PALM BAY ROAD SIGNAL RETIMING AND COORDINATION STUDY

The City of Palm Bay Florida
A Perfect Place to Grow

Prepared by:

Kwabena Ofosu, Ph.D., P.E.
Growth Management Department
5240 Babcock St, NE
Palm Bay, FL 32905

Elia Twigg, P.E.
Public Works Department
1050 Malabar Rd, SW
Palm Bay, FL 32907

Alan Done
Traffic Operations
1730 Main St
Palm Bay, FL 32905

November 25, 2010

The procedures and references used to develop the results contained in these computations are standard to the professional practice of Traffic and Transportation Engineering as applied through professional judgment and experience.

Signed and Sealed:

Name: Kwabena Ofosu, Ph.D.
Florida P.E. No.: 71729
Traffic Engineer
City of Palm Bay, FL

Date: December 7, 2010

TABLE OF CONTENTS

List of Figures

List of Tables

EXECUTIVE SUMMARY

The objective of this study was to evaluate, retime and coordinate traffic signals on Palm Bay Road from Minton Road to Robert J. Conlan Boulevard, as well as Minton Road from Emerson Drive to Hield Road, in Brevard County, Florida. Data collected included turning movement counts at all signalized intersections on the corridors as well as roadway segment volumes. Speed studies were also conducted to establish the 85^{th} percentile speeds on the corridors. *TRANSYT-7F* was used to calculate and optimize the traffic signal timings at each intersection, as well the offsets between intersections to establish coordinated patterns. The network was simulated in *Synchro 7*. Coordinated traffic signal timing plans were developed for each intersection for the weekday as well as the weekend morning peak hour, midday peak hour, and afternoon peak hour.

1. BACKGROUND

The study area encompasses Palm Bay Road (CR516) from Minton Road (CR509) to Robert J. Conlan Boulevard, as well as Minton Road (CR509) from Emerson Drive to Hield Road in Brevard County, Florida (Fig. 1).

Both roadways are two-way urban principal arterials. Palm Bay Road runs east–west for approximately 4.5 miles, traversing the municipalities of Palm Bay, West Melbourne, Melbourne, and unincorporated Brevard County. The Minton Road corridor is approximately 0.5 miles with the sector south of Palm Bay Road in the City of Palm Bay and the sector north of Palm Bay Road being in the unincorporated Brevard County. Traffic operations on both corridors are administered by Brevard County.

The Palm Bay Road corridor has recently been upgraded from a 4-lane divided highway to 6-lanes divided facility. This has necessitated a reevaluation of the traffic signal operations in the context of the new traffic patterns. The Minton Road corridor is a 4-lane divided facility.

2. OBJECTIVES

The objective of this study is to evaluate existing traffic signals and to develop new coordinated traffic signal timing plans for the intersections along the Palm Bay Road and Minton Road corridors. Of particular concern is the lack of progression along the corridors during the morning, midday, and afternoon peak hours.

The signalized intersections along the Minton Road corridor are:

1. Minton Road/ Emerson Drive
2. Minton Road/ Palm Bay Road
3. Minton Road/ Hield Road

The signalized intersections along the Palm Bay Road corridor are:

1. Palm Bay Road/ Athens Drive
2. Palm Bay Road/ Culver Drive
3. Palm Bay Road/ I 95 Southbound Ramps
4. Palm Bay Road/ I-95 Northbound Ramps
5. Palm Bay Road/ Hollywood Boulevard
6. Palm Bay Road/ Dairy Road
7. Palm Bay Road/ Port Malabar Boulevard
8. Palm Bay Road/ Stack Boulevard
9. Palm Bay Road/ Riviera Drive
10. Palm Bay Road/ Babcock Street
11. Palm Bay Road/ Pinewood Drive
12. Palm Bay Road/ Lipscomb Street
13. Palm Bay Road/ Troutman Boulevard
14. Palm Bay Road/ RJ Conlan Boulevard

Fig 1: Study area

3. DESCRIPTION OF STUDY INTERSECTIONS

A summary of the roadway geometry and intersection configurations is provided in Appendix A.

