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Development of ITS-Based Investigation for the Rhode Island TRAC Program

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16. Abstract

This is an educational project directed toward the development of an ITS-Based investigation for the Rhode Island TRAC program. The TRAC program is a hands-on program that allows junior and senior high school students use math and science to solve real-world problems in transportation and civil engineering. At the center of the program is a TRAC pack. This "TRAC" pack is the **T**ransportation **R**esearch **A**ctivities **C**enter pack, which is self-contained laboratory that serves as a teaching tool kit that goes into the classroom. It contains equipment and instructions for activities that students use to explore concepts in math, science, and social science.

The project that was developed involves the analysis of the impact of various diversion scenarios once an incident is introduced to a transportation system. The scenario that the students investigate is the use of variable message signs (VMS) being placed upstream of the junction of the NB I-95/ NB I-295 split in Rhode Island. In this case, the diversion messages are posted for northbound travelers, and different levels of diversion are being analyzed to determine what works best. Students are provided with data from the outcome of simulations run in the micro-simulation package, CORSIM.

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Abstract.

This is an educational project directed toward the development of an ITS-Based Investigation for the Rhode Island TRAC program. The TRAC program is a hands-on program that allows junior and senior high school students use math and science to solve real-world problems in transportation and civil engineering. At the center of the program is a TRAC pack. This "TRAC" pack is the Transportation Research Activities Center pack, which is a self-contained laboratory that serves as a teaching tool kit that goes into the classroom. It contains equipment and instructions for activities that students use to explore concepts in math, science, and social science.

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Development of ITS-Based Investigation for the Rhode Island TRAC Program

Introduction

The Rhode Island Department of Transportation (RIDOT) has adopted the **Tra**nsportation and **C**ivil Engineering Careers (TRAC) program as a form of outreach to attract pre-college students to transportation. This program is a hands-on program that allows junior and senior high school students use math and science to solve real-world problems in transportation and civil engineering. Currently, there are 17 schools involved with this program. At the center of the program is a TRAC pack. This TRAC pack is the **T**ransportation **R**esearch **A**ctivities **C**enter pack, which is a self-contained laboratory that serves as a teaching tool kit that goes into the classroom. It contains equipment and instructions for activities that students use to explore concepts in math, science, and social science.

This particular educational project is directed toward the development of an investigation activity for the TRAC program. This report provides information on how the activity was developed, as well as providing the documentation for the actual activity for the students.

Problem Statement

One of the issues with the TRAC pack in its current status is that it does not contain a good activity regarding Intelligent Transportation Systems. One of the existing investigations goes through a flow diagram chart and asks students if traffic should be diverted if there is an accident on a roadway. The chart simply states that one should divert traffic, and this is with disregard to level of flow or capacity on the diversion route. Students have stated that this exercise is too short and that it is not engaging. Ultimately, it was not challenging for the students.

This project seeks to address the aforementioned problem by developing a more rigorous ITS-based investigation for the Rhode Island TRAC program. The project will provide some level of visual representation of an ITS strategy along with some level of quantitative analysis that is thought-provoking. To this end, the project is oriented toward developing an investigation that studies the impact of using variable message signs to deploy traffic diversion strategies near the junction of I-95 and I-295 NB in Rhode Island.

Project Goal

- To develop an ITS-based investigation for students involved in the Rhode Island TRAC program

Objectives

- To present pre-college students the opportunity to major in engineering at the college level
- To expose students to new non-traditional civil/ transportation engineering opportunities involving ITS
- To show students a real-world application of graphical analysis and interpretation from various route diversion scenarios involving Rhode Island interstate routes, I-95 and I-295.

Methodology

The methodology for this project involved five specific tasks. They are listed below and accompanied by a short description.

- **Collect traffic and geometric data on the traffic routes of interest**

This involved collecting traffic volume data on the roadways, numbers of lanes, ramps, and alignment data.

- **Develop the network in the CORSIM model**

This involved the actual configuration of the network in the CORSIM model using the ITRAF input module.

- **Determine the incident and deployment scenarios**

This involved enacting the coding that allowed the entrance of a 3-lane blocking incident for a duration of 30 minutes, as well as changing the traffic distribution for three levels of diversion strategies, which were a total of 30%, 50%, and 60% of possible traffic prior to the junction of I-95 and I-295 diverting to I-295. The existing pattern consisted of 24% of the vehicle traffic using I-295.

- **Collect data output and place in tabular and graphical format**

This involved sorting through the output data and placing pertinent data in tabular format and graphing the outcomes from the various diversion scenarios.

- **Develop the investigation for TRAC program students**

This involved the development of the appropriate tables and figures that need to be distributed to students, as well as the development of questions for the students to solve.

Results & Discussion

The results of the simulation modeling are illustrated in Figures 1.1 through 1.3. The figures illustrate in the respective measures: (1) average vehicle delay; (2) average travel time; and (3) average speed. These were the average results for the simulation period.

The average vehicle delay revealed intuitive results as delay began to increase on I-295 as traffic was diverted to it, and the delay decreased on I-95. With the incident and no diversion on I-95, the average delay sky-rocketed to an increase of 2700% to 134.4 seconds per vehicle from 4.8 seconds of average vehicle delay. The average vehicle delay did increase from 9.6 seconds to 13.2 seconds per vehicle (an increase of 37.5%) on I-295 due to increased merging activity at the junction. At the 50% diversion level, I-295 experienced a slight drop and then returned to the 13.2 seconds level with 60% diversion.

