ROOSEVELT BOULEVARD

Enhanced Bus Service
Operations Analysis

DELAWARE VALLEY REGIONAL PLANNING COMMISSION (dvrpc)

JANUARY 2017

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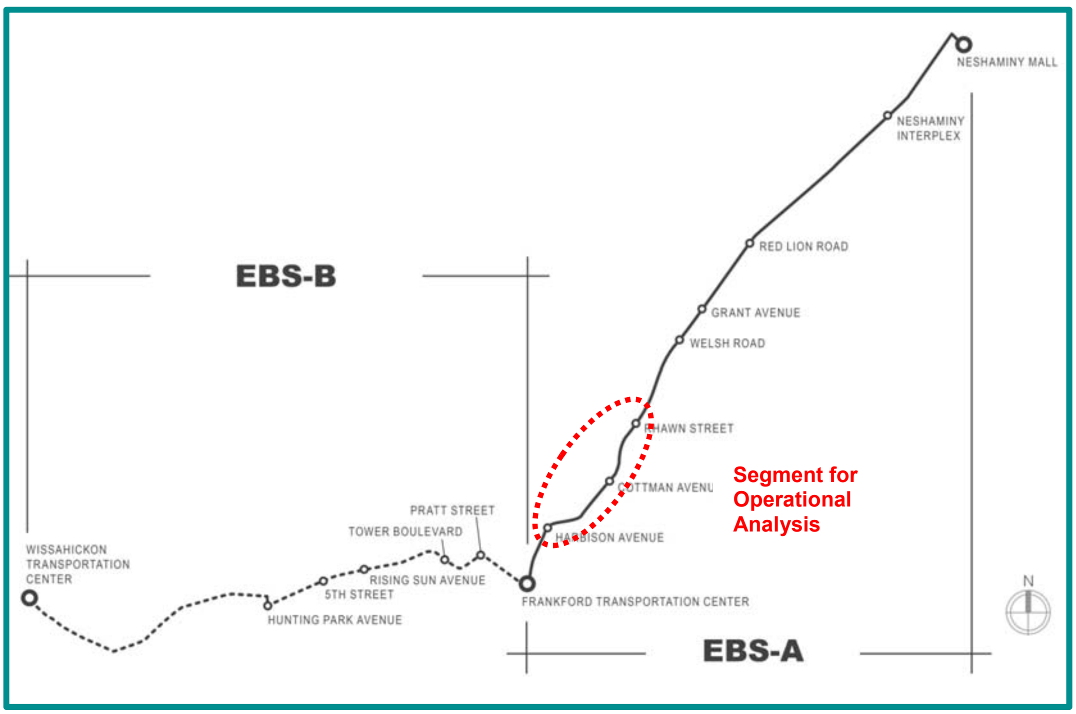
Executive Summary

Transit service along Roosevelt Boulevard (US 1) is not competitive with private vehicle travel. During the afternoon rush hour, a trip on the Southeastern Pennsylvania Transportation Authority's (SEPTA's) Route 14 local bus takes about twice as long as an equivalent trip in a private auto. Delaware Valley Regional Planning Commission (DVRPC) staff conducted *Alternatives Development for Roosevelt Boulevard Transit Enhancements*[1] and identified a program of actions to improve the transit user's experience. Two Enhanced Bus Service (EBS) branches were identified (A and B), with short-term (operational) and long-term (capital-intensive) improvement plans cited for each. Short-term options included express bus service with consolidated stops, well-lit bus shelters, low-friction fare payment with multidoor boarding, bus priority at traffic signals, and semi-exclusive transit lanes on the Boulevard. Long-term recommendations call for a busway in the median.

This project—*Roosevelt Boulevard Enhanced Bus Service Operations Analysis*—was subsequently undertaken to explore the effectiveness and deliverability of the short-term operational recommendations, and as a pilot for subsequent comprehensive engineering work. The work was performed in a 2.3-mile-long segment of the EBS-A branch.

EBS Diagram and Operations Analysis Study Area



Source: DVRPC, 2016

[1] DVRPC, May 2016, Publication Number 13072.

Alternatives

VISSIM micro-simulation software was used to model transportation conditions and produce performance data to evaluate existing conditions and four alternative operational scenarios:

- existing conditions during the weekday PM peak period;
- express bus service with consolidated transit stops for the SEPTA Route 14 bus: stops proposed at Harbison Avenue, Cottman Avenue, and Rhawn Street;
- traffic signal timing optimization for all vehicles;
- transit signal priority (TSP) at traffic signals; and
- business access and transit (BAT) lanes: a semi-exclusive transit lane designated for the outermost travel lane in both directions.

Constraints

The operational evaluations were performed with the understanding that major physical changes to roadway and intersection geometry, or major disruptions to pedestrian and traffic crossing movements, were not viable elements in a near-term service plan.

The evaluations revealed that the corridor's present geometry constrains the ability to adjust signal timings or apply more robust traffic signalization techniques. Specifically, the width of Roosevelt Boulevard requires long pedestrian crossing times. Because of this, cross streets are given more green time than is needed for vehicles, and less time is available for the higher volumes on Roosevelt Boulevard. Non-uniform traffic signal spacing, high travel speeds, and heavy volume and congestion also have an impact on the effectiveness of traffic signal progression. Any benefits of setting an optimal progression for one direction may be offset in the opposite direction.

Evaluation

Working within programmatic and geometric constraints, the operational evaluations concluded that:

- Existing overall traffic operations are satisfactory, and the traffic signal systems regulating the Boulevard are close to optimal.
- Consolidating bus stops and creating an express bus bervice plan for the SEPTA Route 14 bus will significantly improve bus travel times without affecting the flow of general traffic.
- The success of traffic signalization improvements, specifically signal optimization and TSP, were hampered by the corridor's physical constraints and had minimal effect on transit and traffic operations.
- Dedicating BAT lanes for use by the Route 14 Express and all local buses would further improve bus travel times. However, the loss of a general-purpose travel lane resulted in congestion in the remaining outer lanes. For this reason, the northbound BAT lane is recommended to begin after Harbison Avenue.

In the final evaluation, the modified BAT lane retains the benefit of a designated transit lane along the rest of the detailed study corridor without causing severe congestion. Taken together—and extrapolated to the full length of the EBS-A service plan—the transit operational enhancements (express bus service and the modified BAT lanes) are estimated to save Route 14 bus riders 18 minutes in the predominant northbound direction and seven minutes in the southbound direction compared to existing local bus travel times during the PM peak period.

Applicability

The findings of this project validate the recommendations of the parent *Alternatives* project. Express bus service with consolidated bus stops shows merit as a valid near-term improvement. BAT lanes would further improve bus travel times, but stakeholders are cautioned about this feature's effect on corridor traffic flow.

Similarly, both this *Operations Analysis* and the parent *Alternatives Analysis* projects identify suboptimal conditions surrounding the proposed Harbison Avenue EBS station stop. In the near term, Bustleton Avenue south of Roosevelt Boulevard should be considered as a substitute first-northbound and next-to-last-southbound stop. The BAT lane should be provided north of Harbison Avenue, and the Route 14 Express bus should operate in mixed traffic between Bustleton and Harbison.

Potential capital-intensive and long-term improvement plans for a busway should address the corridor's geometric constraints. Specifically, shortening the crossing distance of Roosevelt Boulevard service roads should be evaluated for opportunities to:

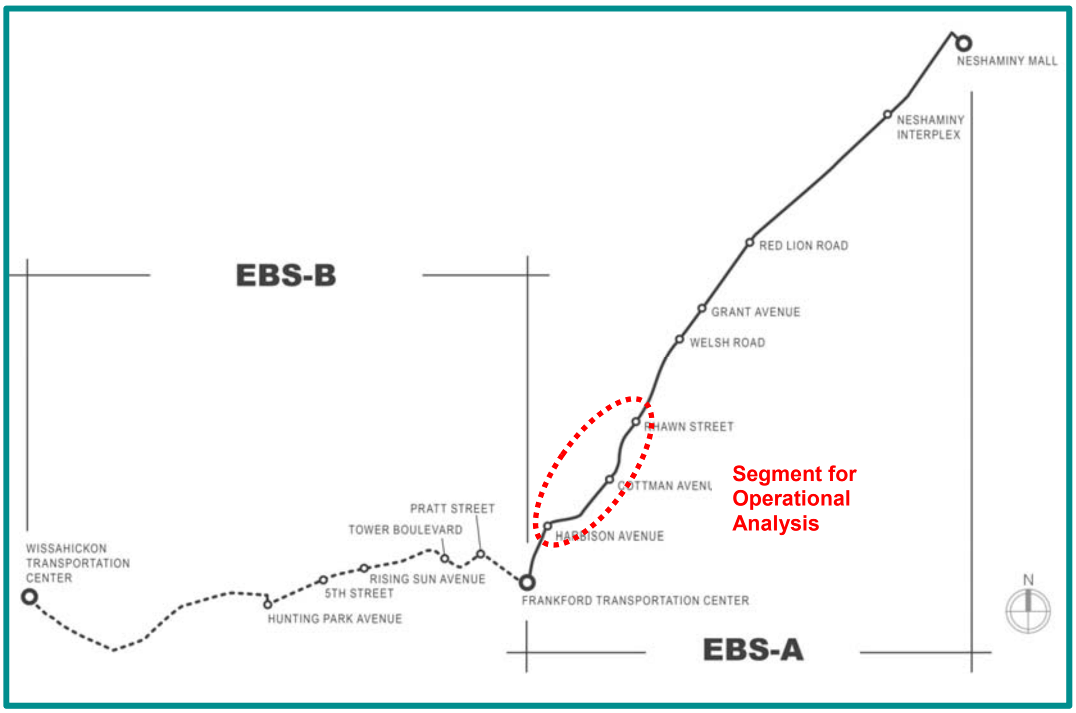
- Improve pedestrian safety by reducing crossing distances.
- Introduce opportunities to retime traffic signals to decrease pedestrian waiting time and discourage jaywalking.
- Improve traffic flow by allowing green time to be transferred from the cross streets to Roosevelt Boulevard by reducing the pedestrian crossing time.
- Permit more flexibility for shorter traffic signal cycle lengths and potentially accommodate a more robust TSP system.
- Introduce the possibility for an adaptive traffic signal system to achieve increased benefits throughout the corridor.