4. TRAFFIC VOLUMES

Turning movement counts were conducted by the Brevard Transportation Planning Organization's contractor at the study intersections from August 17, 2010 through August 28, 2010. These counts were conducted during the morning peak period (7:00 – 8:00a.m.), the midday peak hour (12:00 – 1:00pm), and afternoon peak period (5:00 – 6:00p.m.), on weekdays and a Saturday. The results of the turning movement counts for each peak hour are presented in Appendix B.

In addition, roadway segment counts (tube counts), and speed data collection, were conducted by City of Palm Bay Traffic Operations on selected segments of the study corridors. The purpose of these counts was to accurately establish the time periods when coordination of the signal timings will be most effective, as well as the applicable speed to base the signal coordination on. Fig 2 shows a summary of the roadway segment volumes and how they fluctuate in the course of a typical weekday at selected locations on Palm Bay Road, from which the periods for peak hour signal timing and coordination can be clearly derived. Fig 3 shows the corresponding 85th percentile speeds. For example, from Fig 3 the coordination of Palm Bay Road on segments abutting Athens shall be based on the 85th percentile speed of 45 mph in the AM peak hour and the midday peak hour, and 50 mph in the PM peak hour. Speeds on segments abutting Troutman remained constant throughout the day. The complete roadway segment volumes and speed data is presented in Appendix C.

