

Final Report

New Jersey Traffic Signal Retiming

Egg Harbor Road (CR 630)

Delsea Drive (SR 47)/Hurffville Road (SR 41) to Hurffville-Cross Keys Road (CR 654)

Hurffville-Cross Keys Road (CR 654)

Greentree Road (CR 651) to Cross Keys Bypass (CR 689)

Cross Keys Bypass (CR 689)

Hurffville-Cross Keys Road (CR 654) to Black Horse Pike (SR 42)

Prepared for:

Delaware Valley Regional Planning Commission (DVRPC)



and

Gloucester County, New Jersey



Prepared by:

iteris[®]

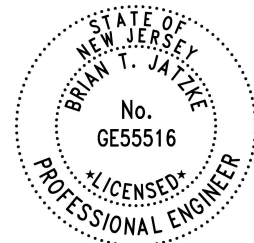
225 Wilmington-West Chester Pike, Suite 200

Chadds Ford, PA 19317

Subconsultants:



May 2023



Professional Engineer: Brian Jatzke
New Jersey PE Number: GE55516

EXECUTIVE SUMMARY

Iteris, Inc. was contracted by the Delaware Valley Regional Planning Commission (DVRPC) through the New Jersey Traffic Signal Retiming Program to provide engineering services for the full retiming of twenty-five intersections in Gloucester County, New Jersey on Egg Harbor Road (CR 630), Hurffville-Cross Keys Road (CR 654) and Cross Keys By-Pass (CR 689). These signals are all located within the municipality of Washington Township, New Jersey. Two of the signals are owned and maintained by the New Jersey Department of Transportation (NJDOT). The subconsultants on this project were Imperial Traffic & Data Collection and Taylor Wiseman & Taylor.

Following the NJ Signal Retiming Regional Corridor Prioritization project completed in 2022, this signal system was identified to be the highest priority corridor in Gloucester County utilizing a scoring system developed to rank signal systems throughout the region. The goal of the retiming program 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.

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.

The majority of the traffic signals included in this project had not been retimed within the last 15-20 years according to the available documents within the traffic cabinets and most were running simple basic timing programs and not in coordinated operation. With the volume growth that has occurred over that time and the density of signals along this system, coordinated signal timings along this network is clearly appropriate as it provides progression between signals for high volume movements. There is significant commuter traffic along the major arteries and there is a large hospital and school system on the network, also making this a high priority corridor.

There were a number of vehicle detection and operational issues through the system that were identified and reported to Gloucester County. Over the course of this project, controller programming was updated as optimally as possible to limit the impact of these issues to the system. These were generally related to video detection not functioning properly, resulting in certain movements utilizing all of their allotted time, regardless of vehicle demand. These issues and observations are included within the body of this report and suggested recommendations are also provided.

This project was developed to evaluate coordination needs given current conditions and equipment throughout the network and to reduce traffic signal delay and stops to help improve system performance.

Project Accomplishments

As part of this project, the Iteris team developed and implemented six unique time-of-day patterns through the network, along with additional patterns at impacted intersections to specifically address school impacts and to account for recurring fluctuations in traffic throughout the system. Four of the patterns were developed for weekday operation and two patterns were developed specifically to address weekend traffic characteristics. Based on the volume trends collected in this project, the following time periods were analyzed for timing pattern development:

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

*Weekend AM Peak and Weekend PM Peak were analyzed independently but due to similarity in traffic characteristics, it was determined to run the same pattern for those time periods. Weekend AM Peak (WA) is shown in the figures within this report.

Through the completion of this project, all clearance intervals for both vehicles and pedestrians were brought up to standard utilizing the NJDOT methodology for vehicles and the Manual on Uniform Traffic Control (MUTCD). Pedestrian crosswalks were manually measured for these calculations and all pedestrian buttons were tested and any issues were documented and reported to Gloucester County.

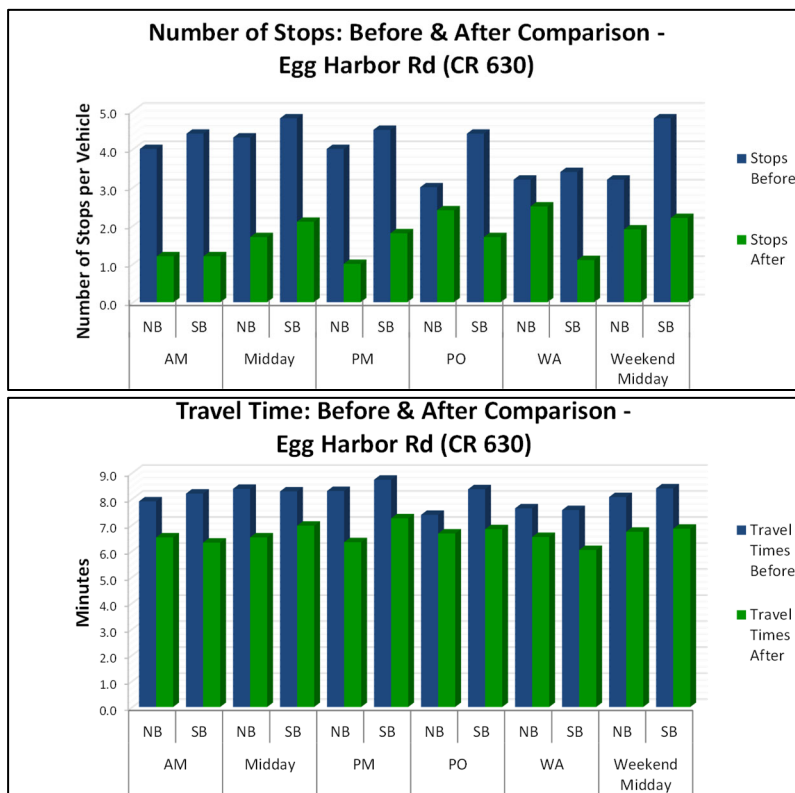
The highest congestion area within this network was the westbound movement at the intersection of Hurffville-Cross Keys Road (CR 654) & Fish Pond Road (CR 634). The congestion is largely due to there being one lane servicing the high-volume movement since there is a lane drop from two lanes to one lane approximately 450’ west of Fries Mill Road (CR 655) and continues as one lane until just before the intersection of Egg Harbor Road (CR 630). The westbound movement is over capacity during the peak periods, but timing adjustments were able to reduce delay significantly during most times of day. Average queues were observed to be much shorter than existing conditions, though phase failures and long queues still do occur due to the capacity issue.

With a few exceptions, the traffic signals on this network were running in free operation at the start of this project, meaning each signal only considered its own detector inputs and controller programming while servicing the various movements throughout the day and there was no coordination between the included signals. At the conclusion of this project, the 23 Gloucester County maintained signals run consistent coordinated cycle lengths throughout the network for both weekday and weekend operations and are consistently programmed with all necessary safety functions properly programmed. Cross coordination was also implemented between the three major roadways, Egg Harbor Road (CR 630), Hurffville-Cross Keys Road (CR 654) and Cross Keys Bypass (CR 689).

Traffic Operations Analysis Summary

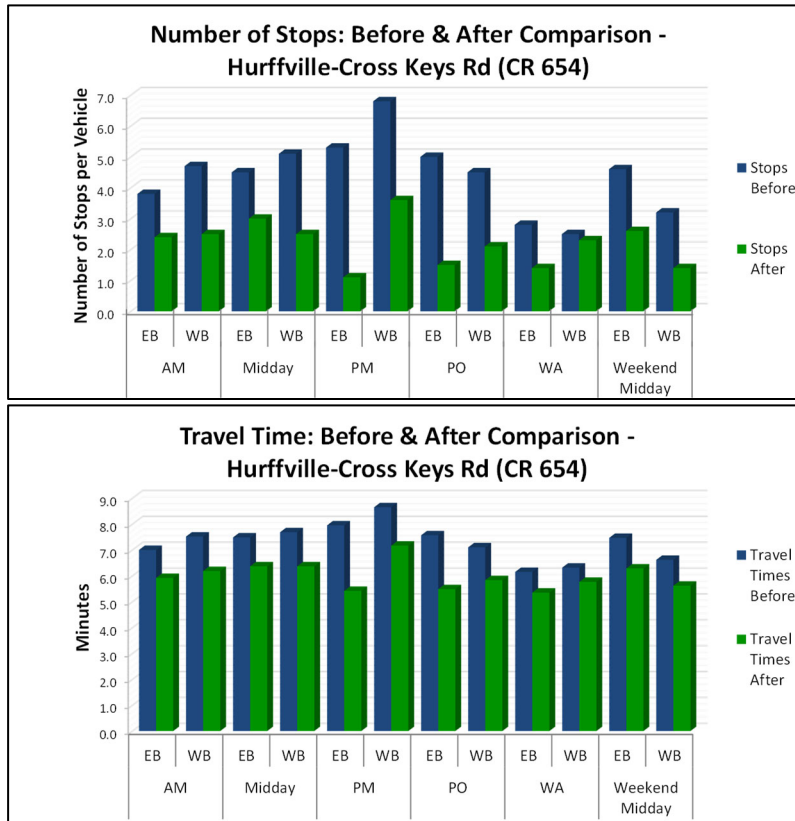
Field measured travel time runs were conducted along both Egg Harbor Road (CR 630) and Hurffville-Cross Keys Road (CR 654). Along Egg Harbor Road (CR 630), travel time runs were completed between Hurffville-Cross Keys Road (CR 654) and Ronald Lane/Blackwood Barnsboro Road (CR 603). In the northbound direction, weekday travel times decreased by up to 118 seconds (23.7%) and weekend travel times decreased by up to 80 seconds (16.5%). In the southbound direction, weekday travel times decreased by up to 113 seconds (23.0%) and weekend travel times decreased by up to 93 seconds (18.5%).

Tru-Traffic Before and After Analysis – Egg Harbor Rd (CR 630)



Along the Hurffville-Cross Keys Road (CR 654) section, travel time runs were completed between Greentree Road (CR 651) and Cross Keys Bypass (CR 689). In the eastbound direction, weekday travel times decreased by up to 152 seconds (31.9%) and weekend travel times decreased by up to 71 seconds (15.8%). In the westbound direction, weekday travel times decreased by up to 89 seconds (17.1%) and weekend travel times decreased by up to 60 seconds (15.1%).

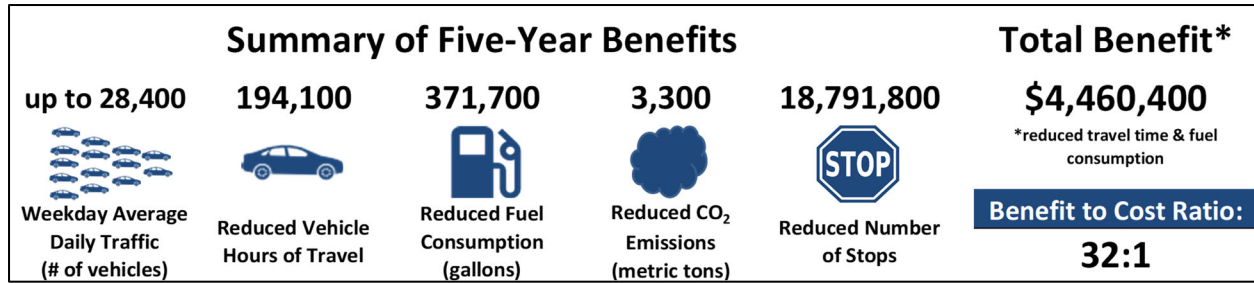
Tru-Traffic Before and After Analysis – Hurffville-Cross Keys Rd (CR 654)



Before and After Analysis – CR 630, CR 654 & CR 689

Though there are many benefits to signal retiming projects, two general benefit types were focused on 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 costs 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 reviewing and addressing vehicle and pedestrian detection issues throughout the network. The known issues are summarized in the Field Notes Summary provided in the Appendix of this report, which was last updated at the completion of this project in May 2023. A priority list of addressing known detection issues is provided in Section 8.2 of this report, which ranks the areas where functional detection would have the most impact. Addressing the detection problems would allow cycle time to be distributed more appropriately at some critical intersections throughout this network.
- Consider installing GPS units to each cabinet to maintain consistent controller time throughout the network or developing a regular routine of setting controller clocks every six to eight weeks or as often as possible. 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 set consistently again.
- Several right turn overlaps are recommended in this report, which entails adding a 5-section signal head in replacement of the existing 3-section signal head and would allow high volume side street right turn movements to be provided a protected arrow while side street movements are servicing. The proposed overlap arrows would improve capacity and reduce traffic delay in each case recommended in this 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.

Egg Harbor Road (CR 630) & Ganttown Road (CR 639)

- Consider replacing the controller at this intersection due to the existing controller not being able to maintain a consistent controller time. This is the one location that consistently would not hold time after being set manually throughout the project. All other project controllers would hold time for several weeks, but this clock drifts several seconds per day, thus reducing the impact of the coordinated signal timings quickly.

Hurffville-Cross Keys Road (CR 654) & Fish Pond Road (CR 634)

- Consider studying the feasibility of extending a second westbound through lane between Egg Harbor Road (CR 630) and Fries Mill Road (CR 655). The analysis of this recommendation shows significant improvements within that entire section of Hurffville-Cross Keys Road (CR 654) if possible. The added capacity the additional westbound lane would provide would result in significant improvements in travel times, stops and delay.

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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 full retiming of twenty-five intersections in Gloucester County, New Jersey on Egg Harbor Road (CR 630), Hurffville-Cross Keys Road (CR 654) and Cross Keys By-Pass (CR 689). These signals are all located within the municipality of Washington Township, New Jersey and two of the included signals are owned and maintained by the New Jersey Department of Transportation (NJDOT). 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 four unique timing patterns for weekday operation and three patterns for weekends.
- 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	<i>Egg Harbor Road (CR 630) & Delsea Drive (SR 47)/Hurffville Road (SR 41) (NJDOT Signal)</i>
2	Egg Harbor Road (CR 630) & Ronald Lane/Blackwood Barnsboro Road (CR 603)
3	Egg Harbor Road (CR 630) & County House Road (CR 621)
4	Egg Harbor Road (CR 630) & Long Bow Drive/Long Bow Circle
5	Egg Harbor Road (CR 630) & Saddlebrook Way/Mt Pleasant Road
6	Egg Harbor Road (CR 630) & Salina Road
7	Egg Harbor Road (CR 630) & Hurffville Grenloch Road (CR 635)
8	Egg Harbor Road (CR 630) & Bently Drive/Trent Road
9	Egg Harbor Road (CR 630) & Greentree Road (CR 651)
10	Egg Harbor Road (CR 630) & Ganttown Road (CR 639)
11	Egg Harbor Road (CR 630) & Medical Center Drive
12	Hurffville-Cross Keys Road (CR 654) & Greentree Road (CR 651)
13	Hurffville-Cross Keys Road (CR 654) & Minuteman Drive/Brook Lane
14	Hurffville-Cross Keys Road (CR 654) & Ganttown Road/Chapel Heights Road (CR 639)
15	Hurffville-Cross Keys Road (CR 654) & Altair Drive
16	Hurffville-Cross Keys Road (CR 654) & Regulus Drive
17	Hurffville-Cross Keys Road (CR 654) & Egg Harbor Road (CR 630)
18	Hurffville-Cross Keys Road (CR 654) & Fish Pond Road (CR 634)
19	Hurffville-Cross Keys Road (CR 654) & Fries Mill Road (CR 655)
20	Hurffville-Cross Keys Road (CR 654) & Town Center Boulevard
21	Hurffville-Cross Keys Road (CR 654) & Sun Haven Drive
22	Hurffville-Cross Keys Road (CR 654) & Cross Keys Bypass (CR 689)
23	Cross Keys Bypass (CR 689) & Tuckahoe Road (CR 555)
24	Cross Keys Bypass (CR 689) & Home Depot Driveway/Berlin-Cross Keys Road
25	<i>Cross Keys Bypass (CR 689) & Black Horse Pike (SR 42) (NJDOT Signal)</i>

Note that throughout this report, Egg Harbor Road (CR 630) is considered North-South in directionality, Hurffville-Cross Keys Road (CR 654) is considered East-West and Cross Keys Bypass is considered North-South. The models, timing sheets and timing directives developed for this project will also reflect this assumption consistently.

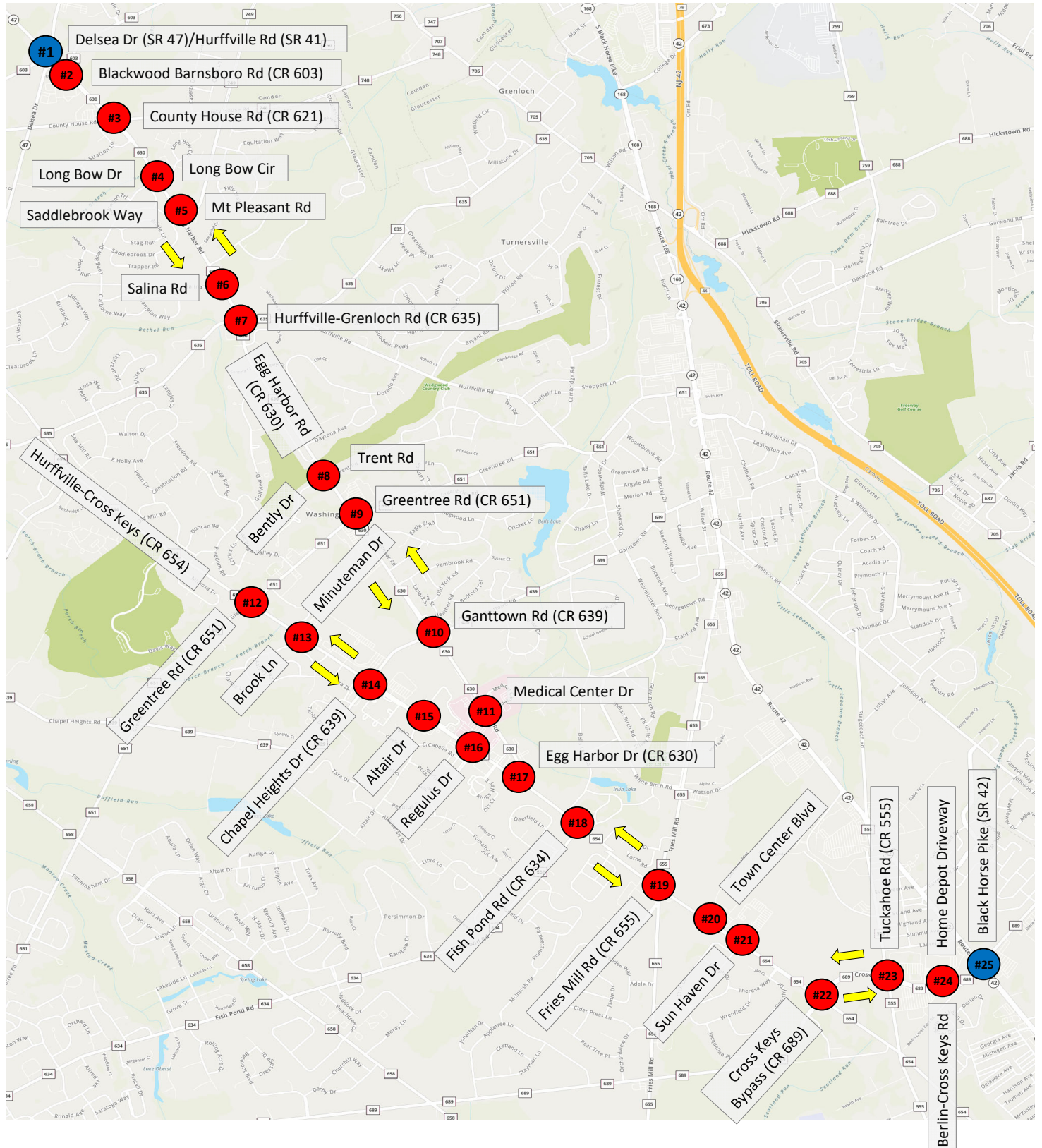
The lane configurations vary throughout the included system but are summarized below:

- Egg Harbor Road (CR 630) is primarily a four-lane roadway and spans approximately 4.1 miles with a mix of undivided medians and two-way left turn lanes. The posted speed limit is 45 mph in both directions through the majority of the network, with the exception being around Delsea Drive (SR 47)/Hurffville Road (SR 41), where the northbound and southbound posted speed limit is 50 mph for a short segment within the network and extends to the west of that signal.

There are two sections where the roadway is reduced to a two-lane roadway with a two-way left turn lane, which are as follows:

- Approximately 1600 feet south of Hurffville-Grenloch Road (CR 635) to approximately 450 feet north of Bently Road/Trent Drive.
 - Approximately six hundred feet to the south of Greentree Road (CR 651) to approximately 450 feet north of Ganttown Road (CR 639).
- Hurffville-Cross Keys Road (CR 654), within the limits of this project, is primarily a four-lane undivided roadway and spans 3.2 miles and speed limits vary from 40 mph to 45 mph. There is also a 30-mph school zone which runs during Washington Township schools' ingress and egress periods. The westbound roadway approximately 650 feet west of Fries Mill Road (CR 655) drops from two-lanes to one-lane and transitions back to two lanes approximately three hundred feet east of Egg Harbor Road (CR 630).
 - Cross Keys Bypass (CR 689), within the portion of this project, is primarily a four-lane divided roadway and spans approximately 0.8 miles. The posted speed limit is 45 mph throughout the included segment within this project.

Figure 1 on pages 3 illustrate the locations of the signals included in this report.



- Gloucester County Study Intersection: ●
- NJDOT Maintained Study Intersection: ●
- 7-day, 24-hr Count Locations (by Direction): ➔

Figure 1

Traffic Signal Locations

Egg Harbor Rd (CR 630), Hurffville-Cross Keys Rd (CR 654) & Cross Keys Bypass (CR 689)

2.0 DATA COLLECTION

2.1 7-Day, 24-Hour Volumes

24-hour segment counts were conducted by Imperial Traffic & Data Collection (ITDC) during June of 2022 while Washington Township schools were in session. Counts were collected at two locations on Egg Harbor Road (CR 630), three locations on Hurffville-Cross Keys Road (CR 654) and one location on Cross Keys Bypass (CR 689). These counts were collected to illustrate the various traffic patterns that occur during a typical day on the various roadways at the count locations.

The Average Daily Traffic (ADT) volume on Egg Harbor Road (CR 630) from the locations counted was as high as 21,500 on weekdays and 16,300 on weekends. The ADT volume on Hurffville-Cross Keys Road (CR 654) was as high as approximately 28,400 on weekdays and 22,200 on weekends. The ADT volume along Cross Keys Bypass (CR 689) the location counted was approximately 21,700 on weekdays and 18,800 on weekends.

Figure 2 through Figure 9 on pages 6 – 13 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 25 locations throughout the project limits.

TMCs for all signals in the network were collected from 7:00 am – 9:00 am, 12:00 pm – 1:30 pm, 2:15 pm – 5:45 pm, and 6:15 pm – 7:15 pm on weekdays. On Saturdays, the intersections were counted from 8:30 am – 10:30 am, 11:00 am – 3:00 pm, and 4:30 pm – 6:30 pm.

These volumes were then increased by a growth factor of five percent 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 20 through Figure 44 on pages 40 – 64. Raw TMC data can be found on the project website.

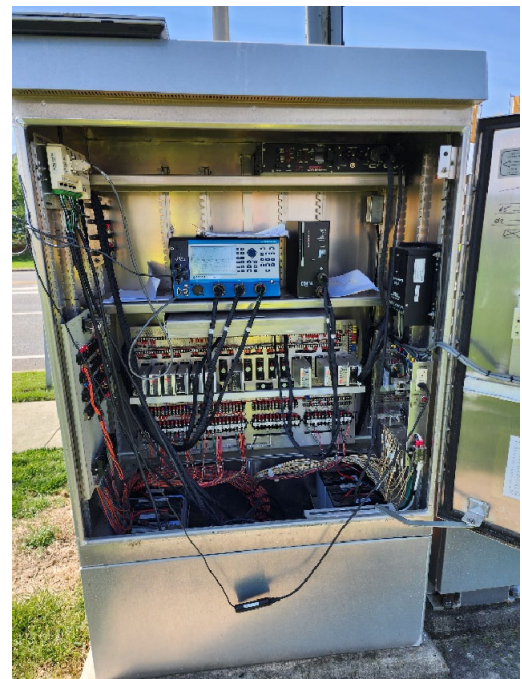
2.3 Traffic Signal Timing and Phasing Data

Existing data files were uploaded via Aries Zone Manager, an Econolite direct connect software, directly from each local controller.

2.4 Field Notes

Field notes were collected by Iteris, Inc. staff 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 was reviewed, and pedestrian push buttons (if present) were tested for proper operation. Other unusual or unique characteristics were also recorded. The summary of findings from the Field Notes can be found in Field Notes folder within on the project website. These findings were reported to Gloucester County in November of 2022 and the provided table was also updated at the conclusion of the project to account for changes within



the system since the initial field notes were done. The final table will be accurate as of May 18, 2023, 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 Egg Harbor Road (CR 630) and Hurffville-Cross Keys Road (CR 654). 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 to be used in developing comparison videos. Complete travel time data can be found in the Tru-Traffic folder on the project website.

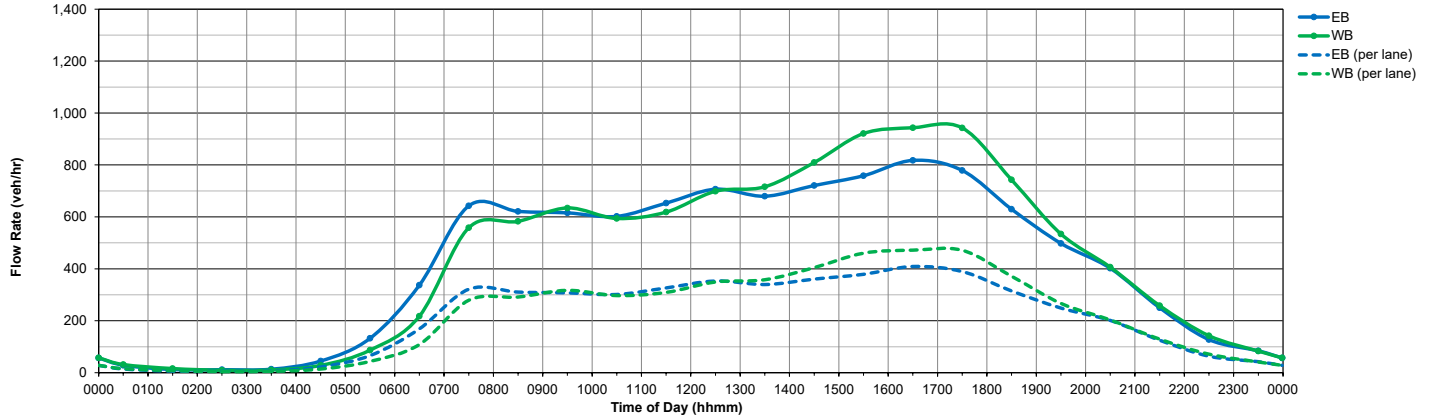


Sample Time-Space Diagram from Tru-Traffic Software – Hurffville-Cross Keys Rd (CR 654) PM Peak Period

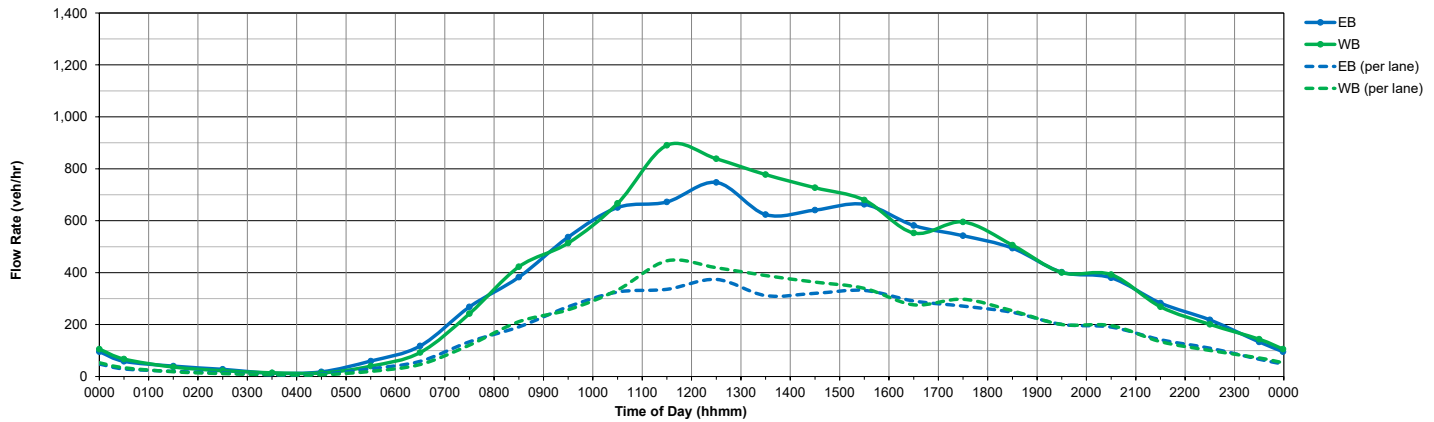
Hourly Volumes - Average for Count Locations on Egg Harbor Rd (CR 630) between Saddlebrook Rd/Mt. Pleasant Rd and Ganttown Rd (CR 639)

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	23	24	33	35	27	33	29	32	33	34	59	68	76	88	29	31	67	78
0100	0200	7	19	12	19	16	13	14	14	13	18	40	37	45	52	12	16	43	44
0200	0300	15	13	8	6	13	6	11	13	12	9	28	23	24	25	12	9	26	24
0300	0400	11	10	12	13	14	13	13	13	21	7	13	15	18	12	14	11	16	13
0400	0500	46	28	41	30	47	33	47	20	45	30	18	14	15	15	45	28	17	14
0500	0600	111	81	138	104	129	81	145	80	139	91	60	40	34	32	132	87	47	36
0600	0700	317	193	343	209	334	222	366	231	327	232	118	93	78	73	337	217	98	83
0700	0800	660	541	666	556	619	569	686	569	585	557	268	242	177	151	643	556	223	197
0800	0900	647	563	630	588	587	596	650	592	594	577	383	423	276	294	621	583	329	358
0900	1000	602	603	634	634	597	628	608	633	637	675	537	514	416	435	615	634	477	474
1000	1100	582	587	580	579	631	598	589	570	630	638	651	667	560	493	602	594	605	580
1100	1200	623	597	660	639	645	619	627	586	713	652	672	891	675	648	653	619	674	769
1200	1300	713	659	696	687	690	661	696	689	740	801	748	839	659	634	707	699	703	736
1300	1400	638	667	683	689	677	720	626	731	776	775	624	778	461	425	680	716	542	601
1400	1500	745	767	720	816	692	792	700	817	749	858	641	727	777	573	721	810	709	650
1500	1600	739	885	710	880	771	933	781	919	792	969	663	680	598	542	759	921	630	611
1600	1700	846	896	782	919	829	914	847	932	787	1,058	582	553	527	520	816	944	554	536
1700	1800	761	891	789	921	776	896	772	1,020	799	986	543	595	485	474	779	943	514	535
1800	1900	611	754	593	743	661	746	637	675	646	798	495	506	485	432	630	743	490	469
1900	2000	504	519	529	513	498	543	436	496	525	601	402	401	420	342	498	534	411	371
2000	2100	400	382	392	408	451	468	350	342	421	434	381	393	344	308	403	407	362	350
2100	2200	232	255	231	253	273	277	225	219	290	290	283	269	225	191	250	259	254	230
2200	2300	119	145	109	105	124	142	118	112	168	201	218	201	121	102	128	143	170	152
2300	0000	85	83	63	53	77	88	78	69	121	125	133	144	68	74	85	83	101	109
Sub-total		10,031	10,157	10,048	10,392	10,173	10,584	10,044	10,378	10,559	11,430	8,554	9,105	7,562	6,930	10,171	10,588	8,058	8,017
Total		20,187		20,440		20,757		20,422		21,989		17,659		14,491		20,759		16,075	

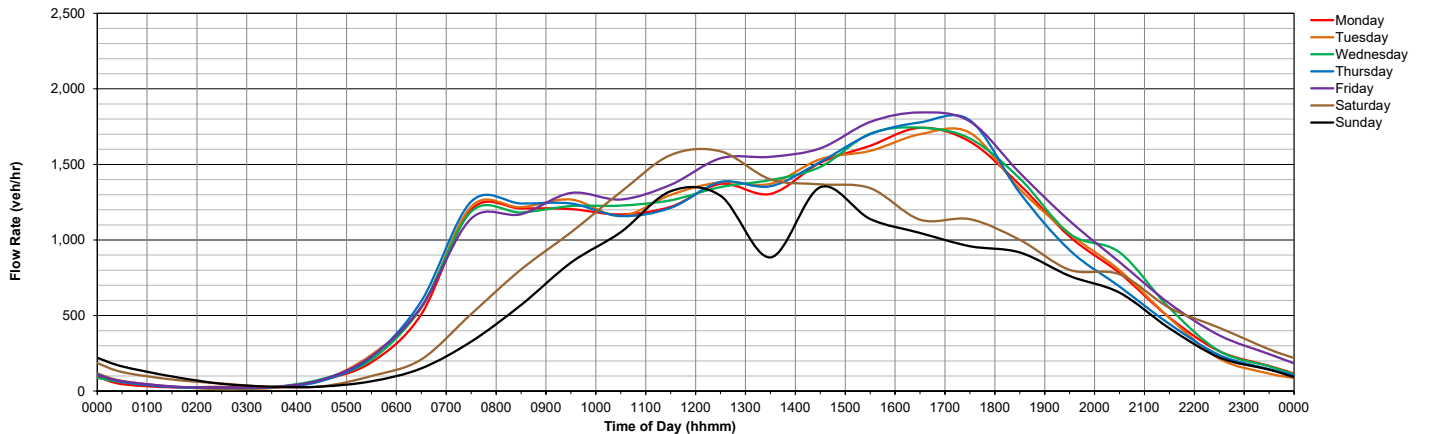
Weekday Average Hourly Volumes



Saturday Hourly Volumes



Hourly Volumes by Day



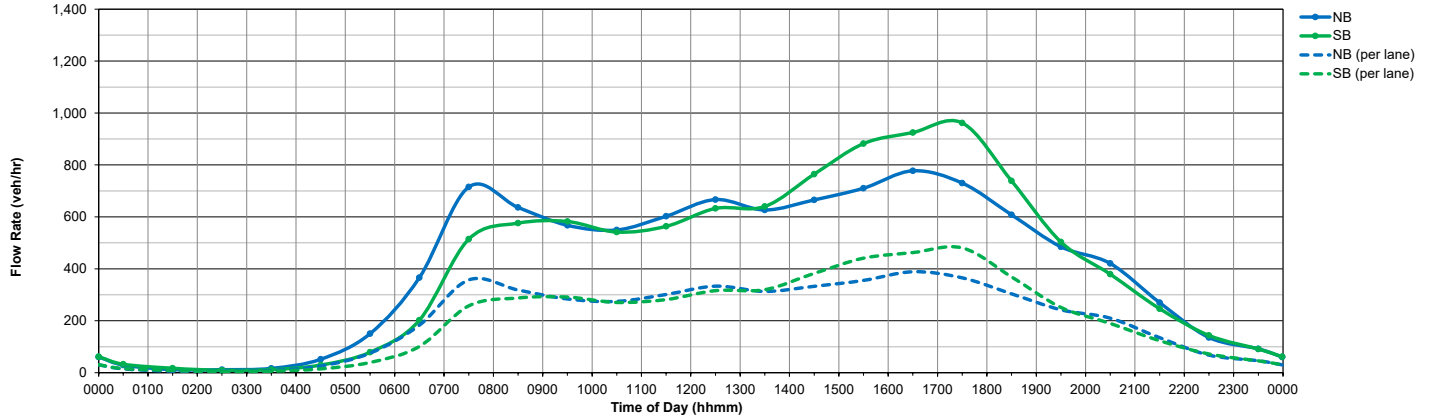
Average for Count Locations on Egg Harbor Rd (CR 630) between Saddlebrook Rd/Mt. Pleasant Rd and Ganttown Rd (CR 639)

Figure 2
7-Day, 24-Hour Volumes

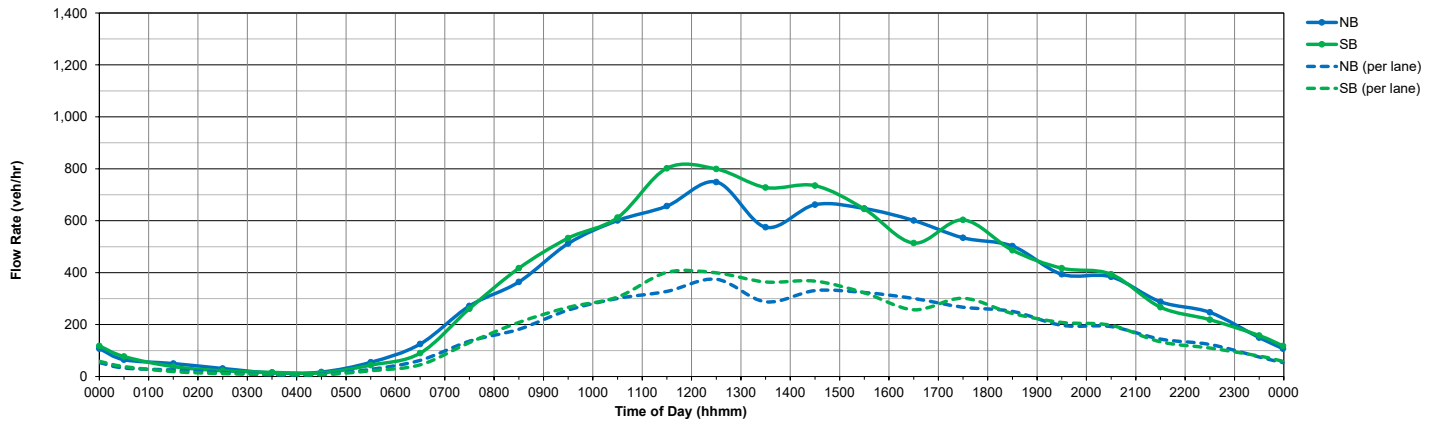
Hourly Volumes - Egg Harbor Rd (CR 630) between Saddlebrook Way/Mt. Pleasant Rd and Salina Rd

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	22	24	33	31	28	30	31	38	33	40	65	77	88	93	29	33	77	85
0100	0200	9	17	9	20	15	13	15	16	12	19	50	38	56	50	12	17	53	44
0200	0300	14	12	7	7	15	7	12	13	10	8	31	22	19	23	12	9	25	23
0300	0400	13	11	16	10	18	14	12	16	25	9	14	16	17	16	17	12	16	16
0400	0500	52	32	47	29	61	38	52	19	48	31	17	14	15	11	52	30	16	13
0500	0600	126	68	159	98	144	72	166	69	158	89	55	44	29	38	151	79	42	41
0600	0700	348	175	381	197	367	217	393	211	340	211	125	90	73	68	366	202	99	79
0700	0800	714	480	750	524	710	521	775	526	628	522	272	261	153	163	715	515	213	212
0800	0900	668	546	645	588	608	578	681	589	581	579	364	417	271	289	637	576	318	353
0900	1000	546	570	571	558	548	566	580	578	593	641	512	533	362	432	568	583	437	483
1000	1100	528	515	518	518	600	543	520	531	583	601	601	612	534	475	550	542	568	544
1100	1200	568	522	616	592	576	572	592	520	662	612	656	802	721	588	803	564	689	695
1200	1300	660	601	630	593	670	601	655	623	719	745	749	799	685	591	867	633	717	695
1300	1400	563	569	622	598	625	647	593	660	730	726	575	728	566	456	627	640	571	592
1400	1500	679	714	655	732	635	754	642	797	718	828	662	735	755	512	866	765	709	624
1500	1600	669	824	641	810	738	889	724	900	781	968	647	645	592	526	711	882	620	586
1600	1700	797	855	710	862	789	900	802	918	780	1,090	601	514	513	469	778	925	557	492
1700	1800	684	885	715	940	703	900	745	1,024	805	1,059	534	603	477	463	730	962	506	533
1800	1900	582	722	548	730	638	757	614	673	659	812	502	486	498	401	608	739	500	444
1900	2000	520	508	494	454	480	533	428	452	502	570	394	417	439	338	485	503	417	378
2000	2100	423	370	417	357	488	424	335	328	440	418	384	394	344	283	421	379	364	339
2100	2200	252	243	244	226	313	263	229	217	311	284	288	267	248	197	270	247	268	232
2200	2300	116	143	114	107	141	147	127	111	181	211	247	219	139	105	136	144	193	162
2300	0000	90	88	65	58	83	97	80	71	142	142	150	158	76	85	92	91	113	122
Sub-total		9,643	9,494	9,607	9,639	10,003	10,083	9,803	9,900	10,441	11,235	8,495	8,891	7,670	6,672	9,889	10,070	8,083	7,782
Total		19,137		19,246		20,086		19,703		21,676		17,386		14,342		19,970		15,864	

Weekday Average Hourly Volumes



Saturday Hourly Volumes



Hourly Volumes by Day

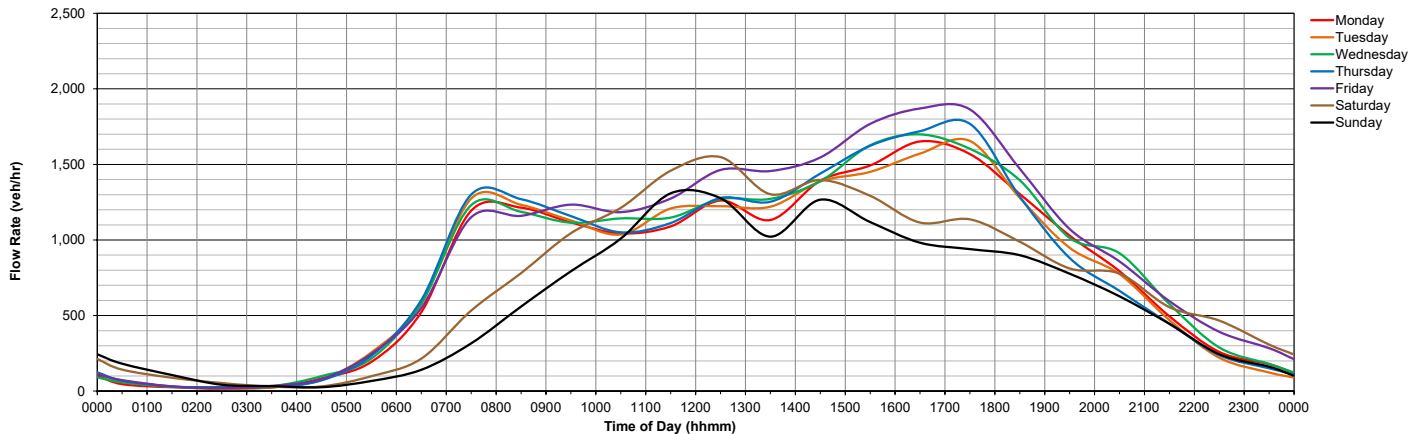


Figure 3

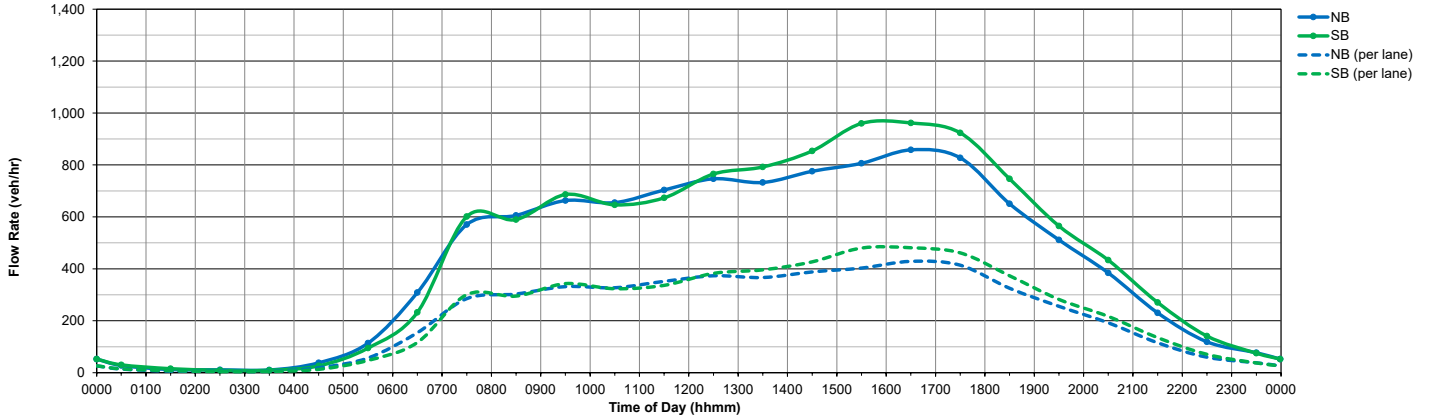
7-Day, 24-Hour Volumes

Egg Harbor Rd (CR 630) between Saddlebrook Way/Mt. Pleasant Rd and Salina Rd

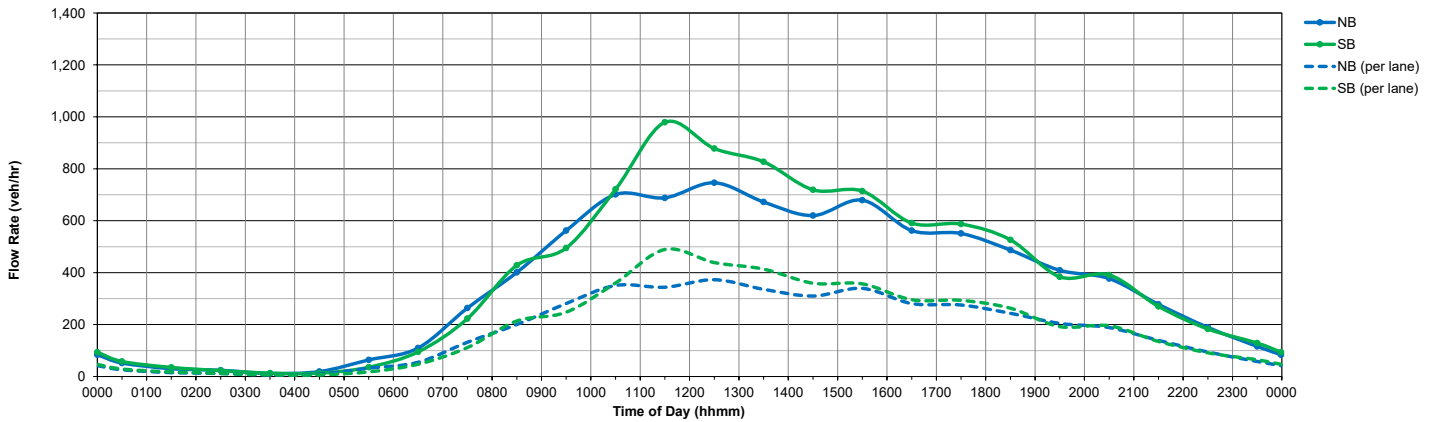
Hourly Volumes - Egg Harbor Rd (CR 630) between Greentree Rd (CR 651) and Ganttown Rd (CR 639)

