REGION 4 ATMS
LOCAL EVALUATION REPORT

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PIN 4ITV.08

Prepared for

New York State Department of Transportation

Prepared by

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In association with

Cambridge Systematics
Fisher Associates

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EXECUTIVE SUMMARY

In March, 1996, the *Rochester Areawide Advanced Transportation Management System Report* (6) established the need for an ITS as well as a strategic implementation / deployment plan. This plan has, in part, been implemented through the design and construction of ITS on the following corridors:

- Route 104 – Goodman St to Salt Rd.
- Route 590 – Route 286 (Browncroft Blvd.) to Titus Ave.
- I-490 – I-390 to Goodman St.

In addition, three highway emergency local patrol (HELP) beats were established.

This *Region 4 ATMS Local Evaluation Report* prepared under Task 1 of the project provides an evaluation of the ITS program implemented to date along with a discussion of institutional issues.

This evaluation will be followed by a study to reevaluate the *Rochester Areawide Advanced Transportation Management System Report* in the light of current experience, and to modify the strategic implementation / deployment plan accordingly.

Key results of the study include the following:

	ITS Corridor		
	Route 104	**Route 590**	**I-490**
Delay Prior to ITS (veh hrs per year)	81,500	112,400	399,200
Delay reduced by ITS (veh hrs per year)	19,050	18,540	52,660
% Delay Reduction by ITS	23	16	13
Accidents/yr Prior to ITS	157	124	456
Accidents/yr Reduced by ITS	9	7	27
% Accident Reduction	5.9	5.9	5.9
Benefit to Cost Ratio for ITS	1.5	4.0	6.2

The ITS benefits result from the reduction in non-recurrent delay obtained by improved incident detection, improved incident management and information to motorists, enabling them to avoid congested facilities. These benefits are highest for I-490, the facility with the most delay.

The HELP beats (routes) include considerably more roadway mileage than does the ITS. The annual benefits and cost of the HELP program include a reduction of 147,500 vehicle hours of delay at a benefit to cost ratio of 10.9.

A number of other agencies, including law enforcement and emergency responders, were interviewed to determine their impressions of the effect of ITS on the duration and effectiveness of emergency response operations. Twenty-six percent of the agencies interviewed indicated that the system has generated a major improvement in reducing the number of secondary accidents, reducing the number of fatalities and diverting traffic away from an incident. Reduction in information dissemination time was also rated as being important.

The Region 4 Local Evaluation Report identified the following objectives for the ITS program:

- Reduced fuel consumption
- Reduced user delay
- Improved Safety
- Improved communication between transportation providers

Significant progress has been made towards accomplishing the first three objectives in the corridors implemented with ITS. With the commencement of NYSDOT and MCDOT operations in the RTOC, the last objective has been largely accomplished. By means of shared displays and close personal interaction, communication and coordination between these major transportation providers has been significantly improved.

Other conclusions include the following:

- Benefit-to-cost ratios for the corridors range from 1.5 to 6.2 with an average of 3.5 for the system installed to date. The benefit-to-cost ratios justify the current ITS installations and their extensions to other roadways.

- Because of the high benefit-to-cost ratio already achieved on the I-490 Corridor, benefits might be significantly increased by the increase in the deployment intensity of surveillance devices (leading to improved incident detection and management) for this corridor.

- Communication technology selections are critical in obtaining a high benefit-to-cost ratio.

- The HELP beats were well selected, and show a high value of benefits and a high benefit-to-cost ratio. Expansion of this service may be warranted. Consideration might be given to an additional beat or increase in time coverage for the current beats.

- The wide differences in benefits and benefit to cost ratios among the corridors emphasizes the need to implement future ITS deployments using criteria that maximize the investment payoff.

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1.0 INTRODUCTION

Background

The initial deployments of the Rochester Areawide Advanced Transportation Management System addressed the improvement of mobility and safety in the following three corridors:

- Route 104 – Goodman St. to Salt Rd.
- Route 590 – Route 286 (Browncroft Blvd.) to Titus Ave.
- I-490 – I-390 to Goodman St.

In addition, a highway emergency local patrol (HELP) service was established.

The ITS deployments to date use CCTV, variable message signs (VMS) and highway advisory radio (HAR). These devices, operated from the Rochester Traffic Operations Center (RTOC), provide motorists with information that facilitates avoidance of areas of congestion resulting from traffic incidents. In addition, the ITS operation reduces the level of expressway congestion by reducing the duration of the incident. This is accomplished by detecting and confirming incidents more quickly, and assisting in the coordination of incident responders.

An area wide ITS implementation plan is described in the March 1996 *Rochester Areawide Advanced Transportation Management System Report* (6).

Purpose of Study

This project accomplishes the following:

- Evaluation of the benefits and costs of the current ITS installation and HELP operation, and identification of the path to possible improvements in future ITS installations and operations. This was accomplished during Task 1 of this study, and is the subject of this report.

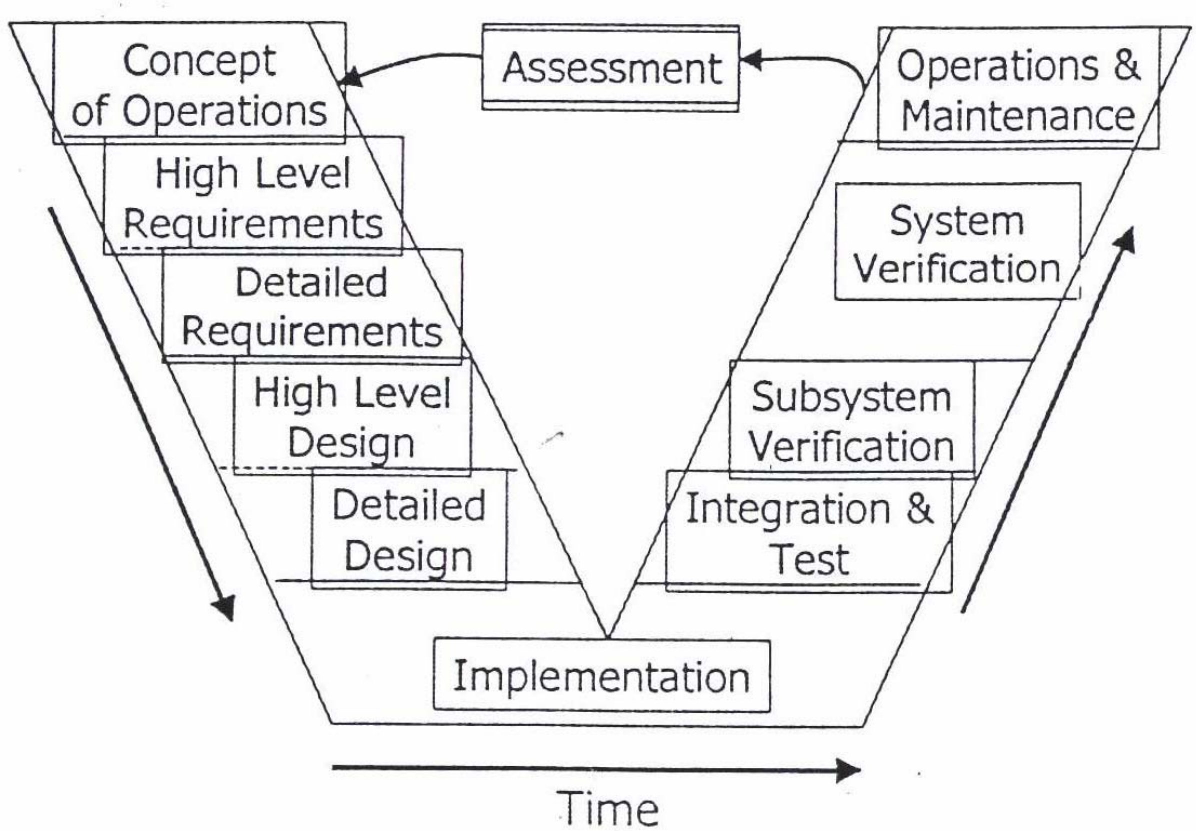
  The evaluation provides the feedback recommended by the FHWA systems engineering life cycle process. This process is illustrated by the "Vee" diagram (Exhibit 1-1).

- The 1996 *Rochester Areawide Advanced Transportation Management System Report* (6) provides a roadmap for guidance for ITS deployments. Task 2 of this project will update that guidance for future ITS projects. This will be based on an updated assessment of ITS needs, and on the lessons learned and documented in this report. Task 2 will update the NYSDOT related component of the Regional ITS Architecture and will provide the implementation plan for future ITS deployments

Summary of Methodologies Used

EXHIBIT 1-1

VEE Representation of the Systems Engineering Life Cycle



The following summarizes the approach used in the study:

- *Collection of Traffic and Accident Data*
  The latest available counts and accident data for the corridors analyzed were collected and structured by sections suitable for further analysis.

- *Accident Analysis*
  The accidents were analyzed according to various characteristics, with emphasis on the higher accident rate locations.
  .

- *Development of Baseline Non-Recurrent Delay Conditions*
  Baseline non-recurrent delay conditions (prior to installation of ITS) were developed by the use of the IDAS model (1) for each of the three corridors. The characteristics of this model are summarized in Appendix D. The IDAS results were corroborated by an incident model developed under this project for Region 4.

- *Estimation of Delay and Accident Reduction by ITS and HELP*
  The IDAS model was used to estimate the reduction of delay resulting from ITS for each of the three corridors, and the reduction of delay resulting from the HELP patrols. Accident reduction estimates for the ITS were based on the conservative use of nationally reported factors.

- *Cost of ITS and HELP Implementation and Benefit vs. Cost Analysis*
  Because the fiber optic cable network installed under the current program was designed to carry additional signals from future ITS installations, these costs were prorated among current and future corridors. Similarly, the VMS and RTOC will be used for both current and future ITS, and similar compensations were made. Monetary values for the delay saved and accidents reduced were developed by the use of NYSDOT factors, and a benefit vs. cost analysis was developed.

- *Stakeholder Evaluation of ITS Service*
  Interviews with law enforcement and incident responders were conducted to determine their perceptions of the improvements made by ITS.

2. 0 TRAFFIC OPERATIONS ANALYSIS

2.1 Volume and Accident Data

Appendix H summarizes the volume and accident data collected under this project for the Task 1 roadways. Hourly data counts were analyzed at two locations in each direction on each of the three roadways. An example of such an hourly count distribution is shown in Exhibit 2-1.

Accident data for the project were collected and analyzed. The accident analysis is described in Section 3.

2.2 Delay

Delay may consist of two components, recurrent delay (demand volume exceeds normal roadway capacity) and non-recurrent delay (delay resulting from a restriction in roadway capacity caused by incidents). Since traffic demand in the Rochester area is generally below roadway capacity, almost all of the delay is non-recurrent delay. Estimation of non-recurrent delay utilized two key tools:

- An incident model to describe the incident distribution characteristics.
- A delay model that uses these characteristics in conjunction with traffic demands to estimate delay.

The incident model is shown in Exhibit 2-2. The basis for the model and the methodology used to compute non-recurrent delay is described in Appendix A. Detailed delay estimates are also provided in that appendix. The model was further validated by observations made under this project. These are described in Appendix B. A summary of the pre-ITS delay in the corridors studied is shown in the table below.

Roadway	Annual Vehicle Delay (hours)
Route 104 – Goodman St to Salt Rd.	81,500
Route 590 – Route 286 (Browncroft Blvd.) to Titus Ave.	112,400
I-490 – I-390 to Goodman St.	399,200

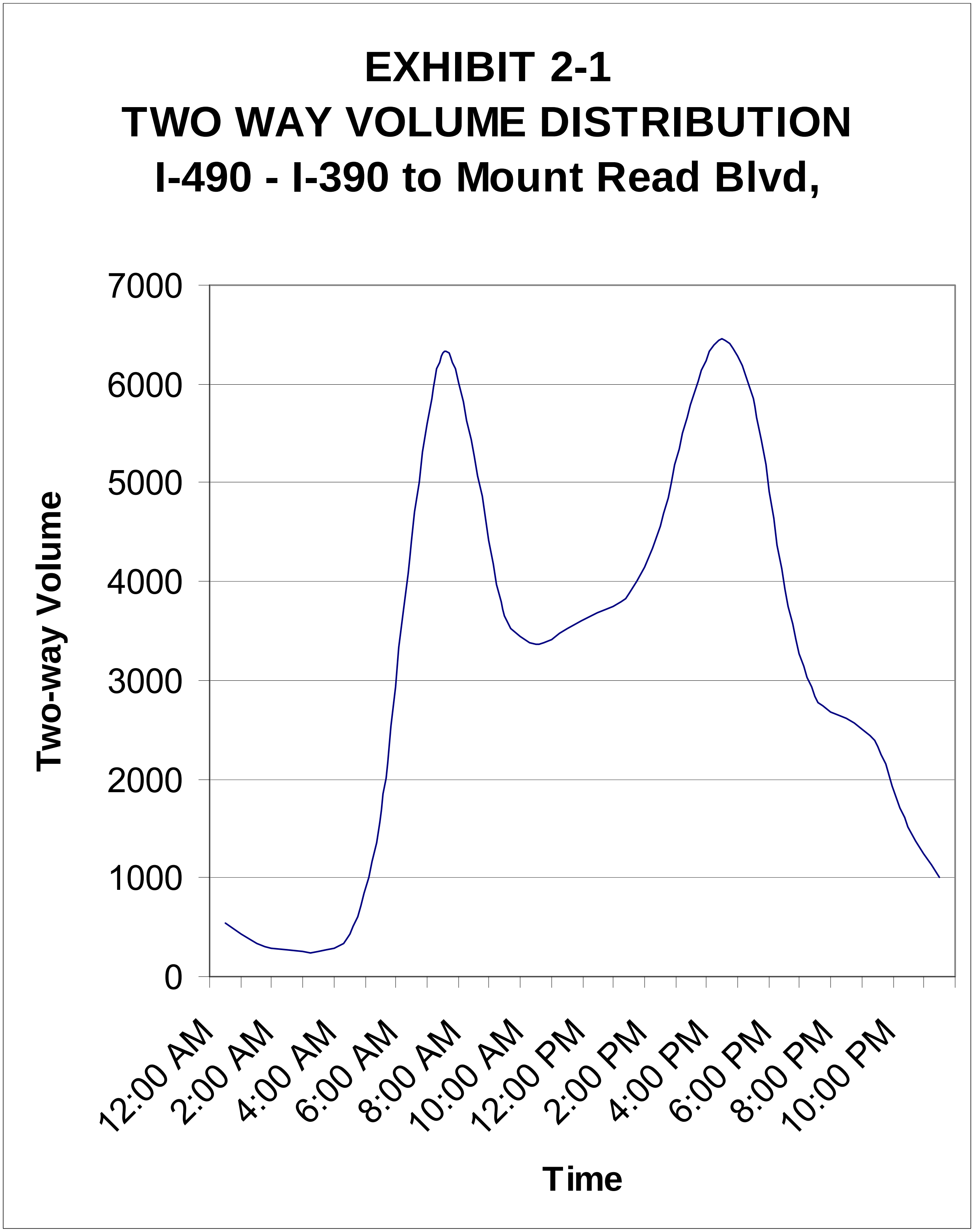
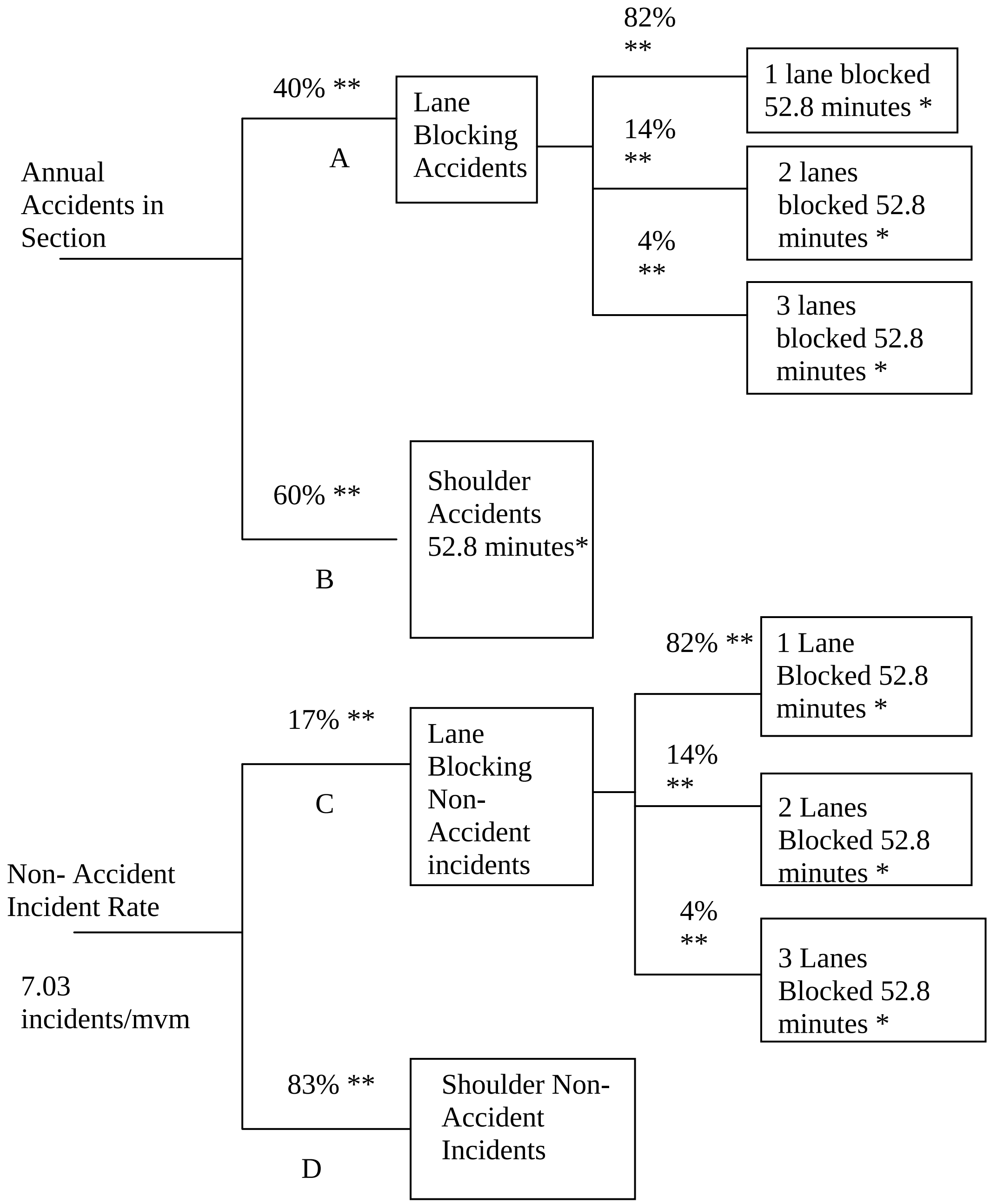


EXHIBIT 2-1
TWO WAY VOLUME DISTRIBUTION
I-490 - I-390 to Mount Read Blvd,
7000
6000
5000
4000
3000
2000
1000
0
Two-way Volume
12:00 AM
2:00 AM
4:00 AM
6:00 AM
8:00 AM
10:00 AM
12:00 PM
2:00 PM
4:00 PM
6:00 PM
8:00 PM
10:00 PM
Time

EXHIBIT 2-2
REGION 4 INCIDENT MODEL



* Derived from Exhibit A-1 data
** Derived from Region 1 data

3.0 ACCIDENT ANALYSIS

An accident analysis was performed for the following expressways as part of New York State Department of Transportation's (NYSDOT) Rochester Intelligent Transportation System (ITS) Evaluation and Integration Planning Study:

- NYS Route 104 – Goodman Street to Salt Road
- NYS Route 590 – Browncroft Boulevard to Ridge Road
- NYS Route 490 – NYS Route 390 to Goodman Street

The NYSDOT Safety Information Management System (SIMS) summary sheets were obtained for each expressway. The accident data were analyzed by accident rate, severity, and wet road percentages. The analysis results are provided in Appendix C. The fixed object percentages and light conditions information were also available within the SIMS summary sheets and are described in Appendix C.

A summary of the accident data obtained from March 1, 2000 to Feb 28, 2002 is provided below.

	NYS Route 104 Goodman St. Interchange to Salt Rd. Interchange	NYS Route 590 Browncroft Blvd. Interchange to Ridge Rd. Interchange	I-490 Route 390 Interchange to Goodman St. Interchange
Total Accidents	465	273	840
Length (mi.)	10.2	3.7	5.4
Accident Rate (Accidents per mvm)	0.96	1.94	1.95
Statewide Accident Rate	1.94	1.94	1.94

The following expressway links had accident rates higher than the statewide average rate for a similar facility type:

Route	Link	Accident Rate (acc/mvm)	Statewide Average Rate (acc/mvm)
NYS Route 104	Goodman Street Interchange	2.68	2.26
Interstate 490	Inner Loop Area	2.50	1.94
NYS Route 590	Ridge Road Interchange	1.60	1.47

Contributing factors to the above average accident rates include:

- Goodman Street Interchange – A merge / diverge area between a crest vertical on Route 104 over Goodman Street and a sag vertical curve under Portland Avenue.
- Inner Loop Area – Heavy congestion with several on-off ramps and a merge / diverge with the Inner Loop.
- Ridge Road Interchange – A transition area between the grade separated and at grade roadways and a crest vertical curve over Ridge Road.

Only three links along Route 104 experience accident severities over the statewide averages (Bay Road Interchange, Bay Road to Five Mile Line Road, and the Salt Road Interchange). These links all had relatively low total numbers of accidents (32, 12, and 8, respectively); therefore, the severities may not indicate problems along the links. All other links on Route 104, Route 590, and Route 490 had accident severities less than the statewide averages.

The Goodman Street Interchange with Route 104, entire length of Route 490, and Empire Boulevard Interchange with Route 590 all had Wet Road accident rates higher than the statewide averages. The wet road accidents at the Goodman Street interchange and Browncroft Boulevard interchanges typically occurred at the merge / diverge areas where drivers are more likely to lose control in wet road situations. The use of devices such as radar controlled speed warning signs might be considered. Route 490 is heavily congested with drivers accelerating / decelerating, changing lanes, and merging / diverging with surrounding traffic where drivers, again, are more likely to lose control in wet road situations.

Consideration of ITS components is recommended at the areas with above average accident rates and severities to enhance driver awareness in these areas, reduce incident detection, response, and clean up times, and improve the safety of the environment for the emergency responders. The ITS components will likely provide cost-effective solutions rather than using the traditional costly physical modifications, typically used to improve the safety along expressways.

4.0 BENEFITS AND COSTS FOR EXISTING ITS

4.1 Summary of Results

The key annual benefits and costs for the ITS corridors are as follows:

	ITS CORRIDORS			TOTAL
	Route 104	Route 590	I-490	
Vehicle hours saved	19,050	18,540	52,660	90,250
Fuel saved (gallons)	29,600	28,600	81,600	139,800
Accidents reduced	9	7	27	43
Monetary value of benefits ($K)	965	845	2779	4588
Cost ($K)	647	212.5	448.5	1308
Benefit-to-cost ratio	1.5	4.0	6.2	3.5

The ITS benefits result from the reduction in non-recurrent delay obtained by improved incident detection, improved incident management and information to motorists enabling them to avoid congested facilities. These benefits are highest for I-490, the facility with the most delay.

The table below summarizes the annual benefits and cost of the HELP program.

Vehicle hours saved	147,500
Fuel saved (gallons)	229,200
Monetary value of benefits ($K)	3,753
Cost ($K)	345
Benefit-to-cost ratio	10.9

4.2 Benefit Estimation for Savings in Non-recurrent Delay for Existing ITS

This section discusses the benefits of the ITS installations on three corridors. These benefits do not include the recently instituted HELP program. HELP benefits are covered in Section 5.

The ITS Deployment Analysis System (IDAS) developed by FHWA (1) was used to evaluate the ITS currently deployed on the Route 104, Route 590 and I-490 corridors.

IDAS uses a transportation planning model to generate volumes, capacities, etc. on the roadway links directly included in the analysis as well as links in the region that might be used to service expressway traffic affected by ITS related traffic diversions engendered by incidents. The traffic model used for this project was provided by the Genesee Transportation Council. A discussion of the IDAS modeling approach is provided in Appendix D.

