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MEMORANDUM REPORT NUMBER 117

TRAFFIC STUDY OF SELECTED INTERSECTIONS IN THE VILLAGE OF HARTLAND

WAUKESHA COUNTY, WISCONSIN

Prepared by the

Southeastern Wisconsin Regional Planning Commission P. O. Box 1607 Old Courthouse 916 N. East Avenue Waukesha, Wisconsin 53187-1607

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SEWRPC Memorandum Report No. 117

TRAFFIC STUDY OF SELECTED INTERSECTIONS IN THE VILLAGE OF HARTLAND: 1996

INTRODUCTION

In a letter dated December 7, 1995, the Village of Hartland requested the Regional Planning Commission staff to conduct a traffic study of six Village intersections. These intersections were: 1) the intersection of E. Capitol Drive (CTH JJ), Lisbon Avenue (CTH JK), Merton Avenue (CTH KC) and Highland Avenue; 2) the intersection of E. Capitol Drive and Maple Avenue; 3) the intersection of E. Capitol Drive and Church Street; 4) the intersection of E. Capitol Drive, North Avenue, and Hill Street; 5) the intersection of Cottonwood Avenue, W. Capitol Drive and Haight Drive; and, 6) the intersection of W. Capitol Drive, W. Park Avenue and Prospect Avenue. This report presents the findings and recommendations of the requested study.

Following this brief introduction, this report presents in turn for each of the six intersections inventory findings with respect to the physical and operational characteristics of the intersections, analyses of potential traffic problems, identification and evaluation of alternatives considered to abate those problems, and the recommended actions and the estimated cost to implement them. The final section of the report summarizes the study findings and recommendations.

INTERSECTION OF E. CAPITOL DRIVE (CTH JJ), LISBON AVENUE (CTH JK), MERTON AVENUE (CTH KC), AND HIGHLAND AVENUE

This section documents the inventory findings, potential traffic problems, and evaluation of alternatives for the intersection of E. Capitol Drive, Lisbon Avenue, Merton Avenue, and Highland Avenue.

Jurisdictional Classification

A number of the legs of the subject intersection are county trunk arterial highways under the jurisdiction of Waukesha County. Therefore, any actions taken that would substantially alter the use or capacity of this intersection would require the concurrence of Waukesha County. County trunk highways include E. Capitol Drive east of Merton Avenue which is designated CTH JJ. Similarly, Lisbon Avenue east of Merton Avenue is a county trunk highway designated CTH JK. Finally, Merton Avenue north of E. Capitol Drive is signed as a county trunk highway--CTH KC--but is currently under the jurisdiction of the Village between E. Capitol Drive and STH 16.

Under the adopted Waukesha County Jurisdictional Highway System Plan each of these facilities is expected to operate as an arterial facility under the jurisdiction of Waukesha County with the exception of Highland Avenue. Highland Avenue is expected to function as a land access facility under the jurisdiction of the Village.

Intersection Physical and Operational Characteristics

The "intersection" of E. Capitol Drive, Lisbon Avenue, Merton Avenue, and Highland Avenue is, in fact, three closely spaced intersections as shown in Figure 1. The westernmost intersection is a "three-legged", "Y" intersection with the angle of intersection between legs of the "Y" approximating 22 degrees. This intersection is located approximately 150 feet west of two "four-legged" intersections. The northernmost intersection of the two "four-legged" intersections is separated from the southern intersection by approximately 60 feet. All legs of the existing intersection are constructed to urban cross-sections. The posted speed limit on all legs of the intersection is 25 miles per hour.

Merton Avenue north of E. Capitol Drive has an existing pavement width of 36 feet from curb face to curb face. Parking is allowed on both the east and west sides of Merton Avenue. An exclusive right turn lane exists to accommodate southbound vehicles making right turns onto E. Capitol Drive.

Lisbon Avenue east of E. Capitol Drive has an existing pavement width of 22 feet. Parking is permitted on both the north and south sides of Lisbon Avenue.





E. Capitol Drive east of Highland Avenue has an existing pavement width of 24 feet. Parking is allowed on both the north and south sides of E. Capitol Drive.

Highland Avenue south of E. Capitol Drive has an existing pavement width of 24 feet from curb face to curb face. Parking is allowed on both the east and west sides of Highland Avenue.

E. Capitol Drive west of Merton Avenue has an existing pavement width of 40 feet from curb face to curb face. Parking is allowed on both the north and south sides of E. Capitol Drive.

The approaches to the intersection are stop sign controlled, with the following exceptions: eastbound traffic on E. Capitol Drive is uncontrolled, and westbound traffic on E. Capitol Drive is uncontrolled at its intersection with Highland Avenue and Merton Avenue. The sight distances from the stop lines on the approaches to this intersection are generally adequate.

Traffic Volumes

The Commission staff conducted manual turning movement counts and 24 hour machine traffic counts in June, 1996. Based upon the 24 hour machine counts, the average weekday traffic counts on Merton Avenue were approximately 7,005 vehicles per average weekday on E. Capitol Drive just north of E. Capitol Drive; about 7,450 vehicles per average weekday on E. Capitol Drive just west of the "Y" intersection; approximately 435 vehicles per average weekday on Highland Avenue just south of E. Capitol Drive; about 1,890 vehicles per average weekday on E. Capitol Drive; and about 1,005 vehicles per average weekday on Lisbon Avenue just east of Merton Avenue. Approximately 8,620 vehicles entered the intersection on an average weekday in 1996. It may be noted that during the morning peak traffic period of 6:00 a.m. to 9:00 a.m. and evening peak traffic period of 3:00 p.m. to 6:00 p.m. no vehicular queues greater than two vehicles were observed and that attendant delay was insignificant.

The manual turning movement counts were collected during the morning peak traffic period from 6:00 a.m. to 9:00 a.m. and the evening peak traffic period from 3:00 p.m. to 6:00 p.m.. These time periods included both the morning and evening peak

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hours of traffic flow. Based upon the manual turning counts, the number of vehicles entering the intersection on an average weekday between 6:00 a.m. to 9:00 a.m. and between 3:00 p.m. to 6:00 p.m. was approximately 3,530 in 1996, representing about 41 percent of total weekday traffic volume. The morning and evening peak hour manual turning movement counts are shown in Figure 2 along with the estimated 1996 average weekday turning movement volumes.

A significant portion of the eastbound traffic on E. Capitol Drive turns left onto Merton Avenue. During the morning peak hour, approximately 280 vehicles, or about 85 percent of the total eastbound traffic stream on E. Capitol Drive turns left. Similarly a substantial percentage of the southbound Merton Avenue traffic stream is involved in turning right to E. Capitol Drive. During the evening peak hour, approximately 235 vehicles, or about 82 percent of the total southbound traffic stream, turn right. The number of vehicles turning right from the southbound approach of the intersection exceeded 200 vehicles per hour three times during the six hours manual turning movement counts were collected. The number of vehicles turning left from the eastbound approach of the intersection exceeded 200 vehicles per hour twice during the six hours manual turning movements were collected.

A second significant movement involves the traffic on E. Capitol Drive. In the evening peak hour, about 70 vehicles turn right from the westernmost E. Capitol Drive intersection to continue on E. Capitol Drive toward the southern intersection. Of those 70 vehicles, about 60 vehicles, or 86 percent, proceed through the southern intersection to E. Capitol Drive. During the evening peak hour approximately 100 vehicles entered the intersection of E. Capitol Drive and Highland Avenue from the east, where approximately 70 of the vehicles, or 70 percent, proceed through that intersection, and then west through the "Y" intersection.

Thus, the predominant movement of traffic at the intersection is between E. Capitol Drive west of the intersection and Merton Avenue north of the intersection. This movement accounts for 5,405, or 63 percent, of the total 8,620 vehicles entering the intersection on an average weekday.

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TURNING MOVEMENT TRAFFIC VOLUMES AT THE INTERSECTIONS OF E. CAPITOL DRIVE, MERTON AVENUE, LISBON AVENUE, AND HIGHLAND AVENUE IN THE VILLAGE OF HARTLAND: 1996

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TURNING MOVEMENT TRAFFIC VOLUMES AT THE INTERSECTIONS OF E. CAPITOL DRIVE, MERTON AVENUE, LISBON AVENUE, AND HIGHLAND AVENUE IN THE VILLAGE OF HARTLAND: 1996



Traffic Accidents

The incidence and pattern of traffic accidents can provide an indication of the efficiency and operating characteristics of an intersection. A three-year motor vehicle accident history from January 1, 1993, to December 31, 1995, for the intersection of E. Capitol Drive, Lisbon Avenue, Merton Avenue, and Highland Avenue was collected. During this time, no accidents occurred at this intersection.

Identification of Potential Traffic Problems

The inventory data were compared to generally accepted traffic engineering and geometric design standards to determine if any traffic operational, safety, or geometric design problems exist at the subject intersection. As previously noted, no accidents occurred during the three year period reviewed, and insignificant traffic delay and vehicle queues were observed at this intersection. However, two geometric design elements were identified as substandard: 1) the acute angle of intersection between legs of the "Y" intersection; and 2) the close proximity of the three intersections.

One of the substandard design elements is the angle of intersection at the "Y" intersection. The desired angle of intersection is 90 degrees and the minimum angle of intersection is 60 degrees. The existing angle of intersection between legs of the "Y" intersection is 22 degrees, substantially less than even the minimum angle of intersection. As a result, motorists who must stop on the westbound E. Capitol Drive approach at the "Y" intersection must find a gap in traffic by looking directly ahead at eastbound E. Capitol Drive traffic, and then looking back over their right shoulder to the east to check for traffic heading west from the Lisbon Avenue and Merton Avenue intersection. In addition, this westbound traffic on E. Capitol Drive must travel a long distance to physically cross the northern intersection leg. Significant vehicle gaps must exist for the westbound traffic to cross this intersection.

Another substandard design element is the proximity of the three individual intersections. The spacing of these intersections, which ranges from about 60 feet to 150 feet, is substantially less than the desired 300 foot spacing between adjacent intersections.

Another deficiency in the design of the intersection is that the predominant movement of traffic involves turning movements between E. Capitol Drive and Merton Avenue. It would be desirable for the predominant movement of traffic to be direct, and involve no turns.

Another deficiency in the operation of the intersection is that it does not follow the typical practice of arterial intersection traffic control of having all approaches stop sign controlled, or approaches on one street uncontrolled and on the cross street stop sign controlled. At the intersection of E. Capitol Drive with Merton Avenue and Lisbon Avenue, the intersection approaches are controlled by stop signs except the eastbound approach.

Even though there are these substandard design elements--acute angle of intersection, inadequate intersection spacing, predominant movement of traffic through the intersection is a turning movement, and an operational problem of nonstandard intersection approach traffic control--at these intersections, no accidents have occurred during the three-year accident history reviewed and observation of traffic indicated minimal vehicle delay.

Alternatives Considered to Abate Identified Traffic Problems

A number of alternative actions were considered to address the identified design Three alternatives -- Alternatives 1, 2, and 3-- as shown in Table deficiencies. 1, were developed to eliminate the acute angle of intersection and the nonstandard intersection traffic control problems, and to reduce the intersection These three alternatives would eliminate the "Y" intersection spacing problem. by abandoning the leg of E. Capitol Drive to the west of Highland Avenue as shown in Figure 3. Under these three alternatives, traffic control at the northern intersection would be modified to provide stop sign control on all approaches at the intersection. The traffic control at the southern intersection would have stop sign control only on the Highland Avenue intersection approach. The advantages and disadvantages of each of these three alternatives is set forth in Table 1, along with the estimated construction cost to implement each alternative.

