WISCONSIN DEPARTMENT OF TRANSPORTATION

STH 164 SPEED MANAGEMENT PLAN AND IMPLEMENTATION STRATEGY

WASHINGTON COUNTY, WI

OPUS

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1.0 INTRODUCTION

1.1 Background

The Wisconsin Department of Transportation (WisDOT) has received a request from the Washington County Board of Supervisors to reduce the speed limit on a section of STH 164. This letter stemmed from a belief that the posted speed limits on STH 164 between CTH Q and STH 60 (see FIGURE 1.1) are inappropriately high along this corridor. As a result of this request, WisDOT is currently considering the implementation of a uniform 45 mph speed limit on this section of STH 164.

STH 164 is classified as a rural principal arterial and is a designated truck route. Commuters use this route between USH 41 to the north and IH-94 in Pewaukee to the south. High traffic speeds, relatively high traffic volumes, and a high proportion of non-local traffic, are among the concerns that have been expressed about this corridor. WisDOT has identified this section of the STH 164 corridor as part of the *Connections 2030* plan as a key major passenger and freight corridor linking Waukesha County to northern Wisconsin. As a result WisDOT is currently considering long-term enhancements of extending the divided four lane section which currently ends in Waukesha County just north of Good Hope Road.

WisDOT has initiated this traffic study to consult with stakeholders, quantify traffic and safety issues along the corridor, and identify potential short- to medium-range mitigating measures that address community concerns related to vehicle speeds, safety and mobility.

1.2 Study Objectives

The objectives of this project are to improve safety on STH 164 in Washington County through the implementation of a comprehensive speed management strategy. In 2007 the *STH 164 Traffic Speed and Safety Study, Howard Lane to STH 175, Washington County* was completed for the WisDOT Southeast Region. This study identified several safety issues on the STH 164 corridor related to speed and suggested several short-, medium- and long-term strategies to address these issues.

This specific project will develop a more comprehensive implementation plan for a speed management strategy for STH 164 in Washington County. This plan will focus on engineering, enforcement and educational strategies that can be utilized to reduce speeds on STH 164.

1.3 Study Location

The specific study corridor (FIGURE 1.1) starts from the intersection of STH 164 and CTH Q on the Washington/Waukesha County Line and extends north to STH 60, for a distance of approximately eleven miles. The study corridor encompasses the intersections of STH 164 and Hubertus Road, STH 167, Pleasant Hill Road, CTH E and other minor roads.

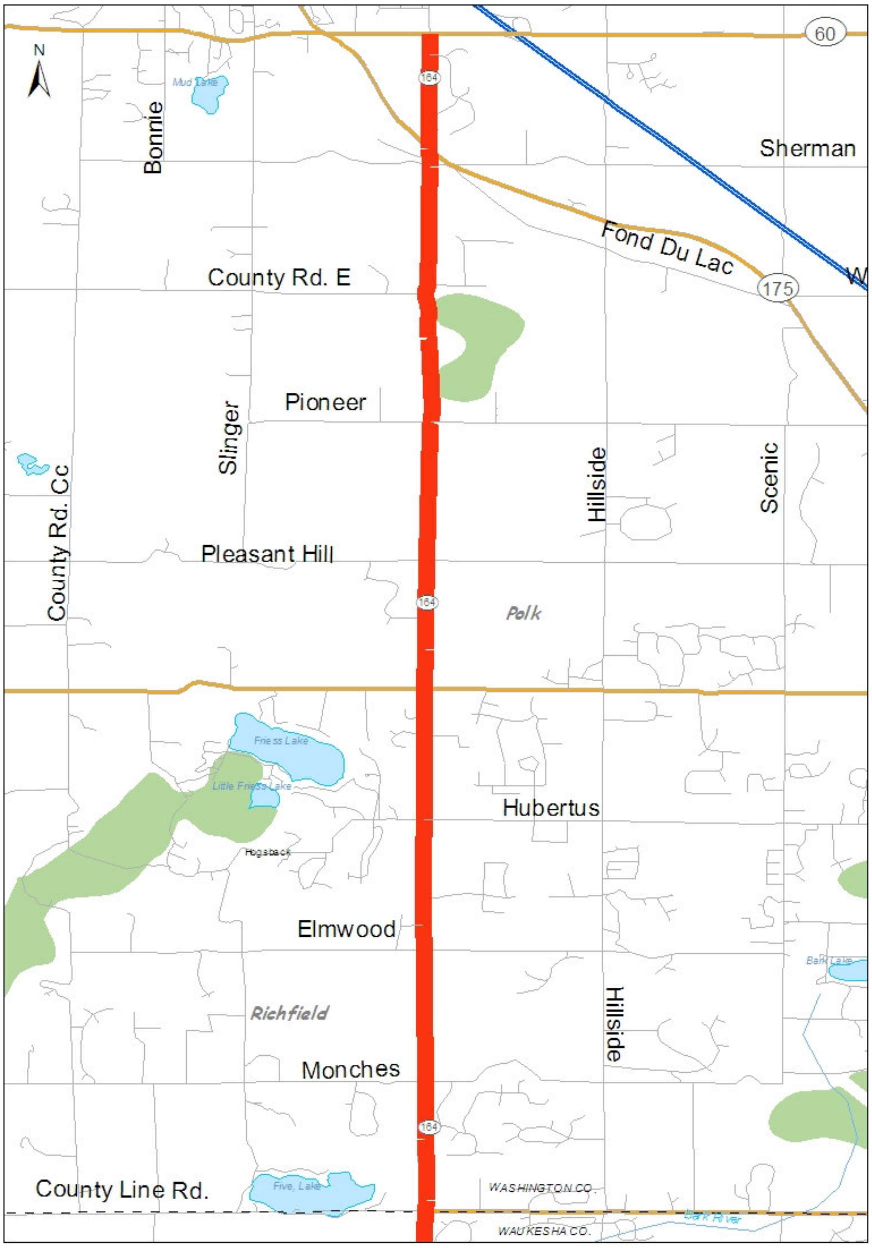

FIGURE 1.1 STUDY CORRIDOR

1.4 Method

To achieve the study objectives, the following tasks were completed in this study:

- Start-up meeting with project stakeholders.
- A Field review to observe the existing conditions along the study corridor.
- Development of a Speed Management Plan and Implementation Strategy which focuses on:
  - The short-term priorities.
  - The identification of early-winner components, and momentum-builders.
  - Road maintenance requirements and implications for the high priority projects.
  - Inclusion of expected project costs and benefits.
  - Taking advantage of opportunities to “piggy-back” projects to package projects in an optimal manner.
  - Implementation of engineering techniques
  - Implementation of a law enforcement techniques
  - Education outreach strategies
  - Criteria for project evaluation (i.e., speed, traffic diversion, crashes, etc.)
  - Post-evaluation plan(s) based on results of evaluation (i.e., keep new posted speed limit, modify speed limits, reinstate previous posted speeds, etc.)

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2.0 RESEARCH INTO SPEED LIMIT METHODS

2.1 Literature Review

The objective of this literature review is to take stock of the relationship between speed and safety, to find current criteria or processes for setting up acceptable speed levels, to summarize basic principles, as well as to determine accepted practices. The purpose of the current practices review is to document other municipalities' speed limit policies, method of its implementation, and the outcome of their policies.

2.2 Purpose of Speed Limits

Managing Speed (Transportation Research Board, 1998) states that there are three main reasons for establishing speed limits. The first reason is defined as 'externalities.' This is based on situations and risks that an individual may impose on society or other motorists based on his or her speed choices. A driver with a higher risk tolerance, for example one who is willing to accept a higher collision risk in order to reduce trip time, also imposes this higher risk on the drivers around him or her. These drivers may not be willing to accept this risk, but would have no choice in this situation. Even a single vehicle with a single driver who is involved in a collision due to speed decisions may incur costs that society will have to pay.

Secondly, drivers may be unable to accurately judge their capabilities and those of their vehicle, specifically when combined with roadway conditions. Ordinarily, drivers are able to adjust their speeds based on their surroundings; however, in new situations and conditions they may not be conscious of appropriate speeds.

The final reason for establishing speed limits is due to the fact that drivers may misjudge the influence that speed may have on collision probability and severity. This is especially true in young and inexperienced drivers.

Managing Speed also states two objectives of speed limits. The first is to provide an upper boundary on speed, using speed limits as a limiting function, in order to reduce the number and severity of collisions. The second objective is to coordinate speeds and keep the range of speeds to a minimum. The narrower the range of speeds, the less likely traffic conflicts will occur. In deciding upon speed limits, safety and efficiency must be balanced. Risk to pedestrians and motorists must be minimized, without sacrificing the efficiency required of a roadway, specifically with reference to highways or main routes.

2.3 Design Speed versus Posted Speed

The *Traffic Engineering Handbook, 4th Edition,* defines design speed as "the maximum safe speed that can be maintained over a specified section of highway when conditions are so favorable that the design features of the highway govern." Design speed takes into consideration such things as stopping sight distance, passing sight distance, decision sight distance, horizontal curve radius, and vertical curve radius, among others. One of these factors posted speed takes into consideration is design speed. The posted speed of a section of roadway is generally lower than the design speed to allow for a safety margin.

