PATRICK STREET AND PATRICK STREET PLAZA/KANAWHA BOULEVARD WEST

ROAD SAFETY AUDIT

Regional Intergovernmental Council

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1.0 Executive Summary

The purpose of this study is to analyze the existing safety and capacity conditions and to determine potential countermeasures to mitigate crashes and improve traffic operations in the area near Patrick Street Plaza in Charleston, West Virginia in Kanawha County. Patrick Street is a north-south principal arterial with a speed limit of 25 mph and four 10-foot lanes. The study includes the signalized intersections of Patrick Street with Kanawha Boulevard West/Patrick Street Plaza and 4th Avenue along with the intersection of Patrick Street and 3rd Avenue/Kanawha Boulevard West.

Crash data from January 1, 2016 to December 31, 2018 was downloaded from the ReportBeam website. Each crash report was reviewed to determine potential factors contributing to crashes. In the three-year study period, there were 70 crashes with 15 (21 percent) resulting in injury and one crash (1 percent) resulting in a fatality. Rear end crashes and sideswipe passing collisions were the most common crash types.

Based on the crash patterns and traffic operations in the study corridor, the following countermeasures are recommended:

<u>Short-Term</u>

- Evaluate if the existing signal equipment can support backplates on the eastbound and westbound approaches. If backplates can be supported, install them as part of maintenance activities.
- Check vehicular clearance intervals.
- Implement coordinated signal timing along Patrick Street.
- Split-phase the eastbound and westbound approaches of Patrick Street and Kanawha Boulevard West.
- Revise the overhead sign along southbound Patrick Street for Kanawha Boulevard West to indicate that the right lane is not an exit only lane to Kanawha Boulevard West.

<u>Medium-Term</u>

- Construct a northbound left-turn lane at the Patrick Street Plaza/Kanawha Boulevard West intersection by converting one of the southbound receiving lanes to a northbound exclusive left-turn only lane. Through this modification, widening is not required and there will not likely be property impacts. In total, this improvement is estimated to cost approximately $258,000.
- Improve pedestrian and bicycle facilities per the *Kanawha-Putnam Bicycle and Pedestrian Plan*. These improvements include striping crosswalks on all signalized intersection approaches, installing pedestrian push buttons and signals, and ADA compliant curb ramps.

2.0 Purpose and Location

The purpose of this study is to analyze the existing safety and capacity conditions and to determine potential countermeasures to mitigate crashes and improve traffic operations in the area near Patrick Street Plaza in Charleston, West Virginia in Kanawha County. The study area is shown below in **Figure 1.**

