CITY OF MADISON

CAPITOL LOOP TRAFFIC NEEDS STUDY

FINAL DRAFT REPORT

October 31, 2005

Prepared For:
City of Madison
Traffic Department
210 Martin Luther King Jr. Blvd.
Room 100
Madison, WI 53703
Contact: Dan Dettmann, P.E.

Prepared By:
HNTB Corporation
10 East Doty Street
Suite 615
Madison, WI 53703
Contact: Rob Beuthling, P.E.

AS REVISED
(1/18/06)

INTRODUCTION AND PURPOSE OF STUDY

INTRODUCTION

The Capitol Square and the Capitol Loop are primary destinations in Madison and the State of Wisconsin.

The Capitol Square provides access to the State Capitol Building, plus the surrounding lodging, commercial, financial, educational, and retail land uses. The City of Madison has emphasized the pedestrian and transit functions of the Square while still providing some lanes for vehicles and parking.

The Capitol Loop serves the City and County government centers, state office buildings, the Federal Court House, the Monona Terrace Convention Center, the Overture Center, the Madison Public Library, high density condominiums as well as numerous office buildings, and retail businesses. The Capitol Loop is the primary vehicle thoroughfare through downtown Madison. Pedestrians travel across and along the Capital Loop throughout the day and evening.

Over 15 public and private parking facilities are directly adjacent to the Capitol Loop. As a result, vehicle, pedestrian and bicycle traffic is heavy during the morning, midday and evening peak hours. As drivers leave their cars, they become pedestrians and complete their walk to work or visit Madison attractions.

PURPOSE OF STUDY

The purpose of the study is to evaluate the impacts to pedestrians and vehicular operations with the installation of traffic signals at each of the currently unsignalized intersections on the Capitol Loop. Through data collected in the field and the use of computer simulation model (Synchro and SimTraffic), the study compiled and analyzed the data. The report summarizes the study area and transportation system, the collected data, the steps used to analyze the data, and the findings of the analysis.

EXISTING CONDITIONS

STUDY AREA

There are sixteen intersections around the Capitol Loop, eight of which are signalized. Both the Capitol Loop and the Square consist of one way streets, circulating counter-clockwise around the Capitol.

The study area includes:

> The Capitol Loop: Dayton Street, Fairchild Street, Doty Street, and Webster Street.
>
> The Capitol Square: Mifflin Street, Carroll Street, Main Street, and Pinckney Street.
>
> Relevant Intersections: Wilson Street, Henry Street, & Hamilton Street and Wilson Street, King Street, & Butler Street

Exhibit 1 shows the study area. Exhibit 2 shows the existing intersection geometry for each of the Square and Capitol Loop intersections.

EXISTING TRAFFIC VOLUMES

HNTB collected intersection volume counts for pedestrians, vehicles, heavy vehicles and buses during the morning (AM), midday (MD), and evening (PM) peak periods. For each peak period, HNTB determined the peak hour of vehicle and pedestrian traffic. The counts were at the following eighteen intersections:

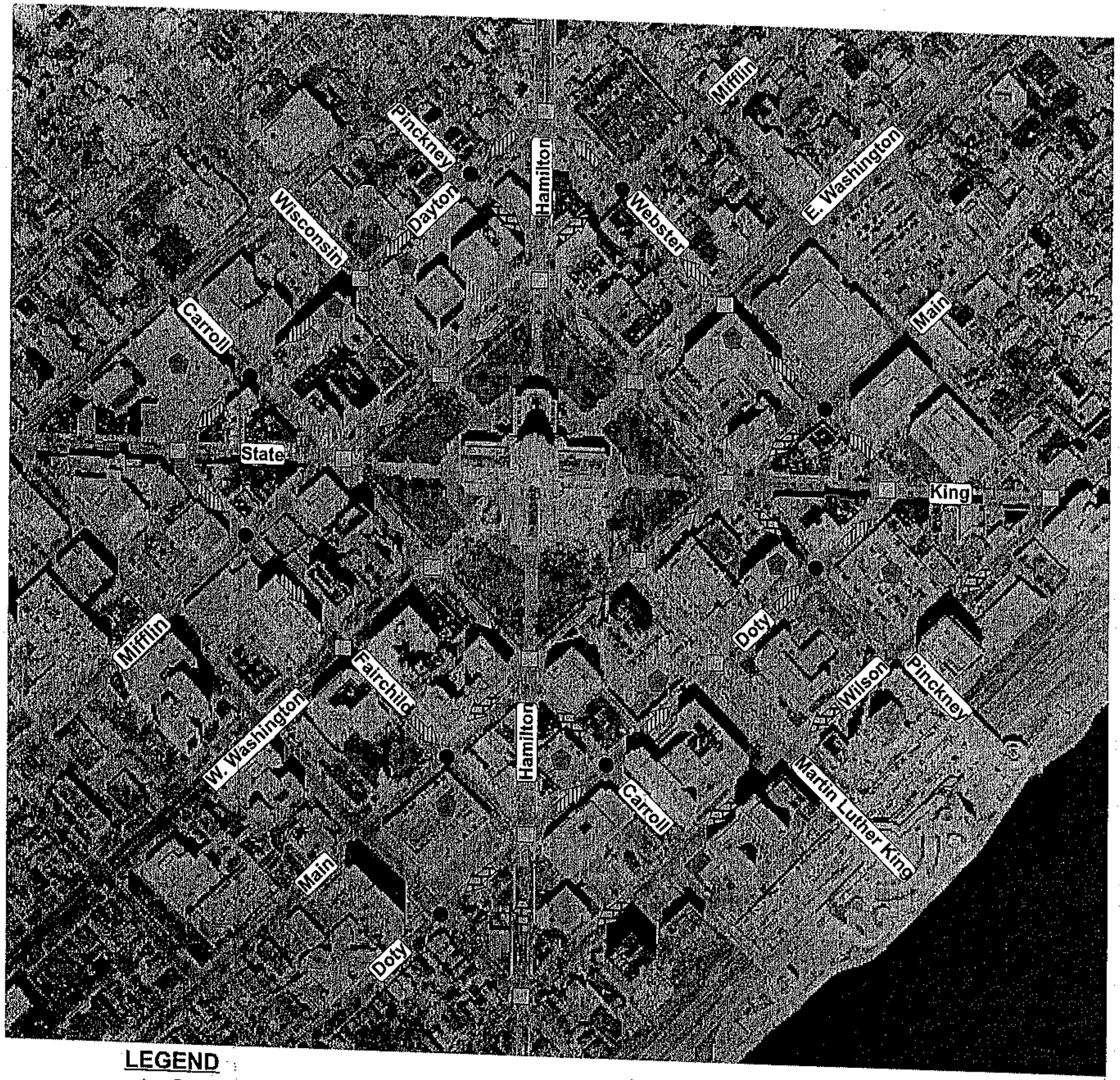
- Doty Street and Carroll Street
- Doty Street and Martin Luther King Jr. Boulevard
- Doty Street and Pinckney Street
- Doty Street, Webster Street and King Street
- Webster Street and Main Street
- Webster Street and East Washington Avenue
- Webster Street and Mifflin Street
- Webster Street, Dayton Street and Hamilton Street
- Dayton Street and Pinckney Street
- Dayton Street and Wisconsin Avenue
- Dayton Street and Carroll Street
- Dayton Street, Fairchild Street and State Street
- Fairchild Street and Mifflin Street
- Fairchild Street and West Washington Avenue
- Fairchild Street and Main Street
- Fairchild Street, Doty Street and Hamilton Street
- Hamilton Street, Henry Street and Wilson Street
- Wilson Street, Butler Street and King Street

Intersection traffic counts are included in the Appendix (not included in this Draft). Based on the traffic data, the peak hours were identified as follows:

- AM Peak: 7:45 to 8:45 am
- MD Peak: 11:45 am to 12:45 pm
- PM Peak: 4:30 to 5:30 pm

The traffic data was collected on different days for each of the intersections. Minor adjustments to these counts balanced the traffic as it proceeded from one intersection to the next. Balancing the intersection volumes thus created a consistent reasonable flow of traffic in the study area and enabled the calibration of the simulation models.

The Capitol Square intersections were not counted; but by using the same balancing technique, volumes for those intersections were developed based on vehicles coming from the Capitol Loop and parking facilities along the Square. Exhibit 3, Exhibit 4, and Exhibit 5 show the vehicular turning volumes in the study area. Exhibit 6, Exhibit 7, and Exhibit 8 show the pedestrian crossing volumes for the Capitol Loop intersections.

