Application # 16852

PALISADES

Traffic Impact Study



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EXECUTIVE SUMMARY

In response to citizens' concerns, the District of Columbia Department of Transportation (DDOT) has conducted a study evaluating traffic conditions in the Palisades, Foxhall and Wesley Heights areas of the District. The consulting firm DMJM+HARRIS (Consultant) conducted the study with assistance from DDOT staff.

The main goals of the study were to assess existing traffic conditions in the study area and make recommendations to improve mobility, traffic safety, compliance with speed limit regulations and pedestrian safety. The study area consists of the following five corridors and their surrounding residential neighborhoods:

- Canal Road from Key Bridge to the Maryland line
- Foxhall Road from Canal Road to Loughboro Road
- MacArthur Boulevard from Foxhall Road to Loughboro Road
- Loughboro Road from MacArthur Boulevard to Foxhall Road
- Arizona Avenue from Canal Road to Loughboro Road

The study was conducted with assistance from the area residents. The area residents provided valuable input that was used in the evaluation of existing conditions and the development of improvement options.

The study was conducted between the months of November, 2001 and March, 2002. This report summarizes the assessment of existing conditions, presents an evaluation of proposed improvements and describes the improvements that are recommended for implementation.

The Study Team conducted an extensive data collection and performed multiple field evaluations to assess existing conditions, forecast future conditions and develop recommended improvements.

The recommendations in this study are intended to address transportation needs of the studied arterials and thereby reduce the amount of cut-through traffic on residential streets. However, if the recommended measures, including several instances of traffic calming, do not reduce cut-through traffic, DDOT will revisit the residential streets and implement additional traffic calming measures where necessary.

The main findings of the study are the following:

- The five major travel corridors in the study area are Canal Road, Foxhall Road, Loughboro Road, MacArthur Boulevard and Arizona Avenue.

- Mass transit service is provided by four WMATA bus routes. These routes travel on MacArthur, Arizona Avenue and Loughboro Road.

- Canal Road is the roadway in the study area with the largest traffic volumes. Foxhall Road carries over 16,000 two-way daily vehicles. This is a large number of vehicles for a two-lane road.

- Vehicles exceeding the speed limit is a significant problem in the study area. Vehicles frequently drive at speeds more than 10 miles per hour over the speed limit on Canal Road, Foxhall Road and MacArthur Boulevard.

- Most of the vehicles that enter the study area during the peak periods are destined to locations outside the study area. Less than 12 percent of the vehicles that enter the study area during the peak periods are destined to locations in the study area.

- The most used route to traverse the study area is used by vehicles entering the Clara Barton Parkway and exiting via the Whitehurst Freeway.

- Roads in the study area are being used for commute trips from Virginia origins to Virginia destinations. For example, 12 percent of the vehicles traveling to Virginia via the Key Bridge during the AM peak period enter the study area via Chain Bridge.

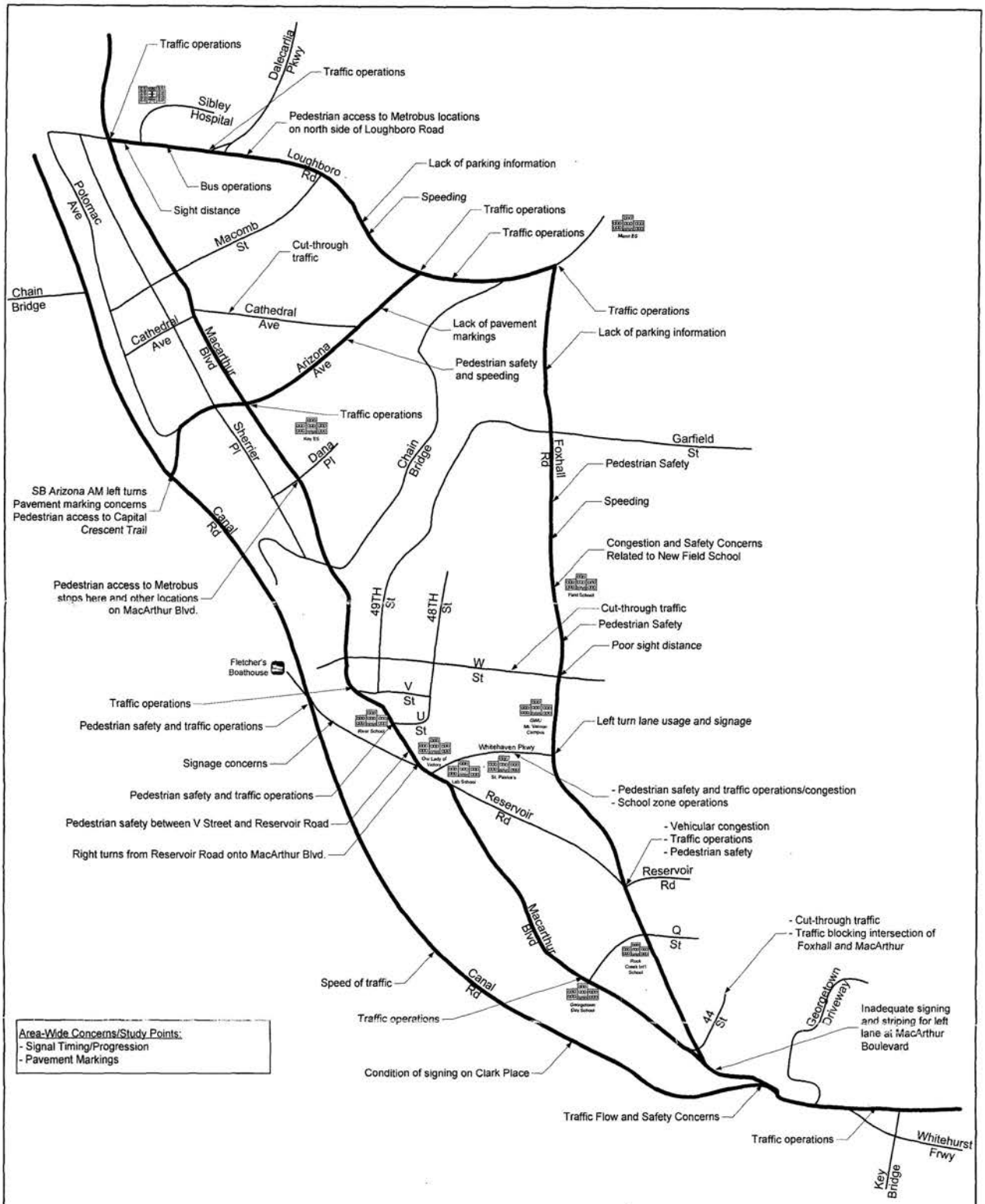
- The intersections with the highest number of accidents in the last three years are Canal Road and Arizona Avenue, Canal Road and Foxhall Road and Canal Road and Foxhall Road and Reservoir Road. The high number of accidents on Canal Road can be attributed in part the reversible lane operation and the high speeds at which vehicles travel on this road.

- Parking availability appears to be adequate throughout the study area. Parking utilization appears to be high enough to preclude corridor-wide elimination of parking to increase the capacity of the critical corridors in the area. However, elimination it is possible to eliminate parking at selected locations to improve operations at key intersections.

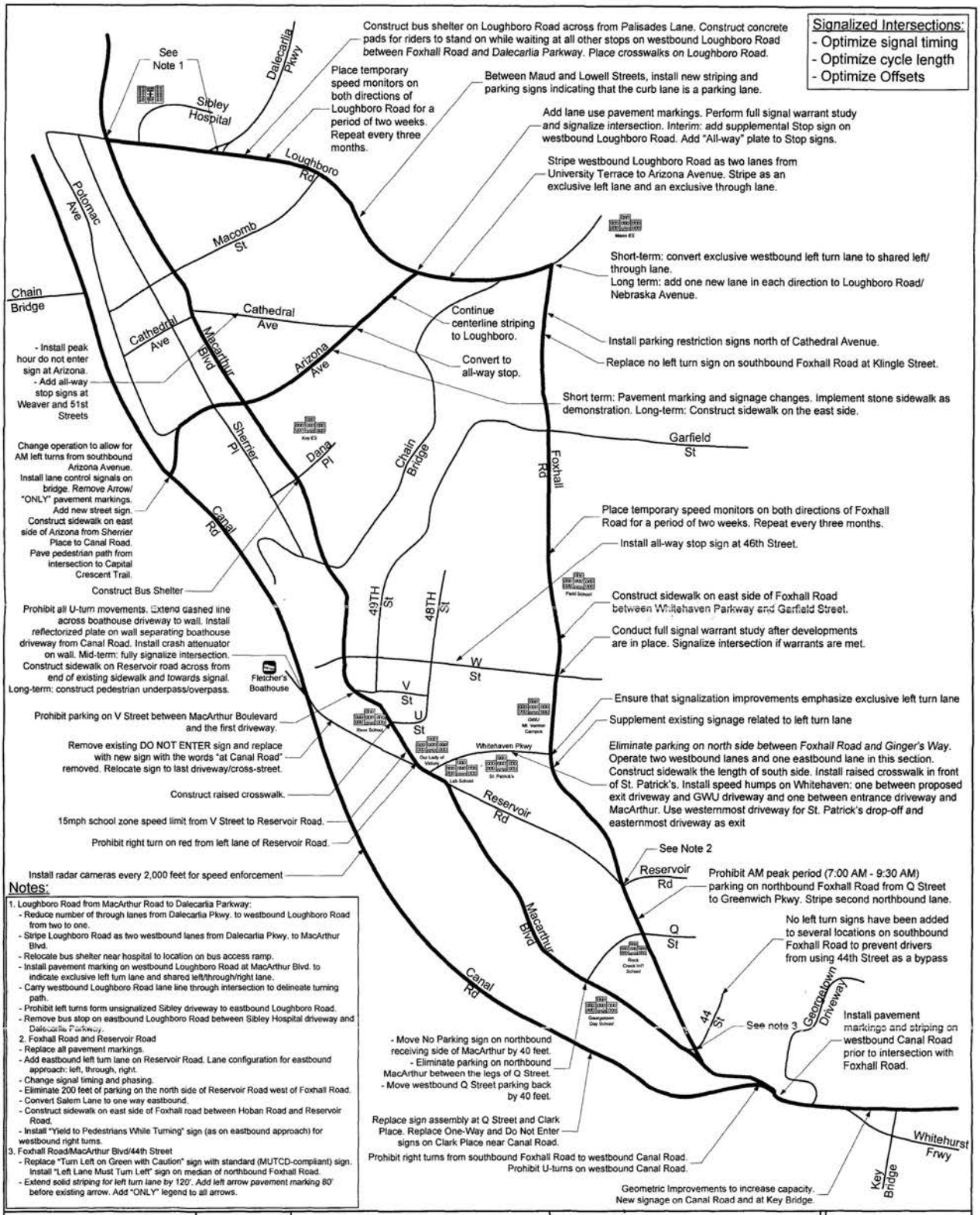
- There are several intersections in the study area operating at undesirable levels of service ((LOS) E and F during the AM and PM peak hours. The intersections operating with the longest delays during either the AM or PM peak hours are Chain Bridge and Canal Road, Canal Road and Arizona Avenue, Canal Road and Foxhall Road, Canal Road and Whitehurst Freeway, Foxhall Road and Reservoir Road, Loughboro Road and Arizona Avenue.

- Background in traffic growth and the construction of new developments will further deteriorate traffic conditions in the study area if no improvements are implemented. Some of the intersections that are currently operating at acceptable levels of service, such as Foxhall Road and Whitehaven Parkway, are expected to operate at LOS F if no improvements are implemented.

The study team used the data collected for the study, the field evaluations and input from the citizens to develop a comprehensive list of transportation issues in the study area. These issues are summarized in Figure A-1. The Study Team developed preliminary improvements to address the issues noted in Figure A-1. The Study Team developed preliminary improvements, evaluated these improvements and developed a set of final recommendations. The recommended improvements, summarized in Figure A-2 are classified as short-term, mid-term or long-term. Short-Term improvements are those that can be implemented within a one-year time period. Mid-Term and Long Term improvements are those that can be implemented within five and ten year timeframes.



Not to Scale		Palisades Traffic Impact Study	Transportation Issues in the Study Area	FIGURE A-1
August, 2002				



Not to Scale		Palisades Traffic Impact Study	Recommended Improvements	FIGURE A-2
August, 2002				

INTRODUCTION

In response to citizens' concerns, the District of Columbia Department Transportation (DDOT) has conducted a study evaluating traffic conditions in the Palisades, Foxhall and Wesley Heights areas of the District. The consulting firm DMJM+HARRIS (Consultant) conducted the study with assistance from DDOT staff. In this report the team of Consultant and DDOT staff is referred to as the "Study Team."

The main goals of the study were to assess existing traffic conditions in the study area and make recommendations to improve mobility, traffic safety, compliance with speeding regulations and pedestrian safety. The study area, shown in Figure 1, consists of the following five corridors and their surrounding residential neighborhoods:

- Canal Road from Key Bridge to the Maryland line
- Foxhall Road from Canal Road to Loughboro Road
- MacArthur Boulevard from Foxhall Road to Loughboro Road
- Loughboro Road from MacArthur Boulevard to Foxhall Road
- Arizona Avenue from Canal Road to Loughboro Road

The study was conducted with assistance from the area residents. The Study Team (Consultant and DDOT representatives) held several meetings with area residents to discuss transportation issues and preliminary improvement options. The area residents provided additional input via e-mail and regular correspondence. The input from the residents was helpful in the identification of key transportation issues and in the assessment of proposed improvements.

The study was conducted between the months of November, 2001 and March, 2002. This report summarizes the assessment of existing conditions, presents an evaluation of proposed improvements and describes the improvements that are recommended for implementation.

The recommendations in this study are intended to address transportation needs of the studied arterials and thereby reduce the amount of cut-through traffic on residential streets. However, if the recommended measures, including several instances of traffic calming, do not reduce cut-through traffic, DDOT will revisit the residential streets and implement additional traffic calming measures where necessary.

EXISTING CONDITIONS

The Study Team conducted an extensive data collection effort to gain an understanding of existing conditions in the study area. In addition to collecting data for the quantitative assessment of existing conditions, the Study Team conducted field evaluations throughout the study area during peak and off-peak hours to further assist in the assessment of existing conditions. This section of the report summarizes the data collected for the study and addresses issues and deficiencies in the transportation infrastructure.

MAJOR ROADWAYS IN THE STUDY AREA

The study area, located in Northwest Washington, DC and shown in Figure 1, is bounded by Loughboro Road in the north; Canal Road and MacArthur Boulevard in the west; and Foxhall Road in the east. Canal, MacArthur and Foxhall converge in the southeast section of the study area. The southeastern boundary is the intersection of Canal Road with the Key Bridge. The primary focus of this study was the evaluation of traffic, safety, transit and pedestrian conditions of the critical corridors shown in Figure 1.

Canal Road

Canal Road is a principal arterial[1] generally running northwest-southeast from its beginning at the intersection of the Clara Barton Parkway and the Chain Bridge to the Key Bridge. The posted speed limit is 35 miles per hour (mph). Canal Road between Chain Bridge and Arizona Avenue is three lanes wide. As shown in Figure 2, between Arizona Avenue and Foxhall Road, it is two lanes wide. East of Foxhall Road, Canal Road widens and is divided by a concrete median. There are two lanes in each direction in the section east of Foxhall Road. An exclusive left turn lane is provided for westbound traffic at the intersection of Canal Road and Foxhall Road.

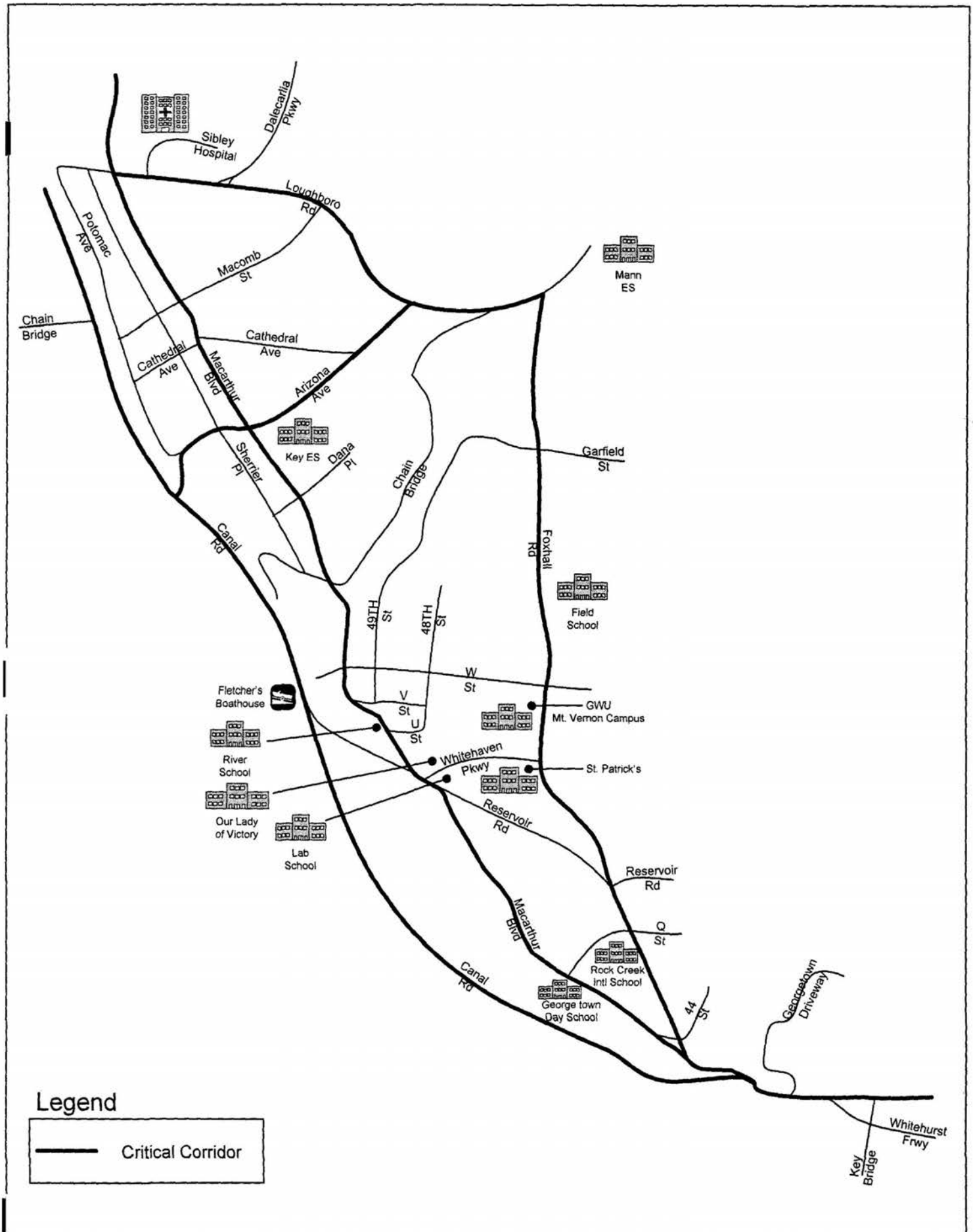
In the section between Arizona Avenue and Foxhall Road, Canal Road runs as one-way inbound between the hours of 6:00 AM - 10:15 AM, and one-way outbound from 2:45 PM - 7:15 PM. There are no shoulders or parking in this section of the road.