CHAPTER 1: Purpose and Need

Roosevelt Boulevard's high transit ridership but slow bus travel times have created a public interest in improving the corridor's transit service. In response, DVRPC staff prepared *Alternatives Development for Roosevelt Boulevard Transit Enhancements*. The *Alternatives* report identified near-term operational improvements and long-term capital improvements that would improve transit travel time and the transit user's experience in the corridor. Short-term options included express bus service with consolidated stops, well-lit bus shelters, low-friction fare payment with multi-door boarding, bus priority at traffic signals, and semi-exclusive transit lanes on the Boulevard. Long-term recommendations call for a busway in the median. The report identified two service branches for corridor-wide improvement.

This project—*Roosevelt Boulevard Enhanced Bus Service Operations Analysis*—was subsequently undertaken to explore the effectiveness of the short-term operational recommendations of the parent study, and as a pilot for subsequent comprehensive engineering work. The work was performed in a 2.3-mile-long segment of the EBS-A branch (**Figure 1**).

Figure 1: EBS Diagram and Operations Analysis Study Area



Source: DVRPC, 2016

The City of Philadelphia has received a $2.5 million Transportation Investment Generating Economic Recovery (TIGER) grant to further develop all of the proposals in the *Alternatives* report. The *Operations Analysis*'s findings will inform the TIGER study's development by quantifying the benefits of the enhancement features and offering recommendations about the most suitable transit enhancement features. The *Operations* report also identifies corridor geometric constraints that should be addressed to accommodate a more advanced, capital-intensive Bus Rapid Transit system in the corridor.

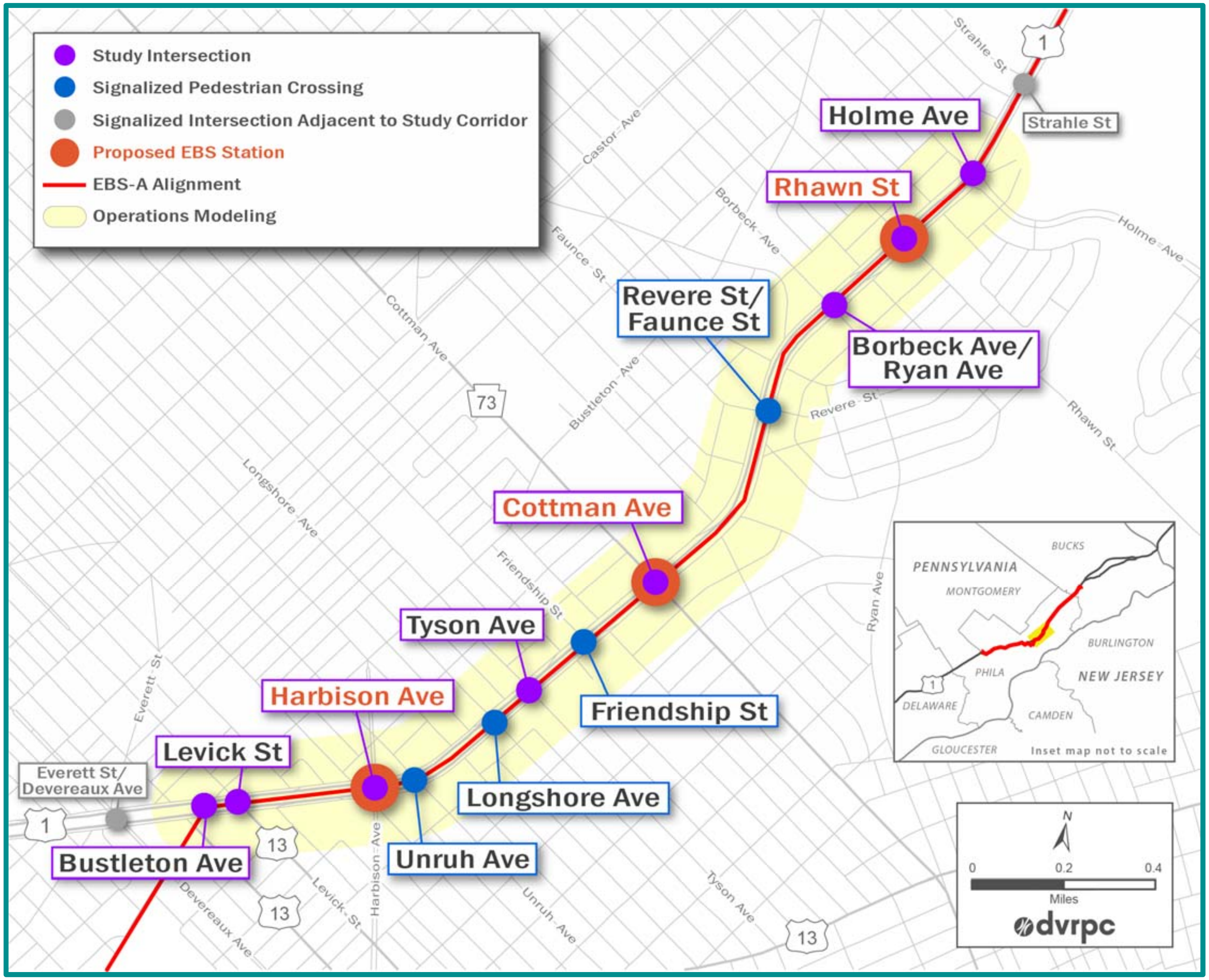
CHAPTER 2: Corridor Transportation Conditions

Micro-simulation transportation modeling software (VISSIM) was employed to evaluate transit and traffic conditions in a 2.3-mile-long segment of Roosevelt Boulevard between Bustleton Avenue and Holme Avenue (**Figure 2**, page 8). The section was chosen as a representative section of the EBS-A service plan area (10.5 miles in overall length) because it has lane geometries typical of the corridor, encompasses both residential and commercial areas, has volume levels consistent with the rest of the corridor, and includes one of the busiest transit connections at Cottman Avenue.

Corridor Description

The study segment contains eight signalized intersections serving vehicles and pedestrians, and four pedestrian-only actuated signals. The highway is comprised of six travel lanes in each direction: three inner lanes and three outer lanes. The inner lanes are limited-access express lanes, while the outer lanes are local and provide access to businesses and side streets. There are two main intersection configurations: surface-level configuration and an underpass configuration where the inner lanes are depressed and bypass the intersection. **Table 1** (on page 9) identifies selected characteristics of the corridor and its signalized intersections. Several same-direction crossovers are found within the study corridor. They provide a mid-block transfer between the inner and outer lanes. However, the crossovers have limited queuing capacity, provide minimal room for acceleration, and have poor visibility for those merging due to the severe angle of the approach. Posted speed limits in the study area vary from 40 to 45 miles per hour, with the higher limit at the study segment’s northern end.

Figure 2: Operations Analysis Study Corridor



Source: DVRPC, 2016

Table 1: Signalized Intersection Inventory

Roosevelt Boulevard w/	Intersection Serves	Inner Lanes Intersect	Outer Lanes Intersect	Distance between Intersections (feet)	Proposed EBS Service Station?	Proposed EBS Service Location
Everett St / Devereaux Ave	Vehicles & Pedestrians	at grade	at grade	1,060		
Bustleton Ave	Vehicles & Pedestrians	at grade	at grade			
				440		
Levick St	Vehicles & Pedestrians	at grade	at grade			
				1,560		
Harbison Ave	Vehicles & Pedestrians	at grade	at grade		Yes	NB and SB: far side
				550		
Unruh Ave	Pedestrians	at grade	at grade			
				1,140		
Longshore Ave	Pedestrians	at grade	at grade			
				550		
Tyson Ave	Vehicles & Pedestrians	at grade	at grade			
				900		
Friendship St	Pedestrians	at grade	at grade			
				1,070		
Cottman Ave	Vehicles & Pedestrians	grade separated	at grade		Yes	NB: far side, SB: near side
				2,510		
Revere St / Faunce St	Pedestrians	at grade	at grade			
				1,470		
Ryan Ave / Borbeck Ave	Vehicles & Pedestrians	at grade	at grade			
				1,150		
Rhawn St	Vehicles & Pedestrians	at grade	at grade		Yes	NB and SB: far side
				1,090		
Holme Ave	Vehicles & Pedestrians	grade separated	at grade			
Strahle St	Vehicles & Pedestrians	at grade	at grade	1,320		

Source: DVRPC, 2016

Traffic Counts

Traffic and pedestrian counts were conducted on weekdays between 3:00 PM and 6:00 PM during the spring of 2015. Volumes were processed and entered into the corridor's transportation model. Representative hourly traffic volumes within the study corridor are shown in **Table 2**.

Table 2: Traffic Volumes (between 4:00 PM and 5:00 PM)

Roosevelt Boulevard at	Northbound			Southbound			Grand Total
	Inner Lanes	Outer Lanes	Total	Inner Lanes	Outer Lanes	Total	
Harbison Ave	1,570	1,630	3,200	1,300	860	2,160	5,360
Rhawn St	1,680	1,420	3,100	1,550	1,180	2,730	5,830

Source: DVRPC, 2016

Transit Operations

SEPTA's Route 14 bus currently provides local service along the US 1 corridor between the Frankford Transportation Center (FTC) and the Oxford Valley Mall. The proposed EBS-A service plan would create a new express version of this route with limited stops between the FTC and the Neshaminy Mall. In the 2.3-mile study segment, stops are proposed at Harbison Avenue, Cottman Avenue, and Rhawn Street. Local service will be maintained. Other bus lines operating on Roosevelt Boulevard include SEPTA routes 1, 20, and 50. Additionally, SEPTA's bus routes 26, 28, 58, 70, and 77 traverse Roosevelt Boulevard at various points in the corridor. All of these services will be maintained. Ridership data for the study area routes was obtained from SEPTA.