COMPARISON OF THE ALTERNATIVE ACTIONS CONSIDERED TO ABATE THE SUBSTANDARD DESIGN ELEMENTS IDENTIFIED AT THE INTERSECTION OF E. CAPITOL DRIVE, LISBON AVENUE, MERTON AVENUE AND HIGHLAND AVENUE

Table 1

				Estimated
Action/ Description	Problem/Deficiency Address	Advantages	Disadvantages	Cost
Alternative 1 Eliminate the southern "leg" of the "V" intersection and convert the E. Capitol Drive, Lisbon Avenue, and Merton Avenue intersection to four- way stop control (see Figure 3)	 Acute intersection angle Number of intersections and spacing Provide standard intersection traffic control^a 	 Reduce number of intersections from three to two Standardizes intersection traffic control Eliminate sight distance problem at "Y" intersection Potential to be implemented on a trial basis and its effectiveness evaluated by Village prior to permanent installation No right-of-way acquisition required Construction could be done as part of currently planned reconstruction of E. Capitol Drive between Maple Avenue and Merton Avenue Increases green space at these intersections; plant material should be limited to grass or low growing ground cover shrubbery 	 Conversion to four-way stop control will cause eastbound motorist to incur delay and may result in rear-end accidents on the eastbound approach Without an exclusive left turn lane, the increase in the number of northbound left turning vehicles may delay other traffic on northbound approach of northeastern intersection thereby modestly increasing overall travel times Distance between the two remaining intersections is still substandard Predominant movement through intersection would remain a turning movement, rather than be a direct movement 	\$21,000
Alternative 2 Eliminate the southern "leg" of the "Y" intersection, and relocate the southernmost intersection and convert the E. Capitol Drive, Lisbon Avenue, and Merton Avenue intersection to four-way stop control (see Figure 4)	 Acute intersection angle Number of intersections and spacing Provide standard intersection traffic control^a 	 Reduce number of intersections from three to two Standardizes intersection traffic control Eliminate sight distance problem at "Y" intersection Reduce proximity of intersections Improved angle of intersection of southernmost intersection Construction could be done as part of the currently planned reconstruction of E. Capitol Drive between Maple Avenue and Merton Avenue Increases green space at these intersections; plant material should be limited to grass or low growing ground cover shrubbery 	 Conversion to four-way stop control will cause eastbound motorist to incur delay and may result in rear-end accidents on the eastbound approach Northbound left turns may slow other traffic on northbound approach of northeastern intersection Distance between the two remaining intersections is still substandard Right-of-way acquisition may be required Predominant movement through intersection would remain a turning movement, rather than be a direct movement 	\$31,000
Alternative 3 Eliminate the southern "leg" of the "Y" intersection, relocate the southernmost intersection, and provide selected exclusive turn lanes and convert the E. Capitol Drive, Lisbon Avenue, and Merton Avenue intersection to four-way stop control (see Figure 5)	 Acute intersection angle Number of intersections and spacing Provide standard intersection traffic control^a 	 Reduce number of intersections from three to two Standardizes intersection traffic control Eliminate sight distance problem at "Y" intersection Reduce proximity of intersections Improved angle of intersection of southernmost intersection Separation of through and selected turning traffic on eastbound and northbound approaches of northeastern intersection Increases green space at these intersections; plant material should be limited to grass or low growing ground cover shrubbery 	 Conversion to four-way stop control will cause eastbound motorist to incur delay and may result in rear-end accidents on the eastbound approach Distance between the two remaining intersections is still substandard Right-of-way acquisition may be required Predominant movement through intersection would remain a turning movement, rather than be a direct movement 	\$40,100

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Table 1 - continued

Action/ Description	Problem/Deficiency Address	Advantages	Disadvantages	Estimated Construction Cost
Alternative 4 Provide for a direct through route of the predominant traffic movement at the intersection; eliminate the southern "Leg" of the "Y" intersection, relocate the southernmost intersection, and provide selected exclusive turn lanes (See Figure 6)	 Acute intersection angle Number of intersections and spacing Convert principal intersection movement from turning to direct Provide standard intersection traffic control 	 Facilitate the movement of traffic between Capitol Drive and Merton Avenue by eliminating the existing right angle turn Standardizes intersection traffic control Reduce number of intersections from three to two Eliminate sight distance problem at "Y" intersection Reduce proximity of intersections Modestly improved angle of intersection of southernmost intersection Construction could be done as part of the currently planned reconstruction of E. Capitol Drive between Maple Avenue and Merton Avenue Increases green space at these intersections; plant material should be limited to grass or low growing ground cover akrubbery 	 Distance between the two remaining intersections is still substandard Substantial right-of-way acquisition required Modest travel indirection between Lisbon Avenue and points north and west of existing intersection Reconstruction includes facilities currently under the jurisdiction of Waukesha County Edge of roadway approximately 30 feet nearer residence in northwest quadrant of northern intersection; approximately 25 feet nearer to the residence east of Merton Avenue and south of Lisbon Avenue 	\$310,000

^a In order to address the nonstandard intersection control deficiency, the installation of a "STOP" sign on the eastbound E. Capitol Drive approach to the E. Capitol Drive, Lisbon Avenue, and Merton Avenue intersection was considered. This would standardize the intersection control and eliminate any uncertainty with respect to right-of-way at the intersection particularly for non-resident motorists. Requiring all motorists to stop may be expected to improve student-pedestrian safety at the intersection. However, the installation of "STOP" signs, in general, may result in rear-end accidents and, in this instance, imposes delay on motorists using the previously uncontrolled approach.

Source: SEWRPC.

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Figure 3

PROPOSED REALIGNMENT ALTERNATIVE NUMBER 1 FOR THE INTERSECTION OF E. CAPITOL DRIVE, LISBON AVENUE, MERTON AVENUE, AND HIGHLAND AVENUE





The first alternative, Alternative 1, is shown on Figure 3. It could be constructed entirely within existing right-of-way and within the limits of existing pavement.

The second alternative considered would include implementation of the first alternative and, as well the realignment of Highland Avenue to meet E. Capitol Drive at a right angle by introducing a radius into Highland Avenue's alignment as shown in Figure 4. The advantages and disadvantages of this the alternative are set forth in Table 1 along with the estimated construction cost of implementing this alternative.

The third alternative would be essentially the same as the second alternative but would include the provision of an exclusive right-turn lane for eastbound traffic on E. Capitol Drive, and an exclusive left-turn lane for the northbound approach to the northernmost intersection as shown in Figure 5. The advantages and disadvantages of this alternative are set forth in Table 1 along with the estimated construction cost of implementing this alternative. Each of these three alternatives may be constructed largely within the existing right-of-way, and at a cost ranging from \$21,000 to \$40,100. The primary disadvantages of these alternatives are that the principal movement through the intersection remains a turning movement, and the imposition of four-way stop control at the northern intersection may be expected to result in an increase in traffic delay.

A fourth alternative, as shown on Figure 6, was considered which would address all of the intersection design problems: acute angle of intersection, number of intersections and inadequate spacing, turn movement at principal intersection movement, and nonstandard intersection traffic control. This alternative would directly connect Merton Avenue with E. Capitol Drive west of Merton Avenue. However, as shown in Table 1, it would have an estimated cost of \$310,000, and require the acquisition of right-of-way with taking of substantial strips of property from four residences. The resultant reconstructed intersections would still have less than 90 degree angles, would occur on or near horizontal curvature, and would have less than desirable spacing.

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Figure 4

PROPOSED REALIGNMENT ALTERNATIVE NUMBER 2 FOR THE INTERSECTION OF E. CAPITOL DRIVE, LISBON AVENUE, MERTON AVENUE, AND HIGHLAND AVENUE







Figure 5

PROPOSED REALIGNMENT ALTERNATIVE NUMBER 3 FOR THE INTERSECTION OF E. CAPITOL DRIVE, LISBON AVENUE, MERTON AVENUE, AND HIGHLAND AVENUE









Source: SEWRPC.



Figure 6

Summary and Conclusions

Of the four intersection improvement alternatives evaluated, only Alternative 4 which would directly connect Merton Avenue to E. Capitol Drive, would address all four of the design problems at the intersection--acute angle of intersection, inadequate intersection spacing, principal intersection movement is turning movement, and nonstandard intersection traffic control. However, Alternative 4 has a substantial construction cost of \$310,000 and entails taking of strips of right-of-way from seven residences, including substantial strips from four residences.

Each of the three remaining alternatives would address the acute angle of intersection, inadequate intersection spacing, and nonstandard intersection traffic control, but the predominant traffic movement would continue to require a turning movement. The conversion to four-way stop control will cause eastbound traffic to incur delay it does not currently incur and may result in rear-end accidents on the eastbound approach. Of these three alternatives, Alternative 3 best addresses the acute angle of intersection, inadequate intersection spacing, and nonstandard intersection traffic control problems.

It is recommended that the Village of Hartland consider implementation of either Alternative 3 or Alternative 4 as part of the reconstruction of E. Capitol Drive from Maple Avenue to Merton Avenue. Alternative 4 would best improve traffic flow through the intersection, but requires the acquisition of right-of-way and has a significantly greater construction cost. Alternative 3 would address the intersection design problems at a significantly lower cost and with less rightof-way acquisition but may be expected to increase intersection traffic delay.

In the consideration of these intersection improvement alternatives, it should be noted that the existing intersection, even with its four design problems, has been operating very efficiently and based upon forecast year 2010 traffic volumes, may continue such operation. No traffic accidents have occurred at the intersection over the past three years, and minimal to no delay was observed to occur at the intersection on an average weekday, including during peak traffic periods.

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INTERSECTIONS OF E. CAPITOL DRIVE AND MAPLE AVENUE, AND E. CAPITOL DRIVE AND CHURCH STREET

This section documents the inventory findings, potential traffic problems, and evaluation of alternatives for the intersections of E. Capitol Drive and Maple Avenue, and E. Capitol Drive and Church Street. These two intersections were considered together due to their proximity--approximately 120 feet--to one another.

Jurisdictional Classification

The E. Capitol Drive and Maple Avenue legs of the intersection are current and planned arterial facilities, and the Church Street leg is a current and planned land access street. All of the legs of the subject intersections are currently under the jurisdiction of the Village of Hartland.

Under the adopted Waukesha County Jurisdictional Highway System Plan, E. Capitol Drive and Maple Avenue are proposed to be county trunk highways under the jurisdiction of Waukesha County. Church Street is expected to continue functioning as a land access facility under the jurisdiction of the Village.

Intersection Physical and Operational Characteristics

The intersections of E. Capitol Drive and Maple Avenue, and E. Capitol Drive and Church Street are two closely spaced intersections as shown in Figure 7, separated by approximately 120 feet. The intersection of E. Capitol Drive and Maple Avenue is a "three-legged", "tee" intersection. The intersection of E. Capitol Drive and Church Street is a "four-legged" intersection with the fourth leg being a commercial driveway on the south side of E. Capitol Drive opposite Church Street. No exclusive turn lanes are provided on any intersection approach at either intersection. All legs of the existing intersection are constructed to urban cross-sections. The posted speed limit on all legs of the intersection is 25 miles per hour.

Church Street north of E. Capitol Drive has an existing pavement width of 32 feet from curb face to curb face. Parking is allowed on both the east and west sides of Church Street.

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EXISTING E. CAPITOL DRIVE AND MAPLE AVENUE, AND E. CAPITOL DRIVE AND CHURCH STREET INTERSECTIONS: 1996 East Capitol Drive through both intersections has an existing pavement width of 40 feet from curb face to curb face. No parking is allowed on the south side between Church Street and Maple Avenue. No parking is allowed on the north side of E. Capitol Drive from a point approximately 125 feet east of Maple Avenue, to Church Street on weekdays. Parking is permitted on the north side of E. Capitol Drive on Saturday, Sunday and holidays.

Maple Avenue south of E. Capitol Drive has an existing pavement width of 30 feet. No parking is allowed on either the east or west sides of Maple Avenue for a distance of about 0.6 miles south of Capitol Drive.

The southbound approach of Church Street is stop sign controlled at E. Capitol Drive. All three legs of the intersection of E. Capitol Drive and Maple Avenue are stop controlled. Advance signing which provides warning of the stop control is posted east of Maple Avenue on the westbound E. Capitol Drive approach and west of Church Street on the eastbound E. Capitol Drive. The sight distances from the stop lines on all approaches to both intersections are adequate.

Northbound Maple Avenue has a "SCHOOL CROSSING" sign with a "15 MILES PER HOUR WHEN CHILDREN ARE PRESENT" speed limit sign located approximately 190 feet south of E. Capitol Drive.

Traffic Volumes

The Commission staff conducted manual turning movement counts and 24 hour machine traffic counts at this intersection in June, 1996. Based upon the 24 hour machine counts, the average weekday traffic counts on E. Capitol Drive were approximately 6,455 vehicles per average weekday west of Church Street; about 575 vehicles per average weekday on Church Street north of E. Capitol Drive; approximately 7,205 vehicles per average weekday on E. Capitol Drive east of Maple Avenue; and about 6,855 vehicles per average weekday on Maple Avenue south of E. Capitol Drive. Approximately 6,945 vehicles entered the intersection of E. Capitol Drive and Church Street, and approximately 10,925 vehicles entered the intersection of E. Capitol Drive and Maple Avenue on an average weekday in 1996.

