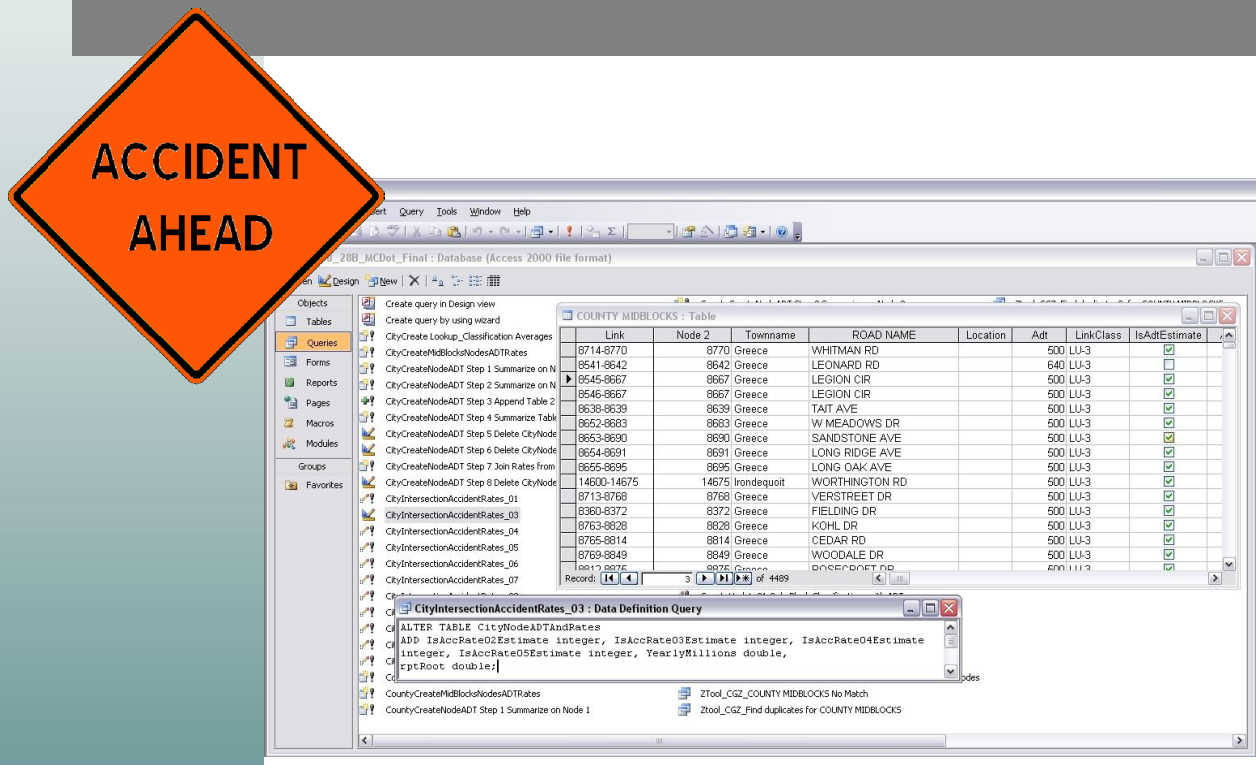
MONROE COUNTY
NEW YORK

Intersection Accident Database Enhancement Project (UPWP 4380)



FINAL

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Executive Summary

One of the primary functions of a transportation agency is to track the safety record along all roads under its jurisdiction, both at intersections and mid-block locations. The Monroe County Department of Transportation (MCDOT) maintains a database of traffic volume and crash data to assist in the identification and prioritization of high crash locations. A wealth of traffic data on New York State and MCDOT highways has facilitated the identification of high crash locations along "major" routes including arterials and expressways and at locations where they intersect. Unfortunately, a lack of comprehensive volume data for "minor" public rural roads and City of Rochester streets has made it difficult to identify intersections with high crash rates involving these facilities. The sheer number of minor public road and city street intersections within Monroe County and the City of Rochester has rendered it cost and time prohibitive to collect comprehensive traffic volume data for each and every facility.

According to the United States Department of Transportation (USDOT) Federal Highway Administration (FHWA), "intersection crashes account for more than 45 percent of all reported crashes, and 21 percent of all fatalities nationwide." This emphasizes the need to be able to track accident rates at all intersections, regardless of the intersecting road's volume.

The purpose of this project was to provide reliable volume estimates for minor (non-county and non-state) public roads where they intersect MCDOT highways and for urban street intersections within the City of Rochester, thereby enhancing the existing MCDOT accident database and high crash location identification process. The integration and use of GIS technology to provide additional identification tools was considered a critical component.

A multi step process was developed to complete the project. Study intersections were identified first. These were intersections where town and village roads intersect highways owned and maintained by the MCDOT and minor street intersections with the City of Rochester. Approaches to each study intersection were then identified using GIS. A classification system was developed covering all identified approaches. Different classification systems were necessary for the City of Rochester and suburban and rural towns of Monroe County due to the inherent differences in land use, population density, and character. Existing traffic volume data was reviewed and supplemental data was collected throughout Monroe County to develop traffic volume estimates for each classification. An Average Daily Traffic (ADT) volume estimate was then created and assigned to each classification. The volume of traffic entering each intersection was tabulated and utilized to calculate an accident rate.

A Microsoft Access database was prepared and delivered to the MCDOT for future use. This tool allows the user to assign appropriate ADT values to classified intersection approaches and calculate accident rates. The database can be paired with GIS maps of the City and County to examine accident rates graphically. An added benefit is that the tool allows the MCDOT to graphically display road volume data over the entire County.