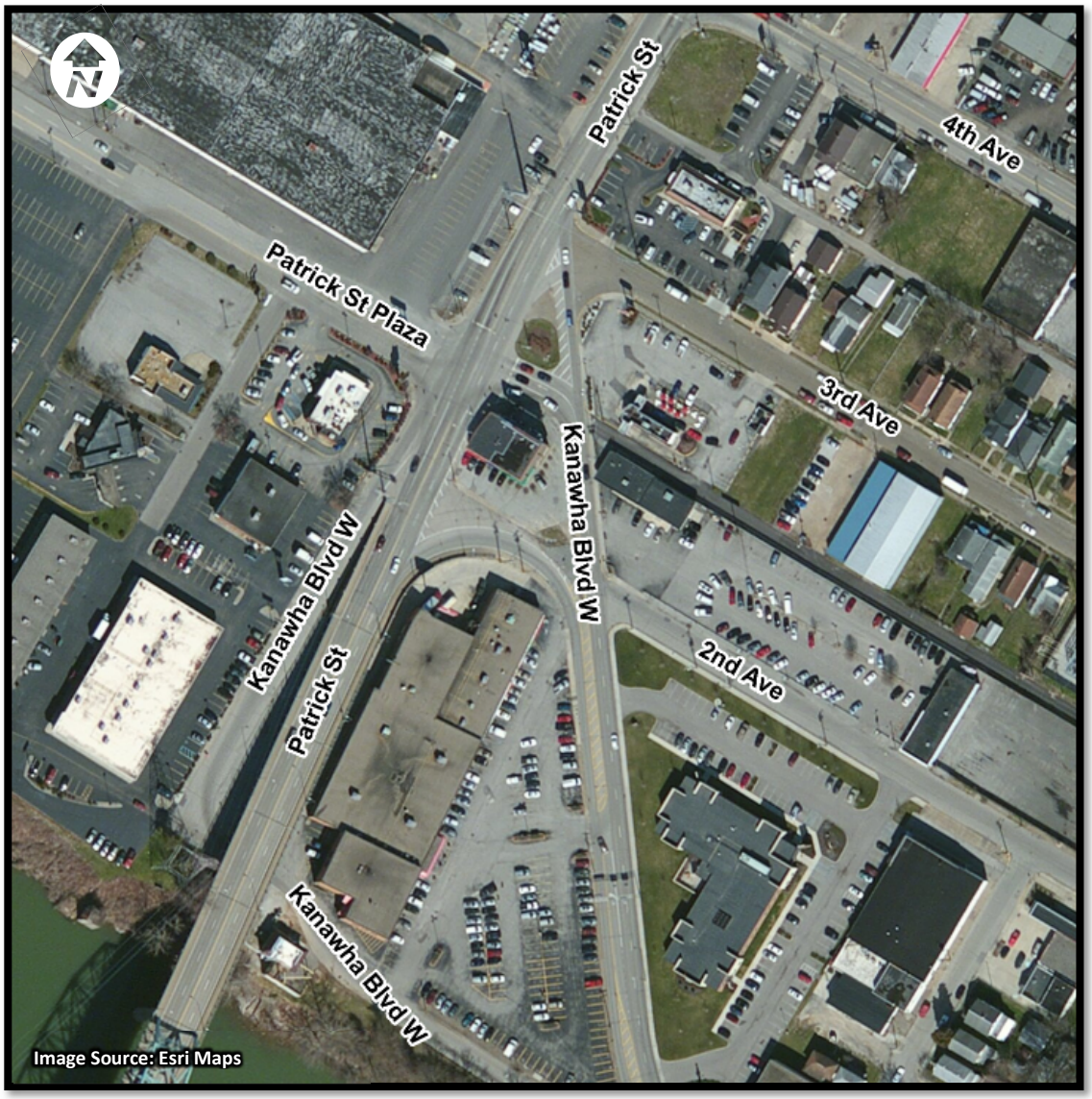


Figure 1: Study Area

3.0 Existing Conditions

Roadway Conditions

The land use in this area is mainly commercial; it is located near a large shopping center and several restaurants. Patrick Street is a four lane north-south principal arterial with a speed limit of 25 mph and 10-foot lanes. Lighting is provided throughout the corridor, and sidewalk is located on both sides of the street. Flex posts are located on the centerline of Patrick Street between Kanawha Boulevard West and 4th Avenue, illustrated in **Photo 1.** Due to the 10-foot lanes on Patrick Street, large trucks were observed occupying both through lanes to prevent driving over the flex posts. During the field visit, a near-miss was observed when a vehicle attempted to change lanes to turn right into Patrick Street Plaza and did not ensure the other lane was clear. This interaction is shown in **Photo 2.** Just south of the study area, Patrick Street continues over the Kanawha River. Many of the vehicles traveling northbound from the bridge were observed to accelerate down the hill towards the intersection at Patrick Street Plaza.

Photo 1: Flex Posts Along Patrick Street

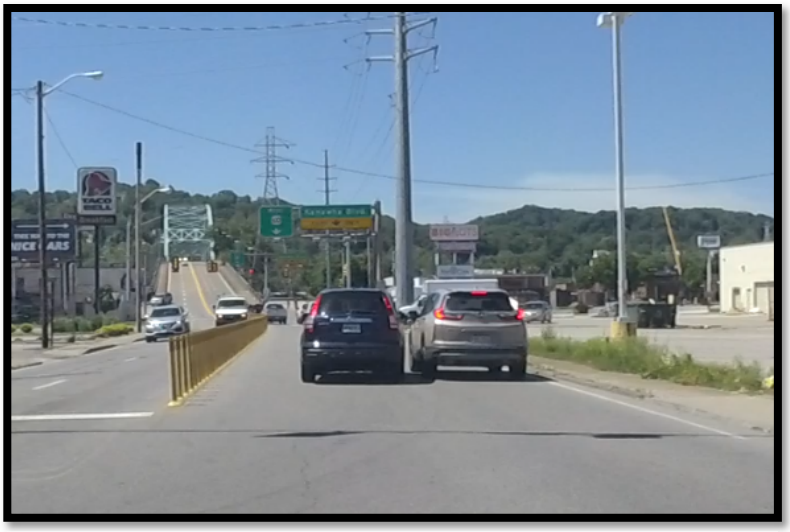


Photo 2: Near Miss on Southbound Patrick Street

Kanawha Boulevard West is an undivided east-west principal arterial with two lanes westbound and one lane eastbound. Kanawha Boulevard West has a speed limit of 25 mph. Lighting is present, and a sidewalk is on both sides of the street.

3rd Avenue is an eastbound one-way street with a speed limit of 25 mph and on-street parking on both sides of the roadway. 3rd Avenue provides access to a residential neighborhood east of the study area. 4th Avenue is a three-lane road with two-lanes in the westbound direction and one-lane in the eastbound direction. On-street parking is available on the south side of the roadway. Sidewalks are located on both sides of 3rd Avenue and 4th Avenue.

Intersection Conditions

Patrick Street and Kanawha Boulevard West/Patrick Street Plaza

The lane configuration for the intersection of Patrick Street with Kanawha Boulevard West/Patrick Street Plaza is shown in **Figure 2.** The intersection has a box span signal with backplates in the north-south direction along Patrick Street. Pedestrian signal heads are provided for crossing all legs except the south leg of the intersection. Pedestrian push buttons are provided on the east and north legs. A crosswalk is striped along the east leg across Kanawha Boulevard West. Left-turn phasing is protected/permitted northbound on Patrick Street, protected westbound on Kanawha Boulevard West and permissive eastbound on Patrick Street Plaza. Left-turns are prohibited from southbound Patrick Street. Southbound vehicles access Kanawha Boulevard West from the fifth leg of the intersection at Patrick Street Plaza/Kanawha Boulevard West. This one-way roadway extends under the Patrick Street Bridge before forming the two-way Kanawha Boulevard West that runs parallel to the Kanawha River. An overhead sign is provided along southbound Patrick Street to indicate this split as shown in **Photo 3.** However, the sign legend appears to indicate that the right-most lane is only for vehicles traveling to Kanawha Boulevard West.

Figure 2: Patrick St and Kanawha Blvd W Lane Configuration

Photo 3: Patrick St and Kanawha Blvd W Southbound Approach

Vehicles traveling northbound can access Kanawha Boulevard West from a channelized right-turn about 200 feet south of the intersection. The proximity of the building on the southeast corner obstructs the visibility at the intersection, shown in **Photo 4.** The westbound approach enters the intersection on a curve, shown in **Photo 5.**

Photo 4: Patrick St and Kanawha Blvd W Northbound Approach

Photo 5: Patrick St and Kanawha Blvd W Westbound Approach

Patrick Street and 3rd Avenue and Kanawha Boulevard West

Figure 3 shows the lane configuration and the location of the yield signs at Patrick Street and 3rd Avenue. A short northbound right-turn lane on Patrick Street allows vehicles to turn onto 3rd Avenue by yielding to vehicles on Kanawha Boulevard West. Vehicles traveling north-west on Kanawha Boulevard West yield to northbound vehicles on Patrick Street. During the field visit, northbound vehicles waiting to turn right onto 3rd Avenue were observed to queue onto Patrick Street as a result of the short storage length of the right-turn lane and because vehicles on Kanawha Boulevard West are also waiting to merge onto Patrick Street. These vehicles would block access to 3rd Avenue, shown in **Photo 6.** Additionally, there is a lack of pavement markings at the intersection, shown in **Photo 7.** There are no pedestrian accommodations at this intersection.

