

# MONTROSE DRIVE AND MACCORKLE AVENUE 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 at the intersection of MacCorkle Avenue (US 60) and Montrose Drive in South Charleston, West Virginia. MacCorkle Avenue is a four-lane divided arterial with a speed limit of 40 mph. Montrose Drive is a six-lane divided roadway with a speed limit of 35 mph. The north leg of the study intersection is the DOW Chemical Plant entrance/exit.

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 67 crashes with 41 (39 percent) resulting in injury. No fatalities occurred in the study period.

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

### Short-Term

- Revise the overhead sign along Montrose Drive for US 60 East and 2<sup>nd</sup> Avenue (approximate cost: \$1,500).
- Protect the westbound left-turn phase
- Protect the eastbound left-turn phase
- Add dotted pavement markings for the northbound dual-left turn lanes
- Move the eastbound left-turn stop bar back from the intersection to prevent path overlap with northbound left-turning vehicles.

### Medium-Term

- Construct an eastbound right-turn lane and signalize the right-turn movement. This improvement will require modifying the existing signal by adding a five-section signal head which will likely necessitate a full signal upgrade accommodate the appropriate placement of the signal head (approximate cost: \$925,000).
- Reconstruct and signalize the northbound right-turn lane. This improvement will also require modifying the existing signal by adding a five-section signal head. Further analysis is required to determine if this modification can be accommodated with the existing span wire configuration (approximate cost (without full signal reconstruction): \$171,000).
- Extend the westbound left-turn lane to the east. This improvement will require modifying the median on the east leg of the intersection (approximate cost: \$342,000).
- Remove concrete median to the east and west of the intersection to allow for wider left-turn lanes.
- Improve pedestrian and bicycle facilities. As part of the improvements to the intersection with the addition/modification of the turn lanes, crosswalks should be striped on all approaches. because the signal will require reconstruction to accommodate the new turn lanes, pedestrian push buttons and signal heads should be upgraded with the new equipment. ADA compliant curb ramps could also be constructed at a reasonably low cost.

### Long-Term

- Construct dual westbound left-turn lanes. This improvement should be considered if capacity concerns persist after other improvements have been made (approximate cost: \$992,000).

## 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 at the intersection of MacCorkle Avenue (US 60) and Montrose Drive in South Charleston, West Virginia. The study area is shown in **Figure 1**.



Figure 1: Study Area

### 3.0 Existing Conditions

#### Roadway Conditions

MacCorkle Avenue is a four-lane divided arterial with a speed limit of 40 mph. Montrose Drive is a six-lane divided roadway with a speed limit of 35 mph. An interchange with I-64 is located approximately 1,000 feet south of the study intersection on Montrose Drive. The north leg of the study intersection is the DOW chemical plant entrance/exit. Sidewalk is provided on MacCorkle Avenue on the southern side of the roadway. A 10-foot gravel shoulder is provided on the northern side of the intersection.

#### Intersection Conditions

The intersection of MacCorkle Avenue and Montrose Drive is a four-legged signalized intersection with a box span configuration. Backplates are provided on the eastbound and westbound signal heads at the intersection. The lane configuration is shown in **Figure 2**. Overhead lighting is provided at this intersection. Pedestrian push buttons and pedestrian signal heads were present for crossing all legs but the south leg of the intersection. The pedestrian signal heads for the east leg of the intersection are set back from the intersection as seen **Photo 1**. During the field review it was observed that the pedestrian signal heads were not operating correctly as the walk symbol never appeared even after actuated. There were no crosswalks provided at the intersection.



Figure 2: Lane Configuration

The northbound and southbound approaches are split phased due to the shared through and left-turn lane on the northbound approach. The left-turn phases for eastbound and westbound approaches both operate protected-permitted.

Access from 3rd Avenue to Montrose Drive is provided approximately 90 feet south of the intersection. While this access is one-way from 3rd Avenue to Montrose Avenue and a “NO RIGHT TURN” (**Photo 2**) and a “DO NOT ENTER” (**Photo 3**) sign are posted, some vehicles were observed to disregard the signs and turn right onto 3rd Avenue from Montrose Drive.



Photo 1: Pedestrian Signal Head on East Leg



Photo 2: 3<sup>rd</sup> Avenue Signage



Photo 3: "DO NOT ENTER" Sign

At the yield-controlled northbound channelized right-turn lane, a short 100-foot acceleration lane is provided, shown in **Photo 4**. The majority of vehicles making this movement did not use the acceleration lane to merge onto MacCorkle Avenue and instead waited for the eastbound lanes to clear before making their turn from Montrose Drive.

Northbound left-turning vehicles were observed driving over the concrete median as they turned onto MacCorkle Avenue, shown in **Photo 5** and as evidenced by the deteriorating and broken concrete observed in the field.

The westbound left-turn lane is only 10 feet wide, causing trucks and large vehicles to travel into the adjacent through-lane, as shown in **Photo 6**.

