1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/OH-2007/13A		
4. Title and subtitle **Crash Base Rates for Freeways/Reduction Strategies for Rear End Crashes - Volume 1: Crash Base Rates for Freeways in Ohio**		5. Report Date **June 2007**
		6. Performing Organization Code
7. Author(s) **Prahlad D. Pant, Ph.D.** **Subarna Panta**		8. Performing Organization Report No.
		10. Work Unit No. (TRAIS)
9. Performing Organization Name and Address **PDP Associates Inc.** **P.O. Box 888264** **Atlanta, GA 30356**		11. Contract or Grant No. **134230**
		13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address **Ohio Department of Transportation** **1980 West Broad Street** **Columbus, Ohio 43223**		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

A safety analysis of a specific location includes a "base crash rate" analysis for identifying crash patterns at the study location. If the calculated crash rate for any crash type at a particular location is found to be higher than the "base crash rate", then that location is chosen for further study to determine if a safety problem actually exists at that location and, if so, what counter measure(s) can be used.

The primary objective of this study was to develop a set of mathematical models to estimate base crash rates for freeways in Ohio. The models estimate the incremental changes in the dependent variables (crash rate for different types of crashes) resulting from changes in the independent variables including geometric features, operational controls, and environmental conditions.

The base crash density/rate models were developed for the following crash types: (a) Injury crashes, (b) PDO crashes, (c) Total crashes, (d) Angle crashes, (e) Fixed crashes, (f) Rear end crashes, (g) Sideswipe crashes, (h) Wet road crashes, and (i) Night crashes. To evaluate the complex interaction among the dependent and independent variables, Automatic Interaction Detection (AID) technique was used. After the completion of AID analysis, stepwise multiple regression technique was used to develop mathematical models for the split groups. Finally, the models were validated with the one-third data that was set aside for validation.

This study developed state-wide and district-wide base crash density and rate models for freeways. These models are recommended for use by ODOT for evaluating freeway crashes. The results of this study have a high potential of implementation in Ohio.

17. Key Words		18. Distribution Statement	
Crash Base Rate, Accident Base Rate, Freeways, Automatic Interaction Detection, Crash Density, Crash Rate, Accident Density, Accident Rate		No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages	22. Price
Form DOT F 1700.7 (8-72)	**Reproduction of completed pages authorized**		

This page intentionally left blank.

Crash Base Rates for Freeways/Reduction Strategies for Rear End Crashes
Volume 1: Crash Base Rates for Freeways in Ohio

Prepared by
Prahlad D. Pant, Ph.D.
Principal Investigator
and
Subarna Panta
Systems Analyst

Research Performed By
PDP Associates Inc.
P.O.Box 888264
Atlanta, GA 30356

Research Performed Under
State Job No.: 134230
Agreement No.: 20819

Sponsored by
State of Ohio
Department of Transportation
In cooperation with
U.S. Department of Transportation,
Federal Highway Administration

June, 2007

This page intentionally left blank.

Disclaimer Statement

This page intentionally left blank

ACKNOWLEDGEMENT

The researchers thank the following officials of the Ohio Department of Transportation for their assistance in the conduct of this research study:

- Ms. Monique Evans P.E., Administrator, Office of Research & Development;
- Ms. Jennifer Townley P.E., Administrator, Office of Systems Planning and Program Management;
- Mr. Don P. Fisher P.E., Transportation Engineer, Office of Systems Planning and Program Management;
- Mr. Jonathan Hughes, P.E., Office of Systems Planning and Program Management; and
- Mr. Tom Ramsay, Office of Systems Planning and Program Management

This page intentionally left blank

TABLE OF CONTENTS

1.0 Statement of the problem	-	-	-	-	21
2.0 Objectives	-	-	-	-	23
3.0 Methodology	-	-	-	-	25
4.0 Data Collection and Extraction	-	-	-	-	27
4.1 Data Compilation	-	-	-	-	27
4.2 Roadway Segmentation	-	-	-	-	
4.3 Population Density	-	-	-	-	27
4.3 Distance to Interchange	-	-	-	-	27
4.4 Master Database	-	-	-	-	27
4.5 Data Validation	-	-	-	-	30
4.6 Data Analysis	-	-	-	-	30
5.0 Model Building Using Automated Interaction and Detection (AID) and Regression Technique	-	-	-	-	47
5.1 Model Building Using Automated Interaction and Detection (AID)	-	-	-	-	47
5.2 Model Building Using Regression	-	-	-	-	67
6.0 Model Validation for Crash Base Rate Studies	-	-	-	-	73
7.0 Applications, Conclusions and Recommendations	-	-	-	-	77
7.1 Applications	-	-	-	-	77
7.2 Summary and Conclusions	-	-	-	-	79
7.3 Recommendations	-	-	-	-	80
Reference	-	-	-	-	81
Appendix I Districtwide Descriptive Statistics	-	-	-	-	85
Appendix II Statewide and Districtwide AID Trees	-	-	-	-	97
Appendix III Statewide and Districtwide Crash Density and Rate Models	-	-	-	-	285
Appendix IV Statewide and Districtwide Model Validation	-	-	-	-	319
Appendix V Statewide and Districtwide Crash Density and Rate Models	-	-	-	-	351

This page is intentionally left blank

LIST OF FIGURES

Figure 1: Methodology for Developing Base Crash Rate …………………….. 26
Figure 2. Statewide distribution of Segment Length …………………….. 30
Figure 3. Statewide distribution of Speed Limit …………………….. 31
Figure 4. Statewide distribution of Lanes …………………….. 32
Figure 5. Statewide distribution of Average Daily Traffic …………………….. 33
Figure 6. Statewide distribution of Population Density …………………….. 34
Figure 7. Statewide distribution of Roadway Width …………………….. 35
Figure 8. Statewide distribution of Surface Width …………………….. 36
Figure 9. Statewide distribution of Shoulder left Inside Width …………………….. 37
Figure 10. Statewide distribution of Shoulder left Outside Width …………………….. 38
Figure 11. Statewide distribution of Shoulder Right Inside Width …………………….. 38
Figure 12. Statewide distribution of Shoulder Right Outside Width …………………….. 39
Figure 13. Statewide distribution of Barrier …………………….. 40
Figure 14. Statewide distribution of Median Width …………………….. 41
Figure 15. Statewide distribution of Curve Degree …………………….. 42
Figure 16. Statewide distribution of Grade Percentage …………………….. 43
Figure 17. Statewide distribution of V/C Ratio …………………….. 44
Figure 18. Statewide distribution of Distance to Interchange …………………….. 45
Figure 19. Statewide distribution of Crash Types …………………….. 46
Figure 20.Statewide Injury/Fatal Crash Density …………………….. 49
Figure 21.Statewide Property Damage Only Crash Density …………………….. 50
Figure 23.Statewide Total Crash Density …………………….. 51
Figure 24. Statewide Angle Crash Density …………………….. 52
Figure 25. Statewide Fixed Object Crash Density …………………….. 53
Figure 26. Statewide Rear end Crash Density …………………….. 54
Figure 27. Statewide Sideswipe Crash Density …………………….. 55
Figure 28. Statewide Road Wet Crash Density …………………….. 56
Figure 29. Statewide Night Crash Density …………………….. 57
Figure 30.Statewide Injury/Fatal Crash Rate …………………….. 58
Figure 31.Statewide Property Damage Only Crash Rate …………………….. 59
Figure 32.Statewide Total Crash Rate …………………….. 60
Figure 33.Statewide Angle Crash Rate …………………….. 61
Figure 34.Statewide Fixed Object Crash Rate …………………….. 62
Figure 35.Statewide Rear end Crash Rate …………………….. 63
Figure 36.Statewide Sideswipe Crash Rate …………………….. 64
Figure 37.Statewide Road Wet Crash Rate …………………….. 65
Figure 38.Statewide Night Crash Rate …………………….. 66

Figure 2.1.Statewide Injury/Fatal Crash Density …………………….. 100
Figure 2.2.Statewide Property Damage Only Crash Density …………………….. 101
Figure 2.3.Statewide Total Crash Density …………………….. 102
Figure 2.4.Statewide Angle Crash Density …………………….. 103
Figure 2.5.Statewide Fixed Object Crash Density …………………….. 104
Figure 2.6.Statewide Rear end Crash Density …………………….. 105
Figure 2.7.Statewide Sideswipe Crash Density …………………….. 106
Figure 2.8.Statewide Road Wet Crash Density …………………….. 107
Figure 2.9.Statewide Night Crash Density …………………….. 108
Figure 2.10.Statewide Injury/Fatal Crash Density …………………….. 109
Figure 2.11.Statewide Property Damage Only Crash Density …………………….. 110
Figure 2.12.Statewide Total Crash Density …………………….. 111
Figure 2.13.Statewide Angle Crash Density …………………….. 112
Figure 2.14.Statewide Fixed Object Crash Density …………………….. 113
Figure 2.15.Statewide Rear end Crash Density …………………….. 114
Figure 2.16.Statewide Sideswipe Crash Density …………………….. 115
Figure 2.17.Statewide Road Wet Crash Density …………………….. 116
Figure 2.18.Statewide Night Crash Density …………………….. 117
Figure 2.19.District 1 Injury/Fatal Crash Density …………………….. 118
Figure 2.20.District 1 Property Damage Only Crash Density …………………….. 119
Figure 2.21.District 1 Total Crash Density …………………….. 120
Figure 2.22.District 1 Angle Crash Density …………………….. 121
Figure 2.23.District 1 Fixed Object Crash Density …………………….. 122
Figure 2.24.District 1 Rear end Crash Density …………………….. 123
Figure 2.25.District 1 Sideswipe Crash Density …………………….. 123
Figure 2.26.District 1 Road Wet Crash Density …………………….. 124
Figure 2.27.District 1 Night Crash Density …………………….. 125
Figure 2.28.District 1 Injury/Fatal Crash Rate …………………….. 126
Figure 2.29.District 1 Property Damage Only Crash Rate …………………….. 127
Figure 2.30.District 1 Total Crash Rate …………………….. 128
Figure 2.31.District 1 Angle Crash Rate …………………….. 129
Figure 2.32.District 1 Fixed Object Crash Rate …………………….. 130
Figure 2.33.District 1 Rear end Crash Rate …………………….. 131
Figure 2.34.District 1 Sideswipe Crash Rate …………………….. 131
Figure 2.35.District 1 Road Wet Crash Rate …………………….. 132
Figure 2.36.District 1 Night Crash Rate …………………….. 132
Figure 2.37.District 2 Injury/Fatal Crash Density …………………….. 133
Figure 2.38.District 2 Property Damage Only Crash Density …………………….. 133
Figure 2.39.District 2 Total Crash Density …………………….. 134
Figure 2.40.District 2 Angle Crash Density …………………….. 134
Figure 2.41.District 2 Fixed Object Crash Density …………………….. 135

Figure 2.42.District 2 Rear end Crash Density …………………….. 135
Figure 2.43.District 2 Sideswipe Crash Density …………………….. 136
Figure 2.44.District 2 Road Wet Crash Density …………………….. 136
Figure 2.45.District 2 Night Crash Density …………………….. 137
Figure 2.46.District 2 Injury/Fatal Crash Rate …………………….. 137
Figure 2.47.District 2 Property Damage Only Crash Rate …………………….. 138
Figure 2.48.District 2 Total Crash Rate …………………….. 138
Figure 2.49.District 2 Angle Crash Rate …………………….. 139
Figure 2.50.District 2 Fixed Object Crash Rate …………………….. 140
Figure 2.51.District 2 Rear end Crash Rate …………………….. 141
Figure 2.52.District 2 Sideswipe Crash Rate …………………….. 141
Figure 2.53.District 2 Road Wet Crash Rate …………………….. 142
Figure 2.54.District 2 Night Crash Rate …………………….. 142
Figure 2.55.District 3 Injury/Fatal Crash Density …………………….. 143
Figure 2.56.District 3 Property Damage Only Crash Density …………………….. 143
Figure 2.57.District 3 Total Crash Density …………………….. 144
Figure 2.58.District 3 Angle Crash Density …………………….. 144
Figure 2.59.District 3 Fixed Object Crash Density …………………….. 145
Figure 2.60.District 3 Rear end Crash Density …………………….. 145
Figure 2.61.District 3 Sideswipe Crash Density …………………….. 146
Figure 2.62.District 3 Road Wet Crash Density …………………….. 146
Figure 2.63.District 3 Night Crash Density …………………….. 147
Figure 2.64.District 3 Injury/Fatal Crash Rate …………………….. 147
Figure 2.65.District 3 Property Damage Only Crash Rate …………………….. 148
Figure 2.66.District 3 Total Crash Rate …………………….. 148
Figure 2.67.District 3 Angle Crash Rate …………………….. 149
Figure 2.68.District 3 Fixed Object Crash Rate …………………….. 150
Figure 2.69.District 3 Rear end Crash Rate …………………….. 151
Figure 2.70.District 3 Sideswipe Crash Rate …………………….. 152
Figure 2.71.District 3 Road Wet Crash Rate …………………….. 153
Figure 2.72.District 3 Night Crash Rate …………………….. 154
Figure 2.73.District 4 Injury/Fatal Crash Density …………………….. 155
Figure 2.74.District 4 Property Damage Only Crash Density …………………….. 156
Figure 2.75.District 4 Total Crash Density …………………….. 157
Figure 2.76.District 4 Angle Crash Density …………………….. 158
Figure 2.77.District 4 Fixed Object Crash Density …………………….. 159
Figure 2.78.District 4 Rear end Crash Density …………………….. 160
Figure 2.79.District 4 Sideswipe Crash Density …………………….. 161
Figure 2.80.District 4 Road Wet Crash Density …………………….. 162
Figure 2.81.District 4 Night Crash Density …………………….. 163
Figure 2.82.District 4 Injury/Fatal Crash Rate …………………….. 164

Figure 2.83.District 4 Property Damage Only Crash Rate …………………….. 165
Figure 2.84.District 4 Total Crash Rate …………………….. 166
Figure 2.85.District 4 Angle Crash Rate …………………….. 167
Figure 2.86.District 4 Fixed Object Crash Rate …………………….. 168
Figure 2.87.District 4 Rear end Crash Rate …………………….. 169
Figure 2.88.District 4 Sideswipe Crash Rate …………………….. 170
Figure 2.89.District 4 Road Wet Crash Rate …………………….. 171
Figure 2.90.District 4 Night Crash Rate …………………….. 172
Figure 2.91.District 5 Injury/Fatal Crash Density …………………….. 173
Figure 2.92.District 5 Property Damage Only Crash Density …………………….. 174
Figure 2.93.District 5 Total Crash Density …………………….. 175
Figure 2.94.District 5 Angle Crash Density …………………….. 175
Figure 2.95.District 5 Fixed Object Crash Density …………………….. 176
Figure 2.96.District 5 Rear end Crash Density …………………….. 177
Figure 2.97.District 5 Sideswipe Crash Density …………………….. 178
Figure 2.98.District 5 Road Wet Crash Density …………………….. 179
Figure 2.99.District 5 Night Crash Density …………………….. 180
Figure 2.100.District 5 Injury/Fatal Crash Rate …………………….. 181
Figure 2.101.District 5 Property Damage Only Crash Rate …………………….. 182
Figure 2.102.District 5 Total Crash Rate …………………….. 183
Figure 2.103.District 5 Angle Crash Rate …………………….. 184
Figure 2.104.District 5 Fixed Object Crash Rate …………………….. 185
Figure 2.105.District 5 Rear end Crash Rate …………………….. 186
Figure 2.106.District 5 Sideswipe Crash Rate …………………….. 187
Figure 2.107.District 5 Road Wet Crash Rate …………………….. 187
Figure 2.108.District 5 Night Crash Rate …………………….. 188
Figure 2.109.District 6 Injury/Fatal Crash Density …………………….. 189
Figure 2.110.District 6 Property Damage Only Crash Density …………………….. 190
Figure 2.111.District 6 Total Crash Density …………………….. 191
Figure 2.112.District 6 Angle Crash Density …………………….. 192
Figure 2.113.District 6 Fixed Object Crash Density …………………….. 193
Figure 2.114.District 6 Rear end Crash Density …………………….. 194
Figure 2.115.District 6 Sideswipe Crash Density …………………….. 195
Figure 2.116.District 6 Road Wet Crash Density …………………….. 196
Figure 2.117.District 6 Night Crash Density …………………….. 197
Figure 2.118.District 6 Injury/Fatal Crash Rate …………………….. 198
Figure 2.119.District 6 Property Damage Only Crash Rate …………………….. 199
Figure 2.120.District 6 Total Crash Rate …………………….. 200
Figure 2.121.District 6 Angle Crash Rate …………………….. 201
Figure 2.122.District 6 Fixed Object Crash Rate …………………….. 202
Figure 2.123.District 6 Rear end Crash Rate …………………….. 203

Figure 2.124.District 6 Sideswipe Crash Rate …………………….. 204
Figure 2.125.District 6 Road Wet Crash Rate …………………….. 205
Figure 2.126.District 6 Night Crash Rate …………………….. 206
Figure 2.127.District 7 Injury/Fatal Crash Density …………………….. 207
Figure 2.128.District 7 Property Damage Only Crash Density …………………….. 208
Figure 2.129.District 7 Total Crash Density …………………….. 209
Figure 2.130.District 7 Angle Crash Density …………………….. 210
Figure 2.131.District 7 Fixed Object Crash Density …………………….. 211
Figure 2.132.District 7 Rear end Crash Density …………………….. 211
Figure 2.133.District 7 Sideswipe Crash Density …………………….. 212
Figure 2.134.District 7 Road Wet Crash Density …………………….. 213
Figure 2.135.District 7 Night Crash Density …………………….. 214
Figure 2.136.District 7 Injury/Fatal Crash Rate …………………….. 215
Figure 2.137.District 7 Property Damage Only Crash Rate …………………….. 216
Figure 2.138.District 7 Total Crash Rate …………………….. 217
Figure 2.139.District 7 Angle Crash Rate …………………….. 218
Figure 2.140.District 7 Fixed Object Crash Rate …………………….. 219
Figure 2.141.District 7 Rear end Crash Rate …………………….. 220
Figure 2.142.District 7 Sideswipe Crash Rate …………………….. 221
Figure 2.143.District 7 Road Wet Crash Rate …………………….. 222
Figure 2.144.District 7 Night Crash Rate …………………….. 223
Figure 2.145.District 8 Injury/Fatal Crash Density …………………….. 224
Figure 2.146.District 8 Property Damage Only Crash Density …………………….. 225
Figure 2.147.District 8 Total Crash Density …………………….. 226
Figure 2.148.District 8 Angle Crash Density …………………….. 227
Figure 2.149.District 8 Fixed Object Crash Density …………………….. 228
Figure 2.150.District 8 Rear end Crash Density …………………….. 229
Figure 2.151.District 8 Sideswipe Crash Density …………………….. 230
Figure 2.152.District 8 Road Wet Crash Density …………………….. 231
Figure 2.153.District 8 Night Crash Density …………………….. 232
Figure 2.154.District 8 Injury/Fatal Crash Rate …………………….. 233
Figure 2.155.District 8 Property Damage Only Crash Rate …………………….. 234
Figure 2.156.District 8 Total Crash Rate …………………….. 235
Figure 2.157.District 8 Angle Crash Rate …………………….. 236
Figure 2.158.District 8 Fixed Object Crash Rate …………………….. 237
Figure 2.159.District 8 Rear end Crash Rate …………………….. 238
Figure 2.160.District 8 Sideswipe Crash Rate …………………….. 239
Figure 2.161.District 8 Road Wet Crash Rate …………………….. 240
Figure 2.162.District 8 Night Crash Rate …………………….. 241
Figure 2.163.District 10 Injury/Fatal Crash Density …………………….. 242
Figure 2.164.District 10 Property Damage Only Crash Density …………………….. 242

Figure 2.165.District 10 Total Crash Density ……………………. 243
Figure 2.166.District 10 Angle Crash Density ……………………. 243
Figure 2.167.District 10 Fixed Object Crash Density ……………………. 244
Figure 2.168.District 10 Rear end Crash Density ……………………. 244
Figure 2.169.District 10 Sideswipe Crash Density ……………………. 245
Figure 2.170.District 10 Road Wet Crash Density ……………………. 245
Figure 2.171.District 10 Night Crash Density ……………………. 246
Figure 2.172.District 10 Injury/Fatal Crash Rate ……………………. 246
Figure 2.173.District 10 Property Damage Only Crash Rate ……………………. 247
Figure 2.174.District 10 Total Crash Rate ……………………. 247
Figure 2.175.District 10 Angle Crash Rate ……………………. 248
Figure 2.176.District 10 Fixed Object Crash Rate ……………………. 248
Figure 2.177.District 10 Rear end Crash Rate ……………………. 249
Figure 2.178.District 10 Sideswipe Crash Rate ……………………. 249
Figure 2.179.District 10 Road Wet Crash Rate ……………………. 250
Figure 2.180.District 10 Night Crash Rate ……………………. 250
Figure 2.181.District 11 Injury/Fatal Crash Density ……………………. 251
Figure 2.182.District 11 Property Damage Only Crash Density ……………………. 252
Figure 2.183.District 11 Total Crash Density ……………………. 253
Figure 2.184.District 11 Angle Crash Density ……………………. 254
Figure 2.185.District 11 Fixed Object Crash Density ……………………. 255
Figure 2.186.District 11 Rear end Crash Density ……………………. 256
Figure 2.187.District 11 Sideswipe Crash Density ……………………. 257
Figure 2.188.District 11 Road Wet Crash Density ……………………. 258
Figure 2.189.District 11 Night Crash Density ……………………. 259
Figure 2.190.District 11 Injury/Fatal Crash Rate ……………………. 260
Figure 2.191.District 11 Property Damage Only Crash Rate ……………………. 261
Figure 2.192.District 11 Total Crash Rate ……………………. 262
Figure 2.193.District 11 Angle Crash Rate ……………………. 262
Figure 2.194.District 11 Fixed Object Crash Rate ……………………. 263
Figure 2.195.District 11 Rear end Crash Rate ……………………. 263
Figure 2.196.District 11 Sideswipe Crash Rate ……………………. 264
Figure 2.197.District 11 Road Wet Crash Rate ……………………. 265
Figure 2.198.District 11 Night Crash Rate ……………………. 266
Figure 2.199.District 12 Injury/Fatal Crash Density ……………………. 267
Figure 2.200.District 12 Property Damage Only Crash Density ……………………. 268
Figure 2.201.District 12 Total Crash Density ……………………. 269
Figure 2.202.District 12 Angle Crash Density ……………………. 270
Figure 2.203.District 12 Fixed Object Crash Density ……………………. 271
Figure 2.204.District 12 Rear end Crash Density ……………………. 272
Figure 2.205.District 12 Sideswipe Crash Density ……………………. 273

Figure 2.206.District 12 Road Wet Crash Density …………………….. 274
Figure 2.207.District 12 Night Crash Density …………………….. 275
Figure 2.208.District 12 Injury/Fatal Crash Rate …………………….. 276
Figure 2.209.District 12 Property Damage Only Crash Rate …………………….. 276
Figure 2.210.District 12 Total Crash Rate …………………….. 277
Figure 2.211.District 12 Angle Crash Rate …………………….. 278
Figure 2.212.District 12 Fixed Object Crash Rate …………………….. 279
Figure 2.213.District 12 Rear end Crash Rate …………………….. 280
Figure 2.214.District 12 Sideswipe Crash Rate …………………….. 281
Figure 2.215.District 12 Road Wet Crash Rate …………………….. 282
Figure 2.216.District 12 Night Crash Rate …………………….. 283

LIST OF TABLES

Table 1. Statewide distribution of Segment Length	……………………..	30
Table 2. Statewide distribution of Speed Limit	……………………..	31
Table 3. Statewide distribution of Lanes	……………………..	31
Table 4. Statewide distribution of Average daily Traffic	……………………..	32
Table 5. Statewide distribution of Population Density	……………………..	33
Table 6. Statewide distribution of Roadway Width	……………………..	34
Table 7. Statewide distribution of Surface Width	……………………..	35
Table 8. Statewide distribution of Shoulder Left Inside Width	……………………..	36
Table 9. Statewide distribution of Shoulder Left Outside Width	……………………..	37
Table 10. Statewide distribution of Shoulder Right Inside Width	……………………..	38
Table 11. Statewide distribution of Shoulder Right Outside Width	……………………..	39
Table 12. Statewide distribution of Barrier	……………………..	39
Table 13. Statewide distribution of Median Width	……………………..	40
Table 14. Statewide distribution of Curve Degree	……………………..	41
Table 15. Statewide distribution of Grade Percentage	……………………..	42
Table 16. Statewide distribution of V/C Ratio	……………………..	43
Table 17. Statewide distribution of Distance to Interchange	……………………..	44
Table 18. Statewide distribution of Crash Types	……………………..	45
Table 19. Statewide Crash Density Models	……………………..	69
Table 20. Statewide Crash Rate Models	……………………..	71
Table 21. Statewide Crash Density Model Validation	……………………..	74
Table 22. Statewide Crash Rate Model Validation	……………………..	76
Table 1.1. Districtwide distribution of Segment Length	……………………..	87
Table 1.2. Districtwide distribution of Speed Limit	……………………..	87
Table 1.3. Districtwide distribution of Average Daily Traffic	……………………..	88
Table 1.4. Districtwide distribution of Lanes	……………………..	88
Table 1.5. Districtwide distribution of Population Density	……………………..	89
Table 1.6. Districtwide distribution of Roadway Width	……………………..	89
Table 1.7. Districtwide distribution of Surface Width	……………………..	90
Table 1.8. Districtwide distribution of Shoulder Left Inside Width	……………………..	90
Table 1.9. Districtwide distribution of Shoulder Left Outside Width	……………………..	91
Table 1.10. Districtwide distribution of Shoulder Right Inside Width	……………………..	91
Table 1.11. Districtwide distribution of Shoulder Right Outside Width	……………………..	92
Table 1.12. Districtwide distribution of Barrier	……………………..	92
Table 1.13. Districtwide distribution of Median Width	……………………..	93
Table 1.14. Districtwide distribution of Curve Degree	……………………..	93
Table 1.15. Districtwide distribution of Grade Percentage	……………………..	94

Table 1.16. Districtwide distribution of VC Ratio …………………….. 94
Table 1.17. Districtwide distribution of Distance to Interchange …………………….. 95
Table 1.18. Districtwide distribution of Crash Types …………………….. 95
Table 3.1.Statewide Crash Density Models …………………….. 288
Table 3.2.Statewide Crash Rate Models …………………….. 290
Table 3.3.District 1 Crash Density Models …………………….. 292
Table 3.4.District 1 Crash Rate Models …………………….. 293
Table 3.5.District 2 Crash Density Models …………………….. 294
Table 3.6.District 2 Crash Rate Models …………………….. 295
Table 3.7.District 3 Crash Density Models …………………….. 296
Table 3.8.District 3 Crash Rate Models …………………….. 297
Table 3.9.District 4 Crash Density Models …………………….. 298
Table 3.10.District 4 Crash Rate Models …………………….. 299
Table 3.11.District 5 Crash Density Models …………………….. 300
Table 3.12.District 5 Crash Rate Models …………………….. 301
Table 3.13.District 6 Crash Density Models …………………….. 302
Table 3.14.District 6 Crash Rate Models …………………….. 304
Table 3.15.District 7 Crash Density Models …………………….. 306
Table 3.16.District 7 Crash Rate Models …………………….. 307
Table 3.17.District 8 Crash Density Models …………………….. 308
Table 3.18.District 8 Crash Rate Models …………………….. 310
Table 3.19.District 10 Crash Density Models …………………….. 312
Table 3.20.District 10 Crash Rate Models …………………….. 313
Table 3.21.District 11 Crash Density Models …………………….. 314
Table 3.22.District 11 Crash Rate Models …………………….. 315
Table 3.23.District 12 Crash Density Models …………………….. 316
Table 3.24.District 12 Crash Rate Models …………………….. 317
Table 4.1.Statewide Crash Density Model Validation …………………….. 322
Table 4.2.Statewide Crash Rate Model Validation …………………….. 324
Table 4.3.District 1 Crash Density Model Validation …………………….. 325
Table 4.4.District 1 Crash Rate Model Validation …………………….. 326
Table 4.5.District 2 Crash Density Model Validation …………………….. 327
Table 4.6.District 2 Crash Rate Model Validation …………………….. 328
Table 4.7.District 3 Crash Density Model Validation …………………….. 329
Table 4.8.District 3 Crash Rate Model Validation …………………….. 330
Table 4.9.District 4 Crash Density Model Validation …………………….. 331
Table 4.10.District 4 Crash Rate Model Validation …………………….. 332
Table 4.11.District 5 Crash Density Model Validation …………………….. 333
Table 4.12.District 5 Crash Rate Model Validation …………………….. 334
Table 4.13.District 6 Crash Density Model Validation …………………….. 335
Table 4.14.District 6 Crash Rate Model Validation …………………….. 337

Table 4.15.District 7 Crash Density Model Validation …………………….. 338
Table 4.16.District 7 Crash Rate Model Validation …………………….. 339
Table 4.17.District 8 Crash Density Model Validation …………………….. 340
Table 4.18.District 8 Crash Rate Model Validation …………………….. 342
Table 4.19.District 10 Crash Density Model Validation …………………….. 344
Table 4.20.District 10 Crash Rate Model Validation …………………….. 345
Table 4.21.District 11 Crash Density Model Validation …………………….. 346
Table 4.22.District 11 Crash Rate Model Validation …………………….. 347
Table 4.23.District 12 Crash Density Model Validation …………………….. 348
Table 4.24.District 12 Crash Rate Model Validation …………………….. 349
Table 5.1.Statewide Crash Density Models …………………….. 354
Table 5.2.Statewide Crash Rate Models …………………….. 356
Table 5.3.District 1 Crash Density Models …………………….. 358
Table 5.4.District 1 Crash Rate Models …………………….. 359
Table 5.5.District 2 Crash Density Models …………………….. 360
Table 5.6.District 2 Crash Rate Models …………………….. 361
Table 5.7.District 3 Crash Density Models …………………….. 362
Table 5.8.District 3 Crash Rate Models …………………….. 363
Table 5.9.District 4 Crash Density Models …………………….. 364
Table 5.10.District 4 Crash Rate Models …………………….. 366
Table 5.11.District 5 Crash Density Models …………………….. 368
Table 5.12.District 5 Crash Rate Models …………………….. 369
Table 5.13.District 6 Crash Density Models …………………….. 370
Table 5.14.District 6 Crash Rate Models …………………….. 372
Table 5.15.District 7 Crash Density Models …………………….. 374
Table 5.16.District 7 Crash Rate Models …………………….. 375
Table 5.17.District 8 Crash Density Models …………………….. 376
Table 5.18.District 8 Crash Rate Models …………………….. 378
Table 5.19.District 10 Crash Density Models …………………….. 380
Table 5.20.District 10 Crash Rate Models …………………….. 381
Table 5.21.District 11 Crash Density Models …………………….. 382
Table 5.22.District 11 Crash Rate Models …………………….. 383
Table 5.23.District 12 Crash Density Models …………………….. 384
Table 5.24.District 12 Crash Rate Models …………………….. 386

VOLUME 1: CRASH BASE RATES FOR FREEWAYS IN OHIO

1.0: Statement of the Problem

The statistics published by the Ohio Department of Transportation reveals an improvement in the overall crash rate in Ohio over the last 10 years. However, the total number of crashes has remained consistent at about 380,000 crashes a year. Thirty three percent of these crashes occur on the freeways (1, 2). ODOT aims to reduce the crash rate by 10 percent from the baseline 2002 year (3).

One of the major challenges the traffic engineers and planners meet is to identify problem locations on freeways and to find solutions to ease the problems. A problem location is one that represents a risk to the user in terms of high probability of crash occurrence or severity. The safety related tools available to the Ohio Department of Transportation includes Highway Safety Program – Ohio Enhanced Crash Location Identification System (OECLIS) (4).

Freeway safety studies can be further enhanced with the use of “crash base rates”. A safety analysis of a specific freeway location entails understanding of “crash base rates”, also known as “base accident rates” or “expected values”, for identifying abnormal crash patterns at the study location. The crash base rate allows transportation engineers or planners to objectively determine whether a crash pattern at a study location is significantly higher than the same crash pattern at other locations with similar geometric, traffic, and environmental factors. Typically, after the crash rate for each crash type is calculated for a study section, each crash rate is compared to the “crash base rate”. If the calculated crash rate for any of the crash type is found to be higher than the “crash base rate”, then the location is generally chosen for further study to determine if a safety problem actually exists at the location and, if so, what countermeasure(s) can be used.

Base crash rates are developed from real-world crash data collected from sites located within each highway agency jurisdiction. The Ohio Department of Transportation, in an effort to develop a set of reliable base crash rates initiated a research project in 1998 with the University of Cincinnati. The study was titled “Rational Schedule of Base Accident Rates for Rural Highways in Ohio, Phase I”. The researchers successfully developed a set of mathematical models to estimate base accident density/rate for non-intersections in rural highways in ODOT District 8. Phase II study was completed in 2003 to develop a set of mathematical models to estimate base accident density/rate for non-intersections in rural highways in the remaining eleven ODOT districts. Another study to develop a set of mathematical models to estimate base crash rates for intersections in Ohio was been completed in December 2006. The results of the above mentioned studies can be used for safety-related analysis ODOT engineers or planners and will provide more reliable results and safety projects can be selected and implemented on a more objective and cost effective basis.

This page is intentionally left blank

2.0: Objectives

The primary objective of this research is to develop a set of mathematical models to estimate base crash rates for freeways in Ohio. The models estimate the incremental changes in the dependent variables - crashes density/rate for different types of crashes - resulting from changes in the independent variables including geometric features, operational controls, and environmental conditions. This study also examines potential factors for freeway crashes by considering site specific conditions such as geometrics, population density, volume/capacity ratio, and percent trucks. This research has used the relevant information from the previous University of Cincinnati studies listed below:

- “Rational Schedule of Base Accident Rates for Rural Highways in Ohio-Phase I” by P. D. Pant, Y. Liu and G. Vasisht; completed January 2000 (5).
- “Rational Schedule of Base Accident Rates for Rural Highways in Ohio-Phase II”, by P. D. Pant, A. Rajagopal and Y. Cheng; completed June 2003 (6).
- “Crash Base Rates for Intersections in Ohio” - by P. D. Pant and N. Kashayi; completed Dec. 2006 (7).

This page is intentionally left blank

3.0: Methodology:

Figure 1 provides an overview of the methodology implemented in this research. This study mainly consisted of four steps.

Step 1: Data collection

- Select all interstate freeways in Ohio.
- Collect crash data and interstate data from ODOT.
- Divide the freeway into small segments and insert crash data, geometric data and operational data into the freeway segments
- Integrate all the data into a single master database

Step 2: Data processing and analysis

- Analyze the distribution of each variable and identify the dependent and independent variables
- Calculate crash density and rate
- Divide the master database randomly into two sets – 2/3 for model developing and 1/3 for data validation

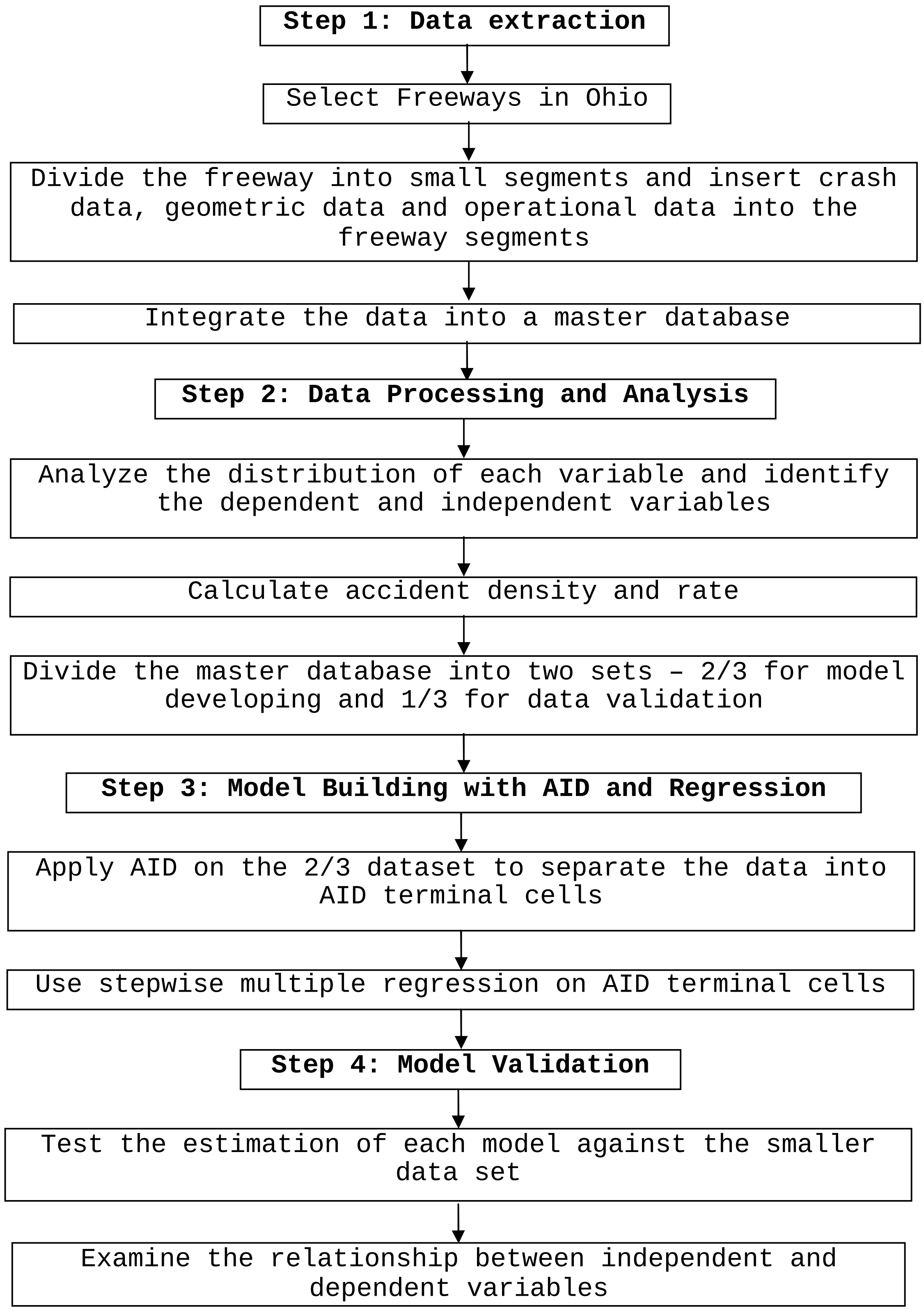
Step 3: Model building with AID and Regression Analysis

- Apply AID on the 2/3 dataset to separate the data into AID terminal cells
- Use stepwise multiple regression on AID terminal cells

Step 4: Model Validation

- Test the estimation of each model against the smaller data set
- Examine the relationship between independent and dependent variables

Figure 1: Methodology for Developing Base Crash Rates



4.0: Data Collection and Extraction

The primary objective of this step was to collect the required freeway data and extract the data for each freeway segment. A master database was the final outcome of this step.

4.1: Data Compilation:

This study explores all the freeways in Ohio. Crash data, geometric data and environmental data related to freeways were required for this study. Ohio DOT provided the following data.

1. Interstate crash data without work zones (2002 -2004).
2. Interstate traffic and geometric features

4.2: Roadway Segmentation:

The first task during data compilation was to divide the interstate data into predetermined segments lengths. Based upon the guidelines established in the previous studies, the freeway segments were divided into uniform lengths of.0.25 miles. Table 1 shows the distribution of the freeway sections used in this study. This study did not use segment length less than 0.05 miles. Considerable time and efforts were required for the process of freeway segmentation.

4.3: Population Density

The MS Excel database generated during the freeway segmentation provided the beginning and the ending log points of each freeway segment. The log points from this database were provided to ODOT. ODOT on the basis of these log points provided the latitude and longitude for each freeway segment. Based on this information, the researchers generated the population density data by using GIS software. Population density within 2 miles radius from the beginning log point was derived from the 2000 census data.

4.3: Distance to Interchange

ODOT provided the log point for each interchange on the freeway. This data was appended to the corresponding segment in the excel database. With this information, the midpoint between two interchanges was calculated. Thereafter, distance to interchange was calculated as the difference between the interchange log point and the mid point.

4.4: Master Database

An Excel database with freeway segments, population density and distance to interchange was created after the completion of the above steps. The next step was to add into each segment the following data provided by ODOT.

1. V/C Ratio
2. Curve Degree
3. Grade Percentage

The next step was to insert crash data. ODOT provided crash data from year 2002 to 2004. The crash data included the route number, log point, severity of the crash and crash type. Microsoft Access program, Structured Query Language and Microsoft Excel were used to compile and insert the crash data into each freeway segment.

Based on the previous crash base rate studies conducted by the University of Cincinnati, the following crashes were considered for this research study.

1. Injury/ Fatal
2. Property damage only
3. Total
4. Angle
5. Fixed object
6. Rear end
7. Sideswipe
8. Wet road
9. Night

The next step was to calculate crash density and crash rate for each of the above crash types. Crash density and crash rate were calculated using the following equations.

Crash Density:

$D_{Segment} = C / L$

where:

$D_{segment}$ = Crash density for the section in crashes per mile

C = Number of crashes reported during the analysis period

L = Length of segment in miles (1 mile = 1.6 km)

Crash Rate:

$R_{segment} = (C * 1{,}000{,}000) / (365 * T * V * L)$

where:

$R_{segment}$ = Crash rate for the section in crashes per million vehicle- miles

C = Number of crashes reported during the analysis period

L = Length of segment in miles (1 mile = 1.6 km)

V = Average daily traffic volume

T = Time of analysis period in years

After the completion of the above steps the master database was created, which contained the following list of data field:

1. District
2. County
3. Route
4. NLF ID
5. Log county
6. Log state
7. Length
8. Functional class
9. Speed limit
10. ADT total
11. Population density

12. Lanes
13. Roadway width
14. Surface width
15. Shoulder left inside width
16. Shoulder left outside width
17. Shoulder right inside width
18. Shoulder right outside width
19. Unprotected barrier
20. Positive barrier
21. Curbed barrier
22. Median width
23. Curve degree
24. Grade percentage
25. V/C ratio
26. Distance to interchange
27. Injury/Fatal crashes
28. Property damage only crashes
29. Total crashes
30. Angle crashes
31. Fixed object crashes
32. Rear end crashes
33. Sideswipe crashes
34. Road wet crashes
35. Night crashes
36. Injury/Fatal crashes - Density
37. Property damage only crashes - Density
38. Total crashes - Density
39. Angle crashes - Density
40. Fixed object crashes - Density
41. Rear end crashes - Density
42. Sideswipe crashes - Density
43. Road wet crashes - Density
44. Night crashes- Density
45. Injury/Fatal crashes -Rate
46. Property damage only crashes -Rate
47. Total crashes - Rate
48. Angle crashes - Rate
49. Fixed object crashes -Rate
50. Rear end crashes -Rate
51. Sideswipe crashes -Rate
52. Road wet crashes -Rate
53. Night crashes- Rate

4.5 Data Validation:
The next step after the creation of database was to validate the data. The generated master database was systematically inspected and reviewed for completeness and reasonableness. This was done by reconciling suspect values in the excel database. Erroneous values were eliminated. The data base was also queried to range test. The data was compared to lower and upper limiting values and invalid values were removed.

4.6 Data Analysis:
Table 1 and Figure 2 show the distribution of the freeway segments used in this study. This study did not consider segment length less than 0.05 miles (0.80 km). The master database contains 5981 freeway segments, a total of 1325.79 miles (2121.26 km).

Table 1. Statewide Distribution of Segment Length

No. of Segments	Segment Length in miles (km)	Percentage
2137	< 0.25 (0.4)	35.73
3106	0.25 (0.4)	51.93
738	> 0.25 (0.4)	12.34

Figure 2. Statewide distribution of Segment Length

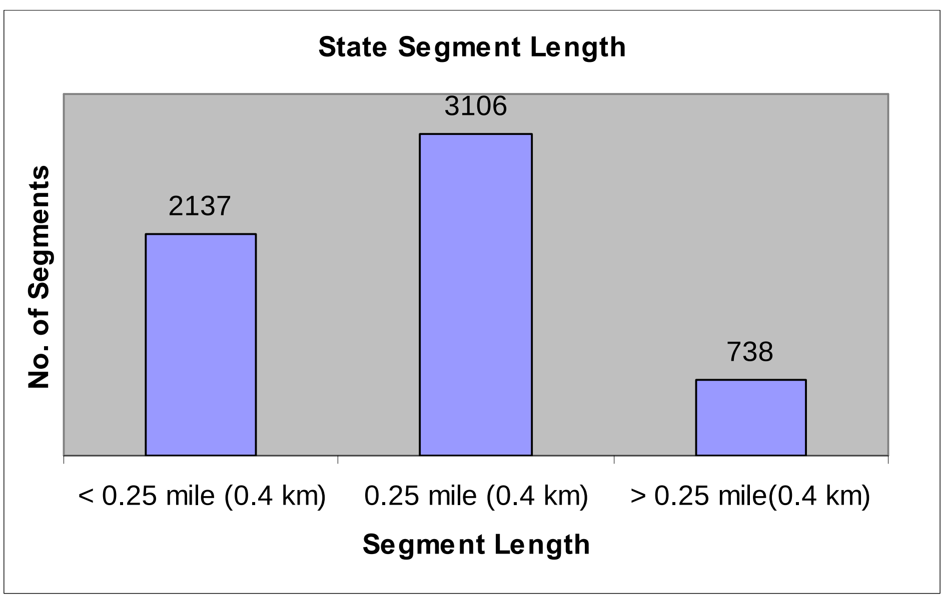


Table 2 and Figure 3 show the distribution of posted freeway speed limit. 65 mph (104 km) has the highest number of frequency.

Table 2. Statewide Distribution of Speed Limit

No. of Segments	Speed Limit mph (kmph)	Percentage
3	45 (72)	0.05
73	50 (80)	1.22
315	55 (88)	5.27
687	60 (96)	11.49
4903	65 (104)	81.98

Figure 3. Statewide Distribution of Speed Limit

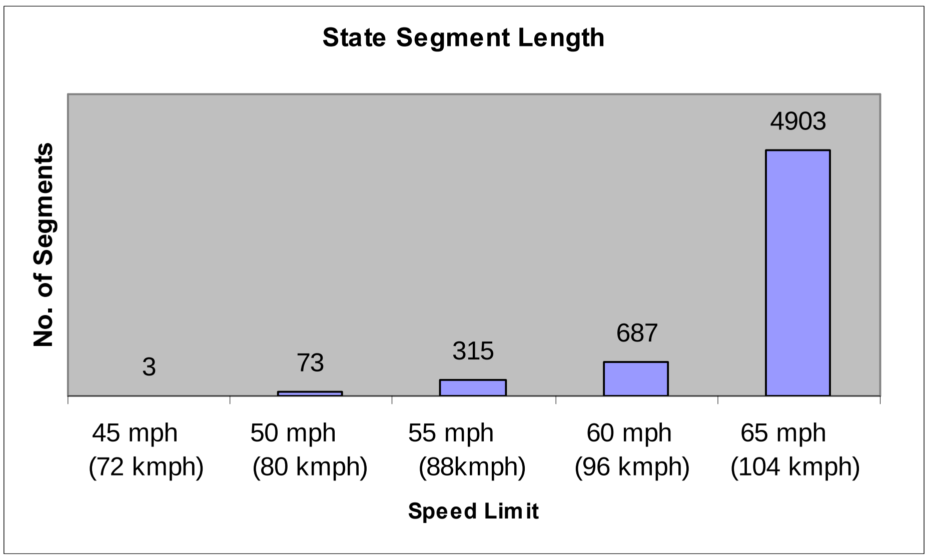


Table 3 and Figure 4 show the distribution of freeway lanes.

Table 3. Statewide Distribution of Lanes

No. of Segments	No. of Lanes	Percentage
3735	4	62.70
120	5	2.01
1537	6	25.80
81	7	1.36
408	8	6.85
8	9	0.13
65	10	1.09
3	11	0.05

Figure 4. Statewide Distribution of Lanes

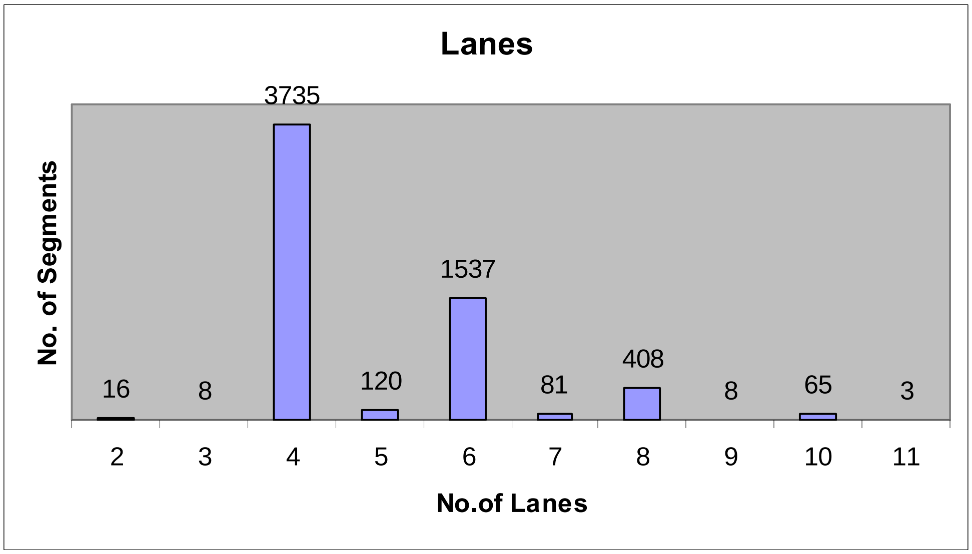


Table 4 and Figure 5 show the distribution of average daily traffic.

Table 4. Statewide Distribution of Average Daily Traffic

No. of Segments	ADT	Percentage
360	< 20000	6.02
1806	< 40000	30.20
1569	< 60000	26.23
780	< 80000	13.04
531	< 100000	8.88
406	< 120000	6.79
256	< 140000	4.28
203	< 160000	3.39
70	< 180000	1.17

Figure 5. Statewide Distribution of Average Daily Traffic

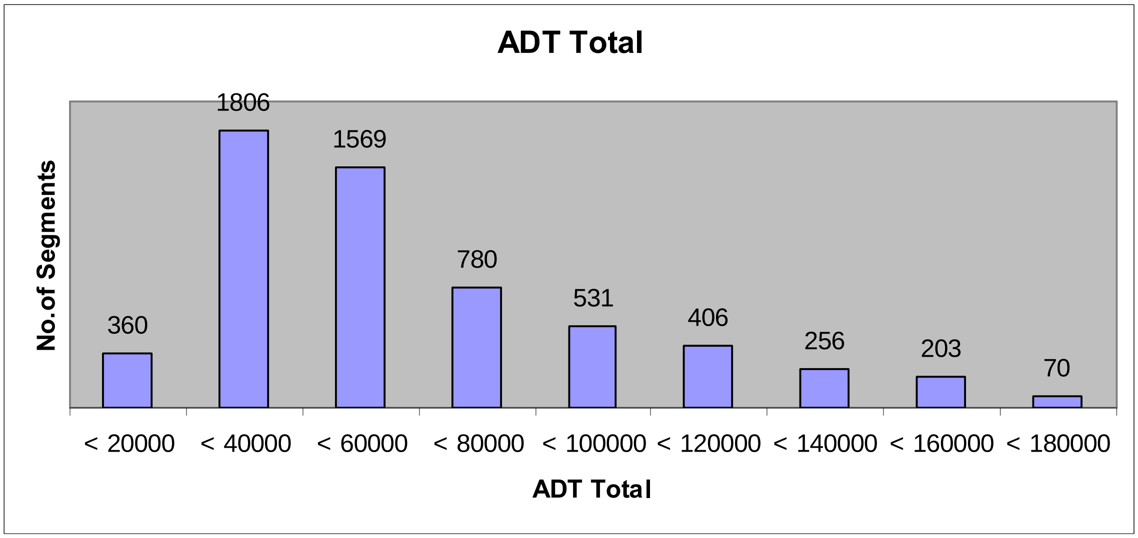


Table 5 and Figure 6 show the distribution of population density within a radius of 1.99 miles (3.2 km) of the beginning log county.

Table 5. Statewide Distribution of Population Density calculated at 1.99 miles (3.2 km) from begin log county

No. of Segments	Population Density	Percentage
1657	0 - 50	27.70
676	50 -100	11.30
596	100-200	9.96
1001	200-500	16.74
1018	500-1000	17.02
590	1000-1500	9.86
245	1500-2000	4.10
127	2000-2500	2.12
71	<2500	1.19

Figure 6. Statewide Distribution of Population Density calculated at 1.99 miles (3.2 km) from begin log county

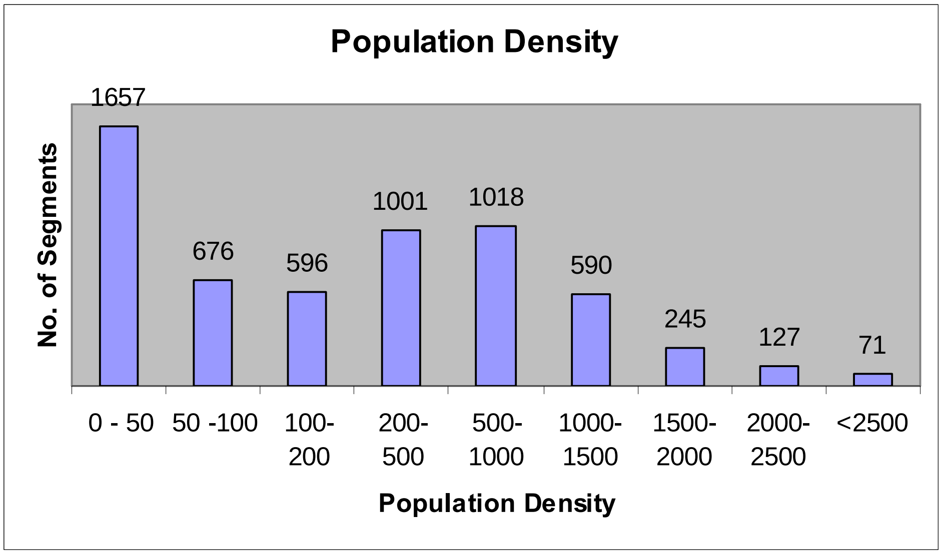


Table 6 and Figure 7 show the distribution of Roadway width.

Table 6. Statewide distribution of Roadway Width

No. of Segments	Roadway width ft. (m)	Percentage
4	44 (15.31)	0.07
3537	45-88 (15.66-30.62)	59.14
2046	89-132 (30.97-45.94)	34.21
331	133-176 (46.28-61.25)	5.53
63	177-222 (61.60-77.26)	1.05

Figure 7. Statewide Distribution of Roadway Width

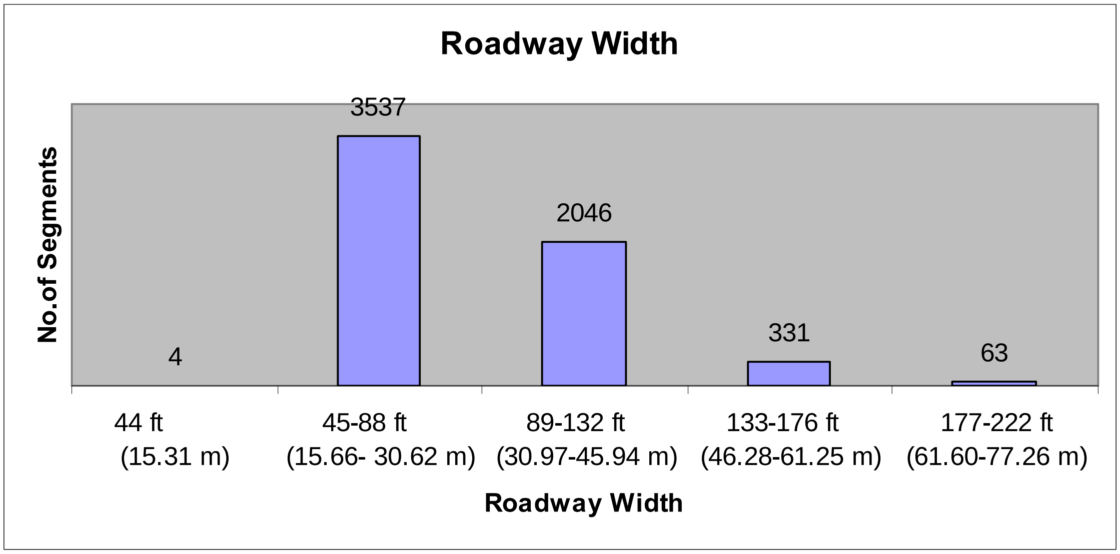


Table 7and Figure 8 show the distribution of surface width.

Table 7. Statewide Distribution of Surface Width

No. of Segments	Surface Width ft. (m)	Percentage
19	32 (11.14)	0.32
3848	33-60 (11.48-20.88)	64.34
1612	61-90 (21.23-31.32)	26.95
431	91-110 (31.67-38.28)	7.21
71	111-132 (38.63-45.94)	1.19

Figure 8. Statewide distribution of Surface Width

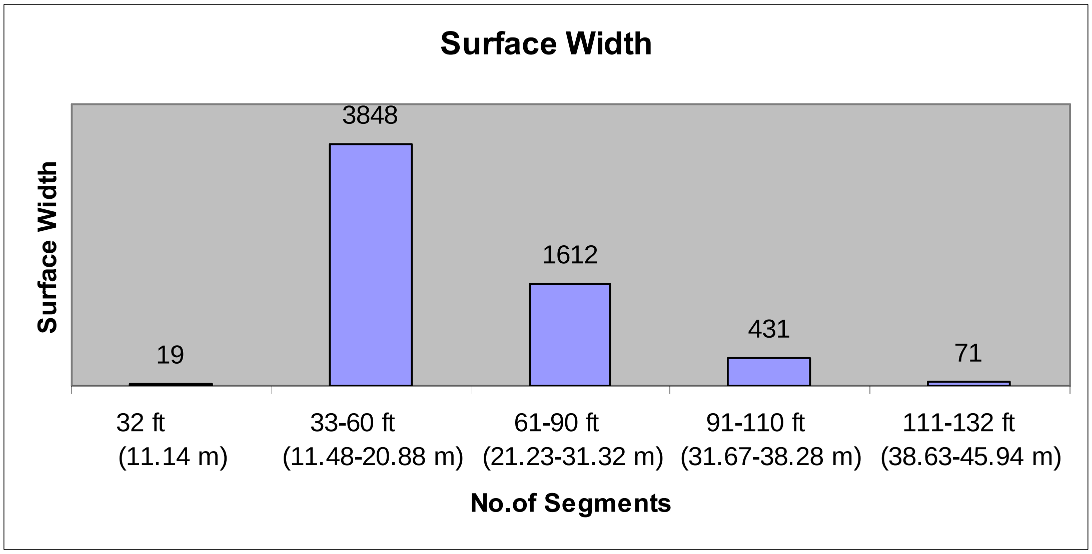


Table 8 and Figure 9 show the distribution of shoulder left inside width (SLIW).

Table 8. Statewide distribution of Shoulder Left Inside Width

No. of Segments	SLIW ft. (m)	Percentage
4780	< 10 (3.48)	79.92
1068	< 20 (6.96)	17.86
118	< 30 (10.44)	1.97
15	< 36 (12.53)	0.25

Figure 9. Statewide Distribution of Shoulder Left Inside Width

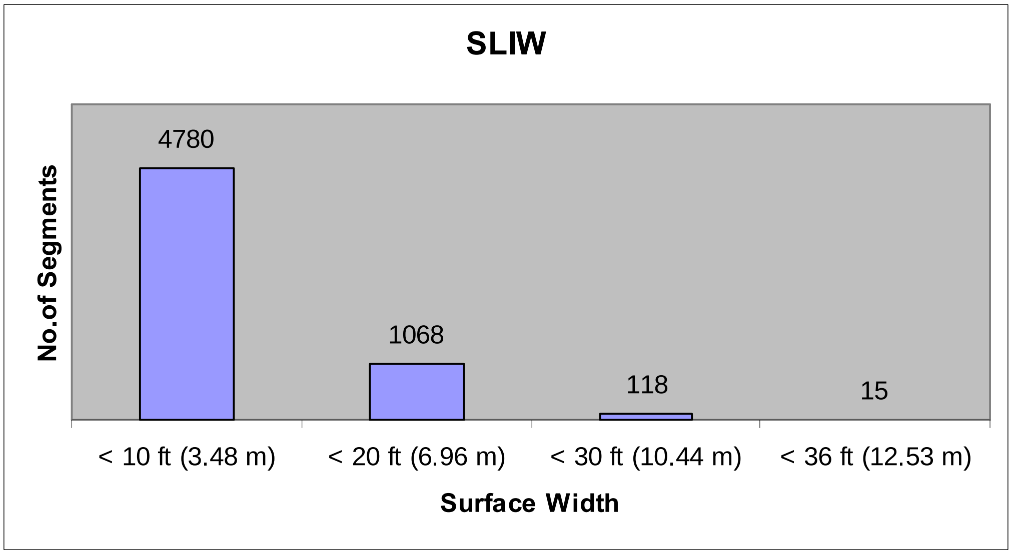


Table 9 and Figure 10 show the distribution of shoulder left outside width (SLOW).

Table 9. Statewide Distribution of Shoulder Left Outside Width

No. of Segments	SLOW ft. (m)	Percentage
41	< 5 (1.74)	0.69
136	< 10 (3.48)	2.27
5735	< 15 (5.22)	95.89
69	< 22 (7.66)	1.15

Figure 10. Statewide Distribution of Shoulder Left Outside Width

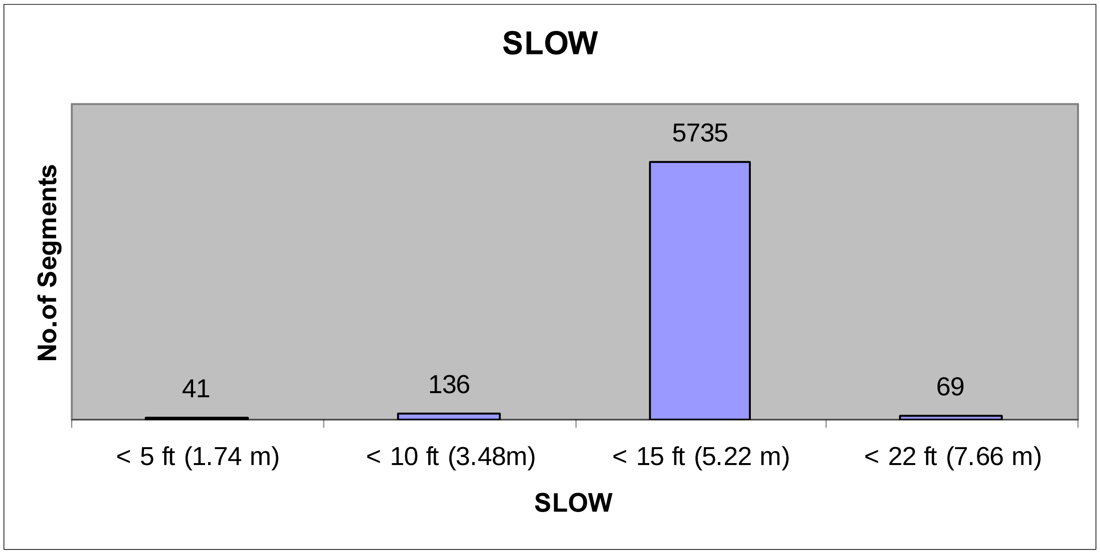


Table 10 and Figure 11 show the distribution of shoulder right inside width.

Table 10. Statewide Distribution of Shoulder Right Inside Width

No. of Segments	SRIW ft. (m)	Percentage
4782	< 10 (3.48)	79.95
1065	< 20 (6.96)	17.81
119	< 30 (10.44)	1.99
15	< 36 (12.53)	0.25

Figure 11. Statewide Distribution of Shoulder Right Inside Width

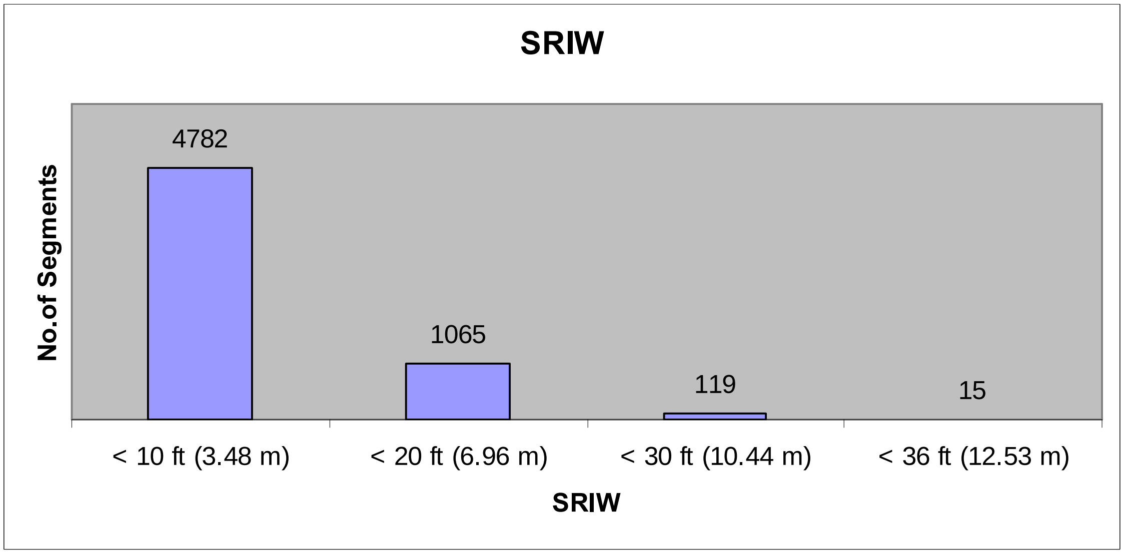


Table 11and Figure 12 show the distribution of shoulder right outside width.

Table 11. Statewide Distribution of Shoulder Right Outside Width

No. of Segments	SROW ft. (m)	Percentage
41	< 5 (1.74)	0.69
112	< 10 (3.48)	1.87
5765	< 15 (5.22)	96.39
63	< 22 (7.66)	1.05

Figure 12. Statewide Distribution of Shoulder Right Outside Width

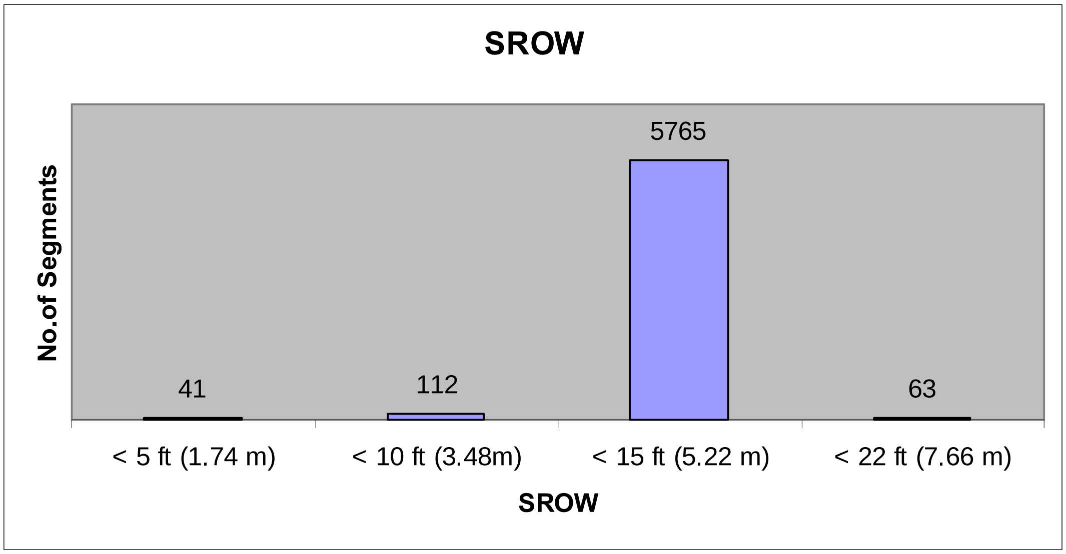


Table 12 and Figure 13 show the distribution of freeway barriers

Table 12. Statewide Distribution of Barrier

No. of Segments	Barrier	Percentage
4464	Unprotected	74.64
1514	Positive	25.31
3	Curbed	0.05

Figure 13. Statewide Distribution of Barrier

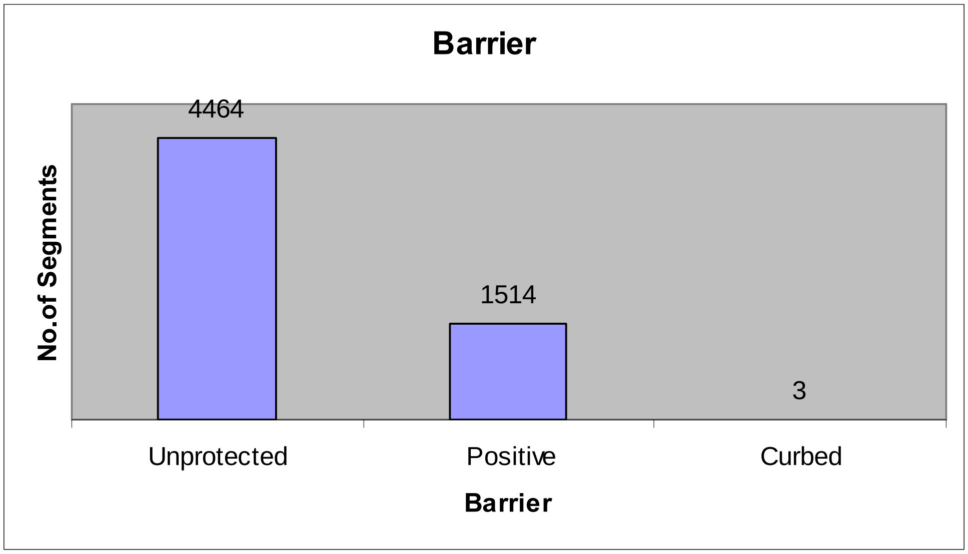


Table 13 and Figure 14 show the distribution of median width

Table 13. Statewide Distribution of Median Width

No. of Segments	Median Width ft. (m)	Percentage
1257	< 20 (6.96)	21.02
453	< 40 (13.92)	7.57
1215	< 60 (20.88)	20.31
1360	< 80 (27.84)	22.74
1436	< 100 (34.80)	24.01
28	< 120 (41.75)	0.47
43	< 160 (55.68)	0.72
117	< 200 (69.60)	1.96
72	> 200 (69.60)	1.20

Figure 14. Statewide Distribution of Median Width

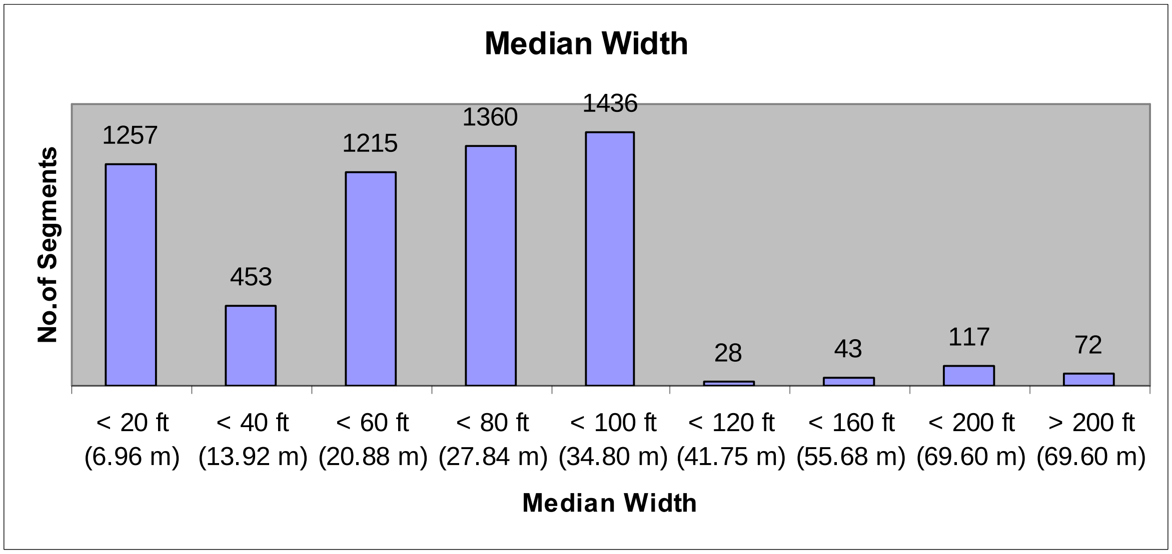


Table 14 and Figure 15 show the distribution of curve degree

Table 14. Statewide Distribution of Curve Degree

No. of Segments	Curve Degree	Percentage
5865	0	98.06
60	≤ 3	1.00
43	≤ 6	0.72
9	≤ 9	0.15
2	≤ 12	0.03
2	≤ 15	0.03

Figure 15. Statewide distribution of Curve Degree

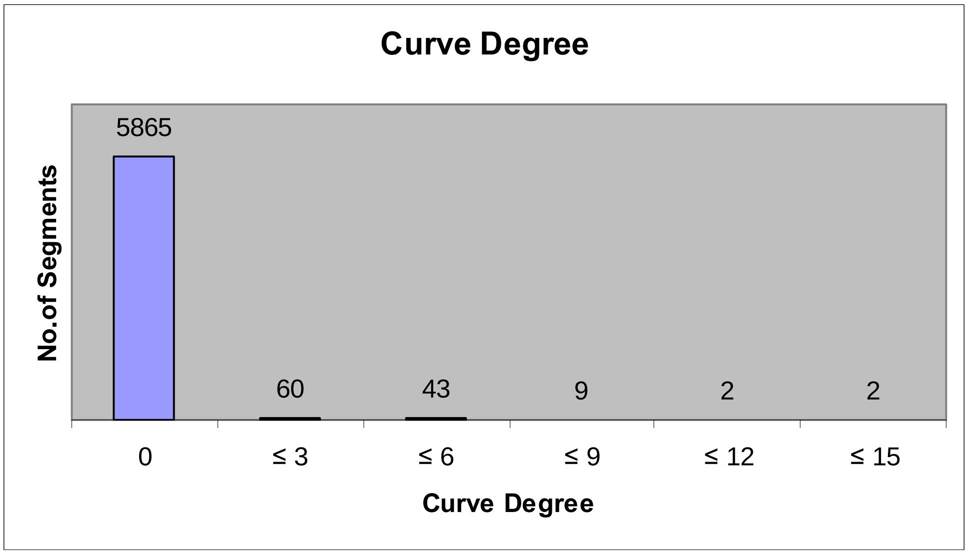


Table 15 and Figure 16 show the distribution of grade percentage

Table 15. Statewide distribution of Grade Percentage

No. of Segments	Grade Percentage	Percentage
5506	0	92.06
1	1	0.02
0	2	0.00
367	3	6.14
88	4	1.47
13	5	0.22
6	6	0.10

Figure 16. Statewide Distribution of Grade Percentage

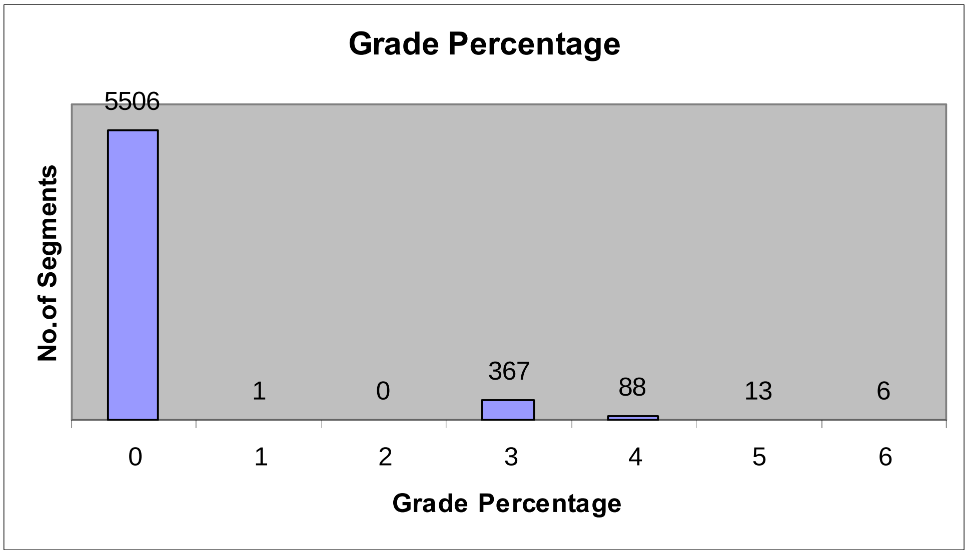


Table 16 and Figure 17 show the distribution of V/C Ratio

Table 16. Statewide Distribution of V/C Ratio

No. of Segments	V/C Ratio	Percentage
19	< 0.15	0.32
355	< 0.30	5.95
628	< 0.45	10.53
1428	< 0.60	23.94
1103	<0 .75	18.49
1102	<0 .90	18.47
634	< 1.05	10.63
372	< 1.20	6.24
324	< 1.35	5.43

Figure 17. Statewide Distribution of V/C Ratio

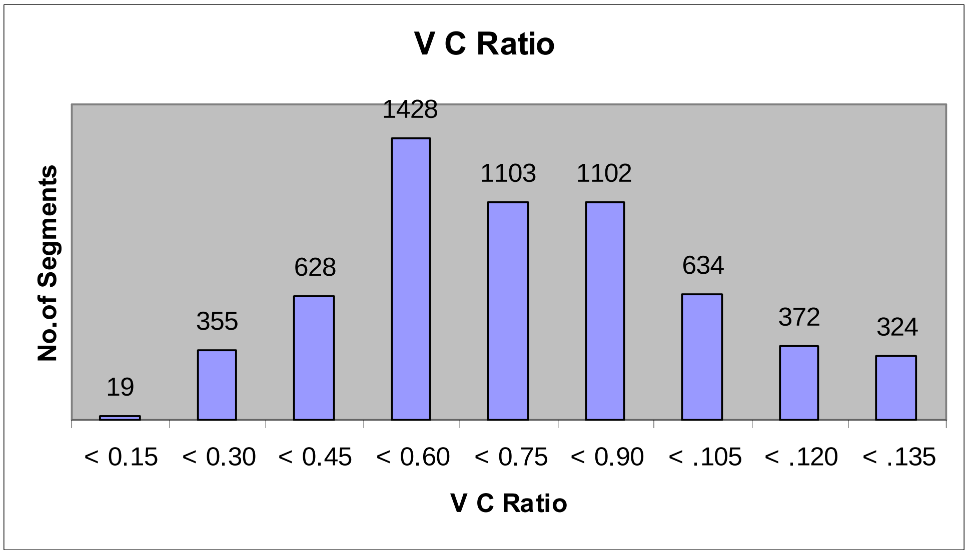


Table 17 and Figure 18 show the distribution of Distance to Interchange.

Table 17. Statewide Distribution of Distance to Interchange

No. of Segments	Distance to Interchange miles (km)	Percentage
1102	0-0.20 (0-0.32)	19.28
855	0.21-0.40 (0.34-0.64)	14.96
667	0.41-0.60 (0.66-0.96)	11.67
536	0.61-0.80 (0.98-1.28)	9.38
419	0.81-1.0 (1.30-1.60)	7.33
346	1.01-1.20 (1.62-1.92)	6.05
275	1.21-1.40 (1.94-2.24)	4.81
235	1.41 -1.60 (2.26-2.56)	4.11
192	1.61-1.80 (2.58-2.88)	3.36
173	1.81-2.0 (2.90-3.20)	3.03
549	2.01-3.0 (3.22-4.80)	9.61
228	3.01-4.0 (4.82-6.40)	3.99
107	4.01-5.0 (6.42-8.00)	1.87
22	5.01-6.0 (8.02-9.60)	0.38
9	6.01-7.04 (9.62-11.26)	0.16

Figure 18. Statewide Distribution of Distance to Interchange

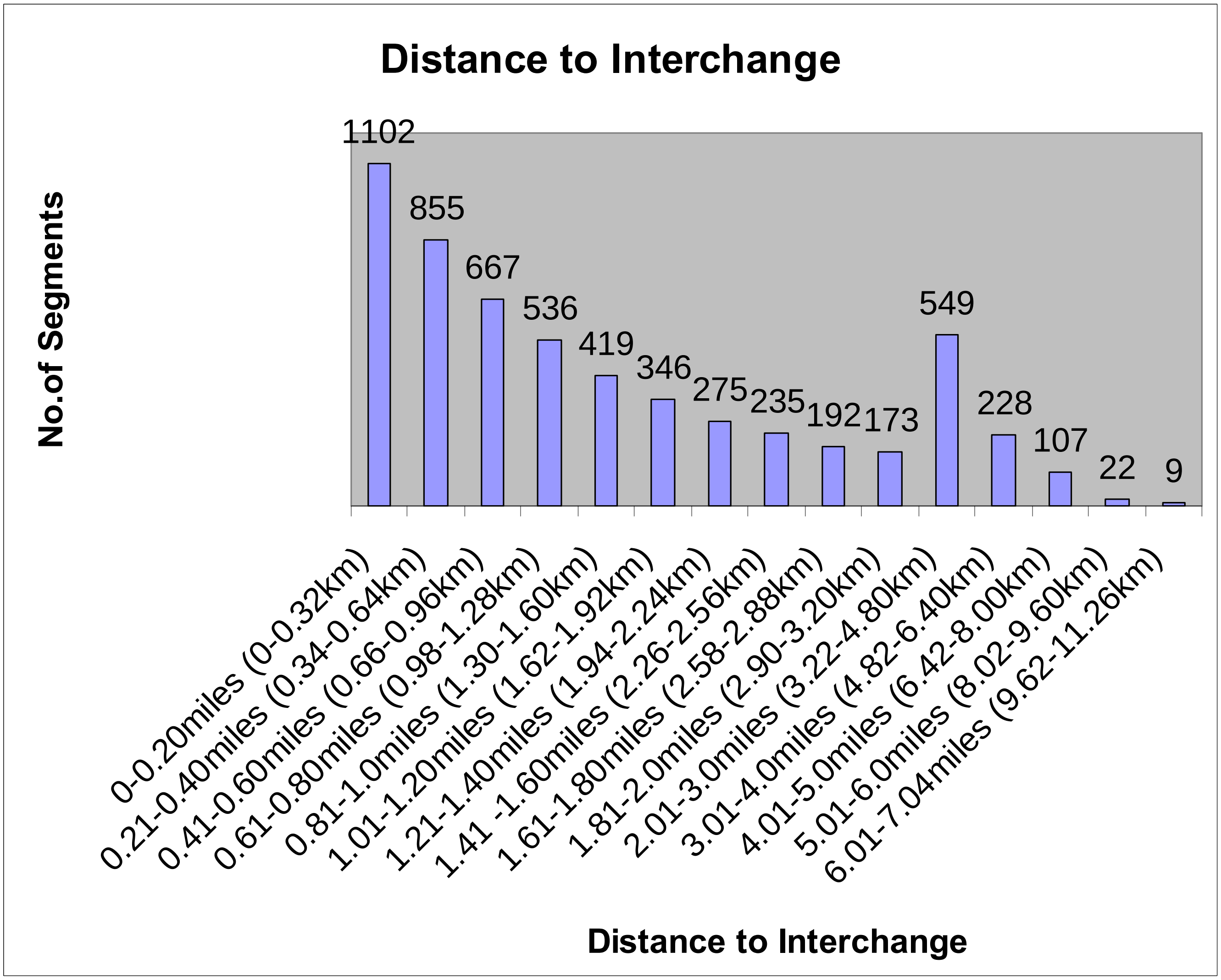
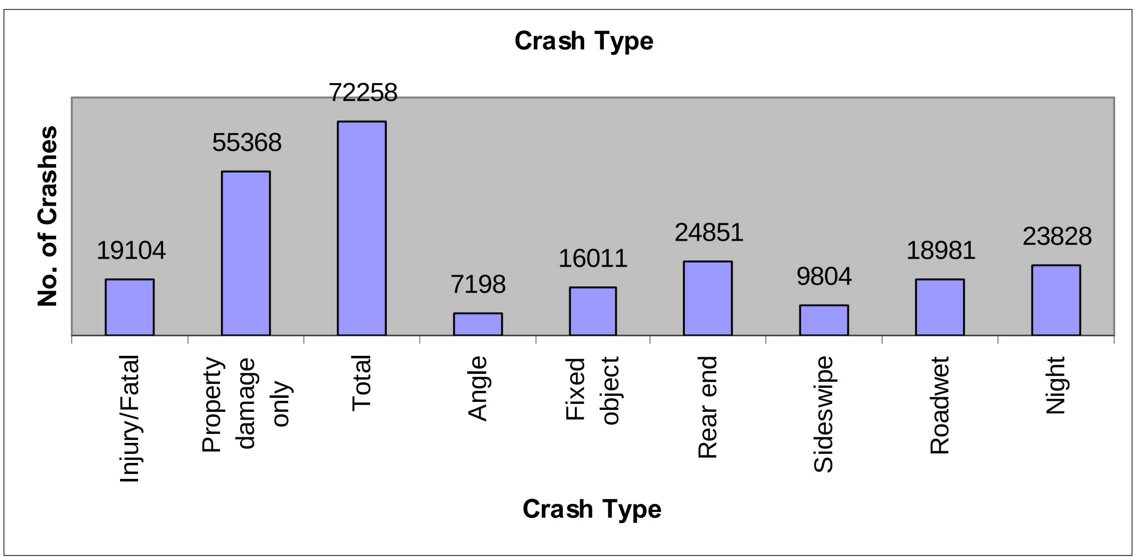


Table 18 and Figure 19 show the distribution of crash types

Table 18. Statewide Distribution of Crash Types

Crash Types	No. of Crashes	Percentage
Injury/Fatal	19104	7.72
Property damage only	55368	22.38
Total	72258	29.21
Angle	7198	2.91
Fixed object	16011	6.47
Rear end	24851	10.04
Sideswipe	9804	3.96
Road wet	18981	7.67
Night	23828	9.63

Figure 19. Statewide Distribution of Crash Types



Descriptive statistics for each district is shown in Appendix I.

This page intentionally left blank.

5.0: Model Building Using Automated Interaction and Detection (AID) and Regression Technique:

5.1 Model Building Using Automated Interaction and Detection (AID)

Automated Interaction Detection technique was successfully used in the Crash Base Rate research studies performed by the University of Cincinnati. AID technique is very useful in determining the type of relationship that may exist between the dependent and independent variables. AID is a classification tree technique that not only evaluates complex interactions among predictors, but also displays the modeling results in an easy-to-interpret tree diagram. The "trunk" of the tree represents the total modeling database. AID then creates a first layer of "branches" by displaying values of the strongest predictor of the dependent variable. AID automatically determines how to group the values of this predictor into a manageable number of categories. (e.g., we may start with ten categories of ADT, and AID might collapse these ten categories down to only four or five statistically significantly different groups). AID then creates additional layers of branches, using the strongest of the remaining predictors. It continues this branching procedure until the final branches or "twigs" of the tree have been generated. If AID is being used to generate a predictive model, then these terminal branches are the final segments.

The initial analysis of the data is performed by AID. As per the objective of AID, the data are classified into mutually exclusive groups such that the data in the same group are similar to each other, yet different from the data in other groups. No assumption is made about linearity and the independent variables may exhibit interaction and/or be nominally scaled. It begins with a single cluster of cases and searches a candidate set of predictor variables for a way to split the cluster into two. The algorithm first calculates the total sum of squares for the data set and examines all (n-1) ways for each independent variable to split the data into two subgroups.

$$\text{SST} = \sum_{i=1}^{n} (y_i - \bar{y}_i)^2$$

where SST = Total sum of squares
n = Number of observations in the data set
yi = the value of the dependent variable
$\bar{y}$ = the mean value of the dependent variable

The between sum of squares (BSS) about the mean of these subgroup on the dependent variable is calculated on each possible split. The between sum of squares for the subgroups j and k with sample size of m and (n-m) respectively is

$$BSS = \sum_{i=1}^{n} (y_i - \bar{y})^2 - \left[\sum_{i=1}^{m} (y_{ij} - \bar{y}_j)^2 + \sum_{i=1}^{n-m} (y_{ik} - \bar{y}_k)^2 \right]$$

If any prospective split exceeds the threshold limit of reducibility coefficient, the split giving the largest ratio of BSS/TSS is selected and two sub groups are created from the subgroups until no further significant reduction in the variance is possible. The variance explained, R^2_{AID}, is the summation of Sum of Squares (SS) of each terminal cell divided by the SST.

$$R^2_{\text{AID}} = \frac{\sum_{i=1}^{n} SS_i}{SST}$$

The sensitivity of AID runs is tested by coefficient of 0.025. Reducibility coefficient determines when the AID splitting should stop by requiring a minimum improvement of the reduction in the variance. For example, when the reducibility coefficient is set to be 0.025, then AID will allow the splitting only if the prospective split can reduce the variance by at least 2.5%. . The minimum sample size of the terminal cell was set as 30. Based on the trial runs a default value of 0.025 was used for further analysis.

The computer package SYSTAT, which was used to perform AID computations and regression analysis in the previous researches by the University of Cincinnati, was used in the present study also. The present study used SYSTAT version 11.0 for Windows.

AID runs were made for 9 types of crash density and 9 types of crash rate. A total of 216 runs were made and it resulted in 628 terminal cells. The following figures 20 to 38 illustrate the statewide AID trees. A complete set of statewide and districtwide AID trees are included in Appendix II.

The keys to read the following figures are:

SPEEDLIMIT = Speed Limit in miles (1 mile = 1.6 km)
ADTTOTAL= Average Daily Traffic
POPDEN = Population Density (within a radius of 1.99 miles (3.2 km) of the begin log county)
LANES = No. of Lanes
ROADWAYWIDT = Roadway Width in ft. (1 ft. = .0348 m)
SURFACE_WIDT = Surface Width in ft. (1 ft. = .0348 m)
SLIW = Shoulder Left Inside Width in ft. (1 ft. = .0348 m)
SRIW = Shoulder Right Inside Width in ft. (1 ft. = .0348 m)
MEDIANWIDTH = Median Width in ft. (1 ft. = .0348 m)
VC_RATIO = V/C Ratio
DIST_TO_INTC = Distance to Interchange in miles (1 mile = 1.6 km)
DINJFAT = Injury/ Fatal crash density
DPDO =Property damage only crash density
DTOTAL =Total crash density
DANGLE = Angle crash density
DFIXEDOBJ = Fixed object crash density
DREAREND = Rear end crash density
DSIDESWIPE = Sideswipe crash density
DROADWET =Road wet crash density
DNIGHT = Night crash density
RINJFAT = Injury/ Fatal crash rate
RPDO =Property damage only crash rate
RTOTAL =Total crash rate
RANGLE = Angle crash rate
RFIXEDOBJ = Fixed object crash rate
RREAREND = Rear end crash rate
RSIDESWIPE = Sideswipe crash rate
RROADWET =Road wet crash rate
RNIGHT = Night crash rate

