

**Connecticut Department of Transportation
Bureau of Highway Operations
ITS Engineering and Support**

**Before and After Evaluation
of Computerized Traffic Signal System Timing Plans
for Route 15 Berlin, Connecticut
October 2014**



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Acronyms

ITS	Intelligent Transportation Systems
GPS	Global Positioning Systems
Department	Connecticut Department of Transportation
FHWA	Federal Highway Administration
MOE	Measures of Effectiveness
MPH	Miles per Hour
NTOC	National Transportation Operations Coalition
Timing Plans	Computerized Traffic Signal System Timing Plans

I. Summary

This study summarizes the results of the “Before and After” reevaluation of a closed loop computerized traffic signal system timing plans (timing plans) for Route 15 in the Town of Berlin, Connecticut. The last update to the Route 15 Berlin timing plans was in October 2002. The timing plan re-evaluation of the Route 15 arterial in Berlin reduced delay, travel time and number of stops and improved travel speed and corresponding fuel consumption and emissions reduction.

- **Reduced Delay** by 78%
- **Reduced Travel Time** by 9%
- **Reduced Stops** by 70%
- **Improved Speed** by 9%

This study parallels the concerns discussed in FHWA’s Connecticut Office **Program Review: Local Agency Traffic Signal Operations and Maintenance May 2012**. The Program Review reported the National Transportation Operations Coalition (NTOC) citing 2005 Management and Operations report card of D- and a grade of D in 2007. The NTOC National Report Card for traffic signal operations has since scored a grade of D+ for 2012. See link: <http://www.ite.org/reportcard/>

The significance of the FHWA’s Program Review and the national report card indicates that benefits could be realized if agencies dedicated efforts and the resources to achieve a higher score. According to FHWA’s Program Review:

- **Delay** would decrease by 15-20%
- **Travel Time** would reduce up to 25%
- **Emissions** would reduce up to 22%
- **Fuel Consumption** would reduce up to 10%
- **Benefit-cost ratio** up to 40:1

II. Description

The Bureau of Highway Operations ITS Engineering and Support Unit conducted a “Before” and “After” evaluation of Route 15 in Berlin to determine what benefits were achieved through the re-timing of the computerized signal system. The re-timing was limited to the program and coordination intervals. Adjustments were made to the pattern time and days as well as the cycle, splits and offsets. By conducting travel time and delay studies, traffic performance of the system was determined through measurements of effectiveness (MOE’s) in terms of delay, travel time, stops and speed was achieved.

Study Objectives:

Major objectives of the study were to:

- Improve the traffic flow on Route 15 in Berlin.
- Measure the system performance before and after system re-timing.
- Evaluate the MOE’s and the impact on traffic flow.
- Analyze the performance of system hardware, software, traffic signal detection and signal system timing.

III. Evaluation Procedure

Approach:

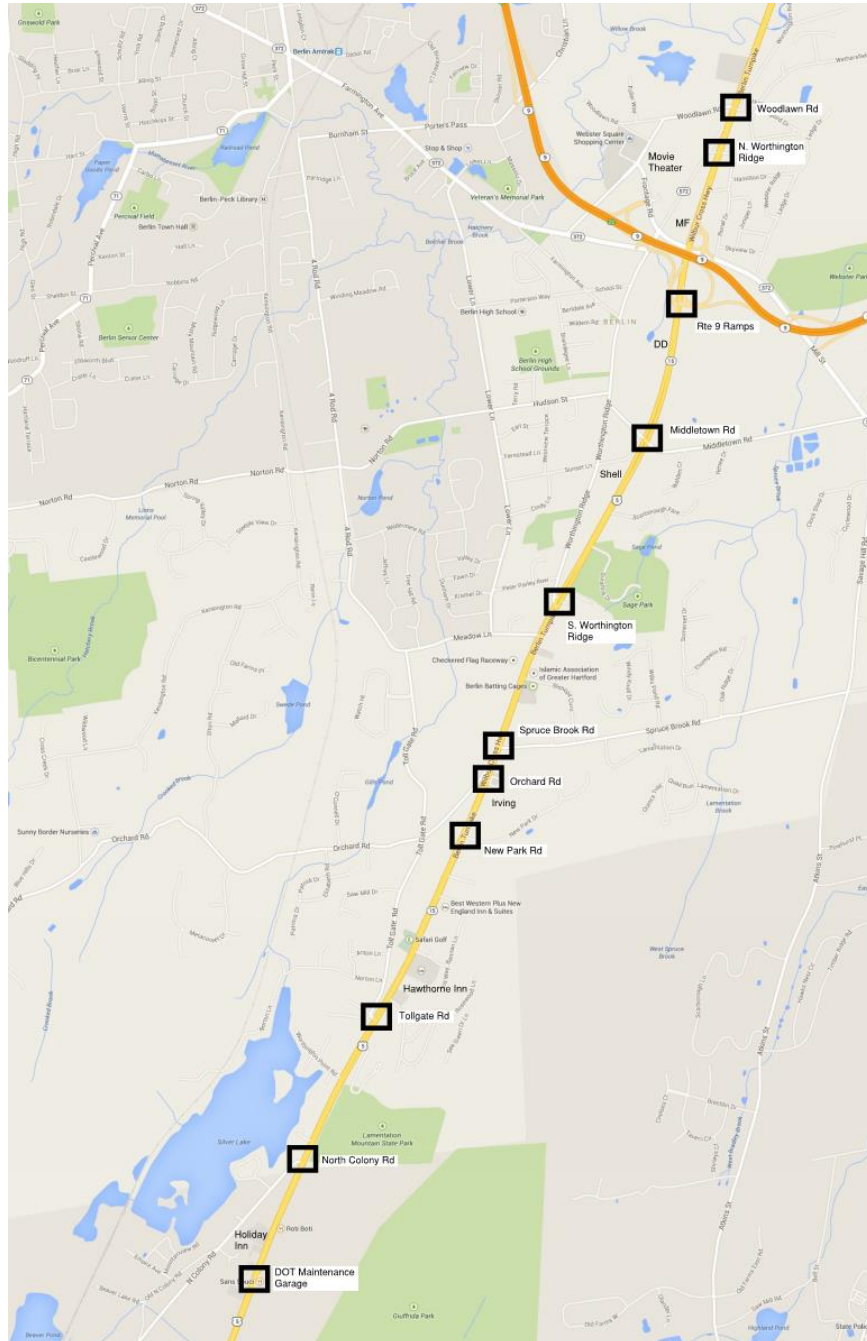
The data collection approach for system evaluation was developed to provide comparable statistics against that collected prior to the re-timing of the signal system. “Before” study and “After” study evaluations were accomplished using a hand held Global Positioning System tracking device (GPS). The systems engineer travelled through (runs) the system along with other vehicles (See Table 1 for travel time periods) and recorded delay, travel time, stops and speed. The engineer replicated the same number of runs for the same time periods for both the before and after re-evaluation.

