BURGESS & NIPLE Memorandum

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Fayette-Raleigh MPO

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Subject: Pedestrian Accommodations at Robert C. Byrd Drive and Prince Street and Neville Street

Background and Purpose

On February 27, 2017, a walk-about was conducted by Dr. Ron Eck of the West Virginia Local Technical Assistance Program for the intersections of Robert C. Byrd Drive with Neville Street and Prince Street in the City of Beckley. These two signalized intersections are located approximately 250 feet apart. The purpose of the walk-about was to assess the adequacy of current pedestrian accommodations at and near the intersections. During the field review, a significant number of pedestrians were observed on the sidewalks on both sides of Robert C. Byrd Drive. Dr. Eck recommended that pedestrians be accommodated at the intersections with marked crosswalks and pedestrian signal phases, including pedestrian signal heads. The walk-about study was cursory in nature and did not include traffic analysis or geometric layouts.

This memorandum summarizes the feasibility and impacts of implementing pedestrian crossings at these intersections including traffic analyses and preliminary geometric layouts. The signals at both intersections are currently being redesigned. It is anticipated that the most feasible pedestrian improvements as determined by this analysis will be implemented as part of the signal reconstruction project.

Existing Conditions

Sidewalk is currently provided on both sides of Robert C. Byrd Drive, Prince Street, and Neville Street. Non-ADA compliant curb ramps are also provided at the intersections to cross Prince Street and Neville Street; there are no existing curb ramps for pedestrians crossing Robert C. Byrd Drive. The existing width of Robert C Byrd Drive south of Neville Street is approximately 66 feet wide and north of Prince Street is approximately 80 feet wide. There are no marked crosswalks or pedestrian signal heads or push buttons. The existing vehicular lane configurations are illustrated in **Figure 1**.

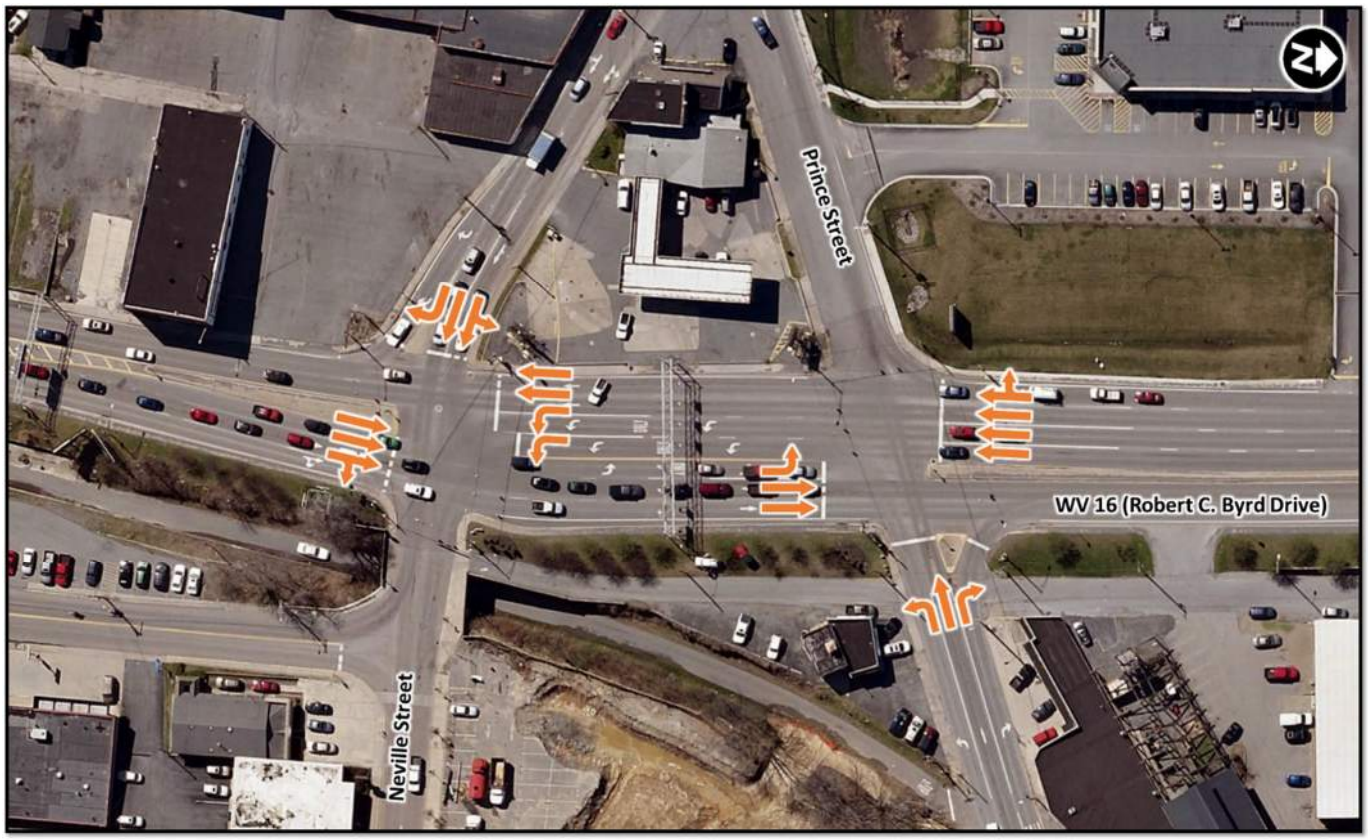

Figure 1: Existing Lane Configurations

Crash Analysis

Crash data for the study intersections was provided by the West Virginia Division of Highways (WVDOH). Crash diagrams were generated to illustrate the locations and details of the pedestrian crashes at the study intersections for the four calendar years between 2013 and 2016. This diagram is illustrated in **Figure 2**.

Four pedestrian crashes occurred within the four-year period – one in 2013, one in 2014, and two in 2015. All four crashes occurred under daylight conditions at the Neville Street intersection and all resulted in injury. Two crashes occurred when a pedestrian crossed the north leg of the Neville Street intersection and was struck by a vehicle making an eastbound left-turn from Neville Street onto northbound Robert C. Byrd Drive. In both cases, the pedestrian was cited for failing to yield to the left-turning vehicle.

The vehicular crashes that occurred at the intersections during the three-year period between 2014 and 2016 are summarized in **Figure 3**. 51 multi-vehicle crashes occurred at the Neville Street intersection while 43 occurred at the Prince Street intersection. Six of the 51 crashes (12 percent) at Neville Street resulted injury while 13 of the 43 crashes (30 percent) at Prince Street resulted in injury.

At the Neville Street intersection, 17 of the 51 (33 percent) the crashes were rear end collisions – 10 occurring between northbound vehicles and seven occurring between southbound vehicles. Per the officer's narrative, one of the southbound rear end crashes was caused by a bicycle in the intersection. The second most prominent crash type at the intersection was left-turn crashes. 16 left-turn crashes occurred in the three-year period when the southbound left-turning vehicle collided with a northbound through vehicle. Several angle and sideswipe-passing collisions also occurred at this intersection.