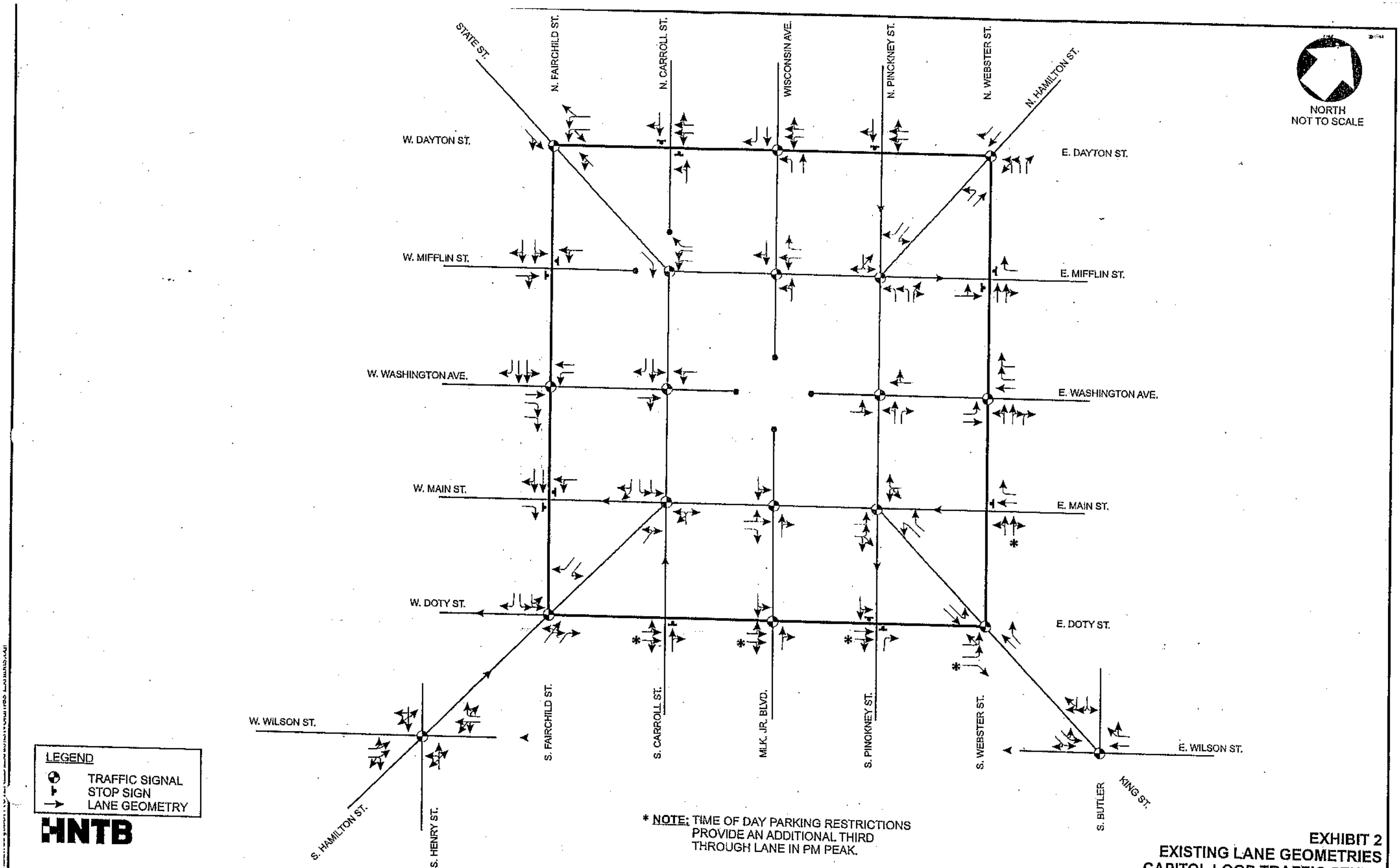


LEGEND

- Outer (Capitol) Loop
- Inner Loop
- Other One-way Street
- Signalized Intersection
- Unsignalized Intersection
- Parking

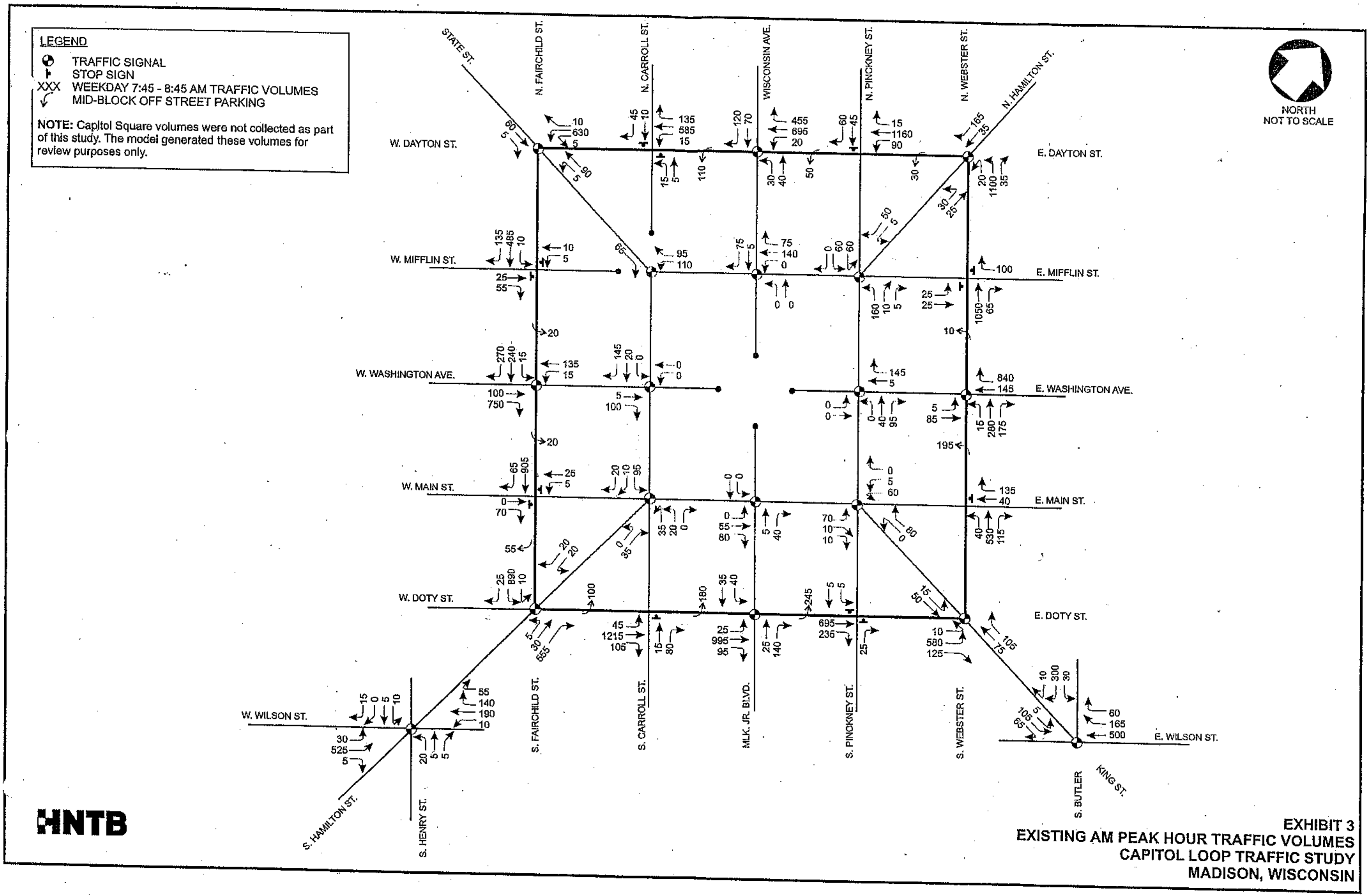
EXHIBIT 1
STUDY AREA
CAPITOL LOOP TRAFFIC STUDY
MADISON, WISCONSIN

\\Madw00\pmwork\Jobs\41012\Exhibits\Downtown Exhibit.cdr



* **NOTE:** TIME OF DAY PARKING RESTRICTIONS PROVIDE AN ADDITIONAL THIRD THROUGH LANE IN PM PEAK.

