OBSERVATION AND ANALYSIS OF DRIVER BEHAVIOR AT INTERSECTIONS IN MALFUNCTION FLASH MODE

A Thesis
Presented to
The Academic Faculty

by

Y-Thao Truong

In Partial Fulfillment
Of the Requirements for the Degree
Masters of Science in the
School of Civil Engineering

Georgia Institute of Technology
December 2008

OBSERVATION AND ANALYSIS OF DRIVER BEHAVIOR AT INTERSECTIONS IN MALFUNCTION FLASH MODE

Approved by:

Dr. Michael Hunter, Advisor
School of Civil Engineering
Georgia Institute of Technology

Dr. Michael Rodgers
School of Civil Engineering
Georgia Institute of Technology

Dr. Michael Meyer
School of Civil Engineering
Georgia Institute of Technology

Date Approved: November 17, 2008

ACKNOWLEDGEMENTS

I would like express gratitude to my advisor, Dr. Michael Hunter, for his advice, support, and motivation throughout the research project. I would also like to extend my gratitude to the two other members of my thesis committee, Dr. Michael Meyer and Dr. Michael Rodgers, for their much needed suggestions. Additionally, my thanks goes to Chris Watson and Dwayne Henclewood who have been great helping with various aspects of the project, from literature materials to camcorder technical support. A special thanks goes to my dear friend, Vy, for her company during hours of intersection filming.

Most especially, my appreciation goes to my Bố Mẹ, my family and friends whose love and support have made the completion of this thesis possible.

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iii
LIST OF TABLES	vi
LIST OF FIGURES	xv
SUMMARY	xviii
CHAPTER	
1 INTRODUCTION	1
1.1 Need for Study	2
1.2 Study Objectives	3
1.3 Study Overview	3
2 LITERATURE REVIEW	5
2.1 Rules of the Road	5
2.2 Driver Comprehension of Traffic Control	6
2.3 Driver Behavior	8
2.4 Data Collection and Analysis Techniques	13
2.5 Literature Review Summary	16
3 METHODOLOGY	17
3.1 Right of way Determination	17
3.2 Data Extraction	19
3.3 Data Collection for Stop-Controlled Intersections	23
4 DATA ANALYSIS	25
4.1 Red/Red Flash Analysis	25
4.1.1 Stop Violation	25

4.1.2 Presence Analysis 30

4.1.3 Out-of-turn Analysis 38

4.2 Yellow/Red Flash Analysis 43

4.2.1 Stop Violation 43

4.2.2 Presence Analysis 47

4.2.3 Out-of-turn Analysis 53

4.3 Observations of Stop-Controlled Intersections 59

4.3.1 Two-way Stop-controlled Intersections 59

4.3.2 All-way Stop-controlled Intersections 60

4.4 Chapter Summary 61

5 CONCLUSIONS AND RECOMMENDATIONS 63

5.1 Findings and Conclusions 63

5.2 Study Limitations and Recommendations 66

APPENDIX A: AERIAL PHOTOGRAPHS AND VOLUME COUNTS OF STOP-CONTROLLED INTERSECIONS 67

APPENDIX B: RAW DATA: RED/RED VIOLATION AND OPPORTUNITY 70

APPENDIX C: RAW DATA: YELLOW/RED VIOLATION AND OPPORTUNITY 82

REFERENCES 162

LIST OF TABLES

Page

Table 3.3: Stop-controlled Intersections in Study 24

Table 4.1: Average Violation/Opportunity Rates for All Red/Red Intersections at All Approaches 30

Table A.1: Volume Count at Arcado Rd. and Emily Dr. 7:20-8:20 AM (Peak-hour) 68

Table A.2: Volume Count at Arcado Rd. and Emily Dr. 8:20-9:20 AM (Non-peak) 68

Table A.3: Volume Count at Pirkle Rd. and Oakbrook Dr. 3:10-4:10 PM (Non-peak) 69

Table A.4: Volume Count at Pirkle Rd. and Oakbrook Dr. 4:30-5:30 PM (Non-peak) 69

Table B.1: Keys to Raw Data Events at Red/Red Intersections 71

Table B.2: 10th St. and Peachtree Stop Violation Counts 72

Table B.3: 10th St. and Peachtree Out-of-turn Counts 72

Table B.4: 10th St. and Peachtree Opportunity for Stop Violation Counts 72

Table B.5: 10th St. and Peachtree Opportunity for Out-of-turn Counts 72

Table B.6: 14th St. and State Stop Violation Counts 73

Table B.7: 14th St. and State Out-of-turn Counts 73

Table B.8: 14th St. and State Opportunity for Stop Violation Counts 73

Table B.9: 14th St. and State Opportunity for Out-of-turn Counts 73

Table B.10: 17th St. and Market Stop Violation Counts 74

Table B.11: 17th St. and Market Out-of-turn Counts 74

Table B.12: 17th St. and Market Opportunity for Stop Violation Counts 74

Table B.13: 17th St. and Market Opportunity for Out-of-turn Counts 74

Table B.14: Fowler St. and 5th St. Stop Violation Counts 75

Table B.15: Fowler St. and 5th St. Out-of-turn Counts 75

Table B.16: Fowler St. and 5th St. Opportunity for Stop Violation Counts 75

Table B.17: Fowler St. and 5th St. Opportunity for Out-of-turn Counts 75

Table B.18: Market St. and 18th Stop Violation Counts 76

Table B.19: Market St. and 18th Out-of-turn Counts 76

Table B.20: Market St. and 18th Opportunity for Stop Violation Counts 76

Table B.21: Market St. and 18th Opportunity for Out-of-turn Counts 76

Table B.22: Northside Dr. and 14thSt. Stop Violation Counts 77

Table B.23: Northside Dr. and 14th St. Out-of-turn Counts 77

Table B.24: Northside Dr. and 14th St. Opportunity for Stop Violation Counts 77

Table B.25: Northside Dr. and 14th St. Opportunity for Out-of-turn Counts 77

Table B.26: Piedmont Ave. and North Ave. Stop Violation Counts 78

Table B.27: Piedmont Ave. and North Ave. Out-of-turn Counts 78

Table B.28: Piedmont Ave. and North Ave. Opportunity for Stop Violation Counts 78

Table B.29: Piedmont Ave. and North Ave. Opportunity for Out-of-turn Counts 78

Table B.30: Piedmont Ave. and Prado Stop Violation Counts 79

Table B.31: Piedmont Ave. and Prado Out-of-turn Counts 79

Table B.32: Piedmont Ave. and Prado Opportunity for Stop Violation Counts 79

Table B.33: Piedmont Ave. and Prado Opportunity for Out-of-turn Counts 79

Table B.34: Roswell Rd. and W. Wieuca Rd. 1 Stop Violation Counts 80

Table B.35: Roswell Rd. and W. Wieuca Rd. 1 Out-of-turn Counts 80

Table B.36: Roswell Rd. and W. Wieuca Rd. 1 Opportunity for Stop Violation Counts80

Table B.37: Roswell Rd. and W. Wieuca Rd. 1 Opportunity for Out-of-turn Counts 80

Table B.38: Roswell Rd. and W. Wieuca Rd. 2 Stop Violation Counts 81

Table B.39: Roswell Rd. and W. Wieuca Rd. 2 Out-of-turn Counts 81

Table B.40: Roswell Rd. and W. Wieuca Rd. 2 Opportunity for Stop Violation Counts81

Table B.41: Roswell Rd. and W. Wieuca Rd. 2 Opportunity for Out-of-turn Counts 81

Table C.1: Keys to Raw Data Events at Yellow/Red Intersections 83

Table C.2: 10th St. and 75-85 SB Stop Violation Counts 84

Table C.3: 10th St. and 75-85 SB Out-of-turn Counts 84

Table C.4: 10th St. and 75-85 SB Opportunity for Stop Violation Counts 85

Table C.5: 10th St. and 75-85 SB Opportunity for Out-of-turn Counts 85

Table C.6: 10th St. and Hemphill Ave. 1 Stop Violation Counts 86

Table C.7: 10th St. and Hemphill Ave. 1 Out-of-turn Counts 86

Table C.8: 10th St. and Hemphill Ave. 1 Opportunity for Stop Violation Counts 87

Table C.9: 10th St. and Hemphill Ave. 1 Opportunity for Out-of-turn Counts 87

Table C.10: 10th St. and Hemphill Ave. 2 Stop Violation Counts 88

Table C.11: 10th St. and Hemphill Ave. 2 Out-of-turn Counts 88

Table C.12: 10th St. and Hemphill Ave. 2 Opportunity for Stop Violation Counts 89

Table C.13: 10th St. and Hemphill Ave. 2 Opportunity for Out-of-turn Counts 89

Table C.14: 10th St. and Holly St. 1 Stop Violation Counts 90

Table C.15: 10th St. and Holly St. 1 Out-of-turn Counts 90

Table C.16: 10th St. and Holly St. 1 Opportunity for Stop Violation Counts 91

Table C.17: 10th St. and Holly St. 1 Opportunity for Out-of-turn Counts 91

Table C.18: 10th St. and Holly St. 2 Stop Violation Counts 92

Table C.19: 10th St. and Holly St. 2 Out-of-turn Counts 92

Table C.20: 10th St. and Holly St. 2 Opportunity for Stop Violation Counts 93

Table C.21: 10th St. and Holly St. 2 Opportunity for Out-of-turn Counts 93

Table C.22: 14th St. and Williams Stop Violation Counts 94

Table C.23: 14th St. and Williams Out-of-turn Counts 94

Table C.24: 14th St. and Williams Opportunity for Stop Violation Counts 95

Table C.25: 14th St. and Williams Opportunity for Out-of-turn Counts 95

Table C.26: 17th St. and 75-85 SB Stop Violation Counts 96

Table C.27: 17th St. and 75-85 SB Out-of-turn Counts 96

Table C.28: 17th St. and 75-85 SB Opportunity for Stop Violation Counts 97

Table C.29: 17th St. and 75-85 SB Opportunity for Out-of-turn Counts 97

Table C.30: 17th St. and Bishop St. Stop Violation Counts 98

Table C.31: 17th St. and Bishop St. Out-of-turn Counts 98

Table C.32: 17th St. and Bishop St. Opportunity for Stop Violation Counts 99

Table C.33: 17th St. and Bishop St. Opportunity for Out-of-turn Counts 99

Table C.34: Ashford Dunwoody Rd. and Harts Mill Rd. Stop Violation Counts 100

Table C.35: Ashford Dunwoody Rd. and Harts Mill Rd. Out-of-turn Counts 100

Table C.36: Ashford Dunwoody Rd. and Harts Mill Rd. Opportunity for Stop Violation Counts 101

Table C.37: Ashford Dunwoody Rd. and Harts Mill Rd. Opportunity for Out-of-turn Counts 101

Table C.38: Charles Allen Dr. and 8th St. 1 Stop Violation Counts 102

Table C.39: Charles Allen Dr. and 8th St. 1 Out-of-turn Counts 102

Table C.40: Charles Allen Dr. and 8th St. 1 Opportunity for Stop Violation Counts 103

Table C.41: Charles Allen Dr. and 8th St. 1 Opportunity for Out-of-turn Counts 103

Table C.42: Charles Allen Dr. and 8th St. 2 Stop Violation Counts 104

Table C.43: Charles Allen Dr. and 8th St. 2 Out-of-turn Counts 104

Table C.44: Charles Allen Dr. and 8th St. 2 Opportunity for Stop Violation Counts 105

Table C.45: Charles Allen Dr. and 8th St. 2 Opportunity for Out-of-turn Counts 105

Table C.46: Collier Rd. and Post Collier Hills Apts. Stop Violation Counts 106

Table C.47: Collier Rd. and Post Collier Hills Apts. Out-of-turn Counts 106

Table C.48: Collier Rd. and Post Collier Hills Apts. Opportunity for Stop Violation Counts 107

Table C.49: Collier Rd. and Post Collier Hills Apts. Opportunity for Out-of-turn Counts 107

Table C.50: E. Rock Springs Rd. and Barclay Pl. Stop Violation Counts 108

Table C.51: E. Rock Springs Rd. and Barclay Pl. Out-of-turn Counts 108

Table C.52: E. Rock Springs Rd. and Barclay Pl. Opportunity for Stop Violation Counts 109

Table C.53: E. Rock Springs Rd. and Barclay Pl. Opportunity for Out-of-turn Counts 109

Table C.54: Howell Mill Rd. and 75 SB Stop Violation Counts 110

Table C.55: Howell Mill Rd. and 75 SB Out-of-turn Counts 110

Table C.56: Howell Mill Rd. and 75 SB Opportunity for Stop Violation Counts 111

Table C.57: Howell Mill Rd. and 75 SB Opportunity for Out-of-turn Counts 111

Table C.58: Juniper St. and 12th St. Stop Violation Counts 112

Table C.59: Juniper St. and 12th St. Out-of-turn Counts 112

Table C.60: Juniper St. and 12th St. Opportunity for Stop Violation Counts 113

Table C.61: Juniper St. and 12th St. Opportunity for Out-of-turn Counts 113

Table C.62: Lenox Rd. and Phipps Stop Violation Counts 114

Table C.63: Lenox Rd. and Phipps Out-of-turn Counts 114

Table C.64: Lenox Rd. and Phipps Opportunity for Stop Violation Counts 115

Table C.65: Lenox Rd. and Phipps Opportunity for Out-of-turn Counts 115

Table C.66: Lindbergh Dr. and Acorn Ave. Stop Violation Counts 116

Table C.67: Lindbergh Dr. and Acorn Ave. Out-of-turn Counts 116

Table C.68: Lindbergh Dr. and Acorn Ave. Opportunity for Stop Violation Counts 117

Table C.69: Lindbergh Dr. and Acorn Ave. Opportunity for Out-of-turn Counts 117

Table C.70: Lindbergh Dr. and Parkdale Pl. 1 Stop Violation Counts 118

Table C.71: Lindbergh Dr. and Parkdale Pl. 1 Out-of-turn Counts 118

Table C.72: Lindbergh Dr. and Parkdale Pl. 1 Opportunity for Stop Violation Counts 119

Table C.73: Lindbergh Dr. and Parkdale Pl. 1 Opportunity for Out-of-turn Counts 119

Table C.74: Lindbergh Dr. and Parkdale Pl. 2 Stop Violation Counts 120

Table C.75: Lindbergh Dr. and Parkdale Pl. 2 Out-of-turn Counts 120

Table C.76: Lindbergh Dr. and Parkdale Pl. 2 Opportunity for Stop Violation Counts 121

Table C.77: Lindbergh Dr. and Parkdale Pl. 2 Opportunity for Out-of-turn Counts 121

Table C.78: Market St. and 18th 1 Stop Violation Counts 122

Table C.79: Market St. and 18th 1 Out-of-turn Counts 122

Table C.80: Market St. and 18th 1 Opportunity for Stop Violation Counts 123

Table C.81: Market St. and 18th 1 Opportunity for Out-of-turn Counts 123

Table C.82: Monroe Dr. and 10th St. Stop Violation Counts 124

Table C.83: Monroe Dr. and 10th St. Out-of-turn Counts 124

Table C.84: Monroe Dr. and 10th St. Opportunity for Stop Violation Counts 125

Table C.85: Monroe Dr. and 10th St. Opportunity for Out-of-turn Counts 125

Table C.86: N. Highland Ave. and University Dr. Stop Violation Counts 126

Table C.87: N. Highland Ave. and University Dr. Out-of-turn Counts 126

Table C.88: N. Highland Ave. and University Dr. Opportunity for Stop Violation Counts 127

Table C.89: N. Highland Ave. and University Dr. Opportunity for Out-of-turn Counts 127

Table C.90: Northside Dr. and Peachtree Battle Ave. Stop Violation Counts 128

Table C.91: Northside Dr. and Peachtree Battle Ave. Out-of-turn Counts 128

Table C.92: Northside Dr. and Peachtree Battle Ave. Opportunity for Stop Violation Counts 129

Table C.93: Northside Dr. and Peachtree Battle Ave. Opportunity for Out-of-turn Counts 129

Table C.94: Paces Ferry Rd. and Paces Mill Rd. Stop Violation Counts 130

Table C.95: Paces Ferry Rd. and Paces Mill Rd. Out-of-turn Counts 130

Table C.96: Paces Ferry Rd. and Paces Mill Rd. Opportunity for Stop Violation Counts 131

Table C.97: Paces Ferry Rd. and Paces Mill Rd. Opportunity for Out-of-turn Counts 131

Table C.98: Peachtree St. and 8th Stop Violation Counts 132

Table C.99: Peachtree St. and 8th Out-of-turn Counts 132

Table C.100: Peachtree St. and 8th Opportunity for Stop Violation Counts 133

Table C.101: Peachtree St. and 8th Opportunity for Out-of-turn Counts 133

Table C.102: Peachtree St. and Pine Stop Violation Counts 134

Table C.103: Peachtree St. and Pine Out-of-turn Counts 134

Table C.104: Peachtree St. and Pine Opportunity for Stop Violation Counts 135

Table C.105: Peachtree St. and Pine Opportunity for Out-of-turn Counts 135

Table C.106: Peachtree St. and Sheridan Dr. Stop Violation Counts 136

Table C.107: Peachtree St. and Sheridan Dr. Out-of-turn Counts 136

Table C.108: Peachtree St. and Sheridan Dr. Opportunity for Stop Violation Counts 137

Table C.109: Peachtree St. and Sheridan Dr. Opportunity for Out-of-turn Counts 137

Table C.110: Ponce de Leon Ave. and Fairview/Lullwater Rd. Stop Violation Counts 138

Table C.111: Ponce de Leon Ave. and Fairview/Lullwater Rd. Out-of-turn Counts 138

Table C.112: Ponce de Leon Ave. and Fairview/Lullwater Rd. Opportunity for Stop Violation Counts 139

Table C.113: Ponce de Leon Ave. and Fairview/Lullwater Rd. Opportunity for Out-of turn Counts 139

Table C.114: Ponce de Leon Ave. and Frederica St. Stop Violation Counts 140

Table C.115: Ponce de Leon Ave. and Frederica St. Out-of-turn Counts 140

Table C.116: Ponce de Leon Ave. and Frederica St. Opportunity for Stop Violation Counts 141

Table C.117: Ponce de Leon Ave. and Frederica St. Opportunity for Out-of-turn Counts 141

Table C.118: Roxboro Rd. and Pritchard Dr. Stop Violation Counts 142

Table C.119: Roxboro Rd. and Pritchard Dr. Out-of-turn Counts 142

Table C.120: Roxboro Rd. and Pritchard Dr. Opportunity for Stop Violation Counts 143

Table C.121: Roxboro Rd. and Pritchard Dr. Opportunity for Out-of-turn Counts 143

Table C.122: Spring St. and 8th Stop Violation Counts 144

Table C.123: Spring St. and 8th Out-of-turn Counts 144

Table C.124: Spring St. and 8th Opportunity for Stop Violation Counts 145

Table C.125: Spring St. and 8th Opportunity for Out-of-turn Counts 145

Table C.126: Spring St. and 17th St. Stop Violation Counts 146

Table C.127: Spring St. and 17th St. Out-of-turn Counts 146

Table C.128: Spring St. and 17th St. Opportunity for Stop Violation Counts 147

Table C.129: Spring St. and 17th St. Opportunity for Out-of-turn Counts 147

Table C.130: Spring St. and Abercrombie Pl. Stop Violation Counts 148

Table C.131: Spring St. and Abercrombie Pl. Out-of-turn Counts 148

Table C.132: Spring St. and Abercrombie Pl. Opportunity for Stop Violation Counts 149

Table C.133: Spring St. and Abercrombie Pl. Opportunity for Out-of-turn Counts 149

Table C.134: Techwood Dr. and Merritts Ave. 1 Stop Violation Counts 150

Table C.135: Techwood Dr. and Merritts Ave. 1 Out-of-turn Counts 150

Table C.136: Techwood Dr. and Merritts Ave. 1 Opportunity for Stop Violation Counts 151

Table C.137: Techwood Dr. and Merritts Ave. 1 Opportunity for Out-of-turn Counts 151

Table C.138: Techwood Dr. and Merritts Ave. 2 Stop Violation Counts 152

Table C.139: Techwood Dr. and Merritts Ave. 2 Out-of-turn Counts 152

Table C.140: Techwood Dr. and Merritts Ave. 2 Opportunity for Stop Violation Counts 153

Table C.141: Techwood Dr. and Merritts Ave. 2 Opportunity for Out-of-turn Counts 153

Table C.142: W. Peachtree St. and 11th St. Stop Violation Counts 154

Table C.143: W. Peachtree St. and 11th St. Out-of-turn Counts 154

Table C.144: W. Peachtree St. and 11th St. Opportunity for Stop Violation Counts 155

Table C.145: W. Peachtree St. and 11th St. Opportunity for Out-of-turn Counts 155

Table C.146: W. Peachtree St. and 16th St. 1 Stop Violation Counts 156

Table C.147: W. Peachtree St. and 16th St. 1 Out-of-turn Counts 156

Table C.148: W. Peachtree St. and 16th St. 1 Opportunity for Stop Violation Counts 157

Table C.149: W. Peachtree St. and 16th St. 1 Opportunity for Out-of-turn Counts 157

Table C.150: W. Peachtree St. and 16th St. 2 Stop Violation Counts 158

Table C.151: W. Peachtree St. and 16th St. 2 Out-of-turn Counts 158

Table C.152: W. Peachtree St. and 16th St. 2 Opportunity for Stop Violation Counts 159

Table C.153: W. Peachtree St. and 16th St. 2 Opportunity for Out-of-turn Counts 159

Table C.154: W. Peachtree St. and Peachtree Place Stop Violation Counts 160

Table C.155: W. Peachtree St. and Peachtree Place Out-of-turn Counts 160

Table C.156: W. Peachtree St. and Peachtree Place Opportunity for Stop Violation Counts 161

Table C.157: W. Peachtree St. and Peachtree Place Opportunity for Out-of-turn Counts 161

LIST OF FIGURES

Page

Figure 3.1: Approach Name Convention 19

Figure 4.1: Stop Violation Rate for Left and Through Movements by Major-Minor Approach Definition at Red/Red Malfunction Flash 28

Figure 4.2: Stop Violation Rate for Right Movements by Major-Minor Approach Definition Red/Red at Malfunction Flash 29

Figure 4.3: Stop Violation Rate for Right Movements by Descending Approach Volume at Red/Red Malfunction Flash 29

Figure 4.4: Violation Percentage in Presence of Other Vehicles at Red/Red Malfunction Flash 31

Figure 4.5: Major 1 Left and Through Vehicles Non-Stops/Opportunity Rate in Presence of Number of Conflicting Vehicles at Red/Red Malfunction Flash 32

Figure 4.6: Major 2 Left and Through Vehicles Non-Stops/Opportunity Rate in Presence of Number of Conflicting Vehicles at Red/Red Malfunction Flash 32

Figure 4.7: Minor 1 Left and Through Vehicles Non-Stops/Opportunity Rate in Presence of Number of Conflicting Vehicles at Red/Red Malfunction Flash 33

Figure 4.8: Minor 2 Left and Through Vehicles Non-Stops/Opportunity Rate in Presence of Number of Conflicting Vehicles at Red/Red Malfunction Flash 33

Figure 4.9: Major 1 Right Vehicles Non-Stops/Opportunity Rate in Presence of Number of Conflicting Vehicles at Red/Red Malfunction Flash 36

Figure 4.10: Major 2 Right Vehicles Non-Stops/Opportunity Rate in Presence of Number of Conflicting Vehicles at Red/Red Malfunction Flash 36

Figure 4.11: Minor 1 Right Vehicles Non-Stops/Opportunity Rate in Presence of Number of Conflicting Vehicles at Red/Red Malfunction Flash 37

Figure 4.12: Minor 2 Right Vehicles Non-Stops/Opportunity Rate in Presence of Number of Conflicting Vehicles at Red/Red Malfunction Flash 37

Figure 4.13: Major Approaches Out-of-turn by Time Violations vs. Minor/Major Volume Ratio at Red/Red Malfunction Flash 39

Figure 4.14: Minor Approaches Out-of-turn by Time Violation vs. Minor/Major Volume Ratio at Red/Red Malfunction Flash 40

Figure 4.15: Out-of-turn by Position Violations vs. Minor/Major Volume Ratio Red/Red Malfunction Flash 40

Figure 4.16: Major Cross-street Out-of-turn by Time Violations at Red/Red Malfunction Flash 41

Figure 4.17: Minor Cross-street Out-of-turn by Time Violations at Red/Red Malfunction Flash 41

Figure 4.18: Major Opposing OFT by Time Violations at Red/Red Malfunction Flash 42

Figure 4.19: Minor Opposing OFT by Time Violations at Red/Red Malfunction Flash 43

Figure 4.20: Major Approaches Right and Through Vehicles Stopping Rate vs. Minor/Major Volume Ratio at Yellow/Red Malfunction Flash 45

Figure 4.21: Minor Approaches Left and Through Vehicles Non-Stopping Rate vs. Minor/Major Volume Ratio Yellow/Red Malfunction Flash 45

Figure 4.22: Minor 1 Non-Stopping Rate Yellow/Red Malfunction Flash 46

Figure 4.23: Minor 2 Non-Stopping Rate Yellow/Red Malfunction Flash 46

Figure 4.24: Minor 1 Through and Left Vehicles Stops/Opportunity Rate vs. Presence of Other Conflicting Vehicles Yellow/Red Intersections 48

Figure 4.25: Minor 2 Through and Left Vehicles Non-Stops/Opportunity Rate vs. Presence of Other Conflicting Vehicles at Yellow/Red Malfunction Flash 48

Figure 4.26: Major 1 Through and Right Vehicles Stops/Opportunity Rate vs. Presence of Other Conflicting Vehicles at Yellow/Red Malfunction Flash 50

Figure 4.27: Major 2 Through and Right Vehicles Stops/Opportunity Rate vs. Presence of Other Conflicting Vehicles at Yellow/Red Malfunction Flash 50

Figure 4.28: Major 1 Left Vehicles Non-Stops/Opportunity Rate vs. Presence of Other Conflicting Vehicles at Yellow/Red Malfunction Flash 52

Figure 4.29: Major 2 Left Vehicles Non-Stops/Opportunity Rate vs. Presence of Other Conflicting Vehicles at Yellow/Red Malfunction Flash 52

Figure 4.30: Minor Approaches OFT Violations vs. Minor/Major Volume Ratio at Yellow/Red Malfunction Flash 53

Figure 4.31: Minor 1 Opposing OFT by Time at Yellow/Red Malfunction Flash 55

Figure 4.32: Minor 2 Opposing OFT by Time at Yellow/Red Malfunction Flash 55

Figure 4.33: Major 1-Minor1 Cross-street OFT by Time at Yellow/Red Malfunction Flash 56

Figure 4.34: Major 1-Minor 2 Cross-street OFT by Time at Yellow/Red Malfunction Flash 57

Figure 4.35: Major 2-Minor 1 Cross-street OFT by Time at Yellow/Red Malfunction Flash 57

Figure 4.36: Major 2-Minor 2 Cross-street OFT by Time at Yellow/Red Malfunction Flash 58

Figure A.1: Aerial Photograph of Arcado Rd. and Emily Dr. Intersection 68

Figure A.2: Aerial Photograph of Pirkle Rd. and Oakbrook Dr. Intersection 69

SUMMARY

Since instances of malfunction flash are rare and random, driver expectancy is compromised when vehicles arrive at a flashing intersection that was not previously in flash mode. Immediately, drivers must interpret what the flash (red or yellow) means and how to proceed accordingly. Furthermore, those facing the red flash will have to determine what the cross-street is facing as well. Unlike at stop-controlled intersections where there is usually an "all-way" indication below the stop sign to indicate that all approaches must stop, drivers at malfunction flash intersections must depend on cross-street characteristics and stopping behaviors to make a guess at whether the cross-street is required to stop.

From the study's findings, this task is difficult at intersections with high minor/major volume ratios. At these intersections, volumes may seem equally heavy. In addition, drivers facing the yellow flash frequently stop in caution regardless of whether there is another conflicting vehicle present or not. Such inconsistent stopping behavior sends an unclear message to drivers facing the red flash. For those who do stop on a red flash, there are high rates of out-of-turn departures after stopping. These rates suggest confusion in right of way priority comprehension. Although Yellow/Red operates well under low minor/major volume ratio, having a few exceptions of Yellow/Red mode usage among mostly Red/Red cases may lead to false driver expectancy. It is recommended that Red/Red flash mode be used in all cases to remove uncertainty about which mode the flash is operating in. Having a higher and more consistent stopping rate from all approaches by operating in Red/Red flash mode will lead to less hazardous conditions.

CHAPTER 1

INTRODUCTION

Flash signal is one of many intersection controls used in the United States. In most flashing instances, the signal is programmed to flash during a set period of time. Sometimes, however, signals go into flash due to malfunctioning equipment. Whichever the case may be, road users are faced with two possible situations: a Red/Red flash or a Yellow/Red flash. While there is no official preference or guideline on which flash mode to use in the case of a malfunction signal, most agencies choose the Yellow/Red flash for its theoretical operational benefits [1]. Studies which have been performed, either by using accident data or simulations, have reported sound operational and safety performance at Yellow/Red flash intersections. Studies with accident data, however, mostly pertain to programmed flash, and studies using simulation models do not validate the assumed driver behavior which is required to produce the efficient performance.

If in fact all drivers facing the red flash stop and yield, and all drivers facing the yellow flash proceed without stopping, there would be little concern over the potential safety of the intersection. That assumption, however, may very well be conditional. Bansen [2] and Jenior [1] at Georgia Tech have previously collected field data from 51 intersections in malfunction flash operation. Both look at operational characteristics that are later simulated by Oricchio [3]. One of the characteristics reviewed is the stopping rate of vehicles. It is found that the stopping rate differs greatly from that which is assumed in previous studies. This discovery prompts the need to look into driver behavior at malfunction flash intersections in greater depth.

1.1 Need for Study

There are safety concerns associated with intersections in malfunction flash that have not been addressed in depth by previous research efforts. While the occurrence of programmed flash may be controlled and limited, malfunction flash may occur at any time under any demand condition. Under moderate to high traffic demands drivers often have no expectancy, or even an incorrect expectancy, of proper operations.

Drivers are to traverse through an intersection in malfunction flash mode in the same manner as an intersection controlled by a stop-sign. Red/Red flash corresponds to all-way stop control (AWSC) and Yellow/Red flash corresponds to two-way stop control (TWSC). However, at a red flashing signal there is no assurance that a road user is able to identify the cross street indication (i.e., yellow or red flash) and is therefore unable to determine if the intersection is operating as a two-way or four-way flash based on observations of the signal control alone. As such, the vehicle on the minor street may stop, but fail to subsequently yield to a vehicle on the major street. At a yellow flashing signal, drivers may be overly cautious and stop when they should not, fearing the cross street vehicle may not stop. This action may allow drivers to avoid cross-street collisions, but will increase opportunities for same-direction rear end crashes. It may also solidify the assumption of a cross street driver that the intersection is operating under Red/Red flash when it is actually in Yellow/Red flash. In addition, some drivers appear unclear on the basic rules at a flashing signal regardless of the cross-street factor. This confusion makes the intersection even more accident prone.

The impacts of aforementioned behaviors on the intersection safety performance may be significantly hazardous. As agencies are attempting to update their standard for

when to use each flash mode, it is important to determine the potential dangers of each mode and whether one is preferred over the other.

1.2 Study Objective

The objective of this study is to determine the level of drivers' understanding of the two modes of flash control through an analysis of the types and rates of violation, along with related driving behaviors at recorded intersections in malfunction flash. Comparing these violation rates to those at comparable stop-control intersections will help illustrate the difference in drivers' understanding of these similar intersection control devices. Similar analysis will also be conducted between Red/Red flash and Yellow/Red flash to compare how motorists behave at the two types of flashing intersection.

1.3 Study Overview

1.3.1 Literature Review

The next chapter of this report summarizes the findings from previous research efforts on driver behavior and safety analysis at intersections in malfunction flash mode. Since there is little existing research on these topics literature on stop-controlled intersections are also consulted for an expanded review of existing data collection methods and results. It is interesting to note that there is no literature found which focuses specifically on the safety of intersections operating in malfunction flash. It is found that intersection safety analysis on other conventional unsignalized intersections is mostly based on simulations and accident data. However, simulations are only as accurate as their underlying assumptions. As the assumptions for malfunction flash intersections have not been verified, simulation may not yet be an appropriate means to

study this special traffic control case. Sufficient accident data for malfunction flash scenarios is also difficult to accumulate and thus one of this study's objectives is to determine another method of analysis.