As northbound vehicles approach the intersection on Montrose Drive, overhead lane-use signage is provided as illustrated in **Photo 7**. However, the right sign appears to indicate that the off-ramp to 2<sup>nd</sup> Avenue provides access to US 60 east and does not provide direction to 2<sup>nd</sup> Avenue



Photo 4: Acceleration Lane for Northbound Right-Turn



Photo 5: Northbound Left-Turning Vehicle



Photo 6: Large Truck in Westbound Left-Turn Lane



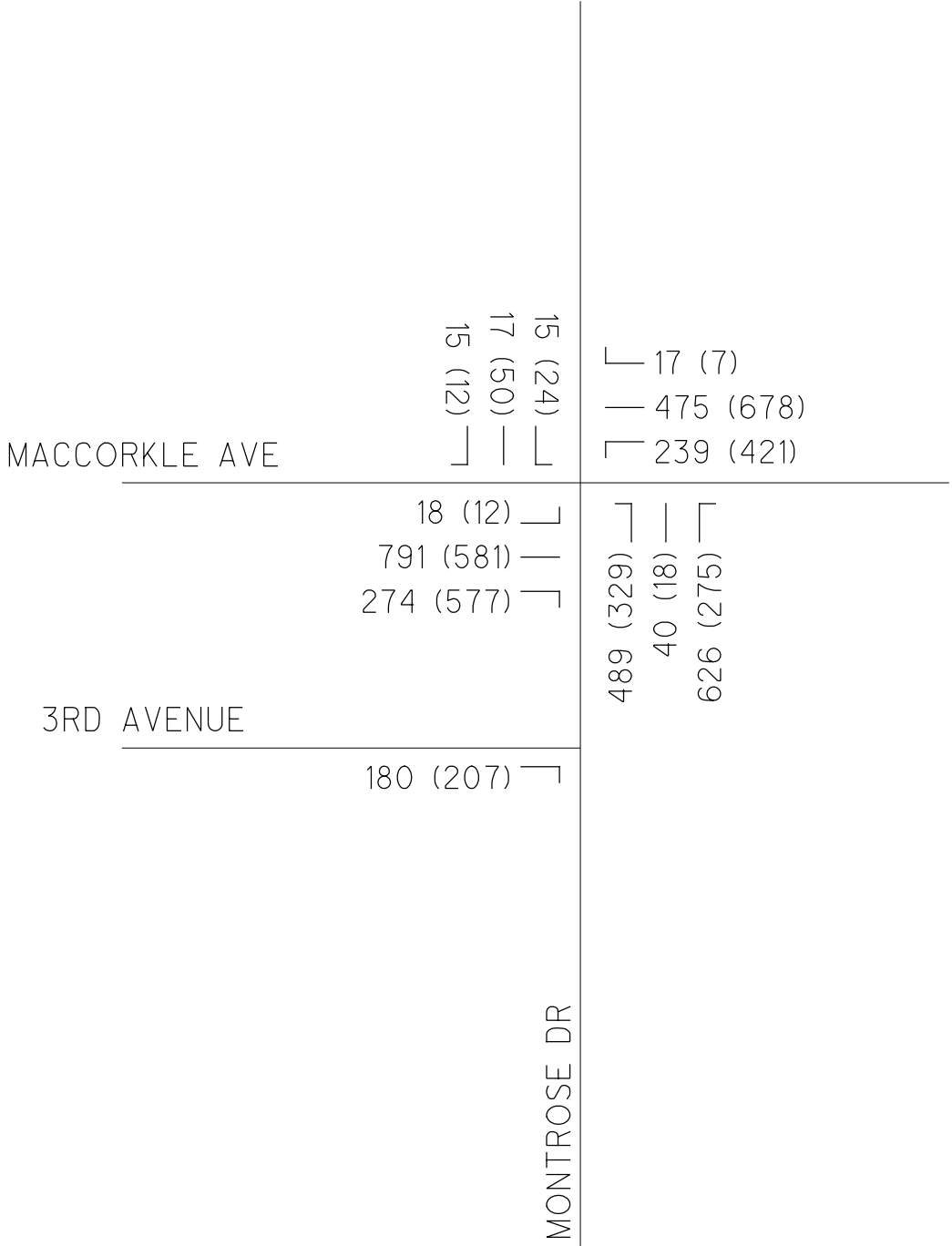
Photo 7: Overhead Lane Use Signs

During the site visit, it was observed that the majority of westbound left-turning traffic desired to be in the right-most travel lane on Montrose Drive in order to access westbound I-64 while a majority of the eastbound right-turning traffic at the intersection desired to be in the left-most lane on Montrose Drive to access eastbound I-64. Even though the eastbound right-turn movement has its own lane on Montrose Drive, when turning at the same time as westbound left-turning vehicles, near misses were observed.

## 4.0 Data Collection

A turning movement count at MacCorkle Avenue and Montrose Drive was collected for 24 hours on Wednesday October 14, 2020. A tube count was collected along the one-way portion of 3<sup>rd</sup> Avenue at Montrose Drive. The AM peak hour was determined to be 7:30 AM to 8:30 AM while the PM peak hour was 4:00 PM to 5:00 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 1.84 and 1.32 was used for the AM and PM peak hours, respectively. The final adjusted 2020 peak hour volumes are summarized in **Figure 3**. Raw traffic counts are provided in **Appendix A**.