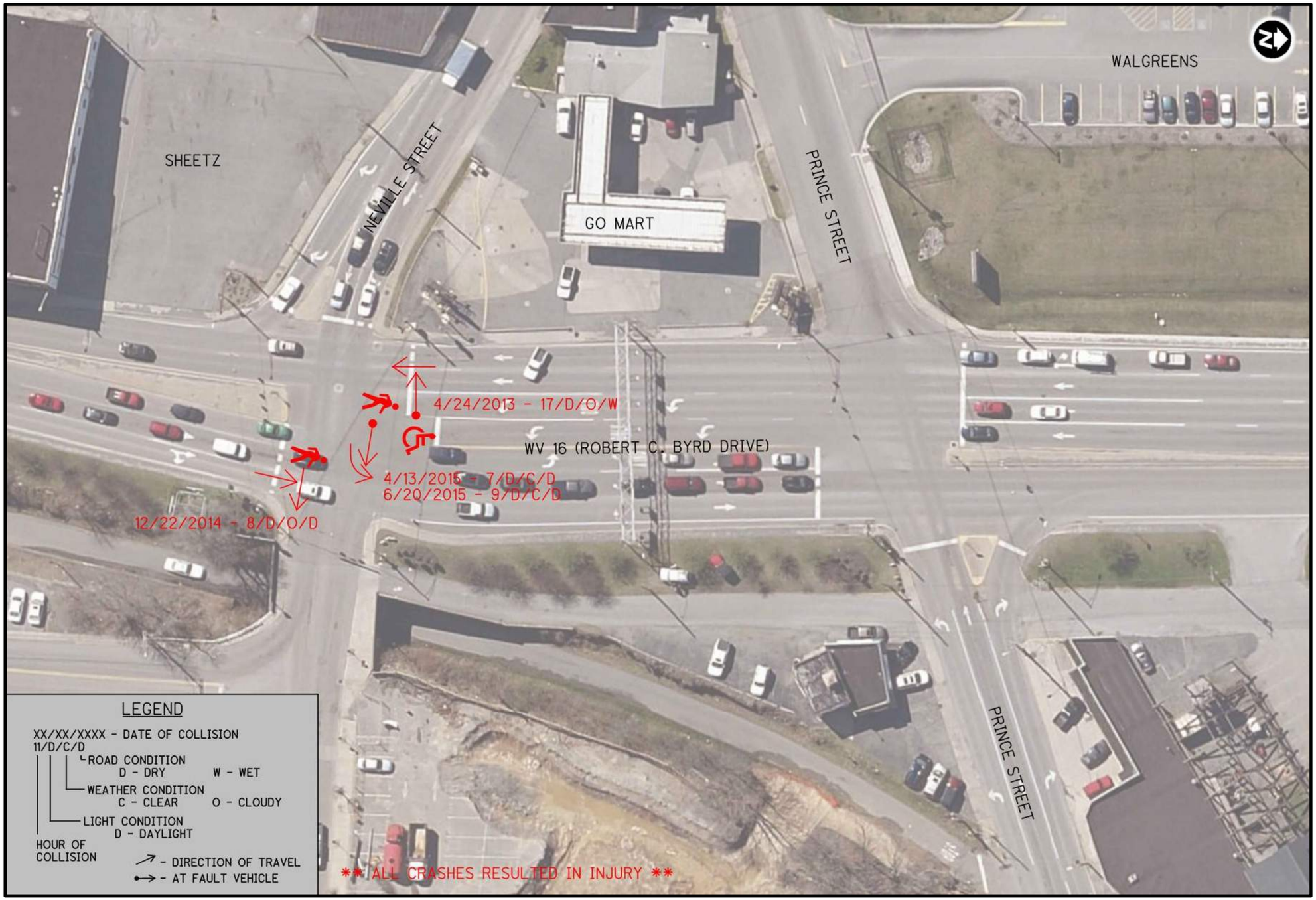

Figure 2: Pedestrian Crash Diagram

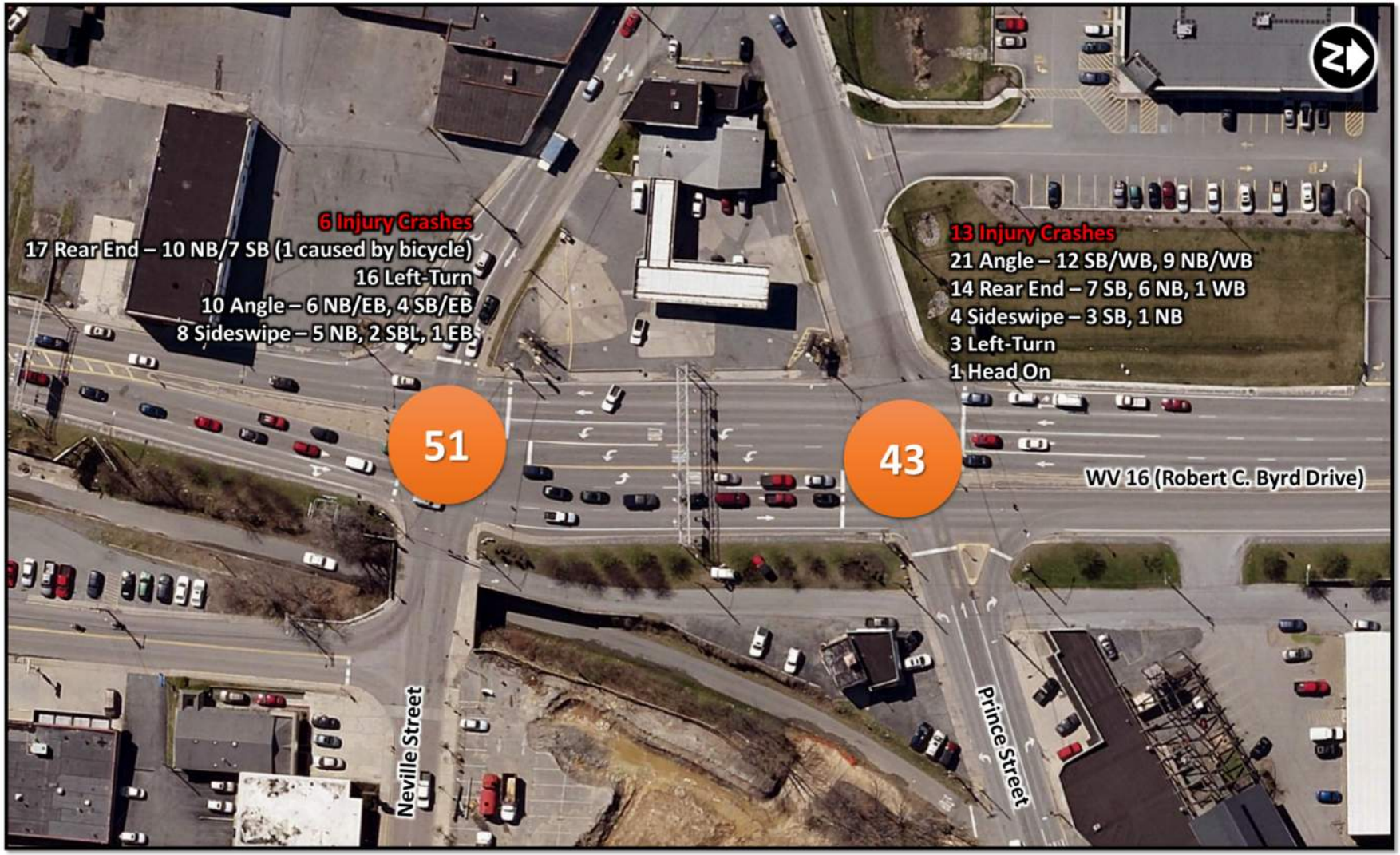

Figure 3: Vehicular Crash Summary (2014 – 2016)

Of the 43 crashes occurring at the Prince Street intersection, 21 (49 percent) were angle collisions with 12 crashes occurring between a southbound and westbound vehicle and the other nine between a northbound and westbound vehicle. 14 rear end collisions also occurred at this intersection – seven between southbound vehicles, six between northbound vehicles, and one between westbound vehicles. Additionally, there were four sideswipe-passing crashes, three left-turn crashes, and one head on crash at this intersection in the three-year analysis period.

Crash rates were calculated for the two study intersections. The crash rate per million vehicles entering is 1.83 for the Neville Street intersection and 1.43 for the Prince Street intersection.

Traffic Counts

Pedestrian crossing volumes were collected by West Virginia University Institute of Technology (WVU Tech) at the intersection of Robert C. Byrd Drive and Prince Street between the hours of 7:00 AM and 7:00 PM on Thursday, April 26. Given the closely spaced intersections, it was assumed that volumes and travel patterns were similar at the Robert C. Byrd Drive and Neville Street intersection. During this 12-hour period, 90 pedestrians crossed Robert C. Byrd Drive at this intersection. Furthermore, there were an additional 37 pedestrians that crossed the Prince Street approaches, walking north-south along Robert C. Byrd Drive. The 12-hour pedestrian counts and associated crossing maneuvers are summarized in **Figure 4**. The count data indicates that when crossing Robert C. Byrd Drive, the majority of pedestrians cross the north leg of the intersection. Several factors could be contributing to this crossing pattern. First, the origins and destinations of McDonald's, Walgreen's, and other commercial areas towards the north of the intersection could result in a more direct path if the north leg is used. Secondly, when crossing the north leg, the pedestrian does not conflict with the westbound left-turning vehicle. The pedestrian may feel safer crossing the north