Figure 3: Patrick St and 3rd Ave Lane Configuration

Photo 6: Patrick St and 3rd Ave Northbound Approach

Photo 7: Patrick St and 3rd Ave North-Westbound Approach

Patrick Street and 4th Avenue

The lane configuration of the intersection of Patrick Street and 4th Avenue is shown in **Figure 4.** The intersection has a box span signal with backplates in the north-south direction along Patrick Street. Signs mounted on the span wire indicate that left-turns are prohibited in both the northbound and southbound directions. Overhead lane-use signs are provided approximately 90 feet east of the stop bar on the westbound approach and on the span wire for the northbound and eastbound approaches. A railroad crossing is located approximately 200 feet north of 4th Avenue. Pedestrian signal heads are provided to cross all legs. A crosswalk is striped for crossing the west leg of the intersection, but the pavement markings are faded and barely visible as shown in **Photo 8**. Push buttons are available to cross the north and south legs of the intersection. The pushbutton signs are faded as seen in **Photo 9.** The pavement is uneven and cracked on the west leg of the intersection at the entrance/exit of the shopping center, also shown in **Photo 8.**

Figure 4: Patrick St and 4th Ave Lane Configuration

Photo 8: Patrick St and 4th Ave Pavement

Photo 9: Patrick St and 4th Ave Pedestrian Push Button

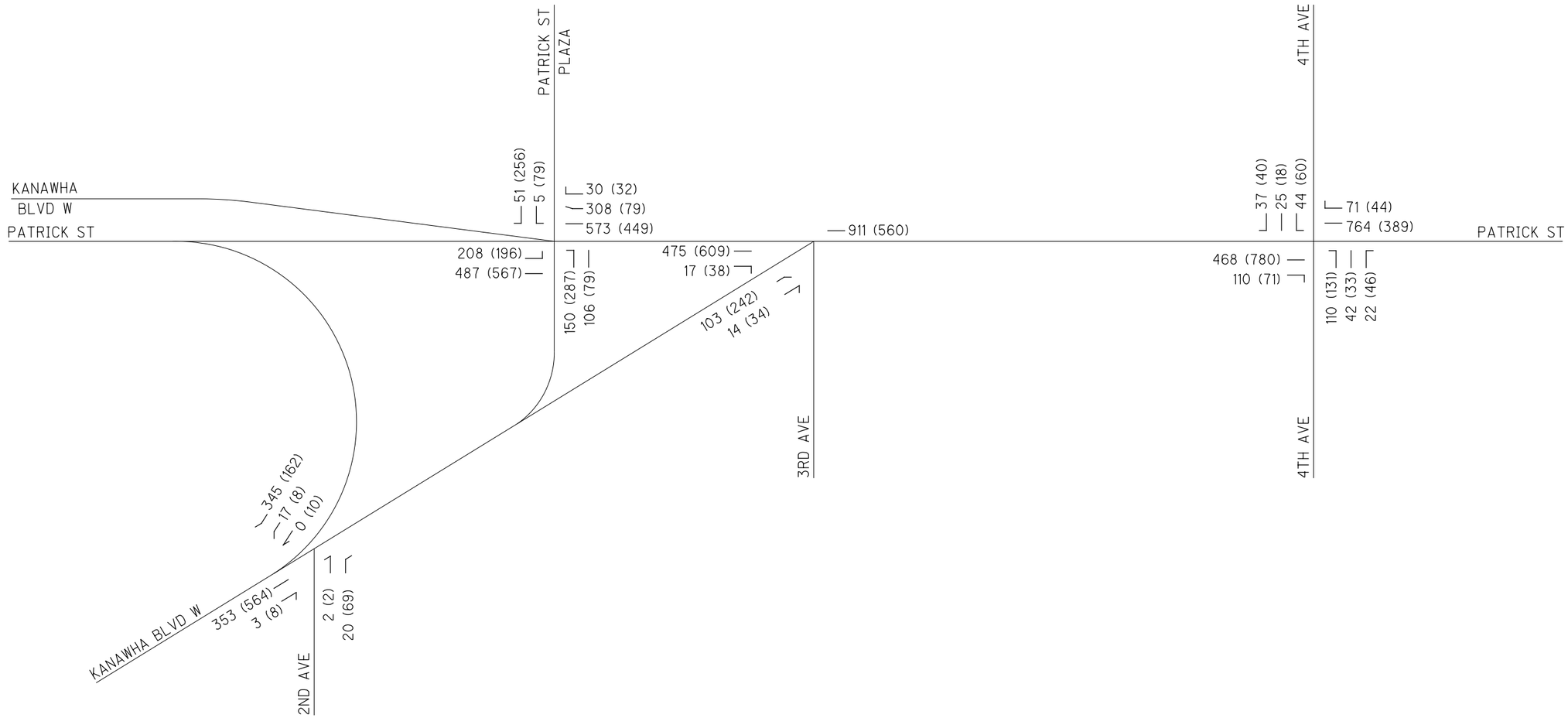
4.0 Data Collection

Turning movement counts were collected for 24 hours on Tuesday June 2, 2020 at the following intersections:

- Patrick Street and Kanawha Boulevard West/Patrick Street Plaza
- Patrick Street and 3rd Avenue
- Patrick Street and 4th Avenue
- Kanawha Boulevard W and 2nd Avenue

The AM peak hour was determined to be 7:30 AM to 8:30 AM while the PM peak hour was 4:15 PM to 5:15 PM. The volumes were adjusted to account for the changes in traffic volumes due to the COVID-19 pandemic using existing 24-hour 2019 counts. An adjustment factor of 1.69 and 1.00 was used for the AM and PM peak, respectively. The final adjusted 2020 peak hour volumes are summarized in **Figure 5**. Note that the volumes were increased, balanced, and smoothed where appropriate. Raw traffic counts are provided in **Appendix A**.