XX: 2020 AM PEAK HOUR 7:30AM TO 8:30AM  
 (XX): 2020 PM PEAK HOUR 4:00PM TO 5:00PM



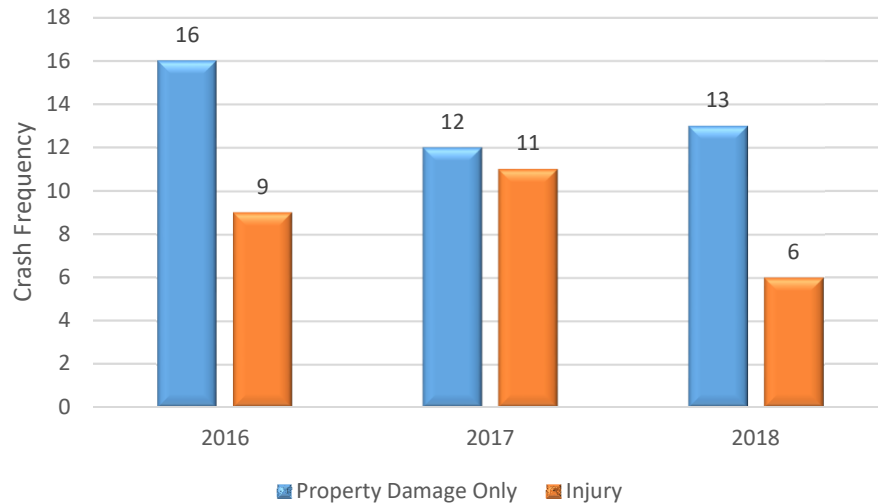
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NOT TO SCALE

MONTROSE DR AND MACCORKLE AVE ROAD SAFETY AUDIT  
 2020 ADJUSTED PEAK HOUR COUNTS

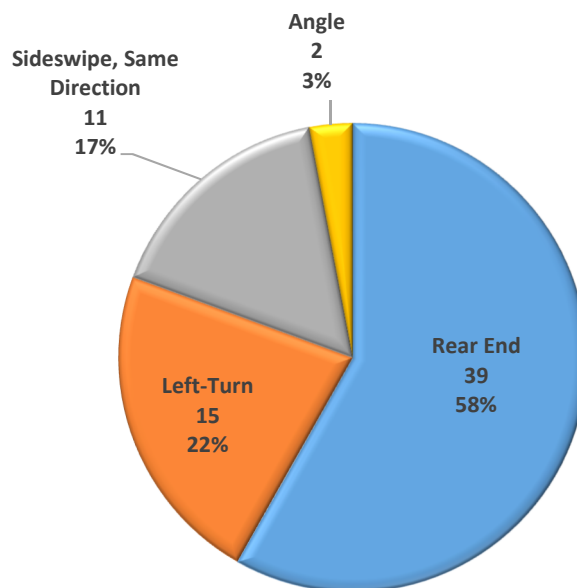
## 5.0 Crash Data

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 67 crashes with 41 (39 percent) resulting in injury. No fatalities occurred in the study period. The majority of crashes occurred on dry pavement (79 percent) and during the daylight (82 percent). **Figure 4** shows the crash breakdown per year by severity.



**Figure 4: Frequency of Crashes by Year and Severity**

**Figure 5** illustrates the crash frequency by type of crash. The majority of the crashes at this intersection were rear end collisions (58 percent). One of the main rear end crash patterns was in the northbound right-turn lane. This pattern of rear end crashes likely occurs when a right-turning vehicle begins to accelerate after finding a gap in traffic along MacCorkle Avenue. The driver then



**Figure 5: Crash Frequency by Crash Type**

realizes that the gap is not adequate, abruptly brakes and is rear ended by the vehicle behind them. The six rear end crashes on 3<sup>rd</sup> Avenue likely resulted from the same situation, especially due to the short distance between the eastbound right-turn lane and the 3<sup>rd</sup> Avenue intersection.

Another main crash type at this intersection was left-turn collisions (22 percent). All the left-turn collisions at the intersection involved a westbound left-turning vehicle and an eastbound through vehicle. The majority of these collisions were caused by westbound vehicles failing to yield to vehicles traveling eastbound. Out of the 15 left-turn collisions, 10 (67 percent) resulted in injury. Some of the crash reports indicated that the westbound vehicle turned because they thought the opposing eastbound vehicle was turning right.

## 6.0 Existing Capacity Analysis

Intersection capacity analysis was evaluated to assess existing operations using 2020 traffic volumes, existing lane configurations and traffic control. Existing signal timings at the intersections were determined from timing traffic videos during the peak hours. *SimTraffic* was used to obtain the 95<sup>th</sup> 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.

The analysis results were obtained using *Synchro* methodologies because *Highway Capacity Manual* (HCM) methodologies cannot accurately evaluate right-turn movements when they are yield-controlled. Existing operational analysis results from *Synchro* and *SimTraffic* are summarized in **Table 1** with analysis output provided in **Appendix C**.

