SUM-8-0.00

Interchange Modification Study

Prepared for:

Ohio Department of Transportation

June 2020

Prepared by: **Burgess & Niple**

Interchange Modification Study

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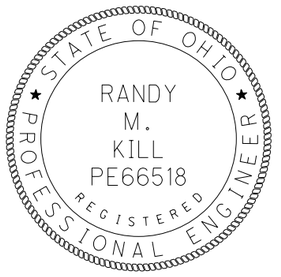


6-16-2020

Contents

Satisfying the FHWA Policy Requirements

FHWA provides Interstate Modification Study guidance in the *Policy on Access to the Interstate System,* dated May 22, 2017, which details two policy requirements the States must follow when seeking FHWA approval for a change-in-access to the Interstate system. This section discusses each policy requirement as it relates to the I-77 and SR 8 corridor between I-277 and Tallmadge Avenue.

Policy Requirement #1

"An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified ramps, ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections. The analysis should, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access (23 CFR 625.2(a), 655.603(d) and 771.111(f)). The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, should be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local street network (23 CFR 625.2(a) and 655.603(d)). Requests for a proposed change in access should include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute and accommodate traffic on the Interstate facility, ramps, intersection of ramps with crossroad, and local street network (23 CFR 625.2(a) and 655.603(d)). Each request should also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d))."

Policy Requirement #1 has been satisfied. Traffic operational analysis conducted for the study limits concludes that no significant adverse impact to safety or operations of I-77 and SR 8 would occur in the 2045 design year as a result of the proposed lane addition.

The conceptual signing plan, presented in **Appendix C**, illustrates adequate signing can be placed along the interstate in accordance with MUTCD guidelines without adverse impacts to other signs or drivers' expectations.

Policy Requirement #2

"The proposed access connects to a public road only and will provide for all traffic movements. Less than "full interchanges" may be considered on a case-by-case basis for applications requiring special access, such as managed lanes (e.g., transit or high occupancy vehicle and high occupancy toll lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards (23 CFR 625.2(a), 625.4(a)(2), and 655.603(d)). In rare instances where all basic movements are not provided by the proposed design, the report should include a full-interchange option with a comparison of the operational and safety analyses to the partial-interchange option. This report should also include the mitigation proposed to compensate for the missing movements, including wayfinding signage, impacts on local intersections, mitigation of driver expectation leading to wrong-way movements on ramps, etc. The report should describe whether future provision for a full interchange is precluded by the proposed design."

Policy Requirement #2 has been satisfied. The existing I-77 and SR 8 freeway only connects to public roads. There are existing partial interchanges through the corridor but the proposed improvements in this Interchange Modification Study does not impact the access to the freeway, It is a mainline lane addition.

Recommendation
Based on the analysis presented in this report, the proposed mainline widening does not degrade freeway operation within the study area. The recommended alternative (PBPD plus Braid) will also meet the purpose and need of the project which is to address capacity and safety issues along the I-77 and SR 8 corridor.

I. Executive Summary

The SUM-8-0.00 (PID 107834) corridor study identified that an additional lane of capacity is necessary in both directions along I-77 and SR 8 and improvements need to be made to the southbound SR 8 segment between the Carroll Street entrance ramp and the exit ramp to I-76/I-77 due to the high weaving volume. This Interchange Modification Study (IMS) will address the congestion and safety issues in the corridor. The I-77 Pavement Rehabilitation design build project will reconstruct pavement or resurface a large portion of the I-77 and SR 8 study area. Incorporating the additional mainline lane as part of this design build project will allow the Ohio Department of Transportation to save approximately 60% of the construction cost.

The recommended alternative was found to satisfy all the key elements of the project's purpose and need. The additional mainline lane will address capacity issues along the I-77 and SR 8 corridor. In addition, the recommended alternative will reduce crashes in the corridor by an estimated 18% compared to the No-Build condition.

This report documents that the build improvement does not degrade the freeway operations on I-77 and SR 8 and will enhance both the safety and operations of the corridor. Therefore, the build improvement is recommended.

II. Background

The sections of I-77 from the I-277/US 224 interchange to the Central Interchange and SR 8 from the Central Interchange to Tallmadge Road were identified in the Akron Beltway Study (PID 95831) as a congested link in the system. These sections were also identified on the 2016 Highway Safety Improvement Program (HSIP) Study Location List. An abbreviated Safety Study was performed for the SR 8 segment of this study, and several recommendations were identified as part of this study. The SUM-8 Corridor Study (PID 107834) was performed to build upon the previous Safety Study to confirm the medium-term and long-term ideas that were proposed and determine additional ideas that could be implemented to solve the capacity and safety concerns within the corridor. The conclusion of the SUM-8 Corridor Study was that an additional lane of capacity is necessary in both directions along I-77 and SR 8 and improvements need to be made to the southbound SR 8 segment between the Carroll Street entrance ramp and the exit ramp to I-76/I-77 due to the high weaving volume. The existing two-lane segment of SR 8 through the Central Interchange and the SR 8 SB section between Carroll and the Central Interchange were showing up as bottlenecks along the corridor.

The I-77 Pavement Rehabilitation Design Build project (PID 102329) will include pavement replacement, structural rehabs and other infrastructure upgrades along segments of I-76, I-77 and SR 8. It will also include the Central Interchange reconstruction project (PID 101402), which will perform pavement replacement along I-77 from Lovers Lane to the Central Interchange and pavement resurfacing along SR 8 from the Central Interchange to the bridge over Beacon Street. This project is scheduled to begin construction in 2021. During the SUM-8 Corridor Study it was determined that ODOT could save up to 60% of the construction cost for the additional mainline lane along I-77 and SR 8 if it were constructed now as part of the design build project. Therefore, the scope of the design build project has been adjusted to include the improvements necessary to provide the additional mainline lane between the I-277/US-224 interchange and Carroll Street.

III. Purpose and Need

The purpose of the project is to address capacity and safety issues along the I-77 and SR 8 mainline between I-277 and Tallmadge Avenue. Capacity analysis for the segments in question identified that most of the corridor will operate at Level of Service (LOS) F in the 2045 Design Year in the No-Build alternative. In addition, the existing crash analysis shows that the corridor is experiencing more crashes than would be expected for a similar facility with comparable traffic volumes. Most crashes are rear-end and sideswipe-passing, which are indicative of congestions.

IV. Study Area

The I-77/SR 8 project, **Figure 1**, is in Summit County in the eastern portion of the Akron metropolitan area. Limits are from Mile Post 9.5 to Mile Post 11.8 on I-77 and Mile Post 0.0 to Mile Post 3.5 on SR 8.

The traffic analysis study area includes all mainline, ramp and weaving locations for the following freeways:

- I-77 from the northern ramps at the I-77/I-277/US-224 system interchange to the I-76/I-77/SR 8 system interchange.
- SR 8 from the I-76/I-77/SR 8 system interchange through the Tallmadge Avenue interchange.

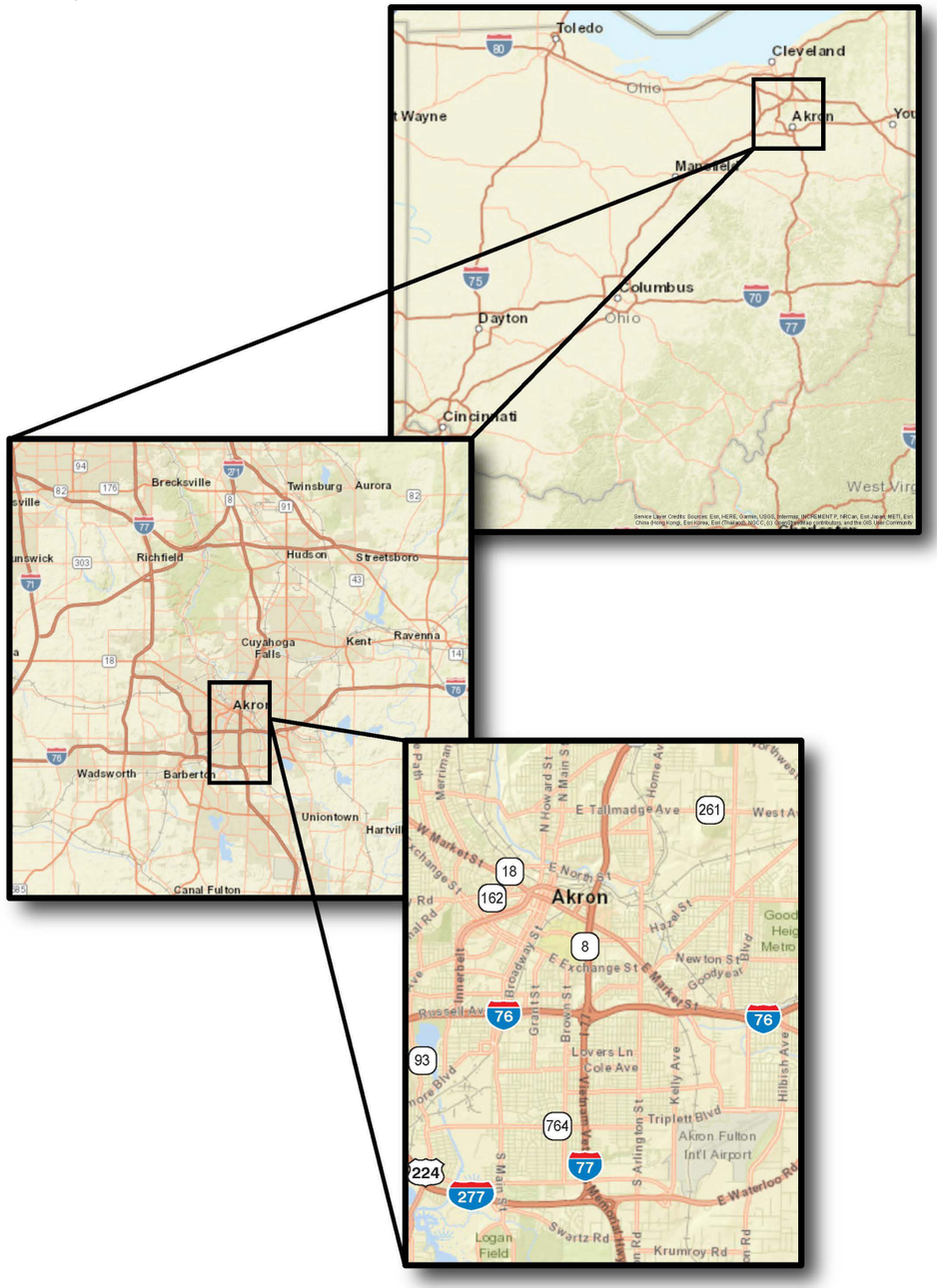
The following interchanges were included in the operational analysis of this Interchange Modification Study (IMS) document:

- I-77 & I-277/US-224 (northern ramps only)
- I-77 & Waterloo Road
- I-77 & Wilbreth Road (SR 764)
- I-77 & Archwood Avenue
- I-76/I-77/SR 8 system interchange
- SR 8 & Carroll Street
- SR 8 & Buchtel Avenue
- SR 8 & Perkins Street
- SR 8 & Glenwood Avenue
- SR 8 & Tallmadge Avenue

The following intersections were included in the operational analysis of this IMS document:

- Carroll Street & Fountain Street
- Carroll Street & Goodkirk Street
- Carroll Street & Spicer Street

Figure 1: Study Area



V. Analysis Years

Opening Year for the Interchange Modification project is 2025 with the Design Year established as 2045. The No-Build Condition for this study is defined as the existing interchange configuration plus any projects that will be constructed prior to 2045. The following projects were included as a No-Build condition:

- I-277/US-224 interchange improvement project, PID 106002 – improvements to the I-77/I-277/US-224 system interchange. Will provide an additional mainline lane in each direction on I-77 through the interchange in both directions.
- Central Interchange reconstruction project, PID 101402 – modifications to the I-76/I-77/SR 8 system interchange. The southbound I-77 ramp to Lovers Lane will be removed. C-D roadway for ramps from I-76 to southbound I-77 will be removed. Ramps will join I-77 mainline as separate add lanes.
- SUM-8-1.95 bridge replacement project, PID 91710 – will widen the SR 8 mainline between Perkins Street and Glenwood Avenue to add a fourth lane in each direction. Fourth lane will be an auxiliary lane between Perkins Street and Glenwood Avenue.

VI. Alternatives Considered

When it was determined that an additional lane in each direction would be necessary along SR-8 through the Central Interchange, the limits of the additional lane was further investigated. The limits of these additional lanes and where to terminate them was evaluated based on coordination with the traffic analysis, geometrics, and ODOT input, resulting in the following limits:

- In the SB direction, the additional lane would begin at the Perkins Street interchange and extend south along SR 8 and I-77 to the I-277/US 224 interchange.
- In the NB direction, the additional lane would begin at the I-277/US 224 interchange and extend north along I-77 and SR 8 to the Perkins Street interchange. Additionally, roadway widening would be incorporated to change the NB exit ramp to Glenwood Avenue from an exit-only diverge to a diverge with an additional lane of capacity continuing north along SR 8. Also, the exit ramp at Tallmadge Avenue would be revised from a diverge to an exit-only diverge.

Three geometric alternatives were developed to improve the capacity along SR 8 and I-77 in both directions between the I-277/US 224 interchange and Tallmadge Avenue. These alternatives are:

Full-Standard Alternative – This alternative added the additional lane of capacity for the entire length of the project utilizing lane and shoulder widths that met ODOT's Location and Design, Volume 1 standards. This means using 12-foot wide lanes and 10-foot left and right shoulders along I-77 and SR 8. Achieving these widths required the replacement of 14 city street, ramp, and interstate bridges over the freeway and the widening of four mainline bridges over the city streets. In addition to the reconstruction of the bridges, several retaining walls and acquisition of additional right-of-way is required. The most significant impacts to providing the full standard widths occurred in the Central Interchange because it required the replacement of the Johnston Street bridge, the SB to EB system ramp bridge, the NB to WB system ramp bridge, and the I-76 WB bridge. Initial preliminary construction cost estimates that were developed for this alternative placed the cost of this alternative at nearly $86M. Because of the high estimated construction cost anticipated to

implement this alternative, detailed evaluation of implementation strategy or studies related to the impacts of this option were not completed.

PBPD Alternative – Recognizing the high construction cost and impacts associated with the Full Standard Alternative make that option infeasible to implement in the short-term, an option was explored that introduced a PBPD strategy of reducing the lane widths and shoulder widths to retain the existing pavement footprint at the critical locations along the corridor, minimize impacts, eliminate the need to replace existing bridges, and reduce the costs.

To begin developing this alternative, the lateral width was determined at the critical locations, largely located at the existing mainline and overhead bridges, using a combination of new survey and existing plans. Lidar scans were completed for the bridges included in the three-level portion of the system interchange as well as for the Johnston Street bridge over SR 8. These lidar bridge scans were completed because it was understood that these areas were the narrowest width along SR 8 and detailed information was needed for ODOT to determine whether the shoulder widths provided in the PBPD solution would be acceptable. Outside of the Central Interchange, existing plans were used to determine the lateral widths of the bridges.

Once the lateral widths were determined at the critical locations, a typical section was developed that fit the additional width in these areas without impacting the bridges or requiring additional right-of-way. Along I-77, because it is a Federal Aid Primary (FAP) Route and a roadway on the National Network, one 12-foot wide lane was required in both directions. For this reason, the typical section proposed along I-77 included 11-foot wide travel lanes with one 12-foot wide lane in each direction, a 4-foot wide minimum left (median) shoulder, and a 4-foot wide minimum right (outside) shoulder that widened out to the standard width of 10 feet between the bridges.

Along SR 8, because it is not an FAP Route or on the National Network, all the lane widths could be 11 feet. The typical section along SR 8 included 11-foot wide travel lanes, a 4-foot wide minimum left (median) shoulder except through the Central Interchange, and a 4-foot wide minimum right (outside) shoulder, except through the Central Interchange and under the Perkins Street bridge, that widened out to the standard width of 10 feet between the bridges. Within the Central Interchange, the median shoulder widths were reduced below 4-feet at the proposed bridge pier locations for the new EB to NB and WB to SB flyover ramp bridges and at the Johnston Street bridge. The outside shoulder widths were reduced to a minimum of 2.7 feet for about 225 feet through the Central Interchange and under the existing Perkins Street bridge. This was extensively coordinated with ODOT.

The existing horizontal alignment of SR 8 and I-77 is largely along a tangential alignment with large radii horizontal curves on the southern and northern ends of the project. Truck turning templates were used to confirm that the reduce lane width didn't create a safety issue with path overlap between lanes. The large radii horizontal curves and tangent alignments ensured that the reduce shoulder widths doesn't reduce the available stopping sight distance below the 60-mph design speed requirements along the freeway.

Braid Alternative – With the concern the traffic analysis identified regarding the weave segment along SR 8 SB between the Carroll Street entrance and the exit to the Central Interchange, an alternative was developed that braided the SR 8 SB exit to the Central Interchange and the Carroll Street entrance to SR 8 SB ramp movements. For this option, the SR 8 SB to the Central Interchange exit ramp diverged from SR 8 SB just south of the Carroll Street bridge and traveled under the proposed Carroll Street to SR 8 SB ramp before matching grade and elevation as a collector-distributor road adjacent to the freeway on the west side that connected to the Central Interchange. The Carroll Street ramp split just south of the existing intersection with Carroll Street with one movement continuing south to match into the Collector-Distributor roadway that ultimately connects to the Central Interchange ramps. The other movement went over the proposed SR 8 SB to the Central Interchange ramp and merged onto SR 8 SB. The Braid Alternative is designed to match into the PBPD Alternative utilizing a three-lane SR 8 SB freeway.

For additional information on the alternatives, see the ***SUM-8-0.00 (PID) 107834) Phase 2 Technical Memorandum,*** dated April 30, 2020.

Recommended Alternative

As a result of the *SUM-8 Corridor Study Phase 2 Technical Memorandum* and extensive coordination with ODOT, the combination of the PBPD and the Braid Alternatives was selected as the recommended alternative. See **Appendix A** for the conceptual alternative schematic drawings of the recommended alternative.

In order to take advantage of the cost savings realized by constructing the additional mainline lane as part of the upcoming I-77 Pavement Rehabilitation Design Build project, construction of the recommended alternative will be phased.

- Phase 1 (Interim Build) – added to the Design Build project scope and expected to begin construction in April 2021
  - SB - PBPD Alternative from the Carroll Street entrance ramp to the I-277/US 224 interchange
  - NB – PBPD Alternative from the I-277/US 224 interchange to the southern edge of the Central Interchange at the I-77 exit from SR 8. Included in the NB direction is the conversion of the exit ramp from Carroll Street from a single-lane ramp to a two-lane ramp
  - Refer to **Appendix B** for the conceptual alternative schematic drawing for Phase 1 (Interim Build)
- Phase 2 (Full Build) – separate future project to construct Braid Alternative and remaining PBPD Alternative elements
  - SB – PBPD Alternative from the Glenwood Avenue bridge to the Carroll Street interchange; includes the Braid Alternative
  - NB – PBPD Alternative from the southern edge of the Central Interchange at the I-77 exit from SR 8 to the Glenwood Avenue bridge
  - At this point the full recommended alternative will have been constructed

Figure 2 through **Figure 6** shows the lane usage for the No-Build, Interim Build and Full Build conditions. Schematic drawings for the recommended alternative can be found in **Appendix A**. A conceptual signing plan for the recommended alternative is shown in **Appendix C.**

Design Exceptions

The following design exceptions were requested for the recommended alternative. These design exceptions were written, submitted for review, and approved by ODOT. Their approval dates are included in the summaries below.