1.3.2 Data Extraction

Most of the video data extraction effort has previously been completed by Bansen [2] and Jenior [1], the two earlier students who worked on this research topic at Georgia Tech. The new pieces of information which are required to conduct analysis in this research are extracted from existing data through the use of VBA codes programmed in Microsoft Office Excel©. A detailed description of the methodology and the basis for the coding logic are provided in Chapter 3.

1.3.3 Data Analysis

Chapter 4 of this report presents the results of the data analysis. Quantifications and observations of different behavioral events are presented in an attempt to identify driver behavior at both malfunction flash modes. Stopping behavior is observed with a detailed breakdown of presence and absence of conflicting vehicles. As part of the analysis of driver behavior out-of-turn movements, which occurs after a vehicle stops, are also considered along with platoon effects. Findings from intersections in each mode of malfunction flash are also compared with several stop-controlled sites to verify the underlying assumption that the behavior at Red/Red malfunction flash should be the same as AWSC and the behavior at Yellow/Red malfunction flash should be the same as TWSC. Finally Chapter 5 summarizes the findings presented in Chapter 4 and outlines the conclusions based upon these findings. A discussion of research limitations pertaining to this study is also included, followed by recommendations for future studies.

CHAPTER 2

LITERATURE REVIEW

This chapter presents an overview of previous literature that discusses driver comprehension and driver behavior, and their implication on safety at both malfunction flash and stop-controlled intersections. Data analysis techniques are also explored for a better understanding of possible study approaches.

2.1 Rules of the Road

Before touching on drivers' comprehension of a flashing signal's meaning and how well drivers comply, it is necessary to first explore the exact regulations which drivers are expected to obey. The following codes and instructions are from the state of Georgia as all intersections under study are from this particular state. However, similar codes and instructions have been found for other states (Texas, Massachusetts, etc.) as well.

According to section 40-6-23 of the Official Code of Georgia Annotated [4], and the more common source of traffic laws available to the average driver, the 2008 Georgia Driver's Manual [5], the driver facing the flashing red indication at a flashing signal has to stop and then follow the right of way rules for a stop sign controlled approach. The driver with a flashing yellow indication may "cautiously" move through. No further elaboration is given. In the literature cited by Bansen [2], the Georgia DOT expanded the explanation to advice road users that a flashing Yellow/Red intersection operates like a two-way stop-controlled (TWSC) intersection while a flashing Red/Red intersection operates like an all-way stop-controlled (AWSC) intersection.

Having established that the two flashing scenarios should be treated like the two stop-controlled scenarios, the next logical question is: What are the rules regarding stop-controlled intersections? Under section 40-7-72 of the Georgia Code [4], which covers the right of way for stop and yield signs, it is stated:

> "Except when directed to proceed by a police officer, every driver of a vehicle approaching a stop sign shall stop at a clearly marked stop line or, if there is no stop line, before entering the crosswalk on the near side of the intersection or, if there is no crosswalk, at the point nearest the intersecting roadway where the driver has a view of approaching traffic on the intersecting roadway before entering it. After stopping, the driver shall yield the right of way to any vehicle in the intersection or approaching on another roadway so closely as to constitute an immediate hazard during the time when such driver is moving across or within the intersection or junction of roadways."

The Georgia Driver Manual [5] goes into further detail by explaining that at an AWSC intersection, it is "first come, first serve." If two vehicles arrive at the intersection simultaneously, the one on the right may go first. There is no discussion about the possibility of three or more vehicles arriving simultaneously. The Georgia Driver manual also offers no additional detail for TWSC intersections. Most other states' driver manuals also do not go into detail about stop-controlled intersection right of way. This lack of clear explanation potentially leads to a hazy understanding on the part of drivers of the right of way rules at stop controlled intersections, which may cause unfortunate accidents on top of poor intersection operation.

2.2 Driver Comprehension of Traffic Controls

According to findings from Bansen's literature review [2], a TTI study in 1993 [6] shows a high percentage of drivers do comprehend the meaning of yellow and red flashing indications. However, drivers expressed uncertainty in their expectation of cross street traffic behavior. In this study, it is found that 41% of drivers thought that the cross

street would stop and the same percentage did not know what the cross street would do. Many drivers thus may incorrectly assume that the cross-street traffic is either also being displayed a flashing red (when they could be facing a flashing yellow) or should stop if they are facing a flashing yellow. A FHWA survey [7] cites by Bansen similarly finds that over 60% of the participants either thought the cross street would stop or they could not tell what the cross street would do.

Bansen's field data findings show that the stopping rate for a major street through movement is as high as 42% at flashing yellow indications even in the absence of minor street vehicles, and as high as 68% when considering all vehicles. The variability in vehicle stopping of Red/Red flash is much lower compared to Yellow/Red flash. As such, driver expectancy is further compromised. The drivers who stop unnecessarily at a flashing yellow are unsure themselves of the appropriate driving rules and they are also potentially adding to the confusion of those who arrive behind them and those on the cross street. The Yellow/Red flash controlled intersections thus have the high likelihood, particularly under higher demands, of behaving more similarly to an AWSC intersection than a TWSC intersection. Such confusion is dangerous as it leads to rear-end collisions and the more severe angle or head-on collisions. In fact, three crashes are noted from Bansen's observations, two of which are at intersections with flashing Yellow/Red.

Similar confusion has been noted at TWSC and AWSC intersections. Stokes [8] cites Picha et al. [9], who notes that drivers may misinterpret a two-way stop-controlled intersection as a four-way stop-controlled intersection as a result of several conditions. Among them are similar volumes, similar high speeds, and similar geometric elements on the approaches. Picha et al. as well as Gattis [10], who conducts a separate study,

recommend using a supplemental sign to relieve misunderstandings. However, Gattis warns of the danger of drivers expecting the sign at all two-way stop-controlled intersections. Many engineers fear the same false expectancy should most flashing instances become Red/Red. That choice would make the few Yellow/Red cases much more dangerous.

2.3 Driver Behavior

The following is a brief summary of several studies pertaining to the topic of driver behavior at both malfunction flash and stop-controlled intersections. The first three are from the series of Master's theses on the topic of malfunction flash operation at Georgia Tech. The last two studies pertain to stop-controlled intersections.

2.3.1 Evaluation of Traffic Operations at Intersections in Malfunction Flash Mode (2006)

Bansen [2] starts the malfunction flash mode study at the Georgia Institute of Technology with data from the original sample of 13 intersections. Bansen finds that at low volumes, minor street flow rates are low enough that they do not force major street vehicles facing a flashing yellow indication to stop. At high volumes, however, Yellow/Red flash intersections tend to operates as a four-way stop controlled intersection from time to time, resulting in a high rate of major street vehicles stopping. At low minor street flow rates (< 200 vph), the percentage of vehicles stopping on a yellow indication is fewer than 20% (still arguably a high rate of confusion). Inside the transitional area of 330-500 vph, the percentage of vehicles stopping on the yellow varies widely. When minor street volumes exceeds 500 vph, the percentage of major street vehicles stopping on the yellow is generally anywhere from 40 to 60%. Clearly, as the side street volumes

increase the intersection does not operate according to the design expectations, that is, as a two-way stop controlled intersection. For the two signals with Red/Red flashing operation, an average of 87% of major street through vehicles stopped when a minor street vehicle is present. However, when a minor street vehicle is absent, the percent stopping dropped to 73.4% on average. This is an indication that vehicles are more likely to violate a flashing red signal when there is no conflicting minor street traffic.

2.3.2 Observation and Modeling of Traffic Operations at Intersections in Malfunction Flash Mode (2007)

Jenior [1] continues the study and expands the sample size to 34 malfunction Yellow/Red flash instances and 9 malfunction Red/Red instances. Major through stopping percentage is analyzed as a function of minor street volume and minor street to major street volume ratio, similar to Bansen's analysis. Here, it is similarly found that at low minor street volumes, the percentage of major street through vehicles stopping is less than 25%. At high volume minor street volumes, the percentage of major street vehicles stopping may reach 60%. Thus it can be seen that Yellow/Red flash operates closer to expectation at low minor street volumes (< 200 vph) than at higher minor street volumes (> 500 vph).

Jenior also develops logit models using volume ratio as an independent variable to predict the probability of a vehicle stopping when facing a yellow flash indication. A scaling factor of 0.62 is used for the model which is based on the presence of a minor street vehicle. A scaling factor of 0.31 is used for the model which is based on the absence of a minor street vehicle. Although the scaling factors are not interpreted as the actual stopping probability, one being twice the other means that the probability of

stopping with the presence of a minor street vehicle is twice that of having no minor street vehicle, all else being constant. These models will be used in Oricchio's [3] simulation as discussed in the next section.

When observing red flash violation, the author finds that most cases have a stopping rate of below 90% when the ideal stopping rate should be 100%. The phenomenon of platoons moving through the intersection is also observed in Jenior's study as a partial explanation for the high non-stopping rates of vehicles facing a red flashing indication. That is, vehicles previously stopped in the queue are seen to follow a lead vehicle through the intersection without coming to a stop at the stop bar. However, this phenomenon did not account for a significant percentage of non-stopping vehicles. Many intersections with low traffic volumes and good visibility have a high red flash violation rate due to vehicles treating the stop control flash as a yield control. When there are no vehicles making conflicting movements, minor street drivers proceed as they would at a yield sign without fully coming to a stop. When compared to other published results, Jenior notes that even higher stop violation rates have been observed at AWSC intersections. A possible explanation may be that drivers are more unfamiliar with a flash signal than a stop sign, therefore the violation rates would fall lower as drivers may be more cautious proceeding through a flashing intersection.

2.3.3 Microscopic Simulation Model of Traffic Operations at Intersections in Malfunction Flash (2007)

Oricchio [3], the third to work on the Georgia Tech malfunction flash project, uses findings from the previous two studies to develop a VISSIM simulation model of operations at intersections in flash mode. Previous models have assumed a zero stopping rate for yellow flash indication and a 100 stopping rate for red flash indication, which is unrealistic when compared to Bansen [2] and Jenior's [1] field findings. Oricchio's simulation model uses Jenior's logit model as a basis for predicting stopping rates to better reflect the observed driver behavior. Results from the simulation also show that under low volume conditions, a Yellow/Red malfunction flash may operate similarly to a TWSC intersection. However, operations change to resemble an AWSC intersection as the volume increases. Oricchio recommends selecting Yellow/Red flash only when the highest approach volume is at most 400 veh/hr/ln and when the minor to major volume ratio is at most 0.3. Speaking from an operations perspective, Oricchio argues that once drivers start to treat the intersection as an AWSC intersection, the operational benefits of a Yellow/Red flash over a Red/Red flash are lost.

2.3.4 Driver Behavior and Traffic Stream Interactions at Unsignalized Intersections (2000)

This research [11] focuses on improving the existing gap-acceptance simulation models at unsignalized intersection by also considering driver behavior to better model the traffic stream interactions. The authors argue that at unsignalized intersections drivers safe navigation through the intersection is primarily dependent on their own decision-making. Where there is high major road volume, minor road vehicles may get

tired of waiting and end up accepting a shorter gap than they normally would. As such, driver learning, impatience, and aggressiveness are all taken into account as influencing characteristics.

Simulation results show that as aggressive drivers share goes up from 40% to 60%, the delay on the minor streets decreases by 1.4 s/vehicle while the delay on the major streets increases by 5.6 s/vehicle. This intersection performance resulted in the number of conflicts increasing from 80 to 134 per hour. The study concludes that intersections with lack of control have performance which reflects aggressive driving practices and may potentially be dangerous. The simulation is applied to the city of Beirut where motorists treat stop-controlled intersections as uncontrolled. Although the results may not apply to U.S. stop-controlled intersections, the validity may still hold for malfunction Yellow/Red flash-controlled intersections where longer delays resulting from higher volumes may cause greater risk-taking.

2.3.5 Analysis of Rural Intersection Accidents Caused by Stop Sign Violation and Failure to Yield the Right of way (2000)

This research conducted by the Kansas DOT, Kansas State University, and the University of Kansas [8] aims to identify the contributing factors of accidents caused by failure to stop and failure to yield right of way at a TWSC intersection. There are several key findings which are included in this paper, both from the research results and from previous efforts. From Gattis [10], the following two results are found, with the second also reported by Mounce [12]:

1. There is a 67.6% stop sign violation rate from 142 urban sites in which one third of the drivers stated they violated the control because cross street volumes were low.
2. Stop-sign violation rates decrease as major road volumes increase.

From Stokes et al. [8], the following is found:

3. Only 11% of all accidents in the study period involve stop sign violation.

Although the data are from different study sites, one may suspect those who run a stop sign do so when there generally isn't the presence of other conflicting vehicles, thus resulting in a low share of accidents despite the high violation rate.

From Stokes, the following are also found:

4. Eighty-seven percent (87%) of the accidents involve drivers who failed to yield the right of way.
5. Eighty-eight percent (88%) of the accidents are collisions between a major roadway vehicle and an entering vehicle from the minor roadway.

The authors suggest that drivers on a minor roadway either have poor sight distance or fail to correctly estimate the oncoming speeds on the major roadway. This goes parallel with the driver behavior concept mentioned in the previous paper where drivers are expected to judge for themselves the safety of their movement. From the two reviewed research papers, it is thus apparent that not only is traffic control compliance important to observe, what a driver does after stopping also has a major implication on intersection safety.

2.4 Data Collection and Analysis Techniques

To answer questions concerning driver comprehension and driver behavior, and their implications on intersection safety, researchers have undertaken different routes in data collection procedures and analysis techniques to arrive at their conclusions. The TWSC study done by Stokes et al. [8] utilizes three years worth of accident reports from 1994 to 1996. Field data collection undertaken by the researchers is limited to intersection site observations to identify possible contributing conditions (such as geometric layouts and surrounding elements). The drawback on this procedure is that several years of accident data are needed, and there is no insight on specific behavioral patterns. For example, the crash database used in this study comes from police reports. Whether it was recorded that a vehicle failed to yield right of way or failed to stop depends on the driver's testimony. It is possible that drivers would admit to driver error (poor judgment when pulling into the intersection) rather than to admit to traffic law violation (running the stop sign).

Bansen [2] and Jenior [1] both collect field data and analyze stopping rates and platooning effect as measures of intersection performance. While these are valuable information, other aspects of intersection behavior are left out due to the scope of the projects as well as having a restrained time limit.

Instead of using only accident data, and to gain a more detailed analysis from field data, many have turned to using conflict data as a supplement for safety analysis. According to the FHWA engineer's guide [13], a traffic conflict is "an event involving the interaction of road users where at least one driver takes evasive action to avoid a collision." In other words, they are near-accident events. These events are surrogates to

accidents and have been found to be an effective measure of accident potential. This way, dangerous situations which did not escalate into accidents are also taken into account rather than relying solely on the rare crashes for analysis. Those with field data may also conduct a study without waiting for several-years worth of crash data.

A basic set of conflict definitions is described by the guide, with each categorized by type of maneuver. The primary types include: same direction, opposing left turn, cross traffic, right-turn-on-red, pedestrian, and secondary. Same direction conflicts involve a slowing vehicle which may put itself and the vehicle behind it in danger of a rear-end collision. Opposing left turn conflicts involve a left turning vehicle which places itself and an opposing approach vehicle in danger of a head-on collision. A cross traffic conflict involves a near accident between two vehicles from two cross streets. Right-turn-on-red conflicts are those which occur when a vehicle makes an unprotected right turn, placing another vehicle in danger of a collision. Pedestrian conflicts are conflicts which involve pedestrians, while secondary conflicts are conflicts which involve at least a third vehicle beside the primary two. With conflicts broken down into types, the analysis allows for a more detailed assessment of driver behavior which may be useful to determine site hazards.

Conflicts are usually presented as a daily count or a per 1000 one-way approach vehicle rate. Many have also used total entry volume (TEV) and other volume combinations in their analyses. In a study titled *Various Volume Definitions with Conflicts at Unsignalized Intersections* [14], Katamine looks into the correlations between different volume combinations and certain types of conflicts. Although there is a positive correlation between TEV and total conflicts, the author does not believe that

the TEV of the intersection provides enough insight into the effects on the conflicts. Findings indeed prove that different types of conflicts are correlated with different volume combinations. Conflicts between through movements and cross-street traffic are highly correlated with the volume combination of either major approach together with both minor approaches. Same-direction conflicts are correlated with the volume combination of both major approaches. Left-turn conflicts are also correlated with the volume of both major approaches. Conflicts between right-hand-side right-turn and left-turn with cross traffic are correlated with the volume combination of either major approach and the volume of the right-hand-side minor approach. Such results show that volume combinations play an important role in lending insights into conflict types and should be considered when doing a similar intersection analysis.

2.5 Literature Review Summary

Previous research has shown that high violation rates and a high level of confusion at intersections which require greater autonomy in self-organization may pose safety concerns to road users. In addition, the few existing efforts on malfunction flash operations imply that common assumptions on driver behavior often fall short of representing real-world interactions and that these intersections are neither as efficient nor as safe as typically assumed.

Although extensive research has been undertaken for stop-controlled intersections, detailed study on driver behaviors and safety issues at intersections operating in malfunction flash mode have not been conducted. This lack of literature thus provides little guidance in research methods as well as little comparable data.

CHAPTER 3

FIELD DATA

Chapter three discusses the methodology involved in data collection. There are two major components in the methodology: right of way determination and data extraction and processing. As the interest of the study is to observe driver behavior in an attempt to determine driver understanding of flash control, it is necessary to determine who has the right of way in different scenarios for subsequent analysis of driver behavior.

3.1 Right of Way Determination

From this section onward, the approach naming convention in Figure 3.1 is used. Right cross-street refers to the right-hand intersection approach relative to the reference vehicle. Left cross-street refers to the left-hand intersection approach relative to the reference vehicle. Opposing refers to the opposite intersection approach relative to the reference vehicle.

At Red/Red malfunction flash intersections, it is assumed that the right of way rules are similar to those at AWSC intersections. Thus, all vehicles are expected to stop and then proceed in a first-come-first-serve manner. The following are considered "violations" of the traffic control at Red/Red intersections:

1. vehicle does not stop completely before moving across intersection
2. vehicle stops but crosses the intersection before another vehicle which arrived first
3. vehicle stops but crosses the intersection before a right cross-street vehicle which arrived at the same time

4. left-turn vehicle stops but crosses the intersection before a through or right-turn opposing vehicle that arrived at the same time.

At intersections operating in Yellow/Red flash mode, it is assumed that the right of way rules are similar to those at TWSC intersections. Thus, vehicles on the cross-streets with the red flash are required to stop whereas vehicles on the cross-streets with the yellow flash are not. The following are considered violations of the traffic control at Yellow/Red intersections:

1. left-turn vehicle on major street does not stop at the intersection in the presence of a major through vehicle on the opposing approach
2. vehicle on minor street does not stop when it arrives at the intersection
3. vehicle on minor street stops, but crosses the intersection before its turn
    a. right-turn or through on a minor approach goes before opposing right-turn or through on the other minor approach which arrived first
    b. left-turn on a minor approach goes before opposing right-turn or through on the other minor approach
    c. any movement on a minor approach goes before a major left on either cross-street

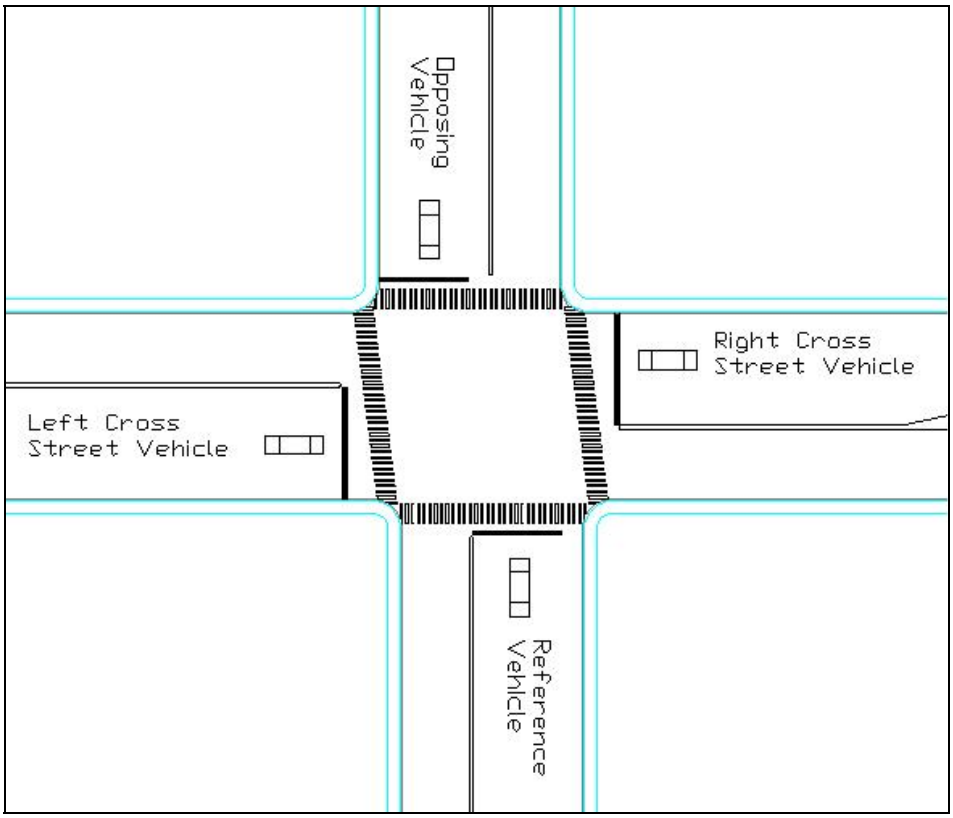

Figure 3.1 Approach Naming Convention

3.2 Data Extraction

Fifty one instances of flash operation in the Atlanta region are captured by Bansen and Jenior. Thirteen of which are included in Bansen's study, while the latter thirty eight are added by Jenior. Excel sheets have been generated by Bansen and Jenior to include processed data from the video footage. The extracted information includes records of vehicle movements and their arrival and departure times. The discussion of the data collection and video reduction method may be found in Bansen's *Evaluation of Traffic Operations at Intersections in Malfunction Flash Mode* [2] and Jenior's *Observation and Modeling of Traffic Operations at Intersections in Malfunction Flash Mode* [1]. This study makes use of the Bansen and Jenior data to extract additional information required

for the current analysis. Based on the right of way assumptions in the previous discussion, the following is a summary of specific violations to be identified.

3.2.1 Data Extraction Procedure

A stop violation involves a vehicle which fails to stop after arriving at the intersection. Stopping vehicles have already been marked in the existing Excel files by the string value "Stopped" next to a particular vehicle movement. Stop violations for each appropriate movement therefore can be identified through the absence of these markers. The arrival and departure times of all vehicles at the intersection are used to further categorize stop violations. The arrival time and departure time of a vehicle identified as making a stop violation is compared to the arrival time and departure time of vehicles on other approaches to determine conflicting vehicle presence or absence. There are eight possible cases for a vehicle noted as making a stop violation:

1. Presence of right cross-street vehicle only
2. Presence of left cross-street vehicle only
3. Presence of opposing approach vehicle only
4. Presence of right cross-street and opposing approach vehicles
5. Presence of left cross-street and opposing approach vehicles
6. Presence of both left and right cross-street vehicles
7. Presence of vehicles on all approaches
8. Absence of another vehicle

Out-of-turn (OFT) violations committed by vehicles at the intersections are also determined by comparing arrival and departure times. Out-of-turn violations are separated into two situations: out of turn by time, and out of turn by position. Out-of-turn

by time is defined as a vehicle violating the first-come-first-serve rule of an AWSC intersection. Out-of-turn by position means that two or more vehicles arrive at the intersection at the same time and a left-turning vehicle or a left cross-street vehicle departs first. Violating vehicles are only counted once even when the vehicle departs before several vehicles with the right of way. There are eleven cases of out-of-turn for Red/Red flash. The italicized cases are recorded for out-of-turn by position, but are not considered violations due to the right of way regulations.

1. Left cross-street vehicle departs prior to right cross-street vehicle that arrived first (or at the same time in the case of OFT by position).
2. *Right cross-street vehicle departs prior to left cross-street vehicle that arrived first.*
3. Opposing left vehicle departs before opposing Thru/Right vehicle that arrived first (or at the same time in the case of OFT by position).
4. *Opposing Thru/Right vehicle departs prior to opposing left vehicle that arrived first.*
5. A vehicle departs prior to both cross-streets that arrived first (or at the same time in the case of OFT by position).
6. Turning left departs prior to opposing right/thru and right cross-street that arrived first (or at the same time in the case of OFT by position)
7. Turning left departs prior to opposing right/thru and left cross-street that arrived first (or at the same time in the case of OFT by position)
8. Turning left departs prior to opposing right/thru and both cross-streets that arrived first (or at the same time in the case of OFT by position)

9. *Thru/right departs prior to opposing left and right cross-street that arrived first*
10. *Thru/right departs prior to opposing left and left cross-street*
11. *Thru/right departs prior to opposing left and both cross-streets*

Similarly, these are the cases of out-of-turn for Yellow/Red flash:

1. Minor movements a major left on either cross-street
2. Minor movements vehicle departs prior to major lefts on both cross-streets
3. Minor thru/right vehicle departs prior to opposing minor thru/right that arrived first
4. Minor left vehicle departs prior to opposing minor thru/right that arrived first.

Since the data is recorded in Excel© spreadsheets, Visual Basic for Applications codes are used to aid the data extraction (refer to Appendix B for code samples.) The same definition of minor presence used in Jenior's study is used in this study to determine the presence of vehicles on other approaches. That is, it is assumed a vehicle is present at the intersection from the time it arrives at the stop bar until three seconds after it departs the stop bar, thereby allowing three seconds to clear the intersection.

To process the data five new columns are inserted for each intersection approach (Arrival Time, Opp, Right, Left, and Violation) into the spreadsheets developed by Bansen and Jenior. The Arrival Time column displays the arrival time of each vehicle. The Opp column is used to indicate a violation with the presence of an opposing approach vehicle. The Right column is used to indicate a violation with the presence of a right cross-street vehicle. The Left column is used to indicate a violation with the presence of a left cross-street vehicle. The Violation column is used to indicate the violation type, determined by checking the Opp, Right, and Left columns to identify

whether zero, one, two, or three other vehicles are present at the time the violation occurs. The developed codes analyze the first hour of data for each intersection. For intersection video datasets less than 1 hour, violations are scaled up to the equivalent hourly rate.

3.2.2 Quality Control

The mistakes in data extraction come from the coding logic errors as well as simple coding typing errors. In an attempt to combat these errors code is written in small units and tested on a subset of the data. The results are then able to be confirmed by hand. The smaller units of code are then combined for a larger analysis. The final analysis is also spot checked throughout the excel file against the available raw video footage itself to ensure accurate data processing.

3.3 Data Collection for Stop-controlled Intersections

As one of the study objectives is to compare driver behavior at regular stop-controlled intersections to that at malfunction flash intersections, four video recordings are captured at two stop-controlled intersections. Two recording are made at an AWSC intersection and two recordings at a TWSC. For each intersection the peak and off-peak time periods are recorded. As shown in Table 3.3, the TWSC intersection location is at Arcado Rd. and Emily Dr. in Lilburn city and the AWSC intersection location is at Pirkle Rd. and Oakbrook Dr. in Norcross city. Both locations are in the suburbs of Atlanta. Aerial photos of these intersections can be found in Appendix A.

Table 3.3 Stop-controlled Intersections in Study

Intersection	Control Type	City	County	Date	Start Time	Condition
Oakbrook and Pirkle	AWSC	Norcross	Gwinnett	9/10/08	3:10 PM	Partly Cloudy
Oakbrook and Pirkle*	AWSC	Norcross	Gwinnett	9/10/08	4:21 PM	Partly Cloudy
Arcado and Emily*	TWSC	Lilburn	Gwinnett	9/16/08	7:22 AM	Partly Cloudy
Arcado and Emily	TWSC	Lilburn	Gwinnett	9/16/08	8:25 AM	Partly Cloudy

*These intersections are captured during peak-hour

The same violation and maneuvers checked for the malfunction flash intersections are also analyzed at the stop-controlled intersections. Volume count data for each intersection leg is collected manually using a Jamar© board. Driver behavior and violation types listed from section 3.2.1 are observed and recorded while watching the videos. As with the malfunction flash data only the first hour of each dataset is used.

CHAPTER 4

DATA ANALYSIS

There have been few studies regarding malfunction flash at intersections, thus there is no existing standard safety analysis procedure for this situation. One possible safety analysis procedure that may be applicable is conflict analysis, which is found in the FHWA's engineer guide [13]. While conflicts (near-accident events) are correlated with the hazard level of an intersection, it is difficult to get such data from recorded videos which do not have optimal filming angles (i.e., bird's-eye-view). Unfortunately the video data available for this study is not suitable to direct conflict analysis. Thus, instead of studying conflicts directly this study focuses on specific behavioral events, such as stops and non-stops, out-of-turn movements, and platooning, where the driver's actions do not meet the right of way rules of malfunction flash operation. In addition, these behaviors are quantified as they relate to the presence of other conflicting vehicles. As general vehicle stopping behavior for this data set has been covered by Bansen and Jenior, only a brief discussion is offer within, followed by the more in-depth discussion on the main behavioral analysis.

4.1 Red/Red Analysis

4.1.1 Stop Violation

There are ten Red/Red sites included in this study, 9 of which are malfunction flash while 1 is a newly installed signal. The newly installed signal at Market St. and 18th St. is included in the analysis since it is also an unexpected event from previous

experience. For those intersections which are filmed twice, a "1" and "2" are attached to the intersection names to represent the 1st and 2nd recording respectively. At a Red/Red malfunction flash vehicles on all approaches are required to stop before proceeding through the intersection according to the right of way rules of an AWSC intersection. For the recorded Red/Red malfunction flash occurrences it is seen that on average major street approach vehicles stop with a frequency of 83.6% (16.4% violation) compared to an 87.9% compliance rate by the minor street approach vehicles (12.1% violation). The violation rates of the left and through movement vehicles for each approach of the Red/Red malfunction flash occurrence are shown in Figure 4.1. It is anticipated that the violation rates for the major approaches would be higher than those for the minor approaches. However, nearly half of the intersection approaches do not follow this expectation. In many instances, the minor approach violation rate is as high as, or even higher than the major approach violation rate. At the extreme is the Market St. and 18th St. minor 1 approach violation rate of 66 percent. However, Market St. and 18th St. is a T-intersection where minor 1 has no through volume. When considering the absolute number of left-turn vehicles, it is found that there are two violations out of only three left-turns at that approach, clearly too little data to draw any conclusions. At the Northside Dr. and 14th St. and Roswell Rd. and Weiuca St. 1 (first recording) intersections, one-third of the violations on minor 1 are due to platooning, that is, queued vehicles are "piggy-backing" on vehicles in front of them to travel through the intersection rather arriving at the stop bar and independently running the red flash. At Piedmont Ave. and North Ave. intersection the minor approach is the approach with the highest vehicle volume, so the high violation rate actually fits expectation. At 10th St. and Peachtree St.,

the near equal violation rate may be attributed to the fact that the minor-major volume ratio at this intersection is nearly 1.0, implying there is not clearly defined major street from the driver's perspective.

It is also anticipated that right-turning vehicles may have a lower compliance rate than the left-turning and through vehicles as right-turning vehicles have fewer potential conflicts and also shorter maneuvers to complete. The data set thus is divided to allow for separate analysis. As seen in Figure 4.2 there is no clear trend regarding right-turn violation rates when using the major-minor approach definitions. Figure 4.3 identifies each approach in order from highest to lowest volume. This method of graphical data representation allows for data comparison with respect to vehicle volume rather than the major-minor approach definition. In figure 4.3 a general trend is seen of the higher approach volumes having the higher right-turn vehicle stopping violation rates. The primary exceptions are 14th St. and State St. which has a relatively balanced violation rate and Roswell Rd. and W. Wieuca Rd. 1 in which the third lowest volume approach has the highest violation rate. Likely this is a result of 14th St. and State St. having similar right-turn volumes on all four approaches and at Roswell Rd. and W. Wieuca Rd. 1 (1st recording) the minor approach right-turn volumes being significantly greater than those on the major approaches.

