4. Approach

Since a flashing white light does not conform to the Federal Highway Administration's Manual on Uniform Traffic Control Devices (MUTCD), the Department was required to obtain "Permission to Experiment" from the Federal Highway Administration, which was granted on July 14, 2003. Permission to Experiment requires that the Department perform a study to determine the effects of the device on traffic operations and safety. Five measures of effectiveness (MOEs) were used for this evaluation:

- ✓ Speed,
- ✓ Compliance,
- ✓ Contractor perception,
- ✓ Work zone crash data,
- ✓ Driver perception.

Work zone crash data from 1997 to 2004 was obtained and examined to determine if there was a measurable difference in work zone crashes after the use of Act 229 signs had been instituted. 9 locations distributed within the Commonwealth were selected to evaluate the before and after situations. The test locations were chosen from PennDOT Districts 2-0, 3-0, 4-0, 11-0 and 12-0. Among the test sites, three types of roadways were evaluated:

- ✓ Urban freeway
- ✓ Rural freeway
- ✓ Major arterial

### 4.3. *Speed*

In each case, the before situation was evaluated using automatic traffic recorders placed in the traffic lanes for a 24-hour period at two locations:

- ✓ at least 100 feet prior to any work zone signing approaching the work zone,
- ✓ within the limits of the work zone.

These recordings were taken after other signing associated with Publication 203 was erected but before signing specified in Act 229 was erected. The data collected measured the quantity and classification of vehicles that entered the work zone during the study as well as the 85<sup>th</sup> percentile speed.

After the signing associated with Act 229 was correctly installed for three weeks, the automated traffic recorders were redeployed at the same locations as the before situation and the quantity, classification and 85<sup>th</sup> percentile speed of vehicles were recorded. A comparison of the before and after situation was drawn to determine if the signs associated with Act 229 were effective in reducing speeds in a work zone.



Nu-metrics Automated Traffic Recorder

#### *4.4. Compliance*

During the after situation, observers counted the number of vehicles that had headlights turned on at least 1000 feet prior to any work zone signing and the number of vehicles that had headlights turned on after passing the R22-1 sign. Using this procedure minimized the affect that daytime running lights had on the overall consistency of the study. A comparison was drawn between the two data sets to determine if the R22-1 sign is effective.

Headlight usage was observed for a three hour time period during one peak period while the automated traffic recording devices were in place. Turning movement counters were used to count the number of vehicles with headlights illuminated prior to the work zone and in within the work zone after the W21-19 sign. At no time did these observations impact traffic flow or contractor operations.

---

#### 4.5. Contractor Perception

During the field observations, contractors from the sites selected were surveyed to gauge their opinion of the effectiveness of the signs associated with Act 229. The results of the survey were tabulated and any trends identified. Below are the survey questions that were asked of contractors from the selected sites.

*PennDOT is conducting a research study to determine if the signs associated with Act 229 are effective. I would appreciate a few minutes of your time and your response to the following questions.*

1. How much time is involved in erecting the R22-1, W21-19 and W21-20 signs?
2. How much does erecting the R22-1, W21-19 and W21-20 signs cost?
3. How are the white lights on the W21-19 signs activated?
4. Do you ever receive comments regarding the intensity of the white light?
5. Do you ever receive calls or complaints if the light is on and active work is not apparent to the motorist?
6. How do you determine if the work zone is active?
7. What is your opinion of the effectiveness of the signing associated with Act 229?
8. Do you have any suggestions for improving the signing associated with Act 229?

#### Work Zone Crash Data

Crash data was collected in work zones. An evaluation of crash quantities, types, location and severity was conducted to determine if any improvement was realized that may be attributable to the signing associated with Act 229.

#### 4.6. *Motorist Perception*

The Department also conducted a survey of motorists at driver service centers throughout the commonwealth. The following questions were asked and the survey was available from August 24, 2006 through October 31, 2006.

1. Are you a resident of Pennsylvania?
2. In what county do you reside?
3. Do you possess a valid Pennsylvania driver's license?
4. Compared to moving violation fines elsewhere on Pennsylvania roads, fines for moving violations in Active Work Zones with posted warning signs are, (5 choices).
5. When traveling through Work Zones (Active and Inactive) with posted warning signs, Pennsylvania state law requires that, (5 choices).
6. Concerning travel through an Active Work Zone with posted warning signs, Pennsylvania state law requires suspension of a driver's license if convicted of, (5 choices).
7. According to Pennsylvania state law, a motorist can be cited for traveling 1 mph or more over the posted speed limit of an Active Work Zone with posted warning signs?
8. PennDOT Active Work Zone warning signs are easy to understand.
9. Most motorists obey Active Work Zone warning signs.
10. Active Work Zone warning signs would be more effective if penalties for violations were increased.
11. Please provide any comments about Pennsylvania's Work Zone traffic regulations.

## 5. Locations Evaluated

Within the Commonwealth of Pennsylvania, 9 locations were selected to evaluate the effectiveness of the W21-19, W21-20, and R22-1 signs. Originally all roadway facility types were to be evaluated, but after closer examination, two-lane facilities with work zones would force traffic to stop nullifying free-flow speed measurements. The three facility types examined in this study were major arterials, rural freeways, and urban freeways. The 9 locations selected were:

Evaluation Site	PennDOT District	County	AADT	Facility Type	Before Situation Evaluation Date	After Situation Evaluation Date
S.R. 0322 Section N02	2-0	Centre	11,354	Major Arterial	5/9/2006	7/18/2006
S.R. 0006 Section 98M	3-0	Tioga	4,970	Major Arterial	5/31/2006	6/14/2006
S.R. 0081 Section SPI	4-0	Susquehanna	15,182	Rural Freeway	5/31/2006	6/5/2006
S.R. 0079 Section A12	11-0	Allegheny	44,190	Urban Freeway	4/25/2006	5/16/2006
S.R. 0022 Section B08	12-0	Westmoreland	9,523	Rural Freeway	9/13/2006	10/5/2006
S.R. 0051 Section 22R	12-0	Westmoreland	11,460	Major Arterial	6/21/2006	8/3/2006
S.R. 0051 Section B31	11-0	Beaver	5,135	Major Arterial	6/20/2006	8/2/2006
S.R. 0051 Section A58	11-0	Allegheny	13,079	Major Arterial	8/16/2006	10/4/2006
S.R. 0885 Section A28	11-0	Allegheny	20,376	Major Arterial	8/16/2006	10/3/2006

## 6. Results

Five measures of effectiveness were used to determine if signs associated with Act 229 provide a benefit. Motorist 85<sup>th</sup> percentile speed, headlight compliance, and crash data were the primary analysis tools. Contractor and driver perceptions were also examined to gauge the perception of Act 229 signing.

