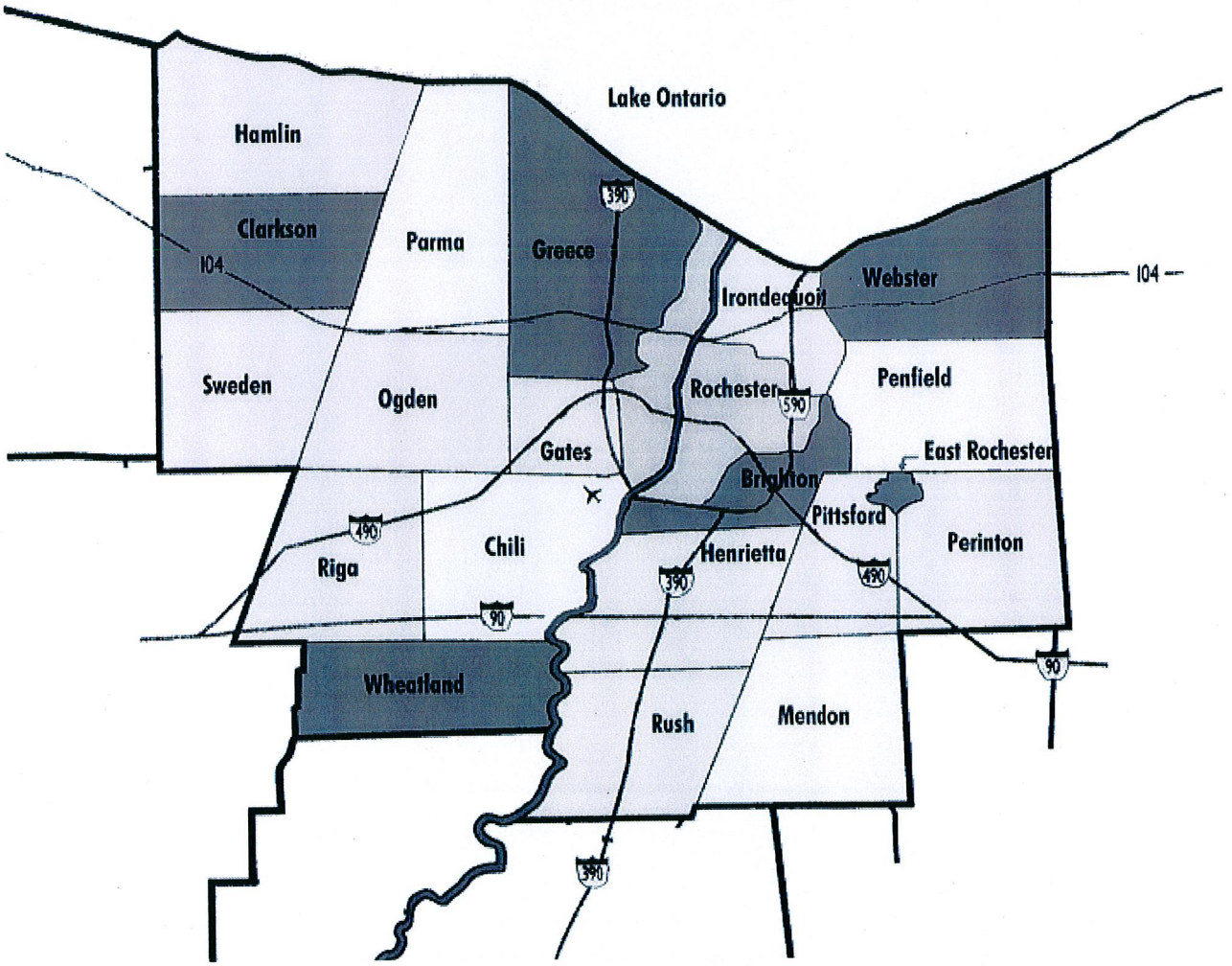
Monroe County Department of Transportation
Horizontal Curve Study

UPWP #6225

Monroe County, New York



January 2013

PREPARED FOR:

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EXECUTIVE SUMMARY

Background

The Monroe County Horizontal Curve Study was initiated by the Monroe County Department of Transportation (MCDOT) to perform ball bank studies on all of the horizontal curves on County roads with existing curve warning signs, and the known horizontal curves on City of Rochester streets. The curves currently have warning signs in place which included horizontal curve warning and/or advisory speed plaque signs. The consultant evaluated the existing traffic control devices in place and made recommendations to the existing signage or for any additional traffic control devices that may be required. These recommendations were made in accordance with the 2009 National Manual of Uniform Traffic Control Devices (NMUTCD) and the current New York State Supplement to the MUTCD.

