InSync Adaptive Traffic Control System for the Veterans Memorial Hwy Corridor on Long Island, NY

Prepared for

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ENERGY RESEARCH AND DEVELOPMENT AUTHORITY
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ABSTRACT

This report documents Rhythm Engineering's adaptive traffic control system field installation performed by New York State Department of Transportation (NYSDOT) along Veterans Memorial Hwy in Long Island, NY. This report reviews the reason for the installation (improve progression along the Veterans Memorial Hwy intersections selected), the initial methods of testing the InSync equipment in NYSDOT's lab and those results along with the full scope of this project (the testing, installation and configuration of the InSync:Fusion system through nine intersections along Veterans Memorial Hwy). This report documents key milestones through this project: From the kickoff meeting held on 9/13/10, through the on-site training by Rhythm Technicians on 1/18/11, to the completion of the installation by NYSDOT on 2/25/11, to the adaptive turn-on and configuration by a Rhythm Engineer starting on 3/1/11 to the "After Study" being performed from 4/11/11 thru 4/15/11. Disclosure of the Before and After Study results are captured in the Appendix areas of this report.

KEYWORDS

Adaptive, Fusion, InSync, Directional congestion, C1 cable, arterial, traffic signal, traffic control, traffic engineering, congestion, transportation, fuel, vehicles, emissions

TABLE OF CONTENTS

Notice ii
Disclaimer ii
DOT Form 1700.7 iii
Abstract iv
Key Words iv
Table of Contents v
List of Figures vi
List of Tables vi

Executive Summary 1
Introduction 1
- Scope of Work 2
- Project Timeline 3

InSync Equipment Testing 5
- C1 Cable Development 5
- InSync:Fusion Processor 10
- NYSDOT Testing Scenarios 12
- NYSDOT Testing Results 12

InSync Training 14
- Agenda 14
- Field Installation 15

InSync Installation (NYSDOT) 16
- Noted Delays 16
- Communications 17
- Camera Views Set 18

Arterial Before/After Study (NYSDOT/HDR, Inc) 21
InSync Adaptive Turn-on / Configuration 21
- C1 Cable Design Update 21
- Detector Mode 21
- Adaptive Turn-on 22
- Configuration 22

Project Hardware Failures 24
Project Conclusion and Recommendations 25
- Project Objectives 25
- Phasing Change Impact on Corridor Performance 25
- Driver Perceptions of Full Adaptive Operation 25
- Impact of Heavy Volume Crossing-Arterial 26
- Operational Issues 27
- Availability of Software Tools 27
- Communication Outages 27
- Corridor Characteristics/Suitability for Adaptive Operation 27
- Recommendations 27

Appendix A 29
Appendix B 38
Appendix C 48

LIST OF FIGURES

Figure 1: Veterans Memorial Hwy Corridor 2
Figure 2: Visio Timeline 4
Figure 3: C1 Pin-out Design 9
Figure 4: InSync:Fusion Processor Connections 11
Figure 5: Johnson Electric during Training 16
Figure 6: Camera Mounting Locations 18
Figure 7: Orville Dr intersection 20
Figure 8: Crossing-Arterial: additional signal consideration 26

LIST OF TABLES

Table 1: C1 Cable Pin-out 5
Table 2: Temperature Cycling Test Chart 13
Table 3: Field Final Validation Checklist 15

EXECUTIVE SUMMARY

Between 70-90 percent of traffic signals in the U.S. use outdated technology, are poorly timed and cause unnecessary delays. Based on this finding, traffic congestion is a problem that is costly both in terms of its impact on the environment and its price tag. A report from the Texas Transportation Institute (2010) shows that roadway congestion in the United States results in 4.8 billion hours of wasted time and 3.9 billion gallons of wasted fuel each year, to the tune of $115 billion annually.

InSync is an adaptive traffic signal system developed by Rhythm Engineering that uses state-of-the-art sensor technology, image processing and artificial intelligence. These elements are integrated into a system that automatically optimizes local traffic signals and coordinates signals along roadway arterials according to real-time traffic demand, resulting in reductions in fuel consumption, emissions, stops and travel times, as well as significant improvements in quality of life for communities nationwide.

The use of InSync eliminates the need for static signal coordination plans. As an example, a six-intersection arterial can be fully installed, initially configured and operational in 2-3 days. Within two weeks, after some initial remote monitoring, the arterial can be running in a fully-optimized mode. Rhythm Engineering has worked with New York State Department of Transportation (NYSDOT) to install and maintain a 9-intersection corridor along Veterans Memorial Highway on Long Island, New York.

On a whole, following the installation of the InSync system, the Veterans Memorial Highway corridor has seen the motorist fuel consumption decline by 2,429 daily gallons, total travel time reduction by 19% on average with starts from red, and an emissions reduction by 42% on average. Currently, the corridor adaptive system has been disconnected and is awaiting a final decision on activity by the New York State Energy Research and Development Authority (NYSERDA). Rhythm Engineering recognizes InSync did not meet the proposed performance objective, however we remain committed to delivering benefits to the motorists and communities of New York State. The conclusion of this report describes challenges that were faced during this project and a number of key recommendations from Rhythm Engineering to facilitate positive change.

INTRODUCTION

In March, 2011, the 454/Veterans Memorial Hwy corridor was a congested suburban arterial in the Long Island area. The nine (9) intersections identified by the NYSDOT for possible InSync upgrades, were based on the number and extent of grant approvals. The corridor selected is running in excess of 85% of capacity during peak travel times. The average daily volume of vehicle traffic is at least 40,900 vehicles.

After responding to a joint NYS Program Opportunity Notice (PON 1554), the relationship between Rhythm Engineering, NYSERDA and NYSDOT started in the fall of 2009. The InSync system received accepted status from NYSERDA in December of that year. Upon submission of a quote in early February of 2010, NYSDOT requested a model be sent for evaluation. This brought us to the point of a purchase order being submitted in early August for the InSync system with the InSync:Fusion functionality (video detection + existing vehicle detection) on the identified intersections along the Veterans Memorial Hwy corridor.

Rhythm Engineering provided the material and system integration services required for delivering a fully functioning adaptive traffic management system. NYSDOT provided the installation labor to mount the cameras (including wire pulling) and the communications infrastructure according to Rhythm Engineering's specifications.

Rhythm Engineering provides project management, configuration of the adaptive parameters and remote technical support which results in a fully operational traffic adaptive system. An outside consulting firm (HDR, Inc.) provided the Before/After study data to prove out the InSync system usefulness.

With the deployment of Rhythm Engineering's InSync system to improve progression, it was anticipated that travel times on this section of the corridor would decrease by a minimum of 20% - and provide the associated benefits of fuel consumption and emissions reductions.

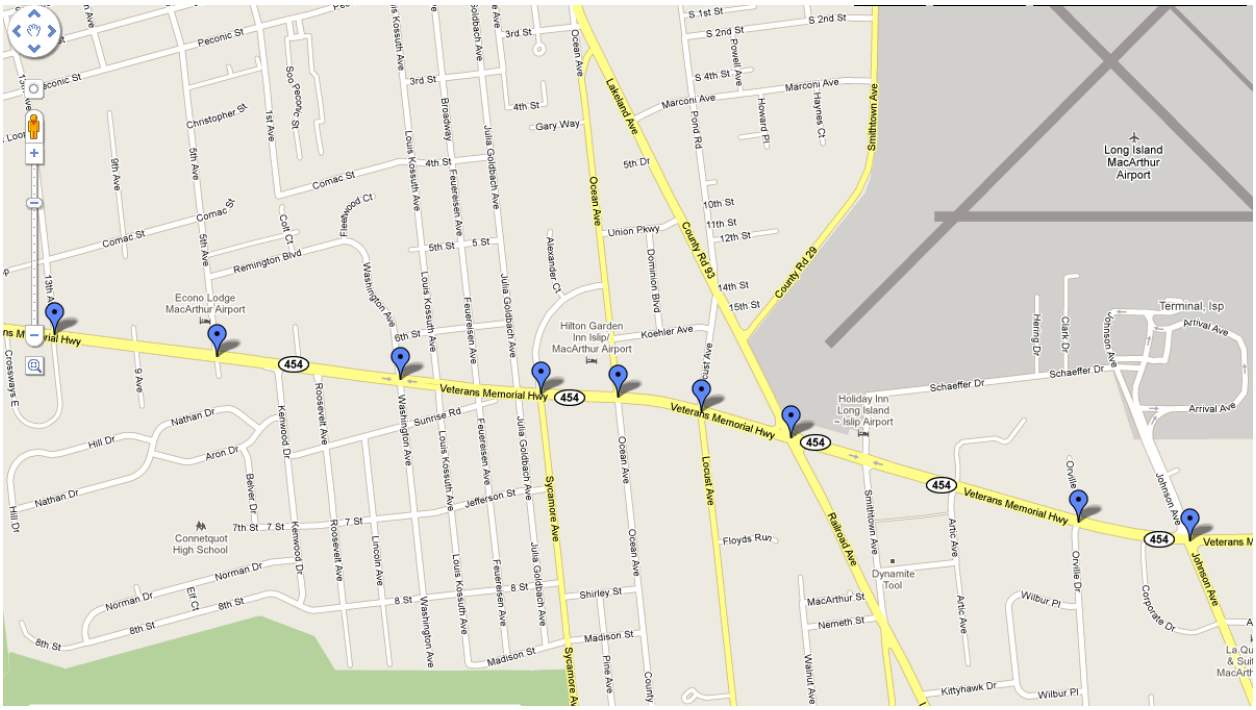


Figure 1: Veterans Memorial Hwy Corridor

SCOPE OF WORK

Under a cost-shared research agreement, Rhythm Engineering had been contracted by NYSERDA to work with NYSDOT to provide the InSync:Fusion Adaptive Traffic Control System at nine signals, using 36 cameras along a 2.5 mile stretch of Veterans Memorial Hwy on Long Island, NY.

- Nine (9) InSync:Fusion processors (+ 1 spare)
- 36 video cameras pole mounted for span-wire signals (+ 4 spare cameras)
- Nine (9) pole-mounted 330-style cabinets along corridor
- Nine (9) C1 cables interfacing the InSync processor with the controller are required
- Nine (9) monitors, keyboards and mice included
- Camera mounting hardware was provided by Rhythm Engineering for nine (9) intersections

- Remote access into NYSDOT's corridor via VPN communications is required by Rhythm Engineering

The project intersections are as follows (*all with 4 approaches & pole-mounted span wire signals*):

1. Johnson Ave/Route 12 & Veterans Memorial Hwy
2. Orville Dr & Veterans Memorial Hwy
3. Railroad Ave/County Rd 93/Lakeland Ave & Veterans Memorial Hwy
4. Locust Ave & Veterans Memorial Hwy
5. Ocean Ave & Veterans Memorial Hwy
6. Sycamore Ave/Alexander Ave & Veterans Memorial Hwy
7. Washington Ave & Veterans Memorial Hwy
8. 5th Ave & Veterans Memorial Hwy
9. 13th Ave & Veterans Memorial Hwy

PROJECT TIMELINE

The associated timeline for this project is based on the following key milestones:

- External Kickoff Meeting – Rhythm Engineering project manager holds a meeting with the Client, Installation point-of-contact, IT/communications point-of-contact and Rhythm lead technician/engineer to review all aspects of the project, discuss risks/roadblocks, define mitigation and establish a cooperative timeline to proceed.
- InSync Shipment – Assembly of InSync equipment, specific to each intersection (configured IP addresses for the cameras), is packaged and shipped to client's location. Complete intersection components in a single box (1 per intersection).
- Communications Validation – As a prerequisite to Rhythm staff coming on-site for training, remote communications into the corridor must be established.
- Training – Rhythm Engineering's lead technician is on-site for three days. AM of first day is classroom training walking through installation and maintenance of equipment. PM of first day is intersection installation, from hanging the cameras to terminating all connections in the cabinet. The second day, the lead tech takes a supervisor's role and supports the installation crew through advice and techniques on the second and possibly third intersections. The third day is final instruction and answering of any questions before departure.
- Adaptive Turn-on/Configuration – Rhythm Engineering's project engineer is on-site for four days to take the controllers in each intersection out of detector mode and place in adaptive mode through the InSync processor. Following this step, the Engineer configures the corridor intersection-by-intersection to optimize the traffic flow from beginning to end.

Within this project, the original timeline was to begin in late September 2010 and complete the configuration by mid-December 2010. One aspect of the timeline was a test period of the InSync equipment by NYSDOT in their Albany offices. This delayed the completion of the project. The winter of 2010-2011 caused considerable delays due to the record snow falls for the northeast United States. This delayed the completion of the project numerous times as well.

Figure 2 below depicts the original timeline (**RED**) accepted by all parties during the External Kickoff. The updated timeline (**BLUE**) shows the new schedule and completion dates for the configuration.

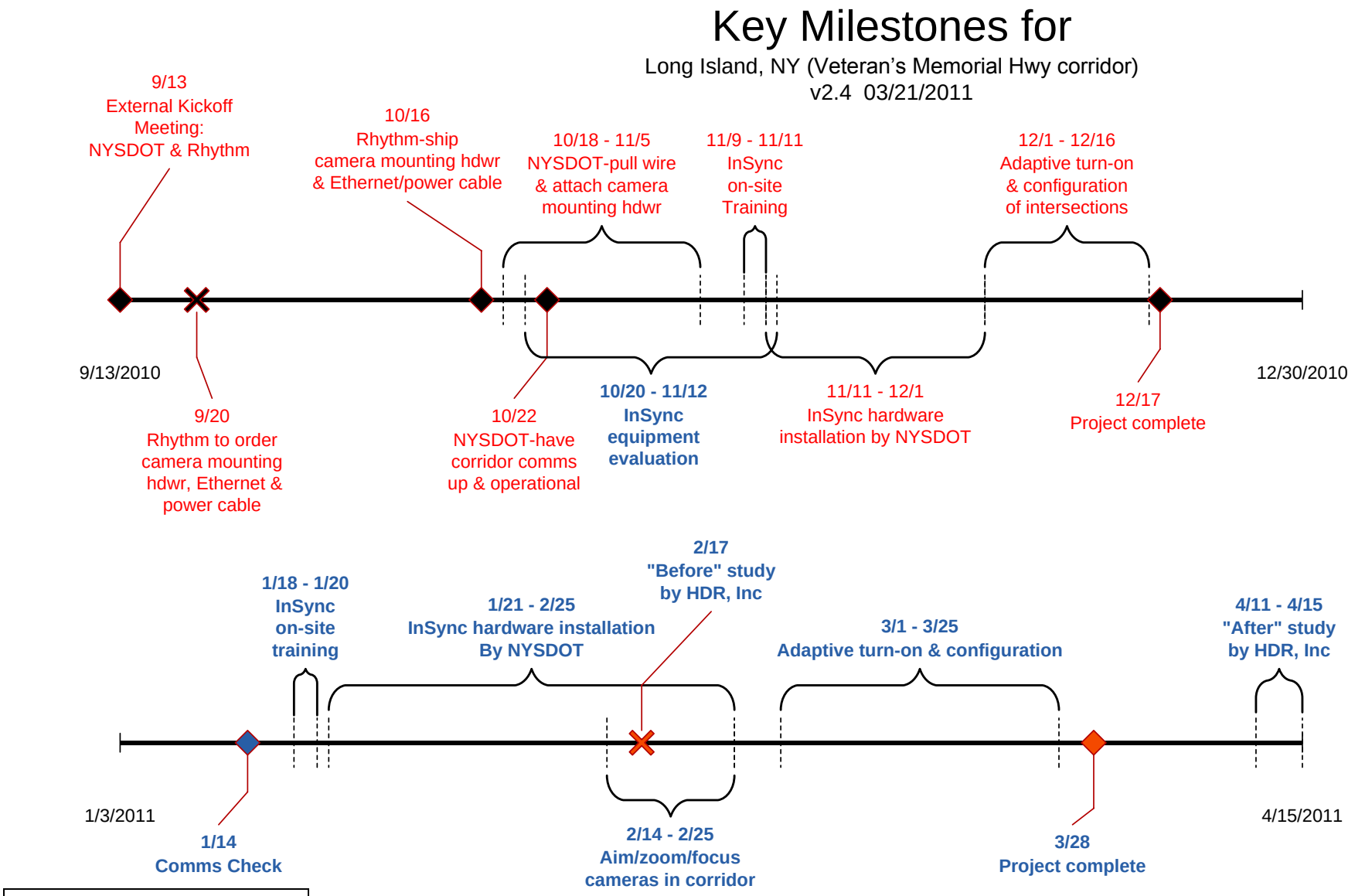


Figure 2: Project Timeline

INSYNC EQUIPMENT TESTING

As part of the approval for Rhythm Engineering to receive the Veterans Memorial Hwy project, an evaluation of all InSync equipment configured and functioning was required. The simulations and environmental production testing administered by NYSDOT produced acceptable results on all equipment reviewed. The testing was based on temperature variations (-34 ○ C to +74 ○ C operating) over a specified period of time.

C1 CABLE DEVELOPMENT

The C1 cable was developed specifically for the application of InSync:Fusion connectivity. This particular cable is used in the 330 style cabinets. The C1 cable's primary use is to view and intercept information sent to the controller. Based on the physical location of the cabinets along the Veterans Memorial Hwy corridor, access was not available into the back of the cabinet for direct wiring. The C1 cable is a clean way of both intercepting information submitted to the controller (i.e., pedestrian push for the cross walk or using the loop detection along with camera views of the intersection) as well as viewing information that is passed through. Simply stated, the C1 cable sits in the middle between inputs to the controller and processing information into the InSync processor.

The following table displays the pin-out designed for the C1 cable used in Long Island, NY.

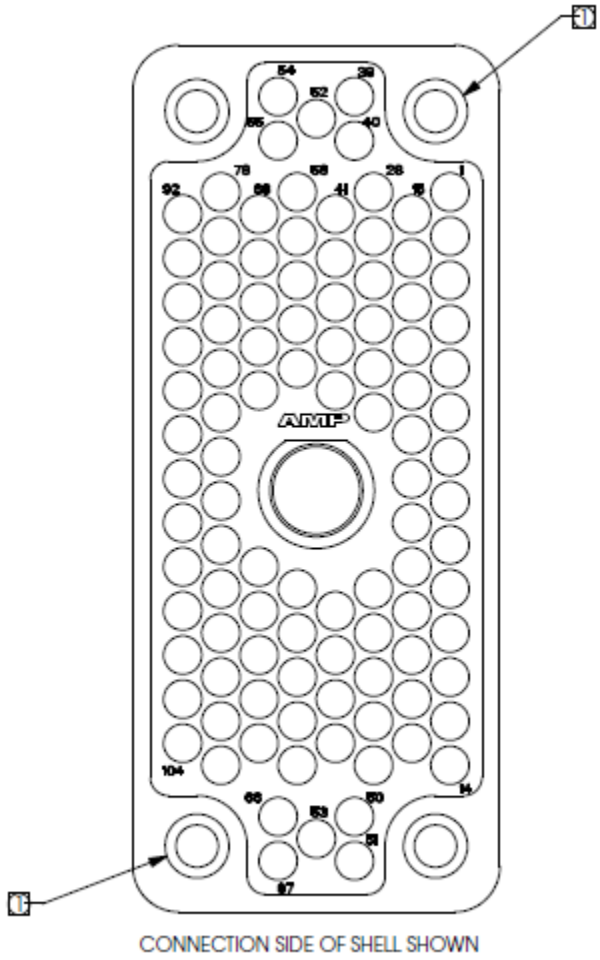
"From" Connector	Pin	→	"To" Connector	Pin	Length (feet)	termination	termination	
fem C1	1		male C1	1	1 ft	66104-8	66102-8	
fem C1	2		male C1	2	1 ft	66104-8	66102-8	
fem C1	3		male C1	3	1 ft	66104-8	66102-8	
			J6	24	6 ft		1658539-1	diode
fem C1	4		male C1	4	1 ft	66104-8	66102-8	
fem C1	5		male C1	5	1 ft	66104-8	66102-8	
fem C1	6		male C1	6	1 ft	66104-8	66102-8	
			J5	15	6 ft		1658539-1	diode
fem C1	7		male C1	7	1 ft	66104-8	66102-8	
fem C1	8		male C1	8	1 ft	66104-8	66102-8	
fem C1	9		male C1	9	1 ft	66104-8	66102-8	
			J5	2	6 ft		1658539-1	diode
fem C1	10		male C1	10	1 ft	66104-8	66102-8	
fem C1	11		male C1	11	1 ft	66104-8	66102-8	
			J6	11	6 ft		1658539-1	diode
fem C1	12		male C1	12	1 ft	66104-8	66102-8	
fem C1	13		male C1	13	1 ft	66104-8	66102-8	
fem C1	14		male C1	14	1 ft	66104-8	66102-8	
			J5	13	6 ft		1658539-1	
J5	13		J6	13	12 ft	1658539-1	1658539-1	
male C1	14		J4	13	6 ft	66102-8	1658537-3	

fem C1	15		male C1	15	1 ft	66104-8	66102-8	
			J5	14	6 ft		1658539-1	diode
fem C1	16		male C1	16	1 ft	66104-8	66102-8	
fem C1	17		male C1	17	1 ft	66104-8	66102-8	
fem C1	18		male C1	18	1 ft	66104-8	66102-8	
			J5	1	6 ft		1658539-1	diode
fem C1	19		male C1	19	1 ft	66104-8	66102-8	
fem C1	20		male C1	20	1 ft	66104-8	66102-8	
			J6	25	6 ft		1658539-1	diode
fem C1	21		male C1	21	1 ft	66104-8	66102-8	
fem C1	22		male C1	22	1 ft	66104-8	66102-8	
fem C1	23		male C1	23	1 ft	66104-8	66102-8	
			J5	17	6 ft		1658539-1	diode
fem C1	24		male C1	24	1 ft	66104-8	66102-8	
fem C1	25		male C1	25	1 ft	66104-8	66102-8	
fem C1	26		male C1	26	1 ft	66104-8	66102-8	
			J5	4	6 ft		1658539-1	diode
fem C1	27		male C1	27	1 ft	66104-8	66102-8	
fem C1	28		male C1	28	1 ft	66104-8	66102-8	
			J6	12	6 ft		1658539-1	diode
fem C1	29		male C1	29	1 ft	66104-8	66102-8	
fem C1	30		male C1	30	1 ft	66104-8	66102-8	
fem C1	31		male C1	31	1 ft	66104-8	66102-8	
			J5	16	6 ft		1658539-1	diode
fem C1	32		male C1	32	1 ft	66104-8	66102-8	
fem C1	33		male C1	33	1 ft	66104-8	66102-8	
fem C1	34		male C1	34	1 ft	66104-8	66102-8	
			J5	3	6 ft		1658539-1	diode
fem C1	35		male C1	35	1 ft	66104-8	66102-8	
fem C1	36		male C1	36	1 ft	66104-8	66102-8	
fem C1	37		male C1	37	1 ft	66104-8	66102-8	
fem C1	38		male C1	38	1 ft	66104-8	66102-8	
fem C1	39		J5	8	6 ft	66104-8	1658539-1	
fem C1	40		J6	3	6 ft	66104-8	1658539-1	
fem C1	41		J5	24	6 ft	66104-8	1658539-1	
fem C1	42		J6	19	6 ft	66104-8	1658539-1	
fem C1	43		J5	21	6 ft	66104-8	1658539-1	
fem C1	44		J6	16	6 ft	66104-8	1658539-1	
fem C1	45		J5	12	6 ft	66104-8	1658539-1	
fem C1	46		J6	7	6 ft	66104-8	1658539-1	
fem C1	47		J5	22	6 ft	66104-8	1658539-1	
fem C1	48		J6	17	6 ft	66104-8	1658539-1	

fem C1	49		J6	1	6 ft	66104-8	1658539-1	
fem C1	50		J6	8	6 ft	66104-8	1658539-1	
fem C1	51		J5	5	6 ft	66104-8	1658539-1	
fem C1	52		J5	18	6 ft	66104-8	1658539-1	
fem C1	53		J5	6	6 ft	66104-8	1658539-1	
fem C1	54		J5	19	6 ft	66104-8	1658539-1	
fem C1	55		J6	2	6 ft	66104-8	1658539-1	
fem C1	56		J5	7	6 ft	66104-8	1658539-1	
fem C1	57		J6	18	6 ft	66104-8	1658539-1	
fem C1	58		J5	23	6 ft	66104-8	1658539-1	
fem C1	59		J6	15	6 ft	66104-8	1658539-1	
fem C1	60		J5	20	6 ft	66104-8	1658539-1	
fem C1	61		J6	6	6 ft	66104-8	1658539-1	
fem C1	62		J5	11	6 ft	66104-8	1658539-1	
fem C1	63		male C1	63	1 ft	66104-8	66102-8	
fem C1	64		male C1	64	1 ft	66104-8	66102-8	
fem C1	65		male C1	65	1 ft	66104-8	66102-8	
fem C1	66		male C1	66	1 ft	66104-8	66102-8	
fem C1	67		J6	9	6 ft	66104-8	1658539-1	
fem C1	68		J6	22	6 ft	66104-8	1658539-1	
fem C1	69		J6	10	6 ft	66104-8	1658539-1	
fem C1	70		J6	23	6 ft	66104-8	1658539-1	
fem C1	71		male C1	71	1 ft	66104-8	66102-8	
fem C1	72		male C1	72	1 ft	66104-8	66102-8	
fem C1	73		male C1	73	1 ft	66104-8	66102-8	
fem C1	74		male C1	74	1 ft	66104-8	66102-8	
fem C1	75		male C1	75	1 ft	66104-8	66102-8	
fem C1	76		male C1	76	1 ft	66104-8	66102-8	
fem C1	77		male C1	77	1 ft	66104-8	66102-8	
fem C1	78		male C1	78	1 ft	66104-8	66102-8	
fem C1	79		male C1	79	1 ft	66104-8	66102-8	
fem C1	80		male C1	80	1 ft	66104-8	66102-8	
fem C1	81		male C1	81	1 ft	66104-8	66102-8	
fem C1	82		male C1	82	1 ft	66104-8	66102-8	
fem C1	83		male C1	83	1 ft	66104-8	66102-8	
fem C1	84		male C1	84	1 ft	66104-8	66102-8	
fem C1	85		male C1	85	1 ft	66104-8	66102-8	
fem C1	86		male C1	86	1 ft	66104-8	66102-8	
fem C1	87		male C1	87	1 ft	66104-8	66102-8	
			J6	21	6 ft		1658539-1	diode
fem C1	88		male C1	88	1 ft	66104-8	66102-8	
fem C1	89		male C1	89	1 ft	66104-8	66102-8	

fem C1	90		male C1	90	1 ft	66104-8	66102-8	
			J6	20	6 ft		1658539-1	diode
fem C1	91		male C1	91	1 ft	66104-8	66102-8	
fem C1	92		male C1	92	1 ft	66104-8	66102-8	
fem C1	93		male C1	93	1 ft	66104-8	66102-8	
fem C1	94		male C1	94	1 ft	66104-8	66102-8	
fem C1	95		male C1	95	1 ft	66104-8	66102-8	
fem C1	96		male C1	96	1 ft	66104-8	66102-8	
fem C1	97		male C1	97	1 ft	66104-8	66102-8	
fem C1	98		male C1	98	1 ft	66104-8	66102-8	
fem C1	99		male C1	99	1 ft	66104-8	66102-8	
fem C1	100		male C1	100	1 ft	66104-8	66102-8	
fem C1	101		male C1	101	1 ft	66104-8	66102-8	
fem C1	102		male C1	102	1 ft	66104-8	66102-8	
fem C1	103		male C1	103	1 ft	66104-8	66102-8	
fem C1	104		male C1	104	1 ft	66104-8	66102-8	
J4	1		male C1	56	6 ft	1658537-3	66102-8	
J4	2		male C1	58	6 ft	1658537-3	66102-8	
J4	3		male C1	55	6 ft	1658537-3	66102-8	
J4	4		male C1	57	6 ft	1658537-3	66102-8	
J4	5		male C1	43	6 ft	1658537-3	66102-8	
J4	6		male C1	45	6 ft	1658537-3	66102-8	
J4	7		male C1	47	6 ft	1658537-3	66102-8	
J4	8		male C1	49	6 ft	1658537-3	66102-8	
J4	9		male C1	51	6 ft	1658537-3	66102-8	
J4	10		male C1	53	6 ft	1658537-3	66102-8	
J4	11		male C1	59	6 ft	1658537-3	66102-8	
J4	12		male C1	61	6 ft	1658537-3	66102-8	
J4	13		male C1	14	6 ft	NOTE: Already accounted for above		
J4	14		male C1	39	6 ft	1658537-3	66102-8	
J4	15		male C1	41	6 ft	1658537-3	66102-8	
J4	16		male C1	40	6 ft	1658537-3	66102-8	
J4	17		male C1	42	6 ft	1658537-3	66102-8	
J4	18		male C1	44	6 ft	1658537-3	66102-8	
J4	19		male C1	46	6 ft	1658537-3	66102-8	
J4	20		male C1	48	6 ft	1658537-3	66102-8	
J4	21		male C1	50	6 ft	1658537-3	66102-8	
J4	22		male C1	52	6 ft	1658537-3	66102-8	
J4	23		male C1	54	6 ft	1658537-3	66102-8	
J4	24		male C1	60	6 ft	1658537-3	66102-8	
J4	25		male C1	62	6 ft	1658537-3	66102-8	

Table 1: C1 Cable Pin-out



NOTES:
1. POSITION OF GUIDE PINS IN CONNECTOR

Figure 3: C1 Pin-out Design

INSYNC:FUSION PROCESSOR

Video detection of vehicles is the best technology for real-time adaptive traffic control. Instead of using outdated analog hardware, InSync makes existing traffic cabinets digital. This allows the user to watch traffic camera feeds from any Internet-connected computer and even adjust settings remotely.

Yet video of any kind has some inherent limitations. Circumstances beyond the traffic engineer's control – such as shadows caused by large trees and shrubs, inclement weather or camera angles that create occlusion – can cause false calls.

By integrating detection data from inductive loops and other existing methods with InSync's state-of-the-art video detection, InSync:Fusion is able to overcome the limitations that plague other video detection systems. This "fused" approach essentially eliminates the possibility for false calls, creating an adaptive traffic control system that is nearly 100% error-free.

The InSync:Fusion processor incorporates existing detection (i.e., ground loop) with the adaptive video monitoring available with the InSync system. The InSync:Fusion system uses the connections offered through the C1 cable to intercept commands intended for the controller. As seen in Figure 4, the processor connects directly into the cabinet through the C1 cable.

For this particular application, NYSDOT constructed and installed extension cables from one cabinet to another to make connection, via the RS232 ports, with the C1cable in the auxiliary cabinet housing the controller.

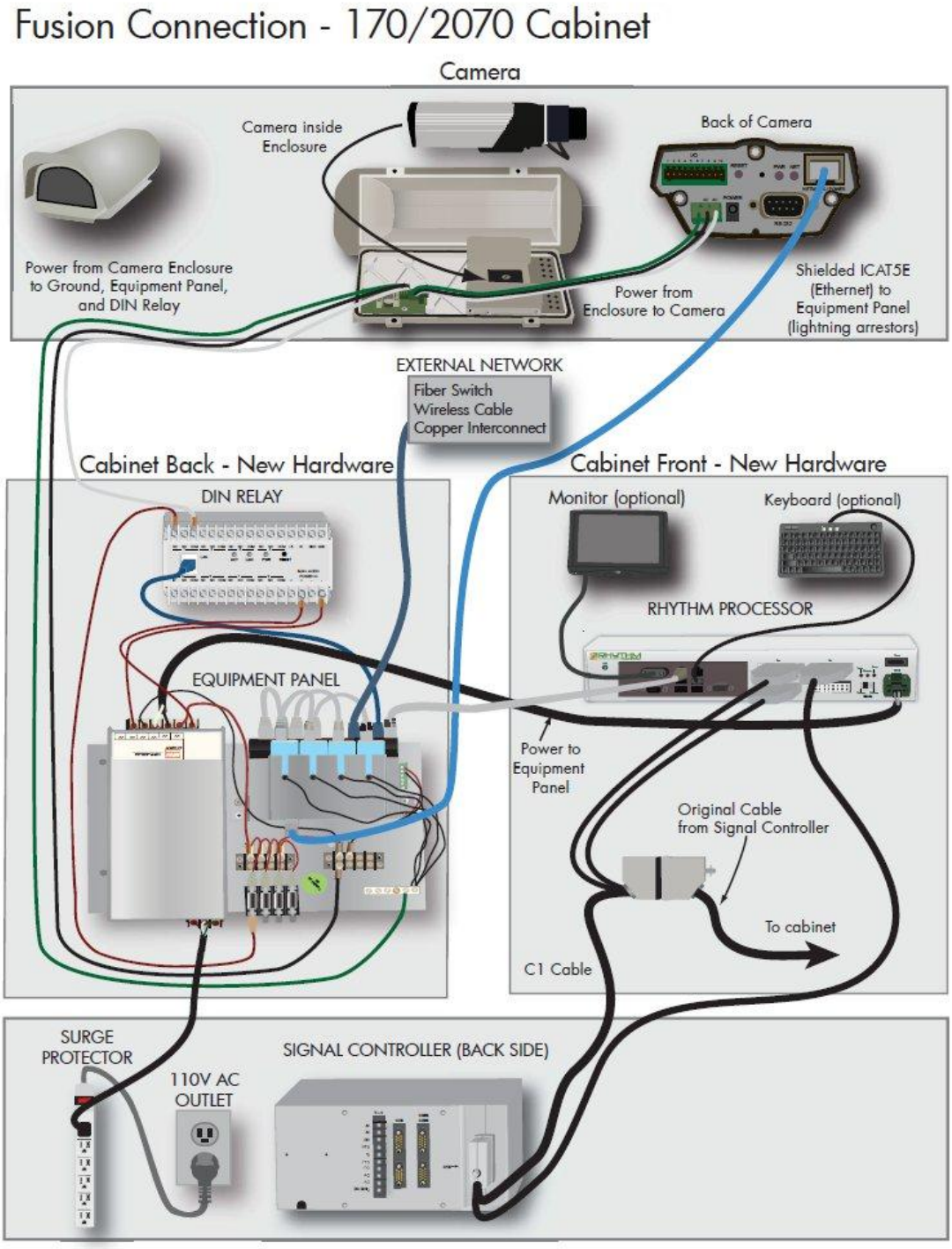


Figure 4: InSync:Fusion Processor Connections

NYSDOT TESTING SCENARIOS

Prior to the installation of InSync equipment along the Veterans Memorial Hwy on Long Island, NY, NYSDOT planned a series of tests (physical inspection, functionality and environmental) to evaluate the adaptive traffic control system. Below are the testing scenarios and results from that testing.

Equipment was received in the NYSDOT Traffic Signal Laboratory on 10/13/2010. All lab tests were completed by 10/29/2010. The following pieces of equipment were submitted by Rhythm Engineering for testing:

- InSync:Fusion processor
- C1 adapter cable
- Axis 221 IP Network cameras (qty 4)
- Equipment panel (includes power supply, Ethernet switch, lightning arrestors)
- Camera enclosure (qty 1)
- Instruction manuals

Environmental Test

The testing was performed with a 330R cabinet and 2070 controller. Multiple tests were conducted at room temperature and in the environmental chamber at hot (+ 155 ○ F) and cold (- 25 ○ F) to test functionality of the system.