leg than the south leg of the intersection if this vehicular conflict is avoided. Lastly, the small concrete median between the northbound and southbound lanes provides a refuge for pedestrians to make a two-stage crossing maneuver. On the south leg, the pedestrian must cross all lanes on Robert C. Byrd Drive without stopping. The median and resulting refuge area may provide an additional factor of safety for pedestrians crossing Robert C. Byrd Drive.

As part of another study being conducted in the vicinity, 24-hour vehicular turning movement counts were collected at both intersections on Tuesday, April 25, 2017 by Cummins Consulting Services. AM and PM peak hour turning movement counts are illustrated in **Figure 5**. The AM peak hour was determined to be 7:30 AM to 8:30 AM while the PM peak hour was 3:30 PM to 4:30 PM. Traffic counts are included in the **Appendix**.

Traffic Operations

Using the *Highway Capacity Manual* (HCM) methodologies within the *Synchro* software, the intersections of Robert C. Byrd Drive with Prince Street and Neville Street were evaluated during the AM and PM peak hours. The existing signal timings were provided by WVDOH and were used in this analysis. **Table 1** summarizes the levels-of-service (LOS), delays (in seconds), volume-to-capacity ratios (v/c), and 95th percentile queue lengths (in feet) for the study intersections. The 95th percentile queue length was determined by averaging five microsimulation runs from *SimTraffic*, the microsimulation software included in the *Synchro* software suite. Analysis results are included in the **Appendix**.

Through observations of the video provided with the traffic counts, the dual southbound left-turn lanes at the Neville Street intersection are not equally utilized. Approximately 74 percent of left-turning traffic in the AM peak hour and 78 percent of left-turning traffic in the PM peak hour use the right-most left-turn lane. From the video, it appears the majority of traffic in this lane is turning right immediately onto 3rd Avenue. In the operational analysis, the *Synchro* default lane utilization factors were modified so that the analysis results reflect the actual conditions at this intersection.