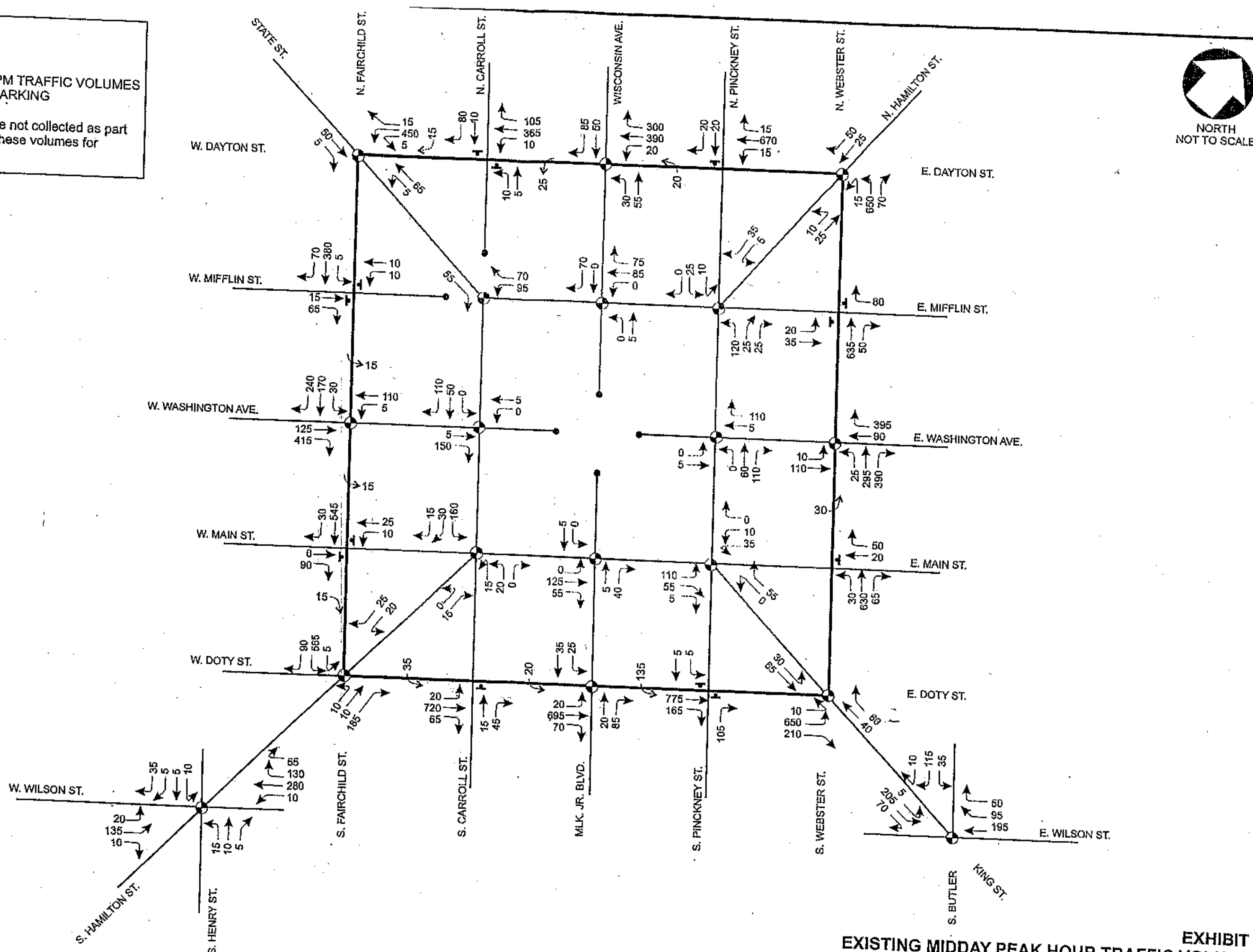
EXHIBIT 2
EXISTING LANE GEOMETRIES
CAPITOL LOOP TRAFFIC STUDY
MADISON, WISCONSIN


LEGEND
TRAFFIC SIGNAL
STOP SIGN
XXX WEEKDAY 7:45 - 8:45 AM TRAFFIC VOLUMES
MID-BLOCK OFF STREET PARKING
NOTE: Capitol Square volumes were not collected as part of this study. The model generated these volumes for review purposes only.
NORTH
NOT TO SCALE
STATE ST.
N. FAIRCHILD ST.
N. CARROLL ST.
WISCONSIN AVE.
N. PINCKNEY ST.
N. WEBSTER ST.
N. HAMILTON ST.
W. DAYTON ST.
E. DAYTON ST.
W. MIFFLIN ST.
E. MIFFLIN ST.
W. WASHINGTON AVE.
E. WASHINGTON AVE.
W. MAIN ST.
E. MAIN ST.
W. DOTY ST.
E. DOTY ST.
W. WILSON ST.
E. WILSON ST.
S. FAIRCHILD ST.
S. CARROLL ST.
MLK. JR. BLVD.
S. PINCKNEY ST.
S. WEBSTER ST.
S. HAMILTON ST.
S. HENRY ST.
S. BUTLER
KING ST.
HNTB
EXHIBIT 3
EXISTING AM PEAK HOUR TRAFFIC VOLUMES
CAPITOL LOOP TRAFFIC STUDY
MADISON, WISCONSIN

LEGEND

- TRAFFIC SIGNAL
- STOP SIGN
- XXX WEEKDAY 11:45 AM-12:45 PM TRAFFIC VOLUMES
- MID-BLOCK OFF STREET PARKING

NOTE: Capitol Square volumes were not collected as part of this study. The model generated these volumes for review purposes only.



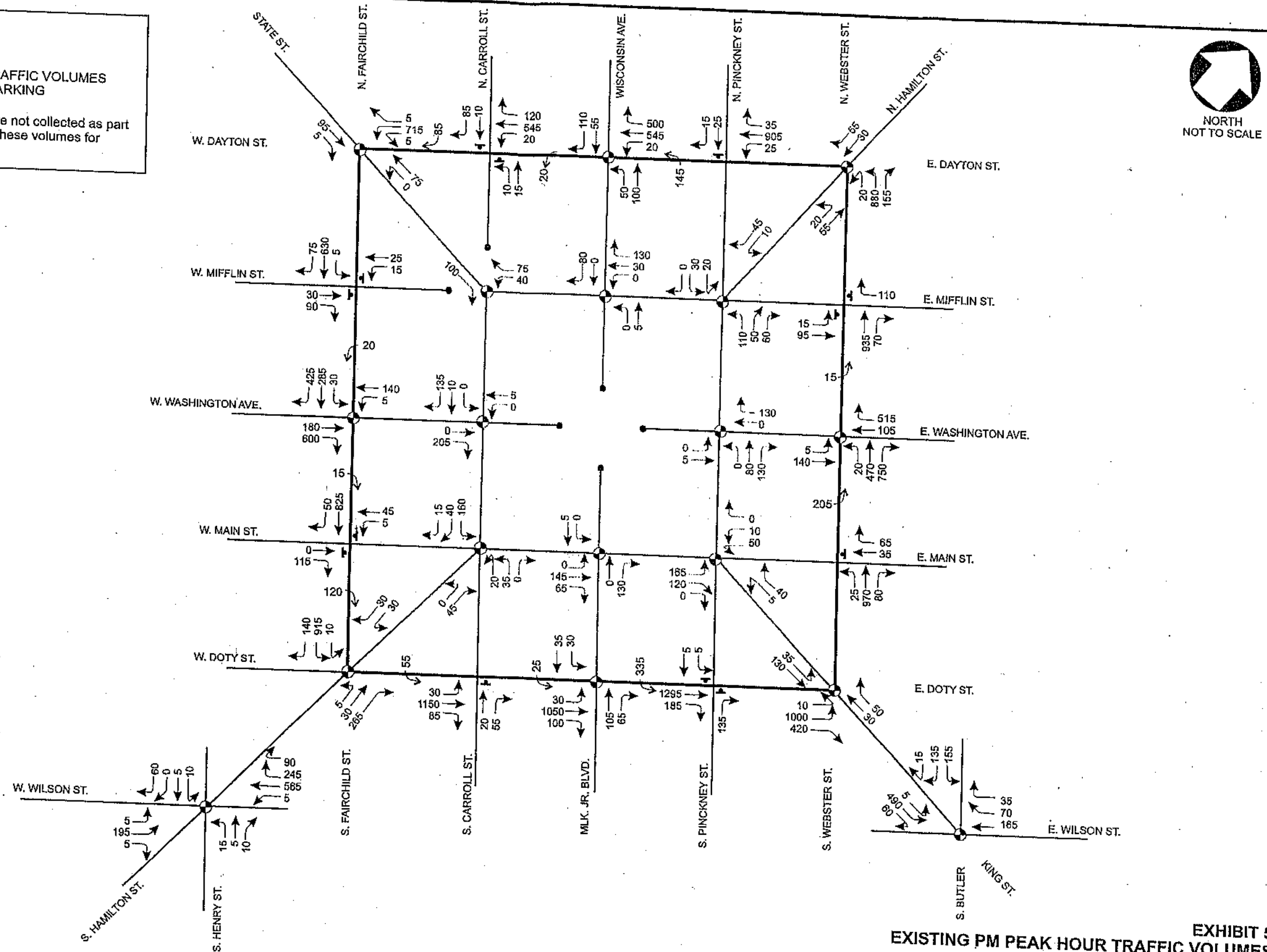
HNTB

EXHIBIT 4
EXISTING MIDDAY PEAK HOUR TRAFFIC VOLUMES
CAPITOL LOOP TRAFFIC STUDY
MADISON, WISCONSIN

LEGEND

- TRAFFIC SIGNAL
- STOP SIGN
- XXX WEEKDAY 4:30 - 5:30 PM TRAFFIC VOLUMES
- MID-BLOCK OFF STREET PARKING

NOTE: Capitol Square volumes were not collected as part of this study. The model generated these volumes for review purposes only.