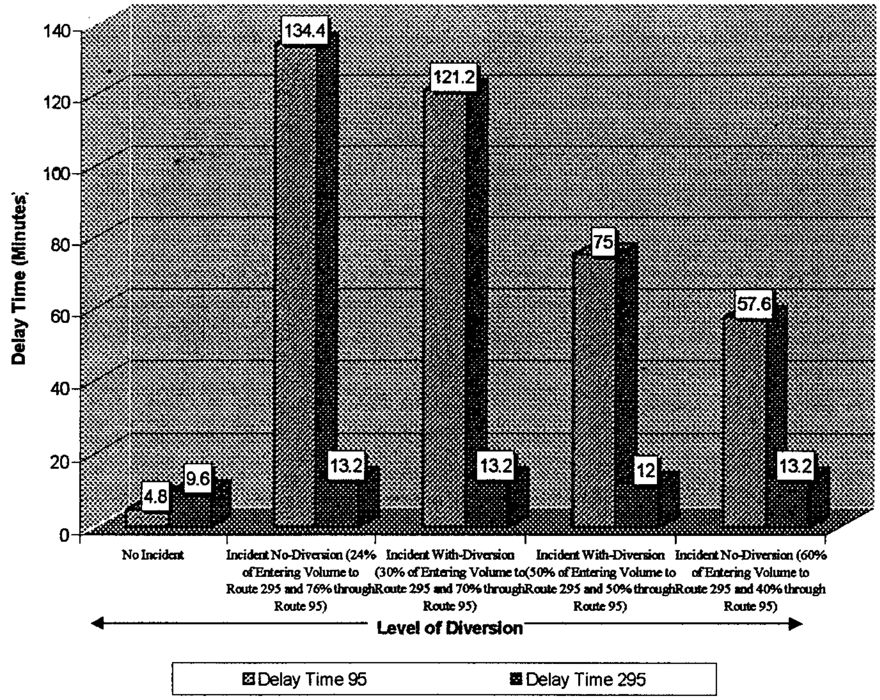


Figure 1. Average Vehicle Delay for Vehicles Traveling on NB I-95 and NB I-295

The travel time measure yields results similar to the average vehicle delay. The travel time increases tremendously for the I-95 traffic with the introduction of the incident as witnessed by an increase from 59.4 seconds to 275.4 seconds for the average vehicle. This relates to a vehicle using traveling through that segment in one minute versus taking approximately 4.5 minutes to travel the same difference. This yields a 364% increase in travel time. The travel time continually decreases with the notification to divert just upstream of the I-95/ I-295 NB junction.

The travel time on I-295 NB is the one that results in a strange fashion, instead of revealing incremental changes. With the introduction of the incident, there is actually a small increase in travel time of four seconds from 64.2 seconds to 68.4 seconds, an increase of 6.5%. The travel time actually drops for the next two scenarios as vehicles as more vehicles are introduced to I-295, but in the final scenario with 60% of the vehicles traveling this route, the travel time shoots up to 150 seconds (134 % increase).

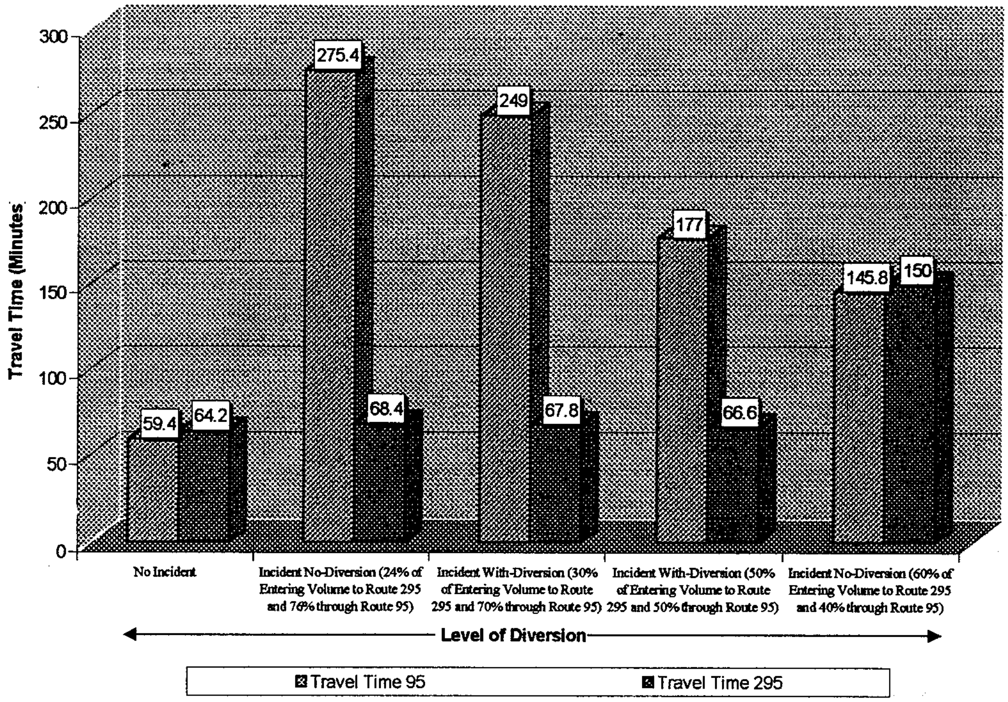


Figure 1.2 Travel Times for Vehicles Traveling on I-95 or I-295 NB

Speed also demonstrates the severity of the impact of the incident on the traffic speed. With the introduction of the incident there is a precipitous drop in speed as it goes from 60 mph to an average of 22 mph. With the introduction of the diversion strategy, the average speed slowly increases and reaches 30 mph with 60% of the traffic using I-295. The average speed for I-295 does not drop drastically with the lowest average speed measured as 53 mph.

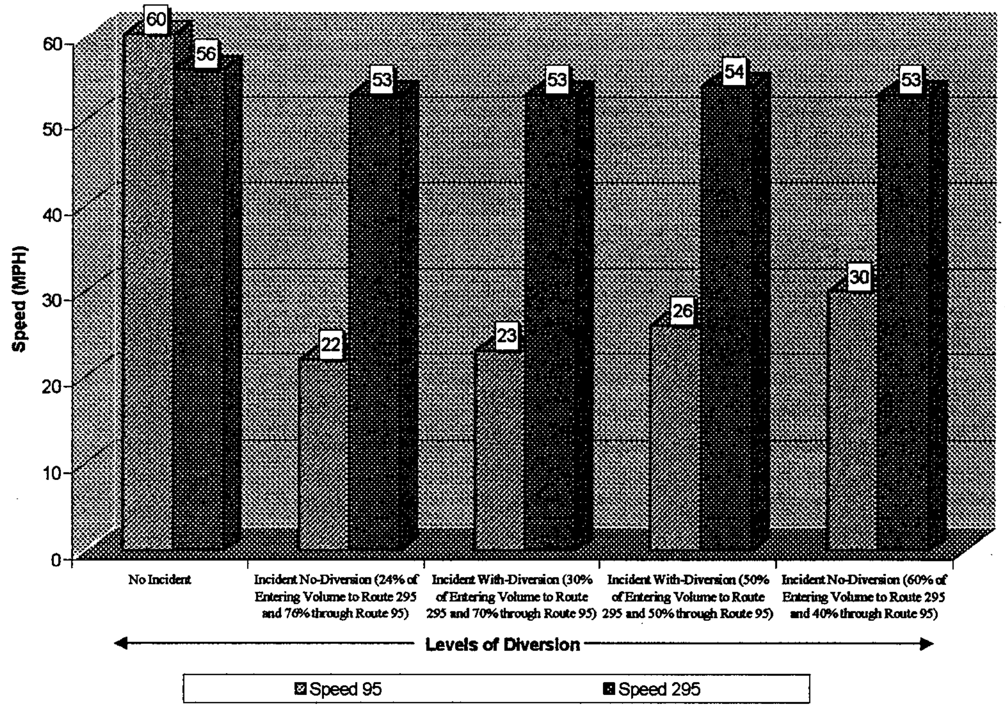


Figure 1.3 Speed Results for I-95 and I-295 Traffic

Investigation Presentation

This section of the report presents the guidelines that an instructor could follow to present this investigation to students. Specifically presented in this section are:

- Study Area location map
- Investigation Guidelines
- All data to be presented to the students during activity

Figure 1.4 Displays the study area.

