#### **OBJECTIVE**

This document represents the final Road Safety Audit (RSA) report for the Blair Road/Cedar Road/4<sup>th</sup> Street intersection in the District of Columbia. The RSA audit team identified several transportation issues related to the traffic and pedestrian safety. Based on the inputs of the RSA team, District Department of Transportation staff developed recommendations addressing pedestrian and traffic safety issues at the study intersection.

#### **BACKGROUND**

Members of the RSA team consisted of several members from District Department of Transportation -Safety Team, Traffic Signal, Pedestrian Coordinators, Bike Team, Transit Operation and Coordination,

Urban Forestry, Transportation Planning, Washington United States Department of Transportation - Federal Highway Administration, Metropolitan Area Transit Authority (WMATA), Metropolitan Police Department (MPD) and Fire and Emergency Management (FEMA). The RSA team met on February 16<sup>th</sup>, 2012 to discuss transportation safety issues at the study intersection. An informal fact finding tour was also held with the community leaders and business owners. A formal field review was conducted by the RSA team on February 22<sup>nd</sup>, 2012. **Table 1** lists the audit team members and their affiliations.



Figure 1: RSA Audit Team

RSA Team Member	Agency
Victorine Gwei, Levon Petrosian and Aaron Rhones	DDOT Safety and TST
Jamie Henson and Anna Chamberlin	DDOT PPSA
Jim Sebastian and Mike Goodno	DDOT Pedestrian and Bike
John Thomas and Sharon Dendy	DDOT UFA
Carole Lewis	DDOT NHTSA
Brooke Fossey and Aaron Overman	DDOT PTSA
Jama Abdi	DDOT Streetlighting
Clarence Dickerson	DDOT IPMA
Wasim Raja	DDOT Signals
Damon Harvey	DDOT Parking
James Hamre and Douglas Stallworth	WMATA
James Crane, Nicholas Breul and Lisa Sutter	MPD
Erick Johnson and Sean Egan	FEMA
Ewa Flom	USDOT - FHWA
Sandra Jackson	USDOT - FHWA

#### **Table 1: Road Safety Audit Team Members**

### **PROJECT LOCATION DESCRIPTION**

The study intersection has multiple legs – Blair Road (northbound and southbound direction), Cedar Street (eastbound and westbound direction) and 4<sup>th</sup> Street. The intersection is located west of the Takoma Metro Station which generates high pedestrian and bike traffic. The intersection is also one block away from the Takoma Park Library and two blocks from Takoma Education Campus. There are several commercial businesses adjacent to the intersection. The aerial image of the study intersection is shown in **Figure 1**. The intersection has skewed geometric design which complicates traffic flow and pedestrian movement through at this location. Georgia Avenue and Piney Branch Road are major arterials in the vicinity of the study intersection. Georgia Avenue, Piney Branch Road and Blair Road serve as primary commuter corridor between Maryland and Washington D.C.



**Figure 2: Study Intersection Location** 

### **Blair Road**

Blair Road is a two-lane north-south minor arterial running from Peabody Street to Georgia Avenue. Blair Road runs west of the Takoma Metro Station on the Red line. The posted speed limit between North Capital Street and Van Buren Street is 30 mph; between Van Buren Street and Eastern Avenue is 25 mph; and between Eastern Avenue and Georgia Avenue is 30 mph. From Whittier Street to Peabody Street, on-street or off-street residential parking is provided on the west side of Blair Road only. There is no parking allowed on Blair Road from Whittier Street to Georgia Avenue. Blair Road has narrow sidewalks on the west side from Eastern Avenue to Cedar Street. The estimated 2010 Average Daily Traffic volumes on Blair Road is 15,000 vehicles. Blair Road has posted speed of 25 mph at the study intersection. However, 2010 speed study shows the 85<sup>th</sup> percentile speed along Blair Road is **32 mph** at this location.

#### 4<sup>th</sup> Street

4<sup>th</sup> Street is a two-lane road running north-south between Blair Road and Van Buren Street. It serves as a collector between Blair Road and Aspen Street and as a local street between Aspen Street and Van Buren Street. The posted speed limit is 25 mph. The estimated 2010 Average Daily Traffic volumes on 4<sup>th</sup> Street is 1600 vehicles. 4<sup>th</sup> Street serves as primary conduit for Metro bus routes 52, 53, 54, 62 and 63.

### **Cedar Street**

Cedar Street is a two-lane road running east-west at the study intersection. It serves as a minor arterial east of the intersection and a local street west of the intersection. Cedar Street primarily serves residential neighborhoods west of the intersection. The posted speed limit is 25 mph. The estimated 2010 Average Daily Traffic volumes on Cedar Street is 5300 vehicles. Cedar Street serves as primary conduit for Metro bus routes 52, 53, 54, 62 and 63.

### Georgia Avenue

Georgia Avenue is a principal arterial running north-south in the vicinity of the study intersection. The posted speed limit is 30 mph. It is a 2-lane road between Peabody Street and Eastern Avenue with onstreet parking and additional curb lane on each side. There are adequate sidewalks on both sides of Georgia Avenue in the vicinity of the study intersection. The estimated 2010 Average Daily Traffic volumes on Georgia Avenue is 22,000 vehicles.

# **Piney Branch Road**

Piney Branch Road is generally a two-way north-south minor arterial running from Georgia Avenue to Philadelphia Avenue. The posted speed limit is 30 mph. On-street parking or residential parking is allowed on the majority of Piney Branch Road, but is limited to the west side of the roadway from Butternut Street to Dahlia Street. Takoma Elementary School is located near the intersection of Piney Branch Road and Cedar Street. There are sidewalks provided along Piney Branch Road with the exception of a section on the southwest corner at the intersection with Blair Road. The estimated 2010 Average Daily Traffic volumes on Georgia Avenue is 15,300 vehicles.