### 6.1. Speed Comparison

Motorist speeds were broken down into two situations, a before and after situation. Within each situation, motorist's speeds were recorded before and inside the work zone. In the table below are the recorded speed values of each evaluation site for the before situation.

Site Evaluated	Speed Before Work Zone (mph)	Speed Inside Work Zone (mph)
S.R. 0322 Section N02	59	47
S.R. 0006 Section 98M	48	54
S.R. 0081 Section SPI	73	57
S.R. 0079 Section A12	69	64
S.R. 0022 Section B08	60	57
S.R. 0051 Section 22R	66	54
S.R. 0051 Section B31	49	50
S.R. 0051 Section A58	60	59
S.R. 0885 Section A28	48	54

As illustrated in the table above, in 3 of the 9 work zones evaluated motorist's 85<sup>th</sup> percentile speed in the work zone increased by an average of 4.3 mph. In 6 of the 9 work zones examined, motorist's 85<sup>th</sup> percentile speed was reduced by an average of 8.2 mph.

In the table below are the recorded speed values of each evaluation site for the after situation.

Site Evaluated	Speed Before Work Zone (mph)	Speed Inside Work Zone (mph)
S.R. 0322 Section N02	60	43
S.R. 0006 Section 98M	51	52
S.R. 0081 Section SPI	72	58
S.R. 0079 Section A12	72	64
S.R. 0022 Section B08	61	57
S.R. 0051 Section 22R	67	51
S.R. 0051 Section B31	46	54
S.R. 0051 Section A58	56	53
S.R. 0885 Section A28	45	51

As illustrated in the table above, in 3 of the 9 work zones evaluated motorist's 85<sup>th</sup> percentile speed in the work zone increased by an average of 5 mph. In 6 of the 9 work zones examined, motorist's 85<sup>th</sup> percentile speed was reduced by an average of 10.3 mph. All speed and volume data will be included in Appendix A.

When comparing the before and after study results, the W21-19 and W21-20 signs produced a minimal speed reduction through the work zone. The average speed reduction through the work zone was 2.1 mph. A maximum speed reduction of 6 mph occurred at SR. 0051 Section A58. In both the before and after situations, the same evaluation sites produced either a reduction or increase in motorist's 85<sup>th</sup> percentile speed within the work zone. At the following evaluation sites (SR. 0006 Section 98M, SR. 0051 Section B31, and SR. 0085 Section A28) motorist's 85<sup>th</sup> percentile speed increased by an average of 4.7 mph.

### 6.2. Headlight Compliance

Headlight usage was recorded before and inside the work zone to determine the effectiveness of the R22-1 sign. Below is a table that displays the percentage of vehicles that had their headlights on before the work zone and the percentage of vehicles with their headlights on when entering the work zone.

Site Evaluated	% of Vehicles with Headlights on Before Work Zone	% of Vehicles with Headlights on Inside Work Zone	% Increase in Headlight Usage
S.R. 0322 Section N02	61	68	7
S.R. 0006 Section 98M	42	55	13
S.R. 0079 Section A12	21	27	6
S.R. 0022 Section B08	57	83	26
S.R. 0051 Section 22R	44	44	0
S.R. 0051 Section B31	72	81	9
S.R. 0051 Section A58	66	73	7
S.R. 0885 Section A28	71	76	5

As illustrated in the chart above, the average increase of vehicles with headlights on entering the work zone was 8.1 percent. The majority of motorists had their headlights on prior to entering the work zone.

### 6.3. *Work Zone Crash Data*

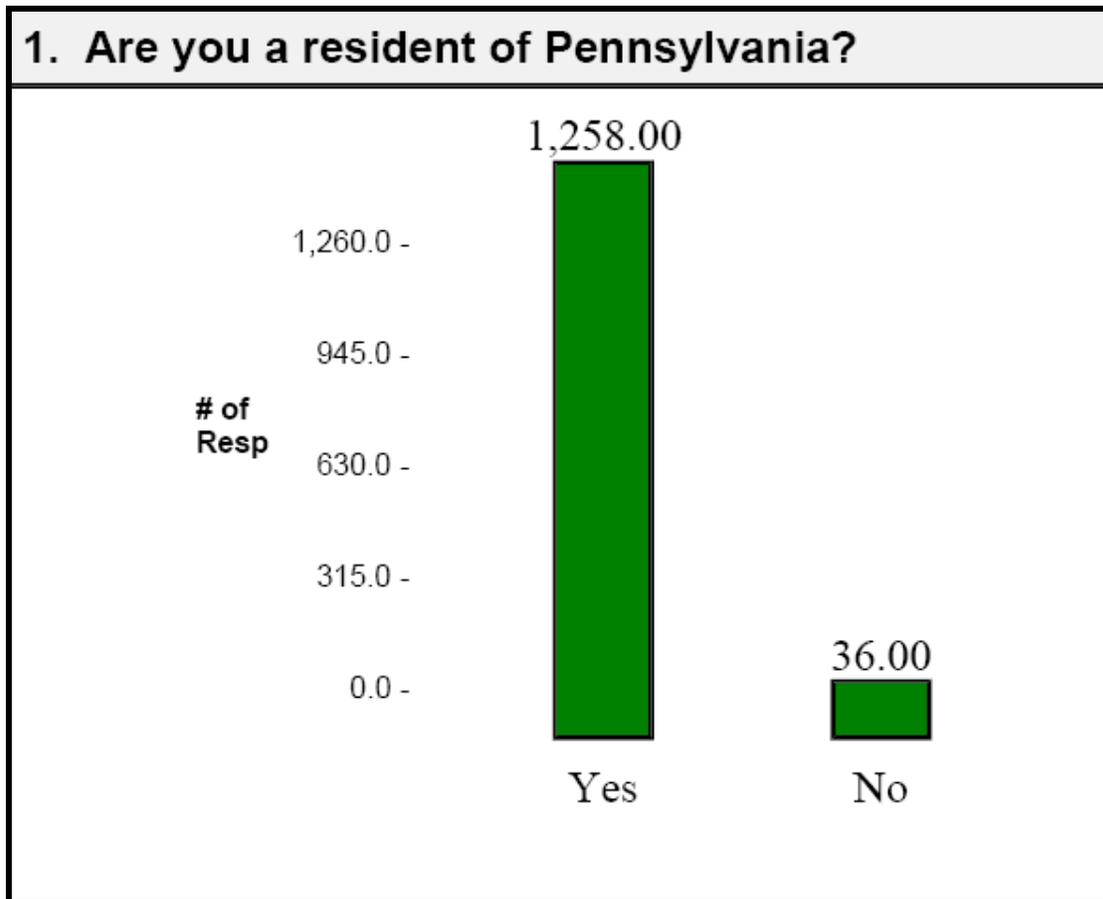
Work zone crash data was provided by PennDOT from 1997-2005, with the exception of 2002. The data was broken down into two periods, before implementation of Act 229 and after. Each analysis period was 19 months; the first analysis period was from November 1, 2000 – June 1, 2003 and the remaining period was from June 1, 2003 – December 31, 2004. Below is a summary of the work zone crash data.