HNTB

EXHIBIT 5
EXISTING PM PEAK HOUR TRAFFIC VOLUMES
CAPITOL LOOP TRAFFIC STUDY
MADISON, WISCONSIN

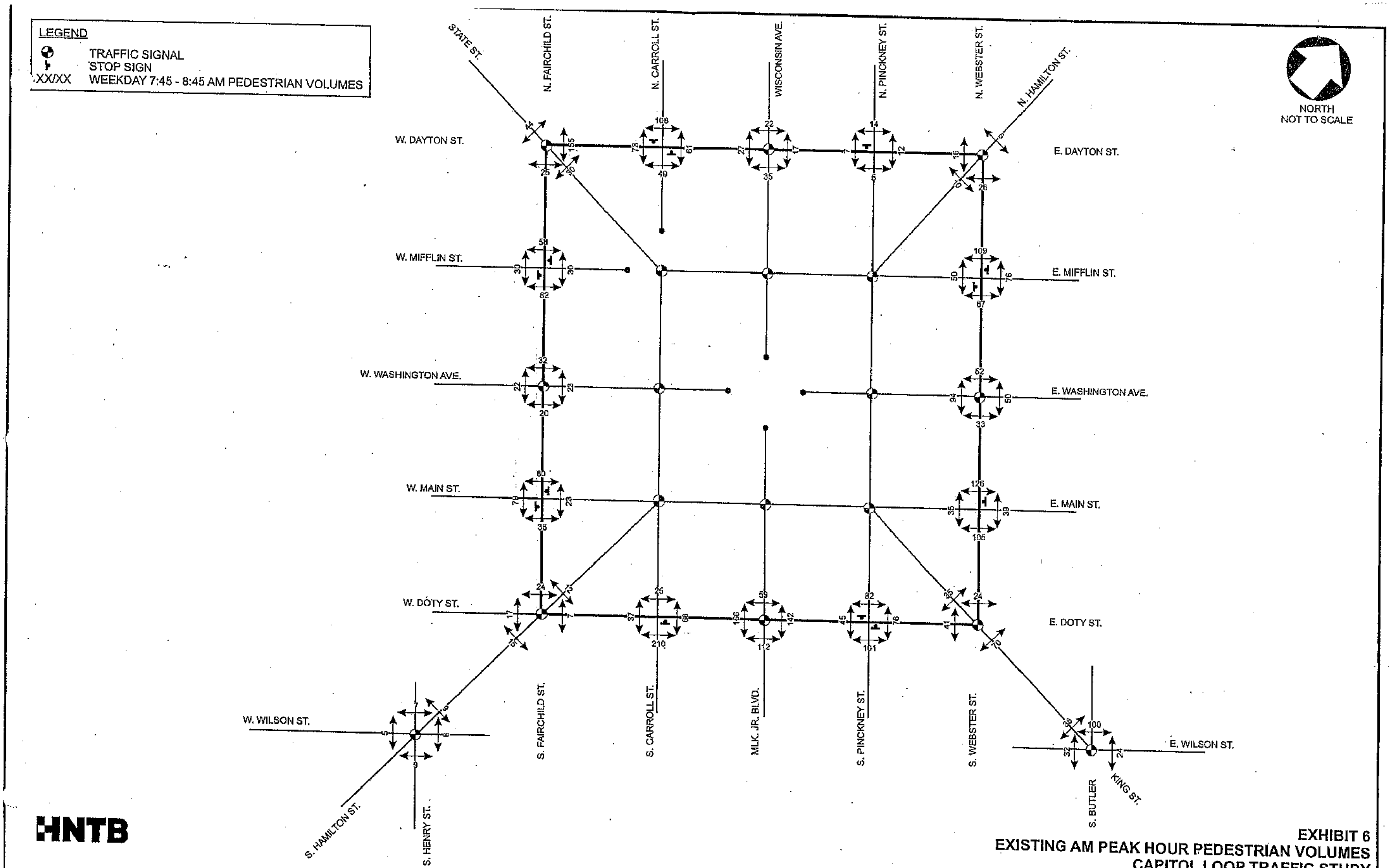


EXHIBIT 6
EXISTING AM PEAK HOUR PEDESTRIAN VOLUMES
CAPITOL LOOP TRAFFIC STUDY
MADISON, WISCONSIN

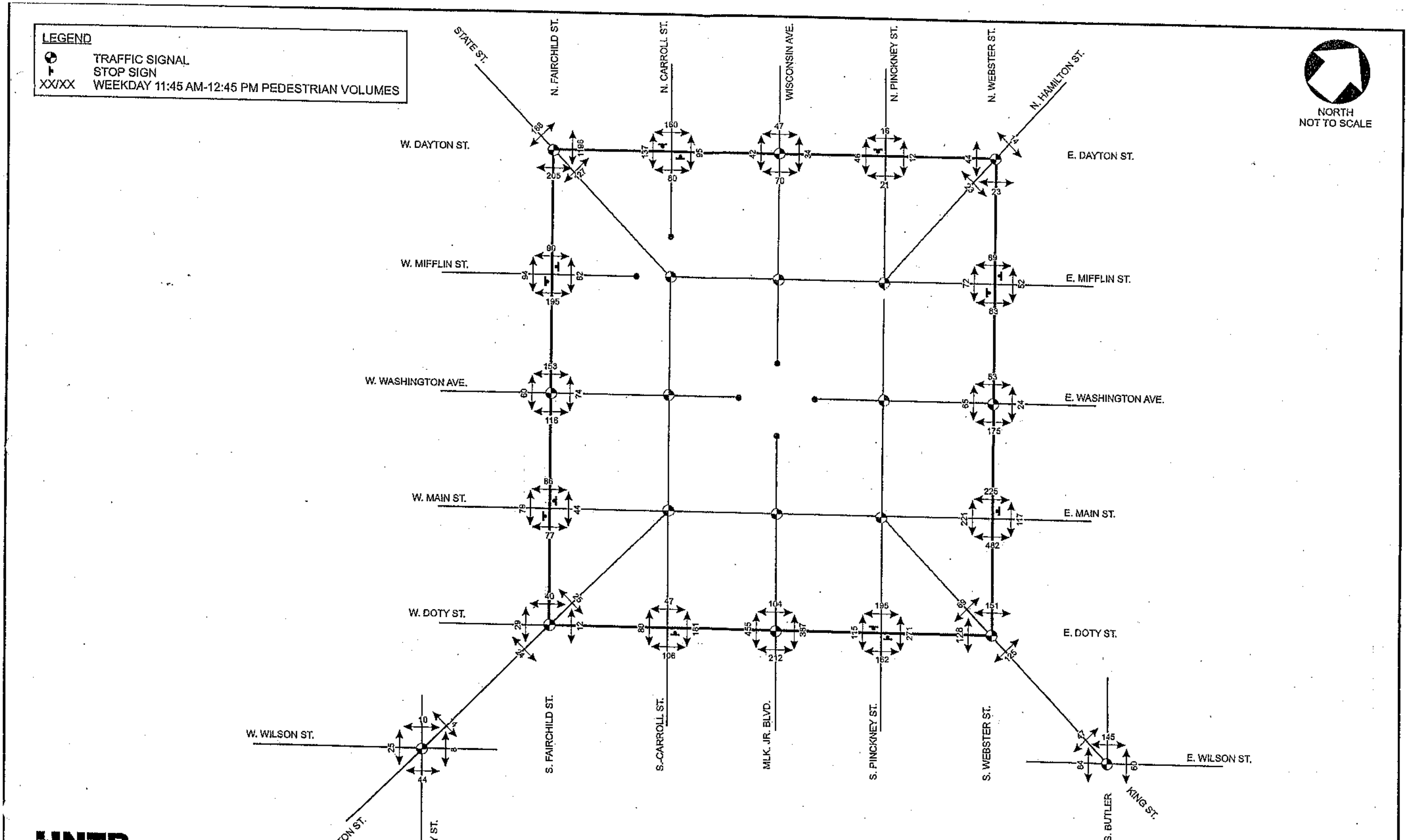


EXHIBIT 7
EXISTING MD PEAK HOUR PEDESTRIAN VOLUMES
CAPITOL LOOP TRAFFIC STUDY
MADISON, WISCONSIN

LEGEND

- TRAFFIC SIGNAL
- STOP SIGN
- XX/XX WEEKDAY 4:30 - 5:30 PM PEDESTRIAN VOLUMES

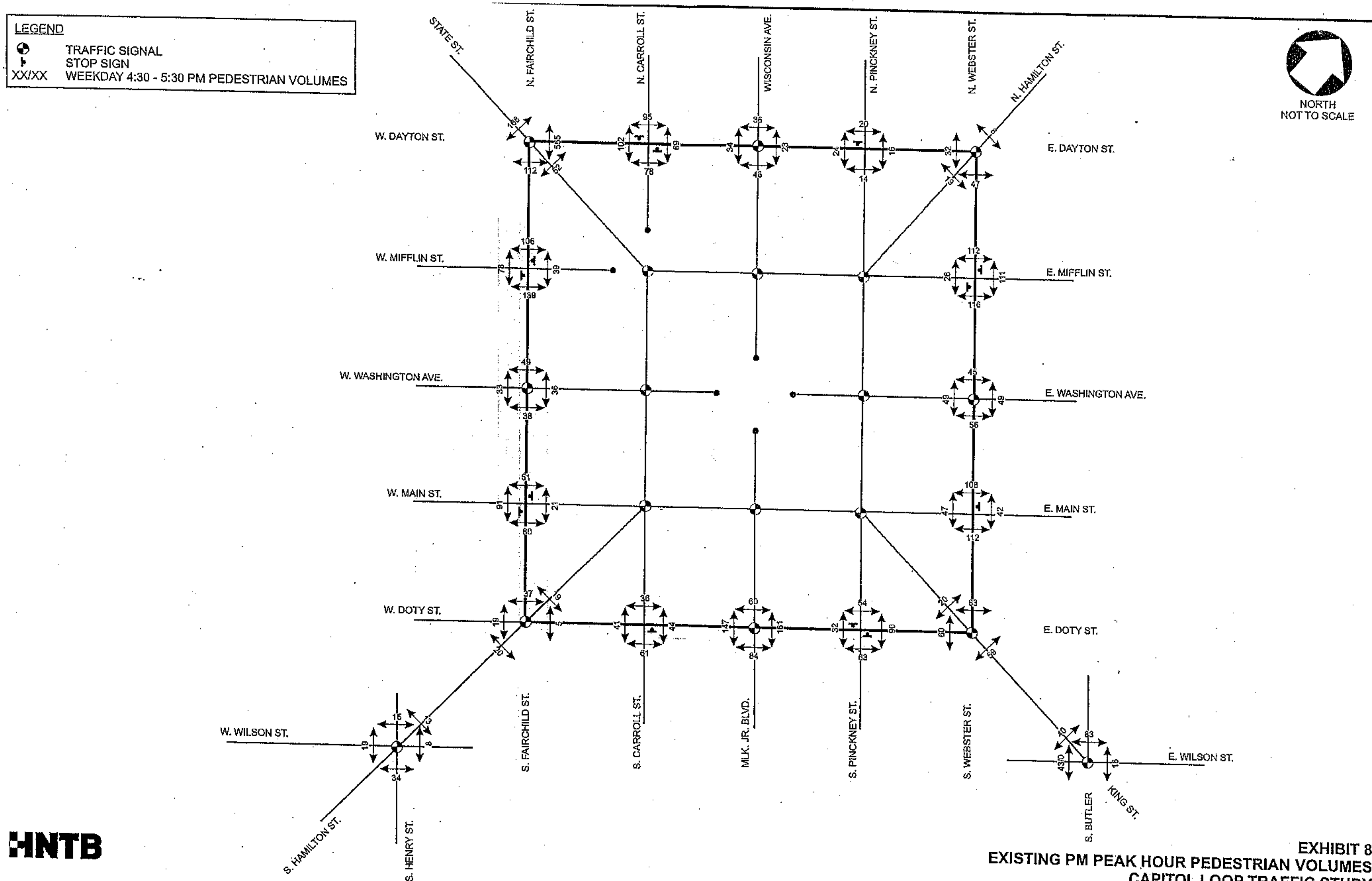


EXHIBIT 8
EXISTING PM PEAK HOUR PEDESTRIAN VOLUMES
CAPITOL LOOP TRAFFIC STUDY
MADISON, WISCONSIN

ANALYSIS

TRAFFIC ANALYSIS

The purpose of the study is to investigate the operations of the existing Capitol Loop and identify the impacts to pedestrian and vehicle delay if signals were to be added to the eight remaining unsignalized intersections in the Capitol Loop.

The evaluation of the Capitol Loop was completed in five major steps:

1) Collect vehicle turning movement and pedestrian volumes at the Capitol Loop intersections.
2) Develop and calibrate peak hour traffic simulation models for the existing conditions.
3) Collect and analyze pedestrian delay at the unsignalized Capitol Loop intersections.
4) Run traffic simulation models with signals at each of the Capitol Loop intersections to evaluate the impacts to vehicle delay.
5) Calculate expected delay to pedestrians with the installation of additional signals on the Capitol Loop.

TRAFFIC SIMULATION

With the assistance of the City of Madison, HNTB collected intersection geometry, signal timing, bus data, parking generation and the vehicular and pedestrian traffic. The entire study area was simulated in the Synchro/SimTraffic software package for the AM, midday, and PM peak hours.

Table 1 summarizes the delays from SimTraffic of the study area intersections in Capitol Loop traffic models. The models represent existing conditions. These delays will be used as a basis of comparison when evaluating alternatives.

Table 1: Intersection Vehicle Delay – Existing System

Capitol Loop Intersection	I/S Control	Average Delay / Vehicle (sec)		
		AM	MD	PM
Doty & Carroll	Stop	3.7	3.8	2.9
Doty & MLK Jr.	Signal	8.3	10.5	10.6
Doty & Pinckney	Stop	3.1	14.7	6.8
Doty/Webster & King	Signal	9.6	14.1	12.5
Webster & Main	Stop	4.9	19.2	4.7
Webster & E. Washington	Signal	14.8	19.2	20.2
Webster & Mifflin	Stop	7.2	3.6	9.2
Webster/Dayton & N. Hamilton	Signal	11.7	8.9	12.1
Dayton & Pinckney	Stop	3.7	2.3	3.2
Dayton & Wisconsin	Signal	6.7	6.6	9.7
Dayton & Carroll	Stop	2.8	4.0	3.8
Dayton/Fairchild & State	Signal	8.2	8.8	10.0
Fairchild & Mifflin	Stop	3.0	3.8	6.1
Fairchild & W. Washington	Signal	25.0	34.1	29.9
Fairchild & Main	Stop	2.9	3.5	5.7
Fairchild/Doty & S. Hamilton	Signal	6.7	10.5	13.8
System Delay		**46.7**	**58.5**	**62.0**

Table 1 shows that all intersections have delays less than 35 seconds per vehicle, which is within standard acceptable limits set forth in the Highway Capacity Manual (HCM). The system delay includes all the links in the model, including the Capitol Square intersections and the Wilson Street intersections with Henry and Butler streets. Because of the way this data is calculated it cannot be compared to the delay limits set forth in the HCM.

PEDESTRIAN DELAY STUDY