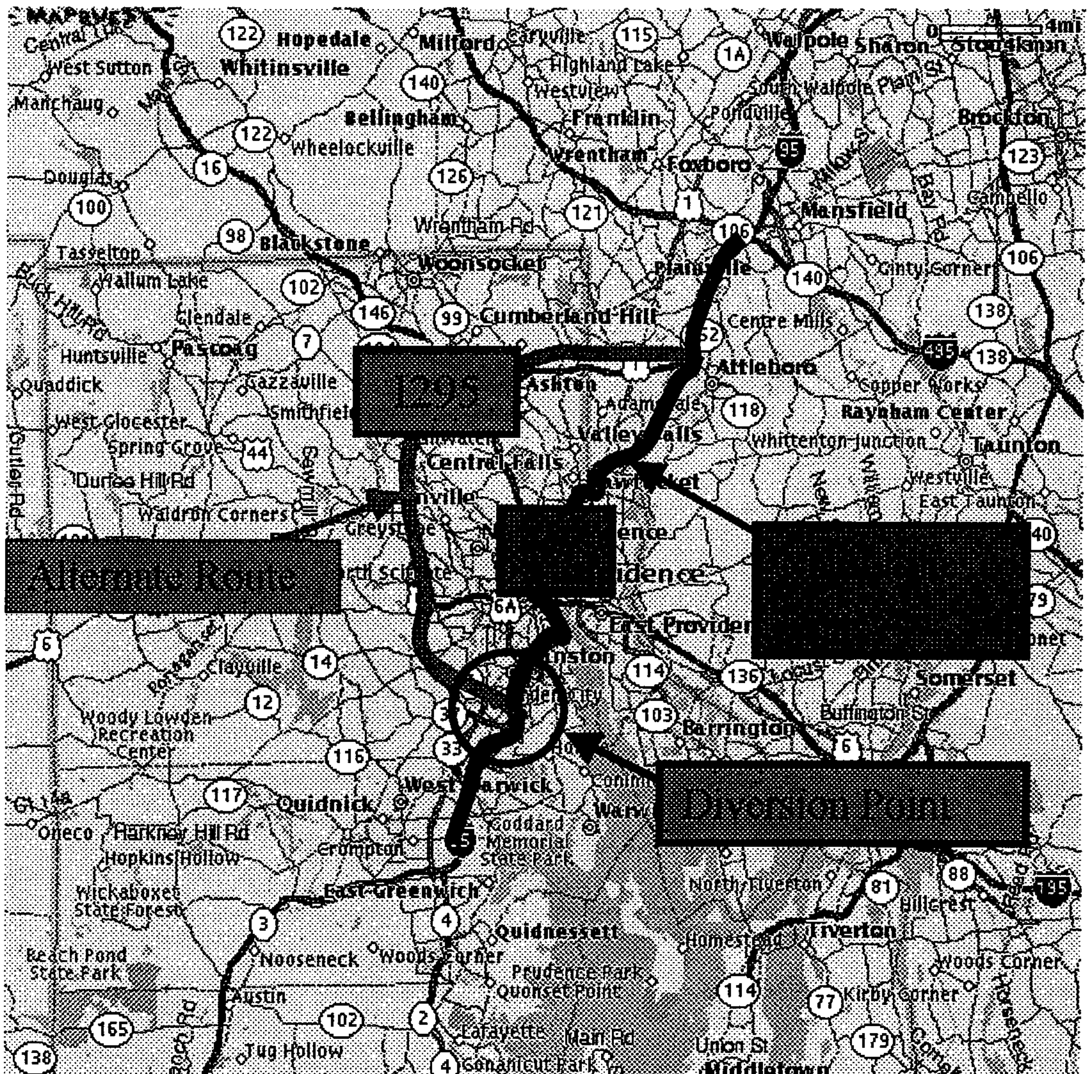


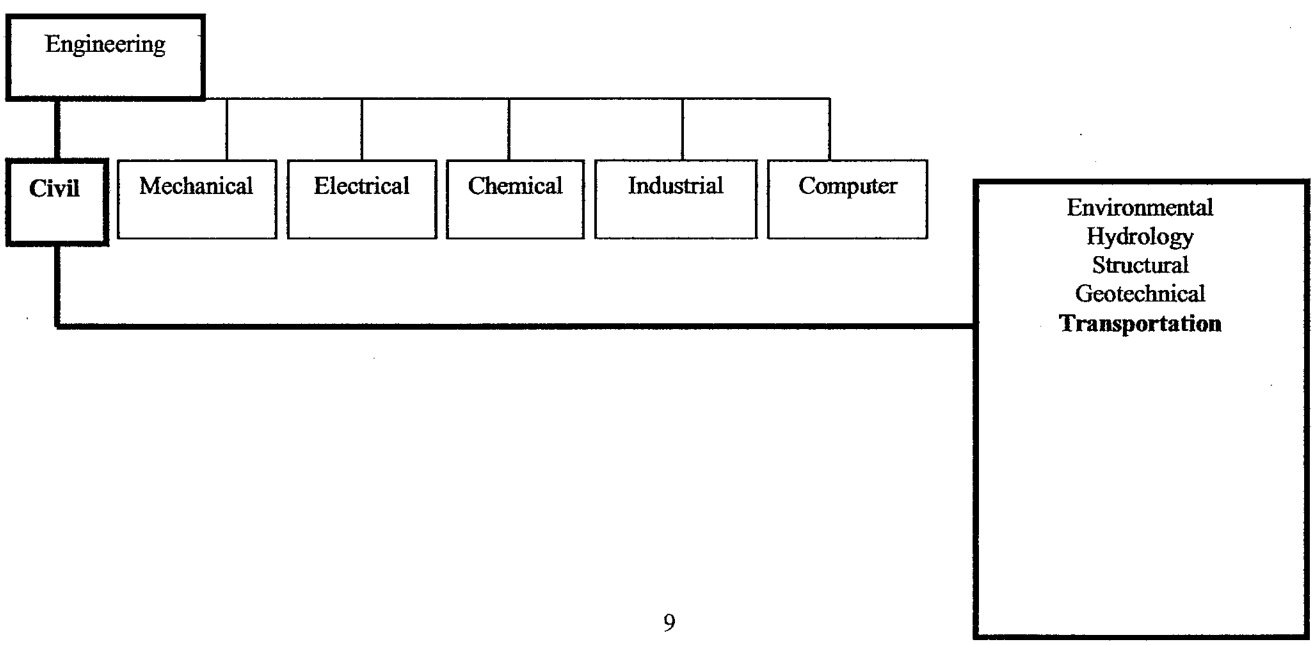
Figure 1.4 Map Illustrating the Study Area including the Mainline Freeway (I95) and Alternate Route (I295)

This TRAC Pack Exercise has 3 Overall Goals:

- Expose pre-college students to new non-traditional civil/transportation engineering opportunities.
- Present to pre-college students the opportunity to major in engineering at the college level.
- Show the students a real world application of mathematics using graphs and tabular data.