Foxhall Road

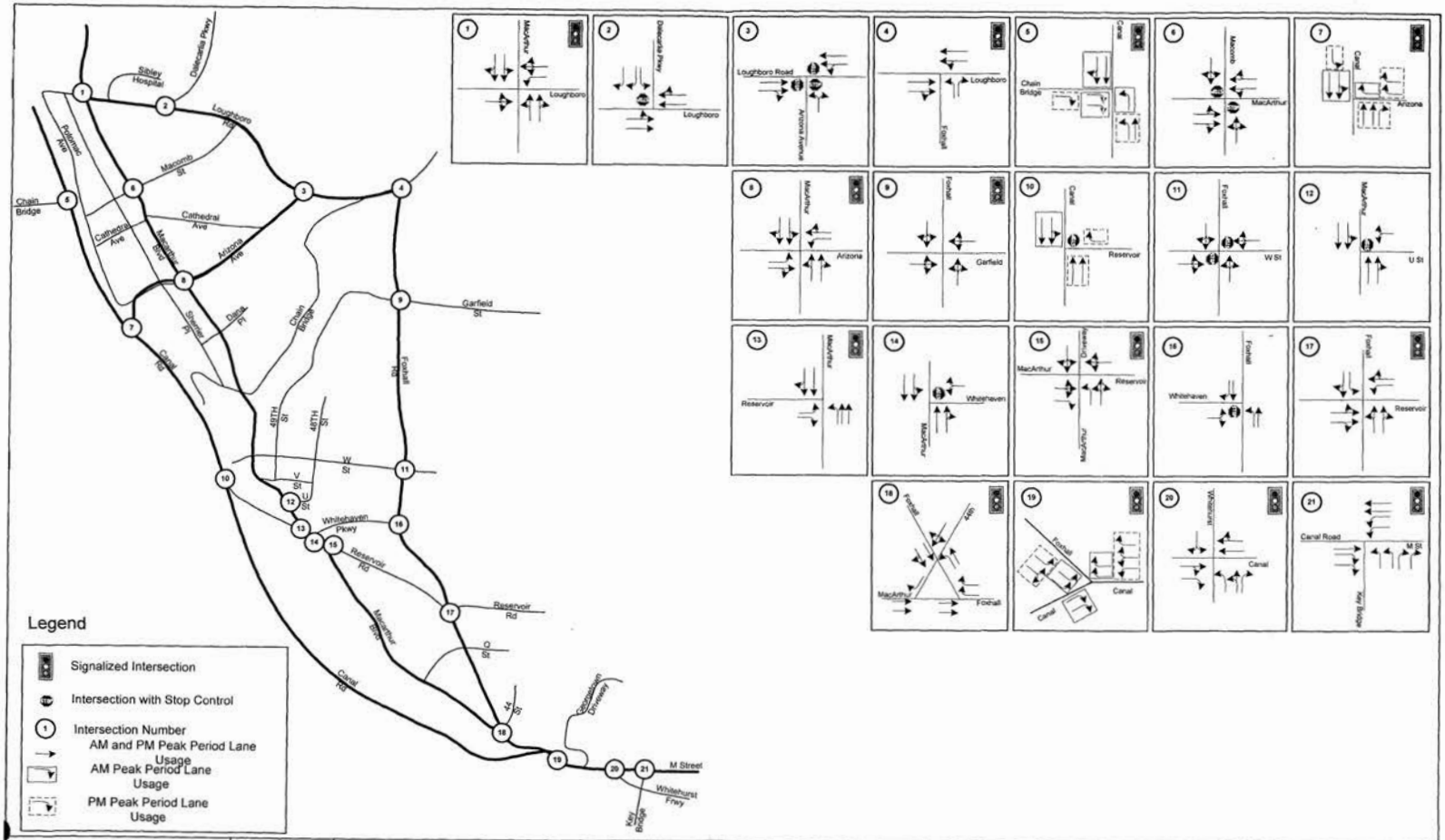
Foxhall Road is a two-way, two-lane minor arterial running north-south through the study area. There are, however, short sections where the roadway widens to two lanes in each direction. It has a posted speed limit of 25 mph.

Between MacArthur and Reservoir Road, Foxhall Road is predominantly residential, although a small commercial area exists between Q Street and Reservoir Road. The Rock Creek International School is located at the intersection of Foxhall Road and Q

[1] All roadway classifications were taken from the District of Columbia Functional Classification Map, Draft, January 1, 2002.



Not to Scale		Palisades Traffic Impact Study	Study Area	FIGURE 1
August, 2002				


Sibley Hospital
Oallezella Pkwy
Loughboro Rd
Macomb St
Potomac Ave
Chain Bridge
Cathedral Ave
Massachusetts Blvd
Arizona Ave
Sherier Pl
Foxhall Rd
Canal Rd
49TH St
V St
W St
Whitehaven Pkwy
Reservoir Rd
MacArthur Blvd
Garfield St
O St
M Street
Whitehurst Freyy
Key Bridge
Georgetown Dowery
Legend
Signalized Intersection
Intersection with Stop Control
Intersection Number
AM and PM Peak Period Lane Usage
AM Peak Period Lane Usage
PM Peak Period Lane Usage
Not to Scale
August, 2002
Palisades Traffic Impact Study
Lane Configurations and Traffic Control
FIGURE 2

Street. Foxhall Road is predominantly one lane in each direction in this area, with parking allowed on both sides.

Between Reservoir Road and Whitehaven Parkway, Foxhall Road is two lanes in each direction with no parking. There is a sidewalk on the western side. North of Whitehaven Parkway, it reverts to one lane in each direction. This section of Foxhall Road is narrow and curbed, with no shoulders or sidewalks. No parking is allowed.

There are two major developments under construction along Foxhall Road. The Mt. Vernon Campus of the George Washington University, located on Foxhall Road between Whitehaven Parkway and W Street, is undergoing an expansion. No existing or planned permanent access exists from Foxhall Road, although a temporary construction driveway currently exists. A traffic signal is scheduled to be installed at the intersection of Foxhall Road and Whitehaven Parkway before the end of 2002. North of W Street, the Field School is currently under construction on the east side of Foxhall Road. A traffic signal is planned for installation at the intersection of Foxhall Road and the Field School driveway. Foxhall Road is narrow through this area, with a narrow two to three-foot wide sidewalk on the east side. This narrow sidewalk is displayed in Figure 3.

A wider sidewalk begins on the west side of Foxhall Road north of Garfield Street, as does a larger concentration of residential development. There are numerous residential driveways on Foxhall Road between Garfield Street and Loughboro Road. Many homes have semi-circular driveways with two access points to Foxhall Road. North of Cathedral Avenue, there are sidewalks on each side of Foxhall Road, as well as parking on both sides. Foxhall Road ends at its intersection with Loughboro Road and Nebraska Avenue.

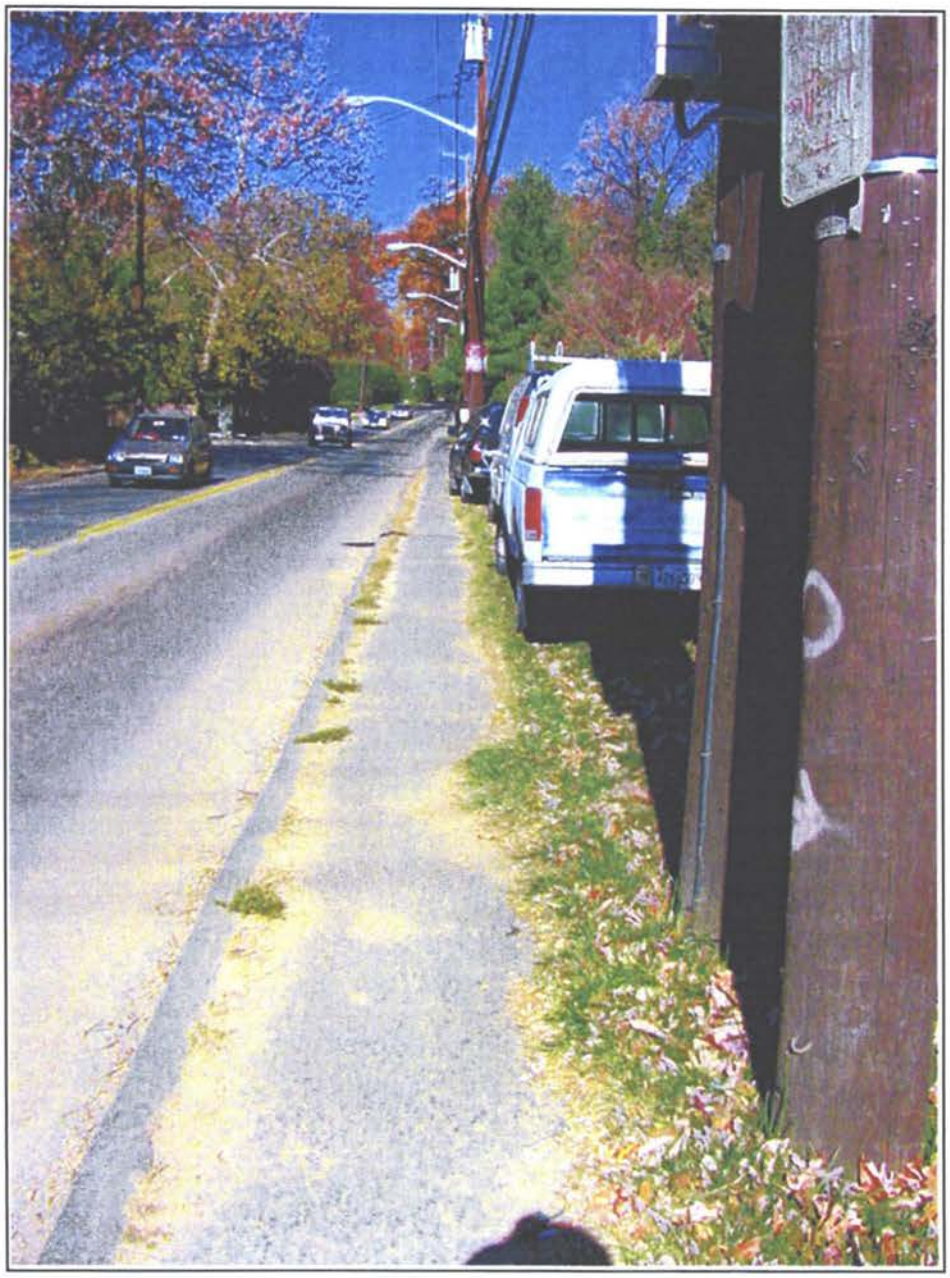
Loughboro Road

Loughboro Road is a two-way east-west road. It is the continuation of Nebraska Avenue between Foxhall Road and MacArthur Boulevard Aside from Sibley Hospital, located near Dalecarlia Parkway, Loughboro Road is surrounded by residential development. It has a posted speed limit of 25 mph. Between MacArthur Boulevard and Dalecarlia Parkway, Loughboro Road is classified as a minor arterial. From Dalecarlia Parkway to Indian Lane/Chain Bridge Road, it is a collector, and from this point to Foxhall Road, it is a principal arterial.

Between Foxhall Road and Indian Lane/Chain Bridge Road, Loughboro Road is striped as two lanes in each direction. As shown in Figure 4, from Indian Lane/Chain Bridge Road to Arizona Avenue, it is striped as two lanes, but drivers often use it as a four-lane roadway. There are no parking restriction signs, with the exception of a few "No parking emergency snow route" signs, along this stretch of Loughboro Road. There are several bus stops on both sides of the road.

Between Arizona Avenue and the Sibley Hospital driveway, Loughboro is striped as only two lanes, but occasionally drivers use it as a four-lane road. West of the Sibley Hospital

Figure 3
Narrow Sidewalk Along Foxhall Road



driveway, the westbound approach of Loughboro Road is striped as one lane. However, based on the existing roadway signs, displayed in Figure 5, the pavement should have markings for two westbound lanes on Loughboro Road approaching MacArthur Boulevard. Parking is permitted on the south side of Loughboro Road.

Figure 4
Two-Lane Section of Loughboro Road Used as a Four-Lane Section



Figure 5
Loughboro Road Westbound Approach to MacArthur Boulevard



MacArthur Boulevard

MacArthur Boulevard is a two-way, four-lane minor arterial that traverses the study area in a north-south direction. Between Loughboro Road and Reservoir Road, it has a landscaped median with a variable width ranging from 10 to 15 feet. There is parking on both sides, except in designated areas. The posted speed limit is 25 mph. Most of MacArthur Boulevard has sidewalks on both sides of the road. As Figure 6 indicates, the primary use in the areas adjacent to MacArthur Boulevard is residential. However, there are pockets of low-density commercial uses.

The commercial areas of MacArthur Boulevard are as follows:

- East side near Cathedral Avenue
- Both sides from Arizona Avenue to Dana Place
- Both sides from V Street to Reservoir Road (mixed residential/commercial)

Arizona Avenue

Arizona Avenue is a two-way minor arterial oriented predominantly northeast to southwest. It has a posted speed limit of 25 mph. Between MacArthur Boulevard and Loughboro Road, Arizona Avenue has one lane in each direction with parking on both sides of the road. The section between Canal Road and MacArthur Boulevard varies between one and two lanes in each direction. This section is at a steep grade, has sharp curves, and the pavement is in poor condition. The only sidewalks on Arizona Avenue are between MacArthur Boulevard and Sherrier Place.

PUBLIC TRANSPORTATION

The Washington Metropolitan Area Transit Authority (WMATA) provides bus service in the study area. As shown in Figure 7, the four routes that serve the study area operate primarily along MacArthur Boulevard and Loughboro Road. In addition to the four WMATA routes that serve the study area, Montgomery County Ride-On Route 23 provides transit service from Sibley Hospital to the Friendship Heights Metro Station in Montgomery County. There is no Metro Rail Station in the study area. The closest Metro Rail Stations are Foggy Bottom, located on 23rd Street N.W. and Eye Street N.W., and the Tenleytown AU Station, located on Wisconsin Avenue at Albemarle Street. The Metro Rail stations served by the buses that traverse the study area are Dupont Circle, Farragut North and Tenleytown – AU stations.

WMATA Route D6 - Sibley Hospital – Stadium-Armory Line

Route D6 operates on the same roads in the study area as Route D3. Route D6 operates every day of the week. Monday through Friday, Route D6 operates from 4:13 AM until 2:50 AM. During these weekdays, Route D6 runs with variable headways that range from 10 to 20 minutes[1]. On Saturday, Route D6 operates from 4:48 AM until 2:23 AM.