The IDAS model was first used to establish a baseline condition for vehicle miles traveled and for delay prior to the implementation of ITS. These values were then compared with the values estimated earlier (Section 2) by an entirely different process (Appendix A). These comparisons are shown in Exhibits 4-1 and 4-2. These comparisons show an overall difference of 10.7% in vehicle miles traveled and 4.7% in delay. Thus they are sufficiently close to provide a high level of confidence in the IDAS baseline.

The principal mechanisms for delay reduction with ITS are:

- Reduction in incident clearance time resulting from more rapid incident detection and improved management of the incident clearance process.

- Reduction in delay resulting from diversion by the use of variable message signs (VMS) and highway advisory radio (HAR).

Improvement is limited to the period of time that the RTOC is staffed (weekdays from 6 AM to 7 PM). This is approximately 38.5% of the time during which approximately 58.6% of the vehicle miles are traveled. The analysis includes this factor.

The analysis results are dependent on the improvement factors assigned for the ITS processes. The key factors used for this analysis are conservative estimates of the impact values based on results reported by other agencies and compiled in the FHWA database.

Appendix D provides further discussion of these factors as well as the results of the IDAS Analysis.

EXHIBIT 4-1
ANNUAL BASELINE VMT BY ROADWAY SEGMENT
COMPARISON OF IDAS AND SECTION 2 RESULTS

	Route 104 Goodman St. to Salt Rd.	Rt. 590 - Route 286 (Browncroft Blvd) to Titus Ave.	I-490 - I-390 to Goodman St.
IDAS Results			
VMT			
(AM period)	47,565	22,127	43,487
(PM period)	55,605	26,505	49,249
(Both periods)	103,170	48,632	92,736
Daily/Peak Factor (Reference 2, Table 7))	6.04	5.89	5.97
Estimated Daily VMT	623,147	286,442	553,634
Annual Factor	365	365	365
Estimated Annual VMT (IDAS)	227,449,000	104,552,000	202,076,000
Section 2 Calculation	187,460,000	98,870,000	195,810,000
Difference in Estimates	21.3%	5.7%	3.2%

EXHIBIT 4-2
ANNUAL HOURS OF BASELINE DELAY BY ROADWAY SEGMENT
COMPARISON OF IDAS AND SECTION 2 RESULTS

	Route 104 Goodman St. to Salt Rd.	Rt. 590 - Route 286 (Browncroft Blvd) to Titus Ave.	I-490 - I-390 to Goodman St.
IDAS Results			
(AM period)	11.91	24.84	74.27
(PM period)	26.22	45.26	102.67
(Both periods)	38.13	70.10	176.94
Daily/Peak Factor (Reference 2, Table 7)	6.04	5.89	5.97
Estimated Daily Hours of Delay	230	413	1,056
Annual Factor	365	365	365
Estimated Annual Delay (IDAS)	84,061	150,704	385,561
Delay estimated in Section 2	81,500	112,400	399,200
Difference	-3.0%	-25.4%	3.5%

4.3 Reduction in Accidents for Current ITS Programs

ITS reduces the accident rate in the following ways:

- By reducing the incident clearance time, the time that the motorist is exposed to the possibility of becoming a secondary accident is reduced.

- Motorists who divert as a result of information provided by the ITS are not exposed to the incident related queues and therefore do not become candidates for secondary accidents.

The benefits reported in the literature vary considerably from location to location. This analysis assumes an improvement of 10% during the period that the RTOC is in operation, or 5.9% of the corridor accidents. The 10% value assumed for accident improvement falls on the conservative portion of the distribution of results reported in the literature. A summary of the reported safety results for systems similar to those installed in Rochester is provided in Appendix E. The benefits by corridor are shown in Exhibit 4-3.

EXHIBIT 4-3
ACCIDENT REDUCTION BENEFITS OF ITS (ACCIDENTS/YEAR)

	Route 104	Route 590	I-490
Annual Accidents	157	124	456
Annual Accidents Reduced by ITS	9	7	27

4.4 Cost Analysis for Existing ITS Corridors

This section describes the cost assessment for the three operational traffic corridors. While two major construction contracts have, to date, implemented these three corridors, certain aspects of the design and operations were implemented with the concept of region wide ITS operation. In particular, sections of the fiber optics communications network will not only serve two of the currently implemented corridors, but these sections will also provide data paths for future signals. Similarly, VMS on Route 390 and I-390 will serve future as well as current ITS deployments. Current system capital and operating costs are therefore somewhat higher than would otherwise be needed to implement only these corridors.

The table below provides a summary of the costs attributable to the three currently operational ITS corridors.

Annualized Costs for Current ITS Corridors ($K)

	Route 104 Corridor	Route 590 Corridor	I-490 Corridor	Total
Capital Cost	424.2	129.1	322.6	875.9
Operations Cost	84.9	42.0	47.8	174.7
Maintenance Cost	137.9	41.4	78	257.3
Total	647.0	212.5	448.5	1308

The detailed estimates, along with the cost calculation methodology are described in Appendix F.

4.5 Comparison of Benefits with Costs

4.5.1 Basis for Monetary Benefits

The ITS benefits developed in Sections 4.2 and 4.3 include the following:

- Reduction in vehicle delay
- Reduction in accidents
- Reduction in fuel consumption
- Reduction in emissions

The first three of these benefits may be directly converted to monetary benefits. The procedure for doing this is described below.

<u>Reduction in Vehicle Delay</u>

The value of vehicle delay hours is generally based on Reference 4.
There are three components contributing to benefits

- Value of non-commercial traveler time

  In Reference 4 the value of non-commercial traveler time in congestion is $13.58 per hour in 1996 dollars. Adjusting this value to current dollars by means of the Bureau of Labor Statistics Consumer Price Index provides $16.88 per traveler hour. With 1.15 travelers per vehicle, this equates to $19.41 per vehicle hour.

- Value of truck driver's time

  A truck driver's salary of $21 per hour in 1999 dollars equates to $23.97 per current vehicle hour (one person assumed per truck).

- Inventory value of commercial vehicle load

  This is given in Reference 4 as $39 per vehicle hour in 1999 dollars and is $44.45 per vehicle hour in current dollars.

A truck fraction of 6% was assumed for the project roadways.

<u>Reduction in Accidents</u>

The 1999 value for an accident is $46,700 (5). This is $53,300 in current dollars.

<u>Reduction in Fuel Consumption</u>

Reference 4 provides the following expression for the value of fuel saved per vehicle hour of delay.

$1.45 x 0.9 x current fuel price.

The factor 0.9 is used to deemphasize fuel price volatility.

Using $2.00 per gallon as the current fuel price, the value of fuel per vehicle hour of delay is $2.61.

4.5.2 Benefit vs. Cost Analysis

Monetary equivalents of the corridor benefits estimated in Sections 4.2 and 4.3 were developed using the monetary benefit values provided in Section 4.5.1. The results of this analysis are provided in Exhibit 4-4.

The wide disparity in the benefit to cost ratio among corridors is attributable to:

- The higher value for baseline delay on I-490 as compared with Route 104 (Section 2.2). Route 590 provides an intermediate value. The opportunity for benefits is much greater on I-490 and ITS measures have a greater benefit for this corridor.

- The high annual cost for Route 104 is largely attributable to the relatively high fiber optics cable system cost attributed to Route 104 (Appendix F).

- The higher accident rate on I-490 is reflected in the greater number of accidents on this corridor (Appendix H, Exhibit H-1). ITS measures for accident improvement therefore have a greater benefit.

EXHIBIT 4-4

ANNUAL BENEFITS AND COST

Benefit (Characteristic Reduced by ITS)	Unit Value of Benefit	Route 104		Route 590		I-490		All Corridors	
		Quantity	Dollar Value ($K)	Quantity	Dollar Value ($K)	Quantity	Dollar Value ($K)	Quantity	Dollar Value ($K)
Delay to Passenger Car Travelers (vehicle hours)	$19.41 (1.15 persons/veh)	17910	348	17430	338	49500	961	84840	1647
Delay to Truck Drivers (vehicle hours)	23.97	1140	27	1110	27	3160	76	5410	130
Goods Inventory Delay (vehicle hours)	44.45	1140	51	1110	49	3160	140	5410	240
Fuel (gallons)	$2.00	29600	59	28600	57	81600	163	139800	280
Accidents	$53,300	9	480	7	373	27	1439	43	2292
Total Annual Benefit ($K)			965		845		2779		4588
Annual Cost ($K)			647		212.5		448.5		1308
Benefit to Cost Ratio			1.5		4.0		6.2		3.5

4.6 Highway Emergency Local Patrol (HELP)

HELP (motorist aid service) was initiated in the spring of 2004 on the three beats (routes) shown in Exhibit 4-5. Hours of operation are weekdays 6 AM to 10AM and 3 PM to 7 PM.

The delay reduction provided by HELP was estimated by IDAS and is shown in Exhibit 4-6. Fuel and emissions benefit estimates are based on this delay.

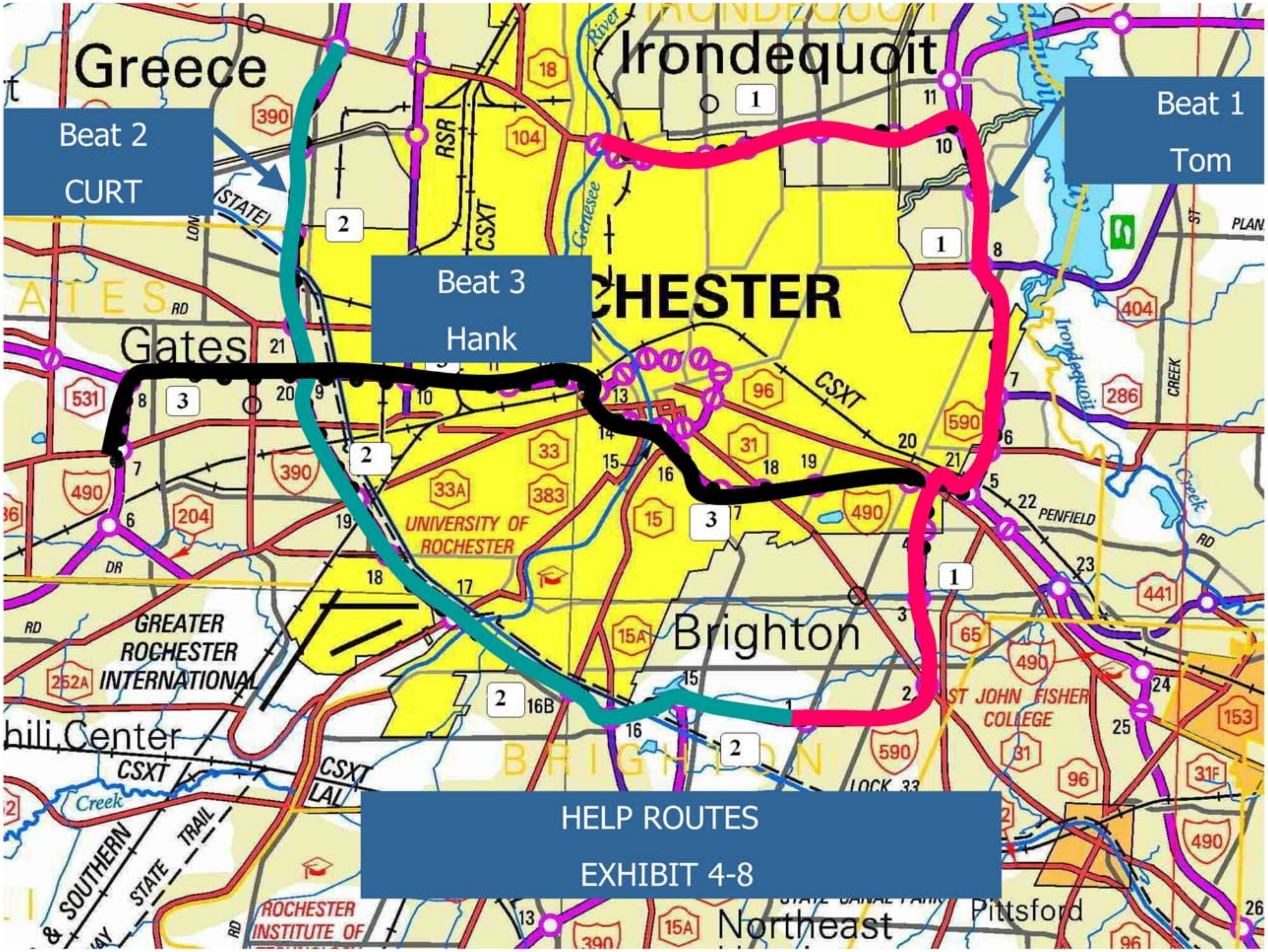
EXHIBIT 4-6
ANNUAL VEHICLE TIME SAVED, FUEL SAVED AND EMISSIONS REDUCED BY HELP

Vehicle hours reduced	138,700 Passenger cars 8,800 Trucks
Fuel saved (gallons)	229,200
Hydrocarbons, ROG Tons Reduced	7.3
Oxides of Nitrogen Tons Reduced	4.1
Carbon Monoxide Tons Reduced	61.7

The monetary benefits of these savings are provided in Exhibit 4-8. Because the literature does not provide significant guidance on the reduction in secondary accidents due to HELP, benefits for this reduction were not estimated.

EXHIBIT 4-7
HELP BENEFIT VS. COST ANALYSIS

		HELP Benefit	
Benefit	**Unit Value of Benefit**	**Quantity**	**Dollar Value ($K)**
Delay to Passenger Car Travelers (vehicle hours)	$19.41 (1.15 persons / veh)	138700	2692
Delay to Truck Drivers (vehicle hours)	23.97	8800	211
Goods Inventory Delay (vehicle hours)	44.45	8800	391
Fuel (gallons)	$2.00	229200	458
Total Annual Benefit ($K)			3753
Annual Cost ($K)			345
Benefit to Cost Ratio			10.9


Beat 2
CURT
Beat 3
Hank
Beat 1
Tom
HELP ROUTES
EXHIBIT 4-8
Greece
Irondequoit
Gates
Brighton
Northeast
Pittsford
GREATER ROCHESTER INTERNATIONAL
UNIVERSITY OF ROCHESTER
ST JOHN FISHER COLLEGE
ROCHESTER INSTITUTE OF

5.0 CONSULTATION WITH OTHER AGENCIES

This task involved interviewing the various incident management responders about their policies, procedures, and responsibilities regarding incident management. The consultant team also inquired about how the ITS has impacted incident management. Twenty interviews were conducted and the results are summarized in Appendix G. As multiple organizations (local law enforcement, transportation and other agencies) provide incident management services, each plays a distinct role and therefore relates differently to the capabilities of the NYSDOT Region 4 ITS program.

A discussion guide was developed for the interviews, which were conducted either in person or via telephone. The guide provided a brief description of this project and the purpose of the interview. Questions focused on familiarity with the ITS program, incident management practices, data sharing activities, effectiveness of the ITS, and general comments / feedback.

In general, each of the state and county agencies (NYSP, Sheriff's Office, OEP, Metro Networks, 911 Center, Monroe Ambulance, Fire Bureau, and MC DOT) offered unique perspectives. Local agencies on the other hand, had similar perspectives. As local departments have comparable roles and responsibilities when responding to incidents on the expressways, their responses have been compiled into three groups for police, fire, and ambulance. The Genesee Transportation Council (GTC) provides the essential support and funding of incident management and ITS projects in the metropolitan area; however they are not directly involved with everyday incident management practices.

Although the survey participants were unable to provide quantitative information on incident detection and verification times, response times or clearance times, more than half of the interviewees felt comfortable providing qualitative information on the effectiveness of the NYSDOT Region 4 ITS.

Choosing from "major improvement," "minor improvement," "no improvement," and "don't know," participants rated the system's success in reducing the number of accidents and fatalities, as well as its impact on detection, verification, response and clearance times. Twenty-six percent of respondents indicated the system has generated a major improvement in "reducing the number of secondary accidents," "reducing the number of fatalities," and "diverting traffic away from an incident." "Reduction in information dissemination time" was also highly ranked.

Quantifying benefits is a difficult task for any new system. Although interviewees were unable to provide exact statistics, their responses provided an in-depth understanding of the incident management process in the region and the role the ITS plays relative to each participant. Overall, the responses were positive. Participants agree that the ITS has great potential to benefit their incident management operations. They feel it will become increasingly effective as it becomes expanded and more widely used. They also agree that the system successfully diverts traffic, thereby freeing up roadway space to reduce response and clearance times. Faster incident clearance times reduce congestion around an incident and decrease the risk of secondary accidents.

6.0 CONCLUSIONS

The ITS elements installed to date, along with the RTOC operations have made significant strides in the accomplishment of the program objectives stated in Section I C of Reference 6. These objectives are:

- Reduced fuel consumption
- Reduced user delay
- Improved safety
- Improved communication between transportation providers

The progress towards accomplishing the first three objectives in the corridors implemented with ITS is shown in Section 4.1. With the commencement of NYSDOT and MCDOT operations in the RTOC, the last objective has been largely accomplished. By means of shared displays and close personal interaction, communication and coordination between these major transportation providers has been significantly improved.

Other conclusions include the following:

- Benefit-to-cost ratios for the corridors range from 1.5 to 6.2 with an average of 3.5 for the system installed to date. The benefit-to-cost ratios justify the current ITS installations and their extensions to other roadways.

- The wide disparity in benefit-to-cost ratios is attributable to the higher per mile values of delay (prior to ITS) and higher accident rate in the I-490 Corridor, with intermediate values on the Route 590 Corridor and lower values on the Route 104 corridor. Higher communications equipment costs contribute to the lower benefit-to-cost ratio on Route 104.

- Because of the high benefit-to-cost ratio already achieved on the I-490 Corridor, benefits might be significantly increased by the increase in the deployment intensity of surveillance devices (leading to improved incident detection and management) for this corridor.

- Communication technology selections are critical in obtaining a high benefit-to-cost ratio.

- The HELP beats were well selected and show a high value of benefits, and a high benefit-to-cost ratio. Expansion of this service may be warranted. Consideration might be given to an additional beat or increase in time coverage for the current beats.

- The wide differences in benefits and benefit to cost ratios among the corridors (Section 4.1) emphasize the need to implement future ITS deployments using criteria that maximize the investment payoff. The Task 2 studies can accomplish this by:

  - Recommending ITS field equipment deployment intensities that are scaled to the traffic conditions on the particular expressway. Appendix 6 of the NYSDOT Project Development Manual (3) provides guidelines for establishing levels of deployment based on traffic conditions. The appendix also provides application factors for estimating the quantity of field equipment.

  - Focusing the need for further expansion of the fiber optics cable communication system on those expressways that will be implemented with a relatively high density level of ITS field devices.

  - Coordinating closely with MCDOT in the development of recommendations for ITS equipment deployment and operations.

  - Coordinating with the other stakeholders in order to maximize the mobility of information transfer and to optimize the use of this information.

REFERENCES

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2. Rochester ITS Evaluation and Integration Planning, Monroe County, Technical Memorandum, "Highway Traffic Operations Analysis (Task 1.5)", Dunn Engineering Associates, P.C., June 2004.

3. "Project Development Manual", Appendix 6, Design Quality Assurance Bureau, New York State Department of Transportation.

4. "Total Cost per Hour of Delay", internal NYSDOT memo, October 19, 2000.

5. "Average Accident Costs / Severity Distribution State Highways", NYSDOT Safety Information Management System, http://www.dot.state.ny.us/traffic/files/sevedist.pdf

6. "Rochester Advanced Transportation Management System", HNTB et al, March 1996.

7. "An Overview of Systems Engineering – Participating Workbook", NHI Course 137024, Publication FHWA NHI-01-046, Federal Highway Administration, 2001.

8. Rochester ITS Evaluation and Integration Planning, Monroe County, Technical Memorandum, "Highway Accident Analysis (Task 1.4)", Dunn Engineering Associates, P.C., May, 2004.

9. "Traffic Incident Management Handbook", PB Farradyne, November 2000.

APPENDIX A
COMPUTATION OF NON-RECURRENT DELAY

1.0 Incident Model

The purpose of an incident model is to provide context for the duration and frequency of various types of incidents. This information will be used in connection with a queuing model in Section 4 to provide estimates of delay.

Region 4 incident data is in the form of a log that documents major incidents (Levels 4 and 5). Attachment 1 to this appendix shows this log. The average duration of a major incident is 154 minutes.

Because the incident log does not document all lane blocking incidents, the MIST data from Region 1 (which was believed to be a reasonable surrogate) was analyzed for:

- Incident rate
- Lane distribution of incidents.
- Incident duration.

Region 1 MIST incident data from July 7, 2000 through July 15, 2000 was analyzed for the following roadway sections:

- I-90 from I-787 to I-87.
- I-87 from I-90 to the Saratoga County line.
- I-787 from NY 32 to NY 7.

A comparison of the Region 4 roadways and the Region 1 roadways for which surrogate data was developed is shown below.

Roadway	Approximate AADT Range for Comparison	Interchanges/mile
Region 4		
I-490 (I-390 to Goodman St.)	78000-92000	1.0
NY 590 (NY 286 to NY 104	74000 - 93000	1.0
NY 104 (Culver Rd. to 5 Mile Line Rd – six lane section)	49000-63000	0.6
Region 1		
I-90 (I-787 to I-87)	71000-116000	1.2
I- 87 (I-90 to the Saratoga County line.)	61000-117000	0.9
I-787 (NY 32 to NY 7).	41000-86000	0.7

A summary of Region 1 incident distribution data is as follows:

All incidents analyzed – 233 (100%)

- Total Accidents – 70
    - In lane accidents – 28 (12% of all incidents, 40% of accidents)
    - Shoulder accidents – 42 (18% of all incidents, 60% of accidents)
- In-lane non-accident incidents – 28 (12% of all incidents, 17% of non-
- accident incidents).
- Shoulder non-accident incidents – 135 (58% of all incidents, 83% of non-
- accident incidents).

The distribution of lane blocking accidents and other lane blocking incidents is given below:

	Accidents	Other Incidents
One Lane Blocked	82%	82%
Two Lanes Blocked	14%	14%
Three Lanes Blocked	4%	4%

To obtain an estimate of the non-accident incident frequency, the MIST data for incidents on I-90 between the NYS Thruway and I-787 was analyzed for an eighteen- day period. Forty-five non-accident incidents were reported during this period. The data was adjusted for the loss of reports due to the control center not being staffed on a 24/7 basis (assumed as 25% loss) and the loss due to incomplete CCTV coverage (assumed as 25% loss). The number of non-accident incidents was therefore estimated as

$$\frac{45}{(.75)*(.75)} = 80$$

Using this figure the mainline non-accident incident rate was estimated as 7.03 per million vehicle miles.

The Region 1 data was analyzed for incident duration. The average duration of shoulder incidents is 140 minutes.

The average duration of all shoulder non-accident incidents was reported as 249 minutes. This figure is, however, strongly influenced by a small number of vehicles left on the shoulder for very long periods. Because Region 1 data was examined for use as a surrogate for Region 4, it was considered prudent to take a conservative approach to avoid overestimation of benefits. Thus eight of the longest shoulder incidents (over fourteen hours) were removed from the 135 incidents analyzed. This resulted in the reduction of the average incident duration to 205 minutes.

The reported incident durations in Region 1 do not appear to be consistent with those reported in the literature in other locations. Exhibit A-1 provides an overview of representative data from other locations on incident duration. In many cases, the data in

Exhibit A-1 was obtained with the ITS already in place. To normalize this to a pre-ITS condition, five minutes (representing an estimate of time saved by ITS from incident inception to clearance weighted by frequency and type of incident) was added to the data at locations where the ITS was in place.

The average incident duration in the table prior to ITS is 52.8 minutes. Reference E in Exhibit A-1 is particularly interesting as it provides a linkage between severe incidents (corresponding to the Region 4 Level 4 and 5 incidents) and the average of all incidents. The severe incidents in Reference E are generally comparable to the Region 4 Levels 4 and 5 incidents shown above, thus it appears to be reasonable to assume that the average incident duration in the table (52.8 minutes) can be used to represent the average Region 4 incident.

Exhibit A-2 depicts an incident model that assembles and organizes the data described in this section

2.0 Computation of Non-Recurrent Delay

The following steps are involved in the computation of non-recurrent delay

a. Definition of model to compute delay per incident.

b. Development of delay for average lane blocking incident as a function of number of lanes blocked.

c. Development of delay for average shoulder accident.

d. Computation of annual delay.

2.1 Model to Compute Delay Per Incident

This model uses standard queuing theory. It is described in Exhibit A-3. The area bounded by the triangle formed by the volumes S1, S2 and S3 represents the delay and is provided by the last five equations in the exhibit.