Figure 20.Statewide Injury/Fatal Crash Density

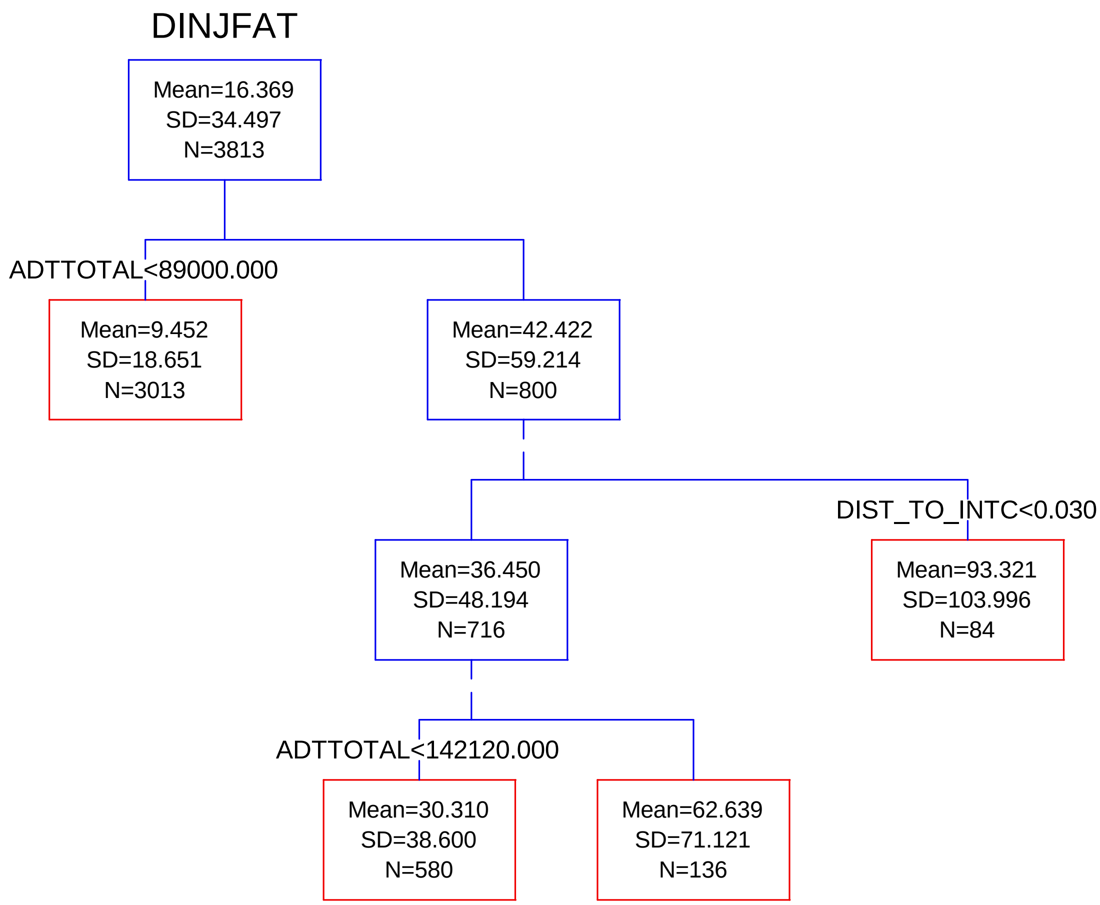


Figure 21.Statewide Property Damage Only Crash Density

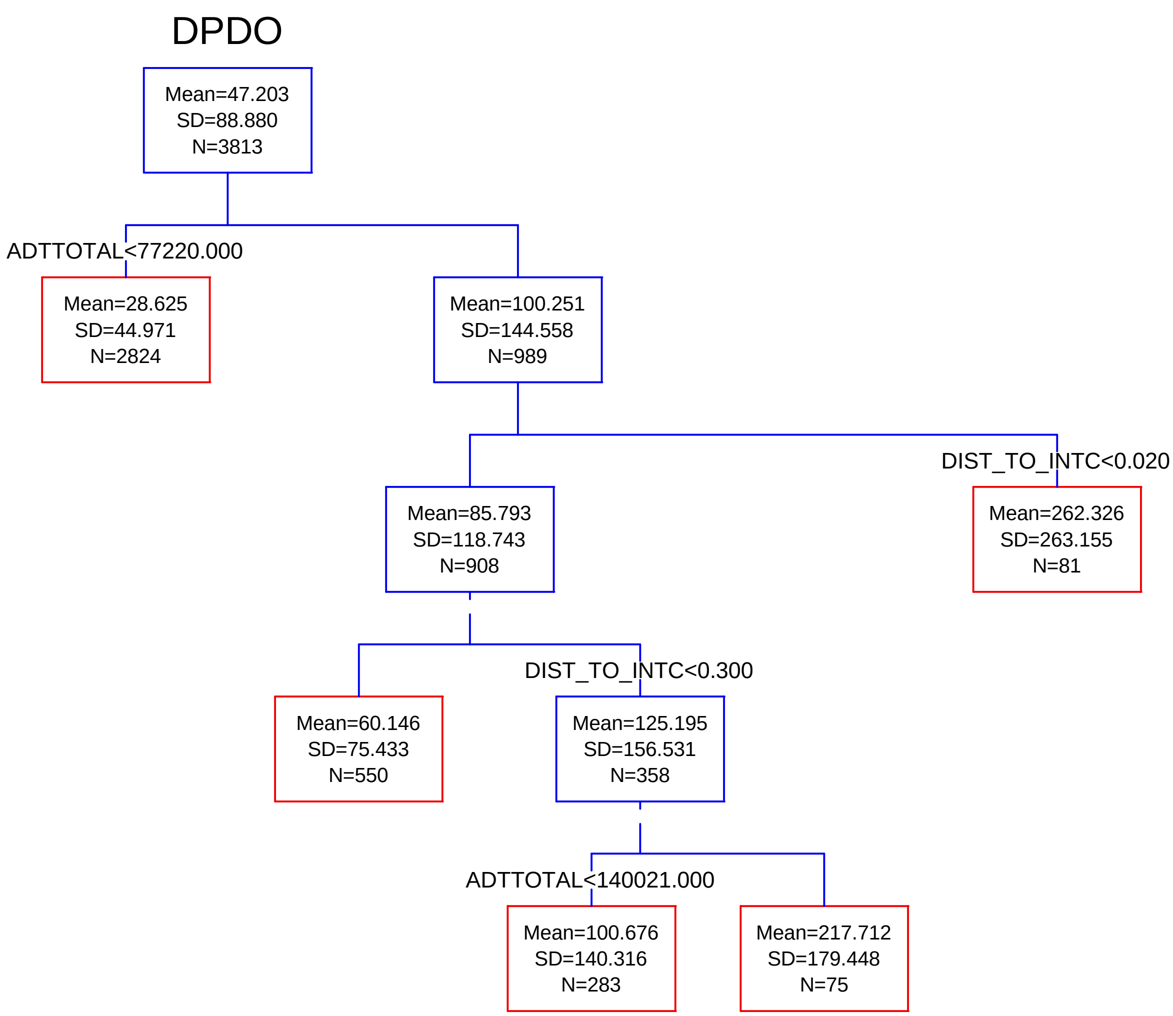


Figure 23.Statewide Total Crash Density

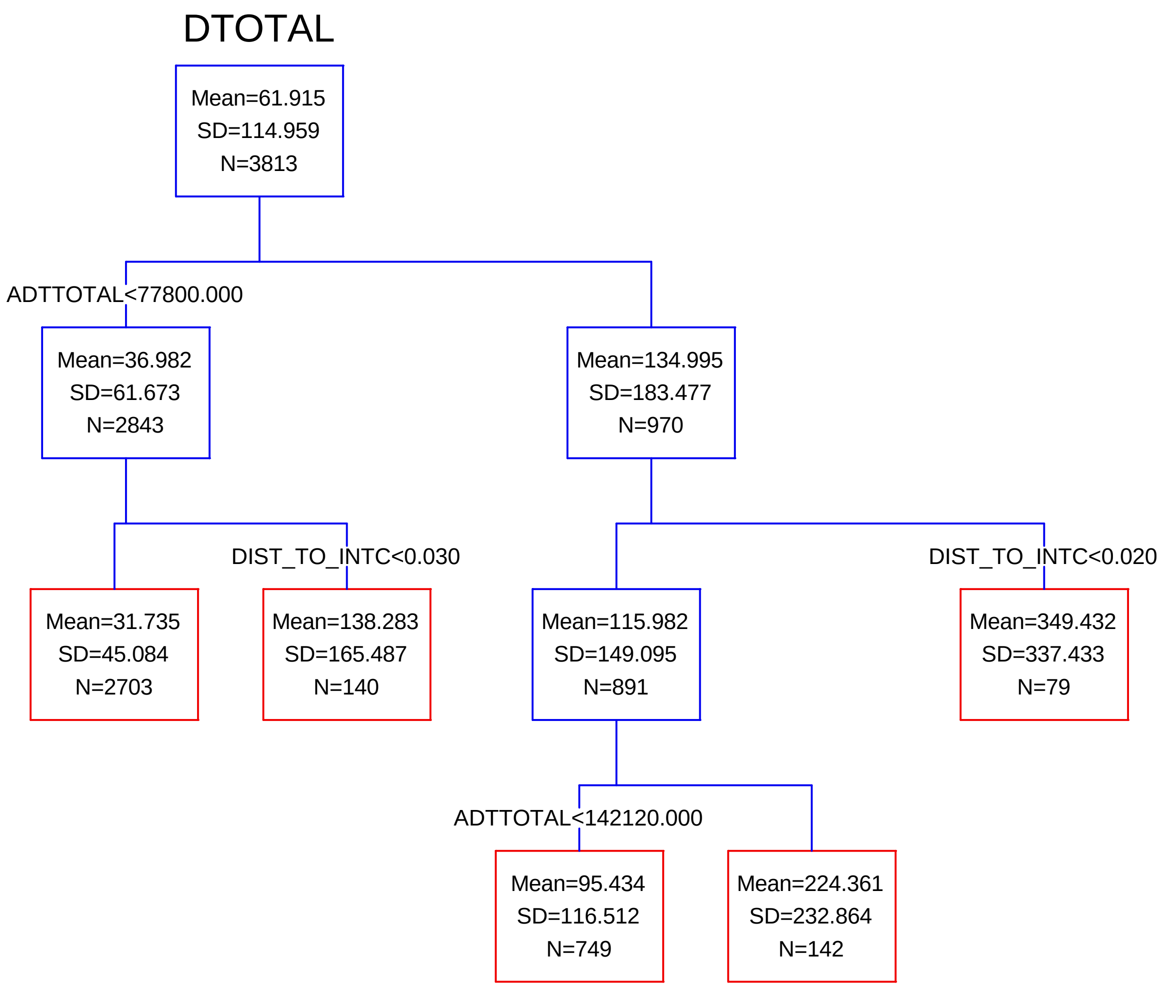


Figure 24. Statewide Angle Crash Density

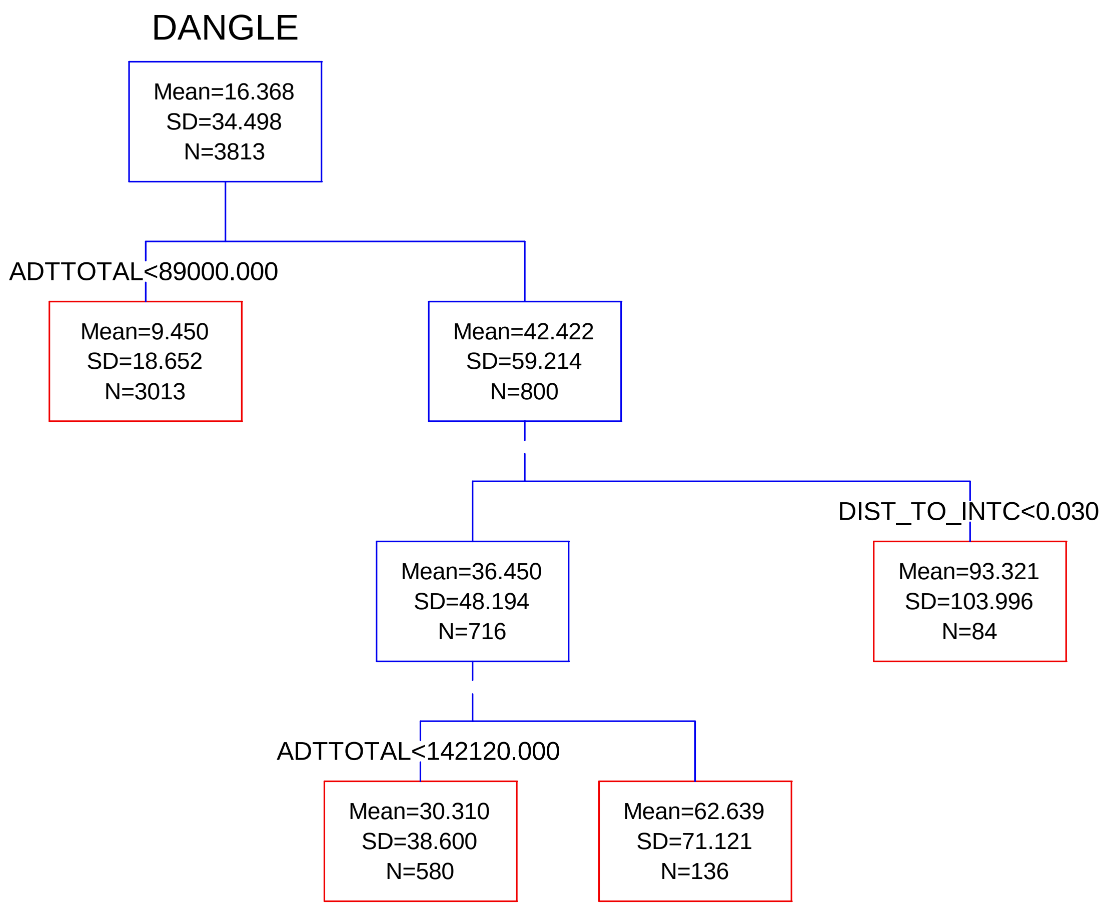


Figure 25. Statewide Fixed Object Crash Density

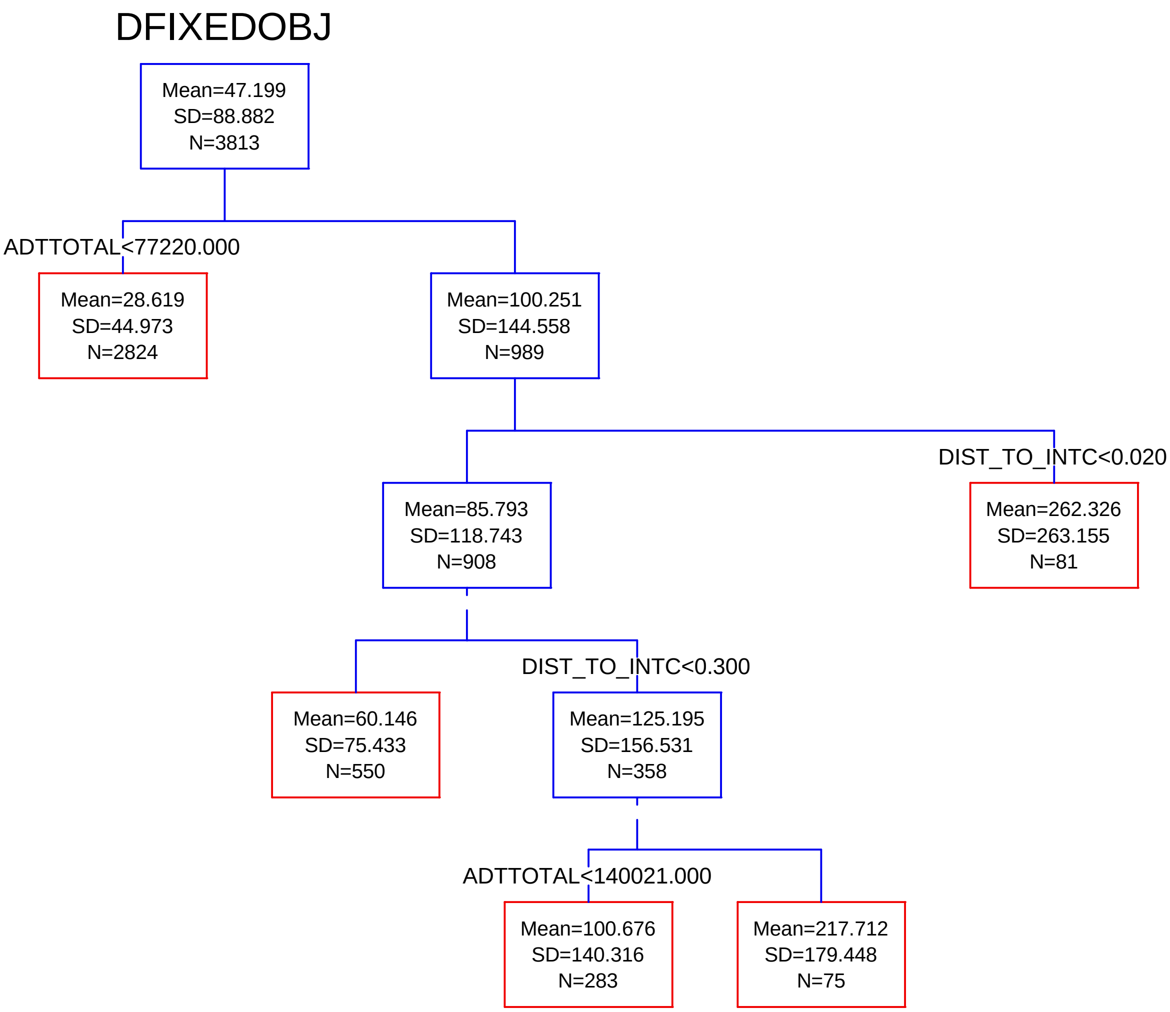


Figure 26. Statewide Rear End Crash Density

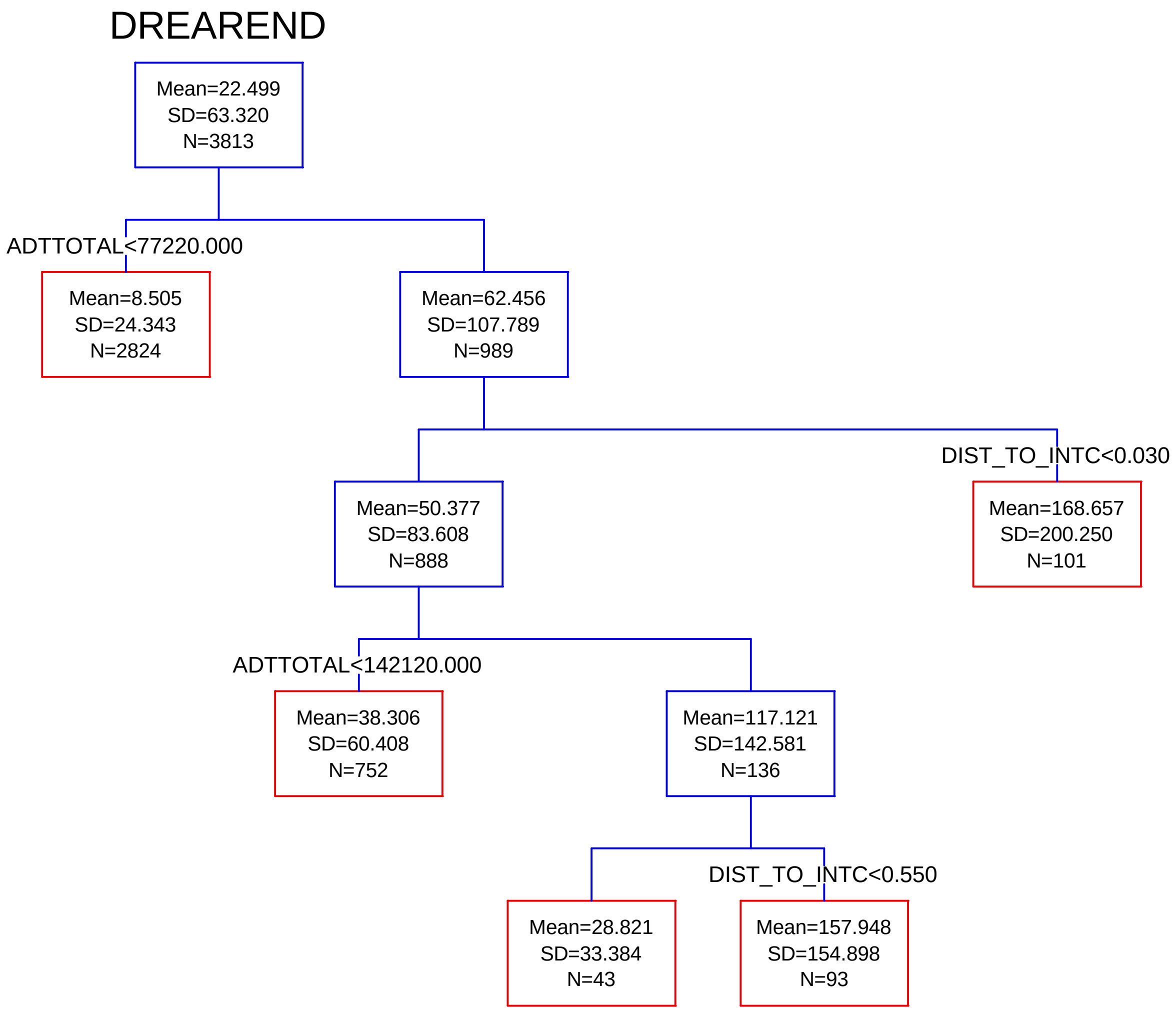


Figure 27. Statewide Sideswipe Crash Density

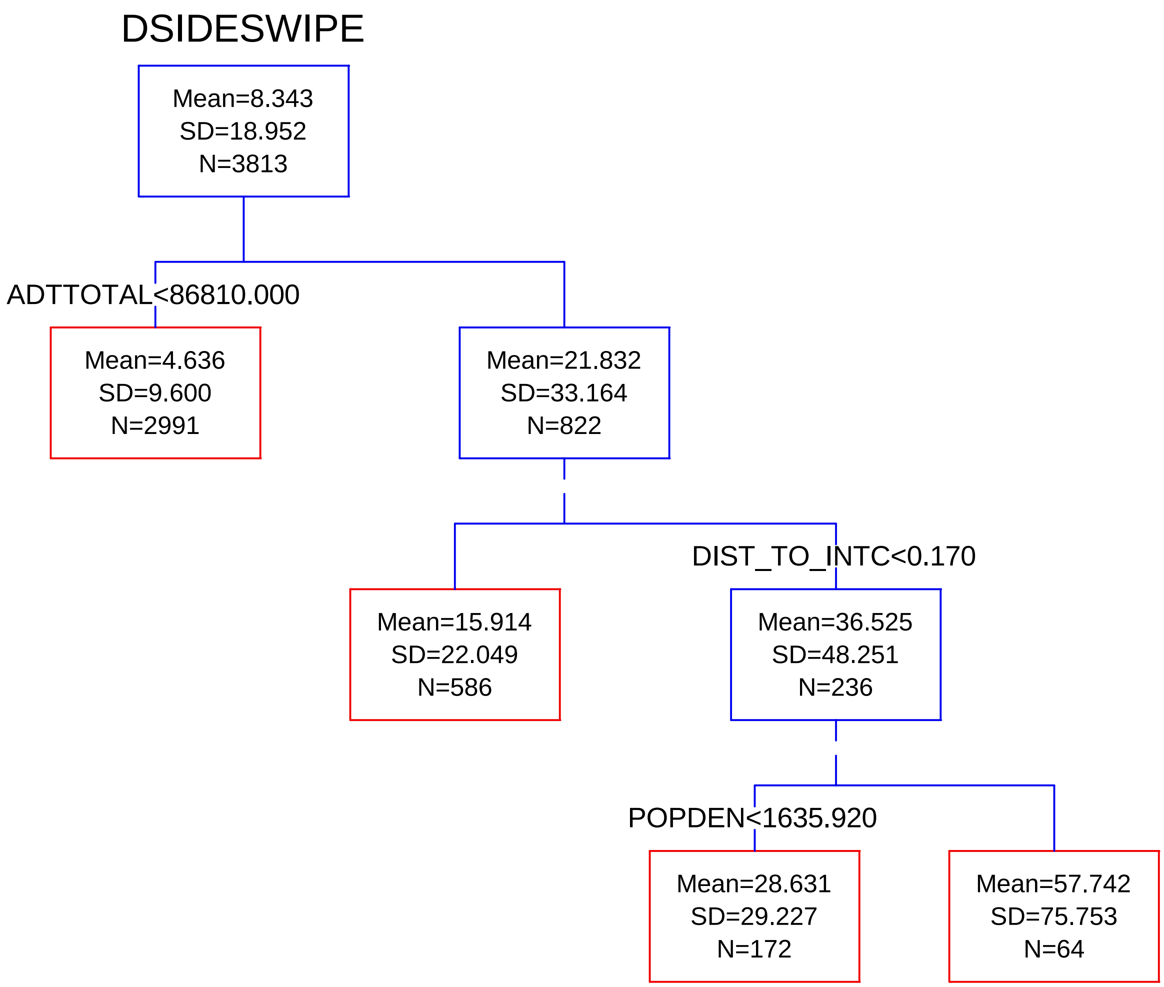


Figure 28. Statewide Road Wet Crash Density

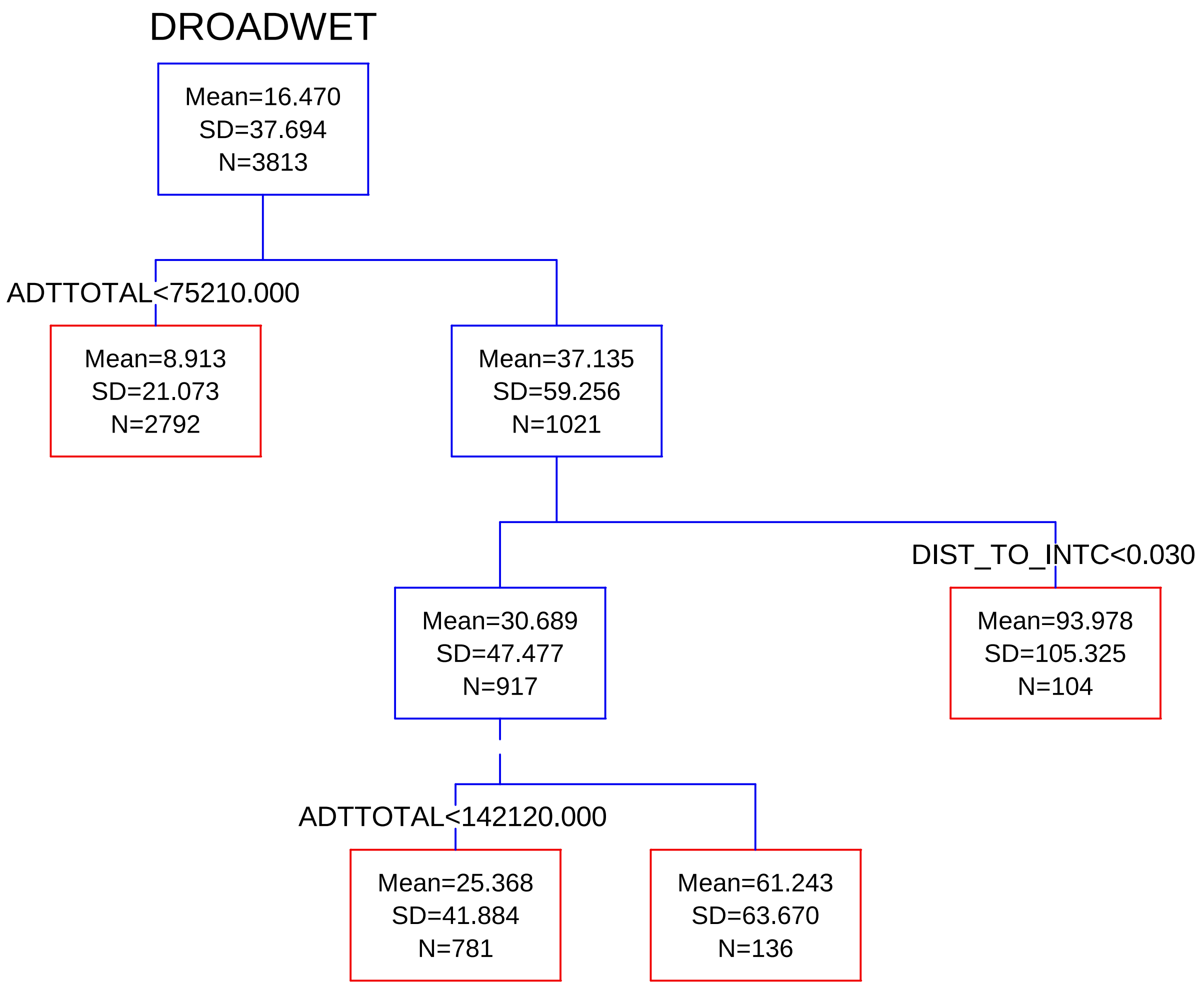


Figure 29. Statewide Night Crash Density

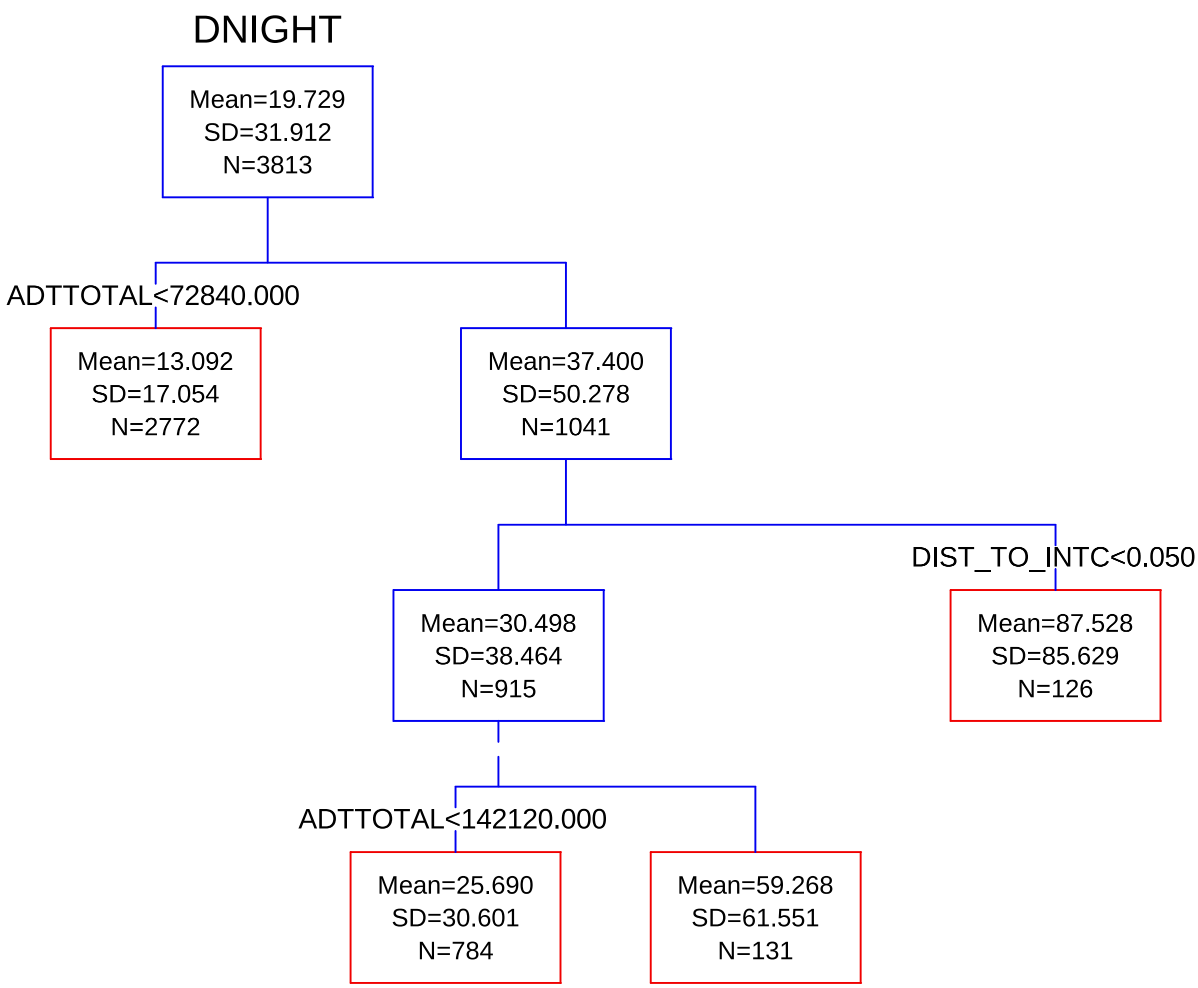


Figure 30.Statewide Injury/Fatal Crash Rate

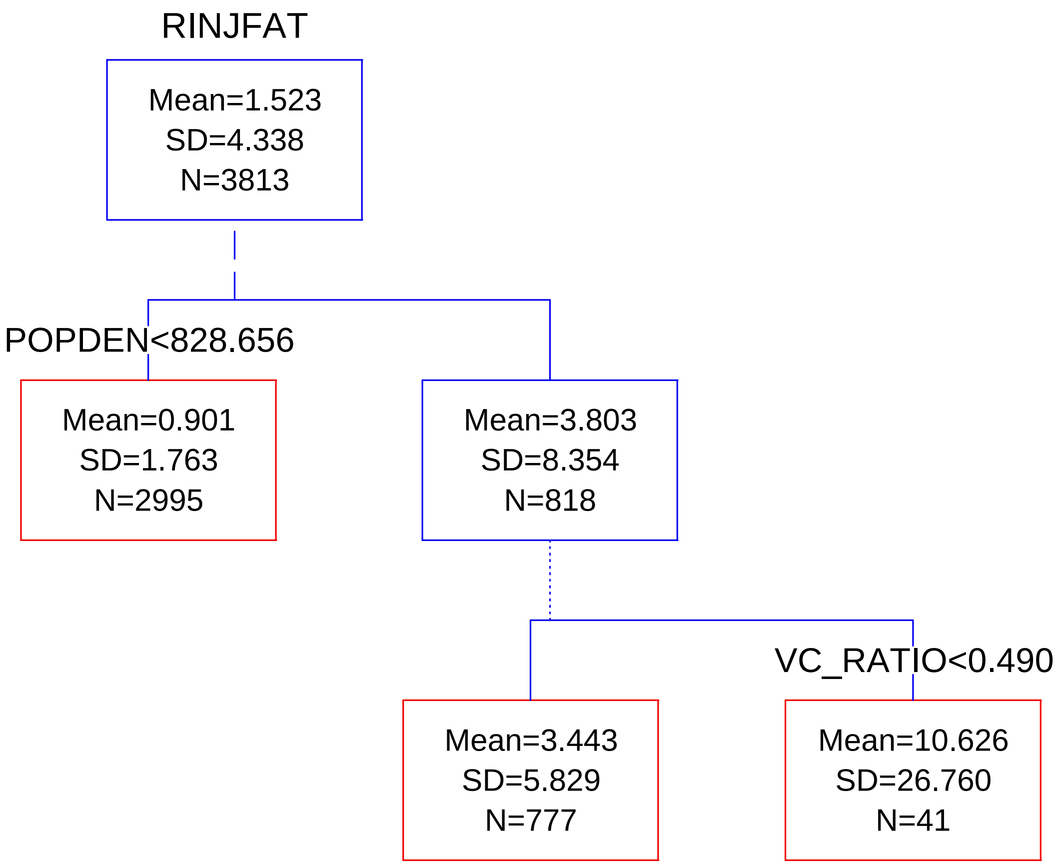


Figure 31.Statewide Property Damage Only Crash Rate

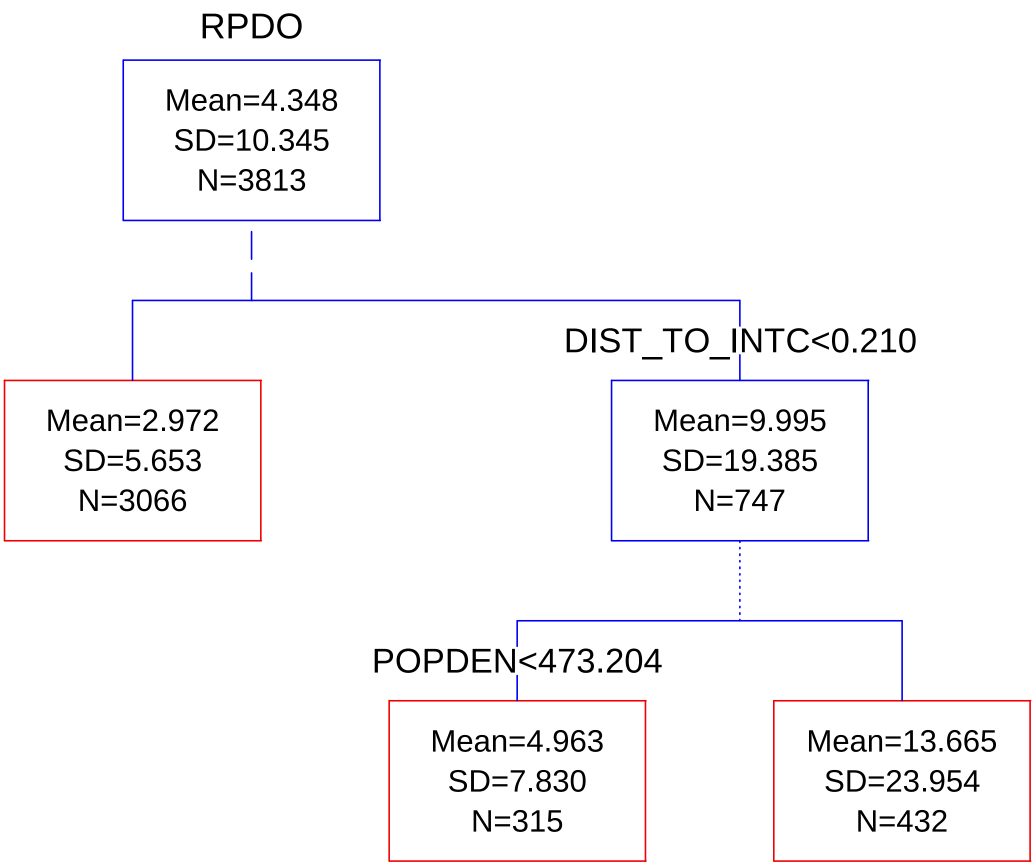


Figure 32.Statewide Total Crash Rate

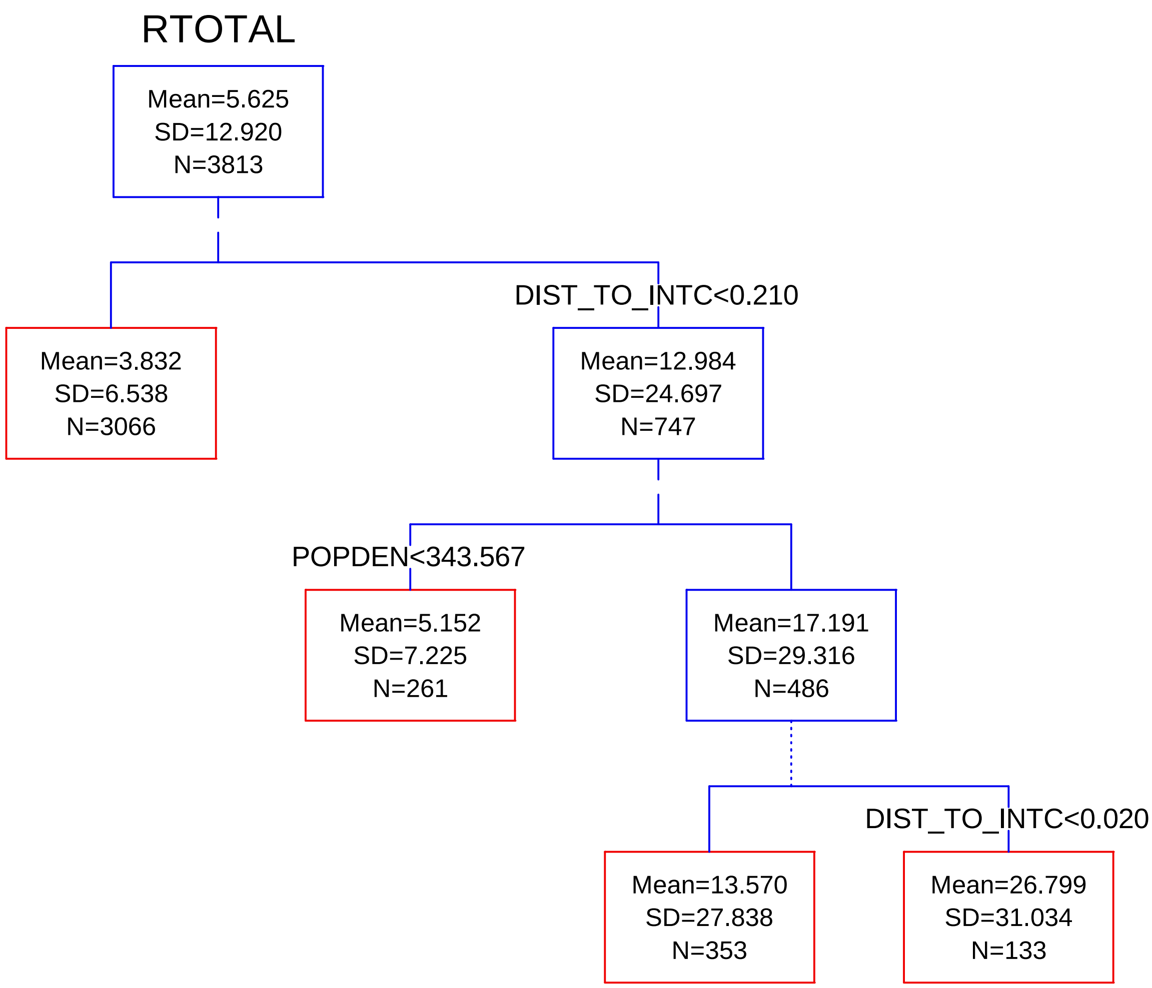


Figure 33.Statewide Angle Crash Rate

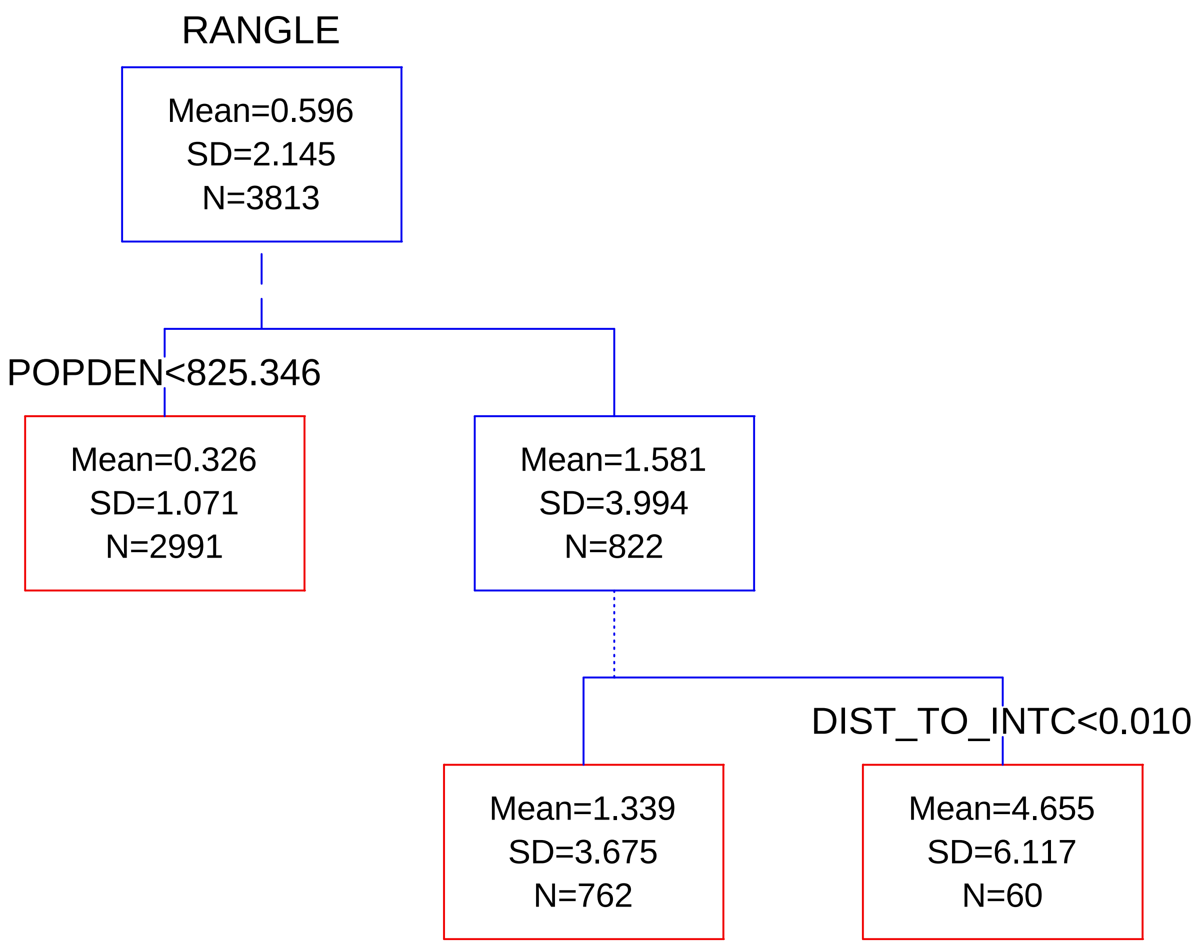


Figure 34.Statewide Fixed Object Crash Rate

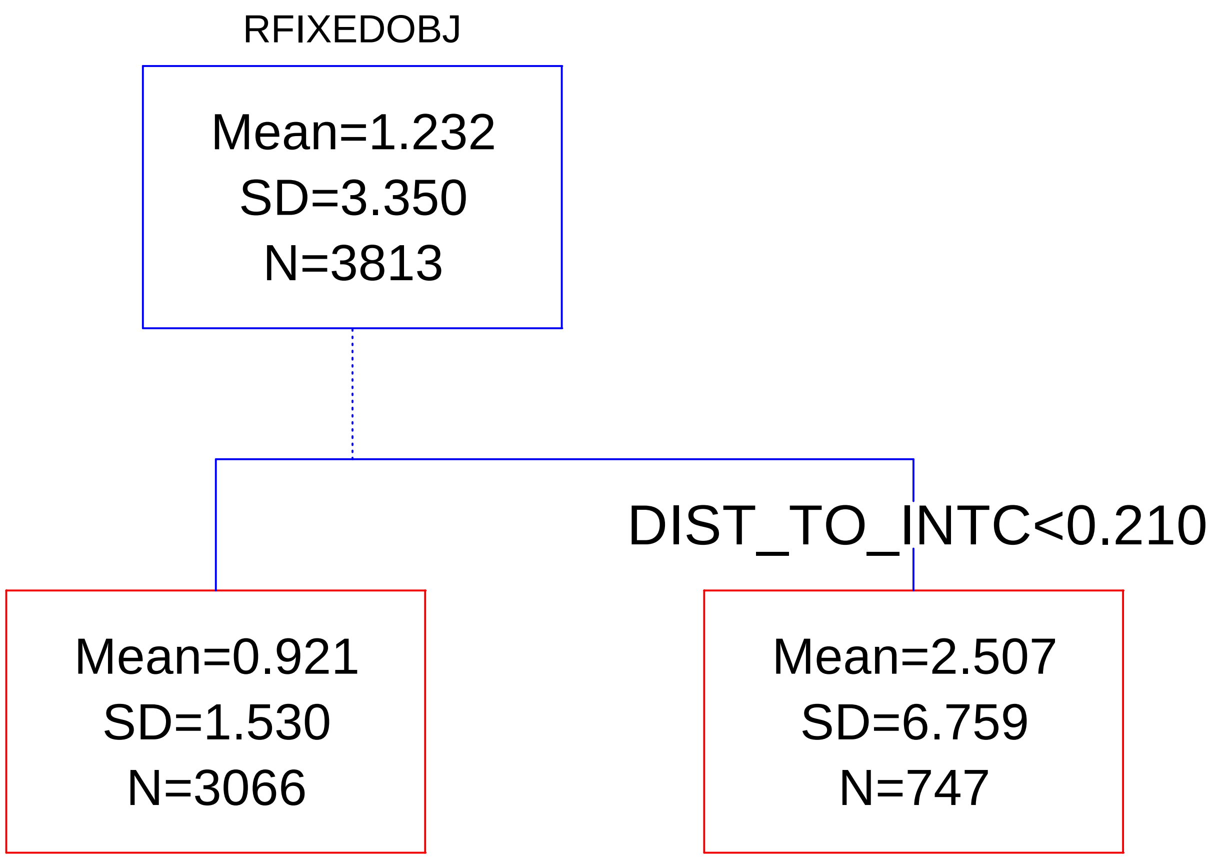


Figure 35.Statewide Rear End Crash Rate

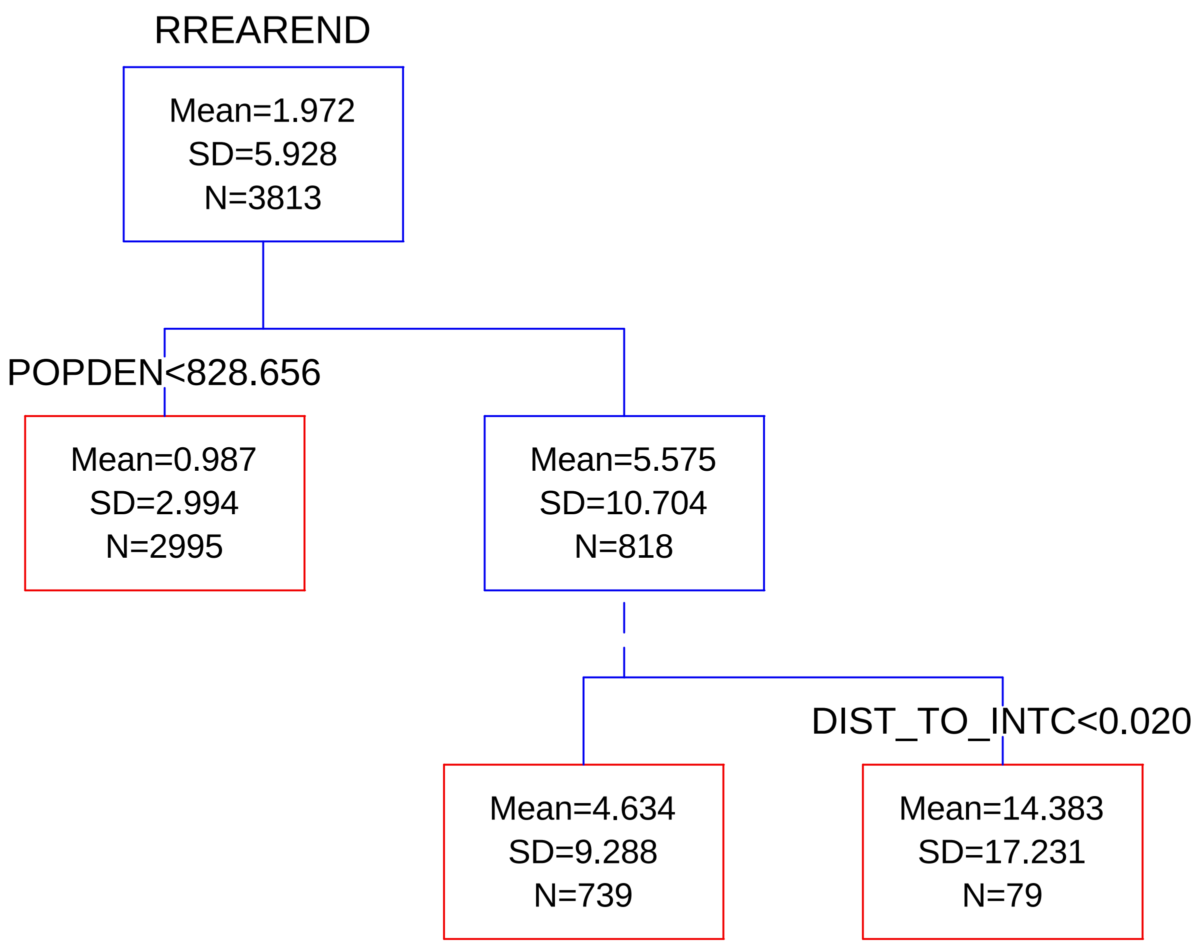


Figure 36.Statewide Sideswipe Crash Rate

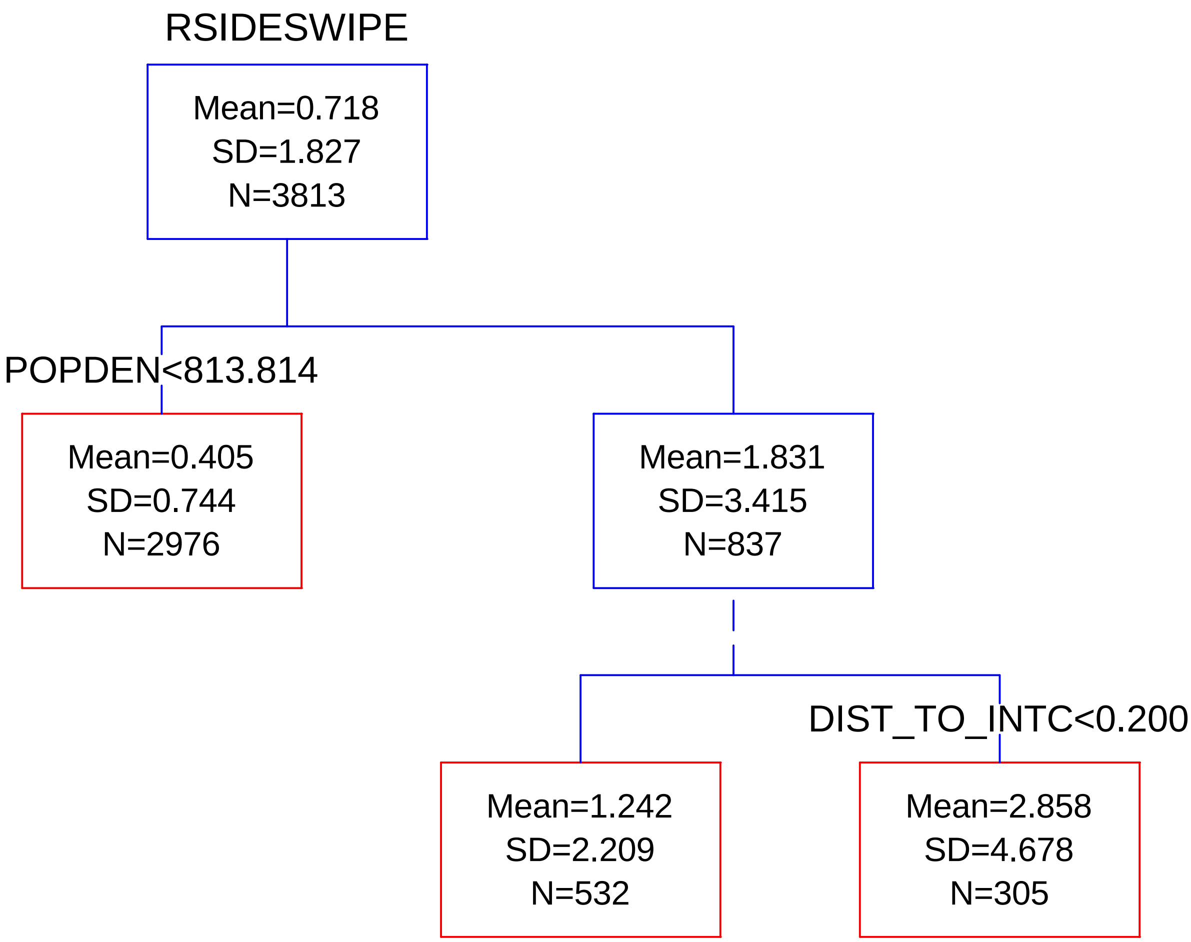


Figure 37.Statewide Road Wet Crash Rate

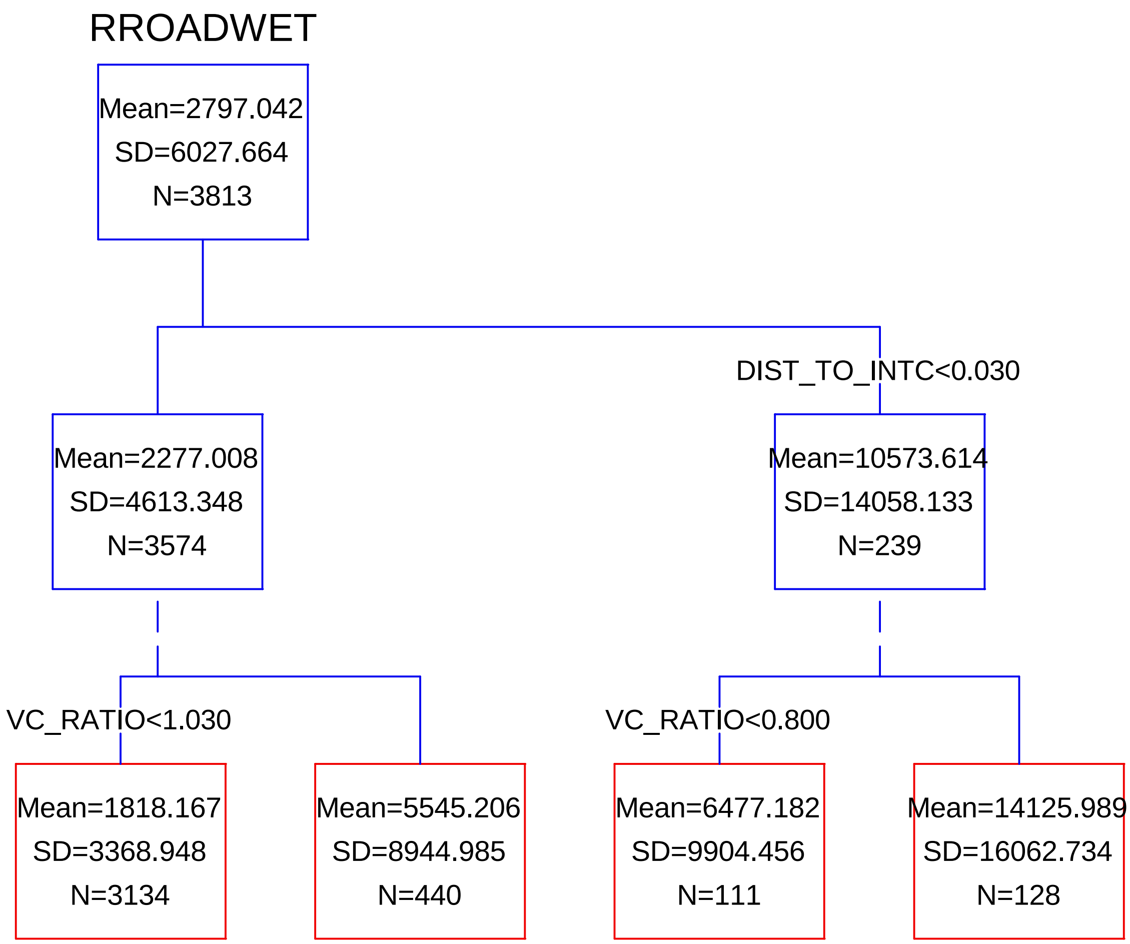
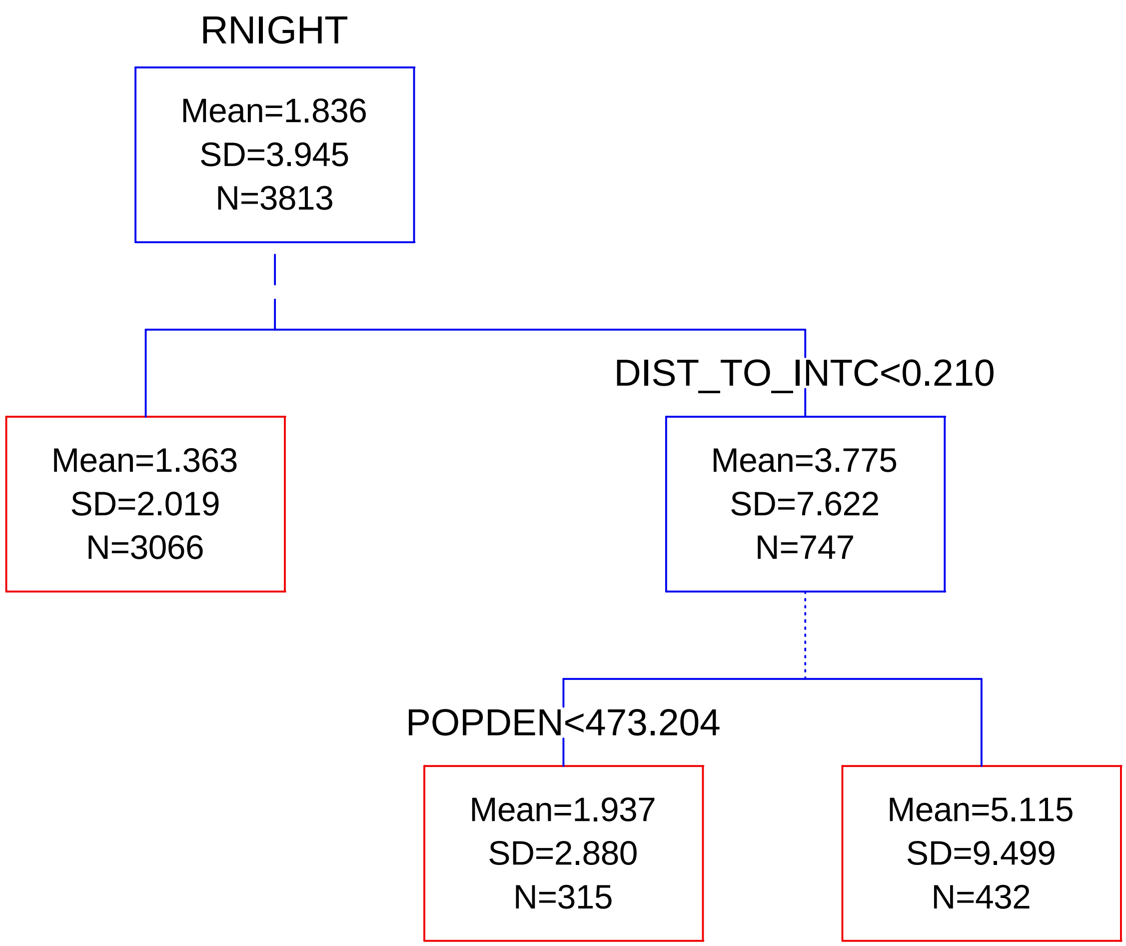


Figure 38.Statewide Night Crash Rate



5.2: Model Building Using Regression

Regression analysis is useful when we are using several variables to predict the values of a continuous dependent variable, such as crash rate or density. We can include various predictor variables such as ADT, population density, lane width, and others, and then use linear regression to determine the unique influence of each variable on crash rate or density. Linear regression can show us the unique and relative importance of each predictor by examining all of the predictors' simultaneous influences on the dependent variable. Regression analysis generates exact coefficients for each predictor, and shows what proportion of the variability of the dependent variable (crash rate or density) is uniquely explained by each individual predictor. This makes it possible to build a predictive model, which has predictor coefficients.

Multiple regression technique is applied to each group of data derived by the AID technique. The analysis is applied to the selected dependent variables for each of the AID terminal cells. One linear regression model is attempted for each terminal cell. Stepwise regression allows the generation of the best regression model while using the fewest independent variables. The criterion for selecting an independent variable to add or delete at each step is based on an F statistic. The goodness of fit for the estimated multiple regression equation is commonly measured by the multiple coefficient of determination (R^2).

The adjusted multiple coefficient of determination is used to avoid overestimating the impact of adding an independent variable on the amount of variability explained by the estimated regression equation. The objective of the model building process is to reduce the unexplained variance as much as possible. Stepwise regression, a variable of multiple regression, is employed in this research. An independent variable is added or removed from the equation at each step until the largest reduction in Sum of Squares due to Error (SSE) is derived. The value of SSE is the measure of the error in using regression model to calculate the values of the dependent variables.

$$SSE = \sum_{i=1}^{n}(y_i - \hat{y}_i)^2$$

where
SSE = Sum of squares due to error
N = Number of observations
y_i= Value of the ith dependent variable
$\hat{y}_i$= Predicted value of the ith dependent variable

Stepwise regression model allows the generation of the best regression model using minimum number of variables. F statistics is the standard for including an independent variable at each step The computed F value is compared with a user specified cutoff value $F\alpha$.The cut off value was set at 4.0 in this research. A variable can enter the equation if $F \geq 4.0$ and a variable is removed if $F < 4.0$.

The goodness of fit for the estimated multiple regression is commonly measured by the multiple coefficient of determination. It is computed as:

$$R^2 = \frac{SSR}{SST}$$

where:
R^2 = multiple coefficient of determination

SSR = Sum of squares due to regression = $\sum_{i=1}^{n}(y_i - \hat{y}_i)^2$

SST = Total sum of squares = $\sum_{i=1}^{n}(y_i - \bar{y}_i)^2$

The adjusted multiple coefficient of determination is employed to avoid overestimating the impact of adding an independent variable on the amount of variability explained by the estimated regression equation. Adjusted multiple coefficient of determination is computed as:

$$R^2_{adj} = 1 - (1 - R^2)\frac{n-1}{n-p-1}$$

where n = number of observations
p = number of independent variables.

The objective of the model building procedure is to reduce the unexplained variance as much as possible. The most fit occurs when R^2 and R^2_{adj} are close to 1.00.

Standard Error of Estimate (SEE) is used to evaluate the absolute unexplained variance. SEE is calculated as follows:

$$SEE = \sqrt{\frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{n-2}}$$

where:
y_i = observed value of ith dependent variable
$\hat{y}_i$ = predicted value of ith dependent variable.
n = sample size

The R^2_{adj} and SEE values of the regression runs are shown in the following tables. The R^2_{adj} values ranged from 0 to 1.00.

The key to read the models are as followings:
speed = Speed Limit in mph (1 mph= 1.6 kmph)
adt = Average Daily Traffic
popd = Population Density within a radius of 1.99 miles (3.2 km) of the begin log county
lanes = No. of Lanes
roway_wi =Roadway Width in ft. (1 ft. = .0348 m)
surface_wi = Surface Width in ft. (1 ft. = .0348 m)
sliw = Shoulder Left Inside Width in ft. (1 ft. = .0348 m)
sriw = Shoulder Right Inside Width in ft. (1 ft. = .0348 m)
med_wi= Median Width in ft. (1 ft. = .0348 m)
vc_r = V/C Ratio
dti = Distance to Interchange in miles (1 mile= 1.6 km)

Table 19. Statewide Crash Density Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	16.37	34.40	1	adt < 89000	3013	0.10	17.69
			2	adt ≥ 89000 dti <.0300	84	0.06	100.74
			3	adt ≥89000, dti ≥.0300, adt<1421120	580	0.06	37.52
			4	adt ≥89000,dti ≥.0300, adt≥1421120	136	0.08	68.24
Property Damage Only	47.20	88.88		adt<77220	2824	0.08	43.16
			2	adt ≥77220 dti<.0200	81	0.00	263.16
			3	adt ≥77220 dti ≥.0200 dti≥.0300	550	0.09	71.93
			4	adt ≥77220 dti ≥.0200, dti ≥.0300, adt<140021	283	0.00	140.32
			5	adt ≥77220 dti ≥.0200, dti ≥.0300 adt≥140021	75	0.00	179.45
Total	36.98	61.67	1	adt < 77800 dti<.0300	140	0.13	154.79
			2	adt ≥77800 dti ≥.0300	2703	0.08	43.18
			3	adt ≥77220 dti <.0200	79	0.00	337.43
			4	adt ≥77800 dti ≥.0200, adt<140021	749	0.05	113.80
			5	adt ≥77800 dti ≥.0200, adt≥140021	142	0.15	215.10
Angle	16.37	34.50	1	adt < 89000	3013	0.10	17.69
			2	adt ≥89000 dti <.0300	84	0.06	100.74
			3	adt ≥89000 dti ≥.0300 adt<1421120	580	0.06	37.52
			4	adt ≥89000 dti ≥.0300 adt≥1421120	136	0.08	68.24
Fixed Object	47.20	88.88	1	adt < 77220	2824	0.08	43.17
			2	adt ≥77220 dti <.0200	81	0.00	263.16
			3	adt ≥77220 dti ≥.0200 dti≥.0300	550	0.09	71.93
			4	adt ≥77220 dti ≥.0200, dti ≥.0300 adt<140021	283	0.00	140.32
			5	adt ≥77220 dti ≥.0200, dti ≥.0300 adt≥140021	75	0.00	179.45
Rear end	22.50	63.32	1	adt < 77220	2824	0.10	23.05

			2	adt ≥77220 dti <.0300	101	0.00	200.25
			3	adt ≥77220 dti ≥.0300 adt<142120	752	0.06	58.69
			4	adt ≥77220 dti ≥.0300,adt≥142120 dti<.550	93	0.09	147.60
			5	adt ≥77220 dti ≥.0300,adt≥142120 dti≥.550	43	0.21	29.59
Sideswipe	8.34	18.95	1	adt < 86810	2991	0.11	9.03
			2	adt ≥86810 dti≥.0170	586	0.11	20.80
			3	adt ≥86810 dti <.0170, popd<1635.920	172	0.06	28.36
			4	adt ≥77220 dti <.0170, popd≥1635.920	64	0.23	66.52
Road wet	16.47	37.69	1	adt < 75210	2792	0.06	20.46
			2	adt ≥75210 dti <.0300	104	0.00	105.32
			3	adt ≥75210 dti ≥.0300 adt<1421120	781	0.04	40.97
			4	adt ≥75210 dti ≥.0300 adt≥1421120	136	0.25	55.16
Night	19.73	31.91	1	adt < 72840	2772	0.05	16.66
			2	adt ≥ 72840 dti <.0500	126	0.00	85.63
			3	adt ≥72840 dti ≥.0500 adt < 1421120	784	0.04	29.93
			4	adt ≥72840 dti ≥.0500 adt ≥ 1421120	131	0.07	59.40

Table 20. Statewide Crash Rate Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Std.Dev**	**R^2 Adj**	**SEE**
Injury/Fatal	1.52	4.34	1	popd < 828.656	2995	0.12	1.66
			2	popd ≥828.656 vc_r <.0490	41	0.06	23.06
			3	popd ≥828.656 vc_r ≥.0490	777	0.03	5.73
Property Damage Only	4.35	10.35	1	dti ≥ .210	3066	0.09	5.40
			2	dti < 210 popd < 473.204	315	0.07	7.54
			3	dti < 210 popd≥.473.204	432	0.00	23.95
Total	5.63	12.92	1	dti ≥ .210	3066	0.12	6.13
			2	dti<.210 popd < 343.567	261	0.06	7.00
			3	dti<.210 popd ≥.343.567 dti<.020	133	0.00	31.03
			4	dti<.210 popd ≥.343.567 dti≥.020	353	0.01	27.63
Angle	0.60	2.15	1	popd < 825.346	2991	0.07	1.03
			2	popd ≥828.656 dti<.010	60	0.07	5.89
			3	popd ≥828.656 dti≥ .010	762	0.02	3.64
Fixed Object	1.23	3.35	1	dti < 0.210	747	0.01	6.73
			2	dti ≥ 0.210	3066	0.06	1.49
Rear end	1.97	5.93	1	popd < 828.656	2995	0.12	2.81
			2	popd ≥828.656 dti <.020	79	0.09	16.41
			3	popd ≥828.656 dti ≥.020	739	0.03	9.13
Sideswipe	0.72	1.83	1	popd < 813.814	2976	0.15	0.69
			2	popd ≥813.814 dti <.200	305	0.00	4.68
			3	popd ≥813.814 dti ≥.200	532	0.04	2.16
Road wet	2797.04	6027.66	1	dti < .030, vc_r ≥ .800	111	0.04	9702.93
			2	dti < .030, vc_r < .800	128	0.00	16062.70
			3	dti ≥ 0.030 vc_r < 1.030	3134	0.08	3223.65
			4	dti ≥ 0.030 vc_r ≥1.030	440	0.06	8770.34
Night	1.84	3.95	1	dti ≥ .210	3066	0.07	1.94
			2	dti <.210 popd < 473.204	315	0.08	2.77

			3	dti <.210, popd ≥ 473.204	432	0.00	9.50

A complete set of Statewide and districtwide crash density and crash rate models is included in Appendix III.

6.0 Model Validation for Crash Base Rate Studies

The final step of the research was to validate the crash estimation models. As described earlier, 2/3 of the data is used for the development of models. The remaining 1/3 data is used for model testing and validation. The 1/3 set of data, which was split from the master database, was further split according to the conditions of the AID terminal cells.

The candidate models were tested against the observations in the validation data. The mean of the sample and the mean of estimated crashes were calculated. The difference between the estimated and observed means and Standard Error of Estimate (SEE) were also calculated for each model. The statewide crash density and statewide crash rate model validation are shown in Tables 21 and 22.
A complete set of statewide and districtwide crash density and crash rate model validation is included in Appendix IV.

The key to read the models are as followings:

speed = Speed Limit in mph (1 mph= 1.6 kmph)
adt = Average Daily Traffic
popd = Population Density within a radius of 1.99 miles (3.2 km) of the beginning log point
lanes = No. of Lanes
roway_wi =Roadway Width in ft. (1 ft. = .0348 m)
surface_wi = Surface Width in ft. (1 ft. = .0348 m)
sliw = Shoulder Left Inside Width in ft. (1 ft. = .0348 m)
sriw = Shoulder Right Inside Width in ft. (1 ft. = .0348 m)
med_wi= Median Width in ft. (1 ft. = .0348 m)
vc_r = V/C Ratio
dti = Distance to Interchange in miles (1 mile= 1.6 km)

Table 21. Statewide Crash Density Model Validation

Crash Type		Condition	Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	adt < 89000	1583	9.55	9.49	0.61	19.38
	2	adt ≥ 89000 dti <.0300	42	123.70	98.23	20.59	213.87
	3	adt ≥89000 dti ≥.0300 adt < 1421120	305	32.13	30.62	4.71	46.23
	4	adt ≥89000 dti ≥.0300 adt≥1421120	61	52.74	65.07	23.38	53.54
Property Damage Only	1	adt < 77220	1479	28.94	28.81	0.47	55.80
	2	adt ≥77220 dti <.0200	45	245.22	262.33	6.98	62.52
	3	adt ≥77220 dti ≥.0200 dti≥.0300	295	65.91	60.74	7.86	37.69
	4	adt ≥77220 dti ≥.0200, dti ≥.0300, adt<140021	137	105.82	100.68	4.86	150.66
	5	adt ≥77220 dti ≥.0200, dti ≥.0300 adt≥140021	35	173.35	217.71	25.59	159.47
Total	1	adt < 77800 dti<.0300	79	138.24	142.56	3.13	210.34
	2	adt ≥77800 dti ≥.0300	1411	32.07	31.87	0.62	50.80
	3	adt ≥77220 dti <.0200	44	312.52	349.43	11.81	310.25
	4	adt ≥77800 dti ≥.0200, adt<140021	381	91.58	95.91	4.73	127.50
	5	adt ≥77800 dti ≥.0200, adt≥140021	77	170.03	196.18	15.38	200.48
Angle	1	adt < 89000	1583	9.55	9.49	0.64	19.38
	2	adt ≥89000 dti <.0300	42	123.70	98.23	20.59	213.87
	3	adt ≥89000 dti ≥.0300 adt<1421120	305	32.13	30.62	4.71	46.15
	4	adt ≥89000 dti ≥.0300 adt≥1421120	61	52.74	65.07	23.38	53.54
Fixed Object	1	adt < 77220	1479	28.94	28.79	0.52	55.80
	2	adt ≥77220 dti <.0200	45	245.22	262.33	6.98	62.52
	3	adt ≥77220 dti ≥.0200 dti≥.0300	295	65.91	60.74	7.86	84.34
	4	adt ≥77220 dti ≥.0200, dti ≥.0300 adt<140021	136	105.82	100.68	4.86	150.66
	5	adt ≥77220 dti ≥.0200, dti ≥.0300 adt≥140021	34	173.35	217.71	25.59	159.47
Rear end	1	adt < 77220	1479	9.13	8.53	6.53	1.02

	2	adt ≥77220 dti <.0300	52	127.55	168.66	32.23	23.85
	3	adt ≥77220 dti ≥.0300 adt<142120	399	42.26	39.74	5.98	4.00
	4	adt ≥77220 dti ≥.0300, adt≥142120 dti<.550	41	107.67	167.50	55.56	18.93
	5	adt ≥77220 dti ≥.0300, adt≥142120 dti≥.550	20	1069.94	31.65	97.04	15.46
Sideswipe	1	adt < 86810	1574	4.69	4.59	2.19	9.09
	2	adt ≥86810 dti≥.0170	318	16.76	16.07	4.14	22.94
	3	adt ≥86810 dti <.0170, popd<1635.920	65	39.59	29.57	25.31	62.75
	4	adt ≥77220 dti <.0170, popd≥1635.920	37	38.78	58.15	49.95	65.12
Wet road	1	adt < 75210	1459	8.82	8.97	1.66	0.17
	2	adt ≥75210 dti <.0300	55	97.31	93.98	3.43	19.14
	3	adt ≥75210 dti ≥.0300 adt<1421120	416	26.55	26.13	1.57	2.31
	4	adt ≥75210 dti ≥.0300 adt≥1421120	61	49.57	60.81	22.68	7.92
Night	1	adt < 72840	1449	13.28	13.13	1.07	0.49
	2	adt ≥ 72840 dti <.0500	67	93.25	87.53	6.14	17.84
	3	adt ≥ 72840 dti ≥.0500 adt < 1421120	415	25.89	26.03	0.54	1.62
	4	adt ≥72840 dti ≥.0500 adt ≥ 1421120	61	41.34	59.63	44.25	7.02

Table 22. Statewide Crash Rate Model Validation

Crash Type		Condition	Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	popd < 828.656	1573	1.01	0.94	6.79	0.09
	2	popd ≥828.656 vc_r <.0490	31	11.09	7.56	31.79	4.06
	3	popd ≥828.656 vc_r ≥.0490	387	3.69	3.47	5.85	0.36
Property Damage Only	1	dti ≥ .210	1636	3.12	2.98	4.53	0.23
	2	dti < 210 popd< 473.204	156	6.69	5.69	15.04	0.85
	3	dti < 210 popd≥.473.204	199	14.28	13.67	4.32	1.78
Total	1	dti ≥ .210	1636	3.78	3.82	0.97	0.13
	2	dti<.210 popd < 343.567	111	5.33	5.52	3.66	0.62
	3	dti<.210 popd ≥.343.567 dti<.020	72	27.93	26.80	4.06	3.92
	4	dti<.210 popd ≥.343.567 dti≥.020	172	14.86	13.72	7.73	2.49
Angle	1	popd < 825.346	1573	0.37	0.33	8.95	0.05
	2	popd ≥828.656 dti<.010	26	3.52	5.51	56.47	0.90
	3	popd ≥828.656 dti≥ .010	392	1.25	1.35	8.14	0.16
Fixed Object	1	dti < 0.210	355	2.59	2.53	2.35	0.25
	2	dti ≥ 0.210	1636	1.06	0.93	12.80	0.09
Rear end	1	popd < 828.656	1573	1.08	1.02	5.67	0.12
	2	popd ≥828.656 dti <.020	36	11.65	16.18	38.92	2.99
	3	popd ≥828.656 dti ≥.020	382	4.70	4.63	1.37	0.42
Sideswipe	1	popd < 813.814	1567	0.46	0.43	4.98	0.03
	2	popd ≥813.814 dti <.200	142	3.48	2.86	17.88	0.51
	3	popd ≥813.814 dti ≥.200	282	1.18	1.27	7.58	0.10
Wet road	1	dti < .030, vc_r ≥ .800	72	7022.53	6963.02	0.85	1533.32
	2	dti < .030, vc_r < .800	57	12997.05	14126.00	8.69	2701.53
	3	dti ≥ 0.030, vc_r < 1.030	1638	2021.57	1828.24	9.56	148.76
	4	dti ≥ 0.030 vc_r ≥1.030,	224	4970.43	5525.73	11.17	519.56
Night	1	dti ≥ .210	1636	1.36	1.37	0.73	0.05
	2	dti <.210, popd < 473.204	156	2.71	2.21	18.56	0.30
	3	dti <.210, popd ≥ 473.204	199	5.33	5.12	4.01	0.65

7. 0. Applications, Conclusions and Recommendations

7.1 Applications

The models in this study were based on statistical analysis. Therefore, a tolerance range is required to be employed for applying the AID and regression models.

Standard Error of Estimate is used as the unit of tolerance range for regression models. Standard Error of Estimate (SEE) is the measure of accuracy of the estimation. It measures the error range of the estimation away from the observed values. The upper limit of the tolerance range as follows:

$$E v + n*SEE$$

where

Ev = Estimated base crash rate
n = Tolerance level
SEE = Standard Error of Estimate

The tolerance range is adjusted by varying the tolerance level, n. If n is assigned a larger value, fewer segments are considered abnormal and if n is assigned a smaller value more segments are considered abnormal.

Standard deviation is used as unit of tolerance for AID terminal cell models, The upper limit of the tolerance range as follows:

$$E v + n*SD$$

where

Ev = Estimated base crash rate
n = Tolerance level
SD = Standard Deviation

It is statistically acceptable, if an observed crash rate is consistent with the estimation within the tolerance range. If the observed crash rate is beyond the upper limit of that range, it is considered as an outlier.

An example of the application of the tolerance range is as follows:

The recommended Injury/Fatal crash density model for State are:

Condition 1	adt < 89000	Y = 5.293625 + 0.000221 * J2 + 0.003659 * L2 - 0.063245 * N2 + 3.510843 * U2 + 0.733322 * Y2 - 1.759859 * AA2
Condition 2	adt ≥89000 dti <.0300	Y = 82.084359 + 0.039166 * L2 - 55.275346 * U2

Condition 3	adt ≥89000 dti ≥.0300adt< 1421120	Y = 33.447052 + 0.004655 * L2 + 3.872260 * X2 - 19.689666 * AA2
Condition 4	adt ≥89000 dti ≥.0300adt≥ 1421120	Y = 156.142922 - 0.655347 * N2 - 39.947759 * T2

The characteristics of a freeway segment are as follows:

J2	Speed Limit	65
L2	Population Density	232.92
N2	Roadway width	76
U2	Positive Barrier	0
Y2	Grade Percentage	0
AA2	Distance to Interchange	.21

The estimated values can be obtained by inputting the above values of the independent variables. Therefore, the number of base crashes = 5.293625 + 0.000221 * 65 + 0.003659 * 232.92 - 0.063245 * 76 + 3.510843 * 0 + 0.733322 * 0 - 1.759859 * 0.21

Let us assume the tolerance level as 2, and the Standard Error of Estimate for Condition 1 for Injury/Fatal crashes for signal controlled legs is 17.69. The upper limit of tolerance range is:

Ev + n*SEE = .98 +2*17.69 =36.36

The actual number of Injury/Fatal crash density is 16. Since 16 < 36, the number of crashes at this segment is within the tolerance range, and hence it is statistically accepted

The standard deviation for Condition 1 for Injury/Fatal crashes state is 18.651. If we consider 2 * standard deviation as the tolerance range, the upper limit of the tolerance range is:

Ev + n*SD = .98 +2* 18.651 = 38.28

The actual number of crashes is 16. Since 16 < 36.36 the crash rate is within the tolerance range and statistically accepted to be normal.

7.2 Summary and Conclusions:
This study was performed to develop crash base rates for freeways in Ohio. The models developed in this study are based on statistical calculations and analysis. One set of base crash rates for freeways was developed for

1. Entire State of Ohio
2. Each of the 11 districts of Ohio (except District 9 which has no freeways).

. The base crash rate models were developed for the following crash types:

1. Injury/Fatal
2. PDO
3. Total
4. Angle
5. Fixed Object
6. Rear end
7. Sideswipe
8. Wet Road
9. Night

The following independent variables were used in the development of the models:

1. Speed Limit
2. ADT Total
3. Population Density
4. Lanes
5. Roadway width
6. Surface Width
7. Shoulder Left Inside Width
8. Shoulder Left Outside Width
9. Shoulder Right Inside Width
10. Shoulder Right Outside Width
11. Unprotected Barrier
12. Positive Barrier
13. Curbed Barrier
14. Median Width
15. Curve Degree
16. Grade Percentage
17. V/C Ratio
18. Distance to Interchange

A master database was created by using data available from ODOT. The master database was randomly divided into two-third for model building and one-third for model validation. Automatic Interaction Detection (AID) technique was used to evaluate the complex interaction among the dependent and independent variables. AID assisted in identifying a set of independent variables that have significant relationship with each dependent variable. The data was split into mutually exclusive groups such that the data in the same group were similar to each other.

Stepwise multiple regression technique was used in the next step to develop mathematical models for the split groups. Finally, the models were validated with the one-third dataset.

7.3 Recommendations:

- Statewide and districtwide crash density and rate models for freeways were developed in this study. These models are recommended for use by ODOT for evaluating freeway crashes.
- It is recommended that the means and standard deviations for different crashes provided by the AID analysis be used for calculating base crash rates. The AID models are given in Appendix II.
- The regression equations may be used as an additional tool for predicting statewide or districtwide base crash rates for each crash type. These equations are given in Appendix V.

Reference

1: Crash Information. Department of Public Safety, Ohio Department of Transportation. http://www.publicsafety.ohio.gov/crash_reports.asp, Accessed February 21, 2007.

3: Greg Murphy and Jennifer Townley, "*Strategies for Improving Safety and Mobility on Ohio Roads*", http://www.otecohio.org/presentations/OTECpresentations/Se15/JT_GM-Safety.pdf , February 21, 2007.

3: Highway Safety, Ohio Department of Transportation. http://www.dot.state.oh.us/roadwaysafety/GoalsandObjectives.htm, Accessed February 21, 2007

4: Highway Safety Program, Ohio Enhanced Crash Location Identification System. ODOT, Office of systems management and program management, http://dot.state.oh.us/planning/Safety/2005Data/HSP%202005%20Web%20Introduction.PDF, Accessed Feb 20,2007

5: Pant, P.D., Rajagopal, A. and Cheng, Y., "Rational Schedule of Base Crash Rates for Rural Highways in Ohio(Phase-II)". Publication FHWA/OH 2003/008. Ohio Department of Transportation , 2000.

6: Pant, P.D., Liu Y. and Vasisht G., "Rational Schedule of Base Crash Rates for Rural Highways in Ohio(Phase-I)". Publication FHWA/OH 2000/003. Ohio Department of Transportation , 2003.

7: Pant, P.D. and Rajgopal, A., "Research Proposal Crash Base Rates for Intersections in Ohio", Prepared for the Ohio Department of Transportation by University of Cincinnati, Ohio. May 2003.

This page is intentionally left blank

The remaining pages of this report contain
Appendix I
Appendix II
Appendix III
Appendix IV and
Appendix V

This page is intentionally left blank

Appendix I

Districtwide Descriptive Statistics

This page is intentionally left blank

Table 1.1. Districtwide Distribution of Segment Length

	Segment Length		
District	**0.05-0.24 miles (0.08-0.38 km)**	**0.25 miles (0.40 km)**	**0.26-0.43 miles (0.42-0.69 km)**
1	65	129	19
2	143	157	51
3	123	278	55
4	260	478	100
5	131	288	62
6	405	405	127
7	228	322	75
8	348	482	119
10	42	111	8
11	94	183	27
12	298	273	95

Table 1.2. Districtwide distribution of Speed Limit

	Speed Limit mph (kmph)					
District	**45 (72)**	**50 (80)**	**55 (88)**	**60 (96)**	**65 (104)**	
1	0	0	0	0	213	**No. of Segments**
2	0	4	0	71	276	
3	0	0	0	11	445	
4	0	33	123	24	658	
5	0	0	11	0	470	
6	0	0	46	0	891	
7	0	4	27	0	594	
8	0	1	96	53	799	
10	0	0	0	21	140	
11	0	0	2	0	302	
12	3	31	10	507	115	

Table 1.3. Districtwide distribution of Average Daily Traffic

	Average Daily Traffic									
District	<20000	<40000	<60000	<80000	<100000	<120000	<140000	<160000	<180000	No. of Segments
1	0	145	68	0	0	0	0	0	0	
2	0	29	176	77	51	18	0	0	0	
3	15	142	294	5	0	0	0	0	0	
4	24	349	253	117	64	22	9	0	0	
5	70	284	78	42	7	0	0	0	0	
6	2	183	214	149	74	116	92	82	25	
7	0	137	267	121	70	25	5	0	0	
8	0	295	275	15	110	71	82	77	24	
10	161	0	0	0	0	0	0	0	0	
11	88	187	29	0	0	0	0	0	0	
12	0	55	94	90	140	154	68	44	21	

Table 1.4. Districtwide distribution of Lanes

	No. of Lanes									
District	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	No. of Segments
1	0	1	212	0	0	0	0	0	0	0	
2	7	0	271	2	54	3	14	0	0	0	
3	0	0	316	4	136	0	0	0	0	0	
4	4	2	675	16	132	2	7	0	0	0	
5	0	0	437	1	43	0	0	0	0	0	
6	2	0	384	18	354	40	131	0	8	0	
7	2	4	444	4	171	0	0	0	0	0	
8	0	1	396	24	443	13	68	4	0	0	
10	0	0	161	0	0	0	0	0	0	0	
11	0	0	269	31	4	0	0	0	0	0	
12	1	0	170	20	200	23	188	4	57	3	

Table 1.5. Districtwide distribution of Population Density within a radius of 1.99 miles (3.2 km) of begin log point

	Population Density									
District	0 -50	50 - 100	100-200	200-500	500-1000	1000-1500	1500-2000	2000-2500	<2500	No. of Segments
1	97	21	37	30	28	0	0	0	0	
2	82	17	16	68	84	25	29	30	0	
3	144	138	77	61	36	0	0	0	0	
4	170	120	116	191	117	69	32	23	0	
5	243	114	56	41	21	6	0	0	0	
6	308	70	22	87	168	169	83	17	13	
7	123	80	95	158	126	39	4	0	0	
8	203	38	91	181	259	111	30	21	15	
10	121	8	7	25	0	0	0	0	0	
11	151	51	34	60	8	0	0	0	0	
12	18	16	29	115	171	171	67	36	43	

Table 1.6. Districtwide distribution of Roadway width

	Roadway width ft. (m)					
District	≤44 (≤13.41)	45-88 (13.72-26.82)	89-132 (27.13-40.23)	133-176 (40.54-53.64)	177-222 (53.95-67.67)	No. of Segments
1	0	213	0	0	0	
2	0	280	71	0	0	
3	0	271	168	17	0	
4	1	689	148	0	0	
5	0	438	43	0	0	
6	378	427	132	0	0	
7	2	416	207	0	0	
8	1	411	486	51	0	
10	0	161	0	0	0	
11	0	261	43	0	0	
12	0	170	362	74	60	

Table 1.7. Districtwide distribution of Surface Width

	Surface Width ft. (m)					
District	**≤32 (9.75)**	**33-60 (10.06-18.29)**	**61-90 (18.59-27.43)**	**91-110 (27.74-33.53)**	**111-132 (33.83-40.23)**	
1	0	213	0	0	0	**No. of Segments**
2	7	272	59	13	0	
3	3	317	136	0	0	
4	4	692	134	8	0	
5	0	438	43	0	0	
6	2	400	389	138	8	
7	2	445	178	0	0	
8	1	419	457	72	0	
10	0	161	0	0	0	
11	0	300	4	0	0	
12	0	191	212	200	63	

Table 1.8. Districtwide distribution of Shoulder Left Inside Width

	Shoulder Left Inside Width ft. (m)				
District	**≤10 (3.05)**	**<20 (6.10)**	**<30 (9.14)**	**<36 (10.97)**	
1	213	0	0	0	**No. of Segments**
2	351	0	0	0	
3	389	16	36	15	
4	815	21	2	0	
5	481	0	0	0	
6	731	200	6	0	
7	568	57	0	0	
8	852	97	0	0	
10	161	0	0	0	
11	288	16	0	0	
12	496	96	74	0	

Table 1.9. Districtwide distribution of Shoulder Left Outside Width

	Shoulder Left Outside Width				
District	**≤5 (1.52)**	**≤10 (3.05)**	**≤15 (4.57)**	**≤22 (6.71)**	
1	0	213	0	0	**No. of Segments**
2	8	343	0	0	
3	14	442	0	0	
4	7	800	31	0	
5	0	478	3	0	
6	6	863	68	0	
7	2	574	49	0	
8	9	932	8	0	
10	0	161	0	0	
11	0	300	4	0	
12	4	593	63	6	

Table 1.10. Districtwide distribution of Shoulder Right Inside Width

	Shoulder Right Inside Width				
District	**≤10 (3.05)**	**<20 (6.10)**	**<30 (9.14)**	**<36 (10.97)**	
1	213	0	0	0	**No. of Segments**
2	351	0	0	0	
3	389	16	36	15	
4	815	21	2	0	
5	481	0	0	0	
6	729	208	0	0	
7	568	57	0	0	
8	852	97	0	0	
10	161	0	0	0	
11	288	16	0	0	
12	490	95	81	0	

Table 1.11. Districtwide distribution of Shoulder Right Outside Width

	Shoulder Right Outside Width				
District	≤5 (1.52)	≤10 (3.05)	≤15 (4.57)	≤22 (6.71)	
1	0	213	0	0	No. of Segments
2	8	339	4	0	
3	14	442	0	0	
4	7	800	31	0	
5	0	478	3	0	
6	6	921	10	0	
7	2	574	49	0	
8	9	932	8	0	
10	0	161	0	0	
11	0	300	4	0	
12	4	599	0	63	

Table 1.12. Districtwide distribution of Barrier

	Barrier			
District	Unprotected	Positive	Curbed	
1	174	39	0	No. of Segments
2	221	130	0	
3	429	27	0	
4	655	180	3	
5	431	50	0	
6	662	275	0	
7	511	114	0	
8	705	244	0	
10	158	3	0	
11	252	52	0	
12	266	400	0	

Table 1.13. Districtwide distribution of Median Width

	Median Width ft. (m)										
District	≤20 (6.10)	≤40 (12.19)	≤60 (18.29)	≤80 (24.38)	≤100 (30.48)	≤120 (36.58)	≤160 (48.77)	≤180 (54.86)	≤200 (60.96)	>200 (60.96)	
1	39	58	71	45	0	0	0	0	0	0	No. of Segments
2	118	16	61	153	0	0	0	0	0	3	
3	0	124	149	10	168	0	5	0	0	0	
4	158	90	184	181	183	14	4	0	17	7	
5	51	59	54	64	253	0	0	0	0	0	
6	234	130	295	67	198	0	0	0	0	13	
7	110	29	295	58	97	0	0	0	30	6	
8	173	86	229	140	259	47	15	0	0	0	
10	3	27	122	9	0	0	0	0	0	0	
11	52	98	153	1	0	0	0	0	0	0	
12	338	67	7	52	111	22	1	7	47	14	

Table 1.14. Districtwide distribution of Curve Degree

	Curve Degree						
District	0	≤ 3	≤ 6	≤ 9	≤ 12	≤ 15	
1	207	6	0	0	0	0	No. of Segments
2	340	5	6	0	0	0	
3	452	2	0	2	0	0	
4	828	7	3	0	0	0	
5	481	0	0	0	0	0	
6	928	1	8	0	0	0	
7	616	3	2	4	0	0	
8	893	34	17	3	2	0	
10	161	0	0	0	0	0	
11	300	2	2	0	0	0	
12	659	0	5	0	0	2	

Table 1.15. Districtwide distribution of Grade Percentage

	Grade Percentage							
District	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**No. of Segments**
1	210	0	0	3	0	0	0	
2	334	0	0	15	2	0	0	
3	430	0	0	15	11	0	0	
4	773	0	0	54	11	0	0	
5	371	0	0	93	17	0	0	
6	925	0	0	12	0	0	0	
7	595	0	0	30	0	0	0	
8	862	1	0	52	25	5	4	
10	128	0	0	33	22	0	0	
11	222	0	0	50	22	8	2	
12	656	0	0	10	0	0	0	

Table 1.16. Districtwide distribution of VC Ratio

	VC Ratio									
District	**< .15**	**< .30**	**< .45**	**< .60**	**< .75**	**< .90**	**< .105**	**< .120**	**< .135**	**No. of Segments**
1	0	0	0	110	56	23	24	0	0	
2	7	0	31	9	89	115	53	16	31	
3	10	22	160	96	126	42	0	0	0	
4	13	12	205	215	113	172	71	24	13	
5	0	94	90	168	52	40	33	3	1	
6	3	8	11	215	244	151	128	77	100	
7	2	0	0	74	129	157	134	101	28	
8	0	0	31	264	222	162	104	80	86	
10	0	161	0	0	0	0	0	0	0	
11	0	101	82	94	22	5	0	0	0	
12	1	6	16	135	208	112	95	41	52	

Table 1.17. Districtwide distribution of Distance to Interchange

	Distance to Interchange miles (km)									
District	**0-0.20 (0-32)**	**0.21-0.40 (0.34-0.64)**	**0.41-0.60 (0.66-0.96)**	**0.61-0.80 (0.98-1.28)**	**0.81-1.0 (1.30-1.60)**	**1.01-1.50 (1.62-2.40)**	**1.51-2.0 (2.42-3.20)**	**2.01-3.0 (3.22-4.80)**	**>3.0 (4.80)**	
1	33	29	24	24	21	31	16	13	22	**No. of Segments**
2	90	68	45	39	18	24	21	20	8	
3	51	42	36	34	32	57	48	54	61	
4	170	122	93	67	53	94	67	88	8	
5	56	47	39	39	38	82	61	74	45	
6	152	134	108	92	62	117	73	83	104	
7	109	95	77	69	54	100	48	48	9	
8	198	140	113	85	79	126	61	72	28	
10	12	9	8	8	8	20	18	34	42	
11	39	30	30	28	20	47	34	37	25	
12	192	139	94	51	34	47	29	26	14	

Table 1.18. Districtwide distribution of Crash Types

	Crash Types								
District	**Injury/Fatal**	**PDO**	**Total**	**Angle**	**Fixed object**	**Rear end**	**Sideswipe**	**Wet road**	**Night**
1	322	1153	1430	94	486	245	181	380	553
2	985	3500	4215	453	896	1416	722	1006	1369
3	685	2473	3176	227	934	660	346	770	1323
4	2118	5943	7827	707	2103	2384	932	1949	2634
5	703	2656	3260	182	1116	465	335	894	1385
6	4116	9490	13714	1615	2402	5504	1947	3229	4328
7	1843	5440	6950	630	1869	1863	956	1869	2348
8	4106	13617	16805	1572	3183	7087	2368	4577	4980
10	98	437	535	8	157	18	26	96	269
11	357	1409	1622	105	512	228	167	349	703
12	3771	9250	12724	1605	2353	4981	1824	3862	3936

This page is intentionally left blank

Appendix II

Statewide and Districtwide AID Trees

This page is intentionally left blank

The keys to read the following figures are:

SPEEDLIMIT = Speed Limit in miles (1 mile = 1.6 km)
ADTTOTAL= Average Daily Traffic
POPDEN = Population Density (within a radius of 1.99 miles (3.2 km) of the begin log county)
LANES = No. of Lanes
ROADWAYWIDT = Roadway Width in ft. (1 ft. = .0348 m)
SURFACE_WIDT = Surface Width in ft. (1 ft. = .0348 m)
SLIW = Shoulder Left Inside Width in ft. (1 ft. = .0348 m)
SRIW = Shoulder Right Inside Width in ft. (1 ft. = .0348 m)
MEDIANWIDTH = Median Width in ft. (1 ft. = .0348 m)
VC_RATIO = V/C Ratio
DIST_TO_INTC = Distance to Interchange in miles (1 mile = 1.6 km)
DINJFAT = Injury/ Fatal crash density
DPDO =Property damage only crash density
DTOTAL =Total crash density
DANGLE = Angle crash density
DFIXEDOBJ = Fixed object crash density
DREAREND = Rear end crash density
DSIDESWIPE = Sideswipe crash density
DROADWET =Road wet crash density
DNIGHT = Night crash density
RINJFAT = Injury/ Fatal crash rate
RPDO =Property damage only crash rate
RTOTAL =Total crash rate
RANGLE = Angle crash rate
RFIXEDOBJ = Fixed object crash rate
RREAREND = Rear end crash rate
RSIDESWIPE = Sideswipe crash rate
RROADWET =Road wet crash rate
RNIGHT = Night crash rate