XX: 2020 AM PEAK HOUR COUNT 7:30AM TO 8:30AM
(XX): 2020 PM PEAK HOUR COUNT 4:15PM TO 5:15PM



NOT TO SCALE

PATRICK STREET ROAD SAFETY AUDIT
2020 ADJUSTED PEAK HOUR COUNTS

FIGURE
5

5.0 Crash Data

Crash data from January 1, 2016 to December 31, 2018 was downloaded from the ReportBeam website. Each crash report was reviewed to determine potential factors contributing to crashes. A collision diagram that shows crash patterns by illustrating the approximate location of each reported crash is provided in **Appendix B**. In the three-year study period, there were 70 crashes with 15 (21 percent) resulting in injury and one crash (1 percent) resulting in a fatality. The fatality occurred when a vehicle traveling southbound was reportedly speeding, ran a red light and collided with a northbound vehicle turning left at the intersection of Patrick Street and Kanawha Boulevard. The 23-year-old male driver of the southbound vehicle passed away at the hospital. **Figure 6** shows the crash frequency by year and severity.

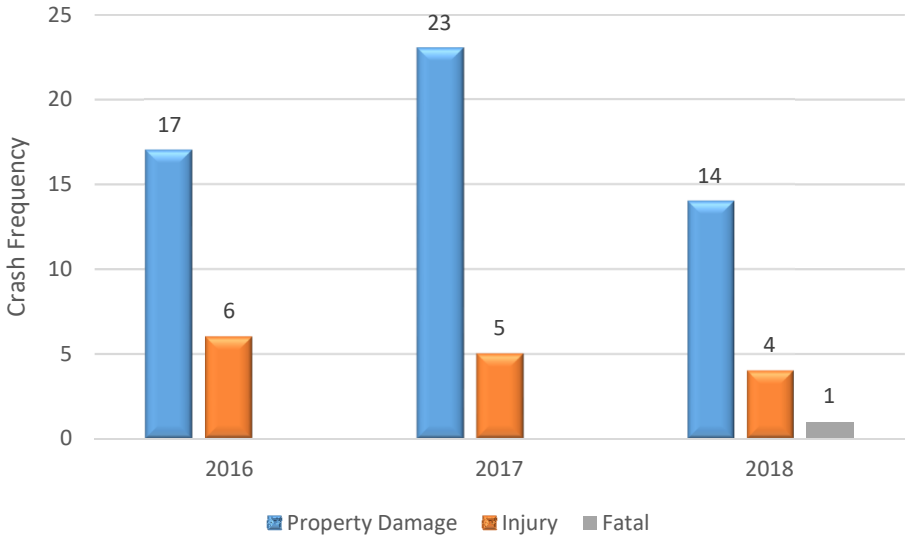


Figure 6: Frequency of Crashes by Year and Severity

Figure 7 illustrates the breakdown of crashes in the study area by crash type. Rear end crashes (30 percent) occurred on almost all approaches of the intersections in the study area which is likely the result of congestion as over half occurred during the AM and PM peak hours. The sideswipe crashes (27 percent) were most likely due to the narrow 10-foot lanes, as many of the crashes occurred when vehicles collided with each other's side mirrors. These crashes were also caused by abrupt lane changes.

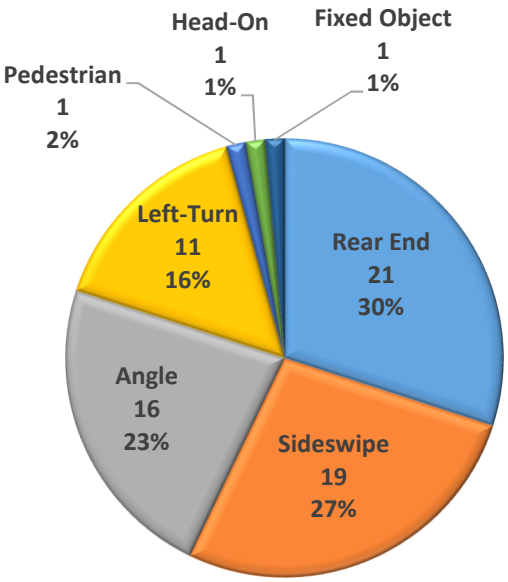


Figure 7: Crash Frequency by Crash Type

Figure 8 illustrates the breakdown of crashes in the study area by hour of the day. 39 percent of the crashes occurred between 3:00 PM and 7:00 PM with the majority occurring at 4:00 PM. The majority of the crashes occurred on dry pavement (73 percent), indicating that the weather is not a major contributing factor to crashes in the study area.

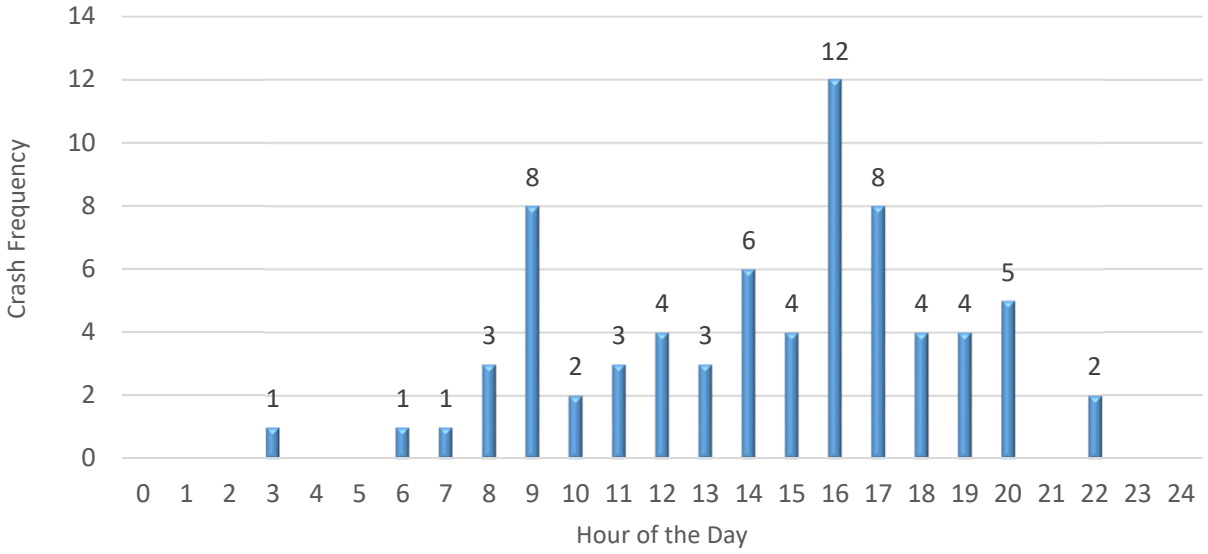


Figure 8: Crash Frequency by Hour of the Day

Patrick Street and Patrick Street Plaza/Kanawha Boulevard West

The highest frequency of rear end crashes at this intersection occurred in the left-most northbound lane on Patrick Street. Vehicles slowing or stopping in the lane to turn left into Patrick Street Plaza contributed to several of these crashes. Additionally, several of the sideswipe crashes on the northbound approach were a result of vehicles attempting to get around other vehicles who were stopped in the lane.