<b>Work Zone Crash Summary</b>		
<b>November 1, 2000 – June 1, 2003 (with exception of 2002)</b>	<b>June 1, 2003 – December 31, 2004</b>	<b>Growth Rate %</b>
85,295 VMT (millions)	88,124 VMT (millions)	1.6
4,339 Crashes	4,445 Crashes	1.2

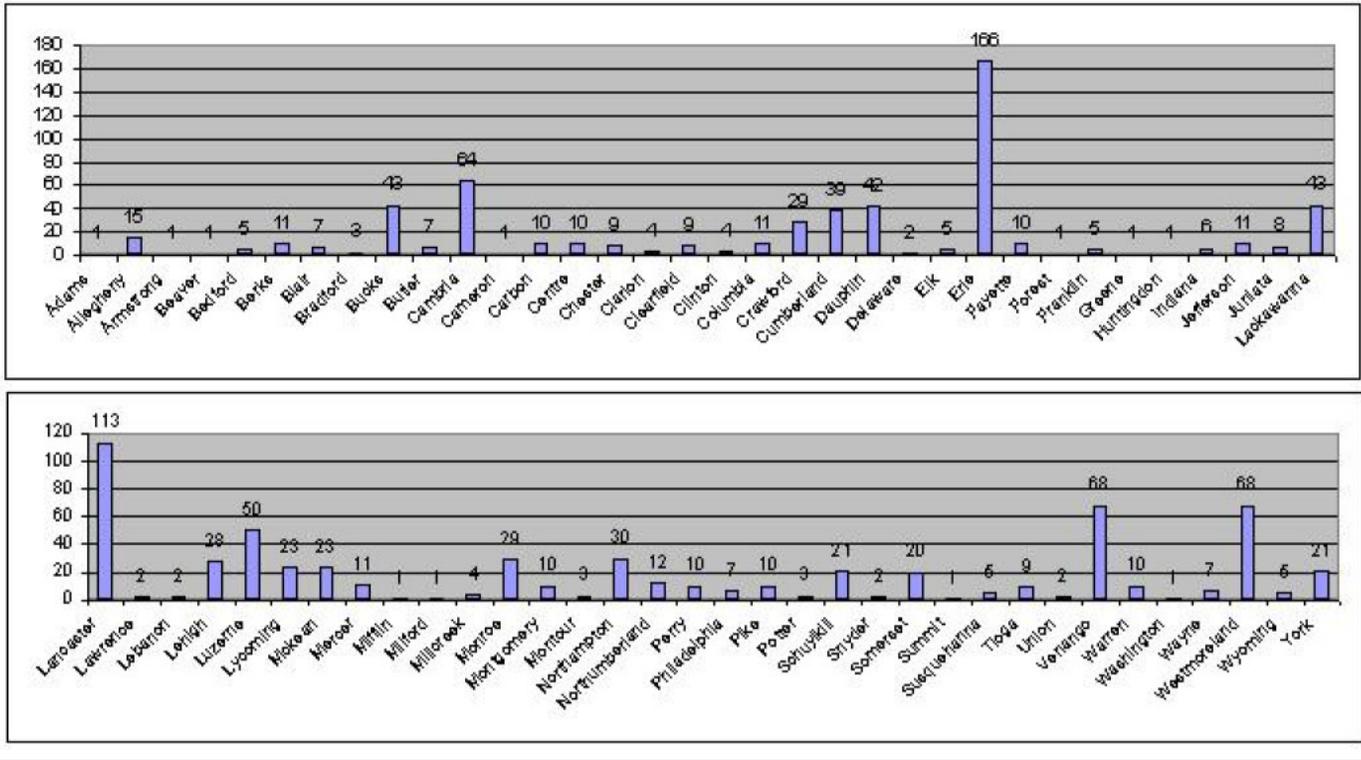
As the table above indicates, crashes have increased at a lower rate than the volume of traffic on the Commonwealth of Pennsylvania roadways. However, for this analysis the total number and length of work zones was not known for either time period, and thus not considered.

#### 6.4. Driver Survey

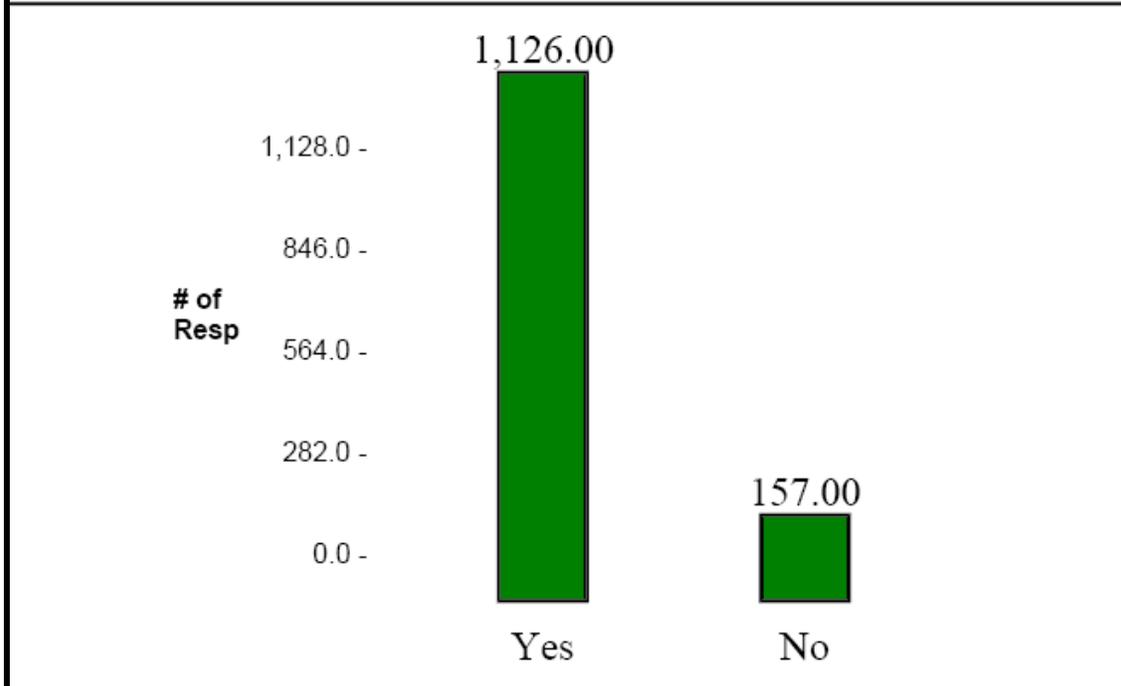
PennDOT created a work zone traffic survey to acquire the public's general knowledge of work zone regulations and if they had any comments on the Commonwealth's active work zone traffic regulations. The survey was conducted from Aug 24, 2006 until Oct 31, 2006. Below are the questions and results of PennDOT's driver survey along with the public's most frequent comments.