A pedestrian delay study was conducted to assess the actual delay incurred by pedestrians while they wait to cross the Capitol Loop at the unsignalized intersections. In 15 second intervals, the number of people waiting at each corner was recorded. Concurrently, the total number of pedestrians and vehicles using each intersection was recorded. This provided two data sets:

1. Total number of pedestrians that had to stop to cross the Capitol Loop streets; recorded in fifteen second intervals for the peak hour.
2. Total number of pedestrians that crossed the street within the peak hour.

The average delay was calculated as follows:

$$\text{Average Pedestrian Delay} = \frac{\text{Total Stopped Pedestrians}}{\text{Total Pedestrians}} * 15\text{Seconds}$$

where:

- "Total Stopped Pedestrians" are the sum of pedestrians stopped at the intersection at the end of each 15 second interval for peak hour
- "Total Pedestrians" are those that crossed the Capitol Loop for the peak hour.

It's important to note that the stopped pedestrian did not have to wait for 15 seconds to be counted. Rather, they were counted if they were stopped at the end of a 15 second interval. Similarly, they were not counted if they arrived, waited and crossed within the 15 second interval. There were often times where pedestrians waited for more than fifteen seconds and thus were counted multiple times across several intervals. The 15-second factor accounts for the random arrivals and provides for an average delay. The results are summarized in Table 2 and shown graphically in Exhibit 9.

Table 2: Pedestrian Delay

Unsignalized Intersection	AM		MD		PM	
	Ave. Delay (s)	Total Peds	Ave. Delay (s)	Total Peds	Ave. Delay (s)	Total Peds
Doty & Carroll	13.5	71	**8.1**	175	16.9	64
Doty & Pinckney	9.3	135	3.9	380	**17.3**	112
Webster & Main	5.9	**235**	6.1	**640**	14.3	**225**
Webster & Mifflin	10.2	138	6.5	149	9.4	179
Dayton & Pinckney	**16.6**	37	6.8	46	5.7	34
Dayton & Carroll	7.2	119	7.0	183	7.4	116
Fairchild & Mifflin	8.0	105	5.3	306	11.4	222
Fairchild & Main	5.6	148	4.6	150	4.7	119

Table 2 highlights the intersections with the highest average pedestrian delay and volumes. The intersection of Webster & Main had the highest pedestrian volumes for each of the three peak hours. Employees in the State Office buildings are the main users of this intersection. However, the highest pedestrian delay occurred at different locations throughout the day, but not at this location.

In the morning, the highest average delay occurs the Pinckney Street intersection with Dayton Street. This is due to the high volume of cars turning from N. Hamilton Street to Dayton Street, filling in the gaps produced by the signalized intersection.

Generally, pedestrians experience a reduced amount of delay during the midday peak, with the Carroll intersection with Doty Street peaking at 8.1 seconds per pedestrian. The lower vehicular volumes along with the increase in pedestrian volume are the main reasons for the decrease in delay.

During the evening peak, vehicle traffic volumes are at their highest, and the pedestrian delays increase accordingly. The Doty Street intersection with Pinckney Street has the highest average delay at 17.3 seconds per pedestrian. Drivers exiting the Block 89 parking structure, located just west of the intersection, are one cause for the increase in delay. Vehicles leaving the dual-lane ramp exit utilize the gaps in the traffic flow to pull into traffic, thereby causing the pedestrians to wait longer for an acceptable gap.