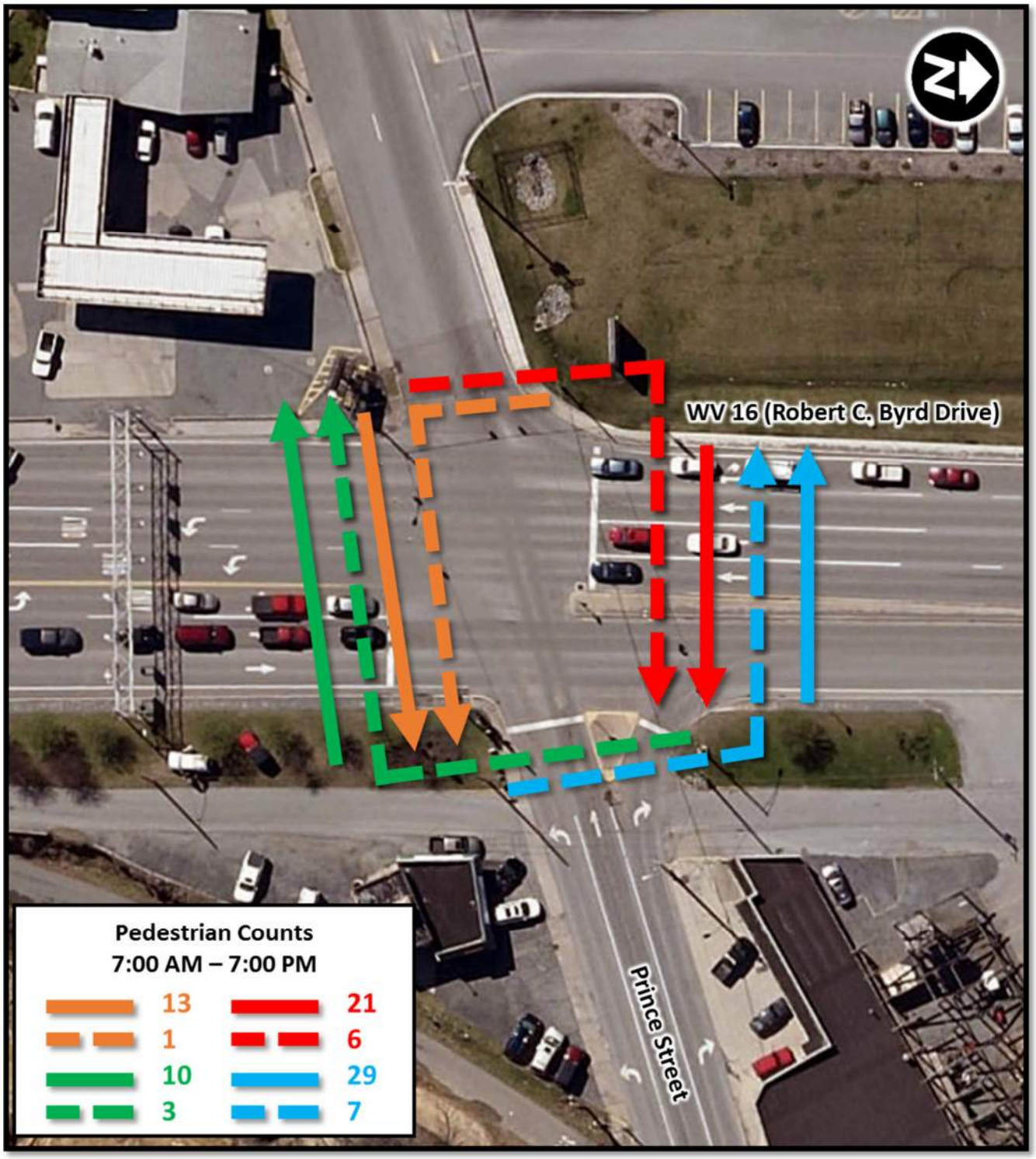

Figure 4: Pedestrian Crossing Volumes

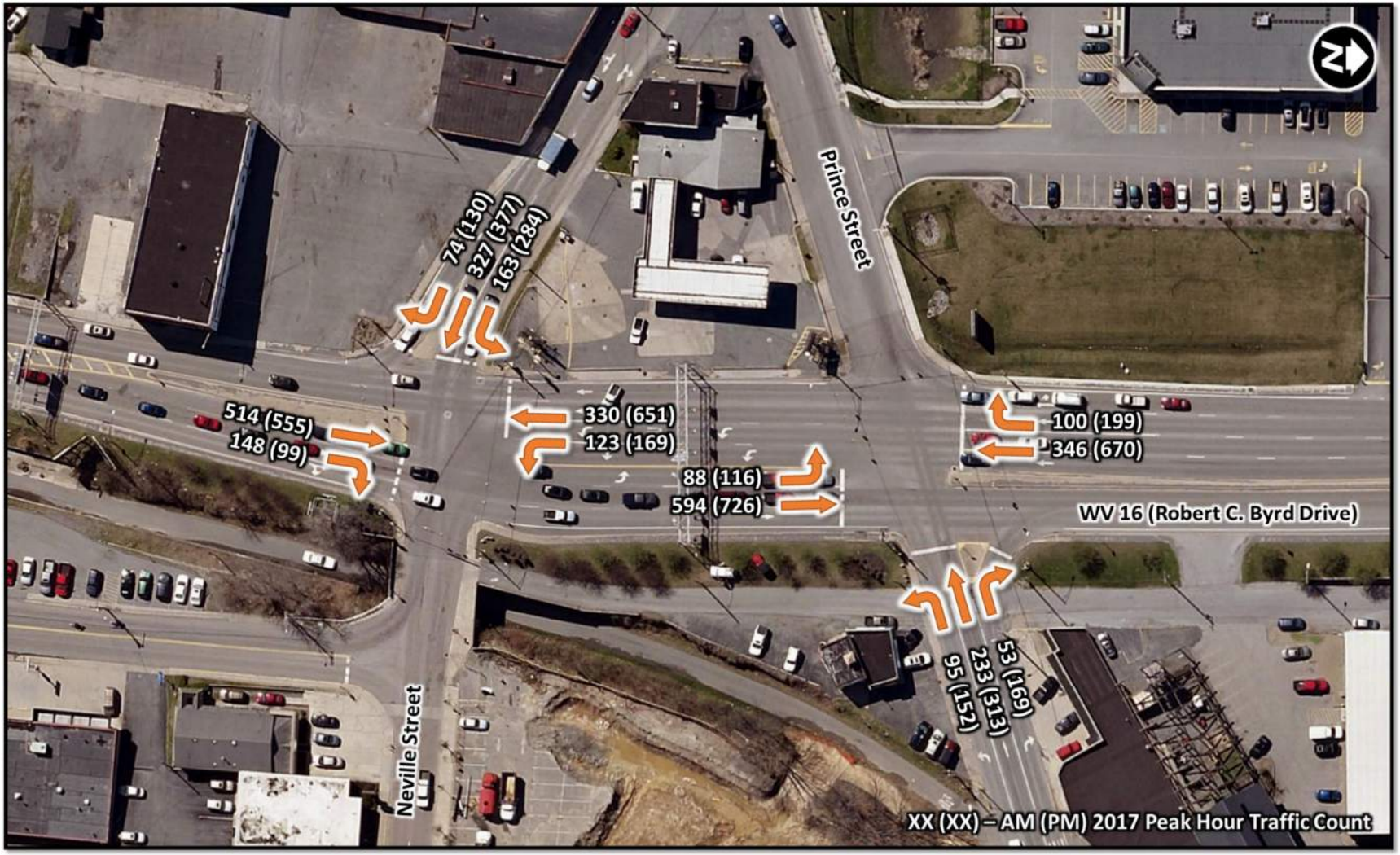

Figure 5: Peak Hour Vehicular Turning Movement Counts

Table 1: Operational Analysis Results – Existing Conditions

Prince Street								
	Overall Intersection	Westbound Prince Street			Northbound Robert C. Byrd Drive		Southbound Robert C. Byrd Drive	
		LT	TH	RT	LT	TH	TH	RT
AM Peak Hour								
LOS	C	C	D	C	A	B	B	
Delay	21.8	30.7	36.9	29.8	8.5	19.6	16.1	
v/c		0.26	0.57	0.18	0.14	0.28	0.17	
95th Percentile Queue		80′	201′	59′	35′	32′	113′	
		C – 34.3			B – 18.0		B – 16.1	
PM Peak Hour								
LOS	B	C	D	D	A	A	B	
Delay	18.0	32.6	43.7	35.4	7.1	0.3	17.7	
v/c		0.37	0.74	0.49	0.23	0.33	0.32	
95th Percentile Queue		127′	266′	81′	81′	87′	201′	
		D – 38.9			A – 1.3		B – 17.7	
Neville Street								
	Overall Intersection	Eastbound Neville Street			Northbound Robert C. Byrd Drive		Southbound Robert C. Byrd Drive	
		LT	TH	RT	TH	RT	LT	TH
AM Peak Hour								
LOS	C	C		C	C		A	A
Delay	20.2	32.0		26.6	21.8		7.9	0.2
v/c		0.53		0.22	0.38		0.16	0.18
95th Percentile Queue		290′		47′	207′		68′	120′
		C – 31.4			C – 21.8		A – 2.3	
PM Peak Hour								
LOS	B	D		C	C		A	A
Delay	19.0	36.0		28.9	21.3		8.2	0.4
v/c		0.66		0.36	0.35		0.24	0.35
95th Percentile Queue		355′		83′	214′		72′	98′
		C – 34.7			C – 21.3		A – 2.0	

* Approximately 200 feet between stop bars on Prince Street and Neville Street. Values in green indicate queue lengths less than 200 feet between Prince Street and Neville Street along Robert C. Byrd Drive.