Each traffic signal in the system was observed using the computerized traffic signal software for “split monitoring.” The split monitoring provides valuable information for phase split time usage with each cycle. The split monitoring allows the engineer to observe if too much, too little or the correct amount of split time is being provided. The phase split monitoring provides information if the traffic signal detectors are properly operating. At low volume time periods, the phase splits should at some time during the observation period not use all of the phase split time. If the split monitoring recorded 100% phase split utilization for the entire observation, the systems engineer would call the Traffic Signal Lab for repair before the travel time runs were to be initiated.

Data Collection:

The systems engineer reviewed the existing traffic signal system layout, timing plans, traffic signal plans and the computerized signal system database for consistency. (See Figure 1 for study map.) Speed limits and intersection geometry were reviewed for each signalized intersection. Volume data from the computerized signal system detectors were retrieved and analyzed to determine if pattern schedule and cycle length adjustments were required.

Figure 1: Before and After Study Map for Route 15 Berlin



Travel Time and Delay Data Recording:

In-vehicle travel time and delay studies were conducted to evaluate the efficiency of the arterial and determine where the most congested areas are located. Each run determined the amount of time taken to travel the system. A by-product of the “Before” data accumulation is the systems engineer’s observation of traffic patterns and progression that will assist in re-timing of the phase split intervals and progression offsets.

Three (3) runs for each morning, midday and evening peak hour travel time were taken in each direction for both the “Before” and “After” periods. The systems engineer had the responsibility of maintaining a speed representative of the posted speed limit and that of traffic flow. (See Table 2 for Route 15 study limits)

Table 1 Before and After Study Periods

Route/Town(s)	Before	After
15 Berlin/Meriden	9/30/14 – 10/1/14	10/14/14 – 10/15/14

Table 2 Route 15 Study Limits

Route/Town(s)	Terminus		Travel Direction	No. of Signals	Mileage
	Start	End			
15 Berlin/Meriden	Woodlawn Rd.	Old DOT Garage	North/South	11	4.55

The driver uses a hand held Global Positioning System tracking device. The device was turned on as the drive entered the arterial and accumulated the location of the driver as the drive traversed the arterial. The device saved the data in the device. The driver turned off the device and returned to the Department office to download the recorded data to the computer. (See Appendix 1) The driver analyzed the data and copied the data into spreadsheets. (See Figure 2) Each spread sheet was average by period and direction. (See Table 3)

Figure 2: Example of Run Summary Report

Run Summary of: Route 15
 From: Woodlawn Rd
 To: DOT Maintenance Garage
 Date of Run: 9/30/2014
 Time of Run 11:57:02
 Direction: South

Link	Cross St. at end of the link	Link Length, ft	Delay Time, sec	Number of Stops	Travel Time, sec	Average Speed, mph
	Woodlawn Rd	-	-	-	-	-
1	North Worthington Ridge	911	0	0	15	37.3
2	Route 9 Ramps	2980	0	0	41	49.5
3	Middletown Rd	2648	0	0	36	50.4
4	South Worthington Ridge	3567	0	0	49	49.3
5	Spruce Brook Rd	2913	0	0	41	48.9
6	Orchard Rd	684	0	0	9	47.9
7	New Park Dr	1133	0	0	17	48.4
8	Tollgate Rd	3841	0	0	54	47.3
9	North Colony Rd	3065	26	1	74	29.8
10	DOT Maintenance Garage	2299	0	0	34	43.6
Summary		24041	26 (0:26)	1	370 (6:10)	45.24

Table 3: Measures of Effectiveness Summaries

Direction	Time Period	Average Travel Time, min			Average Speed, mph		
		Before	After	% Change	Before	After	% Change
Southbound	AM Peak	6.38	6.45	+1	42	42	0
	Midday	6.17	5.85	-5	45	47	+4
	PM Peak	6.97	5.83	-16	40	47	+18
	Average	6.51	6.04	-7	42	45	+7
Northbound	AM Peak	6.98	6.28	-10	39	43	+10
	Midday	6.05	5.67	-6	45	48	+7
	PM Peak	7.03	5.92	-16	39	46	+18
	Average	6.69	5.96	-11	41	46	+12

Total	6.60	6.00	-9	42	46	+9
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Direction	Time Period	Average Number of Stops			Average Delay Time, sec		
		Before	After	% Change	Before	After	% Change
Southbound	AM Peak	1	1	0	23	15	-35
	Midday	1	1	0	22	11	-50
	PM Peak	2	0.33	-84	28	1	-96
	Average	1.33	0.78	-42	24	9	-63
Northbound	AM Peak	2	0.67	-67	40	6	-85
	Midday	1	0.33	-67	10	2	-80
	PM Peak	4	0	-100	38	0	-100
	Average	2.33	0.33	-86	29	3	-91

Total	1.83	0.56	-70	27	6	-78
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IV. Analysis

The “Before and After” Study for Route 15 in Berlin revealed that the efficiency of the corridor traffic improved considerably.

Travel time and speed are two (2) key performance indicators used to measure traffic signal system efficiency. The overall travel time was reduced by 9% while increasing the overall speed 9%. The number of stops and delay were reduced by 70% and 78% respectively. However, the measures show the average number of stops from approximately two (2) stops to less than one (1) and the delay from 27 seconds to 6 seconds. The reduction in stops and delay typically lead to a reduction in the number of rear end and side swipe same direction crashes.¹ The travel in both directions improved with smoother, safer and more efficient operation with the changes to the timing plans.

The determining factors in improving timing plans and traffic flow can be attributed to the following:

- Increasing the cycle length to provide a wider green band allowing more vehicles to pass through the signalized intersections each cycle.
- The fine tuning of phase splits by tracking the computerized signal system real time split monitoring tool.
- The fine tuning of offsets by analyzing the travel time runs and comparing the data with the time space diagrams.
- Monitoring the systems hardware and reporting malfunctions for repair.

Fuel and emissions decrease or increase is considered a corresponding by-product of the changes in the travel MOE’s. Specific determinations for the fuel and emissions MOE’s are not part of this study.

V. Conclusions

It is clear that periodic evaluation of the computerized traffic signal systems timing plans provide significant and immediate results. The motorists’ are able to save fuel and time resulting in by-products such as reduced emissions, safer roads and improving the economy.

The computerized traffic signal system provides the tools required by the systems engineer to implement numerous traffic control strategies and to evaluate their effectiveness in terms of traffic performance and hardware reliability. Having this flexibility places the Department in an advantageous position to efficiently make traffic flow improvements with minimal expenditure.