EXHIBIT A-1
REVIEW OF KEY DATA ON INCIDENT DURATION

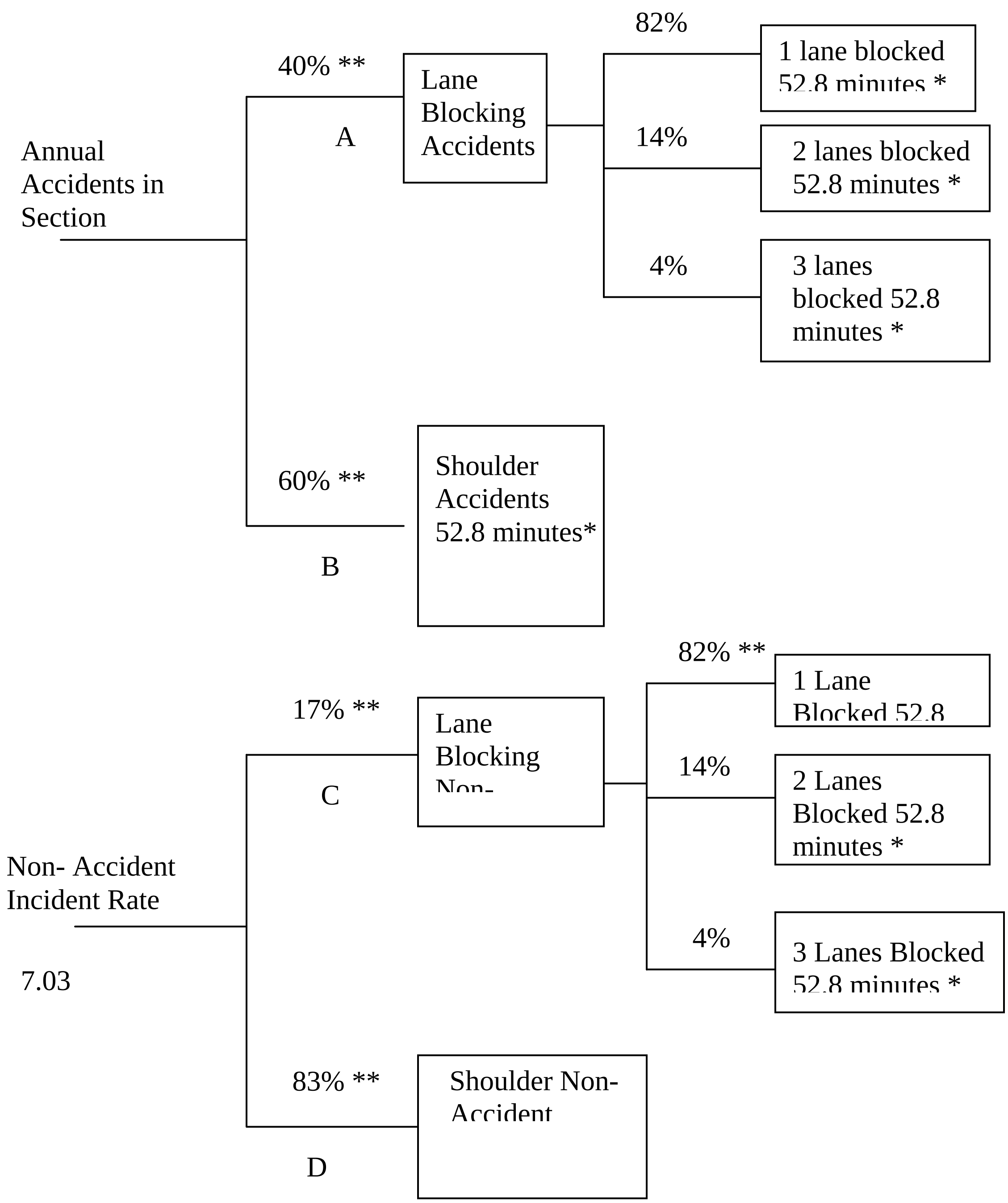
LOCATION	AVERAGE INCIDENT DURATION AFTER ITS (MIN)	AVERAGE INCIDENT DURATION BEFORE ITS (MIN)	REFERENCE	REMARKS
Inform	44.6 D	49.6 C	A	Analysis of 223 incidents on Long Island Expressway, Northern State Parkway, Southern State Parkway, Grand Central Parkway.
Chicago area	40.3 D	45.3 C	B	Data edited to remove traffic stops from data base.
Atlanta area	41 D	64 D	C	
Hayward CA (San Francisco area)	40 D	45 C	D	
Seattle area	55 D	60 C	E	Data in columns 2 and 3 shows average incident duration. Duration of severe incidents was 173.5 minutes in 1994 and 152.9 minutes in 1995.
AVERAGE		52.8		

C – Computed by adding 5 minutes to “After ITS” data
D – Data from reference

References

A. Analysis of Inform incident data.
B. Raub, R. Schofer, J.L., “Managing Incidents on Urban Arterial Roadways”, Transportation Research Record 1603, Washington, DC 1997.
C. Presley, M.W., Wyrosdick, K.G., Sulbaran, T.A., “Calculating Benefits for NAVIGATOR, Georgia ITS”, Presented at the 79th Annual Meeting of the Transportation Research Board, Washington, D.C. January 2000.
D. Prevedouros, P.D., Kasamoto, K.D., “Incident Management Simulation on a Two Freeway Corridor in Honolulu”, (Web search).
E. Carson, L. J., Legg, B., Mannering, F.L., Nam, D., Nee, J. “Are Incident Management Programs Effective? Findings From Washington State”, Presented at the 79th Annual Meeting of the Transportation Research Board, Washington, D.C. January 1999.

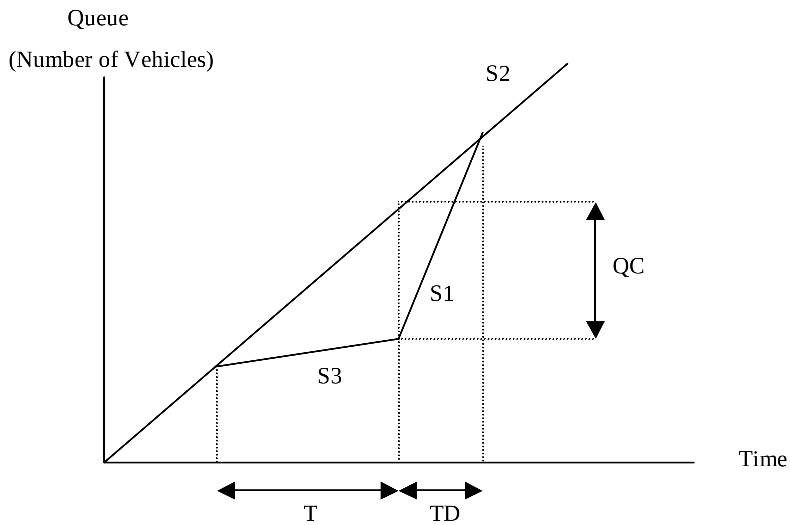
EXHIBIT A-2
REGION 4 INCIDENT MODEL



* Derived from Exhibit A-1 data
** Derived from Region 1 data

EXHIBIT A-3

DELAY TIME FOR INCIDENT



S1 –Volume at incident clearance (roadway capacity)

S2 –Volume entering incident location (demand volume)

S3 – Volume when incident is present (incident capacity)

T – Time from start of incident

TD – Time to dissipate queue after incident clearance

QC –Number of vehicles in queue at incident clearance time

DC – Delay up to incident clearance

DQC – Delay from incident clearance to queue dissipation

DELAY – Total Delay

$DC = (S2\text{-}S3)*T*T/2 = (S2\text{-}S3*T^2/2$

$QC = (S2\text{-}S3)*T$

$TD = QC/(S1\text{-}S2) = (S2\text{-}S3)*T/(S1\text{-}S2)$

$DQC = QC*TD/2 = (S2\text{-}S3)*T*(S2\text{-}S3)*T/(2*(S1\text{-}S2)) = (S2\text{-}S3)^2T^2/(2*(S1\text{-}S2))$

$DELAY = DC + DQC$

The following table (9) provides the incident capacities (S3) used in the delay calculation.

Percentage of Freeway Capacity Available Under Incident Conditions

Number of Freeway Lanes in Each Direction	Shoulder Disablement	Shoulder Accident	*Lanes Blocked*		
			One	Two	Three
2	0.95	0.81	0.35	0.00	N/A
3	0.99	0.83	0.49	0.17	0.00

2.2 Development of Delay for Average Lane Blocking Incident

Because incidents may occur at any time during the day, demand volume (S2 in Exhibit A-3) will vary. In order to estimate the volume of traffic at each volume to capacity level, the representative hourly traffic volumes were classified into "cohorts" designed to capture the effect of the various lane blockage scenarios. The cohorts are identified as follows:

Cohort Number	V/C Range in Cohort	*Representative V/C Used in Analysis*
1	V/C > .7	.8
2	.49 < V/C < .7	.6
3	.17 < V/C < .49	.33
4	0 < V/C< .17	.1

Notice that the cohort range definitions (.49 and .17) correspond to the blocked lane capacities.

The hourly volumes for each representative hourly volume set were assigned to the proper cohort and summed. This data was used to identify the fraction of the AADT that is present when different lane blockages occur. A similar analysis was performed for the two lane roadway sections

Exhibit A-4 identifies the cohort fractions used for each traffic section (traffic sections are identified in Exhibit 2-1). An example of the spreadsheet analysis used to obtain the cohort fractions is shown in Exhibit A-5.

The table in Section 2.1 of this appendix depicting the percentage of freeway capacity under incident conditions on the shoulder shows that for three lane freeways, a V/C of .99 must be present for the incident to have an effect. Since this condition rarely occurs in Region 4, that type of incident is not a consideration. The table does, however, show that shoulder accidents may develop congestion under some Region 4 conditions. The analysis shown in Exhibit A-5 also identifies the fraction of AADT for which shoulder accidents will influence delay.

The cohort fraction data (Exhibit A-4) was used in conjunction with the incident delay model (Exhibit A-3) to compute the delay for lane blocking incidents for each lane

EXHIBIT A-4
TRAFFIC FRACTIONS IN EACH COHORT

THREE LANE ROADWAY SECTIONS

SECTION	COHORT 1	COHORT 2	COHORT 3	COHORT 4
NY 104				
17	0	.187	.743	.070
18	0	.187	.743	.070
19	0	.153	.756	.080
20	0	.153	.756	.080
I-490				
61	.263	.040	.623	.075
62	.253	.253	.433	.061
63	.253	.253	.433	.061
64	.253	.253	.433	.061
65	.253	.253	.433	.061
66	.253	.253	.433	.061
NY 590				
90	.197	.208	.541	.053
91	.197	.208	.541	.053
92	.089	.315	.534	.062
93	.089	.315	.534	.062

TWO LANE ROADWAY SECTIONS

SECTION	COHORT 1	COHORT 2	COHORT 3
NY 104			
21	0	0.493	0.506
22	0	0.493	0.506
23	0	0.493	0.506
24	0	0.493	0.506

EXHIBIT A-5 - COHORT ANALYSIS

I-490 from I-390 To Mt. Read Blvd. (Representational of Segment 61)

Beginning Hour	Direction Eastbd.	Westbd.	Total	Est Cap 1 way	eastbound v/c	westbound v/c	eb cohort 1	eb cohort 2	eb cohort 3	eb cohort 4	wb cohort 1	wb cohort 2	wb cohort 3	wb cohort 4	eb v/c>= .83	wb v/c>= .83
12:00 AM	284	671	955	6300	0.045	0.107	0	0	0	284	0	0	0	671	0	0
1:00 AM	164	519	683	6300	0.026	0.082	0	0	0	164	0	0	0	519	0	0
2:00 AM	164	490	654	6300	0.026	0.078	0	0	0	164	0	0	0	490	0	0
3:00 AM	222	468	690	6300	0.035	0.074	0	0	0	222	0	0	0	468	0	0
4:00 AM	441	519	960	6300	0.070	0.082	0	0	0	441	0	0	0	519	0	0
5:00 AM	1550	842	2392	6300	0.246	0.134	0	0	1550	0	0	0	0	842	0	0
6:00 AM	3831	2088	5919	6300	0.608	0.331	0	3831	0	0	0	0	2088	0	0	0
7:00 AM	5830	2769	8599	6300	0.925	0.440	5830	0	0	0	0	0	2769	0	5830	0
8:00 AM	4714	2300	7014	6300	0.748	0.365	4714	0	0	0	0	0	2300	0	0	0
9:00 AM	2751	1869	4620	6300	0.437	0.297	0	0	2751	0	0	0	1869	0	0	0
10:00 AM	2182	1832	4014	6300	0.346	0.291	0	0	2182	0	0	0	1832	0	0	0
11:00 AM	2142	2031	4173	6300	0.340	0.322	0	0	2142	0	0	0	2031	0	0	0
12:00 PM	2143	2180	4323	6300	0.340	0.346	0	0	2143	0	0	0	2180	0	0	0
1:00 PM	2201	2170	4371	6300	0.349	0.344	0	0	2201	0	0	0	2170	0	0	0
2:00 PM	2591	3064	5655	6300	0.411	0.486	0	0	2591	0	0	0	3064	0	0	0
3:00 PM	2869	4472	7341	6300	0.455	0.710	0	0	2869	0	4472	0	0	0	0	0
4:00 PM	2956	5282	8238	6300	0.469	0.838	0	0	2956	0	5282	0	0	0	0	5282
5:00 PM	2988	5148	8136	6300	0.474	0.817	0	0	2988	0	5148	0	0	0	0	0
6:00 PM	2151	2896	5047	6300	0.341	0.460	0	0	2151	0	0	0	2896	0	0	0
7:00 PM	1514	1905	3419	6300	0.240	0.302	0	0	1514	0	0	0	1905	0	0	0
8:00 PM	1261	1789	3050	6300	0.200	0.284	0	0	1261	0	0	0	1789	0	0	0
9:00 PM	1222	1659	2881	6300	0.194	0.263	0	0	1222	0	0	0	1659	0	0	0
10:00 PM	870	1207	2077	6300	0.138	0.192	0	0	0	870	0	0	1207	0	0	0
11:00 PM	505	1067	1572	6300	0.080	0.169	0	0	0	505	0	0	0	1067	0	0
Total =	47546	49237	96783			Total	10544	3831	30521	2650	14902	0	29759	4576	5830	5282

K=	0.089
DA	0.678
DP	0.649

cohort	fraction
1	0.263
2	0.040
3	0.623
4	0.075

Frac shoulder accidents >= .83 0.115

blocked. This was then used in conjunction with the percentage of incidents for which the lane groups are blocked (see model in Exhibit A-2) to arrive at the average delay per lane blocking incident. An example for this calculation is shown in Exhibit A-6.

The delay per incident (DELAY) column in Exhibit A-6 is computed from the delay model in Exhibit A-3.

The average delay per lane blocking incident for the corridor sections is shown in Exhibit A-7.

2.3 Development of Delay for Average Shoulder Incident

The table in Section 2.1 of this appendix shows that for three lane sections, shoulder disablements reduce freeway capacity to 99% of normal. Since the Region 4 traffic data shows very little incidence of this type of traffic condition, no delay is estimated for these incidents.

Where shoulder accidents are experienced in three lane sections, the table shows traffic queues will build when demand exceeds 83% of normal capacity. In two lane sections this figure is 81%.

Examining peak hour volumes indicates that only I-490 and Sections 90 and 91 of NY 590 experience this condition. A queuing analysis was performed for these three lane sections (assuming an average V/C of .88 for this situation) to determine the average delay for shoulder accidents under these conditions, and a delay of 173 vehicle hours per incident was obtained for these conditions.

Hourly volume data was analyzed to identify the percentage of AADT that exceeds this threshold in a manner similar to that used for the cohort analysis. An example of the results of such an analysis is also shown in Exhibit A-5. The results for all of the sections are summarized in Exhibit A-8.

2.4 Annual Delays Resulting From Incidents

Annual delays were computed for each section from the foregoing data by computing the sum of the delays due to lane blocking accidents, lane blocking non-accident incidences and shoulder accidents. The computation is shown in Exhibit A-9:

Exhibit A-10 shows major inputs to the calculations as well as the delay for each section and the delay totals for each roadway. The accident data was obtained from Appendix H. The delay columns were computed by the process described earlier in this section

EXHIBIT A-6 – DELAY FOR LANE BLOCKING INCIDENTS

I-490 Section 61

Inc Type	Duration Hr	Capacity S1	Demand Vol Fraction	Demand Vol S2	Inc Cap Fraction La1	Inc. Cap S3	Delay per incident Veh hr DELAY	Frac in Cohort FC	Del per inc. for vol frac AD	Lane weighting for this type	Weighted Delay for Accidents Veh hr
3Lanes 1 Lane Blocked											
			Fraction	S2	La1	S3	Veh hr	FC	vol frac		
	0.88	6300	0.8	5040	0.49	3087	1928	0.263	507.1		
	0.88	6300	0.6	3780	0.49	3087	342	0.039	13.3		
	0.88	6300	0.33	2079	0.49	3087	0	0.623	0.0		
	0.88	6300	0.2	1260	0.49	3087	0	0.075	0.0		
							Total weighted delay per inc. type		520.5	0.82	427
3Lanes - 2 Lanes Blocked											
			Fraction	S2	La1	S3	Veh hr	FC	vol frac		
	0.88	6300	0.8	5040	0.17	1071	6378	0.263	1677.3		
	0.88	6300	0.6	3780	0.17	1071	2177	0.039	84.9		
	0.88	6300	0.33	2079	0.17	1071	484	0.623	301.2		
	0.88	6300	0.2	1260	0.17	1071	76	0.075	5.7		
							Total weighted delay per inc. type		2069.1	0.14	290
3Lanes - 3 Lanes Blocked											
			Fraction	S2	La1	S3	Veh hr	FC	vol frac		
	0.88	6300	0.8	5040	0	0	9757	0.263	2566.2		
	0.88	6300	0.6	3780	0	0	3659	0.039	142.7		
	0.88	6300	0.33	2079	0	0	1201	0.623	748.5		
	0.88	6300	0.2	1260	0	0	610	0.075	45.7		
							Total weighted delay per inc. type		3503.2	0.04	140

Total weighted delay per incident type computed as follows
Sum over all four cohorts
$\sum DELAY*FC$

Delay for average incident AD	857

EXHIBIT A-7
AVERAGE DELAY PER LANE BLOCKING INCIDENT

SECTION	AVERAGE DELAY PER INCIDENT – Veh Hr
NY 104	
17	225
18	225
19	203
20	203
21	360
22	360
23	360
24	360
I-490	
61	857
62	962
63	962
64	962
65	962
66	962
NY 590	
90	781
91	781
92	549
93	549

EXHIBIT A-8
FRACTION OF AADT FOR WHICH V/C > .83

SECTION	FRACTION OF AADT FOR WHICH V/C > 0 .IN 3 LANE SECTIONS, V/C > 0.81 IN TWO LANE SECTIONS
NY 104	
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
I-490	
61	.115
62	.161
63	.161
64	.161
65	.161
66	.161
NY 590	
90	.106
91	.106
92	0
93	0

EXHIBIT A-9
COMPUTATION OF ANNUAL DELAY

AD = Delay per lane blocking accident and lane blocking non-accident incidents.
DSA = Delay per shoulder accident.
NA = Annual accidents in section.
IR = Non-accident incident rate per MVM (7.03).
FR = Fraction of shoulder accidents > V/C = .83 (V/C > .81 for two lane section).
A = Fraction of accidents that block lanes (0.4).
B = Fraction of accidents on shoulder (0.6).
C = Fraction of incidents that block lanes (.17).
YM = Annual Million Vehicle Miles in section.
ASD = Annual delay in section.

ASD = AD*((NA*A) + (IR*C*YM)) + DSA*FR*B*NA

EXHIBIT A-10 – ANNUAL DELAY

SECTION	AADT	ANNUAL VOL	DIST MI	ANNUAL MILLION VEH MI YM	ACCIDENTS PER YEAR NA	ACCIDENT RATE ACC/MVM	DELAY PER INCIDENT IN LANES AD	DELAY PER SHOULDER ACCIDENT DSA	FRAC SHOULDER ACC WHEN V/C+>.83 FR	ANNUAL DELAY ASD
NY104										
17	73000	26645000	0.73	19.45	18	0.925	225	173	0	6,850
18	70000	25550000	1.41	36.03	52	1.443	225	173	0	14,367
19	67800	24747000	0.99	24.50	16	0.653	203	173	0	7,243
20	62000	22630000	0.7	15.84	8	0.505	203	173	0	4,493
21	57500	20987500	1.25	26.23	6	0.229	360	173	0	12,151
22	46000	16790000	2.96	49.70	50	1.006	360	173	0	28,582
23	42000	15330000	0.79	12.11	3	0.248	360	173	0	5,642
24	32900	12008500	0.3	3.60	4	1.110	360	173	0	2,126
	TOT NY 104			187.46	157	0.837				81,454
I-490										
61	94000	34310000	1.27	43.57	75	1.721	857	173	0.115	71,233
62	99600	36354000	0.19	6.91	6	0.869	962	173	0.161	10,350
63	99600	36354000	0.47	17.09	53	3.102	962	173	0.161	40,924
64	91000	33215000	1.46	48.49	115	2.371	962	173	0.161	101,927
65	94500	34492500	1.59	54.84	165	3.009	962	173	0.161	129,302
66	92200	33653000	0.74	24.90	42	1.687	962	173	0.161	45,494
	TOT I-490			195.81	456	2.329				399,231
NY 590										
90	100300	36609500	0.67	24.53	16	0.652	781	173	0.106	28,069
91	100300	36609500	0.58	21.23	57	2.684	781	173	0.106	38,253
92	97500	35587500	0.75	26.69	24	0.899	549	173	0	22,782
93	57000	20805000	1.27	26.42	27	1.022	549	173	0	23,265
	TOT NY 590			98.87	124	1.254				112,369

ATTACHMENT 1 – INCIDENT LOG

Roadway	Dir.	Exit Numbers	Location	Date	Time Detected	Time Cleared	Incident Type	No. of Lanes Blocked	Secondary Accident
I-490	EB	10	Mt. Read	7/8/2002	11:56	15:01	A	3	
I-390	NB	10-11	Rt 5&20 to Rt 251	7/12/2002	14:15	18:16	A	2	
I-390	NB	9-10	Rt 15 to Rt 5&20	7/12/2002	17:00	21:46	A	2	S
I-490	WB	6	NY 204	7/30/2002	17:00	19:00 (est)	A+S+P	2	
!-490	WB	5-6	Rt 386	8/28/2002	21:45	3:45 (8/29)	A+F	2	
I-490	WB	14-16	Clinton	8/29/2002	15:30	16:21	NV	3	
I-390	NB	6	Rt 36	8/29/2002	15:40	18:05	A+D	2	
390	SB	23-24	Just S of NY104	9/18/2002	16:16	17:24	A	3	
I-490	WB	2-4	Rt 259 to Rt 33A	9/19/2002	20:53	1:20 (9/20)	S	2	
I-490	EB	9-10	Just E of I-390	9/25/2002	8:20	9:20 (est)	A	1	
I-390	SB	4-5	Rt 36 to Rt 436	11/7/2002	8:15	10:15	A	2	
I-390	NB	13-14	Hylan Dr.	11/19/2002	8:51	12:55	A+F	3	
390	NB	19-20	Chili Ave.	12/3/2002	19:47	21:25	A	3	
I-390	SB	11-12	Rt 251	12/4/2002	3:05	5:25	A	1	
390	NB	23-24	Ridgeway Ave.	12/7/2002	4:30	17:00	A	3	
I-390	NB	17-18	Scottsville Rd.	1/3/2003	12:40	13:27	A	1	
I-490	WB	25	On ramp from 31F	1/10/2003	7:00	10:10	A	3	
I-490	EB	10-11	Ames St.	1/20/2003	9:42	11:00	A	3	
I-390	NB	15-16	I-590	1/23/2003	4:55	7:50	A	2	
590	SB	8	Empire Blvd.	1/23/2003	14:00	14:35	A	3	
104	EB+WB		Bay to 5 Mile Line Rd	1/23/2003	16:05	16:10	A	4	
104	EB		Holt Rd-Cty Line	1/24/2003	9:30	10:39	A	2	
590	NB	10 to Culver Rd	NY 104 WB	2/5/2003	6:50	7:45	A	1	
I-490	EB	16-17	Alexander St to Clinton St	2/6/2003	16:21	18:50	A	3	
I-490	WB	29-Thruway Exit 45	NYS Thruway	2/12/2003	8:33	9:22	B	2	
590	SB	10-11	NY 104	2/12/2003	11:16	12:49	A	3	
404			Winton&Daytona	2/19/2003	14:53	16:40	NV	1	
404			Winton&Daytona	2/20/2003	13:59	16:30	NV	1	
404			Winton&Daytona	2/21/2003	13:20	16:30	NV	1	