- *I-77 Shoulder Width* – This project is adding an additional lane along I-77 through the project limits utilizing Performance-Based Practical Design that squeezes the additional lane in the existing pavement footprint under and over bridges to avoid costly bridge reconstruction and replacement. To achieve this, the inside and outside shoulders widths and lane widths were reduced at these pinch points. The design standard recommends 10 feet shoulder width along I-77. This Design Exception is for shoulder width for the left (median) shoulder width in both directions along I-77. This project is utilizing 5.5 feet, with a minimum of 4 feet at the bridge piers. This Design Exception was approved on 5/12/20.
- *SR 8 Shoulder Width* – This project is adding an additional lane along SR 8 SB through the project limits utilizing Performance-Based Practical Design that squeezes the additional lane in the existing pavement footprint under and over bridges to avoid costly bridge reconstruction and replacement. To achieve this, the inside and outside shoulders widths and lane widths were reduced at these pinch points. The design standard recommends 10 feet shoulder width along SR 8. This Design Exception is for shoulder width for the left (median) shoulder width in the SB direction along SR 8. This project is utilizing 5.5 feet, with a minimum of 4 feet at the bridge piers. This Design Exception was approved on 5/12/20.
- *I-77 Lane Width* - This project is adding an additional lane along I-77 through the project limits utilizing Performance-Based Practical Design that squeezes the additional lane in the existing pavement footprint under and over bridges to avoid costly bridge reconstruction and replacement. To achieve this, the inside and outside shoulders widths and lane widths were reduced at these pinch points. The design standard recommends 12 feet lane width along I-77. This Design Exception is for lane width in both directions along I-77. This project is utilizing 11 feet lane widths. This Design Exception was approved on 5/12/20.
- *SR 8 Lane Width* - This project is adding an additional lane along SR 8 SB through the project limits utilizing Performance-Based Practical Design that squeezes the additional lane in the existing pavement footprint under and over bridges to avoid costly bridge reconstruction and replacement. To achieve this, the inside and outside shoulders widths and lane widths were reduced at these pinch points. The design standard recommends 10 feet lane width along SR 8. This Design Exception is for lane width in the SB direction along SR 8. This project is utilizing 11 feet. This Design Exception was approved on 5/12/20.
- *Ramp P Stopping Sight Distance* - This project is adding an additional lane along I-77 and SR 8 SB through the project limits utilizing Performance-Based Practical Design that squeezes the additional lane in the existing pavement footprint under and over bridges to avoid costly bridge reconstruction and replacement. The lane from which Ramp P, the SR 8 SB to I-76/I-77 ramp, is exiting is shifted west closer to the existing western abutment of the Johnston Street bridge over SR 8. The design standard recommends 360 feet of stopping sight distance bring provided for 45 mph design. The horizontal design achieves 235 feet of horizontal stopping sight distance, which meets 33 mph design standards and exceeds the existing stopping sight distance of 216 feet. This was done to avoid extensive pavement and bridge reconstruction along Johnston Street and a large retaining wall between this street and the ramp. This Design Exception was approved on 5/13/20.

Figure 2: No-Build – Interim – Full Build Lane Usage (1 of 5)

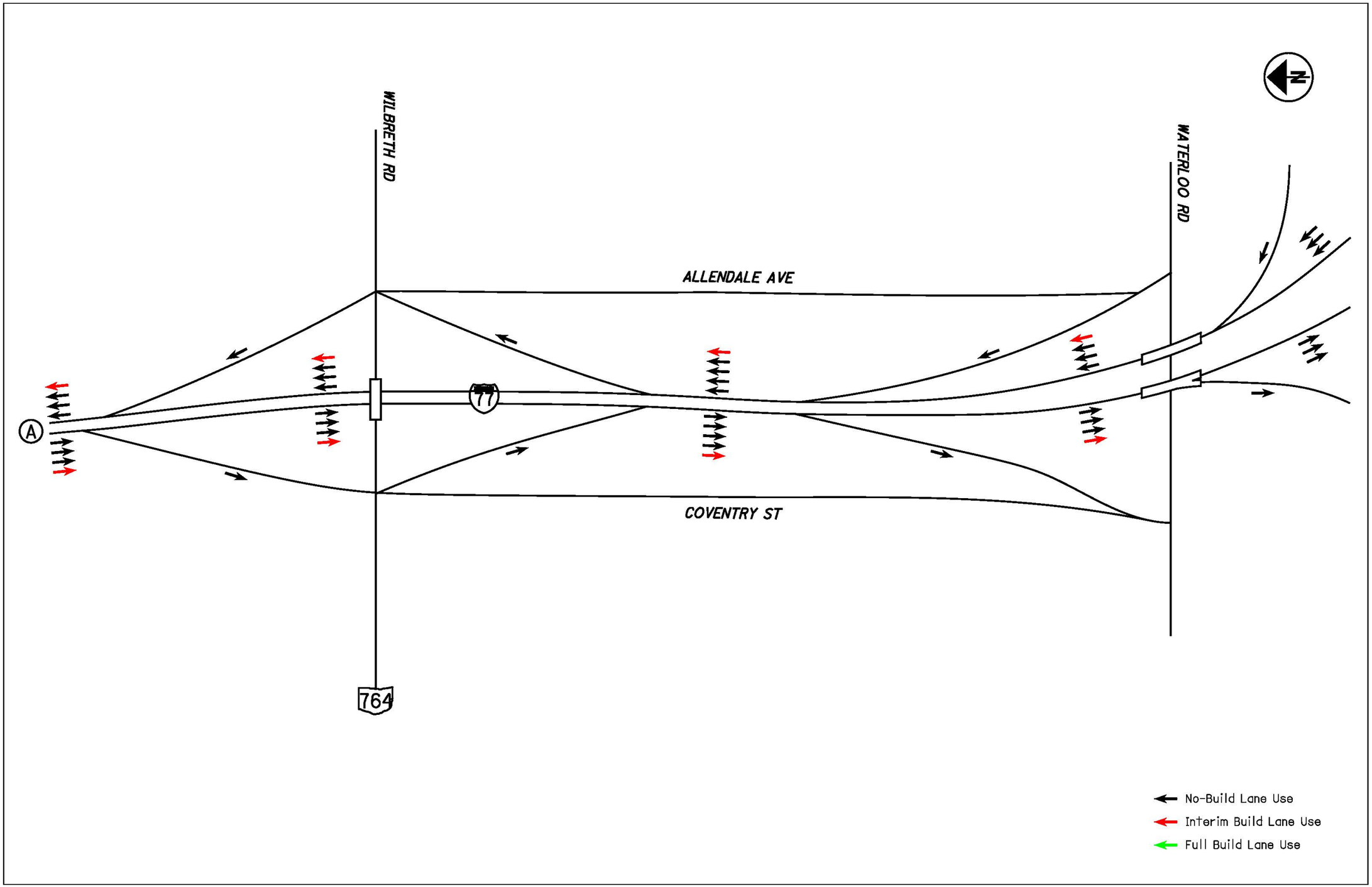


Figure 3: No-Build – Interim – Full Build Lane Usage (2 of 5)

