An Evaluation of the Effectiveness of Digital Speed Limit Signs and Work Zone Presence Lighting on Speed Compliance During Lane Closure Operations

INTERIM REPORT

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Introduction

The Work Zone Traffic Control Section is collecting speed data on 6 random Interstate/Freeway projects across the state that are using both Digital Speed Limit Signs and Work Zone Presence Lights during nightly lane closures.

Our desire is to understand the impact these devices have on driver speeds approaching the lane closure and we believe the collected speed data will measure their influence on speed compliance.

This interim report contains the collected speed data on two projects, measuring the influence on driver speeds with Digital Speed Limit Signs alone and when Work Zone Presence Lights are used in conjunction with the Digital Speed Limit Signs.

We will continue data collection on the other projects when paving operations resume in Spring/Summer 2020.

Project Information

The first project selected is on I-95 in Robeson/Cumberland Counties between Mile Marker 30 and Mile Marker 38.5. This is a rural 4 lane Interstate with an average daily traffic (ADT) volume ranging between 50,000 and 55,000 vehicles per day. All the work is conducted at night during lane closures. The existing speed limit is 65 MPH and the reduced work zone speed limit is 55 MPH. The speed data was collected between October 8th and October 24th.

The second project selected was on US-264 in Pitt/Greene Counties between Mile Marker 63 and Mile Marker 71. This is a rural 4 lane Freeway with an ADT volume ranging between 20,000 and 25,000 vehicles per day. All the work is conducted at night using lane closures. The existing speed limit is 70 MPH and the reduced work zone speed limit is 60 MPH. The speed data was collected between October 30th and November 17th.

Data Collection Methodology and Test Conditions

Each project had 3 test conditions in which to collect the speed data. The speed data was collected using two speed sensors in the advance warning area between ½ mile downstream from the changeable message sign and the merge area. Sensor #1 was placed near/beside the 1st Lane Closure Sign (Right Lane Closed Ahead) and Sensor #2 was placed near/beside the last Lane Closure Sign (Right Lane Closed). Speed data was collected for each condition for 3 nights.

The 3 test conditions are as follows:

1) Install Lane Closures with portable speed limit signs only for the Work Zone Speed Limit Reduction. No Digital Speed Limit Signs or Work Zone Presence Lights were used for this test condition. This data is used for the baseline speeds in the Advance Warning Area.
2) Install Lane Closures with Digital Speed Limit Signs only. No Work Zone Presence Lights were used in Condition #2. The speed information determines the influence on driver speeds with the use of Digital Speed Limit Signs only.

3) Install Lane Closures with Digital Speed Limit Signs AND with Work Zone Presence Lights. The speed information determines the influence on driver speeds with the use of both Digital Speed Limit signs and Work Zone Presence Lights.

Test Condition Set Up

The lane closures were installed per our NCDOT Roadway Standard Drawings, except for the addition of the Digital Speed Limit Signs and Work Zone Presence Lights. See detail drawing on the last page of this report for a depiction of the Digital Speed Limit Sign and Work Zone Presence Lights installation and layout in relation to the active work area.

For Condition #1, portable speed limit signs were used to display the reduced work zone speed limit instead of the Digital Speed Limit Signs. No Work Zone Presence Lights were used for this data collection period.

For Condition #2, two Digital Speed Limit Signs were placed approximately 2,000' in advance of the merge taper. They were placed on both the median and outside shoulders. The reduced work zone speed limit was displayed on the signs and the flashing beacons were active during lane closure operations. The speed limit returned to the existing posted speed limit at the end of the work night. No Work Zone Presence Lights were used for this data collection period.

For Condition #3, both Work Zone Presence Lights and Digital Speed Limit Signs were installed with the lane closure. The Work Zone Presence Lights began halfway between the changeable message sign and the first lane closure sign, identified as Area #1. The Lights continue through subsequent lane closure signs, identified as Area #2, and spaced closer together than in Area #1. See detail drawing for a depiction of Condition #3 with the Digital Speed Limit Signs and Work Zone Presence Lights installed.

The spacing between each light is dependent on the amount of light emitted and surface area of the light fixture.

