



WORRELLS RIVER RESIDENTIAL DEVELOPMENT

Traffic Impact Analysis

Belmont, North Carolina

Prepared for:

City of Belmont

June 8, 2018

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**Traffic Impact Analysis for
Worrells River Residential Development
Belmont, North Carolina**

Prepared for:

**City of Belmont
Belmont, North Carolina**

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**June 2018
015020007**

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1.0 Executive Summary

The purpose of this Traffic Impact Analysis (TIA) is to evaluate the vehicular traffic impacts on the surrounding transportation infrastructure as a result of the proposed Worrells River residential development. The primary objectives of the study are:

- To estimate trip generation and distribution for the proposed development.
- To perform intersection capacity analyses for the identified study area.
- To determine the potential traffic impacts of the proposed development.
- To identify improvements to mitigate the proposed development's traffic impacts.

The proposed Worrells River residential development is located along the existing Worrells River Road, west of S New Hope Road (NC 279) and north of the Daniel Stowe Botanical Garden in Belmont, North Carolina. Based on the site plan provided by the applicant, the proposed development is currently envisioned to consist of approximately 209 single-family homes.

For the purposes of this TIA, the development is assumed to be completed (built-out) in 2024. Based on the provided site plan and information provided by the applicant, the proposed development will realign the existing Worrells River Road to connect to S New Hope Road (NC 279) at the existing construction delivery driveway for the Daniel Stowe Botanical Garden. The realigned Worrells River Road will provide direct access to the proposed development. The existing construction delivery driveway will be relocated to the existing Worrells River Road (separating access between the proposed development and Daniel Stowe Botanical Garden property).

A TIA scoping meeting was held with the City of Belmont and representatives of the applicant in Belmont on April 18, 2018, to obtain background information and to ascertain the scope and parameters to be included in this TIA. A Memorandum of Understanding (MOU) was developed based on discussions from this meeting that documented all scoping parameters to be used for the TIA and was reviewed and agreed upon by the City of Belmont and the applicant. Additionally, North Carolina Department of Transportation (NCDOT) reviewed and approved the MOU, which is included in the **Appendix**.

The following AM and PM peak-hour scenarios were analyzed to determine the proposed development's transportation impacts on the surrounding network:

- 2018 Existing Conditions
- 2024 Background Conditions
- 2024 Build-out Conditions
- 2029 Build-out Conditions + 5 years

Based on coordination with the City, NCDOT and the applicant, this TIA evaluated operations under each of the AM and PM peak-hour scenarios above for the following study area intersections:

1. S New Hope Road (NC 279) and Union New Hope Road
2. S New Hope Road (NC 279) and Lake Wylie Road
3. S New Hope Road (NC 279) and Worrells River Road
4. S New Hope Road (NC 279) and Armstrong Road (NC 273)

The study area was based on the *City of Belmont Land Development Code – Section 16.14 Traffic Impact Analysis*, where it states "At a minimum, the study area shall include all streets and

signalized intersections within a 1-mile radius of the proposed site and/or where site traffic estimated for build-out of the project will constitute 10% or more of any signalized intersection approach during the peak hour. Unsignalized intersections between the required signalized intersections will be added to the scope as directed by the City.” Note that the intersections along S New Hope Road (NC 279) at both Union New Hope Road and at Lake Wylie Road are currently unsignalized; however, the approved, but not yet constructed, Riverside development is planning to signalize both of these intersections (assumed to be installed prior to the 2024 build-out year of the Worrells River residential development). Based on the scoping parameters documented in the MOU, the proposed project is expected to contribute more than 10% of the traffic at one or more approaches at each of the intersections listed above, therefore included in the study area.

Kimley-Horn was retained to determine the potential traffic impacts of this development (in accordance with the traffic study guidelines in the *NCDOT Policy on Street and Driveway Access to North Carolina Highways* and set forth by the *City of Belmont Land Development Code – Section 16.14 Traffic Impact Analysis*), and to identify transportation improvements that may be required to mitigate these impacts. This report presents trip generation, distribution, capacity analyses, crash analyses and identified transportation improvements required to mitigate anticipated traffic demands produced by the subject development.