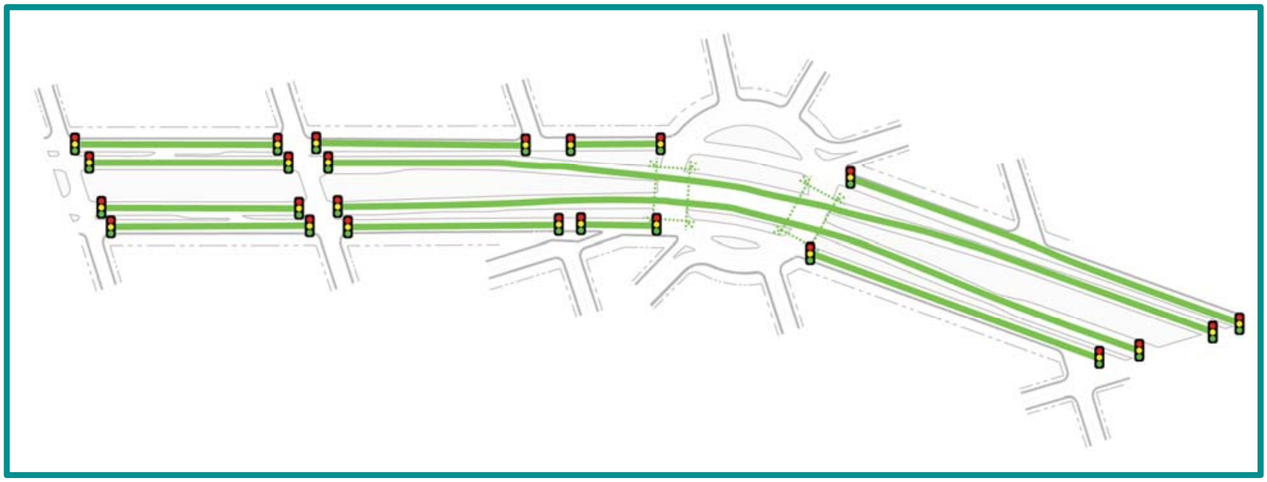
Geometric Constraints

Physical constraints in the corridor warrant attention when considering transit enhancements and traffic improvements. Roosevelt Boulevard currently functions with a fixed-time traffic signal system, operating consistently during predetermined times of the day. Due to inconsistent intersection geometry (**Figure 3**, page 11), the corridor uses multiple fixed-time traffic signal progression schemes. Within each, traffic signals operate on 60-, 90-, or 120-second cycles. This means traffic signals have set cycle and phase lengths that do not vary from one cycle to the next, do not respond to varying internal traffic conditions, and are not necessarily coordinated with adjacent progression plans.

The width of Roosevelt Boulevard, with its 12 travel lanes and wide medians, requires a significant amount of pedestrian crossing time on the side-street green phase. More often than not, two full cycles are required for a pedestrian to complete a crossing. The green phase timing is close to an even split between Roosevelt Boulevard and the side street, even though the Boulevard carries up to five times more volume. It is nearly impossible to "steal" side-street green time for the Boulevard's need.

Traffic signal spacing, travel speeds, and congestion also have an impact on the effectiveness of traffic signal progression along the Boulevard. The study corridor's characteristics include long distances between intersections, high travel speeds, and high peak-period volumes that limit the effectiveness of signal progression. Uniformly and closely spaced coordinated intersections create and process vehicles in platoons. When intersections are spaced far apart, platoons dissipate and the advantage from progression is less pronounced. Additionally, northbound and southbound traffic volumes are reasonably balanced by direction. Any benefits of setting an optimal progression for one direction may be offset by a loss in travel time in the opposing direction.

Figure 3: Irregular Geometry



Complicated intersection geometry and non-uniform traffic signal spacing thwart traffic progression along Roosevelt Boulevard.

Source: DVRPC, 2016

CHAPTER 3: Transportation Model and Scenario Development

The project's operational analysis used VISSIM (release 7.0) to simulate the travel of vehicles through the study area's 12 signalized intersections. VISSIM is a mixed-traffic operations and planning tool that supplies the ability to compute and collect performance data for transportation networks. In turn, the data can be assessed for changes between scenarios, and related improvements can be judged for their effectiveness. VISSIM's animations also provide the ability to visually inspect running simulations, which adds another dimension to the analyses.

Existing traffic and transit operations were evaluated on Roosevelt Boulevard, extending from just south of Bustleton Avenue, on the south end of the corridor, through Holme Avenue on the north—a distance of 2.3 miles. Four enhancement scenarios were modeled in agreement with recommendations cited in the *Alternatives* report and in coordination with project stakeholders. The scenarios assessed were:

- existing conditions during the weekday PM peak period;
- express bus service with consolidated transit stops for the SEPTA Route 14 bus: stops proposed at Harbison Avenue, Cottman Avenue, and Rhawn Street;
- traffic signal timing optimization for all vehicles;
- TSP at traffic signals; and
- BAT lanes: a semi-exclusive transit lane designated for the outermost travel lane in both directions.

Sensitivity analysis was performed within individual scenarios to explore constraints and opportunities.

Existing Conditions

A transportation model was prepared in VISSIM to incorporate the existing physical and regulatory environment of Roosevelt Boulevard. Aerial photography was used to replicate the study segment's geometry in the model. Traffic signal condition diagrams (obtained from the City of Philadelphia) served as a guide for entering timing, phasing, and sequence events for all of the signalized intersections. Signal timings and offsets were verified via field visits.

All study area buses were inventoried. Scheduling and routing data was compiled, and with assistance from SEPTA, stop-level ridership counts were collected. The data provided the total number of boarding and alighting passengers for each bus entering the study area within the 3:00 PM to 6:00 PM window. The data was added in the model.

Automatic Traffic Recorder, manual turning movement traffic counts, and pedestrian crossing counts were conducted between 3:00 PM and 6:00 PM on typical weekdays in the spring of 2015 and processed in 15-minute intervals. Small adjustments were made to the raw counts for balance and flow within the network. The resulting volumes were input to the VISSIM model.

BlueTOAD® devices that detect anonymous, wireless identification were used, and Vehicle Probe Project data were tapped to obtain travel time and speed data along the corridor between 3:00 PM and 6:00 PM. This data was used for model calibration. Calibration was conducted by inserting a series of data collection points on links throughout the modeled network. Model runs followed by adjustments to modeling parameters were performed iteratively until the turning movement volumes and speed outputs from VISSIM replicated ground count data within 5 percent.

Express Bus Service

The express bus service scenario created and modeled express service for the SEPTA Route 14 bus. The modeled service plan reflects the operating and patronage patterns of the enhanced Route 14 bus described in the *Alternatives* report. The study area model includes express stops at Harbison Avenue, Cottman Avenue, and Rhawn Street. The essence of the improved service is:

- consolidated stops (three versus 15 in each direction)—each optimally located relative to the cross-street intersection (near-side or far-side);
- 10-minute headways for the EBS; and
- low-friction fare payment with multi-door boarding and alighting (reducing per-passenger service time from 2.9 to 1.2 seconds, as approximated in the *Alternatives* report).

Except for the three station stops, the Route 14 Express bus will operate in mixed traffic. Transit passenger information, which would influence dwell times at the consolidated stops, was obtained from the *Alternatives* report and entered into the model. Local bus route stopping patterns remain unchanged in the alternative.

Signal Optimization

Modeling and analyses were performed to determine benefit of a single traffic signal progression plan—with a uniform traffic signal cycle length—governing flow along the length of the study corridor.

In corridors like Roosevelt Boulevard that have consistent traffic flow, fixed-time systems can operate nearly as efficiently as an actuated system. Still, traffic signal timings can be changed to prioritize traffic flow, either by direction or movement. Therefore, optimization was evaluated assuming a common cycle length (60, 90, and 120 seconds) and adjusted signal offset coordination and phase lengths. The scenario assumes express bus service operating in the corridor. Results were compared to the express bus service plan.

TSP

The TSP scenario assumed that all buses, both local and express, operating on the Boulevard, and all signalized intersection approaches on the Boulevard, are equipped with communications equipment (emitters and receivers, respectively). The equipment allows buses to extend the green phase and reduce signal delay encountered in their operation.

Evaluations were performed on top of the express bus service platform and included adjusting the splits within the overall fixed-cycle length, and extending the cycle length to accommodate the added transit green time. Two cycle extension plans were explored.

BAT Lane

The BAT lane scenario created a semi-exclusive lane for transit vehicles, allowing buses to operate outside of general traffic congestion in the corridor. The BAT lane will occupy the rightmost lane of the northbound and southbound outer service road and thus remove a general-purpose travel lane from each direction of Roosevelt Boulevard. Non-transit vehicles are only allowed to enter the lane to complete right turns at intersections or to access driveways.

Besides transit travel times, the modeling work also explored the loss of capacity for general traffic and the quality of traffic operations at adjacent intersections. Two BAT lane scenarios were tested. The first included lanes along the full length of the study corridor. The second modified the extent of the BAT lane. The models were built on top of the express bus service model.

CHAPTER 4: Sensitivity Tests

Sensitivity analysis was performed within individual scenarios to explore constraints and opportunities. Background for the tests and descriptions of their findings follow. Summarized performance results for each scenario's final or best modeling iteration are presented in the next chapter.