### Metro Transit Routes (WMATA)

4<sup>th</sup> street and Cedar Street serve the Metro bus routes 52, 53 and 54 on the 14<sup>th</sup> Street line (Takoma Metro Station to L'Enfant Plaza Metro Station) and routes 62 and 63 on the Takoma-Petworth line (Takoma Metro Station to Federal Triangle). When departing Takoma Metro Station, metro buses for both 14<sup>th</sup> Street and Takoma-Petworth lines first turn left from Cedar Street on to the 4<sup>th</sup> Street (Blair Road/Cedar Road and 4<sup>th</sup> Street intersection) and then right from 4<sup>th</sup> Street on to the Butternut Street (4<sup>th</sup> Street and Butternut Street intersection) and further travel southbound to reach their destinations.

When arriving Takoma Metro Station, metro buses for both lines first turn left on 4<sup>th</sup> Street from the Butternut Street (4<sup>th</sup> Street and Butternut Street intersection) and then right to Cedar Street from 4<sup>th</sup> Street (Blair Road/Cedar Road and 4<sup>th</sup> Street intersection) to reach the Takoma Metro Station.

# ACCIDENT ANALYSIS

DDOT staff performed 3-year accident analysis at the intersection. Between 2008 and 2010, a total of 24 vehicular accidents and 3 pedestrian accidents were reported at the study intersection (Figure 2). About 60% of accidents (15 crashes) occurred on Blair Road approach at Cedar Street while 30% of accidents (7 crashes) occurred on 4<sup>th</sup> Street approach at Cedar Street. The remaining 10% of accidents (2 crashes) occurred on Blair Road approach at 4<sup>th</sup> Street.

Accident data shows 11 out of the 24 crashes (about 50%) resulted in injuries. Nine of the eleven injury crashes (about 80%) occurred on Blair Road approach at Cedar Street while the remaining two of the eleven injury crashes (about 20%) occurred on 4<sup>th</sup> Street approach at Cedar Street. No injury crashes were reported on Blair Road approach at 4<sup>th</sup> Street. The crash frequency for the vehicles and pedestrians is shown in **Figure 2**.



Figure 3: Study Intersection Accident Frequency: 2008 – 2010

Accident data also shows 4 out of the 24 crashes (about 20%) resulted in disabling or incapacitating injuries. One out of the four disabling injuries resulted from a pedestrian crash. Three out of the four disabling injury crashes occurred on Blair Road approach at Cedar Street while one disabling injury crash occurred on 4<sup>th</sup> Street approach at Cedar Street. No disabling injury crashes were reported on Blair Road approach at 4<sup>th</sup> Street.

Majority of the vehicular accidents occurred during the day under adequate lighting conditions. Of the 24 crashes, 18 crashes occurred during the day, four crashes occurred during night, and the lighting condition for the remaining two crashes was unknown. A majority of the vehicular accidents also occurred under the dry road surface conditions. The accident severity at the study intersection is shown in **Figure 3**.



Figure 4: Accident Severity 2008 – 2010

# **Traffic Analysis**

DDOT staff performed traffic analysis for the three alternative scenarios at the study intersection. The traffic analysis was performed for both AM and PM peak periods utilizing the recent peak-hour traffic counts conducted on February 28, 2012. A comparison of the recent peak-hour traffic counts to the historic 2002 peak-hour traffic counts at the same location indicates that traffic volumes have decreased in the study area in the recent years. DDOT staff also performed traffic analysis at several adjacent intersections along Blair Road, Piney Branch Road, Aspen Street, Butternut Street and Cedar Street. The traffic analysis at the adjacent intersections was performed utilizing all the three alternative scenarios to determine the most feasible traffic mitigation solution for the study area.

### **Existing Conditions**

The study intersection currently operates at LOS E during the AM peak-hour and LOS F during the PM peak-hour. The Blair Road intersection at Piney Branch Road operates at LOS E during the AM peak-hour and LOS D during the PM peak-hour. The remaining intersections near the vicinity of the study location would operate at LOS D or better during both AM and PM peak-hours. A summary of the existing level of service analysis at all the study intersections is included in **Table 2**.

Intersection		AM Peak-Hour		PM Peak-Hour	
		LOS	Delay	LOS	Delay
1	Blair Road and Piney Branch Road	Е	73.4 sec	D	39.2 sec
2	Blair Road and Dahlia Road/5th Street	D	27.2 sec	D	33.9 sec
3	Blair Road, Cedar Street and 4th Street NW	D	43.0 sec	F	82.5 sec
4	Blair Road and Butternut Street	С	16.1 sec	С	20.7 sec
5	Blair Road and Aspen Street	В	16.6 sec	С	21.4 sec
6	Piney Branch Road and Eastern Avenue	D	52.8 sec	D	38.1 sec
7	Piney Branch Road and Dahlia Road	F	61.3 sec	D	28.8 sec
8	Piney Branch Road and Cedar Street	В	16.2 sec	Α	6.4 sec
9	Piney Branch Road and Butternut Street	С	24.3 sec	С	26.7 sec
10	Piney Branch Road and Aspen Street	D	37.3 sec	С	24.1 sec
11	Cedar Street and 5th Street	Α	7.3 sec	Α	9.0 sec
12	Cedar Street and 6th Street	Α	8.2 sec	Α	7.4 sec
13	Butternut Street and 4th Street	Α	8.8 sec	Α	9.0 sec
14	Butternut Street and 5th Street	Α	8.3 sec	Α	9.0 sec
15	Butternut Street and 6th Street	Α	8.9 sec	Α	8.8 sec
16	Aspen Street and 4th Street	Α	9.6 sec	В	11.2 sec
17	Aspen Street and 5th Street	Α	9.7 sec	Α	9.7 sec
18	Aspen Street and 6th Street	Α	9.6 sec	Α	9.0 sec
19	Carroll Street and Cedar Avenue	В	13.4 sec	В	13.4 sec
20	Carroll Street and Maple Street	Α	9.0 sec	Α	8.9 sec
21	Carroll Street and Willow Street/Eastern Avenue	D	41.3 sec	С	26.4 sec

# Table 2 Level of Service Analysis for Existing Conditions

# **ROAD SAFETY AUDIT OBSERVATIONS**

Based on field observations on Wednesday, February 22, 2012, and subsequent discussions, the RSA team determined that the intersection has the following issues that affect pedestrian and traffic safety:

- Complex intersection geometry;
- Significant Pedestrian-Vehicle conflicts;
- High accident frequency;
- Insufficient traffic signage;
- Faded pavement markings

The study intersection also operates at deficient level of service during the PM peak-hour. Based on several meetings with public and the participating agencies, the RSA team identified following three alternatives to mitigate the pedestrian and traffic safety issues at the study intersection:

# Alternative #1

The first alternative proposes following improvements:

### **Roadway Geometric Improvements**

- Convert 4<sup>th</sup> Street to one-way lane only in the southbound direction between Cedar Street and Butternut Street; eliminate entire northbound traffic on 4<sup>th</sup> Street
- Convert Butternut Street to one-way lane only in the eastbound direction between Blair Road and 4<sup>th</sup> Street; eliminate entire westbound traffic on Butternut Street
- The north leg of Blair Road, between Dahlia Road and Cedar Street, should be converted to oneway lane operation in the "southbound direction" only; no northbound traffic allowed on north leg of Blair Road between Cedar Street and Butternut Street
- The south leg of Blair Road, between Cedar Street and Butternut Street should be converted to one-way lane operation in the "northbound direction" only; no southbound traffic allowed on south leg of Blair Road between Cedar Street and Butternut Street
- Eliminate right-turn lane on the westbound approach of Cedar Street
- Sidewalk modifications will be reviewed by the final design team
- No on-street parking will be allowed for delivery trucks along Blair Road and Cedar Street

# **Traffic Signal Improvements**

No traffic signal improvements have been proposed in the first alternative.

# Alternative #2

The second alternative proposes following improvements related to roadway geometrics and traffic signal:

# **Roadway Geometric Improvements**

- Convert 4<sup>th</sup> Street to one-way lane only in the southbound direction between Cedar Street and Butternut Street; eliminate entire northbound traffic on 4<sup>th</sup> Street
- Convert Butternut Street to one-way lane only in the eastbound direction between 4<sup>th</sup> Street and Blair Road; eliminate entire westbound traffic on Butternut Street
- Provide right-turn lane with 100 feet of storage on the eastbound approach of Cedar Street
- Relocate the east crosswalk on Cedar Street approximately 50 feet west to its existing location
- Remove the crosswalks along the park frontage on Blair Road and 4<sup>th</sup> Street and extend the existing curb to the centerline of the 4<sup>th</sup> Street
- Provide quick curbs on Blair Road intersection at Butternut Street to discourage northbound leftturning traffic from entering on to Butternut Street
- Sidewalk modifications will be reviewed by the final design team
- No on-street parking will be allowed for delivery truck along Blair Road and Cedar Street

# **Traffic Signal Improvements**

- Split phasing on Blair Road with overlap for westbound right-turning vehicles on Cedar Street
- No right-turn on red (RTOR) for westbound right-turning vehicles on Cedar Street
- Protected-permissive with leading left-turn phasing for the westbound vehicles on Cedar Street
- Restrict the northbound left-turning vehicles from Blair Road on to the Cedar Street
- Restrict the eastbound left-turning vehicles from Cedar Street on to the Blair Road

# Alternative #3

The third alternative proposes following improvements:

# **Roadway Geometric Improvements**

- Permanently close the 4<sup>th</sup> Street approach at the study intersection. Restrict all the vehicles entering and exiting to and from the 4<sup>th</sup> Street towards Blair Road and Cedar Road
- Convert Butternut Street to one-way lane only in the eastbound direction between Blair Road and 4<sup>th</sup> Street; eliminate entire westbound traffic on Butternut Street
- The north leg of Blair Road, between Dahlia Road and Cedar Street, should be converted to oneway lane operation in the "southbound direction" only; no northbound traffic allowed on north leg of Blair Road between Cedar Street and Butternut Street
- The south leg of Blair Road, between Cedar Street and Butternut Street should be converted to one-way lane operation in the "northbound direction" only; no southbound traffic allowed on south leg of Blair Road between Cedar Street and Butternut Street
- Convert Cedar Street to one-way lane in the westbound direction between 5<sup>th</sup> Street and 4<sup>th</sup> Street; restrict all the vehicles traveling eastbound on Cedar Street between 5<sup>th</sup> Street and 4<sup>th</sup> Street
- Eliminate right-turn lane on the westbound approach of Cedar Street
- Sidewalk modifications will be reviewed by the final design team
- No on-street parking will be allowed for delivery truck along Blair Road and Cedar Street

# **Traffic Signal Improvements**

No traffic signal improvements have been proposed in the first alternative.

### **Future Conditions**

#### <u>Alternative #1</u>

The study intersection would operate at LOS C or better with the proposed roadway improvements under the first alternative. However, the proposed detour "one-way only" operations on Blair Road and 4<sup>th</sup> Street would significantly increase vehicular traffic on Aspen Street and Piney Branch Road. The Aspen Street intersections on 4<sup>th</sup> Street and 5<sup>th</sup> Street, presently operating at LOS B or better, would operate at LOS E and LOS F respectively with the proposed roadway detour improvements. The intersection of Piney Branch Road at Blair Road, presently operating at LOS E, would operate at LOS F with much higher delay during the AM peak-hour. A summary of the level of service analysis at the study intersections with the roadway improvements from the first alternative is included in **Table 3**.