Some vehicle delay during the morning peak traffic period of 6:00 a.m. to 9:00 a.m. and the afternoon peak traffic period of 3:00 p.m. to 6:00 p.m. was observed on all legs of the intersection of E. Capitol Drive and Maple Avenue. The maximum queue of vehicles was observed on the westbound approach to this intersection and was observed to be about six vehicles. The maximum delay to any vehicle was less than 60 seconds and the longer vehicle queues tended to dissipate entirely before the next queue developed.

Manual turning movement counts were collected during the morning peak traffic period from 6:00 a.m. to 9:00 a.m.; the evening peak traffic period from 3:00 p.m. to 6:00 p.m. as well as the intervening midday hours from 9:00 a.m. to 3:00 Manual turning movement counts were collected during the midday traffic p.m. period from 9:00 a.m. to 3:00 p.m. because traffic patterns observed during the peak traffic periods indicated that turn lanes may be warranted, and the additional data was necessary to establish the need during the peak traffic period. Based upon the 12 hour manual turning counts, the number of vehicles entering the intersection of E. Capitol Drive and Church Street on an average weekday between 6:00 a.m. and 6:00 p.m. was approximately 4,670 in 1996, representing about 67 percent of the total weekday traffic volume. Similarly, based upon the 12 hour manual turning counts, the number of vehicles entering the intersection of E. Capitol Drive and Maple Avenue on an average weekday between 6:00 a.m. and 6:00 p.m. was approximately 6,980 in 1996, representing about 68 percent of the total weekday traffic volume. The morning and evening peak hour manual turning movement counts are shown in Figure 8 along with the estimated 1996 average weekday turning movement volumes.

The manual turning movement count data indicated that turning movements accounted for about 60 percent of all movements at the intersection of E. Capitol Drive and Maple Avenue between 6:00 a.m. and 6:00 p.m, but just 12 percent of all movements at the intersection of E. Capitol Drive and Church street during the same time period. During the morning peak hour, more than 65 percent of all vehicles were observed turning at the intersection of E. Capitol Drive and Maple Avenue. The northbound right-turn represented the highest turning movement observed during the morning peak hour at 215 vehicles representing almost 77 percent of the northbound traffic. At the intersection of E. Capitol Drive and Church Street,



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TURNING MOVEMENT TRAFFIC VOLUMES AT THE INTERSECTIONS OF E. CAPITOL DRIVE AND MAPLE AVENUE, AND E. CAPITOL DRIVE AND CHURCH STREET IN THE VILLAGE OF HARTLAND: 1996



just 14 percent of all vehicles were observed turning during the morning peak hour.

At the intersection of E. Capitol Drive and Church Street, less than 10 percent of all vehicles were observed turning during the evening peak hour. However, more than 66 percent of all vehicles were observed turning at the intersection of E. Capitol Drive and Maple Avenue. The westbound left-turn represented the highest turning movement observed during the evening peak hour at 265 vehicles. This volume represents about 62 percent of all westbound traffic. During the evening peak hour, it was observed that the through traffic and left-turning traffic would split into two separate traffic streams on the 20 foot wide westbound approach. This results in two, ten-foot wide, traffic lanes--two feet narrower than the desired 12 foot lane width--and this substandard lane width may present a traffic safety problem. The hourly number of vehicles turning left from the westbound approach of the intersection for the 12 hours between 6:00 a.m. and 6:00 p.m. exceeded 100 vehicles per hour three times, and exceeded 250 vehicles per hour one time.

Substantial turning traffic was also observed on the eastbound approach to this intersection during the evening peak hour. Approximately 105 vehicles were observed turning right, or about 33 percent of all eastbound traffic during the evening peak hour. Because of the volume of right-turns at this intersection, it was observed that the through traffic and right-turning traffic would split into two separate traffic streams by movement on the 20 foot wide eastbound approach. This results in two 10 foot wide traffic lanes--two feet narrower than the desired 12 foot lane width--and this substandard lane width may create a traffic safety problem.

In addition, the northbound approach to this intersection experienced high volumes during the evening peak traffic hour. During the evening peak hour, 220 vehicles turned right and 140 vehicles turned left from the northbound approach. The right-turning traffic exceeded 100 vehicles per hour six times, and exceeded 200 vehicles per hour twice during an average weekday in 1996. The left-turning traffic exceeded 90 vehicles per hour three times, and exceeded 100 vehicles per hour once during an average weekday in 1996. The total traffic on this approach

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is nearly evenly divided during an average weekday with respect to destination as approximately 45 percent of all northbound traffic turned left and the remainder turned right.

Traffic Accidents

The incidence and pattern of traffic accidents can provide an indication of the efficiency and operating characteristics of an intersection. A three-year motor vehicle accident history from January 1, 1993 to December 31, 1995 for the intersections of E. Capitol Drive and Maple Avenue, and E. Capitol Drive and Church Street, was collected and analyzed. As shown in Table 2, a total of two accidents occurred during the three-year period concerned, with one accident in 1993, and one in 1995. Neither of the accidents involved personal injury or a fatality.

Analysis of the three-year accident history data for the intersections concerned indicates that both of the accidents were multiple vehicle accidents. One of the accidents was a right-angle collision. The other accident occurred when a vehicle drove over a curb and the trailer being towed by the vehicle rolled over onto another vehicle. Because only two motor vehicle accidents were observed, one in 1993 and one in 1995, it may be concluded that during the three year period for which accident data were reviewed, no pattern of traffic accidents exists and the intersection is currently operating safely.

Identification of Potential Traffic Problems

The physical and operational characteristics of the two intersections were compared to generally accepted traffic engineering and geometric design standards to determine if any traffic operational or safety problems or geometric design problems exist at the subject intersection. As previously noted, no pattern of accidents occurred at this intersection during the three year period reviewed. Although vehicle queues and attendant delay were observed, the intersection generally operated with minimal delay. Thus, it may be concluded that no traffic safety or vehicle delay or congestion problem exists.

However, one potential operational problem was observed at this location. Typically, the provision of an exclusive left turn lane should be considered when

Table 2

INCIDENCE AND SEVERITY OF MOTOR VEHICLE ACCIDENTS AT THE INTERSECTION OF E. CAPITOL DRIVE AND MAPLE AVENUE BETWEEN JANUARY 1, 1993 AND DECEMBER 31, 1995^a

Year	Injury	Property Damage	Total
January 1 to December 31, 1993	0	1	1
January 1 to December 31, 1994	0	0	0
January 1 to December 31, 1995	0	1	1
Total	0	2	2

^aAny accident occurring within 150 feet of the intersection was considered an intersection accident.

Source: Wisconsin Department of Transportation, Division of Motor Vehicles, and SEWRPC.

the number of turning vehicles executing a left-turning movement from an intersection approach exceeds 100 vehicles in the peak hour. Based upon the manual turning movement counts conducted by the Commission staff, the number of left-turning vehicles observed on the northbound Maple Avenue approach during the evening peak hour was 140. Thus, because the number of left-turning vehicles observed during the evening peak hour exceeds the threshold for the provision of an exclusive left-turn lane, and because approximately 45 percent of the total traffic on the northbound approach turns left on an average weekday, it may be concluded that two lanes--one for left-turns--should be provided on the northbound approach.

Two potential geometric design elements were identified as substandard: 1) the 10 foot-wide lanes which result from the division of the approach traffic into two separate streams on a single 20 foot wide lane; and, 2) the close proximity of the two intersections.

One of the substandard design elements is the 10 foot lane width on the east- and westbound approaches at the E. Capitol Drive and Maple Avenue intersection. Because of high turning movement traffic volumes on the east- and westbound E. Capitol Drive approaches to Maple Avenue, traffic in each direction separates into two streams operating on a single 20 foot wide approach. This in turn creates two unmarked 10 foot wide lanes which are two feet narrower than the desired 12 foot lane width.

The other substandard design element is the proximity of the two individual intersections. The spacing of these intersections is approximately 120 feet, substantially less than the desired 300 foot spacing between adjacent intersections.

Lastly, there is a pictographic "SCHOOL CROSSING" sign posted approximately 190 feet south of the subject intersection facing northbound traffic. The <u>Manual on</u> <u>Uniform Traffic Control Devices</u> (MUTCD) requires that this School Crossing sign be erected at a crosswalk or at the minimum distance possible in advance of the crosswalk. The MUTCD further recommends that this sign not be posted at crossings controlled by stop signs. Because there is not a crossing in the vicinity of this sign, and because the nearest intersection is stop sign controlled, it may be concluded that this sign does not conform to the standards of the MUTCD and is inappropriate.

Even though there are substandard design elements--inadequate intersection spacing and substandard lane width on the east- and westbound approaches at the E. Capitol Drive and Maple Avenue intersection, predominant movement of traffic through the intersection is a turning movement, and an operational problem owing to the lack of an exclusive northbound left turn lane--at these intersections, only two accidents have occurred during the three-year accident history reviewed and observation of traffic indicated minimal vehicle delay.

Alternatives Considered to Abate Identified Traffic Problems

Two alternative actions set forth in Table 3 were considered to address the problems of substandard lane width attendant to the division of the approach traffic into two streams by movements within a single 20 foot wide traffic lane and the lack of an exclusive lane to accommodate the high volume of left-turning traffic on the northbound approach to the intersection of E. Capitol Drive and Maple Avenue. The first alternative action considered was the provision of an exclusive left-turn lane on the westbound approach and separate lanes for the left- and right-turning traffic on the northbound approach of the intersection of E. Capitol Drive and Maple Avenue as shown in Figure 9. Each of these lanes is proposed to be 12 feet in width. Traffic control at the intersections would remain the same.¹ The advantages and disadvantages are also set forth in Table 3, along with the estimated construction cost to implement this alternative. The provision of a single, 12 foot-wide lane on the eastbound approach would prevent the traffic on this approach from dividing into two separate traffic movements, the through movement and the right-turning movement as it currently does. As a result, vehicle queues and delay may be expected to substantially increase on this approach. Queues during the peak hours may be expected to extend back to

¹ Analyses at the intersection indicated that none of the warrants for the installation of traffic signals set forth in the Manual of Uniform Traffic Control Devices were met. Therefore, the installation of traffic signals is not recommended at the current time, as such installation may be expected to increase traffic delay and reduce traffic safety.

Table 3

COMPARISON OF ALTERNATIVE ACTIONS CONSIDERED TO ABATE THE SUBSTANDARD DESIGN ELEMENTS AT THE INTERSECTION OF E. CAPITOL DRIVE AND CHURCH STREET, AND E. CAPITOL DRIVE AND MAPLE AVENUE

Action/ Description	Advantages	Disadvantages	Estimated Construction Cost	
Alternative 1 Provision of an exclusive left- turn lane on the westbound ap- proach and separate turn lanes on the northbound approach of the intersection of E. Capitol Drive and Maple Avenue (see Figure 9)	 Separation of through and turning traffic on only the westbound approach to E. Capitol Drive and Maple Avenue intersection Separation of left and right turning traffic on the northbound approach to E. Capitol Drive and Maple Avenue Two 12 foot lanes would be provided on the westbound and northbound approaches to E. Capitol Drive and Maple Avenue intersection^a 	 Increased vehicle delay on eastbound approach as through and right turning vehicles are restricted to the same 12 foot wide lane Widening of Maple Avenue would eliminate the existing curb lawn on the east side of Maple Avenue Right-of-way acquisition may be required Does not resolve substandard intersection spacing problem Assuming 22 foot long parking spaces, an estimated 24 E. Capitol Drive weekday parking spaces eliminated, 19 spaces east of Maple Avenue, and five spaces west of Church Street, and an additional nine spaces on weekend days on the north side of E. Capitol Drive east of Church Street 	\$24,900	- 15a -
Alternative 2 Provision of exclusive left-turn lane on the westbound approach, separate turn lanes on the northbound approach, and an exclusive right-turn lane on the eastbound approach of the intersection of E. Capitol Drive and Maple Avenue (see Figure 10)	 Separation of through and turning traffic on the east- and westbound approaches to E. Capitol Drive and Maple Avenue intersection Two twelve foot lanes would be provided on all approaches to E. Capitol Drive and Maple Avenue intersection^a 	 Widening of both Maple Avenue and E. Capitol Drive would eliminate existing curb lawns and large trees within the curb lawns and may eliminate trees outside the curb lawn Right-of-way acquisition may be required Does not resolve substandard intersection spacing problem Assuming 22 foot long parking spaces, an estimated 33 weekday parking spaces, an estimated on E. Capitol Drive, 19 spaces east of Maple Avenue, and 14 spaces west of Church Street, and an additional nine spaces on weekend days on the north side of E. Capitol Drive east of Church Street 	\$76,400	

^aAlthough a lane width of 12 feet is the recommended standard for arterial facilities, an 11 foot lane width may be adequate under low speed, interrupted-flow conditions.