The result of this project was an improvement to the method by which the MCDOT can identify, study, and address issues at high crash locations that would otherwise go undetected, ultimately improving overall safety for the traveling public. The methodology, database, and GIS tool offer a defendable rationale for the identification of high crash locations and will be useful evidence should the MCDOT pursue Federal and other funding from applicable programs for future accident countermeasure projects.

1.0 Introduction

One of the primary functions of a transportation agency is to track the safety record along all roads under its jurisdiction, both at intersections and mid-block locations. The Monroe County Department of Transportation (MCDOT) maintains a database of traffic volume and crash data to assist in the identification and prioritization of high crash locations. A wealth of traffic data on New York State and MCDOT highways has facilitated the identification of high crash locations along "major" routes including arterials and expressways and at locations where they intersect. Unfortunately, a lack of comprehensive volume data for "minor" public rural roads and City of Rochester streets has made it difficult to identify intersections with high crash rates involving these facilities. The sheer number of minor public road and city street intersections within Monroe County and the City of Rochester has rendered it cost and time prohibitive to collect comprehensive traffic volume data for each and every facility.

According to the United States Department of Transportation (USDOT) Federal Highway Administration (FHWA), "intersection crashes account for more than 45 percent of all reported crashes, and 21 percent of all fatalities nationwide." This emphasizes the need to be able to track accident rates at all intersections, regardless of the intersecting road's volume.

The purpose of this project was to provide reliable volume estimates for minor (non-county and non-state) public roads where they intersect MCDOT highways and for urban street intersections within the City of Rochester, thereby enhancing the existing MCDOT accident database and high crash location identification process. In this way, the accident rate at every such intersection can be checked. The integration and use of GIS technology to provide additional identification tools was considered a critical component. This report summarizes the project process and describes the final product delivered to the MCDOT.

2.0 Project Area

The study area included all of Monroe County, New York (including the City of Rochester) and is shown on Exhibit 1.

3.0 Project Process

The steps taken to complete this project are illustrated in Exhibit 2 and are summarized as follows:

1: Identify all intersections (nodes) of interest
2: Identify all approach segments to those intersections (links)
3: Develop classifications for each minor public roadway and city street approach segment.
4: Distribute count sites among the classifications
5: Perform manual traffic counts to supplement pre-existing count data
6: Generate an Average Daily Traffic volume estimate for each classification
7: Develop an Average Daily Traffic estimate for each study intersection
8: Utilize MCDOT supplied crash data to calculate and graphically display accident rates