This TRAC Pack Exercise will achieve these goals by utilizing traffic analysis software and output data from a freeway incident simulation. The students will be presented with the data in a packet of 7 handouts. After the students view the simulation via TRAFVU simulation animation software they will perform a basic analysis of what level of diversion should be used for each specific degree of incident. This exercise attempts to balance general information about engineering opportunities with a specific problem solving exercise. The classroom presentation could resemble the following procedure:

1. Present an overview of the engineering fields and some applications of each. Give the students a true sense of what an engineer does in terms of utilizing procedures and mathematics to design, develop, and construct safe systems, machines, and structures. This could be the most important part of the presentation because it will expose to most students a new arena of profitable career opportunities. It should be stressed that engineering is routed in logic and that computational skills are critical and that communication skills are valued as well, since great logic and computations need to be explained to those who are making decisions. (7-10 Minutes)



2. Present the students with the problem: there is a traffic incident that is blocking three lanes of traffic about half a mile north of the I-95/I-295 split in Rhode Island. (3-5 Minutes)

3. Question the students about why it is important to efficiently handle traffic incidents (3-5 Minutes)

   - Alleviate congestions (Money lost, harmful emissions, delay time)
   - Emergency vehicles

4. Discuss with the students some of the tools available to the transportation engineer to analyze problems like this. Among these tools is traffic simulation software. Relate to students that a transportation engineer uses this software and computers to determine how anything that might effect how traffic may perform can be modeled and analyzed. An emphasis could be placed on the importance of incident management. When incidents occur transportation managers and engineers must have plans in place for incident management so that time is not lost during an emergency. One way to prepare for highway incidents is to simulate incidents on roadway sections that experience frequent incidents and re-route traffic to various diversion routes. It is important to relate to students that the entire system is affected by re-routing and that what might seem to alleviate one congested area may initiate another if the capacity of diversion roadway's is exceeded. (5-10 Minutes)

5. Demonstrate the TRAFVU software in order to give students an idea of what the software is analyzing. Three or four animations could be run with different levels of diversion so that students could see that the system experiences lower amounts of congestion when traffic is diverted. This will only take 4-5 minutes. The students will be taught that the engineer does not just arbitrarily divert traffic to alternate routes because the excess traffic may congest that roadway. Careful analysis should be performed on various levels of incident (two lane, three lane, ectre) to determine when or if diversion is necessary. (7-10 Minutes)

6. Distribute a packet to the students including: a map of the systems as it was entered into the simulation software showing the incident and where in the system it took place; and bar graphs relating the phenomena they just watched that ask them to perform basic traffic analysis based on this evidence. Ask the students to enter the data into a spreadsheet and perform a "before/after" type analysis that will allow them to determine the best level of diversion for the system. Ask the students to make a brief presentation based on this data whether or not they would recommend traffic diversion and how would they sell it to the head of the DOT. (10-15 Minutes)

7. Conclude the presentation with question and answer portion and student evaluation of exercise. (5-10 Minutes)

The total presentation time should be anywhere from 45 to 60 minutes.

The following tables display the output data from CORSIM. This data is used to generate graphs and percentages to aid students in determining if the traffic diversion is beneficial to the entire roadway system.

Table 1.1 Data for the TRAC Pack Sample Activity: Roadway System Statistics

Level of Diversion	Delay Time (Seconds)	Travel Time (Seconds)	Speed (MPH)
No Incident	14.4	123.6	56
Incident No-Diversion (24% of Entering Volume to Route 295 and 76% through Route 95)	147.6	343.8	53
Incident With-Diversion (30% of Entering Volume to Route 295 and 70% through Route 95)	134.4	316.8	53
Incident With-Diversion (50% of Entering Volume to Route 295 and 50% through Route 95)	87	243.6	54
Incident With-Diversion (60% of Entering Volume to Route 295 and 40% through Route 95)	70.8	625.8	53

Table 1.2 Data for the TRAC Pack Sample Activity: Route I295 Statistics

Level of Diversion	Delay Time (Seconds)	Travel Time (Seconds)	Speed (MPH)
No Incident	9.6	64.2	56
Incident No-Diversion (24% of Entering Volume to Route 295 and 76% through Route 95)	13.2	68.4	53
Incident With-Diversion (30% of Entering Volume to Route 295 and 70% through Route 95)	13.2	67.8	53
Incident With-Diversion (50% of Entering Volume to Route 295 and 50% through Route 95)	12	66.6	54
Incident With-Diversion (60% of Entering Volume to Route 295 and 40% through Route 95)	13.2	480	53

Table 1.3 Data for the TRAC Pack Sample Activity: Route I95 Statistics			
Level of Diversion	Delay Time (Seconds)	Travel Time (Seconds)	Speed (MPH)
No Incident	4.8	59.4	60
Incident No-Diversion (24% of Entering Volume to Route 295 and 76% through Route 95)	134.4	275.4	22
Incident With-Diversion (30% of Entering Volume to Route 295 and 70% through Route 95)	121.2	249	23
Incident With-Diversion (50% of Entering Volume to Route 295 and 50% through Route 95)	75	177	26
Incident With-Diversion (60% of Entering Volume to Route 295 and 40% through Route 95)	57.6	145.8	30

The next set of tables displays output data from CORSIM corresponding to 15-minute intervals. This data illustrates how the system reacts, responds, and recovers during an un-planned traffic incident.