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Figure 9



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and, in some cases, through the Church Street intersection even under existing traffic volume. Thus, the operation of both intersections would be degraded, and as well the intersection spacing problem is unresolved.

The second alternative action considered would be essentially the same as the first alternative, but would also include the provision of an exclusive rightturn lane on the eastbound approach of the intersection of E. Capitol Drive and Maple Avenue as shown in Figure 10. Traffic control at the intersections will remain the same. The advantages and disadvantages of this alternative are also set forth in Table 3, along with the estimated construction cost to implement this alternative. The provision of two, 12 foot-wide lanes on the eastbound approach would facilitate the division of the traffic on this approach into two separate traffic streams, one for the through movement and one for the rightturning movement as it currently does. The provision of two 12 foot-wide, marked . and signed lanes not only on this approach but on the westbound approach as well, would eliminate the current practice of division into two traffic streams in a single 20 foot-wide lane. Traffic safety would thereby be enhanced by the provision of wider lanes and elimination of any possible motorist confusion with respect to which movements are permissible from which lane. Further, no degradation of traffic operations would be expected under existing traffic volumes. The intersection spacing problem would remain unresolved.

As shown in Figures 9 and 10, the provision of 12 foot wide lanes--the standard for arterial facilities--would shift the existing curb on the east side of Maple Avenue approximately six feet to the east. Continuing to provide the existing curb lawn and sidewalk would require that these elements be shifted six feet as well. However, there may be sufficient distance between the existing sidewalks such that the design could accommodate three lanes, two for northbound and one for southbound traffic, without shifting either sidewalk, particularly if 11 foot wide lanes are used. This would result in the virtual elimination of the existing curb lawn and the attendant snow storage on one or both sides of Maple Avenue. Consideration should also be given to increasing the curb radius between intersecting roadways to minimize vehicular encroachment on adjacent lanes during turning maneuvers particularly if 11 foot lanes are incorporated into the final design.

Figure 10

PROPOSED REALIGNMENT ALTERNATIVE NUMBER 2 FOR THE INTERSECTIONS OF E. CAPITOL DRIVE AND MAPLE AVENUE, AND E. CAPITOL DRIVE AND CHURCH STREET



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Similarly, Figure 10 shows that the widening of E. Capitol Drive to accommodate four 12 foot wide lanes would occur on the north side of the roadway. Continuing to provide the existing curb lawn and sidewalk would require that these elements be shifted eight feet north also. However, there may be sufficient distance between the existing sidewalks such that the design could accommodate four lanes, two lanes on each approach, without shifting either sidewalk, particularly if 11 foot wide lanes are used. There would be an attendant loss of curb lawn and snow storage capacity.

A third alternative which would result in a "four-legged" intersection by realigning Church Street to the east directly opposite Maple Avenue, or by realigning Maple Avenue directly opposite Church Street, was designed to address the substandard intersection spacing problem as well as the substandard lane width and lack of exclusive left turn lane problems. This alternative was recommended to be rejected from further consideration for the following reasons. First, the volume of traffic currently travelling between Church Street and Maple Avenue is less than 300 vehicles per average weekday and thus less than 2 percent of the combined total traffic entering the two intersections would benefit directly. Second, there is no pattern of accidents to indicate that the turning movements currently required to travel between Church Street and Maple Avenue results in a traffic safety problem. Third, the intersection operates satisfactorily under the existing traffic patterns experiencing little vehicular queuing and nominal delays. Fourth, substantial right-of-way acquisition, relocation, demolition would be required including one business and one residence to realign Maple Avenue, or one multifamily apartment building to realign Church Street. Finally, the estimated construction cost to implement this alternative approximates \$375,000. Thus because no existing operational or safety problems result from the substandard intersection spacing, and because of it significant capital cost and attendant disruption, this alternative was recommended to be rejected from further consideration.

Summary and Conclusions

Two alternatives were reviewed in order to address the potential traffic operation problem and the substandard lane width problem. It is recommended that Alternative 2, which would provide exclusive lanes for each traffic movement, be

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considered by the Village for implementation as part of the reconstruction of E. Capitol Drive from Maple Avenue to Merton Avenue. Of the two alternatives evaluated, only the second alternative would abate two of the traffic operation and design problems at the intersection--division of the approach traffic into two traffic streams by movement in a single lane of insufficient width to accommodate two lanes; lack of exclusive lanes to serve the turning movements at the intersection; and substandard intersection spacing. However, Alternative 2 has a higher construction cost--\$76,400--than Alternative 1, and potentially entails acquisition of strips of right-of-way from five residences; one business; and one institution. In the consideration of the implementation of this action, it should be noted that the existing intersections operate efficiently even with the identified operational and design problems, and, based upon forecast year 2010 traffic volumes may be expected to continue such operation. Only nominal delay was observed at the intersection on an average weekday including peak traffic periods and only two accidents have occurred at the intersection over the past three years.

It is also recommended that the existing pictographic "SCHOOL CROSSING" sign facing northbound Maple Avenue approximately 190 feet south of E. Capitol Drive be removed.

INTERSECTION OF E. CAPITOL DRIVE, NORTH AVENUE, AND HILL STREET AND COTTONWOOD AVENUE, W. CAPITOL DRIVE, AND HAIGHT DRIVE

This section documents the inventory findings, potential traffic problems, and evaluation of alternatives for the intersections of E. Capitol Drive, North Avenue, and Hill Street and Cottonwood Avenue, W. Capitol Drive, and Haight Drive.

Jurisdictional Classification

The E. and W. Capitol Drive and the North Avenue legs of the subject intersections are currently local trunk arterial highways. Cottonwood Avenue is a local collector and Hill Street and Haight Drive are land access streets. All of the facilities are currently under the jurisdiction of the Village of Hartland. Under the adopted Waukesha County Jurisdictional Highway System Plan, E. Capitol Drive, W. Capitol Drive, and North Avenue are proposed to be county trunk highways under the jurisdiction of Waukesha County. Cottonwood Avenue is expected to continue functioning as a collector, and Hill Street and Haight Drive are expected to continue functioning as land access facilities under the jurisdiction of the Village.

Intersection Physical and Operational Characteristics

The intersection of E. Capitol Drive, North Avenue, and Hill Street and the intersection of Cottonwood Avenue, W. Capitol Drive, and Haight Drive are two closely spaced "four-legged" intersections as shown in Figure 11. The northern intersection of E. Capitol Drive, North Avenue, and Hill Street is located approximately 200 feet north of the southern intersection of Cottonwood Avenue, W. Capitol Drive, and Haight Drive. The geometry of the southern intersection is atypical as the west leg of the intersection intersects the north and south legs of the intersection at an acute 52 degree angle rather than the typical 90 degree angle. These two intersections in this section of the report. All legs of the existing intersections are constructed to urban cross-sections. The posted speed limit on all legs of the intersection is 25 miles per hour.

These intersections are located in the central business district of the Village of Hartland. All of the streets in these intersections operate as two-way facilities. On-street parking is permitted in some areas in these intersections, and prohibited in others, as shown in Figure 11. All of the approaches to the intersections are stop controlled, with the exception of the southbound approach to the south intersection which has no traffic control.

The legs of the intersection vary in width. At the north intersection, E. Capitol Drive has an existing pavement width of 36 feet from curb face to curb face. North Avenue has an existing pavement width of 44 feet from curb face to curb face. Hill Street has an existing pavement width of 30 feet from curb face to curb face. At the south intersection, Cottonwood Avenue has an existing pavement width of 42 feet from curb face to curb face. W. Capitol Drive, west of the intersection, has an existing pavement width of 36 feet from curb face to

Figure 11

EXISTING E. CAPITOL DRIVE, NORTH AVENUE, AND HILL STREET AND, COTTONWOOD AVENUE, W. CAPITOL DRIVE, AND HAIGHT DRIVE INTERSECTIONS: 1996



100

200

PEET

curb face. Haight Drive has an existing pavement width of 30 feet from curb face to curb face.

At the north intersection sight distance in the north- and southwest quadrants is restricted by a building located on the northwest corner of the intersection and by a large evergreen tree on the southwest corner. However, vehicles at the Hill Street stop bar are visible to the motorists at the stop bars of all other approaches. Similarly, motorists at the Hill Street stop bar are able to see vehicles at the stop bar on the other three intersection approaches. Thus, the four way stop sign control at the intersection serves to abate this potential traffic safety problem.

At the south intersection, sight distance in the southwest quadrant is restricted in part by the acute angle of intersection between the northeast- and northbound intersection legs and in part by a building on the southwest corner of the intersection. However, vehicles at the stop bars on these legs are visible to motorists on the other leg and thus the stop control serves to abate this potential sight distance problem. However, sight distance in the northeast quadrant of the intersection is restricted by shrubbery located adjacent to the back of curb on the northeast corner of the intersection. The restricted sight distance combined with a lack of control on the southbound approach presents a potential traffic safety problem as motorists on the westbound approach have less time to perceive and react to southbound traffic.

Not only do the individual intersections have sight distance restrictions, but because of the close proximity of the two intersections, the sight distances between the two intersections are restricted as well. Traffic from the east side of the north intersection has restricted sight distance to the east and south side of the southern intersection due to the proximity of the buildings along the east sides of the segment of W. Capitol Drive between the two intersections. Similarly, the sight distance from the south and east of the southern intersection are restricted to the east side of the north intersection. These sight restrictions have the potential to create a traffic safety problem.

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Traffic Volumes

The Commission staff conducted manual turning movement counts and 24 hour machine traffic counts in July, 1996. Based upon the 24 hour machine counts, the average weekday traffic counts on E. Capitol Drive were approximately 6,545 vehicles per average weekday on North Avenue just north Avenue; about 9,285 vehicles per average weekday on Hill Street just west of North Avenue; approximately 10,045 vehicles per average weekday on the segment between the north and south intersections; about 750 vehicles per average weekday on Haight Drive just east of Cottonwood Avenue; approximately 8,090 vehicles per average weekday on Cottonwood Avenue just south of Haight Drive; and approximately 2,455 vehicles per average weekday on W. Capitol Drive just west of Cottonwood Avenue. Approximately 13,935 vehicles entered the north intersection on an average weekday.

The manual turning movement counts were collected during the morning peak traffic period from 6:00 a.m. to 9:00 a.m. and the evening peak traffic period from 3:00 p.m. to 7:00 p.m. These time periods included both the morning and evening peak hours of traffic flow. Based upon the manual turning counts, the number of vehicles entering the north and south intersection on an average weekday between 6:00 a.m. to 9:00 a.m. and between 3:00 p.m. to 7:00 p.m. were approximately 5,620 and 4,145, respectively, in 1996, representing 40 percent of the total weekday traffic volumes at the north intersection, and 39 percent of the total weekday traffic volumes at the south intersection. Unlike other intersections in this report, manual turning movement counts were extended in the evening until 7:00 p.m. This was because these intersections are located within the central business district of the Village of Hartland. The commercial nature of the land uses abutting these intersections creates the potential for traffic peaking in hours other than those in which peaking would generally be observed. The morning and evening peak hour manual turning movement counts are shown in Figure 12 along with the estimated 1996 average weekday turning movement volumes.

Analyses of the estimated 24 hour turning movement data at these intersections indicated that the predominant traffic movement is between the north and south

Figure 12

TURNING MOVEMENT TRAFFIC VOLUMES AT THE INTERSECTIONS OF E. CAPITOL DRIVE, NORTH AVENUE, AND HILL STREET, AND COTTONWOOD AVENUE, W. CAPITOL DRIVE, AND HAIGHT DRIVE IN THE VILLAGE OF HARTLAND: 1996



Source: SEWRPC.

Not to Scale

legs directly through both intersections, although significant secondary traffic movements were also indicated. Namely, these include turning movements between the east leg and the north and south legs at the northern intersection and between the north and west leg of the southern intersection.²

The manual turning movement count data indicated that turning movements accounted for about 52 percent of all movements at the north intersection between 6:00 a.m. to 9:00 a.m. and 3:00 p.m. to 7:00 p.m., and 29 percent of all movements at the south intersection during the same time periods. During the morning peak hour, about 50 percent of all vehicles were observed turning at the north intersection. The westbound right-turn represented the highest turning movement observed during the morning peak hour at 75 vehicles, representing about 50 percent of the westbound traffic. About 32 percent of all vehicles were observed turning at the south intersection during the morning peak hour. The northeastbound left-turn represented the highest turning movement observed during the morning peak hour at 55 vehicles, representing about 85 percent of all northeastbound traffic.