Left-turn collisions were a prevalent crash type at this intersection, with three resulting in injury and one in a fatality. One of the main patterns occurred when eastbound left-turning vehicles failed to yield to westbound vehicles traveling straight into Patrick Street Plaza. The curve in the westbound approach and resulting sight distance obstructions to oncoming westbound through vehicles likely contributes to these crashes. Additionally, northbound left-turning vehicles were involved in crashes after failing to yield to vehicles traveling southbound, likely due to drivers growing impatient and selecting an inadequate gap in southbound traffic.

Angle collisions occurred most frequently due to red-light running, especially on the southbound and northbound approaches.

Patrick Street and 3rd Avenue and Kanawha Boulevard West

A main crash pattern at this intersection was rear end collisions at the yielding movement on Kanawha Boulevard West. The building on the southeast corner of the intersection obstructs sight distances at the intersection, especially for this right-turn movement from Kanawha Boulevard West to northbound Patrick Street. When the vehicle immediately at the yield line begins to accelerate, the second vehicle begins to accelerate as well. However, when the driver of the first vehicle realizes the gap is not acceptable and abruptly stop, a rear end crash results. Angle collisions also occurred when vehicles would incorrectly judge gaps in traffic and collide with northbound vehicles on Patrick Street.

6.0 Existing Capacity Analysis

Intersection capacity was evaluated to assess existing intersection operations using 2020 traffic volumes and existing lane configurations and traffic control. Existing signal timings at the intersections were determined by observing videos of the intersection at the peak hours and were confirmed by the signal timings provided by the City of Charleston. *SimTraffic* was used to obtain 95th percentile queue lengths. *SimTraffic* is the microsimulation package included with *Synchro.* The results of five microsimulation runs were averaged together to obtain the results provided herein. Existing operational analysis results from *Synchro* and *SimTraffic* are summarized in **Table 1** with analysis output provided in **Appendix C.** The intersection of Patrick Street with 4th Avenue was also analyzed to ensure that the identified countermeasures at Patrick Street Plaza/Kanawha Boulevard West do not adversely affect operations at that intersection.

Table 1: Operational Analysis Results for Existing (2020) Conditions

Patrick Street & Patrick Street Plaza / Kanawha Boulevard West									
	Overall Intersection	Eastbound Patrick St Plaza		Westbound Kanawha Blvd		Northbound Patrick St		Southbound Patrick St	
		LT	RT	LT	TH	LT	TH	TH	RT
AM Peak Hour									
LOS	B	D	A	E	D	B		A	
Delay	12.6	49.4	7.8	55.6	35.8	10.9		5.1	
v/c		0.07	0.29	0.56	0.23	0.59		0.40	
95th % Queue		33’	53’	58’	57’	191’		91’	
		B – 11.7		D – 44.0		B – 10.9		A – 5.1	
PM Peak Hour									
LOS	C	E	B	D	C	C		B	
Delay	24.0	66.9	14.0	54.2	20.8	21.6		11.0	
v/c		0.63	0.67	0.79	0.07	0.66		0.30	
95th % Queue		125’	114’	50’	54’	180’		95’	
		C – 26.5		D – 46.9		C – 21.6		B – 11.0	
Patrick Street & 4th Avenue									
	Overall Intersection	Eastbound 4th Ave			Westbound 4th Ave			Northbound Patrick St		Southbound WV Patrick St	
		LT	TH	RT	LT	TH	RT	LT	TH	TH	RT
AM Peak Hour											
LOS	B	D	D		D	D		A		A	
Delay	13.3	50.3	54.0		42.2	36.9		6.5		7.4	
v/c		0.32	0.59		0.51	0.22		0.28		0.39	
95th % Queue		86’	99’		147’	97		134’		258’	
		D – 52.5			D – 40.2			A – 6.5		A – 7.4	
PM Peak Hour											
LOS	B	D	D		D	D		A		A	
Delay	14.5	51.4	52.5		41.7	36.7		7.5		6.0	
v/c		0.40	0.52		0.51	0.24		0.37		0.19	
95th % Queue		100’	75’		151’	87’		143’		146’	
		D –51.9			D – 39.8			A – 7.5		A – 6.0	

Under existing conditions, both intersections operate overall at LOS C or better. All approaches operate at LOS D or better except for the westbound approach at the intersection of Patrick Street and Kanawha Boulevard West. In the AM peak, this approach is performing at LOS E, likely due to the signal timings favoring the mainline movements. No movements are over capacity.

7.0 Countermeasures for Consideration

The following countermeasures were identified to mitigate crashes and improve safety within the study area.