Under both the AM and PM peak hours, the study intersections operate acceptably at LOS D or better with all movements having v/c below 1. Additionally, the queues generally do not spill back into the adjacent intersections. However, between the video reviews and the operational analysis, there are some inefficiencies with the existing signal timings. Because the signal runs pretimed, some movements have more green time than is necessary. With the upcoming signal modification project, detection will be provided on all approaches so that the signal can operate in an actuated-coordinated mode so to efficiently allocate green time.

Additionally, all the intersection clearance intervals are not in accordance with the latest National Cooperative Highway Research Program (NCHRP) guidance. Clearance intervals are a function of operating speed, the width of the intersection area, lengths of vehicles, and driver operational parameters such as reaction, braking, and decision-making time. In the case of the two study intersections, all phases have a four second yellow clearance time without an all-red phase which indicates that the intervals were arbitrarily set and are not calculated based on the intersection

conditions. For safety reasons, it is important that these clearance intervals are calculated and implemented properly.

Clearance intervals that are too short can contribute to rear end crashes caused by drivers stopping abruptly and angle crashes resulting from red-light running. Conversely, clearance intervals should not be too long so to encourage disrespect of the clearance interval, thereby contributing to red-light running and even more severe crashes.

According to research conducted by the FHWA, when the clearance intervals are properly calculated, multivehicle crashes can be reduced by 9% with a 12% reduction in injury crashes. Another study showed an 18% decrease in all types of crashes with proper clearance intervals.

Clearance intervals were calculated for all study intersections based on methods outlined in the NCHRP Report 731 – *Guidelines for Timing Yellow and All-Red Intervals at Signalized Intersections*. The calculated clearance intervals are summarized in **Table 2** and are provided in the **Appendix**.

Table 2: Calculated Vehicular Clearance Intervals

Prince Street				
	NBT	WBTL	NBL	SBT
Yellow	4.4	3.5	3.5	4.4
All-Red	1.0	2.7	1.1	1.0
Y + AR	**5.4**	**6.7**	**4.6**	**5.4**
Neville Street				
	SBT	EB	SBL	NBT
Yellow	4.1	4.0	3.2	4.1
All-Red	1.0	2.4	2.2	1.0
Y + AR	**5.1**	**6.4**	**5.4**	**5.1**

The calculated clearance intervals were used in a No Build operational analysis in which the existing signal timings were optimized assuming that detection would soon be implemented so that the signal could operate as actuated-coordinated. The existing cycle lengths were maintained so that these intersections could be coordinated with adjacent intersections for better traffic flow along Robert C. Byrd Drive. The No Build analysis results are summarized in **Table 3** and in the **Appendix**. The existing volumes and lane configurations were used for this analysis.

Table 3: Operational Analysis Results – No Build Conditions (Revised Clearance Intervals and Optimized Signal Timings)

Prince Street								
	Overall Intersection	Westbound Prince Street			Northbound Robert C. Byrd Drive		Southbound Robert C. Byrd Drive	
		LT	TH	RT	LT	TH	TH	RT
AM Peak Hour								
LOS	C	C	C	C	B	C	C	
Delay	24.2	21.3	24.3	20.8	17.1	21.4	30.3	
v/c		0.18	0.39	0.13	0.18	0.36	0.30	
95th Percentile Queue		70’	181’	54’	84’	85’	141’	
		C – 23.0			C – 20.8		C – 30.3	
PM Peak Hour								
LOS	B	C	C	C	B	A	C	
Delay	20.0	21.6	25.6	22.9	14.9	0.9	33.0	
v/c		0.25	0.50	0.33	0.29	0.43	0.53	
95th Percentile Queue		113’	242’	84’	106’	136’	254’	
		C – 23.9			A – 2.9		C – 33.0	
Neville Street								
	Overall Intersection	Eastbound Neville Street			Northbound Robert C. Byrd Drive		Southbound Robert C. Byrd Drive	
		LT	TH	RT	TH	RT	LT	TH
AM Peak Hour								
LOS	C	C		C	C		B	A
Delay	22.3	28.1		23.8	29.8		11.9	0.2
v/c		0.47		0.20	0.49		0.19	0.20
95th Percentile Queue		265’		41’	231’		68’	86’
		C – 27.6			C – 29.8		A – 3.4	
PM Peak Hour								
LOS	B	C		C	C		B	A
Delay	19.7	27.6		23.2	32.0		13.8	0.6
v/c		0.54		0.30	0.50		0.29	0.42
95th Percentile Queue		342’		251’	229’		100’	123’
		C – 26.8			C – 32.0		A – 3.3	

* Approximately 200 feet between stop bars on Prince Street and Neville Street. Values in green indicate queue lengths less than 200 feet between Prince Street and Neville Street along Robert C. Byrd Drive.

Under the No Build conditions, both intersections and all movements operate at LOS C or better with no v/c over 1. Any minor increases in delays over the existing conditions are attributed to the addition of the all-red clearance intervals or the reallocation of green time for more efficient overall intersection operations.

Potential Improvement Concepts
Based on the recommendations from Dr. Eck's walk-about, in conjunction this analysis, two potential improvement options were considered.

Concept A
Concept A is illustrated in **Figure 6**. At the Neville Street intersection, crosswalks are provided across Neville Street on both the east and west sides of Robert C. Byrd Drive. Only one crossing is provided to cross Robert C. Byrd Drive. A two-stage crossing is provided using the existing median on the south side of Neville Street. Similarly, at the Prince Street intersection, crossings are provided on both sides of Robert C. Byrd Drive to cross Prince Street. By eliminating the left-most left-turn lane at Neville Street and the storage length for this lane at Prince Street, a median refuge area is provided to cross Robert C. Byrd Drive north of Prince Street.

Concept B
Concept B is illustrated in **Figure 7**. Identical crossings to those in Concept A are provided on Neville Street and Prince Street. In Concept B, single-stage crossings are provided to cross Robert C. Byrd Drive. These crossings are more direct and take less time for the pedestrian to cross, but the pedestrian clearance intervals are substantially longer with a single-stage crossing than with a two-stage crossing. The vehicular lane configurations in Concept B do not differ from existing conditions.