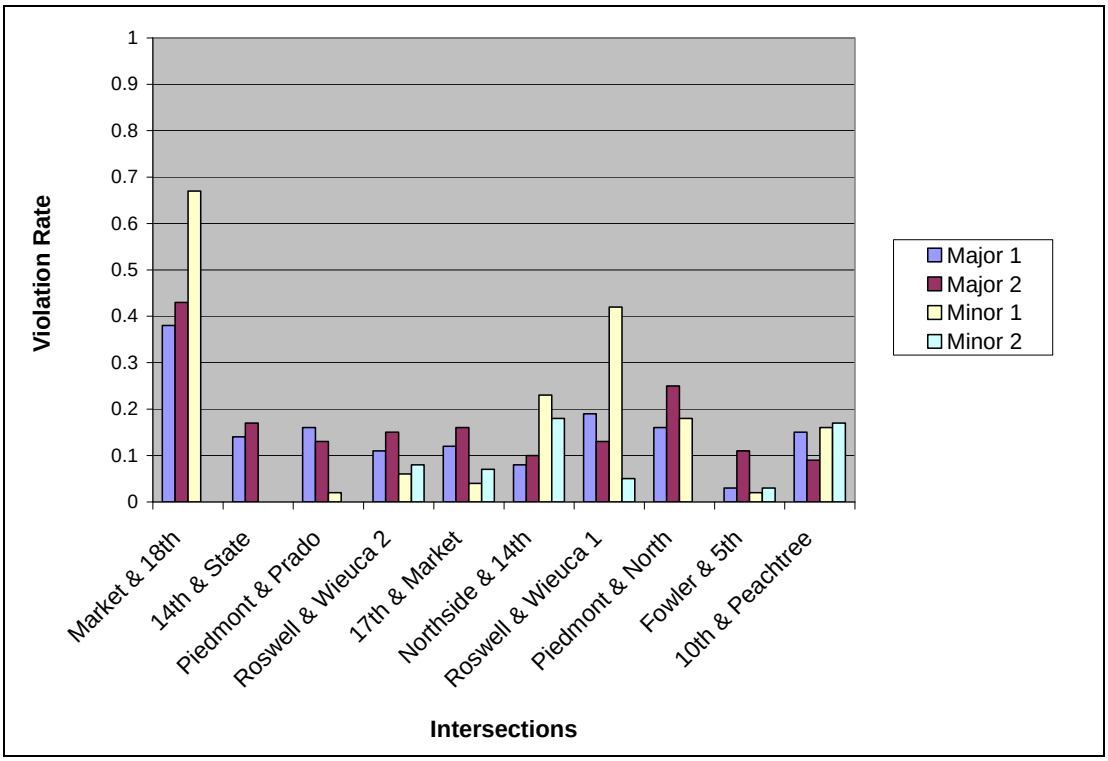

Figure 4.1 Stop Violation Rate for Left and Through Movements by Major-Minor Approach Definition at Red/Red Malfunction Flash

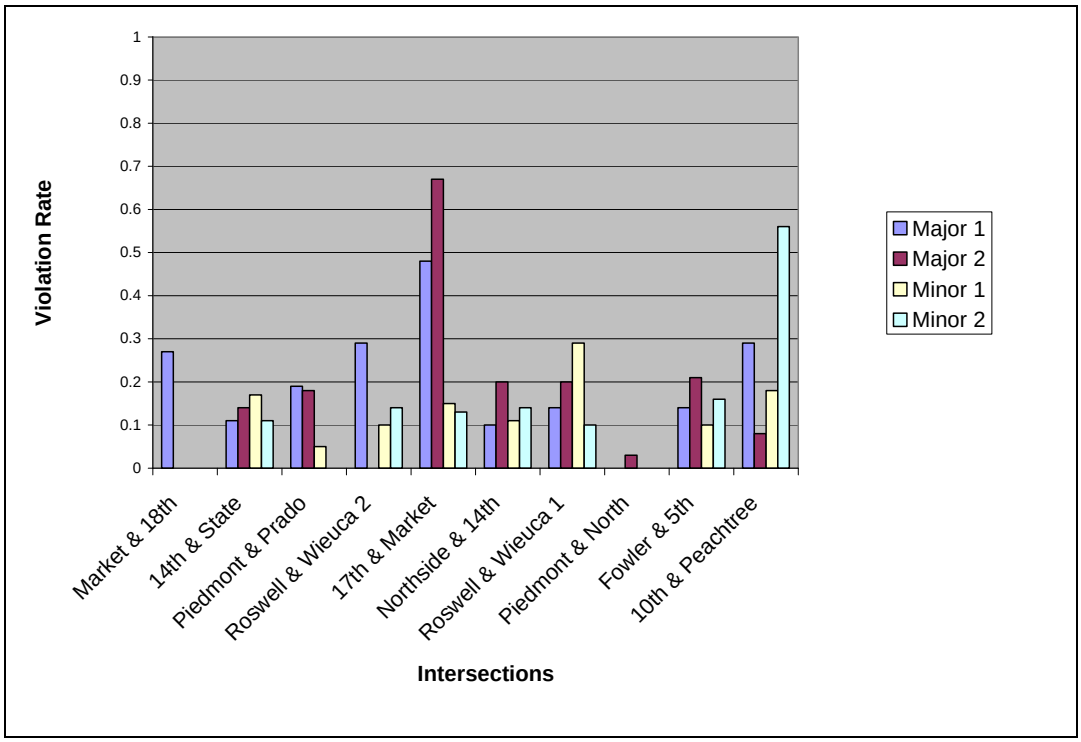

Figure 4.2 Stop Violation Rate for Right-Turning Vehicles by Major-Minor Approach Definition at Red/Red Malfunction Flash

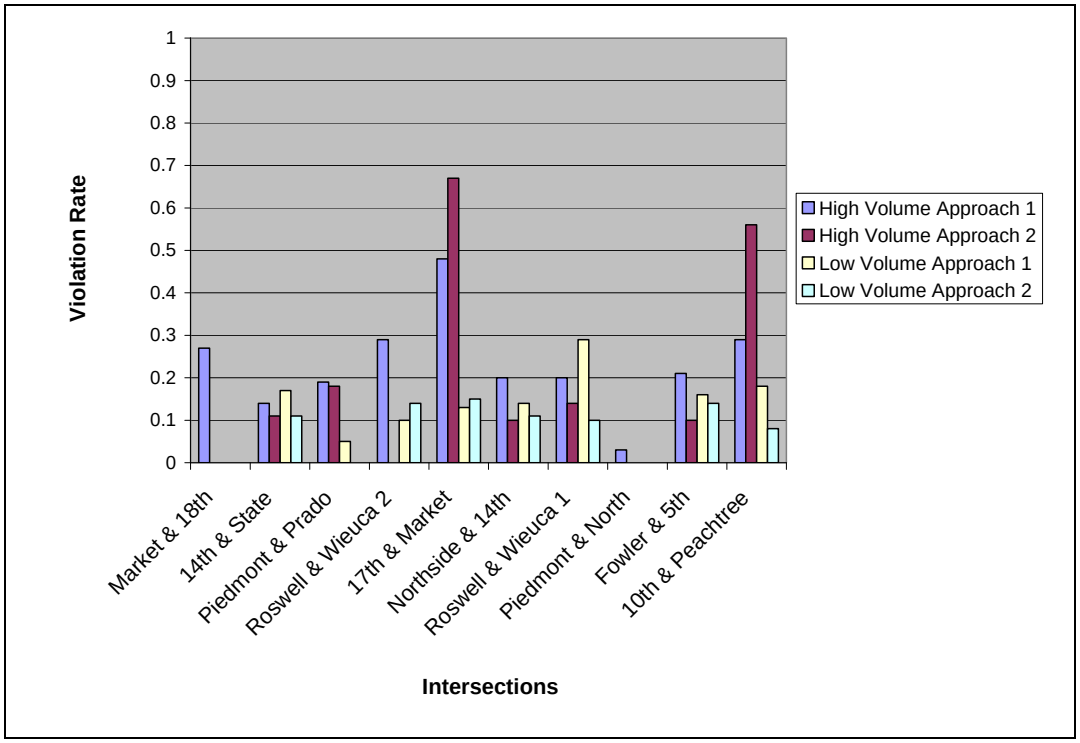

Figure 4.3 Stop Violation Rate for Right Turning Vehicles by Descending Approach Volume at Red/Red Malfunction Flashing

4.1.2 Presence Analysis

Presence analysis is used to study stopping behavior with respect to the presence of other conflicting vehicles at the intersection. As stated in the methodology section, presence of a vehicle is defined as the time from when the vehicle arrives at the intersection until three seconds after the vehicle departs the stop bar. If a significant percentage of the violations occur when no conflicting vehicles are present one may hypothesize that that drivers are only violating the control because they feel it is safe to do so. However, if a significant percentage of violations occur when there are conflicting vehicles at the intersection this may be a strong indication of either a lack of driver understanding about the right of way rules at flashing red or a disregard for these rules. As seen in Figure 4.4, only at low minor-major volume ratios do violations occur in absence of other vehicles. For most of the study sites, close to 100% of the violations occur in presence of other vehicles. These alarming percentages of violations in presence of other vehicles likely suggest the above mentioned lack of driver comprehension or right of way disregard.

The next set of analyses examines violations with respect to the number of other vehicles present. Figures 4.5 and 4.6 are box plots of the major 1 and major 2 approach non-stopping rates versus the number of other vehicles present, respectively, and figures 4.7 and 4.8 are box plots of the minor 1 and minor 2 approach non-stopping rates versus the number of other vehicles present, respectively. The 25^{th} through 75^{th} percentile are shown as well as the means, maximum and minimum extends, and outliers (if any). The violation rate is calculated as the number of actual occurrences over the number of opportunities available, representing the likelihood of a violation under each condition.

For example, assume there are 12 occurrences over an hour in which a vehicle arrives on a specific intersection approach and there is only one vehicle present on one of the other approaches. If out of those 12 occurrences the vehicle stops 6 times the violation rate for the 1- vehicle present category would be 0.50. From Figures 4.5 through 4.8 it is seen that drivers tend to be more likely to fail to stop when there are fewer conflicting cars present. Thus, while stop violations do occur in presence of conflicting vehicles, drivers do seem more likely to stop as the number of potential conflicts increases. For Major 1, when there is an absence of other vehicles, the violation rate is 0.22 on average. The average rates decrease steadily for 1 vehicle, 2 vehicles, and 3 vehicles being present, being 0.16, 0.13, and 0.10 respectively. The average rates for other approaches are shown in Table 4.1.

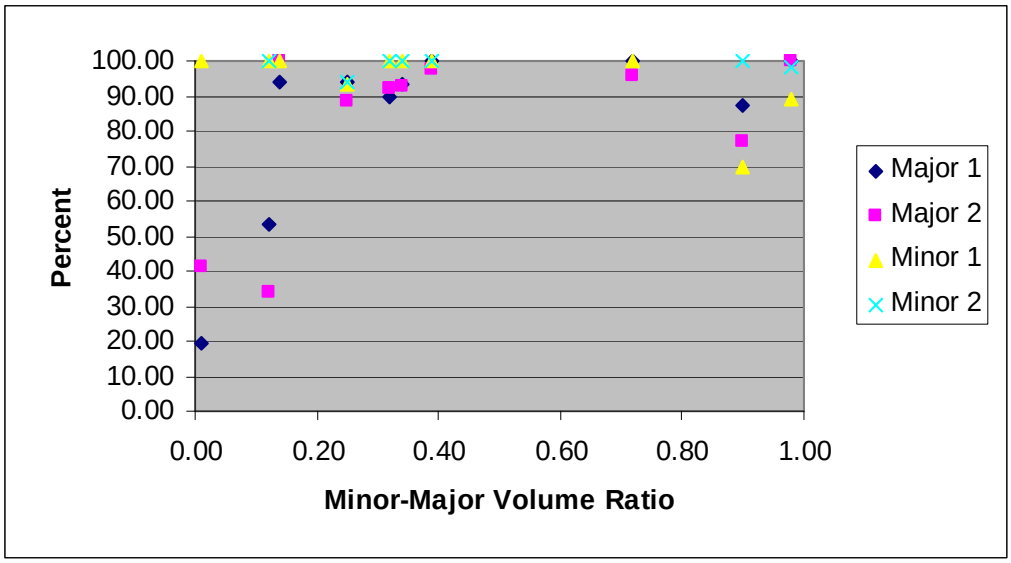

Figure 4.4 Violation Percentage in Presence of Other Vehicles at Red/Red Malfunction Flash

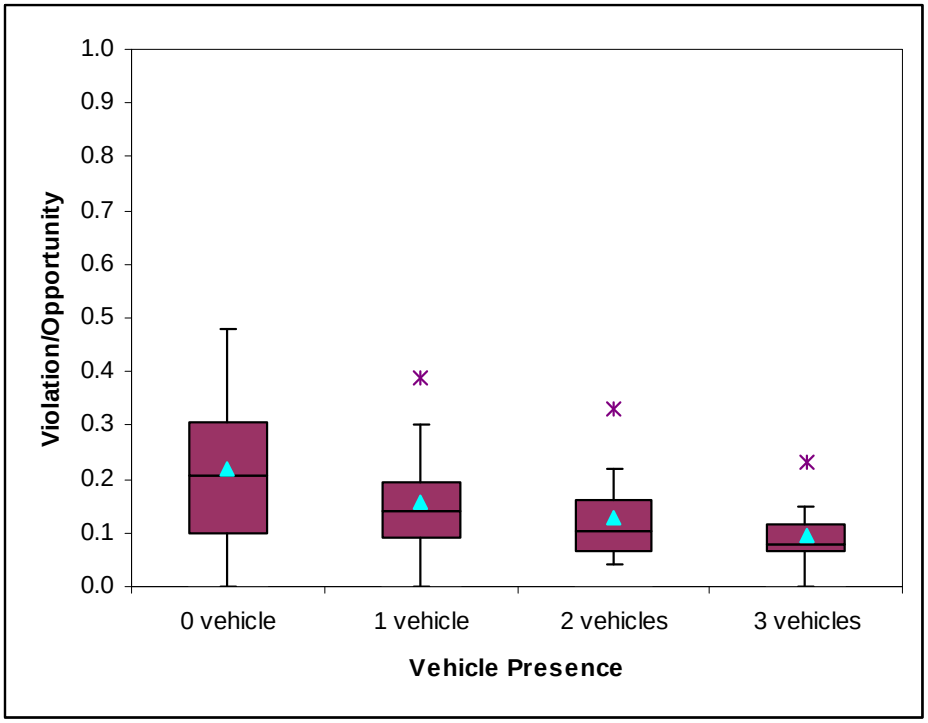

Figure 4.5 Major 1 Left and Through Vehicles Non-Stops/Opportunity Rate in Presence of Number of Conflicting Vehicles at Red/Red Malfunction Flash

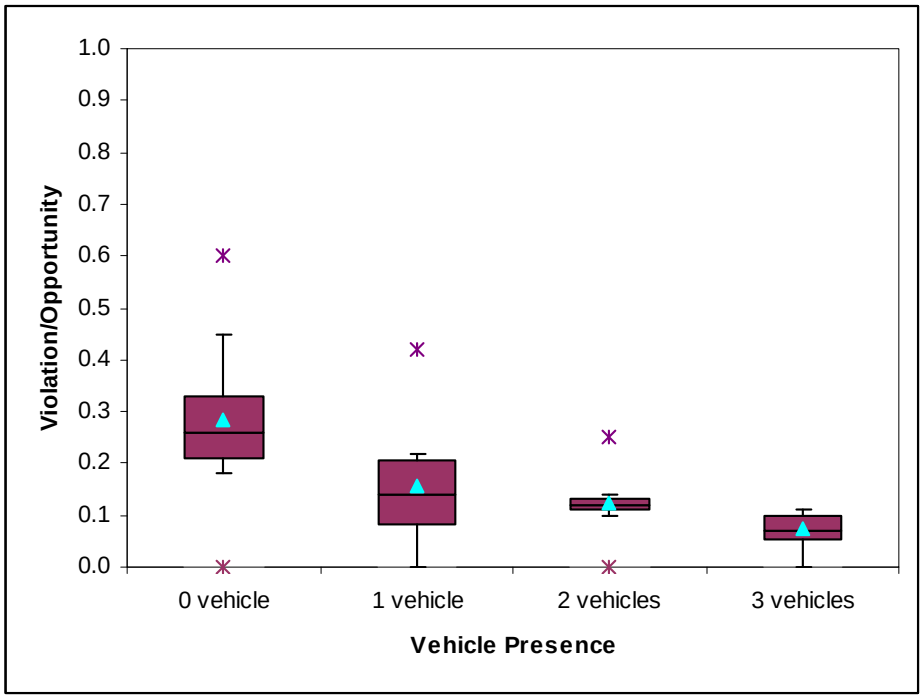

Figure 4.6 Major 2 Left and Through Vehicles Non-Stops/Opportunity Rate vs. Presence of Number of Conflicting Vehicles at Red/Red Malfunction Flash

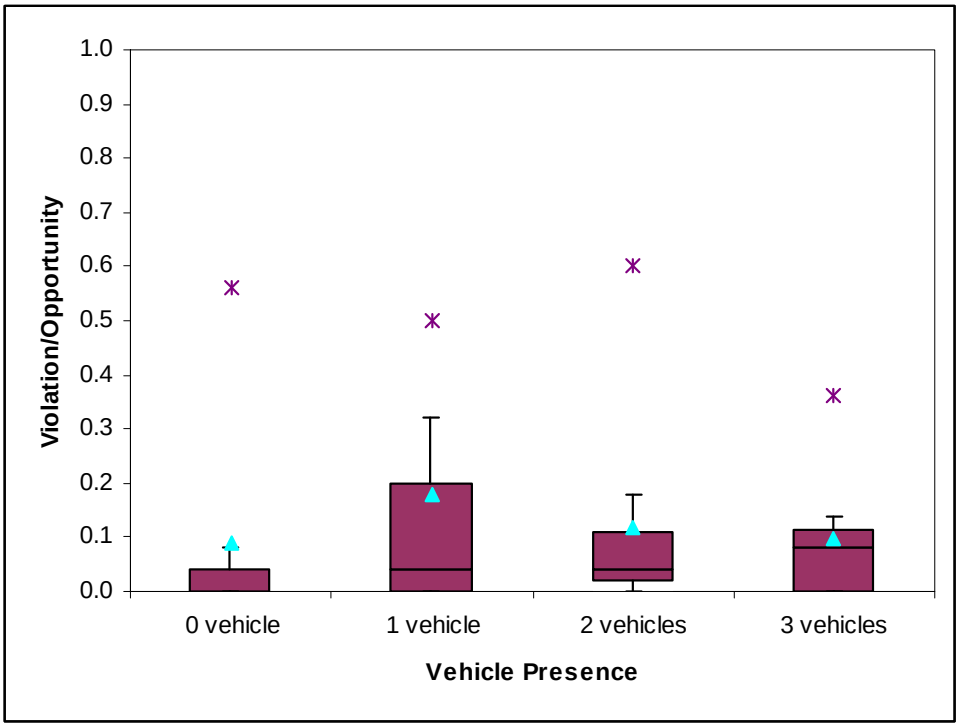

Figure 4.7 Minor 1 Left and Through Vehicles Non-Stops/Opportunity Rate vs. Presence of Number of Conflicting Vehicles at Red/Red Malfunction Flash

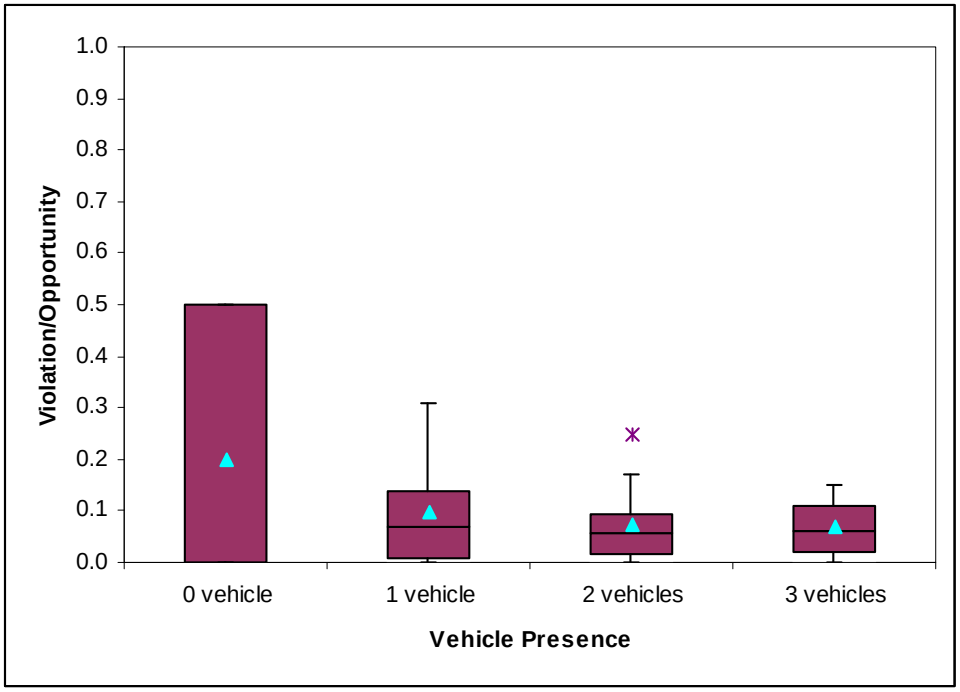

Figure 4.8 Minor 2 Left and Through Vehicles Non-Stops/Opportunity Rate vs. Presence of Number of Conflicting Vehicles at Red/Red Malfunction Flash

Table 4.1 Average Violation/Opportunity Rates for All Red/Red Intersections at All Approaches

	0 Vehicle	1 Vehicles	2 Vehicles	3 Vehicles
Major 1	0.22	0.16	0.13	0.10
Major 2	0.29	0.16	0.12	0.07
Minor 1	0.09	0.18	0.12	0.10
Minor 2	0.20	0.10	0.08	0.07

For the absence-of-vehicle case at the Minor 1 approaches, the average rate is surprisingly low at 0.09. This is due to the extremely low likelihood of a minor approach vehicle arriving at an empty intersection. Several intersections have a 0.00 violation rate due to there being no violations out of 1 or 2 opportunities. There is also an unexpectedly high violation rate for 2 and 3 vehicles present on minor 1 for the first Roswell Rd. and W. Wieuca Rd. recording. As explained in the previous stop-violation section, this is partly due to a high number of platooning vehicles.

A similar analysis is completed for the right-turn vehicle movements of each approach. From Figure 4.9 to Figure 4.11 (Major 1, Major 2, Minor 1), it is seen that a violation is more likely to occur when only a cross-street vehicle is present than when there is both a cross-street and an opposing vehicle. While it is assumed that a violation is most likely to occur when there is an absence of other vehicles the data (i.e. number of occurrences of such event) is insufficient to confirm or reject this assumption. There is also insufficient data to draw any conclusion where only an opposing vehicle is presence. There are again a few 1.0 violation rates which go against expectancy. However, in all but one case, there is only 1 violation out of 1 opportunity. In the case of violations with

both vehicles present for major 2 on 17th St. and Market, there are 4 violations out of 4 opportunities. Thus, they are all cases with very few data points.

For minor 2 right-turns (Figure 4.12), the violations trend is opposite that seen in for the other approaches. It would seem drivers are more likely to have a stop violation when there are two vehicles present than when there is only one. However, Northside Dr. and 14th St. has a low right-turning vehicle volume (7 in total) while 14th St. and State St. has only 9 right-turns in total. These low turning volumes are insufficient to reasonably identify any trends.

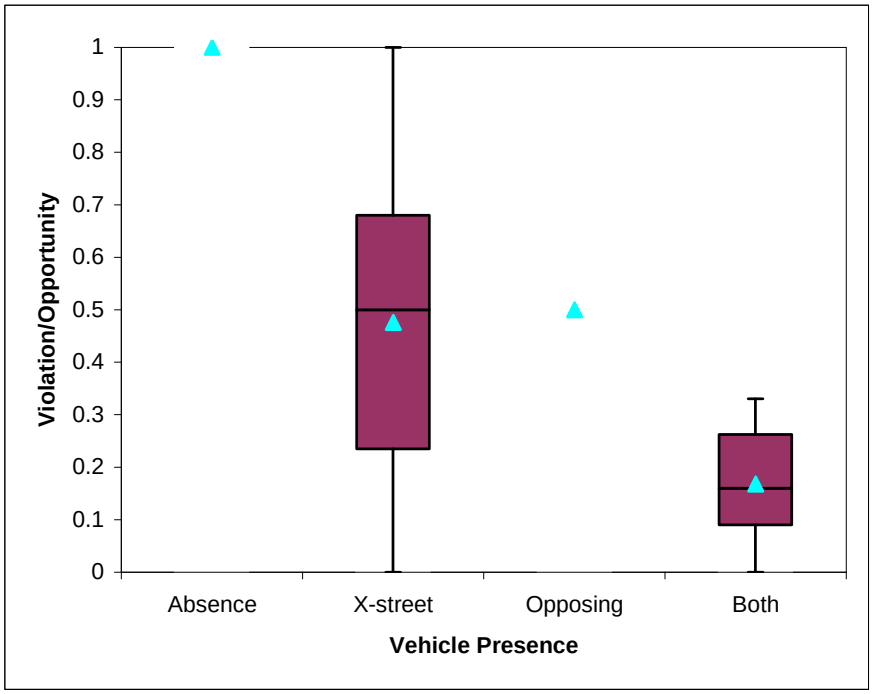

Figure 4.9 Major 1 Right Vehicles Non-Stops/Opportunity Rate vs. Presence of Conflicting Vehicles at Red/Red Malfunction Flash

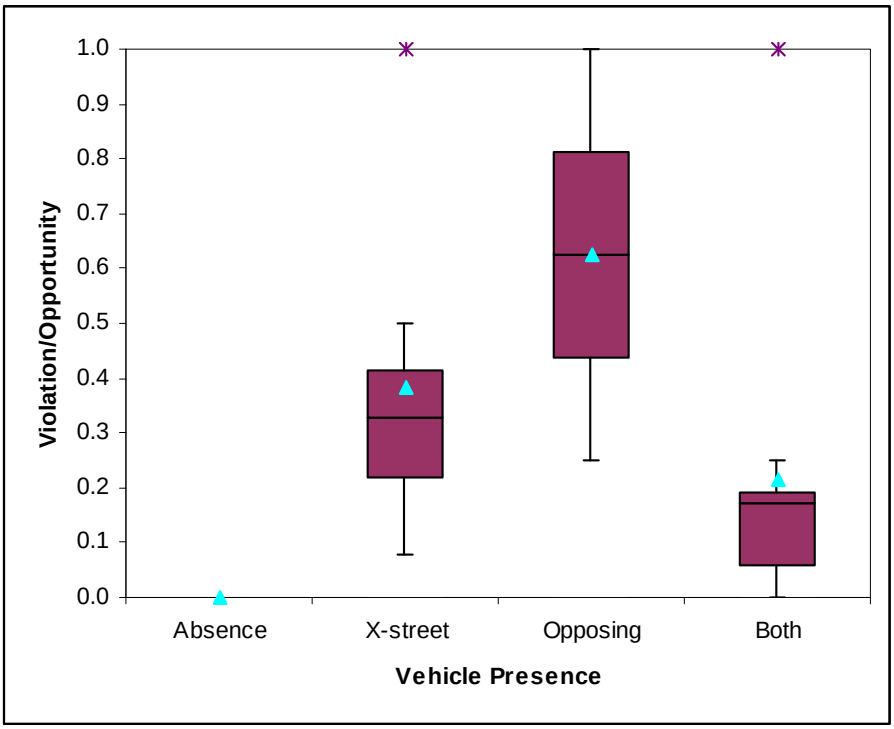

Figure 4.10 Major 2 Right Vehicles Non-Stops/Opportunity Rate vs Presence of Conflicting Vehicles at Red/Red Malfunction Flash

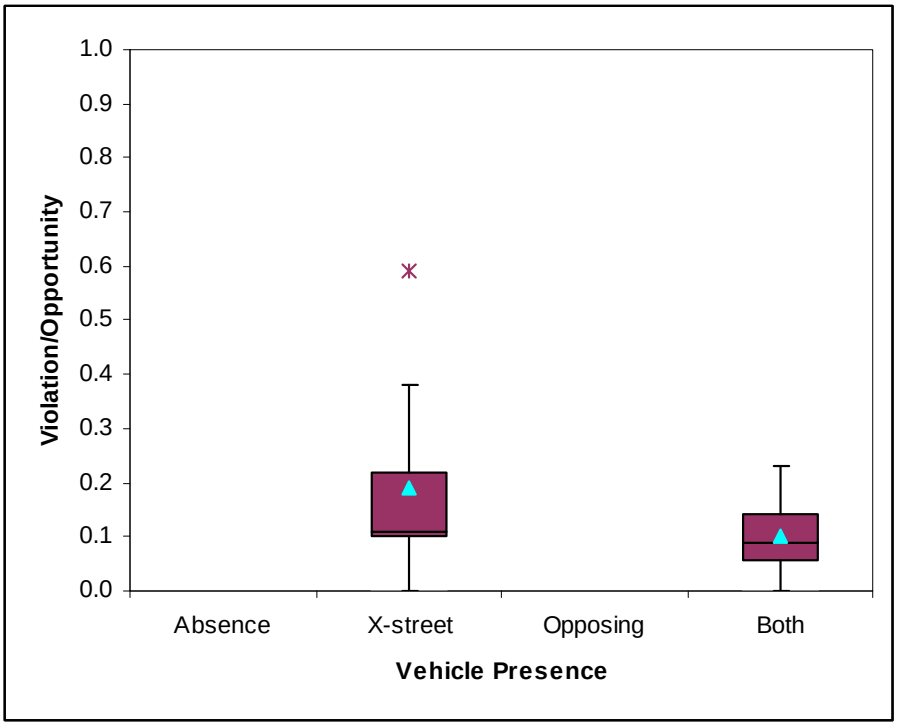

Figure 4.11 Minor 1 Right Vehicles Non-Stops/Opportunity Rate vs. Presence of Conflicting Vehicles at Red/Red Malfunction Flash

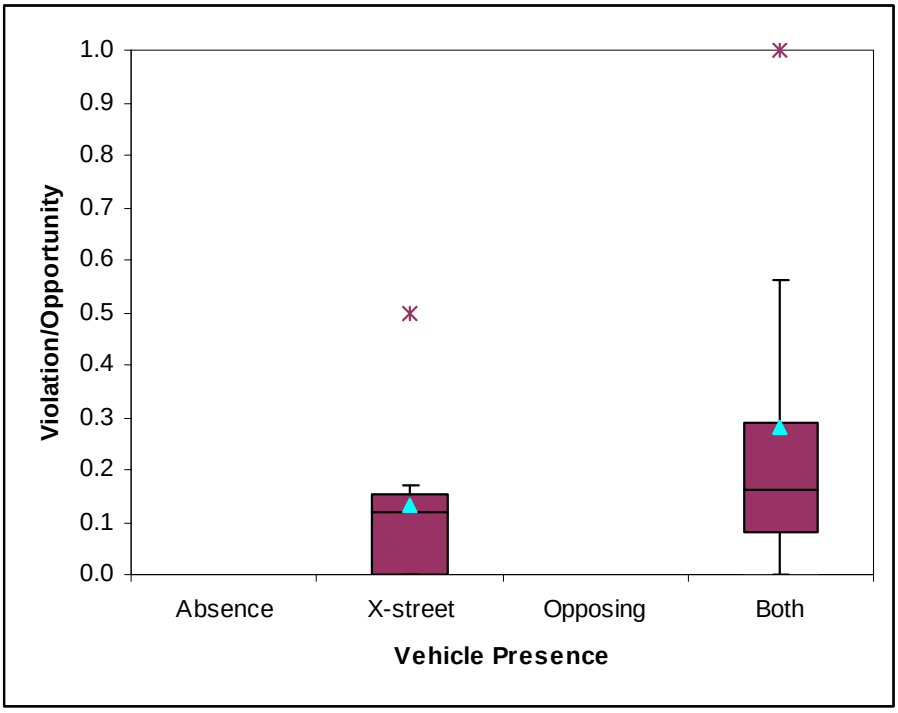

Figure 4.12 Minor 2 Right Vehicles Stop Violation:Opportunity Ratio vs. Presence Conflicting Vehicles at Red/Red Malfunction Flash

4.1.3 Out-of-turn Analysis

The purpose of this analysis is to determine how well drivers comply with the right of way regulations after they decide to stop, adding additional insight into driver comprehension. A high stopping rate means a high compliance rate, but not necessarily a high understanding of correct intersection operations. For instance, perhaps drivers stop out of confusion. It would be useful to analyze post-stop driver behavior to determine whether the intersection control is effectively understood.