In Wisconsin, the traditional practice has been to generally post speed limits at about 5 mph less than the design speed. This has resulted in drivers "reading the road" which typically results in an 85th percentile speed of about 5 mph higher than the posted limit.

2.4 Speed and Safety

Speed is closely related to safety in the context of collisions. This correlation can be seen as two separate relationships. The first is regarding crash probability, the second being crash severity. Speed and crash probability is based mostly on experimental data and observation, while speed and crash severity can be directly related through scientific laws.

A. Crash Probability

There are several links between speed and crashes. The first approach is labeled the 'information processing approach' in which a driver must process the information received about his or her surroundings while driving. A higher rate of speed requires a higher rate of processing information. This leaves less time both for processing information, as well as for action and reaction based on the information. This approach maintains that once the driver cannot process information quickly enough, a crash is likely to occur. The higher the rate of speed, the more likely it is that the driver will not be able to properly process the information and account for it when making decisions while driving.

The second approach is given as the 'traffic conflict approach'. Traffic conflicts are more likely to occur as an individual's speed differs from those around him. The greater the speed difference, the more likely it is that a conflict will occur. This approach relates only to two-lane rural roads, according to *Managing Speed*. The third approach, the 'risk-homeostasis motivational approach', relates speed and collisions based on the driver's perception of risks. It holds that a driver adjusts his speed based on the information he has about possible risks. In this case, the danger comes from a driver basing his speed decision on incorrect risk perception, rather than the posted speed.

B. Crash Severity

A more direct link exists between speed and crash severity, due to the laws of physics and momentum. A vehicle that is involved in a crash sustains a rapid change in velocity upon impact. However, the occupants of the vehicle do not immediately sustain this change, but instead continue forward with momentum. The higher the speed, the more momentum both the vehicle and occupants have, thus the more severe the crash is when the change in velocity occurs. While the probability of a crash may not necessarily increase with speed, the probability of injury, and the severity of injury does increase. .

2.5 Speed Management

Speed Management is achieved mainly through several methods – traffic calming, other engineering measures or through speed enforcement. Traffic calming is used to force vehicles to lower their speed, due to the physical characteristics of the roadway. Speed limits encourage drivers to travel at a safe speed, relevant to the roadway.

Traffic calming is used to physically control vehicle speeds or volumes on residential and rural streets. Traffic calming may include such techniques as speed humps, traffic diverters, narrow roadways, and staggered alignment. Traffic calming is considered effective and appropriate on local roads, and separate policies guide the implementation of traffic calming devices. Other engineering measures such as roundabouts, medians and active warning devices have been found to be effective on higher classifications of roadways. Speed enforcement (see SECTION 2.8) is another type of speed management.

2.6 Approaches to Setting Speed Limits

The following brief summary outlines several methods that are regularly used to set speed limits.

A. Engineering Study Method

Seemingly, the most commonly accepted and practiced method for setting speed limits is the Engineering Study Method. This method consists of data collection and analysis, including dominant traffic speeds, collision data, and information on roadway conditions. *Managing Speeds* states that a survey by Fitzpatrick et al. conducted in 1997 determined that the 85th percentile speed is the most influential factor used to establish speed limits. This speed is used as a first estimate of an appropriate speed limit; factors such as collision experience, roadside surroundings, and roadway geometry are then used to adjust the limit. This method makes one key assumption, but then allows for minimal enforcement.

Using the 85th percentile as a guide for setting speed limits assumes that the majority of drivers are able to judge correctly a safe speed at which to travel. At the 85th percentile, the majority of drivers will be within the speed limit, leaving approximately 15 percent requiring speed enforcement.

While setting a speed limit at the roadway's 85th percentile speed aids in enforcement, it does not necessarily limit collision risks. The speed limit itself is not as much as a risk factor as is the range of speeds. *Managing Speed,* points out that 'the narrower the speed dispersion – the less the spread between the average speed and the 85th percentile speed – the greater the safety benefits'.

As previously mentioned, other factors of influence must also be considered along with the 85th percentile speed. For example, roads providing residential access may need lower speeds to ensure the safety of motorists turning on and off a main route.

Rather than rely on the 85th percentile speed to set the posted speed limit, it is better to use the 85th percentile speed as a logic check against the suggested posted speed limit that is derived from the characteristics of the road.

B. Pace Limits

Pace limits follow the logic of the 85th percentile method, attempting to include the majority of drivers within the speed limit to minimize enforcement and speed disparity. Pace speed is described as the top (approximately) 10 mph range within which most vehicles travel. The limit is then generally set at the upper value of this range. This method generally yields similar results to the 85th percentile approach. However, pace limits pinpoints the speed range within which the majority of vehicles travel, and the 85th percentile establishes a speed demarcation.

C. Expert-Systems Based Approach

The Expert-Systems Based Approach was developed in Australia and has been recently adapted to US called USLIMITS. Software was developed to suggest posted speed limits based on inputted information. The user first enters the following information:

- 85th Percentile Speed;
- 50th Percentile Speed;
- Section Length (in miles);
- Statutory Speed Limit;

- Presence of Adverse Alignment;
- Presence of a Transition Zone;
- Average Annual Daily Traffic;
- Roadside Hazard Rating (on a scale of 1-7; with one being least hazardous); and,
- Roadway Type.

From this information, the software produces a proposed speed limit. The output may also point out specific issues that should be further investigated. These systems tend to recommend a speed limit close to the 85th percentile, when used for a highway or main roadway. When applied to more urbanized roadways, with a greater volume of pedestrians and cyclists, the speed limit suggested tends to be lower.

2.7 Current WisDOT Policy

According to TGM 13-05-01, WisDOT Region offices currently have the authority to alter regulatory speed limits on local roads, streets, and trunk highways in their respective jurisdictions. Before doing so, however, the Regions must prepare a report, in the prescribed submittal/approval format, documenting their traffic investigation. The report should include speed checks to determine the 85th percentile speed; a speed zone log; crash history of the study area; a map of the existing and proposed speed zoning; and documentation of any concurrences or protests by the local governing body. If the criteria for approval are not met, the Region office fills out the recommendation information portion of the letter, indicating the material that is being transmitted with the recommendation. The respective traffic liaison engineer of the Bureau of Highway Operations then reviews the Region's submittal. Upon approval, the official records are updated and the Region is notified.

2.8 Speed Enforcement

The primary purpose of speed limits is to regulate driving speeds to achieve an appropriate balance between travel time and risk for a road class or specific highway section. A speed limit sign should convey two basic messages:

- The maximum speed for a reasonable and prudent driver traveling in free flowing traffic with good visibility and under fair weather conditions
- The speed that will be enforced within some tolerance for minor measurement error

Law enforcement agencies work to reduce incidents of speeding on roadways and, thereby, reduce the number and severity of crashes taking place on those roadways.

Most experts agree that enforcement is critical to achieving compliance with speed limits. Simply posting a speed limit sign will not achieve desired driving speeds. Even if most motorists believe that the speed limits are reasonable and they comply within a small tolerance, enforcement is still necessary to ensure the conformity of drivers who will obey laws only if they perceive a credible threat of detection and punishment for noncompliance.

In many cases, maintaining the deterrence effect requires a level of enforcement that is difficult to sustain because of limited resources provided for speed enforcement and competing enforcement priorities. Policy makers can affect the level of enforcement through resource allocation, but enforcement is expensive. Thus, the police should deploy enforcement efforts strategically on those roads and at times when speed-related incidents are most common or where road conditions are most hazardous.

Police can boost the longevity of the deterrence effect by combining enforcement initiatives with high-profile public information campaigns to increase driver awareness that speed limits will be enforced. Publicity must be followed up by actual enforcement if the approach is to successfully deter speeding. Moreover, making permanent behavior changes requires a long-term sustained effort.

3.0 STUDY CORRIDOR

3.1 Roadway Characteristics

The geometric and other characteristics for the STH 164 corridor are summarized in TABLE 3.1. Characteristics that are associated with safety issues are highlighted in the table.

TABLE 3.1 CORRIDOR CHARACTERISTICS

CHARACTERISTICS	DETAILS	ILLUSTRATION OR COMMENT
Jurisdiction	WisDOT	--
Horizontal alignment	Straight	
Vertical alignment	There are vertical curves present along the corridor. Several of the intersections along the corridor are located on vertical curves. Examples of the vertical curves at the following intersections are shown (*right*): ▪ Northbound STH 164 at Hubertus ▪ Northbound STH 164 at	 *Northbound STH 164 and Hubertus*

CHARACTERISTICS	DETAILS	ILLUSTRATION OR COMMENT
	STH 167	 *Northbound STH 164 and STH 167*
Land Use	The surrounding land use for the STH 164 corridor (County Line Rd. to STH 60) is zoned primarily as farm land and residential, with some commercial/retail	
Road User Characteristics	The primary road users for the STH 164 corridor are passenger cars, farm equipment and trucks, with the occasional pedestrian or bicyclist *(arrow).*	

CHARACTERISTICS	DETAILS	ILLUSTRATION OR COMMENT
		
Influences	STH 164 provides a link between USH-41 to the north and IH-94 in Waukesha County to the south.	--
Access	Many commercial driveways and residential driveways *(arrows)* are located along the corridor.	
School Zone	There is a designated school zone for the school located on the northeast corner of STH 164 and STH 167. No school speed limit is posted.	 *Northbound STH 164 and STH 167*

CHARACTERISTICS	DETAILS	ILLUSTRATION OR COMMENT
Clear Zone	Adequate clear zone is present along most of the corridor except at the intersection of STH 164 and Pleasant Hill Road. At this intersection, buildings are located extremely close to the edge of the roadway.	 *Northbound STH 164 and Pleasant Hill Road*

3.2 Traffic Volumes

WisDOT provided 24-hour vehicle counts[1] along the STH 164 corridor. Traffic volumes along the study corridor are generally highest from 7:00 AM to 8:00 AM and from 5:00 PM to 6:00 PM. Average annual daily traffic (AADT) volumes along STH 164 between CTH Q and STH 60, for the years of 2001 and 2004 were collected from the WisDOT website. The results of the counts are summarized in TABLE 3.2.