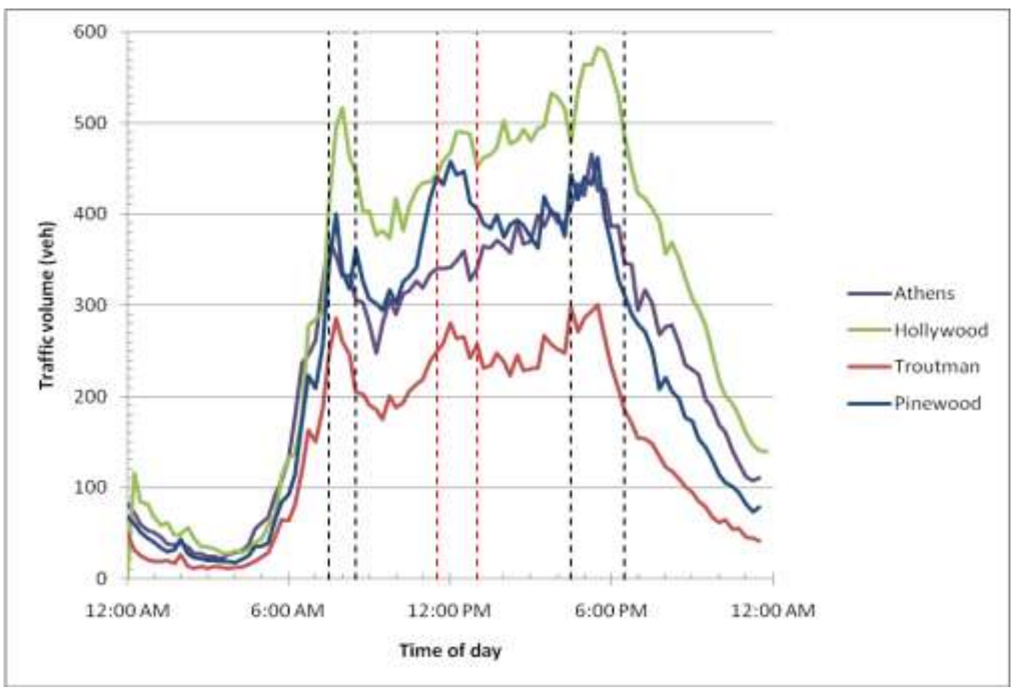

Fig 2: Palm Bay Rd traffic volume profile

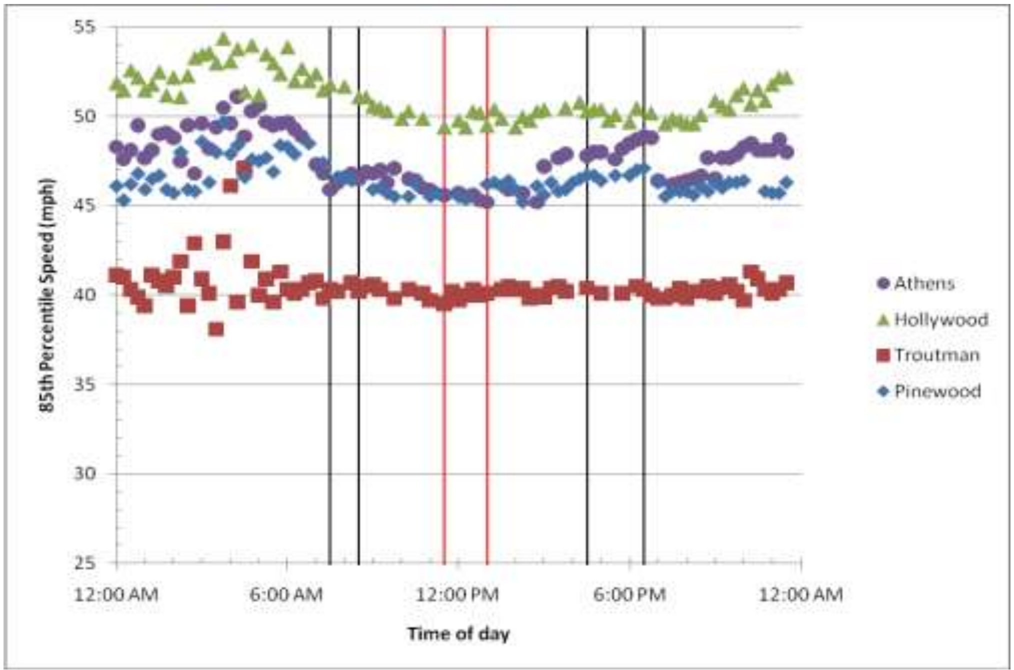

Fig 3: Palm Bay Rd speed profile

5. SIGNAL COORDINATION AND OPTIMIZATION

The objective of this study is to investigate the potential of retiming and coordinating the existing signalization in order to improve traffic operations along the study corridors.

5.1 Signal Coordination Criteria

After evaluating the existing conditions, the following criteria were used to assess the desirability of coordinating the signals on the corridors.

1. Spacing: It is desirable to coordinate signals within 0.5 miles. Some signal spacings along the corridors meet this guideline. It is also desirable that the signal spacings are commensurate. However the signal spacings range from less than 500 feet to over half a mile at various locations along the corridor(s). Therefore the corridors shall be split into distinct coordinated sub-sections to facilitate coordinated signalization of the network.

2. Speeds: The posted speed limit on Minton Road and on Palm Bay Road is 45 mph. The speed studies (Appendix C) showed running speeds generally range between 40 to 50 mph during the peak hours. Coordination is feasible for these operations.

3. Storage: This criterion assesses whether there is adequate storage between intersections to prevent potential blockage problems that will affect progression. Observation and examination using the simulation model indicated that storage distances along the Palm Bay Road corridor at and west of the I-95 interchange may be inadequate for westbound traffic, particularly during the PM peak hour. The westbound left turn lanes at the

intersection of Palm Bay Road and Minton Road also pose a challenge and must be considered carefully. Also the southbound approaches of the intersection of Minton Road and Palm Bay Road, as well as Minton Road and Hield Road may potentially result in blockage in some situations. The potential storage deficiencies identified do not preclude the benefits of coordination, however they must be closely monitored as the high volumes (and/ or turning volumes) have the potential to cause blockage problems.

4. Platooning: It is desirable that traffic along the corridor be densely platooned rather than spread out. This criterion applies to the effects of traffic from side streets and mid-blocks and if they cause platoons on the corridors to be dispersed or remain dense. The field observations indicated that traffic on both the Palm Bay Road and Minton Road corridors is reasonably platooned at the study intersections during the peak hours, and signal coordination will be effective.

5. Through volumes versus turn volumes: It is desirable that through volumes are significantly higher, relative to left turn volumes. This is generally the case along both corridors making them suitable for coordination. The exceptions include the intersections of Palm Bay Road and Minton Road, Minton Road and Emerson Drive, and Palm Bay Road and Babcock Street. However, if the corridors will be split into coordinated sub-sections due to other factors, these locations can be made terminal intersections within their coordinated sub-section and the potential disruption of the coordination can be minimized.