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	24	23	32	38	26	36	26	26	32	27	52	58	64	84	28	30	58	71
0100	0200	4	4	14	17	13	13	12	11	14	17	30	35	34	54	12	16	32	45
0200	0300	16	14	8	5	11	4	9	13	13	10	24	23	29	26	11	9	27	25
0300	0400	8	9	7	15	9	11	13	9	16	4	12	13	19	7	11	10	16	10
0400	0500	39	23	35	31	33	28	42	21	41	29	19	13	15	19	38	26	17	16
0500	0600	96	93	116	109	114	89	124	91	120	93	64	36	39	25	114	95	52	31
0600	0700	286	211	304	221	301	227	338	251	314	253	110	85	83	77	309	233	97	86
0700	0800	605	602	582	587	527	618	596	611	542	592	264	223	201	139	570	602	233	181
0800	0900	625	579	614	588	566	613	618	595	607	574	401	428	281	299	606	590	341	364
0900	1000	657	636	697	709	645	690	636	688	681	708	562	495	470	437	663	686	516	466
1000	1100	636	659	642	639	661	652	668	608	677	675	701	721	585	510	655	647	643	616
1100	1200	677	672	704	686	713	665	661	652	764	692	688	979	629	707	704	673	659	843
1200	1300	765	717	761	780	710	720	736	754	761	856	746	878	632	677	747	765	689	778
1300	1400	713	765	744	779	728	793	658	801	821	823	672	827	355	393	733	792	514	610
1400	1500	810	819	784	899	749	829	757	837	780	887	620	719	798	633	776	854	709	676
1500	1600	809	946	779	950	803	977	838	938	803	990	679	714	603	557	806	960	641	636
1600	1700	895	937	853	975	859	926	891	945	793	1,025	562	591	541	571	856	962	552	581
1700	1800	837	896	862	902	848	892	798	1,016	793	912	551	587	493	485	828	924	522	536
1800	1900	640	785	637	756	684	735	680	676	633	783	487	526	472	463	651	747	480	495
1900	2000	487	529	563	571	515	552	444	540	547	632	409	384	401	346	511	565	405	365
2000	2100	376	394	367	458	414	511	365	356	401	449	377	391	344	332	385	434	361	362
2100	2200	212	266	218	280	233	290	221	221	269	295	278	270	202	185	231	270	240	228
2200	2300	122	147	104	103	106	136	109	130	155	191	189	183	103	99	119	141	146	141
2300	0000	79	77	61	47	71	78	75	66	99	108	116	129	60	63	77	75	88	96
Sub-total		10,418	10,819	10,488	11,145	10,343	11,085	10,285	10,856	10,676	11,625	8,613	9,318	7,453	7,187	10,442	11,106	8,033	8,253
Total		21,237		21,633		21,428		21,141		22,301		17,931		14,640		21,548		16,286	

Weekday Average Hourly Volumes



Saturday Hourly Volumes



Hourly Volumes by Day

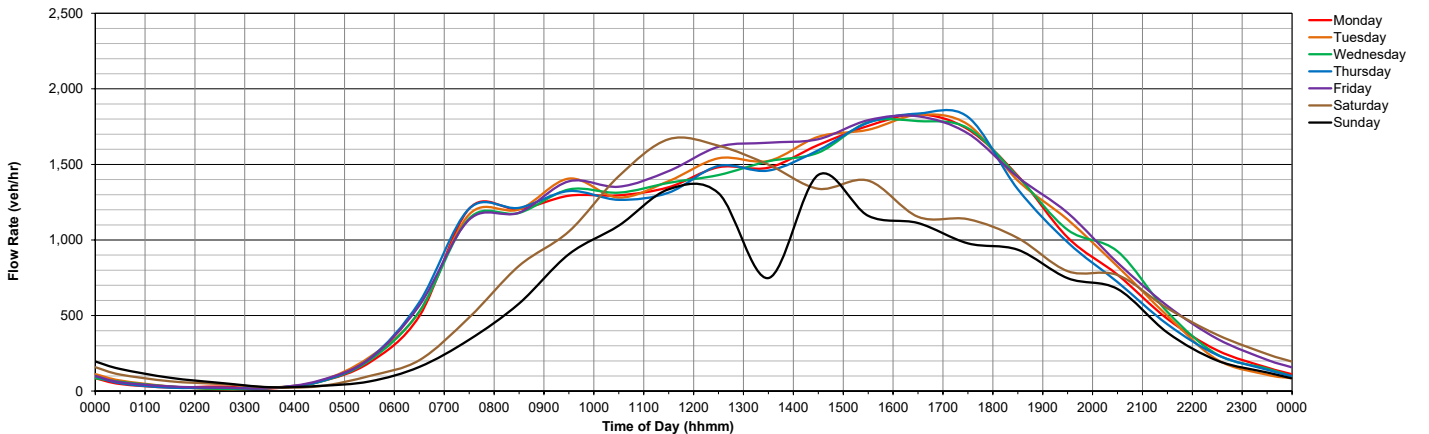


Figure 4

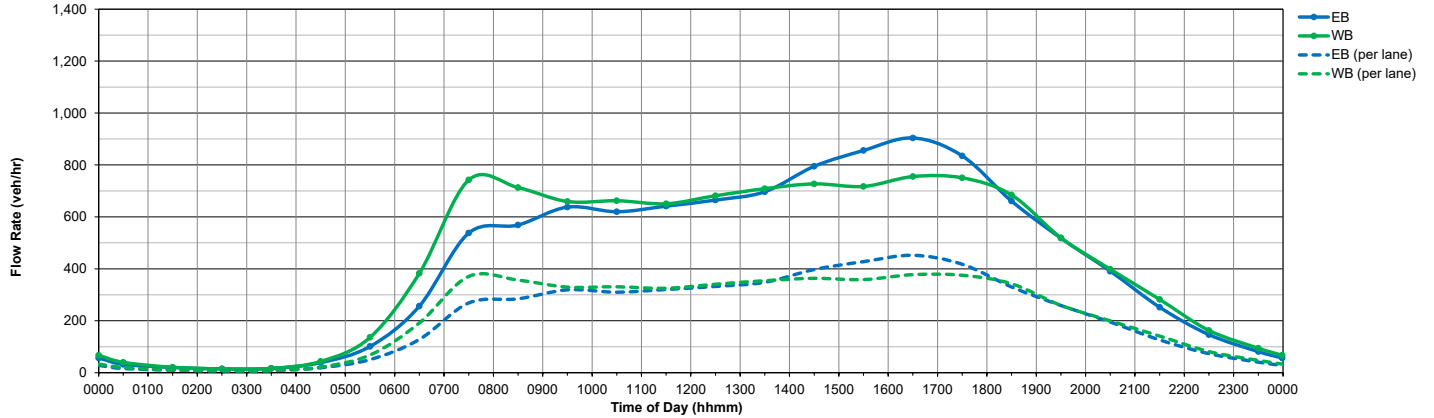
7-Day, 24-Hour Volumes

Egg Harbor Rd (CR 630) between Greentree Rd (CR 651) and Ganttown Rd (CR 639)

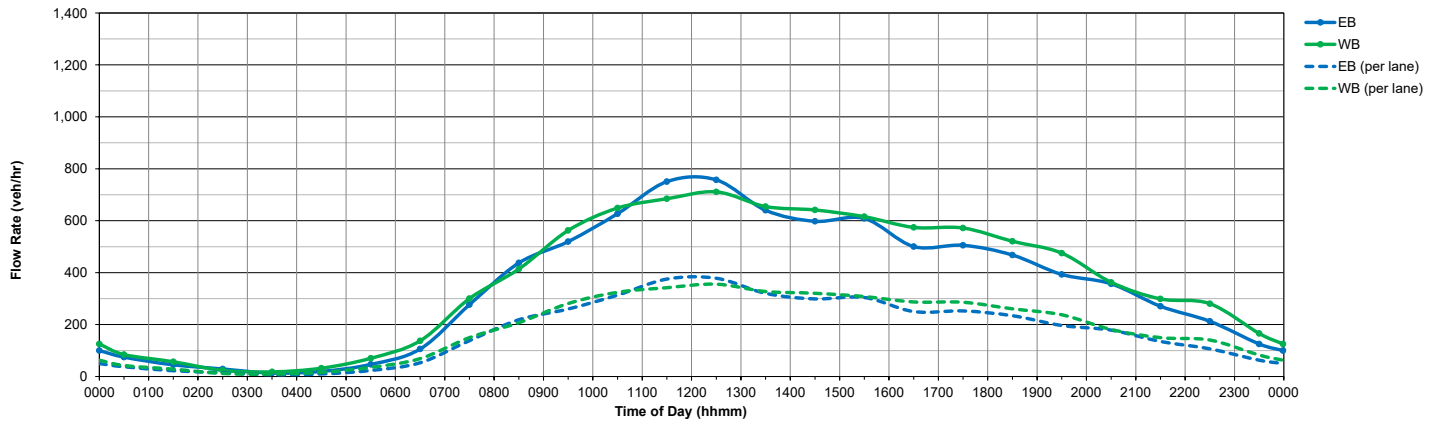
Hourly Volumes - Average for Hurffville-Cross Keys Rd (CR 654) between Minuteman Dr/Brook Ln and Cross Keys Bypass (CR 689)

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	30	35	27	38	34	47	31	37	22	43	75	85	75	93	32	40	75	89
0100	0200	16	24	17	20	21	18	25	21	22	23	45	57	59	49	20	21	52	53
0200	0300	9	15	14	14	13	13	17	19	20	11	29	24	29	28	15	15	29	26
0300	0400	14	11	16	14	15	17	19	23	20	17	13	18	14	22	17	17	14	20
0400	0500	42	35	40	42	34	43	38	47	40	51	20	32	15	17	39	44	17	25
0500	0600	102	121	108	145	100	127	101	146	95	143	47	70	31	36	101	136	39	53
0600	0700	240	359	259	386	246	372	271	412	266	386	106	138	75	111	256	383	90	124
0700	0800	512	716	551	724	530	736	571	792	525	743	277	300	158	170	538	742	218	235
0800	0900	557	736	562	713	561	688	595	708	570	721	437	414	220	272	569	713	329	343
0900	1000	605	668	641	665	649	671	682	624	636	520	562	371	414	638	659	446	488	
1000	1100	628	657	610	685	630	655	599	669	633	646	627	649	437	488	620	662	532	569
1100	1200	633	634	638	641	657	664	653	637	625	677	751	684	541	515	641	651	646	600
1200	1300	672	677	635	673	654	699	670	684	692	676	757	711	562	541	665	682	655	626
1300	1400	702	708	676	692	650	692	721	716	735	735	640	655	564	634	697	709	602	645
1400	1500	804	749	765	708	762	718	881	761	761	701	598	641	522	710	795	727	560	676
1500	1600	849	727	848	742	884	743	890	734	809	641	609	616	537	627	856	717	573	621
1600	1700	894	763	895	743	888	758	884	736	949	756	501	574	461	546	904	755	461	560
1700	1800	818	760	824	759	837	748	890	756	807	733	505	572	438	532	835	751	472	552
1800	1900	654	713	641	690	678	701	648	672	683	649	468	521	399	508	661	685	434	514
1900	2000	510	518	508	526	522	538	525	466	526	550	393	475	362	434	518	519	378	455
2000	2100	420	376	395	393	431	441	318	343	390	441	357	363	321	327	391	399	339	345
2100	2200	228	268	265	264	267	305	202	273	300	300	270	299	239	200	252	282	255	250
2200	2300	135	161	120	140	150	144	133	150	196	219	213	281	103	143	147	163	158	212
2300	0000	80	95	70	76	69	79	78	80	108	142	125	166	67	79	81	94	96	122
Sub-total		10,153	10,547	10,125	10,492	10,283	10,590	10,442	10,562	10,436	10,640	8,383	8,906	6,590	7,495	10,288	10,566	7,487	8,201
Total		20,700		20,616		20,874		21,004		21,076		17,289		14,085		20,854		15,687	

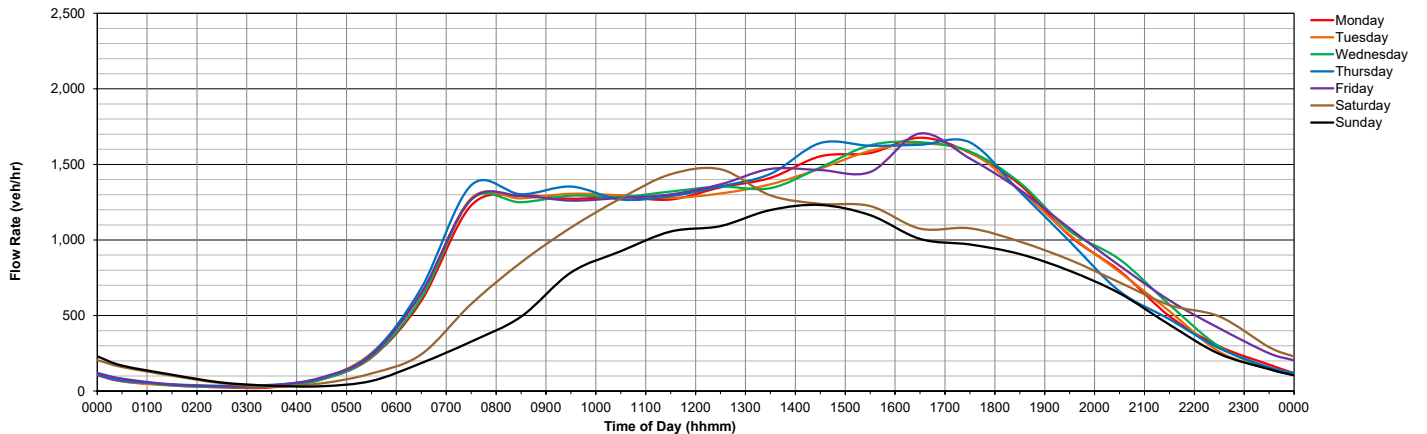
Weekday Average Hourly Volumes



Saturday Hourly Volumes



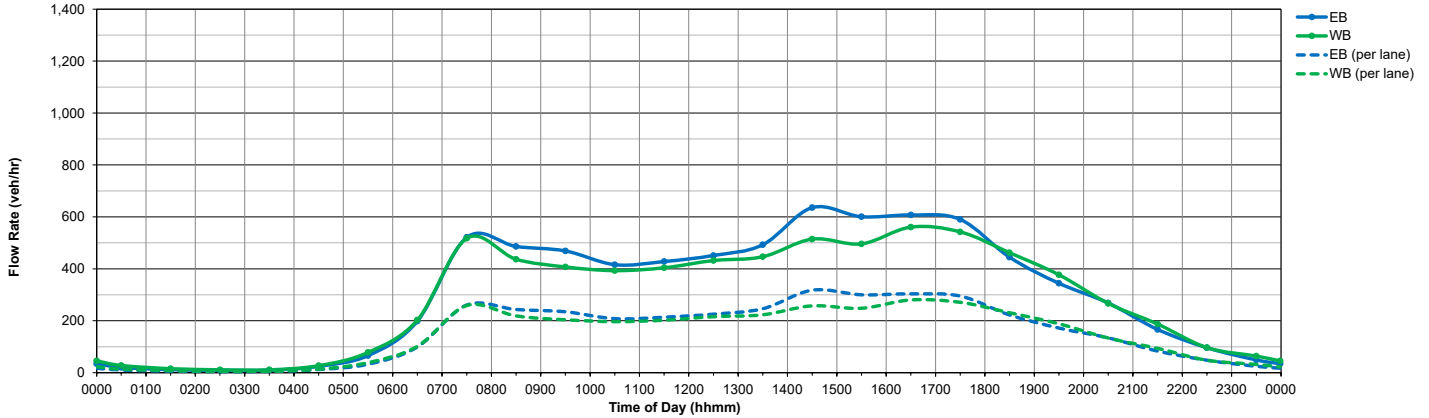
Hourly Volumes by Day



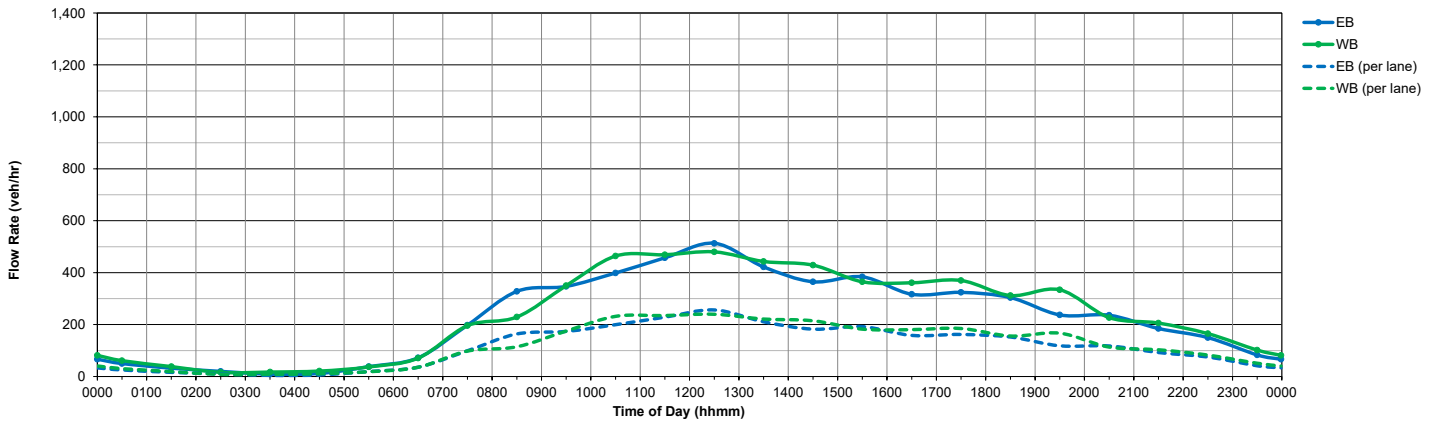
Hourly Volumes - Hurffville-Cross Keys Rd (CR 654) between Minuteman Dr/Brook Ln and Ganttown Rd/Chapel Heights Rd (CR 639)

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	25	23	21	26	19	30	16	27	21	32	50	61	55	61	20	28	53	61
0100	0200	12	18	7	16	15	14	15	17	11	13	32	38	47	30	12	16	40	34
0200	0300	8	9	6	6	12	12	9	21	11	9	20	16	27	18	9	11	24	17
0300	0400	6	7	8	11	8	16	13	11	14	11	9	17	10	11	10	11	10	14
0400	0500	20	20	23	33	24	25	26	30	29	28	12	21	6	13	24	27	9	17
0500	0600	60	75	76	87	69	74	58	74	66	81	38	37	26	20	66	78	32	29
0600	0700	183	199	199	209	185	178	208	221	217	208	72	71	50	57	199	203	61	64
0700	0800	510	488	521	510	503	528	553	530	519	532	198	196	87	99	521	518	143	148
0800	0900	486	447	494	420	481	441	492	434	479	444	328	229	132	156	486	437	230	193
0900	1000	448	392	487	395	469	429	461	404	481	417	347	350	224	261	469	407	286	306
1000	1100	404	404	397	399	432	363	415	405	433	396	399	464	318	331	416	393	359	398
1100	1200	412	382	438	409	444	439	446	409	400	381	457	469	329	357	428	404	393	413
1200	1300	434	436	427	394	469	449	452	441	475	440	513	480	410	331	451	432	462	406
1300	1400	493	412	484	432	469	432	507	497	513	460	422	443	320	355	493	447	371	399
1400	1500	655	490	601	535	620	500	671	538	632	510	365	429	348	408	636	515	357	419
1500	1600	594	493	609	505	603	485	590	509	607	489	384	365	386	371	601	496	385	368
1600	1700	588	562	616	539	628	577	579	540	626	586	317	361	324	328	607	561	321	345
1700	1800	566	572	577	520	584	545	687	534	539	541	324	370	319	345	591	542	322	358
1800	1900	425	502	461	456	460	465	438	465	440	423	304	312	308	356	445	462	306	334
1900	2000	351	370	320	385	341	421	366	328	343	381	237	334	239	310	344	377	238	322
2000	2100	299	241	268	280	307	281	186	239	282	294	236	227	248	200	268	267	242	214
2100	2200	139	191	186	181	174	179	123	171	211	215	185	206	202	124	167	187	194	165
2200	2300	82	85	80	87	97	90	84	103	138	118	150	165	62	93	96	97	106	129
2300	0000	48	74	46	50	36	48	53	51	63	97	83	102	45	38	49	64	64	70
Sub-total		7,248	6,892	7,352	6,885	7,449	7,021	7,448	6,999	7,550	7,106	5,482	5,763	4,522	4,673	7,409	6,981	5,002	5,218
Total		14,140		14,237		14,470		14,447		14,656		11,245		9,195		14,390		10,220	

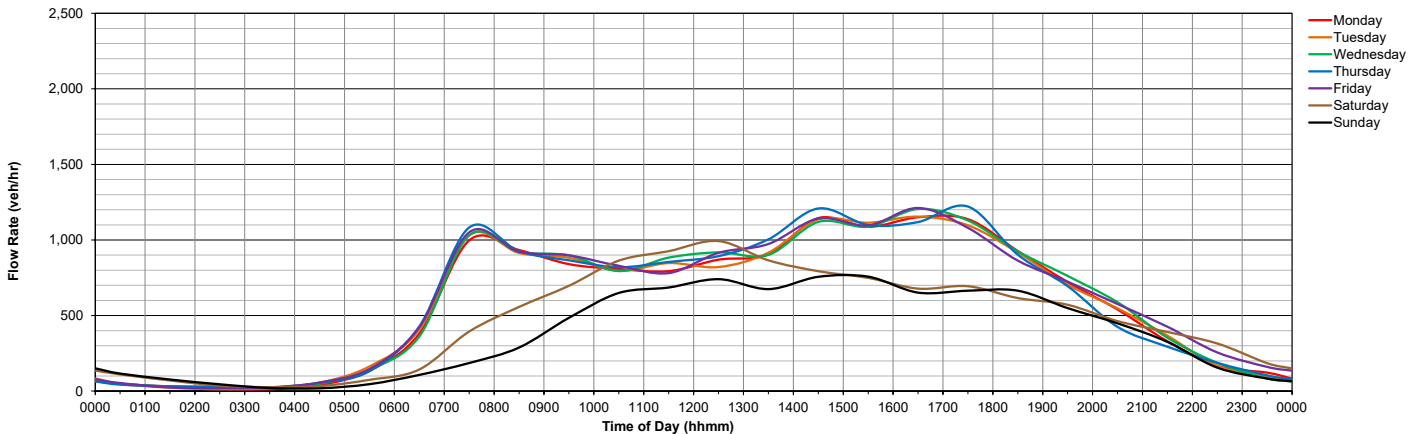
Weekday Average Hourly Volumes



Saturday Hourly Volumes



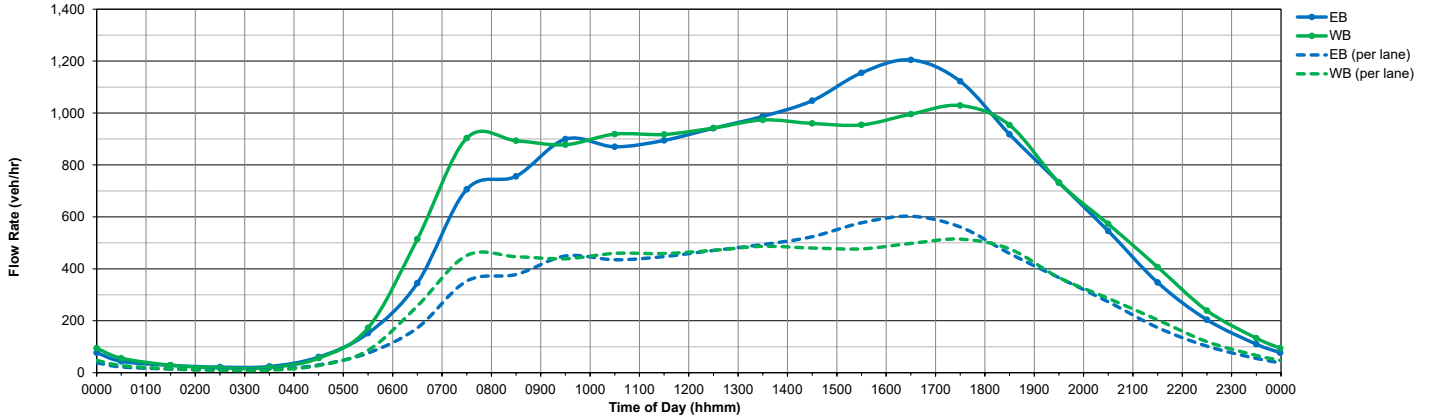
Hourly Volumes by Day



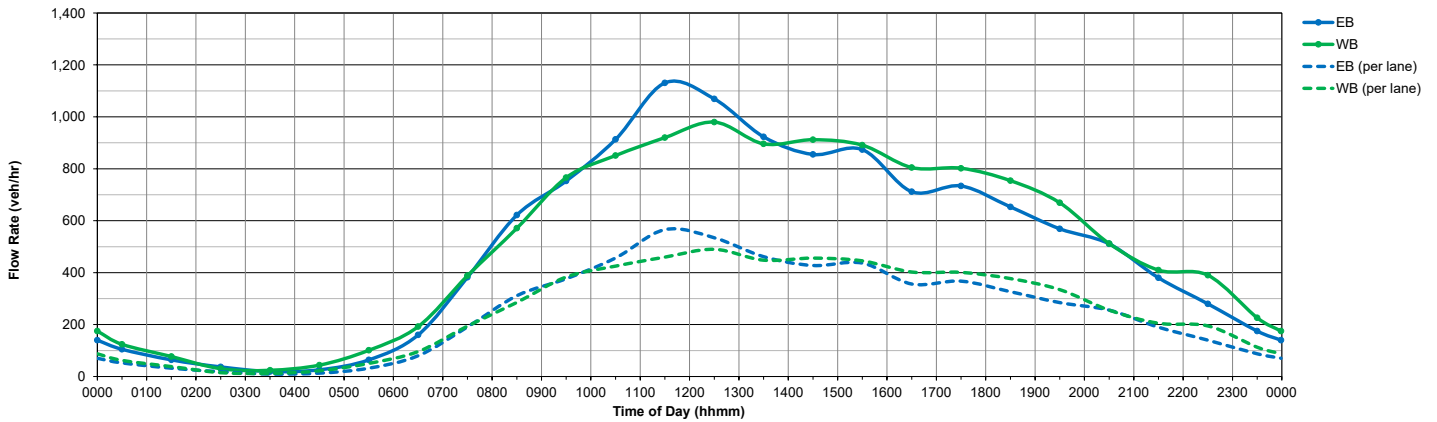
Hourly Volumes - Hurffville-Cross Keys Rd (CR 654) between Fish Pond Rd (CR 634) and Fries Mill Rd (CR 655)

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	38	45	36	52	46	27	26	47	54	53	61	105	124	105	134	44	56	105	129
0100	0200	25	33	28	27	27	26	32	30	30	30	64	77	74	71	28	29	69	74	
0200	0300	13	22	22	19	18	15	26	21	29	16	37	30	37	38	22	19	37	34	
0300	0400	22	14	23	15	19	18	29	31	26	22	19	24	19	33	24	20	19	29	
0400	0500	67	44	64	53	55	57	58	59	57	67	26	44	28	24	60	56	27	34	
0500	0600	151	150	156	182	153	158	162	189	138	184	64	101	44	49	152	173	54	75	
0600	0700	328	481	345	514	329	509	365	541	357	527	160	192	119	160	345	514	140	176	
0700	0800	656	914	734	892	720	886	732	932	690	894	382	388	242	231	706	904	312	310	
0800	0900	740	935	735	911	754	825	783	896	770	901	622	571	310	366	756	894	466	469	
0900	1000	840	898	897	894	911	844	993	914	858	840	753	766	556	573	900	878	655	670	
1000	1100	911	917	878	964	883	916	815	912	863	886	913	851	735	681	870	919	824	766	
1100	1200	906	903	886	884	913	932	900	894	869	976	1,131	920	817	798	895	918	974	859	
1200	1300	944	955	903	980	907	951	961	920	974	906	1,069	980	710	662	942	942	890	821	
1300	1400	1,009	1,010	950	956	911	944	1,019	935	1,048	1,023	923	896	827	901	987	974	875	899	
1400	1500	1,061	1,035	1,028	934	977	968	1,177	980	995	884	855	912	741	1,020	1,048	960	798	966	
1500	1600	1,134	980	1,122	1,026	1,234	1,030	1,249	943	1,036	793	874	891	1,026	883	1,155	954	813	887	
1600	1700	1,200	1,064	1,170	1,033	1,184	972	1,210	930	1,260	980	712	805	643	783	1,205	996	678	794	
1700	1800	1,111	1,027	1,099	1,055	1,116	1,042	1,174	1,034	1,111	987	734	802	596	734	1,122	1,029	665	788	
1800	1900	931	995	884	980	917	986	894	911	966	896	653	754	546	699	918	954	600	727	
1900	2000	704	740	724	735	732	740	725	665	775	782	569	669	526	611	732	732	548	640	
2000	2100	573	541	545	555	590	652	477	494	545	623	511	512	441	500	546	573	476	506	
2100	2200	334	387	346	378	359	449	283	402	415	419	380	410	308	285	347	407	344	348	
2200	2300	186	240	160	203	215	207	187	212	273	335	280	390	146	204	204	239	213	297	
2300	0000	109	131	85	101	95	119	108	112	153	202	175	226	93	117	110	133	134	172	
Sub-total		13,993	14,461	13,820	14,343	14,065	14,313	14,426	14,011	14,291	14,234	12,011	12,335	9,415	10,557	14,119	14,272	10,713	11,446	
Total		28,454		28,163		28,378		28,437		28,525		24,346		19,972		28,391		22,159		

Weekday Average Hourly Volumes



Saturday Hourly Volumes



Hourly Volumes by Day

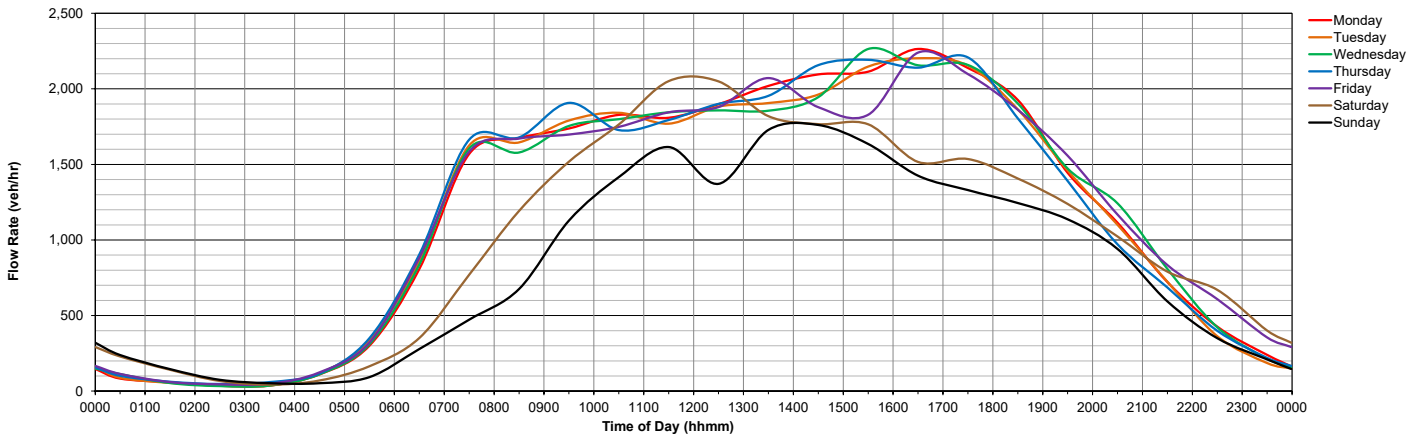


Figure 7

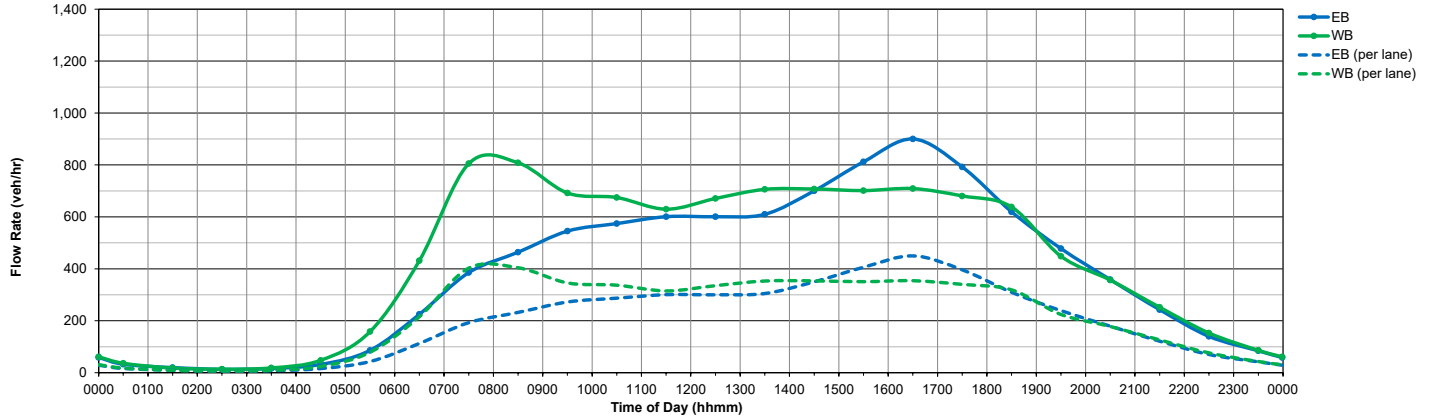
7-Day, 24-Hour Volumes

Hurffville-Cross Keys Rd (CR 654) between Fish Pond Rd (CR 634) and Fries Mill Rd (CR 655)

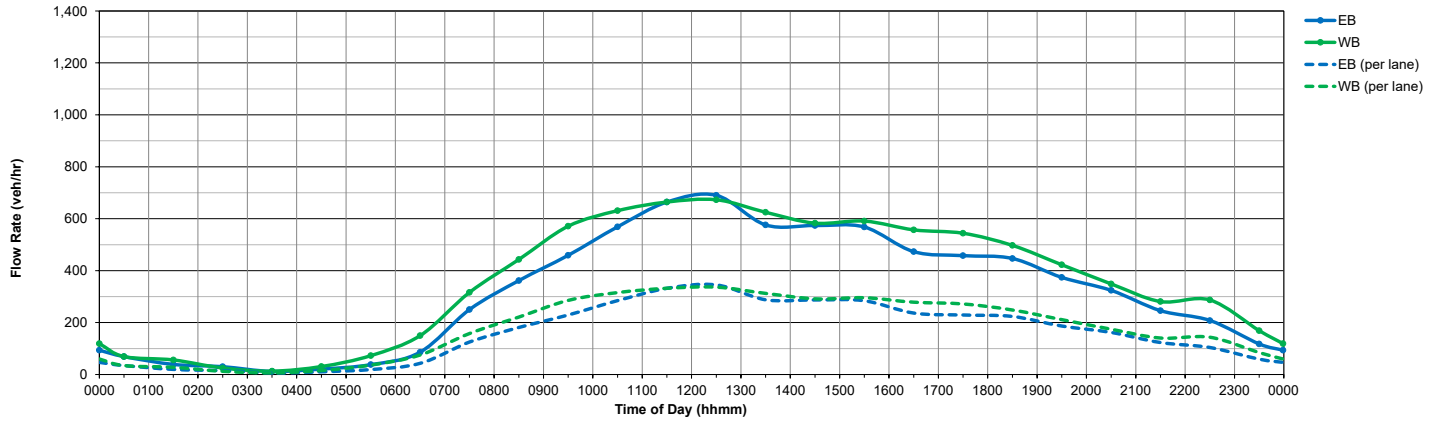
Hourly Volumes - Hurffville-Cross Keys Rd (CR 654) between Sun Haven Dr and Cross Keys Bypass (CR 689)

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	27	36	25	35	37	44	30	31	44	36	69	69	66	85	33	36	68	77
0100	0200	11	17	16	16	20	13	27	15	24	25	39	56	57	46	20	18	48	51
0200	0300	6	15	14	17	10	13	15	15	20	9	30	25	23	27	13	14	27	26
0300	0400	13	11	16	17	17	18	15	27	19	19	12	13	13	21	16	18	13	17
0400	0500	39	40	34	40	23	48	29	53	34	58	21	31	11	15	32	48	16	23
0500	0600	95	139	92	165	78	150	84	174	81	163	38	73	23	39	86	158	31	56
0600	0700	208	398	232	434	223	428	240	475	223	422	88	150	55	116	225	431	71	133
0700	0800	370	747	397	771	367	795	427	913	367	802	250	316	146	179	386	806	198	248
0800	0900	445	825	457	808	448	799	509	793	462	817	362	443	219	294	464	808	291	369
0900	1000	526	714	539	707	567	660	560	728	534	651	459	571	334	407	545	692	397	489
1000	1100	570	651	555	692	576	685	568	689	602	656	569	631	259	453	574	675	414	542
1100	1200	582	618	590	629	615	620	613	608	605	675	664	664	477	390	601	630	571	527
1200	1300	637	639	576	645	586	698	578	691	627	682	690	673	535	629	601	671	613	651
1300	1400	605	703	594	689	571	701	636	717	644	721	576	625	545	647	610	706	561	636
1400	1500	697	723	665	655	689	685	796	764	656	710	574	583	476	701	701	707	525	642
1500	1600	818	708	812	695	816	713	831	750	784	641	568	591	474	626	812	701	521	609
1600	1700	894	723	898	657	853	725	884	737	961	703	473	557	416	527	900	709	445	542
1700	1800	776	680	796	698	812	656	809	699	770	670	458	544	398	518	733	681	428	531
1800	1900	605	641	578	633	658	651	613	639	644	628	447	497	344	468	620	638	396	483
1900	2000	475	443	480	458	493	452	483	404	460	487	374	423	320	380	478	449	347	402
2000	2100	388	347	373	345	396	391	292	296	344	405	324	349	273	281	359	357	299	315
2100	2200	210	227	262	233	267	288	201	246	275	267	246	281	207	192	243	252	227	237
2200	2300	136	159	120	131	139	134	128	135	177	205	208	287	101	132	140	153	155	210
2300	0000	84	80	79	77	75	70	74	76	109	128	118	169	62	81	84	86	90	125
Sub-total		9,217	10,288	9,202	10,247	9,336	10,437	9,452	10,675	9,466	10,580	7,655	8,621	5,834	7,254	9,335	10,445	6,745	7,938
Total		19,505		19,449		19,773		20,127		20,046		16,276		13,088		19,780		14,682	

Weekday Average Hourly Volumes



Saturday Hourly Volumes



Hourly Volumes by Day

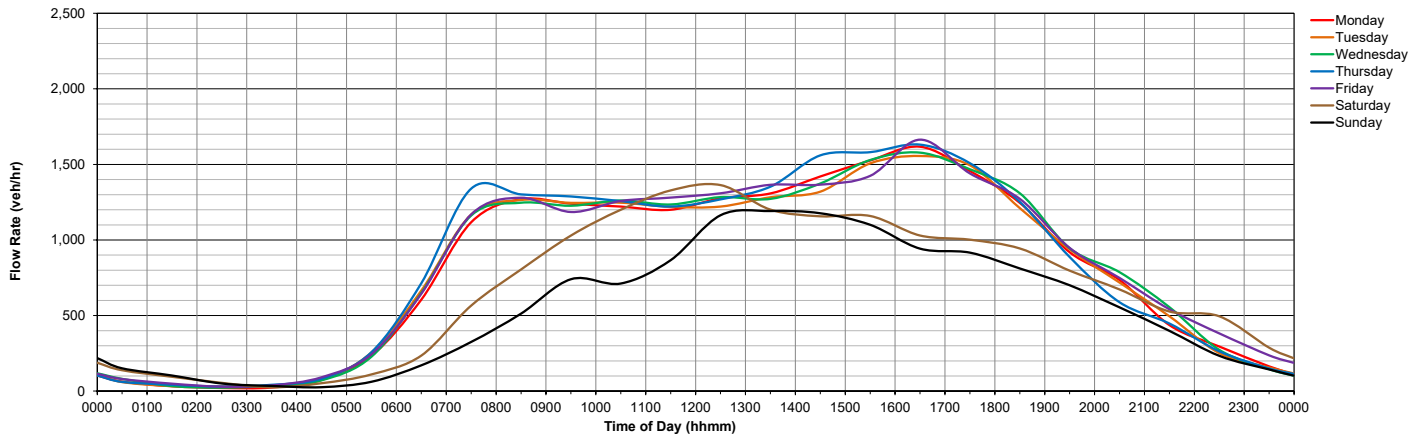


Figure 8

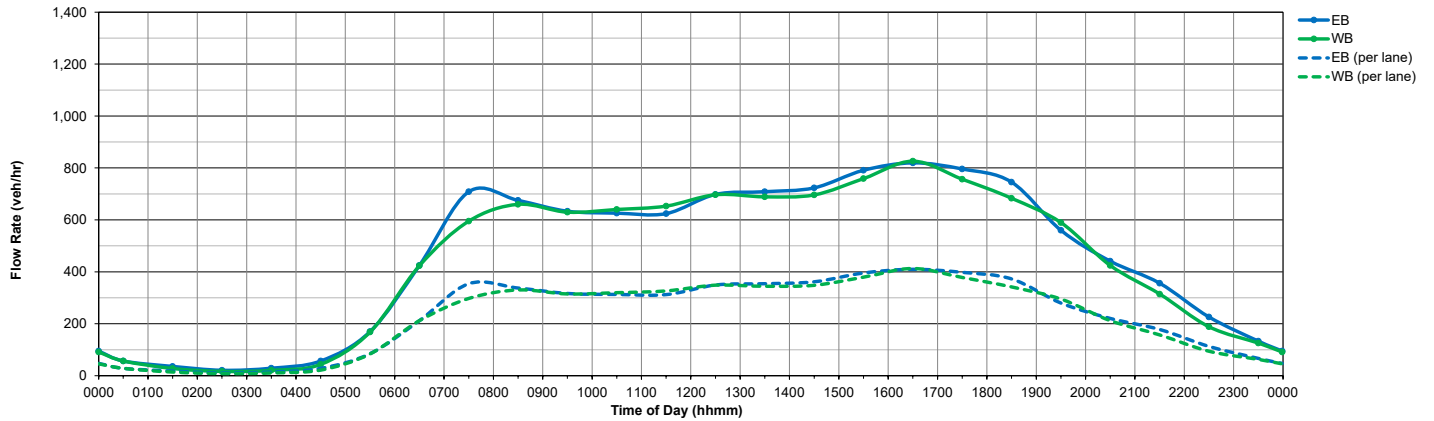
7-Day, 24-Hour Volumes

Hurffville-Cross Keys Rd (CR 654) between Sun Haven Dr and Cross Keys Bypass (CR 689)

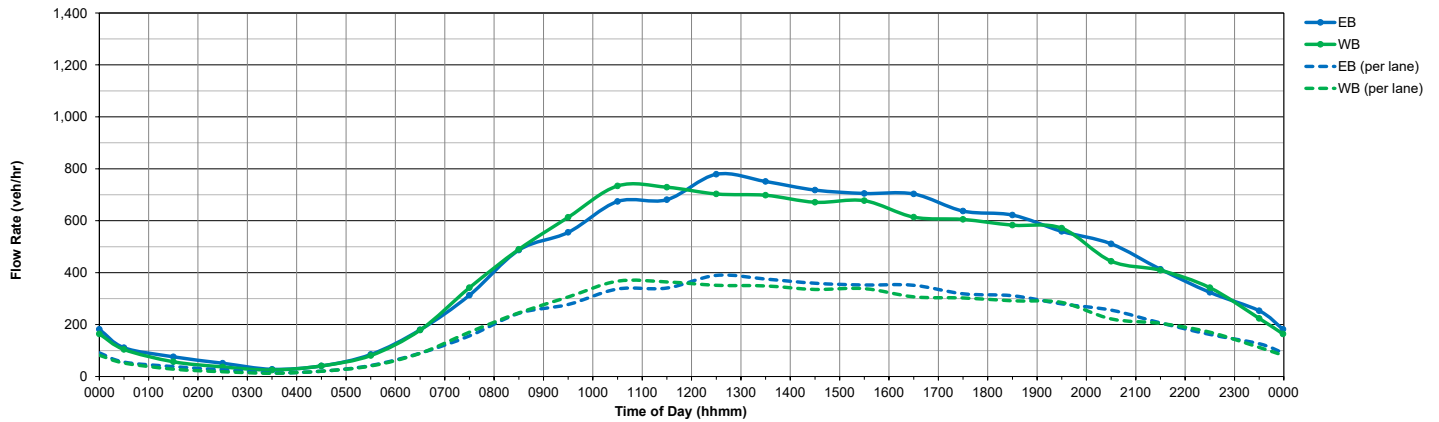
Hourly Volumes - Cross Keys Bypass (CR 689) between Tuckahoe Rd (CR 655) and Home Depot Driveway/Berlin Cross Keys Rd

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	48	65	57	63	58	47	49	46	71	63	111	104	147	117	57	57	129	111
0100	0200	35	18	26	25	37	28	38	41	44	28	76	57	79	62	36	28	78	60
0200	0300	19	17	23	17	22	11	20	18	21	19	51	37	60	54	21	16	56	46
0300	0400	27	23	30	22	29	18	27	14	32	27	28	25	33	24	29	21	31	25
0400	0500	55	44	52	51	52	45	65	43	61	36	41	41	26	33	57	44	34	37
0500	0600	147	163	179	188	169	165	176	163	179	161	85	81	57	45	170	168	71	63
0600	0700	410	397	406	436	414	422	459	459	433	403	180	179	137	94	424	423	159	137
0700	0800	703	590	757	624	703	565	731	621	640	575	313	342	176	192	709	595	245	267
0800	0900	668	632	702	681	688	629	644	685	674	673	487	490	327	320	675	660	407	405
0900	1000	659	597	623	658	599	645	628	620	658	629	555	613	239	475	633	630	397	544
1000	1100	598	628	618	657	591	637	640	603	684	675	674	734	548	528	626	640	611	631
1100	1200	634	626	631	665	602	674	628	647	627	655	681	729	653	694	624	653	667	712
1200	1300	666	774	668	684	704	704	701	633	753	690	779	703	803	693	698	697	791	698
1300	1400	735	641	686	716	709	684	671	701	742	703	751	698	746	701	709	689	749	700
1400	1500	672	710	670	675	737	708	757	730	782	659	718	671	862	667	724	696	790	669
1500	1600	825	742	797	769	798	787	774	738	762	759	705	677	727	650	791	759	716	664
1600	1700	815	813	839	810	829	786	771	834	845	888	703	614	679	575	820	826	691	595
1700	1800	787	732	822	780	797	782	816	756	759	754	637	605	604	564	796	757	621	585
1800	1900	747	658	756	622	711	712	755	645	758	781	622	583	595	450	746	684	609	517
1900	2000	596	547	562	533	540	645	419	543	683	681	559	571	549	436	560	590	554	504
2000	2100	406	430	468	411	518	456	316	356	499	470	511	444	394	356	441	425	453	400
2100	2200	349	294	325	300	365	322	298	262	445	395	413	409	305	285	356	315	359	347
2200	2300	211	162	210	160	196	190	169	177	345	253	324	342	206	149	226	188	265	246
2300	0000	111	115	92	116	122	101	108	112	234	184	253	224	114	100	133	126	184	162
Sub-total		10,923	10,418	11,001	10,663	10,990	10,743	10,660	10,447	11,740	11,161	10,257	9,973	9,066	8,264	11,063	10,686	9,662	9,119
Total		21,341		21,664		21,733		21,107		22,901		20,230		17,330		21,749		18,780	

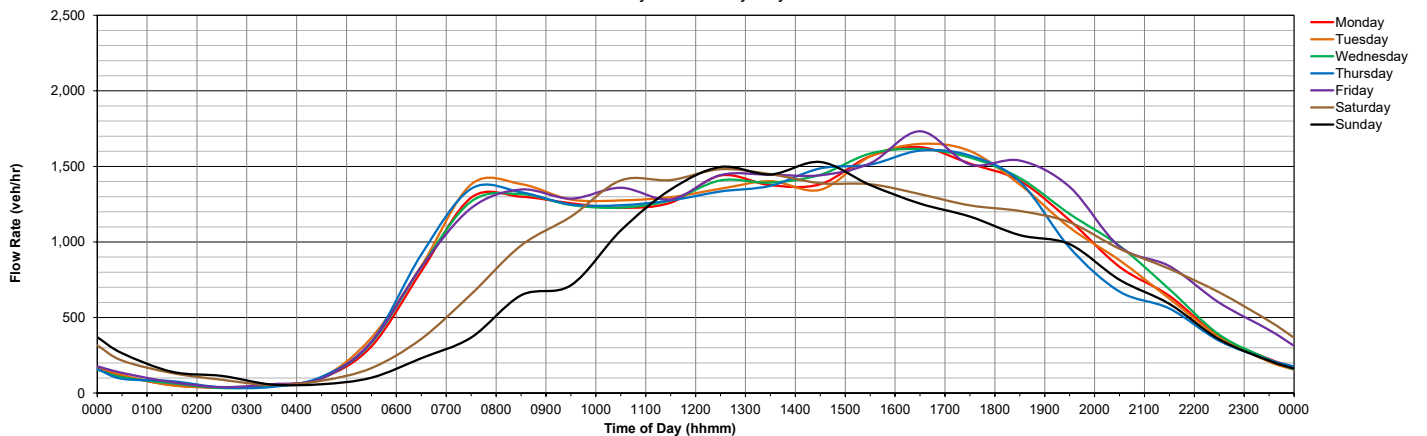
Weekday Average Hourly Volumes



Saturday Hourly Volumes



Hourly Volumes by Day



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 was submitted to Gloucester County personnel to be reviewed and addressed. An observation of all signals was conducted during daytime operation.