Average annual daily traffic on STH 164 is highest towards the southern section of the corridor between CTH Q and STH 167. During 2004, average annual daily traffic volumes gradually decreased from STH 167 to CTH E, and gradually increased from CTH E to STH 60.

TABLE 3.2 CORRIDOR TRAFFIC VOLUMES

LOCATION	AVERAGE ANNUAL DAILY TRAFFIC		% GROWTH RATE
	2001	2004	
South of STH 60	--	5,600 veh/day	--
North of CTH E	5,000 veh/day	5,300 veh/day	+1.5 %
South of CTH E	5,100 veh/day	5,000 veh/day	-0.5 %
North of STH 167	6,700 veh/day	6,400 veh/day	-1.0 %
South of STH 167	7,800 veh/day	7,800 veh/day	0 %

3.3 Vehicle Speeds

WisDOT provided vehicle speeds which were collected as part of the earlier *STH 164 Traffic Speed and Safety Study: Howard Lane to STH 175.* The speed limits and 85th percentile speeds are listed below in TABLE 3.3.

TABLE 3.3 VEHICLE SPEEDS

SEGMENT LOCATION	POSTED SPEED LIMIT	85th PERCENTILE SPEED	
		Northbound	*Southbound*
STH 60 to STH 175	45 mph	54 mph	54 mph
STH 175 to Majestic Drive	55 mph	50 mph	61 mph
Majestic Drive to Greystone Drive	40 mph	50 mph	52 mph
Greystone Drive to STH 167	50 mph	52 mph	49 mph

[1] *STH 164 Traffic Speed and Safety Study: Howard Lane to STH 175*

STH 167 to Cherokee Trail	50 mph	59 mph	59 mph
Cherokee Trail to CTH Q	55 mph	60 mph	62 mph

The posted speed limit varies from segment to segment, decreasing or increasing anywhere from 5 mph to 15 mph. The 85th percentile speeds indicate low speed limit compliance in both traveling directions. The variation in the posted speed limits may contribute to the varying 85th percentile speeds in the northbound and southbound direction especially from STH 175 to Majestic Drive. At Majestic Drive the posted speed limit decreases from 55 mph to 40 mph in the southbound direction. The 85th percentile speed in the southbound direction along this segment decreases from 61 mph to 52 mph. The posted speed limit from Majestic Drive to Greystone Drive is 40 mph; therefore vehicles are reportedly traveling at 12 mph over the speed limit along this segment. Northbound vehicle speeds remained steady at 50 mph regardless of a 15 mph increase in posted speed limit from 40 mph to 55 mph.

3.4 Traffic Crash Analysis

WisDOT provided MV4000 police collision reports for 2004 through 2007 and included information on date, location, time, weather, severity, and type of crash A total of 125 collision records occurred along STH 164.

Corridor-Wide Collision Trends

As summarized in FIGURE 3.1, 55 percent of the collisions resulted in at least one injury. A head-on collision near STH 167 resulted in a fatality. The remainder of the collisions involved property damage only.

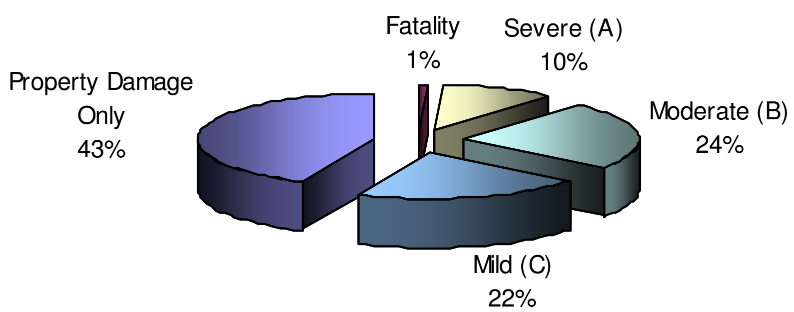


FIGURE 3.1 COLLISION SEVERITY DISTRIBUTION

Collision type distributions for the STH 164 corridor are summarized in FIGURE 3.2. A review of the collision types shows that angle collisions and single vehicle collisions are predominant, representing 34% and 28% of the collisions respectively.

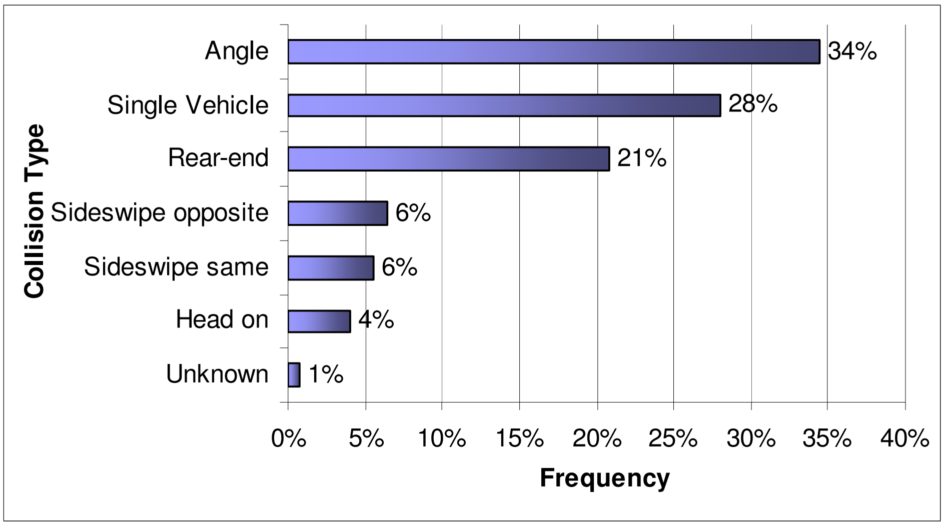


FIGURE 3.2 COLLISION TYPES

The temporal collision trends for the corridor are shown in FIGURE 3.3.

- Between 2004 and 2007, the number of collisions per year remained steady between 27 collisions (occurring in 2004) and 34 collisions (occurring in 2005).
- Monthly distributions do not show strong seasonal trends. Collisions occurred more frequently during February and May with 18 percent and 13 percent of the collisions occurring, respectively.
- Collisions occurred most frequently on Monday and Saturday.

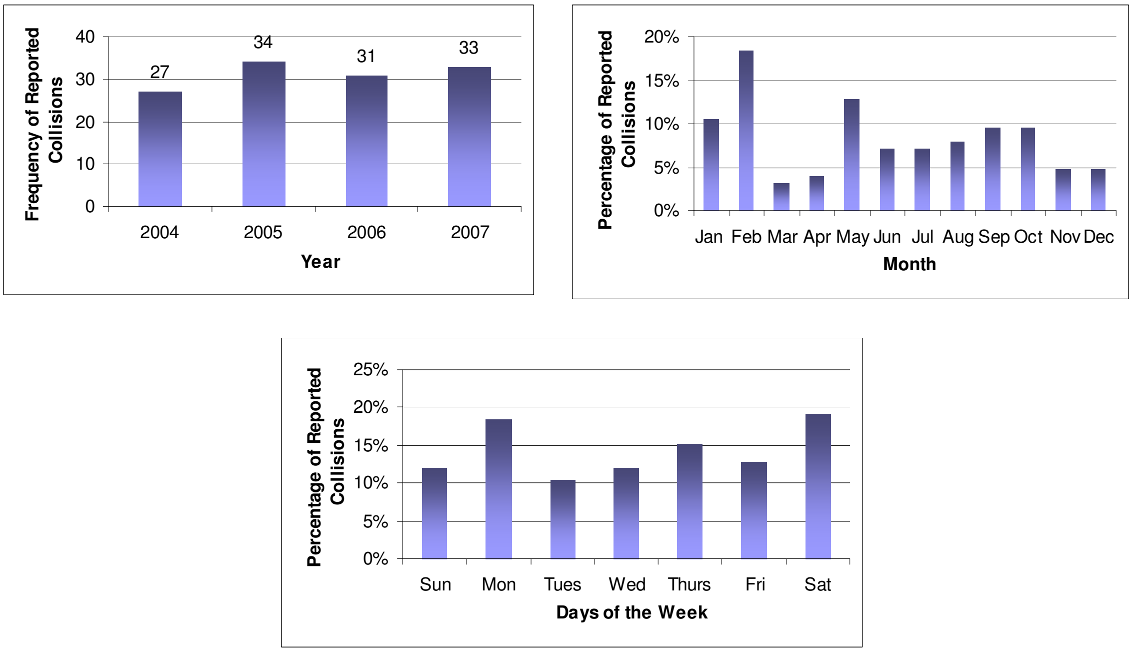


FIGURE 3.3 TEMPORAL COLLISION DISTRIBUTIONS

The environmental collision trends for the corridor are shown in FIGURE 3.4. Over two-thirds of all reported collisions occurred in daylight and on dry pavement. These distributions, which are broadly consistent with environmental conditions, suggest that environmental conditions are not substantial contributors to collisions reported along the corridor.