Based on the capacity analyses performed at each of the identified study intersections, along with review of auxiliary turn-lane warrants and crash analyses contained herein, the following improvements are identified to mitigate the impact of the proposed development on the adjacent street network:

S New Hope Road (NC 279) and Union New Hope Road

- Construction of an eastbound right-turn lane along Union New Hope Road with a minimum of 225' of storage

S New Hope Road (NC 279) and Worrells River Road

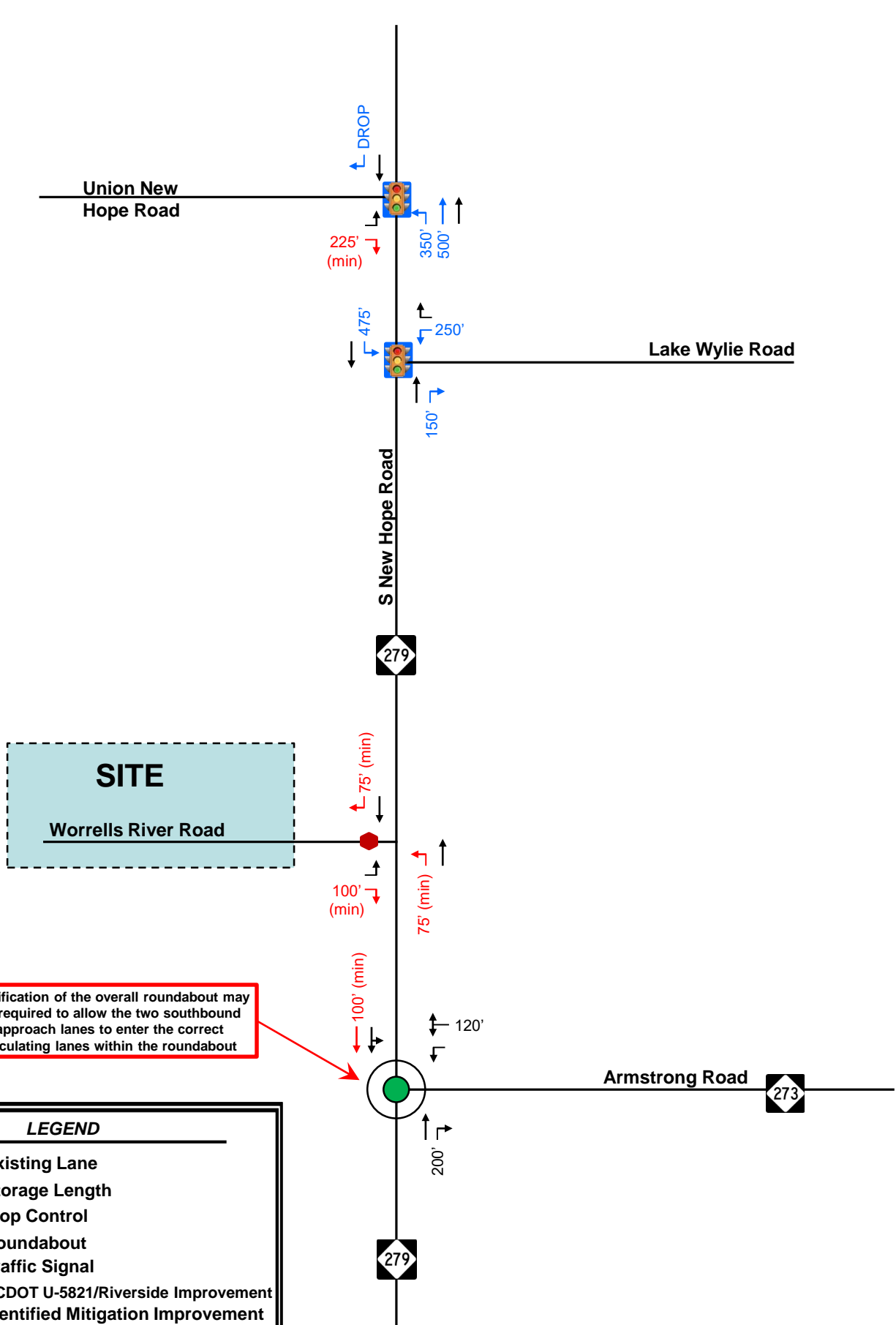
- Construction of an eastbound right-turn lane along Worrells River Road with a minimum of 100' of storage
- Construction of a northbound left-turn lane along S New Hope Road (NC 279) with a minimum of 75' of storage
- Construction of a southbound right-turn lane along S New Hope Road (NC 279) with a minimum of 75' of storage