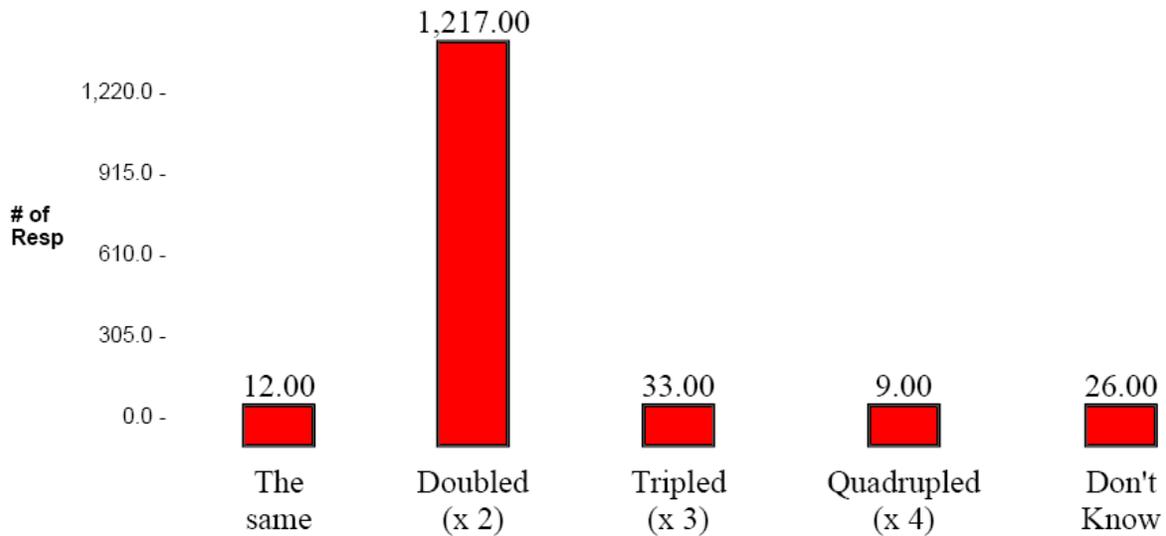
### 2. In what county do you reside?



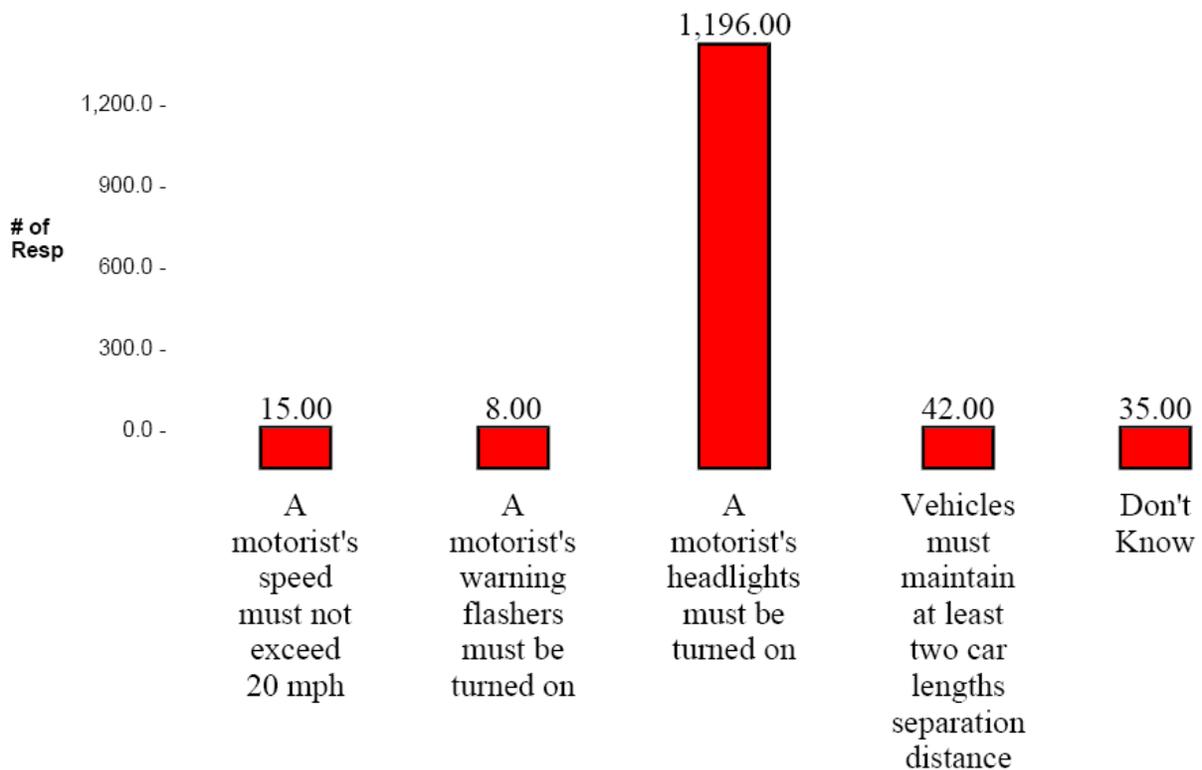
### 3. Do you possess a valid Pennsylvania driver's license?