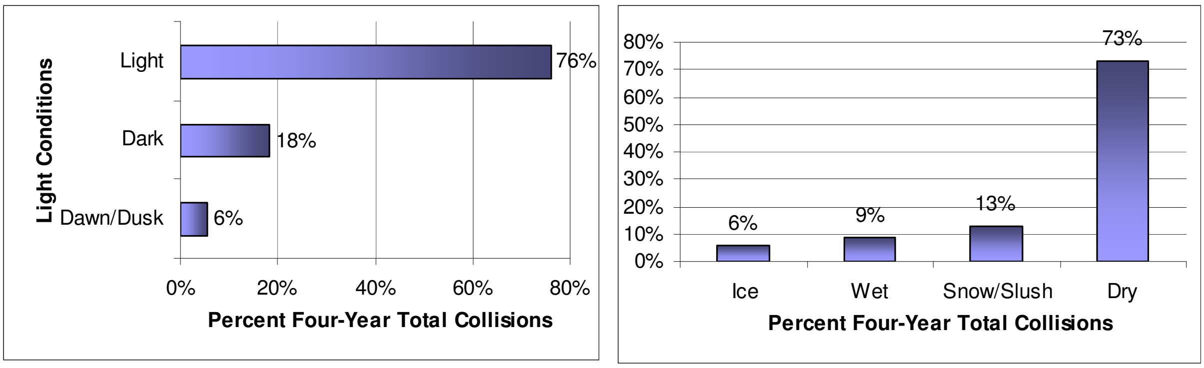


FIGURE 3.4 ENVIRONMENTAL COLLISION DISTRIBUTIONS

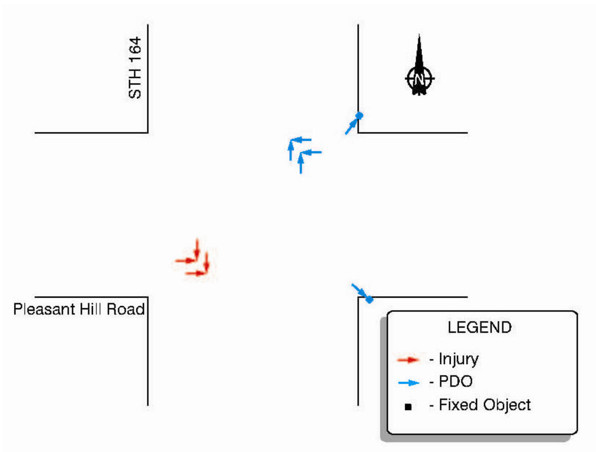
Intersection Collision Trends

The spatial diagrams for intersection collisions are shown in FIGURE 3.5 and APPENDIX B. The collision type distribution and crash rate for the corridor intersections are shown in TABLE 3.4.

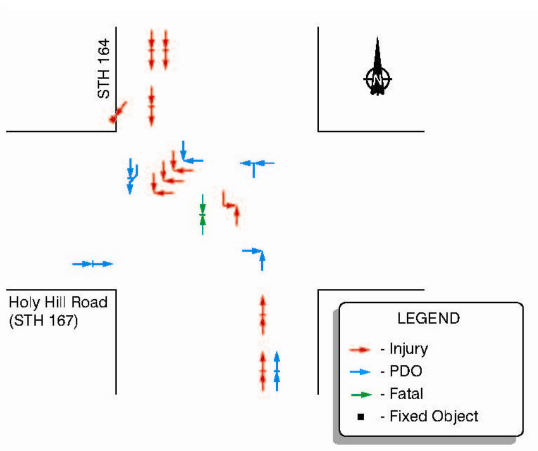
- Angle collisions and single vehicle collisions are the predominant collisions types occurring at intersections along the corridor.
- The CTH Q intersection had the highest collision frequency during the four-year period. Fourteen of the nineteen collisions that occurred at this intersection were angle collisions.
- The intersections at Hubertus and CTH E experienced the highest crash rate at 1.46 and 1.03 crashes per million vehicle miles of travel, respectively.

TABLE 3.4 INTERSECTION COLLISION TYPE DISTRIBUTIONS

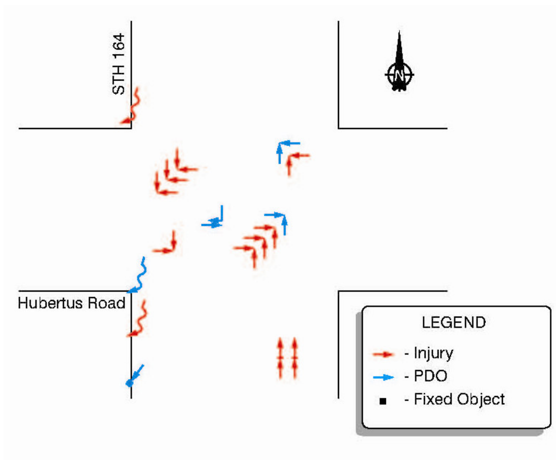
COLLISION TYPE	INTERSECTION								
	CTH E	Pioneer	Pleasant Hill	STH 167	Hubertus	Elmwood	Monches	CTH Q	Plain View
Angle	1	3	4	6	11	3	1	14	2
Single Vehicle	5	1	5	1	4	4	6	1	2
Rear-end	3	1	--	7	2	1	1	2	1
Left-turn	1	--	--	1	--	--	--	1	--
Sideswipe opposite	1	--	--	--	--	--	1	--	--
Sideswipe same	1	--	--	1	--	--	1	1	--
Head on	--	--	--	1	--	1	--	--	--
Total	12	5	6	17	17	9	10	19	5
Crash Rate	**1.03**	**0.60**	**0.63**	**0.86**	**1.46**	**0.79**	**0.88**	**0.87**	**0.49**



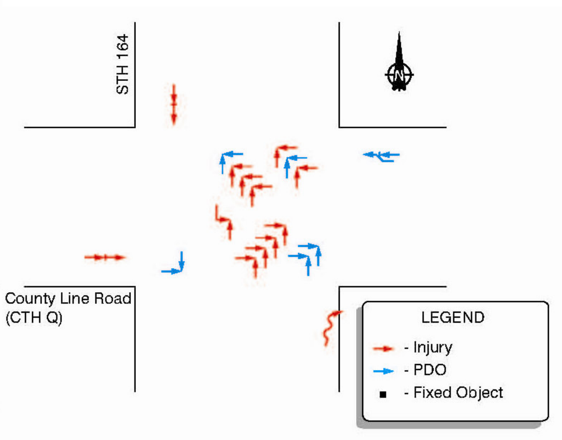
STH 164 AND PLEASANT HILL ROAD



STH 164 AND HOLY HILL ROAD (STH 167)



STH 164 AND HUBERTUS ROAD



STH 164 AND COUNTY LINE ROAD (CTH Q)

FIGURE 3.5 COLLISION DIAGRAMS

4.0 PROPOSED UNIFORM 45 MPH SPEED LIMIT

4.1 Issues Related to the Proposed Change

On its face, lowering any speed limit should derive traffic safety benefits. Lower speeds mean increased reaction time for evasive action in the case of an emergency event. Lower speeds also result in reduced kinematic energies so that if vehicles do collide with another vehicle or an obstacle, the result is a general decrease in injury severity. The problem is that lowering the speed limit on STH 164 likely will not result in any significant reduction in overall travel speeds. In fact, lowering the speed limit to a uniform 45 mph may serve to actually increase the frequency and severity of crashes for reasons stated below.

What might be the impact of making a significant reduction in the posted speed limit along STH 164 in terms of speed and crashes? In 1992 the FHWA commissioned a study entitled *Effects of Raising and Lowering Speed Limits* (Report No. FHWA-RD-92-084).

The objectives of this research were to determine the effects of raising and lowering posted speed limits on driver behavior and crashes for non-limited access rural and urban highways. Speed and crash data were collected in 22 States at 100 sites before and after speed limits were altered. Before and after data were also collected simultaneously at comparison sites where speed limits were not changed to control for the time trends. Repeated measurements were made at 14 sites to examine short - and long-term effects of speed limit changes.

The results of the study indicated that lowering posted speed limits by as much as 20 mph or raising speed limits by as much as 15 mph had little effect on motorist speed. The majority of motorists did not drive 5 mph above the posted speed limits when speed limits were raised, nor did they reduce their speed by 5 or 10 mph when speed limits are lowered. Lowering speed limits below the 50th percentile did not reduce crashes, but did significantly increase driver violations of the speed limit. Conversely, raising the posted speed limits did not increase speeds or crashes.

There are many experts who believe that adjusting a speed limit appreciably lower than called for through generally accepted engineering processes can actually raise the probability of crashes taking place. The National Highway Traffic Safety Administration (NHTSA) has recently created a complete set of materials intended to educate highway transportation professionals on issues like this through their “Speed Safety Workshop” training sessions. NHTSA advises in those materials the following regarding raising or reducing speed limits.