S New Hope Road (NC 279) and Armstrong Road (NC 273)

- Construction of an additional southbound through lane along S New Hope Road (NC 279) with a minimum of 100' of storage (modification of the overall roundabout may be necessary to allow the two southbound approach lanes to enter the correct circulating lanes within the roundabout)

The mitigation improvements identified within the study area are shown in **Figure 1.1**. The improvements shown in this figure are subject to approval by NCDOT and the City of Belmont. All additions and attachments to the State and City roadway system shall be properly permitted, designed and constructed in conformance to standards maintained by the agencies.

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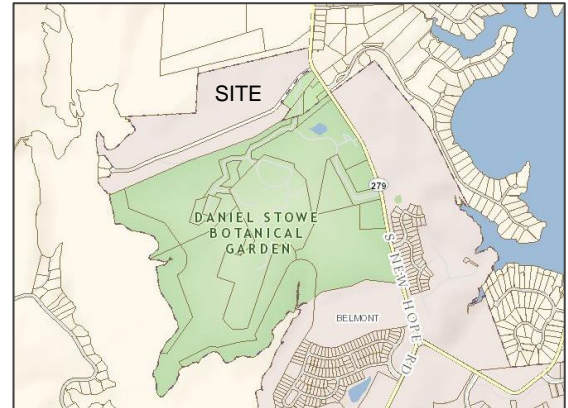


LEGEND

- Existing Lane
- X' Storage Length
- Stop Control
- Roundabout
- 🚦 Traffic Signal
- 🟦 NCDOT U-5821/Riverside Improvement
- 🟥 Identified Mitigation Improvement

2.0 Introduction

The proposed Worrells River residential development is located along the existing Worrells River Road, west of S New Hope Road (NC 279) and north of the Daniel Stowe Botanical Garden in Belmont, North Carolina. The location shown to the right. Based on the site plan provided by the applicant, the proposed development is currently envisioned to consist of approximately 209 single-family homes.



For the purposes of this TIA, the development is assumed to be completed (built-out) in 2024. Based on the provided site plan and information provided by the applicant, the proposed development will realign the existing Worrells River Road to connect to S New Hope Road (NC 279) at the existing construction delivery driveway for the Daniel Stowe Botanical Garden. The realigned Worrells River Road will provide direct access to the proposed development. The existing construction delivery driveway will be relocated to the existing Worrells River Road (separating access between the proposed development and Daniel Stowe Botanical Garden property).

A TIA scoping meeting was held with the City of Belmont and representatives of the applicant in Belmont on April 18, 2018, to obtain background information and to ascertain the scope and parameters to be included in this TIA. A Memorandum of Understanding (MOU) was developed based on discussions from this meeting that documented all scoping parameters to be used for the TIA and was reviewed and agreed upon by the City of Belmont and the applicant. Additionally, NCDOT reviewed and approved the MOU, which is included in the **Appendix**.