[1] The timetables and detailed route maps for the bus routes that serve the study area are included in Appendix A

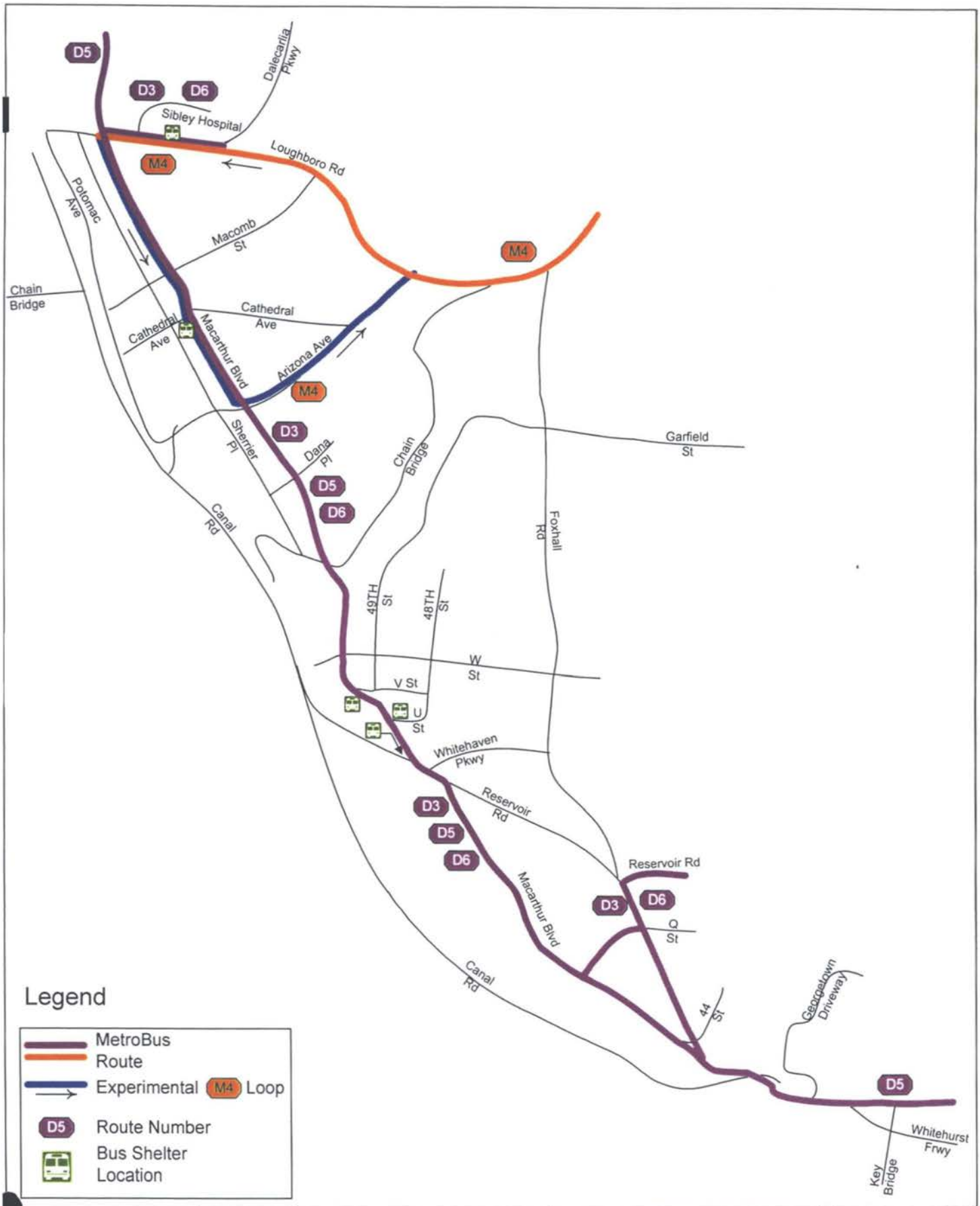


Map prepared by
District of Columbia Office of Planning
801 North Capitol Street N.E., Suite 4000, Washington, D.C. 20002

Legend

- Low density residential
- Moderate density residential
- Low density commercial
- Institutional
- Parks, recreation and open space
- Local public facilities

Not to Scale		Palisades Traffic Impact Study	Generalized Land Use Map	FIGURE 6
August, 2002				



Not to Scale		Palisades Traffic Impact Study	Mass Transit Service	FIGURE 7
August, 2002	N			

On Sunday, this route operates from 5:16 AM until 1:15AM[1]. The trip path, roadways served in the study area, and Metro Stations served by this route are the same as the ones described above for Route D3.

WMATA Route D5 – MacArthur Boulevard – Georgetown Line

Route D5 operates on weekdays only. The route provides eastbound service during the morning rush hours, 6:52 AM – 9:20 AM, and westbound service during the afternoon rush hours, 4:29 PM – 7:14 PM. The bus operates with headways that range from 20 to 30 minutes[1]. As shown in Figure 7, the bus serves MacArthur Boulevard and Canal Road. The terminal for the eastbound trip, AM peak hours, and starting point for the westbound trip, PM peak hours, is the Farragut North Metro Station.

Route M4 – Nebraska Avenue Line

Route M4 enters the study area via Loughboro Road. The bus travels west on Loughboro Road to serve Sibley Hospital, continues south on MacArthur Boulevard and turns left on Arizona Avenue to travel east on Loughboro Road. This bus operates on weekdays only. Service begins at 5:56 AM and ends at 9:33 PM. The most prevalent headway is 20 minutes but they range from five to 30 minutes throughout the day[1]. This bus serves the Tenleytown – American University Metro Station. The loop around Arizona Avenue is a feature recently implemented and according to study area residents it has been received as a positive improvement of transit service in the community.

TRAFFIC VOLUMES

In order to evaluate existing traffic conditions throughout the study area, the Study Team collected turning movement counts at critical intersections during the peak periods. Additionally, the Study Team collected daily traffic counts at key locations throughout the study area. The following are the 21 critical intersections where the Study Team collected turning movement count data:

1. MacArthur Boulevard and Loughboro Road
2. Loughboro Road and Dalecarlia Parkway
3. Loughboro Road and Arizona Avenue
4. Foxhall Road and Loughboro Road
5. Canal Road and Chain Bridge
6. MacArthur Boulevard and Macomb Street
7. Canal Road and Arizona Avenue
8. MacArthur Boulevard and Arizona Avenue
9. Foxhall Road and Garfield Street
10. Canal Road and Reservoir Road
11. Foxhall Road and W Street
12. MacArthur Boulevard and U Street

[1] The timetables and detailed route maps for the bus routes that serve the study area are included in Appendix A

13. MacArthur Boulevard and Reservoir Road (North Leg)
14. MacArthur Boulevard and Whitehaven Parkway
15. MacArthur Boulevard and Reservoir Road (South Leg)
16. Foxhall Road and Whitehaven Parkway
17. Foxhall Road and Reservoir Road
18. Foxhall Road and MacArthur Boulevard
19. Canal Road and Foxhall Road
20. Canal Road and Key Bridge
21. Canal Road and Whitehurst Freeway

The counts were taken during the AM and PM peak periods, 7:00 AM - 9:00 AM and 4:00 PM - 6:00 PM, respectively, on a typical weekday (Tuesday, Wednesday or Thursday) during the months of November and December of 2001. No counts were taken the week of Thanksgiving.

Because all of the intersections were not counted the same day, there were minor discrepancies in the overall balance of traffic volumes throughout the study area network. The discrepancies are due primarily to traffic variations that occur from day to day. In order to improve the modeling of existing traffic conditions, the Study Team applied standard traffic engineering techniques to adjust the turning movement counts at intersections where unjustified imbalances were found. Figure 8 presents the existing, 2001, balanced peak hour turning movement counts for the study area. Appendix B presents the raw volume counts for the 21 intersections shown in Figure 8.

The Study Team collected automated Average Daily Traffic (ADT) counts over a two-week period, covering the end of November and beginning of December, at the following locations:

1. Canal Road between Foxhall Road and the Georgetown University driveway
2. Canal Road between Chain Bridge and Arizona Avenue
3. Foxhall Road between Whitehaven Parkway and Reservoir Road
4. MacArthur Road between Arizona Avenue and Chain Bridge Road
5. Loughboro Road between Dalecarlia Parkway and MacArthur Road

As Figure 8 indicates, Canal Road is the roadway in the study area with the largest daily volumes. East of Foxhall Road, Canal Road carries approximately 22,000 daily vehicular trips in each direction. Foxhall Road, north of Reservoir Road, carries approximately 8,000 daily vehicles in each direction. This is a large daily volume for a two-lane road.

SPEED AND TRAVEL TIMES

In order to gain an understanding of driving patterns and to gather information needed in the development of the traffic model for the study area, the Study Team collected information on speed and travel times on the critical corridors. The Study Team collected the data on travel times and delay on December 5th, 6th and 11th, 2001.

Study Team data collectors drove each of the five critical corridors several times in each direction during both the AM and PM peak hours, and recorded the elapsed travel times at predetermined travel points and the distance between the selected travel points. For the travel time runs, the data collectors were instructed to drive at the same speed as most of the vehicles traversing the study area. Thus, in some sections of the critical corridors, the data collectors traveled at speeds above the speed limit.

The Study Team calculated average speed for each roadway segment as well as an overall average speed for the corridor using the data collected on travel times and distances between time points. Vehicles consistently drive at speeds that exceed the speed limit. For example, as Figures 9 and 10 indicate, the average speed on Canal Road from Chain Bridge to Foxhall Road is 36 mph during the AM peak period and 37 mph during the PM peak period. This average speed calculation includes delays at the traffic signal at Foxhall Road during the AM peak period and at Arizona Avenue during the PM peak hour. If the delays at the traffic signals were not included, the estimated speeds would be much greater than the 35 mph speed limit. For example, as Table 1 shows, the recorded average speed on Northbound Canal Road between Foxhall Road and Reservoir was more than 10 mph over the posted speed limit.

As shown in Figure 9, the average speed on Foxhall Road and MacArthur Boulevard from Canal Road to Loughboro Road ranges from 19 to 23 mph during the AM peak period. There are several traffic signals that create delays for vehicles traveling on these two roads. Similarly to the observation on Canal Road, vehicles exceed the speed limits along certain segments of Foxhall Road and MacArthur Boulevard. As Table 1 notes, on in some segments of Foxhall Road vehicles travel at speeds that exceed the speed limit by more than 10 mph. While no speed data was collected during off-peak hours, the Study Team observed that speeds were generally higher than during peak hours.

The lowest speeds in the study area were recorded in the section of Canal Road between Foxhall Road and the Key Bridge. The average recorded speed for eastbound traffic was six and nine mph during the AM and PM peak hours, respectively.

Table 1
Average Travel Speed at Selected Segments

Roadway and Direction	Segment	Speed Limit	AM Peak	PM Peak
Canal Road Northbound	Foxhall Road - Reservoir Road	35	N/A	44.5
Canal Road Southbound	Reservoir Road – Foxhall Road	35	37.6	N/A
MacArthur Boulevard Northbound	Arizona Avenue - Cathedral Avenue	25	24.5	30.4
MacArthur Boulevard Southbound	Whitehaven Pkwy. - Reservoir Road	25	31.4	29.0
Foxhall Road Northbound	Whitehaven Pkwy. - W Street	25	30.1	21.4
Foxhall Road Southbound	W Street - Whitehaven Pkwy.	25	36.0	35.1
Loughboro Road Eastbound	Dalecarlia Pkwy. - Arizona Avenue	25	25.8	26.8
Loughboro Road Westbound	Arizona Avenue - Dalecarlia Pkwy.	25	25.9	27.7
Arizona Avenue Eastbound	MacArthur Boulevard - Loughboro Road	25	18.0	23.4
Arizona Avenue Westbound	Loughboro Road - MacArthur Boulevard	25	17.8	14.0

Note: n/a = not applicable.

Appendix C presents a list of the recorded speeds for all the studied segments in the Study Area.

ORIGIN-DESTINATION PATTERNS IN THE STUDY AREA

In order to gain an understanding of existing traffic patterns in the study area, the Study Team conducted a comprehensive assessment of origins and destinations for vehicles entering and exiting the study area during the AM and PM peak period. The origin-destination survey helped identify the travel patterns of all vehicles entering the study area during the peak hours.

Data Collection for Origin-Destination Survey

The data collection effort for the origin-destination survey encompassed the following tasks:

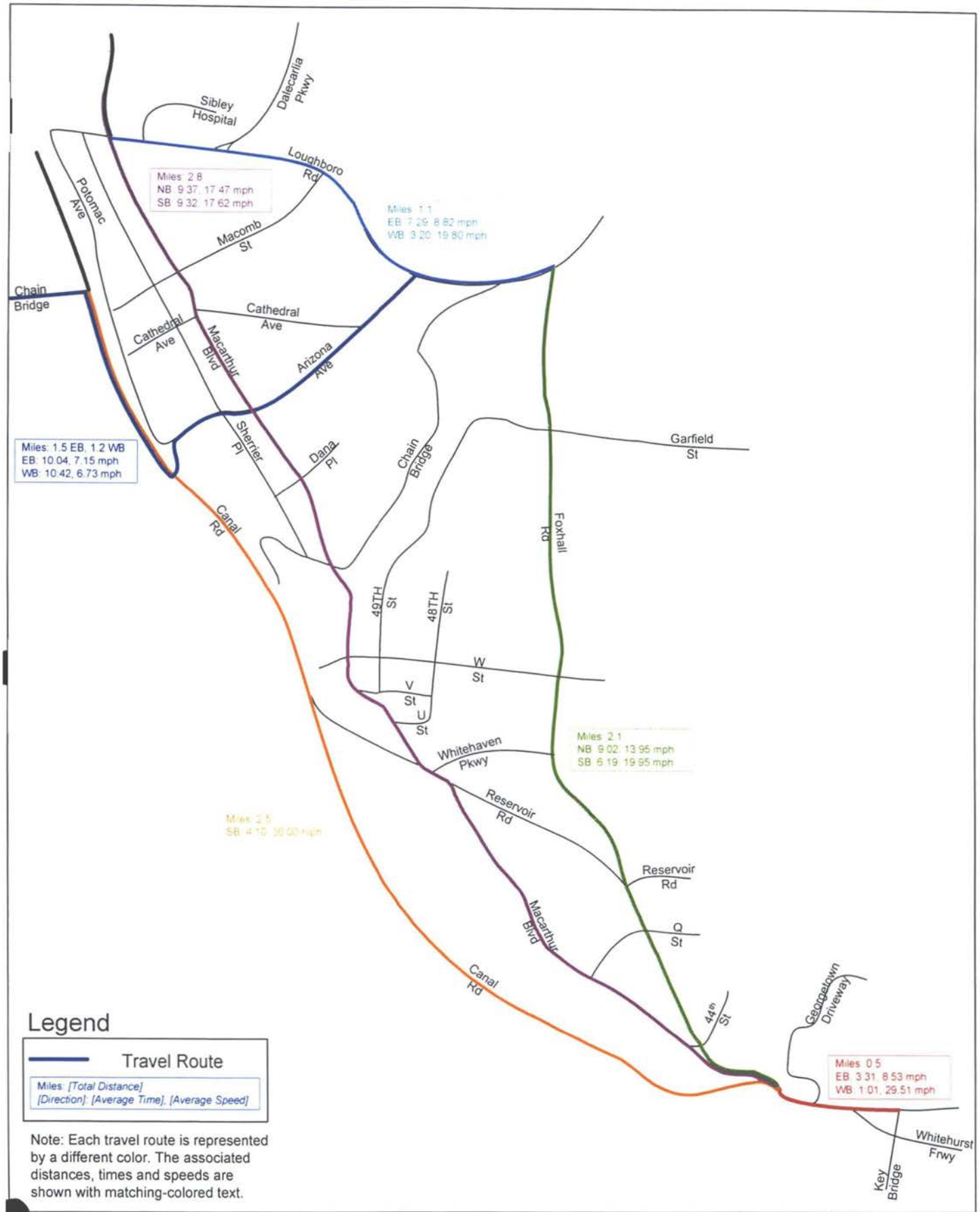
1. Recording of license plates at all major entry and exit points of vehicles entering and exiting the study area: survey personnel (surveyors) recorded license plate data, state and number, onto tape recorders at the locations shown in Figure 11 on December 18, 2001.
2. Recording of missed vehicles: if a surveyor could not get the license plate of a vehicle, he/she was instructed to note the vehicle as a "missed" to have control totals that could be used for the expansion of the survey data.
3. Transcription of license plate records: surveyors entered the state and license plate data for each location onto a computerized database.

Data Processing for Origin-Destination Survey

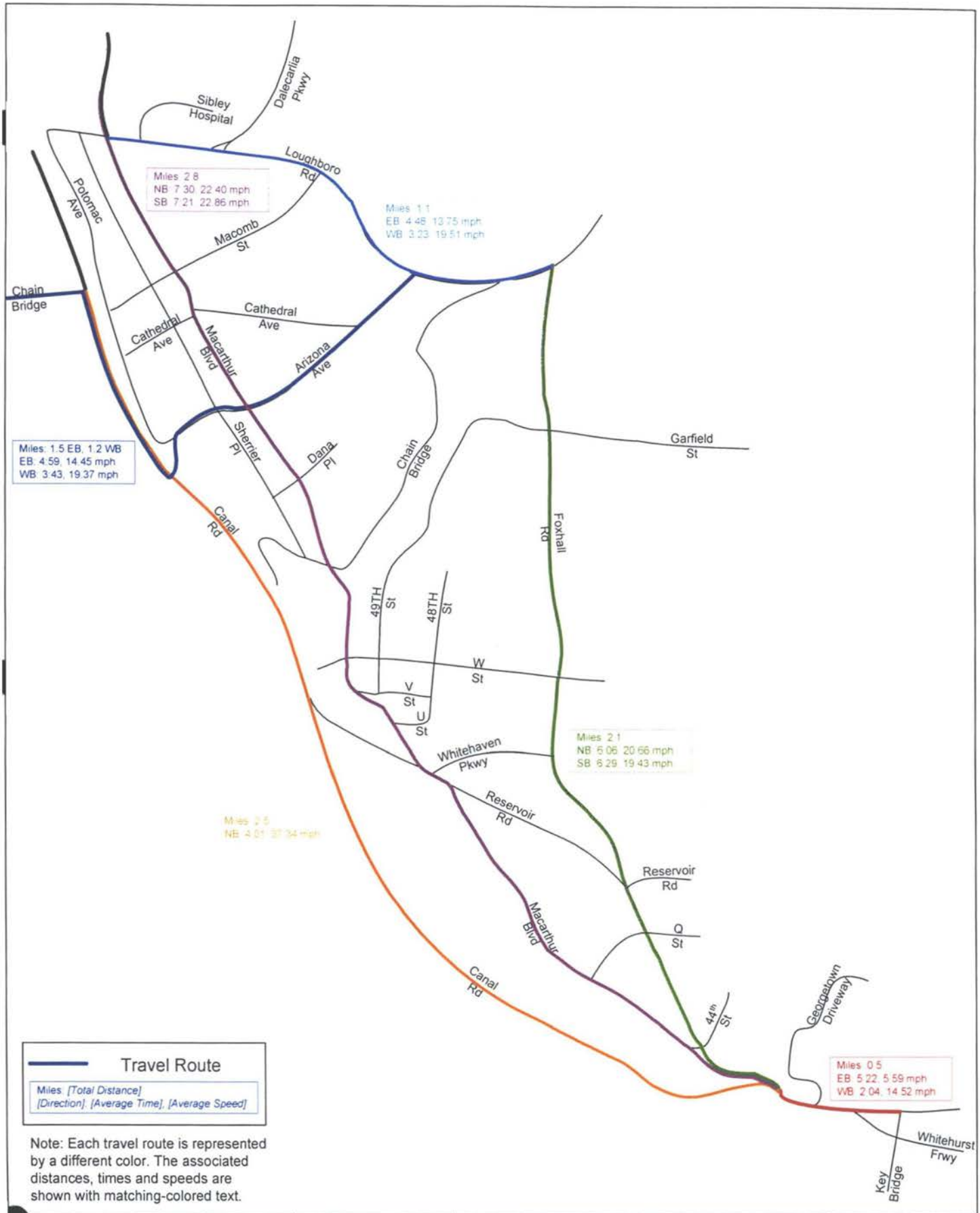
Study Team staff used the license plate database to match entering and exiting vehicles. The Study Team made the following assumptions in the database matching process:

1. Unmatched exiting vehicles with D.C. license plates were assumed to originate their trips in the study area.
2. Unmatched entering vehicles were assumed to terminate their trips in the study area.
3. 15 percent of the unmatched volumes at the entry and exit points were assumed to have entered or exited the study area via streets where license plate data was not collected.
4. The missed vehicles have the same travel patterns as the vehicles for which origin origin-destination matches were found.