During the evening peak hour, about 52 percent of all vehicles at the north intersection were observed turning. The westbound right-turn--130 vehicles--and the westbound left-turn--also 130 vehicles--represented the highest turning movements observed during the evening peak hour with each turning movement representing about 45 percent of the westbound traffic. During the evening peak hour, it was observed that the through traffic and left-turning traffic would split into separate traffic streams by movement on the southbound and westbound approaches to the northern intersection. Occasionally traffic on the southbound approach splits into two separate streams even though neither vehicle turned. The two traffic streams operate within a single 20 foot wide lane on both approaches. This situation results in two 10 foot wide lanes on two feet less than the desired 12 foot lane width and may create a potential traffic safety problem.

 $^{^2}$ A 1983 traffic study of this intersection by the Commission staff determined that the predominant traffic movement at the southern intersection at that time was between the northern and western intersection legs.

The number of vehicles turning left from the westbound approach exceeded 95 vehicles per hour four times, and exceeded 115 vehicles per hour three times. The number of vehicles turning left from the southbound approach exceeded 80 vehicles per hour three times and 100 vehicles per hour one time. About 28 percent of all vehicles were observed turning at the south intersection during the evening peak hour. The northeastbound left-turn represented the highest turning movement observed during the evening peak hour at 65 vehicles, representing about 93 percent of all northeastbound traffic.

Occasional vehicular delay was observed on the northbound, southbound, and westbound approaches to the north intersection during the evening peak hour. The maximum vehicular queue observed--four vehicles--occurred on the southbound approach to this intersection. Vehicles were not observed to experience delay exceeding 40 seconds and the longer vehicular queues tended to dissipate entirely before the next queue developed. It may be noted that no vehicular queues greater than two vehicles were observed and that attendant delay was insignificant at the southern intersection.

Traffic Accidents

The incidence and pattern of traffic accidents can provide an indication of the efficiency and operating characteristics of an intersection. A three-year motor vehicle accident history from January 1, 1993, to December 31, 1995, for the intersections of E. Capitol Drive, North Avenue, and Hill Street, and Cottonwood Avenue, W. Capitol Drive, and Haight Drive, was collected and analyzed. As shown in Table 4, a total of 5 accidents occurred at these intersections during the three-year period concerned, with one accident in 1993, two in 1994, and two in 1995. None of the accidents involved personal injury or a fatality. Two of the five accidents occurred at the north intersection, and the remaining three occurred at the south intersection. The three accidents at the south intersection occurred within a twelve month period.

Analysis of the three-year accident history data for the intersections concerned indicates that all five of the accidents were multiple vehicle accidents. Four of the five accidents, or 80 percent, were right-angle collisions, and the fifth accident was a head-on collision.

Table 4

INCIDENCE AND SEVERITY OF MOTOR VEHICLE ACCIDENTS AT THE INTERSECTIONS OF E. CAPITOL DRIVE, NORTH AVENUE, AND HILL STREET (NORTH INTERSECTION) AND W. CAPITOL DRIVE, COTTONWOOD AVENUE, AND HAIGHT STREET (SOUTH INTERSECTION) BETWEEN JANUARY 1, 1993, AND DECEMBER 31, 1995^a

	Injury		Property Damage		Total	
Year	North Intersection	South Intersection	North Intersection	South Intersection	North Intersection	South Intersection
January 1 to December 31, 1993	0	0	1	0	1	0
January 1 to December 31, 1994	0	0	1	1	1	1
January 1 to December 31, 1995	0	0	0	2	0	2
Total	0	0	2	3	2	3

^aAny accident occurring within 150 feet of the intersection was considered an intersection accident.

Source: Wisconsin Department of Transportation, Division of Motor Vehicles, and SEWRPC.

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It may be concluded that no traffic safety problem exists at the northern intersection during the three year period for which traffic accident data were analyzed. However, because three accidents occurred within the 12 month period from September 22, 1994, to September 12, 1995, additional analysis of these accidents was conducted to determine if a pattern of collision types exists.

Two of the three accidents analyzed at the W. Capitol Drive, Cottonwood Avenue, and Haight Drive intersection were right-angle collisions and the third collision type was a head-on collision. Although two accidents involved right-angle collisions, they did not involve the same intersection legs--one involved a southbound and an eastbound vehicle, and the other involved a northbound and a westbound vehicle. Thus, because the two right angle collision accidents did not involve vehicles on the same two intersection legs, no discernable collision pattern exists.

Identification of Potential Traffic Problems

The physical and operational characteristic of the two intersections were compared to generally accepted traffic engineering and geometric design standards to determine if any traffic operational, safety, or geometric design problems exist at the subject intersections.

Although some vehicle queues with attendant delay were observed, generally the north intersection operated with very modest delay, and the south intersection operated with nominal delay. Thus, it may be concluded that vehicle delay and congestion are not problems at the present time. Although three accidents occurred at the south intersection within a twelve month period, because there is no pattern of collision types, and because more than 50 weeks occurred between the first and third accidents it may be concluded that traffic safety is not a problem at the present time.

An operational deficiency exists, however, in the operation of the southern intersection. The existing traffic control does not follow typical practice for "four-legged" arterial intersections. Typical practice provides for either: 1) control on both approaches of one of the two intersecting roadways with no control on either approach of the other intersecting roadway; or, 2) control on

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both approaches of both intersecting roadways. At this intersection, the southbound approach is currently uncontrolled while the three other approaches are controlled.

A number of substandard geometric design elements were also observed: 1) the acute angle of intersection at the south intersection; 2) the close proximity of the two intersections; 3) the sight distance from westbound Haight Drive to the north; and 4) the division of approach traffic on the westbound and southbound approaches to the north intersection into two traffic streams operating within single 20 foot wide lanes.

One of the substandard design elements is the angle of intersection at the southern intersection. The desired angle of intersection is 90 degrees and the minimum angle of intersection is 60 degrees. The existing angle of intersection between the west leg and the south leg of the intersection is 52 degrees, less than even the minimum angle of intersection. As a result, motorists who must stop on the eastbound W. Capitol Drive approach at the intersection must find a gap in traffic by looking directly ahead at southbound and westbound traffic, and then looking back over their right shoulder to the south to check for traffic heading north.

Another substandard design element is the proximity of the two individual intersections. The spacing between these two intersections--about 200 feet--is less than the desired 300 foot spacing between adjacent intersections.

Another substandard design element is the restricted sight distance in the northeast quadrant of the southern intersection. The available sight distance should be a minimum of 250 feet which is greater than the 150 feet available. The restricted sight distance and lack of control on the southbound approach reduces the time westbound motorists have to perceive and react to southbound traffic.

Lastly, another substandard design element is the 10 foot lane width on the south and westbound approaches at the E. Capitol Drive, North Avenue and Hill Street inter-section. Because of high left-turning traffic volumes on the westbound E. Capitol Drive approach and on the southbound North Avenue approach at the north intersection, traffic in each direction separates into two streams operating on a single 20 foot wide approach. This in turn creates two unmarked 10 foot wide lanes which are two feet narrower than the desired 12 foot lane width.

Even though there are substandard design elements--substandard acute angle of intersection, substandard intersection spacing, restricted sight distance and substandard lane width, and the operational problem related to nonstandard intersection approach traffic control--at these intersections, only two accidents have occurred at the northern intersection and only three accidents have occurred at the southern intersection during the three-year accident history reviewed and observation of traffic indicated very modest vehicle delay.

Actions Considered to Address Identified Traffic Problems

A number of actions were considered to address the operational and substandard geometric design elements identified at the subject intersections.

In a traffic study requested by the Village and conducted by the Commission staff in 1983 six alternatives were considered for implementation at the southern Because the physical and operational characteristics of the intersection. southern intersection have remained generally unchanged since 1983, these alternatives were evaluated to determine their suitability in addressing the problems identified at this time. Two of those alternatives proposed the conversion from two-way to one-way westbound traffic operations on W. Capitol Drive, between Prospect Avenue and Cottonwood Avenue. These alternatives were recommended to be rejected from further consideration in 1983 and continue to be so recommended because of the diversion of one-way eastbound traffic arterial type traffic from W. Capitol Drive to W. Park Avenue, a land access street. Two other alternatives considered the closure of Haight Drive at Cottonwood Avenue. These alternatives were recommended to be rejected from further consideration in 1983 and continue to be so recommended because of their disruption to existing traffic patterns.

The two remaining alternatives considered proposed creation of a "tee" intersection either by realigning Cottonwood Avenue at W. Capitol Drive or by realigning W. Capitol Drive at Cottonwood Avenue to thereby create a 90 degree angle of

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intersection and also included the conversion of Haight Drive from two-way to one-way eastbound operation. In 1983 both alternatives were recommended to be considered. In 1983, manual turning movement counts indicated the predominant traffic movement was between the north and west legs of the intersection. However, the manual turning movement counts conducted in 1996 showed that the predominant traffic movement has changed and is now between the north and south legs of the intersection. Because the realignment of Cottonwood Avenue would not facilitate this change in traffic flow, it was recommended to be rejected from further consideration. Thus, of the alternatives considered in 1983, only the realignment of W. Capitol Drive at Cottonwood Avenue to create a "tee" intersection and the conversion of Haight Drive from two-way to one-way operation was recommended for further consideration at this time.

The action considered to address the substandard lane width problem at the north intersection was the provision of two 12 foot wide lanes including exclusive left-turn lanes on the southbound and westbound approaches, as shown in Figure 13, to accommodate the substantial left-turning volume observed on these approaches. The advantages of this action are that through and left-turning traffic is separated on these approaches thereby enhancing traffic safety, and no right-of-way is required for implementation. It may be noted, as well, that the provision of exclusive left-turn lanes is warranted based upon the observed turning volumes on the subject approaches. The disadvantages of this action include the elimination of an estimated 25 parking spaces; 17 spaces on E. Gapitol Drive and eight spaces on North Avenue, and no change in existing intersection spacing. The estimated construction cost to implement this action is approximately \$3,200. The traffic control at the north intersection would remain the same as the existing control.³

Two actions were considered to address the substandard geometric elements and the existing atypical traffic control at the southern intersection. It is intended

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³ Analyses at the intersection indicated that none of the warrants for the installation of traffic signals set forth in the Manual of Uniform Traffic Control Devices were met. Therefore, the installation of traffic signals is not recommended at the current time, as such installation may be expected to increase traffic delay and reduce traffic safety.

that the actions discussed below--the conversion from two-way to one-way eastbound travel on Haight Drive and the realignment of W. Capitol Drive to provide 90 degree angle of intersection with Capitol Drive, and traffic control modification--be implemented at the same time. A third action is also presented to address the restricted sight distance problem in the northeast quadrant of the southern intersection in the event that one-way operations are not implemented on Haight Drive.

The first action considered to address the identified problems was first proposed in 1983. This action includes the conversion from two-way to one-way east-bound traffic on Haight Drive from Cottonwood Avenue to the alley east of and parallel to Cottonwood Avenue, and the realignment of W. Capitol Drive at its intersection with Cottonwood Avenue by constructing a radius to create a 90 degree angle of intersection. The realignment of W. Capitol Drive would eliminate the existing substandard angle of intersection with Cottonwood Avenue. A pavement choker is also proposed in the northwest quadrant as part of the reconstruction to more clearly define the new approach. The conversion to one-way eastbound operation would specifically address the restricted sight distance problem in the northeast intersection quadrant. Its implementation would require construction of a pavement choker on Haight Drive at Cottonwood Avenue to prevent westbound travel. Regulatory signing would be required both at Cottonwood Avenue and the alley east of Cottonwood Avenue to advise motorists of the one-way roadway segment. This action is also shown in Figure 13.

The advantages of this action include elimination of the restricted sight distance problem in the northeast intersection quadrant and elimination of the substandard angle of intersection between W. Capitol Drive and Cottonwood Avenue. Traffic safety is enhanced as the volume of traffic entering the intersection is reduced and the number of potential conflict points is reduced from 24 to 16. The pavement choker proposed in the northwest quadrant has the potential to increase green space and reduces the expanse of pavement to be monitored by eastbound motorists for potential conflicting vehicles.