Roadway	Dir.	Exit Numbers	Location	Date	Time Detected	Time Cleared	Incident Type	No. of Lanes Blocked	Secondary Accident
I-390	NB	7-8	Rt 408 to Rt 20A	2/23/2003	9:50	10:08	A	2	
I-390	NB	Ramp to Tway	Exit 12 Tway ramp	3/4/2003	15:15	18:12	A	2	
I-490	WB	18-19	Monroe to Culver	3/7/2003	21:00	00:02 (3/8)	A+D	3	
104	WB		Iron. Bay Bridge	4/28/2003	6:10	6:50	A	2	
104	EB+WB		Lake Ave.	4/29/2003	1:09	18:38	A+F+S	4	
104	EB		Iro. Bay Bridge	5/5/2003	14:15	20:47	A	2	
Mt. Read	NB+SB		Ridgeway to Driving Park	5/6/2003	19:30	22:51	F	4	
I-390	NB	12-13	S. of Hylan Dr.	5/13/2003	13:22	15:30	NV	2	
I-390	NB	3-4	Rt 21- Rt 36	5/19/2003	13:30	15:30	A	2	
I-490	EB	17-18	S. Goodman	5/20/2003	19:04	1:30 (5/21)	A	2	
I-590	NB	Ramp to 490E	Ramp - I-490EB	6/2/2003	7:40	11:18	A	1	
I-390	SB	16 A to 16B	NY15A	6/4/2003	10:59	13:55	A+S	2	
I-390	NB	10-11	Mon-Liv Co Line	6/25/2003	11:14	11:44	A	1	
390	SB	Ramp to 490 E	Ramp - I-490EB	7/2/2003	3:51	6:00	A	2	
104	WB		Iron Bay Bridge	7/13/2003	18:40	23:15	A	3	
I-490	EB	12-14	Frontier Field	7/26/2003	7:10	11:56	A+D	3	
I-390	SB	19-20	I-490 - NY33	8/8/2003	6:30	8:30 (est)	A+D	3	
104	WB		T/Webster	8/12/2003	10:20	14:30	NV	3	(Police Road Block)
I-490	EB	21	I-590	8/22/2003	7:41	8:37	A	1	
I-390	NB	6-7	Rt 36 to Rt 408	8/28/2003	2:47	9:00	A	1	
390	NB	22 - Off ramp to Lexington	Ramp to Lexington	9/4/2003	9:03	10:30	A	1	
590	SB	6-7	Browncroft Blvd	9/4/2003	9:06	10:15	A	3	
I-490	EB	9-10	Mt. Read Blvd.	9/9/2003	7:30	7:50	A	1	
I-490	EB	11-12	Child St.	9/18/2003	13:04	13:13	A	2	
104	WB		Lake & Maplewood	10/8/2003	4:10	7:00	A+D	4	
I-490	EB	11-12	Ames St.	10/9/2003	15:51	16:29	A	?	
I-490	EB	21 - Ramp to 590 N	Ramp to 590	10/21/2003	9:13	11:07	S	2	
I-490	EB	Twy Exit 45	Ramp to Truway	10/23/2003	15:22	18:41	A	1	
I-490	EB	9-10	Mt. Read	10/24/2003	16:05	17:34	A	1	
Inner Loop	EB	13- Water Street	Water St.	10/26/2003	9:23	12:30	A+S	1	Inner Loop

Roadway	Dir.	Exit Numbers	Location	Date	Time		Incident	No. of Lanes	Secondary
					Detected	Cleared	Type	Blocked	Accident
I-490	EB	Ramp to 390 N	Ramp to 390 NB	10/27/2003	12:02	11:55 (10/28)	A+S	1	
NY 383	NB		bet 252 & Paul Rd.	11/13/2003	9:51	14:47	NV	4	
I-390	NB	11-12	Rush Exit	11/13/2003	10:59	12:50	A	1	
104	EB		Keeler St. Flyover	11/14/2003	9:43	10:30	A	2	
590	SB	7-8	Ramp Empire Blvd.	11/14/2003	9:56	10:50	A	1	
NY 390	NB	at exit 24	at 104 E & W	11/28/2003	12:37	13:34	NV	2	Flooding
I-490	WB	9-10	at Mt. Read	11/28/2003	16:26	17:12	A	3	
I-490	EB	27-28	Rt 96	12/1/2003	22:25	23:00	A	3	
I-390	SB	14-15	south of 590	12/2/2003	7:00	7:50	A	2	
590	NB	9-10	Bet 104 & Norton	12/13/2003	14:14	14:38	A	2	
I-490	WB	19	at Culver Rd.	12/18/2003	16:50	17:43	A + P	2	
I-490	WB	14-15	at Troup Howell Br.	12/24/2003	12:35	13:35	A	2	
I-490	WB	9-10	RR overpass/Mt. Read	1/9/2004	7:45	9:30	A	1	
I-490	EB	5-6	Rt 386 to Rt 204	1/9/2004	10:43	12:49	NV	2	
I-490	WB	13-14	Inner Loop	1/9/2004	12:00	12:35	A + P	3	
I-490	EB	19-20	bet. Culver & Winton	1/10/2004	10:58	12:30	A + P	3	
104	EB		IBB	1/10/2004	12:59	13:03	A	2	

APPENDIX B
INCIDENT DATA ANALYSIS AND COMPARISON WITH REGION 4 INCIDENT MODEL

Summary

A limited number of observations of incidents were conducted in the RTOC to evaluate the validity of the Region 4 incident model. The analysis of this data concluded that the model was adequate for use in this project.

Purpose of Study

An incident model was developed for Region 4. The model used data from Region 1 for the distribution of incidents by lane, including whether the incident was on the shoulder or in the traffic lane. The frequency of non-accident incidents is also a key parameter in the model. A lesser objective was to evaluate the incident duration parameter used in the model. The incident rates and physical distributions from literature as well as incident logs from ITS are often influenced by what the agency (or operator) defines as an incident making comparison studies of this type of data difficult. This study, although limited in the duration of data collection, was designed to allow the analyst to evaluate probable incidents as they might potentially affect traffic flow.

Data Collection Procedures

The ITS cameras in the RTOC were observed by a special observer for four days from 6 AM to 2 PM and for four days from 11 AM to 7 PM. The cameras were operated by RTOC personnel in the usual fashion. They are primarily sequenced by a camera tour, with special observations when an incident is detected. The observer was instructed to note all vehicle stoppages and their lane location and duration. The data collected is shown in Exhibit B-1. Data was also collected to estimate the coverage provided by each of the active cameras in its normal position (i.e. the position used during camera tours).

Analysis of Data

The following parameters were used to estimate the vehicle miles observed.

Approximate average AADT in coverage area: 90000
Roadway under observation: 5.776 miles
% AADT observed: 48%
Number of days observed: 8

The product of these numbers results in an observation of 1.996 million vehicle miles of travel.

During this period a total of 42 vehicle stoppages or roadway obstacles were observed. Of these there were 14 occurrences of shoulder stoppages for five minutes or less (mostly consisting of vehicles stopped for the convenience of the motorist. As these stoppages did not have the potential to cause significant traffic delay even under the high v/c conditions experienced in Region 4, they were not considered as incidents, and were removed form the analysis.

EXHIBIT B-1
OBSERVATIONS OF INCIDENTS

					Place "X" in the appropriate box				Were any Lanes closed?						
ID	Date	Incident Detection Time	Time incident Clears	Duration	Accident	Non-Accident	Shoulder Incident	Moving Lane Incident	If so how many?	CCTV Camera ID	Camera Direction	Roadway	Location & Direction on Roadway	Description of incident type and other commentary	Location - Back of Queue Max
1	7/26/2004	7:36	7:41	0:05		X	X		no	2	W	104	Just before the Bay Road on-ramp from	A car pulled over to the shoulder for a brief period of time, then returned to roadway	no queue
				0:00									Route 104 eastbound		
2	7/26/2004	7:50	7:54	0:04		X	X		no	2	W	104	Just before the Bay Road on-ramp from	A car pulled over to the shoulder for a brief period of time, then returned to roadway	no queue
				0:00									Route 104 eastbound		
3	7/26/2004	8:12	8:45	0:33		X	X		no	16	N	490	Avril Ave Overpass EB	A billboard truck illegally pulled over onto the shoulder on overpass.	no queue
4	7/26/2004	8:15	8:36	0:21		X		X	1	16	N	490	490 WB out of view	lane closure by police	back to Clinton
				0:00											
5	7/26/2004	8:40	9:21	0:41	X		X		no	16	SE	490	490 WB, just west of Clinton St bridge	Vehicle collission, apparent rear end, vehicles pulled over to shoulder, police resond	no queue
				0:00										Police & V1 leave 9:09, V2 towed 9:21	
6	7/26/2004	10:45	10:58	0:13	X		X		no	11	E	490	490 EB just west of offramp to Child St.	unknown accident type involving 2 vehicles, police responded, warning flares set in r	no queue
				0:00										V1 and police 1 leave 10:54, V2 towed	
7	7/26/2004	12:07	12:12	0:05		X	X		no	2	W	104	Just before the Bay Road on-ramp from	A truck with a boat in tow pulled over to the shoulder for a brief period of time, then r	no queue
				0:00									Route 104 eastbound		
8	7/26/2004	1:07	1:40	0:33		X	X		no	7	W	104	104 EB just east of the offramp to 5 mile line Rd	A car pulled over to the shoulder for a brief period of time, then returned to roadway	no queue
				0:00											
9	7/26/2004	1:17	1:25	0:08		X	X		no	6	S	590	590 EB just east of Offramp to Empire Blvd	A car pulled over to the shoulder for a brief period of time, then returned to roadway	no queue
				0:00											
				0:00											
10	7/27/2004	6:30	6:39	0:09		x	x		no	14	NW	490	WB 490 near inner loop	Car pulled off onto shoulder for flat tire	no queue
				0:00											
11	7/27/2004	6:35	6:39	0:04		x	x		no (see note)	13	E	490	EB 490 near Grape St Bridge	Tractortrailer pulled mostly off onto shoulder	no queue
				0:00											
12	7/27/2004	9:01	9:21	0:20		x	x		no	12	W	490	WB 490 at Ames St on ramp	Vehicle abandon on shoulder, Police tagged vehcile	no queue
				0:00											
13	7/27/2004	11:25	12:32	1:07	x		x		1	13	NE	490	WB east of Saxton Street	Pas Car and TT accident. Vehciles parked on sholder	no queue
				0:00											
14	7/28/2004	9:30	10:00	0:30		x		x	no	13	E	490		Concrete debris in roadway	no queue
				0:00											
15	7/28/2004	9:52	11:19	1:27		x	x		no	9	E	490	490 WB between Mt Read & 390 near Uturn	Small truck had flat tire on it's trailer & pulled over to the shoulder to change it	no queue
				0:00										Police Responded, Service truck responded to assist	
16	7/28/2004	11:20	11:28	0:08		x	x		no	9	E	490	490 WB between Mt Read & 390 at Uturn	non police car broke down & pulled over into uturn area	no queue
				0:00										police responded	
17	7/28/2004	12:30	12:45	0:15		x	x		no	16	N	490	Avril Ave Overpass EB	car broke down and pulled over to the shoulder	no queue
				0:00											
18	7/28/2004	1:45	1:57	0:12		x	x		no	16	N	490	Avril Ave Overpass WB	A billboard truck illegally pulled over onto the shoulder on overpass.	
				0:00											
19	7/30/2004	6:29	6:33	0:04		x	x		no	1	E	104	EB at five mile line on ramp	tractor trailer on shoulder	
				0:00											
				0:00											
20	8/3/2004	1:10	1:50	0:40		x		x	2	8	E	490	490 WB	lane closure due to	Back to Mt Read
				0:00											
21	8/3/2004	1:24	1:32	0:08		x	x		no	5	N	590	590 S in the 104 West interchange	object flew out of convertible, driver pulled over to shoulder to look for object	no queue
				0:00											
22	8/3/2004	1:40	1:42	0:02		x	x		no	2	W	104	104 WB just west of Bay Rd offramp to 104	truck pulled over to shoulder briefly and then returned to roadway	no queue
				0:00											
23	8/3/2004	3:18	3:34	0:16		x	x		no	10	W	490	490 WB, just west of railroad bridge	car broke down & pulled to shoulder, service vehicle responded	no queue
				0:00										car towed	
24	8/3/2004	4:15	4:41	0:26		x	x		no	13	E	490	490 WB, just west of bridge	car broke down & pulled to shoulder, service vehicle responded	no queue
				0:00										driver driven away 4:41, car remained at scene	
25	8/3/2004	4:35	4:45	0:10	x			x	1	5	N	590	590 NB, just north of 104	car hit guide rail, police responded, car drove away	no queue
				0:00											
26	8/3/2004	5:15	5:30	0:15		x		x	2	16	N	490	490WB at Plymouth	Vehicle broke down in center lane, service vehicle and police responded to move	back to Meigs St
				0:00										vehicle to the shoulder	
				0:00											
27	8/10/2004	12:13	12:16	0:03		x	x		no	10	W	490	490 EB just west of RR Bridge	tractor trailer pulled over to shoulder briefly and then returned to roadway	no queue
				0:00											
28	8/10/2004	12:31	12:33	0:02		x	x		no	10	W	490	490 WB just west of RR Bridge	car pulled over to shoulder briefly and then returned to roadway	no queue
				0:00											
29	8/10/2004	12:38	12:42	0:04		x	x	x	no	3	W	104	104 EB halfway across Bay Bridge	object fell off of van into expressway, van pulled over to shoulder and picked up	no queue
				0:00										object, van then returned to roadway	
30	8/10/2004	2:10	2:15	0:05		x	x		no	2	W	104	104 EB just west of Bay Rd onramp from 104	truck pulled over to shoulder briefly and then returned to roadway	no queue
				0:00											
31	8/10/2004	3:47	3:52	0:05		x	x		no	7	W	104	on 104 EB Offramp to 5 mile line Rd	car pulled over to shoulder briefly and then returned to roadway	no queue
				0:00											
32	8/10/2004	5:44	5:47	0:03		x	x		no	6	S	590	590 NB in Empire Blvd junction	A truck pulled over to the shoulder for a brief period of time, then returned to roadwa	no queue
				0:00											
				0:00											
33	8/11/2004	12:31	12:33	0:02		x	x		no	12	W	490	490 WB just west of Ames St.	A truck pulled over to the shoulder for a brief period of time, then returned to roadwa	no queue
				0:00											
34	8/11/2004	2:35	3:36	1:01	x			x	WB-all	2	W	104	104 WB just west of Bay Rd	A car flipped over & caught fire in the innermost lane. EB & WB roadways closed.	WB-to 5 mile ln Rd
		2:40	3:17	0:37					EB-2lanes					104 EB closed due to emergency vehicles.	EB - just past Bay Bridge
				0:00											
35	8/11/2004	3:52	3:55	0:03		x	x		no	6	S	590	590 NB in Empire Blvd junction	A truck pulled over to the shoulder for a brief period of time, then returned to roadwa	no queue
				0:00											
36	8/11/2004	6:02	6:15	0:13		x	x		no	6	N	590	590 SB in Empire Blvd junction	A car broke down & pulled to the shoulder, driver added fluid then returned to roadw	no queue
				0:00											
				0:00											
37	8/12/2004	1:58	2:02	0:04		x	x		no	9	E	490	490 WB @ the U-turn east of canal	car and police car on the shoulder	no queue
				0:00											
38	8/12/2004	3:15	3:21	0:06		x	x		no	6	N	590	590 sb @ OFF-RAMP	car and police on the shoulder	no queue
				0:00											
39	8/12/2004	4:30	4:47	0:17		x	x		no	3	SE	104	104 eb - End of Bay Bridge at t. of webster sign	car on shoulder for flat tire	no queue
				0:00											
40	8/12/2004	5:00	5:21	0:21		x	x		no	10	SW	490	490 eb from 390 nb	car and police on shoulder	no queue
				0:00											
41	8/12/2004	5:29	5:45	0:16		x	x		no	9	E	490	490 wb east of canal and west of railroad bridge	motorist stopped on shoulder trying to help a dog, animal control assisted	no queue
				0:00											
42	8/12/2004	5:49	5:52	0:03		x	x		no	3	W	104	wb 104 west end of Bay Bridge	car on shoulder	no queue

Exhibit B-2 shows the results of the analysis of the remaining incidents. The Exhibit compares the data with the data in the Region 4 incident model. The lane distribution data compares very closely with the model. The data collected is somewhat higher than the model, but well within the standard error of the estimate. The lane blocking times are near the limits of the standard estimate.

Although the sample sizes of the collected data are low, the results generally corroborate the Region 4 incident model.

EXHIBIT B-2
COMPARISON OF REGION 4 INCIDENT MODEL TO OBSERVED DATA

	REGION 4 INCIDENT MODEL	DATA COLLECTED *	COMMENTS
ACCIDENT MODEL PARAMETER			
% Lane Blocking	40%	40%	
- Time Lane Blocked	52.8 min	38.4 min	Standard error of data collected = ±26.4 min
% On Shoulder	60%	60%	
- Time On Shoulder	52.8 min	Data not significant	
NON-ACCIDENT INCIDENTS			
Non-Accident Incident Rate	7.03 inc/mvm	9.51 inc/mvm	Standard error of data collected = ±2.8 inc/mvm
% Lane Blocking	17%	19%	
% On Shoulder	83%	81%	
Time Lane Blocked	52.8 min	33.4 min	Standard error of data collected = ±18.1 min

* Incidents were considered to consist of all lane blocking incidents and shoulder incidents with duration of over 5 minutes. Shoulder stoppages of five minutes or less generally did not involve any vehicle problem and were motorist convenience stops.

APPENDIX C
DETAILS OF ACCIDENT ANALYSIS

1.0 Overview

An accident analysis was completed for the following expressways as part of NYSDOT's Rochester ITS Evaluation and Integration Planning Study:

- NYS Route 104 – Goodman Street to Salt Road
- NYS Route 590 – Browncroft Boulevard to Ridge Road
- NYS Route 490 – NYS Route 390 to Goodman Street

The expressways were divided into links during the analysis in order to analyze the individual characteristics of each portion of the expressway. The links represent the major interchanges and/or sections of expressway that contained similar physical characteristics. Exhibit C-1 presents a breakdown of the expressway links analyzed during the study.

Exhibit C-1 - Expressway Links

Link	Link Description
NYS Route 104	Goodman Street Interchange
	Culver Road Interchange
	Route 590 Interchange
	Route 590 to Bay Road
	Bay Road Interchange
	Bay Road to Five Mile Line Road
	Five Mile Line Road to Route 250
	Phillips Road to Salt Road
	Salt Road Interchange
Interstate 490	Route 390 Interchange
	Mt. Read Interchange
	Mt. Read Boulevard to Inner Loop Area
	Inner Loop Area
	Goodman Street Interchange
NYS Route 590	Browncroft Boulevard Interchange
	Browncroft Boulevard to Empire Boulevard
	Empire Boulevard Interchange
	Empire Boulevard to Route 104
	Route 104 Interchange
	Ridge Road Interchange

The New York State Department of Transportation's, (NYSDOT) Safety Information Management System (SIMS), Summary Report By Segment And/Or Intersection, were obtained from the NYSDOT for the links of each route listed above. The reports were for the latest two years of accident information on file, March 1, 2000 to February 28, 2002.

The information was summarized for the total number of accidents, accident severity, wet road accidents, fixed object accidents, and light conditions.

The 2003 NYSDOT Highway Sufficiency Ratings were also obtained from the NYSDOT to determine the number of lanes and annual average daily traffic (AADT) volumes along each route. This information was used in conjunction with the accident information to determine the accident rate along each link of expressway. These rates were then compared with the NYSDOT Average Accident Rates for State Highways by Facility Type.

2.0 Accident Rate

The accident rates were calculated for the interchanges, links, and overall corridors and compared to the Statewide Average Accident Rates for similar facility types. Exhibit C-2 presents the accident rates for all of the study area expressways analyzed.

Route 104

Route 104 experienced 465 accidents from Goodman Street to Salt Road during the two-year study period analyzed. The overall accident rate for the corridor was 0.96 accidents per million vehicle-miles (acc/mvm) which is approximately half the statewide average accident rate of 1.94 acc/mvm for a similar facility type. Only the Goodman Street interchange had an average accident rate (2.68 acc/mvm) higher than the statewide average for a similar facility type (2.26 acc/mvm). All other links had accident rates significantly below the statewide average accident rates for similar facility types.

A review of the accident data at the Goodman Street interchange indicates that 50 of the 120 accidents (42 percent) occurred at reference marker 104 4303 3002. This reference marker includes the ramp junctions on the west side of the interchange, to and from the adjacent service roads. Drivers traveling west on Route 104, experience a crest in the expressway as Route 104 crosses over Goodman Street, then drop quickly to travel under Portland Avenue. The eastbound drivers experience the opposite as they travel under Portland Avenue, then rise quickly to the crest over Goodman Street. The change in grade and merge/diverge maneuvers through this area may be a contributing factor to the above average accident rate at this interchange.

Route 490

Route 490 experienced 840 accidents between Route 390 and Goodman Street during the two-year period analyzed. The overall accident rate for the corridor was 1.95 acc/mvm, which is approximately the same as the Statewide Average Rate of 1.94 acc/mvm for a similar facility type. The Inner Loop area link had an accident rate of 2.50 acc/mvm, which was higher than the statewide average accident rate of 1.94 acc/mvm. All other links had accident rates below the statewide average accident rates for similar facility types.

EXHIBIT C-2 - ACCIDENT RATES

Roadway	Accident Period - March 1, 2000 to February 28, 2002					
Link	**Link Description**	**Total Accidents**	**Average AADT**	**Link Length (miles)**	**Accident Rate**	**Statewide Average Rate**
NYS Route 104	Goodman Street Interchange	120	68,200	0.80	2.68	2.26
	Culver Road Interchange	72	73,000	0.80	1.50	2.26
	Route 590 Interchange	71	70,000	0.80	1.54	1.94
	Route 590 to Bay Road	46	68,000	1.60	0.55	1.78
	Bay Road Interchange	32	62,000	0.80	0.79	2.26
	Bay Road to Five Mile Line Road	12	57,000	1.25	0.21	1.09
	Five Mile Line Road to Route 250	88	45,000	2.86	0.91	1.47
	Phillips Road to Salt Road	16	42,000	0.90	0.52	1.47
	Salt Road Interchange	8	33,000	0.40	0.66	1.47
	Route 104 Totals	**465**	**64,257**	**10.21**	**0.96**	**1.94**
Interstate 490	Route 390 Interchange	141	90,000	1.46	1.38	1.94
	Mt. Read Interchange	60	100,000	0.47	1.44	2.26
	Mt. Read Boulevard to Inner Loop Area	229	92,000	1.46	2.19	2.26
	Inner Loop Area	330	107,000	1.59	2.50	1.94
	Goodman Street Interchange	80	92,000	0.50	1.99	2.26
	Route 490 Totals	**840**	**105,770**	**5.48**	**1.95**	**1.94**
NYS Route 590	Browncroft Boulevard Interchange	29	90,000	0.40	0.88	2.26
	Browncroft Boulevard to Empire Boulevard	31	101,000	0.67	0.55	1.78
	Empire Boulevard Interchange	113	101,000	0.58	2.25	2.26
	Empire Boulevard to Route 104	55	98,000	0.85	0.81	1.78
	Route 104 Interchange	27	76,000	0.60	0.70	1.47
	Ridge Road Interchange	18	22,000	0.60	1.60	1.47
	Route 590 Totals	**273**	**50,725**	**3.70**	**1.94**	**1.94**

X.XX - Average Accident Rate higher than the Statewide Average Rate for similar facility type.

The Inner Loop area represents the section of Route 490 from approximately Broad Street to Clinton Avenue. This is a heavily congested area with several on-off ramps, including the merge/diverge with the Inner Loop. The section of expressway has very unique physical characteristics tying the urban Inner Loop area with the Interstate expressway which is probably contributing to the above average accident rate.

