Final Report

New Jersey Traffic Signal Retiming Initiative

Whitehorse-Mercerville Road (CR 533)
Mercer County, New Jersey

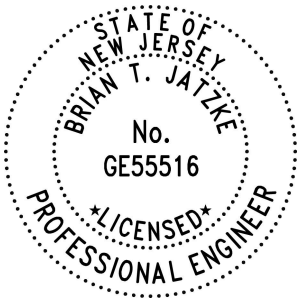
Prepared for:
Delaware Valley Regional Planning Commission (DVRPC)

and

Mercer County, NJ

Prepared by:

May 2024



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EXECUTIVE SUMMARY

Iteris, Inc. was contracted by the Delaware Valley Regional Planning Commission (DVRPC) to provide engineering services for the full retiming of 16 intersections in Mercer County, New Jersey on Whitehorse-Mercerville Road (CR 533), Nottingham Way (NJ Route 33/CR 653) and Kuser Road (CR 619). These signals are all located within Hamilton Township, New Jersey and eleven of the included signals are owned by Mercer County, four are owned by the New Jersey Department of Transportation and one is owned and maintained by Hamilton Township. Imperial Traffic & Data Collection was a subconsultant on this project and was responsible for data collection.

Following the NJ Signal Retiming Regional Corridor Prioritization task completed in 2022, this signal system was identified as a high priority corridor for Mercer County. The priority analysis utilized a scoring system developed to rank signal systems throughout the region utilizing a number of volume, equity and system characteristic variables as well as input from each DVRPC New Jersey County. The goal of the retiming initiative is to optimize signal timings along critical corridors given current conditions and utilizing existing equipment, with a focus on optimizing signal operations at the study intersections while considering all users of the system. This system was selected for analysis because it has a high number of signals, high signal density, and experienced significant delays during the peak periods under existing conditions. Both roadways on this system, Whitehorse-Mercerville Road (CR 533) and Nottingham Way (CR 653) are significant commuter corridors that have high vehicle volumes during peak periods. Also, the five-leg intersection of Quakerbridge Road/Whitehorse-Mercerville Road (CR 533) & Nottingham Way (CR 653)/Edinburg Road (CR 535) is a major intersection that experienced significant queueing and delays during peak periods, so this retiming analysis was done to potentially alleviate some of the congestion issues.

Project Vision

- **Goal:** Optimize traffic operations and timings throughout the system utilizing existing equipment.
- **Goal**: Improve air quality through decreased motor vehicle emissions and fuel consumption.
- **Goal**: Improve reliability and predictability of travel along arterials.
- **Goal**: Improve the safety of motorists, pedestrians, and bicyclists.
- **Goal**: Identify equipment issues, report them to the maintaining agency and recommend improvements.

According to the available documentation, the majority of the signals on this network had not been retimed in at least the past ten years. Also, most signals were not operating as shown on the existing conditions timing directives. The Mercer County owned signals all operate a consistent controller type, which is a Naztec 2070 (76.x firmware) and all have some level of ethernet/fiber connectivity. Throughout the completion of this project, most signals were connected and had a consistent time source but ideally, these signals will eventually all be moved to a platform, such as Streetwise, ATMS.now or a field master, which would ensure a consistent clock source would be regularly updating the controllers on this network.

The goal of this project was to evaluate signal timing needs given current conditions and existing equipment throughout the network and to reduce traffic signal delay and stops to help improve system performance. This corridor was selected since it is a major corridor to the region and had not been timed recently, so a retiming analysis would yield significant results in reducing delay, stops and travel times while also bringing clearance intervals up to date and improving pedestrian safety.

Project Accomplishments

As part of this project, the Iteris team developed and fully implemented seven unique time-of-day patterns through the network. The following are the patterns that were developed and analyzed for this project:

Pattern Number	Time-of-Day	Abbreviation For Figures
1	AM Peak	AM
2	Midday Peak	MD
3	PM Peak	PM
4	PM Off-peak	PO
5	Weekend AM Peak	WA
6	Weekend Midday Peak	WM
7	Weekend PM Peak	WP

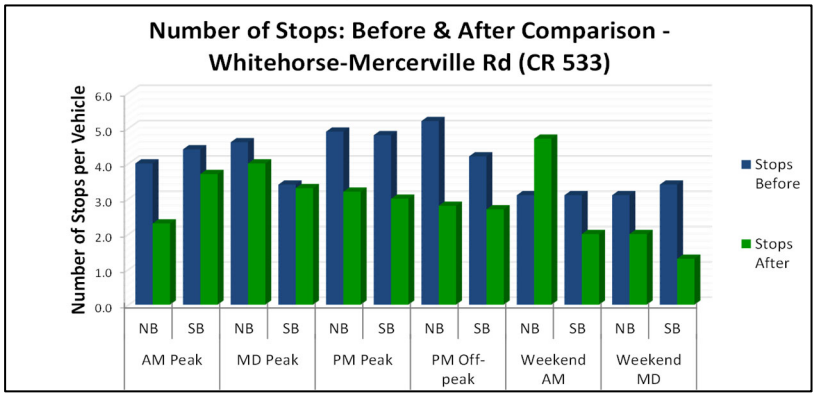
Through the completion of this project, all clearance intervals for both vehicle and pedestrian movements were brought up to standard utilizing the NJDOT methodology for vehicles and the Manual on Uniform Traffic Control (MUTCD) for pedestrian clearance intervals. Pedestrian crosswalks, grades and clearance measurements were all manually measured for these calculations and all issues were documented and reported to Mercer County. Pedestrians have a significant impact on this corridor and there are several elementary schools in close proximity to the corridor and one middle school on Whitehorse Hamilton Square Road. Accurately programming the pedestrian clearance times will improve safety throughout the network and ensure each movement has sufficient crossing time.

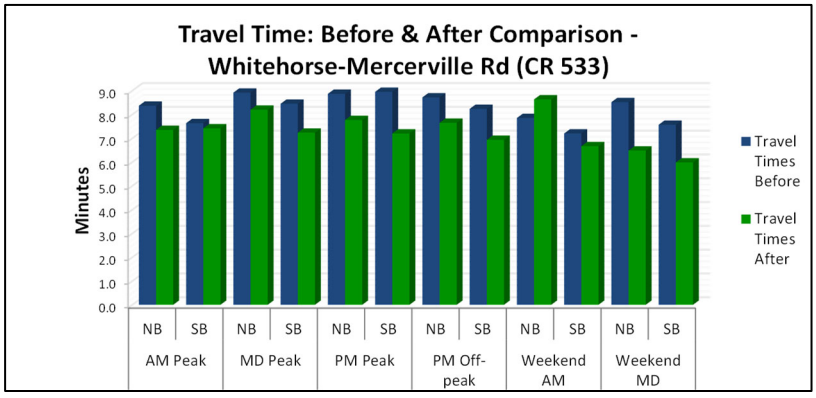
One of the traffic signals on this network was running in free operation at the start of this project and most of the controller clocks differed from GPS time. Free operation means the signal considers its own inputs and controller programming only while servicing the various movements throughout the day and there is no coordination between that signal and those to either direction. Signal timing coordination requires a consistent time for each signal along a network, so when controller clocks do not match, the benefits of effective coordination are either lost or diminished. So under existing conditions, there was inefficient operations and travel times through this network, which led to added delays and stops. At the conclusion of this project, the signals were programmed to run in logical subsystems with consistent coordinated cycle lengths for both weekday and weekend operations and each signal is accurately programmed with all necessary safety functions properly programmed. During the project, controller clocks were regularly set to GPS time and were noted to hold time relatively well, significantly improving travel times and reducing delay. At the request of Mercer County, CR 533 & Justice Samuel Alito Jr Way was timed with a slower pedestrian walking speed, so provided an increase in pedestrian clearance.

Traffic Operations Analysis Summary

Field measured travel time runs were conducted on Whitehorse-Mercerville Rd (CR 533) between South Clinton Avenue and Nottingham Way (CR 653)/Edinburg Road (CR 535). In the northbound direction, weekday travel times decreased by up to 66 seconds (12.4%) and weekend travel times decreased by up to 122 seconds (23.9%). In the southbound direction, weekday travel times decreased by up to 105 seconds (19.6%) and weekend travel times decreased by up to 95 seconds (20.9%).

Tru-Traffic Before and After Analysis – Whitehorse-Mercerville Road (CR 533)

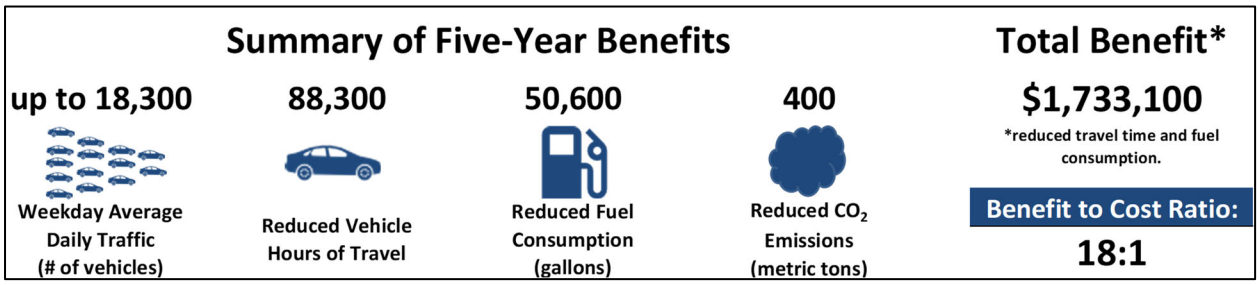




Before and After Analysis – Whitehorse-Mercerville Rd (CR 533)

Though there are many benefits to signal retiming projects, two general benefit types were focused on in this report to quantify the improvements experienced through this project. The first is user benefits, which are enjoyed directly by travelers and are determined by a reduction in travel time costs and operating costs. Crash costs are generally improved through signal retiming projects but require a comparison of crash data over at least three years, so could be considered and measured in the future. These cost measures are explained in more detail in the body of this report, but travel time and number of stops comparisons were measured using Synchro and operating costs are estimated using a combination of vehicle occupancy, heavy vehicle percentages, the average cost of fuel within the region according to the US Energy Information Administration (EIA) and the current Consumer Price Index. The second type of benefit used in this report is non-user benefits, which include environmental impacts, air quality, and reduced motorist frustration. The emissions estimate shown is calculated using an equation provided by the US Environmental Protection Agency (EPA).

The various values and assumed benefit lifetime utilized are all conservative, so actual improvements are likely much higher than estimated in this report. The figure below summarizes the numerous benefits measured for this project.



Recommendations for Safety Improvements

Safety, operational and capacity related recommendations are provided and analyzed in the body of this report. The potential high impact recommendations are summarized below to highlight areas where there could be significant benefit in making certain improvements to this traffic network.

General Recommendations

- Consider fixing broken vehicle detection and pedestrian pushbuttons throughout the network. Several instances of failed detection were noted during field inspections and most were addressed over the course of this project but several still remain. Proper functioning vehicle detection will allow the implemented timings to provide the greatest benefit to the system.
- Consider installing GPS units to each Mercer County owned cabinet or pursuing getting all of the signals communicating on an ATMS platform, such as Streetwise or ATMS.now, which are compatible with the Naztec 2070 controllers on this network. Under current conditions, some signals are staying on GPS time but others are drifting over time since there is not consistent communications throughout the network. The goal would be to maintain consistent controller time throughout the network so all timings and offsets would be referencing a consistent source. An ATMS network would download a server of GPS time sync every few hours, ensuring all are consistent when communication is working. In the meantime, it is recommended to develop a regular routine of setting controller clocks as often as possible. Existing controller clocks were noted in this project to maintain time well generally but over time, the clocks will slowly drift apart, and the coordinated timings will gradually lose effectiveness until clocks are set consistently again. More information on the communication status is provided in the body of the report.
- As this system continues to develop in the future, consider the impact to the signal timings for activities such as replacing controllers, upgrading equipment, new developments, or any roadway adjustments.

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1.0 INTRODUCTION

1.1 Purpose

Iteris, Inc. was contracted by the Delaware Valley Regional Planning Commission (DVRPC) to provide engineering services for the retiming of 16 intersections in Mercer County, NJ on Whitehorse-Mercerville Road (CR 533), Nottingham Way (NJ Route 33/CR 653) and Kuser Road (CR 619). These signals are all located within Hamilton Township, New Jersey and eleven are owned by Mercer County, four are owned by NJDOT and one owned by Hamilton Township. The goal of the project was to optimize signal timings given current conditions and utilizing existing equipment, with a focus on optimizing signal operations at the study intersections while considering all users of the system.

The tasks involved in this analysis were:

- Collected existing geometric, volume, and traffic signal timing data and existing timing directives.
- Conducted field visits to develop understanding of intersection and corridor issues.
- Conducted travel time runs to benchmark existing conditions.
- Updated and developed existing traffic operations models to benchmark existing capacity analysis.
- Updated basic timing parameters for both vehicle and pedestrian movements.
- Developed seven unique timing patterns for weekday and weekend operations.
- Modified day plan schedules and implemented new signal timing plans.
- Performed post-implementation observation and fine-tuning of timing and conducted travel time runs.
- Developed implemented operations models to compare and measure improvements.
- Updated timing directives to reflect new timings and placed final copy in each traffic cabinet.
- Documented all work performed and summarized findings in this technical report.
- Updated project website to include all deliverables and project material.

1.2 Traffic Signal Locations

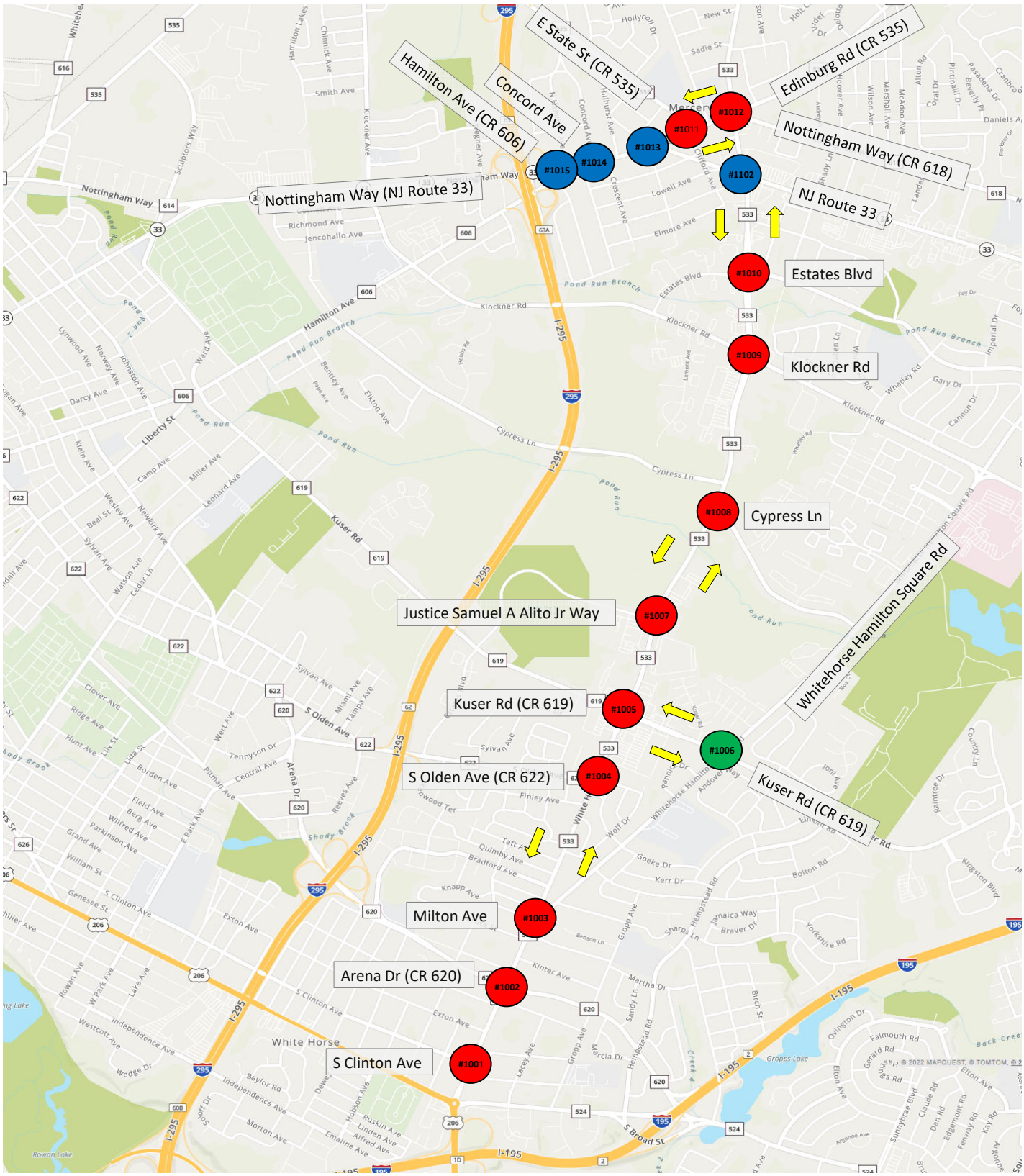
The traffic signals included in this project are:

No.	Intersection
1	Whitehorse-Mercerville Rd (CR 533) & Nottingham Way (CR 653)/Edinburg Rd (CR 535)
2	Whitehorse-Mercerville Rd (CR 533) & NJ Route 33 *(NJDOT)*
3	Whitehorse-Mercerville Rd (CR 533) & Estates Blvd
4	Whitehorse-Mercerville Rd (CR 533) & Klockner Rd
5	Whitehorse-Mercerville Rd (CR 533) & Cypress Ln
6	Whitehorse-Mercerville Rd (CR 533) & Justice Samuel A Alito Jr Way
7	Whitehorse Ave (CR 533) & Kuser Rd (CR 619)
8	Whitehorse Ave (CR 533) & S Olden Ave (CR 622)
9	Whitehorse Ave (CR 533) & Milton Ave/Whitehorse Hamilton Sq Rd
10	Whitehorse Ave (CR 533) & Arena Dr (CR 620)
11	Whitehorse Ave (CR 533) & Clinton Ave
12	Kuser Rd (CR 619) & Whitehorse Hamilton Square Rd
13	Nottingham Way (CR 652) & East State St (CR 535)
14	Nottingham Way (CR 652) & NJ Route 33/Winslow Ave *(NJDOT)*
15	Nottingham Way (CR 652) & Concord Ave *(NJDOT)*
16	Nottingham Way (CR 652) & Hamilton Ave (CR 606) *(NJDOT)*

Note that throughout this report, Whitehorse-Mercerville Rd (CR 533) is considered north-south in directionality and Nottingham Way (NJ Route 33/CR 653) is considered east-west. The models, timing sheets and timing directives developed for this project will also reflect this assumption consistently.

Whitehorse-Mercerville Rd (CR 533) is a two-lane undivided roadway that spans approximately 3.4 miles within the limits of this project. The posted speed limit for both directions is 45 mph between S Olden Ave (CR 622) and Estates Blvd, otherwise it is 35 mph. There are several elementary schools near the corridor and one middle school on Whitehorse Hamilton Sq Rd that contribute to morning and afternoon spikes in traffic. Nottingham Way (NJ Route 33/CR 653) is a four-lane undivided roadway with a 35-mph posted speed limit throughout that spans approximately 0.6 miles within the limits of this network.

Figure 1 on page 2 illustrates the locations of the signals included in this report.



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Mercer County Study Intersection:

Hamilton Township Intersection:

NJDOT Maintained Study Intersection:

7-day, 24-hr Count Location (Directional): Whitehorse-Mercerville Rd (CR 533)

Figure 1

Traffic Signal Locations

2.0 DATA COLLECTION

2.1 7-Day, 24-Hour Volumes

7-day, 24-hour segment counts were conducted by Imperial Traffic & Data Collection (ITDC) during June of 2023 with public schools in full session. Counts were collected at three locations on Whitehorse-Mercerville Rd (CR 533), one location on Kuser Rd (619), and one location on Nottingham Way (NJ Route 33/CR 653), and these counts were collected to illustrate the various traffic patterns that occur during a typical day and week on the various roadways at the count locations.

The Average Daily Traffic (ADT) volume on Whitehorse-Mercerville Rd (CR 533) from the locations counted was as high as 13,600 on weekdays and 9,900 on weekends. The ADT volume Kuser Rd (CR 619) was as high as 16,300 on weekdays and 12,000 on weekends. The ADT volume on Nottingham Way (CR 652) was as high as 18,300 on weekdays and 14,500 on weekends.

Figure 2 through Figure 5 on pages 5 – 8 illustrate the average weekday, Saturday and daily hourly volume data for the counts collected for this project.

2.2 Turning Movement Counts

Turning movement counts (TMCs) were collected by ITDC at all 16 locations throughout the project limits.

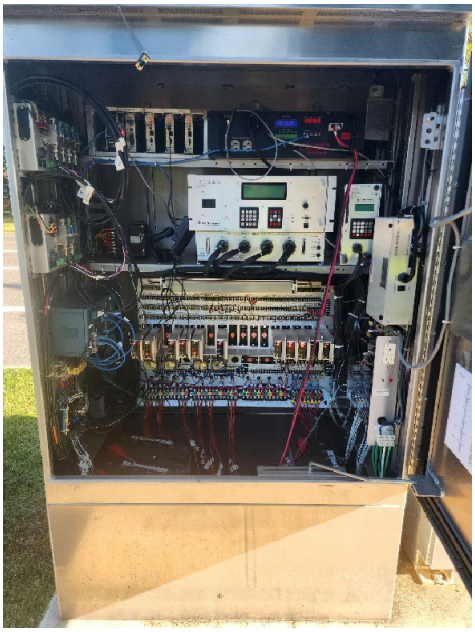
TMCs for all signals in the network were collected from 7:00 am – 9:00 am, 12:00 pm – 2:00 pm, 3:00 pm – 6:00 pm, and 6:30 pm – 7:30 pm on weekdays, and from 8:30 am – 10:30 am, 11:30 am – 4:30 pm, and 6:00 pm – 7:00 pm on weekends. So eight (8) hours of data were processed for both weekday and weekend operations.

These volumes were then increased by a growth factor to account for fluctuations in daily traffic volumes and to factor in some future volume growth. TMC diagrams illustrating hourly volumes for each developed timing pattern can be found on Figure 16 through Figure 47 on pages 32 – 63. Raw TMC data can be found on the project website.

2.3 Traffic Signal Timing and Phasing Data

There were two traffic controller types on this corridor, Econolite and Naztec. Existing data files were uploaded directly from each local controller. The Naztec controller databases were uploaded using StreetSync on Iteris computers and the Econolite controllers were uploaded utilizing Aries. In both cases, the databases were directly uploaded from the local controllers, ensuring we had accurate controller timings for existing conditions.

2.4 Field Notes



Field notes were collected by Iteris, Inc. staff during September 2023 at each intersection on various signal and traffic characteristics to assist in model development and signal optimization. The field notes contain information on various intersections, signal, and traffic characteristics. Diagrams within the field notes contain lane geometry at the stop bar, measured lane storage lengths, number of signal heads, and cabinet locations. Posted speed limits, left turn types (protected only, protected/permissive, or permissive only), turn restrictions, and the presence of roadway lighting and signal back plates were noted.

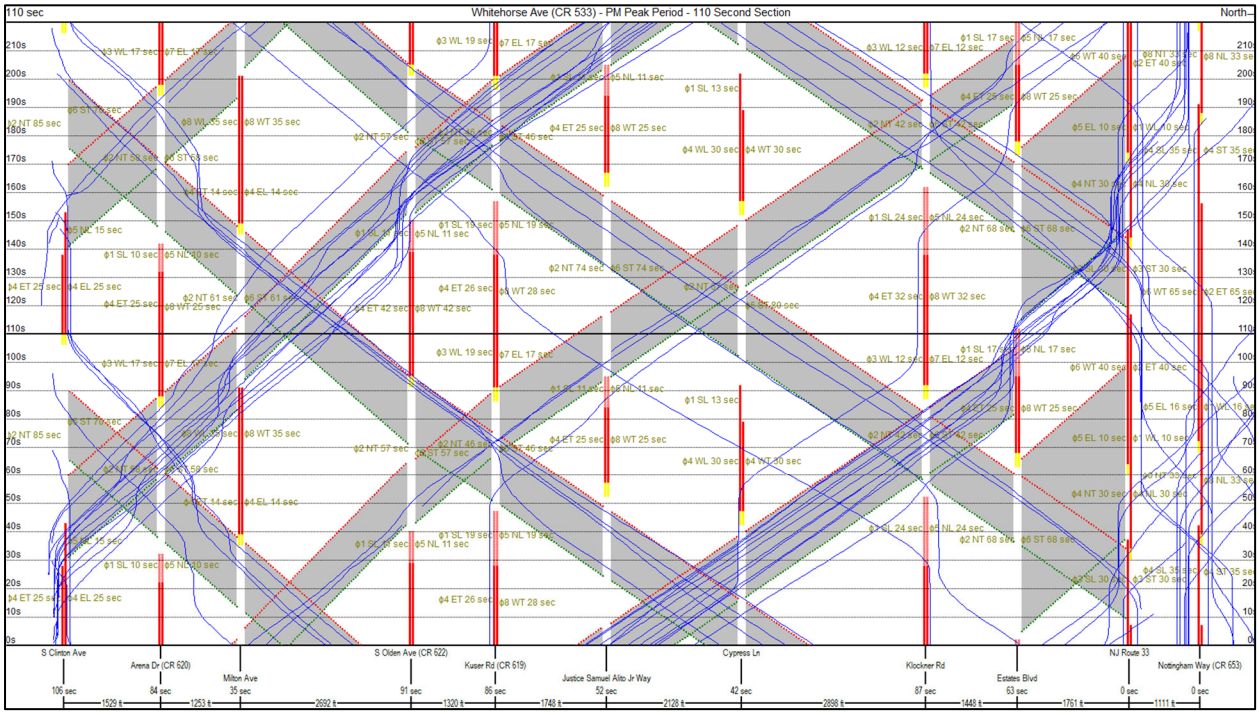
For each approach, vehicle and pedestrian clearance distances and median widths were measured. Vehicle detection and pedestrian pushbuttons, where present, were reviewed and tested for proper operation. Other unusual or unique characteristics were also recorded. The summary of findings from the field notes can be found on the project website. The Appendix of this report contains a table summarizing the status of those observations at the end of the project, since most of the observations had changed or been addressed since the field reviews. The final table will be accurate as of June 29, 2024, when detection was last reviewed for this project.

Photographs were taken within every traffic cabinet and approach photos were also collected for all intersections. The photographs are a record of the current geometrics and other intersection, signal, and roadside characteristics. Field notes and intersection photographs can be found within the project website.

2.5 Travel Time Runs

Travel time runs were conducted under both existing and implemented signal timings on Whitehorse-Mercerville Rd (CR 533). These data were collected to both fine-tune implemented signal timing as well as provide a field-measured metric by which existing and implemented signal timing can be compared using floating car studies. Travel time data is presented and analyzed in Section 6.4 of this report.

Video was collected during both the existing and implemented conditions travel time runs in the PM peak period to be used in developing comparison videos. Complete travel time data can be found in the Tru-Traffic folder on the project website.

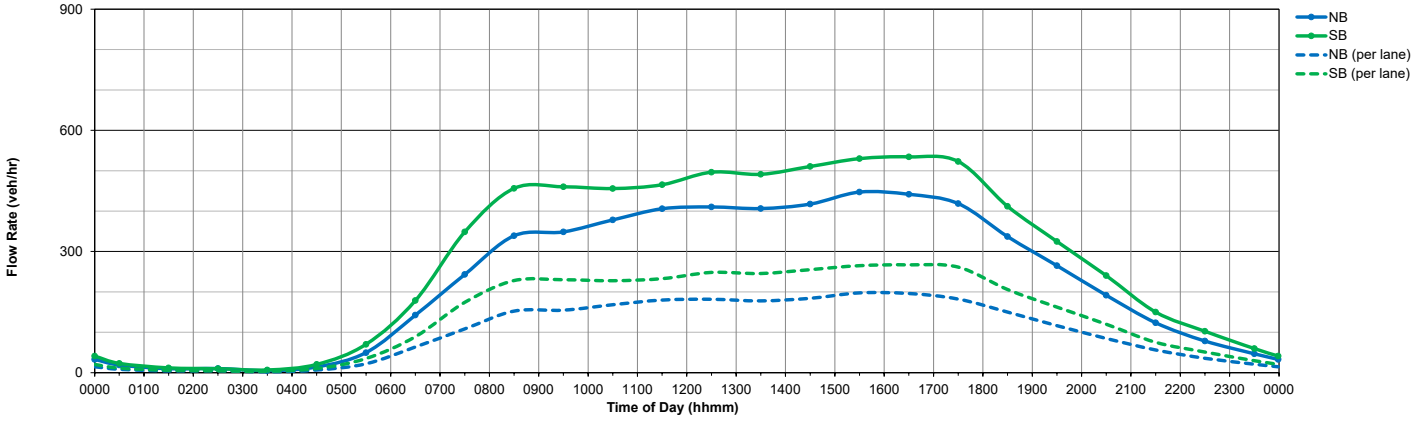


Sample Time-Space Diagram from Tru-Traffic Software – Whitehorse-Mercerville Rd (CR 533) - PM Peak Period

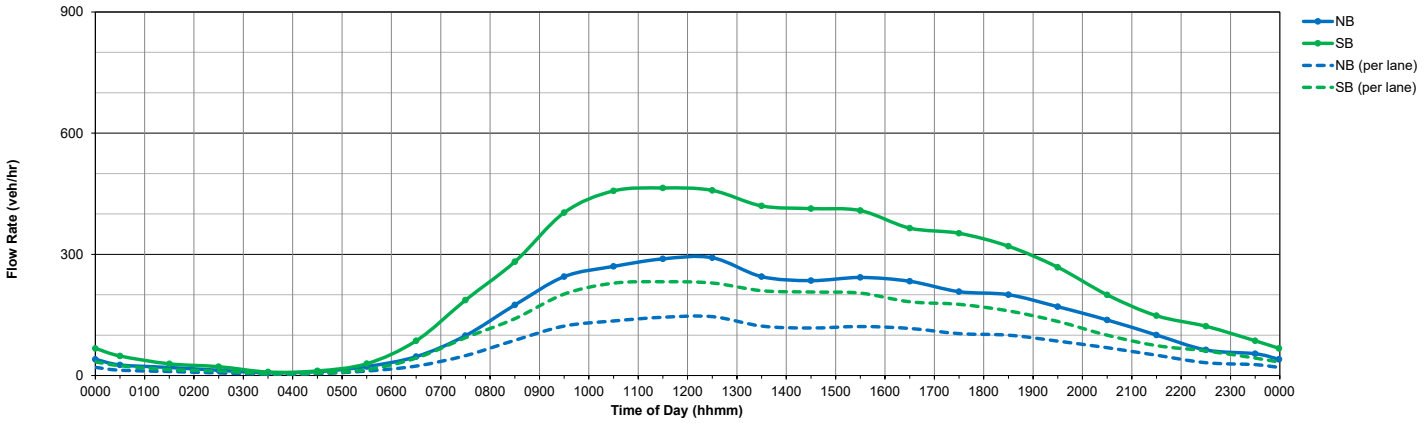
Hourly Volumes - Average for Count Locations on Whitehorse-Mercerville Rd (CR 533) between NJ Route 33 and Milton Ave/Whitehorse Hamilton Square Rd

		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday		Avg. Weekday		Avg. Weekend	
From	To	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
0000	0100	26	23	21	22	24	24	13	21	13	25	26	48	34	52	19	23	30	50
0100	0200	11	14	11	11	13	14	7	12	7	9	20	29	18	26	10	12	19	28
0200	0300	11	9	13	11	11	10	7	9	11	11	13	22	11	15	10	10	12	19
0300	0400	3	6	7	5	5	6	5	7	5	10	7	9	7	6	5	7	7	8
0400	0500	16	17	16	24	16	22	12	21	13	19	9	11	13	10	14	21	11	11
0500	0600	52	65	64	77	60	75	37	71	36	63	22	29	14	12	50	70	18	21
0600	0700	157	182	174	159	157	182	115	187	110	183	47	86	41	57	143	179	44	71
0700	0800	282	329	279	348	277	348	201	381	177	337	99	187	65	110	243	349	82	148
0800	0900	409	464	338	418	391	462	282	503	275	434	175	282	110	184	339	456	143	233
0900	1000	405	463	402	425	394	446	272	489	269	478	245	403	163	259	349	460	204	331
1000	1100	460	459	413	434	406	427	300	483	312	476	270	457	214	330	378	456	242	394
1100	1200	448	446	482	463	457	460	332	501	310	458	289	464	237	330	406	466	263	397
1200	1300	476	488	486	495	471	510	310	504	310	486	292	458	332	359	410	497	312	409
1300	1400	475	487	476	499	451	456	312	505	317	510	245	420	356	353	406	491	301	387
1400	1500	483	492	496	541	466	505	323	509	320	507	235	413	368	401	418	511	301	407
1500	1600	545	567	502	507	503	530	353	555	334	490	243	408	348	348	447	530	295	378
1600	1700	549	556	501	501	490	522	340	581	329	511	233	365	311	338	442	534	272	352
1700	1800	497	521	509	550	440	497	335	543	312	504	208	352	281	299	419	523	245	326
1800	1900	387	392	401	413	358	386	270	437	268	432	200	320	255	275	337	412	228	298
1900	2000	288	299	315	321	266	280	222	360	233	365	170	268	212	235	265	325	191	252
2000	2100	213	229	225	236	187	205	175	268	159	264	138	200	176	211	192	240	157	205
2100	2200	126	129	140	147	125	139	107	151	121	186	100	148	114	124	124	150	107	136
2200	2300	82	81	84	91	72	96	69	112	85	133	63	122	76	72	78	103	70	97
2300	0000	44	53	50	52	39	45	46	54	55	95	54	86	42	47	47	60	48	67
	Sub-total	6,445	6,771	6,407	6,752	6,079	6,645	4,444	7,266	4,381	6,986	3,402	5,589	3,798	4,453	5,551	6,884	3,600	5,021
	Total	13,216		13,158		12,724		11,711		11,367		8,991		8,251		12,435		8,621	

Weekday Average Hourly Volumes



Saturday Hourly Volumes



Hourly Volumes by Day

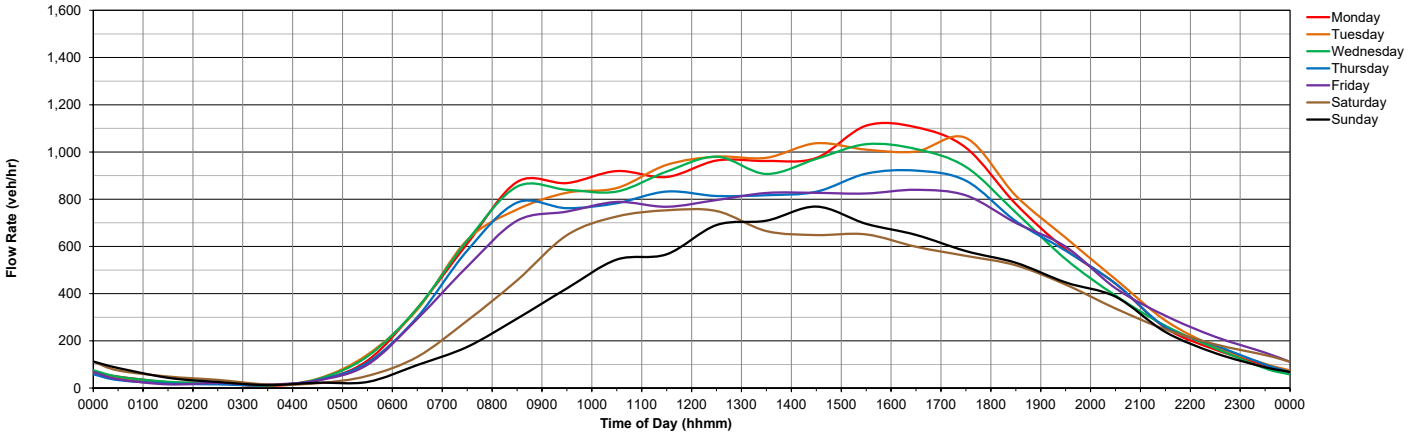
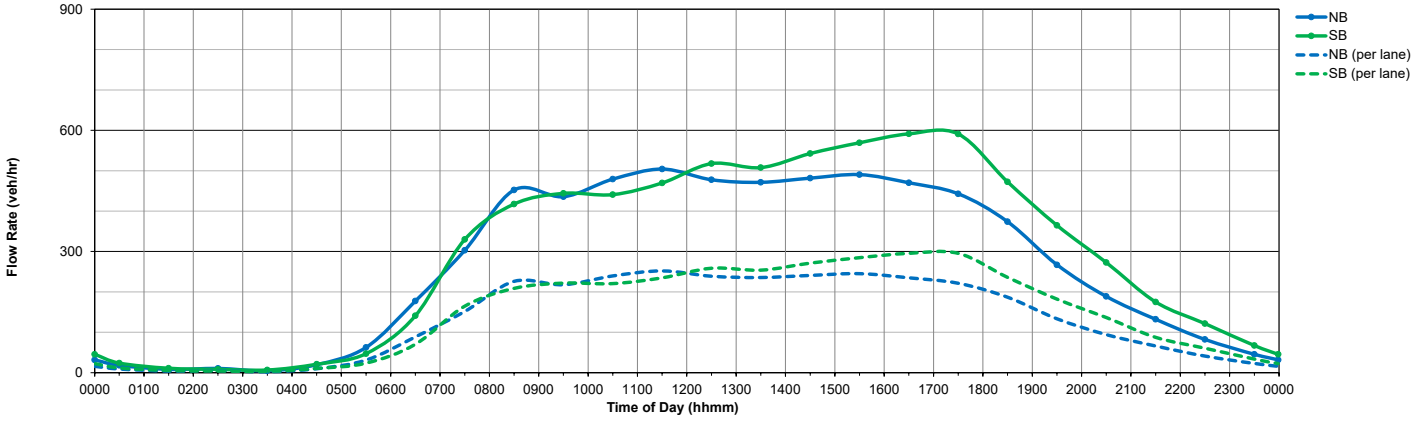


Figure 2
7-Day, 24-Hour Volumes
Average for Count Locations on Whitehorse-Mercerville Rd (CR 533) between NJ Route 33 and Milton Ave/Whitehorse Hamilton Square Rd

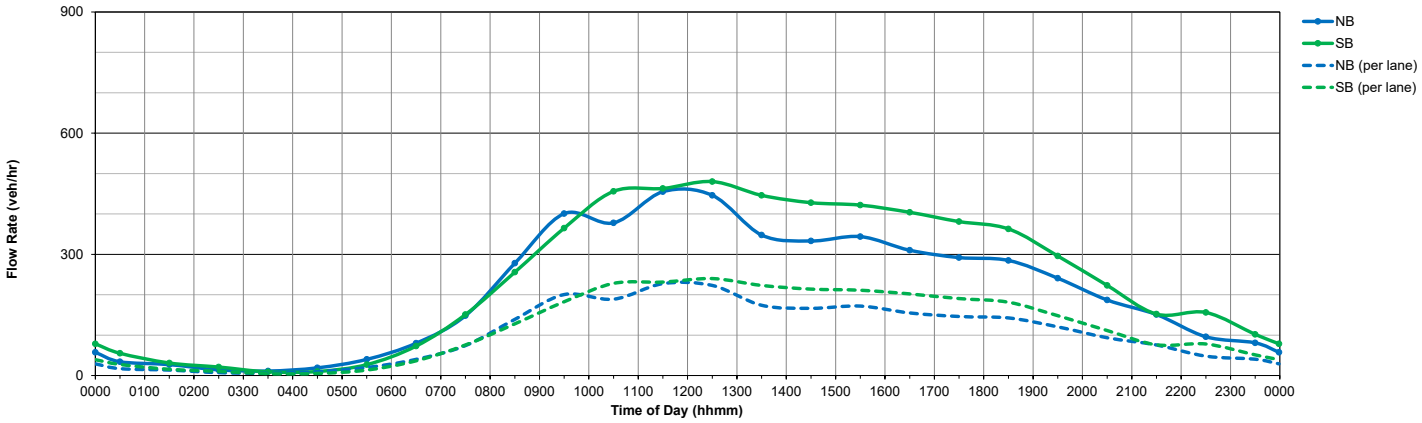
Hourly Volumes - Whitehorse-Mercerville Rd (CR 533) between NJ Route 33 and Estates Blvd

From	To	Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday		Avg. Weekday		Avg. Weekend	
		NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
0000	0100	20	22	14	25	18	23	20	21	19	28	34	55	51	60	18	24	43	58
0100	0200	9	17	6	10	5	11	10	11	11	6	27	31	24	13	8	11	26	22
0200	0300	8	7	10	10	9	9	10	5	16	11	14	21	10	13	11	8	12	17
0300	0400	3	8	3	2	2	9	6	7	10	8	11	9	10	9	5	7	11	9
0400	0500	15	18	15	27	19	20	26	25	25	16	19	10	24	11	20	21	22	11
0500	0600	49	40	68	52	60	49	67	58	70	37	40	27	27	13	63	47	34	20
0600	0700	165	129	156	129	167	143	206	166	193	138	80	73	69	46	177	141	75	60
0700	0800	306	302	294	309	270	334	349	398	297	307	148	151	94	100	303	330	121	126
0800	0900	493	419	368	418	427	424	499	464	474	362	278	256	151	177	452	417	215	217
0900	1000	418	461	435	412	406	443	492	459	428	445	401	365	234	241	436	444	318	303
1000	1100	461	457	467	445	449	419	505	450	514	434	378	456	357	315	479	441	368	386
1100	1200	477	457	503	470	492	469	545	502	504	451	455	463	389	249	504	470	422	356
1200	1300	482	533	484	520	446	531	482	503	495	501	446	480	387	395	478	518	417	438
1300	1400	465	485	434	526	453	486	485	521	520	521	348	446	394	361	471	508	371	404
1400	1500	479	517	451	564	473	546	508	561	498	525	333	428	377	431	482	543	355	430
1500	1600	505	629	475	534	440	578	536	581	497	525	344	422	367	396	491	569	356	409
1600	1700	477	611	473	544	417	585	487	649	497	568	310	404	296	386	470	591	303	395
1700	1800	454	599	432	605	373	590	471	581	485	580	292	381	270	298	443	591	281	340
1800	1900	380	445	371	497	306	452	394	477	419	492	285	363	224	285	374	473	255	324
1900	2000	240	344	235	357	206	336	319	379	336	408	241	296	182	262	267	365	212	279
2000	2100	175	265	173	262	163	238	219	306	214	294	187	223	124	253	189	273	156	238
2100	2200	120	156	123	174	85	161	162	168	171	217	151	152	99	152	132	175	125	152
2200	2300	68	107	76	111	55	117	101	121	112	152	96	156	70	68	82	122	83	112
2300	0000	30	62	32	62	23	52	61	45	82	115	81	102	29	59	46	67	55	81
Sub-total		6,299	7,090	6,098	7,065	5,764	7,025	6,960	7,458	6,887	7,141	4,999	5,770	4,259	4,593	6,402	7,156	4,629	5,182
Total		13,389		13,163		12,789		14,418		14,028		10,769		8,852		13,557		9,811	

Weekday Average Hourly Volumes



Saturday Hourly Volumes



Hourly Volumes by Day

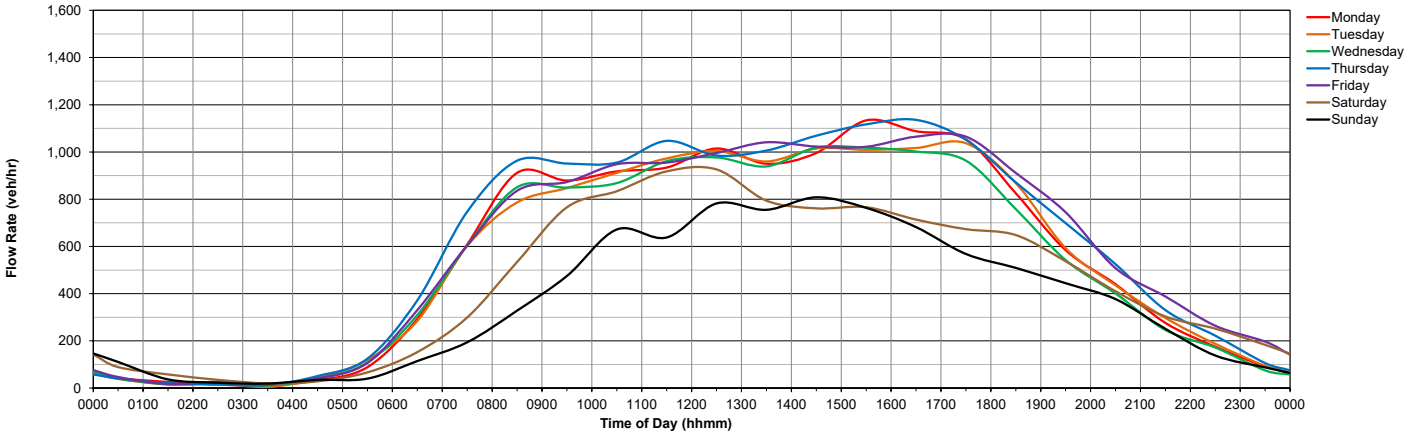
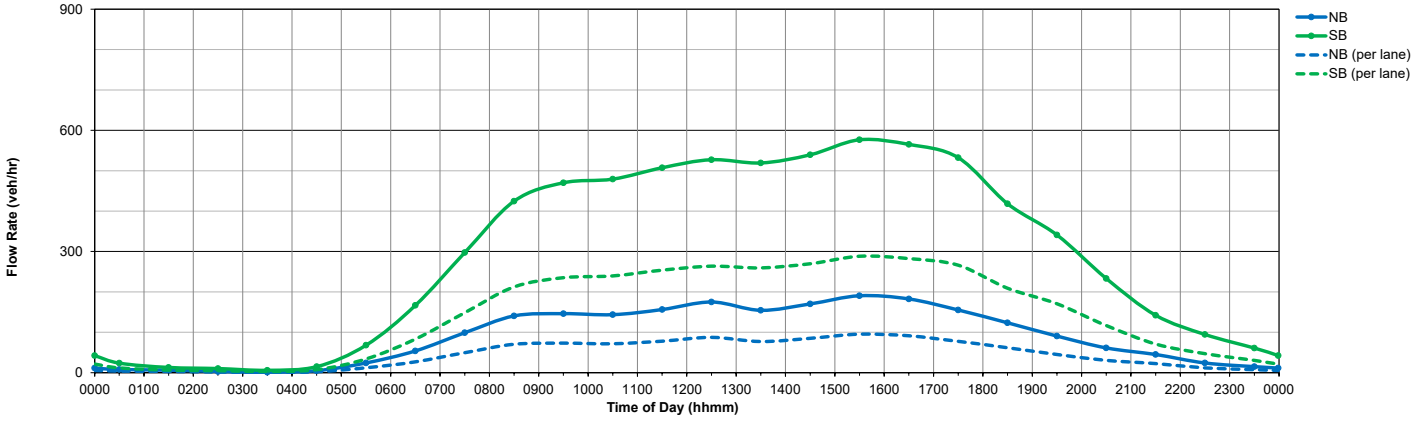