The advantages and disadvantages of the two concepts are discussed in more detail below.

Safety Considerations
In both concepts, the crosswalk to cross Robert C. Byrd Drive was strategically placed south of Neville Street and north of Prince Street. Per the counts collected at Prince Street, this location was the most heavily traversed travel path at the intersection. Secondly, by constructing the crosswalk in this location with the one-way street system, the pedestrian conflicts with left-turning vehicles from Prince Street and Neville Street are avoided.

Median Width and Crossing Location
Both concepts utilize medians for the pedestrian crossing. Per the National Association of City Transportation Officials (NACTO) *Urban Street Design Guide*, the recommended minimum pedestrian refuge median width is six feet and the minimum preferred width is eight to 10 feet. Pedestrian refuges can be used with either a single stage or two stage crossing.

Concept A provides a new median on the northern leg with a width of 20 feet. By providing a wider median, more space is provided for pedestrian queueing, bicyclists (especially bicyclists with trailers), and pedestrians with strollers. The wider median also increases pedestrian comfort by providing more separation from the vehicles on the adjacent roadway and shortens the pedestrian crossing by 12 feet. At the southern crossing, the median design is beneficial for several reasons. The zig-zag in the median provides additional room for pedestrian queueing and bicyclists. This crossing also shifts the curb ramp and crossing in the southwestern quadrant of the intersection further away from the intersection and the right-turn movement. Increasing this distance from the intersection provides right-turning vehicles more time to react to a pedestrian after completing the right turn maneuver.

Concept B maintains the existing median widths, which meet or exceed the minimum eight-foot preferred width. At the southwestern corner of Neville Street, the curb ramp and crosswalk at the southern leg are closer to the right-turn bypass lane and could create a conflict between pedestrians and drivers who are looking north for oncoming traffic prior to making the right-turn.

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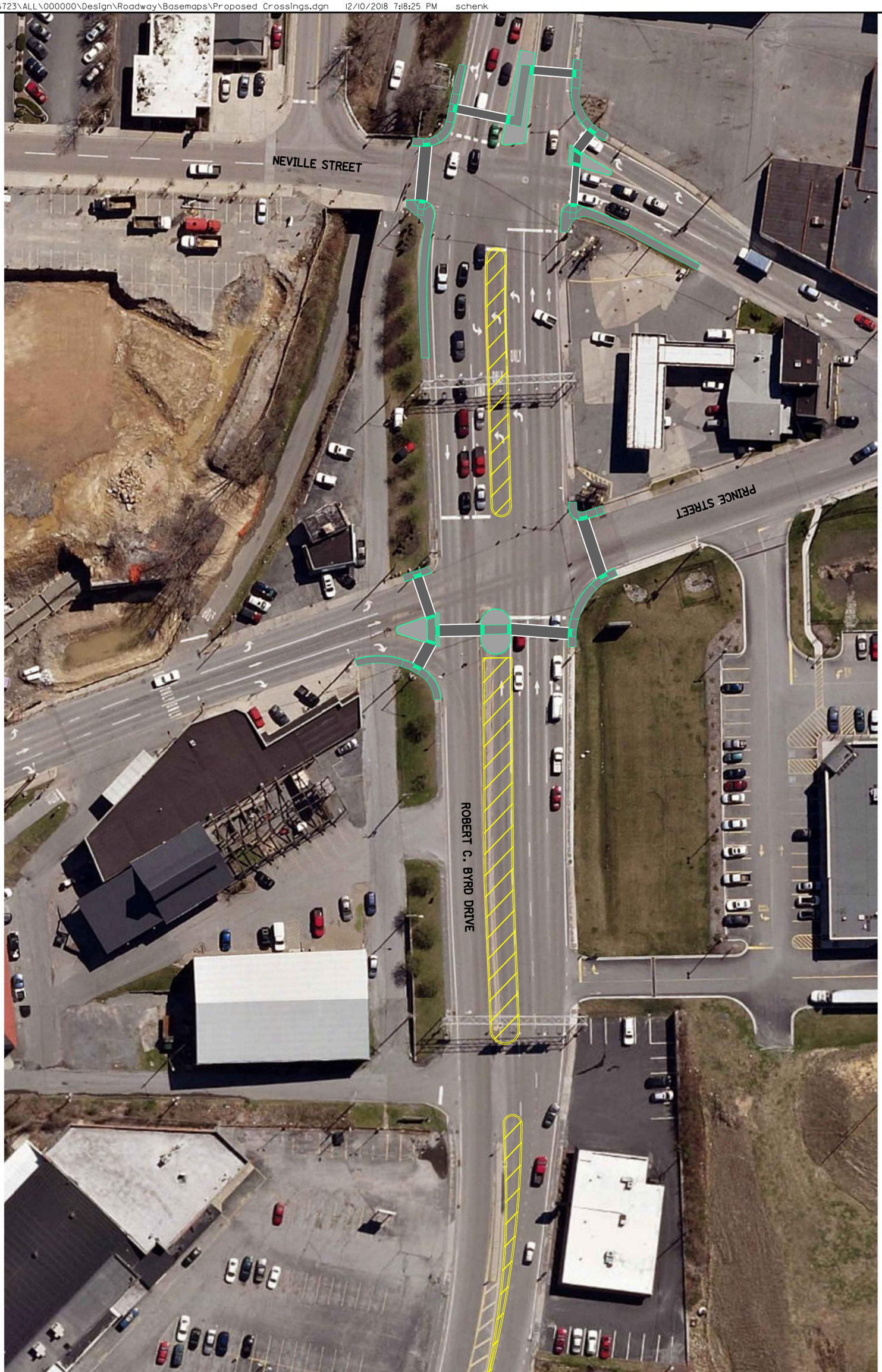