“Studies have attempted to determine whether there is a link between speed and crash probability. In the benchmark study conducted by Solomon (1964), travel speeds of crash-

involved vehicles obtained from police reports were compared with the average speed of free-flowing traffic on two- and four-lane, non-limited-access rural highways. Solomon found that crash-involved vehicles were over-represented in the high- and low-speed areas of the traffic speed distribution. His well-known U-shaped curve showed that crash involvement rates are lowest at speeds slightly above average traffic speeds. The greater the deviation between a motorist's speed and the average speed of traffic—both above and below the average speed—the greater the chance of involvement in a crash. The correlation between crash involvement rates and deviations from average traffic speed gave rise to the often-cited hypothesis that it is speed deviation, not speed per se, that increases the probability of driver involvement in a crash. Hauer's subsequent theory of traffic conflict (1971) provided a theoretical basis for Solomon's findings. Solomon's U-shaped relationship was replicated by Munden (1967) using a different analytic method on main rural roads in the United Kingdom, by Cirillo (1968) on U.S. Interstate highways."

This conclusion was supported in more recent research by the Texas Transportation Institute (1990). Thus, the research suggests that decreasing speeds significantly below those recommended by engineering studies – strongly influenced by the 85th percentile speed – may actually increase the frequency of crashes. This is due to the speed differential created between motorists obeying the new posted speed limit and a majority of those still following the higher, but comfortable, speed previously established. As a result, the number of motorists consistently and significantly out of compliance with the new speed limit will likely exceed 50%.

On STH 164, the principal types of crashes that may be aggravated and elevated through a uniform 45 mph speed limit include head-on (from improper overtaking or passing), rear end and run-off-road crashes. All of these crash types can involve serious injuries. While there is no certainty that crashes along STH 164 will increase, probability suggests that they may.

4.2 USLIMITS Analysis

Speed data, traffic counts, crash data and roadway conditions were entered into the USLIMITS models which were discussed in SECTION 2.6. The results of this analysis are outlined TABLE 4.1. The higher 85th percentile and 50th percentile speeds listed in TABLE 3.3 was used in this analysis. The USLIMITS outputs are included in APPENDIX A.

TABLE 4.1 USLIMITS ANALYSIS

SEGMENT	**Existing Speed Limit**	**85^{th} Percentile Speed**	**USLIMITS Recommended Speed Limit**
CTH Q to Elmwood Rd.	55 mph	62 mph	60 mph
Elmwood Rd. to STH 167	50 mph	59 mph	55 mph
Near Pleasant Hill Rd.	40 mph	52 mph	50 mph
Pioneer to STH 175	55 mph	61 mph	60 mph

5.0 EXISTING SAFETY MEASURES

WisDOT has already implemented several measures to improve road safety along the STH 164 corridor, which are illustrated in TABLE 5.1.

TABLE 5.1 EXISTING SAFETY MEASURES

CHARACTERISTIC	DETAILS	ILLUSTRATION OR COMMENT
Intersection Lighting	Intersection lighting along the STH 164 corridor increases approaching drivers' awareness of intersections, and sight distance at intersections, where conflicts with vehicles (slowing and turning) are most likely to occur. The use of varying intersection types along the corridor (four-leg intersections, three-leg intersections, and four way stops) limit drivers' ability to anticipate intersection configurations, and therefore the possible conflicts at intersections. This has been addressed through the use of intersection lighting along the corridor.	 *Lighting at STH 164 and Hubertus*  *Lighting at STH 164 and CTH Q*
Four Way Stops	Four-way stop control has been found to be an effective means to reduce total crashes and angle crashes at rural intersections. Converting from a two-way to four-way stop control has been found to reduce angle crashes by 84%. While this is the case, this type of traffic control does not always operate as efficiently.	 *Four Way Stop Control at STH 164 and CTH Q*

CHARACTERISTIC	DETAILS	ILLUSTRATION OR COMMENT
Reduced Speed Limit near Pleasant Hill Road	Due to the significant restrictions in clear zone and intersection sight distance at STH 164 and Pleasant Hill Road, the speed limit has been reduced to 40 mph. This speed limit reduction has been effective as the 85th percentile speed is lower on this segment than along other segments of the corridor.	 *40 mph Speed Zone near Pleasant Hill Road*
Paved Shoulders	Providing a paved shoulder has been found to be a proven strategy in reducing run-off-road crashes on high-speed roadways. Wider shoulders allow for a smoother area in which to initiate a recovery if a vehicle departs the travel lane. Research has shown that there is a 2.8% reduction in crashes for every foot of paved shoulder.	
Clear Zone	Wide clear zones which exceed the 30-foot minimum suggested in the *AASHTO Roadside Design Guide* are present throughout the corridor. Wide clear zones minimize the risk of striking a fixed object after leaving the roadway.	
Advance Intersection Signing	Advanced intersection signing is suggested on approaches to intersections with sight distance restrictions and for senior drivers. Research by the Missouri DOT has found the use of intersection warning signs to reduce crashes by 40%.	

6.0 IMPROVEMENT STRATEGY

Based on the stakeholder consultation process and preliminary analysis, an improvement strategy was developed for the study corridor. The strategy consists of the following elements:

- Improvements for Immediate Implementation
- Medium-Term Corridor Improvements
- Long-Term Corridor Improvements
- Enforcement
- Public Information and Education
- Coordination with the Washington County Courts

The site-specific countermeasures address road safety engineering issues that were observed during site visits at specific corridor locations, and may be implemented on an immediate basis.

The medium-term and long-term countermeasures address the major road safety concerns along the STH 164 corridor. It is suggested that WisDOT monitor the effectiveness of each stage of improvements prior to implementing the next stage. The implementation of the medium- and long-term improvements may require further engineering analysis, planning and design, and continued consultation with the local residents and stakeholders. FIGURE 6.1 illustrates several of the potential engineering improvements.

6.1 Site-Specific Improvements for Immediate Implementation

The site-specific improvements that are recommended for immediate improvement are:

- Permanent Speed Feedback Signs
- Transverse Speed Bars

A. Permanent Speed Feedback Signs

A permanent speed feedback sign informs drivers of the speed at which they are traveling, and helps mitigate high speeds. In 2003 the Texas Transportation Institute conducted a research study titled *Evaluation of Dynamic Speed Display Signs (DSDS)* (Report No. FHWA-TX 0-4475).

The objectives of this research was to determine the effectiveness of permanently installed dynamic speed display signs, also known as speed feedback signs, on reducing speed limits for a long period of time. Speed data was collected at seven sites in Texas before, immediately after, and a few months after the installation. The data collection process involved speed data collection at a controlled site upstream from the test site, to determine the impact the speed feedback sign had on drivers.

The results of the study indicated that the permanent speed feedback sign is more effective if a perceived level of enforcement exists, on a two-lane highway, where sight distance may be obstructed. Therefore, a speed feedback sign on STH 164 may effectively reduce speeds due to a vehicle slowing down which may influence vehicles following to slow down. The speed feed back sign may be more effective due to the sight distance restrictions caused by variations in vertical alignment of the roadway.

It is suggested that speed feedback signs be considered at the approach to Pleasant Hill and on the segment between Elmwood and Monches, where the existing posted speed limit is currently at 55 mph and 85th percentile speeds exceed 60 mph. The speed feedback sign will alert drivers of the speeds being traveled, and may help reduce drivers' speed according the proposed speed limit.

B. Transverse Speed Bars

Transverse speed bars are a series of perpendicular markings placed across the entire travel lane along the roadway pavement, which are implemented to reduce vehicle speeds. A recent study by Katz and Rakha, *Determination of Effective Design of Peripheral Transverse Bars to Reduce Vehicle Speeds on a Controlled Roadway* (2008), evaluated the effectiveness of peripheral transverse bars.

Twenty-four research participants were tested in a controlled environment on the Virginia Tech Smart Road. The data collection process involved the change in vehicle speed, vehicle speed profile with respect to distance, and brake position with respect to distance approaching two different types of curves. One curve represented a freeway ramp and the other curve represented a cul-de-sac.

The results of the study indicated that the treatment was not effective when the curve can be seen from a distance, such as the test approach to a cul-de-sac. The peripheral transverse bars were effective at the approach to a freeway ramp, where the sight distance to the curve is limited. It is suggested that peripheral transverse bars, spaced 4 bars per second, may be considered where drivers need additional information to recognize the need to slow down.