Figure 2.1.Statewide Injury/Fatal Crash Density

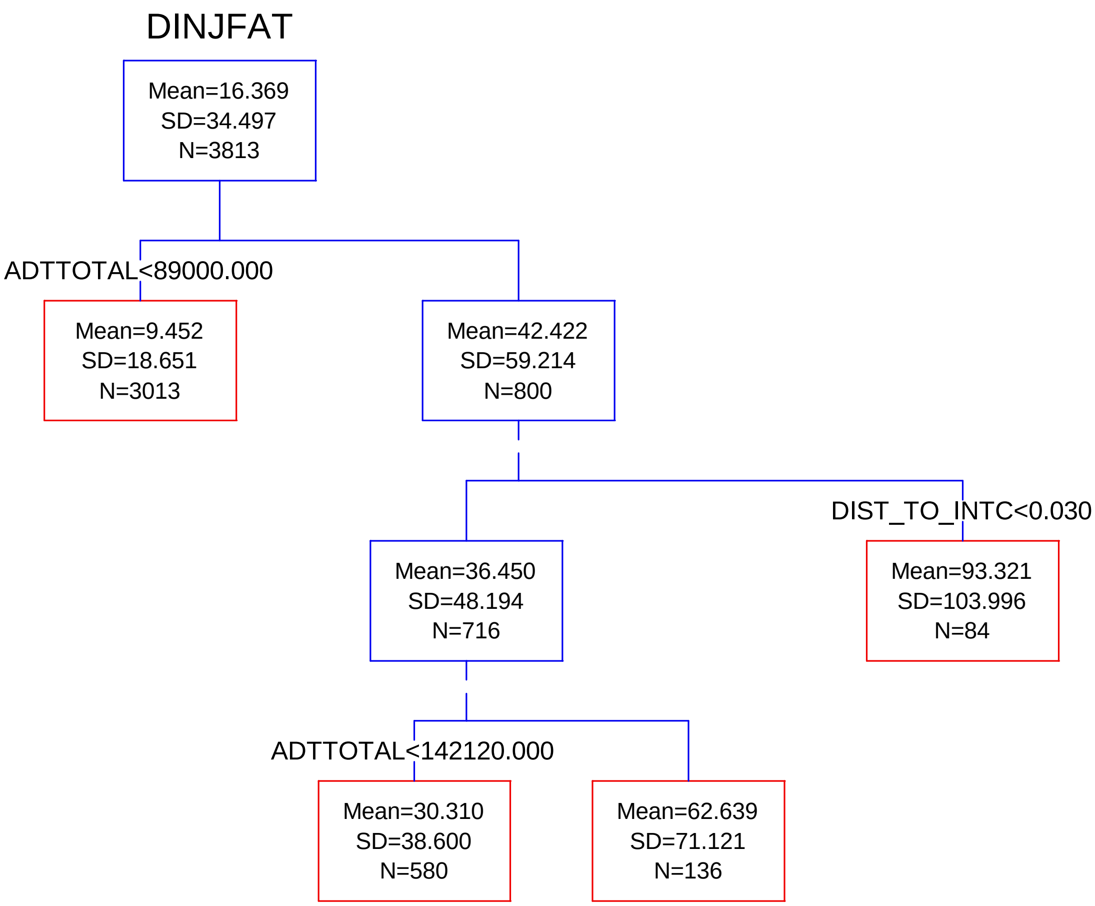


Figure 2.2.Statewide Property damage only Crash Density

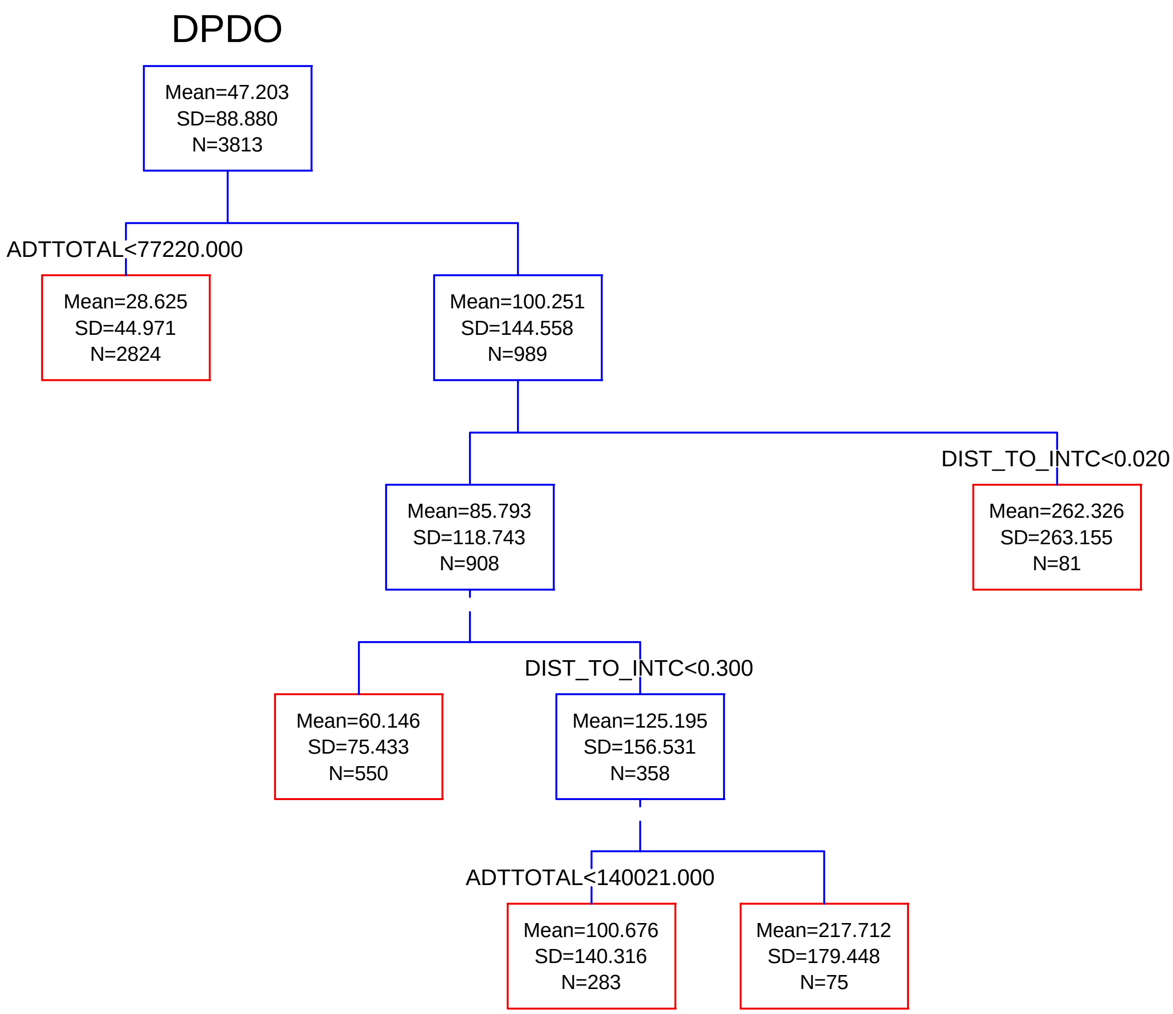


Figure 2.3.Statewide Total Crash Density

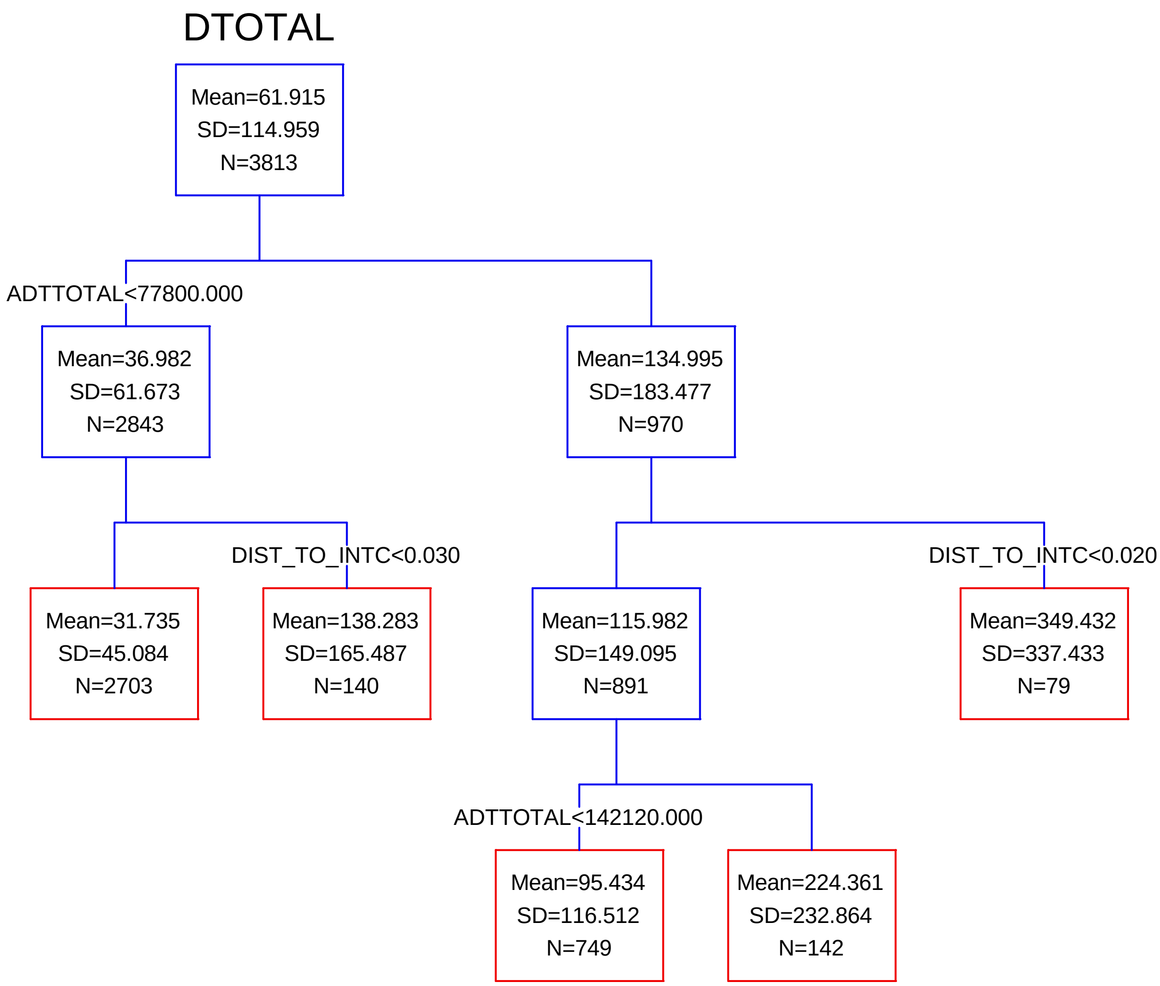


Figure 2.4. Statewide Angle Crash Density

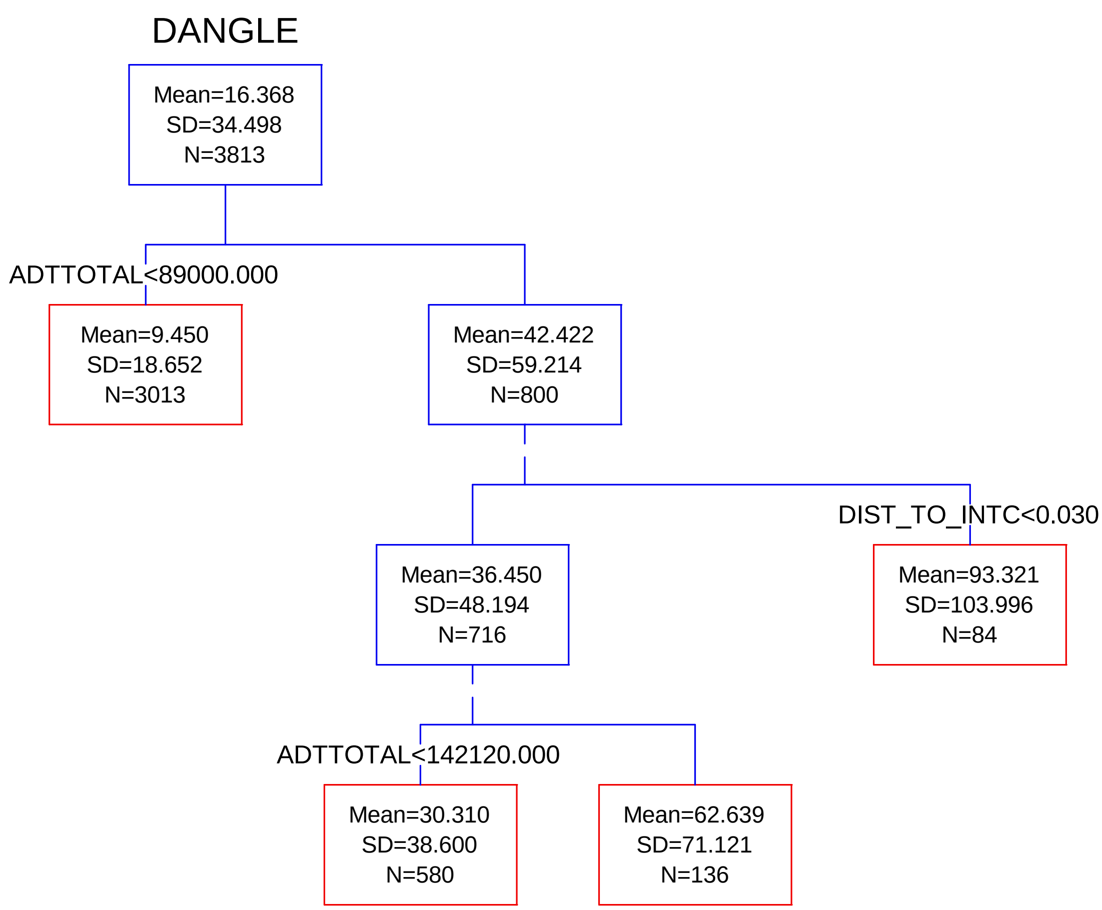


Figure 2.5. Statewide Fixed Object Crash Density

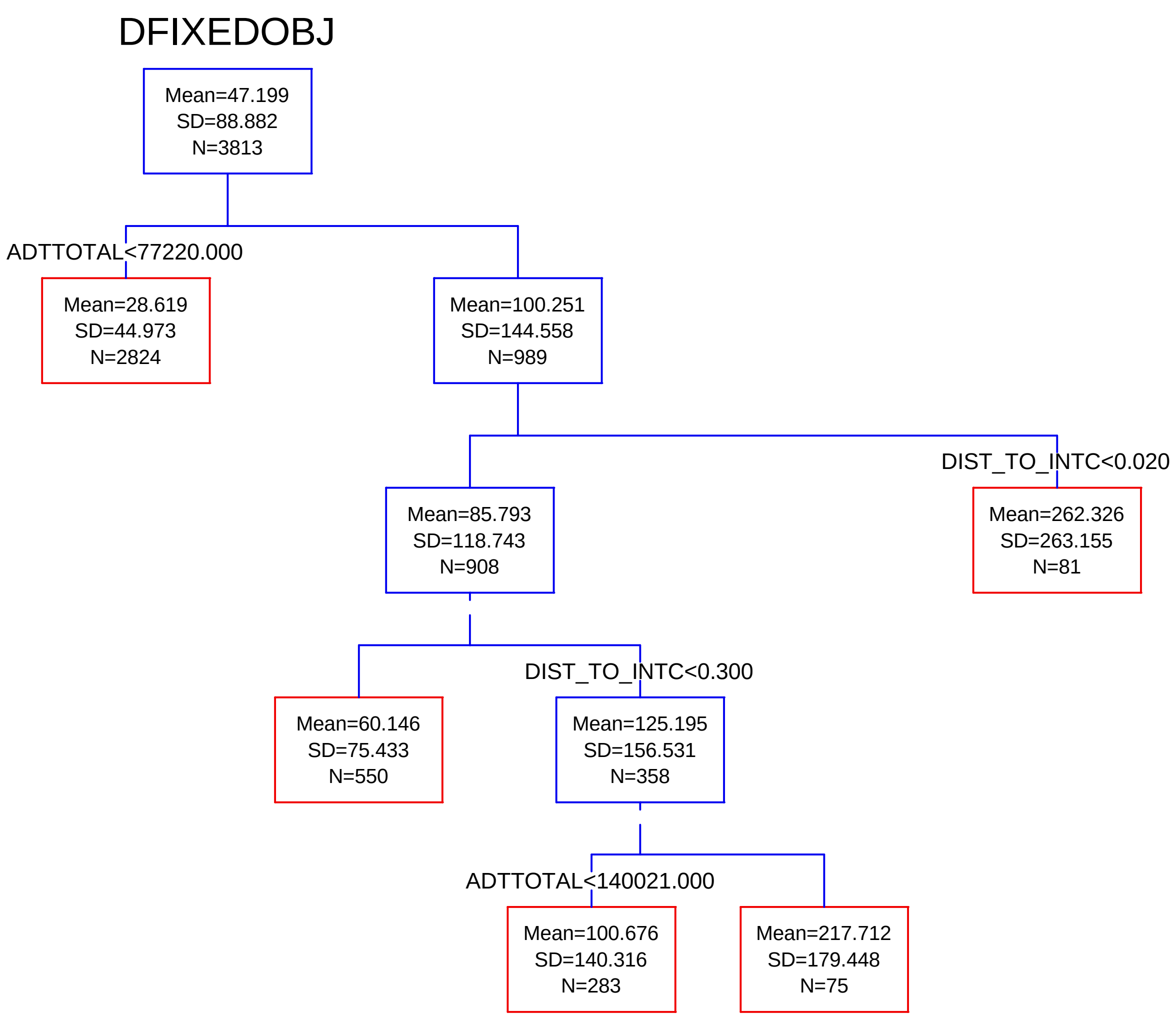


Figure 2.6. Statewide Rear end Crash Density

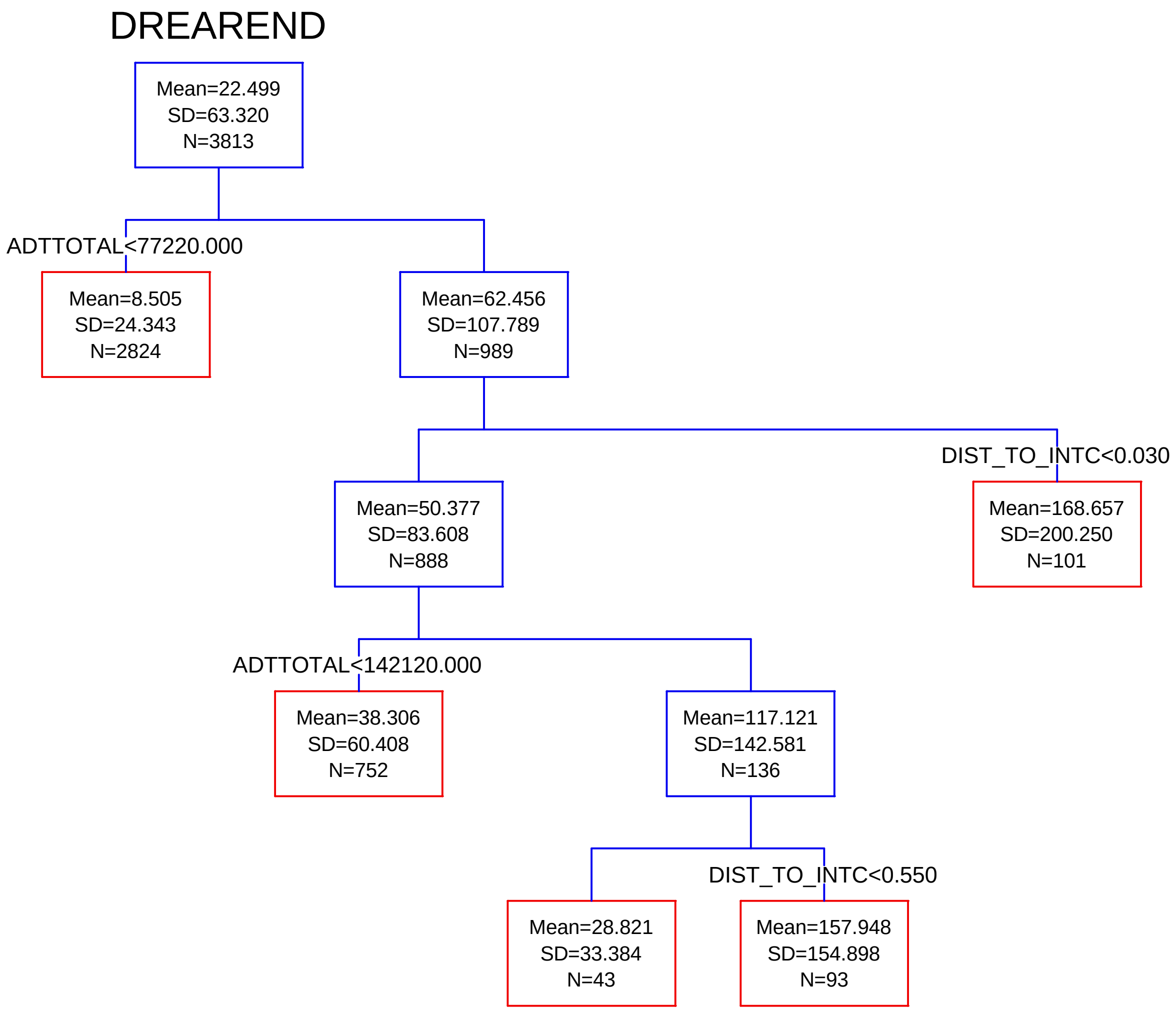


Figure 2.7. Statewide Sideswipe Crash Density

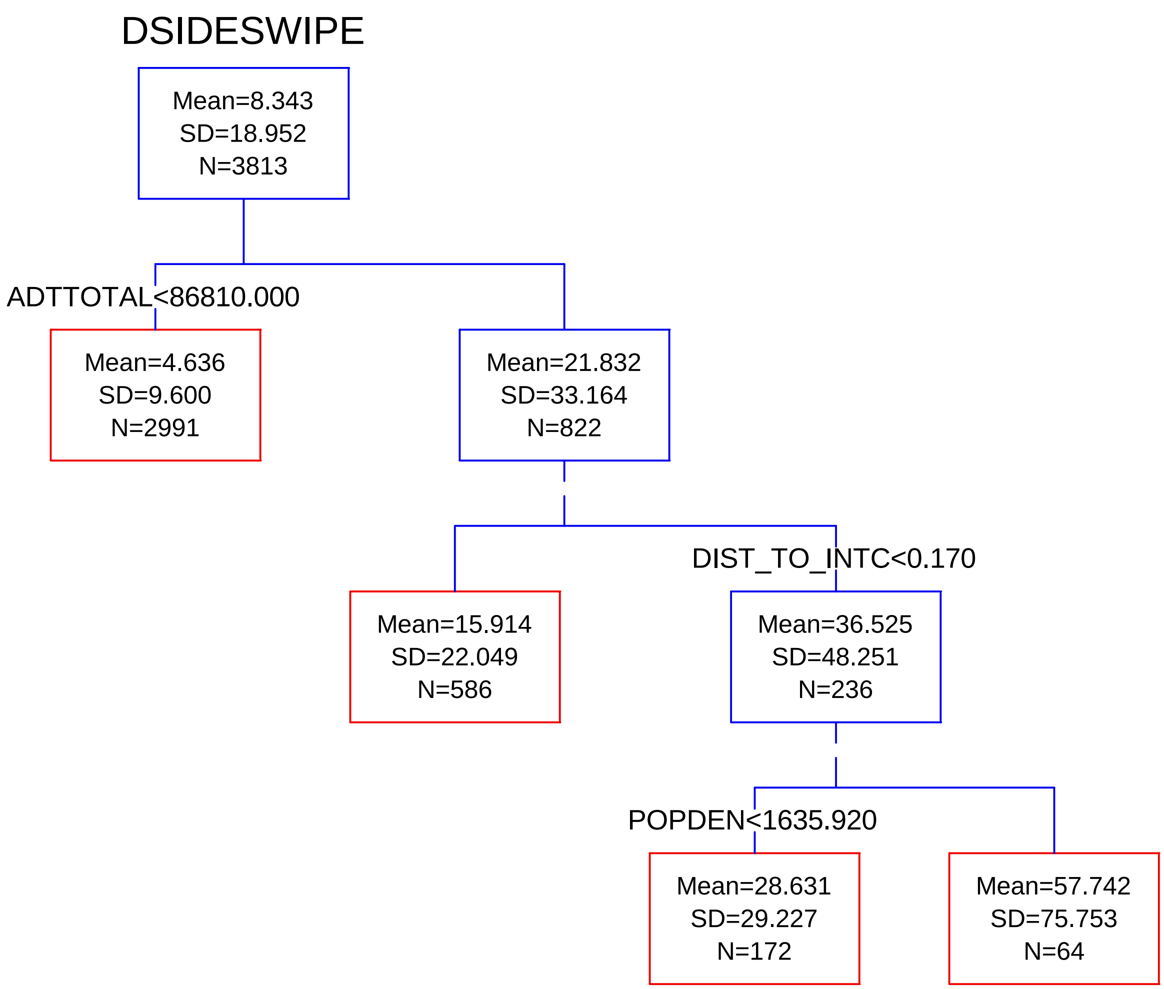


Figure 2.8. Statewide Road wet Crash Density

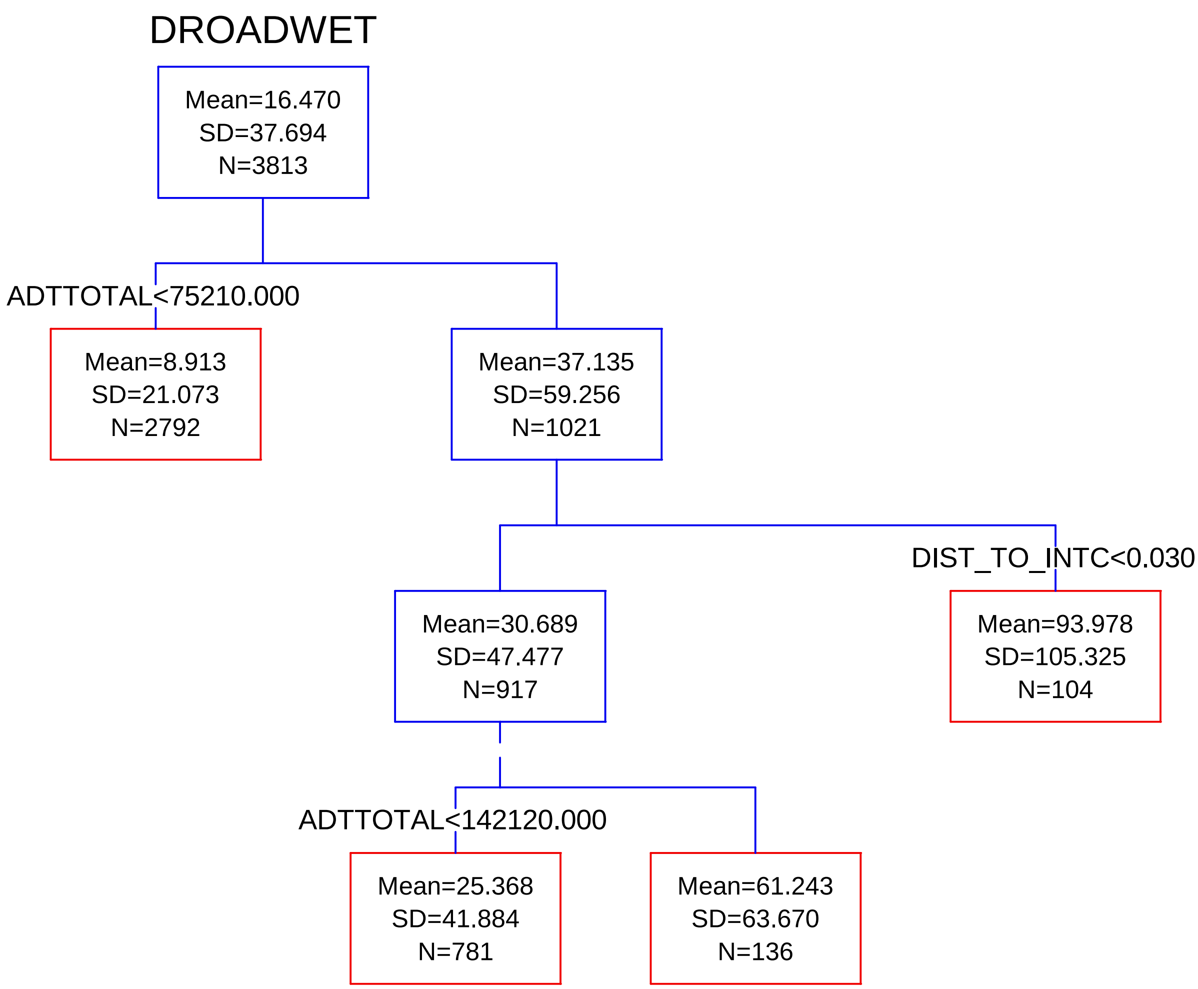


Figure 2.9. Statewide Night Crash Density

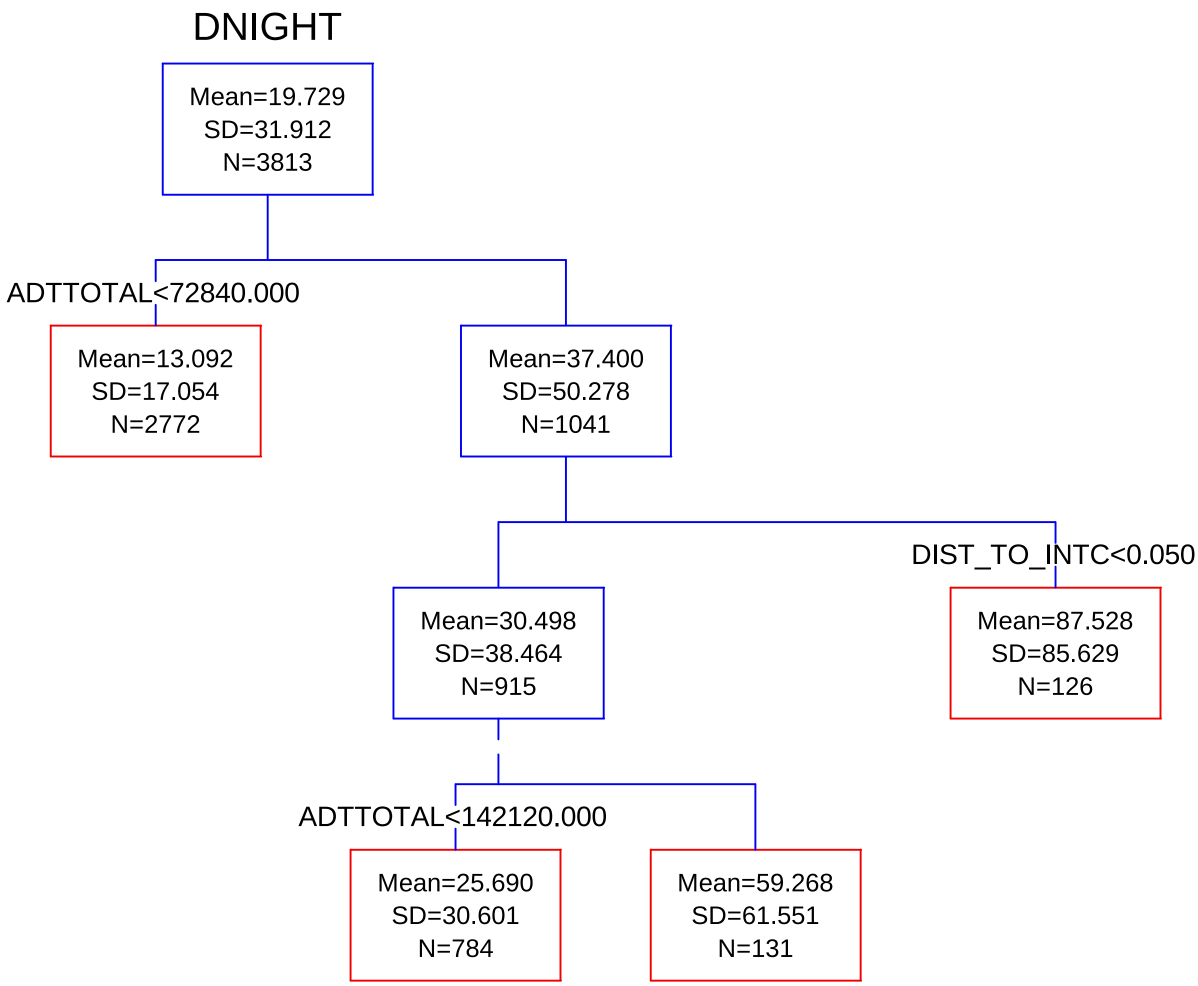


Figure 2.10.Statewide Injury/Fatal Crash Rate

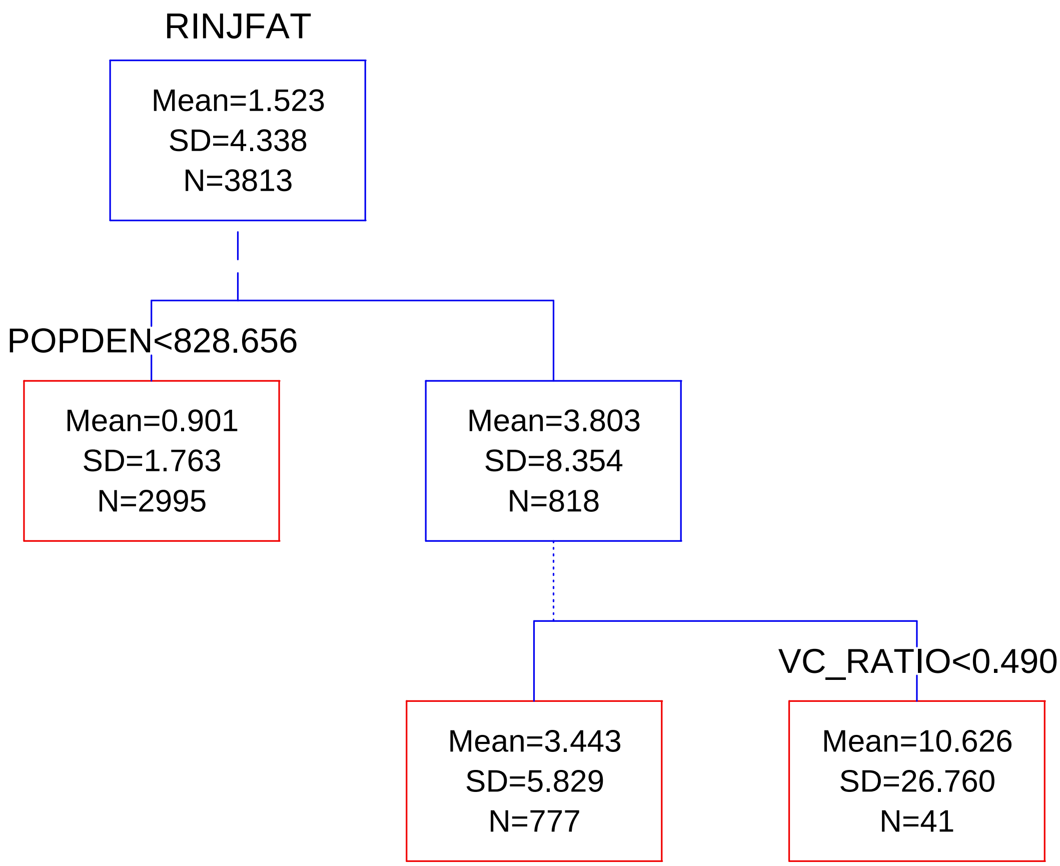


Figure 2.11.Statewide Property damage only Crash Rate

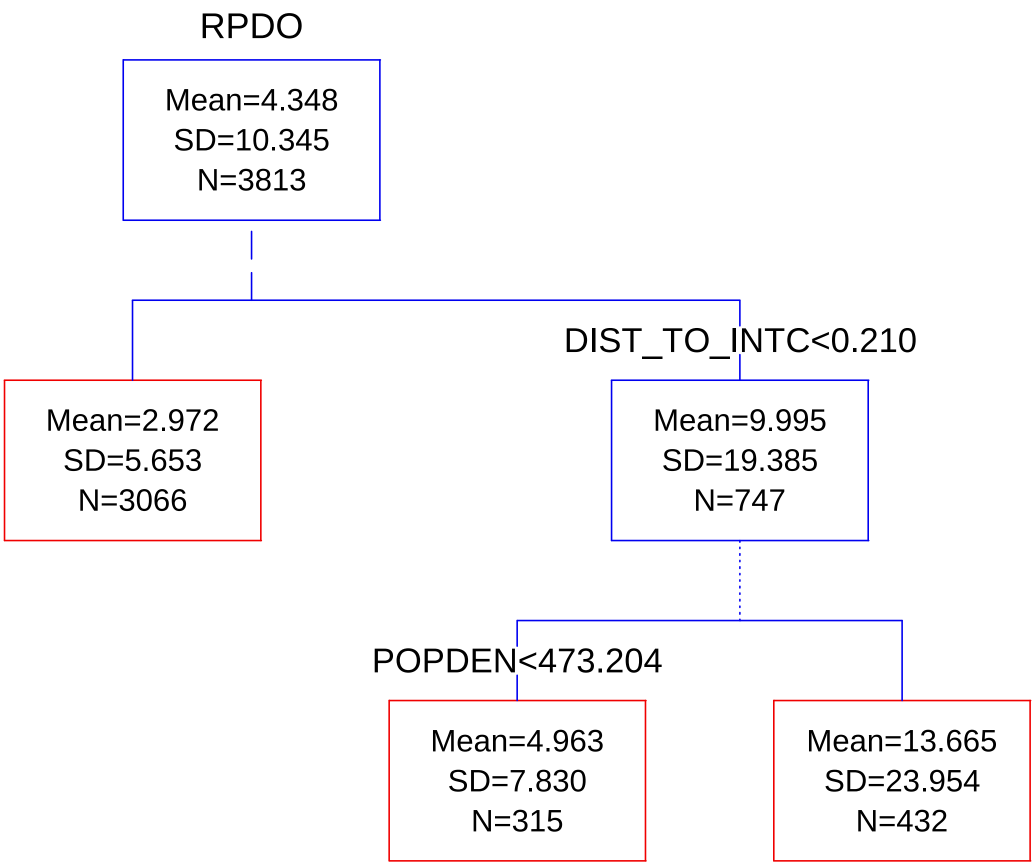


Figure 2.12.Statewide Total Crash Rate

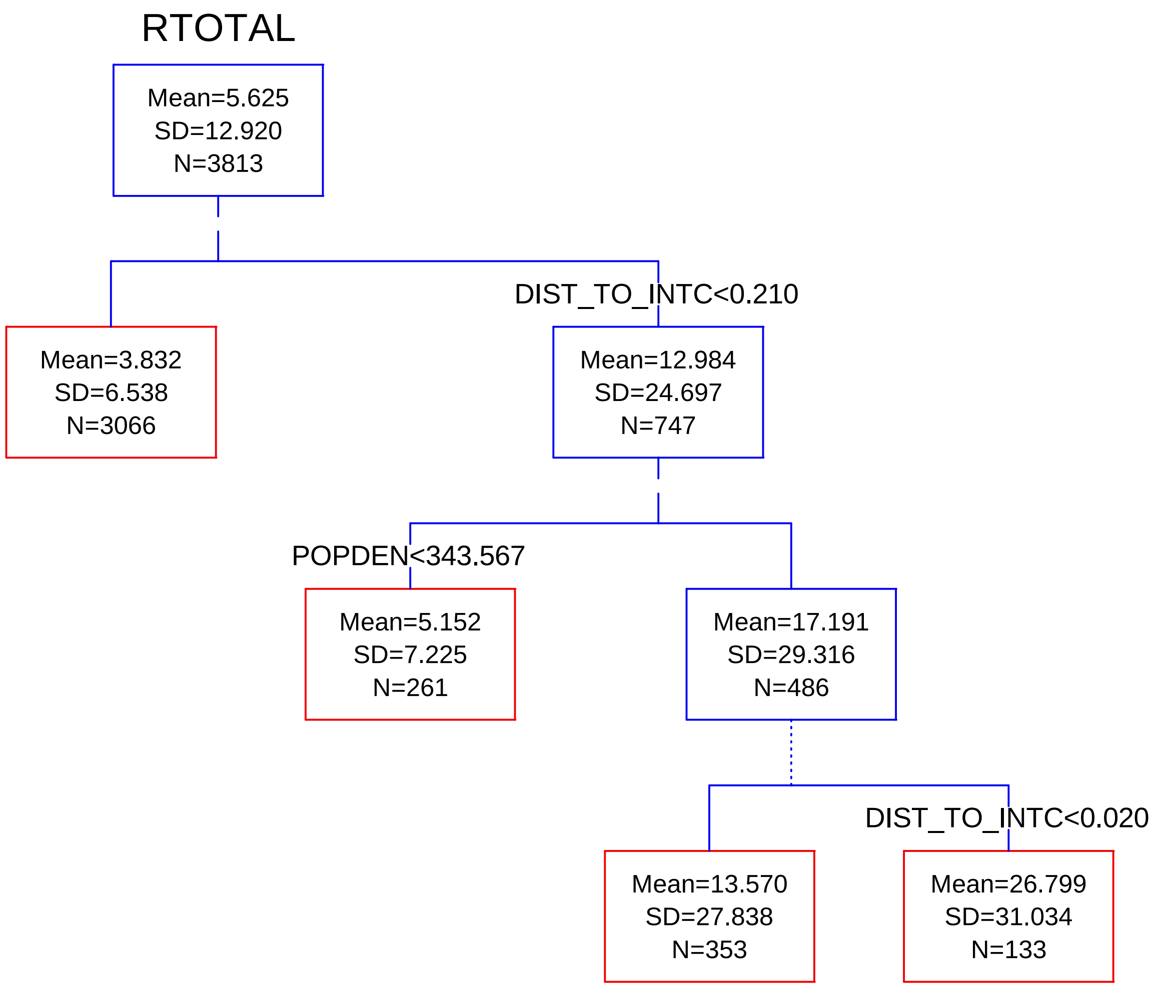


Figure 2.13.Statewide Angle Crash Rate

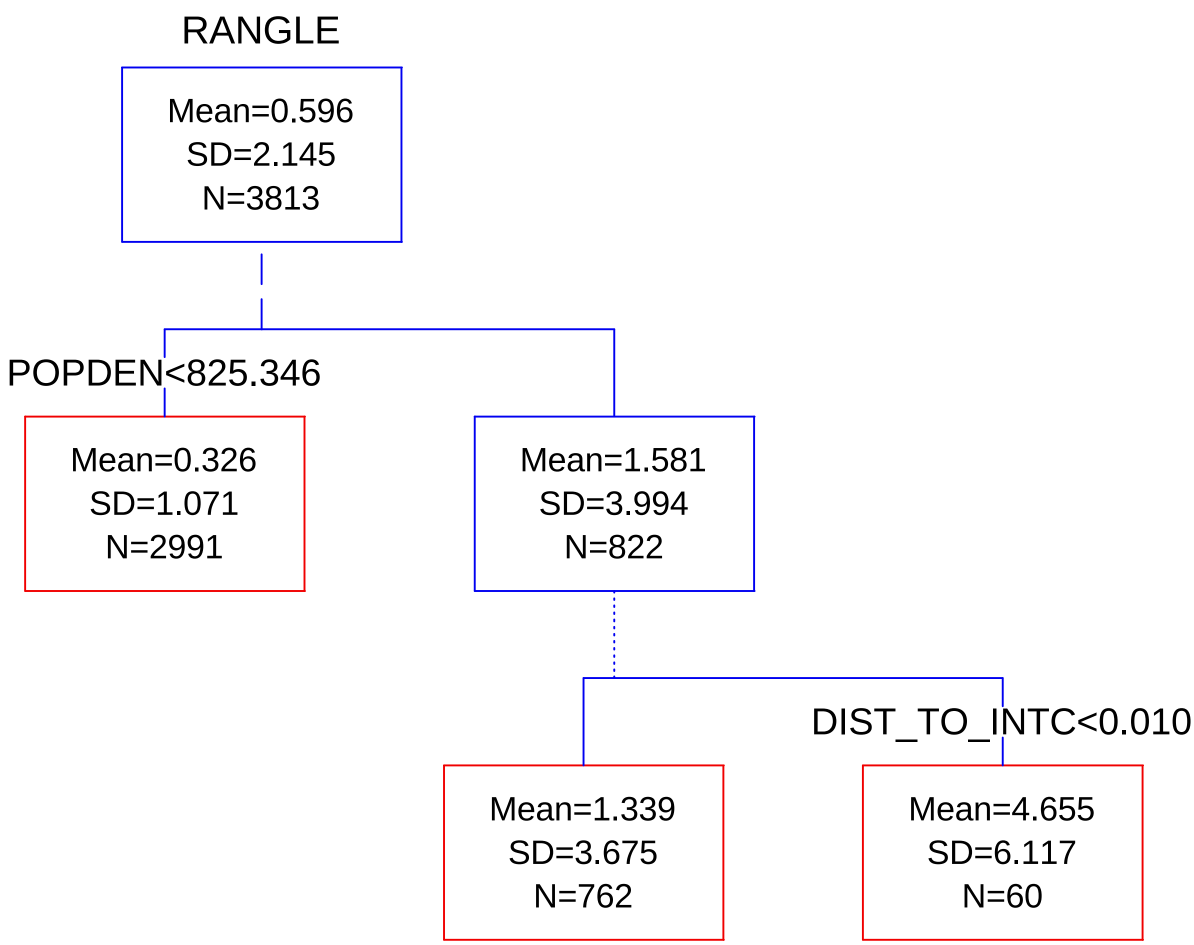


Figure 2.14.Statewide Fixed Object Crash Rate

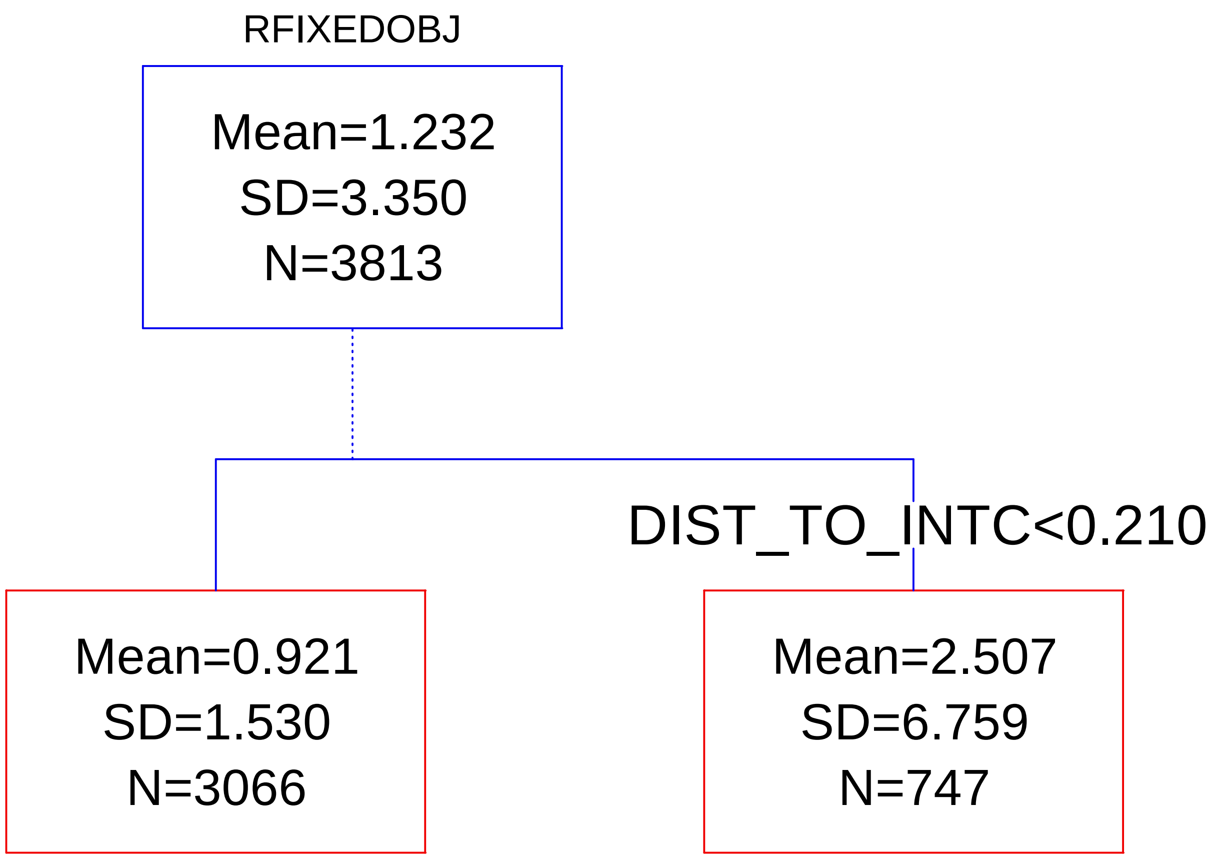


Figure 2.15.Statewide Rear end Crash Rate

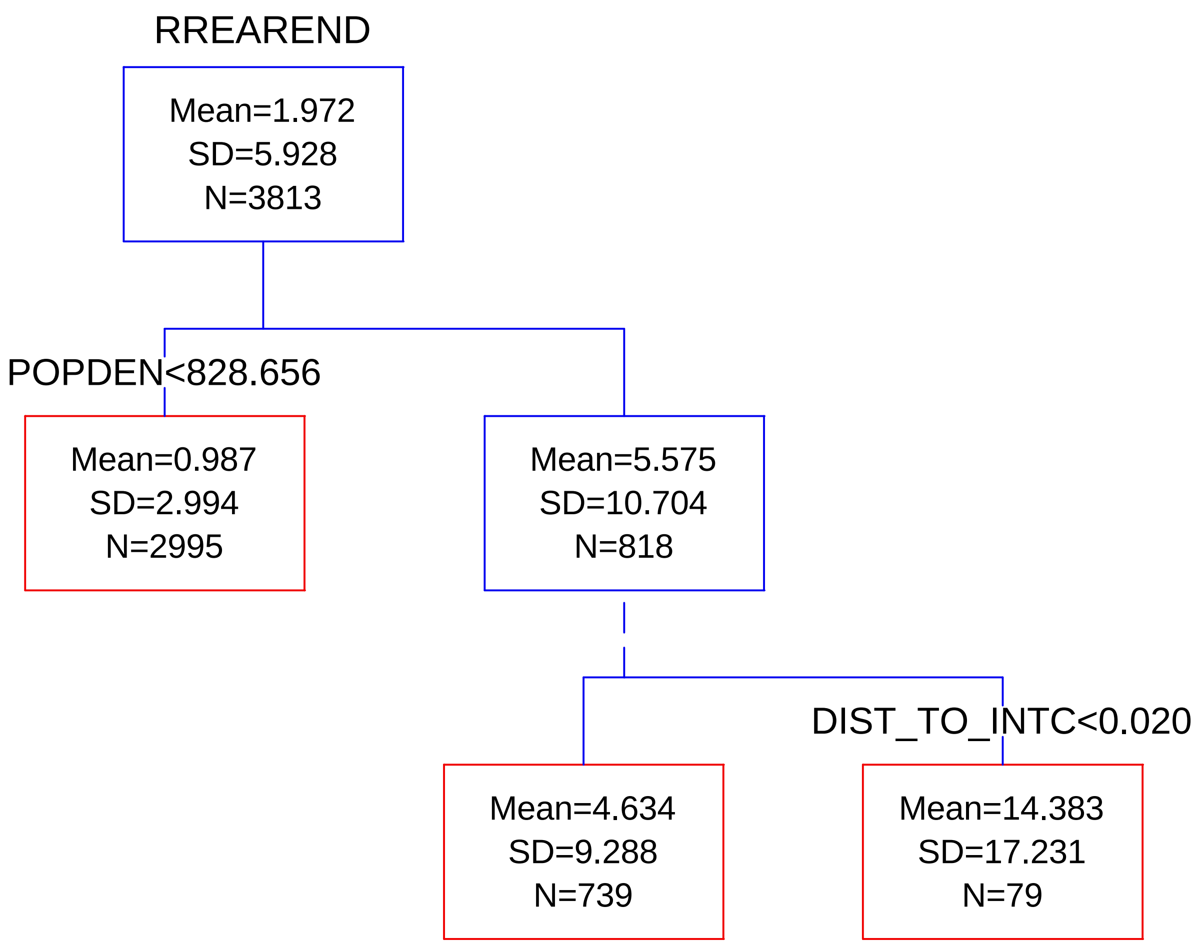


Figure 2.16.Statewide Sideswipe Crash Rate

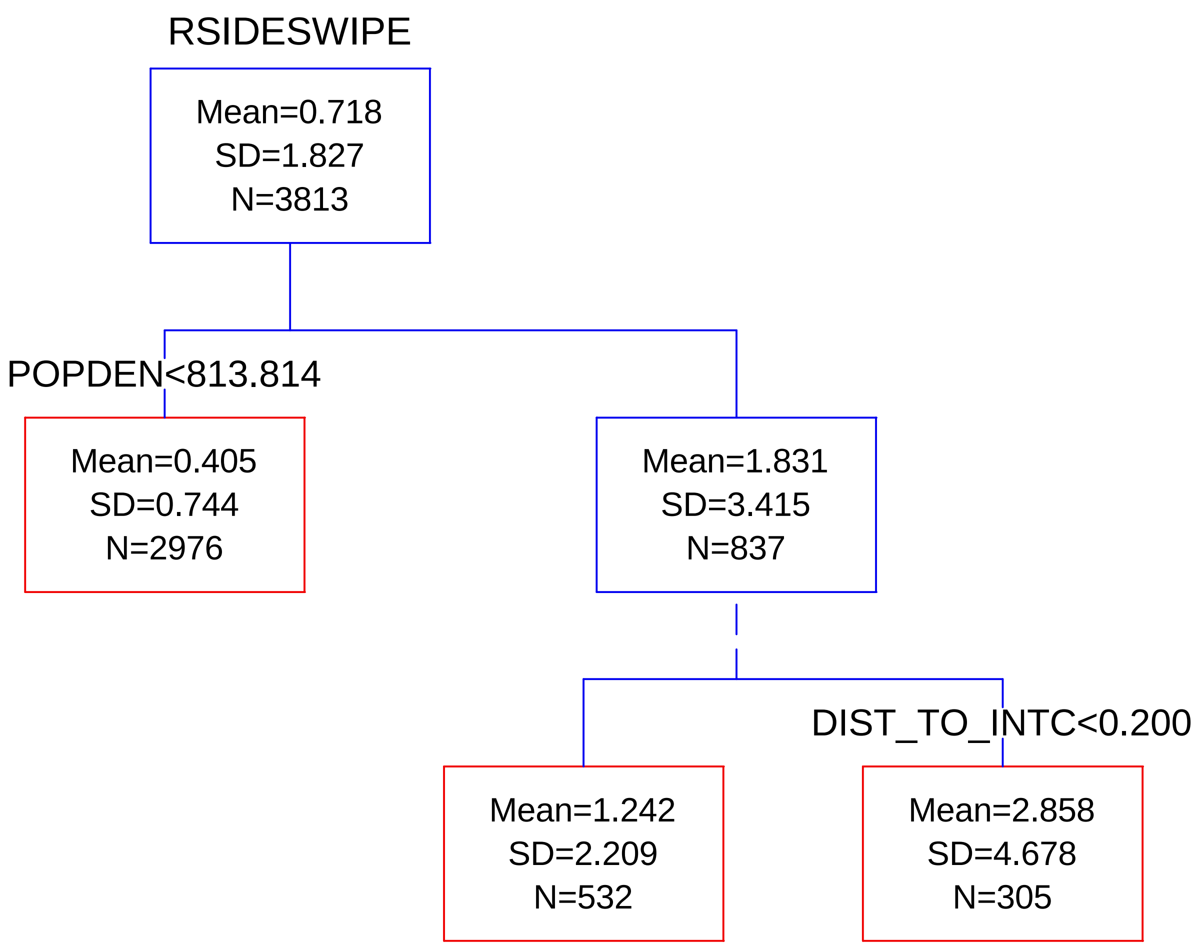


Figure 2.17.Statewide Road wet Crash Rate

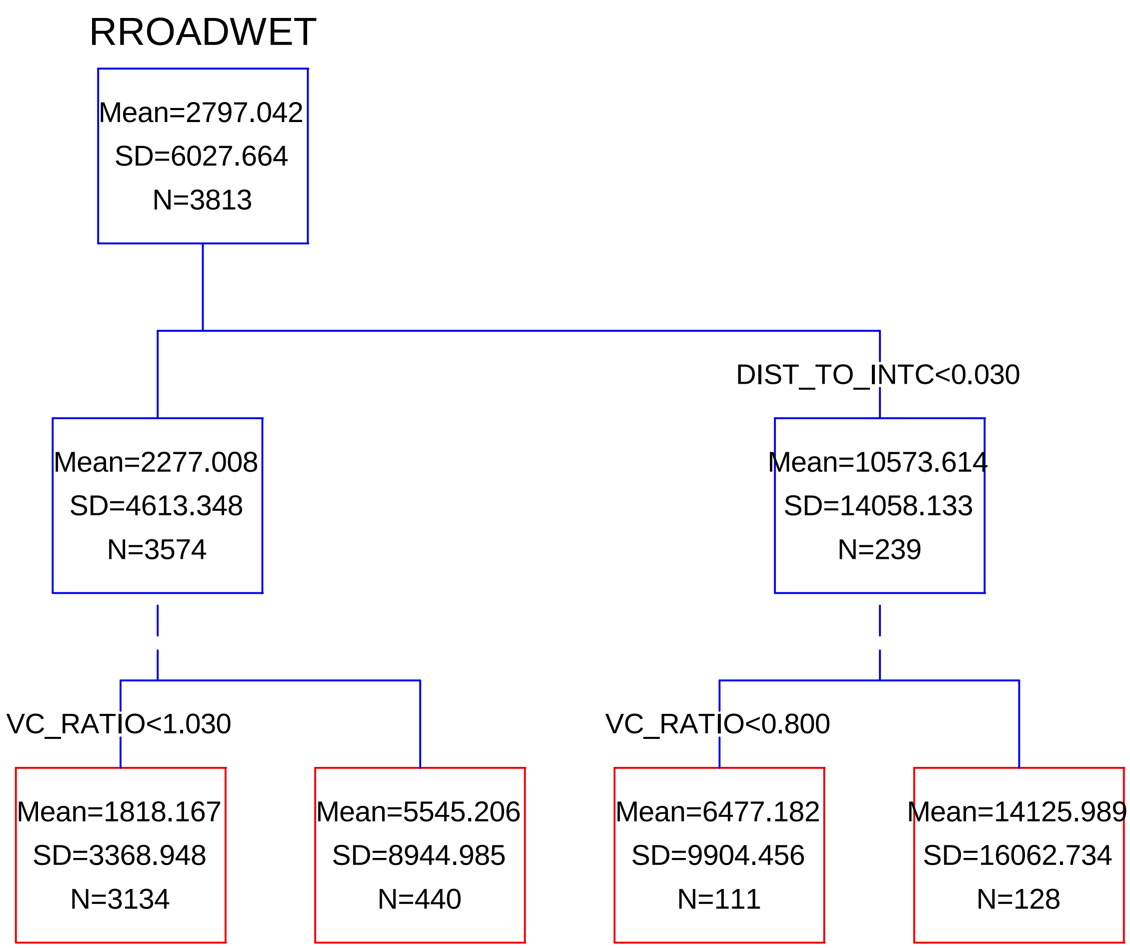
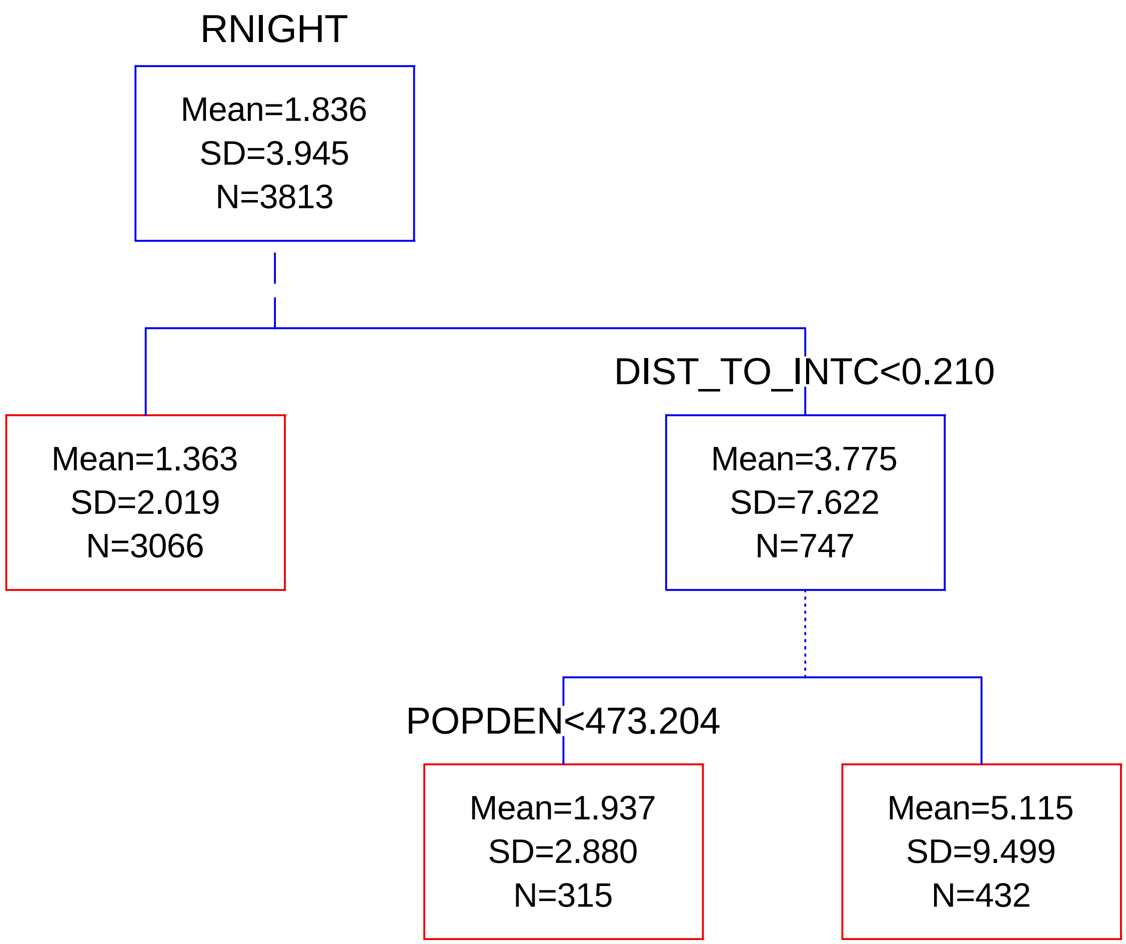


Figure 2.18.Statewide Night Crash Rate



District 1 AID Trees

Figure 2.19.District 1 Injury/Fatal Crash Density

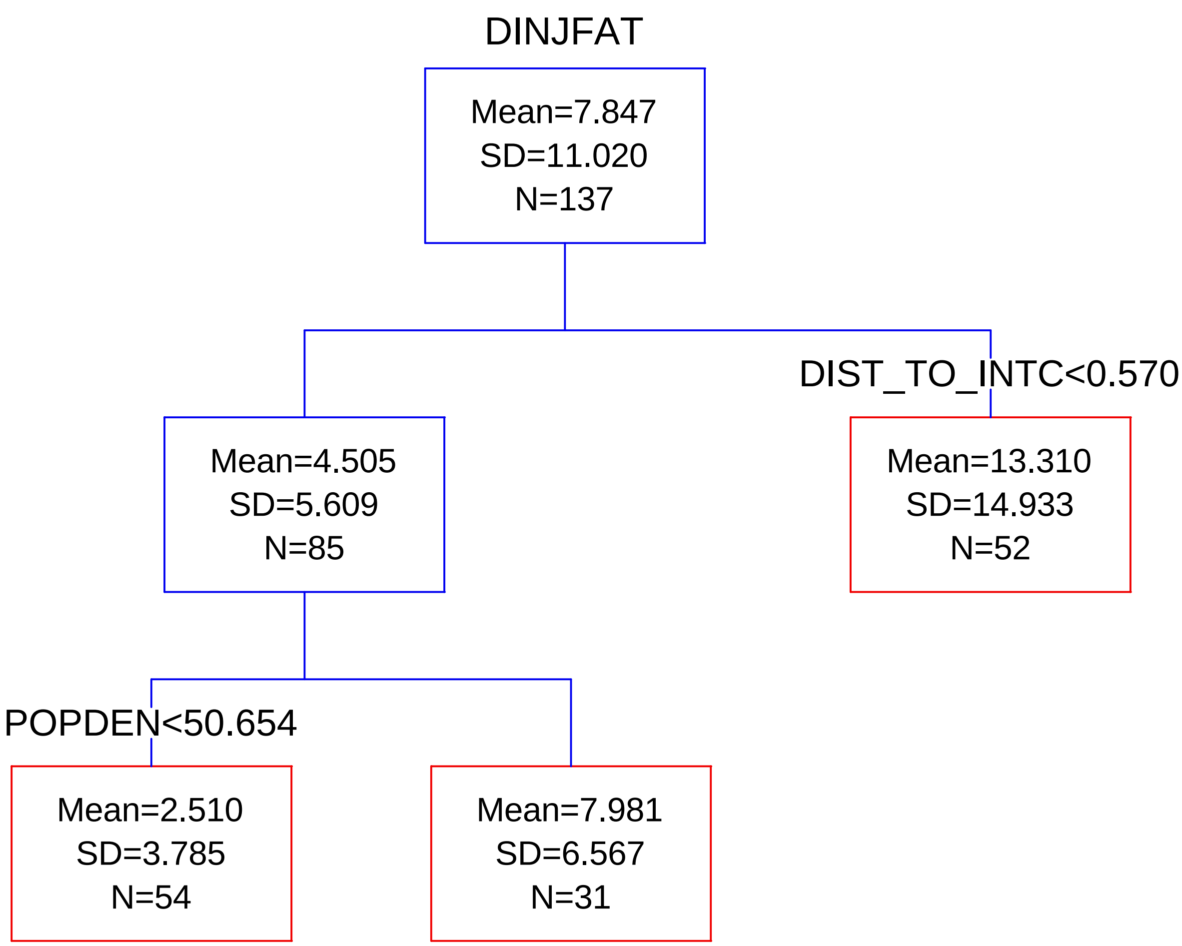


Figure 2.20.District 1 Property damage only Crash Density

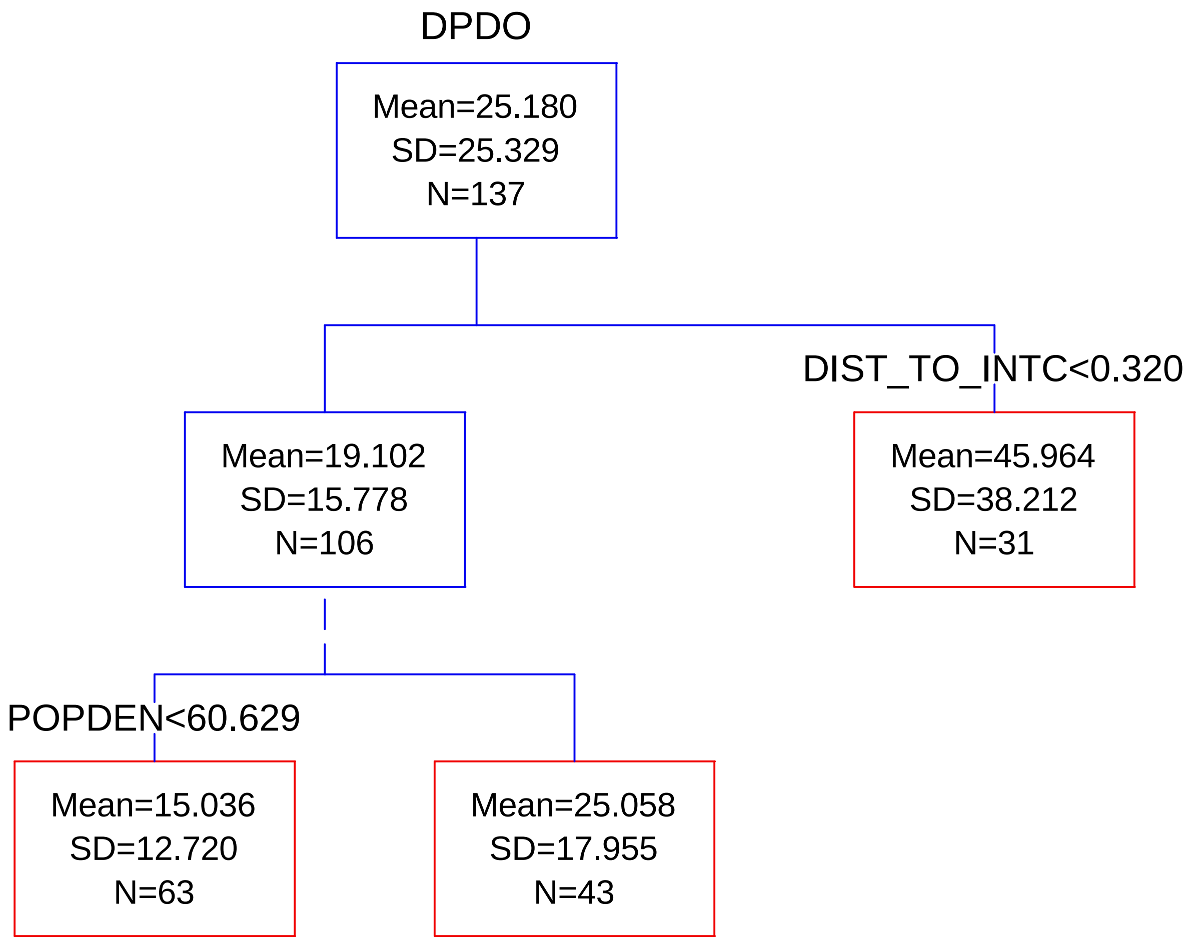


Figure 2.21.District 1 Total Crash Density

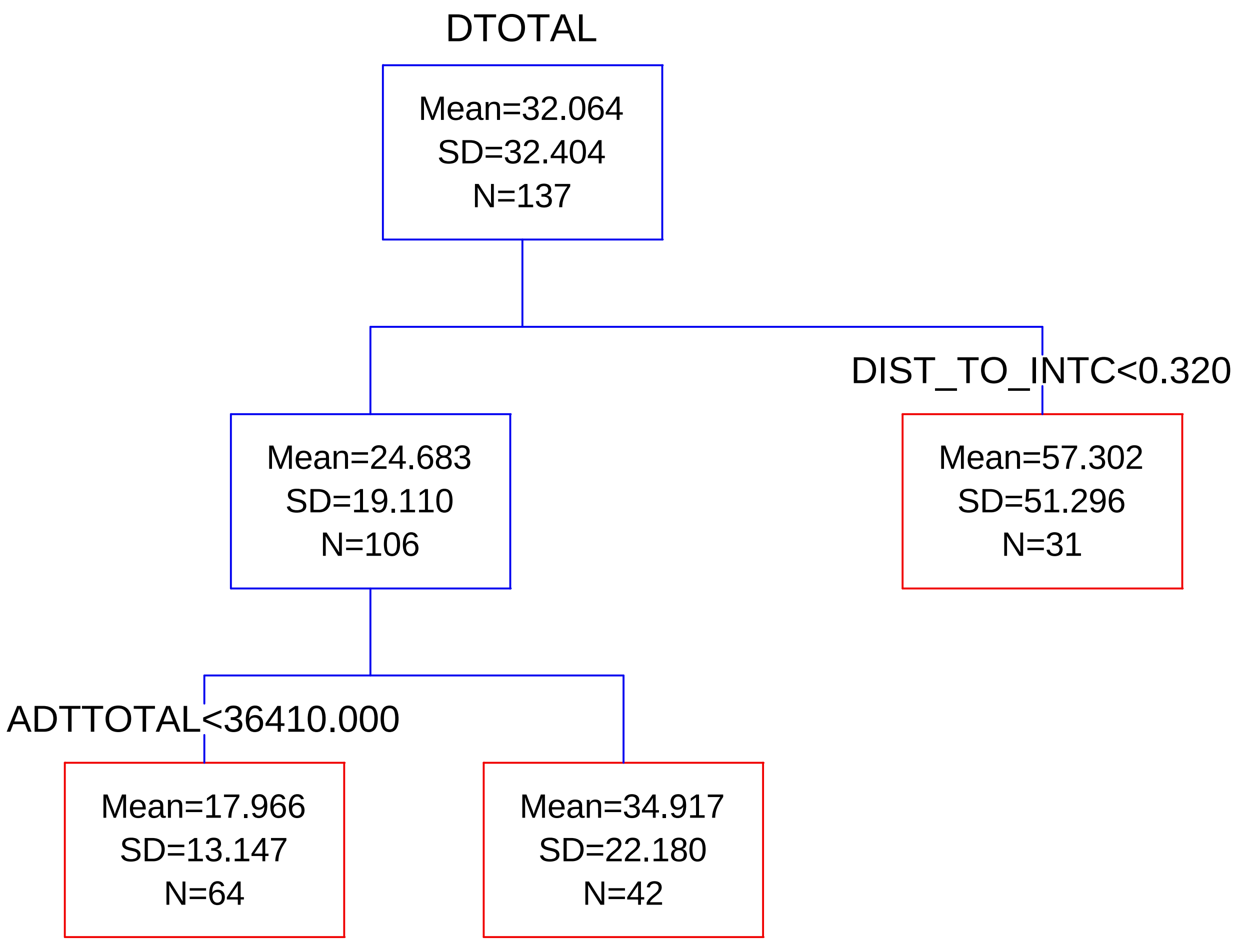


Figure 2.22.District 1 Angle Crash Density

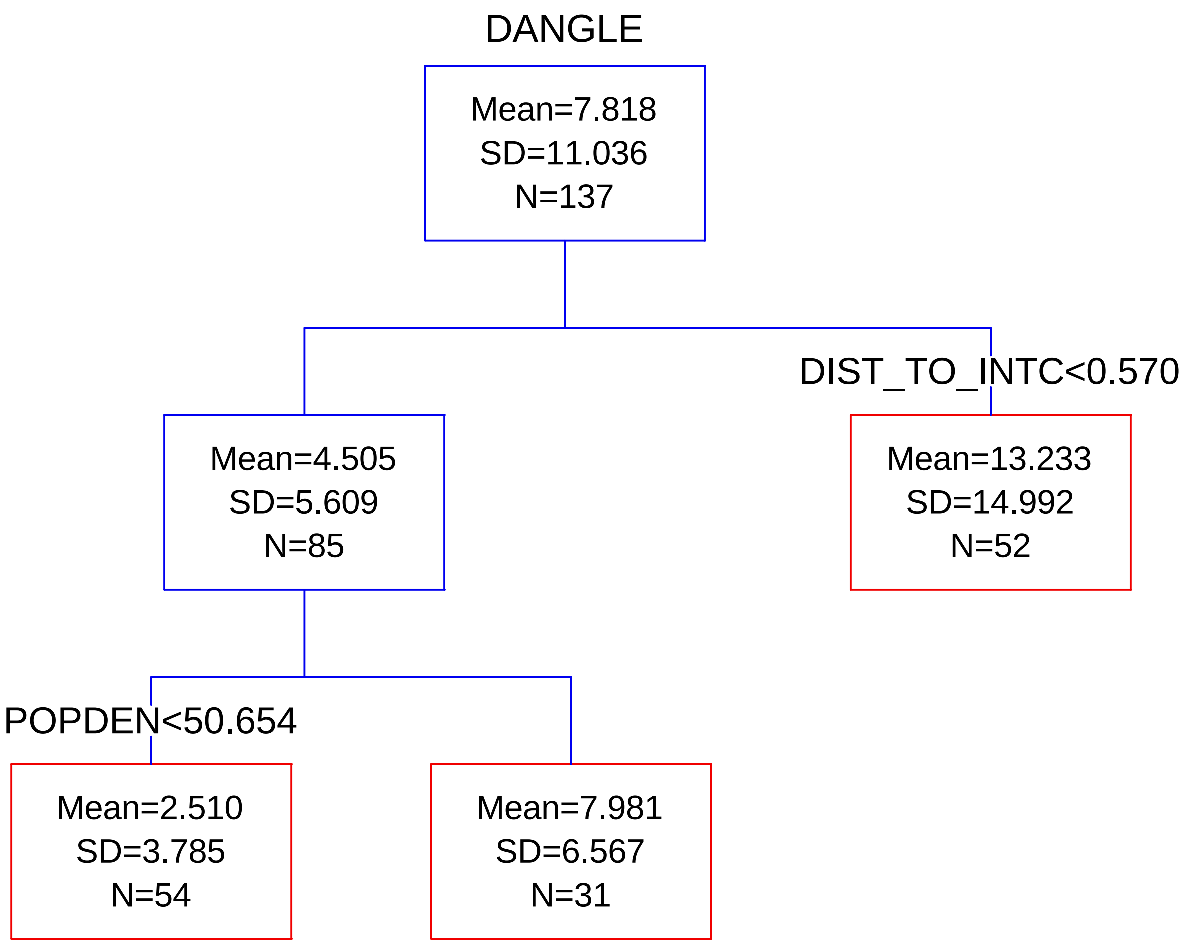


Figure 2.23.District 1 Fixed Object Crash Density

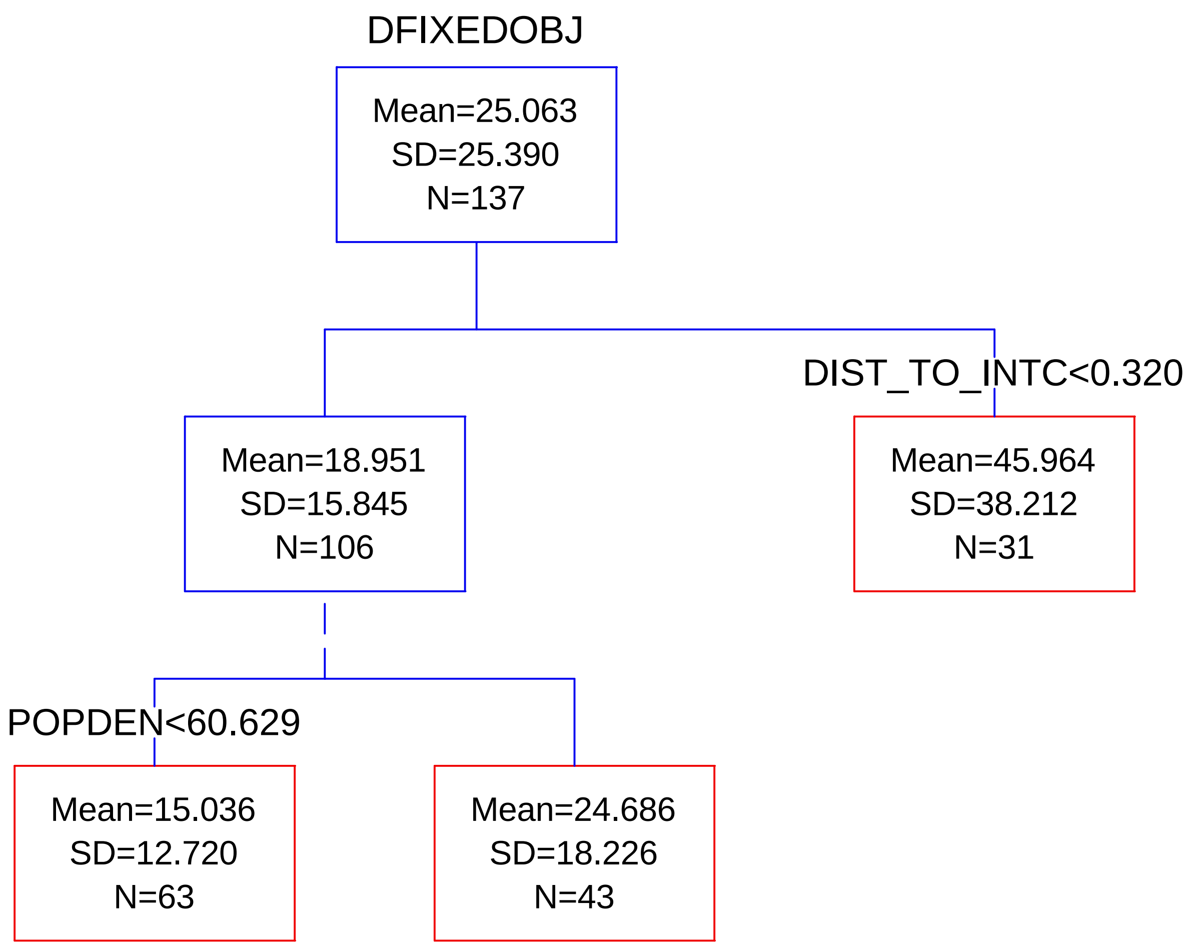


Figure 2.24.District 1 Rear end Crash Density

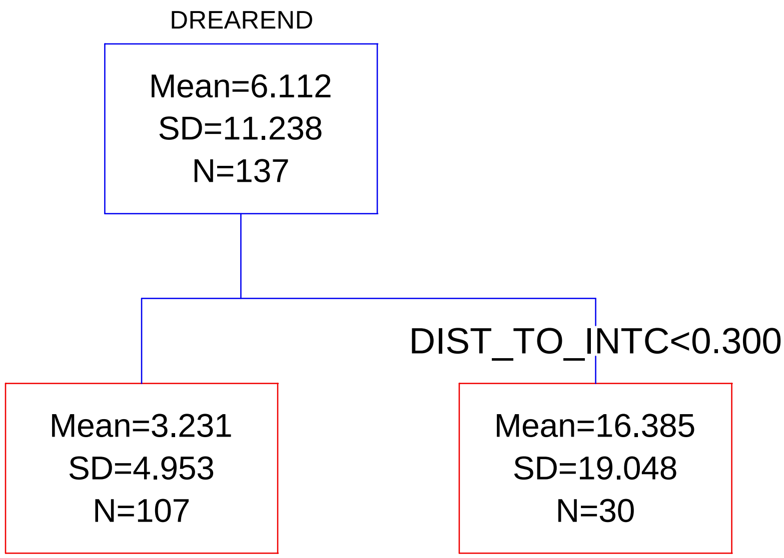


Figure 2.25.District 1 Sideswipe Crash Density

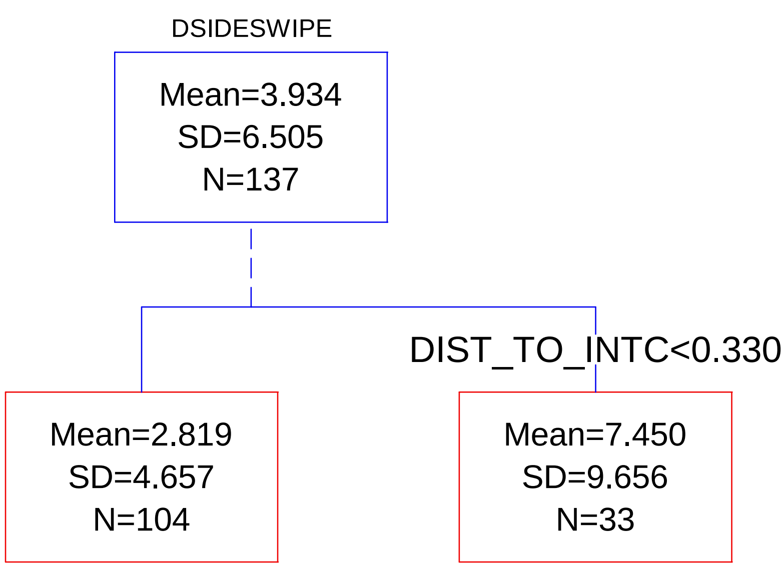


Figure 2.26.District 1 Road wet Crash Density

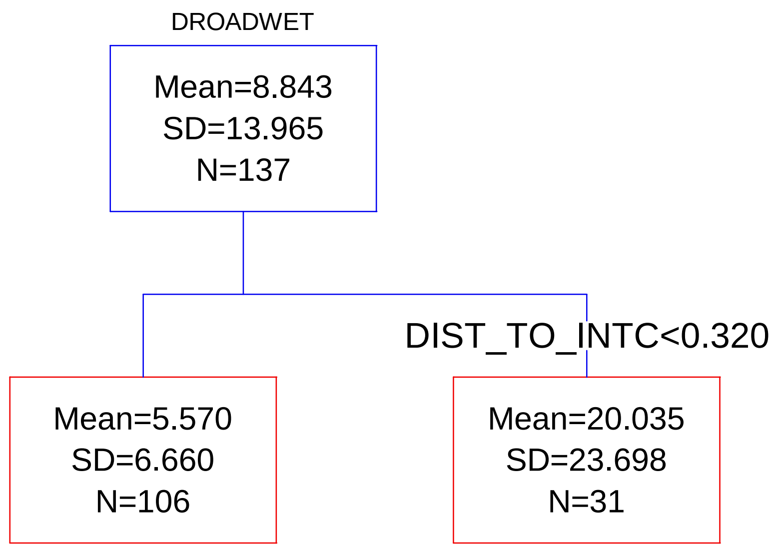


Figure 2.27.District 1 Night Crash Density

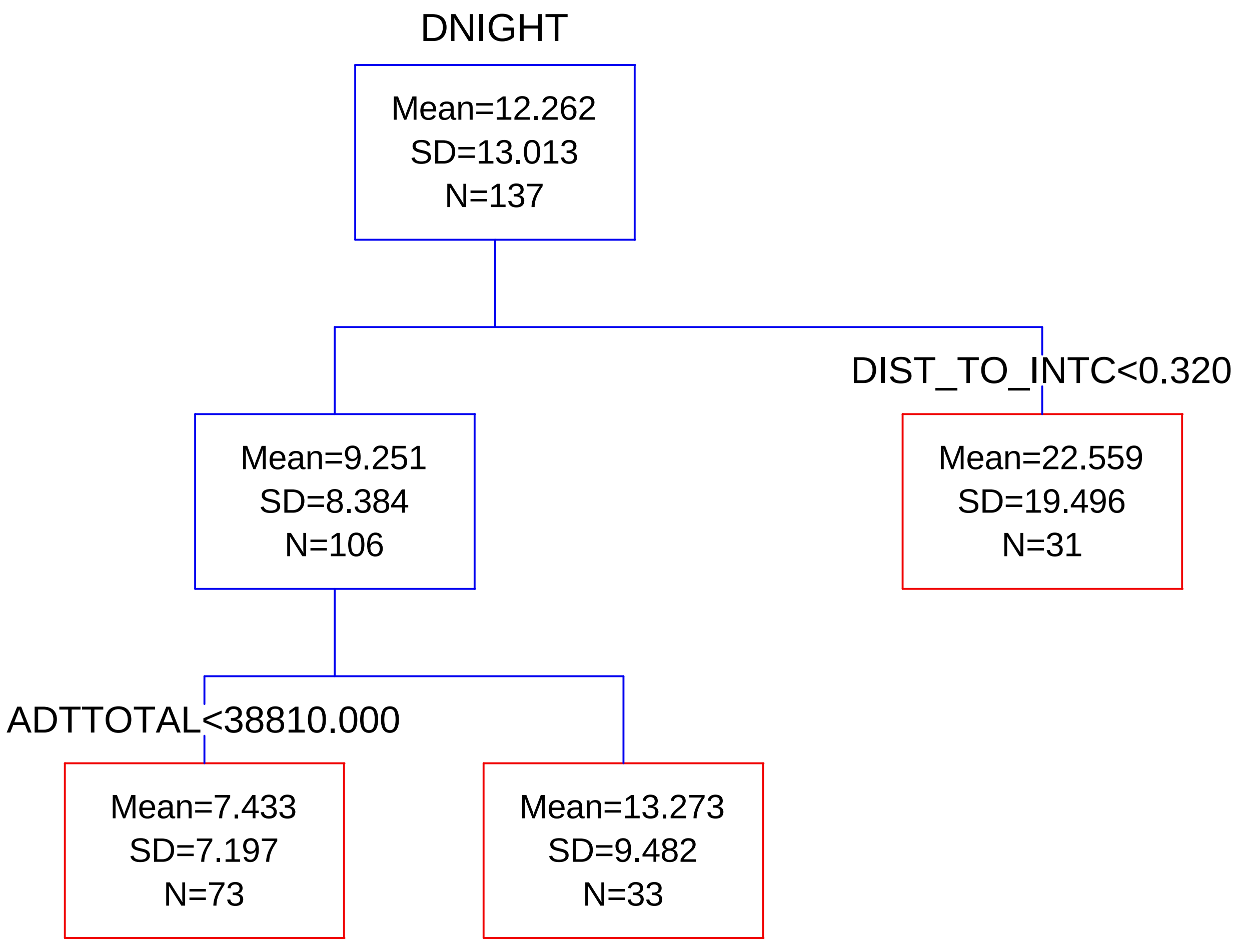


Figure 2.28.District 1 Injury/Fatal Crash Rate

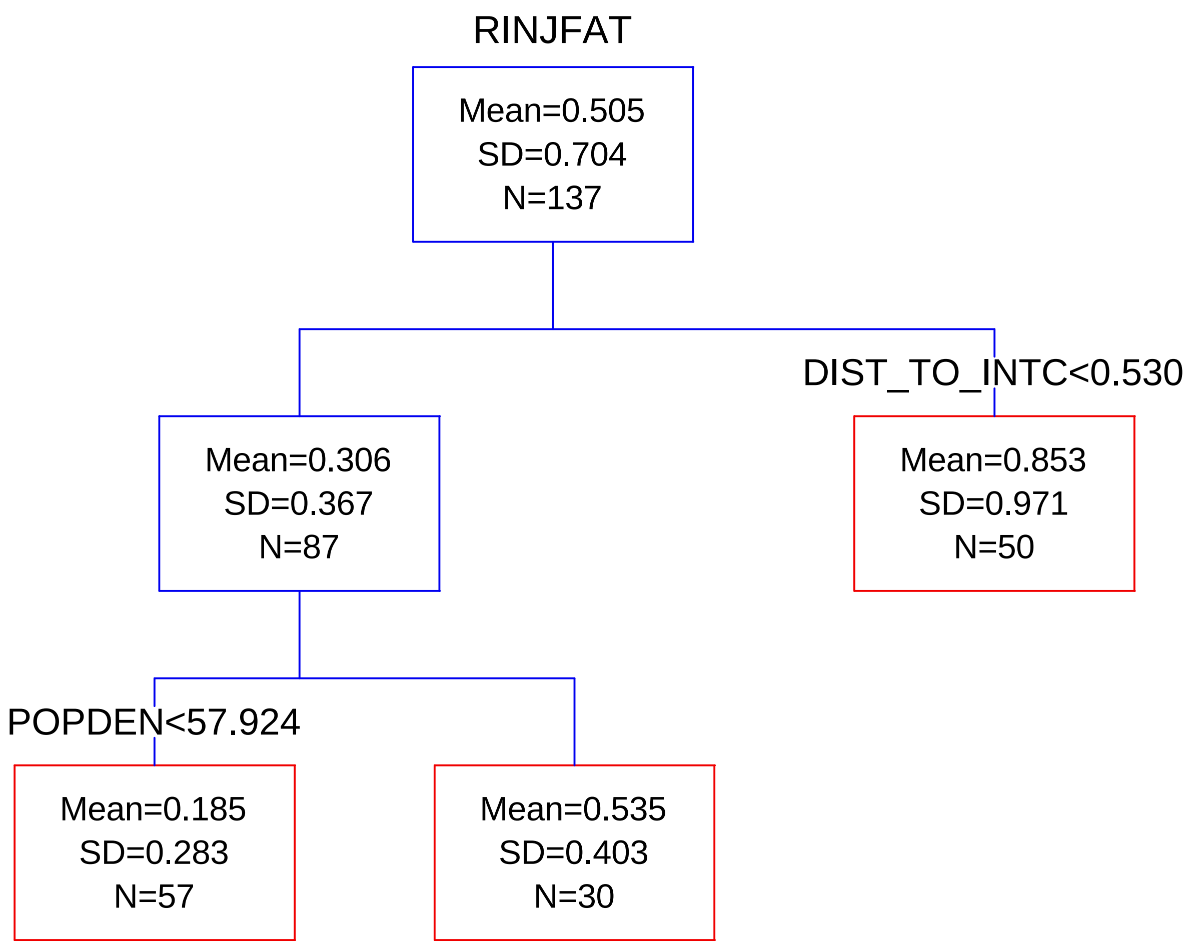


Figure 2.29.District 1 Property damage only Crash Rate

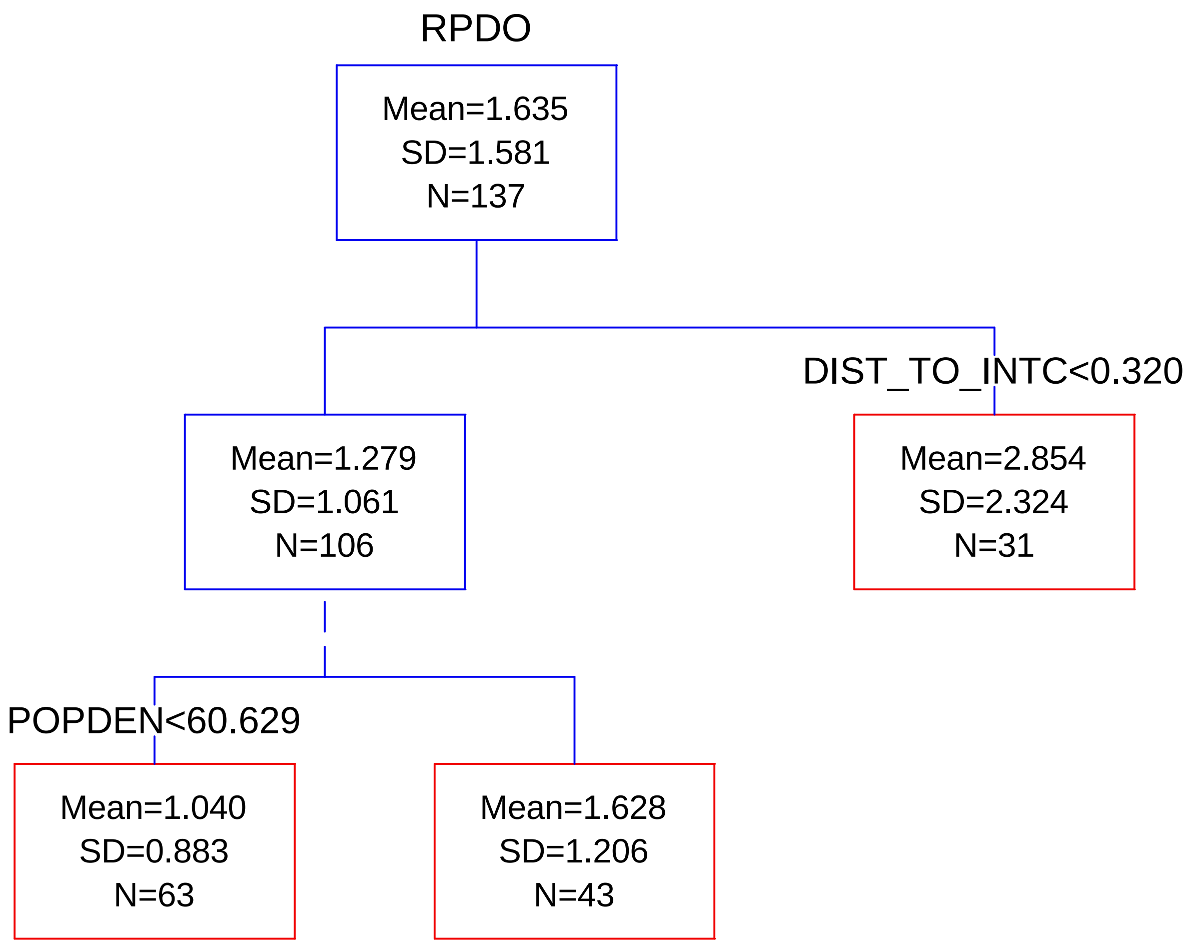


Figure 2.30.District 1 Total Crash Rate

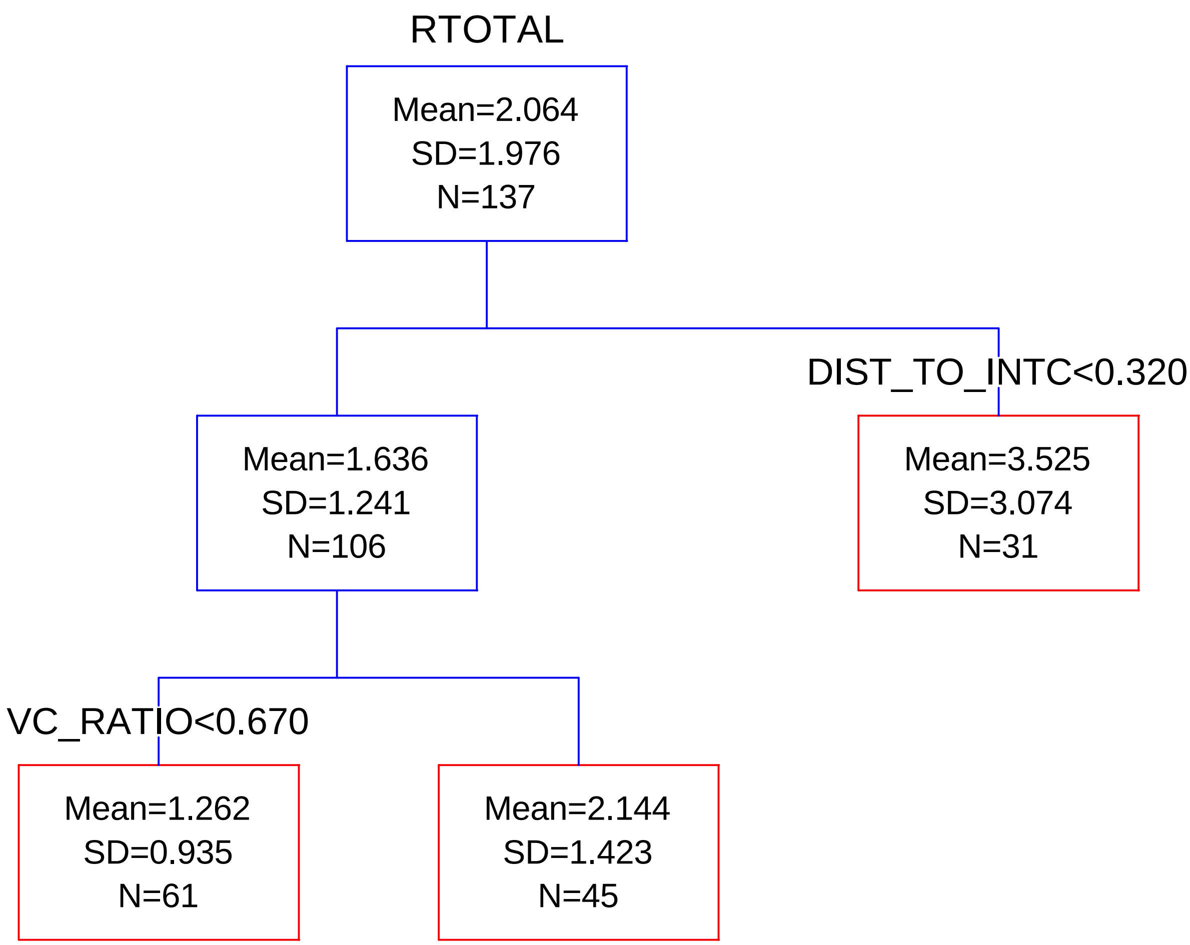


Figure 2.31.District 1 Angle Crash Rate

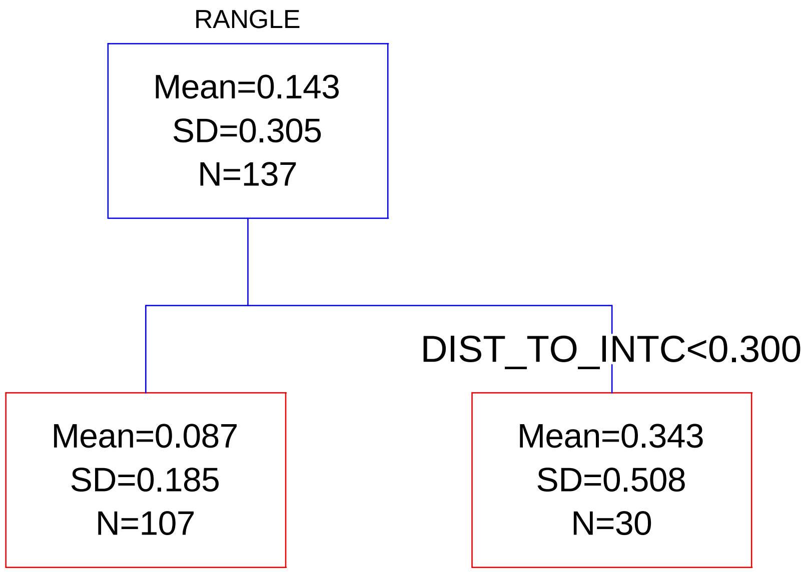


Figure 2.32.District 1 Fixed Object Crash Rate

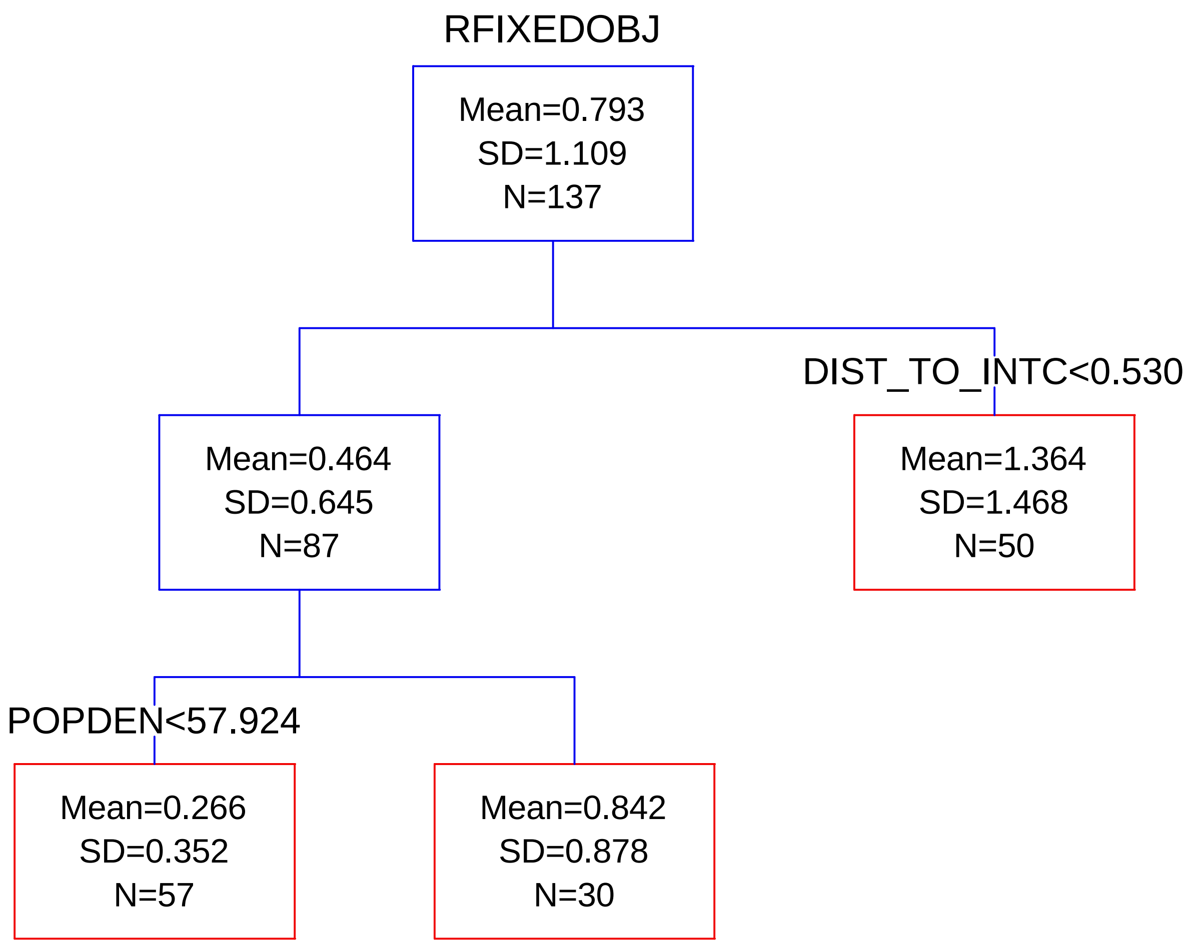


Figure 2.33.District 1 Rear end Crash Rate

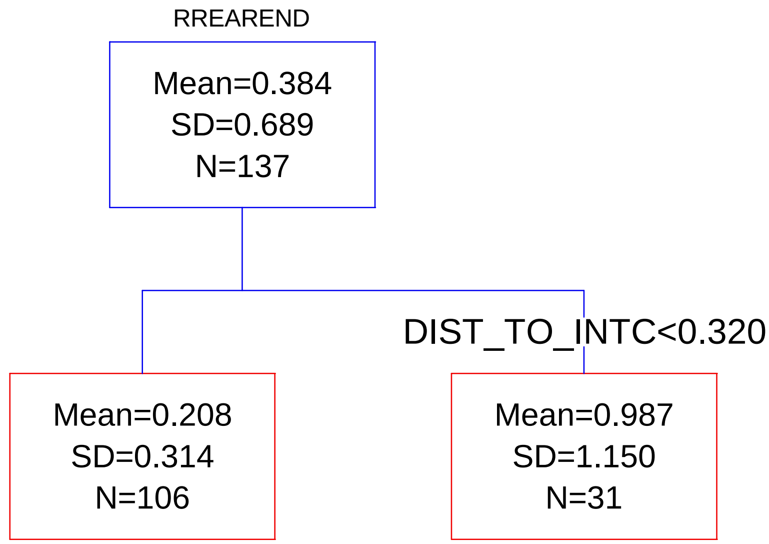


Figure 2.34.District 1 Sideswipe Crash Rate

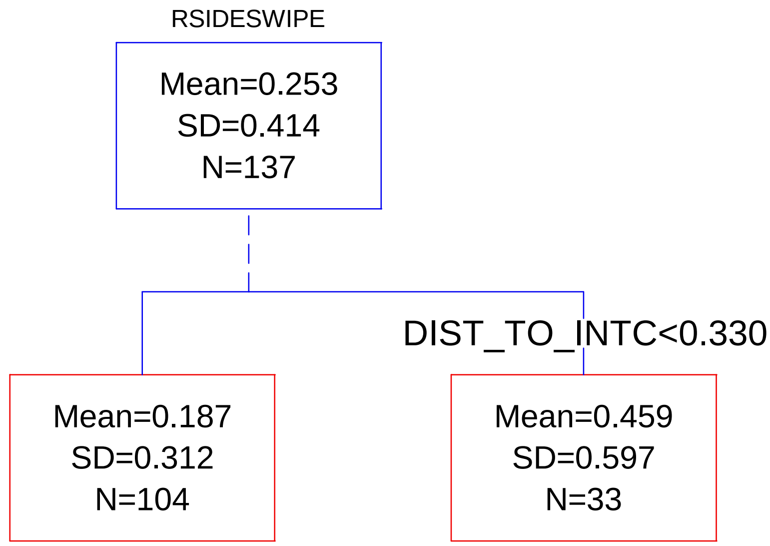


Figure 2.35.District 1 Road wet Crash Rate

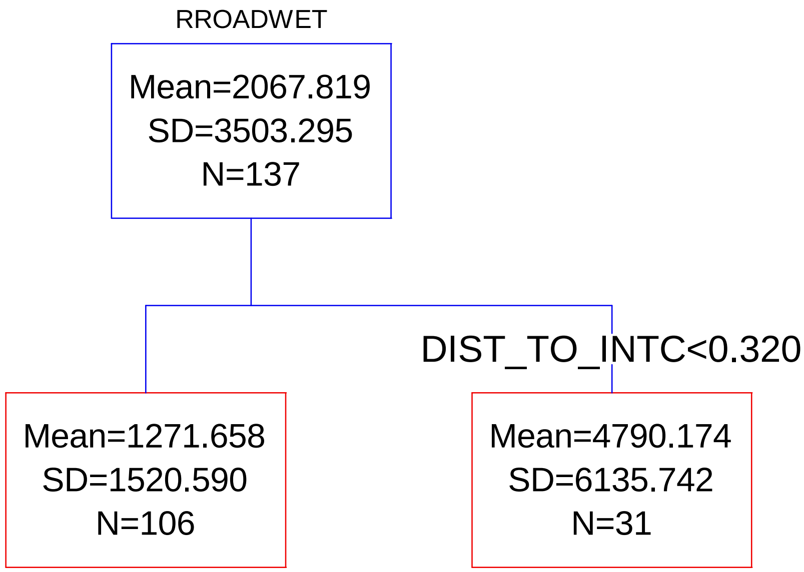
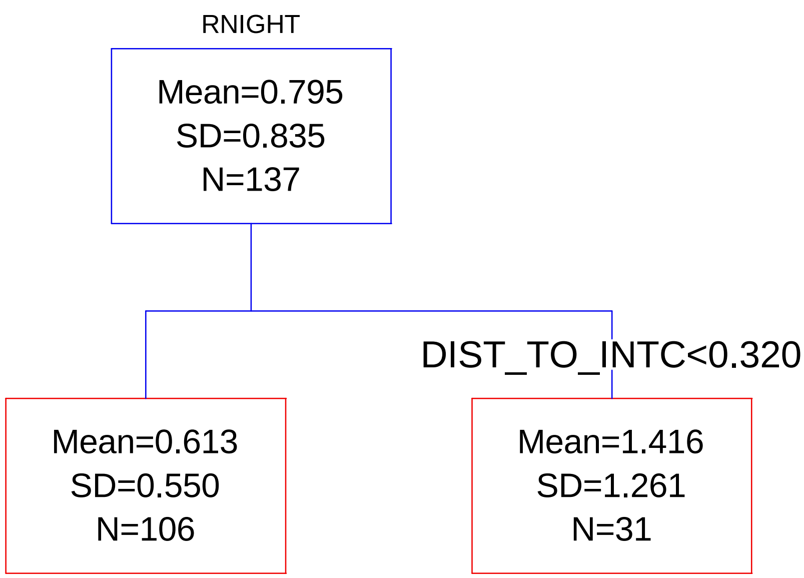


Figure 2.36.District 1 Night Crash Rate



District 2 AID Trees

Figure 2.37.District 2 Injury/Fatal Crash Density

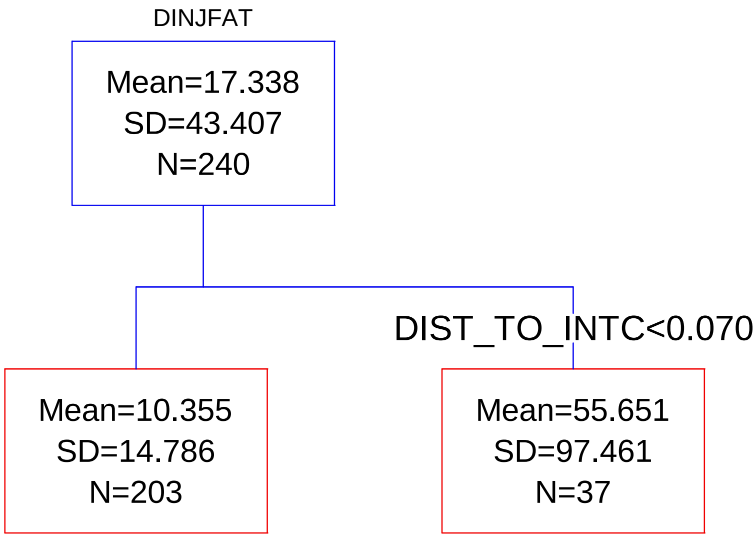


Figure 2.38.District 2 Property damage only Crash Density

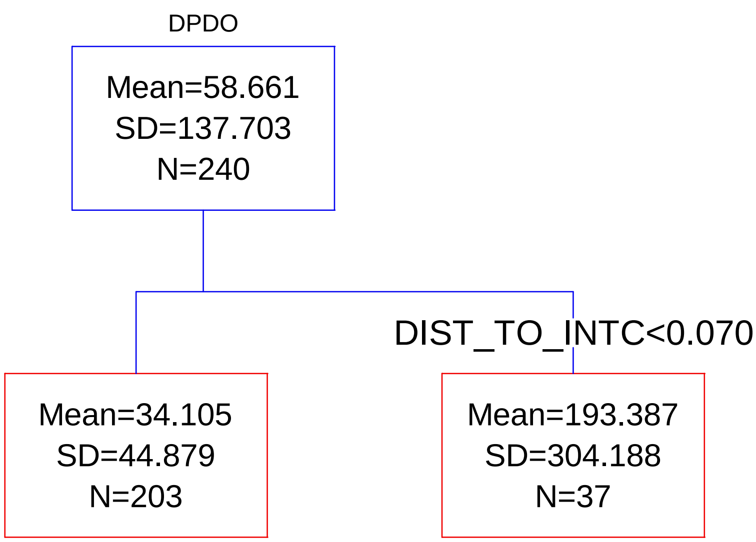


Figure 2.39.District 2 Total Crash Density

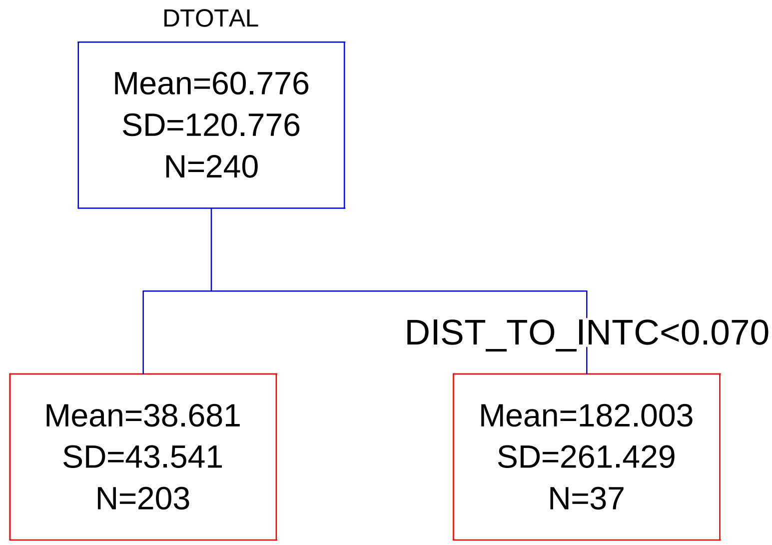


Figure 2.40.District 2 Angle Crash Density

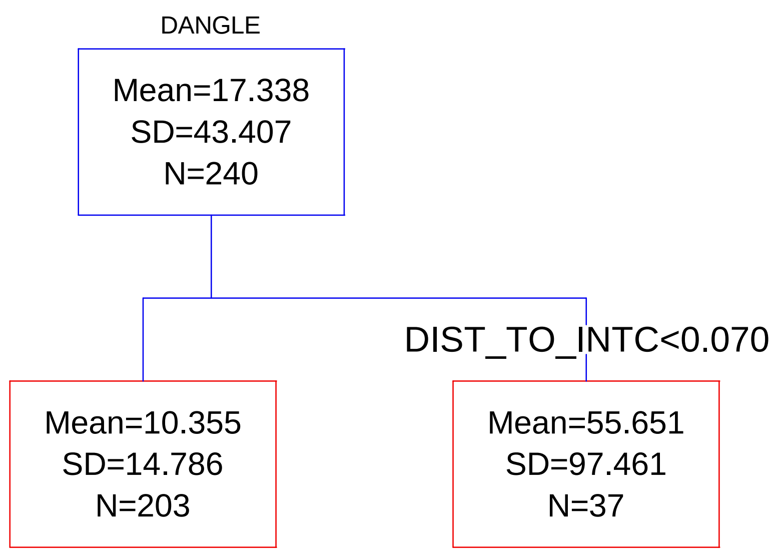


Figure 2.41.District 2 Fixed Object Crash Density

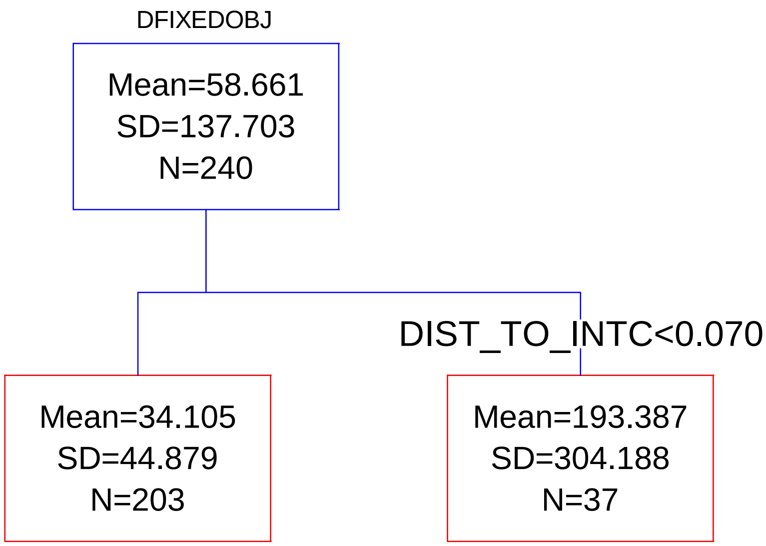


Figure 2.42.District 2 Rear end Crash Density

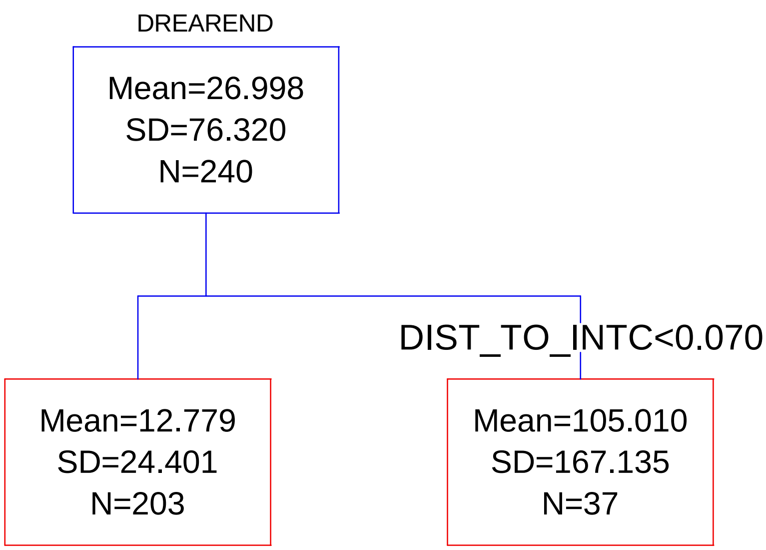


Figure 2.43.District 2 Sideswipe Crash Density

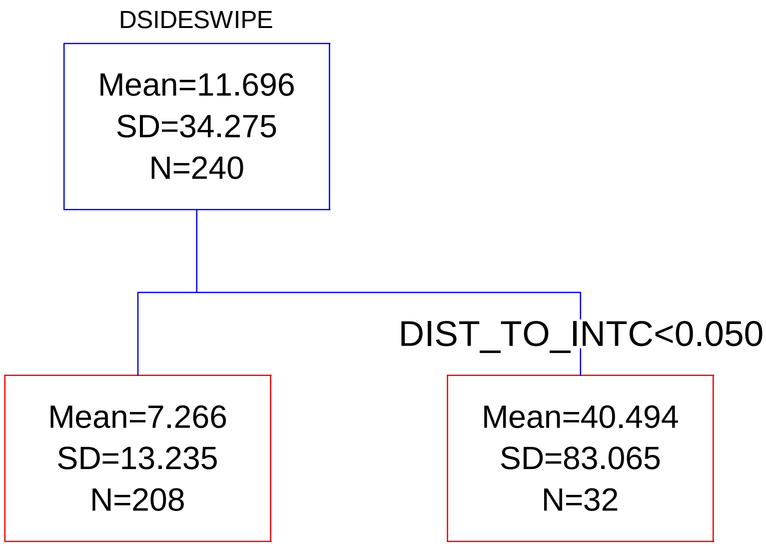


Figure 2.44.District 2 Road wet Crash Density

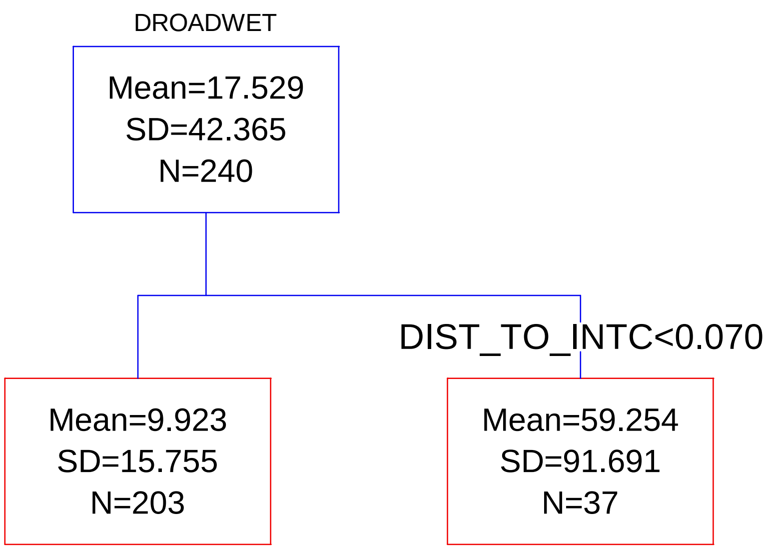


Figure 2.45.District 2 Night Crash Density

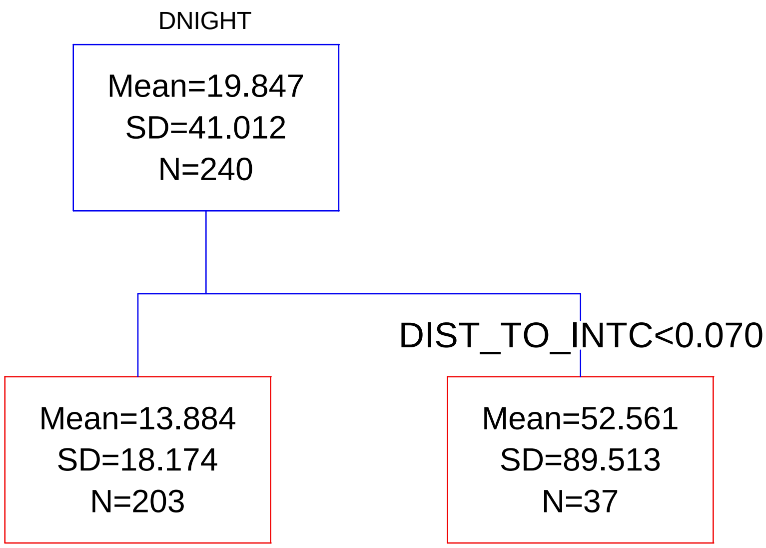


Figure 2.46.District 2 Injury/Fatal Crash Rate

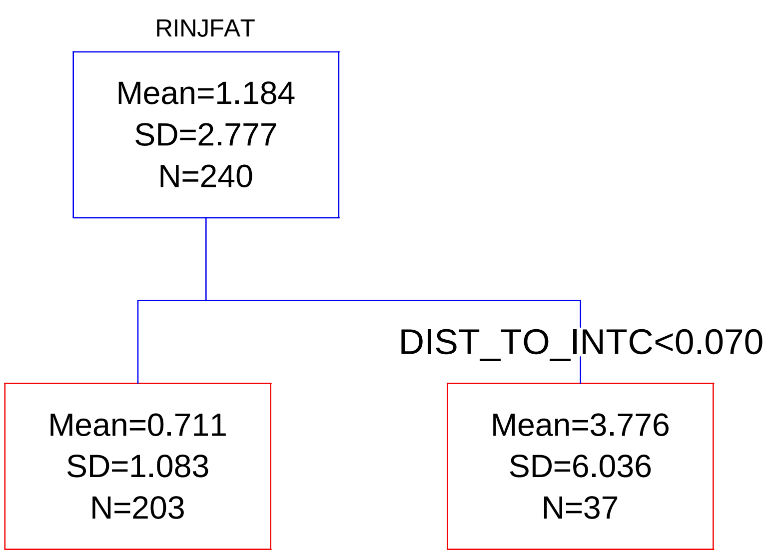


Figure 2.47.District 2 Property damage only Crash Rate

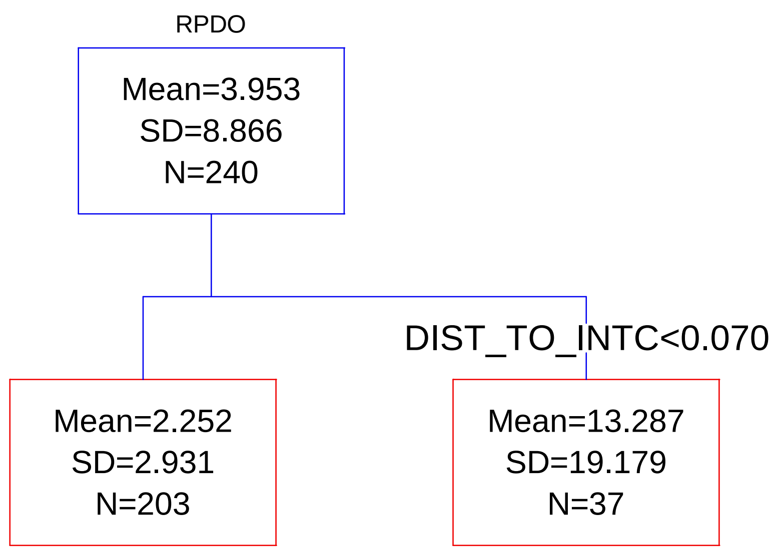


Figure 2.48.District 2 Total Crash Rate

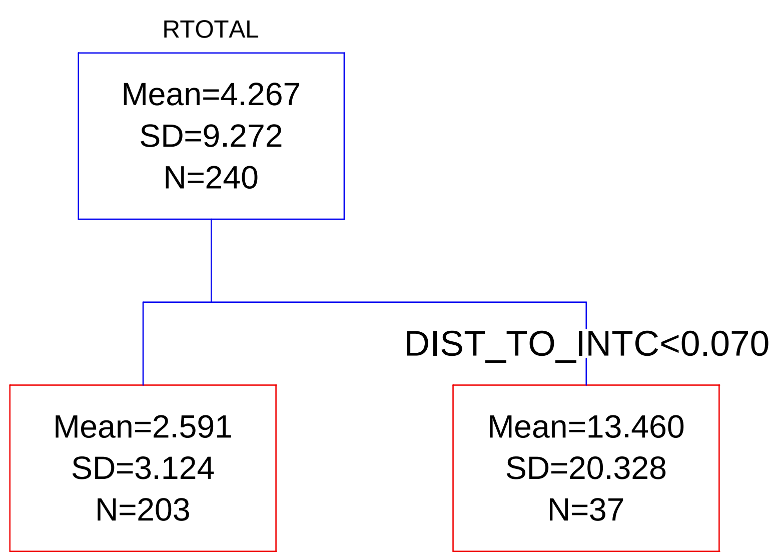


Figure 2.49.District 2 Angle Crash Rate

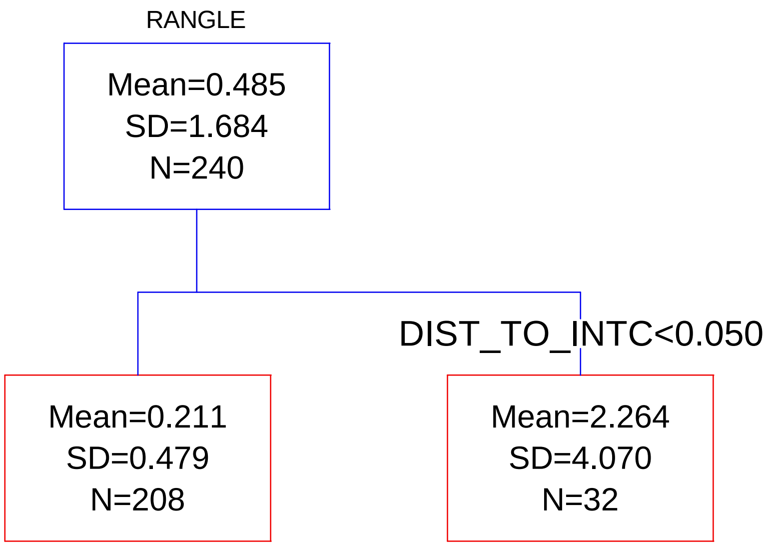


Figure 2.50.District 2 Fixed Object Crash Rate

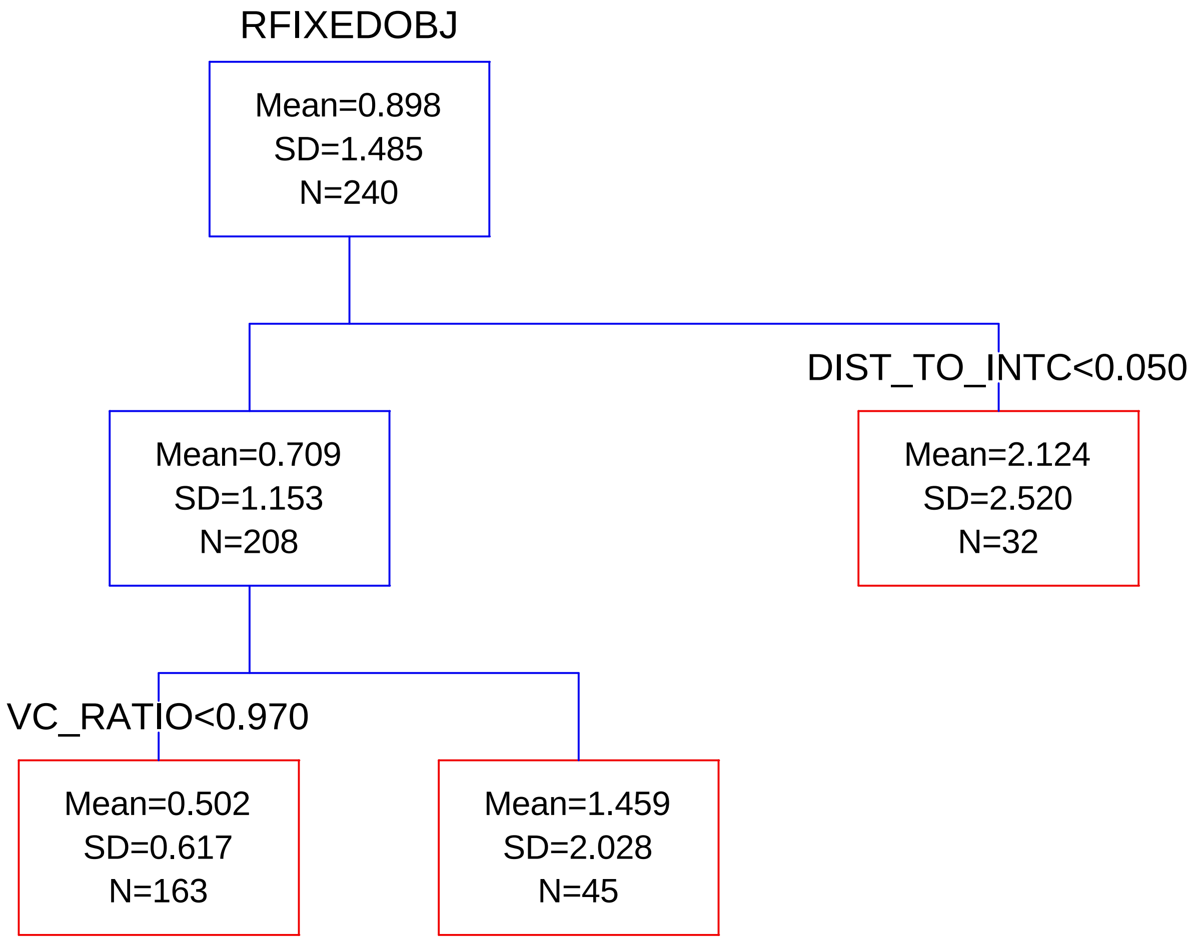


Figure 2.51.District 2 Rear end Crash Rate

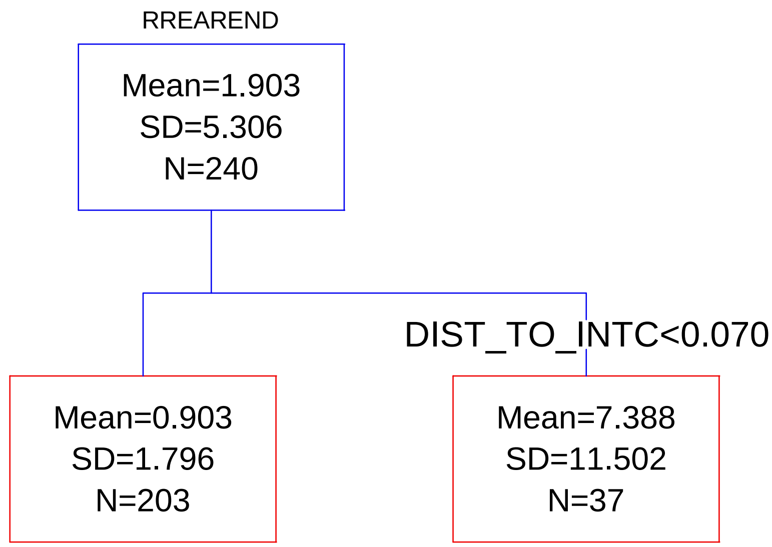


Figure 2.52.District 2 Sideswipe Crash Rate

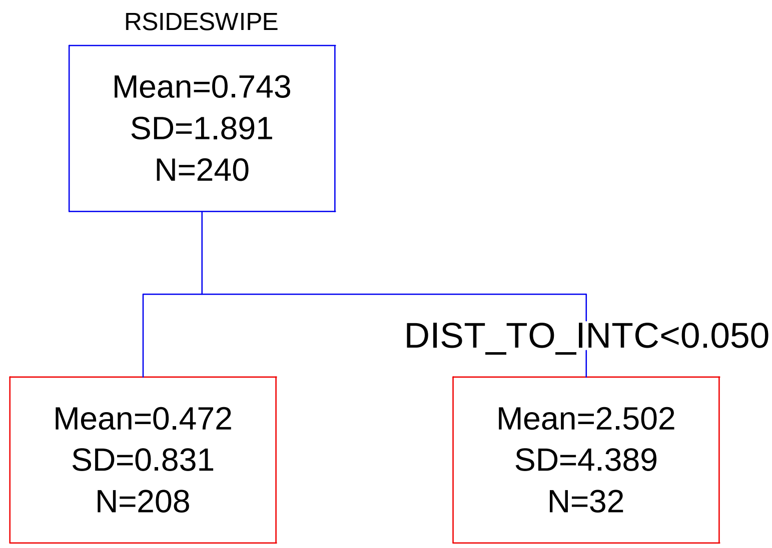


Figure 2.53.District 2 Road wet Crash Rate

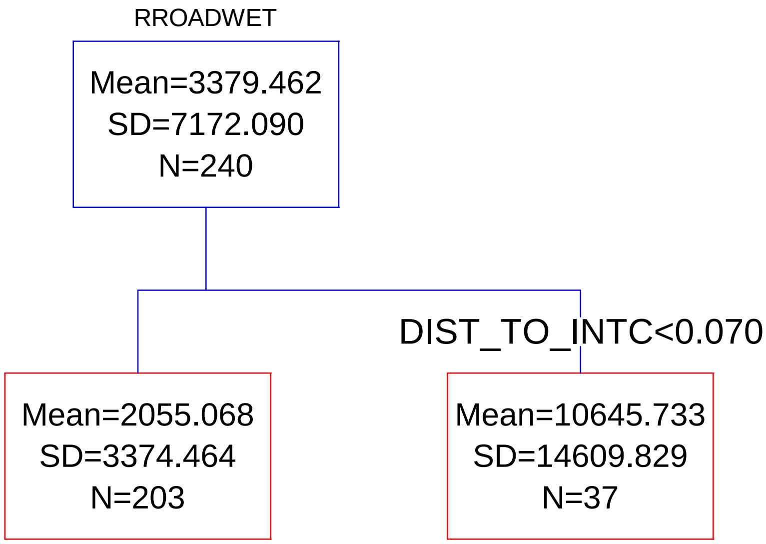
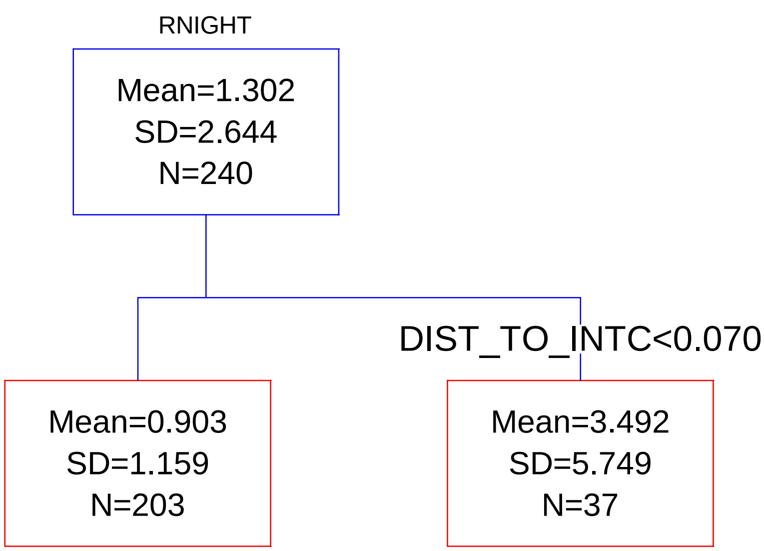