3.2 Summary of Field Observations

The following observations were noted during the site survey:

General Observations

- Under existing conditions, most signals within this network were running in free operation. This resulted in inconsistency throughout the network and unpredictable arrivals at intersections. This created 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, which increases 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 the primary arterials.
- None of the existing traffic cabinets were equipped with any way to maintain a consistent time source, such as a GPS. Also, some controller clocks were never set under existing conditions, so even though coordinated timings were programmed in the traffic controller, signals were operating in free operation due to the controller clocks not being set.
- In general, the controller clocks hold time well with a few exceptions. When clocks were set, they were observed to drift together, so two weeks after being set, most clocks would be fast by five seconds, but at least all signals would be off the same amount.

Egg Harbor Road (CR 630) & Delsea Drive (SR 47)/Hurffville Road (SR 41)

- During the AM and PM periods, southbound queues extended up to approximately 0.8 miles, resulting in multiple phase failures. Also, the eastbound left turn queue extended up to approximately four hundred feet, resulting in phase failures. This intersection clearly was observed failing in multiple directions during the peak periods.
- This signal is programmed to run in free operation at all times but requires significant maximum times for each movement, so requires cycle lengths larger than what would be appropriate for the County signals.

Egg Harbor Road (CR 630) & Ronald Lane/Blackwood Barnsboro Road (CR 603)

- During the midday and PM periods, westbound queues occasionally extended up to approximately 250 feet and experienced cycle failures. This primarily occurred when there was significant eastbound traffic from Ronald Lane, causing westbound left turning vehicles to wait for gaps in eastbound traffic.

Egg Harbor Road (CR 630) & County House Road (CR 621)

- During the PM period, eastbound queues extended up to approximately four hundred feet, resulting in occasional cycle failures. Westbound queues during the AM peak period were observed extending approximately 350 feet but did not observe any cycle failures.

Egg Harbor Road (CR 630) & Hurffville-Grenloch Road (CR 635)

- During all time periods but primarily the PM peak, eastbound queues extended up to approximately 550 feet, resulting in cycle failures.

Egg Harbor Road (CR 630) & Greentree Road (CR 651)

- During the midday and PM peak periods, eastbound left turn queues extended up to approximately two hundred feet, resulting in occasional cycle failures.

Egg Harbor Road (CR 630) & Ganttown Road (CR 639)

- During the AM and PM periods, both eastbound and westbound queues were observed to occasionally fail, with queues extending up to approximately four hundred feet.
- During the midday, PM and weekend midday periods, southbound left turn queues extended up to approximately three hundred feet, resulting in consistent cycle failures.
- The controller at this intersection was observed to not be able to hold correct time for more than a few hours at a time.

Hurffville-Cross Keys Road (CR 654) & Greentree Road (CR 651)

- During the AM period, westbound queues extended up to approximately 250 feet, resulting in cycle failures when the Washington Township schools were active during ingress and egress periods.

Hurffville-Cross Keys Road (CR 654) & Minuteman Drive/Brook Lane

- Washington Township High School heavily impacts this signal, especially during school ingress and egress times. During the AM period, there was heavy eastbound left turning traffic into the school parking lot and during the midday and PM period, there was significant traffic exiting the school. Phase failures were observed during the school egress when southbound queues were observed extending up to approximately 350 feet.
- Moderate pedestrian traffic was observed at this intersection during the school ingress and egress periods and sporadically through all other time periods as well.

Hurffville-Cross Keys Road (CR 654) & Ganttown Road/Chapel Heights Road (CR 639)

- Detection was not operational during existing or implemented conditions, meaning each phase utilized the full allotted time regardless of vehicle demand. This resulted in time not being optimally distributed and a lot of cycle time being given to movements where it was unnecessary.
- Significant pedestrian activity was observed between the parking lot on the northwest corner of this intersection and the bus lot just south along Chapel Heights Boulevard (CR 639). This resulted in added delays for all phases at this intersection during the AM and PM periods. School bus drivers park their personal vehicles in the lot on the northwest corner and walk across Hurffville-Cross Keys Road (CR 654) to and from the bus lot located just south of this signal.
- During the PM peak and school egress period, southbound left turn queues extended up to approximately four hundred feet and resulted in cycle failures. This was due to heavy traffic exiting the school area and the heavy percentage of school buses for a brief period of time.

Hurffville-Cross Keys Road (CR 654) & Altair Drive

- Sporadically through all time periods, northbound queues would extend up to approximately 250 feet and result in cycle failures. This was observed to be due to the interaction with the Wawa driveway and inefficient use of time allotted to that movement.

Hurffville-Cross Keys Road (CR 654) & Egg Harbor Road (CR 630)

- During the AM and PM periods, westbound queues extended up to approximately seven hundred feet, resulting in cycle failures. This was observed to be caused by slow traffic travelling westbound from Fish Pond Road (CR 634) and the relatively short westbound right turn bay.

Hurffville-Cross Keys Road (CR 654) & Fish Pond Road (CR 634)

- During all time periods, the westbound movement experienced significant cycle failures. The longest queues were through Fries Mill Road (CR 655) and would often take three to four cycles to clear the intersection at Fish Pond Road (CR 634)
- Northbound queues extended up to approximately four hundred feet and experienced cycle failures as well during all time periods but primarily the AM, midday, and PM periods.
- Turning movement counts using Miovision equipment can only count the vehicles that reach the intersection. This intersection required a larger growth factor for westbound volumes to account for the vehicle demand that did not reach the intersection to be counted. So added growth factors were manually added to each time period and SimTraffic was utilized to accurately reflect real world conditions.

Hurffville-Cross Keys Road (CR 654) & Fries Mill Road (CR 655)

- Queueing from Fish Pond Road was observed reaching this intersection during the midday, PM, and weekend midday periods. When this occurred, certain movements had nowhere to go, so would experience cycle failures until vehicles were processed at Fish Pond Road (CR 634).
- Due to a westbound lane drop between Fries Mill Road (CR 655) and Fish Pond Road (CR 634) approximately 650 feet to the west of Fries Mill Road (CR 655), poor lane utilization was observed and modeled to accurately model existing conditions.

Hurffville-Cross Keys Road (CR 654) & Cross Keys Bypass (CR 689)

- Detection was not operational during existing conditions, meaning each phase would use the full allotted time regardless of vehicle demand. This resulted in time not being optimally distributed and a lot of cycle time being given to movements where it was unnecessary.
- During the PM peak period, eastbound left turn queues extended up to approximately five hundred feet, resulting in cycle failures.

Cross Keys Bypass (CR 689) & Tuckahoe Road (CR 555)

- During the midday and PM periods, northbound and southbound queues occasionally extended up to approximately three hundred feet and experienced cycle failures. This primarily occurred when there was significant opposing traffic, causing left turning vehicles to wait for gaps in opposing traffic.

Cross Keys Bypass (CR 689) & Black Horse Pike (SR 42)

- Northbound queues were observed to extend through the Home Depot Driveway/Berlin-Cross Keys Road intersection, resulting in multiple cycle failures during peak periods. The coordinated signal timings clearly prioritized Black Horse Pike (SR 42) movements. All of the side street movements along Cross Keys Bypass (CR 689) were observed to fail during all time periods.
- Through communication with NJDOT, it was noted that this signal is included in an upcoming adaptive system project and was retimed recently via another project in 2022.

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 proposal provided at the beginning of this project.

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 were calculated for all intersections.

Minimum Green

Minimum values were reviewed and updated, as necessary. In general, the following were used:

- Main Street through movements: 15-20 seconds depending on detection layout and pedestrian operation.
- Left turn movements: 5 seconds.
- Side street through movements: 7-10 seconds depending on side street volume and detection layout.
- In many cases, existing minimum greens were not reduced but all were reviewed for 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/sec²)

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.

Though a red clearance interval is not necessary under NJDOT guidelines for protected/permissive left turn movements, each red interval was at least one second. This was done to add an extra buffer time between the end of left turn movements yellow interval and the opposing movement and intended to improve safety.

Walk Time

A value of seven or more seconds based on 2009 MUTCD requirements and engineering judgment was used if pedestrian phases are present. There were some exceptions made to this at locations where there were no pedestrian pushbuttons for main street movements in an effort to limit cycle lengths. In those cases, Walk times of five seconds may have been used if necessary to accommodate the shorter cycle length. Any location that had an actuated pedestrian button present utilized a walk time of 7 seconds or higher.

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.

For specific information, the existing and implemented timing sheets can be found on the project website.

4.3 Phasing

During the optimization process, it may be determined that the basic phasing structure of the intersection should be changed or further evaluated to improve the operation and/or safety of the intersection or corridor. The one change in phase sequence was able to be made via controller programming.

Under existing conditions, at Hurffville-Cross Keys Road (CR 654) & Altair Drive was programmed to first service northbound (phase 4) and then southbound (phase 8). Since phase 8 is a low volume movement and phase 4 is a higher volume movement and accommodates the Wawa on the southwest corner, it was determined that it would be beneficial to swap the order of the sequence to allow southbound to service and then follow that with northbound. The programming was then set up to allow for the unused southbound time to be utilized by northbound when it was available.

4.4 Day Plan Schedules

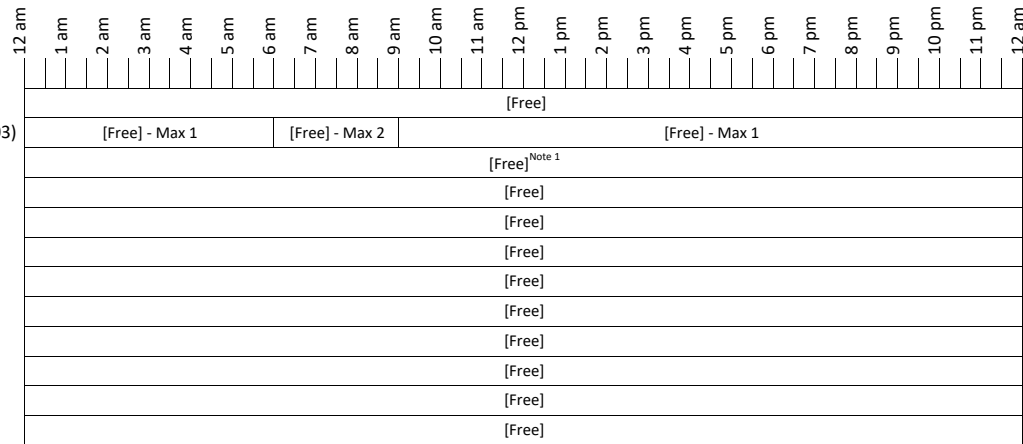
The process of determining the day plan schedule is primarily based on 7-day, 24-hour traffic volume counts and engineering judgment. During fine-tuning, one sub pattern was developed and implemented to specifically handle the Washington Township High School release at Hurffville-Cross Keys Road (CR 654) & Ganttown Road/Chapel Heights Rd, where southbound volumes routinely spike for about a half hour while vehicles exit the school. So, a special pattern was implemented. Within this system, these sub patterns included both coordinated and free operation plans. Figure 10 through Figure 12 on pages 19 – 21 illustrate the existing and implemented day plan schedules.

EXISTING SCHEDULES

Egg Harbor Rd (CR 630)

Weekday

- 1 Delsea Dr (SR 47)/Hurffville Rd (SR 41)
- 2 Ronald Ln/Blackwood Barnsboro Rd (CR 603)
- 3 County House Rd (CR 621)
- 4 Long Bow Dr/Long Bow Cir
- 5 Saddlebrook Way/Mt. Pleasant Rd
- 6 Salina Rd
- 7 Hurffville-Grenloch Rd (CR 635)
- 8 Bently Dr/Trent Rd
- 9 Greentree Rd (CR 651)
- 10 Ganttown Rd (CR 639)
- 11 Medical Center Dr
- 17 Hurffville-Cross Keys Rd (CR 654)



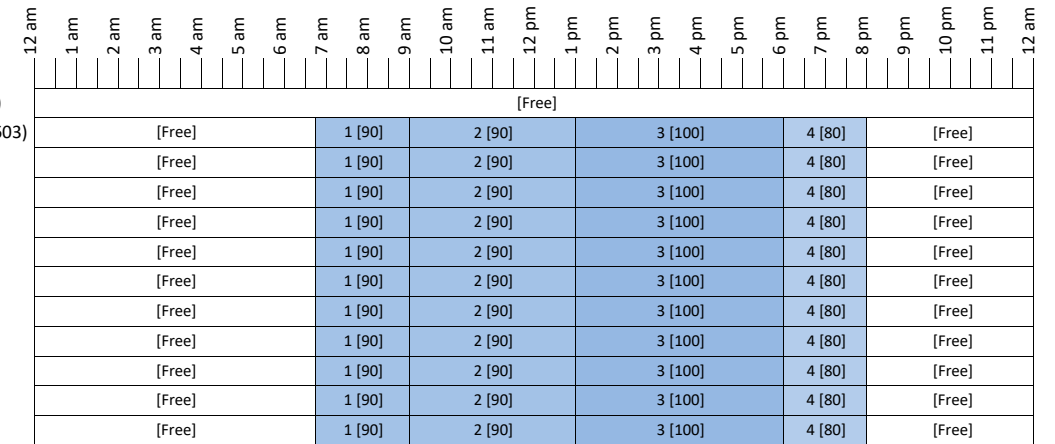
Notes: 1 - Controller programmed to run coordination but controller clock not set, so running free under existing conditions.

IMPLEMENTED SCHEDULES

Egg Harbor Rd (CR 630)

Weekday

- 1 Delsea Dr (SR 47)/Hurffville Rd (SR 41)
- 2 Ronald Ln/Blackwood Barnsboro Rd (CR 603)
- 3 County House Rd (CR 621)
- 4 Long Bow Dr/Long Bow Cir
- 5 Saddlebrook Way/Mt. Pleasant Rd
- 6 Salina Rd
- 7 Hurffville-Grenloch Rd (CR 635)
- 8 Bently Dr/Trent Rd
- 9 Greentree Rd (CR 651)
- 10 Ganttown Rd (CR 639)
- 11 Medical Center Dr
- 17 Hurffville-Cross Keys Rd (CR 654)



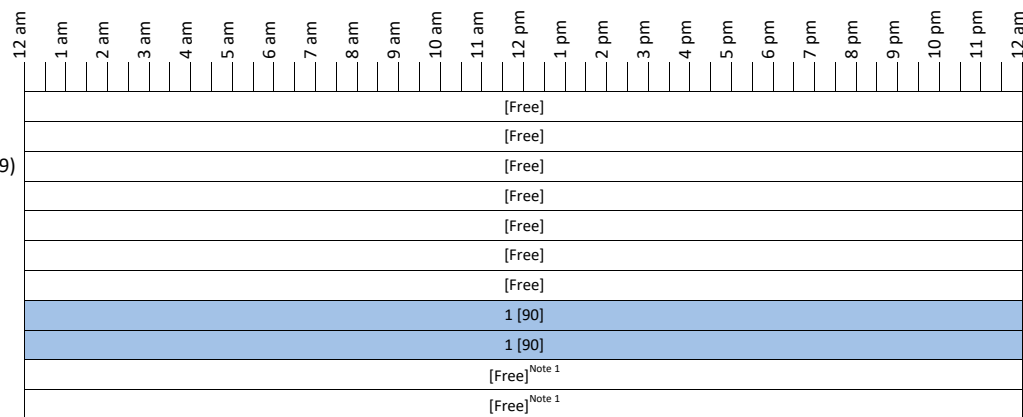
Notes:

EXISTING SCHEDULES

Hurffville-Cross Keys Rd (CR 654)

Weekday

- 12 Greentree Rd (CR 651)
- 13 Minuteman Dr/Brook Ln
- 14 Ganttown Rd/Chapel Heights Dr (CR 639)
- 15 Altair Dr
- 16 Regulus Dr
- 17 Egg Harbor Rd (CR 630)
- 18 Fish Pond Rd (CR 634)
- 19 Fries Mill Rd (CR 655)
- 20 Town Center Blvd
- 21 Sun Haven Dr
- 22 Cross Keys Bypass (CR 689)



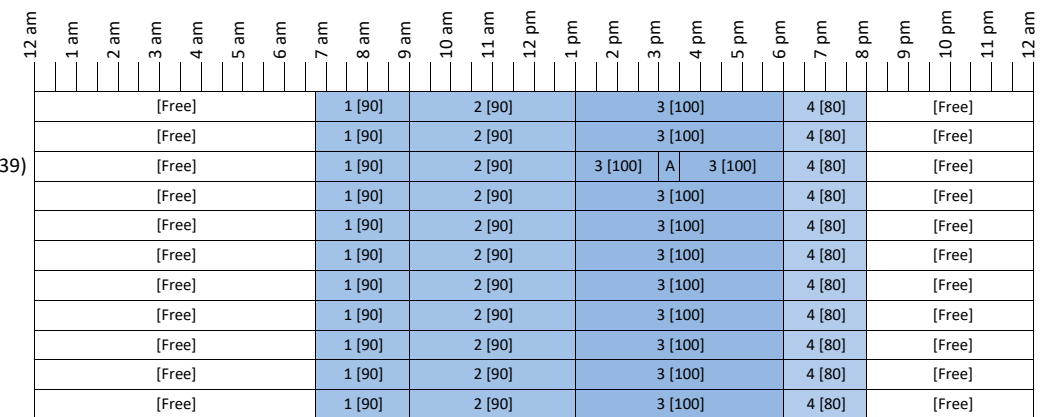
Notes: 1 - Controller programmed to run coordination but controller clock not set, so running free under existing conditions, 2 - Programmed to run in coordination but manual pattern 0 [FREE] being called

IMPLEMENTED SCHEDULES

Hurffville-Cross Keys Rd (CR 654)

Weekday

- 12 Greentree Rd (CR 651)
- 13 Minuteman Dr/Brook Ln
- 14 Ganttown Rd/Chapel Heights Dr (CR 639)
- 15 Altair Dr
- 16 Regulus Dr
- 17 Egg Harbor Rd (CR 630)
- 18 Fish Pond Rd (CR 634)
- 19 Fries Mill Rd (CR 655)
- 20 Town Center Blvd
- 21 Sun Haven Dr
- 22 Cross Keys Bypass (CR 689)



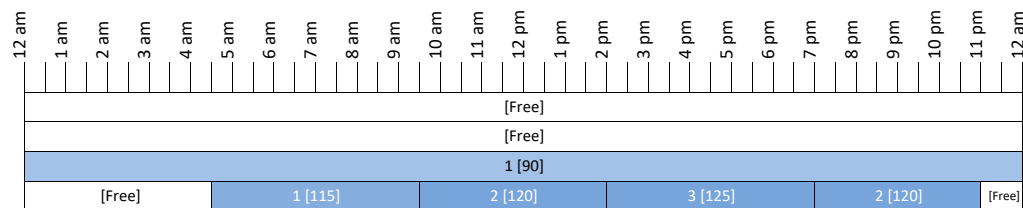
Notes: A - 13[100] operates from 3:00 PM - 3:30 PM to give additional time to the southbound movements (phases 4+7) to better service the traffic exiting Washington Township High School.

EXISTING SCHEDULES

Cross Keys Bypass (CR 689)

Weekday

- 22 Hurffville-Cross Keys Rd (CR 654)
- 23 Tuckahoe Rd (CR 555)
- 24 Home Depot Dwy/Berlin Cross Keys Rd
- 25 Black Horse Pike (SR 42)



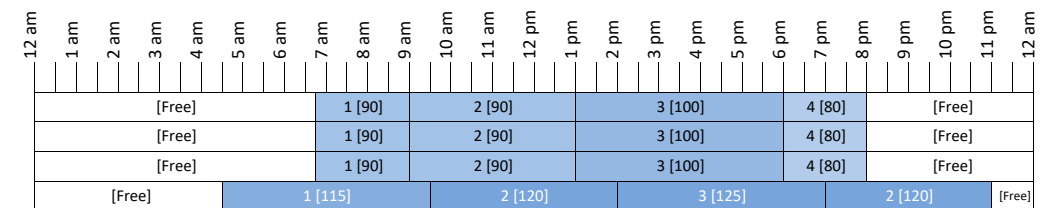
Notes:

IMPLEMENTED SCHEDULES

Cross Keys Bypass (CR 689)

Weekday

- 22 Hurffville-Cross Keys Rd (CR 654)
- 23 Tuckahoe Rd (CR 555)
- 24 Home Depot Dwy/Berlin Cross Keys Rd
- 25 Black Horse Pike (SR 42)



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
Weekday Day Plan Schedules
Egg Harbor Rd (CR 630), Hurffville Cross Keys Rd (CR 654) & Cross Keys Bypass (CR 689)

4.5 Pattern Optimization

The list below summarizes each unique pattern that was developed for this system. 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. There were two primary sections in developing the timing plans and the peaks varied slightly, so the peak hours modeled for each time period are summarized below.

Time-of-Day	Abbreviation	Pattern No.	Network Peak Hour
Weekday AM Peak	AM	1	7:30 am – 8:30 am
Weekday Midday Peak	MD	2	12:00 pm – 1:00 pm
Weekday PM Peak	PM	3	3:45 pm – 4:45 pm
Weekday PM Off-peak	PO	4	6:15 pm – 7:15 pm
Weekend AM Peak	WA	5	9:30 am – 10:30 am
Weekend Midday Peak	WM	6	11:45 am – 12:45 pm
Weekend PM Peak	WP	5	5:30 pm – 6:30 pm

Notes: Weekend AM Peak and Weekend PM peak were analyzed separately but it was decided to run the same pattern based on traffic volumes and characteristics. So those two periods are modeled separately but run the same timing plan.

Cycle lengths were developed in an effort to balance optimal progression along the main corridors and limiting the delay experienced by pedestrians and side street traffic. Even though most signals were operating in free operation under existing conditions, cycle lengths were selected in an effort to make the adjustment to coordinated timings as unnoticeable as possible to typical drivers on the network. There are some locations where this isn't feasible given some shorter cycles in free operation. In those cases, some advanced programming was utilized to attempt to better accommodate side street traffic. These locations specifically include Egg Harbor Road (CR 630) & Long Bow Drive/Long Bow Circle and Hurffville-Cross Keys Road (CR 654) & Minuteman Drive/Brook Lane. These locations run longer cycles than they had previously under previous operation prior to this project but do allow for better coordination for primary main street volumes through each of these signals. In both cases, significant benefits are realized by keeping these signals in coordination and running the network cycle lengths.

The two signals owned by NJDOT were both modeled and analyzed for this project. Timing directives and signal plans were acquired from NJDOT and turning movement counts were collected at both locations. The intersection of Egg Harbor Road (CR 630) & Delsea Drive (SR 47)/Hurffville Road (SR 41) runs in free operation at all times and requires cycle lengths significantly higher than what is appropriate along the Gloucester County signals on Egg Harbor Road (CR 630). The traffic volumes are over capacity for several movements during peak periods at this location and the existing timings handle the fluctuation in volumes well. The consultant team will provide a summary of observations and potential improvements to NJDOT for potential consideration.

The signal of Cross Keys Bypass (CR 689) & Black Horse Pike (SR 42) does run coordinated signal timings, with cycles ranging from 115 to 125 seconds and prioritizes the movements along Black Horse Pike (SR 42) instead of Cross Keys Bypass (CR 689). In communication with NJDOT, it was determined that this signal is included in an active capital program that will make Black Horse Pike (SR 42) an adaptive controlled system. Leading to that project, this signal was a part of a recent retiming project of that corridor which was completed in 2022. Considering the recent retiming and future adaptive plans, this signal was not changed during this project. However, the consultant team will provide a summary of the observations to NJDOT relating to potential improvements, primarily in potentially placing more of a priority to the Cross Keys Bypass (CR 689) movements. So without the inclusion of the NJDOT maintained signals, the focus of this project was primarily on the Gloucester County owned and maintained signals.

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 16 through Figure 19 on pages 36 – 39.

There was one location where a sequence adjustment was done during this project. The side street phasing order at the intersection of Hurffville-Cross Keys Road (CR 654) was swapped from northbound first then southbound to southbound first then northbound follows. This was done to allow the northbound movement to utilize any unused time from the low volume southbound movement. The northbound volume fluctuates throughout a typical day, largely due to the Wawa on the southwest corner, so this change allows any unused southbound time to be available for use by the northbound movement so it will be better serviced, and delay would be reduced.

4.7 Pre-Implementation Memorandum

Once all timings were developed, the proposed timings were summarized in a series of figures and presented to Gloucester County for review and approval. Timing directives were created reflecting the proposed timings and simple 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 within the project website. An implementation plan was also proposed to Gloucester County and the consultant team scheduled the 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 appropriate. For this system, the Econolite Aries Zone Manager software was utilized since there was a mix of Econolite ASC 2, ASC 3 and Cobalt controllers. Once each database was tested successfully, each database was downloaded to the local controllers on Tuesday, April 4, 2023, and Wednesday, April 5, 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.

At three locations, controllers were changed out since the Field Notes were completed for this project in November of 2022. So at these locations, programming of the controllers was done on site and tested locally during the implementation step. These locations were as follows:

- Egg Harbor Rd (CR 630) & Medical Center Dr – Changed from Econolite ASC/2 to Econolite Cobalt controller.
- Hurffville-Cross Keys Rd (CR 654) & Altair Dr – Changed from Econolite ASC/2 to Econolite Cobalt controller.
- Hurffville-Cross Keys Rd (CR 654) & Sun Haven Dr – Changed from Econolite ASC/2 to Econolite Cobalt controller.

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 those that only run on both Saturday and Sunday. 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.

Most of the changes made during fine-tuning in this project were minor but one of the major changes during fine-tuning was adjusting the transition time from midday (Pattern 2) to PM Peak (Pattern 3) from 2:00 PM to 1:00 PM based on observations made during fine-tuning. The consultant team noticed some phase failures occurring between 1:00 PM and 2:00 PM initially, so it was determined the longer cycle length of Pattern 3 would operate more efficiently starting at 1:00 PM. Also, the intersection of Hurffville-Cross Keys Road (CR 654) & Minuteman Drive/Brook Lane was adjusted heavily to provide considerable time exiting the Washington Township High School. Significant attention was also given to the Fish Pond Road (CR 634) to Fries Mill Road (CR 655) area along Hurffville Cross Keys Road (CR 654) as well and several adjustments were made to balance the time allocation appropriately between main street and side street movements.

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 20 through Figure 44 on pages 40 – 64.

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	23	20	17	19	19	17	19
delay increased ≤ 5 sec/veh	2	5	8	6	6	8	6
delay increased > 5 sec/veh	0	0	0	0	0	0	0

While delay largely decreased across all periods, there were several intersections where delay increased slightly. However, no intersections experienced a delay increase greater than 5 seconds/vehicle for any time period. The locations where delay increased slightly generally is caused by several factors, including increased clearance intervals, and converting a signal from free operation to coordinated operation. Free operation may result in reduced delay at single intersection but when coordinated across a network, delay is decreased for the overall system.

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 calculated (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 2 – CR 630, CR 654 & CR 689 Synchro Network Performance Measures

	AM Peak			Midday Peak			PM Peak			PM Off-peak		
	Existing	Implemented	Difference	Existing	Implemented	Difference	Existing	Implemented	Difference	Existing	Implemented	Difference
Total Delay (hr)	362	305	-15.7%	303	277	-8.6%	547	509	-6.9%	254	233	-8.3%
Total Stops	31,169	27,578	-11.5%	30,293	26,528	-12.4%	40,246	36,705	-8.8%	26,296	24,316	-7.5%
Total Travel Time (hr)	732	675	-7.8%	676	649	-4.0%	1,020	981	-3.8%	585	564	-3.6%
Fuel Consumed (gal)	1,212	1,126	-7.1%	1,161	1,097	-5.5%	1,612	1,541	-4.4%	1,013	974	-3.8%
	Weekend AM Peak			Weekend Midday Peak			Weekend PM Peak					
	Existing	Implemented	Difference	Existing	Implemented	Difference	Existing	Implemented	Difference			
Total Delay (hr)	256	240	-6.3%	373	352	-5.6%	224	211	-5.8%			
Total Stops	25,999	24,702	-5.0%	33,641	29,866	-11.2%	24,163	22,412	-7.2%			
Total Travel Time (hr)	585	569	-2.7%	783	762	-2.7%	532	519	-2.4%			
Fuel Consumed (gal)	1,011	984	-2.7%	1,314	1,253	-4.6%	934	904	-3.2%			

Table 3 – CR 630, CR 654 & CR 689 SimTraffic Network Performance Measures

	AM Peak			Midday Peak			PM Peak			PM Off-peak		
	Existing	Implemented	Difference	Existing	Implemented	Difference	Existing	Implemented	Difference	Existing	Implemented	Difference
Total Delay (hr)	613	494	-19.4%	364	319	-12.4%	833	759	-8.9%	266	254	-4.4%
Total Stops	29,564	26,350	-10.9%	28,831	24,884	-13.7%	42,808	39,268	-8.3%	23,540	21,965	-6.7%
Total Travel Time (hr)	1,287	1,101	-14.4%	939	852	-9.2%	1,731	1,549	-10.5%	746	733	-1.7%
Fuel Consumed (gal)	860	822	-4.4%	816	790	-3.1%	1,135	1,097	-3.3%	713	701	-1.7%
	Weekend AM Peak			Weekend Midday Peak			Weekend PM Peak					
	Existing	Implemented	Difference	Existing	Implemented	Difference	Existing	Implemented	Difference			
Total Delay (hr)	280	262	-6.3%	580	523	-9.9%	246	232	-5.7%			
Total Stops	24,063	21,630	-10.1%	34,569	30,982	-10.4%	21,707	19,872	-8.5%			
Total Travel Time (hr)	760	737	-3.0%	1,221	1,142	-6.5%	701	684	-2.4%			
Fuel Consumed (gal)	712	700	-1.7%	942	917	-2.7%	677	662	-2.3%			

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 194,100 hours (9.0%), stops by 18,791,800 (9.7%), and fuel consumption by 371,680 gallons (4.9%). Based on the fuel savings above, the implemented signal timing is estimated to reduce carbon dioxide emissions by 3,300 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 Egg Harbor Road (CR 630) as well as Hurffville–Cross Keys Road (CR 654) 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 13 and Figure 14 on pages 28 – 29 illustrate the average cumulative travel time on the corridors for each direction with existing and implemented signal timings. The tables at the top of these figures summarize the average travel times and delays with existing and implemented signal timings and the percent change in those measurements.

Within the Egg Harbor Road (CR 630) section, travel time runs were completed between Ronald Lane/Blackwood Barnsboro Road (CR 603) and Hurffville–Cross Keys Road (CR 654). In the northbound direction, weekday travel times decreased by up to 118 seconds (23.7%) and weekend travel times decreased by up to 80 seconds (16.5%). In the southbound direction, weekday travel times decreased by up to 111 seconds (23.0%) and weekend travel times decreased by up to 93 seconds (18.5%).

For the Hurffville–Cross Keys Road (CR 654) section, travel time runs were completed between Greentree Road (CR 651) and Cross Keys Bypass (CR 689). In the eastbound direction, weekday travel times decreased by up to 152 seconds (31.9%) and weekend travel times decreased by up to 71 seconds (15.8%). In the westbound direction, weekday travel times decreased up to 89 seconds (17.1%) and weekend travel times decreased up to 60 seconds (15.1%).

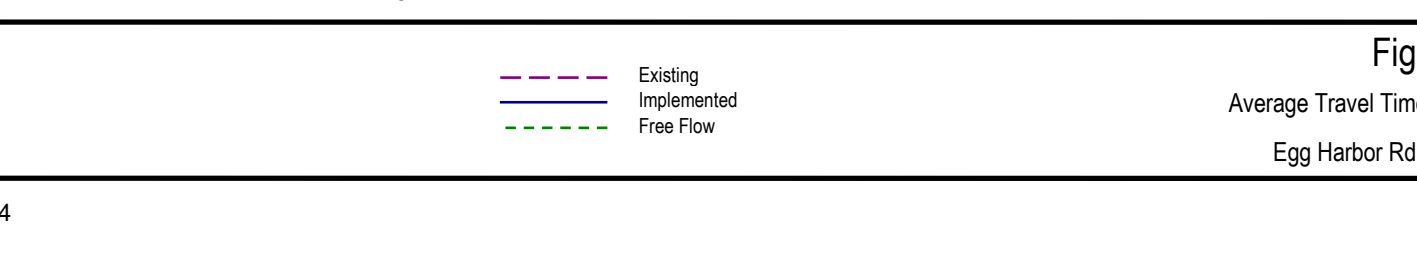
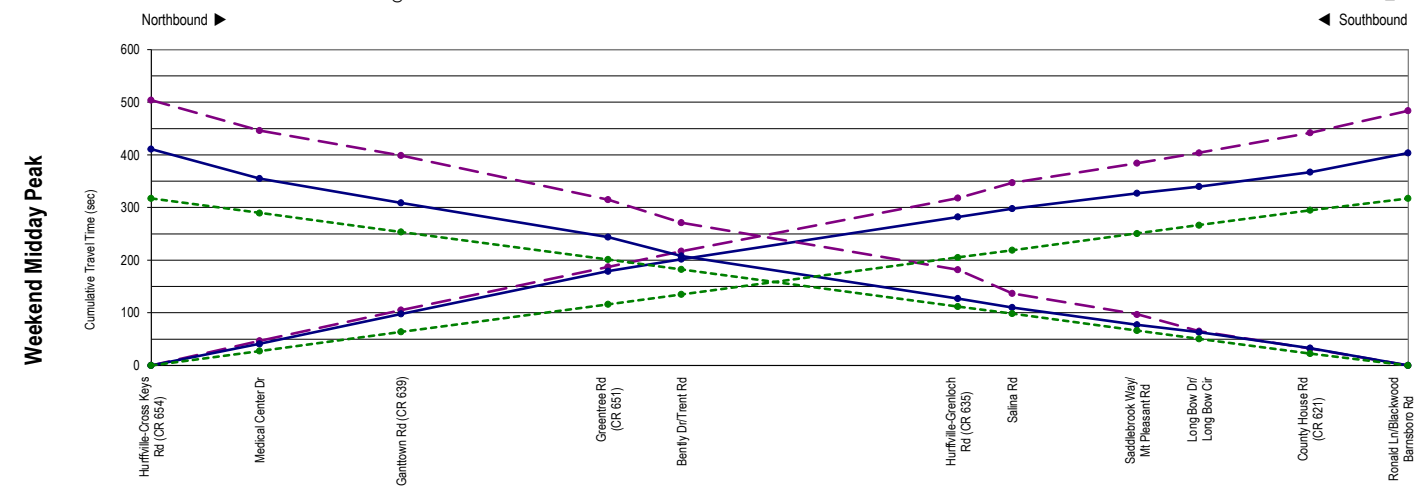
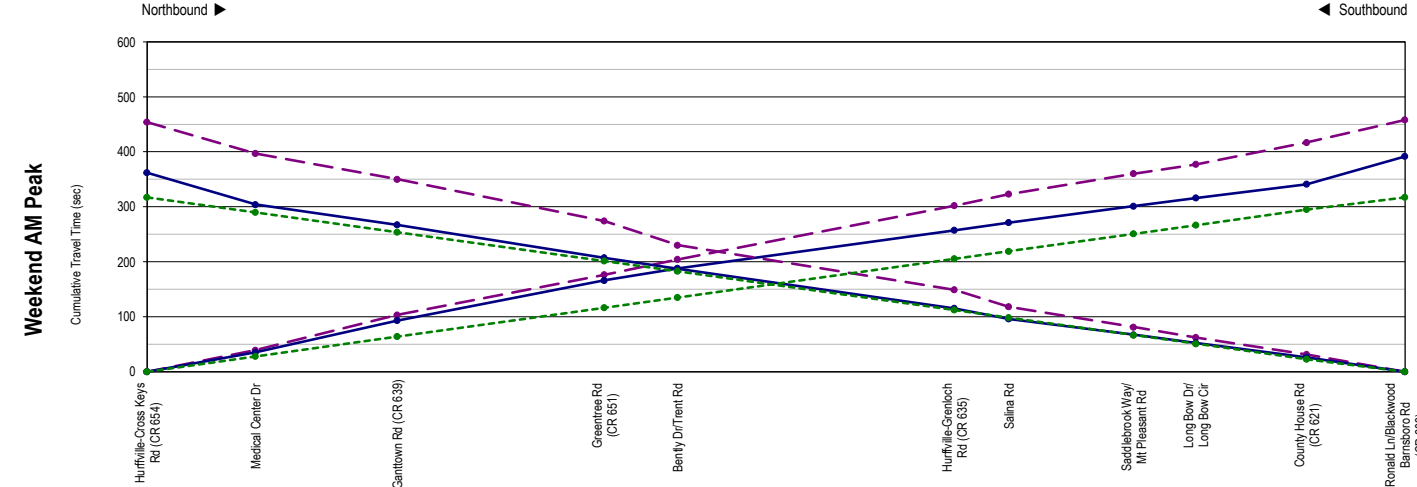
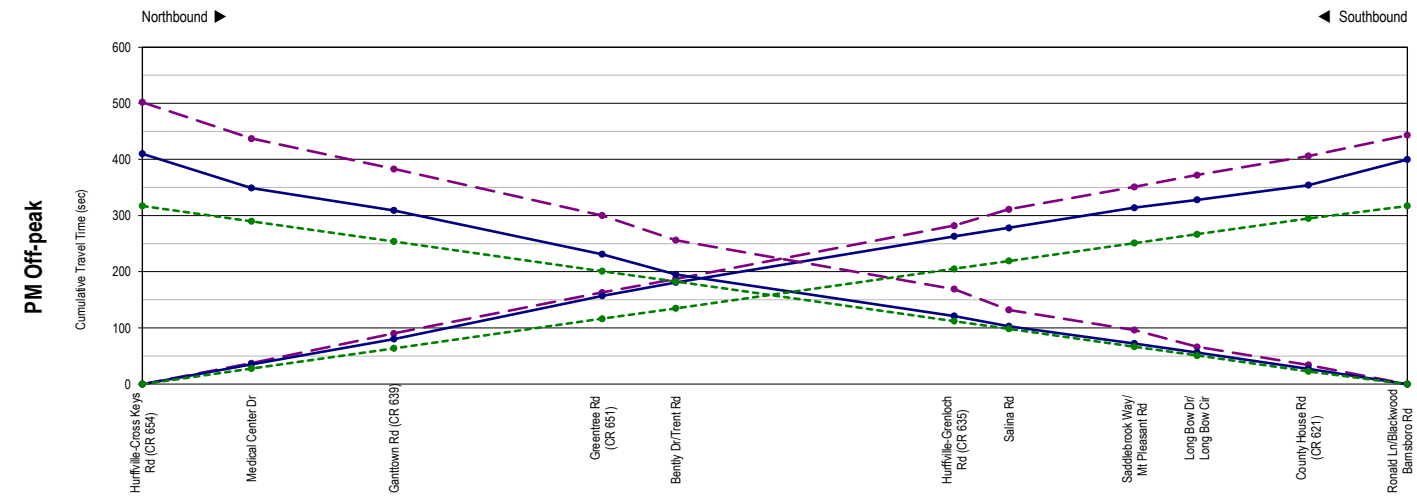
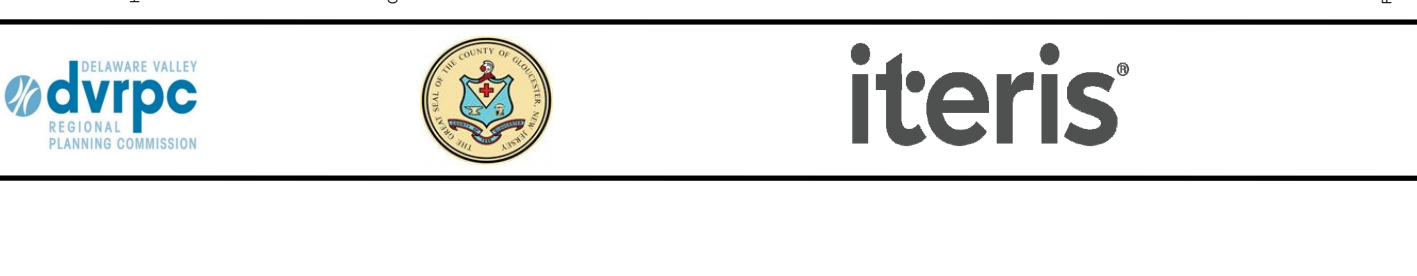
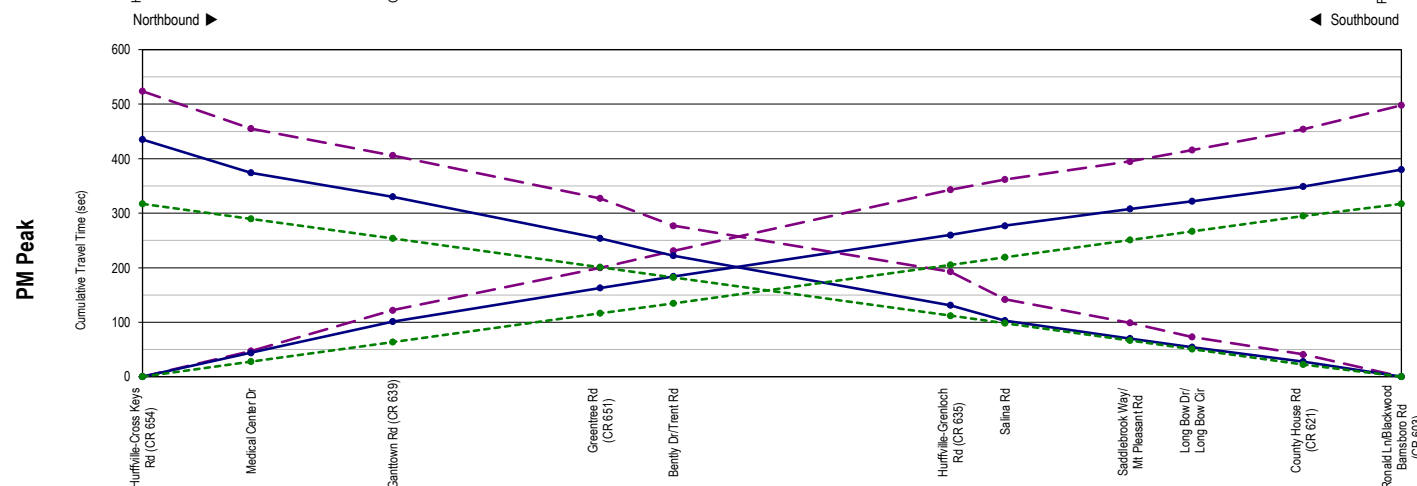
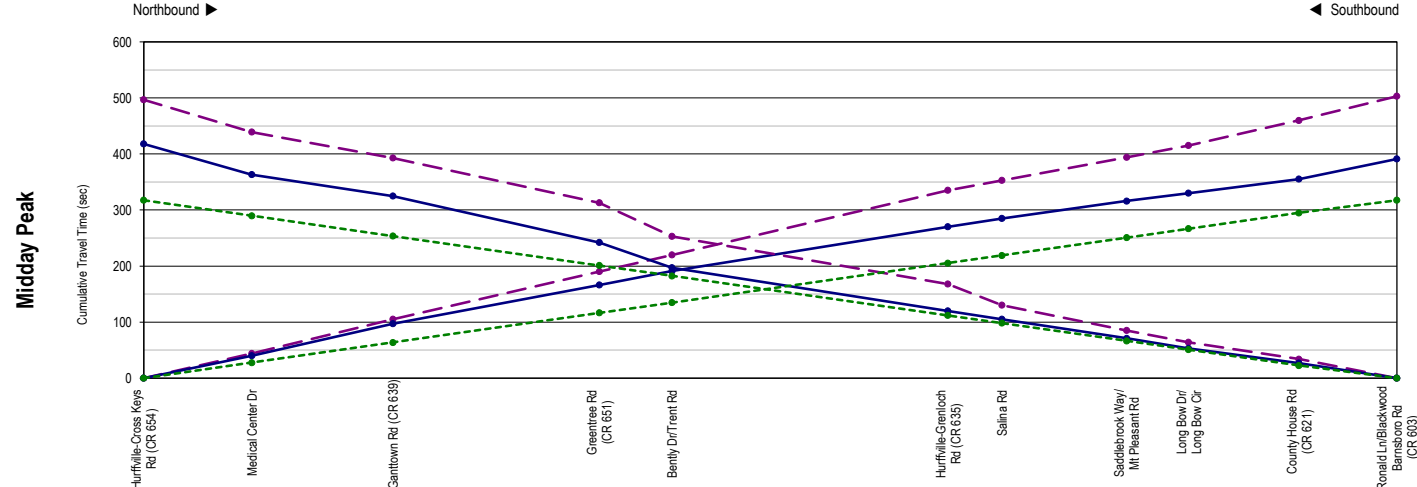
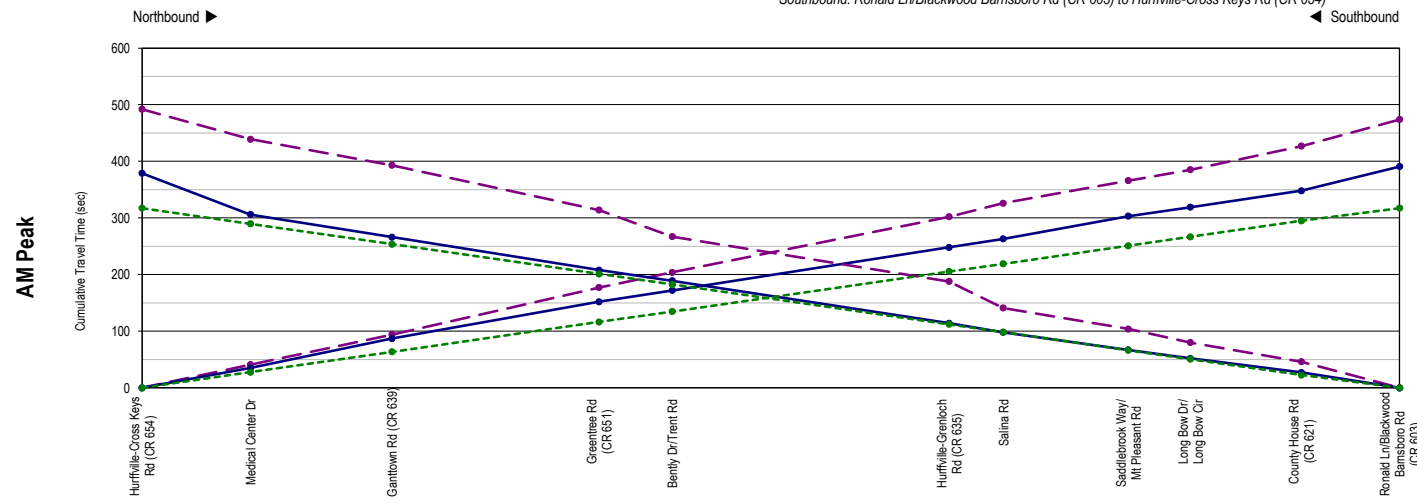
During the travel time runs under both existing and implemented conditions, dash cam video was collected. Those videos were then processed into several comparison videos detailing the improvements across both Egg Harbor Road (CR 630) and Hurffville–Cross Keys Road (CR 654). Those videos are available on the project website and were developed for both the AM and PM peak periods in the direction of the higher volumes for each time period.