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

	Overall Intersection	Eastbound MacCorkle Ave			Westbound MacCorkle Ave			Northbound Montrose Dr			Southbound Montrose Dr		
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
<b>AM Peak Hour</b>													
LOS	D	B	D	F	B	E	E	A	D				
Delay	39.1	13.6	46.5	94.6	18.4	64.8	63.9	0.0	37.8				
v/c		0.05	0.94	1.03	0.33	0.85	0.85	0.00	0.17				
95 <sup>th</sup> % Queue		147'	526'	294'	174'	384'	455'	0'	72'				
		D - 45.9			D - 43.4			C - 30.0			D - 37.8		
<b>PM Peak Hour</b>													
LOS	E	B	C	F	B	D	D	A	D				
Delay	56.1	11.5	29.4	240.4	14.5	52.8	52.2	0.0	41.90				
v/c		0.03	0.85	1.44	0.36	0.66	0.65	0.19	0.21				
95 <sup>th</sup> % Queue		31'	419'	618'	1276'	208'	186'	0'	56'				
		C - 29.3			F - 100.5			C - 29.4			D - 41.9		

In both the AM and PM peak hours, the westbound left-turn movement operates over capacity. The 95<sup>th</sup> percentile queue shows that westbound left-turn queue extends outside of the 450-foot left-turn lane in the PM peak hour during some of the cycles, backing up into the through lanes.

## 7.0 Countermeasures for Consideration

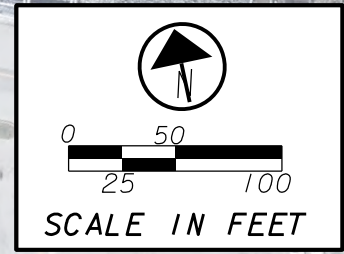
The following countermeasures were identified at the intersection to improve safety. The improvements are illustrated in **Figure 6** and **Figure 7**.

- **Remove the channelization northbound right-turn slip lane and control the right-turn movement by the signal** (Improvement A on **Figure 6** and **Figure 7**): By removing the yield control and controlling the movement by the signal, many of the rear end collisions would be mitigated as vehicles would not be stopping and starting in an attempt to find a gap on MacCorkle Avenue. In order to improve traffic operations, this movement can also be served with an overlap phase to operate concurrently with the westbound left-turn protected phase.
- **Add dotted pavement markings for northbound dual-left turn lanes** (Improvement B on **Figure 6** and **Figure 7**): Dotted pavement markings are recommended to delineate the path of each turn lane. This improvement will prevent vehicles from driving over the concrete median.
- **Stagger eastbound left-turn lane stop bar**: In addition to better delineating the vehicle paths of northbound left-turning vehicles, the eastbound left-turn lane stop bar can be relocated to that vehicles waiting at the stop bar are not within the path of left-turning vehicles.
- **Construct an exclusive, signalized eastbound right-turn lane** (Improvement C on **Figure 6** and **Figure 7**): Currently when three or four vehicles are queued in the right eastbound through-lane, the entrance to the right-turn slip lane is blocked and vehicles are not able turn onto Montrose Drive. The eastbound right-turn volume is high, especially in the PM peak hour with 577 right-turning vehicles, likely because of the direct access to I-64 from Montrose Drive. Adding an exclusive right-turn lane will remove right-turning vehicles from of the through-lane and will reduce queuing along MacCorkle Avenue. Signalizing the right-turn movement will also allow turning traffic to turn into their desired lane on Montrose Drive since many were observed to turn into the left-most lane. The right-turn will also be served while the northbound approach has the green indication. The traffic signal will need to be upgraded if the eastbound right-turn is signalized because the current box span configuration cannot accommodate the acceptable placement of the five-section head for the right-turn overlap. Without impacting the DSO Mechanical Building, approximately 230 feet of storage can be provided for the eastbound right-turn movement. If the intersection is realigned to the north (as illustrated in **Figure 7**), a full 300 feet of storage can be provided (as determined is required for adequate storage).
- **Close access from 3<sup>rd</sup> Avenue to Montrose Drive** (Improvement D on **Figure 6** and **Figure 7**): The current configuration of 3<sup>rd</sup> Avenue results in collisions because of limited sight distances and large amounts of conflicting traffic turning onto Montrose Drive from MacCorkle Avenue. With this closure, vehicles would be instead re-routed to B Street and MacCorkle Avenue, and then to the intersection of MacCorkle Avenue and Montrose Drive. If this option is implemented, observations should be conducted at the intersection of B Street/4<sup>th</sup> Avenue and MacCorkle Avenue to ensure that the added traffic volumes will not create operational or safety issues.
- **Remove concrete median on west and east legs of intersection to widen the left-turn lanes** (Improvement E on **Figure 6** and **Figure 7**): By removing the median, the width of the eastbound and westbound approaches will be increased. The portion of median removed will not affect the access management in the corridor. The wider median further from the intersection will remain to control access into and out of adjacent businesses.