Functionality Test

The tests focused on key options required by DOT for the 2070 controllers and 330R cabinets. All Rhythm Engineering devices were configured with a 330R cabinet and a 2070 controller through a modified C1 connector (guide pins were originally located on the wrong corners of the connector). Following the adjustment made to the C1 cable connector, the cable was successfully integrated between the InSync system, the 330R cabinet and the 2070 controller.

NYSDOT TESTING RESULTS

Functionality Test

With the aid of Rhythm technicians, the processor software was configured for collecting calls from network cameras and registering the calls to the 2070 controllers. This test was successful. The InSync software was also monitored through Street Wise software, and the same result was found.

Environmental Test

Chamber testing of the system was completed and all equipment continued to work except that the camera enclosure lost power during the 1st test at low temperature. This was initially due to a fault in the cable provided by NYSDOT. The power cable was equipped with a 2 AMP fuse which failed when the enclosure's heater came on. During the 2nd test, the enclosure was wired directly without any extra fuses.

The unit registered calls to the controller during the room temperature and high temperature testing, but failed to place calls from the defined zones during the low temperature testing and subsequent room temperature testing. This was potentially a programming fault of the detection zones.

Comments: The system performed well under hot and room but struggled under cold temperatures in the testing.

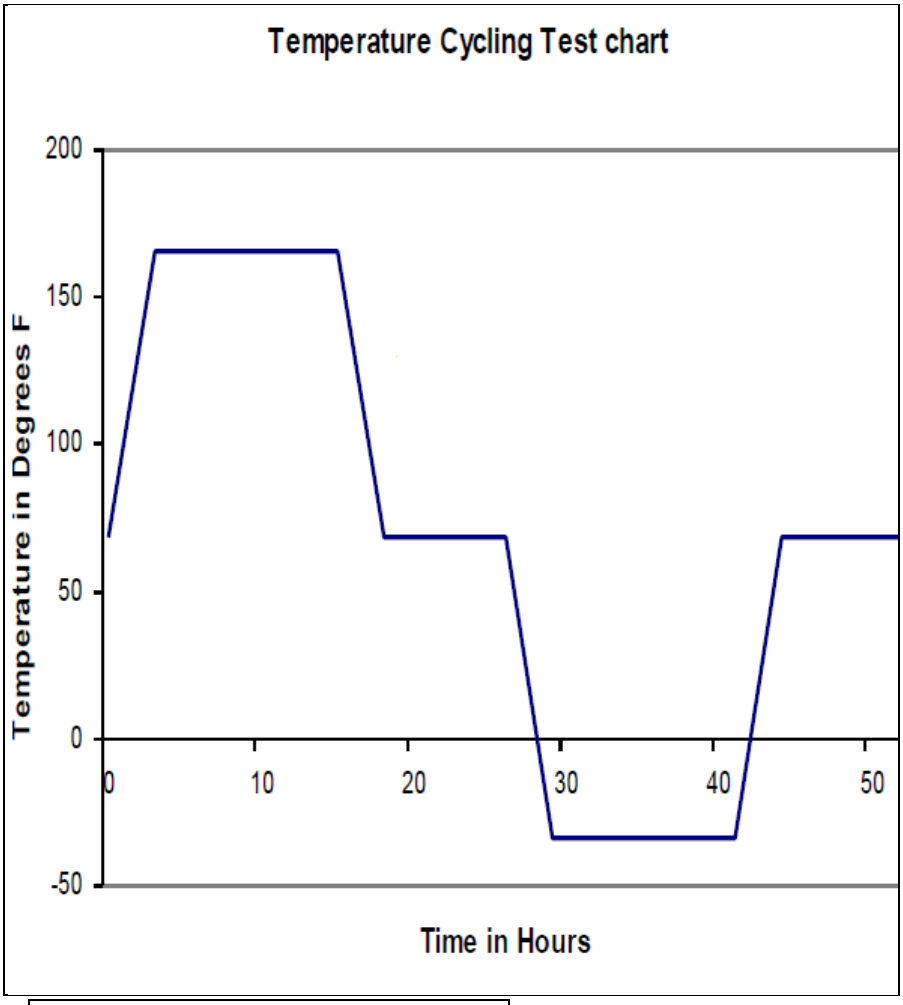


Table 2: Temperature Cycling Test Chart

Overall Testing Results

The InSync system has the ability to collect the calls through IP network cameras and then process and place the calls to the 2070 controller through the InSync processor.

As per the test results, the system can be used in NYSDOT's traffic signal system upon completion of the following changes:

1. Guide pin of the C1 connector needs to be corrected (completed 12/2/2010)
2. The length of the C1 connector cable needs to be increased by 2 feet (NYSDOT added extenders to support the pull through the conduit – C1 connectors were too big)
3. All required software has to be included to use the hardware, as well as to view the live video from the powered single cameras (processor configuration with cameras was complete prior to adaptive turn-on – 3/1/2011)

INSYNC TRAINING

On-site training on the operation of the InSync adaptive equipment was performed in Long Island, NY at the NYSDOT field office from January 18-20, 2011. The training was designed for the installation team as well as those who were to maintain the systems following the configuration.

The standard training progression was followed and is listed below:

- 1st Day: AM – Classroom-style training with material hand outs and a PowerPoint
- 1st Day: PM – Intersection installation (applying the practical knowledge attained in the morning session with hands-on installation at the first intersection to show camera installation and complete terminations of cable into the cabinet)
- 2nd Day: AM – The Rhythm technician becomes a supervisor and instructs the installation team on the 2nd intersection; the tech answers questions and instructs as needed
- 2nd Day: PM – Move to the 3rd intersection (if applicable) for installation
- 3rd Day: AM – Rhythm technician answers any final questions before departure

AGENDA

The following agenda was submitted to the management at NYSDOT prior to training to set expectations for the 1st Day – AM session. All items listed were reviewed via material handouts, a PowerPoint presentation or discussion.

<u>AM 1st Day Classroom training</u>

1. Administer Sign-In Sheet
2. Hand out training docs
3. Set out InSync system hardware components for demonstration examples (if available)
4. PowerPoint Presentation (required: client, parties responsible for installation and future maintenance of systems)
    a. Hardware Installation
    b. Camera Set-up
    c. Web UI
    d. Confirming system set-up
5. InSync Web UI demonstration (installation contractor can potentially be dismissed at this point, required: client, parties responsible for future system maintenance)
    a. Log into live intersection remotely
    b. Walk through Web UI
        i. Log in info
        ii. Configure Tab
            1. Network Configuration
            2. Configure Directions
            3. GPS Coordinates
        iii. Cameras Tab
            1. Single View
            2. Quad View
            3. Preprocessed Views

iv. Statistics Tab
    1. Statistics (available in following formats based on TOD/DOW for previous 30 days: Graph, Table, Excel, Text)
        a. Vehicle Count
        b. Stop Delay
        c. Level of Service
    2. History Viewer
        a. Highlight/Filter wait times over X amount of seconds

FIELD INSTALLATION

PM 1st Day Field Training

1. Rhythm takes lead in demonstrating proper installation procedure and best practices
2. Complete installation of one InSync system at one intersection
3. Complete final field validation checklist (as reviewed by the Rhythm Engineering technician with the installers to follow as a guide when placing the intersection in detector mode in preparation for the adaptive turn-on)

Field Final Validation Checklist

Intersection _____
Corridor _____
Install Date _____

☐ Verify all detector cards are set to correct phases and in correct slot
☐ Label all detector cards
☐ Verify I/O Board is functioning normally in TraVis program
☐ Walk thru calls and test reset using the I/O Board Tester
☐ Verify camera views labels match reality
☐ Verify RG Returns in camera views are correct
☐ Verify processor is labeled with correct IP address
☐ Verify all Ethernet cables are fully engaged
☐ Set external I/O Board switch to "Adaptive" (even for detector systems)
☐ Verify system time and time zone
☐ Grab backgrounds from camera views
☐ Verify Amber times, Red times, etc. – or have it done remotely
☐ Verify Protected/Permissive settings – or have it done remotely
☐ **Peds** – Interception and configuration tested
☐ **Fusion** – Loops verified and configured
☐ Archive configuration to jump drive
☐ Phasing – NB _____ SB _____ EB _____ WB _____

NOTES:

Table 3: Field Final Validation Checklist

Figure 5: Johnson Electric during training

INSYNC INSTALLATION (NYSDOT)

Following the training by a Rhythm Engineering technician, it was the responsibility of NYSDOT Signal Dept. to complete the installation on the remaining seven (7) intersections. During the training, two intersections were completely installed (cameras up, wires connected and terminated into the cabinet, processors mounted). Prior to training, 8 of the 9 intersections had camera mounting hardware installed. The post-training installation by NYSDOT and Johnson Electric was delayed numerous times due to the heavy snow fall received by the Northeast this past winter.

NOTED DELAYS

Please find displayed, in chronological order, the delays impacting the progression of this project in Long Island, NY. These are recorded to show a historical picture of the project.

- 1/10/2011 – Camera mounting hardware has been installed on 8 of the 9 intersections along the Veterans Memorial Hwy – experiencing snow issues at Lakeland Ave in preparation for training
- 1/12/2011 – NYSDOT located a single bad Ethernet cable which was replaced; this cleared up the communications issue they were experiencing in preparation for training

- 1/18/2011 – The following comments were made by Rhythm's lead technician while on-site for training: "Very wet. Had a pretty good productive morning at DOT office. Had 16 attendees not including Emilio. Afternoon was a wash-out. Should be good weather in the morning."
- 1/19/2011 - The following comments were made by Rhythm's lead technician while on-site for training: "Still wet and cloudy. Johnson Electric started hanging other two cameras at Washington while I looked at the cabinet work. Cabinet work is excellent. Rain started again. Tried to finish the two cameras with Rhythm's assistance, but no good."

  "John Litteer asked if a return trip would be necessary due to the weather issues. I believe Emilio's crew and Johnson Electric have things well in hand. My training filled in a few blanks and answered a few questions. The deployment can proceed easily with remote assistance from Rhythm. I expressed this to John. Emilio agreed."
- 1/24/2011 – Before Study was to begin with Luigi Casinelli (HDR, Inc.) – delayed due to weather conditions
- 2/7/2011 – Per Emilio in a status report, there was minor progress since he and Rhythm last spoke on 1/25. Snow accumulation at the intersections would not allow access to poles to continue the installation of camera units.
- 2/8/2011 – Grant Niehus (project engineer) was originally scheduled to travel to NY for the adaptive turn-on and configuration on 2/7. Installation by Johnson Electric was delayed due to winter weather (changed configuration to 2/15 in late January)
- 2/9/2011 – Emilio's team will return to the field on Wed., 2/9 to begin installing the remaining cameras. Currently, 10 cameras are up and we can see them remotely (4 of the 10 cameras are unable to be seen as of Mon, 2/7). Emilio said there is one intersection where his team is having difficulty getting to the pole due to piled snow – he expects to have access to that prior to on-site configuration.
- 2/10/2011 – We will move the adaptive turn-on and configuration to the week of 2/28. Grant will fly out on 2/28, on 3/1 the controllers will need to be freed up so we can put processors in adaptive mode. Grant will then begin configuring the corridor intersection-by-intersection. On 3/2, Grant will continue to make adjustments as he configures the corridor. Grant will spend the full day on 3/3 making adjustments. Grant will leave for Kansas City on 3/4. The following week, Grant will work remotely on the configuration.

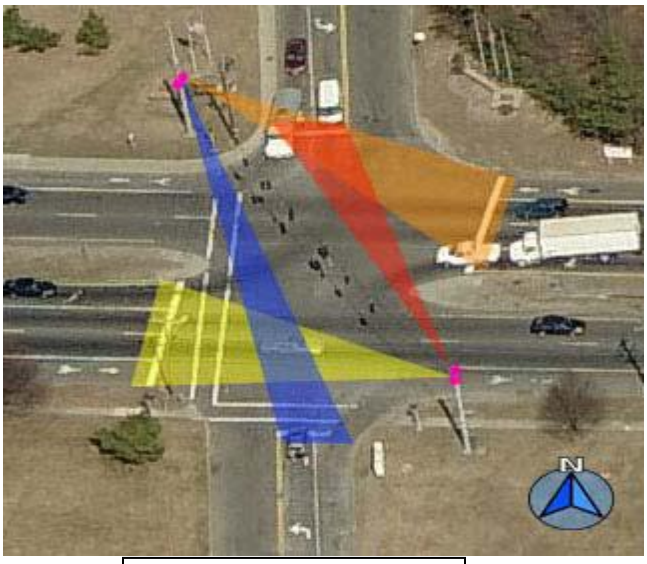
COMMUNICATIONS

The communication equipment was provided and installed by NYSDOT along this corridor. The signal interconnect may have already been in place before InSync. The router for remote VPN access resides in the NYSDOT maintenance shop and is accessed via a public IP address.

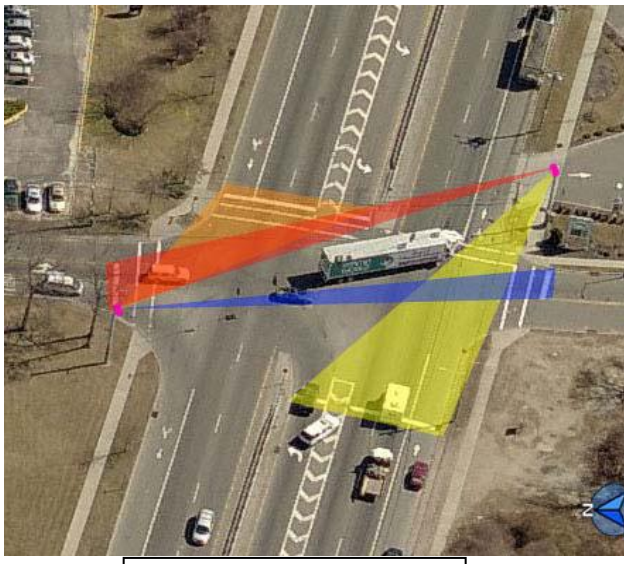
CAMERA VIEWS SET

Prior to the adaptive turn-on, all cameras views must be reviewed and approved by the Engineering department at Rhythm Engineering. This practice helps to move along the configuration time and optimize the traffic flow leading up to an intersection to extend the green as is needed based on the volume.

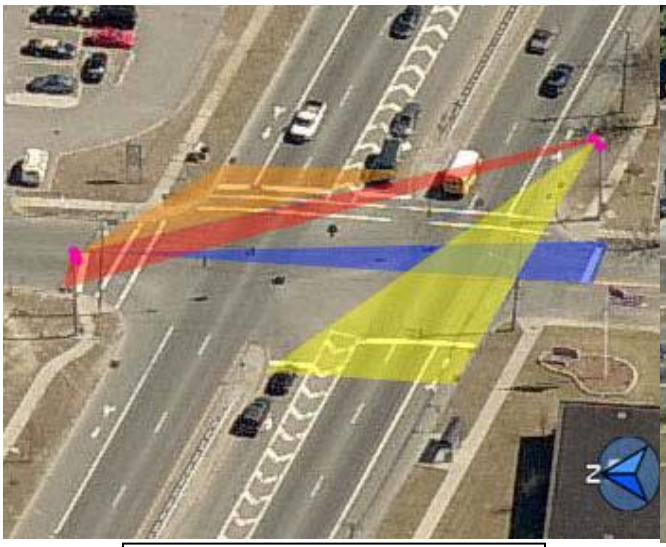
Shown in figure 6 are the pre-determined camera locations identified by a Project Engineer assigned to the #50 Long Island, NY (NYSERDA) project.



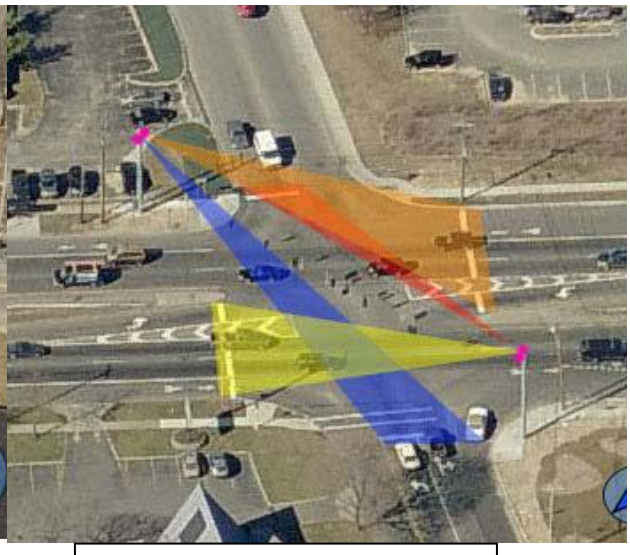
Veterans Hwy & 13th Avenue



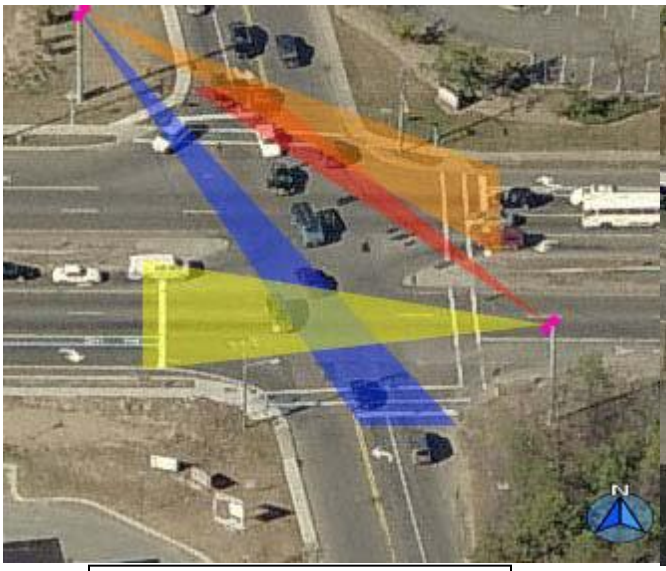
Veterans Hwy & 5th Avenue



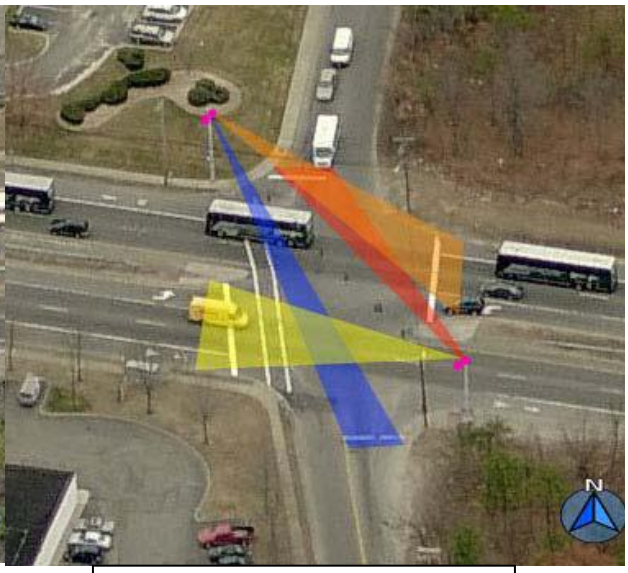
Veterans Hwy & Washington



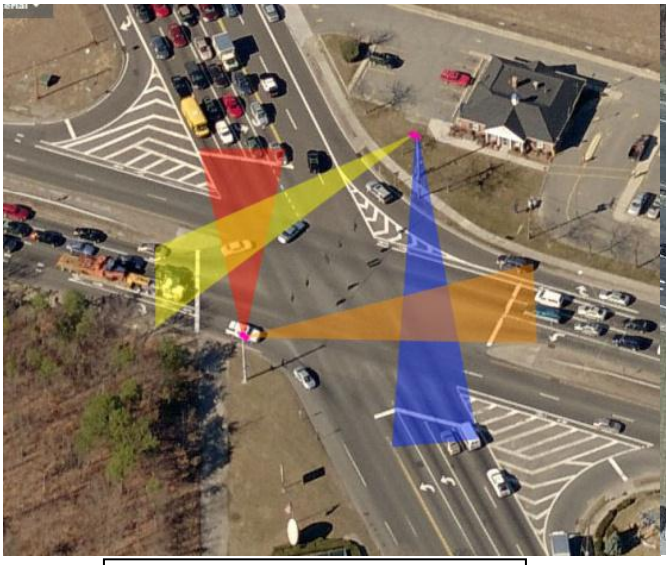
Veterans Hwy & Sycamore Avenue



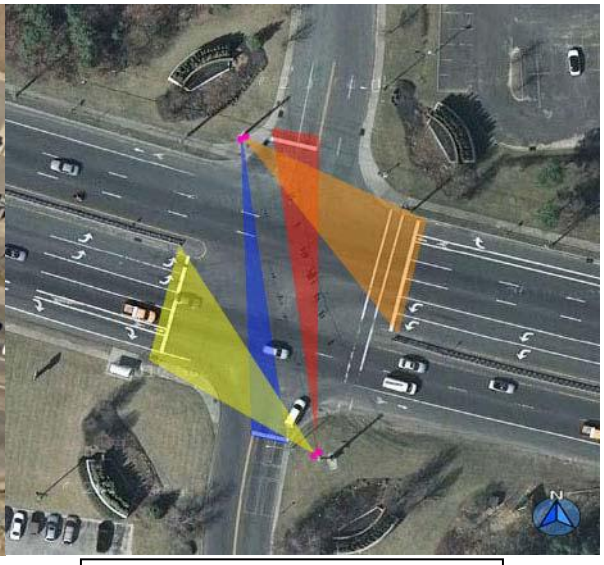
Veterans Hwv & Ocean Avenue



Veterans Hwv & Locust Avenue



Veterans Hwv & Railroad Avenue



Veterans Hwv & Orville Drive

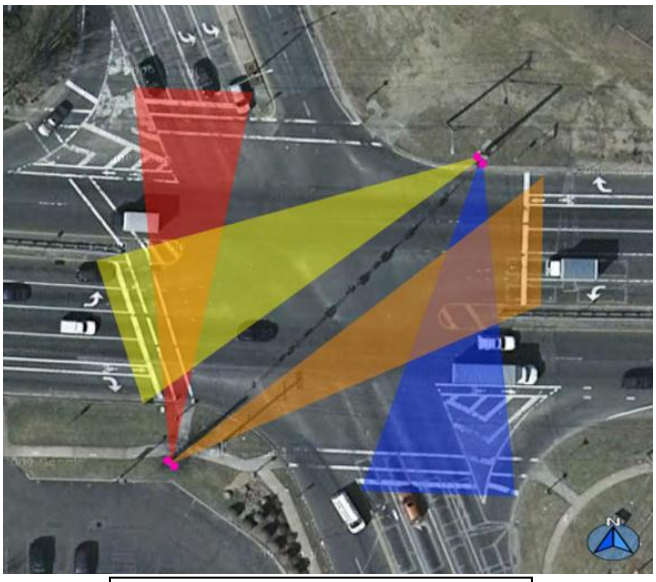


Figure 6: Camera Mounting Locations

Veterans Hwy & Johnson Avenue

All cameras are mounted on extensions coming off the span wire posts. In figure 7 below, the Veterans Memorial Hwy & Orville Dr intersection camera view is displayed showing the angle of the camera defining the need to see vehicles beyond the first in line for green movement.

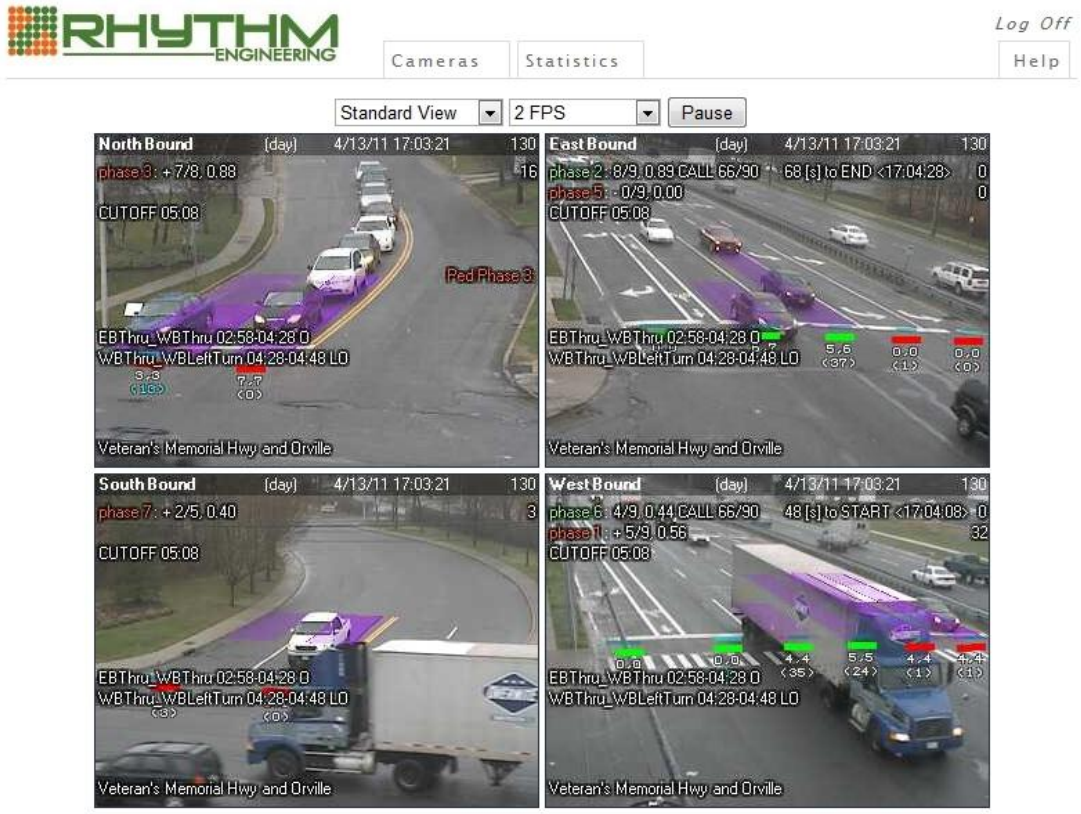


Figure 7: Orville Drive Intersection

ARTERIAL BEFORE/AFTER STUDY

Prior to adaptive turn-on, a before study was conducted along the Veterans Memorial Hwy corridor by both NYSDOT and an outside, third-party (HDR, Inc). Data and video from this study was submitted to Rhythm Engineering for marketing purposes.

The after study was scheduled following the configuration for the week of May 2, 2011 by HDR, Inc. and NYSDOT. Following the study, a report will be generated by May 20th. The initial report missed key information that was captured during a later After Study and resubmitted to Rhythm Engineering the week of July 4th.

See **Appendix A** for study results captured by HDR, Inc. for Rhythm Engineering. See **Appendix C** for Study results collected and analyzed by HDR, Inc. as a comparison.

INSYNC ADAPTIVE TURN-ON / CONFIGURATION

The adaptive turn-on and configuration is a culmination of a great deal of up-front work. From the point that the Rhythm Regional Account Manager (RAM) has the internal kickoff meeting with Operations – specifics of the corridor are reviewed (i.e., # of intersections, # of cameras per intersection, pedestrian actuations, cabinet type, etc.) to the timeline defined in the external kickoff meeting with the client. The project engineer uses this information along with the supplied Syncro files to create a simulation that is the backbone of the configuration plan that will be installed. With remote communications, the engineer will continue to make adjustments to the corridor even after leaving the site. This also allows the support team to continue to manage the corridor and upload new software enhancements over the two-year warranty period.

C1 CABLE DESIGN UPDATE

The guide pins on the connector required a simple location swap that was performed on-site at the test facility. Based on this information, the manufacturer made the appropriate changes to the remaining eight (8) cables prior to shipment. All pin outs were verified through continuity from pin to pin prior to shipment to NYSDOT.

Prior to installation, the skirt on the connector was manufactured incorrectly by attaching the skirt to the pin platform extending too far out and not allowing the pins to make contact with the female connectors. Our lead technician removed and adjusted the placement of the skirt to allow for an accurate connection. This was tested and validated.

DETECTOR MODE

As the installations were being completed intersection-by-intersection, once the cameras views were defined by Rhythm Engineering (remotely) and the installer completed all the terminations in the cabinet, the cabinet was placed in "detector mode" in preparation for the adaptive turn-on. This is where the remote communications played a key role as Rhythm Engineering worked closely with the installer to aim/zoom/focus each camera in the intersection and make all final preparations before moving on. This was a smooth transition from the installation stage to the configuration stage.

ADAPTIVE TURN-ON

As part of the adaptive turn-on, all controllers must be "freed up" (coordination plans are moved from the original traffic plan to the free mode setting). NYSDOT was needed on-site at each cabinet to follow the steps listed below to make the controller available for the adaptive configuration:

1) Disable all coordination (set controller into "free/uncoordinated" mode)
2) Enable Detector Diagnostic Failure Mode
    a. Set On failure to 250 minutes
    b. Set Off failure to 5 minutes
        i) Diagnostic failure mode on a 170 will allow itself to come out of failure.
3) Set all min times to 5 sec or as client feels comfortable.
4) Leave maximum green times as before
5) Set all Gap/Passage time to 1 sec.
6) For protected/permitted left turns, omit the left turn call when the opposing thru movement is green.

    Notes:

    - This will prevent a yellow trap if the controller receives calls on permitted left turn phases when the opposing thru is green, but may not bring on the adjacent green thru movement to allow the left turn a permitted movement.
7) Enable Soft Recall on the mainline
8) Yellow and Red detector locking disabled.
9) Remove all detector delays.
10) Disable all recalls: Max, Min, etc.
11) Remove extensions.
12) Disable Anti-Backup or Left Turn Trap
13) Enable or turn on MRI (Max Recall Inhibit)

The cabinet/controller are now ready to go "active" and bring the configured plan into play for the corridor.

CONFIGURATION

Following the initial step of the adaptive turn-on, the configuration of the corridor, intersection-by-intersection, is accomplished through the project engineer driving the corridor and making adjustments along the way concerning primary and secondary approaches into the corridor. The primary approach is the Veterans Memorial Hwy; the secondary approach is the side-street access points: 13th Ave, 5th Ave, Washington Ave, Sycamore Ave, Ocean Ave, Locust Ave, Railroad Ave, Orville Dr, and Johnson Ave. Veterans Memorial Hwy ran East/West and the side streets ran North/South.

The on-site configuration took into consideration the AM, midday and PM traffic patterns. These were reviewed over multiple periods. Upon completion of this initial configuration, the project engineer continued to make minor adjustments to the configuration remotely from the Rhythm Engineering Lenexa, KS location.

Grant Niehus, the project engineer, made one final trip to the site to complete the configuration the week of April 11th. The adjustments made by Grant complete the configuration for Veterans Memorial Hwy – the corridor is now officially in a "Support Mode" through November 7, 2012.

Attached is the portal link, requested by NYSDOT, to view the intersections: http://10.21.0.20/portal.htm. The user will need to be on the corridor network in order to view the portal page.

PROJECT HARWARE FAILURES

During the course of the project, an Issues Log was maintained to identify and mitigate hardware-related failures. This section will display all know hardware issues and their resolution. For detailed information into these issues, see **Appendix B**.

Issue Detail: See Appendix B

ID #

#1162	Issue: Veterans Hwy and Ocean Southbound camera is down. I have tried to power cycle via DIN Relay to no avail.
	Resolution: Hans worked with Matt (NY Field Tech) to install a spare camera
#1103	Issue: The SB camera is down at Veterans Memorial & Washington
	Resolution: Upon later exam, the camera was apparently swapped; everything is up and operational.
#1344	Issue: NB camera at Veterans Memorial & 5th was blown off target viewing area towards sky, placed in EM mode.
	Resolution: System uninstalled.
#1345	Issue: WB camera at Veterans Memorial & Johnson offline, DIN relay inaccessible to allow remote power cycle.
	Resolution: System uninstalled.
#1320	Issue: Andrew called reporting short greens on the mainline at Johnson intersection. They had comms issue and could not connect from their office. Further investigation showed IO Board failure on both Johnson and Orville intersections. Recommended to him to replace both, but have not heard back from him yet.
	Resolution: Andrew discovered that the storm fried the loop detector cards. Once those were replaced everything worked correctly.
#1063	Issue: Image at Veterans Memorial & Johnson fading to white.
	Resolution: Camera did not behave abnormally during testing. Unit will be reset and placed back in inventory.
#1164	Issue: NYSDOT emailed to report that side street movements were not getting served. After looking into the logs, there is a lot of controller unresponsive moments. I have contacted NYSDOT to make sure that they have all controller settings correct.
	Resolution: Related to controller settings that were changed when comms were down. System is fine now.
#1371	Issue: Client's VPN router appears to be down, not responding to our attempts to connect (IPSEC tunnel). No remote access to Veterans Hwy systems.
	Resolution: System uninstalled.
#1160	Issue: We have lost communication to Veterans and Locust through Johnson. This is not only a remote communication issue but also a local communication issue because the facilitator is not passing messages along the corridor.
	Resolution: Lost power to the Ethernet switch on our Equipment Panel, which caused a break in communications, because NYSERDA is running their communications in-series through our Ethernet switch. After repairing the power connection, communications were restored.

PROJECT CONCLUSIONS AND RECOMMENDATIONS

PROJECT OBJECTIVES

NYSERDA, NYSDOT and Rhythm Engineering entered into the adaptive pilot project on Veterans Memorial Hwy with the overall objective of reducing travel times on the corridor by 20%. Due to the characteristics of the traffic flows, roadway geometries, and phasing constraints at a key intersection, travel time reductions did not meet the project goal of 20%. The after-study and analysis performed by HDR shows that AM Peak Eastbound was reduced by 8.72%, the PM Peak Eastbound was reduced by17.93%, and the PM Peak Westbound was reduced by 9.64%. The after-study and analysis performed by Rhythm Engineering (using a different methodology that more closely aligns with the InSync adaptive operation) shows an overall average travel time reduction of 19%. These periods represent the highest vehicular volumes and the resulting over-saturated conditions. Although these results did not meet the initial project goals, they represent significant improvement over all other alternatives and provide substantial benefit to the motorists.

PHASING CHANGE IMPACT ON CORRIDOR PERFORMANCE

The primary optimization objective for the corridor was to improve progression through the corridor during the AM and PM peak periods. One of the critical intersections in the arterial network on Veterans Memorial Hwy is Lakeland Ave as it carries significantly more crossing volume than the other cross-streets. Prior to the implementation of InSync, standard 8 phase operation with protected lefts was in use at the intersection which is ideal as it provides the most flexibility and efficiency of adaptive operation. NYSDOT indicated that it was necessary to implement split phasing at the intersection due to a signal controller malfunction which sporadically put the intersection into flash mode unless the controller was running in split phase operation. This controller re-configuration to split phasing eliminated the option to move side-street traffic through lead/lag or leading left sequencing in adaptive operation. It is expected that resolving the controller malfunction issue and re-instating the previous protected-left phasing would greatly increase the efficiency of the Lakeland Ave. intersection and the entire corridor.