Average Total Travel Time & Delay

Egg Harbor Rd (CR 630): 4 miles

	AM Peak		Midday Peak		PM Peak		PM Off-peak		Weekend AM Peak		Weekend Midday 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	474	157	503	186	498	180	443	126	458	141	484	167
Implemented	391	74	391	74	380	63	400	83	392	75	404	87
Difference		-83		-112		-118		-43		-66		-80
% Difference	-17.5%	-52.9%	-22.3%	-60.2%	-23.7%	-65.6%	-9.7%	-34.1%	-14.4%	-46.8%	-16.5%	-47.9%
Existing	492	172	497	177	502	182	502	182	454	134	504	184
Implemented	379	59	418	98	435	115	410	90	362	42	411	92
Difference		-113		-79		-89		-92		-92		-93
% Difference	-23.0%	-65.7%	-15.9%	-44.6%	-17.0%	-43.6%	-18.3%	-50.5%	-20.3%	-68.7%	-18.5%	-50.5%
Southbound												
Existing	474	157	503	186	498	180	443	126	458	141	484	167
Implemented	391	74	391	74	380	63	400	83	392	75	404	87
Difference		-83		-112		-118		-43		-66		-80
% Difference	-17.5%	-52.9%	-22.3%	-60.2%	-23.7%	-65.6%	-9.7%	-34.1%	-14.4%	-46.8%	-16.5%	-47.9%
Existing	492	172	497	177	502	182	502	182	454	134	504	184
Implemented	379	59	418	98	435	115	410	90	362	42	411	92
Difference		-113		-79		-89		-92		-92		-93
% Difference	-23.0%	-65.7%	-15.9%	-44.6%	-17.0%	-43.6%	-18.3%	-50.5%	-20.3%	-68.7%	-18.5%	-50.5%

Northbound: Hurffville-Cross Keys Rd (CR 654) to Ronald Ln/Blackwood Barnsboro Rd (CR 603)
 Southbound: Ronald Ln/Blackwood Barnsboro Rd (CR 603) to Hurffville-Cross Keys Rd (CR 654)



Existing
 Implemented
 Free Flow

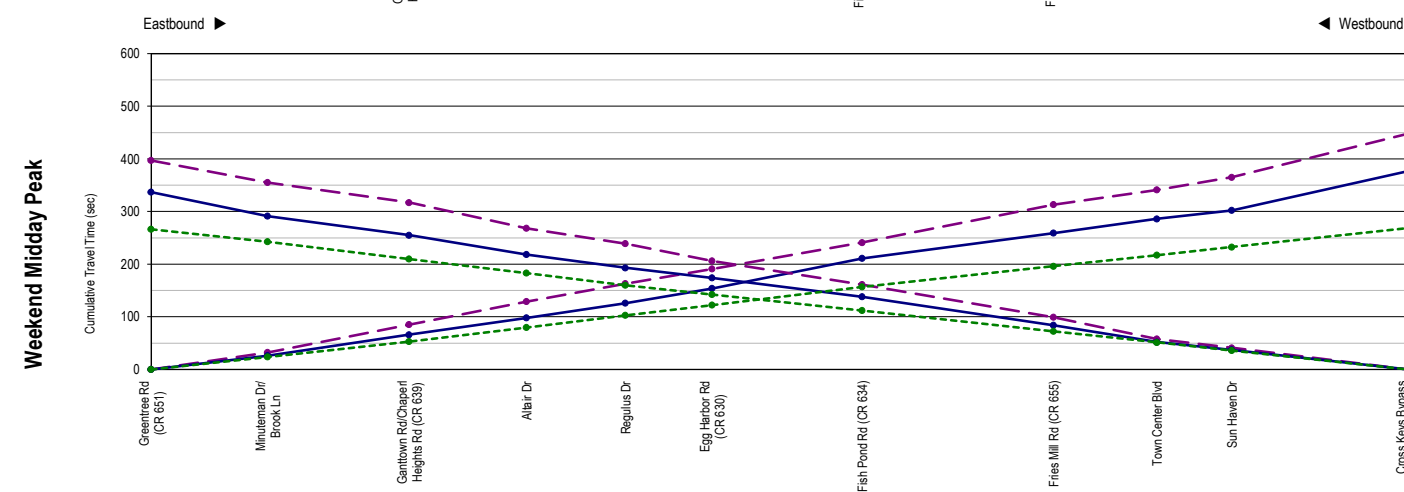
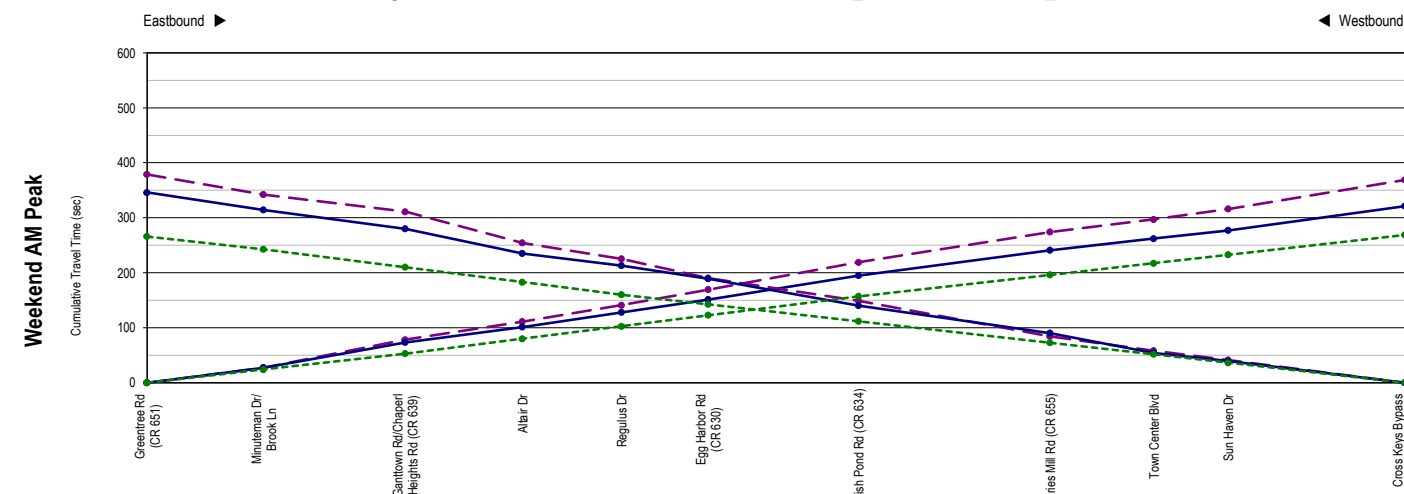
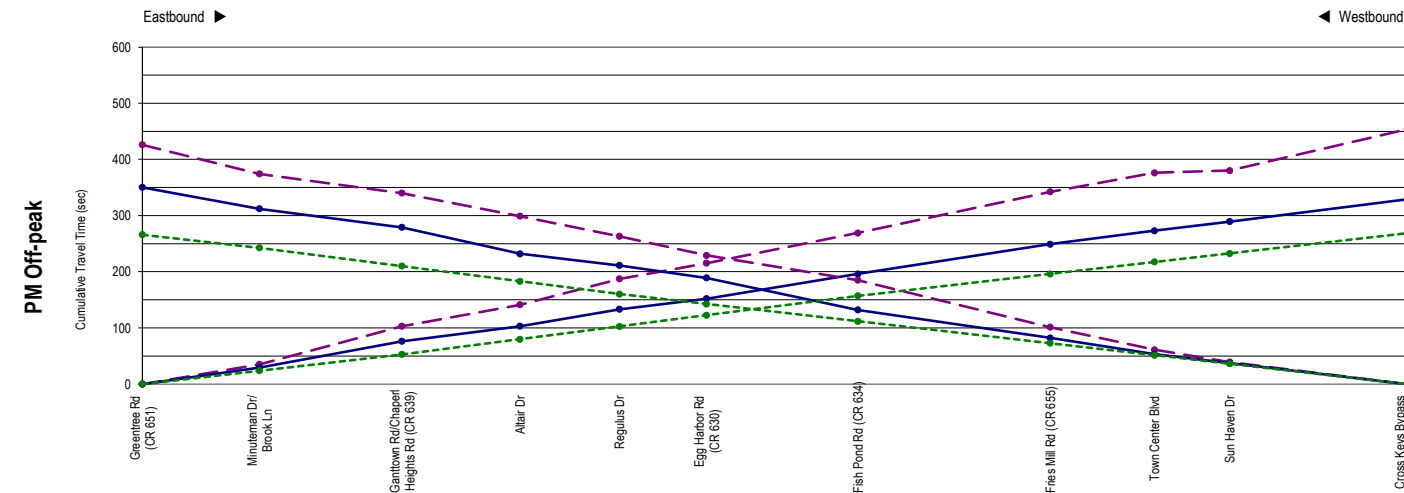
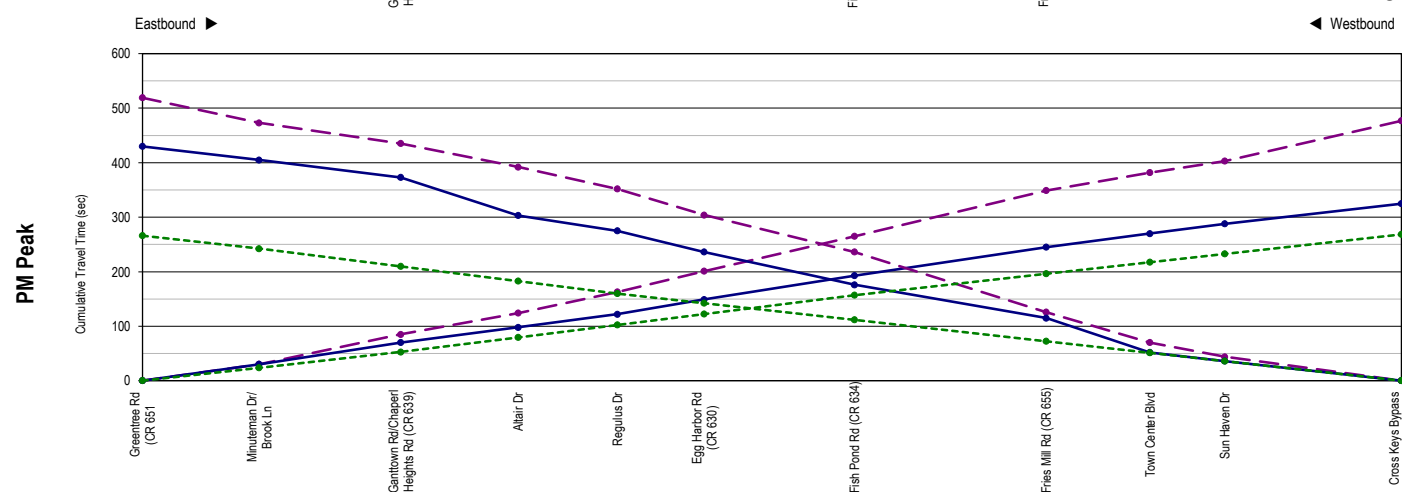
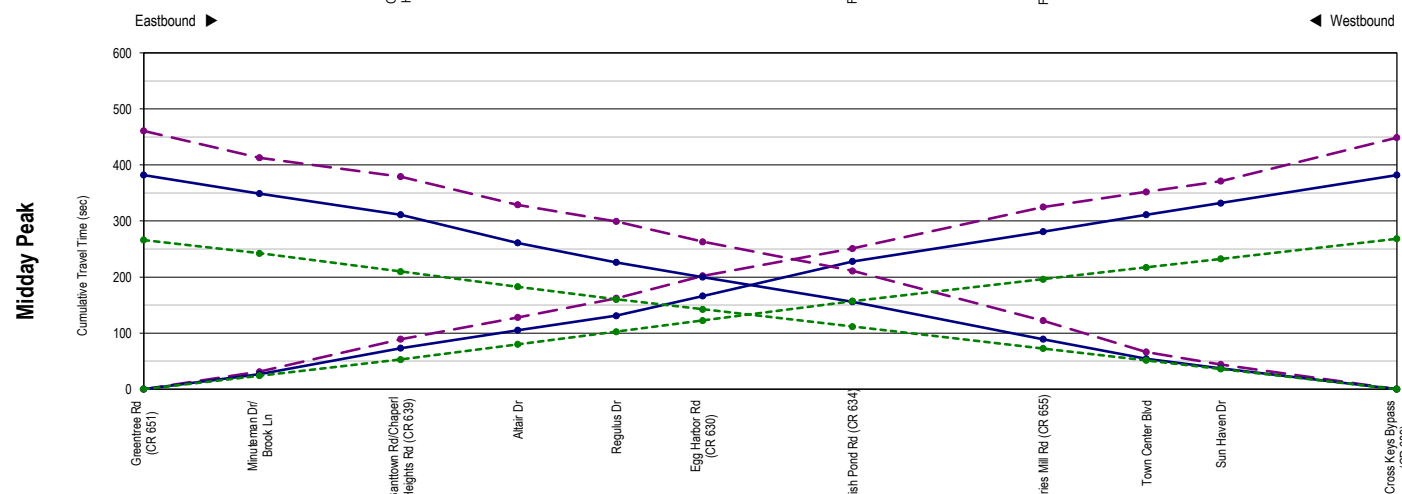
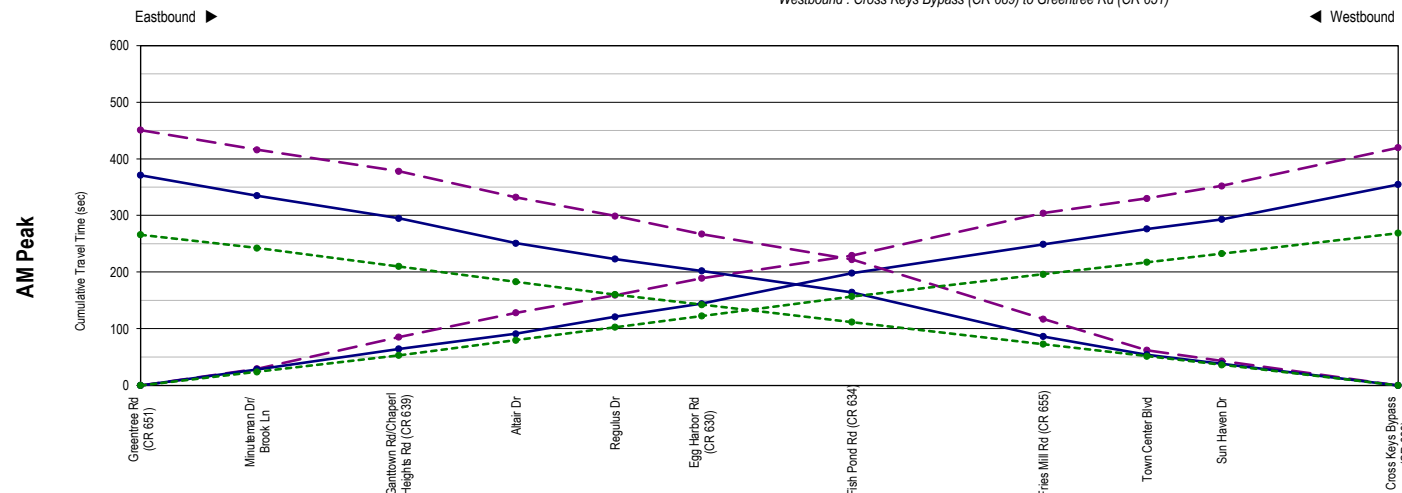
Figure 13
 Average Travel Time & Delay
 Egg Harbor Rd (CR 630)

Average Total Travel Time & Delay

	AM Peak		Midday Peak		PM Peak		PM Off-peak		Weekend AM Peak		Weekend Midday 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)
Eastbound												
Existing	420	151	449	181	477	208	454	186	369	101	448	179
Implemented	355	86	382	114	325	57	329	60	321	52	377	108
Difference	-65	-65	-67	-67	-152	-152	-125	-125	-48	-48	-71	-71
% Difference	-15.5%	-43.0%	-14.9%	-37.0%	-31.9%	-73.1%	-27.5%	-67.2%	-13.0%	-47.5%	-15.8%	-39.7%
Westbound												
Existing	451	186	461	196	519	254	426	161	379	114	397	133
Implemented	371	106	382	117	430	165	350	86	346	81	337	73
Difference	-80	-80	-79	-79	-89	-89	-76	-76	-33	-33	-60	-60
% Difference	-17.7%	-43.0%	-17.1%	-40.3%	-17.1%	-35.0%	-17.8%	-47.2%	-8.7%	-28.9%	-15.1%	-45.1%

Eastbound : Greentree Rd (CR 651) to Cross Keys Bypass (CR 689)
 Westbound : Cross Keys Bypass (CR 689) to Greentree Rd (CR 651)

Hurffville-Cross Keys Rd (CR 654): 3.2 miles



- - - Existing
- Implemented
- · - · Free Flow

Figure 14
 Average Travel Time & Delay
 Hurffville-Cross Keys Rd (CR 654)

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 4 below. The value of time is determined from the Consumer Price Index while the heavy vehicle percentage of three percent on this system was estimated based on the turning movement count data collected in this project, which includes volume counts by classification.

Table 4 – Weekly Benefit for Change in Travel Time Costs – CR 630, CR 654 & CR 689

Delay (h)	AM	MD	PM	PO	WA	WM	WP	
Existing Timings	362	303	547	254	256	373	224	
Implemented Timings	305	277	509	233	240	352	211	
Change	-57	-26	-38	-21	-16	-21	-13	
Estimated Change during other hours				-75			-29	
Total Daily Change				-217			-79	
Total Weekly Change in Delay				-1,085			-158	
						Auto	Truck	
				Vehicle Type		97%	3%	
				Value-of-Time (\$/hr) ¹²		\$11.09	\$ 114.70	
				Auto Occupancy ¹		1.25	1.00	
				Total		\$16,711	\$4,276	
Weekly Benefit for Change in Travel Time Costs							\$20,987	

¹ Taken from Urban Mobility Report, Texas Transportation Institute, 2012 and adjusted based on Consumer Price Index for May 2023

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 5 on page 31.

Table 5 – Weekly Benefit for Change in Operating Costs – CR 630, CR 654 & CR 689

Fuel Consumption (gal)	AM	MD	PM	PO	WA	WM	WP
Existing Timings	1,212	1,161	1,612	1,013	1,011	1,314	934
Implemented Timings	1,126	1,097	1,541	974	984	1,253	904
Change	-86	-64	-71	-39	-27	-61	-30
Estimated Change during other hours				-141			-70
Total Daily Change				-401			-188
Total Weekly Change				-2,005			-377
Fuel Cost ³							\$3.86
Weekly Benefit for Change in Operating Costs							\$9,192

³ 52-week average fuel cost, US Energy Information Administration Gasoline Prices for the Central Atlantic Region, May 2023 - www.eia.gov

Based on the previous tables, the total weekly benefit is \$30,178.

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 6 summarizes the present values of annual benefits.

Table 6 – Present Value of Annual Benefits

Year	Annual Benefit Present Value
Year 1	\$1,545,533
Year 2	\$1,200,414
Year 3	\$874,088
Year 4	\$565,753
Year 5	\$274,637

The present value of total lifetime benefits based on the table above is approximately \$4,460,400.

Costs

The total cost to conduct all the tasks for the intersections within the scope of this project was \$140,185.

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 32:1.

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 thorough list of pedestrian detection issues relating to both pedestrian pushbuttons as well as pedestrian displays is included on the project website and was last updated following the timing implementation in April 2023. Consider utilizing that list of observations to update and address detection and display issues to improve pedestrian safety and consistency.
- Over the course of this project, three controllers were replaced from older Econolite ASC/2s to newer Econolite Cobalt controllers. When this occurs with other intersections in this network in the future, ensure the timings developed in this project are utilized in the new controllers programming.

Hurffville-Cross Keys Road (CR 654) & Fries Mill Road (CR 655)

- The northbound channelized right turn movement is currently not signalized or signed as a yield or stop controlled movement. Consider reviewing this situation and installing a yield sign to avoid potential conflicts since this is a channelized turn.

Hurffville-Cross Keys Road (CR 654) & Cross Keys Bypass (CR 689)

- There is a lane assignment sign directly in front of the southbound right turn overlap's 5-section signal head, making it difficult for vehicles to properly observe that signal. Consider moving the sign back to a point where it will not be blocking the signal head for southbound right turning vehicles.

Hurffville-Cross Keys Road (CR 654) & Altair Drive

- As mentioned within this report, the side street sequence was adjusted from northbound then southbound to the reverse. There is an existing 'DELAYED GREEN' sign in the field for the southbound movement, which is no longer applicable. Considering the northbound and southbound movements are sequential and not concurrent at any point in the cycle, this sign is not necessary.

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 cabinets to keep all controller clocks on consistent time source. Since there are no GPS units installed and there is no central communication system, the controller clocks on this project will drift over time along the network, gradually reducing the effectiveness of the signal timing and the positive results summarized throughout this report. The installation of GPS units will keep all controllers on the same time and will maintain the programming as completed through this project and as shown on the updated timing directives.

Another option is to develop a plan to regularly reset controller clocks manually to maintain consistent clocks. With the exception of the controller at Egg Harbor Road (CR 630) & Ganttown Road (CR 639), which drifts much quicker, the majority of the clocks were observed to drift together and relatively slowly, so setting the clocks every six to eight weeks should maintain the time enough to continue to realize benefits

from this signal retiming. If this is not feasible, consider at least adding a step to the regular preventative maintenance program already being completed for these signals to manually set the controller time.

- Consider reviewing and addressing detection concerns across the network. Autoscope video detection is present for most movements throughout the network, with only a few exceptions, but there were some critical movements which had failing detection which could improve operations significantly. If prioritizing addressing detection, the priority for addressing issues should be as follows:
 - Hurffville-Cross Keys Road (CR 654) & Ganttown Road/Chapel Heights Rd (CR 639)
 - All detection failing, resulting in constant calls for all movements.
 - Hurffville-Cross Keys Road (CR 654) & Cross Keys Bypass (CR 689)
 - All detection failing, resulting in constant calls for all movements.
 - Egg Harbor Road (CR 630) & Blackwood-Barnsboro Road (CR 603)
 - Both westbound and southbound left turn detection failing, resulting in constant calls.
 - Cross Keys Bypass (CR 689) & Tuckahoe Road (CR 555)
 - Northbound and southbound left turn detection failing, resulting in constant call.
 - Egg Harbor Road (CR 630) & Salina Road
 - Northbound and northbound left turn detection intermittently would not receive calls and at other times would show constant calls so review detection zone for camera.

Hurffville-Cross Keys Road (CR 654) & Fish Pond Road (CR 634)

- Consider studying the feasibility of extending a second westbound through lane between Egg Harbor Road (CR 630) and Fries Mill Road (CR 655). This would clearly be a larger scale project but from initial review, appears some of the added lane section could be achieved by reassigning the two-way-left-turn lane to a westbound through lane. Figure 37 on page 57 shows the measures of effectiveness with that layout and can be compared to the existing configuration. The results show significant improvements within that entire section of Hurffville-Cross Keys Road (CR 654), so would be a dramatic improvement if it could be achieved.
- Also, consider installing a 5-section head for the northbound right turn movement and programming an overlap linking a protected northbound right turn arrow with the westbound left turn phase. This is a high-volume movement at certain times of day and there is a 'No Turn On Red' sign posted. Considering the significant delay experienced by the westbound movement, time allotted to that movement is minimal and the northbound movement will fail occasionally for that reason. The addition of this overlap would allow for the northbound right turn to remain green when the northbound movement terminates and continues to service while the westbound left turn is serving, adding additional capacity to the northbound right turn.

Egg Harbor Road (CR 630) & Ronald Ln/Blackwood Barnsboro Road (CR 603)

- Consider installing a 5-section head for the westbound right turn movement and programming an overlap linking a protected westbound right turn arrow with the southbound left turn. This is a high-volume movement at certain times of day and that volume will increase once the new Wawa is fully open and operational. The addition of an overlap for this movement would reduce delay and add additional capacity to that movement.

Egg Harbor Road (CR 630) & Ganttown Road (CR 639)

- Consider installing a 5-section signal head for the westbound right turn and programming an overlap linking a protected westbound right turn arrow with the southbound left turn. This is a high-volume movement at peak times and installing this overlap would reduce delay and add additional capacity to that movement.

Hurffville-Cross Keys Road (CR 654) & Town Center Boulevard

- Consider installing a 5-section head for the southbound right turn movement and programming an overlap linking a protected southbound right turn arrow with the eastbound left turn. This is a high-volume movement at certain times of day and installing this overlap would reduce delay and add additional capacity to that movement. This overlap would allow for the southbound right turn to remain green when the southbound movement terminates and continue to service while the eastbound left turn is serving.

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 15)
- Phase Sequence Diagrams (Figures 16 – 19)
- Traffic Operations Analysis figures (Figures 20 – 44)

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-NJSigalTiming>

Individual Project page under Project Page section:

Egg Harbor Rd (CR 630), Hurffville-Cross Keys Rd (CR 654) & Cross Keys Bypass (CR 689) - Gloucester County

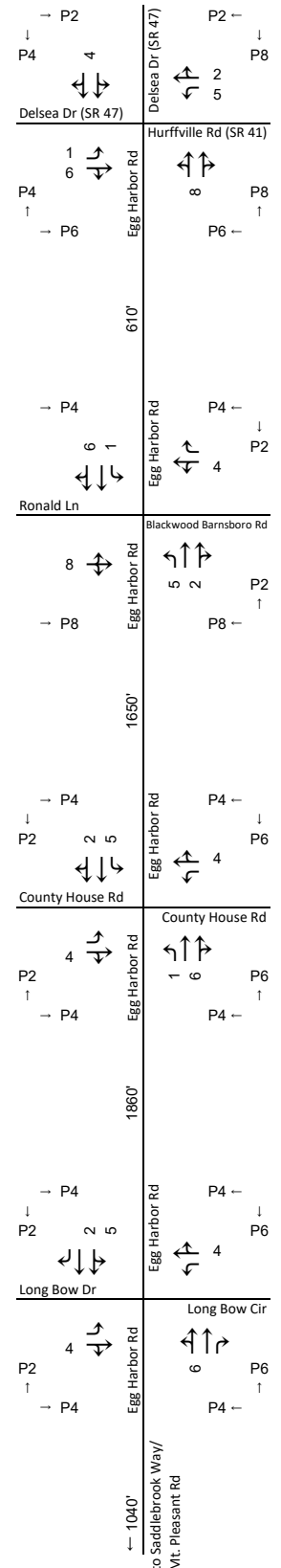
Please note that permissions must be manually added to access SharePoint website, so please direct any requests for access to Brian Jatzke at bjatzke@iteris.com.

ID	Intersection	Date of Last Observation	Controller Type	Notes and observations from Field Notes
				<i>Directionality Notes: Egg Harbor Rd (CR 630) assumed North-South, Hurffville-Cross Keys Rd assumed E-W and Cross Keys Bypass (CR 689) assumed North-South</i>
1	Egg Harbor Rd (CR 630) & Hurffville Rd (SR 41)/Delsea Dr (SR 47)	---	---	NIDOT maintained signal, no issues.
2	Egg Harbor Rd (CR 630) & Blackwood Barnsboro Rd (CR 603)	05/18/2023	Econolite Cobalt	Ø4 (westbound) has constant call on video detector, so services each cycle and uses full time each cycle regardless of demand. Pedestrian buttons on NE corner do not place call for NB ped, in recall so not impacting operations but recall could be removed during free operation if pedestrian button were fixed. Ø1 (SBLT) video detector has constant call as well, resulting in constant call and servicing each cycle regardless of demand.
3	Egg Harbor Rd (CR 630) & County House Rd (CR 621)	05/18/2023	Econolite ASC/25-2100	Pedestrian pushbutton for Ø4 (eastbound+westbound) on southwest corner does not place call. No pushbutton present for pedestrian Ø4 on northeast corner for either NB or WB movement. Pedestrian countdown not illuminating for pedestrian Ø6 (northbound) on northeast corner.
4	Egg Harbor Rd (CR 630) & Long Bow Dr/Long Bow Cir	05/18/2023	Econolite ASC/25-2100	Pedestrian countdowns not illuminating for pedestrian Ø4 (eastbound+westbound) for heads on NE and NW corners and pedestrian phase 2 (southbound) on southeast corner. Hand out for pedestrian signal head on SE corner for NB ped.
5	Egg Harbor Rd (CR 630) & Saddlebrook Way/Mt. Pleasant Rd	05/18/2023	Econolite ASC/25-2100	Pedestrian pushbutton on southwest corner does not place call for Ø4 on southwest corner. Countdown for pedestrian Ø2 (southbound) on southwest corner not illuminating. Side street detection occasionally maxing out, caused by shadows being picked up in video detection. Cabinet infested with ants, could chew away at wires over time.
6	Egg Harbor Rd (CR 630) & Salina Rd	05/18/2023	Econolite ASC/25-2100	Ø1 (northbound left-turn) and Ø6 (northbound) getting no calls, so skipping the northbound left turn each cycle. Those two phases are on the same camera, so that camera needs to have zones reviewed.
7	Egg Harbor Rd (CR 630) & Hurffville Grenloch Rd (CR 635)	05/18/2023	Econolite ASC/3-2100	Pedestrian countdowns not illuminating for all pedestrian signal heads. Walk and hand displays are both fine but just no countdowns.
8	Egg Harbor Rd (CR 630) & Bently Dr/Trent Rd	05/18/2023	Econolite ASC/3-2100	Pedestrian countdown for Ø2 (northbound) display on northeast corner does not display.
9	Egg Harbor Rd (CR 630) & Greentree Rd (CR 651)	05/18/2023	Econolite ASC/25-2100	No issues, all detection working properly. No timing directive in cabinet, new directive developed using phases instead of signal head numbering.
10	Egg Harbor Rd (CR 630) & Ganttown Rd (CR 639)	05/18/2023	Econolite ASC/25-2100	Pedestrian countdown on southwest corner for Ø4 (westbound) does not illuminate. Hand portion of pedestrian display does not illuminate (dark) for pedestrian Ø6 (northbound) on southeast corner. Westbound left turn observed servicing without demand intermittently, but not consistently. Northbound pedestrian display mounted behind utility pool, cannot see from the crosswalk. Controller clock drifting very fast, unlike others. Time will only hold for several hours.
11	Egg Harbor Rd (CR 630) & Medical Center Dr	05/18/2023	Econolite Cobalt	Pedestrian countdown for pedestrian Ø4 (eastbound) on southwest corner and pedestrian Ø8 (westbound) on northwest corner do not illuminate. Countdown for NB ped on Southeast corner only works part of the time during countdown and then shuts off and only shows flashing hand.
12	Hurffville-Cross Keys Rd (CR 654) & Greentree Rd (CR 651)	05/18/2023	Econolite ASC/25-2100	Pedestrian countdowns not illuminating for either Ø2 (northbound) pedestrian head (northeast and southeast corners).
13	Hurffville-Cross Keys Rd (CR 654) & Minuteman Dr/Brook Ln	05/18/2023	Econolite ASC/25-2100	All pedestrian countdowns not illuminating <u>except</u> for the heads for pedestrian Ø2 (westbound) on northwest corner.
14	Hurffville-Cross Keys Rd (CR 654) & Ganttown Rd (CR 639)/Chapel Heights Rd (CR 639)	05/18/2023	Econolite ASC/25-2100	All vehicle detection have constant calls, so using all allotted time regardless of demand. Pedestrian countdowns not illuminating for Ø4 (southbound) on northwest corner, either pedestrian head for Ø6 (westbound) and pedestrian Ø8 (northbound) on northeast corner.
15	Hurffville-Cross Keys Rd (CR 654) & Altair Dr	05/18/2023	Econolite ASC/25-2100	Pedestrian Ø6 (eastbound) pushbutton on southwest corner and pedestrian Ø2 (westbound) pushbutton on northeast corner do not place calls in controller.
16	Hurffville-Cross Keys Rd (CR 654) & Regulus Dr	05/18/2023	Econolite ASC/25-2100	Pedestrian countdown for Ø4 (southbound) on southwest corner does not illuminate. Pedestrian pushbutton on northeast corner for pedestrian phase 4 (southbound) does not place call in controller.
17	Hurffville-Cross Keys Rd (CR 654) & Egg Harbor Rd (CR 630)	05/18/2023	Econolite ASC/25-2100	Pedestrian countdowns for both displays for pedestrian Ø4 (southbound) not illuminating.
18	Hurffville-Cross Keys Rd (CR 654) & Fish Pond Rd (CR 634)	05/18/2023	Econolite ASC/25-2100	Pedestrian countdown for pedestrian Ø4 (northbound) does not illuminate.
19	Hurffville-Cross Keys Rd (CR 654) & Fries Mill Rd (CR 655)	05/18/2023	Econolite ASC/25-2100	Pedestrian countdown for pedestrian Ø2 (southbound) on northwest corner does not display. Due to intersection configuration, northbound right turn looks as though it should be yield controlled but there is no sign. It may have been knocked down and removed.
20	Hurffville-Cross Keys Rd (CR 654) & Town Center Blvd	05/18/2023	Econolite ASC/3-2100	No issues, all detection working properly.
21	Hurffville-Cross Keys Rd (CR 654) & Sun Haven Dr	05/18/2023	Econolite Cobalt	Green ball out for Ø6 (eastbound) on outside 3-section head. On signal display on side of road near-side near eastbound stop bar.
22	Hurffville-Cross Keys Rd (CR 654) & Cross Keys Bypass (CR 689)	05/18/2023	Econolite ASC/25-2100	All detection has constant calls, so servicing and utilizing all allotted time each cycle regardless of demand. Southbound right turn overlap 5-section head blocked by lane assignment sign, making it difficult for vehicles to pick up on the overlap, eliminating the potential for capacity being added.
23	Cross Keys By-Pass (CR 689) & Tuckahoe Road (CR 555)	05/18/2023	Econolite ASC/25-2100	Ø1 (northbound left-turn) and Ø5 (southbound left-turn) have constant calls in detectors, causing phases to use maximum time allotment each cycle.. Don't Walk and Flashing Don't Walk phases of pedestrian head for Ø6 (northbound) on northeast corner do not display, so signal head dark when active unless in Walk phase. Countdown for pedestrian Ø4 (westbound) on northwest corner does not illuminate. Inconsistency on pedestrian instruction signs.
24	Cross Keys By-Pass (CR 689) & Home Depot Driveway/Berlin Cross Keys Rd	05/18/2023	Econolite Cobalt	Yellow ball bulb out for Ø4 (eastbound) middle 3-section head out. Referring to the only signal on the far-side mast-arm and only the yellow is out as Green and Red are OK. Clear evidence of mice being in cabinet - paperwork chews on, especially in cabinet drawer.
25	Cross Keys By-Pass (CR 689) & Black Horse Pike (SR 42)	---	---	NIDOT maintained signal, no issues.



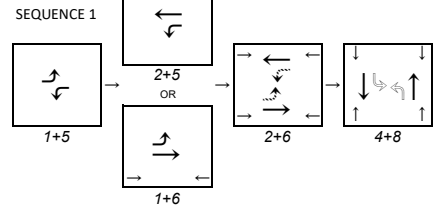
Figure 15
Field Notes Summary

Egg Harbor Rd (CR 630), Hurffville-Cross Keys Rd (CR 654) & Cross Keys Bypass (CR 689)



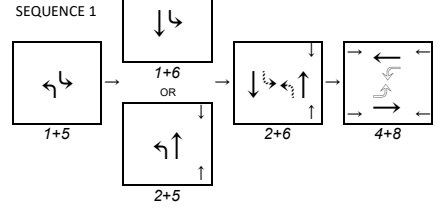
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Sequences

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



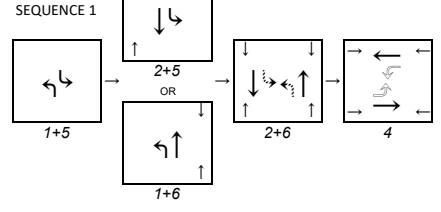
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Sequences

Per	Ex	Pro
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MD	1	1
PM	1	1
PO	1	1
WA	1	1
WM	1	1
WP	1	1



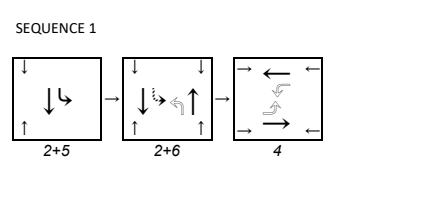
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Sequences

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



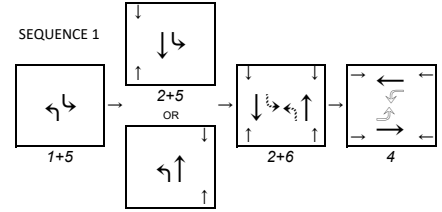
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Sequences

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



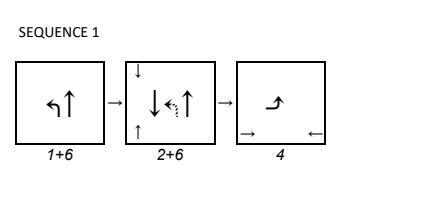
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Sequences

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



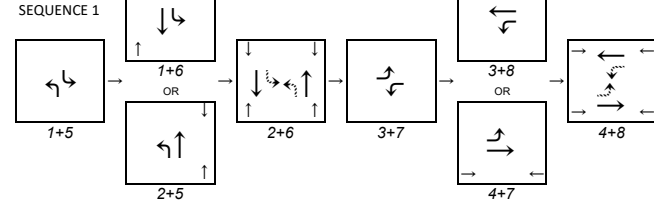
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Sequences

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



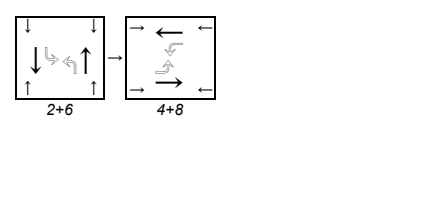
Signal ID: 7
Sequences

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



Signal ID: 8
Sequences

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



Phase Diagrams

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

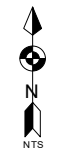
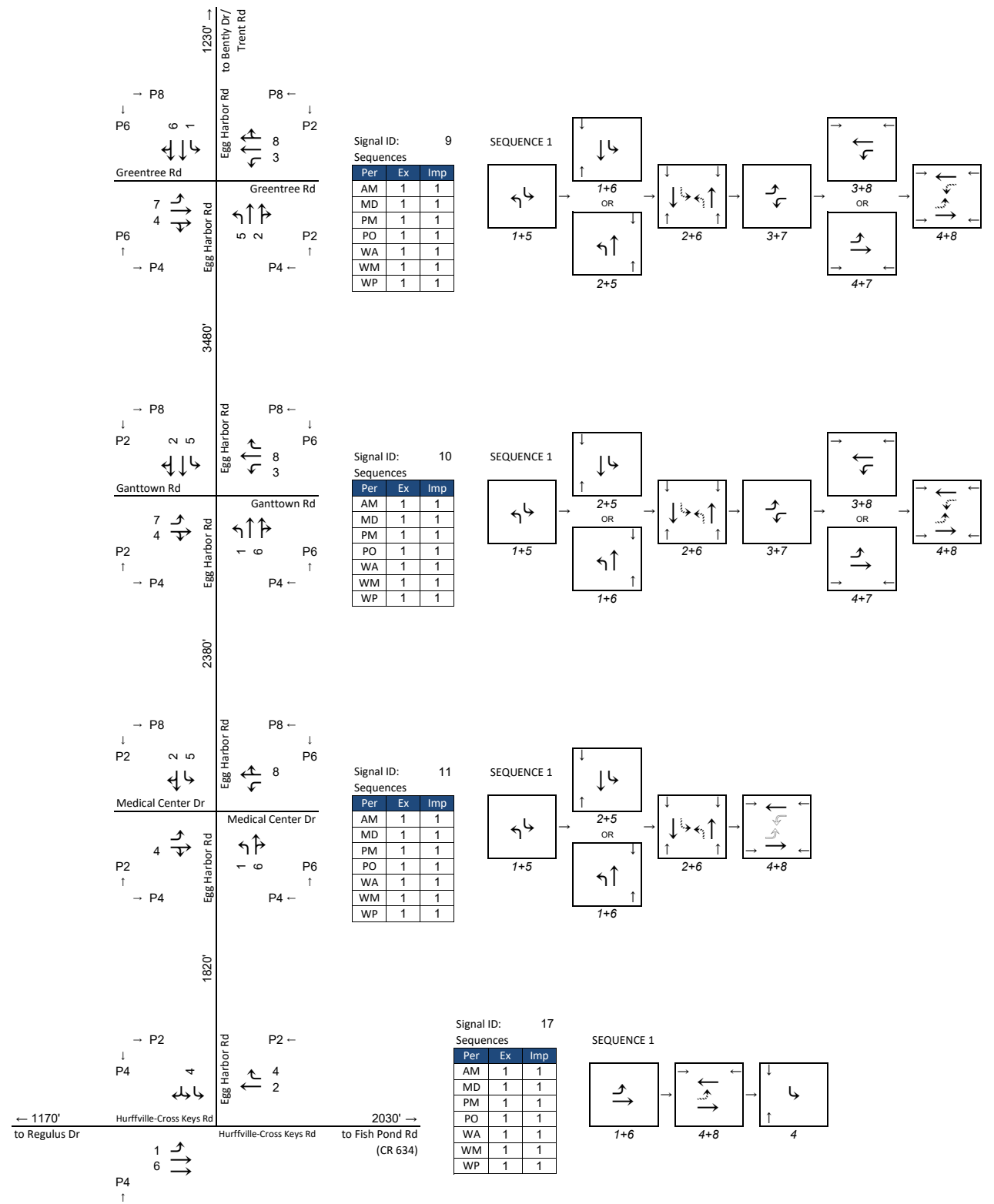


Figure 16
Phase Sequence Diagrams
Egg Harbor Rd (CR 630) from Delsea Dr (SR 47)/Hurffville Rd (SR 41) to Bently Dr/Trent Rd



Signal ID: 9

Sequences

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

Signal ID: 10

Sequences

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

Signal ID: 11

Sequences

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

Signal ID: 17

Sequences

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

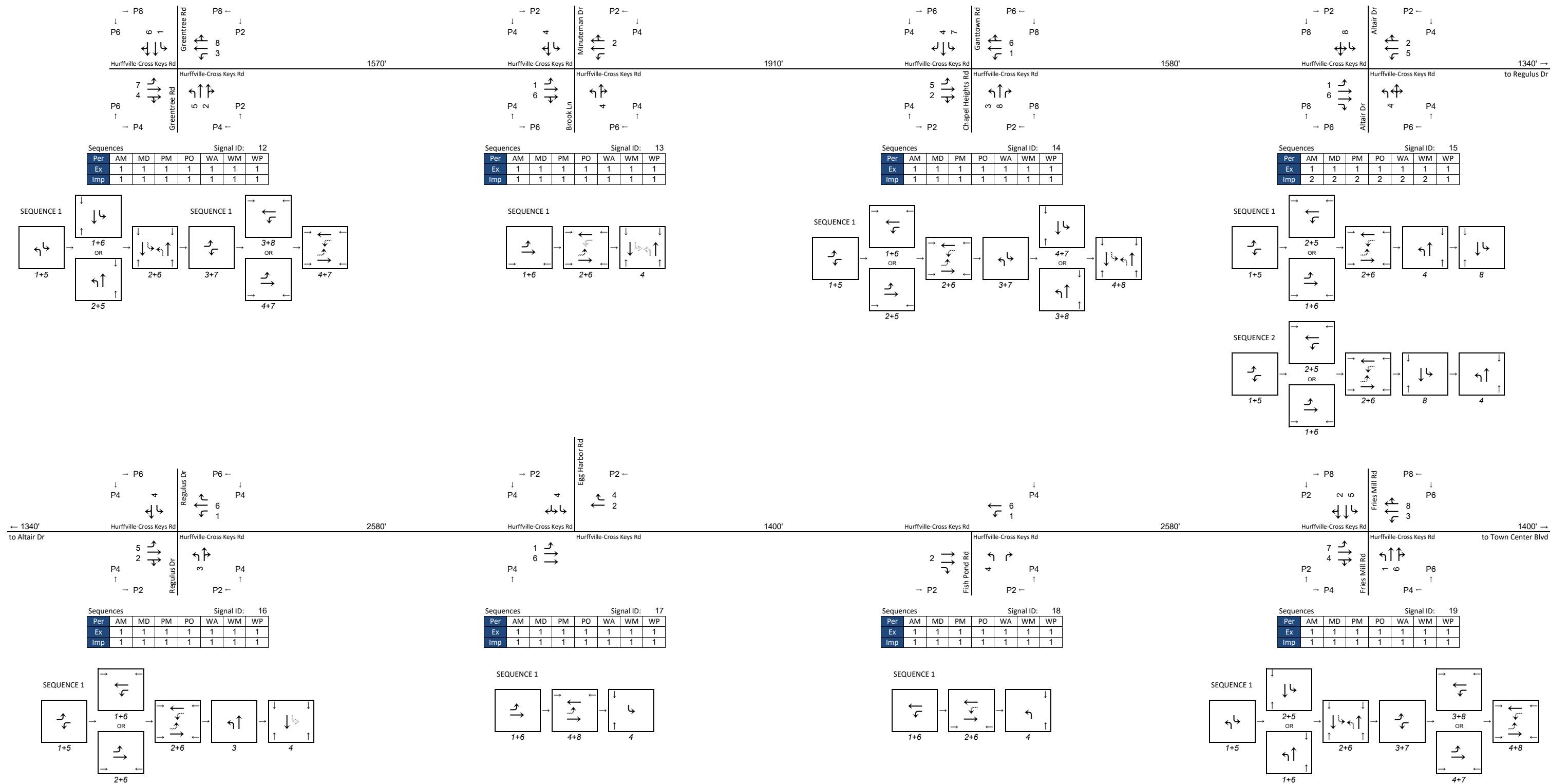
Phase Diagrams

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



Figure 17
Phase Sequence Diagrams

Egg Harbor Rd (CR 630) from Greentree Rd (CR 651) to Hurffville-Cross Keys Rd (CR 654)



Phase Diagrams

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



Figure 18

Phase Sequence Diagrams

Hurffville-Cross Keys Rd (CR 654) from Greentree Rd (CR 651) to Fries Mill Rd (CR 655)



Phase Diagrams

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



Hurffville-Cross Keys Rd (CR 654) from Town Center Blvd to Cross Keys Bypass (CR 689) and Cross Keys Bypass from Hurffville-Cross Keys Rd to Home Depot