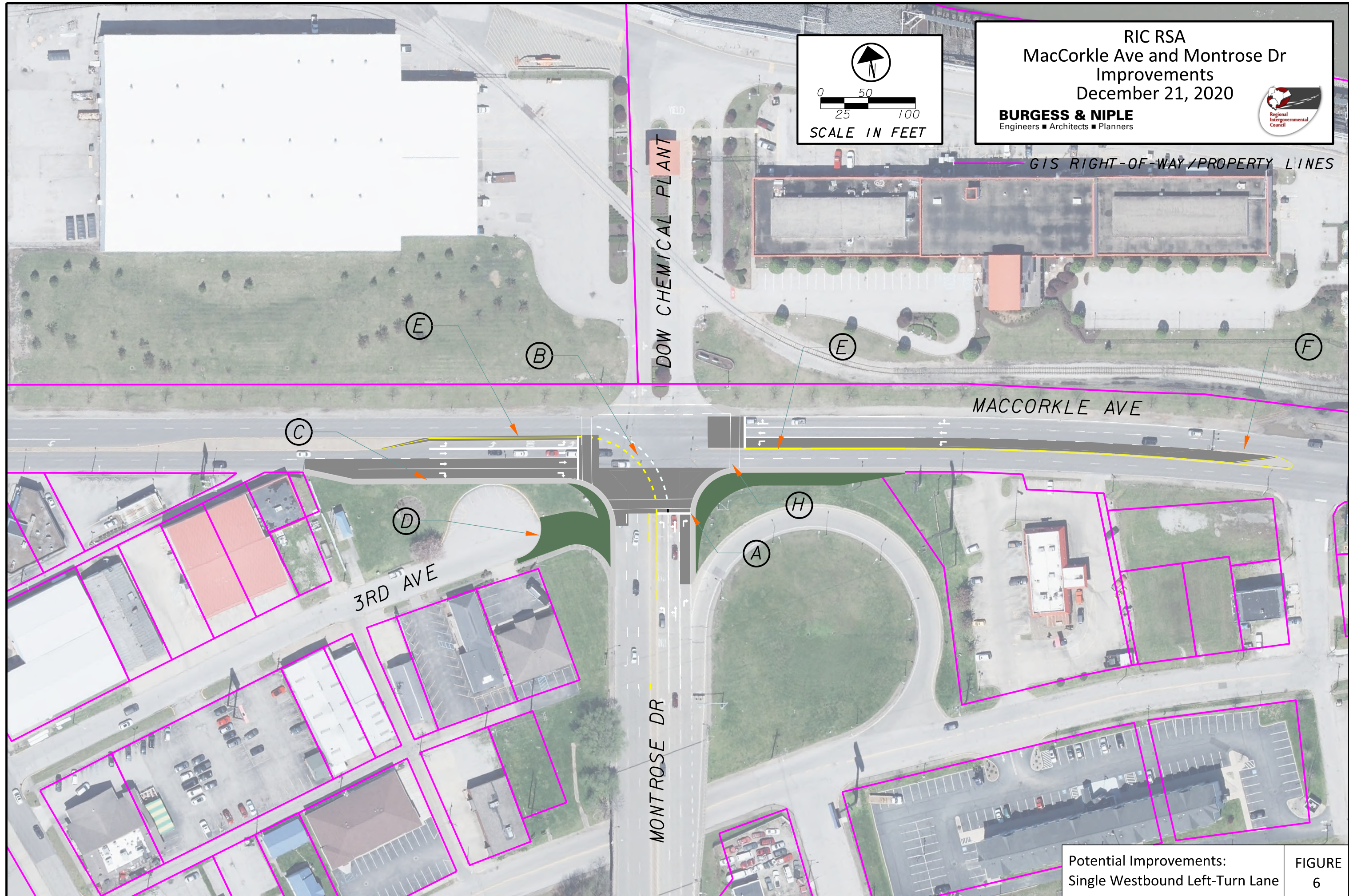
- **Protect the westbound and eastbound left-turn phases:** Westbound left-turn collisions where the left-turning driver failed to yield resulted in the most injury collisions at the intersection. By protecting the left-turn phases, the decision for drivers to select an adequate gap will be eliminated. Protecting the westbound left-turn phase will require the westbound left-turn lane to be extended (Improvement F on **Figure 6**) or the installation of dual turn lanes to prevent queuing into the westbound through lane (Improvement G on **Figure 7**). While operational analysis indicates that 550 feet of storage is required (see the next section) for the single left-turn lane, only 520 feet can be provided so to not impact access to Short Street. Left-turn lanes each with 270 feet of storage is proposed if the roadway is widened to provide dual left-turn lanes.
- **Improve pedestrian and bicycle facilities** (Improvement H on **Figure 6** and **Figure 7**): Potential improvements at this intersection include marking crosswalks, constructing ADA compliant curb ramps, upgrading push buttons and moving the pedestrian signal heads so they are visible and accessible from the sidewalk. These improvements should be constructed when the signal is reconstructed to accommodate the eastbound right-turn lane.