DRIVER PERCEPTIONS OF FULL ADAPTIVE OPERATION

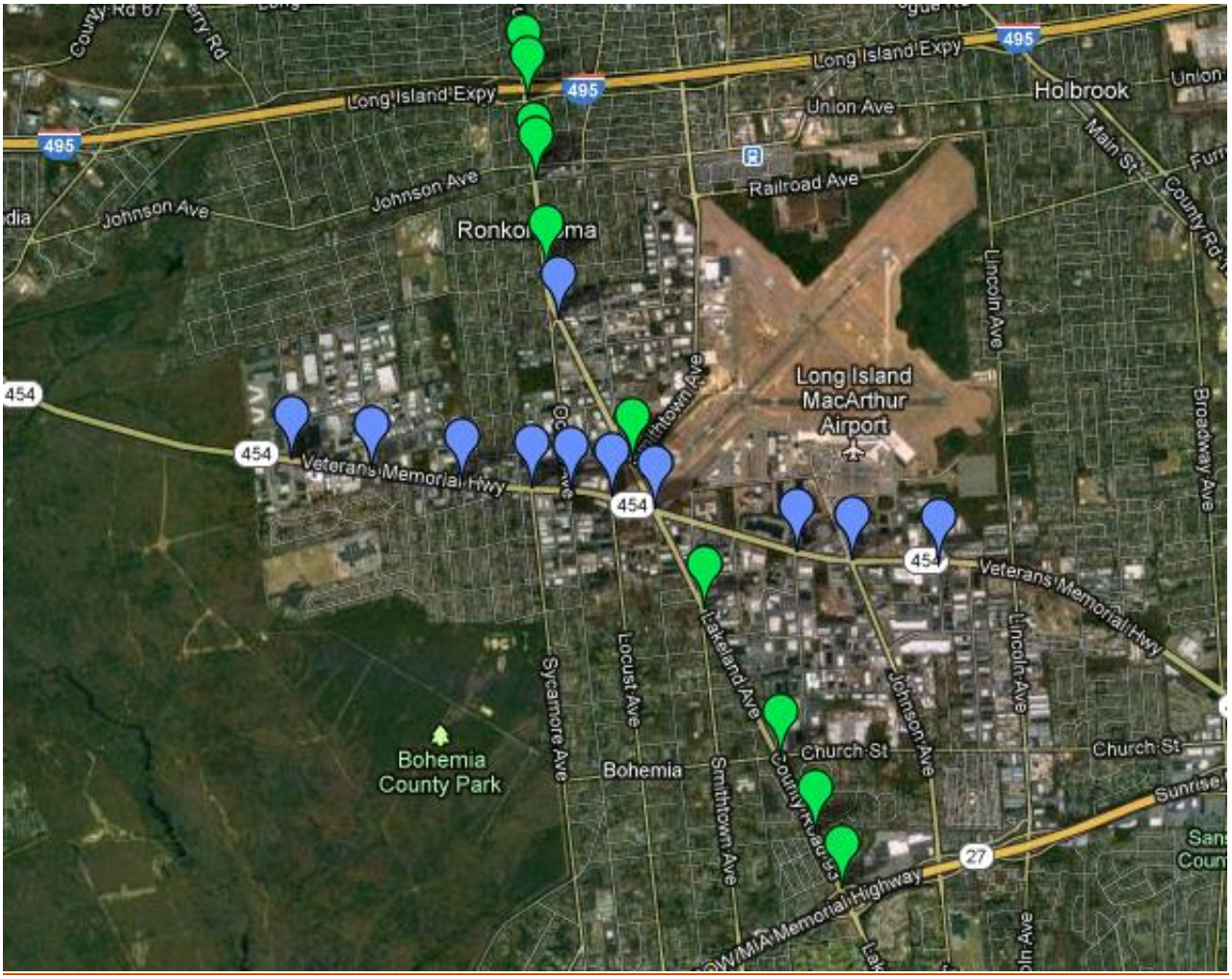
NYSDOT stated that they received motorist complaints about the change in the predictability in which phases were served after the system was put into adaptive operation. Implementing InSync creates changes to the order of signalization, and often times individual motorists are unaware of or cannot recognize the benefits of this change even though the measured benefits are conclusive. What may appear as a “skipped phase” to a driver is actually a well thought-out movement to allow higher demand traffic to proceed through the intersection.

InSync increases the level of service to motorists in a number ways, one of which is dynamic distribution of green signals. InSync determines which vehicles are in the greatest need of a green signal. This means InSync can serve a particular phase more than once or not at all during a period if demand warrants. It means a phase can be served sooner than another when warranted by demand as well as user-defined inputs. After deploying InSync, public traffic engineers typically report a few weeks of adjustment time needed by the public. After this time, public feedback on the dynamic serving of green lights ceases. Many traffic professionals believe InSync’s dynamic serving of green lights contributes to the system’s documented safety improvement benefit, as the dynamic serving of green signals makes drivers pay better attention to the signal and not guess at or cheat the light. If requested by the traffic agency, it is possible to limit InSync’s dynamic serving of green signals so that the signal operates more traditionally during certain times of day or all times of day.

IMPACT OF HEAVY VOLUME CROSSING-ARTERIAL

High-volume, crossing arterials can have a significant impact on a corridor under adaptive operation if critical, signalized intersections on the crossing arterial are not incorporated into the adaptive system or accommodated by other means. An alternative to full adaptive operation on a crossing arterial would be to coordinate the adaptive operation on the main line with the cycle lengths of the intersections on the crossing-arterial (that are not in adaptive operation). This alternative is highly dependent upon accurate time synchronization of the signals not on the adaptive network.

A potential solution to increase the performance of the Veterans Memorial Hwy and Lakeland intersection would be to incorporate the signals (or a subset) between Route 27 south of Veterans Memorial Hwy and Lakeland and those to the north, starting with the intersection just north of the Long Island Expressway. This would facilitate adaptive configurations that would effectively coordinate and synchronize flows of crossing traffic into the key intersection at Veterans Memorial Hwy and Lakeland Avenue and increase the overall performance at the intersection and the entire Veterans Memorial Hwy adaptive corridor.



Additional signals to be considered for adaptive operation are identified by the **green markers*

OPERATIONAL ISSUES

AVAILABILITY OF SOFTWARE TOOLS

NYSDOT commented that they feel InSync is a "black box" and they had no ability to see what was going on, make changes, nor troubleshoot. Rhythm provided training on the Web User Interface that was available at the time of installation. This was the primary interface for configuration of the system on an intersection by intersection basis. Since that time, Rhythm Engineering has released the CentralSync companion software tool for InSync. CentralSync is used for configuration of the InSync system on a network-wide basis. This tool is now in production and is available free of charge. Extensive training is available on software and hardware configuration, system monitoring and troubleshooting. Rhythm will provide a refresher course to NYSDOT at no charge if requested.

COMMUNICATION OUTAGES

There was a period of approximately 15 days where communications between critical intersections were down unrelated to the InSync equipment. This significantly impacted the progression along the corridor as the then critical intersection-to-intersection messages were not able to be passed. Since, Rhythm has introduced fault tolerance functionality via a free software upgrade that eliminates the impact of communication failures between intersections to ensure consistent, continued optimization in the InSync network. Rhythm support is available to NYSDOT should they opt to install this software upgrade.

CORRIDOR CHARACTERISTICS/SUITABILITY FOR ADAPTIVE OPERATION

The Veterans Memorial Hwy corridor consistently becomes saturated to over-saturated during the peak periods. These conditions will considerably impact the performance of any adaptive operation as there is little flexibility to adjust signal phases due to constant demand on all approaches. However, it is expected that the onset of saturation was delayed and the duration reduced by the InSync system. Analysis of this potential benefit was beyond the scope of the required before-and-after study.

Although the objective of 20% reduction in travel times during all periods was not met, there were still considerable travel time reductions during most periods that provided significant benefits to motorists exceeding the performance of the timing plans that were in effect prior to the adaptive operation.

RECOMMENDATIONS

Rhythm Engineering is confident that each of the following measures will substantially improve the traffic conditions and average travel times on Veterans Memorial Hwy. They can be exercised individually or collectively:

- Allow Rhythm Engineering to upgrade the software on each InSync processor to bring to bear the latest features including but not limited to mitigation of many issues created by the loss of communications
- Resolve intranet-work signal communication issues such that failures are rare or eliminated. Doing so empowers InSync to operate at optimal levels as well as empowers Rhythm Engineering to remotely and independently resolve many hardware-related issues
- Allow Rhythm Engineering to provide the software and training on CentralSync such that agency practitioners have greater visibility into and control of InSync

- Allow Rhythm Engineering additional time and opportunity to fine-tune InSync and provide any and all training and information to the local operators of NYSDOT
- Either independently or in collaboration with Rhythm Engineering, communicate with motorists the reasons for and benefits of the signalization change
- Allow Rhythm Engineering to slowly introduce dynamic phasing and sequencing over several weeks so that motorists are eased into the change, thereby reducing their perceived issues and negative feedback to NYSDOT
- Resolve the controller issue at Lakeland which disallows InSync from progressing traffic at that intersection and thereby hurts both the Veterans Memorial Hwy main line and Lakeland side street level of service
- Equip with InSync one signal on each side of Veterans Memorial Hwy at Lakeland, for a total of two additional signals

With the exception of the final recommendation above, the addition of InSync systems to two signals, Rhythm Engineering offers its participation and expertise as applicable at no charge. These actions can be made within a matter of a few weeks if so requested by NYSDOT.

Alternatively, Rhythm remains committed to providing a successful InSync installation to NYSDOT and NYSERDA. If NYSDOT and NYSERDA conclude that the functionality, performance, and operational aspects of the InSync system installed on Veterans Memorial Hwy do not provide an acceptable overall benefit to the agency and the motorists, Rhythm will provide support to re-locate the system to another corridor in New York State. Ultimately, we are committed to delivering a best-in-class product and unmatched service and support. We will do what it takes to partner with NYSERDA and NYSDOT to benefit the motorists and communities of New York State.

See **Appendix A for study results analyzed by Rhythm Engineering based on HDR, Inc. data from travel runs beginning with a stopped condition at the first intersection. See **Appendix C** for study results collected and analyzed by HDR, Inc. based on the random arrival travel run method.

The InSync operational model is typically based upon a "green tunnel" initiation following a red stop at the beginning of a corridor. The primary optimization objective for InSync is typically to maintain progression throughout the corridor. The Rhythm Engineering study uses the "**Stop from Red**" travel study technique to most accurately align with the InSync adaptive operation. The HDR study utilizes the **Random Arrival** technique with movements through the first intersection at any given signal phase. This seldom guarantees that the observer will be part of a platoon that traverses the corridor on all greens as facilited by the InSync adaptive operation.

Appendix A

BEFORE/AFTER STUDY RESULTS

RHYTHM ENGINEERING

BEFORE/AFTER STUDY RESULTS

PROJECT DESCRIPTION

The New York State Energy Research and Development Authority (NYSERDA) partnered with the New York State Department of Transportation (NYSDOT) to install the InSync adaptive traffic control system at nine intersections on Veterans Memorial Highway (NY-454) from 13th Ave. to Johnson Ave. The project was funded by a joint NYS Program Opportunity Notice (PON 1554) using State Planning and Research (SPR) funds. This study compares the operation of the Veterans Highway corridor under its existing timing scheme with its operation using the InSync adaptive traffic control system.

CRITERIA

Reduce stops, travel time, delay, fuel consumption and emissions along the artery by optimizing traffic signal operations using InSync.

CHALLENGE

The major challenges of coordinating the signals on the Veterans Memorial Hwy corridor are unpredictable fluctuations in traffic volume related to the adjacent airport and shipping facility, as well as heavy commuter traffic. The corridor was previously controlled by a coordinated timing plan.

SOLUTION

Rhythm Engineering deployed the InSync adaptive traffic signal system at nine intersections along a 2.5 mile portion of the corridor in March 2011. Following the install, Rhythm Engineering configured the system, monitored its performance and made adjustments to the system to work toward an optimized traffic flow.

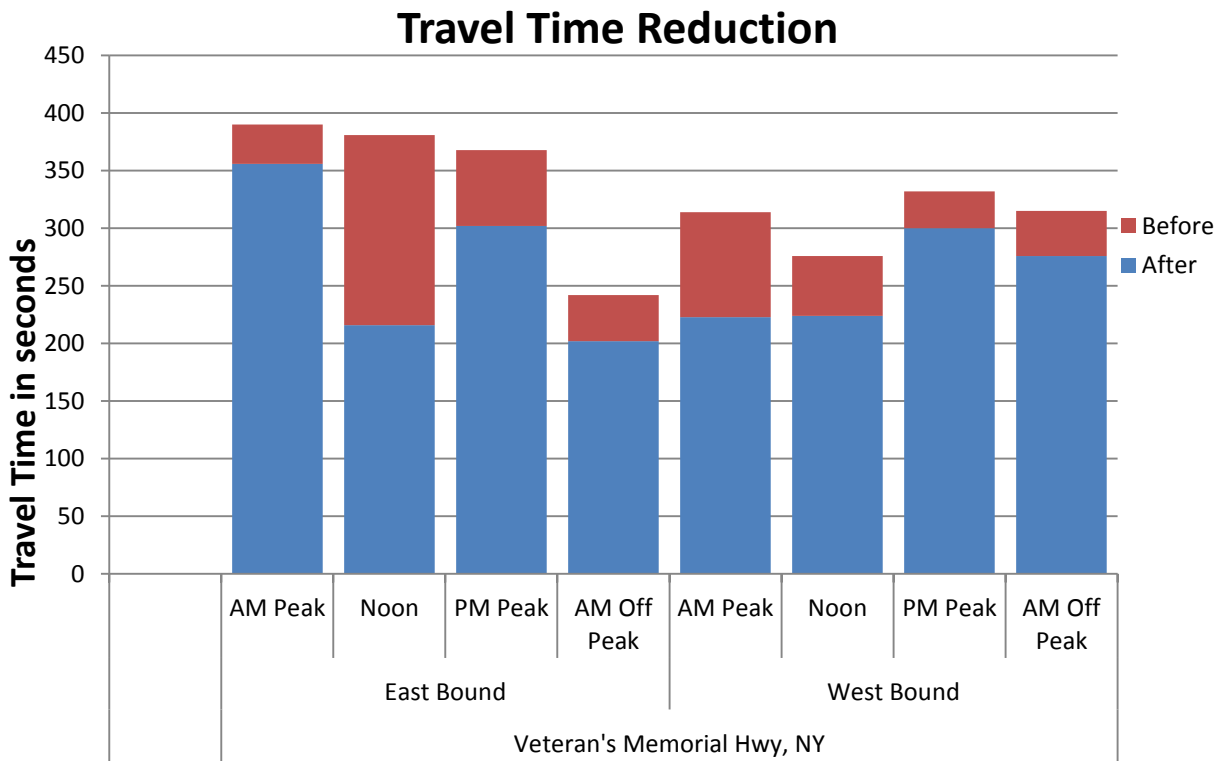
DATA COLLECTION

To evaluate the performance of the InSync system, data was collected along Route 454 corridor during four different weekday time periods. The data collection time periods were the same for both the before installation and after installation travel runs. They included:

- AM Peak Period (8:00-9:00 AM)
- Off-Peak Period (10:00-11:00 AM)
- Midday Peak Period (1:00-2:00 PM)
- PM Peak Period (5:00-6:00 PM)

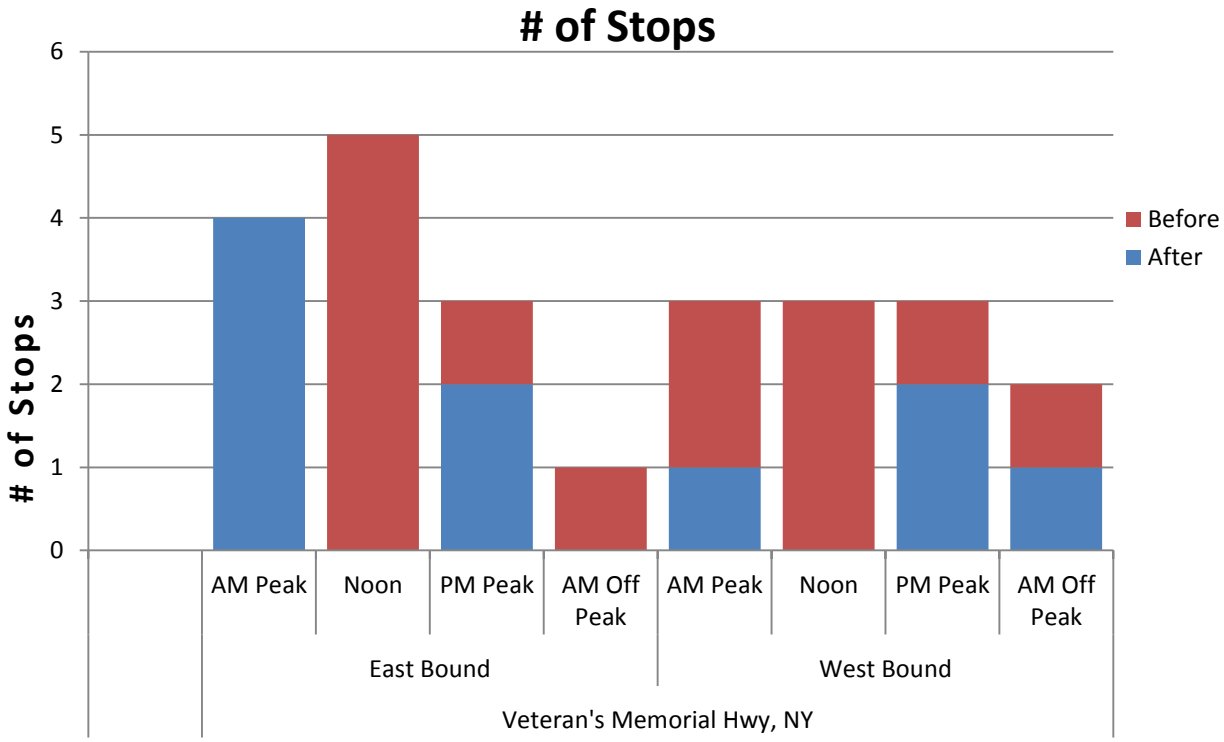
The travel time runs were collected using the floating car method, beginning from red at each end of the corridor, in which the drivers attempt to travel with the flow of traffic, changing lanes so as to pass as many cars as they are passed by. This method was used to compare the before and after conditions of a typical platoon progressing through Route 454. Before data used for comparison was travel time runs that began at a red indication with the exception of the westbound AM Off Peak and PM Peak runs where there was no available collected data that began on red. In those two cases, the before runs were collected using a random arrival method. Additionally, the after data collected for the eastbound AM Peak runs were skewed due to a truck being disabled in the right lane near Ocean Avenue on Route 454.

Data was gathered using Global Positioning System (GPS) technology and HDR, Inc.'s iTREK traffic time study software.

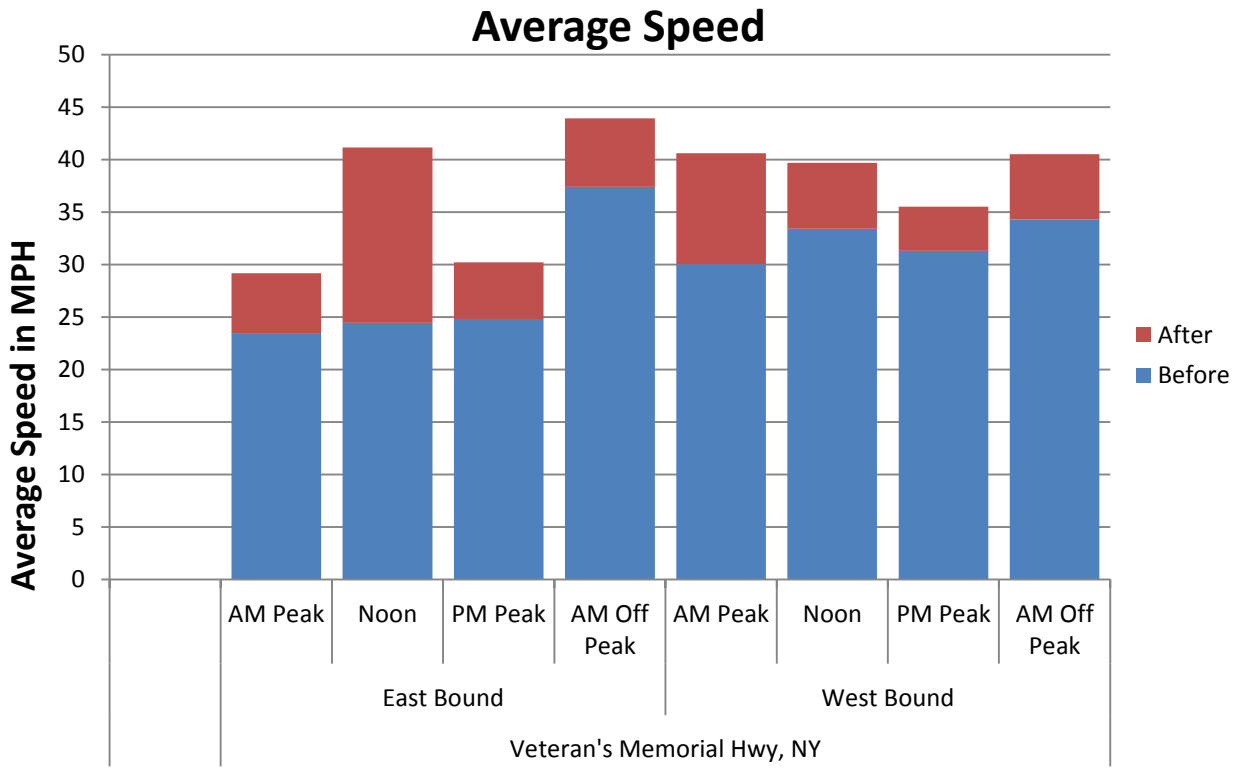


Time Period	East Bound			West Bound		
	Before	After	% Change	Before	After	% Change
AM Peak	390	356	8.72%	314	223	28.98%
Noon Peak	381	216	43.31%	276	224	18.84%
PM Peak	368	302	17.93%	332	300	9.64%
AM Off	242	202		315	276	
Noon Off			Avg. 16.53%			Avg. 12.38%
PM Off						

*Lakeland Avenue (CR-93) used heavily by motorists going to and from RT-27 south of the corridor and RT-495 north of the corridor.

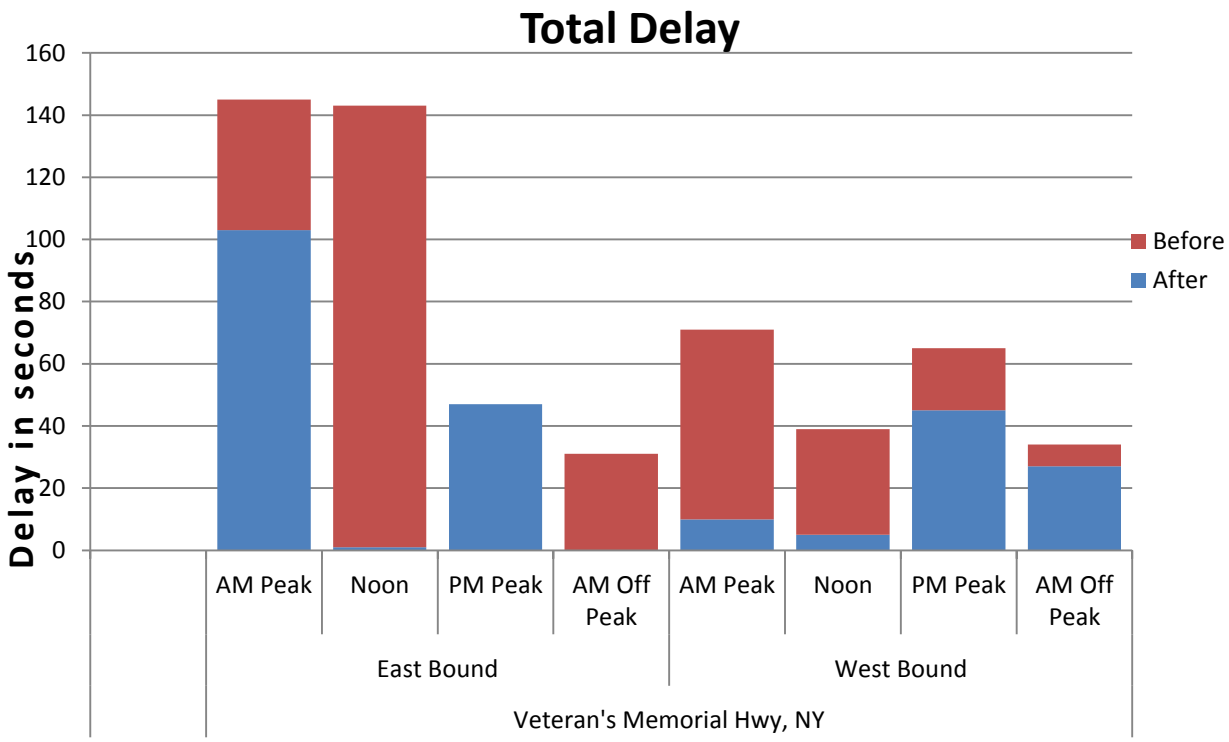


Time Period	East Bound			West Bound		
	Before	After	% Change	Before	After	% Change
AM Peak	3	4	-33.33%	3	1	66.67%
Noon Peak	5	0	100.00%	3	0	100.00%
PM Peak	3	2	33.33%	3	2	33.33%
AM Off	1	0	Avg. 100.00%	2	1	Average 50.00%
Noon Off						
PM Off						

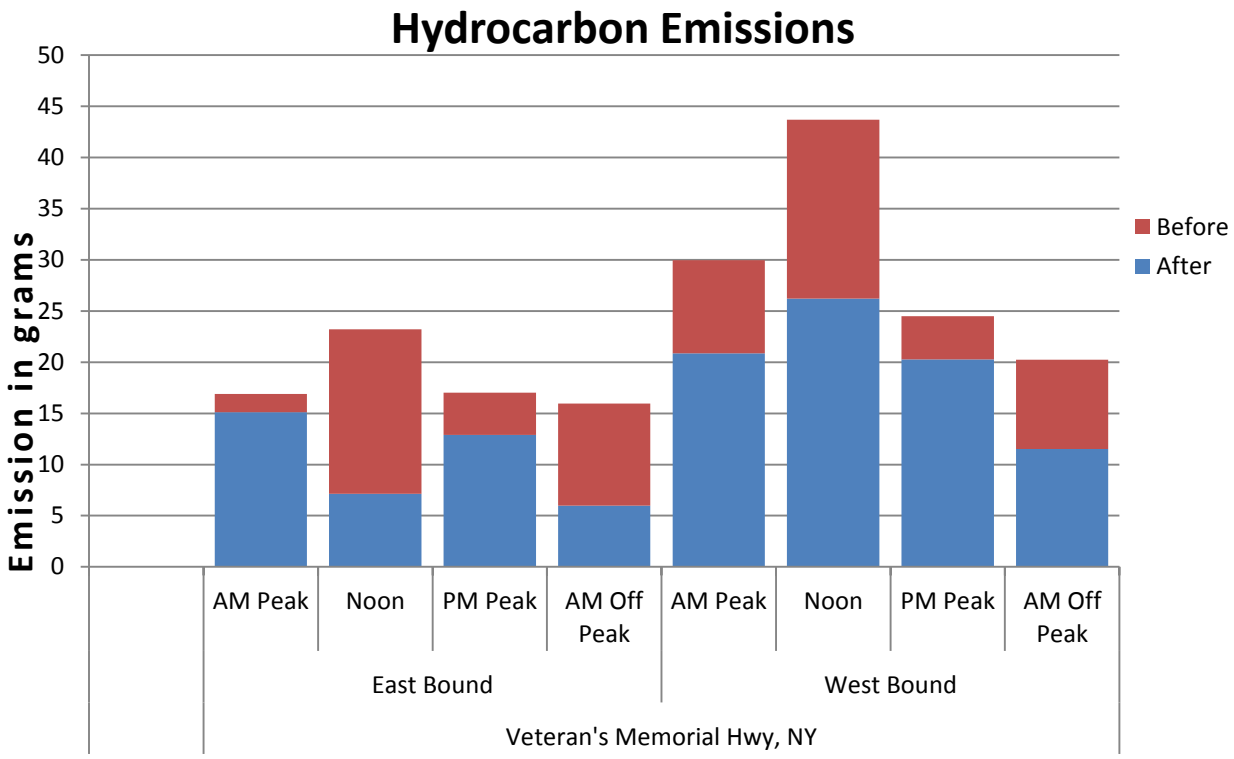


Time Period	East Bound			West Bound		
	Before	After	% Change	Before	After	% Change
AM Peak	23.48	29.17	24.23%	30.01	40.61	35.32%
Noon Peak	24.46	41.16	68.27%	33.40	39.70	18.86%
PM Peak	24.80	30.20	21.77%	31.30	35.50	13.42%
AM Off	37.39	43.93	Avg. 17.49%	34.30	40.50	Average 18.08%
Noon Off						
PM Off						

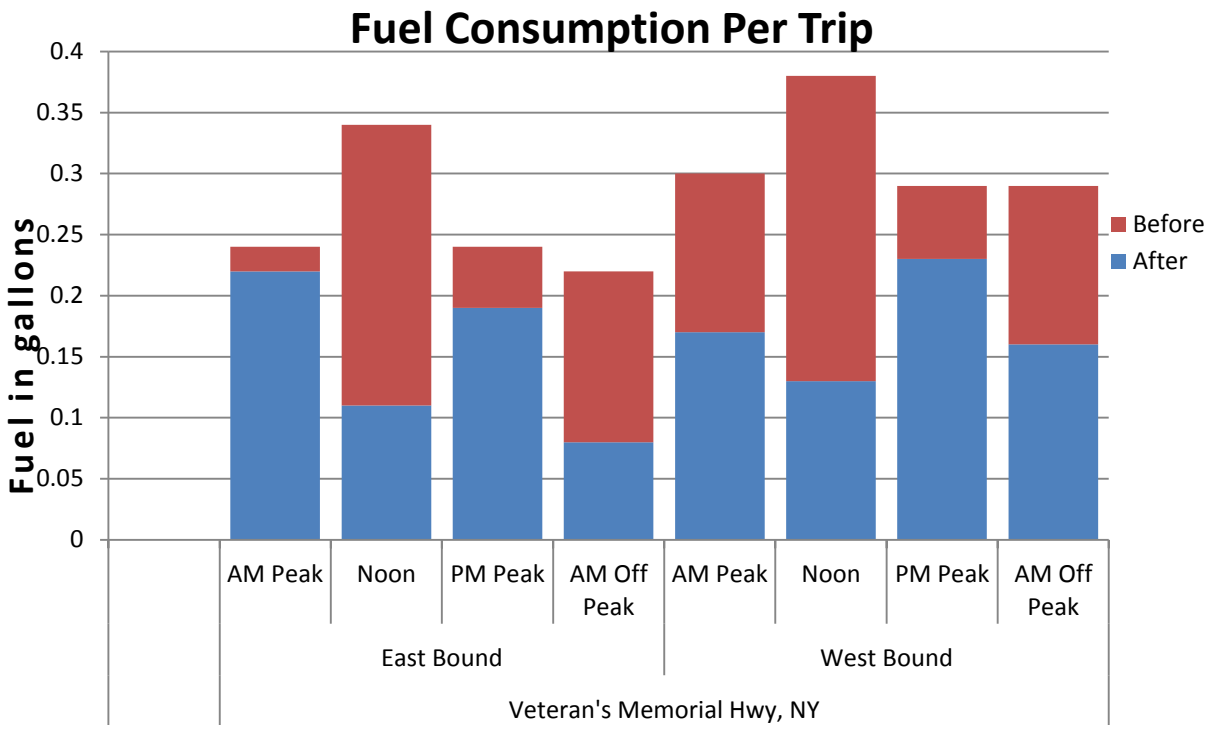
*Colors for Before & After study graph lines are reversed to reflect the trends in increase in speed through the corridor



Time Period	East Bound			West Bound		
	Before	After	% Change	Before	After	% Change
AM Peak	145	103	28.97%	71	10	85.92%
Noon Peak	143	1	99.30%	39	5	87.18%
PM Peak	47	47	0.00%	65	45	30.77%
AM Off	31	0	Avg. 100.00%	34	27	Average 20.59%
Noon Off						
PM Off						



Time Period	East Bound			West Bound		
	Before	After	% Change	Before	After	% Change
AM Peak	16.91	15.10	10.70%	20.87	11.76	43.65%
Noon Peak	23.21	7.15	69.19%	26.21	8.73	66.69%
PM Peak	17.01	12.89	24.22%	20.27	16.05	20.82%
AM Off	15.96	5.97		20.24	11.52	
Noon Off			Avg. 62.59%			Average 43.08%
PM Off						



Time Period	East Bound			West Bound		
	Before	After	% Change	Before	After	% Change
AM Peak	0.24	0.22	8.33%	0.3	0.17	43.33%
Noon Peak	0.34	0.11	67.65%	0.38	0.13	65.79%
PM Peak	0.24	0.19	20.83%	0.29	0.23	20.69%
AM Off	0.22	0.08		0.29	0.16	
Noon Off			Avg. 63.64%			Average 44.83%
PM Off						

After Study East bound: TRAVEL TIME AND DELAY SUMMARY (POST INSTALLATION)

THURSDAY--JUNE 9, 2011

Route 454 Eastbound AM Peak Hour (8:00 AM-9:00 AM)										
Run No.	**Length (Miles)**	**Travel Time (min:sec)**	**Average Speed (MPH)**	**No. of Stops**	**Stopped Delay (sec)**	**Fuel (GAL)**	**Vehicle Efficiency (MPG)**	**CO (g)**	**NOx (g)**	**VOC (g)**
1	2.47	3:14	45.64	0	0	0.08	29.30	5.89	1.15	1.36
2	2.47	5:09	28.78	2	87	0.24	10.36	16.68	3.25	3.87
3	2.46	3:19	44.46	0	0	0.08	29.06	5.92	1.15	1.37
4	2.47	7:25	20.05	10	150	0.35	7.01	24.66	4.80	5.72
5	2.47	8:17	17.95	7	198	0.27	9.20	18.79	3.66	4.36
6	2.47	8:12	18.11	7	181	0.27	9.27	18.65	3.63	4.32
Average	**2.47**	**5:56**	**29.17**	**4**	**103**	**0.22**	**15.70**	**15.10**	**2.94**	**3.50**
Note: An incident occurred during the travel time runs. A truck was disabled on the right lane near Ocean Avenue on Route 454.										