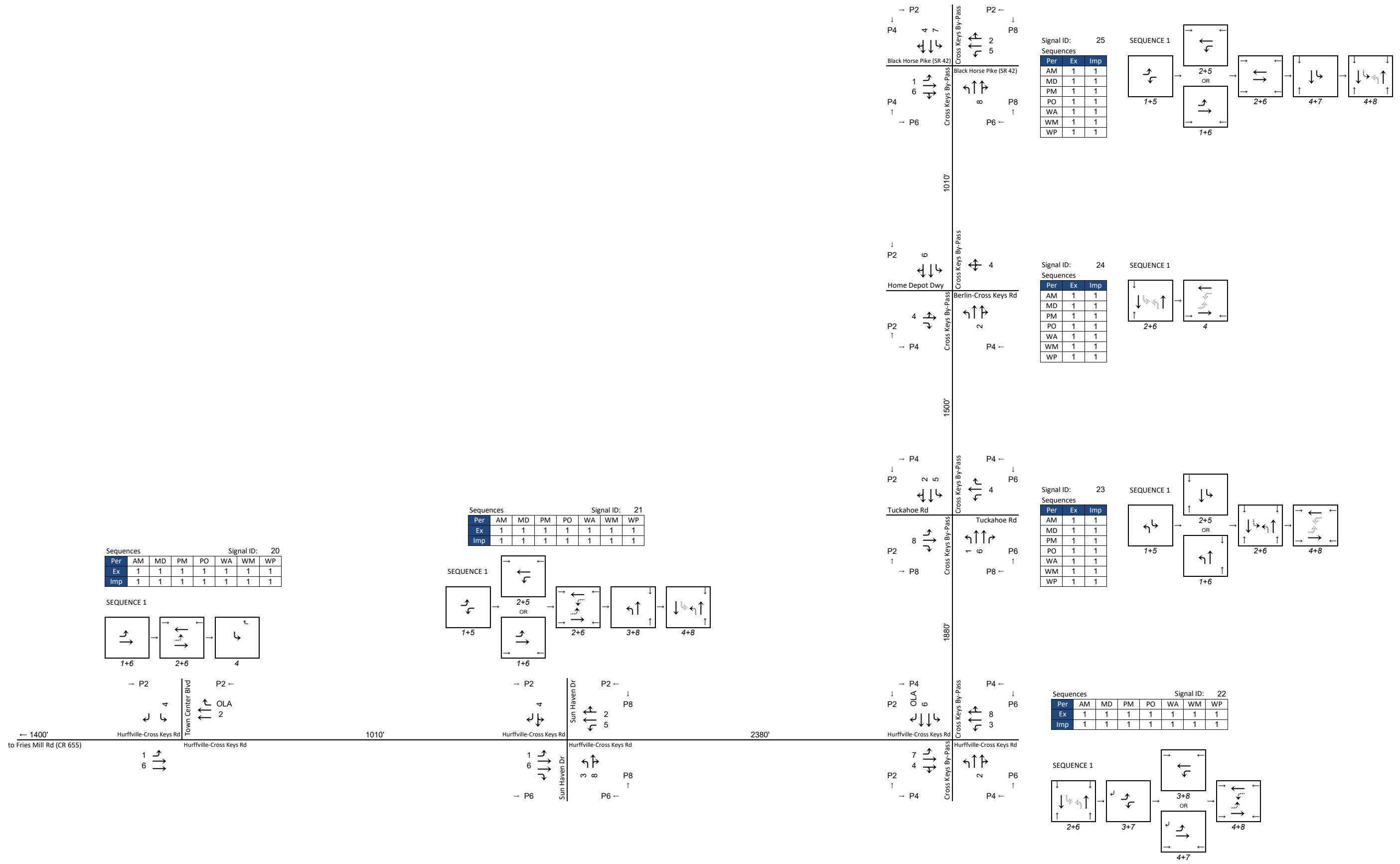
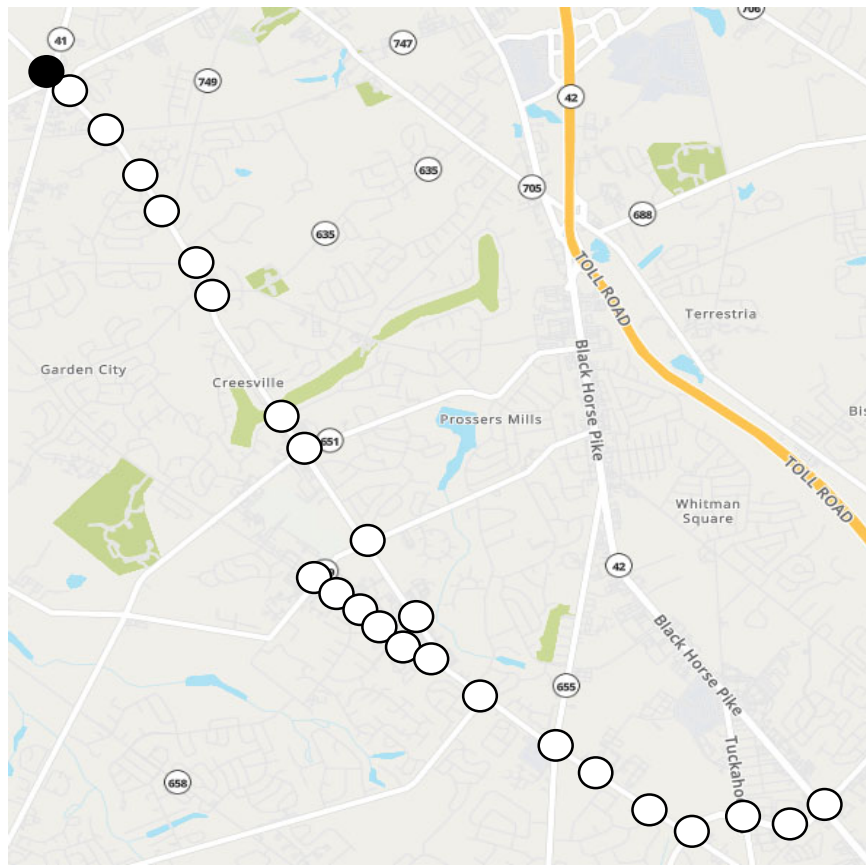
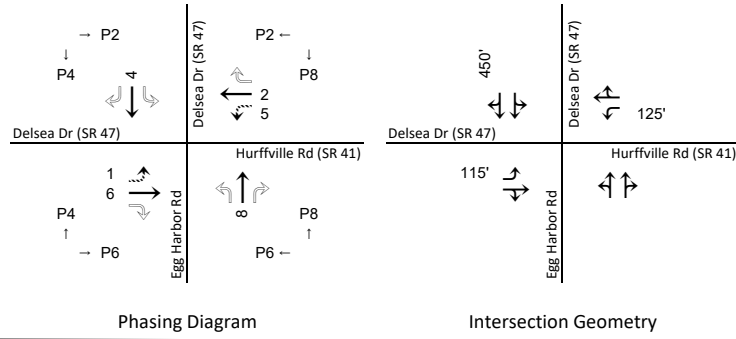
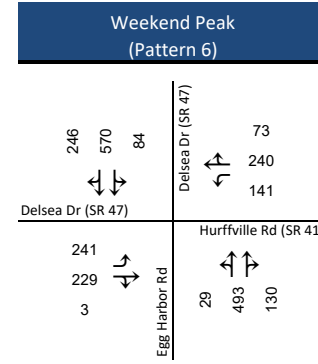
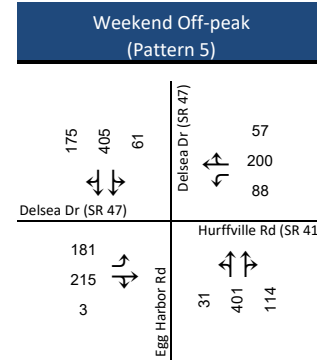
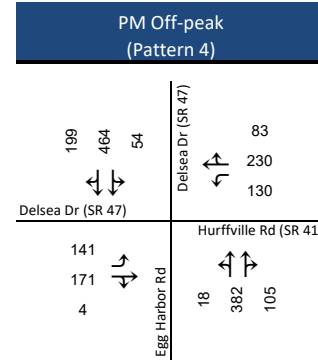
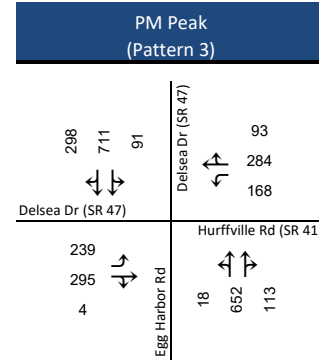
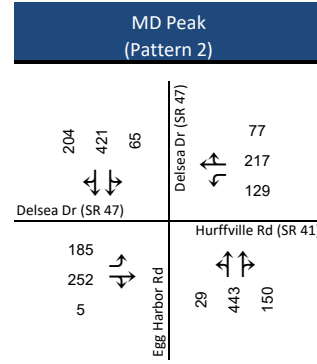
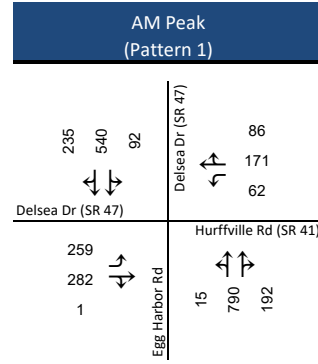


Figure 19

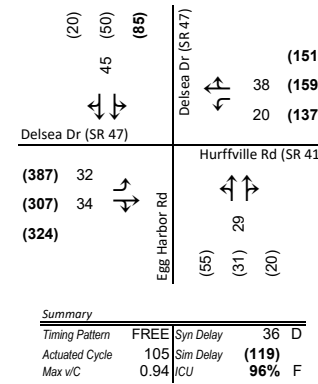
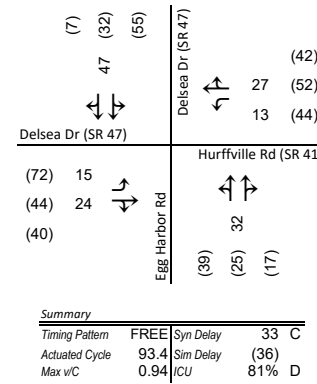
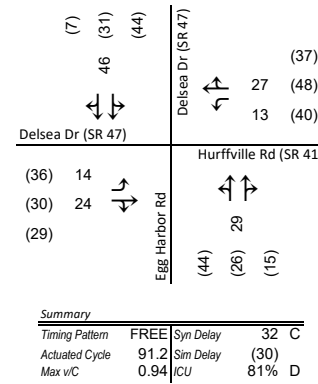
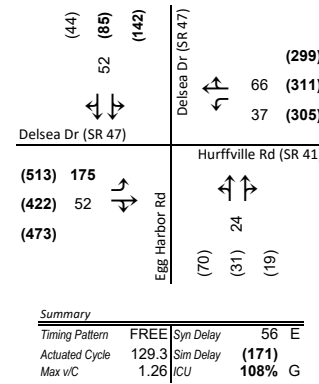
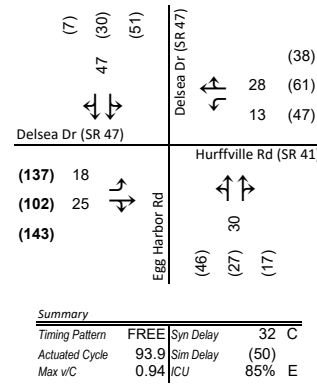
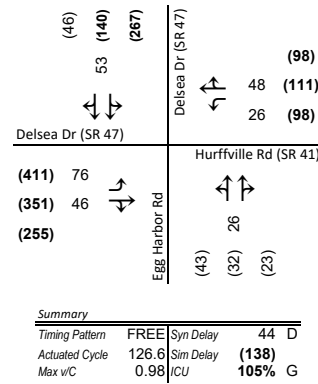
Phase Sequence Diagrams



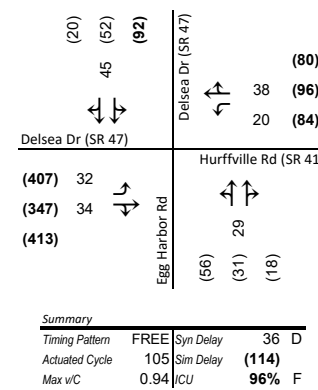
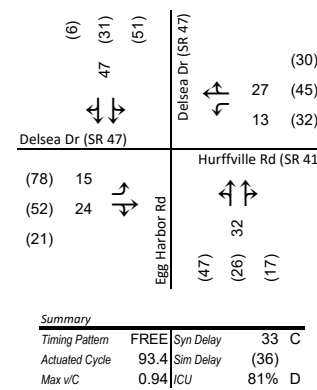
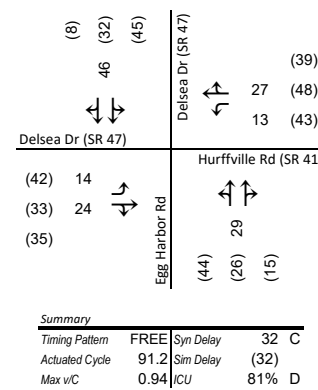
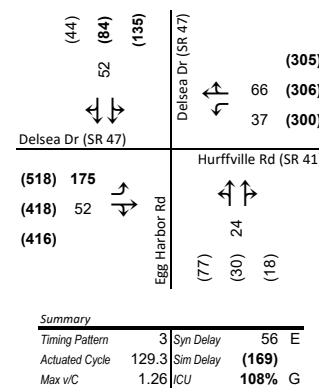
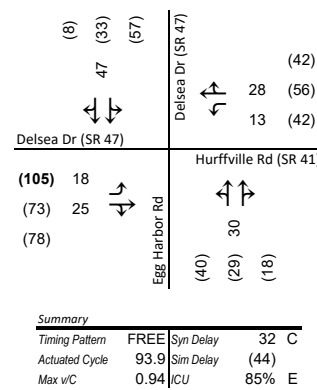
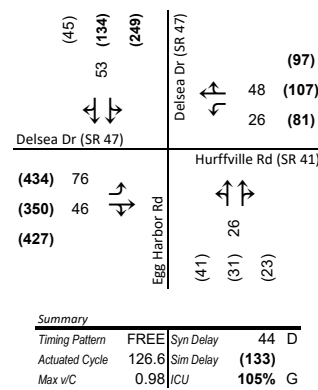
Hourly Volumes



Existing Operations



Implemented Operations



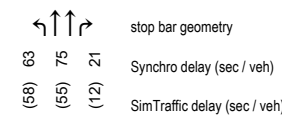
Operations with Improvements

No operational improvements recommended at this time.



HCM Levels of Service		ICU Levels of Service	
LOS	Delay/Veh (s)	LOS	Utilization (%)
A	≤10	A	≤55%
B	>10 and ≤20	B	>55% and ≤64%
C	>20 and ≤35	C	>64% and ≤73%
D	>35 and ≤55	D	>73% and ≤82%
E	>55 and ≤80	E	>82% and ≤91%
F	>80	F	>91% and ≤100%
		G	>100% and ≤109%
		H	>109%

Operations Diagrams



Hourly Volume Diagrams

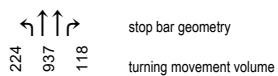
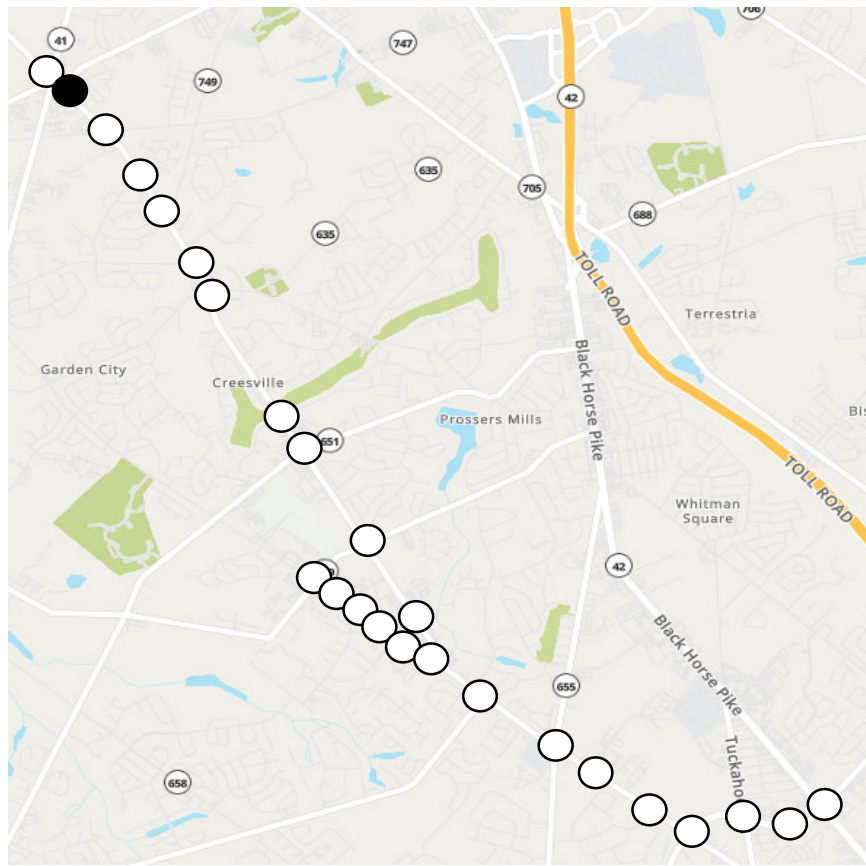
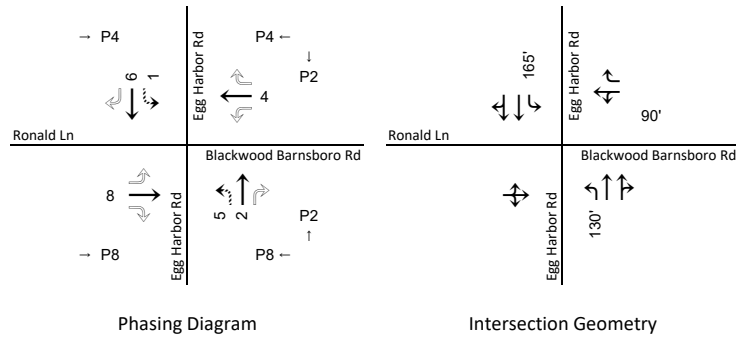


Figure 20

Traffic Operations Analysis

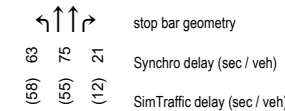
Egg Harbor Rd (CR 630) & Delsea Dr (SR 47) & Hurffville Rd (SR 41)



	AM Peak (Pattern 1)	MD Peak (Pattern 2)	PM Peak (Pattern 3)	PM Off-peak (Pattern 4)	Weekend Off-peak (Pattern 5)	Weekend Peak (Pattern 6)
Hourly Volumes						
Existing Operations						
Implemented Operations						
Operations with Improvements						
Summary	Timing Pattern: FREE Actuated Cycle: 85.6 Max v/C: 0.69 Syn Delay: 22 C Sim Delay: (20) ICU: 71% C	Timing Pattern: FREE Actuated Cycle: 83.7 Max v/C: 0.43 Syn Delay: 18 B Sim Delay: (16) ICU: 60% B	Timing Pattern: FREE Actuated Cycle: 86 Max v/C: 0.60 Syn Delay: 20 B Sim Delay: (20) ICU: 68% C	Timing Pattern: FREE Actuated Cycle: 84.3 Max v/C: 0.40 Syn Delay: 16 B Sim Delay: (16) ICU: 60% B	Timing Pattern: FREE Actuated Cycle: 83.6 Max v/C: 0.46 Syn Delay: 18 B Sim Delay: (17) ICU: 60% B	Timing Pattern: FREE Actuated Cycle: 84.9 Max v/C: 0.43 Syn Delay: 18 B Sim Delay: (18) ICU: 63% B

HCM Levels of Service		ICU Levels of Service	
LOS	Delay/Veh (s)	LOS	Utilization (%)
A	≤10	A	≤55%
B	>10 and ≤20	B	>55% and ≤64%
C	>20 and ≤35	C	>64% and ≤73%
D	>35 and ≤55	D	>73% and ≤82%
E	>55 and ≤80	E	>82% and ≤91%
F	>80	F	>91% and ≤100%
		G	>100% and ≤109%
		H	>109%

Operations Diagrams



Hourly Volume Diagrams

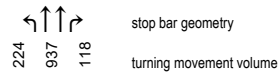
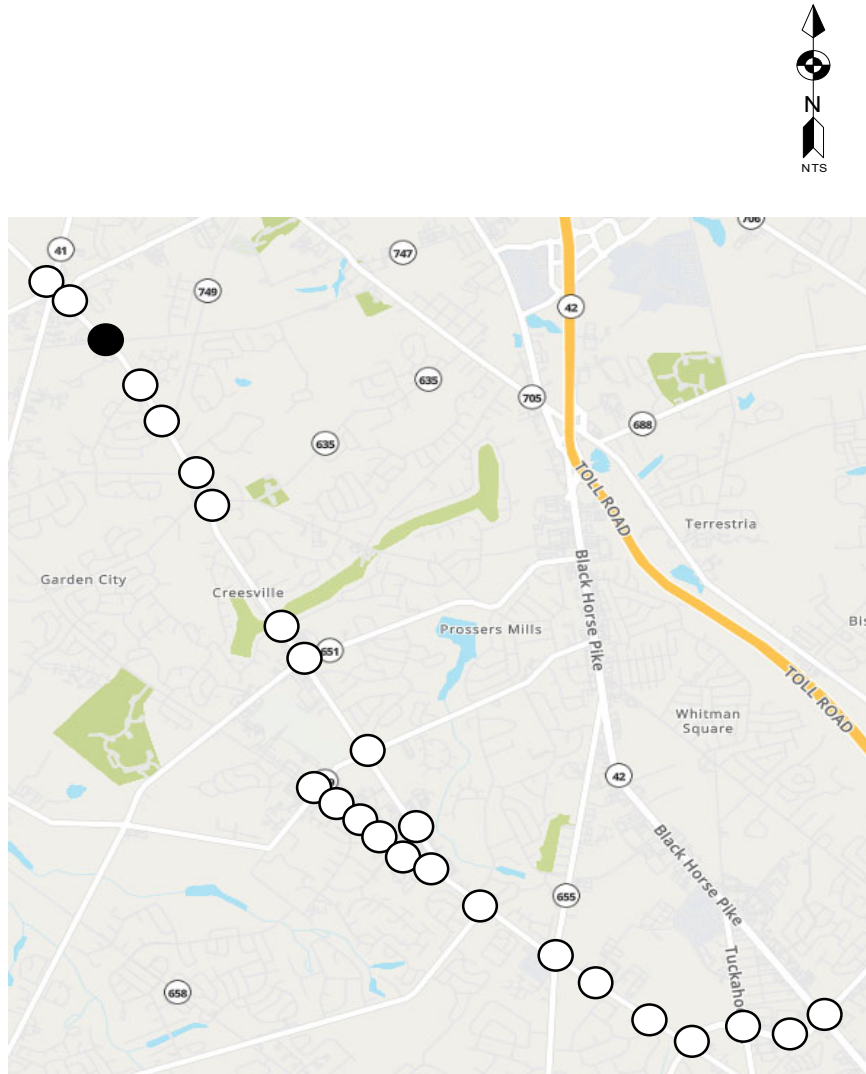
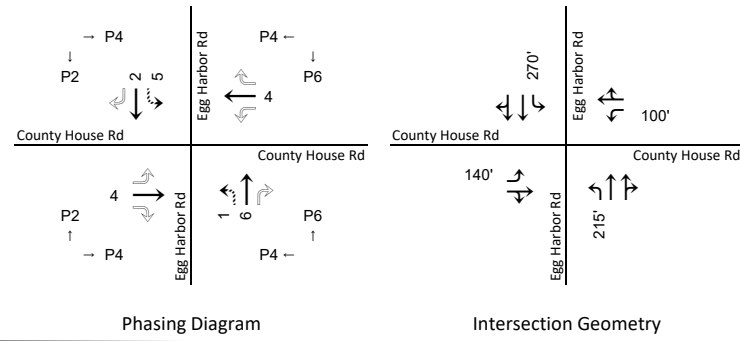


Figure 21

Traffic Operations Analysis

Egg Harbor Rd (CR 630) & Ronald Ln/Blackwood Barnsboro Rd (CR 603)



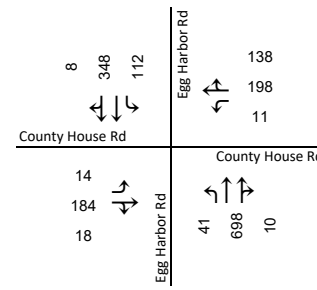
Hourly Volumes

Existing Operations

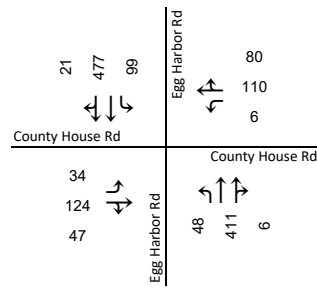
Implemented Operations

Operations with Improvements

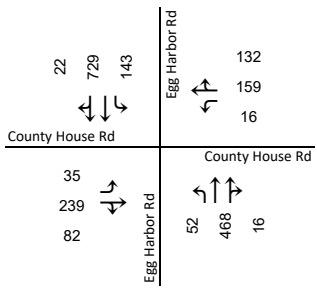
AM Peak (Pattern 1)



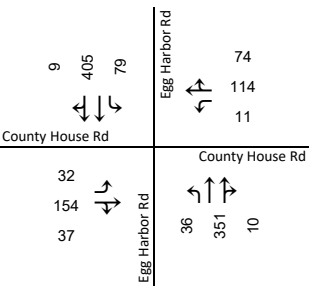
MD Peak (Pattern 2)



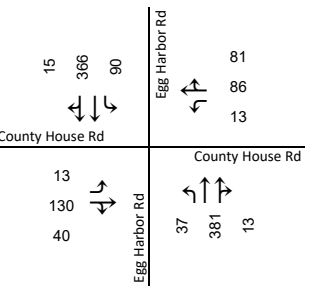
PM Peak (Pattern 3)



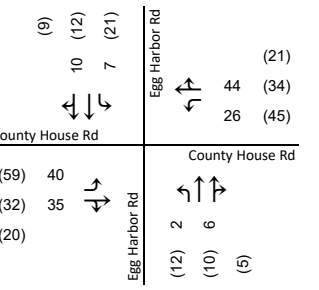
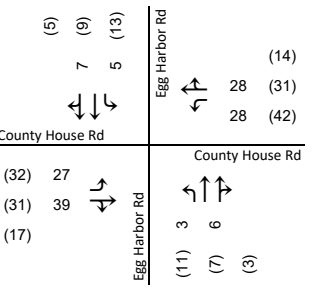
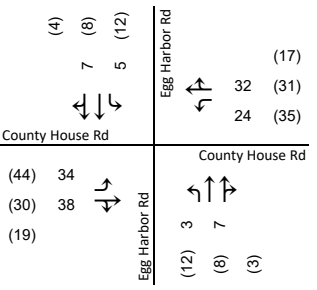
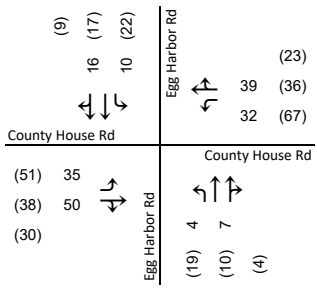
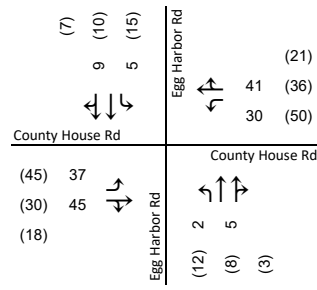
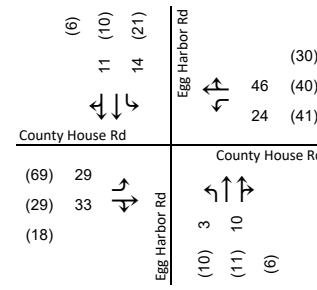
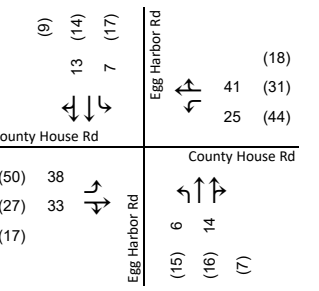
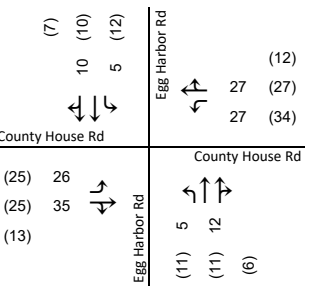
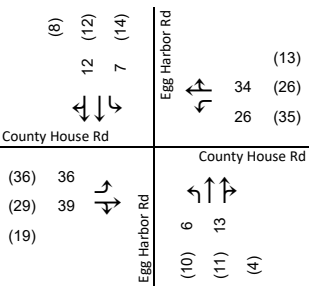
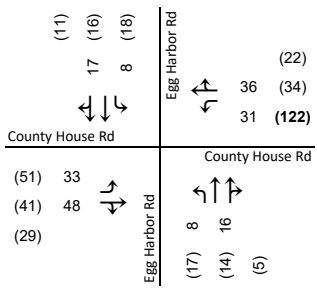
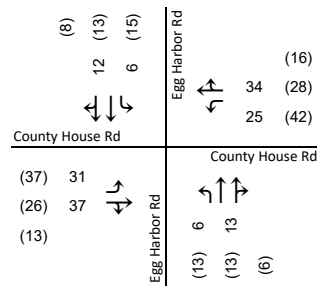
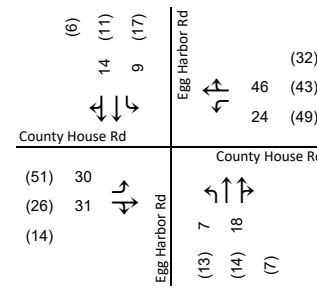
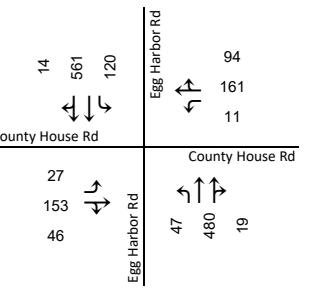
PM Off-peak (Pattern 4)



Weekend Off-peak (Pattern 5)



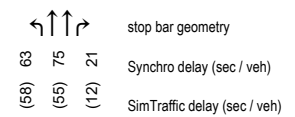
Weekend Peak (Pattern 6)



No operational improvements recommended at this time.

HCM Levels of Service		ICU Levels of Service	
LOS	Delay/Veh (s)	LOS	Utilization (%)
A	≤10	A	≤55%
B	>10 and ≤20	B	>55% and ≤64%
C	>20 and ≤35	C	>64% and ≤73%
D	>35 and ≤55	D	>73% and ≤82%
E	>55 and ≤80	E	>82% and ≤91%
F	>80	F	>91% and ≤100%
		G	>100% and ≤109%
		H	>109%

Operations Diagrams



Hourly Volume Diagrams

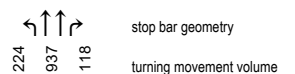
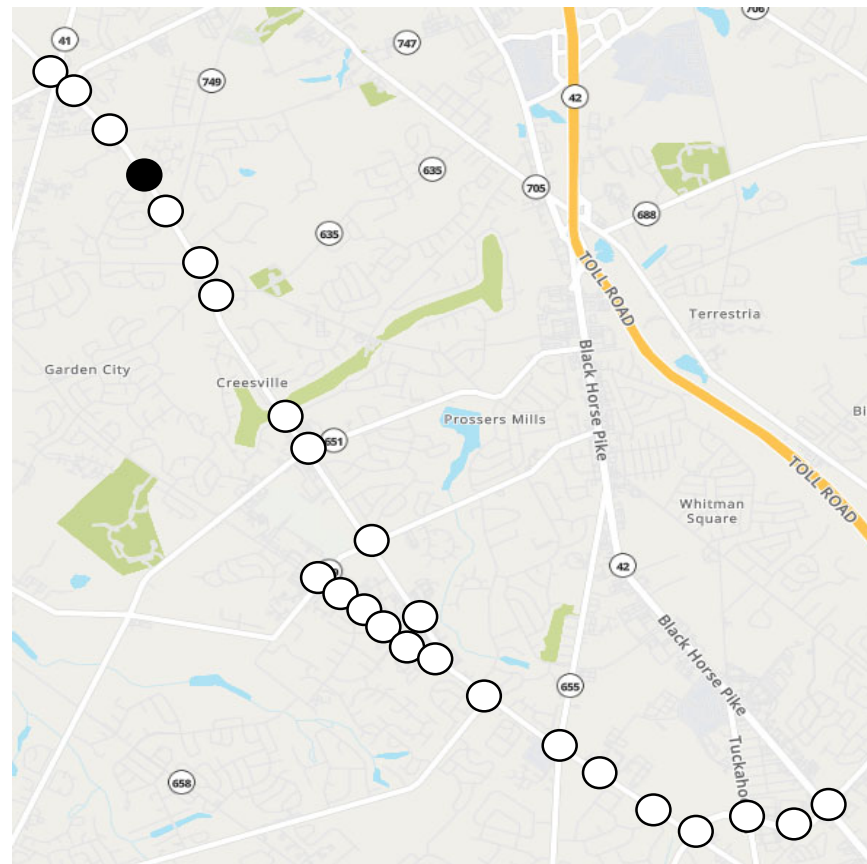
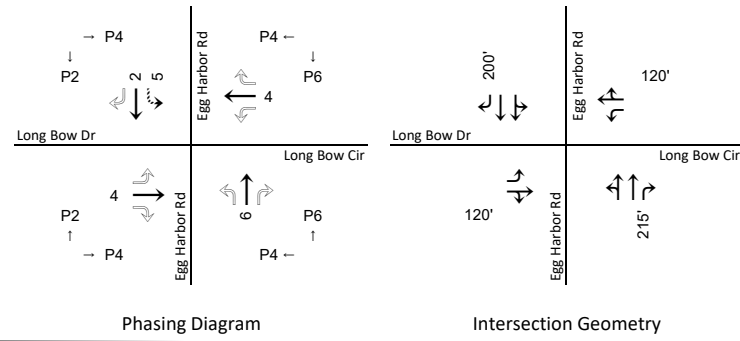


Figure 22

Traffic Operations Analysis

Egg Harbor Rd (CR 630) & County House Rd (CR 621)



	AM Peak (Pattern 1)	MD Peak (Pattern 2)	PM Peak (Pattern 3)	PM Off-peak (Pattern 4)	Weekend Off-peak (Pattern 5)	Weekend Peak (Pattern 6)
Hourly Volumes						
Existing Operations						
Implemented Operations						
Operations with Improvements	No operational improvements recommended at this time.					

HCM Levels of Service		ICU Levels of Service	
LOS	Delay/Veh (s)	LOS	Utilization (%)
A	≤10	A	≤55%
B	>10 and ≤20	B	>55% and ≤64%
C	>20 and ≤35	C	>64% and ≤73%
D	>35 and ≤55	D	>73% and ≤82%
E	>55 and ≤80	E	>82% and ≤91%
F	>80	F	>91% and ≤100%
		G	>100% and ≤109%
		H	>109%

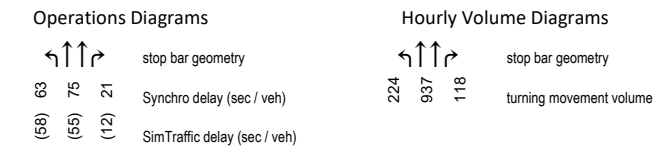
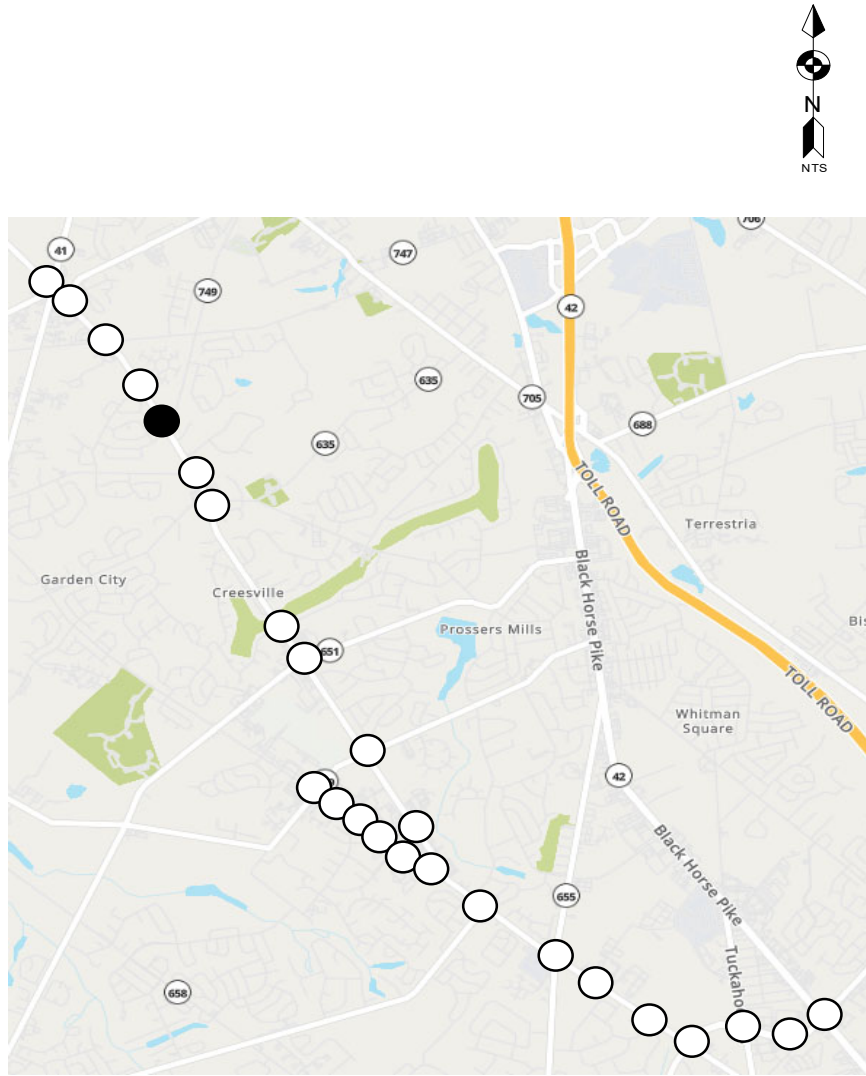
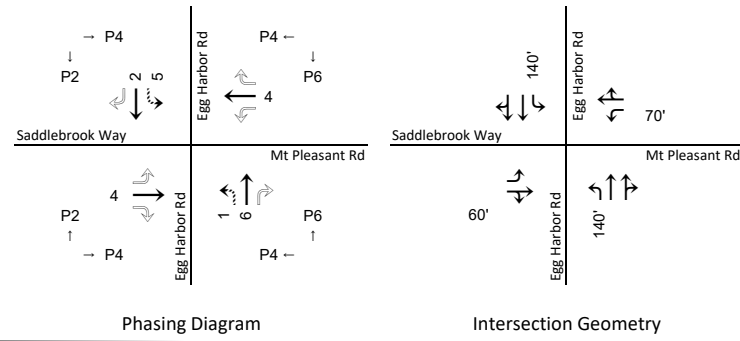


Figure 23

Traffic Operations Analysis

Egg Harbor Rd (CR 630) & Long Bow Dr/Long Bow Cir

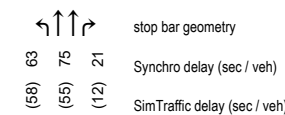


	AM Peak (Pattern 1)	MD Peak (Pattern 2)	PM Peak (Pattern 3)	PM Off-peak (Pattern 4)	Weekend Off-peak (Pattern 5)	Weekend Peak (Pattern 6)
Hourly Volumes						
Existing Operations						
Implemented Operations						
Operations with Improvements	No operational improvements recommended at this time.					



HCM Levels of Service		ICU Levels of Service	
LOS	Delay/Veh (s)	LOS	Utilization (%)
A	≤10	A	≤55%
B	>10 and ≤20	B	>55% and ≤64%
C	>20 and ≤35	C	>64% and ≤73%
D	>35 and ≤55	D	>73% and ≤82%
E	>55 and ≤80	E	>82% and ≤91%
F	>80	F	>91% and ≤100%
		G	>100% and ≤109%
		H	>109%

Operations Diagrams



Hourly Volume Diagrams

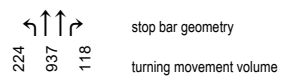
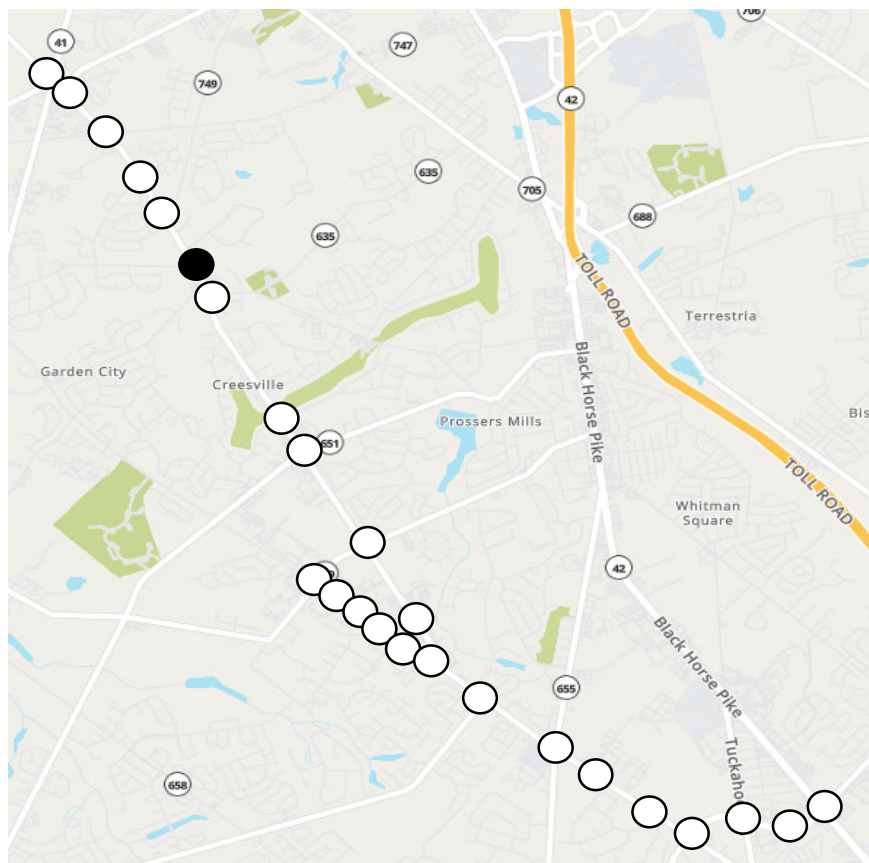
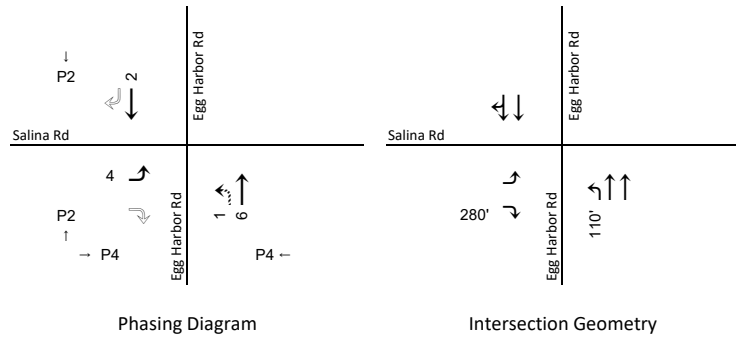


Figure 24

Traffic Operations Analysis

Egg Harbor Rd (CR 630) & Saddlebrook Way/Mt Pleasant Rd

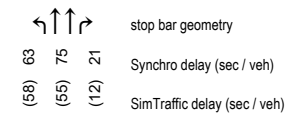


	AM Peak (Pattern 1)	MD Peak (Pattern 2)	PM Peak (Pattern 3)	PM Off-peak (Pattern 4)	Weekend Off-peak (Pattern 5)	Weekend Peak (Pattern 6)
Hourly Volumes	Salina Rd: 13 (left), 530 (through/right); Egg Harbor Rd: 87 (left), 94 (right), 782 (through/right)	Salina Rd: 14 (left), 650 (through/right); Egg Harbor Rd: 72 (left), 78 (right), 608 (through/right)	Salina Rd: 30 (left), 977 (through/right); Egg Harbor Rd: 118 (left), 126 (right), 720 (through/right)	Salina Rd: 26 (left), 538 (through/right); Egg Harbor Rd: 94 (left), 84 (right), 512 (through/right)	Salina Rd: 13 (left), 579 (through/right); Egg Harbor Rd: 107 (left), 79 (right), 536 (through/right)	Salina Rd: 27 (left), 772 (through/right); Egg Harbor Rd: 102 (left), 89 (right), 713 (through/right)
Existing Operations	Summary: Timing Pattern FREE, Syn Delay 7 A, Actuated Cycle 55.6, Sim Delay (7), Max vC 0.38, ICU 47% A	Summary: Timing Pattern FREE, Syn Delay 8 A, Actuated Cycle 55.6, Sim Delay (8), Max vC 0.45, ICU 47% A	Summary: Timing Pattern FREE, Syn Delay 10 A, Actuated Cycle 55.8, Sim Delay (12), Max vC 0.64, ICU 58% B	Summary: Timing Pattern FREE, Syn Delay 8 A, Actuated Cycle 55.7, Sim Delay (8), Max vC 0.47, ICU 47% A	Summary: Timing Pattern FREE, Syn Delay 8 A, Actuated Cycle 55.7, Sim Delay (8), Max vC 0.40, ICU 48% A	Summary: Timing Pattern FREE, Syn Delay 8 A, Actuated Cycle 55.7, Sim Delay (9), Max vC 0.50, ICU 49% A
Implemented Operations	Summary: Timing Pattern 1, Syn Delay 4 A, Actuated Cycle 90, Sim Delay (5), Max vC 0.45, ICU 43% A	Summary: Timing Pattern 2, Syn Delay 5 A, Actuated Cycle 90, Sim Delay (5), Max vC 0.45, ICU 45% A	Summary: Timing Pattern 3, Syn Delay 7 A, Actuated Cycle 100, Sim Delay (8), Max vC 0.57, ICU 59% B	Summary: Timing Pattern 4, Syn Delay 5 A, Actuated Cycle 80, Sim Delay (5), Max vC 0.48, ICU 43% A	Summary: Timing Pattern 5, Syn Delay 5 A, Actuated Cycle 80, Sim Delay (6), Max vC 0.49, ICU 44% A	Summary: Timing Pattern 6, Syn Delay 5 A, Actuated Cycle 90, Sim Delay (6), Max vC 0.49, ICU 50% A
Operations with Improvements	No operational improvements recommended at this time.					



HCM Levels of Service		ICU Levels of Service	
LOS	Delay/Veh (s)	LOS	Utilization (%)
A	≤10	A	≤55%
B	>10 and ≤20	B	>55% and ≤64%
C	>20 and ≤35	C	>64% and ≤73%
D	>35 and ≤55	D	>73% and ≤82%
E	>55 and ≤80	E	>82% and ≤91%
F	>80	F	>91% and ≤100%
		G	>100% and ≤109%
		H	>109%

Operations Diagrams



Hourly Volume Diagrams

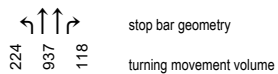
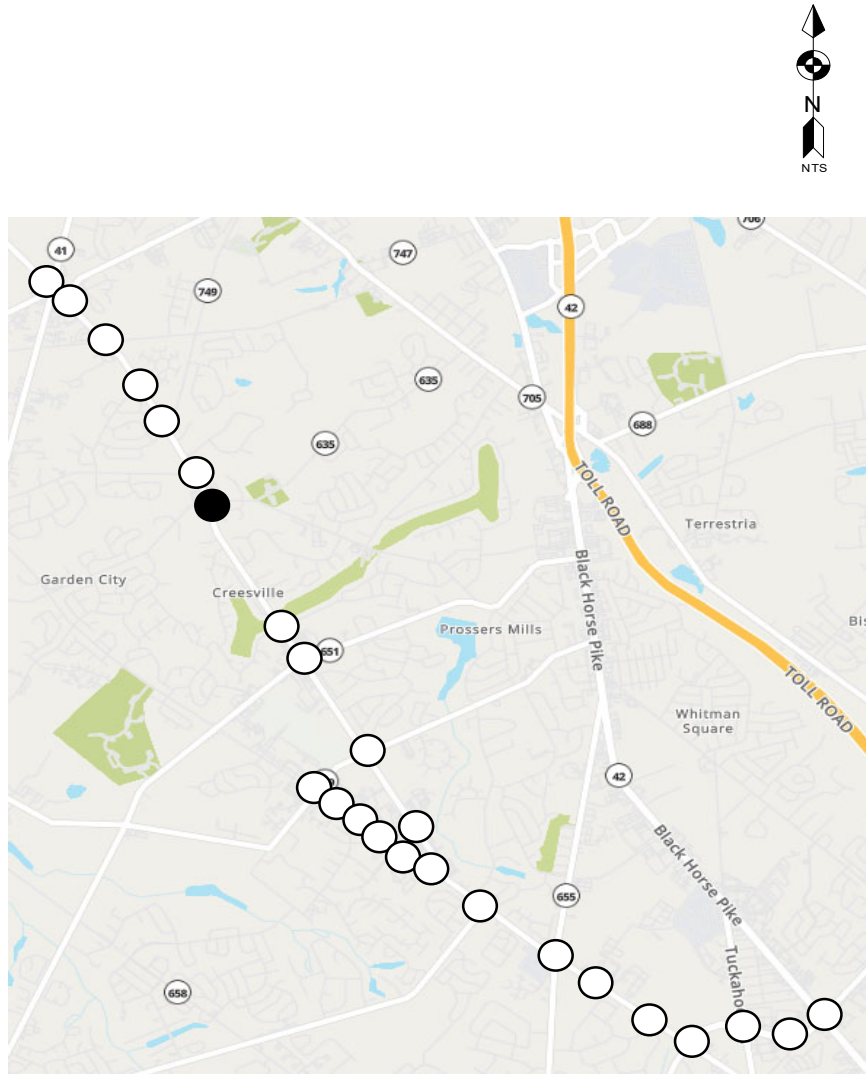
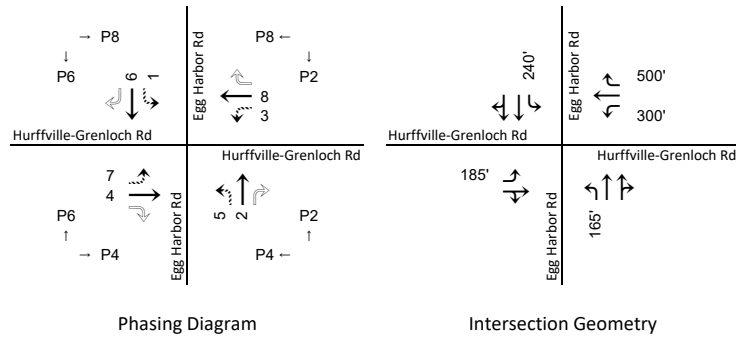


Figure 25

Traffic Operations Analysis

Egg Harbor Rd (CR 630) & Salina Rd



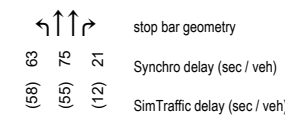
	AM Peak (Pattern 1)	MD Peak (Pattern 2)	PM Peak (Pattern 3)	PM Off-peak (Pattern 4)	Weekend Off-peak (Pattern 5)	Weekend Peak (Pattern 6)
Hourly Volumes						
Existing Operations						
Implemented Operations						
Operations with Improvements	No operational improvements recommended at this time.					