Existing Conditions

The calibrated existing conditions model for the weekday PM peak period, between 3:00 PM and 6:00 PM, formed the structure upon which the rest of the scenarios were built.

Express Bus Service

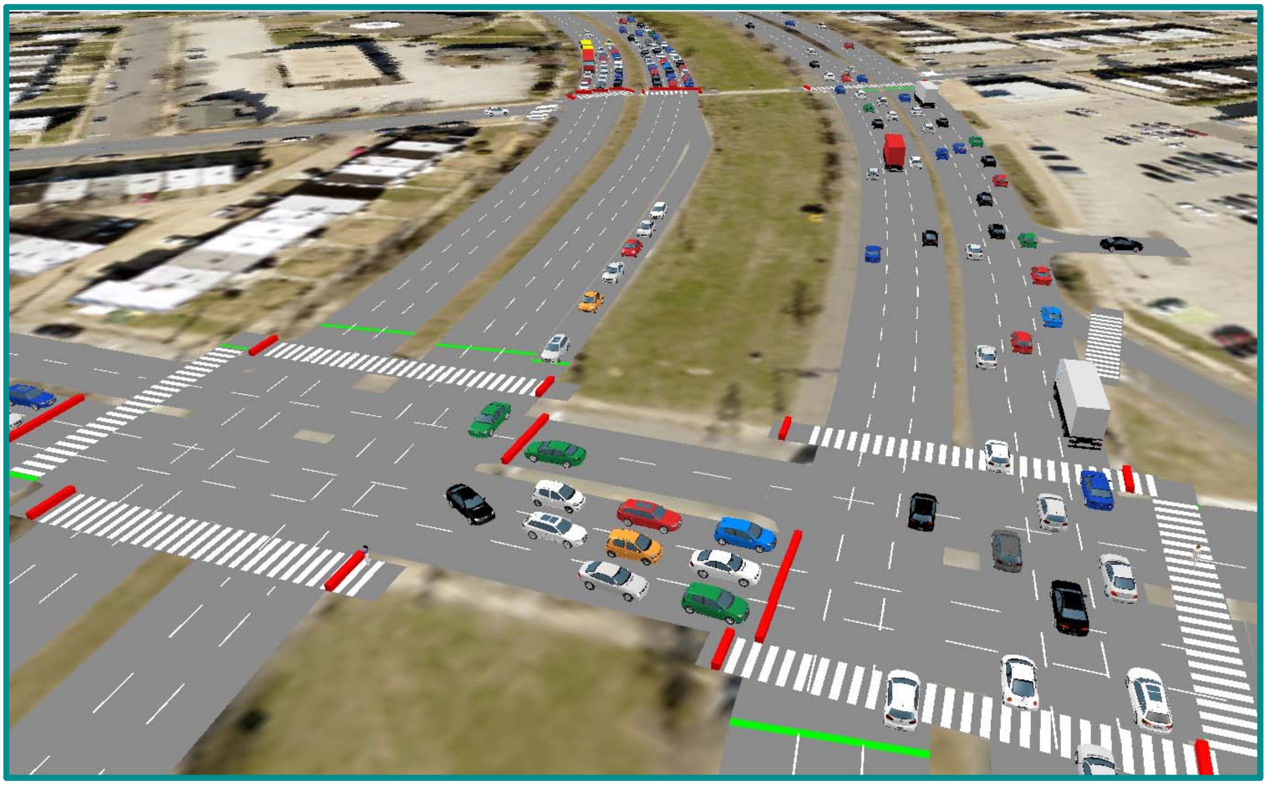
The express bus service scenario created and modeled express service for the SEPTA Route 14 bus. The study area model includes express stops at Harbison Avenue, Cottman Avenue, and Rhawn Street. Otherwise, the bus operates in mixed traffic. Local bus routes and service patterns remain unchanged.

Signal Optimization

Ideally, a major travel corridor has a consistent cycle length as it allows for a better signal coordination. As such, traffic signal optimization was evaluated for the Roosevelt Boulevard study segment with a common cycle length (60, 90, and 120 seconds) and adjusted signal offset coordination and phase lengths.

Typically, shorter cycle lengths are used at simple junctions while longer cycles are best for complicated intersections (i.e., those having more than four approach legs and requiring three or more signal phases). A uniform 60-second cycle was judged inadequate for the complicated intersections within the corridor. A consistent 90-second cycle was evaluated as a balance between the short and long. The 90-second cycle reduced queuing associated with a 120-second cycle and avoided the startup-lost time of a 60-second cycle. The 90-second cycle performed well operationally but did not yield adequate time for pedestrian crossings. A consistent 120-second cycle length was tested but resulted in excessive queues of left-turning vehicles emanating from the median storage space between the northbound and southbound express lanes (see **Figure 4**, on page 16).

Figure 4: Cycle Length versus Left-Turn Processing, Queueing, and Storage



Traffic operations can worsen with longer cycle lengths. Fewer cycles per hour reduce clear-out opportunities for left-turning vehicles in the median area. Shown above is a VISSIM screenshot of existing conditions at Harbison Avenue with a 90-second cycle. Extending the cycle to 120 seconds reduces clear-out opportunities by 25 percent and results in overflows of the southbound left-turn-storage lane.

Source: DVRPC, 2016

Ultimately, little opportunity was presented for improved traffic progression because of the variable distances between signalized intersections. In the end, within the constraints of low-capital investment, the existing timing scheme along the Boulevard was used to accommodate the express bus service plan.

TSP

Two alternatives were explored, including reproportioning green time within the fixed cycle and adding green time to extend the length of the cycle.

In a fixed-time system such as Roosevelt Boulevard, to extend green time for the bus, green time was reduced on the cross-street phase to maintain a consistent cycle length. In subsequent cycles, if no "call" is made from a bus, the traffic signal reverts back to the original split.

The geometric configuration of Roosevelt Boulevard makes it difficult to implement the fixed-time TSP system. For each intersection in the corridor, the minimum phase time was calculated for the cross streets based on Pennsylvania Department of Transportation guidelines. The guidelines dictate how much green time can be “taken” from the cross street and used to extend green time for buses on Roosevelt Boulevard. For most intersections along the corridor, either no time or a negligible amount (one to five seconds) of side-street green time is available and transferrable for extending green time for buses. For this reason, a typical TSP configuration would not deliver much benefit along Roosevelt Boulevard.

An alternative TSP concept was developed and explored. Rather than maintain a consistent cycle length, the system alternated cycle lengths. For example, when a bus approaches an intersection with a 120-second cycle, it would add 10 seconds to the Roosevelt Boulevard phase and the cross-street phase length would remain unchanged, creating a 130-second cycle. This is not typical practice for long corridors with fixed-time and variable-length signal cycles due to disruptions in the signal timing and progression. For portions of the study corridor, however, there may be possibilities for TSP benefits due to certain commonalities.

To explore the possibilities, two iterations of TSP were modeled and analyzed for benefits where similar intersection configuration, spacing, and mainline traffic volumes exist: in the northern end of the corridor through the Ryan, Rhawn, and Holme intersections. The modeling tests included a 10-second transit-vehicle time extension and a 15-second extension. Both yielded positive benefits to overall vehicle travel times along the Boulevard. Both delivered a negative impact on overall express bus service travel times due to the disruption of the progression speeds, and both increased delays on the side-street approaches. Performance changes associated with the 15-second extension were generally more dramatic than the 10-second extension. In both cases, adding time to the cycle lengths compromised left-turn clear-out opportunities in the median area, and increased pedestrian-crossing waiting times. Outputs associated with the 10-second extension were used to summarize the modeling tests.

BAT Lane

With the introduction of a BAT lane and loss of capacity, it was understood that a certain amount of volume would shift from the outer lanes to the inner lanes. It was assumed that volume would shift until intersection approach delay and queue lengths were roughly the same for both the inner and outer lanes. Based on this criterion, equilibrium was reached with a 15 percent shift in traffic volume.

The initial modeling scenario assumed BAT lanes along the length of the corridor. However, the reduction in vehicle capacity resulted in significant northbound congestion in the outer lanes between Harbison Avenue and Levick Street. Vehicles queued into the Levick Street intersection, reflecting breakdown conditions in the remaining outer general-purpose lanes (see **Figure 5**, page 18).

To avoid the congestion issues at Levick Street, a modified BAT lane scenario was created in which the northbound BAT lane starts immediately after Harbison Avenue. This was considered an agreeable and feasible alternative as the Harbison EBS Station is located on the far side of the intersection, and the distance between Harbison Avenue and Tyson Avenue is sufficiently long to allow a safe lane shift. The modified scenario retains the benefit of a designated transit lane along the rest of the study corridor without causing severe congestion.

The final modeling iteration for the scenario included the 15 percent traffic shift and the northbound BAT lane starting after Harbison Avenue.

Figure 5: Traffic Queues and Modified BAT Lane

VISSIM screenshot showing northbound outer lane traffic backups at Harbison Avenue. When the BAT lane replaces a general-purpose lane on Roosevelt Boulevard, queues extend into the Levick Street intersection. This observation led to model refinement, and the recommendation to begin the BAT lane after Harbison Avenue.

Source: DVRPC, 2016

CHAPTER 5: Performance Results

The performance results of each scenario's final modeling iteration are presented in this chapter. Performance measures used to evaluate the networks included:

- traffic delay and level of service (LOS) criteria; and
- travel time data.

Delay and LOS

Delay in seconds and the associated LOS were calculated based on *2010 Highway Capacity Manual* (HCM) criteria for signalized intersections. At signalized intersections, average delay per vehicle is the definitive parameter for LOS. Letters (A through F) are also assigned in the HCM to convey a qualitative measure for specified ranges of delay (**Table 3**).