- **Add backplates to signal heads:** Backplates are recommended on the eastbound and westbound approaches at the intersections of Patrick Street with Patrick Street Plaza/Kanawha Boulevard West and 4th Avenue to improve signal visibility and help reduce red-light running. In some cases, the existing signal supports cannot accommodate the additional weight and wind load of backplates. Calculations would be required to determine if a new signal support would be required to make these improvements.
- **Check vehicular clearance intervals:** Clearance intervals that are too short can contribute to rear end collisions related to drivers stopping abruptly. Short clearance intervals can also lead to angle crashes because vehicles could still be clearing the intersection when a conflicting approach is given the green indication. Conversely, clearance intervals that are too long can encourage drivers to disrespect the interval thereby contributing to angle crashes when vehicles run the red light. In order to improve safety throughout the study area, it is recommended that the yellow and all-red clearance intervals be recalculated at the signalized intersection of Patrick Street and Patrick Street Plaza/Kanawha Boulevard West.
- **Implement coordinated signal timings at the intersections along Patrick Street**: In order to improve traffic flow between the two intersections along Patrick Street, optimized, coordinated signal timings should be implemented. Coordinating timings will minimize queuing between the intersections and the likelihood that traffic will queue into the adjacent intersection, thus reducing the potential for rear end collisions.
- **Split-phase the eastbound and westbound approaches of Patrick Street and Patrick Street Plaza/Kanawha Boulevard West:** Currently, the eastbound left-turn phase is permitted-only. Due to the sharp curve on the westbound approach and the building on the southeast corner of the intersection, it is difficult to see westbound vehicles approaching the intersection. As a result, four left-turn collisions have occurred along this approach when eastbound left-turning vehicles fail to yield to the westbound through vehicles. By providing split phasing on the eastbound and westbound approaches, right-of-way is assigned sequentially to each approach instead of concurrently.
- **Revise the overhead sign along southbound Patrick Street for Kanawha Boulevard West:** The exit sign for southbound vehicles traveling onto Kanawha Boulevard West appears as though the right lane is an exit-only lane. This confusion could be contributing to some sideswipe crashes as drivers think only the left lane continues over the Kanawha River. It is proposed that the sign be revised to say, “Kanawha Boulevard West – Keep Right, No Trucks”. The current yellow sign with black lettering gives drivers the impression that the right lane is an exit-only lane. The new sign will be green with white lettering.
- **Improve pedestrian and bicycle facilities:** As part of the *Kanawha-Putnam Bicycle and Pedestrian Plan* published in 2019, this location was determined to be on the lists of both high priority bicycle and high priority pedestrian improvement projects. Proposed

improvements include providing crosswalks and pedestrian signals on Patrick Street and installing "Share the road" signs. While there were no documented pedestrian crashes in the area, there was observed pedestrian activity and noted lack of pedestrian facilities in the study area.

- **Reconfigure right-turn from Kanawha Boulevard West to northbound Patrick Street:** To mitigate crashes and reduce confusion associated with the slip lanes around the 3rd Avenue area, it is proposed that the right-turn movement be realigned as a traditional movement at the intersection with Patrick Street and Patrick Street Plaza (see **Figure 9 or 10**). With this improvement, the small slip lane from Patrick Street to southbound 3rd Avenue would be removed. The Kanawha Boulevard West approach would be modified to provide one exclusive left-turn lane, one shared through and right-turn lane, and one exclusive right-turn lane. As part of this configuration, right-turns would be prohibited on red because of the sight distance obstructions created by the building on the southeast corner of the intersection.
- **Construct northbound left-turn lane at Patrick Street Plaza/Kanawha Boulevard West:** One of the predominant crash types in the study area involved northbound vehicles slowing or stopping in the left-most travel lane to turn into Patrick Street Plaza. Providing an exclusive left-turn lane for this movement will separate slower, turning vehicles from through traffic. The left-turn lane could be constructed in one of three ways:
    - Widen the south leg of the intersection to maintain two northbound and southbound through lanes in addition to the exclusive left-turn lane. Because this improvement would require the bridge over the Kanawha River to be widened, this improvement was considered cost-prohibitive and was not evaluated further.
    - Convert the northbound approach to one exclusive left-turn lane and one exclusive through lane while maintaining two southbound lanes. This alternative will not require widening. Based on the traffic counts, the single through lane will not accommodate the amount of northbound through traffic. Therefore, this alternative was not evaluated further.
    - Reconfigure the southbound approach so that the left-most southbound lane continues onto Patrick Street over the Kanawha River and the right-most southbound lane continues to Kanawha Boulevard West (see **Figure 9**). With only one lane from the intersection continuing over the bridge, the second southbound through lane south of Patrick Street Plaza would be converted to an exclusive northbound left-turn lane so that two northbound through lane. This alternative does not require widening.
- **Construct northbound left-turn lane at 4th Avenue:** Instead of constructing the exclusive northbound left-turn lane at Patrick Street Plaza, northbound left-turns could be prohibited at that intersection altogether. Instead, left-turns could be re-routed to the 4th Avenue intersection. To accommodate these turns, an exclusive northbound left-turn lane should be constructed at 4th Avenue. The left-turn lane could be constructed in one of two ways:
    - Convert the northbound approach to provide one exclusive left-turn lane and one exclusive through lane. This alternative would not require widening. However, based on traffic volumes, the northbound through traffic could not be adequately accommodated in a single through lane. Furthermore, this configuration would likely result in lane imbalances at the Patrick Street Plaza/Kanawha Boulevard West intersection. Northbound drivers may favor the right lane at the Patrick Street Plaza/Kanawha Boulevard West intersection since that is the lane that continues north past 4th Avenue. For these reasons, this alternative was not evaluated further.

- Widen the south leg of the 4th Avenue intersection to construct an exclusive northbound left-turn lane while maintaining two northbound through lanes and two southbound receiving lanes (see **Figure 10**). To avoid the large transmission pole on the west side of Patrick Street, the turn lane can only provide approximately 100 feet of storage. The cost of relocating the transmission pole would be cost-prohibitive. There are no anticipated impacts to the railroad north of 4th Avenue.

RIC RSA
Kanawha Blvd. W & Patrick St. Plaza Improvements
August 31, 2020

BURGESS & NIPLE
Engineers ■ Architects ■ Planners

Regional Intergovernmental Council

0 50
25 100
SCALE IN FEET

GIS RIGHT-OF-WAY/PROPERTY LINES

SINGLE SOUTHBOUND RECEIVING LANE

350' TURN LANE

PROTECTED-ONLY LEFT-TURN LANE

RECONFIGURE TO PROVIDE
DUAL RIGHT-TURN LANES

LEFT LANE TO PATRICK STREET
RIGHT LANE TO KANAWHA BLVD.
AND PATRICK STREET PLAZA

NO IMPACT TO POLES

RAILROAD

PATRICK ST. PLAZA

PATRICK ST.

KANAWHA BLVD W

2ND AVENUE

3RD AVENUE

4TH AVENUE

Construction Cost Estimate: $258,000

Notes:
- Cost estimate does not include right-of-way or utility relocations
- All shading shown is assumed to be restriping except for resurfacing between Patrick St. Plaza and 4th Ave.