Disadvantages of this action include increased travel time and distance for existing westbound Haight Drive traffic with an attendant increase in air

-28a-Figure 13

PROPOSED REALIGNMENT ALTERNATIVES FOR THE INTERSECTIONS OF E. CAPITOL DRIVE, NORTH AVENUE, AND HILL STREET AND COTTONWOOD AVENUE, W. CAPITOL DRIVE, AND HAIGHT DRIVE



pollutant emissions and fuel consumption. Existing westbound Haight Drive traffic would divert to the intersections of Goodwin Avenue at E. Capitol Drive and W. Park Avenue at Cottonwood Avenue as no complimentary one-way westbound facility is to be provided. This short segment of one-way street would decrease access to and from parking for businesses north of Haight Drive adjacent to the one-way segment. This in turn may result in motorist frustration and lead to some enforcement problems. Increasing the angle of intersection between W. Capitol Drive and Cottonwood Avenue from 52 to 90 degrees will require a reduction in speeds at which southbound traffic executes the right-turn maneuver. Also, tractor-trailer truck traffic making turns between the north and west intersection legs may encroach on the adjacent opposing traffic lane on the west The estimated construction cost to implement this alternative is about leg. \$19,700. The westbound stop sign control may be eliminated, but the eastbound stop control would remain.

The second action considered for simultaneous implementation was the modification of existing traffic control. The stop sign control on the northbound approach would be eliminated to facilitate traffic movement between the north and south intersection legs which has been identified as the predominant movement. Α "CROSS TRAFFIC DOES NOT STOP" advisory plate would be added to the existing "STOP" sign on the northeastbound approach to the south intersection. A "STOP AHEAD" advance warning sign should be posted on W. Capitol Drive facing northeastbound traffic 100 feet in advance of the intersection. The advantages of this action are that the predominant traffic movement through the southern intersection is facilitated and stops and delay for northbound motorists are eliminated. The intersection control would be representative of the control typical at other intersections. Motorists on the northeastbound approach would be warned of the stop sign control in advance of the intersection itself. The disadvantages of this action would include a potential increase in delay incurred by motorists on the W. Capitol Drive approach and it would not address the substandard intersection spacing problem. The estimated cost to implement this alternative is about \$300.

An alternative action considered to address the restricted sight distance problem to the north from the westbound intersection approach if traffic operations on Haight Drive are not converted to one-way was to replace the existing shrubbery adjacent to the curb line along the northeast corner of the south intersection with ground cover plantings. This action should only be considered if one-way operations are not implemented on Haight Drive. If this action is implemented the existing "STOP" sign control on the westbound approach should remain in place and a supplemental "CROSS TRAFFIC DOES NOT STOP" plate should be added. The advantage of this alternative is that the sight distance in the northeast corner would be improved as the existing shrubbery is replaced by shorter plants. The disadvantage of this alternative is that it would not address the substandard intersection spacing problem.

The substandard intersection spacing problem could only be addressed by moving the existing W. Capitol Drive, Cottonwood Avenue, and Haight Drive to a location approximately 100 feet south of its existing location. This action would require the realignment of W. Capitol Drive and Haight Drive from a point on W. Capitol Drive approximately 425 feet southwest of the existing intersection to the Haight Drive and Goodwin Avenue intersection. The advantage of this alternative is that the resultant intersection spacing would conform to the standard. Disadvantages include the attendant need for substantial right-of-way acquisition; the edge of the new roadway would be about 15 feet from the Village's public library and would displace some patron parking, and the existing Haight Drive bridge over the Bark River may need to be reconstructed to accommodate the roadway realignment. Finally the estimated construction cost to implement this alternative approximates \$475,000. Thus, because there is no pattern of accidents to indicate that a traffic safety problem exists, the existing intersection operates satisfactorily under the existing traffic patterns experiencing little vehicular queuing and nominal delays; and because of the significant disadvantages identified, this alternative was recommended to be rejected from further consideration.

Summary and Conclusions

The substandard design elements identified at the intersections included substandard lane width at the north intersection; substandard spacing between the north and south intersections; and a substandard acute angle of intersection, restricted sight distance, and nonstandard intersection approach traffic control at the south intersection. It should be noted, however, that the intersections

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appear to be operating efficiently, as only modest delay was observed during the peak period of traffic counting, and only five traffic accidents have occurred in a three year period.

Three actions were recommended to be implemented to address the substandard design elements. The provision of exclusive left-turn lanes is recommended for implementation on the south- and westbound approaches to the E. Capitol Drive, Hill Street, and North Avenue intersection. These turn lanes and the through and right-turn lanes on these two intersection approaches should be provided with a desirable 12 foot lane width to specifically address the substandard lane width problem at the intersection. This action has an estimated cost of \$3,200, and would eliminate an estimated 25 existing on-street parking stalls.

Also recommended for implementation is the conversion of Haight Drive from twoway to one-way eastbound operation from Cottonwood Avenue to the alley parallel to and east of Cottonwood Avenue, and the realignment of W. Capitol Drive to create a 90 degree angle of intersection at Cottonwood Avenue. Lastly, to facilitate traffic flow for the predominant traffic movement at the intersection of W. Capitol Drive, Cottonwood Avenue and Haight Drive, modification of the existing traffic control through the removal of the northbound Cottonwood Avenue stop sign control is recommended for implementation. These actions at the south intersection have an estimated construction cost of approximately \$20,700. Implementation would result in circuitous travel for about 240 motorists on an average weekday, and may make turning movements between the north and west intersection legs more difficult for tractor-trailer trucks.

INTERSECTION OF W. CAPITOL DRIVE, W. PARK AVENUE, AND PROSPECT AVENUE

This section documents the inventory findings, potential traffic problems, and evaluation of alternatives for the intersection of W. Capitol Drive, W. Park Avenue, and Prospect Avenue.

Jurisdictional Classification

The West Capitol Drive intersection legs are currently local trunk highways. West Park Avenue currently functions as a local collector as it carries collector type traffic which is destined to properties along Cottonwood Drive. Prospect Avenue currently functions as a local land access street. Each of these facilities is currently under the jurisdiction of the Village of Hartland.

Under the adopted Waukesha County Jurisdictional Highway System Plan, W. Capitol Drive is proposed to be a county trunk highway under the jurisdiction of Waukesha County. West Park Avenue and Prospect Avenue are expected to continue functioning as collector or land access facilities under the jurisdiction of the Village.

Intersection Physical and Operational Characteristics

The intersection of W. Capitol Drive, W. Park Avenue, and Prospect Avenue is a single intersection having four legs as shown in Figure 14. Rather than a typical four-legged intersection whose basic geometry is a cross with 90 degree angles of intersection, the geometry of this intersection includes two acute angles which create two "Y"s. The angle of intersection between legs of W. Capitol Drive and Park Avenue is approximately 32 degrees, and the angle of intersection between legs of W. Capitol Drive and Park Avenue is approximately 32 degrees, and the angle of intersection between legs of W. Capitol Drive and Prospect Avenue is approximate-ly 58 degrees. All legs of the existing intersection are constructed to urban cross-sections. The posted speed limit of all legs of the intersection is 25 miles per hour.

West Capitol Drive has an existing pavement width of 36 feet. Parking is allowed on both the north and south sides of W. Capitol Drive.

Prospect Avenue has an existing pavement width of 34 feet. Parking is allowed on both the east and west sides of Prospect Avenue.

West Park Avenue has an existing pavement width of 30 feet and currently operates as a one-way facility to the east. Parking is permitted only on the south side of W. Park Avenue. One-way operations were likely implemented to reduce the volume of traffic entering the existing intersection thereby improving traffic safety. Not only would this eliminate the need for westbound motorists to look back over their shoulder for gaps in westbound W. Capitol Drive, but it also eliminates the restricted sight distance which would otherwise exist between the





Source: SEWRPC.

Figure 14

EXISTING W. CAPITOL DRIVE, W. PARK AVENUE, AND PROSPECT AVENUE INTERSECTION: 1996 westbound W. Capitol Drive and the W. Park Avenue approaches. Parking is permitted only on the south side of W. Park Avenue.

The northbound approach of Prospect Avenue is stop controlled at W. Capitol Drive. Since W. Park Avenue is a one-way facility to the east, all travel is away from the intersection, and thus there is no control of this leg at the intersection. The sight distances from the stop lines of the approaches to this intersection are adequate.

Traffic Volumes

The Commission staff also conducted manual turning movement counts and 24 hour machine traffic counts in July 1996. Based upon the 24 hour machine counts, there were approximately 2,175 vehicles per average weekday on W. Capitol Drive just east of the intersection; about 2,350 vehicles per average weekday on W. Capitol Drive just west of the intersection; approximately 320 vehicles per average weekday on W. Prospect Avenue just south of the intersection; and about 425 vehicles per average weekday on Park Avenue just east of the intersection.⁴ Approximately 2,635 vehicles entered the intersection on an average weekday in 1996. No vehicular queues or vehicle delays were observed at this intersection between 6:00 a.m. and 9:00 a.m. or 3:00 p.m. and 6:00 p.m., the morning or evening peak traffic periods, respectively.

The manual turning movement counts were collected during the morning peak traffic period from 6:00 a.m. to 9:00 a.m. and the evening peak traffic period from 3:00 p.m. to 6:00 p.m.. These time periods included both the morning and evening peak hours of traffic flow. Based upon the manual turning counts, the number of vehicles entering the intersection on an average weekday between 6:00 a.m. to 9:00 a.m. and between 3:00 p.m. to 6:00 p.m. was approximately 851 in 1996,

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⁴ Applying a trip generation rate of about ten vehicle trips per household on an average weekday to the 13 residences which abut W. Park Avenue it may be assumed that approximately 130 vehicle trips, or about 30 percent of the total 425 vehicles observed on average weekday, are local trips generated by abutting properties. The remaining 295 vehicle trips are collector type trips having neither an origin or destination on W. Park Place.

and evening peak hour manual turning movement counts are shown in Figure 15 along with the estimated 1996 average weekday turning movement volumes.

The manual turning movement count data indicated that turning movements accounted for only 30 percent of all movements at the intersection during the six hours manual turning data was collected. This pattern of traffic was consistent in both the morning and evening peak traffic periods. Between 6:00 a.m. and 9:00 a.m. about 82 vehicles turned at the intersection, representing about 36 percent of all movements. The eastbound right-turn to W. Park Avenue represented the highest turning movement observed during the morning peak hour at 25 vehicles. This volume represents about 36 percent of all eastbound traffic. From 3:00 p.m. to 6:00 p.m. about 170 vehicles turned at the intersection, or about 27 percent of all movements. The eastbound right-turn to W. Park Avenue also represented the highest turning movement observed during the evening peak hour at 30 vehicles. This volume represents about 25 percent of all eastbound traffic.

Traffic Accidents

The incidence and pattern of traffic accidents can provide an indication of the efficiency and operating characteristics of an intersection. A three-year motor vehicle accident history from January 1, 1993 to December 31, 1995 for the intersection of W. Capitol Drive, Park Avenue, and Prospect Avenue was collected. During this time, no accidents occurred at this intersection.

Identification of Potential Traffic Problems

The physical and operational characteristics of the intersection were compared to generally accepted traffic engineering and geometric design standards to determine if any traffic operational, safety, or geometric design problems exist at this intersection. As previously noted, no accidents occurred during the three year period reviewed, and there were no traffic delays, or vehicular queues observed at the intersection. Thus, it may be concluded that no traffic operational or safety problems exist at the present time. However, one geometric design element was identified as substandard: the angle of intersection between legs of the intersection. As previously noted, the desired angle of intersection is 90 degrees and the minimum angle of intersection is 60 degrees.

Figure 15

TURNING MOVEMENT TRAFFIC VOLUMES AT THE INTERSECTION OF W. CAPITOL DRIVE, W. PARK AVENUE, AND PROSPECT AVENUE IN THE VILLAGE OF HARTLAND: 1996



Source: SEWRPC.

Not to Scale

The existing acute angles of intersection between legs of the "Y" intersections are 32 and 58 degrees; both less than the minimum angle of intersection and one substantially less. As a result, motorists who must stop on the northbound Prospect Avenue approach must search for gaps in traffic by looking back over their left shoulder. In addition, motorists on the northbound approach may experience some confusion as motorists turning from W. Capitol Drive may turn to either Prospect Avenue or W. Park Avenue. Depending upon the destination of the traffic turning off W. Capitol Drive, then, it may or may not cross the path of motorists on the northbound Prospect Avenue approach.