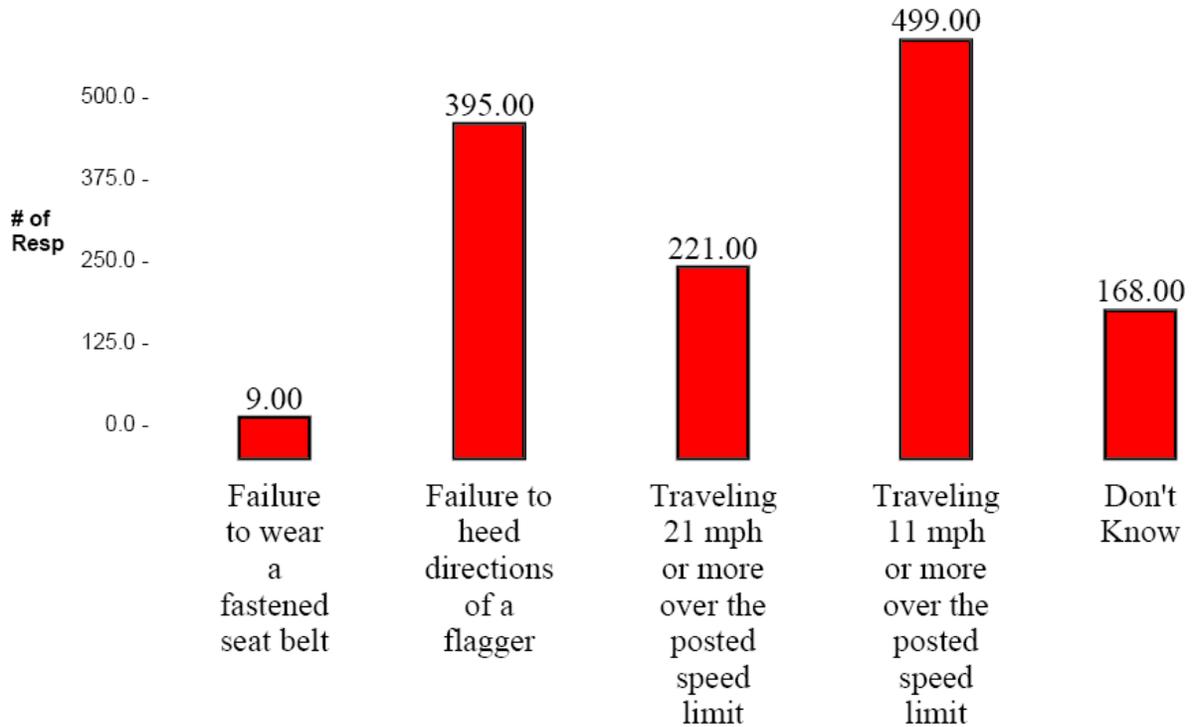
**4. Compared to moving violation fines elsewhere on Pennsylvania roads, fines for moving violations in Active Work Zones with posted warning signs are:**



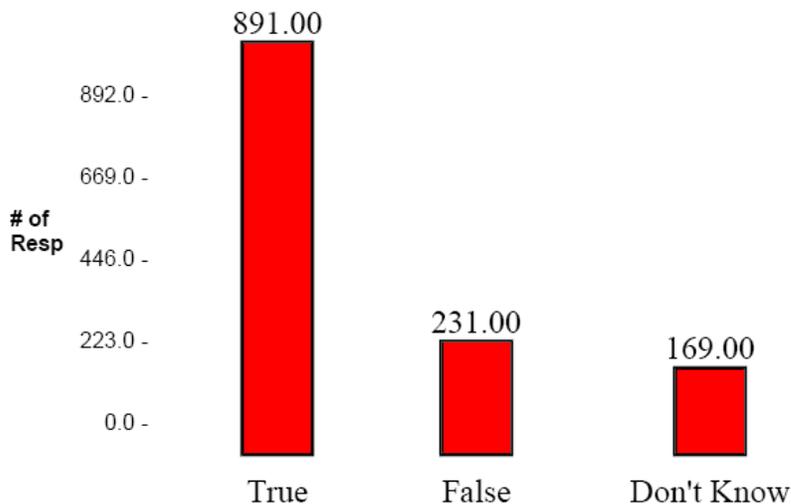
**5. When traveling through Work Zones (Active and Inactive) with posted warning signs, Pennsylvania state law requires that:**



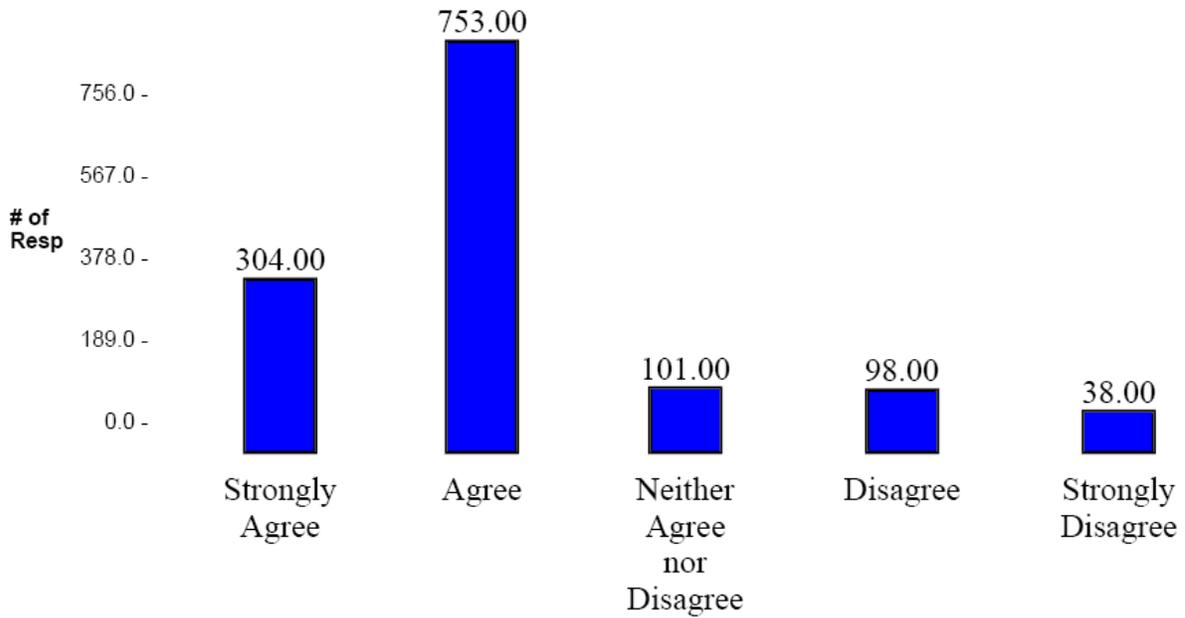
**6. Concerning travel through an Active Work Zone with posted warning signs, Pennsylvania state law requires suspension of a driver's license if convicted of:**