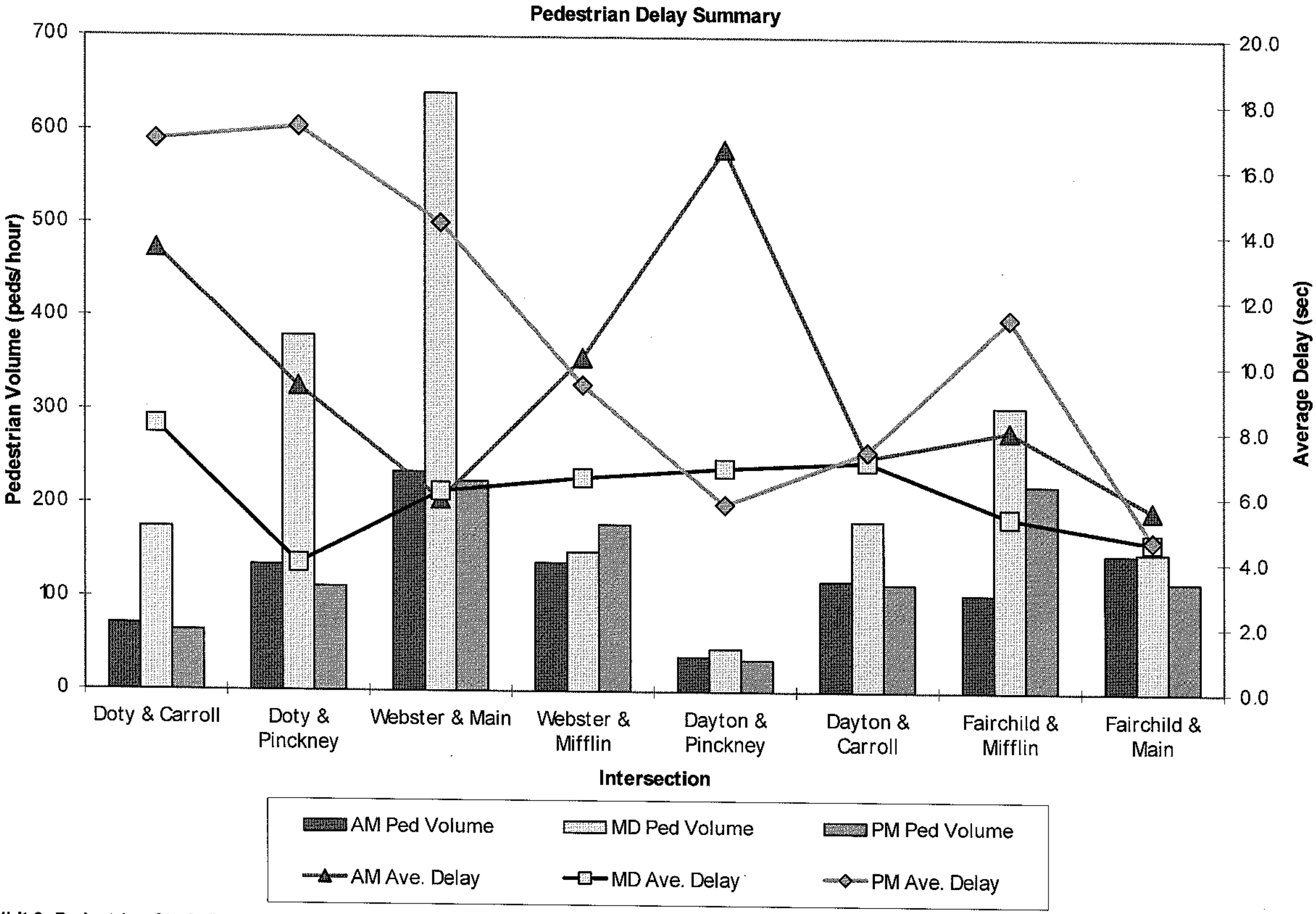


Exhibit 9: Pedestrian Study Delay Summary

VEHICLE DELAY EVALUATION

The traffic simulation models were run with the addition of traffic signals at each of the currently unsignalized intersections in the Capitol Loop. Each intersection was timed so that the flow of traffic around the Capitol Loop was progressive and disrupted as little as possible. Table 3 summarizes the expected average vehicle delay for each of the Capitol Loop intersections. The results are from the SimTraffic model.

Table 3: Intersection Vehicle Delay – Total Signalized System

Capitol Loop Intersection	I/S Control	Average Delay / Vehicle (sec)		
		AM	MD	PM
Doty & Carroll	Signal	5.9	6.8	10.5
Doty & MLK Jr.		6.9	6.7	10.3
Doty & Pinckney		5.0	7.2	6.9
Doty/Webster & King		7.4	7.0	11.1
Webster & Main		10.0	7.9	7.7
Webster & E. Washington		13.2	14.6	19.3
Webster & Mifflin		4.0	3.4	7.6
Webster/Dayton & N. Hamilton		9.8	7.7	8.1
Dayton & Pinckney		5.5	3.3	4.1
Dayton & Wisconsin		7.5	6.7	9.1
Dayton & Carroll		5.1	6.0	8.4
Dayton/Fairchild & State		5.8	6.2	7.1
Fairchild & Mifflin		6.8	5.2	8.3
Fairchild & W. Washington		21.6	32.4	25.6
Fairchild & Main		5.1	3.9	6.3
Fairchild/Doty & S. Hamilton		5.9	7.7	11.5
System Total		**46.5**	**49.8**	**60.4**

Table 3 shows that all the intersections have vehicle delays at or less than 35 seconds per vehicle, which are within acceptable limits set forth by the HCM. Because the newly signalized intersections were timed such that Capitol Loop traffic was disrupted as little as possible, there were little differences in vehicle delay for the overall system. Table 4 summarizes the difference in average vehicle delay between the existing and all signalized traffic simulation models.

Table 4: Intersection Vehicle Delay – Difference between Existing & Total Signalized Systems

Capitol Loop Intersection	Existing I/S Control	AM			MD			PM		
		Existing Delay	All-Signalized Delay	Diff.	Existing Delay	All-Signalized Delay	Diff.	Existing Delay	All-Signalized Delay	Diff.
Doty & Carroll	Stop	3.7	5.9	2.2	3.8	6.8	3.0	2.9	10.5	7.6
Doty & MLK Jr.	Signal	8.3	6.9	-1.4	10.5	6.7	-3.8	10.6	10.3	-0.3
Doty & Pinckney	Stop	3.1	5.0	1.9	14.7	7.2	-7.5	6.8	6.9	0.1
Doty/Webster & King	Signal	9.6	7.4	-2.2	14.1	7.0	-7.1	12.5	11.1	-1.4
Webster & Main	Stop	4.9	10.0	5.1	19.2	7.9	-11.3	4.7	7.7	3.0
Webster & E. Washington	Signal	14.8	13.2	-1.6	19.2	14.6	-4.6	20.2	19.3	-0.9
Webster & Mifflin	Stop	7.2	4.0	-3.2	3.6	3.4	-0.2	9.2	7.6	-1.6
Webster/ Dayton & N. Hamilton	Signal	11.7	9.8	-1.9	8.9	7.7	-1.2	12.1	8.1	-4.0
Dayton & Pinckney	Stop	3.7	5.5	1.8	2.3	3.3	1.0	3.2	4.1	0.9
Dayton & Wisconsin	Signal	6.7	7.5	0.8	6.6	6.7	0.1	9.7	9.1	-0.6
Dayton & Carroll	Stop	2.8	5.1	2.3	4.0	6.0	2.0	3.8	8.4	4.6
Dayton/ Fairchild & State	Signal	8.2	5.8	-2.4	8.8	6.2	-2.6	10.0	7.1	-2.9
Fairchild & Mifflin	Stop	3.0	6.8	3.8	3.8	5.2	1.4	6.1	8.3	2.2
Fairchild & W. Washington	Signal	25.0	21.6	-3.4	34.1	32.4	-1.7	29.9	25.6	-4.3
Fairchild & Main	Stop	2.9	5.1	2.2	3.5	3.9	0.4	5.7	6.3	0.6
Fairchild/ Doty & S. Hamilton	Signal	6.7	5.9	-0.8	10.5	7.7	-2.8	13.8	11.5	-2.3
TOTAL SYSTEM		**46.7**	**46.5**	**-0.2**	**58.5**	**49.8**	**-8.7**	**62.0**	**60.4**	**-1.6**

In Table 4, note that the existing signalized intersections generally have a decrease in average delay, while the unsignalized intersections increase in delay. The general decrease in delay at the signalized intersections is attributed to the effect the new signals have on the downstream intersections. The newly signalized intersections capture traffic turning onto the Capitol Loop from the side streets and off-street parking facilities, and meter this traffic flow to an extent. The delay is incurred at the newly signalized intersections, rather than at the existing signalized intersections.

There are three exceptions to the increase in delay at the newly signalized intersections:

- Doty Street & Pinckney Street (Midday peak hour)
- Webster Street & Main Street (Midday peak hour), and
- Webster Street & Mifflin Street (PM peak hour).

These intersections have a decrease in delay of 7.5, 11.3 and 1.6 seconds, respectively.

This is due to the model's pedestrian-vehicle interaction methodology. For an unsignalized intersection, the model places an emphasis on the pedestrian's right to cross the street. This resulted in higher than expected vehicle delays and a more conservative analysis. When signals are installed, the pedestrians cross as directed by the signal control and vehicle delays are improved. Note that during the midday peak, when pedestrian volumes are highest, the vehicle delay improves the most.

PEDESTRIAN DELAY EVALUATION

The study included an evaluation of the impacts to pedestrian delay with the installation of traffic signals at each of the unsignalized intersections. The following parameters were used to assess the impact to delay:

- Existing cycle lengths were used (AM & PM: 80 seconds, MD: 65 seconds).
- The WALK indicator is displayed for seven seconds.
- Pedestrians arrive uniformly across the entire cycle length, providing for an average delay.
- Pedestrians commence crossing only during the WALK phase.

Based on these parameters, the average delay for a pedestrian was calculated to be 31.8 seconds in the AM & PM peaks, and 20.1 seconds in the midday peak. Note that the delay is independent of the number of pedestrians using the intersection, and the delay is the average for the intersection. Table 5 summarizes the increase in delay at each of the intersections for each peak hour.