Route 490 is currently being reconstructed from just east of the Route 390 interchange, through to the Genesee River (located within the Inner Loop area link). A goal of the reconstruction project is to improve traffic flow through the corridor and will likely change the accident patterns and rates once complete.

Route 590

Route 590 experienced 273 accidents between Browncroft Boulevard and Ridge Road during the two-year period analyzed. The average accident rate for the corridor was 1.94 acc/mvm, equal to the statewide average accident rate of 1.94 acc/mvm for a similar facility type. Only the Ridge Road Interchange experienced an average accident rate, 1.60 acc/mvm, above the statewide average accident rate of 1.47 acc/mvm for a similar facility type. The Empire Boulevard Interchange experienced an accident rate of 2.25 acc/mvm, approximately equal to the statewide average accident rate of 2.26 acc/mvm, while all other links experienced accident rates well below the statewide average accident rates for similar facility types.

The Ridge Road interchange with Route 590 experienced 18 accidents during the two-year study period analyzed and experiences significantly less traffic than the remainder of the corridor. As a point of reference, two less accidents in this area would have brought the accident rate down below the statewide average accident rate for a similar facility type. This interchange is in the transition zone between the grade separated expressway portion of Route 590, south of Ridge Road, and the at-grade arterial portion of Route 590, north of Ridge Road. Route 590 also travels over Ridge Road and creates a crest in the expressway. These factors likely contributed to the above average accident rate.

3. Accident Severity

The accident severity was calculated for the interchanges, links, and overall corridors and compared to the statewide average severity rates for similar facility types. Exhibit C-3 presents the accident severity for all of the study area expressways analyzed.

Route 104

The average severity of accidents that occurred through the Route 104 corridor was less than the Statewide Average Severity rates. The fatality and injury accidents along Route 104 represented 27.1 percent of the total accidents, while the Statewide Average for

EXHIBIT C-3 ACCIDENT SEVERITY

Roadway	Accident Period - March 1, 2000 to February 28, 2002							
		Severity						
Link	Link Description	Fatality		Injury		Property Damage		Total Accidents
		Total	Percent	Total	Percent	Total	Percent	
NYS Route 104	Goodman Street Interchange	0	0.00%	31	25.83%	89	74.17%	120
	Culver Road Interchange	0	0.00%	17	23.61%	55	76.39%	72
	Route 590 Interchange	0	0.00%	11	15.49%	60	84.51%	71
	Route 590 to Bay Road	0	0.00%	13	28.26%	33	71.74%	46
	Bay Road Interchange	0	0.00%	14	43.75%	18	56.25%	32
	Bay Road to Five Mile Line Road	0	0.00%	5	41.67%	7	58.33%	12
	Five Mile Line, Hard, Holt, Route 250 Interchanges	1	1.14%	26	29.55%	61	69.32%	88
	Phillips Road to Salt Road	0	0.00%	4	25.00%	12	75.00%	16
	Salt Road Interchange	0	0.00%	4	50.00%	4	50.00%	8
	Route 104 Total Accidents and Severity Distribution	**1**	**0.22%**	**125**	**26.88%**	**339**	**72.90%**	**465**
	NYSDOT Average Severity Distribution		**0.35%**		**33.12%**		**66.53%**	
Interstate 490	Route 390 Interchange	0	0.00%	38	26.95%	103	73.05%	141
	Mt. Read Interchange	0	0.00%	18	30.00%	42	70.00%	60
	Mt. Read Boulevard to Inner Loop Area	0	0.00%	58	25.33%	171	74.67%	229
	Inner Loop Area	1	0.30%	84	25.45%	245	74.24%	330
	Goodman Street Interchange	0	0.00%	19	23.75%	61	76.25%	80
	Route 490 Total Accidents and Severity Distribution	**1**	**0.12%**	**217**	**25.83%**	**622**	**74.05%**	**840**
	NYSDOT Average Severity Distribution		**0.35%**		**33.12%**		**66.53%**	
NYS Route 590	Browncroft Boulevard Interchange	0	0.00%	5	17.24%	24	82.76%	29
	Browncroft Boulevard to Empire Boulevard	0	0.00%	9	29.03%	22	70.97%	31
	Empire Boulevard Interchange	0	0.00%	29	25.66%	84	74.34%	113
	Empire Boulevard to Route 104	0	0.00%	18	32.73%	37	67.27%	55
	Route 104 Interchange	0	0.00%	2	7.41%	25	92.59%	27
	Ridge Road Interchange	1	5.56%	1	5.56%	16	88.89%	18
	Route 590 Total Accidents and Severity Distribution	**1**	**0.37%**	**64**	**23.44%**	**208**	**76.19%**	**273**
	NYSDOT Average Severity Distribution		**0.35%**		**33.12%**		**66.53%**	

fatality and injury accidents is 33.47 percent. One fatality occurred on Route 104 during the two-year study period within the Five Mile Line Road to Route 250 link. The accident information for the fatal accident indicated alcohol involvement as a cause of the accident where a driver collided with the guide rail within a Work Area.

The Bay Road interchange, Bay Road to Five Mile Line Road link, and Salt Road interchange all had fatality/injury percentages higher than the Statewide Averages for similar facility types. Each link was reviewed for possible contributing factors, however, all had relatively low total numbers of accidents (32, 12, and 8, respectively), therefore, the severities may not indicate problems along the links.

Eight of the 14 injury accidents that occurred at the Bay Road interchange were at the ramp from Bay Road to Route 104 westbound where drivers are attempting to merge with high speed traffic on Route 104.

The five injury accidents that occurred along the Bay Road to Five Mile Line link were spread along the link with no identifiable high injury accident locations.

All four injury accidents at the Salt Road interchange occurred on the eastern side of the interchange where drivers are negotiating both a horizontal and vertical curve and merge/diverge area. This interchange is also the first grade separated interchange for westbound drivers as they transition from an at-grade portion of Route 104 to the grade separated expressway. Eastbound drivers are negotiating the horizontal and vertical curves, traffic merging from Salt Road, and preparing for the at-grade portion of Route 104 immediately ahead.

Route 490

The average severity of accidents that occurred through the Route 490 corridor was less than the statewide average severity rates for similar facility types. The fatality and injury accidents along Route 490 represented 25.95 percent of the total accidents, while the statewide average for fatality and injury accidents is 33.47 percent. One fatality occurred on Route 490 during the two-year study period within the Inner Loop area link. The accident information for the fatal accident indicated alcohol involvement as a cause of the accident where a driver collided with a bridge structure.

All remaining links had average severity rates less than the statewide average severity rates for similar facility types.

Route 590

The average severity of accidents that occurred through the Route 590 corridor was less than the statewide average severity rates for similar facility types. The fatality and injury accidents along Route 590 represented 23.81 percent of the total accidents, while the Statewide Average for fatality and injury accidents is 33.47 percent. One fatality occurred on Route 590 during the two-year study period at the Ridge Road interchange.

The accident information for the fatal accident indicated a driver lost control on snow/ice covered pavement and struck the guide rail.

All remaining links had average severity rates less than the Statewide Average Severity rates for similar facility types.

4. Wet Road Accidents

The wet road accident rates were summarized for all expressway links and interchanges and are presented in Exhibit C- 4 – Wet Road Accident Rates.

Route 104

Route 104 experienced a wet road accident rate of 0.09 acc/mvm, which was below the statewide average wet road accident rate of 0.20 acc/mvm for similar facility types. Only the Goodman Street interchange experienced a wet road accident rate higher than the statewide rate (0.29 acc/mvm versus 0.22 acc/mvm, respectively). Seven of the 13 wet road accidents at this interchange occurred at the ramp junctions on the west side of the interchange, to and from the adjacent service roads, as described previously in the Accident Rate section. This location contains a grade change and merge/diverge areas where drivers are likely changing lanes and may lose control of the vehicle easier due to the wet road conditions.

Route 490

Route 490 experienced a wet road accident rate of 0.34 acc/mvm, which was above the statewide average wet road accident rate of 0.20 acc/mvm for similar facility types. All links and interchanges within the corridor were also above the respective statewide averages. The Route 490 corridor is heavily traveled and congested with drivers accelerating/decelerating, changing lanes, and merging/diverging with surrounding traffic. These maneuvers increase in complexity with wet roads likely lead to the above average wet road accident rates.

Route 590

Route 590 experienced a wet road accident rate of 0.31 acc/mvm, which was above the statewide average wet road accident rate of 0.20 acc/mvm for similar facility types. Only the Empire Boulevard interchange experienced a wet road accident rate above the statewide average wet road accident rate (0.44 acc/mvm versus 0.22 acc/mvm, respectively). Half of all wet road accidents, 22, that occurred along the Route 590 corridor analyzed, occurred at the Empire Boulevard interchange. The wet road accidents appeared to be concentrated at the merge/diverge areas within the interchange links. In these areas drivers are accelerating/decelerating and changing lanes to negotiate the surrounding traffic and are more likely to lose control under wet road conditions.

EXHIBIT C-4 WET ROAD ACCIDENT RATES

Roadway	Accident Period - March 1, 2000 to February 28, 2002						
Link	Link Description	Total Accidents	Wet Road Accidents*	AADT	Link Length (miles)	Wet Road Accident Rate* (acc/mvm)	Statewide Average Wet Road Rate* (acc/mvm)
NYS Route 104	Goodman Street Interchange	120	13	68,200	0.80	0.29	0.22
	Culver Road Interchange	72	6	73,000	0.80	0.13	0.22
	Route 590 Interchange	71	4	70,000	0.80	0.09	0.20
	Route 590 to Bay Road	46	7	68,000	1.60	0.08	0.17
	Bay Road Interchange	32	5	62,000	0.80	0.12	0.22
	Bay Road to Five Mile Line Road	12	0	57,000	1.25	0.00	0.12
	Five Mile Line Road to Route 250	88	7	45,000	2.86	0.07	0.16
	Phillips Road to Salt Road	16	1	42,000	0.90	0.03	0.16
	Salt Road Interchange	8	0	33,000	0.40	0.00	0.16
	Route 104 Totals	**465**	**43**	**64,257**	**10.21**	**0.09**	**0.20**
Interstate 490	Route 390 Interchange	141	22	90,000	1.46	0.21	0.20
	Mt. Read Interchange	60	14	100,000	0.47	0.34	0.22
	Mt. Read Boulevard to Inner Loop Area	229	42	92,000	1.46	0.40	0.22
	Inner Loop Area	330	58	107,000	1.59	0.44	0.20
	Goodman Street Interchange	80	11	92,000	0.50	0.27	0.22
	Route 490 Totals	**840**	**147**	**105,770**	**5.48**	**0.34**	**0.20**
NYS Route 590	Browncroft Boulevard Interchange	29	5	90,000	0.40	0.15	0.22
	Browncroft Boulevard to Empire Boulevard	31	7	101,000	0.67	0.12	0.17
	Empire Boulevard Interchange	113	22	101,000	0.58	0.44	0.22
	Empire Boulevard to Route 104	55	6	98,000	0.85	0.09	0.17
	Route 104 Interchange	27	4	76,000	0.60	0.10	0.16
	Ridge Road Interchange	18	0	22,000	0.60	0.00	0.16
	Route 590 Totals	**273**	**44**	**50,725**	**3.70**	**0.31**	**0.20**

X.XX - Average Accident Rate higher than the Statewide Average Rate for similar facility type.

* - Excludes Non-Reportable Accidents

5. Fixed Object Accidents & Light Conditions

Available on the SIMS Summary were the fixed object accidents and light conditions for the accidents that occurred on the study area expressways. These were summarized and are presented in Exhibits C-5 & C-6.

6. Summary & Conclusions

The accident analysis has shown that the accident rates and severity along most of the study area expressways are below the statewide averages for similar facility types. Only a few links have averages or severities above the statewide averages, and in these instances, the link averages are not excessively above the statewide averages.

Consideration of ITS components is recommended at the areas with above average accident rates and severities to enhance driver awareness in these areas, reduce incident detection, response, and clean up times, and improve the safety of the environment for the emergency responders. The ITS components will likely provide cost-effective solutions rather than using the traditional costly physical modifications, typically used to improve the safety along expressways.

EXHIBIT C-5 FIXED OBJECT ACCIDENT RATES

Roadway	Accident Period - March 1, 2000 to February 28, 2002						
Link	**Link Description**	**Total Accidents**	**Fixed Object Accidents***	**AADT**	**Link Length (miles)**	**Fixed Object Accident Rate* (acc/mvm)**	**Statewide Average Fixed Object Rate* (acc/mvm)**
NYS Route 104	Goodman Street Interchange	120	14	68,200	0.80	0.31	0.20
	Culver Road Interchange	72	10	73,000	0.80	0.21	0.20
	Route 590 Interchange	71	19	70,000	0.80	0.41	0.20
	Route 590 to Bay Road	46	14	68,000	1.60	0.17	0.16
	Bay Road Interchange	32	5	62,000	0.80	0.12	0.20
	Bay Road to Five Mile Line Road	12	3	57,000	1.25	0.05	0.21
	Five Mile Line Road to Route 250	88	11	45,000	2.86	0.11	0.24
	Phillips Road to Salt Road	16	1	42,000	0.90	0.03	0.24
	Salt Road Interchange	8	0	33,000	0.40	0.00	0.24
	Route 104 Totals	**465**	**77**	**64,257**	**10.21**	**0.16**	**0.20**
Interstate 490	Route 390 Interchange	141	30	90,000	1.46	0.29	0.20
	Mt. Read Interchange	60	21	100,000	0.47	0.50	0.20
	Mt. Read Boulevard to Inner Loop Area	229	29	92,000	1.46	0.28	0.20
	Inner Loop Area	330	68	107,000	1.59	0.52	0.20
	Goodman Street Interchange	80	10	92,000	0.50	0.25	0.20
	Route 490 Totals	**840**	**158**	**105,770**	**5.48**	**0.37**	**0.20**
NYS Route 590	Browncroft Boulevard Interchange	29	4	90,000	0.40	0.12	0.20
	Browncroft Boulevard to Empire Boulevard	31	7	101,000	0.67	0.12	0.16
	Empire Boulevard Interchange	113	25	101,000	0.58	0.50	0.20
	Empire Boulevard to Route 104	55	10	98,000	0.85	0.15	0.16
	Route 104 Interchange	27	5	76,000	0.60	0.13	0.24
	Ridge Road Interchange	18	7	22,000	0.60	0.62	0.24
	Route 590 Totals	**273**	**58**	**50,725**	**3.70**	**0.41**	**0.20**

X.XX - Average Accident Rate higher than the Statewide Average Rate for similar facility type.

* - Excludes Non-Reportable Accidents

EXHIBIT C-6 LIGHT CONDITIONS

Roadway	Accident Period - March 1, 2000 to February 28, 2002					
Link	**Link Description**	**Dawn/Dusk**	**Day**	**Night**	**Not Reported**	**Total Accidents**
NYS Route 104	Goodman Street Interchange	2	49	13	56	120
	Culver Road Interchange	2	30	11	29	72
	Route 590 Interchange	1	22	17	31	71
	Route 590 to Bay Road	1	17	6	22	46
	Bay Road Interchange	1	11	2	18	32
	Bay Road to Five Mile Line Road	1	3	2	6	12
	Five Mile Line Road to Route 250	1	23	8	56	88
	Phillips Road to Salt Road	0	3	2	11	16
	Salt Road Interchange	0	3	0	5	8
	Route 104 Totals	**9**	**161**	**61**	**234**	**465**
Interstate 490	Route 390 Interchange	3	72	21	45	141
	Mt. Read Interchange	4	31	20	5	60
	Mt. Read Boulevard to Inner Loop Area	6	95	30	98	229
	Inner Loop Area	8	116	64	142	330
	Goodman Street Interchange	2	32	7	39	80
	Route 490 Totals	**23**	**346**	**142**	**329**	**840**
NYS Route 590	Browncroft Boulevard Interchange	1	6	5	17	29
	Browncroft Boulevard to Empire Boulevard	1	13	7	10	31
	Empire Boulevard Interchange	3	39	17	54	113
	Empire Boulevard to Route 104	0	23	12	20	55
	Route 104 Interchange	1	8	5	13	27
	Ridge Road Interchange	0	9	2	7	18
	Route 590 Totals	**6**	**98**	**48**	**121**	**273**

APPENDIX D
SUMMARY OF IDAS MODELING APPROACH AND MODELING RESULTS

The *Benefits Module* within IDAS is used to generate estimates of the impacts of deploying ITS on the model network. The IDAS Benefits Module is analogous to the mode choice and traffic assignment functions within standard travel demand models. The IDAS Benefits Module and assignment submodule. Traffic is assigned to the network in multiple iterations until the assignment routine converges on an optimal result. While not identical, the IDAS assignment routines are similar to those developed for travel demand models and the results generated by IDAS in Rochester provided a reasonable reflection of the assignment results from the Genesee County MPO travel demand model.

The volume/delay curves within the IDAS provide factors that instruct the assignment routine on how to reduce link speeds during the assignment as the traffic volume on the link approaches (or exceeds) the stated capacity. The IDAS software provides the capability to define six different volume/delay curves. The different curves are typically applied to various links first according to the *Facility Type*, and secondarily by the *Area Type* designations of the link.

The IDAS tool works by importing the results from travel demand models in order to recreate the validated regional network structure and travel demand within IDAS. The data are imported into IDAS using a special internal input/output interface, which is capable of reading and interpreting ASCII text data files. Once the data are imported, they are stored in a database accessible by the IDAS software and may be viewed in a graphical output by the user.

Once the data input is complete, the IDAS user is then able to create analysis alternatives by selecting ITS components from a menu of over 60 ITS improvements, and placing these on the desired location on the network. The user then provides additional information regarding their deployment, such as the implementation date and proposed operational strategies. Once the analysis alternative has been created, the IDAS software then modifies the network or travel characteristics to represent the likely impacts of the ITS deployments placed on the network by the user. These modifications are based on real-world impacts observed in other regions following their deployment of similar ITS components, and may include changes in link capacities or speeds, zone-to-zone travel times, accident or emissions rates, or other impacts specific to the ITS component.

The IDAS model then uses analysis techniques similar to those used by travel demand models to analyze the impacts created by the modifications to the alternative network and travel characteristics. A traffic assignment routine is used to estimate the changes in travel patterns caused by the modifications, and a mode shift routine can be used if adequate information are available to estimate any travel mode changes. The results of this analysis are revised link volumes and speeds, and mode shares. The changes in link volumes and speeds, and mode shares are then used by IDAS in another series of analyses to calculate changes in the travel time, the number of accidents, the amount of emissions, and other impacts. Dollar values are then applied by IDAS to these impacts to provide an estimate of the benefits of the ITS components deployed in the alternative. In a separate process, the costs of the ITS deployments are estimated by IDAS, and are compared with the benefits in the form of a benefit/cost ratio. These outputs are summarized and displayed to the user in several formats.

Exhibit D-1 provides the key values used for the IDAS analysis.

EXHIBIT D-1
IMPACT VALUES USED FOR IDAS ANALYSIS

Impact Measure	Study Value
Incident Management Systems	
Reduction in incident duration	15%
Reduction in emissions and fuel	8%
Dynamic Message Signs	
Percent time DMS sign is on and disseminating information	5%
Percent vehicles that save time	28%
Time savings	4 minutes
Highway Advisory Radio	
Percent vehicles tuned into broadcast	5%
Percent vehicles that save time	25%
Percent time of congested conditions	10%
Time savings per traveler	4 minutes

IDAS was used to estimate vehicle hours of delay saved by ITS. These results are shown in Exhibit D-2. Fuel and emissions improvements are based on vehicle hours of delay. The parameters used for this computation are shown in Exhibit D-3.

EXHIBIT D-2
ANNUAL VEHICLE TIME SAVED, FUEL SAVED AND EMISSIONS REDUCED

	Route 104 Goodman Street to Salt Road	Route 590 Route 286 Browncroft Blvd. to Titus Avenue	Route 490 I-390 to Goodman Street
Vehicle hours reduced	17,910 Passenger cars 1,140 Trucks	17,430 Passenger cars 1110 Trucks	49,540 Passenger cars 3,160 Trucks
Fuel saved (gallons)	29,600	28,600	81,600
Hydrocarbons, ROG* Tons Reduced	0.94	0.92	2.60
Oxides of Nitrogen Tons Reduced	0.53	0.52	1.41
Carbon Monoxide Tons Reduced	7.97	7.72	21.96

*Reactive Organic Gases

EXHIBIT D-3
FUEL CONSUMPTION AND EMISSIONS PARAMETERS

	Value
Auto fuel consumption rate @ 10 mph (gal/hr)	1.45
Comm. veh. fuel consumption rate @ 10 mph (gal/hr)	3.16
HC emissions rate for autos (grams/hr @ 10 mph)	43.0
HC emissions rate for comm. veh. (grams/hr @ 10 mph)	75.9
CO emissions rate for autos (grams/hr @ 10 mph)	355.5
CO emissions rate for comm. veh. (grams/hr @ 10 mph)	751.9
NO_X emissions rate for autos (grams/hr @ 10 mph)	17.8
NO_X emissions rate for comm. veh. (grams/hr @ 10 mph)	142.8

APPENDIX E
SUMMARY OF ACCIDENT REDUCTION DATA

Accident reduction is a key benefit of improved incident management and motorist information provided by ITS. Except for ramp metering (not applicable in Rochester), this benefit largely accrues from the reduction in secondary accidents resulting from shorter incident duration and the associated queue, and from improved motorist information. An accident rate reduction of 10% for the period that the RTOC is operating was assumed for the benefits analysis since comparative before and after data was not available. This assumption is based on a conservative interpretation of the data provided in the literature for improved incident management and motorist information. A summary of data on which this interpretation is based is provided below:

- The IDAS Build 2.3 manual (February 2004) describes a 21% reduction in fatalities due to a combination of improved incident detection/verification.

- The Mitre Corporation report " Intelligent Transportation Infrastructure Benefits: Expected and Experienced", January 1996 describes an accident reduction rate of 15% to 50% for freeway management systems and 10% for incident management programs.

- The Texas Transportation Institute report "Review of Evaluation methods and Reported Benefits", (S. Turner et al), Report FHWA/TX – 99/1790-1, October 1998 reports a 15% reduction in the crash rate for the initial installation of an ITS system in San Antonio.

- The FHWA database (http://www.benefitcost.its.dot.gov) reports a 40% reduction in secondary accidents in Pennsylvania resulting from the use of the Traffic Incident and Management System (TIMS) between 1993 and 1997.

APPENDIX F
COST ANALYSIS DETAILS AND METHODOLOGIES

This appendix describes the approach used to calculate costs, and provides detailed costs.

The cost elements were broken into appropriate corridor assignments. In some cases a residual cost represents that portion of the cost element that is attributable to expanded area-wide ITS operations as called for in the ITS implementation plan. This residual cost appears in the "Non-attributed Cost" column of Exhibit F-1.

Exhibit F-1 provides a summary of the costs. Details of this summary are described in the following sections. Line 5 of the exhibit indicates the capital costs and line 6 provides the annual value of these costs based on a 20 year project life and annual interest rate of 7%.

1. Fiber Optic Communication Cable Cost Distribution

The currently installed fiber optic communication system serves the ITS field equipment installations on Routes 104 and 590, and returns the signals to the RTOC through fiber optic cable on I-590 and I-390. This routing is shown by the green and light blue lines in Exhibit F-2. The installation was not only designed to serve the corridors on which ITS is currently installed, but will also service a number of corridors for which ITS will be provided in the future.

The current ITS installation on I-490 is served by leased communications. Future plans call for a fiber optic cable installation on I-490 to be returned to the RTOC via future fiber cable on I-390.

Since the fiber optic cable system will be coordinated with an area-wide ITS implementation plan, a preliminary fiber optic system deployment concept was developed for this purpose.

To identify such a network, a preliminary ITS deployment plan was first developed. This plan assumes that ITS field equipment deployment intensities will be provided in accordance with traffic conditions. This was done by using the ITS deployment levels recommended in the ITS Scoping Methodologies developed by NYSDOT (3). Three deployment levels are defined as follows:

Deployment Level 3 – Level of Service D or worse. ITS device deployment includes nearly continuous surveillance and robust motorist information.

Deployment Level 2 – Level of Service C or worse (small congested sections may be included). ITS device deployments are generally similar to that used on Route 104.