Kimley-Horn was retained to determine the potential traffic impacts of this development (in accordance with the traffic study guidelines in the *NCDOT Policy on Street and Driveway Access to North Carolina Highways* and set forth by the *City of Belmont Land Development Code – Section 16.14 Traffic Impact Analysis*), and to identify transportation improvements that may be required to mitigate these impacts. This report presents trip generation, distribution, capacity analyses, crash analyses and identified transportation improvements required to mitigate anticipated traffic demands produced by the subject development.

3.0 Existing Traffic Conditions

Existing traffic conditions were coordinated with City of Belmont and NCDOT staff and collected through field observations and turning-movement counts to establish the existing conditions baseline analysis.

3.1 STUDY AREA

Based on coordination with the City, NCDOT and the applicant, the study area for this TIA includes the following existing intersections:

1. S New Hope Road (NC 279) and Union New Hope Road
2. S New Hope Road (NC 279) and Lake Wylie Road
3. S New Hope Road (NC 279) and Worrells River Road
4. S New Hope Road (NC 279) and Armstrong Road (NC 273)

The study area was based on the *City of Belmont Land Development Code – Section 16.14 Traffic Impact Analysis*, where it states “At a minimum, the study area shall include all streets and signalized intersections within a 1-mile radius of the proposed site and/or where site traffic estimated for build-out of the project will constitute 10% or more of any signalized intersection approach during the peak hour. Unsignalized intersections between the required signalized intersections will be added to the scope as directed by the City.” Note that the intersections along S New Hope Road (NC 279) at both Union New Hope Road and at Lake Wylie Road are currently unsignalized; however, the approved, but not yet constructed, Riverside development is planning to signalize both of these intersections (assumed to be installed prior to the 2024 build-out year of the Worrells River residential development). Based on the scoping parameters documented in the MOU, the proposed project is expected to contribute more than 10% of the traffic at one or more approaches at each of the intersections listed above, therefore included in the study area.

Figure 3.1 shows the study area intersections and the site location, **Figure 3.2** shows the proposed site plan for the development as provided by the applicant and **Figure 3.3** shows the existing roadway geometry at the study intersections.

The primary roadways in the vicinity of the site are S New Hope Road (NC 279), Union New Hope Road, and Armstrong Road (NC 273).

S New Hope Road (NC 279) is currently a two-lane, undivided minor arterial with a posted speed limit of 45 mph throughout the study area. This route serves both North Carolina and South Carolina commuters via a bridged connection to York County, South Carolina. S New Hope Road (NC 279) carries an annual average daily traffic (AADT) volume of 11,000 vehicles per day (vpd) north of Union New Hope Road, 6,800 vpd just north of Lake Wylie Road and 3,200 vpd just north of Worrells River Road based on 2016 NCDOT AADT data.

Union New Hope Road is a two-lane major collector that connects S New Hope Road (NC 279) to Union Road (NC 274). Union New Hope Road has a posted speed limit of 35 mph and an AADT volume of 4,200 vpd based on 2016 NCDOT AADT data.

Armstrong Road (NC 273) is a two-lane, undivided minor arterial running east-west and connects S Point Road (NC 273) to S New Hope Road (NC 279), a primary connection into York County,

South Carolina. Armstrong Road (NC 273) has a posted speed limit of 45 mph and an AADT volume 6,000 vpd based on 2016 NCDOT AADT data.

3.2 EXISTING TRAFFIC VOLUME DEVELOPMENT

AM (6:30-8:30 AM) and PM (4:30-7:00 PM) intersection turning-movement, heavy-vehicle, pedestrian and bicycle counts were performed by National Data & Surveying Services on Wednesday, May 2, 2018, at the following intersections:

1. S New Hope Road (NC 279) and Union New Hope Road
2. S New Hope Road (NC 279) and Lake Wylie Road
3. S New Hope Road (NC 279) and Worrells River Road
4. S New Hope Road (NC 279) and Armstrong Road (NC 273)