Out-of-turn (OFT) violations are violations which involve a stopped vehicle that departs out of turn. Two types of violations are possible, 1) violating first-in-first-out, that is, a vehicle departs the intersection before another vehicle that arrived first, or 2) that the vehicle arrives at the same time as another vehicle and violates the positional right of way rules. Under the first-in-first-out rule, all vehicles which depart before a vehicle that arrived earlier are marked as OFT by time. Vehicles which depart before a same-arrival-time vehicle on the right-hand side or left-turning vehicles which depart before a same-arrival-time right/thru opposing vehicle are marked as OFT by position.

In Figure 4.13, the relationship between the major approaches' OFT by Time Violations and the minor/major volume ratio seems to be positive from the range of 0.00 to 0.40. The relationship may simply be a result of increasing percentages of cross street traffic creating more opportunities for violations. However, it may also suggest that as there are more vehicles on the cross-streets, the task of keeping up with arrival order may become more demanding. There's also the possibility of vehicles becoming impatient as their queue wait time increases. There is a gap of data for the mid-range ratios preventing confirmation of this trend for this region. For the minor approaches there is

no clear relationship between OFT by time violations and minor/major volume ratio (Figure 4.14). Violation rates are also greater than for the major approaches. These higher OFT rates may be caused by the high stop violation rates found in section 4.1.1 committed by the major approaches.

There is no meaningful conclusion drawn for the OFT by position case (Figure 4.15) as the opportunities for two vehicles to arrive at the same time are quite rare. Most violation rates, if there are any violations, stay below 0.03 (3%), no intersections have a violation rate exceeding 0.05 (5%).

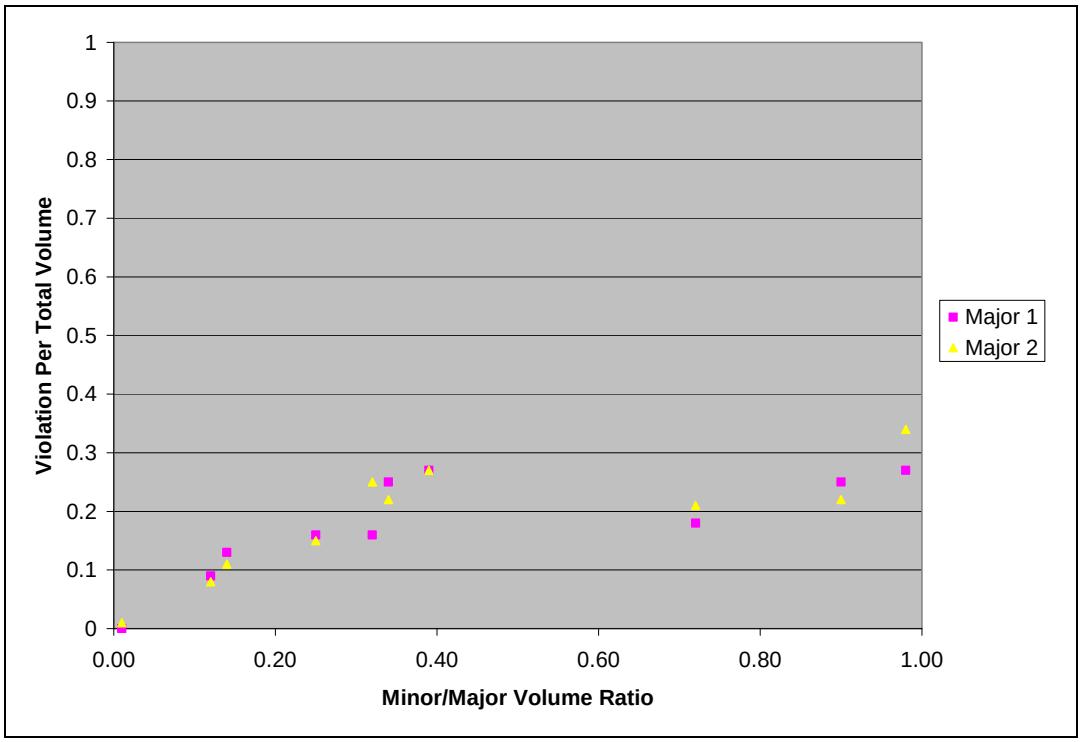

Figure 4.13 Major Approaches Out-of-Turn by Time Violations vs. Minor/Major Volume Ratio at Red/Red Malfunction Flash

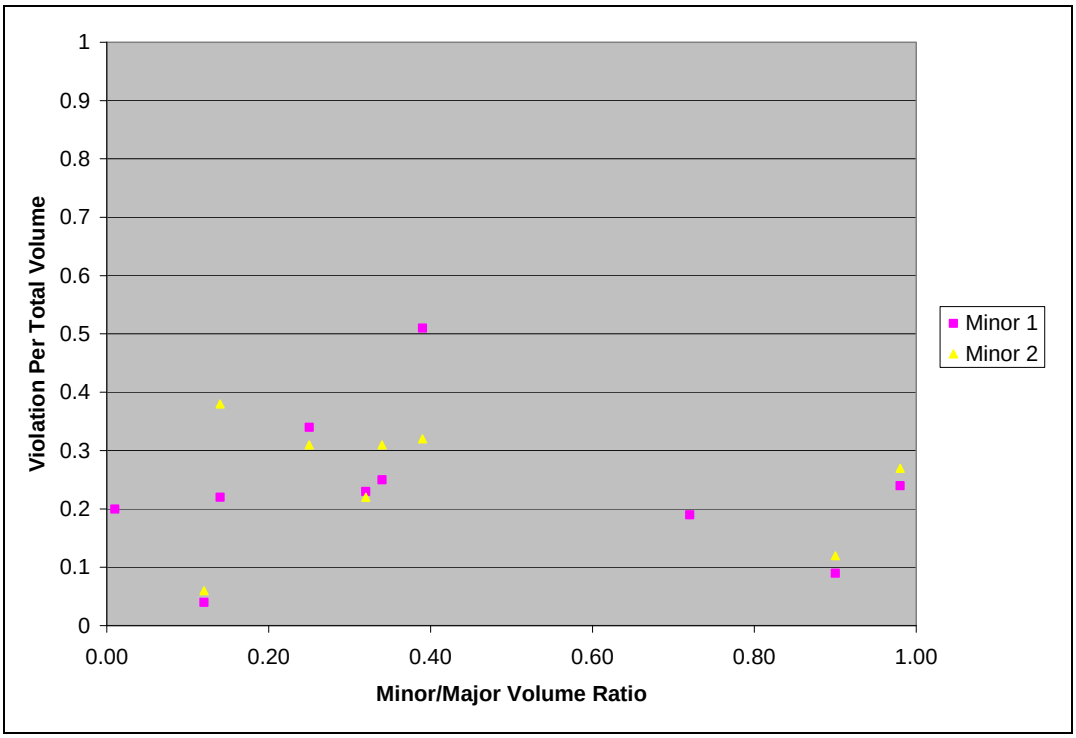

Figure 4.14 Minor Approaches Out-of-Turn by Time Violations vs. Minor/Major Volume Ratio at Red/Red Malfunction Flash

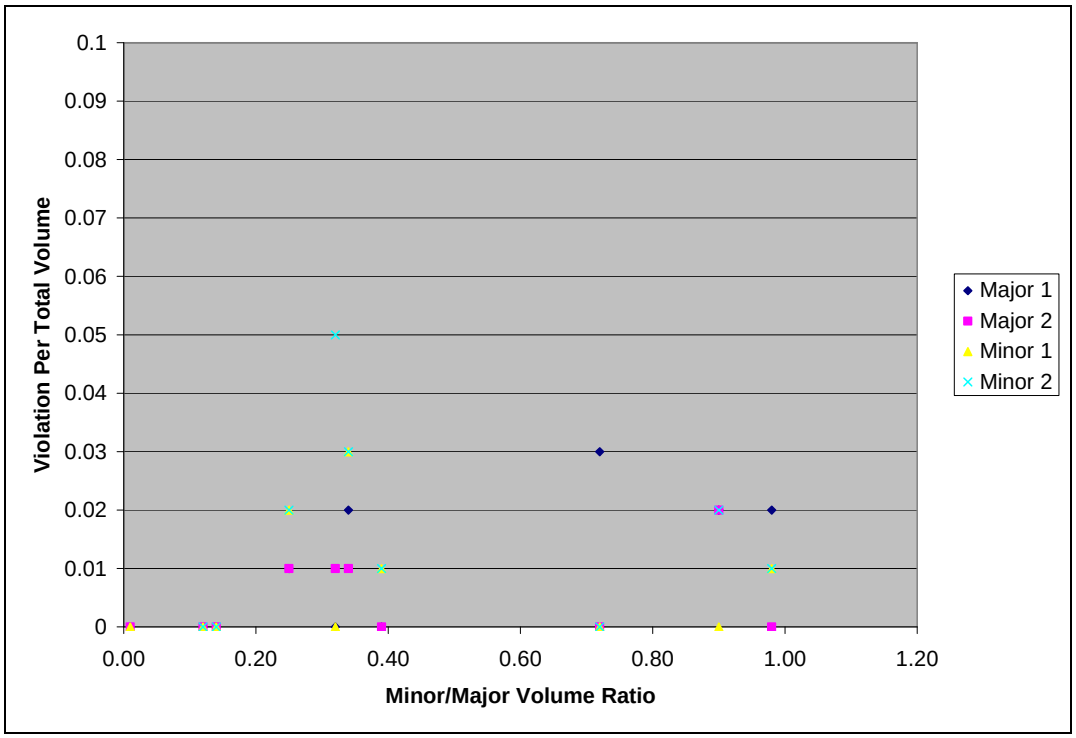

Figure 4.15 Out-of-Turn by Position Violations vs. Minor/Major Volume Ratio at Red/Red Malfunction Flash

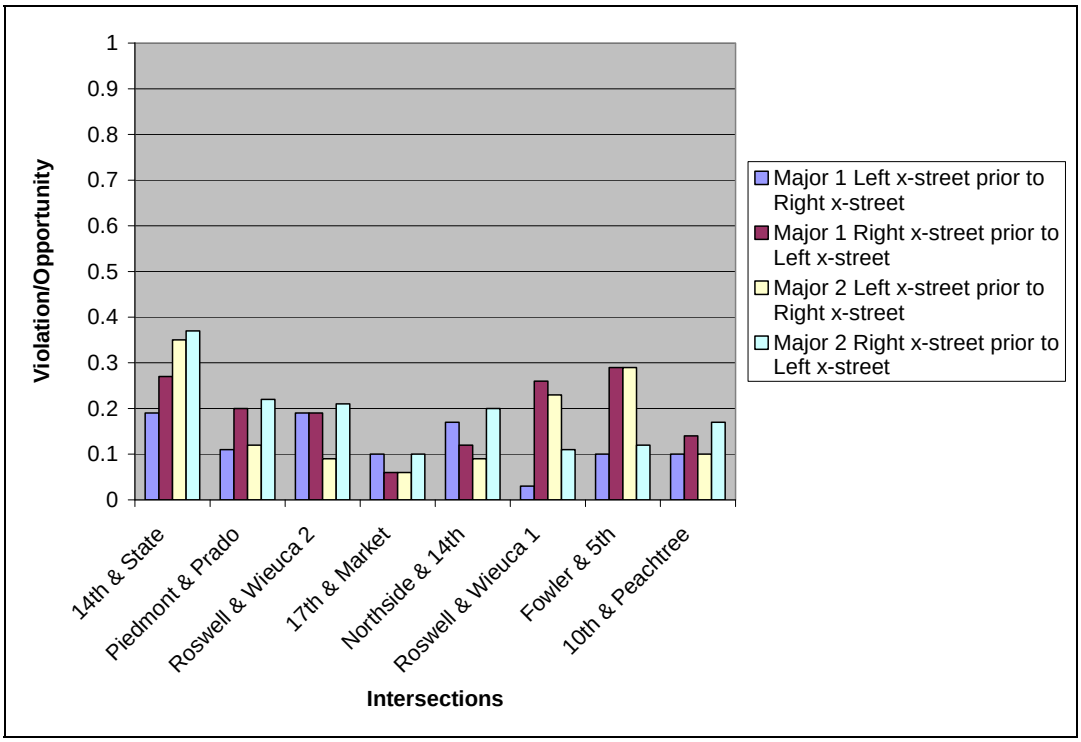

Figure 4.16 Major Cross-Street Out-of-Turn by Time Violations at Red/Red Malfunction Flash

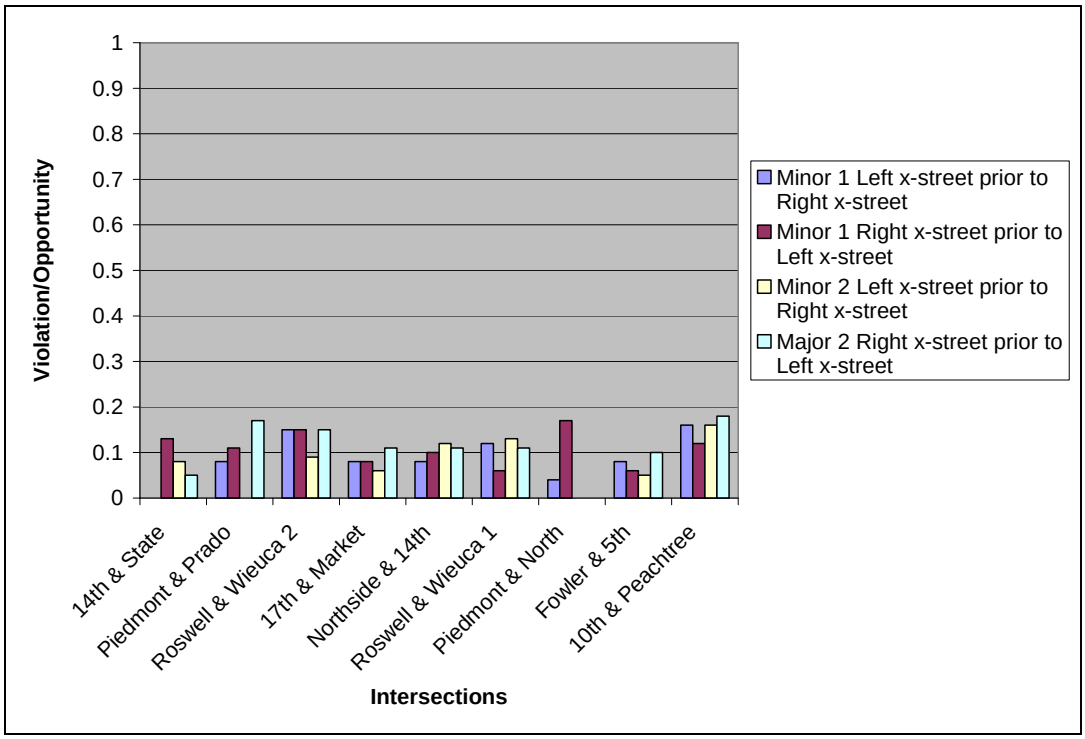

Figure 4.17 Minor Cross-street Out-of-Turn by Time Violations at Red/Red Malfunction Flash

There is not a consistent behavioral tendency when comparing the rates at which a vehicle departs out-of-turn over a cross street vehicle. That is, there does not seem to be a higher likelihood that a vehicle will depart out of turn over a left-hand or right-hand cross-street vehicle. This is the case for both major and minor approaches (Figure 4.16 and 4.17). Similarly, there is no definite preference found in the OFT by position cases. Although thru/right movements do go first more often, the difference is not consistent.

When comparing the likelihood of a left turning vehicle departing early against a through or right turning vehicle versus a through or right turning vehicle departing early against a left turning vehicle, it is found that the through/right turning vehicles tend to jump ahead more often (Figures 4.18 and 4.19). There are insufficient events where two conflicting opposing vehicles arrive at the same time, thus an analysis for the opposing OFT by position is not feasible.

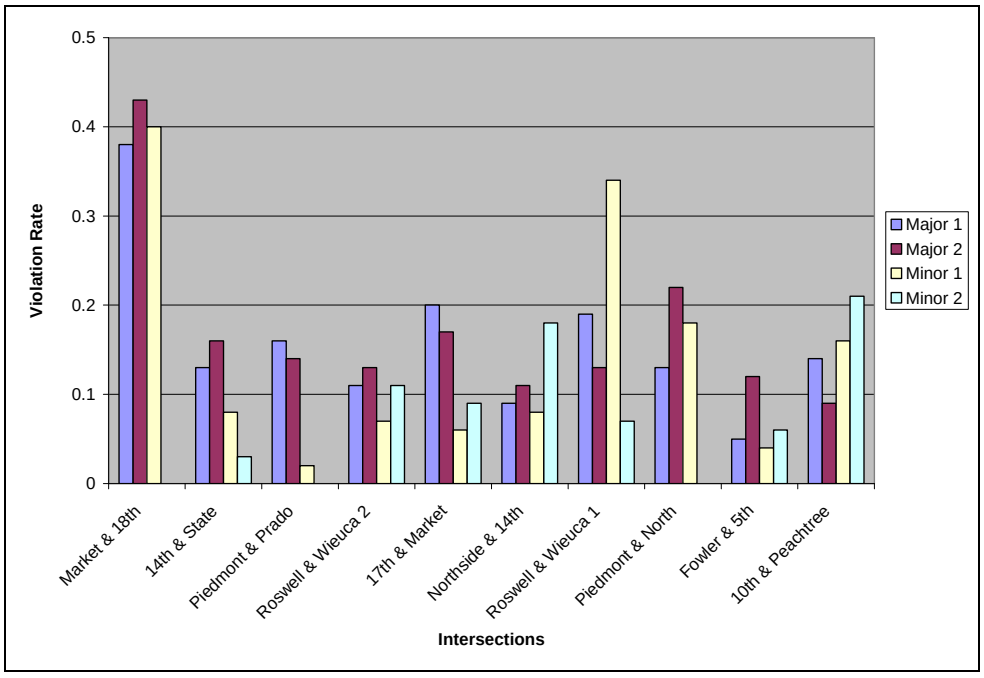

Figure 4.18 Major Opposing OFT by Time Violations at Red/Red Malfunction Flash

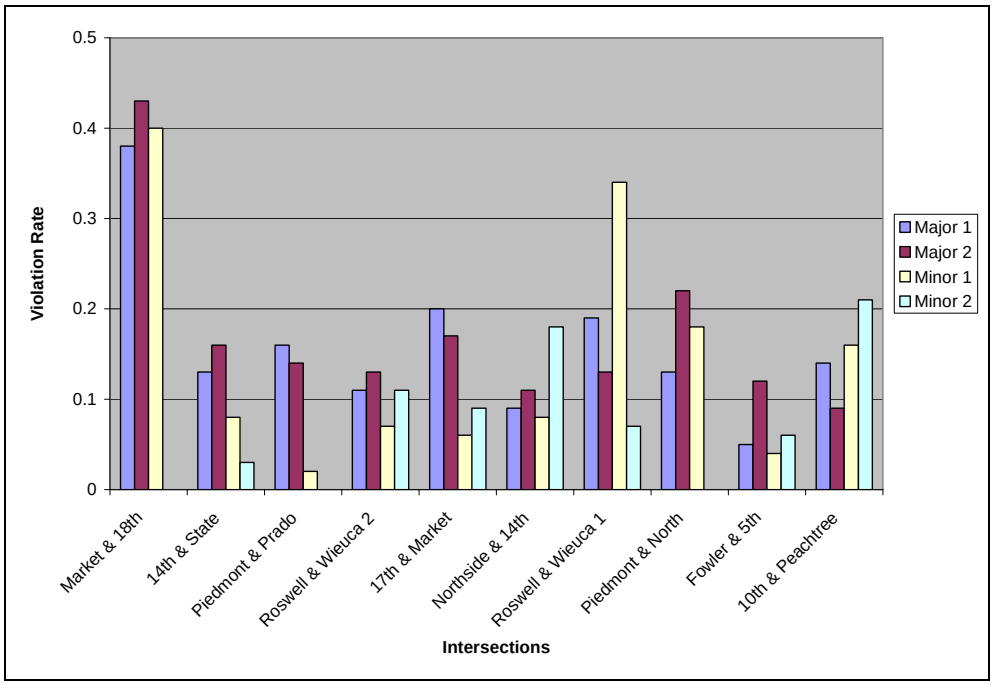

Figure 4.19 Minor Opposing OFT by Time Violations at Red/Red Malfunction Flash

In summary, major approach vehicles are more likely to violate the flash control than are minor approach vehicles. Although stop-violations at Red/Red malfunction flash intersections mostly occur in the presence of other conflicting vehicles, there is evidence that drivers are less likely to violate the control in presence of greater number of conflicts. There are, however, no clear preference in the type of conflict a vehicle faces when the driver makes the violation.

4.2 Yellow/Red Analysis

4.2.1 Stop Violation

There is a positive relationship between Major street stops and minor:major volume ratio as shown in Figure 4.20 on the following page. Intuitively, this trend is expected as drivers are more likely to be cautious when there is a more balanced ratio.

The same analysis can be found in Jenior's study with an extensive discussion regarding transitional periods as well as a related analysis with respect to minor street volumes. For minor street non-stops, two intersections' footages do not have sufficient camera angle to view the minor approaches and thus are excluded from the analysis. They are Rainbow Dr. and Candler Dr., and Howell Mill Rd. and 75 NB ramp. From the plot in Figure 4.21, no definite relationship can be indentified between minor street non-stops and minor/major volume ratio. Most minor street non-stop violation rates remain under a 0.30, compliance far better than high rate of vehicles stopping that receive a yellow flash, as is also noted by Jenior [1]. There are a few intersections which experienced higher rates as seen on Figure 4.21. At Techwood Dr. and Merritts Ave. for example, the rate is 0.50. This rate corresponds to one violation out of two opportunities. Such high rates are often seen at low-opportunity sites. At Howell Mill Rd. and I-75 SB ramp, however, the explanation for a 0.80 violation rate may actually be due to the fact that the off-ramp minor approach has heavy turning volumes. An overall 0.70 compliance rate, nonetheless, is still far too low. When a significant subset of vehicles receiving the yellow indication stop while a significant subset of vehicles receiving the red indication are not stopping, the original intention in using a Yellow/Red flash becomes meaningless.

When comparing the stop violation rate between minor left turning and thru movements and minor right turn movements, it is found that the violation rate of right-turns is in fact higher on average. Note in Figures 4.22 and 4.23 that the red bar (right-turn violations) are typically higher than the blue bar (left-turn and through violations). Again, this is probably a result of right-turns not being in direct conflict with their right-hand side approach and thus fewer conflicts requiring the right turning vehicle to stop.

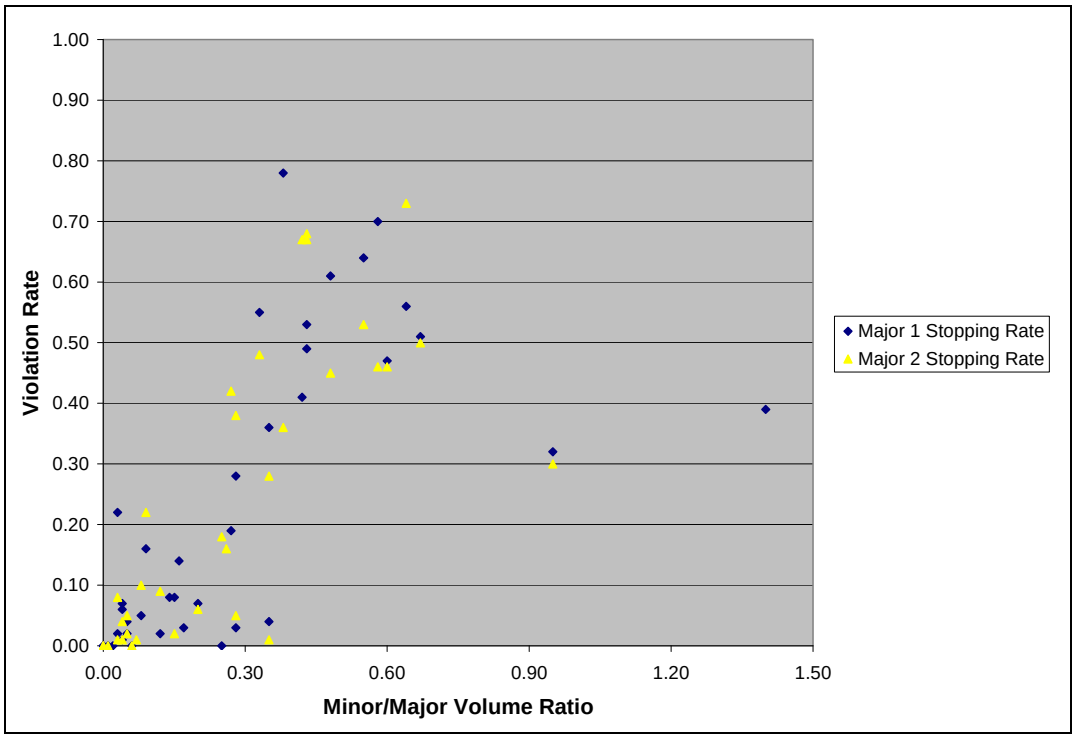

Figure 4.20 Major Approaches Right and Through Vehicles Stopping Rate vs. Minor/Major Volume Ratio at Yellow/Red Malfunction Flash

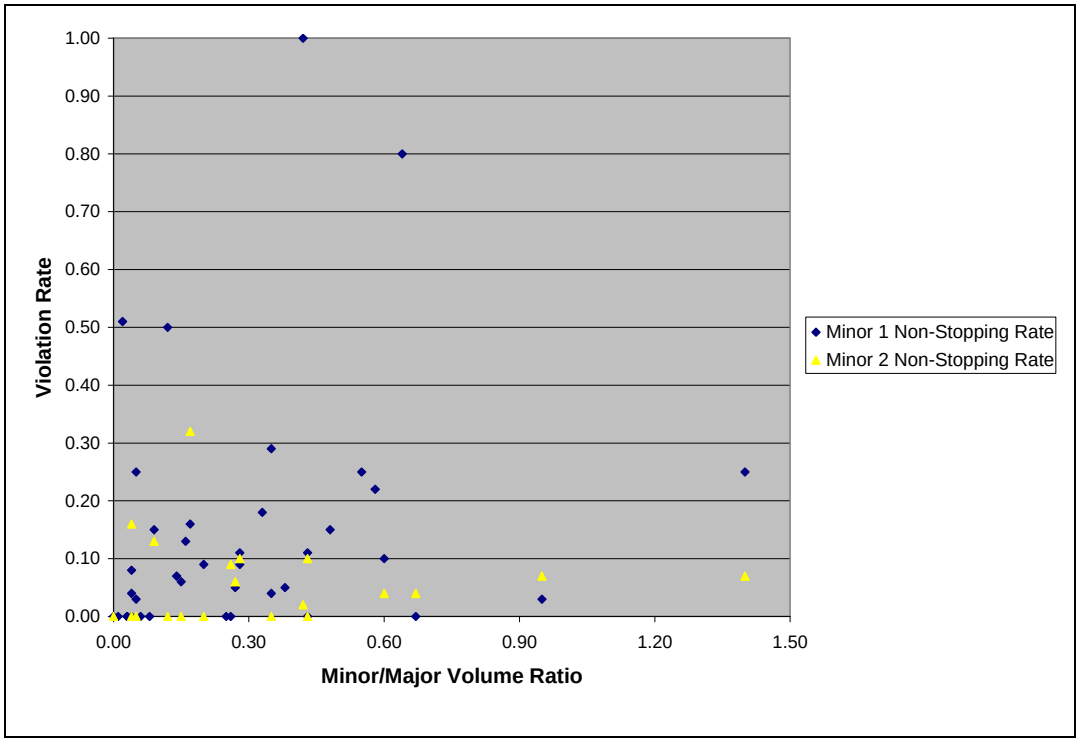

Figure 4.21 Minor Approaches Left and Through Vehicles Non-Stopping Rate vs. Minor/Major Volume Ratio at Yellow/Red Malfunction Flash

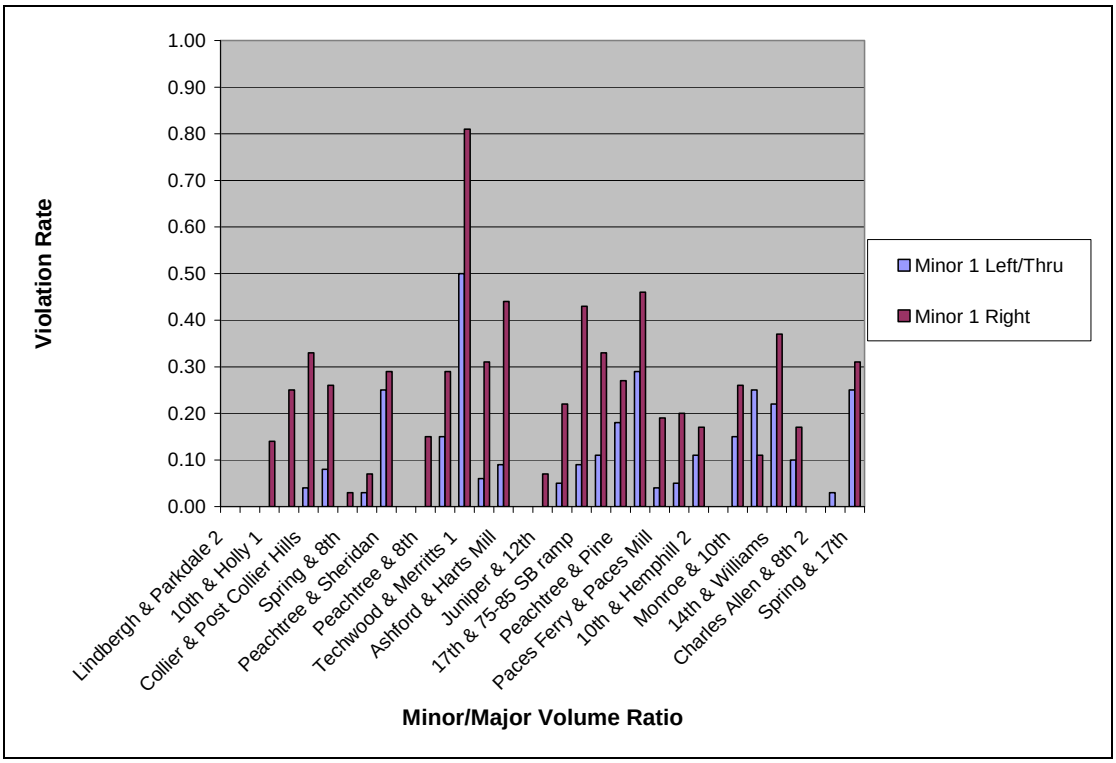

Figure 4.22 Minor 1 Non-Stopping Rate at Yellow/Red Malfunction Flash

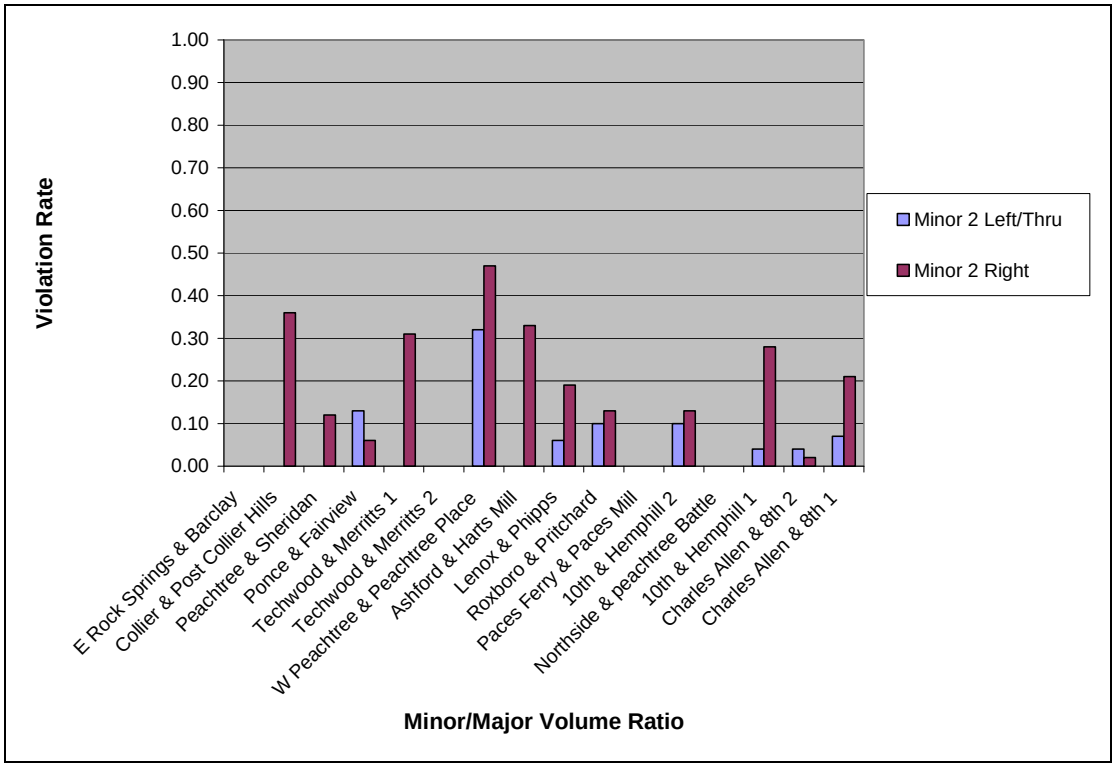

Figure 4.23 Minor 2 Non-Stopping Rate at Yellow/Red Malfunction Flash

4.2.2 Presence Analysis

Presence analysis is conducted for Yellow/Red malfunction flash in a manner similar to that undertaken for Red/Red malfunction flash occurrences. This evaluation includes separate analyses for all minor approach movements, through and right turn movements from major approaches, and left turn movements from major approaches.