Intersection		AM Peak-Hour		PM Peak-Hour	
		LOS	Delay	LOS	Delay
1	Blair Road and Piney Branch Road	F	198.6 sec	F	82.4 sec
2	Blair Road and Dahlia Road/5th Street	С	15.8 sec	D	28.2 sec
3	Blair Road, Cedar Street and 4th Street NW	В	19.1 sec	С	31.7 sec
4	Blair Road and Butternut Street	В	10.2 sec	Α	9.3 sec
5	Blair Road and Aspen Street	С	23.7 sec	D	42.2 sec
6	Piney Branch Road and Eastern Avenue	D	52.8 sec	D	38.1 sec
7	Piney Branch Road and Dahlia Road	F	205.7 sec	F	705.7 sec
8	Piney Branch Road and Cedar Street	С	34.6 sec	Α	7.5 sec
9	Piney Branch Road and Butternut Street	Е	66.2 sec	С	30.4 sec
10	Piney Branch Road and Aspen Street	Е	70.0 sec	D	43.5 sec
11	Cedar Street and 5th Street	В	12.8 sec	В	10.4 sec
12	Cedar Street and 6th Street	Α	9.3 sec	Α	8.2 sec
13	Butternut Street and 4th Street	Α	9.1 sec	Α	8.1 sec
14	Butternut Street and 5th Street	В	11.6 sec	В	11.7 sec
15	Butternut Street and 6th Street	Α	8.9 sec	Α	8.6 sec
16	Aspen Street and 4th Street	Е	38.1 sec	С	24.6 sec
17	Aspen Street and 5th Street	F	54.2 sec	D	31.0 sec
18	Aspen Street and 6th Street	В	13.1 sec	В	11.4 sec
19	Carroll Street and Cedar Avenue	В	13.4 sec	В	13.4 sec
20	Carroll Street and Maple Street	Α	9.0 sec	Α	8.9 sec
21	Carroll Street and Willow Street/Eastern Avenue	D	41.3 sec	С	26.4 sec

#### Table 3: Level of Service Analysis for Alternative #1

#### Impacts to Metro Transit under Alternative #1

As mentioned earlier, metro buses for both 14<sup>th</sup> Street line (routes 52, 53 and 54) and Takoma-Petworth line (routes 62 and 63) turn left on 4<sup>th</sup> Street from Butternut Street and then right on Cedar Street from 4<sup>th</sup> Street while traveling northbound towards the Takoma Metrorail Station. However with the proposed one-way "southbound only" operations under the first alternative, the metro buses would now have to turn left on Blair Road from Butternut Street and then right on Cedar Street Takoma Metrorail Station.

Blair Road intersects Butternut Street at an acute angle. The westbound left-turn maneuver analysis utilizing WB-60 truck template performed by the DDOT staff indicates that it would be difficult for buses to turn left on Blair Road from Butternut Street due to tight intersection radius. In addition, the stop control on Butternut Street may increase delays for buses waiting to finding adequate gaps on the Blair Road traffic, especially during the AM and PM peak-hours.

Hence, DDOT staff performed westbound left-turn maneuver analysis at Aspen Street intersection on Blair Road (using WB-60 truck template) to check if metro buses can turn left on Blair Road from Aspen Street. The analysis indicates metro buses can easily perform left-turn maneuver on Blair Road from Aspen Street as compared to the Butternut Street. The signalized traffic control on Aspen Street intersection at Blair Road would assign separate right-of-way to metro buses. In addition, metro buse routes 52, 53 and 54 already utilize Aspen Street to reach their final destinations.

Therefore, DDOT staff suggests metro buses should utilize Aspen Street to turn left on Blair Road instead of Butternut Street while traveling northbound to reach the Takoma Metrorail Station.

### <u>Alternative #2</u>

The roadway improvements under second alternative would include "one-way only" operations on 4<sup>th</sup> Street and Butternut Street. The east crosswalk on Cedar Street would be relocated 50 west of its existing location. The crosswalks on Blair Road and 4<sup>th</sup> Street along the park frontage would also be removed and the curb along the park frontage would be extended to the centerline of the 4<sup>th</sup> Street. Hence, vehicles traveling northbound on Blair Road would now only stop at the Blair Road crosswalk directly south of the study intersection. The existing curb along the park frontage would be extended along the centerline of the 4<sup>th</sup> Street.

# **Proposed Traffic Signal Phasing**

The southbound traffic from Blair Road would receive the right-of-way at the beginning of the traffic signal cycle. The overlap phase would allow westbound right-turning vehicles from Cedar Street to concurrently maneuver along with the southbound traffic from Blair Road. The west cross-walk along Cedar Street would also receive concurrent walk interval along with the start of green interval for the southbound traffic. The overlap phase for the westbound right-turns from Cedar Street would terminate along with the beginning of red interval for southbound traffic on Blair Road. It is proposed to introduce "No Turn On Red" sign (MUTCD R10-11) which would prohibit westbound right-turning vehicles from leaving the intersection after the termination of the overlap phase.

The northbound traffic on Blair Road would receive the right-of-way after the termination of the exclusive southbound plus the right-turn overlap phase. The east cross-walk along Cedar Street would receive concurrent walk interval along with the start of green interval for the northbound traffic from the Blair Road. The pedestrian crosswalks on the Cedar Street would concurrently receive the Do Not Walk interval along with the start of red interval for the northbound traffic on Blair Road. It should be noted that proposed improvements would prohibit the northbound left-turns at this location.

The north crosswalk on Blair Road would concurrently receive walk interval along with the start of leading left-turn phase for the westbound vehicles on Cedar Street. It should be noted that westbound right-turning vehicles would be prohibited from turning on Blair Road at this time. The eastbound traffic would receive the green interval after the termination of leading left-turn phase on the westbound approach. The south crosswalk on Blair Road would concurrently receive the walk interval along with the start of green interval for the eastbound vehicles on Cedar Street. It should be noted that the proposed improvements would prohibit the eastbound left-turns at this location. The crosswalks on Blair Road would concurrently receive the do not walk interval along with the termination of east-west phase for Cedar Street at the end of the traffic signal cycle.

# Level of Service Analysis

With the proposed roadway and traffic signal improvements in the second alternative, the study intersection would operate at LOS D during both AM and PM peak-hour. The intersection of Blair Road at Butternut Street would operate at LOS C or better during both AM and PM peak-hour. The remaining intersections would continue to operate at the existing service levels.