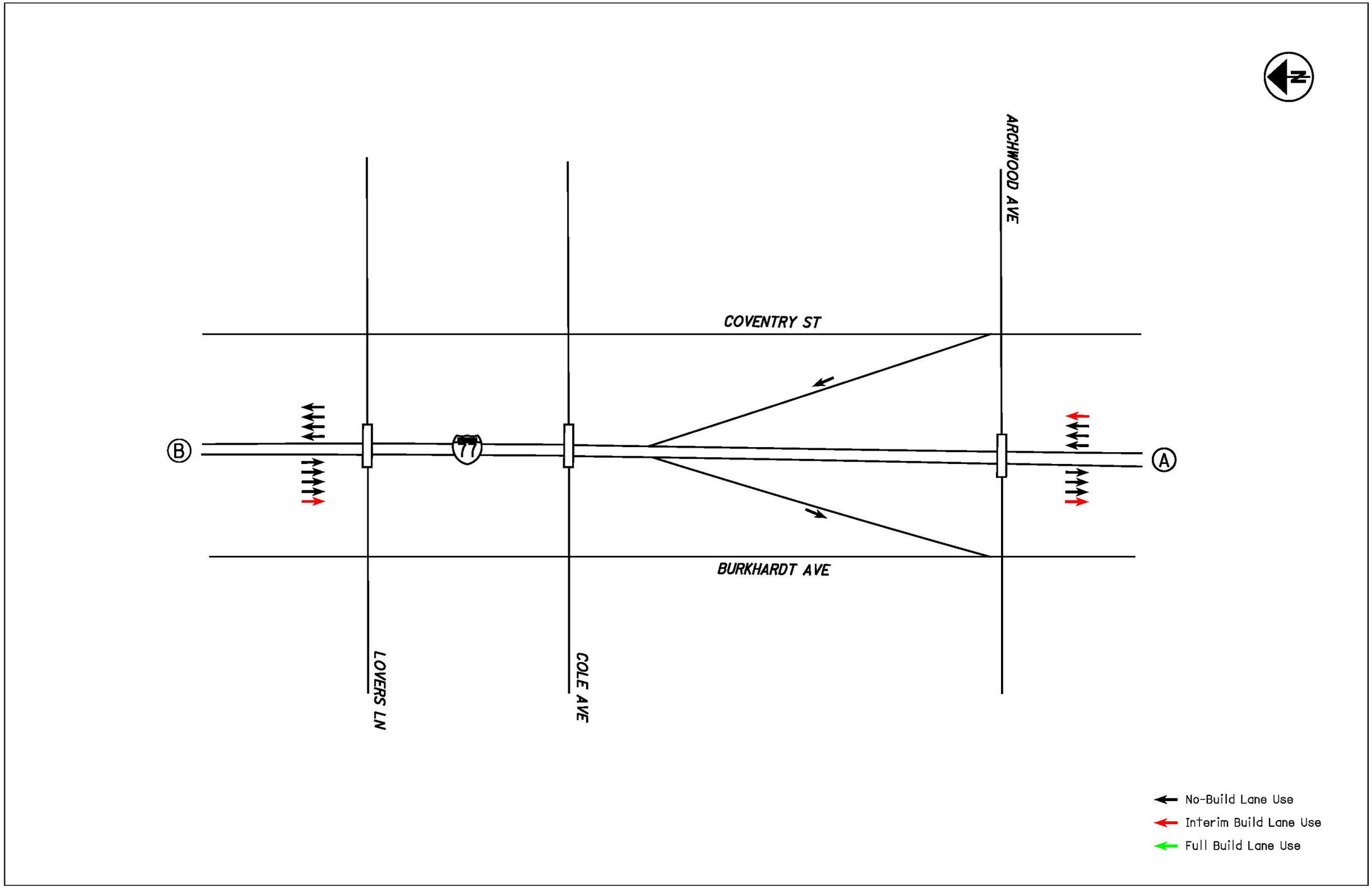


Figure 4: No-Build – Interim – Full Build Lane Usage (3 of 5)

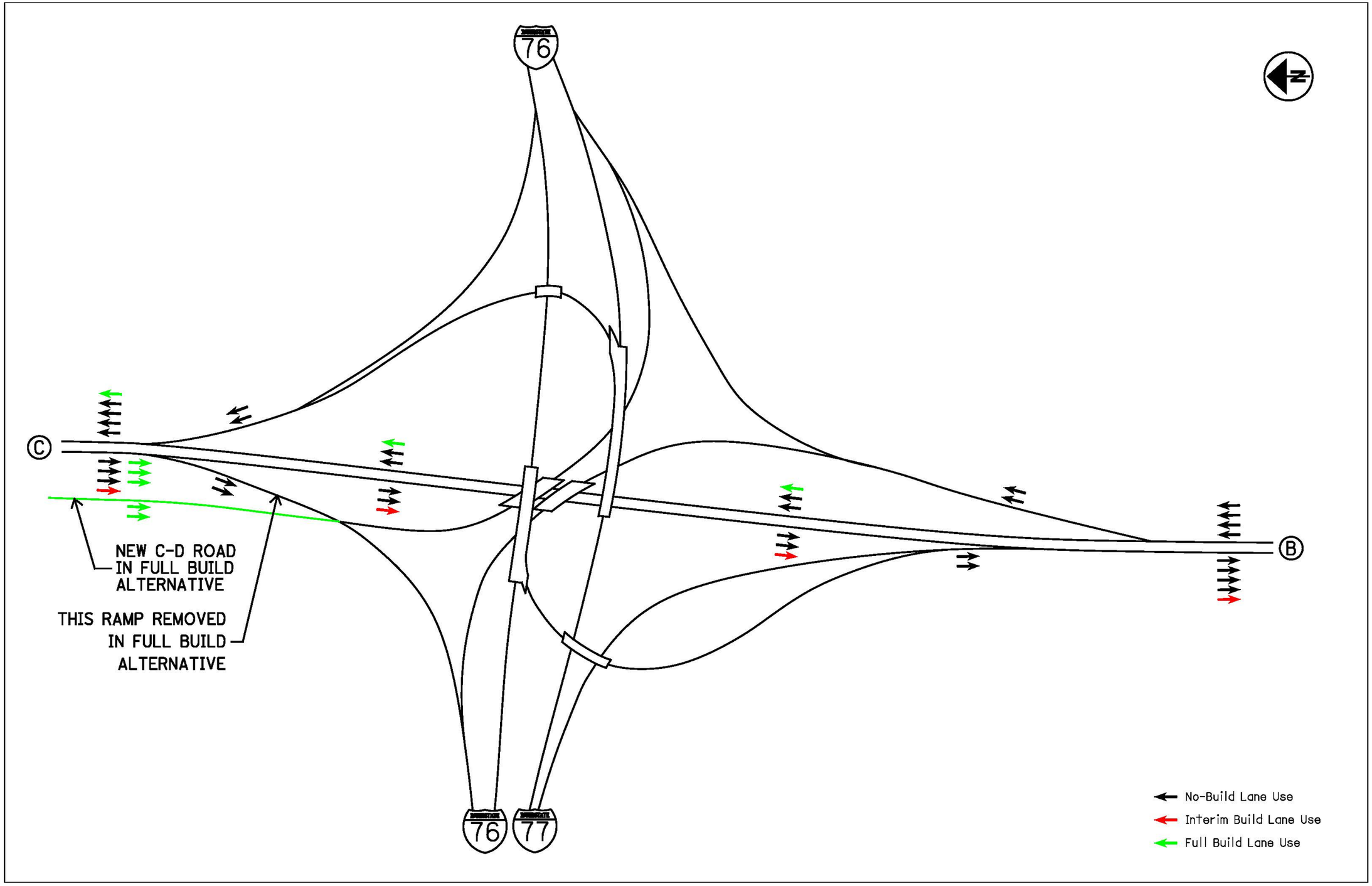


Figure 5: No-Build – Interim – Full Build Lane Usage (4 of 5)

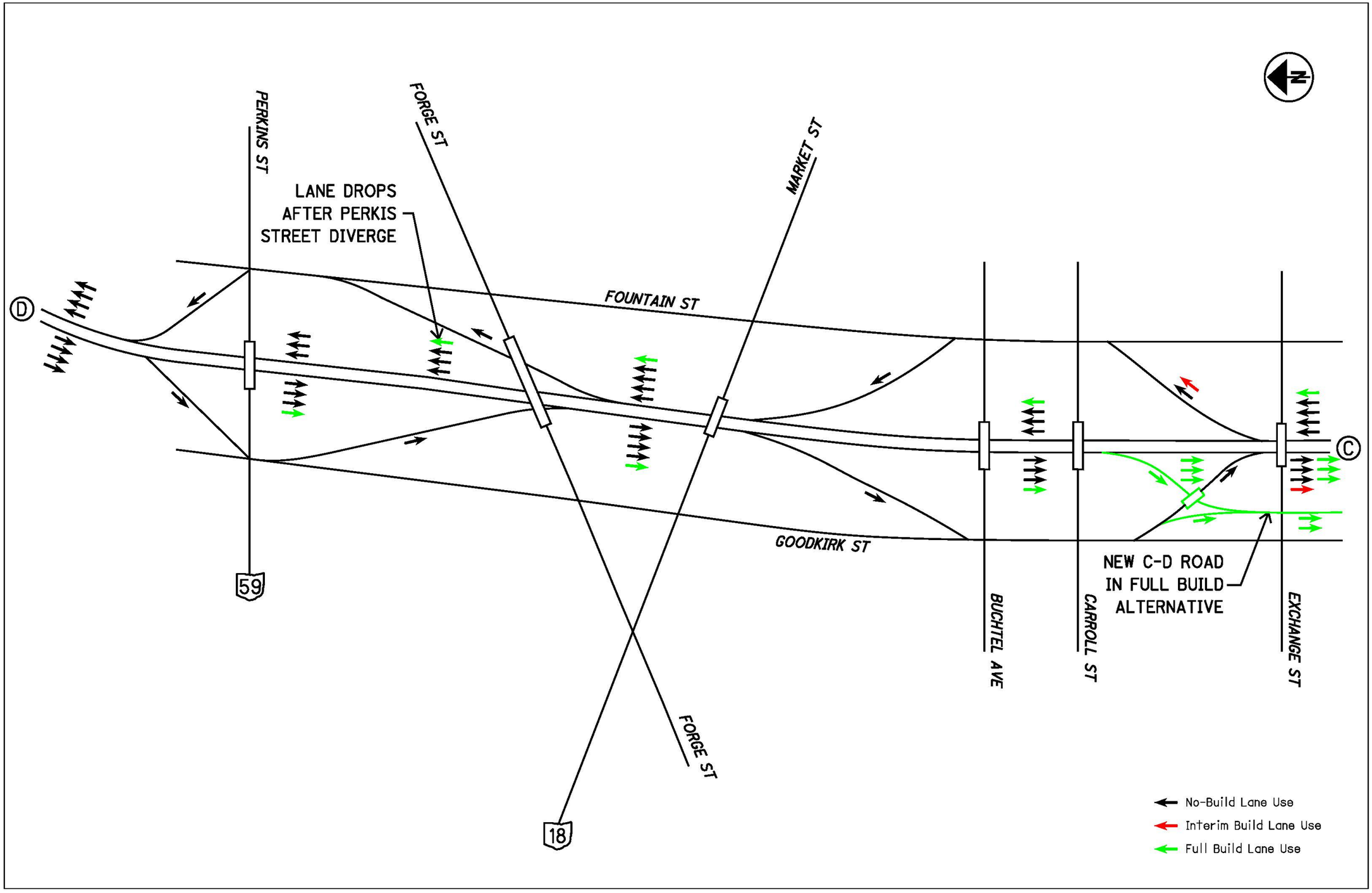
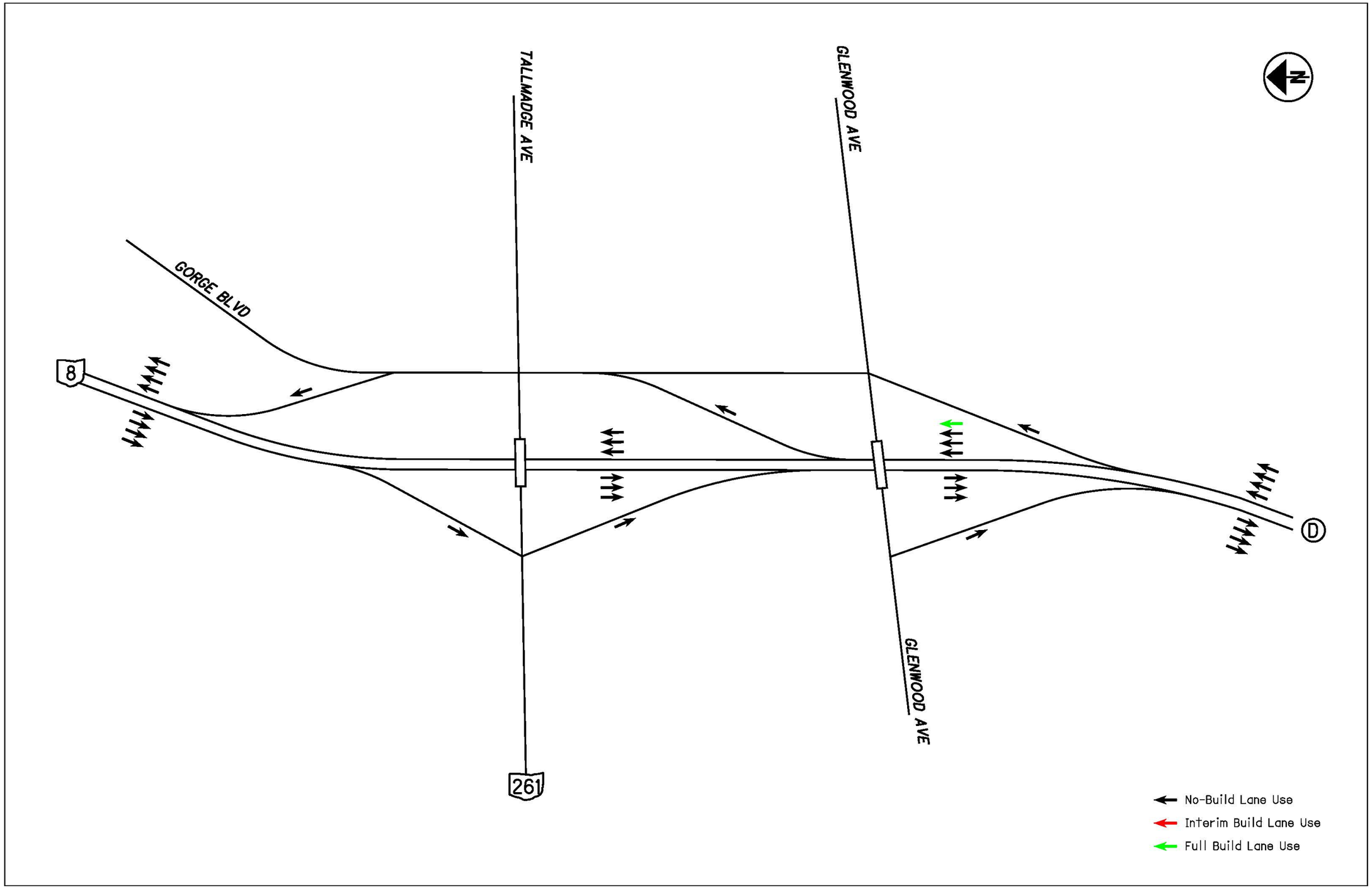