4.2.2.1 Minor Approach Movements

Stop violations on minor approaches facing a red flash occur more often as the likelihood of a conflicting vehicle being present decreases. This trend is shown to exist for minor 1 from 0 vehicles to 2 vehicles present (Figure 4.24). However, there seems to be a higher violation rate when there are 3 vehicles present compared to other scenarios. This is due to the low chances of arriving at an intersection with vehicles present on all three other approaches. Hence there is a lack of data points for the 3 vehicles present case. There is also a reverse trend at Ponce de Leon Ave. and Fairview/Lullwater Rd. for minor 2. This is due to the low volume levels. There are 2, 3, and 2 violations for 1 vehicle, 2 vehicles, and 3 vehicles present respectively. So for four available opportunities, only 2 violations resulted in a 0.50 violation rate. For 10th St. and Hemphill Ave. 1, there are two violations out of five opportunities. Again, low opportunities allow for high violation rates should there be any violation. This is one of the drawbacks in choosing to represent data using rates rather than raw numbers.

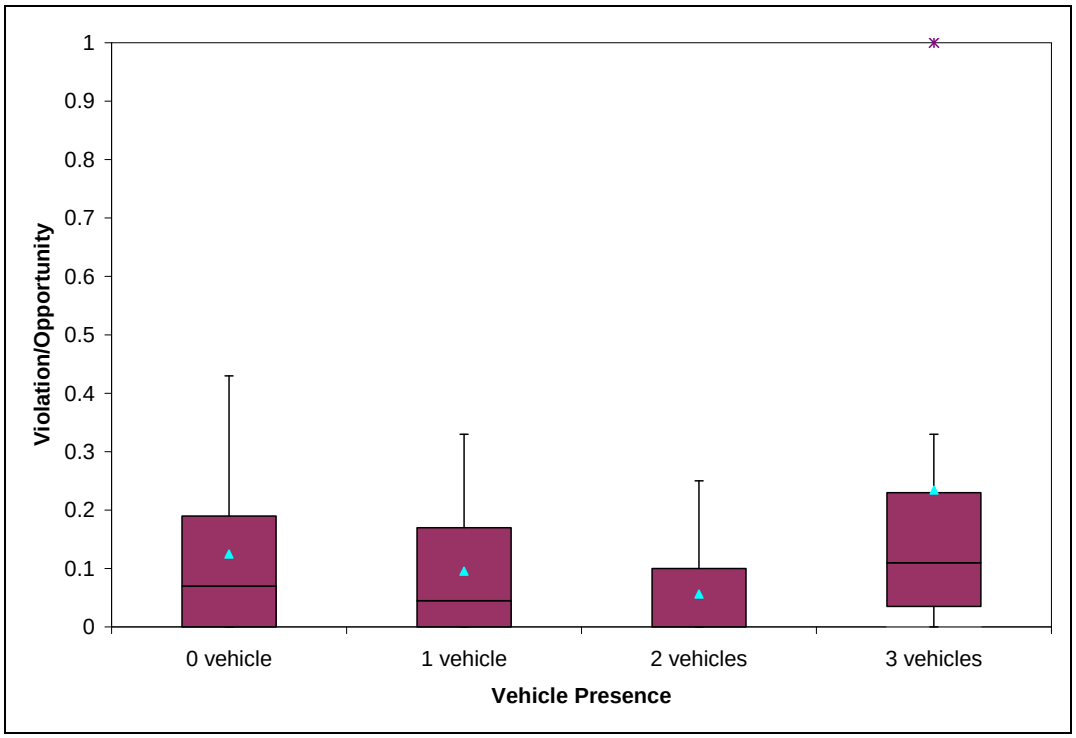

Figure 4.24 Minor 1 Through and Left Vehicles Stops/Opportunity Rate vs. Presence of Other Conflicting Vehicles at Yellow/Red Malfunction Flash

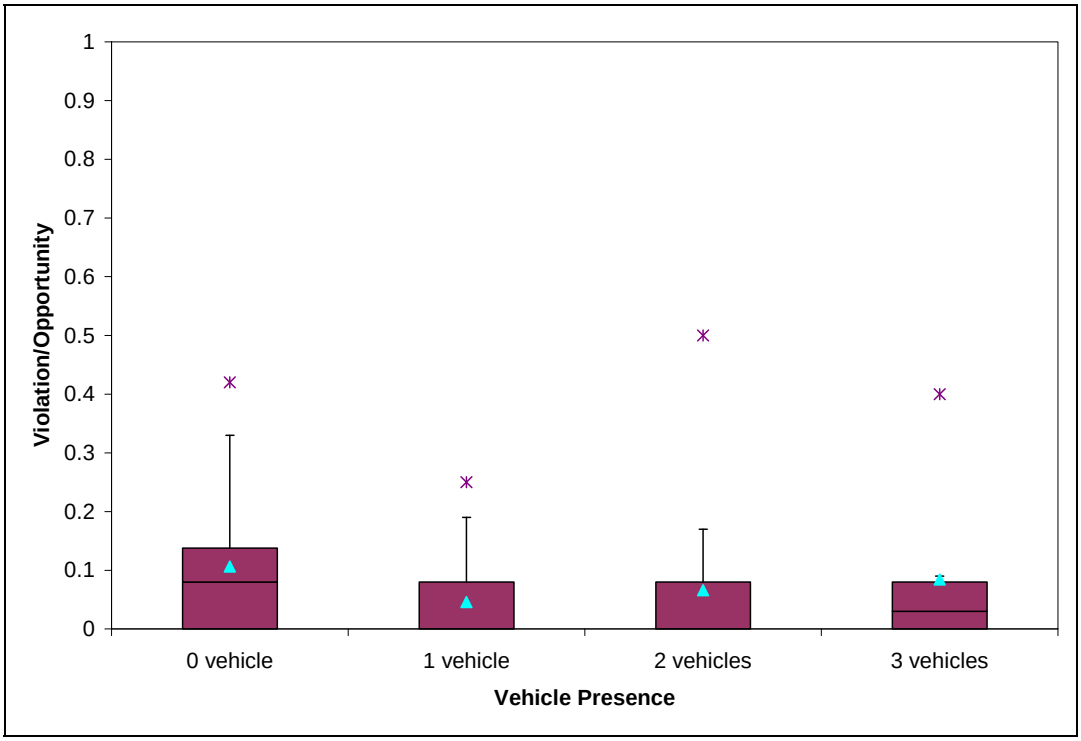

Figure 4.25 Minor 2 Through and Left Vehicles Non-Stops/Opportunity Rate vs. Presence of Other Conflicting Vehicles at Yellow/Red Malfunction Flash

4.2.2.2 Major Thru and Right Turning Vehicles

For major approaches, it is expected that the likelihood of a vehicle facing the yellow flash indication stopping increases as the number of vehicles present at the intersection increases or there is conflicting vehicle actively crossing the intersection. For major 1 (Figure 4.26), there are not enough instances of 3 vehicles being present to conclusively include that occurrence in the trend. It is shown, nonetheless, that vehicles stop less when there is an absence of other vehicles and more when there are 1, 2, or non-stopping vehicles from other approaches. The trend continues for major 2 (Figure 4.27), with more instances of 3 vehicles presence than on major 1, showing that vehicles do indeed stop more when there are potentially more conflicting vehicles present. The high stopping rates for absence of a vehicle (as high as 0.50), however, indicate that at some intersections drivers are either cautious or uncomfortable with traversing through the intersection even though they receive the yellow indication. This phenomenon will cause longer queues and greater confusion among others which will prolong the ineffective operational pattern. This result matches well with those of Jenior [1] where it is suggested that the relative functional classes of the intersecting roadways is a likely factor in the rate of stopping of vehicles on an approach facing a flashing yellow.

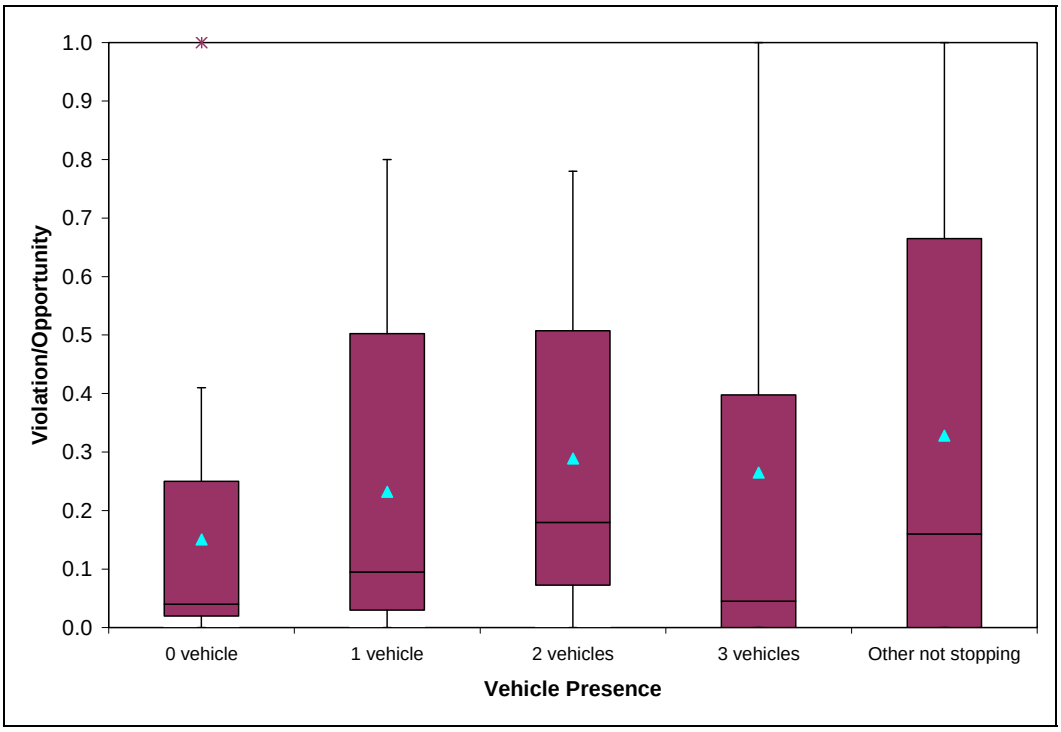

Figure 4.26 Major 1 Through and Right Vehicles Stops/Opportunity Rate vs. Presence of Other Conflicting Vehicles at Yellow/Red Malfunction Flash

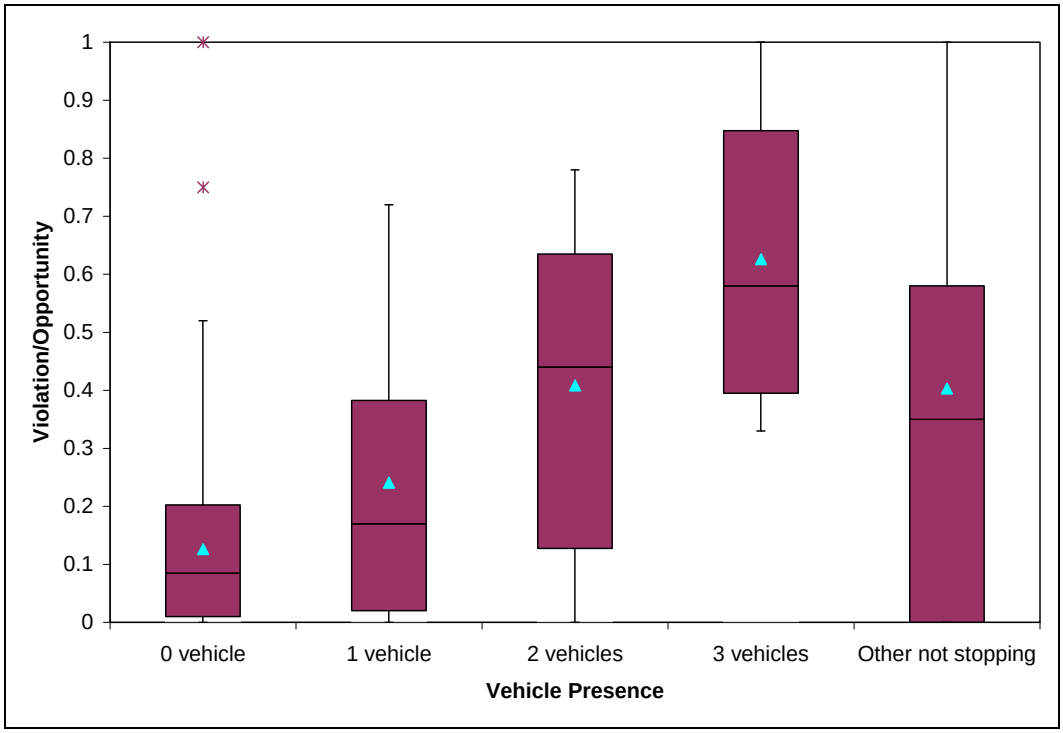

Figure 4.27 Major 2 Through and Right Vehicles Stops/Opportunity Rate vs. Presence of Other Conflicting Vehicles at Yellow/Red Malfunction Flash

4.2.2.3 Major Left Turning Vehicles

For left-turns on the major approaches, it is anticipated that most non-stops will occur when there are no other vehicles present. A clear expectation does not exist on whether major left-turns will yield to the minor vehicles waiting on the cross-streets. From the data compilation represented in Figures 4.28 and 4.29, it is shown that most left-turning vehicle non-stops occur when there are no vehicles present. There seems to be some consideration for the presence of minor approach vehicles as seen for major 1. The same indication is not as clear for major 2, which may suggest confusion among drivers. The non-stopping rate decreases significantly in the presence of a major approach vehicle. Violations are least likely to occur when there are both major and minor approach vehicles present at the same time.

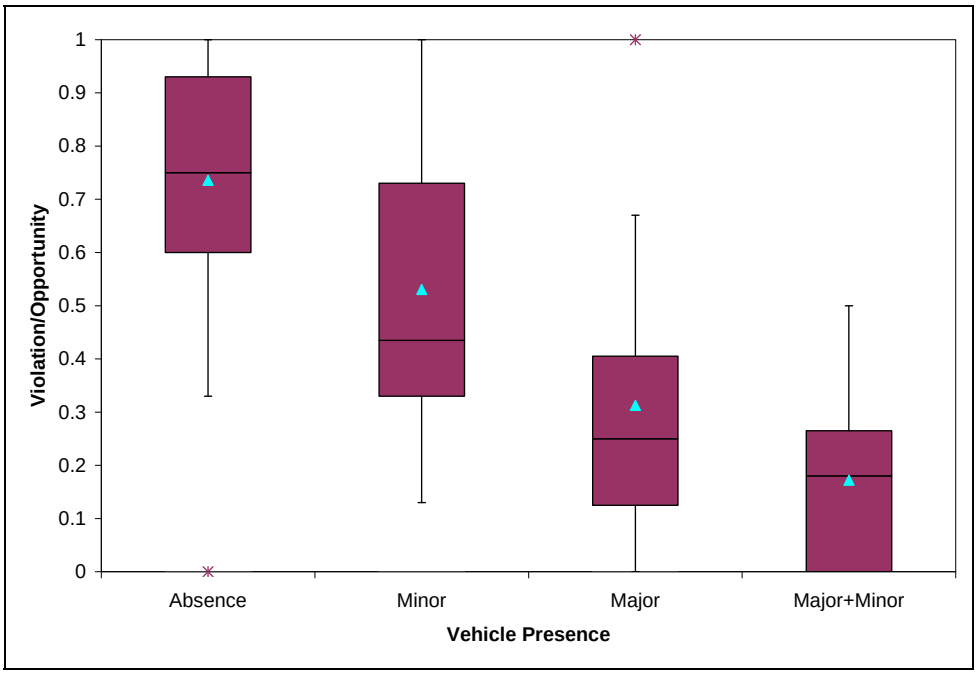

Figure 4.28 Major 1 Left Vehicles Non-Stops /Opportunity Rate vs. Presence of Other Conflicting Vehicles at Yellow/Red Malfunction Flash

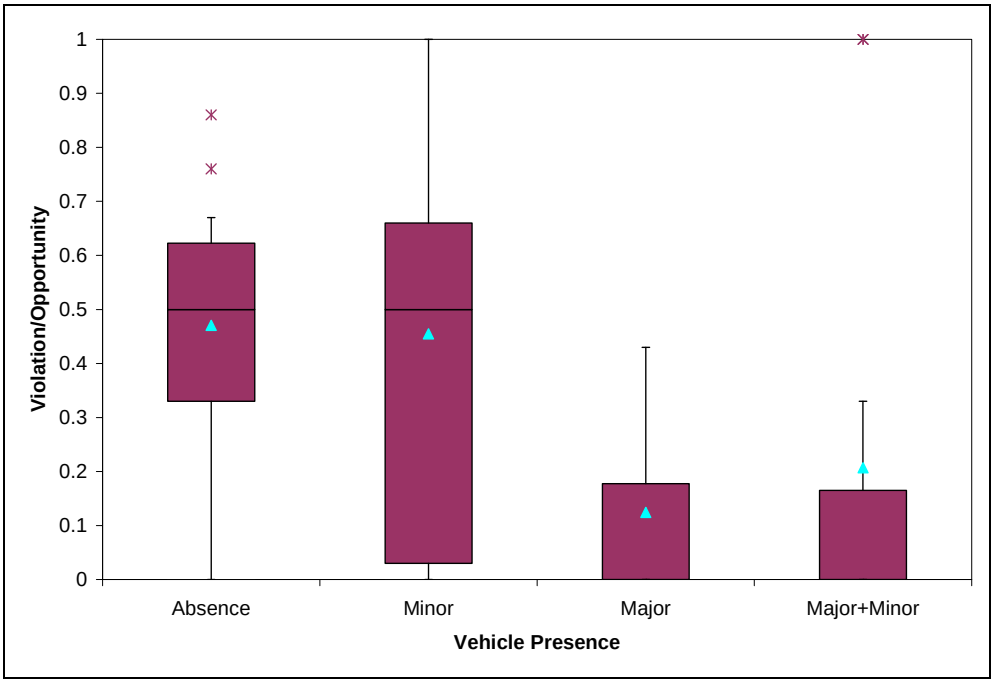

Figure 4.29 Major 2 Left Vehicles Non-Stops/Opportunity Rate vs. Presence of Other Conflicting Vehicles at Yellow/Red Malfunction Flash

4.2.3 Out-of-turn Analysis

Figure 4.30 plots the OFT violation rates of the minor approaches for all Yellow/Red malfunction flash occurrences. Here, the violation rates are seemingly lower than those from the Red/Red intersections. However, it is important to note that OFT violations by minor street vehicles at Yellow/Red malfunction flash intersections only include cases in which the minor street vehicles depart before other minor street vehicles or major street lefts that have the right of way. These violations do not include minor street vehicles OFT violations against major thru or right vehicle as in the Red/Red malfunction flash analysis. Thus, the opportunities for predefined violation types decrease substantially, leading to lower rates. Again, there is no correlation between violation rates and minor/major volume ratio.

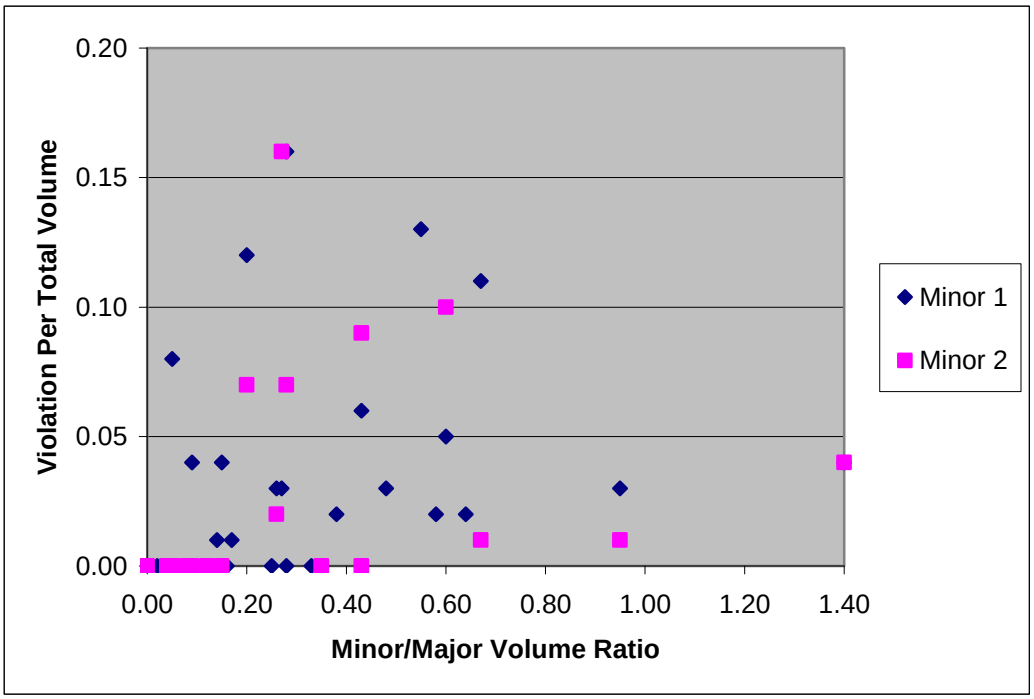

Figure 4.30 Minor Approaches OFT Violations vs. Minor/Major Volume Ratio at Yellow/Red Malfunction Flash

Similar to the out-of-turn analysis for Red/Red malfunction flash intersections, OFT violation comparisons between opposing left-turn and right-turn/thru movements are conducted for Yellow/Red malfunction flash intersections. While there is a strong indication that right-turn and through movement vehicles tend to depart before opposing left-turn vehicles on minor 2 (Figure 4.32), the same trend is not seen on minor 1 (Figure 4.31). Likely this is a result of factors unique to the intersections. For instance, 10th St. and Hemphill Ave. 2 has a heavy left-turning volume. This may explain the aggressive level of OFT violations. Charles Allen Dr. and 8th 2 on the other hand has a very low left-turning volume. Its high violation rate is a result of 2 of 5 violation opportunities resulting in an actual violation. Also, out of the original 41 Yellow/Red intersections, only 14 are four leg intersections. In other words, many of these intersections do not have a minor 2 approach. Many major approaches also do not have any left-turning volumes. The dataset for each minor approach is thus reduced significantly to only include intersections with opportunities for violations at that particular approach.

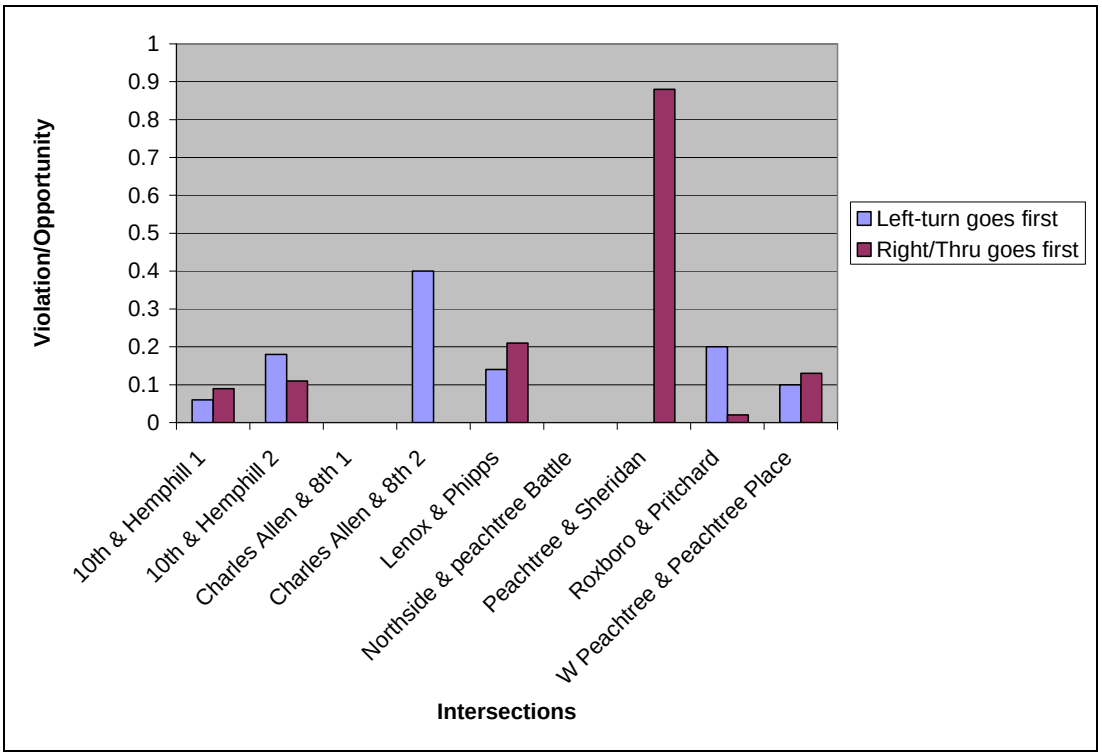

Figure 4.31 Minor 1 Opposing OFT by Time at Yellow/Red Malfunction Flash

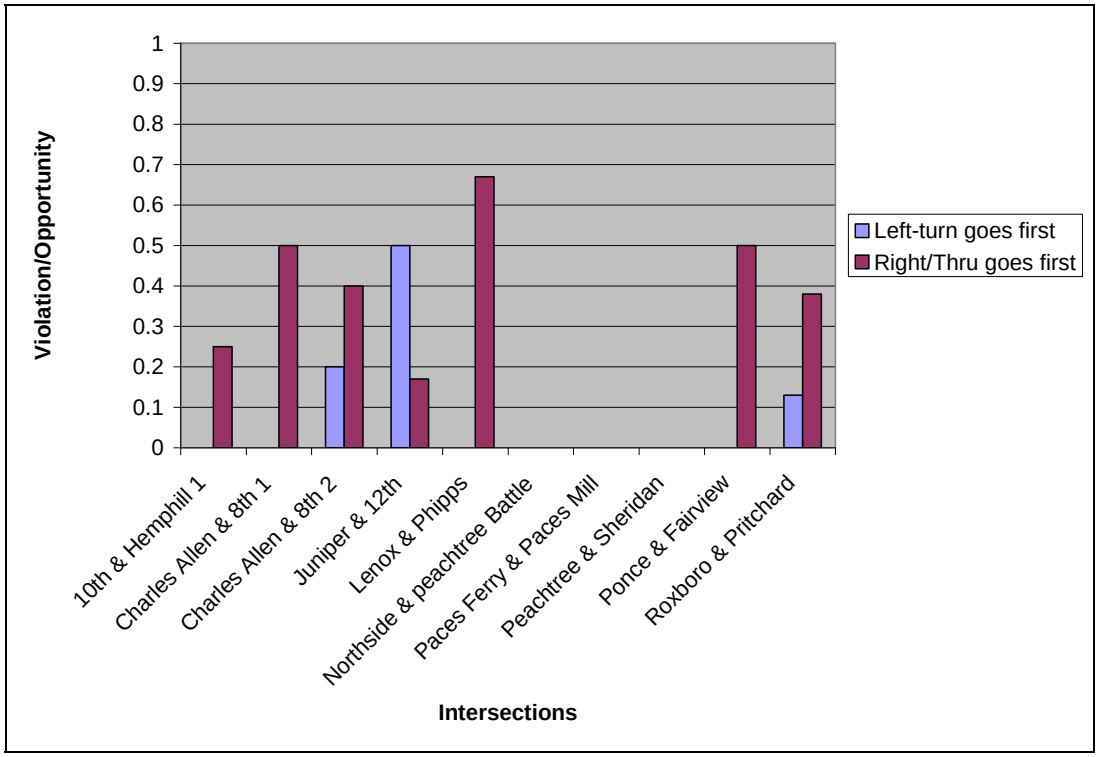

Figure 4.32 Minor 2 Opposing OFT by Time at Yellow/Red Malfunction flash

OFT violations at a Yellow/Red malfunction flash intersection are defined to only include conflicts between major lefts and minor street vehicles. The objective of this analysis is to determine whether major lefts are more likely to have priority over vehicles on the minor approaches, regardless of arrival time. Figures 4.33 through 4.36 illustrate violation rates of each major/minor approach pair. As seen, there is a significant subset of intersections where minor street vehicles tend to depart before major street left-turns. In many cases, it is found that these intersections have a higher minor approach volume compared to the major left-turning volume. Whether these violations are caused by confusion or sheer impatience, the lack of order may result in hazardous intersection conditions.