Rt 95 Links Only - Delay Time Averages (Seconds)					
Time of Day	No Incident	Incident No Diversion	Incident 30% to 295	Incident 50% to 295	Incident 60% to 295
8:15	4.80	4.80	4.80	4.80	4.80
8:30	4.80	92.40	85.80	68.40	49.80
8:45	4.80	247.20	217.80	127.80	98.40
9:00	4.80	182.40	165.00	97.20	74.40
9:15	4.80	146.40	132.60	78.00	59.40
Average	4.80	134.64	121.20	75.24	57.36

Rt 295 Links Only - Delay Time Averages (Seconds)					
Time of Day	No Incident	Incident No Diversion	Incident 30% to 295	Incident 50% to 295	Incident 60% to 295
8:15	10.20	10.20	10.20	10.20	10.20
8:30	9.60	9.60	10.20	12.60	13.80
8:45	9.60	12.60	13.80	13.20	14.40
9:00	9.60	18.00	16.20	12.60	13.80
9:15	9.60	16.80	14.40	12.00	13.20
Average	9.72	13.44	12.96	12.12	13.08

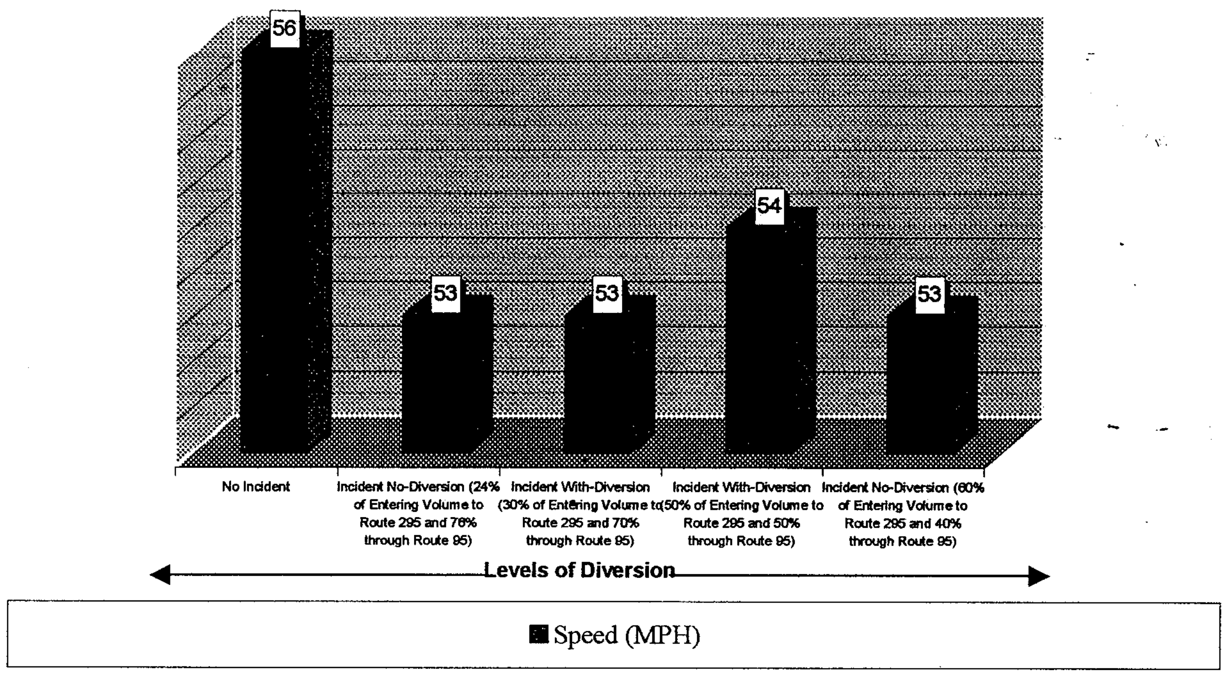
Rt 95 Links Only - Travel Times Averages (Seconds)					
Time of Day	No Incident	Incident No Diversion	Incident 30% to 295	Incident 50% to 295	Incident 60% to 295
8:15	59.40	59.40	59.40	59.40	59.40
8:30	59.40	209.40	195.60	167.40	132.60
8:45	60.00	469.20	411.00	265.20	214.80
9:00	59.40	348.00	315.00	212.40	174.00
9:15	59.40	290.40	263.40	180.00	148.80
Average	59.52	275.28	248.88	176.88	145.92

Rt 295 Links Only - Travel Times Averages (Seconds)					
Time of Day	No Incident	Incident No Diversion	Incident 30% to 295	Incident 50% to 295	Incident 60% to 295
8:15	64.80	64.80	64.80	64.80	64.80
8:30	64.20	64.20	64.80	67.20	69.00
8:45	64.20	67.80	69.00	67.80	69.60
9:00	64.20	73.20	71.40	67.20	68.40
9:15	64.20	71.40	69.60	66.60	68.40
Average	64.32	68.28	67.92	66.72	68.04

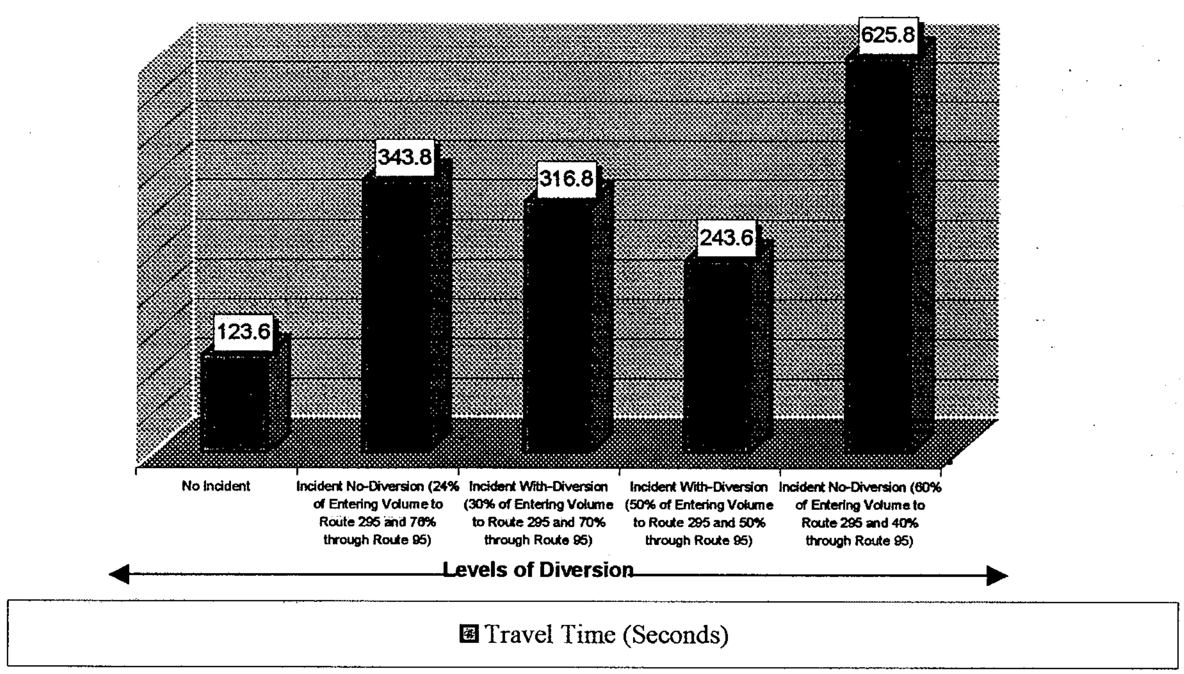
Rt 95 Links Only - Speeds (MPH)					
Time of Day	No Incident	Incident No Diversion	Incident 30% to 295	Incident 50% to 295	Incident 60% to 295
8:15	60	60	60	60	60
8:30	60	17	18	22	27
8:45	60	8	9	14	17
9:00	60	10	11	17	21
9:15	60	12	14	20	24
Average	60	22	23	26	30
Rt 295 Links Only - Speeds (MPH)					
Time of Day	No Incident	Incident No Diversion	Incident 30% to 295	Incident 50% to 295	Incident 60% to 295
8:15	56	56	56	56	56
8:30	56	56	55	53	52
8:45	56	53	52	53	52
9:00	56	49	51	53	52
9:15	56	50	52	54	53
Average	56	53	53	54	53