RIC RSA  
MacCorkle Ave and Montrose Dr  
Improvements  
December 21, 2020

**BURGESS & NIPLE**  
Engineers ■ Architects ■ Planners



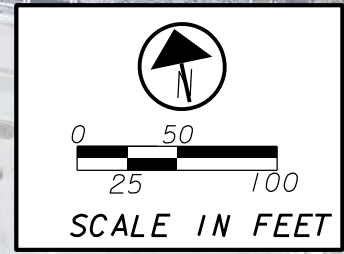
GIS RIGHT-OF-WAY / PROPERTY LINES



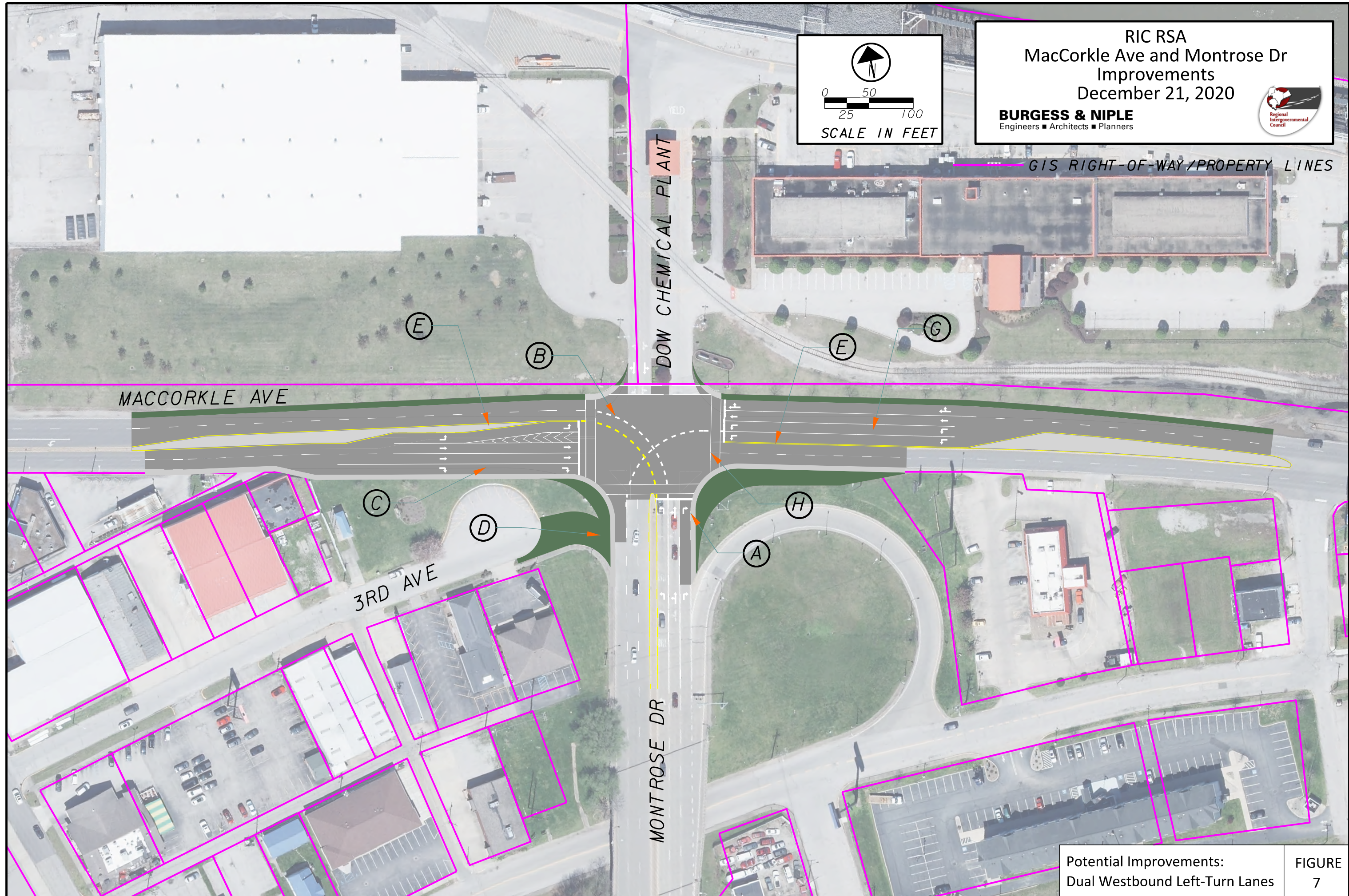
Potential Improvements:  
Single Westbound Left-Turn Lane

RIC RSA  
MacCorkle Ave and Montrose Dr  
Improvements  
December 21, 2020

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GIS RIGHT-OF-WAY / PROPERTY LINES



Potential Improvements:  
Dual Westbound Left-Turn Lanes

FIGURE  
7

- **Revise the overhead sign along Montrose Drive for US 60 East:** The overhead sign on Montrose Drive for northbound appears to indicate that the off-ramp to 2<sup>nd</sup> Avenue leads to US 60 east. It is proposed that the sign be revised to include a second right-turn arrow indicating that 2<sup>nd</sup> Avenue is the first right-turn while MacCorkle Avenue is the second right-turn (see **Figure 8**).