¹ Before and After Evaluation of Computerized Urban Traffic Control Systems, CTDOT, July 1990

Appendix A: Route 15 Berlin/Meriden Revised Computerized Signal System Timing Plans

NAZTEC TIME-SPACE DIAGRAM COVER SHEET																			
ROUTE:	15	HOURS OF OPERATION: 0630-0900										CYCLE:	1	LENGTH:	90 "				
SECTION:	15	DAY(S) OF OPERATION: MON - FRI										SPLIT:							
PROJ #:		TOWN(S): BERLIN / MERIDEN										OFFSET:	1						
INT #	ADD #		PHASES (sec-%)										OFFSET		DIST (ft)				
			φ1	φ2	φ3	φ4	φ5	φ6	φ7	φ8	(sec-%)	(ft)							
079-211	803	DOT MAINTENANCE GARAGE	20	22%	41	46%	14	16%	15	17%	20	22%	41	46%	80	89%	0		
007-201	804	NORTH COLONY ROAD	15	17%	53	59%			22	24%	15	17%	53	59%	21	23%	2325		
007-202	805	TOLLGATE ROAD	15	17%	60	67%			15	17%	15	17%	60	67%	62	69%	3060		
007-215	806	NEW PARK ROAD			50	56%			15	17%	25	28%	50	56%	22	24%	3839		
007-203	807	ORCHARD ROAD	15	17%	60	67%			15	17%	15	17%	60	67%	42	47%	1148		
007-251	808	SPRUCE BROOK ROAD			60	67%			15	17%	15	17%	60	67%	53	59%	689		
007-204	809	S. WORTHINGTON RIDGE ROAD	20	22%	55	61%			15	17%	20	22%	55	61%	1	1%	2854		
007-205	810	MIDDLETOWN ROAD	15	17%	55	61%			20	22%	15	17%	55	61%	47	52%	3609		
007-239	811	RTE 9 SB RAMPS			50	56%	15	17%	25	28%					84	93%	2700		
007-206	812	N. WORTHINGTON RIDGE	15	17%	55	61%			20	22%	15	17%	55	61%	20	22%	44	49%	3000
007-207	813	WOODLAWN ROAD	15	17%	57	63%			18	20%	15	17%	57	63%	18	20%	56	62%	886

NAZTEC TIME-SPACE DIAGRAM COVER SHEET																			
ROUTE:	15	HOURS OF OPERATION: 0900-1500,1900-2000 / 0900-1800										CYCLE:	2	LENGTH:	85 "				
SECTION:	15	DAY(S) OF OPERATION: MON-FRI / SAT-SUN										SPLIT:							
PROJ #:		TOWN(S): BERLIN / MERIDEN										OFFSET:	1						
INT #	ADD #		PHASES (sec-%)										OFFSET		DIST (ft)				
			φ1	φ2	φ3	φ4	φ5	φ6	φ7	φ8	(sec-%)	(ft)							
079-211	803	DOT MAINTENANCE GARAGE	15	18%	41	48%	14	17%	15	18%	15	18%	41	48%	68	80%	0		
007-201	804	NORTH COLONY ROAD	15	18%	48	57%			22	26%	15	18%	48	57%	3	4%	2325		
007-202	805	TOLLGATE ROAD	18	21%	52	61%			15	18%	18	21%	52	61%	52	61%	3060		
007-215	806	NEW PARK ROAD			50	59%			15	18%	20	24%	50	59%	18	21%	3839		
007-203	807	ORCHARD ROAD	15	18%	55	65%			15	18%	15	18%	55	65%	48	57%	1148		
007-251	808	SPRUCE BROOK ROAD			52	61%			15	18%	18	21%	52	61%	48	57%	689		
007-204	809	S. WORTHINGTON RIDGE ROAD	22	26%	48	57%			15	18%	22	26%	48	57%	10	12%	2854		
007-205	810	MIDDLETOWN ROAD	15	18%	48	57%			22	26%	15	18%	48	57%	22	26%	48	57%	3609
007-239	811	RTE 9 SB RAMPS			45	53%	15	18%	25	29%					12	14%	2700		
007-206	812	N. WORTHINGTON RIDGE	20	24%	43	51%			22	26%	20	24%	43	51%	22	26%	57	67%	3000
007-207	813	WOODLAWN ROAD	20	24%	43	51%			22	26%	20	24%	43	51%	22	26%	57	67%	886

NAZTEC TIME-SPACE DIAGRAM COVER SHEET																			
ROUTE:	15	HOURS OF OPERATION: ALL OTHER TIMES										CYCLE:	4	LENGTH:	65 "				
SECTION:	15	DAY(S) OF OPERATION:										SPLIT:							
PROJ #:		TOWN(S): BERLIN / MERIDEN										OFFSET:	1						
INT #	ADD #		PHASES (sec-%)										OFFSET		DIST (ft)				
			φ1	φ2	φ3	φ4	φ5	φ6	φ7	φ8	(sec-%)	(ft)							
079-211	803	DOT MAINTENANCE GARAGE	14	22%	24	37%	14	22%	13	20%	14	22%	24	37%	14	22%	0		
007-201	804	NORTH COLONY ROAD	16	25%	29	45%			20	31%	16	25%	29	45%	39	60%	2325		
007-202	805	TOLLGATE ROAD	16	25%	34	52%			15	23%	16	25%	34	52%	15	23%	3060		
007-215	806	NEW PARK ROAD			33	51%			17	26%	15	23%	33	51%	60	92%	3839		
007-203	807	ORCHARD ROAD	16	25%	34	52%			15	23%	16	25%	34	52%	45	69%	1148		
007-251	808	SPRUCE BROOK ROAD			34	52%			15	23%	16	25%	34	52%	54	83%	689		
007-204	809	S. WORTHINGTON RIDGE ROAD	16	25%	33	51%			16	25%	14	22%	33	51%	2	3%	2854		
007-205	810	MIDDLETOWN ROAD	16	25%	29	45%			20	31%	16	25%	29	45%	18	28%	3609		
007-239	811	RTE 9 SB RAMPS			25	39%	15	23%	25	39%					49	75%	2700		
007-206	812	N. WORTHINGTON RIDGE	16	25%	29	45%			20	31%	16	25%	29	45%	20	31%	25	39%	3000
007-207	813	WOODLAWN ROAD	16	25%	27	42%			22	34%	16	25%	27	42%	22	34%	25	39%	886

NAZTEC TIME-SPACE DIAGRAM COVER SHEET

ROUTE:	15	HOURS OF OPERATION:	1500-1900	CYCLE:	5	LENGTH:	100 "
SECTION:	15	DAY(S) OF OPERATION:	MON - FRI	SPLIT:			
PROJ #:		TOWN(S):	BERLIN / MERIDEN	OFFSET:	1		