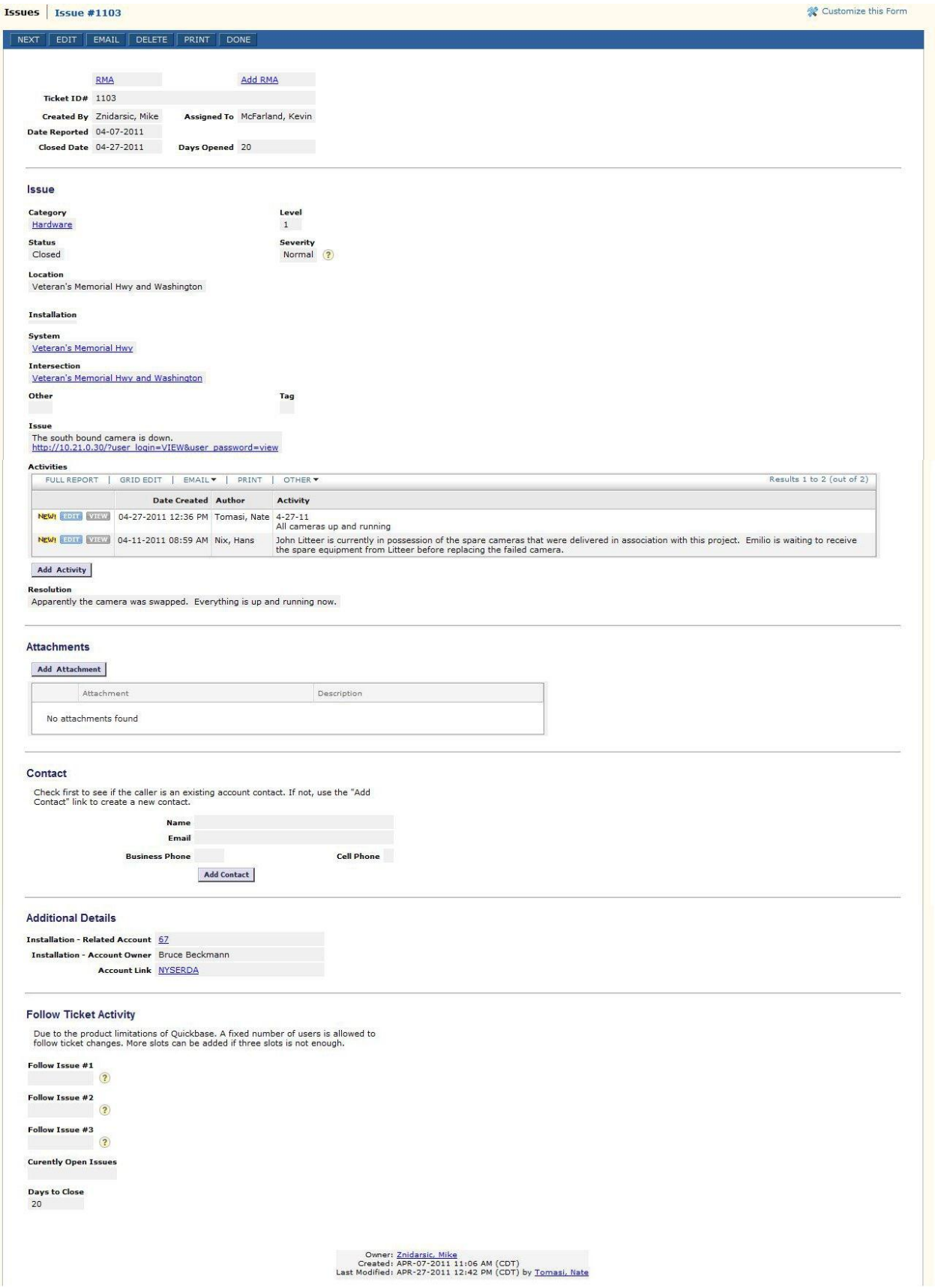
BENEFITS OF INSYNC DEPLOYMENT IN LONG ISLAND, NY

InSync creates the following benefits along Veterans Memorial Highway during AM peak, noon, PM peak and AM off-peak times on weekdays, which accounts for 44% of the corridor's volume. Calculations are based on an ADT of 43,160 vehicles using data from HDR, Inc., Google 2008 traffic counts and InSync video detection. Calculations are based on normal weekday travel and the results indicate approximate benefits to drivers.

Total Project Benefits	**Daily Benefit**	**Annual Benefit**
Vehicle Hours of Travel (reduction)	334 hours	87,000 hours
Fuel consumption (decrease)	2,429 gallons	631,645 gallons
Stops (eliminated)	31,083 stops	8,081,549 stops
Total Economic Benefit ***(fuel*$3.50) + (stops*$0.10) + (time*$15.00/hr.)***	**$16,630**	**$4,323,917**

Appendix B

HARDWARE FAILURE – ISSUES LOG TICKETS



Issues | Issue #1103

Customize this Form

NEXT | EDIT | EMAIL | DELETE | PRINT | DONE

RMA | Add RMA

Ticket ID# 1103

Created By Znidarsic, Mike | Assigned To McFarland, Kevin

Date Reported 04-07-2011

Closed Date 04-27-2011 | Days Opened 20

Issue

Category: Hardware

Level: 1

Status: Closed

Severity: Normal

Location: Veteran's Memorial Hwy and Washington

Installation:

System: Veteran's Memorial Hwy

Intersection: Veteran's Memorial Hwy and Washington

Other:

Tag:

Issue:
The south bound camera is down.
http://10.21.0.30/?user_login=VIEW&user_password=view

Activities

FULL REPORT | GRID EDIT | EMAIL | PRINT | OTHER — Results 1 to 2 (out of 2)

	Date Created	Author	Activity
NEW! EDIT VIEW	04-27-2011 12:36 PM	Tomasi, Nate	4-27-11 All cameras up and running
NEW! EDIT VIEW	04-11-2011 08:59 AM	Nix, Hans	John Litteer is currently in possession of the spare cameras that were delivered in association with this project. Emilio is waiting to receive the spare equipment from Litteer before replacing the failed camera.

Add Activity

Resolution:
Apparently the camera was swapped. Everything is up and running now.

Attachments

Add Attachment

	Attachment	Description
No attachments found		

Contact

Check first to see if the caller is an existing account contact. If not, use the "Add Contact" link to create a new contact.

Name

Email

Business Phone | Cell Phone

Add Contact

Additional Details

Installation - Related Account: 67

Installation - Account Owner: Bruce Beckmann

Account Link: NYSERDA

Follow Ticket Activity

Due to the product limitations of Quickbase. A fixed number of users is allowed to follow ticket changes. More slots can be added if three slots is not enough.

Follow Issue #1

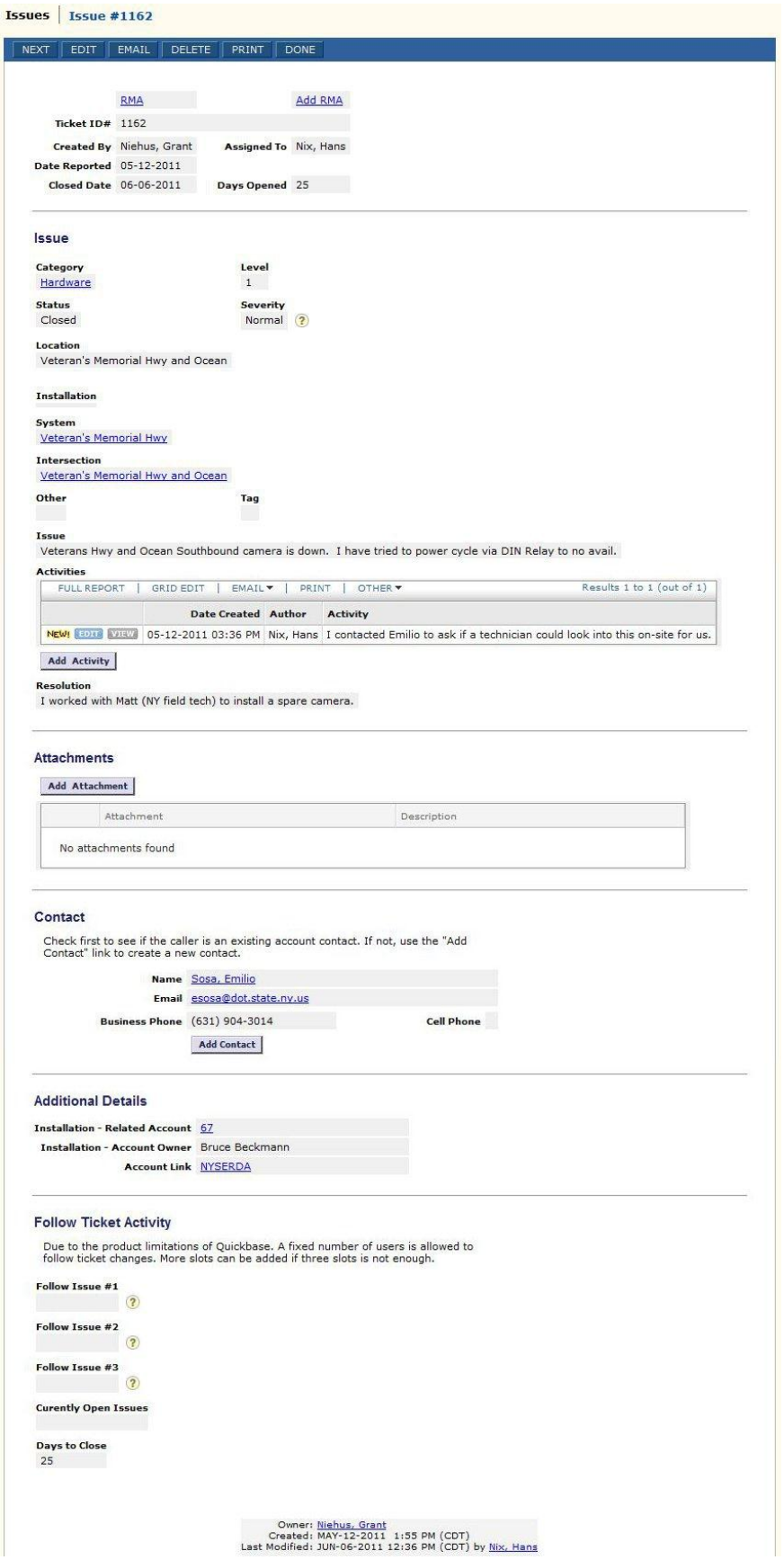
Follow Issue #2

Follow Issue #3

Curently Open Issues

Days to Close: 20

Owner: Znidarsic, Mike
Created: APR-07-2011 11:06 AM (CDT)
Last Modified: APR-27-2011 12:42 PM (CDT) by Tomasi, Nate



Issues | Issue #1162

NEXT EDIT EMAIL DELETE PRINT DONE

RMA Add RMA

Ticket ID# 1162

Created By Niehus, Grant Assigned To Nix, Hans

Date Reported 05-12-2011

Closed Date 06-06-2011 Days Opened 25

Issue

Category: Hardware
Level: 1
Status: Closed
Severity: Normal
Location: Veteran's Memorial Hwy and Ocean
Installation:
System: Veteran's Memorial Hwy
Intersection: Veteran's Memorial Hwy and Ocean
Other:
Tag:

Issue
Veterans Hwy and Ocean Southbound camera is down. I have tried to power cycle via DIN Relay to no avail.

Activities

FULL REPORT | GRID EDIT | EMAIL | PRINT | OTHER Results 1 to 1 (out of 1)

	Date Created	Author	Activity
NEW! EDIT VIEW	05-12-2011 03:36 PM	Nix, Hans	I contacted Emilio to ask if a technician could look into this on-site for us.

Add Activity

Resolution
I worked with Matt (NY field tech) to install a spare camera.

Attachments

Add Attachment

	Attachment	Description
No attachments found		

Contact

Check first to see if the caller is an existing account contact. If not, use the "Add Contact" link to create a new contact.

Name: Sosa, Emilio
Email: esosa@dot.state.ny.us
Business Phone: (631) 904-3014 Cell Phone:

Add Contact

Additional Details

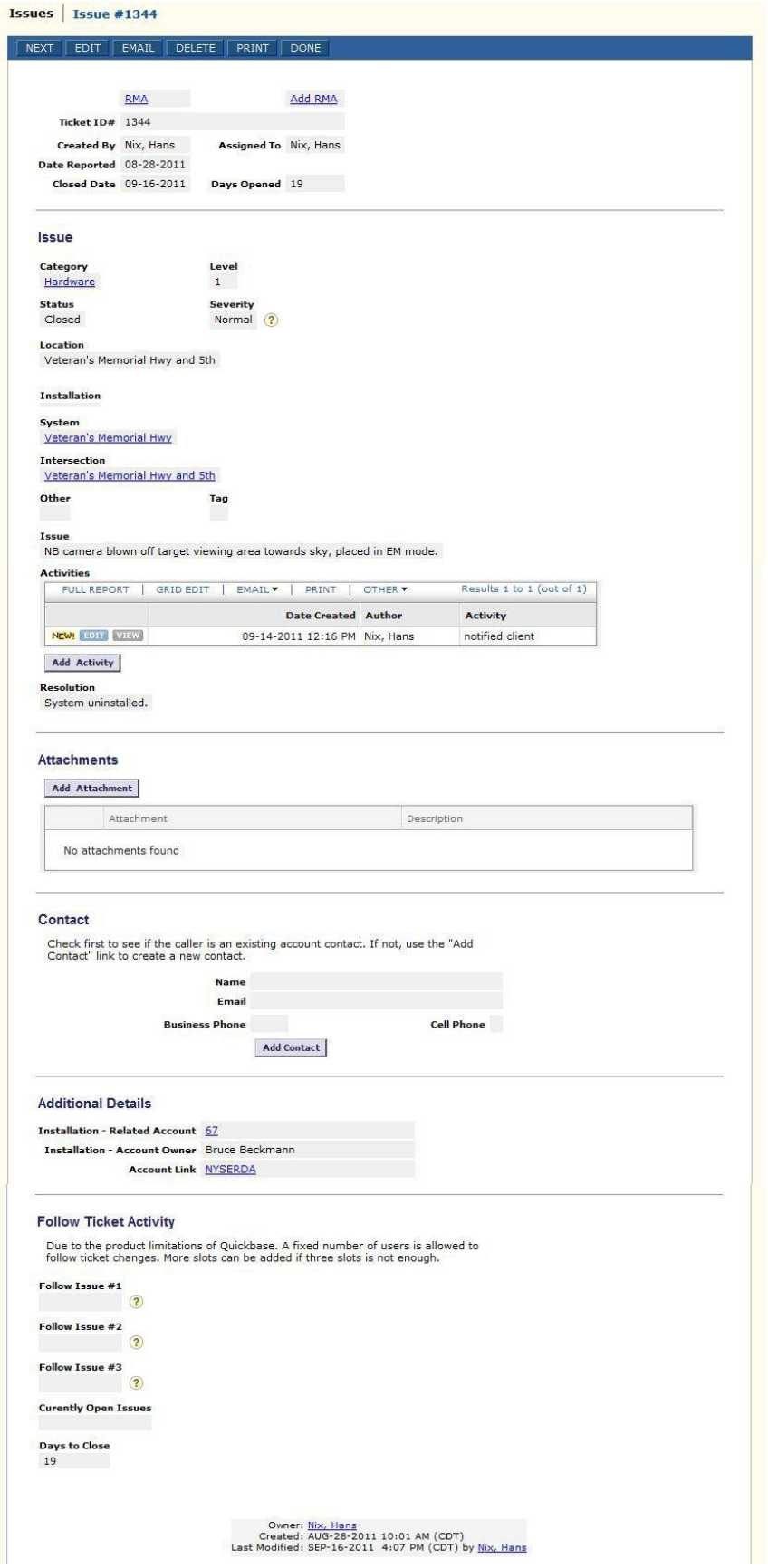
Installation - Related Account: 67
Installation - Account Owner: Bruce Beckmann
Account Link: NYSERDA

Follow Ticket Activity

Due to the product limitations of Quickbase. A fixed number of users is allowed to follow ticket changes. More slots can be added if three slots is not enough.

Follow Issue #1
Follow Issue #2
Follow Issue #3
Curently Open Issues
Days to Close: 25

Owner: Niehus, Grant
Created: MAY-12-2011 1:55 PM (CDT)
Last Modified: JUN-06-2011 12:36 PM (CDT) by Nix, Hans



Issues | Issue #1344

NEXT EDIT EMAIL DELETE PRINT DONE

RMA Add RMA

Ticket ID# 1344

Created By Nix, Hans Assigned To Nix, Hans

Date Reported 08-28-2011

Closed Date 09-16-2011 Days Opened 19

Issue

Category: Hardware
Level: 1
Status: Closed
Severity: Normal
Location: Veteran's Memorial Hwy and 5th
Installation:
System: Veteran's Memorial Hwy
Intersection: Veteran's Memorial Hwy and 5th
Other:
Tag:
Issue: NB camera blown off target viewing area towards sky, placed in EM mode.

Activities

FULL REPORT | GRID EDIT | EMAIL | PRINT | OTHER Results 1 to 1 (out of 1)

	Date Created	Author	Activity
NEW! EDIT VIEW	09-14-2011 12:16 PM	Nix, Hans	notified client

Add Activity

Resolution: System uninstalled.

Attachments

Add Attachment

	Attachment	Description
No attachments found		

Contact

Check first to see if the caller is an existing account contact. If not, use the "Add Contact" link to create a new contact.

Name
Email
Business Phone Cell Phone

Add Contact

Additional Details

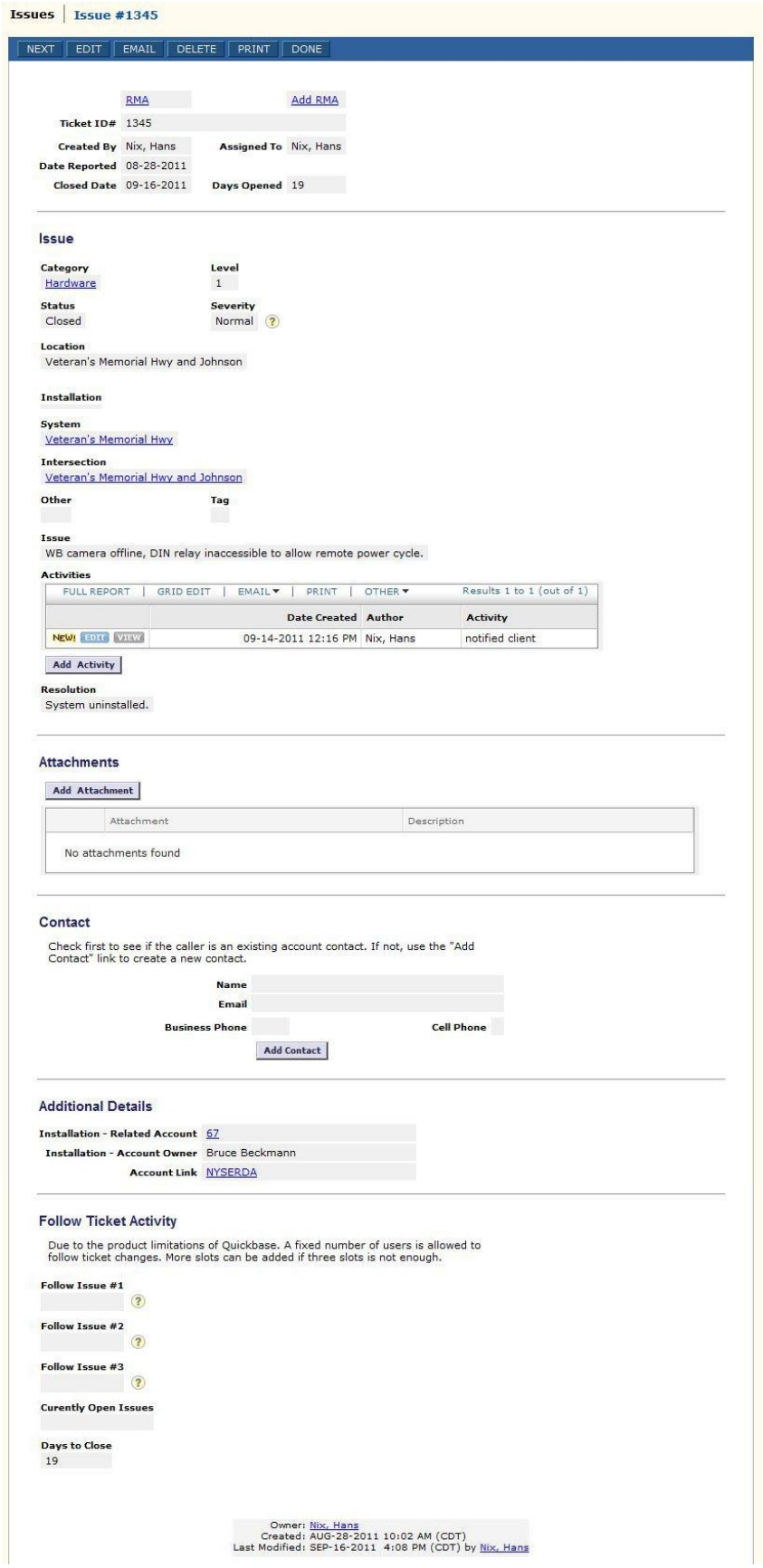
Installation - Related Account: 67
Installation - Account Owner: Bruce Beckmann
Account Link: NYSERDA

Follow Ticket Activity

Due to the product limitations of Quickbase. A fixed number of users is allowed to follow ticket changes. More slots can be added if three slots is not enough.

Follow Issue #1
Follow Issue #2
Follow Issue #3
Curently Open Issues
Days to Close: 19

Owner: Nix, Hans
Created: AUG-28-2011 10:01 AM (CDT)
Last Modified: SEP-16-2011 4:07 PM (CDT) by Nix, Hans


Issues | Issue #1345
NEXT EDIT EMAIL DELETE PRINT DONE
RMA
Add RMA
Ticket ID# 1345
Created By Nix, Hans
Assigned To Nix, Hans
Date Reported 08-28-2011
Closed Date 09-16-2011
Days Opened 19
Issue
Category
Hardware
Level
1
Status
Closed
Severity
Normal
Location
Veteran's Memorial Hwy and Johnson
Installation
System
Veteran's Memorial Hwy
Intersection
Veteran's Memorial Hwy and Johnson
Other
Tag
Issue
WB camera offline, DIN relay inaccessible to allow remote power cycle.
Activities
FULL REPORT | GRID EDIT | EMAIL | PRINT | OTHER
Results 1 to 1 (out of 1)
Date Created
Author
Activity
NEW! EDIT VIEW
09-14-2011 12:16 PM
Nix, Hans
notified client
Add Activity
Resolution
System uninstalled.
Attachments
Add Attachment
Attachment
Description
No attachments found
Contact
Check first to see if the caller is an existing account contact. If not, use the "Add Contact" link to create a new contact.
Name
Email
Business Phone
Cell Phone
Add Contact
Additional Details
Installation - Related Account
67
Installation - Account Owner
Bruce Beckmann
Account Link
NYSERDA
Follow Ticket Activity
Due to the product limitations of Quickbase. A fixed number of users is allowed to follow ticket changes. More slots can be added if three slots is not enough.
Follow Issue #1
Follow Issue #2
Follow Issue #3
Curently Open Issues
Days to Close
19
Owner: Nix, Hans
Created: AUG-28-2011 10:02 AM (CDT)
Last Modified: SEP-16-2011 4:08 PM (CDT) by Nix, Hans

Issues | **Issue #1320** Customize this Form

NEXT | EDIT | EMAIL | DELETE | PRINT | DONE

RMA Add RMA

Ticket ID# 1320

Created By Cook, Dan **Assigned To** Nix, Hans

Date Reported 08-15-2011

Closed Date 08-29-2011 **Days Opened** 14

Issue

Category
Hardware

Level
1

Status
Closed

Severity
Normal

Location
Veteran's Memorial Hwy

Installation

System
Veteran's Memorial Hwy

Intersection

Other

Tag

Issue
Andrew called reporting short greens on the mainline at Johnson intersection. They had comms issue and could not connect from their office. Further investigation showed IO Board failure on both Johnson and Orville intersections. Recommended to him to replace both, but have not heard back from him yet.

Activities

FULL REPORT | GRID EDIT | EMAIL | PRINT | OTHER Results 1 to 1 (out of 1)

	Date Created	Author	Activity
NEW! EDIT VIEW	08-19-2011 08:14 AM	Nix, Hans	Worked with Andrew to replace processor at Orville and Johnson, not receiving loop input info on phases 1 & 5.

Add Activity

Resolution
Andrew discovered that the storm fried the loop detector cards. Once those were replaced everything worked correctly.

Attachments

Add Attachment

FULL REPORT | GRID EDIT | EMAIL | PRINT | OTHER Results 1 to 1 (out of 1)

	Attachment	Description
NEW! EDIT VIEW	Copy of InputsSummaryRev2.xlsx	C-1 Cable Inputs/Functions (edit mapping)

Contact

Check first to see if the caller is an existing account contact. If not, use the "Add Contact" link to create a new contact.

Name

Email

Business Phone **Cell Phone**

Add Contact

Additional Details

Installation - Related Account 67

Installation - Account Owner Bruce Beckmann

Account Link NYSERDA

Follow Ticket Activity

Due to the product limitations of Quickbase. A fixed number of users is allowed to follow ticket changes. More slots can be added if three slots is not enough.

Follow Issue #1
Cook, Dan

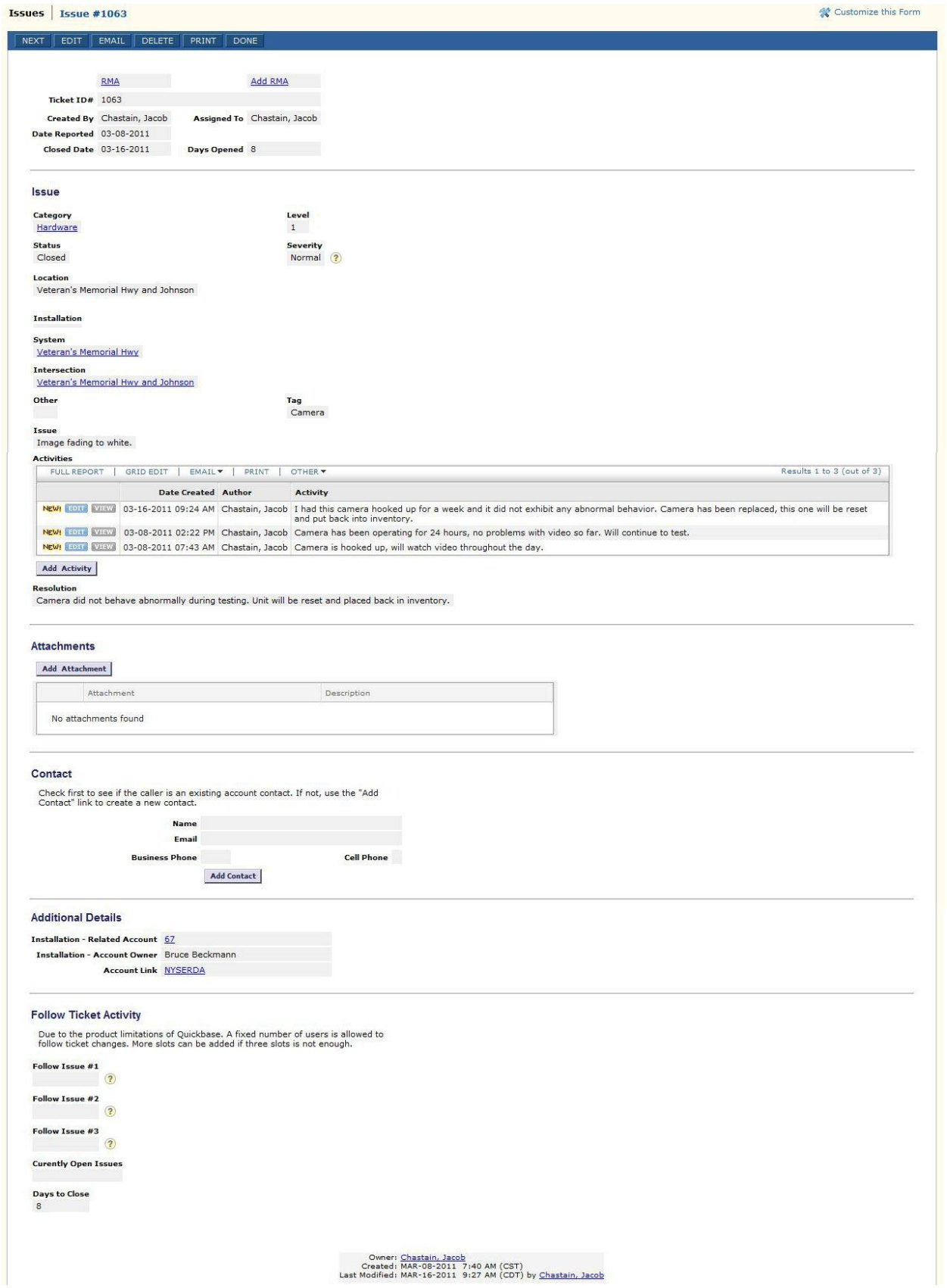
Follow Issue #2

Follow Issue #3

Curently Open Issues

Days to Close
14

Owner: Cook, Dan
Created: AUG-15-2011 3:41 PM (CDT)
Last Modified: AUG-29-2011 1:08 PM (CDT) by Niehus, Grant


Issues | Issue #1063
Customize this Form
NEXT EDIT EMAIL DELETE PRINT DONE
RMA
Add RMA
Ticket ID# 1063
Created By Chastain, Jacob
Assigned To Chastain, Jacob
Date Reported 03-08-2011
Closed Date 03-16-2011
Days Opened 8
Issue
Category
Hardware
Level
1
Status
Closed
Severity
Normal
Location
Veteran's Memorial Hwy and Johnson
Installation
System
Veteran's Memorial Hwy
Intersection
Veteran's Memorial Hwy and Johnson
Other
Tag
Camera
Issue
Image fading to white.
Activities
FULL REPORT | GRID EDIT | EMAIL | PRINT | OTHER
Results 1 to 3 (out of 3)
Date Created
Author
Activity
NEW! EDIT VIEW
03-16-2011 09:24 AM
Chastain, Jacob
I had this camera hooked up for a week and it did not exhibit any abnormal behavior. Camera has been replaced, this one will be reset and put back into inventory.
NEW! EDIT VIEW
03-08-2011 02:22 PM
Chastain, Jacob
Camera has been operating for 24 hours, no problems with video so far. Will continue to test.
NEW! EDIT VIEW
03-08-2011 07:43 AM
Chastain, Jacob
Camera is hooked up, will watch video throughout the day.
Add Activity
Resolution
Camera did not behave abnormally during testing. Unit will be reset and placed back in inventory.
Attachments
Add Attachment
Attachment
Description
No attachments found
Contact
Check first to see if the caller is an existing account contact. If not, use the "Add Contact" link to create a new contact.
Name
Email
Business Phone
Cell Phone
Add Contact
Additional Details
Installation - Related Account 67
Installation - Account Owner Bruce Beckmann
Account Link NYSERDA
Follow Ticket Activity
Due to the product limitations of Quickbase. A fixed number of users is allowed to follow ticket changes. More slots can be added if three slots is not enough.
Follow Issue #1
Follow Issue #2
Follow Issue #3
Curently Open Issues
Days to Close
8
Owner: Chastain, Jacob
Created: MAR-08-2011 7:40 AM (CST)
Last Modified: MAR-16-2011 9:27 AM (CDT) by Chastain, Jacob

Issues | **Issue #1164** Customize this Form

NEXT | EDIT | EMAIL | DELETE | PRINT | DONE

RMA | Add RMA

Ticket ID# 1164

Created By Niehus, Grant **Assigned To** Niehus, Grant

Date Reported 05-13-2011

Closed Date 05-17-2011 **Days Opened** 4

Issue

Category
Other

Level
1

Status
Closed

Severity
Normal

Location
Veteran's Memorial Hwy and Sycamore

Installation

System
Veteran's Memorial Hwy

Intersection
Veteran's Memorial Hwy and Sycamore

Other

Tag

Issue
NYSDOT emailed to report that side street movements were not getting served. After looking into the logs, there is a lot of controller unresponsive moments. I have contacted NYSDOT to make sure that they have all controller settings correct.

Activities

Date...	Author	Activity
No activities found		

Add Activity

Resolution
related to controller settings that were changed when comms were down. system is fine now.

Attachments

Add Attachment

	Attachment	Description
No attachments found		

Contact

Check first to see if the caller is an existing account contact. If not, use the "Add Contact" link to create a new contact.

Name Sosa, Emilio

Email esosa@dot.state.ny.us

Business Phone (631) 904-3014 **Cell Phone**

Add Contact

Additional Details

Installation - Related Account 67

Installation - Account Owner Bruce Beckmann

Account Link NYSERDA

Follow Ticket Activity

Due to the product limitations of Quickbase. A fixed number of users is allowed to follow ticket changes. More slots can be added if three slots is not enough.

Follow Issue #1

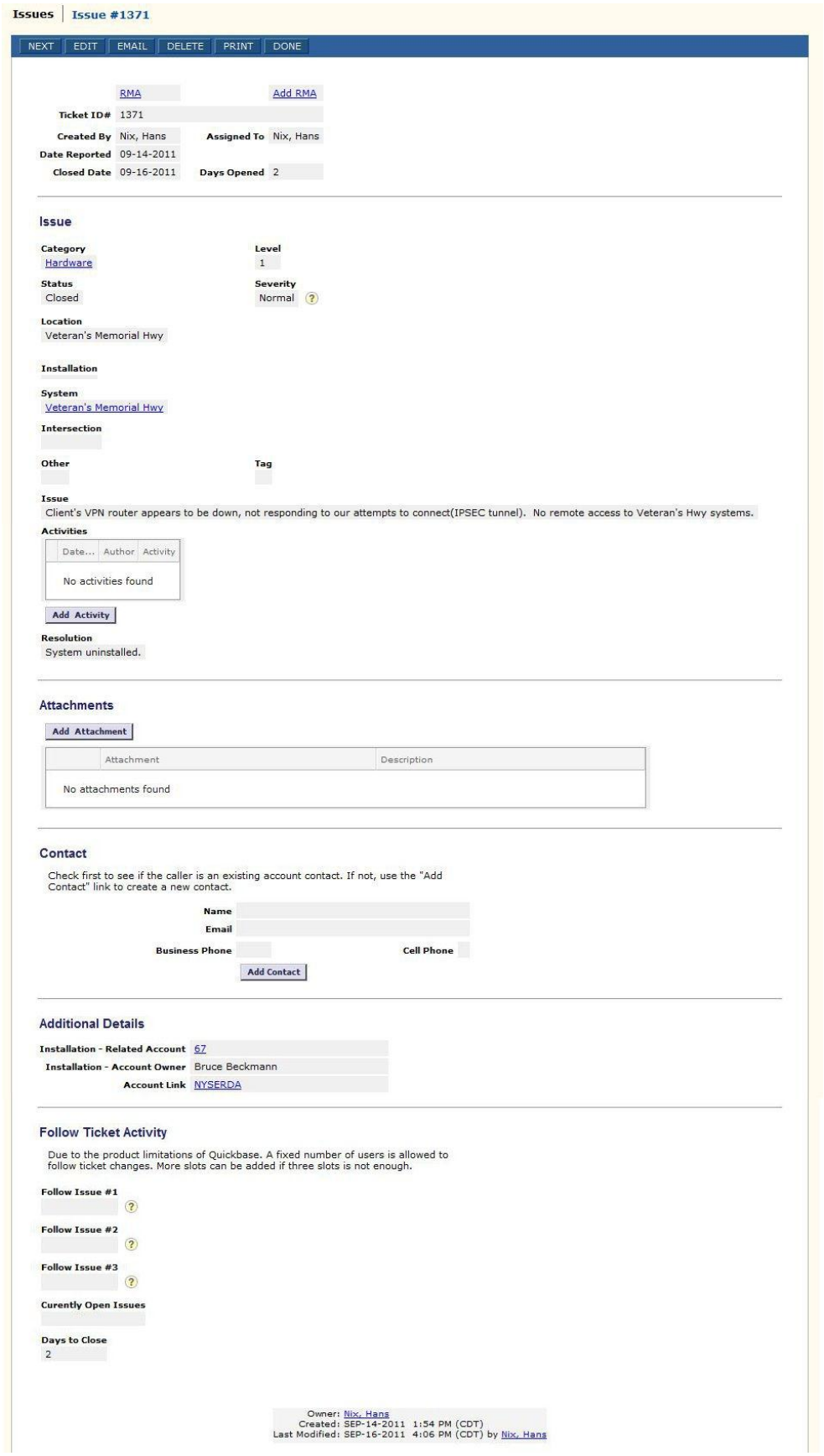
Follow Issue #2

Follow Issue #3

Curently Open Issues

Days to Close
4

Owner: Niehus, Grant
Created: MAY-13-2011 8:52 AM (CDT)
Last Modified: MAY-17-2011 10:34 AM (CDT) by Nix, Hans



Issues | Issue #1371

NEXT EDIT EMAIL DELETE PRINT DONE

RMA Add RMA

Ticket ID# 1371

Created By Nix, Hans Assigned To Nix, Hans

Date Reported 09-14-2011

Closed Date 09-16-2011 Days Opened 2

Issue

Category: Hardware
Level: 1
Status: Closed
Severity: Normal
Location: Veteran's Memorial Hwy
Installation:
System: Veteran's Memorial Hwy
Intersection:
Other:
Tag:
Issue: Client's VPN router appears to be down, not responding to our attempts to connect(IPSEC tunnel). No remote access to Veteran's Hwy systems.
Activities

Date...	Author	Activity
No activities found		

Add Activity

Resolution: System uninstalled.