6. Cycle Lengths: The "natural" cycle lengths must be compatible. The closer the cycle lengths the easier they are to coordinate without increasing delays to uncoordinated movements. The distinct coordinated sub-systems will have equal cycle lengths for their constituent signals. A qualitative assessment indicates "natural" cycle lengths ranging from 90 to 180 seconds, which poses challenges for coordination purposes. The wide range of cycle lengths indicates that coordination of the network may increase delays on some approaches such as the uncoordinated movements, minor routes crossing a corridor, and intersections with significantly different "natural" cycle lengths than the system cycle length under coordination. This may be minimized by choosing an appropriate cycle length for the coordinated sub-sections during the coordination optimization process and applying techniques such as double-cycling where appropriate.

In summary, the assessment indicates that coordination is desirable, though challenging and constrained, and can be expected to reduce overall delays, stops, excessive queues, and fuel consumption, and improve progression along the corridors.

Based on the signal coordination criteria, the network was split into coordinated subsections and isolated (uncoordinated) intersections as summarized in Table 1.

.

Table 1: Partition of network

Peak Hour	Sub-section	Coordinated Intersections	Master Intersection	Peak Travel Direction
AM	Zone A	Minton Road/Emerson Drive	Yes	Northbound
		Minton Road/Palm Bay Road		
		Minton Road/ Hield Road		
	Zone B	Palm Bay Rd/ Athens Drive	Yes	Eastbound
		Palm Bay Rd/ Culver Drive		
	Zone C	Palm Bay Road/ Southbound Ramps	Yes	Eastbound
		Palm Bay Road/ Northbound Ramps		
		Palm Bay Road/ Hollywood Boulevard		
	Zone D	Palm Bay Road/ Dairy Road	Yes	Eastbound
		Palm Bay Road/ Port Malabar Boulevard		
	Zone E	Palm Bay Road/ Stack Boulevard	Yes	Eastbound
		Palm Bay Road/ Riviera Drive		
	Zone F	Palm Bay Road/ Lipscomb Street	Yes	Eastbound
		Palm Bay Road/ Troutman Boulevard		
	Isolated Intersection	Palm Bay Road/ Babcock Street	-	-
	Isolated Intersection	Palm Bay Road/ Pinewood Drive	-	-
	Isolated Intersection	Palm Bay Road/ RJ Conlan Boulevard	-	-

Table 1 (continued): Partition of network

Peak Hour	Sub-section	Coordinated Intersections	Master Intersection	Peak Travel Direction
Midday	Zone A	Minton Road/Emerson Drive		
		Minton Road/Palm Bay Road		
		Minton Road/ Hield Road	Yes	Southbound
	Zone B	Palm Bay Rd/ Athens Drive	Yes	Eastbound
		Palm Bay Rd/ Culver Drive		
	Zone C	Palm Bay Road/ Southbound Ramps	Yes	Eastbound
		Palm Bay Road/ Northbound Ramps		
		Palm Bay Road/ Hollywood Boulevard		
	Zone D	Palm Bay Road/ Dairy Road	Yes	Eastbound
		Palm Bay Road/ Port Malabar Boulevard		
	Zone E	Palm Bay Road/ Stack Boulevard	Yes	Eastbound
		Palm Bay Road/ Riviera Drive		
	Zone F	Palm Bay Road/ Lipscomb Street	Yes	Westbound
		Palm Bay Road/ Troutman Boulevard		
	Isolated Intersection	Palm Bay Road/ Babcock Street	-	-
	Isolated Intersection	Palm Bay Road/ Pinewood Drive	-	-
	Isolated Intersection	Palm Bay Road/ RJ Conlan Boulevard	-	-

Table 1 (continued): Partition of network

Peak Hour	Sub-section	Coordinated Intersections	Master Intersection	Peak Travel Direction
PM	Isolated Intersection	Minton Road/Emerson Drive	-	-
	Isolated Intersection	Minton Road/Palm Bay Road		
	Isolated Intersection	Minton Road/ Hield Road		
	Zone B	Palm Bay Rd/ Athens Drive		
		Palm Bay Rd/ Culver Drive		
		Palm Bay Road/ Southbound Ramps		
		Palm Bay Road/ Northbound Ramps		
		Palm Bay Road/ Hollywood Boulevard	Yes	Westbound
	Zone C	Palm Bay Road/ Dairy Road		
		Palm Bay Road/ Port Malabar Boulevard	Yes	Westbound
	Zone D	Palm Bay Road/ Stack Boulevard		
		Palm Bay Road/ Riviera drive	Yes	Westbound
	Zone F	Palm Bay Road/ Lipscomb Street		
		Palm Bay Road/ Troutman Boulevard	Yes	Westbound
	Isolated Intersection	Palm Bay Road/ Babcock Street	-	-
	Isolated Intersection	Palm Bay Road/ Pinewood Drive	-	-
	Isolated Intersection	Palm Bay Road/ RJ Conlan Boulevard	-	-

5.2 Optimization

Overview

TRANSYT-7F was used to optimize the signal timings for coordination and its corollary benefits. The objective of the optimization was to increase progression and reduce delays along the Palm Bay Road and Minton Road corridors respectively. The results were then input into *Synchro 7* for simulation and animation of the new traffic operations.

