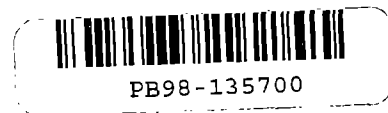
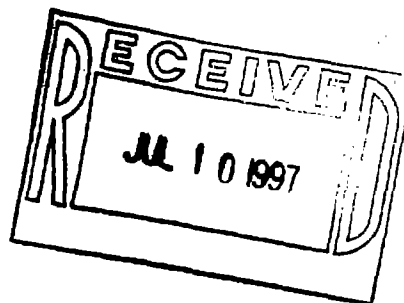




530 Broadway
Providence, Rhode Island 02909
401 272-8100
FAX 401 273-9694



Memorandum To: Thomas Conboy, RI DOT Date: June 26, 1997
cc: Paul Silva, RI DOT
Robert Shaw, VHB
Robert Brown, VHB
Dan Baxter, VHB

Project No.: 70618

From: Thomas Wholley
Robert Michaud

Re: Air Quality Evaluation of
Rhode Island's Incident
Management Program

The 1990 Clean Air Act Amendments (CAAA) established new emission reduction requirements for areas whose air quality levels exceeded the National Ambient Air Quality Standards (NAAQS). The NAAQS were set by the U.S. Environmental Protection Agency (EPA). Developing and implementing Congestion Management Systems Plan (CMS) is strongly encouraged in the CAAA as a Transportation Control Measure (TCM) for reducing mobile source emissions. Freeway incident management systems, such as Rhode Island's Incident Management Program, are considered to be TCMs. Rhode Island's Incident Management Program is expected to have a beneficial impact on traffic flow and will help reduce roadway congestion. Reduced congestion levels are expected to increase average trip speed, will reduce incident-related vehicle pollution emissions, and will improve regional air quality.

The objective of this preliminary air quality analysis was to assess the potential air quality benefits associated with the implementation of Providence's Metropolitan portion of Rhode Island's Incident Management Program. Specifically, the air quality analysis calculated the ozone precursor emissions (oxides of nitrogen and volatile organic compounds) and carbon monoxide (CO) emissions using mesoscale analysis techniques. The mesoscale modeling relied on existing incident and traffic characteristics for the I-95 and I-195 corridors. The mesoscale air quality analysis also predicted the emission reductions of ozone precursor and CO emissions due to changes in traffic characteristics associated with Providence's Metropolitan portion of Rhode Island's Incident Management Program. The analysis was conducted for the year 1999 and followed the same procedures as were used in the development of emissions in the Rhode Island State Implementation Plan (SIP). The year 1999 was chosen as the year of analysis because it is a critical year for the SIP and the Providence Metropolitan portion of Rhode Island's Incident Management Program would be operational at that time. Rhode Island's Incident Management Program will be expanding area of coverage and implementing other measure which could be included in future air quality analyses.

REPRODUCED BY:
U.S. Department of Commerce
National Technical Information Service
Springfield, Virginia 22161

PROTECTED UNDER INTERNATIONAL COPYRIGHT
ALL RIGHTS RESERVED.
NATIONAL TECHNICAL INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE

Background

The I-95 and I-195 corridors are located within an ozone nonattainment area. The 1990 CAAA resulted in the entire state of Rhode Island being classified as a "Serious" ozone nonattainment area. Rhode Island is required under the CAAA to implement emission reduction measures to achieve attainment of the NAAQS. Emission reductions from TCMs, such as Rhode Island's Incident Management Program can play an important role in achieving the NAAQS for ozone.

Methodology

The air quality analysis evaluated the areawide emission reductions for metropolitan Providence associated with implementation of Rhode Island's Incident Management Program. Total emissions of VOCs, CO, and NO_x associated with pre- and post-incident conditions were calculated with and without the programs implementation. The Rhode Island's Incident Management Program's emission estimates were compared to emissions predicted to result without the program (the No-Build condition). The Rhode Island's Incident Management Program Build condition reflects the operational characteristics that are based on "average" system benefits that are likely to be achieved in metropolitan Providence. Specifically, the Build conditions assume a 5- and 10-minute reduction in the detection/response/clearance time.

Traffic Parameters

The traffic parameters (traffic volumes, roadway geometry, and speeds) and incident-condition traffic characteristics (vehicle delays, queue lengths, and roadway capacities) necessary for modeling incident-related vehicle emissions are based on observations of peak hour traffic conditions and existing traffic documentation for the I-95 and I-195 corridors.

Vehicle Emissions Model

All of the vehicle emission factors used in the air quality analysis were obtained using the EPA's MOBILE5a emissions model. MOBILE5a is a computer model that is used to calculate VOC, CO, and NO_x emission rates from vehicles in grams per vehicle-mile. The emission rates calculated in this study were adjusted to reflect Rhode Island-specific vehicle characteristics and emission control programs. Specifically, these plans and programs included the state vehicle registration age distribution, the Stage II Vapor Recovery System, alternative-fueled vehicle programs, and temperatures representative of the summer ozone season.