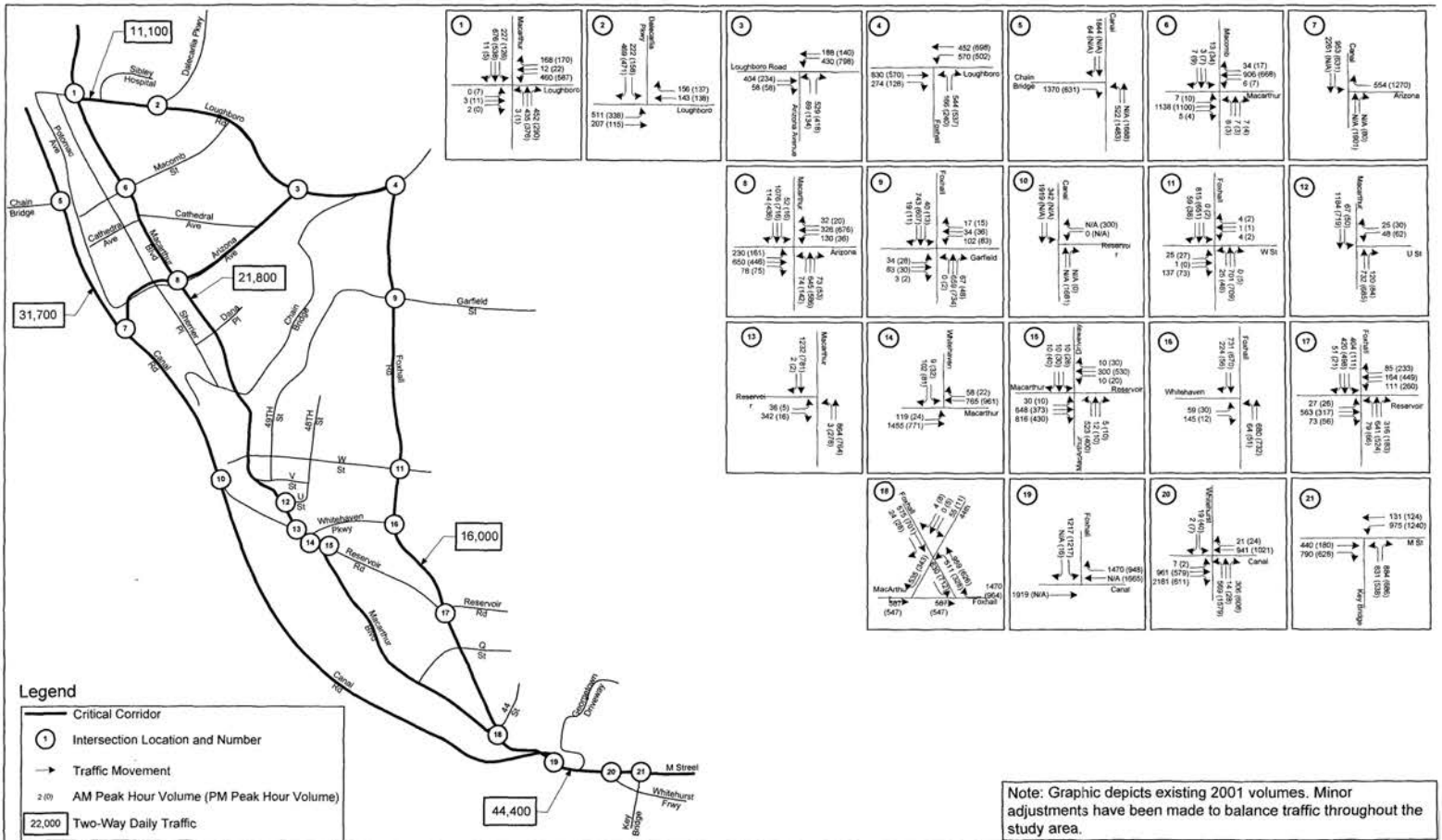
In the first step of the license plate matching process, the Study Team developed a "raw" origin-destination trip matrix excluding unmatched vehicles and missed vehicles. In the second step, the Study Team used the assumptions listed above to determine a "total" origin-destination trip matrix for all vehicles entering and exiting the study area.



Not to Scale		Palisades Traffic Impact Study	Speed and Travel Times During The AM Peak Period	FIGURE 9
August, 2002				

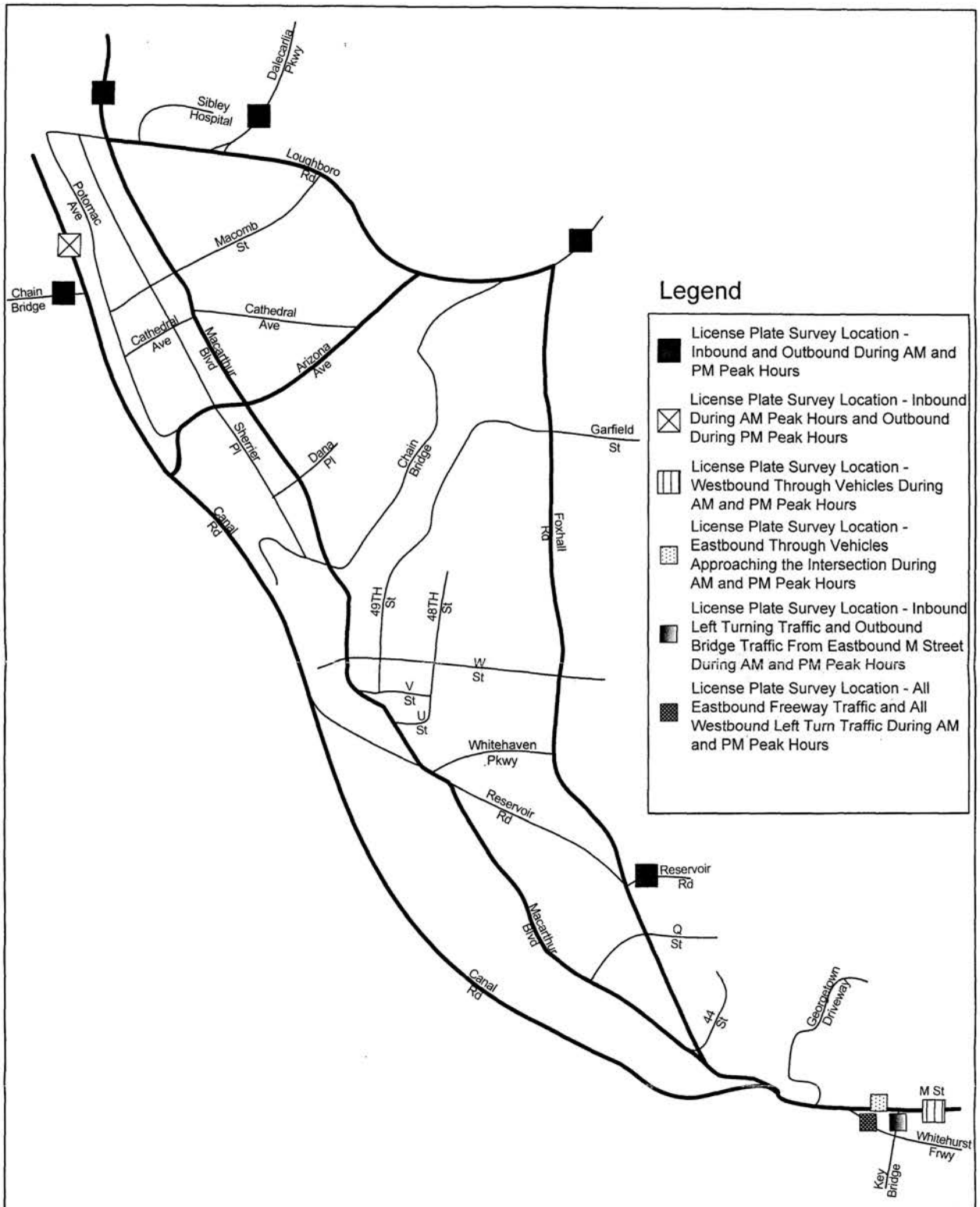


Not to Scale August, 2002	N	Palisades Traffic Impact Study	Speed and Travel Times During The PM Peak Period	FIGURE 10



Note: Graphic depicts existing 2001 volumes. Minor adjustments have been made to balance traffic throughout the study area.

Not to Scale		Palisades Traffic Impact Study	2001 Existing Traffic Volumes	FIGURE 8
August, 2002				



Not to Scale		Palisades Traffic Impact Study	License Plate Survey Locations for Origin-Destination Study	FIGURE 11
August, 2002				

Trip Matrices and Findings of Origin-Destination Surveys

Tables 2 and 3 present the results of the vehicle matching for the study area during the AM peak period (7:00 AM – 9:00 AM). The matrix of origins and destinations shown in Table 2 includes the adjustments to account for unmatched and missed vehicles[1]. The main findings of the origin-destination survey results for the AM peak period are:

- Approximately 12 percent of the vehicles entering the study area are destined to locations within the study area.
- Approximately 10 percent of the vehicles exiting the study area originate their trips within the study area.
- The most used entry roadways during the AM peak period are the Clara Barton Parkway and the Chain Bridge.
- The most used exit roadway is the Whitehurst Freeway.
- The percentage of internally generated trips at the exit points ranges from seven to 18 percent for the various exit roadways.
- The most used route to traverse the study area is used by vehicles entering on Clara Barton Parkway and exiting via the Whitehurst Freeway.
- Roads in the study area are being used for commute trips from Virginia origins to Virginia destinations. For example, 12 percent of the vehicles traveling to Virginia via the Key Bridge enter the study area via the Chain Bridge.
- Approximately one-half of the vehicles exiting via Nebraska Avenue originate their trip at the Southern end of the study area, the Key Bridge and Whitehurst Freeway.
- Over 40 percent of the vehicles destined to the study area enter through the intersection of Chain Bridge and Clara Barton Parkway.
- As shown in Figure 12, at all the study area exit roadways there were more Virginia or Maryland license plates than license plates from the District of Columbia.
- Virginia and Maryland are also the most prevalent license plates for all study area entry roadways, with the exception of Reservoir Road and Nebraska Avenue. At these two entry points, there were more District of Columbia license plates than from any other jurisdiction.

Tables 4 and 5 present the results of the vehicle matching for the study area during the PM peak period (4:00 PM – 6:00 PM). The matrix of origins and destinations shown in Table 4 includes the adjustments to account for unmatched and missed vehicles[1]. The main findings of the origin-destination survey results for the PM peak period are:

- Approximately three percent of the vehicles entering the study area during the PM peak period are destined to locations within the study area.
- Approximately nine percent of the vehicles exiting the study area during the PM peak period originate their trips within the study area.

[1] The unadjusted "raw" origin-destination matrices are included in Appendix D.

Table 2
Origin-Destination Trips During the AM Peak Hours (7:00 AM - 9:00 AM)

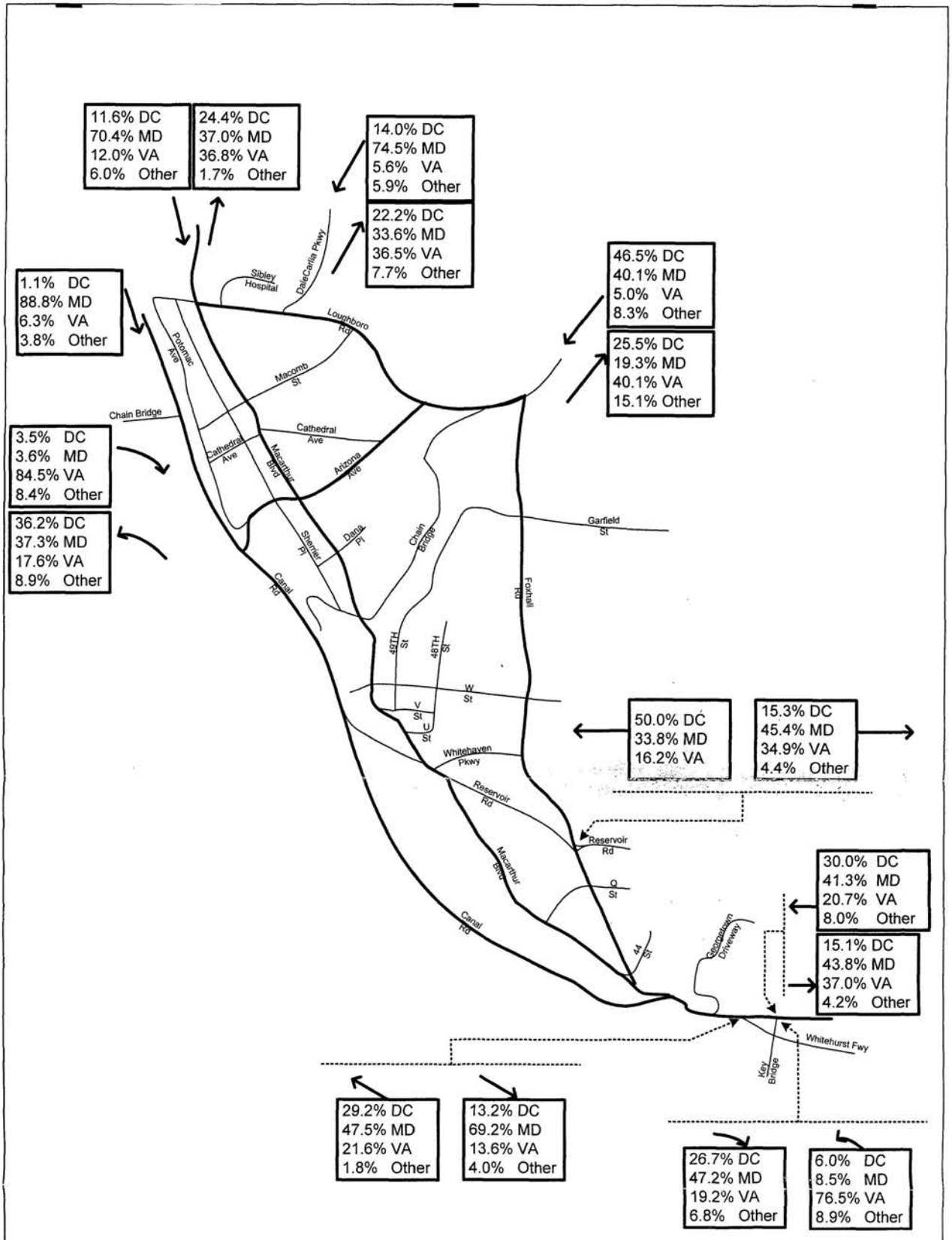
		DESTINATIONS									
	LOCATION	M Street Eastbound	Key Bridge Outbound	Whitehurst Freeway Eastbound	Reservoir Rd Eastbound	Nebraska Av Eastbound	Dalecarlia Pkwy Northbound	MacArthur Blvd Northbound	Northbound Clara Barton Pkwy	Chain Bridge Outbound	Internals
ORIGINS	M Street Westbound at Key Bridge	**0**	4	34	8	22	6	17	0	17	19
	Key Bridge Inbound Left Turns	57	**0**	145	23	640	95	109	0	46	121
	Westbound Whitehurst Freeway	103	135	**0**	80	517	167	157	0	123	199
	Westbound Reservoir Road	8	15	48	**0**	40	28	43	0	47	13
	Westbound Nebraska Avenue	28	78	262	37	**0**	77	134	0	274	243
	Southbound Dalecarlia Pkwy	38	54	364	54	99	**0**	119	0	180	132
	Southbound MacArthur Blvd	67	64	454	108	107	68	**0**	0	84	209
	Southbound Clara Barton Pkwy	168	199	1511	172	239	146	164	**0**	190	198
	Inbound Chain Bridge	163	91	409	157	551	269	198	0	**0**	487
	Internals	72	137	335	73	169	168	109	0	185	**N/A**

Note: 1. The Volumes shown on the table are for a two hour period.
2. The trips shown on this table include adjustments to the raw matching data to account for license plates that were not adequately documented in the data collection process and license plates that were not adequately matched in the database matching process.
3. N/A = not applicable

Table 3
Origin-Destination Trips During the AM Peak Hours (7:00 AM - 9:00 AM)
As Percentage of Exit Volumes