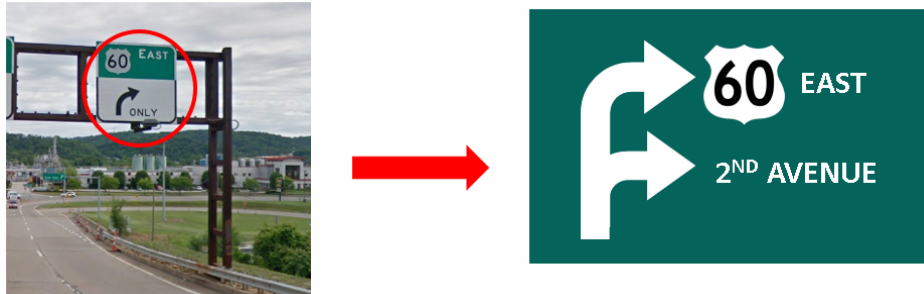


Figure 8: Potential Sign Revision

## 8.0 Countermeasure Evaluation

### 8.1 Operational Evaluation

To assess traffic operations for the countermeasures under further consideration, capacity analysis was performed using *Synchro*. While each of these improvements could be implemented independent of each other, the following alternatives were evaluated assuming they would be constructed together:

- **Alternative 1**
  - The eastbound and westbound left-turn phases were protected.
  - The westbound left-turn lane was extended for a total length of 520 feet.
  - An exclusive eastbound right-turn lane was added, and the right-turn was signalized.
  - The northbound right-turn was signalized and the channelization and acceleration lane were removed.
- **Alternative 2** – This alternative includes the same improvements as Alternative 1 but the right-turn from 3<sup>rd</sup> Avenue onto Montrose Drive is closed. The 3<sup>rd</sup> Avenue volume was added to the eastbound right-turn movement at MacCorkle Avenue and Montrose Drive.
- **Alternative 3** – This alternative has the same improvements as Alternative 1 with the addition of westbound dual left-turn lanes. Access to Montrose Drive from 3<sup>rd</sup> Avenue is still open under this alternative.

The 95<sup>th</sup> percentile queue lengths indicate that the eastbound right-turn lane should be 300 feet to accommodate the required traffic with the addition of the traffic from 3<sup>rd</sup> Avenue. However, only 230 could be provided so to not impact the DSO Mechanical building which is located immediately adjacent to the sidewalk on MacCorkle Avenue. The relocation of the stop bar to accommodate pedestrian facilities at the intersection also limits the available storage length. Based on the analysis, 230 feet should still accommodate right-turning traffic during most signal cycles throughout the day and will not queue into the through lanes very often. When the intersection is shifted to the north to accommodate the dual westbound left-turn lanes, the eastbound right-turn lane can be extended the full 300 feet.

With a single westbound left-turn lane, the 95<sup>th</sup> percentile queue lengths indicated nearly 580 feet of storage was required to accommodate the left-turn queues. So to not impact the access to Short Street, only 520 feet of storage length could be provided. When dual left-turn lanes are constructed, they each need 270 feet of storage which can be accommodated by shifting the intersection to the north.

Storage length calculations are shown **Appendix D**.

Capacity analysis results using adjusted 2020 volumes for Alternative 1, Alternative 2 and Alternative 3 are summarized in **Table 2**, **Table 3** and **Table 4** respectively. *Synchro* output is provided in **Appendix E**. Signal timings have been optimized for these alternatives.

**Table 2: Operational Analysis Results for Alternative 1 (2020 Conditions)**

	Overall Intersection	Eastbound MacCorkle Ave			Westbound MacCorkle Ave			Northbound Montrose Dr			Southbound Montrose Dr		
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
<b>AM Peak Hour</b>													
LOS	D	E	D	A	E	B	E	E	C	D			
Delay	39.0	56.2	51.0	2.3	57.5	17.6	63.2	62.4	29.0	37.7			
v/c		0.17	0.90	0.32	0.78	0.33	0.83	0.83	0.90	0.17			
95 <sup>th</sup> % Queue		164'	493'	280'	284'	174'	362'	570'	634'	86'			
		D - 38.8			C - 30.6			D - 44.5			D - 37.7		
<b>PM Peak Hour</b>													
LOS	C	D	D	B	D	B	E	E	A	D			
Delay	30.9	54.2	40.6	18.4	51.8	14.4	60.4	59.5	3.4	44.5			
v/c		0.09	0.67	0.70	0.85	0.36	0.69	0.68	0.33	0.22			
95 <sup>th</sup> % Queue		61'	308'	104'	378'	173'	226'	204'	156'	112'			
		C - 29.8			C - 28.6			C - 35.0			D - 44.5		

In Alternative 1, all intersection approaches are operating at LOS D or better in both the AM and PM peak hours. Compared to the existing conditions, in the PM peak hour, the overall intersection improved from LOS E to LOS C while the AM peak hour still operates at LOS D. In this alternative, likely because of optimized signal timings, the westbound left-turn movement is no longer operating over capacity in both the AM and PM peak hours.

**Table 3: Operational Analysis Results for Alternative 2 (2020 Conditions)**

	Overall Intersection	Eastbound MacCorkle Ave			Westbound MacCorkle Ave			Northbound Montrose Dr			Southbound Montrose Dr		
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
<b>AM Peak Hour</b>													
LOS	D	E	D	A	E	B	E	E	C	D			
Delay	37.3	56.2	50.5	5.2	57.7	17.5	63.6	62.8	29.2	37.7			
v/c		0.17	0.89	0.50	0.78	0.33	0.83	0.83	0.90	0.17			
95 <sup>th</sup> % Queue		173'	516'	295'	290'	161'	387'	634'	644'	75'			
		C - 34.3			C - 30.7			D - 44.8			D - 37.7		
<b>PM Peak Hour</b>													
LOS	D	D	E	C	E	C	D	D	A	D			
Delay	37.9	54.8	55.3	33.6	67.5	22.2	39.6	39.3	2.1	45.0			
v/c		0.10	0.83	0.91	0.92	0.43	0.43	0.43	0.30	0.24			
95 <sup>th</sup> % Queue		79'	373'	246'	578'	982'	204'	175'	135'	109'			
		D - 42.9			D - 39.5			C - 22.9			D - 45.0		

Alternative 2 is also an improvement over the existing conditions as the intersection is performing at LOS D in the PM peak hour, compared to LOS E. Additionally, the westbound left-turn movement is no longer operating over capacity in the AM or PM peak hours. Compared to Alternative 1, the overall intersection is performing the same in the AM peak hour and slightly worse in the PM peak hour. This was due to the higher volume of right-turn traffic on the eastbound approach during the PM peak hour.