INT #	ADD #		PHASES (sec-%)								OFFSET (sec-%)	DIST (ft)								
			φ1	φ2	φ3	φ4	φ5	φ6	φ7	φ8										
079-211	803	DOT MAINTENANCE GARAGE	17	17%	52	52%	14	14%	17	17%	17	17%	52	52%			60	60%	0	
007-201	804	NORTH COLONY ROAD	17	17%	60	60%			23	23%	17	17%	60	60%			84	84%	2325	
007-202	805	TOLLGATE ROAD	15	15%	68	68%			17	17%	15	15%	68	68%			42	42%	3060	
007-215	806	NEW PARK ROAD			68	68%			15	15%	17	17%	58	58%			90	90%	3839	
007-203	807	ORCHARD ROAD	17	17%	66	66%			17	17%	17	17%	66	66%			86	86%	1148	
007-251	808	SPRUCE BROOK ROAD			65	65%			17	17%	18	18%	65	65%			86	86%	689	
007-204	809	S. WORTHINGTON RIDGE ROAD	19	19%	64	64%			17	17%	19	19%	64	64%			31	31%	2854	
007-205	810	MIDDLETOWN ROAD	15	15%	61	61%			24	24%	15	15%	61	61%			82	82%	3609	
007-239	811	RTE 9 SB RAMPS			58	58%	19	19%	23	23%							42	42%	2700	
007-206	812	N. WORTHINGTON RIDGE	15	15%	65	65%			20	20%	15	15%	65	65%		20	20%	0	0%	3000
007-207	813	WOODLAWN ROAD	15	15%	65	65%			20	20%	15	15%	65	65%		20	20%	0	0%	886

Appendix B

Run Summary of: Route 15
 From: Woodlawn Rd
 To: DOT Maintenance Garage
 Date of Run: 9/30/2014
 Time of Run 11:57:02
 Direction: South

Date	Time (local)	Latitude	Longitude	Altitude (feet)	Speed (mi/hr)	
9/30/2014	11:57:02	41.632765	-72.73774	104.99	22.8	Woodlawn Rd
9/30/2014	11:57:03	41.632765	-72.73774	104.99	22.8	
9/30/2014	11:57:04	41.632667	-72.737787	104.99	26.53	
9/30/2014	11:57:05	41.632557	-72.737838	104.99	30.01	
9/30/2014	11:57:06	41.632433	-72.737897	104.99	33.68	
9/30/2014	11:57:07	41.632295	-72.737958	108.27	36.1	
9/30/2014	11:57:08	41.63215	-72.738023	108.27	37.84	
9/30/2014	11:57:09	41.632002	-72.73809	108.27	38.46	
9/30/2014	11:57:10	41.631852	-72.738158	111.55	40.13	
9/30/2014	11:57:11	41.631693	-72.738228	114.83	41.2	
9/30/2014	11:57:12	41.631535	-72.738303	118.11	40.76	
9/30/2014	11:57:13	41.631375	-72.73838	118.11	41.45	
9/30/2014	11:57:14	41.631213	-72.738458	114.83	42.75	
9/30/2014	11:57:15	41.631043	-72.738533	118.11	43.86	
9/30/2014	11:57:16	41.63087	-72.73861	114.83	44.3	
9/30/2014	11:57:17	41.630698	-72.738688	118.11	45.61	
9/30/2014	11:57:17	41.630522	-72.738765	118.11	45.86	N. Worthington Ridge
9/30/2014	11:57:18	41.630522	-72.738765	118.11	45.86	
9/30/2014	11:57:19	41.630338	-72.738843	118.11	46.11	
9/30/2014	11:57:20	41.630157	-72.738922	118.11	47.22	
9/30/2014	11:57:21	41.629968	-72.739003	118.11	49.03	
9/30/2014	11:57:22	41.629775	-72.739085	114.83	49.4	
9/30/2014	11:57:23	41.629583	-72.73917	114.83	49.52	
9/30/2014	11:57:24	41.629393	-72.739255	114.83	49.45	
9/30/2014	11:57:25	41.629203	-72.73934	114.83	49.77	
9/30/2014	11:57:26	41.629012	-72.739432	118.11	50.08	
9/30/2014	11:57:27	41.628817	-72.739517	114.83	49.71	
9/30/2014	11:57:28	41.628628	-72.739607	114.83	49.45	
9/30/2014	11:57:29	41.628438	-72.739697	114.83	49.52	
9/30/2014	11:57:30	41.62825	-72.739785	111.55	49.52	
9/30/2014	11:57:31	41.62806	-72.739872	111.55	49.03	
9/30/2014	11:57:32	41.627873	-72.739957	108.27	48.52	

9/30/2014	11:57:33	41.627685	-72.74004	108.27	48.65	
9/30/2014	11:57:34	41.627498	-72.740122	104.99	49.21	
9/30/2014	11:57:35	41.627308	-72.740203	104.99	49.09	
9/30/2014	11:57:36	41.627117	-72.740285	104.99	49.71	
9/30/2014	11:57:37	41.626923	-72.740368	104.99	51.01	
9/30/2014	11:57:38	41.626728	-72.740452	101.71	50.95	
9/30/2014	11:57:39	41.626535	-72.740538	98.43	50.95	
9/30/2014	11:57:40	41.626343	-72.740627	95.14	51.01	
9/30/2014	11:57:41	41.626148	-72.740712	91.86	51.57	
9/30/2014	11:57:42	41.625953	-72.740792	88.58	50.64	
9/30/2014	11:57:43	41.625758	-72.740865	85.3	49.65	
9/30/2014	11:57:44	41.625563	-72.740937	82.02	50.64	
9/30/2014	11:57:45	41.625185	-72.741072	78.74	48.34	
9/30/2014	11:57:46	41.625185	-72.741072	78.74	48.34	
9/30/2014	11:57:47	41.624998	-72.74114	75.46	48.72	
9/30/2014	11:57:48	41.624818	-72.74121	75.46	47.47	
9/30/2014	11:57:49	41.624625	-72.74127	75.46	49.34	
9/30/2014	11:57:50	41.62442	-72.741318	72.18	51.7	
9/30/2014	11:57:51	41.624208	-72.74136	68.9	52.13	
9/30/2014	11:57:52	41.623998	-72.7414	65.62	51.45	
9/30/2014	11:57:53	41.623788	-72.74144	65.62	50.89	
9/30/2014	11:57:54	41.623587	-72.741477	62.34	50.95	
9/30/2014	11:57:55	41.623385	-72.741512	59.06	50.39	
9/30/2014	11:57:56	41.623185	-72.741547	59.06	49.9	
9/30/2014	11:57:57	41.622987	-72.741587	59.06	49.45	
9/30/2014	11:57:58	41.62279	-72.741623	62.34	49.59	
9/30/2014	11:57:58	41.622592	-72.741663	62.34	49.52	Rte 9 Ramps
9/30/2014	11:57:59	41.622592	-72.741663	62.34	49.52	
9/30/2014	11:58:00	41.622395	-72.741698	65.62	50.02	
9/30/2014	11:58:01	41.622195	-72.741737	65.62	50.89	
9/30/2014	11:58:02	41.621995	-72.741778	65.62	50.95	
9/30/2014	11:58:03	41.621787	-72.741818	62.34	51.95	
9/30/2014	11:58:04	41.621578	-72.741862	65.62	52.94	
9/30/2014	11:58:05	41.621367	-72.741905	65.62	53.56	
9/30/2014	11:58:06	41.621152	-72.741948	68.9	54.68	
9/30/2014	11:58:07	41.620933	-72.741992	68.9	55.3	
9/30/2014	11:58:08	41.620717	-72.742038	72.18	55.43	
9/30/2014	11:58:09	41.620497	-72.74208	72.18	55.55	
9/30/2014	11:58:10	41.620277	-72.742128	72.18	54.8	
9/30/2014	11:58:11	41.620057	-72.742175	72.18	54.25	
9/30/2014	11:58:12	41.61985	-72.74222	72.18	51.82	
9/30/2014	11:58:13	41.619647	-72.742263	72.18	50.58	
9/30/2014	11:58:14	41.619452	-72.742312	75.46	49.27	