Recent updates to the NMUTCD made revisions to key sections that directly affect the existing warning signage on the roadways today. These revisions have superseded prior ball banking standards that were developed based on research from the 1930's. In specific, Section 2C.05 Placement of Warning Signs; Section 2C.06 Horizontal Alignment Warning Signs; Section 2C.07 Horizontal Alignment Signs; Section 2C.08 Advisory Speed Plaque and Section 2C.09 Chevron Alignment Signs of the 2009 NMUTCD were revised. The New York State supplement to the NMUTCD replaces Section 2C.07 in its entirety since it changed the majority of that section.

Previously, New York State accepted the standards set forth in the American Association of State Highway and Transportation Officials (AASHTO) green manual entitled "A Policy on Geometric Design of Highways and Streets" for determining safe speeds on horizontal curves. These speeds were established in Section 2C.08 Advisory Speed Plaque of the 2009 NMUTCD. With the acceptance of these new standards, Monroe County retained Hunt Engineers, Architects and Land Surveyors, PC (HUNT) to perform the Horizontal Curve Study via UPWP Project #6225.

Horizontal Curve Analysis

Monroe County provided HUNT a master list of curves for each town in the County as well as in the City of Rochester. Incorporated in this list was a Distance Measuring Instrument (DMI) reading that was used to create maps for each town. Since there was no formal inventory in the City of Rochester there are no DMI readings on those streets. The DMI is a lineal footage reading from the southerly to northerly or westerly to easterly end of the roadway to the curves located on each county road. This map was used in the field to locate each curve and a number was given to the curve to correlate between the field sheets and the individual town maps. Most of the 504 curves were known through the county supplied list. There were a few additional curves that were discovered throughout the study. Refer to county wide map, Figure 1 A for an overview of Monroe County owned and maintained roads. City of Rochester streets are not referenced on this map.

It should be noted that Monroe County owns and maintains all traffic control devices (signs, signals, etc.) on City of Rochester streets, but the City owns and maintains the actual roadways. The County has no formal inventory of signs on City streets and the "known" curves provided by the County for the City streets was based upon a visual review of a City of Rochester map and MCDOT's local knowledge of City streets.

A family type sedan vehicle with an automatic transmission was used to complete the ball banking procedure for each curve. The vehicle type used represents the average vehicle driven on the roadways today. SUV's, trucks and sports cars were not permitted to complete the analysis as these vehicle suspensions were too stiff to accurately collect the ball bank readings. HUNT used a *Reiker RDS-BB-09* electronic Ball Bank Indicator (BBI), connected to a laptop computer to collect the ball bank degree readings as set forth in the 2009 NMUTCD. The BBI takes a reading every 250 milliseconds providing extremely accurate degree readings for the study. The readings were recorded to the nearest hundredth of a degree. The field data was collected during favorable weather conditions and off peak travel times to limit any possible deficiencies in the data collection process.

Once the field technician arrived at a curve location, the data collection process began by taking an inventory of the existing horizontal alignment warning sign, existing advisory speed from the advisory plaque (if there is a plaque) and any chevrons or arrows located within the curve. The technician would then start the actual electronic ball bank collection process by driving the curve at the existing advisory speed (if one exists) to determine what the existing degree of ball banking was in relation to the existing advisory speed. At this point the technician determined if the next speed trial would be an increase in speed, decrease in speed or if the speed would remain the same. If the advisory speed was to increase the technician would increase the vehicle speed by 5 mph to the next advisory speed. (Example, if the existing advisory speed was 35mph the next speed trial would be completed at 40mph.) This increase continued until the degree of ball banking matched with the correct advisory speed as shown below in Table 1. The table shows the degree of ball bank to advisory speed relationship. This same process applied if there was a decrease in speed. Once the advisory speed and the degree of ball bank matched, the technician would complete the analysis two more times at the corrected advisory speed (three total times) to eliminate any possible irregularities in speed trials.