Attachments

Add Attachment

	Attachment	Description
No attachments found		

Contact

Check first to see if the caller is an existing account contact. If not, use the "Add Contact" link to create a new contact.

Name
Email
Business Phone Cell Phone

Add Contact

Additional Details

Installation - Related Account 67
Installation - Account Owner Bruce Beckmann
Account Link NYSERDA

Follow Ticket Activity

Due to the product limitations of Quickbase. A fixed number of users is allowed to follow ticket changes. More slots can be added if three slots is not enough.

Follow Issue #1
Follow Issue #2
Follow Issue #3
Curently Open Issues
Days to Close: 2

Owner: Nix, Hans
Created: SEP-14-2011 1:54 PM (CDT)
Last Modified: SEP-16-2011 4:06 PM (CDT) by Nix, Hans

Issues | **Issue #1160** Customize this Form

NEXT | EDIT | EMAIL | DELETE | PRINT | DONE

RMA Add RMA

Ticket ID# 1160

Created By Niehus, Grant **Assigned To** Nix, Hans

Date Reported 05-12-2011

Closed Date 05-12-2011 **Days Opened** 0

Issue

Category
Hardware

Level
1

Status
Closed

Severity
Normal

Location
Veteran's Memorial Hwy

Installation

System
Veteran's Memorial Hwy

Intersection

Other

Tag

Issue
We have lost communication to Veterans and Locust through Johnson. This is not only a remote communication issue but also a local communication issue because the facilitator is not passing messages along the corridor.

Activities

Date...	Author	Activity
No activities found		

Add Activity

Resolution
Lost power to the Ethernet switch on our Equipment Panel, which caused a break in communications, because NYSERDA is running their communications in-series through our Ethernet switch. After repairing the power power connection, communications were restored.

Attachments

Add Attachment

	Attachment	Description
No attachments found		

Contact

Check first to see if the caller is an existing account contact. If not, use the "Add Contact" link to create a new contact.

Name Sosa, Emilio

Email esosa@dot.state.ny.us

Business Phone (631) 904-3014 **Cell Phone**

Add Contact

Additional Details

Installation - Related Account 67

Installation - Account Owner Bruce Beckmann

Account Link NYSERDA

Follow Ticket Activity

Due to the product limitations of Quickbase. A fixed number of users is allowed to follow ticket changes. More slots can be added if three slots is not enough.

Follow Issue #1

Follow Issue #2

Follow Issue #3

Curently Open Issues

Days to Close
0

Owner: Niehus, Grant
Created: MAY-12-2011 8:37 AM (CDT)
Last Modified: MAY-12-2011 3:29 PM (CDT) by Nix, Hans

Appendix C

BEFORE/AFTER STUDY RESULTS

HDR, INC.

Adaptive Traffic Signal Control System

Before and After
Travel Time and Delay Study

Route 454: Veterans Memorial Highway
Islip, New York

NYSDOT: Region 10

Prepared for:

RHYTHM ENGINEERING

Prepared by

HDR

HDR Engineering, Inc.

July 7, 2011

Table of Contents

1.0 Executive Summary 1
2.0 Project Overview and Study Purpose 2
3.0 System Installation 3
4.0 Data Collection and Measures of Effectiveness 4
5.0 Route 454 Analysis Results 5
5.1. Travel Time 5
5.2. Speed 8
5.3. Stopped Time 10
5.4. Stops, Fuel Consumption, and Vehicle Efficiency 11
5.5. Vehicle Emissions 12
6.0 Conclusions and Recommendations 13

List of Tables

Table 1.0.1: Route 454 Travel Time and Speed Summary 1
Table 4.0.1: Travel Time Runs 5
Table 5.1.1: Route 454 Corridor Travel Time 6
Table 5.2.1: Route 454 Corridor Average Speed 8
Table 5.3.1: Route 454 Corridor Stopped Time 10
Table 5.4.1: Route 454 Corridor Average Number of Stops 11
Table 5.4.2: Route 454 Corridor Fuel Consumption 11
Table 5.4.3: Route 454 Corridor Vehicle Efficiency 11
Table 5.5.3: Route 454 Eastbound NOx (g) 12
Table 5.5.1: Route 454 Eastbound CO (g) 12
Table 5.5.4: Route 454 Eastbound Total CO+Nox+VOC (g) 12
Table 5.5.2: Route 454 Eastbound VOC (g) 12
Table 5.5.7: Route 454 Westbound NOx (g) 12
Table 5.5.5: Route 454 Westbound CO (g) 12
Table 7.1.1: Route 454 Eastbound Summary 13
Table 7.1.2: Route 454 Westbound Summary 13
Table 5.5.8: Route 454 Westbound Total CO+Nox+VOC (g) 13
Table 5.5.6: Route 454 Westbound VOC (g) 13

List of Figures

Figure 2.0.1: Route 454 Study Area Map 2
Figure 2.0.2: Route 454 Insync Intersection Locations 3
Figure 5.1.1: Route 454 Eastbound Travel Time (minutes) 6
Figure 5.1.2: Route 454 Westbound Travel Time (minutes) 6
Figure 5.1.3: Route 454 Corridor Before & After Travel Time Comparison 7
Figure 5.2.2: Route 454 Westbound Average Speed (mph) 8
Figure 5.2.1: Route 454 Eastbound Average Speed (mph) 8
Figure 5.2.3: Route 454 Corridor Before and After Speed Comparison 9
Figure 5.3.1: Route 454 Eastbound Stopped Time (minutes) 10
Figure 5.3.2: Route 454 Westbound Stopped Time (minutes) 10

List of Appendices

Appendix A—iTREC Analysis Reports

1.0 EXECUTIVE SUMMARY

This report presents the findings of HDR's evaluation of the recently installed NYSDOT Region 10 Route 454 InSync system. Based on an analysis of travel time runs conducted before and after system installation, it is clear that the InSync system has reduced travel times and increased speeds for the vast majority of highway users. Specifically, corridor travel times have decreased by over 10 percent during all study time periods in the westbound direction. Average westbound speeds increased by 14 to 18 percent. In the eastbound direction travel times decreased even more during the AM and Midday peak periods with reductions of approximately one-minute per vehicle. Average eastbound speeds during this time increased over 20 percent. During the Off-Peak and PM Peak periods, the eastbound travel direction saw much less or even no benefit. It may be worthwhile to investigate further regarding why these two sets of results differed from the others.

Table 1.0.1: Route 454 Travel Time and Speed Summary

	Eastbound				Westbound			
	Travel time (min:sec)		Average Speed (mph)		Travel time (min:sec)		Average Speed (mph)	
	Change	%	Change	%	Change	%	Change	%
AM	-00:55	-14%	5.9	22%	-00:40	-11%	4.8	15%
OFF	+00:13	-5%	-2.6	-7%	-00:39	-12%	6.2	18%
MID	-01:05	-19%	6.9	21%	-00:40	-13%	4.9	15%
PM	+00:04	1%	0.8	3%	-00:32	-10%	4.3	14%

2.0 PROJECT OVERVIEW AND STUDY PURPOSE

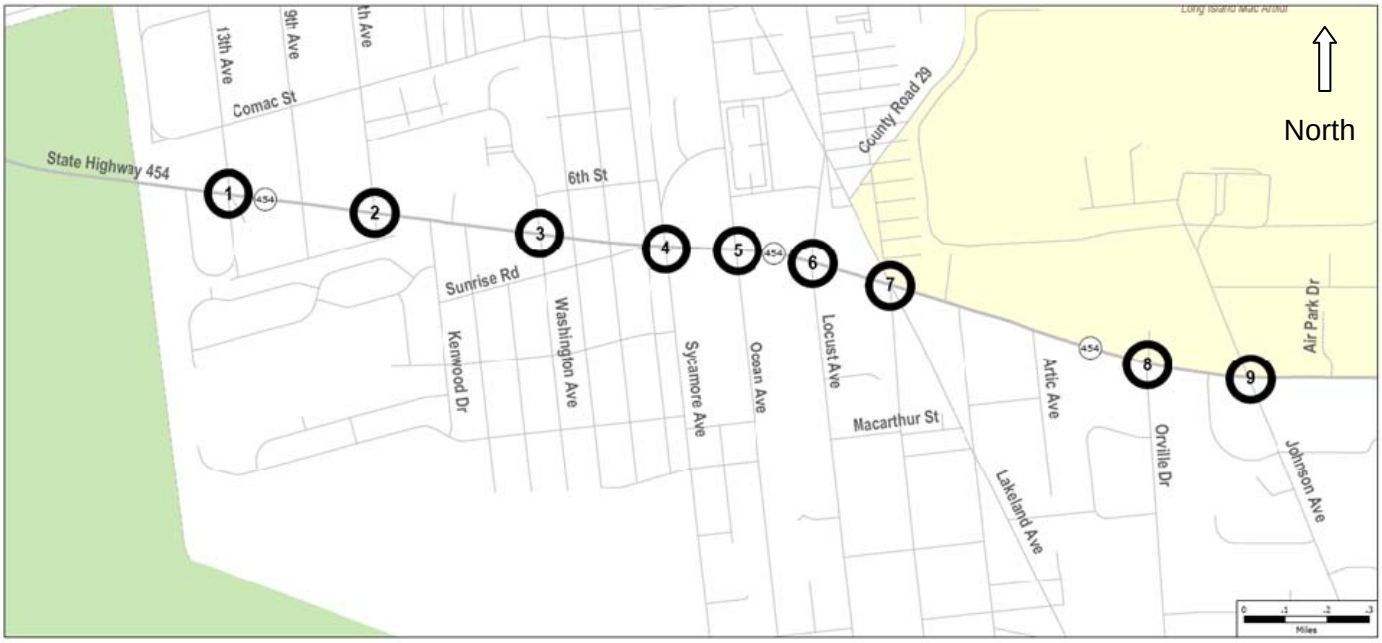
The New York State Department of Transportation (NYSDOT) Region 10 identified the 2.5 mile corridor on NY Route 454 (Veterans Memorial Highway) from 13th Avenue to Johnson Avenue as a critical corridor for congestion relief. The highway serves the Long Island Mac Arthur Airport in the east as well as numerous commercial, government, and residential uses throughout the study area. A little over two miles to the west, Route 454 provides access to I-495 (Long Island Expressway).

Figure 2.0.1: Route 454 Study Area Map

In the study corridor, Route 454 is primarily a four-lane divided highway with right and left turn-lanes at major intersections. There are nine signalized intersections in the study corridor as well as a number of unsignalized intersections with channelized left-turns (typically preventing side-street through movements). Many developments and some roadways are served by right-in/right-out only access. There are bike lanes in both directions and the center raised (grass) median is over 24 feet wide. Based on 2008 traffic counts, the daily traffic in the corridor is approximately 42,000 to 44,000 vehicles per day (vpd).[1]

[1] Source: Market Planning Solutions Inc. / Google. 2008 traffic counts: 42,470 vehicles per day near Washington Avenue and 43,850 vehicles per day near Orville Drive.

Figure 2.0.2: Route 454 Insync Intersection Locations



Given the high traffic volumes, important regional traffic destinations and good access control, this corridor was a good candidate for testing the benefits of adaptive traffic signal control system technology (ATCS). In 2010, NYSDOT selected the InSync system to test this technology in the corridor.

HDR was subsequently requested to analyze the before and after performance of the system. To that end, HDR collected travel time data both before and after the InSync system implementation. This allowed for a direct comparison of travel patterns with and without the system in place.

3.0 SYSTEM INSTALLATION

The InSync system was installed at the nine signalized intersections in the corridor. The goal of the installation was to coordinate the timing for the nine signals in a dynamic manner (taking into account real-time changes in traffic flows) such that vehicle progression on Route 454 was maximized and delays and stops were minimized. This can lead to increased side-street delays.

The signals were already part of a signal system, so communication equipment was in place to serve the system. New video detection cameras were added for each signal approach (typically four per intersection). The video detection cameras serve a critical data collection role within the system. The software uses the data collected by the cameras to call individual phases at specific signals, but also to adjust the critical system operating parameters such as cycle length, intersection offsets, and green times. In addition to the cameras, an InSync processor is placed inside the traffic cabinet to communicate with the signal controller at each intersection.[2]

[2] For more information on the actual InSync system please refer to the website:
http://rhythmtraffic.com/index.php/insync/insyncfusion/

4.0 DATA COLLECTION AND MEASURES OF EFFECTIVENESS

To evaluate the performance of the InSync system, HDR collected travel data in the Route 454 corridor during four different weekday time periods. The data collection time periods were the same for both the before installation and after installation travel runs. They included:

- AM Peak Period (8:00-9:00 AM)
- Off-Peak Period (10:00-11:00 AM)
- Midday Peak Period (1:00-2:00 PM)
- PM Peak Period (5:00-6:00 PM)

The travel time corridors were:

- Eastbound Route 454 from just west of 13th Street to Air Park Drive Just east of Johnson Drive

- Westbound Route 454 from just west of 13th Street to Air Park Drive Just east of Johnson Drive

A random arrival procedure was used in the data collection, meaning that probe vehicles sometimes began traveling the corridor inside the platoon (from a stop at the first intersection) and sometimes they arrived during the green phase and traveled some, or all, of the corridor outside the platoon. This is in keeping with the data collection procedure recommended by the Institute of Transportation Engineers (*Traffic Engineering Studies*), and should reasonably represent the entire population of vehicles traveling the corridor during this general time period.

The data was collected using the floating car method.[3] Global Positioning System (GPS) technology was employed to allow for detailed time and distance measurements. Specifically, Holux M-241 units were used in each field vehicle. Once this data was collected, it was analyzed using iTREC. iTREC is a stand-alone software package developed by HDR/iTRANS to integrate GPS hardware with a laptop computer to record specific locations and reference times. From this information, it can calculate speed, direction, delay, number of stops and other important evaluation measures. These measures are averaged for a group of travel runs (i.e. for the same direction and time period). The data output from iTREC formed the basis of the comparative before and after analysis described in the following two sections. The iTREC data summary sheets are included in the Appendix. The key data outputs are defined here for easy reference.

Distance and Length: The distance traveled is tracked using GPS and converted to a length in miles by iTREC.

Travel Time: This is measured in minutes and seconds and includes the entire travel time from start point to end point on the designated corridor.

Average Travel Speed: The GPS/iTREC analysis estimates “instantaneous” travel speeds in miles per hour for each second of a travel time run. The data can be aggregated to provide an average for an entire travel run or to provide an average for a group of runs.

[3] The floating car method involves driving a specific corridor between pre-determined points at the prevailing speed of traffic on the roadway (essentially passing as many cars as pass the data collection vehicle). The vehicle location is then recorded over time to allow for the calculation of a mean speed.

Stop Time: The time that a vehicle is stopped is estimated from the data using 6 mph as the threshold for a vehicle to be considered stopped. A vehicle deceleration rate of -1.24 mph/sec is also used as a threshold for determining if a vehicle is stopped.

Number of Stops: The number of times a vehicle stops during a travel time run is recorded, using the criteria discussed above for stop time.

Fuel Consumption: iTREC uses the travel data (e.g. speed and acceleration/deceleration) and vehicle performance assumptions to estimate vehicle fuel consumption for a specific travel run in gallons.

Vehicle Efficiency: The travel data and vehicle performance assumptions are used to estimate vehicle efficiency for a specific travel run in miles per gallon (mpg).

Emissions: Vehicle emissions are calculated using the travel data and emissions related vehicle performance assumptions. These values are related to the fuel consumption and efficiency calculations above. The specific emissions estimated include carbon monoxide (CO), nitrous oxides (NOx), and volatile organic compounds (VOC). All measurements are in grams.

The before installation field data collection was conducted on February 16, 2011 and the after installation field data was collected on May 5, 2011. Overall, 117 runs were conducted along Route 454. Table 1 presents the travel time runs by roadway, direction and time. Additionally, video was captured, showing the traffic conditions during the travel time runs.

Table 4.0.1:
Travel Time Runs

		Before Installation (2/16/11)				After Installation (5/5/11)			
		AM	Off Peak	Midday	PM	AM	Off Peak	Midday	PM
Route 454	Eastbound	6	8	6	7	7	9	7	7
	Westbound	5	8	8	8	8	9	7	7

5.0 ROUTE 454 ANALYSIS RESULTS

5.1. Travel Time

Before implementation, average eastbound travel times on Route 454 over the 2.5 mile corridor were between 4:48 (min:sec) and 6:23. With implementation of the InSync signal system travel times decreased by approximately one minute during the AM and Midday time periods (14% and 19% respectively). Travel times during the PM and Off-Peak periods increased by 1% and 5% respectively.

In the westbound direction, before implementation, travel times were between 5:15 and 5:49. After implementation, travel times decreased by approximately 30 to 40 seconds. This translates into decreases of 10% to 13%.

Table 5.1.1: Route 454 Corridor Travel Time

	Eastbound Corridor Travel Time				Westbound Corridor Travel Time			
	Before	After	Difference	%	Before	After	Difference	%
AM	06:23	05:28	-00:55	-14%	05:49	05:09	-00:40	-11%
OFF	04:48	05:01	00:13	5%	05:15	04:36	-00:39	-12%
MID	05:38	04:33	-01:05	-19%	05:15	04:35	-00:40	-13%
PM	06:03	06:07	00:04	1%	05:32	05:00	-00:32	-10%

Figure 5.1.1: Route 454 Eastbound Travel Time (minutes)

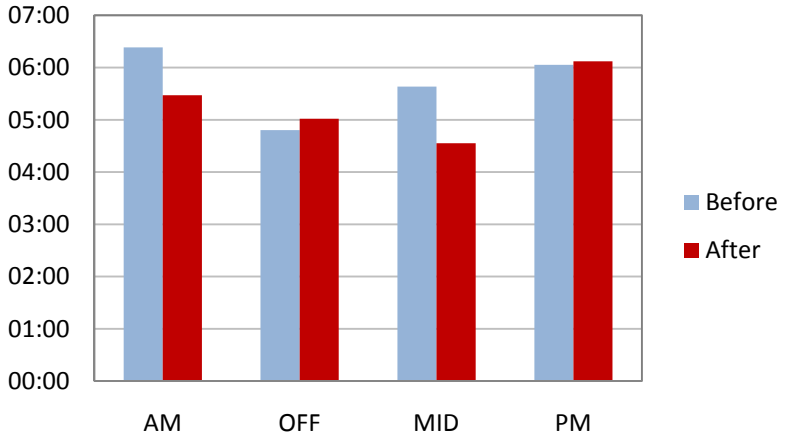
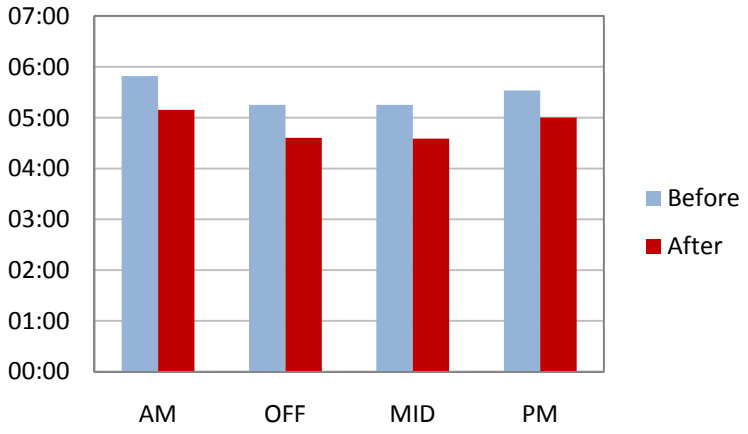
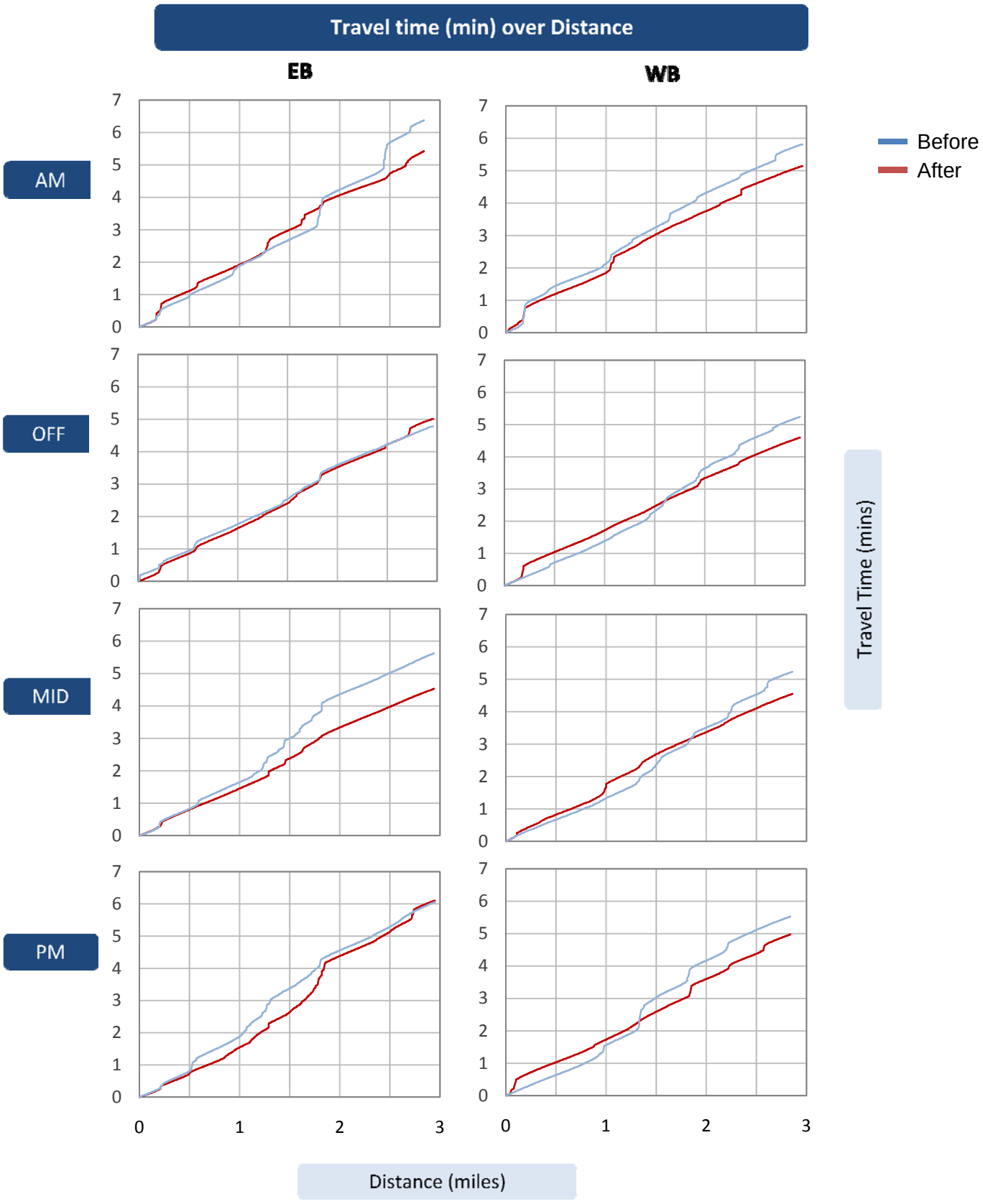


Figure 5.1.2: Route 454 Westbound Travel Time (minutes)



In addition, to the above tables, the average travel time was plotted against distance for both directions and all four time periods as shown in Figure 5.1. These plots represent the average travel time for all runs in each group.

Figure 5.1.3: Route 454 Corridor Before & After Travel Time Comparison



5.2. Speed

The average eastbound speeds on Route 454 prior to system implementation were between 27 mph and 38.5 mph. After system implementation the average eastbound speeds were higher during three of the four time periods. During the AM and Midday periods the average speeds increased by 6 mph and 7 mph respectively (over 20%). During the Off-Peak period the average speed decreased by 2.6 miles per hour (7%).

In the westbound direction, the before average speeds were more tightly grouped in the 31 to 35 mph range. Similar to the travel time measure, all four of these values increased. The increase was near 5 mph for each time period, resulting in increases of 14% to 18%.

The average speeds were also plotted over the length of the corridor as shown on the next page.

Table 5.2.1: Route 454 Corridor Average Speed

	EB Average Speed (mph)				WB Average Speed (mph)			
	Before	After	Difference	%	Before	After	Difference	%
AM	27.0	32.9	5.9	22%	31.2	36.0	4.8	15%
PM	30.3	31.1	0.8	3%	31.3	35.5	4.3	14%
MID	32.8	39.8	6.9	21%	33.4	38.3	4.9	15%
OFF	38.5	35.9	-2.6	-7%	34.3	40.5	6.2	18%

Figure 5.2.1: Route 454 Eastbound Average Speed (mph)

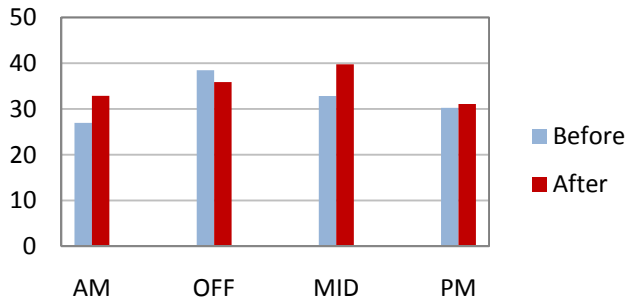


Figure 5.2.2: Route 454 Westbound Average Speed (mph)

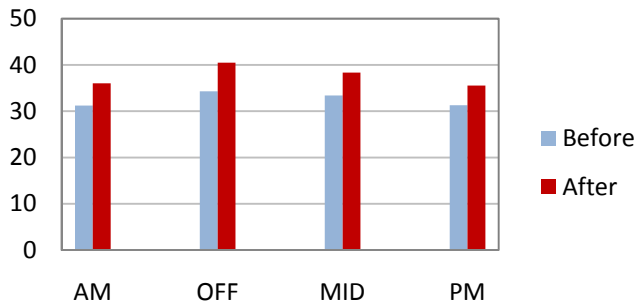
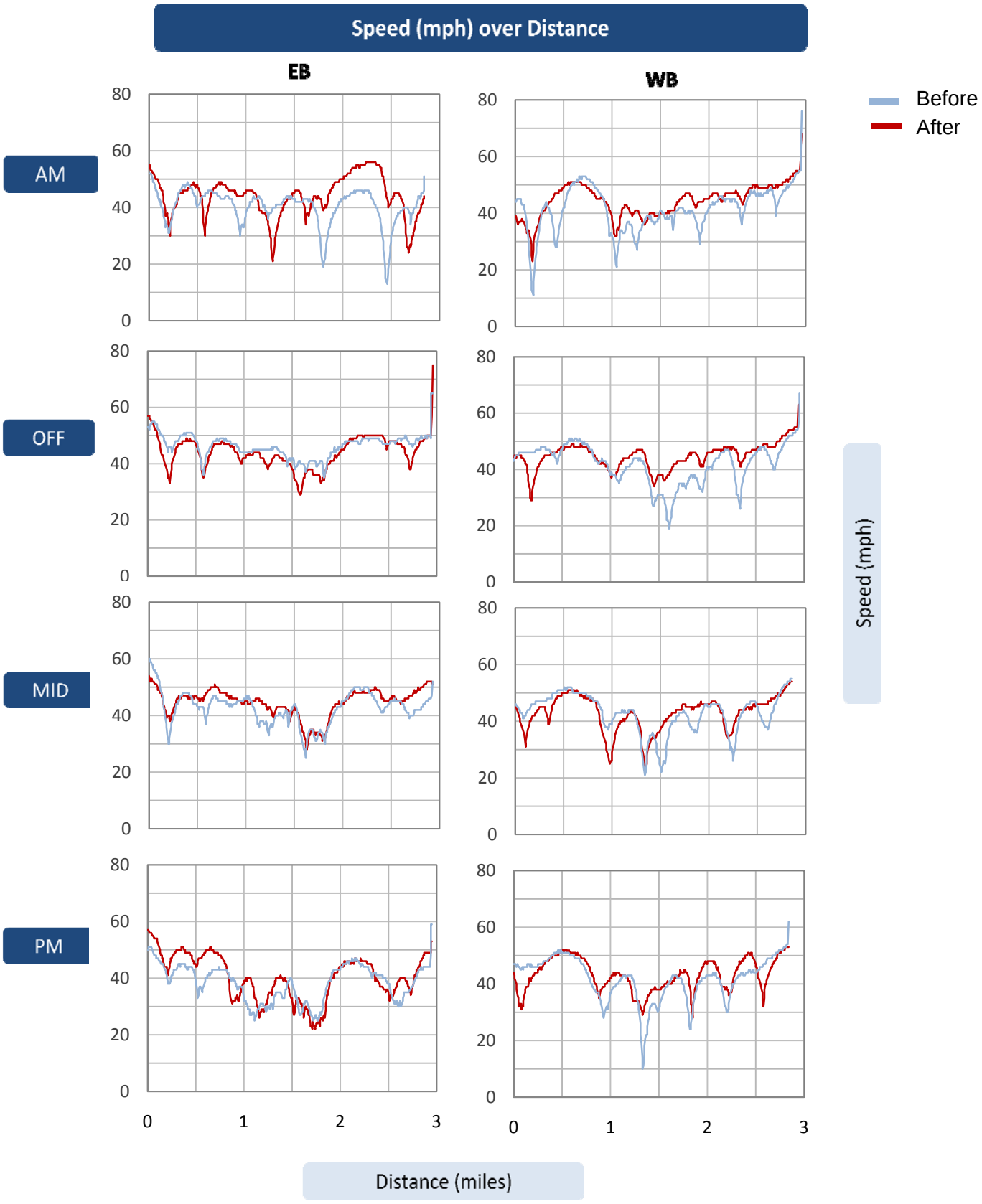


Figure 5.2.3: Route 454 Corridor Before and After Speed Comparison



5.3. Stopped Time

Prior to implementation, eastbound stopped time ranged from 44 seconds to 1 minute and 45 seconds as shown below. With the InSync system in place eastbound stopped times decreased substantially in the AM Peak and Midday periods, with drops of 35% and 66% percent respectively. In the PM Peak period stopped time increased by 13 seconds (23%).

In the westbound direction, the results are consistent with the travel time results; stopped time decreased for all four periods. The decreases ranged from 7 to 32 seconds (21% to 64%). The westbound results are shown below.

Table 5.3.1: Route 454 Corridor Stopped Time

	Eastbound Stopped Time				Westbound Stopped Time			
	Before	After	Difference	%	Before	After	Difference	%
AM	01:45	01:08	-00:37	-35%	01:06	00:52	-00:14	-21%
OFF	00:44	00:43	-00:01	-2%	00:34	00:27	-00:07	-21%
MID	01:08	00:23	-00:45	-66%	00:50	00:18	-00:32	-64%
PM	00:57	01:10	00:13	23%	01:05	00:45	-00:20	-31%

Figure 5.3.1: Route 454 Eastbound Stopped Time (minutes)

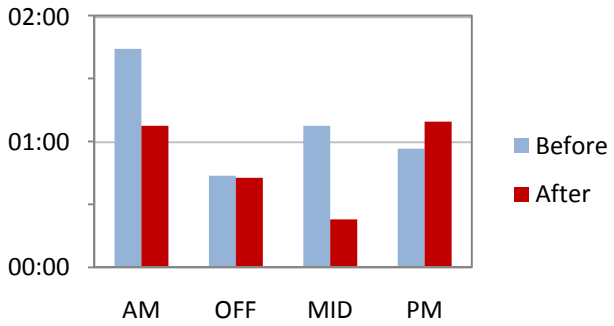
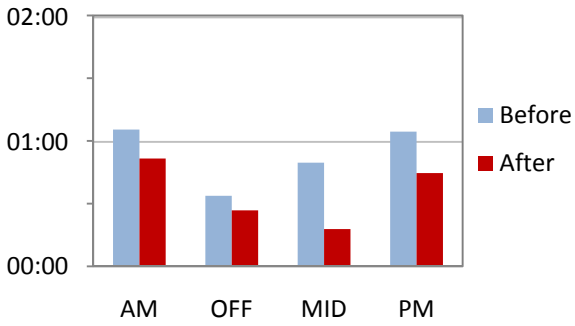


Figure 5.3.2: Route 454 Westbound Stopped Time (minutes)



5.4. Stops, Fuel Consumption, and Vehicle Efficiency

The implementation of the InSync system had a generally positive affect on the average number of stops as well as on fuel consumption and vehicle efficiency (miles per gallon). The results for these three performance measures are summarized in the tables below.

In the eastbound direction the average number of stops (rounded) decreased during the Midday, increased in the PM, and remained unchanged during the remaining time periods. Fuel consumption in the eastbound direction dropped considerably during the Midday period with a decrease of 0.06 gallons (22%). It increased slightly (3-4%) during the other three time periods. Vehicle efficiency (miles per gallon) also increased substantially during the Midday. It was flat or decreased slightly during the other time periods.

In the westbound direction, the results were more uniform, with a reduction of one to two vehicle stops during all four time periods. With regard to fuel consumption there were decreases of 0.06 to 0.13 gallons (21-45%). Vehicle efficiency increased significantly with mpg increases of over 100% for two of the time periods.