Exhibit 1: Project Area Map

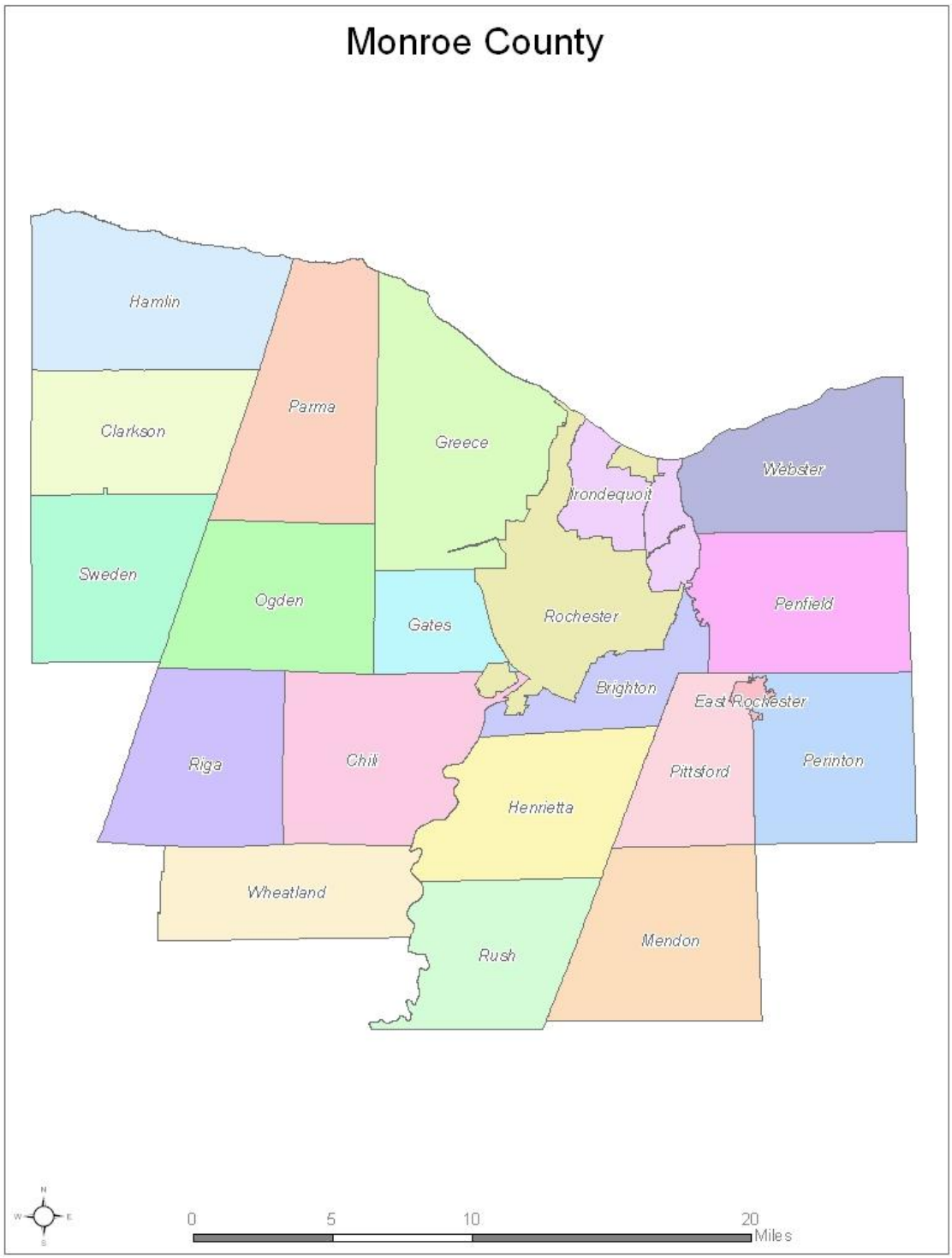
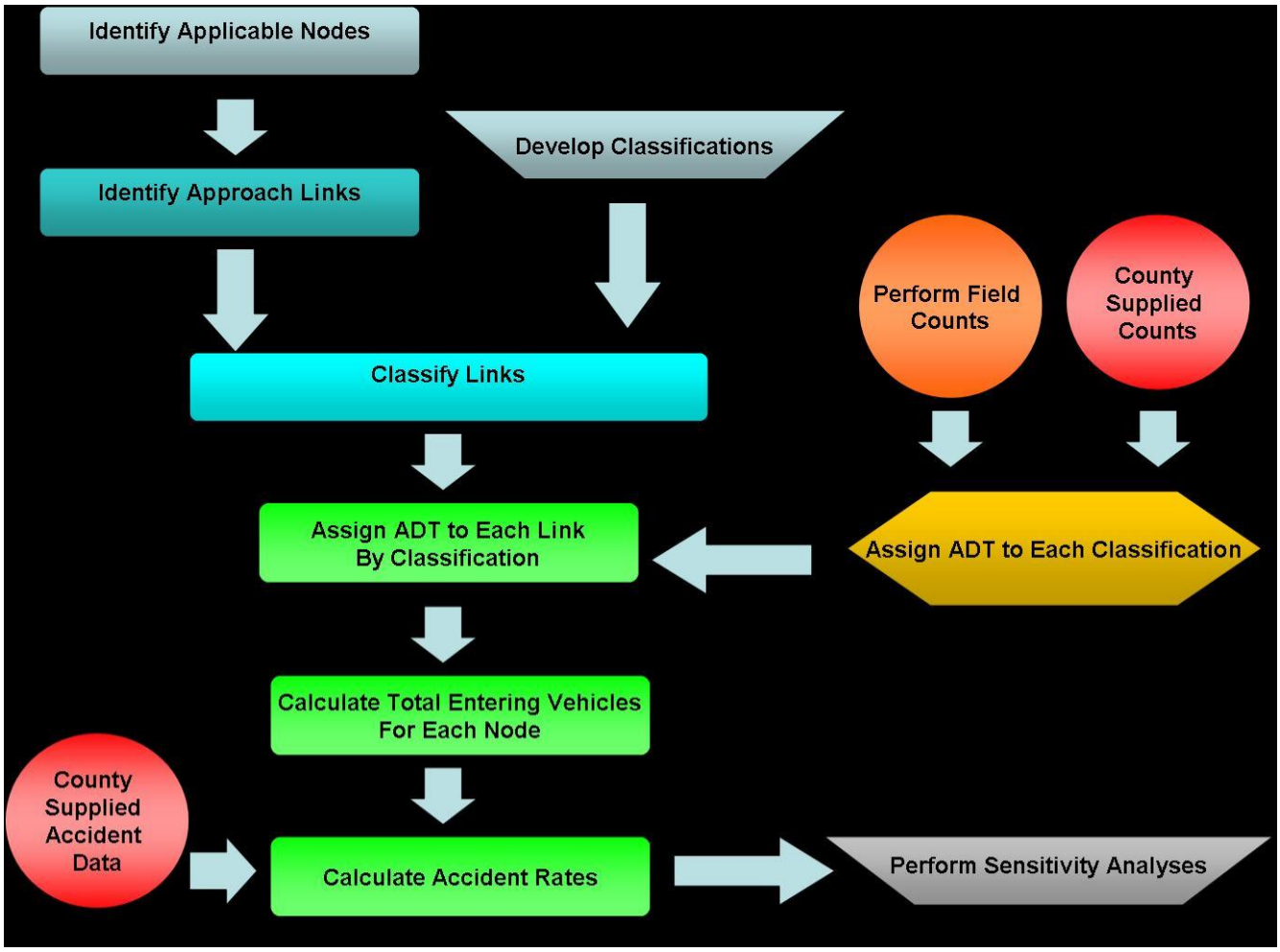


Exhibit 2: MCDOT Accident Database Enhancement Project Flowchart



3.1 Identify Intersections

The project involved only intersections where minor public roads (i.e. town roads, village roads, etc.) meet roadways owned and maintained by the MCDOT. It also included all minor road and street intersections (i.e. those not involving facilities owned and maintained by the New York State Department of Transportation (NYSDOT)) within the City of Rochester.

Geographic maps were developed for each town within Monroe County and the City of Rochester based on data supplied by the Monroe County Department of Environmental Services (MCDES). Node coordinate data was supplied by the New York State Centralized Local Accident Surveillance System (CLASS). Project intersections, also known as "nodes of interest", were each represented by a point on these maps. Each node was given a unique identification number. Copies of the maps are available in Appendix A.

3.2 Identify Local Road Approaches

The next step was to identify all approach segments to project intersections and associate those "links" with the appropriate node of interest. This was done differently for the suburban and rural towns of Monroe County and the City of Rochester due to the number of segments involved.