Air Quality Mesoscale Model

The objective of the mesoscale model is to calculate total vehicle incident-related emissions for the I-95 and I-195 corridors under various traffic conditions based on the incident modeling output and the vehicle emissions model output. This is achieved by converting incident characteristics to equivalent emission rates and multiplying these rates by estimated vehicle-miles traveled by vehicles impacted by the incident. I-95 and I-195 vehicle emissions were determined by calculating incident emissions for each roadway based upon incident type. The vehicle emission rates are a function of travel speed. Under free-flow (pre-incident) conditions, vehicle speeds were determined based on roadway volume to capacity (V/C) ratios. Incident-condition travel speeds were determined by factoring in average vehicle-delay over the individual roadway link to the time normally required to traverse the link under free-flow conditions. Calculated pre- and

post-incident travel speeds were then matched with emission rates from the Mobile5a model output. The pre- and post-incident VMT was calculated based on number of affected vehicles (a function of incident duration) and roadway length. The number of affected vehicles was determined by multiplying the average hourly vehicle demand rate during the incident period by incident duration. Total incident-related vehicle-miles traveled was calculated by multiplying the total affected vehicles by the length of roadway under evaluation. Table 1 presents the results of the air quality analysis.

Results

The implementation of Rhode Island's Incident Management Program will reduce the increased emissions that result from incidents. The peak hour free flow emissions from the Providence Metropolitan portion of the I-95 and I-195 corridors are 76 kilograms (kg) of VOCs, 456 kg of CO and 167 kg of NOx. On a typical day with incidents (assuming 1.5 incidents per day during the peak traffic period), the peak hour emissions would be 111 kg of VOCs, 782 kg of CO and 167 kg of NOx. These are increases of 35 kg for VOCs and 326 kg for CO. The changes in NOx levels were insignificant. The implementation of Rhode Island's Incident Management Program that would result in a 5 minute savings in detection/response/clearance time would reduce the incident emissions levels by 9 kg for VOCs and 84 kg for CO. If Rhode Island's Incident Management Program resulted in a 10 minute savings in detection/response/clearance time, then the incident emissions levels would be reduced by 22 kg for VOCs and 206 kg for CO. All of the air quality results are presented in Table 1.

**Table 1 - Rhode Island's Incident Management Program
1999 Peak Hour Emissions (Kilograms)**

<u>Scenario</u>	<u>VOCs</u>	<u>CO</u>	<u>NOx</u>	<u>Difference From Incident Emissions</u>		
				<u>VOCs</u>	<u>CO</u>	<u>NOx</u>
Free Flow	76	456	167	-35	-326	No Change
Incident	111	782	167	NA	NA	NA
IMS (5 Minutes)	102	698	167	-9	-84	No Change
IMS (10 Minutes)	89	576	167	-22	-206	No Change

The mesoscale analysis is a conservative estimate of emission benefits because it did not account for changes in emissions from the following conditions:

- The "off-corridor" emission impacts such as diversion routing. While better communications with motorists is expected to occur under the I-95/I-195 IMS program, route diversion to local roadways is not likely to noticeably increase with I-95 IMS when compared to existing conditions,
- the "shock-wave" effects typical of incidents are not accounted for, which if considered would result in longer queuing lengths than those calculated, longer estimated accident duration, and larger values of total vehicle-hours of delay,
- the analysis does not account for the effects of travel speed reductions in opposing lanes of traffic due to "curiosity factors,"
- the effects of reduced travel speeds approaching an accident queue zone are not accounted for, and the accident duration assumes an "instantaneous" change in roadway capacity once an incident is cleared, rather than the more gradual change that occurs as the vehicle queue dissipates following an accident (i.e., the vehicle queue "collapse wave"). Consequently, post-accident recovery periods may be underestimated.

AIR QUALITY APPENDIX

- ▶ Mesoscale Analysis
- ▶ MOBILE5a Output Summary
- ▶ Incident Volume/Delay Model
- ▶ Incident Calculations
- ▶ Incident Management Calculations (5 Minutes)
- ▶ Incident Management Calculations (10 Minutes)

Mesoscale Analysis

EMISSION CALCULATION WORKSHEET - Accident Conditions

Providence

1999

TOTAL ACCIDENT DURATION: 30 Minutes Pollutant: Volatil Organic Compounds - VOC

Shoulder Blockage Conditions

Link	VMT Calculation			Speed Calculation			Incident Characteristics			Emissions Calculation				
	Distance (Miles)	Demand (Veh/hr)	VMT (Veh-m)	Freeflow Speed (mph)	Delay (min.)	Congested Speed (mph)	Affected Vehicles	Total Delay (veh-hr)	Incident Duration (Min.)	Emission Factor		Total Emissions		Incident Emissions (Kg)
I-95	8.60	8640	74,304	45	2.10	38	5760	202	40.00	0.73	0.83	54	62	7
I-195	4.30	6890	29,627	45	5.03	24	12632	1089	110.00	0.73	1.2	22	36	14
Subtotal												76	97	21

Single Lane Blockage Conditions

Link	VMT Calculation			Speed Calculation			Incident Characteristics			Emissions Calculation				
	Distance (Miles)	Demand (Veh/hr)	VMT (Veh-m)	Freeflow Speed (mph)	Delay (min.)	Congested Speed (mph)	Affected Vehicles	Total Delay (veh-hr)	Incident Duration (Min.)	Emission Factor		Total Emissions		Incident Emissions (Kg)
I-95	8.60	8640	74,304	45	6.35	29	20160	2135	140.00	0.73	1.04	54	77	23
I-195	4.30	6890	29,627	45	10.56	16	27560	4850	240.00	0.73	1.58	22	47	25
Subtotal												76	124	48

Total Accident Statistics					
Link	Shoulder Emissions	1-Lane Emissions	50% Shoulder	50% 1-Lane	Total Emissions
I-95	7.4	23.0	3.7	11.5	15.2
I-195	13.9	25.2	7.0	12.6	19.6
Subtotal					
Total Increase in Emission (Kilograms)			35		