Figure 2.54.District 2 Night Crash Rate



AID Tree for District 3

Figure 2.55.District 3 Injury/Fatal Crash Density

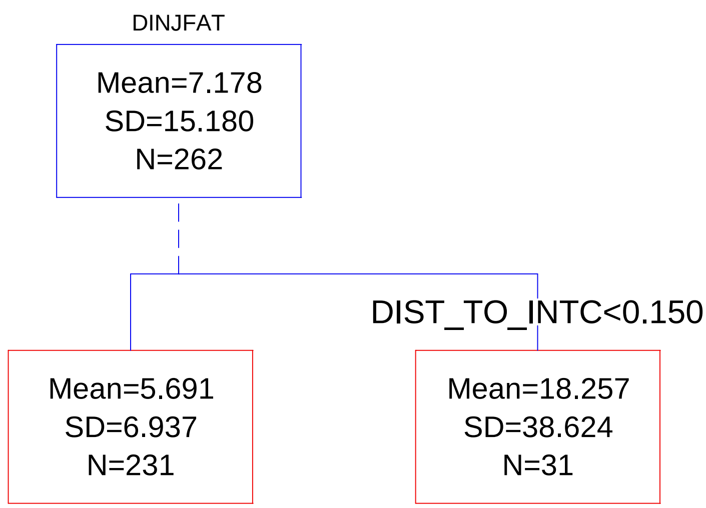


Figure 2.56.District 3 Property damage only Crash Density

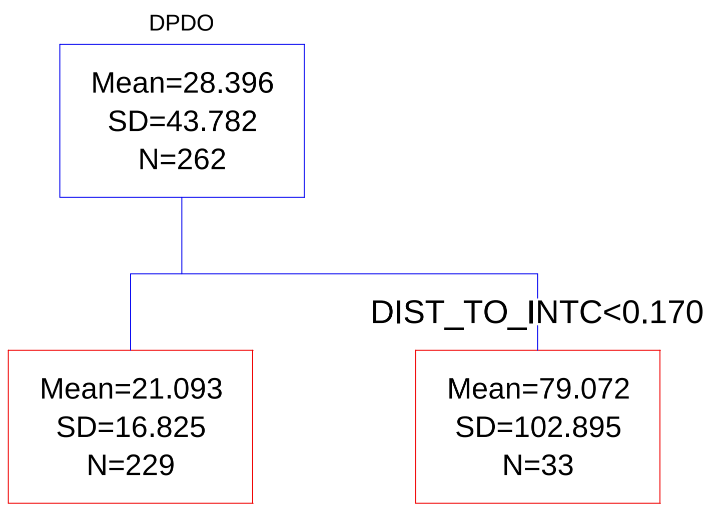


Figure 2.57.District 3 Total Crash Density

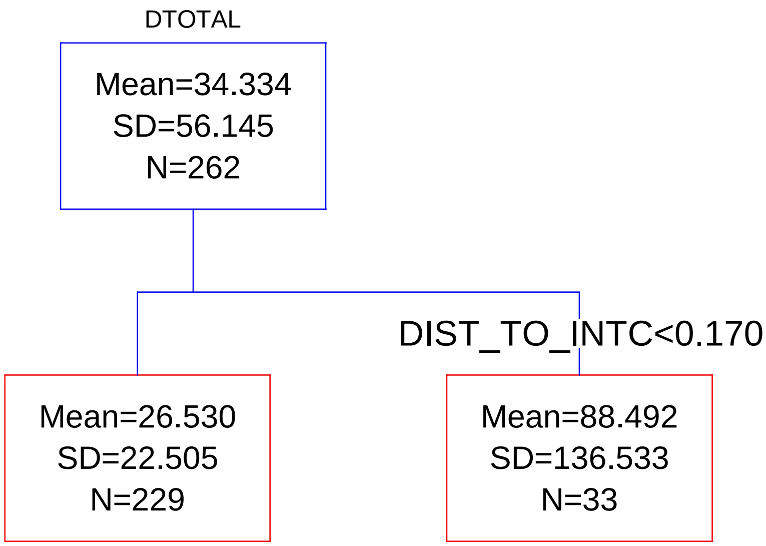


Figure 2.58.District 3 Angle Crash Density

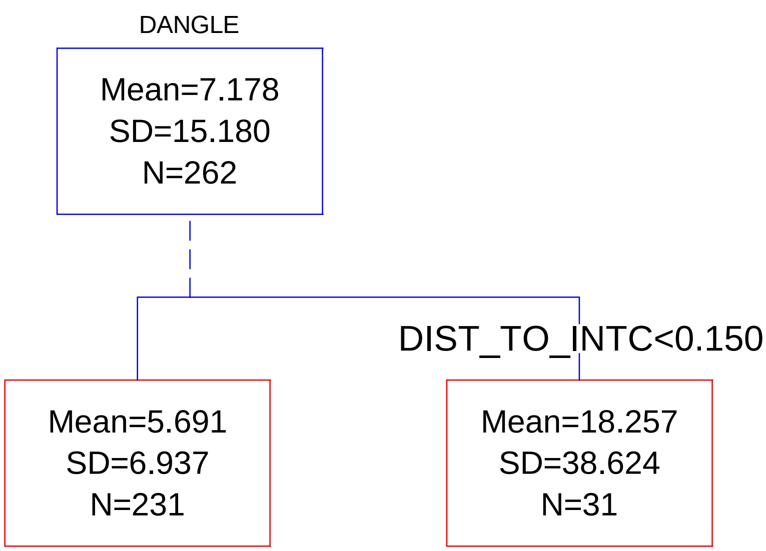


Figure 2.59.District 3 Fixed Object Crash Density

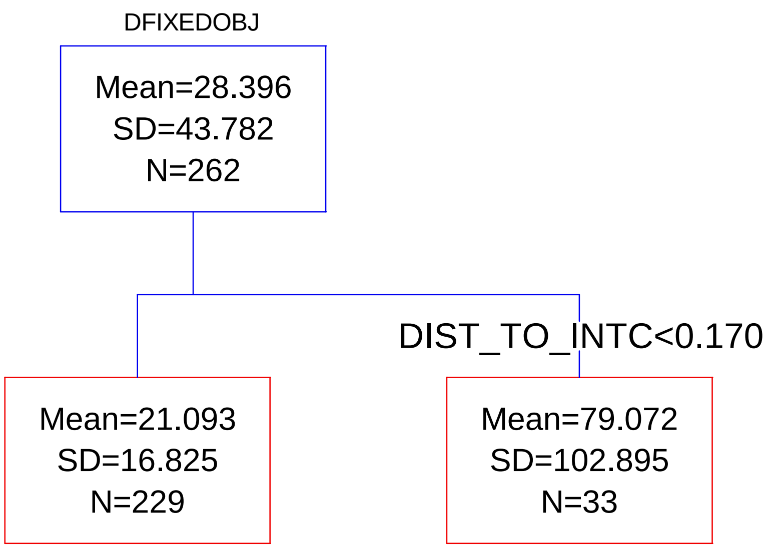


Figure 2.60.District 3 Rear end Crash Density

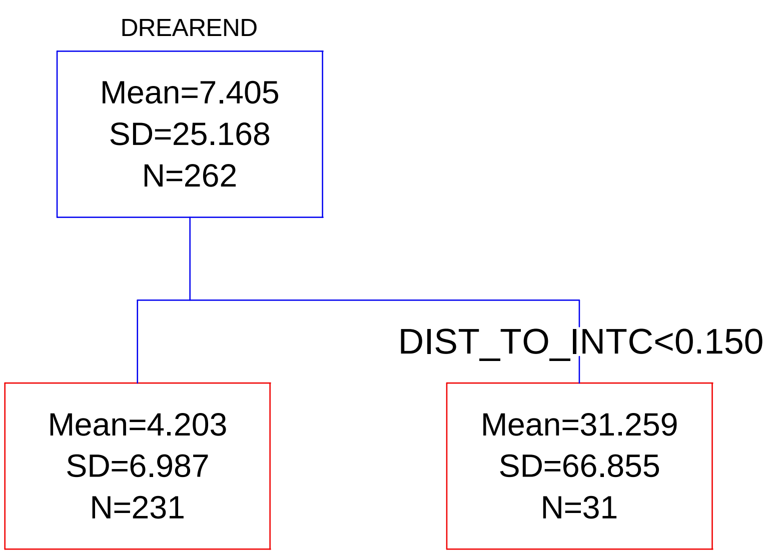


Figure 2.61.District 3 Sideswipe Crash Density

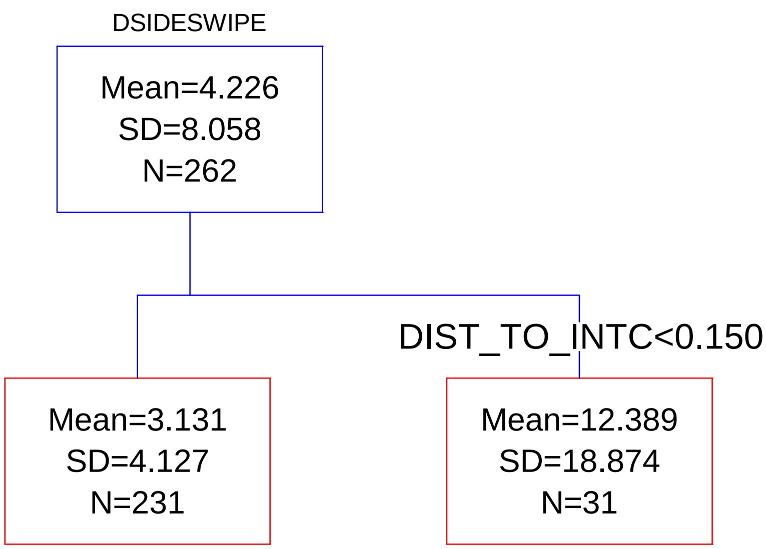


Figure 2.62.District 3 Road wet Crash Density

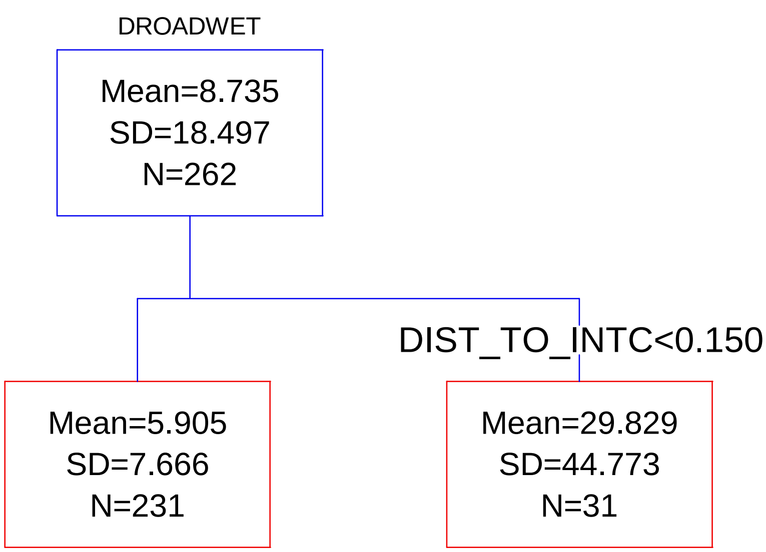


Figure 2.63.District 3 Night Crash Density

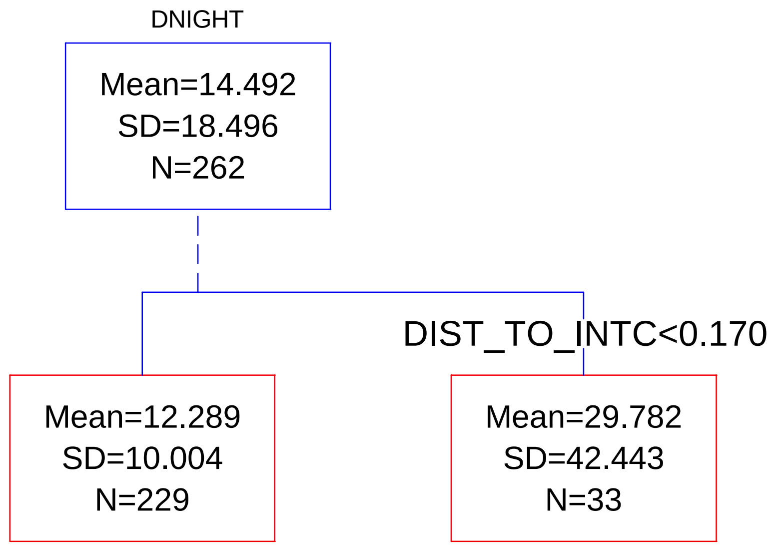


Figure 2.64.District 3 Injury/Fatal Crash Rate

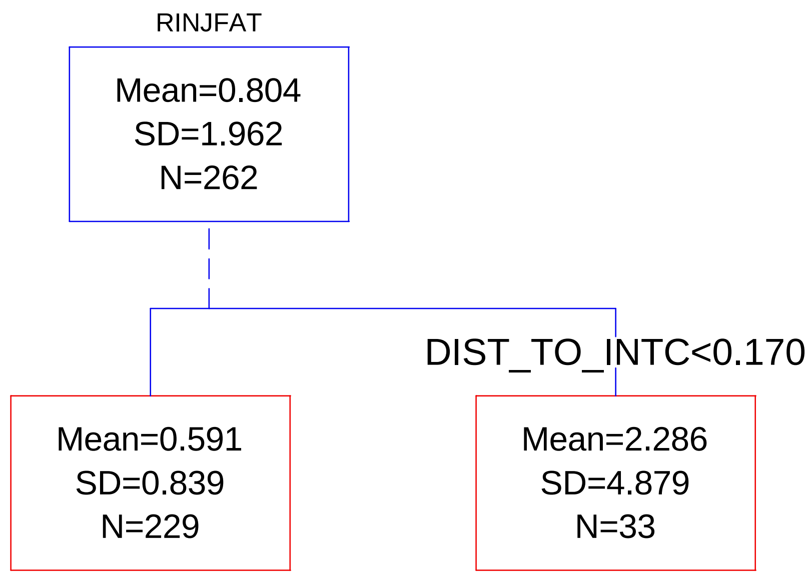


Figure 2.65.District 3 Property damage only Crash Rate

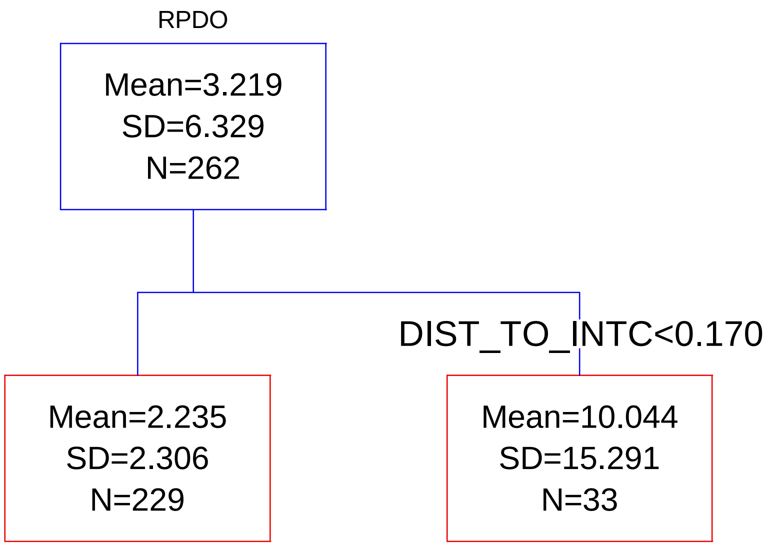


Figure 2.66.District 3 Total Crash Rate

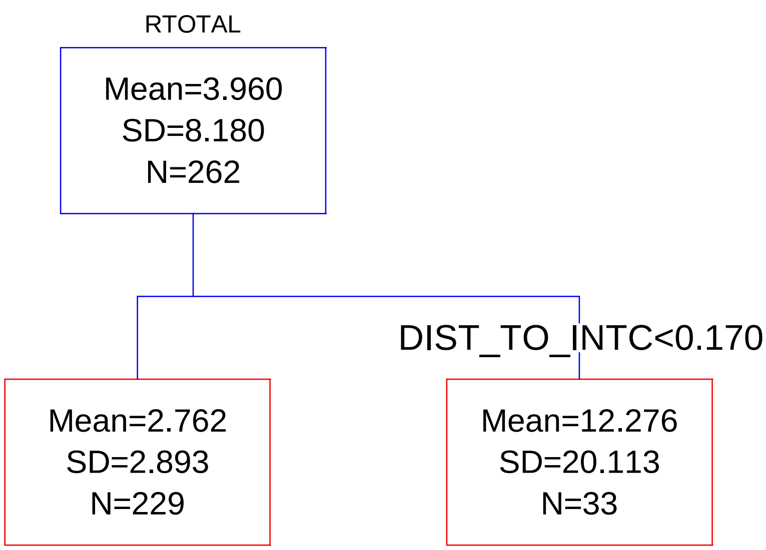


Figure 2.67.District 3 Angle Crash Rate

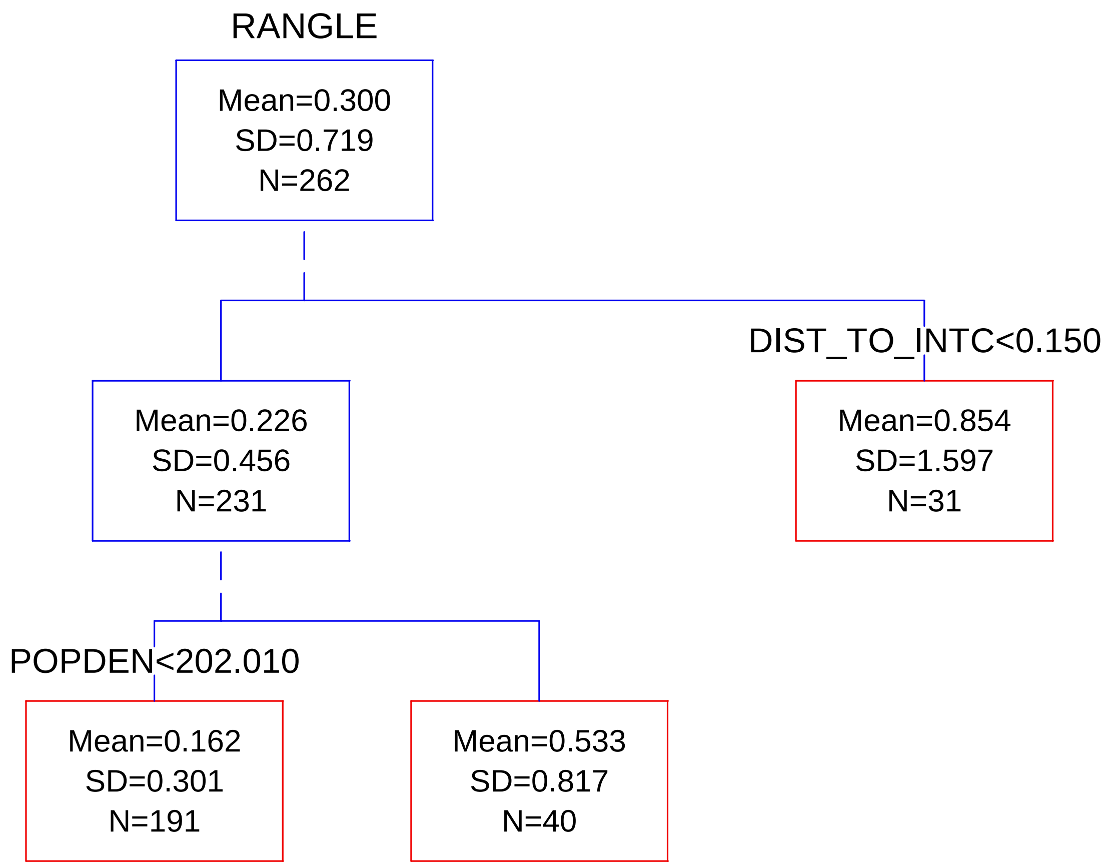


Figure 2.68.District 3 Fixed Object Crash Rate

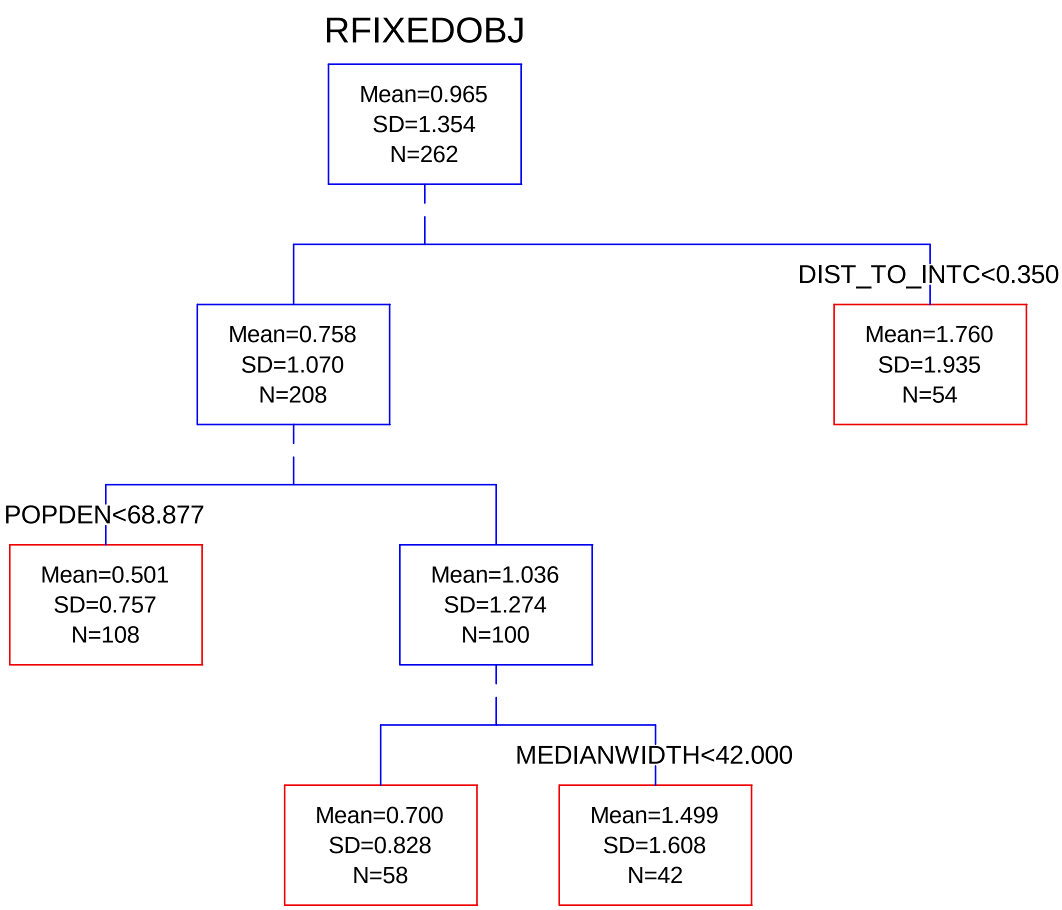


Figure 2.69.District 3 Rear end Crash Rate

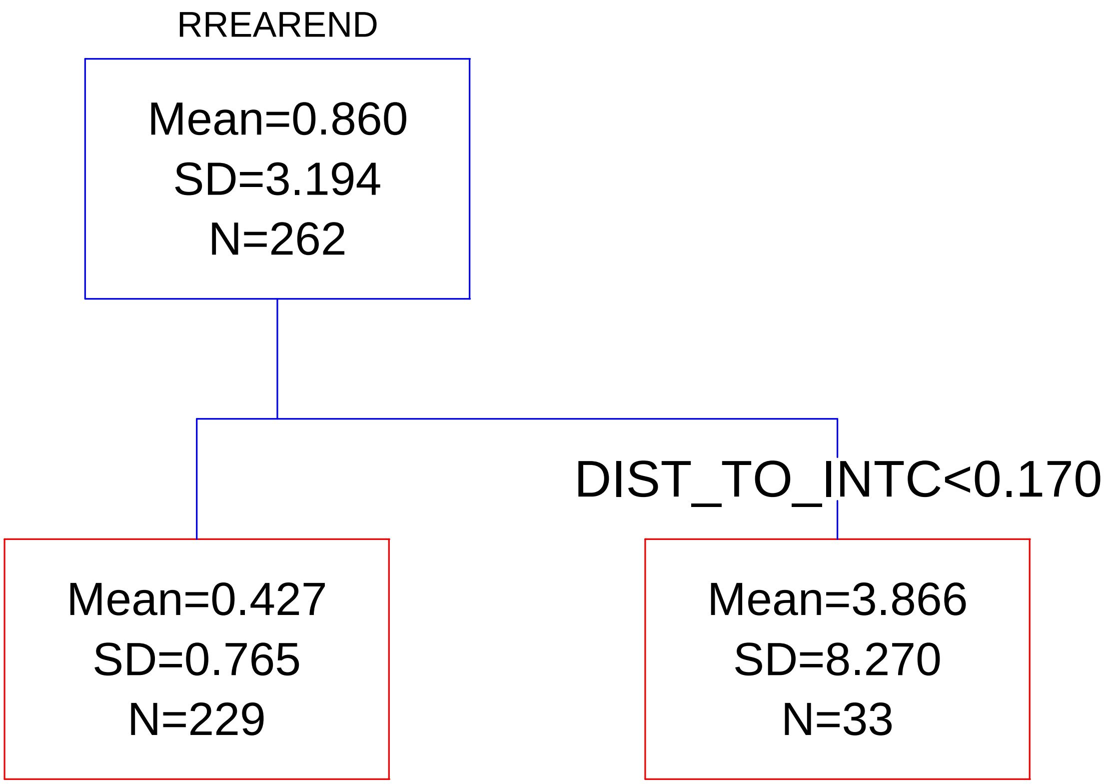


Figure 2.70.District 3 Sideswipe Crash Rate

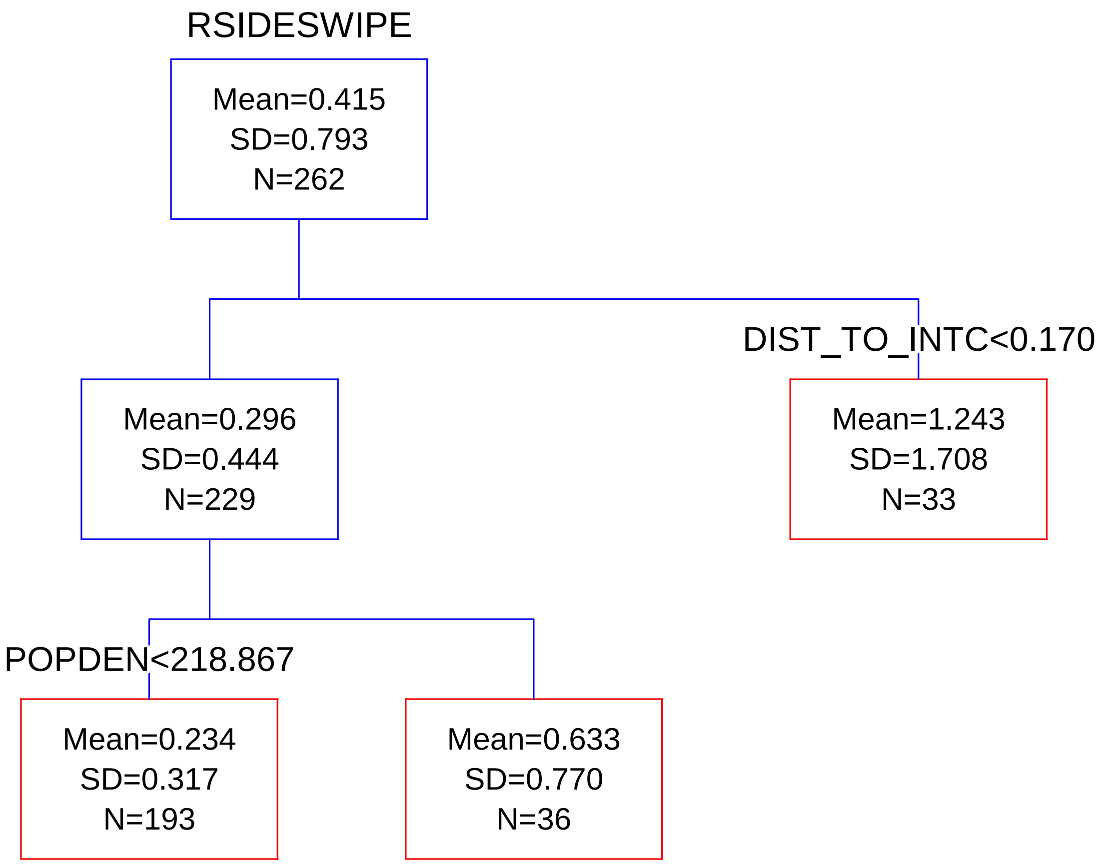


Figure 2.71.District 3 Road wet Crash Rate

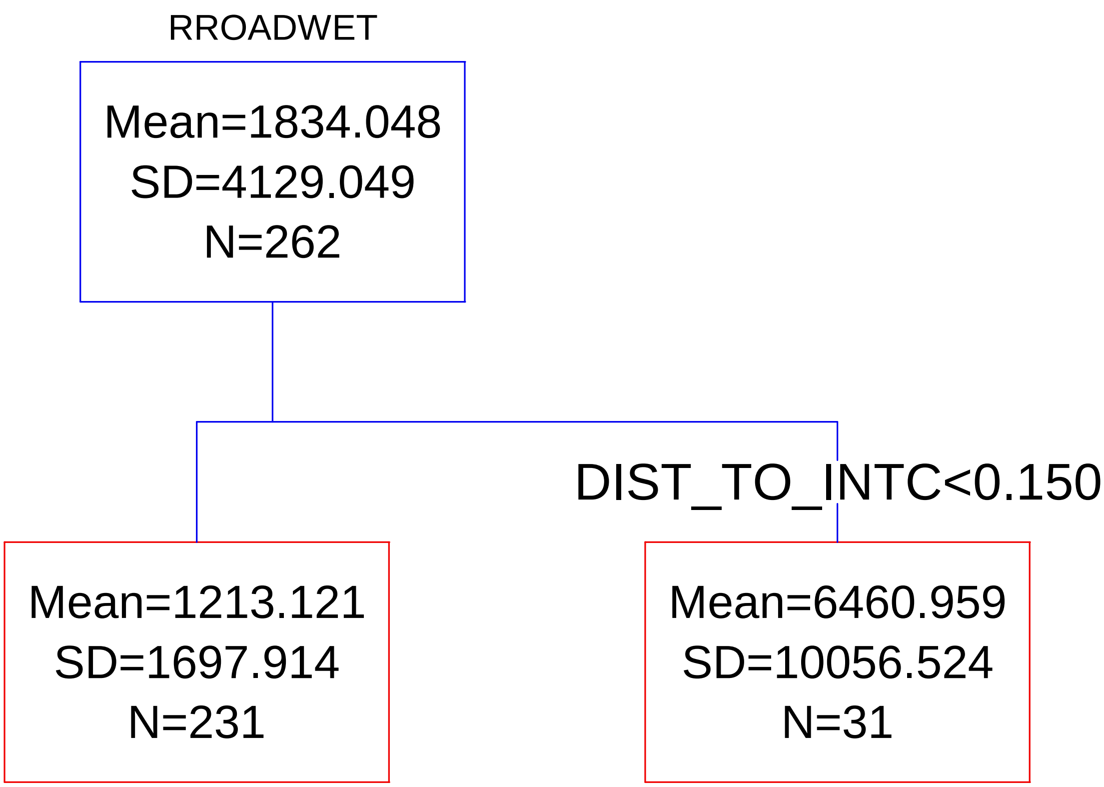
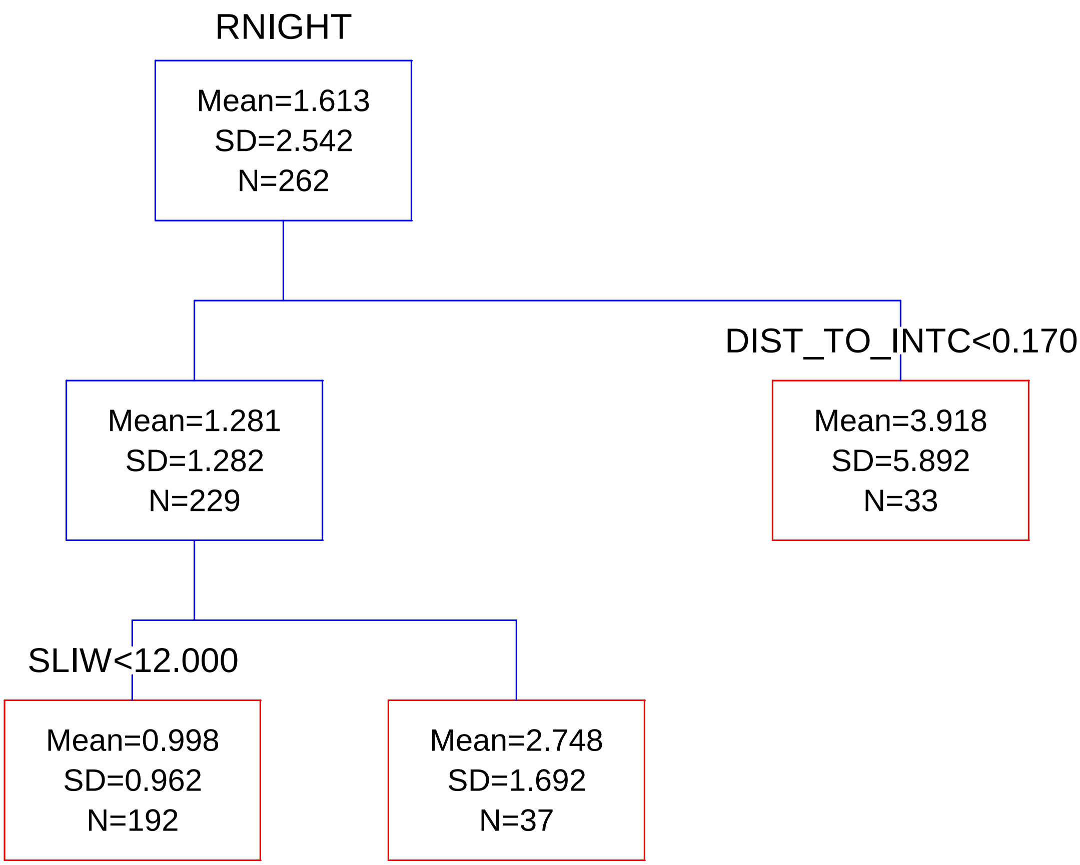


Figure 2.72.District 3 Night Crash Rate



AID Tree for District 4

Figure 2.73.District 4 Injury/Fatal Crash Density

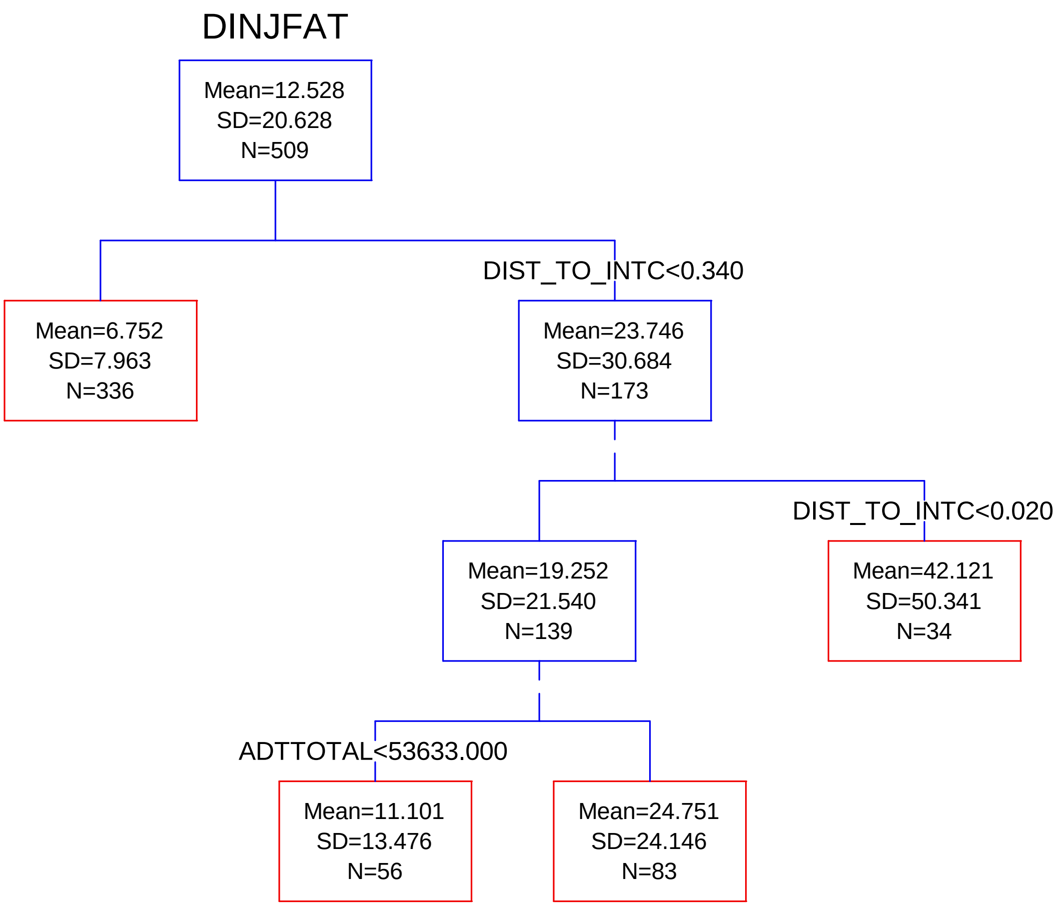


Figure 2.74.District 4 Property damage only Crash Density

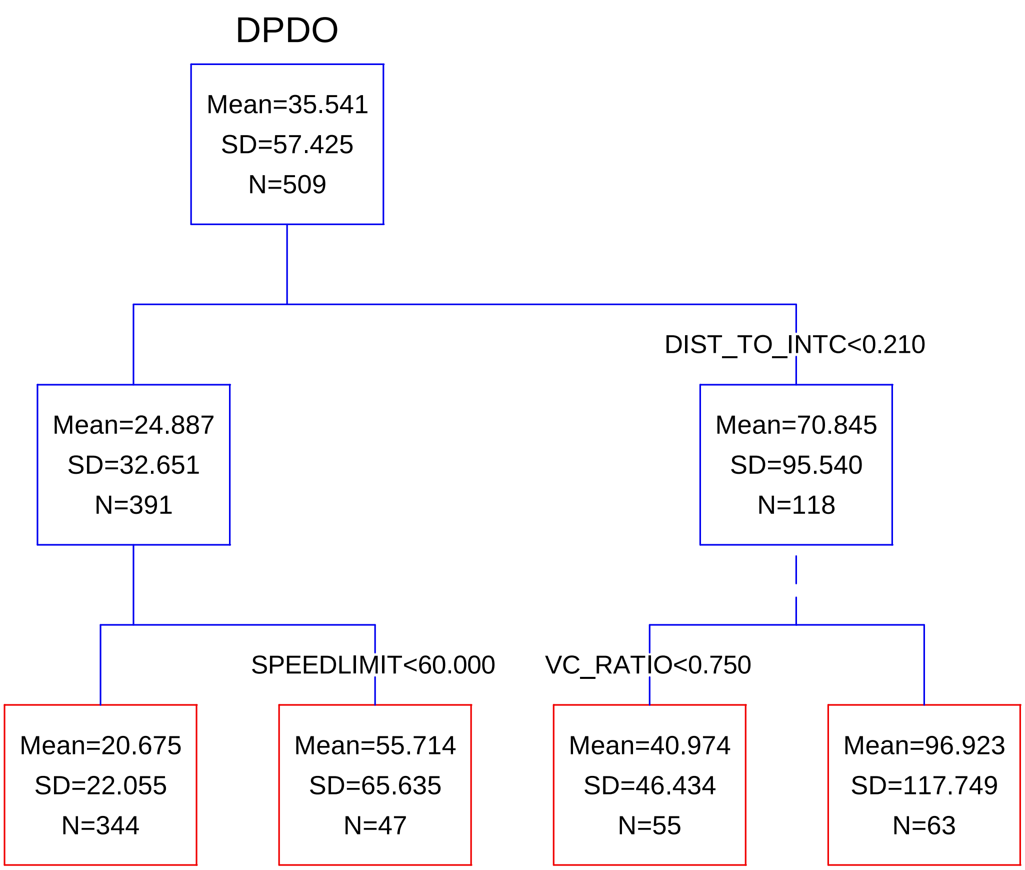


Figure 2.75.District 4 Total Crash Density

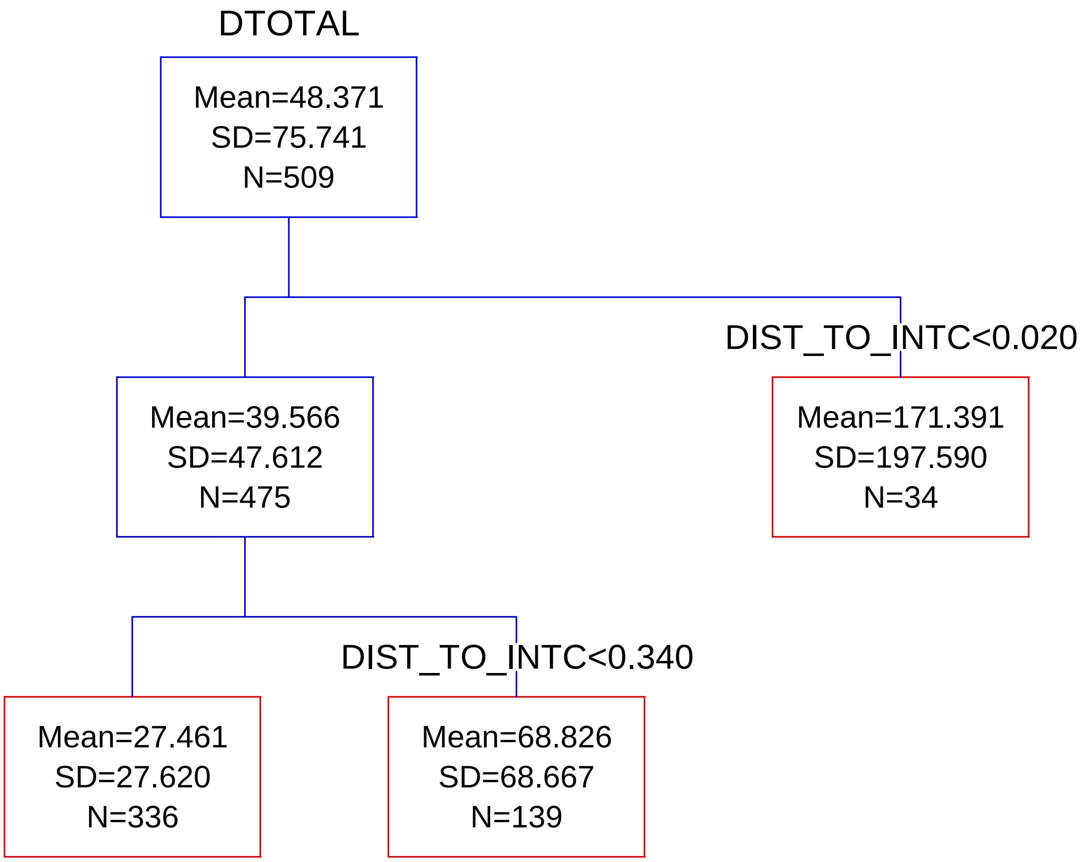


Figure 2.76.District 4 Angle Crash Density

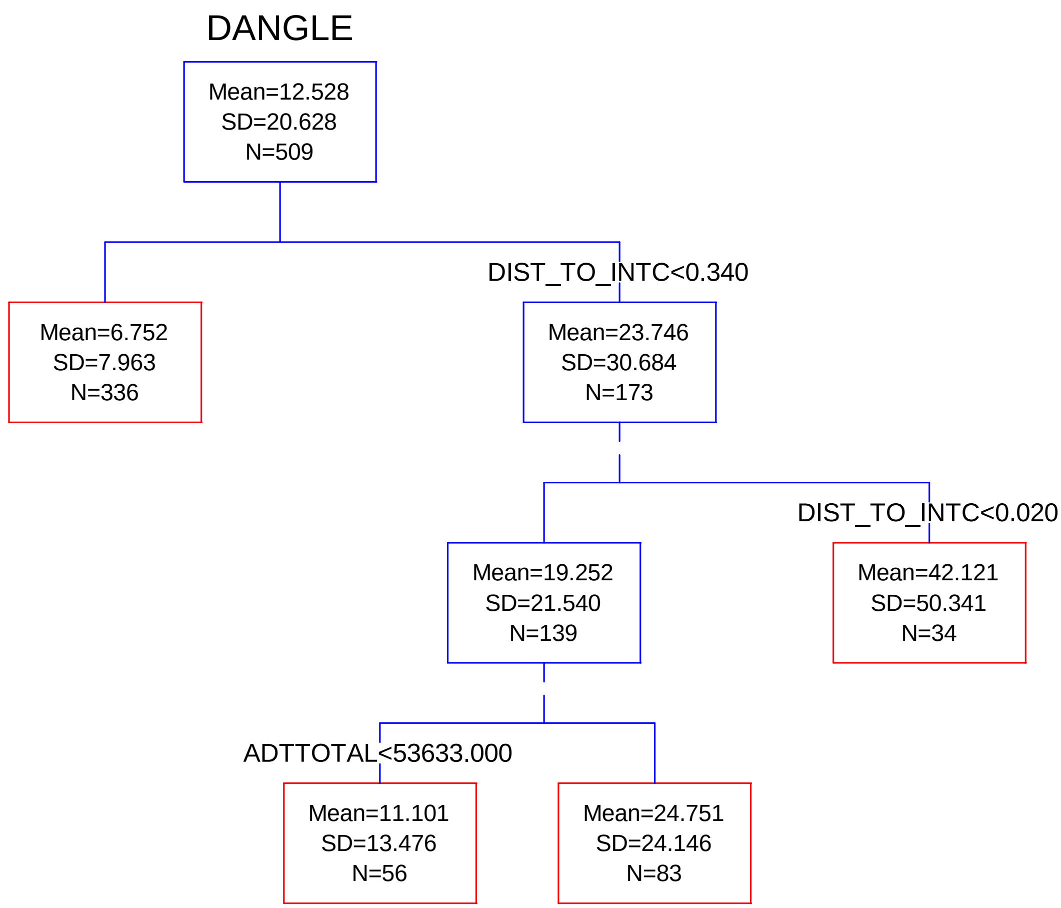


Figure 2.77.District 4 Fixed Object Crash Density

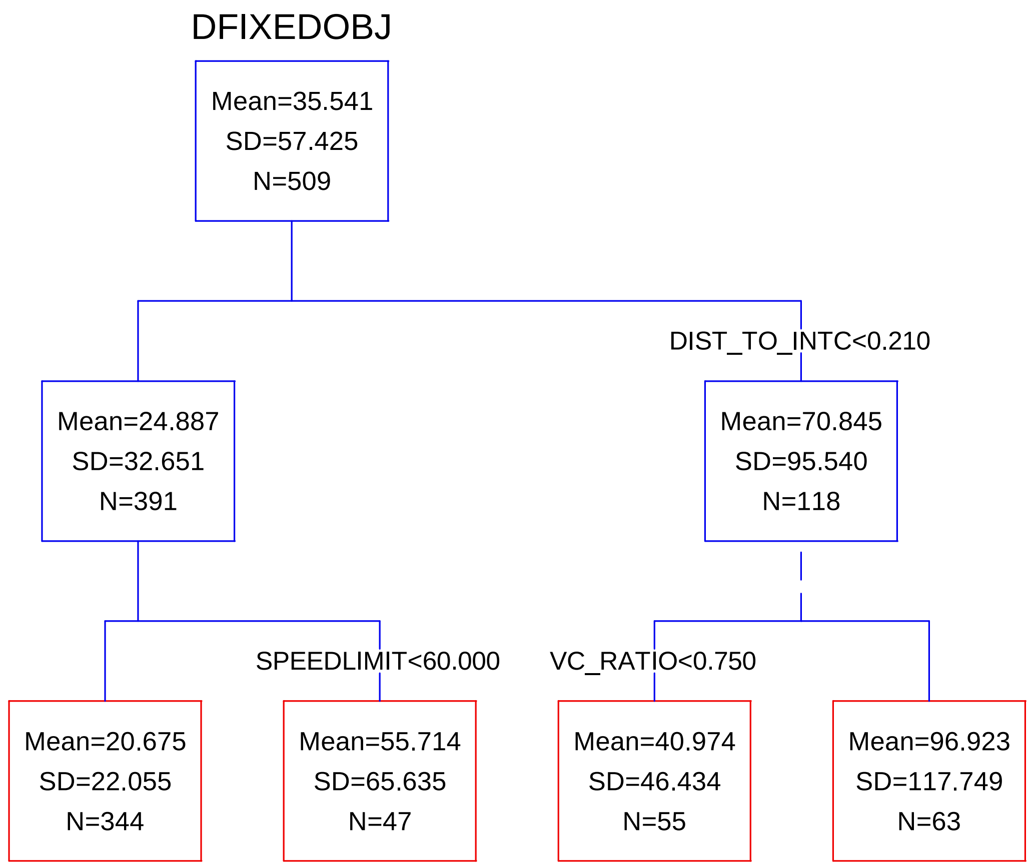


Figure 2.78.District 4 Rear end Crash Density

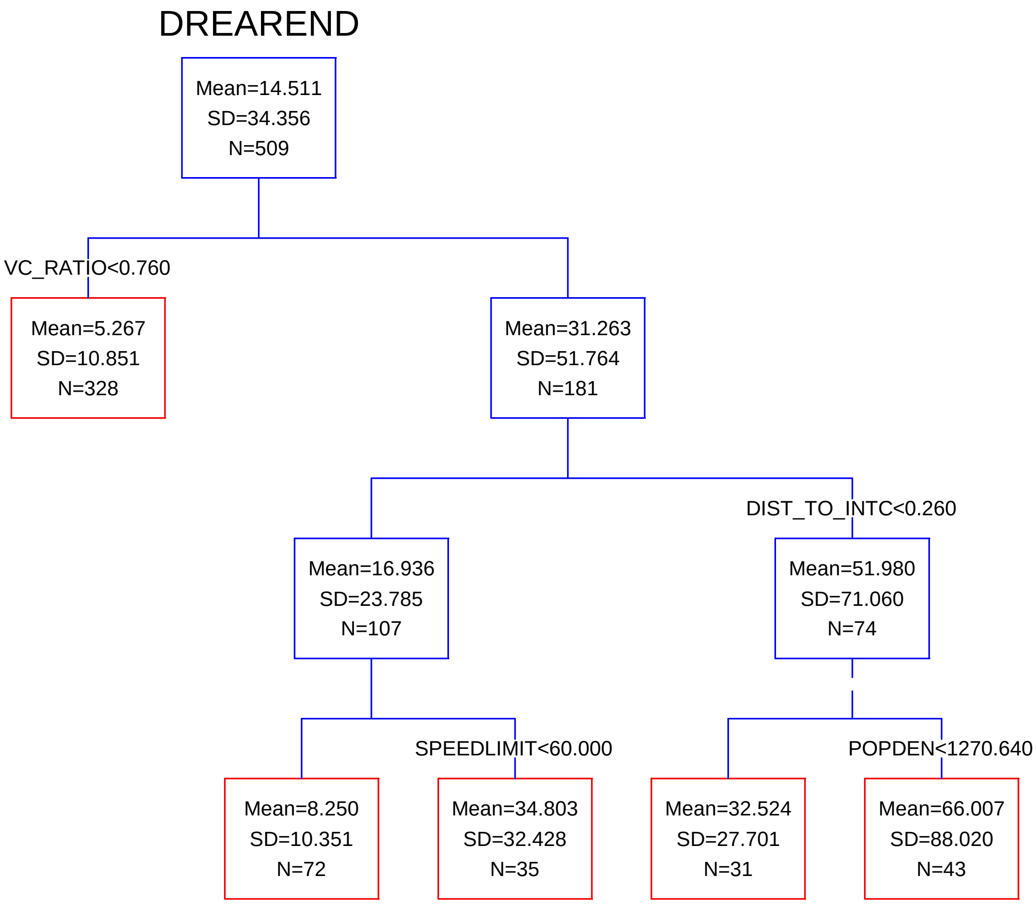


Figure 2.79.District 4 Sideswipe Crash Density

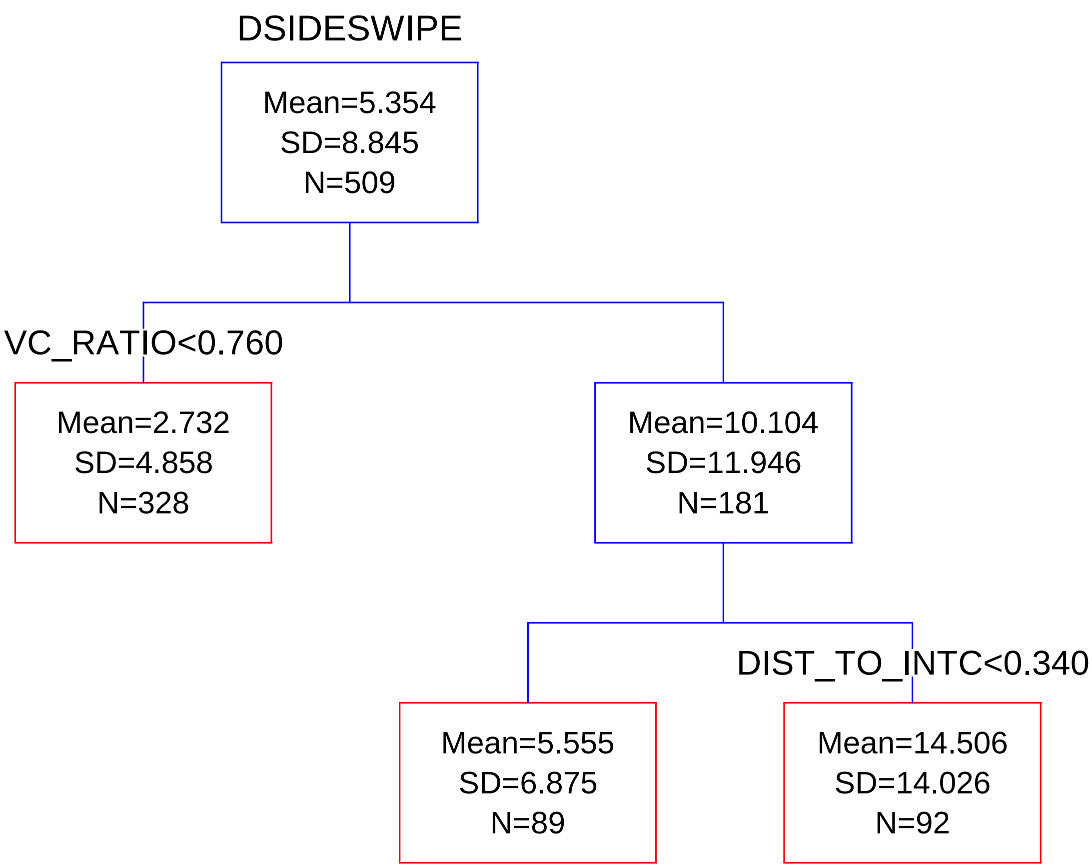


Figure 2.80.District 4 Road wet Crash Density

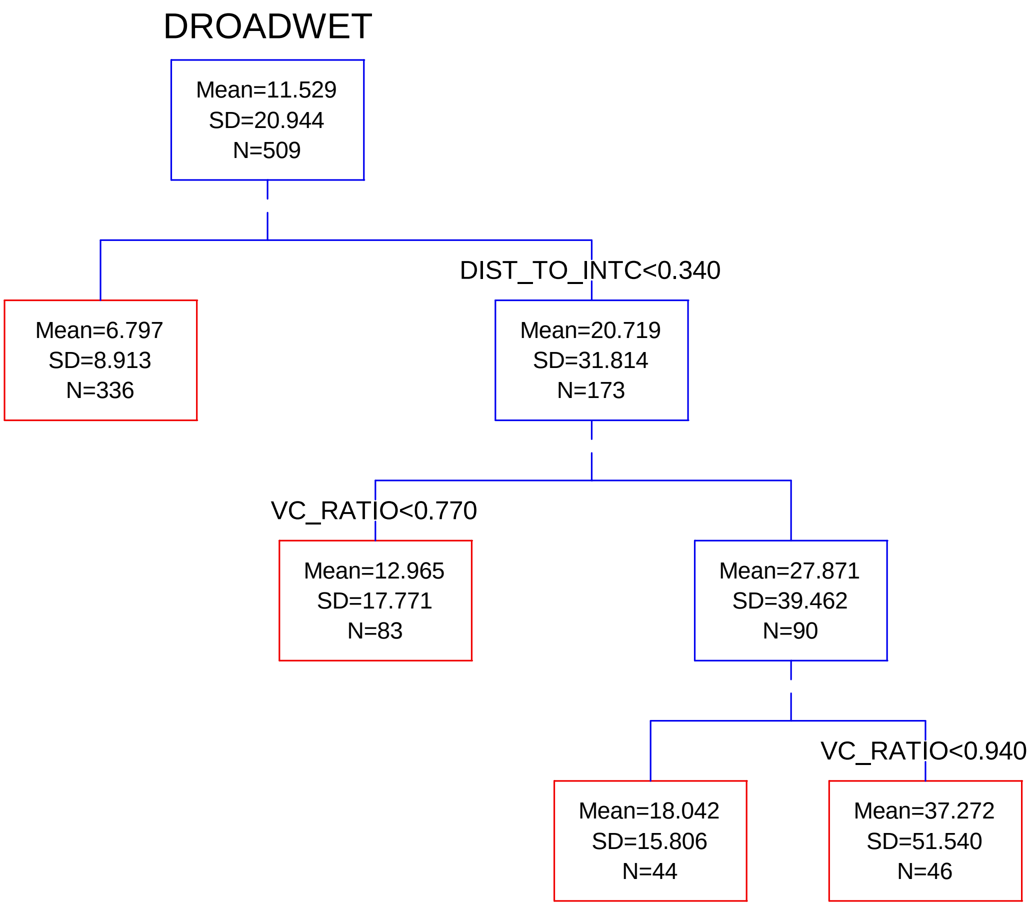


Figure 2.81.District 4 Night Crash Density

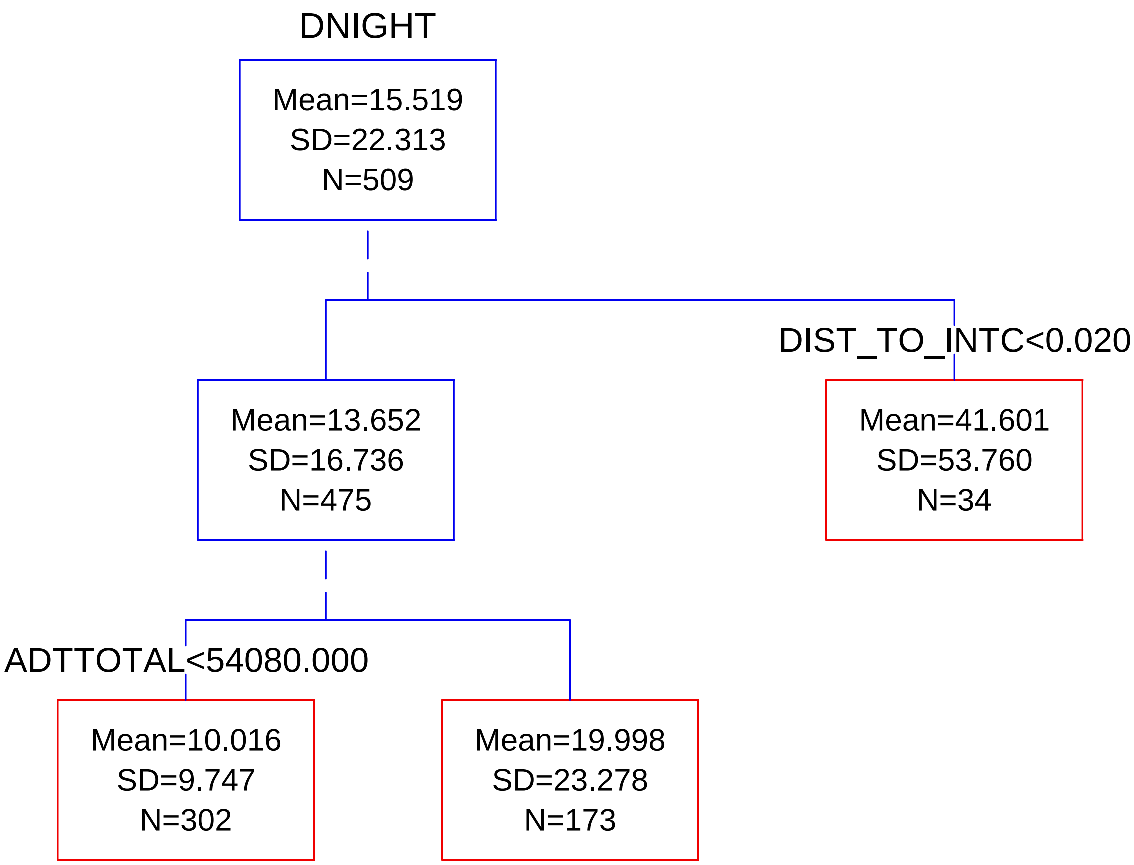


Figure 2.82.District 4 Injury/Fatal Crash Rate

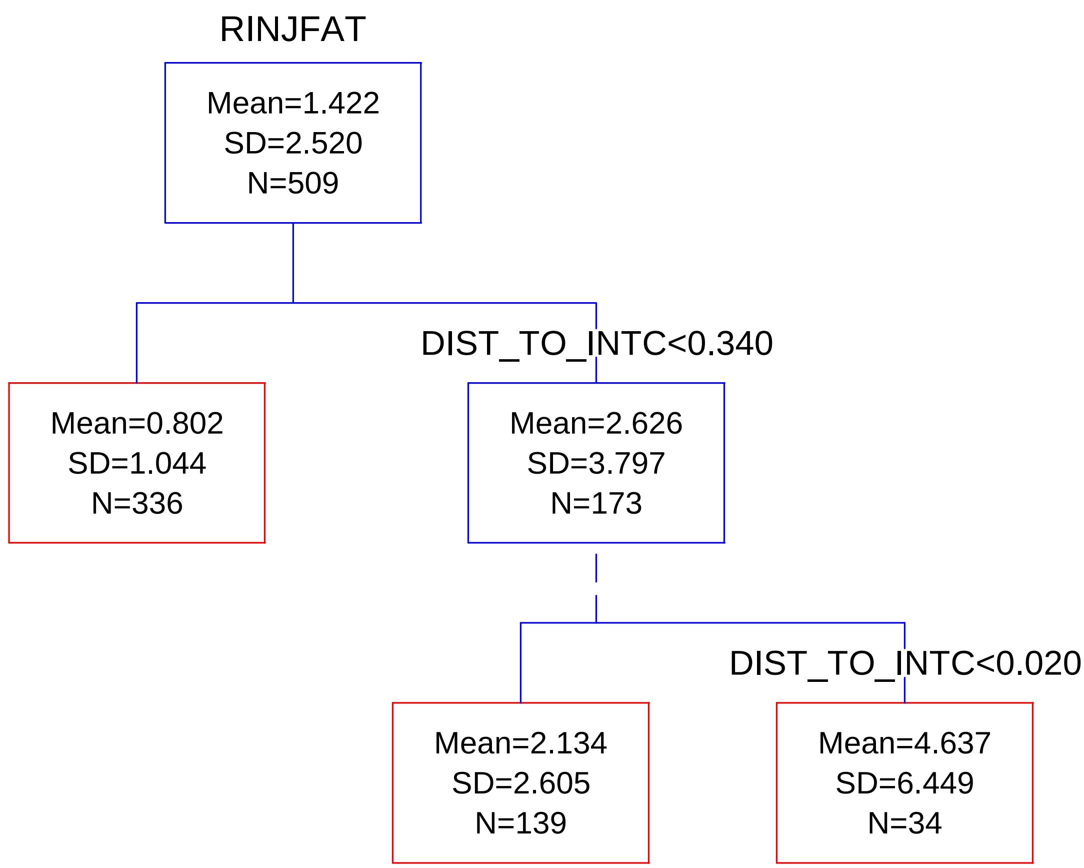


Figure 2.83.District 4 Property damage only Crash Rate

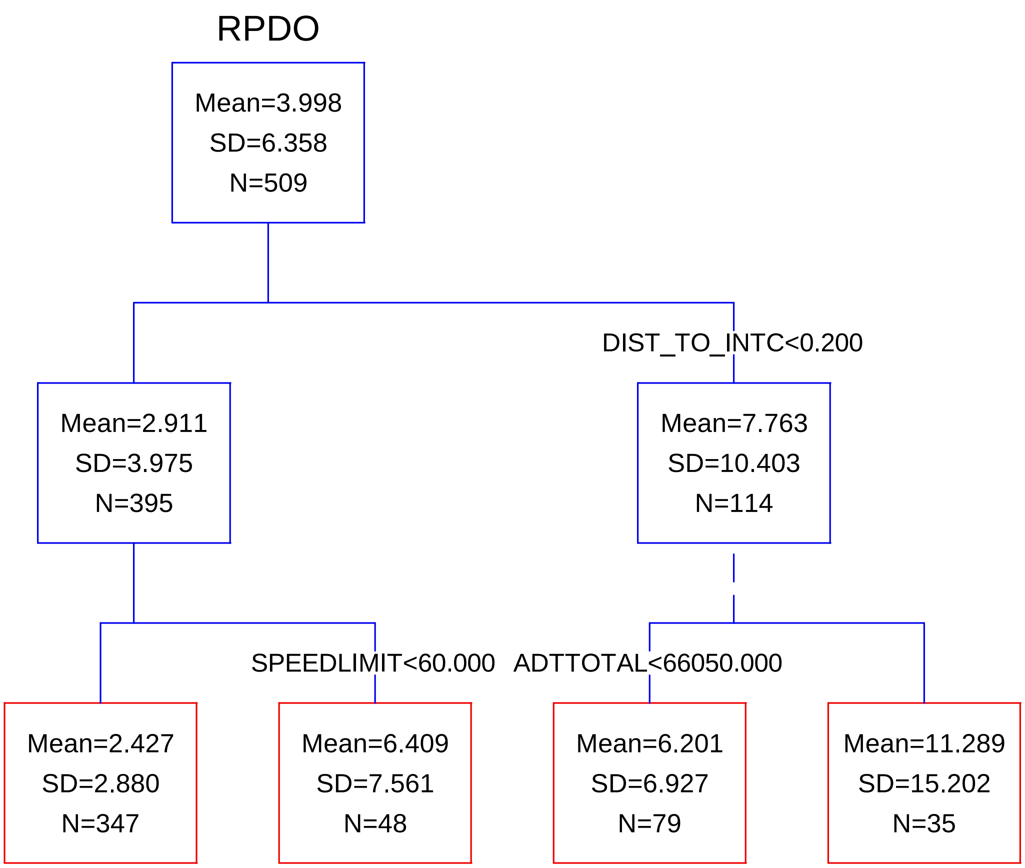


Figure 2.84.District 4 Total Crash Rate

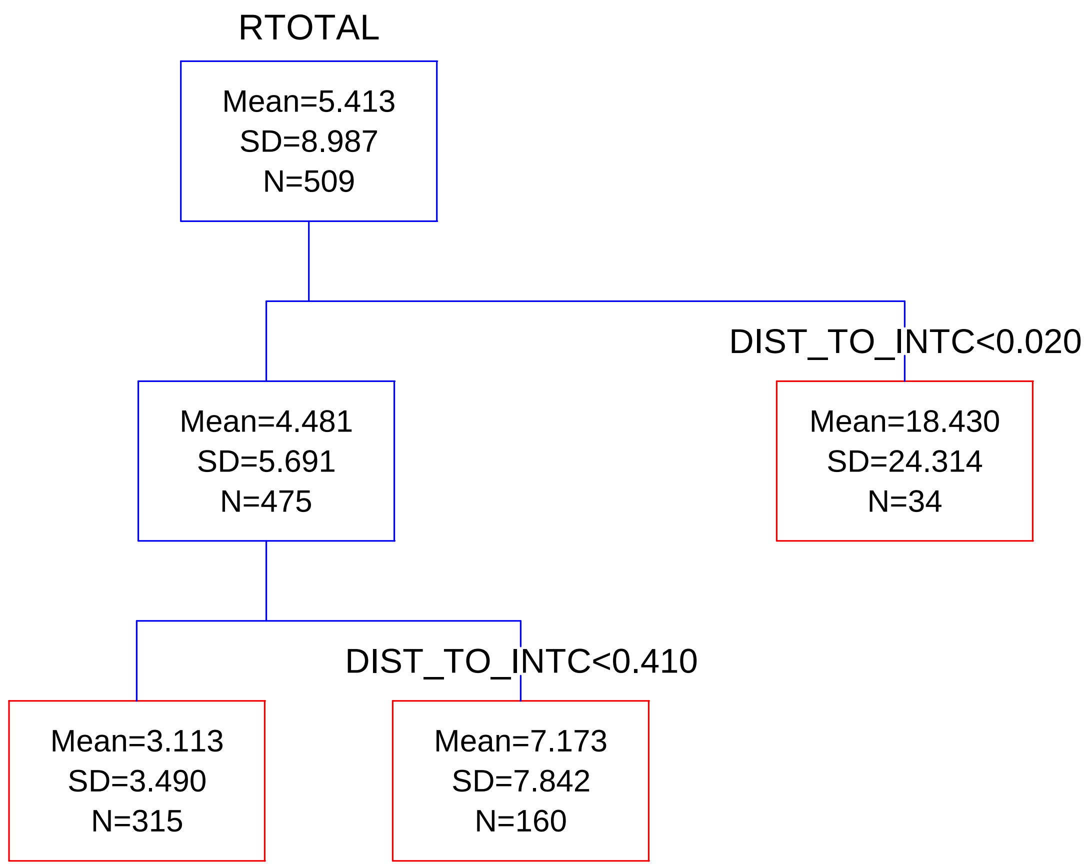


Figure 2.85.District 4 Angle Crash Rate

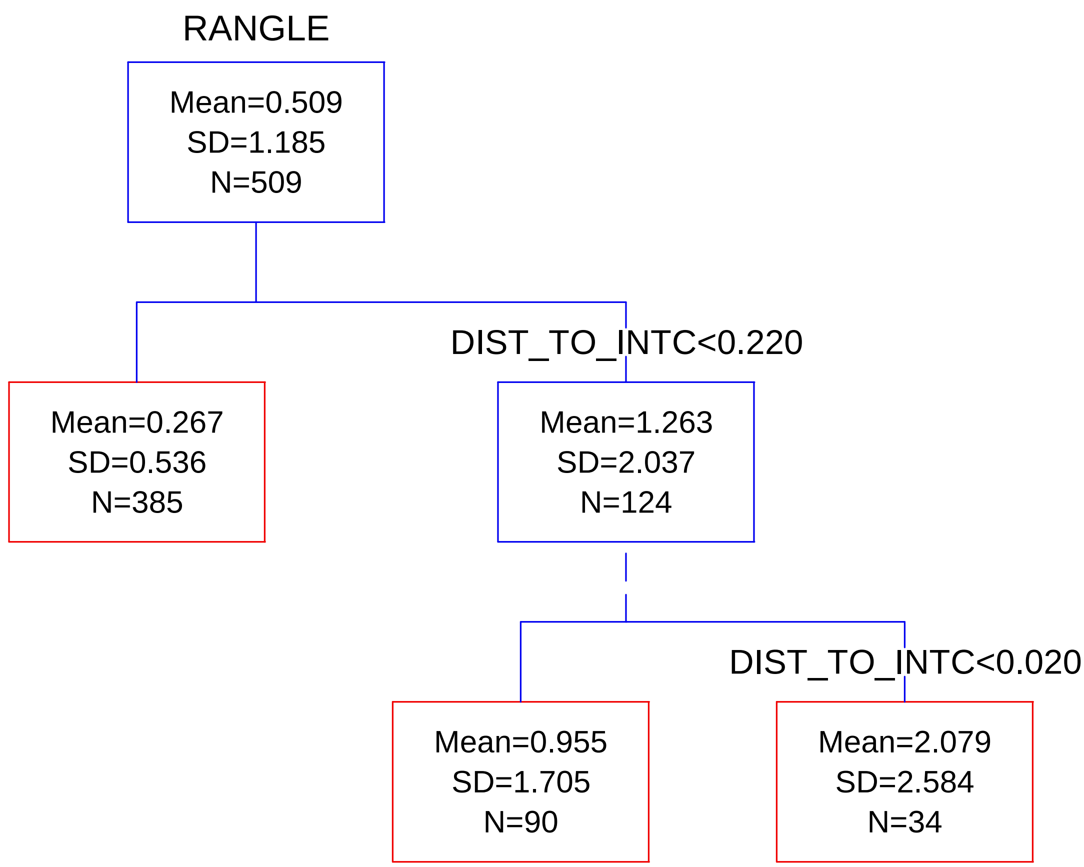


Figure 2.86.District 4 Fixed Object Crash Rate

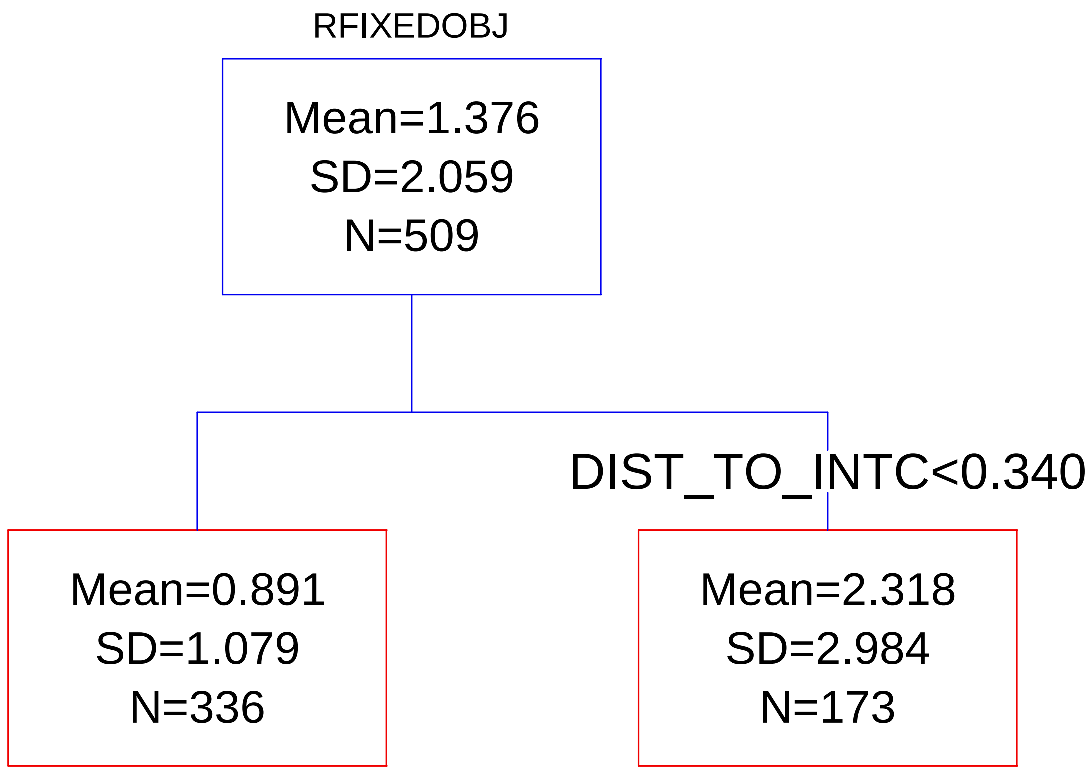


Figure 2.87.District 4 Rear end Crash Rate

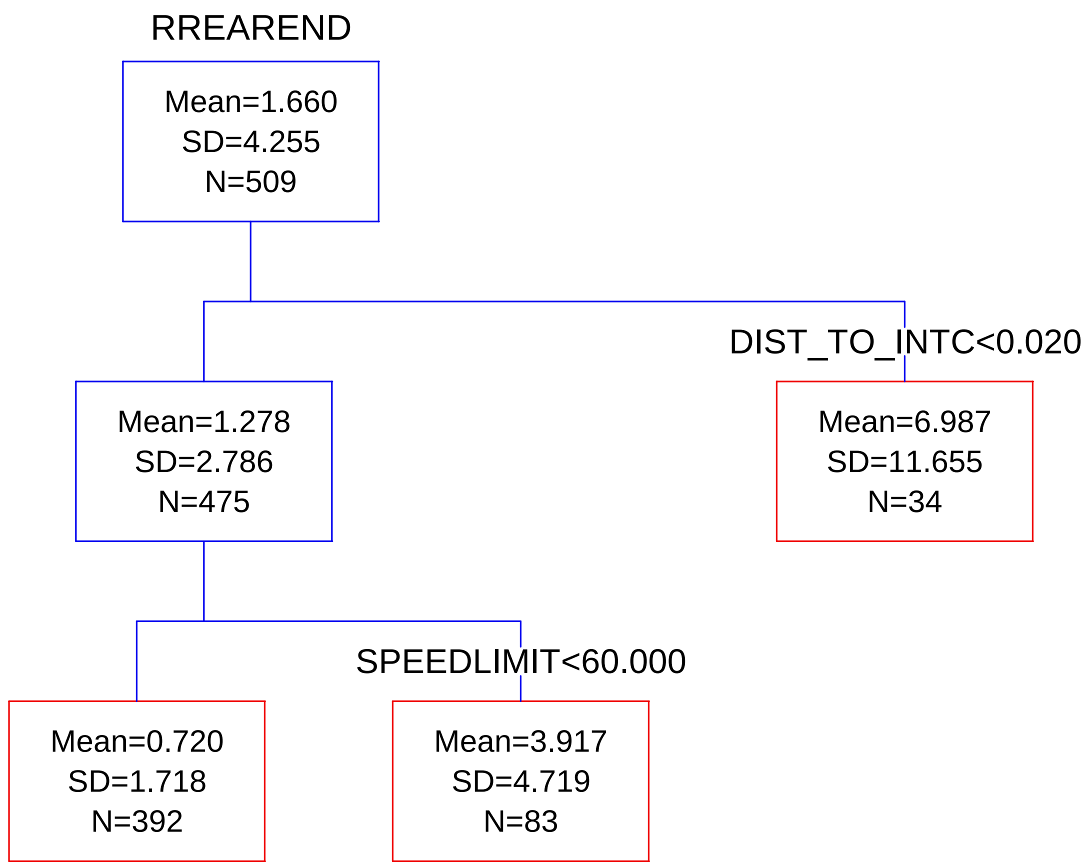


Figure 2.88.District 4 Sideswipe Crash Rate

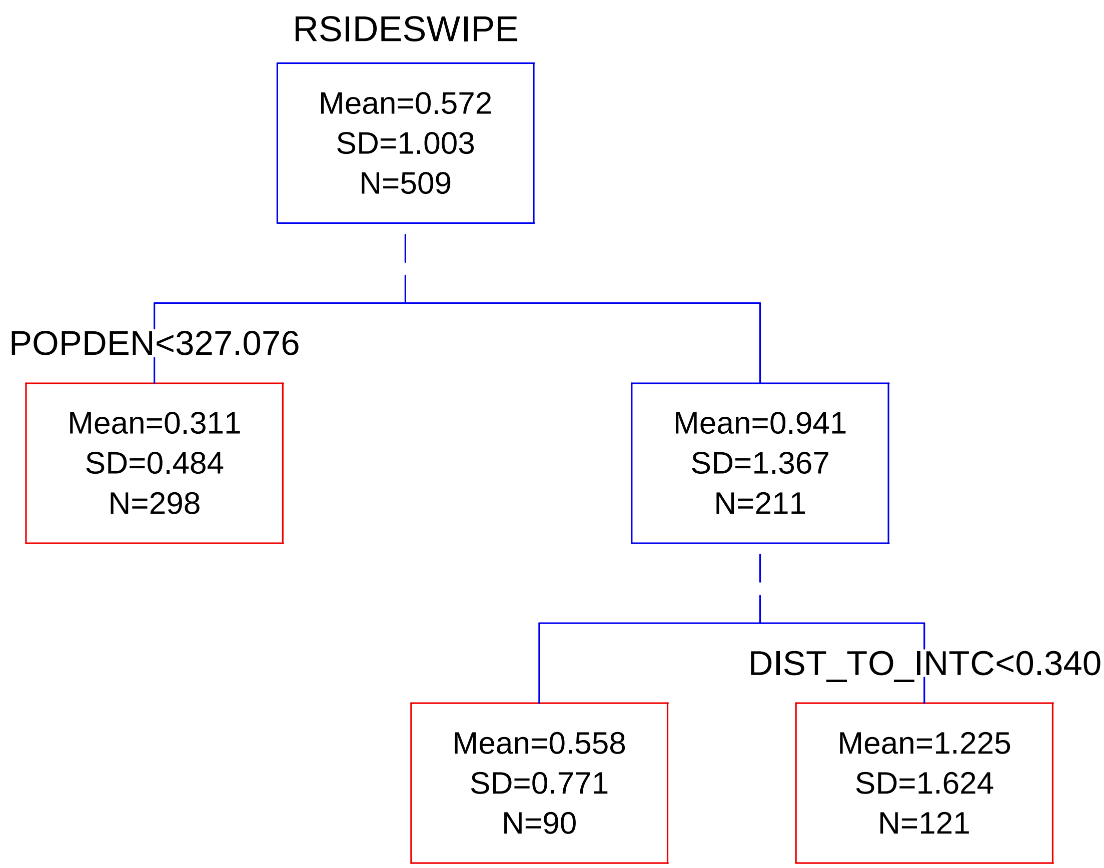


Figure 2.89.District 4 Road wet Crash Rate

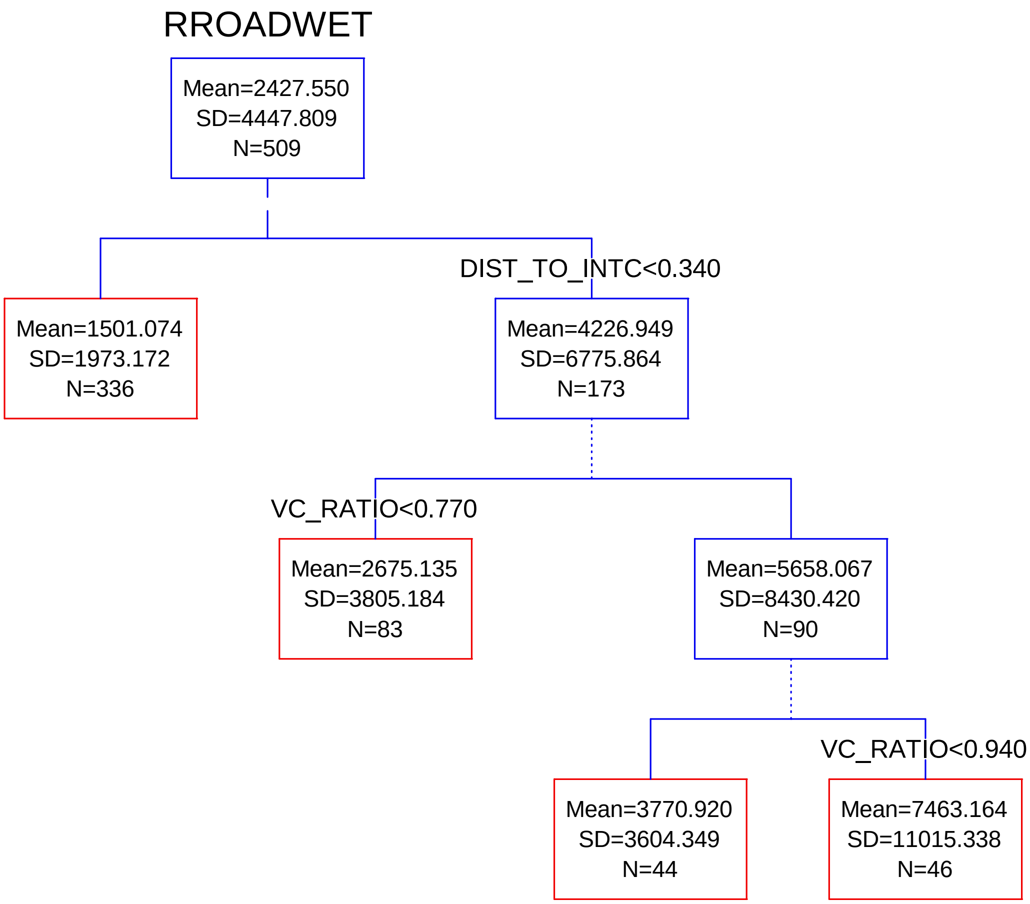
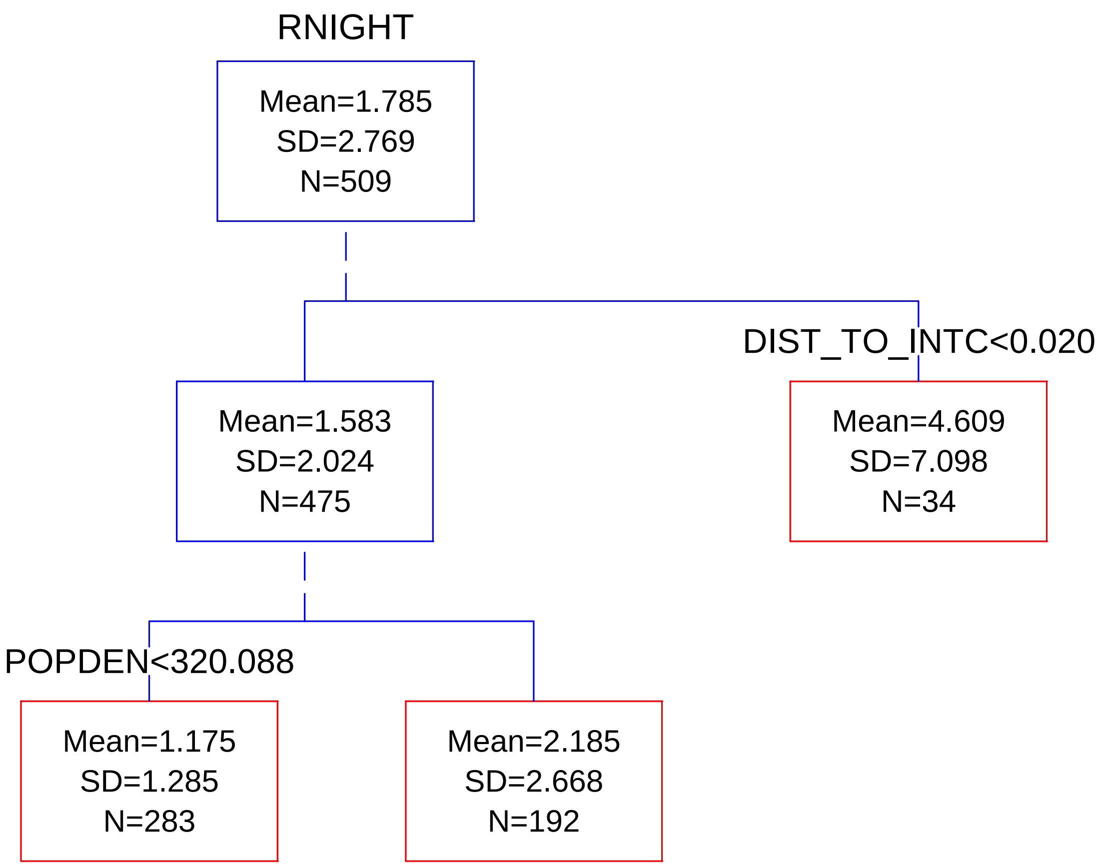


Figure 2.90.District 4 Night Crash Rate



AID Trees for District 5

Figure 2.91.District 5 Injury/Fatal Crash Density

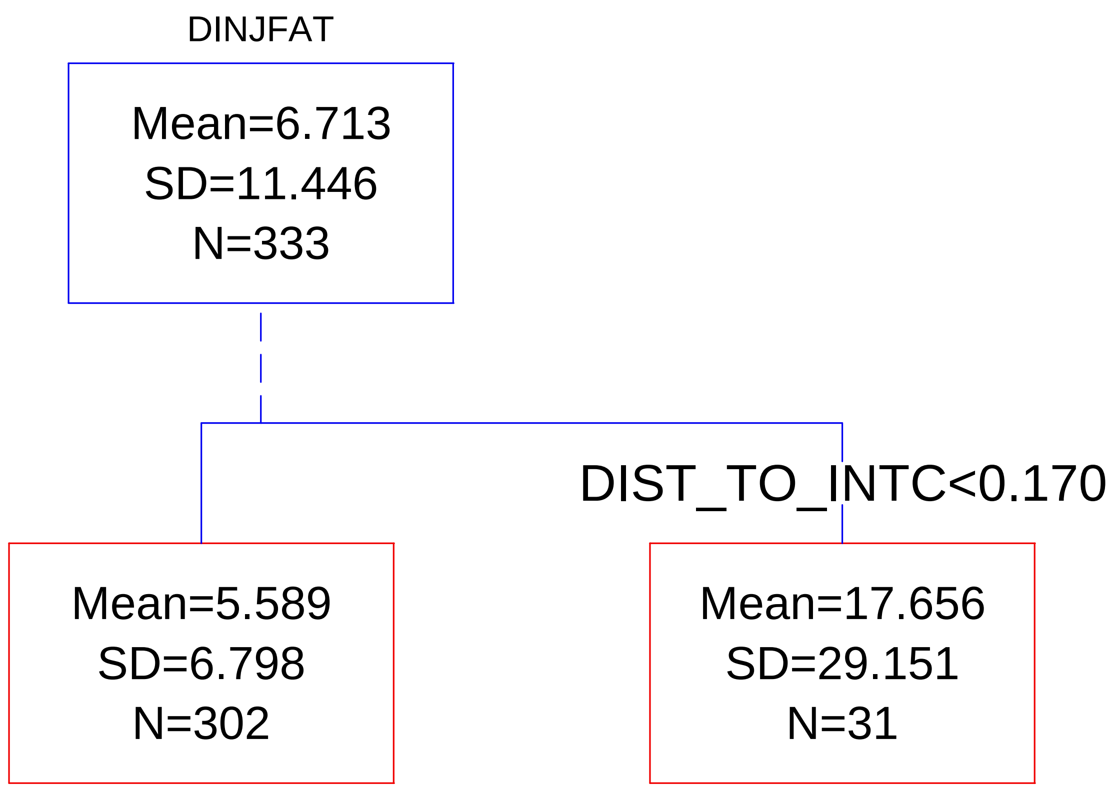


Figure 2.92.District 5 Property damage only Crash Density

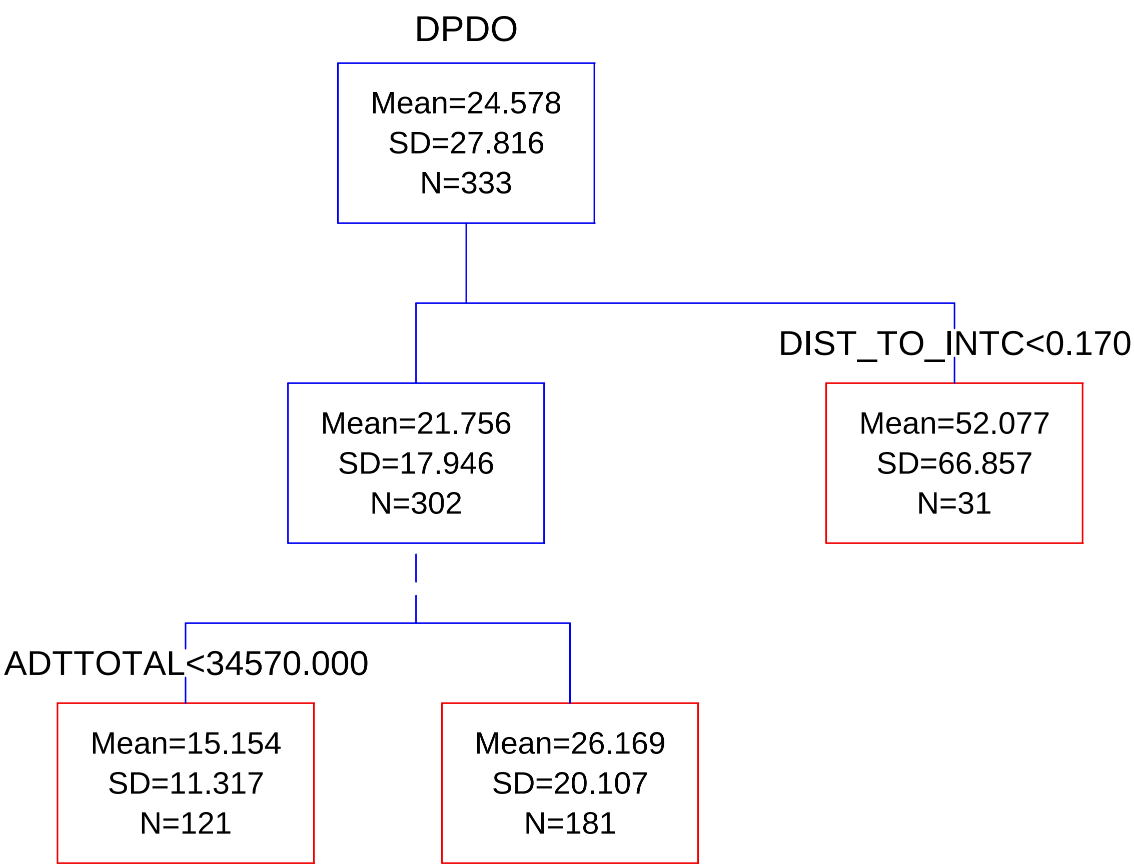


Figure 2.93.District 5 Total Crash Density

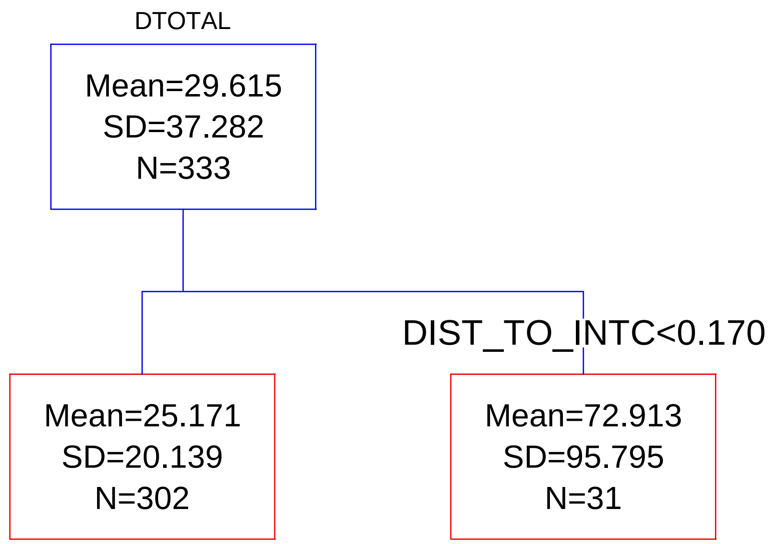


Figure 2.94.District 5 Angle Crash Density

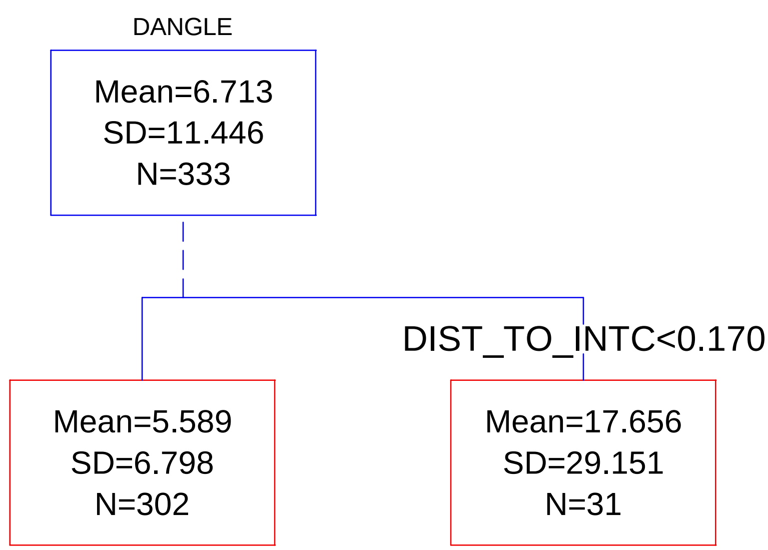


Figure 2.95.District 5 Fixed Object Crash Density

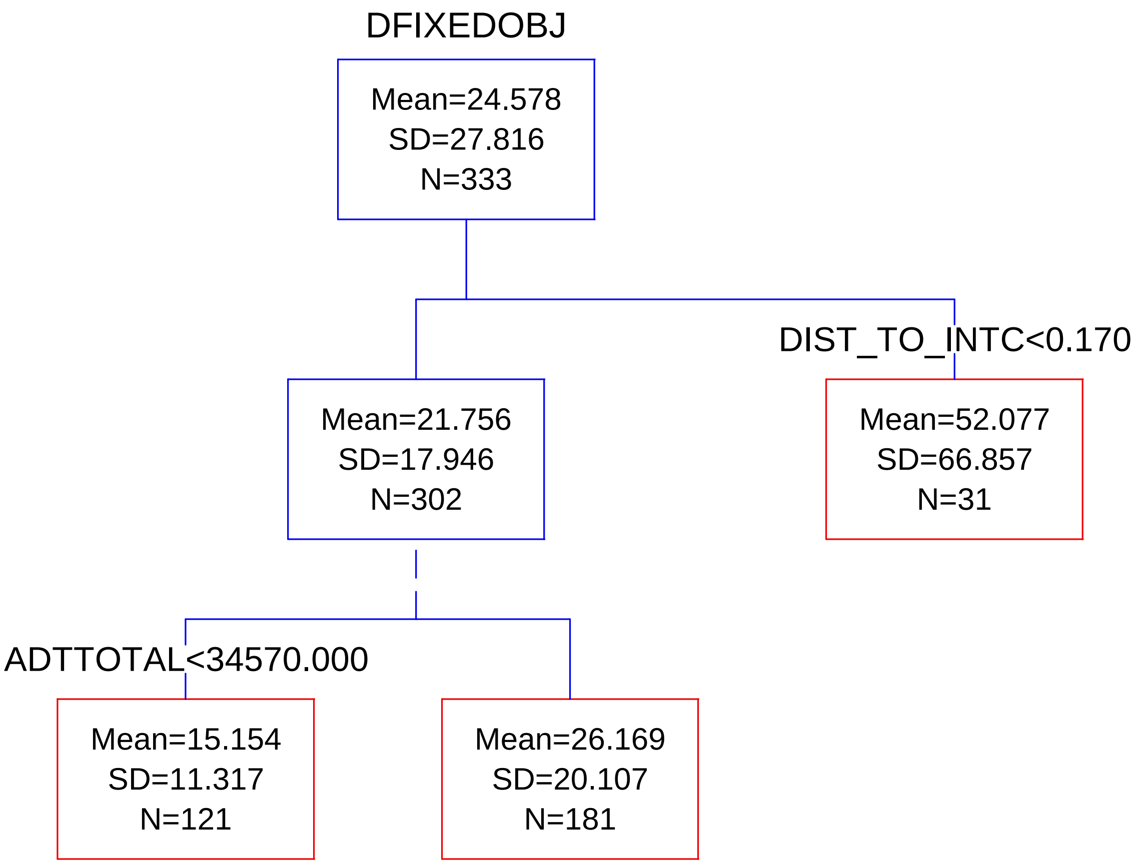


Figure 2.96.District 5 Rear end Crash Density

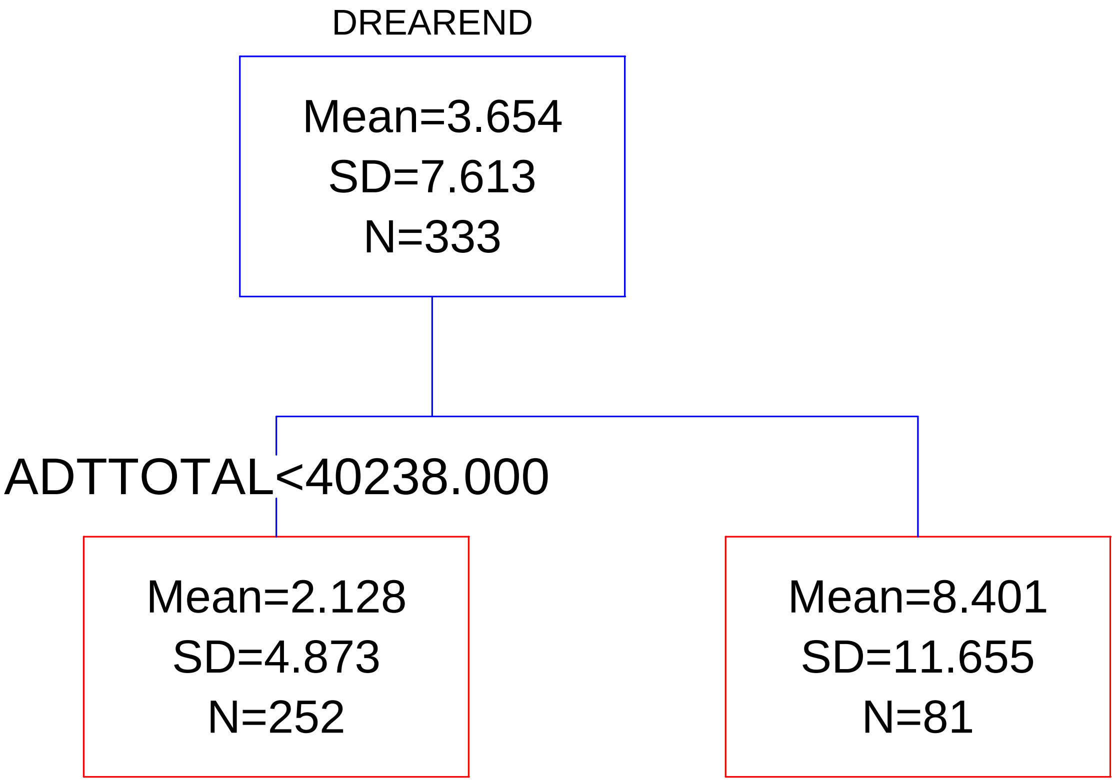


Figure 2.97.District 5 Sideswipe Crash Density

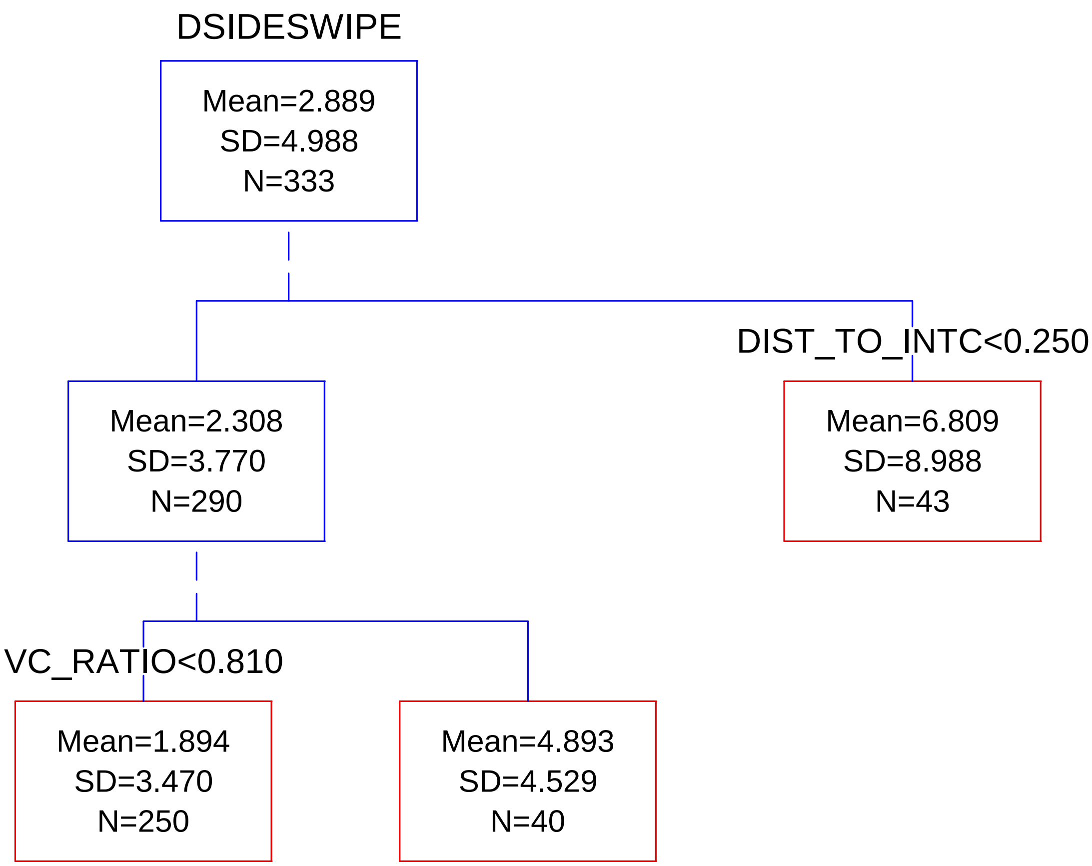


Figure 2.98.District 5 Road wet Crash Density

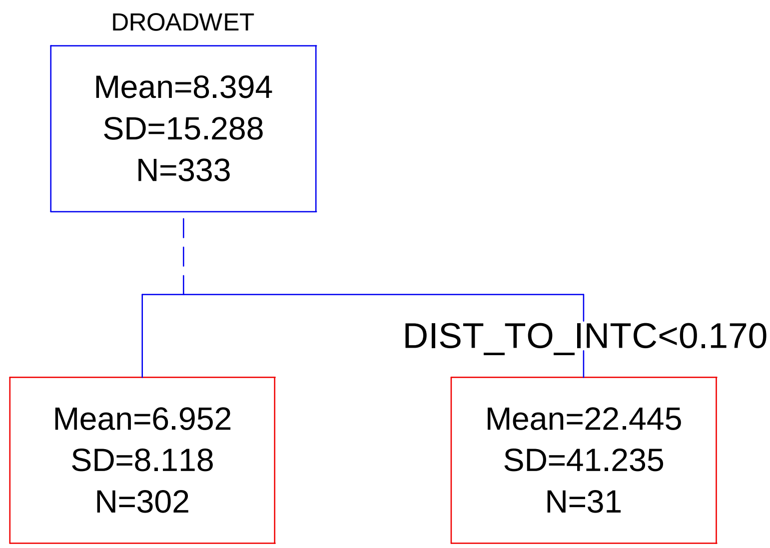


Figure 2.99.District 5 Night Crash Density

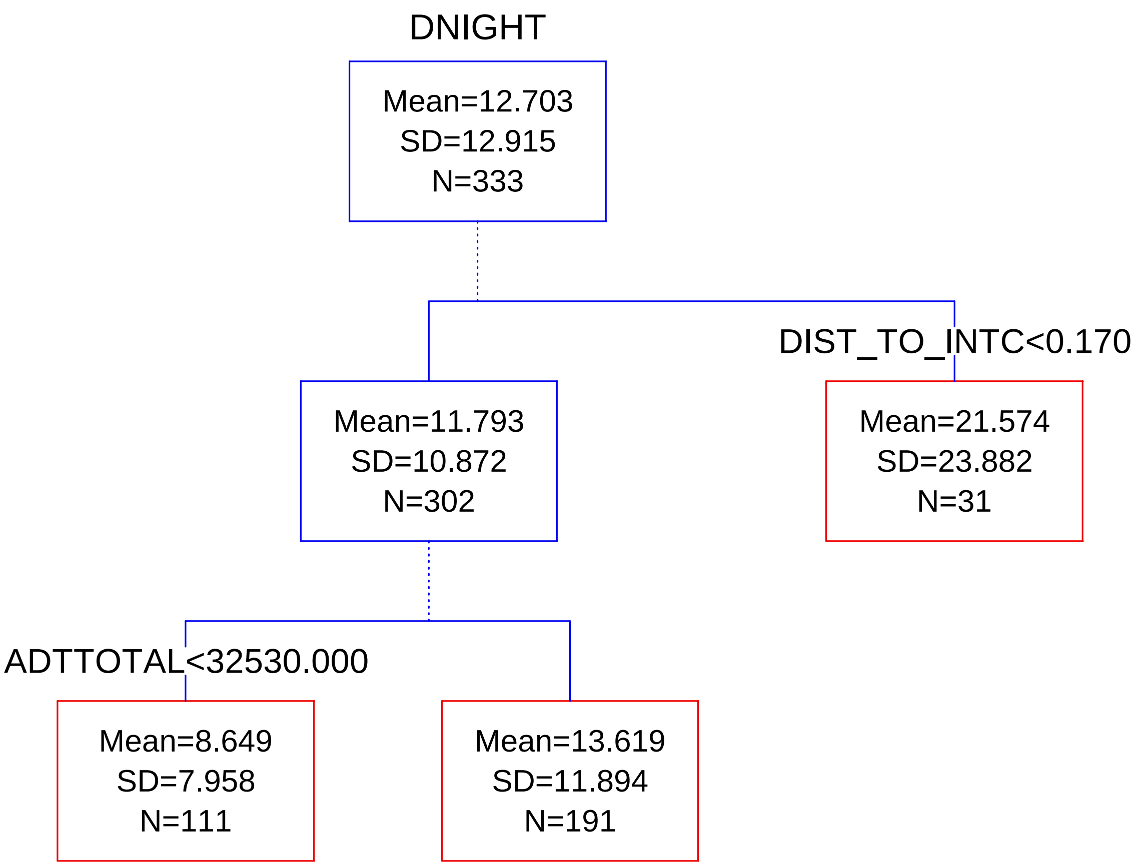


Figure 2.100.District 5 Injury/Fatal Crash Rate

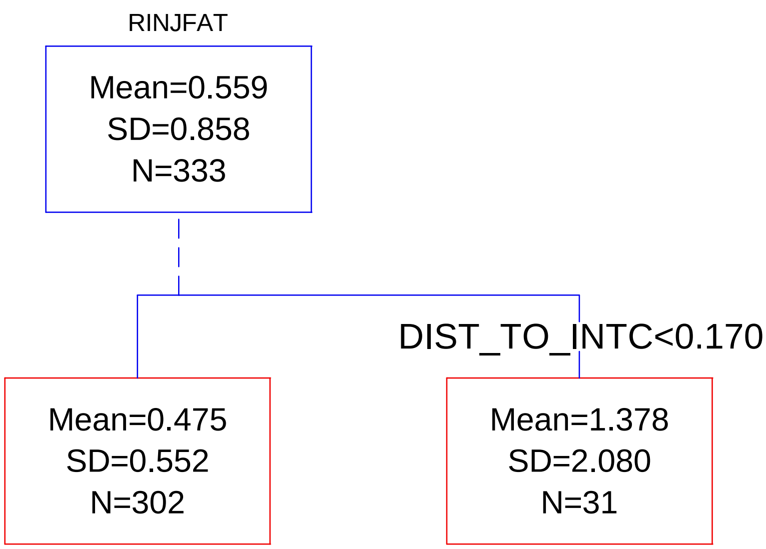


Figure 2.101.District 5 Property damage only Crash Rate

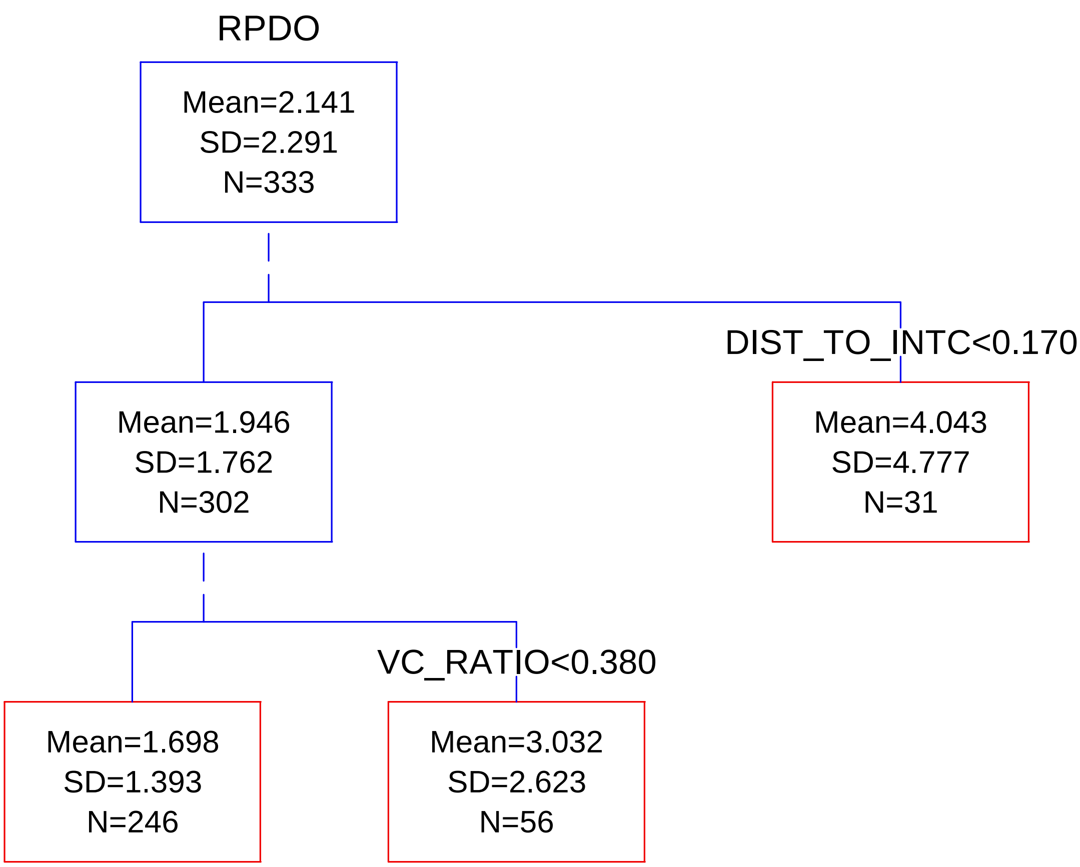


Figure 2.102.District 5 Total Crash Rate

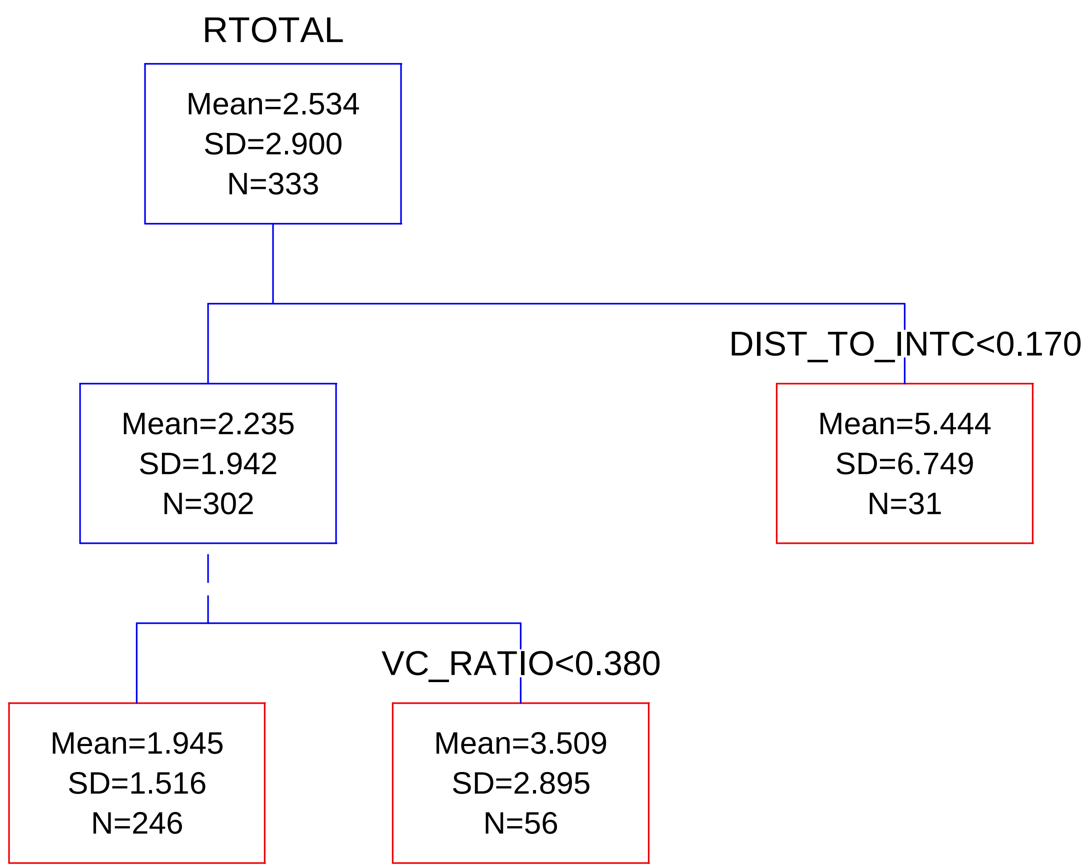


Figure 2.103.District 5 Angle Crash Rate

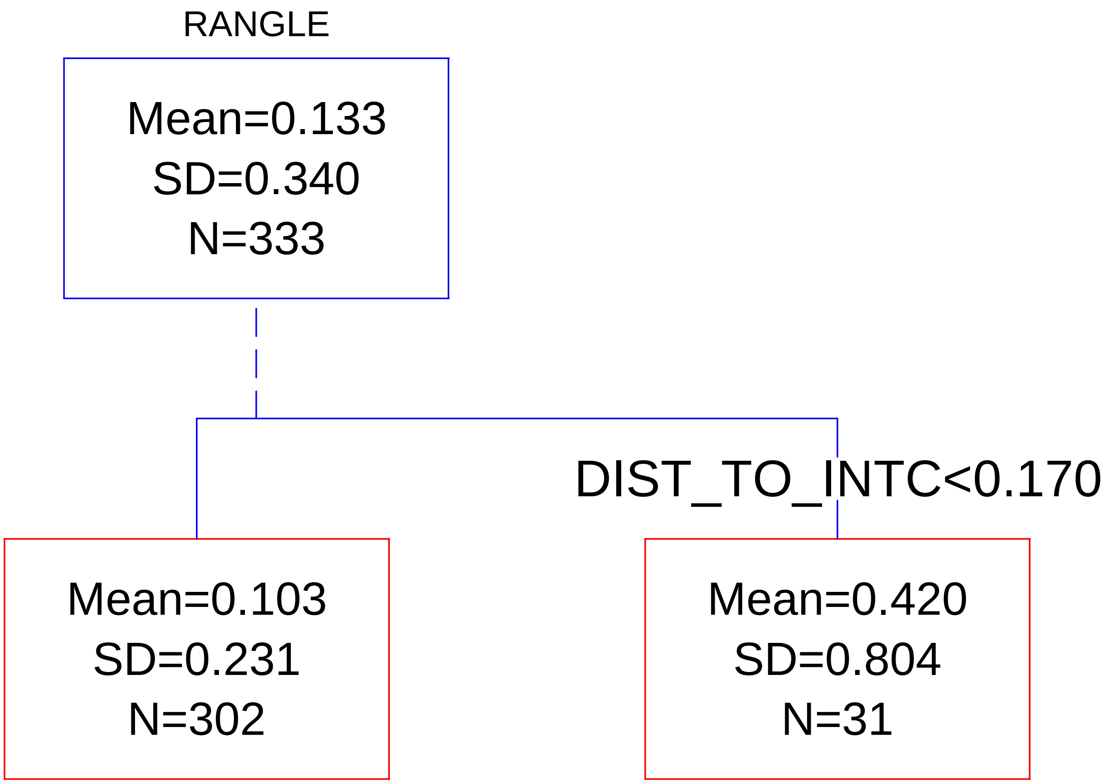


Figure 2.104.District 5 Fixed Object Crash Rate

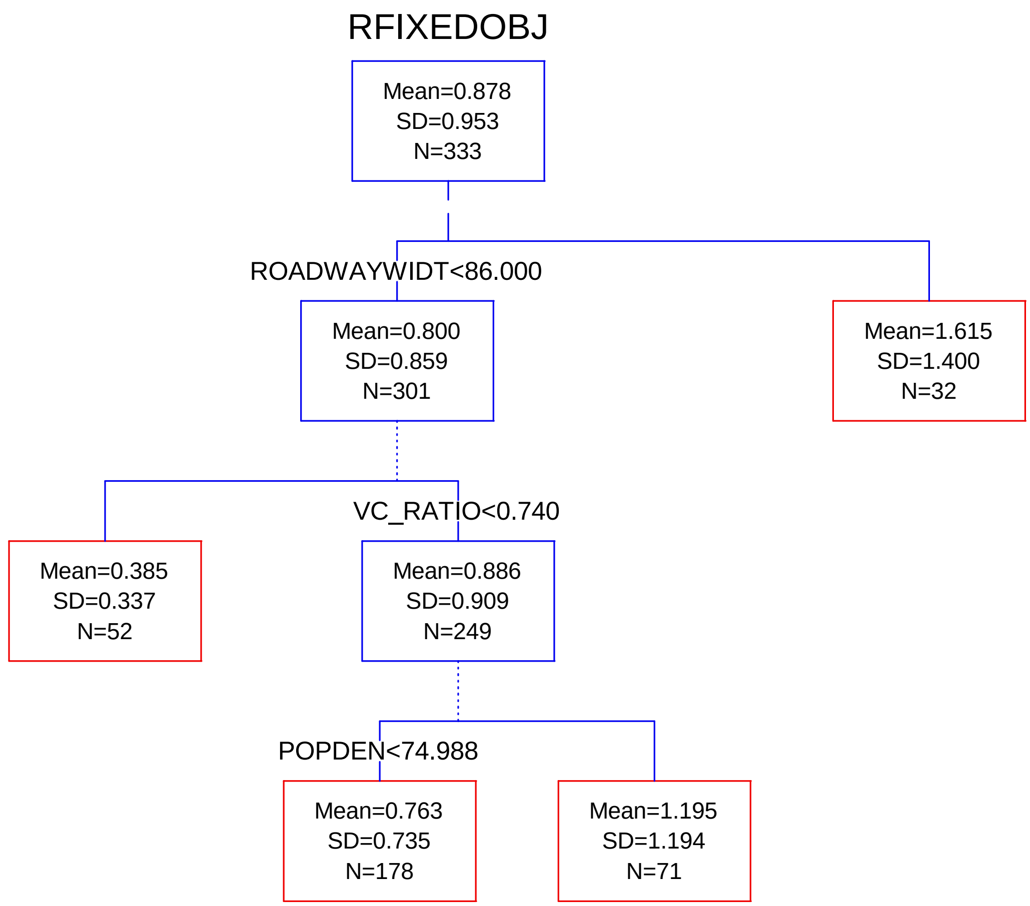


Figure 2.105.District 5 Rear end Crash Rate

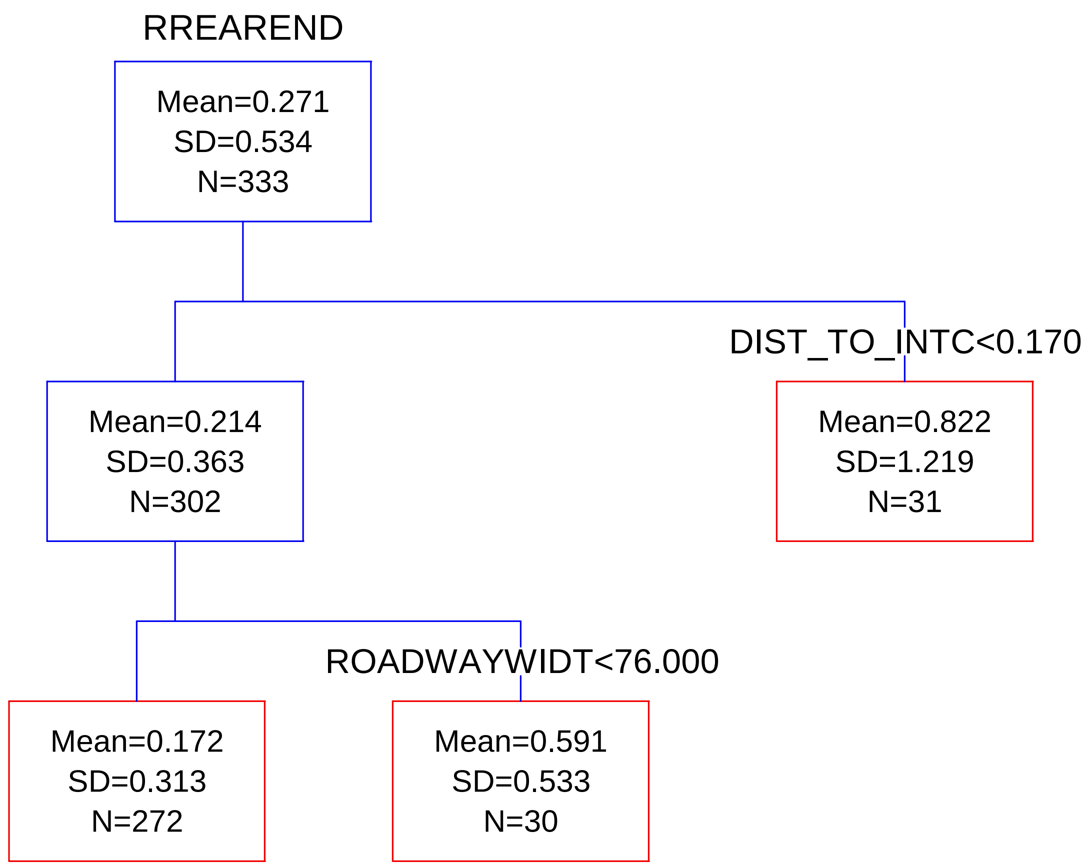


Figure 2.106.District 5 Sideswipe Crash Rate

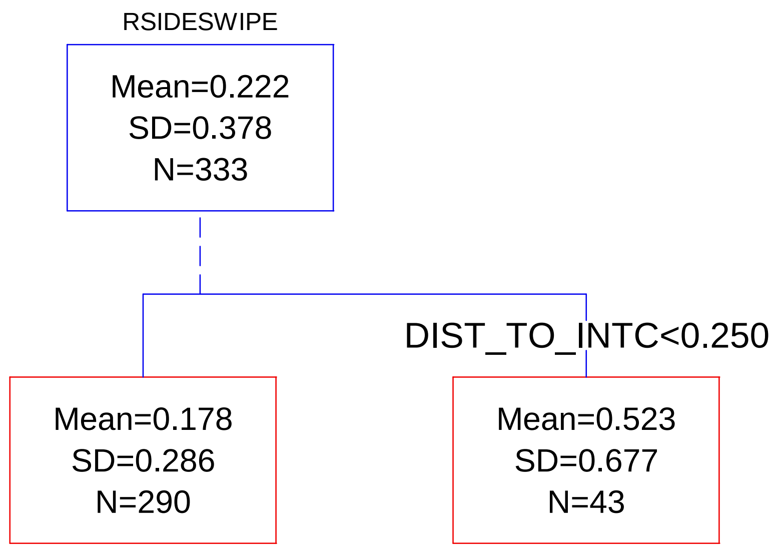


Figure 2.107.District 5 Road wet Crash Rate

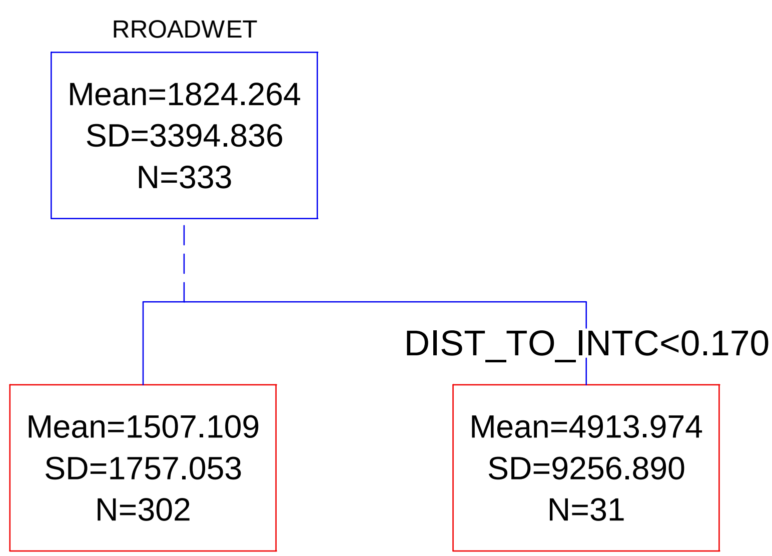
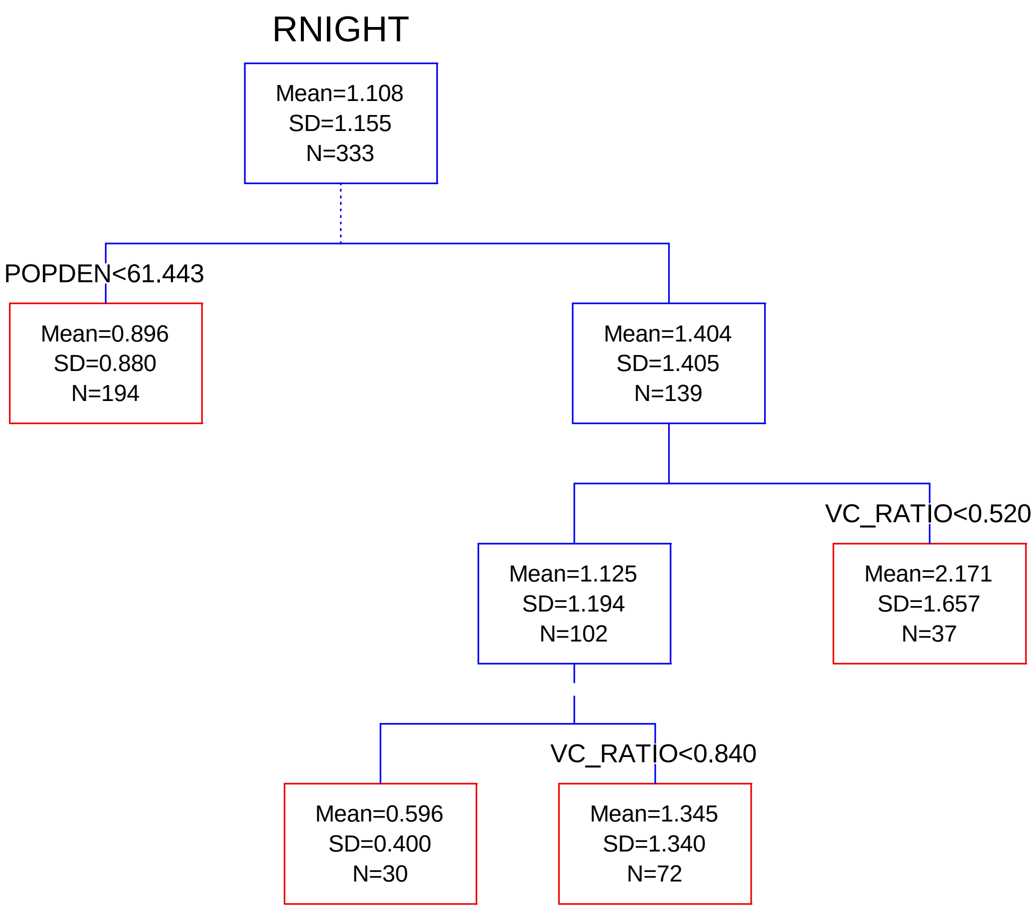