For the suburban and rural towns, identification began with node (point) features. The MCDOT Microsoft Access database table however, contains node to node links. Therefore this node feature class was updated to contain an attribute for an adjoining node, thereby creating a link. Additional nodes were created as needed. When all links were identified, a table was exported from GIS to Microsoft Access and a series of queries were written to transfer the classification information for all adjacent links at each node-of-interest into the MCDOT County Midblocks table.

Within the City of Rochester, the sheer number of nodes made this approach unworkable. A custom "Draw Lines Tool" was designed to create links from nodes and then these links were classified. The City Midblocks (link) table was used to create the links and these links were classified within GIS. All nodes within the city were considered project intersections. Therefore all city links were classified. When all links were identified, a table was exported from GIS to Microsoft Access and a series of queries were written to transfer the information into the MCDOT City Midblocks table.

The "Draw Lines Tool" can be used with county or city nodes and the associated Midblocks table to show link classification or any other piece of link data present in the table. Complete documentation for the tool developed to create a line feature class from a point feature class and a table representing the point-to-point links can be found in Appendix B.

3.3 Develop a Classification System and Assign Classes to Approaches

A system was developed to classify all minor public roadway approach segments (links) to project intersections (nodes of interest). These classifications would later be used to assign appropriate traffic volume estimates.

There is an inherent difference between the City of Rochester's urban character and that of the suburban and rural towns of Monroe County. That difference affects roadway types, their function, and the amount of traffic carried. To account for this difference, separate classification systems were developed for the City of Rochester and its surrounding towns.

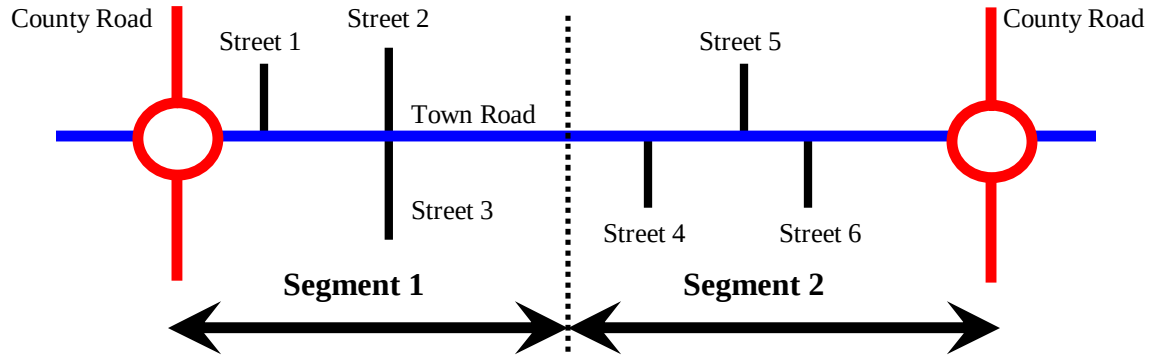
3.3.1 Classifications within the Rural and Suburban Towns of Monroe County

Within the suburban and rural towns, roadway classifications were first based on overall function within the surrounding network of streets and highways. For example, roadways directly serving farms, homes, businesses, or subdivisions were placed into the category of "Local Roads". Those facilities that gather traffic from multiple local roads were categorized as "Collectors".

A second level addressed the intensity and type of surrounding development. Three categories were used to describe the varied character of suburban and rural Monroe County. Rural areas dominated by subdivisions and more populated villages and hamlets around the county typify what was called "Urban Dense Development." Lots characterized by this type of land use are commonly small and have a limited roadway frontage (less than 70 feet). The "Suburban Moderate Development" category covered rural-residential areas, where single family homes on parcels with larger frontages between 70 feet and 120 feet are common. Areas with "Rural Light Development" generally included farmland and other large parcels having a frontage of more than 120 feet. A mean frontage was calculated based on GIS parcel data for each roadway approach segment. This value was compared to the categories above and used to assist in the classification process.

The third and final criteria for classification within the rural and suburban towns involved the number of "internal" connecting streets on the approach segment being examined. This part of the classification process is illustrated by Exhibit 3. Subject roadways were first broken into appropriate segments. Next it was assumed that traffic would generally enter and exit the subject roadway at its closest end. In the example shown, the minor public roadway has two connections to MCDOT highways with one at each end. It also has 6 connecting streets. The minor public roadway is therefore broken into two approach segments, each with 3 connecting streets. Minor public roadways were grouped into those with 2 or fewer connecting streets, more than 2 but less than or equal to 5, and more than 5.

Exhibit 3: Segmentation Example



In many cases judgment and local knowledge were also employed in the classification of an approach segment. The result was an array of 18 possible classifications. The code used to represent each class of minor public road segment within the rural and suburban towns of Monroe County is listed in Exhibit 4.

Exhibit 4: Classification Codes for the Rural and Suburban Towns of Monroe County

Step 1: Select type of road			
Type of Road	**L:** Local	**C**: Collector	
Step 2: Determine frontage category			
Frontage	**R**: Rural, large >= 120 ft	**S**: Suburban, medium, > 70 ft and < 120 ft	**U**: Urban, small, <= 70ft
Step 3: Determine number of intersecting streets on the segment			
Number of Intersecting Streets	**1**: > 5	**2**: > 2 and <= 5	**3**: <= 2
Set classification – possible choices below			
Classification	LR-1 LS-1 LU-1 CR-1 CS-1 CU-1		
	LR-2 LS-2 LU-2 CR-2 CS-2 CU-2		
	LR-3 LS-3 LU-3 CR-3 CS-3 CU-3		

3.3.2 Classifications within the City of Rochester

Classifications within the City of Rochester were based solely on roadway characteristics. All land uses generally fall into an urban category. Frontages throughout city neighborhoods are relatively consistent.