Coordination Concept

The concept of the coordination in this study is to prioritize progression in the peak directions of travel during the relevant peak hours. The optimization was performed to retime and coordinate signals on a sub-section by sub-section basis. As such, a motorist entering a sub-section on the "mainline" can expect to receive a green indication at each signal within that sub-section. The overall coordination concept in the respective peak hours is depicted in Fig 4 through Fig 6

Methodology

The optimization methodology for the retiming and coordination for each sub-section involved the following steps:

1) The geometry of the intersections were updated to include the recently completed Florida Department of Transportation (FDOT) 6-laning as well as any on-going and planned improvements by the City of Palm Bay, the City of West Melbourne, the City of Melbourne, and Brevard County.

2) Existing signal timing plans from FDOT and Brevard County were entered as a baseline for the new signal timing calculations.

3) Using *TRANSYT-7F*, optimize the cycle length for the sub-system to obtain the optimal cycle length for current traffic volumes. The objective(s) of this optimization was to maximize arterial progression (PROS) and minimize the sum of delay, stops, fuel consumption, and excess queue penalty, collectively called the disutility index (DI).

4) Using the optimal cycle length and holding it constant, optimize phasing sequence, phase splits, and offsets based on current volumes. The objectives of this optimization were again to maximize arterial progression and minimize disutility. This step assigns the new phase sequences, and computes their timings and offsets between the signals to provide the coordination. To facilitate the optimization process, signals were added and optimized sequentially in the peak direction.

5) The new signal timing plans for each sub-system and at each signal were reviewed and manually adjusted where applicable to ensure operations were consistent with local conditions, practices, and driver expectations. All intersections' approaches were checked to ensure adequate time for pedestrians and were adjusted where warranted. Offsets were also manually adjusted where applicable to further maximize the "green tunnel" and/ or reduce delays to vehicles on side streets.

.