FIGURE 6

BECKLEY, WV

PEDESTRIAN ACCOMMODATIONS
CONCEPT A

CALCULATED ALR
CHECKED KMS

0 30
15 60
HORIZONTAL SCALE IN FEET

N

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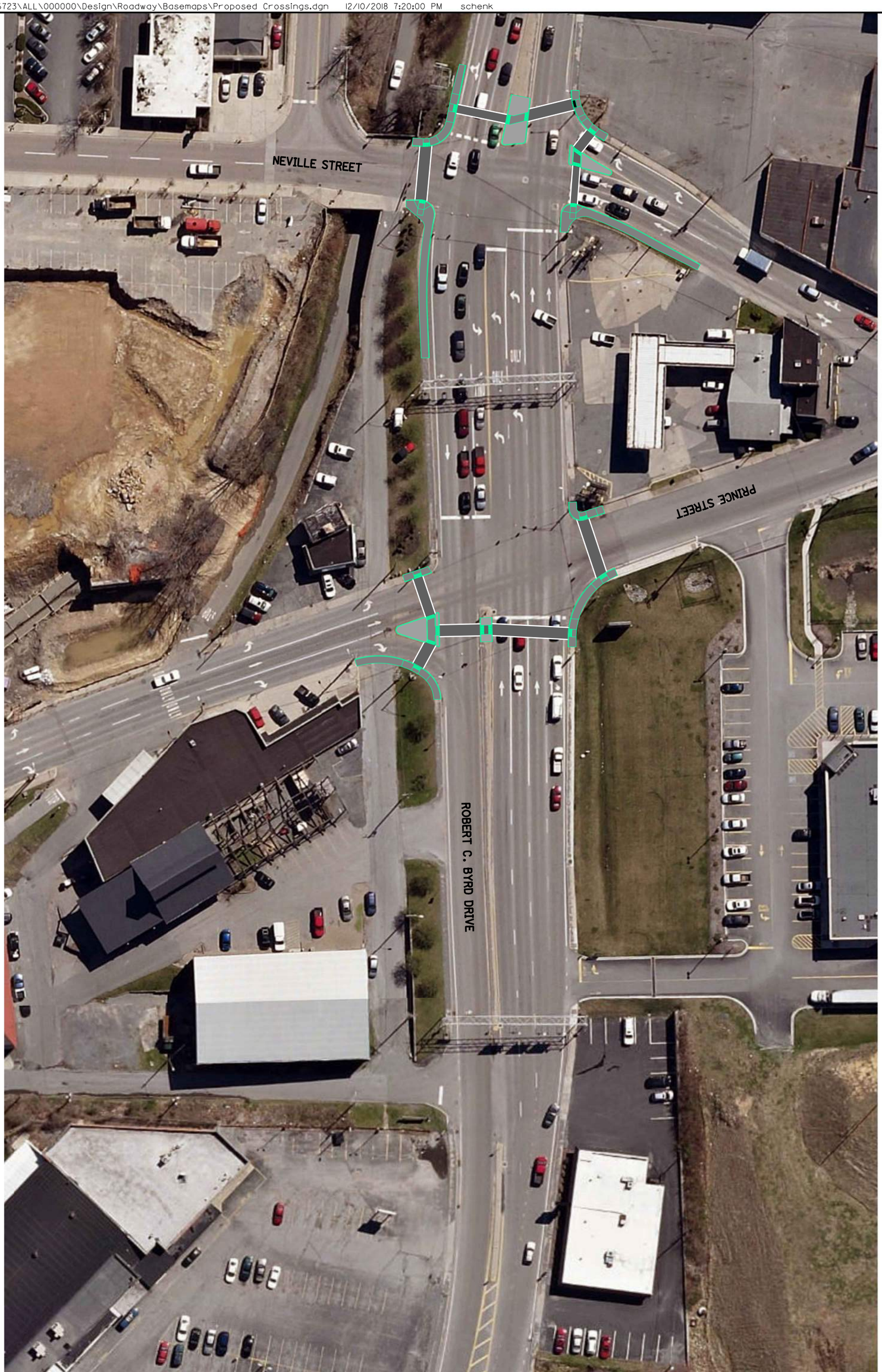

FIGURE 7

BECKLEY, WV

PEDESTRIAN ACCOMMODATIONS
CONCEPT B

CALCULATED ALR
CHECKED KMS

0 30
15 60
HORIZONTAL SCALE IN FEET

N

Pedestrian Crossing Maneuvers

With Concept A, median refuge islands are provided so that pedestrians can complete their crossing maneuver in two-stages. These crossing islands simplify the crossing maneuver by allowing a pedestrian to focus only on direction of traffic and reduce the pedestrian exposure time to vehicles at a crossing. Based on the Crash Modification Factor (CMF) Clearinghouse, installing a median refuge has the potential to reduce vehicle/pedestrian crashes by more than 31 percent.

While Concept B has a median refuge for the southernmost crossing, the movement will be a single stage crossing maneuverer. Pedestrians will need to focus on both the north and southbound traffic movements while crossing the roadways. It is possible to maintain the existing medians and implement a two-stage crossing cycle; with the existing median width at the northern leg, the pedestrian storage area is small if there are numerous pedestrians waiting to cross.

Traffic Operations Considerations

Vehicular traffic operations could be affected by both of the identified concepts. Intersection lane configurations are not modified from existing conditions in Concept B. However, in Concept A, to install a median refuge on Robert C. Byrd Drive at Prince Street, the left-most southbound left-turn lane at Neville Street must be eliminated. For vehicular safety purposes because of the left-turn lane offset from northbound traffic, this left-turn movement must operate with a protected-only phase.

In addition to these lane changes, the vehicular and pedestrian clearance intervals will be lengthened to accommodate the new crosswalks. With the construction of the crosswalks, the stop bar locations must be offset away from the intersection which makes the vehicular crossing distance longer. Calculations indicate a very small increase of 0.1 to 0.2 seconds of red time for the vehicular clearance intervals is needed. These calculations are provided in the **Appendix**.

Currently, no pedestrian signal crossing timings are provided at the intersections. With the construction of the crosswalks, pedestrian walk and clearance intervals (flashing DON'T WALK interval) must be included in the signal timings. When a pedestrian actuates the signal to cross Robert C. Byrd Drive, the green time given to the vehicles on the side street (either Prince Street or Neville Street) must be a minimum of the sum of the walk and flashing DON'T WALK period and the vehicular yellow and all red clearance intervals. The calculated minimum phase splits are summarized in **Table 4** with calculations provided in the **Appendix**. In many cases, especially in off-peak hours, the green time required to serve the vehicular demand is shorter than the minimum split required to serve the pedestrians.

Table 4: Minimum Phase Splits

Prince Street					
	Walk	Flashing DON'T WALK	Vehicular Clearance		Minimum Split
			Yellow	All Red	
Concept A					
NB (Crossing Prince Street East of RCB)	7	6	4.4	1.0	18.4
WB (Crossing Robert C. Byrd Drive)	7	9	3.5	2.9	22.4
SB (Crossing Prince Street West of RCB)	7	6	4.4	1.0	18.4
Concept B					
NB (Crossing Prince Street East of RCB)	7	6	4.4	1.0	18.4
WB (Crossing Robert C. Byrd Drive)	10	22	3.5	2.9	38.4
SB (Crossing Prince Street West of RCB)	7	6	4.4	1.0	18.4
Neville Street					
	Walk	Don't Walk	Yellow	All Red	Minimum Split
Concept A					
SB (Crossing Neville Street West of RCB)	8	12	4.1	1.0	25.1
EB (Crossing Robert C. Byrd Drive)	7	7	4.0	2.6	20.6
NB (Crossing Neville Street East of RCB)	7	7	4.1	1.0	19.1
Concept B					
SB (Crossing Neville Street West of RCB)	8	12	4.1	1.0	25.1
EB (Crossing Robert C. Byrd Drive)	7	20	4.0	2.6	33.6
NB (Crossing Neville Street East of RCB)	7	7	4.1	1.0	19.1

After optimizing the signal timings for the two study intersections prior to including the pedestrian clearance times, the optimized splits for both the westbound movements on Prince Street and the eastbound movements on Neville Street, were longer than the minimum required splits to accommodate the pedestrian crossing. Therefore, the long pedestrian clearance intervals will not likely adversely affect AM and PM peak hour traffic. However, during off-peak hours when there is very little traffic on Prince Street or Neville Street and a pedestrian actuates the signal, traffic on Robert C. Byrd Drive will experience increased delays because of the longer required split.