Table 5.4.1: Route 454 Corridor Average Number of Stops

	EB Average Number of Stops				WB Average Number of Stops			
	Before	After	Difference	%	Before	After	Difference	%
AM	3	3	0	0%	4	2	-2	-50%
OFF	2	2	0	0%	2	1	-1	-50%
MID	3	1	-2	-67%	3	2	-1	-33%
PM	2	3	1	50%	3	2	-1	-33%

Table 5.4.2: Route 454 Corridor Fuel Consumption

	EB Fuel Consumption (gallons)				WB Fuel Consumption (gallons)			
	Before	After	Difference	%	Before	After	Difference	%
AM	0.29	0.30	0.01	3%	0.33	0.23	-0.10	-30%
OFF	0.24	0.25	0.01	4%	0.29	0.16	-0.13	-45%
MID	0.27	0.21	-0.06	-22%	0.35	0.26	-0.09	-26%
PM	0.23	0.24	0.01	4%	0.29	0.23	-0.06	-21%

Table 5.4.3: Route 454 Corridor Vehicle Efficiency

	EB Vehicle Efficiency (mpg)				WB Vehicle Efficiency (mpg)			
	Before	After	Difference	%	Before	After	Difference	%
AM	10.2	10.1	0.0	0%	9.2	16.1	6.9	74%
OFF	15.5	13.0	-2.5	-16%	10.7	21.9	11.2	105%
MID	13.0	18.5	5.5	42%	8.4	16.9	8.6	103%
PM	14.3	14.1	-0.3	-2%	9.9	15.9	6.0	60%

5.5. Vehicle Emissions

The impact on average vehicle emissions followed the pattern of fuel consumption. In the eastbound direction the estimated emissions decreased considerably during the midday peak (-6.26 grams, -23%), but during the other three time periods the total emissions were estimated to increase by approximately 1 to 1.58 grams (4-6%).

Table 5.5.1: Route 454 Eastbound CO (g)

Eastbound	Before	After	Difference	%
AM	19.75	20.86	1.11	6%
OFF	16.78	17.64	0.86	5%
MID	19.23	14.83	-4.40	-23%
PM	16.04	16.74	0.70	4%

Table 5.5.3: Route 454 Eastbound NOx (g)

Before	After	Difference	%
3.84	4.06	0.22	6%
3.26	3.43	0.17	5%
3.74	2.89	-0.85	-23%
3.12	3.26	0.14	4%

Table 5.5.2: Route 454 Eastbound VOC (g)

Eastbound	Before	After	Difference	%
AM	4.58	4.83	0.25	5%
OFF	3.89	4.09	0.20	5%
MID	4.46	3.44	-1.02	-23%
PM	3.72	3.88	0.16	4%

Table 5.5.4: Route 454 Eastbound Total CO+Nox+VOC (g)

Before	After	Difference	%
28.17	29.75	1.58	6%
23.93	25.16	1.23	5%
27.43	21.16	-6.27	-23%
22.88	23.88	1.00	4%

The westbound before and after travel runs yielded estimated decreases in total vehicle emissions during all four time periods. The decrease was most pronounced during the off-peak at -12.44 grams (-43%). During the remaining three time periods the decrease was in the -21% to -29% range. These are substantial decreases compared to the baseline (before) emissions, bringing the total per vehicle emissions from around 30 grams to around 20 grams.

Table 5.5.5: Route 454 Westbound CO (g)

Westbound	Before	After	Difference	%
AM	23.06	16.30	-6.76	-29%
OFF	20.24	11.52	-8.72	-43%
MID	24.57	18.40	-6.17	-25%
PM	20.27	16.05	-4.22	-21%

Table 5.5.7: Route 454 Westbound NOx (g)

Before	After	Difference	%
4.49	3.17	-1.32	-29%
3.94	2.24	-1.70	-43%
4.78	3.58	-1.20	-25%
3.94	3.12	-0.82	-21%

Table 5.5.6: Route 454 Westbound VOC (g)

Westbound	Before	After	Difference	%
AM	5.34	3.78	-1.56	-29%
OFF	4.69	2.67	-2.02	-43%
MID	5.69	4.26	-1.43	-25%
PM	4.70	3.72	-0.98	-21%

Table 5.5.8: Route 454 Westbound Total CO+Nox+VOC (g)

Before	After	Difference	%
32.89	23.25	-9.64	-29%
28.87	16.43	-12.44	-43%
35.04	26.24	-8.80	-25%
28.91	22.89	-6.02	-21%

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis of the before and after implementation travel time runs, the InSync installation appears to have generally decreased travel times and stopped times, increased average speeds, reduced stops, and provided vehicle efficiency and emissions benefits. However, the benefits were not equal for the two directions, nor were they uniform over the four analysis time periods. In particular, there appeared to be considerably larger benefits in the westbound direction in comparison to the eastbound direction. There were also larger benefits during the AM Peak, Off-Peak and Midday time periods.

In the westbound there were substantial increases in speed and reductions in travel times. These translated into benefits in fuel consumption and estimated emissions. These benefits are summarized in the table below.

Table 7.1.1: Route 454 Eastbound Summary

	Travel time (min:sec)		Stopped Time (min:sec)		Average Speed (mph)		Fuel Consumption (gal)		Total Emissions (g)	
	Change	%	Change	%	Change	%	Change	%	Change	%
AM	-00:55	-14%	-00:37	-35%	5.9	22%	0.01	3%	1.58	6%
OFF	+00:13	-5%	-00:01	-2%	-2.6	-7%	0.01	4%	1.23	5%
MID	-01:05	-19%	-00:45	-66%	6.9	21%	-0.06	-22%	-6.27	-23%
PM	+00:04	1%	+00:13	23%	0.8	3%	0.01	4%	1.00	4%

Table 7.1.2: Route 454 Westbound Summary

	Travel time (min:sec)		Stopped Time (min:sec)		Average Speed (mph)		Fuel Consumption (gal)		Total Emissions (g)	
	Change	%	Change	%	Change	%	Change	%	Change	%
AM	-00:40	-11%	-00:14	-21%	4.8	15%	-0.10	-30%	-9.64	-29%
OFF	-00:39	-12%	-00:07	-21%	6.2	18%	-0.13	-45%	-12.44	-43%
MID	-00:40	-13%	-00:32	-64%	4.9	15%	-0.09	-26%	-8.80	-25%
PM	-00:32	-10%	-00:20	-31%	4.3	14%	-0.06	-21%	-6.02	-21%

- XX% = change is more than +/- 20%

In the eastbound direction the benefits were mainly limited to the AM Peak period and the Midday period. There the improvements were often in line with the westbound improvements.

For the Off-Peak period and the PM Peak period, there were decreases in speed and increases in travel time. There are a number of possible explanations for these results.

One possible explanation for the limited benefits in the eastbound direction during the off-peak is that speeds during that time period were relatively stable with few stops and moderate stopped delay. In fact, the speeds were almost always above 30 mph. Therefore, improvements in that direction during that time period would be difficult. In the PM peak, the eastbound direction was observed to have heavy traffic. Therefore, it would be difficult to simultaneously improve both the eastbound and westbound directions. In addition, it appears that priority for progression may have been given to the eastbound traffic as it had a more consistent speed profile than the westbound traffic. The InSync system may have adjusted that preference, providing more benefit to the westbound traffic at some cost to the eastbound traffic. Additional evaluation (including traffic counts and a review of signal timing) would be necessary to more fully explore these results.

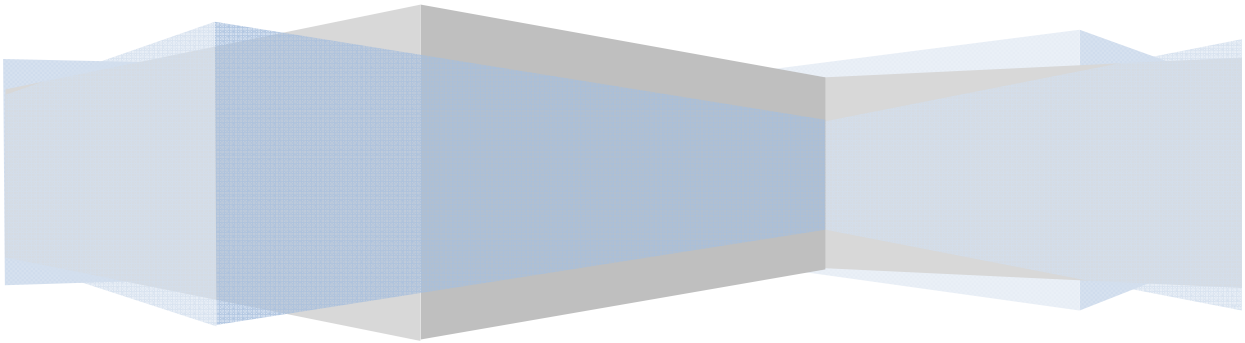
Adaptive Traffic Signal Control System
Route 454: Veterans Memorial Highway
Islip, New York

Before and After
Travel Time and Delay Study

Appendix A

I-Trec Analysis Reports

July 2011



iTREC Report

Print Date: Friday, May 13, 2011

Print Time: 10:34:58 AM

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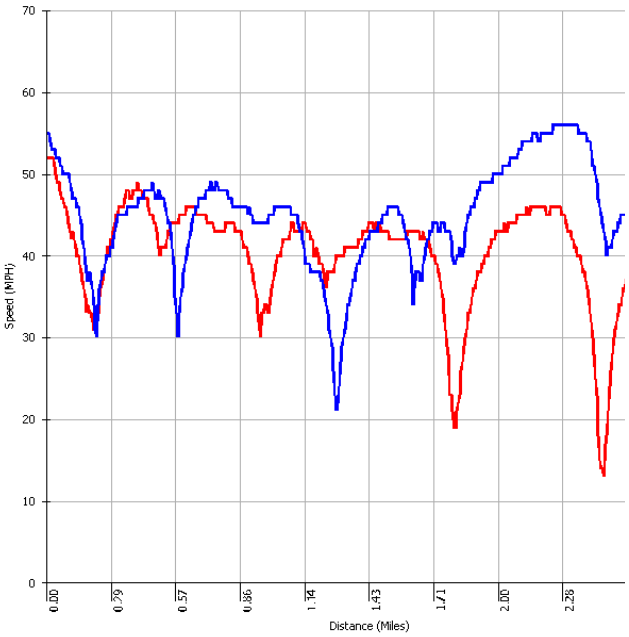
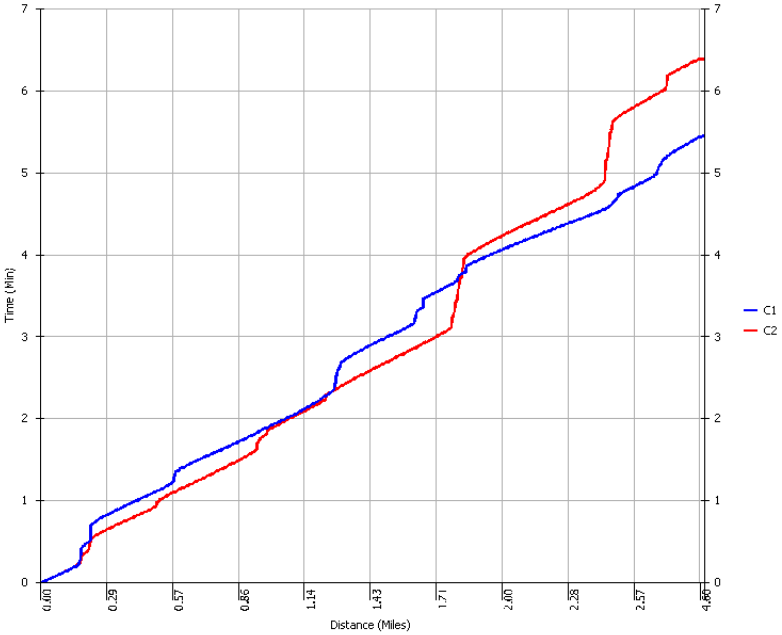
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB AM										
C2	2.85	6:23	26.96	3	1:45	0.29	10.17	19.75	3.84	4.58

Speed/Distance Graph



Time/Distance Graph



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Print Time: 10:31:29 AM

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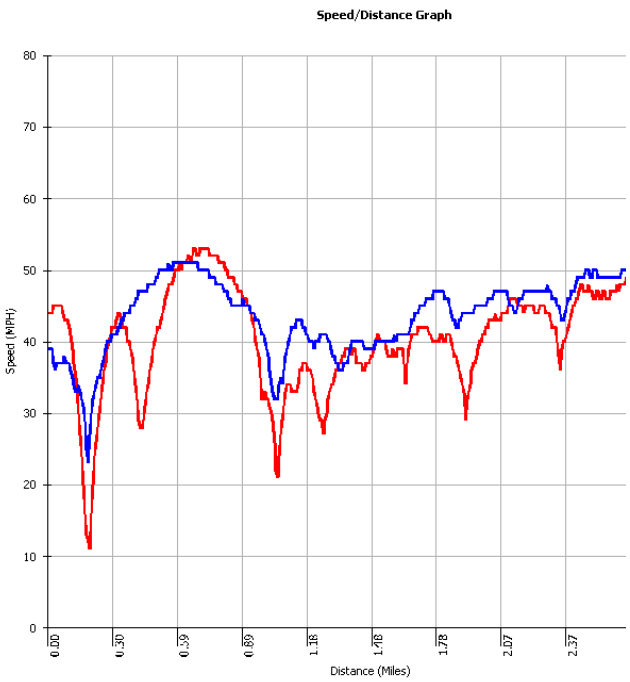
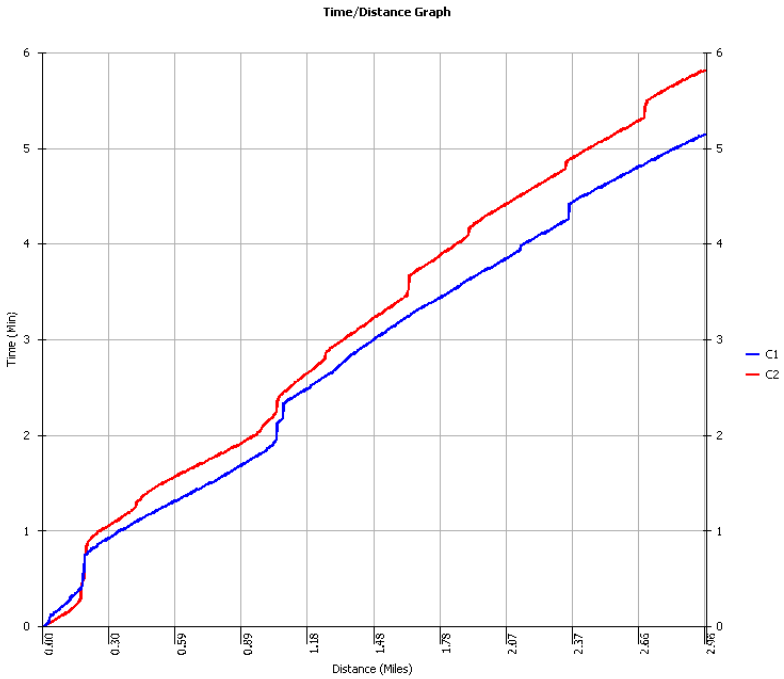
C1	2.96	5:09	36.02	2	0:52	0.23	16.08	16.30	3.17	3.78
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB AM										
C2	2.96	5:49	31.23	4	1:06	0.33	9.22	23.06	4.49	5.34





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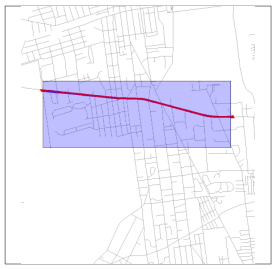
Print Time: 9:35:03 AM



Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)
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C1	2.88	4:28	39.53	1	0:23	0.21	18.35	14.70	2.86	3.41
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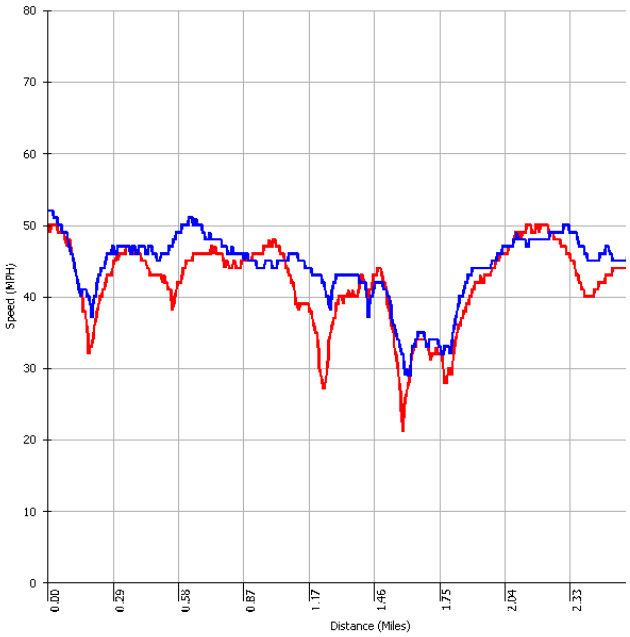
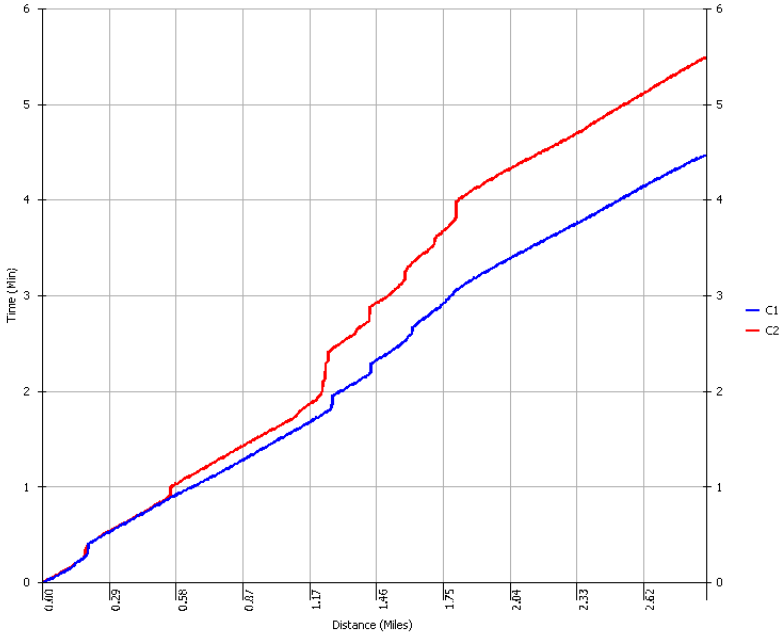
C2	2.89	5:29	32.75	2	1:00	0.25	13.38	17.75	3.45	4.11

Speed/Distance Graph



Time/Distance Graph



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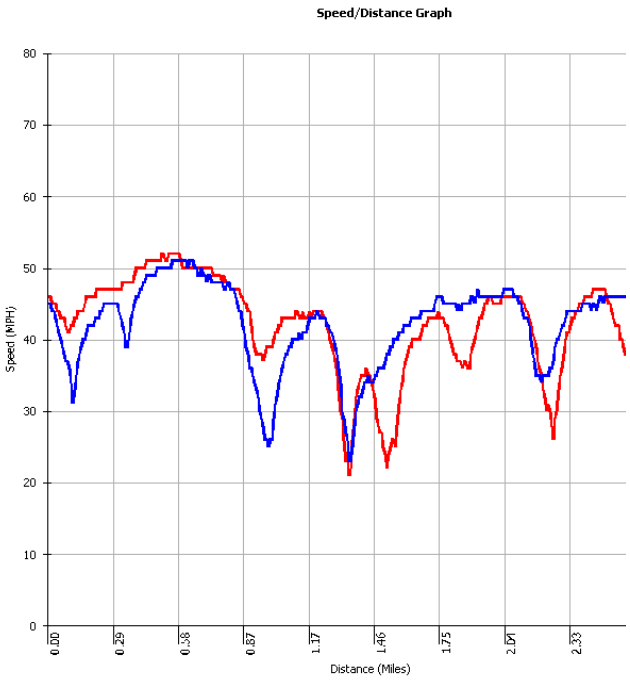
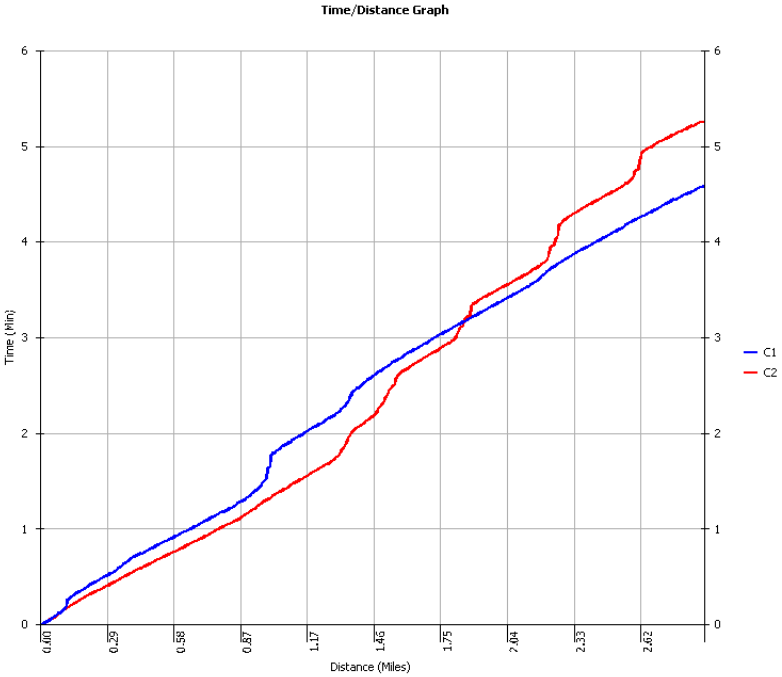
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB MID										
C1	2.89	4:35	38.34	2	0:18	0.26	16.93	18.40	3.58	4.26
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB MID										
C2	2.88	5:15	33.41	3	0:50	0.35	8.36	24.57	4.78	5.69





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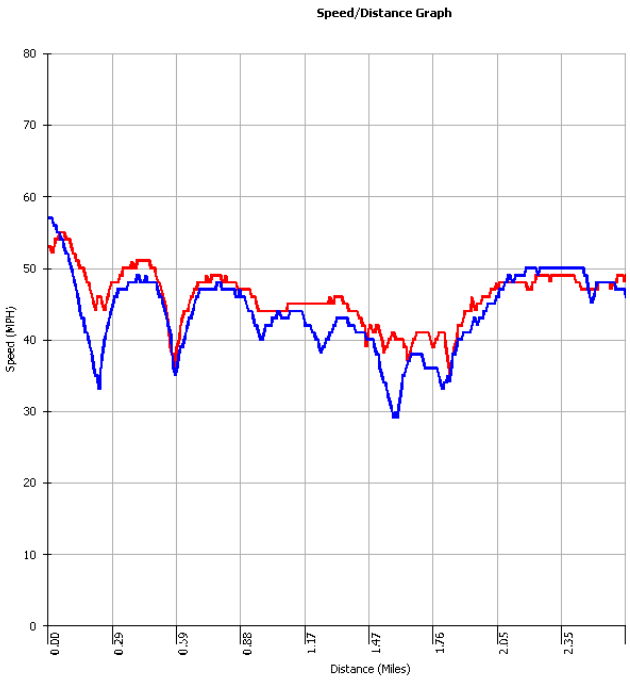
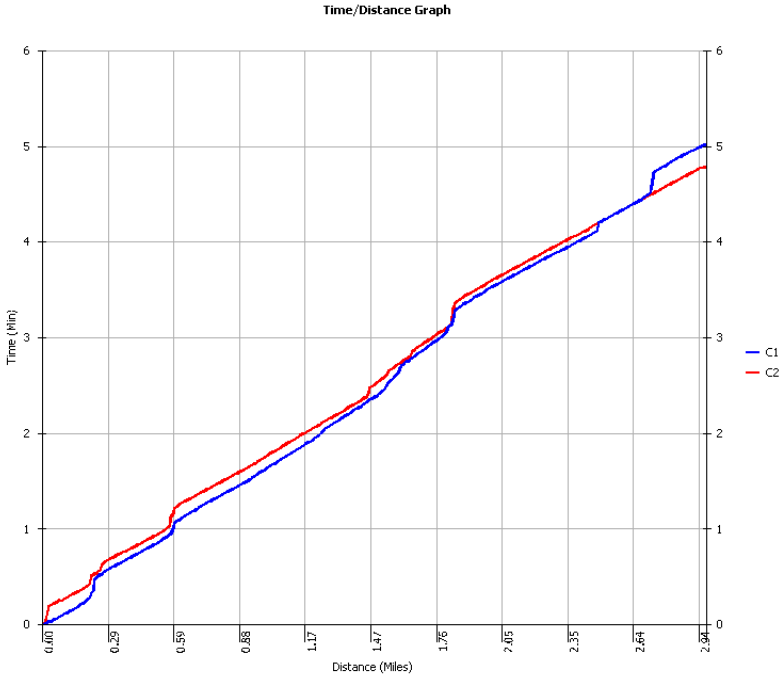
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB OFF PK										
C1	2.95	5:01	35.87	2	0:43	0.25	13.04	17.64	3.43	4.09
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB OFF PK										
C2	2.96	4:48	38.48	2	0:44	0.24	15.49	16.78	3.26	3.89





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Print Time: 10:59:27 AM

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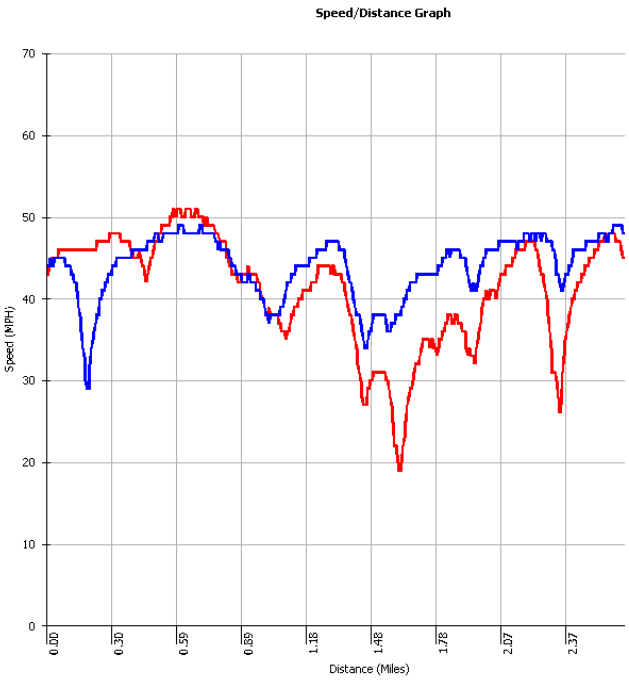
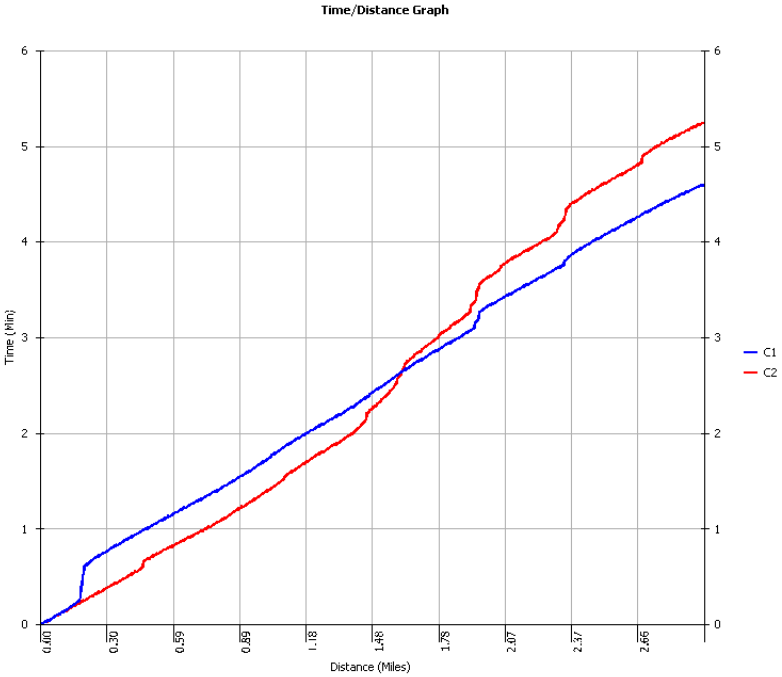
C1	2.96	4:36	40.50	1	0:27	0.16	21.89	11.52	2.24	2.67
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB OFF PK										
C2	2.96	5:15	34.30	2	0:34	0.29	10.66	20.24	3.94	4.69





iTREC Report

Print Date: Friday, May 13, 2011

Print Time: 11:18:22 AM

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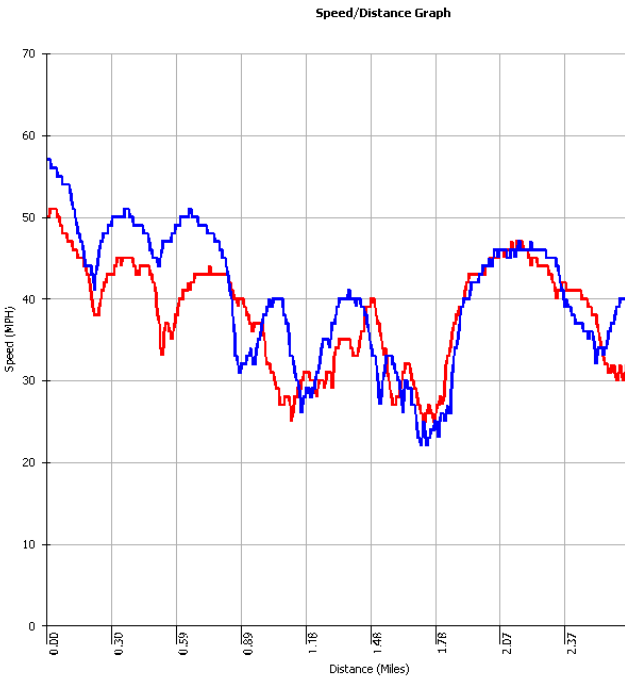
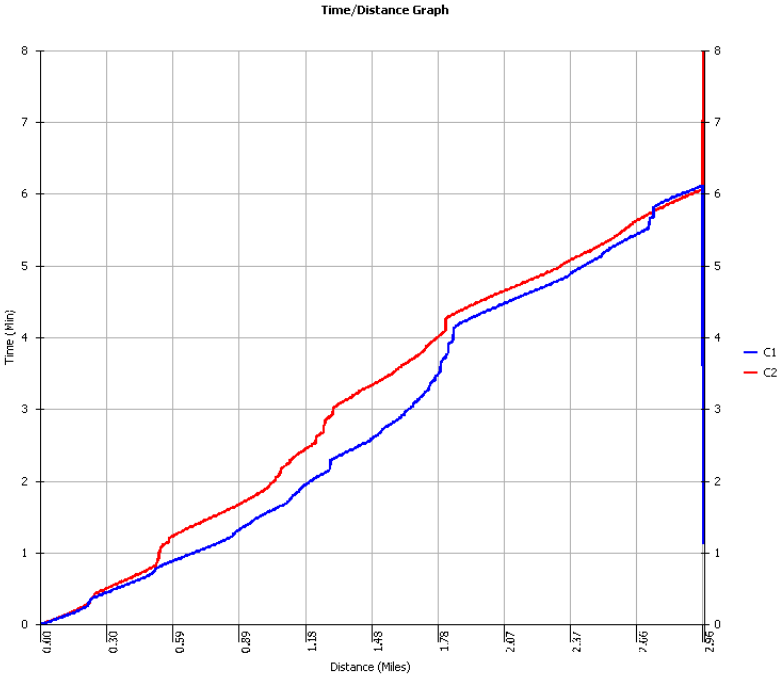
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB PM										
C1	2.96	6:07	31.10	3	1:10	0.24	14.07	16.74	3.26	3.88
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB PM										
C2	2.95	6:03	30.26	2	0:57	0.23	14.32	16.04	3.12	3.72





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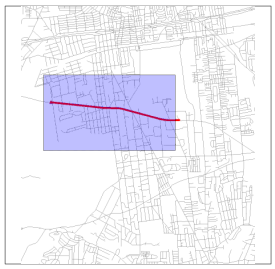

Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)
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C1	2.86	5:00	35.54	2	0:45	0.23	15.85	16.05	3.12	3.72
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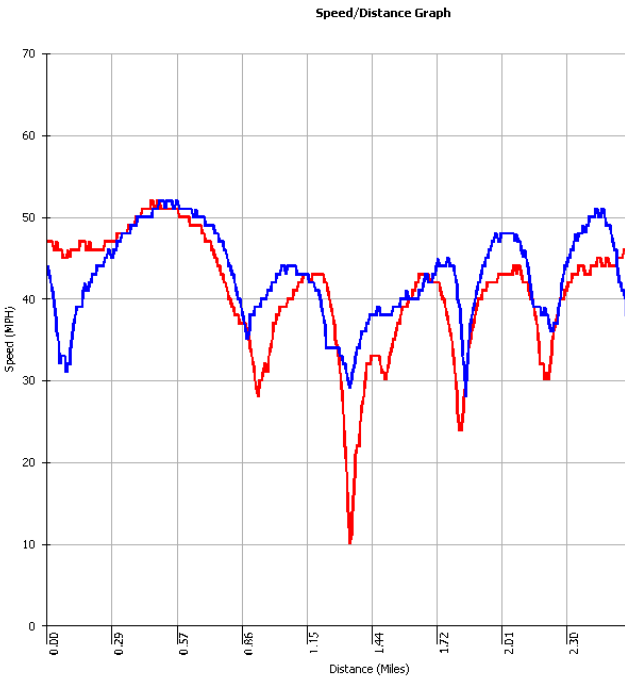