Table 3: LOS Thresholds at Signalized Intersections

2010 HCM Criteria		Qualitative Description of Traffic Operations
LOS (v/c ≤ 1.0)	**Control Delay (seconds per vehicle)**	
A	≤ 10	Stable and Predictable
B	> 10 – 20	
C	> 20 – 35	
D	> 35 – 55	Predictable, but Approaching Unstable
E	> 55 – 80	Unstable and Unpredictable
F	> 80	

Sources: 2010 HCM; DVRPC

Signalized intersection LOS results are summarized on an overall-intersection basis in **Table 4** (page 20), and by individual approach for each intersection in the **Appendix**.

Table 4: LOS Analyses Results

Analytical Period	Intersection	Existing Conditions		Express Bus Service		Signal Optimization		TSP (w/ 10-second extension between Ryan and Holme)		BAT Lane (NB begins after Harbison; 15% traffic shift from local lanes)	
		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
3:00 PM - 4:00 PM	Roosevelt Blvd & Bustleton Ave	22.5	C	22.3	C	22.3	C	22.4	C	22.3	C
	Roosevelt Blvd & Levick St	18.0	B	18.1	B	18.1	B	18.2	B	18.0	B
	Roosevelt Blvd & Harbison Ave	29.3	C	28.8	C	29.0	C	29.1	C	28.6	C
	Roosevelt Blvd & Tyson Ave	24.9	C	24.9	C	25.4	C	25.9	C	25.6	C
	Roosevelt Blvd & Cottman	27.2	C	26.1	C	26.0	C	27.0	C	27.2	C
	Roosevelt Blvd & Ryan Ave	31.8	C	32.0	C	33.4	C	30.6	C	35.6	D
	Roosevelt Blvd & Rhawn St	37.9	D	37.3	D	35.9	D	32.6	C	39.2	D
	Roosevelt Blvd & Holme Ave	31.4	C	31.4	C	36.6	D	35.7	D	32.5	C
4:00 PM - 5:00 PM	Roosevelt Blvd & Bustleton Ave	24.4	C	24.7	C	24.4	C	25.2	C	24.7	C
	Roosevelt Blvd & Levick St	19.2	B	19.2	B	19.3	B	19.4	B	19.5	B
	Roosevelt Blvd & Harbison Ave	31.4	C	30.5	C	30.7	C	31.0	C	29.5	C
	Roosevelt Blvd & Tyson Ave	26.1	C	26.2	C	26.9	C	26.9	C	26.6	C
	Roosevelt Blvd & Cottman	28.7	C	27.1	C	27.5	C	29.4	C	30.3	C
	Roosevelt Blvd & Ryan Ave	34.6	C	34.6	C	35.3	D	32.1	C	38.9	D
	Roosevelt Blvd & Rhawn St	38.7	D	38.2	D	36.6	D	32.5	C	41.0	D
	Roosevelt Blvd & Holme Ave	33.0	C	33.6	C	38.4	D	36.8	D	33.8	C
5:00 PM - 6:00 PM	Roosevelt Blvd & Bustleton Ave	24.6	C	24.0	C	24.3	C	23.0	C	24.4	C
	Roosevelt Blvd & Levick St	19.4	B	19.3	B	19.5	B	19.1	B	20.1	C
	Roosevelt Blvd & Harbison Ave	30.0	C	29.8	C	29.7	C	29.6	C	28.9	C
	Roosevelt Blvd & Tyson Ave	25.3	C	26.3	C	26.3	C	26.8	C	26.0	C
	Roosevelt Blvd & Cottman	28.8	C	27.6	C	28.7	C	31.6	C	30.4	C
	Roosevelt Blvd & Ryan Ave	34.1	C	33.9	C	35.0	D	33.2	C	37.8	D
	Roosevelt Blvd & Rhawn St	38.4	D	38.1	D	35.7	D	31.7	C	41.0	D
	Roosevelt Blvd & Holme Ave	32.7	C	32.7	C	37.5	D	35.6	D	33.4	C

Source: DVRPC, 2016

Summary of Findings

A brief summary of peak-period traffic operating conditions can be drawn for all the scenarios.

- **Existing Conditions:** Roosevelt Boulevard's existing traffic signal timing scheme is close to optimal. Operating conditions are quite good, given the vehicular volume on and crossing the Boulevard and the lengthy side-street green times dedicated for pedestrian crossings. Overall intersection operations range between LOS B and LOS D. Individual approaches throughout the corridor operate within the same range.
- **All Build Scenarios:** The signal system can successfully serve near-term traffic and transit levels associated with all of the alternatives. Variable changes were registered for overall intersection performance but remain in the LOS B to LOS D range. Some approaches dip to LOS E at certain times, notably side-street approaches when operating under longer cycle lengths.

Travel Times

Corridor-level travel time data was collected from the various networks and summarized for buses and all vehicles to allow a comparison between the modes. The outputs are summarized in **Table 5** on page 23.

Summary of Findings

In the following summary, values for enhanced Route 14 service in the Express Bus Service column are compared to existing conditions for transit vehicles. Each additional scenario is measured against the express bus platform.

- **Existing Conditions:** Travel speeds of traffic and transit vehicles are substantially less than posted speed limits, and slower in the predominant-volume northbound direction. On average, Bus Route 14's local service operates between nine miles per hour (northbound) and 13 miles per hour (southbound) during the PM peak period.
- **Express Bus Service:** Consolidating bus stops—to optimal locations—and expressing Route 14's service will significantly improve transit operating speed versus the existing situation. Over the 2.3-mile modeled section, express service will improve transit travel time between 17 and 20 percent in the predominant northbound direction. Southbound express bus service will operate between 9 percent and 10 percent faster than the present service. Other local bus routes and general traffic travel times are unaffected.
- **Signal Optimization:** Ultimately, given the heavy traffic demands along the corridor, improving the progression for one direction negatively affected conditions in the opposing direction. In comparison to the express bus service scenario, little if any travel time differences are shown for transit or general traffic.
- **TSP (10-second green-time extension between Ryan and Holme):** Modeling performed in a "uniform" subarea of the corridor indicated that extending green times marginally benefited the flow of all vehicles along the Boulevard. Conversely, lengthening individual cycle lengths degraded system-wide progression and express bus operations. Operationally, longer cycles also increased queueing on side-street approaches.
- **BAT Lane (15 percent traffic shift; northbound lane begins after Harbison Avenue):** A modified BAT lane arrangement—beginning after Harbison Avenue—was determined necessary and reasonable, and was modeled. Additional travel time savings between 8 percent and 14 percent will accrue to Route 14's express operation in the northbound direction. Southbound express service will save an additional 1 percent to 7 percent with a designated transit lane. All local bus services in the corridor will experience travel time savings compared to existing conditions. Loss of capacity to general traffic can be absorbed in the Boulevard's express lanes with marginal increases in overall travel times.

Table 5: Travel Time Results

Analytical Period	Mode	Travel Segment	Existing Conditions		Express Bus Service			Signal Optimization			TSP (w/ 10-second extension between Ryan and Holme)			BAT Lane (NB BAT lane begins after Harbison; 15% traffic shift from local lanes)		
			Average Speed (mph)	Average Travel Time (minutes)	Average Speed (mph)	Average Travel Time (minutes)	Change in Travel Time vs. Existing Conditions	Average Speed (mph)	Average Travel Time (minutes)	Change in Travel Time vs. Express Bus	Average Speed (mph)	Average Travel Time (minutes)	Change in Travel Time vs. Express Bus	Average Speed (mph)	Average Travel Time (minutes)	Change in Travel Time vs. Express Bus
3:00 PM – 4:00 PM	All Vehicles	Roosevelt Outer NB from Bustleton to Rhawn	14.2	9.7	14.5	9.5	-2%	14.3	9.6	1%	14.7	9.4	-1%	13.1	9.9	4%
		Roosevelt Outer SB from Rhawn to Bustleton	23.3	5.9	23.1	6.0	1%	23.0	6.0	0%	24.0	5.8	-4%	21.5	6.4	7%
		Roosevelt Inner NB from Bustleton to Rhawn	15.8	8.7	15.8	8.8	0%	15.6	8.8	1%	16.2	8.5	-2%	14.9	9.3	6%
		Roosevelt Inner SB from Rhawn to Bustleton	24.8	5.6	24.8	5.6	0%	24.6	5.6	0%	25.0	5.5	-1%	24.8	5.6	0%
	Buses	Route 14 NB from Bustleton to Holme	9.5	14.6	9.9	14.0	-4%	9.8	14.1	1%	10.4	13.3	-5%	11.3	12.2	-12%
		Route 14 SB from Holme to Bustleton	13.1	10.6	12.9	10.7	1%	12.3	11.3	5%	13.2	10.4	-3%	13.9	9.9	-7%
		Enhanced Route 14 Bus NB from Bustleton to Holme	**NA**	**NA**	11.8	**11.7**	**-20%**	11.8	**11.7**	**0%**	11.0	**12.6**	**8%**	12.8	**10.8**	**-8%**
		Enhanced Route 14 Bus SB from Holme to Bustleton	**NA**	**NA**	14.5	**9.5**	**-10%**	15.5	**9.0**	**-6%**	15.2	**9.1**	**-4%**	15.6	**8.9**	**-7%**
4:00 PM – 5:00 PM	All Vehicles	Roosevelt Outer NB from Bustleton to Rhawn	13.4	10.3	13.6	10.2	-2%	13.6	10.2	0%	13.8	10.0	-2%	12.6	11.0	8%
		Roosevelt Outer SB from Rhawn to Bustleton	23.0	6.0	22.9	6.0	1%	22.9	6.0	0%	23.9	5.8	-4%	21.7	6.3	5%
		Roosevelt Inner NB from Bustleton to Rhawn	15.5	8.9	15.5	8.9	0%	15.4	9.0	0%	16.0	8.6	-3%	14.6	9.4	6%
		Roosevelt Inner SB from Rhawn to Bustleton	24.5	5.6	24.6	5.6	0%	24.6	5.6	0%	25.1	5.5	-2%	24.6	5.6	0%
	Buses	Route 14 NB from Bustleton to Holme	9.0	15.3	9.4	14.7	-3%	9.4	14.7	-1%	9.6	14.4	-3%	10.9	12.7	-14%
		Route 14 SB from Holme to Bustleton	12.8	10.8	12.7	10.9	1%	12.6	11.0	1%	13.0	10.6	-2%	14.2	9.7	-11%
		Enhanced Route 14 Bus NB from Bustleton to Holme	**NA**	**NA**	10.8	**12.7**	**-17%**	10.8	**12.8**	**1%**	10.5	**13.1**	**3%**	12.6	**10.9**	**-14%**
		Enhanced Route 14 Bus SB from Holme to Bustleton	**NA**	**NA**	14.3	**9.6**	**-10%**	15.5	**8.9**	**-8%**	14.8	**9.3**	**-4%**	15.1	**9.1**	**-5%**
5:00 PM – 6:00 PM	All Vehicles	Roosevelt Outer NB from Bustleton to Rhawn	13.5	10.2	13.7	10.1	-1%	13.7	10.1	0%	14.1	9.8	-3%	12.8	10.8	7%
		Roosevelt Outer SB from Rhawn to Bustleton	23.0	6.0	22.7	6.1	1%	22.5	6.1	1%	23.5	5.9	-4%	21.1	6.6	8%
		Roosevelt Inner NB from Bustleton to Rhawn	15.6	8.8	15.6	8.9	0%	15.5	8.9	1%	15.9	8.7	-2%	14.7	9.4	6%
		Roosevelt Inner SB from Rhawn to Bustleton	24.0	5.8	24.1	5.7	-1%	24.1	5.7	0%	24.5	5.6	-2%	24.1	5.7	0%
	Buses	Route 14 NB from Bustleton to Holme	9.1	15.2	9.4	14.7	-3%	9.4	14.8	0%	9.7	14.3	-3%	11.1	12.5	-15%
		Route 14 SB from Holme to Bustleton	13.5	10.2	13.1	10.5	2%	12.8	10.8	3%	13.1	10.5	0%	14.4	9.6	-8%
		Enhanced Route 14 Bus NB from Bustleton to Holme	**NA**	**NA**	11.2	**12.3**	**-19%**	10.8	**12.8**	**3%**	10.7	**12.9**	**4%**	12.5	**11.0**	**-11%**
		Enhanced Route 14 Bus SB from Holme to Bustleton	**NA**	**NA**	14.8	**9.3**	**-9%**	15.1	**9.1**	**-2%**	14.2	**9.7**	**5%**	14.9	**9.3**	**-1%**