Both concepts were analyzed using the HCM methodologies in the *Synchro* software. The existing cycle lengths were maintained so that these intersections could be coordinated with adjacent intersections for better traffic flow along Robert C. Byrd Drive. The calculated vehicular and pedestrian clearance intervals were used in the analysis. In the analysis of Concept A, the left-most southbound left-turn lane at Neville Street was removed and the left-turn phase operates as protected-only. This left-turn movement remains as protected-permitted phasing with dual left-turn lanes in Concept B. These results are summarized in **Table 5** and **Table 6** and in the **Appendix**.

Table 5: Operational Analysis Results – Concept A

Prince Street								
	Overall Intersection	Westbound Prince Street			Northbound Robert C. Byrd Drive		Southbound Robert C. Byrd Drive	
		LT	TH	RT	LT	TH	TH	RT
AM Peak Hour								
LOS	B	D	D	D	A	A	B	
Delay	15.3	36.4	43.6	35.5	5.4	0.2	13.7	
v/c		0.36	0.81	0.26	0.15	0.26	0.20	
95th Percentile Queue		87’	204’	53’	53’	45’	98’	
		D – 40.6			A – 1.0		B – 13.7	
PM Peak Hour								
LOS	B	C	D	C	A	A	B	
Delay	18.3	33.1	41.4	34.8	8.1	0.3	19.2	
v/c		0.41	0.82	0.54	0.23	0.33	0.41	
95th Percentile Queue		133’	264’	92’	99’	51’	276’	
		D – 37.7			A – 1.5		B – 19.2	
Neville Street								
	Overall Intersection	Eastbound Neville Street			Northbound Robert C. Byrd Drive		Southbound Robert C. Byrd Drive	
		LT	TH	RT	TH	RT	LT	TH
AM Peak Hour								
LOS	C	D		C	C		B	A
Delay	27.0	39.6		33.3	30.8		14.9	0.1
v/c		0.74		0.32	0.51		0.25	0.16
95th Percentile Queue		296’		56’	225’		137’	128’
		D – 39.1			C – 30.8		A – 4.1	
PM Peak Hour								
LOS	C	D		C	D		C	B
Delay	30.2	38.7		31.2	35.5		31.6	15.9
v/c		0.77		0.43	0.55		0.36	0.35
95th Percentile Queue		352’		75’	234’		163’	196’
		D – 37.5			D – 35.5		B – 19.2	

* Approximately 200 feet between stop bars on Prince Street and Neville Street. Values in green indicate queue lengths less than 200 feet between Prince Street and Neville Street along Robert C. Byrd Drive.

Table 6: Operational Analysis Results – Concept B

Prince Street								
	Overall Intersection	Westbound Prince Street			Northbound Robert C. Byrd Drive		Southbound Robert C. Byrd Drive	
		LT	TH	RT	LT	TH	TH	RT
AM Peak Hour								
LOS	C	C	C	C	B	C	C	
Delay	24.3	21.5	24.5	20.9	17.1	21.4	30.3	
v/c		0.18	0.39	0.13	0.18	0.36	0.30	
95th Percentile Queue		72'	176'	54'	83'	85'	147'	
		C – 23.2			C – 20.8		C – 30.3	
PM Peak Hour								
LOS	C	C	C	C	B	A	C	
Delay	20.0	21.8	25.8	23.0	14.9	0.9	33.0	
v/c		0.25	0.50	0.33	0.29	0.43	0.53	
95th Percentile Queue		109'	239'	82'	112'	141'	275'	
		C – 24.1			A – 2.9		C – 33.0	
Neville Street								
	Overall Intersection	Eastbound Neville Street			Northbound Robert C. Byrd Drive		Southbound Robert C. Byrd Drive	
		LT	TH	RT	TH	RT	LT	TH
AM Peak Hour								
LOS	C	C		C	C		B	A
Delay	22.4	28.3		23.9	29.8		11.9	0.2
v/c		0.48		0.20	0.49		0.19	0.20
95th Percentile Queue		274'		48'	243'		65'	85'
		C – 27.8			C – 29.8		A – 3.4	
PM Peak Hour								
LOS	B	C		C	C		B	A
Delay	19.7	27.8		23.4	32.0		13.8	0.6
v/c		0.54		0.30	0.50		0.29	0.42
95th Percentile Queue		349'		76'	231'		97'	128'
		C – 27.0			C – 32.0		A – 3.3	

* Approximately 200 feet between stop bars on Prince Street and Neville Street. Values in green indicate queue lengths less than 200 feet between Prince Street and Neville Street along Robert C. Byrd Drive.

Based on the operational analysis, all movements operation at LOS D or better under both concepts and queueing is minimal. Even with the single southbound left-turn lane at Neville Street and the protected-only phase, the operations are similar or slightly better than the No Build and Concept B conditions. Because of the protected left-turn phasing, the southbound left-turn phase can be served after the northbound through phase (as a lagging left-turn phase). As a result, there is better signal progression between the two closely spaced intersections with more vehicles being served with each phase. Concept B operates similarly to the No Build condition because the optimized splits in the No Build condition accommodate the pedestrian crossing times included as part of Concept B. It is important to note that the southbound left-turn phase at Neville Street could be made protected-only as part of Concept B and operations similar to Concept A could be achieved.

In summary, this analysis shows that by including pedestrian accommodations at the intersection, vehicular traffic is affected; however, the resulting operations are still acceptable for an urban corridor.

Construction Cost Considerations

Construction costs for the two concepts were estimated (see **Appendix**). These cost estimates include curb ramps including the costs of any curb, sidewalk, detectable warning surfaces, and landings within the curb ramp limits, new medians, and the crosswalk striping. A 20-percent contingency is also included. The pedestrian signal heads and push buttons are not included in these costs as they are identical between the two concepts and should be included in the signal reconstruction project.

The estimated construction costs of Concept A are $71,000 while Concept B is expected to cost $59,000. The largest reason for the cost differences is because of the new median proposed as part of Concept A.

Conclusion and Recommendations

The analysis conducted indicates that either concept would be acceptable at this location. Given the safety benefits of the two-stage crossing and shorter pedestrian crossing times that are less likely to adversely affect vehicular traffic, the implementation of a two-stage crossing regardless of the median concept is preferred. Additionally, for safety and operational purposes, the southbound left-turn phase at Neville Street should be modified from protected/permitted to protected-only, regardless if the dual left-turn lanes remain or if a single left-turn lane is constructed.