EXHIBIT F-1
PROJECT COST

	ITEM	COST (K$)	Rt 104 Corridor Attribution Cost Factor	Rt 104 $K	Rt 590 Corridor Attribution Cost Factor	Rt 590 $K	I-490 Corridor Attribution Cost Factor	I-490 $K	Non-attributed Cost Factor	Non-attributed $K
1	Capital less fiber			1333		667		2496		600
2	Attributed fiber comm		0.581	3078.3	0.124	659.4	0.125	661.5	0.170	900.8
3	Attributed 5 yr leased comm.							215		
4	Attributed additional TOC	500	0.165	82.5	0.082	41	0.091	45.5	0.662	331
5	Total Capital Cost			4493.8		1367.4		3418		1831.8
6	Annualized Capital Cost			424.2		129.1		322.6		
	OPERATIONS (ANNUAL)									
7	TOC Office	366	0.165	60.4	0.082	30.0	0.091	33.3	0.662	242.292
8	Attributed Utilities (excluding leased communications)	50	0.49	24.5	0.24	12	0.29	14.5		
9	Total Operations			84.9		42.0		47.8		242.3
	MAINTENANCE (ANNUAL)									
10	Non-fiber optics equipment			41.69		20.81		78.02		18.75
11	Fiber optics cable equipment			96.23		20.61				48.88
12	Total maintenance	325	0.581	137.92	0.124	41.42		78.02	0.295	67.63
13	TOTAL ANNUALIZED COST			647.0		212.5		448.5		

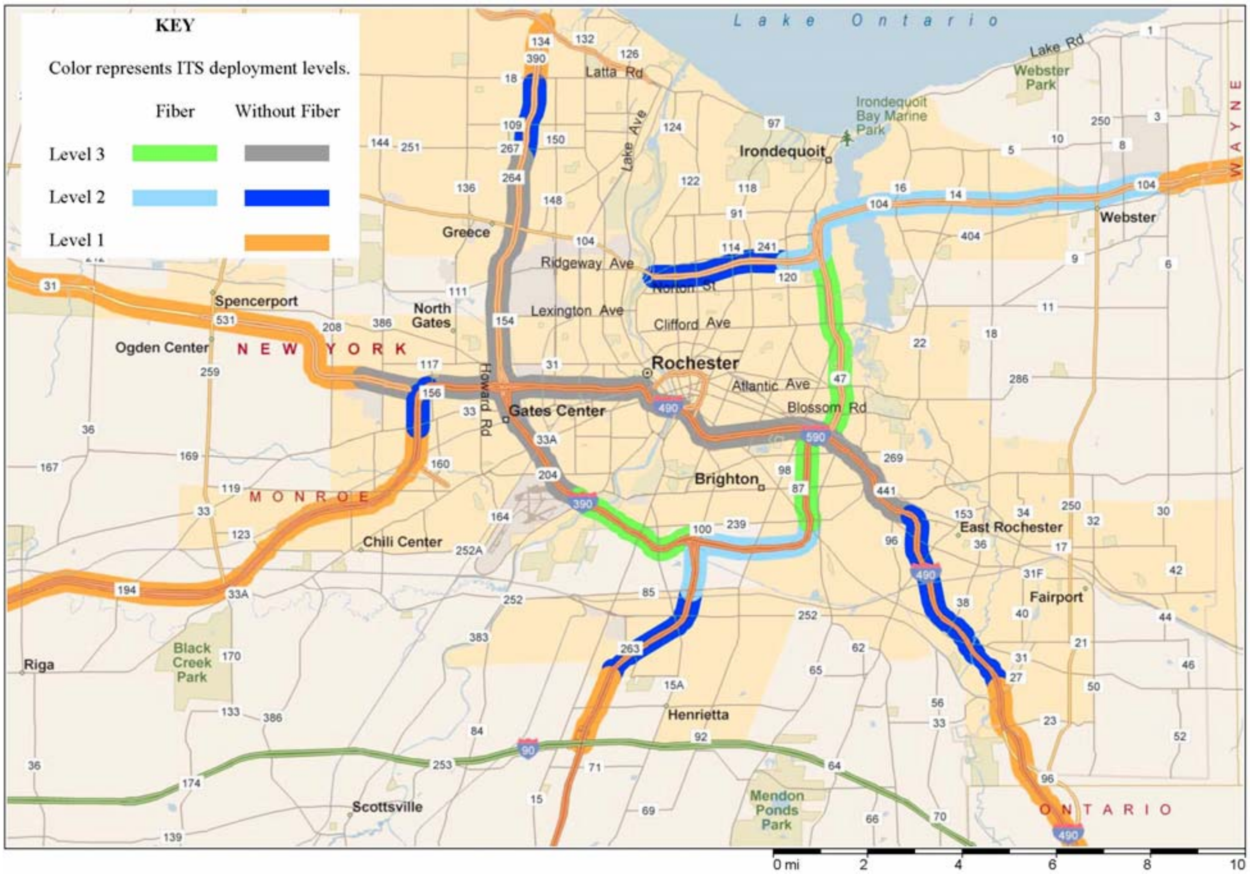


EXHIBIT F-2
ASSUMED DEPLOYMENT LEVELS AND EXISTING FIBER OPTIC COMMUNICATIONS

Deployment Level 1– Generally better than level of Service C. ITS device deployments are relatively sparse and motorist information for other conditions such as construction, weather, special events, etc. may be important objectives.

The expressways were categorized by these levels using current volumes and anticipated near term growth as a basis. Exhibit F-2 shows these categories, along with current fiber optics cable deployments.

It is anticipated that the Level 3 roadway sections not currently serviced by fiber will ultimately receive fiber cable installations. Thus the fiber plant when completed will include the current fiber deployment (shown in green lines in the figure) and additional Level 3 roadways (shown by the grey lines in the figure).

Exhibit F-3 shows the nodes attached to the fiber optic system deployment concept for the purpose of facilitating the cost analysis. The cost analysis technique is described below.

The actual (physical) cost of the fiber installation for a section is the fraction of the cost of the entire fiber network prorated by mileage. Thus the cost for physical section KP is given by

Physical cost (KP) = (Cost of fiber network)*Miles(KP)/(Miles in fiber network)

Each physical section of the roadway may be functionally used by the ITS devices in either of the following ways:

- It may collect the data from devices in the section.
- It may transport the data developed by another section.

The spreadsheet cells populated by "1" represent the condition where a physical section of cable either collects the data from devices in the functional section or transports the data from another section. The cost of the functional section is represented by the fraction of the fiber it uses in each of the physical sections through which the signal travels.

Thus, computation of the functional cost for Section JK requires the consideration of signals originating in JK as well as the pass through service that sections KP and AP provide for these signals.

Note that Section JK also provides "pass through" service to signals originating in Section CJ. Thus physical section JK services two functional sections as shown in the "Total Number Sections Served" column in Exhibit F-4. The other physical sections that contribute to service for JK (Sections AK and KP) are charged to Section KJ in a similar way. This leads to the following expression

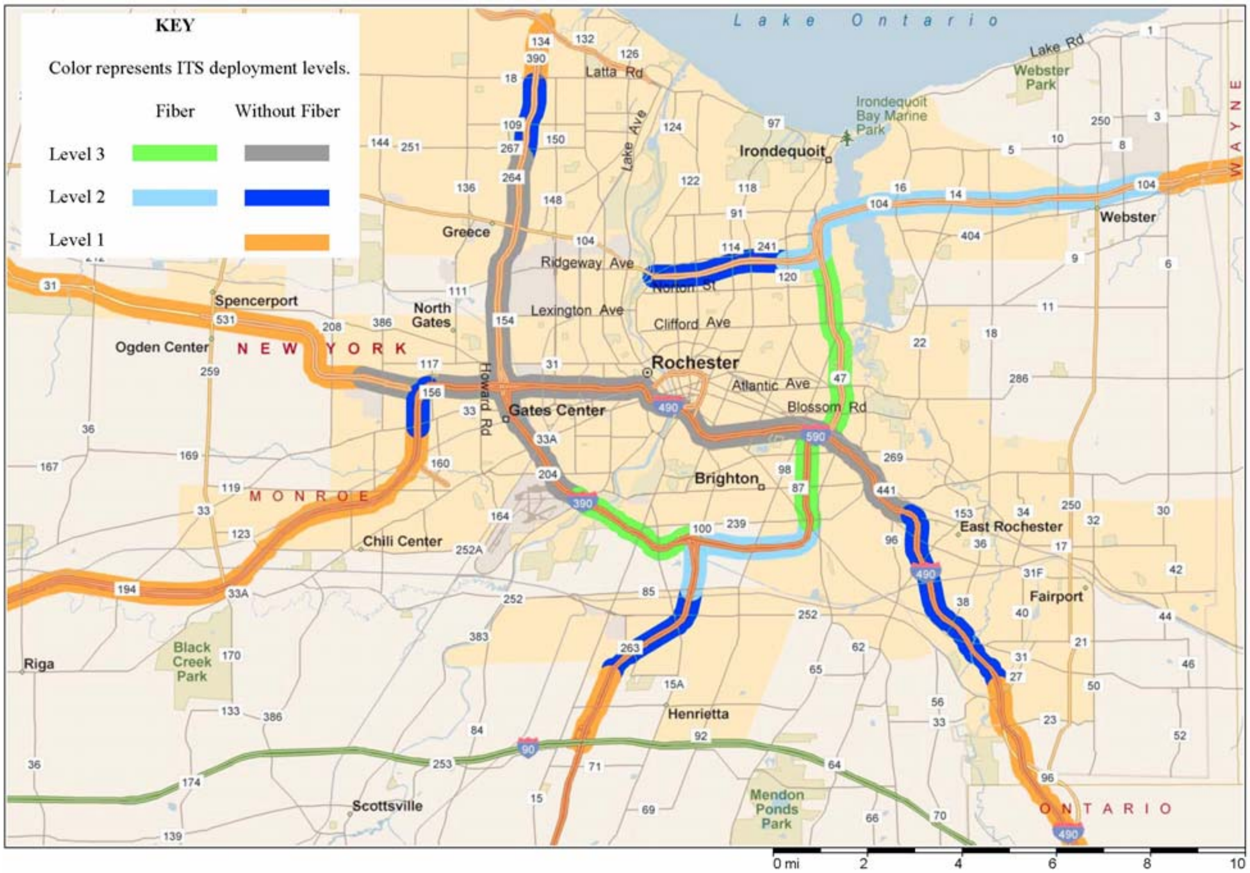


EXHIBIT F-3
NODES FOR EXISTING FIBER OPTIC SYSTEM

Functional cost(JK) = Physical cost(AP)/16 + Physical cost(JK)/2 + Physical cost(KP)/6

This analysis was implemented by the spreadsheet shown in Exhibit F-4.

The projected cost of the completed fiber optic cable system shown in Exhibit F-2 is $9.516 million. Exhibit F-1 (line 2) provides the allocation of this cost among the current corridors on the basis of a completed fiber optic cable system.

Currently, leased communication lines connect the devices on I-490 with the RTOC. Since it is expected that this service will be provided for only five years and that fiber optic cable will be employed after that time, the five year leased costs were treated as a lump sum item equivalent to capital cost (line 3 of Exhibit F-1).

2. ITS Non-Fiber Optic Field Equipment Capital Cost

The capital cost for the non-fiber optic field equipment (Exhibit F-1, line 1) for the three corridors was computed as follows:

Route 104 and Route 590

The difference between the total construction cost of the ITS installation on these expressways (Contract D258274) and the fiber optics cable system cost included in this contract represents the capital cost of the ITS non-communications field equipment. This cost was allocated between the two routes on a mileage basis. The cost for the shared section of roadway for these routes was distributed equally between these routes.

I-490

The contract under which the ITS for I-490 was implemented (D259124) also contains one VMS on route 390 and one VMS on I-390. While these VMS influence traffic on I-490, they also influence traffic on Route 390 and I-390. Similarly, VMS on I-490 also influence traffic destined for other corridors. For this reason, the ITS equipment cost (with the exception of fiber optics communications) will be allocated to the corridor on which this equipment is located. Thus, the capital cost for ITS equipment on I-490 was considered to be the value of Contract D259124 less the cost of the installation of the VMS on route 390 and on I-390.

3. Field Equipment Maintenance Cost

The maintenance cost of the currently installed field equipment is estimated at $325,000 per year. This cost covers the maintenance of current ITS devices as well as the maintenance of the existing fiber optics communication system. Maintenance cost estimates for the individual corridors were developed in the following way:

EXHIBIT F-4

FIBER OPTIC COMMUNICATIONS ANALYSIS
SECTION FUNCTIONALLY SERVED

CABLE SECTION	CABLE SECTION PHYSICAL COST $K	BP	BQ	BS	CJ	CR	CS	DR	EF	EH	ER	FG	JK	KL	KM	KP	MN	TOTAL NUMBER SECTIONS SERVED	CABLE SECTION	Existing Cable Length Mi	Prorate Cost Existing $K	Proposed Cable Length Mi	Prorate Cost Proposed $K
AP	69.66	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16	AP	0.3	69.66		
BP	643.194	1	1	1		1	1	1	1	1	1	1						10	BP	2.77	643.194		
BQ	373.842		1															1	BQ	1.61	373.842		
BS	645.516			1		1	1	1	1	1	1	1						8	BS	2.78	645.516		
CJ	76.626				1													1	CJ	0.33	76.626		
CR	76.626					1		1	1	1	1	1						6	CR		0	0.33	76.626
CS	450.468					1	1	1	1	1	1	1						7	CS	1.94	450.468		0
DR	580.5							1										1	DR		0	2.5	580.5
EF	181.116								1			1						2	EF	0.78	181.116		0
EH	192.726									1								1	EH	0.83	192.726		0
ER	903.258								1	1	1	1						4	ER	3.89	903.258		0
FG	1699.704											1						1	FG	7.32	1699.704		0
JK	1091.34				1								1					2	JK			4.7	1091.34
KL	1212.084													1				1	KL			5.22	1212.084
KM	394.74														1		1	2	KM			1.7	394.74
KP	668.736				1								1	1	1	1	1	6	KP			2.88	668.736
MN	255.42																1	1	MN			1.1	255.42
TOT	9515.556																						
COST OF FUNCTIONAL SECTION		68.7	442.5	149.4	738.1	226.5	213.7	807.0	542.9	645.0	387.9	2161.9	661.5	1327.9	313.2	115.8	568.6		TOTAL	22.55	5236.11	17.33	4279.446

SUM FUNCTIONAL SECTIONS = 9370.5

* Physical cost (KP) = (Cost of fiber network)* Miles(KP)/ (Miles in fiber network)

** Functional cost(JK) = Physical cost (AP)/16 + Physical cost (JK)/2 + Physical cost (KP)/6

Current cable cost = 5300

Cable system cost for complete system 9373

Complete estimated mileage 39.88

Functional Cost for Fiber Comminications for Existing ITS ($K)

Functional Routes	Functional Cost
Route 104 (Sections FG, EH, 0.5*EF)	3078.3
Route 590 (Section ER, 0.5*EF)	659.4
I-490 (Section JK)	661.5

a. Costs were broken into fiber optics maintenance costs and maintenance for the other ITS field devices as a proportion of capital cost.
b. The non-fiber optics ITS devices maintenance costs were apportioned to corridors based on construction cost. Mileage was used as the basis for dividing the cost between the Route 104 and the Route 590 corridors. These costs are shown in the Route 104 and Route 590 columns of line 10 in Exhibit F-1.
c. The non-fiber optics maintenance cost for the equipment installed under the I-490 contract was apportioned between the I-490 Corridor and the non-attributed cost column on the same basis as the capital costs. This is shown on line 10 of Exhibit F-1 in the I-490 Corridor and non-attributed columns.
d. The fiber optics maintenance costs were computed as follows. The fiber optics cable system maintenance costs for the Route 104 and Route 590 corridors were assigned in the same proportion as the capital cost proportions (Line 2). Since the I-490 corridor currently has no fiber optics cable, the share of the maintenance that would have resulted from the attributed capital cost in line 2 (.125) was included in the "Non – attributed Cost" column, in addition to the non-attributed cost share on line 2 (.170).

4. RTOC and Other Costs

Capital Equipment

The principal capital equipment cost not included in the corridor construction contracts is the cost of the computer equipment and software located in the RTOC ($500,000). This equipment will not only serve the current corridors but will also coordinate equipment for future ITS installations. When complete, the bulk of the ITS equipment will be located in the Level 2 and Level 3 corridors of Exhibit F-2. The allocations of the computer equipment costs to each current corridor and to future corridors (non-attributed cost column) were made on the basis of mileage and are shown in line 4 of Exhibit F-1.

Operations

The current annual staffing cost is $271,000. The staff will serve, with some additions, to operate the entire ITS network when complete. Assuming a 35% increase for this purpose, the cost to operate the corridor is estimated at $366,000. This was distributed among the corridors in the same proportions as for the RTOC equipment cost (see line 7 of Exhibit F-1).

Utilities

The utility costs for existing field equipment ($50,000) were apportioned to the existing ITS corridors on a mileage basis (line 8 of Exhibit F-1).

APPENDIX G
CONSULTATION WITH LOCAL LAW ENFORCEMENT, TRANSPORTATION AND OTHER AGENCIES

Meetings and telephone conversations were conducted with agencies charged with the provision of law enforcement, emergency services and other transportation related officials to assess the ability of ITS to facilitate incident management. This appendix summarizes the results of this study.

1.0 INTERVIEW PARTICIPANTS

Twenty-seven organizations were invited to participate in the data collection process. The interviews spanned different agency types in order to assess the impact of ITS on individual incident management responsibilities. Twenty interviews were conducted. Participants are listed below along with a brief description of their role in incident management.

- Brighton Ambulance - Brighton Ambulance responds to incidents on Route 590 (from Browncroft to Route 390), Route 490 (from the East Rochester to Can of Worms), and Route 390 (from Brighton Henrietta Townline Road to West Henrietta Road).
- Brighton Fire Department - Brighton Fire responds to incidents on Route 490 (from Route 31F to Can of Worms), Route 390 (Erie Canal on both sides), and Route 590 (from Browncroft to I-390).
- Brighton Police Department - Brighton Police responds to incidents on expressway ramps within the Town of Brighton.
- Gates Police Department - Gates Police provides assistance when the Sheriff's Office and/or NYSP request help with major incidents on the expressway.
- Gates Fire Department - Gates Fire responds to incidents on I-390, I-490, and NY 531.
- Genesee Transportation Council (GTC) - GTC is the Metropolitan Planning Organization (MPO) for the Rochester metro area. They provide planning services in support of ITS projects.
- Irondequoit Ambulance - Irondequoit Ambulance responds to incidents on Route 104 and Route 590 within the Town of Irondequoit.
- Irondequoit Police Department (IPD) - Irondequoit Police support the NYSP on Route 104 and Route 590 within the town limits during the daytime, and they provide one patrol car on the expressways from about midnight to 8:00 a.m.
- Metro Networks - Metro Networks is a private media company that monitors traffic conditions and distributes traveler information.
- Monroe Ambulance - Monroe Ambulance responds to incidents in Monroe, Livingston, and Wyoming.
- Monroe County Department of Transportation (MC DOT) - Located in the RTOC, MC DOT controls all of the traffic signals in the County. MC DOT works with NYSDOT to create and execute incident diversion plans.
- Monroe County Emergency Communications Department (911 Center) - The 911 Center is the hub for all communication with all parties regarding incidents in the Rochester area. Police, fire, and ambulance are dispatched via the 911 Center.
- Monroe County Office of Emergency Preparedness (OEP) - The OEP gets involved in extremely severe incidents of regionwide significance. In addition, the physical components of the EOC act as a redundant system in case of RTOC system failure.

- Monroe County Office of the Fire Bureau - The Fire Bureau responds to all HAZMAT incidents and coordinates multiple agency response to major incidents on the expressways.
- Monroe County Sheriff's Office - When a County Sheriff car is closest to an incident in the State's jurisdiction, the Sheriff's Office acts as the first responder. Otherwise, they provide back-up to State Troopers on the expressways.
- New York State Police, Rochester (NYSP) - State Troopers are the primary responders for Route 104 in Webster,/Irondequoit/Rochester, I-590 in Rochester, I-490 in Rochester, I-390 in Greece, and the Innerloop.
- Ridge Road Fire Department - Ridge Road Fire responds to incidents on Route 390 (from Lexington to LOSP) and Route 104 (from Mt. Read to Manitou Road).
- Webster Fire Department - Webster Fire responds to incidents on Route 104 from Salt Road to Hard Road.
- Webster Police Department - When a Webster Police car is closest to an incident on Route 104 in the town of Webster, Webster Police acts as the first responder. Otherwise, they provide back-up.
- West Webster Fire Department - West Webster Fire responds to incidents on Route 104 from the Irondequoit Bay Bridge to Hard Road.
- We were unable to conduct interviews with the following organizations:
- Gates Ambulance - Unable to schedule interview.
- Greece Ambulance - Unable to schedule interview.
- Greece Police Department - Unable to schedule interview.
- Irondequoit Fire Department - Unable to schedule interview.
- Rochester Fire Department - Rochester Fire declined to participate and recommended interviewing the Fire Bureau.
- Rochester Police Department - Rochester Police declined to participate and deferred to county and state police. They do not typically respond to traffic incidents on any of the expressways.
- Rural Metro Ambulance - Unable to schedule interview.

2.0 INTERVIEW RESULTS

A discussion guide was developed for the interviews, which were conducted either in person or via telephone. The guide provided a brief description of this project and the purpose of the interview. Questions focused on familiarity with the ITS program, incident management practices, data sharing activities, effectiveness of the ITS, and general comments/feedback.

In general, each of the state and county agencies (NYSP, Sheriff's Office, OEP, Metro Networks, 911 Center, Monroe Ambulance, Fire Bureau, and MC DOT) offered unique perspectives. Local agencies on the other hand, had similar perspectives. As local departments have comparable roles and responsibilities when responding to incidents on the expressways, their responses have been compiled into three groups for police, fire, and ambulance. The Genesee Transportation Council (GTC) provides the essential support and funding of incident management and ITS projects in the metropolitan area, however they are not directly involved with everyday incident management practices. Therefore the data they provided is not included in the following quantitative analysis. The information GTC provided is in Section 2.5. The following sections summarize the results of the data collection effort.

2.1 FAMILIARITY WITH ITS

Interviews were arranged with individuals based on their availability. Therefore the staff person with the most knowledge about Rochester's ITS program wasn't necessarily involved in the interview. For instance, interviews with local emergency response departments involved representatives with anywhere from five to 30 years of experience. It is possible that this accounts for some of the lack of familiarity with the Rochester ITS program.

As shown in Figure 2.1, the large majority of interviewees were at least somewhat familiar with the capabilities of the ITS in and around Rochester. However, most local municipalities do not know the term "ITS" and required a description of the DMS and HAR signs in order to answer this question. Four of the 19 respondents were not at all familiar with the system. Two of these four indicated although not familiar with the system, they are somewhat familiar with the field devices. As area residents, they had seen the signs, but did not know the true capabilities of the system and/or have never seen the signs in operation.

Just over half (10) of the interviewees have not visited the RTOC. Most of these are local fire/ambulance/police, however Monroe Ambulance and the County Fire Bureau are included on this list. Although they had not actually been there, five of the 10 indicated they were at least somewhat familiar with RTOC personnel and their duties. The response to the question about familiarity with RTOC staff and functions is provided in Figure 2.2.