Table 1

Ball Bank Indicator Criteria Per NMUTCD Sec. 2C.08.07
16 Degrees of ball bank for speeds of 20 mph or less
14 Degrees of ball bank for speeds of 25 to 30 mph
12 Degrees of ball bank for speeds of 35 mph or higher

If no advisory speed plaque existed the technician would begin the analysis at the existing posted speed limit. If no advisory speed was necessary, three trials were still completed to insure accuracy. If an advisory speed was required where one did not exist, the technician began at the speed limit, or at the highest possible safe traveling speed. Where it was determined due to safety issues the speed limit was too fast to complete the analysis, the technician would begin the speed trial at a safer speed. For example, if 55 mph was the posted speed limit and the analysis had to be aborted due to safety concerns, the technician began the analysis at 45mph. The vehicle speed was then decreased by 5 mph to establish a new advisory speed. Once again three trials were completed at the new advisory speed to ensure accuracy. All of the data was recorded on a field sheet developed by HUNT specifically for the Horizontal Curve Study. Refer to figure 2 for the field data collection sheet used.

Office Analysis

Once all of the field data collection was completed, the data from the field sheets was entered into a detailed spreadsheet developed by HUNT and Monroe County to analyze the curves. Spreadsheets were created for each town containing information for all curves in that town. The developed spreadsheet includes an MCDOT UNIT ID number. These numbers are identifiers for signs on county roads and again they are not associated with signs on City of Rochester streets. HUNT also created a numbering system that coincides with the UNIT ID number to show a direct link between HUNT and MCDOT curve numbering.

Each town's spreadsheet shows existing warning signage; existing posted speed limit; advisory speed; curve direction; existing chevrons or arrows and BBI reading. It also includes required warning signage and advisory speed per BBI reading. If chevrons or arrows were required as part of the analysis it was conveyed in a column entitled "Chevrons or Arrows required". According the NMUTCD, chevrons or arrows are required (indicated in the manual as "shall") if the difference between the posted speed limit and advisory speed is 15 mph or more, and recommended (indicated in the manual and "should") if the difference is 10 mph or more. However, per NYSDOT interpretation of the NMUTCD a "should" will be a "shall" unless there is a sound engineering reason. Thus, Hunt indicated in the spreadsheet that chevrons or arrows are required for both of these conditions. The spreadsheet also included the date and weather conditions at the time of data collection. A sample of one town's (Town of Hamlin) spreadsheet with recommendations is attached to this summary.

Conclusion

Many of the current warning signs (especially the advisory speed plaques) are out of date with regard to current standards when the horizontal curves are driven due to indicated speeds that are slower than the vehicles of today can safely negotiate. It is very important to note that this study and its recommendations do not change the actual speed limit, but just the advisory speed for a particular curve. The new advisory speeds will coincide with advances in automobile and tire technology as well as highway design. Having the correct warning signs and advisory speed plaques will assist the motorist in safely navigating county roads and City streets.

There were 504 curves that were analyzed as part of this study, 343 of them require a change per the new regulations. The remaining 161 locations require no signage revisions however; the county will need to evaluate each location to determine if the current sign locations meet the revised standards. There are a variety of changes that will be required, ranging from removing the advisory speed plaque and relocating the sign, to requiring a full sign replacement, including chevron installation. Regardless of the required changes, the outcome will be a much safer roadway network designed for today's vehicles.