9/30/2014	11:58:15	41.619258	-72.74236	75.46	48.65	
9/30/2014	11:58:16	41.61907	-72.742412	75.46	48.4	
9/30/2014	11:58:17	41.61888	-72.742467	78.74	48.34	
9/30/2014	11:58:18	41.618693	-72.742525	78.74	48.03	
9/30/2014	11:58:19	41.618505	-72.742583	78.74	47.72	
9/30/2014	11:58:20	41.61832	-72.742645	82.02	47.97	
9/30/2014	11:58:21	41.618133	-72.742708	82.02	47.66	
9/30/2014	11:58:22	41.617952	-72.742777	82.02	46.91	
9/30/2014	11:58:23	41.617768	-72.742848	85.3	47.22	
9/30/2014	11:58:24	41.6174	-72.743002	85.3	48.52	
9/30/2014	11:58:25	41.6174	-72.743002	85.3	48.52	
9/30/2014	11:58:26	41.617213	-72.743083	85.3	49.09	
9/30/2014	11:58:27	41.617027	-72.743167	85.3	49.27	
9/30/2014	11:58:28	41.616838	-72.743252	85.3	49.21	
9/30/2014	11:58:29	41.61665	-72.743338	88.58	49.65	
9/30/2014	11:58:30	41.616462	-72.74343	88.58	49.77	
9/30/2014	11:58:31	41.616272	-72.743522	91.86	50.27	
9/30/2014	11:58:32	41.616085	-72.743618	91.86	49.77	
9/30/2014	11:58:33	41.6159	-72.743717	91.86	49.83	
9/30/2014	11:58:34	41.615717	-72.743815	91.86	49.52	
9/30/2014	11:58:34	41.615535	-72.743915	95.14	49.09	Middletown Rd
9/30/2014	11:58:35	41.615535	-72.743915	95.14	49.09	
9/30/2014	11:58:36	41.615357	-72.74402	95.14	48.96	
9/30/2014	11:58:37	41.615177	-72.744125	95.14	48.78	
9/30/2014	11:58:38	41.614995	-72.744235	98.43	49.34	
9/30/2014	11:58:39	41.614633	-72.744468	98.43	49.4	
9/30/2014	11:58:40	41.614633	-72.744468	98.43	49.4	
9/30/2014	11:58:41	41.614455	-72.744587	101.71	49.27	
9/30/2014	11:58:42	41.614277	-72.744705	101.71	48.9	
9/30/2014	11:58:43	41.614098	-72.744822	101.71	49.14	
9/30/2014	11:58:44	41.613922	-72.744942	101.71	49.21	
9/30/2014	11:58:45	41.613743	-72.745062	104.99	49.96	
9/30/2014	11:58:46	41.613565	-72.745182	104.99	49.83	
9/30/2014	11:58:47	41.613383	-72.745303	108.27	50.33	
9/30/2014	11:58:48	41.613203	-72.745425	111.55	50.02	
9/30/2014	11:58:49	41.613025	-72.745547	114.83	49.14	
9/30/2014	11:58:50	41.61285	-72.745668	114.83	49.14	
9/30/2014	11:58:51	41.612675	-72.745792	118.11	49.14	
9/30/2014	11:58:52	41.6125	-72.745917	121.39	49.52	
9/30/2014	11:58:53	41.612323	-72.746045	121.39	49.83	
9/30/2014	11:58:54	41.612145	-72.746172	121.39	50.21	
9/30/2014	11:58:55	41.611788	-72.746425	124.67	49.9	
9/30/2014	11:58:56	41.611788	-72.746425	124.67	49.9	