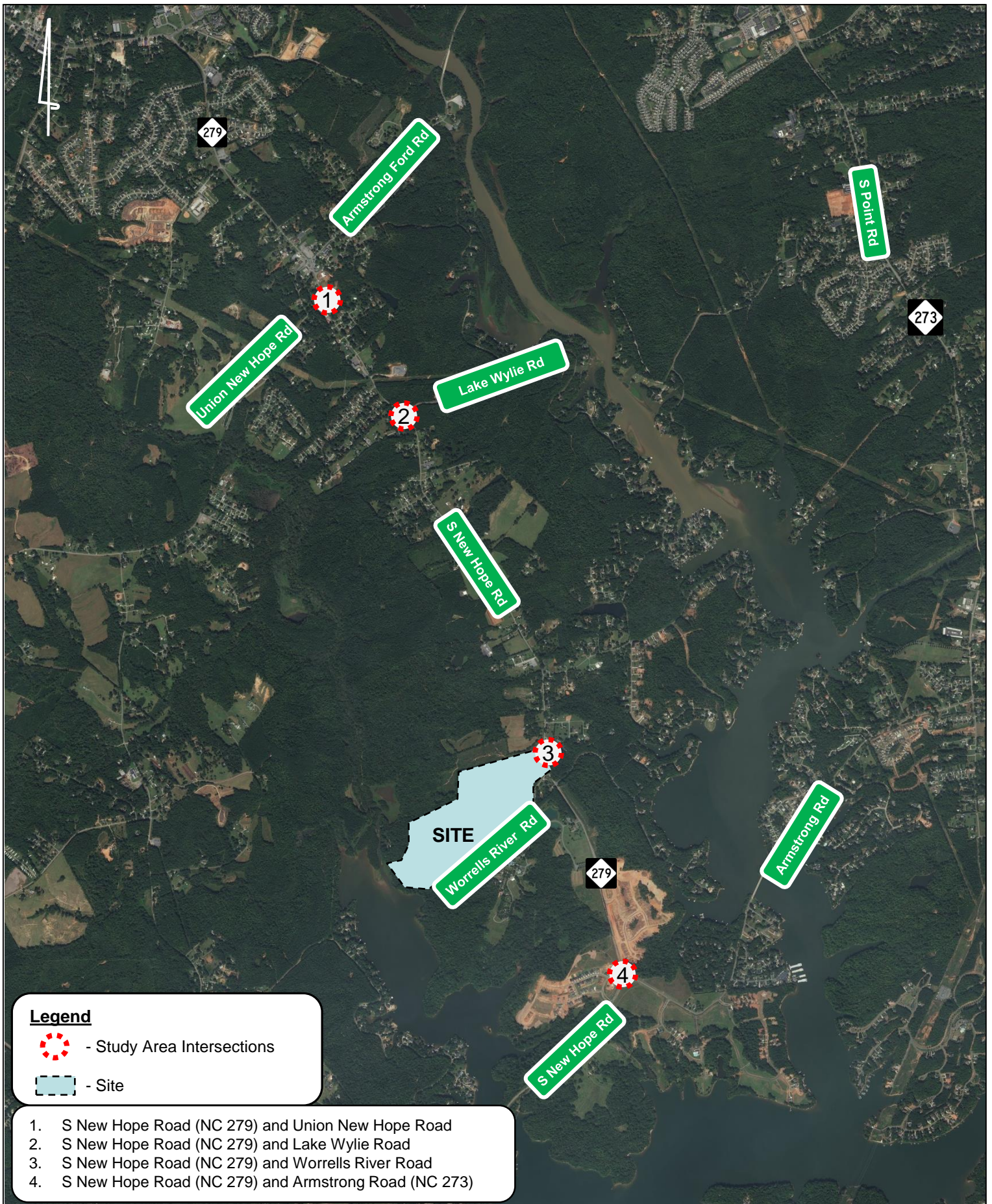
The specific AM and PM peak hours identified through the data collection differed amongst some of the study intersections. The peak hour of each individual intersection was used as the baseline data to represent the highest collected traffic volumes within the specified count timeframes. The peak hours for each of the intersections are shown in **Table 3.1**.