Intersection		AM Peak-Hour		PM Peak-Hour	
		LOS	Delay	LOS	Delay
1	Blair Road and Piney Branch Road	Е	73.4 sec	D	39.2 sec
2	Blair Road and Dahlia Road/5th Street	D	27.2 sec	D	33.9 sec
3	Blair Road, Cedar Street and 4th Street NW	D	37.4 sec	D	48.8 sec
4	Blair Road and Butternut Street	С	15.7 sec	С	17.6 sec
5	Blair Road and Aspen Street	В	16.6 sec	С	20.9 sec
6	Piney Branch Road and Eastern Avenue	D	52.8 sec	D	38.1 sec
7	Piney Branch Road and Dahlia Road	F	61.3 sec	D	28.8 sec
8	Piney Branch Road and Cedar Street	В	16.2 sec	Α	6.4 sec
9	Piney Branch Road and Butternut Street	В	15.0 sec	С	26.7 sec
10	Piney Branch Road and Aspen Street	D	37.3 sec	С	24.1 sec
11	Cedar Street and 5th Street	Α	4.1 sec	В	15.0 sec
12	Cedar Street and 6th Street	Α	8.6 sec	Α	7.9 sec
13	Butternut Street and 4th Street	Α	8.1 sec	Α	8.0 sec
14	Butternut Street and 5th Street	Α	8.2 sec	Α	9.5 sec
15	Butternut Street and 6th Street	Α	8.3 sec	Α	8.8 sec
16	Aspen Street and 4th Street	Α	9.4 sec	В	11.2 sec
17	Aspen Street and 5th Street	Α	9.3 sec	В	10.2 sec
18	Aspen Street and 6th Street	Α	9.4 sec	Α	9.0 sec
19	Carroll Street and Cedar Avenue	В	13.4 sec	В	13.4 sec
20	Carroll Street and Maple Street	Α	9.0 sec	Α	8.9 sec
21	Carroll Street and Willow Street/Eastern Avenue	D	41.3 sec	С	26.4 sec

# Table 4: Level of Service Analysis for Alternative #2

#### Impacts to Metro Transit under Alternative #2

As mentioned earlier, metro buses for both 14<sup>th</sup> Street line (routes 52, 53 and 54) and Takoma-Petworth line (routes 62 and 63) turn left on 4<sup>th</sup> Street from Butternut Street and then right on Cedar Street from 4<sup>th</sup> Street while traveling northbound towards the Takoma Metrorail Station. However with the proposed one-way "southbound only" operations under the second alternative, the metro buses would now have to turn left on Blair Road from Butternut Street and then right on Cedar Street from Blair Road to reach Takoma Metrorail Station.

Blair Road intersects Butternut Street at an acute angle. The westbound left-turn maneuver analysis utilizing WB-60 truck template performed by the DDOT staff indicates that it would be difficult for buses to turn left on Blair Road from Butternut Street due to tight intersection radius. In addition, the stop control on Butternut Street may increase delays for buses waiting to finding adequate gaps on the Blair Road traffic, especially during the AM and PM peak-hours.

Hence, DDOT staff performed westbound left-turn maneuver analysis at Aspen Street intersection on Blair Road (using WB-60 truck template) to check if metro buses can turn left on Blair Road from Aspen Street. The analysis indicates metro buses can easily perform left-turn maneuver on Blair Road from Aspen Street as compared to the Butternut Street. The signalized traffic control on Aspen Street intersection at Blair Road would assign separate right-of-way to metro buses. In addition, metro buse routes 52, 53 and 54 already utilize Aspen Street to reach their final destinations.

Therefore, DDOT staff suggests metro buses should utilize Aspen Street to turn left on Blair Road instead of Butternut Street while traveling northbound to reach the Takoma Metrorail Station.

#### <u>Alternative #3</u>

The study intersection would operate at LOS B or better with the proposed roadway improvements under the third alternative. However, the proposed detour "one-way only" operations on Blair Road, Cedar Street and 4<sup>th</sup> Street would significantly increase vehicular traffic on Aspen Street, Butternut Street and Piney Branch Road. It is estimated that Butternut Street would handle over 350 vehicles on southbound approach only because of the proposed detour "one-way only" operations on Blair Road and Cedar Street. This would create significant traffic calming concerns in the local residential neighborhood along Butternut Street. The Aspen Street intersections on 4<sup>th</sup> Street and 5<sup>th</sup> Street would operate at LOS E and LOS F respectively with the proposed roadway improvements in the third alternative. The intersection of Piney Branch Road at Blair Road, presently operating at LOS E, would operate at LOS F with much higher delay during the AM peak-hour.

Intersection		AM Peak-Hour		PM Peak-Hour	
		LOS	Delay	LOS	Delay
1	Blair Road and Piney Branch Road	F	198.6 sec	F	82.4 sec
2	Blair Road and Dahlia Road/5th Street	С	15.6 sec	С	19.1 sec
3	Blair Road, Cedar Street and 4th Street NW	В	14.5 sec	В	13.3 sec
4	Blair Road and Butternut Street	В	12.4 sec	В	10.9 sec
5	Blair Road and Aspen Street	С	23.7 sec	D	42.2 sec
6	Piney Branch Road and Eastern Avenue	D	52.8 sec	D	38.1 sec
7	Piney Branch Road and Dahlia Road	F	205.7 sec	F	705.7 sec
8	Piney Branch Road and Cedar Street	С	34.6 sec	Α	7.5 sec
9	Piney Branch Road and Butternut Street	Е	66.2 sec	С	30.4 sec
10	Piney Branch Road and Aspen Street	Е	70.0 sec	D	43.5 sec
11	Cedar Street and 5th Street	В	14.0 sec	Α	8.3 sec
12	Cedar Street and 6th Street	А	9.3 sec	Α	8.2 sec
13	Butternut Street and 4th Street	Α	9.1 sec	В	11.3 sec
14	Butternut Street and 5th Street	D	33.8 sec	С	23.8 sec
15	Butternut Street and 6th Street	А	8.9 sec	Α	8.6 sec
16	Aspen Street and 4th Street	Е	38.1 sec	С	24.6 sec
17	Aspen Street and 5th Street	F	54.2 sec	D	31.0 sec
18	Aspen Street and 6th Street	В	13.1 sec	В	11.4 sec
19	Carroll Street and Cedar Avenue	В	13.4 sec	В	13.4 sec
20	Carroll Street and Maple Street	Α	9.0 sec	Α	8.9 sec
21	Carroll Street and Willow Street/Eastern Avenue	D	41.3 sec	С	26.4 sec

Table 5: Level of Service Analysis for Alternative #3

#### Impacts to Metro Transit under Alternative #3

Metro buses for both 14<sup>th</sup> Street line (routes 52, 53 and 54) and Takoma-Petworth line (routes 62 and 63) utilize Cedar Street and 4<sup>th</sup> Street to reach their final destinations. However with the proposed closure of 4<sup>th</sup> Street under third alternative, the metro buses would now have to turn left on 5<sup>th</sup> Street from Cedar Street while traveling southbound to reach their final destinations.