9/30/2014	11:58:57	41.611612	-72.74655	124.67	49.96	
9/30/2014	11:58:58	41.611437	-72.746675	124.67	49.03	
9/30/2014	11:58:59	41.611262	-72.746803	127.95	49.27	
9/30/2014	11:59:00	41.611088	-72.746932	131.23	49.4	
9/30/2014	11:59:01	41.610917	-72.747063	134.51	48.96	
9/30/2014	11:59:02	41.610748	-72.747193	134.51	47.97	
9/30/2014	11:59:03	41.610415	-72.74745	131.23	47.9	
9/30/2014	11:59:04	41.610415	-72.74745	131.23	47.9	
9/30/2014	11:59:05	41.610245	-72.747578	134.51	48.47	
9/30/2014	11:59:06	41.610075	-72.747708	134.51	48.65	
9/30/2014	11:59:07	41.609902	-72.747837	137.8	49.52	
9/30/2014	11:59:08	41.609725	-72.747965	137.8	49.65	
9/30/2014	11:59:09	41.60955	-72.748092	137.8	48.59	
9/30/2014	11:59:10	41.609378	-72.748215	137.8	48.28	
9/30/2014	11:59:11	41.609205	-72.748338	137.8	48.65	
9/30/2014	11:59:12	41.60903	-72.748462	141.08	49.27	
9/30/2014	11:59:13	41.608853	-72.748588	141.08	49.59	
9/30/2014	11:59:14	41.608675	-72.748717	141.08	50.21	
9/30/2014	11:59:15	41.608497	-72.748847	141.08	50.27	
9/30/2014	11:59:16	41.608318	-72.748978	144.36	50.33	
9/30/2014	11:59:17	41.608142	-72.74911	144.36	49.71	
9/30/2014	11:59:18	41.607968	-72.74924	144.36	48.72	
9/30/2014	11:59:19	41.6078	-72.749373	144.36	48.72	
9/30/2014	11:59:20	41.607627	-72.749505	141.08	49.27	
9/30/2014	11:59:21	41.607452	-72.74964	141.08	49.14	
9/30/2014	11:59:22	41.607282	-72.749773	141.08	49.27	
9/30/2014	11:59:23	41.607107	-72.749905	141.08	49.34	
9/30/2014	11:59:23	41.606933	-72.750032	141.08	49.03	S. Worthington Ridge
9/30/2014	11:59:24	41.606933	-72.750032	141.08	49.03	
9/30/2014	11:59:25	41.606762	-72.750157	141.08	48.4	
9/30/2014	11:59:26	41.606592	-72.75028	137.8	47.72	
9/30/2014	11:59:27	41.606422	-72.750405	134.51	48.34	
9/30/2014	11:59:28	41.606252	-72.750528	134.51	48.59	
9/30/2014	11:59:29	41.606078	-72.750652	134.51	48.83	
9/30/2014	11:59:30	41.6059	-72.750773	137.8	49.34	
9/30/2014	11:59:31	41.605722	-72.750892	137.8	49.45	
9/30/2014	11:59:32	41.605538	-72.751007	137.8	49.83	
9/30/2014	11:59:33	41.605357	-72.751122	137.8	49.71	
9/30/2014	11:59:34	41.605177	-72.751238	137.8	49.96	
9/30/2014	11:59:35	41.604993	-72.751358	141.08	50.7	
9/30/2014	11:59:36	41.604813	-72.751477	141.08	49.71	
9/30/2014	11:59:37	41.604637	-72.751595	144.36	49.21	
9/30/2014	11:59:38	41.604457	-72.75171	144.36	49.52	

9/30/2014	11:59:39	41.604272	-72.75182	144.36	49.83	
9/30/2014	11:59:40	41.604087	-72.751927	144.36	49.59	
9/30/2014	11:59:41	41.6039	-72.752025	144.36	48.96	
9/30/2014	11:59:42	41.603717	-72.75212	144.36	48.65	
9/30/2014	11:59:43	41.603532	-72.752212	144.36	48.47	
9/30/2014	11:59:44	41.603343	-72.752295	147.64	48.28	
9/30/2014	11:59:45	41.603153	-72.752375	147.64	48.4	
9/30/2014	11:59:46	41.602968	-72.752455	150.92	48.28	
9/30/2014	11:59:47	41.602783	-72.752537	154.2	48.16	
9/30/2014	11:59:48	41.6026	-72.75262	154.2	48.16	
9/30/2014	11:59:49	41.602418	-72.752703	157.48	47.85	
9/30/2014	11:59:50	41.602053	-72.752875	157.48	48.47	
9/30/2014	11:59:51	41.602053	-72.752875	157.48	48.47	
9/30/2014	11:59:52	41.601868	-72.75296	157.48	47.59	
9/30/2014	11:59:53	41.601687	-72.753045	160.76	47.41	
9/30/2014	11:59:54	41.601505	-72.753132	160.76	48.4	
9/30/2014	11:59:55	41.601317	-72.753218	160.76	50.08	
9/30/2014	11:59:56	41.601123	-72.753305	164.04	51.39	
9/30/2014	11:59:57	41.60093	-72.753392	167.32	50.89	
9/30/2014	11:59:58	41.600737	-72.753478	170.6	50.77	
9/30/2014	11:59:59	41.600542	-72.753567	173.88	50.39	
9/30/2014	12:00:00	41.600355	-72.753653	177.17	49.09	
9/30/2014	12:00:01	41.600168	-72.753737	177.17	48.16	
9/30/2014	12:00:02	41.59998	-72.753817	177.17	48.21	
9/30/2014	12:00:03	41.599798	-72.753895	177.17	47.04	
9/30/2014	12:00:04	41.599618	-72.753977	180.45	47.22	
9/30/2014	12:00:04	41.599442	-72.754058	180.45	46.91	Spruce Brook Rd
9/30/2014	12:00:05	41.599442	-72.754058	180.45	46.91	
9/30/2014	12:00:06	41.599268	-72.754145	180.45	46.42	
9/30/2014	12:00:07	41.599098	-72.754238	183.73	46.23	
9/30/2014	12:00:08	41.598923	-72.754327	183.73	46.79	
9/30/2014	12:00:09	41.598752	-72.754415	187.01	47.16	
9/30/2014	12:00:10	41.598575	-72.754505	187.01	48.16	
9/30/2014	12:00:11	41.598393	-72.754598	187.01	48.83	
9/30/2014	12:00:12	41.598212	-72.754695	187.01	49.09	
9/30/2014	12:00:13	41.598027	-72.754792	183.73	50.02	
9/30/2014	12:00:13	41.597837	-72.75489	183.73	50.58	Orchard Rd
9/30/2014	12:00:14	41.597837	-72.75489	183.73	50.58	
9/30/2014	12:00:15	41.597648	-72.754987	180.45	50.58	
9/30/2014	12:00:16	41.59746	-72.755085	177.17	50.52	
9/30/2014	12:00:17	41.59727	-72.755185	177.17	50.64	
9/30/2014	12:00:18	41.59708	-72.755282	173.88	50.58	
9/30/2014	12:00:19	41.596885	-72.755375	173.88	50.64	