Table 5: Increase in Pedestrian Delay with Signal Installation

Intersection	AM			MD			PM		
	Existing Delay	Signal Delay	Change	Existing Delay	Signal Delay	Change	Existing Delay	Signal Delay	Change
Doty & Carroll	13.5	31.8	18.3	8.1	20.1	12.0	16.9	31.8	14.9
Doty & Pinckney	9.3	31.8	22.5	3.9	20.1	16.2	17.3	31.8	14.5
Webster & Main	5.9	31.8	25.9	6.1	20.1	14.0	14.3	31.8	17.5
Webster & Mifflin	10.2	31.8	21.6	6.5	20.1	13.6	9.4	31.8	22.4
Dayton & Pinckney	16.6	31.8	15.2	6.8	20.1	13.3	5.7	31.8	26.1
Dayton & Carroll	7.2	31.8	24.6	7.0	20.1	13.1	7.4	31.8	24.4
Fairchild & Mifflin	8.0	31.8	23.8	5.3	20.1	14.8	11.4	31.8	20.4
Fairchild & Main	5.6	31.8	26.2	4.6	20.1	15.5	4.7	31.8	27.1
Average:	**9.5**		**22.3**	**6.1**		**14.0**	**10.9**		**20.9**

In Table 5, the expected average pedestrian delay of each intersection increases an average of 22 seconds in the AM peak, 14 seconds in the midday peak, and 21 seconds in the PM peak.

While the delay to the pedestrians may increase with signal control, the apparent safety of the crossing may be increased. Currently, when a pedestrian crosses within an acceptable gap in the traffic flow, the conflicting traffic must yield to the pedestrian. Although this is the law, field observations show that this is not always the case. Several times pedestrians were seen hurrying across the street to avoid conflicting traffic that refused to yield the right-of-way. Traffic almost always obeys the control of a traffic signal. This may provide a crossing that could be perceived by the public as safer to cross and worth the wait the additional time to cross safely.

PEDESTRIAN VOLUME WARRANT ANALYSIS

The Manual on Uniform Traffic Control Devices provides a set of Warrants that are evaluated when traffic signals are proposed as an intersection control device. Warrant 4, The Pedestrian Volume Warrant is intended for locations where the traffic is so heavy that pedestrians experience excessive delay. In order to justify signal installation, there are two criteria that must be met:

A. The pedestrian volume crossing the major street at an intersection or midblock location during an average day is 100 or more for each of any 4 hours or 190 or more during any 1 hour; and
B. There are fewer than 60 gaps per hour in the traffic stream of adequate length to allow pedestrians to cross during the same period when the pedestrian volume criterion is satisfied. Where there is a divided street having a median of sufficient width for pedestrians to wait, the requirement applies separately to each direction of vehicular traffic.

This study did not collect gap data, so criterion B could not be evaluated. However, the pedestrian volumes were collected at each of the unsignalized intersections on two separate occasions. The first occurred with the initial data collection, the second during the pedestrian delay study. Each collection period included three separate peak hours. This provided enough data to evaluate the one-hour 190 pedestrian threshold of criterion A.

Exhibit 10 shows that criterion A is satisfied using the one-hour (190 pedestrians) threshold at the following intersections:

- Doty and Carroll,
- Doty and Pinckney,
- Webster and Main,
- Dayton and Carroll, and
- Fairchild and Mifflin.

The Webster & Mifflin and Fairchild & Main intersections do not meet the one-hour pedestrian threshold. However, they meet the four-hour (100 pedestrian) threshold for the three peak hours. Further data collection would provide more insight on which intersections fully meet criterion A. To justify signal installation based solely on this warrant, a gap data would have to be collected to evaluate criterion B. Note that the City Engineer maintains the discretion based on engineering judgment to install signal control where appropriate whether or not this warrant is met.

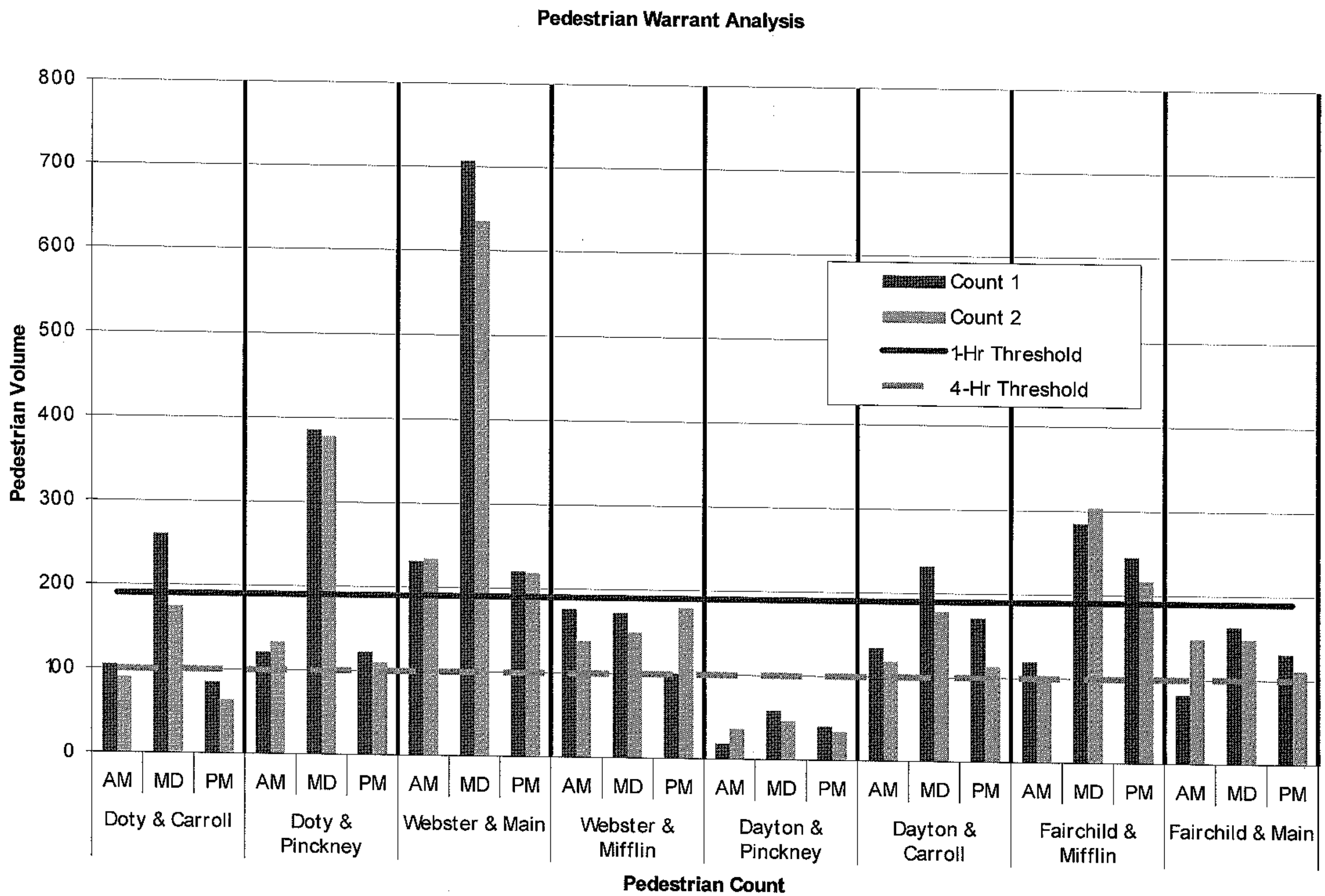


Exhibit 10: Pedestrian Warrant Analysis

CRASH HISTORY

The City of Madison provided crash diagrams and a listing of every crash that occurred in the study area. The study reviewed the crash documents from January 2000 to December 2004. Table 6 summarizes the crashes on the Capitol Loop intersections.

Table 6: Crashes at Capitol Loop Intersections from January 2000 through December 2004

Intersection	I/S Control	# of Crashes	# of Fatalities	# of Injuries	# of Pedestrians	# of Bikes
Doty & Carroll	Stop	3		3	1	
Doty & MLK Jr.	Signal	9		3	1	
Doty & Pinckney	Stop	3		2		
Doty/Webster & King	Signal	2				
Webster & Main	Stop	3				
Webster & E. Washington	Signal	13		2		
Webster & Mifflin	Stop	6		4		
Webster/Dayton & N. Hamilton	Signal	3		2		
Dayton & Pinckney	Stop	1				
Dayton & Wisconsin	Signal	11		7	3	1
Dayton & Carroll	Stop	3				
Dayton/Fairchild & State	Signal	5		1	2	
Fairchild & Mifflin	Stop	3		2	2	
Fairchild & W. Washington	Signal	16	1	13	1	
Fairchild & Main	Stop	3		2	2	
Fairchild/Doty & S. Hamilton	Signal	7				
	Totals:	**91**	**1**	**41**	**12**	**1**

In the five years that were reviewed, there were 91 crashes, the most occurring at the Fairchild intersection with West Washington Avenue. That intersection also included the lone fatality, which was a pedestrian in 2003. Of the 12 crashes involving pedestrians, 11 were struck by a vehicle, and seven incurred injuries related to the crash. The lone bike crash struck a pedestrian.