Data Collection

Although the data collection process was directed to be collected progressively from Condition #1 (No Digital Speed Limit Signs or Work Zone Presence Lights) to Condition #2 (Digital Speed Limit Signs only) to Condition #3 (Digital Speed Limit Signs and Work Zone Presence Lights), both of the projects collected the speed data in reverse order, starting with Condition #3 and finishing with Condition #1. Also, though each condition should have 3 nights of data collection, some conditions were collected for less than 3 nights. Hopefully, we can address and improve upon the speed data collection methods in Spring/Summer 2020.

Speed Sensors

The sensors used to collect the speed data were doppler units supplied by Vermac, Inc and were supplied at no cost to the project. These units were used because they are discreet, so as not to affect vehicular speeds, and could store the speed data in the Vermac cloud storage service. This

was more efficient and safer since workers were not required to extract the speed data from the individual sensor units. The reported vehicular speeds are the average speeds of every 3 minutes. In other words, this average is determined taking an average speed every minute for 3 minutes (creating 3 separate speeds) and averaging them to one speed. Individual vehicular speeds were not possible to be captured using these units. During most of the data collection, only 1 sensor was operational.

Results

Project	Route	Posted Speed Limit (MPH)	WZ Speed Limit (MPH)	Avg. Speeds w/o DSLS or Lights (MPH)	Avg. Speeds w/ DSLS only (MPH)	Avg. Speeds w/ DSLS and Lights (MPH)
1	I-95	65	55	62.92	55.63	52.34
2	US-264	70	60	62.22	55.64	54.18
-	Average	N/A	N/A	62.57	55.64	53.26

Findings

Project	Route	Avg. Speed Reduction w/ DSLS only (MPH)	Avg. Speed Reduction w/ DSLS and Lights (MPH)
1	I-95	**9.37**	**12.66**
2	US-264	**14.36**	**15.82**
-	Average	11.87	14.24

Conclusions

Although the research is just under way and continuing, the interim results suggest the motorists are reacting positively to the Digital Speed Limit Signs and Work Zone Presence Lights. To date, the largest overall decrease in speed from the Posted Speed Limit to the Work Zone Speed Limit is realized through the combined use of the Digital Speed Limits and Work Zone Presence Lights. On both projects, the speeds were below the Work Zone Speed Limits displayed on the Digital Speed Limit Signs and resulted in an average 14.24 MPH speed reduction when compared to the Posted Speed Limit. The largest percentage of the speed reduction was achieved with the use of the Digital Speed Limit signs. The average reduction was 11.87 MPH when compared to the Posted Speed Limit.