		DESTINATIONS									
	LOCATION	M Street Eastbound	Key Bridge Outbound	Whitehurst Freeway Eastbound	Reservoir Rd Eastbound	Nebraska Av Eastbound	Dalecarlia Pkwy Northbound	MacArthur Blvd Northbound	Northbound Clara Barton Pkwy	Chain Bridge Outbound	Internals
ORIGINS	M Street Westbound at Key Bridge	**0.0%**	0.5%	0.9%	1.1%	0.9%	0.5%	1.7%	0.0%	1.5%	1.2%
	Key Bridge Inbound Left Turns	8.1%	**0.0%**	4.1%	3.2%	26.9%	9.3%	10.4%	0.0%	4.0%	7.4%
	Westbound Whitehurst Freeway	14.7%	17.4%	**0.0%**	11.2%	21.7%	16.3%	14.9%	0.0%	10.7%	12.3%
	Westbound Reservoir Road	1.1%	1.9%	1.4%	**0.0%**	1.7%	2.7%	4.1%	0.0%	4.1%	0.8%
	Westbound Nebraska Avenue	3.9%	10.1%	7.4%	5.2%	**0.0%**	7.6%	12.7%	0.0%	23.9%	15.0%
	Southbound Dalecarlia Pkwy	5.4%	7.0%	10.2%	7.6%	4.1%	**0.0%**	11.4%	0.0%	15.7%	8.1%
	Southbound MacArthur Blvd	9.5%	8.3%	12.7%	15.2%	4.5%	6.6%	**0.0%**	0.0%	7.3%	12.9%
	Southbound Clara Barton Pkwy	23.8%	25.6%	42.4%	24.2%	10.0%	14.3%	15.6%	**0.0%**	16.6%	12.2%
	Inbound Chain Bridge	23.2%	11.7%	11.5%	22.1%	23.1%	26.3%	18.8%	0.0%	**0.0%**	30.1%
	Internals	10.2%	17.6%	9.4%	10.3%	7.1%	16.4%	10.4%	0.0%	16.1%	**N/A**
	TOTAL EXIT VOLUME	**703**	**777**	**3563**	**712**	**2383**	**1024**	**1051**	**0**	**1146**	**1619**

Note: 1. The Volumes shown on the table are for a two hour period.
2. N/A = not applicable



Not to Scale		Palisades Traffic Impact Study	AM Peak Hours (7:00 AM - 9:00 AM) License Plate Survey Results	FIGURE 12
August, 2002				

Table 4
Origin-Destination Trips During the PM Peak Hours (4:00 PM - 6:00 PM)

		DESTINATIONS									
	LOCATION	M Street Eastbound	Key Bridge Outbound	Whitehurst Freeway Eastbound	Reservoir Rd Eastbound	Nebraska Av Eastbound	Dalecarlia Pkwy Northbound	MacArthur Blvd Northbound	Northbound Clara Barton Pkwy	Chain Bridge Outbound	Internals
ORIGINS	M Street Westbound at Key Bridge	**0**	43	20	9	42	41	21	149	74	21
	Key Bridge Inbound Left Turns	26	**0**	59	7	347	77	60	235	115	47
	Westbound Whitehurst Freeway	84	391	**0**	29	244	179	148	1193	219	82
	Westbound Reservoir Road	10	75	80	**0**	29	53	82	153	185	4
	Westbound Nebraska Avenue	26	203	165	17	**0**	83	128	127	641	92
	Southbound Dalecarlia Pkwy	8	97	106	26	112	**0**	108	77	421	19
	Southbound MacArthur Blvd	23	153	260	55	87	76	**0**	63	278	24
	Southbound Clara Barton Pkwy	0	0	0	0	0	0	0	**0**	0	0
	Inbound Chain Bridge	16	138	76	65	459	274	117	0	**0**	38
	Internals	44	76	129	92	302	172	47	31	75	**N/A**

Note: 1. The Volumes shown on the table are for a two hour period.
2. The trips shown on this table include adjustments to the raw matching data to account for license plates that were not adequately documented in the data collection process and license plates that were not adequately matched in the database matching process.
3. N/A = Not applicable

Table 5
Origin-Destination Trips During the PM Peak Hours (4:00 PM - 6:00 PM)
As Percentage of Exit Volumes

		DESTINATIONS									
	LOCATION	M Street Eastbound	Key Bridge Outbound	Whitehurst Freeway Eastbound	Reservoir Rd Eastbound	Nebraska Av Eastbound	Dalecarlia Pkwy Northbound	MacArthur Blvd Northbound	Northbound Clara Barton Pkwy	Chain Bridge Outbound	Internals
ORIGINS	M Street Westbound at Key Bridge	**0.0%**	3.6%	2.2%	3.1%	2.6%	4.3%	3.0%	7.3%	3.7%	6.3%
	Key Bridge Inbound Left Turns	10.9%	**0.0%**	6.6%	2.5%	21.4%	8.1%	8.4%	11.6%	5.7%	14.3%
	Westbound Whitehurst Freeway	35.5%	33.2%	**0.0%**	9.6%	15.1%	18.8%	20.8%	58.8%	10.9%	25.1%
	Westbound Reservoir Road	4.2%	6.4%	8.9%	**0.0%**	1.8%	5.5%	11.5%	7.6%	9.2%	1.3%
	Westbound Nebraska Avenue	11.1%	17.2%	18.4%	5.6%	**0.0%**	8.7%	18.0%	6.3%	31.9%	28.0%
	Southbound Dalecarlia Pkwy	3.5%	8.3%	11.9%	8.8%	6.9%	**0.0%**	15.1%	3.8%	21.0%	5.9%
	Southbound MacArthur Blvd	9.6%	13.0%	29.1%	18.3%	5.3%	8.0%	**0.0%**	3.1%	13.8%	7.4%
	Southbound Clara Barton Pkwy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**	0.0%	0.0%
	Inbound Chain Bridge	6.7%	11.8%	8.5%	21.5%	28.3%	28.7%	16.5%	0.0%	**0.0%**	11.7%
	Internals	18.6%	6.5%	14.4%	30.6%	18.6%	18.0%	6.6%	1.5%	3.7%	**N/A**
	TOTAL EXIT VOLUME	**237**	**1176**	**895**	**300**	**1622**	**956**	**711**	**2028**	**2008**	**327**

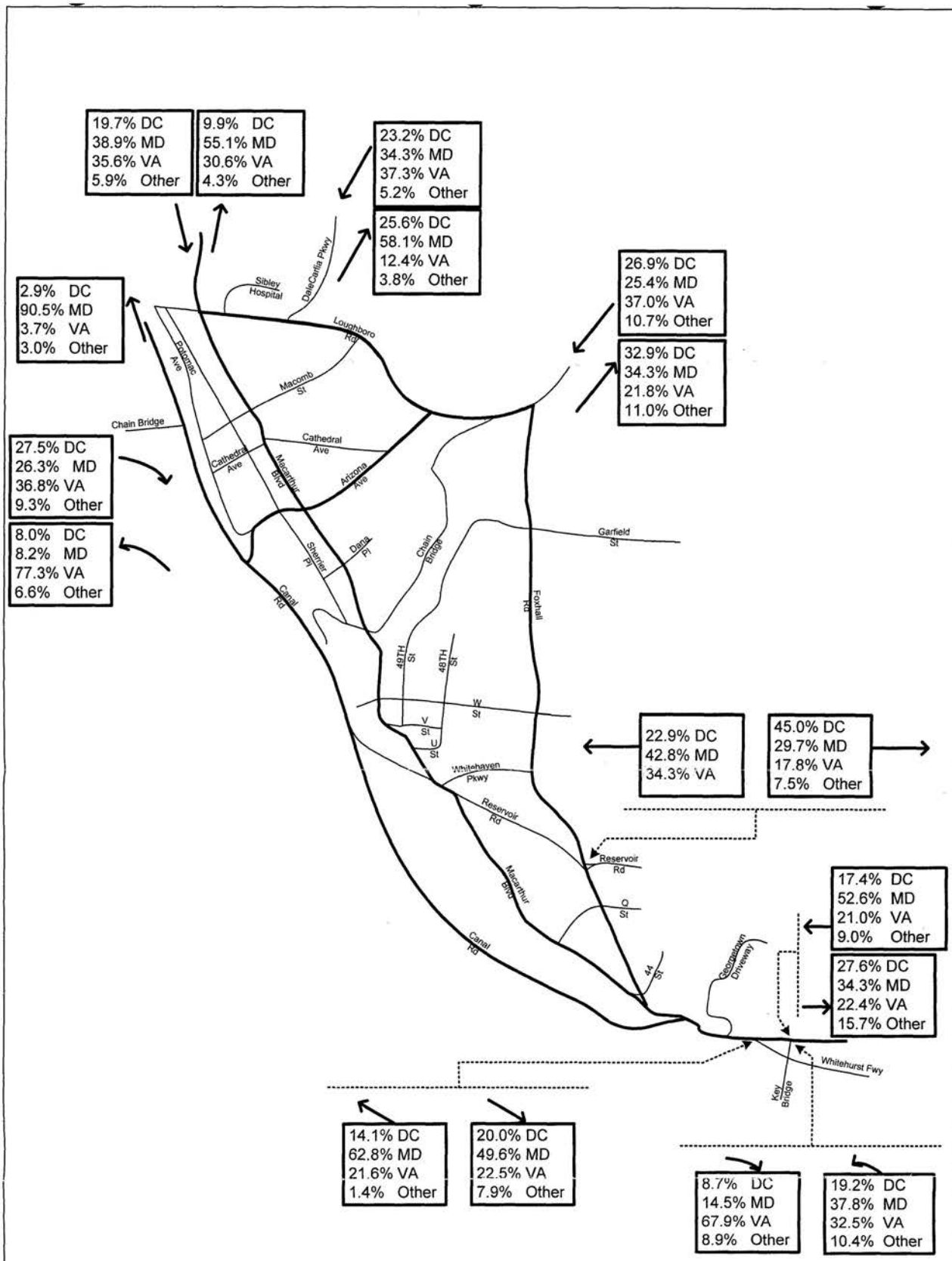
Note: 1. The Volumes shown on the table are for a two hour period.
2. N/A = Not applicable

- The most used entry roadway during the PM peak period is the Whitehurst Freeway.
- The most used exit roadways during the PM peak period are the Clara Barton Parkway and the Chain Bridge.
- The percentage of internally generated trips at the exit points ranges from two to 31 percent for the various exit roadways.
- The most used route to traverse the study area is used by vehicles entering on the Whitehurst Freeway and exiting via Clara Barton Parkway.
- Roads in the study area are being used for commute trips from Virginia origins to Virginia destinations. For example, 12 percent of the vehicles traveling to Virginia via the Key Bridge enter the study area via the Chain Bridge.
- The number of vehicles exiting the study area via MacArthur Boulevard is approximately one-third the number of vehicles that exit via Clara Barton Parkway.
- As shown in Figure 13, at all the study area exit roadways there were more Virginia or Maryland license plates than license plates from the District of Columbia, with the exception of Reservoir Road. At this entry point, there were more District of Columbia license plates than license plates from any other jurisdiction.
- Almost one-third of vehicles exiting the study area during the PM peak period via MacArthur Boulevard have a Virginia license plate.
- At all the study area entry roadways there were more Virginia or Maryland license plates than license plates from the District of Columbia.

SAFETY

In order to assess safety conditions in the study area, the Study Team obtained accident data from the District Department of Transportation (DDOT) for each of the five corridors, for the years 1997 through 1999. As the information summarized on Table 6 indicates, the intersection of Canal Road and Arizona Avenue is the location with the largest number of accidents in the study area. Rear end and side-swipe were the most prevalent type of accidents at this intersection. This indicates that enhancements to signing and signalization at this location could improve the safety of traffic operations.

The intersections of Canal Road with Foxhall Road and with Reservoir Road ranked second and third in terms of number of accidents between 1997 and 1999. The high number of accidents on Canal Road can be attributed in part to the reversible lane operation and the high speed at which vehicles travel on this roadway. Two of the accidents at Canal Road and Reservoir Road involved fixed objects. The Study Team noticed safety deficiencies at this intersection that can be eliminated with the implementation of proposed improvements. The recommendations are described in the Issues and Recommended Improvements section of this document.



Not to Scale		Palisades Traffic Impact Study	PM Peak Hours (4:00 PM - 6:00 PM) License Plate Survey Results	FIGURE 13
August, 2002				

Table 6
Summary of Accident Data

Intersection	Total Number of Accidents			AM Peak Hour Percentage			PM Peak Hour Percentage			Off-Peak Percentage			Accident Type(s) (1997-1999)
	1997	1998	1999	1997	1998	1999	1997	1998	1999	1997	1998	1999	
Foxhall Road /Reservoir Road	4	1	4	0	0	0	50	0	25	50	100	75	Right Angle - 1 Rear End - 3 Side Swiped - 1 Fixed Object - 3 Other - 1
MacArthur Boulevard/Loughboro Road	0	4	1	0	50	0	0	25	100	0	25	0	Left Turn - 1 Rear End - 2 Side Swiped - 2
Foxhall Road/Canal Road	5	4	3	20	25	33.3	20	50	33.3	60	25	33.3	Rear End - 4 Side Swiped - 3 Head On - 2 Fixed Object - 2 Non Collision - 1
Canal Road/Arizona Avenue	7	4	8	0	0	12.5	28.6	25	0	71.4	75	87.5	Left Turn - 3 Right Turn - 2 Rear End - 8 Side Swiped - 6
Canal Road/Reservoir Road	3	5	2	0	0	0	0	0	50	100	100	50	Left Turn - 2 Rear End - 5 Fixed Object - 2
MacArthur Boulevard/Foxhall Road	4	3	1	0	0	0	0	0	0	100	100	100	Right Angle - 1 Left Turn - 1 Rear End - 4 Head On - 1 Parked - 1

N/A: Not Available
Appendix E presents the complete accident data worksheets used to generate the summary presented in Table 6.

Table 6
Summary of Accident Data
(Continued)

Intersection	Total Number of Accidents			AM Peak Hour Percentage			PM Peak Hour Percentage			Off-Peak Percentage			Accident Type(s)
	1997-1999			1997-1999			1997-1999			1997-1999			1997-1999
Foxhall Road/W Street	4	N/A	N/A	0	N/A	N/A	50	N/A	N/A	50	N/A	N/A	Right Angle - 1 Rear End - 1 Parked - 1 Other - 1
Canal Road/Key Bridge/M Street	5			0			20			80			Rear End - 1 Side Swiped - 1 Head On - 1 Parked - 1 Ran Off Road - 1
Canal Road/Chain Bridge	6			0			0			100			Rear End - 4 Head On - 2
Loughboro Road/MacArthur Boulevard	5			40			40			20			Left Turn - 1 Rear End - 2 Side Swiped - 2
Loughboro Road/Dalecarlia Pkwy	4			25			0			75			Rear End - 1 Head On - 1 Fixed Object - 1 Other - 1
Loughboro Road/Glenbrook Road	3			33.3			0			66.7			Right Angle - 3
Loughboro Road/Chain Bridge Road	2			0			0			100			Right Angle - 1 Rear End - 1

N/A: Not Available
Appendix E presents the complete accident data worksheets used to generate the summary presented in Table 6.

As Table 6 indicates, at the intersection of Foxhall Road and Canal Road a large proportion of the accidents occurred during the AM or PM peak hours. During these hours, the reversible lane operations are in effect at this location. Two of the accidents were head-on collisions. The Study Team is making recommendations to address observed safety deficiencies at this location. The recommendations are described in the Issues and Recommended Improvements section of this document.

Table 6 also shows that several intersections along Foxhall Road had a large number of accidents during the 1997-1999 time period. The intersections of Foxhall Road with Reservoir Road and MacArthur Boulevard had more than eight accidents each during the three-year time period. The Study Team is making recommendations to improve safety and traffic operations at these intersections. The recommendations are described in the Issues and Recommended Improvements section of this document.

PARKING

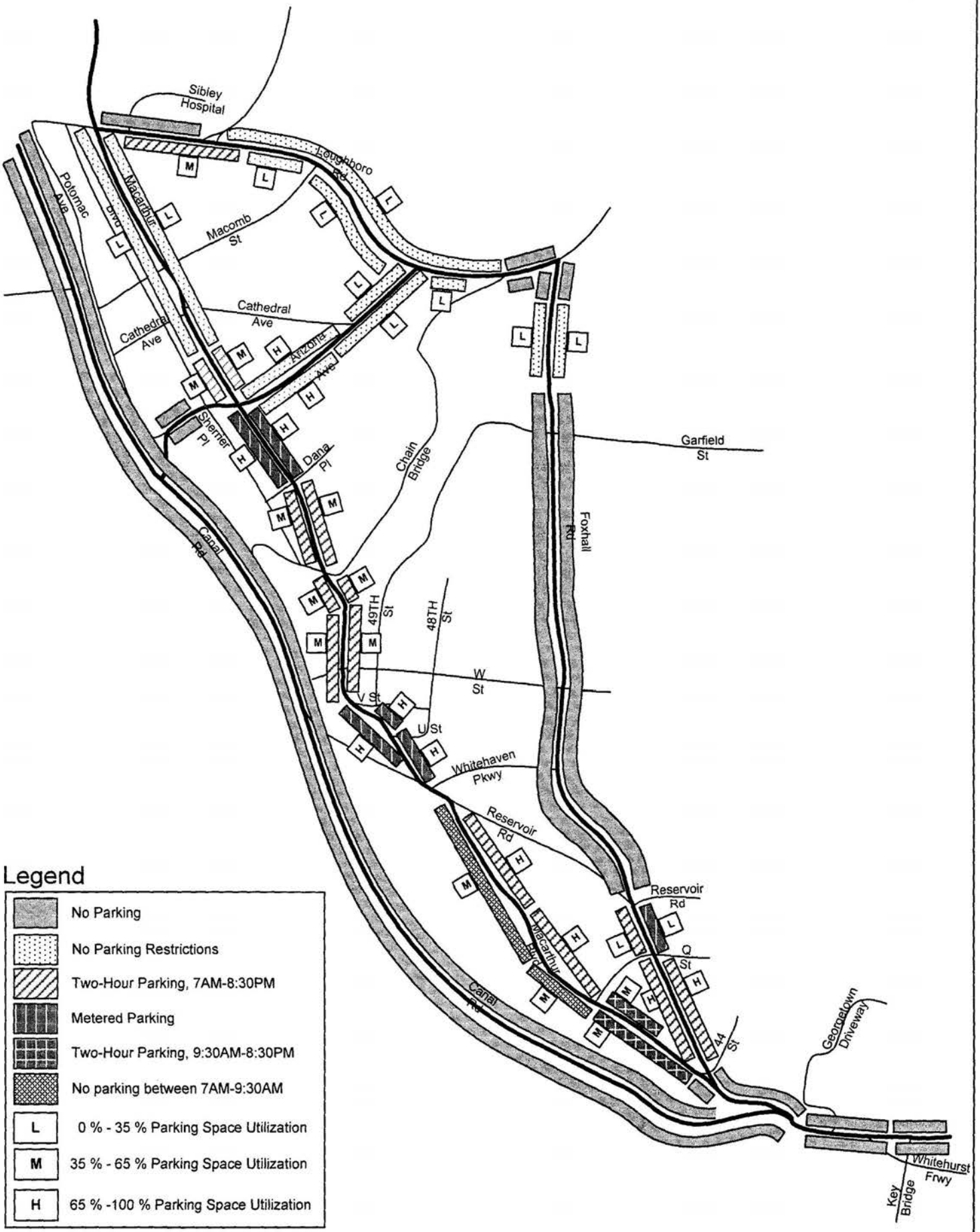
Parking restrictions vary significantly for the different corridors in the Study Area. As shown in Figure 14, while Canal Road has no parking, parking is allowed throughout MacArthur Boulevard. While there are long sections of Foxhall Road with no parking allowed, parking is allowed along most of Loughboro Road.