Fig 4: Coordination concept, AM peak hour

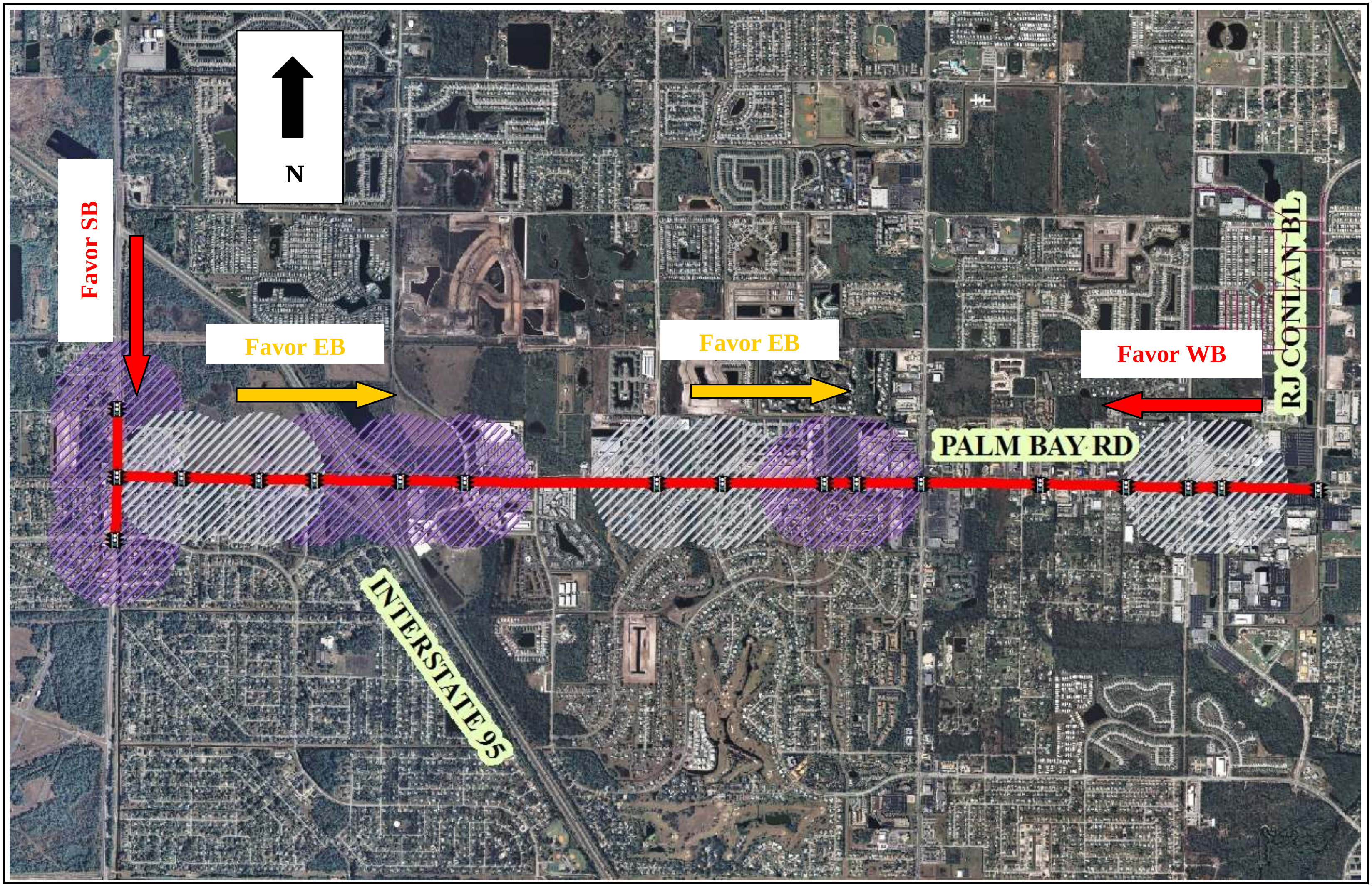

Fig 5: Coordination concept, midday peak hour

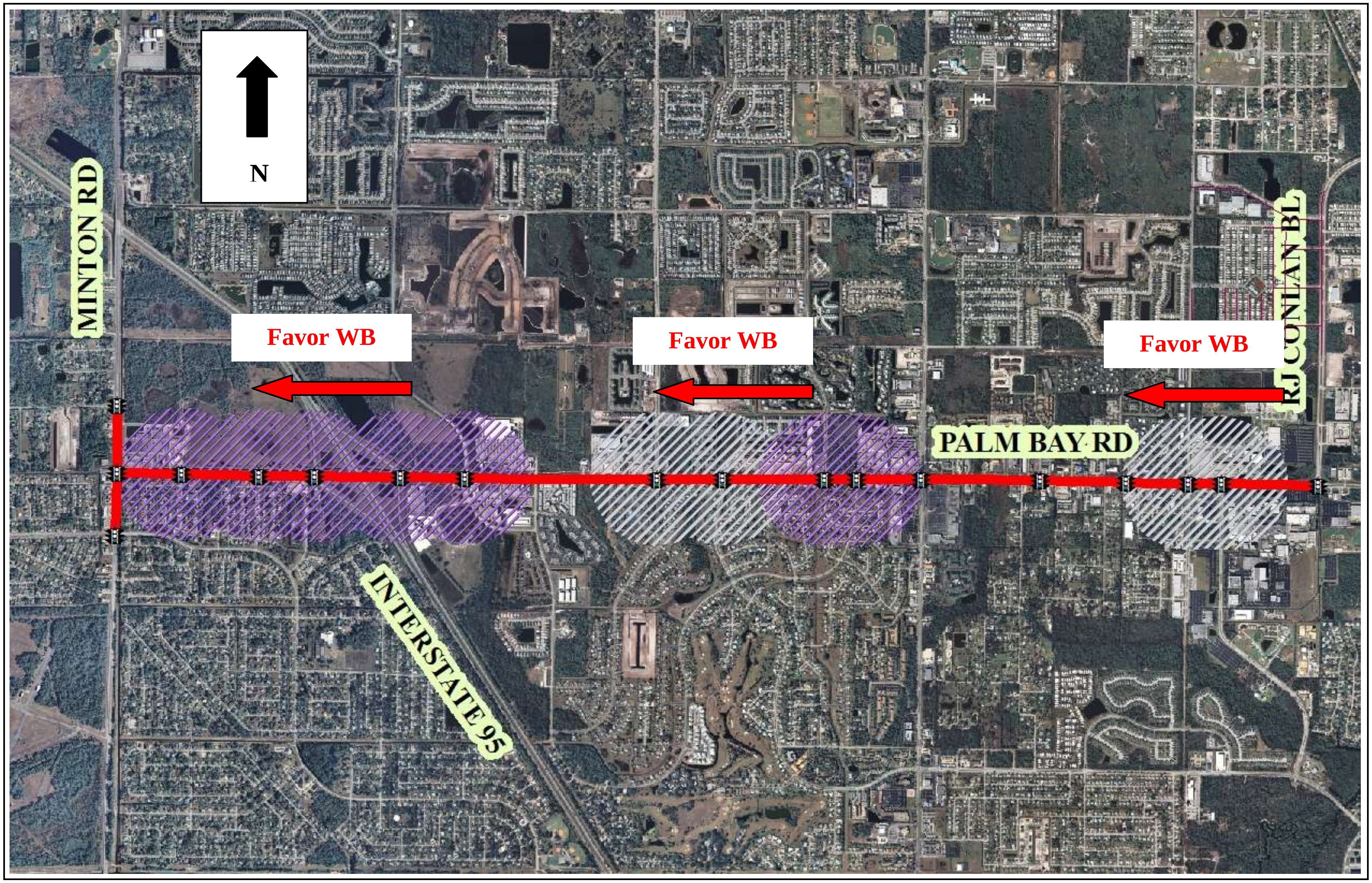

Fig 6: Coordination concept, PM peak hour

6) Network Integration: The retimed sub-systems were combined into an integrated network by modeling the transition from one sub-system to the next, for systems within the influence area of another sub-system. This was done by using dummy nodes at the termini of abutting segments. The discharge out of one segment at its cycle length was discharged into the abutting segment at that segment's cycle length. In this step the offsets between signals within each system from the previous step were held constant. Phase sequences and splits were allowed to be optimized to produce further refinement over the previous sub-system-wise optimization. The offsets allowed to be optimized in this run were those from one sub-system to another only.

7) Simulation of the optimized network. The optimized network was reviewed and manual adjustments were made where applicable. The optimized network was then simulated in *Synchro 7*. Offset optimization was performed to further refine the coordination plans. The animation tools of *Synchro 7* were applied to visually monitor the network and check the queuing, delays, the "green tunnel", and potential blockage problems. Where any of these problems were identified, adjustments were made and steps 3 though 7 were repeated.

The *TRANSYT-7F* optimization details which consist of signal retiming and coordination computations, route progression computations, and the time-space diagrams are provided in Appendix D. The *Synchro 7* simulation details as well the timing plans for implementation are presented in Appendix E.

<u>Modeling Issues</u>

The simulation revealed potential excessive queues and blockage on southbound Minton Road at Hield and at Palm Bay Road during the PM peak hour under signal coordination. This in turn led to excessive queues on the westbound approach at the intersection of Palm Bay Road and Minton Road. As a result, during the PM peak hour, the Minton corridor shall not be under coordination. The simulation showed that when the Minton corridor's coordination was deactivated, the excessive queues on the westbound approach of the intersection of Palm Bay Road and Minton Road were dissipated, however motorists on southbound Minton may have to stop each time at Hield, and then stop again at Palm Bay Road, before being able to clear the corridor.

6. CONCLUSIONS

The study reached the following conclusions and recommendations:

1 A retiming and coordination plan was developed for the signalized intersections on Minton Road from Emerson Drive to Hield Road, and on Palm Bay Road from Minton Road to RJ Conlan Boulevard.

2 Timing plans for the AM peak hour, midday peak hour, and PM peak hour were successfully developed and may be implemented as soon as possible.

3 A speed study and roadway segment volume study was also conducted which accurately deduced the best times of day to implement the coordinated plans for each peak period.

4 City of Palm Bay staff and Brevard County staff must collaborate to implement the new timings plans to improve the driving experience for commuters.