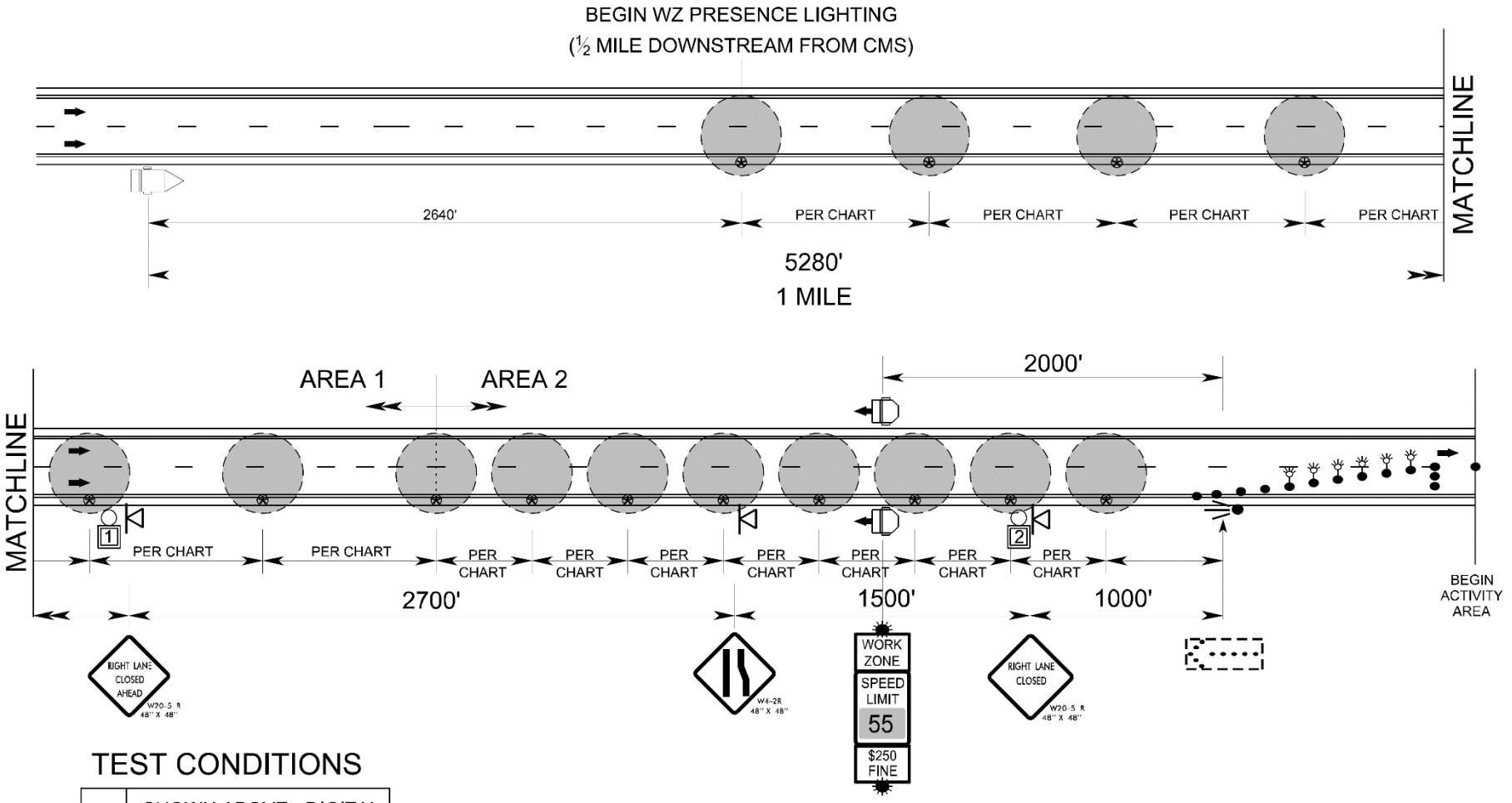
On both projects, where the Digital Speed Limit Signs were used alone and in combination with the Work Presence Lights, the approach speeds measured were at or below the Work Zone Speed Limit.

We cannot know definitively until the research is completed, but it is our belief the visual cues the Digital Speed Limit Signs present along with additional conspicuity the Work Zone Presence Lights provide are having a dramatic influence on driver speeds when approaching the work zone.

The Digital Speed Limit signs alone provided the biggest influence on speed compliance with the work zone speed limit, especially when the flashing beacons were activated. However, we believe the beacons will lose effectiveness if the beacons remain flashing continuously. Therefore, it is important to keep them off when speeds are not reduced.

The preliminary results identified that portable speed limit signs are not as effective in reducing speeds as shown in the table.

Once the remaining speed data is collected for the other 4 projects, we will analyze and provide a final report on the results.



TEST CONDITIONS

3	SHOWN ABOVE - DIGITAL SPEED LIMIT SIGNS AND WZ PRESENCE LIGHTS
2	DIGITAL SPEED LIMIT SIGNS ONLY
1	NO DIGITAL SPEED LIMIT SIGNS OR WZ PRESENCE LIGHTS

PRESENCE LIGHTS SPACING CHART

Light Output	Fixture Area	AREA 1		AREA 2	
(Lumens)	(Minimum)	# of Lights	Spacing*	# of Lights	Spacing*
14K to 35K	4	6	640' (16 skips)	8	480' (12 skips)
35.1K to 60K	5	5	800' (20 skips)	6	640' (16 skips)
60K +	6+	4	1000' (25 skips)	5	800' (20 skips)

*SKIPS REFER TO TRADITIONAL 10' PAVEMENT MARKING LINES WITH 30' GAPS.

AREA 1: BEGINS 2,640' DOWNSTREAM FROM CMS; EXTENDS TO JUST PAST 1ST LANE CLOSURE SIGN

AREA 2: BEGINS AFTER THE 1ST LANE CLOSURE SIGN; EXTENDS TO THE LAST LANE CLOSURE SIGN