Figure 3
7-Day, 24-Hour Volumes
Whitehorse-Mercerville Rd (CR 533) between NJ Route 33 and Estates Blvd

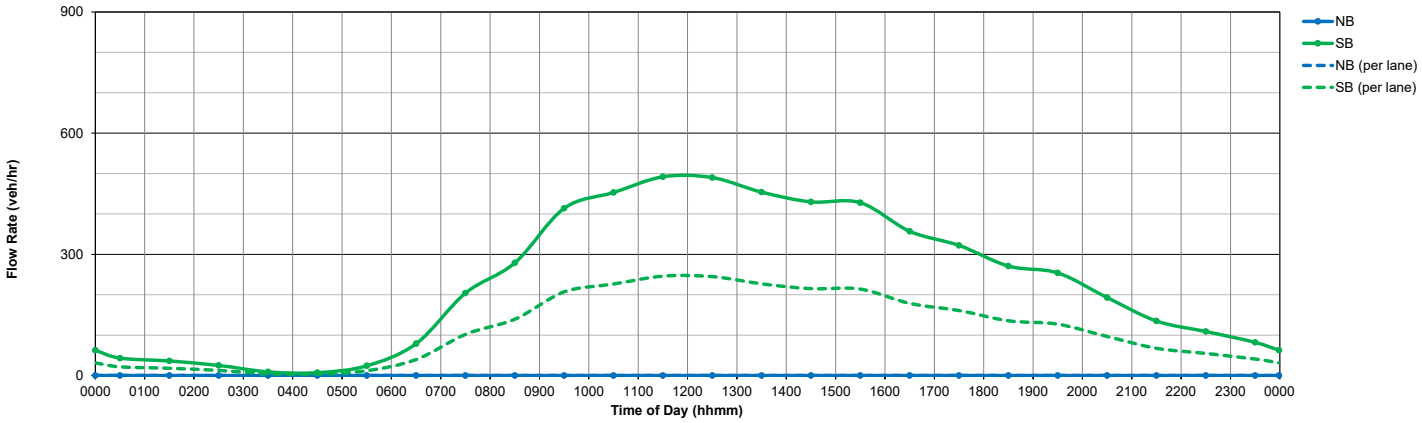
Hourly Volumes - Whitehorse-Mercerville Rd (CR 533) between Cypress Ln and Justice Samuel A Alito Jr. Way

From	To	Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday		Avg. Weekday		Avg. Weekend	
		NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
0000	0100	27	27	24	24	24	24	0	20	0	27	0	43	0	54	8	24	0	49
0100	0200	13	13	11	11	19	19	0	12	0	10	0	36	0	37	6	13	0	37
0200	0300	9	9	10	10	9	9	0	7	0	16	0	25	0	19	3	10	0	22
0300	0400	3	3	6	6	4	4	0	8	0	9	0	9	0	3	1	6	0	6
0400	0500	14	14	16	16	15	15	0	14	0	16	0	7	0	11	5	15	0	9
0500	0600	62	62	71	71	73	73	0	63	0	72	0	24	0	8	24	68	0	16
0600	0700	162	162	175	175	162	162	0	163	0	171	0	79	0	54	54	167	0	67
0700	0800	298	298	298	298	297	297	0	316	0	278	0	204	0	102	99	297	0	153
0800	0900	417	417	370	370	422	422	0	507	0	408	0	279	0	172	141	425	0	226
0900	1000	448	448	432	432	439	439	0	527	0	506	0	414	0	274	146	470	0	344
1000	1100	489	489	427	427	431	431	0	528	0	521	0	453	0	316	144	479	0	385
1100	1200	501	501	499	499	469	469	0	562	0	507	0	492	0	334	156	508	0	413
1200	1300	506	506	549	549	525	525	0	524	0	533	0	490	257	294	175	527	129	392
1300	1400	524	524	543	543	464	464	0	535	0	530	0	454	321	321	155	519	161	388
1400	1500	522	522	555	555	511	511	0	550	0	560	0	430	358	358	170	540	179	394
1500	1600	600	600	561	561	572	572	0	627	0	523	0	428	323	323	191	577	162	376
1600	1700	587	587	522	522	548	548	0	634	0	535	0	357	330	330	183	565	165	344
1700	1800	532	532	585	585	466	466	0	579	0	500	0	322	293	293	155	532	147	308
1800	1900	392	392	405	405	371	371	0	502	0	422	0	271	248	248	124	418	124	260
1900	2000	314	314	347	347	272	272	0	408	0	365	0	254	213	213	91	341	107	234
2000	2100	212	212	240	240	184	184	0	293	0	238	0	193	203	203	61	233	102	198
2100	2200	112	112	140	140	135	135	0	142	0	182	0	135	111	111	45	142	56	123
2200	2300	75	75	75	75	72	72	0	114	0	137	0	109	64	64	24	95	32	87
2300	0000	50	50	51	51	45	45	0	64	0	96	0	82	48	48	15	61	24	65
	Sub-total	6,869	6,869	6,912	6,912	6,529	6,529	0	7,699	0	7,162	0	5,590	2,769	4,190	2,176	7,033	1,385	4,890
	Total	13,738		13,824		13,058		7,699		7,162		5,590		6,959		9,210		6,275	

Weekday Average Hourly Volumes



Saturday Hourly Volumes



Hourly Volumes by Day

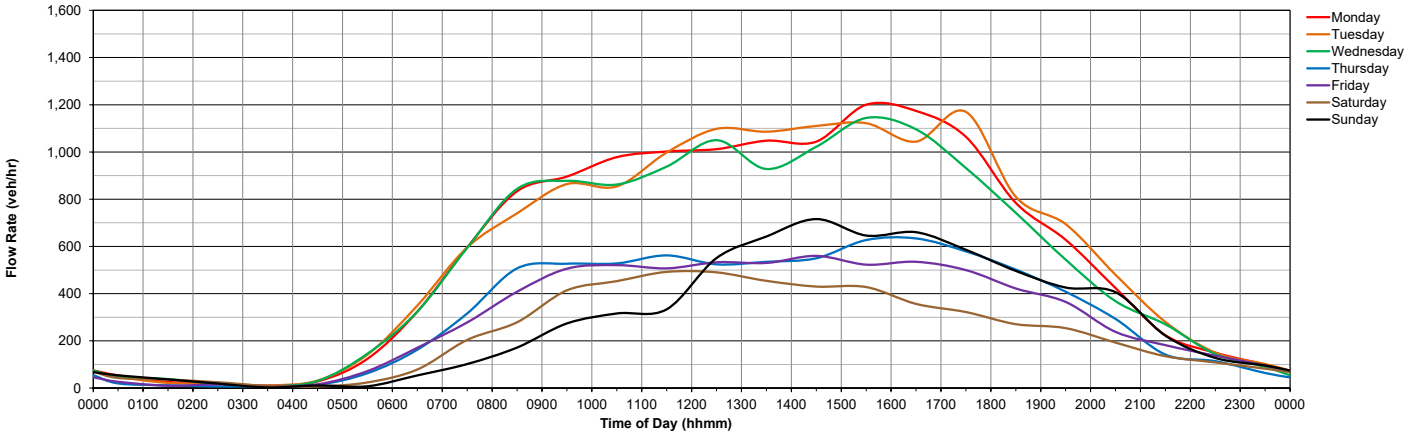
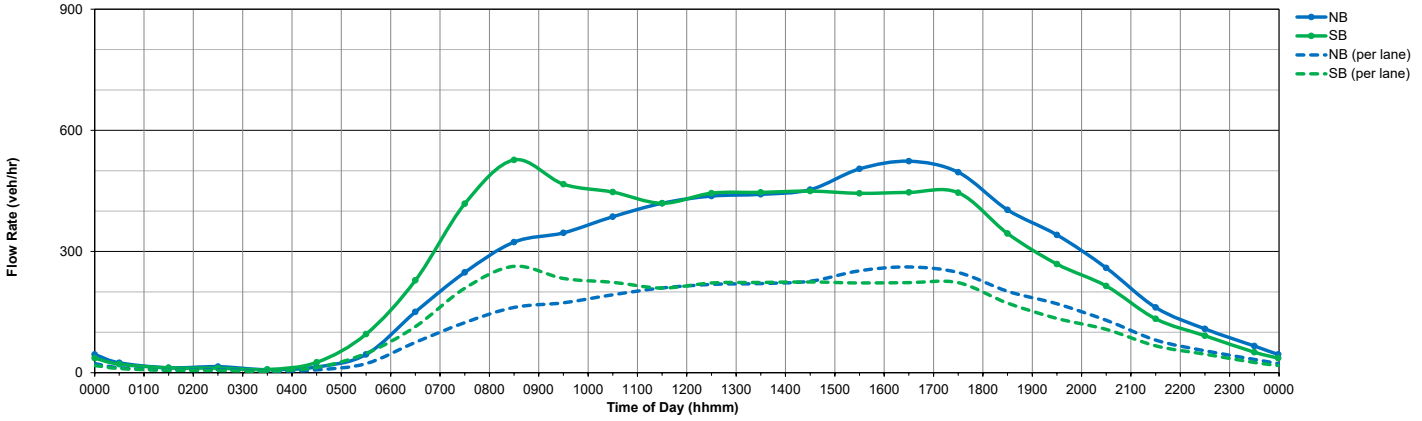


Figure 4
7-Day, 24-Hour Volumes
Whitehorse-Mercerville Rd (CR 533) between Cypress Ln and Justice Samuel A Alito Jr. Way

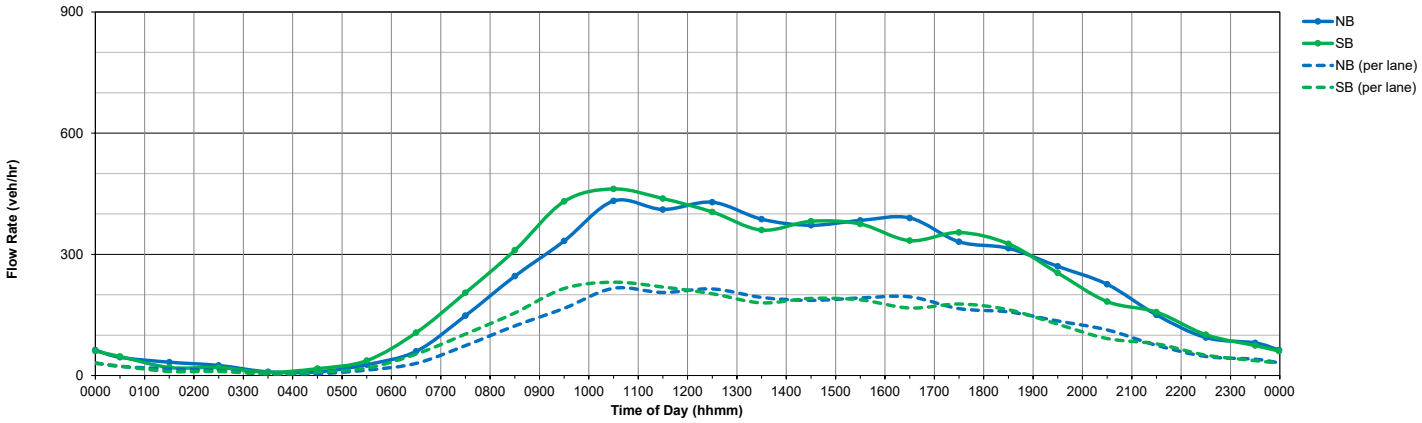
Hourly Volumes - Whitehorse-Mercerville Rd (CR 533) between Olden Ave (CR 622) and Milton Ave/Whitehorse Hamilton Square Rd

From	To	Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday		Avg. Weekday		Avg. Weekend	
		NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
0000	0100	30	20	24	17	31	26	18	23	19	19	45	47	50	41	24	21	48	44
0100	0200	11	12	16	11	14	12	11	14	10	11	33	20	29	28	12	12	31	24
0200	0300	15	11	18	12	15	12	10	16	17	5	25	20	22	14	15	11	24	17
0300	0400	3	7	12	7	9	5	9	7	5	14	9	8	10	7	8	8	10	8
0400	0500	18	19	16	29	13	31	11	24	14	26	9	17	14	9	14	26	12	13
0500	0600	44	93	54	109	46	103	44	93	38	80	27	37	15	16	45	96	21	27
0600	0700	144	255	190	174	142	241	138	231	138	241	60	106	54	70	150	228	57	88
0700	0800	243	387	245	437	263	412	255	430	235	425	148	205	101	127	248	418	125	166
0800	0900	317	557	276	467	324	541	348	538	352	531	246	310	180	204	323	527	213	257
0900	1000	349	481	340	432	338	455	325	482	380	484	333	431	256	263	346	467	295	347
1000	1100	430	432	346	430	338	430	394	472	423	473	432	462	286	359	386	447	359	411
1100	1200	367	379	445	420	409	443	450	439	427	416	411	438	321	407	420	419	366	423
1200	1300	440	425	424	415	441	473	447	485	435	425	429	405	352	388	437	445	391	397
1300	1400	437	451	452	429	437	417	452	458	430	478	387	360	353	377	442	447	370	369
1400	1500	447	437	483	503	414	457	461	415	461	436	372	382	368	414	453	450	370	398
1500	1600	529	472	471	427	496	441	523	458	504	423	384	375	354	324	505	444	369	350
1600	1700	582	471	507	438	506	433	533	460	490	430	390	334	307	298	524	446	349	316
1700	1800	506	431	511	460	480	435	534	470	450	433	331	354	281	305	496	446	306	330
1800	1900	390	339	428	338	397	334	416	332	385	381	315	326	294	293	403	345	305	310
1900	2000	311	239	363	260	321	231	347	292	364	323	270	254	242	230	341	269	256	242
2000	2100	252	210	263	206	215	192	305	205	263	260	226	183	201	177	260	215	214	180
2100	2200	147	118	156	126	155	121	159	144	191	158	150	157	132	108	162	133	141	133
2200	2300	103	61	102	87	90	100	106	101	142	109	94	101	95	83	109	92	95	92
2300	0000	53	46	68	44	49	37	77	53	83	74	81	74	48	34	66	51	65	54
	Sub-total	6,168	6,353	6,210	6,278	5,943	6,382	6,373	6,642	6,256	6,655	5,207	5,406	4,365	4,576	6,190	6,462	4,786	4,991
	Total	12,521		12,488		12,325		13,015		12,911		10,613		8,941		12,652		9,777	

Weekday Average Hourly Volumes



Saturday Hourly Volumes



Hourly Volumes by Day

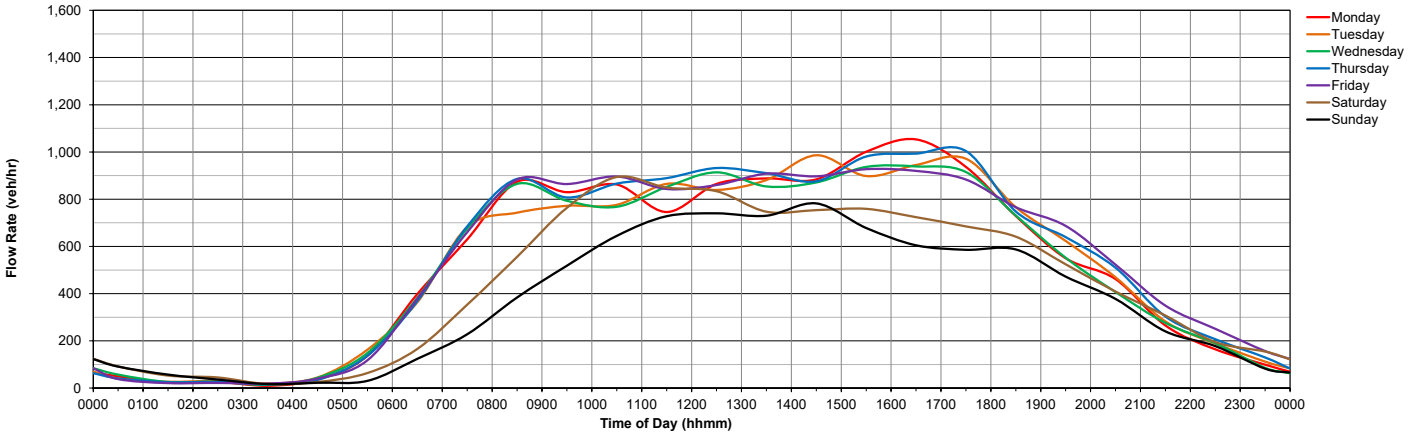
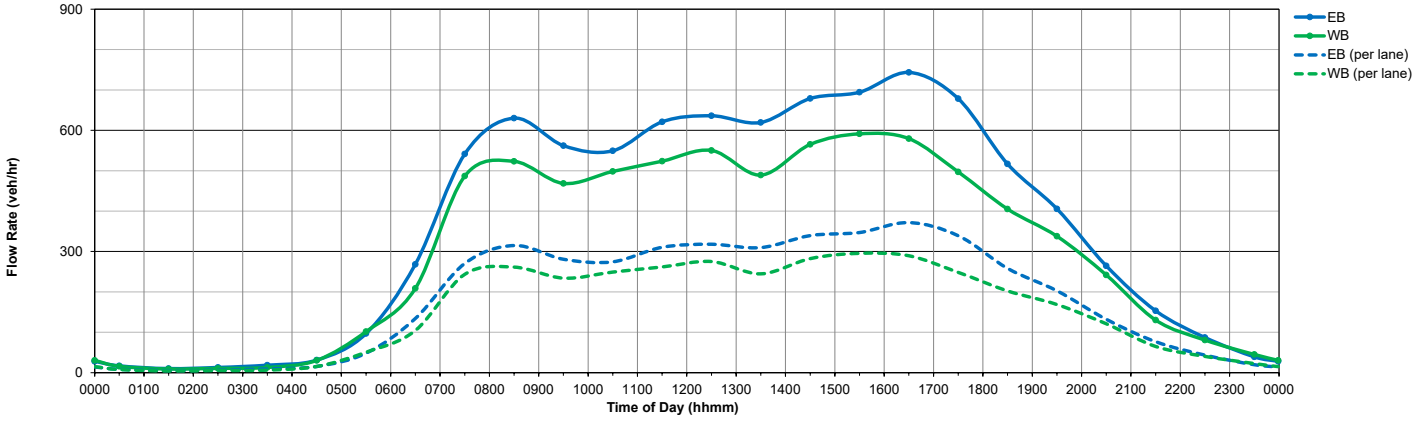


Figure 5
7-Day, 24-Hour Volumes
Whitehorse-Mercerville Rd (CR 533) between Olden Ave (CR 622) and Milton Ave/Whitehorse Hamilton Square Rd

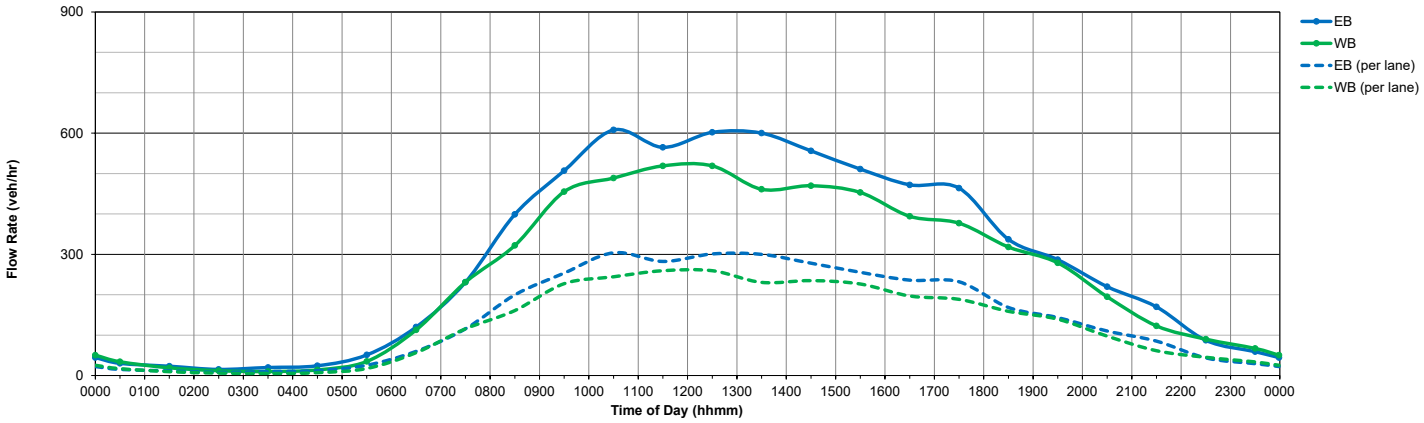
Hourly Volumes - Kuser Road (CR 619) between Whitehorse Ave and Whitehorse Hamilton Square Rd

From	To	Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday		Avg. Weekday		Avg. Weekend	
		EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
0000	0100	18	13	21	13	21	13	7	15	18	25	30	34	35	25	17	16	33	30
0100	0200	12	4	5	8	10	9	11	12	13	12	23	19	12	14	10	9	18	17
0200	0300	13	6	12	13	9	8	17	13	14	14	15	12	12	8	13	11	14	10
0300	0400	12	9	18	10	19	17	25	16	20	13	20	10	16	5	19	13	18	8
0400	0500	19	22	45	41	26	25	34	31	32	34	24	14	15	11	31	31	20	13
0500	0600	83	92	97	105	116	103	99	116	90	93	51	35	38	16	97	102	45	26
0600	0700	264	223	261	186	282	211	271	216	264	208	120	113	98	91	268	209	109	102
0700	0800	574	469	488	426	536	467	551	564	558	509	231	231	133	140	541	487	182	186
0800	0900	654	494	591	432	634	535	624	576	648	579	399	322	283	218	630	523	341	270
0900	1000	526	416	539	477	554	427	598	507	593	516	507	455	427	293	562	469	467	374
1000	1100	565	458	574	471	483	479	578	531	547	553	608	489	490	396	549	498	549	443
1100	1200	618	501	594	522	618	464	642	549	634	583	565	519	532	420	621	524	549	470
1200	1300	655	514	646	543	626	527	627	594	626	574	602	519	524	327	636	550	563	423
1300	1400	649	511	598	446	590	447	668	516	592	527	600	461	495	388	619	489	548	425
1400	1500	686	548	644	544	682	558	687	578	695	598	556	470	515	411	679	565	536	441
1500	1600	754	576	701	554	658	537	727	652	632	638	511	453	488	365	694	591	500	409
1600	1700	751	603	768	574	674	514	769	642	755	564	472	394	451	358	743	579	462	376
1700	1800	676	505	715	506	621	455	688	533	692	486	464	377	442	320	678	497	453	349
1800	1900	519	392	549	465	474	330	542	420	500	419	337	318	353	344	517	405	345	331
1900	2000	419	321	430	339	326	230	434	424	420	375	287	279	273	243	406	338	280	261
2000	2100	273	211	286	234	201	191	265	258	298	317	220	195	212	239	265	242	216	217
2100	2200	137	134	167	107	133	106	136	144	194	160	170	123	98	95	153	130	134	109
2200	2300	90	63	94	84	68	62	87	94	97	101	87	90	92	60	87	81	90	75
2300	0000	19	36	36	51	43	30	44	47	55	62	59	67	30	19	39	45	45	43
Sub-total		8,986	7,121	8,879	7,151	8,404	6,745	9,131	8,048	8,987	7,960	6,958	5,999	6,064	4,806	8,877	7,405	6,511	5,403
Total		16,107		16,030		15,149		17,179		16,947		12,957		10,870		16,282		11,914	

Weekday Average Hourly Volumes



Saturday Hourly Volumes



Hourly Volumes by Day

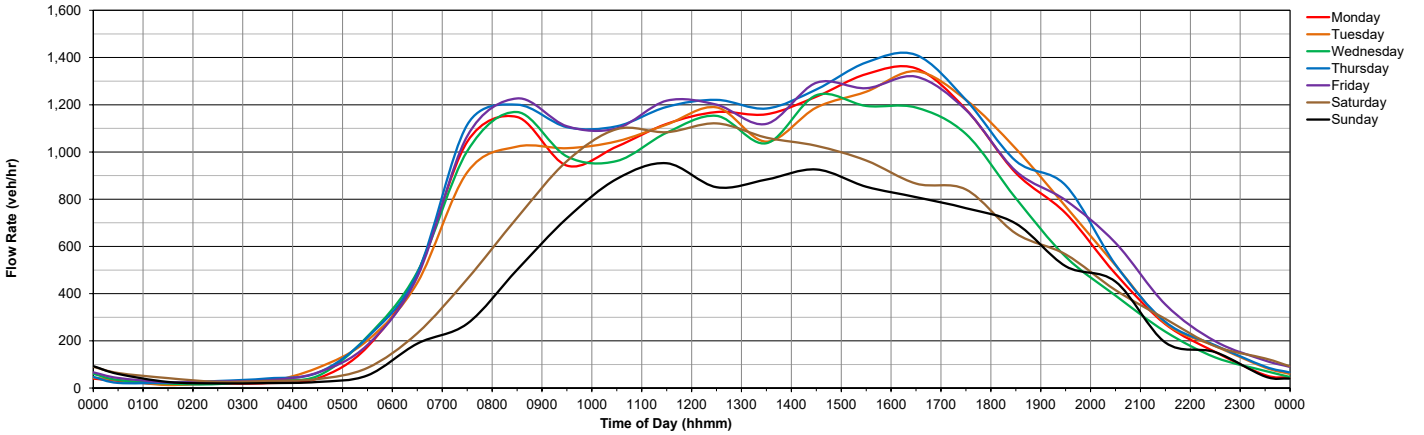
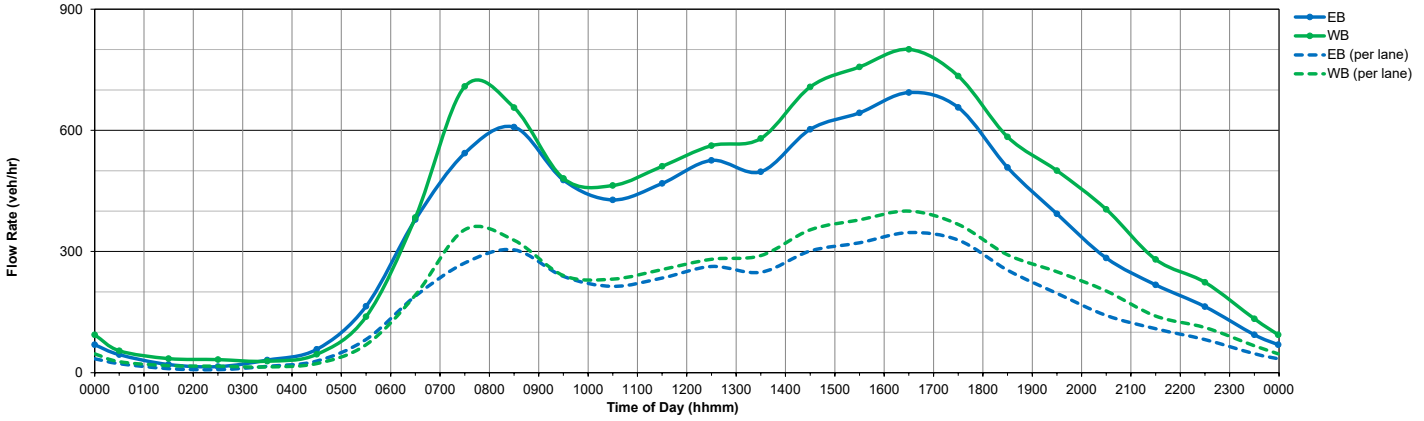


Figure 6
7-Day, 24-Hour Volumes
Kuser Road (CR 619) between Whitehorse Ave and Whitehorse Hamilton Square Rd

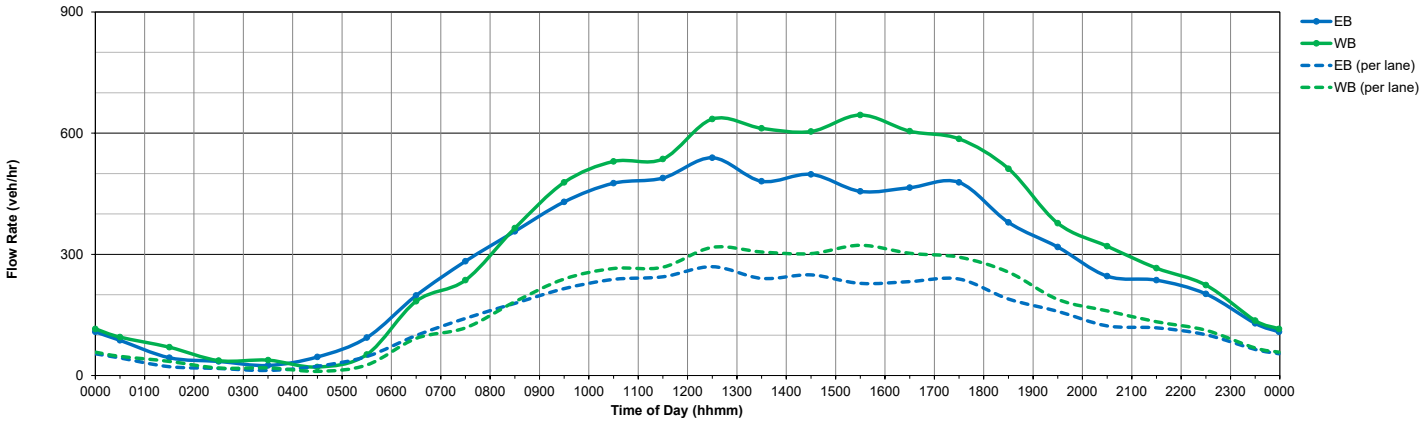
Hourly Volumes - Nottingham Way (CR 652) between State St and Quakerbridge Rd/Whitehorse-Mercerville Rd (CR 533)

		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday		Avg. Weekday		Avg. Weekend	
From	To	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
0000	0100	42	42	45	56	41	60	35	51	60	63	87	95	75	74	45	54	81	85
0100	0200	22	21	20	25	16	44	18	39	25	46	44	70	43	47	20	35	44	59
0200	0300	11	16	14	34	15	46	15	32	21	34	35	37	32	27	15	32	34	32
0300	0400	33	17	32	31	32	26	28	30	32	38	25	38	22	31	31	28	24	35
0400	0500	62	46	67	64	57	39	55	38	49	40	46	21	35	30	58	45	41	26
0500	0600	164	134	171	159	166	128	161	129	161	143	94	52	66	42	165	139	80	47
0600	0700	366	357	383	372	380	404	375	405	392	383	198	184	128	115	379	384	163	150
0700	0800	516	670	520	681	509	763	589	743	583	686	283	236	240	181	543	709	262	209
0800	0900	611	652	512	617	632	667	676	671	610	674	357	365	292	274	608	656	325	320
0900	1000	420	464	485	482	456	457	491	506	533	496	430	478	335	423	477	481	383	451
1000	1100	426	480	407	456	410	459	420	435	477	487	476	530	388	420	428	463	432	475
1100	1200	450	492	477	514	442	495	465	481	510	574	489	536	376	494	469	511	433	515
1200	1300	481	515	510	680	531	537	524	511	583	567	539	635	509	578	526	562	524	607
1300	1400	499	562	462	604	500	568	518	607	509	558	481	612	507	513	498	580	494	563
1400	1500	590	647	602	649	591	728	598	750	632	764	498	604	508	612	603	708	503	608
1500	1600	662	748	604	756	662	733	626	814	663	734	456	645	519	587	643	757	488	616
1600	1700	709	799	691	811	726	749	642	845	701	798	465	605	479	571	694	800	472	588
1700	1800	691	723	693	704	617	664	648	856	634	726	478	586	399	566	657	735	439	576
1800	1900	487	555	492	637	448	485	581	657	533	586	379	512	362	638	508	584	371	575
1900	2000	356	496	411	487	342	386	422	552	435	580	318	377	320	524	393	500	319	451
2000	2100	289	413	283	386	242	329	287	467	319	428	246	320	243	385	284	405	245	353
2100	2200	174	274	207	240	184	216	225	306	298	366	236	266	183	224	218	280	210	245
2200	2300	148	212	157	219	146	176	170	231	198	281	202	224	119	139	164	224	161	182
2300	0000	82	122	88	114	78	116	95	139	127	176	129	136	94	67	94	133	112	102
	Sub-total	8,291	9,457	8,333	9,778	8,223	9,275	8,664	10,295	9,085	10,228	6,991	8,164	6,274	7,562	8,519	9,807	6,633	7,863
	Total	17,748		18,111		17,498		18,959		19,313		15,155		13,836		18,326		14,496	

Weekday Average Hourly Volumes



Saturday Hourly Volumes



Hourly Volumes by Day

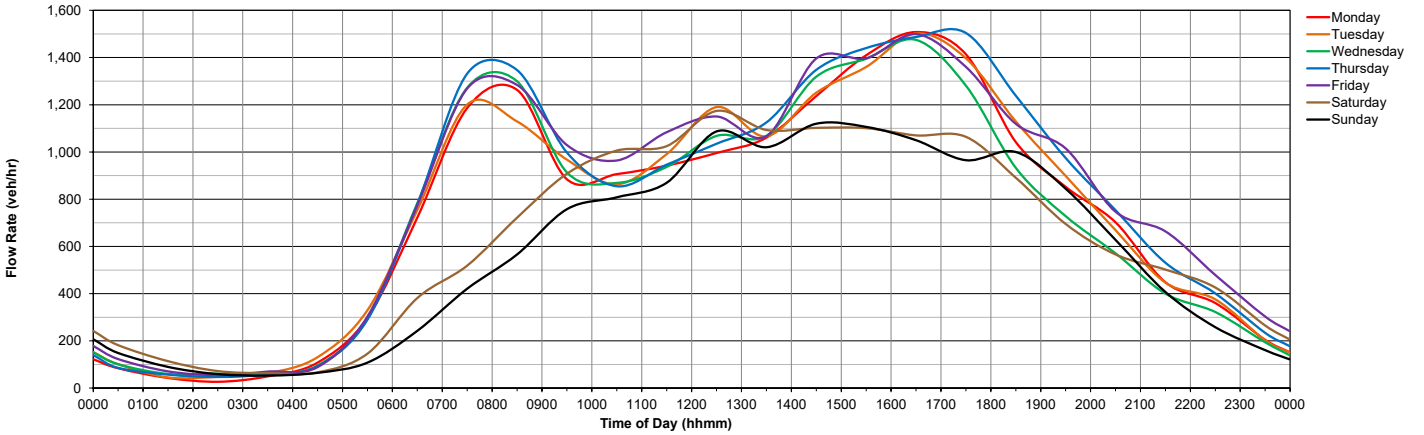


Figure 7
7-Day, 24-Hour Volumes
Nottingham Way (CR 652) between State St and Quakerbridge Rd/Whitehorse-Mercerville Rd (CR 533)

3.0 SITE SURVEY

Prior to conducting any analysis, a site survey was performed to observe the signal equipment in the cabinet and operation of the traffic signal as well as the geometric, traffic, and signal timing characteristics of each intersection.

3.1 Intersection Observation

A general observation of the interaction between traffic, the signal, and intersection design was also made during the site survey. The purpose of these observations was to note any characteristics (such as low lane utilization) that may not be inferred from any other available data sources but could significantly affect the performance of the new signal timings. Any potential safety hazards observed during the site survey, such as missing, damaged, or obstructed signs, signals, or pavement markings were also noted. All vehicle and pedestrian detectors were observed and tested for proper operation. A summary of those detection issues at the time of the field notes is included on the project website while a summary of observations at the end of this retiming project can be found in the Appendix on Figure 12 on page 28. An observation of all signals was conducted during daytime operation under normal weather conditions.

3.2 Summary of Field Observations

The following observations were noted during the site survey:

General Observations

- Under existing conditions, controller clocks along the network were off by different amounts of time but did seem to have some subsystems that were communicating with each other. This resulted in inconsistency throughout the network and unpredictable arrivals at intersections, creating scenarios where a platoon of vehicles could be arriving at a signal and the indications would go to the yellow and red intervals on the main street at the most inopportune time. This increased the number of dilemma zone conflicts along the network, resulting in more rear end crashes, hard braking and red light running throughout the network. Also, vehicles could stop at several signals in a row and experience significant delays while travelling down Whitehorse-Mercerville Rd (CR 533).
- Heavy pedestrian volumes were noted for all time periods throughout the network and especially during school ingress and egress periods.

Quakerbridge Road/Whitehorse-Mercerville Road (CR 533) & Nottingham Way (CR 653)/Edinburg Rd (CR 535)

- During the AM, midday and PM periods, southbound queues extended up to approximately 800 feet and experienced cycle failures.
- During the AM period, eastbound left-turn queues extended up to 300 feet and experienced multiple cycle failures. The allocated split to this movement was short and the volume demand was significant, especially during school ingress and egress times. These queues extended well beyond the turn bay storage and spilled into the adjacent through lane, blocking eastbound through traffic temporarily, significantly reducing the eastbound capacity.
- This signal was observed to be overcapacity during most time periods and had cycle failures for the northbound, eastbound and north westbound movements at various times throughout a typical week. The westbound and westbound left-turn movements were the only movements that were not observed to experience regular cycle failures.

Whitehorse-Mercerville Road (CR 533) & NJ Route 33 (NJDOT Signal)

- During the PM period, northbound queues extended up to approximately 500 feet and experienced cycle failures regularly. The northbound and southbound movements are sequential (or split phased), so those movements experience added delays while the NJ Route 33 eastbound and westbound movements were not observed to have much of any issues.

Whitehorse-Mercerville Road (CR 533) & Klockner Road

- During the AM period, westbound queues extended up to approximately 400 feet and experienced cycle failures.

Whitehorse-Mercerville Road (CR 533) & Kuser Road (CR 619)

- During the midday and weekend midday peaks, the southbound left-turn was observed to experience cycle failures. Queues extended up to approximately 250 feet and were observed to be somewhat sporadic as the failures were not consistent.
- During the PM period, westbound left-turn queues extended up to approximately 350 feet and experienced consistent cycle failures.

Whitehorse Avenue (CR 533) & South Olden Avenue (CR 622)

- Eastbound detection was not operational at this intersection so long split allotments were serviced consistently with not much traffic.

Whitehorse-Mercerville Road (CR 533) & Milton Avenue/Whitehorse Hamilton Square Road

- During school ingress and egress, the south westbound movement would experience heavy surges, particularly in the afternoon during late midday and early PM. Queues were observed extended to approximately 1,500 feet and experienced multiple cycle failures. There were also a high percentage of school buses in those queues.

Whitehorse-Mercerville Road (CR 533) & Arena Drive (CR 620)

- During field notes and implementation, all detection was faulting at this intersection, which resulted in this signal operation pre-timed, meaning each phase got its allotted time, regardless of the demand. Southbound queues were observed extending into and beyond Milton Avenue/Whitehorse Hamilton Square Road, with maximum queues observed to be approximately 750 feet. This resulted in cycle failures through this part of the network southbound.
- During AM and PM peak periods, northbound queues extended up to approximately 600 feet and experienced cycle failures. There was a lot of friction for vehicles travelling northbound through this signal, with a high percentage of vehicles making the northbound right-turn movement and that there is only a single lane for the northbound movement.
- During the AM period, westbound queues extended up to approximately 350 feet and experienced cycle failures.
- During the AM and PM periods, eastbound queues extended up to approximately 250 feet and experienced cycle failures.

Whitehorse Avenue (CR 533) & South Clinton Avenue

- During the field notes and implementation, the eastbound pedestrian was operating in recall due to a malfunctioning pedestrian pushbutton. This resulted in long split allotments for the eastbound movement, even when there was little or no vehicle demand.
- Southbound queues extended up to approximately 500 feet and experienced cycle failures. This was primarily caused by poor signal timing coordination as there is only one lane servicing southbound, so when the queues are stopped, it results in significant startup time to get moving again.

Nottingham Way (CR 535) & East State Street

- During AM and PM periods, eastbound queues had no storage to clear intersection, so experienced cycle failures. This was primarily caused by the eastbound and eastbound left-turn queues at Quakerbridge Road/Whitehorse-Mercerville Road (CR 533).

4.0 SIGNAL TIMING IMPLEMENTATION

4.1 Model Development

The basic link-node structure of the roadway network was built in Synchro on a coordinate-specific, Bing Maps image of roads provided within Synchro. This type of reference ensures precise intersection placement as well as proper link curvature and length. Node numbers (intersection IDs) were assumed based on the signal controller ID numbers and the numbering provided on the existing timing directives in each cabinet.

Once all existing geometric, volume, and signal timing data were coded into the models and general field observations were completed, new signal timings were developed.

4.2 Basic Signal Timing Parameters

The basic timing parameters, such as minimum green, yellow change, red clearance, vehicle extension, recall mode, walk time, and pedestrian clearance (flashing don't walk), were reviewed and updated as necessary for each traffic signal phase. These parameters are discussed in greater detail below. All clearance intervals for both vehicles and pedestrians were calculated for all intersections.

Minimum Green

Minimum values were reviewed and updated, as necessary. In general, minimum greens were maintained with their existing values but were updated for several locations due to detection layout and consistency along the network. Each minimum green was reviewed to ensure its appropriateness.

Yellow Change and Red Clearance Intervals

The yellow change and red clearance intervals were calculated from equations provided by the NJDOT Traffic Engineering Division as follows:

$$\text{Total Clearance (TC)} = t + \frac{V}{2a} + \frac{w+L}{V}$$

t = perception-reaction time (s)
V = approach speed (ft/sec)
a = deceleration rate (ft/sec^2)
w = width of intersection (stop bar to furthest conflict point)
L = length of vehicle

Yellow time for each movement is calculated based on the approach posted speed limit, with one second per 10 mph and rounded up to the nearest whole number. If speeds vary on the concurrent approaches, the higher value is utilized, and the concurrent phases have matching yellow and red intervals. The red interval is then calculated by subtracting the yellow interval from the Total Clearance equation shown above and rounded up the nearest whole number.

Walk Time

Generally, a value of seven or more seconds based on 2009 MUTCD requirements and engineering judgment was used if pedestrian phases were present. Some adjustments were made where there were capacity concerns and where pedestrian pushbuttons were not operating properly during implementation. For all location, the MUTCD minimum of four seconds of Walk was not violated.

Pedestrian Clearance (Flashing Don't Walk)

The length of this interval is a function of the crosswalk length, pedestrian push button distance from the curb, and a standard pedestrian walking speed of 3.5 ft/s. MUTCD guidelines were utilized in calculating appropriate flashing don't walk times.

At the intersection of Whitehorse-Mercerville Road (CR 533) & Justice Samuel A Alito Jr Way, a walk time of 10 seconds and flashing don't walk of 35 seconds was implemented for the eastbound and westbound pedestrian movements based on a request from Mercer County. That walk is 3 seconds higher than the calculations would have resulted and is 10 seconds higher than the flashing don't walk calculation would output.

For specific information, the existing and implemented timing directives and summary timing sheets can be found on the project website. All clearance measurements and calculations for both vehicle and pedestrian movements are provided on the project website.

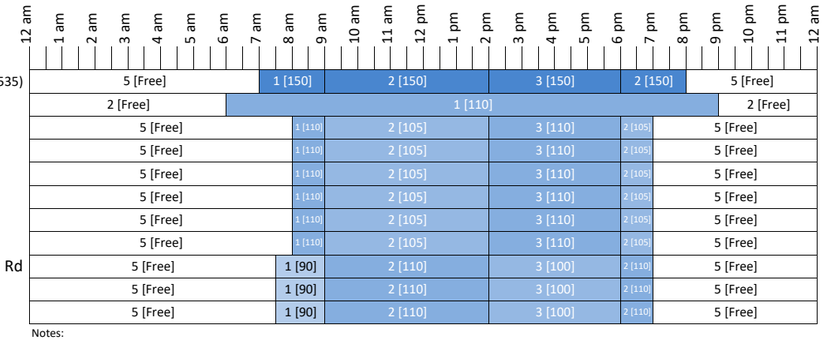
4.3 Phasing

During the optimization process, it may be determined that the basic phasing structure of an intersection should be changed or further evaluated to improve the operation and/or safety of the intersection or corridor. No such recommendations are being presented for this system.