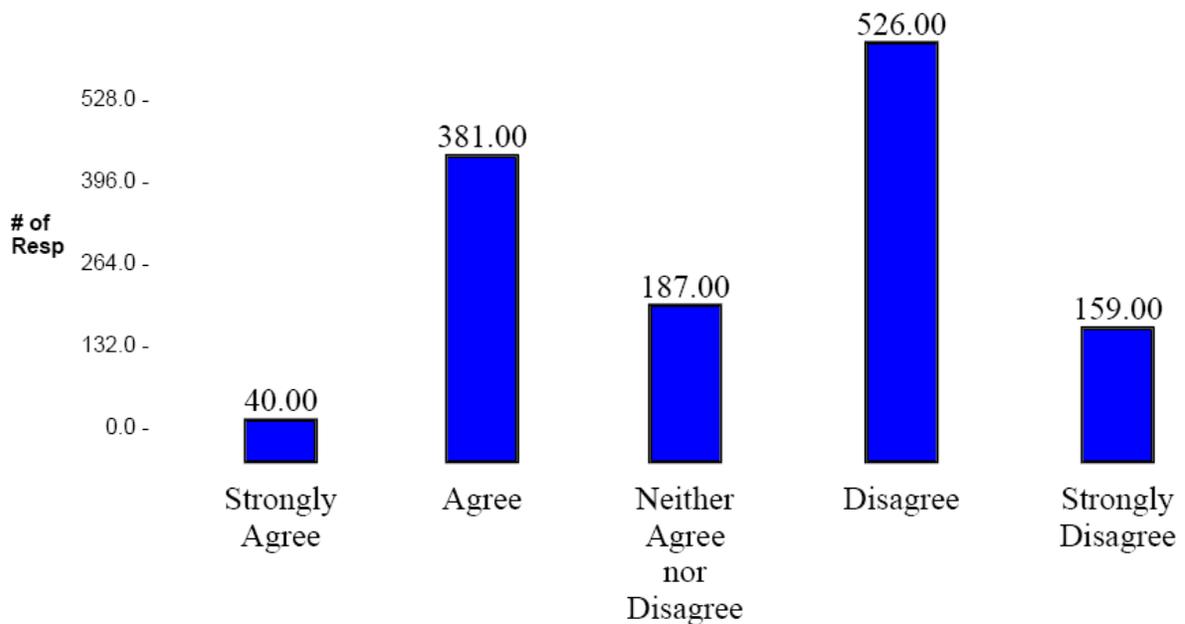
**7. According to Pennsylvania state law, a motorist can be cited for traveling 1 mph or more over the posted speed limit of an Active Work Zone with posted warning signs.**



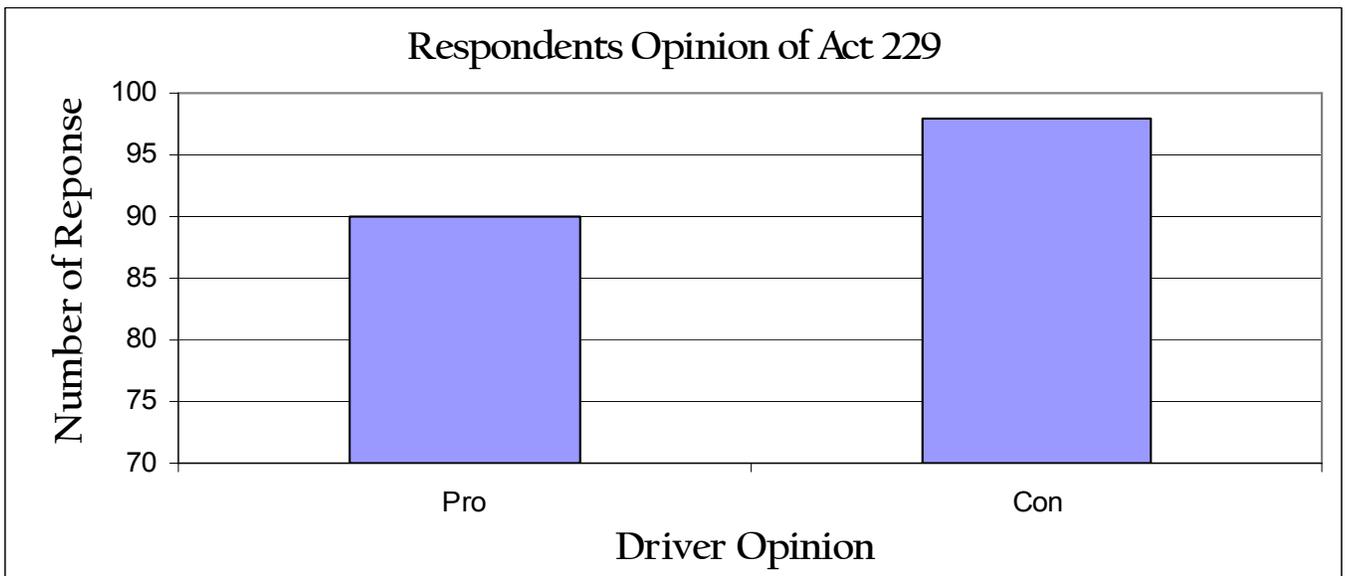
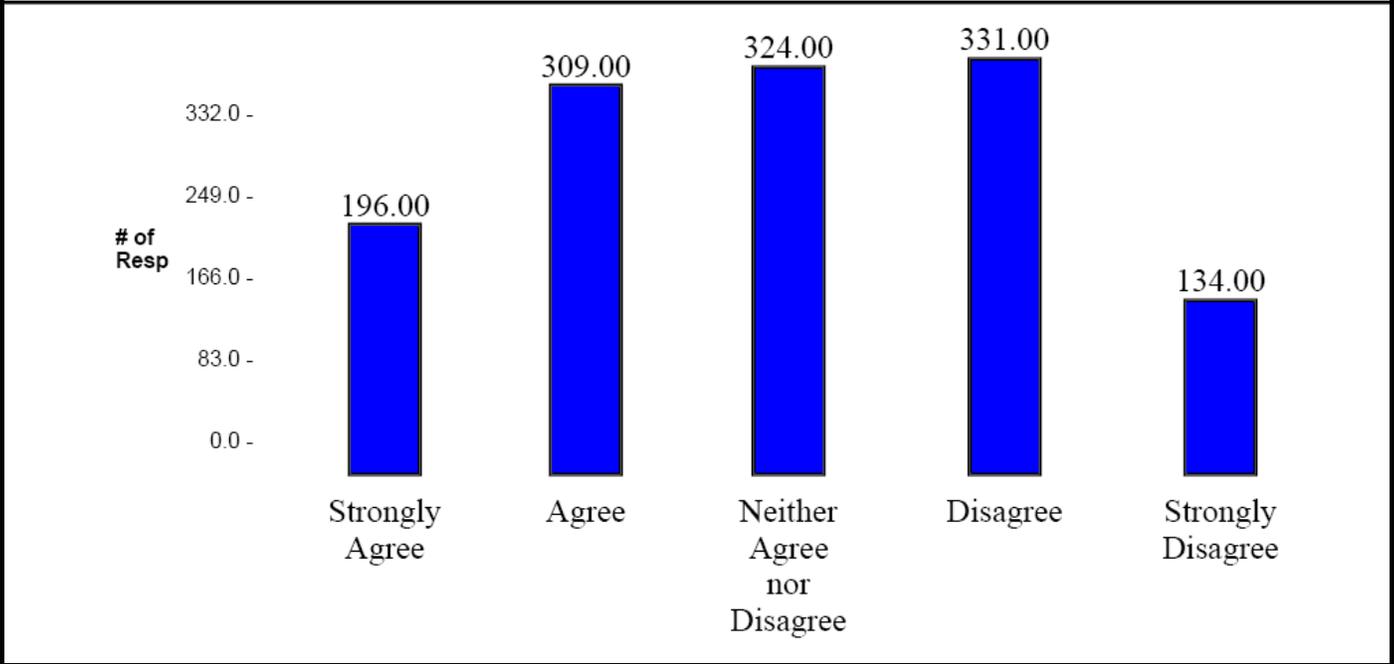
**8. PennDOT Active Work Zone warning signs are easy to understand.**