Total Free Flow Emissions 76
Total Incident Emissions 111

TOTAL ACCIDENT DURATION: 25 Minutes Pollutant: Volatil Organic Compounds - VOC

Shoulder Blockage Conditions

Link	VMT Calculation			Speed Calculation			Incident Characteristics			Emissions Calculation				
	Distance (Miles)	Demand (Veh/hr)	VMT (Veh-m)	Freeflow Speed (mph)	Delay (min.)	Congested Speed (mph)	Affected Vehicles	Total Delay (veh-hr)	Incident Duration (Min.)	Emission Factor		Total Emissions		Incident Emissions (Kg)
I-95	8.60	8640	74,304	45	1.68	39	4320	121	30.00	0.73	0.81	54	60	6
I-195	4.30	6890	29,627	45	3.36	28	8038	450	70.00	0.73	1.04	22	31	9
Subtotal												76	91	15

Single Lane Blockage Conditions

Link	VMT Calculation			Speed Calculation			Incident Characteristics			Emissions Calculation				
	Distance (Miles)	Demand (Veh/hr)	VMT (Veh-m)	Freeflow Speed (mph)	Delay (min.)	Congested Speed (mph)	Affected Vehicles	Total Delay (veh-hr)	Incident Duration (Min.)	Emission Factor		Total Emissions		Incident Emissions (Kg)
I-95	8.60	8640	74,304	45	4.24	33	12960	916	90.00	0.73	0.92	54	68	14
I-195	4.30	6890	29,627	45	9.24	17	24115	3715	210.00	0.73	1.51	22	45	23
Subtotal												76	113	37

Total Accident Statistics					
Link	Shoulder Emissions	1-Lane Emissions	50% Shoulder	50% 1-Lane	Total Emissions
I-95	5.9	14.1	3.0	7.1	10.0
I-195	9.2	23.1	4.6	11.6	16.1
Subtotal					
Total Increase in Emission (Kilograms)			26		

Total Incident Emissions 102

TOTAL ACCIDENT DURATION: 20 Minutes Pollutant: Volatil Organic Compounds - VOC

Shoulder Blockage Conditions

Link	VMT Calculation			Speed Calculation			Incident Characteristics			Emissions Calculation				
	Distance (Miles)	Demand (Veh/hr)	VMT (Veh-m)	Freeflow Speed (mph)	Delay (min.)	Congested Speed (mph)	Affected Vehicles	Total Delay (veh-hr)	Incident Duration (Min.)	Emission Factor		Total Emissions		Incident Emissions (Kg)
I-95	8.60	8640	74,304	45	0.83	42	1440	20	10.00	0.73	0.77	54	57	3
I-195	4.30	6890	29,627	45	1.67	35	3445	96	30.00	0.73	0.88	22	26	4
Subtotal												76	83	7

Single Lane Blockage Conditions

Link	VMT Calculation			Speed Calculation			Incident Characteristics			Emissions Calculation				
	Distance (Miles)	Demand (Veh/hr)	VMT (Veh-m)	Freeflow Speed (mph)	Delay (min.)	Congested Speed (mph)	Affected Vehicles	Total Delay (veh-hr)	Incident Duration (Min.)	Emission Factor		Total Emissions		Incident Emissions (Kg)
I-95	8.60	8640	74,304	45	2.13	38	5760	204	40.00	0.73	0.83	54	62	7
I-195	4.30	6890	29,627	45	4.62	25	11483	885	100.00	0.73	1.13	22	33	12
Subtotal												76	95	19

Total Accident Statistics					
Link	Shoulder Emissions	1-Lane Emissions	50% Shoulder	50% 1-Lane	Total Emissions
I-95	3.0	7.4	1.5	3.7	5.2
I-195	4.4	11.9	2.2	5.9	8.1
Subtotal					
Total Increase in Emission (Kilograms)			13		

Total Incident Emissions 89

MOBILE5a Output Summary

Vanasse Hangen Brustlin, Inc.

MOBILE5a Output File:

ROF99.OUT

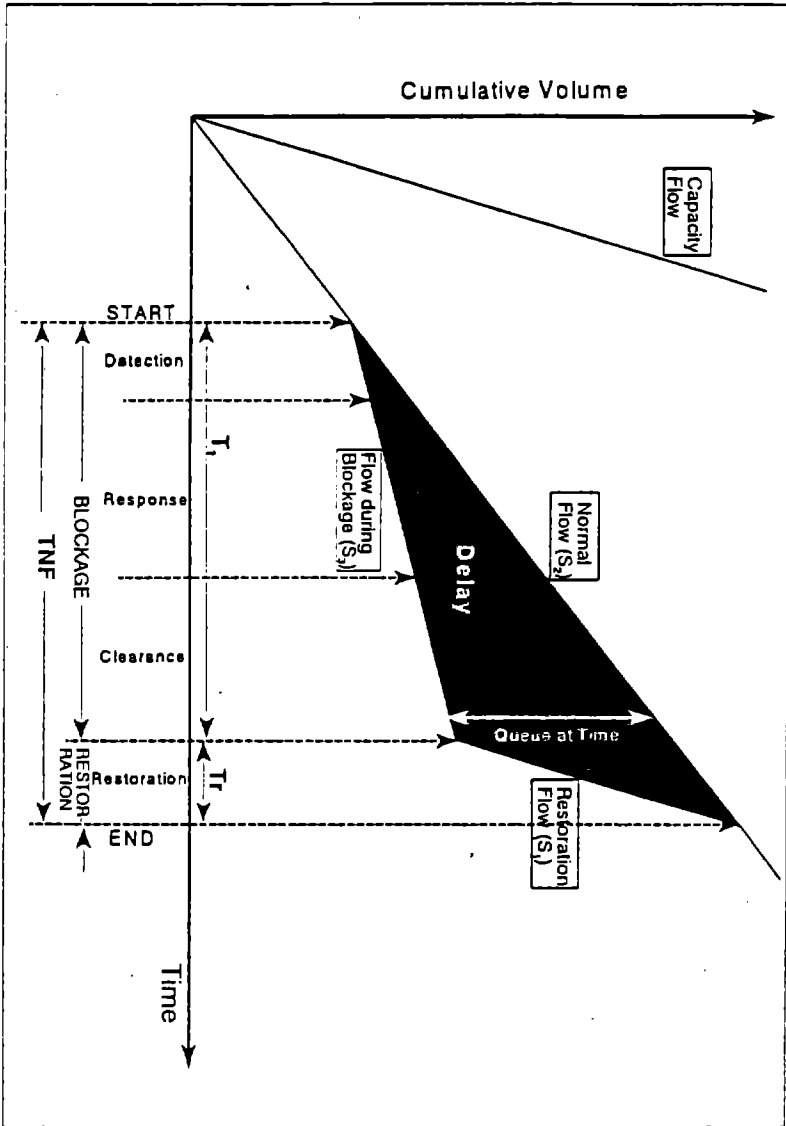
1/4/95

Mobile 2 Excel v3.0

1999

Speed	VOC Emission Factors	CO Emission Factors	NOx Emission Factors
	Total	Total	Total
3	5.88	43.22	2.17
4	4.45	34.19	2.02
5	3.64	28.61	1.92
6	3.11	24.81	1.85
7	2.74	22.04	1.80
8	2.51	19.93	1.75
9	2.33	18.27	1.72
10	2.18	16.92	1.69
11	2.05	15.81	1.66
12	1.93	14.87	1.64
13	1.83	14.08	1.62
14	1.74	13.39	1.60
15	1.65	12.79	1.58
16	1.58	12.26	1.57
17	1.51	11.79	1.55
18	1.44	11.37	1.54
19	1.38	10.99	1.53
20	1.32	10.54	1.53
21	1.28	10.01	1.53
22	1.23	9.52	1.53
23	1.20	9.08	1.53
24	1.16	8.67	1.53
25	1.13	8.29	1.53
26	1.09	7.94	1.53
27	1.06	7.62	1.54
28	1.04	7.32	1.54
29	1.01	7.04	1.54
30	0.99	6.78	1.54
31	0.96	6.54	1.54
32	0.94	6.32	1.55
33	0.92	6.10	1.55
34	0.90	5.91	1.55
35	0.88	5.72	1.56
36	0.86	5.54	1.56
37	0.84	5.38	1.57
38	0.83	5.23	1.57
39	0.81	5.08	1.58
40	0.80	4.95	1.58
41	0.78	4.82	1.59
42	0.77	4.70	1.59
43	0.75	4.59	1.60
44	0.74	4.49	1.61
45	0.73	4.39	1.61
46	0.72	4.29	1.62
47	0.71	4.21	1.63
48	0.69	4.12	1.64
49	0.69	4.13	1.69
50	0.69	4.13	1.73
51	0.69	4.14	1.78
52	0.69	4.15	1.83
53	0.69	4.15	1.88
54	0.68	4.16	1.93
55	0.68	4.18	1.98
56	0.70	4.62	2.03
57	0.71	5.06	2.09
58	0.73	5.51	2.14
59	0.74	5.96	2.20
60	0.75	6.40	2.25
61	0.77	6.86	2.31
62	0.78	7.31	2.37
63	0.80	7.77	2.43
64	0.81	8.23	2.49
65	0.83	8.69	2.56

Incident Volume/Delay Model



Source: *Alternative Surveillance Concepts and Methods for Freeway Incident Management*. Report No. FHWA-RD-77-58/63. Washington, DC. Federal Highway Administration. March 1978.

Incident Calculations

I-95							
Total Accident Duration:			0:30	Minutes			
Detection/Response Time:			0:15				
Clearance Time:			0:15				
Growth Fac:		1%	Annual				
Years		9					
Peak Flow		7900	1990				
Peak Flow		8640	1999				
Capacity		2400					
Block Cap.		Shoulder:	2016				
Block Cap.		1-lane:	1272				
Block Type:		SHOULDER		Shoulder or 1 lane			
Blocked Capacity		1344	Per Increment				
Freflo Capacity		1600	Per Increment				
Increment Demand		1440					
Increment Time:		10 Minutes					
I-95							
Elapsed Time	Demand	Capacity	Q	Increment Delay	Duration (Elapsed Minutes)		
0:10	1440	1344	96	1216	10	10	
0:20	2880	2688	192	2432	20	20	
0:30	4320	4032	288	3648	30	30	
0:40	5760	5632	128	4821	40	40	
0:50	7200	7232	0	0	50	0	
1:00	8640	8832	0	0	60	0	
1:10	10080	10432	0	0	70	0	
1:20	11520	12032	0	0	80	0	
1:30	12960	13632	0	0	90	0	
1:40	14400	15232	0	0	100	0	
1:50	15840	16832	0	0	110	0	
2:00	17280	18432	0	0	120	0	
2:10	18720	20032	0	0	130	0	
2:20	20160	21632	0	0	140	0	
2:30	21600	23232	0	0	150	0	
2:40	23040	24832	0	0	160	0	
2:50	24480	26432	0	0	170	0	
3:00	25920	28032	0	0	180	0	
3:10	27360	29632	0	0	190	0	
3:20	28800	31232	0	0	200	0	
3:30	30240	32832	0	0	210	0	
3:40	31680	34432	0	0	220	0	
3:50	33120	36032	0	0	230	0	
4:00	34560	37632	0	0	240	0	
Max Q:		1.6	Miles				
Total Delay:		202	Veh-Hours				
Accident Duration:		40	minutes				