4.4 Day Plan Schedules

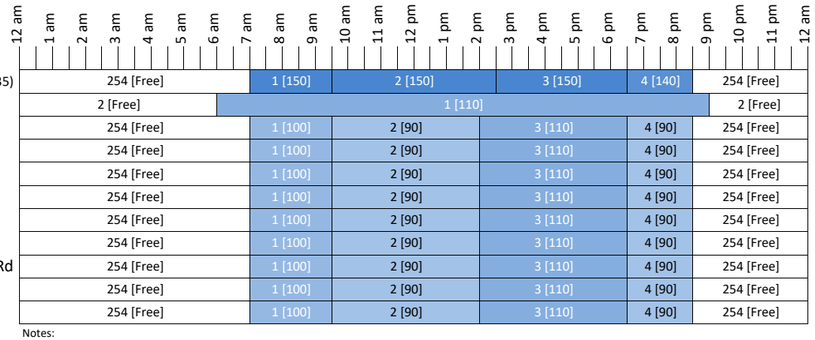
The process of determining the day plan schedule is primarily based on the 7-day, 24-hour traffic volume counts and engineering judgment. Figure 8 through Figure 10 on pages 15 – 17 illustrates the existing and implemented day plan schedules.

EXISTING SCHEDULES
Whitehorse-Mercerville Rd (CR 533)
Weekday



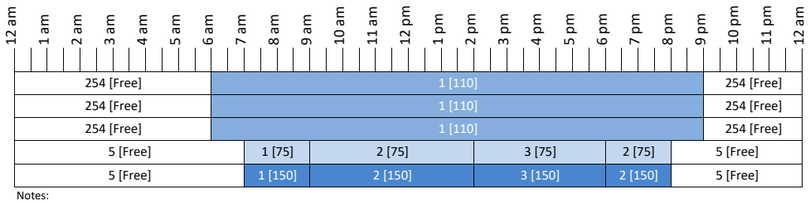
Notes:

IMPLEMENTED SCHEDULES
Whitehorse-Mercerville Rd (CR 533)
Weekday



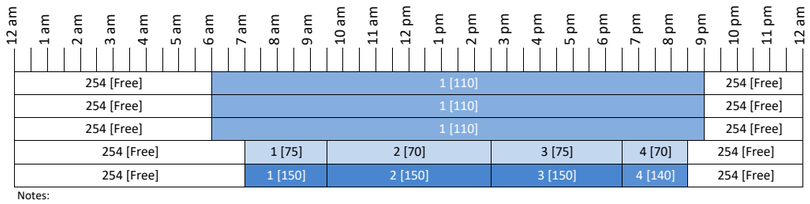
Notes:

EXISTING SCHEDULES
Nottingham Way (NJ Rt 33/CR 653)
Weekday



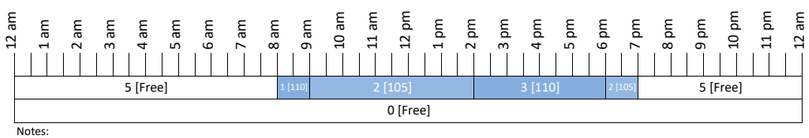
Notes:

IMPLEMENTED SCHEDULES
Nottingham Way (NJ Rt 33/CR 653)
Weekday



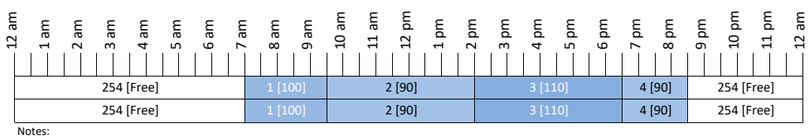
Notes:

EXISTING SCHEDULES
Kuser Rd (CR 619)
Weekday



Notes:

PROPOSED SCHEDULES
Kuser Rd (CR 619)
Weekday

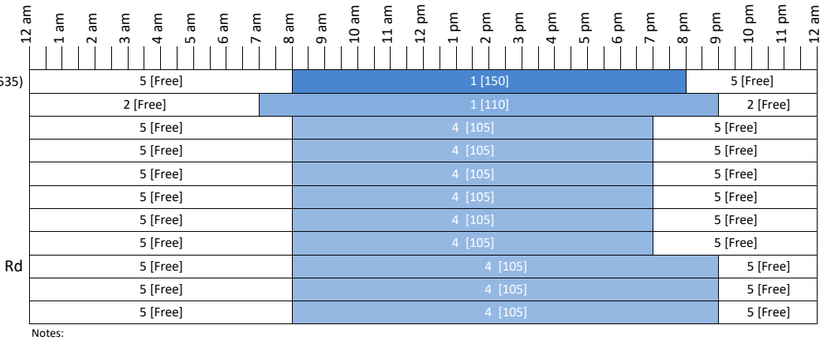


Notes:

LEGEND
A white box indicates FREE operation, a shaded box indicates coordinated operation.
The first number specifies the pattern, the second number [in brackets] is the cycle length (s).
Darker shades represent a longer cycle length.

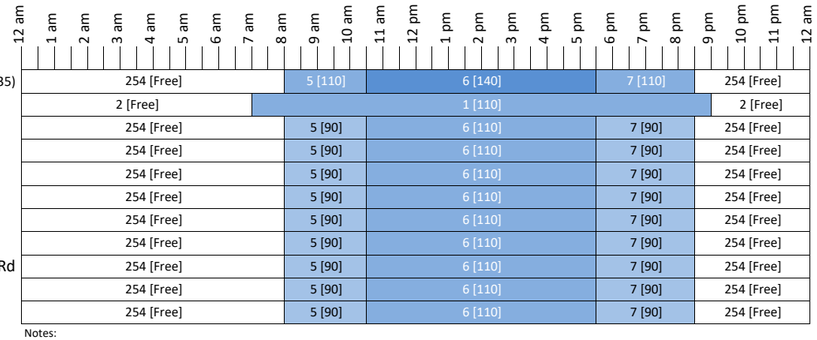
Figure 8
Weekday Day Plan Schedules
Whitehorse-Mercerville Rd (CR 533) & Nottingham Way (NJ Route 33/CR 653)

EXISTING SCHEDULES
Whitehorse-Mercerville Rd (CR 533)
Saturday



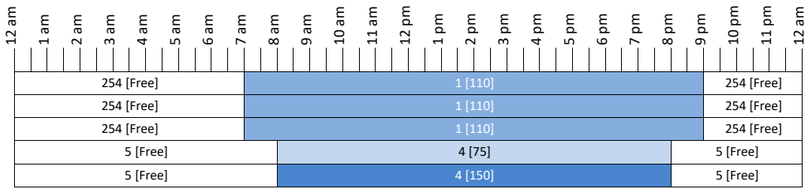
Notes:

IMPLEMENTED SCHEDULES
Whitehorse-Mercerville Rd (CR 533)
Saturday



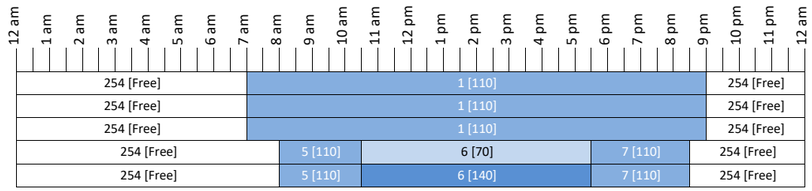
Notes:

EXISTING SCHEDULES
Nottingham Way (NJ Rt 33/CR 653)
Saturday



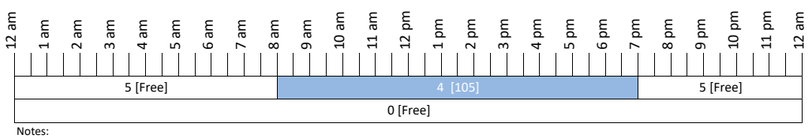
Notes:

IMPLEMENTED SCHEDULES
Nottingham Way (NJ Rt 33/CR 653)
Saturday



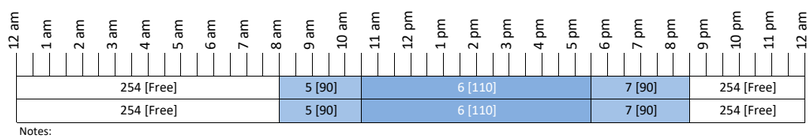
Notes:

EXISTING SCHEDULES
Kuser Rd (CR 619)
Saturday



Notes:

PROPOSED SCHEDULES
Kuser Rd (CR 619)
Saturday

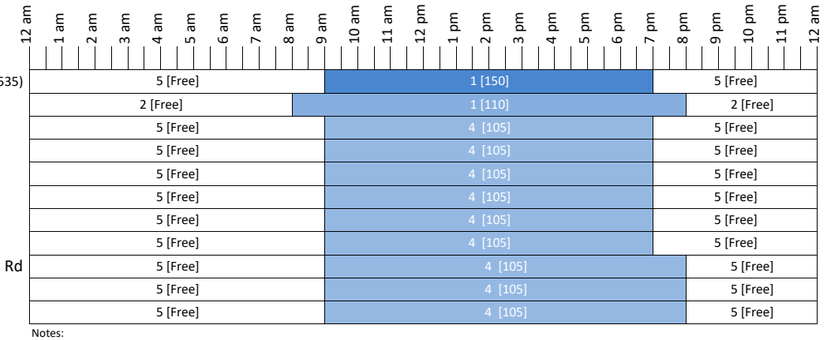


Notes:

LEGEND
A white box indicates FREE operation, a shaded box indicates coordinated operation.
The first number specifies the pattern, the second number [in brackets] is the cycle length (s).
Darker shades represent a longer cycle length.

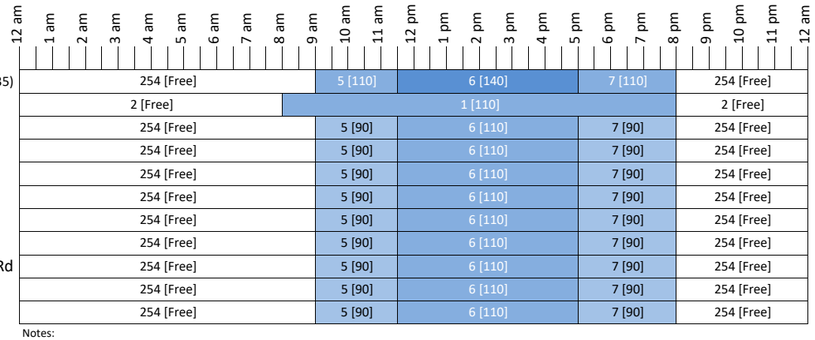
Figure 9
Saturday Day Plan Schedules
Whitehorse-Mercerville Rd (CR 533) & Nottingham Way (NJ Route 33/CR 653)

EXISTING SCHEDULES
Whitehorse-Mercerville Rd (CR 533)
Sunday



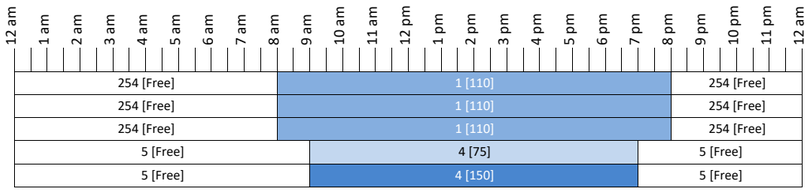
Notes:

IMPLEMENTED SCHEDULES
Whitehorse-Mercerville Rd (CR 533)
Sunday



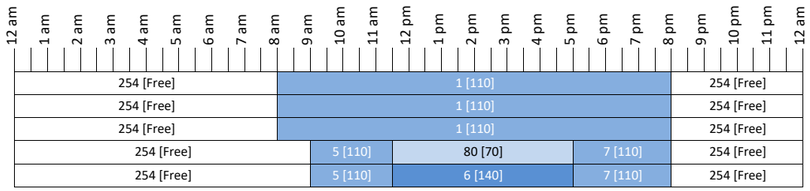
Notes:

EXISTING SCHEDULES
Nottingham Way (NJ Rt 33/CR 653)
Sunday



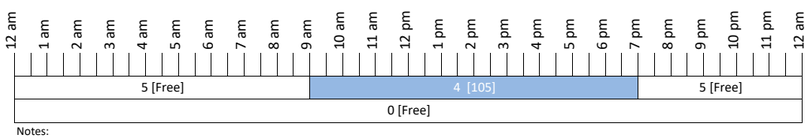
Notes:

IMPLEMENTED SCHEDULES
Nottingham Way (NJ Rt 33/CR 653)
Sunday



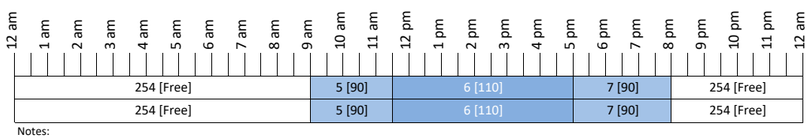
Notes:

EXISTING SCHEDULES
Kuser Rd (CR 619)
Sunday



Notes:

PROPOSED SCHEDULES
Kuser Rd (CR 619)
Sunday



Notes:

LEGEND
A white box indicates FREE operation, a shaded box indicates coordinated operation.
The first number specifies the pattern, the second number [in brackets] is the cycle length (s).
Darker shades represent a longer cycle length.

Figure 10
Sunday Day Plan Schedules
Whitehorse-Mercerville Rd (CR 533) & Nottingham Way (NJ Route 33/CR 653)

4.5 Pattern Optimization

The list below summarizes each time period that was modeled and analyzed for this system and the overall peak hour that was determined from the volumes collected for this project. Within the network, however, each signal was optimized using volumes from its own individual peak hour within the period for which the pattern was designed to operate instead of the overall peak hour.

Time-of-Day	Abbreviation	Pattern No.	Network Peak Hour
Weekday AM Peak	AM	1	8:00 am – 9:00 am
Weekday Midday Peak	MD	2	12:45 pm – 1:45 pm
Weekday PM Peak	PM	3	4:30 pm – 5:30 pm
Weekday PM Off-peak	PO	4	6:30 pm – 7:30 pm
Weekend AM Peak	WA	5	9:30 am – 10:30 am
Weekend Midday Peak	WM	6	12:00 pm – 1:00 pm
Weekend PM Peak	WP	7	6:00 pm – 7:00 pm

Cycle lengths were developed in an effort to balance optimal progression along Whitehorse-Mercerville Rd (CR 533) and to limit the delay experienced by pedestrians and side street traffic. One signal, Kuser Road (CR 619) & Whitehorse Hamilton Square Road, was operating in free operation under existing conditions, so cycle lengths were selected in an effort to make the adjustment to coordinated timings as unnoticeable as possible to typical drivers on the network.

The existing cycle lengths for the coordinated signals along Whitehorse-Mercerville Rd (CR 533) were typically decreased across all time periods to provide more optimal coordination along the corridor. The cycle lengths on Nottingham Way (NJ Rt 33/CR 653) generally remained the same as the existing but was reduced for several off-peak time periods, such as the PM off-peak (PO). In communication with NJDOT, the signals along NJ Route 33 had been recently retimed, so those signals were analyzed for improvements and were ultimately treated as fixed timings to tie in the Mercer County signals. The existing cycles for the NJDOT signals were appropriate and the clearances were all recently completed and up to standard.

The coordination under existing conditions had the Whitehorse Avenue (CR 533) signals between South Clinton Avenue and Milton Avenue/Whitehorse Hamilton Square Rd on one network, then the signals between South Olden Avenue (CR 622) and Estates Boulevard on another. In the optimization, it was determined that those networks should run a consistent cycle length due to corridor characteristics and existing observations. The two Mercer County signals on Nottingham Way (CR 653) continued to run different cycle lengths with the signal at East State Street generally half cycled to service the side streets faster. During some time periods, the weekend AM (WA) and weekend PM (WP), those two signals are coordinated with the NJDOT network at a 110 second cycle length. The main point is there was significant analysis put into the development of cycle lengths and subsystems for this project.

4.6 Phase Sequences

Phase sequence diagrams illustrate the phasing at each intersection as well as the sequences that are used with existing and implemented timing patterns. Sequence diagrams are shown in Figure 13 and Figure 15 on pages 29 – 31. For this project, there were no changes in phase sequence from existing to implemented conditions.

4.7 Pre-Implementation Memorandum

Once all timings were developed, the proposed timings were summarized in a series of figures and sent to Mercer County representatives for review. Initial timing directives were created reflecting the proposed timings and simple summary timing sheets were also developed to match the programming style and terminology in each controller. The provided Pre-Implementation Memorandum is included in the Report folder on the project website. An implementation plan was proposed to Mercer County and Iteris then gained approval for implementation by Mercer County. This was to be done while schools were still in full session to ensure the traffic volumes would not be lower than normal for implementation.

5.0 SIGNAL TIMING IMPLEMENTATION

5.1 Controller Programming

After the basic timing parameters were updated, optimized signal timings were developed, and an updated day plan schedule was created, this information was coded into database files and tested with coordination diagnostic tools and test controllers where possible. For this system, the Trafficware StreetSync was utilized for the Naztec controllers and Econolite Aries Zone Manager software was utilized for the Econolite signals. Once each database was tested successfully, each database was downloaded to the local controllers on Tuesday, October 31, 2023. Following the initial downloads, the signals were observed for proper operation and each controller was observed to address any issues that could have occurred during the data transfer. Mercer County staff supported the initial downloads of the new timings into the controllers. In coordination with Hamilton Township, the timing directive was provided to the Township for implementation from the maintenance provider. The four NJDOT signals were confirmed to be running the appropriate timings and the timing directives were thoroughly backchecked for accuracy.

5.2 Fine-Tuning of Signal Timings

Each new timing plan was observed at each intersection at some point during its respective peak hour to ensure each phase split was appropriate for the traffic conditions present. At some intersections, fine-tuning may consist of simply increasing or decreasing a split for one or more phases. If a movement or intersection is over capacity, split adjustments may be required to manage queue spillback and blockage.

In addition to fine-tuning splits, offset adjustments often have a larger effect on the performance of the network. Offset adjustments at coordinated intersections were determined by conducting travel time runs along the corridor. Travel time runs were conducted using Tru-Traffic (v 10.0). Tru-Traffic, in conjunction with a direct connect GPS unit, tracks the location of the test vehicle within the traffic signal system. Because the software uses the actual traffic signal timing settings and an actual vehicle in the traffic stream, this fine-tuning tool can be powerful. This also provides the user dynamic information about the performance of the traffic signal system such as travel time and delay. Results of the travel time runs under existing signal timings (the “before” runs) and implemented signal timings (the “after” runs) are discussed in Section 6.4 of this report.

The fine-tuning process for this project took place over the course of a week and all signals were observed for proper and optimal operation during each time period, including the off-peak pattern on both Saturdays and Sundays. All changes to the proposed timings presented in the Pre-Implementation Memorandum were documented and updated in each model, timing sheet and timing directive. Once fine-tuning was completed and timings were finalized, timing directives were thoroughly reviewed for accuracy to match the controller programming and were placed in each local cabinet for reference during any maintenance visit that may occur in the future. The changes made during fine-tuning for this project were minor and included offset and phase allocation adjustments to balance optimal progression and side street operations.

Following the completion of fine-tuning, final timing directives and summary timing sheets were updated to reflect the new timings in each controller. Those files were placed in each physical cabinet and old directives were marked to denote that they are now outdated.

6.0 TRAFFIC OPERATIONS ANALYSIS

Operations analysis was conducted, using the traffic models, on each of the periods with existing signal timings. This analysis established a benchmark by which traffic operations with implemented signal timings are compared. In addition to the models, travel time runs were conducted in the field to specifically measure the change in travel time and delay on the primary corridor.

6.1 Intersection Performance Measures

Synchro (v11) was used to determine the delay (in seconds per vehicle) for each lane group as well as the delay and level of service (LOS) for the intersection. SimTraffic was used to determine the delay for each movement and the intersection by averaging five, one-hour simulations. The intersection capacity utilization (ICU) was also determined for each intersection. The delay, LOS, and ICU for each intersection can be found in Figure 16 through Figure 47 on pages 32 – 63.

The figures illustrate traffic operations at the same intersection for the various periods and scenarios analyzed. The top row illustrates each period with existing hourly volumes. The second row illustrates each period with existing signal timings. The third row illustrates each period with implemented signal timings. The bottom row, if present, summarizes traffic operations for each period if recommended capacity improvements are made at the intersection. These recommended improvements are described in Section 8.2 of this report. This arrangement allows easy comparison of operations across all periods and scenarios.

In general, intersections may experience an increase in overall intersection delay when 1) the cycle length is significantly adjusted from its optimal cycle length to provide coordination, 2) green times are allocated with the objective of providing maximum progression on the major street or 3) green times are allocated to prevent queue spillback and blockage. Table 1, below, summarizes the number of intersections that experienced an increase or decrease in overall intersection delay during each period.

Table 1 – Summary of Changes in Intersection Delay

Number of intersections where:	AM	MD	PM	PO	WA	WM	WP
delay decreased	9	13	11	15	11	7	13
delay increased ≤ 5 sec/veh	7	3	5	1	4	8	2
delay increased > 5 sec/veh	0	0	0	0	1	1	1

Table 2 – Intersection(s) where Delay Increased Greater than Five Seconds per Vehicle

Intersection	Period	Existing Delay (s/veh) - LOS	Implemented Delay (s/veh) - LOS
Whitehorse Ave (CR 533) & Kuser Rd (CR 619)	WM	31 - C	37 - D
Nottingham Way (CR 653) & E State St (CR 535)	WA	12 - B	20 - B
	WP	11 - B	19 - B

While delay largely decreased across all periods, there are two intersections where delay increased more than five seconds per vehicle during a peak period. The intersection of Whitehorse Avenue (CR 533) & Kuser Road (CR 619) shows a delay increase in the weekend midday (WM) period. The cycle length was increased during this time period, and an increase in cycle length along with increased clearance intervals can cause an increase in delay. At the intersection of Nottingham Way (CR 653) & E State St (CR 535), the increase in delay occurring during the weekend AM (WA) and weekend PM (WP) time periods were a result of longer cycle lengths. For this time period, all signals on the network run a consistent 110 second cycle length. While this signal is typically half-cycled, that was not possible for this time period given coordination minimums, so the cycle had to be increased. In all of the cases listed, the LOS remains below an F.

6.2 Network Performance Measures

While the figures in Section 6.1 summarize performance of each individual intersection by delay, LOS, and ICU, the tables in this section combine and summarize four performance measures for all intersections in the network: total delay, total stops, total travel time, and total fuel consumption. The tables also summarize the percent reduction of each measure, which illustrates the overall improvement to the network with the implemented signal timings. The performance measures were calculate1d (not field-measured) by two separate models, Synchro and SimTraffic. The models summarize data for all vehicles in the network. Network performance measures developed by Synchro and SimTraffic can be found below.

Table 3 – Whitehorse-Mercerville Rd (CR 533) Synchro Network Performance Measures

	AM Peak			MD Peak			PM Peak			PM Off-peak		
	Existing	Implemented	Difference	Existing	Implemented	Difference	Existing	Implemented	Difference	Existing	Implemented	Difference
Total Delay (hr)	264	239	-9.5%	226	216	-4.4%	326	307	-5.8%	155	145	-6.5%
Total Stops	17,117	17,266	0.9%	15,566	15,557	-0.1%	20,637	20,342	-1.4%	12,437	12,809	3.0%
Total Travel Time (hr)	515	491	-4.7%	471	461	-2.1%	620	602	-2.9%	357	347	-2.8%
Fuel Consumed (gal)	676	661	-2.2%	632	626	-0.9%	814	800	-1.7%	493	490	-0.6%
	Weekend AM Peak			Weekend MD Peak			Weekend PM Peak					
	Existing	Implemented	Difference	Existing	Implemented	Difference	Existing	Implemented	Difference			
Total Delay (hr)	193	178	-7.8%	201	198	-1.5%	117	107	-8.5%			
Total Stops	13,647	13,874	1.7%	14,617	14,858	1.6%	10,049	10,511	4.6%			
Total Travel Time (hr)	411	396	-3.6%	440	436	-0.9%	284	274	-3.5%			
Fuel Consumed (gal)	553	545	-1.4%	597	596	-0.2%	398	395	-0.8%			

Table 4 – Whitehorse-Mercerville (CR 533) SimTraffic Network Performance Measures

	AM Peak			MD Peak			PM Peak			PM Off-peak		
	Existing	Implemented	Difference	Existing	Implemented	Difference	Existing	Implemented	Difference	Existing	Implemented	Difference
Total Delay (hr)	284	232	-18.3%	220	216	-1.9%	422	394	-6.5%	144	139	-3.5%
Total Stops	17,840	16,504	-7.5%	15,084	15,313	1.5%	22,145	21,249	-4.0%	11,662	11,420	-2.1%
Total Travel Time (hr)	699	628	-10.2%	590	584	-0.9%	880	852	-3.2%	455	451	-0.8%
Fuel Consumed (gal)	486	469	-3.3%	446	444	-0.5%	578	571	-1.3%	363	360	-0.8%
	Weekend AM Peak			Weekend MD Peak			Weekend PM Peak					
	Existing	Implemented	Difference	Existing	Implemented	Difference	Existing	Implemented	Difference			
Total Delay (hr)	209	179	-14.2%	198	196	-0.9%	111	103	-7.3%			
Total Stops	13,492	13,138	-2.6%	14,531	14,354	-1.2%	9,299	9,112	-2.0%			
Total Travel Time (hr)	539	507	-6.0%	564	561	-0.6%	367	361	-1.9%			
Fuel Consumed (gal)	398	390	-2.0%	436	433	-0.6%	298	296	-0.6%			

The overall network performance measures improved during all time periods in both Synchro and SimTraffic. Over the expected five-year life of the project and based upon calculated values, the implemented signal timing is estimated to reduce delay by 88,300 hours (6.4%), stops by 600,000 (0.7%) and fuel consumption by 50,600 gallons (1.3%). Based on the fuel savings above, the implemented signal timing is estimated to reduce carbon dioxide emissions by 400 metric tons over the life of the project. That estimate is calculated utilizing an equation developed by the US Environmental Protection Agency and factors in a number of the measures from Synchro.

6.3 Time-Space Diagrams

Time-space diagrams can be used as a tool for fine-tuning splits and offsets and maximizing corridor bandwidth and progression. Time-space diagrams for each of the implemented patterns for each roadway are included on the project website. These diagrams show the designed progression for each roadway and the relationship between intersections across the network.

6.4 Travel Time Runs

As stated in Section 2.5, travel time runs were conducted as a fine-tuning tool. In addition to fine-tuning, travel time runs also provide the analyst field-measured metrics such as delay and travel time reductions. While only travel time and delay are summarized here, information on other measures such as the number of stops, stopped delay, and average speed can be found on the project website.

Travel time runs for both directions on Whitehorse-Mercerville Rd (CR 533) were conducted before and after the new signal timings were implemented. The average of the "existing" runs was compared to the average of the "implemented" runs to determine travel time savings on the corridor. These performance data are field-measured and apply only to vehicles on the main corridor. Figure 11 on page 23 illustrates the average cumulative travel time on the corridor for each direction with existing and implemented signal timings. The tables at the top of these figures summarize the average travel time and delays with existing and implemented signal timings and the percent change in those measurements.

Along Whitehorse-Mercerville Rd (CR 533), travel time runs were completed between South Clinton Avenue and Nottingham Way (CR 653)/Edinburg Road (CR 535). In the northbound direction, weekday travel times decreased by up to 66 seconds (12.4%) and weekend travel times decreased by up to 122 seconds (23.9%). In the southbound direction, weekday travel times decreased by up to 105 seconds (19.6%) and weekend travel times decreased by up to 95 seconds (20.9%).

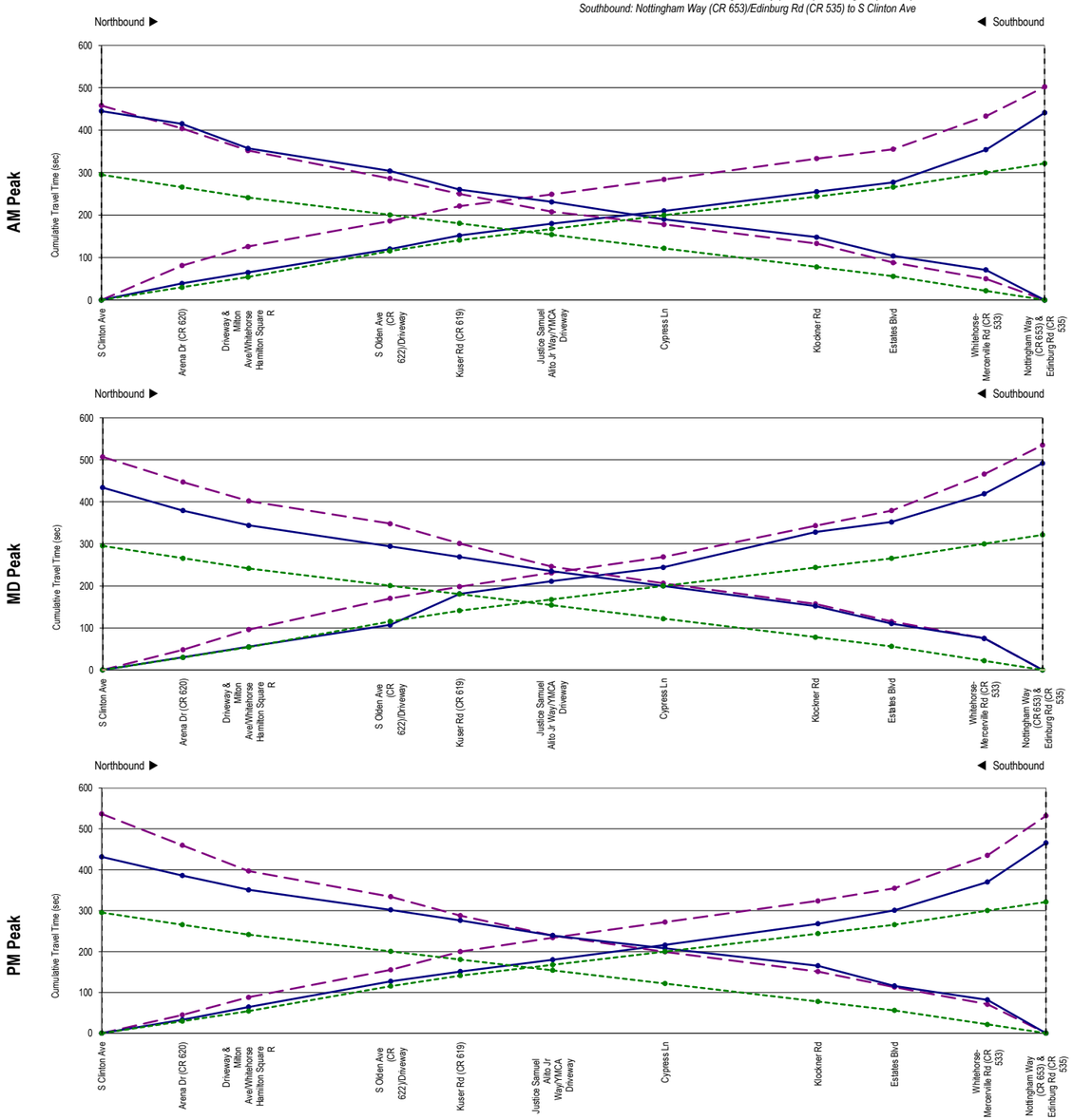
During the travel time runs conducted under both existing and implemented conditions, dash cam video was collected. Those videos were then processed into several comparison videos detailing visually side by side the improvements across the network. Those videos are available on the project website and were developed for the northbound direction in the AM period and both the northbound and southbound directions for the PM period.

Average Total Travel Time & Delay

Whitehorse Ave (CR 533): 3.4 miles

		AM Peak		MD Peak		PM Peak		PM Off-peak		Weekend AM Peak		Weekend MD Peak	
		Travel Time (s)	Delay (s)	Travel Time (s)	Delay (s)	Travel Time (s)	Delay (s)	Travel Time (s)	Delay (s)	Travel Time (s)	Delay (s)	Travel Time (s)	Delay (s)
Northbound	Existing	502	181	535	214	532	211	523	202	471	150	511	189
	Implemented	441	119	492	170	466	145	459	137	422	100	389	68
	Difference	-61		-43		-66		-64		-49		-122	
	% Difference	-12.2%	-33.7%	-8.0%	-20.1%	-12.4%	-31.3%	-12.2%	-31.7%	-10.4%	-32.7%	-23.9%	-64.6%
Southbound	Existing	458	158	507	208	537	237	494	195	432	133	454	155
	Implemented	445	146	434	134	432	133	416	117	400	100	359	60
	Difference	-13		-73		-105		-78		-32		-95	
	% Difference	-2.8%	-8.2%	-14.4%	-35.1%	-19.6%	-44.3%	-15.8%	-40.0%	-7.4%	-24.1%	-20.9%	-61.3%

Northbound: S Clinton Ave to Nottingham Way (CR 653)/Edinburg Rd (CR 535)
Southbound: Nottingham Way (CR 653)/Edinburg Rd (CR 535) to S Clinton Ave



Existing
Implemented
Free Flow

7.0 TRAFFIC SIGNAL RETIMING BENEFIT-COST ANALYSIS

The purpose of this analysis is to establish a project's merit by economically quantifying the benefits and costs associated with the project over its lifetime. According to the ITE, "signal retiming is a beneficial method for maintaining efficient traffic signal operations" and "is the most cost-effective technique to reduce congestion, improve air quality, and potentially reduce accidents." The following discusses the methodology used to determine the benefits and costs of implementing new signal timings at the intersections within the scope of this project.

There are two types of benefits as they relate to transportation improvements. User benefits, or direct benefits, are enjoyed directly by travelers and are determined by a reduction in three distinct travel costs: travel time costs, operating costs, and crash costs. The second type of benefit is non-user benefits, or indirect benefits. These benefits include environmental impacts, air quality, and reduced motorist frustration.

While improved signal timing reduces certain types of crashes, it is difficult to determine the actual reduction without collecting several years of data. Therefore, this analysis assumes the number of crashes will remain constant throughout the life of the project. However, it should be noted that the implemented signal timing and updated clearance intervals may reduce the frequency of some types of crashes at all intersections. Studies reported by the Federal Highway Administration have shown that total crashes are reduced by an average of 15% through retiming; and right-angle crashes reduced by an average of 25% to 32%.

7.1 Travel Time & Operations Benefit-Cost Analysis

Travel time benefits were calculated by modeling delay with existing and implemented signal timings during each hour modeled within Synchro. Each pattern modeled analyzes only the single peak hour for each time period, so benefits were also estimated for non-peak hours during which implemented timings are in coordinated operation. The total delay was multiplied by a value-of-time and auto occupancy to determine the total weekly benefit as a result of reduction in travel time as shown in Table 5 below. The value of time is determined from the Consumer Price Index while the heavy vehicle percentage of four percent on this system was estimated based on the turning movement count data collected in this project, which includes volume counts by classification.

Table 5 – Weekly Benefit for Change in Travel Time Costs – Whitehorse-Mercerville Rd (CR 533)

Delay (h)	AM	MD	PM	PO	WA	WM	WP
Existing Timings	264	226	326	155	193	201	117
Implemented Timings	239	216	307	145	178	198	107
Change	-25	-10	-19	-10	-15	-3	-10
Estimated Change during other hours				-33			-13
Total Daily Change				-97			-41
Total Weekly Change in Delay				-485			-83

	Auto	Truck
Vehicle Type	96%	4%
Value-of-Time ($/hr) [1,2]	$11.48	$118.75
Auto Occupancy [1]	1.25	1.00
Total	$7,825	$2,697
Weekly Benefit for Change in Travel Time Costs		**$10,522**

[1] *Taken from* Urban Mobility Report, *Texas Transportation Institute, 2012 and adjusted based on Consumer Price Index for May 2024*

[2] *Adjusted for trip type per AASHTO* User Benefit Analysis for Highways, *2003*

Benefits for the reduction in operating costs were calculated by modeling fuel consumption within Synchro with existing and implemented signal timings during each peak hour and estimating fuel consumption during non-peak hours. The total change in fuel consumption was multiplied by the twelve-month average fuel cost from the US Energy Information Administration (EIA) for the Central Atlantic Region where this corridor is located. The weekly benefit for change in operating costs is shown in Table 6 on page 25.

Table 6 – Weekly Benefit for Change in Operating Costs – Whitehorse-Mercerville Rd (CR 533)

Fuel Consumption (gal)	AM	MD	PM	PO	WA	WM	WP
Existing Timings	676	632	814	493	553	597	398
Implemented Timings	661	626	800	490	545	596	395
Change	-15	-6	-14	-3	-8	-1	-3
Estimated Change during other hours				-20			-6
Total Daily Change				-58			-18
Total Weekly Change				-290			-36
Fuel Cost [1]							$3.70
Weekly Benefit for Change in Operating Costs							**$1,205**

[3] *52-week average fuel cost, US Energy Information Administration Gasoline Prices for the Central Atlantic Region, June 2024 - www.eia.gov*

Based on the previous tables, the total weekly benefit is $11,726.

In order to calculate the total lifetime benefit present value, it was assumed the life of this project will be five years even though the benefit should long outlive that period. As with most of estimates made in the benefit section, the analysis used conservative values, so actual benefits are likely much higher. A discount rate of 3% was used for this estimate. It was also assumed that 100% of the total daily benefit will be realized in Year 1. However, as traffic volumes change, the benefits will decrease. Therefore, benefits in subsequent years are reduced by 20% each year. Table 7 summarizes the present values of annual benefits.

Table 7 – Present Value of Annual Benefits

Year	Annual Benefit Present Value
Year 1	$600,531
Year 2	$466,432
Year 3	$339,635
Year 4	$219,828
Year 5	$106,713

The present value of total lifetime benefits based on the table above is approximately $1,733,100.

Costs

The total cost to conduct all the tasks for the intersections within the scope of this project was $96,611.

Benefit-Cost Ratio

Comparing the anticipated benefits from savings in travel time and operating costs to the overall project costs, the anticipated benefit-cost ratio for this project is 18:1.

8.0 RECOMMENDATIONS

8.1 Recommendations for Safety Improvements

Based on the field observations in Section 2.0, the following improvements are recommended to mitigate potentially hazardous conditions.

General Recommendations

- A list of pedestrian and vehicle detection issues relating to pedestrian pushbuttons and vehicle detectors is included within the Appendix in Figure 12 on page 28. That list is accurate as of June 29, 2024, so could change before it is reviewed in the field. Consider utilizing that list to update and address all pedestrian and vehicle detection issues to improve pedestrian safety and signal coordination.
- As controllers or cabinet components are upgraded in the future, ensure the timings developed in this project are utilized in the new controllers programming. All critical programming entries are in the timing sheets and directives placed in each cabinet. When controllers are replaced, ensure the controller clocks are set when operational so the background coordinated timings can run as designed through this project.

8.2 Recommendations for Capacity and Operational Improvements

Beyond optimizing traffic signal timing, other improvements such as additional capacity can further improve the performance of an intersection and roadway network. Additional consideration should be given to improvements required by future traffic growth and costs of right-of-way, design, construction, etc. However, these considerations are not included in the scope of this project.

General Recommendations

- Consider installing GPS units to all Mercer County and Hamilton Township cabinets to keep all controller clocks on a consistent time source. Where there are no GPS units installed and there is no central communication system, controller clocks will drift over time. This will gradually reduce the effectiveness of the signal timings and increase the potential for running timings that are not intended from the controller programming. The installation of GPS units would keep all controllers on the same time and will maintain the timings as programmed through this project and as shown on the updated timing directives. If this is not feasible, consider developing a plan to manually set controller clocks regularly as often as possible but at a minimum, every six to eight weeks. This could also be added to any regular preventative maintenance program already in place for these signals. Through this project, it was determined that the signals on Whitehorse Ave (CR 533) between South Clinton Avenue and Milton Avenue/Whitehorse Hamilton Square Road did not have any functional communication. The signals to the north on Whitehorse-Mercerville Road (CR 533) between South Olden Avenue (CR 622) and Estates Boulevard and the two county owned signals on Nottingham Way (CR 653) were observed to have their time drift together, so could be on their own system. A deeper analysis of the communication status would be warranted for this network.
- As this system continues to develop in the future, consider the impact any changes may have to the signal timings for activities such as replacing controllers, upgrading equipment, new developments, or any roadway adjustments.

9.0 APPENDIX

Included in the Appendix within this report are as follows:

- Field Notes Summary with detailed list of detection and operational issues found during project (Figure 12)
- Phase Sequence Diagrams (Figure 13 – Figure 15)
- Traffic Operations Analysis figures (Figure 16 – Figure 47)

Documents included on the project website:

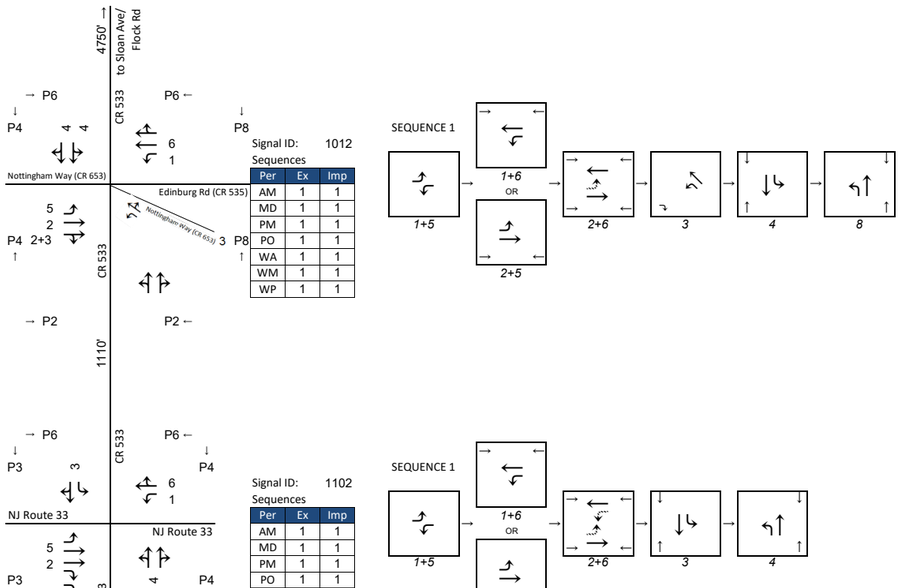
- 7-day, 24-hour directional raw volume counts
- Turning movement counts
- Clearance calculations
- Existing and implemented timing sheets
- Existing and implementing timing directives
- Intersection cabinet, approach, and aerial photographs
- Field notes
- Synchro models with existing and implemented signal timings and report files
- Tru-Traffic files and travel time reports displaying time-space diagrams with implemented signal timings
- Travel time run comparison videos
- Final report

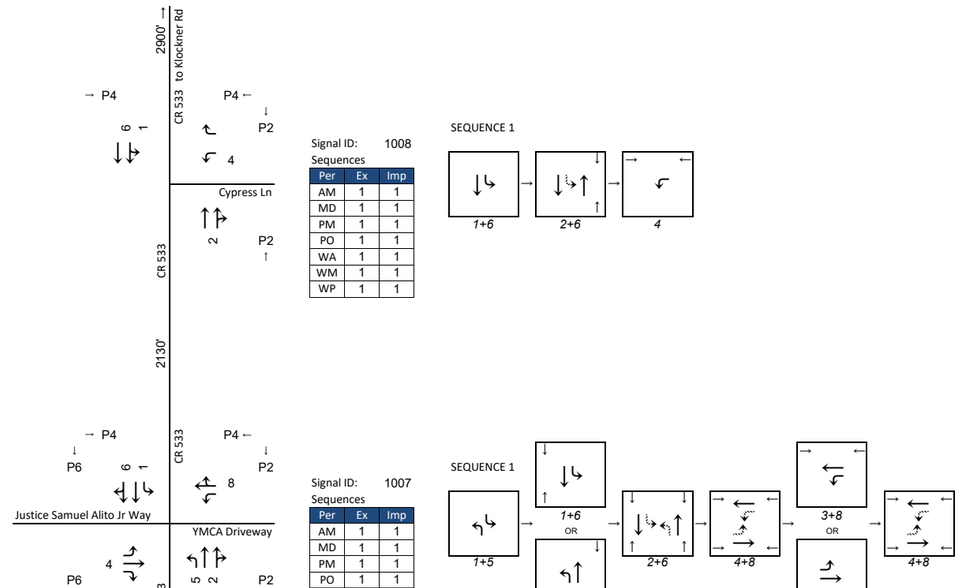
Full NJ Signal Retiming Project URL is as follows:
https://iterisinc1.sharepoint.com/sites/CS-Ext-NJSignalTiming

Individual Project page under Project Page section:
Whitehorse-Mercerville Rd (CR 533) - Mercer County

Please note that permissions must be manually added to access SharePoint website, so please direct any requests for access to Brian Jatzke at bjatzke@iteris.com.