- The following figures display the various network evaluators for the various situations modeled.

Speeds for the Route 95 North and Route 295 North System Modeled



- **Travel Times for the Route 95 North and Route 295 North System Modeled**



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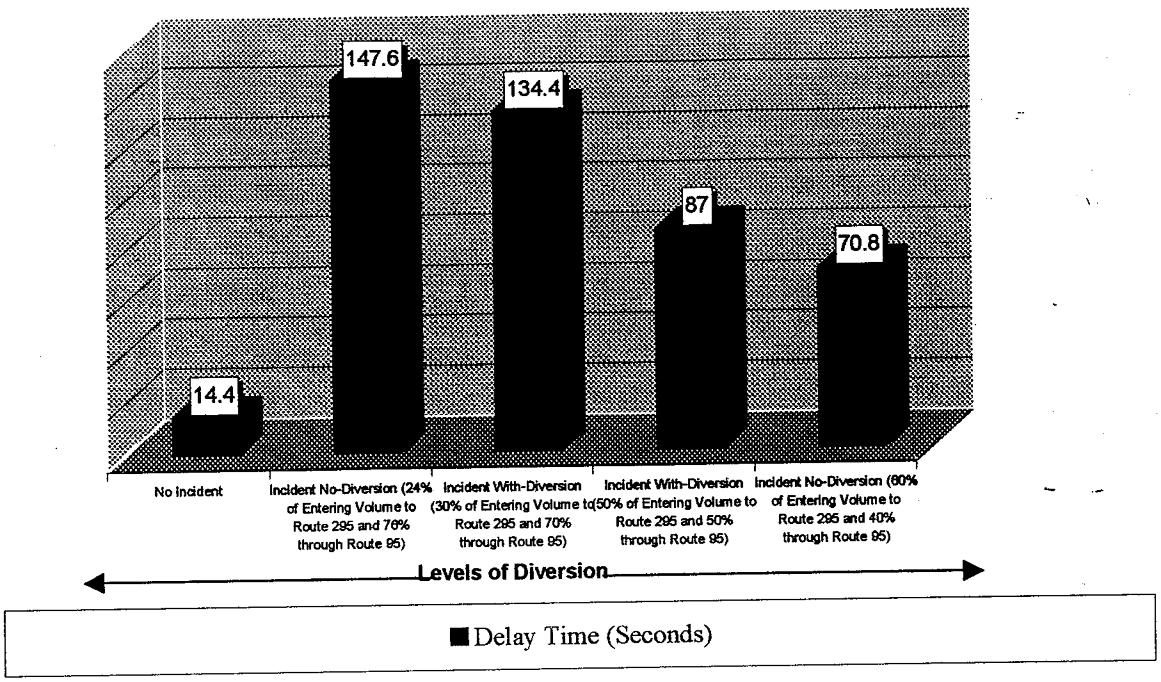
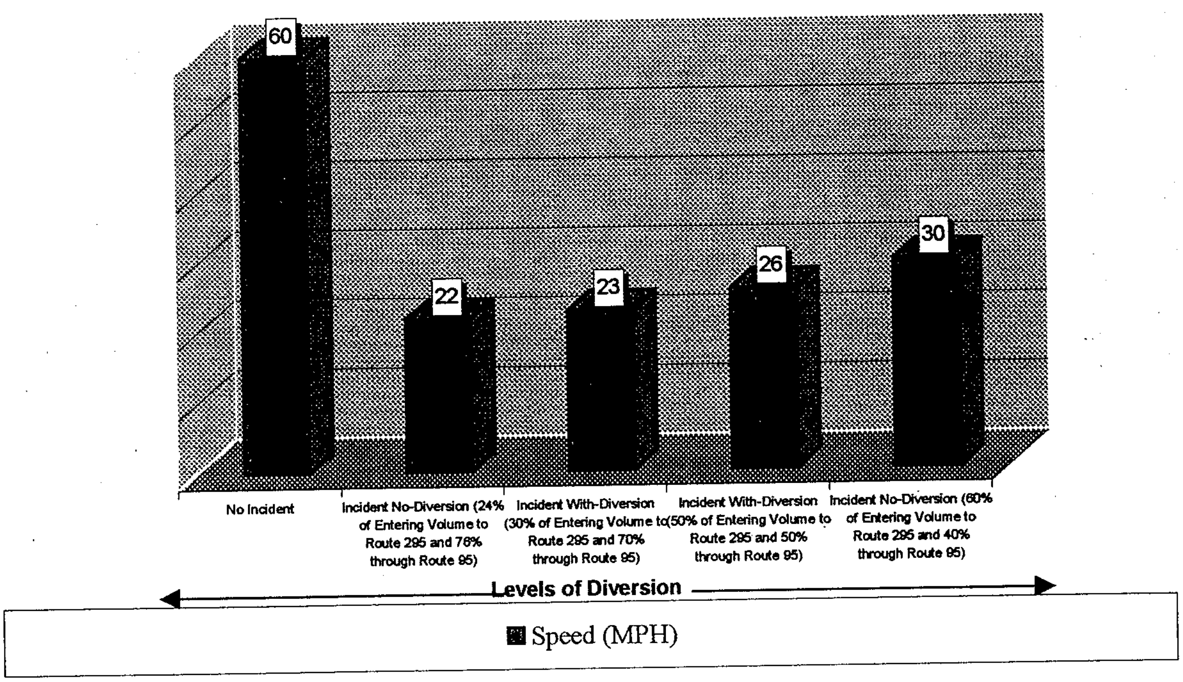
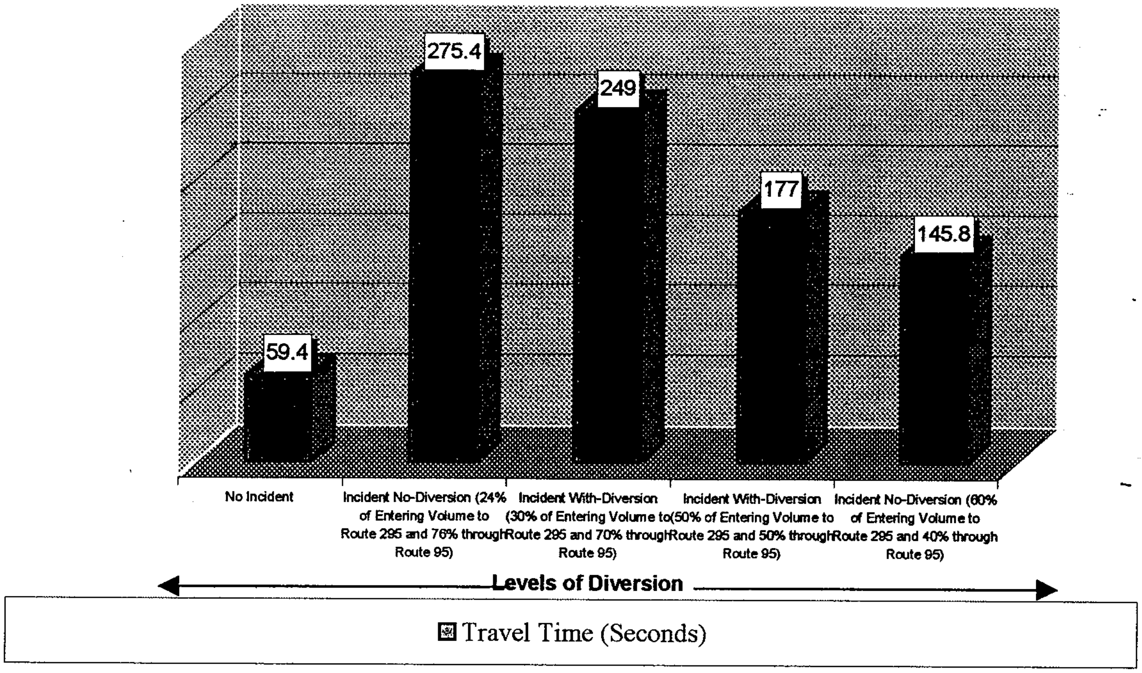
Delay Times for the Route 95 North and Route 295 North System Modeled