Source: DVRPC, 2016

CHAPTER 6: Summary and Conclusions

Given its overall activity levels, general traffic operations along Roosevelt Boulevard are quite good. Public bus service operations are not. Transit travel times can take twice as long as a trip in a private auto. Deliverable, near-term transportation improvement alternatives have been identified to close that gap. DVRPC staff modeled and evaluated existing PM peak-period conditions and four improvement alternatives with micro-simulation software for a 2.3-mile-long sample section of the Boulevard to explore the effectiveness of each.

Constraints posed by the corridor's physical geometry are not readily surmounted with traditional traffic signalization techniques. Available options were evaluated but were ambiguous in their benefit to improve the flow of transit vehicles and general traffic. The options remain open with a long-term capital improvement for the corridor.

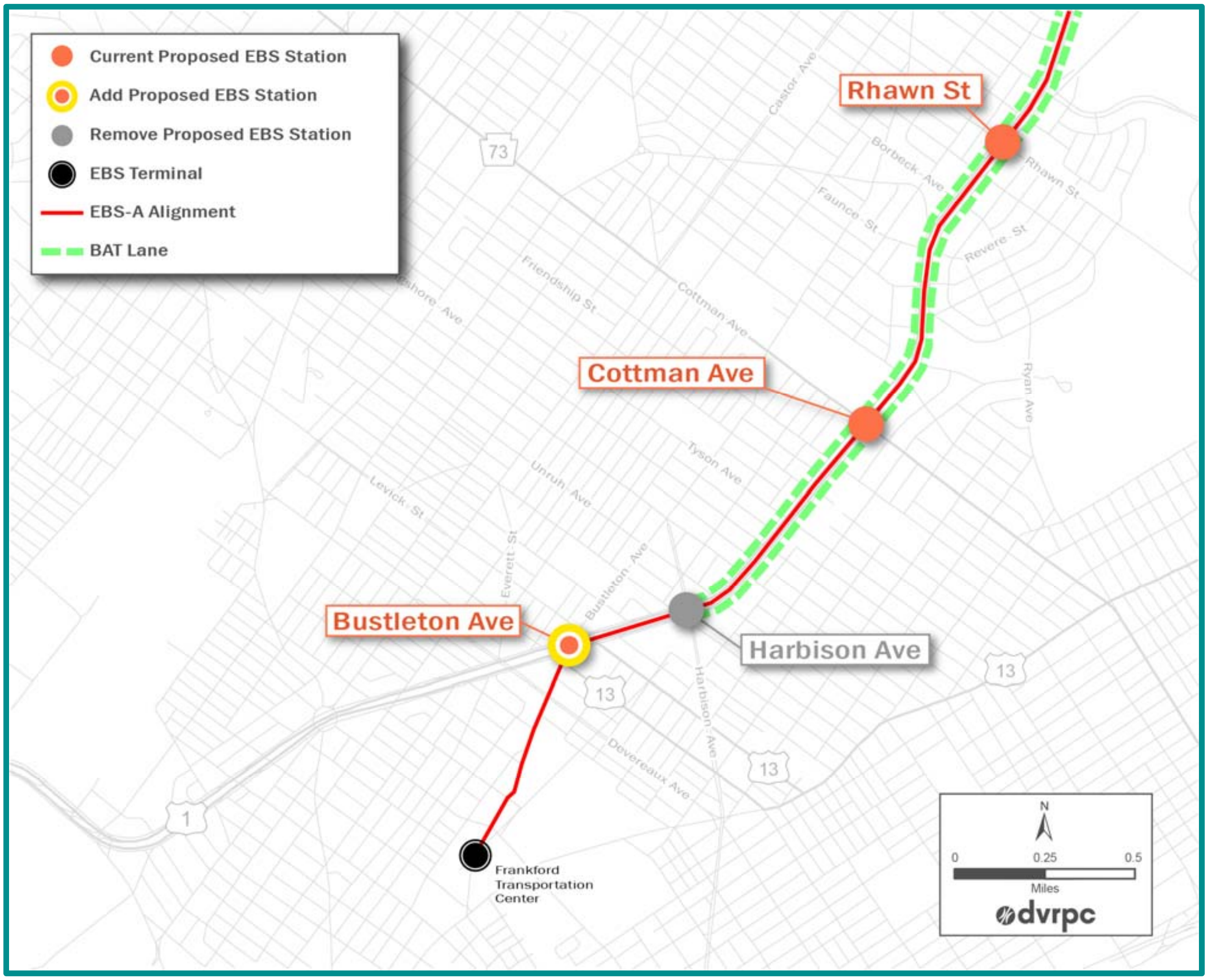
In the near term, two transit operational improvements are unequivocal in their benefit.

- Consolidating bus stops and creating an express bus service plan for the SEPTA Route 14 bus will significantly improve bus travel times without affecting the flow of general traffic.
- Dedicating BAT lanes for use by the Route 14 Express and all local buses would further improve bus travel times. However, the loss of a general-purpose travel lane would result in congestion in the remaining outer lanes. For this reason, the northbound BAT lane is recommended to begin after Harbison Avenue. The modified BAT lane retained its benefit along the rest of the detailed study corridor without causing severe congestion.

Taken together—and extrapolated to the full length of the EBS-A service plan—the transit operational enhancements are estimated to save Route 14 Express bus riders 18 minutes in the predominant northbound direction and seven minutes in the southbound direction compared to existing local bus travel times during the PM peak period.

That said, both this *Operations Analysis* and the parent *Alternatives Analysis* projects recognize operational shortcomings surrounding the proposed Harbison Avenue EBS station stop. In the near term, Bustleton Avenue south of Roosevelt Boulevard should be considered as a substitute first-northbound and next-to-last-southbound stop. The BAT lane should be provided north of Harbison Avenue, and the Route 14 Express bus should operate in mixed traffic between Bustleton and Harbison (see **Figure 6**, on page 26).

Figure 6: Suggested BAT Lane Realignment



Source: DVRPC, 2016

Finally, a long-term vision for Bus Rapid Transit, operating in the median, remains to be explored operationally. Implementing a capital-intensive busway also presents the chance to rectify some of the Boulevard's physical impediments: specifically, shortening the crossing distance of the outer service roads. In turn, opportunities would be reopened to evaluate:

- traffic signal optimization; and
- TSP at traffic signals.

In the long term, an adaptive traffic signal control system regulating the corridor may be more capable of delivering traffic signalization benefits than current equipment and should be incorporated into the operational modeling and analysis.