**Table 4: Operational Analysis Results for Alternative 3 (2020 Conditions)**

	Overall Intersection	Eastbound MacCorkle Ave			Westbound MacCorkle Ave			Northbound Montrose Dr			Southbound Montrose Dr		
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
<b>AM Peak Hour</b>													
LOS	D	E	D	A	D	B	E	E	C	D			
Delay	37.5	56.2	50.6	2.3	40.1	17.6	62.8	62.0	29.3	37.7			
v/c		0.17	0.90	0.31	0.41	0.33	0.83	0.82	0.90	0.17			
95 <sup>th</sup> % Queue		156'	501'	272'	198'	173'	400'	591'	623'	74'			
		D - 38.5			C - 25.0			D - 44.4			D - 37.7		
<b>PM Peak Hour</b>													
LOS	C	D	C	B	D	B	D	D	A	D			
Delay	26.2	52.2	32.2	12.2	45.0	17.6	46.3	46.0	4.3	42.2			
v/c		0.08	0.57	0.63	0.68	0.41	0.56	0.55	0.37	0.20			
95 <sup>th</sup> % Queue		43'	272'	75'	267'	195'	214'	190'	175'	103'			
		C - 22.5			C - 28.1			C - 27.7			D - 42.2		

Alternative 3 is also performing better than existing conditions as PM peak hour improved from LOS E to LOS C. All intersection approaches operate at LOS D or better in both the AM and PM peak hours. Out of all the alternatives, the westbound left-turn movement performs the best in this alternative (LOS D) because of dual left-turn lanes. However, what is not accounted for in this analysis is the potential lane imbalance that may result from vehicles favoring the right-most left-turn lane because they are destined to westbound I-64. As a result, the results presented here may be better than what may actually occur if this alternative is constructed.

### 8.2 Cost Considerations

**Table 5** shows the cost breakdown of each improvement. 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 for the eastbound right-turn lane and westbound dual left-turn lanes. The cost of the eastbound right-turn lane includes the cost the traffic signal upgrade along with the cost of upgrading the pedestrian accommodations since modifying the signal requires that all pedestrian facilities be made compliant with ADA polices (approximately \$250,000). A detailed breakdown of the construction cost estimates is provided in **Appendix F**.

**Table 5: Cost Estimate by Potential Improvement**

	<b>Cost Estimate</b>
Northbound Right-Turn Lane Modifications	\$ 171,000
Eastbound Right-Turn Lane	\$ 925,000
Close 3rd Avenue	\$ 49,000
Extend Westbound Single Left-Turn Lane	\$ 342,000
Westbound Dual Left-Turn Lanes*	\$ 992,000
US 60 East Sign Revision	\$1,500

\*Would likely require signal reconstruction (approximately \$250,000), but signal costs were assumed to be included with the eastbound right-turn lane modifications.

## 9.0 Conclusions and Recommendations

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

### Short-Term

- Revise the overhead sign along Montrose Drive for US 60 East and 2<sup>nd</sup> Avenue (approximate cost: \$1,500).
- Protect the westbound left-turn phase
- Protect the eastbound left-turn phase
- Add dotted pavement markings for the northbound dual-left turn lanes
- Move the eastbound left-turn stop bar back from the intersection to prevent path overlap with northbound left-turning vehicles.

### Medium-Term

- Construct an eastbound right-turn lane and signalize the right-turn movement. This improvement will require modifying the existing signal by adding a five-section signal head which will likely necessitate a full signal upgrade accommodate the appropriate placement of the signal head (approximate cost: \$925,000).
- Reconstruct and signalize the northbound right-turn lane. This improvement will also require modifying the existing signal by adding a five-section signal head. Further analysis is required to determine if this modification can be accommodated with the existing span wire configuration (approximate cost (without full signal reconstruction): \$171,000).
- Extend the westbound left-turn lane to the east. This improvement will require modifying the median on the east leg of the intersection (approximate cost: \$342,000).
- Remove concrete median to the east and west of the intersection to allow for wider left-turn lanes.
- Improve pedestrian and bicycle facilities. As part of the improvements to the intersection with the addition/modification of the turn lanes, crosswalks should be striped on all approaches. because the signal will require reconstruction to accommodate the new turn lanes, pedestrian push buttons and signal heads should be upgraded with the new equipment. ADA compliant curb ramps could also be constructed at a reasonably low cost.

### Long-Term

- Construct dual westbound left-turn lanes. This improvement should be considered if capacity concerns persist after other improvements have been made (approximate cost: \$992,000).