Figure 2.108.District 5 Night Crash Rate



AID Tree for District 6

Figure 2.109.District 6 Injury/Fatal Crash Density

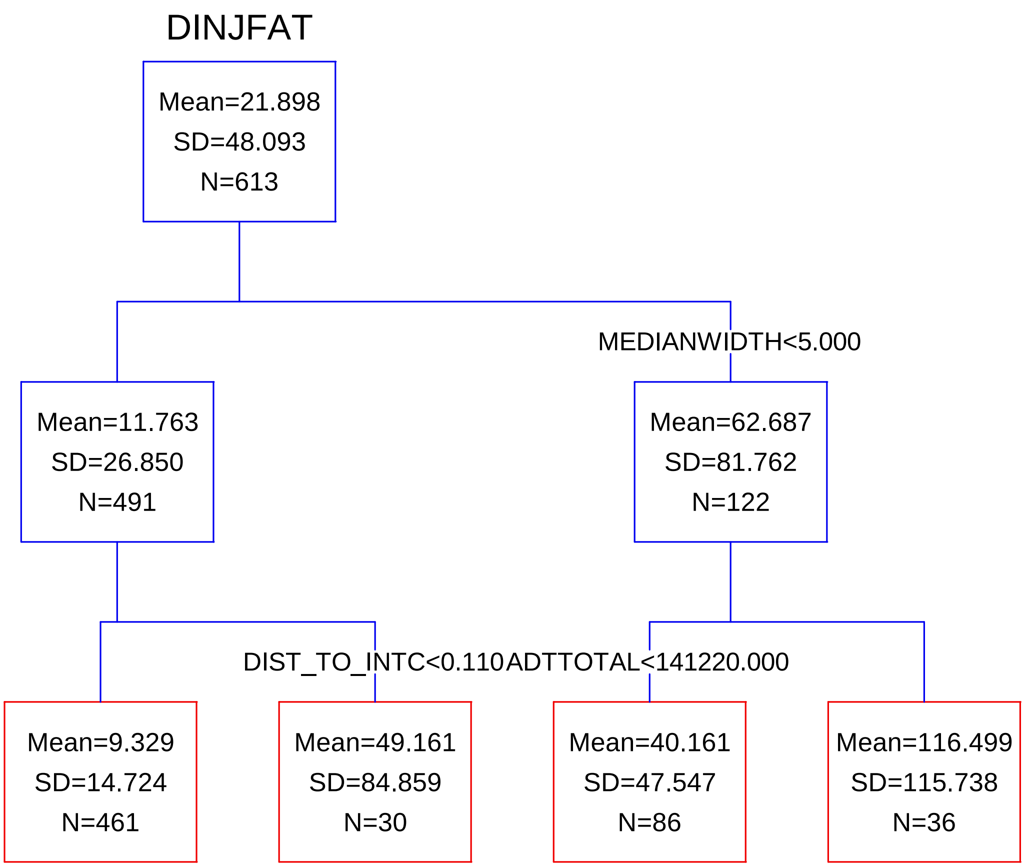


Figure 2.110.District 6 Property damage only Crash Density

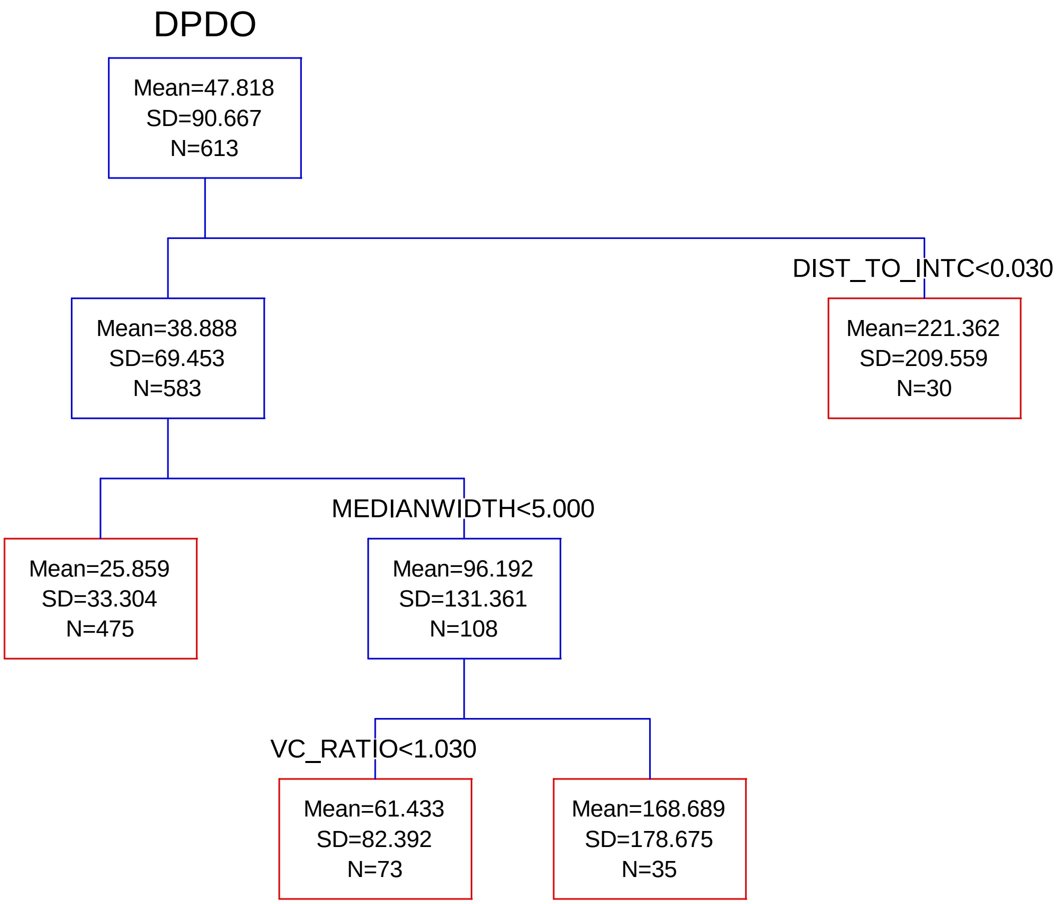


Figure 2.111.District 6 Total Crash Density

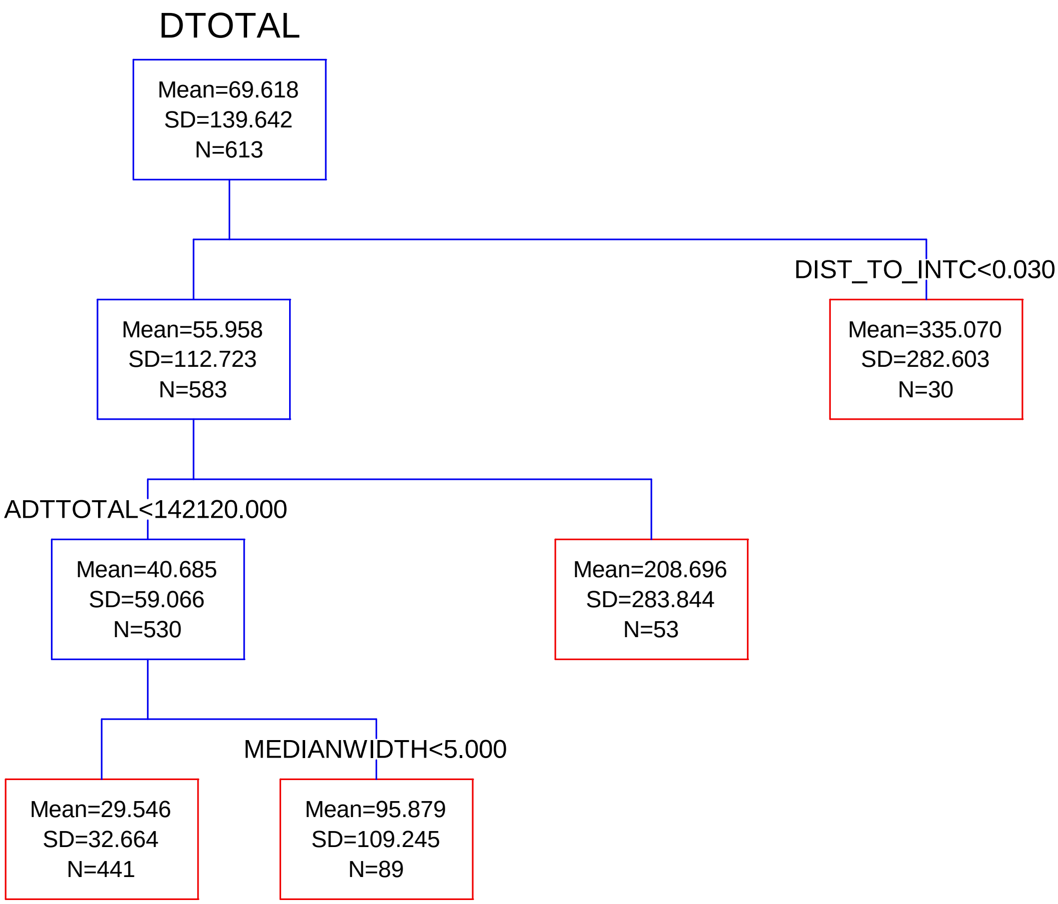


Figure 2.112.District 6 Angle Crash Density

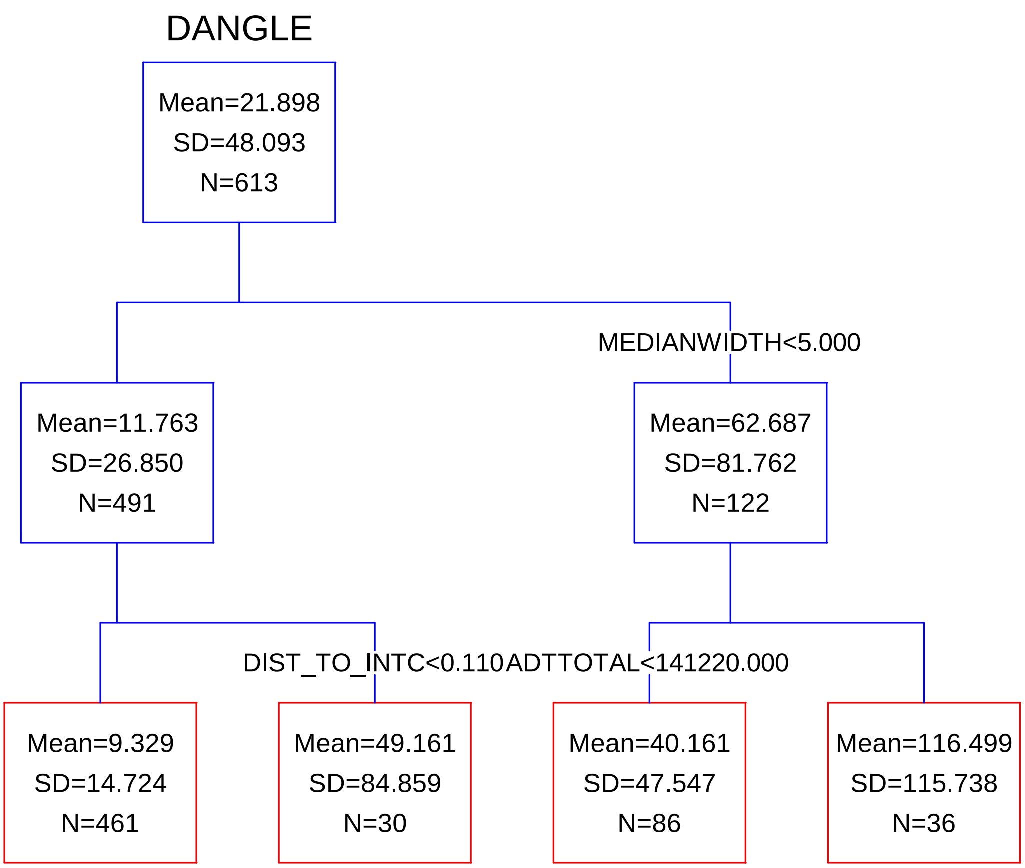


Figure 2.113.District 6 Fixed Object Crash Density

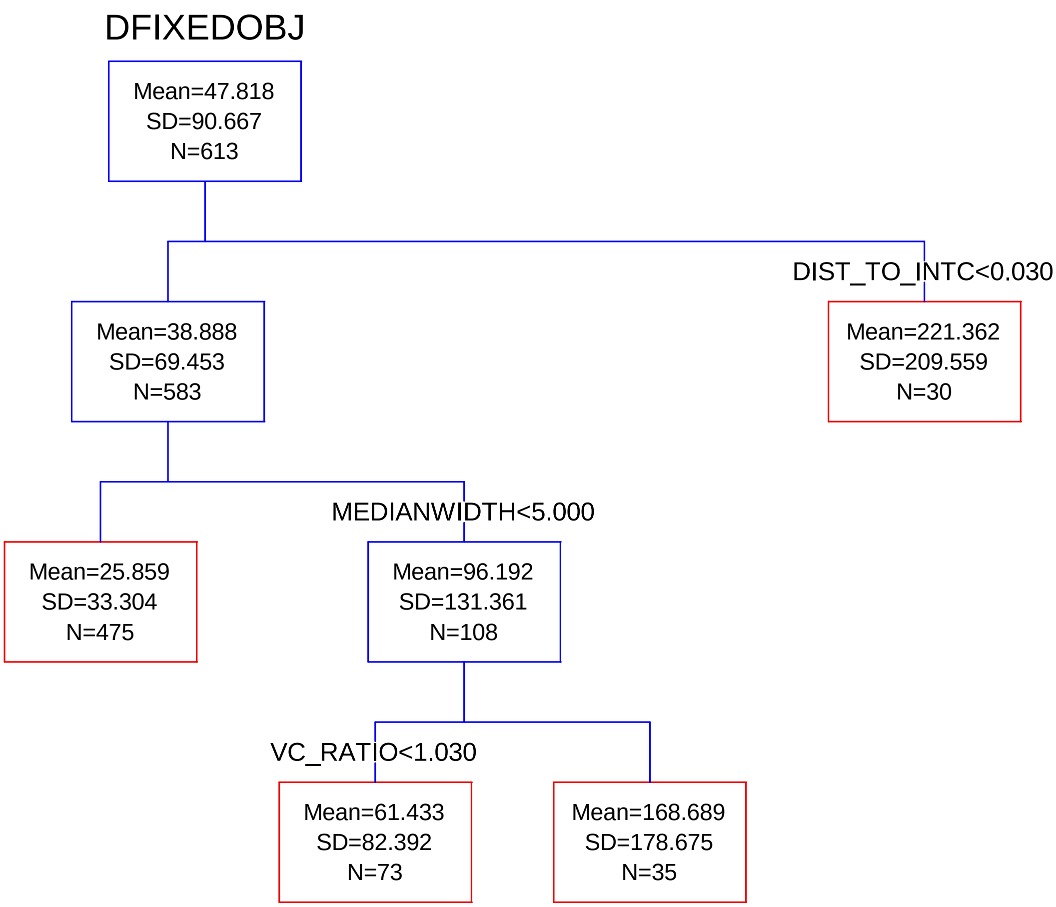


Figure 2.114.District 6 Rear end Crash Density

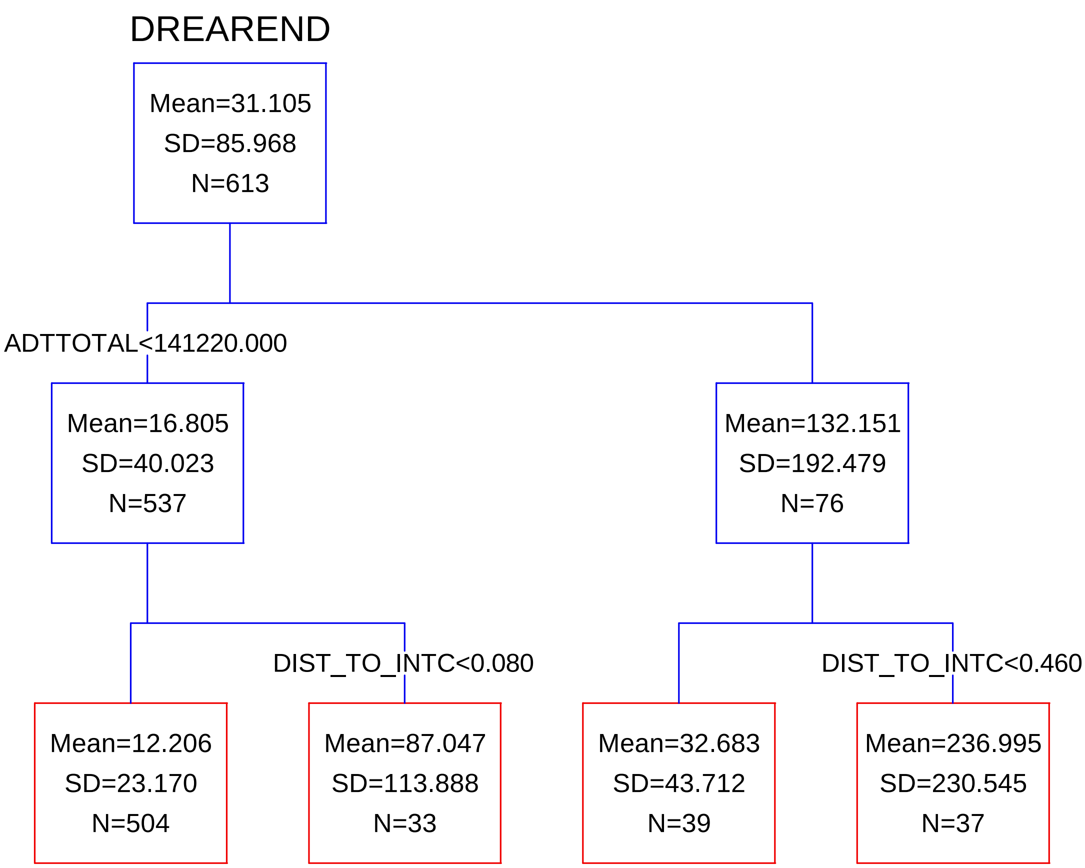


Figure 2.115.District 6 Sideswipe Crash Density

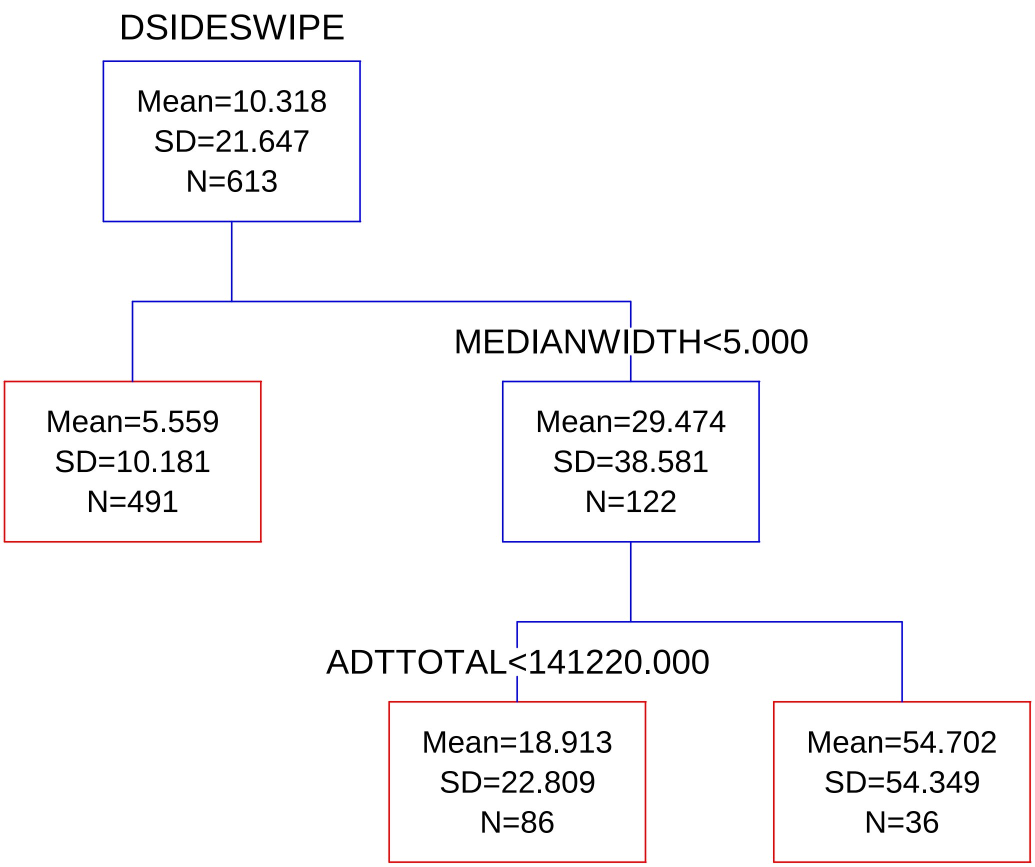


Figure 2.116.District 6 Road wet Crash Density

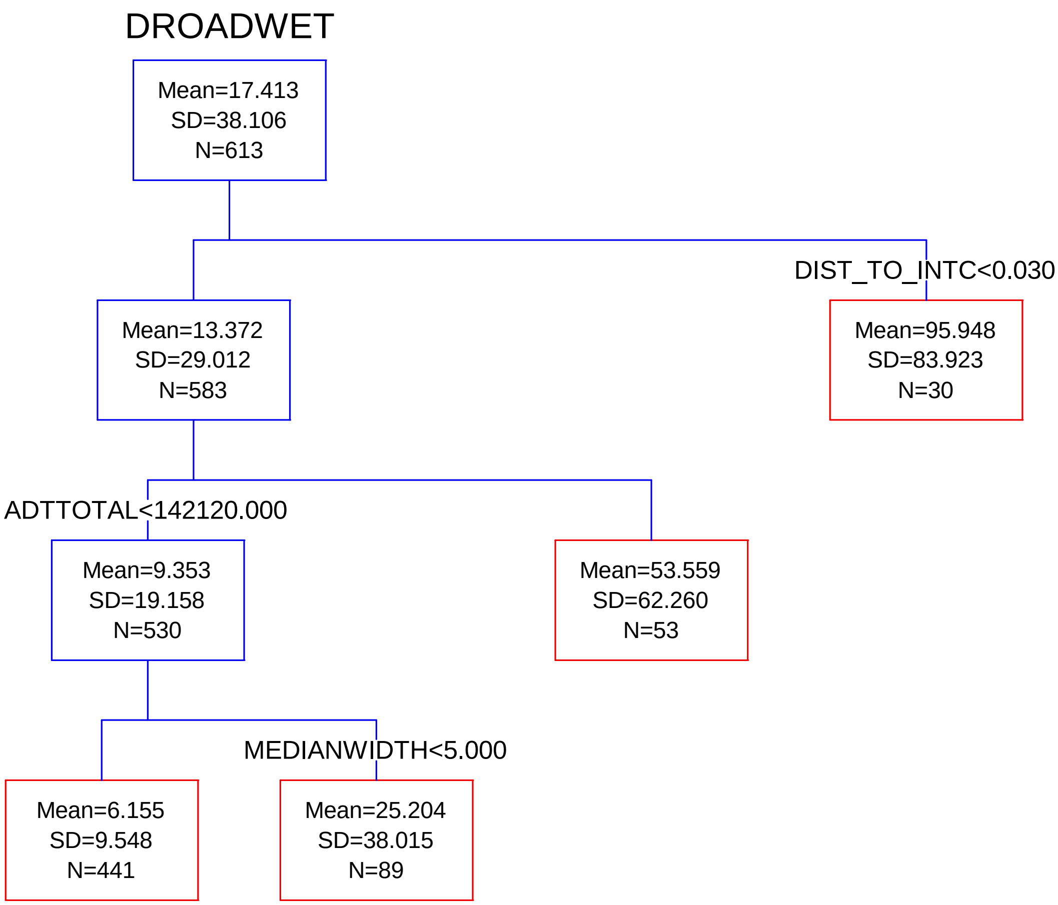


Figure 2.117.District 6 Night Crash Density

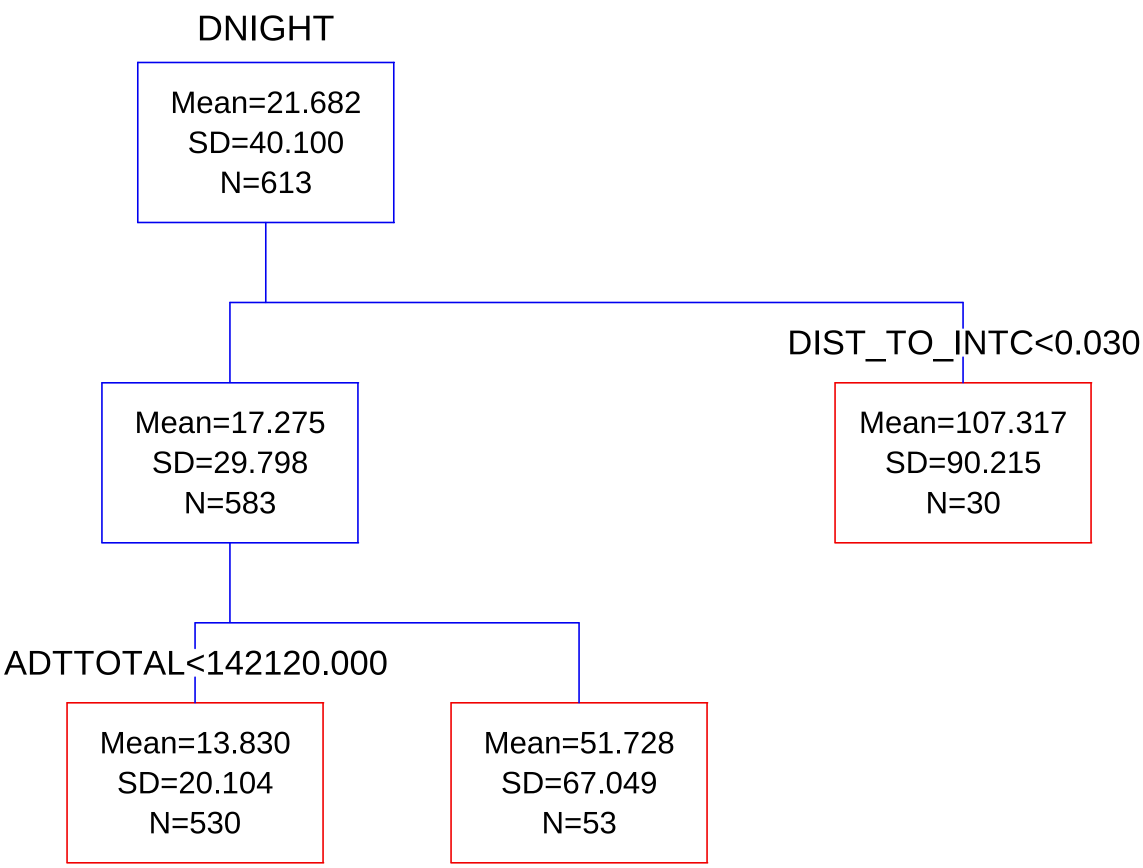


Figure 2.118.District 6 Injury/Fatal Crash Rate

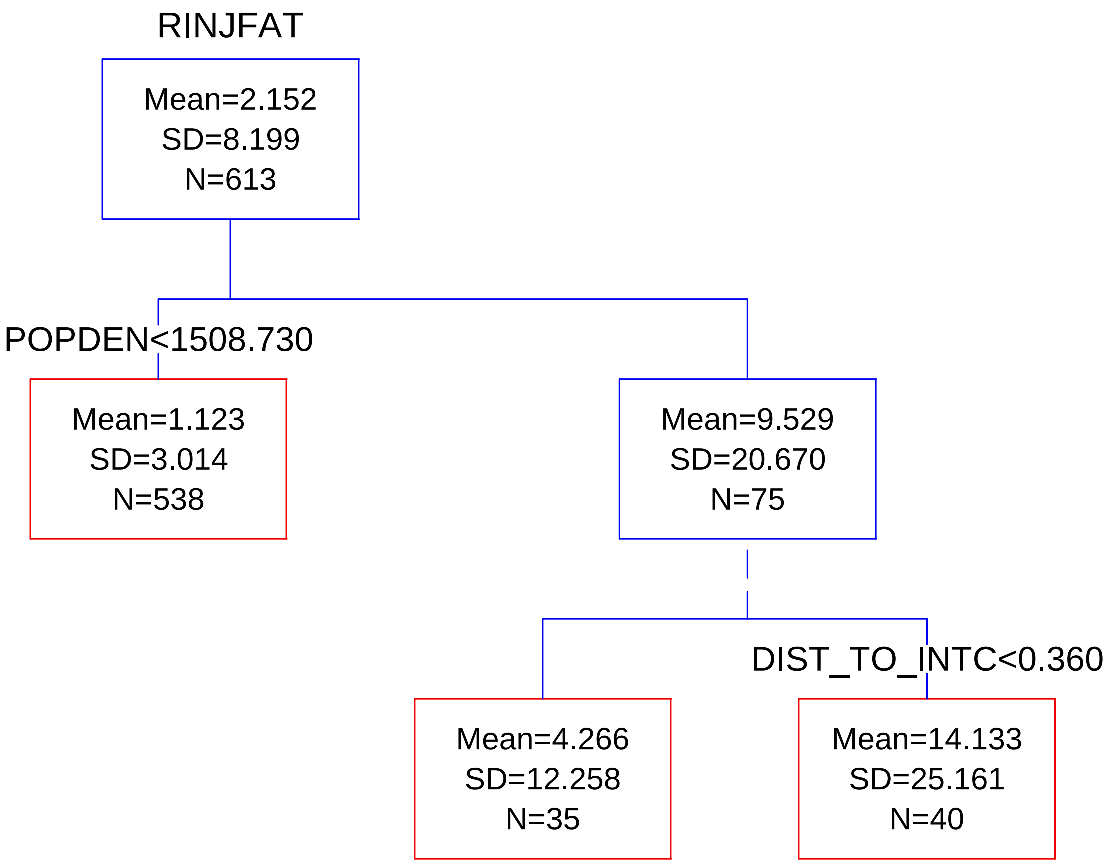


Figure 2.119.District 6 Property damage only Crash Rate

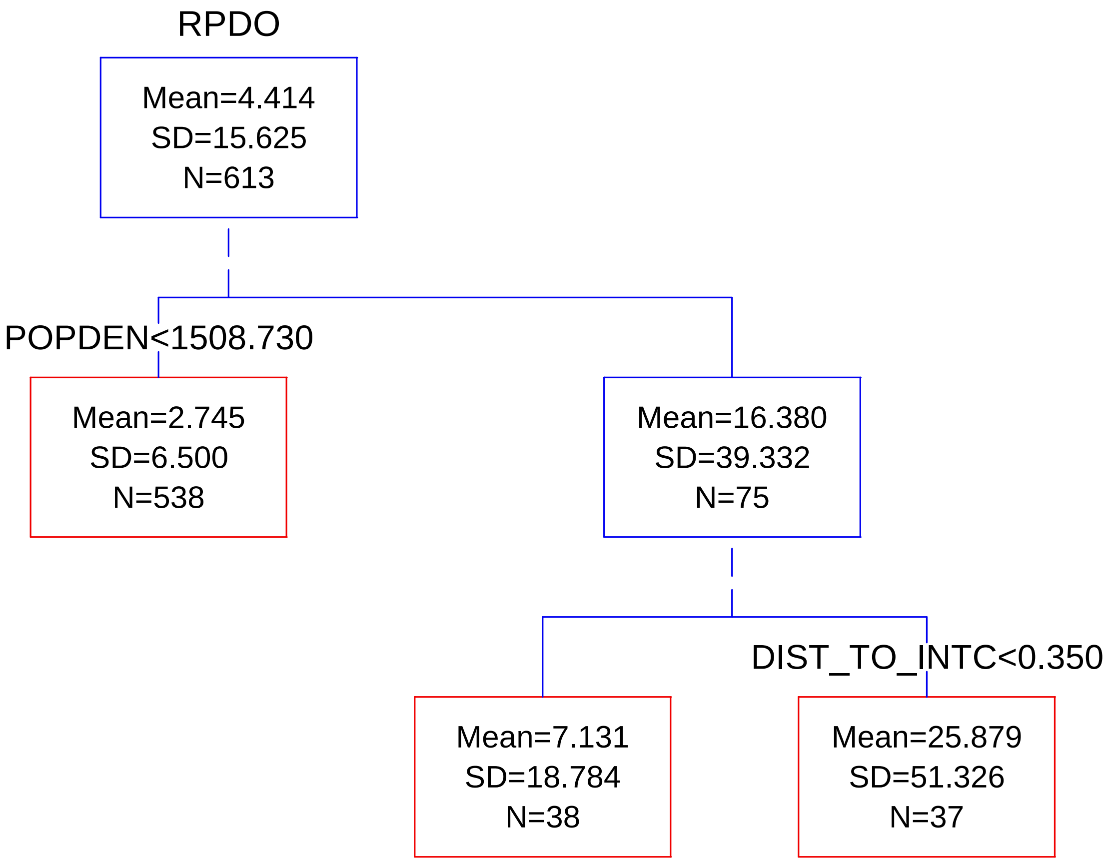


Figure 2.120.District 6 Total Crash Rate

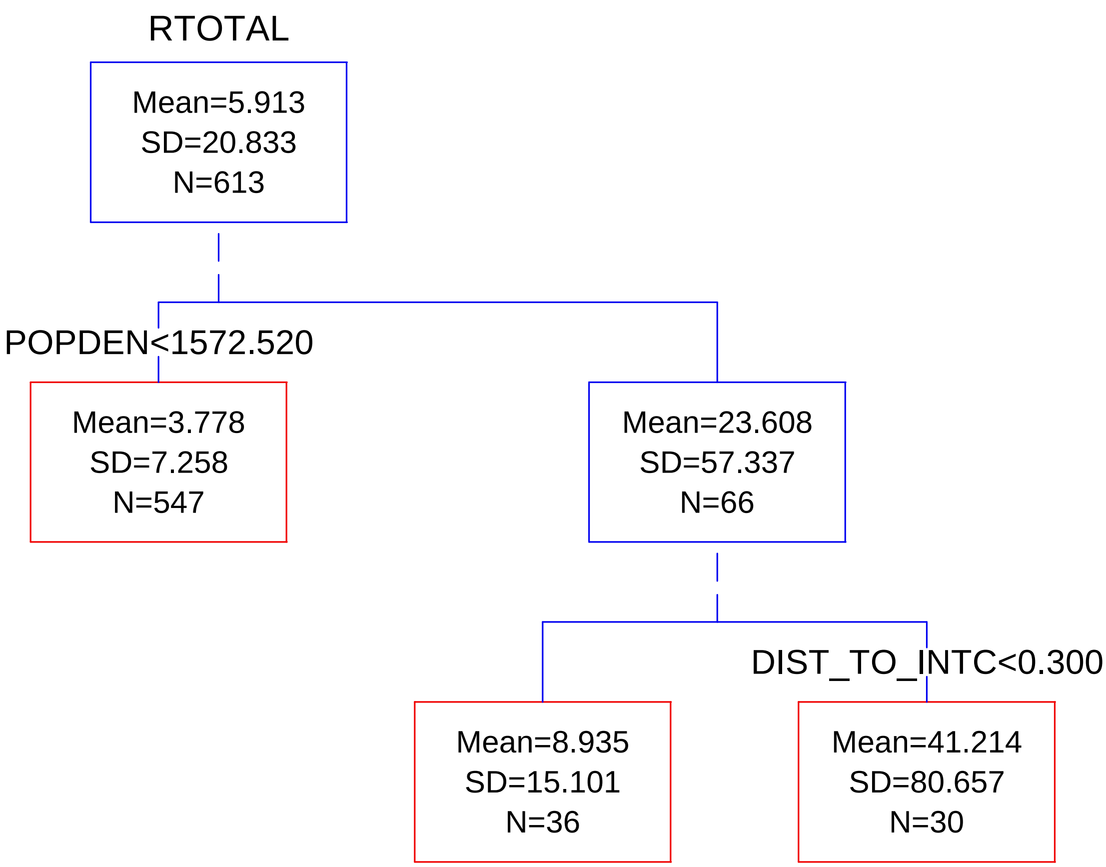


Figure 2.121.District 6 Angle Crash Rate

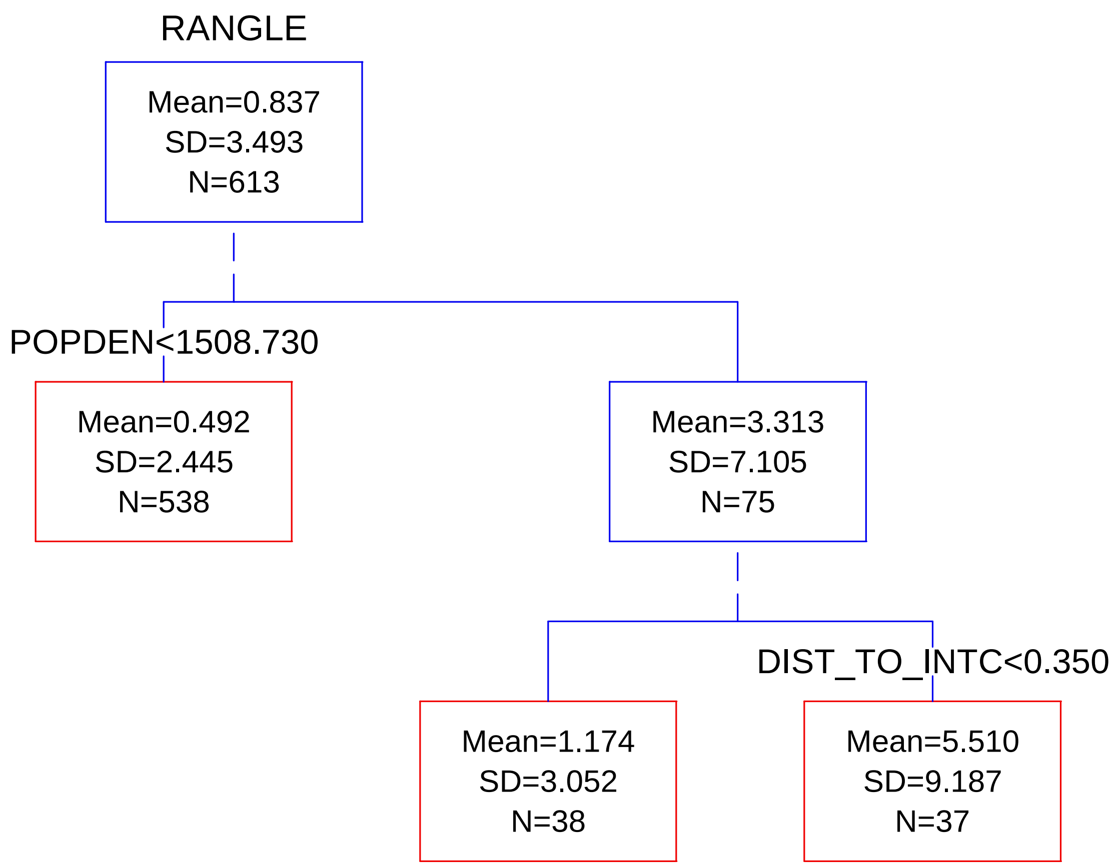


Figure 2.122.District 6 Fixed Object Crash Rate

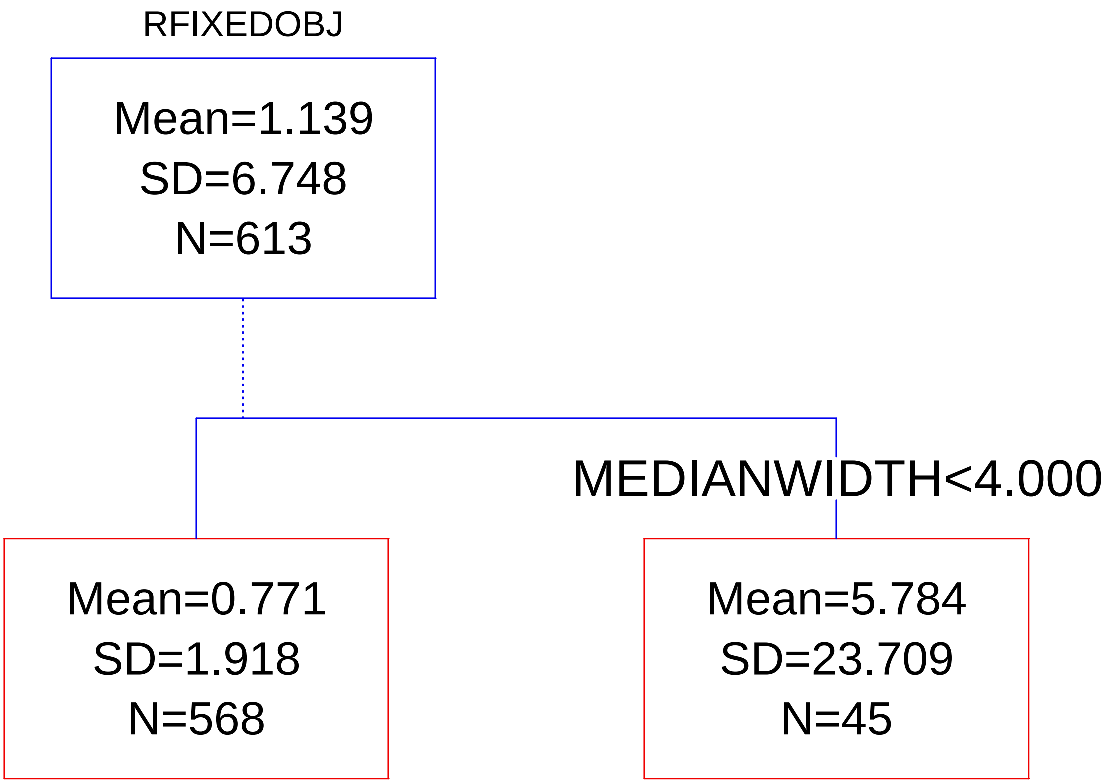


Figure 2.123.District 6 Rear end Crash Rate

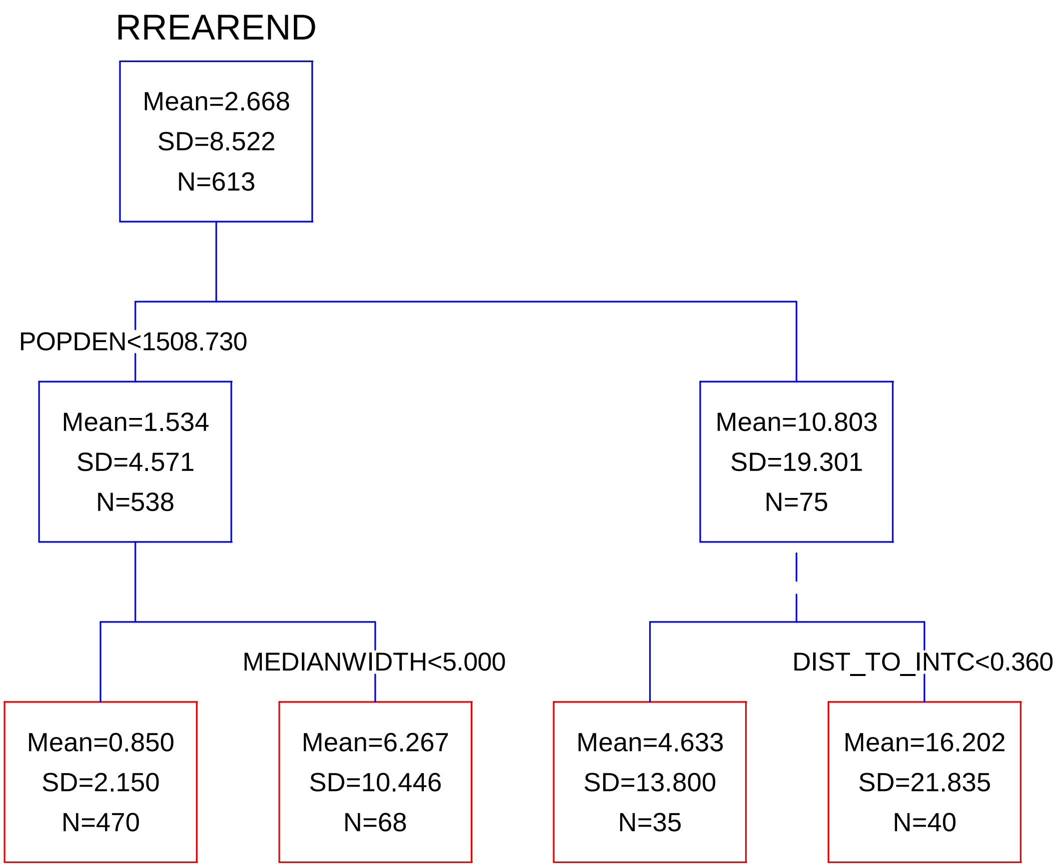


Figure 2.124.District 6 Sideswipe Crash Rate

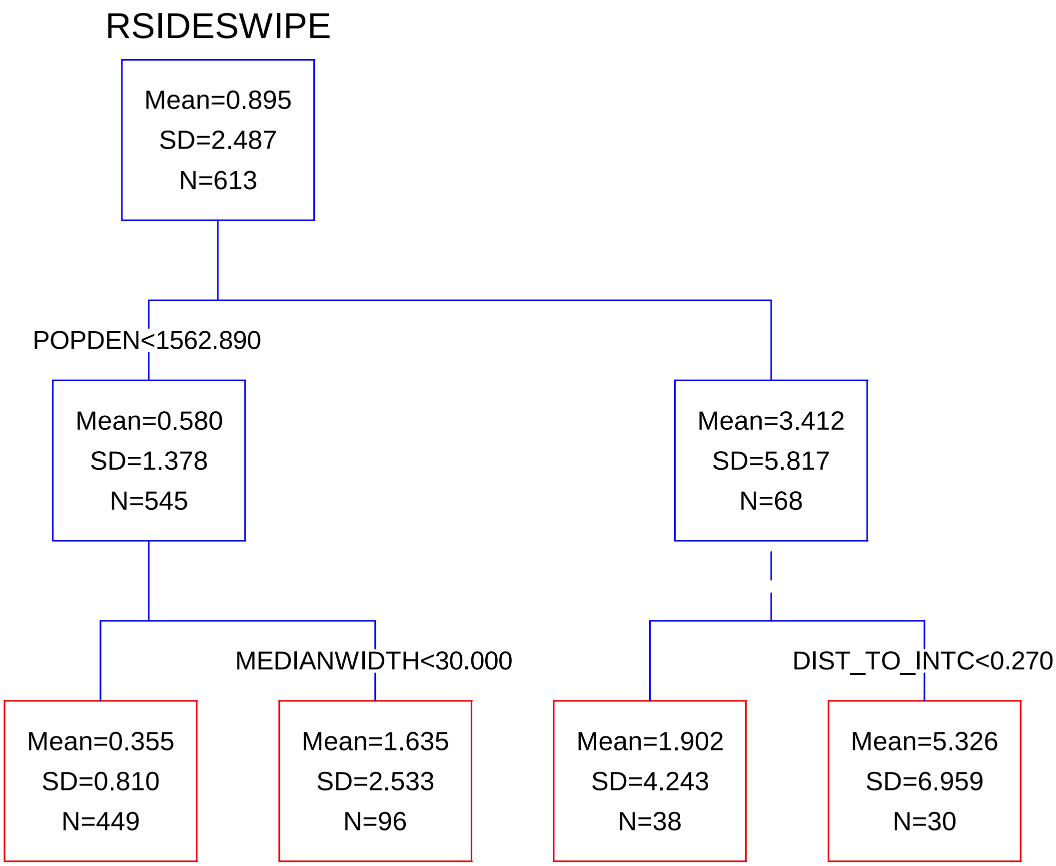


Figure 2.125.District 6 Road wet Crash Rate

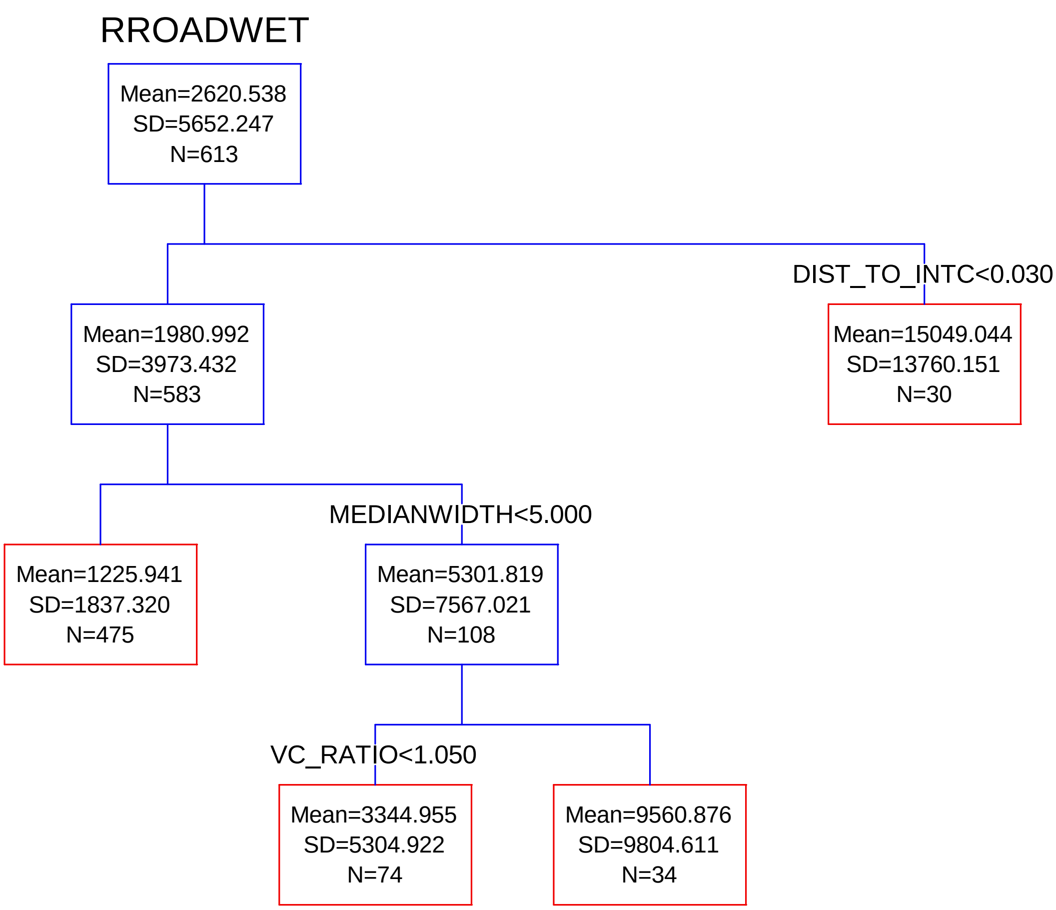
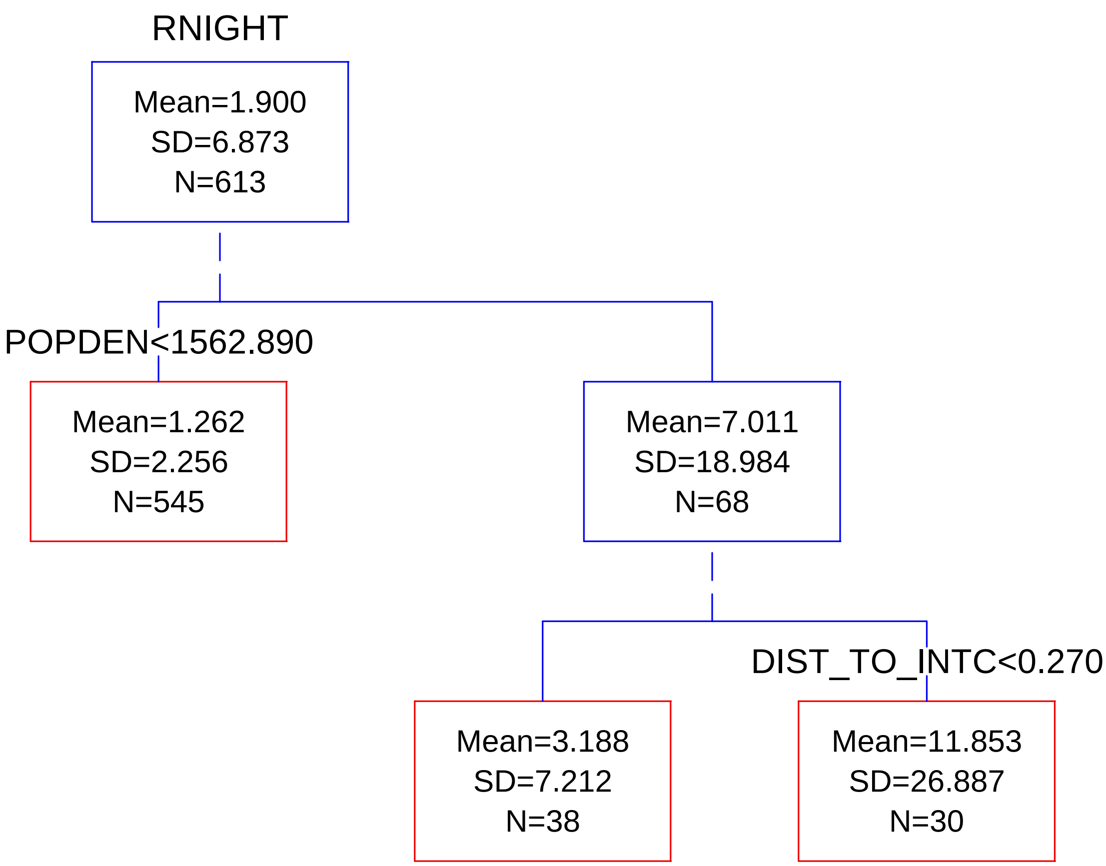


Figure 2.126.District 6 Night Crash Rate



AID Tree for District 7

Figure 2.127.District 7 Injury/Fatal Crash Density

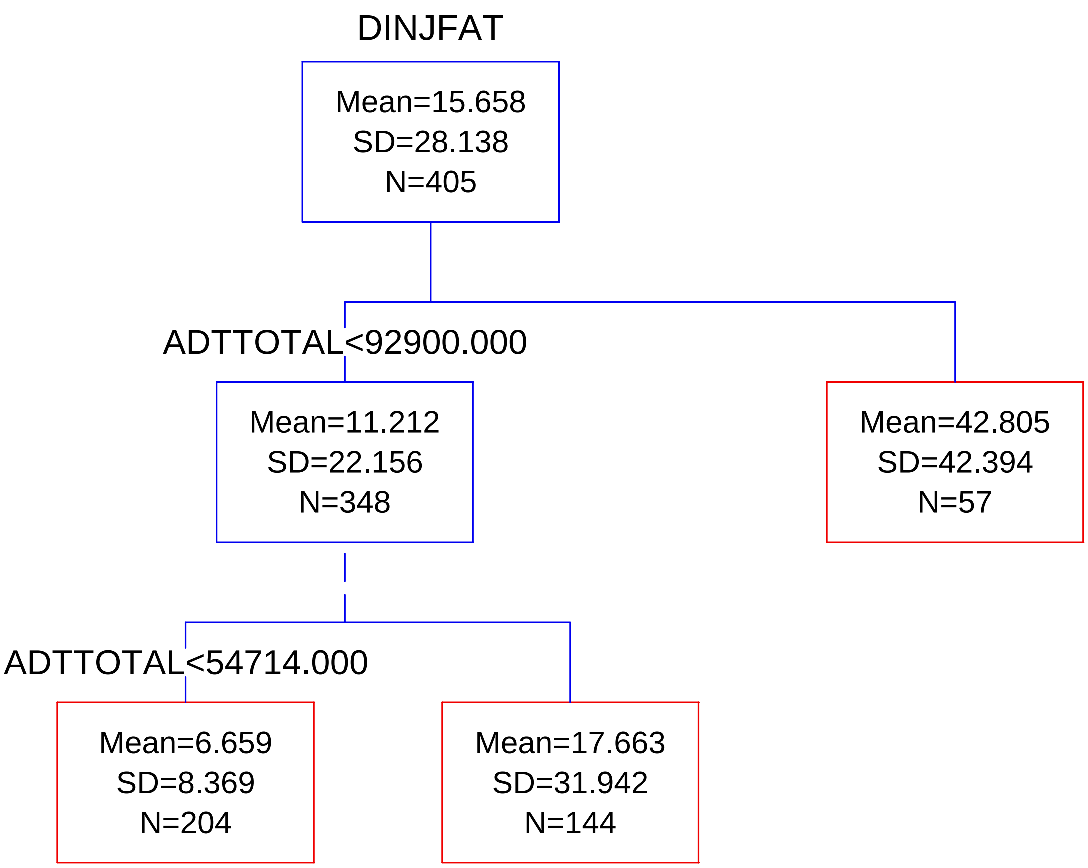


Figure 2.128.District 7 Property damage only Crash Density

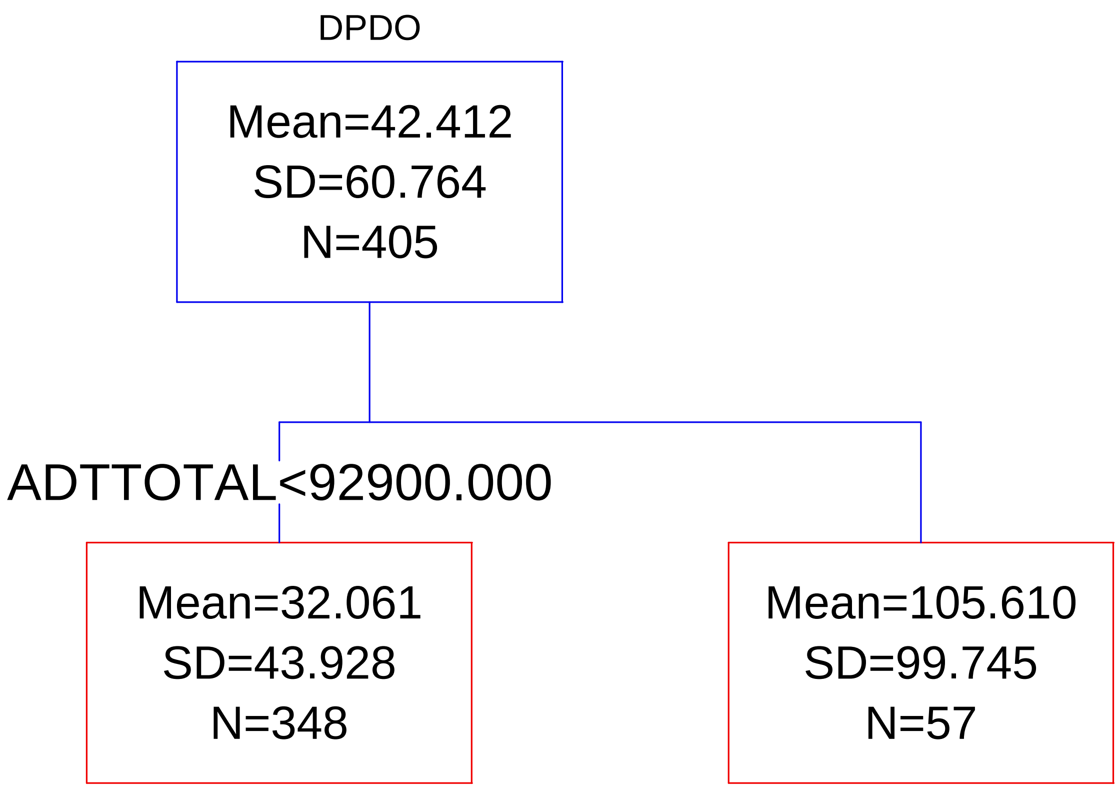


Figure 2.129.District 7 Total Crash Density

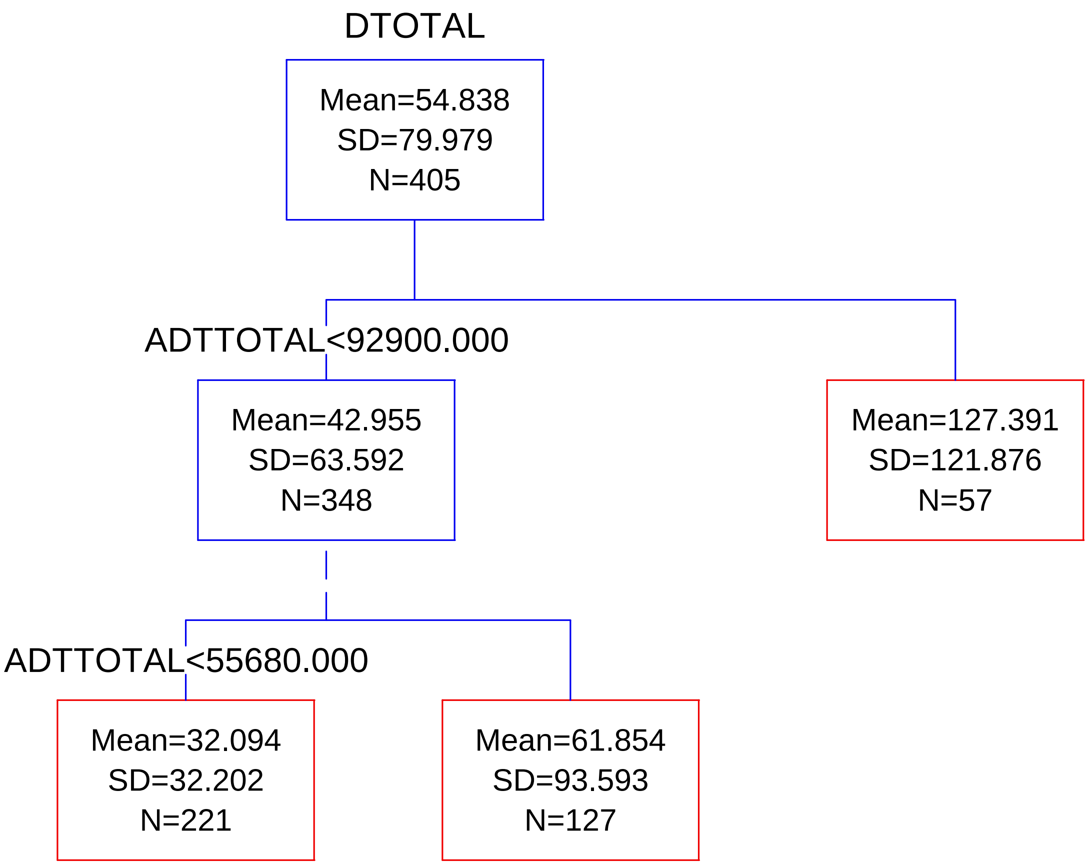


Figure 2.130.District 7 Angle Crash Density

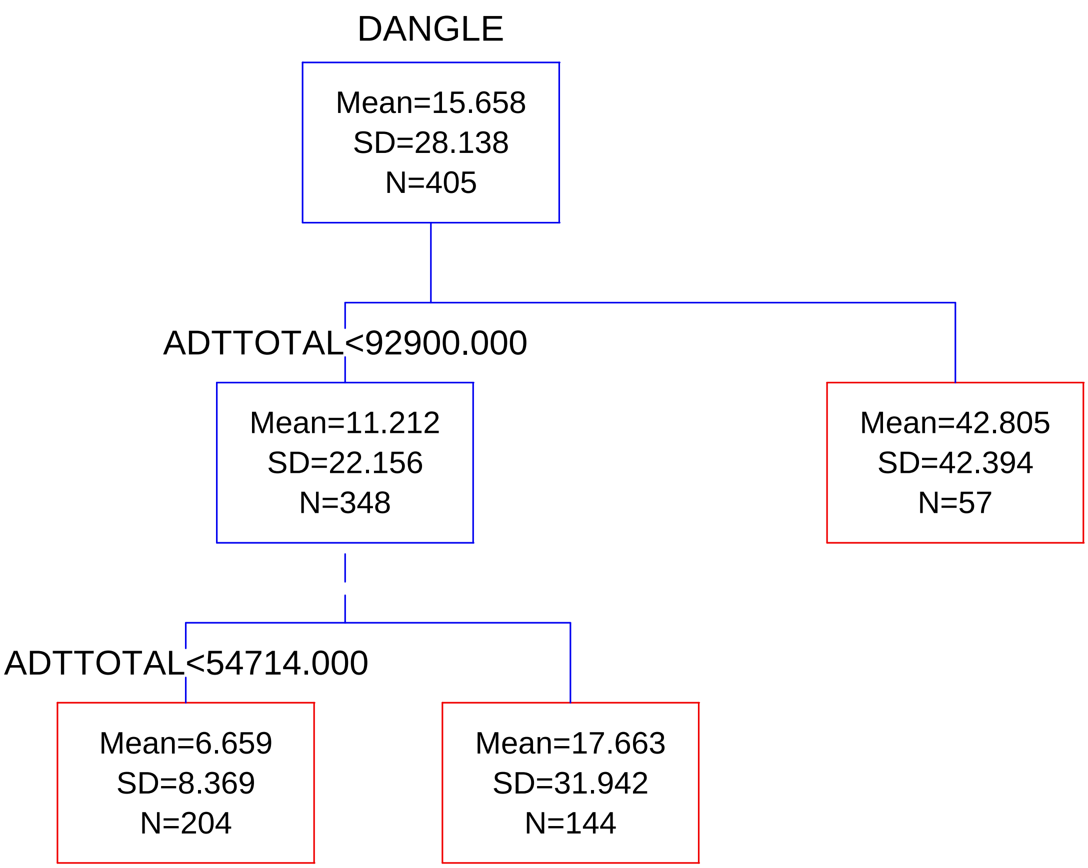


Figure 2.131.District 7 Fixed Object Crash Density

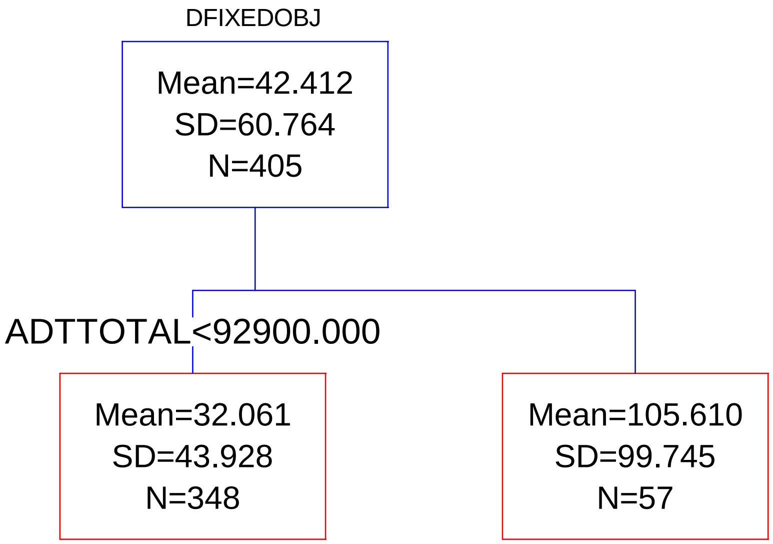


Figure 2.132.District 7 Rear end Crash Density

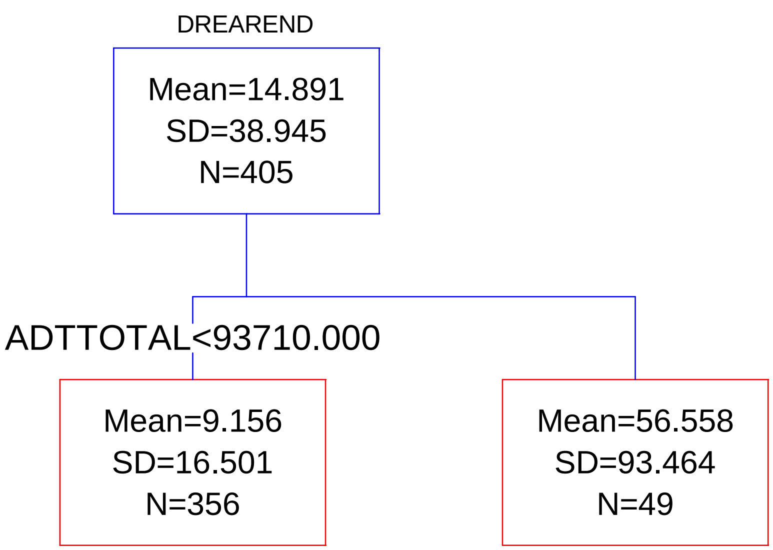


Figure 2.133.District 7 Sideswipe Crash Density

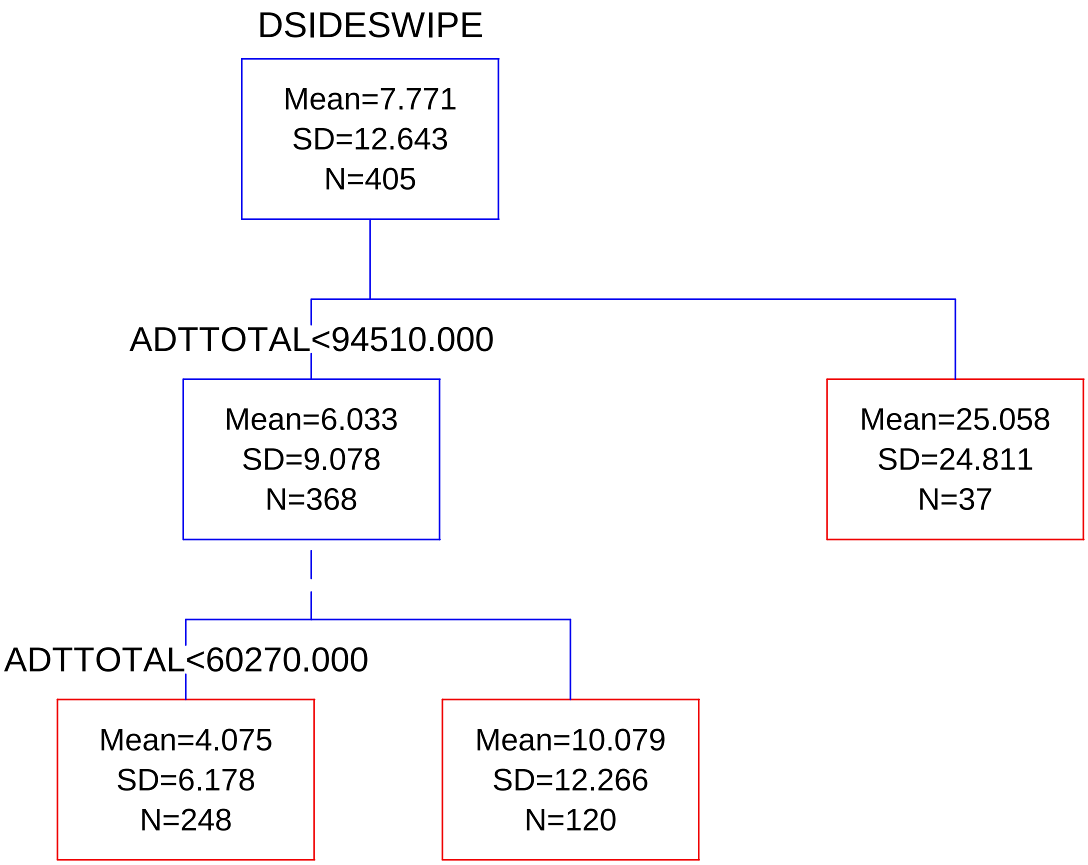


Figure 2.134.District 7 Road wet Crash Density

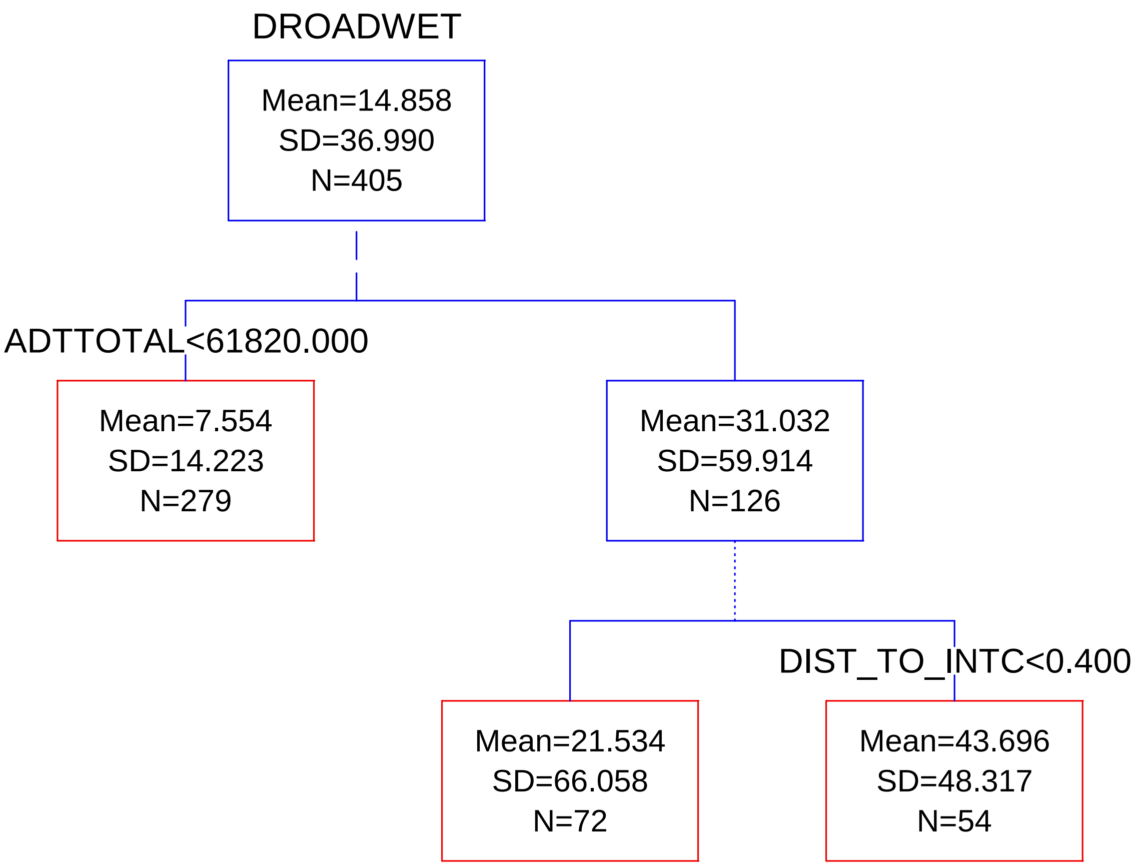


Figure 2.135.District 7 Night Crash Density

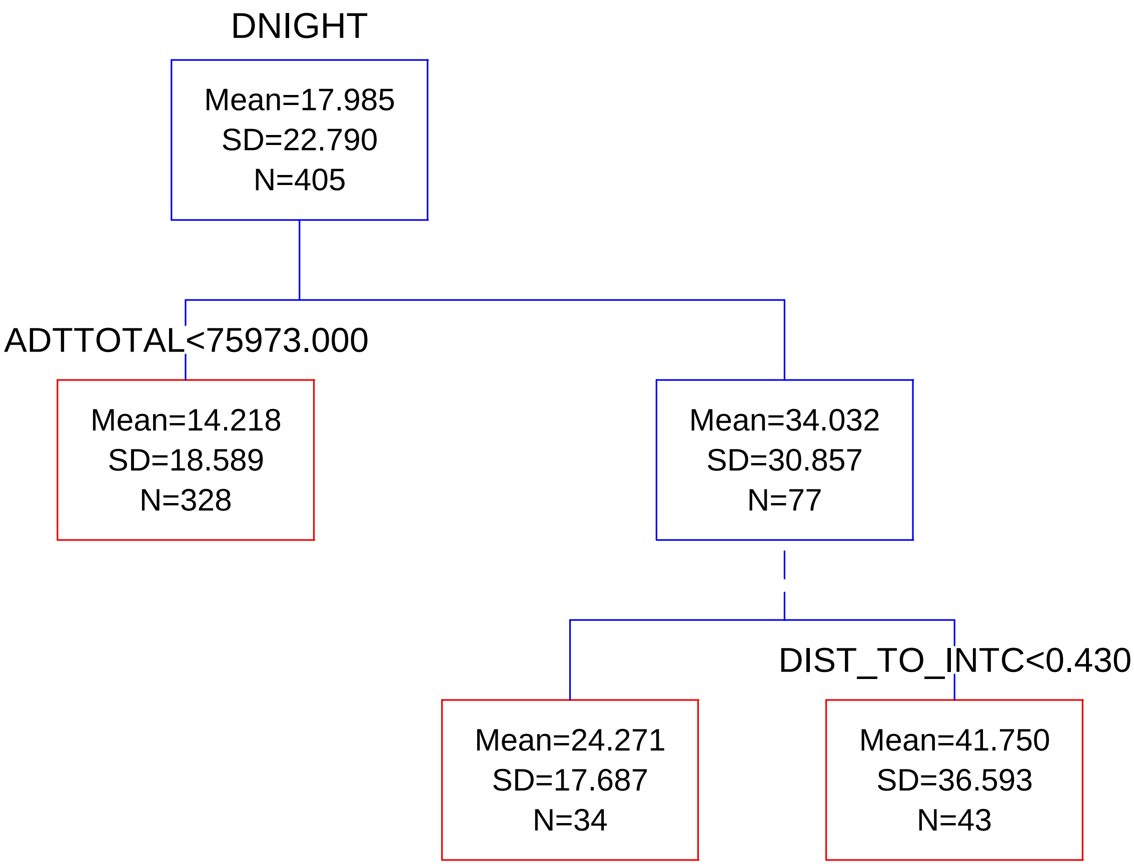


Figure 2.136.District 7 Injury/Fatal Crash Rate

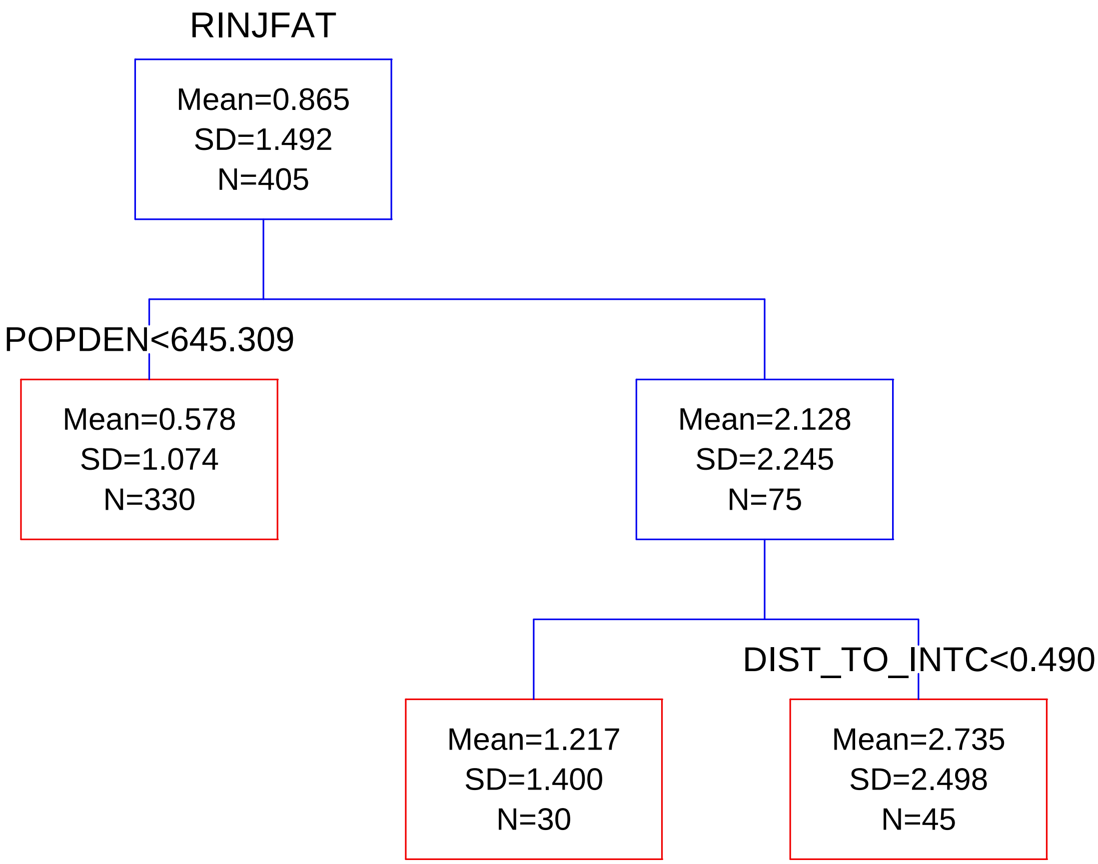


Figure 2.137.District 7 Property damage only Crash Rate

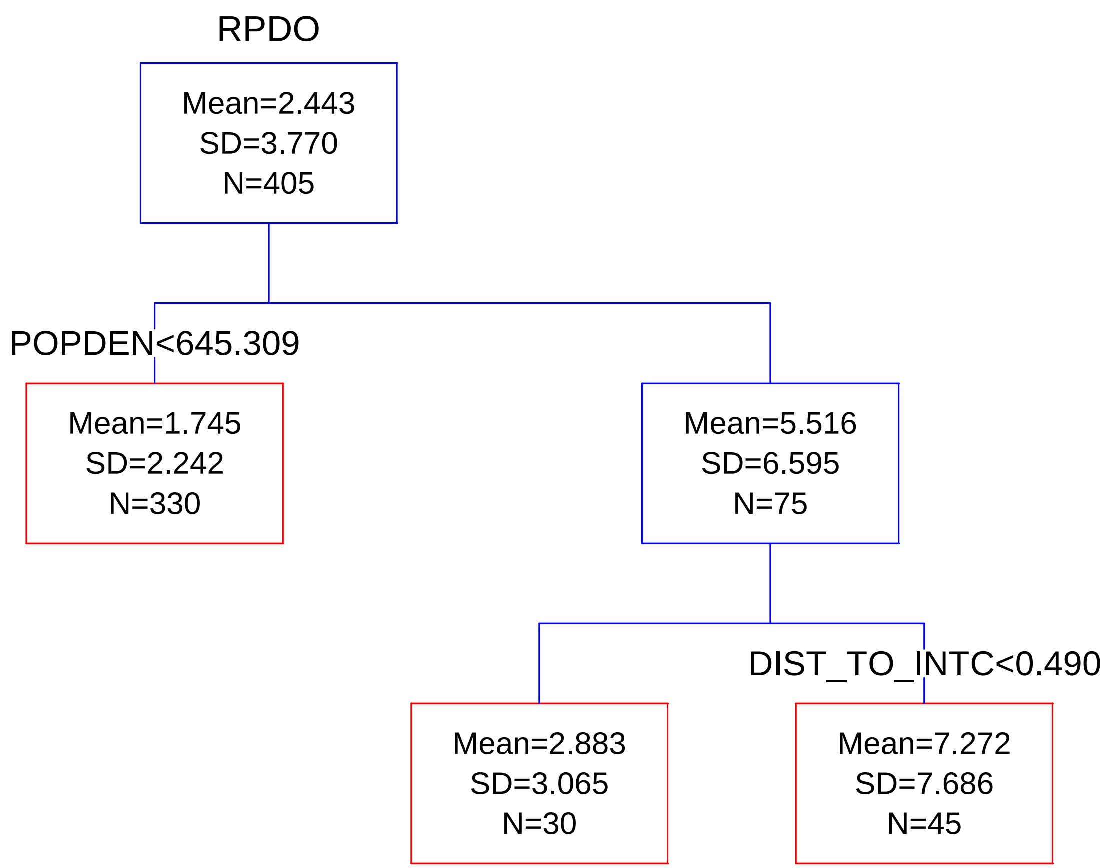


Figure 2.138.District 7 Total Crash Rate

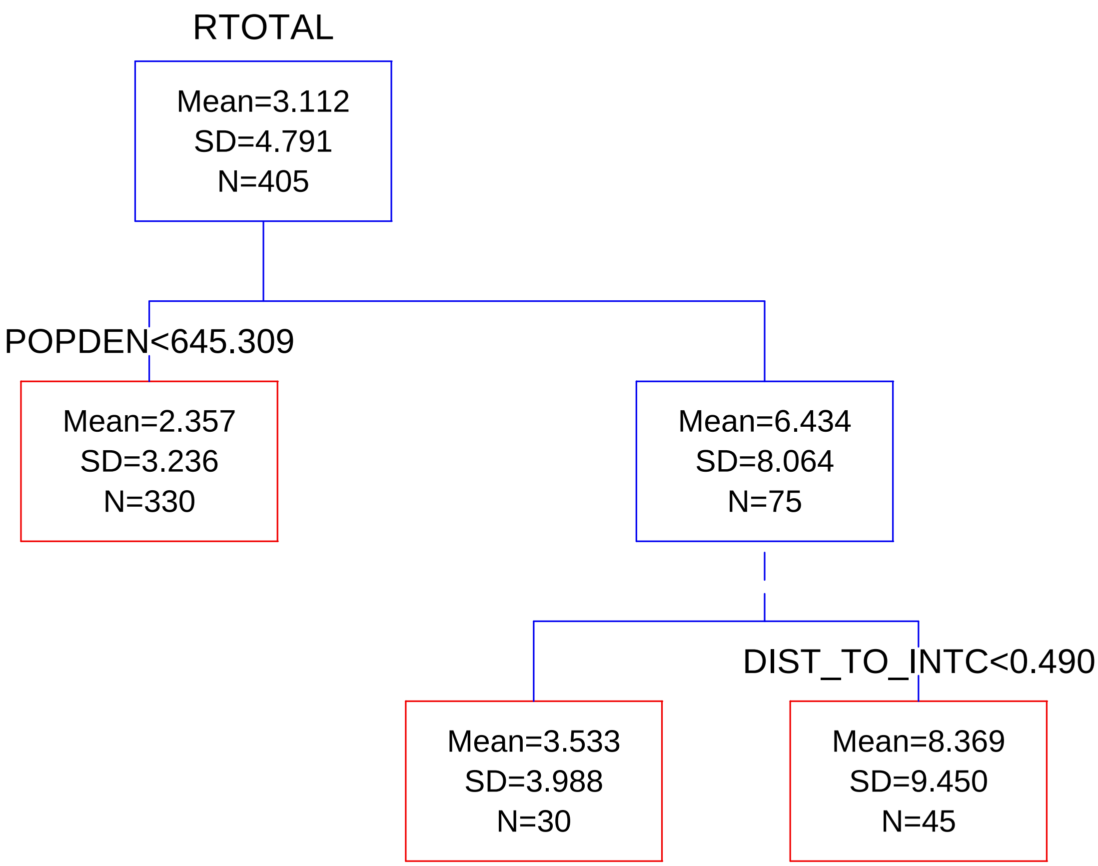


Figure 2.139.District 7 Angle Crash Rate

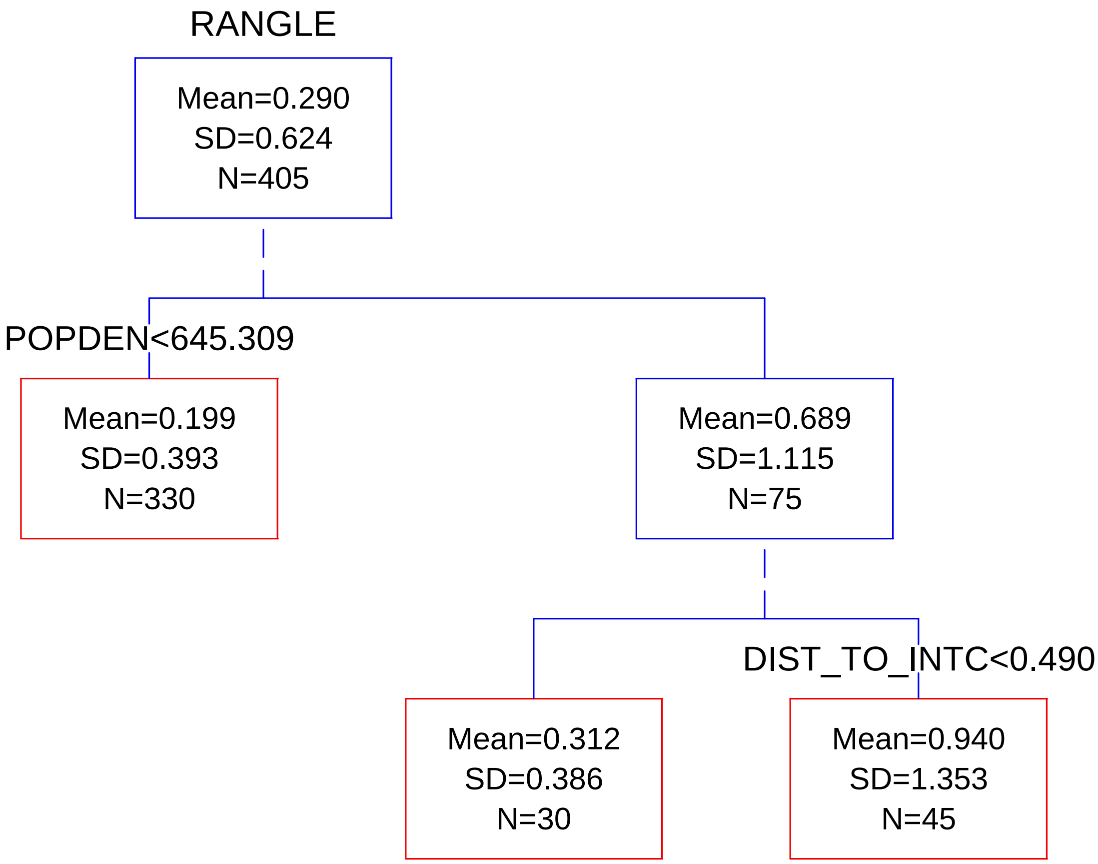


Figure 2.140.District 7 Fixed Object Crash Rate

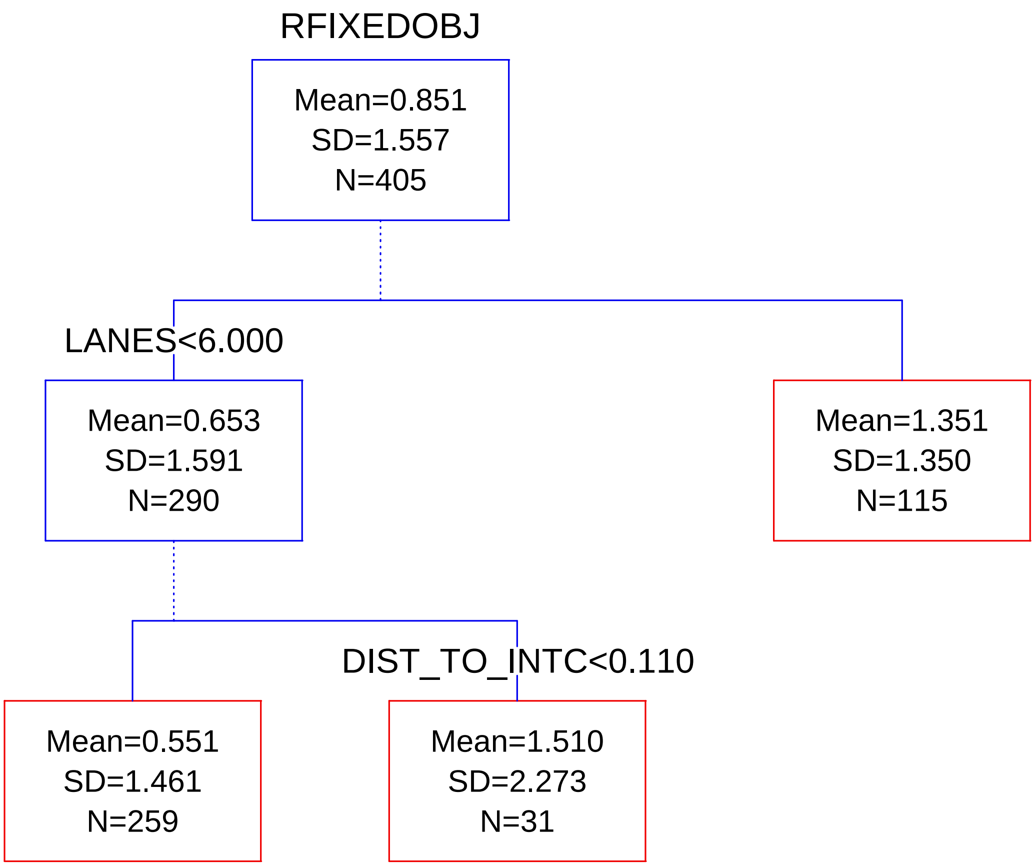


Figure 2.141.District 7 Rear end Crash Rate

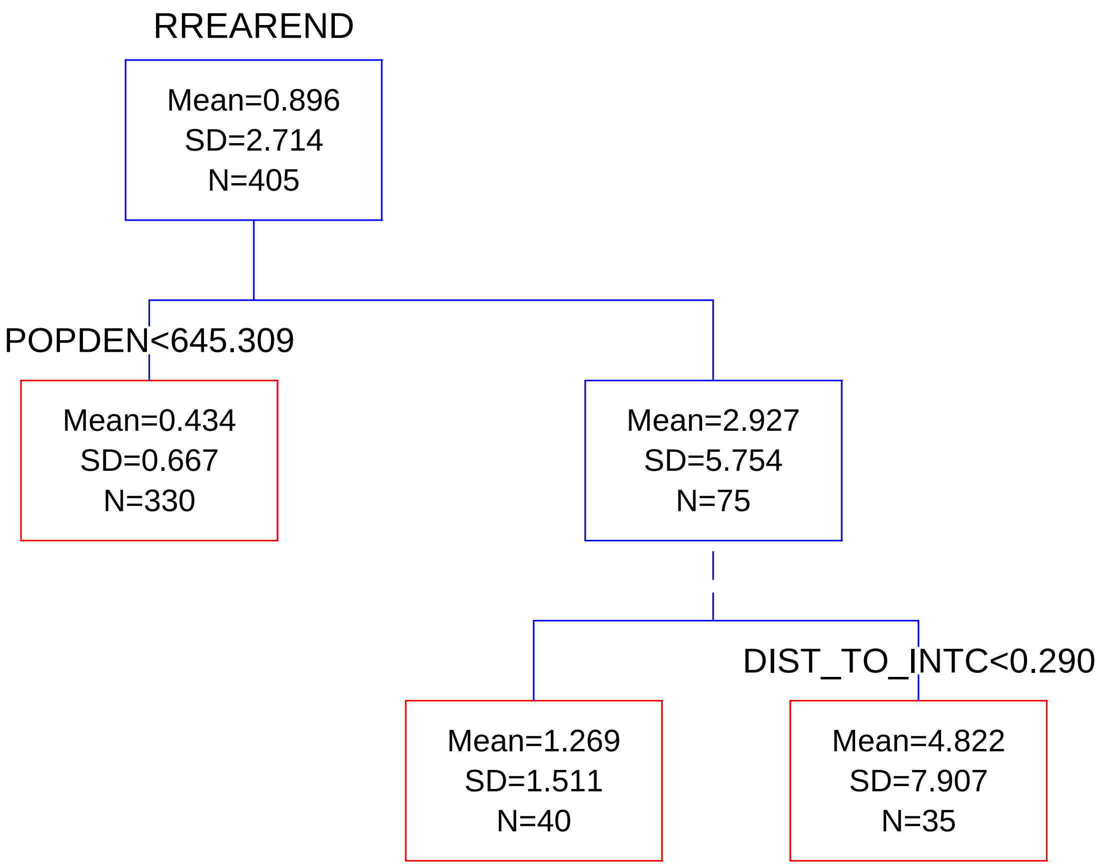


Figure 2.142.District 7 Sideswipe Crash Rate

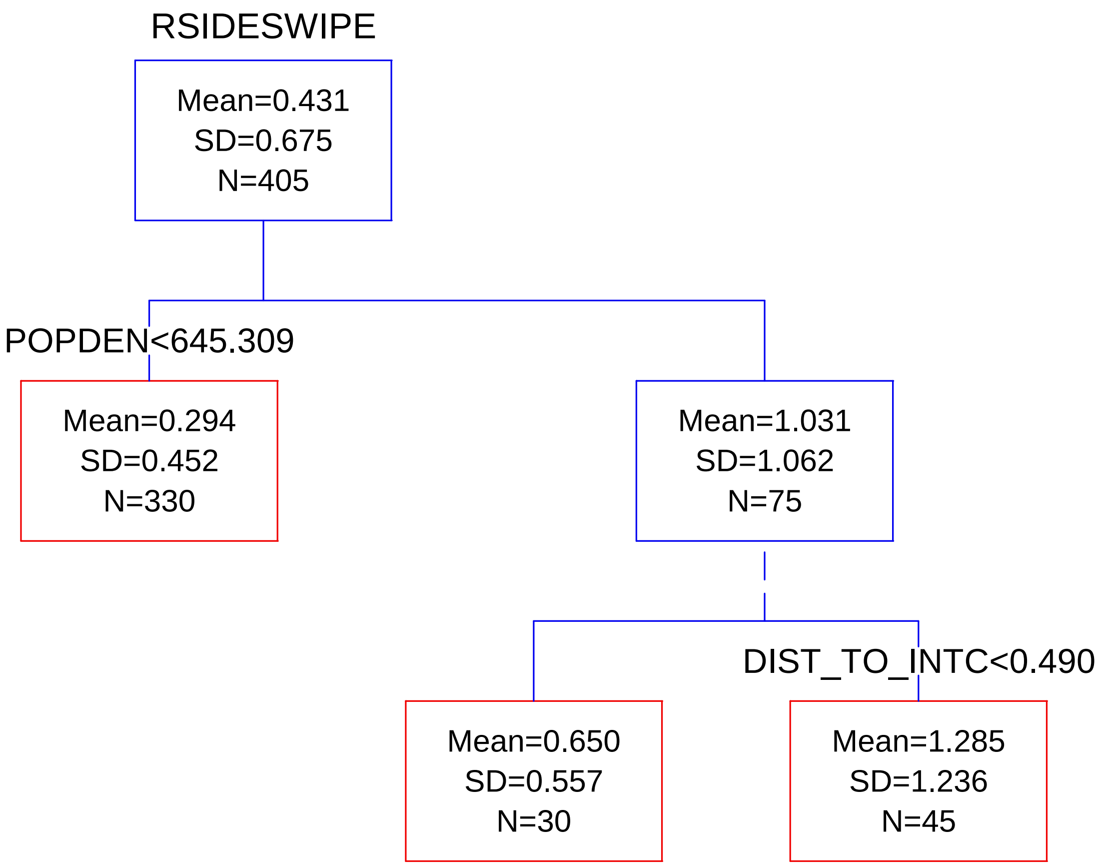


Figure 2.143.District 7 Road wet Crash Rate

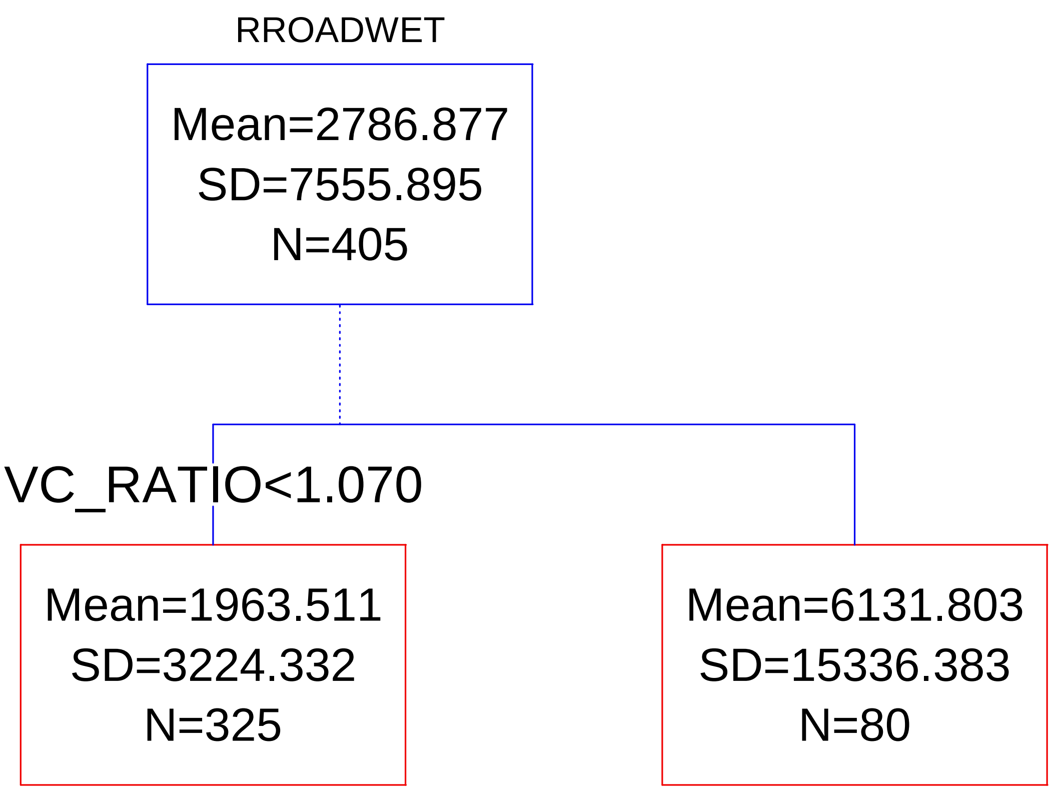
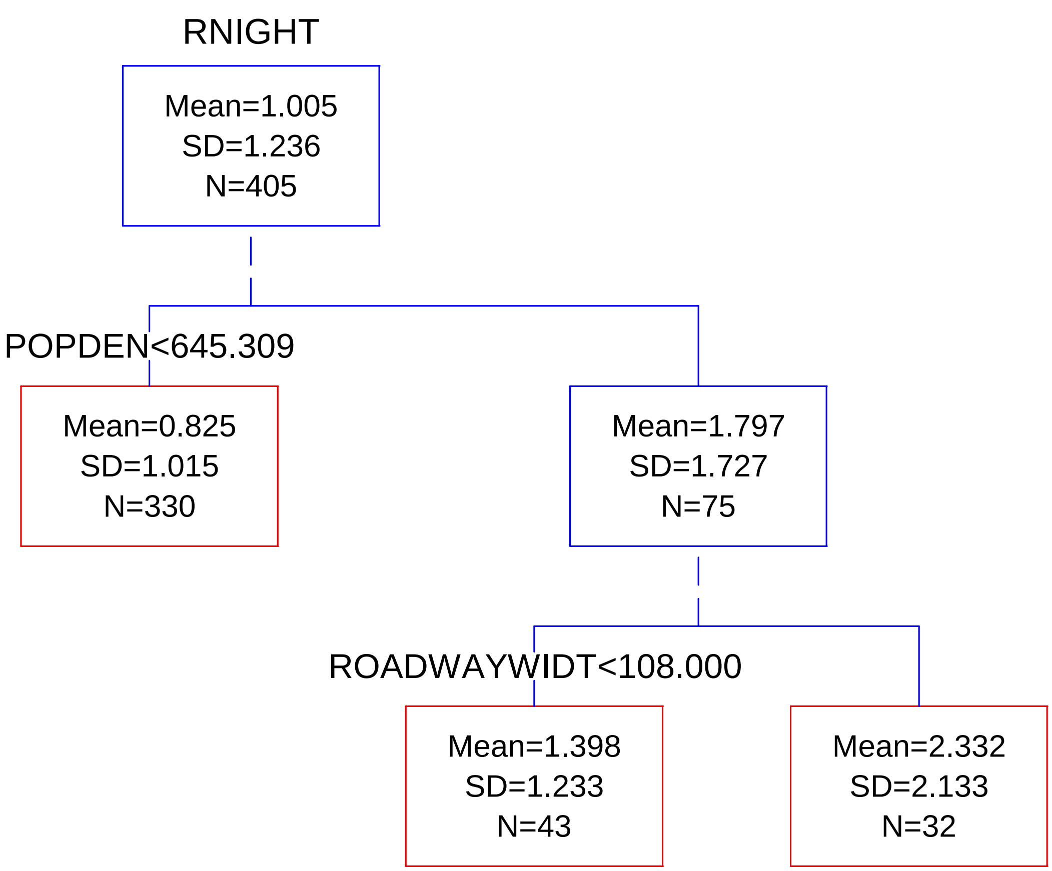