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

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



Hourly Volume Diagrams

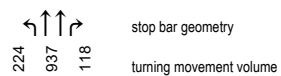
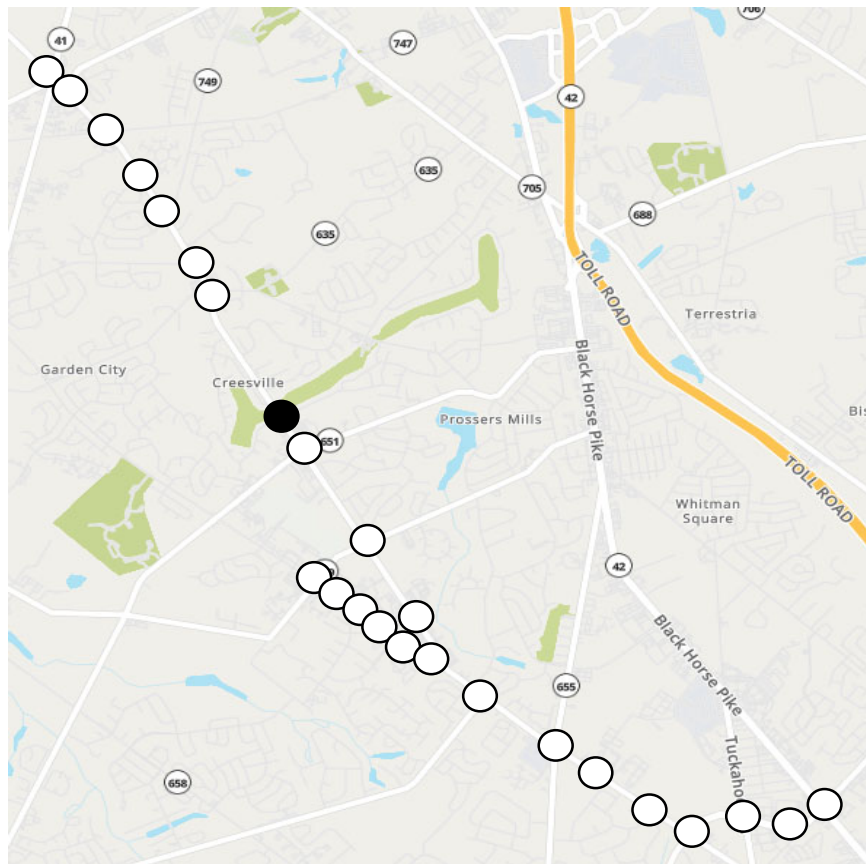
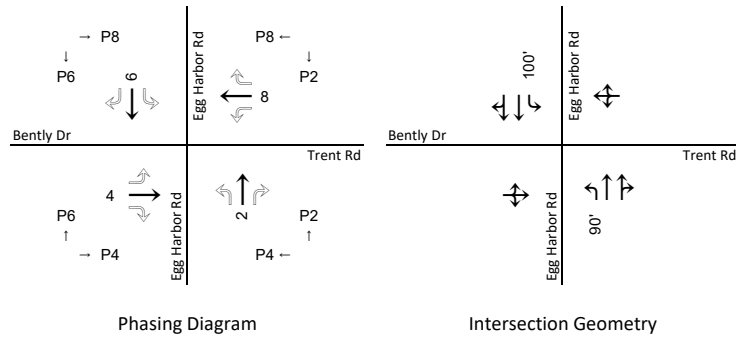


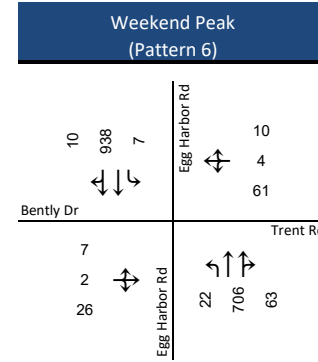
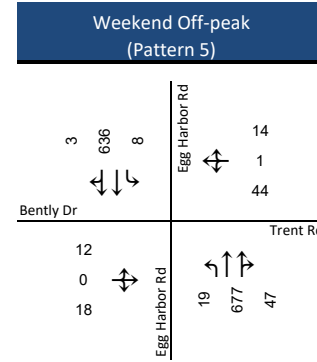
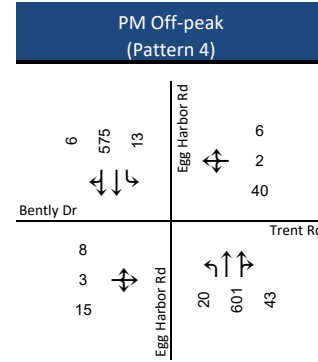
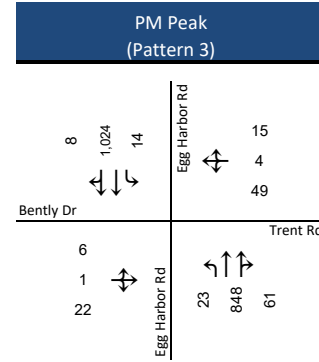
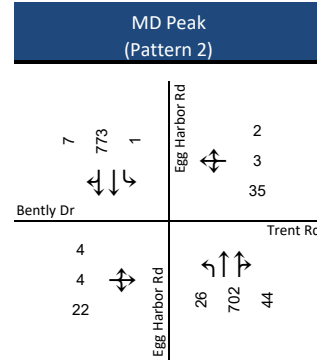
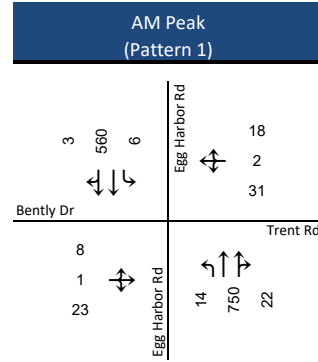
Figure 26

Traffic Operations Analysis

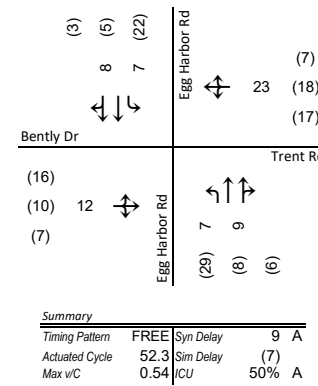
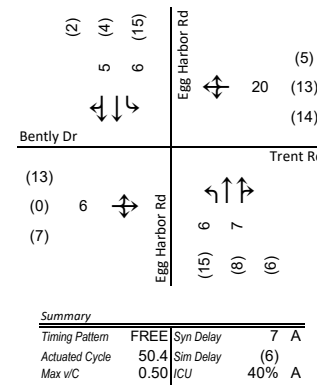
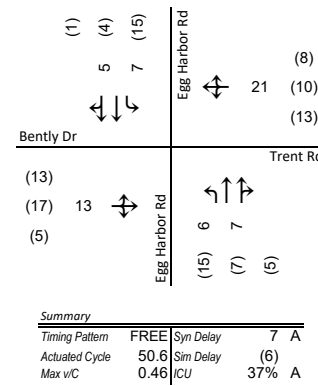
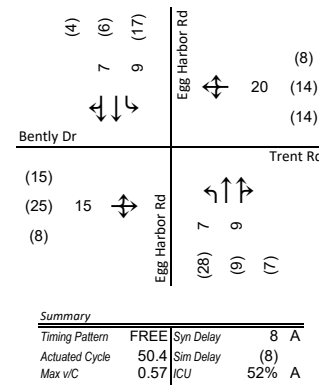
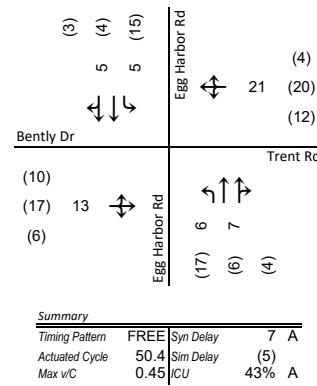
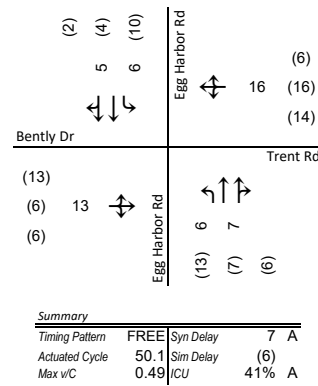
Egg Harbor Rd (CR 630) & Hurffville-Grenloch Rd (CR 635)



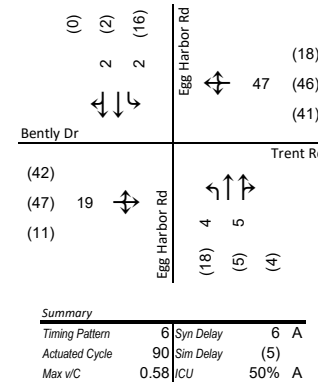
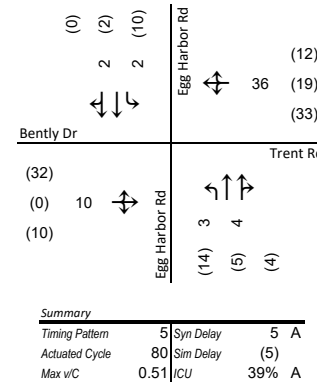
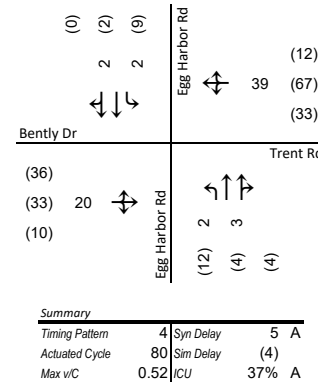
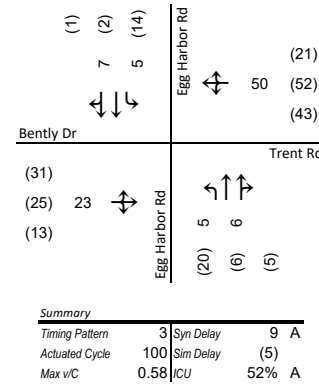
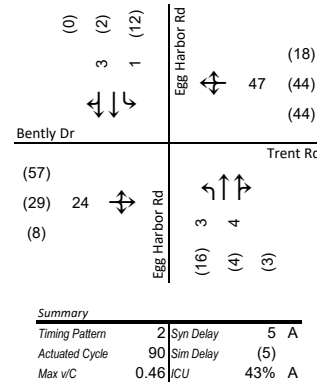
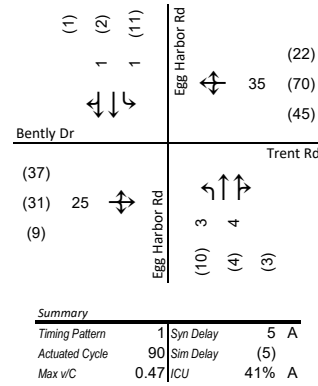
Hourly Volumes



Existing Operations



Implemented Operations



Operations with Improvements

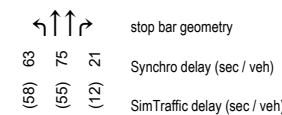
No operational improvements recommended at this time.



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%
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



Hourly Volume Diagrams

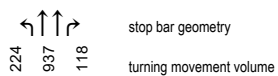
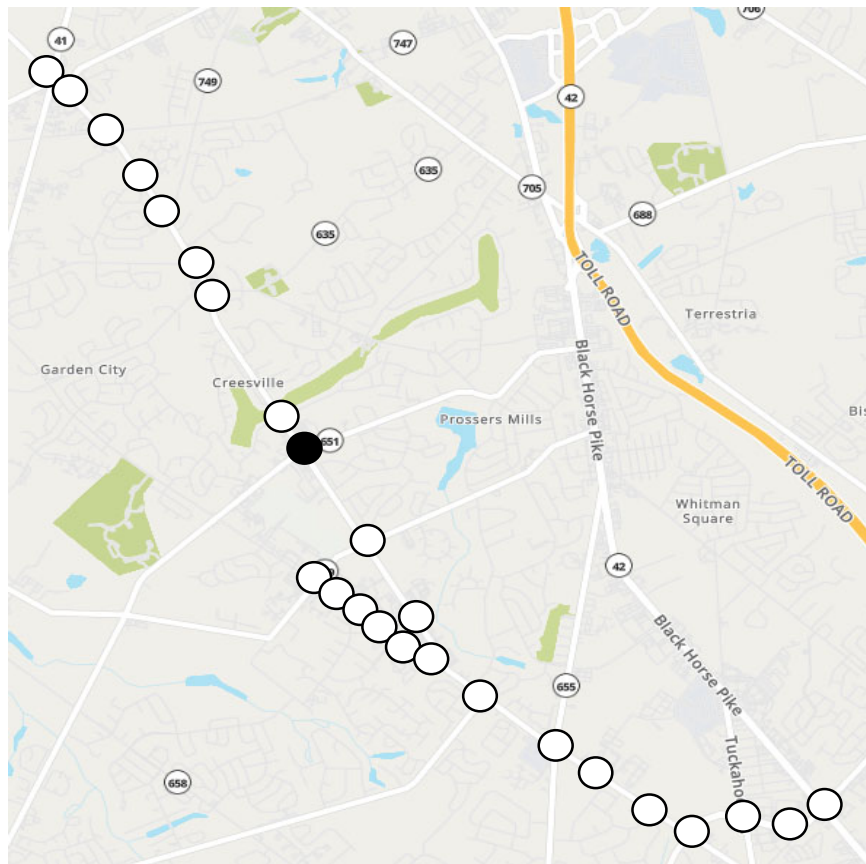
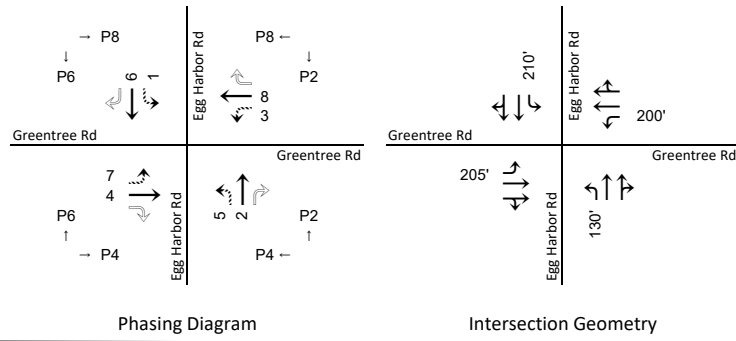


Figure 27

Traffic Operations Analysis

Egg Harbor Rd (CR 630) & Bently Dr/Trent Rd



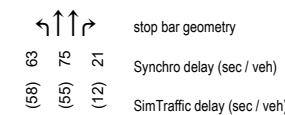
	AM Peak (Pattern 1)	MD Peak (Pattern 2)	PM Peak (Pattern 3)	PM Off-peak (Pattern 4)	Weekend Off-peak (Pattern 5)	Weekend Peak (Pattern 6)
Hourly Volumes						
Existing Operations						
Implemented Operations						
Operations with Improvements	No operational improvements recommended at this time.					



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%
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



Hourly Volume Diagrams

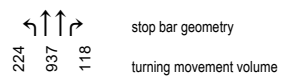
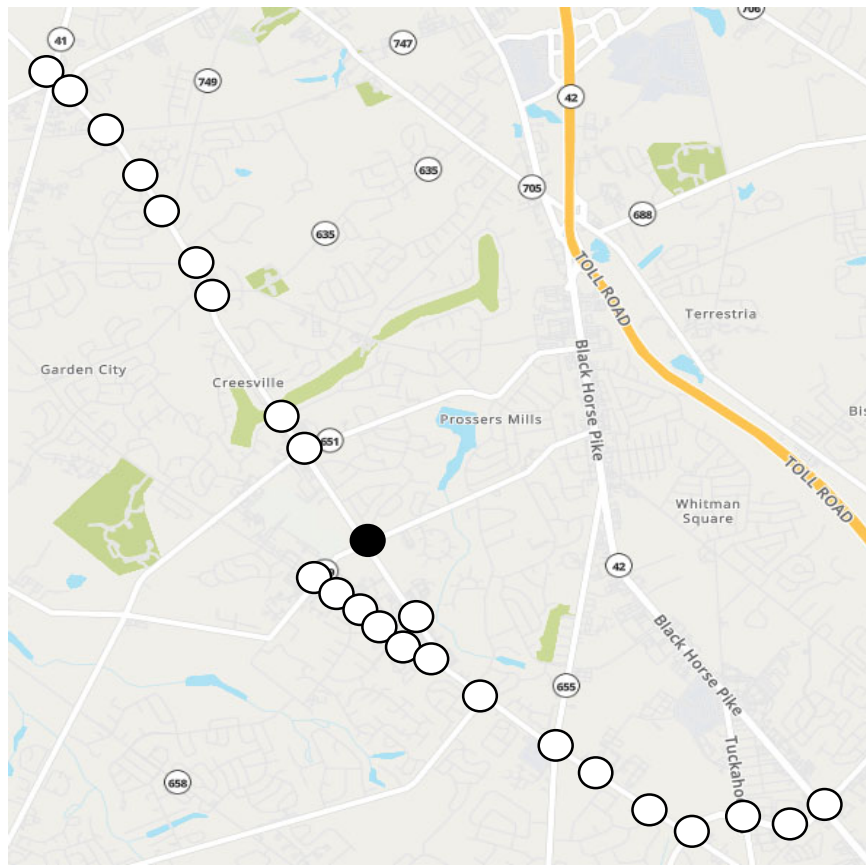
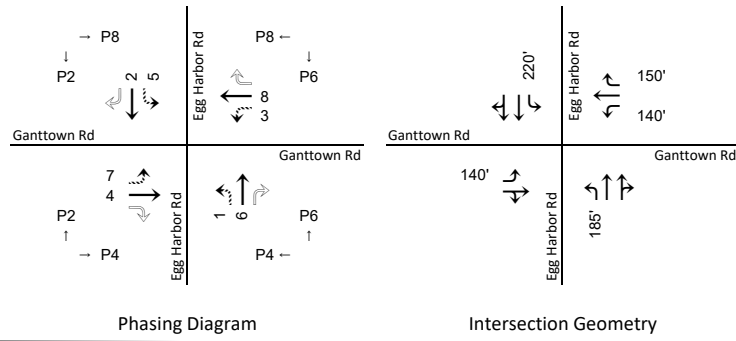


Figure 28

Traffic Operations Analysis

Egg Harbor Rd (CR 630) & Greentree Rd (CR 651)



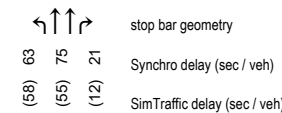
	AM Peak (Pattern 1)	MD Peak (Pattern 2)	PM Peak (Pattern 3)	PM Off-peak (Pattern 4)	Weekend Off-peak (Pattern 5)	Weekend Peak (Pattern 6)
Hourly Volumes						
Existing Operations						
Implemented Operations						
Operations with Improvements						



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

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



Hourly Volume Diagrams

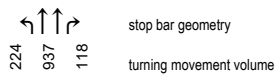
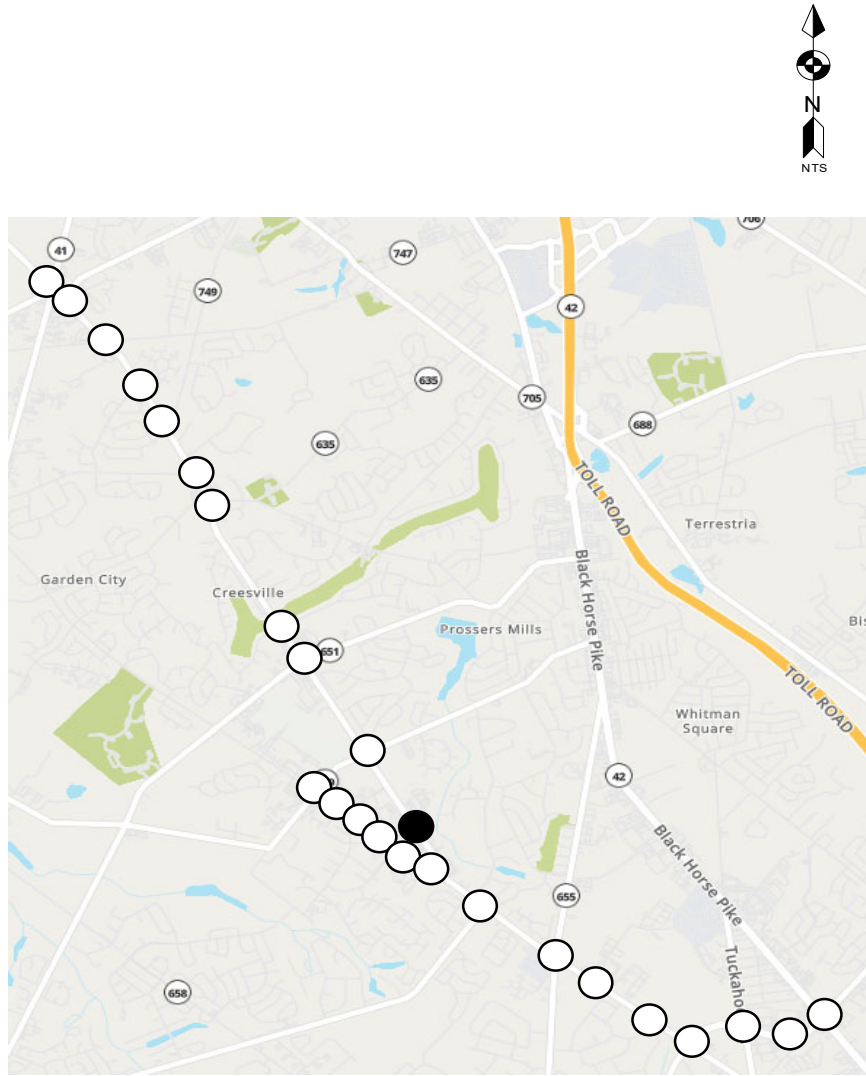
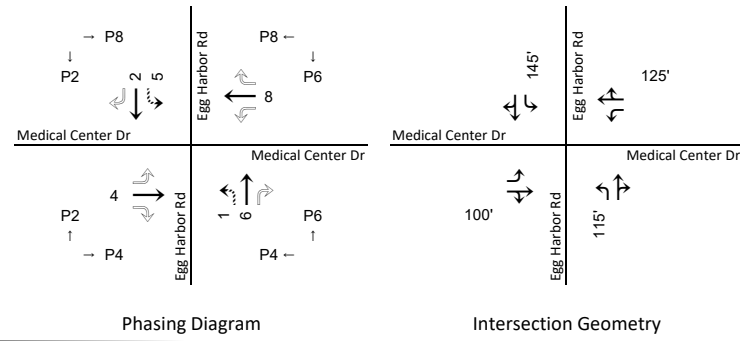


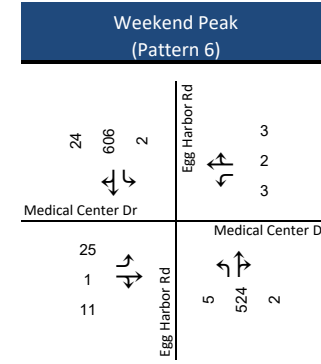
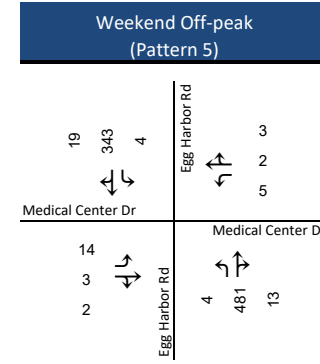
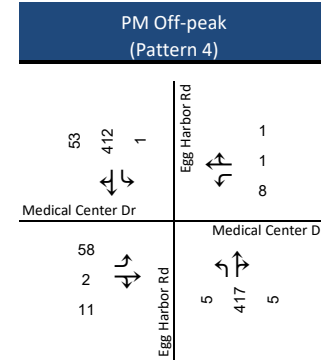
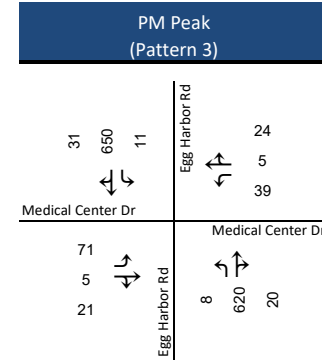
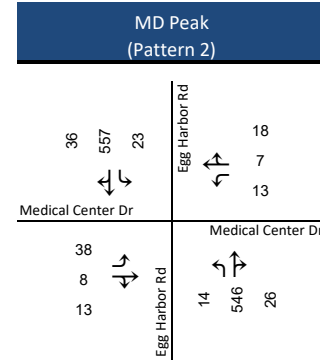
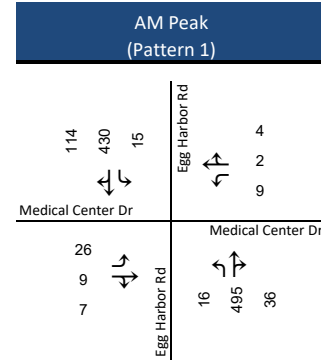
Figure 29

Traffic Operations Analysis

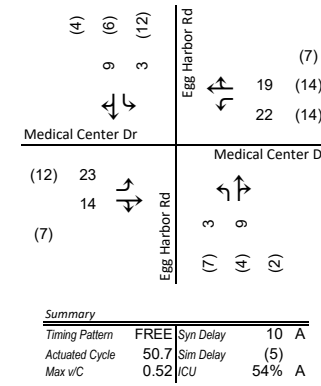
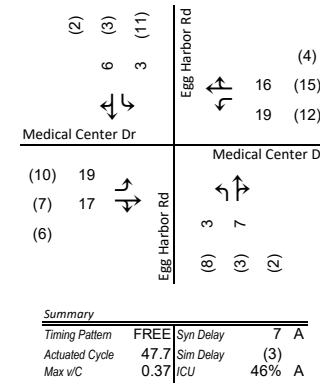
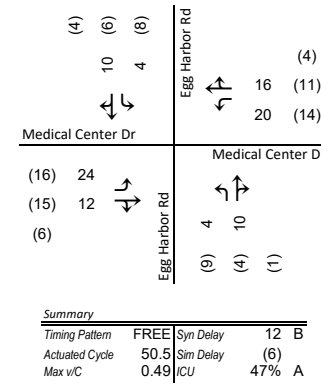
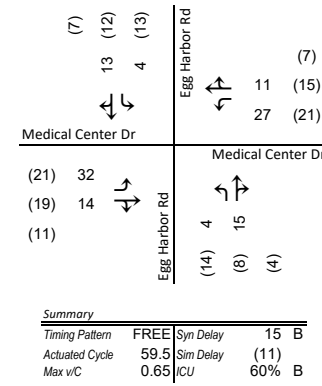
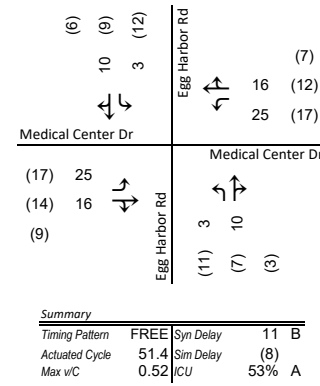
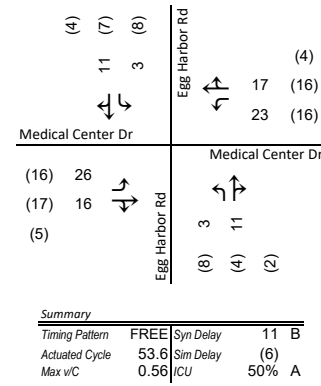
Egg Harbor Rd (CR 630) & Ganttown Rd (CR 639)



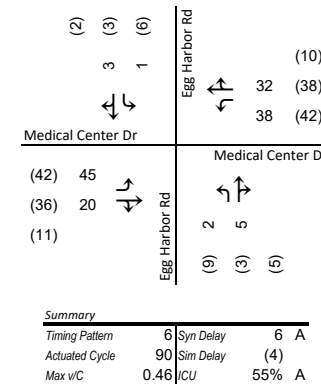
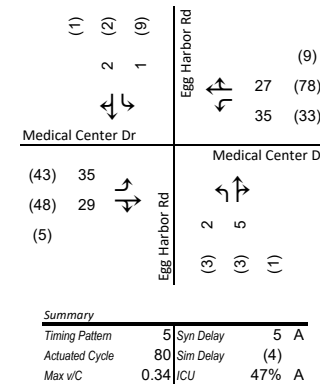
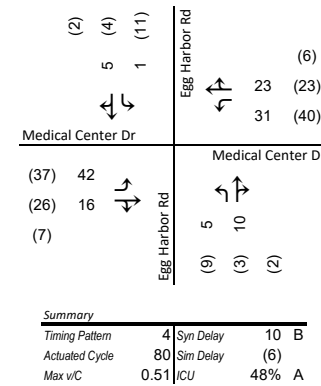
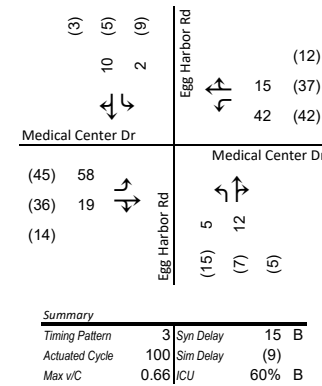
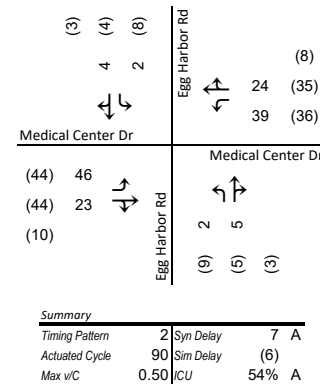
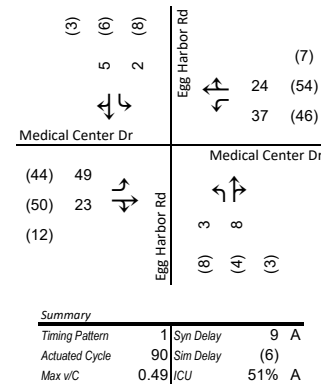
Hourly Volumes



Existing Operations



Implemented Operations



Operations with Improvements

No operational improvements recommended at this time.

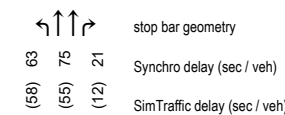
HCM Levels of Service

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%
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



Hourly Volume Diagrams

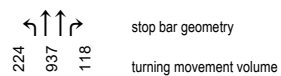
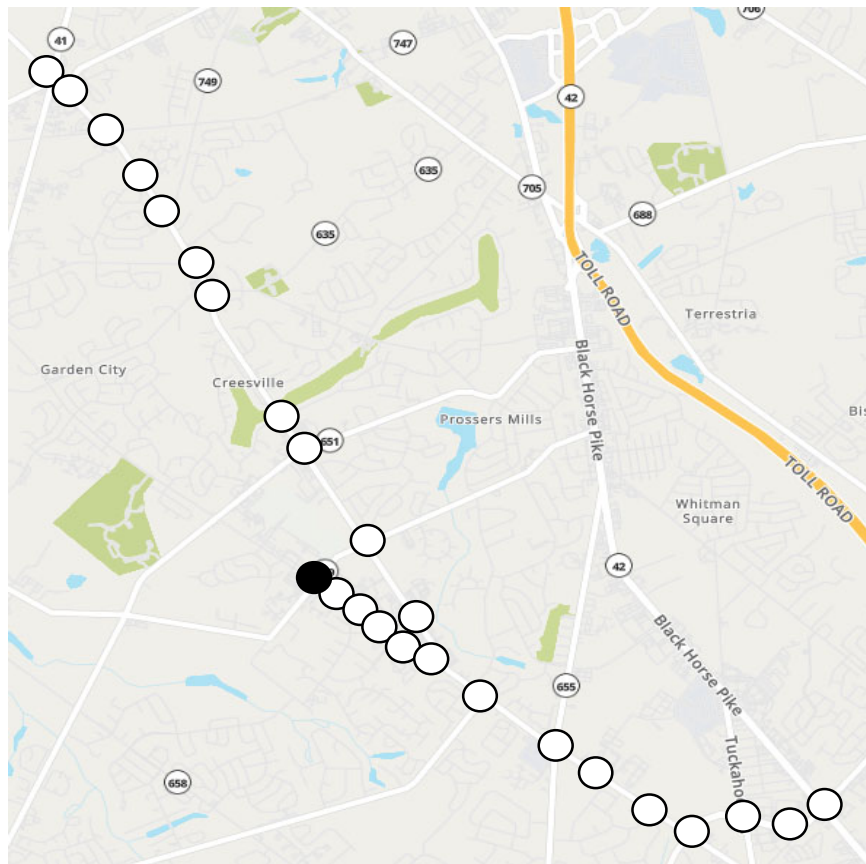
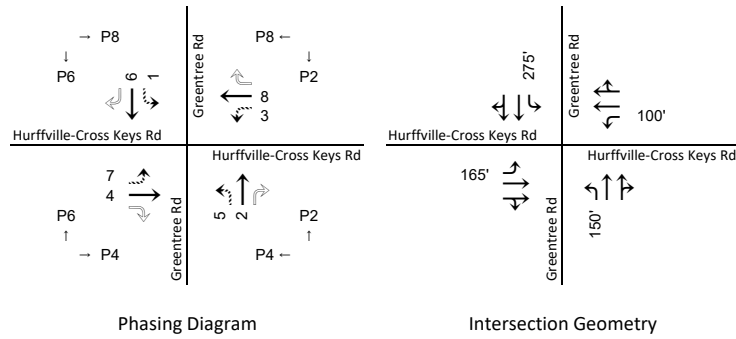


Figure 30

Traffic Operations Analysis

Egg Harbor Rd (CR 630) & Medical Center Dr



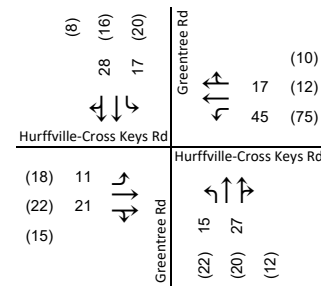
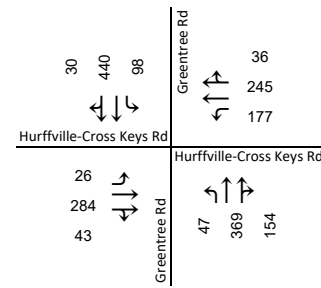
Hourly Volumes

Existing Operations

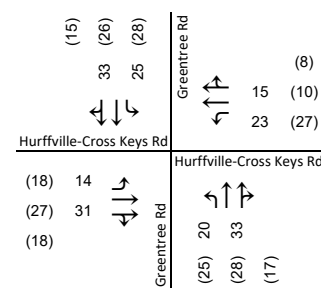
Implemented Operations

Operations with Improvements

AM Peak (Pattern 1)

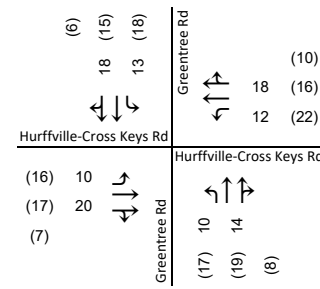
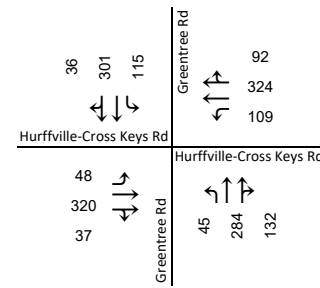


Summary			
Timing Pattern	FREE	Syn Delay	26 C
Actuated Cycle	65.7	Sim Delay	(22)
Max v/C	0.89	ICU	60% B

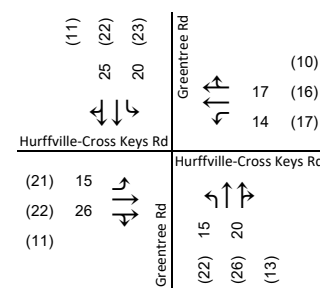


Summary			
Timing Pattern	1	Syn Delay	28 C
Actuated Cycle	90	Sim Delay	(22)
Max v/C	0.80	ICU	60% B

MD Peak (Pattern 2)

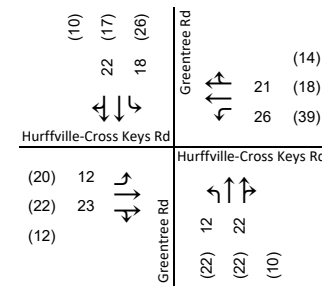
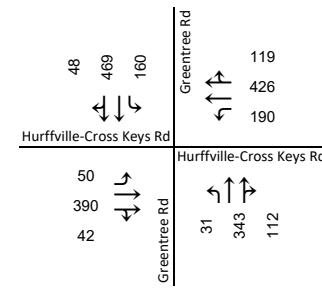


Summary			
Timing Pattern	FREE	Syn Delay	16 B
Actuated Cycle	49.1	Sim Delay	(16)
Max v/C	0.63	ICU	55% A

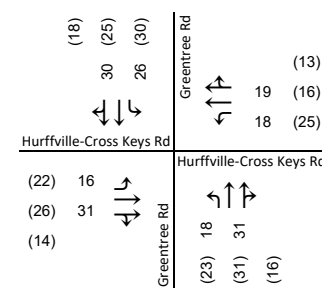


Summary			
Timing Pattern	2	Syn Delay	21 C
Actuated Cycle	90	Sim Delay	(19)
Max v/C	0.55	ICU	55% A

PM Peak (Pattern 3)

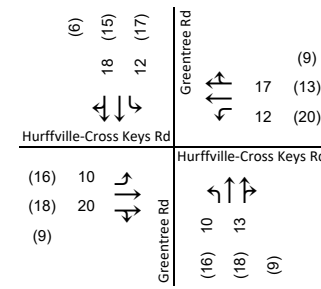
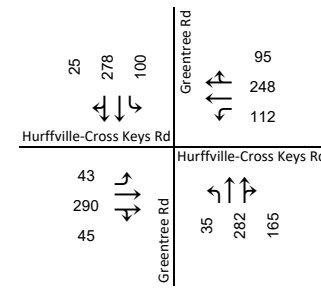


Summary			
Timing Pattern	FREE	Syn Delay	22 C
Actuated Cycle	61.7	Sim Delay	(20)
Max v/C	0.71	ICU	65% C

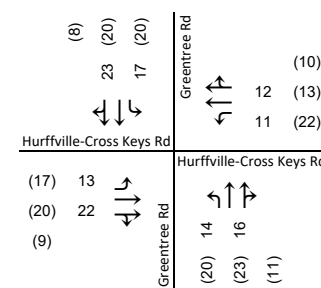


Summary			
Timing Pattern	3	Syn Delay	26 C
Actuated Cycle	100	Sim Delay	(23)
Max v/C	0.63	ICU	65% C

PM Off-peak (Pattern 4)

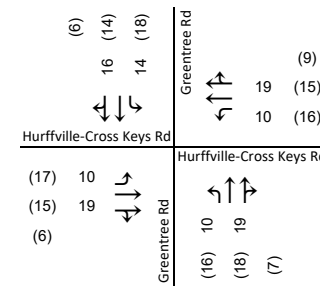
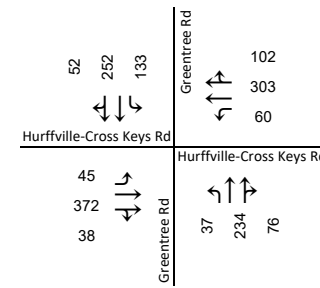


Summary			
Timing Pattern	FREE	Syn Delay	16 B
Actuated Cycle	49.2	Sim Delay	(15)
Max v/C	0.65	ICU	54% A

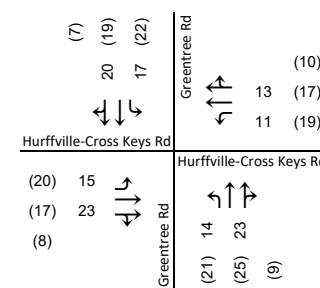


Summary			
Timing Pattern	4	Syn Delay	17 B
Actuated Cycle	80	Sim Delay	(17)
Max v/C	0.56	ICU	54% A

Weekend Off-peak (Pattern 5)

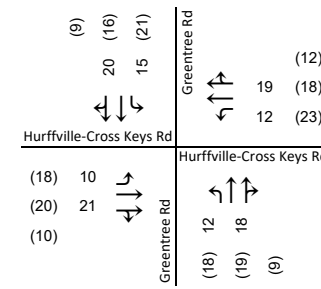
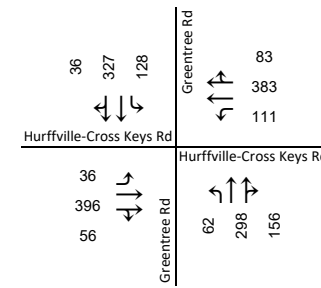


Summary			
Timing Pattern	FREE	Syn Delay	17 B
Actuated Cycle	49.9	Sim Delay	(14)
Max v/C	0.60	ICU	52% A

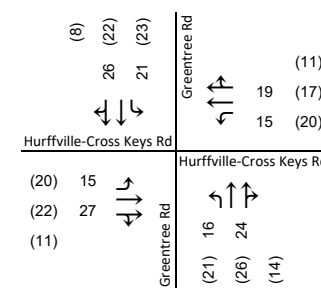


Summary			
Timing Pattern	5	Syn Delay	19 B
Actuated Cycle	80	Sim Delay	(18)
Max v/C	0.44	ICU	52% A

Weekend Peak (Pattern 6)



Summary			
Timing Pattern	FREE	Syn Delay	18 B
Actuated Cycle	52.7	Sim Delay	(17)
Max v/C	0.63	ICU	60% B



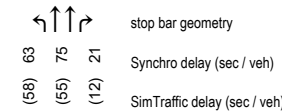
Summary			
Timing Pattern	6	Syn Delay	23 C
Actuated Cycle	90	Sim Delay	(20)
Max v/C	0.56	ICU	60% B

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



Hourly Volume Diagrams

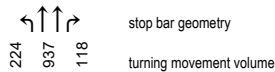
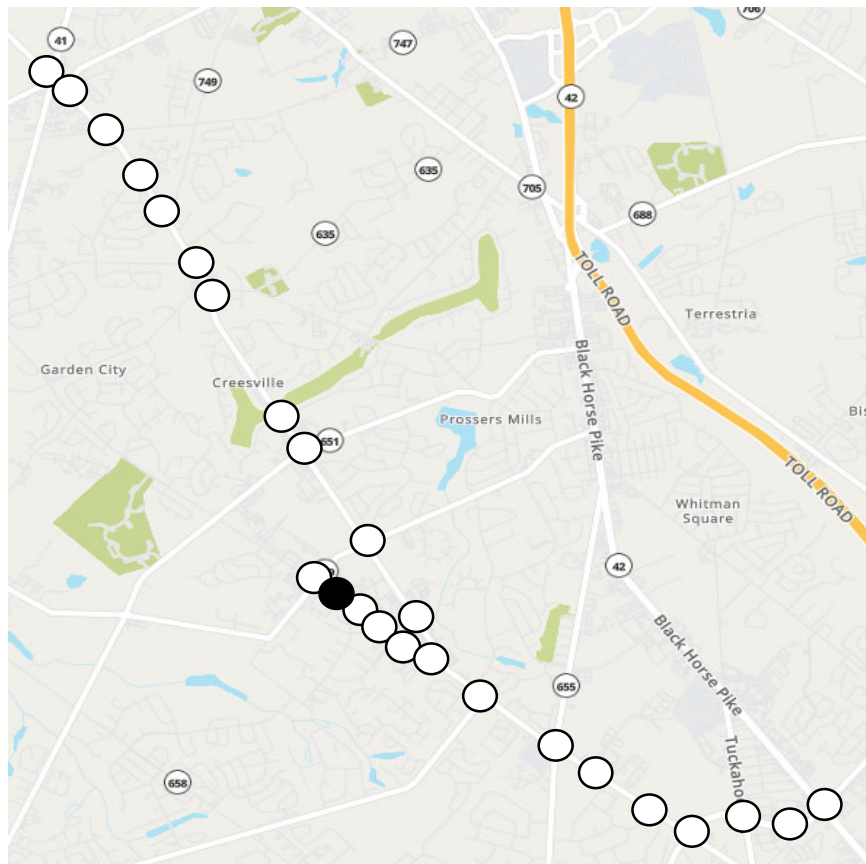
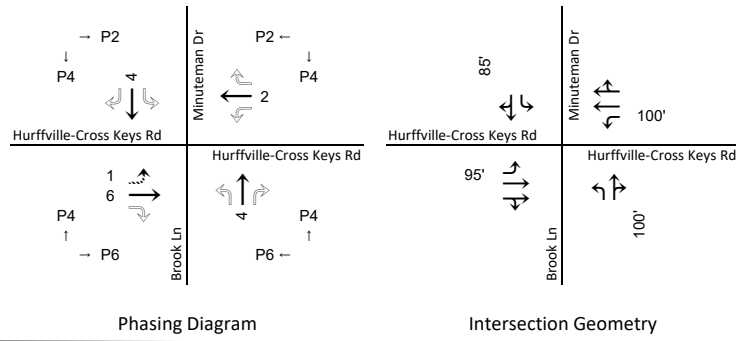


Figure 31

Traffic Operations Analysis

Hurffville-Cross Keys Rd (CR 654) & Greentree Rd (CR 651)

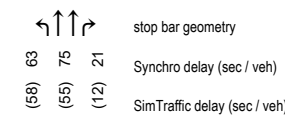


	AM Peak (Pattern 1)	MD Peak (Pattern 2)	PM Peak (Pattern 3)	PM Off-peak (Pattern 4)	Weekend Off-peak (Pattern 5)	Weekend Peak (Pattern 6)
Hourly Volumes						
Existing Operations						
Implemented Operations						
Operations with Improvements	No operational improvements recommended at this time.					