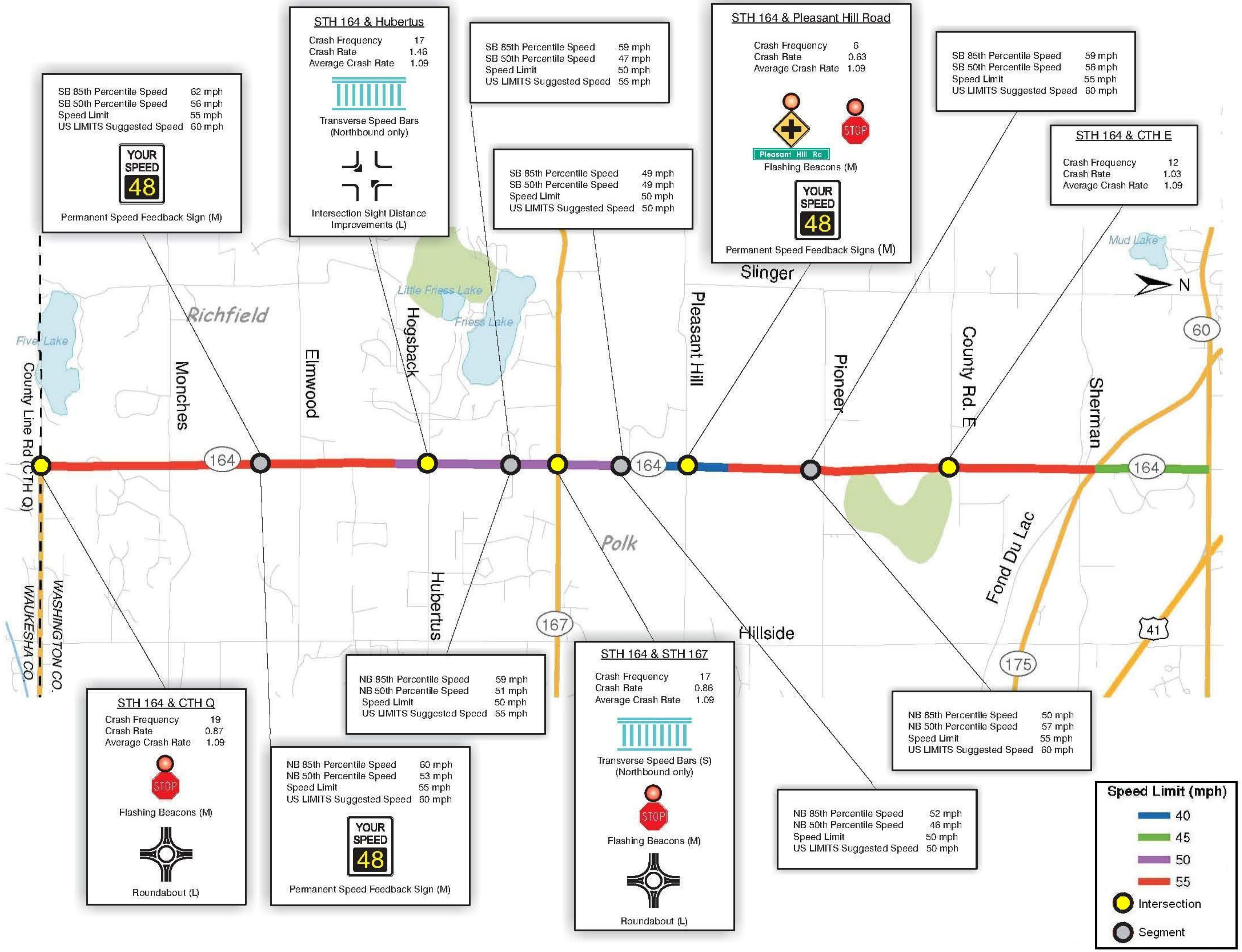


FIGURE 6.1 POTENTIAL ENGINEERING IMPROVEMENTS

6.2 Medium-Term Corridor Improvements

The medium-term improvements that are recommended for implementation are:

- Flashing Beacons at Stop-Controlled Intersections
- Rumble Strips

A. Flashing Beacons at Stop Controlled Intersections

The crash data indicated a high percentage of angle crashes at several of the stop-controlled intersections. Flashing beacons at stop-controlled intersections enhance the conspicuity of the intersection by calling driver attention to the stop signs. Flashing beacons have been found to be an effective method of targeting angle crashes at unsignalized intersections. Based on a recent Minnesota Department of Transportation study, it is suggested that red stop beacons be placed above the stop sign and yellow beacons be placed above an intersection warning sign. It is suggested that stop beacons be considered at the four way stops at CTH Q and STH 167.

C. Rumble Strips

Single vehicle run-of-road crashes were the second highest collision type along the corridor. An engineering countermeasure that has been found to be effective in reducing single vehicle run-off-road crashes are shoulder rumble strips. Rumble strips are widely used on freeways and expressways throughout Wisconsin to prevent these types of crashes. It is suggested that shoulder rumble strips be considered for some or the entire corridor. Along the corridor some of the shoulders may need to be upgraded.

Centerline rumble strips have been found to be an effective means of reducing head-on crashes on two-lane roads. It is suggested that centerline rumble strips be considered along the corridor. The impact of noise from both shoulder and centerline rumble strips on the local residents should also be considered because houses are located along the corridor.

D. Non-suggested Countermeasures

Narrow lanes and traffic calming measures are not suggested for implementation along this corridor. Narrow lanes have been found to be effective on approaches to

intersections in urban areas but not on high speed rural roads where they can lead to an increase in head-on and sideswipe opposite crashes.
Traffic calming measures such as planters, diverters are not suggested as they would be considered fixed objects within the clear zone on a high speed roadway. Thus increasing the likelihood of severe fixed object crashes.

6.3 Long-Term Corridor Improvements

The long-term improvements that can be considered for implementation, further to more detailed planning and design work, are:

- Install Roundabouts
- Install Medians
- Implement Intersection Sight Distance Improvements

A. Install Roundabouts

Research has found that roundabouts provide an extremely effective alternative to stop controlled intersections. As a result, WisDOT has been extremely proactive in implementing roundabouts around the state. During the stakeholder meetings it was indicated that roundabouts have been discussed for the intersections of STH 164 & CTH Q and STH 164 & STH 167.

Both of these intersections have trends in angle crashes that could be mitigated through the implementation of roundabouts. Roundabouts will also reduce the speeds as drivers travel through these intersections. This is accomplished through the deflection of the curves on the roundabout approaches. In addition, the roundabouts can also be used to break up the monotony of traveling down a straight two-lane road, which can lead drivers to travel at higher speeds. It is suggested that roundabouts be considered for implementation at the two intersections stated above.

B. Install Median Islands

It is suggested that median islands be placed along the corridor as a means to slow drivers down. These medians will break up the monotony by providing breaks in the continuous centerline markings. As a result, drivers will likely slow down as they will need to slightly alter their course to drive around the median. Raised pavement markers should be considered on the median noses to assist with delineation in areas with no overhead lighting. With the installation of median islands come additional costs for maintenance.

C. Implement Intersection Sight Distance Improvements

Restrictions in intersection sight distance were observed at several locations along the STH 164 corridor. In particular this was an issue at the Hubertus and Pleasant Hill Road intersections. At Hubertus Road, the sight distance restrictions are caused by the vertical alignment while at Pleasant Hill Road, the restrictions are caused by the buildings located extremely close to the intersection.

It is suggested that intersection sight distance improvements be considered at those locations during the next major roadway reconstruction project. Improvements to intersection sight distance will help to reduce angle crashes at these intersections.

6.4 Enforcement Countermeasures

An enforcement plan should be considered for development which assigns patrols to specific stretches of the STH 164 corridor during specially selected time periods correlating to both excessive speeding and associated crashes. Excessive speeds are most often identified as being the top 10 percent of the speeds recorded – or 90^{th} percentile and higher. Crashes are typically lowest within the 5 percent span on either side of the 85^{th} percentile speed. Also, almost all enforcement agencies do not take enforcement action until a minimum of 5 mph over the posted speed limit due to the limitations of speed detection equipment. Therefore, most enforcement agencies begin writing citations between 5-10 mph over the posted speed limit with a clear majority leaning toward the upper end of that range.

Not every law enforcement agency will follow all of the steps of this model. In many cases, due to lack of resources or knowledge, agencies will simply concentrate their patrols on wherever the highest speeding is taking place. While this option is fallible in not connecting speed related crashes to speed enforcement, it will often still serve an objective in showing the public that speeding is not tolerated.

How much selective speed enforcement is enough to reduce speeds is not an exact science. Most models call for an increase of 200-300 percent (combined with a public information and education campaign which is discussed in SECTION 6.5) in patrols and enforcement on a designated roadway. This means that, if a roadway is receiving 5 hours per week of enforcement, a suggested amount would be 10-15 hours per week of dedicated enforcement carefully targeted by time of day and day of week.

This assumes that patrols will be targeting the top 10 percent of violators; all of them well over the 85^{th} percentile speed. If the posted speed on STH 164 is set at 45 mph, which is approximately 15 mph below the 85^{th} percentile speed, patrols will be targeting over 50 percent of the motorists traveling the corridor. Furthermore, these motorists will likely be violating the 45 mph speed limit 24 hours per day, seven days per week. Based on our research, there is no standard available for an enforcement project targeting 50% of motorists over most of an 11 mile stretch of roadway at all times of the day.

Discussions with both the Washington County Sheriff and Wisconsin State Patrol suggest that STH 164 now receives a minimum level of speed enforcement. Neither agency currently considers this portion of STH 164 to be a high-risk corridor requiring their limited resources. The five hours per week noted in the example above probably represents the upper end of their combined, dedicated speed enforcement efforts on this segment of STH 164.

As a result, it is likely that up to a ten fold increase in enforcement presence will be needed to significantly nudge speeds downward on STH 164. This would take the form of, a minimum, eight hours targeted speed enforcement patrol every day. It is suggested under this scenario that patrols be assigned in two, four-hour blocks to match up with the heaviest traffic volumes; commuter morning and afternoon travel periods.