Figure 2.144.District 7 Night Crash Rate



AID Tree for District 8

Figure 2.145.District 8 Injury/Fatal Crash Density

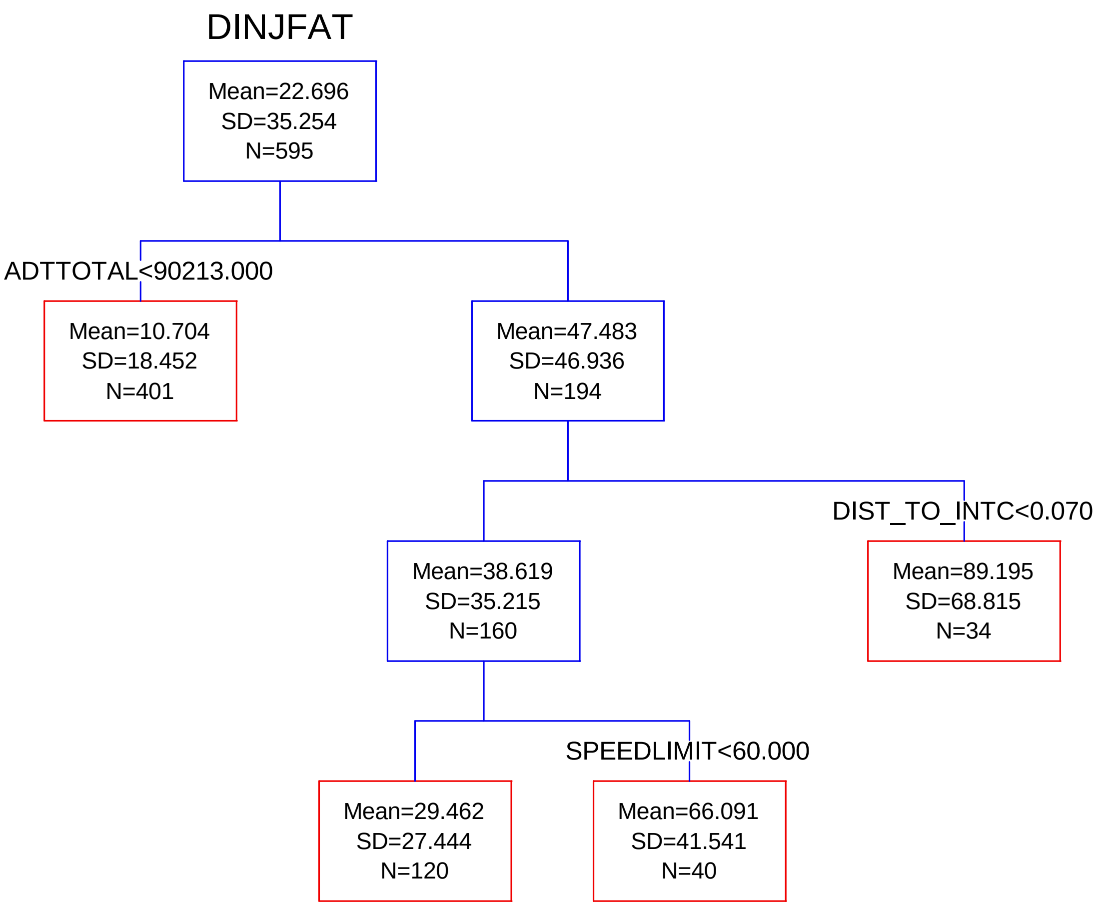


Figure 2.146.District 8 Property damage only Crash Density

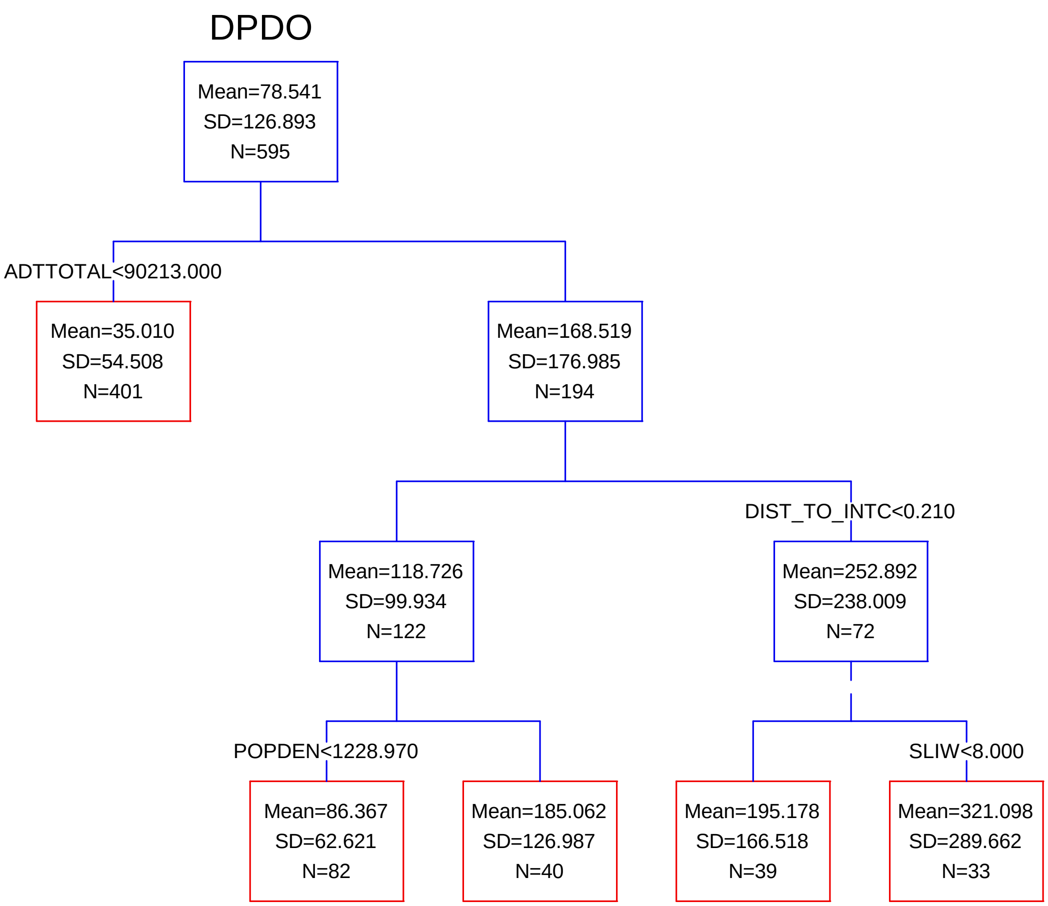


Figure 2.147.District 8 Total Crash Density

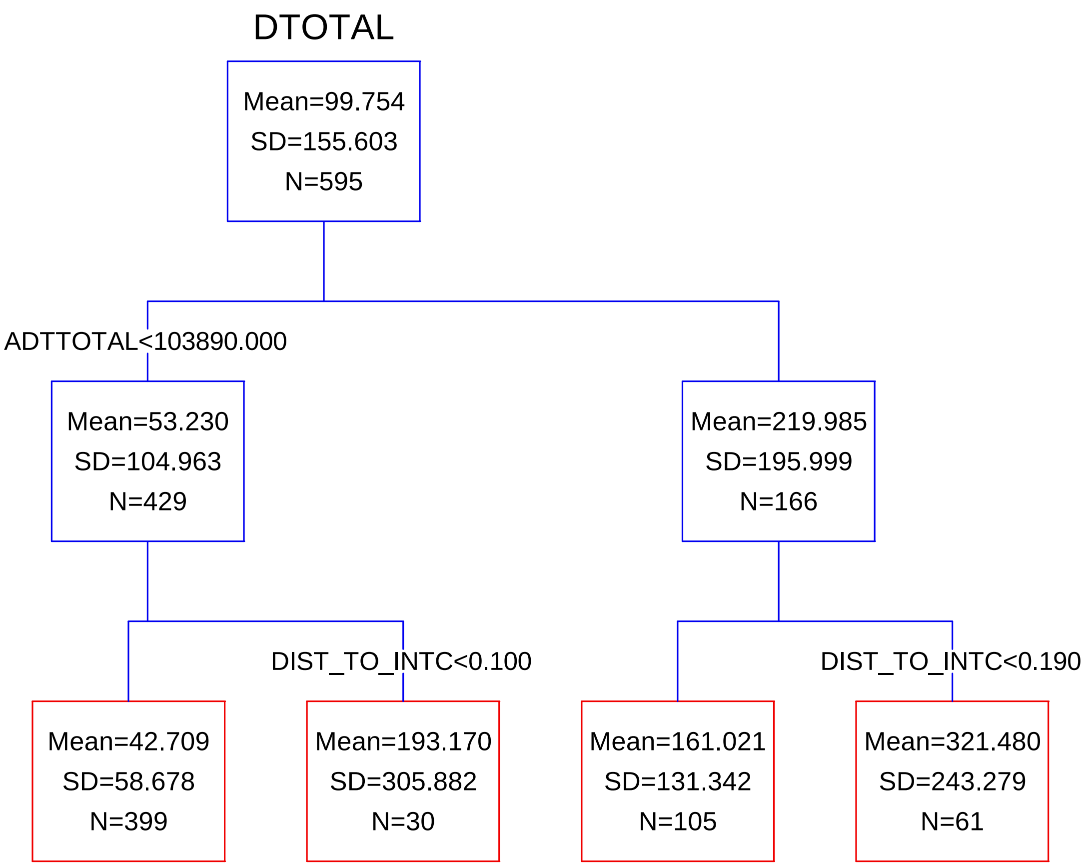


Figure 2.148.District 8 Angle Crash Density

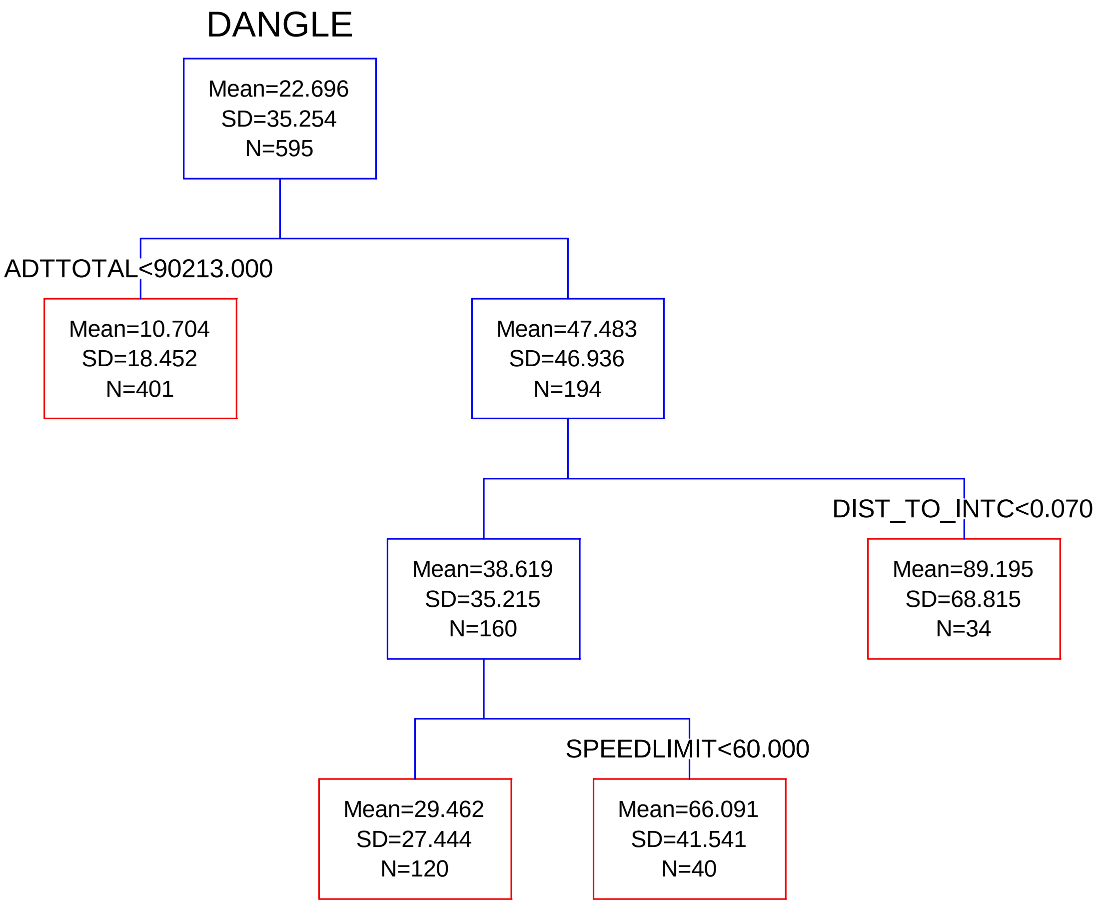


Figure 2.149.District 8 Fixed Object Crash Density

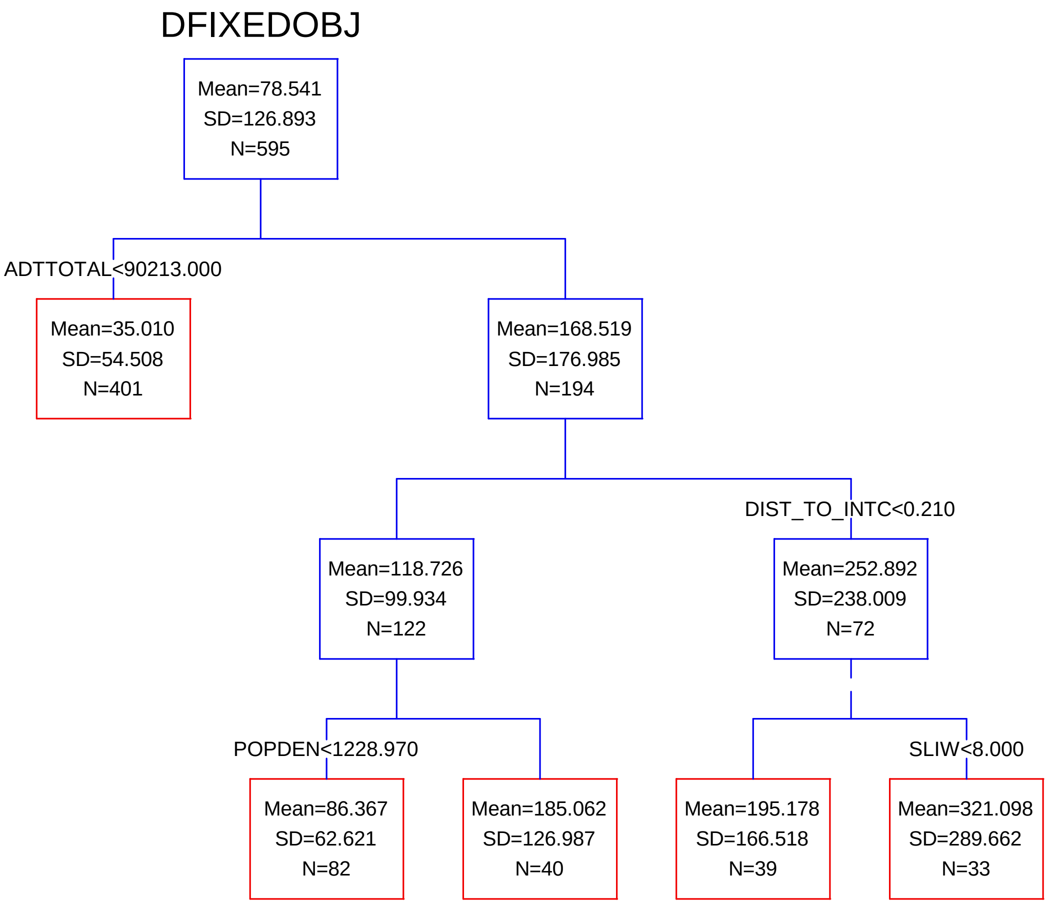


Figure 2.150.District 8 Rear end Crash Density

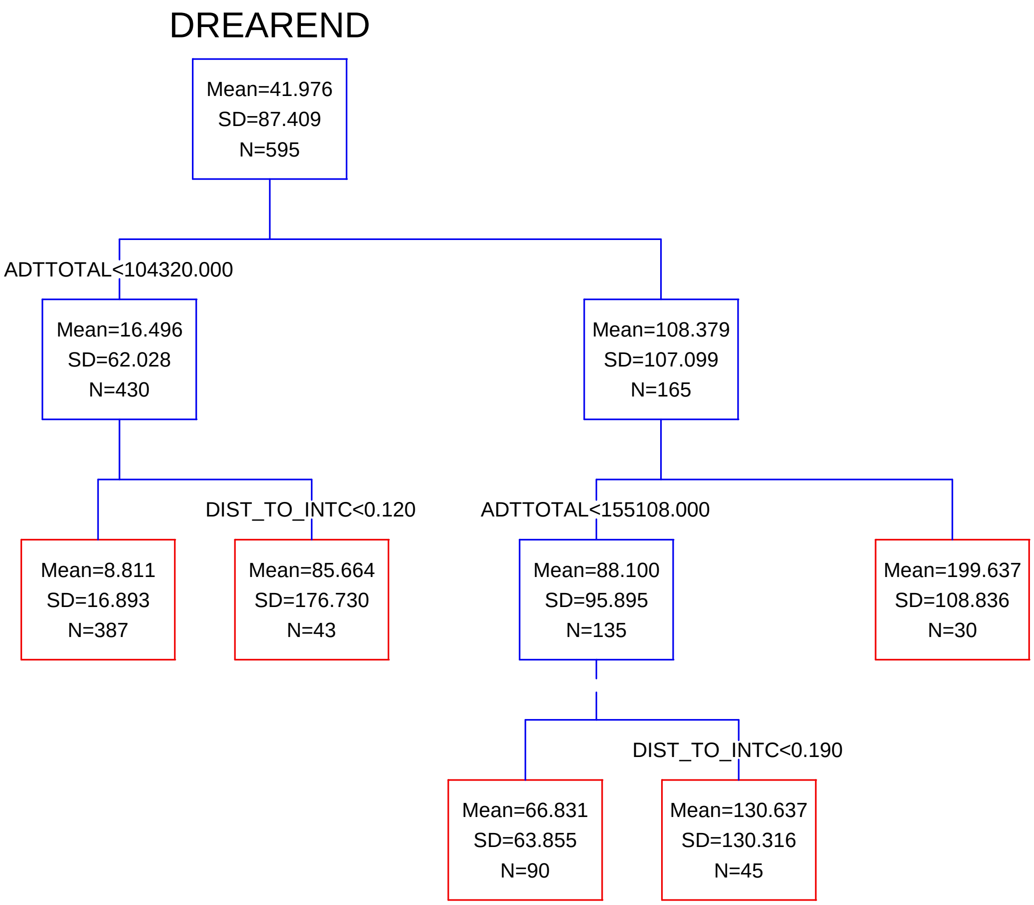


Figure 2.151.District 8 Sideswipe Crash Density

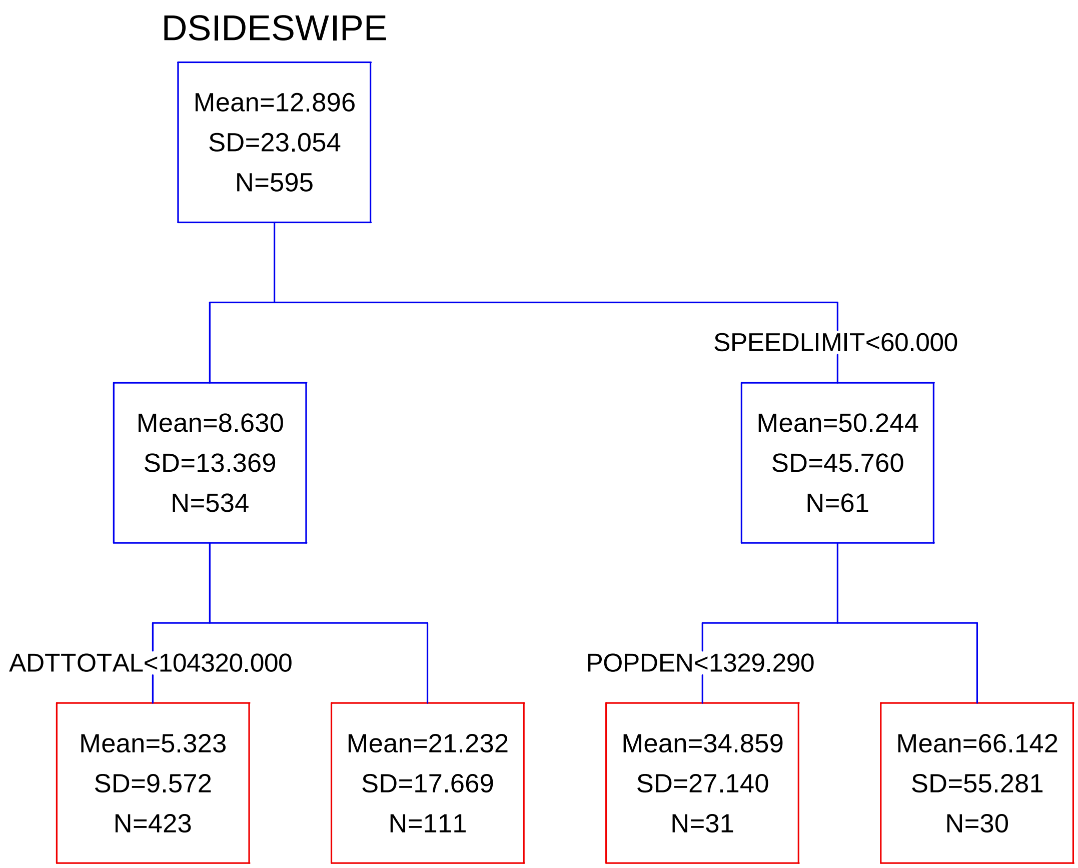


Figure 2.152.District 8 Road wet Crash Density

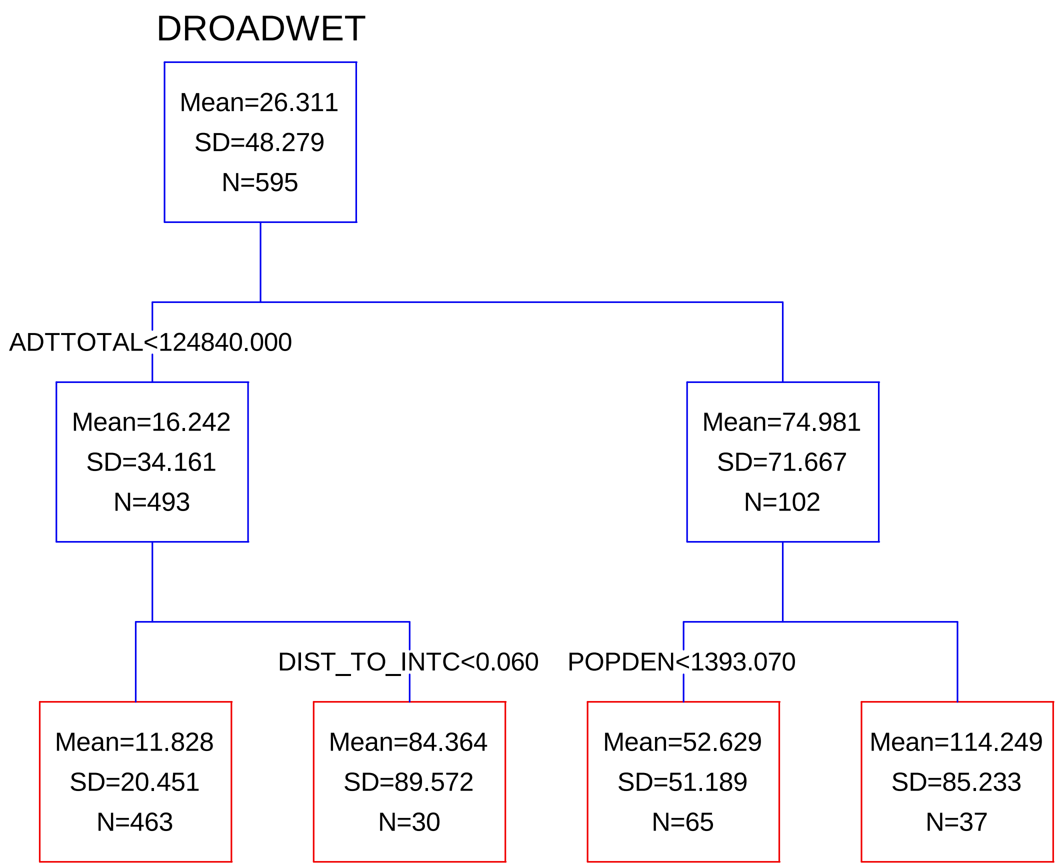


Figure 2.153.District 8 Night Crash Density

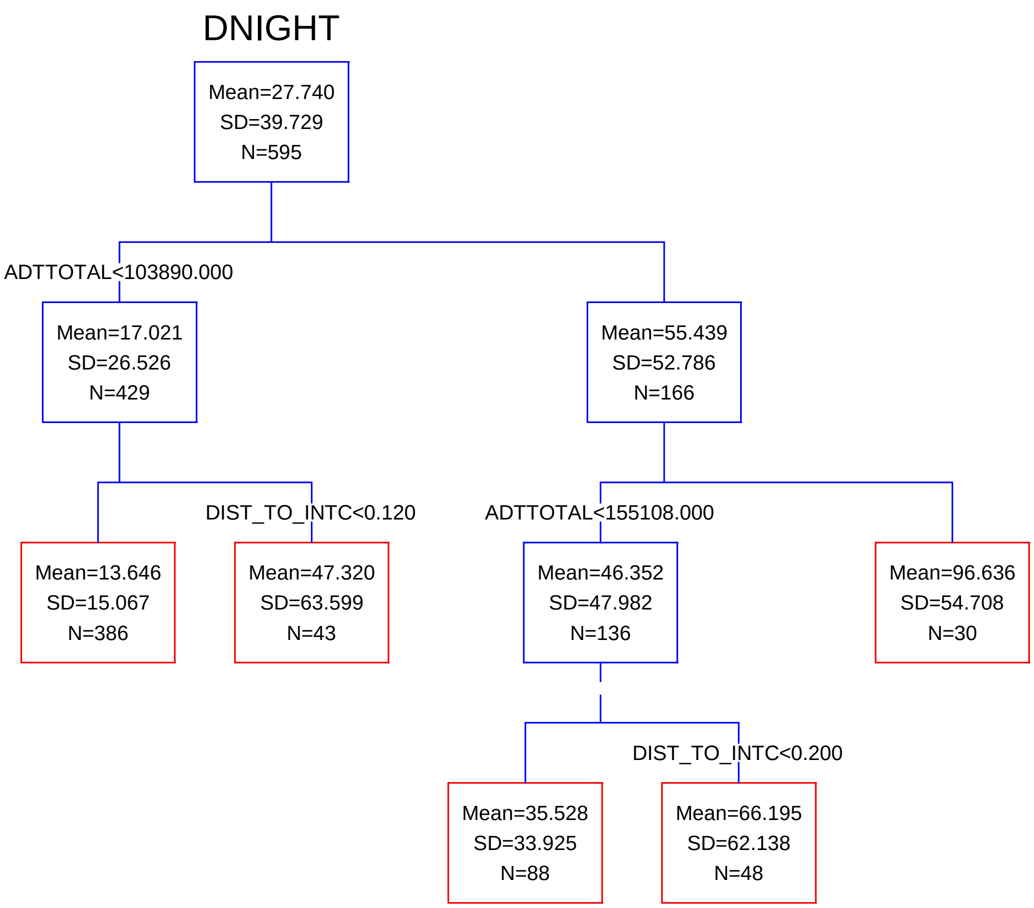


Figure 2.154.District 8 Injury/Fatal Crash Rate

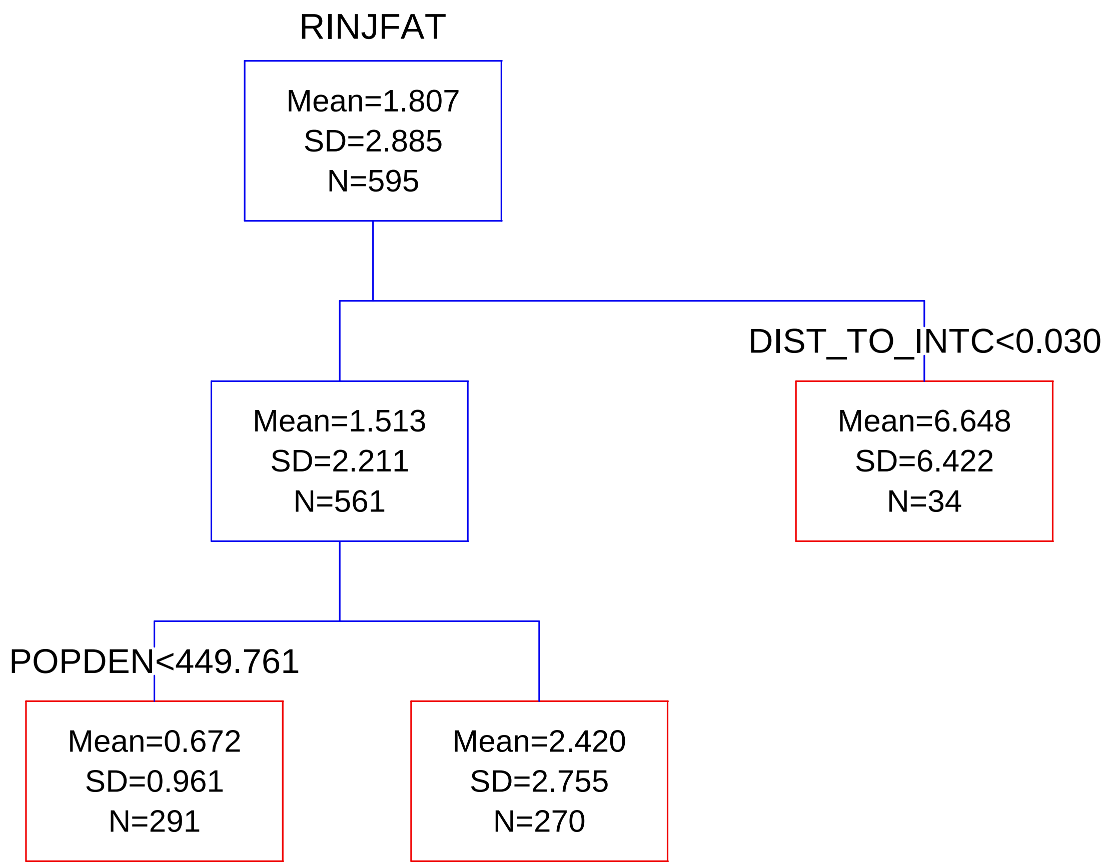


Figure 2.155.District 8 Property damage only Crash Rate

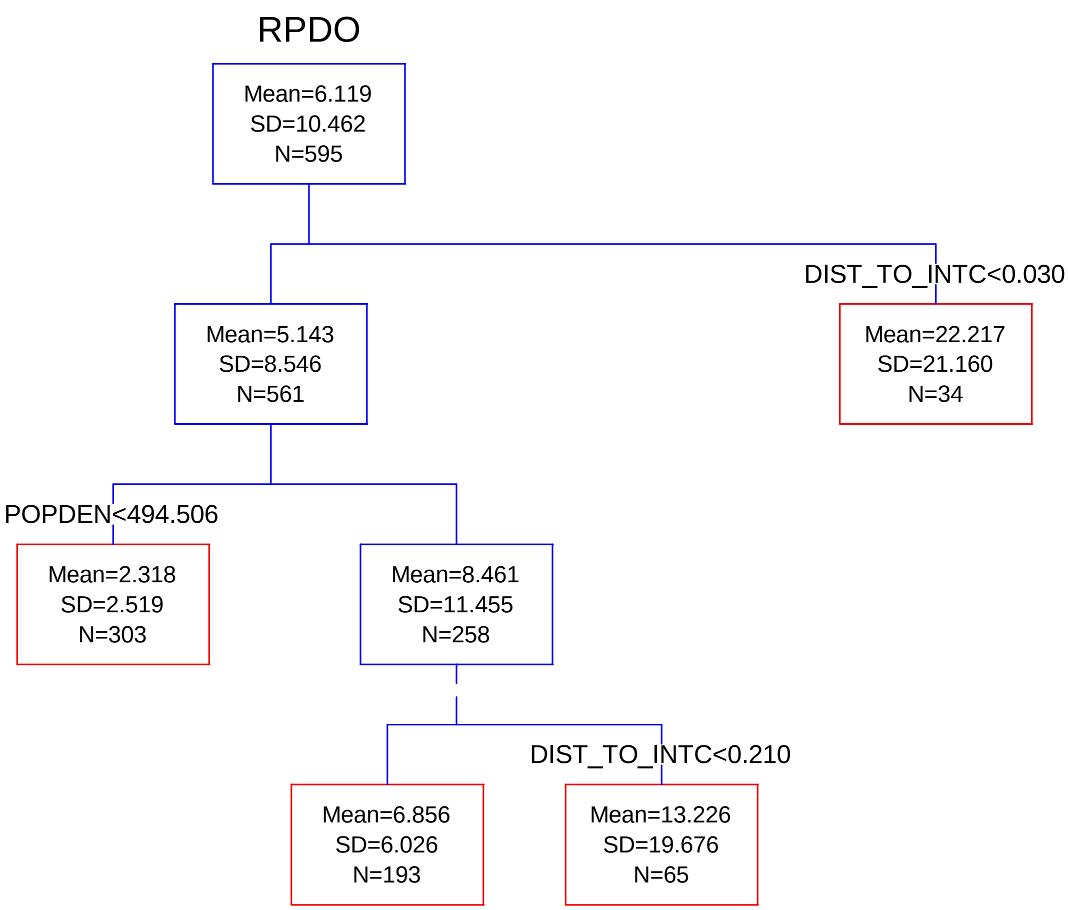


Figure 2.156.District 8 Total Crash Rate

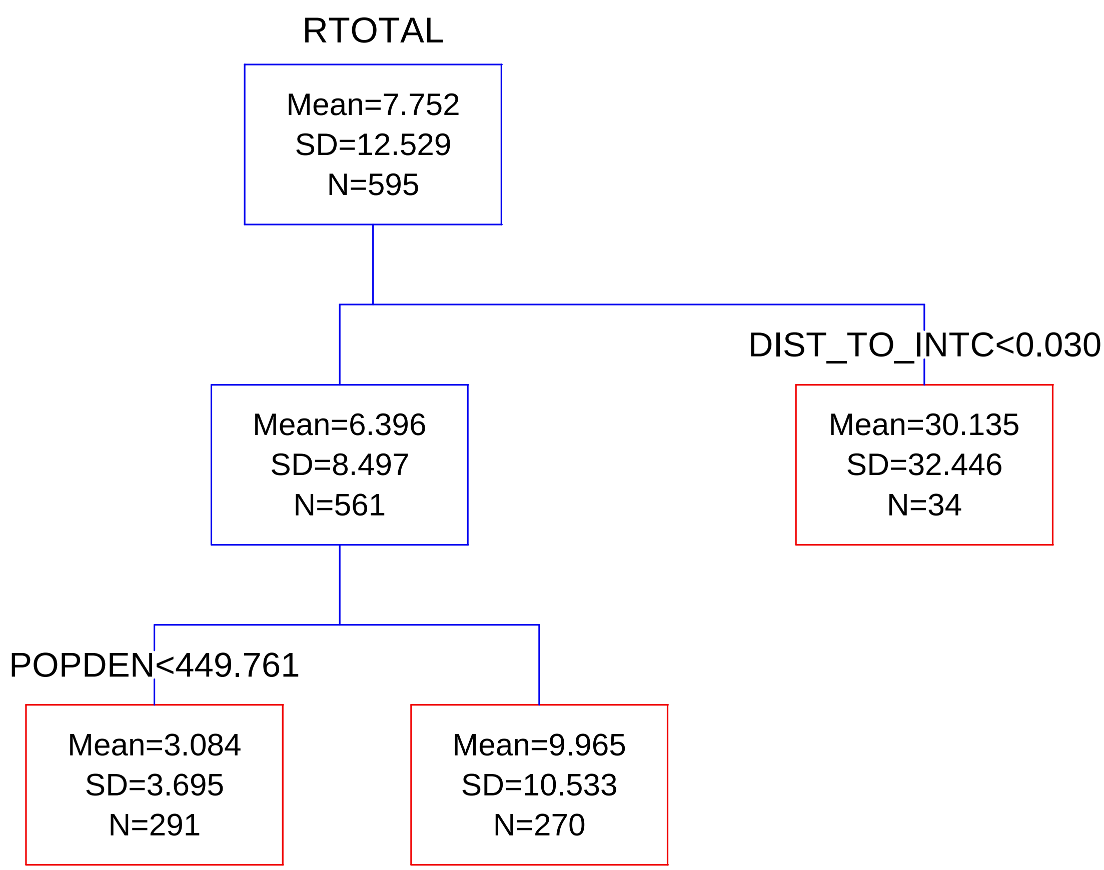


Figure 2.157.District 8 Angle Crash Rate

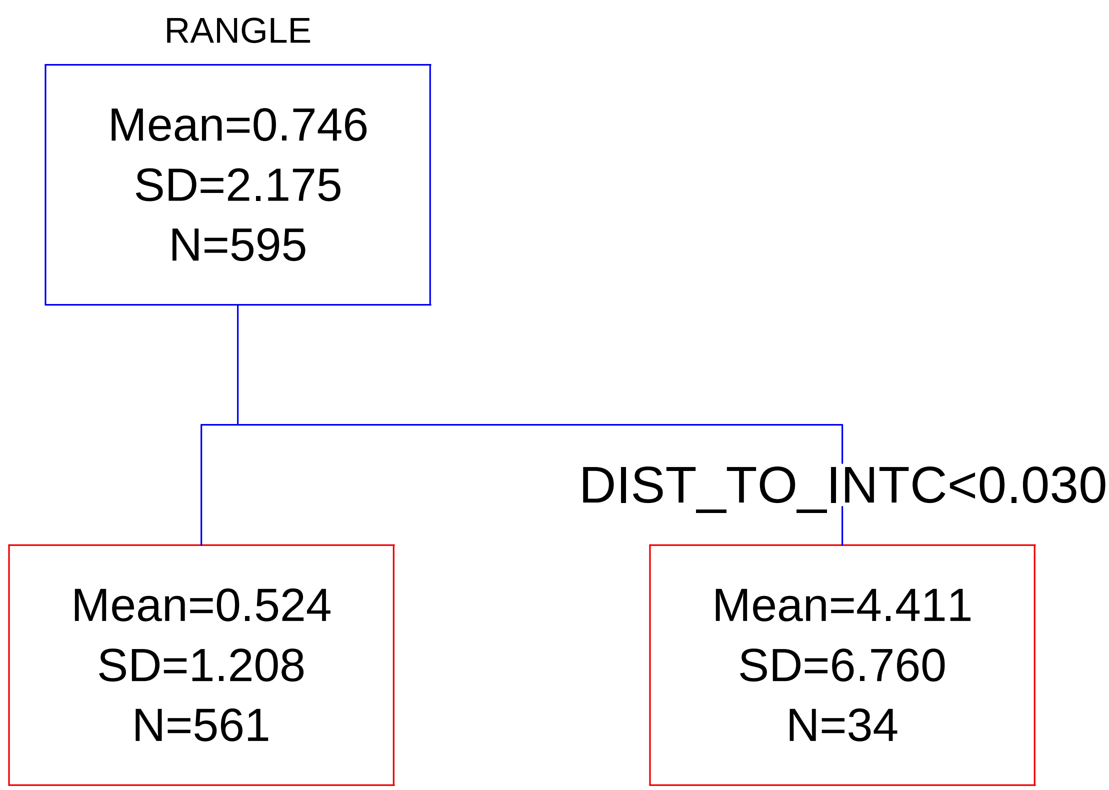


Figure 2.158.District 8 Fixed Object Crash Rate

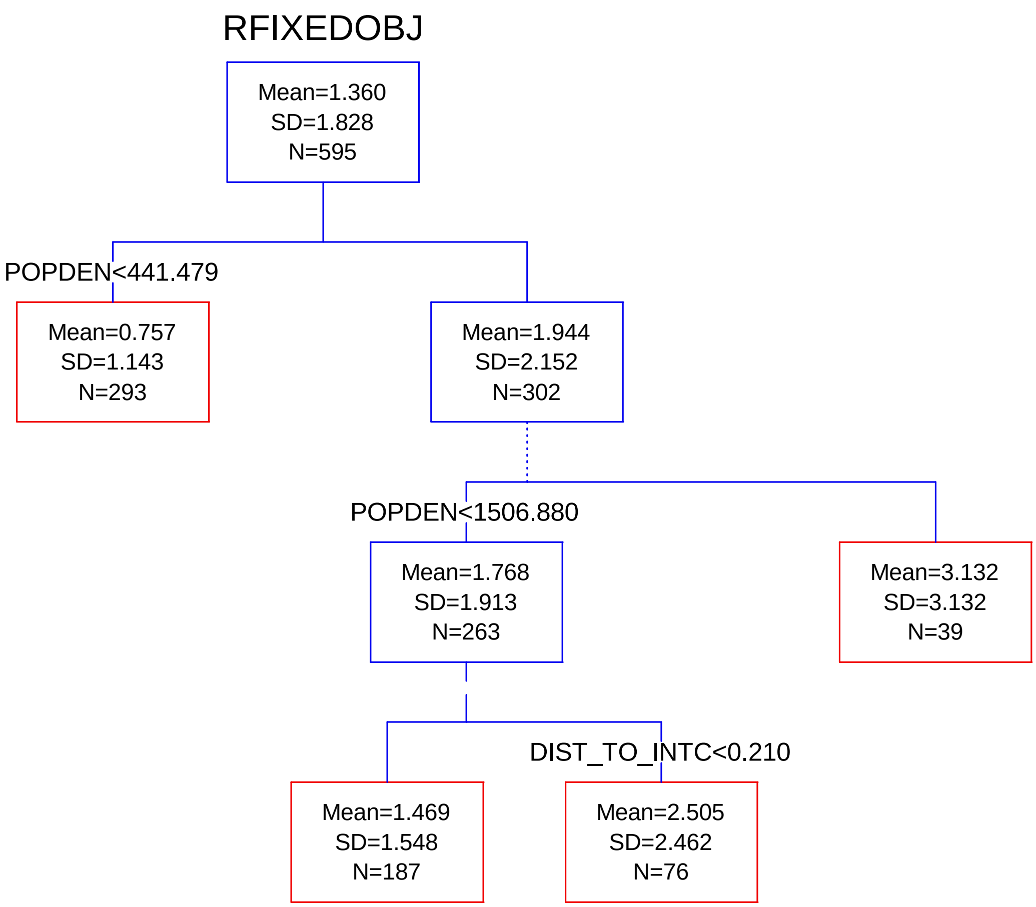


Figure 2.159.District 8 Rear end Crash Rate

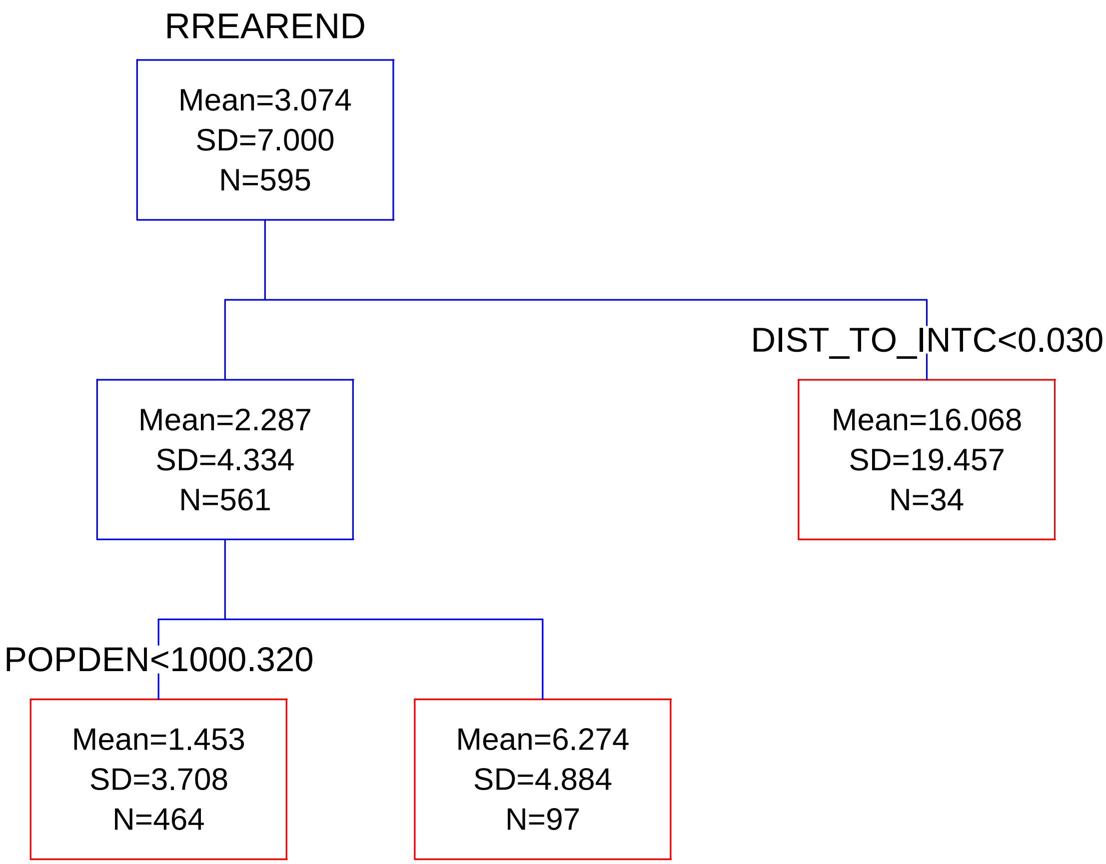


Figure 2.160.District 8 Sideswipe Crash Rate

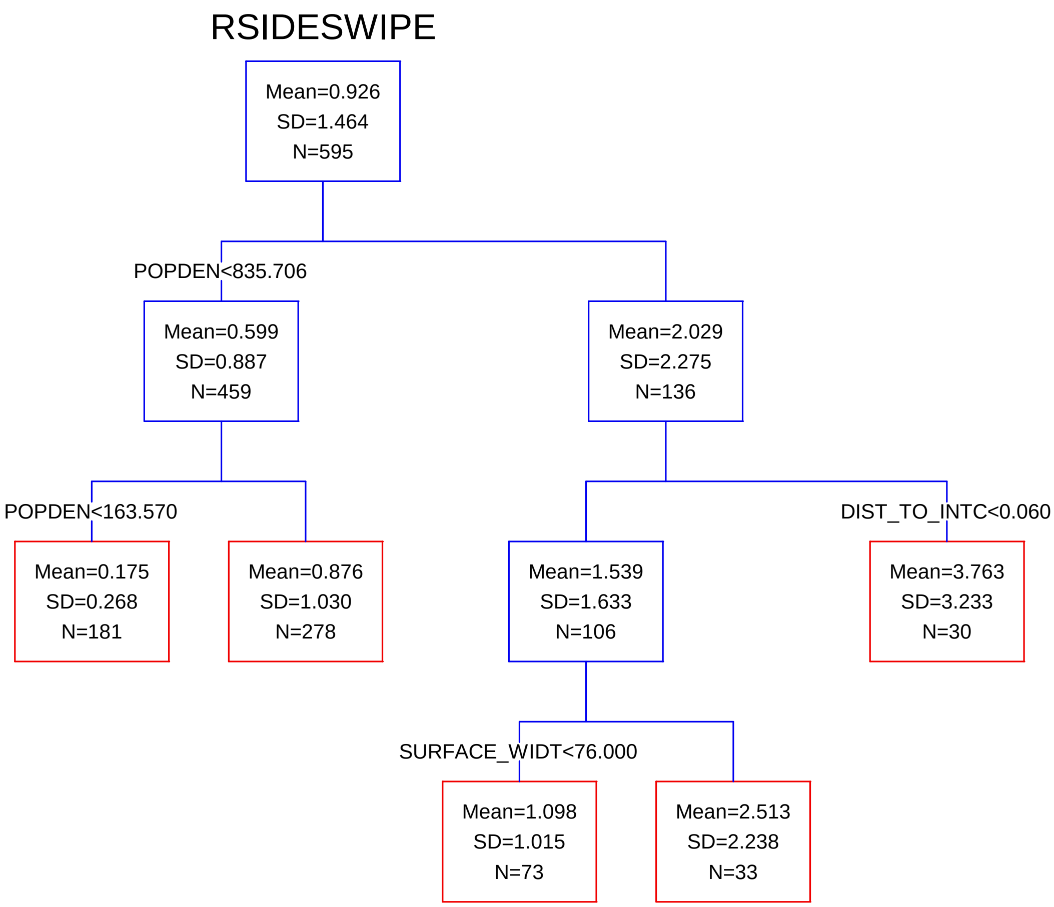


Figure 2.161.District 8 Road wet Crash Rate

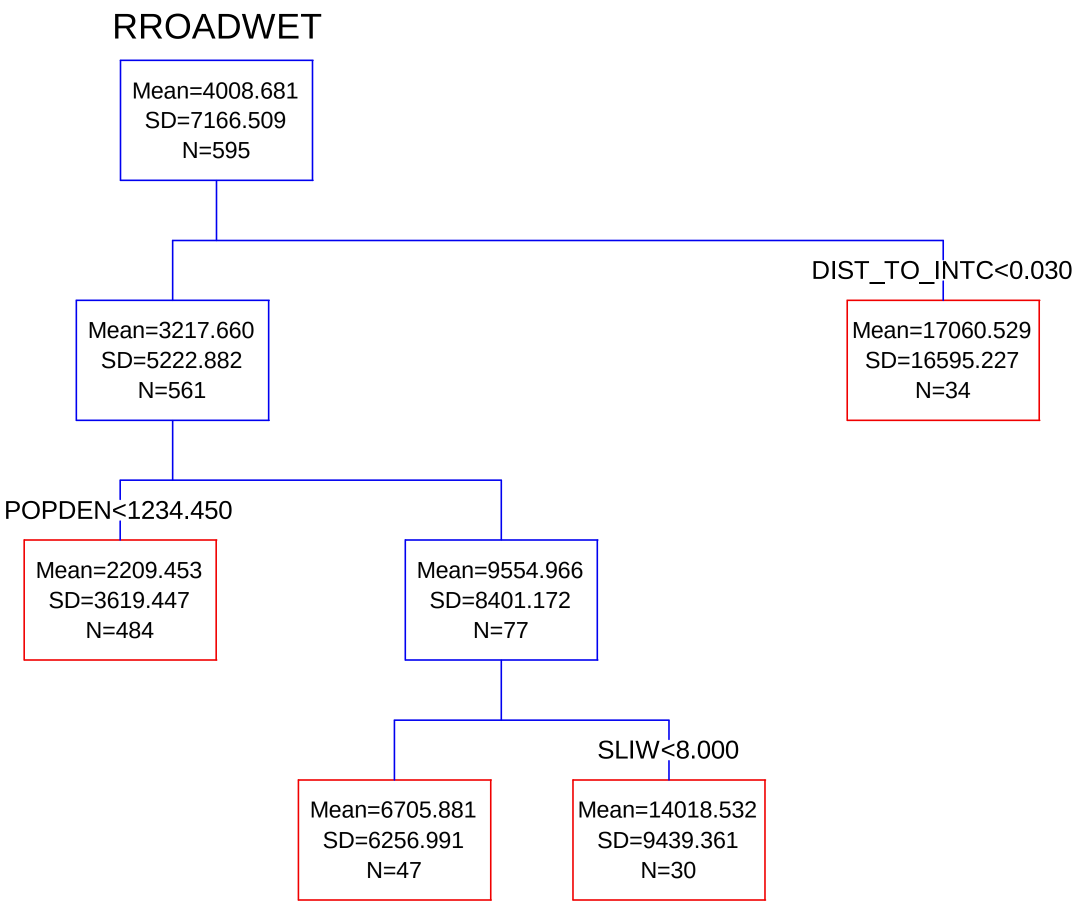
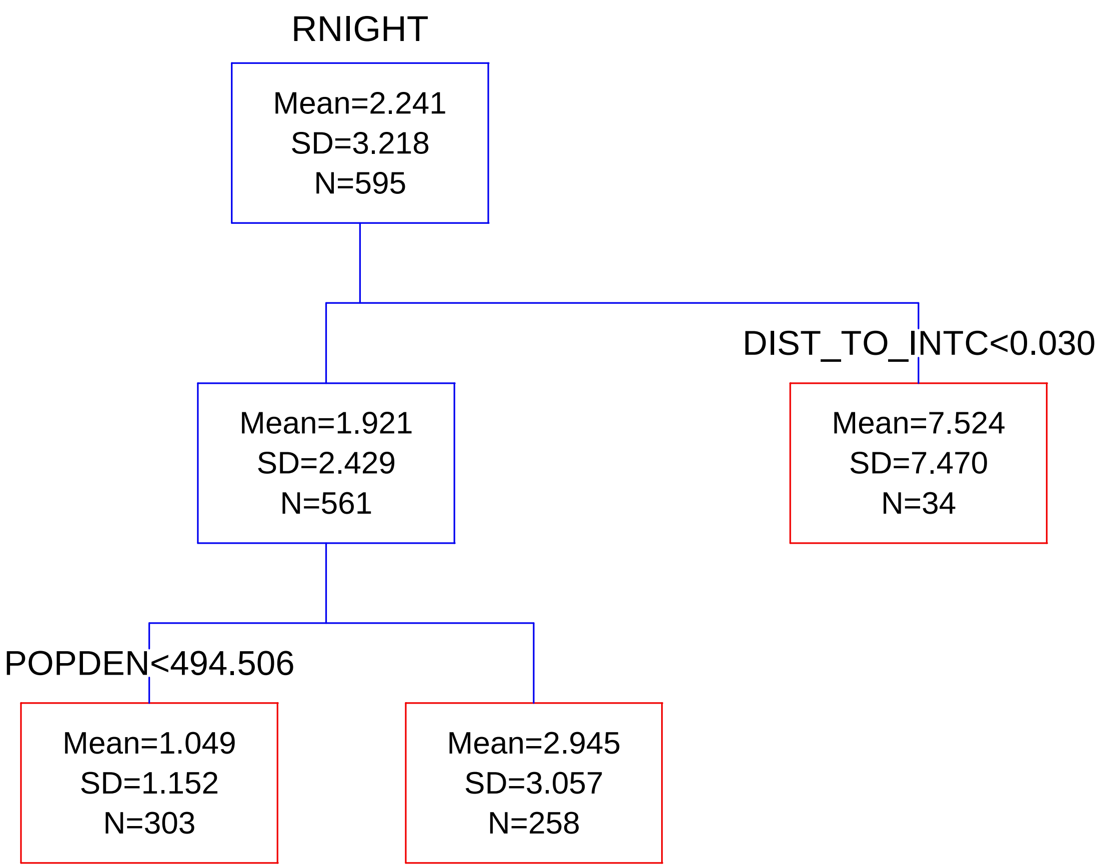


Figure 2.162.District 8 Night Crash Rate



AID Tree for District 10

Figure 2.163.District 10 Injury/Fatal Crash Density

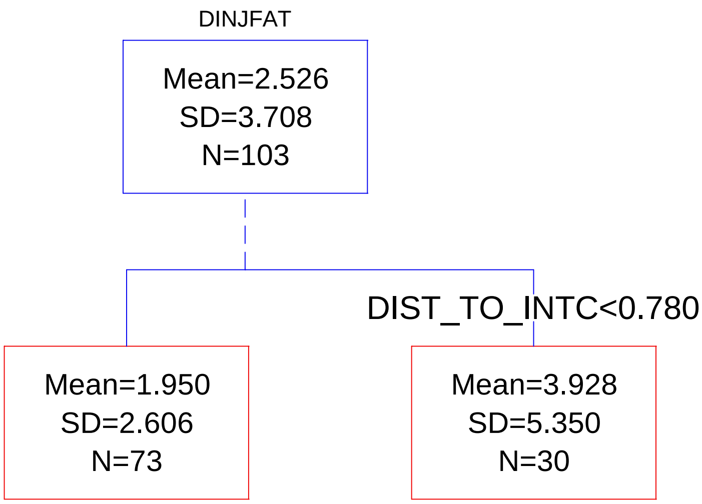


Figure 2.164.District 10 Property damage only Crash Density

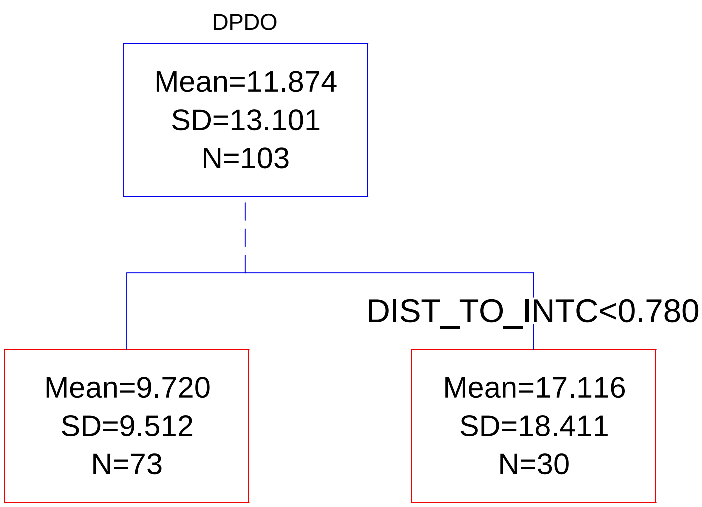


Figure 2.165.District 10 Total Crash Density

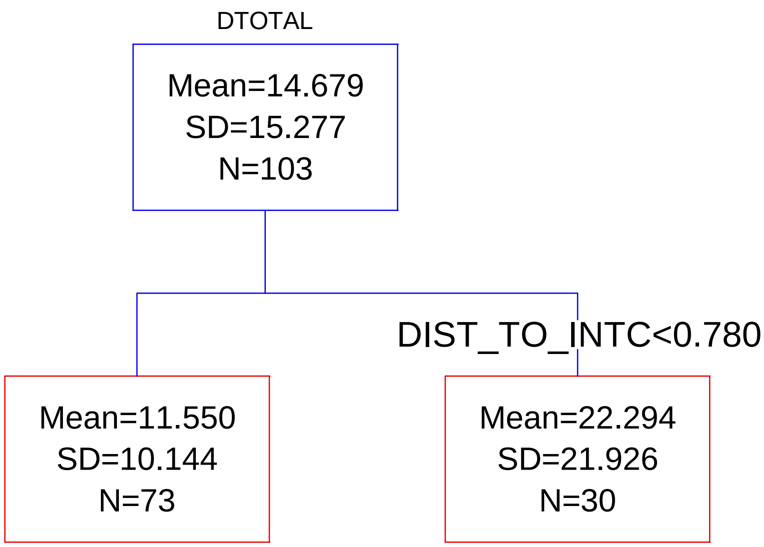


Figure 2.166.District 10 Angle Crash Density

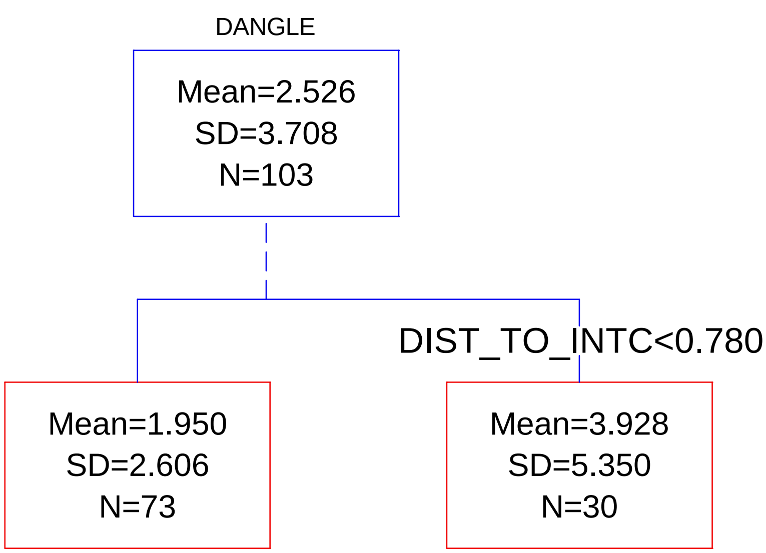


Figure 2.167.District 10 Fixed Object Crash Density

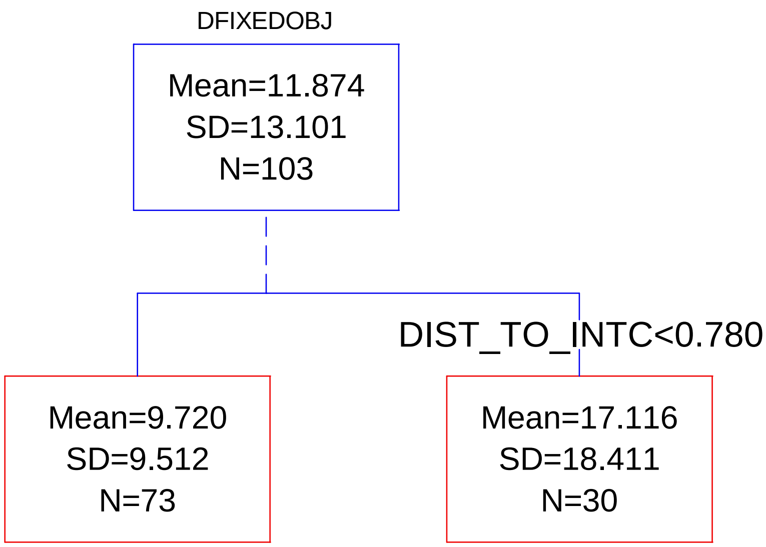


Figure 2.168.District 10 Rear end Crash Density

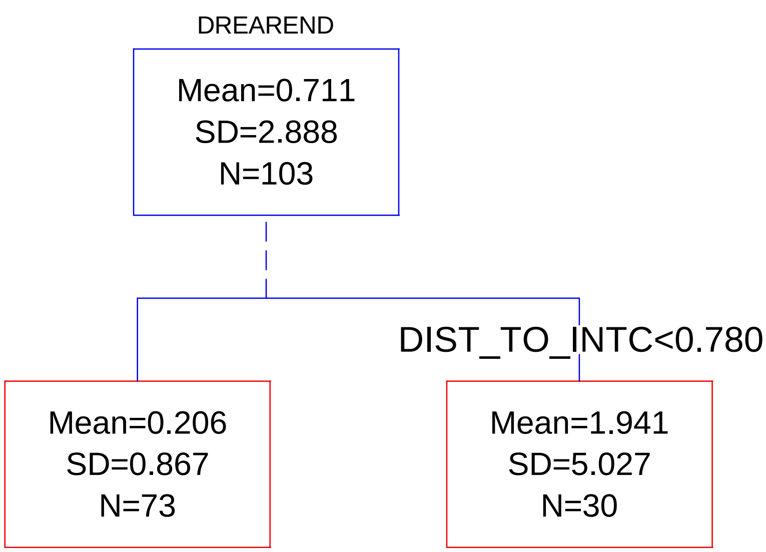


Figure 2.169.District 10 Sideswipe Crash Density

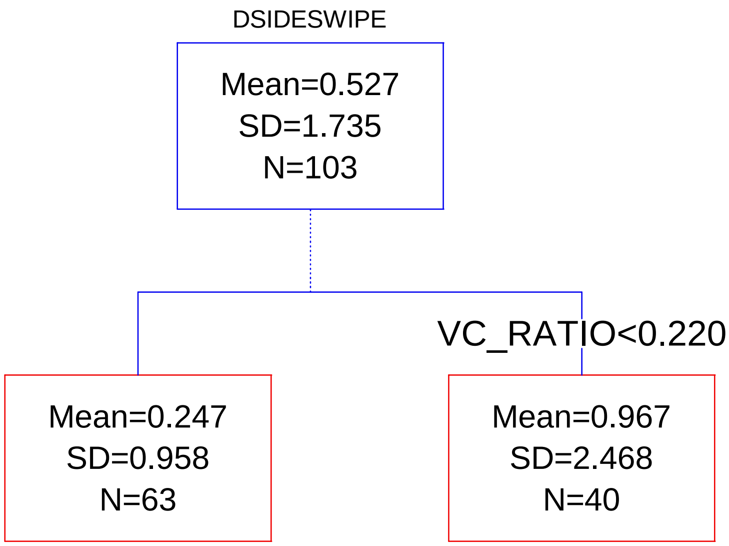


Figure 2.170.District 10 Road wet Crash Density

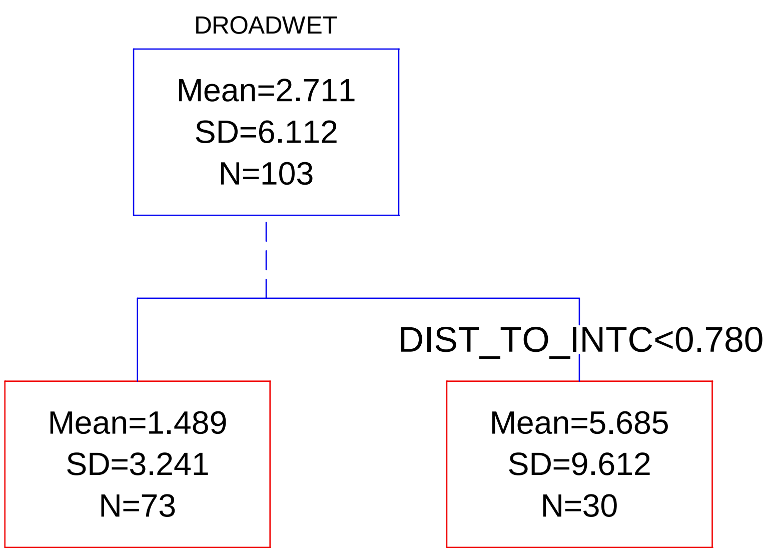


Figure 2.171.District 10 Night Crash Density

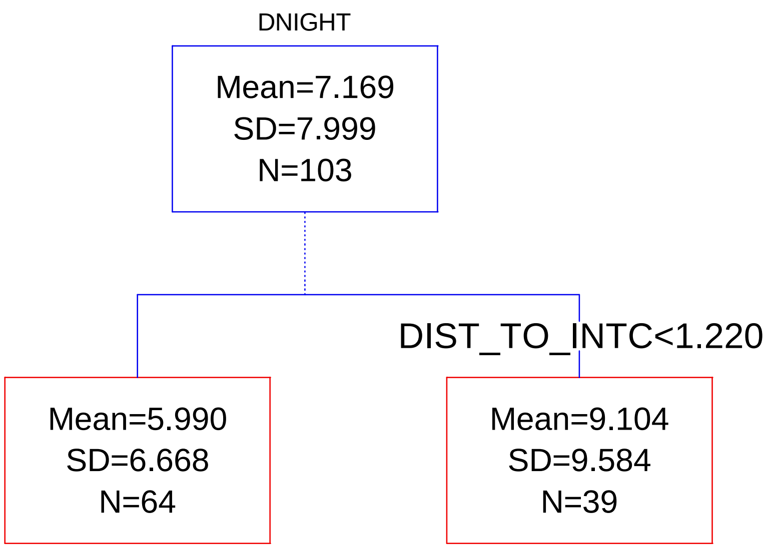


Figure 2.172.District 10 Injury/Fatal Crash Rate

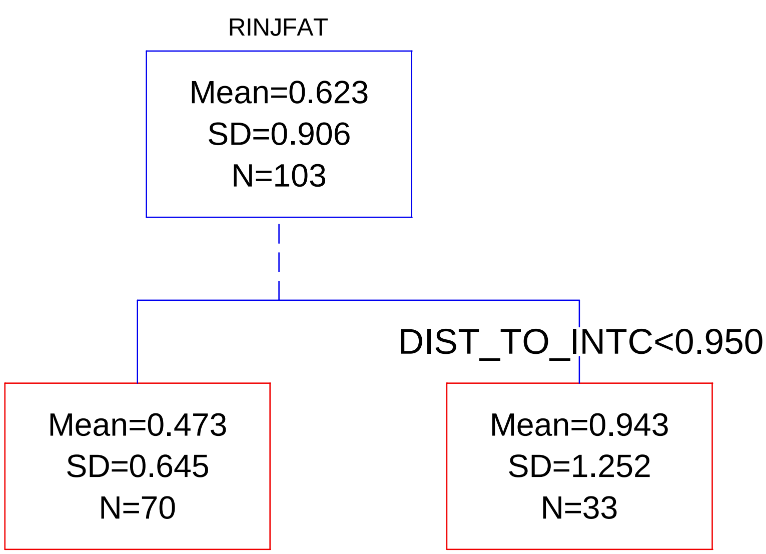


Figure 2.173.District 10 Property damage only Crash Rate

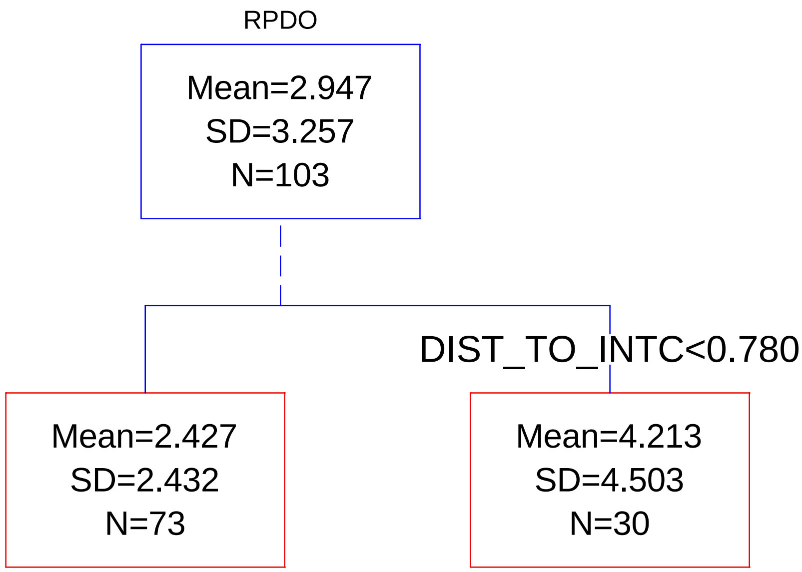


Figure 2.174.District 10 Total Crash Rate

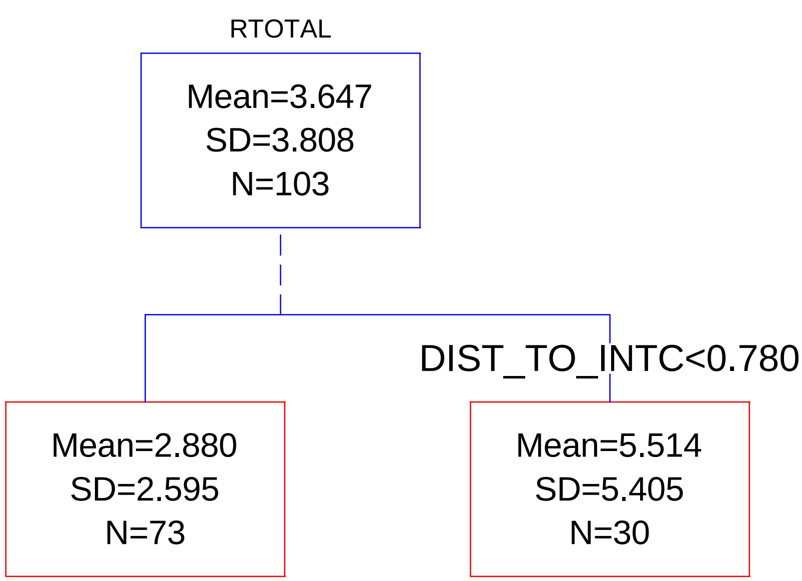


Figure 2.175.District 10 Angle Crash Rate

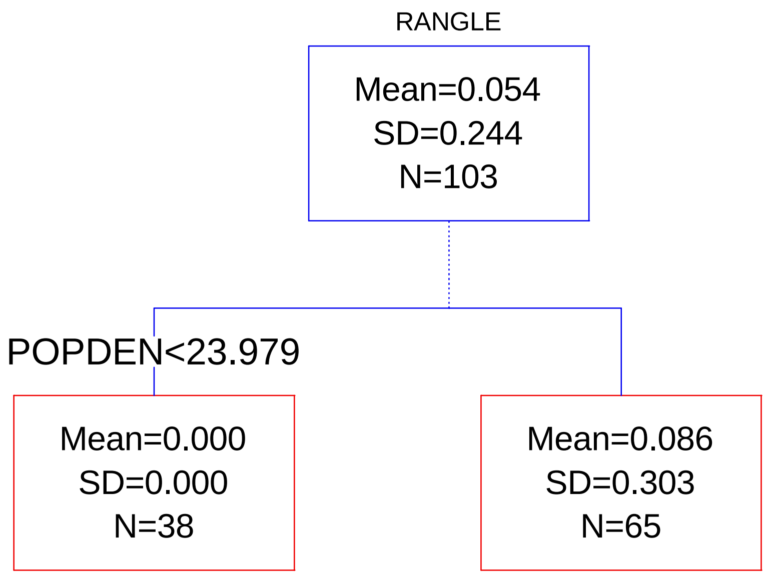


Figure 2.176.District 10 Fixed Object Crash Rate

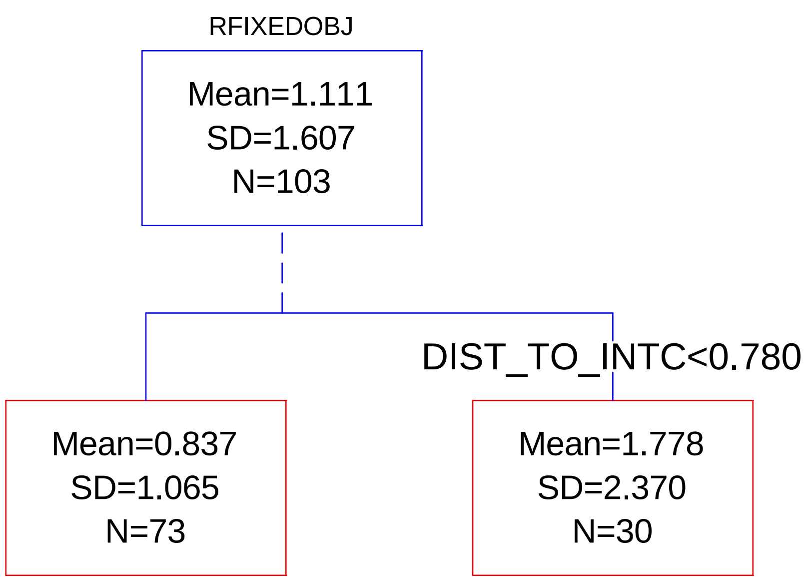


Figure 2.177.District 10 Rear end Crash Rate

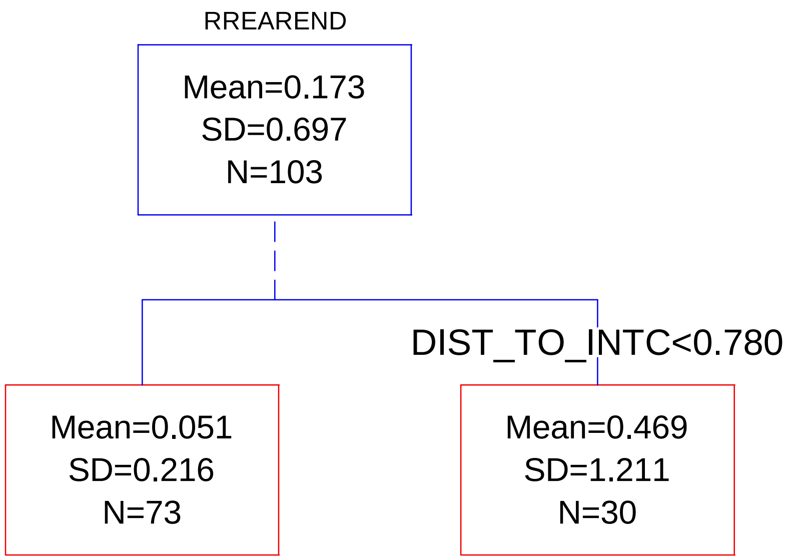


Figure 2.178.District 10 Sideswipe Crash Rate

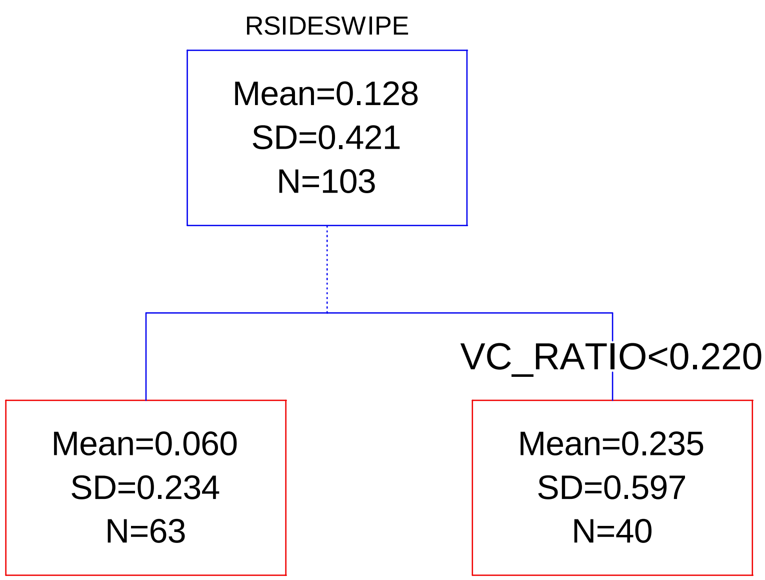


Figure 2.179.District 10 Road wet Crash Rate

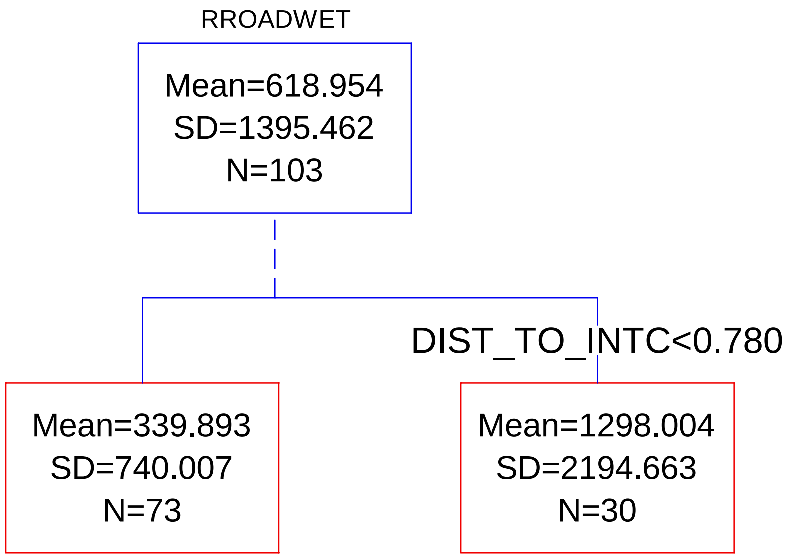
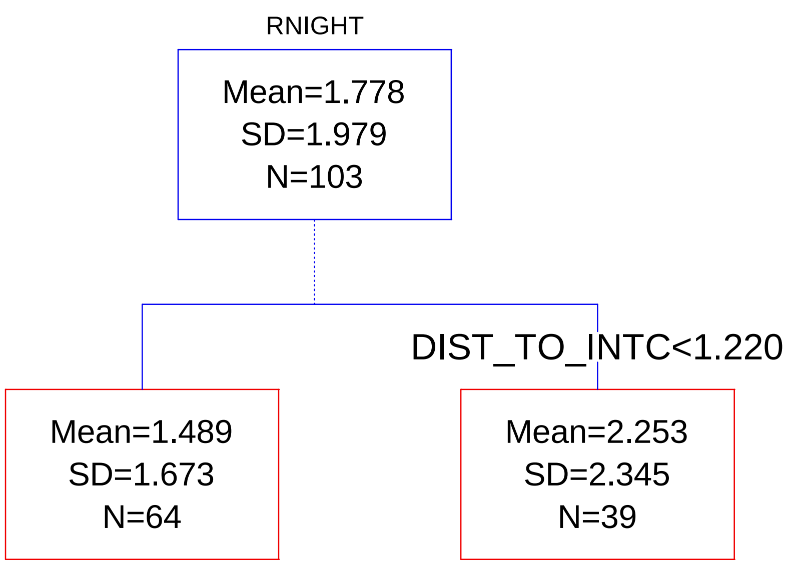


Figure 2.180.District 10 Night Crash Rate



AID Trees for District 11

Figure 2.181.District 11 Injury/Fatal Crash Density

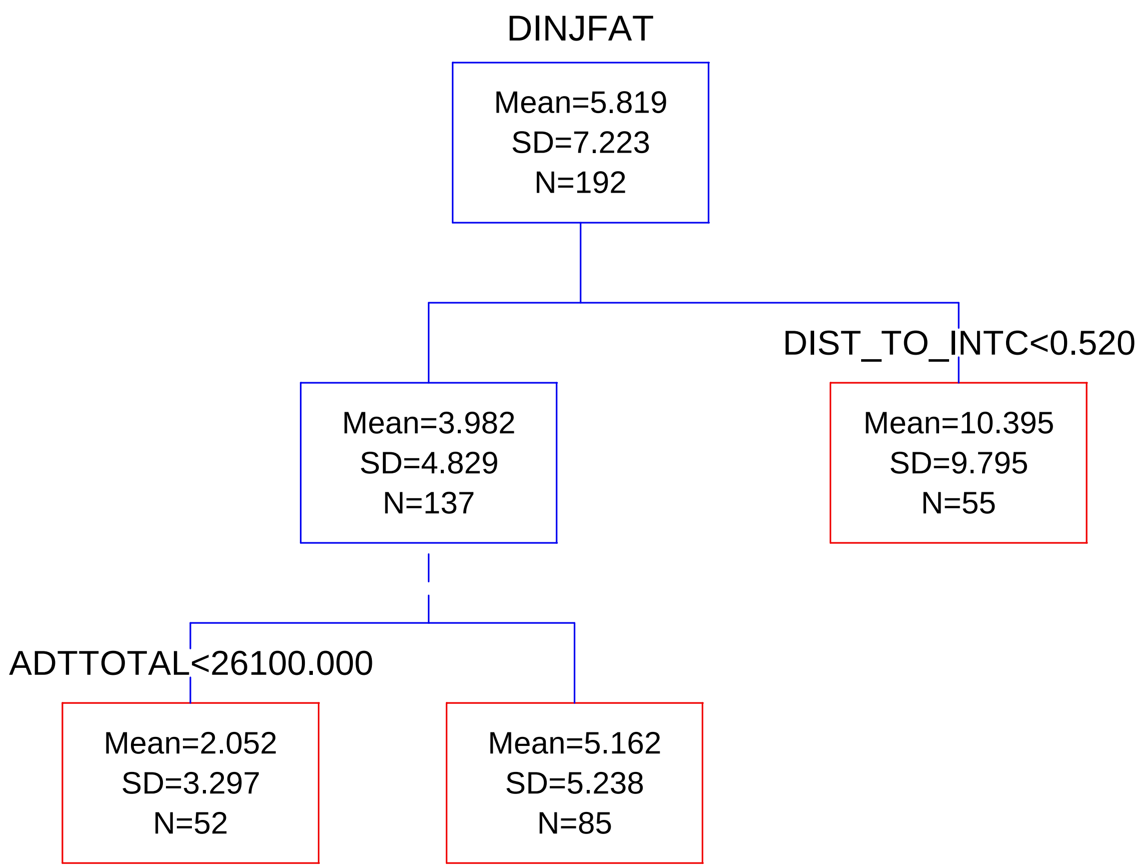


Figure 2.182.District 11 Property damage only Crash Density

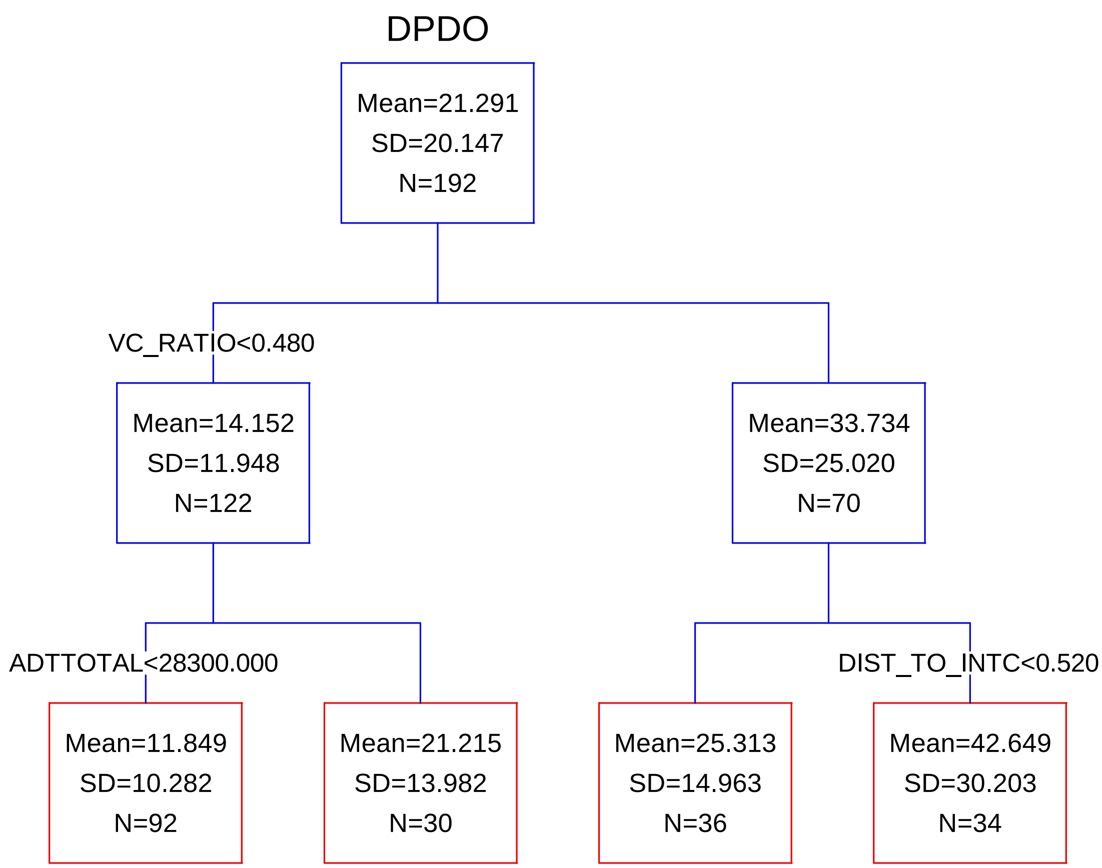


Figure 2.183.District 11 Total Crash Density

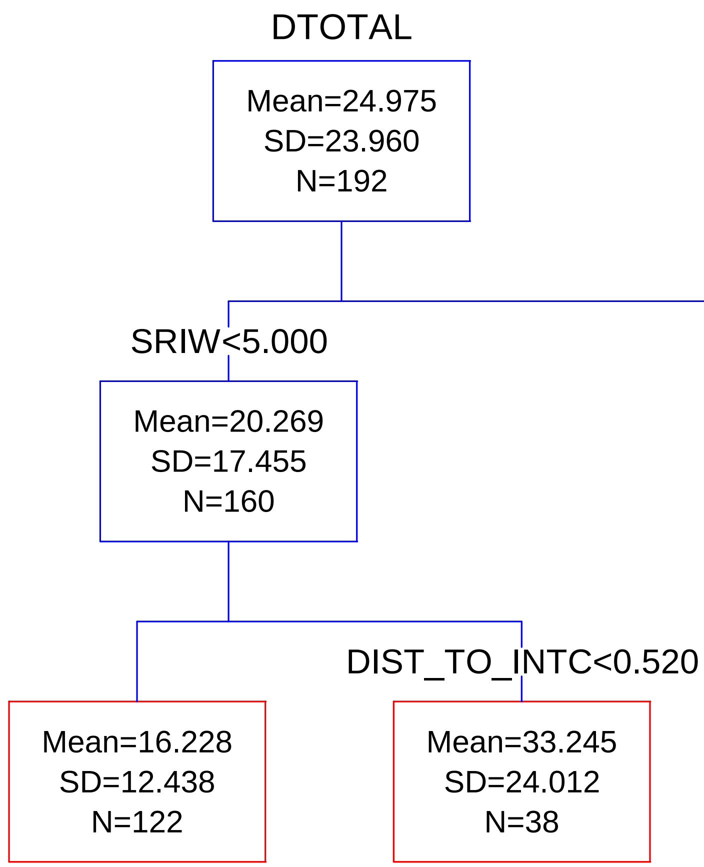


Figure 2.184.District 11 Angle Crash Density

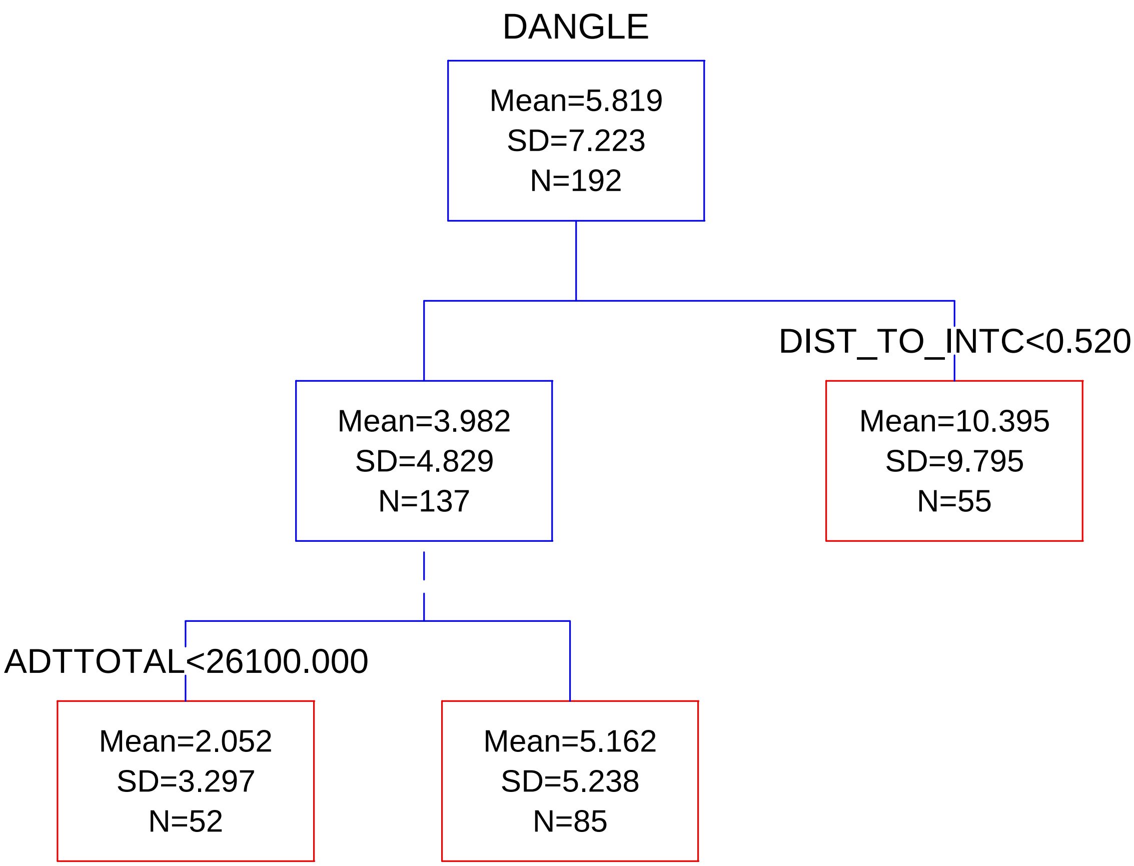


Figure 2.185.District 11 Fixed Object Crash Density

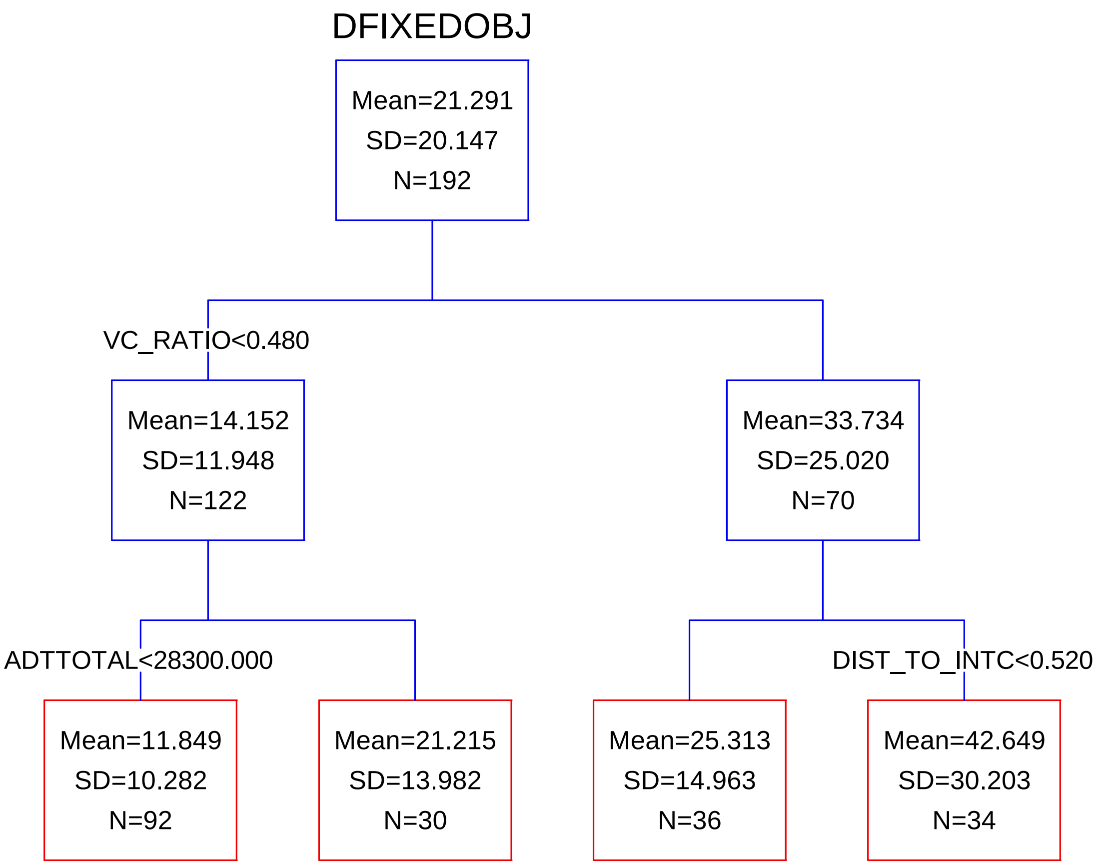


Figure 2.186.District 11 Rear end Crash Density

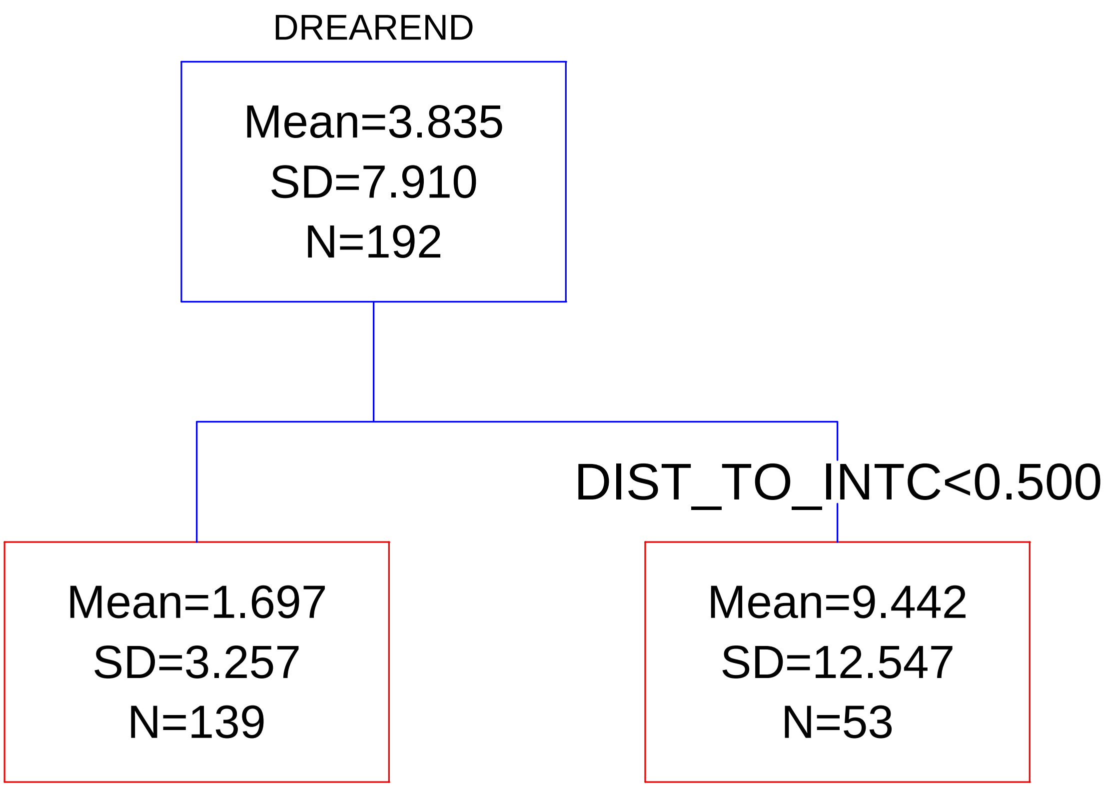


Figure 2.187.District 11 Sideswipe Crash Density

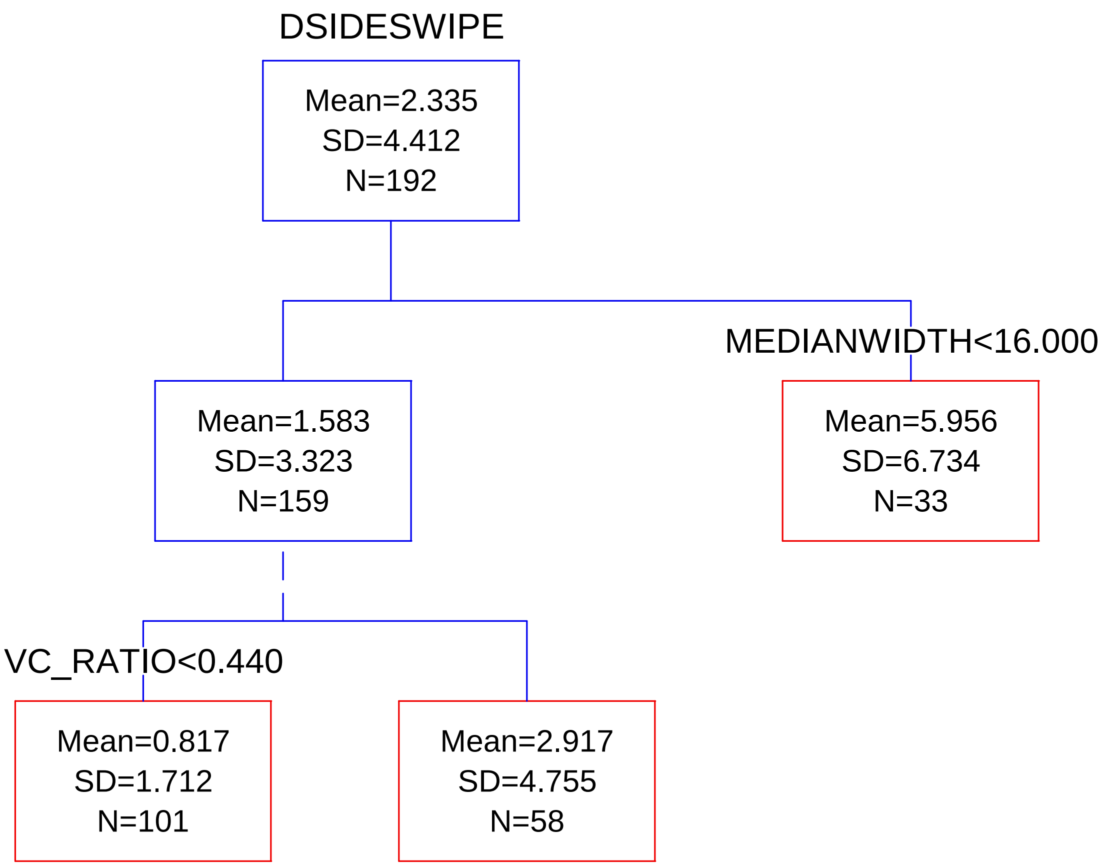


Figure 2.188.District 11 Road wet Crash Density

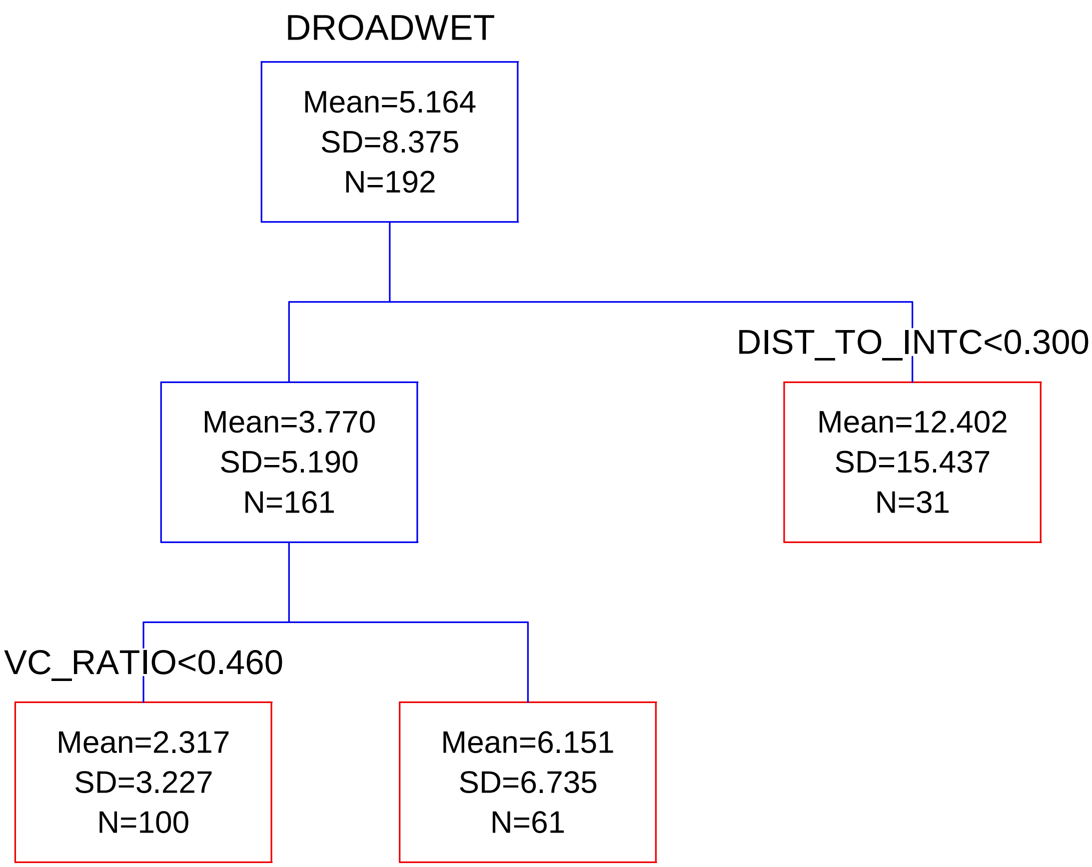


Figure 2.189.District 11 Night Crash Density

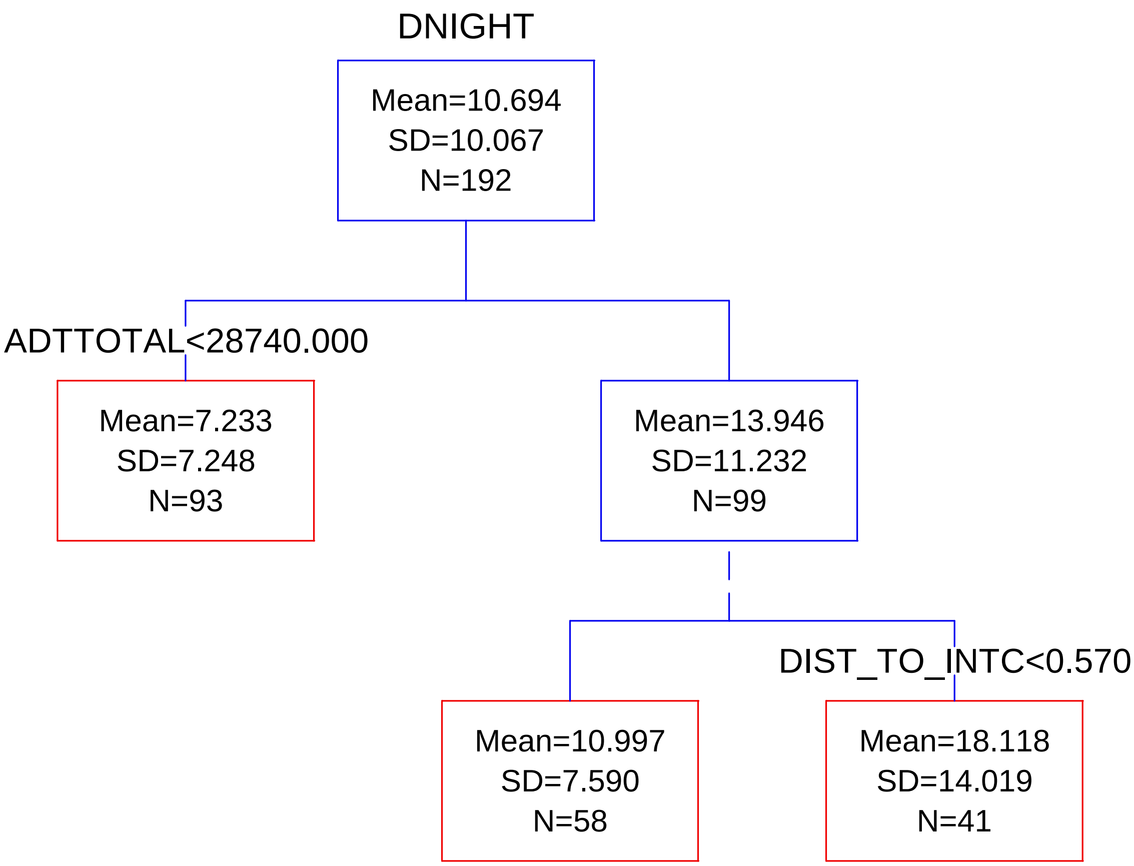


Figure 2.190.District 11 Injury/Fatal Crash Rate

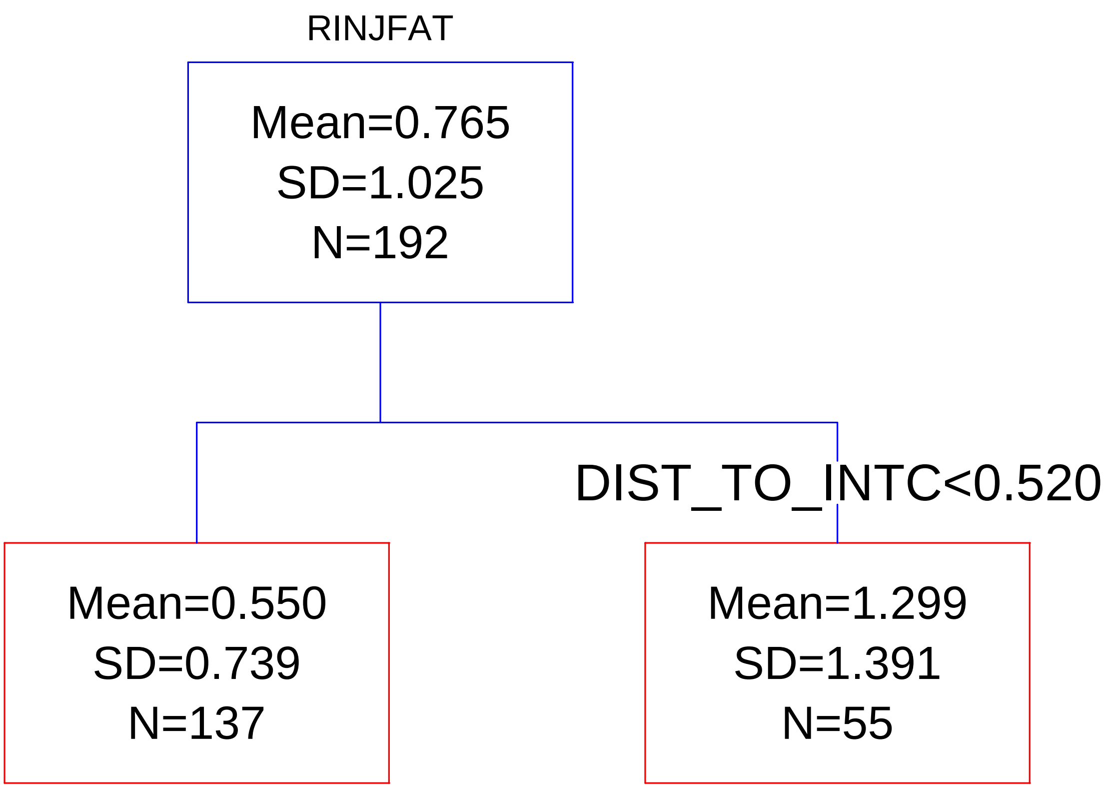


Figure 2.191.District 11 Property damage only Crash Rate

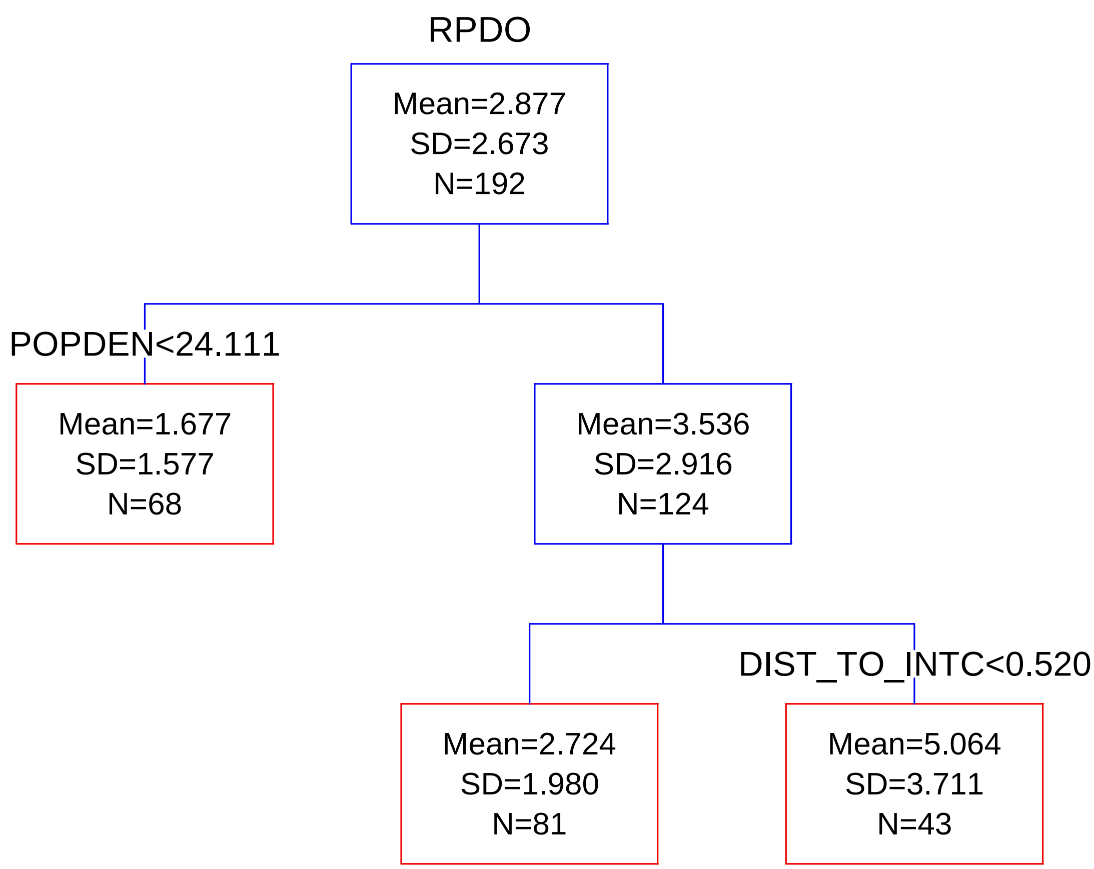


Figure 2.192.District 11 Total Crash Rate

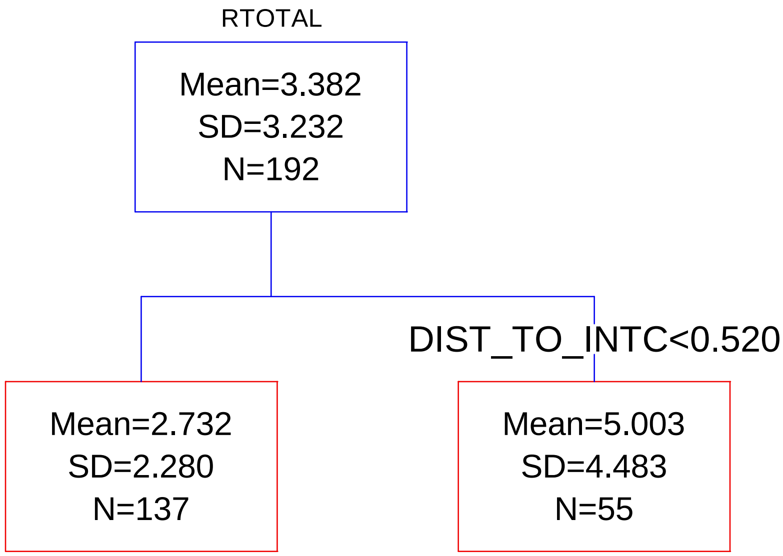


Figure 2.193.District 11 Angle Crash Rate

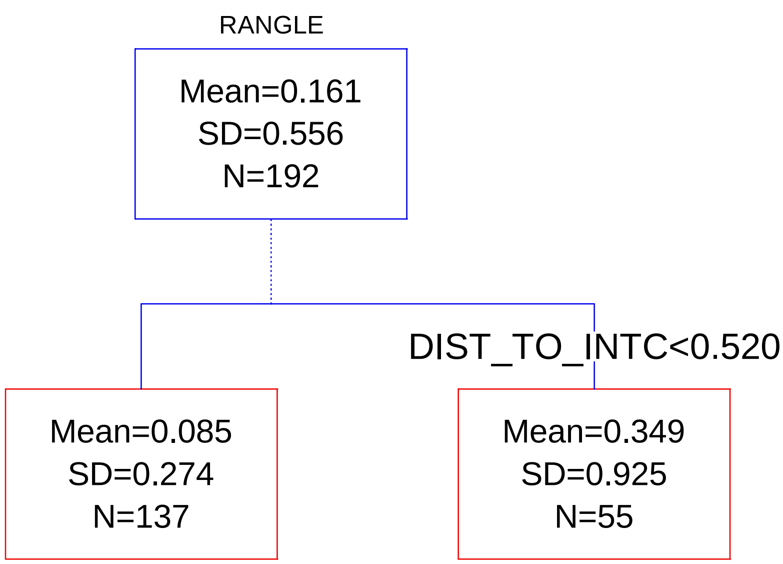


Figure 2.194.District 11 Fixed Object Crash Rate

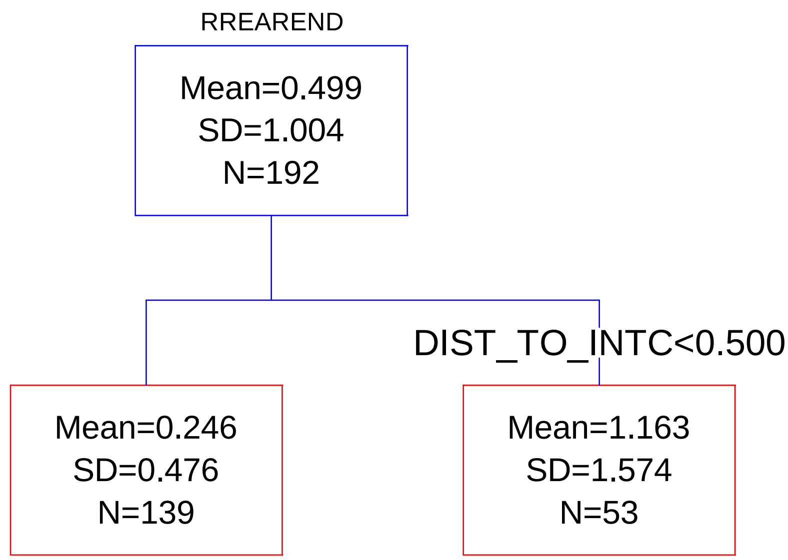


Figure 2.195.District 11 Rear end Crash Rate

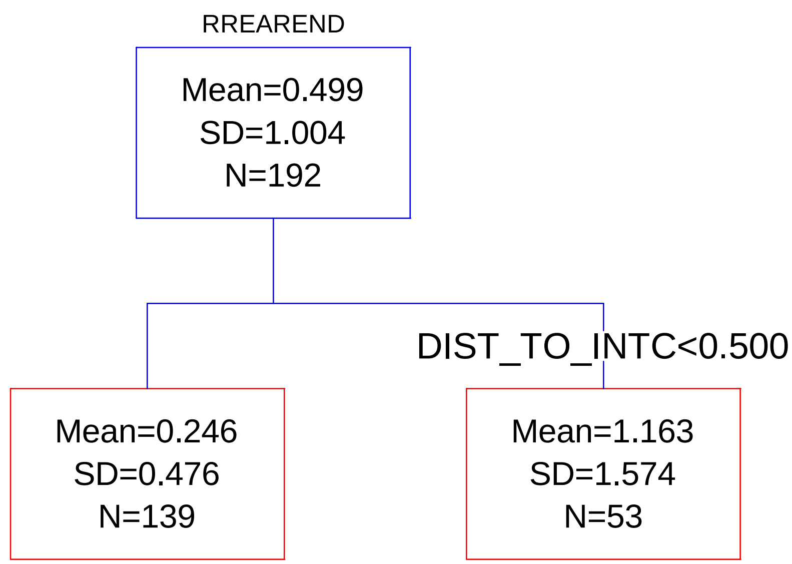


Figure 2.196.District 11 Sideswipe Crash Rate

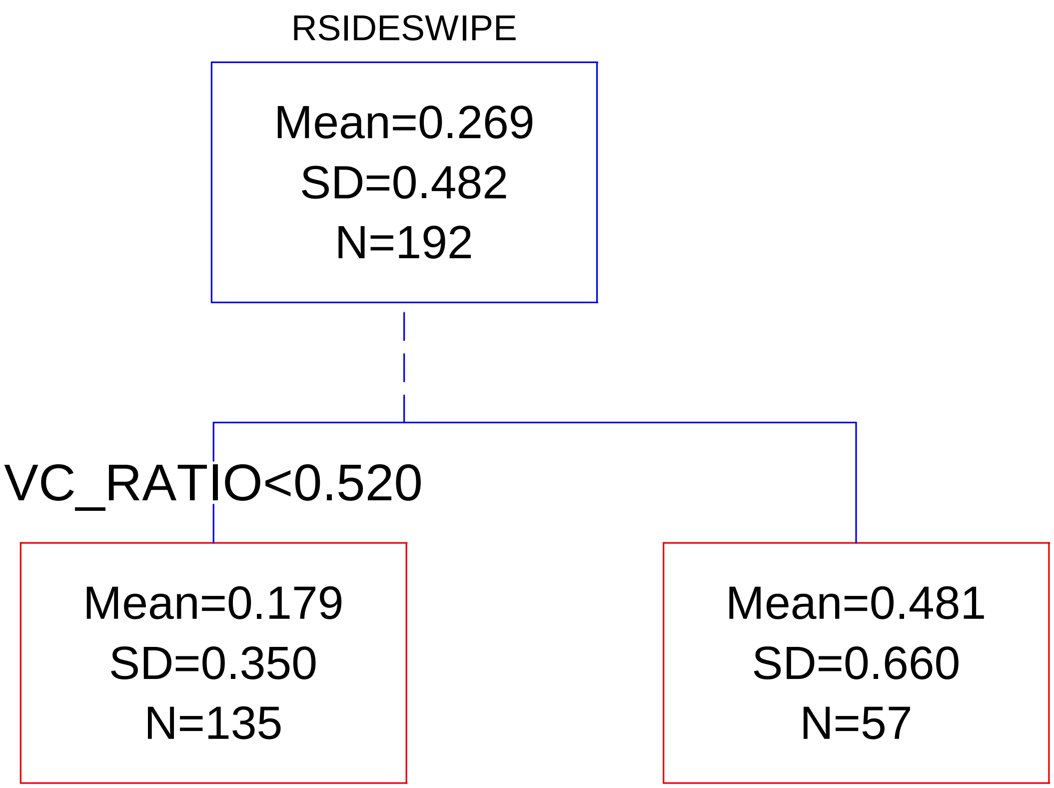


Figure 2.197.District 11 Road wet Crash Rate

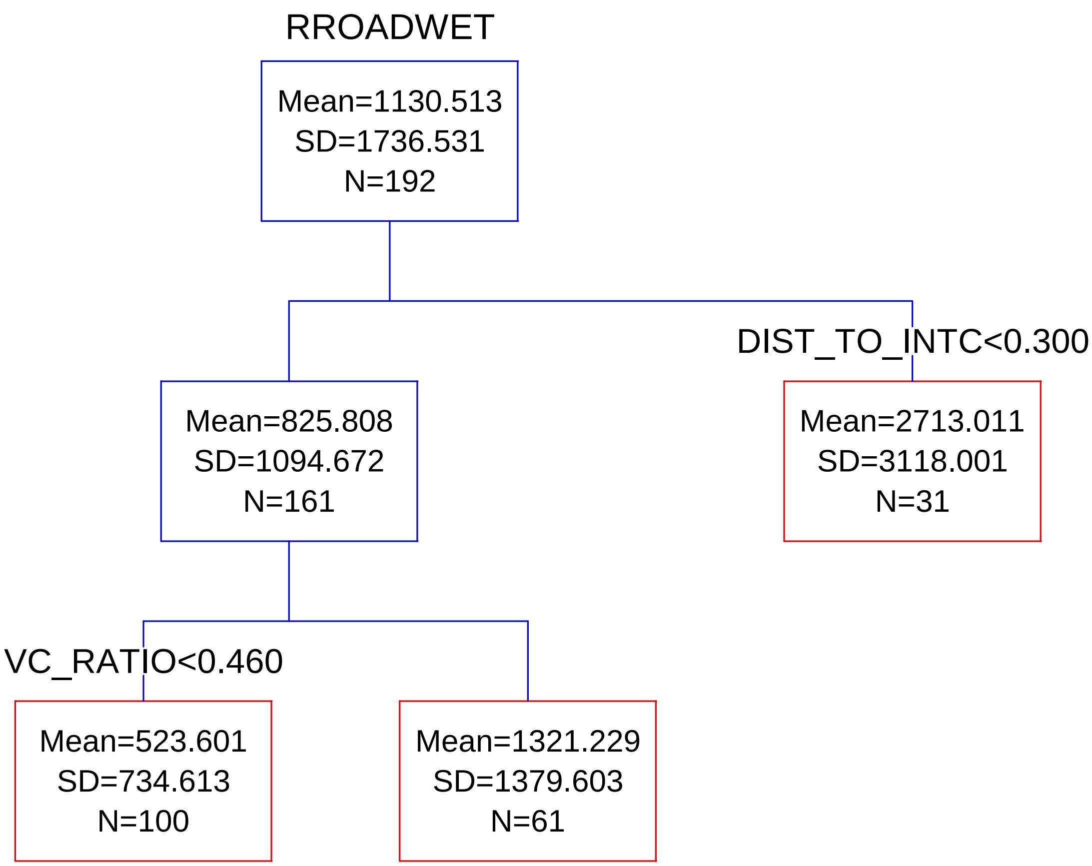
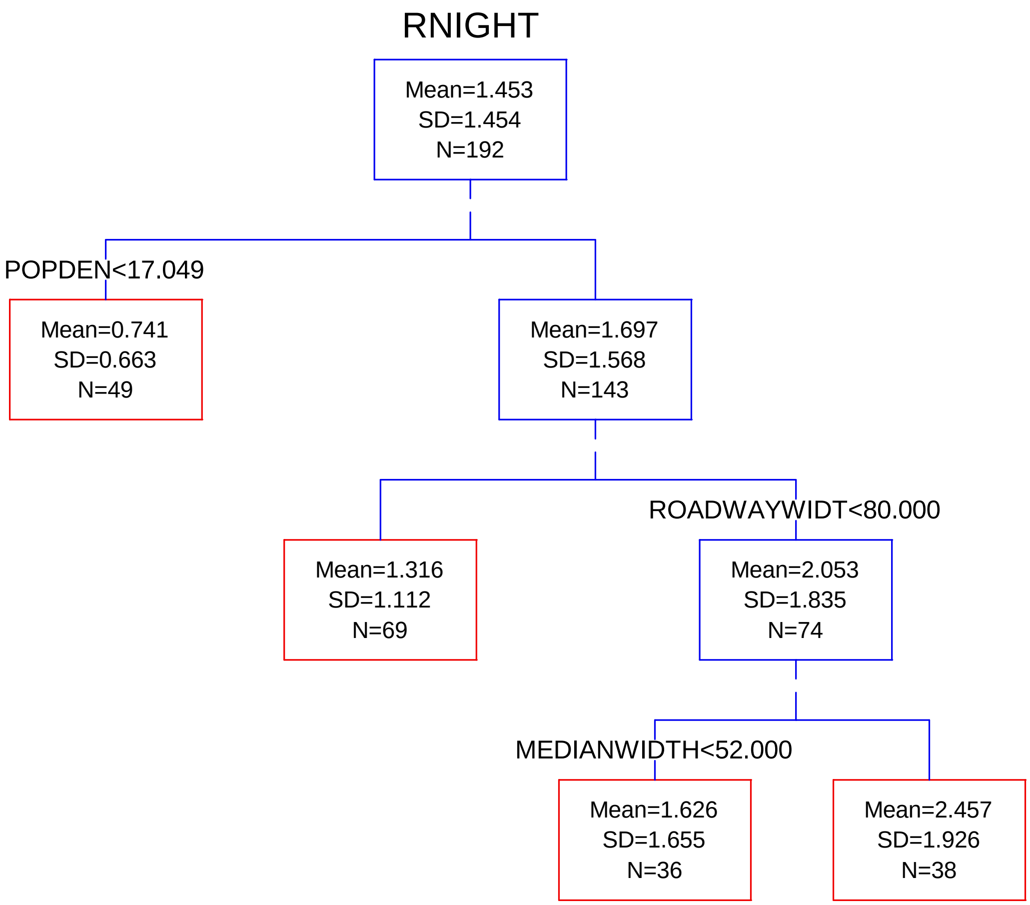