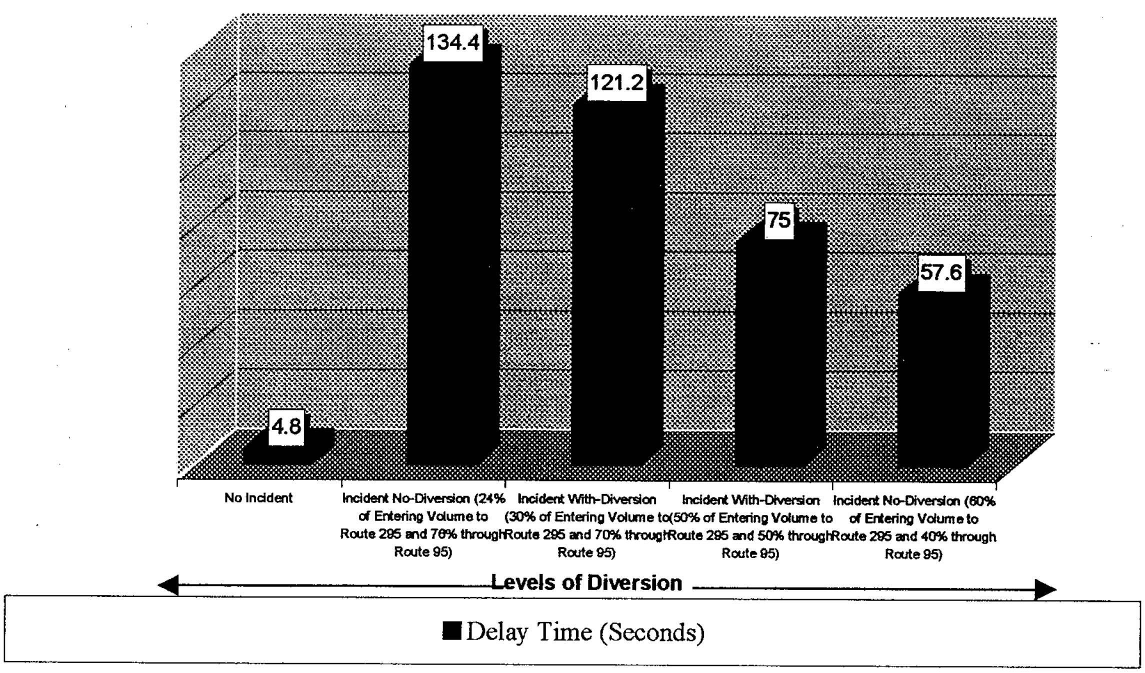
Speeds for the Route 95 North Segment in Warwick, Rhode Island



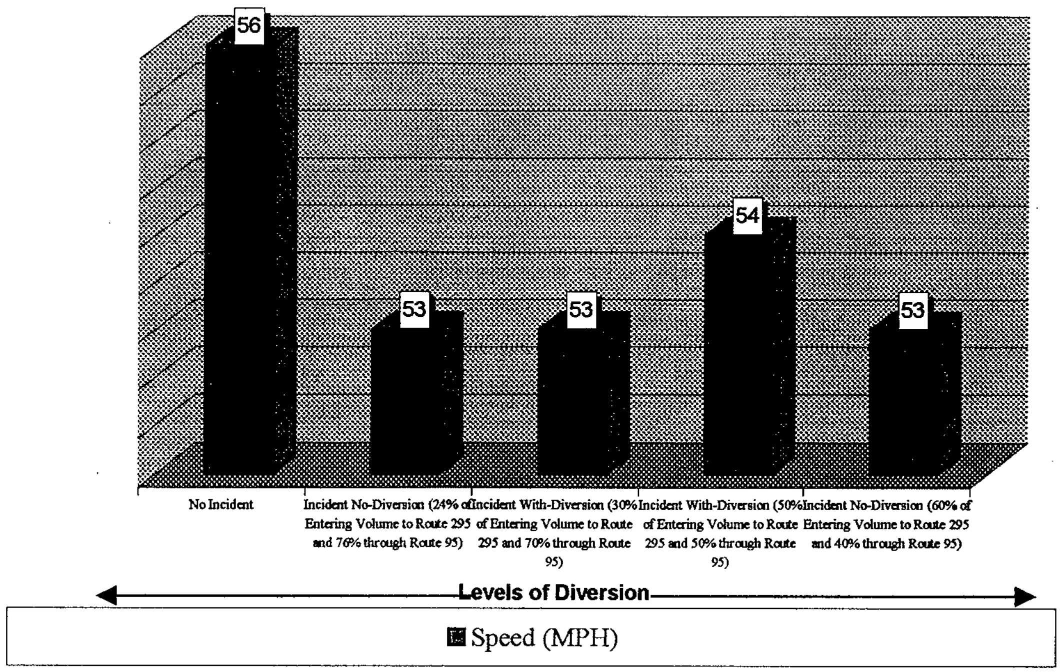
Travel Times for the Route 95 North Segment in Warwick, Rhode Island