ID	Intersection	Date of Last Observation	Controller Type	Date/Time Status	Notes and observations from Field Notes *Directionality Notes: CR 533 assumed North-South throughout network, Nottingham Way assumed East-West*
1001	Whitehorse Ave (CR 533) & S Clinton Ave	06/29/2024	Naztec 2070	Date OK, clock 15 seconds slow from GPS time	Clock at #1001, 1002 and 1003 appear to drift faster than the others, potentially getting a daily time sync from another source? Applies to #1001 - 1003 (still applies at conclusion of project)
1002	Whitehorse Ave (CR 533) & Arena Dr (CR 620)	06/29/2024	Naztec 2070	Date OK, clock 15 seconds slow from GPS time	Detection issues from retiming project all addressed as of final inspection but remaining issue is Ø7 (EBLT) was observed to hold calls without presence. May have been due to wind or shadows impacting the detection zone. - This clock drifts faster than the others, potentially getting a daily time sync from another source? Applies to #1001 - 1003
1003	Whitehorse Ave (CR 533) & Milton Ave-Whitehorse Hamilton Sq Rd	06/29/2024	Naztec 2070	Date OK, Clock 15 seconds slow from GPS time	- This clock drifts faster than the others, potentially getting a daily time sync from another source? Applies to #1001 - 1003
1004	Whitehorse Ave (CR 533) & S Olden Ave (CR 622)	06/29/2024	Naztec 2070	Date OK, clock 6 seconds fast from GPS time	- Ø4 (eastbound) detection not functioning by not picking up calls, so Ø2 (northbound), Ø4 (Eastbound) and Ø6 (southbound) all in maximum recall to account for that in programming. This may be on purpose due to the heavy eastbound movement but Whitehorse Ave would function significantly better, especially during off-peak periods, if there was solid side street detection at this intersection.
1005	Whitehorse Ave (CR 533) & Kuser Rd (CR 619)	06/29/2024	Naztec 2070	Date OK, clock 10 seconds slow from GPS time	- Detection all working properly as of last inspection.
1007	Whitehorse-Mercerville Rd (CR 533) & Justice Samuel A Alito Jr Way	06/29/2024	Naztec 2070	Date OK, Clock 10 seconds slow from GPS time	- No issues observed. Intermittently observed northbound left-turn servicing full alottment without demand but when checked in controller, looked to be operating properly. Specifically noted the detection issue to occur in the AM period, so could be a shadow or wind issue. There is tight progression through this signal, so addressing this issue would help operations rather significantly.
1008	Whitehorse-Mercerville Rd (CR 533) & Cypress Ln	06/29/2024	Naztec 2070	Date OK, clock 11 seconds slow from GPS time	- No detection for Ø1 (southbound left-turn), Ø2 (northbound) or Ø6 (southbound). Phases 1, 2 & 6 in maximum recall. The progression design factored this in, so not an issue necessarily.
1009	Whitehorse-Mercerville Rd (CR 533) & Klockner Rd	06/29/2024	Naztec 2070	Date OK, clock 2 seconds slow from GPS time	- No issues observed
1010	Whitehorse-Mercerville Rd (CR 533) & Estates Blvd	06/29/2024	Naztec 2070	Date OK, clock 10 seconds slow from GPS time	- No issues observed
1102	Whitehorse-Mercerville Rd (CR 533) & NJ Route 33 (NJDOT)	06/29/2024	Naztec 980 TS2	GPS in cabinet, date and time both right on with GPS time.	- NJDOT Maintained signal, no issues observed.
1012	Whitehorse-Mercerville Rd (CR 533) & Nottingham Way (CR 618)/ Edinburg (CR 535)	06/29/2024	Naztec 2070	Date OK, clock 1 second slow from GPS time	- All detection and pedestrian buttons working properly.
1011	Nottingham Way (CR 652) & East State St (CR 535)	06/29/2024	Naztec 2070	Date OK, clock 13 seconds fast from GPS time	- No detection for Ø2 (eastbound), Ø5 (eastbound left-turn) or Ø6 (westbound). Phases 2, 5 & 6 in maximum recall
1013	Nottingham Way (SR 33-CR 652) & NJ Route 33/Winslow Ave	11/04/2023	Econolite Cobalt	GPS in cabinet, date and time both right on with GPS time.	- NJDOT Maintained signal. No detection for Ø2 (eastbound) and Ø6 (westbound) movements.
1014	Nottingham Way (SR 33) & Concord Ave	11/04/2023	Econolite Cobalt	GPS in cabinet, date and time both right on with GPS time.	- NJDOT Maintained signal. No detection for Ø2 (eastbound) and Ø6 (westbound) movements. Northbound 3-section head on southwest corner difficult to see as it is blocked by a tree.
1015	Nottingham Way (SR 33) & Hamilton Ave (CR 606)	11/04/2023	Econolite Cobalt	GPS in cabinet, date and time both right on with GPS time.	- NJDOT Maintained signal. No detection for Ø2 (eastbound) and Ø6 (westbound) movements.
1006	Kuser Rd (CR 619) & Whitehorse Hamilton Square Rd	06/29/2024	Econolite ASC/3-2100	Date OK, clock 2 minute fast from GPS time	- Local municipality (Hamilton Township) maintained signal. No detection for Ø2 (northbound) or Ø6 (southbound).





Phase Diagrams

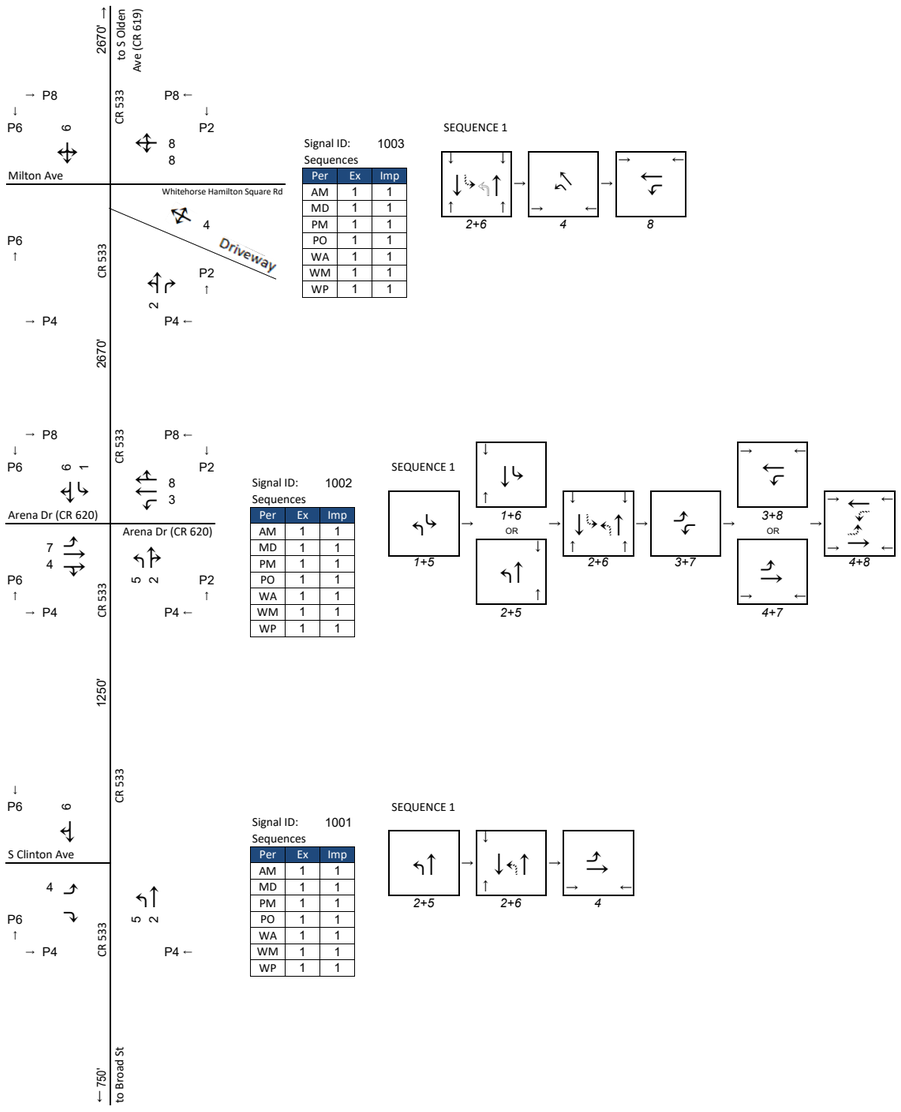
- Permissive Movement
- Protected + Permissive Movement
- Protected-Only Movement

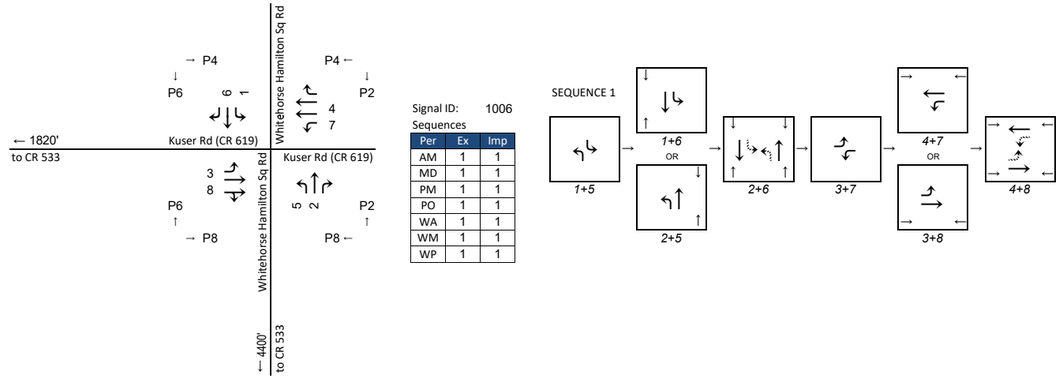
NTS

Figure 13

Phase Sequence Diagrams

Whitehorse Ave (CR 533) - Nottingham Way (CR 653)/Edinburg Rd (CR 535) to S Olden Ave (CR 622)





Phase Diagrams

- Permissive Movement
- Protected + Permissive Movement
- Protected-Only Movement

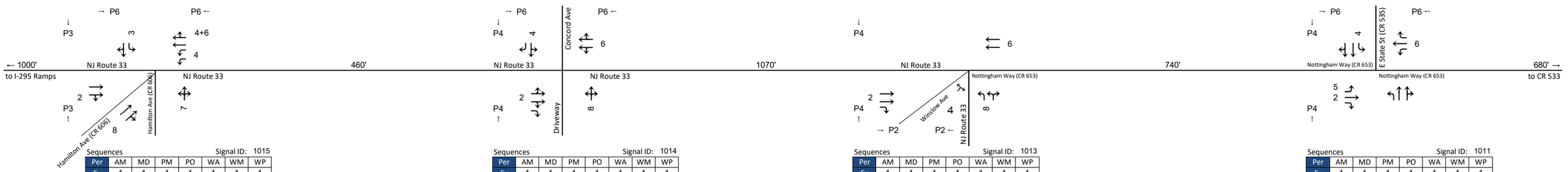
N
NTS

Figure 14

Phase Sequence Diagrams

Whitehorse Ave (CR 533) - Milton Ave/Whitehorse Hamilton Square Rd to S Clinton Ave

Signal is 5 leg, this is showing a simplified version of the layout



Sequences — Signal ID: 1015

	AM	MD	PM	PO	WA	WM	WP
Per							
Ex	1	1	1	1	1	1	1
Imp	1	1	1	1	1	1	1

Sequences — Signal ID: 1014

	AM	MD	PM	PO	WA	WM	WP
Per							
Ex	1	1	1	1	1	1	1
Imp	1	1	1	1	1	1	1

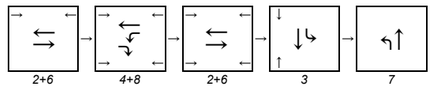
Sequences — Signal ID: 1013

	AM	MD	PM	PO	WA	WM	WP
Per							
Ex	1	1	1	1	1	1	1
Imp	1	1	1	1	1	1	1

Sequences — Signal ID: 1011

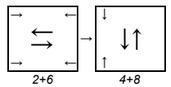
	AM	MD	PM	PO	WA	WM	WP
Per							
Ex	1	1	1	1	1	1	1
Imp	1	1	1	1	1	1	1

SEQUENCE 1

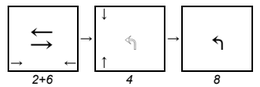


WBLT on NJ Rt 33 and Hamilton Ave Northbound movement

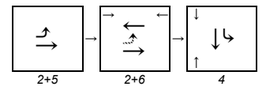
SEQUENCE 1



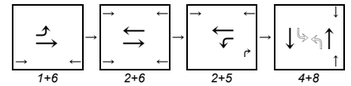
SEQUENCE 1



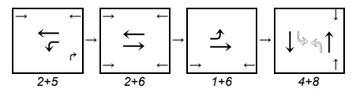
SEQUENCE 1



SEQUENCE 2



SEQUENCE 3



Phase Diagrams

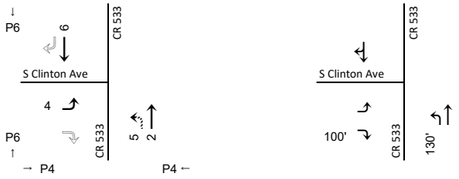
- Permissive Movement
- Protected + Permissive Movement
- Protected-Only Movement

NTS

Figure 15

Phase Sequence Diagrams

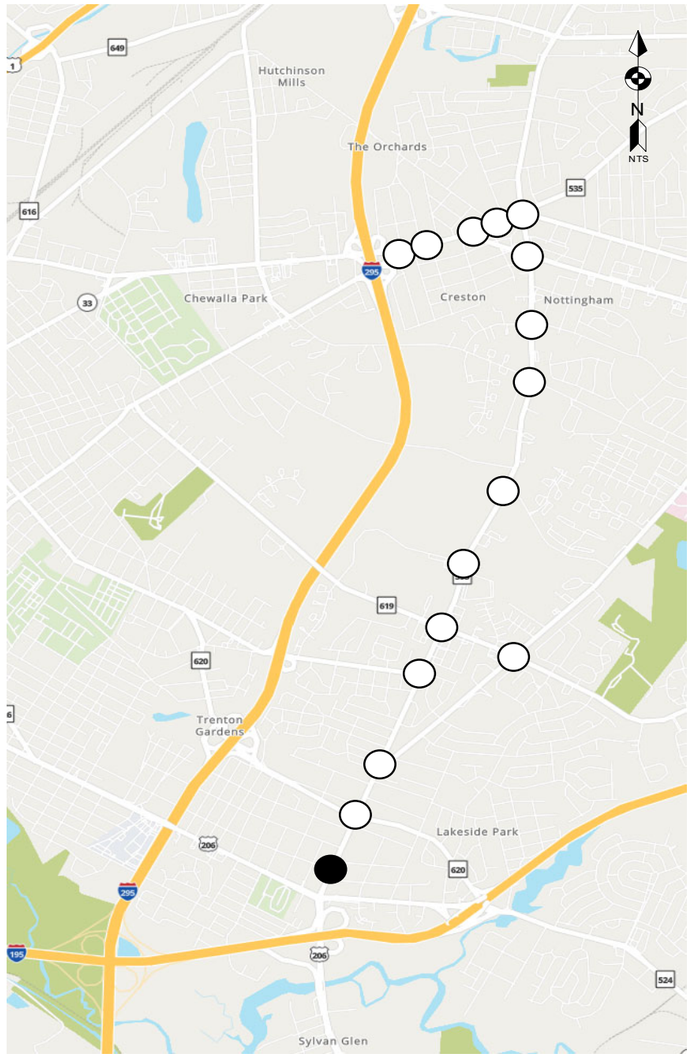
Nottingham Way (NJ Route 33) - Hamilton Ave (CR 606) to East State St (CR 535)



Phasing Diagram

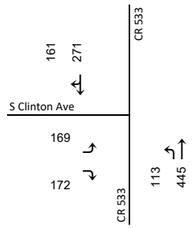
Intersection Geometry

Intersection ID # 1001

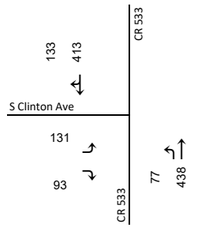


Hourly Volumes

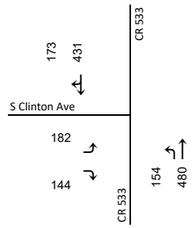
AM Peak Period



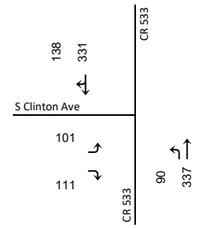
Midday Peak Period



PM Peak Period

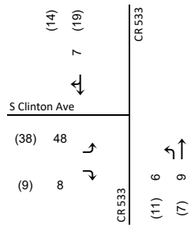


PM Off-peak Period



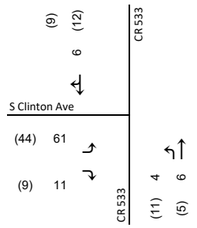
Existing Operations

AM Peak Period



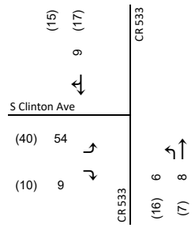
Summary				
Timing Pattern	1	Syn Delay	15	B
Actuated Cycle	90	Sim Delay	(15)	
Max v/C	0.72	ICU	56%	B

Midday Peak Period



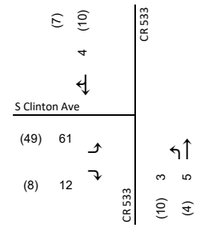
Summary				
Timing Pattern	2	Syn Delay	12	B
Actuated Cycle	110	Sim Delay	(12)	
Max v/C	0.69	ICU	58%	B

PM Peak Period



Summary				
Timing Pattern	3	Syn Delay	14	B
Actuated Cycle	100	Sim Delay	(16)	
Max v/C	0.73	ICU	69%	C

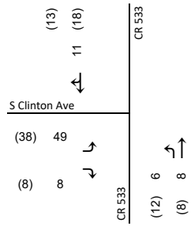
PM Off-peak Period



Summary				
Timing Pattern	2	Syn Delay	11	B
Actuated Cycle	110	Sim Delay	(11)	
Max v/C	0.65	ICU	52%	A

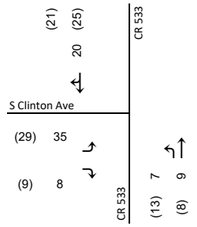
Implemented Operations

AM Peak Period



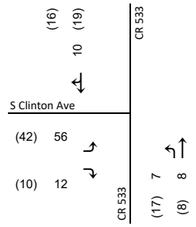
Summary				
Timing Pattern	1	Syn Delay	14	B
Actuated Cycle	100	Sim Delay	(15)	
Max v/C	0.67	ICU	56%	B

Midday Peak Period



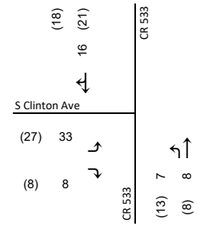
Summary				
Timing Pattern	2	Syn Delay	16	B
Actuated Cycle	90	Sim Delay	(18)	
Max v/C	0.65	ICU	58%	B

PM Peak Period



Summary				
Timing Pattern	3	Syn Delay	15	B
Actuated Cycle	110	Sim Delay	(17)	
Max v/C	0.70	ICU	69%	C

PM Off-peak Period



Summary				
Timing Pattern	4	Syn Delay	14	B
Actuated Cycle	90	Sim Delay	(15)	
Max v/C	0.58	ICU	52%	A

Operations with Improvements

No operational improvements recommended at this time.

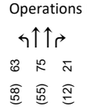
HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams



stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams

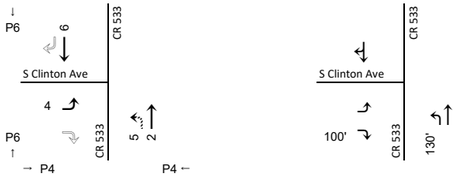
stop bar geometry

turning movement volume

Figure 16

Weekday Traffic Operations Analysis

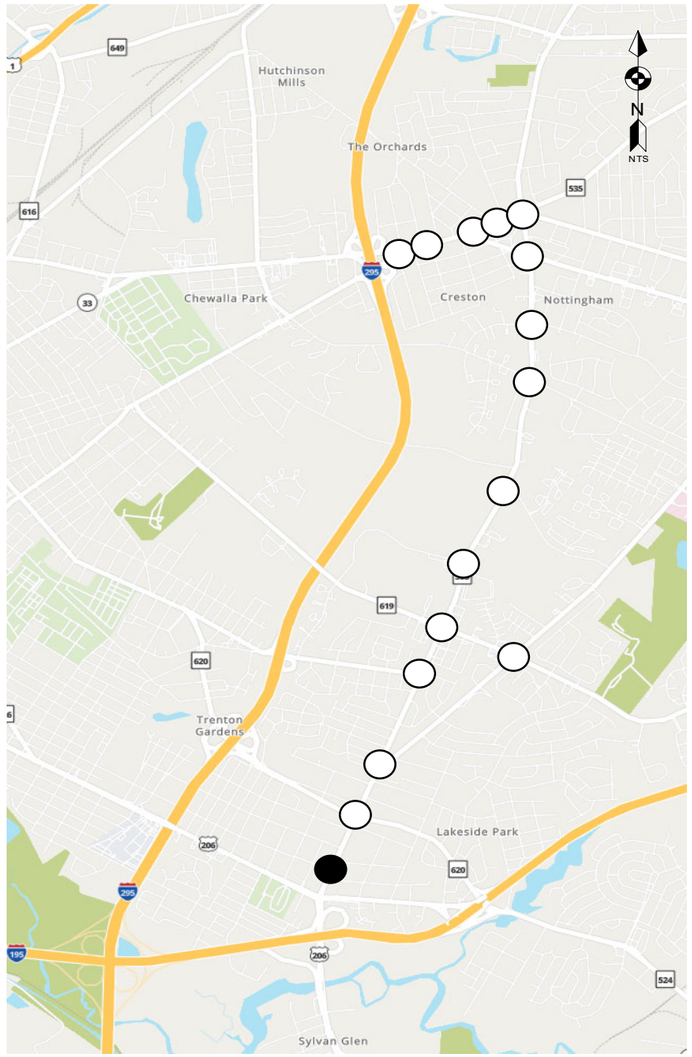
Whitehorse Ave (CR 533) & S Clinton Ave



Phasing Diagram

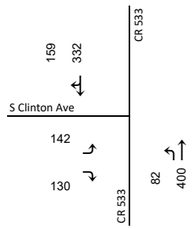
Intersection Geometry

Intersection ID # 1001

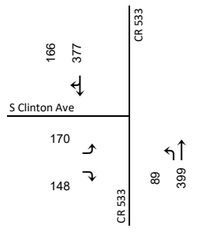


Hourly Volumes

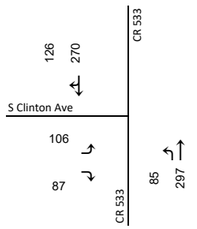
Weekend AM Peak Period



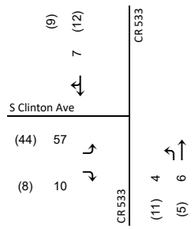
Weekend Midday Peak Period



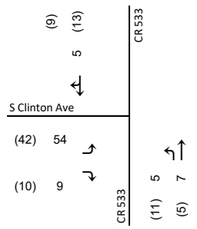
Weekend PM Peak Period



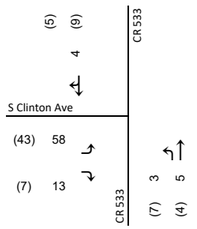
Existing Operations



Summary				
Timing Pattern	4	Syn Delay	13	B
Actuated Cycle	105	Sim Delay	(12)	
Max v/C	0.71	ICU	56%	B

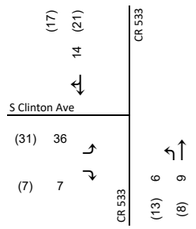


Summary				
Timing Pattern	4	Syn Delay	12	B
Actuated Cycle	100	Sim Delay	(14)	
Max v/C	0.72	ICU	61%	B

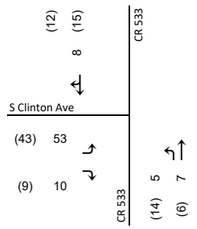


Summary				
Timing Pattern	4	Syn Delay	10	B
Actuated Cycle	105	Sim Delay	(10)	
Max v/C	0.62	ICU	48%	A

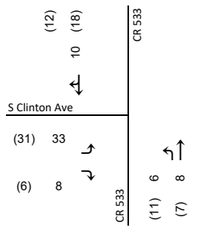
Implemented Operations



Summary				
Timing Pattern	5	Syn Delay	14	B
Actuated Cycle	90	Sim Delay	(15)	
Max v/C	0.59	ICU	56%	B



Summary				
Timing Pattern	6	Syn Delay	14	B
Actuated Cycle	110	Sim Delay	(15)	
Max v/C	0.65	ICU	61%	B



Summary				
Timing Pattern	7	Syn Delay	11	B
Actuated Cycle	90	Sim Delay	(13)	
Max v/C	0.47	ICU	48%	A

Operations with Improvements

No operational improvements recommended at this time.

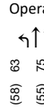
HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams



stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams

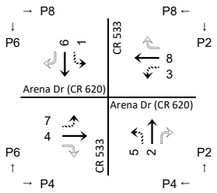
stop bar geometry

turning movement volume

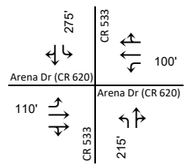
Figure 17

Weekend Traffic Operations Analysis

Whitehorse Ave (CR 533) & S Clinton Ave

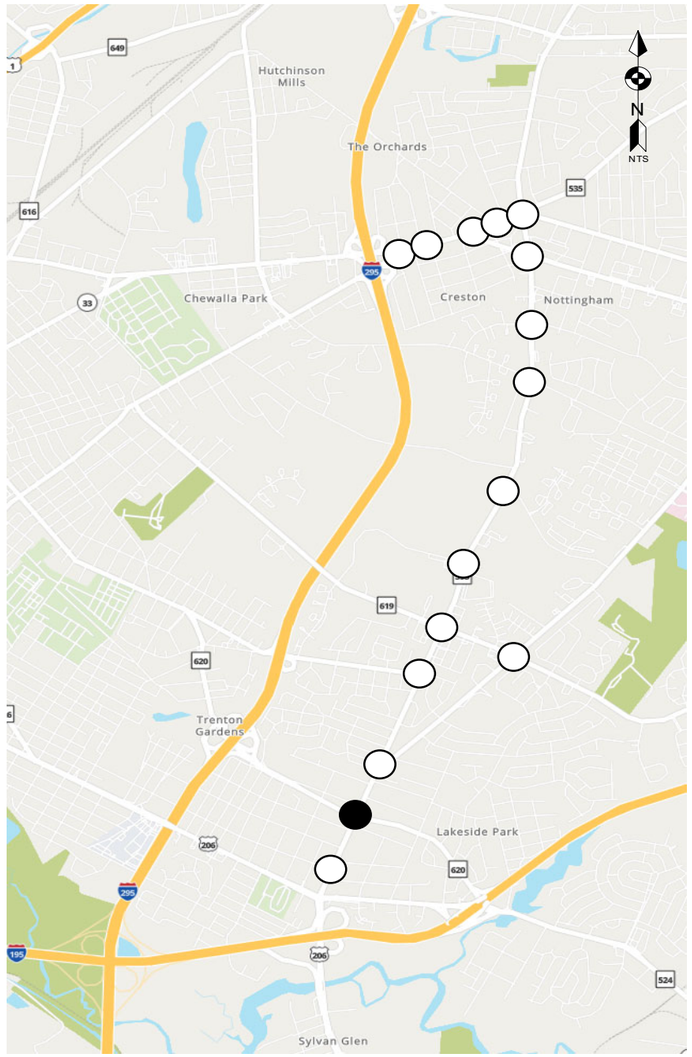


Phasing Diagram



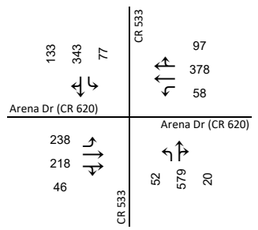
Intersection Geometry

Intersection ID # 1002

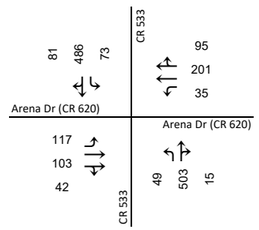


Hourly Volumes

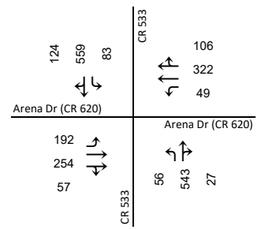
AM Peak Period



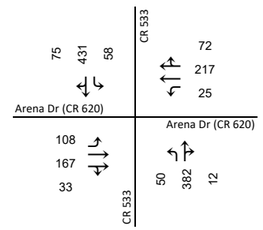
Midday Peak Period



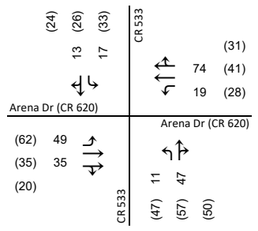
PM Peak Period



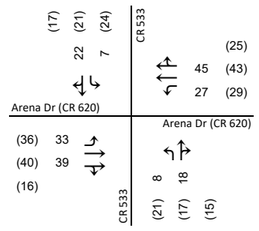
PM Off-peak Period



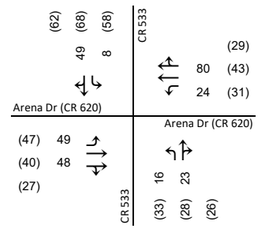
Existing Operations



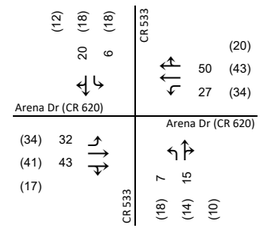
Summary				
Timing Pattern	1	Syn Delay	45	D
Actuated Cycle	90	Sim Delay	(42)	
Max v/C	1.00	ICU	83%	E



Summary				
Timing Pattern	2	Syn Delay	26	C
Actuated Cycle	110	Sim Delay	(24)	
Max v/C	0.79	ICU	70%	C

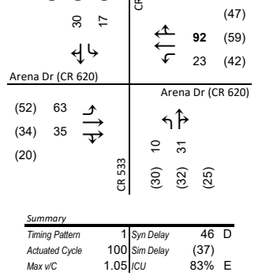


Summary				
Timing Pattern	3	Syn Delay	46	D
Actuated Cycle	100	Sim Delay	(45)	
Max v/C	1.00	ICU	85%	E

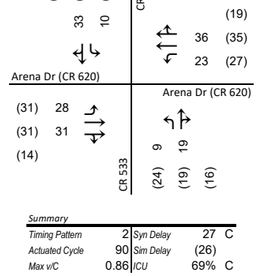


Summary				
Timing Pattern	2	Syn Delay	27	C
Actuated Cycle	110	Sim Delay	(24)	
Max v/C	0.73	ICU	65%	C

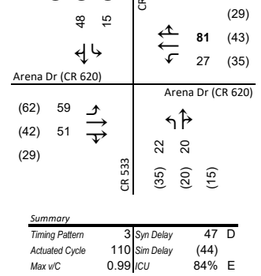
Implemented Operations



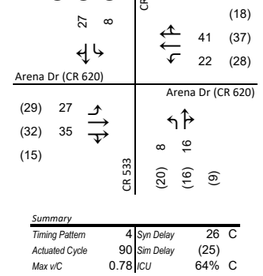
Summary				
Timing Pattern	1	Syn Delay	46	D
Actuated Cycle	100	Sim Delay	(37)	
Max v/C	1.05	ICU	83%	E



Summary				
Timing Pattern	2	Syn Delay	27	C
Actuated Cycle	90	Sim Delay	(26)	
Max v/C	0.86	ICU	69%	C



Summary				
Timing Pattern	3	Syn Delay	47	D
Actuated Cycle	110	Sim Delay	(44)	
Max v/C	0.99	ICU	84%	E



Summary				
Timing Pattern	4	Syn Delay	26	C
Actuated Cycle	90	Sim Delay	(25)	
Max v/C	0.78	ICU	64%	C

Operations with Improvements

No operational improvements recommended at this time.

HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

63 75 21
(58) (55) (12)

stop bar geometry
Synchro delay (sec / veh)
SimTraffic delay (sec / veh)

Hourly Volume Diagrams

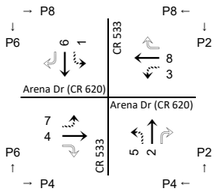
224 937 118

stop bar geometry
turning movement volume

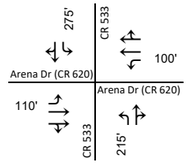
Figure 18

Weekday Traffic Operations Analysis

Whitehorse Ave (CR 533) & Arena Dr (CR 620)

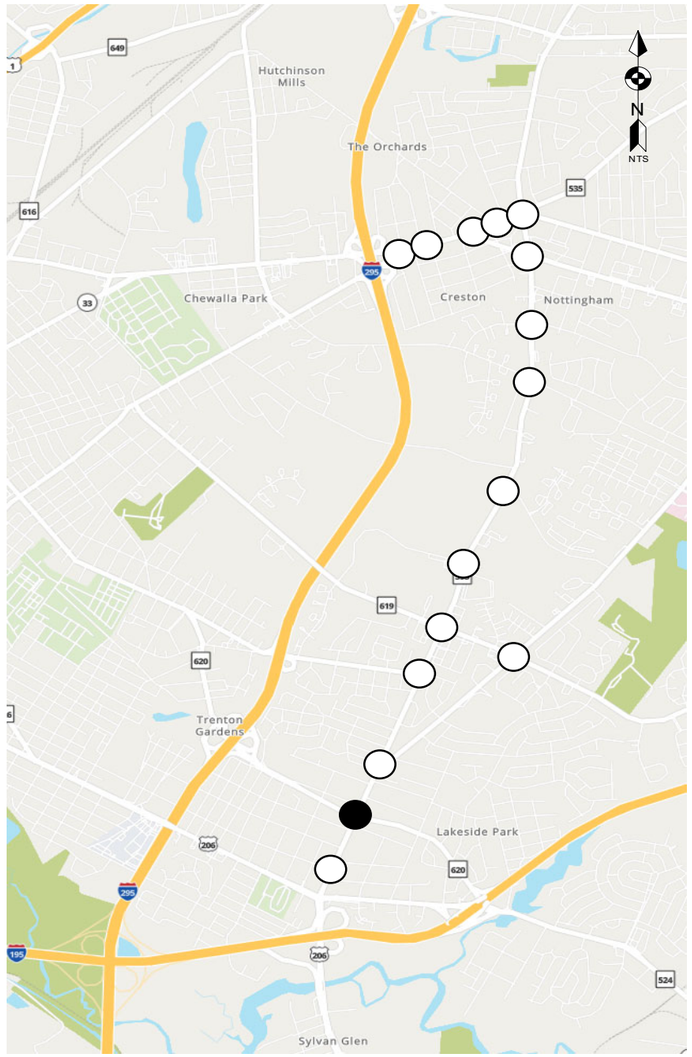


Phasing Diagram



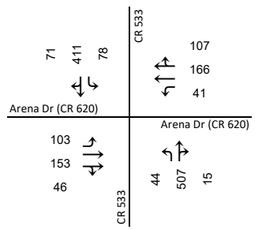
Intersection Geometry

Intersection ID # 1002

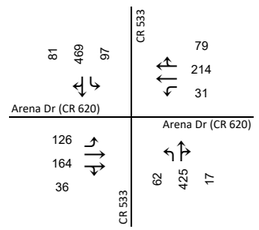


Hourly Volumes

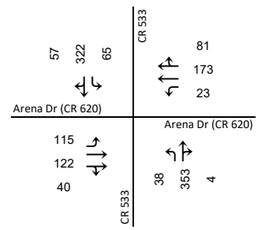
Weekend AM Peak Period



Weekend Midday Peak Period

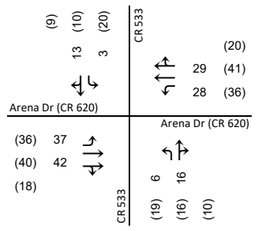


Weekend PM Peak Period



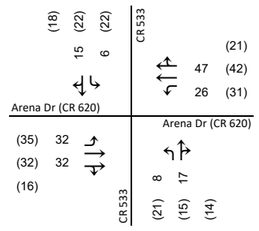
Existing Operations

Weekend AM Peak Period



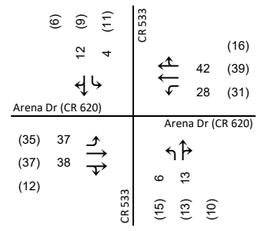
Summary				
Timing Pattern	4	Syn Delay	21	C
Actuated Cycle	105	Sim Delay	(20)	
Max v/C	0.64	ICU	65%	C

Weekend Midday Peak Period



Summary				
Timing Pattern	4	Syn Delay	23	C
Actuated Cycle	100	Sim Delay	(24)	
Max v/C	0.74	ICU	69%	C

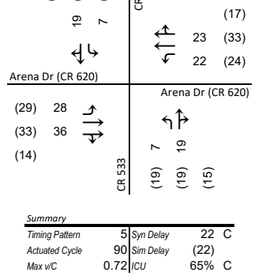
Weekend PM Peak Period



Summary				
Timing Pattern	4	Syn Delay	23	C
Actuated Cycle	105	Sim Delay	(19)	
Max v/C	0.63	ICU	58%	B

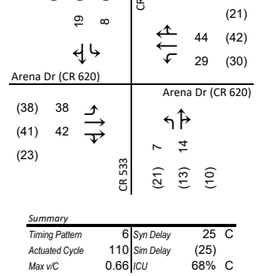
Implemented Operations

Weekend AM Peak Period



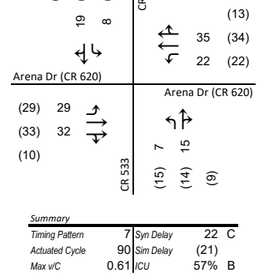
Summary				
Timing Pattern	5	Syn Delay	22	C
Actuated Cycle	90	Sim Delay	(22)	
Max v/C	0.72	ICU	65%	C

Weekend Midday Peak Period



Summary				
Timing Pattern	6	Syn Delay	25	C
Actuated Cycle	110	Sim Delay	(25)	
Max v/C	0.66	ICU	68%	C

Weekend PM Peak Period



Summary				
Timing Pattern	7	Syn Delay	22	C
Actuated Cycle	90	Sim Delay	(21)	
Max v/C	0.61	ICU	57%	B

Operations with Improvements

No operational improvements recommended at this time.

HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

63 75 21
(58) (55) (12)

stop bar geometry
Synchro delay (sec / veh)
SimTraffic delay (sec / veh)

Hourly Volume Diagrams

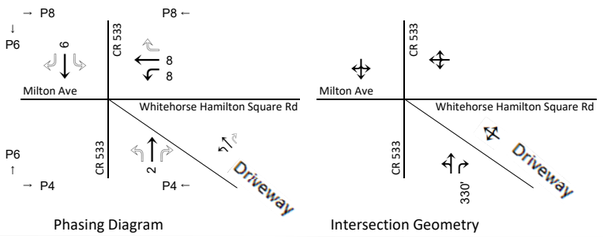
224 937 118

stop bar geometry
turning movement volume

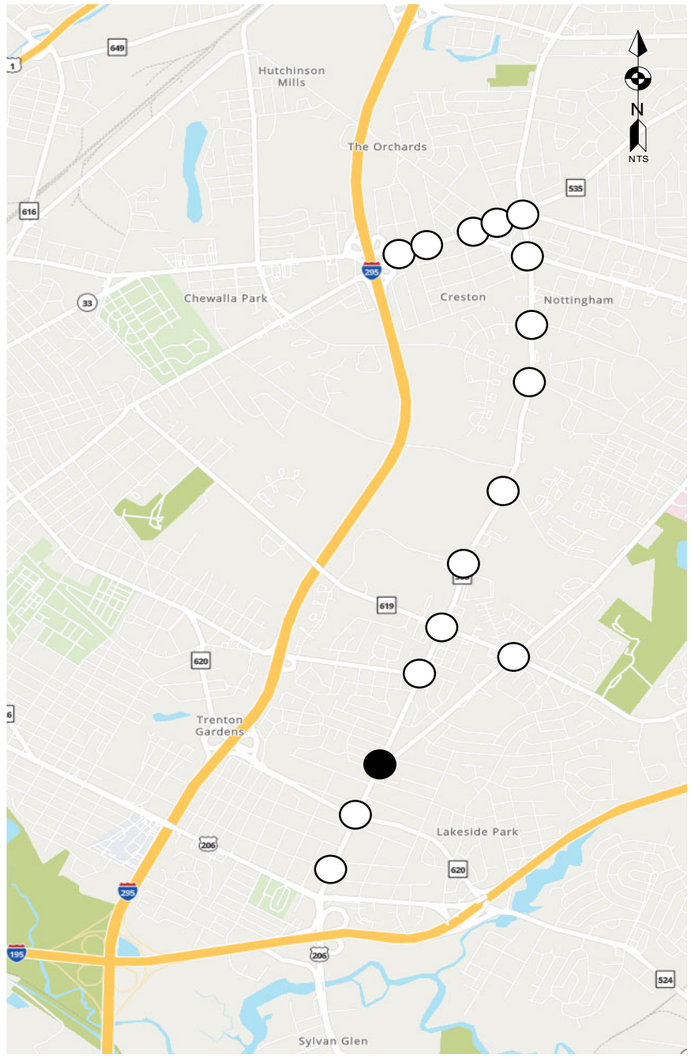
Figure 19

Weekend Traffic Operations Analysis

Whitehorse Ave (CR 533) & Arena Dr (CR 620)

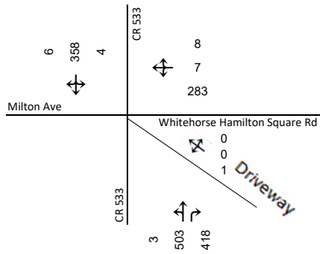


Intersection ID # 1003

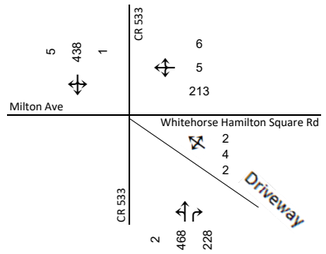


Hourly Volumes

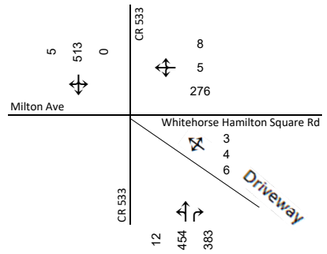
AM Peak Period



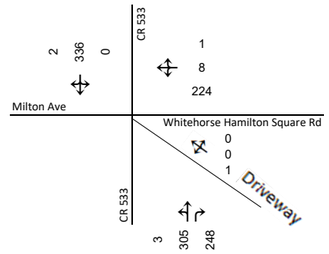
Midday Peak Period



PM Peak Period

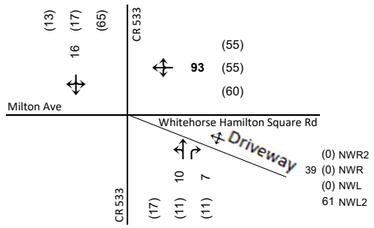


PM Off-peak Period



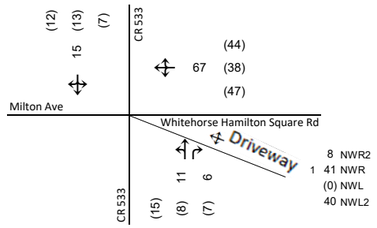
Existing Operations

AM Peak Period



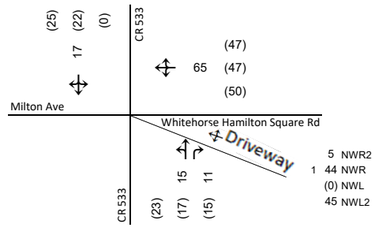
Summary				
Timing Pattern	1	Syn Delay	25	C
Actuated Cycle	90	Sim Delay	(22)	
Max v/C	1.03	ICU	70%	C

Midday Peak Period



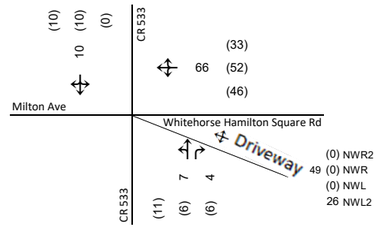
Summary				
Timing Pattern	2	Syn Delay	20	B
Actuated Cycle	110	Sim Delay	(16)	
Max v/C	0.86	ICU	71%	C

PM Peak Period



Summary				
Timing Pattern	3	Syn Delay	24	C
Actuated Cycle	100	Sim Delay	(24)	
Max v/C	0.90	ICU	89%	E

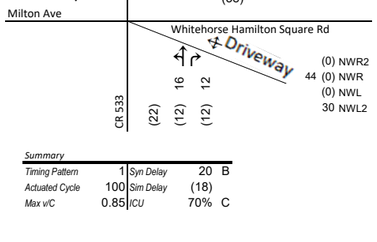
PM Off-peak Period



Summary				
Timing Pattern	2	Syn Delay	19	B
Actuated Cycle	110	Sim Delay	(15)	
Max v/C	0.85	ICU	63%	B

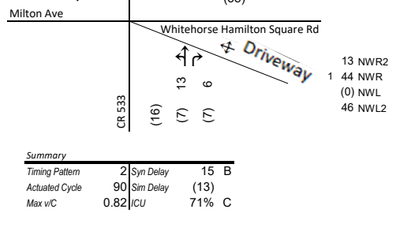
Implemented Operations

AM Peak Period



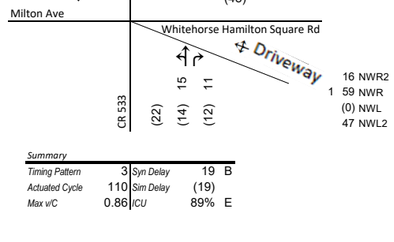
Summary				
Timing Pattern	1	Syn Delay	20	B
Actuated Cycle	100	Sim Delay	(18)	
Max v/C	0.85	ICU	70%	C

Midday Peak Period



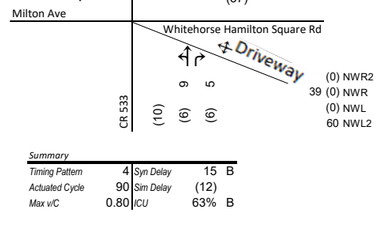
Summary				
Timing Pattern	2	Syn Delay	15	B
Actuated Cycle	90	Sim Delay	(13)	
Max v/C	0.82	ICU	71%	C

PM Peak Period



Summary				
Timing Pattern	3	Syn Delay	19	B
Actuated Cycle	110	Sim Delay	(19)	
Max v/C	0.86	ICU	89%	E

PM Off-peak Period



Summary				
Timing Pattern	4	Syn Delay	15	B
Actuated Cycle	90	Sim Delay	(12)	
Max v/C	0.80	ICU	63%	B

Operations with Improvements

No operational improvements recommended at this time.

HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

stop bar geometry
Synchro delay (sec / veh)
SimTraffic delay (sec / veh)

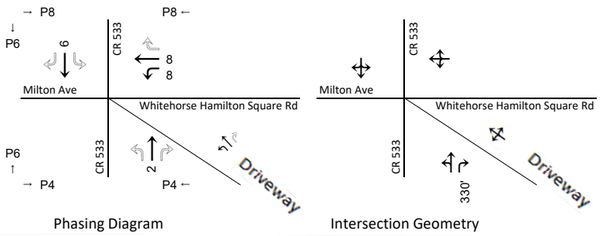
Hourly Volume Diagrams

stop bar geometry
turning movement volume

Figure 20

Weekday Traffic Operations Analysis

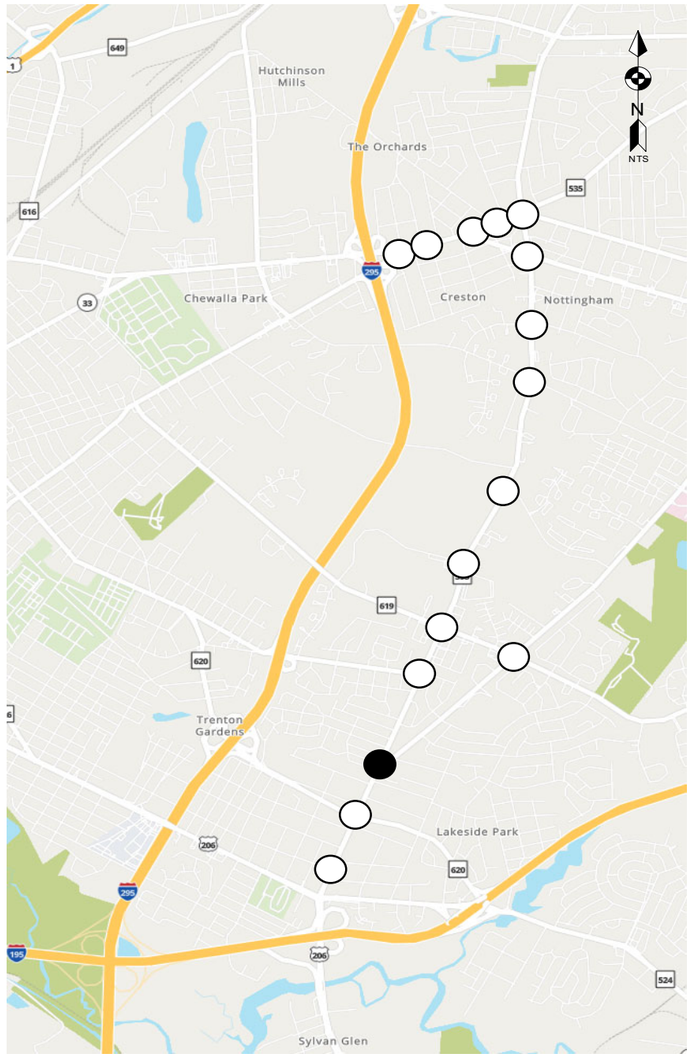
Whitehorse Ave (CR 533) & Whitehorse Hamilton Square Rd



Phasing Diagram

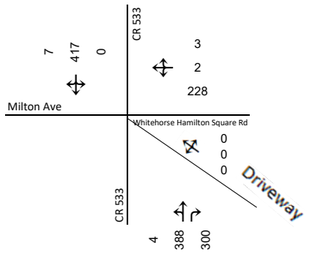
Intersection Geometry

Intersection ID # 1003

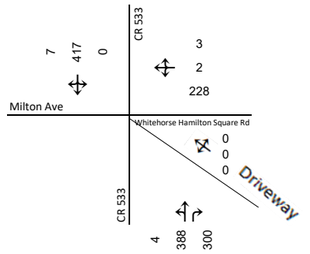


Hourly Volumes

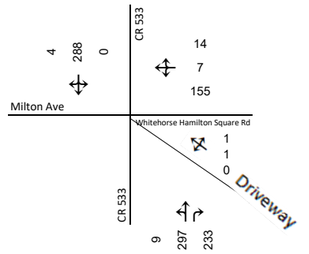
Weekend AM Peak Period



Weekend Midday Peak Period

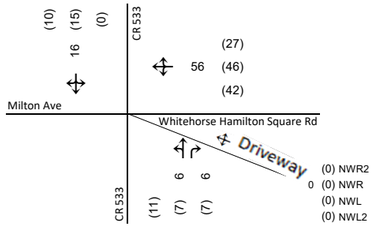


Weekend PM Peak Period



Existing Operations

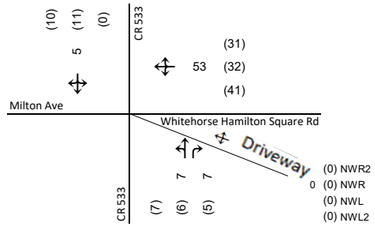
Weekend AM Peak Period



Summary

Timing Pattern	4	*Syn Delay*	18	B
Actuated Cycle	105	*Sim Delay*	(15)	
Max v/C	0.79	*ICU*	55%	A

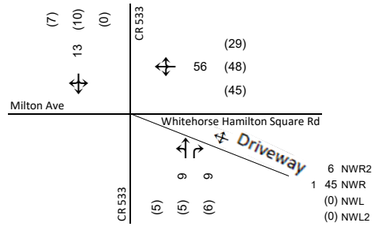
Weekend Midday Peak Period



Summary

Timing Pattern	4	*Syn Delay*	15	B
Actuated Cycle	100	*Sim Delay*	(13)	
Max v/C	0.78	*ICU*	55%	A

Weekend PM Peak Period



Summary

Timing Pattern	4	*Syn Delay*	19	B
Actuated Cycle	105	*Sim Delay*	(13)	
Max v/C	0.77	*ICU*	56%	B

Implemented Operations

Weekend AM Peak Period

Summary

Timing Pattern	5	*Syn Delay*	12	B
Actuated Cycle	90	*Sim Delay*	(12)	
Max v/C	0.77	*ICU*	55%	A

Weekend Midday Peak Period

Summary

Timing Pattern	6	*Syn Delay*	15	B
Actuated Cycle	110	*Sim Delay*	(13)	
Max v/C	0.80	*ICU*	55%	A

Weekend PM Peak Period

Summary

Timing Pattern	7	*Syn Delay*	14	B
Actuated Cycle	90	*Sim Delay*	(11)	
Max v/C	0.75	*ICU*	56%	B

Operations with Improvements

No operational improvements recommended at this time.

HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams

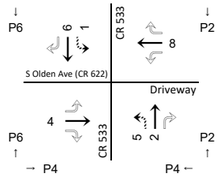
stop bar geometry

turning movement volume

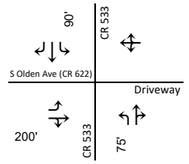
Figure 21

Weekend Traffic Operations Analysis

Whitehorse Ave (CR 533) & Whitehorse Hamilton Square Rd

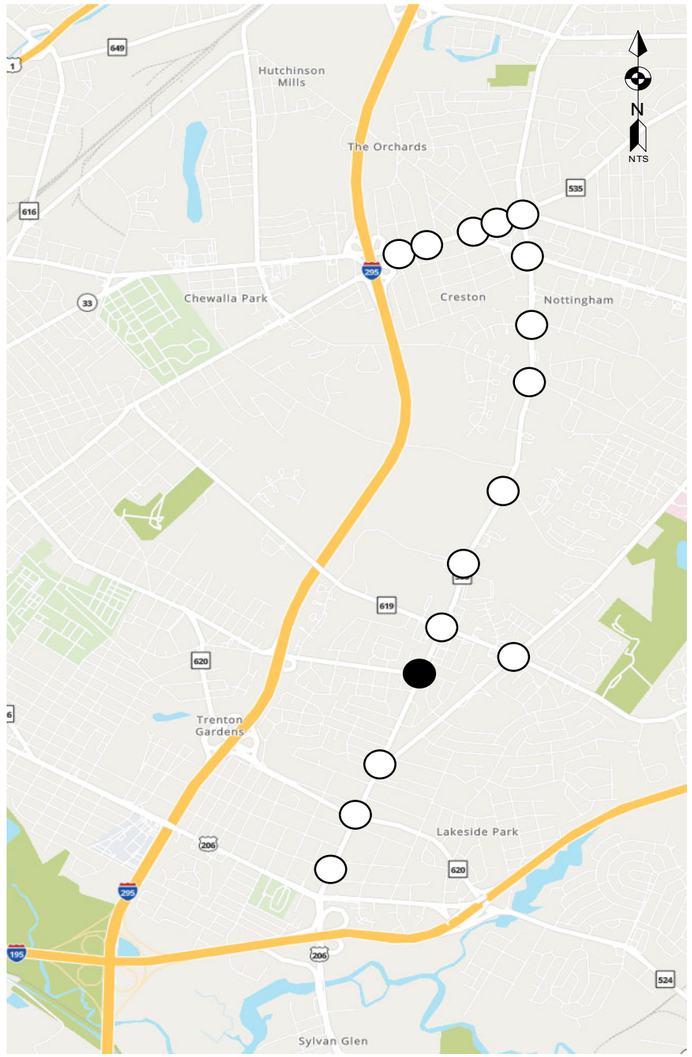


Phasing Diagram



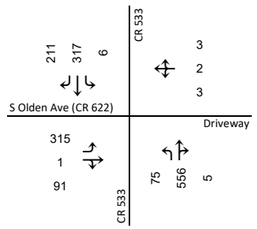
Intersection Geometry

Intersection ID # 1004

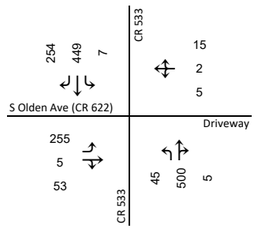


Hourly Volumes

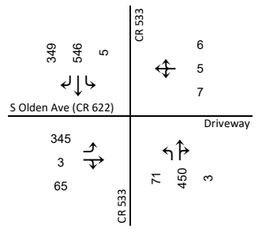
AM Peak Period



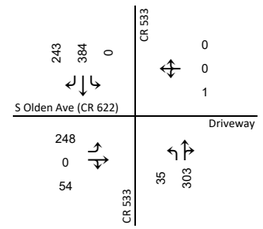
Midday Peak Period



PM Peak Period

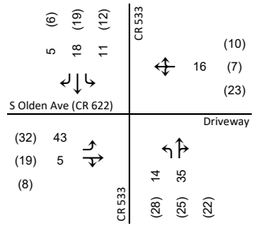


PM Off-peak Period



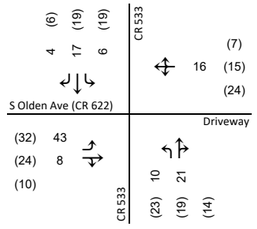
Existing Operations

AM Peak Period



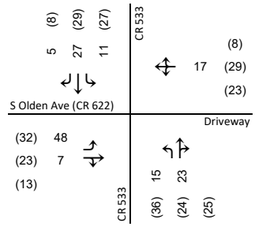
Summary				
Timing Pattern	1	Syn Delay	27	C
Actuated Cycle	110	Sim Delay	(22)	
Max v/C	0.81	ICU	74%	D

Midday Peak Period



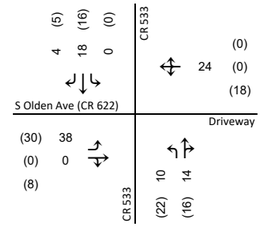
Summary				
Timing Pattern	2	Syn Delay	20	B
Actuated Cycle	105	Sim Delay	(19)	
Max v/C	0.73	ICU	68%	C

PM Peak Period



Summary				
Timing Pattern	3	Syn Delay	25	C
Actuated Cycle	110	Sim Delay	(24)	
Max v/C	0.84	ICU	75%	D

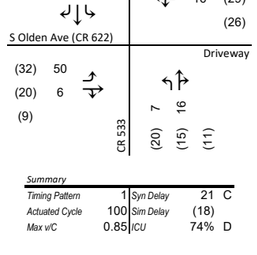
PM Off-peak Period



Summary				
Timing Pattern	2	Syn Delay	17	B
Actuated Cycle	105	Sim Delay	(16)	
Max v/C	0.63	ICU	53%	A

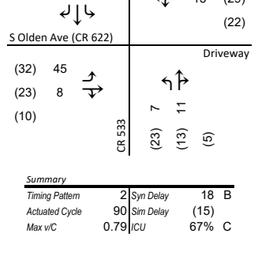
Implemented Operations

AM Peak Period



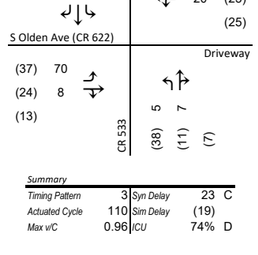
Summary				
Timing Pattern	1	Syn Delay	21	C
Actuated Cycle	100	Sim Delay	(18)	
Max v/C	0.85	ICU	74%	D

Midday Peak Period



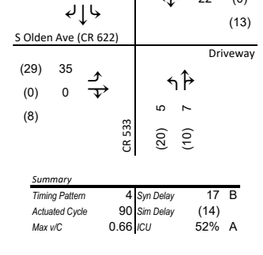
Summary				
Timing Pattern	2	Syn Delay	18	B
Actuated Cycle	90	Sim Delay	(15)	
Max v/C	0.79	ICU	67%	C

PM Peak Period



Summary				
Timing Pattern	3	Syn Delay	23	C
Actuated Cycle	110	Sim Delay	(19)	
Max v/C	0.96	ICU	74%	D

PM Off-peak Period



Summary				
Timing Pattern	4	Syn Delay	17	B
Actuated Cycle	90	Sim Delay	(14)	
Max v/C	0.66	ICU	52%	A

Operations with Improvements

No operational improvements recommended at this time.

HCM Levels of Service	
LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service	
LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

63 75 21
(58) (55) (12)

stop bar geometry
Synchro delay (sec / veh)
SimTraffic delay (sec / veh)

Hourly Volume Diagrams

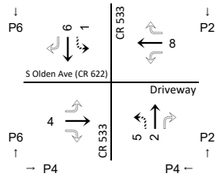
224 937 118

stop bar geometry
turning movement volume

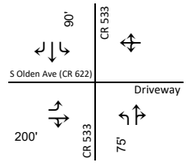
Figure 22

Weekday Traffic Operations Analysis

Whitehorse Ave (CR 533) & S Olden Ave (CR 622)

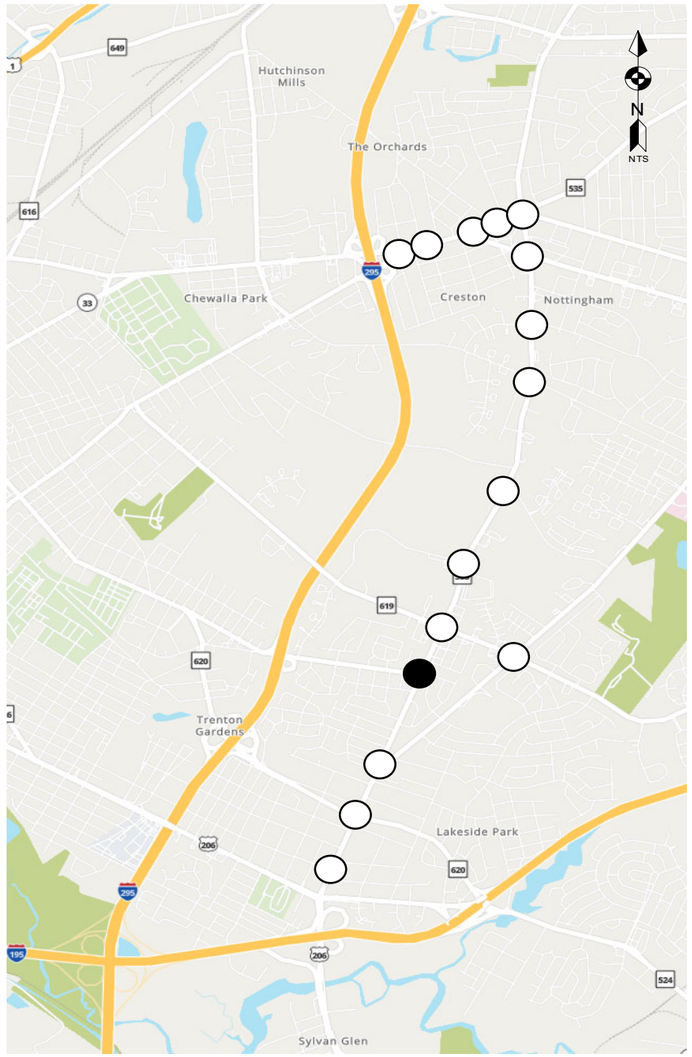


Phasing Diagram



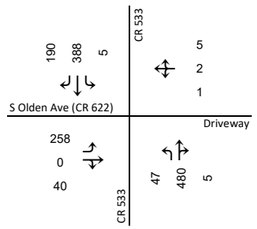
Intersection Geometry

Intersection ID # 1004

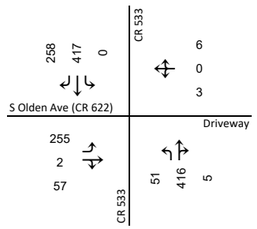


Hourly Volumes

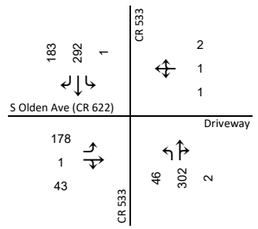
Weekend AM Peak Period



Weekend Midday Peak Period

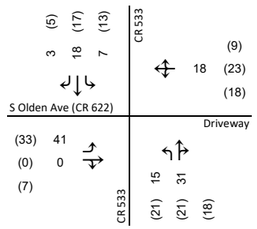


Weekend PM Peak Period



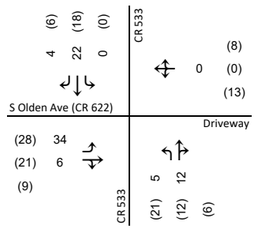
Existing Operations

Weekend AM Peak Period



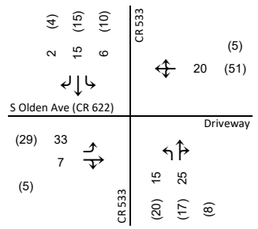
Summary				
Timing Pattern	4	Syn Delay	23	C
Actuated Cycle	105	Sim Delay	(19)	
Max v/C	0.70	ICU	67%	C

Weekend Midday Peak Period



Summary				
Timing Pattern	4	Syn Delay	17	B
Actuated Cycle	100	Sim Delay	(16)	
Max v/C	0.65	ICU	63%	B

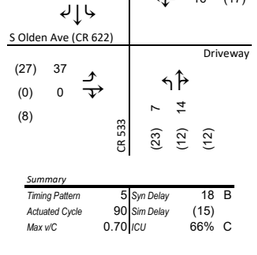
Weekend PM Peak Period



Summary				
Timing Pattern	4	Syn Delay	18	B
Actuated Cycle	105	Sim Delay	(16)	
Max v/C	0.48	ICU	52%	A

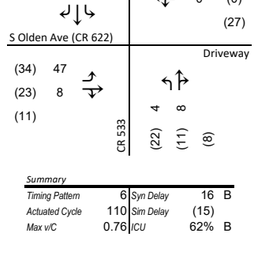
Implemented Operations

Weekend AM Peak Period



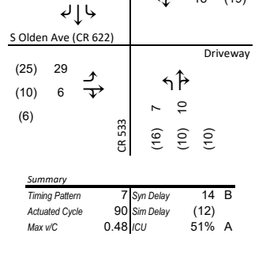
Summary				
Timing Pattern	5	Syn Delay	18	B
Actuated Cycle	90	Sim Delay	(15)	
Max v/C	0.70	ICU	66%	C

Weekend Midday Peak Period



Summary				
Timing Pattern	6	Syn Delay	16	B
Actuated Cycle	110	Sim Delay	(15)	
Max v/C	0.76	ICU	62%	B

Weekend PM Peak Period



Summary				
Timing Pattern	7	Syn Delay	14	B
Actuated Cycle	90	Sim Delay	(12)	
Max v/C	0.48	ICU	51%	A

Operations with Improvements

No operational improvements recommended at this time.

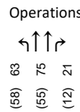
HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

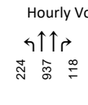


stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams



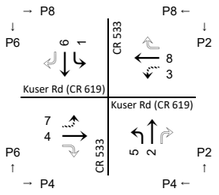
stop bar geometry

turning movement volume

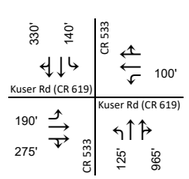
Figure 23

Weekend Traffic Operations Analysis

Whitehorse Ave (CR 533) & S Olden Ave (CR 622)

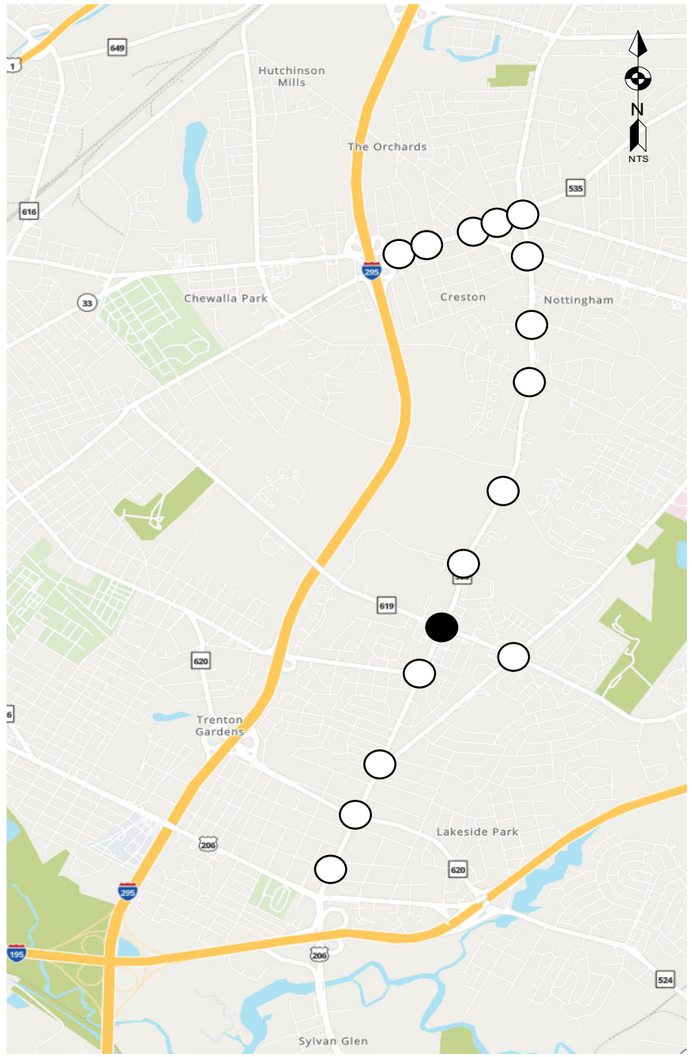


Phasing Diagram



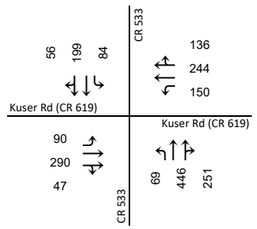
Intersection Geometry

Intersection ID # 1005

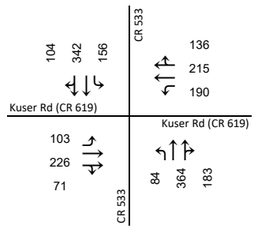


Hourly Volumes

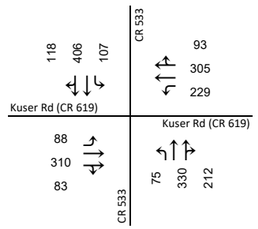
AM Peak Period



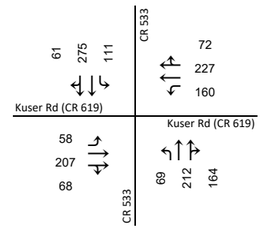
Midday Peak Period



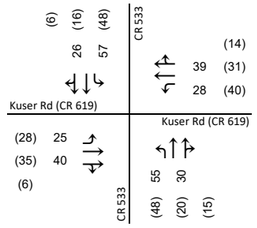
PM Peak Period



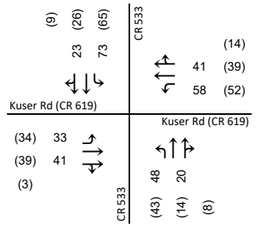
PM Off-peak Period



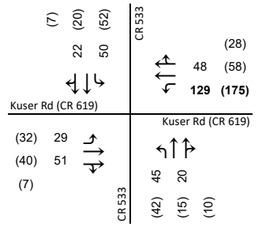
Existing Operations



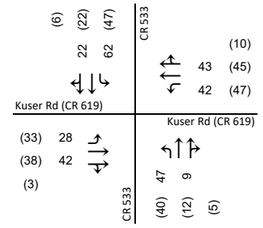
Summary				
Timing Pattern	1	Syn Delay	35	C
Actuated Cycle	110	Sim Delay	(25)	
Max v/C	0.77	ICU	64%	C



Summary				
Timing Pattern	2	Syn Delay	36	D
Actuated Cycle	105	Sim Delay	(28)	
Max v/C	0.86	ICU	65%	C

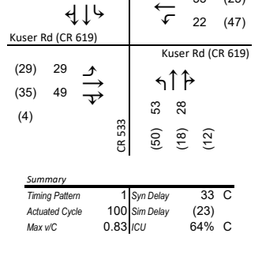


Summary				
Timing Pattern	3	Syn Delay	43	D
Actuated Cycle	110	Sim Delay	(42)	
Max v/C	1.13	ICU	67%	C

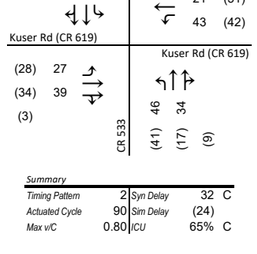


Summary				
Timing Pattern	2	Syn Delay	33	C
Actuated Cycle	105	Sim Delay	(26)	
Max v/C	0.72	ICU	55%	A

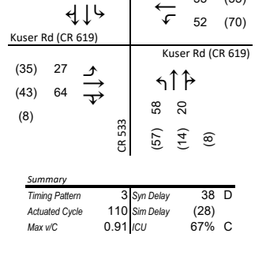
Implemented Operations



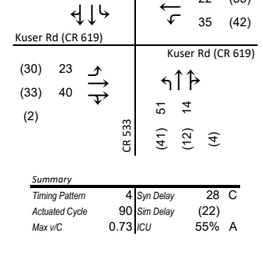
Summary				
Timing Pattern	1	Syn Delay	33	C
Actuated Cycle	100	Sim Delay	(23)	
Max v/C	0.83	ICU	64%	C



Summary				
Timing Pattern	2	Syn Delay	32	C
Actuated Cycle	90	Sim Delay	(24)	
Max v/C	0.80	ICU	65%	C



Summary				
Timing Pattern	3	Syn Delay	38	D
Actuated Cycle	110	Sim Delay	(28)	
Max v/C	0.91	ICU	67%	C



Summary				
Timing Pattern	4	Syn Delay	28	C
Actuated Cycle	90	Sim Delay	(22)	
Max v/C	0.73	ICU	55%	A

Operations with Improvements

No operational improvements recommended at this time.

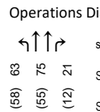
HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

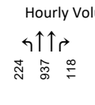


stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams



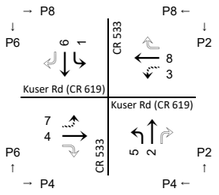
stop bar geometry

turning movement volume

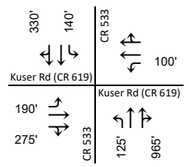
Figure 24

Weekday Traffic Operations Analysis

Whitehorse Ave (CR 533) & Kuser Rd (CR 619)

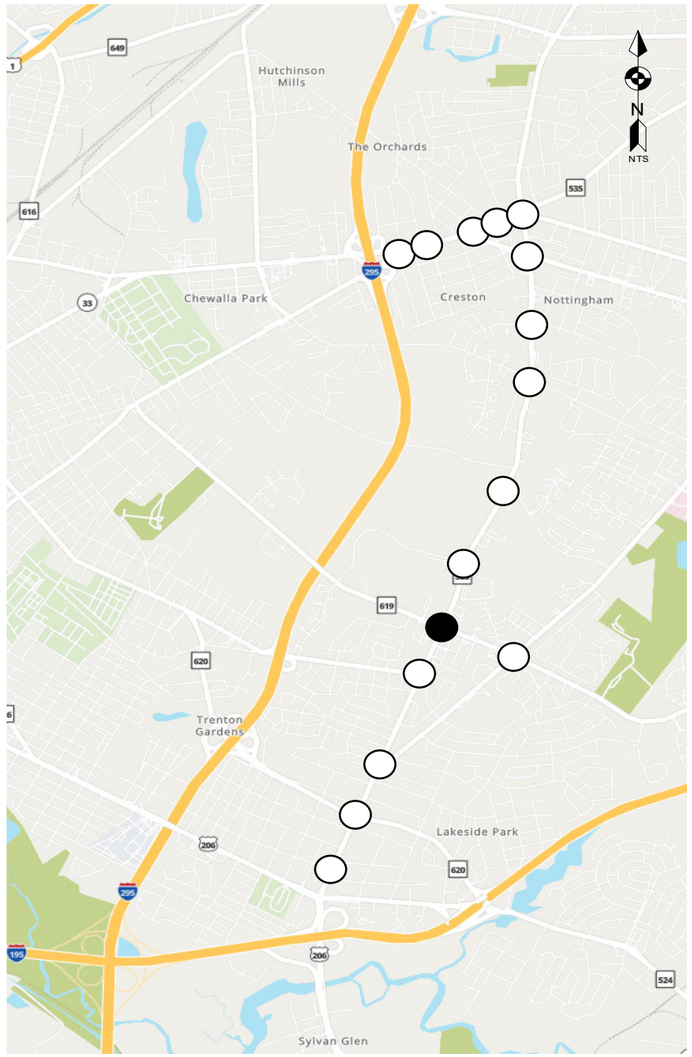


Phasing Diagram



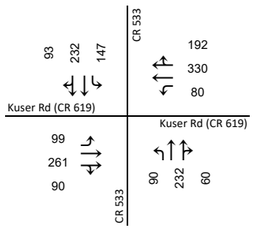
Intersection Geometry

Intersection ID # 1005

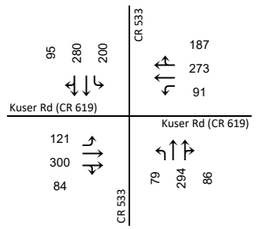


Hourly Volumes

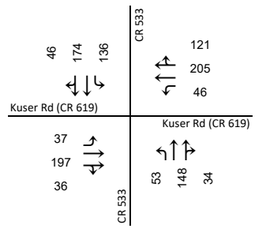
Weekend AM Peak Period



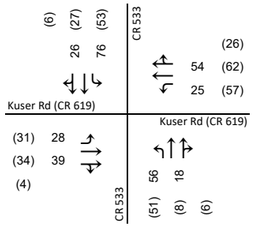
Weekend Midday Peak Period



Weekend PM Peak Period

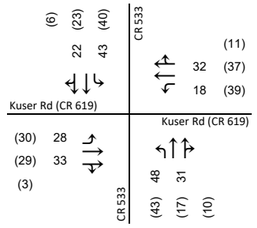


Existing Operations



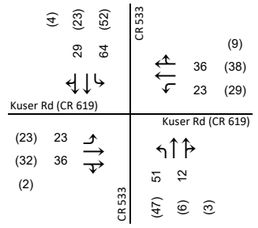
Summary

Timing Pattern	4	*Syn Delay*	40	D
Actuated Cycle	105	*Sim Delay*	(30)	
Max v/C	0.90	*ICU*	58%	B



Summary

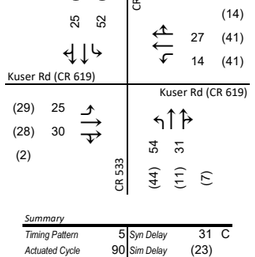
Timing Pattern	4	*Syn Delay*	31	C
Actuated Cycle	100	*Sim Delay*	(24)	
Max v/C	0.84	*ICU*	64%	B



Summary

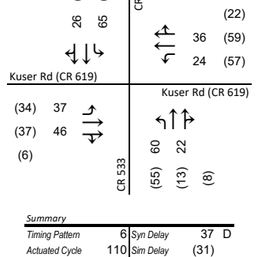
Timing Pattern	4	*Syn Delay*	34	C
Actuated Cycle	105	*Sim Delay*	(23)	
Max v/C	0.79	*ICU*	50%	A

Implemented Operations



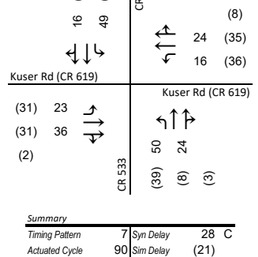
Summary

Timing Pattern	5	*Syn Delay*	31	C
Actuated Cycle	90	*Sim Delay*	(23)	
Max v/C	0.86	*ICU*	58%	B



Summary

Timing Pattern	6	*Syn Delay*	37	D
Actuated Cycle	110	*Sim Delay*	(31)	
Max v/C	0.88	*ICU*	64%	B



Summary

Timing Pattern	7	*Syn Delay*	28	C
Actuated Cycle	90	*Sim Delay*	(21)	
Max v/C	0.73	*ICU*	50%	A

Operations with Improvements

No operational improvements recommended at this time.

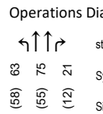
HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

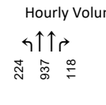


stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams



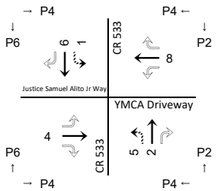
stop bar geometry

turning movement volume

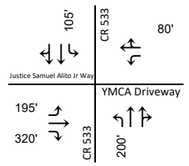
Figure 25

Weekend Traffic Operations Analysis

Whitehorse Ave (CR 533) & Kuser Rd (CR 619)

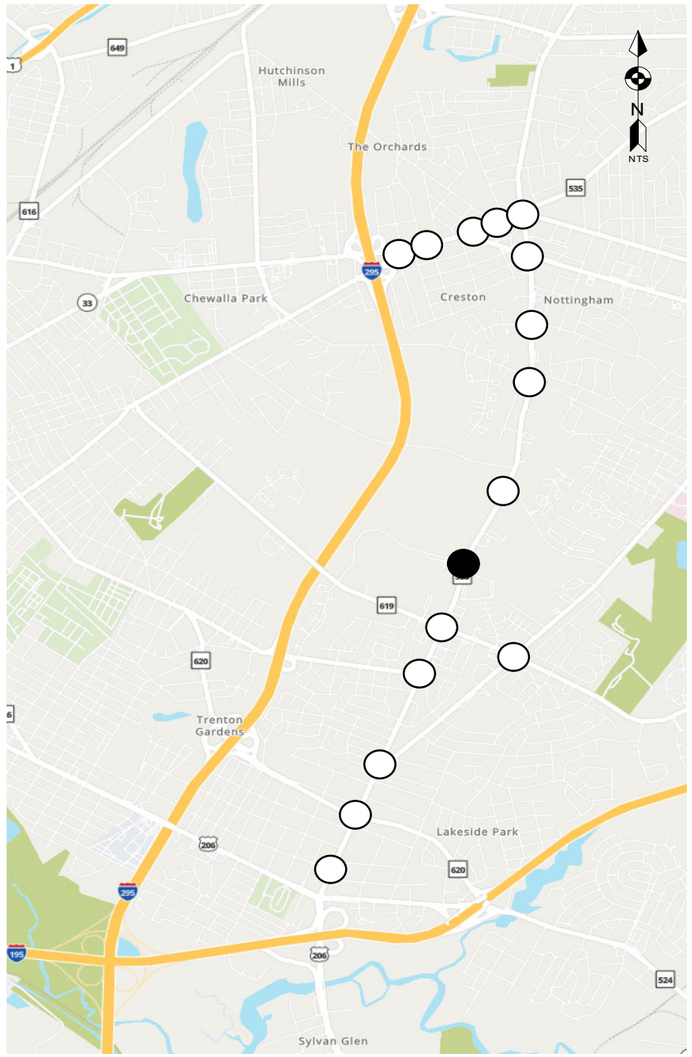


Phasing Diagram



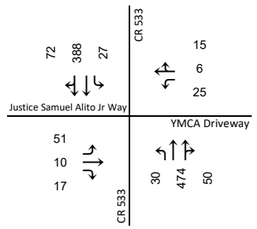
Intersection Geometry

Intersection ID # 1007

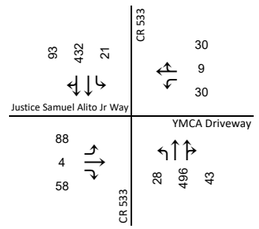


Hourly Volumes

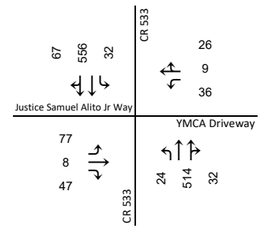
AM Peak Period



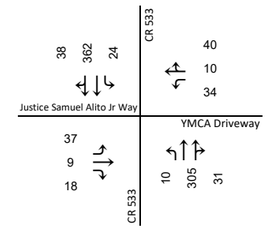
Midday Peak Period



PM Peak Period

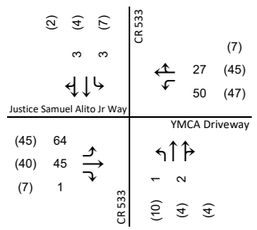


PM Off-peak Period



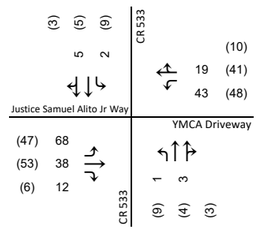
Existing Operations

AM Peak Period



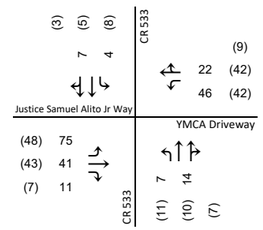
Summary				
Timing Pattern	1	Syn Delay	8	A
Actuated Cycle	110	Sim Delay	(7)	
Max v/C	0.55	ICU	50%	A

Midday Peak Period



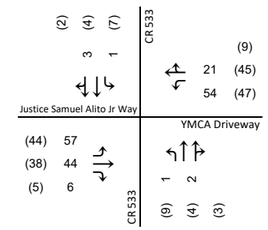
Summary				
Timing Pattern	2	Syn Delay	11	B
Actuated Cycle	105	Sim Delay	(9)	
Max v/C	0.73	ICU	52%	A

PM Peak Period



Summary				
Timing Pattern	3	Syn Delay	16	B
Actuated Cycle	110	Sim Delay	(11)	
Max v/C	0.78	ICU	55%	A

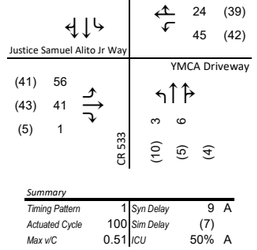
PM Off-peak Period



Summary				
Timing Pattern	2	Syn Delay	8	A
Actuated Cycle	105	Sim Delay	(8)	
Max v/C	0.44	ICU	48%	A

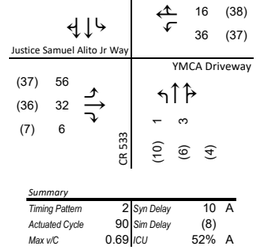
Implemented Operations

AM Peak Period



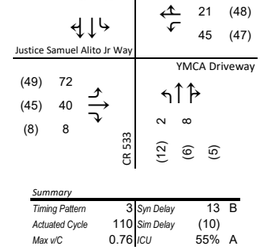
Summary				
Timing Pattern	1	Syn Delay	9	A
Actuated Cycle	100	Sim Delay	(7)	
Max v/C	0.51	ICU	50%	A

Midday Peak Period



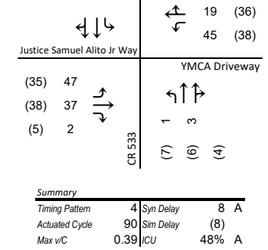
Summary				
Timing Pattern	2	Syn Delay	10	A
Actuated Cycle	90	Sim Delay	(8)	
Max v/C	0.69	ICU	52%	A

PM Peak Period



Summary				
Timing Pattern	3	Syn Delay	13	B
Actuated Cycle	110	Sim Delay	(10)	
Max v/C	0.76	ICU	55%	A

PM Off-peak Period



Summary				
Timing Pattern	4	Syn Delay	8	A
Actuated Cycle	90	Sim Delay	(8)	
Max v/C	0.39	ICU	48%	A

Operations with Improvements

No operational improvements recommended at this time.

HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

63 75 21
(58) (55) (12)

stop bar geometry
Synchro delay (sec / veh)
SimTraffic delay (sec / veh)

Hourly Volume Diagrams

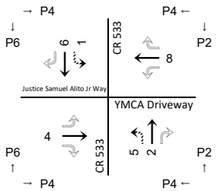
224 937 118

stop bar geometry
turning movement volume

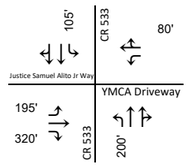
Figure 26

Weekday Traffic Operations Analysis

Whitehorse-Mercerville Rd (CR 533) & Justice Samuel Alito Jr Way

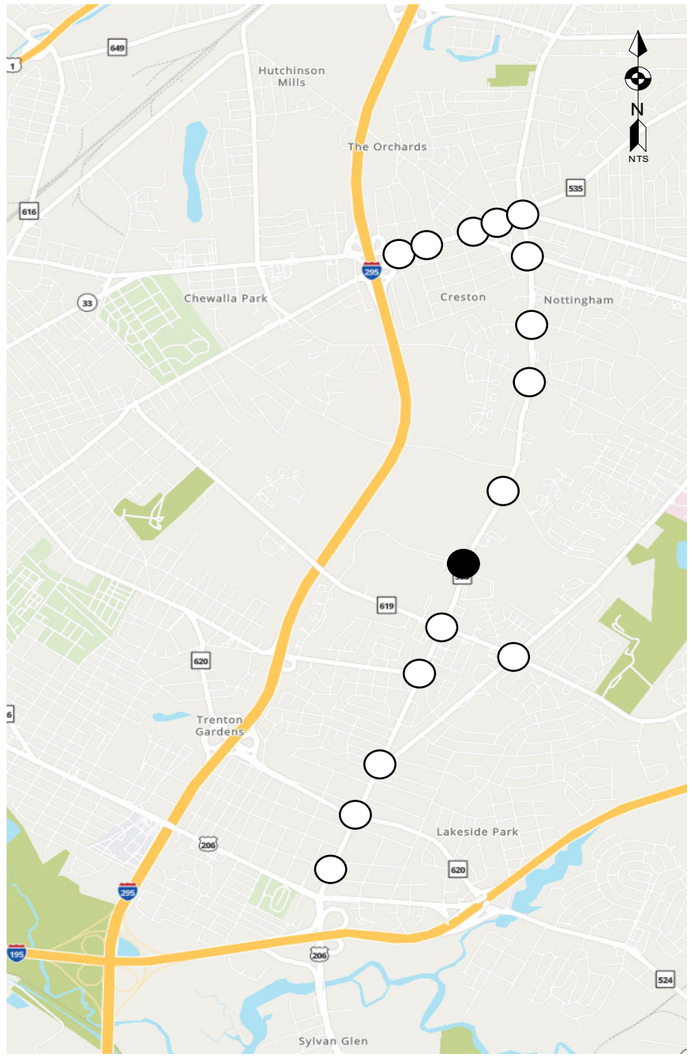


Phasing Diagram



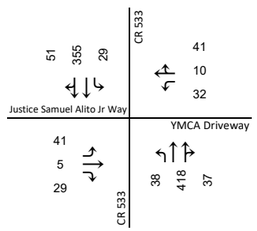
Intersection Geometry

Intersection ID # 1007

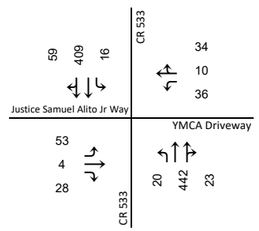


Hourly Volumes

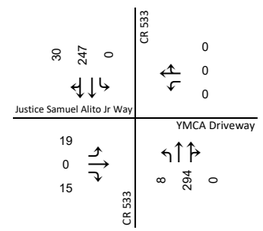
Weekend AM Peak Period



Weekend Midday Peak Period

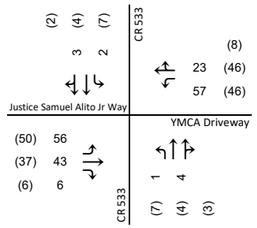


Weekend PM Peak Period



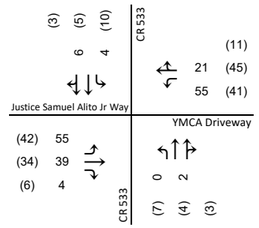
Existing Operations

Weekend AM Peak Period



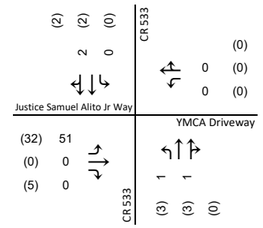
Summary					
Timing Pattern	4	Syn Delay	9	A	
Actuated Cycle	105	Sim Delay	(8)		
Max v/C	0.48	ICU	49%	A	

Weekend Midday Peak Period



Summary					
Timing Pattern	4	Syn Delay	10	A	
Actuated Cycle	100	Sim Delay	(8)		
Max v/C	0.53	ICU	47%	A	

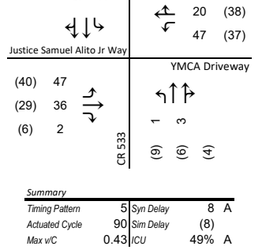
Weekend PM Peak Period



Summary					
Timing Pattern	4	Syn Delay	3	A	
Actuated Cycle	105	Sim Delay	(3)		
Max v/C	0.23	ICU	26%	A	

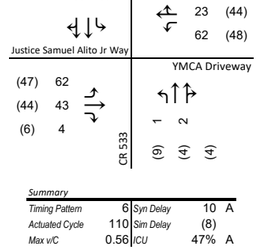
Implemented Operations

Weekend AM Peak Period



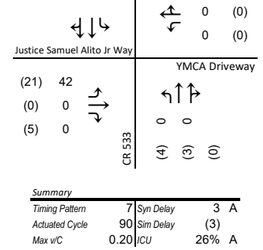
Summary					
Timing Pattern	5	Syn Delay	8	A	
Actuated Cycle	90	Sim Delay	(8)		
Max v/C	0.43	ICU	49%	A	

Weekend Midday Peak Period



Summary					
Timing Pattern	6	Syn Delay	10	A	
Actuated Cycle	110	Sim Delay	(8)		
Max v/C	0.56	ICU	47%	A	

Weekend PM Peak Period



Summary					
Timing Pattern	7	Syn Delay	3	A	
Actuated Cycle	90	Sim Delay	(3)		
Max v/C	0.20	ICU	26%	A	

Operations with Improvements

No operational improvements recommended at this time.