I-195							
Total Accident Duration:				0:30		Minutes	
Detection/Response Time:				0:15			
Clearance Time:				0:15			
Growth Fac:		1% Annual					
Years		9					
Peak Flow		6300		1990			
Peak Flow		6890		1999			
Capacity		2400					
Block Cap.		Shoulder:		2016			
Block Cap.		1-lane:		1272			
Block Type:		SHOULDER				Shoulder or 1 lane	
Blocked Capacity		1008		Per Increment			
Freflo Capacity		1200		Per Increment			
Increment Demand		1148					
Increment Time:		10 Minutes					
I-195							
Elapsed Time		Demand		Capacity		Q	
						Increment Delay	
						Duration (Elapsed Minutes)	
0:10		1148		1008		140	
0:20		2297		2016		281	
0:30		3445		3024		421	
0:40		4593		4224		369	
0:50		5742		5424		318	
1:00		6890		6624		266	
1:10		8039		7824		215	
1:20		9187		9024		163	
1:30		10335		10224		111	
1:40		11484		11424		60	
1:50		12632		12624		8	
2:00		13780		13824		0	
2:10		14929		15024		0	
2:20		16077		16224		0	
2:30		17226		17424		0	
2:40		18374		18624		0	
2:50		19522		19824		0	
3:00		20671		21024		0	
3:10		21819		22224		0	
3:20		22967		23424		0	
3:30		24116		24624		0	
3:40		25264		25824		0	
3:50		26412		27024		0	
4:00		27561		28224		0	
Max Q:		2.4 Miles					
Total Delay:		1059 Veh-Hours					
Accident Duration:		110 minutes					

I-95							
Total Accident Duration:				0:30	Minutes		
Detection/Response Time:				0:15			
Clearance Time:				0:15			
Growth Fac:		1%	Annual				
Years		9					
Peak Flow		7900	1990				
Peak Flow		8640	1999				
Capacity		2400					
Block Cap.		Shoulder:	2016				
Block Cap.		1-lane:	1272				
Block Type:		1		Shoulder or 1 lane			
Blocked Capacity:		848	Per Increment				
Freflo Capacity:		1600	Per Increment				
Increment Demand:		1440					
Increment Time:		10 Minutes					
I-95							
Elapsed				Increment		Duration	
Time	Demand	Capacity	Q	Delay		(Elapsed Minutes)	
0:10	1440	848	592	1299		10	10
0:20	2880	1696	1184	2597		20	20
0:30	4320	2544	1776	3896		30	30
0:40	5760	4144	1616	5069		40	40
0:50	7200	5744	1456	6243		50	50
1:00	8640	7344	1296	7416		60	60
1:10	10080	8944	1136	8589		70	70
1:20	11520	10544	976	9763		80	80
1:30	12960	12144	816	10936		90	90
1:40	14400	13744	656	12110		100	100
1:50	15840	15344	496	13283		110	110
2:00	17280	16944	336	14456		120	120
2:10	18720	18544	176	15630		130	130
2:20	20160	20144	16	16803		140	140
2:30	21600	21744	0	0		150	0
2:40	23040	23344	0	0		160	0
2:50	24480	24944	0	0		170	0
3:00	25920	26544	0	0		180	0
3:10	27360	28144	0	0		190	0
3:20	28800	29744	0	0		200	0
3:30	30240	31344	0	0		210	0
3:40	31680	32944	0	0		220	0
3:50	33120	34544	0	0		230	0
4:00	34560	36144	0	0		240	0
Max Q:		10.1	Miles				
Total Delay:		2135	Veh-Hours				
Accident Duration:		140	minutes				

I-195							
Total Accident Duration:			0:30	Minutes			
Detection/Response Time:			0:15				
Clearance Time:			0:15				
Growth Fac:	1%	Annual					
Years	9						
Peak Flow	6300	1990					
Peak Flow	6890	1999					
Capacity	2400						
Block Cap.	Shoulder:	2016					
Block Cap.	1-lane:	1272					
Block Type:	1			Shoulder or 1 lane			
Blocked Capacity	636	Per Increment					
Freflo Capacity	1200	Per Increment					
Increment Demand	1148						
Increment Time:	10 Minutes						
I-195							
Elapsed Time	Demand	Capacity	Q	Increment Delay	Duration (Elapsed Minutes)		
0:10	1148	636	512	1042	10	10	
0:20	2297	1272	1025	2085	20	20	
0:30	3445	1908	1537	3127	30	30	
0:40	4593	3108	1485	4075	40	40	
0:50	5742	4308	1434	5024	50	50	
1:00	6890	5508	1382	5972	60	60	
1:10	8039	6708	1331	6921	70	70	
1:20	9187	7908	1279	7869	80	80	
1:30	10335	9108	1227	8817	90	90	
1:40	11484	10308	1176	9766	100	100	
1:50	12632	11508	1124	10714	110	110	
2:00	13780	12708	1072	11662	120	120	
2:10	14929	13908	1021	12611	130	130	
2:20	16077	15108	969	13559	140	140	
2:30	17226	16308	918	14508	150	150	
2:40	18374	17508	866	15456	160	160	
2:50	19522	18708	814	16404	170	170	
3:00	20671	19908	763	17353	180	180	
3:10	21819	21108	711	18301	190	190	
3:20	22967	22308	659	19249	200	200	
3:30	24116	23508	608	20198	210	210	
3:40	25264	24708	556	21146	220	220	
3:50	26412	25908	504	22094	230	230	
4:00	27561	27108	453	23043	240	240	
Max Q:	8.7	Miles					
Total Delay:	4850	Veh-Hours					
Accident Duration:	240	minutes					