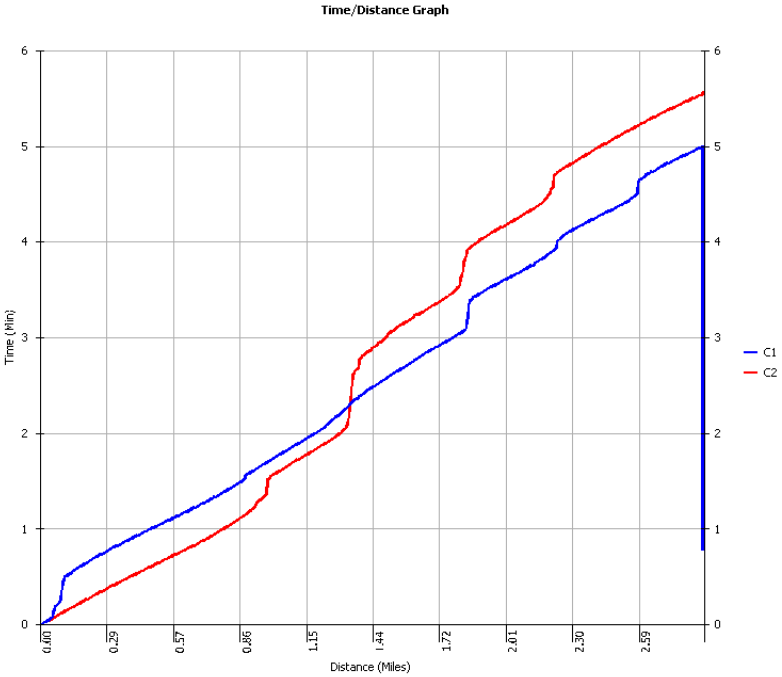

iTREC Report

Print Date: Thursday, May 12, 2011

Print Time: 9:34:17 AM

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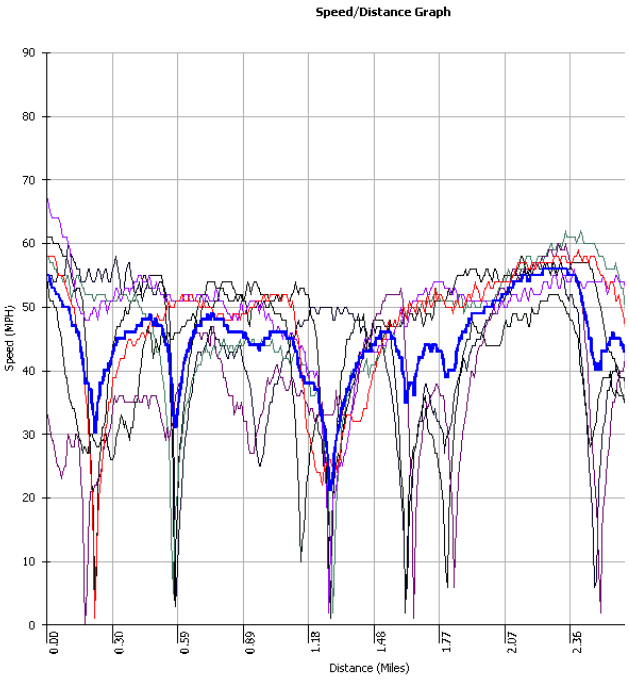
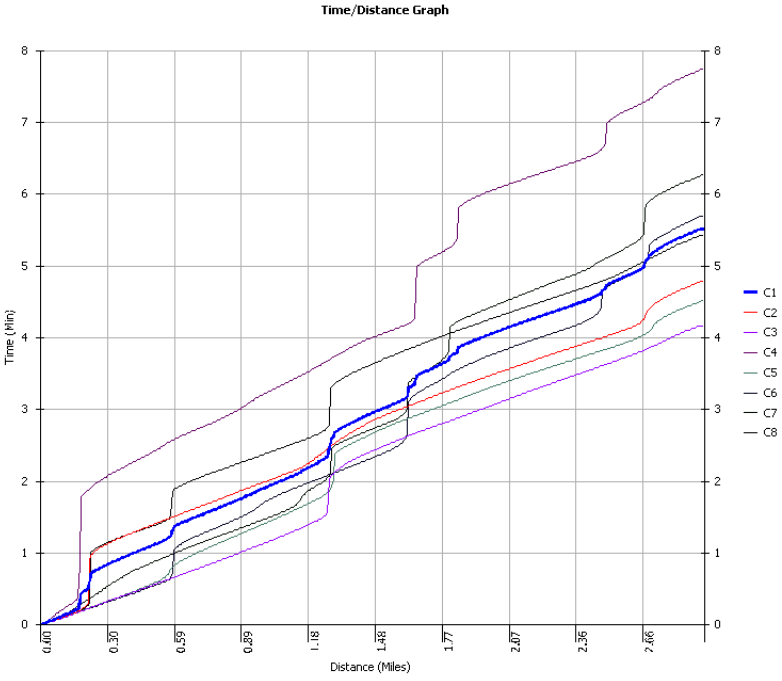
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB AM										
C1	2.91	5:31	33.00	3	1:08	0.30	10.28	20.84	4.05	4.83
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB AM/5/5/2011 08:19:21 - 08:24:12										
C2	2.91	4:47	36.59	1	0:36	0.22	13.06	15.57	3.03	3.61
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB AM/5/5/2011 08:35:52 - 08:40:06										
C3	2.90	4:10	41.91	1	0:26	0.26	11.24	18.05	3.51	4.18
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB AM/5/5/2011 08:53:46 - 09:01:35										
C4	2.93	7:45	22.64	4	2:39	0.27	10.94	18.70	3.64	4.34
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB AM/5/5/2011 09:10:36 - 09:15:11										
C5	2.91	4:31	38.84	1	0:22	0.23	12.64	16.12	3.14	3.74
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB AM/5/5/2011 08:26:22 - 08:32:08										
C6	2.91	5:42	30.75	5	1:06	0.44	6.63	30.73	5.98	7.12
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB AM/5/5/2011 08:44:45 - 08:51:05										
C7	2.92	6:16	28.00	4	1:21	0.32	9.02	22.64	4.40	5.25
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB AM/5/5/2011 08:58:51 - 09:04:20										
C8	2.90	5:25	32.25	3	1:28	0.34	8.44	24.04	4.68	5.57





iTREC Report

Print Date: Thursday, May 12, 2011

Print Time: 9:26:23 AM

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sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB AM										
C1	2.96	5:09	36.02	2	0:52	0.23	16.08	16.30	3.17	3.78
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C2	2.96	4:49	36.87	1	0:16	0.21	13.86	14.91	2.90	3.46
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB AM/5/5/2011 08:26:50 - 08:32:47										
C3	2.98	5:56	30.09	1	1:09	0.19	15.50	13.42	2.61	3.11
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB AM/5/5/2011 08:41:49 - 08:47:58										
C4	2.97	6:08	29.08	4	1:39	0.35	8.56	24.25	4.72	5.62
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB AM/5/5/2011 09:04:17 - 09:07:47										
C5	2.96	3:29	51.06	0	0:00	0.10	29.92	6.92	1.35	1.60
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB AM/5/5/2011 08:16:41 - 08:22:07										
C6	2.96	5:25	32.83	4	0:50	0.42	7.09	29.22	5.69	6.77
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB AM/5/5/2011 08:34:11 - 08:40:38										
C7	2.97	6:26	27.69	3	1:44	0.28	10.60	19.59	3.81	4.54
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB AM/5/5/2011 08:54:10 - 08:59:21										
C8	2.95	5:10	34.21	1	1:16	0.22	13.68	15.05	2.93	3.49
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB AM/5/5/2011 09:06:52 - 09:10:42										
C9	2.95	3:49	46.35	0	0:00	0.10	29.42	7.01	1.36	1.63

iTREC Report

Print Date: Thursday, May 12, 2011

Print Time: 9:26:23 AM

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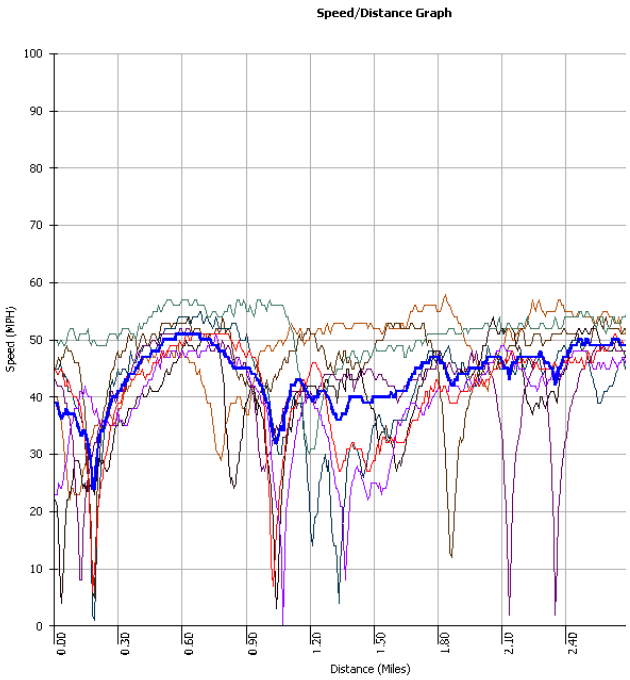
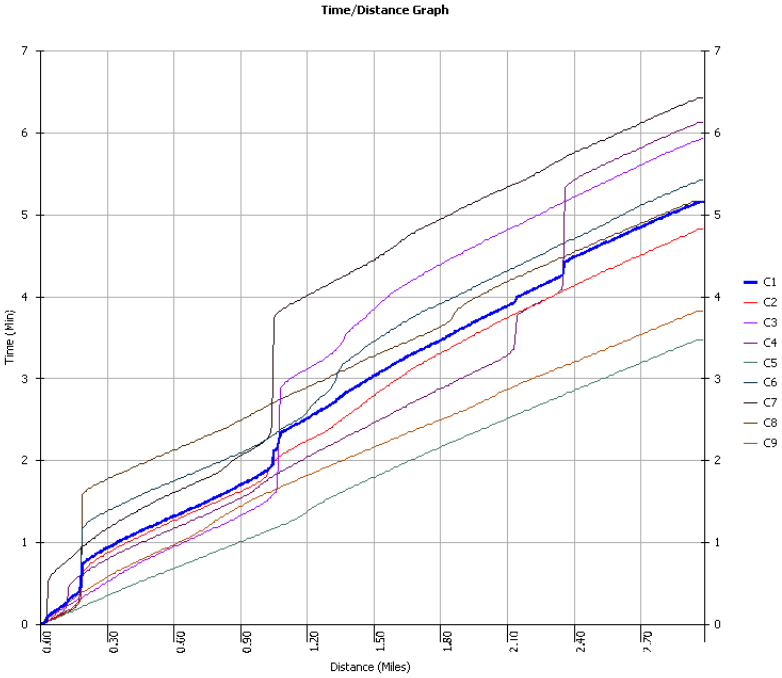




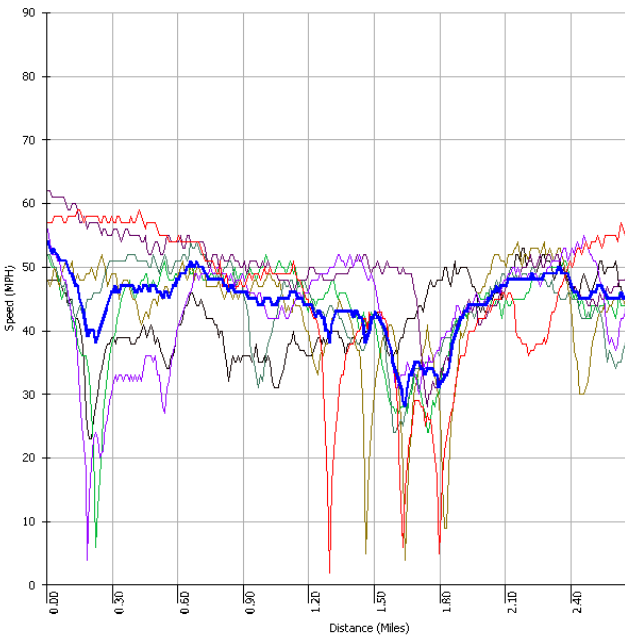
iTREC Report

Print Date: Thursday, May 12, 2011

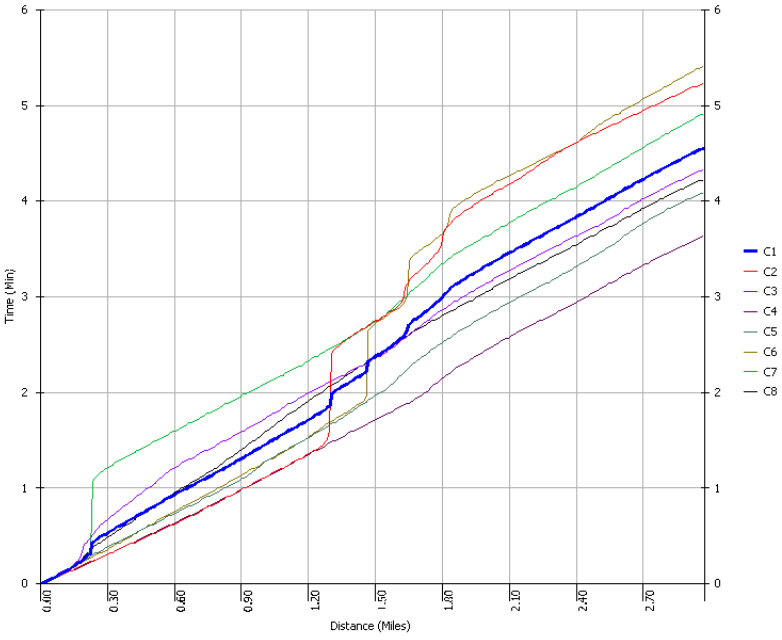
Print Time: 2:21:58 PM

Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB MID										
C1	2.96	4:33	39.75	1	0:23	0.21	18.45	14.83	2.89	3.44
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB MID/5/5/2011 13:08:49 - 13:14:04										
C2	2.96	5:14	34.00	3	0:55	0.37	8.06	25.65	4.99	5.94
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB MID/5/5/2011 13:22:47 - 13:27:08										
C3	2.96	4:20	41.04	1	0:02	0.25	11.83	17.48	3.40	4.05
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB MID/5/5/2011 13:36:44 - 13:40:23										
C4	2.96	3:38	48.91	0	0:00	0.10	29.77	6.95	1.35	1.61
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB MID/5/5/2011 13:51:09 - 13:55:15										
C5	2.95	4:05	43.38	0	0:00	0.10	28.82	7.16	1.39	1.66
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB MID/5/5/2011 13:15:00 - 13:20:26										
C6	2.96	5:25	32.84	3	1:02	0.35	8.52	24.31	4.73	5.63
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB MID/5/5/2011 13:30:58 - 13:35:53										
C7	2.95	4:54	36.17	1	0:40	0.22	13.71	15.05	2.93	3.49
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB MID/5/5/2011 13:47:01 - 13:51:15										
C8	2.95	4:13	41.90	0	0:00	0.10	28.45	7.24	1.41	1.68

Speed/Distance Graph



Time/Distance Graph

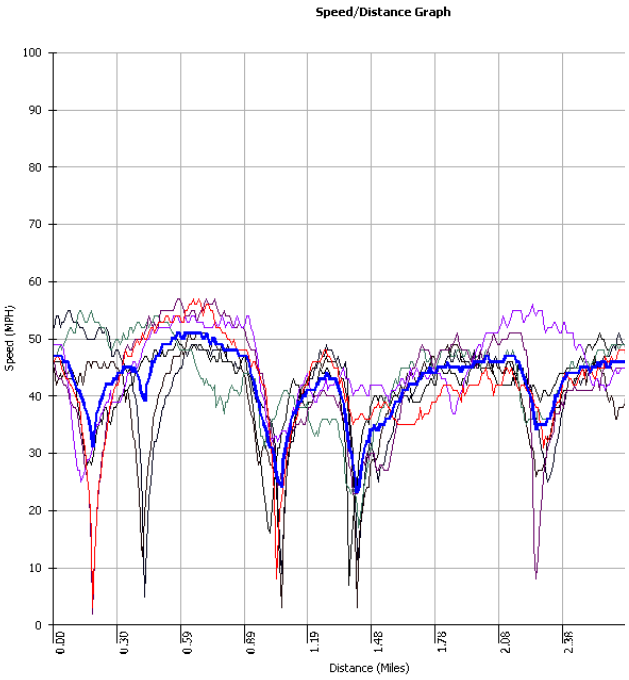


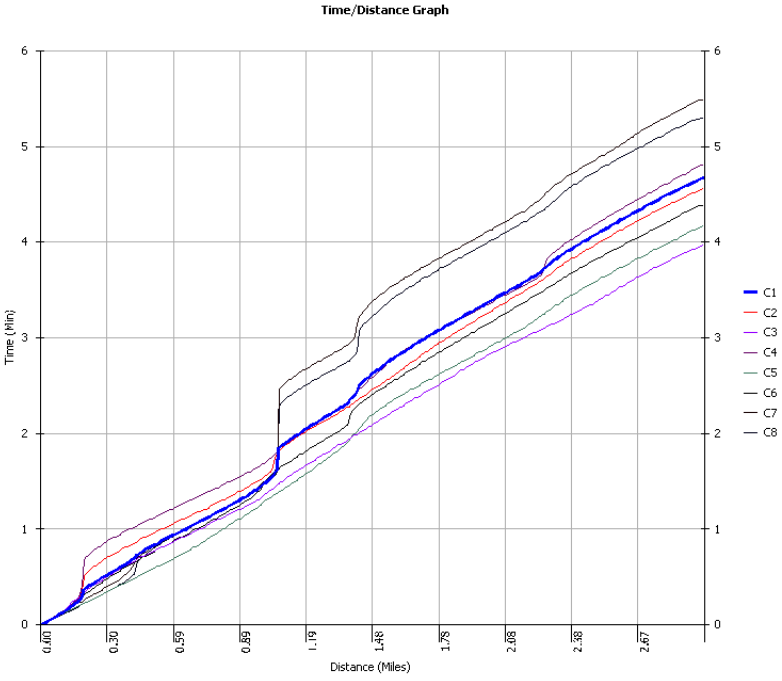
iTREC Report

Print Date: Thursday, May 12, 2011

Print Time: 2:16:23 PM

Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB MID										
C1	2.96	4:40	38.50	2	0:18	0.26	17.00	18.57	3.61	4.30
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB MID/5/5/2011 13:00:10 - 13:04:45										
C2	2.97	4:34	39.02	4	0:09	0.60	4.91	42.28	8.23	9.80
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB MID/5/5/2011 13:15:52 - 13:19:51										
C3	2.96	3:58	44.73	0	0:00	0.10	29.12	7.10	1.38	1.65
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB MID/5/5/2011 13:28:12 - 13:33:02										
C4	2.96	4:49	36.97	2	0:15	0.32	9.18	22.57	4.39	5.23
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB MID/5/5/2011 13:44:13 - 13:48:24										
C5	2.96	4:10	42.64	0	0:00	0.10	28.64	7.22	1.40	1.67
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB MID/5/5/2011 13:22:10 - 13:26:34										
C6	2.95	4:23	40.32	0	0:00	0.11	28.01	7.35	1.43	1.70
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB MID/5/5/2011 13:38:16 - 13:43:46										
C7	2.95	5:29	32.31	3	0:51	0.34	8.71	23.70	4.61	5.49
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB MID/5/5/2011 13:36:11 - 13:41:30										
C8	2.95	5:18	33.46	2	0:49	0.28	10.42	19.79	3.85	4.59





iTREC Report

Print Date: Thursday, May 12, 2011

Print Time: 2:11:02 PM

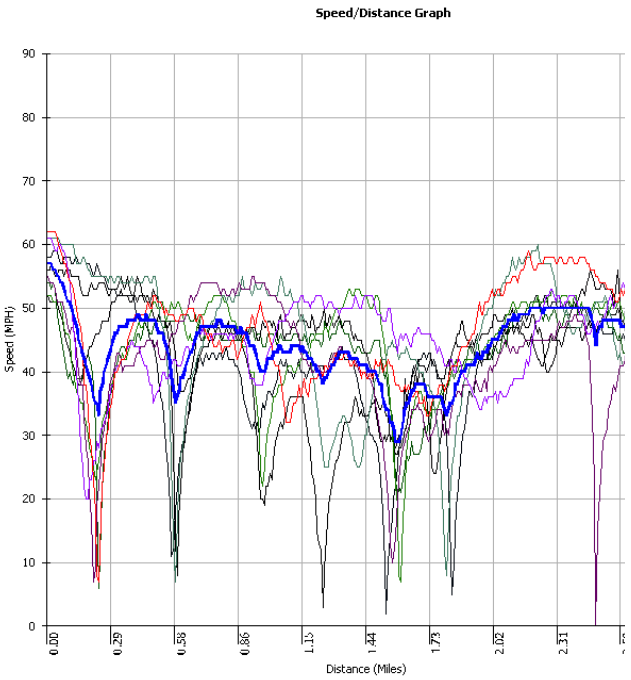
Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB OFF PK										
C1	2.88	4:56	35.64	2	0:43	0.25	12.88	17.49	3.40	4.05
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB OFF PK/5/5/2011 10:07:05 - 10:11:41										
C2	2.88	4:30	38.47	1	0:35	0.23	12.50	16.09	3.13	3.73
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB OFF PK/5/5/2011 10:20:47 - 10:24:48										
C3	2.88	3:55	44.18	0	0:00	0.10	29.00	6.93	1.35	1.61
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB OFF PK/5/5/2011 10:34:49 - 10:40:26										
C4	2.89	5:31	31.44	2	1:02	0.26	11.01	18.34	3.57	4.25
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB OFF PK/5/5/2011 10:48:53 - 10:53:42										
C5	2.88	4:43	36.69	2	0:39	0.32	8.94	22.49	4.38	5.21
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB OFF PK/5/5/2011 10:10:54 - 10:15:29										
C6	2.89	4:29	38.71	1	0:24	0.23	12.59	16.04	3.12	3.72
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB OFF PK/5/5/2011 10:23:04 - 10:28:13										
C7	2.87	5:03	34.25	2	0:31	0.29	9.91	20.26	3.94	4.69
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB OFF PK/5/5/2011 10:39:09 - 10:44:14										
C8	2.89	4:59	34.86	2	0:54	0.30	9.62	21.00	4.09	4.87
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB OFF PK/5/5/2011 10:56:48 - 11:02:16										
C9	2.90	5:22	32.41	2	1:04	0.27	10.74	18.84	3.67	4.37
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB OFF PK/5/5/2011 10:33:06 - 10:39:03										
C10	2.89	5:51	29.74	2	1:19	0.25	11.58	17.45	3.39	4.04

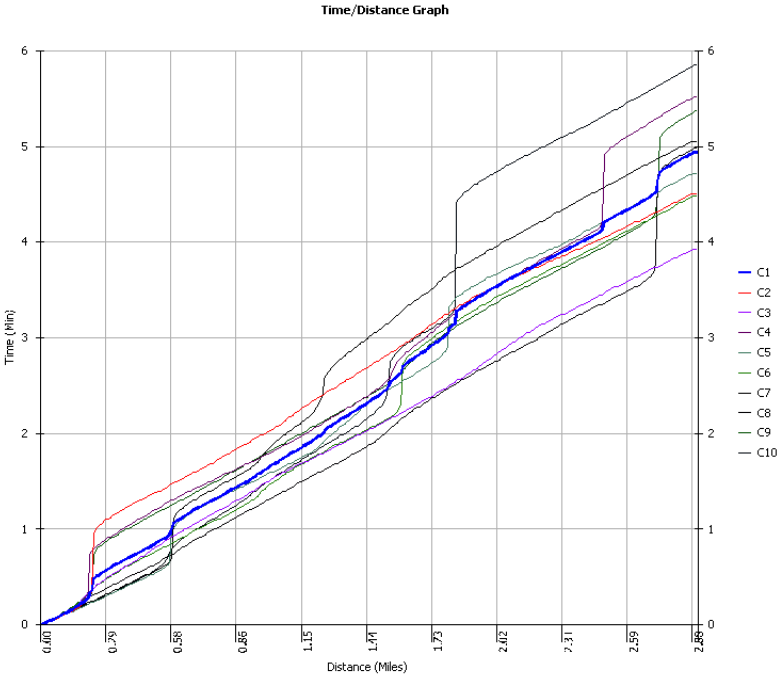
iTREC Report

Print Date: Thursday, May 12, 2011

Print Time: 2:11:02 PM

Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)





iTREC Report

Print Date: Thursday, May 12, 2011

Print Time: 10:17:30 AM

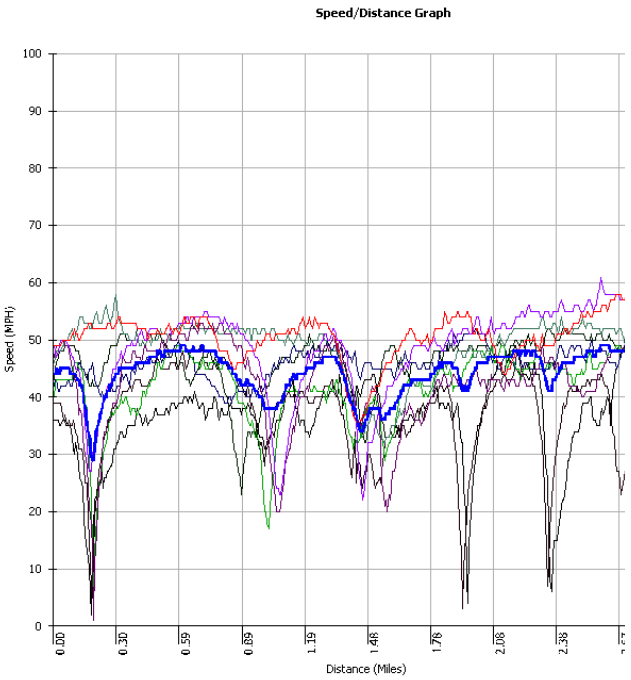
Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB OFF PK										
C1	2.96	4:36	40.50	1	0:27	0.16	21.89	11.52	2.24	2.67
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB OFF PK/5/5/2011 09:59:52 - 10:03:23										
C2	2.96	3:30	50.68	0	0:00	0.10	29.91	6.91	1.35	1.60
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB OFF PK/5/5/2011 10:14:04 - 10:17:51										
C3	2.97	3:46	47.26	0	0:00	0.10	29.56	7.02	1.37	1.63
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB OFF PK/5/5/2011 10:26:09 - 10:31:10										
C4	2.96	5:00	35.58	1	0:38	0.21	13.91	14.90	2.90	3.45
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB OFF PK/5/5/2011 10:42:10 - 10:45:51										
C5	2.96	3:40	48.51	0	0:00	0.10	29.72	6.97	1.36	1.62
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB OFF PK/5/5/2011 10:02:07 - 10:07:21										
C6	2.95	5:13	34.02	1	0:51	0.21	14.07	14.66	2.85	3.40
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB OFF PK/5/5/2011 10:16:21 - 10:20:12										
C7	2.94	3:50	45.98	0	0:00	0.10	29.36	7.00	1.36	1.62
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB OFF PK/5/5/2011 10:30:11 - 10:36:18										
C8	2.96	6:06	29.17	3	1:05	0.29	10.09	20.53	3.99	4.76
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB OFF PK/5/5/2011 10:46:18 - 10:52:52										
C9	2.96	6:33	27.16	3	1:27	0.27	11.04	18.72	3.64	4.34
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB OFF PK/5/5/2011 10:40:07 - 10:43:57										
C10	2.94	3:49	46.18	0	0:00	0.10	29.39	6.99	1.36	1.62

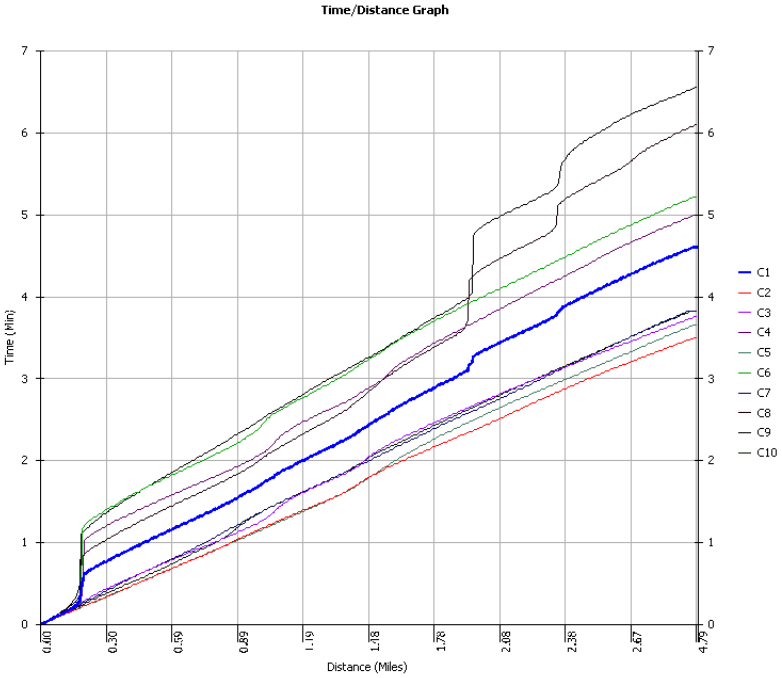
iTREC Report

Print Date: Thursday, May 12, 2011

Print Time: 10:17:30 AM

Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)



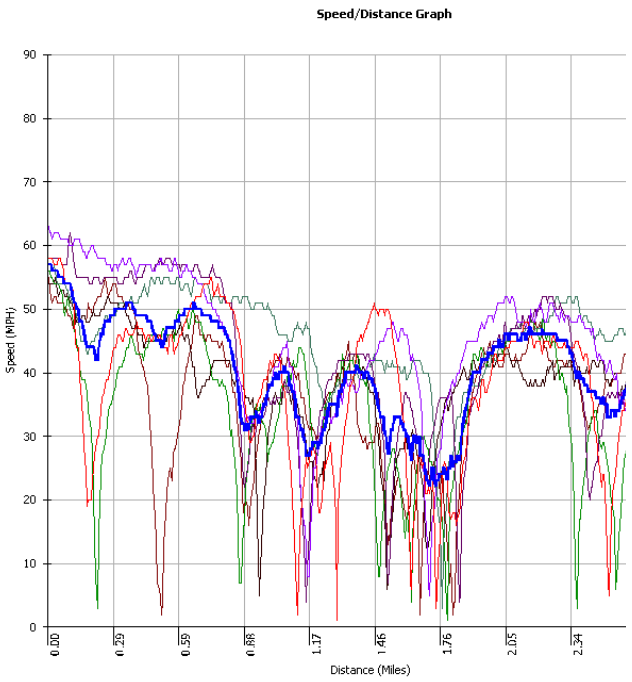


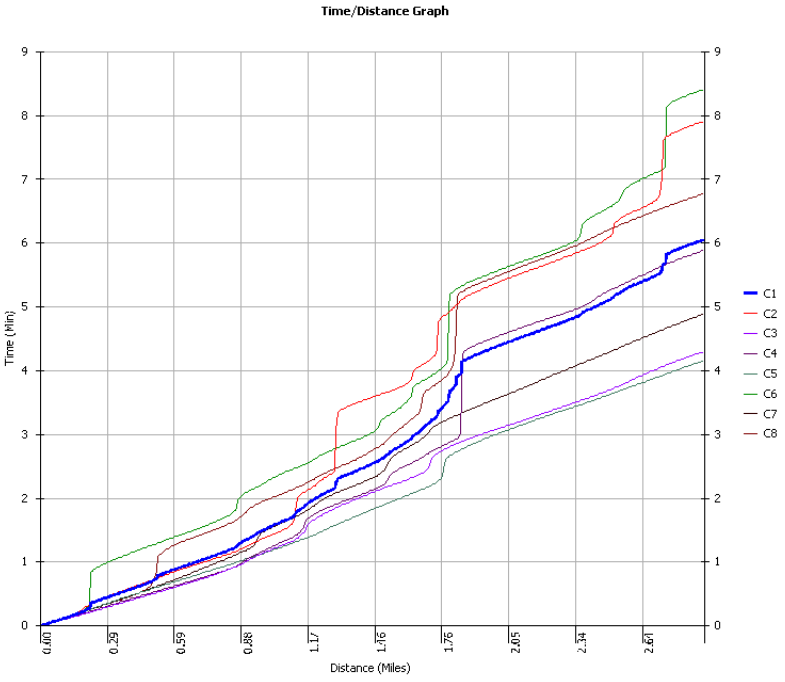
iTREC Report

Print Date: Friday, May 13, 2011

Print Time: 9:16:04 AM

Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB PM										
C1	2.89	6:02	30.88	3	1:10	0.24	13.98	16.48	3.21	3.82
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB PM/5/5/2011 17:12:44 - 17:20:44										
C2	2.89	7:54	22.03	6	2:33	0.31	9.45	21.37	4.16	4.95
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB PM/5/5/2011 17:30:08 - 17:34:30										
C3	2.88	4:17	40.48	0	0:00	0.10	28.06	7.18	1.40	1.66
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB PM/5/5/2011 17:45:21 - 17:51:20										
C4	2.90	5:53	29.63	1	1:15	0.19	15.31	13.22	2.57	3.06
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB PM/5/5/2011 18:00:20 - 18:04:35										
C5	2.89	4:09	41.91	1	0:12	0.25	11.33	17.82	3.47	4.13
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB PM/5/5/2011 17:07:48 - 17:16:18										
C6	2.89	8:24	20.75	7	2:44	0.31	9.42	21.43	4.17	4.97
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB PM/5/5/2011 17:27:37 - 17:32:36										
C7	2.90	4:53	35.64	1	0:02	0.20	14.24	14.22	2.77	3.29
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 EB PM/5/5/2011 17:51:02 - 17:57:54										
C8	2.90	6:46	25.73	4	1:24	0.29	10.06	20.12	3.92	4.66





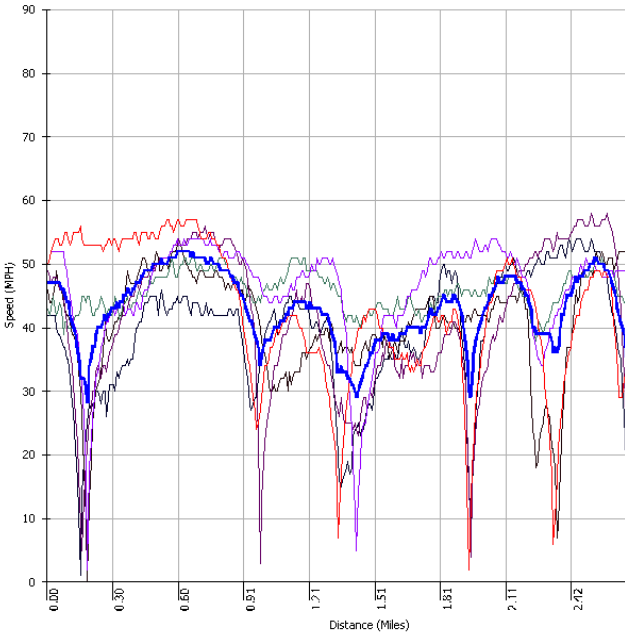
iTREC Report

Print Date: Friday, May 13, 2011

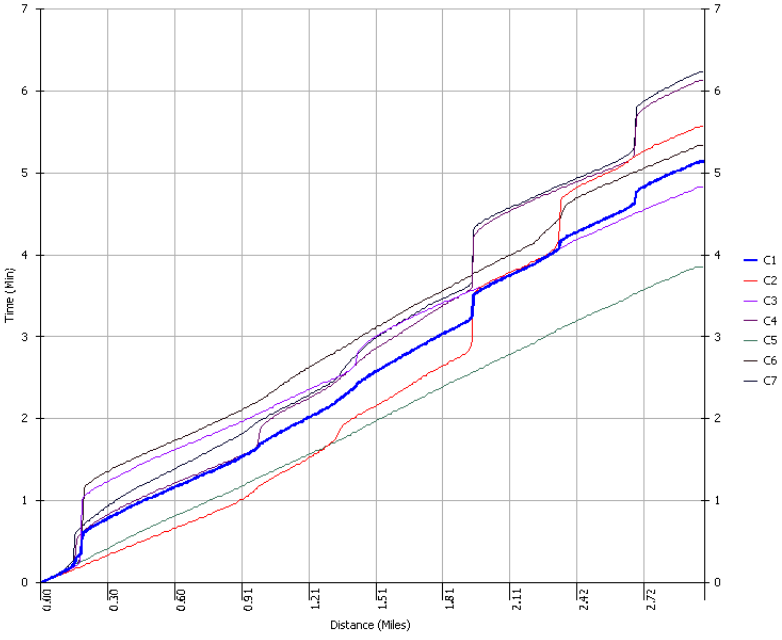
Print Time: 7:47:34 AM

Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB PM										
C1	2.96	5:08	35.78	2	0:45	0.23	16.04	16.28	3.17	3.77
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB PM/5/5/2011 17:01:30 - 17:07:05										
C2	2.97	5:34	32.03	2	1:02	0.27	11.02	18.84	3.67	4.37
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB PM/5/5/2011 17:21:47 - 17:26:37										
C3	2.96	4:49	36.87	2	0:46	0.33	9.02	22.92	4.46	5.31
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB PM/5/5/2011 17:35:25 - 17:41:34										
C4	2.98	6:08	29.13	4	1:19	0.34	8.66	24.02	4.67	5.57
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB PM/5/5/2011 16:59:21 - 17:03:13										
C5	2.95	3:51	45.93	0	0:00	0.10	29.35	7.01	1.36	1.63
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB PM/5/5/2011 17:17:21 - 17:22:42										
C6	2.96	5:20	33.37	1	0:48	0.20	14.77	14.03	2.73	3.25
sqlexpress:itrec/ROUTE 454 AFTER/ROUTE 454 WB PM/5/5/2011 17:35:20 - 17:41:35										
C7	2.96	6:14	28.60	3	1:18	0.29	10.35	20.02	3.90	4.64