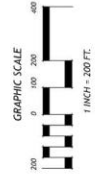
Table 3.1 – AM & PM Intersection Peak Hours

Intersection	AM Peak Hour	PM Peak Hour
1. S New Hope Rd and Union New Hope Rd	7:15 AM - 8:15 AM	5:15 PM - 6:15 PM
2. S New Hope Rd and Lake Wylie Rd	7:15 AM - 8:15 AM	5:00 PM - 6:00 PM
3. S New Hope Rd and Worrells River Rd	7:15 AM - 8:15 AM	5:15 PM - 6:15 PM
4. S New Hope Rd and Armstrong Road	7:00 AM - 8:00 AM	5:00 PM - 6:00 PM

Volume balancing was not performed between study area intersections due to the presence of driveways and distance between the intersections. Peak-hour intersection turning-movement count data is provided in the **Appendix**.

Figure 3.4 illustrates the 2018 existing AM and PM peak-hour traffic volumes.



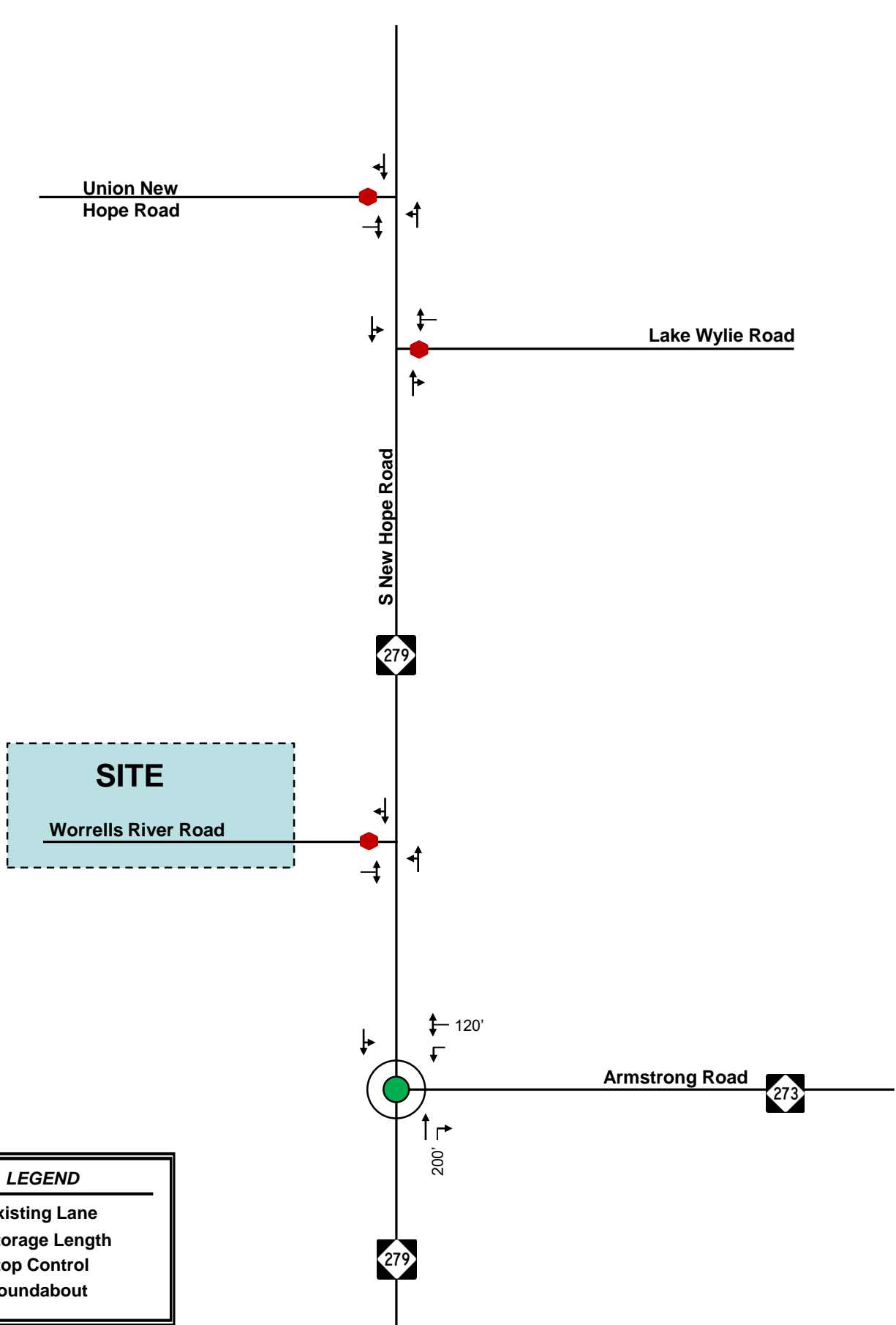


Worrells River Tract
Preliminary Sketch Plan
ESP Job # ER20
March 26, 2018

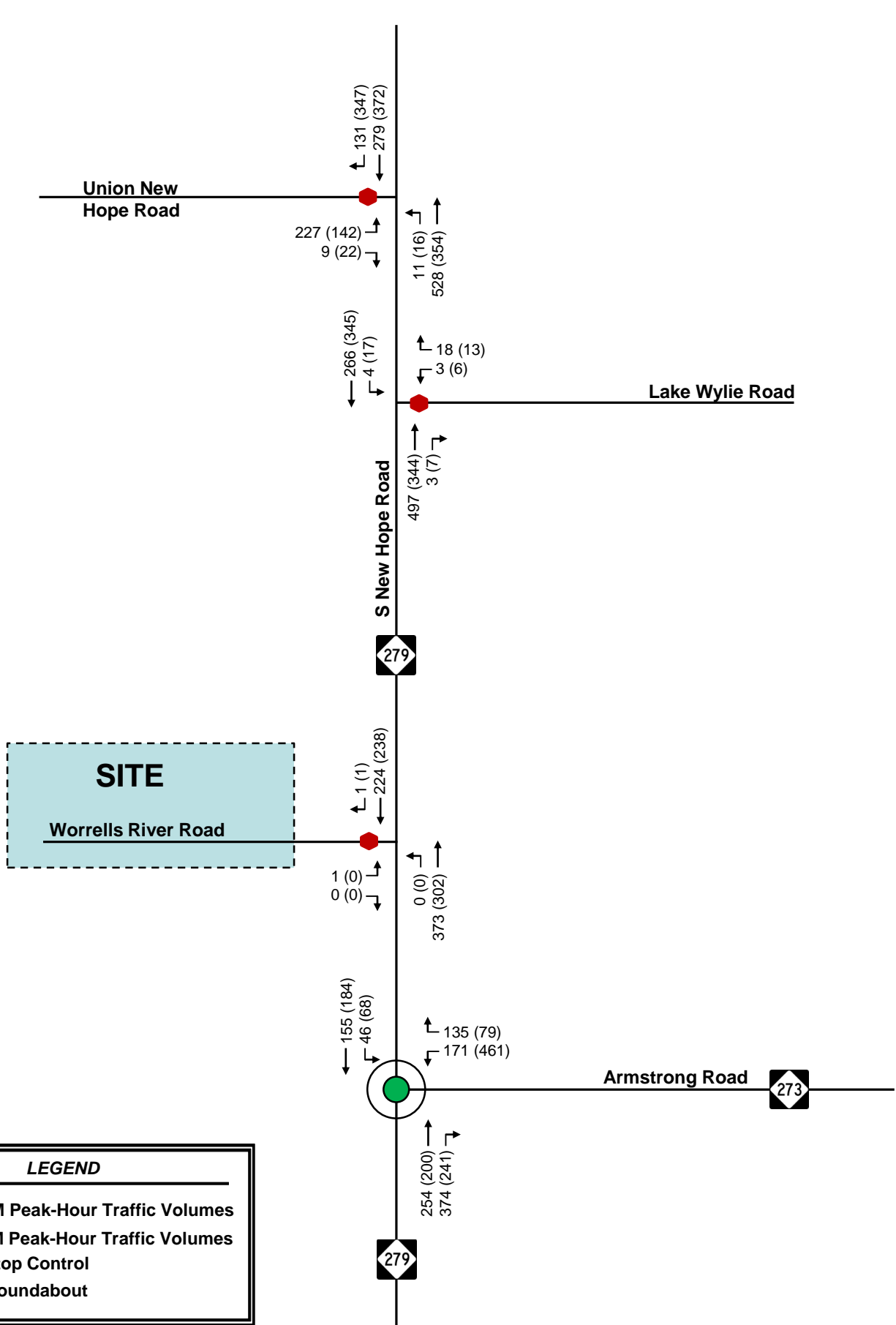


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LEGEND

- XX AM Peak-Hour Traffic Volumes
- (XX) PM Peak-Hour Traffic Volumes
- Stop Control
- Roundabout

4.0 Background Traffic Volume Development

Projected background (non-project) traffic is defined as the expected growth or change in traffic volumes on the surrounding roadway network between the year the existing counts were collected (2018) and the