Figure 6: No-Build – Interim – Full Build Lane Usage (5 of 5)



VII. Existing Conditions

I-77 is a 6-lane urban interstate with a posted speed of 55 mph. Auxiliary lanes are present between the Waterloo Road and Wilbreth Road interchanges and the Archwood Avenue and I-76 interchanges. I-77 carries approximately 117,000 vehicles on an average day through the study area with approximately 6% representing trucks. By 2045, it is anticipated that over 124,000 vehicles will travel through the study area daily.

SR 8 is a 6-lane urban freeway with a posted speed of 55 mph. Auxiliary lanes are present between the I-76 and Carroll Street interchanges, the Buchtel Avenue and Perkins Street interchanges and Perkins Street and Glenwood Avenue interchanges (by 2045 design year). SR-8 carries approximately 108,000 vehicles on an average day through the study area with approximately 5% representing trucks. By 2045, it is anticipated that over 112,000 vehicles will travel through the study area daily.

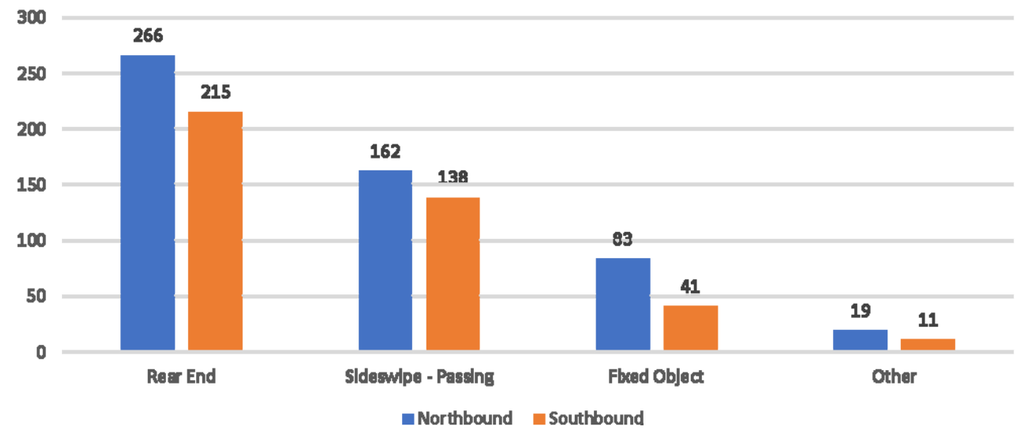
The I-77/I-277/US 224 interchange is a directional interchange and is the southernmost interchange in the study area. It is a system interchange that serves the I-77, I-277 and US-224 freeways. The Waterloo Road interchange is located 0.3 miles to the north. It is a partial diamond interchange with ramps to/from the north. The Wilbreth Road interchange is located 0.75 miles north of Waterloo Road. It is a full access diamond interchange. Archwood Avenue is a partial diamond interchange with ramps to/from the north. It is located 0.5 miles north of Wilbreth Road. The I-76/I-77/SR 8 system interchange is a directional interchange located 1.0 mile north of Archwood Avenue. It serves the I-76, I-77 and SR-8 freeways. The Carroll Street/Buchtel Avenue interchange is a split diamond interchange located 1.0 mile north of I-76. Carroll Street provides access to/from the south and Buchtel Avenue provides access to/from the north. The Perkins Street interchange is located 0.4 mile north of Buchtel Avenue. It is a full access diamond interchange. Glenwood Avenue is located 1.0 mile north of Perkins Street. It is a partial diamond interchange that provides access to/from the south. Finally, the Tallmadge Avenue interchange is located 0.3 miles north of Glenwood Avenue. It is a full access diamond interchange and is the northernmost interchange in the study area.

Crash Data

Crash data from 2015 through 2017 was obtained through ODOT's GIS Crash Analysis Tool (GCAT) via Transportation Information Mapping System (TIMS). Given the construction activities in the area, crash data through 2017 was used to minimize the construction impacts on crashes.

In the three-year study period, there were 935 reported crashes along mainline I-77 and SR 8. Over 51 percent of crashes were rear end collisions. Another 32 percent were sideswipe-passing crashes. This data indicates that over 83 percent of crashes in the study corridor were congestion related. The crash type breakdown by direction is summarized in **Figure 7**. The other crash types include parked vehicle, other non-collision, other object, overturning, backing, and pedestrian. In total, there were 530 northbound crashes and 405 southbound crashes. It is important to note that the southbound segment of SR 8 between Glenwood Avenue and Tallmadge Avenue was not included in this analysis since improvements are not proposed for this segment.

Figure 7: Existing Crash Type By Direction



In total, 192 of the 935 crashes resulted in injury. 22 percent (116 crashes) of the northbound crashes and 19 percent (76 crashes) of the northbound crashes resulted in injury.

VIII. Traffic Volumes

Certified traffic was developed by Burgess & Niple, Inc. and submitted to the ODOT Office of Statewide Planning and Research, Modeling and Forecasting Section for review and approval. Because this project does not alter the access to I-77 and SR 8, it was assumed that the No-Build and Build volumes would be the same. Therefore, only one set of future year traffic forecasts were developed. Traffic forecasts were approved 5/19/2020. As previously stated, the Opening Year is 2025 and the Design Year is 2045. The certified traffic volumes can be found in **Appendix D**.

IX. Traffic Analysis

Based on Certified Traffic, capacity analysis was performed to determine any impacts to mainline I-77 and SR 8 as well as the merge and diverge of the ramps. Analysis was conducted in the Freeway Facilities module of the *Highway Capacity Software Version 7.8.5 (HCS)*.

Capacity analyses for the No-Build, Interim Build and Full Build conditions were conducted for the 2045 design year. All design year traffic analyses are based on the procedures outlined in the *Highway Capacity Manual 6th Edition (HCM)*.