Alternatives Considered to Abate Identified Traffic Problems

Two alternative actions, set forth in Table 5, were considered to address the substandard geometric design element identified at this intersection of substandard angles of intersection. The first alternative considered was the reconstruction of the existing intersection to provide two separate intersections and provide a 90 degree angle of intersection between W. Capitol Drive and W. Park Avenue, as shown in Figure 16. This alternative may be expected to remove some confusion as to which turning maneuver is to be executed by W. Capitol Drive motorists. However, the spacing between these two intersections is substandard and the angle of intersection between W. Capitol Drive and Prospect Avenue remains substandard. The substandard intersection spacing is not a severe problem because W. Park Avenue is one-way eastbound and no traffic enters the intersection from this leg. The number of vehicles which motorists must simultaneously monitor is then reduced. The advantages and disadvantages of this alternative are summarized in Table 5, along with the estimated construction cost to implement this alternative.

The second alternative action considered to address the problem of substandard angles of intersection, was the same as Alternative 1 except that a 90 degree angle of intersection between Prospect Avenue and W. Capitol Drive would also be provided, as shown in Figure 17. Although this alternative does eliminate the substandard intersecting angles at the intersection, the spacing between the two new intersections remains substandard. Despite the substandard intersection spacing, this alternative provides an incremental improvement compared to the existing intersection as it provides a clearer definition of vehicle paths on W.

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Table 5

COMPARISON OF ALTERNATIVE ACTIONS CONSIDERED TO ADDRESS THE SUBSTANDARD DESIGN ELEMENTS IDENTIFIED AT THE INTERSECTION OF W. CAPITOL DRIVE, W. PARK AVENUE, AND PROSPECT AVENUE

Action/ Description	Advantages	Disadvantages	Estimated Construction Cost
Alternative 1 Reconstruct existing intersection to create two separate intersections and provide 90 degree angle of intersection between W. Capitol Drive and W. Park Avenue (see Figure 16)	 Provides separate intersections thereby reducing potential confusion to northbound traffic on Prospect Avenue as to whether traffic on W. Capitol Drive is turning to W. Park Avenue or Prospect Avenue Increases green space No right-of-way acquisition required Provides 90 degree angle of intersection at W. Capitol Drive and W. Park Avenue. 	 Spacing between the two intersections is substandard Angle of intersection remains unchanged between W. Capitol Drive and Prospect Avenue 	\$16,500
Alternative 2 Reconstruct existing intersection to create two separate intersections and to provide 90 degree angle of intersection between W. Capitol Drive and W. Park Avenue and W. Capitol Drive and Prospect Avenue (see Figure 17)	 Provides separate intersections thereby reducing potential confusion to northbound traffic on Prospect Avenue as to whether traffic on W. Capitol Drive is turning to W. Park Avenue or Prospect Avenue Increases green space Provides 90 degree angle of intersection at W. Capitol Drive and W. Park Avenue and W. Capitol Drive and Prospect Avenue Strip right-of-way acquisition required in southwest quadrant of W. Capitol Drive and Prospect Avenue 	 Spacing between the two inter- sections is substandard 	\$31,000

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Figure 16

PROPOSED REALIGNMENT ALTERNATIVE NUMBER 1
FOR THE INTERSECTION OF W. CAPITOL DRIVE,
W. PARK AVENUE, AND PROSPECT AVENUE



LEGEND

New Pavement

New Concrete Curb



, Pavement To Be Removed



Figure 17

PROPOSED REALIGNMENT ALTERNATIVE NUMBER 2 FOR THE INTERSECTION OF W. CAPITOL DRIVE, W. PARK AVENUE, AND PROSPECT AVENUE



LEGEND

New Pavement

New Concrete Curb

///// Pavement To Be Removed



Capitol Drive at the intersection. This may be expected to reduce confusion for northbound Prospect Avenue motorists as the destinations of W. Capitol Drive motorists is clarified. As previously noted, the substandard intersection spacing is less problematical than typical intersections because W. Park Avenue is one-way eastbound. Thus, no traffic enters W. Capitol Drive and the number of vehicles which motorists must simultaneously monitor is reduced. The advantages and disadvantages of this alternative are set forth in Table 5 along with the estimated construction cost to implement this alternative.

In response to a question from the Village staff concerning the advisability of converting W. Park Avenue from its exiting one-way eastbound traffic operation to two-way traffic operation if Alternative 2 as set forth above were implemented, the Commission staff identified the following advantages and disadvantages. The primary advantage of converting to two-way operation would be that the lack of a complimentary one-way westbound facility is eliminated, thereby improving access to parcels abutting W. Park Avenue with an attendant reduction in travel time and indirection for both W. Park Avenue residents and W. Park Avenue non-residents currently using Cottonwood Avenue from W. Park Avenue to W. Capitol Drive, and W. Capitol Drive from Cottonwood Avenue to W. Park Avenue for the westbound half of the trip. Another advantage would be the expected reduction in northbound left-turns at the W. Capitol Drive, Cottonwood Avenue, and Haight Drive intersection, thereby reducing potential vehicle conflicts and improving traffic safety at this intersections.

The primary disadvantage of converting to two-way operation is the diversion from W. Capitol Drive of an estimated 295 westbound collector type vehicle trips--the compliment of the estimated 295 eastbound collector type vehicle trips observed on an average weekday in 1996--due to the fact that W. Park Avenue would be the shortest distance between its intersections with W. Capitol Drive and Cottonwood Avenue . This would increase the existing 425 trips observed on W. Park Avenue to about 720 vehicles per average weekday, or nearly 70 percent. Thus, W. Park Avenue, which is 30 feet wide and is, therefore, constructed to land access street standards, would be functioning basically as a collector facility, a function for which the street clearly is not intended and a situation generally considered undesirable by abutting residents.

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Another potential disadvantage is that the W. Park Avenue horizontal and vertical alignment--straight and flat--coupled with substantial building setbacks and few driveways contribute to a motorist perception that travel speeds greater than the posted limit are acceptable. Another potential disadvantage is an increase from four to nine and from 15 to 24 in the number of potential vehicle conflict points at the W. Park Avenue intersections with W. Capitol Drive and Cottonwood Avenue, respectively. This potential degradation of traffic safety is further exacerbated by the anticipated diversion of left-turning vehicles from the W. Capitol Drive, Cottonwood Avenue, and Haight Drive intersection to the W. Park Avenue and Cottonwood Avenue intersection. The provision of the desired corner sight distance triangle at the proposed new W. Capitol Drive and W. Park Avenue intersection would eliminate an estimated three on-street parking spaces on the south side of W. Capitol Drive east of W. Park Avenue and the existing off-street parking north and west of the existing commercial building in the southeast quadrant of the intersection. Finally, as previously noted, the distance between the W. Capitol Drive intersections with Prospect Avenue and W. Park Avenue would only be about 160 feet, substantially less than the desired 300 feet.

Thus, because the disadvantages of converting W. Park Avenue from one-way to twoway traffic operation outweigh the advantages, it was not recommended at this time. In the consideration of the conversion of W. Park Avenue from one-way to two-way traffic operation; however, it may be noted that the estimated 720 average weekday volume under two-way operation is substantially less than the 1,500 vehicle per weekday threshold generally considered to be the maximum acceptable volume on a land access street. Further, experience indicates that very few residents consider average weekday traffic volumes less than 1,500 vehicles to be a nuisance.

Summary and Conclusions

Two alternatives were reviewed in order to address the substandard angle of intersection problem. It is recommended that Alternative 2, which would provide for 90 degree intersecting angles between W. Capitol Drive and W. Park Avenue and Prospect Avenue, be considered by the Village for implementation. Of the two alternatives evaluated, only the second alternative would address the geometric design problem at the intersection--substandard angle of intersection.

Alternative 2 has an estimated construction cost of \$31,000 and entails the acquisition of a strip of right-of-way from one residence. It may be noted that the existing intersection appears to operate efficiently even with the identified geometric design problem, and, based upon forecast year 2010, traffic volumes may be expected to continue such operation. No delay was observed at the intersection on an average weekday including peak traffic periods and no accidents have occurred at the intersection over the past three years.

STUDY FINDINGS AND RECOMMENDATIONS

By letter dated December 7, 1995, the Village of Hartland requested the Regional Planning Commission staff to conduct a traffic study of six Village intersections: 1) the intersection of E. Capitol Drive (CTH JJ), Lisbon Avenue (CTH JK), Merton Avenue (CTH KC) and Highland Avenue; 2) the intersection of E. Capitol Drive and Maple Avenue; 3) the intersection of E. Capitol Drive and Church Street; 4) the intersection of E. Capitol Drive, North Avenue, and Hill Street; 5) the intersection of Cottonwood Avenue, W. Capitol Drive and Haight Drive; and, 6) the intersection of W. Capitol Drive, W. Park Avenue and Prospect Avenue.

Inventories were conducted to establish the physical and operational characteristics of the intersections. Data were collated on the intersecting angle between intersection legs, intersection spacing, pavement width, and the provision of exclusive turn lanes. Data were also collated on traffic accidents and volumes, intersection control, speed limits and the provision of parking. Vehicle delays and queues were also observed. The inventory findings were compared to generally accepted traffic engineering and geometric design standards to identify potential traffic problems. Alternatives to address those problems were identified and evaluated, and selected actions recommended for implementation.

Intersection of E. Capitol Drive (CTH JJ), Lisbon Avenue (CTH JK), Merton Avenue (CTH KC), And Highland Avenue

Analyses indicated that no traffic accidents occurred during the three year period from January 1, 1993, to December 31, 1995, and that vehicular delay and

queuing were insignificant even during peak traffic periods. However, two geometric design deficiencies which may present traffic safety problems were identified:

- a substandard intersecting angle between legs of the "Y" intersection; and
- the substandard spacing between the three intersections.

Other deficiencies in the operation of the intersections were identified:

- the predominant movement of traffic requires turning movements between E. Capitol Drive and Merton Avenue; and
- the operation of the E. Capitol Drive, Merton Avenue and Lisbon Avenue intersection does not follow the typical intersection traffic control practice of either having all approaches stop sign controlled, or having the approaches on one street stop sign controlled with the cross street approaches uncontrolled.

Four alternatives were evaluated, and implementation of either Alternative 3 or Alternative 4, as shown in Figure 18, was recommended as part of the reconstruction of E. Capitol Drive from Maple Avenue to Merton Avenue. Alternative 4 would address the geometric design problems and best improve traffic flow through the intersection. It would require substantial right-of-way acquisition and has an estimated construction cost of \$310,000. Alternative 3 would address the intersection design problems at an estimated construction cost of \$40,100 and require only modest right-of-way acquisition but would not facilitate the predominant traffic movement and may be expected to increase intersection delay. All of the advantages and disadvantages of these alternatives are set forth in Table 6.

Intersections Of E. Capitol Drive And Maple Avenue, And E. Capitol Drive And Church Street

Analyses indicated that two traffic accidents occurred during the three year period from January 1, 1993, to December 31, 1995, and that vehicular delay and queuing were minimal even during peak traffic periods. However, one potential operational problem was identified, the high volume of left-turning vehicles observed on the northbound Maple Avenue approach during the peak hour, and two Figure 18

PROPOSED REALIGNMENT ALTERNATIVES 3 AND 4 FOR THE INTERSECTION OF E. CAPITOL DRIVE, LISBON AVENUE, MERTON AVENUE, AND HIGHLAND AVENUE

Alternative 4

Alternative 3







部語詞 New Pavement

New Edge Of Pavement or New Lane Line

/////, Pavement To Be Removed

- New Stop Line

H GRAPHIC SCALE IDO PEET 200

Table 6

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Recommended Actions Considered to Abate the Substandard Design Elements Identified at Selected Intersections in the Village of Hartland