9/30/2014	12:00:20	41.5967	-72.75547	170.6	49.83	
9/30/2014	12:00:21	41.596517	-72.75557	167.32	48.96	
9/30/2014	12:00:22	41.596337	-72.755675	164.04	48.28	
9/30/2014	12:00:23	41.596158	-72.755777	160.76	47.47	
9/30/2014	12:00:24	41.595985	-72.755878	160.76	46.97	
9/30/2014	12:00:25	41.595813	-72.755977	157.48	46.54	
9/30/2014	12:00:26	41.595642	-72.756077	154.2	46.11	
9/30/2014	12:00:27	41.595472	-72.756175	150.92	46.11	
9/30/2014	12:00:28	41.5953	-72.756272	147.64	46.23	
9/30/2014	12:00:29	41.59513	-72.756367	144.36	45.98	
9/30/2014	12:00:30	41.594962	-72.75647	144.36	46.29	
9/30/2014	12:00:30	41.59479	-72.756572	141.08	46.73	New Park Dr
9/30/2014	12:00:31	41.59479	-72.756572	141.08	46.73	
9/30/2014	12:00:32	41.594618	-72.756678	137.8	47.72	
9/30/2014	12:00:33	41.594445	-72.756785	134.51	48.21	
9/30/2014	12:00:34	41.594268	-72.756892	134.51	48.52	
9/30/2014	12:00:35	41.594088	-72.756997	134.51	48.4	
9/30/2014	12:00:36	41.593915	-72.757103	134.51	46.97	
9/30/2014	12:00:37	41.593745	-72.75721	137.8	46.48	
9/30/2014	12:00:38	41.593572	-72.757303	141.08	46.11	
9/30/2014	12:00:39	41.593403	-72.757403	141.08	45.17	
9/30/2014	12:00:40	41.59324	-72.757505	137.8	44.48	
9/30/2014	12:00:41	41.593077	-72.757607	141.08	44.86	
9/30/2014	12:00:42	41.592912	-72.757705	141.08	45.36	
9/30/2014	12:00:43	41.592743	-72.757805	141.08	45.98	
9/30/2014	12:00:44	41.592568	-72.757905	144.36	46.54	
9/30/2014	12:00:45	41.592397	-72.758003	144.36	46.73	
9/30/2014	12:00:46	41.592223	-72.758103	147.64	46.79	
9/30/2014	12:00:47	41.592048	-72.758205	150.92	47.28	
9/30/2014	12:00:48	41.591872	-72.758308	154.2	47.22	
9/30/2014	12:00:49	41.5917	-72.75841	157.48	46.42	
9/30/2014	12:00:50	41.591527	-72.75851	160.76	46.04	
9/30/2014	12:00:51	41.59136	-72.758612	167.32	46.04	
9/30/2014	12:00:52	41.591192	-72.758717	167.32	46.35	
9/30/2014	12:00:53	41.591022	-72.758822	170.6	46.91	
9/30/2014	12:00:54	41.590843	-72.758923	173.88	48.28	
9/30/2014	12:00:55	41.590663	-72.759025	177.17	48.83	
9/30/2014	12:00:56	41.59048	-72.759125	180.45	48.52	
9/30/2014	12:00:57	41.590303	-72.759225	183.73	47.35	
9/30/2014	12:00:58	41.590132	-72.759323	187.01	45.42	
9/30/2014	12:00:59	41.589965	-72.75942	190.29	44.93	
9/30/2014	12:01:00	41.589797	-72.759517	190.29	45.24	
9/30/2014	12:01:01	41.58963	-72.759613	193.57	45.61	

9/30/2014	12:01:02	41.589458	-72.759712	193.57	46.11	
9/30/2014	12:01:03	41.589288	-72.759812	196.85	46.23	
9/30/2014	12:01:04	41.58912	-72.75991	196.85	46.04	
9/30/2014	12:01:05	41.58895	-72.760013	196.85	46.6	
9/30/2014	12:01:06	41.588777	-72.76012	200.13	47.47	
9/30/2014	12:01:07	41.588605	-72.76023	200.13	47.47	
9/30/2014	12:01:08	41.588432	-72.760338	203.41	47.53	
9/30/2014	12:01:09	41.58826	-72.760445	203.41	47.1	
9/30/2014	12:01:10	41.58809	-72.760557	203.41	46.85	
9/30/2014	12:01:11	41.58792	-72.760677	206.69	47.85	
9/30/2014	12:01:12	41.58775	-72.760802	209.97	48.21	
9/30/2014	12:01:13	41.58758	-72.760925	209.97	47.47	
9/30/2014	12:01:14	41.587413	-72.761047	209.97	47.53	
9/30/2014	12:01:15	41.587243	-72.76117	209.97	48.03	
9/30/2014	12:01:16	41.587075	-72.761295	209.97	47.78	
9/30/2014	12:01:17	41.586908	-72.76142	209.97	47.41	
9/30/2014	12:01:18	41.586743	-72.761545	206.69	46.73	
9/30/2014	12:01:19	41.586577	-72.761665	206.69	47.35	
9/30/2014	12:01:20	41.586408	-72.761783	203.41	47.35	
9/30/2014	12:01:21	41.586233	-72.761902	203.41	49.65	
9/30/2014	12:01:22	41.586048	-72.762027	200.13	52.01	
9/30/2014	12:01:23	41.585862	-72.762158	196.85	53.38	
9/30/2014	12:01:24	41.585672	-72.762297	196.85	53.25	
9/30/2014	12:01:24	41.585487	-72.762438	193.57	52.75	Tollgate Rd
9/30/2014	12:01:25	41.585487	-72.762438	193.57	52.75	
9/30/2014	12:01:26	41.585302	-72.762578	190.29	52.69	
9/30/2014	12:01:27	41.585117	-72.762722	187.01	52.75	
9/30/2014	12:01:28	41.58493	-72.762862	183.73	53.13	
9/30/2014	12:01:29	41.584745	-72.763002	180.45	53.31	
9/30/2014	12:01:30	41.584373	-72.763275	173.88	52.2	
9/30/2014	12:01:31	41.584373	-72.763275	173.88	52.2	
9/30/2014	12:01:32	41.58419	-72.763407	173.88	52.01	
9/30/2014	12:01:33	41.584007	-72.763537	170.6	51.2	
9/30/2014	12:01:34	41.583827	-72.763662	170.6	50.77	
9/30/2014	12:01:35	41.583648	-72.76379	167.32	50.83	
9/30/2014	12:01:36	41.583472	-72.763925	164.04	50.77	
9/30/2014	12:01:37	41.583298	-72.764062	160.76	50.27	
9/30/2014	12:01:38	41.582963	-72.764338	167.32	49.14	
9/30/2014	12:01:39	41.582963	-72.764338	167.32	49.14	
9/30/2014	12:01:40	41.582793	-72.764468	167.32	48.52	
9/30/2014	12:01:41	41.582623	-72.7646	167.32	48.65	
9/30/2014	12:01:42	41.58245	-72.76473	164.04	49.52	
9/30/2014	12:01:43	41.582275	-72.764862	164.04	50.33	