The participating agencies will also need to consider the enforcement threshold for speeding. It is suggested that in order for this scenario to be effective that enforcement start at 50 mph. This is the lowest threshold practical for a 45 mph posted speed limit. If this is implemented a rigid, and consistent policy in citing violators should be considered. Anything less will likely not result in any significant downward trend in overall vehicle speeds. However, our experience suggests that the rank and file patrol officers may be resistant to this type of enforcement policy. In addition, the motoring public may also not be receptive to an enforcement threshold that differs from the standard applied elsewhere in the county. A public backlash against the effort may be the result.

Assigning eight hours of patrol, every day, requires more than one full-time patrol position to accomplish. Given that both the Washington County Sheriff Department and Wisconsin State Patrol are on 8-hour shifts for road patrol, the Shift Relief Factor to fill eight hours per day 100 percent of the time is approximately 1.7. This means that, in order to meet the eight-hour per day patrol obligation, the equivalent time of 1.7 Deputies and/or Troopers would need to be assigned exclusively to this corridor. Both agencies advised that their current staffing and patrol priorities would preclude this taking place. It should be stressed that neither agency was supportive of adding patrol strength for the sole purpose of targeting speeding on this roadway.

TABLE 6.1 outlines the expected costs of this enforcement scenario using costs provided by both agencies.

TABLE 6.1 EXPECTED COSTS OF ENFORCEMENT SCENERIO

	Annual Cost of a Patrol Position	Shift Relief Factor	Total Annual Cost
Washington County Sheriffs Department	$127,000	1.7	$215,900
Wisconsin State Patrol	$108,000	1.7	$183,600

Unlike some traffic safety strategies, an enforcement program along STH 164 enforcing a 45 mph posted speed limit would have no end. Due to the historical 85th percentile speeds on this roadway, any cessation or reduction in enforcement will result in elevated travel speeds that will quickly approach the previous levels. As a result, speed differentials would increase to a level higher than the current condition which would likely lead to a higher number of crashes. In short, this will very likely need to be a permanent allocation of patrol resources to sustain significantly lower travel speeds.

If speed limits are not changed it is suggested that 10-15 hours per week of enforcement using existing staff resourced be considered. It will cost the enforcement agencies approximately $30,000 to $50,000 a year to implement this strategy. If implemented, the 85th percentile speeds along STH 164 should be reduced by 2-3 mph while the enforcement is present. To maintain any reduction in speeds, the enforcement needs to be continued perpetually.

6.5 Public Information and Education Campaign

As mentioned above, public information and education (PI&E) campaigns should accompany selective enforcement projects. PI&E campaigns maximize the impact of the program by raising the perceived risk in motorist's minds of being cited. The typical message for such a campaign revolves around the premise that high speeds are the result of too many fatal and serious injury crashes.

PI&E campaigns for speeding typically are centered on three key objectives:

- Create buy-in and acceptance to the project among law enforcement officials, judicial stakeholders (judges, prosecutors, etc.), and related transportation agency leaders and staff, to build relationships that will enhance the effectiveness of the effort, and leverage available resources in support of the campaign.

- Attract a cadre of private sector partners to expand local officials' capabilities in carrying out the campaign.
- Reach the broad audience of potential "speeders," while concentrating special effort on the segments of the target population most involved in speeding fatalities.

The goal is a consistent drumbeat of activity and level of visibility across the two-year time period, with strategic peaks that are aligned with more general public outreach to be carried out with project funding. Included in this is the need to establish a suitable theme or message. Perhaps the campaign might include testimonials from residents who live on or near STH 164 about their concerns for safe travel along this roadway. Depending on the aggressiveness of the campaign and whether paid media will be included, the cost for such a campaign would likely range between $10,000-100,000 per year.

6.6 Judicial Coordination

Before any venture involving special enforcement takes place, the relevant prosecutors and judges need to be notified and brought on board. Additional enforcement efforts place greater demands on courts that need advance planning and preparation.

Regarding the planned reduction of the posted speed limit along STH 164 to a uniform 45 mph, Washington County court officials should be apprised of the rationale for the change. Prosecutorial and judicial staff will then assess whether they concur with the changes made from a legal basis. It is suggested that, if this information has not yet been passed on to the court staff on the proposed change to the posted speed limit, it be done as soon as possible. A court's decision not to pursue adjudication of STH 164 speed violations due to a perception that the speed limit has been lowered unreasonably may result in a quick demise to any special speed enforcement efforts.

6.7 Cost Estimates

TABLE 6.2 is a summary of the estimated range of preliminary planning-level costs associated with the countermeasures presented in Sections 6.1 to 6.6.

TABLE 6.2 ESTIMATED RANGE OF COSTS FOR INDIVIDUAL COUNTERMEASURES

CATEGORY	COUNTERMEASURE	ESTIMATED COSTS			
		< $5,000	$5,000 to $100,000	$100,000 to $500,000	>$500,000
Site-Specific	Permanent speed feedback signs		√		
	Transverse speed bars	√			
	Flashing beacons at stop controlled intersections		√		
	Rumble strips		√		
Long-term	Install roundabouts**				√
	Install medians			√	
	Implement Intersection sight distance improvements		√		
Enforcement	Targeted Enforcement			√	
Public Information & Education	PI&E Campaign		√		
Judicial	Coordination with Washington County Courts	√			

** may vary with property acquisition costs.

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7.0 ECONOMIC ANALYSIS

7.1 Economic Evaluation Methodology

An economic evaluation has been conducted to estimate the potential societal benefits that may be attributed to the suggested mitigation measures. The benefits are related to crash characteristics such as severity and frequency, crash reduction potential, and average societal costs.

Societal costs have been based on estimates provided by the National Safety Council, which provides updated average comprehensive costs for motor vehicle crashes. The comprehensive costs include the calculable costs of collisions (wage and productivity losses, medical expenses, administrative expenses, motor vehicle damage, and employer costs) as well as the estimated value of the reduced quality of life. These costs are summarized in TABLE 7.1.

TABLE 7.1 ESTIMATED COSTS OF COLLISIONS

SEVERITY	ESTIMATED COST
Fatal	$3,840,000
Average Injury*	$40,000
incapacitating injury (A)	*$193,800*
non-incapacitating injury (B)	*$49,500*
possible injury (C)	*$23,600*
Property Damage Only	$2,200

NOTE: *****based on weighted average obtained from the distribution of collision severity of injuries at the study intersection, and assuming one dominant injury type per collision*
SOURCE: *"Estimating the Costs of Unintentional Injuries, 2005" from the National Safety Council website www.nsc.org.*

For the purpose of the economic evaluation, the net annual operating costs, maintenance costs, and salvage values were assumed to be negligible. A discount rate of 8 percent was assumed. Crash reduction factors, shown in TABLE 7.2, have been derived from values provided by FHWA[2]. The costs and benefits of the proposed countermeasures, with the expected benefit-cost ratio, are summarized in TABLE 7.2.

[2] *FHWA Desktop Reference for Crash Reduction Factors* (U.S. Department of Transportation Federal Highway Administration, 2007)

7.2 Results of the Evaluation

The implementation of a comprehensive package of countermeasures is expected to result in a reduction of collisions by about 30 percent. The package is expected to generate an estimated annual benefit of $645,000 with a benefit cost ratio of about 0.7 to 1. The assessment of the comprehensive package has been based on the assumption of an overall 20-year service life, consistent with the service life of its major cost components.

TABLE 7.2 ECONOMIC EVALUATION OF SUGGESTED IMPROVEMENTS

IMPROVEMENT	ASSUMED SERVICE LIFE	QUANTITY (number of length)	ESTIMATED COST OF IMPROVE-MENT	EXPECTED CRASH REDUCTION	ESTIMATED ANNUAL BENEFIT	ESTIMATED BENEFIT: COST RATIO
Permanent speed feedback signs	10 years	4 signs	$30,000	15%	$323,000	>10:1
Transverse speed bars	2 years	2 locations	$4,000	25%	$39,000	>10:1
Flashing beacons at stop controlled intersection	10 years	8 signs	$80,000	25%	$280,000	7:1
Rumble strips	10 years	11 miles	$40,000	50% (run-off road crashes)	$104,000	5:1
Install roundabouts	20 years	2 locations	$3,000,000	60%	$718,000	1.1:1
Install medians (each 100' long)	20 years	4 medians	$600,000	25%	$39,000	0.3:1
Intersection sight distance improvements	20 years	1 location	$250,000	30%	$37,000	0.7:1
Enforcement countermeasures- Reduce to 45 mph	1 year	11 miles	$215,900	20%	$430,000	2:1
Enforcement countermeasures- No change to speed limit	1 year	11 miles	$50,000	20%	$430,000	9:1
Public information education	1 year	--	$50,000	10%	$215,000	5:1
Coordination with Washington County courts	--	--	--	--	--	--
Combined measures	20 years	--	$4,319,900	30%	$645,000	0.7:1

APPENDIX A

USLIMITS OUTPUTS

USLIMITS2 Data Output

Basic Project Information

Project Name - CTH Q, Monches Rd., Elmwood Rd.
Project Number - H-U0011.06
Project Date - 01-25-2008
State - Wisconsin
County - Washington County
City -
Route - STH 164
Route Type - Road Section in Undeveloped Area
Route Status - NEW

Roadway Information

85th Percentile Speed - 60 mph
50th Percentile Speed - 55 mph
Section Length - 2.65 mile(s)
Statutory Speed Limit - 55 mile(s)
AADT - 7800
Adverse Alignment - No
Lanes and Presence/Type of Median - Two-lane road or undivided multilane.
Number of Lanes - 2
Roadside Hazard Rating - 2

Crash Data Information

Crash Data Months/Years - 3.00
Crash AADT - 7800
Total Number of Crashes - 39
Total Number of Injury Crashes - 25
Section Crash Rate - 172
Section Injury Rate - 110
Crash Rate Average for Similar Sections - 421
Injury Rate Average for Similar Sections - 292

Comments -

Recommended Speed Limit is:60

Note:

The final recommended speed limit is higher than the statutory speed limit for this type of road. The statutory limit is 55 mph.