Figure 2.198.District 11 Night Crash Rate



ID Tree for District 12

Figure 2.199.District 12 Injury/Fatal Crash Density

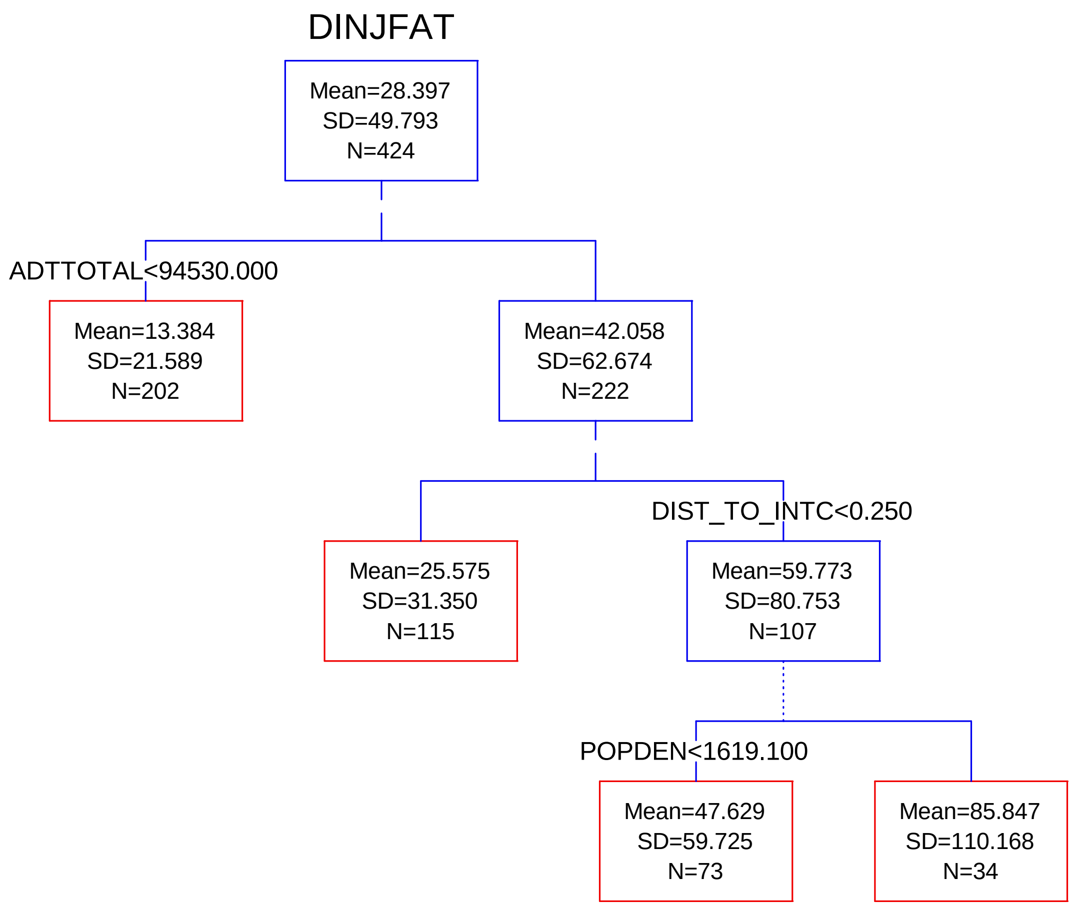


Figure 2.200.District 12 Property damage only Crash Density

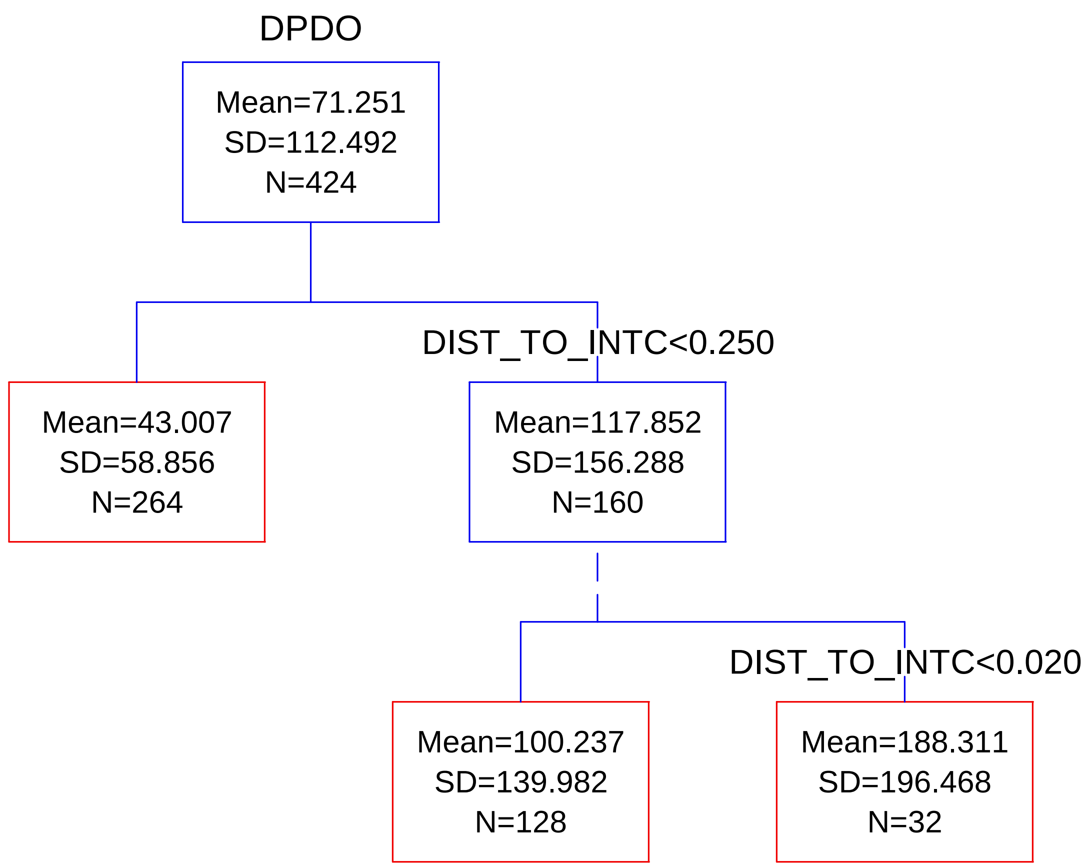


Figure 2.201.District 12 Total Crash Density

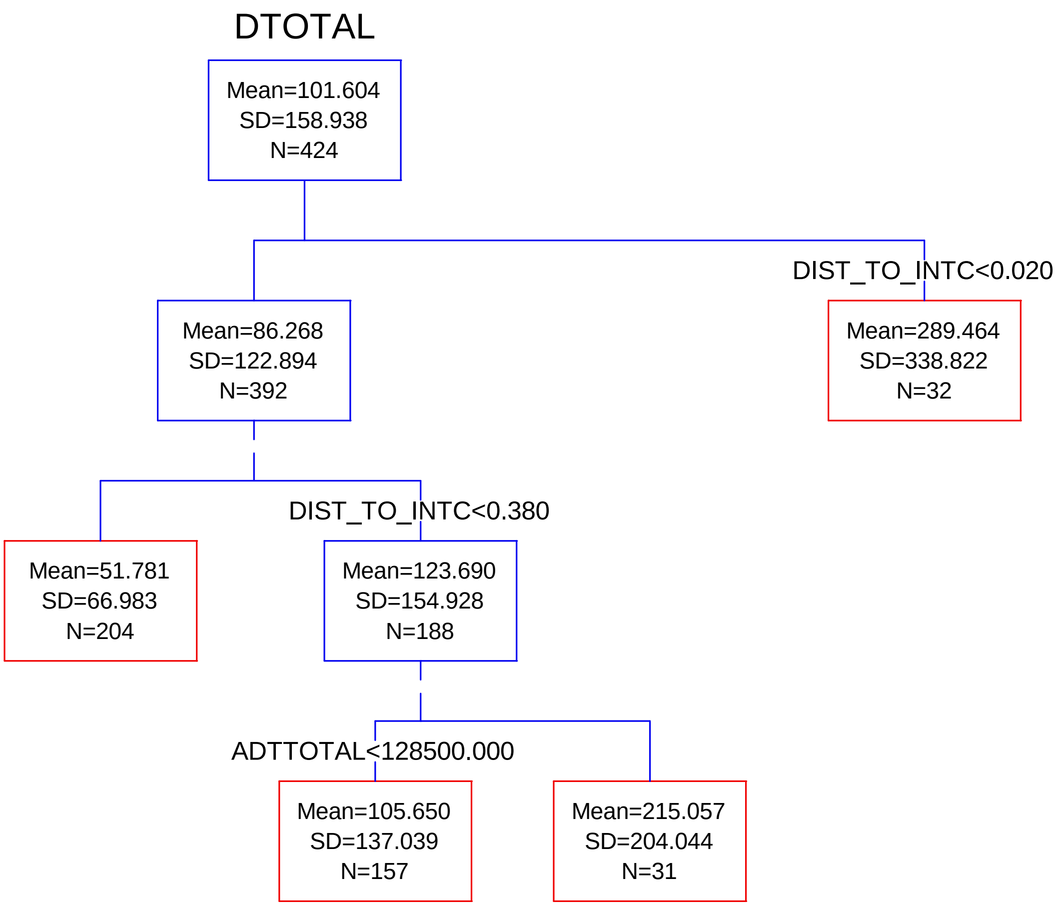


Figure 2.202.District 12 Angle Crash Density

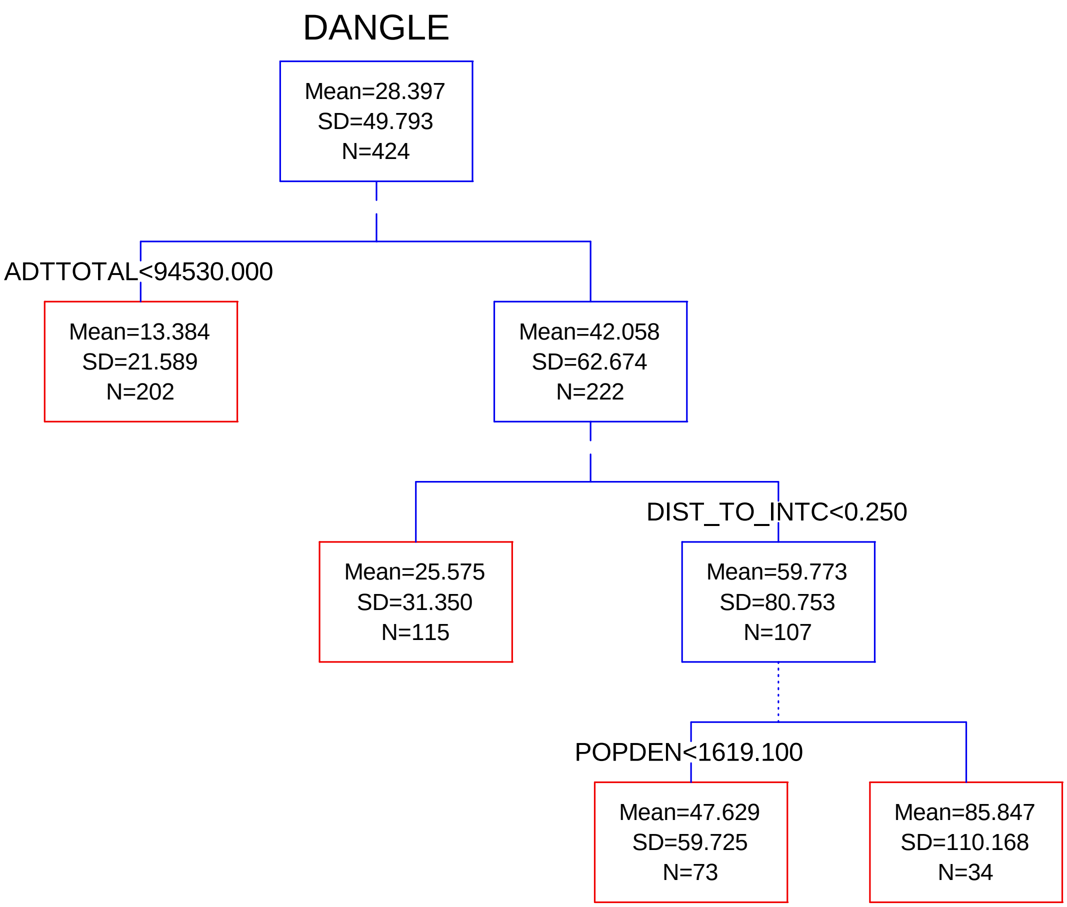


Figure 2.203.District 12 Fixed Object Crash Density

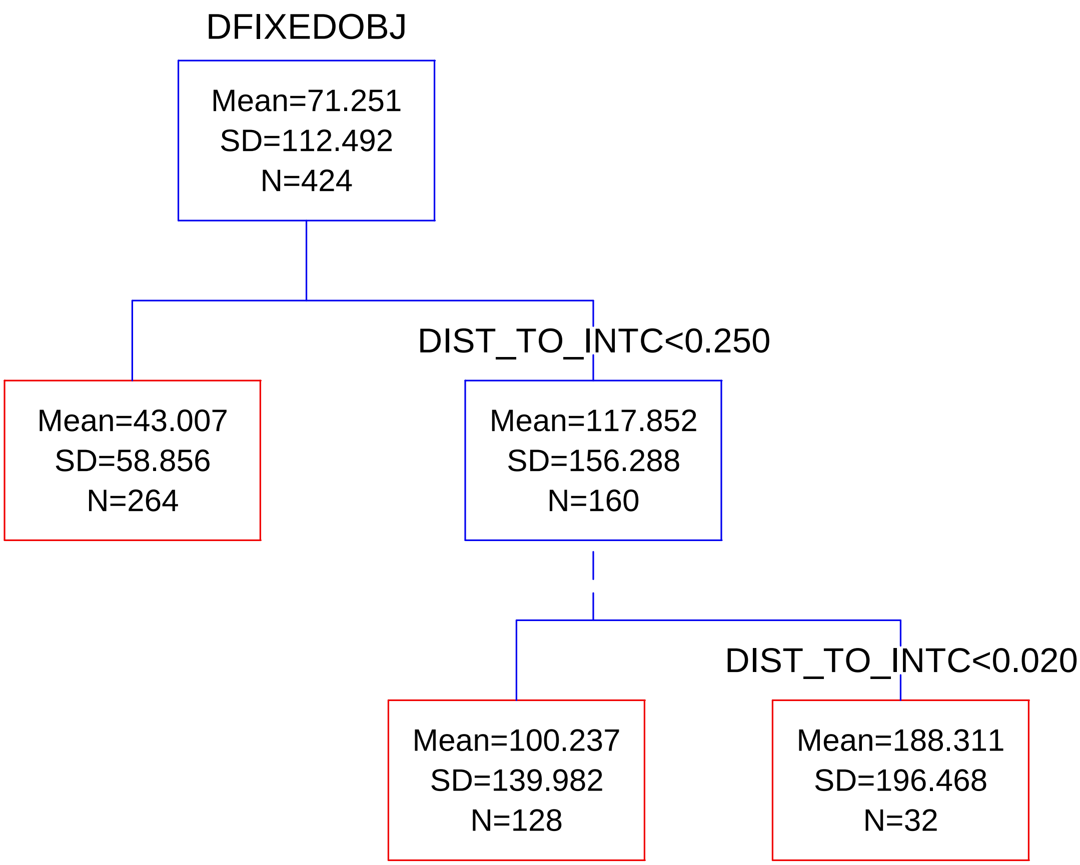


Figure 2.204.District 12 Rear end Crash Density

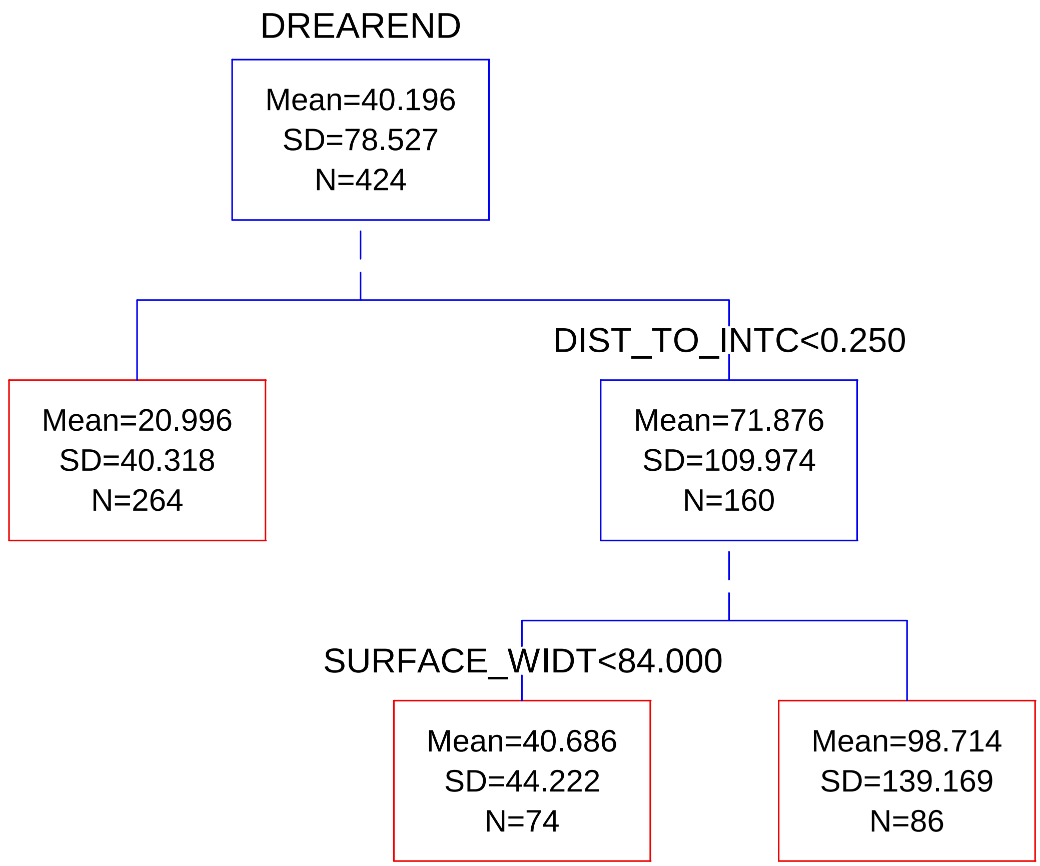


Figure 2.205.District 12 Sideswipe Crash Density

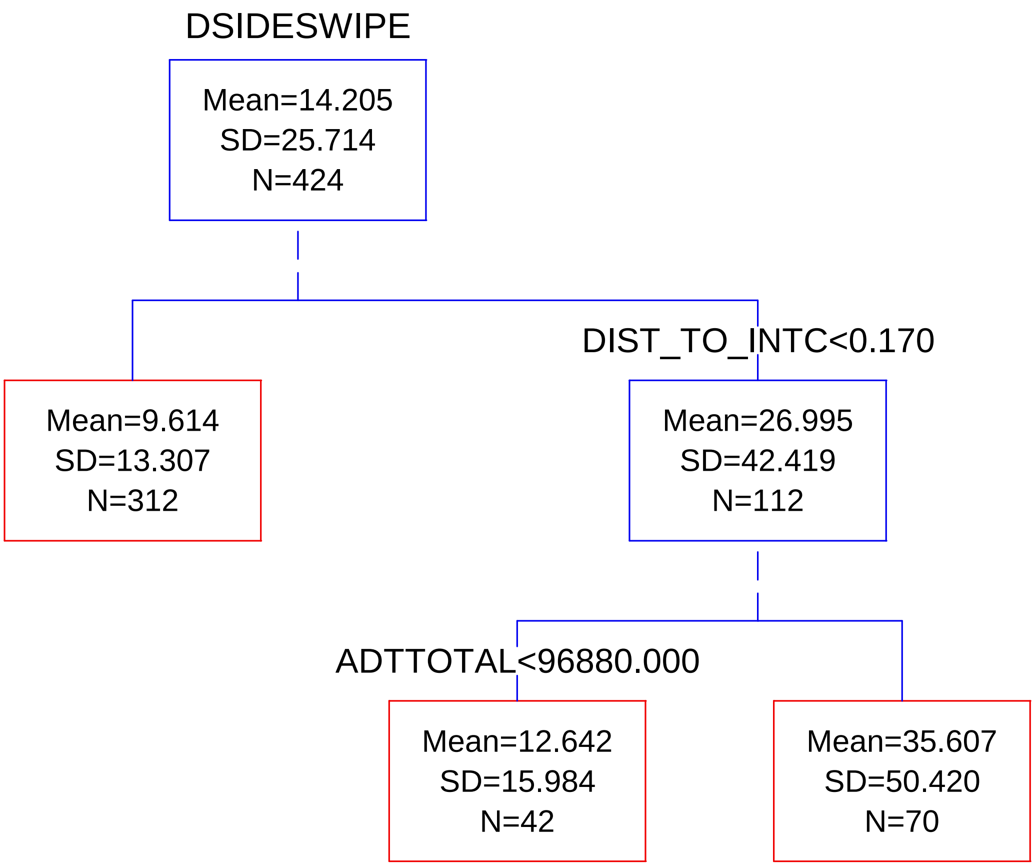


Figure 2.206.District 12 Road wet Crash Density

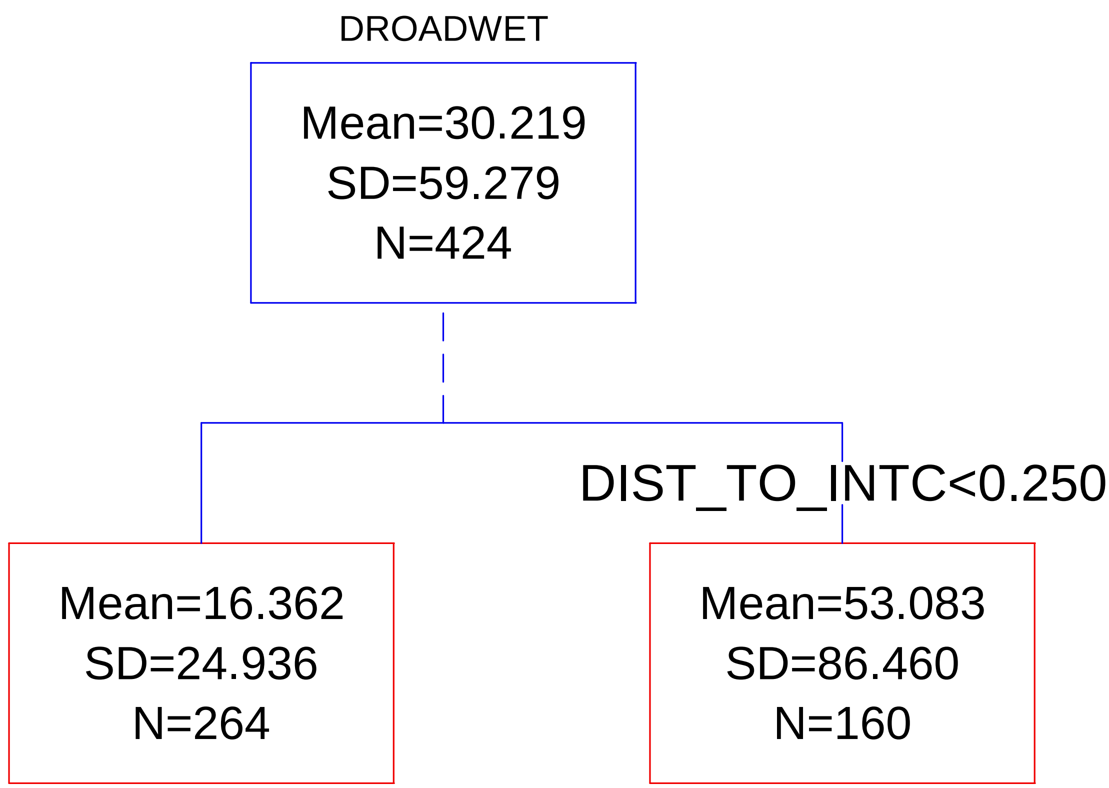


Figure 2.207.District 12 Night Crash Density

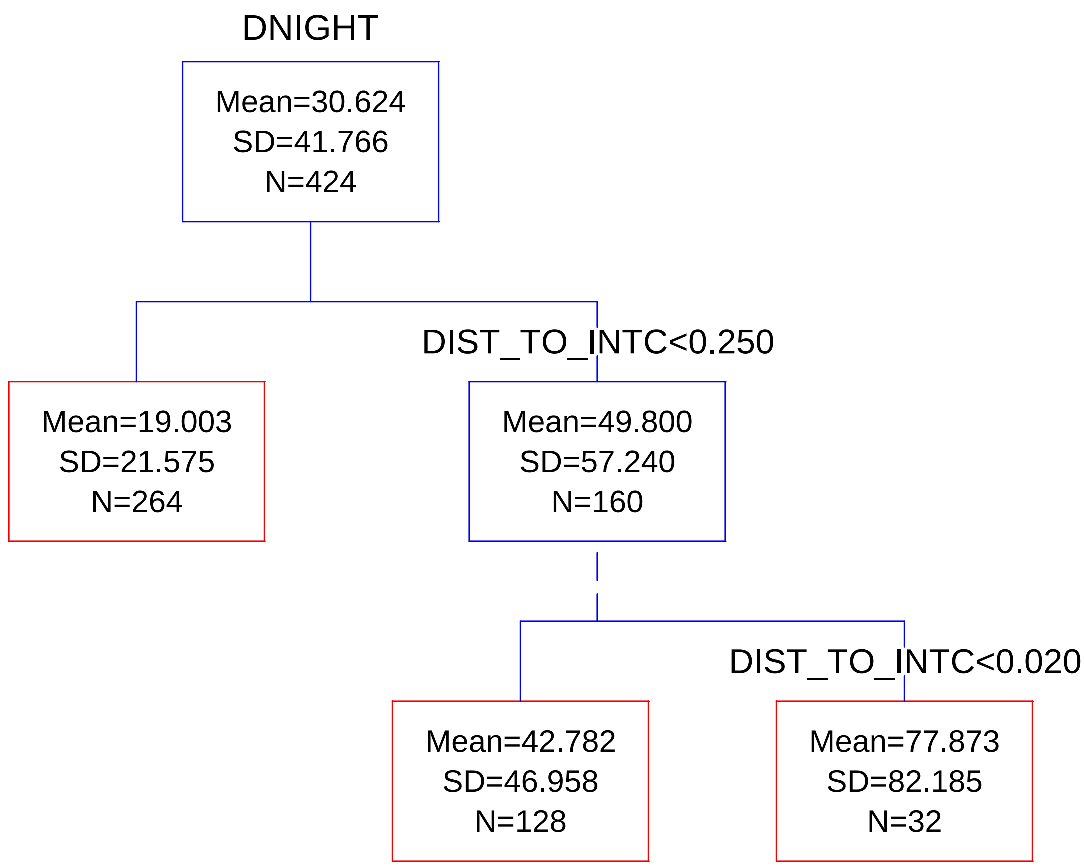


Figure 2.208.District 12 Injury/Fatal Crash Rate

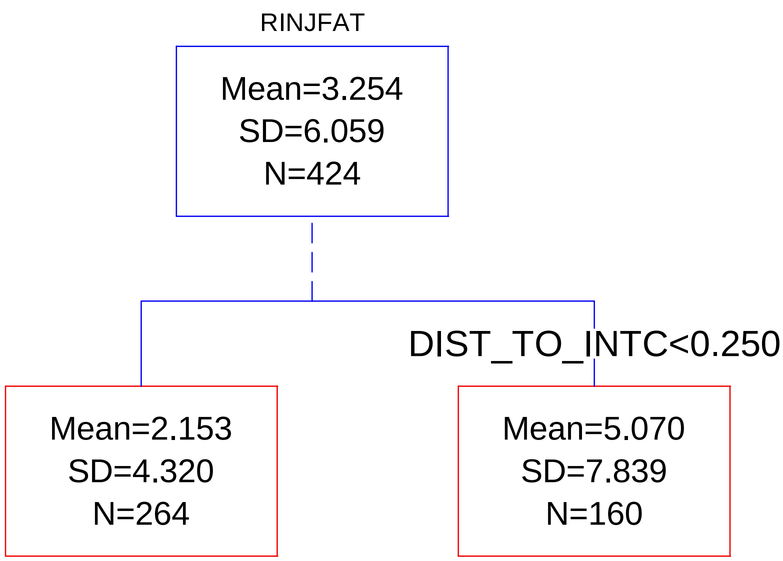


Figure 2.209.District 12 Property damage only Crash Rate

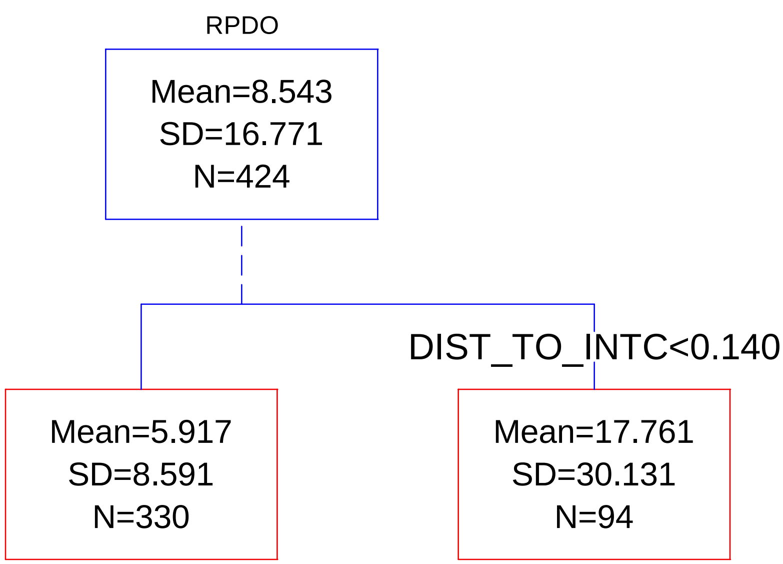


Figure 2.210.District 12 Total Crash Rate

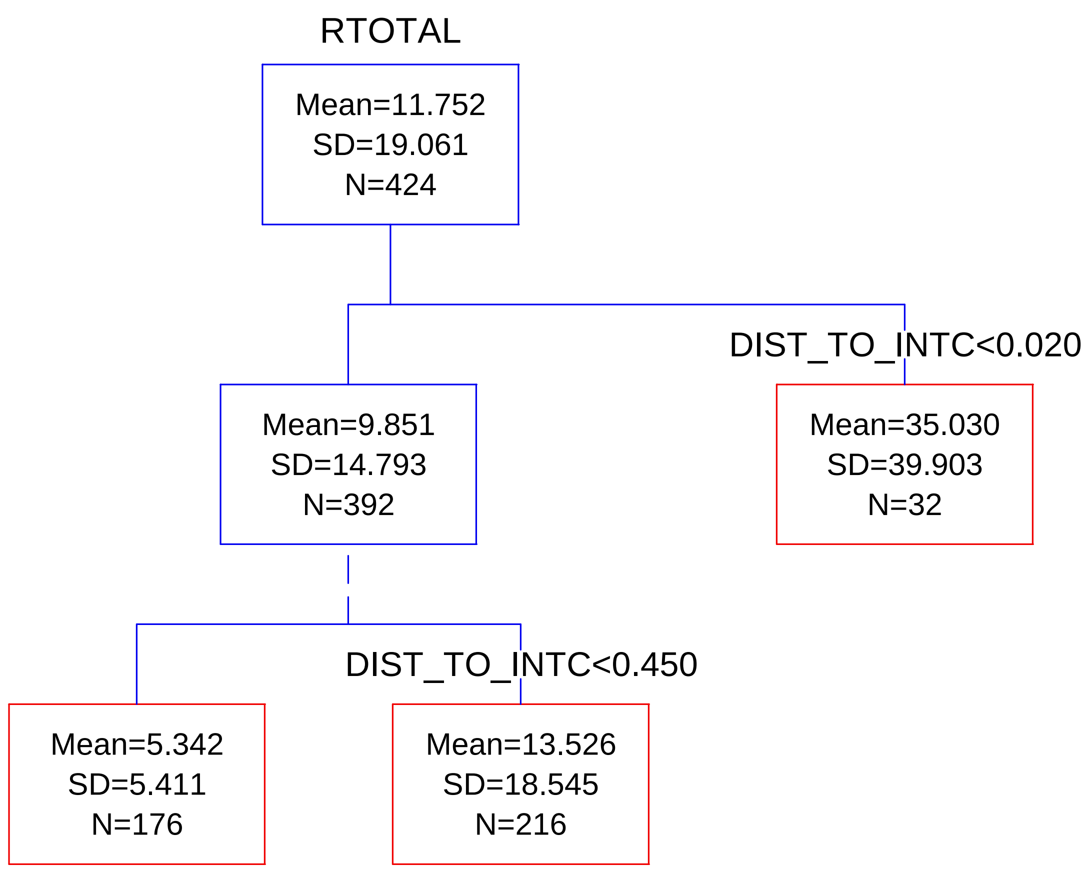


Figure 2.211.District 12 Angle Crash Rate

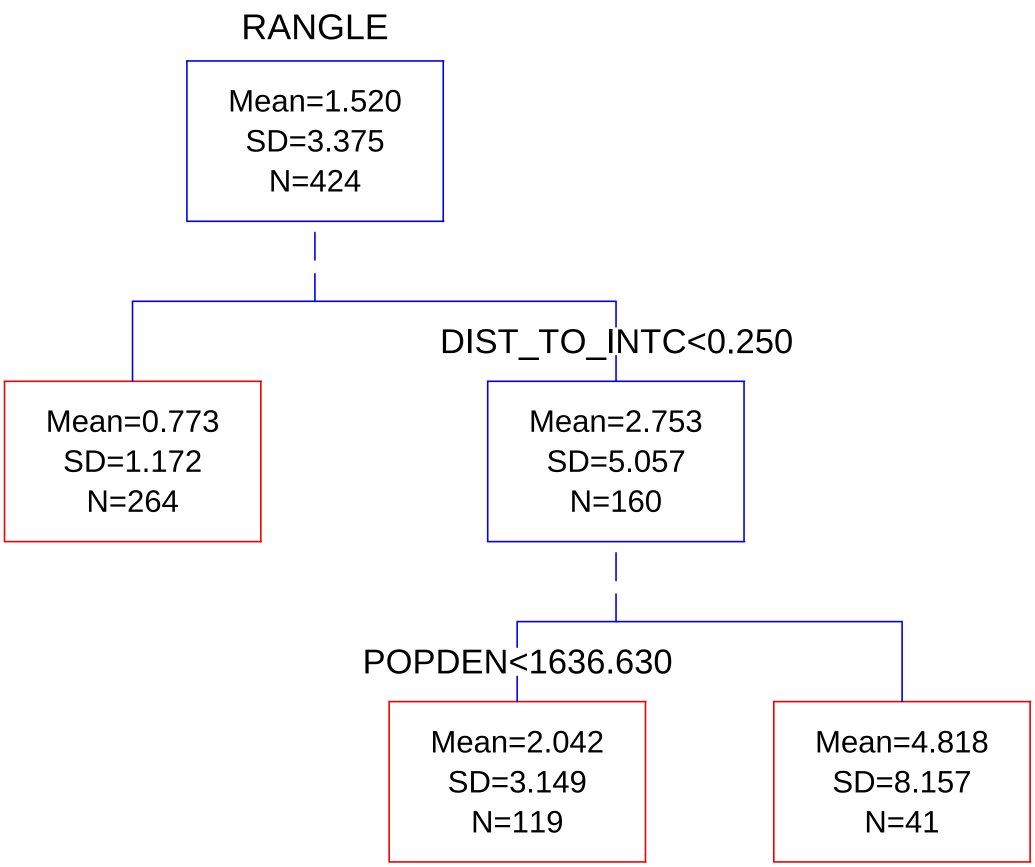


Figure 2.212.District 12 Fixed Object Crash Rate

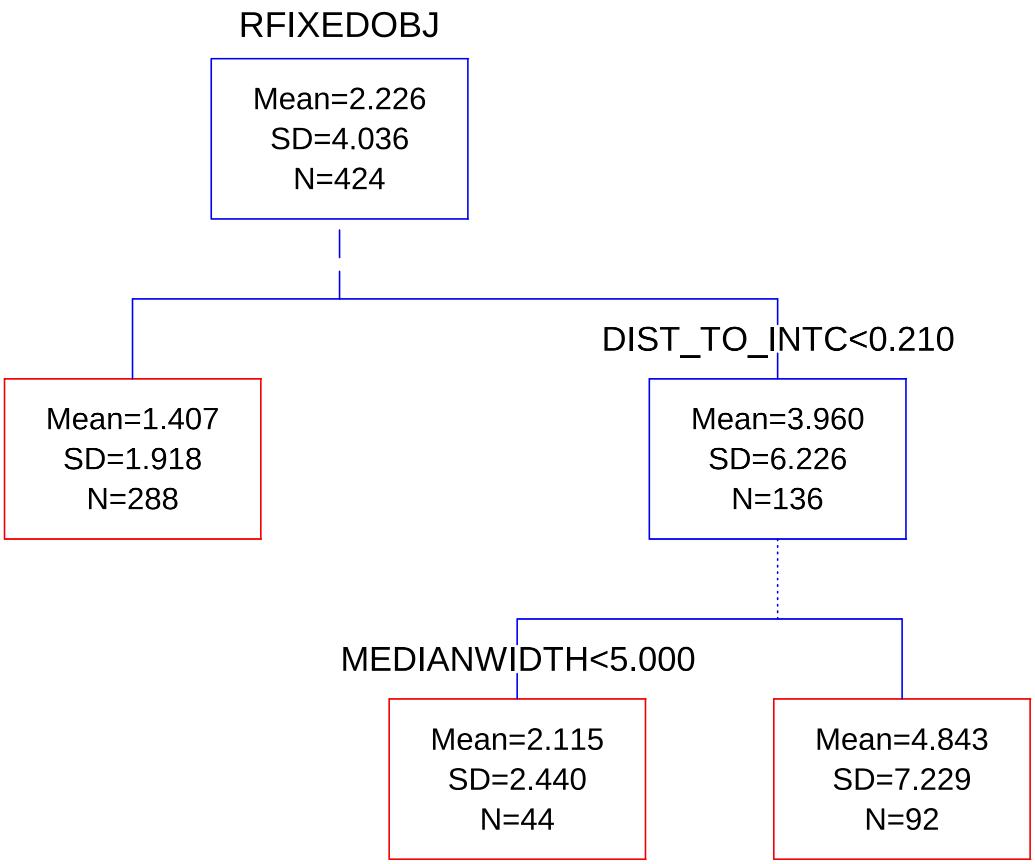


Figure 2.213.District 12 Rear end Crash Rate

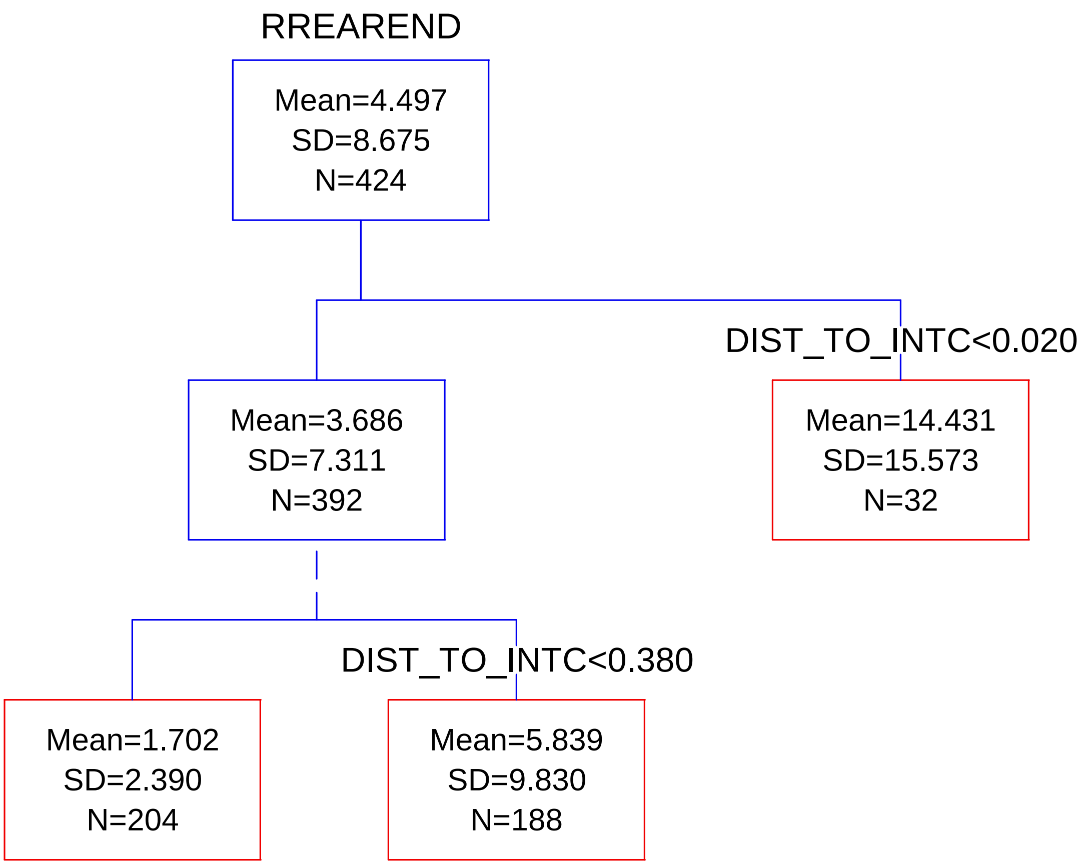


Figure 2.214.District 12 Sideswipe Crash Rate

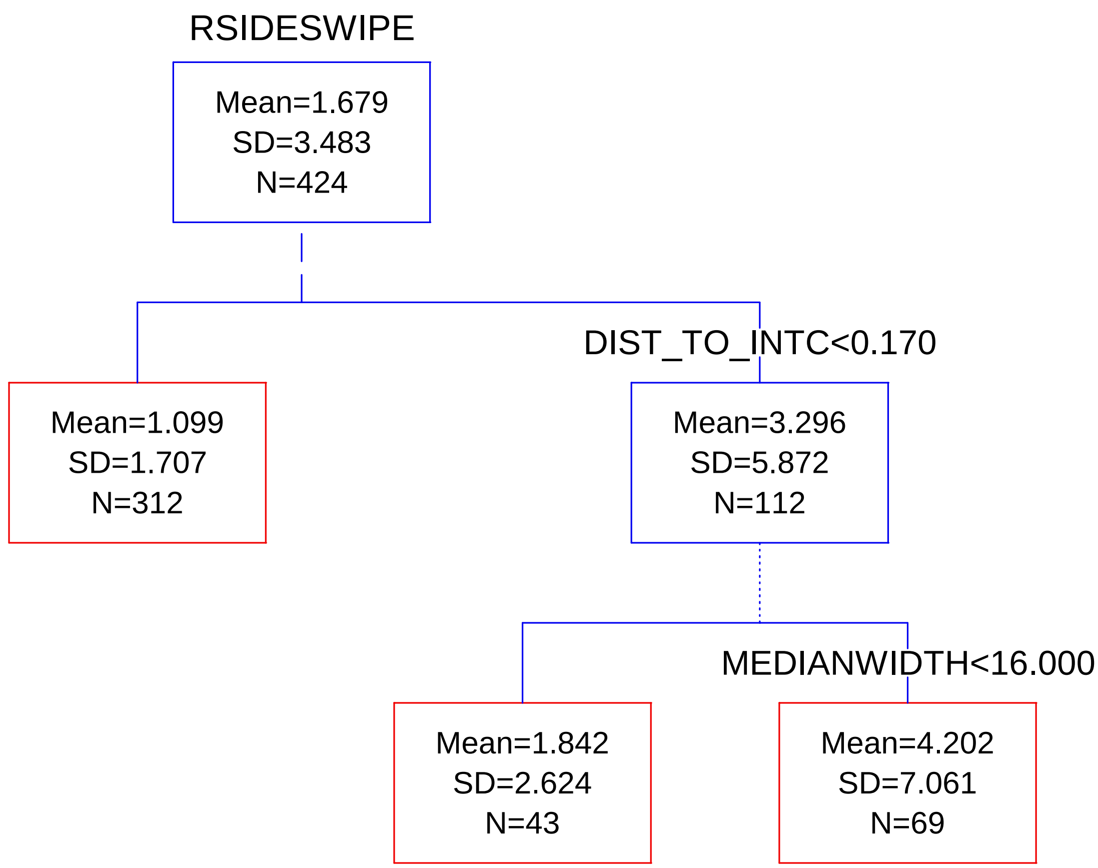


Figure 2.215.District 12 Road wet Crash Rate

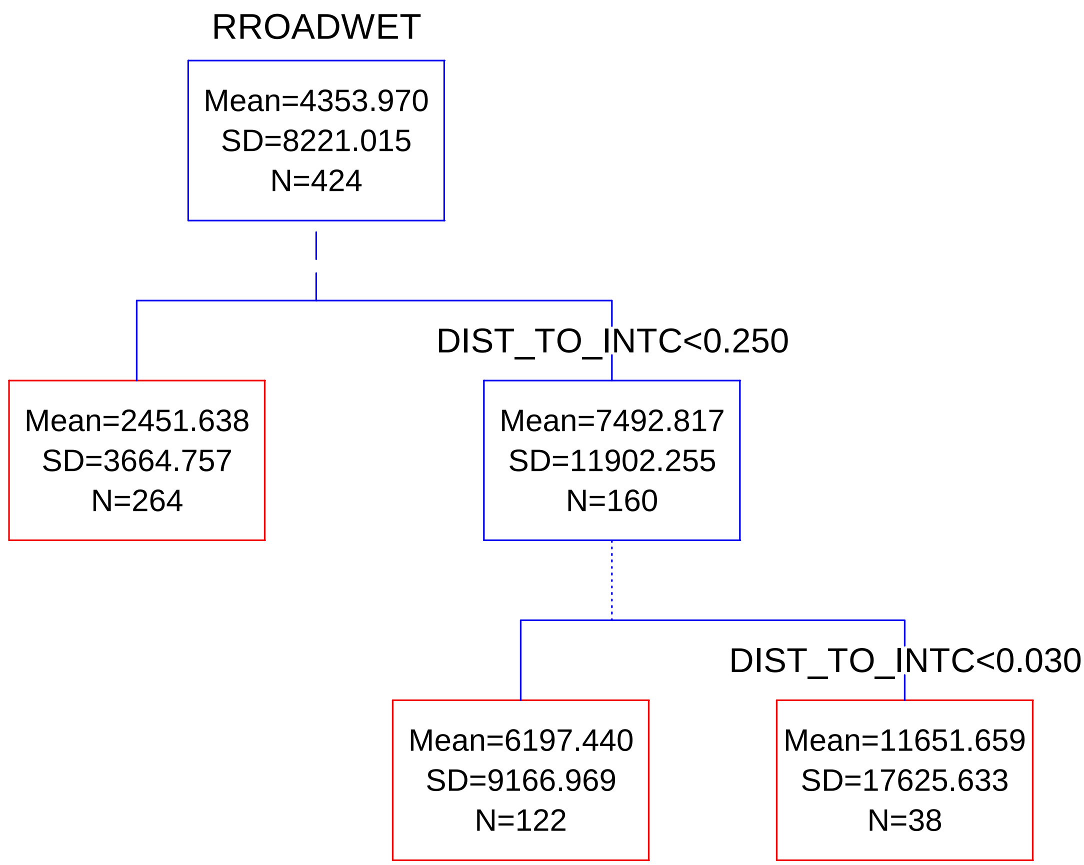
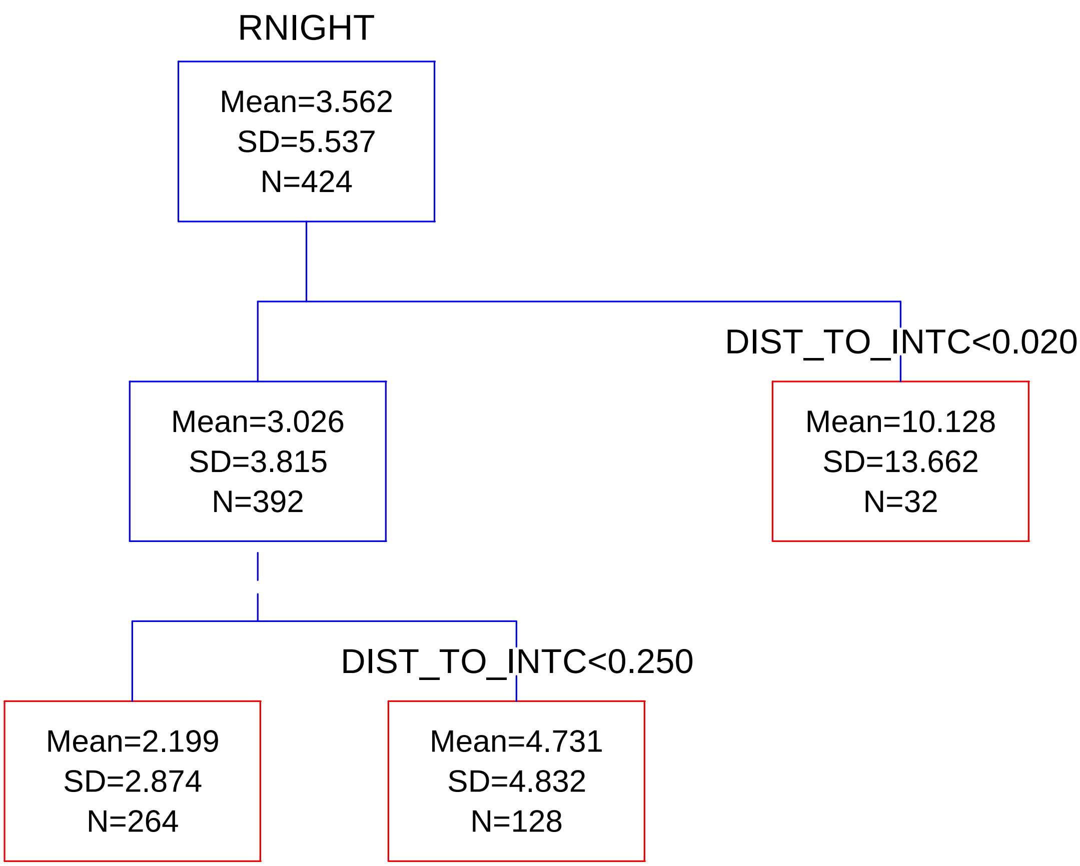


Figure 2.216.District 12 Night Crash Rate



This page is intentionally left blank

APPENDIX III

Stateside and districtwide crash density models

This page is intentionally left blank

The key to read the models are as followings:

speed = Speed Limit in mph (1 mph= 1.6 kmph)
adt = Average Daily Traffic
popd = Population Density within a radius of 1.99 miles (3.2 km) of the begin log county
lanes = No. of Lanes
roway_wi =Roadway Width in ft. (1 ft. = .0348 m)
surface_wi = Surface Width in ft. (1 ft. = .0348 m)
sliw = Shoulder Left Inside Width in ft. (1 ft. = .0348 m)
sriw = Shoulder Right Inside Width in ft. (1 ft. = .0348 m)
med_wi= Median Width in ft. (1 ft. = .0348 m)
vc_r = V/C Ratio
dti = Distance to Interchange in miles (1 mile= 1.6 km)

Table 3.1.Statewide Crash Density Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	16.37	34.40	1	adt < 89000	3013	0.10	17.69
			2	adt ≥ 89000 dti <.0300	84	0.06	100.74
			3	adt ≥89000, dti ≥.0300, adt<1421120	580	0.06	37.52
			4	adt ≥89000,dti ≥.0300, adt≥1421120	136	0.08	68.24
Property Damage Only	47.20	88.88		adt<77220	2824	0.08	43.16
			2	adt ≥77220 dti<.0200	81	0.00	263.16
			3	adt ≥77220 dti ≥.0200 dti≥.0300	550	0.09	71.93
			4	adt ≥77220 dti ≥.0200, dti ≥.0300, adt<140021	283	0.00	140.32
			5	adt ≥77220 dti ≥.0200, dti ≥.0300 adt≥140021	75	0.00	179.45
Total	36.98	61.67	1	adt < 77800 dti<.0300	140	0.13	154.79
			2	adt ≥77800 dti ≥.0300	2703	0.08	43.18
			3	adt ≥77220 dti <.0200	79	0.00	337.43
			4	adt ≥77800 dti ≥.0200, adt<140021	749	0.05	113.80
			5	adt ≥77800 dti ≥.0200, adt≥140021	142	0.15	215.10
Angle	16.37	34.50	1	adt < 89000	3013	0.10	17.69
			2	adt ≥89000 dti <.0300	84	0.06	100.74
			3	adt ≥89000 dti ≥.0300 adt<1421120	580	0.06	37.52
			4	adt ≥89000 dti ≥.0300 adt≥1421120	136	0.08	68.24
Fixed Object	47.20	88.88	1	adt < 77220	2824	0.08	43.17
			2	adt ≥77220 dti <.0200	81	0.00	263.16
			3	adt ≥77220 dti ≥.0200 dti≥.0300	550	0.09	71.93
			4	adt ≥77220 dti ≥.0200, dti ≥.0300 adt<140021	283	0.00	140.32
			5	adt ≥77220 dti ≥.0200, dti ≥.0300 adt≥140021	75	0.00	179.45

Rear end	22.50	63.32	1	adt < 77220	2824	0.10	23.05
			2	adt ≥77220 dti <.0300	101	0.00	200.25
			3	adt ≥77220 dti ≥.0300 adt<142120	752	0.06	58.69
			4	adt ≥77220 dti ≥.0300,adt≥142120 dti<.550	93	0.09	147.60
			5	adt ≥77220 dti ≥.0300,adt≥142120 dti≥.550	43	0.21	29.59
Sideswipe	8.34	18.95	1	adt < 86810	2991	0.11	9.03
			2	adt ≥86810 dti≥.0170	586	0.11	20.80
			3	adt ≥86810 dti <.0170, popd<1635.920	172	0.06	28.36
			4	adt ≥77220 dti <.0170, popd≥1635.920	64	0.23	66.52
Road wet	16.47	37.69	1	adt < 75210	2792	0.06	20.46
			2	adt ≥75210 dti <.0300	104	0.00	105.32
			3	adt ≥75210 dti ≥.0300 adt<1421120	781	0.04	40.97
			4	adt ≥75210 dti ≥.0300 adt≥1421120	136	0.25	55.16
Night	19.73	31.91	1	adt < 72840	2772	0.05	16.66
			2	adt ≥ 72840 dti <.0500	126	0.00	85.63
			3	adt ≥72840 dti ≥.0500 adt < 1421120	784	0.04	29.93
			4	adt ≥72840 dti ≥.0500 adt ≥ 1421120	131	0.07	59.40

Table 3.2.Statewide Crash Rate Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Std.Dev**	**R^2 Adj**	**SEE**
Injury/Fatal	1.52	4.34	1	popd < 828.656	2995	0.12	1.66
			2	popd ≥828.656 vc_r <.0490	41	0.06	23.06
			3	popd ≥828.656 vc_r ≥.0490	777	0.03	5.73
Property Damage Only	4.35	10.35	1	dti ≥ .210	3066	0.09	5.40
			2	dti < 210 popd < 473.204	315	0.07	7.54
			3	dti < 210 popd≥.473.204	432	0.00	23.95
Total	5.63	12.92	1	dti ≥ .210	3066	0.12	6.13
			2	dti<.210 popd < 343.567	261	0.06	7.00
			3	dti<.210 popd ≥.343.567 dti<.020	133	0.00	31.03
			4	dti<.210 popd ≥.343.567 dti≥.020	353	0.01	27.63
Angle	0.60	2.15	1	popd < 825.346	2991	0.07	1.03
			2	popd ≥828.656 dti<.010	60	0.07	5.89
			3	popd ≥828.656 dti≥ .010	762	0.02	3.64
Fixed Object	1.23	3.35	1	dti < 0.210	747	0.01	6.73
			2	dti ≥ 0.210	3066	0.06	1.49
Rear end	1.97	5.93	1	popd < 828.656	2995	0.12	2.81
			2	popd ≥828.656 dti <.020	79	0.09	16.41
			3	popd ≥828.656 dti ≥.020	739	0.03	9.13
Sideswipe	0.72	1.83	1	popd < 813.814	2976	0.15	0.69
			2	popd ≥813.814 dti <.200	305	0.00	4.68
			3	popd ≥813.814 dti ≥.200	532	0.04	2.16
Road wet	2797.04	6027.66	1	dti < .030, vc_r ≥ .800	111	0.04	9702.93
			2	dti < .030, vc_r < .800	128	0.00	16062.70
			3	dti ≥ 0.030 vc_r < 1.030	3134	0.08	3223.65
			4	dti ≥ 0.030 vc_r ≥1.030	440	0.06	8770.34

Night	1.84	3.95	1	dti ≥ .210	3066	0.07	1.94
			2	dti <.210 popd < 473.204	315	0.08	2.77
			3	dti <.210, popd ≥ 473.204	432	0.00	9.50

Table 3.3.District 1 Crash Density Models

						Regression	
Crash Type	**Sample Mean**	**Std. Dev.**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	7.85	11.02	1	dti< .570	52	0.00	14.93
			2	dti≥.570 popd<50.664	54	0.00	3.79
			3	dti ≥.570 popd≥50.664	31	0.00	6.57
Property Damage Only	25.18	25.33	1	dti<.320	31	0.22	33.75
			2	dti≥ 0.32 popd<60.629	63	0.00	12.72
			3	dti≥ 0.32 popd ≥60.629	43	0.00	17.95
Total	32.06	32.40	1	dti<.320	31	0.26	44.03
			2	dti≥ 0.32 adt < 36410	64	0.00	13.15
			3	dti≥ 0.32 adt ≥ 36410	42	0.00	22.18
Angle	7.82	11.04	1	dti<.570	52	0.00	14.99
			2	dti ≥ 0.57 popd <50.654	54	0.00	3.79
			3	dti ≥ 0.57 popd <50.654	31	0.00	6.57
Fixed Object	25.06	25.39	1	dti< 0.32	31	0.22	33.75
			2	dti≥0.32 popd<60.629	63	0.00	12.72
			3	dti≥0.32 popd<60.629	43	0.00	18.23
Rear end	6.11	11.24	1	dti< 0.3	30	0.22	16.83
			2	dti≥ 0.3	107	0.07	4.79
Sideswipe	3.93	6.51	1	dti<.33	33	0.11	9.09
			2	dti≥.33	104	0.00	4.66
Road wet	8.84	13.97	1	dti<.32	31	0.47	17.23
			2	dti≥ 0.32	106	0.11	6.27
Night	12.26	13.01	1	dti<.32	31	0.00	19.50
			2	dti≥.32 adt<38810	73	0.00	7.20
			3	dti ≥ 32 adt≥38810	33	0.00	9.48

Table 3.4.District 1 Crash Rate Models

						Regression	
Crash Type	**Sample Mean**	**Std. Dev.**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	5.51	0.70	1	dti < 0.53	50	0.00	0.97
			2	dti ≥ .530 popd < 57.924	57	0.00	0.28
			3	dti ≥ .530 popd ≥ 57.924	30	0.00	0.40
Property Damage Only	1.64	1.58	1	dti ≥ .320	31	0.00	2.32
			2	dti < .320 popd< 60.629	63	0.00	0.88
			3	dti < .320 popd ≥ 60.629	43	0.00	1.21
Total	2.06	1.98	1	dti <.320	31	0.15	2.84
			2	dti ≥ .320 vc_r < .670	61	0.00	0.94
			3	dti ≥ .320 vc_r ≥.670	45	0.00	1.42
Angle	0.14	0.31	1	dti <.300	30	0.00	0.51
			2	dti ≥.300	107	0.09	0.18
Fixed Object	0.79	1.11	1	dti < 0.530	50	0.00	1.47
			2	dti ≥ 0.530,popd <57.924	57	0.00	0.35
			2	dti ≥ 0.530,popd ≥57.924	30	0.00	0.88
Rear end	0.38	0.69	1	dti < .320	31	0.00	1.15
			2	dti ≥.320	106	0.04	0.31
Sideswipe	0.25	0.41	1	dti <.330	33	0.10	0.57
			2	dti ≥.330	104	0.00	0.31
Road wet	2067.82	3503.30	1	dti <.320	31	0.59	3934.73
			2	dti ≥.320	106	0.11	1432.19
Night	0.80	0.84	1	dti <.320	31	0.00	1.26
			2	dti ≥.320	106	0.00	0.55

Table 3.5.District 2 Crash Density Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	17.34	43.41	1	dti< .070	37	0.19	87.84
			2	dti≥ .070	203	0.14	13.44
Property Damage Only	58.66	137.70	1	dti< .070	37	0.09	290.49
			2	dti≥ .070	203	0.13	41.33
Total	60.78	120.78	1	dti< .070	37	0.00	261.43
			2	dti≥ .070	203	0.12	41.15
Angle	17.34	43.41	1	dti< .070	37	0.19	87.84
			2	dti≥ .070	203	0.14	13.44
Fixed Object	58.66	137.70	1	dti< .070	37	0.09	290.49
			2	dti≥ .070	203	0.13	41.33
Rear end	27.00	76.32	1	dti< .070	37	0.09	159.81
			2	dti≥ .070	203	0.16	22.19
Sideswipe	11.70	34.28	1	dti< .050	32	0.30	69.27
			2	dti≥ .050	208	0.10	12.34
Road wet	17.53	42.37	1	dti< .070	37	0.08	87.76
			2	dti≥ .070	203	0.09	15.47
Night	19.85	41.01	1	dti< .070	37	0.00	89.51
			2	dti≥ .070	203	0.07	17.32

Table 3.6.District 2 Crash Rate Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	1.18	2.78	1	dti< .070	37	0.08	5.79
			2	dti≥ .070	203	0.11	1.00
Property Damage Only	3.95	8.87	1	dti< .070	37	0.09	18.31
			2	dti≥ .070	213	0.12	2.72
Total	4.27	9.27	1	dti< .070	37	0.00	20.33
			2	dti≥ .070	203	0.09	3.06
Angle	0.49	1.68	1	dti <.050	32	0.00	4.07
			2	dti ≥.050	208	0.18	0.45
Fixed object	0.90	1.49	1	dti < 0.050	32	0.00	2.52
			2	dti ≥ 0.050 vc_r <.970	163	0.02	0.68
			3	dti ≥ 0.050 vc_r ≥.970	45	0.00	2.01
Rear end	1.90	5.31	1	dti <.070	37	0.00	11.50
			2	dti ≥.070	203	0.13	1.66
Sideswipe	0.74	1.89	1	dti < .050	32	0.23	3.85
			2	dti ≥.050	208	0.09	0.78
Road Wet	3379.46	7172.09	1	dti <.070	37	0.00	14609.80
			2	dti ≥.070	203	0.08	3383.33
Night	1.30	2.64	1	dti <.070	37	0.00	5.75
			2	dti ≥.070	203	0.07	1.11

Table 3.7.District 3 Crash Density Models

						Regression	
Crash Type	Sample Mean	Std.Dev	Condition		Sample Size	R^2 Adj	SEE
Injury/Fatal	7.18	15.18	1	dti< .150	31	0.00	38.62
			2	dti≥ .150	231	0.00	10.04
Property Damage Only	28.40	43.78	1	dti< .170	33	0.00	37.47
			2	dti≥ .170	229	0.02	24.87
Total	34.33	56.15	1	dti< .170	33	0.00	136.53
			2	dti≥ .170	229	0.01	34.76
Angle	7.18	15.18	1	dti< .150	31	0.00	38.62
			2	dti≥ .150	231	0.00	10.04
Fixed Object	28.40	43.78	1	dti< .170	33	0.00	102.90
			2	dti≥ .170	229	0.02	24.87
Rear end	7.41	25.17	1	dti< .150	31	0.00	66.85
			2	dti≥ .150	231	0.08	6.70
Sideswipe	4.23	8.06	1	dti< .150	31	0.00	18.87
			2	dti≥ .150	231	0.09	3.96
Road wet	8.74	18.50	1	dti< .150	31	0.00	44.77
			2	dti≥ .150	231	0.00	22.06
Night	14.49	18.50	1	dti< .170	33	0.11	40.09
			2	dti≥ .170	229	0.00	11.01

Table 3.8.District 3 Crash Rate Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	0.80	1.96	1	dti< .170	33	0.00	4.88
			2	dti≥ .170	229	0.02	1.50
Property Damage Only	3.22	6.33	1	dti< .170	33	0.00	15.29
			2	dti≥ .170	.	0.07	3.72
Total	3.96	8.18	1	dti< .170	33	0.00	20.11
			2	dti≥ .170	229	0.05	5.22
Angle	0.30	0.07	1	dti < .150	31	0.00	1.60
			2	dti ≥.150, popd< 202	191	0.03	0.30
			3	dti ≥.150, popd≥ 202	40	0.05	0.77
Fixed Object	0.97	1.35	1	dti < 0.350	54	0.16	1.77
			2	dti ≥ 0.350 popd <.68	108	0.14	0.72
			3	dti ≥ 0.350 popd <.68 med_wi <42	42	0.00	1.56
			4	dti ≥ 0.350 popd <.68 med_wi ≥42	58	0.02	6.36
Rear end	0.86	3.19	1	dti < .170	33	0.00	8.27
			2	dti ≥.170	229	0.12	0.72
Sideswipe	0.42	0.79	1	dti < .170	33	0.00	1.71
			2	dti ≥.170 popd< 218	193	0.06	0.33
			3	dti ≥.170 popd ≥ 218	36	0.01	0.80
Road wet	1834.05	4129.05	1	dti < .150	31	0.00	10056.50
			2	dti ≥ .150	231	0.00	5038.44
Night	1.61	2.54	1	dti < .170	33	0.12	5.54
			2	dti ≥.170 sliw<12	192	0.03	1.34
			3	dti ≥.170 sliw ≥12	37	0.11	1.60

Table 3.9.District 4 Crash Density Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	12.53	20.63	1	dti≥ .340	336	0.19	7.08
			2	dti < .340 dti <.020	34	0.00	50.34
			3	dti< .340 dti≥ .020 adt< 536	56	0.00	13.48
			4	dti< .340 dti≥ .020 adt≥ 536	83	0.00	24.15
Property Damage Only	35.54	57.43	1	dti< .210 vc_r< .75	55	0.00	46.43
			2	dti< .210 vc_r≥ .75	63	0.00	117.75
			3	dti≥ .210 speed< 60	47	0.00	62.64
			4	dti≥ .210 speed≥ 60	344	0.07	20.95
Total	48.37	75.74	1	dti< .020	34	0.00	197.59
			2	dti≥ .020 dti<.34	139	0.06	66.63
			3	dti≥ .020 dti≥ .34	388	0.11	25.51
Angle	12.53	20.63	1	dti≥ .340	388	0.20	7.03
			2	dti< .340 dti< .020	56	0.00	13.48
			3	dti< .340 dti≥ .020 adt<53633	34	0.00	50.34
				dti< .340 dti≥ .020 adt≥ 53633	83	0.00	24.15
Fixed Object	35.54	57.43	1	dti< .210 vc_r< .75	55	0.00	46.43
			2	dti< .210 vc_r≥ .75	63	0.00	117.75
			3	dti≥ .210 speed< 60	49	0.00	62.64
			4	dti≥ .210 speed≥ 60	388	0.07	20.95
Rear end	14.51	34.36	1	vc_r< .760	328	0.12	10.20
			2	vc_r≥ .760 dti< .260 popd<270	43	0.11	83.17
			3	vc_r≥ .760 dti< .260 popd ≥ 270	31	0.23	24.24
			4	vc_r≥ .760 dti≥ .260 speed<60	35	0.00	32.43
			5	vc_r≥ .760 dti≥ .260 speed≥60	74	0.24	8.89
Sideswipe	5.35	8.85	1	vc_r< .76	328	0.05	4.74
			2	vc_r≥ .76 dti< .34	92	0.00	14.03
			3	vc_r≥ .76 dti≥ .34	91	0.00	6.81
Road wet	11.53	20.94	1	dti≥ .340	388	0.06	8.45
			2	dti< .340 vc_r< .770	83	0.00	17.77
			3	dti< .340 vc_r≥ .770 vc_r< .940	46	0.00	51.54
			4	dti< .340 vc_r≥ .770 vc_r≥ .940	44	0.00	15.81
Night	15.52	22.31	1	dti< .020	34	0.00	53.76
			2	dti≥ .020 adt< 54080	349	0.01	9.65
			3	dti≥ .020 adt≥ 54080	178	0.00	23.11

Table 3.10.District 4 Crash Rate Models

						Regression	
Crash Type	Sample Mean	Std.Dev	Condition		Sample Size	R^2 Adj	SEE
Injury/Fatal	1.42	2.52	1	dti≥ .340	388	0.09	1.16
			2	dti< .340 dti< .020	34	0.00	6.45
			2	dti< .340 dti≥ .020	139	0.02	2.58
Property Damage Only	4.00	6.36	1	dti< .200 adt< 66050	79	0.00	6.93
			2	dti< .200 adt≥ 66050	35	0.00	15.20
			3	dti≥ .200 speed< 60	56	0.09	6.84
			4	dti≥ .200 speed≥ 60	391	0.02	2.97
Total	5.41	8.99	1	dti< .020	34	0.00	24.31
			2	dti≥ .020 dti<.410	160	0.04	7.70
			3	dti≥ .020 dti≥ .410	367	0.05	3.79
Angle	0.51	1.19	1	dti ≥ .220	437	0.02	0.72
			2	dti <.220, dti<020	34	0.00	2.58
			3	dti <.220 dti≥ 020	90	0.00	1.71
Fixed Object	1.38	2.06	1	dti < 0.340	173	0.03	2.94
			2	dti ≥ 0.340	388	0.02	1.27
Rear end	1.66	4.26	1	dti <.020	34	0.00	11.65
			2	dti ≥.020 speed <60	91	0.00	4.61
			3	dti ≥.020 speed ≥60	392	0.07	1.65
Sideswipe	0.57	1.00	1	popd< .327	298	0.09	0.46
			2	popd ≥.327, dti < .340	121	0.00	1.62
			3	dti ≥.170 dti ≥ .340	101	0.00	0.89
Road wet	2427.55	4447.81	1	dti ≥.340	388	0.07	1844.97
			2	dti <.340 vc_r< .770	83	0.00	3805.18
			3	dti <.340 vc_r≥ .770 vc_r <.940	46	0.00	11015.30
			4	dti <.340 vc_r≥ .770 vc_r≥.940	44	0.13	3364.23
Night	1.79	2.77	1	dti < .020	34	0.00	7.10
			2	dti ≥.020 popd <320	324	0.00	1.33
			3	dti ≥.020 popd ≥ 320	203	0.00	2.72

Table 3.11.District 5 Crash Density Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	6.71	11.45	1	dti< .170	31	0.00	29.15
			2	dti≥ .170	302	0.07	6.54
Property Damage Only	24.58	27.82	1	dti< .170	31	0.00	66.86
			2	dti≥ .170 adt < .34570	121	0.00	11.32
			3	dti≥ .170 adt ≥ 34570	181	0.00	20.11
Total	29.62	37.28	1	dti< .170	31	0.00	95.80
			2	dti≥ .170	302	0.09	19.19
Angle	6.71	11.45	1	dti< .170	31	0.00	29.15
			2	dti≥ .170	302	0.07	6.54
Fixed Object	24.58	27.82	1	dti< .170	31	0.00	66.86
			2	dti≥ .170 adt< .34570	121	0.00	11.32
			3	dti≥ .170 adt ≥ 34570	181	0.00	20.11
Rear end	3.65	7.61	1	adt <.40238	252	0.08	4.67
			2	adt≥ .40238	81	0.00	11.65
Sideswipe	2.89	5.00	1	dti< .250	43	0.00	8.99
			2	dti≥ .250 vc_r < .810	250	0.04	3.41
			3	dti≥ .810 vc_r≥ .810	40	0.11	4.26
Road wet	8.39	15.29	1	dti< .170	31	0.00	41.23
			2	dti≥ .170	302	0.08	7.78
Night	12.70	12.92	1	dti< .170	31	0.00	23.88
			2	dti≥ .170 adt< 32530	111	0.05	7.77
			3	dti≥ .170 adt≥ 32530	191	0.00	11.89

Table 3.12.District 5 Crash Rate Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	0.56	0.86	1	dti< .170	31	0.00	2.08
			2	dti≥ .170	302	0.00	0.55
Property Damage Only	2.14	2.29	1	dti< .170	31	0.00	4.78
			2	dti≥ .170 vc_r<.380	264	0.00	1.39
			3	dti≥ .170 vc_r≥ 60	56	0.07	2.53
Total	2.53	2.90	1	dti< .170	31	0.00	6.75
			2	dti≥ .170 vc_r< .380	56	0.11	2.74
			3	dti≥ .170 vc_r≥ .380	246	0.00	1.52
Angle	0.13	0.34	1	dti< .170	31	0.00	0.80
			2	dti≥ .170	302	0.00	0.23
Fixed Object	0.88	0.95	1	roway_wi ≥ 86	32	0.00	1.40
			2	roway_wi < 86 vc_r ≥.740	52	0.12	0.32
			3	roway_wi < 86 vc_r <.740 popd < 74	178	0.02	0.73
			4	roway_wi < 86 vc_r <.740 popd ≥ 74	71	0.00	1.19
Rear end	0.27	0.53	1	dti <.170	31	0.23	1.07
			2	dti ≥.170 roway_wi <76	30	0.00	0.53
			3	dti ≥.020 roway_wi ≥76	272	0.03	0.31
Sideswipe	0.22	0.38	1	dti<.250	43	0.00	0.68
			2	dti ≥.250	290	0.03	0.28
Road wet	1824.26	3394.84	1	dti < .170	31	0.00	9256.89
			2	dti ≥ .170	302	0.03	1726.26
Night	1.11	1.16	1	popd < 61.443	194	0.00	0.88
			2	popd ≥ 61.443 vc_r < <.520	37	0.00	1.66
			3	popd ≥ 61.443 vc_r ≥ <.520 vc_r < .840	72	0.00	1.34
			4	popd ≥ 61.443 vc_r ≥ <.520 vc_r ≥ .840	30	0.00	0.40

Table 3.13.District 6 Crash Density Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	21.90	48.09	1	med_wi< 5, adt <1412	86	0.11	44.80
			2	med_wi< 5, adt≥ 1412	36	0.16	105.91
			3	med_wi ≥5, dti< .110	30	0.18	76.73
			4	med_wi ≥5 dti ≥ .110	462	0.19	13.46
Property Damage Only	47.82	90.67	1	dti< .030	30	0.00	209.56
			2	dti≥ .030 med_wi ≥ 5.0	476	0.11	31.32
			3	dti≥ .030 med_wi < 5.0 vc_r< 1.030	73	0.05	80.52
			4	dti≥ .170 adt < 34570 vc_r≥ 1.030	35	0.00	178.68
Total	69.62	139.64	1	dti< .030	30	0.17	256.84
			2	dti≥ .030 adt ≥ 142120	53	0.16	260.69
			3	dti≥ .030 adt< 142120 med_wi <5.0	89	0.15	100.97
			4	dti≥ .030 adt< 142120 med_wi≥5.0	441	0.12	30.63
Angle	21.90	48.09	1	med_wi< 5, adt <1412	86	0.11	44.80
			2	med_wi< 5, adt≥ 1412	36	0.16	105.91
			3	med_wi ≥5, dti<.110	30	0.18	76.73
			4	med_wi ≥5 dti ≥.110	462	0.20	13.35
Fixed Object	47.82	90.67	1	dti<.030	30	0.00	209.56
			2	dti≥ 030 med_wi ≥ 5.0	476	0.11	31.32
			3	dti≥.030 med_wi <5.0 vc_r < 1.03	73	0.05	80.52
			4	dti≥.030 med_wi <5.0 vc_r ≥ 1.030	35	0.00	178.68
Rear end	31.11	85.97	1	adt< 141220 dti<.460	37	0.09	220.50
			2	adt< 141220 dti≥.460	39	0.14	40.57
			3	adt≥ 141220, dti<.080	33	0.00	113.89
			4	adt≥ 141220 dti ≥.080	504	0.24	20.18
Sideswipe	10.32	21.65	1	med_wi≥ 5.0	491	0.12	9.57
			2	med_wi< 5.0 adt< 141220	86	0.16	20.95

			3	med_wi< 5.0 adt≥ 141220	36	0.19	48.97
Road wet	17.41	38.11	1	dti< .030	30	0.00	83.92
			2	dti≥ .030 adt≥ 142120	53	0.21	55.39
			3	dti≥ .030 adt< 142120 med_wi < 5.0	89	0.10	36.02
			4	dti≥ .030 adt< 142120 med_wi ≥ 5.0	442	0.17	9.32
Night	21.68	40.10	1	dti< .030	30	0.13	84.30
			2	dti≥ .030 adt< 142120	530	0.08	19.32
			3	dti≥ .030 adt≥ 142120	53	0.08	64.26

Table 3.14.District 6 Crash Rate Models

Crash Type	Sample Mean	Std.Dev	Condition		Sample Size	Regression R^2 Adj	SEE
Injury/Fatal	2.15	8.20	1	popd < 1508	546	0.07	3.74
			2	popd ≥ 1508, dti < .360	40	0.12	23.62
			3	popd ≥ .1508, dti ≥ .360	35	0.94	2.98
Property Damage Only	4.41	15.63	1	popd < 1508	538	0.11	6.14
			2	popd ≥ 1508, dti < .350	37	0.15	47.32
			3	popd ≥ .1508, dti ≥ .350	38	0.95	4.05
Total	5.91	20.83	1	popd < 1572	547	0.16	6.67
			2	popd ≥ 1572, dti < .300	30	0.00	80.66
			3	popd ≥ .1508, dti ≥ .300	36	0.00	15.10
Angle	0.84	3.49	1	popd < 1508	546	0.02	2.91
			2	popd ≥ 1508, dti < .350	37	0.00	9.19
			3	popd ≥ .1508, dti ≥ .350	38	0.96	0.63
Fixed Object	1.14	6.75	1	med_wi < 4.00	52	0.00	22.09
			2	med_wi ≥ 4.00	568	0.28	1.63
Rear end	2.67	8.52	1	popd< 1508, med_wi < 5.0	68	0.04	10.21
			2	popd< 1508, med_wi≥ 5.0	470	0.23	1.89
			3	popd ≥1508, dti< .360	40	0.00	21.83
			4	popd ≥1508, dti ≥ .360	35	0.97	2.56
Sideswipe	0.90	2.49	1	popd< 1562,med_wi < 30.0	103	0.06	2.41
			2	med_wi< 1562, med_wi≥ 30.0	449	0.09	0.77
			3	popd ≥1562, dti< .270	30	0.00	6.96
			4	popd ≥1562, dti ≥ .270	38	0.86	1.61
Road wet	2620.54	5652.25	1	dti< .030	30	0.00	13760.20
			2	dti≥ .030, med_wi ≥ 5.0	476	0.15	1760.15
			3	dti≥ .030, med_wi < 5.0, vc_r< 1.050	81	0.00	5144.61
			4	dti≥ .030, med_wi < 5.0, vc_r ≥ 1.050	34	0.19	8829.71

Night	1.90	6.87	1	popd < 1562	545	0.10	2.14
			2	popd ≥ 1562 dti < <.270	30	0.00	26.89
			3	popd ≥ 1562 dti ≥ <.270	38	0.75	3.58

Table 3.15.District 7 Crash Density Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	15.66	28.14	1	adt≥ 92900,	57	0.15	39.14
			2	adt< 92900, adt< 54714	204	0.03	8.24
			3	adt< 92900, adt≥ 54714	144	0.00	31.94
Property Damage Only	42.41	60.76	1	adt< 92900,	359	0.02	43.31
			2	adt≥ 92900,	57	0.12	93.61
Total	54.84	79.98	1	adt≥ 92900	57	0.11	115.04
			2	adt< 92900, adt< 55680	232	0.00	34.39
			3	adt≥ 92900, adt≥ 55680	127	0.00	93.59
Angle	15.66	28.14	1	adt≥ 92900	57	0.15	39.14
			2	adt< 92900, adt< 54714	204	0.03	8.24
			3	adt≥ 92900, adt≥ 54714	144	0.00	31.94
Fixed Object	42.41	60.76	1	adt< 92900	359	0.02	43.31
			2	adt≥ 92900	57	0.12	93.61
Rear end	14.89	38.95	1	adt< 93710	367	0.14	15.08
			2	adt≥ 93710	49	0.18	84.57
Sideswipe	7.77	12.64	1	adt≥ 94510	37	0.10	23.52
			2	adt< 94510 adt< 60270	259	0.06	5.93
			3	adt< 94510 adt≥ 60270	120	0.00	12.27
Road wet	14.86	36.99	1	adt< 61820	290	0.06	15.08
			2	adt≥ 61820 dti< 0.400	54	0.17	44.06
			3	adt≥ 61820 dti≥ 0.400	72	0.00	66.06
Night	17.99	22.79	1	adt< 75973	399	0.00	18.71
			2	adt≥ 75973 dti< 0.430	43	0.00	36.59
			3	adt≥ 75973 dti≥ 0.430	34	0.00	17.69

Table 3.16.District 7 Crash Rate Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	0.87	1.49	1	popd < 645.309	341	0.01	1.28
			2	popd ≥ 645.309, dti < .490	45	0.00	2.50
			3	popd ≥ 645.309, dti ≥ .490	30	0.00	1.40
Property Damage Only	2.44	3.77	1	popd < 645.309	341	0.00	2.99
			2	popd ≥ 645.309, dti < .490	45	0.00	7.69
			3	popd ≥ 645.309, dti ≥ .490	30	0.00	3.06
Total	3.11	4.79	1	popd < 645.309	341	0.01	4.28
			2	popd ≥ 645.309, dti < .490	45	0.00	9.45
			3	popd ≥ 645.309, dti ≥0.49	30	0.00	3.99
Angle	0.29	0.62	1	popd < 645.309	341	0.02	0.48
			2	popd ≥ 645.309, dti < .490	45	0.00	1.35
			3	popd ≥ 645.309, dti ≥ .490	30	0.00	0.39
Fixed Object	0.85	1.56	1	lane ≥ 6.00	115	0.03	1.33
			2	lane < 6.00 dti < .110	31	0.03	1.33
			3	lane < 6.00 dti ≥ .110	270	0.00	2.28
Rear end	0.90	2.71	1	popd < 645.309	341	0.10	0.69
			2	popd ≥ 645.309, dti < .290	35	0.11	7.44
			3	popd ≥ 645.309, dti ≥ .290	40	0.30	1.26
Sideswipe	0.43	0.68	1	popd < 645.309	341	0.01	0.50
			2	popd ≥ 645.309, dti < .490	45	0.09	1.18
			3	popd ≥ 645.309, dti ≥ .490	30	0.00	0.56
Road wet	2786.88	7555.90	1	vc_r< 1.070	325	0.09	3081.60
			2	vc_r≥ 1.070	80	0.00	15336.40
Night	1.01	1.24	1	popd < 645.309	341	0.00	1.48
			2	popd ≥ 645.309roway_wi < 108	43	0.24	1.08
			3	popd ≥ 645.309roway_wi ≥ 108	32	0.00	2.13

Table 3.17.District 8 Crash Density Models

Crash Type	Sample Mean	Std.Dev	Condition		Sample Size	Regression R^2 Adj	Regression SEE
Injury/Fatal	22.70	35.25	1	adt< 90213	426	0.12	20.52
			2	adt≥ 90213, dti< 070	34	0.09	65.62
			3	adt≥ 90213, dti≥ 070, speed< 60	45	0.14	44.16
			4	adt≥ 90213, dti≥ 070, speed≥ 60	121	0.07	26.61
Property Damage Only	78.54	126.89	1	adt< 90213	426	0.12	56.23
			2	adt ≥ 90213, dti < .210, sliw < 8	33	0.00	289.66
			3	adt≥ 90213, dti< .210, sliw ≥ 8	39	0.11	157.47
			4	adt≥ 90213, dti≥ .210, popd <1228	85	0.04	89.12
			5	adt≥ 90213, dti≥ .210, popd ≥1228	43	0.22	111.27
Total	99.75	155.60	1	adt< 103890, dti< .100	30	0.25	265.43
			2	adt< 103890, dti≥ .100	426	0.13	65.61
			3	adt< 103890, dti< .190	61		243.28
			4	adt< 103890, dti≥ .190	109	0.33	121.83
Angle	22.70	35.25	1	adt< 90213	426	0.12	20.52
			2	adt≥ 90213, dti< 070	34	0.09	65.62
			3	adt≥ 90213, dti≥ 070, speed< 60	45	0.14	44.16
			4	adt≥ 90213, dti≥ 070, speed≥ 60	121	0.07	26.61
Fixed Object	78.54	126.89	1	adt< 90213	426	0.12	56.23
			2	adt ≥ 90213, dti < .210, sliw < 8	33	0.00	289.66
			3	adt≥ 90213, dti< .210, sliw ≥ 8	39	0.11	157.47
			4	adt≥ 90213, dti≥ .210, popd <1228	85	0.04	89.12
			5	adt≥ 90213, dti≥ .210, popd ≥1228	43	0.22	111.27
Rear end	41.98	87.41	1	adt< 104320, dti< 120	43	0.15	162.90
			2	adt< 104320, dti≥ 120	30	0.12	102.37
			3	adt≥ 104320, adt≥ 155108	414	0.20	24.32
			4	adt≥ 104320, adt< 155108, dti< .190	45	0.08	124.91

			5	adt $\geq$ 104320, adt $<$ 155108, dti $\geq$ .190	94	0.17	66.20
Sideswipe	12.90	23.05	1	speed $<$ 60, popd $<$ 1329	36		45.83
			2	speed $<$ 60, popd $\geq$ 1329	37	0.21	47.45
			3	speed $\geq$ 60, adt $<$ 104320	441	0.11	8.89
			4	speed $\geq$ 60, adt $\geq$ 104320	111	0.06	17.17
Road wet	26.31	48.28	1	adt $<$ 124840, dti $<$ .060	30	0.16	82.28
			2	adt $<$ 60, dti $\geq$ .060	491	0.13	23.46
			3	adt $\geq$ 60, popd $<$ 1393	65	0.10	48.69
			4	adt $\geq$ 60, popd $\geq$ 1393	38	0.26	72.57
Night	27.74	39.73	1	adt $<$ 103890, dti $<$ .120	43	0.09	60.67
			2	adt $<$ 103890, dti $\geq$ .120	386	0.09	14.36
			3	adt $\geq$ 103890, adt $\geq$ 155108	30	0.19	49.11
			4	adt $\geq$ 103890, adt $<$ 155108, dti $<$ .200	48	0.00	62.14
			5	adt $\geq$ 103890, adt $<$ 155108, dti $\geq$ .200	92	0.15	36.66

Table 3.18.District 8 Crash Rate Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	1.81	2.89	1	dti < .030	34	0.00	6.42
			2	dti ≥ .030, popd < 449.761	291	0.20	0.86
			3	dti ≥ .030, popd ≥ 449.761	283	0.05	3.42
Property Damage Only	6.12	10.46	1	dti < 030	34	0.00	21.16
			2	dti ≥ .030, popd < 494	303	0.24	2.20
			3	dti ≥ .030, popd ≥ 494, dti<.210	65	0.00	19.68
			4	dti ≥ .030, popd ≥ 494, dti≥.210	206	0.22	7.91
Total	7.75	12.53	1	dti < .030	34	0.10	30.71
			2	dti ≥ .030, popd < 449	291	0.30	3.08
			3	dti ≥ .030, popd ≥ 449	283	0.13	12.04
Angle	0.75	2.18	1	dti < .030	34	0.00	6.76
			2	dti ≥ .030	561	0.10	1.15
Fixed Object	1.36	1.83	1	popd < 441	293	0.10	1.08
			2	popd ≥ 441, popd ≥ 1506	44	0.00	7.10
			3	popd ≥ 441, popd < 1506, dti<.210	76	0.04	2.41
			4	popd ≥ 441, popd < 1506, dti≥.210	195	0.07	2.15
Rear end	3.07	7.00	1	dti < .030	34	0.00	19.46
			2	dti ≥ .030, popd< 1000	464	0.12	3.48
			3	dti ≥ .030, popd ≥ 1000	97	0.03	4.81
Sideswipe	0.93	1.46	1	popd < 835.706,popd < 163.570	198	0.07	0.26
			2	popd < 835.706,popd ≥ 163.570	278	0.10	0.98
			3	popd ≥ 835.706,dti< .060	30	0.00	3.23
			4	popd≥ 835.706 dti≥.060, surface_wi<76	85	0.25	2.62
			5	popd ≥ 835.706, dti≥.060, surface_wi≥76	33	0.24	1.95
Road wet	4008.68	7166.51	1	dti < .030	34	0.09	15813.50

			2	dti ≥ .030,popd < 1234	484	0.15	3336.91
			3	dti ≥ .030,popd ≥ 1234, sliw<8	30	0.27	8048.87
			4	dti ≥ .030,popd ≥ 1234, sliw≥8	47	0.12	5881.55
Night	2.24	3.22	1	dti < .030	34	0.00	7.47
			2	dti ≥ .030,popd < 494	303	0.18	1.04
			3	dti ≥ .030,popd ≥ 494	258	0.04	2.99

Table 3.19.District 10 Crash Density Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	2.53	3.71	1	dti< .780	30	0.00	5.35
			2	dti≥ .780	75	0.00	2.59
Property Damage Only	11.87	13.10	1	dti< .780	30	0.00	18.41
			2	dti≥ .780	75	0.10	9.49
Total	14.68	15.28	1	dti< .780	30	0.00	21.93
			2	dti≥ .780	75	0.00	10.13
Angle	2.53	3.71	1	dti< .780	30	0.00	5.35
			2	dti≥ .780	75	0.00	2.59
Fixed Object	11.87	13.10	1	dti< .780	30	0.00	18.41
			2	dti≥ .780	75	0.10	9.49
Rear end	0.71	2.89	1	dti< .780	30	0.11	4.75
			2	dti≥ .780	75	0.03	0.96
Sideswipe	0.53	1.74	1	vc_r< .220	40	0.00	2.47
			2	vc_r≥ .220	65	0.00	0.94
Road wet	2.71	6.11	1	dti< .780	30	0.25	8.30
			2	dti≥ .780	75	0.00	3.65
Night	7.17	8.00	1	dti < 1.220	39	0.00	9.58
			2	dti ≥ 1.220	66	0.00	6.74

Table 3.20.District 10 Crash Rate Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	0.62	0.91	1	dti< .950	33	0.00	1.25
			2	dti ≥.950	72	0.00	0.64
Property Damage Only	2.95	3.26	1	dti< .780	30	0.00	4.50
			2	dti≥ .780	75	0.10	2.42
Total	3.65	3.81	1	dti< .780	30	0.00	5.40
			2	dti≥ .780	75	0.00	2.59
Angle	0.05	0.24	1	popd < 23.979	38	N/A	N/A
			2	popd ≥ 23.979	67	0.00	0.30
Fixed Object	1.11	1.61	1	dti< .780	30	0.16	2.17
			2	dti≥ .780	75	0.00	1.30
Rear end	0.17	0.70	1	dti< .780	30	0.11	1.14
			2	dti≥ .780	75	0.03	0.24
Sideswipe	0.13	0.42	1	vc_r< .220,	40	0.00	0.60
			2	vc_r≥ .220,	65	0.00	0.23
Road wet	618.95	1395.46	1	dti< .780	30	0.25	1894.97
			2	dti≥ .780	75	0.00	833.60
Night	1.78	1.98	1	dti < 1.220	39	0.00	2.35
			2	dti ≥ 1.220	66	0.00	1.69

Table 3.21.District 11 Crash Density Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	5.82	7.22	1	dti< .520	55	0.00	9.79
			2	dti≥ .520, adt< 26100	52	0.08	3.17
			3	dti≥ .520, adt≥ 26100	85	0.00	5.24
Property Damage Only	21.29	20.15	1	vc_r< .480, adt< 28300	102	0.00	10.05
			2	vc_r< .480, adt≥ 28300	30	0.00	13.98
			3	vc_r≥ .480, dti< .520	34	0.00	30.20
			4	vc_r≥ .480, dti≥ .520	36	0.00	14.96
Total	24.98	23.96	1	sriw≥ 5.00	32	0.00	35.90
			2	sriw< 5.00, dti< .520	38		22.54
			3	sriw< 5.00, dti≥ .520	132	0.06	12.11
Angle	5.82	7.22	1	dti< .520	55	0.00	9.79
			2	dti≥ .520, adt< 26100	52	0.08	3.17
			3	dti≥ .520, adt≥ 26100	85	0.00	5.24
Fixed Object	21.29	20.15	1	vc_r< .480, adt< 28300	102	0.00	10.05
			2	vc_r< .480, adt≥ 28300	30	0.00	13.98
			3	vc_r≥ .480, dti< .520	34	0.00	30.20
			4	vc_r≥ .480, dti≥ .520	36	0.00	14.96
Rear end	3.84	7.91	1	dti< .500	53	0.20	11.20
			2	dti≥ .500	149	0.06	3.09
Sideswipe	2.34	4.41	1	med_wi< 16	33	0.00	6.73
			2	med_wi ≥ 16 vc_r < .440	111	0.00	1.83
			3	med_wi ≥ 16 vc_r ≥.440	58	0.00	4.75
road wet	5.16	8.38	1	dti< .300,	31	0.00	15.44
			2	dti≥ .300, vc_r <.460	110	0.00	3.66
			3	dti≥ .300, vc_r ≥.460	61	0.06	6.54
Night	10.69	10.07	1	adt< 28740	103	0.04	6.99
			2	adt≥ 28740, dti < .570	41	0.00	14.02
			3	adt≥ 28740, dti≥ .570	58	0.00	7.59

Table 3.22.District 11 Crash Rate Models

						Regression	
Crash Type			**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	0.77	1.03	1	dti < .520	55	0.00	1.39
			2	dti ≥ .520	137	0.03	0.73
Property Damage Only	2.88	2.67	1	popd< 24.111	68	0.00	1.58
			2	popd ≥ 24.111, dti < .520	43	0.00	3.71
			3	popd ≥ 24.111, dti≥.520	91	0.00	1.97
Total	3.38	3.23	1	dti < .520	55	0.00	4.48
			2	dti ≥ .520	147	0.02	2.37
Angle	0.16	0.56	1	dti < .520	55	0.00	0.92
			2	dti ≥ .520	147	0.00	0.27
Fixed Object	1.13	1.68	1	dti < .290	30	0.00	3.03
			2	dti ≥ .290	172	0.00	1.20
Rear end	0.50	1.00	1	dti < .500	53	0.14	1.46
			2	dti ≥ .500	149	0.02	0.47
Sideswipe	0.27	0.48	1	vc_r < .520	145	0.00	0.38
			2	vc_r ≥ .520	57	0.00	0.66
Road wet	1130.51	1736.53	1	dti< .300,	31	0.00	3118.00
			2	dti≥ .300, vc_r <.460	110	0.00	834.38
			3	dti≥ .300, vc_r ≥.460	61	0.00	1379.60
Night	1.45	1.45	1	popd< 17.049	49	0.00	0.66
			2	popd ≥ 17.049 , roway_wi ≥ 80	78	0.00	1.20
			3	popd ≥ 17.049 roway_wi < 80, med_wi <52.00	37	0.00	1.65
			4	popd ≥ 17.049 roway_wi< 80, med_wi ≥ 52.00	38	0.00	1.93

Table 3.23.District 12 Crash Density Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	28.40	49.79	1	adt< 94530	209	0.03	22.12
			2	adt≥ 94530, dti≥ .250	137	0.06	28.76
			3	adt≥ 94530, dti< .250, popd< 1619	73	0.00	59.73
			4	adt≥ 94530, dti< .250, popd ≥ 1619	34	0.10	104.51
Property Damage Only	71.25	112.49	1	dti ≥ .250	293	0.04	57.93
			2	dti < .250, dti < .020	32	0.10	186.34
			3	dti < .250, dti ≥ .020	128	0.00	139.98
Total	101.60	158.94	1	dti< .020	32	0.23	296.93
			2	dti≥ .020,dti≥.380	233	0.01	69.62
			3	dti≥ .020,dti< .380,adt<128500	157	0.05	133.52
			4	dti≥.020,dti<.380,adt≥128500	31	0.13	189.79
Angle	28.40	49.79	1	adt<94530	209	0.03	22.12
			2	adt≥94530, dti≥.250	137	0.06	28.76
			3	adt≥94530, dti<.250,popd<1619	73	0.00	59.73
			4	adt≥94530, dti<.250,popd ≥ 1619	34	0.10	104.51
Fixed Object	71.25	112.49	1	dti ≥.250	160	0.00	156.29
			2	dti < .250, dti <.020	32	0.10	186.34
			3	dti < .250, dti ≥ .020	128	0.00	139.98
Rear end	40.20	78.53	1	dti ≥ .250	293	0.08	37.85
			2	dti < .250, surface_wi < 84	74	0.06	42.90
			3	dti < .250, surface_wi ≥ 84	86	0.03	136.79
Sideswipe	14.21	25.71	1	dti ≥ .170	341	0.06	13.01
			2	dti < .170, adt < 96880	42	0.25	13.80
			3	dti < .170, adt ≥ 96880	70	0.00	50.42
Road wet	30.22	59.28	1	dti < .250	160	0.00	86.46
			2	dti ≥ .250	293	0.05	24.68
Night	30.62	41.77	1	dti ≥ .250	293	0.06	21.13
			2	dti < .250, dti <.020	32	0.21	73.17
			3	dti < .250, dti ≥.020	128	0.07	45.40

Table 3.24.District 12 Crash Rate Models

						Regression	
Crash Type	**Sample Mean**	**Std.Dev**	**Condition**		**Sample Size**	**R^2 Adj**	**SEE**
Injury/Fatal	3.25	6.06	1	dti <.250	160	0.03	7.74
			2	dti ≥.250	293	0.02	5.01
Property Damage Only	8.54	16.77	1	dti <.140	94	0.00	30.13
			2	dti ≥.140	330	0.03	8.48
Total	11.75	19.06	1	dti < .020	32	0.21	35.55
			2	dti ≥ .020, dti < .450	216	0.00	18.55
			3	dti ≥ .030, dti ≥ .450	205	0.00	15.21
Angle	1.52	3.38	1	dti ≥ .250	293	0.02	2.74
			2	dti < .250, popd < 1636	119	0.00	3.15
			3	dti < .250, popd ≥ 1636	41	0.00	8.16
Fixed Object	2.23	4.04	1	dti ≥ .210	317	0.04	2.32
			2	dti < .210,med_wi < 5.00	44	0.00	2.44
			3	dti < .210,med_wi ≥ 5.00	92	0.13	6.72
Rear end	4.50	8.68	1	dti < .020	32	0.14	14.41
			2	dti ≥ .020,dti <.380	188	0.00	9.83
			3	dti ≥ .020,dti ≥.380	204	0.04	2.35
Sideswipe	1.68	3.48	1	dti ≥.170	112	0.00	5.87
			2	dti < .170,med_wi < 16	69	0.00	7.06
			3	dti < .170,med_wi ≥ 16	43	0.00	2.62
Road wet	4353.97	8221.02	1	dti ≥ .250	293	0.04	3731.41
			2	dti < .250,dti <.030	38	0.15	16283.70
			3	dti < .030,dti ≥ .030	122	0.07	8820.59
Night	3.56	5.54	1	dti < .020	32	0.09	13.01
			2	dti ≥ .020, dti < .250	128	0.02	4.78
			3	dti ≥ .020, dti ≥ .250	293	0.01	3.93

This page is intentionally left blank

APPENDIX IV

Statewide and districtwide model validation

Keys:

speed = Speed Limit in mph (1 mph= 1.6 kmph)
adt = Average Daily Traffic
popd = Population Density within a radius of 1.99 miles (3.2 km) of the begin log county
lanes = No. of Lanes
roway_wi =Roadway Width in ft. (1 ft. = .0348 m)
surface_wi = Surface Width in ft. (1 ft. = .0348 m)
sliw = Shoulder Left Inside Width in ft. (1 ft. = .0348 m)
sriw = Shoulder Right Inside Width in ft. (1 ft. = .0348 m)
med_wi= Median Width in ft. (1 ft. = .0348 m)
vc_r = V/C Ratio
dti = Distance to Interchange in miles (1 mile= 1.6 km)