Generally, signalized intersections have a higher number of crashes than unsignalized intersections.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSION

Based on the analysis, the following conclusions can be reached:

- The existing system of traffic signals provides acceptable levels of service for the intersections of the Capitol Loop.
- Vehicular traffic is heaviest during the morning and evening peak hours.
- Pedestrian traffic is heaviest during the midday peak.
- Of the unsignalized intersections, the Webster Street intersection with Main Street has the highest volume of pedestrians for all peaks.
- The highest average delay to pedestrians was at the following unsignalized intersections:
    - AM peak: Dayton & Pinckney
    - Midday peak: Doty & Carroll
    - PM peak: Doty & Pinckney

Generally, adding signals to the remaining stop-controlled intersections in the Capitol Loop:

- reduces delay to vehicles at the existing signalized intersections, but
- increases delay at the unsignalized intersections, and
- increases pedestrian delay at all the existing unsignalized intersections after the installation of signals.

A review of the crash history of the Capitol Loop intersections revealed that 91 crashes occurred between January 2000 and December 2004. Twelve crashes involved pedestrians, one of which involved a bike. There was one pedestrian fatality at the currently signalized Fairchild intersection with West Washington Avenue. The signalized intersections have more crashes on average.

Several advantages and disadvantages are apparent concerning the installation of traffic signals.

Advantages:

- Perceived safety to pedestrians. The pedestrians know that a specific time exists for them to cross the street. Motorists will know there will be a dedicated time to stop and permit the pedestrians to cross. The pedestrian is less inclined to assert themselves in the Capitol Loop traffic flow.
- Improved traffic flow. The model showed that vehicle delay on the Capital Loop is reduced slightly as traffic flow around the loop and into the loop from the side streets is controlled to promote better platooning of vehicles.

Disadvantages:

- Increase in pedestrian delay
- Increase in vehicle delay at the newly signalized (currently unsignalized) intersections
- Probable increase in number of crashes; typically rear-end crashes
- Increase in capital, operating and maintenance costs
- Potential to obstruct mid-block access points with vehicle queues
- Additional enforcement required to promote safe pedestrian behavior

RECOMMENDATIONS

It is recommended to maintain the stop control at all of the unsignalized intersections in the Capitol Loop at this time. The increase in pedestrian delay, crashes and costs of installing the traffic signal control appear to outweigh the advantages at this time.

It is also recommended to increase driver awareness of pedestrians crossing at the unsignalized intersections, especially at the mid-block access points that are upstream, specifically the Doty intersections with Carroll and Pinckney Streets. This could be done by phasing in the use of pedestrian crossing signs, flashing beacons, pavement markings, or "Yield to Pedestrian" signs located within the driver's line of sight.

INSTALLATION PRIORITIZATION

If the decision is made to install signals on the Capitol Loop, not all intersections should be signalized at once. Therefore, each of the unsignalized intersection were evaluated in several categories to determine a prioritization of signal installation.

Because the system showed minor improvements to vehicle delay, the prioritization concentrated on the delay to pedestrians. The unsignalized Capitol Loop intersections were ranked in two separate categories: pedestrian volumes and pedestrian delay. Table 7 summarizes the ranks of each intersection in each peak hour, and the average of ranks across all of the peaks. Table 7 also shows the intersections that met the one-hour threshold from criterion A of the pedestrian warrant.

Table 7: Rank of Pedestrian Volumes and Delays

	Rank of Pedestrian Volume				Rank of Pedestrian Delay				Meets Warrant 4, Criterion A		
Capitol Loop Intersection	**AM**	**MD**	**PM**	**Ave.**	**AM**	**MD**	**PM**	**Ave.**	**AM**	**MD**	**PM**
Doty & Carroll	7	5	7	6.3	2	1	2	1.7		X	
Doty & Pinckney	4	2	6	4.0	4	8	1	4.3		X	
Webster & Main	1	1	1	1.0	7	5	3	5.0	X	X	X
Webster & Mifflin	3	7	3	4.3	3	4	5	4.0			
Dayton & Pinckney	8	8	8	8.0	1	3	7	3.7			
Dayton & Carroll	5	4	5	4.7	6	2	6	4.7			
Fairchild & Mifflin	6	3	2	3.7	5	6	4	5.0		X	X
Fairchild & Main	2	6	4	4.0	8	7	8	7.7			

In Table 7, note that the higher the volume and amount of delay, the higher the rank. The intersections with the lowest delay would experience the greatest increase in delay on average if a signal is installed.

The Webster Street intersection with Main Street ranks highest in pedestrian volume and ranks in the middle for pedestrian delay. The same intersection met the one-hour volume threshold for Warrant 4 for all three peaks. The Doty Street intersection with Carroll Street has the highest average rank for pedestrian delay, but ranks second to last for overall pedestrian volume. The intersection met the one-hour threshold for one peak hour (midday) during the first pedestrian count.

Table 8 shows different impacts that may influence the prioritization of the signal installation. Factors include the type of user, the use of the intersection during events and weekend activities, the impact to adjacent, upstream intersections, and if topography has an impact to the intersection and sight lines of the drivers.

Table 8: Other Impacts

Capitol Loop Intersection	User Type	Weekend/ Event Use	Upstream Access & Intersections	Grades/ Sight Lines
Doty & Carroll	Average	High	High	Low
Doty & Pinckney	Average	High	High	Low
Webster & Main	Average	Med	Low	Med
Webster & Mifflin	Average	High	High	High
Dayton & Pinckney	Average	Low	Med	Low
Dayton & Carroll	Average	High	Low	Low
Fairchild & Mifflin	Average	High	Low	Med
Fairchild & Main	Elderly	High	Low	High

The Fairchild intersection with Main Street is the only intersection that encounters a higher volume of elderly pedestrians on a regularly basis. A signal at this location could provide an extended crossing time, specially timed for elderly users. The additional time needed for the pedestrian phase could interrupt and increase delays of the Capitol Loop traffic flow.

Many of the intersections are adjacent to public parking structures and therefore experience a significant amount of pedestrian activity during weekends and special events at the Capitol Square. These include:

- Doty & Carroll
- Doty & Pinckney
- Webster & Mifflin
- Dayton & Carroll
- Fairchild & Mifflin
- Fairchild & Main

There are three intersections that would have a high impact to operations at adjacent, upstream intersections or access points. These are the Doty Street intersections with Carroll and Pinckney Streets and the Webster Street intersection with Mifflin Street. The Doty & Carroll and Webster & Main intersections are unique in that they are the next intersection crossed by vehicles entering the Capitol Loop from S. Hamilton Street and E. Washington Avenue, respectively. A large number of vehicles enter the Capitol Loop traffic flow via S. Hamilton and E. Washington. Due to the corridor timing, these vehicles would have to stop at the next Capitol Loop intersection. As a result, queues may extend into the upstream intersection, creating extensive delay. Also, the queues due to the signals at the Doty Street intersections with Carroll and Pinckney Streets most likely will extend beyond the access points to existing parking structures.

There are two intersections on hills that may affect the sight lines of drivers and pedestrians alike. The Webster Street intersection with Mifflin Street and the Fairchild intersection with Main Street both are on the down side of a hill. Thus, traffic has a limited time to react to a pedestrian in the crosswalk. Likewise the pedestrian has a limited view of vehicles cresting the hill, factoring into their decision if the gap in traffic is acceptable to cross. The signal provides for a specific time for the pedestrian to cross, thereby removing the decision from the pedestrian to cross, and conveys information to the driver that it may be safe to proceed through the intersection.

There are two intersections that have limited sight lines for pedestrians due to on-street parking. They are the Fairchild & Mifflin and Webster & Main intersections.

Table 9: Prioritization Results

Capitol Loop Intersection	Pedestrian Volume	Pedestrian Delay	User Type	Weekend/ Event Use	Upstream Impacts	Grades/ Sight Lines	Overall Score	Overall Rank
Doty & Carroll	6.3	1.7	0	-2	2	0	8.0	6
Doty & Pinckney	4.0	4.3	0	-2	2	0	8.3	7
Webster & Main	1.0	5.0	0	-1	0	-1	4.0	1
Webster & Mifflin	4.3	4.0	0	-2	2	-2	6.3	3
Dayton & Pinckney	8.0	3.7	0	0	1	0	12.7	8
Dayton & Carroll	4.7	4.7	0	-2	0	0	7.3	5
Fairchild & Mifflin	3.7	5.0	0	-2	0	-1	5.7	2
Fairchild & Main	4.0	7.7	-1	-2	0	-2	6.7	4

Table 9 shows an overall score and rank for signal installation. The scores are a combination of the data and factors presented in Table 7 and Table 8. The basis for the signal installation priority is the intersection with the lowest overall score. The lower the score, the higher the priority for a traffic signal.

The qualitative factors in Table 8 were weighted such that their impacts would raise or lower their score accordingly. For example, a "high" weekend/event use altered the score by two, where "med(ium)" altered it by one, and low made no change. Additionally, the impacts from a signal installation were deemed as a negative (hence a positive number) to upstream intersections due to queuing and blocking off-site access points. In this case, the result increased the overall score, potentially reducing its priority relative to the other candidate locations.

It is recommended at this time that when the installation of new traffic signals is deemed appropriate that the ranking shown in Table 9 be used. However, traffic conditions may change over time, especially in terms of volume and delay. These rankings should be reviewed and updated prior to a final decision being rendered and also as redevelopment occurs.