Appendix A

LOS Analyses Results by Intersection, by Approach, and by Alternative

Table A-1: LOS Analyses Results at the Bustleton Avenue Intersection

Analytical Period	Roosevelt Blvd & Bustleton Ave	Existing Conditions		Express Bus Service		Signal Optimization		TSP (w/ 10-second extension between Ryan and Holme)		BAT Lane (NB begins after Harbison; 15% traffic shift from local lanes)	
		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
3:00 PM – 4:00 PM	Roosevelt Blvd NB Outer	26.8	C	25.8	C	26.0	C	26.3	C	23.9	C
	Roosevelt Blvd SB Outer	10.9	B	11.2	B	11.1	B	11.2	B	12.0	B
	Roosevelt Blvd NB Inner	26.1	C	26.0	C	26.0	C	26.1	C	27.2	C
	Roosevelt Blvd SB Inner	9.7	A	9.7	A	9.5	A	9.5	A	9.6	A
	Bustleton Ave EB	39.2	D	39.5	D	39.5	D	39.7	D	39.8	D
	Bustleton Ave WB	42.1	D	42.2	D	42.1	D	43.0	D	42.8	D
4:00 PM – 5:00 PM	Roosevelt Blvd NB Outer	29.8	C	30.2	C	29.1	C	30.6	C	26.2	C
	Roosevelt Blvd SB Outer	13.0	B	13.1	B	13.1	B	13.1	B	14.1	B
	Roosevelt Blvd NB Inner	27.8	C	27.7	C	27.8	C	27.8	C	28.0	C
	Roosevelt Blvd SB Inner	9.9	A	9.8	A	9.6	A	9.7	A	10.6	B
	Bustleton Ave EB	38.9	D	39.0	D	38.9	D	39.4	D	38.9	D
	Bustleton Ave WB	48.4	D	50.6	D	50.9	D	56.1	E	56.5	E
5:00 PM – 6:00 PM	Roosevelt Blvd NB Outer	30.0	C	29.0	C	29.8	C	31.1	C	25.5	C
	Roosevelt Blvd SB Outer	13.9	B	13.8	B	13.8	B	12.7	B	15.1	B
	Roosevelt Blvd NB Inner	27.9	C	28.0	C	28.1	C	28.1	C	28.8	C
	Roosevelt Blvd SB Inner	12.3	B	10.7	B	10.9	B	10.3	B	12.2	B
	Bustleton Ave EB	38.0	D	38.4	D	39.3	D	39.9	D	38.1	D
	Bustleton Ave WB	46.5	D	48.2	D	48.8	D	53.3	D	51.9	D

Source: DVRPC, 2016

Table A-2: LOS Analyses Results at the Levick Street Intersection

Analytical Period	Roosevelt Blvd & Levick St	Existing Conditions		Express Bus Service		Signal Optimization		TSP (w/ 10-second extension between Ryan and Holme)		BAT Lane (NB begins after Harbison; 15% traffic shift from local lanes)	
		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
3:00 PM – 4:00 PM	Roosevelt Blvd NB Outer	24.3	C	24.1	C	24.0	C	24.1	C	20.5	C
	Roosevelt Blvd SB Outer	14.0	B	15.1	B	15.4	B	15.4	B	15.0	B
	Roosevelt Blvd NB Inner	14.8	B	14.8	B	14.8	B	14.8	B	17.9	B
	Roosevelt Blvd SB Inner	12.5	B	12.5	B	12.6	B	13.0	B	12.6	B
	Levick St EB	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Levick St WB	27.6	C	27.6	C	27.6	C	27.6	C	27.7	C
4:00 PM – 5:00 PM	Roosevelt Blvd NB Outer	26.5	C	26.4	C	26.4	C	26.8	C	22.5	C
	Roosevelt Blvd SB Outer	13.8	B	13.6	B	13.8	B	14.4	B	16.1	B
	Roosevelt Blvd NB Inner	14.8	B	15.0	B	15.0	B	14.8	B	18.6	B
	Roosevelt Blvd SB Inner	13.1	B	12.7	B	12.8	B	12.8	B	13.3	B
	Levick St EB	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Levick St WB	28.5	C	28.5	C	28.5	C	28.7	C	28.6	C
5:00 PM – 6:00 PM	Roosevelt Blvd NB Outer	23.5	C	23.5	C	23.5	C	23.5	C	20.2	C
	Roosevelt Blvd SB Outer	13.5	B	13.6	B	13.9	B	15.6	B	20.2	C
	Roosevelt Blvd NB Inner	15.1	B	14.9	B	15.0	B	15.1	B	18.0	B
	Roosevelt Blvd SB Inner	14.9	B	14.5	B	14.2	B	14.1	B	14.7	B
	Levick St EB	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Levick St WB	30.0	C	30.2	C	31.1	C	31.1	C	30.5	C

Source: DVRPC, 2016

Table A-3: LOS Analyses Results at the Harbison Avenue Intersection

Analytical Period	Roosevelt Blvd & Harbison Ave	Existing Conditions		Express Bus Service		Signal Optimization		TSP (w/ 10-second extension between Ryan and Holme)		BAT Lane (NB begins after Harbison; 15% traffic shift from local lanes)	
		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
3:00 PM – 4:00 PM	Roosevelt Blvd NB Outer	31.4	C	29.0	C	29.6	C	29.1	C	23.5	C
	Roosevelt Blvd SB Outer	14.4	B	14.0	B	14.6	B	14.2	B	15.5	B
	Roosevelt Blvd NB Inner	22.6	C	22.6	C	22.6	C	22.7	C	26.0	C
	Roosevelt Blvd SB Inner	35.3	D	35.1	D	35.4	D	34.8	D	35.2	D
	Harbison Ave EB	33.7	C	33.5	C	33.7	C	34.5	C	34.2	C
	Harbison Ave WB	36.2	D	37.2	D	36.8	D	38.1	D	36.7	D
4:00 PM – 5:00 PM	Roosevelt Blvd NB Outer	39.7	D	35.1	D	34.7	C	34.7	C	25.7	C
	Roosevelt Blvd SB Outer	11.8	B	11.7	B	13.0	B	12.8	B	12.6	B
	Roosevelt Blvd NB Inner	24.4	C	24.1	C	24.2	C	24.5	C	27.6	C
	Roosevelt Blvd SB Inner	30.0	C	30.7	C	31.0	C	30.2	C	31.2	C
	Harbison Ave EB	38.7	D	39.1	D	38.9	D	40.7	D	40.2	D
	Harbison Ave WB	38.7	D	38.6	D	39.3	D	41.3	D	38.3	D
5:00 PM – 6:00 PM	Roosevelt Blvd NB Outer	32.4	C	30.2	C	30.0	C	29.3	C	23.8	C
	Roosevelt Blvd SB Outer	13.1	B	12.8	B	13.4	B	13.2	B	13.4	B
	Roosevelt Blvd NB Inner	23.9	C	24.2	C	24.3	C	24.2	C	26.5	C
	Roosevelt Blvd SB Inner	31.1	C	32.4	C	32.2	C	31.5	C	31.0	C
	Harbison Ave EB	35.1	D	35.1	D	35.7	D	37.8	D	36.3	D
	Harbison Ave WB	40.1	D	41.7	D	42.3	D	47.1	D	40.7	D

Source: DVRPC, 2016

Table A-4: LOS Analyses Results at the Tyson Avenue Intersection

Analytical Period	Roosevelt Blvd & Tyson Ave	Existing Conditions		Express Bus Service		Signal Optimization		TSP (w/ 10-second extension between Ryan and Holme)		BAT Lane (NB begins after Harbison; 15% traffic shift from local lanes)	
		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
3:00 PM – 4:00 PM	Roosevelt Blvd NB Outer	19.9	B	20.3	C	21.4	C	21.4	C	21.7	C
	Roosevelt Blvd SB Outer	14.4	B	14.2	B	13.3	B	14.1	B	15.2	B
	Roosevelt Blvd NB Inner	18.1	B	18.3	B	21.0	C	21.0	C	19.6	B
	Roosevelt Blvd SB Inner	26.5	C	26.1	C	26.5	C	27.4	C	26.6	C
	Tyson Ave EB	43.7	D	43.3	D	44.5	D	44.1	D	43.5	D
	Tyson Ave WB	49.8	D	50.5	D	46.3	D	47.9	D	48.4	D
4:00 PM – 5:00 PM	Roosevelt Blvd NB Outer	22.9	C	23.1	C	23.4	C	23.4	C	24.9	C
	Roosevelt Blvd SB Outer	15.1	B	15.3	B	13.6	B	14.4	B	16.1	B
	Roosevelt Blvd NB Inner	19.2	B	19.4	B	21.4	C	21.3	C	21.0	C
	Roosevelt Blvd SB Inner	27.4	C	25.6	C	26.7	C	26.8	C	30.7	C
	Tyson Ave EB	51.9	D	50.1	D	50.5	D	50.2	D	46.3	D
	Tyson Ave WB	47.7	D	49.2	D	50.4	D	49.3	D	47.2	D
5:00 PM – 6:00 PM	Roosevelt Blvd NB Outer	20.9	C	20.9	C	20.8	C	21.1	C	22.0	C
	Roosevelt Blvd SB Outer	14.2	B	14.6	B	13.2	B	14.6	B	15.5	B
	Roosevelt Blvd NB Inner	19.2	B	19.3	B	20.8	C	20.4	C	20.4	C
	Roosevelt Blvd SB Inner	28.4	C	26.4	C	27.4	C	30.9	C	26.6	C
	Tyson Ave EB	51.7	D	56.2	E	54.3	D	55.9	E	52.8	D
	Tyson Ave WB	50.8	D	52.2	D	52.4	D	52.6	D	47.5	D