Incident Management Calculations (5 Minutes)

I-95						
Total Accident Duration:				0:25	Minutes	
Detection/Response Time:				0:10		
Clearance Time:				0:15		
Growth Fac:			1%	Annual		
Years			9			
Peak Flow			7900	1990		
Peak Flow			8640	1999		
Capacity			2400			
Block Cap.			Shoulder:	2016		
Block Cap.			1-lane:	1272		
Block Type:			shoulder		Shoulder or 1 lane	
Blocked Capacity			1344	Per Increment		
Freflo Capacity			1600	Per Increment		
Increment Demand			1440			
Increment Time:			10 Minutes			
I-95						
Elapsed				Increment		Duration
Time	Demand	Capacity	Q	Delay		(Elapsed Minutes)
0:10	1440	1344	96	1216		10 10
0:20	2880	2688	192	2432		20 20
0:30	4320	4288	32	3605		30 30
0:40	5760	5888	0	0		40 0
0:50	7200	7488	0	0		50 0
1:00	8640	9088	0	0		60 0
1:10	10080	10688	0	0		70 0
1:20	11520	12288	0	0		80 0
1:30	12960	13888	0	0		90 0
1:40	14400	15488	0	0		100 0
1:50	15840	17088	0	0		110 0
2:00	17280	18688	0	0		120 0
2:10	18720	20288	0	0		130 0
2:20	20160	21888	0	0		140 0
2:30	21600	23488	0	0		150 0
2:40	23040	25088	0	0		160 0
2:50	24480	26688	0	0		170 0
3:00	25920	28288	0	0		180 0
3:10	27360	29888	0	0		190 0
3:20	28800	31488	0	0		200 0
3:30	30240	33088	0	0		210 0
3:40	31680	34688	0	0		220 0
3:50	33120	36288	0	0		230 0
4:00	34560	37888	0	0		240 0
Max Q:			1.1	Miles		
Total Delay:			121	Veh-Hours		
Accident Duration:			30	minutes		

I-195							
Total Accident Duration:			0:25		Minutes		
Detection/Response Time:			0:10				
Clearance Time:			0:15				
Growth Fac:		1% Annual					
Years		9					
Peak Flow		6300		1990			
Peak Flow		6890		1999			
Capacity		2400					
Block Cap.		Shoulder:		2016			
Block Cap.		1-lane:		1272			
Block Type:		Shoulder		Shoulder or 1 lane			
Blocked Capacity		1008		Per Increment			
Freflo Capacity		1200		Per Increment			
Increment Demand		1148					
Increment Time:		10 Minutes					
I-195							
Elapsed				Increment		Duration	
Time		Demand		Q		Delay	
		Capacity				(Elapsed Minutes)	
0:10		1148		1008		140	
0:20		2297		2016		281	
0:30		3445		3216		229	
0:40		4593		4416		177	
0:50		5742		5616		126	
1:00		6890		6816		74	
1:10		8039		8016		23	
1:20		9187		9216		0	
1:30		10335		10416		0	
1:40		11484		11616		0	
1:50		12632		12816		0	
2:00		13780		14016		0	
2:10		14929		15216		0	
2:20		16077		16416		0	
2:30		17226		17616		0	
2:40		18374		18816		0	
2:50		19522		20016		0	
3:00		20671		21216		0	
3:10		21819		22416		0	
3:20		22967		23616		0	
3:30		24116		24816		0	
3:40		25264		26016		0	
3:50		26412		27216		0	
4:00		27561		28416		0	
Max Q:		1.6 Miles					
Total Delay:		450 Veh-Hours					
Accident Duration:		70 minutes					

I-95							
Total Accident Duration:			0:25		Minutes		
Detection/Response Time:			0:10				
Clearance Time:			0:15				
Growth Fac:		1% Annual					
Years		9					
Peak Flow		7900		1990			
Peak Flow		8640		1999			
Capacity		2400					
Block Cap.		Shoulder:		2016			
Block Cap.		1-lane:		1272			
Block Type:		1		Shoulder or 1 lane			
Blocked Capacity		848		Per Increment			
Freflo Capacity		1600		Per Increment			
Increment Demand		1440					
Increment Time:		10 Minutes					
I-95							
Elapsed Time		Demand		Capacity		Increment	
						Q	
						Delay	
						Duration (Elapsed Minutes)	
0:10		1440		848		592	
0:20		2880		1696		1184	
0:30		4320		3296		1024	
0:40		5760		4896		864	
0:50		7200		6496		704	
1:00		8640		8096		544	
1:10		10080		9696		384	
1:20		11520		11296		224	
1:30		12960		12896		64	
1:40		14400		14496		0	
1:50		15840		16096		0	
2:00		17280		17696		0	
2:10		18720		19296		0	
2:20		20160		20896		0	
2:30		21600		22496		0	
2:40		23040		24096		0	
2:50		24480		25696		0	
3:00		25920		27296		0	
3:10		27360		28896		0	
3:20		28800		30496		0	
3:30		30240		32096		0	
3:40		31680		33696		0	
3:50		33120		35296		0	
4:00		34560		36896		0	
Max Q:		6.7 Miles					
Total Delay:		916 Veh-Hours					
Accident Duration:		90 minutes					