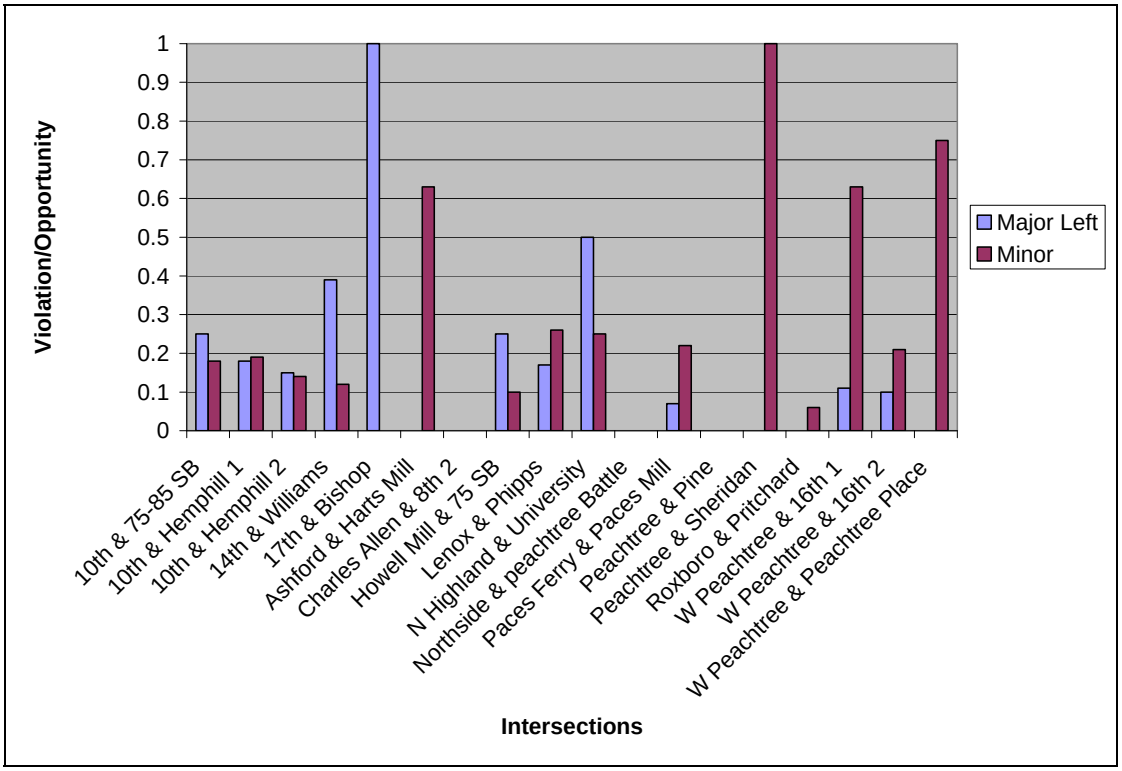

Figure 4.33 Major1-Minor1 Cross-street OFT by Time at Yellow/Red Malfunction Flash

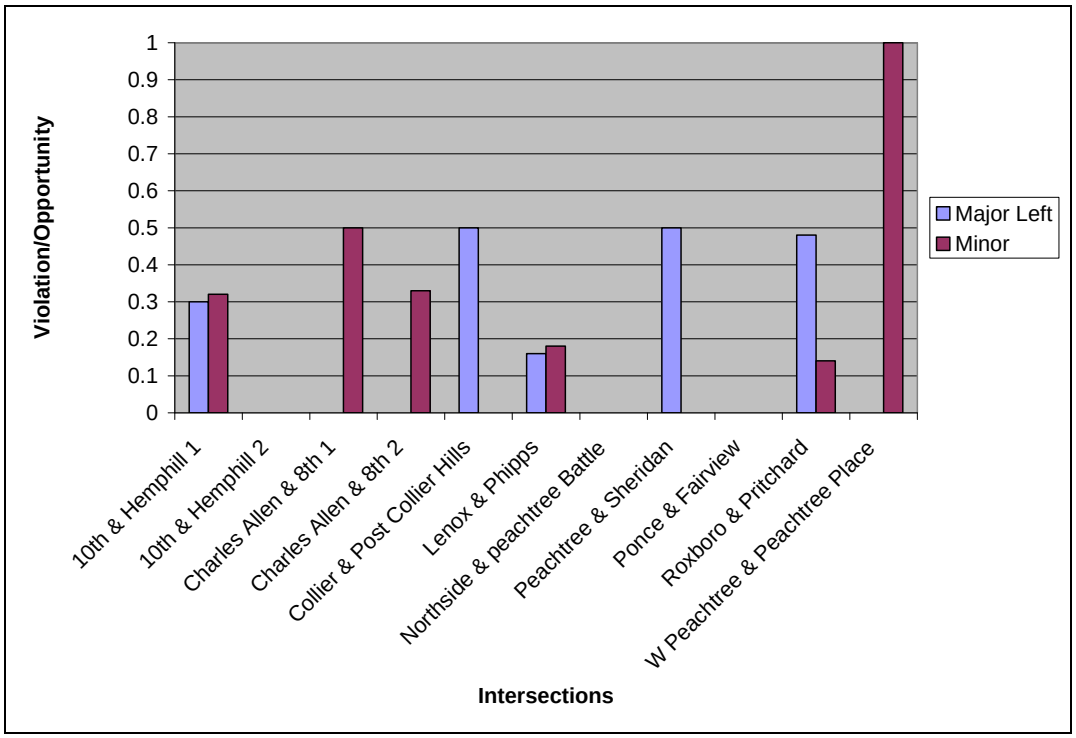

Figure 4.34 Major1-Minor2 Cross-street OFT by Time at Yellow/Red Malfunction Flash

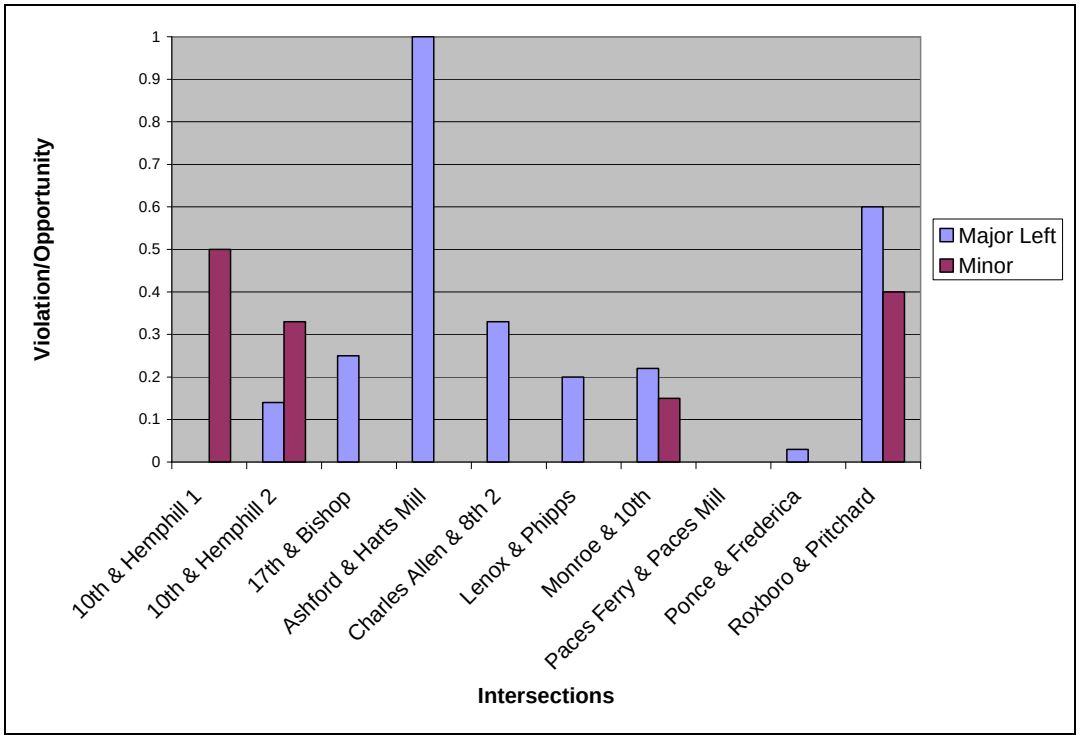

Figure 4.35 Major2-Minor1 Cross-street OFT by Time at Yellow/Red Malfunction Flash

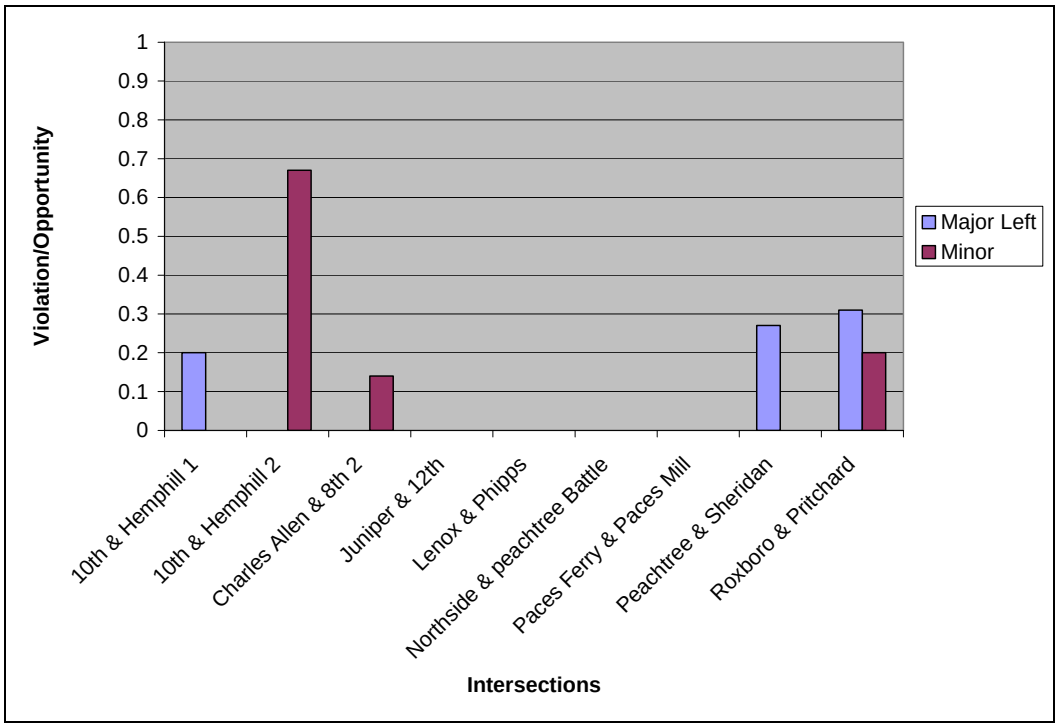

Figure 4.36 Major2-Minor2 Cross-street OFT by Time at Yellow/Red Malfunction Flash

In summary, major approach vehicles at intersections operating in Yellow/Red flash mode tend to stop more often under higher minor/major volume ratios. In addition, the stopping rates also increase with the increase of vehicle presence from the three other approaches. Major approach left-turning vehicles for the most part do not violate the control. However, there is an issue existing with minor approach vehicles departing before a major approach left-turning vehicle. Most of the stop compliance rates from the minor approaches also do not reach 0.90. Such rates are considered low for an expected rate of 1.00.

4.3 Stop-Controlled Observation

Observations from an analysis of two stop-controlled intersections will be discussed in this section. As the expectation exists within the traffic engineering community that driver behavior at the two modes of malfunction flash is similar to stop-controlled intersections it is informative to conduct an actual comparison between compliance and the driver behavior at stop controlled versus malfunction flash controlled intersections. For intersection geometries and volume information, refer to Appendix A.

4.3.1 Two-way Stop-controlled

The intersection at Arcado Rd. and Emily Dr. is chosen as the TWSC study site. Video footage is recorded from 7:20 AM to 9:20 AM, allowing for observations of morning peak and non-peak traffic. The minor/major volume ratio at this intersection is 0.04 for the first hour (peak hour) and 0.05 for the second hour (non-peak) of recording. Throughout the entire observation period (peak and non-peak) no major street through vehicles are observed to stop. Two stop violations by minor-street vehicles are observed during the peak hour, both of which turn right in absence of other conflicting vehicles. In the non-peak hour two right turn vehicles from the minor streets also do not completely stop. Again, the violations are made in absence of other conflicting vehicles. There is one occurrence of a major left-turning vehicle meeting a minor vehicle on the cross-street. The left-turn arrives after the minor cross street vehicle and traverses through the intersection first. There is also one occurrence of a minor left-turning vehicle meeting a minor right-turning vehicle. The left-turn arrives first and also departs before the opposing right-turn. Overall, violation of the traffic control at this intersection is very low.

4.3.2 All-way Stop-controlled

The intersection at Pirkle Rd. and Oakbrook Dr. is chosen as the AWSC study site. The stop signs at this site include an "all-way" sign indicating to drivers on all approaches that it is an AWSC intersection. Video footage is recorded in the afternoon to cover one hour of non-peak traffic (3:10-4:10 PM) and one hour of peak traffic (4:30-5:30 PM). The minor/major volume ratios for the non-peak and peak hour are 0.70 and 1.04, respectively. From observation, there is a higher rate of violations at this AWSC intersection compared to the TWSC intersection at Arcado Rd. and Emily Dr. Notably, there is a 0.17 (32/187) stop violation rate for the right-turning movements on minor 1 during the non-peak hour, in absence of other vehicles. The violation rate in presence of conflicting vehicles is only 0.02 (4/187). These rates suggest that most drivers understand appropriate behavior at a stop sign and likely fail to stop under the assumption it is safe given the lack of conflicting vehicles. Stop violation rates for the same right-turning movement drop to 0.07 (22/327) during peak hour. Likely this is due to the higher volumes resulting in a lower probability of a right turning vehicle arriving at the intersection in absence of conflicting vehicles.

There are only two OFT violations in the first hour, both from major 1. Two additional OFT violations occur on the same approach during the non-peak. OFT violations by minor 1 right-turn vehicles increase from 0 to 11 occurrences going from peak to off-peak. Of these nearly half occur in a very predictable fashion. By definition, an OFT violation is a violation in which a vehicle departs before an earlier arrived vehicle. However, observations seem to suggest that drivers don't adhere strictly to arrival time as an indication of order. Instead, they depart the intersection by approach

order. That is, because a major through was the last to traverse through the intersection, the next major through vehicle would tend to wait in line for a minor right turn vehicle to proceed as long as that minor right turn arrives at the stop-bar before the first major through vehicle clears the intersection. OFT violations from the remaining approaches are more straightforward, with some vehicles departing before their turn. The violations, however, do not seem to be a result of aggressive driving. The violation rates are also significantly less than that witnessed at the Red/Red malfunction flash intersections, with violation rates of only 0.01 for the major approach through movement and 0.03 for the minor approach right movement. The low stop-violation rates along with the orderly traveling pattern are indications of a high level of stop-sign control comprehension.

4.4 Chapter Summary

Intersections operating in Red/Red malfunction flash mode are seen to have lower stop compliance rate than expected. Furthermore, most of the stop violations occur in presence of at least one other conflicting vehicle at the intersection. When checked against the numbers of conflicting vehicles present, it is seen that violations are less likely to occur with more chances of conflict. This finding suggests drivers are aware of their environment and are not disregarding the control out of sheer recklessness. There is also a considerable percentage of vehicles that depart OFT after stopping. Thus, even among drivers who comply with the signal control, there may exist confusion or lack of comfort in traversing the intersection.

Intersections operating in Yellow/Red malfunction flash mode have a more predictable major approach violation rate than does an intersection in Red/Red mode. There is a positive relationship between major approach stops and minor/major volume

ratio. Non-stopping rates for minor approaches, however, seem to have no specific relationship with the volume ratio. There is indication that longer volumes, and thus longer queues may prompt violations by minor approach vehicles (or major lefts) and force major approaches to stop. There is also an OFT issue between minor approach vehicles and major approach left-turning vehicles which is against expectation. Although drivers seem to be mindful of increasing presence of vehicles on conflicting approaches, high violation rates may suggest a lack of comprehension if not a lack of awareness.

Comparing instances of both Yellow/Red and Red/Red flash to conventional stop-controlled intersections, it is seen that the two flash modes operate much different than expected. Intersections in Red/Red flash mode generally experience both higher stop violation rates and OFT violation rates than the AWSC intersection. Intersections in Yellow/Red flash modes have higher major approach stop rates and minor approach non-stop rates compared to the TWSC intersection. OFT violations are also higher at intersections in Yellow/Red flash mode than the TWSC site.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Intersections which operate in malfunction flash pose driver expectancy problems for road users no matter which mode is used. With a lack of literature on driver comprehension and safety at malfunction flash intersections, the objective of this research is to gain an understanding of malfunction flash control comprehension through the study of driver behavior. Quantifications of violation types in addition to behavior observation are completed for 39 instances of Yellow/Red flash and 10 instances of Red/Red flash. Four additional datasets of stop-controlled intersections are gathered for the purpose of cross-comparison. Findings from the analyses and subsequent conclusions are provided in the following sections.

5.1 Findings and Conclusions

For the intersections included in this study it is seen that stop violation rates predominately remain under 0.20 for Red/Red malfunction flash operation. Only in the example of extremely low volume ratios (i.e. 0.01) is this found not to hold, with 40% of the major approach vehicles failing to stop. These rates are significantly higher than those observed at the AWSC site, where violation rates for left and through vehicles are found to be 0.03 and 0.02 for the non-peak and peak periods, respectively. As only one AWSC intersection is observed, it may not be concluded that all AWSC intersections have as high a compliance rate. However, this is clearly an initial indication of likely lower compliance rates at Red/Red malfunction flash. In addition to the higher stop-violation rate, the Red/Red intersections also experienced higher OFT rates which may

indicate a lack of driver comfort with flash conditions or a lack of clear understanding of the right of way for traversing these intersections. Stop violation rates are observed to decrease with the presence of more vehicles. Drivers seem to be considerate of other vehicles and the potential conflict risk they present. While this does not indicate a clear understanding of the control by the drivers, it does indicate a level of awareness and that drivers are not simply ignoring the control.

It is observed that the major approach stopping rate at Yellow/Red intersections are positively correlated to the minor/major volume ratio. The higher the minor volume is relative to the major volume, the more likely a major approach vehicle will stop. At several intersections as many as half of the major approach vehicles stopped even without the presence of a conflicting vehicle. Only at extremely low volume ratios (<0.05) do the stopping rates approach zero. The generally high stopping rates indicate an operational disconnect as major approach vehicles are not expected to stop. There are also many instances where a major approach vehicle is either forced to stop or stops voluntarily to allow an opposing left-turning or minor street vehicles to traverse the intersection, particular in the higher volume scenarios. Thus, the major approach flow efficiency is not achieved at most of the studied Yellow/Red sites. In addition, stop violation rates for minor approaches are random with respect to minor/major volume ratio and are higher on average compared to stop violation rates at Red/Red intersections. This suggests that at high volume intersections, long queues on the minor approaches may test the drivers' patience, resulting in OFT violations.

Another noted difference between TWSC and Yellow/Red flash in found in the behavior of left turning vehicles. At a TWSC intersection priority is given to the major

street left turning vehicles. However, from the OFT analysis, findings show that there are actually high rates of minor approach vehicles traversing the intersection over the left turning vehicles. This is a safety concern as this aggressiveness in the minor streets vehicles may violate the left turning vehicles expectancy, creating dangerous situations.

It is concluded from the findings that while the Yellow/Red flash mode may have greater assumed benefits, they in fact do not operate as expected under higher minor/major volume ratios. At intersections where minor/major volume ratios are higher, especially when a defined minor approach has a volume similar to that of the major approaches, it is recommended that the Red/Red flash be used, removing any confusion over whether a vehicle is required to stop. Red/Red flash mode also simplifies the minor street vehicles' task of deciding when to proceed through the intersection. Also, a collision caused by an OFT movement at a Red/Red malfunction flash will likely be less damaging as it is between slow moving vehicles while collisions under Yellow/Red conditions are likely to occur under high speeds.

In general major street vehicles at Yellow/Red intersections meet operational expectations only under extremely low volume ratios (<0.05) and the major street vehicles at Red/Red intersections violate the control primarily under extremely low volume ratios (0.01). Given this one possible recommendation is that Yellow/Red flash mode be used for only sites with volume ratios lower than 0.05. However, as the number of Red/Red flash intersections increase it is possible drivers will develop a general expectancy of Red/Red flash in all malfunction situations, resulting in a need for all intersections to operation in Red/Red malfunction flash, including those with very low volume ratios.

5.2 Study limitations and Recommendations

Although this research studied out-of-turn violations as a measure for post-stop traffic control compliance, the methods of study did not take into account events in which a minor street vehicle fails to yield the right of way to a major street vehicle at a Yellow/Red flashing intersection as a result of poor speed and distance judgment. It is recommended that these events be incorporated into future analyses. Also due to resource constraints, only two stop-controlled intersections are observed. For a more meaningful comparison it is recommended that additional stop-controlled intersections be included in future studies.

APPENDIX A

AERIAL PHOTOGRAPHS AND VOLUME COUNTS OF STOP-CONTROLLED INTERSECTIONS

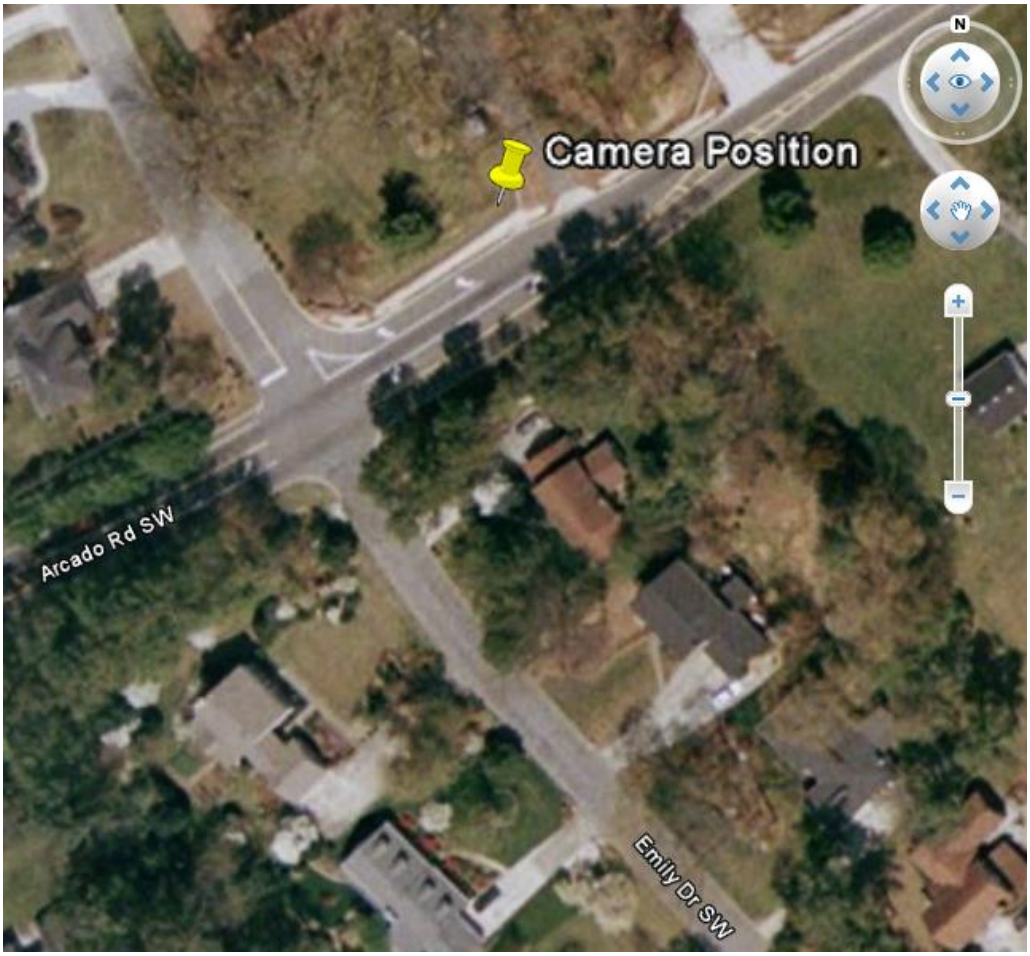

Figure A.1 Aerial Photograph of Arcado Rd. and Emily Dr. Intersection

Table A.1 Volume Count at Arcado Rd. and Emily Dr. 7:20-8:20 AM (Peak-hour)

	Total	Left	Thru	Right
Major 1 (WB)	626	1	618	7
Major 2 (EB)	333	1	329	3
Minor 1 (SB)	11	1	0	10
Minor 2 (NB)	30	17	0	13

Table A.2 Volume Count at Arcado Rd. and Emily Dr. 8:20-9:20 AM (Non-peak)

	Total	Left	Thru	Right
Major 1 (WB)	464	8	451	5
Major 2 (EB)	406	3	399	4
Minor 1 (SB)	18	9	0	9
Minor 2 (NB)	29	7	1	21

Figure A.2 Aerial Photograph of Pirkle Rd. and Oakbrook Dr. Intersection

Table A.3 Volume Count at Pirkle Rd. and Oakbrook Dr. 3:10-4:10 PM (Non-peak)

Major 1 (SB)	223	16	193	14
Major 2 (NB)	211	64	144	3
Minor 1 (EB)	241	40	14	187
Minor 2 (WB)	61	11	10	40

Table A.4 Volume Count at Pirkle Rd. and Oakbrook Dr. 4:30-5:30 PM (Peak-hour)

	Total	Left	Thru	Right
Major 1 (SB)	293	13	268	12
Major 2 (NB)	215	48	165	2
Minor 1 (EB)	382	41	14	327
Minor 2 (WB)	145	29	32	84

APPENDIX B

RED/RED RAW VIOLATION AND OPPORTUNITY DATA

Table B.1 Keys to Raw Data Events at Red/Red Intersections

Keys					
Stop violation	Left or Thru movements		Right-turn movements	Platoons	
Presence of right x-street vehicle	1a			1a1	
Presence of left x-street vehicle	1b		1rb	1b1	1rb1
Presence of opposing vehicle	1c		1rc	1c1	1rc1
Right x-street and opposing	1d		1re	1d1	1re1
Left x-street and opposing	1e			1_e1	
Both x-streets	1f			1f1	
Presence of veh on all approaches	1g			1g1	
Absence of vehicle	2			2_1	
Out of turn by time					
left x-street cuts right x-street	9a				
right x-street cuts left x-street	9b				
opposing L cuts opposing T/R	9c				
opposing T/R cuts opposing L	9d				
Out of turn by position					
left x-street cuts right x-street	10a				
right x-street goes first	10b				
opposing L cuts opposing T/R	10c				
opposing T/R goes first	10d				

Table B.2 10th St.and Peachtree Stop Violation Counts

Violation Data	Behavior Type											
Stop Violation	**1a**	**1b**	**1c**	**1d**	**1e**	**1f**	**1g**	**1rb**	**1rc**	**1re**	**2**	**r2**
Major 1	0	0	0	1	1	2	11	1	0	12	0	0
Major2	0	0	0	0	1	2	3	1	0	2	0	0
Minor 1	0	0	3	0	0	2	9	2	0	6	3	0
Minor 2	1	1	9	10	6	2	18	1	0	15	1	0
Stop Platoon	**1a1**	**1b1**	**1c1**	**1d1**	**1_e1**	**1f1**	**1g1**	**1rb1**	**1rc1**	**1re1**	**2_1**	**r21**
Major 1	0	0	1	4	0	6	16	5	0	0	0	0
Major2	0	0	0	2	1	3	8	1	0	0	0	0
Minor 1	0	2	1	4	1	3	7	0	0	0	2	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0

Table B.3 10th St. and Peachtree Out-of-turn Counts

Violation Data	Behavior Type								
OFT by Time	**9a**	**9b**	**9c**	**9d**	**OFT by Position**	**10a**	**10b**	**10c**	**10d**
Major 1	22	31	8	2	**Major 1**	5	10	1	0
Major2	21	32	0	8	**Major2**	0	5	0	0
Minor 1	25	21	0	1	**Minor 1**	4	2	0	1
Minor 2	28	31	5	1	**Minor 2**	4	5	0	0

Table B.4 10th St.and Peachtree Opportunity for Stop Violation Counts

Base Data	Behavior Type											
Stop Violation	**1a**	**1b**	**1c**	**1d**	**1e**	**1f**	**1g**	**1rb**	**1rc**	**1re**	**2**	**r2**
Major 1	6	4	2	18	20	46	175	12	0	47	0	0
Major2	5	1	1	22	15	42	125	16	0	36	0	0
Minor 1	0	4	15	40	33	17	117	9	0	36	9	0
Minor 2	4	10	22	43	46	18	133	2	0	27	2	0

Table B.5 10th St. and Peachtree Opportunity for Out-of-turn Counts

Base Data	Behavior Type								
OFT by Time	**9a**	**9b**	**9c**	**9d**	**OFT by Position**	**10a**	**10b**	**10c**	**10d**
Major 1	219	221	41	25	**Major 1**	19	23	2	0
Major2	213	186	11	63	**Major2**	3	19	0	1
Minor 1	157	170	20	41	**Minor 1**	20	3	0	3
Minor 2	170	174	35	20	**Minor 2**	12	18	3	0

Table B.6 14th St.and State Stop Violation Counts

Violation Data	Behavior Type											
Stop Violation	**1a**	**1b**	**1c**	**1d**	**1e**	**1f**	**1g**	**1rb**	**1rc**	**1re**	**2**	**r2**
Major 1	2	0	10	0	0	0	0	1	0	1	11	0
Major2	0	1	13	1	2	0	0	1	0	2	37	0
Minor 1	0	0	0	0	0	0	0	4	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	1	0	0
Stop Platoon	**1a1**	**1b1**	**1c1**	**1d1**	**1_e1**	**1f1**	**1g1**	**1rb1**	**1rc1**	**1re1**	**2_1**	**r21**
Major 1	0	0	2	1	0	0	0	0	0	0	3	0
Major2	1	3	3	0	1	0	0	0	0	0	13	0
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0

Table B.7 14th St. and State Out-of-turn Counts

Violation Data	Behavior Type								
OFT by Time	**9a**	**9b**	**9c**	**9d**	**OFT by Position**	**10a**	**10b**	**10c**	**10d**
Major 1	6	3	0	8	**Major 1**	0	0	0	1
Major2	12	19	0	4	**Major2**	0	0	0	0
Minor 1	0	2	0	0	**Minor 1**	0	0	0	0
Minor 2	1	1	0	0	**Minor 2**	0	0	0	0

Table B.8 14th St.and State Opportunity for Stop Violation Counts

Base Data	Behavior Type											
Stop Violation	**1a**	**1b**	**1c**	**1d**	**1e**	**1f**	**1g**	**1rb**	**1rc**	**1re**	**2**	**r2**
Major 1	10	5	91	22	5	0	0	9	0	10	75	0
Major2	24	30	120	7	21	4	0	13	0	8	237	0
Minor 1	10	3	1	1	0	5	0	23	0	0	9	0
Minor 2	0	6	0	0	2	7	0	8	0	1	8	0

Table B.9 14th St. and State Opportunity for Out-of-turn Counts

Base Data	Behavior Type								
OFT by Time	**9a**	**9b**	**9c**	**9d**	**OFT by Position**	**10a**	**10b**	**10c**	**10d**
Major 1	31	11	3	19	**Major 1**	0	0	0	1
Major2	34	52	15	6	**Major2**	0	0	1	0
Minor 1	25	16	0	0	**Minor 1**	0	0	0	0
Minor 2	12	19	1	0	**Minor 2**	0	0	0	0

Table B.10 17th St.and Market St. Stop Violation Counts

Violation Data	Behavior Type											
Stop Violation	**1a**	**1b**	**1c**	**1d**	**1e**	**1f**	**1g**	**1rb**	**1rc**	**1re**	**2**	**r2**
Major 1	5	1	9	0	4	4	2	20	0	25	9	0
Major2	3	1	17	2	6	3	5	1	0	4	4	0
Minor 1	0	0	0	0	0	1	0	13	0	1	0	0
Minor 2	2	0	0	0	0	3	2	3	0	1	0	0
Stop Platoon	**1a1**	**1b1**	**1c1**	**1d1**	**1_e1**	**1f1**	**1g1**	**1rb1**	**1rc1**	**1re1**	**2_1**	**r21**
Major 1	3	3	11	3	0	0	2	14	0	0	6	0
Major2	1	1	6	1	5	0	2	0	0	0	0	0
Minor 1	0	0	0	0	0	0	0	5	0	0	0	0
Minor 2	0	2	0	0	0	0	0	2	0	0	0	0

Table B.11 17th St. and Market Out-of-turn Counts

Violation Data	Behavior Type								
OFT by Time	**9a**	**9b**	**9c**	**9d**	**OFT by Position**	**10a**	**10b**	**10c**	**10d**
Major 1	28	13	5	42	**Major 1**	1	3	0	8
Major2	9	17	10	35	**Major2**	0	5	2	5
Minor 1	9	8	0	5	**Minor 1**	0	1	0	0
Minor 2	6	16	4	2	**Minor 2**	6	2	3	0

Table B.12 17th St.and Market St. Opportunity for Stop Violation Counts

Base Data	Behavior Type											
Stop Violation	**1a**	**1b**	**1c**	**1d**	**1e**	**1f**	**1g**	**1rb**	**1rc**	**1re**	**2**	**r2**
Major 1	54	24	102	72	31	25	64	47	0	75	67	0
Major2	16	15	99	42	78	11	66	1	0	4	16	0
Minor 1	3	0	2	1	2	11	13	48	0	56	1	0
Minor 2	9	16	6	4	7	34	31	29	0	13	0	0

Table B.13 17th St. and Market St. Opportunity for Out-of-turn Counts

Base Data	Behavior Type								
OFT by Time	**9a**	**9b**	**9c**	**9d**	**OFT by Position**	**10a**	**10b**	**10c**	**10d**
Major 1	270	212	46	133	**Major 1**	4	14	1	8
Major2	162	168	61	59	**Major2**	15	25	6	1
Minor 1	118	100	3	49	**Minor 1**	14	11	0	4
Minor 2	103	143	41	3	**Minor 2**	24	7	4	0

Table B.14 Fowler St. and 5th St. Stop Violation Counts

Violation Data	Behavior Type											
Stop Violation	**1a**	**1b**	**1c**	**1d**	**1e**	**1f**	**1g**	**1rb**	**1rc**	**1re**	**2**	**r2**
Major 1	0	0	0	1	1	0	0	0	0	4	0	0
Major2	0	1	1	3	1	4	1	6	0	2	8	0
Minor 1	0	0	1	0	0	0	0	2	0	2	3	0
Minor 2	0	0	1	1	0	0	2	2	0	5	0	0
Stop Platoon	**1a1**	**1b1**	**1c1**	**1d1**	**1_e1**	**1f1**	**1g1**	**1rb1**	**1rc1**	**1re1**	**2_1**	**r21**
Major 1	0	0	0	1	0	0	0	0	0	0	1	0
Major2	2	3	0	2	2	0	0	5	0	0	2	0
Minor 1	0	0	0	0	0	0	0	2	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0