Non MCDOT and NYSDOT roadways were first categorized as "Local", "Collector", "Arterial", or "Highway." The first three categories were chosen according to the Traffic Engineering Handbook (Institute of Transportation Engineers, Fifth Edition, 1999) and the NYSDOT Highway Design Manual, Chapter 2. The classification of "Highway" refers to ramps and service roads connecting to major arterials and expressways. These were kept separate for the purposes of this project, but could be merged with the Arterial class in the future if volume estimates suggest it appropriate. Then, in a manner similar to the rural and suburban towns, each category was further broken down by the number of connecting streets resulting in 12 possible classifications. The classifications are listed in Exhibit 5. As with the rural and suburban towns, judgment and local knowledge were important tools that assisted in assignment of approach classifications within the City.

Exhibit 5: Classification Codes for the City of Rochester

Step 1: Select type of road				
Type of Road	**L:** Local	**C**: Collector	**A**: Arterial	**H**: Highway
Step 2: Determine number of intersecting roads on this segment				
Number of Intersecting Streets	**1**: > 5	**2**: > 2 and <= 5	**3**: <= 2	
Step 3: Set classification – possible choices below				
Classification	L-1 C-1 A-1 H-1			
	L-2 C-2 A-2 H-2			
	L-3 C-3 A-3 H-3			

3.3.3 Classification Test

A brief test was completed to examine the accuracy of the classification system developed for the rural and suburban towns of Monroe County. Paper copies of traffic counts provided by the MCDOT and the MCDOT traffic volume library (a Microsoft Excel spreadsheet containing historic counts taken around the county) were reviewed to identify study intersections where both a classification and historic turning movement count data were available. Comparison sites, study intersections where minor public road approaches were classified but no historic count data existed, were then selected to match. The number of matches fitting these criteria was limited. The result of this exercise was a set of 5 pairs as shown in Exhibit 6.

Exhibit 6: Classification Test Summary

Site Data	Comparison Sites				
	Pair #1	**Pair #2**	**Pair #3**	**Pair #4**	**Pair #5**
Base Site Node #	17713	23790	7657	25936	8764
Classification	LS-1	LS-3	LS-2/CS-1	LR-3	LU-1
Street	Fairfield	Bluff	Wood/Janes	Panorama Cr.	McCall
County Road	Elmwood	Linden	Long Pond	Panorama Tr.	Stone
Town	Brighton	E. Rochester	Greece	Penfield	Greece
Count Date	1995	2000	2002	1997	2005
Comparison Site Node #	8239	15048	26187	6087	14240
Classification	LS-1	LS-3	CS-1	LR-3	LU-1
Street	Stoneycreek	Schofield	Embury	Pixley Industrial	Hillsboro Cove
County Road	English	St. Paul	Five Mile Line	Pixley	Bay
Town	Greece	Irondequoit	Penfield	Gates	Webster

Traffic entering and exiting the minor (classified) public roadway approach was counted during the evening peak hour at each location. Detailed volume comparisons are available in Appendix C. Comparisons at 3 of the 5 sites (#1, #3, and #4) were favorable with traffic volume differences between 8% and 20%. Differences at the remaining sites were more significant at levels in excess of 90% due to heavy cut through volumes at the base site locations. Given a "success rate" of 3 out of 5, the decision was made to move forward with the classification system as designed.

The classes were next assigned to the links identified in Section 3.2. This was done utilizing a linkage between the MCDOT Microsoft Access Database and GIS.

3.4 Distribute Count Sites among the Classifications

The existing MCDOT Microsoft Access database was reviewed for the availability and location of count data. The database contained count data for all MCDOT highways. A great deal of existing count data was also available for streets within the City of Rochester. In contrast, coverage of minor public roadway approaches throughout the rural and suburban towns was sparse. A total of 80 new manual traffic counts were budgeted by the MCDOT to help develop reliable volume estimates. A plan was needed to appropriately spread the available count locations out across the classifications developed in Section 3.3.

Initially, an analysis was performed to determine the number of count locations required to generate a statistically valid volume estimate for each individual classification within the rural and suburban towns. A complete summary of the statistical analysis, including an explanation of confidence levels, is available in Appendix D. The results indicated it would be necessary to count nearly 350 approaches in order to ensure that the resulting volume estimates were generated within a 10% margin of error given a 90% level of confidence for each individual classification.

This effort would far exceed the number of count locations budgeted by the MCDOT, therefore a second statistical analysis was undertaken to determine what level of accuracy could be attained if all 80 counts were taken within the rural and suburban towns. The results indicated that volume predictions generated under this scenario would be within a 30% margin of error given a 90% level of confidence for all classifications as a group. A set of sample sizes could be developed that would allow a user to say they were accurately representing 3 out of 5 or better suburban or rural town locations at a 90% level of confidence.

The ultimate goal of this project was to improve the method by which MCDOT staff can identify, eventually study, and address issues at high crash locations to improve overall safety for the traveling public. The MCDOT therefore suggested that the study team redistribute the 80 field counts based upon accident frequency rather than node classification. The average number of crashes occurring between 2002 and 2005 were subsequently queried for each classification using the MCDOT Microsoft Access Database.

At the same time, it was determined that although the City of Rochester was well covered with existing data, it would be desirable to conduct a small number of new counts to fill in any "gaps" that might exist. To assist in the location of "gaps", geographic maps were plotted illustrating current count coverage throughout the City of Rochester. Copies of these maps are available in Appendix E. Representative locations with little or no count coverage and a significant number of accidents between 2002 and 2005 were identified. As a result, a total of 5 representative count locations were selected within the City of Rochester.