**9. Most motorists obey Active Work Zone warning signs.**



**10. Active Work Zone warning signs would be more effective if penalties for violations were increased.**



A number of comments/suggestions appeared repeatedly throughout the survey, listed below is a list of those comments.

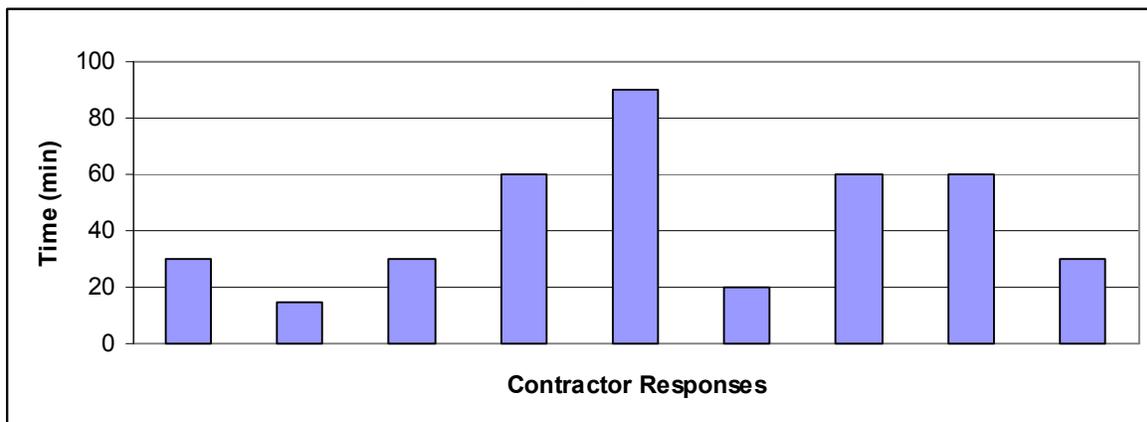
- ✓ Police enforcement was most requested by public
- ✓ Shorter construction zone lengths, if no work is being done at a location then there should not be a lane reduction there
- ✓ Cover W21-19, W21-20, and R22-1 signs if no work is being done
- ✓ Remove W21-19, W21-20, and R22-1 signs if no work is being done
- ✓ Improve visibility of flashing white light
- ✓ Public wants consistent use of Act 229 signs, if workers are no longer present in work zone then flashing beacon should be turned off

All of the public's comments from the PennDOT driver survey will be included in Appendix B.

### 6.5. Contractor Interviews

During the field observations, contractors from the sites selected were surveyed to gauge their opinion of the effectiveness of the signs associated with Act 229. The results of the survey were tabulated and any trends identified. Below are the results from the contractor survey.

How much time is involved in erecting the R22-1, W21-19, and W21-20 signs?



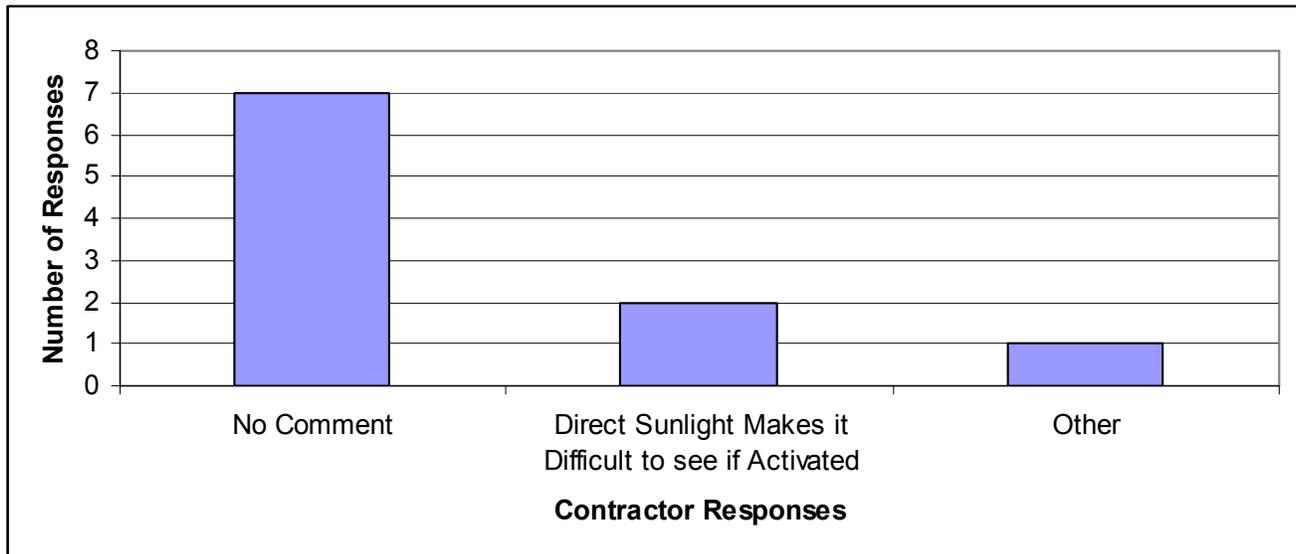
How much does erecting the R22-1, W21-19 and W21-20 signs cost?