Table B.15 Fowler St. and 5th St. Out-of-turn Counts

Violation Data	Behavior Type								
OFT by Time	**9a**	**9b**	**9c**	**9d**	**OFT by Position**	**10a**	**10b**	**10c**	**10d**
Major 1	6	30	1	2	**Major 1**	4	0	0	1
Major2	48	13	0	2	**Major2**	6	6	0	1
Minor 1	8	8	1	2	**Minor 1**	0	2	0	0
Minor 2	5	7	3	5	**Minor 2**	3	3	0	0

Table B.16 Fowler St. and 5th St. Opportunity for Stop Violation Counts

Base Data	Behavior Type											
Stop Violation	**1a**	**1b**	**1c**	**1d**	**1e**	**1f**	**1g**	**1rb**	**1rc**	**1re**	**2**	**r2**
Major 1	5	17	16	17	36	17	24	7	0	22	10	0
Major2	48	29	23	43	21	40	25	36	0	26	55	1
Minor 1	11	35	12	9	24	31	24	40	0	23	37	0
Minor 2	29	3	22	26	14	20	24	17	0	27	15	0

Table B.17 Fowler St. and 5th St. Opportunity for Out-of-turn Counts

Base Data	Behavior Type								
OFT by Time	**9a**	**9b**	**9c**	**9d**	**OFT by Position**	**10a**	**10b**	**10c**	**10d**
Major 1	60	105	16	18	**Major 1**	8	1	2	1
Major2	164	113	21	21	**Major2**	11	12	2	2
Minor 1	99	137	10	18	**Minor 1**	1	12	1	0
Minor 2	108	71	12	18	**Minor 2**	13	8	0	1

Table B.18 Market St. and 18th St. 2 Stop Violation Counts

Violation Data	Behavior Type											
Stop Violation	1a	1b	1c	1d	1e	1f	1g	1rb	1rc	1re	2	r2
Major 1	0	0	16	1	0	0	0	0	1	0	70	0
Major2	0	0	26	0	0	0	0	0	0	0	34	0
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	1rb1	1rc1	1re1	2_1	r21
Major 1	0	0	3	0	0	0	0	0	1	0	19	1
Major2	0	0	1	0	0	0	0	0	0	0	5	0
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0

Table B.19 Market St. and 18th St. 2 Out-of-turn Counts

Violation Data	Behavior Type								
OFT by Time	9a	9b	9c	9d	OFT by Position	10a	10b	10c	10d
Major 1	1	0	0	0	Major 1	0	0	0	0
Major2	0	1	0	0	Major2	0	0	0	0
Minor 1	0	1	0	0	Minor 1	0	0	0	0
Minor 2	0	0	0	0	Minor 2	0	0	0	0

Table B.20 Market St. and 18th St. Opportunity for Stop Violation Counts

Base Data	Behavior Type											
Stop Violation	1a	1b	1c	1d	1e	1f	1g	1rb	1rc	1re	2	r2
Major 1	2	0	61	3	0	0	0	0	4	0	218	1
Major2	0	0	64	0	2	0	0	0	0	0	86	0
Minor 1	0	1	0	0	0	0	0	2	0	0	2	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0

Table B.21 Market and 18th Opportunity for Out-of-turn Counts

Base Data	Behavior Type								
OFT by Time	9a	9b	9c	9d	OFT by Position	10a	10b	10c	10d
Major 1	4	0	0	0	Major 1	0	0	0	0
Major2	0	2	0	1	Major2	0	0	0	0
Minor 1	0	1	0	0	Minor 1	0	0	0	0
Minor 2	0	0	0	0	Minor 2	0	0	0	0

Table B.22 Northside Dr. and 14th St. Stop Violation Counts

Violation Data	Behavior Type											
Stop Violation	**1a**	**1b**	**1c**	**1d**	**1e**	**1f**	**1g**	**1rb**	**1rc**	**1re**	**2**	**r2**
Major 1	0	0	4	1	2	0	5	2	0	7	1	0
Major2	0	0	0	2	8	2	9	0	0	14	0	0
Minor 1	1	1	0	0	0	2	8	1	0	4	0	0
Minor 2	0	2	0	1	2	21	29	0	0	1	0	0
Platoon	**1a1**	**1b1**	**1c1**	**1d1**	**1_e1**	**1f1**	**1g1**	**1rb1**	**1rc1**	**1re1**	**2_1**	**r21**
Major 1	2	1	3	3	6	2	8	5	0	0	2	0
Major2	0	0	5	5	11	2	8	1	1	0	4	0
Minor 1	0	0	0	0	0	2	4	1	0	0	0	0
Minor 2	0	2	0	0	0	0	0	0	0	0	0	0

Table B.23 Northside Dr. and 14th St. Out-of-turn Counts

Violation Data	Behavior Type								
OFT by Time	**9a**	**9b**	**9c**	**9d**	**OFT by Position**	**10a**	**10b**	**10c**	**10d**
Major 1	61	38	0	20	**Major 1**	10	6	0	0
Major2	32	75	3	3	**Major2**	8	8	0	8
Minor 1	19	24	3	1	**Minor 1**	8	8	1	1
Minor 2	26	25	3	7	**Minor 2**	10	10	0	1

Table B.24 Northside Dr. and 14th St. Opportunity for Stop Violation Counts

Base Data	Behavior Type											
Stop Violation	**1a**	**1b**	**1c**	**1d**	**1e**	**1f**	**1g**	**1rb**	**1rc**	**1re**	**2**	**r2**
Major 1	13	12	42	119	86	23	179	11	0	124	11	0
Major2	17	2	51	101	137	14	241	3	1	76	14	0
Minor 1	5	7	0	8	9	82	135	18	0	37	1	0
Minor 2	11	15	1	13	11	81	188	2	0	5	2	0

Table B.25 Northside Dr. and 14th St. Opportunity for Out-of-turn Counts

Base Data	Behavior Type								
OFT by Time	**9a**	**9b**	**9c**	**9d**	**OFT by Position**	**10a**	**10b**	**10c**	**10d**
Major 1	354	316	9	114	**Major 1**	31	30	0	0
Major2	357	383	52	18	**Major2**	30	17	0	0
Minor 1	240	230	28	38	**Minor 1**	16	31	4	2
Minor 2	224	219	35	49	**Minor 2**	24	24	1	2

Table B.26 Piedmont Ave. and North Ave. Stop Violation Counts

Violation Data	Behavior Type											
Stop Violation	**1a**	**1b**	**1c**	**1d**	**1e**	**1f**	**1g**	**1rb**	**1rc**	**1re**	**2**	**r2**
Major 1	0	0	0	4	0	0	0	0	0	0	0	0
Major2	0	0	0	0	7	0	0	0	0	0	0	0
Minor 1	2	0	0	0	0	7	0	0	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	**1a1**	**1b1**	**1c1**	**1d1**	**1_e1**	**1f1**	**1g1**	**1rb1**	**1rc1**	**1re1**	**2_1**	**r21**
Major 1	0	0	0	17	0	0	0	0	0	0	0	0
Major2	0	3	0	0	54	0	0	1	0	0	3	0
Minor 1	7	0	0	0	0	45	0	0	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table B.27 Piedmont Ave. and North Ave. Out-of-turn Counts

Violation Data	Behavior Type								
OFT by Time	**9a**	**9b**	**9c**	**9d**	**OFT by Position**	**10a**	**10b**	**10c**	**10d**
Major 1	24	0	4	0	**Major 1**	4	0	1	0
Major2	0	28	0	33	**Major2**	0	1	0	0
Minor 1	10	41	0	0	**Minor 1**	0	1	0	0
Minor 2	n/a	n/a	n/a	n/a	**Minor 2**	n/a	n/a	n/a	n/a

Table B.28 Piedmont Ave. and North Ave. Opportunity for Stop Violation Counts

Base Data	Behavior Type											
Stop Violation	**1a**	**1b**	**1c**	**1d**	**1e**	**1f**	**1g**	**1rb**	**1rc**	**1re**	**2**	**r2**
Major 1	1	0	0	164	0	0	0	0	0	0	0	0
Major2	0	25	0	0	243	0	0	3	0	30	5	0
Minor 1	43	0	0	0	0	297	0	0	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table B.29 Piedmont Ave. and North Opportunity for Out-of-turn Counts

Base Data	Behavior Type								
OFT by Time	**9a**	**9b**	**9c**	**9d**	**OFT by Position**	**10a**	**10b**	**10c**	**10d**
Major 1	138	0	38	0	**Major 1**	6	0	1	0
Major2	0	228	0	133	**Major2**	0	1	0	1
Minor 1	278	238	0	0	**Minor 1**	1	7	0	0
Minor 2	n/a	n/a	n/a	n/a	**Minor 2**	n/a	n/a	n/a	n/a

Table B.30 Piedmont Ave. and Prado Stop Violation Counts

Violation Data	Behavior Type											
Stop Violation	**1a**	**1b**	**1c**	**1d**	**1e**	**1f**	**1g**	**1rb**	**1rc**	**1re**	**2**	**r2**
Major 1	0	1	18	0	22	0	2	0	0	0	1	0
Major2	0	0	11	9	2	0	1	0	0	8	0	0
Minor 1	0	0	0	0	0	3	0	1	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0
Stop Platoon	**1a1**	**1b1**	**1c1**	**1d1**	**1_e1**	**1f1**	**1g1**	**1rb1**	**1rc1**	**1re1**	**2_1**	**r21**
Major 1	0	0	58	0	48	0	7	1	0	0	9	0
Major2	0	0	47	31	4	0	1	0	1	0	0	0
Minor 1	0	0	0	0	0	2	0	0	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0

Table B.31 Piedmont Ave. and Prado Out-of-turn Counts

Violation Data	Behavior Type								
OFT by Time	**9a**	**9b**	**9c**	**9d**	**OFT by Position**	**10a**	**10b**	**10c**	**10d**
Major 1	6	112	8	2	**Major 1**	0	0	0	0
Major2	51	11	1	21	**Major2**	0	1	0	2
Minor 1	18	26	2	0	**Minor 1**	0	1	0	0
Minor 2	0	4	0	0	**Minor 2**	0	0	0	0

Table B.32 Piedmont Ave. and Prado Opportunity for Stop Violation Counts

Base Data	Behavior Type											
Stop Violation	**1a**	**1b**	**1c**	**1d**	**1e**	**1f**	**1g**	**1rb**	**1rc**	**1re**	**2**	**r2**
Major 1	0	18	375	22	593	1	40	1	0	4	57	0
Major2	7	0	291	435	29	0	27	0	4	46	42	0
Minor 1	9	4	0	0	0	202	14	20	0	1	3	0
Minor 2	0	0	0	0	0	5	4	5	0	10	2	0

Table B.33 Piedmont Ave. and Prado Opportunity for Out-of-turn Counts

Base Data	Behavior Type								
OFT by Time	**9a**	**9b**	**9c**	**9d**	**OFT by Position**	**10a**	**10b**	**10c**	**10d**
Major 1	55	572	43	13	**Major 1**	0	0	1	0
Major2	443	49	5	87	**Major2**	0	1	0	0
Minor 1	239	233	11	0	**Minor 1**	0	2	0	0
Minor 2	23	24	0	12	**Minor 2**	1	0	0	0

Table B.34 Roswell Rd. and W. Wieuca Rd. 1 Stop Violation Counts

Violation Data	Behavior Type											
Stop Violation	**1a**	**1b**	**1c**	**1d**	**1e**	**1f**	**1g**	**1rb**	**1rc**	**1re**	**2**	**r2**
Major 1	0	0	15	4	29	0	9	0	0	2	0	0
Major2	1	0	7	9	1	0	9	0	0	8	1	0
Minor 1	3	0	0	6	0	3	27	14	0	32	0	0
Minor 2	0	1	0	0	0	5	4	5	0	8	0	0
Stop Platoon	**1a1**	**1b1**	**1c1**	**1d1**	**1_e1**	**1f1**	**1g1**	**1rb1**	**1rc1**	**1re1**	**2_1**	**r21**
Major 1	0	0	21	2	62	0	15	0	0	0	0	0
Major2	1	2	17	38	7	0	26	1	0	0	2	0
Minor 1	0	0	0	1	0	2	10	3	0	0	0	0
Minor 2	0	0	0	0	0	0	0	8	0	0	0	0

Table B.35 Roswell Rd. and W. Wieuca Rd. 1 Out-of-turn Counts

Violation Data	Behavior Type								
OFT by Time	**9a**	**9b**	**9c**	**9d**	**OFT by Position**	**10a**	**10b**	**10c**	**10d**
Major 1	9	147	4	34	**Major 1**	1	16	0	0
Major2	167	39	9	15	**Major2**	0	2	0	0
Minor 1	21	11	7	44	**Minor 1**	0	2	0	0
Minor 2	44	41	3	1	**Minor 2**	3	0	0	0

Table B.36 Roswell Rd. and W. Wieuca Rd. 1 Opportunity for Stop Violation Counts

Base Data	Behavior Type											
Stop Violation	**1a**	**1b**	**1c**	**1d**	**1e**	**1f**	**1g**	**1rb**	**1rc**	**1re**	**2**	**r2**
Major 1	0	3	90	39	405	0	285	0	0	14	1	0
Major2	24	5	103	401	40	16	331	2	0	43	9	0
Minor 1	3	0	0	10	0	10	102	29	0	142	0	0
Minor 2	2	12	0	0	5	96	91	111	0	99	0	1

Table B.37 Roswell Rd. and W. Wieuca Rd. 1 Opportunity for Out-of-turn Counts

Violation Data	Behavior Type								
OFT by Time	**9a**	**9b**	**9c**	**9d**	**OFT by Position**	**10a**	**10b**	**10c**	**10d**
Major 1	284	565	66	234	**Major 1**	16	23	0	0
Major2	712	346	117	144	**Major2**	0	14	0	0
Minor 1	178	170	15	80	**Minor 1**	8	11	0	0
Minor 2	335	382	46	18	**Minor 2**	26	0	0	0

Table B.38 Roswell Rd. and W. Wieuca Rd. 2 Stop Violation Counts

Violation Data	Behavior Type											
Stop Violation	1a	1b	1c	1d	1e	1f	1g	1rb	1rc	1re	2	r2
Major 1	0	2	11	3	4	1	4	2	0	15	3	0
Major2	1	3	14	5	6	0	0	0	0	0	6	0
Minor 1	0	1	0	0	0	1	0	6	0	3	0	0
Minor 2	0	0	0	0	0	1	0	4	0	6	1	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	1rb1	1rc1	1re1	2_1	r21
Major 1	0	0	16	10	6	0	2	2	0	0	2	0
Major2	1	4	19	7	22	0	1	0	0	0	5	0
Minor 1	0	0	0	0	0	1	2	0	0	0	0	0
Minor 2	0	0	0	0	0	0	0	3	0	0	0	0

Table B.39 Roswell Rd. and W. Wieuca Rd. 2 Out-of-turn Counts

Violation Data	Behavior Type								
OFT by Time	9a	9b	9c	9d	OFT by Position	10a	10b	10c	10d
Major 1	46	27	3	12	Major 1	3	4	3	2
Major2	13	51	9	15	Major2	3	7	1	0
Minor 1	20	20	3	1	Minor 1	3	4	0	0
Minor 2	8	13	0	5	Minor 2	2	7	0	0

Table B.40 Roswell Rd. and W. Wieuca Rd. 2 Opportunity for Stop Violation Counts

Base Data	Behavior Type											
Stop Violation	1a	1b	1c	1d	1e	1f	1g	1rb	1rc	1re	2	r2
Major 1	26	13	193	152	75	4	74	11	0	55	57	0
Major2	14	34	207	88	184	11	63	0	0	5	42	0
Minor 1	9	6	2	3	3	51	25	54	0	33	3	0
Minor 2	1	0	0	3	5	10	17	48	0	46	2	0

Table B.41 Roswell Rd. and W. Wieuca Rd. 2 Opportunity for Out-of-turn Counts

Violation Data	Behavior Type								
OFT by Time	9a	9b	9c	9d	OFT by Position	10a	10b	10c	10d
Major 1	238	145	50	75	Major 1	14	15	6	5
Major2	148	244	50	106	Major2	14	15	4	4
Minor 1	133	134	20	1	Minor 1	16	14	0	0
Minor 2	87	86	1	28	Minor 2	13	14	0	1

APPENDIX C

YELLOW/RED RAW VIOLATION AND OPPORTUNITY DATA

Table C.1 Keys to Raw Data Events at Yellow/Red Intersections

Keys				
Minor Stop violation	Left or Thru movements	Right-turn movements	Platoons	
Presence of right x-street vehicle	1a		1a1	
Presence of left x-street vehicle	1b	1rb	1b1	1rb1
Presence of opposing vehicle	1c	1rc	1c1	1rc1
Right x-street and opposing	1d	1re	1d1	1re1
Left x-street and opposing	1e		1_e1	
Both x-streets	1f		1f1	
Presence of veh on all approaches	1g		1g1	
Absence of vehicle	2		2_1	
Out of turn by time				
left x-street departs prior to right x-street	9a			
right x-street departs prior to left x-street	9b			
opposing L departs prior to opposing T/R	9c			
opposing T/R departs prior to opposing L	9d			
Out of turn by position				
left x-street departs prior to right x-street	10a			
right x-street departs prior to left x-street	10b			
opposing L departs prior to opposing T/R	10c			
opposing T/R departs prior to opposing L	10d			
Major Thru/Right Stopping				
Presence of Minor on right x-street	3R			
Presence of non-Stopped Minor on left x-street	3L			
Presence of non-Stopped Major Left	3O			
Absence of conflicting vehicle	4			
Presence of non-stopped vehicle	3x			
Major Left not stopping				
Presence of opposing Major	5O		5O1	
Presence of minor on right x-street	5R		5R1	
Presence of minor on left x-street	5L		5L1	
Presence of opposing Major and right x-street	5OR		5OR1	
Presence of opposing Major and left x-street	5OL		5OL1	
Presence of both x-streets	5RL		5RL1	
Presence of all approaches	5ORL		5ORL1	
Absence of conflicting vehicle	6		6_1	

Table C.2 10th St. and 75-85 SB Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	288	n/a	n/a	n/a	n/a	n/a	1	16			
Major 2 T/R	4	n/a	56	n/a	378	n/a	n/a	0	46			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	5	n/a	6	n/a	n/a	n/a	0				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	1	13	n/a	57	n/a	n/a	n/a	0				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	3	n/a	n/a	n/a	24	n/a	0	n/a	n/a	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2-1	r2-1
Minor 1	7	15	n/a	n/a	n/a	135	n/a	1	n/a	n/a	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.3 10th St. and 75-85 SB Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	125	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.4 10th St. and 75-85 SB Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	457	n/a	n/a	n/a	n/a	n/a	1	20			
Major 2 T/R	8	n/a	87	n/a	750	n/a	n/a	0	69			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	3	39	n/a	281	n/a	n/a	n/a	0				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	28	88	n/a	n/a	n/a	812	n/a	11	n/a	n/a	6	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.5 10th St. and 75-85 SB Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	681	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.6 10th St. and Hemphill Ave. 1 Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	23	27	0	0	44	1	30	4			
Major 2 T/R	3	21	11	5	5	25	8	11	1			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	1	3	10	2	1	5	2	11				
Major 2 L	0	1	0	1	0	0	0	0				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	3	3	0	0	5	0	7				
Major 2 L	0	1	0	0	0	0	0	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	0	1	0	2	0	0	0	0	0	3	0
Minor 2	0	0	1	0	0	0	2	9	0	11	4	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	2	0	0	0	1	2	0	0	2	0
Minor 2	0	0	0	0	0	0	0	8	0	0	0	0

Table C.7 10th St. and Hemphill Ave. 1 Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	1	3	1	2	Minor 1	0	0	0	0
Minor 2	6	0	0	15	Minor 2	0	0	0	0

Table C.8 10th St. and Hemphill Ave. 1 Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	46	64	0	2	73	2	82	8			
Major 2 T/R	8	39	23	7	8	41	15	53	1			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	8	18	27	4	10	21	11	26				
Major 2 L	0	4	1	1	0	3	0	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	10	18	28	11	18	8	14	5	0	7	26	0
Minor 2	26	7	24	18	7	9	5	60	0	39	25	0

Table C.9 10th St. and Hemphill Ave. 1 Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	2	16	17	8	Minor 1	0	1	0	0
Minor 2	19	2	7	159	Minor 2	0	0	0	0

Table C.10 10th St. and Hemphill Ave. 2 Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	1	65	13	0	0	34	0	23	3			
Major 2 T/R	19	26	98	11	22	49	21	53	12			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	5	6	3	17	0	0	9	5				
Major 2 L	0	0	0	0	0	0	0	0				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	1	1	1	4	0	2	5	2				
Major 2 L	0	0	0	0	0	0	0	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	7	4	1	1	1	4	3	2	0	1	4	0
Minor 2	0	0	0	1	1	2	1	2	0	6	1	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	0	0	0	0	1	1	0	0	0	0
Minor 2	0	0	0	0	0	0	0	1	0	0	0	0

Table C.11 10th St. and Hemphill Ave. 2 Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	3	7	4	0	Minor 1	0	2	0	0
Minor 2	0	2	0	10	Minor 2	0	0	0	0

Table C.12 10th St. and Hemphill Ave. 2 Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	1	117	32	2	0	60	2	64	4			
Major 2 T/R	25	41	138	15	38	65	24	102	12			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	23	18	6	47	5	6	20	9				
Major 2 L	0	1	3	0	2	1	1	2				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	46	21	10	15	7	69	38	17	0	6	24	0
Minor 2	5	8	4	6	7	10	15	26	0	44	3	0

Table C.13 10th St. and Hemphill Ave. 2 Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	9	49	22	0	Minor 1	0	5	2	0
Minor 2	9	3	3	92	Minor 2	1	0	0	0

Table C.14 10th St. and Holly St. 1 Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	6	n/a	0	n/a	n/a	n/a	9	0			
Major 2 T/R	n/a	n/a	1	n/a	n/a	n/a	n/a	6	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	0	n/a	0	n/a	0	n/a	n/a	2				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	0	n/a	1	n/a	0	n/a	n/a	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	0	n/a	n/a	n/a	0	n/a	3	n/a	n/a	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	n/a	n/a	n/a	0	n/a	0	n/a	n/a	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.15 10th St. and Holly St. 1 Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.16 10th St. and Holly St. 1 Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	3	164	n/a	2	n/a	n/a	n/a	595	0			
Major 2 T/R	n/a	n/a	160	n/a	n/a	n/a	n/a	617	2			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	1	n/a	1	n/a	1	n/a	n/a	3				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	4	5	n/a	n/a	n/a	6	n/a	22	n/a	n/a	9	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.17 10th St. and Holly St. 1 Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.18 10th St. and Holly St. 2 Stop Violation Counts

Violation Data	Behavior Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	1	3	n/a	0	n/a	0	n/a	7	0			
Major 2 T/R	n/a	n/a	2	n/a	n/a	n/a	n/a	9	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	0	n/a	0	n/a	0	n/a	n/a	1				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	0	n/a	0	n/a	0	n/a	n/a	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	0	n/a	n/a	n/a	0	n/a	1	n/a	n/a	1	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	n/a	n/a	n/a	0	n/a	0	n/a	n/a	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.19 10th St. and Holly St. 2 Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.20 10th St. and Holly St. 2 Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	18	100	n/a	0	n/a	0	n/a	398	0			
Major 2 T/R	n/a	n/a	85	n/a	n/a	n/a	n/a	381	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	4	n/a	1	n/a	0	n/a	n/a	3				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	8	5	n/a	n/a	n/a	0	n/a	14	n/a	n/a	18	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.21 10th St. and Holly St. 2 Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	1	0	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.22 14th St. and Williams Stop Violation Counts

Violation Data	Behavior Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	478	n/a	n/a	n/a	n/a	n/a	9	26			
Major 2 T/R	2	n/a	175	n/a	69	n/a	n/a	0	39			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	13	n/a	0	n/a	n/a	0	0				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	24	n/a	25	n/a	n/a	n/a	1				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	6	n/a	n/a	n/a	19	n/a	18	n/a	n/a	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	34	n/a	n/a	n/a	77	n/a	80	n/a	n/a	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.23 14th St. and Williams Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	16	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.24 14th St. and Williams Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	671	n/a	n/a	n/a	n/a	n/a	22	40			
Major 2 T/R	2	n/a	418	n/a	118	n/a	n/a	6	81			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	63	n/a	94	n/a	n/a	0	1				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	1	200	n/a	n/a	n/a	417	n/a	266	n/a	n/a	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.25 14th St. and Williams Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	136	n/a	n/a	Minor 1	0	11	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.26 17th St. and 75-85 SB Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	n/a	16	n/a	n/a	n/a	n/a	4	0			
Major 2 T/R	n/a	22	n/a	n/a	n/a	n/a	n/a	1	3			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	0	n/a	n/a	n/a	1	n/a	67	n/a	n/a	4	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	1	1	n/a	n/a	n/a	0	n/a	33	n/a	n/a	4	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.27 17th St. and 75-85 SB Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	n/a	n/a	n/a	n/a	Minor 1	n/a	n/a	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.28 17th St. and 75-85 SB Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	n/a	462	n/a	n/a	n/a	n/a	256	49			
Major 2 T/R	n/a	351	n/a	n/a	n/a	n/a	n/a	127	15			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	35	20	n/a	n/a	n/a	19	n/a	235	n/a	n/a	46	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.29 17th St. and 75-85 SB Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	n/a	n/a	n/a	n/a	Minor 1	n/a	n/a	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.30 17th St. and Bishop St. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	3	7	n/a	2	n/a	n/a	n/a	0	0			
Major 2 T/R	0	n/a	1	n/a	0	n/a	n/a	2	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	1	0	n/a	0	n/a	n/a	n/a	4				
Major 2 L	3	n/a	15	n/a	0	n/a	n/a	22				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	1	n/a	0	n/a	n/a	n/a	0				
Major 2 L	3	n/a	7	n/a	0	n/a	n/a	7				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	1	0	n/a	n/a	n/a	0	n/a	65	n/a	n/a	4	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	1	0	n/a	n/a	n/a	0	n/a	22	n/a	n/a	1	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.31 17th St. and Bishop St. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.32 17th St. and Bishop St. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	25	93	n/a	19	n/a	n/a	n/a	152	11			
Major 2 T/R	2	n/a	52	n/a	6	n/a	n/a	128	24			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	1	1	n/a	1	n/a	n/a	n/a	7				
Major 2 L	14	n/a	28	n/a	0	6	n/a	38				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	4	1	n/a	n/a	n/a	4	n/a	190	n/a	n/a	15	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.33 17th St. and Bishop St. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	3	1	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.34 Ashford Dunwoody Rd. and Harts Mill Rd. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	1	3	11	0	0	3	0	5	1			
Major 2 T/R	1	16	1	0	0	2	1	4	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	2	0	5	0	2	0	0	4				
Major 2 L	3	2	0	0	0	0	0	4				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	1	4	0	0	0	0	2				
Major 2 L	0	0	0	0	0	0	0	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	0	0	0	0	1	0	29	0	1	2	0
Minor 2	0	0	0	0	0	0	0	2	0	2	0	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	1	0	0	0	0	0	0	10	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0

Table C.35 Ashford Dunwoody Rd. and Harts Mill Rd. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	1	5	Minor 1	0	0	0	0
Minor 2	0	0	0	1	Minor 2	0	0	0	0

Table C.36 Ashford Dunwoody Rd. and Harts Mill Rd. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	11	23	111	0	4	32	0	172	14			
Major 2 T/R	9	143	22	20	11	20	2	183	2			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	6	2	13	0	6	0	0	7				
Major 2 L	7	3	0	2	0	0	0	4				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	10	4	3	2	0	12	0	82	0	9	16	0
Minor 2	1	5	0	0	0	0	3	7	0	5	3	0

Table C.37 Ashford Dunwoody Rd. and Harts Mill Rd. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	1	1	36	52	Minor 1	0	1	0	0
Minor 2	0	0	0	0	Minor 2	0	0	0	0

Table C.38 Charles Allen Dr. and 8th St. 1 Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	4	2	0	0	1	0	13	0			
Major 2 T/R	0	1	3	0	1	0	0	5	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	0	1	0	0	0	0	4				
Major 2 L	0	0	1	0	0	0	0	6				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	0	0	0	0	0	0	1				
Major 2 L	0	0	0	0	0	0	0	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	0	0	0	0	0	0	0	0	0	1	0
Minor 2	0	0	0	0	n/a	0	0	0	0	0	4	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0

Table C.39 Charles Allen Dr. and 8th St. 1 Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	n/a	n/a	n/a	n/a	Minor 1	n/a	n/a	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.40 Charles Allen Dr. and 8th St. 1 Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	5	5	0	0	2	0	51	0			
Major 2 T/R	0	0	1	0	0	0	0	23	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	2	0	2	0	0	1	0	8				
Major 2 L	0	0	1	0	0	0	0	11				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	6	3	5	1	0	0	0	2	0	0	22	1
Minor 2	0	2	7	1	3	0	0	19	0	0	43	0

Table C.41 Charles Allen Dr. and 8th St. 1 Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	2	2	Minor 1	1	0	0	0
Minor 2	0	2	7	38	Minor 2	0	0	0	0

Table C.42 Charles Allen Dr. and 8th St. 2 Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	60	13	6	0	12	0	44	0			
Major 2 T/R	0	5	23	0	1	6	0	21	1			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	0	1	0	0	0	0	1				
Major 2 L	0	0	0	0	0	0	0	5				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	0	0	0	0	0	0	0				
Major 2 L	0	0	0	0	0	0	0	2				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	0	1	1	0	0	0	0	0	0	0	4	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	0	0	0	0	0	0	0	2	0	0	0	0

Table C.43 Charles Allen Dr. and 8th St. 2 Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	2	4	Minor 1	0	0	0	0
Minor 2	0	1	1	0	Minor 2	0	0	0	0

Table C.44 Charles Allen Dr. and 8th St. 2 Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	3	101	16	8	1	14	0	124	0			
Major 2 T/R	1	7	42	0	1	8	0	54	1			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	1	2	0	0	1	1	2				
Major 2 L	3	0	4	1	6	0	1	13				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	8	4	9	7	3	2	2	3	0	1	17	0
Minor 2	11	35	5	1	8	14	1	80	0	7	61	0

Table C.45 Charles Allen Dr. and 8th St. 2 Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	1	1	5	10	Minor 1	0	0	0	0
Minor 2	7	3	5	137	Minor 2	0	0	0	0

Table C.46 Collier Rd. and Post Collier Hills Apts. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	5	10	1	3	0	3	0	21	0			
Major 2 T/R	5	6	4	0	0	0	1	7	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	1	0	2	0	0	0	0	10				
Major 2 L	0	1	0	0	0	0	0	1				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	1	2	0	0	0	0	0	2				
Major 2 L	0	0	0	0	0	0	0	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	0	0	0	0	0	0	3	0	0	1	0
Minor 2	0	0	0	0	0	0	0	5	0	0	0	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0

Table C.47 Collier Rd. and Post Collier Hills Apts. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	0	0	Minor 1	0	0	0	0
Minor 2	0	0	0	0	Minor 2	0	0	0	0

Table C.48 Collier and Post Collier Hills Apts. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	24	73	53	4	1	12	0	567	2			
Major 2 T/R	36	46	48	0	6	3	3	390	3			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	8	6	2	2	1	1	0	20				
Major 2 L	9	1	1	1	1	0	0	3				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	2	9	1	0	0	2	0	9	0	0	9	1
Minor 2	1	1	0	1	0	0	0	13	0	1	0	0

Table C.49 Collier and Post Collier Hills Apts. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	0	0	Minor 1	0	0	0	0
Minor 2	2	0	1	11	Minor 2	0	0	0	0

Table C.50 E. Rock Springs Rd. and Barclay Pl. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	n/a	0	n/a	0	n/a	n/a	0	0			
Major 2 T/R	n/a	0	n/a	n/a	n/a	n/a	n/a	0	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	0	0	n/a	0	n/a	n/a	n/a	1				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	0	0	n/a	0	n/a	n/a	n/a	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0

Table C.51 E. Rock Springs Rd. and Barclay Pl. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	n/a	n/a	n/a	n/a	Minor 1	n/a	n/a	n/a	n/a
Minor 2	0	0	0	0	Minor 2	0	0	0	0

Table C.52 E. Rock Springs Rd. and Barclay Pl. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	1	n/a	1	n/a	0	n/a	n/a	238	0			
Major 2 T/R	n/a	2	n/a	n/a	n/a	n/a	n/a	263	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	0	0	n/a	0	n/a	n/a	n/a	2				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Minor 2	0	1	0	0	0	0	0	1	0	0	0	0

Table C.53 E. Rock Springs Rd. and Barclay Pl. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	n/a	n/a	n/a	n/a	Minor 1	n/a	n/a	n/a	n/a
Minor 2	0	0	0	0	Minor 2	0	0	0	0