Table 4.1.Statewide Crash Density Model Validation

Crash Type		Condition	Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	adt < 89000	1583	9.55	9.49	0.61	19.38
	2	adt ≥ 89000 dti <.0300	42	123.70	98.23	20.59	213.87
	3	adt ≥89000 dti ≥.0300 adt < 1421120	305	32.13	30.62	4.71	46.23
	4	adt ≥89000 dti ≥.0300 adt≥1421120	61	52.74	65.07	23.38	53.54
Property Damage Only	1	adt < 77220	1479	28.94	28.81	0.47	55.80
	2	adt ≥77220 dti <.0200	45	245.22	262.33	6.98	62.52
	3	adt ≥77220 dti ≥.0200 dti≥.0300	295	65.91	60.74	7.86	37.69
	4	adt ≥77220 dti ≥.0200, dti ≥.0300, adt<140021	137	105.82	100.68	4.86	150.66
	5	adt ≥77220 dti ≥.0200, dti ≥.0300 adt≥140021	35	173.35	217.71	25.59	159.47
Total	1	adt < 77800 dti<.0300	79	138.24	142.56	3.13	210.34
	2	adt ≥77800 dti ≥.0300	1411	32.07	31.87	0.62	50.80
	3	adt ≥77220 dti <.0200	44	312.52	349.43	11.81	310.25
	4	adt ≥77800 dti ≥.0200, adt<140021	381	91.58	95.91	4.73	127.50
	5	adt ≥77800 dti ≥.0200, adt≥140021	77	170.03	196.18	15.38	200.48
Angle	1	adt < 89000	1583	9.55	9.49	0.64	19.38
	2	adt ≥89000 dti <.0300	42	123.70	98.23	20.59	213.87
	3	adt ≥89000 dti ≥.0300 adt<1421120	305	32.13	30.62	4.71	46.15
	4	adt ≥89000 dti ≥.0300 adt≥1421120	61	52.74	65.07	23.38	53.54
Fixed Object	1	adt < 77220	1479	28.94	28.79	0.52	55.80
	2	adt ≥77220 dti <.0200	45	245.22	262.33	6.98	62.52
	3	adt ≥77220 dti ≥.0200 dti≥.0300	295	65.91	60.74	7.86	84.34
	4	adt ≥77220 dti ≥.0200, dti ≥.0300 adt<140021	136	105.82	100.68	4.86	150.66
	5	adt ≥77220 dti ≥.0200, dti ≥.0300 adt≥140021	34	173.35	217.71	25.59	159.47
Rear end	1	adt < 77220	1479	9.13	8.53	6.53	1.02

	2	adt ≥77220 dti <.0300	52	127.55	168.66	32.23	23.85
	3	adt ≥77220 dti ≥.0300 adt<142120	399	42.26	39.74	5.98	4.00
	4	adt ≥77220 dti ≥.0300, adt≥142120 dti<.550	41	107.67	167.50	55.56	18.93
	5	adt ≥77220 dti ≥.0300, adt≥142120 dti≥.550	20	1069.94	31.65	97.04	15.46
Sideswipe	1	adt < 86810	1574	4.69	4.59	2.19	9.09
	2	adt ≥86810 dti≥.0170	318	16.76	16.07	4.14	22.94
	3	adt ≥86810 dti <.0170, popd<1635.920	65	39.59	29.57	25.31	62.75
	4	adt ≥77220 dti <.0170, popd≥1635.920	37	38.78	58.15	49.95	65.12
Wet road	1	adt < 75210	1459	8.82	8.97	1.66	0.17
	2	adt ≥75210 dti <.0300	55	97.31	93.98	3.43	19.14
	3	adt ≥75210 dti ≥.0300 adt<1421120	416	26.55	26.13	1.57	2.31
	4	adt ≥75210 dti ≥.0300 adt≥1421120	61	49.57	60.81	22.68	7.92
Night	1	adt < 72840	1449	13.28	13.13	1.07	0.49
	2	adt ≥ 72840 dti <.0500	67	93.25	87.53	6.14	17.84
	3	adt ≥ 72840 dti ≥.0500 adt < 1421120	415	25.89	26.03	0.54	1.62
	4	adt ≥72840 dti ≥.0500 adt ≥ 1421120	61	41.34	59.63	44.25	7.02

Table 4.2.Statewide Crash Rate Model Validation

Crash Type		Condition	Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	popd < 828.656	1573	1.01	0.94	6.79	0.09
	2	popd ≥828.656 vc_r <.0490	31	11.09	7.56	31.79	4.06
	3	popd ≥828.656 vc_r ≥.0490	387	3.69	3.47	5.85	0.36
Property Damage Only	1	dti ≥ .210	1636	3.12	2.98	4.53	0.23
	2	dti < 210 popd< 473.204	156	6.69	5.69	15.04	0.85
	3	dti < 210 popd≥.473.204	199	14.28	13.67	4.32	1.78
Total	1	dti ≥ .210	1636	3.78	3.82	0.97	0.13
	2	dti<.210 popd < 343.567	111	5.33	5.52	3.66	0.62
	3	dti<.210 popd ≥.343.567 dti<.020	72	27.93	26.80	4.06	3.92
	4	dti<.210 popd ≥.343.567 dti≥.020	172	14.86	13.72	7.73	2.49
Angle	1	popd < 825.346	1573	0.37	0.33	8.95	0.05
	2	popd ≥828.656 dti<.010	26	3.52	5.51	56.47	0.90
	3	popd ≥828.656 dti≥ .010	392	1.25	1.35	8.14	0.16
Fixed Object	1	dti < 0.210	355	2.59	2.53	2.35	0.25
	2	dti ≥ 0.210	1636	1.06	0.93	12.80	0.09
Rear end	1	popd < 828.656	1573	1.08	1.02	5.67	0.12
	2	popd ≥828.656 dti <.020	36	11.65	16.18	38.92	2.99
	3	popd ≥828.656 dti ≥.020	382	4.70	4.63	1.37	0.42
Sideswipe	1	popd < 813.814	1567	0.46	0.43	4.98	0.03
	2	popd ≥813.814 dti <.200	142	3.48	2.86	17.88	0.51
	3	popd ≥813.814 dti ≥.200	282	1.18	1.27	7.58	0.10
Wet road	1	dti < .030, vc_r ≥ .800	72	7022.53	6963.02	0.85	1533.32
	2	dti < .030, vc_r < .800	57	12997.05	14126.00	8.69	2701.53
	3	dti ≥ 0.030, vc_r < 1.030	1638	2021.57	1828.24	9.56	148.76
	4	dti ≥ 0.030 vc_r ≥1.030,	224	4970.43	5525.73	11.17	519.56
Night	1	dti ≥ .210	1636	1.36	1.37	0.73	0.05
	2	dti <.210, popd < 473.204	156	2.71	2.21	18.56	0.30
	3	dti <.210, popd ≥ 473.204	199	5.33	5.12	4.01	0.65

Table 4.3.District 1 Crash Density Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti< .570	29	8.48	13.31	56.97	13.68
	2	dti≥ .570 popd< 50.664	28	4.69	2.51	46.51	4.75
	3	dti ≥.570 popd ≥50.664	19	4.72	7.98	69.15	6.40
Property Damage Only	1	dti<.320	17	38.10	45.98	20.69	53.40
	2	dti≥ 0.32 popd< 60.629	31	18.81	15.04	20.06	12.13
	3	dti≥ 0.32 popd ≥60.629	29	22.54	25.06	11.15	18.61
Total	1	dti< .320	16	45.17	60.98	35.00	61.41
	2	dti≥ 0.32 adt < 36410	35	24.92	17.97	27.91	20.30
	3	dti≥ 0.32 adt ≥ 36410	25	27.68	34.92	26.16	17.65
Angle	1	dti<.570	29	38.01	13.23	65.19	13.65
	2	dti ≥ 0.57 popd <50.654	28	4.69	2.51	46.51	4.75
	3	dti ≥ 0.57 popd <50.654	20	4.72	7.98	69.15	6.40
Fixed Object	1	dti< 0.32	16	38.10	45.98	20.69	53.40
	2	dti≥0.32 popd<60.629	32	18.81	15.04	20.06	12.13
	3	dti≥0.32 popd<60.629	29	22.54	24.69	9.50	18.56
Rear end	1	dti< 0.3	16	8.82	16.95	92.28	3.85
	2	dti≥ 0.3	60	3.49	3.24	7.05	0.67
Sideswipe	1	dti< .33	16	8.24	8.71	5.76	2.79
	2	dti≥ .33	60	2.39	2.82	17.82	0.50
Wet road	1	dti< .32	16	15.89	20.87	31.28	6.80
	2	dti≥ 0.32	60	5.78	5.41	6.39	0.95
Night	1	dti< .32	16	14.22	22.56	58.68	6.88
	2	dti≥ .32 adt<38810	46	10.87	7.43	31.59	1.55
	3	dti ≥ .32 adt≥38810	14	12.97	13.27	2.37	2.77

Table 4.4.District 1 Crash Rate Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti < 0.53	28	0.54	0.85	56.89	0.17
	2	dti ≥ .530 popd < 57.924	28	0.31	0.19	40.90	0.06
	3	dti ≥ .530 popd ≥ 57.924	20	0.32	0.54	67.77	0.10
Property Damage Only	1	dti ≥ .320	16	2.35	2.85	21.45	0.72
	2	dti < .320 popd< 60.629	31	1.28	1.04	19.01	0.14
	3	dti < .320 popd ≥ 60.629	29	1.54	1.63	5.91	0.25
Total	1	dti <.320	16	2.80	3.91	39.62	0.92
	2	dti ≥ .320 vc_r < .670	32	1.48	1.26	14.85	0.15
	3	dti ≥ .320 vc_r ≥.670	28	2.10	2.14	2.00	0.29
Angle	1	dti <.300	16	0.27	0.34	26.47	0.16
	2	dti ≥.300	60	0.09	0.08	3.84	0.02
Fixed Object	1	dti < 0.530	28	0.72	1.36	89.27	0.17
	2	dti ≥ 0.530, popd <57.924	28	0.39	0.27	31.12	0.07
	2	dti ≥ 0.530, popd ≥57.924	20	0.48	0.84	76.92	0.16
Rear end	1	dti < .320	16	0.56	0.99	76.22	0.14
	2	dti ≥.320	60	0.24	0.21	11.53	0.08
Sideswipe	1	dti < .330	16	0.51	0.53	4.61	0.18
	2	dti ≥.330	60	0.17	0.19	13.42	0.04
Wet road	1	dti <.320	16	3629	4764	31	1552
	2	dti ≥.320	60	1320	1275	3	198
Night	1	dti < .320	16	0.85	1.42	67.19	0.39
	2	dti ≥.320	60	0.77	0.61	20.69	0.09

Table 4.5.District 2 Crash Density Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti< .070	13	34.74	73.10	110.40	54.33
	2	dti≥ .070	88	9.92	11.34	14.33	12.74
Property Damage Only	1	dti< .070	13	137.47	239.63	74.31	195.60
	2	dti≥ .070	88	28.71	36.02	25.47	40.06
Total	1	dti< .070	13	179.38	182.00	1.46	169.27
	2	dti≥ .070	88	36.02	41.39	14.91	50.15
Angle	1	dti< .070	13	34.74	78.89	127.08	66.67
	2	dti≥ .070	88	9.92	11.34	14.33	12.74
Fixed Object	1	dti< .070	13	137.47	239.63	74.31	195.60
	2	dti≥ .070	88	28.71	36.02	25.47	40.06
Rear end	1	dti< .070	13	52.34	130.19	148.75	103.65
	2	dti≥ .070	88	10.49	14.06	33.97	15.79
Sideswipe	1	dti< .050	11	38.11	41.28	8.30	30.19
	2	dti≥ .050	90	6.10	7.86	28.92	10.65
Wet road	1	dti< .070	13	42.81	72.91	70.31	63.72
	2	dti≥ .070	88	7.71	11.16	44.68	12.87
Night	1	dti< .070	13	50.14	52.56	4.82	39.49
	2	dti≥ .070	88	11.57	14.50	25.39	13.47

Table 4.6.District 2 Crash Rate Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti< .070	13	2.52	4.66	84.88	3.76
	2	dti≥ .070	88	0.71	0.77	8.50	1.02
Property Damage Only	1	dti< .070	13	9.71	16.21	66.95	13.48
	2	dti≥ .070	88	1.97	2.39	21.04	2.62
Total	1	dti< .070	13	12.74	13.46	5.61	13.81
	2	dti≥ .070	88	2.44	2.81	15.20	3.37
Angle	1	dti < .050	11	2.23	2.26	1.54	2.78
	2	dti ≥.050	90	0.27	0.27	0.40	0.74
Fixed object	1	dti < 0.050	11	2.38	2.12	10.77	2.37
	2	dti ≥ 0.050 vc_r <.970	74	0.49	0.52	5.14	0.64
	3	dti ≥ 0.050 vc_r ≥.970	16	0.72	1.40	94.17	1.25
Rear end	1	dti <.070	13	3.88	7.39	90.20	6.12
	2	dti ≥.070	88	0.74	1.04	39.32	1.18
Sideswipe	1	dti < .050	11	2.66	2.56	3.64	1.86
	2	dti ≥.050	90	0.42	0.54	28.85	0.68
Wet road	1	dti < .070	13	8399.70	10645.70	26.74	11255.74
	2	dti ≥.070	88	1646.34	2355.06	43.05	3271.23
Night	1	dti < .070	13	3.45	3.49	1.24	2.95
	2	dti ≥.070	88	0.80	0.95	19.12	1.00

Table 4.7.District 3 Crash Density Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti< .150	12	20.66	18.26	11.64	21.97
	2	dti≥ .150	158	5.75	6.09	5.89	6.80
Property Damage Only	1	dti< .170	14	102.61	17.72	82.73	178.35
	2	dti≥ .170	156	18.24	21.28	16.70	16.63
Total	1	dti< .170	14	117.49	88.49	24.68	174.01
	2	dti≥ .170	156	24.63	27.64	12.25	21.39
Angle	1	dti< .150	12	20.66	18.26	11.64	21.97
	2	dti≥ .150	156	5.75	6.09	5.89	6.80
Fixed Object	1	dti< .170	14	102.61	61.54	40.02	174.03
	2	dti≥ .170	156	18.24	21.28	16.70	16.63
Rear end	1	dti< .150	12	74.29	31.26	57.92	147.04
	2	dti≥ .150	158	5.19	3.83	26.24	16.09
Sideswipe	1	dti< .150	12	8.68	12.39	42.77	14.01
	2	dti≥ .150	158	2.70	2.97	9.98	4.74
Wet road	1	dti< .150	12	18.06	29.83	65.20	25.44
	2	dti≥ .150	158	6.02	7.31	21.35	9.39
Night	1	dti< .170	14	29.78	29.78	0.00	38.85
	2	dti≥ .170	156	12.07	12.07	0.00	10.99

Table 4.8.District 3 Crash Rate Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti< .170	14	2.58	2.29	11.24	2.69
	2	dti≥ .170	156	0.55	0.70	28.25	0.70
Property Damage Only	1	dti< .170	14	102.61	10.04	90.21	20.06
	2	dti≥ .170	156	18.24	2.37	87.02	1.95
Total	1	dti< .170	14	14.63	12.28	16.07	22.44
	2	dti≥ .170	156	2.43	3.04	24.85	2.43
Angle	1	dti < .150	12	1.47	0.85	41.99	1.72
	2	dti ≥.150, popd< 202	127	0.13	0.17	34.37	0.29
	3	dti ≥.150, popd≥ 202	30	0.32	0.51	61.24	0.57
Fixed Object	1	dti < 0.350	24	1.65	1.96	18.58	2.15
	2	dti ≥ 0.350 popd <.68	67	0.65	0.56	14.04	0.87
	3	dti ≥ 0.350; popd<.68 med_wi <42	18	0.79	1.44	82.83	0.99
	4	dti ≥ 0.350 popd <.68 med_wi ≥42	61	0.89	1.96	121.03	1.85
Rear end	1	dti < .170	14	9.87	3.87	60.84	18.13
	2	dti ≥.170	156	0.26	0.35	35.51	0.67
Sideswipe	1	dti < .170	14	1.24	1.24	0.01	1.69
	2	dti ≥.170,popd< 218	129	0.23	0.24	5.20	0.50
	3	dti ≥.170 popd ≥ 218	27	0.39	0.63	63.35	0.58
Wet road	1	dti <.150	12	3750.62	6460.96	72.26	5487.71
	2	dti ≥.150	158	1213.85	1544.56	27.24	1541.87
Night	1	dti <.170	14	4.28	5.71	33.37	4.75
	2	dti ≥.170 sliw<12	141	0.95	1.11	17.53	1.04
	3	dti ≥.170 sliw ≥12	15	1.16	2.63	126.19	1.89

Table 4.9.District 4 Crash Density Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti≥ .340	193	8.17	6.62	19.05	10.38
	2	dti < .340 dti < .020	16	29.04	42.12	45.05	40.49
	3	dti< .340 dti≥ .020 adt< 536	34	14.79	11.10	24.94	24.49
	4	dti< .340 dti≥ .020 adt≥ 536	37	29.01	24.75	14.68	41.23
Property Damage Only	1	dti< .210 vc_r< .75	21	85.20	40.97	51.91	17495.14
	2	dti< .210 vc_r≥ .75	31	52.89	96.92	83.26	75.23
	3	dti≥ .210 speed< 60	36	56.08	49.37	11.98	70.79
	4	dti≥ .210 speed≥ 60	189	21.38	19.88	6.98	24.10
Total	1	dti< .020	16	149.38	171.39	14.73	194.45
	2	dti≥ .020 dti<.34	71	70.16	68.82	1.90	94.32
	3	dti≥ .020 dti≥ .34	193	28.95	27.08	6.46	34.82
Angle	1	dti≥ .340	193	8.17	6.61	19.11	10.62
	2	dti< .340 dti< .020	15	29.04	42.12	45.05	1639.77
	3	dti< .340 dti≥ .020 adt<53633	34	14.79	11.10	24.94	24.49
	4	dti< .340 dti≥ .020 adt≥ 53633	37	29.01	24.75	14.68	41.23
Fixed Object	1	dti< .210 vc_r< .75	21	85.20	40.97	51.91	132.27
	2	dti< .210 vc_r≥ .75	31	52.89	96.92	83.26	75.23
	3	dti≥ .210 speed< 60	36	56.08	49.37	11.98	70.79
	4	dti≥ .210 speed≥ 60	189	21.38	19.88	6.98	24.10
Rear end	1	vc_r< .760	180	3.25	6.04	85.62	23.26
	2	vc_r≥ .760 dti< .260 popd<270	25	31.34	59.40	89.57	73.96
	3	vc_r≥ .760 dti< .260 popd ≥ 270	14	67.03	43.80	34.66	60.25
	4	vc_r≥ .760 dti≥ .260 speed<60	16	43.37	34.80	19.75	42.46
	5	vc_r≥ .760 dti≥ .260 speed≥60	42	12.00	7.50	37.48	14.67
Sideswipe	1	vc_r< .76	180	3.25	2.91	10.54	5.76
	2	vc_r≥ .76 dti< .34	45	12.77	14.51	13.59	17.33
	2	vc_r≥ .76 dti≥ .34	52	6.88	5.50	20.02	6.46
Wet road	1	dti≥ .340	193	7.83	6.62	15.54	12.52
	2	dti< .340 vc_r< .770	43	23.72	12.96	45.34	55.02
	3	dti< .340 vc_r≥ .770 vc_r< .940	30	21.60	37.27	72.55	28.81
	4	dti< .340 vc_r≥ .770 vc_r≥ .940	14	23.45	18.04	23.05	34.96
Night	1	dti< .020	16	39.55	41.60	5.18	43.20
	2	dti≥ .020 adt< 54080	173	10.78	9.55	11.40	13.95
	3	dti≥ .020 adt≥ 54080	88	20.07	19.55	2.60	23.94

Table 4.10.District 4 Crash Rate Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti≥ .340	192	1.02	0.82	19.09	1.71
	2	dti< .340 dti< .020	16	2.65	4.64	75.13	3.24
	3	dti< .340 dti≥ .020	71	2.24	2.11	5.49	2.92
Property Damage Only	1	dti< .200 adt< 66050	32	9.06	6.20	31.52	14.74
	2	dti< .200 adt≥ 66050	19	5.13	11.29	120.26	7.79
	3	dti≥ .200 speed< 60	36	7.42	6.01	18.99	8.49
	4	dti≥ .200 speed≥ 60	190	2.48	2.39	3.51	3.62
Total	1	dti< .020	16	16.12	18.43	14.33	21.60
	2	dti≥ .020 dti< .410	80	5.08	6.95	36.85	7.78
	3	dti≥ .020 dti≥ .410	179	3.49	3.27	6.40	5.46
Angle	1	dti ≥ .220	229	0.25	0.28	9.62	0.61
	2	dti <.220, dti<020	16	1.84	2.08	12.97	1.98
	3	dti <.220 dti≥ 020	38	0.75	0.95	26.49	1.19
Fixed Object	1	dti < 0.340	87	2.34	2.36	0.81	3.36
	2	dti ≥ 0.340	193	1.13	0.95	16.15	1.96
Rear end	1	dti <.020	16	4.94	6.99	41.39	5.80
	2	dti ≥.020 speed <60	47	3.92	3.70	5.62	4.86
	3	dti ≥.020 speed ≥60	214	1.01	0.77	23.81	3.21
Sideswipe	1	popd< .327	173	0.40	0.33	16.22	0.81
	2	popd ≥.327, dti < .340	54	1.22	1.23	0.56	1.49
	3	dti ≥.170 dti ≥ .340	50	0.68	0.62	7.95	0.99
Wet road	1	dti ≥.340	193	1641.81	1440.83	12.24	2402.92
	2	dti <.340 vc_r< .770	43	4841.44	2675.14	44.75	12197.05
	3	dti <.340 vc_r≥ .770 vc_r< .940	30	4200.31	7463.16	77.68	6081.54
	4	dti <.340 vc_r≥ .770 vc_r≥ .940	14	4607.23	3970.18	13.83	6634.88
Night	1	dti < .020	16	4.52	4.61	2.02	5.04
	2	dti ≥.020 popd <320	168	1.23	1.17	5.52	1.49
	3	dti ≥.020 popd ≥ 320	93	2.16	2.25	4.31	2.62

Table 4.11.District 5 Crash Density Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti< .170	15	14.74	17.66	19.79	15.03
	2	dti≥ .170	133	7.31	5.53	24.40	8.02
Property Damage Only	1	dti< .170	15	72.47	52.08	28.14	81.79
	2	dti≥ .170 adt < .34570	56	18.73	15.15	19.09	17.81
	3	dti≥ .170 adt ≥ 34570	77	29.00	26.17	9.77	28.33
Total	1	dti< .170	15	95.46	72.91	23.62	95.53
	2	dti≥ .170	133	31.85	25.22	20.81	29.96
Angle	1	dti< .170	15	14.74	17.66	19.79	15.03
	2	dti≥ .170	134	7.31	5.53	24.40	8.02
Fixed Object	1	dti< .170	15	72.47	52.08	28.14	81.79
	2	dti≥ .170 adt< .34570	56	18.73	15.15	19.09	17.81
	3	dti≥ .170 adt ≥ 34570	77	29.00	26.17	9.77	28.33
Rear end	1	adt < 40238	102	3.01	5.06	68.13	6.60
	2	adt≥ 40238	46	15.42	8.40	45.52	28.90
Sideswipe	1	dti< .250	19	7.53	6.81	9.60	12.33
	2	dti≥ .250 vc_r < .810	105	2.75	1.84	33.13	5.15
	2	dti≥ .810 vc_r ≥ .810	24	7.80	5.58	28.46	9.11
Wet road	1	dti< .170	15	26.87	22.44	16.46	28.12
	2	dti≥ .170	133	8.42	6.89	18.25	10.71
Night	1	dti< .170	15	29.16	21.57	26.03	27.46
	2	dti≥ .170 adt< 32530	53	10.40	9.18	11.71	12.15
	3	dti≥ .170 adt≥ 32530	80	14.54	13.62	6.36	10.41

Table 4.12.District 5 Crash Rate Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti< .170	15	1.21	1.38	13.92	1.36
	2	dti≥ .170	133	0.72	0.48	34.44	1.13
Property Damage Only	1	dti< .170	15	5.40	4.04	25.16	5.17
	2	dti≥ .170 vc_r< .380	31	4.66	2.90	37.73	4.61
	3	dti≥ .170 vc_r≥ 60	102	1.77	1.70	3.83	1.65
Total	1	dti< .170	15	7.06	5.44	22.89	6.29
	2	dti≥ .170 vc_r< .380	31	5.97	3.33	44.26	6.27
	3	dti≥ .170 vc_r≥ .380	102	2.26	1.95	13.82	2.03
Angle	1	dti< .170	15	0.47	0.42	10.61	0.75
	2	dti≥ .170	133	0.21	0.10	50.45	0.53
Fixed Object	1	roway_wi ≥ 86	20	1.44	1.61	11.78	1.39
	2	roway_wi < 86 vc_r ≥ .740	30	0.65	0.35	45.56	0.56
	3	roway_wi < 86 vc_r < .740 popd < 74	65	1.02	0.76	25.21	1.74
	4	roway_wi < 86 vc_r < .740 popd ≥ 74	33	1.38	1.20	13.59	1.37
Rear end	1	dti <.170	15	1.58	0.80	49.47	2.48
	2	dti ≥.170 roway_wi <76	9	1.03	0.59	42.37	0.64
	3	dti ≥.020 roway_wi ≥76	124	0.36	0.18	49.13	0.72
Sideswipe	1	dti<.250	19	0.47	0.52	10.45	0.77
	2	dti ≥.250	129	0.30	0.20	32.82	0.50
Wet road	1	dti < .170	15	5809.65	4913.97	15.42	6227.18
	2	dti ≥ .170	133	1829.15	1502.20	17.87	2355.85
Night	1	popd < 61.443	79	0.96	0.90	7.15	1.03
	2	popd ≥ 61.443 vc_r < <.520	25	3.25	2.17	33.19	3.61
	3	popd ≥ 61.443 vc_r ≥ <.520 vc_r < .840	28	1.43	1.35	5.69	1.12
	4	popd ≥ 61.443 vc_r ≥ <.520 vc_r ≥ .840	16	1.05	0.60	43.48	1.33

Table 4.13.District 6 Crash Density Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	med_wi< 5, adt <1412	46	49.87	40.99	17.80	67.93
	2	med_wi< 5, adt≥ 1412	13	183.47	105.05	42.75	343.98
	3	med_wi ≥5, dti< .110	24	57.72	68.98	19.50	96.45
	4	med_wi ≥5 dti ≥ .110	233	12.09	10.12	16.26	26.93
Property Damage Only	1	dti< .030	24	339.34	221.36	34.77	589.47
	2	dti≥ .030 med_wi ≥ 5.0	239	35.84	26.99	24.70	74.04
	3	dti≥ .030 med_wi < 5.0 vc_r< 1.030	35	67.45	56.69	15.95	16.84
	4	dti≥ .170 adt < 34570 vc_r≥ 1.030	18	189.15	168.69	10.82	177.97
Total	1	dti< .030	24	351.68	323.94	7.89	389.00
	2	dti≥ .030 adt ≥ 142120	27	201.21	218.86	8.77	237.19
	3	dti≥ .030 adt< 142120 med_wi<5.0	41	125.55	93.47	25.55	160.22
	4	dti≥ .030 adt< 142120 Medin_wi≥5.0	224	39.84	31.91	19.92	76.99
Angle	1	med_wi< 5, adt <1412	46	49.87	40.99	17.80	67.18
	2	med_wi< 5, adt≥ 1412	13	183.47	105.05	42.75	343.98
	3	med_wi ≥5, dti< .110	24	57.72	68.98	19.50	77.73
	4	med_wi ≥5 dti ≥ .110	233	12.09	10.38	14.16	26.84
Fixed Object	1	dti< .030	24	339.34	221.36	34.77	589.47
	2	dti≥ .030 med_wi ≥ 5.0	239	35.84	26.99	24.70	74.04
	3	dti≥ .030 med_wi < 5.0 vc_r < 1.03	35	67.45	56.69	15.95	16.84
	4	dti≥ .030 med_wi < 5.0 vc_r ≥ 1.030	18	189.15	168.69	10.82	177.97
Rear end	1	adt< 141220 dti< .460	5	24.04	87.05	262.13	64.44
	2	adt< 141220 dti≥ .460	261	18.95	13.08	30.97	50.65
	3	adt≥ 141220, dti< .080	11	139.50	254.60	82.51	196.23
	4	adt≥ 141220 dti ≥ .080	16	41.54	37.24	10.34	56.29
Sideswipe	1	med_wi≥ 5.0	257	7.60	6.29	17.25	16.69
	2	med_wi< 5.0 adt< 141220	46	27.99	17.73	36.67	38.95
	3	med_wi< 5.0 adt≥ 141220	13	74.78	53.03	29.08	114.48
Wet road	1	dti< .030	24	100.10	95.95	4.15	187.81

	2	dti≥ .030 adt≥ 142120	27	30.24	56.28	86.12	64.97
	3	dti≥ .030 adt< 142120 med_wi < 5.0	41	23.99	23.42	2.36	26.73
	4	dti≥ .030 adt< 142120 med_wi ≥ 5.0	224	8.30	7.46	10.08	18.81
Night	1	dti< .030	24	138.51	101.40	26.80	215.62
	2	dti≥ .030adt< 42120	273	17.58	14.40	18.08	28.08
	3	dti≥ .030 adt≥ 42120	19	42.04	53.16	26.47	80.86

Table 4.14.District 6 Crash Rate Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	popd < 1508	279	2.15	1.33	38.20	9.83
	2	popd ≥ 1508, dti < .360	19	15.55	13.58	12.66	26.92
	3	popd ≥ .1508, dti ≥ .360	16	2.03	2.30	13.22	2.33
Property Damage Only	1	popd < 1508	274	3.89	3.17	18.55	8.76
	2	popd ≥ 1508, dti < .350	19	30.56	23.60	22.80	57.07
	3	popd ≥ .1508, dti ≥ .350	16	4.64	3.88	16.37	4.68
Total	1	popd < 1572	282	6.37	4.30	32.57	18.08
	2	popd ≥ 1572, dti < .300	17	34.77	41.21	18.55	49.30
	3	popd ≥ .1508, dti ≥ .300	15	7.67	8.94	16.55	8.14
Angle	1	popd < 1508	279	0.72	0.62	13.34	4.11
	2	popd ≥ 1508, dti < .350	19	5.52	5.51	0.14	8.89
	3	popd ≥ .1508, dti ≥ .350	16	0.82	0.61	26.03	1.14
Fixed Object	1	med_wi < 4.00	25	4.00	5.12	27.99	8.73
	2	med_wi ≥ 4.00	291	1.61	0.99	38.57	8.64
Rear end	1	popd< 1508, med_wi < 5.0	32	4.71	5.53	17.44	6.07
	2	popd< 1508, med_wi≥ 5.0	247	2.15	1.23	42.71	7.73
	3	popd ≥1508, dti< .360	19	11.38	16.20	42.40	18.41
	4	popd ≥1508, dti ≥ .360	16	2.15	1.58	26.67	1.96
Sideswipe	1	popd< 1562,med_wi < 30.0	54	1.95	1.76	9.73	3.55
	2	med_wi< 1562, med_wi≥ 30.0	229	0.60	0.41	32.14	2.63
	3	popd ≥1562, dti< .270	16	7.58	5.33	29.77	10.44
	4	popd ≥1562, dti ≥ .270	17	1.40	0.77	45.07	3.02
Wet road	1	dti< .030	24	15114.51	15049.00	0.43	28498.27
	2	dti≥ .030, med_wi ≥ 5.0	239	1841.70	1393.18	24.35	4833.34
	3	dti≥ .030, med_wi < 5.0, vc_r< 1.050	35	2663.89	3185.98	19.60	3835.63
	4	dti≥ .030, med_wi < 5.0, vc_r ≥ 1.050	18	10494.93	7575.65	27.82	11631.99
Night	1	popd < 1562	283	1.67	1.37	18.43	3.19
	2	popd ≥ 1562 dti < <.270	16	13.17	11.85	10.02	20.93
	3	popd ≥ 1562 dti ≥ <.270	17	2.66	1.39	47.73	4.98

Table 4.15.District 7 Crash Density Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	adt≥ 92900,	25	46.11	37.87	17.87	67.10
	2	adt< 92900, adt< 54714	121	6.08	6.98	14.74	6.02
	3	adt< 92900, adt≥ 54714	63	13.84	17.66	27.62	15.87
Property Damage Only	1	adt< 92900,	184	31.51	31.66	0.49	30.16
	2	adt≥ 92900,	25	108.98	95.04	12.79	200.82
Total	1	adt≥ 92900	26	107.03	114.96	7.41	161.53
	2	adt< 92900, adt< 55680	128	28.77	33.65	16.95	22.94
	3	adt≥ 92900, adt≥ 55680	54	64.81	61.85	4.56	59.20
Angle	1	adt≥ 92900	25	46.11	37.87	17.87	69.96
	2	adt< 92900, adt< 54714	121	6.08	6.98	14.74	6.07
	3	adt≥ 92900, adt≥ 54714	63	13.84	17.66	27.62	16.13
Fixed Object	1	adt< 92900	184	31.51	31.66	0.49	30.25
	2	adt≥ 92900	25	108.98	95.04	12.79	209.02
Rear end	1	adt< 93710	187	7.42	8.65	16.61	12.02
	2	adt≥ 93710	22	82.51	46.56	43.57	215.47
Sideswipe	1	adt≥ 94510	14	18.63	27.74	48.91	26.38
	2	adt< 94510 adt< 60270	145	4.03	4.26	5.76	6.20
	3	adt< 94510 adt≥ 60270	50	12.11	10.08	16.77	9.60
Wet road	1	adt< 61820	156	6.91	8.23	19.13	9.84
	2	adt≥ 61820 dti< 0.400	25	47.33	48.95	3.43	71.98
	3	adt≥ 61820 dti≥ 0.400	28	22.41	21.53	3.89	19.03
Night	1	adt< 75973	175	14.32	14.55	1.63	14.09
	2	adt≥ 75973 dti< 0.430	18	40.54	41.75	2.98	40.79
	3	adt≥ 75973 dti≥ 0.430	16	22.19	24.27	9.37	10.85

Table 4.16.District 7 Crash Rate Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	popd < 645.309	176	0.57	0.67	17.11	0.78
	2	popd ≥ 645.309, dti < .490	20	2.45	2.73	11.48	4.08
	3	popd ≥ 645.309, dti ≥ .490	13	1.15	1.22	5.67	1.46
Property Damage Only	1	popd < 645.309	176	2.03	2.00	1.39	3.21
	2	popd ≥ 645.309, dti < .490	20	6.95	7.27	4.58	11.99
	3	popd ≥ 645.309, dti ≥ .490	13	2.63	2.88	9.49	1.38
Total	1	popd < 645.309	176	2.60	2.72	4.31	3.79
	2	popd ≥ 645.309, dti < .490	20	6.24	8.37	34.12	9.28
	3	popd ≥ 645.309, dti ≥ .490	13	3.05	3.53	15.90	2.27
Angle	1	popd < 645.309	176	0.20	0.22	11.72	0.50
	2	popd ≥ 645.309, dti < .490	20	0.84	0.94	11.96	1.07
	3	popd ≥ 645.309, dti ≥ .490	13	0.62	0.31	49.37	1.04
Fixed Object	1	lanes ≥ 6.00	56	1.01	1.30	29.69	1.12
	2	lanes < 6.00 dti < .110	15	1.23	1.51	22.69	1.63
	3	lanes < 6.00 dti ≥ .110	138	0.60	0.82	38.36	1.08
Rear end	1	popd < 645.309	176	0.46	0.45	1.97	1.04
	2	popd ≥ 645.309, dti < .290	15	4.82	4.94	2.45	12.96
	3	popd ≥ 645.309, dti ≥ .290	18	1.70	1.61	5.42	2.10
Sideswipe	1	popd < 645.309	176	0.39	0.03	91.49	1.15
	2	popd ≥ 645.309, dti < .490	20	0.88	1.23	40.25	0.95
	3	popd ≥ 645.309, dti ≥ .490	13	0.65	0.65	0.62	0.69
Wet road	1	vc_r< 1.070	179	1827.90	1914.81	4.75	2138.82
	2	vc_r≥ 1.070	30	6880.23	6131.80	10.88	12472.83
Night	1	popd < 645.309	176	0.99	0.96	2.95	1.36
	2	popd ≥ 645.309 roway_wi < 108	16	1.26	1.35	7.42	1.80
	3	popd ≥ 645.309 roway_wi ≥ 108	17	2.26	2.33	3.29	1.96

Table 4.17.District 8 Crash Density Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti < .030	19	3.74	6.65	77.96	5.41
	2	dti ≥ .030, popd < 449.761	158	0.63	0.73	15.77	0.92
	3	dti ≥ .030, popd ≥ 449.761	146	2.51	2.60	3.62	2.96
Property Damage Only	1	dti < 030	19	10.06	22.22	120.94	16.62
	2	dti ≥ .030, popd < 494	165	2.48	2.34	5.52	3.21
	3	dti ≥ .030, popd ≥ 494, dti<.210	28	11.41	13.23	15.90	11.62
	4	dti ≥ .030, popd ≥ 494, dti≥.210	111	6.89	7.35	6.72	7.26
Total	1	dti < .030	19	16.80	35.55	111.59	30.12
	2	dti ≥ .030, popd < 449	158	2.92	3.10	6.19	3.47
	3	dti ≥ .030, popd ≥ 449	146	8.57	10.11	17.96	9.99
Angle	1	dti < .030	19	1.49	4.41	196.79	3.79
	2	dti ≥ .030	304	0.50	0.54	8.35	0.90
Fixed Object	1	popd < 441	170	0.97	0.84	12.79	1.68
	2	popd ≥ 441, popd ≥ 1506	22	3.88	4.06	4.70	2.42
	3	popd ≥ 441, popd < 1506, dti<.210	28	2.98	2.33	21.84	0.42
	4	popd ≥ 441, popd < 1506, dti≥.210	103	1.35	1.67	23.38	0.14
Rear end	1	dti < .030	19	5.81	16.07	176.52	14.95
	2	dti ≥ .030, popd< 1000	252	1.36	1.42	4.66	2.39
	3	dti ≥ .030, popd ≥ 1000	52	6.51	6.09	6.40	5.99
Sideswipe	1	popd < 835.706, popd < 163.570	100	0.17	0.18	3.16	0.30
	2	popd < 835.706, popd ≥ 163.570	150	0.83	0.84	1.22	0.94
	3	popd ≥ 835.706, dti< .060	4	4.56	3.76	17.40	3.83
	4	popd≥ 835.706 dti≥.060, surface_wi<76	49	1.54	1.05	31.72	1.82
	5	popd ≥ 835.706, dti≥.060, surface_wi≥76	20	2.28	2.62	14.96	2.46

Wet road	1	dti < .030	19	8047.33	16620.93	106.54	14157.40
	2	dti ≥ .030, popd < 1234	267	2178.84	2161.87	0.78	3245.44
	3	dti ≥ .030, popd ≥ 1234, sliw<8	16	15992.22	13594.81	14.99	17363.73
	4	dti ≥ .030, popd ≥ 1234, sliw≥8	21	6577.90	6554.71	0.35	6099.79
Night	1	dti < .030	19	4.06	7.52	85.31	5.34
	2	dti ≥ .030, popd < 494	165	1.09	1.11	1.46	1.22
	3	dti ≥ .030, popd ≥ 494	139	2.78	2.96	6.47	3.22

Table 4.18.District 8 Crash Rate Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti < .030	19	3.74	6.65	77.96	5.41
	2	dti ≥ .030, popd < 449.761	158	0.63	0.73	15.77	0.92
	3	dti ≥ .030, popd ≥ 449.761	146	2.51	2.60	3.62	2.96
Property Damage Only	1	dti < 030	19	10.06	22.22	120.94	16.62
	2	dti ≥ .030, popd < 494	165	2.48	2.34	5.52	3.21
	3	dti ≥ .030, popd ≥ 494, dti<.210	28	11.41	13.23	15.90	11.62
	4	dti ≥ .030, popd ≥ 494, dti≥.210	111	6.89	7.35	6.72	7.26
Total	1	dti < .030	19	16.80	35.55	111.59	30.12
	2	dti ≥ .030, popd < 449	158	2.92	3.10	6.19	3.47
	3	dti ≥ .030, popd ≥ 449	146	8.57	10.11	17.96	9.99
Angle	1	dti < .030	19	1.49	4.41	196.79	3.79
	2	dti ≥ .030	304	0.50	0.54	8.35	0.90
Fixed Object	1	popd < 441	170	0.97	0.84	12.79	1.68
	2	popd ≥ 441, popd ≥ 1506	22	3.88	4.06	4.70	2.42
	3	popd ≥ 441, popd < 1506, dti<.210	28	2.98	2.33	21.84	0.42
	4	popd ≥ 441, popd < 1506, dti≥.210	103	1.35	1.67	23.38	0.14
Rear end	1	dti < .030	19	5.81	16.07	176.52	14.95
	2	dti ≥ .030, popd< 1000	252	1.36	1.42	4.66	2.39
	3	dti ≥ .030, popd ≥ 1000	52	6.51	6.09	6.40	5.99
Sideswipe	1	popd < 835.706, popd < 163.570	100	0.17	0.18	3.16	0.30
	2	popd < 835.706, popd ≥ 163.570	150	0.83	0.84	1.22	0.94
	3	popd ≥ 835.706, dti< .060	4	4.56	3.76	17.40	3.83
	4	popd≥ 835.706 dti≥.060, surface_wi<76	49	1.54	1.05	31.72	1.82
	5	popd ≥ 835.706, dti≥.060, surface_wi≥76	20	2.28	2.62	14.96	2.46
Wet road	1	dti < .030	19	8047.33	16620.93	106.54	14157.40
	2	dti ≥ .030, popd <	267	2178.84	2161.87	0.78	3245.44

		1234					
	3	dti ≥ .030, popd ≥ 1234, sliw<8	16	15992.22	13594.81	14.99	17363.73
	4	dti ≥ .030, popd ≥ 1234, sliw≥8	21	6577.90	6554.71	0.35	6099.79
Night	1	dti < .030	19	4.06	7.52	85.31	5.34
	2	dti ≥ .030, popd < 494	165	1.09	1.11	1.46	1.22
	3	dti ≥ .030, popd ≥ 494	139	2.78	2.96	6.47	3.22

Table 4.19.District 10 Crash Density Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti< .780	6	6.76	9.10	34.64	19.08
	2	dti≥ .780	50	2.98	6.06	103.16	7.78
Property Damage Only	1	dti< .780	6	11.54	17.12	48.32	14.98
	2	dti≥ .780	50	13.00	9.61	26.08	10.44
Total	1	dti< .780	6	24.30	22.29	8.26	26.19
	2	dti≥ .780	50	15.26	11.30	25.97	11.88
Angle	1	dti< .780	6	6.76	3.93	41.91	12.94
	2	dti≥ .780	50	2.98	1.95	34.51	3.90
Fixed Object	1	dti< .780	6	11.54	17.12	48.32	14.98
	2	dti≥ .780	50	13.00	9.61	26.08	10.44
Rear end	1	dti< .780	6	0.67	2.11	215.82	3.60
	2	dti≥ .780	50	0.24	0.29	18.94	0.93
Sideswipe	1	vc_r< .220	18	1.56	0.97	37.80	2.58
	2	vc_r≥ .220	38	0.58	0.24	58.74	1.60
Wet road	1	dti< .780	6	6.72	33.34	395.99	5.37
	2	dti≥ .780	50	2.50	1.67	33.11	3.49
Night	1	dti < 1.220	15	11.78	9.10	22.69	12.00
	2	dti ≥ 1.220	41	7.07	6.06	14.27	7.64

Table 4.20.District 10 Crash Rate Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti < .950	8	1.61	0.94	41.37	2.58
	2	dti ≥ .950	48	0.71	0.47	33.56	0.97
Property Damage Only	1	dti< .780	6	2.79	4.21	51.13	3.63
	2	dti≥ .780	50	3.23	2.40	25.88	2.62
Total	1	dti< .780	6	6.07	5.51	9.11	6.63
	2	dti≥ .780	50	3.80	2.82	25.78	3.01
Angle	1	popd < 23.979		n/a	n/a	n/a	n/a
	2	popd ≥ 23.979	29	0.04	0.08	108.90	0.22
Fixed Object	1	dti< .780	6	3.47	1.67	51.94	5.01
	2	dti≥ .780	50	0.76	45.65	5885.36	0.15
Rear end	1	dti< .780	6	0.18	0.51	183.23	0.89
	2	dti≥ .780	50	0.06	0.07	23.47	0.22
Sideswipe	1	vc_r< .220,	18	0.39	0.24	39.14	0.64
	2	vc_r≥ .220,	38	0.14	0.06	58.64	0.39
Wet road	1	dti< .780	6	1534.75	1268.75	17.33	3002.09
	2	dti≥ .780	50	570.42	381.56	33.11	796.24
Night	1	dti < 1.220	15	2.94	2.25	23.48	2.86
	2	dti ≥ 1.220	41	1.76	1.51	14.55	1.96

Table 4.21.District 11 Crash Density Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti< .520	28	9.51	10.40	9.26	14.89
	2	dti≥ .520, adt< 26100	29	2.55	2.07	18.81	3.23
	3	dti≥ .520, adt≥ 26100	45	4.18	5.16	23.45	6.15
Property Damage Only	1	vc_r< .480, adt< 28300	47	14.40	11.83	17.86	13.34
	2	vc_r< .480, adt≥ 28300	25	19.90	21.21	6.60	13.21
	3	vc_r≥ .480, dti< .520	10	72.51	42.65	41.18	73.74
	4	vc_r≥ .480, dti≥ .520	20	18.03	25.31	40.36	13.33
Total	1	sriw≥ 5.00	13	42.53	48.50	14.05	75.68
	2	sriw< 5.00, dti< .520	21	29.28	32.48	10.91	28.91
	3	sriw< 5.00, dti≥ .520	68	18.41	16.81	8.69	13.51
Angle	1	dti< .520	28	9.51	10.40	9.26	14.89
	2	dti≥ .520, adt< 26100	29	2.55	2.07	18.81	3.23
	3	dti≥ .520, adt≥ 26100	45	4.18	5.16	23.45	6.15
Fixed Object	1	vc_r< .480, adt< 28300	47	14.40	11.83	17.86	13.34
	2	vc_r< .480, adt≥ 28300	25	19.90	21.21	6.60	13.21
	3	vc_r≥ .480, dti< .520	10	72.51	42.65	41.18	73.74
	4	vc_r≥ .480, dti≥ .520	20	18.03	25.31	40.36	13.33
Rear end	1	dti< .500	28	7.99	6.71	16.00	16.42
	2	dti≥ .500	74	1.31	1.82	39.33	2.78
Sideswipe	1	med_wi< 16	16	8.01	5.96	25.65	14.89
	2	med_wi ≥ 16 vc_r < .440	55	1.76	0.92	47.98	4.94
	3	med_wi ≥ 16 vc_r ≥.440	30	2.45	2.92	19.00	3.27
Wet road	1	dti< .300,	18	12.81	12.40	3.17	24.74
	2	dti≥ .300, vc_r <.460	53	4.04	2.44	39.57	6.59
	3	dti≥ .300, vc_r ≥.460	31	4.83	5.95	23.27	6.27
Night	1	adt< 28740	47	7.48	7.45	0.32	6.22
	2	adt≥ 28740, dti < .570	21	17.91	18.12	1.15	24.19
	3	adt≥ 28740, dti≥ .570	34	7.56	11.00	45.51	7.55

Table 4.22.District 11 Crash Rate Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti < .520	28	1.12	1.30	16.03	1.72
	2	dti ≥ .520	74	0.52	1.21	131.78	1.45
Property Damage Only	1	popd< 24.111	34	1.81	1.68	7.31	1.66
	2	popd ≥ 24.111, dti < .520	22	5.18	5.06	2.17	4.25
	3	popd ≥ 24.111, dti≥.520	46	2.90	2.74	5.64	2.93
Total	1	dti < .520	28	4.08	5.00	22.69	5.38
	2	dti ≥ .520	74	3.03	2.90	4.43	2.73
Angle	1	dti < .520	28	0.76	0.38	49.88	2.00
	2	dti ≥ .520	74	0.20	0.09	58.07	0.58
Fixed Object	1	dti < .290	18	1.18	2.19	85.93	1.91
	2	dti ≥ .290	84	1.02	0.96	6.30	1.58
Rear end	1	dti < .500	28	0.87	1.04	19.88	1.62
	2	dti ≥ .500	74	0.16	0.26	67.48	0.34
Sideswipe	1	vc_r < .520	79	0.32	0.20	38.57	1.00
	2	vc_r ≥ .520	23	0.63	0.48	23.13	1.11
Wet road	1	dti< .300,	18	2449.41	2563.91	4.67	4476.46
	2	dti≥ .300, vc_r <.460	53	923.40	553.05	40.11	1506.59
	3	dti≥ .300, vc_r ≥.460	31	1087.53	1321.23	21.49	1404.08
Night	1	popd< 17.049	26	0.70	0.74	5.46	0.75
	2	popd ≥ 17.049 , roway_wi ≥ 80	39	1.30	1.45	11.17	1.71
	3	popd ≥ 17.049 roway_wi < 80, med_wi <52.00	14	1.70	1.58	7.11	1.63
	4	popd ≥ 17.049 roway_wi< 80, med_wi ≥ 52.00	23	1.95	2.46	26.04	1.66

Table 4.23.District 12 Crash Density Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	adt< 94530	104	21.43	13.74	35.86	41.85
	2	adt≥ 94530, dti≥ .250	72	25.51	24.38	4.42	46.81
	3	adt≥ 94530, dti< .250, popd< 1619	29	61.81	47.63	22.94	75.53
	4	adt≥ 94530, dti< .250, popd ≥ 1619	9	104.58	112.84	7.90	84.20
Property Damage Only	1	dti ≥ .250	148	38.05	43.02	13.06	59.12
	2	dti < .250, dti < .020	19	177.68	165.92	6.62	157.69
	3	dti < .250, dti ≥ .020	46	115.87	100.24	13.49	169.09
Total	1	dti< .020	19	280.37	251.62	10.26	469.12
	2	dti≥ .020,dti≥.380	119	54.20	51.77	4.50	99.59
	3	dti≥ .020,dti< .380,adt<128500	64	112.29	103.55	7.79	169.16
	4	dti≥.020, dti<.380,adt≥128500	11	77.69	258.21	232.35	225.84
Angle	1	adt<94530	104	21.43	13.74	35.86	41.85
	2	adt≥94530, dti≥.250	72	25.51	24.38	4.42	46.81
	3	adt≥94530, dti<.250,popd<1619	28	61.81	47.63	22.94	75.53
	4	adt≥94530, dti<.250,popd ≥ 1619	9	104.58	112.84	7.90	84.20
Fixed Object	1	dti ≥.250	148	38.05	117.85	209.70	100.74
	2	dti < .250, dti <.020	19	177.68	165.92	6.62	157.69
	3	dti < .250, dti ≥ .020	46	115.87	100.24	13.49	169.09
Rear end	1	dti ≥ .250	148	17.42	20.94	20.22	24.29
	2	dti < .250, surface_wi < 84	33	95.39	42.44	55.51	183.45
	3	dti < .250, surface_wi ≥ 84	32	77.93	141.26	81.25	121.85
Sideswipe	1	dti ≥ .170	169	9.11	9.50	4.31	13.45
	2	dti < .170, adt < 96880	19	29.23	10.47	64.19	53.34
	3	dti < .170, adt ≥ 96880	25	33.76	35.61	5.47	36.76
Wet road	1	dti < .250	65	69.39	53.08	23.50	102.13
	2	dti ≥ .250	148	14.78	16.61	12.36	28.17
Night	1	dti ≥ .250	148	16.57	18.64	12.49	20.85
	2	dti < .250, dti <.020	19	76.91	70.38	8.49	84.71
	3	dti < .250, dti ≥.020	46	45.70	40.84	10.63	56.11

Table 4.24.District 12 Crash Rate Model Validation

Crash Type	Condition		Sample Size	Sample Mean	Estimate Mean	Difference %	SEE
Injury/Fatal	1	dti < .250	65	8.53	4.93	42.16	13.14
	2	dti ≥.250	148	1.96	2.38	21.23	3.18
Property Damage Only	1	dti < .140	40	21.11	17.76	15.88	30.13
	2	dti ≥ .140	173	5.31	5.92	11.63	7.75
Total	1	dti < .020	19	37.75	31.15	17.47	63.43
	2	dti ≥ .020, dti < .450	88	14.26	13.53	5.15	28.66
	3	dti ≥ .030, dti ≥ .450	106	5.13	6.64	29.45	6.64
Angle	1	dti ≥ .250	148	0.54	0.90	66.38	0.87
	2	dti < .250, popd < 1636	52	3.38	2.04	39.58	6.56
	3	dti < .250, popd ≥ 1636	13	4.25	4.82	13.39	5.28
Fixed Object	1	dti ≥ .210	157	1.36	1.51	10.61	1.99
	2	dti < .210,med_wi < 5.00	16	3.51	2.11	39.84	4.16
	3	dti < .210,med_wi ≥ 5.00	40	4.53	4.68	3.33	7.12
Rear end	1	dti < .020	19	19.77	12.39	37.35	33.93
	2	dti ≥ .020,dti < .380	75	5.78	5.84	1.01	9.81
	3	dti ≥ .020,dti ≥ .380	119	1.90	1.76	7.45	3.27
Sideswipe	1	dti ≥.170	169	1.07	3.30	207.70	2.71
	2	dti < .170,med_wi < 16	23	4.76	4.20	11.70	4.48
	3	dti < .170,med_wi ≥ 16	21	3.65	1.84	49.61	9.57
Wet road	1	dti ≥ .250	148	2098.30	2437.64	16.17	4292.09
	2	dti < .250,dti <.030	21	15479.16	11292.64	27.05	19526.16
	3	dti < .030,dti ≥ .030	44	10331.42	8153.87	21.08	32759.76
Night	1	dti < .020	19	10.13	10.46	3.27	12.13
	2	dti ≥ .020, dti < .250	46	6.03	4.73	21.45	9.95
	3	dti ≥ .020, dti ≥ .250	148	1.99	2.25	12.82	2.31

This page is intentionally left blank

APPENDIX V

Statewide and districtwide crash density and rate models

This page is intentionally left blank

The keys to read the regression equation are as followings:

I2	=	Speed Limit in mph (1 mph= 1.6 kmph)
J2	=	Average Daily Traffic
L2	=	Population Density within a radius of 1.99 miles (3.2 km) of the begin log county
M2	=	No. of Lanes
N2	=	Roadway width in ft.1 ft. = .0348 m)
O2	=	Surface Width in ft. (1 ft. = .0348 m)
P2	=	Shoulder Left Inside Width (1 ft. = .0348 m)
Q2	=	Shoulder Left Outside Width in ft. (1 ft. = .0348 m)
R2	=	Shoulder Right Inside Width in ft. (1 ft. = .0348 m)
S2	=	Shoulder Right Outside Width in ft. (1 ft. = .0348 m)
T2	=	Unprotected Barrier
U2	=	Positive Barrier
V2	=	Curbed Barrier
W2	=	Median Width in ft. (1 ft. = .0348 m)
X2	=	Curve Degree
Y2	=	Grade Percentage
Z2	=	V/C Ratio
AA2	=	Distance to interchange in miles (1 mile= 1.6 km)

Table 5.1.Statewide Crash Density Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	adt < 89000	Y = 5.293625 + 0.000221 * J2 + 0.003659 * L2 - 0.063245 * N2 + 3.510843 * U2 + 0.733322 * Y2 - 1.759859 * AA2
	2	adt ≥89000 dti <.0300	Y = 82.084359 + 0.039166 * L2 - 55.275346 * U2
	3	adt ≥89000 dti ≥.0300adt<1421120	Y = 33.447052 + 0.004655 * L2 + 3.872260 * X2 - 19.689666 * AA2
	4	adt ≥89000 dti ≥.0300adt≥1421120	Y = 156.142922 - 0.655347 * N2 - 39.947759 * T2
Property Damage Only	1	adt < 77220	Y = 14.028287 + 0.000424 * J2 + 0.012297 * L2 - 5.250758 * AA2
	2	adt ≥77220 dti <.0200	Y = 262.325556
	3	adt ≥77220 dti ≥.0200 dti≥.0300	Y = -27.924600 + 0.000775 * J2 + 21.877007 * X2
	4	adt ≥77220 dti ≥.0200, dti ≥.0300 adt<140021	Y = 100.676396
	5	adt ≥77220 dti ≥.0200, dti ≥.0300,adt≥140021	Y = 217.711733
Total	1	adt < 77800,dti<.0300	Y = -45.203016 + 0.003863 * J2
	2	adt ≥77800 dti ≥.0300	Y = 57.640094 + 0.000520 * J2 + 0.009864 * L2 - 0.537582 * P2 - 3.419705 * S2 - 9.754559 * T2 - 0.004925 * W2 - 3.273969 * AA2
	3	adt ≥77220 dti <.0200	Y = 349.432152
	4	adt ≥77800 dti ≥.0200, adt<140021	Y = 37.897446 + 0.000709 * J2 + 15.170671 * Y2 - 36.859350 * AA2
	5	adt ≥77800 dti ≥.0200, adt≥140021	Y = - 751.859759 + 0.004541 * J2 + 307.361094 * Z2 - 186.146689 * AA2
Angle	1	adt < 89000	Y = 5.286417 + 0.000221 * J2 + 0.003659 * L2 - 0.063213 * N2 + 3.512002 * U2 + 0.733827 * Y2 - 1.758824 * AA2
	2	adt ≥89000 dti <.0300	Y = 82.084359 + 0.039166 * L2 - 55.275346 * U2
	3	adt ≥89000 dti ≥.0300adt<1421120	Y = 33.447052 + 0.004655 * L2 + 3.872260 * X2 - 19.689666 * AA2
	4	adt ≥89000 dti ≥.0300adt≥1421120	Y = 156.142922 - 0.655347 * N2 - 39.947759 * T2
Fixed object	1	adt < 77220	Y = 14.009209 + 0.000424 * J2 + 0.012299 * L2 - 5.246534 * AA2
	2	adt ≥77220dti <.0200	Y = 262.325556
	3	adt ≥77220 dti ≥.0200 dti≥.0300	Y = - 27.924600 + 0.000775 * J2 + 21.877007 * X2
	4	adt ≥77220 dti ≥.0200, dti ≥.0300,adt<140021	Y = 100.676396
	5	adt ≥77220 dti ≥.0200, dti ≥.0300,adt≥140021	Y= 217.711733
Rear end	1	adt < 77220	Y = 4.227182 + 0.000264 * J2 + 0.011334

			* L2 - 0.129785 * O2 - 2.394131 * AA2
	2	adt ≥77220dti <.0300	Y = 168.657030
	3	adt ≥77220dti ≥.0300adt<142120	Y = 16.008889 + 0.000343 * J2 - 25.801683 * AA2
	4	adt ≥77220 dti ≥.0300, adt≥142120,dti<.550	Y = 455.890859 - 2.349785 * N2
	5	adt ≥77220 dti ≥.0300, adt≥142120,dti≥.550	Y = 26.364524 + 35.211825 * X2
Sideswipe	1	adt < 86810	Y = - 0.600709 + 0.000080 * J2 + 0.001755 * L2 - 0.155880 * P2 + 2.756411 * U2 + 1.123010 * X2 + 3.671694 * Z2 - 0.621884 * AA2
	2	adt ≥86810 dti ≥.0170	Y = - 13.143536 + 0.000176 * J2 - 4.336427 * T2 + 14.673890 * Z2 - 8.042903 * AA2
	3	adt ≥86810 dti <.0170 popd<1635.920	Y = 8.528758 + 0.000226 * J2 - 103.658749 * AA2
	4	adt ≥77220 dti <.0170, popd≥1635.920	Y = 184.546000 - 137.550407 * U2
Road wet	1	adt < 75210	Y = 2.970698 + 0.000162 * J2 + 0.005753 * L2 + 0.858783 * Y2 - 2.068413 * AA2
	2	adt ≥75210dti <.0300	Y = 93.977692
	3	adt ≥75210 dti ≥.0300adt<1421120	Y = 32.463318 + 6.691421 * X2 - 14.740956 * AA2
	4	adt ≥75210dti ≥.0300adt≥1421120	Y = - 221.146063 + 0.001983 * J2 - 3.655036 * R2 + 37.982748 * U2 - 0.004946 * W2 - 42.480579 * AA2
Night	1	adt< 72840	Y = 7.804368 + 0.000180 * J2 - 1.787097 * AA2
	2	adt ≥72840 dti <.0500	Y = 87.527619
	3	adt ≥72840 dti ≥.0500 adt<1421120	Y = 28.532223 + 0.003384 * L2 - 11.865783 * AA2
	4	adt ≥72840 dti ≥.0500 adt≥1421120	Y = 79.495783 - 39.770187 * AA2

Table 5.2.Statewide Crash Rate Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	popd < 828.656	Y = 0.340062 + 0.000009 * J2 + 0.001467 * L2 + 0.119044 * Y2 - 0.171141 * AA2
	2	popd ≥828.656 vc_r <.0490	Y = -18.219612 + 0.020811 * L2
	3	popd ≥828.656 vc_r ≥.0490	Y = 4.531924 - 2.698997 * AA2
Property Damage Only	1	dti ≥ .210	Y = 3.348664 + 0.002215 * L2 - 1.159830 * T2 - 0.276832 * AA2
	2	dti < 210 popd< 473.204	Y = 5.260748 + 0.010485 * L2 - 24.747764 * AA2
	3	dti < .210 popd ≥.473.204	Y = 13.665031
Total	1	dti ≥ .210	Y = 1.928947 + 0.000021 * J2 + 0.002103 * L2 + 1.160931 * U2 + 0.717267 * X2 - 0.345021 * AA2
	2	dti < 210 popd< 343.567	Y = 7.416423 - 27.095481 * AA2
	3	dti <.210 popd ≥.343.567 dti<.020	Y= 26.799496
	4	dti < .210 popd ≥.343.567 dti≥.020	Y = 6.696034 + 0.005755 * L2
Angle	1	popd < 825.346	Y = 0.065840 + 0.000005 * J2 + 0.000516 * L2 + 0.137059 * X2 - 0.084584 * AA2
	2	popd ≥825.356 dti<.010	y = -15.322547 + 0.338606 * I2
	3	popd ≥828.656 dti≥ .010	Y = 1.552339 - 0.000008 * J2 + 0.000678 * L2 - 0.882964 * AA2
Fixed object	1	dti < 0.210	Y = 1.782924 + 0.000901 * L2
	2	dti ≥ 0.210	Y = 1.105636 + 0.000298 * L2 - 0.260419 * T2 + 0.373927 * X2 + 0.077219 * Y2 - 0.107774 * AA2
Rear end	1	popd < 828.656	Y = 0.913034 + 0.000024 * J2 + 0.001905 * L2 - 0.015893 * O2 - 0.367397 * T2 - 0.254705 * AA2
	2	popd ≥828.656 dti <.020	Y = 11.592561 + 13.776372 * T2
	3	popd ≥828.656 dti ≥.020	Y = 6.543984 - 4.293114 * AA2
Sideswipe	1	popd < 813.814	Y = 0.016152 + 0.000008 * J2 + 0.000403 * L2 - 0.053445 * AA2
	2	popd ≥813.814 dti <.200	Y = 2.858324
	3	popd ≥813.814 dti ≥.200	Y = 1.251796 + 0.622108 * U2 - 0.700387 * AA2
Road wet	1	dti < .030, vc_r < .800	Y = -1986.904376 + 14756.000000 * Z2
		dti < .030,	Y = 14126.000

	2	vc_r ≥ .800	
	3	dti ≥ 0.030 vc_r < 1.030	Y = 2131.928584 + 0.020511 * J2 + 0.713229 * L2 - 301.674165 * M2 + 668.886558 * U2 - 292.000388 * AA2
	4	dti ≥ 0.030, vc_r ≥1.030	Y = -236.093643 + 0.049051 * J2 + 1806.908045 * X2
Night	1	dti ≥ .210	Y = 1.146803 + 0.000861 * L2 + 0.207551 * X2 - 0.112827 * AA2
	2	dti <.210, popd <473.204	Y = 2.047406 + 0.003964 * L2 - 9.334755 * AA2
	3	dti <.210, popd ≥ 473.204	Y = 5.115428

Table 5.3.District 1 Crash Density Models

District 1 Crash Density Models			
Crash Type		**Condition**	**Regression Equations**
Injury/Fatal	1	dti< .570	Y = 13.310192
	2	dti≥ .570 popd< 50.664	Y = 2.510000
	3	dti≥ .570 popd ≥50.664	Y = 7.980645
Property Damage Only	1	dti< .320	Y = 744.333298 - 14.173368 * O2 - 150.235661 * AA2
	2	dti≥ .320 popd< 60.629	Y = 15.036349
	3	dti≥ .320 popd ≥60.629	Y = 25.057674
Total	1	dti< .320	Y = 897.465263 - 17.939649 * O2 + 49.227895 * U2
	2	dti≥ .320 adt< 36410	Y = 17.966250
	3	dti≥ .320 adt≥ 36410	Y = 34.917381
Angle	1	dti<.570	Y =13.233269
	2	dti≥ .570 popd< 50.654	Y = 2.510000
	3	dti≥ .570 popd≥ 50.654	Y = 7.980645
Fixed Object	1	dti< .320	Y = 744.333298 - 14.173368 * O2 - 150.235661 * AA2
	2	dti≥ .320 popd< 60.629	Y = 15.036349
	3	dti≥ .320 popd≥ 60.629	Y = 24.685581
Rear end	1	dti< .300	Y = -21.363518 + 0.001236 * J2 - 69.462940 * AA2
	2	dti≥ .300	Y= -4.167522 + 11.545791 * Z2
Sideswipe	1	dti< .330	Y = 4.923182 + 7.581364 * U2
	2	dti≥ .330	Y = 2.818846
Road Wet	1	dti< .320	Y = 1029.925758 - 13.124298 * N2 - 23.224880 * T2
	2	dti≥ .320	Y = -1.847262 + 0.000207 * J2 + 3.629041 * X2
Night	1	dti< .320	Y = 22.558710
	2	dti≥ .320 adt< 38810	Y = 7.433425
	3	dti≥ .320 adt≥ 38810	y = 13.272727

Table 5.4.District 1 Crash Rate Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	dti< .530	Y = 0.852866
	2	dti≥ .530 popd< 57.924	Y = 0.185120
	3	dti≥ .530 popd ≥57.924	Y = 0.535183
Property Damage Only	1	dti ≥ .320	Y = 2.854084
	2	dti < .320 popd< 60.629	Y = 1.039786
	3	dti < .210 popd ≥ 60.629	Y = 1.628422
Total	1	dti <.320	y = 5.228752 -2.641099 * T2
	2	dti ≥ .320 vc_r < .670	Y = 1.261957
	3	dti ≥ .320 vc_r ≥.670	Y = 2.143701
Angle	1	dti < .300	Y = 0.342560
	2	dti ≥.300	Y = 0.077415 + 0.114617 * X2
Fixed Object	1	dti < 0.530	Y = 1.363852
	2	dti ≥ 0.530, popd <57.924	Y = 0.265612
	3	dti ≥ 0.530, popd ≥57.924	Y = 0.841584
Rear end	1	dti < .320	Y = 0.987206
	2	dti ≥.320	y = -0.169434 + 0.588441 * Z2
Sideswipe	1	dti < .330	Y = 0.751938 - 0.439294 * T2
	2	dti ≥.330	Y = 0.187489
Road wet	1	dti < .320	Y = 100816- 24675.7 * M2 +5302.344762 * U2
	2	dti ≥.320	Y = - 467.700325 + 2715.346619 * Z2
Night	1	dti < .320	Y = 1.415957
	2	dti ≥.320	Y = 0.613068

Table 5.5.District 2 Crash Density Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	dti< .070	Y = -40.797825 + 0.002077 * J2 - 71.066020 * U2
	2	dti≥ .070	Y = 3.995266 + 0.000170 * J2 + 0.006099 * L2 - 1.586117 * R2 + 3.659814 * Y2
Property Damage Only	1	dti< .070	Y = -139.320707 + 0.004983 * J2
	2	dti≥ .070	Y = 42.598913 + 0.033290 * L2 - 5.869762 * R2
Total	1	dti< .070	Y = 182.003243
	2	dti≥ .070	Y = 15.766425 + 0.000851 * J2 - 5.735529 * R2 + 12.131110 * X2
Angle	1	dti< .070	Y = -40.797825 + 0.002077 * J2 - 71.066020 * U2
	2	dti≥ .070	Y = 3.995266 + 0.000170 * J2 + 0.006099 * L2 - 1.586117 * R2 + 3.659814 * Y2
Fixed object	1	dti< .070	Y = -139.320707 + 0.004983 * J2
	2	dti≥ .070	Y = 42.598913 + 0.033290 * L2 - 5.869762 * R2
Rear end	1	dti< .070	Y = -75.980170 + 0.002711 * J2
	2	dti≥ .070	Y = 14.914547 + 0.000308 * J2 + 0.012843 * L2 - 3.188726 * M2 - 2.841784 * R2
Sideswipe	1	dti< .050	Y = -91.072808 + 0.001996 * J2 + 240.896658 * T2 - 3.346085 * W2
	2	dti≥ .050	Y = 3.000465 + 0.006975 * L2
Road wet	1	dti< .070	Y = -39.265400 + 0.001475 * J2
	2	dti≥ .070	Y = -3.913770 + 0.000231 * J2 + 5.298157 * Y2
Night	1	dti< .070	Y = 52.561081
	2	dti≥ .070	Y = 21.218217 + 0.009978 * L2 - 2.727570 * R2

Table 5.6.District 2 Crash Rate Models

Crash Type		Condition	Regression Models
Injury/Fatal	1	dti< .070	Y = -2.569068 + 0.000095 * J2
	2	dti≥ .070	Y = -0.398663 + 0.000018 * J2 + 0.352517 * Y2
Property Damage Only	1	dti< .070	Y = -7.740871 + 0.000315 * J2
	2	dti≥ .070	Y = 3.140260 + 0.002142 * L2 - 0.444392 * R2
Total	1	dti< .070	y = 13.460028
	2	dti≥ .070	Y = 0.770481 + 0.000059 * J2 - 0.323445 * R2
Angle	1	dti < .050	Y = 2.263976
	2	dti ≥.050	Y = 0.043137 + 0.000272 * L2 + 0.214483 * Y2
Fixed object	1	dti < 0.050	Y = 2.124028
	2	dti ≥ 0.050 vc_r <.970	Y = 1.109021 - 0.088644 * R2 - 0.241299 * T2
	3	dti ≥ 0.050 vc_r ≥.970	Y = 1.396915
Rear end	1	dti < .070	Y = 7.387523
	2	dti ≥.070	Y = -0.295864 + 0.000039 * J2 - 0.251903 * M2 + 0.446647 * Y2
Sideswipe	1	dti < .050	Y = 6.443817 + 0.000102 * J2 - 10.633198 * U2 - 0.150476 * W2
	2	dti ≥.050	Y = - 0.306207 + 0.000013 * J2 + 0.265118 * Y2
Road wet	1	dti < .070	Y = 10645.70
	2	dti ≥.070	Y = -551.988579 + 0.043937 * J2 + 1243.702347 * Y2
Night	1	dti < .070	Y = 3.492263
	2	dti ≥.070	Y = 1.529946 + 0.000649 * L2 - 0.205897 * R2

Table 5.7.District 3 Crash Density Models

Crash Type		Condition	Regression Models
Injury/Fatal	1	dti< .150	Y = 18.257097
	2	dti≥.150	Y = 6.429935 - 0.159462 * R2 - 0.169991 * S2 - 0.039254 * W2 + 9.504908 * Z2
Property Damage Only	1	dti< .170	Y = 79.07152
	2	dti≥.170	Y = 3.204036 + 11.032885 * T2 - 0.063926 * W2 + 21.885508 * Z2
Total	1	dti< .170	Y = 88.491818
	2	dti≥.170	Y = 31.723162 - 0.604944 * R2 - 1.207797 * S2 - 0.146802 * W2 + 40.760016 * Z2
Angle	1	dti< .150	Y = 18.257097
	2	dti≥.150	Y = 6.429935 - 0.159462 * R2 - 0.169991 * S2 - 0.039254 * W2 + 9.504908 * Z2
Fixed Object	1	dti< .170	Y = 79.071515
	2	dti≥.170	Y = 3.204036 + 11.032885 * T2 - 0.063926 * W2 + 21.885508 * Z2
Rear end	1	dti<.150	Y = 31.259355
	2	dti≥.150	Y = -0.497991 + 0.000250 * J2 - 0.049099 * N2 - 0.663084 * AA2
Sideswipe	1	dti<.150	Y = 12.388710
	2	dti≥.150	Y = -1.175428 + 7.890315 * Z2
Road Wet	1	dti<.150	y = 29.829355
	2	dti≥.150	Y = 7.310235
Night	1	dti<.170	Y = 14.886778 + 0.092713 * L2
	2	dti≥.170	Y = 12.066957

Table 5.8.District 3 Crash Rate Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	dti< .170	y = 2.28639
	2	dti≥.170	Y = 2.269310 + 0.001230 * L2 - 0.013738 * N2 - 0.009817 * W2 + 0.216132 * Z2
Property Damage Only	1	dti< .170	Y = 10.044148
	2	dti≥.170	Y = 8.884398 + 0.003515 * L2 - 1.043137 * M2 - 1.671890 * U2 - 0.034369 * W2
Total	1	dti< .170	Y = 12.276165
	2	dti≥.170	Y = 10.767900 + 0.003887 * L2 - 1.336001 * M2 - 0.034137 * W2
Angle	1	dti < .150	Y = 0.854239
	2	dti≥.150, popd< 202	Y = 0.150194 + 0.080390 * Y2
	3	dti≥.150, popd≥ 202	Y = -0.083146 + 0.000013 * J2
Fixed object	1	dti < 0.350	Y = 13.329491 - 1.186255 * Q2 + 0.789138 * Y2
	2	dti≥ 0.350 popd <.68	Y = 1.983415 - 0.106338 * R2 - 0.012763 * W2 + 0.371505 * Y2
	3	dti ≥ 0.350; popd <.68 med_wi<42	Y = 1.440426
	4	dti≥ 0.350 popd <.68 med_wi ≥42	Y = 8.787582 - 0.551527 * R2 - 0.055349 * W2
Rear end	1	dti < .170	y = 3.866489
	2	dti≥.170	Y = -0.106069 + 0.000028 * J2 - 0.108756 * M2 - 0.088629 * AA2
Sideswipe	1	dti < .170	Y = 1.242803
	2	dti≥.170, popd< 218	Y = 0.252701 + 0.000009 * J2 - 0.006302 * O2
	3	dti≥.170 popd≥ 218	Y = 0.204903 + 0.677837 * Z2
Road wet	1	dti < .150	Y = 6460.959513
	2	dti≥.150	Y = 1532.220134 + 23.468315 * Z2
Night	1	dti < .170	Y = 1.798524 + 0.013195 * L2
	2	dti≥.170 sliw<12	Y = 1.627764 - 0.088495 * R2
	3	dti≥.170 sliw ≥	Y = 8.452191 - 0.046325 * N2

Table 5.9.District 4 Crash Density Models

Crash Type		Condition	Regression equation
Injury/Fatal	1	dti≥.340	Y = -3.172533 + 0.000187 * J2 + 2.177742 * T2
	2	dti<.340 dti<.020	Y = 42.120588
	3	dti<.340 dti≥.020 adt<536	Y = 11.100893
	4	dti<.340 dti≥.020 adt≥536	Y =24.751446
Property Damage Only	1	dti< .210 vc_r<.75	Y = 40.973818
	2	dti<.210 vc_r≥.75	Y = 96.923016
	3	dti≥.210 speed<60	Y = 49.366545
	4	dti≥.210 speed≥60	Y = 23.505985 + 0.000427 * J2 - 0.255554 * N2
Total	1	dti< .020	Y = 171.391471
	2	dti≥.020 dti<.34	Y = 12.877847 + 74.790915 * Z2
	3	dti≥.020 dti≥.34	Y = 7.256711 + 0.000471 * J2 - 0.001792 * W2
Angle	1	dti≥.340	Y = 2.017702 + 0.000176 * J2 - 0.604022 * R2
	2	dti<.340 dti<.020	Y = 42.120588
	3	dti<.340 dti≥.020 adt<53633	Y = 11.100893
	4	dti<.340 dti≥.020 adt≥53633	Y =24.751446
Fixed Object	1	dti< .210 vc_r<.75	Y = 40.973818
	2	dti< .210 vc_r≥.75	y = 96.923016
	2	dti≥.210 speed<60	y = 49.366545
	3	dti≥.210 speed≥60	Y= 23.505985 + 0.000427 * J2 - 0.255554 * N2
Rear end	1	vc_r<.760	Y = 13.560383 - 4.779157 * T2 - 3.604958 * AA2
	2	vc_r≥.760 dti<.260 popd<270	Y = 13.377428 + 0.088800 * L2
	3	vc_r≥.760 dti<.260 popd≥270	Y = - 13.860508 + 0.061126 * L2 - 9.307310 * M2 + 50.469655 * T2 - 2.062461 * W2
	4	vc_r≥.760 dti≥.260	Y = 34.803429

		Speed<60	
	5	vc_r≥.760 dti≥.260 speed≥60	Y = -37.011130 + 0.000532 * J2 + 0.015568 * L2 + 8.798696 * T2
Sideswipe	1	vc_r<.76	Y = 1.786153 + 0.000053 * J2 - 0.871070 * AA2
	2	vc_r≥.76 dti< .34	Y = 14.505870
	2	vc_r≥.76 dti≥.34	Y = 5.501538
Road Wet	1	dti≥.340	Y = 2.287852 + 0.000104 * J2 - 0.000827 * W2
	2	dti<.340 vc_r<.770	Y = 12.964699
	3	dti<.340 vc_r≥.770 vc_r<.940	y = 37.272174
	4	dti<.340 vc_r≥.770 vc_r≥.940	Y = 18.041591
Night	1	dti<.020	y = 41.600882
	2	dti≥.020 adt<54080	Y = 22.892701 + 0.004959 * L2 - 0.182117 * N2
	3	dti≥.020 adt≥54080	Y = 19.551517

Table 5.10.District 4 Crash Rate Models

Crash Type		Condition	Regression equation
Injury/Fatal	1	dti≥ .340	Y = 0.308121 + 0.000019 * J2 - 0.060937 * R2 - 0.000020 * W2
	2	dti<.340 dti<.020	Y = 4.636973
	2	dti<.340 dti≥.020	Y = 2.614730 - 0.890860 * T2
Property Damage Only	1	dti< .200 adt< 66050	Y = 6.201363
	2	dti< .200 adt≥66050	Y = 11.289380
	3	dti≥.200 speed< 60	Y = 16.646363 - 0.180574 * O2
	4	dti≥.200 speed≥60	Y = 2.059428 + 0.001429 * L2 - 0.000028 * W2 + 0.796600 * X2
Total	1	dti< .020	Y = 18.430219
	2	dti≥.020 dti< .410	Y = 14.329828 - 0.101889 * N2 + 3.716957 * U2
	3	dti≥.020 dti≥.410	Y = 2.054835 + 0.000049 * J2 - 0.175873 * R2 - 0.000162 * W2
Angle	1	dti ≥ .220	Y = 0.055340 + 0.000005 * J2
	2	dti<.220, dti<020	Y = 2.078622
	3	dti<.220 dti≥ 020	Y = 0.954985
Fixed Object	1	dti < 0.340	Y = 2.247321 + 1.113938 * X2
	2	dti≥ 0.340	Y = 0.527338 + 0.000009 * J2 + 0.134243 * Y2
Rear end	1	dti<.020	Y = 6.986998
	2	dti≥.020 speed<60	Y = 3.704258
	3	dti≥.020 speed≥60	Y = 0.455236 + 0.000017 * J2 - 0.408479 * AA2
Sideswipe	1	popd< .327	Y = 0.802616 + 0.000011 * J2 - 0.010063 * N2 - 0.077165 * AA2
	2	popd≥.327, dti< .340	Y = 1.225407
	3	dti≥.170 dti≥ .340	Y = 0.621687
Road Wet	1	dti≥.340	Y = 2904.029146 + 0.028848 * J2 - 630.974115 * M2 - 0.282305 * W2
	2	dti<.340 vc_r<.770	Y = 2675.135193
	3	dti<.340 vc_r≥.770	Y = 7463.163896

		vc_r<.940	
	4	dti<.340 vc_r≥.770 vc_r≥.940	Y = 1.0813.40 -1496.953603 * M2
Night	1	dti < .020	Y = 4.609434
	2	dti≥.020 popd<320	Y = 1.123222 + 0.125540 * Y2
	3	dti≥.020 popd≥ 320	Y = 2.251074

Table 5.11.District 5 Crash Density Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	dti<.170	Y = 17.656452
	2	dti≥.170	Y = 1.496688 + 4.693477 * U2 + 6.905722 * Z2
Property Damage Only	1	dti<.170	Y = 52.077097
	2	dti≥.170 adt<.34570	Y = 15.154298
	3	dti≥.170 adt≥34570	Y = 26.168840
Total	1	dti<.170	Y = 72.912581
	2	dti≥.170	Y = -144.279962 + 2.614080 * I2 - 15.275487 * T2 + 26.155309 * Z2
Angle	1	dti<.170	Y = 17.656452
	2	dti≥.170	Y = 1.496688 + 4.693477 * U2 + 6.905722 * Z2
Fixed Object	1	dti<.170	Y = 52.077097
	2	dti≥.170 adt<.34570	Y = 15.154298
	3	dti≥.170 adt≥34570	Y = 26.168840
Rear end	1	adt<.40238	Y = -93.725650 + 1.444219 * I2 + 0.011506 * L2 - 3.004786 * X2 + 9.547726 * Z2
	2	adt≥.40238	y = 8.401358
Sideswipe	1	dti<.250	Y = 6.808605
	2	dti≥.250 vc_r< .810	Y = -27.575422 + 0.445776 * I2 - 1.687783 * T2 + 4.496650 * Z2
	2	dti≥.810 vc_r≥.810	Y = 9.779091 - 0.068150 * W2
Road Wet	1	dti<.170	Y = 22.444516
	2	dti≥.170	Y= -82.895995 + 1.512661 * I2 - 7.404448 * T2 - 1.072655 * AA2
Night	1	dti<.170	Y = 21.573871
	2	dti≥.170 adt<32530	Y = 0.392841 + 0.025171 * L2 + 20.756956 * Z2
	3	dti≥.170 adt≥32530	Y = 13.619476

Table 5.12.District 5 Crash Rate Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	dti<.170	Y = 1.378314
	2	dti≥.170	Y = 0.475154
Property Damage Only	1	dti< .170	Y = 4.043188
	2	dti≥ .170 vc_r<.380	Y = -4.353371 + 0.000390 * J2
	3	dti≥.170 vc_r≥ 60	Y = 1.698211
Total	1	dti< .170	y = 5.443805
	2	dti≥.170 vc_r< .380	Y = -6.144730 + 0.000509 * J2
	3	dti≥.170 vc_r≥.380	Y = 1.945473
Angle	1	dti<.170	Y = 0.420308
	2	dti≥.170	Y = 0.103413
Fixed Object	1	roway_wi≥ 86	Y = 1.614927
	2	roway_wi< 86 vc_r ≥.740	Y = -5.475344 + 0.099552* I2 - 0.627654 * T2
	3	roway_wi< 86 vc_r <.740 popd <74	Y = 0.307827 + 0.000016 * J2
	4	roway_wi< 86 vc_r <.740 popd ≥74	y = 1.195351
Rear end	1	dti<.170	Y = -17.473279 + 0.279103 * I2 + 2.585641 * U2
	2	dti≥.170 roway_wi<76	Y = 0.591167
	3	dti≥.020 roway_wi≥76	Y = 0.006514 + 0.000005 * J2
Sideswipe	1	dti<.250	Y = 0.523221
	2	dti≥.250	Y = -2.583894 + 0.041984 * I2 + 0.000413 * L2
Road Wet	1	dti<.170	Y = 4913.973555
	2	dti≥.170	Y = -13785.10 + 251.870294 * I2 - 759.081298 * T2 - 242.018840 * AA2
Night	1	popd < 61.443	Y = 0.895931
	2	popd≥ 61.443 vc_r <<.520	Y = 2.171392
	3	popd≥ 61.443 vc_r ≥<.520 vc_r <.840	Y = 1.345432
	4	popd≥ 61.443 vc_r ≥<.520 vc_r ≥.840	Y = 0.596173

Table 5.13.District 6 Crash Density Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	med_wi< 5, adt <1412	Y = 135.058766 - 20.208571 * W2 - 55.366737 * AA2
	2	med_wi< 5, adt≥1412	Y = 20.388181 + 0.093070 * L2 - 126.364219 * AA2
	3	med_wi ≥5, dti<.110	Y = 13.877021 + 0.072647 * L2
	4	med_wi ≥5 dti ≥ .110	Y = -0.254033 + 0.000103 * J2 + 0.006517 * L2
Property Damage Only	1	dti<.030	y = 221.362000
	2	dti≥.030 med_wi≥ 5.0	Y = 82.745088 + 0.000298 * J2 - 7.746325 * S2
	3	dti≥.030 med_wi<5.0 vc_r<1.030	Y = 92.276108 - 67.030542 * AA2
	4	dti≥.170 adt<34570 vc_r≥1.030	Y = 168.688857
Total	1	dti<.030	Y = -202.521174 + 554.408567 * Z2
	2	dti≥.030 adt≥142120	Y = -253.478043 - 4.490033 * W2 + 499.130207 * Z2
	3	dti≥.030 adt<142120 med_wi<5.0	Y = 97.238791 + 0.037182 * L2 - 126.798639 * AA2
	4	dti≥.030 adt<142120 med_wi≥5.0	Y = -6.135985 + 0.000356 * J2 + 20.241124 * T2 - 2.862969 * AA2
Angle	1	med_wi< 5 adt <1412	Y = 135.058766 - 20.208571 * W2 - 55.366737 * AA2
	2	med_wi< 5 adt≥1412	Y = 20.388181 + 0.093070 * L2 - 126.364219 * AA2
	3	med_wi ≥5, dti< .110	Y = 13.877021 + 0.072647 * L2
	4	med_wi ≥5 dti ≥ .110	Y = 41.936547 + 0.000120 * J2 + 0.005100 * L2 - 4.286304 * S2 + 0.171163 * X2
Fixed Object	1	dti<.030	Y = 221.362000
	2	dti≥.030 med_wi≥ 5.0	Y = 82.745088 + 0.000298 * J2 - 7.746325 * S2
	3	dti≥.030 med_wi< 5.0 vc_r <1.030	Y = 92.276108 - 67.030542 * AA2
	4	dti≥.030 med_wi< 5.0 vc_r ≥1.030	Y = 168.688857
Rear end	1	adt<141220 dti< .460	Y = 1.162128 + 0.172848 * L2
	2	adt<141220 dti≥.460	Y = -323.050562 + 0.002438 * J2 - 42.279542 * T2
	3	adt≥141220, dti< .080	Y = 87.046667
	4	adt≥141220 dti ≥ .080	Y = 6.593436 + 0.012134 * L2 + 7.711826 * U2 - 1.542256 * AA2

Sideswipe	1	med_wi≥5.0	Y = 20.245265 + 0.000082 * J2 - 2.218563 * S2 + 3.848809 * T2 - 1.052268 * AA2
	2	med_wi<5.0 adt< 141220	Y = 28.014208 + 10.283130 * Y2 - 26.394151 * AA2
	3	med_wi<5.0 adt≥141220	Y = -128.039241 + 162.677614 * Z2
Road Wet	1	dti<.030	Y = 95.948000
	2	dti≥.030 adt≥142120	Y = -47.170400 - 1.126477 * W2 + 112.045011 * Z2
	3	dti≥.030 adt<142120 med_wi< 5.0	Y = 34.660309 + 18.801653 * Y2 - 25.714383 * AA2
	4	dti≥.030 adt<142120 med_wi≥ 5.0	Y = 54.408939 + 0.000095 * J2 + 0.003461 * L2 - 6.181688 * S2 + 7.247947 * T2
Night	1	dti<.030	Y = 14.519089 + 0.000861 * J2
	2	dti≥.030 adt<142120	Y = 12.406803 + 0.006089 * L2 + 5.341770 * Y2 - 1.488275 * AA2
	3	dti≥.030 adt≥142120	Y = -14.180063 + 0.051994 * L2

Table 5.14.District 6 Crash Rate Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	popd <1508	Y = 0.971082 + 0.001702 * L2 - 0.645494 * T2
	2	popd ≥1508, dti < .360	Y = 50.109050 - 0.000305 * J2
	3	popd ≥.1508, dti ≥.360	Y = 119.642311 - 11.729111 * S2 - 0.002451 * W2
Property Damage Only	1	popd <1508	Y = 40.329334 - 3.412407 * S2 - 0.045873 * W2 - 0.723593 * AA2
	2	popd ≥1508, dti < .350	Y = 106.474695 - 0.000692 * J2
	3	popd ≥.1508, dti ≥.350	Y = 195.488470 - 18.712731 * S2 - 0.003643 * W2 - 6.522274 * AA2
Total	1	popd <1572	Y = 34.538774 + 0.000024 * J2 - 2.914613 * S2 - 3.014407 * T2 - 0.788063 * AA2
	2	popd ≥1572, dti < .300	Y = 41.214062
	3	popd ≥.1508, dti ≥.300	Y = 8.935453
Angle	1	popd <1508	Y = 0.160596 + 0.000908 * L2
	2	popd ≥1508, dti < .350	Y = 5.510120
	3	popd ≥.1508, dti ≥.350	Y = 31.195613 - 3.055254 * S2 - 0.001619 * W2 + 2.012707 * X2 + 0.463032 * Y2
Fixed Object	1	med_wi< 4.00	Y = 5.124669
	2	med_wi≥ 4.00	Y = 22.680521 + 0.000395 * L2 - 2.197409 * S2 - 0.130476 * AA2
Rear end	1	popd<1508, med_wi < 5.0	Y = 9.580178 - 9.025808 * AA2
	2	popd<1508, med_wi≥ 5.0	Y = 23.478762 + 0.000012 * J2 - 2.298367 * S2 - 0.283609 * AA2
	3	popd ≥1508, dti<.360	Y = 16.201933
	4	popd ≥1508, dti ≥ .360	Y = 137.284351 + 0.000043 * J2 - 13.758179 * S2 - 0.002673 * W2 - 3.629422 * AA2
Sideswipe	1	popd<1562, med_wi < 30.0	Y = 9.010310 - 0.738595 * Q2
	2	med_wi<1562, med_wi≥ 30.0	Y = 0.319377 * L2 + 0.000470 * AA2 - 0.068925
	3	popd ≥1562 dti<.270	Y = 5.326051
	4	popd ≥1562, dti ≥ .270	Y = 42.503707 - 3.987065 * S2 - 0.000860 * W2 - 2.253339 * AA2
Road Wet	1	dti<.030	Y = 15049.000
	2	dti≥.030, med_wi≥ 5.0	Y = 9086.029724 + 0.019194 * J2 + 0.565224 * L2 - 16.720935 * O2 - 914.144606 * S2 + 880.761209 * T2
	3	dti≥.030, med_wi< 5.0, vc_r<1.050	Y = 3185.976501
	4	dti≥.030, med_wi< 5.0, vc_r ≥1.050	Y = -63605.90 + 0.184287 * J2 + 4856.704034 * Y2 + 3.90519E+04 * Z2

Night	1	popd < 1562	Y = 1.196782 + 0.000534 * L2 + 0.718787 * U2 - 0.239842 * AA2
	2	popd≥ 1562 dti <<.270	Y = 11.852995
	3	popd≥ 1562 dti ≥<.270	Y = 67.051793 - 6.487518 * S2 - 0.001290 * W2

Table 5.15.District 7 Crash Density Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	adt≥92900,	Y = 60.342045 - 47.286026 * AA2
	2	adt<92900 adt<54714	Y = 8.597497 - 1.783573 * AA2
	3	adt<92900, adt≥54714	Y = 17.662569
Property Damage Only	1	adt<92900,	Y = 2.835260 + 0.000572 * J2
	2	adt≥92900	Y = 143.183405 - 101.308613 * AA2
Total	1	adt≥92900	Y = 171.574113 - 119.130295 * AA2
	2	adt<92900, adt< 55680	Y = 33.646853
	3	adt≥92900, adt≥55680	Y = 61.853622
Angle	1	adt≥92900	Y = 60.342045 - 47.286026 * AA2
	2	adt<92900, adt< 54714	Y = 8.597497 - 1.783573 * AA2
	3	adt≥92900, adt≥54714	Y = 17.662569
Fixed Object	1	adt<92900	Y = 2.835260 + 0.000572 * J2
	2	adt≥92900	Y = 143.183405 -101.308613 * AA2
Rear end	1	adt<93710	Y = -5.414042 + 0.000191 * J2 + 0.013702 * L2 + 2.943051 * Y2
	2	adt≥93710	Y = 165.508237 - 88.835954 * U2 - 0.816218 * W2 - 87.427719 * AA2
Sideswipe	1	adt≥94510	Y = -63.003159 + 78.323963 * Z2
	2	adt<94510 adt<60270	Y = 3.088416 + 0.003875 * L2 + 3.065576 * Y2
	3	adt<94510 adt≥60270	Y = 10.079167
Road Wet	1	adt<61820	Y = 8.430801 + 0.010326 * L2 - 0.038331 * N2 + 4.102611 * Y2
	2	adt≥61820 dti<0.400	Y = 95.340151 - 56.291378 * U2 - 0.353160 * W2
	3	adt≥61820 dti≥0.400	Y = 21.533889
Night	1	adt<75973	Y = 14.550442
	2	adt≥75973 dti<0.430	Y = 41.750233
	3	adt≥75973 dti≥0.430	Y = 24.270588

Table 5.16.District 7 Crash Rate Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	popd <645.309	Y = 0.140102 + 0.000010 * J2
	2	popd ≥645.309, dti < .490	Y = 2.734604
	3	popd ≥645.309, dti ≥.490	Y = 1.217342
Property Damage Only	1	popd <645.309	Y = 3.105060 - 0.250371 * M2
	2	popd ≥645.309, dti < .490	Y = 7.271629
	3	popd ≥645.309, dti ≥.490	Y = 2.883345
Total	1	popd <645.309	Y = 1.124680 + 0.000030 * J2
	2	popd ≥645.309, dti < .490	Y = 8.368605
	3	popd ≥645.309, dti ≥.490	Y = 3.532949
Angle	1	popd <645.309	Y = 0.180469 + 0.000412 * L2 - 0.000520 * N2
	2	popd ≥645.309, dti < .490	Y = 0.939749
	3	popd ≥645.309, dti ≥.490	Y = 0.312168
Fixed Object	1	lanes≥ 6.00	Y = 1.651496 - 0.544440* AA2
	2	lanes< 6.00 dti < .110	Y = 1.510074
	3	lanes< 6.00 dti ≥ .110	Y = 0.824726
Rear end	1	popd <645.309	Y = -0.290025 + 0.000015 * J2 - 0.009945 * R2
	2	popd ≥645.309, dti < .290	Y = 2.715753 + 7.623854 * T2 - 0.047821 * W2
	3	popd ≥ 645.309, dti ≥.290	Y = 2.340916 + 0.943964 * X2 - 1.586831 * AA2
Sideswipe	1	popd <645.309	Y = 0.192826 - 0.008777 * R2 + 0.191527 * U2 + 0.175885 * Z2
	2	popd ≥645.309, dti < .490	Y = 1.152097 + 0.171111 * X2
	3	popd ≥645.309, dti ≥.490	Y = 0.649790
Road Wet	1	vc_r<1.070	Y = 37.684045 + 0.043484 * J2 - 507.101875 * AA2
	2	vc_r≥1.070	Y = 6131.802800
Night	1	popd <645.309	Y = 1.369386 - 0.007606 * O2
	2	popd ≥645.309, roway_wi < 108	Y = 1.671103 - 0.905153 * T2 + 0.204230 * X2 + 0.496265 * Y2
	3	popd ≥645.309, roway_wi ≥ 108	Y = 2.332180

Table 5.17.District 8 Crash Density Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	adt<90213	Y = - 1.044652 + 0.000121 * J2 + 0.017995 * L2
	2	adt≥90213 dti<070	Y = 118.425029 - 1242.263752 * AA2
	3	adt≥90213 dti≥070, speed<60	Y = 112.852083 -7.173215 * R2
	4	adt≥90213 dti≥070, speed≥60	Y = 36.687538 - 14.947538 * T2
Property Damage Only	1	adt<90213	Y = 3.654733 + 0.000311 * J2 + 0.049317 * L2
	2	adt ≥90213 dti <.210, sliw <8	Y = 321.098182
	3	adt≥90213 dti<.210, sliw ≥8	Y = 286.517128 - 1041.581280 * AA2
	4	adt≥90213 dti≥.210, popd <1228	Y = -14.345616 - 0.171415 * N2 + 129.262707 * Z2
	5	adt≥90213 dti≥.210, popd ≥1228	Y = 340.870883 - 20.362048 * R2
Total	1	adt<103890, dti< .100	Y = - 1989.548794 + 32.130202 * I2 + 0.387113 * L2 - 3058.015476 * AA2
	2	adt<103890, dti≥.100	Y = -1.985043 + 0.000566 * J2 + 0.046344 * L2
	3	adt<103890, dti< .190	Y = 321.480492
	4	adt<103890, dti≥.190	Y = 197.073781 - 21.688221 * R2 + 194.056444 * U2 + 28.524914 * X2
Angle	1	adt<0213	Y = - 1.044652 + 0.000121 * J2 + 0.017995 * L2
	2	adt≥90213 dti<070	Y = 118.425029 - 1242.263752 * AA2
	3	adt≥90213 dti≥070, speed<60	Y = 112.852083 - 7.173215 * R2
	4	adt≥90213 dti≥070, speed≥60	Y = 36.687538 - 14.947538 * T2
Fixed Object	1	adt<90213	Y = 3.654733 + 0.000311 * J2 + 0.049317 * L2
	2	adt ≥90213 dti <.210, P2 <8	Y = 321.098182
	3	adt≥90213 dti<.210, P2 ≥8	Y = 286.517128 - 1041.581280 * AA2

	4	adt≥90213 dti≥.210, popd <1228	Y = - 14.345616 - 0.171415 * N2 + 129.262707 * Z2
	5	adt≥90213 dti≥.210, popd ≥1228	Y = 340.870883 - 20.362048 * R2
Rear end	1	adt<104320, dti<120	Y = - 1293.875986 + 19.649880 * I2 + 0.226240 * L2
	2	adt<104320, dti≥120	Y = -7.445711 + 0.000188 * J2 + 0.017647 * L2 + 7.500794 * X2
	3	adt≥104320 adt≥155108	Y = 322.223333 - 136.207407 * U2
	4	adt≥104320 adt<155108 dti<.190	Y = 187.930173 -765.043856 * AA2
	5	adt≥104320 adt<155108, dti≥.190	Y = 83.510508 - 50.483267 * T2 + 23.576497 * X2
Sideswipe	1	speed<60, popd<1329	Y = 42.885278
	2	speed<60, popd≥1329	Y = 144.443333 - 92.300980 * U2
	3	speed≥60, adt<104320	Y = -1.885169 + 0.000102 * J2 + 0.004456 * L2
	4	speed≥60, adt≥104320	Y = 26.370327 - 11.864080 * AA2
Road Wet	1	adt<124840, dti<.060	Y = -13.452238 + 0.001322 * J2
	2	adt<60, dti≥.060	Y = -3.138841 + 0.000166 * J2 + 0.013971 * L2
	3	adt≥60, popd<1393	Y = 73.342613 - 70.640602 * AA2
	4	adt≥60, popden≥1393	Y = 252.003380 -18.237650 * R2
Night	1	adt<103890, dti <.120	Y = 17.289899 + 0.056345 * L2
	2	adt<103890, dti ≥.120	Y = 6.026665 + 0.000179 * J2 - 1.940320 * AA2
	3	adt≥103890, adt≥ 155108	Y = -20.033622 + 0.071959* L2
	4	adt≥103890 adt<155108, dti<.200	Y = 66.194792
	5	adt≥103890 adt<155108, dti≥.200	Y = 35.422093 + 21.565969 * X2

Table 5.18.District 8 Crash Rate Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	dti <.030	Y = 6.648217
	2	dti ≥.030, popd < 449.761	Y = 0.791930 + 0.002172 * L2 - 0.003828 * W2 + 0.229576 * Y2 - 0.149660 * AA2
	3	dti ≥.030, popd ≥ 449.761	Y = 3.617537 - 1.628473 * T2
Property Damage Only	1	dti <.030	Y = 22.216506
	2	dti ≥.030, popd < 494	Y = 1.769869 + 0.000031 * J2 - 0.008253 * W2 - 0.506955 * AA2
	3	dti ≥.030, popd ≥494, dti<.210	Y = 13.226478
	4	dti ≥.030, popd ≥494, dti≥.210	Y = 22.837056 -1.744254 * S2 + 5.961115 * U2
Total	1	dti <.030	Y = 61.493482 - 34.591748 * U2 - 0.297490 * W2
	2	dti ≥.030, popd < 449	Y = 1.776740 + 0.000057 * J2 - 0.018825 * W2 + 0.743538 * Y2 - 0.533444 * AA2
	3	dti ≥.030, popd ≥449	Y = 28.375426 - 2.060942 * S2 + 6.488787 * U2
Angle	1	dti <.030	Y = 4.410608
	2	dti ≥.030	Y = 0.330882 + 0.000562 * L2 - 0.124747 * AA2
Fixed Object	1	popd< 441	Y = 1.241142 + 0.001211 * L2 - 0.005574 * W2 + 0.179545 * Y2 - 0.218762 * AA2
	2	popd≥ 441, popd≥ 1506	Y = 4.059841
	3	popd≥ 441, popd< 1506, dti<.210	Y = 4.884264 - 0.251145 * S2
	4	popd≥ 441, popd< 1506, dti≥.210	Y = 3.625188 - 0.162266 * M2 - 0.011203 * N2 + 0.353997 * X2
Rear end	1	dti <.030	Y = 16.068476
	2	dti ≥.030, popd< 1000	Y = 3.761890 + 0.000025 * J2 + 0.001827 * L2 - 0.479063 * M2 - 1.909340 * T2 - 0.441304 * AA2
	3	dti ≥.030, popd ≥1000	Y = 7.546443 - 4.100308 * AA2
Sideswipe	1	popd <835.706, popd <163.570	Y = - 0.021187 + 0.000005 * J2
	2	popd <835.706, popd ≥163.570	Y = 0.606096 + 0.000739 * L2 + 0.639648 * U2 - 0.282698 * AA2
	3	popd ≥ 835.706, dti< .060	Y = 3.763177
	4	popd≥835.706,	Y = 0.120892 + 0.004878 * L2 - 0.454485

		dti≥.060, surface_wi<76	* S2
	5	popd ≥835.706, dti≥.060, surface_wi≥76	Y = 17.154784 - 0.078698 * N2 - 4.523985 * U2
Road Wet	1	dti <.030	Y = -15616.600+ 22171.30 * T2 - 162.566402 * W2 + 31002.80 * Z2
	2	dti ≥.030, popd <1234	Y = -126.171037 - 15.679394 * W2 + 5365.839418 * Z2 - 495.445013 * AA2
	3	dti ≥.030, popd ≥1234, P2<8	Y = 3907.382442 + 0.108496 * J2 - 18505.300 * AA2
	4	dti ≥.030, popd ≥1234, sliw≥8	Y= 6110.649158 + 3108.431073 * X2
Night	1	dti <.030	Y = 7.523611
	2	dti ≥.030, popd < 494	Y = 1.211787 + 0.002040 * L2 - 0.004220 * W2 + 0.285508 * Y2 - 0.187136 * AA2
	3	dti ≥.030, popd ≥ 494	Y = 3.404056 + 0.380363 * X2 - 0.990688 * AA2

Table 5.19.District 10 Crash Density Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	dti<.780	Y = 3.928000
	2	dti≥.780	Y = 1.953867
Property Damage Only	1	dti<.780	Y = 17.115667
	2	dti≥.780	Y = -34.355699 + 195.397849 * Z2
Total	1	dti<.780	Y = 22.293667
	2	dti≥.780	Y = 11.297867
Angle	1	dti<.780	Y = 3.928000
	2	dti≥.780	Y = 1.953867
Fixed Object	1	dti<.780	Y = 17.115667
	2	dti≥.780	Y = -34.355699 + 195.397849 * Z2
Rear end	1	dti<.780	Y = 4.710711 - 7.815742 * AA2
	2	dti≥.780	Y = 0.175000 + 0.184091 * Y2
Sideswipe	1	vc_r<.220	Y = 0.967500
	2	vc_r≥.220	Y = 0.239538
Road Wet	1	dti<.780	Y = 27.712673 - 0.337316 * W2 - 13.172611 * AA2
	2	dti≥.780	Y = 1.671200
Night	1	dti <1.220	Y = 9.103846
	2	dti ≥1.220	Y = 6.061515

Table 5.20.District 10 Crash Rate Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	dti <.950	Y = 0.942547
	2	dti ≥.950	Y = 0.474367
Property Damage Only	1	dti<.780	Y = 4.212806
	2	dti≥.780	Y = -9.179560 + 51.444660 * Z2
Total	1	dti<.780	Y = 5.514112
	2	dti≥.780	Y = 2.816734
Angle	1	L2 <23.979	N/A
	2	L2 ≥23.979	Y = 0.083372
Fixed Object	1	dti<.780	Y = 6.620358 - 0.094081 * W2
	2	dti≥.780	Y = 0.912903
Rear end	1	dti<.780	Y = 1.136748 -1.884220 * AA2
	2	dti≥.780	Y = 0.042784 + 0.047911 * Y2
Sideswipe	1	vc_r<.220,	Y = 0.235395
	2	vc_r≥.220,	Y = 0.058473
Road Wet	1	dti<.780	Y = 6327.708454 - 77.018085 * W2 - 3008.015303 * AA2
	2	dti≥.780	Y = 381.564775
Night	1	dti <1.220	Y = 2.253392
	2	dti ≥1.220	Y = 1.507483

Table 5.21.District 11 Crash Density Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	dti<520	Y =10.395455
	2	dti≥.520 adt<26100	Y = 4.237158 - 0.933489 * AA2
	3	dti≥.520 adt≥26100	Y = 5.162235
Property Damage Only	1	vc_r<.480 adt<28300	Y = 11.826078
	2	vc_r<.480 adt≥28300	Y = 21.214667
	3	vc_r≥.480 dti<.520	Y = 42.649412
	4	vc_r≥.480 dti≥.520	Y = 25.313333
Total	1	R2≥5.00	Y = 48.502187
	2	R2<5.00, dti<.520	Y = 0.391762 + 0.001088* J2
	3	R2<5.00, dti≥ .520	Y = 4.449120 + 0.000463 * J2
Angle	1	dti<.520	Y = 10.395455
	2	dti≥.520 adt<26100	Y = 4.237158 - 0.933489 * AA2
	3	dti≥.520 adt≥26100	Y = 5.162235
Fixed Object	1	vc_r<.480 adt<28300	Y = 11.826078
	2	vc_r<.480 adt≥28300	Y = 21.214667
	3	vc_r≥.480 dti<.520	Y = 42.649412
	4	vc_r≥.480 dti≥.520	Y = 25.313333
Rear end	1	dti<.500	Y = 1.573093 + 0.030910 * L2 + 2.095218 * Y2
	2	dti≥.500	Y = 0.980966 + 0.007967 * L2
Sideswipe	1	med_wi< 16	Y = 5.955758
	2	med_wi ≥ 16 vc_r <.440	Y = 0.915856
	3	med_wi ≥ 16 vc_r ≥.440	Y = 2.917069
Road Wet	1	dti<.300	Y = 12.402258
	2	dti≥.300 vc_r <.460	Y = 2.444182
	3	dti≥.300 vc_r ≥.460	Y = 4.658611 + 3.640989 * U2
Night	1	adt<28740	Y = 23.972945 + 0.000389 * J2 - 0.522784 * O2- 12.455914 * U2 + 0.642499 * Y2
	2	adt≥28740, dti <.570	Y = 18.118049
	3	adt≥28740 dti≥.570	Y = 10.997414

Table 5.22.District 11 Crash Rate Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	dti <.520	Y = 1.298803
	2	dti ≥520	Y = 0.808062 * AA2 - 0.156764
Property Damage Only	1	popd <24.111	Y = 1.677067
	2	popd ≥24.111, dti < .520	Y = 5.063634
	3	popd ≥24.111, dti≥.520	Y = 2.740872
Total	1	dti <.520	Y = 5.002847
	2	dti ≥.520	Y = 1.428285 + 0.000053 * J2
Angle	1	dti <.520	Y = 0.348930
	2	dti ≥.520	Y = 0.085593
Fixed Object	1	dti <.290	Y = 2.189543
	2	dti ≥.290	Y = 0.956841
Rear end	1	dti <.500	Y = 3.070564 + 0.000054 * J2 - 0.417924 * R2 - 2.068194 * T2
	2	dti ≥.500	Y = 0.173613 + 0.000835 * L2
Sideswipe	1	vc_r <.520	Y = 0.199577
	2	vc_r ≥.520	Y = 0.480703
Road Wet	1	dti<.300,	Y = 2713.010902
	2	dti≥.300, vc_r <.460	Y = 553.047468
	3	dti≥.300, vc_r ≥.460	Y = 1321.229471
Night	1	popd<17.049	Y = 0.740942
	2	popd ≥17.049 , roway_wi≥ 80	Y = 1.450198
	3	popd ≥17.049 , roway_wi< 80, med_wi<52.00	Y = 1.581728
	4	popd ≥17.049 , roway_wi< 80, med_wi≥ 52.00	Y = 2.457015

Table 5.23.District 12 Crash Density Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	adt<94530	Y = 2.102700 + 0.000192 * J2
	2	adt≥94530 dti≥.250	Y = -21.057886 + 0.000372 * J2
	3	adt≥94530 dti<.250, popd<1619	Y = 47.628767
	4	adt≥94530 dti<.250, popd ≥ 1619	Y = 153.776123 - 549.904329 * AA2
Property Damage Only	1	dti ≥.250	Y = 26.888943 + 0.000448 * J2 - 0.305735 * O2
	2	dti < .250 dti <.020	Y = 69.523852 + 0.095323 * L2
	3	dti < .250 dti ≥.020	Y = 100.237109
Total	1	dti<.020	Y = -357.901599 + 0.201512 * L2 + 505.180695 * Z2
	2	dti≥.020, dti≥.380	Y = 31.563537 + 0.000241 * J2
	3	dti≥.020, dti<.380, adt<128500	Y = 4.818866 + 0.001148 * J2 + 0.028830 * L2 - 60.881870 * U2
	4	dti≥.020, dti<.380, adt≥128500	Y = -990.039385 + 0.007431 * J2 + 174.757772 * U2
Angle	1	adt<94530	Y = 2.102700 + 0.000192 * J2
	2	adt≥94530, dti≥.250	Y = -21.057886 + 0.000372 * J2
	3	adt≥94530 dti<.250, popd<1619	Y = 47.628767
	4	adt≥94530 dti<.250, popd ≥ 1619	Y = 153.776123 - 549.904329 * AA2
Fixed Object	1	dti ≥.250	Y = 117.851938
	2	dti < .250 dti <.020	Y = 69.523852 + 0.095323 * L2
	3	dti < .250 dti ≥.020	Y = 100.237109
Rear end	1	dti ≥.250	Y = 7.726776 + 0.000369 * J2 - 0.166385 * N2
	2	dti < .250, surface_wi <84	Y = 56.888978 - 155.315329 * AA2
	3	dti < .250, surface_wi ≥84	Y = -33.244368 + 173.735237 + Z2
Sideswipe	1	dti ≥.170	Y = -0.909592 + 0.000072 * J2 + 5.170828 * Z2
	2	dti < .170 adt <96880	Y = -8.168797 + 28.507484 * Z2
	3	dti < .170	Y = 35.606857

		adt ≥96880	
Road Wet	1	dti <.250	Y = 53.082875
	2	dti ≥.250	Y = 2.354963 + 0.000161 * J2
Night	1	dti ≥.250	Y = -3.891581 + 0.189304 * I2 + 0.000184 * J2 - 0.068522 * O2
	2	dti < .250 dti <.020	Y = -76.886560 + 0.042299 * L2 + 130.101098 * Z2
	3	dti < .250 dti ≥.020	Y = -2.847807 + 0.000441 * J2

Table 5.24.District 12 Crash Rate Models

Crash Type		Condition	Regression Equation
Injury/Fatal	1	dti <.250	Y = 2.711442 + 0.001736 * L2
	2	dti ≥.250	Y = 3.075616 -1.599352* T2
Property Damage Only	1	dti <.140	Y = 17.760726
	2	dti ≥.140	Y = 7.423044 - 1.984167 * AA2
Total	1	dti <.020	Y = -39.312424 + 0.021365 * L2 + 60.836144 * Z2
	2	dti ≥.020, dti < .450	Y = 13.526072
	3	dti ≥.030, dti ≥.450	Y = 6.641035
Angle	1	dti ≥.250	Y = 0.429468 + 0.000513* L2
	2	dti <.250, popd < 1636	Y = 2.041803
	3	dti <.250, popd ≥1636	Y = 4.817511
Fixed Object	1	dti ≥.210	Y = 1.794135 - 0.723798 * T2 + 0.988731 * Y2
	2	dti <.210, med_wi < 5.00	Y = 2.114513
	3	dti <.210, med_wi ≥ 5.00	Y = 4.342739 + 2.704651 * X2
Rear end	1	dti < .020	Y = 3.583935 + 0.008705 * L2
	2	dti ≥.020, dti < .380	Y = 5.838543
	3	dti ≥.020, dti ≥.380	Y = 2.358170 - 0.609633 * AA2
Sideswipe	1	dti ≥.170	Y = 3.295601
	2	dti < .170, med_wi < 16	Y = 4.201720
	3	dti <.170, med_wi ≥ 16	Y = 1.841597
Road Wet	1	dti ≥.250	Y = 2829.134181 + 0.026406 * J2 - 35.436779 * O2
	2	dti <.250, dti <.030	Y = -10160.40 + 26928.50 * Z2
	3	dti <.030, dti ≥.030	Y = 5960.079084 + 4826.332956 * X2
Night	1	dti <.020	Y = -3.935227 + 17.928918 * Z2
	2	dti ≥.020, dti < .250	Y = 3.310708 + 0.001024 * L2
	3	dti ≥.020, dti ≥ .250	Y = 1.733839 + 0.000565 * L2