9/30/2014	12:01:44	41.582098	-72.764993	164.04	50.08
9/30/2014	12:01:45	41.581927	-72.76513	164.04	50.52
9/30/2014	12:01:46	41.581745	-72.765265	160.76	52.38
9/30/2014	12:01:47	41.581558	-72.765402	157.48	52.94
9/30/2014	12:01:48	41.581373	-72.765533	154.2	52.44
9/30/2014	12:01:49	41.58119	-72.765655	150.92	50.89
9/30/2014	12:01:50	41.581012	-72.765775	150.92	50.7
9/30/2014	12:01:51	41.58083	-72.765893	154.2	51.39
9/30/2014	12:01:52	41.580645	-72.766013	150.92	50.95
9/30/2014	12:01:53	41.580463	-72.766137	150.92	50.89
9/30/2014	12:01:54	41.580278	-72.766255	154.2	51.01
9/30/2014	12:01:55	41.580093	-72.76637	157.48	50.7
9/30/2014	12:01:56	41.579912	-72.766482	157.48	49.77
9/30/2014	12:01:57	41.579733	-72.766587	160.76	48.83
9/30/2014	12:01:58	41.579562	-72.766693	170.6	47.72
9/30/2014	12:01:59	41.579392	-72.766797	177.17	47.9
9/30/2014	12:02:00	41.579222	-72.766903	177.17	46.23
9/30/2014	12:02:01	41.57906	-72.767013	180.45	46.29
9/30/2014	12:02:02	41.578898	-72.767122	177.17	45.42
9/30/2014	12:02:03	41.578733	-72.767227	177.17	45.24
9/30/2014	12:02:04	41.578577	-72.767327	180.45	42.81
9/30/2014	12:02:05	41.578432	-72.767418	187.01	37.53
9/30/2014	12:02:06	41.578303	-72.767493	190.29	33.06
9/30/2014	12:02:07	41.578193	-72.76756	190.29	27.96
9/30/2014	12:02:08	41.578105	-72.767613	190.29	22.74
9/30/2014	12:02:09	41.578037	-72.767657	193.57	17.15
9/30/2014	12:02:10	41.57799	-72.767688	193.57	11.87
9/30/2014	12:02:11	41.577958	-72.767705	196.85	7.02
9/30/2014	12:02:12	41.577943	-72.767712	200.13	2.24
9/30/2014	12:02:13	41.57794	-72.76771	200.13	0.12
9/30/2014	12:02:14	41.577943	-72.767707	203.41	0.25
9/30/2014	12:02:15	41.577945	-72.767703	203.41	0.19
9/30/2014	12:02:16	41.577947	-72.7677	206.69	0.12
9/30/2014	12:02:17	41.577947	-72.767697	206.69	0.06
9/30/2014	12:02:18	41.577943	-72.767692	206.69	0.12
9/30/2014	12:02:19	41.577943	-72.767692	206.69	0.12
9/30/2014	12:02:20	41.577943	-72.767687	203.41	0.5
9/30/2014	12:02:21	41.57794	-72.767682	203.41	0.43
9/30/2014	12:02:22	41.57794	-72.767678	203.41	0.19
9/30/2014	12:02:23	41.57794	-72.767675	203.41	0.37
9/30/2014	12:02:24	41.577943	-72.767672	203.41	0.06
9/30/2014	12:02:25	41.577943	-72.76767	203.41	0.19
9/30/2014	12:02:26	41.577945	-72.76767	206.69	0.06

9/30/2014	12:02:27	41.577947	-72.767668	206.69	0.12	
9/30/2014	12:02:28	41.577948	-72.767668	206.69	0.37	
9/30/2014	12:02:29	41.57795	-72.767668	206.69	0.12	
9/30/2014	12:02:30	41.57795	-72.767667	209.97	0.31	
9/30/2014	12:02:31	41.57795	-72.767667	209.97	0.19	
9/30/2014	12:02:32	41.57795	-72.767667	209.97	0.25	
9/30/2014	12:02:33	41.57795	-72.767667	213.25	0.81	
9/30/2014	12:02:34	41.577952	-72.767665	216.54	0.68	
9/30/2014	12:02:35	41.577953	-72.767663	216.54	0.25	
9/30/2014	12:02:36	41.577952	-72.767665	213.25	1.3	
9/30/2014	12:02:37	41.577937	-72.767673	213.25	6.65	
9/30/2014	12:02:38	41.5779	-72.7677	216.54	12.3	
9/30/2014	12:02:38	41.57784	-72.767735	216.54	18.08	North Colony Rd
9/30/2014	12:02:39	41.57784	-72.767735	216.54	18.08	
9/30/2014	12:02:40	41.57776	-72.76778	216.54	22.12	
9/30/2014	12:02:41	41.577667	-72.767835	216.54	27.71	
9/30/2014	12:02:42	41.577552	-72.7679	216.54	32.31	
9/30/2014	12:02:43	41.577422	-72.767977	219.82	36.23	
9/30/2014	12:02:44	41.577278	-72.768057	223.1	39.27	
9/30/2014	12:02:45	41.57713	-72.768145	229.66	41.13	
9/30/2014	12:02:46	41.576973	-72.768235	232.94	42.5	
9/30/2014	12:02:47	41.576812	-72.76833	232.94	43.81	
9/30/2014	12:02:48	41.576643	-72.768428	232.94	44.74	
9/30/2014	12:02:49	41.576477	-72.768532	232.94	45.48	
9/30/2014	12:02:50	41.576305	-72.768637	229.66	46.04	
9/30/2014	12:02:51	41.576133	-72.768748	232.94	47.1	
9/30/2014	12:02:52	41.575953	-72.768858	232.94	48.21	
9/30/2014	12:02:53	41.575767	-72.768963	229.66	48.9	
9/30/2014	12:02:54	41.575585	-72.769068	226.38	48.21	
9/30/2014	12:02:55	41.575405	-72.769175	226.38	48.52	
9/30/2014	12:02:56	41.575217	-72.769277	219.82	49.03	
9/30/2014	12:02:57	41.574838	-72.769482	206.69	48.96	
9/30/2014	12:02:58	41.574838	-72.769482	206.69	48.96	
9/30/2014	12:02:59	41.57465	-72.769583	203.41	49.14	
9/30/2014	12:03:00	41.574468	-72.769687	203.41	48.03	
9/30/2014	12:03:01	41.574287	-72.769788	206.69	48.09	
9/30/2014	12:03:02	41.574108	-72.769888	206.69	47.59	
9/30/2014	12:03:03	41.573923	-72.769983	203.41	47.97	
9/30/2014	12:03:04	41.573742	-72.770078	203.41	47.97	
9/30/2014	12:03:05	41.57338	-72.77027	206.69	47.85	
9/30/2014	12:03:06	41.57338	-72.77027	206.69	47.85	
9/30/2014	12:03:07	41.573197	-72.770367	206.69	48.09	
9/30/2014	12:03:08	41.573012	-72.77046	209.97	48.4	

9/30/2014	12:03:09	41.572825	-72.770552	209.97	48.4	
9/30/2014	12:03:10	41.572642	-72.770642	209.97	48.59	
9/30/2014	12:03:11	41.572452	-72.77073	213.25	49.52	
9/30/2014	12:03:12	41.572267	-72.770822	216.54	48.83	
9/30/2014	12:03:12	41.572085	-72.770917	216.54	48.9	DOT Maintenance Garage