Table C.54 Howell Mill Rd. and I-75 SB Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	412	0	n/a	n/a	0	n/a	8	18			
Major 2 T/R	8	0	32	0	195	0	0	1	32			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	18	0	0	0	0	0	3				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	63	0	0	0	0	0	1				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	0	n/a	n/a	n/a	5	n/a	34	n/a	n/a	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	1	n/a	n/a	n/a	5	n/a	46	n/a	n/a	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.55 Howell Mill Rd. and I-75 SB Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	n/a	17	n/a	n/a	Minor 1	n/a	3	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.56 Howell Mill Rd. and I-75 SB Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	518	0	n/a	n/a	0	n/a	18	23			
Major 2 T/R	20	0	101	0	532	0	0	10	78			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	6	85	0	256	0	0	0	4				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	2	51	n/a	n/a	n/a	183	n/a	393	n/a	n/a	4	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.57 Howell Mill Rd. and I-75 SB Opportunity for Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	n/a	172	n/a	n/a	Minor 1	n/a	10	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.58 Juniper St. and 12th St. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a			
Major 2 T/R	n/a	8	20	n/a	n/a	8	n/a	39	2			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	n/a	1	5	n/a	n/a	1	n/a	8				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	n/a	0	1	n/a	n/a	0	n/a	4				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	n/a	0	0	0	0	n/a	n/a	1	0	1	0	0
Minor 2	3	n/a	2	0	0	n/a	n/a	n/a	0	n/a	4	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	n/a	0	0	0	0	n/a	n/a	0	0	0	0	0
Minor 2	0	n/a	0	0	0	n/a	n/a	n/a	0	0	0	0

Table C.59 Juniper St. and 12th St. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	0	1	Minor 1	0	0	0	0
Minor 2	0	0	2	0	Minor 2	0	0	0	0

Table C.60 Juniper St. and 12th St. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a			
Major 2 T/R	n/a	29	126	n/a	n/a	27	n/a	312	2			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	n/a	2	8	n/a	n/a	3	n/a	24				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	n/a	3	1	0	3	0	0	17	0	10	5	0
Minor 2	37	n/a	7	6	0	n/a	n/a	n/a	0	n/a	48	n/a

Table C.61 Juniper St. and 12th St. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	2	0	0	Minor 1	0	0	0	0
Minor 2	3	0	4	0	Minor 2	0	0	0	0

Table C.62 Lenox Rd. and Phipps Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	1	3	65	2	2	13	0	9	5			
Major 2 T/R	47	47	1	185	16	6	28	21	13			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	0	8	0	3	1	3	2				
Major 2 L	0	0	0	0	0	0	0	0				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	3	0	11	1	8	0	3	7				
Major 2 L	0	0	0	0	0	0	0	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	0	0	0	0	0	0	24	0	1	0	0
Minor 2	0	0	0	1	0	0	0	1	0	4	0	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	0	0	0	0	1	48	1	0	1	1
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0

Table C.63 Lenox Rd. and Phipps Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	8	0	1	4	Minor 1	0	0	0	0
Minor 2	0	2	0	6	Minor 2	0	0	0	0

Table C.64 Lenox Rd. and Phipps Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	5	11	305	8	16	11	1	90	33			
Major 2 T/R	126	126	5	124	37	127	77	70	23			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	25	1	52	2	90	2	19	15				
Major 2 L	3	0	0	1	0	0	1	2				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	5	5	2	1	0	37	8	293	3	40	0	0
Minor 2	0	0	2	2	1	4	7	11	1	15	0	0

Table C.65 Lenox Rd. and Phipps Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	46	4	7	6	Minor 1	0	0	0	0
Minor 2	1	11	4	29	Minor 2	0	0	0	0

Table C.66 Lindbergh Dr. and Acorn Ave. SB Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	0	0	0	0	0	0	1	0			
Major 2 T/R	n/a	0	0	n/a	n/a	0	n/a	0	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	0	n/a	1	n/a	0	n/a	n/a	2				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	0	n/a	0	n/a	0	n/a	n/a	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	0	n/a	n/a	n/a	0	n/a	0	n/a	0	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	n/a	n/a	n/a	0	n/a	0	n/a	0	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.67 Lindbergh Dr. and Acorn Ave. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.68 Lindbergh Dr. and Acorn Ave. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	7	57	0	0	0	0	0	314	0			
Major 2 T/R	n/a	0	41	n/a	n/a	0	n/a	323	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	1	n/a	1	n/a	0	n/a	n/a	5				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	7	9	n/a	n/a	n/a	4	n/a	6	n/a	0	26	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.69 Lindbergh Dr. and Acorn Ave. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	1	0	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.70 Lindbergh Dr. and Parkdale Pl. 1 Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	0	0	0	0	0	0	0	0			
Major 2 T/R	0	0	0	0	0	0	0	0	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	0	0	0	0	0	0	2				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	0	0	0	0	0	0	0				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.71 Lindbergh Dr. and Parkdale Pl. 1 Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.72 Lindbergh Dr. and Parkdale Pl. 1 Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	0	5	0	0	0	0	315	0			
Major 2 T/R	0	20	0	0	0	0	0	389	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	0	0	0	0	0	0	2				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	1	1	0	0	0	0	0	3	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.73 Lindbergh Dr. and Parkdale Pl. 1 Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.74 Lindbergh Dr. and Parkdale Pl. 2 Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	0	0	0	0	0	0	0	0			
Major 2 T/R	0	0	0	0	n/a	0	0	0	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	1	0	0	0	0	0	0	1				
Major 2 L	0	0	0	0	0	0	0	0				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	0	0	0	0	0	0	0				
Major 2 L	0	0	0	0	0	0	0	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	Rc	re	2	r2
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.75 Lindbergh Dr. and Parkdale Pl. 2 Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Pos				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	0	0	Minor 1	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.76 Lindbergh Dr. and Parkdale Pl. 2 Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	1	0	2	0	0	0	0	535	0			
Major 2 T/R	0	4	0	0	0	0	0	567	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	1	0	0	0	0	0	0	1				
Major 2 L	1	0	0	0	0	0	0	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	Rc	re	2	r2
Minor 1	0	0	0	0	0	1	0	3	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.77 Lindbergh Dr. and Parkdale Pl. 2 Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	0	0	Minor 1	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.78 Market St. and 18th 1 Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	1	n/a	0	n/a	n/a	n/a	59	0			
Major 2 T/R	n/a	0	1	n/a	n/a	0	n/a	12	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	0	n/a	0	n/a	0	n/a	n/a	5				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	0	n/a	0	n/a	0	n/a	n/a	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	Rc	re	2	r2
Minor 1	0	0	n/a	n/a	n/a	0	n/a	1	n/a	n/a	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	n/a	n/a	n/a	0	n/a	0	n/a	n/a	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.79 Market St. and 18th 1 Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.80 Market St. and 18th 1 Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	5	6	n/a	0	n/a	n/a	n/a	266	1			
Major 2 T/R	n/a	0	6	n/a	n/a	0	n/a	154	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	0	n/a	0	n/a	0	n/a	n/a	8				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	Rc	re	2	r2
Minor 1	3	0	n/a	n/a	n/a	2	n/a	4	n/a	n/a	5	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.81 Market St. and 18th 1 Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.82 Monroe Dr. and 10th St. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	21	118	0	185	0	0	0	12	24			
Major 2 T/R	n/a	n/a	142	n/a	n/a	n/a	n/a	12	10			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	0	n/a	1	n/a	1	n/a	n/a	0				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	4	n/a	0	n/a	6	n/a	n/a	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	Rc	re	2	r2
Minor 1	1	2	n/a	n/a	n/a	7	n/a	32	n/a	0	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	3	4	n/a	n/a	n/a	18	n/a	44	n/a	0	0	1
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.83 Monroe Dr. and 10th St. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	18	0	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.84 Monroe Dr. and 10th St. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	39	208	0	268	0	0	0	38	36			
Major 2 T/R	n/a	n/a	306	n/a	n/a	n/a	n/a	33	27			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	19	n/a	10	n/a	114	n/a	n/a	1				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	Rc	re	2	r2
Minor 1	21	30	n/a	n/a	n/a	181	n/a	295	n/a	0	1	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.85 Monroe Dr. and 10th St. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	120	0	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.86 N. Highland Ave. and University Dr. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	0	0	0	0	0	0	0	0			
Major 2 T/R	5	42	0	1	0	0	0	35	1			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	2	0	5	0	2	0	0	3				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	1	0	2	0	0	0	0	5				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	Rc	re	2	r2
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.87 N. Highland Ave. and University Dr. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	1	0	0	0	Minor 1	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.88 N. Highland Ave. and University Dr. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	0	155	0	0	0	0	235	0			
Major 2 T/R	15	184	0	8	0	0	0	264	2			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	11	0	7	0	10	0	0	12				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	35	20	n/a	n/a	n/a	19	n/a	235	n/a	n/a	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.89 N. Highland Ave. and University Dr. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	2	0	0	0	Minor 1	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.90 Northside Dr. and Peachtree Battle Ave. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	2	91	31	0	3	90	1	25	0			
Major 2 T/R	17	24	92	20	31	21	18	37	5			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	2	5	0	1	2	0	2	6				
Major 2 L	0	0	1	0	0	0	0	0				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	1	2	0	1	1	0	1	5				
Major 2 L	0	0	0	0	0	0	0	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	Rc	re	2	r2
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0

Table C.91 Northside Dr. and Peachtree Battle Ave. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	0	0	Minor 1	0	0	0	0
Minor 2	0	0	0	0	Minor 2	0	0	0	0

Table C.92 Northside Dr. and Peachtree Battle Ave. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	2	171	54	0	4	170	1	132	0			
Major 2 T/R	n/a	351	n/a	n/a	n/a	n/a	n/a	127	15			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	15	15	4	16	14	5	22	15				
Major 2 L	1	0	2	1	0	0	1	2				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	7	9	7	6	5	19	32	32	1	44	7	1
Minor 2	30	22	15	3	9	82	48	18	0	0	23	0

Table C.93 Northside Dr. and Peachtree Battle Ave. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	24	0	5	8	Minor 1	0	0	0	0
Minor 2	2	58	3	218	Minor 2	0	3	0	0

Table C.94 Paces Ferry Rd. and Paces Mill Rd. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	3	62	0	0	0	0	30	1			
Major 2 T/R	6	58	0	5	0	0	0	27	1			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	3	1	7	0	3	0	0	9				
Major 2 L	0	0	0	0	0	0	0	3				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	0	2	0	0	0	0	2				
Major 2 L	0	0	0	1	0	0	0	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	Rc	re	2	r2
Minor 1	2	2	0	0	0	0	0	10	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	0	0	0	0	0	1	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0

Table C.95 Paces Ferry Rd. and Paces Mill Rd. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	1	0	0	0	Minor 1	0	0	0	0
Minor 2	0	0	0	0	Minor 2	0	0	0	0

Table C.96 Paces Ferry Rd. and Paces Mill Rd. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	5	120	0	0	0	0	143	1			
Major 2 T/R	15	175	0	15	0	0	0	135	3			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	7	1	23	0	9	0	0	15				
Major 2 L	1	1	0	1	0	0	0	3				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	Rb	rc	re	2	r2
Minor 1	38	34	0	0	0	30	0	56	0	1	0	0
Minor 2	0	1	0	0	0	0	0	3	0	0	0	0

Table C.97 Paces Ferry Rd. and Paces Mill Rd. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	14	1	0	1	Minor 1	1	0	0	0
Minor 2	0	0	1	3	Minor 2	0	0	0	0

Table C.98 Peachtree St. and 8th St. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	14	1	0	0	0	0	3	0			
Major 2 T/R	2	1	10	0	1	2	1	13	1			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	1	1	0	3	0	0	0	1				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	1	1	0	0	0	0	0	1				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	0	0	0	0	0	0	3	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	0	0	0	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	0	0	0	0	0	2	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	0	0	0	n/a

Table C.99 Peachtree St. and 8th St. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	0	0	Minor 1	0	0	0	0
Minor 2	0	0	0	0	Minor 2	0	0	0	0

Table C.100 Peachtree St. and 8th St. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	181	7	0	0	14	0	126	2			
Major 2 T/R	27	3	106	0	18	7	3	149	7			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	4	4	0	6	0	1	0	3				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	6	5	0	0	0	2	0	31	0	2	2	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2	0	5	n/a	0

Table C.101 Peachtree St. and 8th St. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	0	0	Minor 1	0	0	0	0
Minor 2	0	0	0	7	Minor 2	0	0	0	0

Table C.102 Peachtree St. and Pine St. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	189	0	0	0	0	0	43	9			
Major 2 T/R	0	0	208	0	14	0	0	39	10			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	0	0	0	0	0	0	0				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	1	0	2	0	0	0	1				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	3	6	0	0	0	5	0	15	0	0	1	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	3	10	0	0	0	8	0	17	0	0	3	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.103 Peachtree St. and Pine St. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	0	0	Minor 1	0	0	0	0
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.104 Peachtree St. and Pine St. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	314	0	0	0	0	0	112	11			
Major 2 T/R	2	0	407	0	22	0	0	115	17			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	2	8	0	9	0	0	0	1				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	35	54	0	0	0	110	0	117	0	0	19	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.105 Peachtree St. and Pine St. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	8	0	0	Minor 1	0	1	0	0
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.106 Peachtree St. and Sheridan Dr. SB Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	4	10	5	1	3	6	2	18	3			
Major 2 T/R	7	14	7	1	2	10	2	17	2			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	0	1	0	0	0	0	0				
Major 2 L	1	3	0	0	0	0	0	5				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	0	0	0	0	0	0	0				
Major 2 L	8	0	2	2	1	0	0	10				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	1	0	0	0	0	1	16	0	4	0	0
Minor 2	0	0	0	0	0	0	0	3	0	0	0	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	0	0	0	1	0	4	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0

Table C.107 Peachtree St. and Sheridan Dr. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	1	0	7	Minor 1	0	0	0	0
Minor 2	0	0	0	0	Minor 2	0	0	0	0

Table C.108 Peachtree and Sheridan Dr. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	153	216	153	60	55	95	22	523	18			
Major 2 T/R	88	229	156	10	53	82	2	691	20			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	7	2	2	2	1	0	0	2				
Major 2 L	21	5	2	8	10	1	2	25				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	1	4	0	0	1	3	3	65	0	19	0	0
Minor 2	1	1	0	0	0	2	3	19	0	6	1	0

Table C.109 Peachtree and Sheridan Dr. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	1	1	8	Minor 1	0	0	0	0
Minor 2	1	1	3	22	Minor 2	0	0	0	0

Table C.110 Ponce de Leon Ave. and Fairview/Lullwater Rd. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	25	50	n/a	n/a	4	n/a	43	0			
Major 2 T/R	n/a	22	n/a	n/a	n/a	n/a	n/a	1	3			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	1	0	1	0	0	0	0	3				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	0	0	0	0	0	0	0				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	1	0	0	1	0	0	1	6	0	3	0	0
Minor 2	0	1	0	0	0	3	2	1	0	1	0	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	0	0	0	0	0	1	0	0	0	0
Minor 2	0	1	0	0	0	0	0	0	0	0	0	0

Table C.111 Ponce de Leon Ave. and Fairview/Lullwater Rd. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	0	2	Minor 1	0	0	0	0
Minor 2	0	0	0	0	Minor 2	0	0	0	0

Table C.112 Ponce de Leon Ave. and Fairview/Lullwater Rd. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	73	169	n/a	n/a	17	n/a	484	4			
Major 2 T/R	14	156	64	0	5	11	4	642	11			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	5	1	3	0	0	0	1	4				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	5	1	1	3	2	4	1	28	0	7	0	0
Minor 2	10	14	1	1	2	13	4	27	0	6	0	0

Table C.113 Ponce de Leon Ave. and Fairview/Lullwater Rd. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	0	4	Minor 1	0	0	0	1
Minor 2	1	0	3	4	Minor 2	0	0	0	0

Table C.114 Ponce de Leon Ave. and Frederica St. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	8	38	n/a	6	n/a	n/a	n/a	18	3			
Major 2 T/R	0	n/a	9	n/a	0	n/a	n/a	6	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	0	n/a	0	n/a	n/a	n/a	1				
Major 2 L	2	n/a	0	n/a	0	n/a	n/a	5				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	0	n/a	0	n/a	n/a	n/a	0				
Major 2 L	1	n/a	3	n/a	2	n/a	n/a	7				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	0	n/a	n/a	n/a	0	n/a	14	n/a	n/a	2	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	n/a	n/a	n/a	0	n/a	2	n/a	n/a	0	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.115 Ponce de Leon Ave. and Frederica St. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.116 Ponce de Leon Ave. and Frederica St. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	164	386	n/a	49	n/a	n/a	n/a	459	7			
Major 2 T/R	0	n/a	459	n/a	0	n/a	n/a	692	8			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	0	n/a	0	n/a	n/a	n/a	1				
Major 2 L	17	n/a	7	n/a	6	n/a	n/a	20				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	8	5	n/a	n/a	n/a	8	n/a	65	n/a	n/a	4	1
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.117 Ponce de Leon Ave. and Frederica St. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	5	0	n/a	n/a	Minor 1	0	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.118 Roxboro Rd. and Pritchard Dr. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	8	80	16	0	0	54	0	28	8			
Major 2 T/R	3	15	68	5	23	46	12	23	7			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	1	2	1	0	1	1	3				
Major 2 L	1	0	1	0	0	0	0	1				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	1	2	1	0	1	1	0	3				
Major 2 L	0	0	0	0	0	0	0	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	Rc	re	2	r2
Minor 1	0	0	0	3	1	0	0	11	0	3	2	0
Minor 2	1	1	1	1	2	5	2	0	0	1	8	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	1	0	1	0	0	0	1	0	0	0	0
Minor 2	0	0	0	0	0	0	0	4	0	0	0	0

Table C.119 Roxboro Rd. and Pritchard Dr. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	4	2	12	Minor 1	0	0	0	1
Minor 2	4	4	3	2	Minor 2	0	1	1	0

Table C.120 Roxboro Rd. and Pritchard Dr. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	10	289	31	254	7	289	14	196	15			
Major 2 T/R	13	36	186	34	46	37	19	140	13			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	4	12	3	12	5	12	10	13				
Major 2 L	6	1	1	1	2	1	2	4				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	4	5	4	19	8	7	15	24	0	22	0	0
Minor 2	25	33	11	13	12	51	23	26	0	13	n/a	n/a

Table C.121 Roxboro Rd. and Pritchard Dr. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	5	10	10	32	Minor 1	0	0	0	2
Minor 2	13	28	23	82	Minor 2	0	3	3	0

Table C.122 Spring St. and 8th St. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	9	7	n/a	n/a	1	n/a	7	0			
Major 2 T/R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	0	0	n/a	n/a	0	n/a	17				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	n/a	8	4	n/a	n/a	0	n/a	27				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	n/a	0	0	n/a	0	n/a	n/a	1	0	0	0	0
Minor 2	0	n/a	1	0	n/a	n/a	n/a	n/a	0	n/a	3	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	n/a	0	0	n/a	0	n/a	n/a	0	0	0	0	0
Minor 2	0	n/a	0	0	n/a	n/a	n/a	n/a	0	n/a	0	0

Table C.123 Spring St. and 8th St. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	n/a	0	0	0	Minor 1	n/a	0	0	0
Minor 2	0	n/a	0	0	Minor 2	0	n/a	0	0

Table C.124 Spring St. and 8th St. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	454	199	n/a	n/a	10	n/a	1126	4			
Major 2 T/R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	8	5	n/a	n/a	0	n/a	49				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	n/a	7	1	n/a	0	n/a	n/a	26	0	5	9	0
Minor 2	10	n/a	3	1	n/a	n/a	n/a	n/a	0	n/a	11	0

Table C.125 Spring St. and 8th St. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	n/a	0	0	3	Minor 1	n/a	0	0	1
Minor 2	2	n/a	0	2	Minor 2	0	n/a	0	0

Table C.126 Spring St. and 17th St. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	54	24	n/a	n	78	n	14	25			
Major 2 T/R	n/a	22	n/a	n/a	n/a	n/a	n/a	1	3			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	2	0	n/a	n	3	n	1				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	n/a	2	2	n/a	n/a	6	n/a	1				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	n/a	7	11	n/a	7	n/a	n/a	14	0	13	9	0
Minor 2	3	n/a	4	6	n/a	n/a	n/a	n/a	0	n/a	4	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	n/a	15	11	n/a	16	n/a	n/a	14	0	0	28	0
Minor 2	0	n/a	0	0	n/a	n/a	n/a	n/a	0	n/a	0	0

Table C.127 Spring St. and 17th St. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	n/a	8	0	13	Minor 1	n/a	1	0	0
Minor 2	2	n/a	7	0	Minor 2	0	n/a	0	0

Table C.128 Spring St. and 17th St. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	167	52	n/a	n	175	n	57	33			
Major 2 T/R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	14	7	n/a	n/a	24	n	6				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	n/a	99	76	n/a	126	n/a	n/a	69	0	62	106	0
Minor 2	33	n/a	46	111	n/a	n/a	n/a	n/a	0	n/a	36	0

Table C.129 Spring St. and 17th St. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	n/a	n/a	n/a	n/a	Minor 1	n/a	n/a	n/a	n/a
Minor 2	25	n/a	0	23	Minor 2	0	n/a	0	0

Table C.130 Spring St. and Abercrombie Pl. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	0	0	n/a	n/a	0	n/a	3	0			
Major 2 T/R	n/a	22	n/a	n/a	n/a	n/a	n/a	1	3			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	3	0	n/a	n/a	0	n/a	14				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	n/a	0	0	n/a	n/a	0	n/a	7				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	Rc	re	2	r2
Minor 1	2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.131 Spring St. and Abercrombie Pl. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	n/a	0	n/a	n/a	Minor 1	n/a	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.132 Spring St. and Abercrombie Pl. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	0	17	n/a	n/a	0	n/a	615	1			
Major 2 T/R	n/a	351	n/a	n/a	n/a	n/a	n/a	127	15			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	0	3	n/a	n/a	0	n/a	21				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	7	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.133 Spring St. and Abercrombie Pl. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	n/a	0	n/a	n/a	Minor 1	n/a	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.134 Techwood Dr. and Merritts Ave. 1 Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	0	0	0	0	0	0	2	0			
Major 2 T/R	0	0	0	0		0	0	6	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	0	0	0	0	0	0	13				
Major 2 L	0	0	0	0	0	0	0	2				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	0	0	0	0	0	0	0				
Major 2 L	0	0	0	0	0	0	0	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	Rc	re	2	r2
Minor 1	0	1	0	0	0	0	0	13	0	0	0	0
Minor 2	0	0	0	0	0		0	1	0	0	0	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0

Table C.135 Techwood Dr. and Merritts Ave. 1 Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	0	0	Minor 1	0	0	0	0
Minor 2	0	0	0	0	Minor 2	0	0	0	0

Table C.136 Techwood Dr. and Merritts Ave. 1 Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	2	1	0	0	0	0	100	1			
Major 2 T/R	0	1	1	0		0	0	66	1			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	0	0	0	1	0	0	14				
Major 2 L	0	0	0	0	0	0	0	4				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	2	0	0	0	0	0	16	0	0	0	0
Minor 2	0	0	0	0	0		0	3	0	0	2	0

Table C.137 Techwood Dr. and Merritts Ave. 1 Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	n/a	n/a	n/a	n/a	Minor 1	n/a	n/a	n/a	n/a
Minor 2	25	n/a	0	23	Minor 2	0	n/a	0	0

Table C.138 Techwood Dr. and Merritts Ave. 2 Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	4	0	0	0	0	0	16	0			
Major 2 T/R	0	1	1	0	0	0	0	2	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	1	0	0	0	0	0	0	7				
Major 2 L	0	1	1	0	0	0	0	4				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	0	0	0	0	0	0	1				
Major 2 L	0	0	0	0	0	0	0	2				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	0	0	0	0	0	0	0	4	0	0	2	1
Minor 2	0	0	0	0	0		0	0	0	0	0	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	0	0	0	0	0	0	0	0	0	0	0
Minor 2	0	0	0	0	0	0	0	0	0	0	0	0

Table C.139 Techwood Dr. and Merritts Ave. 2 Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	2	0	Minor 1	0	0	0	0
Minor 2	0	0	0	0	Minor 2	0	0	0	0

Table C.140 Techwood Dr. and Merritts Ave. 2 Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	3	43	6	0	0	0	0	190	0			
Major 2 T/R	0	1	1	0		0	0	66	1			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	1	0	0	0	0	0	0	10				
Major 2 L	1	1	1	0	0	0	0	7				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	3	4	1	0	1	1	0	15	0	0	26	0
Minor 2	0	1	0	0	0	0		10	0	0	3	0

Table C.141 Techwood Dr. and Merritts Ave. 2 Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	0	2	0	Minor 1	0	0	0	0
Minor 2	0	1	0	0	Minor 2	0	0	0	0

Table C.142 W. Peachtree St. and 11th St. Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a			
Major 2 T/R	n/a	n/a	2	n/a	n/a	n/a	n/a	7	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	n/a	n/a	0	n/a	n/a	n/a	n/a	1				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	n/a	n/a	0	n/a	n/a	n/a	n/a	0				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	Rc	re	2	r2
Minor 1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	0	0	n/a	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	0	0	n/a	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.143 W. Peachtree St. and 11th St. Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	n/a	0	n/a	n/a	Minor 1	n/a	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.144 W. Peachtree St. and 11th St. Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a			
Major 2 T/R	n/a	n/a	126	n/a	n/a	n/a	n/a	712	0			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	n/a	n/a	2	n/a	n/a	n/a	n/a	3				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	58	0	0	n/a	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.145 W. Peachtree St. and 11th St. Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	n/a	0	n/a	n/a	Minor 1	n/a	0	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.146 W. Peachtree St. and 16th St. 1 Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	n/a	105	n/a	n/a	n/a	n/a	13	0			
Major 2 T/R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	9	n/a	n/a	n/a	n/a	11				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	n/a	n/a	19	n/a	n/a	n/a	n/a	12				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	6	n/a
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2	n/a
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.147 W. Peachtree St. and 16th St. 1 Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	2	n/a	n/a	n/a	Minor 1	0	n/a	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.148 W. Peachtree St. and 16th St. 1 Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	n/a	1067	n/a	n/a	n/a	n/a	327	4			
Major 2 T/R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	60	n/a	n/a	n/a	n/a	30				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	88	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	122	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.149 W. Peachtree St. and 16th St. 1 Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	18	n/a	n/a	n/a	Minor 1	0	n/a	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.150 W. Peachtree St. and 16th St. 2 Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	200	n/a	n/a	n/a	n/a	n/a	29	13			
Major 2 T/R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	54	n/a	n/a	n/a	n/a	n/a	10				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	n/a	0	n/a	n/a	n/a	n/a	n/a	0				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	28	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	11	n/a
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	n/a
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.151 W. Peachtree St. and 16th St. 2 Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	4	n/a	n/a	n/a	Minor 1	1	n/a	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.152 W. Peachtree St. and 16th St. 2 Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	n/a	1382	n/a	n/a	n/a	n/a	279	29			
Major 2 T/R	n/a	351	n/a	n/a	n/a	n/a	n/a	127	15			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	141	n/a	n/a	n/a	n/a	22				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	223	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	68	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table C.153 W. Peachtree St. and 16th St. 2 Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	42	n/a	n/a	n/a	Minor 1	4	n/a	n/a	n/a
Minor 2	n/a	n/a	n/a	n/a	Minor 2	n/a	n/a	n/a	n/a

Table C.154 W. Peachtree St. and Peachtree Place Stop Violation Counts

Violation Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	0	9	4	0	0	3	0	10	0			
Major 2 T/R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	0	8	1	0	0	2	0	15				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Platoon	5O1	5R1	5L1	5OR1	5OL1	5RL1	5ORL1	6_1				
Major 1 L	0	9	2	0	0	0	0	14				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	1	n/a	0	0	n/a	n/a	n/a	n/a	0	n/a	8	0
Minor 2	n/a	0	4	n/a	0	n/a	n/a	12	0	4	8	0
Platoon	1a1	1b1	1c1	1d1	1_e1	1f1	1g1	rb1	ec1	re1	2_1	r2_1
Minor 1	1	1	n/a	n/a	n/a	0	n/a	33	n/a	n/a	1	0
Minor 2	n/a	0	0	n/a	0	n/a	n/a	4	0	0	0	0

Table C.155 W. Peachtree St. and Peachtree Place Out-of-turn Counts

Violation Data	Presence Type								
OFT by Time					OFT by Position				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	0	n/a	1	0	Minor 1	0	n/a	0	0
Minor 2	n/a	1	0	6	Minor 2	n/a	0	0	0

Table C.156 W. Peachtree St. and Peachtree Place Opportunity for Stop Violation Counts

Base Data	Presence Type											
Stop Violation	3O	3R	3L	3OR	3OL	3RL	3ORL	4	3x			
Major 1 T/R	n/a	n/a	462	n/a	n/a	n/a	n/a	256	49			
Major 2 T/R	n/a	351	n/a	n/a	n/a	n/a	n/a	127	15			
Stop Violation	5O	5R	5L	5OR	5OL	5RL	5ORL	6				
Major 1 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Major 2 L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
Stop Violation	1a	1b	1c	1d	1e	1f	1g	rb	rc	re	2	r2
Minor 1	35	20	n/a	n/a	n/a	19	n/a	235	n/a	n/a	33	0
Minor 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	19	0

Table C.157 W. Peachtree St. and Peachtree Place Opportunity for Out-of-turn Counts

Base Data	Presence Type								
OFT by Time					OFT by Pos				
	9a	9b	9c	9d		10a	10b	10c	10d
Minor 1	4	n/a	10	0	Minor 1	1	n/a	1	0
Minor 2	0	1	0	47	Minor 2	n/a	0	0	0

REFERENCES

[1] Jenior, P. *Observation and Modeling of Traffic Operations at Intersection in Malfunction Flash Mode.* Masters Thesis, Georgia Institute of Technology. May 2007.

[2] Bansen, J. *Evaluation of Traffic Operations at Intersections in Malfunction Flash Mode.* Masters Thesis, Georgia Institute of Technology. May 2006.

[3] Oricchio, V. *Microscopic Simulation Model of Traffic Operations at Intersections in Malfunction Flash Mode.* Masters Thesis, Georgia Institute of Technology. July 2007.

[4] The Official Code of Georgia Annotated. Chapter 40-6-70, 40-6-72. Source: www.legis.state.ga.us. (Accessed July 2008).

[5] 2008 Georgia Driver's Manual. Chapter 1 and 3. Source: www.dds.ga.gov. (Accessed July 2008).

[6] Womack, K.N., Hawkins, J.M. *Motorist Comprehension of Traffic Control Devices: Statewide Survey Results.* Research Report 1261-2. Texas Transportation Institute, Texas A&M University. College Station, TX. February 1993.

[7] Benioff, B., Carson, C., Dock, F.C. *A Study of Clearance Intervals, Flashing Operation, and Left-turn Phasing at Traffic Signals: Volume 3 Flashing Operation.* Final Report. FHWA-RD-78-48. Federal Highway Administration. Washington, D.C. May 1980.

[8] Stokes, R., Rys, M.J., Russell, E.R., Robinson, R.K., Budke, B. *Analysis of Rural Intersection Accidents Caused by Stop Sign Violation and Failure to Yield the Right of way.* Report K-Tran: KSU-98-6. Kansas DOT, Kansas State University, The University of Kansas. Manhattan, KS. September 2000.

[9] Picha, D., Shuckel, C., Parham, A., Mai, C. *Traffic Control Devices at Two-way Stop-controlled Intersections.* Report No. 1374-1F, Texas Transportation Institute. Texas Department of Transportation. Austin TX. November 1996.

[10] Gattis, J. *Supplemental Signing for Stop Signs.* University of Arkansas. Fayetteville, AR. October 1995.

[11] Kaysi, I., Alam, G. *Driver Behavior and Traffic Stream Interactions at Unsignalized Intersections.* Journal of Transportation Engineering. Vol. 126, No. 6, 2000. p 498-505.

[12] Mounce, J.M. *Driver Compliance with Stop-sign Control at Low-Volume Intersections.* Transportation Research Record 808. Transportation Research Board. Washington, D.C. 1981.

[13] *Traffic Conflict Techniques for Safety and Operations – Engineer's Guide.* Federal Highway Administration. McLean, VA. June 1988.

[14] Katamine, N.M. *Various Volume Definitions with Conflicts at Unsignalized Intersections.* Journal of Transportation Engineering. Viol 126, No 1, 2000. p. 27-34.