The intersection of 5<sup>th</sup> Street at Cedar Street primarily serves traffic from the residential neighborhoods. Cedar Street has on-street parking on both sides of the street while 5<sup>th</sup> Street has on-street parking on the east side of the street. The left-turn maneuver analysis indicates it would be very difficult for metro buses to turn left on 5<sup>th</sup> Street from Cedar Street. In addition, metro bus operations on 5<sup>th</sup> Street intersection at Cedar Street may also raise significant traffic calming concerns from the neighborhood residents.

# PROPOSED RECOMMENDATIONS

The proposed roadway improvements under the first alternative and the third alternative would result in significant diversion of the existing travel patterns in the vicinity of the study intersection. Aspen Street, Butternut Street and Cedar Street would experience considerable increase in the traffic volumes because of the "one-way" operations on Blair Road and Cedar Street. The increased cut-through traffic volumes would generate significant traffic calming and pedestrian safety issues from the local residential neighborhoods in the vicinity of the study intersection. In addition, the first and third alternatives do not propose any traffic signal improvements to alleviate the pedestrian collisions at the study intersection.

The proposed geometric and traffic signal improvements under the second alternative do not cause significant diversion of the existing travel patterns in the vicinity of the study location. The geometric improvements would provide adequate sight distance to the motorists to observe the pedestrians in crosswalks at the study intersection. The one-way operations on 4<sup>th</sup> Street and Butternut Street would eliminate the cut through traffic while the traffic signal improvements would restrict the critical turning movements effectively reducing the pedestrian-motor vehicle conflicts at this location.

Hence, the RSA team recommends the second alternative as the best traffic mitigation solution at this location. The suggestions to the safety issues discussed below are based on the roadway and signal improvements identified under the second alternative.

#### Safety Issue #1 – Complex Intersection Geometry and Traffic Control

The study intersection has multiple legs with skewed geometry – Blair Road (north), Blair Road (south), Cedar Street (east), Cedar Street (west) and 4<sup>th</sup> Street. The field observations conducted by the RSA team identified following traffic safety issues related to the

complex intersection geometry at this location:

4<sup>th</sup> Street intersects at a sharp acute angle with the south leg of Blair Road. Also, both 4<sup>th</sup> Street and the Blair Road (south leg) have minor offsets south of the study intersection which makes it difficult for turning vehicles to maneuver safely to and from Blair Road and 4<sup>th</sup> Street. The northbound vehicles from Blair Road and 4<sup>th</sup> Street have to turn right and then left (like "snake pattern") to travel north on Blair Road as shown in Figure 1.



• Blair Road carries heavy northbound and southbound thru traffic. The southbound left-turning

- significantly delay the thru traffic as they cannot find adequate gaps in the oncoming northbound thru traffic. Hence, the southbound thru vehicles cuts across the west crosswalk on Cedar Street, shown in **Figure 2**, to circumvent the left-turning vehicles creating direct pedestrian-motor vehicle conflicts.
- The southbound left-turning vehicles on Blair Road frequently jump the red lights at the study intersection. As shown in **Figure 3**, there are 4 vehicles turning left on Cedar Street during the red interval.
- 4<sup>th</sup> Street currently serves as an outlet for cut through traffic that want to circumvent the queue along Blair Road to access the signalized study intersection.
- The horizontal and vertical alignments at the study intersection do not promote easy access for pedestrians and bicyclists who use this intersection. Pedestrians have insufficient right-of-way (ROW), particularly in the north crosswalk on Blair Road and east crosswalk on Cedar Street, because of the limited available sight distance and the skewed intersection geometry.



Figure 6: SB thru vehicle cuts across west X-walk



Figure 7: SBLT vehicles running red light

• The vehicular and pedestrian traffic signal heads are not properly aligned at this location. The traffic signal heads create confusion for motorists on 4<sup>th</sup> Street and the south leg of Blair Road in deciding (a) when to leave the intersection, and (b) who has the pertinent right-of-way.

**Figure 4** shows a confused motorist on Blair Road who leaves the intersection on red interval because he sees green interval on the other traffic signal. The green interval actually is actually assigning the right-of-way to motorists on 4<sup>th</sup> Street and not on Blair Road.

- **Figure 5** shows various traffic signals displaying red, green and yellow intervals. The display of all the intervals from several traffic signals creates significant confusion for motorists on 4<sup>th</sup> Street and Blair Road.
- There are no pedestrian signal heads for the crosswalk on 4<sup>th</sup> Street, as shown in **Figure 6**, which adds to the pedestrian confusion at the study intersection.
- The pedestrian ramps, as shown in **Figure 7**, do not meet the current ADA specifications.
- There are multiple curb cuts within the intersection influence area that impact the traffic movements, pedestrian access and the sight distance implications



Figure 8: Multiple signals create motorist confusion



Figure 9: Signals showing Red, Green & Yellow lights



Figure 10: No Pedestrian Signals for 4th St X-walk



Figure 11 – Ped Ramps don't meet ADA specifications



Figure 12 – 4<sup>th</sup> St and Blair Rd intersect at acute angle

#### Suggestions for Safety Issue #1

- 1. Removal of the crosswalks along the park frontage on Blair Road with curb extension and "oneway" southbound only operations on 4<sup>th</sup> Street, as identified in the roadway design improvements in the second alternative, would eliminate the skewed geometry of the study intersection. Per the new traffic signal design, the northbound vehicles on Blair Road would only stop at the stop bar located south of the study intersection.
- 2. The "one-way" southbound only operations on 4<sup>th</sup> Street and Butternut Street would eliminate the cut through traffic on 4<sup>th</sup> Street desiring to circumvent queuing along Blair Road to access the study intersection.
- 3. The proposed split phasing on Blair Road would provide exclusive right of way to the southbound vehicles which would stop thru traffic from circumventing the left-turning vehicles. The split phase operations would help to prevent the southbound vehicles from blocking the intersection. Additional consideration should be given for installing red light cameras at this location which would further stop southbound vehicles from running the red light.
- 4. The traffic signal design at the study intersection would be revised to provide adequate intersection sight distance and identify appropriate locations for traffic signal heads for both pedestrians and vehicles.