The 75 remaining counts were spread out proportionately across the rural and suburban town classifications, targeting the highest number of counts to those classifications with the highest frequency of accidents. Classifications that had no representative locations were eliminated from the data set. Classifications that had representative locations but no accidents were assigned at least one count. This method was ultimately chosen by the MCDOT as the preferred process for distributing the available manual traffic counts to derive the greatest overall benefit.

MCDOT staff indicated they could address the inherent margin of error in the volume estimates manually. A sensitivity analysis would be performed to lower and raise each classification's volume projection by up to 30%. Any deficiencies in the volume estimates and their effect on accident rate calculations could be screened out in this way, helping to locate intersections with a truly significant accident rate. Over time the accuracy of the volume estimates can be improved as more actual count data are integrated into the database. The final distribution of counts among the classifications is summarized in Exhibit 7.

Exhibit 7: Number of Counts per Classification Used

Classification	Number of Counts Performed
CR-3	1
CS-1	6
CS-2	1
CS-3	1
CU-1	3
CU-3	1
LR-2	1
LR-3	7
LS-1	7
LS-2	11
LS-3	13
LU-1	3
LU-2	6
LU-3	14
Town Subtotal	75
A-1	1
C-2	1
L-1	2
L-2	1
City Subtotal	**5**
Total	**80**

3.5 Perform Manual Traffic Counts

Count locations were chosen once the total number of counts per classification had been determined. As stated earlier, 5 representative locations were chosen throughout the City of Rochester leaving 75 to be spread over classifications within the rural and suburban towns of Monroe County. These count locations were chosen using the maps discussed in Section 3.1. The locations were spread around the towns to obtain a representative sample for each classification. They were also selected in groups of three to facilitate travel between locations during count operations. A complete listing of all count locations is contained in Appendix F.

Each count was conducted over a 15 minute interval during the evening peak hour between 4:30 and 5:30 PM, thus allowing one individual to cover three sites in one outing. Count data were collected on Tuesdays, Wednesdays, and Thursdays during the weeks of June 10th and 17th, 2007. All vehicles entering and exiting the minor roadway (classified subject approach) were counted, to capture a two-way volume. Where there were multiple minor roadway approaches to the MCDOT facility, all were counted to improve the study data set.

3.6 Assign an Average Daily Traffic Volume Estimate to Each Classification

Count data were reduced utilizing Microsoft Excel. The 15 minute volumes for each classification were multiplied by 4, rounded up to the nearest 25 vehicles, and tabulated. Where available, MCDOT supplied count peak hour count data were added to the tabulation. This occurred most often for the City of Rochester locations. Subsequently the mean, median, minimum, and maximum volumes were calculated for each classification volume data set. In most cases the median value was the most representative statistic and was used to select a peak hour volume estimate. The peak hour volume estimates were extrapolated to average daily traffic (ADT) volumes by dividing the urban and city values by 10% and the rural and suburban values by 8%. These factors were selected based on information contained in the Traffic Engineering Handbook, 5th Edition (Institute of Transportation Engineers, 1999). The ADT projections as calculated and the data used to derive them are available in Appendix G. The final step was to review the ADT volumes with MCDOT staff, adjust the projections as needed, and round the results. The resulting ADT estimates for each classification present within the data set are summarized in Exhibit 8.

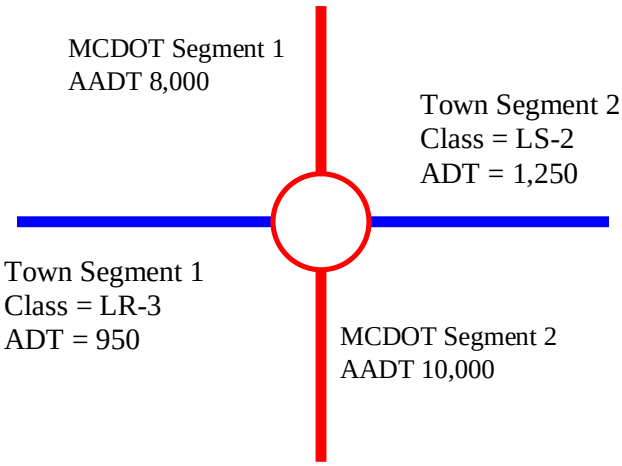
Exhibit 8: Look-Up Table for Average Daily Traffic Estimates by Classification

Classification	Average Daily Traffic Estimate
A-1	15000
A-2	16500
A-3	15500
C-1	9000
C-2	7500
C-3	8500
CR-3	625
CS-1	5625
CS-2	2200
CS-3	2200
CU-1	1750
CU-3	750
H-1	20000
H-2	13000
H-3	11250
L-1	2500
L-2	2000
L-3	1500
LR-2	4075
LR-3	950
LS-1	1575
LS-2	1250
LS-3	625
LU-1	1250
LU-2	1000
LU-3	500

3.7 Develop an Average Daily Traffic Volume Estimate for Each Study Intersection

Calculating an ADT volume for each project intersection required work within the MCDOT Microsoft Access Database. The classifications assigned in Section 3.3, the volume estimates developed in Section 3.6, and existing volume data for MCDOT facilities were used to determine the Average Daily Traffic volumes for each approach. These Average Daily Traffic volumes were then divided by two, and added together to estimate daily entering volumes. Exhibit 9 illustrates this process.