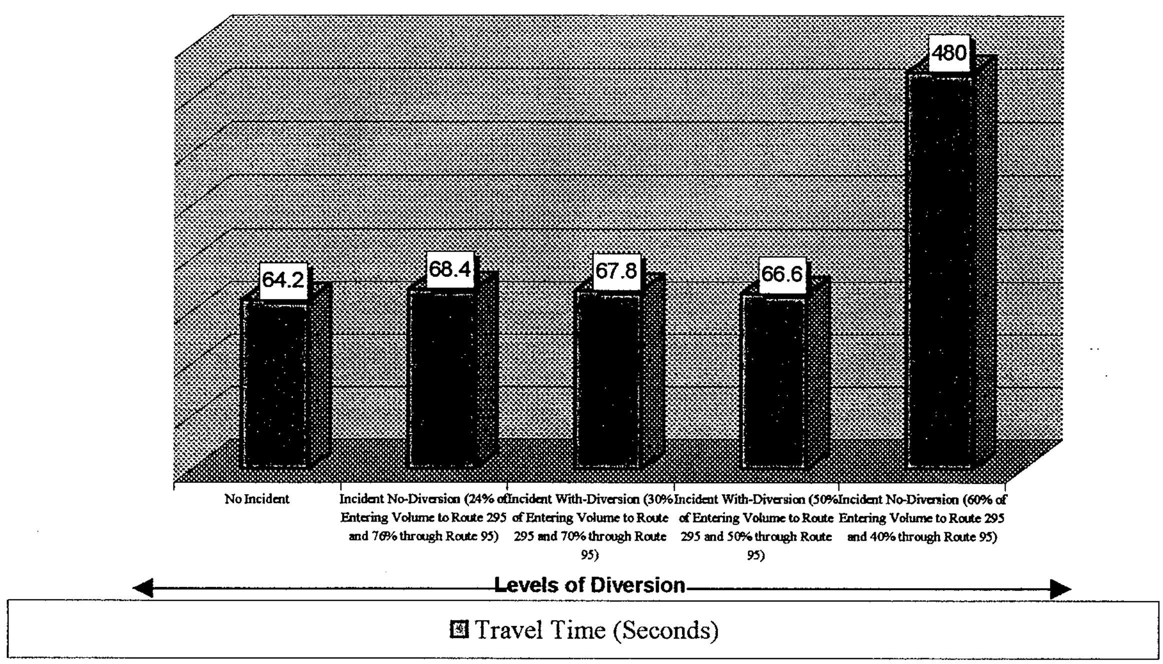
Delay Times for the Route 95 North Segment in Warwick, Rhode Island



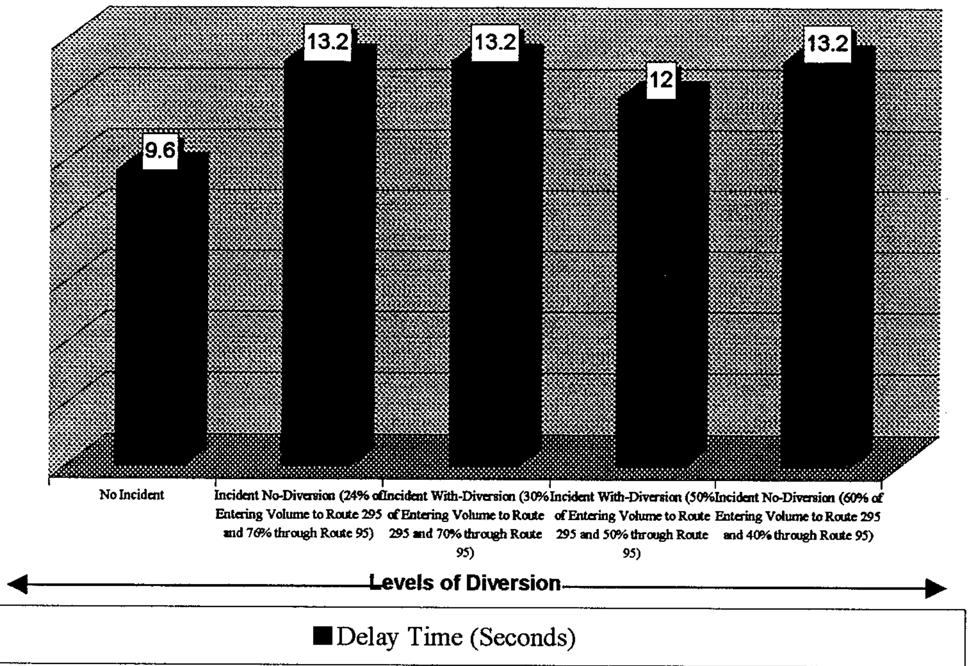
Speed for Route 295 Exit off 95 North



Travel Time for Route 295 Exit off 95 North



Delay Time for Route 295 Exit off 95 North



Conclusion & Recommendation

In conclusion, the project was successful in developing an ITS-based investigation for the Rhode Island TRAC program. The ITS-based investigation will lend the students an understanding of the analytical work that needs to be done to effectively operate a transportation system. It also shows how there must be some fundamental understanding of traffic flow before ITS technologies can be used most efficiently.

As the tools of transportation engineers continue to evolve with modern technology, software development, and advances in micro-computing, it is important that students become familiar with how to use them and begin to understand when to use them. This traffic diversion exercise incorporates how the usage of general software such as a spreadsheet package and how the use of a more sophisticated package, such as CORSIM, help provide solutions to transportation problems.