USLIMITS2 Data Output

Basic Project Information

Project Name - N. of Elmwood, Hubertus, STH 167
Project Number - H-U0011.06
Project Date - 01-25-2008
State - Wisconsin
County - Washington County
City -
Route - STH 164
Route Type - Road Section in Undeveloped Area
Route Status - NEW

Roadway Information

85th Percentile Speed - 55 mph
50th Percentile Speed - 50 mph
Section Length - 1.90 mile(s)
Statutory Speed Limit - 50 mile(s)
AADT - 7100
Adverse Alignment - No
Lanes and Presence/Type of Median - Two-lane road or undivided multilane.
Number of Lanes - 2
Roadside Hazard Rating - 2

Crash Data Information

Crash Data Months/Years - 3.00
Crash AADT - 7100
Total Number of Crashes - 41
Total Number of Injury Crashes - 28
Section Crash Rate - 278
Section Injury Rate - 190
Crash Rate Average for Similar Sections - 527
Injury Rate Average for Similar Sections - 360

Comments -

Recommended Speed Limit is:55

Note:

The final recommended speed limit is higher than the statutory speed limit for this type of road. The statutory limit is 50 mph.

USLIMITS2 Data Output

Basic Project Information

Project Name - Mid-block of STH 167 and Pleasant Hill Rd. to Mid-Block of Pleasant Hill and Pioneer
Project Number - H-U0011.06
Project Date - 01-25-2008
State - Wisconsin
County - Washington County
City -
Route - STH 164
Route Type - Road Section in Undeveloped Area
Route Status - NEW

Roadway Information

85th Percentile Speed - 50 mph
50th Percentile Speed - 47 mph
Section Length - 1 mile(s)
Statutory Speed Limit - 40 mile(s)
AADT - 6400
Adverse Alignment - No
Lanes and Presence/Type of Median - Two-lane road or undivided multilane.
Number of Lanes - 2
Roadside Hazard Rating - 5

Crash Data Information

Crash Data Months/Years - 3.00
Crash AADT - 6400
Total Number of Crashes - 7
Total Number of Injury Crashes - 2
Section Crash Rate - 100
Section Injury Rate - 29
Crash Rate Average for Similar Sections - 100
Injury Rate Average for Similar Sections - 29

Comments -

Recommended Speed Limit is:50

Note:

The final recommended speed limit is higher than the statutory speed limit for this type of road. The statutory limit is 40 mph.
USLIMITS2 Data Output

Basic Project Information

Project Name - Mid-block of Pleasant Hill and Pioneer to STH 175
Project Number - H-U0011.06
Project Date - 01-25-2008
State - Wisconsin
County - Washington County
City -
Route - STH 164
Route Type - Road Section in Undeveloped Area
Route Status - NEW

Roadway Information

85th Percentile Speed - 60 mph
50th Percentile Speed - 57 mph
Section Length - 2.60 mile(s)
Statutory Speed Limit - 55 mile(s)
AADT - 5300
Adverse Alignment - No
Lanes and Presence/Type of Median - Two-lane road or undivided multilane.
Number of Lanes - 2
Roadside Hazard Rating - 2

Crash Data Information

Crash Data Months/Years - 3.00
Crash AADT - 5300
Total Number of Crashes - 18
Total Number of Injury Crashes - 7
Section Crash Rate - 119
Section Injury Rate - 46
Crash Rate Average for Similar Sections - 310
Injury Rate Average for Similar Sections - 121

Comments -

Recommended Speed Limit is:60

Note:

The final recommended speed limit is higher than the statutory speed limit for this type of road. The statutory limit is 55 mph.

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APPENDIX B

COLLISION DIAGRAMS

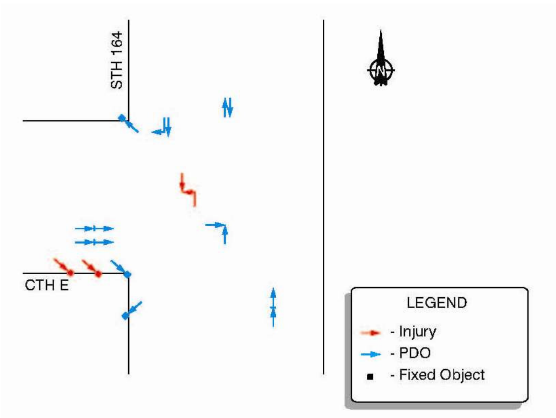

FIGURE A-1 STH 164 AND CTH E

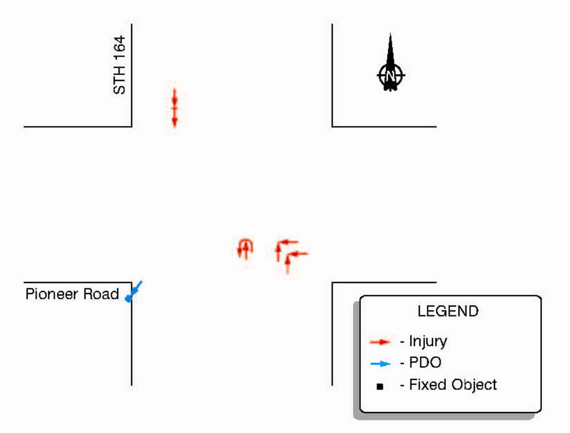

FIGURE A-2 STH 164 AND PIONEER ROAD

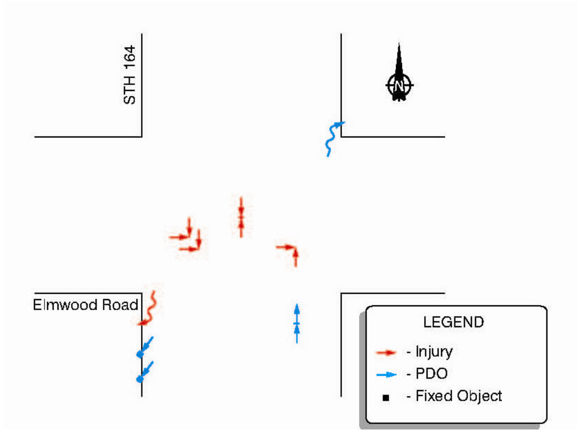

FIGURE A-3 STH 164 AND ELMWOOD ROAD

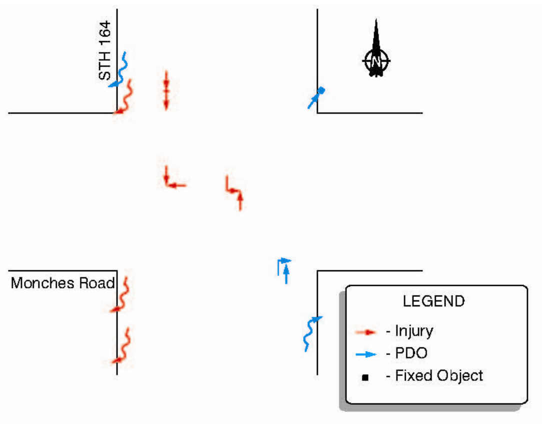

FIGURE A-4 STH 164 AND MONCHES ROAD

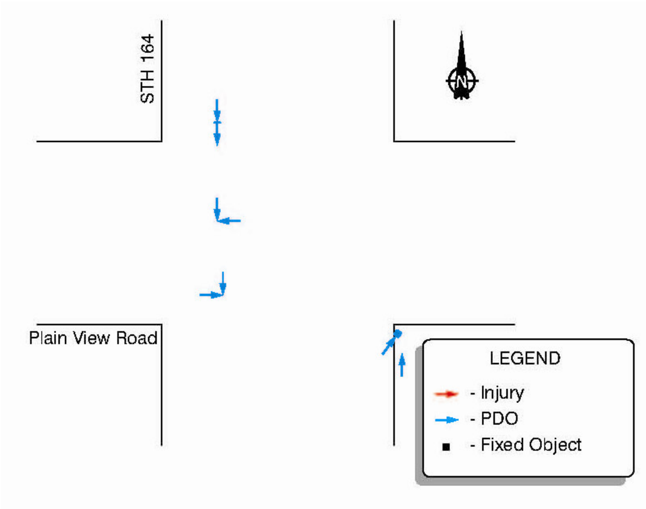

FIGURE A-5 STH 164 AND PLAIN VIEW ROAD

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OPUS

- Road Safety Engineering
- Transportation Planning
- Traffic Operations
- Transit and Sustainability
- Community and School Safety
- Asset Management