Exhibit 9: Illustration of Entering Vehicles Calculation



(8,000/2) + (10,000/2) + (950/2) + (1,250/2) = 10,100
Entering Vehicles

3.8 Calculate and Display Accident Rates

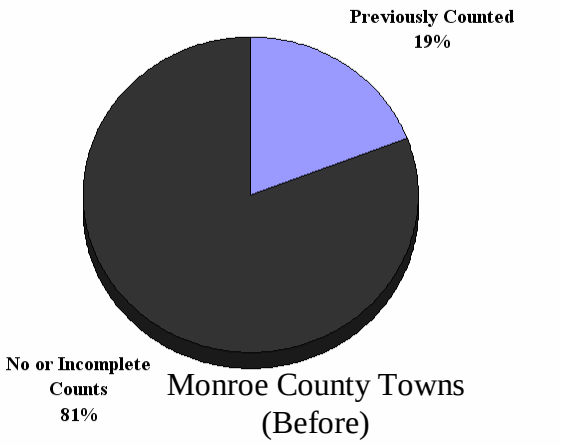
With daily entering volumes in hand for all project intersections and accident information available in the MCDOT Microsoft Access database, accident rates were calculated for each year at each node for which data were available. Because the node number is common between this table and the node feature class within GIS, the two can be joined and accident rates that are above the critical rate can be symbolized and investigated spatially.

4.0 Product Summary

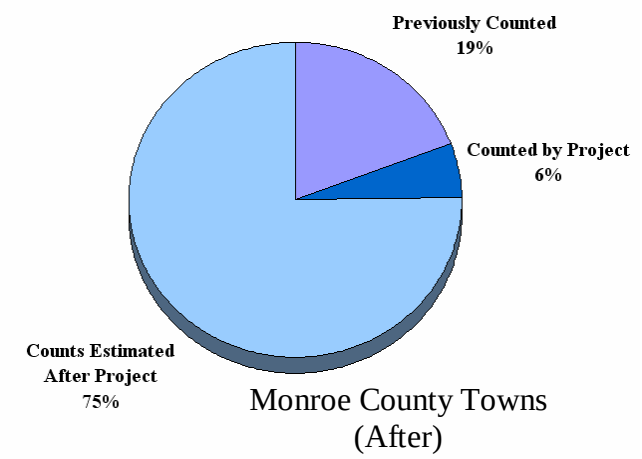
The product deliverables include a Microsoft Access database where classifications have been given to links in the current County Midblocks and City Midblocks tables. Specifically, each link in the City Midblocks table and the town road links intersecting Monroe County roads in the County Midblocks table have been classified. Classifications are used to assign an ADT value to each link. The classification and ADT table are built into a Microsoft Access database and queries are available to assign an appropriate ADT value to each link based on its classification. In addition, queries have been developed to calculate accident rates at intersections using the ADT values at the contributing links. This table can then be joined to a node feature class within GIS to investigate accident rates spatially.

With actual traffic counts and estimated ADT values in hand, the MCDOT now has 100% coverage of intersections involving county highways and minor (non-county and non-state) public roads within Monroe County and urban street intersections in the City of Rochester. A graphical representation of traffic volume data available to the MCDOT before and after this project is made in Exhibit 10. A portion of the increased coverage is also graphically illustrated in Exhibit 11.

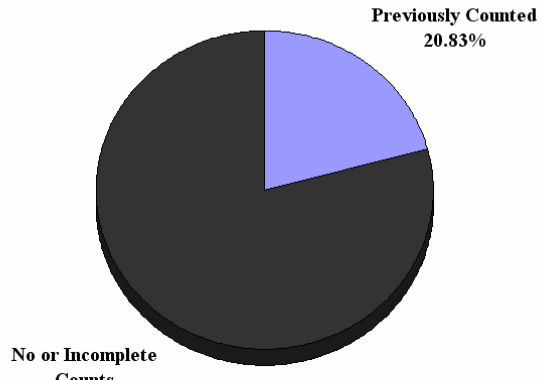
Exhibit 10: Average Daily Traffic Count Availability for Intersections: Before and After



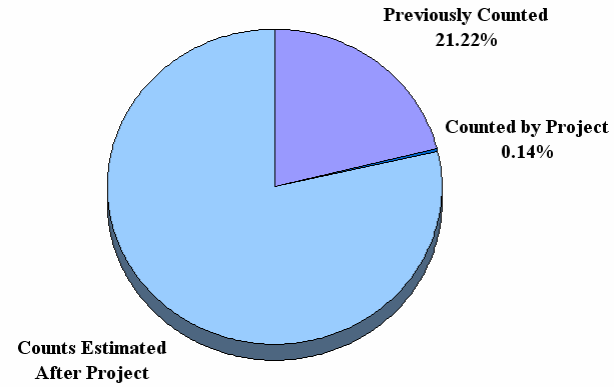
Monroe County Towns
(Before)



Monroe County Towns
(After)