I-195						
Total Accident Duration:			0:25		Minutes	
Detection/Response Time:			0:10			
Clearance Time:			0:15			
Growth Fac:	1% Annual					
Years	9					
Peak Flow	6300	1990				
Peak Flow	6890	1999				
Capacity	2400					
Block Cap.	Shoulder:	2016				
Block Cap.	1-lane:	1272				
Block Type:	1		Shoulder or 1 lane			
Blocked Capacity	636	Per Increment				
Freflo Capacity	1200	Per Increment				
Increment Demand	1148					
Increment Time:	10 Minutes					
I-195						
Elapsed Time	Demand	Capacity	Q	Increment Delay	Duration (Elapsed Minutes)	
0:10	1148	636	512	1042	10	10
0:20	2297	1272	1025	2085	20	20
0:30	3445	2472	973	3033	30	30
0:40	4593	3672	921	3981	40	40
0:50	5742	4872	870	4930	50	50
1:00	6890	6072	818	5878	60	60
1:10	8039	7272	767	6827	70	70
1:20	9187	8472	715	7775	80	80
1:30	10335	9672	663	8723	90	90
1:40	11484	10872	612	9672	100	100
1:50	12632	12072	560	10620	110	110
2:00	13780	13272	508	11568	120	120
2:10	14929	14472	457	12517	130	130
2:20	16077	15672	405	13465	140	140
2:30	17226	16872	354	14414	150	150
2:40	18374	18072	302	15362	160	160
2:50	19522	19272	250	16310	170	170
3:00	20671	20472	199	17259	180	180
3:10	21819	21672	147	18207	190	190
3:20	22967	22872	95	19155	200	200
3:30	24116	24072	44	20104	210	210
3:40	25264	25272	0	0	220	0
3:50	26412	26472	0	0	230	0
4:00	27561	27672	0	0	240	0
Max Q:	5.8 Miles					
Total Delay:	3715 Veh-Hours					
Accident Duration:	210 minutes					


Incident Management Calculations (10 Minutes)

I-95							
Total Accident Duration:				0:19	Minutes		
Detection/Response Time:				0:04			
Clearance Time:				0:15			
Growth Fac:		1%	Annual				
Years		9					
Peak Flow		7900	1990				
Peak Flow		8640	1999				
Capacity		2400					
Block Cap.		Shoulder:	2016				
Block Cap.		1-lane:	1272				
Block Type:		shoulder			Shoulder or 1 lane		
Blocked Capacity		1344	Per Increment				
Freflo Capacity		1600	Per Increment				
Increment Demand		1440					
Increment Time:		10 Minutes					
I-95							
Elapsed Time	Demand	Capacity	Q	Increment Delay	Duration (Elapsed Minutes)		
0:10	1440	1344	96	1216	10	10	
0:20	2880	2944	0	0	20	0	
0:30	4320	4544	0	0	30	0	
0:40	5760	6144	0	0	40	0	
0:50	7200	7744	0	0	50	0	
1:00	8640	9344	0	0	60	0	
1:10	10080	10944	0	0	70	0	
1:20	11520	12544	0	0	80	0	
1:30	12960	14144	0	0	90	0	
1:40	14400	15744	0	0	100	0	
1:50	15840	17344	0	0	110	0	
2:00	17280	18944	0	0	120	0	
2:10	18720	20544	0	0	130	0	
2:20	20160	22144	0	0	140	0	
2:30	21600	23744	0	0	150	0	
2:40	23040	25344	0	0	160	0	
2:50	24480	26944	0	0	170	0	
3:00	25920	28544	0	0	180	0	
3:10	27360	30144	0	0	190	0	
3:20	28800	31744	0	0	200	0	
3:30	30240	33344	0	0	210	0	
3:40	31680	34944	0	0	220	0	
3:50	33120	36544	0	0	230	0	
4:00	34560	38144	0	0	240	0	
Max Q:		0.5	Miles				
Total Delay:		20	Veh-Hours				
Accident Duration:		10	minutes				

I-195							
Total Accident Duration:				0:25	Minutes		
Detection/Response Time:				0:10			
Clearance Time:				0:15			
Growth Fac:		1%	Annual				
Years		9					
Peak Flow		6300	1990				
Peak Flow		6890	1999				
Capacity		2400					
Block Cap.		Shoulder:	2016				
Block Cap.		1-lane:	1272				
Block Type:		Shoulder		Shoulder or 1 lane			
Blocked Capacity		1008	Per Increment				
Frefo Capacity		1200	Per Increment				
Increment Demand		1148					
Increment Time:		10 Minutes					
I-195							
Elapsed Time	Demand	Capacity	Q	Increment Delay	Duration (Elapsed Minutes)		
0:10	1148	1008	140	980	10	10	
0:20	2297	2016	281	1961	20	20	
0:30	3445	3216	229	2909	30	30	
0:40	4593	4416	177	3857	40	40	
0:50	5742	5616	126	4806	50	50	
1:00	6890	6816	74	5754	60	60	
1:10	8039	8016	23	6703	70	70	
1:20	9187	9216	0	0	80	0	
1:30	10335	10416	0	0	90	0	
1:40	11484	11616	0	0	100	0	
1:50	12632	12816	0	0	110	0	
2:00	13780	14016	0	0	120	0	
2:10	14929	15216	0	0	130	0	
2:20	16077	16416	0	0	140	0	
2:30	17226	17616	0	0	150	0	
2:40	18374	18816	0	0	160	0	
2:50	19522	20016	0	0	170	0	
3:00	20671	21216	0	0	180	0	
3:10	21819	22416	0	0	190	0	
3:20	22967	23616	0	0	200	0	
3:30	24116	24816	0	0	210	0	
3:40	25264	26016	0	0	220	0	
3:50	26412	27216	0	0	230	0	
4:00	27561	28416	0	0	240	0	
Max Q:		1.6	Miles				
Total Delay:		450	Veh-Hours				
Accident Duration:		70	minutes				