Parking restrictions vary along the corridors based on the land uses surrounding the roadway. For example, there are no parking restrictions on MacArthur Boulevard in the residential areas north of Arizona Avenue while there is metered parking in the commercial areas south of Arizona Avenue and north of Reservoir Road.

Parking utilization along Loughboro Road is generally low. However, the parking spaces along this road are utilized more intensively in the vicinity of Sibley Hospital. Parking utilization on MacArthur Boulevard is relatively low north of Arizona Avenue, it is high around the commercial areas south of Arizona Avenue. Another segment with high parking utilization is Foxhall Road between MacArthur Boulevard and Reservoir Road.

If more restrictive parking restrictions were imposed on MacArthur Boulevard, for instance limiting parking during peak hours, the capacity of this roadway could be increased. However, because of the relatively high parking utilization along MacArthur Boulevard, the Study Team is not recommending the implementation of new parking restrictions along this road.

Furthermore, while there are areas, such as the commercial enclaves along MacArthur Boulevard, with high utilization of available parking, there does not appear to be any need for supplementing the existing parking availability in these areas. During the peak parking demand periods, parking spaces on the side streets immediately adjacent to MacArthur Boulevard are used as a supplement to the available parking resources.



Not to Scale		Palisades Traffic Impact Study	Parking Restrictions and Utilization on Critical Corridors	FIGURE 14
August, 2002				

QUEUES AT CRITICAL INTERSECTIONS

The Study Team collected information on existing queues at critical intersections in the study area. This information was needed to adequately develop a computerized model of existing traffic conditions. The Study Team took samples of maximum queues for each of the approaches of critical intersections. The Study Team calculated the average of the maximum queues for each of the approaches. Figure 15 summarizes the average of the observed maximum queues for the critical intersections. The intersections with the longest queues are at the entry points to the study area. The longest queues were observed on Chain Bridge during the AM peak hours. Canal Road at Foxhall Road is another location with extremely long queues during the AM peak hours. The queues on Whitehurst Freeway were the longest observed queues during the PM peak hours.

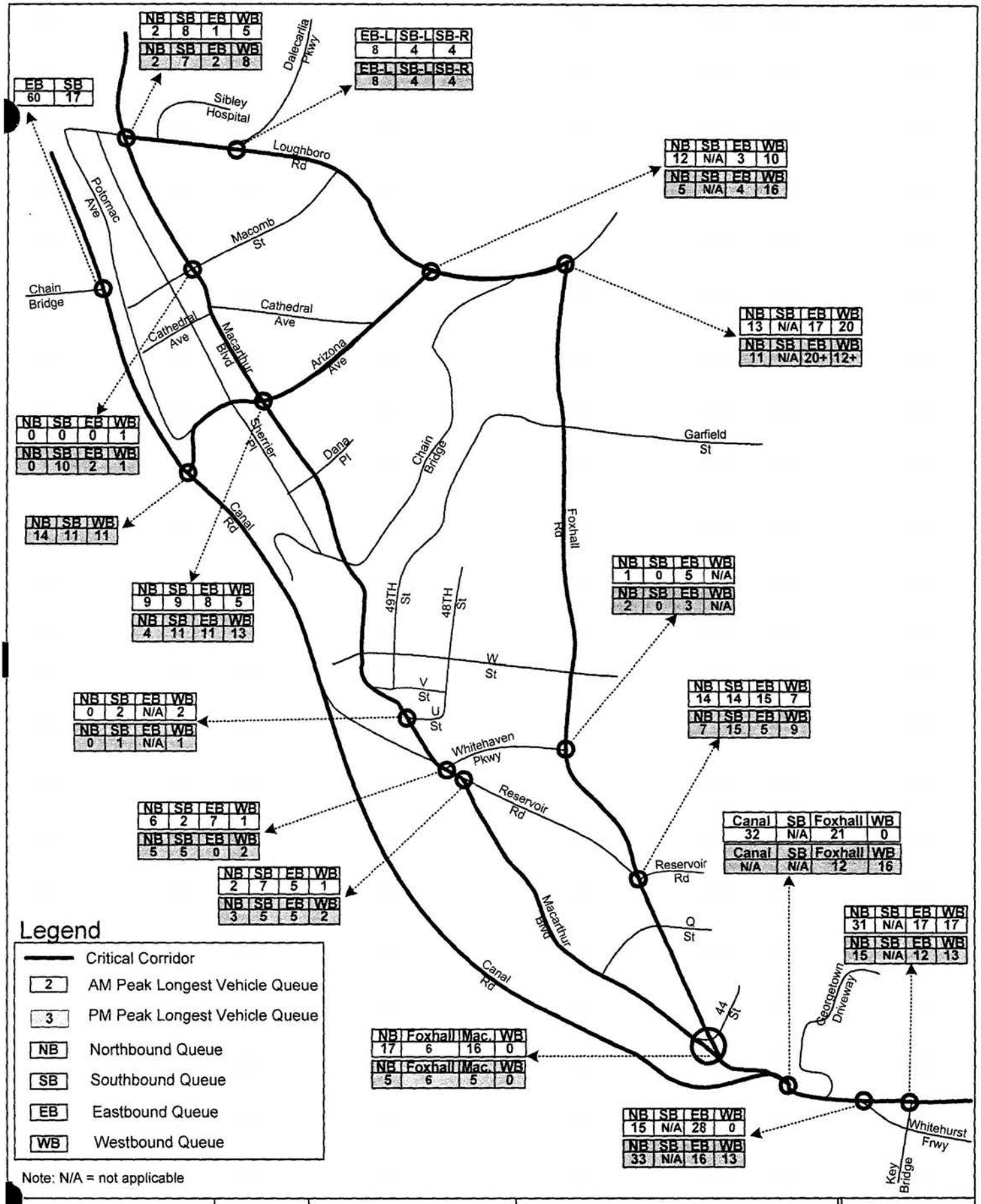
The Study Team used the queue information to develop the traffic model. The results of the traffic simulations were compared to the observed queues. Where the Study Team found significant discrepancies between modeled conditions and observed conditions, the input data used to set up the model was thoroughly examined to eliminate the possibility of errors in the development of the model. After errors were ruled out, discrepancies were reconciled by making adjustments to the traffic model parameters to make the model replicate more accurately observed traffic conditions.

EXISTING LEVELS OF SERVICE

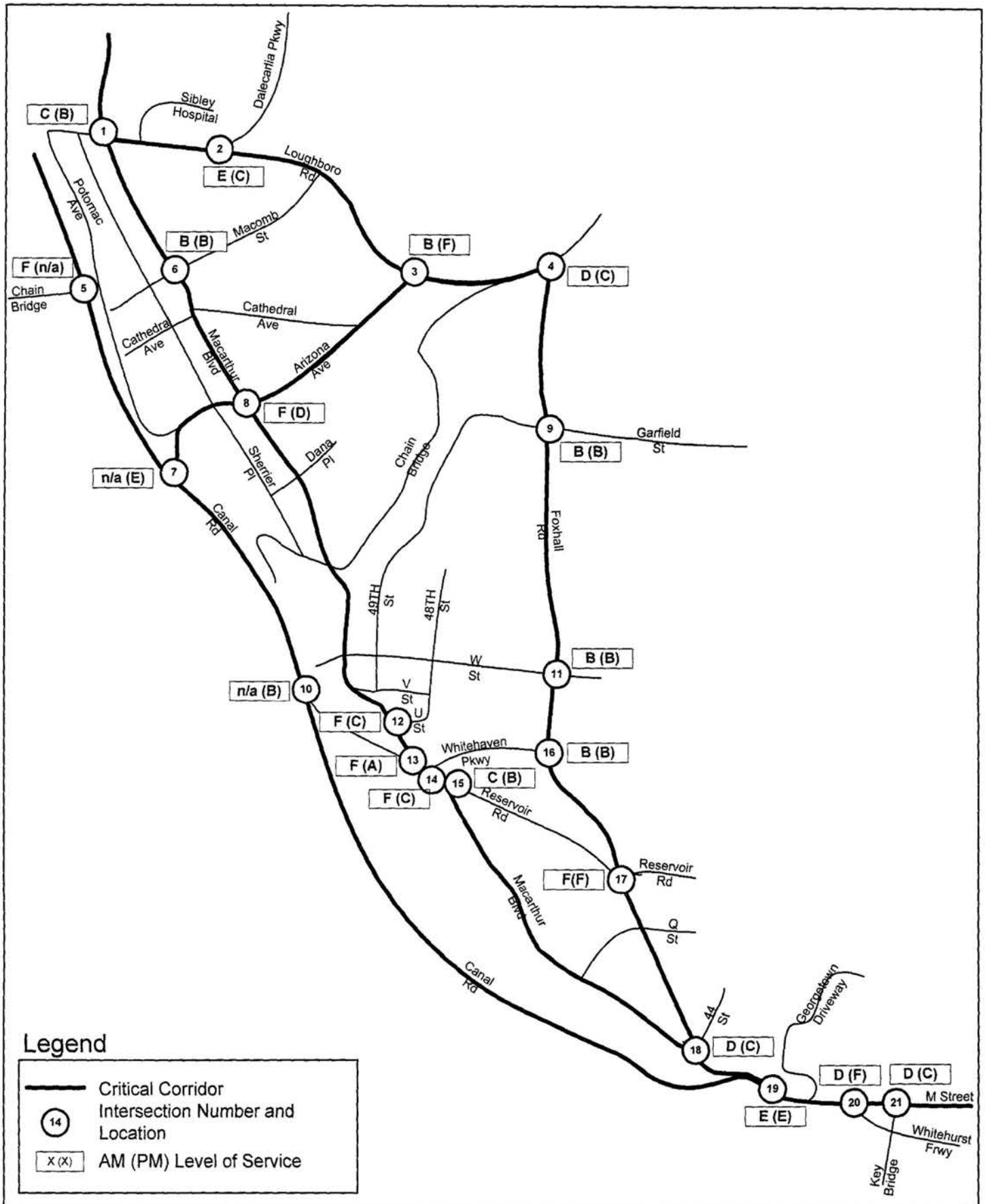
The Consultant used SYNCHRO, a traffic modeling/analysis program, to evaluate existing traffic conditions at the Critical intersections in the study area. For the evaluation, the Consultant entered existing traffic volumes, lane configurations and timings into SYNCHRO to develop a base case, existing conditions model. SimTraffic, SYNCHRO's associated traffic simulation software, was used to assist in the development of a model that replicates accurately existing conditions.

The Consultant used the SimTraffic software results to calculate levels of service (LOS) and the delay per vehicle for all the critical intersections in the study area. The LOS evaluation uses a six-letter grade scale (A to F) to rank the overall traffic handling ability of an intersection or a network. LOS A indicates excellent traffic operations with minimal delays. LOS F represents failing conditions with long delays. Levels of service E and F are generally considered undesirable. Appendix F provides a description of the different levels of service and their associated delays for both signalized and unsignalized intersections.

Figure 16 shows existing levels of service for the network for the AM and PM peak hours. It can be seen that in general levels of service are worse during the AM peak hour than the PM peak hour. This is due in part to the concentrated nature of the AM rush hour versus the PM rush hour and the traffic activity associated with schools in the study area. Additionally, the entry points to the study area have the worst levels of service. In particular, the intersection of Foxhall and Reservoir Roads operates at LOS F during both peak periods.



Not to Scale August, 2002	N	Palisades Traffic Impact Study	**Observed Queues at Critical Intersections** — **FIGURE 15**



Not to Scale		Palisades Traffic Impact Study	Existing Levels of Service (LOS)	FIGURE 16
August, 2002	N			

Some of the intersections, such as Canal Road and Chain Bridge and Canal Road and Whitehurst Freeway, operate at poor levels of service due to high existing volumes, while others, such as Reservoir Road and Foxhall Road, operate at a poor LOS due in part to non-optimized signal timings.

Another location with poor levels of service is the intersection of Foxhall and Canal Road. This intersection is operating at poor level of service largely due to the major arterials of Foxhall Road and MacArthur Boulevard converging and then joining with Canal Road. Essentially, five lanes of traffic converge into two, over a very short distance during the AM peak hour, creating high delays and poor levels of service.

With regards to unsignalized intersections, those performing at the worst LOS include Arizona Avenue and Loughboro Road (PM peak), MacArthur Boulevard and Whitehaven Parkway (AM peak) and Loughboro Road and Dalecarlia Parkway (AM peak).

The Consultant used the existing levels of service to identify locations where future improvements - such as signalization, changes in signal timing/phasing and additional lanes – could be implemented. The recommendations with respect to changes to signal timings and signalization are described in the Issues and Recommended Improvements section of this report.

FUTURE CONDITIONS

The Study Team evaluated future conditions taking into consideration growth in background traffic and traffic generated by new and proposed developments in the study area. The background traffic and new development traffic was added to existing traffic counts to determine future traffic volumes.

BACKGROUND GROWTH

Based on historical counts, the growth rate used for background traffic was 0.5 percent per year. All balanced traffic volumes were grown by this percentage to determine background traffic volumes for one, five and ten years in the future. Developments outside the study are that were not directly analyzed are included in this growth rate.

DEVELOPMENT TRAFFIC

The Study Team identified four developments in the study area that will contribute to future traffic volumes. The developments are as follows:

1. Expansion of St. Patrick's Episcopal Day School (St. Patrick's). St. Patrick's is expanding to add 7th and 8th grade students at a location on MacArthur Boulevard near Ashby Street. These students will be dropped off at the existing school on Whitehaven Parkway and transported via bus to the new school. Additionally, staff trips will take place directly to and from the new school.

2. Field School. The Field School is relocating from its existing campus on Wyoming Avenue to a new location on Foxhall Road, north of W Street.

3. George Washington University at Mount Vernon College (GWU). Expansion of campus on Foxhall Road between Whitehaven Parkway and W Street. Construction of new driveway on Whitehaven Parkway.

4. Mayor's mansion on Foxhall Road between Reservoir Road and Whitehaven Parkway.

TRIP GENERATION

Additional traffic generated by the Field School was taken from the "Traffic Impact Analysis – The Field School" prepared by Gorove/Slade Associates, Inc., and dated June 2, 2000. The projected trips are as follows:

Table 7:
Field School Trip Generation

	AM Peak Hour	PM Peak Hour
Enter	106	14
Exit	68	72
Total	174	86

Traffic generated by GWU was taken from "The George Washington University at Mount Vernon College Master Plan Traffic and Parking Assessment," prepared by Gorove/Slade Associates, Inc., and dated May 17, 1999. The projected trips are as follows:

Table 8:
GWU Trip Generation

	AM Peak Hour	PM Peak Hour
Enter	151	4
Exit	4	143
Total	155	147

Additional traffic that will be generated by the remaining two developments was estimated using the manual *Trip Generation, 6th Edition* (Institute of Transportation Engineers, 1997).

Mayor's Mansion:

To establish rates for the Mayor's Mansion, the average rate for ITE 210 (Single Family Detached Housing) was used. In order to account for additional trips associated with the mansion, the Study Team assumed that the mansion would generate three times as many trips as a single family house. The total generated trips are as follows:

Table 9:
Mayor's Mansion Trip Generation

	AM Peak Hour	PM Peak Hour
Enter	1	3
Exit	4	2
Total	5	5

St. Patrick's:

ITE 521 (Private School, K-12) was used to establish trip generation rates for St. Patrick's. The expansion of the school will add 60 7th and 8th grade students, who will be dropped off and picked up at the existing school on Whitehaven Parkway. Since this expansion will create no new staff positions at the existing school, the total number of entering vehicles determined by ITE was used as the number of exiting vehicles. 33 trips were added each way during the AM peak hour, and 21 trips were added each way during the PM peak hour.

These students will be transported via bus to the new school location at MacArthur Boulevard and Ashby Street. Three bus trips are expected to leave Whitehaven Parkway, travel outbound on MacArthur and drop off the students at Ashby Street. For the return trip, the buses will continue outbound on MacArthur to Arizona Avenue. They will turn right onto Arizona, right onto Loughboro Road, right onto Foxhall Road and finally right onto Whitehaven Parkway to return to St. Patrick's. To model the buses, a passenger car equivalent of two was used, turning three bus trips into six passenger car trips. These bus

trips will only take place during the AM peak hour. The students will return to campus via bus prior to the PM peak hour.