The Levels of Service (LOS) for basic freeway segments, ramp merge and diverge areas and weaving areas for the Design Year (2045) is presented in **Table 1** for the northbound direction and **Table 2** for the southbound direction. Capacity results are discussed below and detailed outputs of the *HCS* analysis are contained in **Appendix E** (No-Build**), Appendix F** (Interim Build) and **Appendix G** (Full Build). Figures showing the inputs for each segment as well as the capacity results are also included in **Appendix E-G**.
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Table 1: Northbound I-77/SR 8 Mainline Capacity Analysis

Segment	Analysis Type	Northbound I-77 Location	2045 AM No-Build			2045 AM Interim Build			2045 AM Full Build			2045 PM No-Build			2045 PM Interim Build			2045 PM Full Build		
			LOS	D/C	Throughput	LOS	D/C	Throughput	LOS	D/C	Throughput	LOS	D/C	Throughput	LOS	D/C	Throughput	LOS	D/C	Throughput
Seg-1-1-1	Basic	NB I-77, South of I-277 WB On-Ramp	F	0.85	4740	D	0.85	5851	D	0.85	5851	D	0.76	5247	D	0.76	5254	D	0.76	5254
Seg-2-2-2	Merge	I-277 WB On-Ramp	F	0.97	4937	D	0.73	6691	D	0.73	6691	C	0.83	5448	C	0.62	5746	C	0.62	5746
Seg-3-3-3	Weaving	NB I-77, Waterloo On to Wilbreth Off	F	0.84	4686	D	0.67	7125	D	0.67	7125	F	0.75	5237	C	0.60	6253	C	0.60	6253
Seg-4-4-4	Basic	NB I-77, South of Wilbreth On-Ramp	F	0.99	4109	D	0.74	6826	D	0.74	6826	F	0.84	4477	C	0.63	5786	C	0.63	5786
Seg-5-5-5	Merge	Wilbreth On-Ramp	F	1.07	4267	C	0.80	7401	C	0.80	7401	F	0.91	4464	C	0.68	6285	C	0.68	6285
Seg-6-6-6	Basic	NB I-77, South of Archwood On-Ramp	F	1.06	4161	D	0.80	7327	D	0.80	7327	F	0.91	4539	D	0.68	6285	D	0.68	6285
Seg-7	Weaving	NB I-77, Archwood On to I-76 Off	F	1.75	4433							F	1.35	4807						
Seg–7-7	Merge	Archwood On-ramp				D	0.89	8182	D	0.89	8182				C	0.75	6865	C	0.75	6865
Seg-8-8	Overlap	NB I-77, Archwood On to I-76 Off				E	0.91	8174	E	0.91	8174				D	0.77	6871	D	0.77	6871
Seg-9-9	Diverge	I-76 Off-ramp				E	0.95	3978	E	0.95	3978				E	0.74	3102	E	0.74	3102
Seg-8-10-10	Basic	NB SR 8, South of I-76 On-Ramp	A	0.94	569	E	0.94	4310	C	0.62	4310	B	0.84	1822	D	0.84	3886	C	0.56	3886
Seg-9-11-11	Weaving	NB SR 8, I-76 On to Carroll Off	F	1.42	3554	E	0.97	7368	D	0.97	7368	F	1.10	4208	D	0.79	6415	C	0.76	6415
Seg-10-12-12	Basic	NB SR 8, South of Buchtel On-Ramp	B	0.84	2002	D	0.84	5796	D	0.65	5796	C	0.81	3394	D	0.83	5601	C	0.63	5601
Seg-11-13-13	Weaving	NB SR 8, Buchtel On to Perkins Off	B	0.75	2265	D	0.75	6060	C	0.60	6060	B	0.79	3666	E	0.79	6372	C	0.63	6372
Seg-12-14-14	Basic	NB SR 8, South of Perkins On-Ramp	A	0.76	1454	D	0.76	5259	D	0.76	5259	C	0.88	3340	E	0.88	6057	E	0.88	6057
Seg-13-15	Weaving	NB SR 8, Perkins On to Glenwood Off	A	0.66	1947	D	0.66	5774				B	0.86	3622	E	0.85	7449			
Seg-15	Merge	Perkins On-Ramp							C	0.23	493							D	0.67	1397
Seg-16	Basic	NB SR 8, South of Glenwood Off-Ramp							C	0.63	5752							D	0.81	7469
Seg-17	Diverge	Glenwood Off-Ramp							C	0.39	812							D	0.31	657
Seg-14-16-18	Diverge	Tallmadge Off-Ramp	A	0.73	1158	C	0.73	5010	C	0.54	5010	B	0.99	2970	D	0.99	6817	D	0.74	6817
Seg-15-17-19	Basic	NB SR 8, South of Tallmadge On-Ramp	A	0.65	626	C	0.65	4468	C	0.65	4468	B	0.93	2579	E	0.93	6426	E	0.93	6426
Seg-16-18-20	Basic	Tallmadge On-Ramp	A	0.19	391	C	0.19	391	C	0.19	391	B	0.31	648	D	0.31	648	D	0.31	648
Seg-17-19-21	Basic	NB SR 8, North of Tallmadge On-Ramp	A	0.53	1017	C	0.53	4855	C	0.53	4855	B	0.77	2848	D	0.77	7056	D	0.77	7056

Facility Length, mi	6.36	6.36	6.36	6.36	6.36	6.36
Space Mean Speed, mi/h	24.8	52.7	54.8	38.6	52.5	55.4
Density, pc/mi/ln	32.1	31.5	27.9	28.8	32.5	28.3
Travel Time, min	15.4	7.3	7.0	9.9	7.3	6.9
LOS	F	D	D	F	D	D

SEG-**X** = No-Build analysis segment reference number
SEG-**Y** = Interim Build analysis segment reference number
SEG-**Z** = Full Build analysis segment reference number

Table 2: Southbound I-77/SR 8 Mainline Capacity Analysis

Segment	Analysis Type	Northbound I-77 Location	2045 AM No-Build			2045 AM Interim Build			2045 AM Full Build			2045 PM No-Build			2045 PM Interim Build			2045 PM Full Build		
			LOS	D/C	Throughput	LOS	D/C	Throughput	LOS	D/C	Throughput	LOS	D/C	Throughput	LOS	D/C	Throughput	LOS	D/C	Throughput
Seg-1-1-1	Basic	SB SR 8, North of Tallmadge Off-Ramp	D	0.72	6657	D	0.72	6657	D	0.72	6657	C	0.58	5347	C	0.58	5347	C	0.58	5347
Seg-2-2-2	Diverge	Tallmadge Off-Ramp	D	0.27	575	D	0.27	575	D	0.27	575	C	0.34	719	C	0.34	719	C	0.34	719
Seg-3-3-3	Basic	SB SR 8, North of Tallmadge On-Ramp	E	0.88	6093	E	0.88	6093	E	0.88	6093	C	0.67	4628	C	0.67	4634	C	0.67	4634
Seg-4-4-4	Merge	Tallmadge On-Ramp	D	0.96	6592	D	0.96	6592	D	0.96	6592	C	0.74	4980	C	0.74	5122	C	0.74	5122
Seg-5	Merge	Glenwood On-Ramp							D	0.21	445							C	0.22	467
Seg-6	Basic	SB SR 8, North of Perkins Off-Ramp							D	0.76	6989							C	0.61	5599
Seg-7	Diverge	Perkins Off-Ramp							D	0.74	1552							C	0.21	445
Seg-5-5	Weaving	SB SR 8, Glenwood On to Perkins Off	E	0.80	6987	E	0.80	6987				C	0.62	5246	D	0.62	5591			
Seg-6-6-8	Basic	SB SR 8, North of Perkins On-Ramp	D	0.79	5464	D	0.79	5464	C	0.59	5464	D	0.75	4797	D	0.75	5149	C	0.56	5149
Seg-7-7-9	Weaving	SB SR 8, Perkins On to Buchtel Off	D	0.73	5796	D	0.73	5796	C	0.58	5796	C	0.74	5067	D	0.74	5859	C	0.59	5859
Seg-8-8	Basic	SB SR 8, North of Carroll On-Ramp	D	0.72	4962	D	0.72	4962				C	0.75	4399	D	0.75	5204			
Seg-9	Merge	Carroll On-Ramp	D	0.29	614							C	0.59	1249						
Seg-10	Overlap	SB SR 8, Carroll On to I-76 Off	D	0.81	5587							D	0.94	4764						
Seg-11-10	Diverge	I-76 Off-Ramp	E	0.55	2323				C	1.01	2115	D	0.48	2016				C	0.79	1665
Seg-11	Basic	SB SR 8, North of Carroll On-Ramp							B	0.41	2805							C	0.51	3539
Seg-12	Merge	Carroll On-Ramp							B	0.20	405							C	0.45	898
Seg-9	Weaving	SB SR 8, Carroll On to I-76 Off				C	0.72	5533							D	0.76	6453			
Seg-12-10-13	Basic	SB SR 8, North of EB I-76 On-Ramp	D	0.70	3218	B	0.47	3218	B	0.47	3218	C	0.96	2748	C	0.64	4437	C	0.64	4437
Seg-13-11-14	Merge	EB I-76 On-Ramp	C	0.61	4208	B	0.46	4208	B	0.46	4208	C	0.89	3120	C	0.67	6118	C	0.67	6118
Seg-14-12-15	Weaving	SB I-77, I-76 On to Archwood Off	E	0.74	5663	C	0.74	5663	C	0.74	5663	B	0.92	3403	E	0.73	7581	E	0.73	7581
Seg-15-13-16	Basic	SB I-77, North of Wilbreth Off-Ramp	D	0.77	5279	C	0.57	5279	C	0.57	5279	F	1.04	2986	D	0.78	7154	D	0.78	7154
Seg-16-14-17	Diverge	Wilbreth Off-Ramp	D	0.16	343	C	0.16	343	C	0.16	343	F	0.19	409	C	0.19	409	C	0.19	409
Seg-17-15-18	Basic	SB I-77, North of Wilbreth On-Ramp	D	0.71	4927	C	0.54	4927	C	0.54	4927	B	0.98	2577	D	0.73	6749	D	0.73	6749
Seg-18-16-19	Weaving	SB I-77, Wilbreth On to Waterloo Off	C	0.63	5375	C	0.50	5375	C	0.50	5375	B	0.87	2848	D	0.69	7463	D	0.69	7463
Seg-19-17-20	Diverge	277 WB Off-Ramp	D	0.73	5018	C	0.55	5018	C	0.55	5018	F	1.07	2431	D	0.77	7067	D	0.77	7067
Seg-20-18-21	Basic	SB I-77, South of 277 WB Off-Ramp	C	0.59	4096	C	0.59	4096	C	0.59	4096	A	0.84	1089	D	0.84	5763	D	0.84	5763