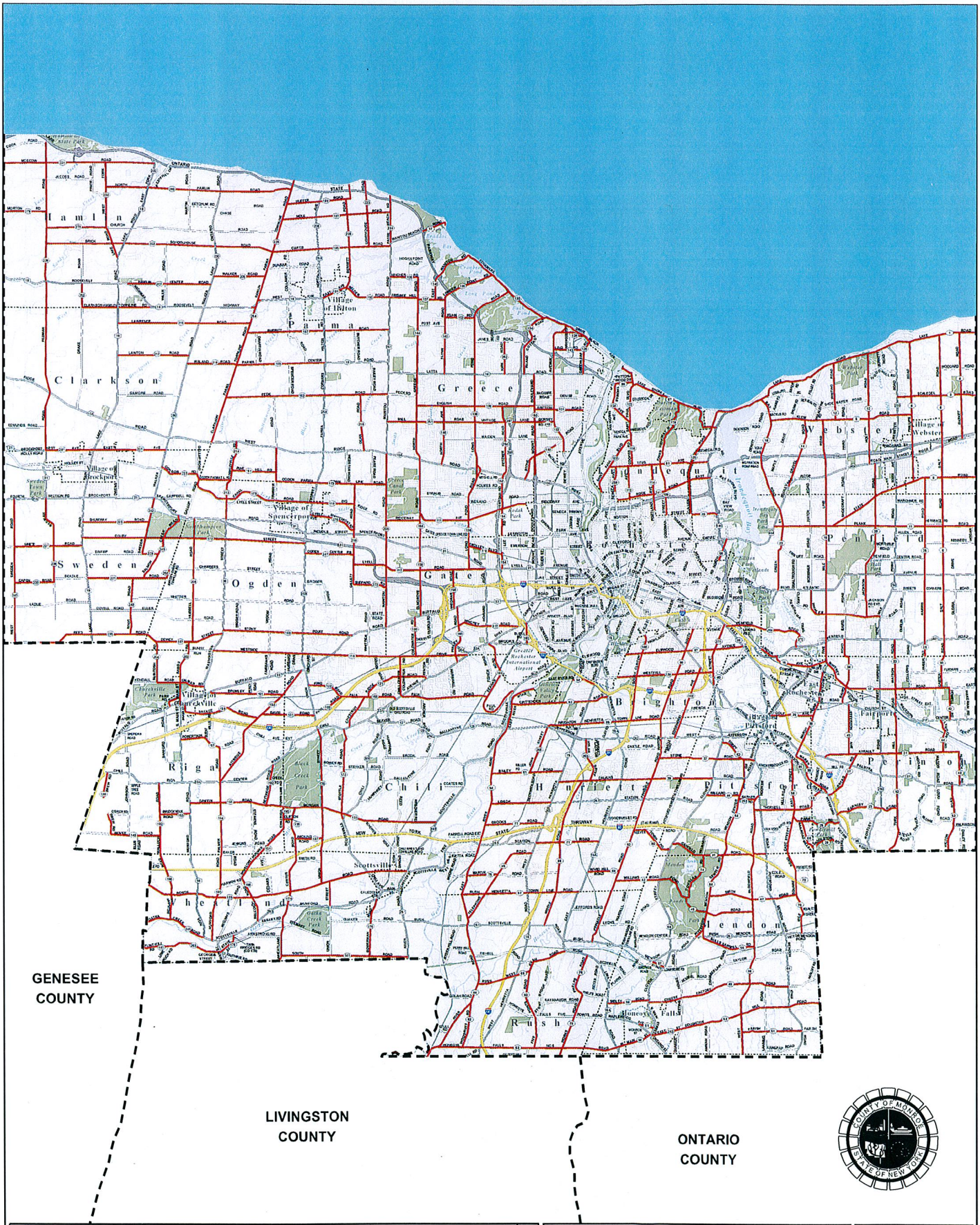

FIGURE 1A

MONROE COUNTY DOT
HORIZONTAL CURVE STUDY

MONROE COUNTY, NEW YORK

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1A

DATE : 1-15-13

PROJECT NO: 2590.005

FIG 2

Driver's Initials: _____ Page ___ of ___

HUNT

Date: _____

Town or Village: _____ Curve Number: _____

Road Name: _____ Cross Street: _____

Weather: Sunny Cloudy Overcast Road Conditions: Dry Mostly Dry

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Direction of Curve: Right Left Traveling: North South East West

Tangent Speed Posted: 20 25 30 35 40 45 50 55

Posted Advisory Speed: 15 20 25 30 35 40 45 50

Existing Signage:

MUTCD #: W1-8 W1-6 W1-5 W1-3 W1-4 W1-2 W1-1 W13-1P

Trial #1:

Travel Speed: Travel at Advisory Speed: _____

Maximum Ball Bank Indicator Readings: Right: + _____ Left: – _____

Trial #2:

Advisory Speed: 10 15 20 25 30 35 40 45 50 55

Maximum Ball Bank Indicator Readings: Right: + _____ Left: – _____

Trial #3:

Advisory Speed: 10 15 20 25 30 35 40 45 50 55

Maximum Ball Bank Indicator Readings: Right: + _____ Left: – _____

Trial #4:

Advisory Speed: 10 15 20 25 30 35 40 45 50 55

Maximum Ball Bank Indicator Readings: Right: + _____ Left: – _____

Trial #5:

Advisory Speed: 10 15 20 25 30 35 40 45 50 55

Maximum Ball Bank Indicator Readings: Right: + _____ Left: – _____

16 DEGREES for 20 MPH OR LESS
14 DEGREES for 25 TO 30 MPH
12 DEGREES for 35 MPH AND HIGHER

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Town of Hamlin																			
Curve Number		Town	Road Name	Closest Cross Street	Direction of Curve	Tangent Posted Speed	Existing Advisory Curve Speed	Existing NMUTCD Sign	Existing Chevrons	Existing Arrows	BBI Reading	Advisory Speed per BBI Reading	Required NMUTCD Sign	Modify Existing Advisory Plaque	Chevrons or Arrows Required	Changes Required	Remarks	Date	Weather
HUNT	MCDOT																		
HA-1 WB	408	Hamlin	BRICK SCHOOLHOUSE RD	Hamlin-Parma	Left	55	30	W 1-2 L/W 13-1 P	Yes	No	11.76	50	W 1-2 L/W 13-1 P	Yes	No	Yes	Increase Advisory Speed	5/15/2012	Sunny/Dry
HA-1 EB	606	Hamlin	BRICK SCHOOLHOUSE RD	Hamlin-Parma	Right	55	35	W 1-2 R/W13-1 P	Yes	No	9.89	50	W 1-2 R/W 13-1 P	Yes	No	Yes	Increase Advisory Speed	5/15/2012	Sunny/Dry
HA-5 NB	700696	Hamlin	LAKE ROAD-WEST FORK	RT279	Right	40	25	W 1-2 R/W13-1 P	No	No	10.97	35	W 1-2 R/W 13-1 P	Yes	No	Yes	Increase Advisory Speed	5/15/2012	Sunny/Dry
HA-5 SB	700706	Hamlin	LAKE ROAD-WEST FORK	RT279	Left	40	25	W 1-2 L/W 13-1 P	No	No	13.13	30	W 1-1 L/W 13-1 P	Yes	Required	Yes	Place new W 1-1L sign and Increase Advisory Speed	5/15/2012	Sunny/Dry
HA-6 EB	17908	Hamlin	NORTH HAMLIN RD	Hamlin-Parma	Right/Left	40	30	W 1-4 R/ W 13-1 P	No	No	7.79/11.05	30	W 1-3 R/ W 13-1 P	No	Required	Yes	Advisory speed remains the same	5/15/2012	Sunny/Dry
HA-6 WB	18106	Hamlin	NORTH HAMLIN RD	Hamlin-Parma	Right/Left	40	30	W 1-4 R/ W 13-1 P	No	No	8.65/11.21	30	W 1-3 R/ W 13-1 P	No	Required	Yes	Advisory speed remains the same	5/15/2012	Sunny/Dry
HA-7 EB	18306	Hamlin	NORTH HAMLIN RD	Hamlin-Parma	Right	40	30	W 1-2 R/W 13-1 P	No	No	5.41	40	W 1-2 R	Yes	No	Yes	Remove Advisory Plaque	5/15/2012	Sunny/Dry
HA-7 WB	18606	Hamlin	NORTH HAMLIN RD	Hamlin-Parma	Left	40	30	W 1-2 L/W 13-1 P	No	No	11.48	40	W 1-2 L	Yes	No	Yes	Remove Advisory Plaque	5/15/2012	Sunny/Dry
HA-8 NB	19206	Hamlin	REDMAN RD	RT 104	Right	55	35	W 1-2 R/W 13-1 P	No	No	10.23	50	W 1-2 R/W 13-1 P	Yes	No	Yes	Increase Advisory Speed	5/15/2012	Sunny/Dry
HA-8 SB	19406	Hamlin	REDMAN RD	RT 104	Left	55	35	W 1-2 L/ W 13-1 P	No	No	11.94	50	W 1-2 L/W 13-1 P	Yes	No	Yes	Increase Advisory Speed	5/15/2012	Sunny/Dry

Ball Bank Indicator Criteria Per NMUTCD Section 2C.08.07
16 Degrees of ball-bank for speeds of 20 mph or less
14 Degrees of ball-bank for speeds of 25 to 30 mph
12 Degrees of ball-bank for speeds of 35 mph or higher

Chevron/Arrow Requirements Per NMUTCD Table 2C-5		
Difference Between Speed Limit and Advisory Speed		
5 MPH	10 MPH	15 MPH or More
Optional	Recommended	Required

Chevron Alignment Sign W1-8

One-Directional Large Arrow W1-6

HUNT