The new school is expected to have a staff of ten. Thusly, ten trips were added directly to the new location at MacArthur Boulevard and Ashby Street.

Table 10 summarizes the total number of projected trips generated by the expansion of St. Patrick's.

Table 10:
St. Patrick's Trip Generation

	AM Peak Hour	PM Peak Hour
Enter	49	21
Exit	39	31
Total	88	52

Table 11 summarizes all trip generation related to the study area:

Table 11:
Total Study Area Trip Generation

	AM Peak Hour	PM Peak Hour
Enter	307	42
Exit	115	248
Total	422	290

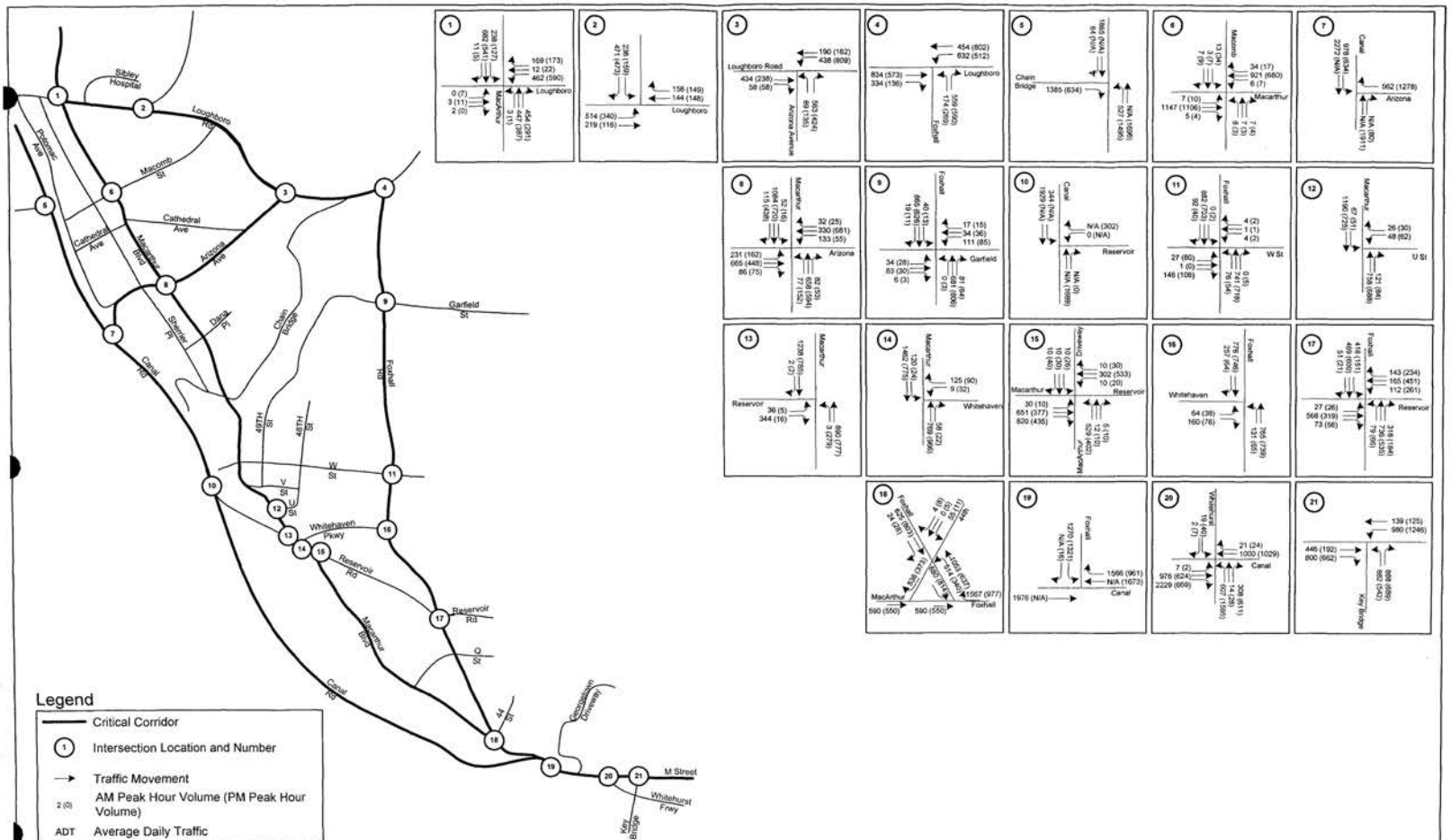
TRIP DISTRIBUTION

In the cases of the Field School and GWU, where possible, trips were distributed according to the information provided in their respective traffic studies. Once the boundaries of these traffic studies were passed, trips were distributed on the basis of existing traffic patterns. Trips for the Mayor's Mansion and St. Patrick's were largely distributed based on existing traffic patterns. Some trips either started or ended within the study area, and in some cases, both started and ended internally.

FUTURE LEVELS OF SERVICE

A one-year build-out was assumed for all developments. Site traffic and one-year background traffic were added at each intersection to create the volumes used for analysis. See Figure 17 for these volumes. Additionally, five and ten-year volumes can be found in Appendix G. No improvements were made to any of the intersections when analyzing the "no-build" condition[1].

[1] "No-build" condition refers to a scenario without the implementation of transportation improvements. The "no-build" condition does include the additional trips generated by new development in the area and growth in background traffic.



Not to Scale August, 2002	N	Palisades Traffic Impact Study	**Forecast One-Year Traffic**

FIGURE 17

As with existing conditions, Synchro and SimTraffic were used to model and simulate future conditions. Table 12 shows levels of service under existing and no-build conditions.

Table 12:
Levels of Service, Existing vs. No Build Condition

Intersection	AM Peak Hour		PM Peak Hour	
	Existing LOS	One-year No-build LOS	Existing LOS	One-year No-build LOS
MacArthur Blvd and Loughboro Road	C	C	B	B
Loughboro Road and Dalecarlia Pkwy	E	E	C	B
Loughboro Road and Arizona Avenue	B	B	F	E
Loughboro Road and Foxhall Road	D	E	C	C
Canal Road and Chain Bridge	F	F	n/a	n/a
MacArthur Blvd and Macomb Street	B	C	B	B
Canal Road and Arizona Avenue	n/a	n/a	E	E
MacArthur Blvd and Arizona Avenue	F	D	D	C
Foxhall Road and Garfield Street	B	B	B	B
Canal Road and Reservoir Road	n/a	n/a	B	C
Foxhall Road and W Street	B	F	B	F
MacArthur Blvd and U Street	F	F	C	C
MacArthur Blvd and Reservoir Road (N)	F	F	A	A
MacArthur Blvd and Whitehaven Pkwy	F	B	C	B
MacArthur Blvd and Reservoir Road (S)	C	C	B	B
Foxhall Road and Whitehaven Pkwy	B	B	B	F
Foxhall Road and Reservoir Road	F	D	F	F
Foxhall Road/MacArthur Blvd/44th Street	D	D	C	C
Foxhall Road and Canal Road	E	E	E	E
Canal Road and Whitehurst Freeway	D	D	F	F
Canal Road and Key Bridge	D	D	C	C

Note: n/a = not applicable. These intersections have no stop-controlled or signalized movements during these time periods.

Although the delay per vehicle increased at most of the intersections, in most cases there was not enough of an increase to degrade the LOS. For intersections that were already operating at LOS F, no increase in delay or volume could lower the LOS. In some cases, delay per vehicle dropped, and LOS improved, due to greater delays at adjacent intersections. If adjacent intersections are so thoroughly congested that very little traffic gets through, traffic operations at downstream intersections may improve slightly.

As expected, the intersections closest to the areas of development – Foxhall Road's intersections with W Street and Whitehaven Parkway – show a noticeable degradation in LOS, from a very good LOS B to LOS F, or failure. When combined with the analysis of existing conditions, the no-build option gave further insight into potential improvements at various intersections.

As the preliminary improvements list was created and refined, analysis was performed for one, five and ten years in the future. All background and site traffic was included. Table 13 shows levels of service for these scenarios:

Table 13:
Future Levels of Service with Background and Site Traffic and Improvements

Intersection	AM LOS			PM LOS		
	1-year	5-year	10-year	1-year	5-year	10-year
MacArthur Blvd and Loughboro Road	C	C	C	B	B	B
Loughboro Road and Dalecarlia Pkwy	F	F	E	C	B	C
Loughboro Road and Arizona Avenue	C	D	D	B	C	C
Loughboro Road and Foxhall Road	E	C	C	C	B	B
Canal Road and Chain Bridge	F	F	F	n/a	n/a	n/a
MacArthur Blvd and Macomb Street	E	E	F	B	C	C
Canal Road and Arizona Avenue	B	C	C	E	E	E
MacArthur Blvd and Arizona Avenue	E	F	F	D	D	D
Foxhall Road and Garfield Street	B	C	B	B	B	B
Canal Road and Reservoir Road	A	A	A	A	B	B
Foxhall Road and W Street	B	C	B	B	B	B
MacArthur Blvd and U Street	C	C	C	B	B	B
MacArthur Blvd and Reservoir Road (N)	B	B	B	A	A	A
MacArthur Blvd and Whitehaven Pkwy	B	B	C	B	B	B
MacArthur Blvd and Reservoir Road (S)	C	C	C	B	B	C
Foxhall Road and Whitehaven Pkwy	A	A	A	A	A	A
Foxhall Road and Reservoir Road	F	F	E	F	F	F
Foxhall Road/MacArthur Blvd/44th Street	C	E	D	C	B	C
Foxhall Road and Canal Road	E	F	E	F	F	F
Canal Road and Whitehurst Freeway	D	D	D	F	F	F
Canal Road and Key Bridge	F	F	F	C	C	C

Note: n/a = not applicable. These intersections have no stop-controlled or signalized movements during these time periods.

Locations where the 10-year LOS is better than the one or five-year are locations where improvements were implemented. These improvements are in the next section of this study. It can be seen that for the majority of the intersections, ten-year levels of service are the same or better than one-year levels of service. In some cases, it took large-scale improvements to improve or maintain LOS. Examples of this are the intersection of Foxhall and Loughboro Roads and the intersection of Canal Road and Whitehurst Freeway. In other cases, simple timing changes were enough to create noticeable improvements.

ISSUES AND RECOMMENDED IMPROVEMENTS

Through field work, assessment of existing conditions data and meetings with area residents, the Study Team compiled the following list of issues and recommended improvements for the entire study area. These issues represent the most pressing concerns and needs for improving safety and traffic operations.

The issues are listed by roadway, and then by intersection/area. They are presented as follows:

- Issue – states the concern, problem or need for improvement.
- Preliminary Improvement(s) – various solutions that could potentially address the issue. This section includes a description of all the improvements considered in the evaluation. Based on the evaluation of alternatives, some of the preliminary improvements may not be recommended for implementation.
- Evaluation – analysis and reporting of findings.
- Recommendation – improvements to be implemented.

All improvements are short-term unless otherwise indicated.

Area-wide changes to traffic signal timing and phasing are evaluated and discussed at the end of this section. Individual intersection improvements were evaluated and recommended, and then the signal network was optimized as a whole.

FOXHALL ROAD

Issue:

- Traffic flow and safety concerns at the intersection of Canal Road and Foxhall Road. Figure 18 illustrates the lack of pavement markings on Canal Road.

Preliminary Improvement(s):

1. Prohibit right turns from inbound Foxhall Road to outbound Canal Road.
2. Prohibit U-turns on eastbound Canal Road. Place appropriate traffic control signs.
3. Place lane markings on westbound Canal Road.

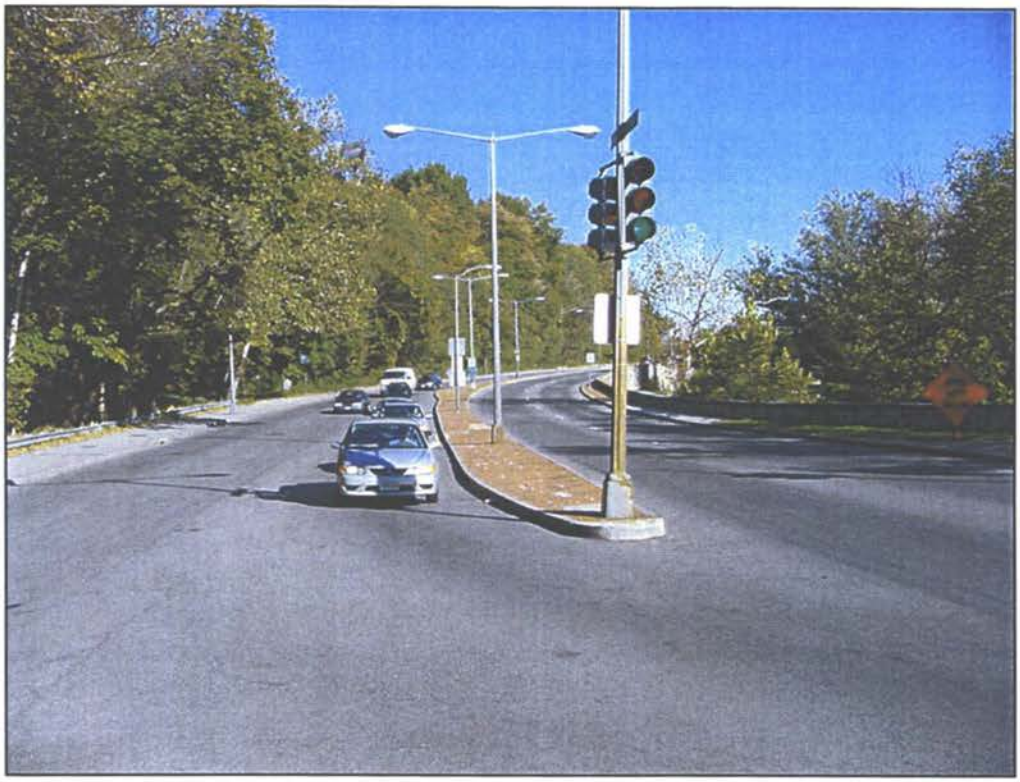
Evaluation:

1. Prohibiting right turns will improve safety, particularly during off-peak hours, when wide right turns encroach onto the inbound lanes of Canal Road. Delay for the inbound approach of Foxhall Road would also decrease due to the elimination of this slow turning movement.
2. Prohibiting U-turns will improve safety and decrease overall intersection delay. TSA staff observed numerous U-turns during field visits. Some vehicles actually made three-point turns when they were unable to make the U-turn.
3. Pavement markings have been added to this section of Canal Road.

Recommendation:

- Implement all the preliminary improvements noted above, i.e. prohibit discussed turns.

Figure 18
Facing East on Canal Road at Foxhall Road



Issue:

- Cut-through traffic on 44th street at Foxhall Road/MacArthur Boulevard

Preliminary Improvement(s):

1. Figure 19 shows the "No Left Turn" signs that have been installed on southbound Foxhall Road at several intersections between Reservoir Road and 44th Street to prevent drivers from using 44th Street as a bypass to Foxhall Road.

Evaluation:

1. The new signs have reduced the amount of cut-through traffic.

Recommendation:

- This improvement has already been implemented and has been successful.

Issue:

- 44th Street traffic blocking intersection with MacArthur Boulevard

Preliminary Improvement(s):

1. Retime signal, allowing 44th Street traffic to travel directly down Foxhall Road towards Canal Road.
2. Long-Term: Construct grade separation or traffic circle.

Figure 19
Southbound Foxhall Road Near Q Street



Evaluation:

1. Retiming the signal in this manner would take away from green time that is currently given to MacArthur Boulevard, which has a much higher traffic volume than 44th Street. Allotting this green time to 44th Street would increase queuing and delay on MacArthur Boulevard. Additionally, this would encourage commuters to use 44th Street as a cut-through route.
2. The construction of grade separation or a traffic circle at this intersection would have an exorbitant cost. The high cost would result from the extensive right-of-way requirements and topography constraints. Furthermore, the construction of a massive structure for an interchange would not fit well with the architectural character of the surrounding residential community.

Recommendation:

- Do not retime this signal. Do not construct a traffic circle or grade separation.

Issue:

- The signing and marking for the left lane on Foxhall Road at MacArthur Boulevard is inadequate.

Preliminary Improvement(s):

1. Install "Left Lane Must Turn Left" sign in the median of Foxhall Road located at the Canal Road intersection.
2. Extend solid white lane stripe 120 feet past current terminus.

3. Place additional left turn arrow 80 feet before existing arrow.
4. Add "ONLY" legend to all pavement marking arrows.
5. Replace "Turn Left on Green with Caution" sign with the following sign:



This sign is compliant with the *Manual on Uniform Traffic Control Devices* (MUTCD).

Evaluation:

1. The new sign will alert drivers unfamiliar with the area that they are in an exclusive turning lane.
2. The new striping will give additional reinforcement to the exclusive left turn lane.
3. The left turn arrow will reinforce the message to the drivers.
4. The addition of "ONLY" will reinforce the message to the drivers.
5. MUTCD-compliant signs are more familiar to drivers and should be used whenever possible.

Recommendation:

- Implement all of the preliminary improvements noted above, i.e. Install/replace signs and add pavement markings.

Issue:

- Vehicular congestion on northbound Foxhall at Reservoir Road.

Preliminary Improvement(s):

1. Implement AM peak hour parking restrictions on northbound Foxhall Road north of Q Street. Stripe Foxhall Road as two lanes.

Evaluation:

1. Removing this parking and creating a second lane will increase capacity on northbound Foxhall Road, reducing delay at the intersection of Foxhall and Reservoir Roads and also reducing the length of the queue on northbound Foxhall Road. This would result in the elimination of some metered parking on Foxhall Road.

Recommendation:

- Eliminate parking to provide second northbound lane during the AM peak period (7:00 AM – 9:30 AM).

Issue:

- Traffic operations, condition of existing striping and pedestrian safety at the intersection of Foxhall and Reservoir Roads.