Location	Recommended Action/Description	Advantages	Disadvantages	Estimated Construction Cost	
Intersection of E. Capitol Drive, Lisbon Avenue, Merton Avenue, and Highland Avenue	Alternative 3 Eliminate the southern "leg" of the "Y" intersection, relocate the southernmost intersection, and provide selected exclusive turn lanes and convert the E. Capitol Drive, Lisbon Avenue, and Merton Avenue intersection to four-way stop control	 Reduce number of intersections from three to two Standardizes intersection traffic control Eliminate sight distance problem at "Y" intersection Reduce proximity of intersections Improved angle of intersection of southernmost intersection Separation of through and selected turning traffic on eastbound and northbound approaches of northeastern intersection Increases green space at these intersections; plant material should be limited to grass or low growing ground cover shrubbery 	 Conversion to four-way stop control will cause eastbound motorist to incur delay and may result in rear-end accidents on the eastbound approach Distance between the two remaining intersections is still substandard Right-of-way acquisition may be required Predominant movement through intersection would remain a turning movement, rather than becoming a direct movement 	\$ 40,100	
Intersection of E. Capitol Drive, Lisbon Avenue, Merton Avenue, and Highland Avenue	Alternative 4 Provide for a direct through route of the predominant traffic movement at the intersection; eliminate the southern "Leg" of the "Y" intersection, relocate the southernmost intersection, and provide selected exclusive turn lanes	 Facilitate the movement of traffic between Capitol Drive and Merton Avenue by eliminating the existing right angle turn Standardizes intersection traffic control Reduce number of intersections from three to two Eliminate sight distance problem at "Y" intersection Reduce proximity of intersections Modestly improved angle of intersection of southernmost intersection Construction could be done as part of the currently planned reconstruction of E. Capitol Drive between Maple Avenue and Merton Avenue Increases green space at these intersections; plant material should be limited to grass or low growing ground cover shrubbery 	 Distance between the two remaining intersections is still substandard Substantial right-of-way acquisition required Modest travel indirection between Lisbon Avenue and points north and west of existing intersection Reconstruction includes facilities currently under the jurisdiction of Waukesha County Edge of roadway approximately 30 feet nearer residence in northwest quadrant of northern intersection; and approximately 35 feet nearer to the residence east of Merton Avenue and south of Lisbon Avenue 	\$310,000	-39b-
Intersections of E. Capitol Drive and Church Street, and E. Capitol Drive and Maple Avenue	Alternative 2 Provision of exclusive left-turn lane on the westbound approach, separate turn lanes on the northbound approach, and an exclusive right- turn lane on the eastbound approach of the intersection of E. Capitol Drive and Maple Avenue	 Separation of through and turning traffic on the east- and westbound approaches to E. Capitol Drive and Maple Avenue intersection Two twelve foot lanes would be provided on all approaches to E. Capitol Drive and Maple Avenue intersection³ 	 Widening of both Maple Avenue and E. Capitol Drive would eliminate existing curb lawns and large trees within the curb lawns and may eliminate trees outside of the curb lawn Right-of-way acquisition may be required Does not resolve substandard intersection spacing problem Assuming 22 foot long parking spaces, an estimated 33 weekday parking spaces eliminated on E. Capitol Drive, 19 spaces east of Maple Avenue, and 14 spaces west of Church Street, and an additional nine spaces on weekend days on the north side of E. Capitol Drive east of Church Street 	\$ 76,400	
	Remove existing pictographic "SCHOOL CROSSING" sign on Maple Avenue 190 feet south of E. Capitol Drive	 Conformity with the <u>Manual on Uniform Traffic Control Devices</u> 	• None	\$ 100	
Table 6 (continued)

Location	Recommended Action/Description	Advantages	Disadvantages	Estimated Construction Cost
Intersection of E. Capitol Drive, North Avenue, and Hill Street	Provide two 12 foot wide lanes including exclusive left turn lane for the southbound approach and westbound approach	 Separation of through and left-turning traffic on two approaches to this intersection thereby enhancing traffic safety Provision of exclusive left-turn lanes warranted based upon left- turning volume 	 Elimination of about 25 parking spaces; 17 spaces on E. Capitol Drive and 8 spaces on North Avenue Does not provide standard intersection spacing 	\$ 3,200
Intersection of W. Capitol Drive, Cottonwood Avenue, and Haight Drive	Implement one-way traffic in the eastbound direction on Haight Drive from Cottonwood Avenue to the alley east of Cottonwood Avenue ^D	 Eliminates the restricted sight distance problem on this approach Reduces the number of conflict points at the intersection from 24 to 16 points, thereby enhancing traffic safety Reduces the volume entering the intersection thereby enhancing traffic safety 	 No complimentary facility for one-way westbound travel Increased travel time and distance for existing westbound traffic on Haight Drive Disruption to existing traffic patterns as existing westbound traffic uses other intersections Attendant increase in air pollution emissions and fuel consumption Decreased access to parking north of Haight Drive adjacent to the one-way segment may generate some motorist frustration resulting in disregard for the one-way segment oreating an enforcement problem Does not provide standard intersection spacing 	\$ 3,500
	Introduce radius to W. Capitol Drive alignment to create a 90 degree intersection and construction of a pavement choker in the northwest intersection quadrant	 Eliminate the acute angle of intersection at this location Reduces the amount of pavement available on the southbound approach thereby providing greater definition to the path of southbound vehicles and reducing the expanse of pavement which must be monitored by east- and westbound motorists for potential conflicting vehicles Increases green space 	 The increase in the angle of intersection between W. Capitol Drive and Cottonwood Avenue from 52 to 90 degrees would require a reduction in speeds at which southbound traffic may execute the right-turn maneuver Tractor-trailer truck traffic may encroach on the adjacent traffic lane when executing turns to and from the east- bound approach Alignment modification insufficient to provide standard intersection spacing 	\$ 16,200
	Eliminate stop sign control on northbound approach/add "CROSS TRAFFIC DOES NOT STOP" supplemental plate "STOP AHEAD" advance warning sign ^C	 Both intersection approaches serving the predominant traffic movement through the intersection would be uncontrolled with the minor eastbound approach remaining controlled reflecting typical intersection control Facilitates the predominant traffic movement through the southern intersection and eliminates stops and delay for northbound motorists Improved traffic control for northeastbound traffic Alerts motorists on the west leg of the intersection that north- and southbound traffic is uncontrolled 	 May increase delay incurred by motorists on the W. Capitol Drive approach Does not provide standard intersection spacing 	\$ 300
Intersection of W. Capitol Drive. W. Park Avenue, and Prospect Avenue	Alternative 2 Reconstruct existing intersection to create two separate intersections and to provide 90 degree angle of intersection between W. Capitol Drive and W. Park Avenue and W. Capitol Drive and Prospect Avenue	 Provides separate intersections thereby reducing potential confusion to northbound traffic on Prospect Avenue as to whether traffic on W. Capitol Drive is turning to W. Park Avenue or Prospect Avenue Increases green space Provides 90 degree angle of intersection at W. Capitol Drive and W. Park Avenue and W. Capitol Drive and Prospect Avenue Strip right-of-way acquisition required in southwest quadrant of W. Capitol Drive and Prospect Avenue 	• Spacing between the two intersections is substandard	\$ 31,000

^a Although a lane width of 12 feet is the recommended standard for arterial facilities, an 11 foot lane width may be adequate under low speed, interrupted-flow conditions. ^bIf the existing two-way traffic on Haight Drive is not converted to one-way traffic, construction of the pavement choker in the northeast quadrant of the intersection as shown in Figure 13 is not required.

^oThis action should not be implemented unless the substandard angle of intersection between W. Capitol Drive and Cottonwood Avenue is eliminated.

Source: SEWRPC.

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geometric design deficiencies which may present traffic safety problems were identified:

- the substandard 10 foot-wide lanes resulting from division of the approach traffic into two separate streams on a single 20 foot wide lane; and,
- the substandard spacing between the two intersections.

Three alternatives were evaluated, and Alternative 2, shown in Figure 9, was recommended to be implemented as part of the reconstruction of E. Capitol Drive from Maple Avenue to Merton Avenue. This alternative would address the operational problem and the substandard lane width problem at an estimated construction cost of \$76,500, but it would also eliminate curb lawns and may require modest right-of-way acquisition. Further, it would not address the substandard intersection spacing problem. All of the advantages and disadvantages of this alternative are set forth in Table 6.

Intersections Of E. Capitol Drive, North Avenue, And Hill Street And Cottonwood Avenue, W. Capitol Drive, And Haight Drive

Analyses indicated that five traffic accidents occurred during the three year period from January 1, 1993, to December 31, 1995, two at the northernmost and three at the southernmost intersection. Vehicular delay and queuing were very modest at the northern intersection and insignificant at the southern intersection even during peak traffic periods. However, four geometric design deficiencies which may present traffic safety problems were identified:

- a substandard intersecting angle between legs of the south intersection;
- the substandard spacing between the two intersections;
- the substandard sight distance from westbound Haight Drive to the north; and,
- the substandard 10 foot-wide lanes resulting from division of the approach traffic into two separate streams on a single 20 foot wide lane on the south- and westbound approaches to the north intersection.

An operational deficiency at the south intersection was identified:

• the intersection does not follow the typical intersection traffic control practice of either having all approaches stop sign controlled, or having the approaches on one street stop sign controlled with the cross street approaches uncontrolled.

Five actions were evaluated and implementation of three actions, as shown in Figure 13, was recommended at these intersections. The first action would address the substandard lane-width deficiency at the northern intersection by providing two exclusive 12 foot wide lanes on the south- and westbound approaches at an estimated cost of \$3,200, but would eliminate about 25 parking spaces, 17 on E. Capitol Drive and eight on North Avenue. The second action would address the substandard angle of intersection and the substandard sight distance deficiencies by converting Haight drive from one-way to two-way operation between Cottonwood Avenue and the alley to the east, and the realignment of W. Capitol Drive to provide a 90 degree angle of intersection with Cottonwood Avenue at an estimated construction cost of \$19,700, thereby enhancing traffic safety. Travel time and distance would increase for existing westbound Haight Drive traffic. The final action would address the atypical traffic control deficiency by eliminating the "STOP" sign on the northbound Cottonwood Avenue approach at an estimated cost of \$300. This would enhance the predominant traffic movement through the intersection. None of these actions would address the substandard intersection spacing deficiency. All of the advantages and disadvantages of these actions are set forth in Table 6.

Intersection Of W. Capitol Drive, W. Park Avenue, And Prospect Avenue

Analyses indicated that no traffic accidents occurred during the three year period from January 1, 1993, to December 31, 1995, and that vehicular delay and queuing were insignificant even during peak traffic periods. However, one geometric design deficiency which may present a traffic safety problem was identified:

ullet a substandard intersecting angle between legs of the intersection.

Two alternatives were evaluated, and implementation of Alternative 2, as shown in Figure 17, was recommended to address the substandard intersection spacing deficiency at an estimated construction cost of \$31,000. This alternative would realign W. Park Avenue and Prospect Avenue to provide two 90 degree intersections with W. Capitol Drive, although the distance between the two new intersections would be substandard. All of the advantages and disadvantages of this alternative are set forth in Table 6. Incidental to the analysis of the W. Capitol Drive, W. Park Avenue, and Prospect Avenue intersection analysis, the Village staff requested identification of potential advantages and disadvantages of converting W. Park Avenue from its existing one-way eastbound traffic operation to two-way traffic operation if Alternative 2 was implemented.

Advantages include:

- eliminates the lack of a complimentary one-way westbound facility;
- improves access to parcels abutting W. Park Avenue;

• reduces travel time and indirection; and,

• expected reduction in northbound left-turns at the W. Capitol Drive, Cottonwood Avenue, and Haight Drive intersection would reduce potential vehicle conflicts and improve traffic safety.

Disadvantages include:

• divert an estimated 295 westbound collector-type vehicle trips from W. Capitol Drive to W. Park Avenue increasing by about 70 percent the W. Park Avenue volume from 425 to 720 vehicles per average weekday;

• W. Park Avenue--designed and constructed as a land access street--would carry nearly 600 collector-type trips on an average weekday and would, therefore, function primarily as a collector facility, a function for which it is clearly not intended and a situation generally considered undesirable by abutting residents;

• the straight and flat alignment of W. Park Avenue, along with substantial building setbacks and few driveways may contribute to a perception that travel speeds greater than the posted speed limit are acceptable;

the number of potential vehicle conflict points at the W. Park Avenue intersections with W. Capitol Drive and Cottonwood Avenue would increase from four to nine and from 15 to 24, respectively. This potential traffic safety degradation is further exacerbated by the expected diversion of left-turning vehicles from the W. Capitol Drive, Cottonwood Avenue, and Haight Drive intersection to the W. Park Avenue and Cottonwood Avenue intersection;
provision of the desired corner sight distance triangle at the proposed new W. Capitol Drive and W. Park Avenue intersection would eliminate an estimated three on-street parking spaces on the south side of W. Capitol Drive east of W. Park Avenue and the existing off-street parking north and

west of the existing commercial building in the southeast quadrant of the intersection; and,

• the distance between the W. Capitol Drive intersections with Prospect Avenue and W. Park Avenue would only be about 160 feet, substantially less than the desired 300 feet.

Accordingly, because the disadvantages outweigh the advantages, the Commission staff recommended that one-way operation be continued, and, in particular, would not recommend any change if the W. Capitol Drive, W. Park Avenue, and Prospect Avenue intersection is not reconstructed.

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