Potential Improvements: Left-Turn at Patrick Street Plaza	FIGURE 9

RIC RSA
Kanawha Blvd. W & Patrick St. Improvements - Left Turn onto Fourth Ave.
August 31, 2020

BURGESS & NIPLE
Engineers ■ Architects ■ Planners

Regional Intergovernmental Council

N

0 50
25 100
SCALE IN FEET

GIS RIGHT-OF-WAY/PROPERTY LINES

PATRICK ST. PLAZA

NO LEFT TURN

100' TURN LANE #

ALL LEFT-TURNS

4TH AVENUE

RAILROAD

POWER POLES IMPACTED

PATRICK ST.

RECONFIGURE TO PROVIDE DUAL RIGHT-TURN LANES

KANAWHA BLVD W

2ND AVENUE

3RD AVENUE

WIDEN AND SHIFT LANES TO ACCOMMODATE LEFT TURN LANE

PROTECTED-ONLY LEFT-TURN LANE

Construction Cost Estimate: $690,000
Notes:
- Cost estimate does not include right-of-way or utility relocations
- All shading shown is assumed to be full depth except for restriping at Kanawha St.
Maximum storage length without impacting transmission pole

Potential Improvements: Left-Turn at 4th Avenue	FIGURE 10

bing

- **Re-route northbound left-turns at Patrick Street and Patrick Street Plaza:** Instead of providing an exclusive left-turn lane along Patrick Street, left-turns could be re-routed to Kanawha Boulevard West (see **Figure 11**). Based on traffic volumes and a preliminary traffic analysis, it was determined that there would be queuing issues for vehicles from Patrick Street trying to merge with northwestbound traffic on Kanawha Boulevard West. Therefore, this alternative was eliminated from further consideration.

Figure 11: Re-Route Northbound Left-Turns at Patrick Street Plaza/Kanawha Boulevard West Intersection

- **Roundabout at Patrick Street and Patrick Street Plaza/Kanawha Boulevard West: This** After laying out a roundabout at this intersection, it was determined that the property and utility impacts were cost-prohibitive compared to the benefit a roundabout would provide. For this reason, this alternative was eliminated from further consideration.

8.0 Countermeasure Evaluation

8.1 Operational Evaluation

To assess traffic operations for the countermeasures under further consideration, capacity analysis was performed using *Synchro*. The following two alternatives were evaluated:

- Alternative 1 – Northbound left-turn lane at Patrick Street Plaza/Kanawha Boulevard West (see **Figure 9**)
- Alternative 2 – Northbound left-turn lane at 4th Avenue (see **Figure 10**).

Capacity analysis results using existing 2020 volumes for Alternative 1 are summarized in **Table 2** while the results for Alternative 2 are summarized in **Table 3**. *Synchro* output is provided in **Appendix D**. Both alternatives include split phasing of the eastbound and westbound approaches and the reconfiguration of the right-turn from Kanawha Boulevard to northbound Patrick Street. Additionally, signal timings have been optimized to provide coordination between the intersections along Patrick Street. In both alternatives, the northbound left-turn operates under protected-only phasing.

Table 2: Operational Analysis Results for Build (2020) Conditions – Left-Turn at Patrick Street Plaza

Patrick Street & Patrick Street Plaza / Kanawha Boulevard West										
	Overall Intersection	Eastbound Patrick St Plaza		Westbound Kanawha Blvd			Northbound Patrick St		Southbound Patrick St	
		LT	RT	LT	TH	RT	LT	TH	TH	RT
AM Peak Hour										
LOS	C	D	D	D	E	D	E	A	B	
Delay	27.1	47.0	51.1	49.2	59.7	50.7	74.6	8.5	17.2	
v/c		0.04	0.46	0.59	0.80	0.65	0.89	0.24	0.80	
95th % Queue		30’	62’	133’	201’	241’	228’	193’	484’	
		D – 50.7		D – 54.0			C – 28.2		B – 14.3	
PM Peak Hour										
LOS	C	D	D	E	D	D	E	B	B	
Delay	34.8	50.9	48.8	62.1	42.0	41.3	70.8	14.0	17.6	
v/c		0.53	0.76	0.88	0.59	0.55	0.88	0.32	0.58	
95th % Queue		114’	149’	110’	130’	84’	212’	186’	416’	
		D – 49.3		D – 50.7			C – 28.6		B – 16.2	
Patrick Street & 4th Avenue										
	Overall Intersection	Eastbound 4th Ave			Westbound 4th Ave			Northbound Patrick St		Southbound Patrick St	
		LT	TH	RT	LT	TH	RT	LT	TH	TH	RT
AM Peak Hour											
LOS	B	D	D		D	D		A		A	
Delay	13.3	50.3	54.0		42.3	37.0		6.4		7.4	
v/c		0.32	0.59		0.51	0.22		0.28		0.39	
95th % Queue		91’	95’		139’	89’		139’		235’	
		D – 52.5			D – 40.3			A – 6.4		A – 7.4	
PM Peak Hour											
LOS	B	D	D		D	D		A		A	
Delay	14.5	51.4	52.5		41.9	36.8		7.4		5.9	
v/c		0.40	0.52		0.52	0.24		0.37		0.19	
95th % Queue		101’	77’		142’	88’		196’		138’	
		D – 51.9			D – 39.9			A – 7.4		A – 5.9	

Under Alternative 1 conditions, intersections operate overall at LOS D or better. All movements and approaches operate at LOS D or better except for the left-turn movements at Patrick Street and Patrick Street Plaza/Kanawha Boulevard West and the westbound-through approach in in AM peak hour. When compared to the existing conditions, the overall intersection at Patrick Street Plaza/Kanawha Boulevard West operations slightly worse. With the addition of a protected-only left-turn phase and conversion of the eastbound and westbound approach to split-phasing, delays are expected to increase. However, operations are still acceptable at LOS D or better.