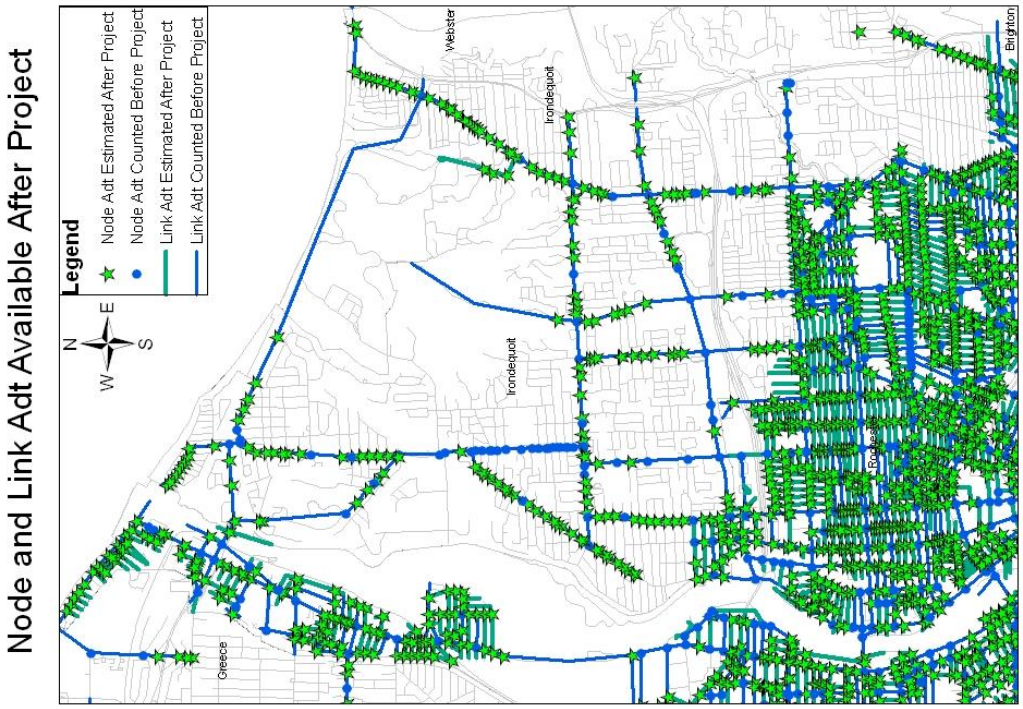


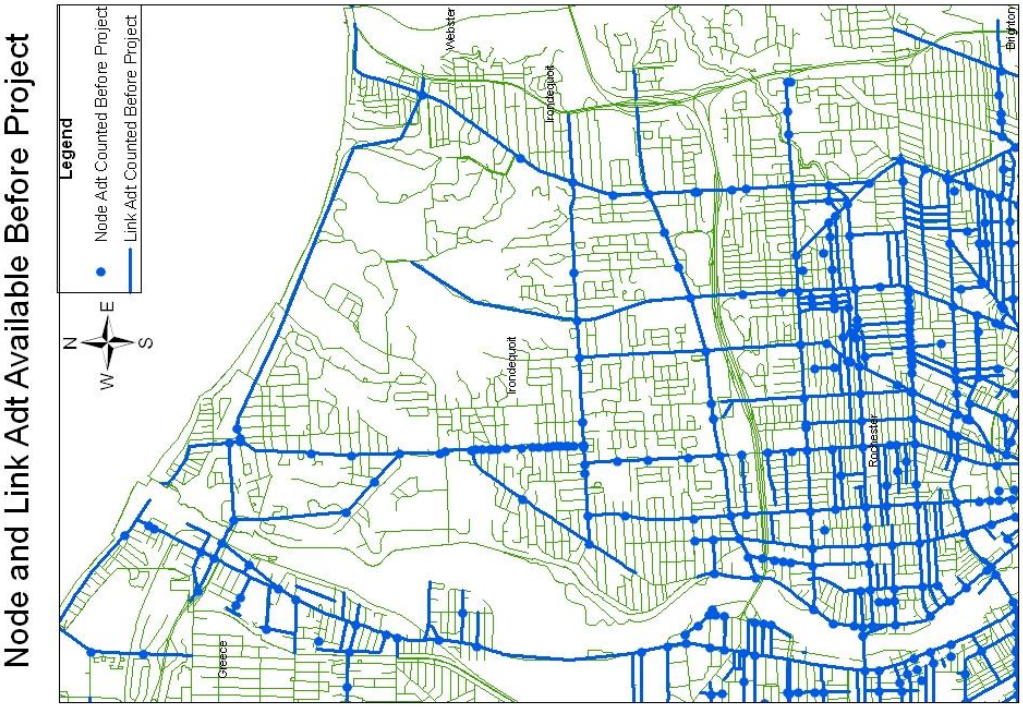
City of Rochester
(Before)



City of Rochester
(After)

Exhibit 11: Average Daily Traffic Counts and Estimates Before and After the Project (Maps)





In addition, a GIS tool was developed which will draw lines between nodes given a point feature class containing a node number attribute and table indicating pairs of node between which lines are to be drawn. The resulting lines can be linked to the City or County Midblocks table to display information present in those tables using GIS. For instance, links can be symbolized by the volume of traffic present on that link. Copies of these products are contained in Appendix H.

5.0 Conclusion

This project has resulted in an enhanced accident database and high crash location identification tool for the MCDOT to utilize and build upon in the future. To support that enhancement, reliable volume estimates were generated for minor (non-county and non-state) public roads where they intersect MCDOT highways throughout the County and for urban street approaches within the City of Rochester. These volume estimates can be updated and refined as additional counts are conducted throughout Monroe County over time.

The GIS tool for drawing lines between nodes opens up these tables for spatial display and analysis within GIS. Link data can be displayed by joining these tables to links created by the tool. For instance, road volume data can now be graphically displayed for the entire county. In addition, queries were written that work with the data in the Midblocks (link) tables. Traffic volumes for each link connected to a node are summed appropriately to calculate the total number of vehicles entering an intersection. Once these intersection traffic estimates have been calculated, intersection accident rates can be derived. These rates can then be linked to node data within GIS and spatially analyzed. This allows for a much richer environment to assist individuals in understanding and presenting accident rate data.

This project and resulting tool will assist the MCDOT in serving the traveling public by identifying and eventually addressing high crash locations throughout Monroe County that might otherwise go undetected. Exhibit 12 illustrates a sample area showing some of the additional High Accident Locations that were identified as a result of this project.

The methodology and tool also offer a defendable rationale for the identification of high crash locations. This will be a useful element when pursuing Federal funding from applicable programs for future accident countermeasure projects.

Exhibit 12: Map Illustrating Previously Known and New High Crash Locations