I-95							
Total Accident Duration:				0:19	Minutes		
Detection/Response Time:				0:04			
Clearance Time:				0:15			
Growth Fac:		1%	Annual				
Years		9					
Peak Flow		7900	1990				
Peak Flow		8640	1999				
Capacity		2400					
Block Cap.		Shoulder:	2016				
Block Cap.		1-lane:	1272				
Block Type:		1			Shoulder or 1 lane		
Blocked Capacity		848	Per Increment				
Freflo Capacity		1600	Per Increment				
Increment Demand		1440					
Increment Time:		10 Minutes					
I-95							
Elapsed Time	Demand	Capacity	Q	Increment Delay	Duration (Elapsed Minutes)		
0:10	1440	848	592	1299	10	10	
0:20	2880	2448	432	2472	20	20	
0:30	4320	4048	272	3645	30	30	
0:40	5760	5648	112	4819	40	40	
0:50	7200	7248	0	0	50	0	
1:00	8640	8848	0	0	60	0	
1:10	10080	10448	0	0	70	0	
1:20	11520	12048	0	0	80	0	
1:30	12960	13648	0	0	90	0	
1:40	14400	15248	0	0	100	0	
1:50	15840	16848	0	0	110	0	
2:00	17280	18448	0	0	120	0	
2:10	18720	20048	0	0	130	0	
2:20	20160	21648	0	0	140	0	
2:30	21600	23248	0	0	150	0	
2:40	23040	24848	0	0	160	0	
2:50	24480	26448	0	0	170	0	
3:00	25920	28048	0	0	180	0	
3:10	27360	29648	0	0	190	0	
3:20	28800	31248	0	0	200	0	
3:30	30240	32848	0	0	210	0	
3:40	31680	34448	0	0	220	0	
3:50	33120	36048	0	0	230	0	
4:00	34560	37648	0	0	240	0	
Max Q:		3.4	Miles				
Total Delay:		204	Veh-Hours				
Accident Duration:		40	minutes				

I-195						
Total Accident Duration:			0:19		Minutes	
Detection/Response Time:			0:04			
Clearance Time:			0:15			
Growth Fac:	1% Annual					
Years	9					
Peak Flow	6300	1990				
Peak Flow	6890	1999				
Capacity	2400					
Block Cap.	Shoulder:	2016				
Block Cap.	1-lane:	1272				
Block Type:	1		Shoulder or 1 lane			
Blocked Capacity	636	Per Increment				
Freflo Capacity	1200	Per Increment				
Increment Demand	1148					
Increment Time:	10 Minutes					
I-195						
Elapsed			Increment		Duration	
Time	Demand	Capacity	Q	Delay	(Elapsed Minutes)	
0:10	1148	636	512	1042	10	10
0:20	2297	1836	461	1991	20	20
0:30	3445	3036	409	2939	30	30
0:40	4593	4236	357	3887	40	40
0:50	5742	5436	306	4836	50	50
1:00	6890	6636	254	5784	60	60
1:10	8039	7836	203	6733	70	70
1:20	9187	9036	151	7681	80	80
1:30	10335	10236	99	8629	90	90
1:40	11484	11436	48	9578	100	100
1:50	12632	12636	0	0	110	0
2:00	13780	13836	0	0	120	0
2:10	14929	15036	0	0	130	0
2:20	16077	16236	0	0	140	0
2:30	17226	17436	0	0	150	0
2:40	18374	18636	0	0	160	0
2:50	19522	19836	0	0	170	0
3:00	20671	21036	0	0	180	0
3:10	21819	22236	0	0	190	0
3:20	22967	23436	0	0	200	0
3:30	24116	24636	0	0	210	0
3:40	25264	25836	0	0	220	0
3:50	26412	27036	0	0	230	0
4:00	27561	28236	0	0	240	0
Max Q:	2.9 Miles					
Total Delay:	885 Veh-Hours					
Accident Duration:	100 minutes					

1. Report No.		 PB98-135700		3. Recipient's Catalog No.	
4. Title and Subtitle Air Quality Evaluation of Rhode Island's Incident Management Program		5. Report Date September 1997		6. Performing Organization Code	
		7. Author(s)		8. Performing Organization Report No.	
9. Performing Organization Name and Address Vanasse Hangen Brustlin, Inc 530 Broadway Providence, RI 02909		10. Work Unit No. (TR AIS)		11. Contract or Grant No. 326-9444(601)	
		12. Sponsoring Agency Name and Address Rhode Island Department of Transportation Traffic and Safety Management Two Capitol Hill Providence RI 02903		13. Type of Report and Period Covered	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract This report contains an air quality analysis of the benefits associated with the implementation of Metropolitan Providence, Rhode Island Incident Management Program.					
17. Key Words Incident Management Plan			18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 25	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