There was some concern surrounding the potential for southbound queueing, especially in the AM peak hour, a result of the revised lane configurations at Patrick Street Plaza/Kanawha Boulevard West. Field reviews indicated that existing traffic does not currently queue from the Patrick Street Plaza/Kanawha Boulevard West intersection through 4th Avenue and past the railroad tracks. Southbound traffic was observed to be slow moving north of the railroad tracks because of the roadway alignment and uneven railroad crossing. Observations also indicated that nearly 30 to 40 percent of the southbound traffic at Patrick Street Plaza/Kanawha Boulevard West intersection was destined for Kanawha Boulevard West which indicates that the southbound lanes under this configuration will be more evenly utilized than originally anticipated. The traffic model and resulting output account for this lane utilization and confirms that southbound queueing will not be a concern under this alternative. While the reported 95th percentile queue shows that the southbound queues may extend to 4th Avenue, the average queue and microsimulation show that this is does not happen often and almost all vehicles clear the intersection in one cycle.

Table 3: Operational Analysis Results for Build (2020) Conditions – Left-Turn at 4th Avenue

Patrick Street & Patrick Street Plaza / Kanawha Boulevard West										
	Overall Intersection	Eastbound Patrick St Plaza		Westbound Kanawha Blvd			Northbound Patrick St		Southbound Patrick St	
		LT	RT	LT	TH	RT	LT	TH	TH	RT
AM Peak Hour										
LOS	C	D	D	D	D	D	A		C	
Delay	26.2	47.0	51.1	48.1	52.3	49.4	9.7		27.8	
v/c		0.04	0.46	0.56	0.76	0.62	0.35		0.45	
95th % Queue		26’	56’	114’	191’	167’	202’		120’	
		D – 50.7		D – 50.2			A – 9.7		C – 27.8	
PM Peak Hour										
LOS	D	D	E	E	D	D	C		C	
Delay	38.5	37.6	57.7	64.8	42.5	41.8	23.4		34.6	
v/c		0.24	0.88	0.89	0.60	0.56	0.53		0.38	
95th % Queue		113’	157’	314’	229’	147’	276’		183’	
		D – 52.9		D –52.2			C – 23.4		C – 34.6	
Patrick Street & 4th Avenue										
	Overall Intersection	Eastbound 4th Ave			Westbound 4th Ave			Northbound Patrick St		Southbound Patrick St	
		LT	TH	RT	LT	TH	RT	LT	TH	TH	RT
AM Peak Hour											
LOS	C	D	D		D	D		D	A	C	
Delay	23.6	50.3	54.0		42.5	37.1		54.1	6.5	20.7	
v/c		0.3	0.59		0.51	0.22		0.90	0.28	0.54	
95th % Queue		89’	98’		145’	98’		200’	332’	343’	
		D – 52.5			D – 40.5			B – 19.0		C – 20.7	
PM Peak Hour											
LOS	C	D	D		D	D		D	A	B	
Delay	20.9	51.4	52.5		41.9	36.8		52.5	7.4	15.3	
v/c		0.40	0.52		0.52	0.24		0.86	0.37	0.25	
95th % Queue		200’	71’		158’	82’		191’	215’	190’	
		D – 51.9			D – 40.0			B – 15.8		B – 15.3	

Under Alternative 2 conditions, both intersections, approaches, and all movements operate at LOS D or better. Given the split phasing for the eastbound and westbound approaches at the Patrick Street Plaza/Kanawha Boulevard West intersection and the addition of a left-turn phase at the 4th Avenue intersection, delays are expected to slightly increase over the existing conditions. However, operations are still expected to be acceptable at LOS D or better. Additionally, the 95th percentile queue lengths for the northbound left-turn lane were determined to be over 200 feet, which means queues could regularly go out of the turn lane during a few signal cycles each day.

8.2 Cost Considerations

Cost estimates for these two alternatives are summarized in **Table 4**. A detailed breakdown of the construction cost estimates is provided in **Appendix E**. Cost estimates included a 30 percent contingency and were inflated for a 2025 construction year. The cost estimates do not include right-of-way costs or utility relocation which may be required as a result of the widening in Alternative 2. Alternative 2 has a higher cost due to the full depth asphalt pavement needed to widen Patrick Street and the new signal that would be required at Patrick Street and 4th Avenue.

Table 4: Cost Estimate Summary

	Cost Estimate
Alternative 1: Left-Turn at Patrick Street Plaza/Kanawha Boulevard West	$ 258,000
Alternative 2: Left-Turn at 4th Avenue	$ 690,000

9.0 Conclusions and Recommendations

Based on the crash patterns and traffic operations in the study corridor, the following countermeasures are recommended:

Short-Term

- Evaluate if the existing signal equipment can support backplates on the eastbound and westbound approaches. If backplates can be supported, install them as part of maintenance activities.
- Check vehicular clearance intervals.
- Implement coordinated signal timing along Patrick Street.
- Split-phase the eastbound and westbound approaches of Patrick Street and Kanawha Boulevard West. This improvement will require modifying the existing signal heads but will not likely require a full signal reconstruction.
- Revise the overhead sign along southbound Patrick Street for Kanawha Boulevard West to reduce lane use confusion. If the northbound left-turn lane is implemented as recommended in the medium-term countermeasures, the existing sign may remain until that improvement is constructed since a new sign will be included with that project. However, if the addition of the northbound left-turn is not going to be implemented in the next three to five years, consideration should be given to modifying the sign in the short-term.

Medium-Term

- Construct a northbound left-turn lane at Patrick Street Plaza/Kanawha Boulevard West – Given the construction cost and operational differences, especially the potential for vehicles to spill out of the left-turn lane at 4th Avenue, constructing a left-turn lane at Patrick Street Plaza/Kanawha Boulevard West is preferred. Per AASHTO guidance, the length of the turn lane should be approximately 350 feet (see **Appendix F** for detailed calculations). The overhead sign along southbound Patrick Street would need to be revised to indicate that the right-lane continues to Kanawha Boulevard West and not Patrick Street. In total, this improvement is estimated to cost approximately $258,000.
- Improve pedestrian and bicycle facilities per the *Kanawha-Putnam Bicycle and Pedestrian Plan*. As part of the improvements to the intersection with the addition of the northbound left-turn lane, crosswalks should be striped on all four approaches. As part of that project or a separate initiative, pedestrian push buttons and signals could be installed without upgrading the rest of the signal equipment. ADA compliant curb ramps could also be constructed at a reasonably low cost.