#### Safety Issue #2 - Significant Pedestrian-Vehicle Conflicts

Field observations conducted by the RSA team analyzed following locations with significant conflicts between pedestrians and the motor vehicles:

#### North crosswalk on Blair Road

The north crosswalk on Blair Road, as shown in **Figure 9** is located far behind the study intersection. There is inadequate sight distance for the westbound right-turning vehicles from Cedar Street to observe the pedestrians in the north crosswalk after they leave the intersection. The businesses located at the corner of this intersection further obstruct the sight distance triangles and visibility of the pedestrians. In addition, the green interval for westbound right-turning vehicles coincides with the walk interval of pedestrians in the north crosswalk which results in simultaneous direct conflicts between pedestrians and motor vehicles at the study intersection.

#### East crosswalk on Cedar Street

The east crosswalk on Cedar Street is also located behind the study intersection. There are sight obstructions that restrict the visibility of southbound left-turning vehicles (on Blair Road) to observe pedestrians in the east crosswalk on the Cedar Street. The limited available sight distance, in conjunction to concurrent pedestrian movements results in direct pedestrian-vehicle conflicts between the southbound left-turning vehicles and pedestrians at this location.



Figure 13: North X-walk far from intersection



Figure 14: WBRT can't see peds on North X-walk



Figure 15: SBLT can't see peds on East X-walk

#### West crosswalk on Cedar Street

As mentioned above, the southbound left-turning vehicles cause significant delay to the southbound thru traffic on Blair Road because they cannot find adequate gaps in the oncoming northbound thru traffic. Hence, the southbound thru traffic cuts across the west crosswalk on Cedar Street, as shown in **Figure 16**, creating direct pedestrian-motor vehicle conflicts, to circumvent the left-turning vehicles and travel south on Blair Road.

#### Pedestrian Jaywalking from Takoma Metro

RSA team observed pedestrians jaywalking along the opening in the raised medians on Cedar Street between the Takoma Metro station and the study intersection. Vehicles traveling at higher speeds on Cedar Street often have inadequate sight distance to stop for the unexpected jaywalkers at this location. As shown in **Figure 17**, the RSA team also observed a SUV making U-turn on Cedar Street via this opening in raised median on the Cedar Street.

# **On-street parking of delivery truck for S&S Liquor Store**

The delivery truck for S&S Liquor store currently parks on Blair Road (south of Cedar Street) for about 30 minutes. The parked delivery truck completely blocks visibility of pedestrians and vehicles for motorists traveling northbound on Blair Road and 4<sup>th</sup> Street and creates direct conflicts with pedestrians on south crosswalk on Blair Road and vehicular traffic on Cedar Street.



Figure 16: SBT vehicles cut across west X-walk



Figure 17: SUV making illegal U-turn maneuver

#### **Suggestions for Safety Issues #2**

- 1. The westbound right-turning vehicles would be allowed to turn only during the overlap phase. The proposed "No Turn on Red" sign would prohibit westbound right-turning vehicles from maneuvering when the north crosswalk on Blair Road receives the walk interval.
- 2. The proposed split phasing would assign exclusive right-of-way to the northbound vehicles on Blair Road. The east crosswalk on Cedar Street would now receive concurrent walk-interval along with the green interval for the northbound vehicles which would eliminate pedestrian conflicts with the southbound left-turning vehicles at this location.
- 3. The proposed split phasing would provide exclusive right of way to the southbound vehicles which would stop thru traffic from cutting-across the west crosswalk to circumvent the left-turning vehicles.
- 4. Install pedestrian fence in the center median on Cedar Street to prohibit jaywalkers from crossing the street and close the opening between the raised medians.
- 5. No on-street parking will be allowed for delivery trucks along Blair Road and Cedar Street.

#### Safety Issue #3 – High Accident Frequency

The 3-year accident analysis, from 2008 to 2010, shows 24 accidents including 3 pedestrian crashes at this location. Approximately 60% of the crashes occurred on the Blair Road approach at Cedar Street while 30% crashes occurred on 4<sup>th</sup> Street approach at Cedar Street. The remaining 10% collisions occurred on 4<sup>th</sup> Street approach at Blair Road. The field observations indicate that skewed intersection geometry may contribute to the high frequency of collisions. The speed study indicates 85<sup>th</sup> percentile speed of 32 mph which is much higher than the posted speed limit of 25 mph. The higher vehicle speeds through the intersection may also contribute to the high incidence of crashes at this location.



Figure 18: SBLT in conflict with Cedar St vehicles

#### Blair Road and Cedar Street

The 3-year accident data shows 15 accidents including one pedestrian crash at this location. Sight distance is the primary traffic safety concern at this approach. The southbound left-turns have been frequently observed to run the red interval at the intersection. This puts them in direct conflict with vehicles on Cedar Street, as shown in **Figure 18**, which results in right-angle and side-swipe collisions at this location.

As shown in **Figure 19**, vehicle traveling southbound thru circumvents the left-turning vehicles to travel south on Blair Road which creates direct conflict with pedestrians in the west crosswalk on the Cedar Street. This also creates potential for rear-end accidents at this location.

There is inadequate sight distance on northbound approach of Blair Road. As shown in **Figure 20**, the northbound vehicles on Blair Road cannot view pedestrians on the east crosswalk on Cedar Street which can also create potential pedestrian-vehicle conflicts.