Figure 2.1 - Familiarity with the ITS Capabilities

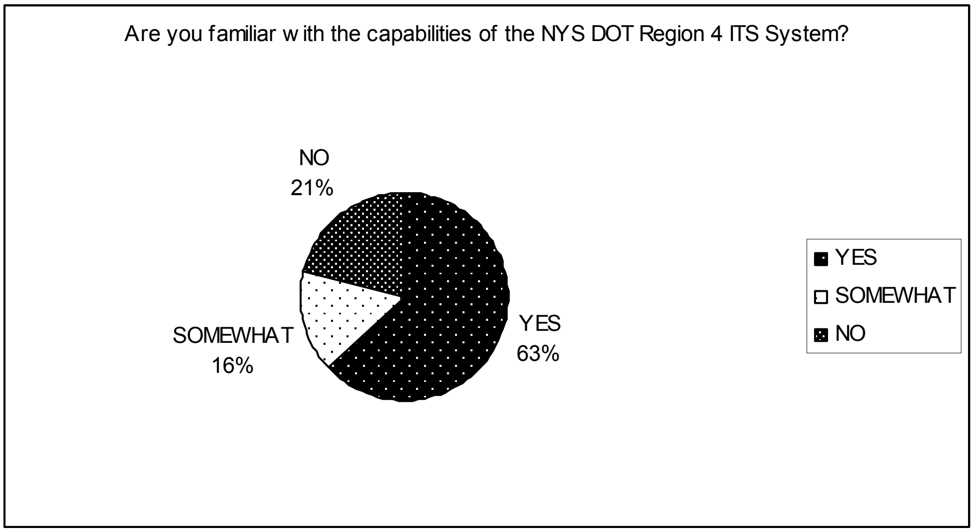
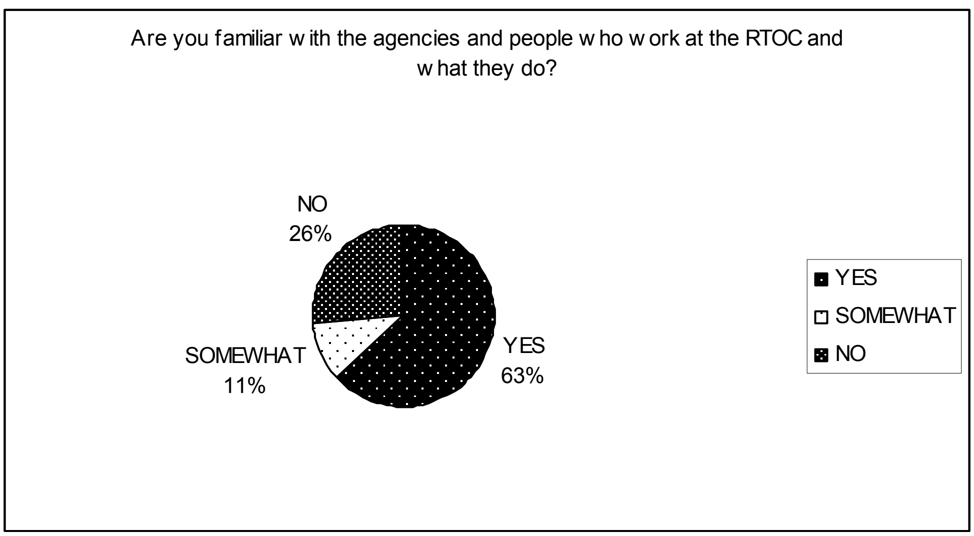


Figure 2.2 - Familiarity with the RTOC Staff and Functions



2.2 INCIDENT MANAGEMENT PRACTICES

Questions 5 through 8 of the discussion guide pertain to incident management practices. As outlined in Section 1.0, each stakeholder plays a distinct role in incident management, particularly with regard to jurisdictional area. All locations in the County are preset with designated primary responders, including ambulance, police, and fire department (based on proximity). This information is formally documented and built into the 911 CAD system to ensure the closest available response vehicle is dispatched to each incident. Piecing together the interview responses, the following sections review how each organization's practices fit together in the overall incident management program for the Rochester area. Generally, information comes in through the 911 Center and is distributed to police, fire, ambulance (for emergency response) and to the RTOC (for traffic management). In extreme cases, the OEP will take over interagency coordination for emergency response. Travel information is disseminated to the public via DMS, HAR, Metro Networks, WHAM 1180, and other media outlets.

911 Center

The 911 Center is accredited and follows formal policies and procedures by the Commission for Accreditation of Law Enforcement Agencies (CALEA) and also by the National Academy of Emergency Dispatch. It serves as the clearinghouse for all incident information and interagency coordination. Calls are logged into the CAD system as they are received. Police, fire, and ambulance are dispatched to incidents through 911. Emergency responders provide feedback to the 911 Center with incident information such as exact incident location and status updates. Requests for specialized equipment or additional support in the field are also made through 911.

Emergency responders communicate with 911 personnel using radio, wireless pagers, text messaging, and Station PCs. Station PCs are located in the RTOC and at all police, fire, and ambulance stations. These computers provide comprehensive incident information from the 911 Center.

Interviewees expressed overwhelming approval of the 911 Center. They agree that having one centralized location for all incident information is efficient and effective. Figure 2.3 shows the Emergency Communications Center building. Figure 2.4 shows a 911operator console in the temporary control center room. A new room is currently under construction and is located in the same building.

Figure 2.3 - Emergency Communications Center (911 Center) Building

Figure 2.4 - 911 Center Control Room

Police

Officially, State Troopers have jurisdiction over all incidents that occur on the expressways. However, policy also states that the closest patrol car to the incident (state or other) shall respond to the scene. The County Sheriff's Office frequently acts as a primary responder when nearest to an incident. They also provide backup support upon request. It is unusual for the Rochester Police to respond to incidents on any of the expressways. Local/town police departments will respond on expressways in their town if they are closest to the incident site, however they typically support the County or State by providing traffic management around a large incident (i.e., closures, detours, etc.). Local police do have jurisdiction over expressway ramps in their respective towns.

Police are dispatched to incidents by the 911 Center. A command post is set up in the field for any incident (small or large) involving multiple emergency response personnel.

Fire

Local fire departments are the first responders to incidents on the expressways within their jurisdictional area. They follow the County Mutual Aid Plan, which states that when the local fire department is not available, the next closest jurisdiction responds. The local department eventually takes over when they arrive on scene. The County Fire Bureau gets involved with all HAZMAT incidents. They also provide coordination during severe incidents when multiple fire departments are required.

For the most part, fire departments are dispatched to incidents by the 911 Center. Some local fire departments have their own dispatch center, however all incident information is relayed to the 911 Center.

Interviewees indicated that by law the local fire department leads incident command in the field, however this is not strictly enforced. They explained that emergency responders are well seasoned in their responsibilities and work well together with all the emergency responders on scene toward a common goal.

Ambulance

Ambulatory responders also follow the County Mutual Aid Plan described above. However, whichever ambulance arrives on scene first remains with the injured in the lead role. Secondary responders play support roles upon arrival. Multiple agency coordination is done at the scene. In contrast to police and fire, the ambulance does not really get involved with traffic management.

All emergency responders follow formal procedures established by the Regional Emergency Medical Administration Council (REMAC). REMAC is a group of doctors that meet regularly to evaluate emergency response. The seven-step process is as follows:

1. Dispatch receives call and classifies the possible injuries from 1 to 4 (1 being most severe).
2. Local Emergency Responder (LER) is dispatched to scene.

3. LER calls 911 with what people and equipment they are responding.
4. LER calls 911 when they arrive on scene to verify original call.
5. LER calls 911 when they leave scene and notifies them where they are going (hospital, etc.).
6. LER calls 911 when they arrive at the hospital, etc.
7. LER calls 911 when they get back to let them know they are available for another call.

Regional Traffic Operations Center

The RTOC is the control center for the system, which includes CCTV cameras, DMS, HAR, RWIS, and traffic signal control. Using these ITS tools, the roadways are continuously monitored and analyzed at the RTOC so they are ready to take action when an incident occurs. All traffic-related incident management responsibilities are coordinated here.

The NYSDOT, MC DOT, and the NYSP are co-located in the RTOC. When an incident occurs on one of the expressways, they work together to identify where traffic can be diverted. NYSDOT will disseminate travel information on the DMS and HAR. MC DOT will temporarily modify signal timing and phasing to accommodate the diverted traffic. Figures 2.5 and 2.6 show the outside and the inside of the RTOC, respectively.

Figure 2.5 - Regional Traffic Operations Center Building

Figure 2.6 - Regional Traffic Operations Center Control Room

Office of Emergency Preparedness

The OEP is activated to manage severe incidents, such as weather events, evacuations, etc., that require a coordinated, regional response. During such an incident, they activate the Emergency Operations Center (EOC) where the OEP brings together and coordinates all related emergency management organizations under one roof. They only become involved in traffic-related incidents in the case of major incidents of regional significance, such as a bridge collapse. Figure 2.7 displays the interior of the EOC, which is located across the street from the RTOC. They have designated seats for all the public agencies who might be involved in managing emergencies and major incidents. NYSDOT staff fills two of these seats and serve as the points of contact with the RTOC. The RTOC remains responsible for traffic management during all incidents.

The physical system in the OEP also serves as a redundant system for the RTOC. In the event of an RTOC system failure, for example, the OEP is equipped with the necessary communications and system components to provide traffic management functionality.

Figure 2.7 - Emergency Operations Center

Metro Networks

Metro Networks is one provider of traveler information services to the public. They coordinate closely with the 911 Center and the RTOC to provide the most up-to-date information on roadway conditions and incident/road work information. They use their airplane to monitor traffic conditions. When weather conditions prohibit flying, they use a car to see how things are moving. Metro Networks provided RTOC with a scanner that allows them to monitor Metro Networks' two-way radio communication. The scanner enabled the RTOC to hear traffic condition and incident information as they are being reported by the airplane or the car.

2.3 DATA SHARING ACTIVITIES

The interviewees responses to questions on data sharing and/or communications links with the RTOC. Results are shown in Table 2.1, along with the specific methods of existing and future planned communications links with the RTOC.

NYSDOT and MC DOT are located inside the RTOC building. The NYSP communications/dispatch console is in the same room as NYSDOT and MC DOT operations personnel. The remainder of the NYSP barracks is located on the other side of the same building. The three agencies work together in the control room and coordinate during incidents. When an incident occurs, they commonly "yell across the room" to communicate with one another.

Table 2.1 Interviewees with Direct Communication Link to RTOC

Agency	Yes	No	Existing Methods	Planned Methods
New York State Police – Rochester	1		Located inside RTOC	HELP (radio)
Monroe County Sheriff's Office		1	None	None
Monroe County Office of Emergency Preparedness	1		Fiber, LAN, WAN, Phone, E-mail	Expand in parallel with RTOC
Metro Networks	1		Phone, E-mail, Scanner, Fax	None
Monroe County 911 Center	1		Station PCs, Scanners	CCTV
Monroe Ambulance		1	None	None
Monroe County Office of the Fire Bureau		1	None	None
Monroe County DOT	1		Located inside RTOC	None
Local Fire		5	None	None
Local Police		4	None	None
Local Ambulance		2	None	None
Total	5	14		

Although the OEP is only active during severe incidents, they are directly connected to the RTOC via fiber optic cable, WAN, LAN, phone and e-mail. The OEP can view NYSDOT's CCTV images and will be able to view County intersection cameras in the future. As the RTOC expands its system capabilities, the EOC plans to increase their capabilities as necessary in order to maintain system redundancy.

Currently the Station PC and wireless paging system serve as the communication links between the 911 Center and the RTOC. The 911 Center plans to view images from the CCTV cameras by the end of 2004.

Metro Networks supplied the RTOC with a scanner that enables the RTOC to monitor Metro Networks' two-way radio communication. The scanner enables the RTOC to listen to incident and traffic condition information as they are being reported by Metro Networks field personnel. The RTOC provides advance notification to Metro Networks regarding upcoming roadwork. Urgent information is exchanged back and forth regularly via telephone regarding incidents and roadway conditions during peak hours.

All the organizations without direct links to the RTOC are indirectly connected through the 911 Center. This includes local ambulance, police, and fire departments as they have Station PCs and wireless pagers that provide incident information. NYSP is the only agency planning to initiate a direct link in the near future. The upcoming HELP program vehicles will be able to communicate directly with the troopers via NEXTEL.

2.4 EFFECTIVENESS OF ITS

With regard to the effectiveness of the ITS, although most of the respondents said they "don't know" or chose not to answer the question, several were comfortable enough to provide their perceptions. In some cases, these speculations are concrete. For example, Metro Networks has witnessed vehicles diverting away from an incident after information has been disseminated.

Both qualitative and quantitative questions were posed, however interviewees were unable or uncomfortable to supply the numerical statistics. None of the interviewees collected data on cost savings.

The following 11 figures show interviewee responses when asked about the effectiveness of the system on:

- Reducing the risk of injury to emergency response personnel;
- Reducing the risk of injury to travelers;
- Reducing the number of accidents;
- Reducing the number of secondary accidents;
- Reducing the number of fatalities;
- Reducing incident detection times;
- Reducing verification times;
- Reducing response times;
- Reducing information dissemination times;
- Reducing clearance times; and
- Diverting traffic away from an incident.