Source: DVRPC, 2016

Table A-5: LOS Analyses Results at the Cottman Avenue Intersection

Analytical Period	Roosevelt Blvd & Cottman Ave	Existing Conditions		Express Bus Service		Signal Optimization		TSP (w/ 10-second extension between Ryan and Holme)		BAT Lane (NB begins after Harbison; 15% traffic shift from local lanes)	
		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
3:00 PM – 4:00 PM	Roosevelt Blvd NB Outer	33.3	C	30.7	C	30.3	C	30.5	C	32.7	C
	Roosevelt Blvd SB Outer	27.4	C	27.0	C	27.0	C	27.7	C	29.3	C
	Roosevelt Blvd NB Inner	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Roosevelt Blvd SB Inner	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Cottman Ave EB	21.2	C	21.1	C	21.2	C	22.7	C	21.0	C
	Cottman Ave WB	22.2	C	22.1	C	22.3	C	24.5	C	22.4	C
4:00 PM – 5:00 PM	Roosevelt Blvd NB Outer	36.5	D	33.0	C	34.2	C	34.1	C	41.9	D
	Roosevelt Blvd SB Outer	28.1	C	27.2	C	26.8	C	28.4	C	28.6	C
	Roosevelt Blvd NB Inner	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Roosevelt Blvd SB Inner	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Cottman Ave EB	21.0	C	21.0	C	21.0	C	25.6	C	21.1	C
	Cottman Ave WB	21.3	C	21.1	C	21.1	C	24.6	C	21.1	C
5:00 PM – 6:00 PM	Roosevelt Blvd NB Outer	37.5	D	34.7	C	35.4	C	34.2	C	41.7	D
	Roosevelt Blvd SB Outer	26.3	C	26.2	C	26.3	C	27.0	C	27.7	C
	Roosevelt Blvd NB Inner	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Roosevelt Blvd SB Inner	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Cottman Ave EB	21.0	C	20.8	C	21.9	C	34.4	C	21.0	C
	Cottman Ave WB	21.0	C	20.7	C	24.8	C	32.4	C	20.9	C

Source: DVRPC, 2016

Table A-6: LOS Analyses Results at the Ryan Avenue Intersection

Analytical Period	Roosevelt Blvd & Ryan Ave	Existing Conditions		Express Bus Service		Signal Optimization		TSP (w/ 10-second extension between Ryan and Holme)		BAT Lane (NB begins after Harbison; 15% traffic shift from local lanes)	
		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
3:00 PM – 4:00 PM	Roosevelt Blvd NB Outer	31.1	C	31.2	C	30.7	C	28.3	C	30.7	C
	Roosevelt Blvd SB Outer	26.7	C	27.3	C	35.9	D	28.6	C	33.1	C
	Roosevelt Blvd NB Inner	41.2	D	41.3	D	40.4	D	36.0	D	48.5	D
	Roosevelt Blvd SB Inner	20.9	C	21.0	C	20.9	C	17.4	B	20.8	C
	Borbeck Ave EB	41.1	D	41.1	D	41.0	D	48.3	D	41.0	D
	Ryan Ave WB	43.6	D	43.6	D	43.6	D	55.3	E	43.5	D
4:00 PM – 5:00 PM	Roosevelt Blvd NB Outer	32.0	C	32.9	C	32.2	C	27.9	C	35.9	D
	Roosevelt Blvd SB Outer	31.4	C	31.4	C	36.3	D	29.0	C	34.1	C
	Roosevelt Blvd NB Inner	42.2	D	42.1	D	42.1	D	36.6	D	51.3	D
	Roosevelt Blvd SB Inner	23.3	C	22.9	C	22.9	C	18.1	B	23.4	C
	Borbeck Ave EB	45.0	D	44.9	D	44.9	D	53.8	D	44.2	D
	Ryan Ave WB	53.0	D	52.7	D	52.7	D	69.2	E	52.1	D
5:00 PM – 6:00 PM	Roosevelt Blvd NB Outer	31.8	C	31.9	C	31.8	C	27.9	C	34.1	C
	Roosevelt Blvd SB Outer	28.0	C	28.3	C	35.8	D	29.0	C	32.9	C
	Roosevelt Blvd NB Inner	39.7	D	39.0	D	38.1	D	34.9	D	47.0	D
	Roosevelt Blvd SB Inner	27.0	C	25.4	C	25.4	C	20.4	C	25.9	C
	Borbeck Ave EB	48.4	D	48.7	D	48.6	D	56.9	E	48.4	D
	Ryan Ave WB	53.1	D	54.1	D	53.9	D	73.0	E	53.6	D

Source: DVRPC, 2016

Table A-7: LOS Analyses Results at the Rhawn Street Intersection

Analytical Period	Roosevelt Blvd & Rhawn St	Existing Conditions		Express Bus Service		Signal Optimization		TSP (w/ 10-second extension between Ryan and Holme)		BAT Lane (NB begins after Harbison; 15% traffic shift from local lanes)	
		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
3:00 PM – 4:00 PM	Roosevelt Blvd NB Outer	40.0	D	38.2	D	38.8	D	28.5	C	42.2	D
	Roosevelt Blvd SB Outer	28.6	C	27.9	C	19.7	B	15.8	B	30.2	C
	Roosevelt Blvd NB Inner	44.6	D	44.1	D	44.7	D	33.6	C	47.2	D
	Roosevelt Blvd SB Inner	29.4	C	29.4	C	29.4	C	27.7	C	29.4	C
	Rhawn St EB	41.1	D	41.5	D	41.3	D	48.9	D	41.4	D
	Rhawn St WB	49.3	D	48.6	D	47.6	D	62.7	E	48.1	D
4:00 PM – 5:00 PM	Roosevelt Blvd NB Outer	46.0	D	43.6	D	43.5	D	31.4	C	51.0	D
	Roosevelt Blvd SB Outer	29.7	C	28.9	C	20.0	C	16.4	B	31.0	C
	Roosevelt Blvd NB Inner	45.2	D	45.8	D	45.4	D	34.8	C	48.5	D
	Roosevelt Blvd SB Inner	30.2	C	30.2	C	30.2	C	29.0	C	30.2	C
	Rhawn St EB	41.4	D	41.1	D	41.3	D	50.1	D	41.8	D
	Rhawn St WB	40.6	D	41.3	D	41.2	D	50.6	D	42.0	D
5:00 PM – 6:00 PM	Roosevelt Blvd NB Outer	45.0	D	43.4	D	40.7	D	29.5	C	49.5	D
	Roosevelt Blvd SB Outer	28.9	C	28.6	C	20.7	C	16.8	B	30.6	C
	Roosevelt Blvd NB Inner	44.1	D	44.9	D	43.7	D	33.2	C	48.3	D
	Roosevelt Blvd SB Inner	30.8	C	30.6	C	30.6	C	29.3	C	30.6	C
	Rhawn St EB	39.9	D	39.9	D	39.9	D	46.4	D	40.0	D
	Rhawn St WB	42.6	D	43.6	D	42.6	D	53.2	D	42.9	D

Source: DVRPC, 2016

Table A-8: LOS Analyses Results at the Holme Avenue Intersection

Analytical Period	Roosevelt Blvd & Holme Ave	Existing Conditions		Express Bus Service		Signal Optimization		TSP (w/ 10-second extension between Ryan and Holme)		BAT Lane (NB begins after Harbison; 15% traffic shift from local lanes)	
		Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
3:00 PM – 4:00 PM	Roosevelt Blvd NB Outer	35.3	D	35.4	D	41.1	D	35.9	D	38.0	D
	Roosevelt Blvd SB Outer	23.6	C	23.7	C	28.8	C	28.9	C	25.0	C
	Roosevelt Blvd NB Inner	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Roosevelt Blvd SB Inner	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Solly Ave EB	36.3	D	36.2	D	40.4	D	44.0	D	36.1	D
	Holme Ave WB	32.2	C	31.9	C	36.9	D	40.3	D	31.8	C
4:00 PM – 5:00 PM	Roosevelt Blvd NB Outer	39.5	D	40.9	D	45.6	D	37.8	D	41.4	D
	Roosevelt Blvd SB Outer	23.6	C	23.6	C	29.0	C	28.9	C	25.1	C
	Roosevelt Blvd NB Inner	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Roosevelt Blvd SB Inner	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Solly Ave EB	36.1	D	36.1	D	40.5	D	44.8	D	36.2	D
	Holme Ave WB	32.4	C	32.2	C	37.0	D	41.6	D	32.0	C
5:00 PM – 6:00 PM	Roosevelt Blvd NB Outer	39.0	D	39.1	D	43.8	D	35.5	D	36.2	D
	Roosevelt Blvd SB Outer	23.6	C	23.7	C	29.1	C	28.4	C	25.1	C
	Roosevelt Blvd NB Inner	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Roosevelt Blvd SB Inner	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Solly Ave EB	36.0	D	35.4	D	40.7	D	45.4	D	46.4	D
	Holme Ave WB	32.5	C	32.6	C	37.4	D	40.6	D	32.1	C

Source: DVRPC, 2016

Roosevelt Boulevard Enhanced Bus Service Operations Analysis

Publication Number: 15028

Date Published: January 2017

Geographic Area Covered:
City of Philadelphia (Northeast Philadelphia)

Key Words:
Roosevelt Boulevard, US 1, Enhanced Bus Service, Express Bus Service, Traffic Signal Optimization, Transit Signal Priority, Exclusive Bus Lane, VISSIM, Level of Service, Travel Time

Abstract:
Near-term transportation improvements have been identified to reduce bus travel times along Roosevelt Boulevard (US 1). Delaware Valley Regional Planning Commission staff modeled and evaluated four alternatives with micro-simulation software in a 2.3-mile-long sample section of the Boulevard. With some modifications, two transit operational improvements are unequivocal in their benefit for the flow of buses: express bus service and designated bus lanes. Two traffic signalization strategies are ambiguous in their benefits for transit and general traffic. Conversely, the signalization options remain open for reevaluation with changes to the corridor's physical geometry that might be accomplished with a long-term and capital-intensive Bus Rapid Transit system in the corridor.

The project was undertaken pursuant to recommendations contained in *Alternatives Development for Roosevelt Boulevard Transit Enhancements* (DVRPC, May 2016, Publication Number 13072). Its findings will inform the City of Philadelphia's $2.5 million Transportation Investment Generating Economic Recovery grant to further develop all of the proposals in the *Alternatives* report.

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