Facility Length, mi	6.33	6.31	6.31	6.33	6.31	6.31
Space Mean Speed, mi/h	50.5	50.3	54.4	55.0	50.6	53.0
Density, pc/mi/ln	32.5	28.6	25.0	21.3	30.7	27.8
Travel Time, min	7.5	7.5	7.0	6.9	7.5	7.10
LOS	D	D	F	F	D	D

SEG-**X** = No-Build analysis segment reference number
SEG-**Y** = Interim Build analysis segment reference number
SEG-**Z** = Full Build analysis segment reference number

Interpretation of Freeway Operational Results

The use of the Freeway Facilities module in HCS allows the freeway segments, merges, diverges and weaves to be evaluated as a system. It computes performance measures for each of the individual segments within a study section, includes the inter-segment impacts of traffic congestion on all affected segments, and provides overall performance measures for the entire study section. As stated in the HCM, the methodology is consistent with individual segment methodologies if all demand volume-to-capacity (D/C) ratios are less than 1.00 and it properly accounts for the interaction of segments when any D/C ratio is greater than 1.00. Analysis of individual segments may fail to capture potential bottleneck impacts at one segment on adjacent upstream and downstream segments. A bottleneck on one segment that is over capacity will reduce the throughout volume on downstream links because the full demand will be unable to travel through the bottleneck. Likewise, links upstream of the bottleneck will have additional queuing and delay caused by the bottleneck. This interaction between segments is captured in the Freeway Facilities analysis. Tables 1 and 2 present the Freeway Facilities results for the northbound and southbound directions, respectively. It should be pointed out that the LOS results reported are based on the vehicles actually able to pass through a segment and is dependent on upstream and downstream bottlenecks in the corridor. D/C ratios are also included. These assume the entire demand can reach the segment. Finally, the throughput for each segment has been reported. This is the volume that can pass through a segment. If there are no bottlenecks in the corridor the throughput for the No-Build, Interim Build and Full Build for each segment would be the same since each is using the same demand.

The overall operational goal for this project was to design all mainline, ramp merge/diverge and weave locations to LOS D or better. Locations where this was not achievable will be discussed in further detail below.

Northbound Direction

As shown in Table 1, several segments in the No-Build condition operate at LOS F with D/C ratios near or greater than 1.0 during the AM and PM peak hours. This is particularly true for the I-77 segments. The weaving segments between the Archwood Avenue on-ramp and the I-76 diverge as well as the I-76 on-ramp and the Carroll Avenue diverge operate with very high D/C ratios. Bottlenecks from these weaves extend upstream and cause LOS F conditions for several mainline segments that are already operating with D/C ratios near 1.0. The overall freeway facility is LOS F in both the AM and PM Peak hours.

In the Interim Build condition, the additional mainline lane along I-77 and the two-lane off-ramp to Carroll Street have made significant improvements to the corridor. There are no segments operating at LOS F in either the AM or PM peak hours. A few segments operate at LOS E with D/C ratios near 1.0. In the AM peak hour, the I-77/SR 8 mainline from the Archwood Avenue on-ramp through the Carroll Street off-ramp operates at LOS E. There were no improvements to these segments as part of the Interim Build. In the PM peak hour, the I-76 off-ramp operates at LOS E and the SR 8 mainline segments from the Buchtel Avenue on-ramp to the Tallmadge Avenue on-ramp operate at LOS E or have D/C ratios greater than 0.95. As was the case in the AM peak hour, these segments did not receive capacity improvements as part of the Interim Build. The overall freeway facility LOS has improved from the LOS F conditions in the No-Build to an overall LOS D.

During the Full Build condition, the additional mainline lane along SR 8 between the I-76 diverge and Perkins Street and the auxiliary lane between the Glenwood Avenue off-ramp Tallmadge Avenue off-ramp has further improved the freeway operations in the northbound direction. In the AM peak hour, the mainline segment between Archwood Avenue and I-76 and the I-76 off-ramp are the only segments that operate at LOS E. In the PM peak hour, the I-76 off-ramp, SR 8 south of the Perkins on-ramp and SR 8 south of the Tallmadge Avenue on-ramp are the only segments that still operate at LOS E. As in the Interim Build, the overall freeway facility operates at LOS D. However, the density for the corridor has reduced by approximately 3 pc/mi/ln, the average speeds have increased over 2 mph and the travel time has reduced by 5% when compared to the Interim Build condition.

Southbound Direction

As shown in Table 2, the southbound direction operates with a mix of LOS D and LOS E in the AM peak hour of the No-Build condition. Only the Tallmadge Avenue on-ramp has a D/C value greater than 0.90. In the PM peak hour, the No-Build condition is generally at or exceeding capacity for the I-77 mainline segments. There are three locations expected to operate at LOS F with D/C greater than 1.0. In addition, there are four segments with a D/C value between 0.90 and 1.0. The overall freeway facility operates at LOS D in the AM peak and LOS F in the PM peak in the No-Build condition.

In the Interim Build condition, the additional mainline lane along I-77 has made significant improvements to the corridor. There are no segments operating at LOS F in either the AM or PM peak hours. Only SR 8 north of the Tallmadge on-ramp and SR 8 between the Glenwood Avenue on-ramp and Perkins Street off-ramp operates at LOS E in the AM peak and the only segment operating at LOS E in the PM peak is SB I-77 between the I-76 on-ramp and the Archwood Avenue off-ramp. The overall freeway facility remained at LOS D in the AM peak and has improved from the LOS F conditions in the No-Build to an overall LOS D during the PM peak hour.

During the Full Build condition, the addition mainline lane along SR 8 between Perkins Street and Carroll Street as well as the Braid at the Carroll Street on-ramp has provided additional improvements over the No-Build condition. Only the SR 8 mainline north of the Tallmadge on-ramp in the AM and I-77 between the I-76 on-ramp and Archwood Avenue off-ramp in the PM peak operate at LOS E. Only one segment in the AM peak hour and no segments in the PM peak hours has a D/C ratio greater the 0.90. The only area of slight concern is the single lane off-ramp from SR 8 to I-76 during the AM peak hour. The volume on this ramp just exceeds the capacity of a single lane ramp. Because this ramp is over capacity, the overall freeway facility LOS during the AM Peak is reported as LOS F. This ramp is part of the Braid alternative. Constructing this as a two-lane ramp can easily be accommodated in the design of the ramp braid. If this were a two-lane ramp the overall corridor LOS would be C. It is recommended that the need for a two-lane off-ramp be reevaluated in the future as funding for the Full Build condition is realized and the design commences. The Overall corridor statistics in the Full Build have also improved compared to the Interim Build. The density for the corridor has reduced by 3 pc/mi/ln, the average speeds have increased over 2 mph and the travel time has reduced by over 5%.

Intersection Analysis

Two intersections on Carroll Street will be impacted by the Full Build alternative. The construction of the braid will cut off access from Goodkirk Street to Exchange Street. This will impact the intersection of Carroll & Goodkirk Street and Carroll & Spicer Street as traffic destined to Exchange Street will shift from Goodkirk Street to Spicer Street. To evaluate the impact of this change, capacity analysis was conducted for the No-Build and Full Build alternatives at the following intersections:

- Carroll Street & Spicer Street
- Carroll Street & Goodkirk Street
- Carrol Street & Fountain Street

The LOS, delay, V/C ratios, 95th percentile queue lengths and queue storage ratios for the Carroll Street & Spicer Street are shown in **Table 3**, Carroll Street & Goodkirk Street in **Table 4** and Carroll Street & Fountain Street are in **Table 5**. Copies of the HCS analysis are included in **Appendix H**. The overall operational goal for the intersection analysis is LOS of D or better for the intersection and each movement, V/C ratios of 0.93 or less and queue storage ratios (QSR) of 1.0 or less.

Table 3: Carroll Street & Spicer Street Intersection Capacity Analysis

	Overall Intersection	Eastbound Carroll St		Westbound Carroll St			Northbound Spicer St			Southbound Spicer St	
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
AM Peak Hour - No-Build and Interim Build 2045													
LOS	C	C	B		D	D		C	D		C	C	
Delay	31.9	24.4	15.8		36.1	35.4		33.6	35.5		24.0	23.8	
V/C Ratio		0.02	0.03		0.24	0.27		0.12	0.33		0.02	0.28	
95th % Queue		10’	16’		232’	280’		46’	169’		9’	178’	
QSR		0.14	0.04		0.77	0.93		0.76	0.61		0.12	0.47	
		B – 18.7			D – 35.7			D – 35.1			C – 23.8		
PM Peak Hour - No-Build and Interim Build 2045													
LOS	C	C	B		D	C		C	D		C	C	
Delay	29.5	23.4	19.3		40.6	34.8		29.7	37.1		24.4	22.1	
V/C Ratio		0.10	0.15		0.18	0.15		0.03	0.60		0.28	0.34	
95th % Queue		48’	94’		155’	160’		10’	322’		89’	227’	
QSR		0.64	0.23		0.52	0.53		0.17	1.17		1.18	0.60	
		C – 20.6			D – 37.5			D – 36.9			C – 22.8		
AM Peak Hour - Full Build 2045													
LOS	C	D	D		C	B		D	D		C	C	
Delay	25.9	40.0	35.8		20.7	13.9		39.7	39.7		29.4	31.7	
V/C Ratio		0.06	0.10		0.64	0.22		0.16	0.39		0.03	0.51	
95th % Queue		29’	51’		384’	133’		51’	180’		10’	296’	
QSR		0.38	0.13		1.28	0.44		0.84	0.65		0.13	0.78	
		D – 37.2			B – 18.8			D – 39.7			C – 31.6		
PM Peak Hour - Full Build 2045													
LOS	D	D	D		D	B		C	D		C	C	
Delay	36.1	41.4	44.1		44.6	17.5		34.0	38.3		27.1	26.8	
V/C Ratio		0.18	0.35		0.93	0.17		0.04	0.61		0.33	0.51	
95th % Queue		67’	153’		274’	101’		11’	327’		95’	331’	
QSR		0.90	0.38		0.91	0.34		0.19	1.19		1.26	0.87	
		D – 43.2			D – 39.7			D – 38.1			C – 26.9		

As shown in Table 3, the intersection of Carroll Street & Spicer Street will meet the LOS goals, V/C goals and most of the QSR goals. In the PM peak hour of the No-Build and Full Build analysis, the northbound through movement and southbound left turn movement QSR will be greater than 1.0. The northbound should not be a significant impact as there is additional length for vehicles to queue, however, the end of the queue may occasionally extend to the minor intersection with Orchard Street. The southbound left turn storage lane would need to be extended by 20’ so the QSR would be lower than 1.0. It appears that it may be possible to do this by borrowing 20’ from the northbound left turn lane at Spicer and Buchtel.