Figure 2.8 - Reducing Risk of Injury to Emergency Response Personnel

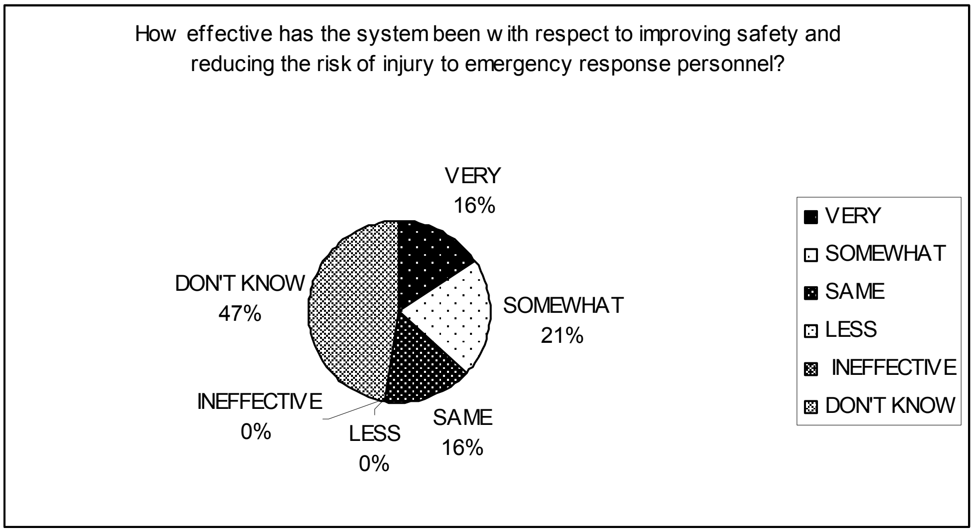


Figure 2.9 - Reducing Risk of Injury to Travelers

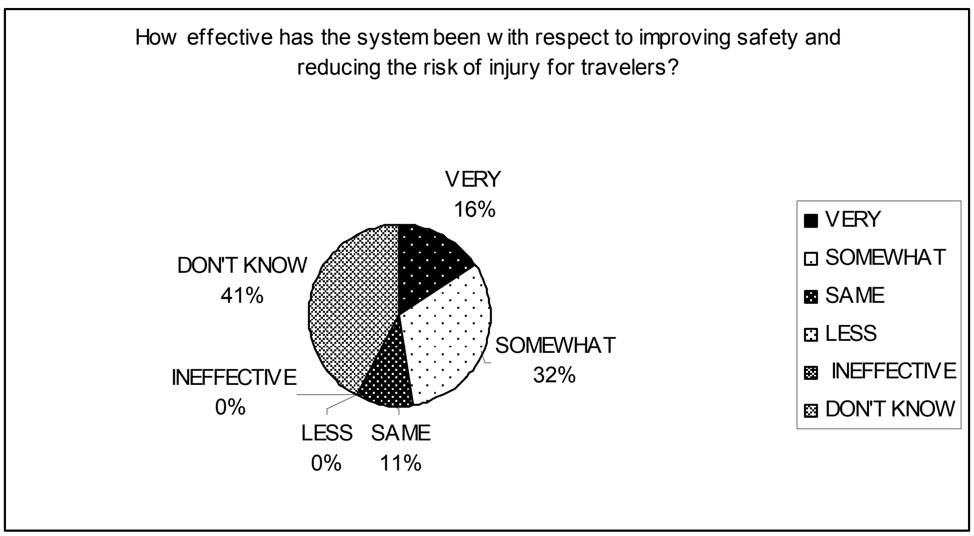


Figure 2.10 - Reducing Number of Accidents

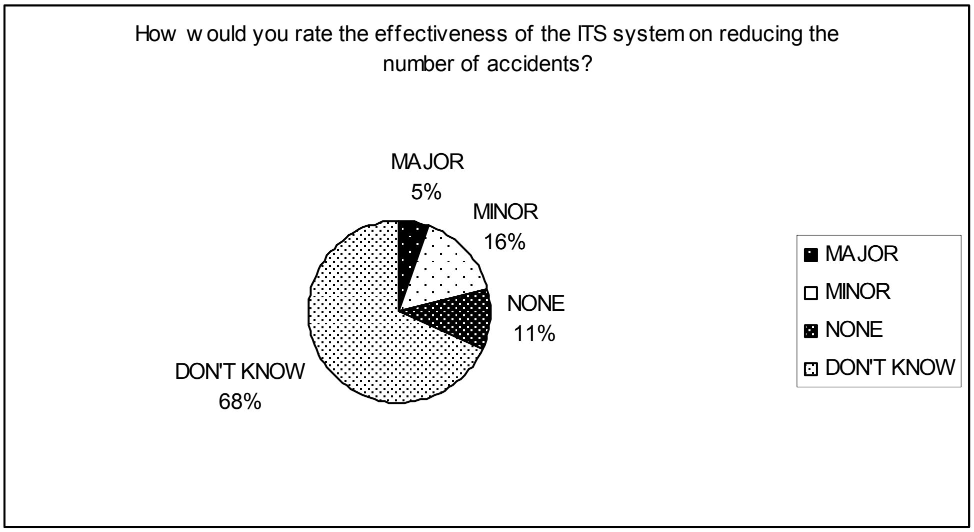


Figure 2.11 - Reducing Number of Secondary Accidents

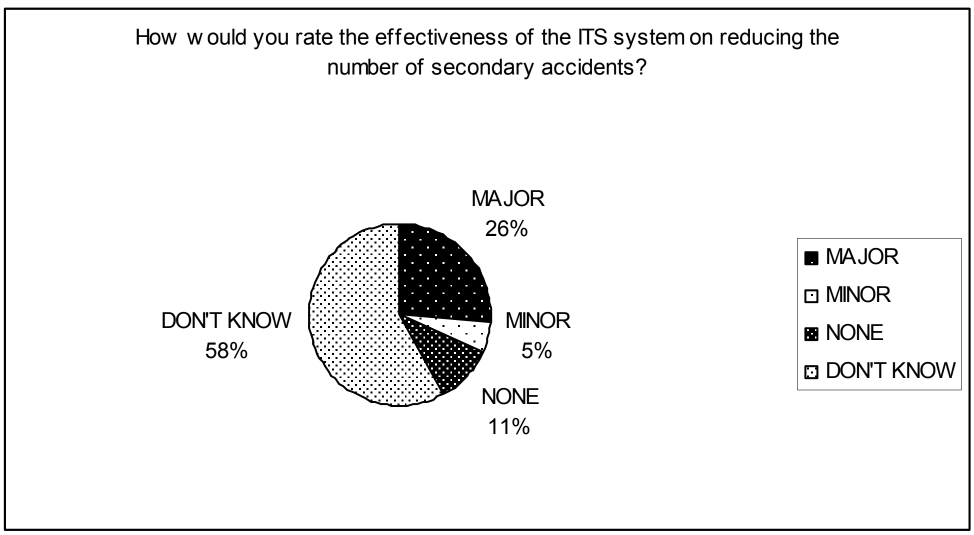


Figure 2.12 - Reducing Number of Fatalities

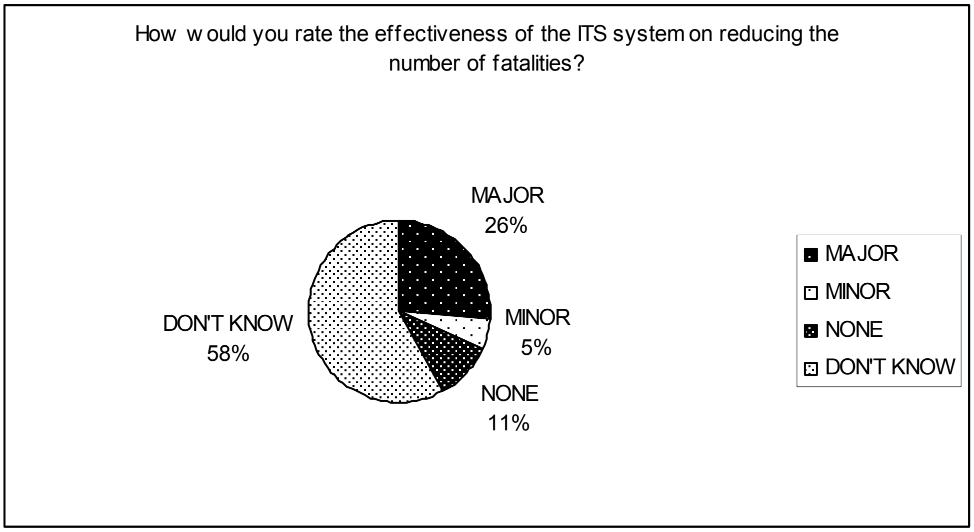


Figure 2.13 - Reducing Incident Detection Times

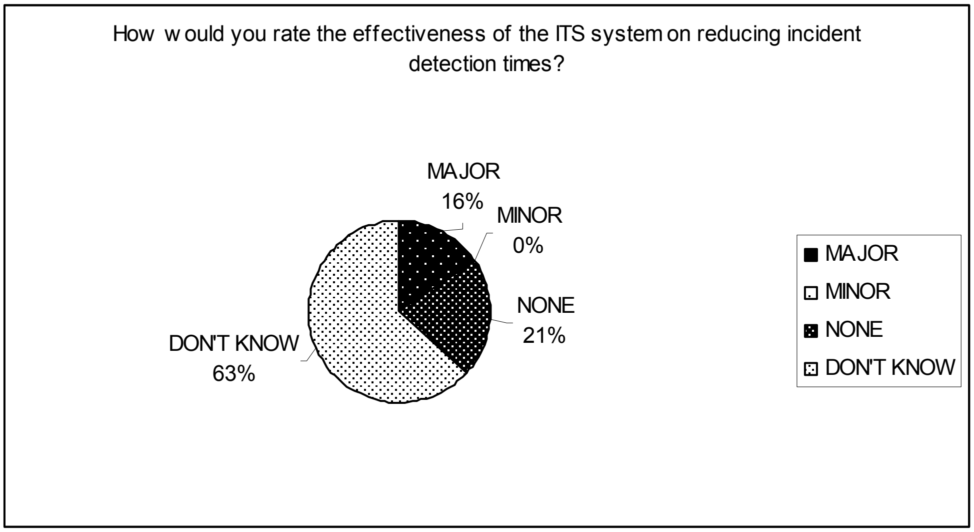


Figure 2.14 - Reducing Verification Times

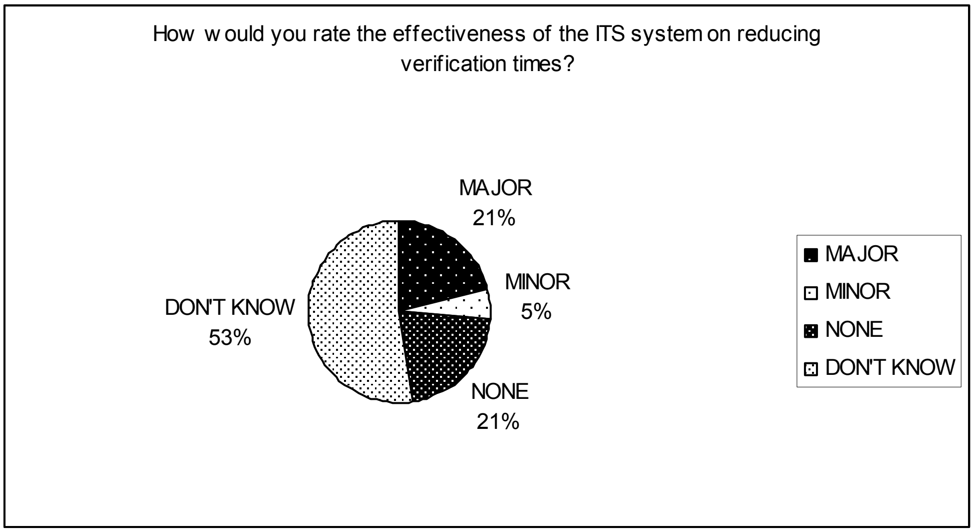


Figure 2.15 - Reducing Response Times

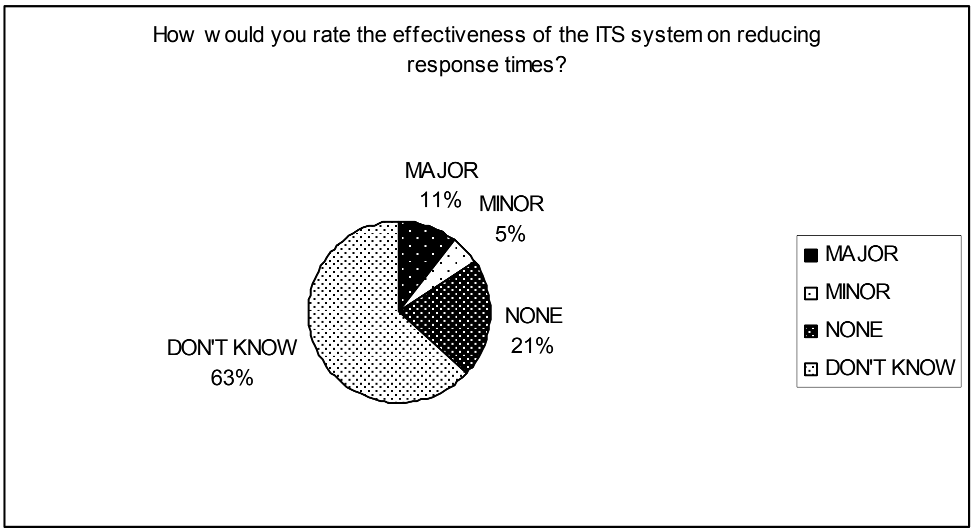


Figure 2.16 - Reducing Information Dissemination Times

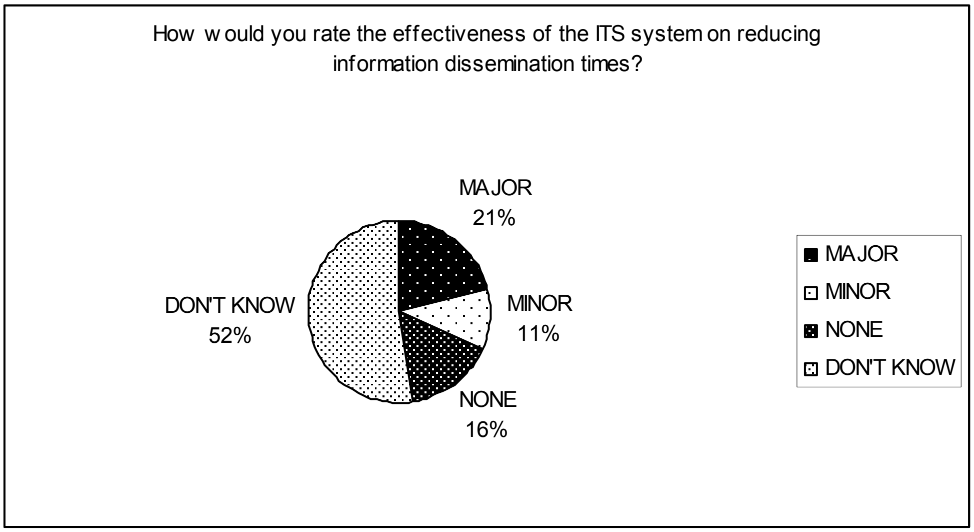


Figure 2.17 - Reducing Clearance Times

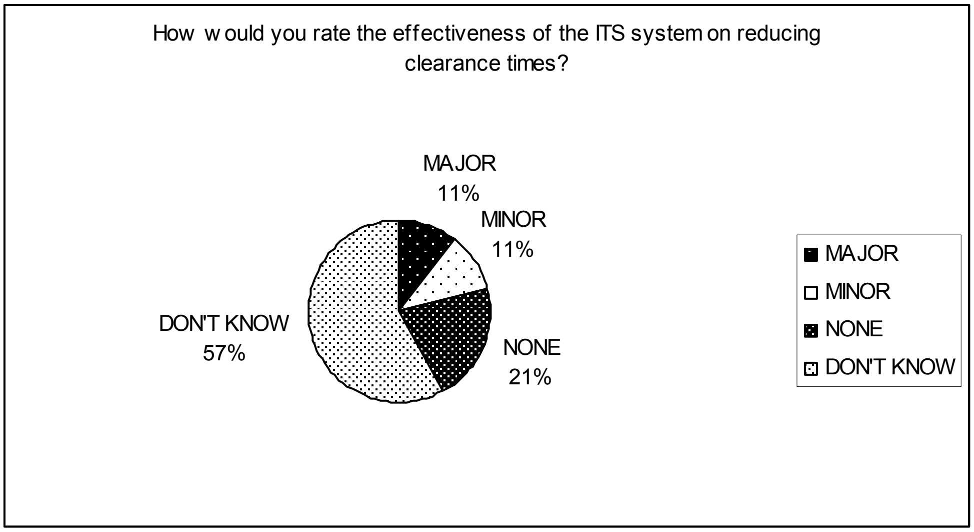


Figure 2.18 - Traffic Diversion

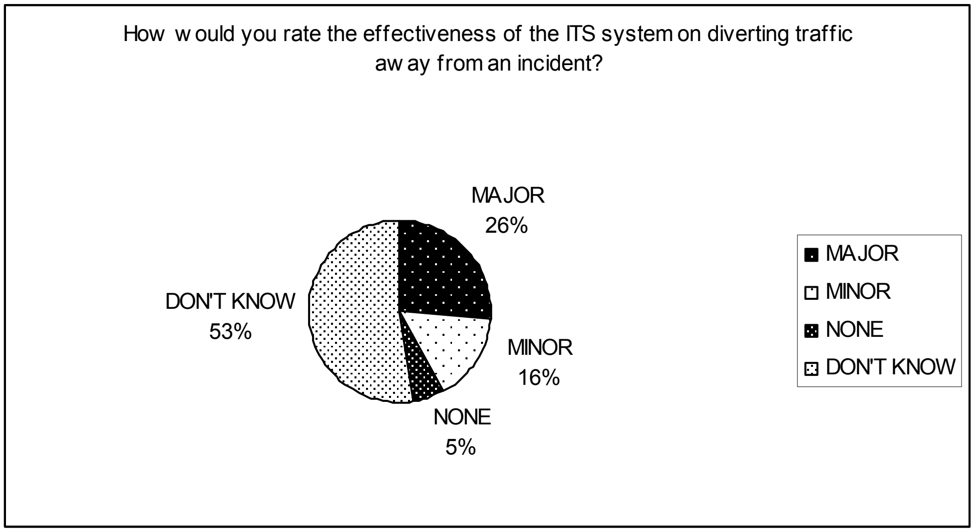


Table 2.2 shows the percentage of agencies that indicated major improvement, minor improvement, no improvement, or don't know for each of the categories in Question 12.

Table 2.2 - Level of Improvement Ratings

Impact	Major	Minor	None	Do Not Know
Number of Accidents	5%	16%	11%	68%
Number of Secondary Accidents	26%	5%	11%	58%
Number of Fatalities	26%	5%	11%	58%
Incident Detection Times	16%	0%	21%	63%
Verification Times	21%	5%	21%	53%
Response Times	11%	5%	21%	63%
Info Dissemination Times	21%	11%	16%	53%
Clearance Times	11%	11%	21%	58%
Traffic Diversion	26%	16%	5%	53%

The most favorable responses applied to the reduction of injury risks, fatalities, secondary accidents, information dissemination times, and diversion of traffic away from an incident.

Interviewees expressed that the system has enabled motorists to be better informed that there is an incident ahead. Motorists are therefore more likely to reduce speeds in advance of an incident, particularly one they would not have otherwise been able to see (e.g., backed up traffic after a sharp curve). They felt the slowing of traffic helps reduce the risk of secondary accidents, injuries, and fatalities.

2.5 INTERVIEWEE COMMENTS AND SUGGESTIONS

The interviews also provided an opportunity to obtain general feedback on the system from the incident responders. These comments are provided below by organization.

All the interviewees believe in the system's potential benefits. Emergency responders are still on the learning curve in terms of remembering to notify the RTOC, and the public is beginning to trust and react to the traveler information it provides.

Those unaware of the system and all its capabilities expressed interest in seeing the RTOC and learning about the system. They think the CCTV feeds would help to improve emergency response, particularly if they could see traffic tie-ups and avoid congested routes.

Those familiar with the system felt the CCTV coverage needs to be expanded throughout the region. Many would also like to see additional DMS in advance of key decision points.

Participants agreed that relative to large cities, Rochester does not have many incidents big enough to warrant the use of the DMS and HAR. However the system is quite effective during both large incidents and construction activities. Many of the interviewees cited the recent bridge work as evidence of the systems effectiveness and success.

NYSP

The DMS system works well. Messages are posted instantaneously. HAR is scratchy and hard to hear at times, but the overall system has great potential. Since the 911 Center is in direct contact with a trooper, it is the trooper's responsibility to notify the RTOC so they can activate any warranted ITS traveler information. It isn't second nature yet for the troopers to call the RTOC, but they are still on the learning curve and the situation is improving. Sometimes the RTOC can pick up an incident (or traffic tie-ups as a result of an incident) on their CCTVs. The ITS is also particularly effective for major incidents such as the recent partial collapse and repair of the Child Street Bridge. During this incident, however, detour routes were altered a few times throughout the construction period and not everyone was informed quickly enough about the changes. Captain Francis Coots suggested creating and distributing a checklist of action items for field personnel to ensure all the appropriate steps are taken each time changes occur during a lengthy incident.

Sheriff's Office

The system has great potential. Since it is a new system, it is not second nature to notify the RTOC right away. It will become more effective as it becomes more widely used. Once additional cameras and DMS are installed, the system will become even more effective. Also, because the HAR and DMS systems have only been online for a short time, motorists are still getting used to them. There has been positive feedback so far and the system will be very effective in the near future.

There appears to have been a major improvement in clearance times. Since the RTOC has become operational, travel lanes open up much faster. The RTOC helps divert traffic away from the scene. State Troopers come to help with clearance and stay as long as needed. They provide specialized clearance equipment for incidents involving trucks, etc. Also, the DOT is more quickly made aware of needed guard rail repairs, resulting in faster repair times.

The Sheriff's Office would like to see more DMS and expanded CCTV coverage. Current CCTV coverage does not include areas in which the Sheriff's Department responds to incidents. They also recommend letting the taxpayers know what is being done to make roads safer/better. NYSDOT should use the media to show off the RTOC/CCTV/DMS and repeat this every couple of years.

OEP

Prior to the RTOC, the OEP used to get together with all other agencies (DOT, etc.) to reroute or adjust traffic around severe incidents. Since its activation, the RTOC has taken over all traffic-related incident management responsibilities. The OEP expressed their opinion that incident management activities are carried out more efficiently than before the RTOC existed. This is likely due to their specific focus on the subject, their ITS tools, and their specialized expertise resulting from everyday incident management experience. They also benefit from a cooperative, multi-agency environment.

The RTOC adds tremendous value by providing a central location for incident management and by alerting motorists to incidents in a timely manner. Incident management is well-coordinated among agencies as was evident during the recent bridgework that required a complete shutdown of I-490 in both directions. ITS was used to inform the public (HAR, DMS), and signal timings were adjusted to accommodate traffic.

In terms of evacuation planning, the OEP has added DMS and HAR to the menu of information dissemination resources. They are useful tools to get the word out about emergency evacuations and are beneficial for circumstances beside purely traffic incidents.

The OEP recommends the implementation of future ITS applications that provide the same data in a timely and accurately manner to other venues. In general, they suggest that existing data be further capitalized by using it in other areas such as:

- Parking Garages - Scrolling DMS signs at the exits of parking garages to get motorists' attention before they enter the highway system.

- Businesses - Provide traveler information on existing dynamic information resources such as elevator TVs and stock information messages.
- Media - Local TV stations allow viewers to sign up for e-mails or phone calls containing emergency information when warranted. RTOC should send the media their data so this information can be transmitted to the public through this venue.

Metro Networks

CCTV provides information on the location of tie-ups and which alternate routes would be appropriate at the time. It also provides the exact location of an incident. This information has improved the quality of the information that Metro Networks provides. It is proven that the public listens to the information provided on the signs and the radio information (both Metro Networks and HAR). They have continuously seen this work during airplane coverage.

Metro Networks would like to view RTOC's CCTV camera images. Currently, they call the RTOC and ask them to describe what they see.

911 Center

The Station PC and wireless paging system serve as the communication links between the 911 Center and the RTOC. In the long term, the 911 Center plans to view images from CCTV cameras located throughout the County by the end of 2004. They hope to integrate all available CCTVs including RTOC and security cameras located throughout the region.

The system proved effective during the recent bridge work. The reason why the system is not yet "very effective" is because DMS signs are only operational during part of the day. Additional off-hours information would increase its effectiveness, especially regarding off-peak construction work. Because the system is new, not everyone remembers to share construction information (e.g., recent CSX railroad work). Additional locations for traveler information would also be helpful to address the issue of backups on surface streets that affect highways.

Monroe Ambulance

It would be helpful if RTOC distributed timely information about construction and congestion to Monroe Ambulance. Unlike the local fire departments (e.g., Greece), they do not receive occasional pages from 911 with information about incidents and whether or not the roadway is open to emergency vehicles at the time. This information would enable faster response as their drivers would be able to avoid unnecessary delays.
Fire Bureau

The system has great potential. The Fire Bureau has not really used it directly as the RTOC staff operate the system. From a motorist's standpoint, the system provides useful travel information. Motorists do not always pay attention, however they listen during a major incident. It proved helpful during the bridge closing and HAZMAT incidents. Outreach and marketing are suggested to get the word out.

Also, during the blackout in 1991, traffic signals had to be checked in the field to see which were operational. During the 2003 blackout, all information was obtainable remotely and instantly at the RTOC.

In places without fixed DMS, portable DMS is recommended to get road work/incident information out ahead of time.

MC DOT

Data sharing between MC DOT and NYSDOT mostly occurs on the display wall in the RTOC. MC DOT can see the state cameras and NYSDOT can see the signal system. Currently there are no formally documented coordination procedures between the State and County. Current focus is on getting the entire signal system online at the RTOC. There are plans to formalize and document coordination procedures between the State and County.

ITS is most effective when you have both a way to detect an incident and then a way to fix the problem. More cameras are critical to the ITS and there are plans to install more cameras along the arterial streets that MC DOT maintains. MC DOT is working to see if there are locations on the arterials that could also see state ramps or expressways to maximize the benefit of the cameras.

Local Fire

Five local fire departments participated in the interviews. In the case of the bridge closure, the system was particularly effective in that the signs told motorists which exit they needed to use in advance of the closure. It is also effective in warning motorists about downstream hazardous weather conditions. This results in fewer motorists and reduced speeds, which in turn make conditions safer for downstream emergency response personnel. (Note that weather-related messages are typically only posted to warn motorists about problems affecting a specific area such as high winds on the Bay Bridge. As a general rule, messages about areawide weather conditions such as "icy roads ahead" are not posted.)

DOT should consider DMS at regular intervals along all major freeway segments. Has seen DMS used effectively to slow down traffic in advance of construction zones; similar applications for incident scenes are needed in the region. Currently motorists are notified of accidents on the radio, however, by the time the accident gets on the radio, it is typically cleaned up and gone.

When installing fixed DMS, the signs should be installed far enough in advance of an exit to allow the motorist ample warning time to exit prior to the incident. There have been some instances where the message is too late for a motorist to exit. If they decide to use portable signs, they should be strategically available at major points around the County (approximately no more than 10 minutes away from any location) so they can be deployed very quickly.

Access to camera feeds would help determine the exact location of accidents. There is a major safety problem resulting from drivers going too fast through incident scenes. Additional DMS would be helpful in warning drivers of incidents ahead and telling them to slow down.

Most of the local fire departments have not visited the RTOC and are not familiar with the true capabilities of the regional ITS. They expressed interest in learning more.

Local Police

Four local police departments participated in the interviews. Some of the local police mentioned that they have not seen the system in action, however they generally believe the system would be highly effective in improving safety.

During a recent major incident, signal timings were adjusted to improve flow along the arterials to which the majority of traffic was diverting. One local police department indicated this modification allowed more traffic to divert and improved safety for everyone. When cars divert from the roadway, injuries are less likely to occur.

Those who have seen the signs activated believe they are effective in providing information on weather conditions and road construction information to drivers. One department claimed that incident duration has not been reduced as the system does not change existing emergency response procedures. However nearly all local police departments believe the signs are a great help in notifying drivers of potential problems and allowing them to divert to other routes to save time and frustration.

One suggestion was made to make local police officers more aware of the ITS. There are monthly Chief of Police meetings attended by the chiefs of all local police departments. These meetings may be a good avenue to provide information to the local police about the RTOC and its capabilities.

Another officer was interested in learning about whether or not the signs could be used in an Amber Alert situation.

Local Ambulance

Two local ambulance departments participated in the interviews. They are not directly involved in the management of traffic in and around an incident. That is the responsibility of fire and police while the ambulance takes care of the injured at the scene. The ambulance departments see value in having access to the CCTV cameras to verify exact incident locations and to determine the best routes to the scene.

GTC

Currently there are no links with the RTOC. GTC would like to get data to help with the MPO's Congestion Management System (CMS). The CMS looks across the region to determine the areas of heaviest congestion, and to see how the congestion problems can be addressed.

The MPO strongly supports any and all efforts to enhance the current ITS. They believe one of their roles is to improve the highway system without adding lanes and expanding infrastructure. ITS will play an important role in achieving this goal. The MPO will make sure that every study that is funded through their office includes an assessment of ITS possibilities. The MPO is currently trying to coordinate the ITS goals of various municipalities in order to obtain more funding for the entire region at once, rather than evaluating each municipality individually.

3.0 CONCLUSIONS

The objective of these interviews was to ascertain the impact of the ITS for use in the next task, the evaluation of ITS benefits. None of the 20 participants were able to provide quantitative estimates regarding changes in detection times, verification times, response times, and clearance times. Each attributed their difficulty in providing numerical answers to the fact that no actual statistics were available before or after the ITS was implemented. They further explained that each incident is unique, making it more challenging to assess the change.

However, more than half of the interviewees felt comfortable providing qualitative information on the effectiveness of the NYSDOT Region 4 ITS (see Table 2.2). Choosing from "major improvement," "minor improvement," "no improvement," and "don't know," participants rated the system's success in reducing the number of accidents and fatalities, as well as its impact on detection, verification, response and clearance times. Twenty-six percent of respondents indicated the system has generated a major improvement in "reducing the number of secondary accidents," "reducing the number of fatalities," and "diverting traffic away from an incident." "Reduction in information dissemination time" was also highly ranked.

Quantifying benefits is a difficult task for any new system. Although interviewees were unable to provide exact statistics, their responses provided an in-depth understanding of the incident management process in the region and the role the ITS plays relative to each participant. Overall, the responses were positive. Participants agree that the ITS has great potential to benefit their incident management operations. They feel it will become increasingly effective as it becomes expanded and more widely used. They also agree that the system successfully diverts traffic, thereby freeing up roadway space to reduce response and clearance times. Faster incident clearance times reduce congestion around an incident and decrease the risk of secondary accidents. These benefits are consistent with the default values in the IDAS benefit/cost database, and with the local benefits values provided in the "Region 4 ATMS Local Evaluation Report." In the following task, IDAS default values will be used and local information from the aforementioned report will be used to supplement the numbers where appropriate and available.

APPENDIX H
VOLUME DATA AND ACCIDENT SUMMARY

Exhibit H-1 provides a summary of the volume and accident data. The accident data in this table was compiled by NYSDOT for the reference marker ranges. The "Segment Average Total" column represents the sum of the reference marker ranges for the section. The sections are identical to those used for the IMAGE Report.

Analysis of the hourly data provides the K factor described in the Highway Capacity Manual (3) and is shown in Exhibit H-2. The K factor identifies the fraction of daily volume flowing during the peak hour.

EXHIBIT H-1 - PRIMARY ROUTES TABLE

Route	Begin Reference Marker	End Reference Marker	Section Location		Existing AADT	Design Hourly Volume	Number of Lanes	Total Length (miles)	Segment Average Total
104	104 43033010	106 43033011	(17)		72,620	4,430	6	0.73	18
104	104 43034000	104 43034000			73,200	4,470	6		
104	104 43035000	104 43035001			73,660	4,490	6		
104	104 43035002	104 43035004			73,660	4,490	6		
104	104 43035005	104 43035005	(18)	590/104 Interchange	73,660	4,490	8	1.41	52
104	104 43035006	104 43035008			73,660	4,490	4		
104	104 43035009	104 43035011			67,830	4,140	4		
104	104 43035012	104 43035012			67,830	4,140	8		
104	104 43035013	104 43035013			67,830	4,140	6		
104	104 43035014	104 43035018			67,830	4,140	6		
104	104 43035019	104 43035021	(19)		67,830	4,140	6	0.99	16
104	104 43035022	104 43035028			67,830	4,140	6		
104	104 43035029	104 43035032	(20)	Bay Road	67,830	4,140	6	0.7	8
104	104 43035033	104 43035035			57,480	3,510	6		
104	10443035036	10443035037	(21)		57,480	3,510	4	1.25	6
104	10443035038	10443035039			57,480	3,510	4		
104	10443035040	10443035048			57,480	3,510	4		
104	104 43035049	104 43035051	(22)	Five Mile Line Road	42,430	2,590	4	2.96	50
104	104 43035052	104 43035069			43,940	2,680	4		
104	104 43035070	104 43035073		Route 250	43,940	2,680	4		
104	104 43035074	104 43035077			49,130	3,000	4		
104	104 43035078	104 43035079	(23)		41,980	2,560	4	0.79	3
104	104 43035080	104 43035085			41,980	2,560	4		
104	104 43035086	104 43035088	(24)	Salt Rd. Interchange	32,890	2,010	4	0.3	4
490I	490I43021172	490I43021172	(61)	I-390 Interchange	89,280	5,450	6	1.27	75
490I	490I43021173	490I43021175			89,280	5,450	8		
490I	490I43021176	490I43021178			89,280	5,450	8		

Route	Begin Reference Marker	End Reference Marker	Section Location		Existing AADT	Design Hourly Volume	Number of Lanes	Total Length (miles)	Segment Average Total
490I	490I43021179	430I43021179			99,610	6,080	4		
490I	490I43021180	490I43021181			99,610	6,080	6		
490I	490I43022000	430I43022002			99,610	6,080	8		
490I	490I43022003	490I43022004	*(62)*		99,610	6,080	8	0.19	6
490I	490I43022005	490I43022009	*(63)*	Mt. Read	99,610	6,080	6	0.47	53
490I	490I43022010	490I43022010	*(64)*		86,470	5,280	6	1.46	115
490I	490I43022011	490I43022015			86,470	5,280	6		
490I	490I43022016	490I43022018			92,230	5,630	6		
490I	490I43022019	490I43022021			95,330	5,820	6		
490I	490I43022022	490I43022024			95,330	5,820	6		
490I	490I43022025	490I43022025	*(65)*	Inner Loop Area	94,350	5,760	4	1.59	165
490I	490I43022026	490I43022026			94,350	5,760	6		
490I	490I43022027	490I43022029			94,350	5,760	6		
490I	490I43022030	490I43022033			120,100	7,330	8		
490I	490I43022034	490I43022036			120,100	7,330	6		
490I	490I43022037	490I43022040			92,190	5,620	6		
490I	490I43022041	490I43022043	*(66)*	Goodman Street	92,190	5,620	6	0.74	42
490I	490I43022044	490I43022044			92,190	5,620	6		
490I	490I43022045	490I43022047			92,190	5,620	6		
590	590 43012004	590 43012006	*(90)*		100,300	6,120	6	0.67	16
590	590 43013000	590 43013003			100,300	6,120	6		
590	590 43013004	590 43013007	*(91)*	404 Interchange	100,300	6,120	6	0.58	57
590	590 43013008	590 43013009			100,300	6,120	6		
590	590 43013010	590 43013017	*(92)*		97,520	5,950	6	0.75	24
590	47 43013017	47 43013020	*(93)*	104 Interchange	94,870	5,790	4	1.27	27
590	47 43013021	47 43013023			56,950	3,470	4		
590	47 4301324	47 43013026			22,600	1,380	4		
590	47 43013027	47 43013029			19,990	1,220	4		

EXHIBIT H-2
K FACTORS FROM HOURLY VOLUMES

SECTION	K
I-490 from I-390 to Mt. Read Blvd.	0.089
I-490 from Mt. Read Blvd. To Inner Loop	0.087
I-590 from Rte.104 to Titus Ave.	0.089
I-590 from Browncroft Blvd. To Rte 104	0.106
Rte 104 from I-590 to Bay Rd.	0.091
Rte. 104 from Goodman St. to I-590	0.086