HCM Levels of Service		ICU Levels of Service	
LOS	Delay/Veh (s)	LOS	Utilization (%)
A	≤10	A	≤55%
B	>10 and ≤20	B	>55% and ≤64%
C	>20 and ≤35	C	>64% and ≤73%
D	>35 and ≤55	D	>73% and ≤82%
E	>55 and ≤80	E	>82% and ≤91%
F	>80	F	>91% and ≤100%
		G	>100% and ≤109%
		H	>109%

Operations Diagrams



Hourly Volume Diagrams

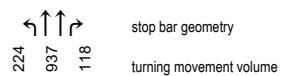
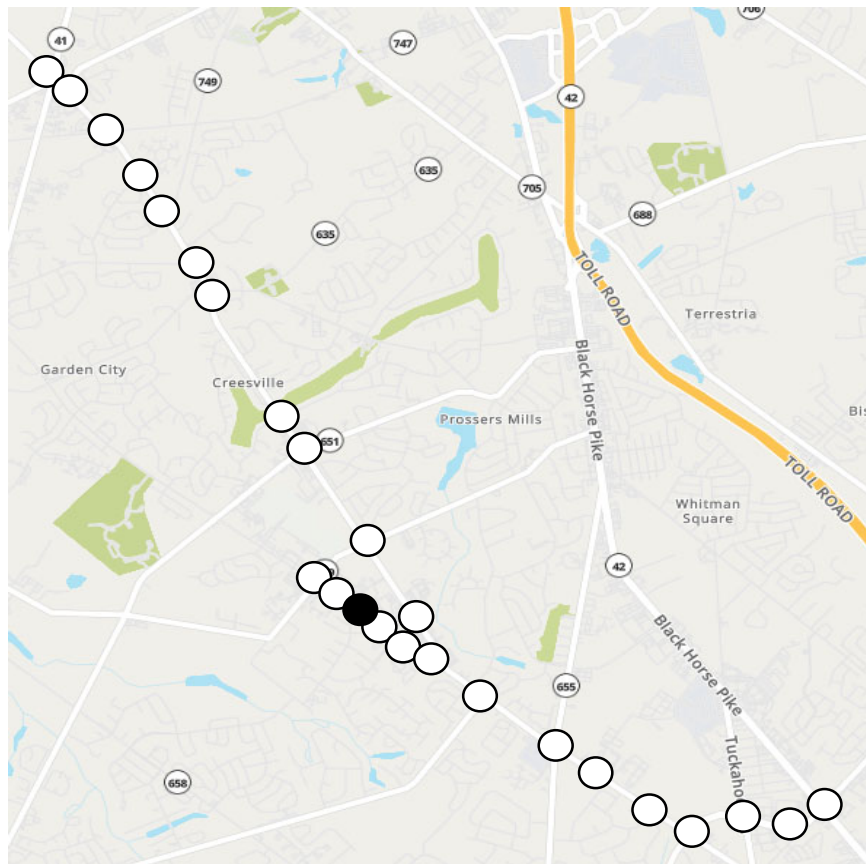
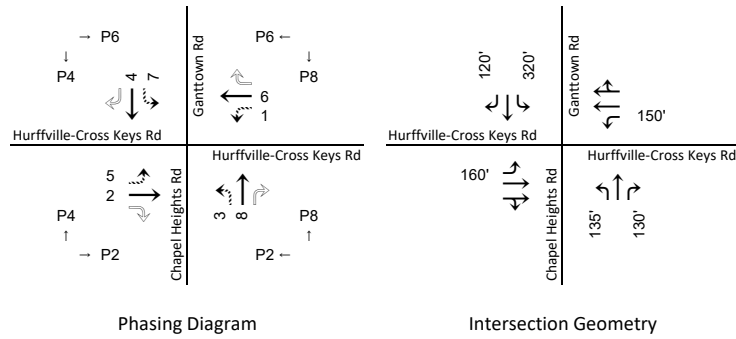


Figure 32

Traffic Operations Analysis

Hurffville-Cross Keys Rd (CR 654) & Brook Ln/Minuteman Dr



Hourly Volumes

AM Peak (Pattern 1)	
Hurffville-Cross Keys Rd	114 (down), 122 (up), 120 (right)
Chapel Heights Rd	70 (left), 361 (right), 50 (right)
Ganttown Rd	154 (left), 428 (right), 59 (right)

MD Peak (Pattern 2)	
Hurffville-Cross Keys Rd	93 (down), 147 (up), 173 (right)
Chapel Heights Rd	77 (left), 349 (right), 41 (right)
Ganttown Rd	129 (left), 303 (right), 106 (right)

PM Peak (Pattern 3)	
Hurffville-Cross Keys Rd	113 (down), 174 (up), 220 (right)
Chapel Heights Rd	140 (left), 528 (right), 63 (right)
Ganttown Rd	133 (left), 389 (right), 123 (right)

PM Off-peak (Pattern 4)	
Hurffville-Cross Keys Rd	76 (down), 113 (up), 173 (right)
Chapel Heights Rd	80 (left), 345 (right), 33 (right)
Ganttown Rd	110 (left), 277 (right), 93 (right)

Weekend Off-peak (Pattern 5)	
Hurffville-Cross Keys Rd	64 (down), 118 (up), 121 (right)
Chapel Heights Rd	54 (left), 271 (right), 18 (right)
Ganttown Rd	128 (left), 285 (right), 62 (right)

Weekend Peak (Pattern 6)	
Hurffville-Cross Keys Rd	79 (down), 158 (up), 128 (right)
Chapel Heights Rd	87 (left), 391 (right), 34 (right)
Ganttown Rd	116 (left), 335 (right), 84 (right)

Existing Operations

Hurffville-Cross Keys Rd	34 (29) (down), 31 (28) (up), 17 (22) (right)
Chapel Heights Rd	(25) 17 (left), (23) 27 (right), (27) (left)
Ganttown Rd	(29) 32 (25) (left), 15 (22) (right)

Hurffville-Cross Keys Rd	29 (25) (down), 31 (26) (up), 17 (23) (right)
Chapel Heights Rd	(24) 15 (left), (24) 26 (right), (24) (left)
Ganttown Rd	(26) 26 (23) (left), 16 (25) (right)

Hurffville-Cross Keys Rd	33 (34) (down), 32 (33) (up), 26 (59) (right)
Chapel Heights Rd	(39) 26 (left), (30) 32 (right), (31) (left)
Ganttown Rd	(28) 28 (27) (left), 30 (39) (right)

Hurffville-Cross Keys Rd	29 (26) (down), 29 (26) (up), 18 (22) (right)
Chapel Heights Rd	(22) 16 (left), (24) 26 (right), (24) (left)
Ganttown Rd	(26) 26 (25) (left), 16 (23) (right)

Hurffville-Cross Keys Rd	28 (26) (down), 29 (28) (up), 17 (22) (right)
Chapel Heights Rd	(22) 15 (left), (21) 25 (right), (23) (left)
Ganttown Rd	(25) 27 (20) (left), 14 (20) (right)

Hurffville-Cross Keys Rd	29 (28) (down), 31 (28) (up), 17 (22) (right)
Chapel Heights Rd	(24) 16 (left), (23) 26 (right), (24) (left)
Ganttown Rd	(25) 27 (24) (left), 16 (22) (right)

Summary	
Timing Pattern	FREE Syn Delay 28 C
Actuated Cycle	94 Sim Delay (25)
Max v/C	0.72 ICU 57% B

Summary	
Timing Pattern	FREE Syn Delay 25 C
Actuated Cycle	94 Sim Delay (25)
Max v/C	0.44 ICU 54% A

Summary	
Timing Pattern	FREE Syn Delay 30 C
Actuated Cycle	94 Sim Delay (34)
Max v/C	0.72 ICU 64% B

Summary	
Timing Pattern	FREE Syn Delay 24 C
Actuated Cycle	94 Sim Delay (24)
Max v/C	0.45 ICU 52% A

Summary	
Timing Pattern	FREE Syn Delay 25 C
Actuated Cycle	94 Sim Delay (23)
Max v/C	0.48 ICU 51% A

Summary	
Timing Pattern	FREE Syn Delay 25 C
Actuated Cycle	94 Sim Delay (25)
Max v/C	0.49 ICU 52% A

Implemented Operations

Hurffville-Cross Keys Rd	35 (28) (down), 32 (30) (up), 20 (25) (right)
Chapel Heights Rd	(24) 13 (left), (17) 18 (right), (23) (left)
Ganttown Rd	(27) 23 (25) (left), 9 (23) (right)

Hurffville-Cross Keys Rd	30 (29) (down), 31 (28) (up), 22 (27) (right)
Chapel Heights Rd	(19) 9 (left), (16) 15 (right), (17) (left)
Ganttown Rd	(23) 17 (18) (left), 10 (22) (right)

Hurffville-Cross Keys Rd	31 (31) (down), 30 (30) (up), 31 (43) (right)
Chapel Heights Rd	(36) 25 (left), (28) 28 (right), (34) (left)
Ganttown Rd	(25) 30 (26) (left), 27 (39) (right)

Hurffville-Cross Keys Rd	27 (25) (down), 27 (23) (up), 19 (22) (right)
Chapel Heights Rd	(21) 10 (left), (22) 16 (right), (24) (left)
Ganttown Rd	(19) 19 (19) (left), 10 (17) (right)

Hurffville-Cross Keys Rd	26 (23) (down), 28 (23) (up), 18 (21) (right)
Chapel Heights Rd	(19) 10 (left), (20) 19 (right), (20) (left)
Ganttown Rd	(23) 25 (20) (left), 10 (16) (right)

Hurffville-Cross Keys Rd	31 (27) (down), 34 (30) (up), 22 (24) (right)
Chapel Heights Rd	(17) 9 (left), (14) 14 (right), (16) (left)
Ganttown Rd	(20) 17 (19) (left), 9 (22) (right)

Summary	
Timing Pattern	1 Syn Delay 24 C
Actuated Cycle	90 Sim Delay (24)
Max v/C	0.67 ICU 55% A

Summary	
Timing Pattern	2 Syn Delay 21 C
Actuated Cycle	90 Sim Delay (23)
Max v/C	0.47 ICU 53% A

Summary	
Timing Pattern	3 Syn Delay 30 C
Actuated Cycle	100 Sim Delay (32)
Max v/C	0.73 ICU 64% B

Summary	
Timing Pattern	4 Syn Delay 20 B
Actuated Cycle	80 Sim Delay (22)
Max v/C	0.44 ICU 51% A

Summary	
Timing Pattern	5 Syn Delay 23 C
Actuated Cycle	80 Sim Delay (22)
Max v/C	0.47 ICU 50% A

Summary	
Timing Pattern	6 Syn Delay 21 C
Actuated Cycle	90 Sim Delay (22)
Max v/C	0.47 ICU 51% A

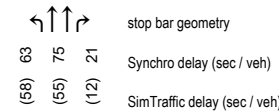
Operations with Improvements

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



Hourly Volume Diagrams

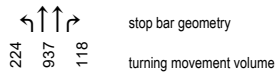
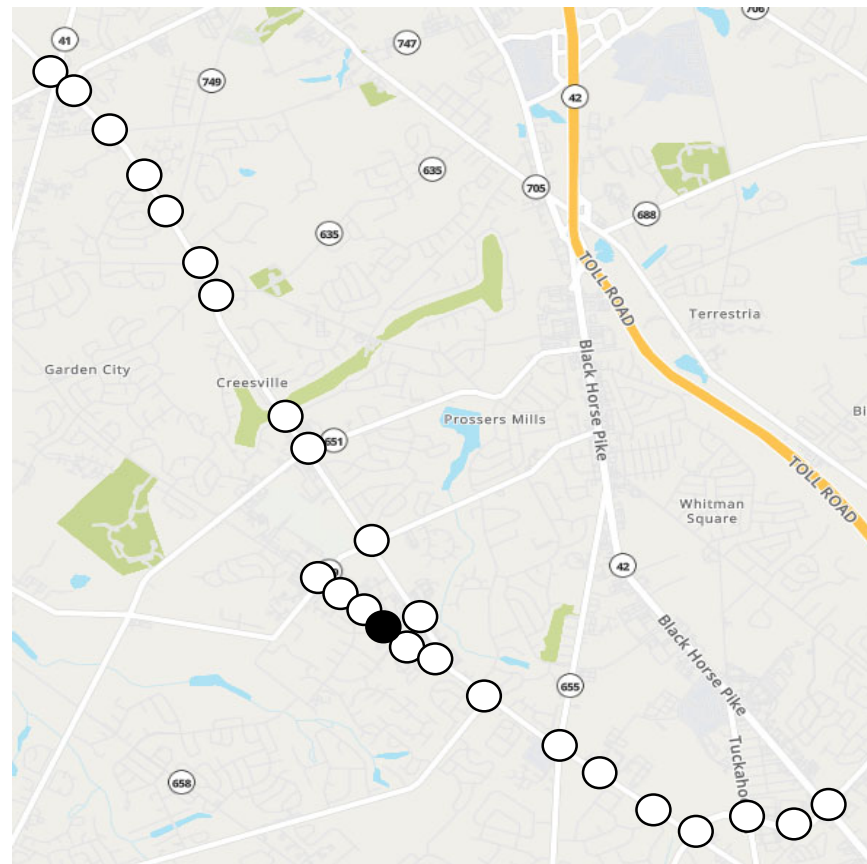
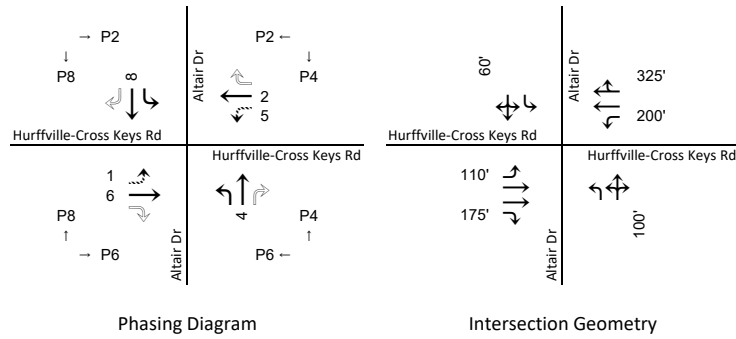


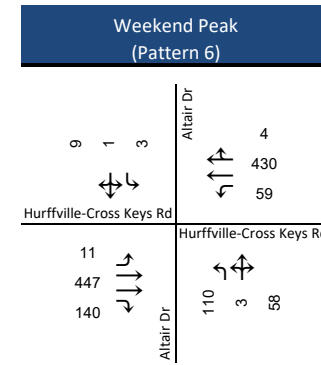
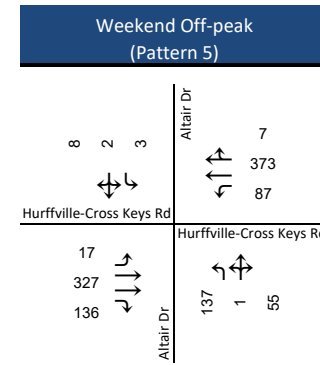
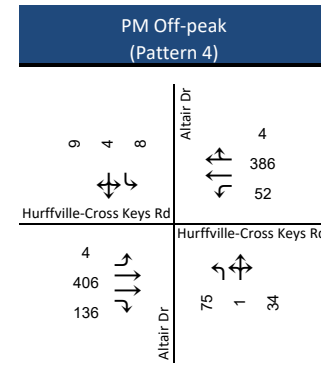
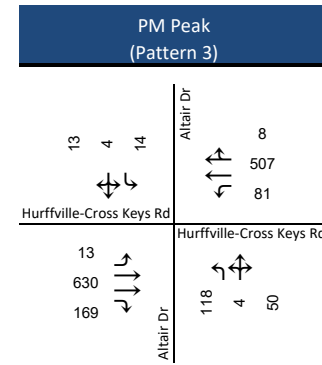
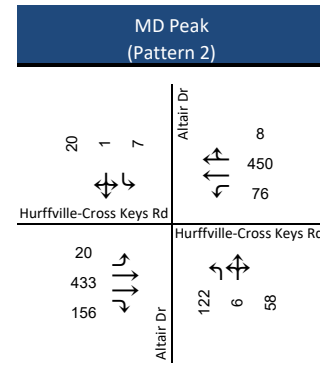
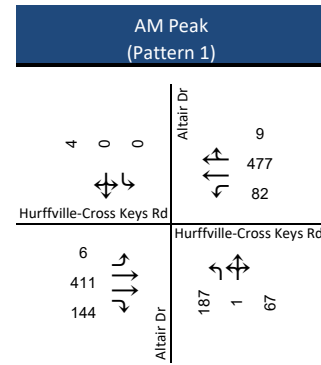
Figure 33

Traffic Operations Analysis

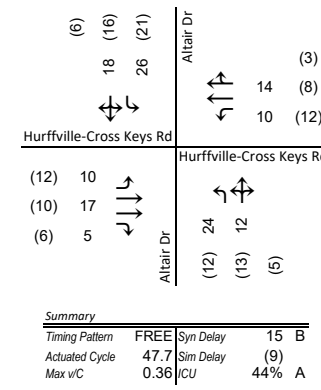
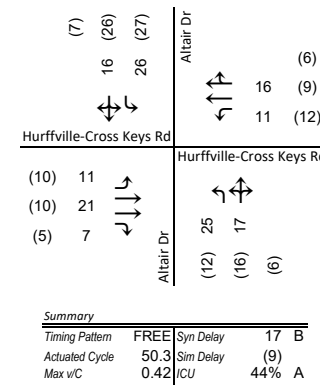
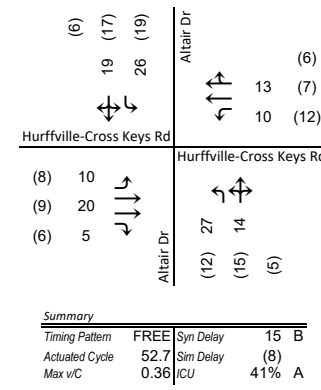
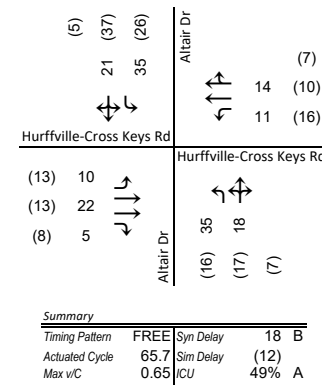
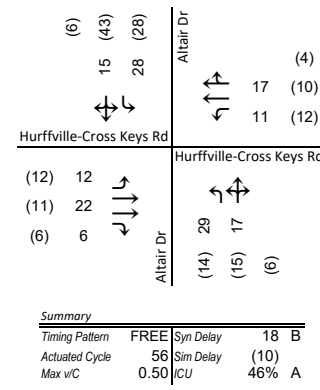
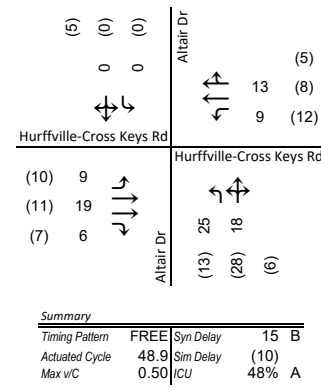
Hurffville-Cross Keys Rd (CR 654) & Chapel Heights Rd (CR 639)/Ganttown Rd (CR 639)



Hourly Volumes



Existing Operations



Summary			
Timing Pattern	FREE	Syn Delay	15 B
Actuated Cycle	48.9	Sim Delay	(10)
Max v/C	0.50	ICU	48% A

Summary			
Timing Pattern	FREE	Syn Delay	18 B
Actuated Cycle	56	Sim Delay	(10)
Max v/C	0.50	ICU	46% A

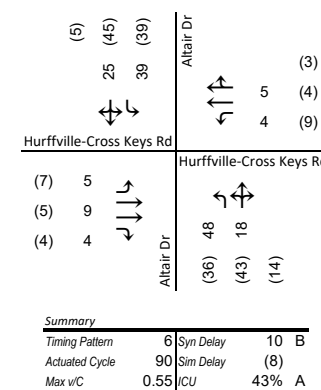
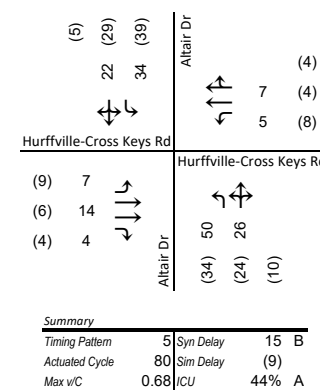
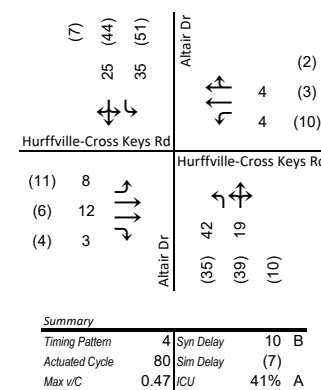
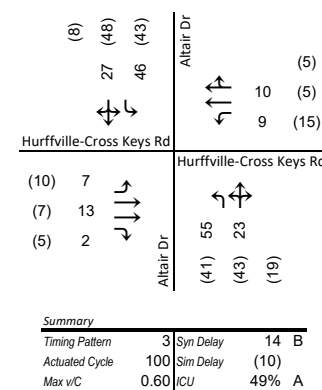
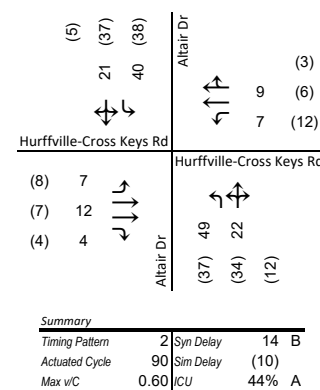
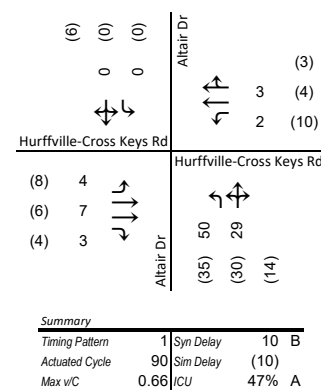
Summary			
Timing Pattern	FREE	Syn Delay	18 B
Actuated Cycle	65.7	Sim Delay	(12)
Max v/C	0.65	ICU	49% A

Summary			
Timing Pattern	FREE	Syn Delay	15 B
Actuated Cycle	52.7	Sim Delay	(8)
Max v/C	0.36	ICU	41% A

Summary			
Timing Pattern	FREE	Syn Delay	17 B
Actuated Cycle	50.3	Sim Delay	(9)
Max v/C	0.42	ICU	44% A

Summary			
Timing Pattern	FREE	Syn Delay	15 B
Actuated Cycle	47.7	Sim Delay	(9)
Max v/C	0.36	ICU	44% A

Implemented Operations



Summary			
Timing Pattern	1	Syn Delay	10 B
Actuated Cycle	90	Sim Delay	(10)
Max v/C	0.66	ICU	47% A

Summary			
Timing Pattern	2	Syn Delay	14 B
Actuated Cycle	90	Sim Delay	(10)
Max v/C	0.60	ICU	44% A

Summary			
Timing Pattern	3	Syn Delay	14 B
Actuated Cycle	100	Sim Delay	(10)
Max v/C	0.60	ICU	49% A

Summary			
Timing Pattern	4	Syn Delay	10 B
Actuated Cycle	80	Sim Delay	(7)
Max v/C	0.47	ICU	41% A

Summary			
Timing Pattern	5	Syn Delay	15 B
Actuated Cycle	80	Sim Delay	(9)
Max v/C	0.68	ICU	44% A

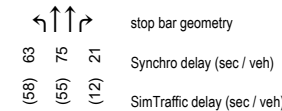
Summary			
Timing Pattern	6	Syn Delay	10 B
Actuated Cycle	90	Sim Delay	(8)
Max v/C	0.55	ICU	43% A

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



Hourly Volume Diagrams

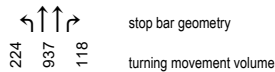
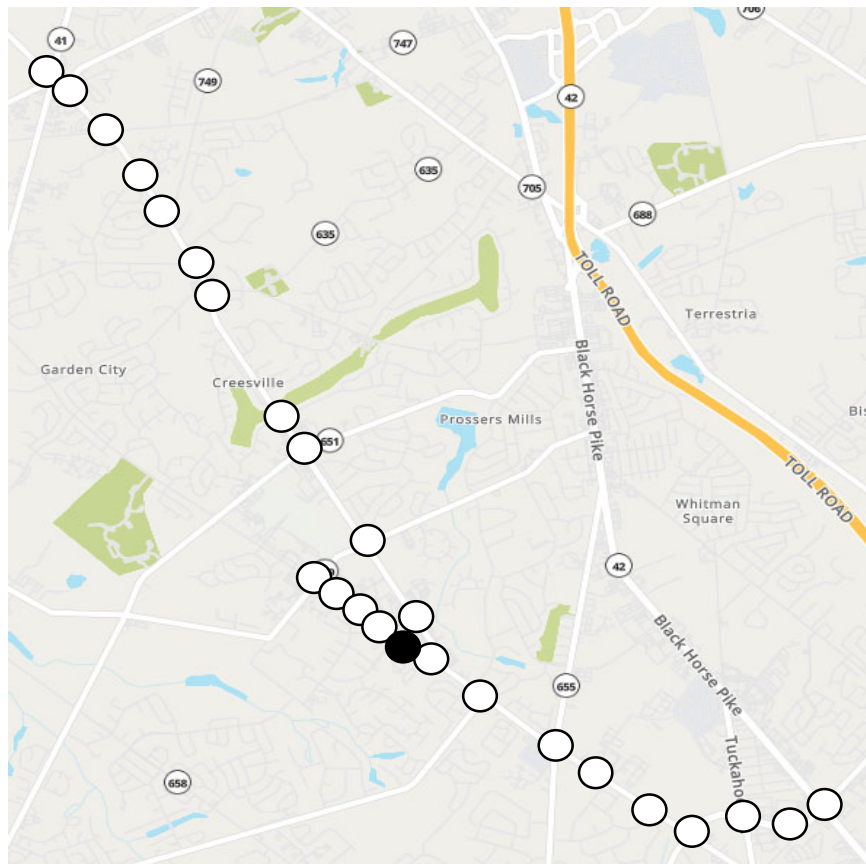
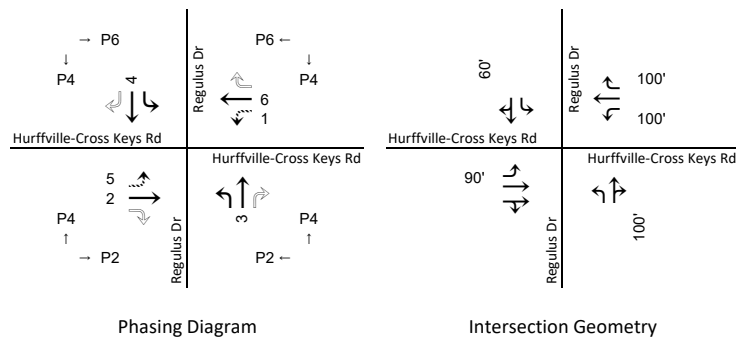


Figure 34

Traffic Operations Analysis

Hurffville-Cross Keys Rd (CR 654) & Altair Dr

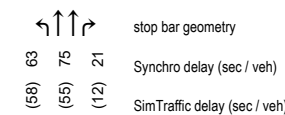


	AM Peak (Pattern 1)	MD Peak (Pattern 2)	PM Peak (Pattern 3)	PM Off-peak (Pattern 4)	Weekend Off-peak (Pattern 5)	Weekend Peak (Pattern 6)
Hourly Volumes						
Existing Operations						
Implemented Operations						
Operations with Improvements	No operational improvements recommended at this time.					



HCM Levels of Service		ICU Levels of Service	
LOS	Delay/Veh (s)	LOS	Utilization (%)
A	≤10	A	≤55%
B	>10 and ≤20	B	>55% and ≤64%
C	>20 and ≤35	C	>64% and ≤73%
D	>35 and ≤55	D	>73% and ≤82%
E	>55 and ≤80	E	>82% and ≤91%
F	>80	F	>91% and ≤100%
		G	>100% and ≤109%
		H	>109%

Operations Diagrams



Hourly Volume Diagrams

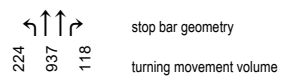
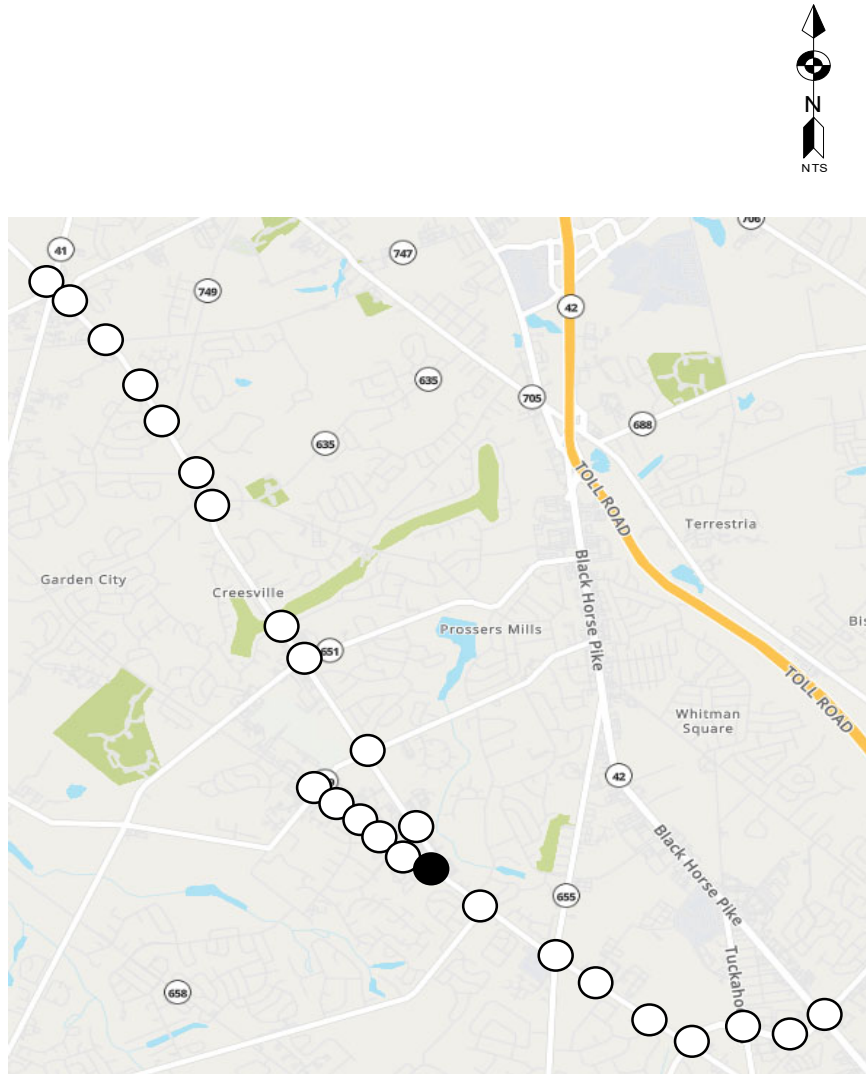
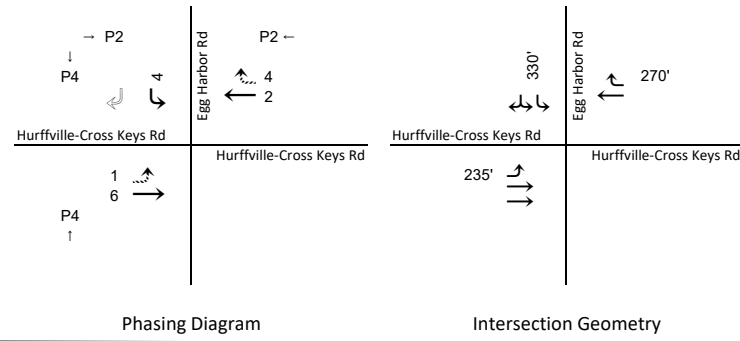


Figure 35

Traffic Operations Analysis

Hurffville-Cross Keys Rd (CR 654) & Regulus Dr



	AM Peak (Pattern 1)	MD Peak (Pattern 2)	PM Peak (Pattern 3)	PM Off-peak (Pattern 4)	Weekend Off-peak (Pattern 5)	Weekend Peak (Pattern 6)
Hourly Volumes						
Existing Operations						
Implemented Operations						
Operations with Improvements	No operational improvements recommended at this time.					

HCM Levels of Service		ICU Levels of Service	
LOS	Delay/Veh (s)	LOS	Utilization (%)
A	≤10	A	≤55%
B	>10 and ≤20	B	>55% and ≤64%
C	>20 and ≤35	C	>64% and ≤73%
D	>35 and ≤55	D	>73% and ≤82%
E	>55 and ≤80	E	>82% and ≤91%
F	>80	F	>91% and ≤100%
		G	>100% and ≤109%
		H	>109%

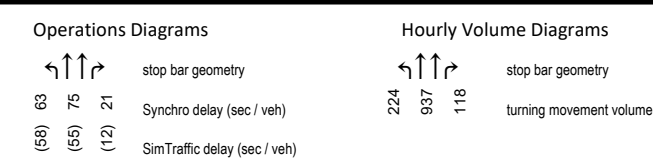
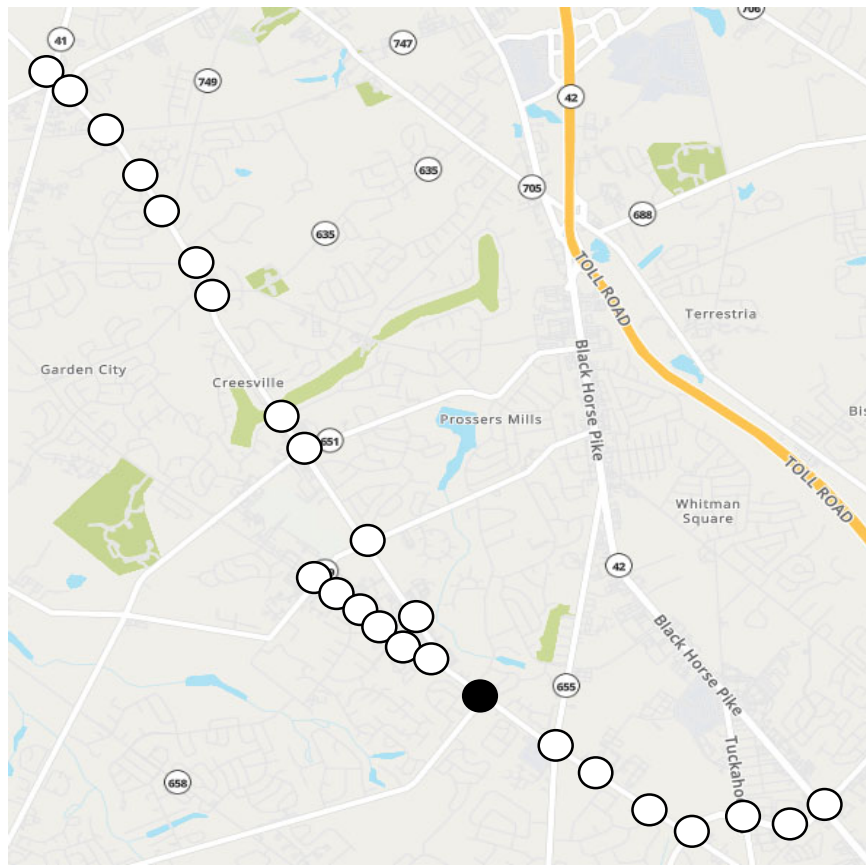
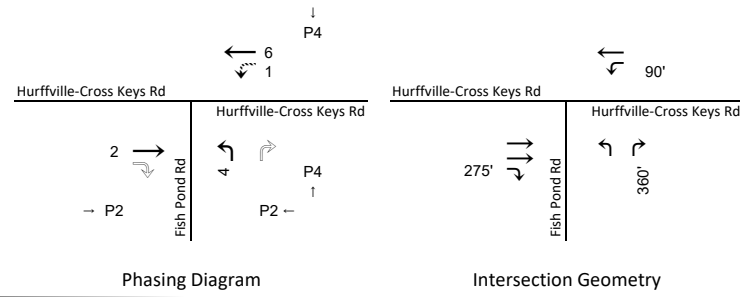


Figure 36

Traffic Operations Analysis

Hurffville-Cross Keys Rd (CR 654) & Egg Harbor Rd (CR 630)



AM Peak (Pattern 1)

MD Peak (Pattern 2)

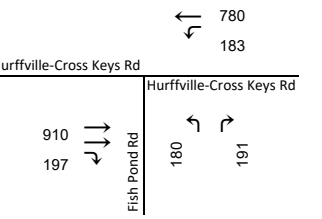
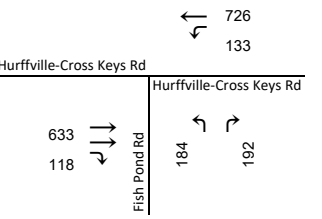
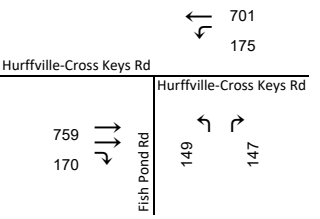
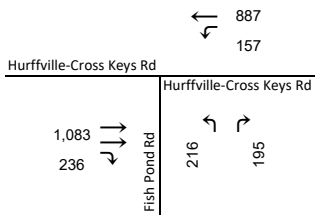
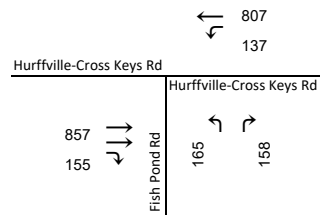
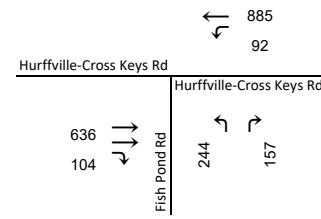
PM Peak (Pattern 3)

PM Off-peak (Pattern 4)

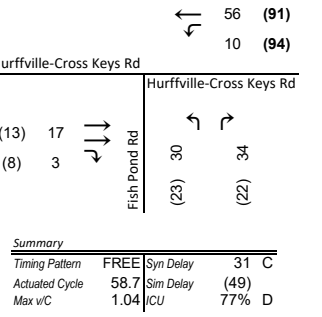
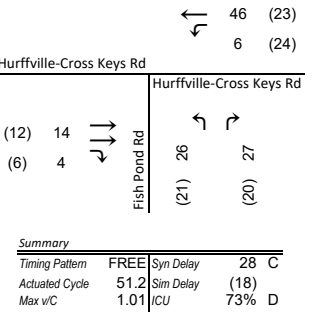
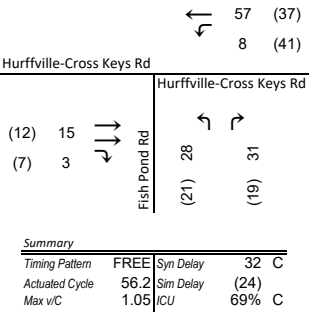
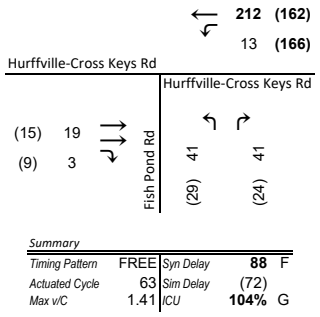
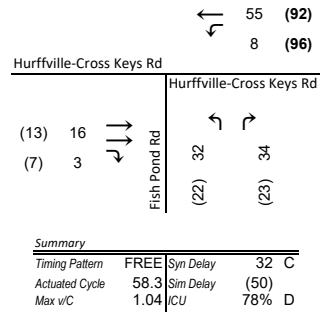
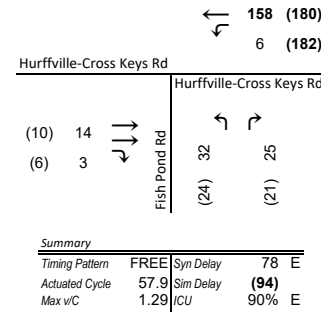
Weekend Off-peak (Pattern 5)

Weekend Peak (Pattern 6)

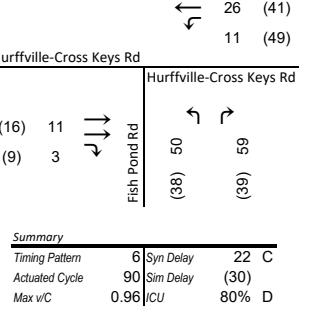
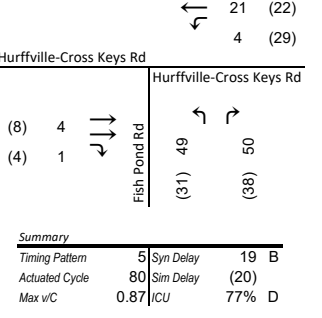
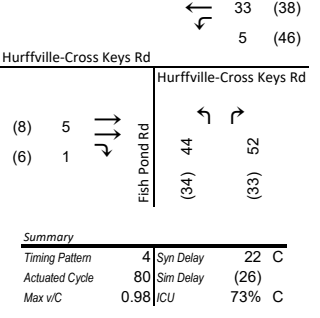
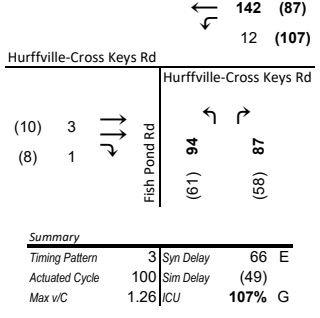
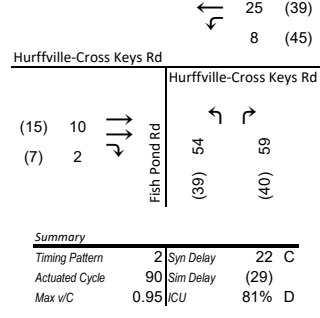
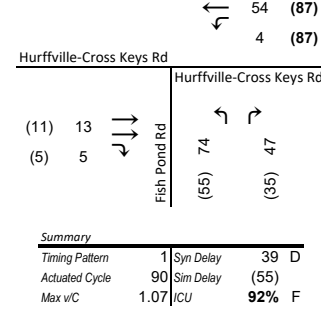
Hourly Volumes



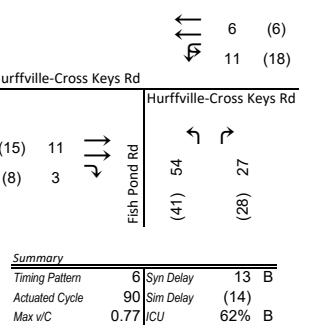
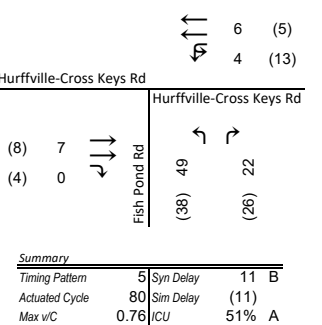
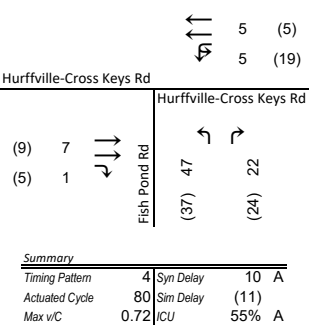
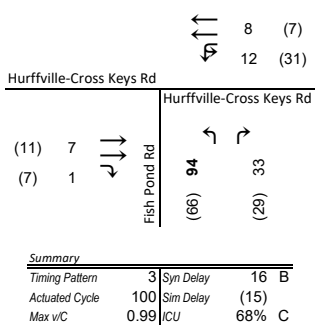
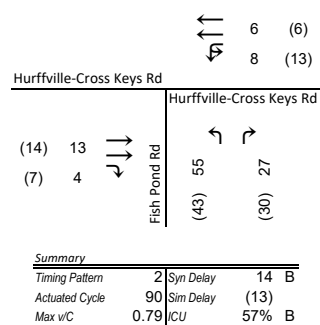
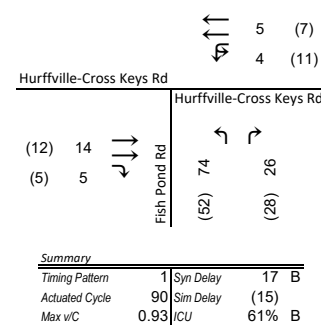
Existing Operations



Implemented Operations



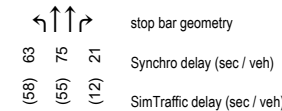
Operations with Improvements



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



Hourly Volume Diagrams

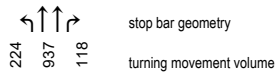
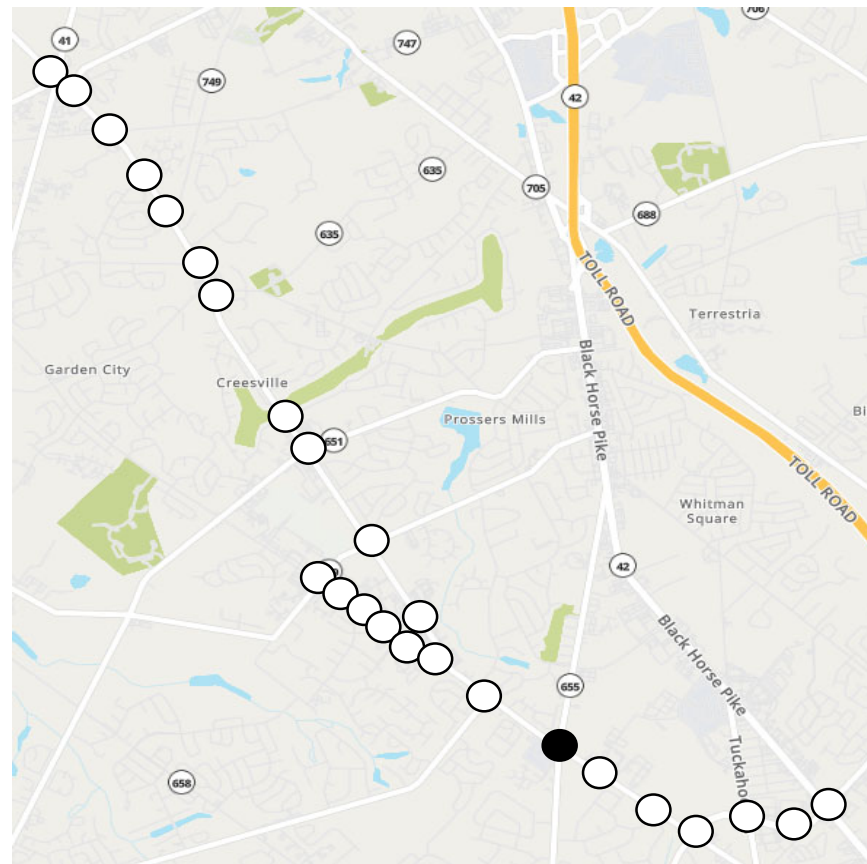
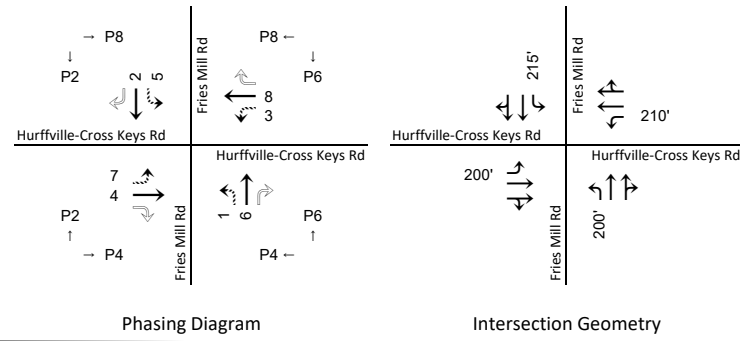


Figure 37

Traffic Operations Analysis

Hurffville-Cross Keys Rd (CR 654) & Fish Pond Rd (CR 634)



	AM Peak (Pattern 1)	MD Peak (Pattern 2)	PM Peak (Pattern 3)	PM Off-peak (Pattern 4)	Weekend Off-peak (Pattern 5)	Weekend Peak (Pattern 6)
Hourly Volumes						
Existing Operations						
Implemented Operations						
Operations with Improvements	No operational improvements recommended at this time.					