Table 4: Carroll Street & Goodkirk Street Intersection Capacity Analysis

	Overall Intersection	Eastbound Carroll St		Westbound Carroll St		Southbound Goodkirk St			
		TH	RT	LT	TH	LT	TH	TH	RT
AM Peak Hour - No-Build and Interim Build 2045									
LOS	B	B		C	A	C		C	
Delay	19.2	13.5		30.9	10.0	20.7		20.1	
V/C Ratio		0.11		0.43	0.50	0.50		0.45	
95th % Queue		22’		78’	127’	326’		293’	
QSR		0.08		0.35	0.57	0.90		0.81	
		B – 13.5		B – 18.0		C – 20.4			
PM Peak Hour - No-Build and Interim Build 2045									
LOS	C	C		D	A	C		C	
Delay	25.3	22.3		38.9	7.0	27.4		24.9	
V/C Ratio		0.49		0.62	0.27	0.74		0.68	
95th % Queue		159’		141’	55’	561’		488’	
QSR		0.54		0.62	0.24	1.52		1.32	
		C – 22.3		C – 24.5		C – 26.2			
AM Peak Hour - Full Build 2045									
LOS	B	B		C	B	C		B	
Delay	19.7	15.6		25.6	19.4	20.5		19.8	
V/C Ratio		0.35		0.10	0.17	0.52		0.48	
95th % Queue		75’		45’	91’	344’		277’	
QSR		0.28		0.20	0.40	0.95		0.77	
		B – 15.6		C – 21.1		C – 20.2			
PM Peak Hour – Full Build 2045									
LOS	C	C		C	A	C		C	
Delay	21.7	24.1		34.1	9.5	23.5		21.8	
V/C Ratio		0.57		0.40	0.46	0.72		0.67	
95th % Queue		162’		155’	97’	547’		438’	
QSR		0.55		0.69	0.43	1.48		1.19	
		C – 24.1		B – 17.1		C – 22.8			

As shown in Table 4, the intersection of Carroll Street & Goodkirk Street will meet the LOS goals, V/C goals and most of the QSR goals. In the PM peak hour of the No-Build and Full Build analysis, the southbound approach QSR will be greater than 1.0 and will extend past the southbound SR 8 ramp junction. This condition currently exists today, and the Full Build condition will not significantly impact the queue length.

Table 5: Carroll Street & Fountain Street Intersection Capacity Analysis

	Overall Intersection	Eastbound Carroll St		Westbound Carroll St		Northbound Fountain St		
		TH	RT	LT	TH	LT	TH	RT
AM Peak Hour - No-Build and Interim Build 2045								
LOS	C	C	A	C		C	C	C
Delay	27.6	20.6	4.9	29.0		25.4	29.8	27.6
V/C Ratio		0.04	0.03	0.13		0.60	0.74	0.68
95th % Queue		16’	5’	76’		366’	542’	412’
QSR		0.07	0.02	0.17		0.73	0.90	0.70
		B – 12.7		C – 29.0		C – 27.8		
PM Peak Hour - No-Build and Interim Build 2045								
LOS	C	C	B	C		C	C	C
Delay	26.6	20.5	15.7	26.7		24.6	28.6	27.3
V/C Ratio		0.07	0.05	0.11		0.48	0.66	0.61
95th % Queue		31’	26’	64’		279’	451’	350’
QSR		0.14	0.11	0.14		0.56	0.75	0.60
		B – 18.1		C – 26.7		C – 27.1		
AM Peak Hour - Full Build 2045								
LOS	C	C	B	C		C	C	C
Delay	27.1	21.4	18.4	27.2		24.7	29.3	27.3
V/C Ratio		0.06	0.03	0.38		0.55	0.72	0.65
95th % Queue		18’	17’	201’		357’	514’	428’
QSR		0.08	0.08	0.83		0.71	0.86	0.73
		B – 19.9		C – 27.2		C – 27.3		
PM Peak Hour – Full Build 2045								
LOS	C	C	B	C		C	C	C
Delay	25.8	20.4	16.8	26.7		23.9	27.6	26.4
V/C Ratio		0.07	0.05	0.11		0.43	0.63	0.58
95th % Queue		30’	27’	64’		273’	423’	360’
QSR		0.13	0.12	0.14		0.55	0.71	0.61
		B – 18.6		C – 26.7		C – 26.2		

As shown in Table 5, the intersection of Carroll Street & Fountain Street will meet the LOS goals, V/C goals and QSR goals. The Full Build condition will not significantly impact the operation of the intersection.

Safety

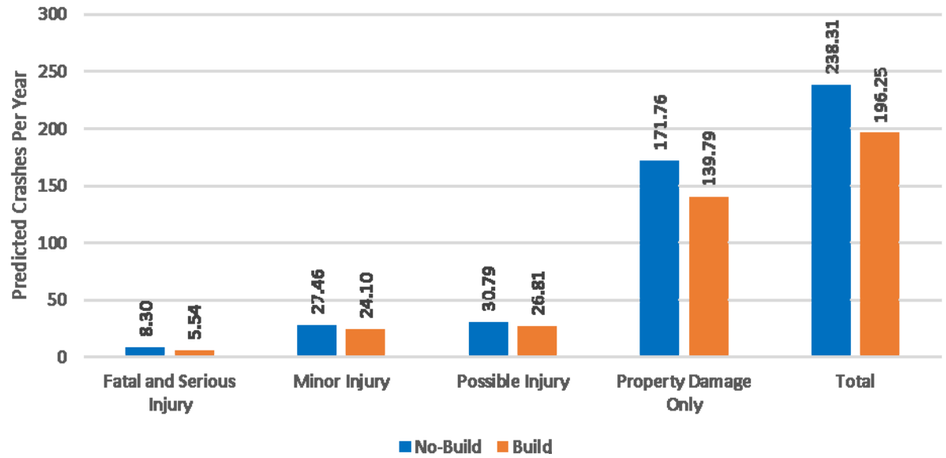
To determine the safety performance of the Build Alternative, an analysis was conducted using the methodologies outlined in Chapters 18 and 19 of the AASHTO *Highway Safety Manual*. These methodologies use roadway horizontal geometry, cross section elements, roadside barrier details, and traffic data to predict the crash frequencies, types and severities for the alternative.

Two alternatives were analyzed as part of this process – No Build and Build. Because of the complex modifications from the existing condition, existing crash data was not used in this analysis. Rather, the predicted number of crashes for each alternative was used to compare the safety performance. The predicted crash frequencies are the average number of anticipated crashes based on the performance of other similar sites with comparable roadway geometric characteristics and traffic volumes. The alternatives were divided into homogenous segments based on the roadway cross section elements and presence of entrance or exit ramps.

ODOT’s Economic Crash Analysis Tool (ECAT) was used to evaluate the safety performance of the No-Build Condition compared to Build Alternative. The annual predicted crash frequency for each of the three conditions is summarized in **Figure 8**. Analysis from ECAT can be found in **Appendix I**.

In addition to widening mainline I-77 and SR 8, several other mitigations are proposed to offset the narrower lane widths and offset to barriers. For the entire length of the project, wider edgelines and raised pavement markers are proposed to better delineate the lanes for drivers. Additionally, upgraded LED lighting is recommended in both directions through the Central Interchange to improve visibility in the segment.

Figure 8: Predicted Crash Frequency per Year



The analysis indicates that crashes will be reduced by nearly 18 percent in the Build Alternative over the No-Build conditions.

X. Cost Estimate

Preliminary construction cost estimates were developed for the initial Interim Build and converting the Interim Build to the Full Build condition. The estimated cost for the Interim Build condition is $10.1 M and is 100% funded by ODOT System Preservation funds. The estimated cost to go from the Interim Build condition to the Full Build condition is $46.0M and is currently unfunded. Detailed cost estimate information is included in **Appendix J**.

Construction Schedule

Construction for the Interim Build condition will begin in the summer of 2021 and will be completed in the fall of 2024. The construction schedule for the Full Build condition is to be determined based on funding.

XI. Recommendations

The Interim Build condition provides a substantial improvement in the operation of the I-77 and SR 8 corridor compared to the No-Build condition. It will resolve all LOS F operation, improving congestion. While it does not provide all the benefits that the Full Build condition does, it is a viable long-term alternative until funding becomes available for the Full Build condition.

Based on the analysis presented in this report, the Interim and Full Build alternatives presented do not degrade freeway operation within the study area. Both alternative will also meet the purpose and need of the project which is to address capacity and safety issues along the I-77 and SR 8 corridor.