Preliminary Improvement(s):

1. Restripe all pavement markings.
2. Two potential lane configuration options were considered for this intersection:
   A. Add one exclusive eastbound left turn lane on Reservoir Road. Re-stripe the eastbound approach to use three eastbound lanes on Reservoir Road – one left turn lane, one through lane and one through-right lane. Prohibit parking on eastbound Reservoir Road for the first 300 feet east of Foxhall Road.
   B. Add one exclusive eastbound left turn lane on Reservoir Road. Re-stripe the eastbound approach to use three eastbound lanes on Reservoir Road, one left turn lane, one through lane and one right turn lane.
3. Change the existing signal phasing and adjust the signal timing to accommodate the change in signal phasing.
4. Convert Salem Lane to one-way eastbound between Foxhall Road and 45th Street.
5. Construct sidewalk on east side of Foxhall Road from Hoban Road to Reservoir Road.
6. Install "yield to pedestrians while turning" sign (like on eastbound approach) for westbound right turns.
7. Eliminate 200 feet of parking on the north side of Reservoir Road west of Foxhall Road.
8. Replace the signalized intersection with a roundabout.

Evaluation:

1. All pavement markings at this intersection are in poor condition. Replacing them will improve visibility and safety.
2. Figure 20 is an aerial photograph of the intersection of Foxhall and Reservoir Roads, with an overlay showing the existing lane configuration, pavement markings and islands/medians. Under existing conditions, this intersection operates at LOS F for both the AM and PM peak hours.

   There are three predominant reasons for the poor level of service:
   - Eastbound left turns block through traffic.
   - Lack of capacity on northbound Foxhall Road.
   - Split-phase timing on Foxhall Road.

   A. By reconfiguring eastbound Reservoir Road to provide three lanes – an exclusive left lane, an exclusive through lane and a shared through/right lane – traffic queued to make the left turn onto northbound Foxhall Road would no longer block through traffic continuing on Reservoir Road. The two eastbound through lanes provide capacity to allow the intersection to operate at LOS E during the AM and PM peak hours. This option is shown in Figure 21.

   In order to safely provide for two eastbound through lanes on Reservoir Road, a distance of 300 feet on the south side of Reservoir Road, east of Foxhall Road, should have no parking. The residents of the surrounding community indicated to the Study Team that the elimination of parking spaces on



Scale: 1" = 55 '		Palisades Traffic Impact Study	Existing Geometry of Reservoir and Foxhall Road	FIGURE 20
August, 2002				



Scale: 1" = 55 '		Palisades Traffic Impact Study	Proposed Improvements for Reservoir and Foxhall Road - Option A	FIGURE 21
August, 2002				

Reservoir Road would be extremely detrimental due to the limited number of parking spaces available to the residents.

B. Providing three lanes as above, but striping the right lane to be an exclusive right-turn lane would not require the elimination of residential parking on Reservoir Road east of Foxhall Road. This option is shown in Figure 22.

With option 2A, the existing problem of eastbound Reservoir Road traffic merging into one lane would merely be shifted further away from the intersection; it would not be eliminated. Only by providing one through lane would the sudden merge problem be entirely eliminated. The Consultant used the SYNCHRO traffic simulation model to evaluate Option 2B. The modeling of this option indicated that the intersection would operate at level of service E with the left-through-right lane configuration during the AM and PM peak hours.

3. Changing the signal timing and phasing will have the greatest impact on the intersection. Currently, the intersection operates on a 120-second cycle during the AM peak hour (42 second northbound phase, 34 second southbound phase) and a 90-second cycle during the PM peak hour (30 second northbound phase, 24 second southbound phase).

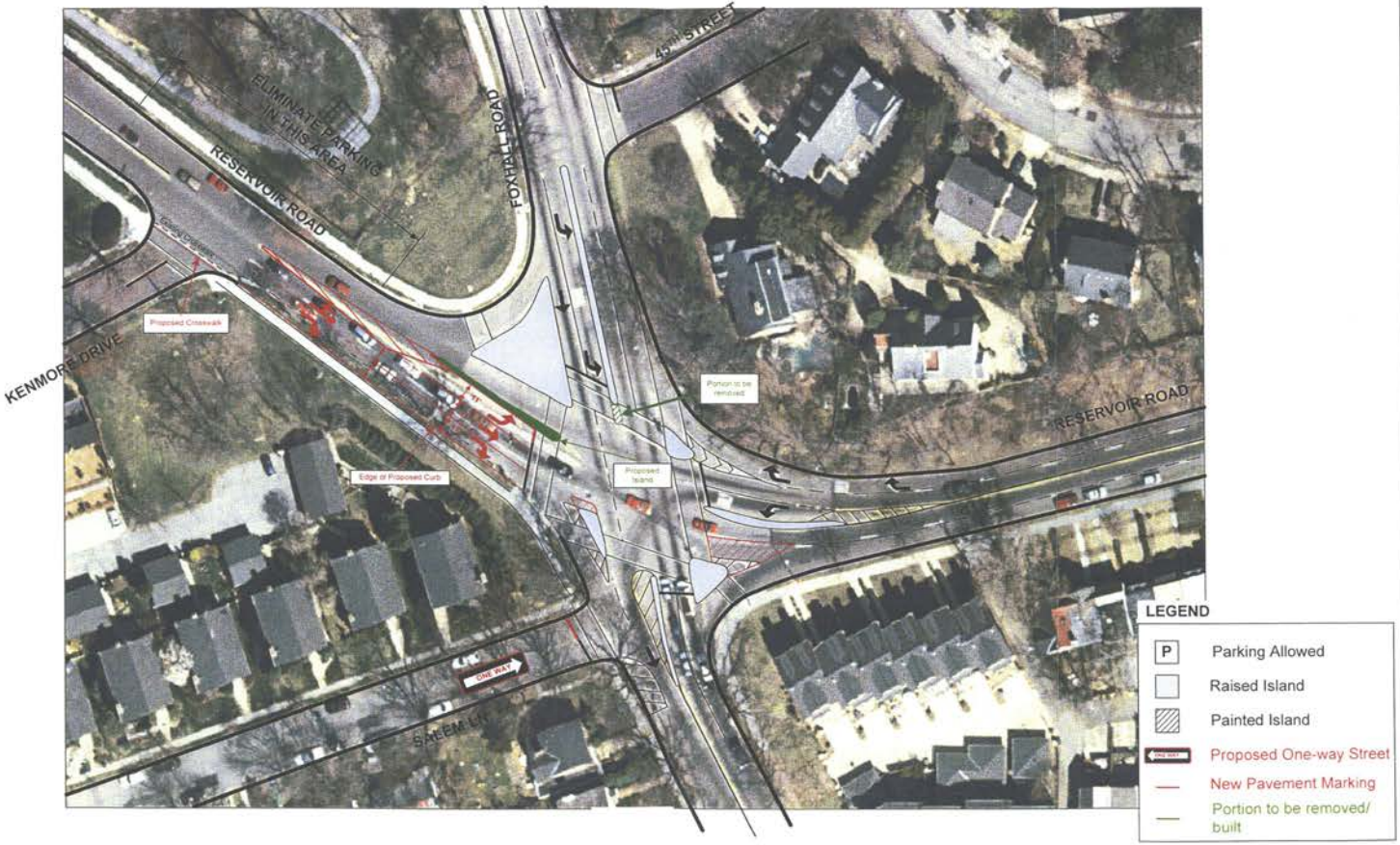
   The proposed optimized timings are as follows: AM peak – 80 second cycle with a 48 second north-south phase, including a 20 second advance southbound phase. PM peak – 120 second cycle with 61 second north-south phase, including a 20 second advance southbound phase.

   Table 14 compares the future, one-year delay and level of service at the intersection for the condition without phasing and timing changes to the condition with optimized phasing and timing, as well as the inclusion of Option 2B. One-year conditions include background growth and site traffic. Optimized conditions include the additional traffic as well as improvements discussed above. As Table 14 indicates, delays can be reduced significantly with the implementation of improvements 1,2B and 3.

Table 14:
Comparison of Levels of Service for Option 2B – Optimized and Non-optimized Conditions

Peak hour	One-year Conditions		Optimized Conditions		Change in Delay
	Delay (s)	LOS	Delay (s)	LOS	
AM	130.0	F	61.0	E	-53.1%
PM	226.1	F	57.0	E	-74.8%

4. Salem Lane should be converted to one-way eastbound operation to prohibit right turns from southbound Foxhall Road and increase safety. Vehicles making this turn often do not see other vehicles making the right turn from eastbound Reservoir Road to southbound Foxhall Road.



Scale: 1" = 55 '		Palisades Traffic Impact Study	Proposed Improvements for Reservoir and Foxhall Road - Option B	FIGURE 22
August, 2002				

REVISION								
DESCRIPTION	DATE	COR.	CHK.	APP.	APP.	APP.	APP.	APP.
A								

GENERAL NOTES:

1. ALL WORK RELATING TO THE INSTALLATION OF TRAFFIC SIGNALS SHALL COMPLY WITH APPROPRIATE PROVISIONS OF D.C. DRAWING NO. S-2100, DCDPW STANDARD SPECIFICATIONS, AND CONTRACT SPECIAL PROVISIONS.
2. THE CONTRACTOR SHALL SUBMIT TO THE DCDPW CATALOG CUTS OF ALL EQUIPMENT AND MATERIALS TO BE FURNISHED AND INSTALLED. WRITTEN APPROVAL FROM DCDPW SHALL BE SECURED PRIOR TO PROCUREMENT.
3. THE LOCATION OF PROPOSED EQUIPMENT SHOWN IS APPROXIMATE. THE LOCATION OF ALL PROPOSED EQUIPMENT AND MATERIAL SHALL BE FIELD LOCATED, VERIFIED, AND APPROVED BY THE ENGINEER PRIOR TO INSTALLATION.
4. THE CONTRACTOR SHALL FURNISH AND INSTALL ALL PROPOSED CONDUITS, MANHOLES, POLE FOUNDATIONS, AND CABINET FOUNDATIONS.
5. THE CONTRACTOR SHALL FURNISH AND INSTALL ALL TRAFFIC AND TRAFFIC SIGNAL POLES, TRAFFIC SIGNAL CONTROLLERS, CABINETS, MAST ARMS, SIGNS AND ALL MOUNTING HARDWARE.

CABLE NOTES:

1. DCDPW PERSONNEL WILL MAKE ALL ELECTRICAL CONNECTIONS INSIDE THE CONTROLLER CABINET. THE CONTRACTOR SHALL MAKE ALL ELECTRICAL CONNECTIONS IN TRAFFIC AND PEDESTRIAN SIGNAL HEADS.
2. THE CONTRACTOR SHALL FURNISH AND INSTALL NEW, UNSPLICED 7C 14 AWG STRANDED CABLE TO ALL SIGNAL HEADS (SEE SHEET 2).
3. THE CONTRACTOR SHALL FURNISH AND INSTALL NEW 12 PAIR 19 AWG COMMUNICATION CABLE (SEE SHEETS 4, 5 AND 6).

MAST ARM NOTES:

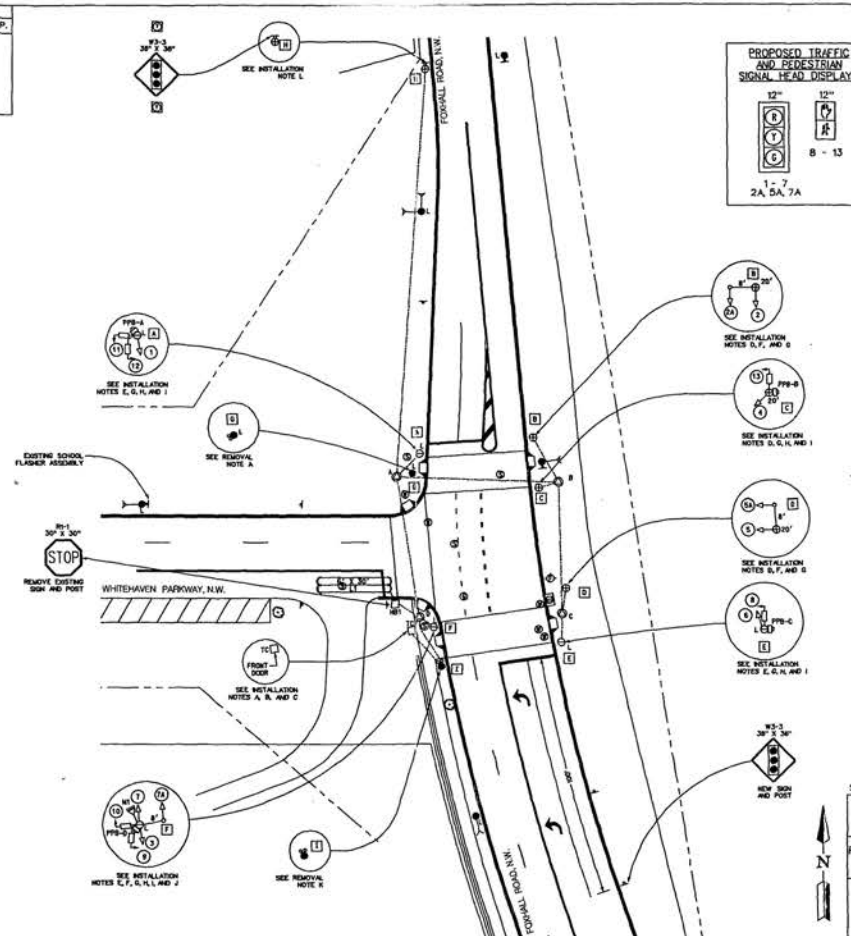
1. A BACK PLATE SHALL BE AFFIXED TO EACH MAST ARM MOUNTED SIGNAL HEAD.
2. THE BOTTOM OF MAST ARM MOUNTED SIGNAL HEADS SHALL BE 16 FEET 14.9 M0 ABOVE THE ROADWAY SURFACE.
3. AN ASTRO-BRAC SHALL BE USED TO MOUNT SIGNAL HEADS (2A, 5A, AND 7A) TO MAST ARMS.

INSTALLATION NOTES:

A. INSTALL TRAFFIC SIGNAL CONTROLLER CABINET FOUNDATION.
B. INSTALL TRAFFIC SIGNAL CONTROLLER CABINET.
C. INSTALL TRAFFIC SIGNAL CONTROLLER.
D. INSTALL 20-FOOT TALL TRAFFIC SIGNAL POLE WITH TRANSFORMER BASE.
E. INSTALL 28-FOOT TALL TRAFFIC SIGNAL POLE ON TRANSFORMER BASE WITH LUMINAIRE.
F. INSTALL MAST ARM WITH CAP AND CLAMP.
G. INSTALL TRAFFIC SIGNAL HEAD(S)
H. INSTALL PEDESTRIAN SIGNAL HEAD(S).
I. INSTALL PEDESTRIAN PUSH BUTTON(S).
J. INSTALL MICROWAVE VEHICLE DETECTOR.
K. INSTALL CONDUIT RISER(S).
L. INSTALL ADVANCED WARNING BEACON.

REMOVAL NOTES:

A. REMOVE LUMINAIRE.



PROPOSED TRAFFIC AND PEDESTRIAN SIGNAL HEAD DISPLAYS

LEGEND:

- PROPOSED TYPE 170 TRAFFIC SIGNAL CONTROLLER WITH MODEL 336S CABINET
- PROPOSED 28 FOOT TALL STREET LIGHT POLE ON TRANSFORMER BASE WITH LUMINAIRE
- PROPOSED 20 FOOT (6 M) TALL TRAFFIC SIGNAL POLE WITH TRANSFORMER BASE
- EXISTING UTILITY POLE, WOOD
- EXISTING UTILITY POLE, WOOD WITH LUMINAIRE
- EXISTING UTILITY POLE (WOOD) WITH LUMINAIRE AND PROPOSED RISER
- EXISTING ANCHOR GUY
- PROPOSED 8 FOOT LONG MAST ARM WITH CAP AND CLAMP
- PROPOSED 3 SECTION VEHICULAR SIGNAL HEAD CONVENTIONAL (ALL LENSES 12 INCHES)
- PROPOSED 2 SECTION PEDESTRIAN SIGNAL HEAD (ALL LENSES 12 INCHES)
- PROPOSED PEDESTRIAN PUSH BUTTON
- PROPOSED INDUCTIVE QUADRUPOLE LOOP DETECTOR
- PROPOSED MICROWAVE VEHICLE DETECTOR
- EXISTING SIGN
- PROPOSED SIGN
- EXISTING STORM CATCH BASIN SQUARE
- EXISTING GAS MANHOLE
- EXISTING SANITARY SEWER MANHOLE
- EXISTING WATER MANHOLE
- PROPOSED DCDPW TRAFFIC SIGNAL MANHOLE
- PROPOSED HAND BOX
- PROPOSED ELECTRICAL PVC CONDUIT
- PROPOSED WHEELCHAIR RAMP
- RIGHT-OF-WAY
- EXISTING FENCE
- EXISTING TREE
- EXISTING SHRUB
- EXISTING FIRE HYDRANT

F.H.W.A REG. NO.	STATE	FED. AID PROJECT NO.	SHEET NO.	TOTAL SHEETS
3	D.C.			

FIGURE 23

SEQUENCE OF OPERATIONS DRAWING NO. TS-1665

DISTRICT OF COLUMBIA
DEPARTMENT OF PUBLIC WORKS
BUREAU OF TRAFFIC SERVICES

FOXHALL ROAD AND WHITEHAVEN PARKWAY, N.W.(1)

TRAFFIC SIGNAL INSTALLATION

FIELD CHECKED BY	BAH/JRW
DESIGNED BY	BAH
DRAWN BY	JRW
DATE	10/01
SCALE	1" = 40'
SHEET	1 OF 5
DRAWING NO.	S-862-A

DMJM HARRIS

S.L.F. NO.
APPROVED BY
DATE