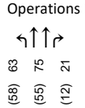
HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

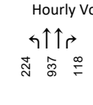


stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams



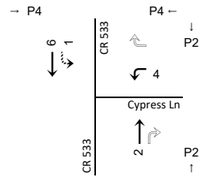
stop bar geometry

turning movement volume

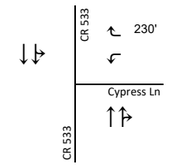
Figure 27

Weekend Traffic Operations Analysis

Whitehorse-Mercerville Rd (CR 533) & Justice Samuel Alito Jr Way

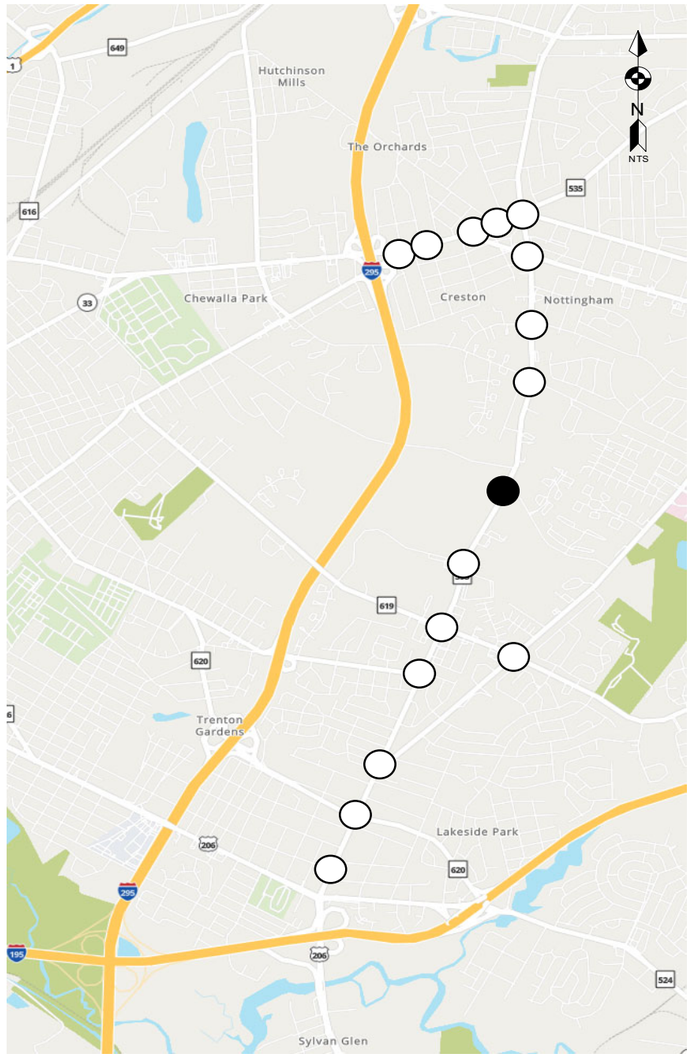


Phasing Diagram



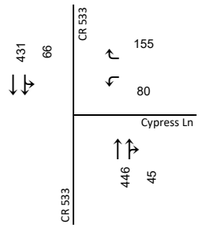
Intersection Geometry

Intersection ID # 1008

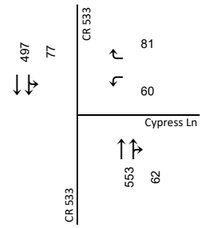


Hourly Volumes

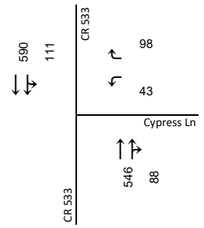
AM Peak Period



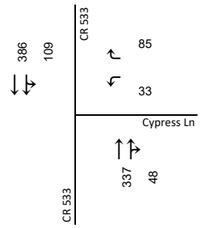
Midday Peak Period



PM Peak Period

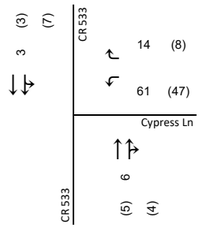


PM Off-peak Period



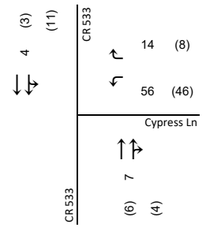
Existing Operations

AM Peak Period



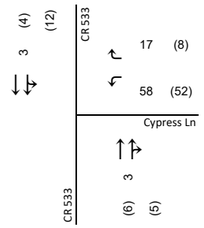
Summary				
Timing Pattern	1	Syn Delay	8	A
Actuated Cycle	110	Sim Delay	(7)	
Max v/C	0.59	ICU	52%	A

Midday Peak Period



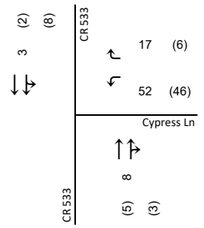
Summary				
Timing Pattern	2	Syn Delay	9	A
Actuated Cycle	105	Sim Delay	(7)	
Max v/C	0.52	ICU	57%	B

PM Peak Period



Summary				
Timing Pattern	3	Syn Delay	6	A
Actuated Cycle	110	Sim Delay	(7)	
Max v/C	0.49	ICU	62%	B

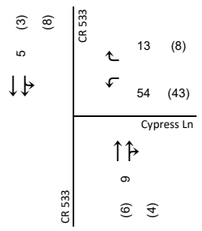
PM Off-peak Period



Summary				
Timing Pattern	2	Syn Delay	8	A
Actuated Cycle	105	Sim Delay	(5)	
Max v/C	0.52	ICU	48%	A

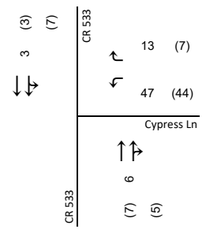
Implemented Operations

AM Peak Period



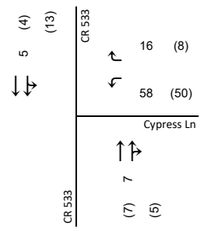
Summary				
Timing Pattern	1	Syn Delay	11	B
Actuated Cycle	100	Sim Delay	(8)	
Max v/C	0.55	ICU	56%	B

Midday Peak Period



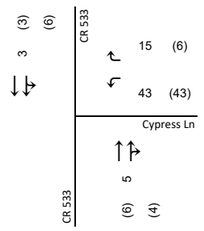
Summary				
Timing Pattern	2	Syn Delay	7	A
Actuated Cycle	90	Sim Delay	(7)	
Max v/C	0.47	ICU	57%	B

PM Peak Period



Summary				
Timing Pattern	3	Syn Delay	9	A
Actuated Cycle	110	Sim Delay	(8)	
Max v/C	0.49	ICU	62%	B

PM Off-peak Period



Summary				
Timing Pattern	4	Syn Delay	6	A
Actuated Cycle	90	Sim Delay	(6)	
Max v/C	0.48	ICU	56%	B

Operations with Improvements

No operational improvements recommended at this time.

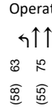
HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams



stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams

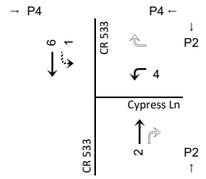
stop bar geometry

turning movement volume

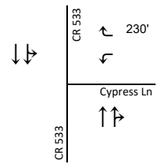
Figure 28

Weekday Traffic Operations Analysis

Whitehorse-Mercerville Rd (CR 533) & Cypress Ln

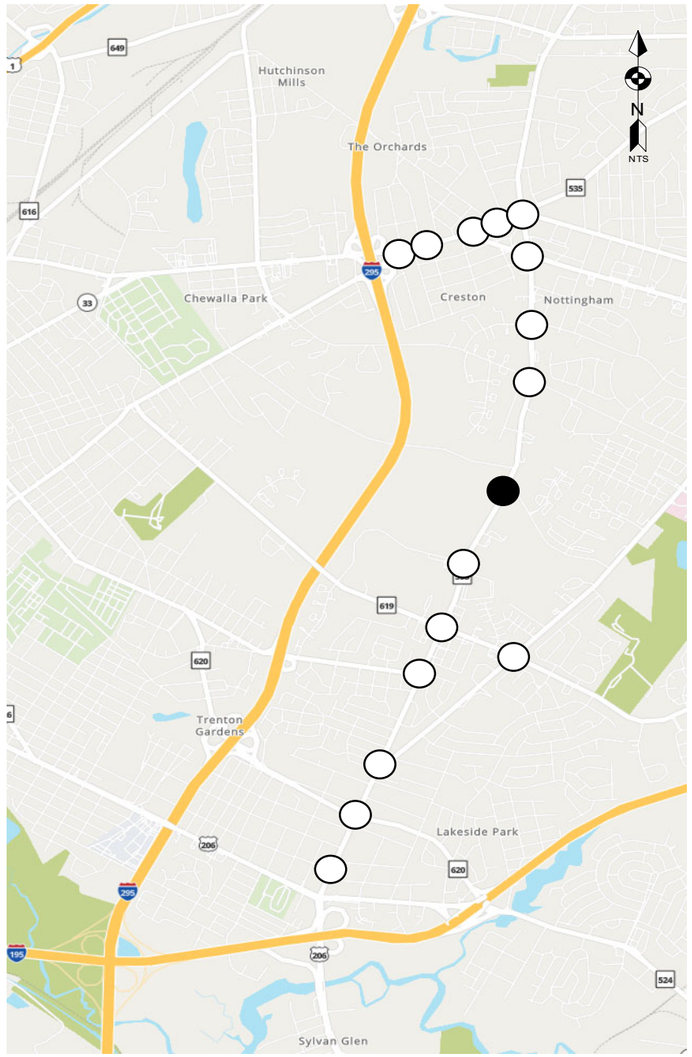


Phasing Diagram



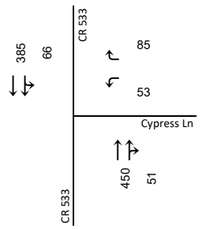
Intersection Geometry

Intersection ID # 1008

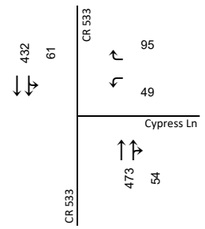


Hourly Volumes

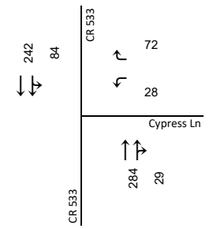
Weekend AM Peak Period



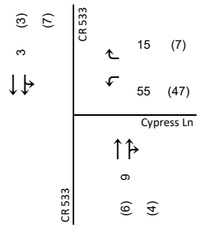
Weekend Midday Peak Period



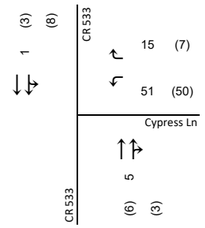
Weekend PM Peak Period



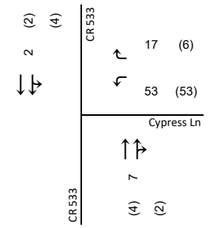
Existing Operations



Summary				
Timing Pattern	4	Syn Delay	9	A
Actuated Cycle	105	Sim Delay	(7)	
Max v/C	0.47	ICU	51%	A

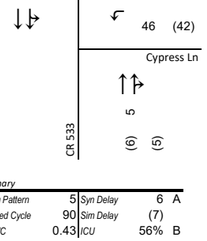


Summary				
Timing Pattern	4	Syn Delay	6	A
Actuated Cycle	100	Sim Delay	(7)	
Max v/C	0.48	ICU	52%	A

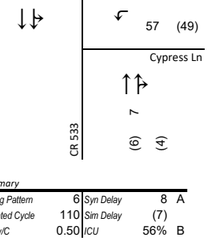


Summary				
Timing Pattern	4	Syn Delay	8	A
Actuated Cycle	105	Sim Delay	(5)	
Max v/C	0.50	ICU	41%	A

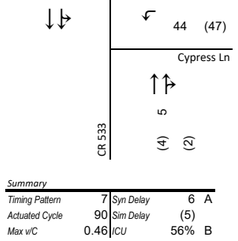
Implemented Operations



Summary				
Timing Pattern	5	Syn Delay	6	A
Actuated Cycle	90	Sim Delay	(7)	
Max v/C	0.43	ICU	56%	B



Summary				
Timing Pattern	6	Syn Delay	8	A
Actuated Cycle	110	Sim Delay	(7)	
Max v/C	0.50	ICU	56%	B



Summary				
Timing Pattern	7	Syn Delay	6	A
Actuated Cycle	90	Sim Delay	(5)	
Max v/C	0.46	ICU	56%	B

Operations with Improvements

No operational improvements recommended at this time.

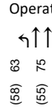
HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams



stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams

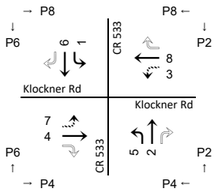
stop bar geometry

turning movement volume

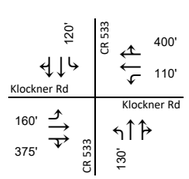
Figure 29

Weekend Traffic Operations Analysis

Whitehorse-Mercerville Rd (CR 533) & Cypress Ln

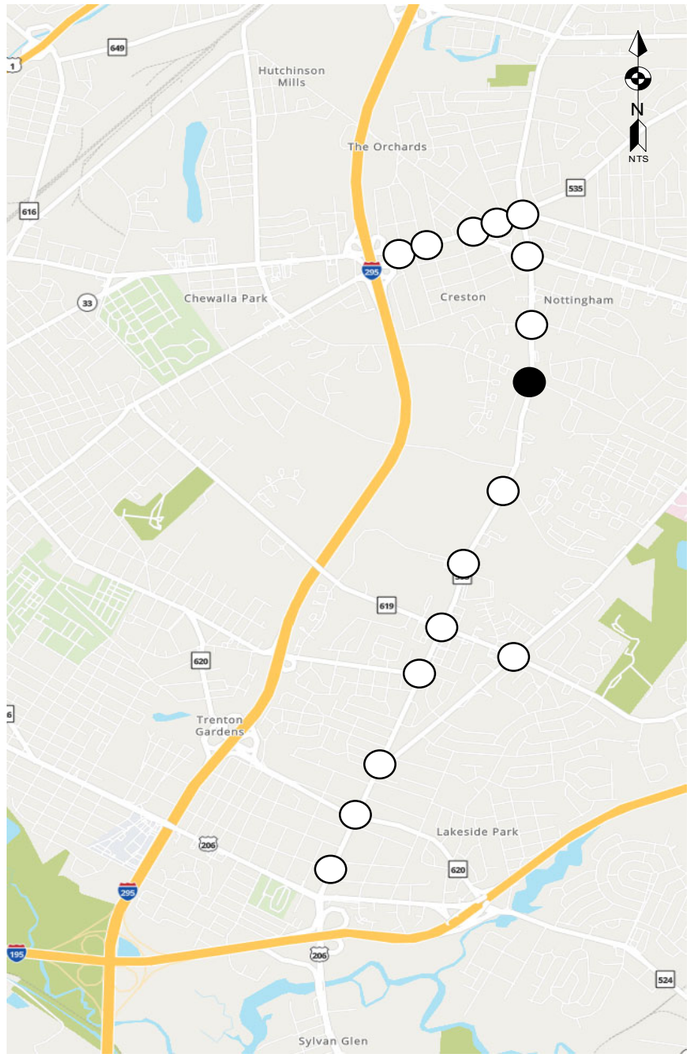


Phasing Diagram



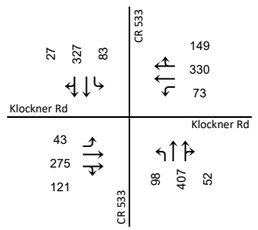
Intersection Geometry

Intersection ID # 1009

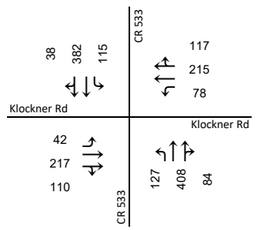


Hourly Volumes

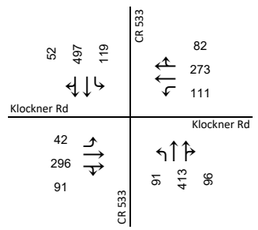
AM Peak Period



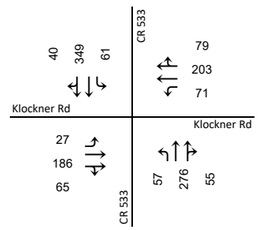
Midday Peak Period



PM Peak Period

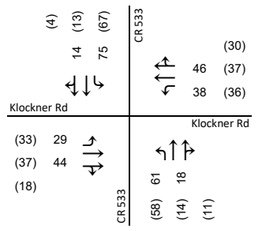


PM Off-peak Period



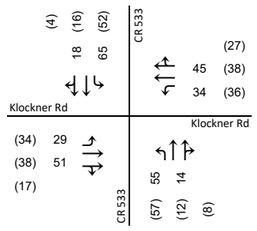
Existing Operations

AM Peak Period



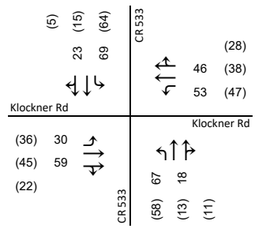
Summary				
Timing Pattern	1	Syn Delay	36	D
Actuated Cycle	110	Sim Delay	(27)	
Max v/C	0.81	ICU	59%	B

Midday Peak Period



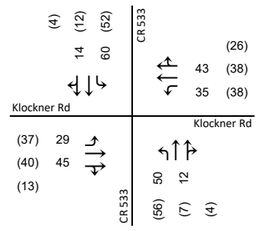
Summary				
Timing Pattern	2	Syn Delay	34	C
Actuated Cycle	105	Sim Delay	(26)	
Max v/C	0.82	ICU	58%	B

PM Peak Period



Summary				
Timing Pattern	3	Syn Delay	38	D
Actuated Cycle	110	Sim Delay	(28)	
Max v/C	0.88	ICU	62%	B

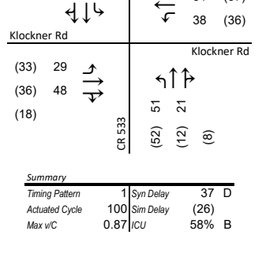
PM Off-peak Period



Summary				
Timing Pattern	2	Syn Delay	29	C
Actuated Cycle	105	Sim Delay	(23)	
Max v/C	0.68	ICU	50%	A

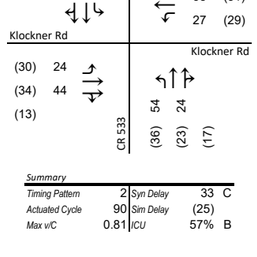
Implemented Operations

AM Peak Period



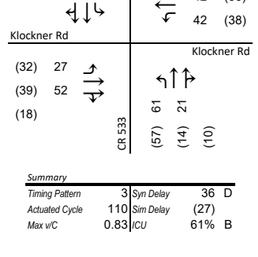
Summary				
Timing Pattern	1	Syn Delay	37	D
Actuated Cycle	100	Sim Delay	(26)	
Max v/C	0.87	ICU	58%	B

Midday Peak Period



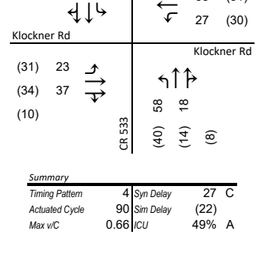
Summary				
Timing Pattern	2	Syn Delay	33	C
Actuated Cycle	90	Sim Delay	(25)	
Max v/C	0.81	ICU	57%	B

PM Peak Period



Summary				
Timing Pattern	3	Syn Delay	36	D
Actuated Cycle	110	Sim Delay	(27)	
Max v/C	0.83	ICU	61%	B

PM Off-peak Period



Summary				
Timing Pattern	4	Syn Delay	27	C
Actuated Cycle	90	Sim Delay	(22)	
Max v/C	0.66	ICU	49%	A

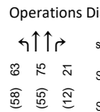
Operations with Improvements

No operational improvements recommended at this time.

HCM Levels of Service	
LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service	
LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

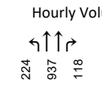


stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams



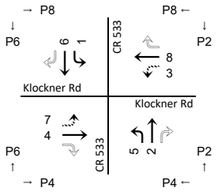
stop bar geometry

turning movement volume

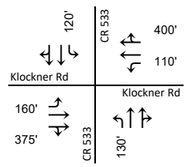
Figure 30

Weekday Traffic Operations Analysis

Whitehorse-Mercerville Rd (CR 533) & Klockner Rd

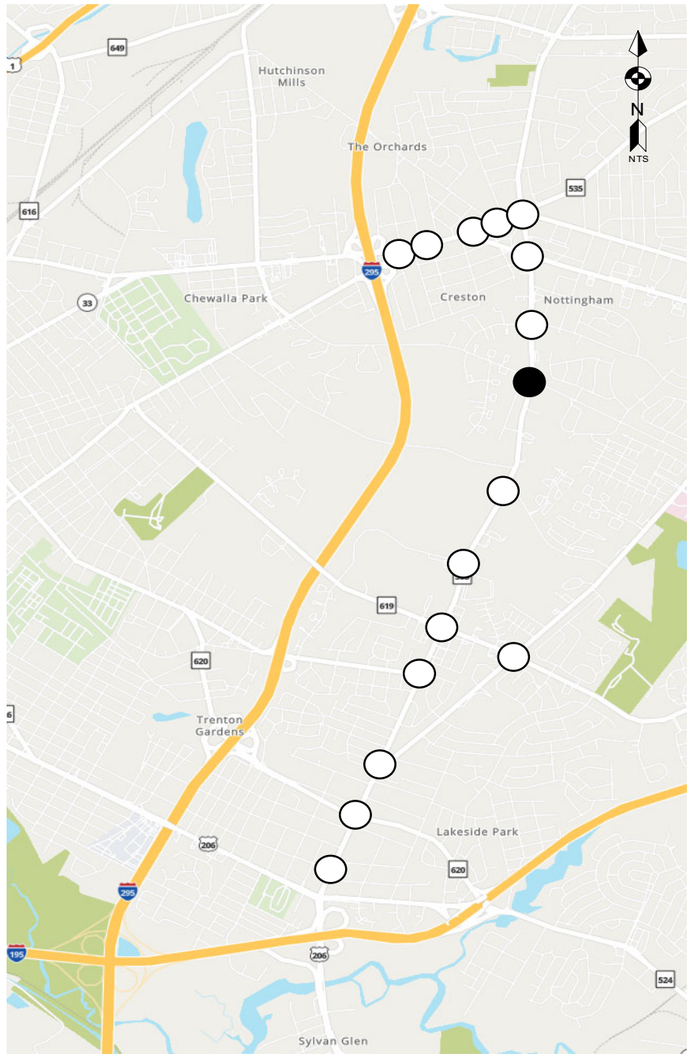


Phasing Diagram



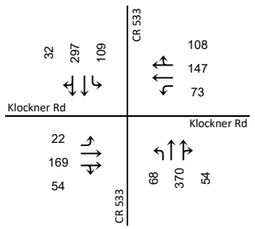
Intersection Geometry

Intersection ID # 1009

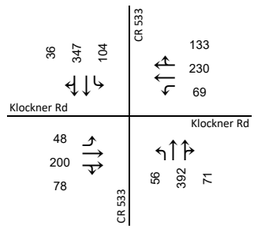


Hourly Volumes

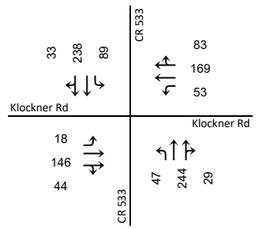
Weekend AM Peak Period



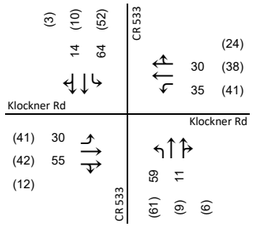
Weekend Midday Peak Period



Weekend PM Peak Period

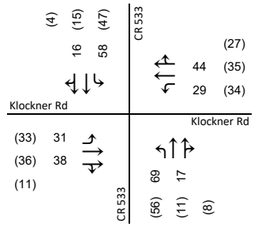


Existing Operations



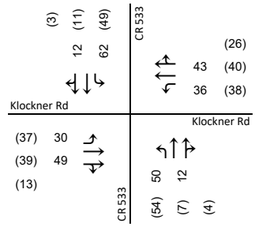
Summary

Timing Pattern	4	*Syn Delay*	30	C
Actuated Cycle	105	*Sim Delay*	(24)	
Max v/C	0.80	*ICU*	53%	A



Summary

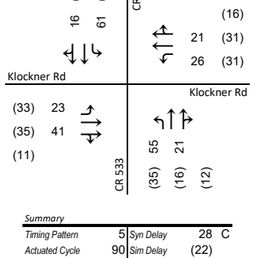
Timing Pattern	4	*Syn Delay*	31	C
Actuated Cycle	100	*Sim Delay*	(23)	
Max v/C	0.81	*ICU*	57%	B



Summary

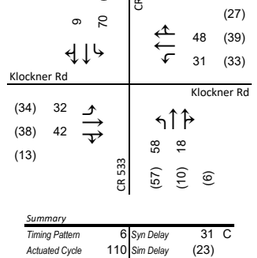
Timing Pattern	4	*Syn Delay*	31	C
Actuated Cycle	105	*Sim Delay*	(24)	
Max v/C	0.67	*ICU*	47%	A

Implemented Operations



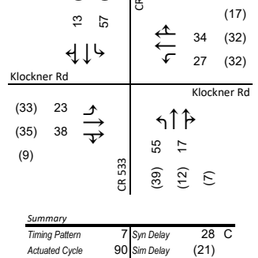
Summary

Timing Pattern	5	*Syn Delay*	28	C
Actuated Cycle	90	*Sim Delay*	(22)	
Max v/C	0.71	*ICU*	52%	A



Summary

Timing Pattern	6	*Syn Delay*	31	C
Actuated Cycle	110	*Sim Delay*	(23)	
Max v/C	0.81	*ICU*	56%	B



Summary

Timing Pattern	7	*Syn Delay*	28	C
Actuated Cycle	90	*Sim Delay*	(21)	
Max v/C	0.62	*ICU*	46%	A

Operations with Improvements

No operational improvements recommended at this time.

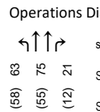
HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

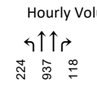


stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams



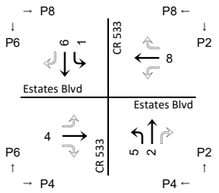
stop bar geometry

turning movement volume

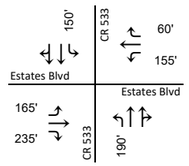
Figure 31

Weekend Traffic Operations Analysis

Whitehorse-Mercerville Rd (CR 533) & Klockner Rd

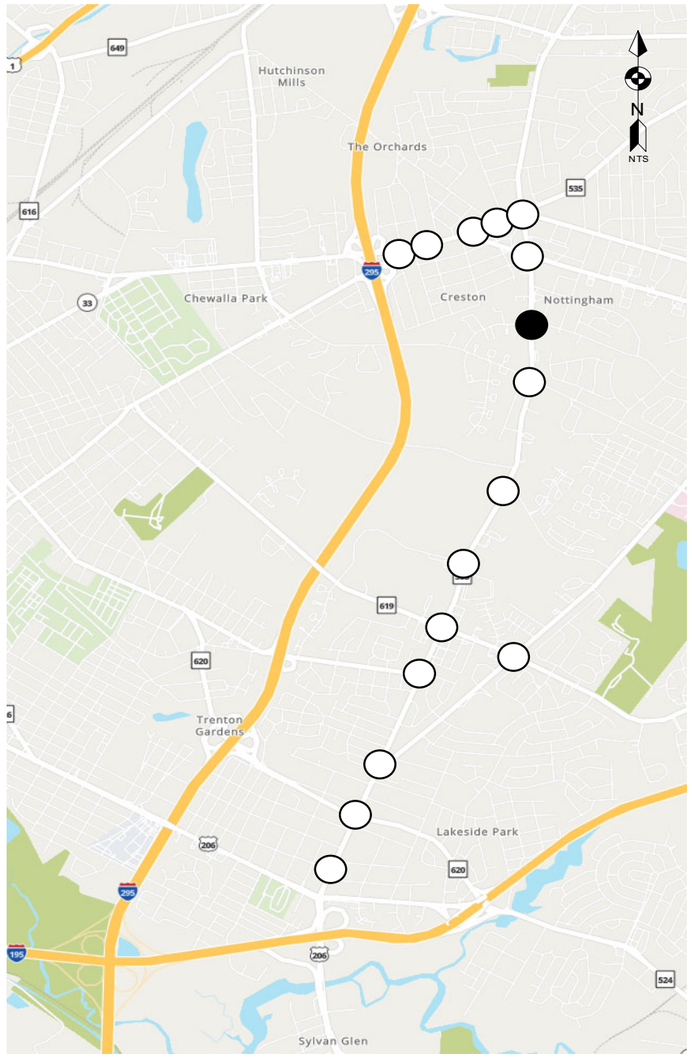


Phasing Diagram



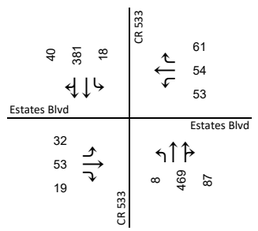
Intersection Geometry

Intersection ID # 1010

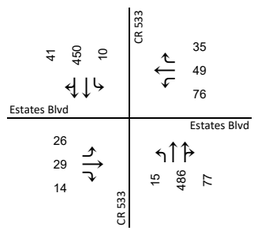


Hourly Volumes

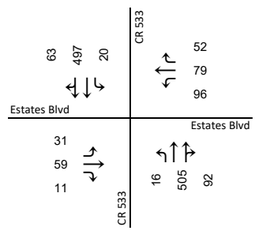
AM Peak Period



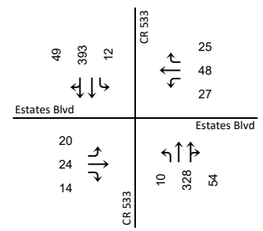
Midday Peak Period



PM Peak Period

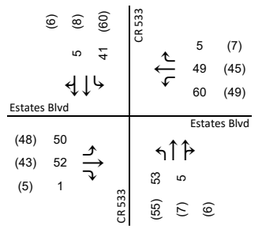


PM Off-peak Period



Existing Operations

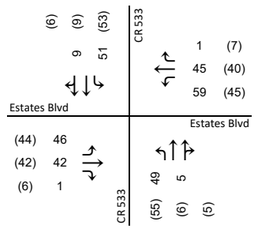
AM Peak Period



Summary

Timing Pattern	1	*Syn Delay*	15	B	
Actuated Cycle	110	*Sim Delay*	(14)		
Max v/C	0.54	*ICU*	46%	A	

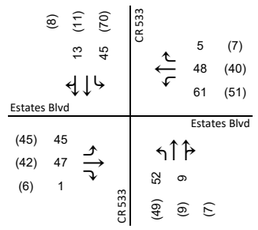
Midday Peak Period



Summary

Timing Pattern	2	*Syn Delay*	14	B	
Actuated Cycle	105	*Sim Delay*	(13)		
Max v/C	0.60	*ICU*	46%	A	

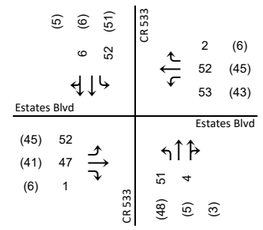
PM Peak Period



Summary

Timing Pattern	3	*Syn Delay*	19	B	
Actuated Cycle	110	*Sim Delay*	(17)		
Max v/C	0.65	*ICU*	47%	A	

PM Off-peak Period

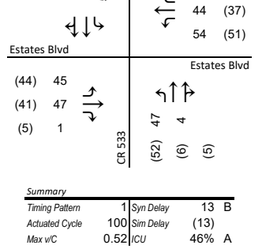


Summary

Timing Pattern	2	*Syn Delay*	12	B	
Actuated Cycle	105	*Sim Delay*	(11)		
Max v/C	0.38	*ICU*	42%	A	

Implemented Operations

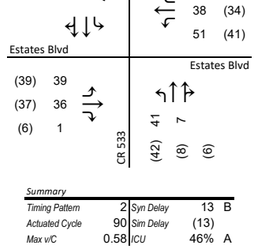
AM Peak Period



Summary

Timing Pattern	1	*Syn Delay*	13	B	
Actuated Cycle	100	*Sim Delay*	(13)		
Max v/C	0.52	*ICU*	46%	A	

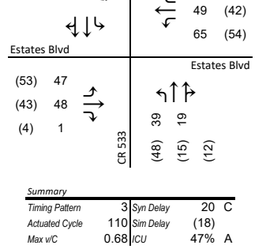
Midday Peak Period



Summary

Timing Pattern	2	*Syn Delay*	13	B	
Actuated Cycle	90	*Sim Delay*	(13)		
Max v/C	0.58	*ICU*	46%	A	

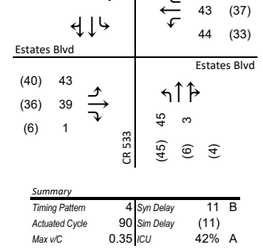
PM Peak Period



Summary

Timing Pattern	3	*Syn Delay*	20	C	
Actuated Cycle	110	*Sim Delay*	(18)		
Max v/C	0.68	*ICU*	47%	A	

PM Off-peak Period



Summary

Timing Pattern	4	*Syn Delay*	11	B	
Actuated Cycle	90	*Sim Delay*	(11)		
Max v/C	0.35	*ICU*	42%	A	

Operations with Improvements

No operational improvements recommended at this time.

HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams

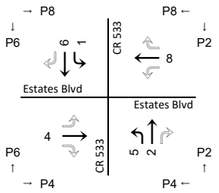
stop bar geometry

turning movement volume

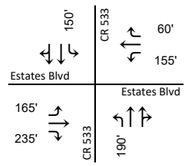
Figure 32

Weekday Traffic Operations Analysis

Whitehorse-Mercerville Rd (CR 533) & Estates Blvd

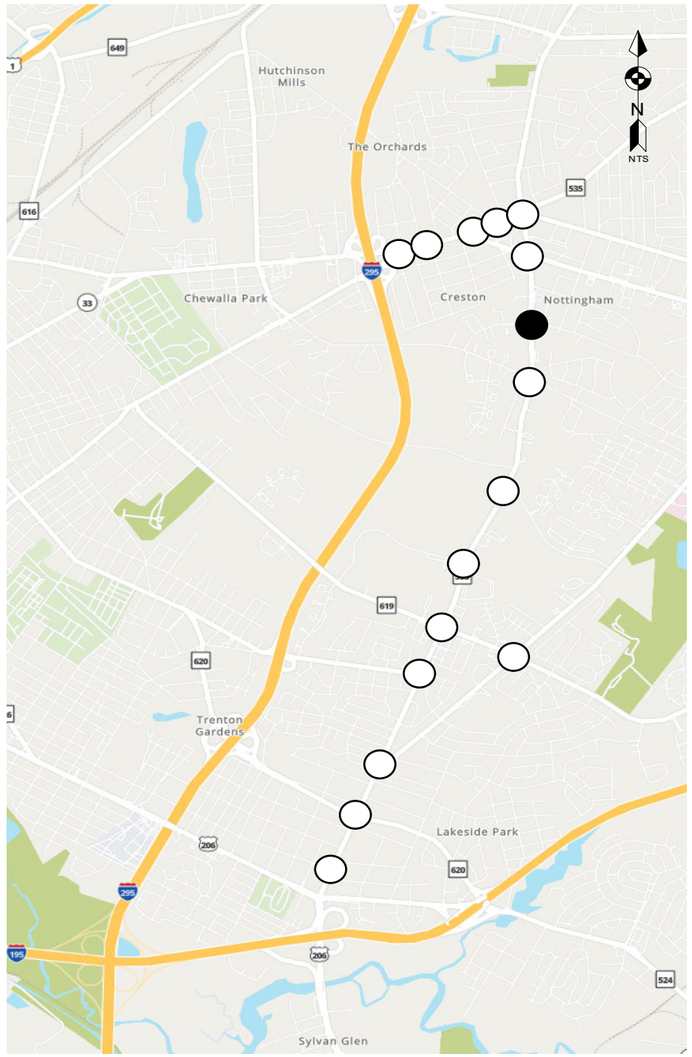


Phasing Diagram



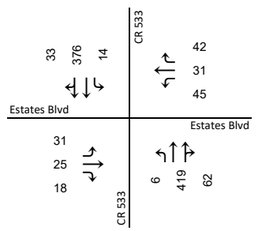
Intersection Geometry

Intersection ID # 1010

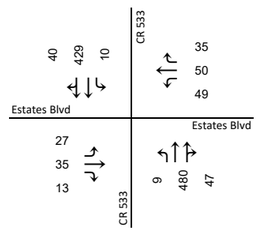


Hourly Volumes

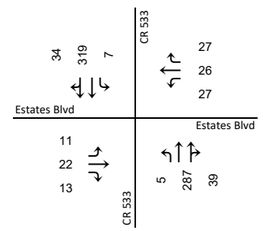
Weekend AM Peak Period



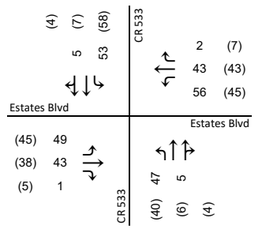
Weekend Midday Peak Period



Weekend PM Peak Period

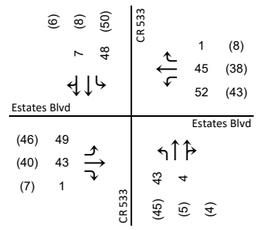


Existing Operations



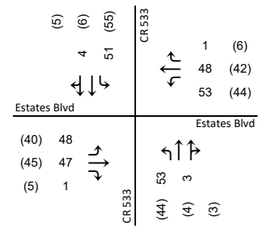
Summary

Timing Pattern	4	*Syn Delay*	12	B	
Actuated Cycle	105	*Sim Delay*	(11)		
Max v/C	0.51	*ICU*	43%	A	



Summary

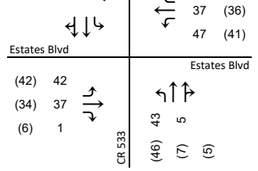
Timing Pattern	4	*Syn Delay*	13	B	
Actuated Cycle	100	*Sim Delay*	(11)		
Max v/C	0.47	*ICU*	45%	A	



Summary

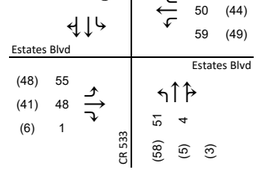
Timing Pattern	4	*Syn Delay*	11	B	
Actuated Cycle	105	*Sim Delay*	(10)		
Max v/C	0.33	*ICU*	40%	A	

Implemented Operations



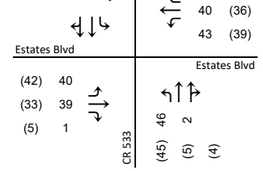
Summary

Timing Pattern	5	*Syn Delay*	11	B	
Actuated Cycle	90	*Sim Delay*	(11)		
Max v/C	0.48	*ICU*	43%	A	



Summary

Timing Pattern	6	*Syn Delay*	14	B	
Actuated Cycle	110	*Sim Delay*	(11)		
Max v/C	0.50	*ICU*	45%	A	



Summary

Timing Pattern	7	*Syn Delay*	9	A	
Actuated Cycle	90	*Sim Delay*	(10)		
Max v/C	0.29	*ICU*	40%	A	

Operations with Improvements

No operational improvements recommended at this time.

HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams

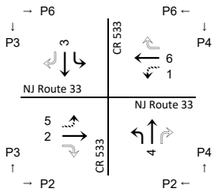
stop bar geometry

turning movement volume

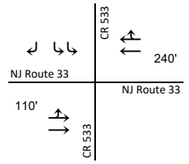
Figure 33

Weekend Traffic Operations Analysis

Whitehorse-Mercerville Rd (CR 533) & Estates Blvd

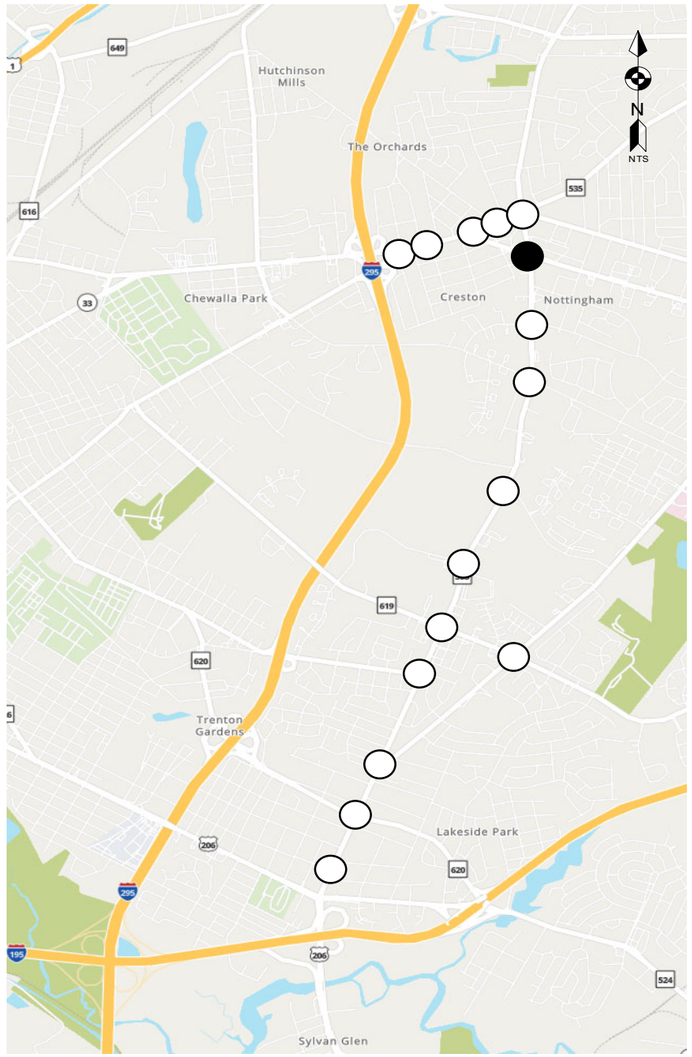


Phasing Diagram

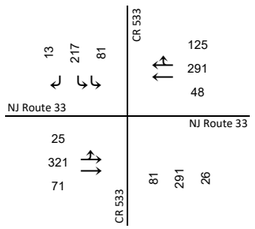


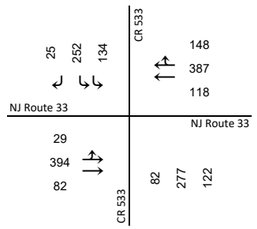
Intersection Geometry

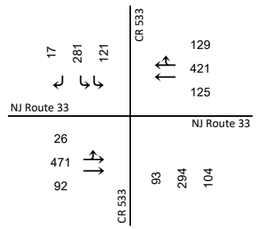
Intersection ID # 1102

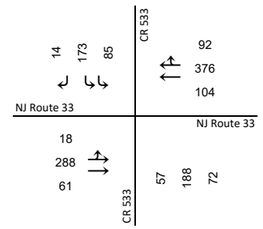


Hourly Volumes

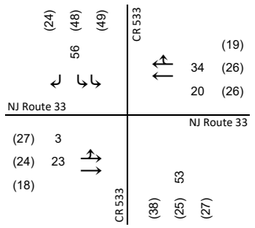






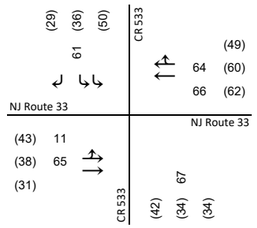


Existing Operations



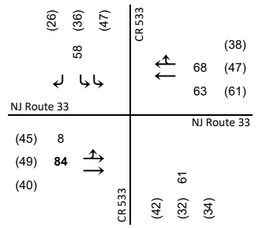
Summary

Timing Pattern	1	*Syn Delay*	39	D
Actuated Cycle	110	*Sim Delay*	(29)	
Max v/C	0.88	*ICU*	70%	C



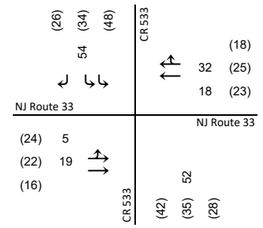
Summary

Timing Pattern	2	*Syn Delay*	64	E
Actuated Cycle	110	*Sim Delay*	(43)	
Max v/C	1.00	*ICU*	83%	E



Summary

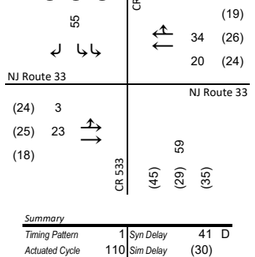
Timing Pattern	3	*Syn Delay*	67	E
Actuated Cycle	110	*Sim Delay*	(42)	
Max v/C	1.08	*ICU*	87%	E



Summary

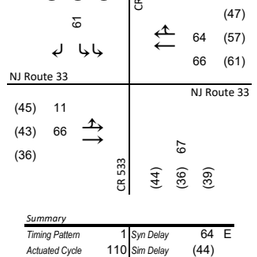
Timing Pattern	2	*Syn Delay*	36	D
Actuated Cycle	110	*Sim Delay*	(28)	
Max v/C	0.77	*ICU*	69%	C

Implemented Operations



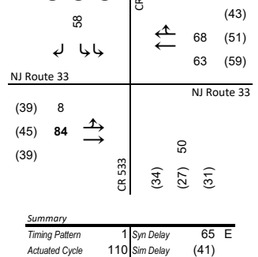
Summary

Timing Pattern	1	*Syn Delay*	41	D
Actuated Cycle	110	*Sim Delay*	(30)	
Max v/C	0.88	*ICU*	70%	C



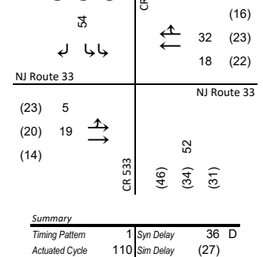
Summary

Timing Pattern	1	*Syn Delay*	64	E
Actuated Cycle	110	*Sim Delay*	(44)	
Max v/C	1.00	*ICU*	83%	E



Summary

Timing Pattern	1	*Syn Delay*	65	E
Actuated Cycle	110	*Sim Delay*	(41)	
Max v/C	1.08	*ICU*	87%	E



Summary

Timing Pattern	1	*Syn Delay*	36	D
Actuated Cycle	110	*Sim Delay*	(27)	
Max v/C	0.77	*ICU*	69%	C

Operations with Improvements

No operational improvements recommended at this time.

HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

63 75 21
(58) (55) (12)

stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams

224 937 118

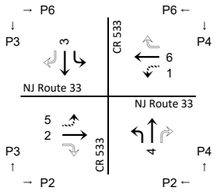
stop bar geometry

turning movement volume

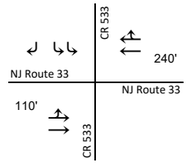
Figure 44

Weekday Traffic Operations Analysis

Whitehorse-Mercerville Rd (CR 533) & NJ Route 33

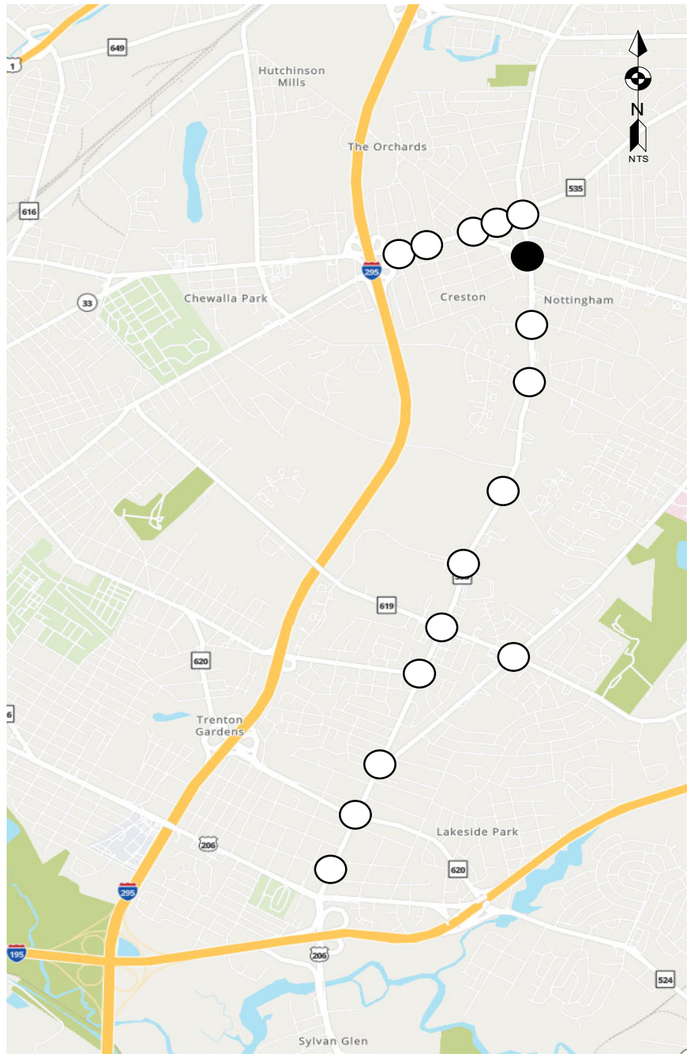


Phasing Diagram



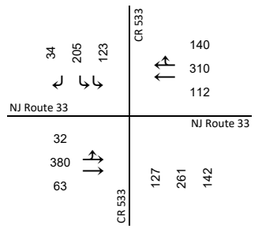
Intersection Geometry

Intersection ID # 1102

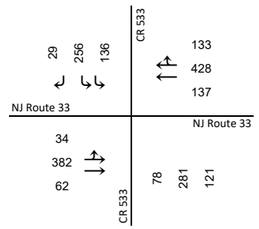


Hourly Volumes

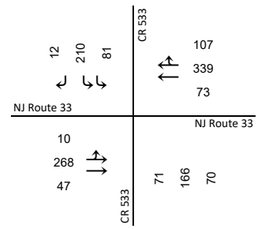
Weekend AM Peak Period



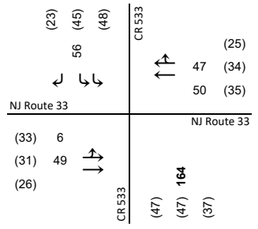
Weekend Midday Peak Period



Weekend PM Peak Period

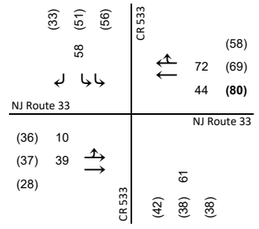


Existing Operations



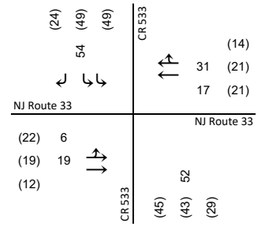
Summary

Timing Pattern	5	*Syn Delay*	**85**	F
Actuated Cycle	110	*Sim Delay*	(37)	
Max v/C	1.26	*ICU*	79%	D



Summary

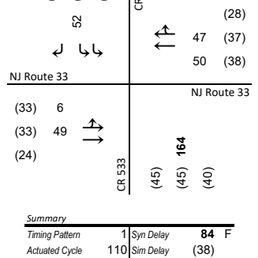
Timing Pattern	6	*Syn Delay*	57	E
Actuated Cycle	110	*Sim Delay*	(50)	
Max v/C	1.00	*ICU*	84%	E



Summary

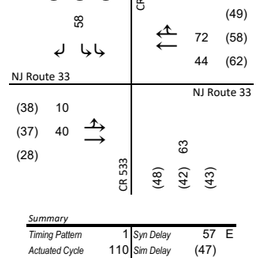
Timing Pattern	7	*Syn Delay*	37	D
Actuated Cycle	110	*Sim Delay*	(30)	
Max v/C	0.78	*ICU*	69%	C

Implemented Operations



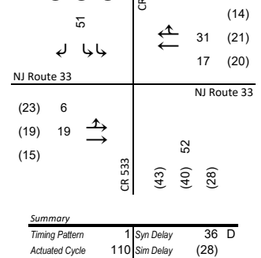
Summary

Timing Pattern	1	*Syn Delay*	**84**	F
Actuated Cycle	110	*Sim Delay*	(38)	
Max v/C	1.26	*ICU*	79%	D



Summary

Timing Pattern	1	*Syn Delay*	57	E
Actuated Cycle	110	*Sim Delay*	(47)	
Max v/C	1.00	*ICU*	84%	E



Summary

Timing Pattern	1	*Syn Delay*	36	D
Actuated Cycle	110	*Sim Delay*	(28)	
Max v/C	0.78	*ICU*	69%	C

Operations with Improvements

No operational improvements recommended at this time.

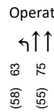
HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

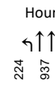


stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams



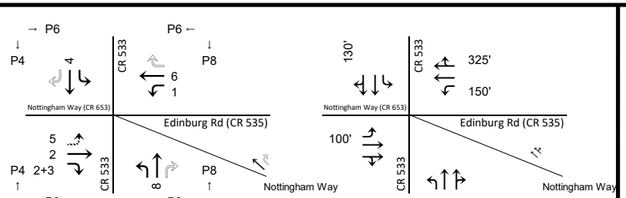
stop bar geometry

turning movement volume

Figure 45

Weekend Traffic Operations Analysis

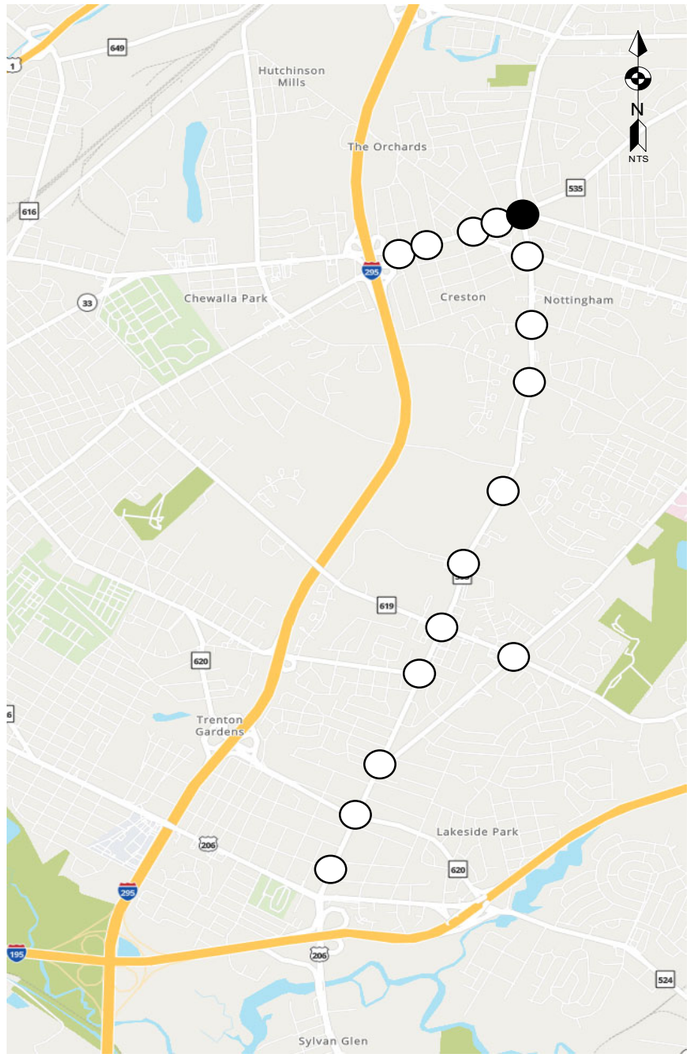
Whitehorse-Mercerville Rd (CR 533) & NJ Route 33



Phasing Diagram

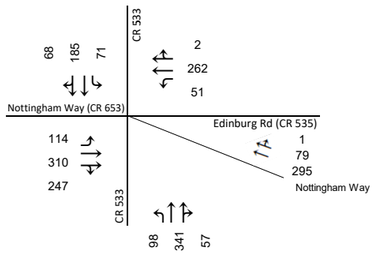
Intersection Geometry

Intersection ID # 1012

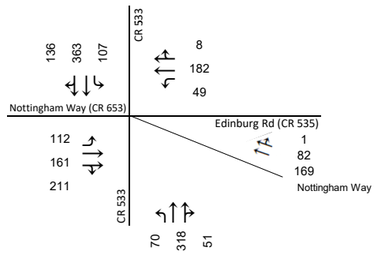


Hourly Volumes

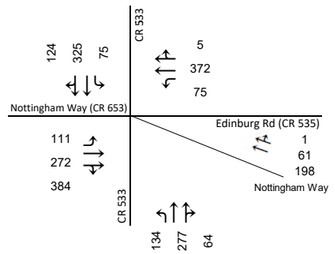
AM Peak Period



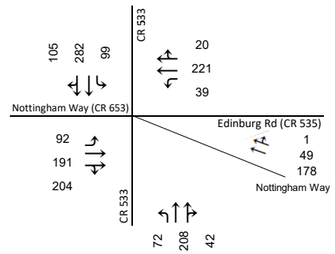
Midday Peak Period



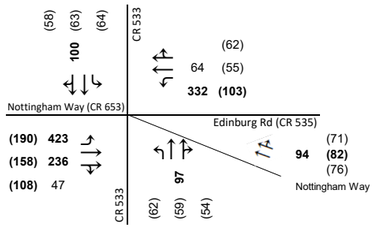
PM Peak Period



PM Off-peak Period

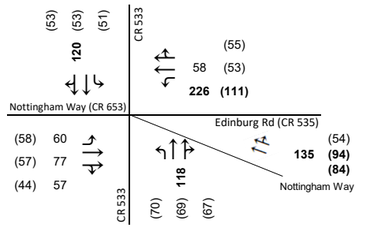


Existing Operations



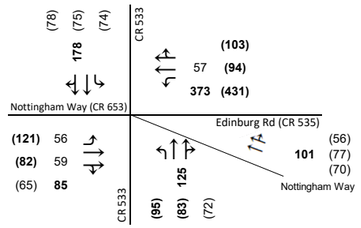
Summary

Timing Pattern	1	*Syn Delay*	**131**	F
Actuated Cycle	150	*Sim Delay*	**(89)**	
Max v/C	1.82	*ICU*	89%	E



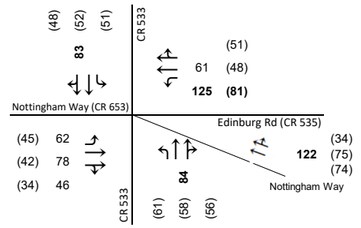
Summary

Timing Pattern	2	*Syn Delay*	**102**	F
Actuated Cycle	150	*Sim Delay*	(61)	
Max v/C	1.16	*ICU*	86%	E



Summary

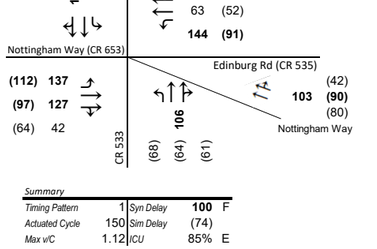
Timing Pattern	3	*Syn Delay*	**113**	F
Actuated Cycle	150	*Sim Delay*	**(91)**	
Max v/C	1.59	*ICU*	**93%**	F



Summary

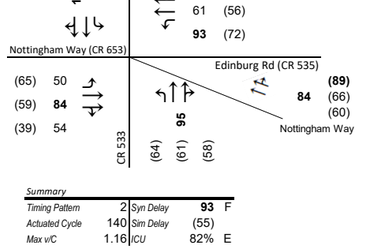
Timing Pattern	2	*Syn Delay*	79	E
Actuated Cycle	150	*Sim Delay*	(52)	
Max v/C	1.01	*ICU*	78%	D

Implemented Operations



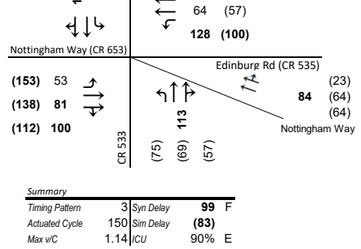
Summary

Timing Pattern	1	*Syn Delay*	**100**	F
Actuated Cycle	150	*Sim Delay*	(74)	
Max v/C	1.12	*ICU*	85%	E



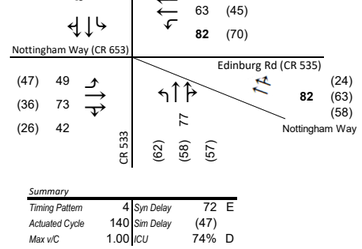
Summary

Timing Pattern	2	*Syn Delay*	**93**	F
Actuated Cycle	140	*Sim Delay*	(55)	
Max v/C	1.16	*ICU*	82%	E



Summary

Timing Pattern	3	*Syn Delay*	**99**	F
Actuated Cycle	150	*Sim Delay*	**(83)**	
Max v/C	1.14	*ICU*	90%	E



Summary

Timing Pattern	4	*Syn Delay*	72	E
Actuated Cycle	140	*Sim Delay*	(47)	
Max v/C	1.00	*ICU*	74%	D

Operations with Improvements

No operational improvements recommended at this time.

HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

63 75 21
(58) (55) (12)

stop bar geometry
Synchro delay (sec / veh)
SimTraffic delay (sec / veh)

Hourly Volume Diagrams

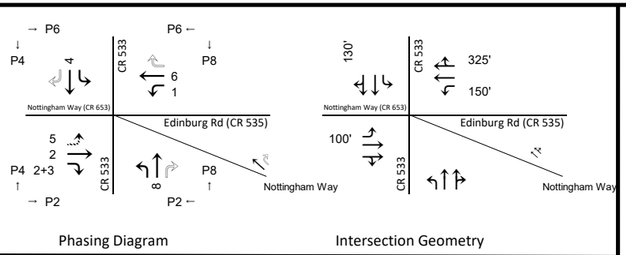
224 937 118

stop bar geometry
turning movement volume

Figure 36

Weekday Traffic Operations Analysis

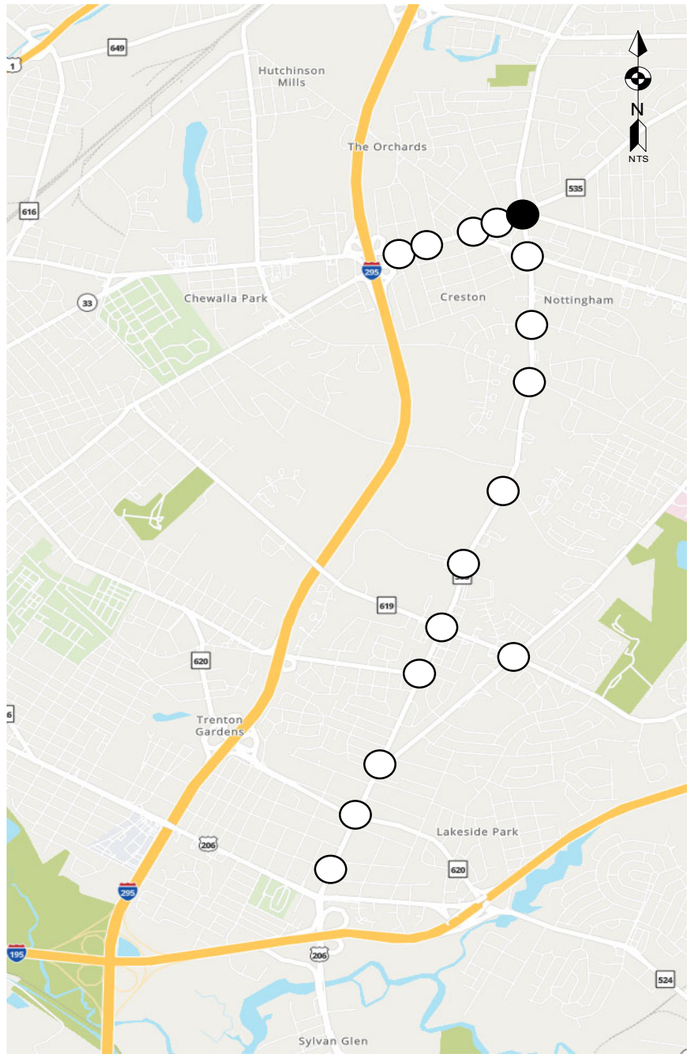
Whitehorse-Mercerville Rd (CR 533) & Nottingham Way (CR 653)



Phasing Diagram

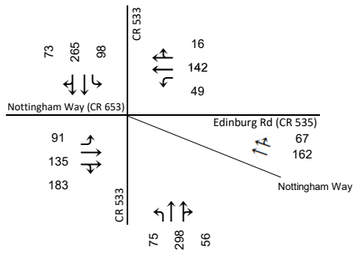
Intersection Geometry

Intersection ID # 1012

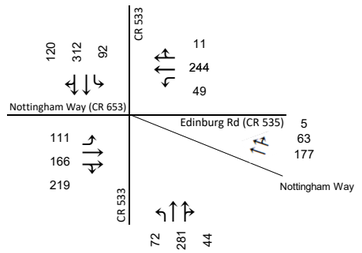


Hourly Volumes

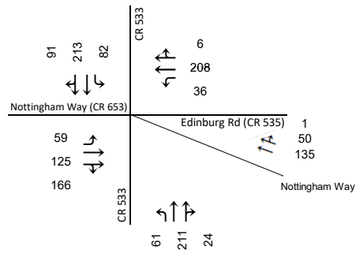
Weekend AM Peak Period



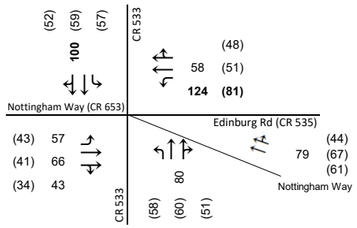
Weekend Midday Peak Period



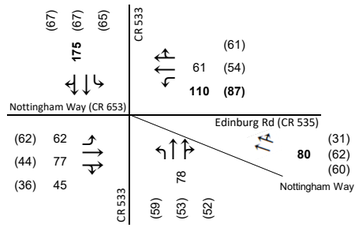
Weekend PM Peak Period



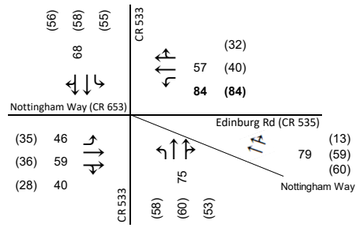
Existing Operations



Summary				
Timing Pattern	1	Syn Delay	76	E
Actuated Cycle	150	Sim Delay	(53)	
Max v/C	1.01	ICU	79%	D

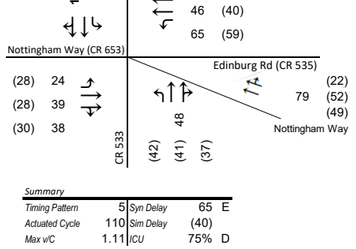


Summary				
Timing Pattern	1	Syn Delay	95	F
Actuated Cycle	150	Sim Delay	(56)	
Max v/C	1.25	ICU	83%	E

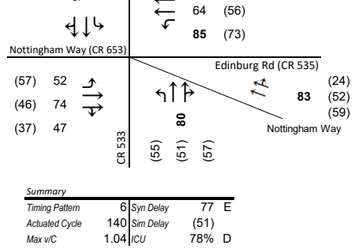


Summary				
Timing Pattern	1	Syn Delay	64	E
Actuated Cycle	150	Sim Delay	(49)	
Max v/C	0.83	ICU	71%	C

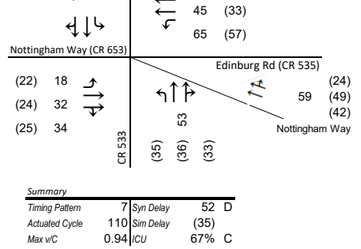
Implemented Operations



Summary				
Timing Pattern	5	Syn Delay	65	E
Actuated Cycle	110	Sim Delay	(40)	
Max v/C	1.11	ICU	75%	D



Summary				
Timing Pattern	6	Syn Delay	77	E
Actuated Cycle	140	Sim Delay	(51)	
Max v/C	1.04	ICU	78%	D



Summary				
Timing Pattern	7	Syn Delay	52	D
Actuated Cycle	110	Sim Delay	(35)	
Max v/C	0.94	ICU	67%	C

Operations with Improvements

No operational improvements recommended at this time.

HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

63 75 21
(58) (55) (12)

stop bar geometry
Synchro delay (sec / veh)
SimTraffic delay (sec / veh)

Hourly Volume Diagrams

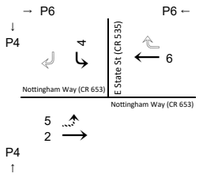
224 937 118

stop bar geometry
turning movement volume

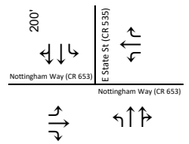
Figure 37

Weekend Traffic Operations Analysis

Whitehorse-Mercerville Rd (CR 533) & Nottingham Way (CR 653)

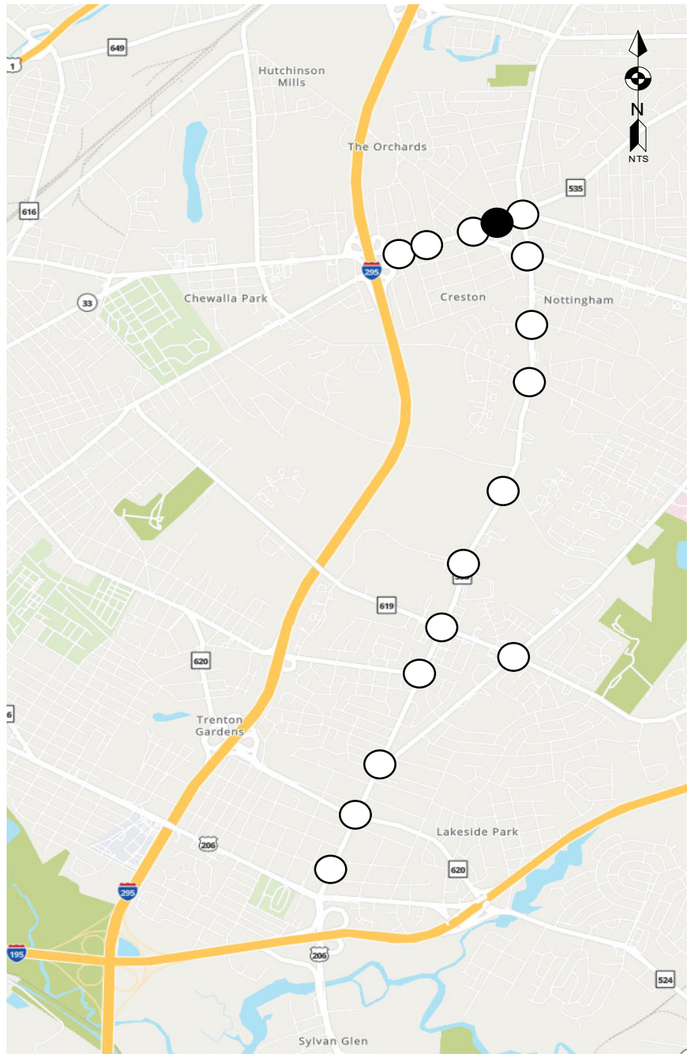


Phasing Diagram



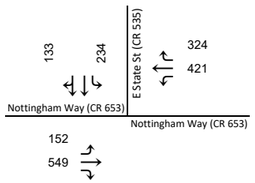
Intersection Geometry

Intersection ID # 1011

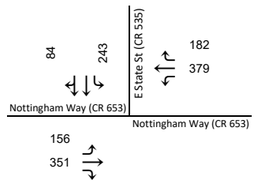


Hourly Volumes

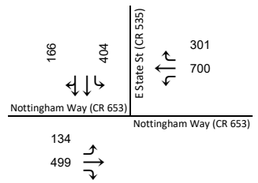
AM Peak Period



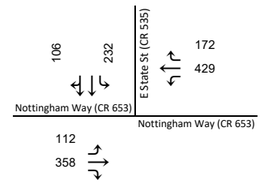
Midday Peak Period



PM Peak Period

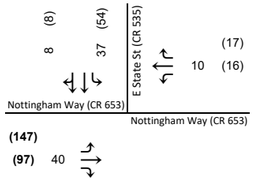


PM Off-peak Period



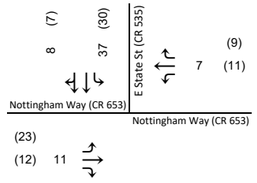
Existing Operations

AM Peak Period



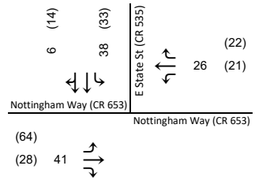
Summary				
Timing Pattern	1	Syn Delay	25	C
Actuated Cycle	75	Sim Delay	(54)	
Max v/C	0.97	ICU	70%	C

Midday Peak Period



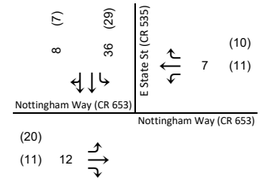
Summary				
Timing Pattern	1	Syn Delay	14	B
Actuated Cycle	75	Sim Delay	(15)	
Max v/C	0.67	ICU	59%	B

PM Peak Period



Summary				
Timing Pattern	1	Syn Delay	31	C
Actuated Cycle	75	Sim Delay	(27)	
Max v/C	0.93	ICU	80%	D

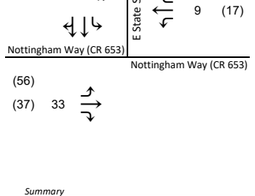
PM Off-peak Period



Summary				
Timing Pattern	1	Syn Delay	13	B
Actuated Cycle	75	Sim Delay	(14)	
Max v/C	0.65	ICU	58%	B

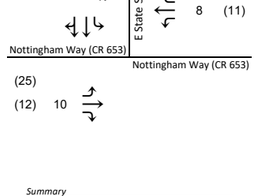
Implemented Operations

AM Peak Period



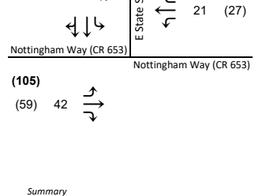
Summary				
Timing Pattern	1	Syn Delay	22	C
Actuated Cycle	75	Sim Delay	(28)	
Max v/C	0.94	ICU	68%	C

Midday Peak Period



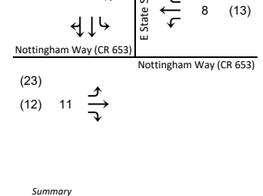
Summary				
Timing Pattern	1	Syn Delay	13	B
Actuated Cycle	70	Sim Delay	(15)	
Max v/C	0.65	ICU	57%	B

PM Peak Period



Summary				
Timing Pattern	1	Syn Delay	29	C
Actuated Cycle	75	Sim Delay	(42)	
Max v/C	0.88	ICU	79%	D

PM Off-peak Period



Summary				
Timing Pattern	1	Syn Delay	13	B
Actuated Cycle	70	Sim Delay	(15)	
Max v/C	0.63	ICU	57%	B

Operations with Improvements

No operational improvements recommended at this time.

HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

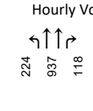
ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

stop bar geometry
Synchro delay (sec / veh)
SimTraffic delay (sec / veh)

Hourly Volume Diagrams

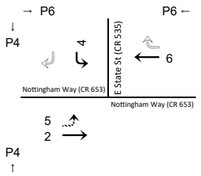


stop bar geometry
turning movement volume

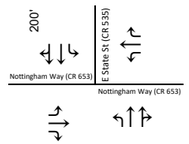
Figure 34

Weekday Traffic Operations Analysis

Nottingham Way (CR 653) & E State St (CR 535)

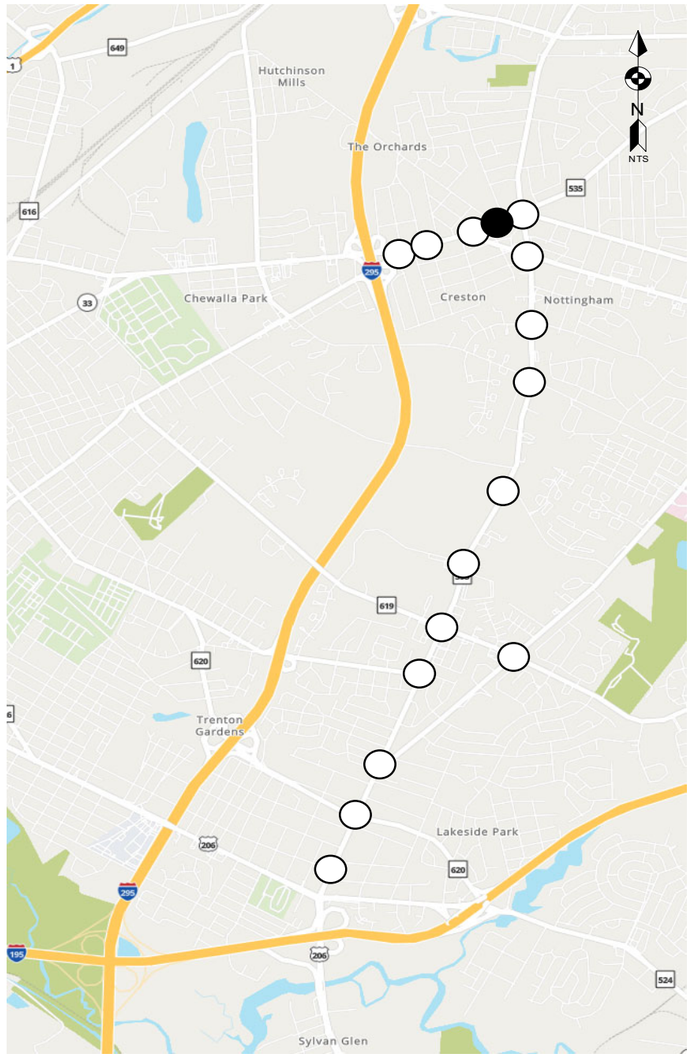


Phasing Diagram



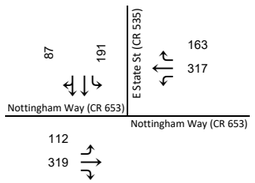
Intersection Geometry

Intersection ID # 1011

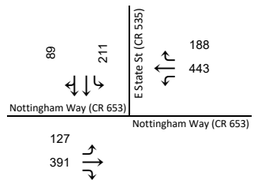


Hourly Volumes

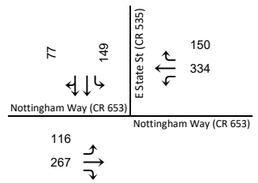
Weekend AM Peak Period



Weekend Midday Peak Period

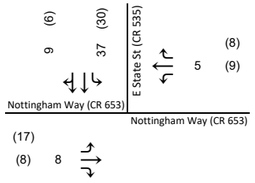


Weekend PM Peak Period



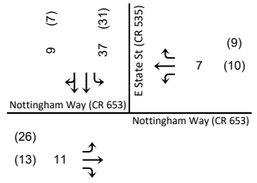
Existing Operations

Weekend AM Peak Period



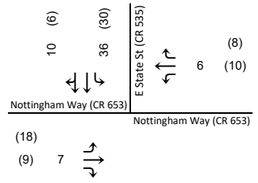
Summary				
Timing Pattern	1	Syn Delay	12	B
Actuated Cycle	75	Sim Delay	(13)	
Max v/C	0.62	ICU	52%	A

Weekend Midday Peak Period



Summary				
Timing Pattern	1	Syn Delay	13	B
Actuated Cycle	75	Sim Delay	(15)	
Max v/C	0.62	ICU	60%	B

Weekend PM Peak Period



Summary				
Timing Pattern	1	Syn Delay	11	B
Actuated Cycle	75	Sim Delay	(13)	
Max v/C	0.57	ICU	51%	A

Implemented Operations

Weekend AM Peak Period

Summary				
Timing Pattern	1	Syn Delay	20	B
Actuated Cycle	110	Sim Delay	(15)	
Max v/C	0.69	ICU	51%	A

Weekend Midday Peak Period

Summary				
Timing Pattern	1	Syn Delay	12	B
Actuated Cycle	70	Sim Delay	(14)	
Max v/C	0.62	ICU	58%	B

Weekend PM Peak Period

Summary				
Timing Pattern	1	Syn Delay	19	B
Actuated Cycle	110	Sim Delay	(14)	
Max v/C	0.66	ICU	51%	A

Operations with Improvements

No operational improvements recommended at this time.

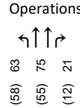
HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams



stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams

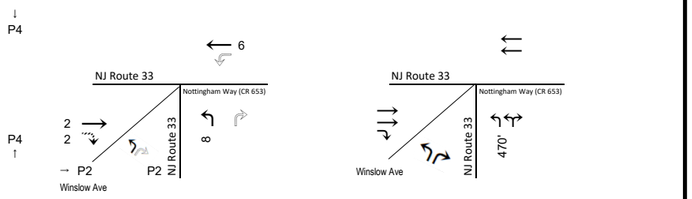
stop bar geometry

turning movement volume

Figure 35

Weekend Traffic Operations Analysis

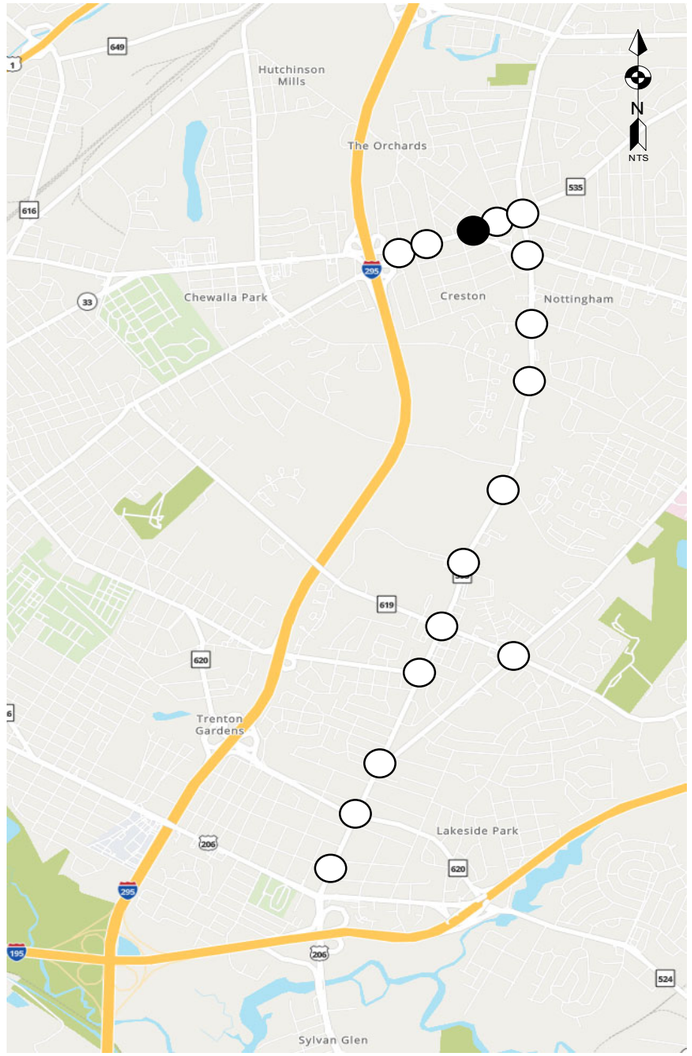
Nottingham Way (CR 653) & E State St (CR 535)



Phasing Diagram

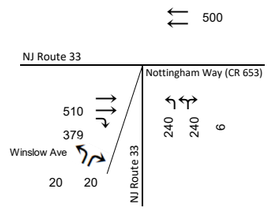
Intersection Geometry

Intersection ID # 1013

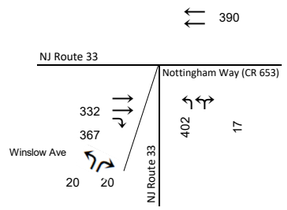


Hourly Volumes

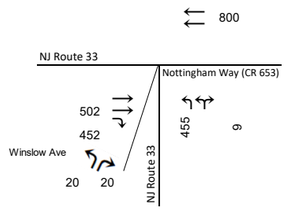
AM Peak Period



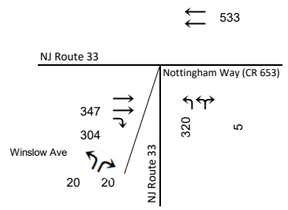
Midday Peak Period



PM Peak Period

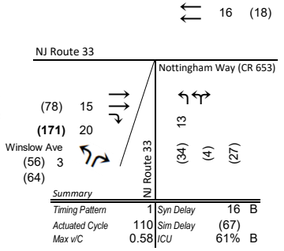


PM Off-peak Period

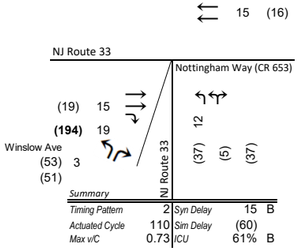


Existing Operations

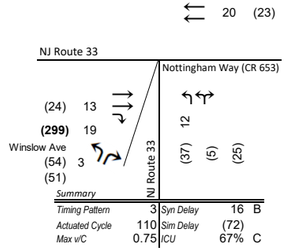
AM Peak Period



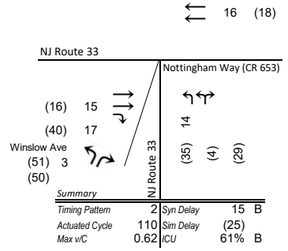
Midday Peak Period



PM Peak Period

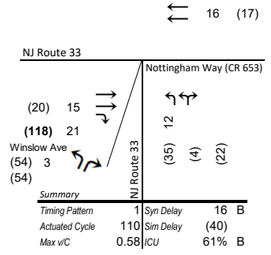


PM Off-peak Period

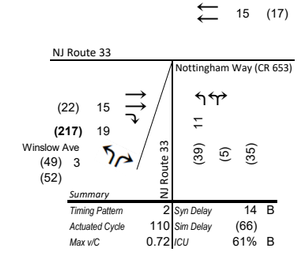


Implemented Operations

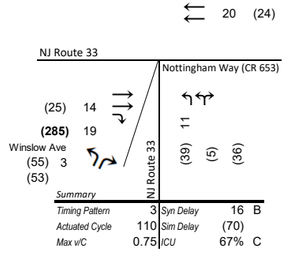
AM Peak Period



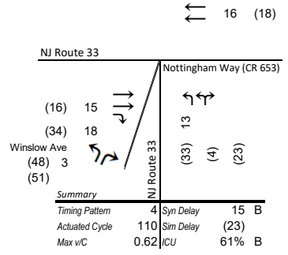
Midday Peak Period



PM Peak Period



PM Off-peak Period



Operations with Improvements

No operational improvements recommended at this time.

HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams

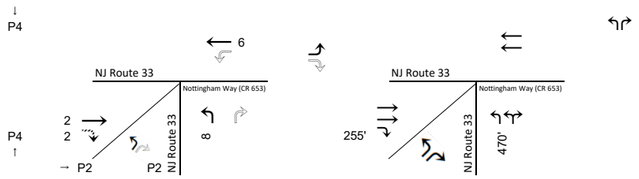
stop bar geometry

turning movement volume

Figure 38

Weekday Traffic Operations Analysis

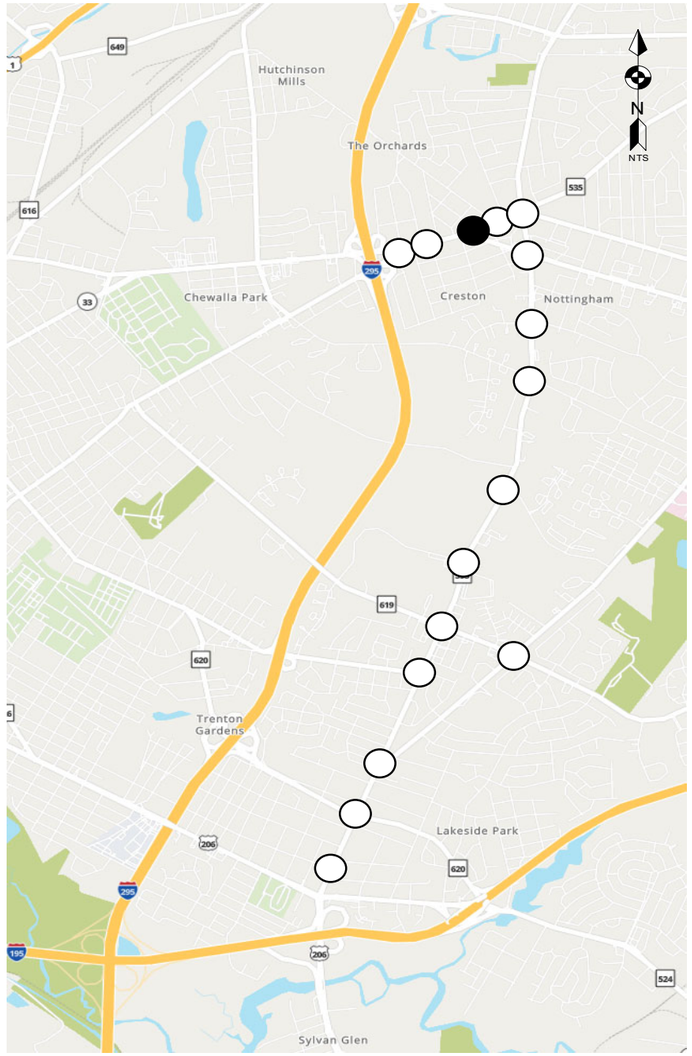
Nottingham Way (NJ Rt 33) & Nottingham Way (CR 653)



Phasing Diagram

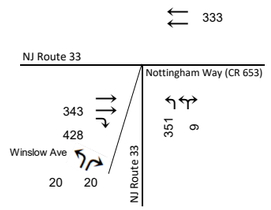
Intersection Geometry

Intersection ID # 1013

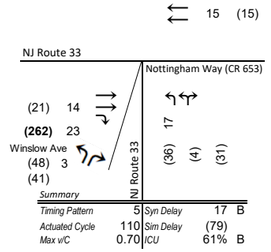


Weekend AM Peak Period

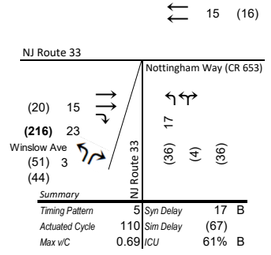
Hourly Volumes



Existing Operations



Implemented Operations

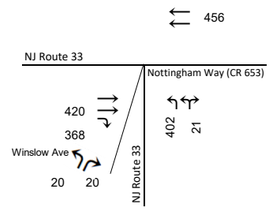


Operations with Improvements

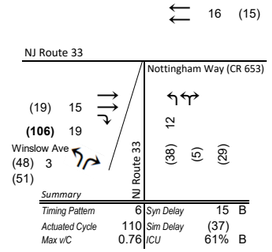
No operational improvements recommended at this time.

Weekend Midday Peak Period

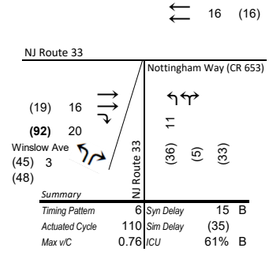
Hourly Volumes



Existing Operations



Implemented Operations

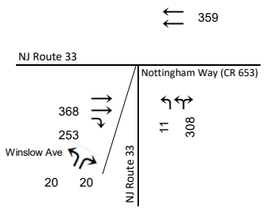


Operations with Improvements

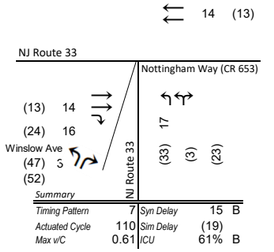
No operational improvements recommended at this time.

Weekend PM Peak Period

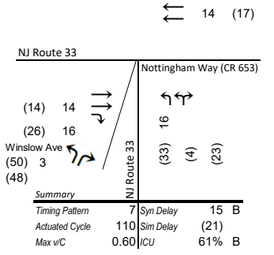
Hourly Volumes



Existing Operations



Implemented Operations



Operations with Improvements

No operational improvements recommended at this time.

HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
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C	>64% and ≤73%
D	>73% and ≤82%
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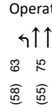
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams



stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams

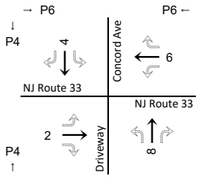
stop bar geometry

turning movement volume

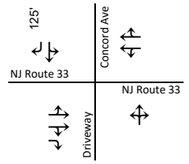
Figure 39

Weekend Traffic Operations Analysis

Nottingham Way (NJ Rt 33) & Nottingham Way (CR 653)

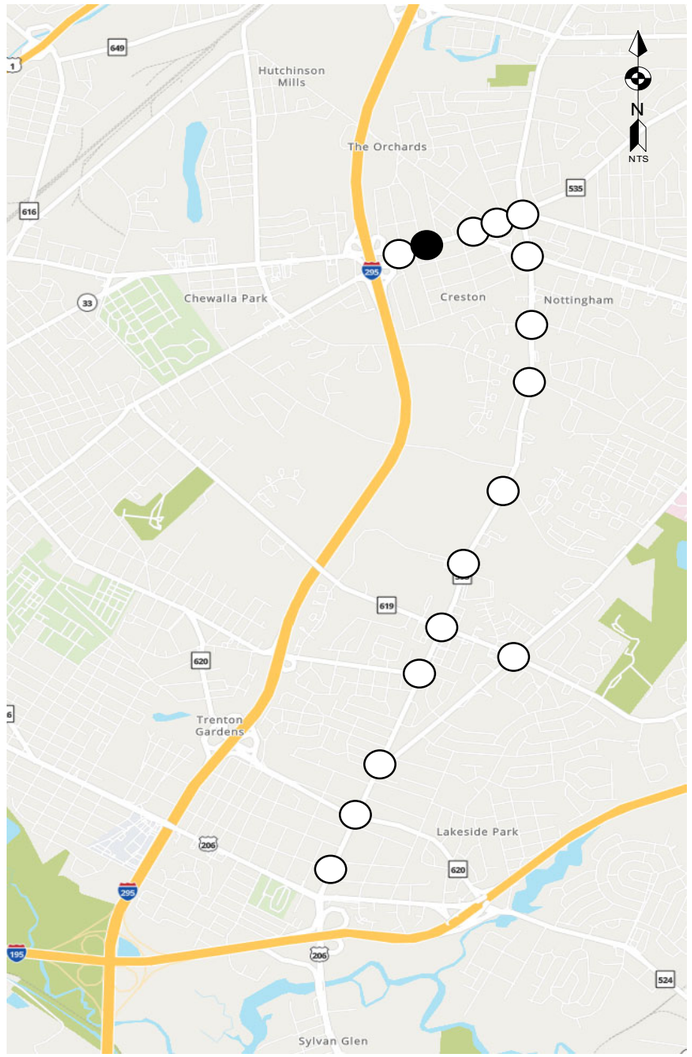


Phasing Diagram



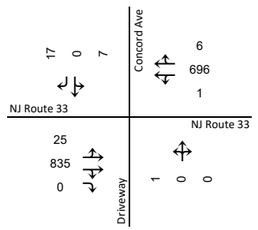
Intersection Geometry

Intersection ID # 1014

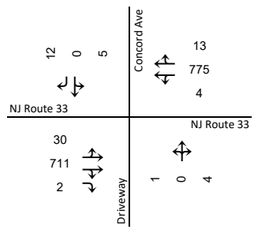


Hourly Volumes

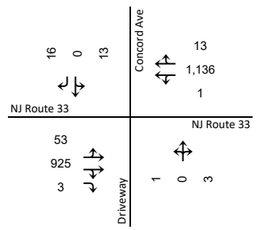
AM Peak Period



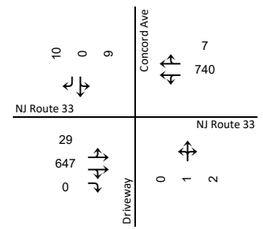
Midday Peak Period



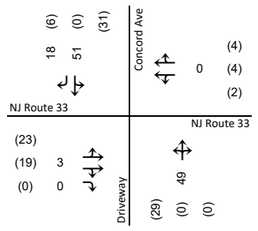
PM Peak Period



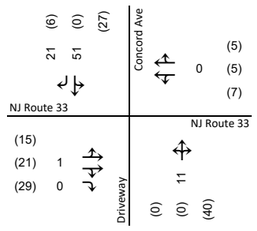
PM Off-peak Period



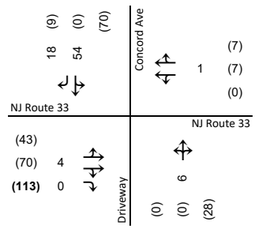
Existing Operations



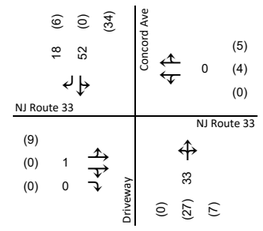
Summary					
Timing Pattern	1	Syn Delay	2	A	
Actuated Cycle	110	Sim Delay	(12)		
Max v/C	0.41	ICU	59%	B	



Summary					
Timing Pattern	1	Syn Delay	1	A	
Actuated Cycle	110	Sim Delay	(13)		
Max v/C	0.33	ICU	60%	B	

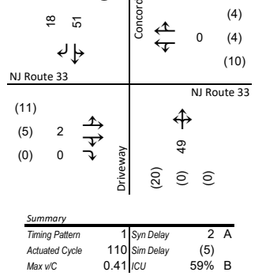


Summary					
Timing Pattern	1	Syn Delay	3	A	
Actuated Cycle	110	Sim Delay	(32)		
Max v/C	0.53	ICU	83%	E	

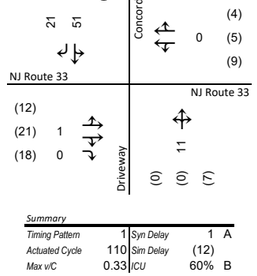


Summary					
Timing Pattern	1	Syn Delay	1	A	
Actuated Cycle	110	Sim Delay	(4)		
Max v/C	0.29	ICU	58%	B	

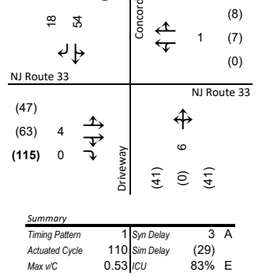
Implemented Operations



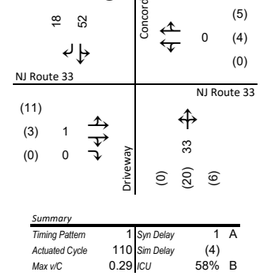
Summary					
Timing Pattern	1	Syn Delay	2	A	
Actuated Cycle	110	Sim Delay	(5)		
Max v/C	0.41	ICU	59%	B	



Summary					
Timing Pattern	1	Syn Delay	1	A	
Actuated Cycle	110	Sim Delay	(12)		
Max v/C	0.33	ICU	60%	B	



Summary					
Timing Pattern	1	Syn Delay	3	A	
Actuated Cycle	110	Sim Delay	(29)		
Max v/C	0.53	ICU	83%	E	



Summary					
Timing Pattern	1	Syn Delay	1	A	
Actuated Cycle	110	Sim Delay	(4)		
Max v/C	0.29	ICU	58%	B	

Operations with Improvements

No operational improvements recommended at this time.

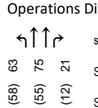
HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

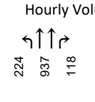


stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams



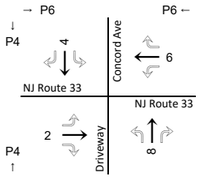
stop bar geometry

turning movement volume

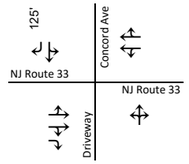
Figure 40

Weekday Traffic Operations Analysis

Nottingham Way (NJ Rt 33) & Concord Ave

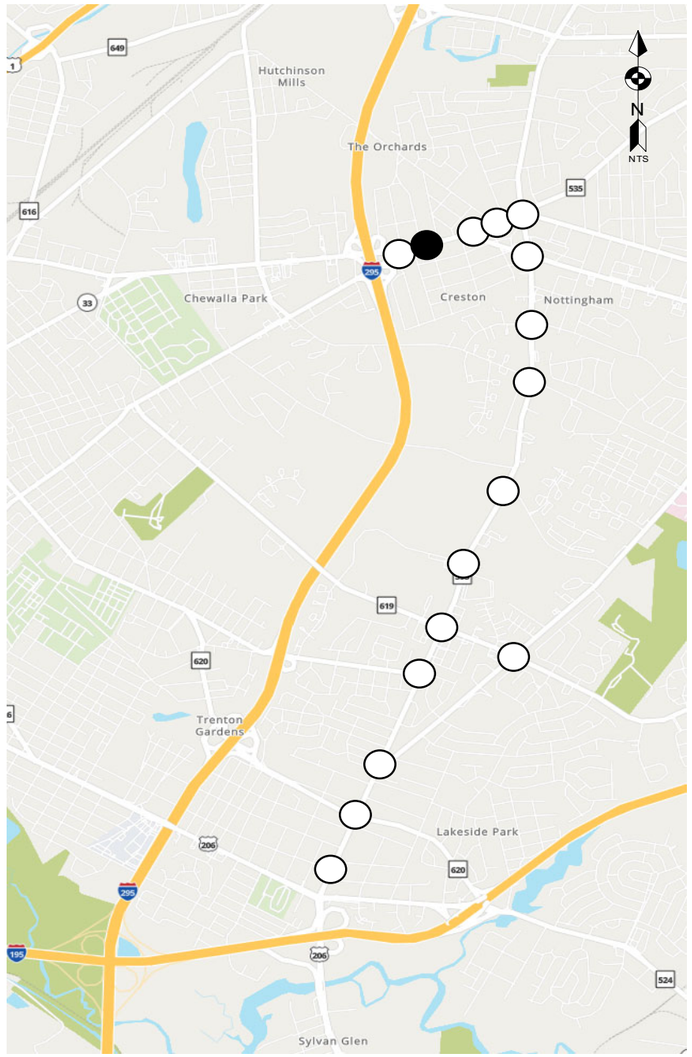


Phasing Diagram



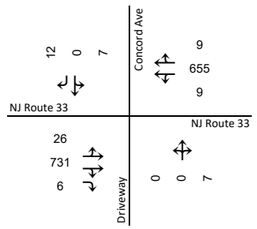
Intersection Geometry

Intersection ID # 1014

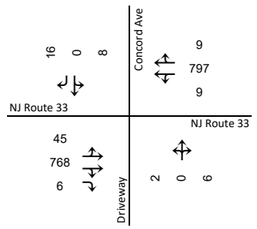


Hourly Volumes

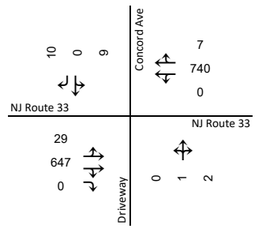
Weekend AM Peak Period



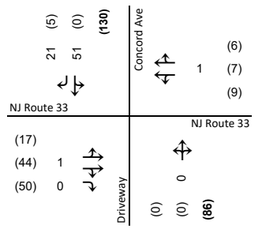
Weekend Midday Peak Period



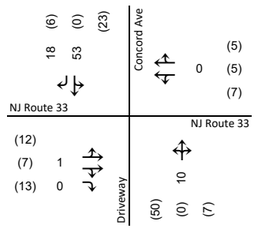
Weekend PM Peak Period



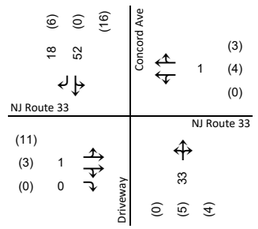
Existing Operations



Summary					
Timing Pattern	1	Syn Delay	1	A	
Actuated Cycle	110	Sim Delay	(26)		
Max v/C	0.32	ICU	57%	B	

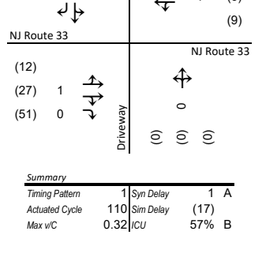


Summary					
Timing Pattern	1	Syn Delay	2	A	
Actuated Cycle	110	Sim Delay	(6)		
Max v/C	0.39	ICU	68%	C	

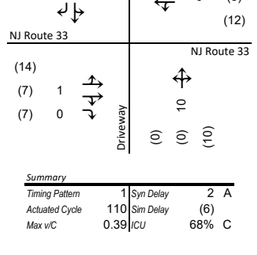


Summary					
Timing Pattern	1	Syn Delay	2	A	
Actuated Cycle	110	Sim Delay	(4)		
Max v/C	0.29	ICU	58%	B	

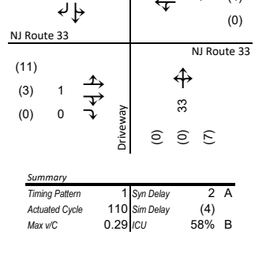
Implemented Operations



Summary					
Timing Pattern	1	Syn Delay	1	A	
Actuated Cycle	110	Sim Delay	(17)		
Max v/C	0.32	ICU	57%	B	



Summary					
Timing Pattern	1	Syn Delay	2	A	
Actuated Cycle	110	Sim Delay	(6)		
Max v/C	0.39	ICU	68%	C	



Summary					
Timing Pattern	1	Syn Delay	2	A	
Actuated Cycle	110	Sim Delay	(4)		
Max v/C	0.29	ICU	58%	B	

Operations with Improvements

No operational improvements recommended at this time.

HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
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D	>35 and ≤55
E	>55 and ≤80
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ICU Levels of Service

LOS	Utilization (%)
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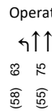
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

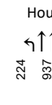


stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams



stop bar geometry

turning movement volume

Figure 41

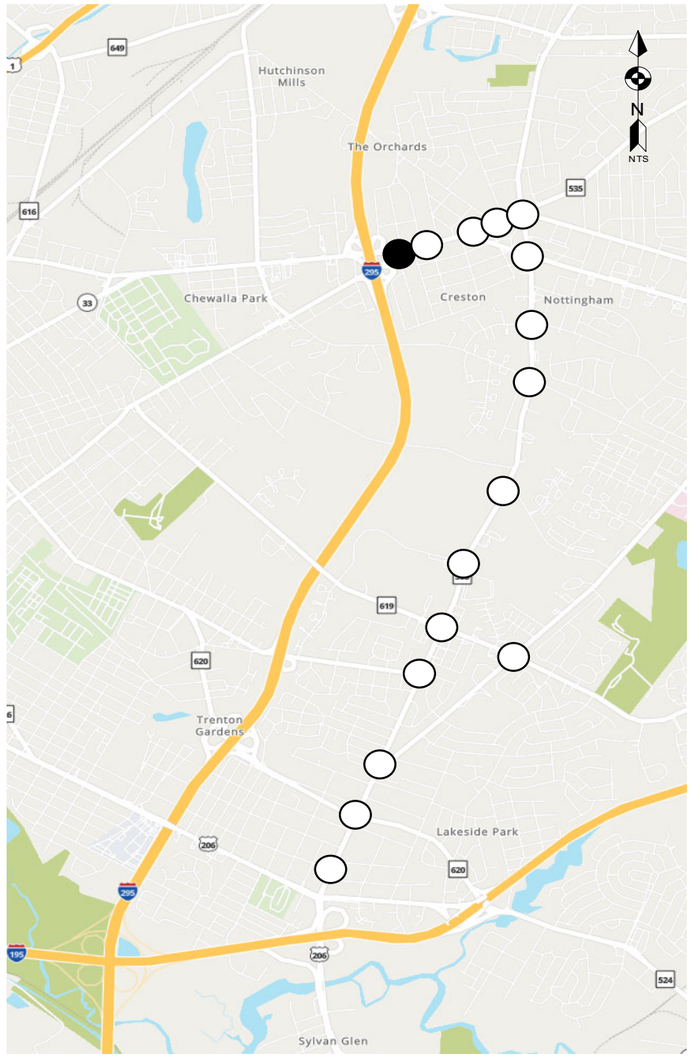
Weekend Traffic Operations Analysis

Nottingham Way (NJ Rt 33) & Concord Ave

Phasing Diagram

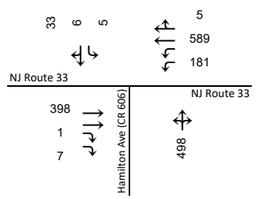
Intersection Geometry

Intersection ID # 1015

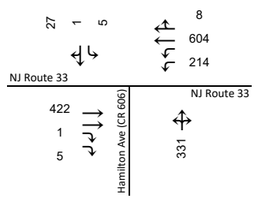


Hourly Volumes

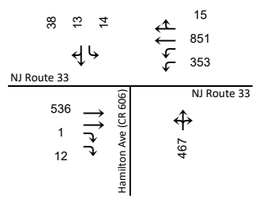
AM Peak Period



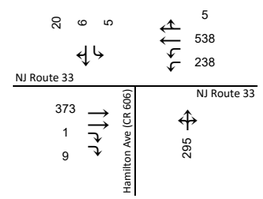
Midday Peak Period



PM Peak Period

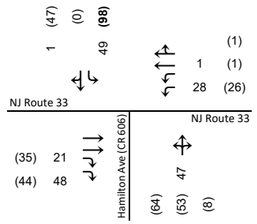


PM Off-peak Period



Existing Operations

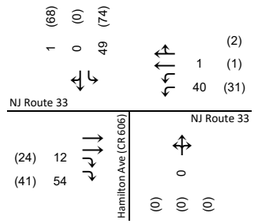
AM Peak Period



Summary

Timing Pattern	1	*Syn Delay*	24	C
Actuated Cycle	110	*Sim Delay*	(26)	
Max v/C	0.84	*ICU*	55%	A

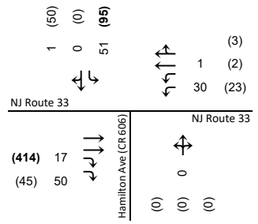
Midday Peak Period



Summary

Timing Pattern	1	*Syn Delay*	20	C
Actuated Cycle	110	*Sim Delay*	(20)	
Max v/C	0.75	*ICU*	44%	A

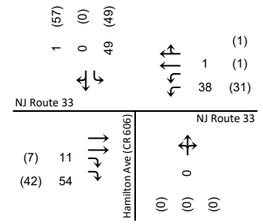
PM Peak Period



Summary

Timing Pattern	1	*Syn Delay*	20	B
Actuated Cycle	110	*Sim Delay*	(117)	
Max v/C	0.81	*ICU*	52%	A

PM Off-peak Period

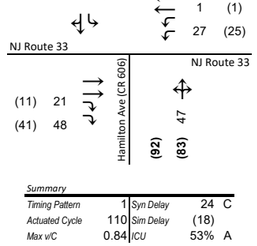


Summary

Timing Pattern	1	*Syn Delay*	20	B
Actuated Cycle	110	*Sim Delay*	(16)	
Max v/C	0.74	*ICU*	44%	A

Implemented Operations

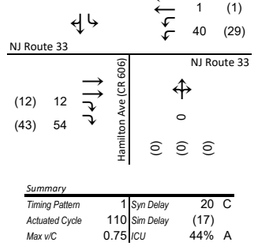
AM Peak Period



Summary

Timing Pattern	1	*Syn Delay*	24	C
Actuated Cycle	110	*Sim Delay*	(18)	
Max v/C	0.84	*ICU*	53%	A

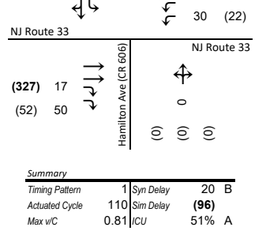
Midday Peak Period



Summary

Timing Pattern	1	*Syn Delay*	20	C
Actuated Cycle	110	*Sim Delay*	(17)	
Max v/C	0.75	*ICU*	44%	A

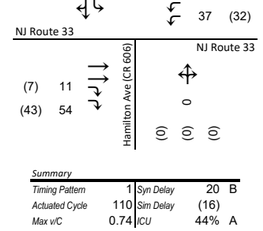
PM Peak Period



Summary

Timing Pattern	1	*Syn Delay*	20	B
Actuated Cycle	110	*Sim Delay*	(96)	
Max v/C	0.81	*ICU*	51%	A

PM Off-peak Period



Summary

Timing Pattern	1	*Syn Delay*	20	B
Actuated Cycle	110	*Sim Delay*	(16)	
Max v/C	0.74	*ICU*	44%	A

Operations with Improvements

No operational improvements recommended at this time.

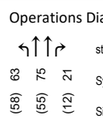
HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

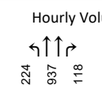


stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams



stop bar geometry

turning movement volume

Figure 42

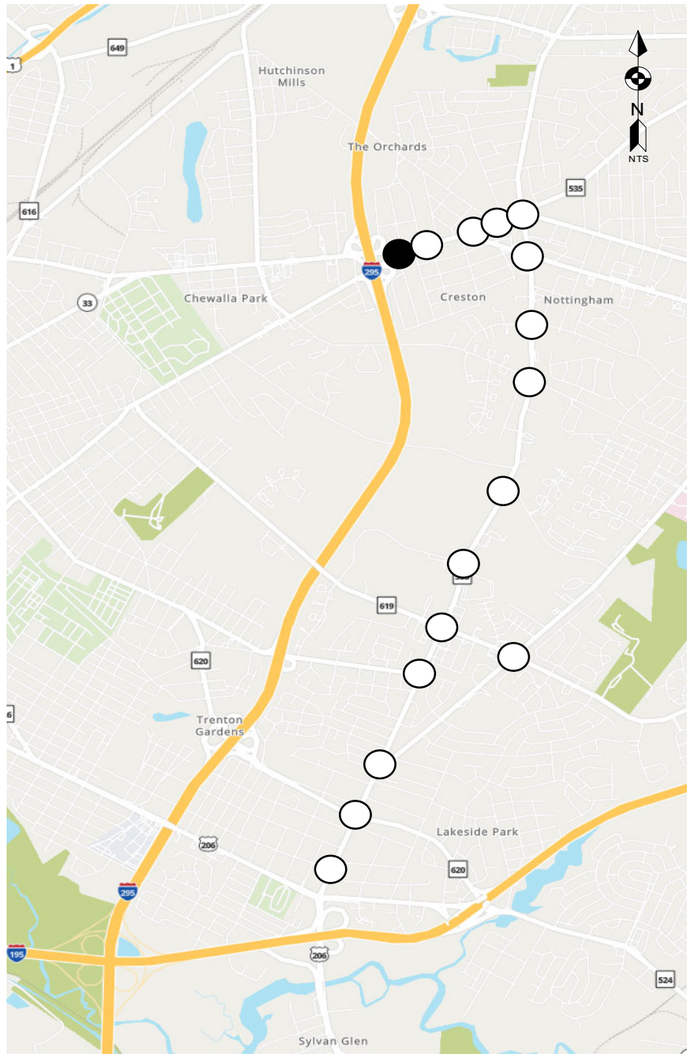
Weekday Traffic Operations Analysis

Nottingham Way (NJ Rt 33) & Hamilton Ave (CR 606)

Phasing Diagram

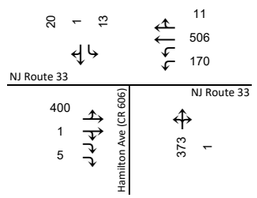
Intersection Geometry

Intersection ID # 1015

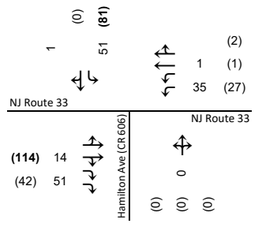


Weekend AM Peak Period

Hourly Volumes

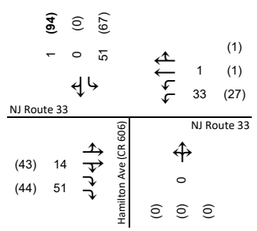


Existing Operations



Summary				
Timing Pattern	1	Syn Delay	21	C
Actuated Cycle	110	Sim Delay	(45)	
Max v/C	0.79	ICU	46%	A

Implemented Operations



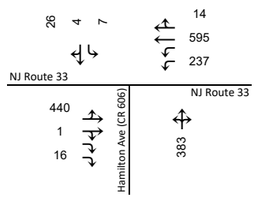
Summary				
Timing Pattern	1	Syn Delay	20	C
Actuated Cycle	110	Sim Delay	(27)	
Max v/C	0.79	ICU	45%	A

Operations with Improvements

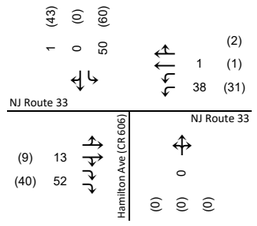
No operational improvements recommended at this time.

Weekend Midday Peak Period

Hourly Volumes

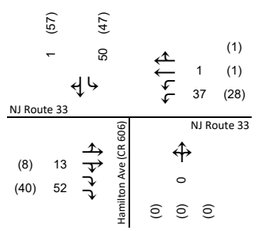


Existing Operations



Summary				
Timing Pattern	1	Syn Delay	22	C
Actuated Cycle	110	Sim Delay	(17)	
Max v/C	0.78	ICU	46%	A

Implemented Operations



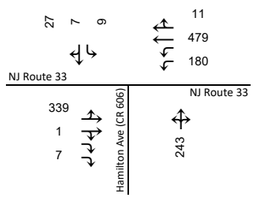
Summary				
Timing Pattern	1	Syn Delay	22	C
Actuated Cycle	110	Sim Delay	(16)	
Max v/C	0.78	ICU	45%	A

Operations with Improvements

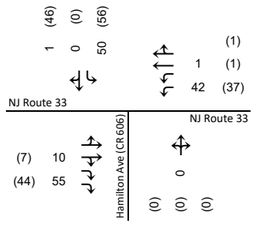
No operational improvements recommended at this time.

Weekend PM Peak Period

Hourly Volumes

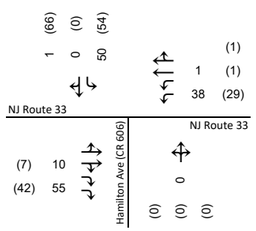


Existing Operations



Summary				
Timing Pattern	1	Syn Delay	19	B
Actuated Cycle	110	Sim Delay	(15)	
Max v/C	0.69	ICU	43%	A

Implemented Operations



Summary				
Timing Pattern	1	Syn Delay	18	B
Actuated Cycle	110	Sim Delay	(14)	
Max v/C	0.69	ICU	43%	A

Operations with Improvements

No operational improvements recommended at this time.

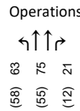
HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

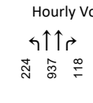


stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams



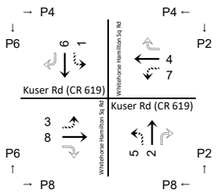
stop bar geometry

turning movement volume

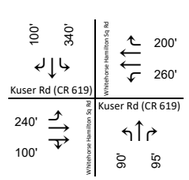
Figure 43

Weekend Traffic Operations Analysis

Nottingham Way (NJ Rt 33) & Hamilton Ave (CR 606)

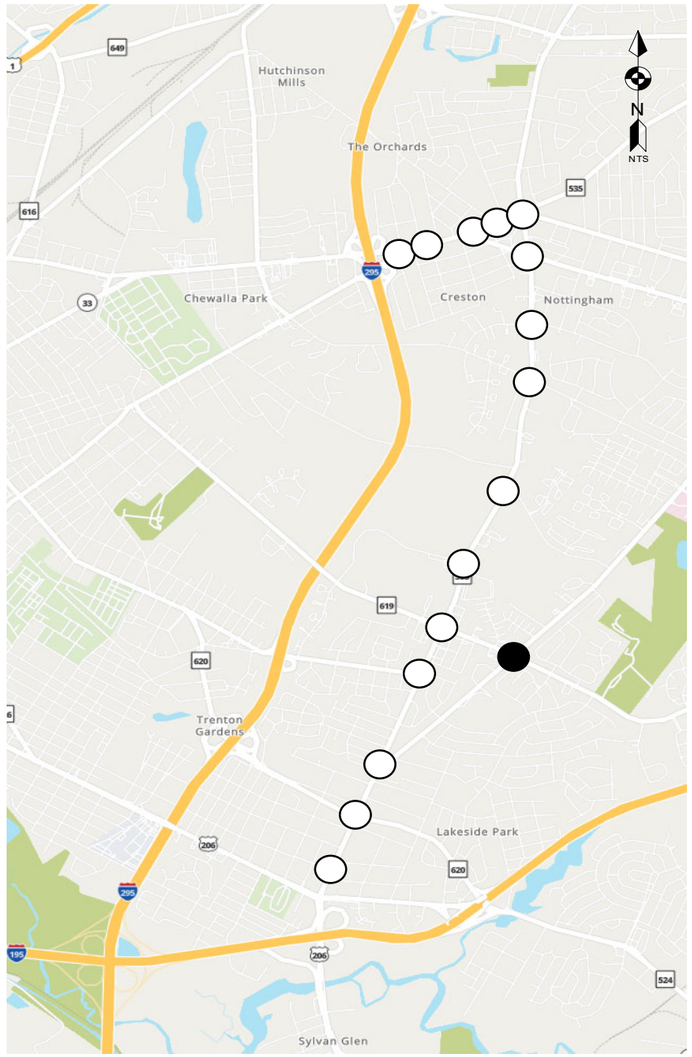


Phasing Diagram



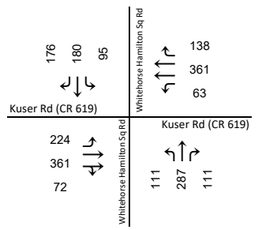
Intersection Geometry

Intersection ID # 1006

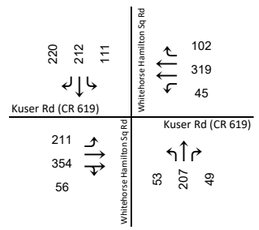


Hourly Volumes

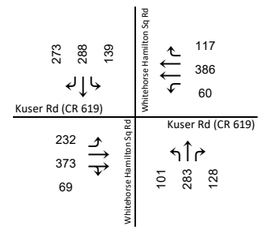
AM Peak Period



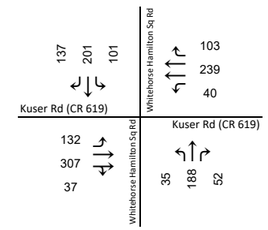
Midday Peak Period



PM Peak Period

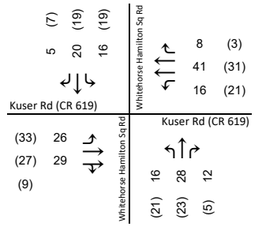


PM Off-peak Period



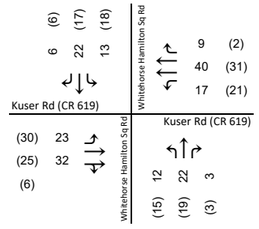
Existing Operations

AM Peak Period



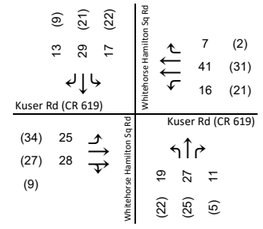
Summary				
Timing Pattern	FREE	Syn Delay	24	C
Actuated Cycle	86.9	Sim Delay	(22)	
Max v/C	0.75	ICU	68%	C

Midday Peak Period



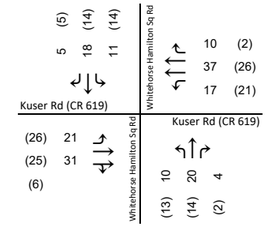
Summary				
Timing Pattern	FREE	Syn Delay	23	C
Actuated Cycle	82.8	Sim Delay	(20)	
Max v/C	0.69	ICU	66%	C

PM Peak Period



Summary				
Timing Pattern	FREE	Syn Delay	24	C
Actuated Cycle	87.2	Sim Delay	(22)	
Max v/C	0.75	ICU	70%	C

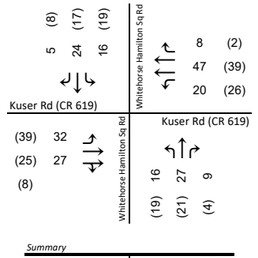
PM Off-peak Period



Summary				
Timing Pattern	FREE	Syn Delay	21	C
Actuated Cycle	78.6	Sim Delay	(17)	
Max v/C	0.60	ICU	59%	B

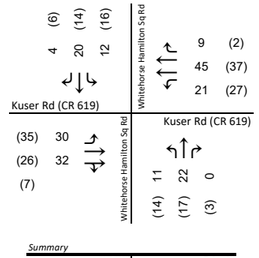
Implemented Operations

AM Peak Period



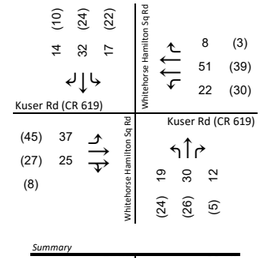
Summary				
Timing Pattern	FREE	Syn Delay	25	C
Actuated Cycle	100	Sim Delay	(23)	
Max v/C	0.79	ICU	62%	B

Midday Peak Period



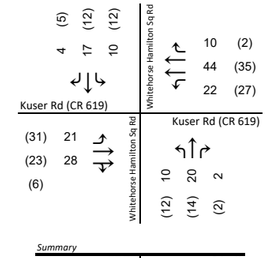
Summary				
Timing Pattern	FREE	Syn Delay	24	C
Actuated Cycle	90	Sim Delay	(21)	
Max v/C	0.76	ICU	57%	B

PM Peak Period



Summary				
Timing Pattern	FREE	Syn Delay	28	C
Actuated Cycle	110	Sim Delay	(25)	
Max v/C	0.78	ICU	65%	C

PM Off-peak Period



Summary				
Timing Pattern	FREE	Syn Delay	21	C
Actuated Cycle	90	Sim Delay	(18)	
Max v/C	0.66	ICU	50%	A

Operations with Improvements

No operational improvements recommended at this time.

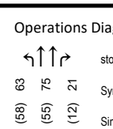
HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

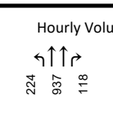


stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams



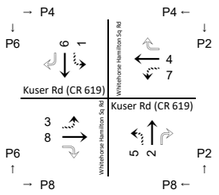
stop bar geometry

turning movement volume

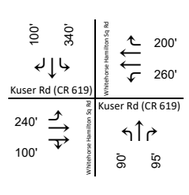
Figure 46

Weekday Traffic Operations Analysis

Kuser Rd (CR 619) & Whitehorse Hamilton Square Rd

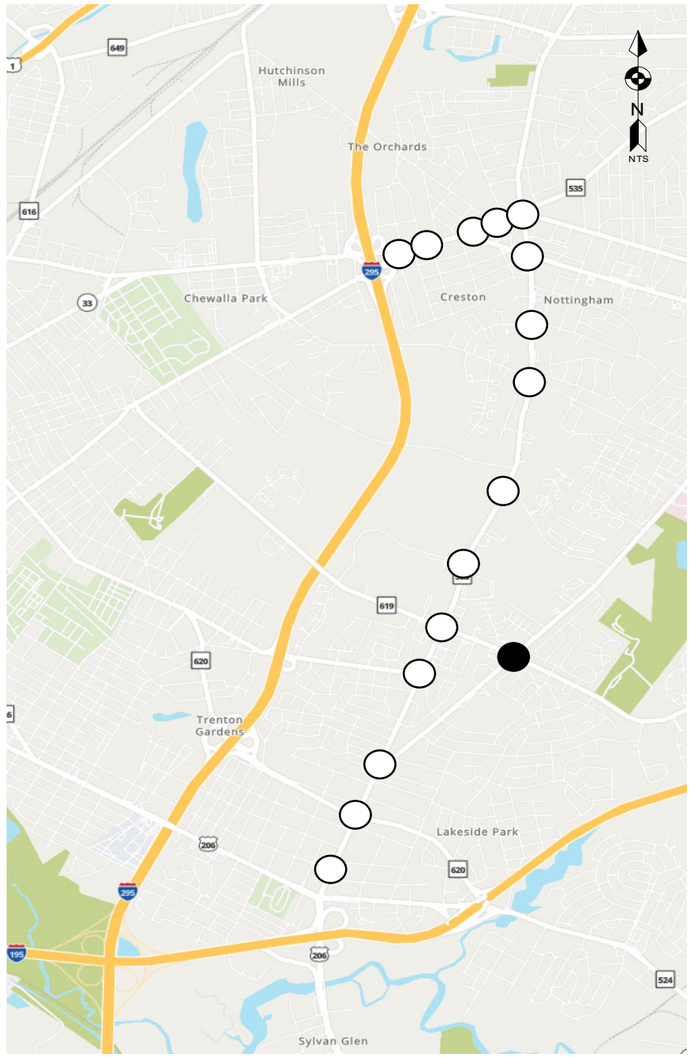


Phasing Diagram



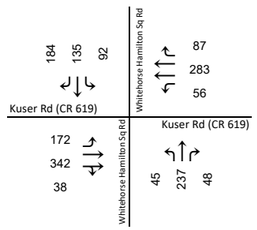
Intersection Geometry

Intersection ID # 1006

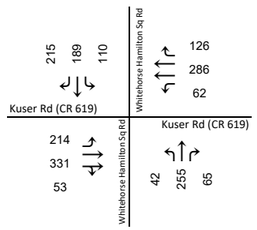


Hourly Volumes

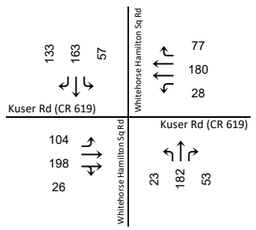
Weekend AM Peak Period



Weekend Midday Peak Period

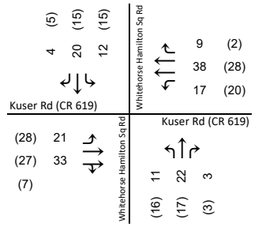


Weekend PM Peak Period



Existing Operations

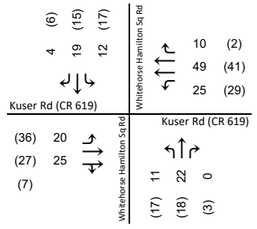
Weekend AM Peak Period



Summary

Timing Pattern	FREE	*Syn Delay*	23	C
Actuated Cycle	79.2	*Sim Delay*	(19)	
Max v/C	0.69	*ICU*	61%	B

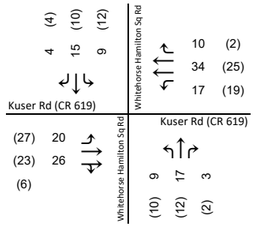
Weekend Midday Peak Period



Summary

Timing Pattern	FREE	*Syn Delay*	22	C
Actuated Cycle	100	*Sim Delay*	(22)	
Max v/C	0.71	*ICU*	65%	C

Weekend PM Peak Period

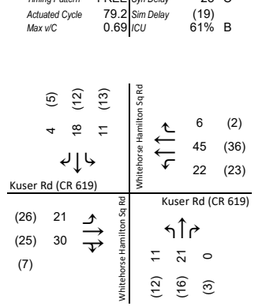


Summary

Timing Pattern	FREE	*Syn Delay*	18	B
Actuated Cycle	74.3	*Sim Delay*	(15)	
Max v/C	0.45	*ICU*	57%	B

Implemented Operations

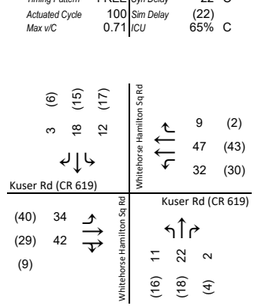
Weekend AM Peak Period



Summary

Timing Pattern	FREE	*Syn Delay*	23	C
Actuated Cycle	90	*Sim Delay*	(19)	
Max v/C	0.77	*ICU*	53%	A

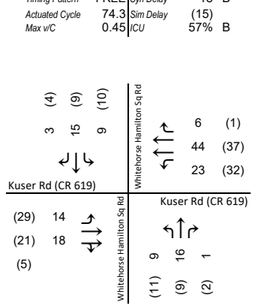
Weekend Midday Peak Period



Summary

Timing Pattern	FREE	*Syn Delay*	26	C
Actuated Cycle	110	*Sim Delay*	(23)	
Max v/C	0.83	*ICU*	58%	B

Weekend PM Peak Period



Summary

Timing Pattern	FREE	*Syn Delay*	17	B
Actuated Cycle	90	*Sim Delay*	(16)	
Max v/C	0.57	*ICU*	45%	A

Operations with Improvements

No operational improvements recommended at this time.

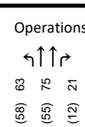
HCM Levels of Service

LOS	Delay/Veh (s)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

ICU Levels of Service

LOS	Utilization (%)
A	≤55%
B	>55% and ≤64%
C	>64% and ≤73%
D	>73% and ≤82%
E	>82% and ≤91%
F	>91% and ≤100%
G	>100% and ≤109%
H	>109%

Operations Diagrams

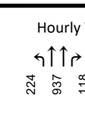


stop bar geometry

Synchro delay (sec / veh)

SimTraffic delay (sec / veh)

Hourly Volume Diagrams



stop bar geometry

turning movement volume

Figure 47

Weekend Traffic Operations Analysis

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