HCM Levels of Service		ICU Levels of Service	
LOS	Delay/Veh (s)	LOS	Utilization (%)
A	≤10	A	≤55%
B	>10 and ≤20	B	>55% and ≤64%
C	>20 and ≤35	C	>64% and ≤73%
D	>35 and ≤55	D	>73% and ≤82%
E	>55 and ≤80	E	>82% and ≤91%
F	>80	F	>91% and ≤100%
		G	>100% and ≤109%
		H	>109%

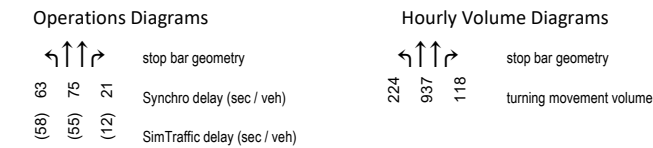
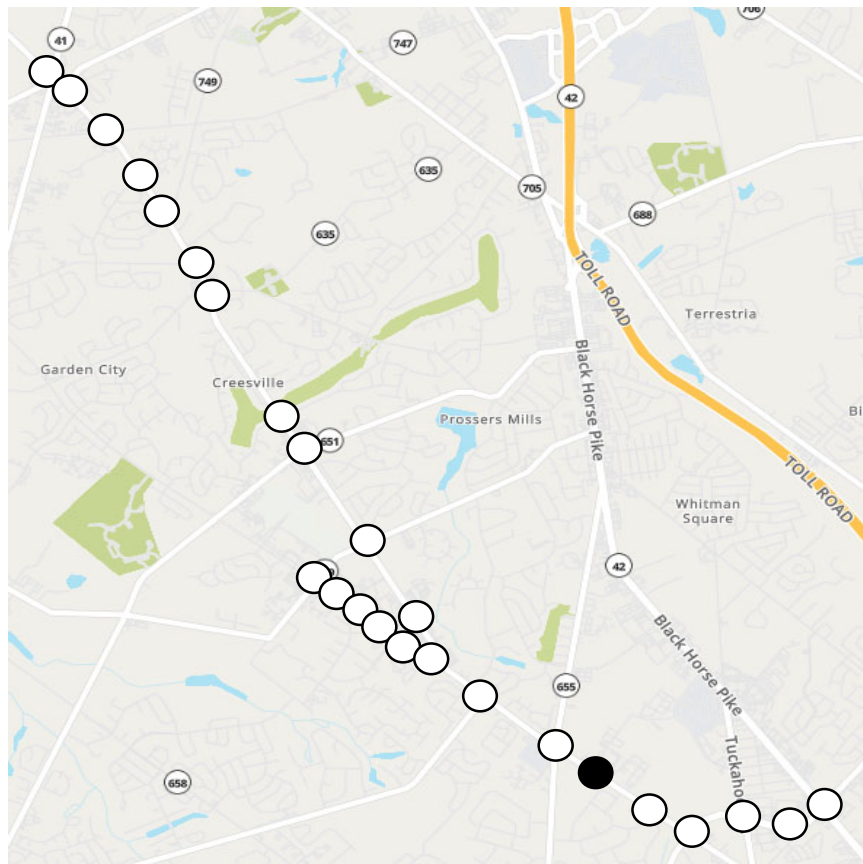
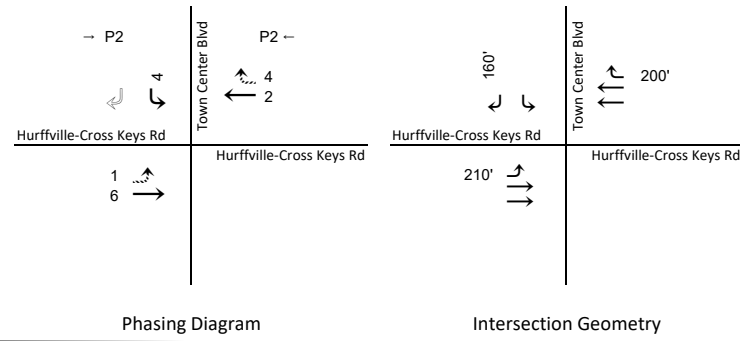


Figure 38

Traffic Operations Analysis

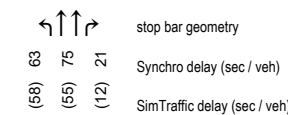
Hurffville-Cross Keys Rd (CR 654) & Fries Mill Rd (CR 655)



	AM Peak (Pattern 1)	MD Peak (Pattern 2)	PM Peak (Pattern 3)	PM Off-peak (Pattern 4)	Weekend Off-peak (Pattern 5)	Weekend Peak (Pattern 6)																																																																																										
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Summary	<table border="1"> <tr><td>Timing Pattern</td><td>1</td><td>Syn Delay</td><td>8</td><td>A</td></tr> <tr><td>Actuated Cycle</td><td>90</td><td>Sim Delay</td><td>(28)</td><td></td></tr> <tr><td>Max v/C</td><td>0.63</td><td>ICU</td><td>57%</td><td>B</td></tr> </table>	Timing Pattern	1	Syn Delay	8	A	Actuated Cycle	90	Sim Delay	(28)		Max v/C	0.63	ICU	57%	B	<table border="1"> <tr><td>Timing Pattern</td><td>1</td><td>Syn Delay</td><td>7</td><td>A</td></tr> <tr><td>Actuated Cycle</td><td>90</td><td>Sim Delay</td><td>(9)</td><td></td></tr> <tr><td>Max v/C</td><td>0.64</td><td>ICU</td><td>55%</td><td>A</td></tr> </table>	Timing Pattern	1	Syn Delay	7	A	Actuated Cycle	90	Sim Delay	(9)		Max v/C	0.64	ICU	55%	A	<table border="1"> <tr><td>Timing Pattern</td><td>1</td><td>Syn Delay</td><td>7</td><td>A</td></tr> <tr><td>Actuated Cycle</td><td>90</td><td>Sim Delay</td><td>(13)</td><td></td></tr> <tr><td>Max v/C</td><td>0.68</td><td>ICU</td><td>59%</td><td>B</td></tr> </table>	Timing Pattern	1	Syn Delay	7	A	Actuated Cycle	90	Sim Delay	(13)		Max v/C	0.68	ICU	59%	B	<table border="1"> <tr><td>Timing Pattern</td><td>1</td><td>Syn Delay</td><td>5</td><td>A</td></tr> <tr><td>Actuated Cycle</td><td>90</td><td>Sim Delay</td><td>(7)</td><td></td></tr> <tr><td>Max v/C</td><td>0.60</td><td>ICU</td><td>44%</td><td>A</td></tr> </table>	Timing Pattern	1	Syn Delay	5	A	Actuated Cycle	90	Sim Delay	(7)		Max v/C	0.60	ICU	44%	A	<table border="1"> <tr><td>Timing Pattern</td><td>1</td><td>Syn Delay</td><td>6</td><td>A</td></tr> <tr><td>Actuated Cycle</td><td>90</td><td>Sim Delay</td><td>(6)</td><td></td></tr> <tr><td>Max v/C</td><td>0.57</td><td>ICU</td><td>43%</td><td>A</td></tr> </table>	Timing Pattern	1	Syn Delay	6	A	Actuated Cycle	90	Sim Delay	(6)		Max v/C	0.57	ICU	43%	A	<table border="1"> <tr><td>Timing Pattern</td><td>1</td><td>Syn Delay</td><td>6</td><td>A</td></tr> <tr><td>Actuated Cycle</td><td>90</td><td>Sim Delay</td><td>(8)</td><td></td></tr> <tr><td>Max v/C</td><td>0.59</td><td>ICU</td><td>51%</td><td>A</td></tr> </table>	Timing Pattern	1	Syn Delay	6	A	Actuated Cycle	90	Sim Delay	(8)		Max v/C	0.59	ICU	51%	A
Timing Pattern	1	Syn Delay	8	A																																																																																												
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HCM Levels of Service		LOS Utilization (%)	
LOS	Delay/Veh (s)	LOS	Utilization (%)
A	≤10	A	≤55%
B	>10 and ≤20	B	>55% and ≤64%
C	>20 and ≤35	C	>64% and ≤73%
D	>35 and ≤55	D	>73% and ≤82%
E	>55 and ≤80	E	>82% and ≤91%
F	>80	F	>91% and ≤100%
		G	>100% and ≤109%
		H	>109%

Operations Diagrams



Hourly Volume Diagrams

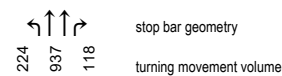
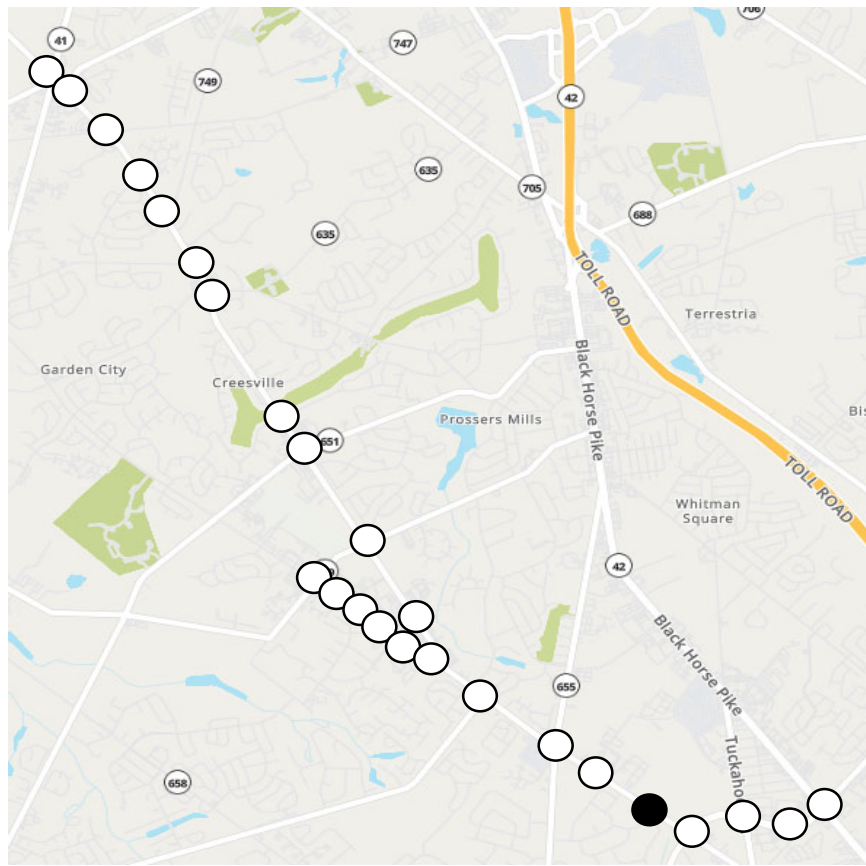
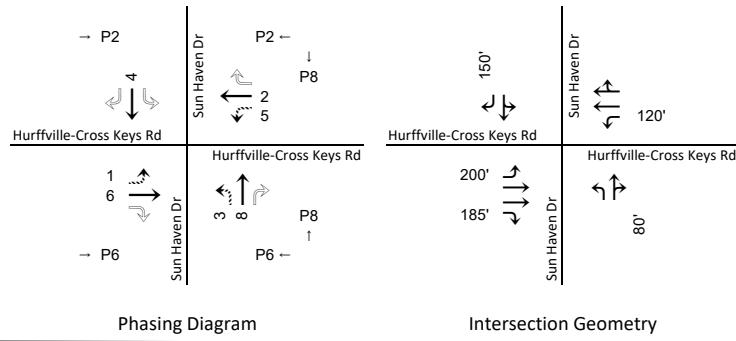


Figure 39

Traffic Operations Analysis

Hurffville-Cross Keys Rd (CR 654) & Town Center Blvd

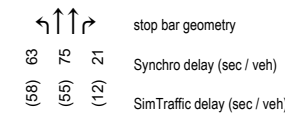


	AM Peak (Pattern 1)	MD Peak (Pattern 2)	PM Peak (Pattern 3)	PM Off-peak (Pattern 4)	Weekend Off-peak (Pattern 5)	Weekend Peak (Pattern 6)
Hourly Volumes						
Existing Operations						
Implemented Operations						
Operations with Improvements	No operational improvements recommended at this time.					



HCM Levels of Service		ICU Levels of Service	
LOS	Delay/Veh (s)	LOS	Utilization (%)
A	≤10	A	≤55%
B	>10 and ≤20	B	>55% and ≤64%
C	>20 and ≤35	C	>64% and ≤73%
D	>35 and ≤55	D	>73% and ≤82%
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F	>80	F	>91% and ≤100%
		G	>100% and ≤109%
		H	>109%

Operations Diagrams



Hourly Volume Diagrams

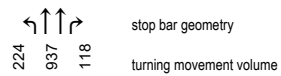
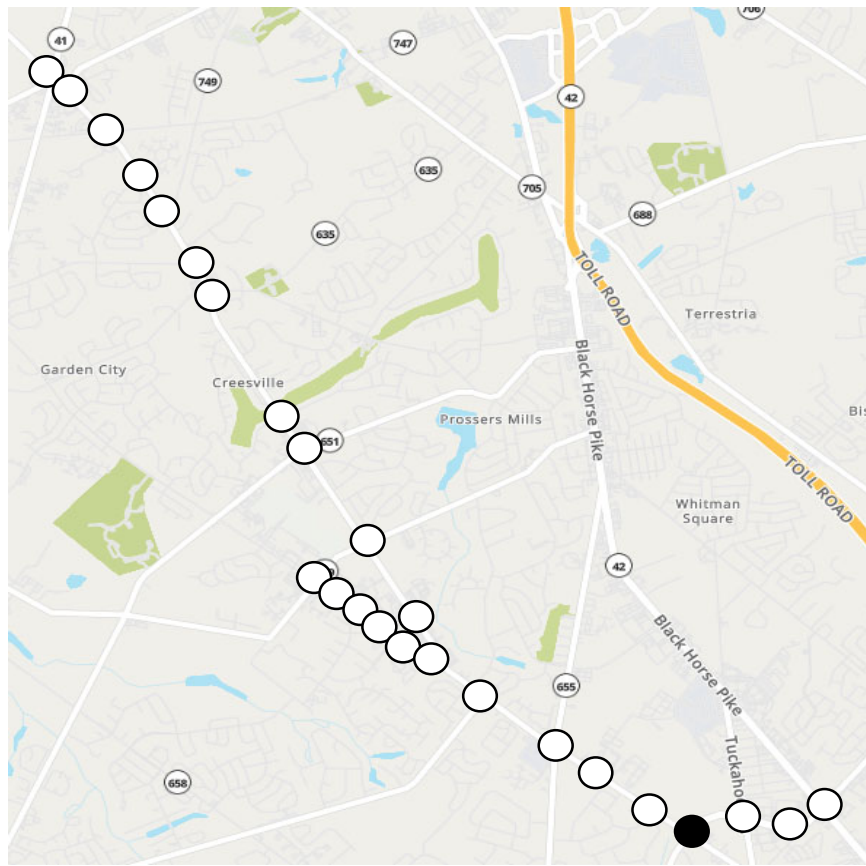
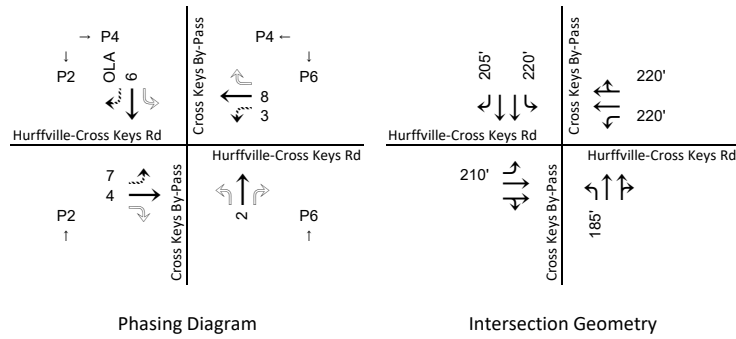


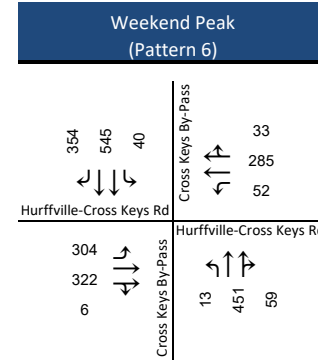
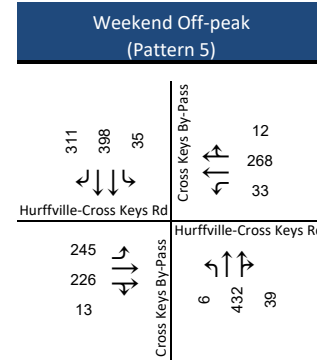
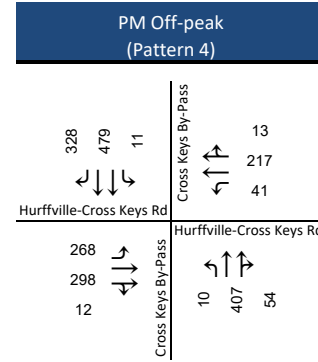
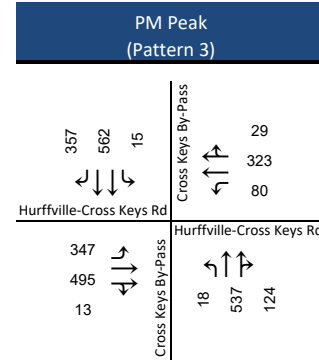
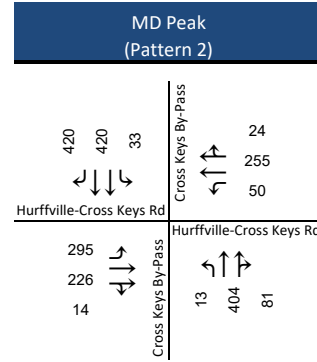
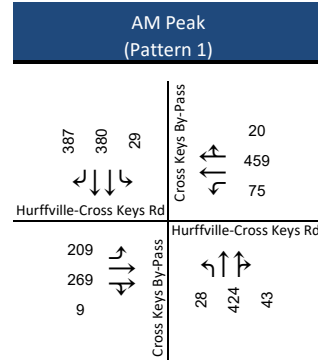
Figure 40

Traffic Operations Analysis

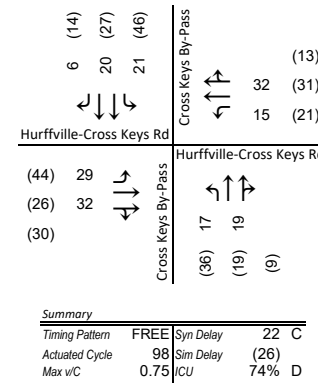
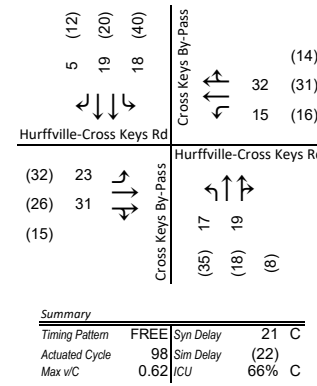
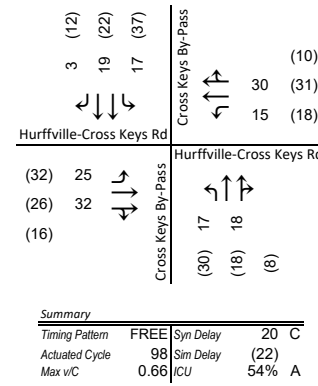
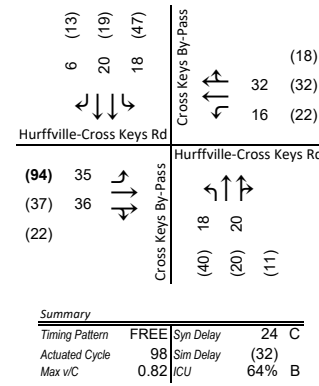
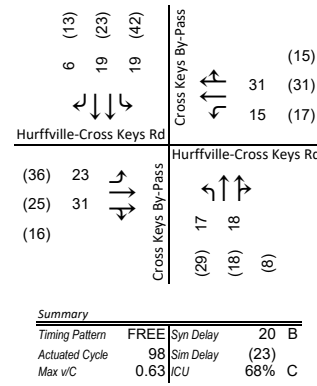
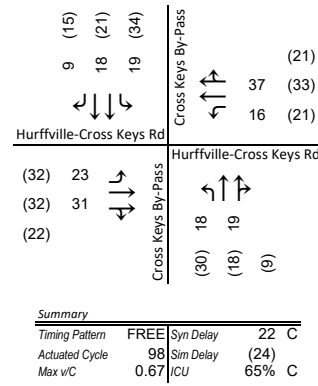
Hurffville-Cross Keys Rd (CR 654) & Sun Haven Dr



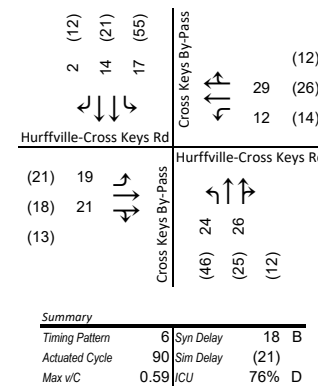
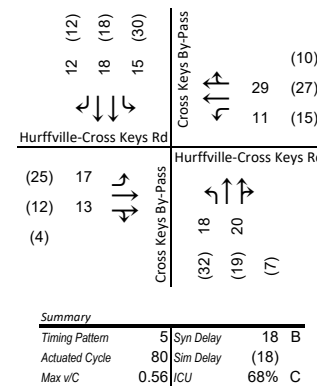
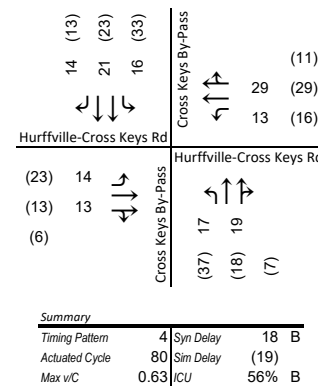
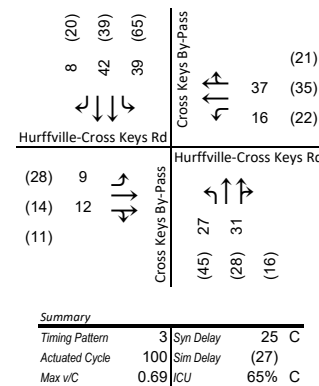
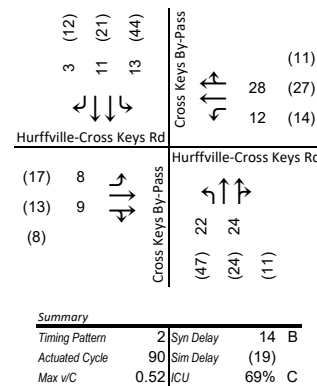
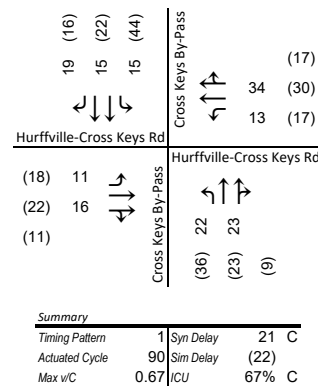
Hourly Volumes



Existing Operations



Implemented Operations



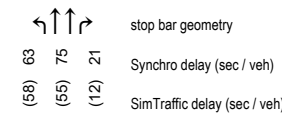
Operations with Improvements

No operational improvements recommended at this time.



HCM Levels of Service		ICU Levels of Service	
LOS	Delay/Veh (s)	LOS	Utilization (%)
A	≤10	A	≤55%
B	>10 and ≤20	B	>55% and ≤64%
C	>20 and ≤35	C	>64% and ≤73%
D	>35 and ≤55	D	>73% and ≤82%
E	>55 and ≤80	E	>82% and ≤91%
F	>80	F	>91% and ≤100%
		G	>100% and ≤109%
		H	>109%

Operations Diagrams



Hourly Volume Diagrams

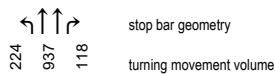
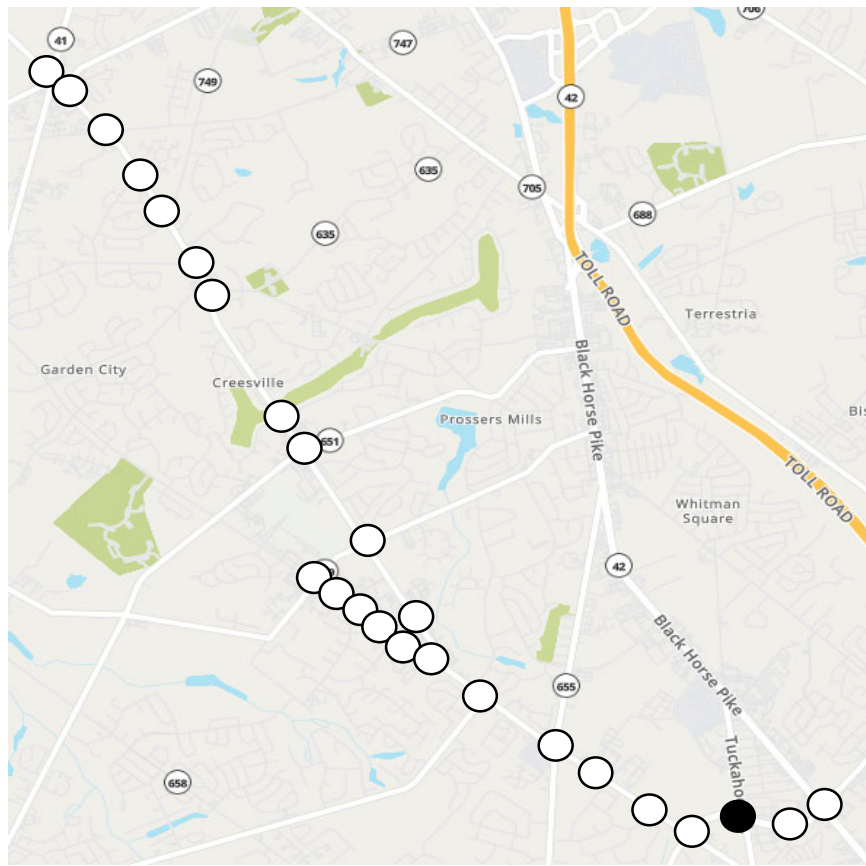
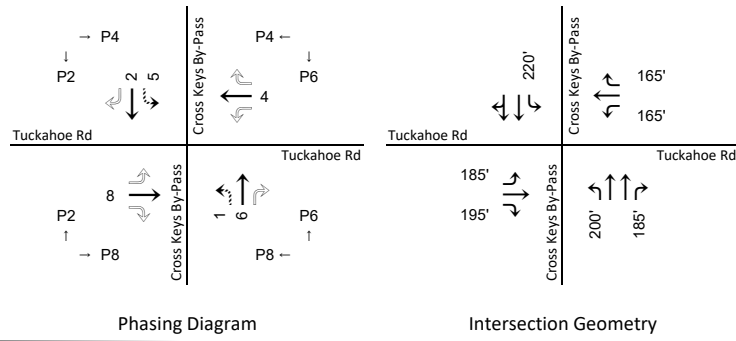


Figure 41

Traffic Operations Analysis

Cross Keys By-Pass (CR 689) & Hurffville-Cross Keys Rd (CR 654)



Hourly Volumes

AM Peak (Pattern 1)	
Tuckahoe Rd	Cross Keys By-Pass
27 674 90	142 294 9

MD Peak (Pattern 2)	
Tuckahoe Rd	Cross Keys By-Pass
56 602 180	114 246 8

PM Peak (Pattern 3)	
Tuckahoe Rd	Cross Keys By-Pass
67 707 219	141 275 5

PM Off-peak (Pattern 4)	
Tuckahoe Rd	Cross Keys By-Pass
74 563 188	110 215 4

Weekend Off-peak (Pattern 5)	
Tuckahoe Rd	Cross Keys By-Pass
88 531 162	184 313 5

Weekend Peak (Pattern 6)	
Tuckahoe Rd	Cross Keys By-Pass
84 597 235	153 299 6

Existing Operations

Summary	
Timing Pattern	FREE Syn Delay 21 C
Actuated Cycle	87 Sim Delay (19)
Max v/c	0.70 ICU 58% B

Summary	
Timing Pattern	FREE Syn Delay 19 B
Actuated Cycle	87 Sim Delay (21)
Max v/c	0.65 ICU 67% C

Summary	
Timing Pattern	FREE Syn Delay 23 C
Actuated Cycle	89.6 Sim Delay (37)
Max v/c	0.89 ICU 78% D

Summary	
Timing Pattern	FREE Syn Delay 20 B
Actuated Cycle	87 Sim Delay (23)
Max v/c	0.72 ICU 73% D

Summary	
Timing Pattern	FREE Syn Delay 20 B
Actuated Cycle	87 Sim Delay (23)
Max v/c	0.76 ICU 66% C

Summary	
Timing Pattern	FREE Syn Delay 22 C
Actuated Cycle	89.6 Sim Delay (35)
Max v/c	0.78 ICU 81% D

Implemented Operations

Summary	
Timing Pattern	1 Syn Delay 20 C
Actuated Cycle	90 Sim Delay (20)
Max v/c	0.68 ICU 60% B

Summary	
Timing Pattern	2 Syn Delay 21 C
Actuated Cycle	90 Sim Delay (22)
Max v/c	0.71 ICU 68% C

Summary	
Timing Pattern	3 Syn Delay 26 C
Actuated Cycle	100 Sim Delay (31)
Max v/c	0.83 ICU 80% D

Summary	
Timing Pattern	4 Syn Delay 20 B
Actuated Cycle	80 Sim Delay (23)
Max v/c	0.75 ICU 75% D

Summary	
Timing Pattern	5 Syn Delay 19 B
Actuated Cycle	80 Sim Delay (24)
Max v/c	0.73 ICU 67% C

Summary	
Timing Pattern	6 Syn Delay 24 C
Actuated Cycle	90 Sim Delay (28)
Max v/c	0.79 ICU 84% E

Operations with Improvements

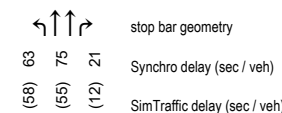
No operational improvements recommended at this time.



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



Hourly Volume Diagrams

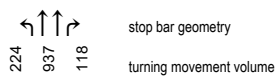
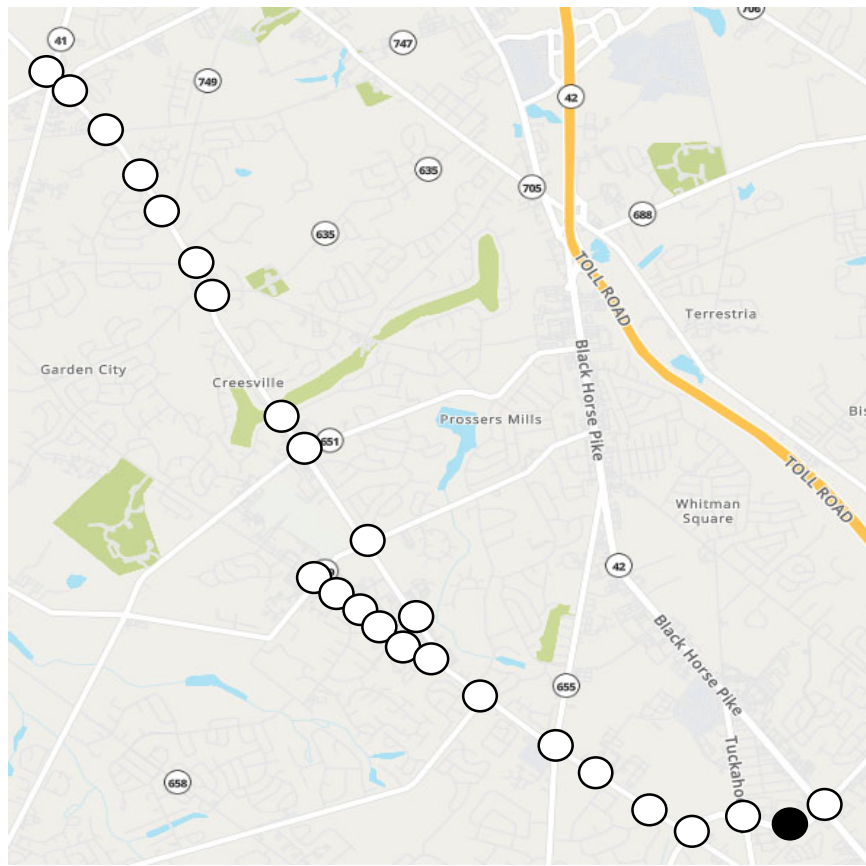
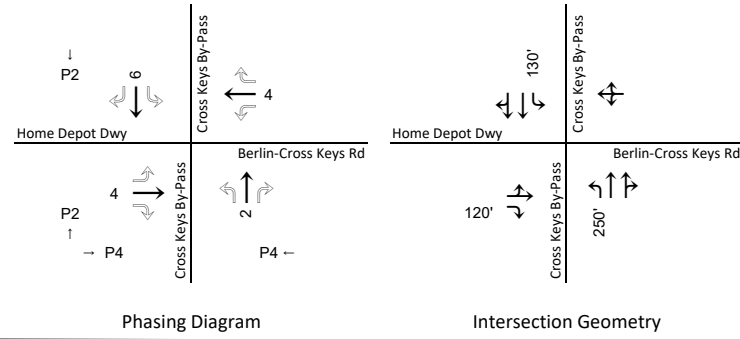


Figure 42

Traffic Operations Analysis

Cross Keys By-Pass (CR 689) & Tuckahoe Rd (CR 555)



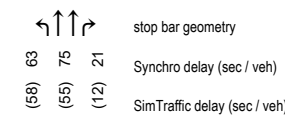
	AM Peak (Pattern 1)	MD Peak (Pattern 2)	PM Peak (Pattern 3)	PM Off-peak (Pattern 4)	Weekend Off-peak (Pattern 5)	Weekend Peak (Pattern 6)																																																																																																																																																																																																																																																
Hourly Volumes	<table border="1"> <tr><td>Home Depot Dwy</td><td>70</td><td>721</td><td>3</td><td>7</td></tr> <tr><td>Cross Keys By-Pass</td><td>4</td><td>0</td><td>4</td><td>7</td></tr> <tr><td>Berlin-Cross Keys Rd</td><td>56</td><td>136</td><td>92</td><td>97</td></tr> <tr><td>Cross Keys By-Pass</td><td>0</td><td>2</td><td>2</td><td>1</td></tr> <tr><td>Home Depot Dwy</td><td>26</td><td>50</td><td>51</td><td>33</td></tr> <tr><td>Cross Keys By-Pass</td><td>69</td><td>88</td><td>96</td><td>53</td></tr> <tr><td>Berlin-Cross Keys Rd</td><td>590</td><td>550</td><td>724</td><td>561</td></tr> <tr><td>Cross Keys By-Pass</td><td>2</td><td>5</td><td>6</td><td>6</td></tr> </table>	Home Depot Dwy	70	721	3	7	Cross Keys By-Pass	4	0	4	7	Berlin-Cross Keys Rd	56	136	92	97	Cross Keys By-Pass	0	2	2	1	Home Depot Dwy	26	50	51	33	Cross Keys By-Pass	69	88	96	53	Berlin-Cross Keys Rd	590	550	724	561	Cross Keys By-Pass	2	5	6	6	<table border="1"> <tr><td>Home Depot 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Summary	<table border="1"> <tr><td>Timing Pattern</td><td>1</td><td>Syn Delay</td><td>6</td><td>A</td></tr> <tr><td>Actuated Cycle</td><td>90</td><td>Sim Delay</td><td>(9)</td><td></td></tr> <tr><td>Max v/C</td><td>0.54</td><td>ICU</td><td>59%</td><td>B</td></tr> </table>	Timing Pattern	1	Syn Delay	6	A	Actuated Cycle	90	Sim Delay	(9)		Max v/C	0.54	ICU	59%	B	<table border="1"> <tr><td>Timing Pattern</td><td>1</td><td>Syn Delay</td><td>10</td><td>A</td></tr> <tr><td>Actuated Cycle</td><td>90</td><td>Sim Delay</td><td>(13)</td><td></td></tr> <tr><td>Max v/C</td><td>0.70</td><td>ICU</td><td>61%</td><td>B</td></tr> </table>	Timing Pattern	1	Syn Delay	10	A	Actuated Cycle	90	Sim Delay	(13)		Max v/C	0.70	ICU	61%	B	<table border="1"> <tr><td>Timing Pattern</td><td>1</td><td>Syn Delay</td><td>8</td><td>A</td></tr> <tr><td>Actuated Cycle</td><td>90</td><td>Sim Delay</td><td>(16)</td><td></td></tr> <tr><td>Max v/C</td><td>0.64</td><td>ICU</td><td>66%</td><td>C</td></tr> </table>	Timing Pattern	1	Syn Delay	8	A	Actuated Cycle	90	Sim Delay	(16)		Max v/C	0.64	ICU	66%	C	<table border="1"> <tr><td>Timing Pattern</td><td>1</td><td>Syn Delay</td><td>9</td><td>A</td></tr> <tr><td>Actuated Cycle</td><td>90</td><td>Sim Delay</td><td>(11)</td><td></td></tr> <tr><td>Max v/C</td><td>0.68</td><td>ICU</td><td>58%</td><td>B</td></tr> </table>	Timing Pattern	1	Syn Delay	9	A	Actuated Cycle	90	Sim Delay	(11)		Max v/C	0.68	ICU	58%	B	<table border="1"> <tr><td>Timing Pattern</td><td>1</td><td>Syn Delay</td><td>10</td><td>A</td></tr> <tr><td>Actuated Cycle</td><td>90</td><td>Sim Delay</td><td>(13)</td><td></td></tr> <tr><td>Max v/C</td><td>0.69</td><td>ICU</td><td>65%</td><td>C</td></tr> </table>	Timing Pattern	1	Syn Delay	10	A	Actuated Cycle	90	Sim Delay	(13)		Max v/C	0.69	ICU	65%	C	<table border="1"> <tr><td>Timing Pattern</td><td>1</td><td>Syn Delay</td><td>14</td><td>B</td></tr> <tr><td>Actuated Cycle</td><td>90</td><td>Sim Delay</td><td>(35)</td><td></td></tr> <tr><td>Max v/C</td><td>0.82</td><td>ICU</td><td>68%</td><td>C</td></tr> </table>	Timing Pattern	1	Syn Delay	14	B	Actuated Cycle	90	Sim Delay	(35)		Max v/C	0.82	ICU	68%	C																																																																																																																																																						
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Timing Pattern	1	Syn Delay	8	A																																																																																																																																																																																																																																																		
Actuated Cycle	90	Sim Delay	(16)																																																																																																																																																																																																																																																			
Max v/C	0.64	ICU	66%	C																																																																																																																																																																																																																																																		
Timing Pattern	1	Syn Delay	9	A																																																																																																																																																																																																																																																		
Actuated Cycle	90	Sim Delay	(11)																																																																																																																																																																																																																																																			
Max v/C	0.68	ICU	58%	B																																																																																																																																																																																																																																																		
Timing Pattern	1	Syn Delay	10	A																																																																																																																																																																																																																																																		
Actuated Cycle	90	Sim Delay	(13)																																																																																																																																																																																																																																																			
Max v/C	0.69	ICU	65%	C																																																																																																																																																																																																																																																		
Timing Pattern	1	Syn Delay	14	B																																																																																																																																																																																																																																																		
Actuated Cycle	90	Sim Delay	(35)																																																																																																																																																																																																																																																			
Max v/C	0.82	ICU	68%	C																																																																																																																																																																																																																																																		

No operational improvements recommended at this time.



HCM Levels of Service		ICU Levels of Service	
LOS	Delay/Veh (s)	LOS	Utilization (%)
A	≤10	A	≤55%
B	>10 and ≤20	B	>55% and ≤64%
C	>20 and ≤35	C	>64% and ≤73%
D	>35 and ≤55	D	>73% and ≤82%
E	>55 and ≤80	E	>82% and ≤91%
F	>80	F	>91% and ≤100%
		G	>100% and ≤109%
		H	>109%

Operations Diagrams



Hourly Volume Diagrams

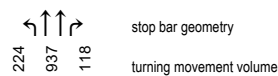
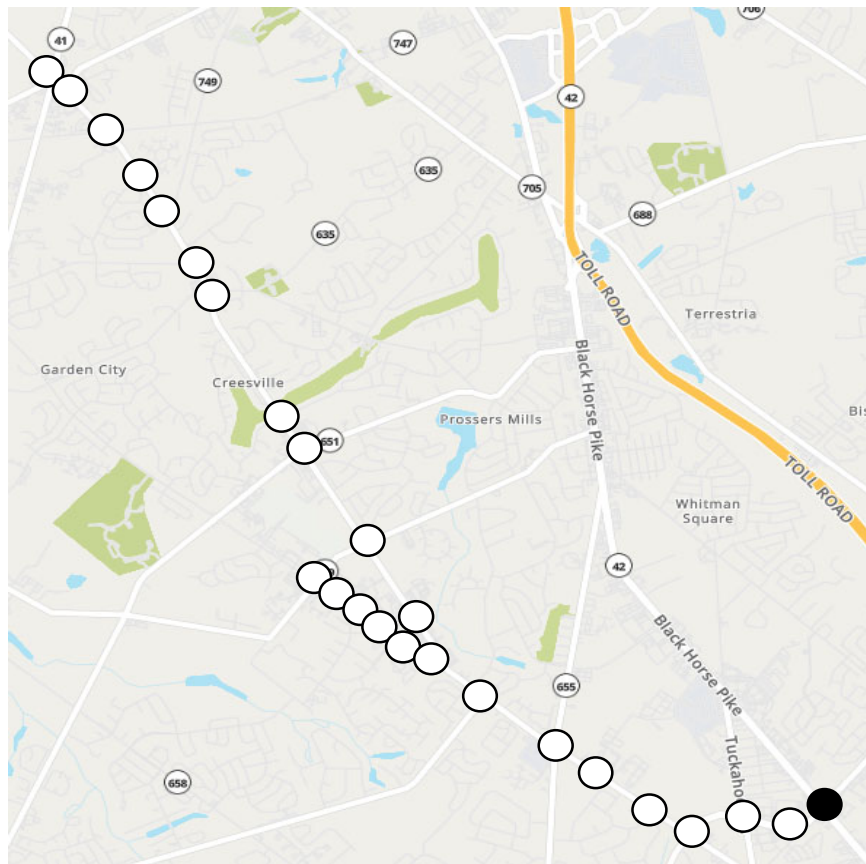
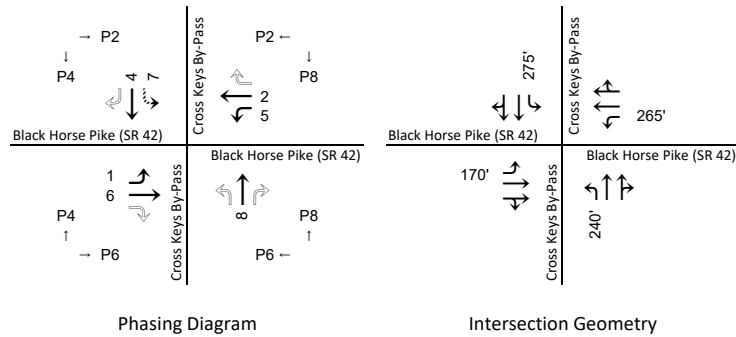


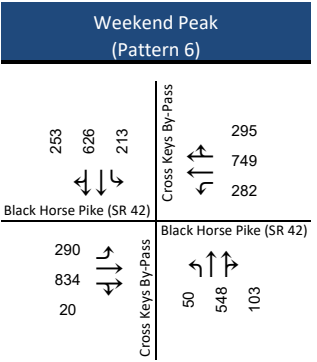
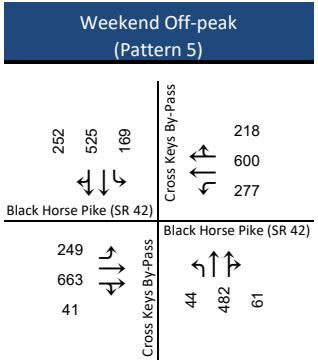
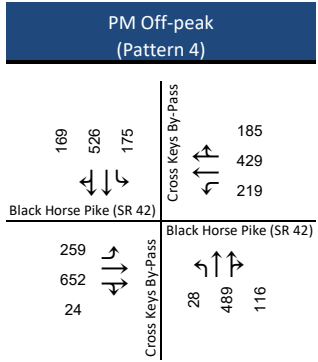
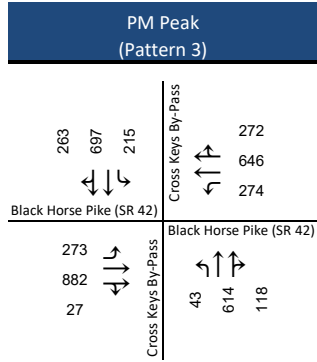
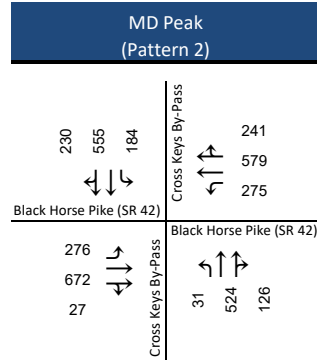
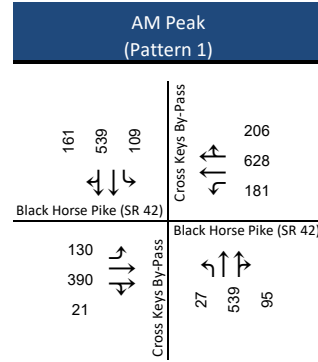
Figure 43

Traffic Operations Analysis

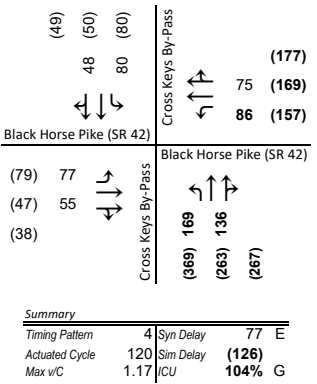
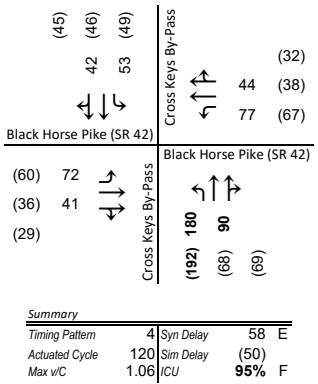
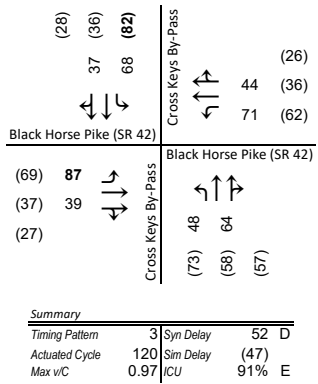
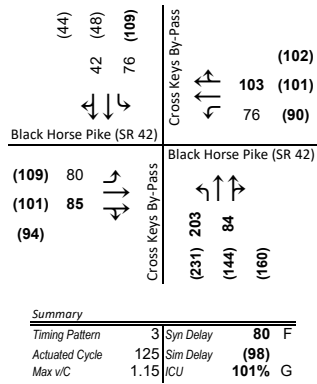
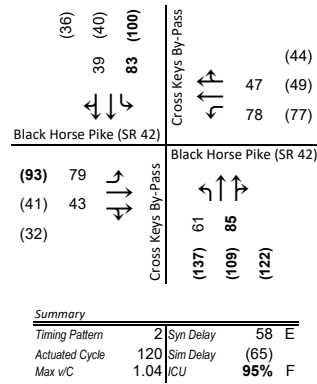
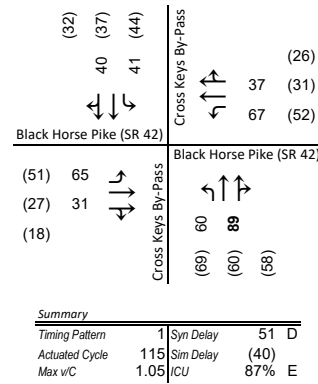
Cross Keys By-Pass (CR 689) & Home Depot Dwy/Berlin-Cross Keys Rd



Hourly Volumes



Existing Operations



Implemented Operations