Speed/Distance Graph



Time/Distance Graph

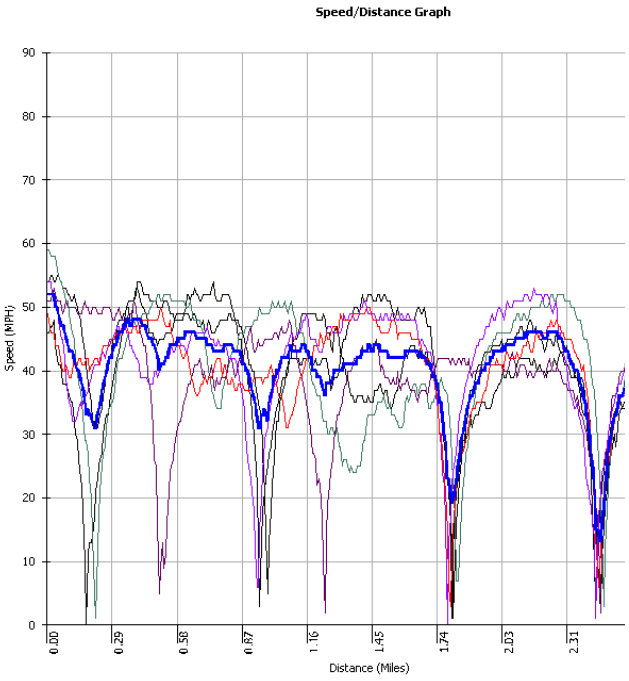


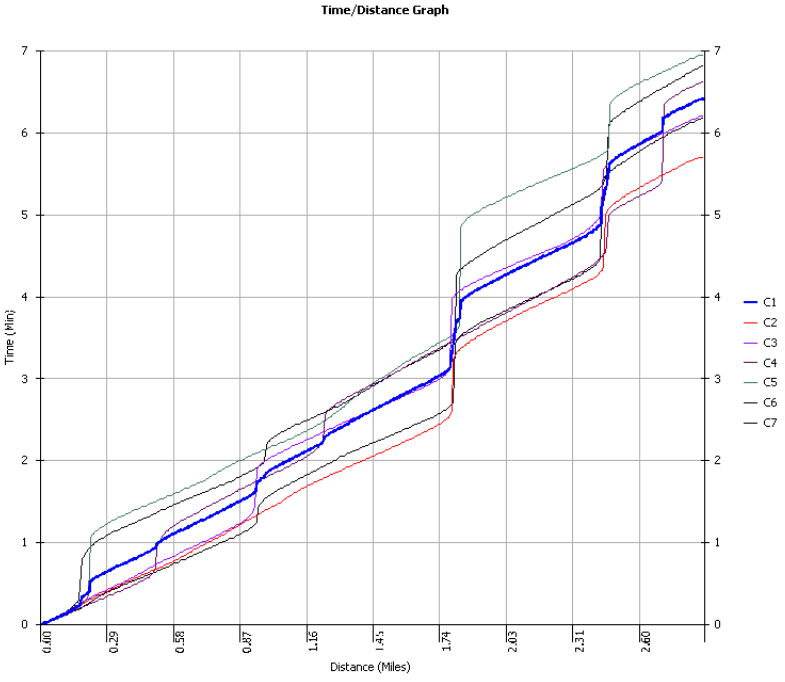
iTREC Report

Print Date: Thursday, May 12, 2011

Print Time: 9:45:22 AM

Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB AM										
C1	2.87	6:25	27.04	3	1:45	0.29	10.19	19.85	3.86	4.60
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB AM/2/16/2011 08:00:29 - 08:06:17										
C2	2.86	5:42	30.14	2	1:13	0.25	11.46	17.43	3.39	4.04
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB AM/2/16/2011 08:20:01 - 08:26:18										
C3	2.87	6:12	27.82	4	1:43	0.33	8.73	23.00	4.47	5.33
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB AM/2/16/2011 08:36:15 - 08:42:57										
C4	2.87	6:37	26.10	4	1:45	0.30	9.62	20.86	4.06	4.84
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB AM/2/16/2011 08:54:00 - 09:01:03										
C5	2.86	6:57	24.85	3	2:19	0.26	11.19	17.90	3.48	4.15
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB AM/2/16/2011 07:59:26 - 08:06:22										
C6	2.88	6:49	25.34	4	1:47	0.29	9.98	20.16	3.92	4.67
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB AM/2/16/2011 08:37:46 - 08:44:04										
C7	2.88	6:11	27.96	3	1:42	0.28	10.18	19.76	3.84	4.58





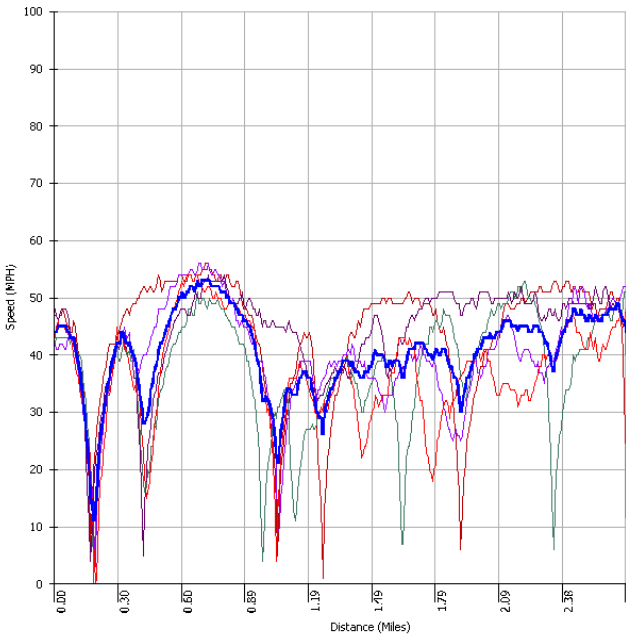
iTREC Report

Print Date: Thursday, May 12, 2011

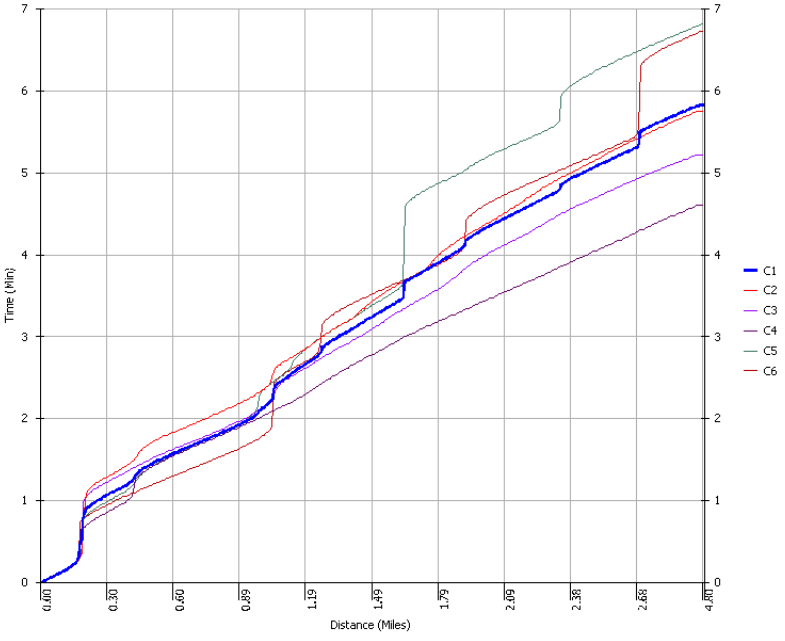
Print Time: 9:27:52 AM

Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB AM										
C1	2.96	5:49	31.23	4	1:06	0.33	9.22	23.06	4.49	5.34
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB AM/2/16/2011 08:08:59 - 08:14:45										
C2	2.95	5:45	30.87	2	0:44	0.25	11.73	17.59	3.42	4.08
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB AM/2/16/2011 08:29:07 - 08:34:21										
C3	2.95	5:13	33.93	2	0:38	0.28	10.36	19.87	3.87	4.61
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB AM/2/16/2011 08:27:02 - 08:31:39										
C4	2.96	4:36	38.58	2	0:20	0.35	8.47	24.42	4.75	5.66
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB AM/2/16/2011 08:44:22 - 08:51:12										
C5	2.98	6:49	26.24	6	1:36	0.37	7.95	26.18	5.09	6.07
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB AM/2/16/2011 09:01:50 - 09:08:34										
C6	2.96	6:43	26.55	6	2:11	0.39	7.60	27.25	5.30	6.32

Speed/Distance Graph



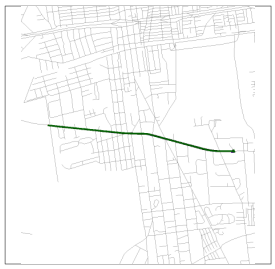
Time/Distance Graph



iTREC Report

Print Date: Thursday, May 12, 2011

Print Time: 2:35:11 PM

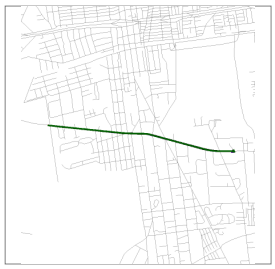


Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB MID										
C1	2.95	8:35	27.20	3	4:00	0.29	11.94	20.36	3.96	4.72
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB MID/2/16/2011 13:35:51 - 13:53:20										
C2	3.00	17:28	10.28	2	12:37	0.34	8.81	23.76	4.62	5.51
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB MID/2/16/2011 13:07:10 - 13:14:59										
C3	2.93	7:48	22.61	6	3:15	0.32	9.09	22.50	4.38	5.21
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB MID/2/16/2011 13:26:59 - 13:32:59										
C4	2.93	5:59	29.42	5	1:08	0.40	7.29	28.05	5.46	6.50
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB MID/2/16/2011 13:44:02 - 13:49:20										
C5	2.93	5:17	33.36	2	0:51	0.28	10.39	19.70	3.83	4.56
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB MID/2/16/2011 13:59:31 - 14:03:22										
C6	2.93	3:50	45.91	0	0:00	0.10	29.34	6.97	1.36	1.62
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB MID/2/16/2011 13:22:28 - 13:27:37										
C7	2.96	5:08	34.66	2	0:45	0.29	10.13	20.42	3.97	4.73
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB MID/2/16/2011 13:37:43 - 13:43:28										
C8	2.96	5:44	31.08	2	0:47	0.25	11.67	17.75	3.45	4.11
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB MID/2/16/2011 13:35:53 - 13:53:20										
C9	2.99	17:26	10.28	2	12:37	0.34	8.80	23.74	4.62	5.50

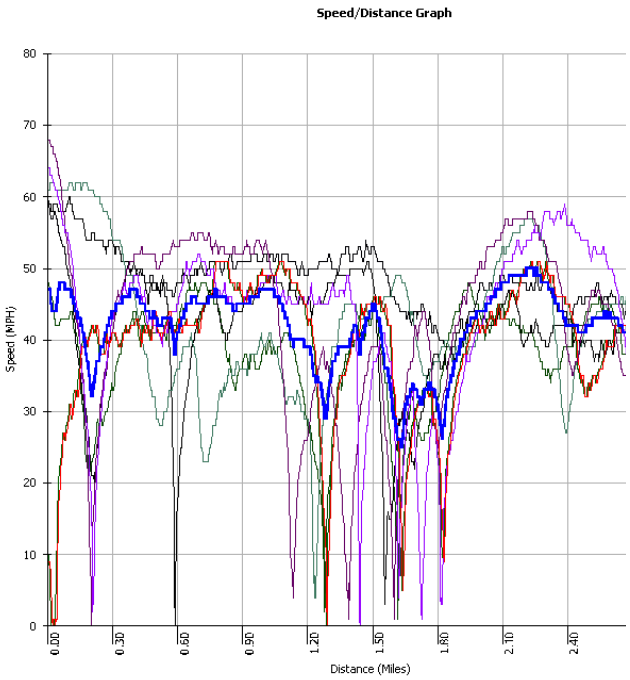
iTREC Report

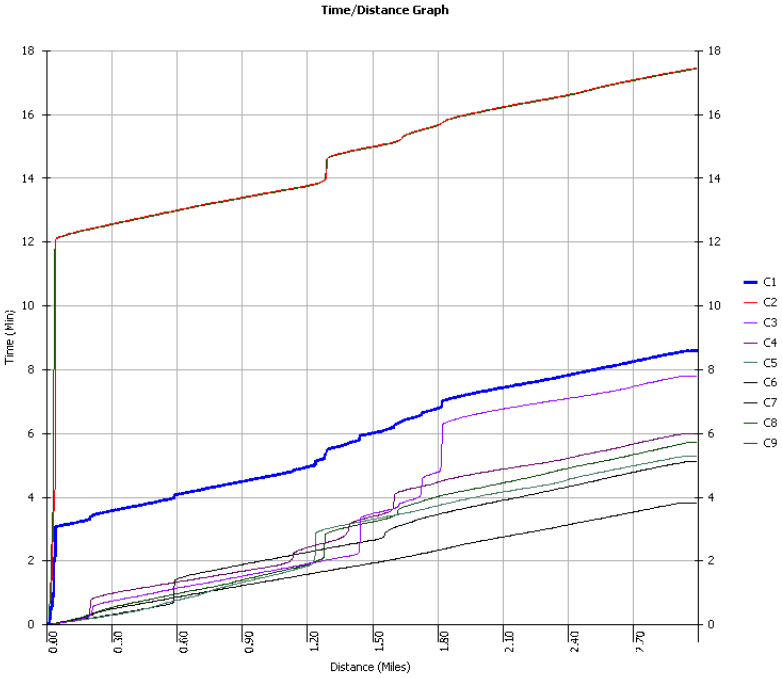
Print Date: Thursday, May 12, 2011

Print Time: 2:35:11 PM



Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)

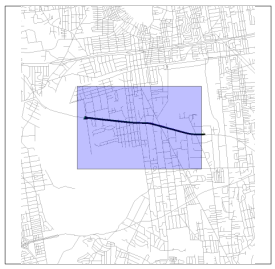




iTREC Report

Print Date: Thursday, May 12, 2011

Print Time: 2:20:07 PM

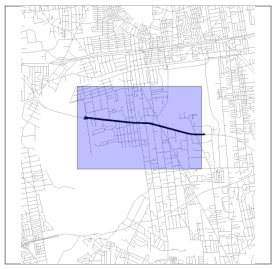


Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB MID										
C1	2.86	5:14	33.37	3	0:50	0.35	8.35	24.49	4.77	5.68
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB MID/2/16/2011 13:54:25 - 13:59:23										
C2	2.86	4:50	35.64	3	0:38	0.40	7.08	28.28	5.50	6.55
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB MID/2/16/2011 12:58:21 - 13:03:20										
C3	2.86	4:52	35.28	2	0:32	0.31	9.34	21.40	4.16	4.96
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB MID/2/16/2011 13:18:11 - 13:23:17										
C4	2.86	5:00	34.41	3	0:35	0.38	7.56	26.49	5.15	6.14
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB MID/2/16/2011 13:34:30 - 13:39:29										
C5	2.86	4:52	35.35	2	0:41	0.31	9.28	21.58	4.20	5.00
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB MID/2/16/2011 13:50:20 - 13:56:41										
C6	2.86	6:14	27.57	6	1:18	0.41	6.99	28.60	5.57	6.63
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB MID/2/16/2011 13:14:25 - 13:18:55										
C7	2.88	4:23	39.42	2	0:06	0.36	7.93	25.34	4.93	5.87
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB MID/2/16/2011 13:28:28 - 13:34:50										
C8	2.87	6:14	27.70	3	1:22	0.28	10.39	19.31	3.76	4.47
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB MID/2/16/2011 13:44:31 - 13:50:32										
C9	2.88	5:53	29.40	3	1:38	0.30	9.47	21.28	4.14	4.93
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB MID/2/16/2011 13:54:25 - 13:59:22										
C10	2.85	4:49	35.56	3	0:38	0.40	7.08	28.17	5.48	6.53

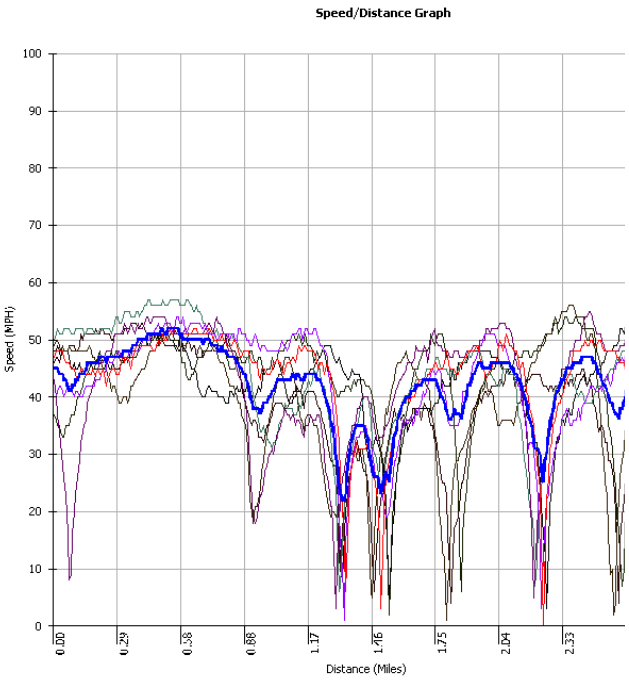
iTREC Report

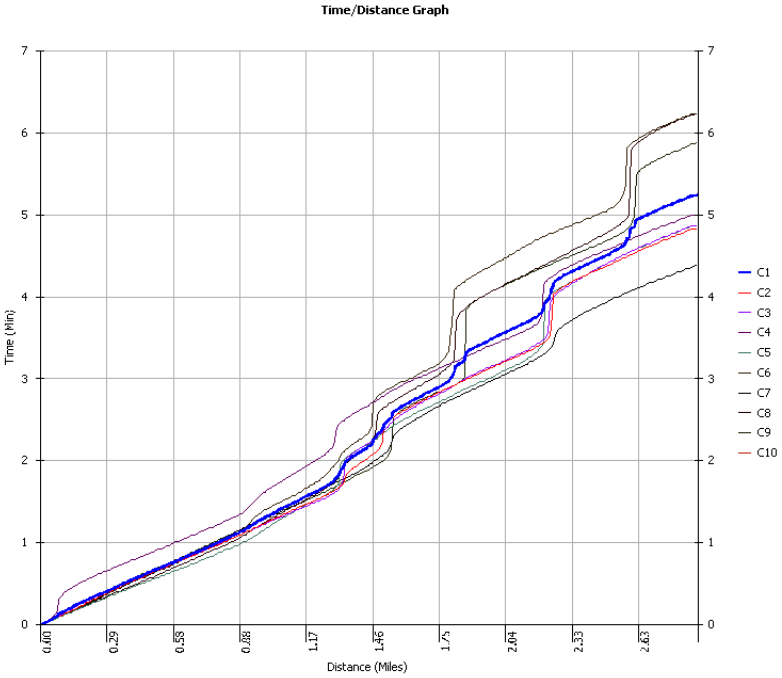
Print Date: Thursday, May 12, 2011

Print Time: 2:20:07 PM



Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)





iTREC Report

Print Date: Thursday, May 12, 2011

Print Time: 2:14:24 PM

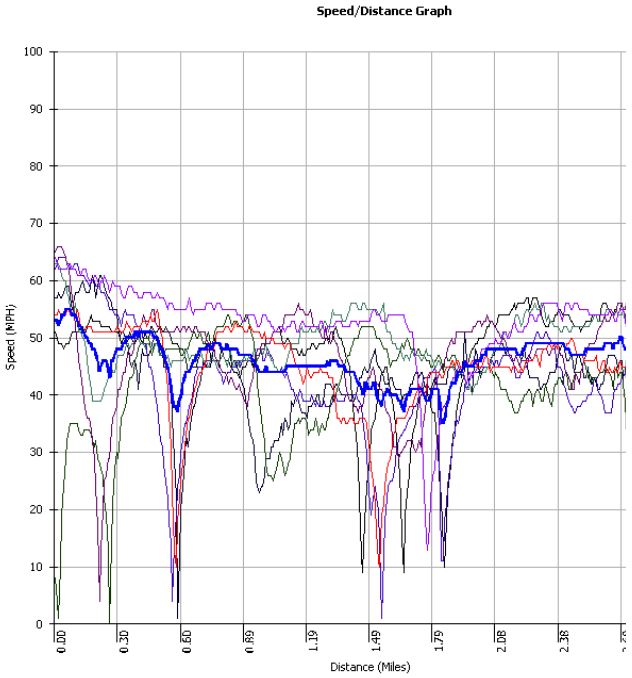
Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB OFF PK										
C1	2.96	4:48	38.48	2	0:44	0.24	15.49	16.78	3.26	3.89
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB OFF PK/2/16/2011 10:20:31 - 10:25:22										
C2	2.95	4:50	36.58	2	0:41	0.32	9.10	22.62	4.40	5.24
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB OFF PK/2/16/2011 10:35:40 - 10:39:09										
C3	2.94	3:28	50.91	0	0:00	0.10	29.92	6.87	1.34	1.59
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB OFF PK/2/16/2011 10:48:44 - 10:53:15										
C4	2.94	4:30	39.29	1	0:35	0.24	12.43	16.53	3.22	3.83
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB OFF PK/2/16/2011 11:01:36 - 11:05:12										
C5	2.94	3:35	49.28	0	0:00	0.10	29.80	6.89	1.34	1.60
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB OFF PK/2/16/2011 10:53:17 - 10:59:30										
C6	3.00	6:12	28.89	3	1:34	0.29	10.21	20.51	3.99	4.75
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB OFF PK/2/16/2011 10:29:05 - 10:35:05										
C7	2.97	5:59	29.90	2	1:22	0.25	11.93	17.40	3.39	4.03
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB OFF PK/2/16/2011 10:46:32 - 10:51:15										
C8	2.97	4:42	38.00	1	0:33	0.23	12.87	16.14	3.14	3.74
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB OFF PK/2/16/2011 11:01:43 - 11:06:51										
C9	2.98	5:07	35.02	3	1:04	0.39	7.64	27.28	5.31	6.32

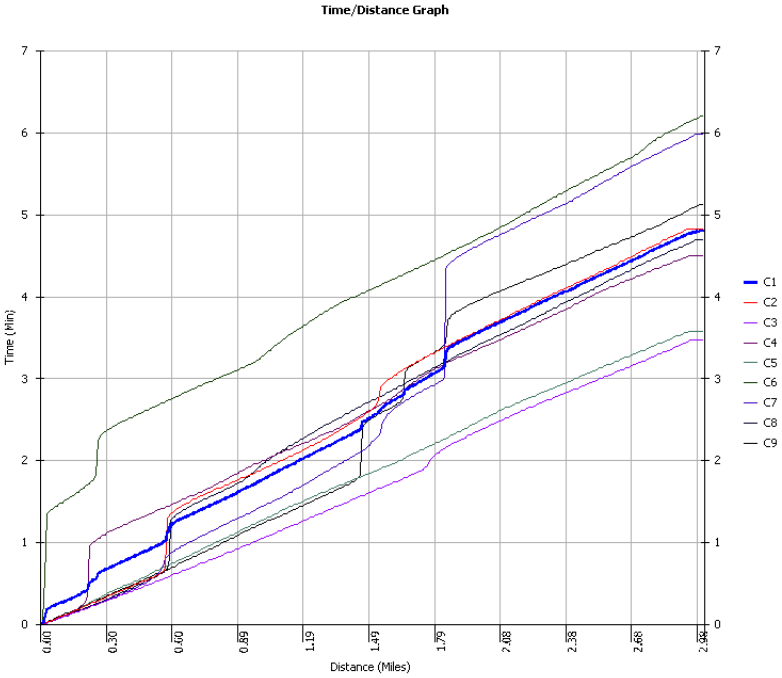
iTREC Report

Print Date: Thursday, May 12, 2011

Print Time: 2:14:24 PM

Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)



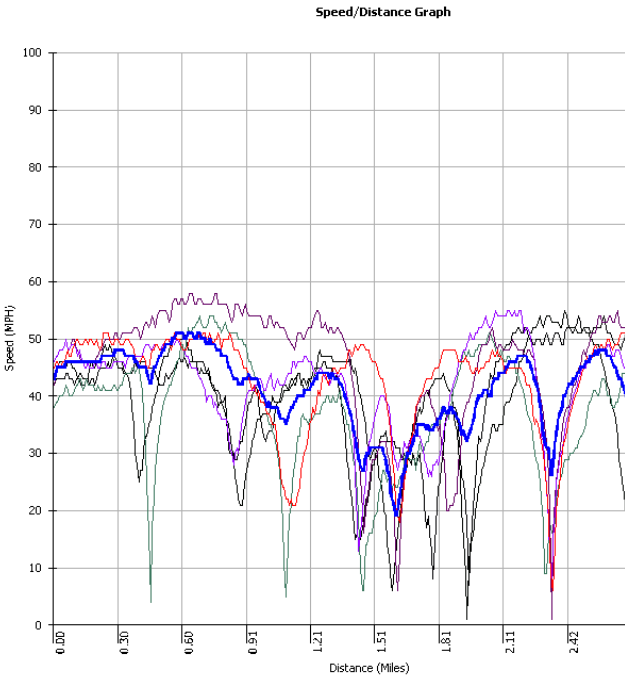


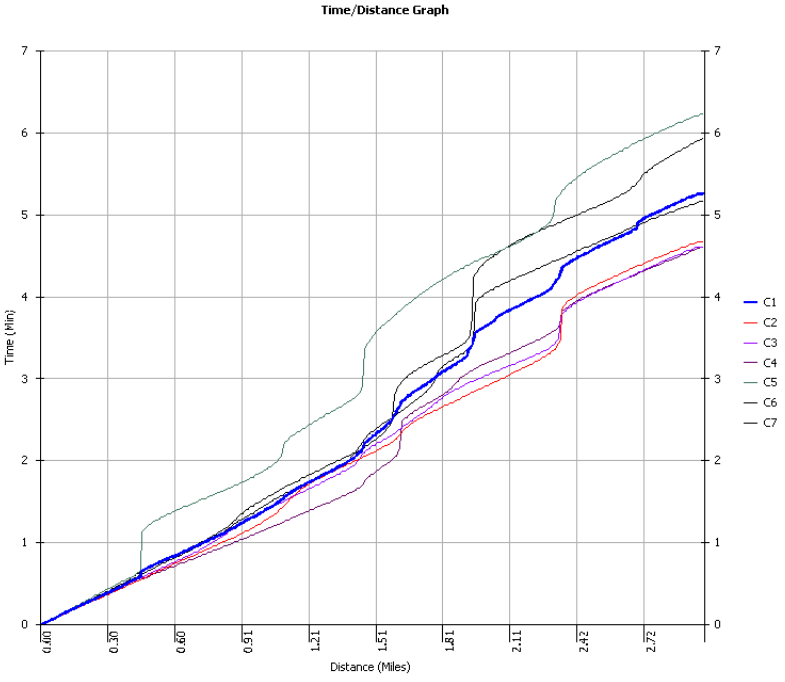
iTREC Report

Print Date: Thursday, May 12, 2011

Print Time: 2:04:45 PM

Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB OFF PK										
C1	2.96	5:15	34.30	2	0:34	0.29	10.66	20.24	3.94	4.69
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB OFF PK/2/16/2011 10:40:21 - 10:45:02										
C2	2.95	4:40	38.00	1	0:20	0.23	12.97	15.90	3.09	3.69
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB OFF PK/2/16/2011 10:54:19 - 10:58:56										
C3	2.95	4:36	38.50	1	0:13	0.23	12.92	15.97	3.11	3.70
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB OFF PK/2/16/2011 11:00:23 - 11:05:00										
C4	2.97	4:36	38.73	2	0:24	0.35	8.43	24.63	4.79	5.71
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB OFF PK/2/16/2011 10:19:04 - 10:25:19										
C5	2.97	6:14	28.65	4	1:00	0.33	8.89	23.34	4.54	5.41
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB OFF PK/2/16/2011 10:36:15 - 10:42:12										
C6	2.98	5:56	30.18	2	0:52	0.24	12.18	17.11	3.33	3.97
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB OFF PK/2/16/2011 10:54:14 - 10:59:25										
C7	2.97	5:10	34.55	2	0:27	0.29	10.31	20.13	3.92	4.67





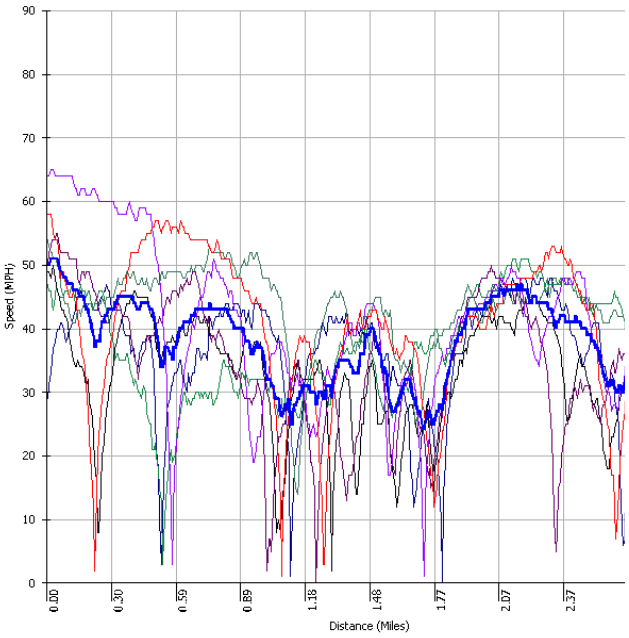
iTREC Report

Print Date: Friday, May 13, 2011

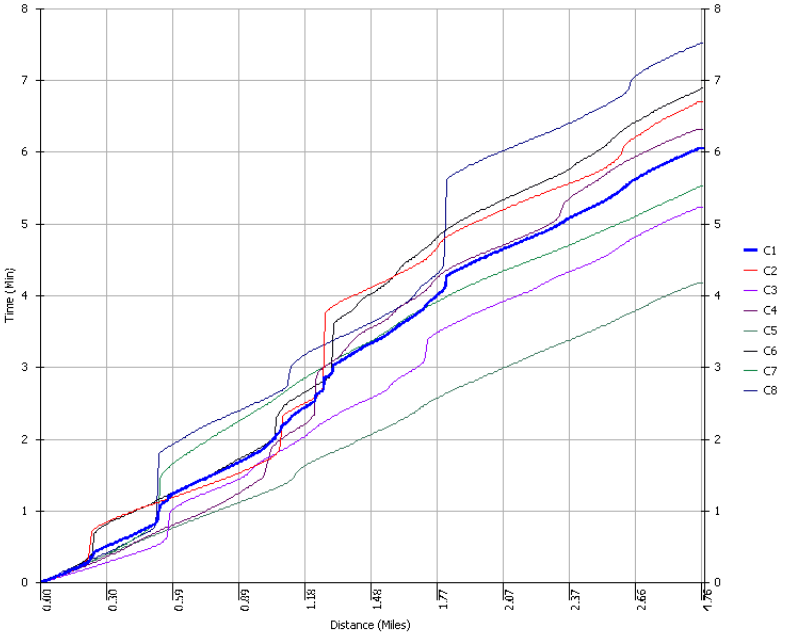
Print Time: 9:19:44 AM

Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB PM										
C1	2.95	6:03	30.26	2	0:57	0.23	14.32	16.04	3.12	3.72
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB PM/2/16/2011 17:09:34 - 17:16:17										
C2	2.94	6:42	26.40	3	1:42	0.27	11.09	18.53	3.61	4.29
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB PM/2/16/2011 17:29:13 - 17:34:28										
C3	2.94	5:14	33.82	2	0:30	0.28	10.44	19.69	3.83	4.56
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB PM/2/16/2011 17:43:52 - 17:50:12										
C4	2.93	6:19	27.89	3	0:38	0.27	11.00	18.64	3.63	4.32
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB PM/2/16/2011 17:59:32 - 18:03:44										
C5	2.95	4:11	42.24	0	0:00	0.10	28.54	7.21	1.40	1.67
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB PM/2/16/2011 17:11:52 - 17:18:47										
C6	2.97	6:54	25.85	3	1:04	0.25	11.82	17.56	3.42	4.07
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB PM/2/16/2011 17:33:29 - 17:39:02										
C7	2.95	5:32	32.01	1	0:30	0.19	15.30	13.49	2.62	3.13
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 EB PM/2/16/2011 17:35:37 - 17:43:09										
C8	2.95	7:31	23.56	3	2:12	0.25	12.04	17.13	3.33	3.97

Speed/Distance Graph



Time/Distance Graph



iTREC Report

Print Date: Friday, May 13, 2011

Print Time: 7:49:38 AM

Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB PM										
C1	2.95	5:45	31.32	3	1:09	0.30	10.01	20.68	4.02	4.79
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB PM/2/16/2011 16:59:20 - 17:05:10										
C2	2.93	5:49	30.27	3	1:19	0.31	9.44	21.72	4.23	5.03
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB PM/2/16/2011 17:17:30 - 17:22:37										
C3	2.94	5:06	34.59	2	0:49	0.30	9.83	20.90	4.07	4.84
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB PM/2/16/2011 17:35:32 - 17:41:06										
C4	2.94	5:33	31.83	3	0:49	0.33	9.00	22.83	4.44	5.29
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB PM/2/16/2011 17:51:06 - 17:56:34										
C5	2.93	5:27	32.29	2	0:53	0.27	10.93	18.72	3.64	4.34
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB PM/2/16/2011 16:59:31 - 17:07:18										
C6	2.96	7:46	22.87	4	3:07	0.28	10.72	19.32	3.76	4.48
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB PM/2/16/2011 17:24:09 - 17:30:07										
C7	2.96	5:57	29.85	3	0:57	0.30	9.93	20.82	4.05	4.82
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB PM/2/16/2011 17:40:00 - 17:45:30										
C8	2.96	5:29	32.37	2	0:42	0.27	11.07	18.68	3.64	4.33
sqlexpress:itrec/ROUTE 454 BEFORE/ROUTE 454 WB PM/2/16/2011 17:44:36 - 17:49:29										
C9	2.96	4:52	36.46	2	0:35	0.32	9.19	22.49	4.38	5.21

iTREC Report

Print Date: Friday, May 13, 2011

Print Time: 7:49:38 AM

Run	Length	Travel Time(m:s)	Average Speed	No. of Stop	Stopped Delay	Fuel Consumption (Gallons)	MPG	Emission CO(g)	Emission NOx(g)	Emission VOC(g)