Figure 19: Ped-Vehicle conflicts on West X-walk



Figure 20: Inadequate sight distance on NB Blair Rd

### 4th Street and Cedar Street

The 3-year accident data shows 7 accidents including two pedestrian collisions at this location. There are about 120 vehicles desiring to turn left from 4<sup>th</sup> Street to Cedar Street during both AM and PM peak-hour. There is inadequate sight distance on northbound approach of 4<sup>th</sup> Street. As shown in **Figure 21**, the northbound left-turning vehicles on 4<sup>th</sup> Street cannot observe pedestrians on west crosswalk of Cedar Street which creates direct pedestrian-vehicle conflicts at this location.

It should also be noted that northbound vehicles on 4<sup>th</sup> Street are also in conflict with southbound left-turning vehicles from Blair Road which frequently block the intersection. This results in potential side-swipe and right-angle collisions at this location.

### 4th Street and Blair Road

The 3-year accident data shows 2 right-angle collisions at this location. There are multiple traffic signal heads for the 4<sup>th</sup> Street and south leg of Blair Road approaches. This redundant traffic control, as shown in **Figure 22**, creates considerable confusion for motorists on 4<sup>th</sup> Street and Blair Road in deciding: (a) when to leave the intersection, and (b) who has the pertinent right-of-way. which results in the right angle collisions at this location

the right-angle collisions at this location.

**Figure 23** shows potential right-angle collision between the vehicles on Blair Road and  $4^{th}$  Street. The green interval on multiple traffic signals gives false signal of relevant right-of-way which results in vehicles simultaneously entering the intersection from Blair Road and  $4^{th}$  Street.



Figure 21: Inadequate sight distance on NB 4<sup>th</sup> St



Figure 22: Confusing traffic signals on 4<sup>th</sup>/Blair



Figure 23: Potential right-angle collision on Blair/4th

### Suggestions for Safety Issue #3

- 1. The proposed split phasing on Blair Road would assign exclusive right-of-way to the northbound and southbound vehicles on Blair Road and would effectively lessen the frequency of right-angle, left-turn and side swipe collisions on Blair Road approach at Cedar Street.
- 2. The proposed removal of crosswalks along the park frontage would provide adequate sight distance to the northbound vehicles on Blair Road as they would now stop directly south of the intersection. The increased pedestrian visibility should lessen the pedestrian crashes on Blair Road approach at Cedar Street.
- 3. The proposed relocation of the east crosswalk on Cedar Street would also provide adequate sight distance for the westbound right-turning vehicles to observe the pedestrians in the north crosswalk on Blair Road.
- 4. The northbound vehicles on Blair Road would stop directly south of the study intersection with the proposed removal of crosswalks along the park frontage. This would provide adequate sight distance to the motorists to observe pedestrians and vehicles on the Cedar Street.
- 5. The proposed "one-way" southbound only operation on 4<sup>th</sup> Street would significantly alleviate the pedestrian and vehicle collisions on 4<sup>th</sup> Street approaches along Cedar Street and Blair Road.
- 6. Enforce the speed limits by in the vicinity of the study intersection through the use of speed cameras or uniformed officers.

#### <u>Safety Issue #4 – Insufficient Traffic Signage</u>

Field observations conducted by the RSA team determined traffic signage at the study intersection is either confusing or missing and needs to be updated. Following issues were identified:

- There are no traffic signs for pedestrian crossings on all the approaches along Blair Road, Cedar Road and 4<sup>th</sup> Street.
- There is no advance warning sign for the north pedestrian crosswalk (along Blair Road) on the westbound approach of the Cedar Street.
- The "right-lane" pedestrian crosswalk sign on westbound approach of Cedar Street (see Figure 24) is confusing to the motorists.
- The "pedestrian use crosswalk" sign along the northwest corner of Blair/Cedar approach (see Figure 25) is also confusing to the motorists and needs to be removed.
- The MUTCD "No Turn On Red" regulatory sign is improperly placed making it difficult for motorists to observe.
- Vegetation restricts the visibility of traffic signage on the eastbound approach of Cedar Street (see Figure 26).
- Sign clutter of traffic signage at the study intersection.



Figure 24: Confusing "Right Lane" Sign



Figure 25: Confusing Ped Use X-walk sign



Figure 26: Limited visibility of traffic signs

#### Suggestions for Safety Issue #4

- 1. Provide pedestrian crossing signage on all the approaches at the study intersection.
- 2. The "No Turn On Red" traffic sign should be appropriately placed on all the approaches to increase the visibility to the motorists at this location.
- 3. Replace the "right-lane" pedestrian crosswalk sign with "Stop Here for Pedestrians" sign (R1-5c, 2009 MUTCD) on westbound approach of Cedar Street (see Figure 27).
- 4. Replace the "pedestrian use crosswalk" sign with the revised "Side of Street Pedestrian" sign (R1-6(a)1) on the northwest corner of Blair Road/Cedar Street (see Figure 28).
- 5. Provide advance warning signage for the north pedestrian crosswalk on the westbound approach of Cedar Street.
- 6. Reorganize the traffic signage to reduce sign clutter on the westbound approach of Cedar Street.
- 7. Replace the damaged signposts and traffic signage at this location.
- 8. Ensure adequate street lighting is provided in the revised traffic signal design of the study intersection.



Figure 27: Stop Here for Pedestrians Sign



Figure 28: Side of Street Pedestrian Sign



Figure 29: Pedestrian Pylon

#### Safety Issue #5 – Faded Pavement Markings

The pavement markings at the study intersection are either worn or missing at the study intersection which adds to the confusion of motorists driving through the intersection and reducing the visibility of the existing pedestrian crosswalks. The pedestrian crosswalks are in conflict with the storm drainage facilities at this intersection which is a significant issue during the inclement weather. The ADA facilities at this location need to be upgraded to the new specifications.

The RSA team saw numerous longitudinal and transverse cracks in the roads at the study intersection. The pavement conditions are generally poor at this location which can create additional safety hazards for pedestrians and cyclists crossing the street.

#### Suggestions for Safety Issue #5

- 1. Restripe and maintain durable pavement markings at the study intersection.
- 2. Ensure pedestrian facilities are designed to the new ADA specifications in the revised traffic signal design for the study intersection.



Figure 30: Cracks and Potholes in Pavements



Figure 31: Storm Drain facility in Crosswalk



Figure 32: Ped ramps don't meet ADA specifications