- ✓ Lump Sum
- ✓ Included in project
- ✓ Two laborers and pick up truck
- ✓ \$21.56/hr
- ✓ \$11/day
- ✓ Labor - \$36/hr
- ✓ Three laborers - \$75/hr
- ✓ \$100/day

How are the white lights on the W21-19 signs activated?

- ✓ Manually

Do you ever receive comments regarding the intensity of the white light?



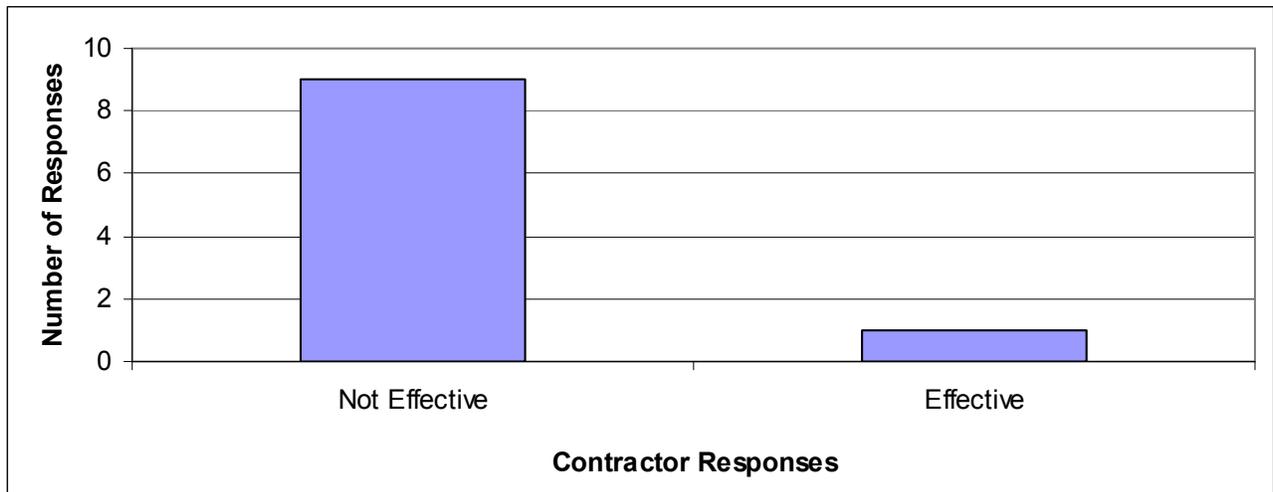
Do you ever receive calls or complaints if the light is on and active work is not apparent to the motorist?

- ✓ No complaints

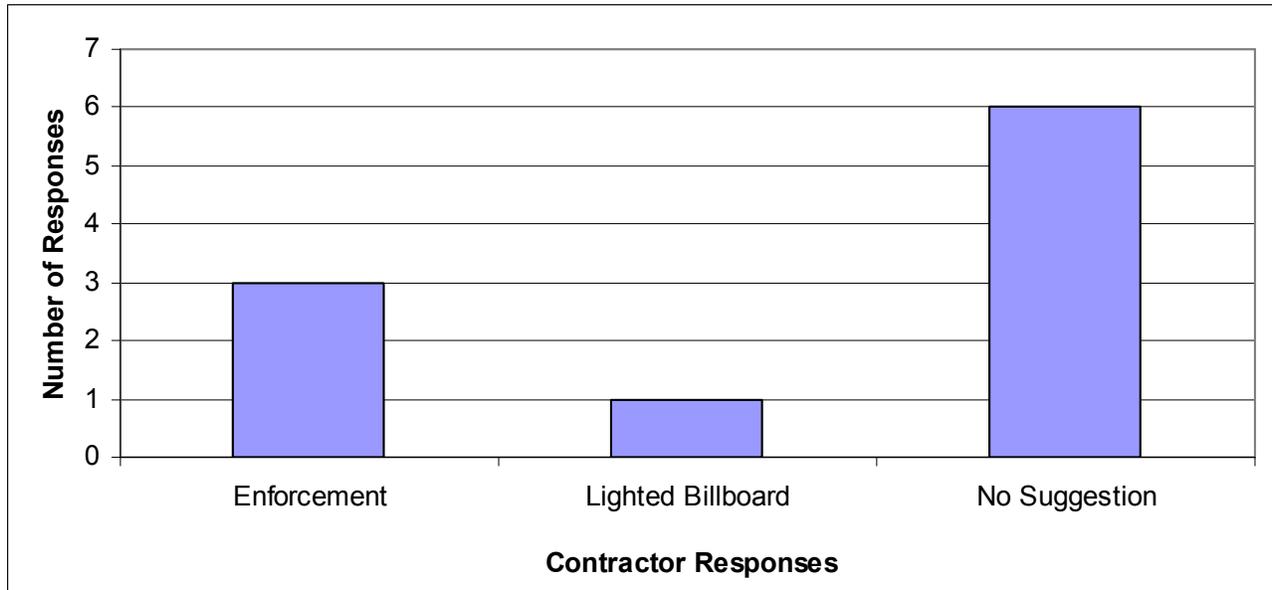
How do you determine if the work zone is active?



What is your opinion of the effectiveness of the signing associated with Act 229?



Do you have any suggestions for improving the signing associated with Act 229?



In summary, the majority of the public and contractors feel that Act 229 signs are ineffective. A number of respondents from the public survey suggested that several changes should be implemented to Act 229. Some of the suggestions were to improve visibility of the flashing white light and if workers are no longer present in the work zone then the flashing beacon should be turned off. Both suggested that police enforcement was most effective in deterring work zone speeding. The contractor surveys will be included in Appendix C.



## 7. Conclusion

After analyzing the five measures of effectiveness it appears that Act 229 has had a minimal impact on motorist speed and safety. Speed was reduced by an average of 2.1 mph when Act 229 signs were erected, but this minute reduction in speed could be attributable to a small fluctuation in traffic volumes associated with the before and after situations. Statistically, this number is insignificant when examining the existing free flow speeds. Since Act 229 was implemented, the number of crashes on Pennsylvania roadways has increased at a lower rate than that of the volume. After examining both motorist and contractor opinions, it appears that both feel the signs are ineffective in deterring speeding and increasing driver awareness of workers presence in active work zones.