expected build-out year (2024) absent the construction and opening of the proposed project. This includes both non-specific general growth based on historical increase in local traffic volumes (historical background growth), along with specific growth and/or change in traffic volumes caused by either approved, but not yet fully-constructed, off-site developments and/or planned transportation projects specifically identified within the vicinity of the proposed development.

4.1 HISTORICAL BACKGROUND GROWTH TRAFFIC

Historical background growth is the increase in existing traffic volumes due to usage increases and non-specific growth throughout the area, and accounts for growth that is independent of specific off-site developments or planned transportation projects. Historical background growth traffic is calculated using an annual growth rate, which is applied to the existing traffic volumes up to the future horizon years. As shown in the approved MOU, an annual growth rate of three percent (3%) was applied to the 2018 existing peak-hour traffic volumes to calculate base 2024 and 2029 background traffic volumes. This growth rate was determined based on review of historical NCDOT AADT maps along with coordination with City of Belmont and NCDOT staff.

4.2 APPROVED DEVELOPMENTS

At the direction of the City of Belmont and NCDOT staff, two approved developments that are expected to impact traffic volumes within the study area were included in the background traffic volumes for this TIA. These developments, land uses and intensities, and build-out percentages are outlined in **Table 4.1**. The table also identifies which of these developments has an associated TIA, and the improvements required by these respective developments.

Table 4.1 – Approved Developments

Development	Land Use/Intensity	% Build-out	TIA Included?	Required Improvements
McLean (Armstrong Rd)	810 Single-Family units 100 Multifamily units 125,000 SF Shopping Center	15%	Yes	No required improvements at study intersections. <i>(Roundabout at Armstrong Road already constructed)</i>
Riverside (Cramerton, NC)	650 Single-Family units 641 Senior Adult detached units 559 Townhomes 20 FP Gas Station w/ C-Store 150,000 SF Medical Office 80,000 SF Shopping Center	0%	Yes	NC 279 and Union New Hope Rd - Install traffic signal - NBL w/ 200' of storage - SBR that extends to Armstrong Ford Rd NC 279 and Lake Wylie Rd - Install traffic signal - NBR w/ 150' of storage - SBL w/ 475' of storage - WBL w/ 250' of storage

Volumes for the McLean and Riverside developments were obtained from the *Hope Armstrong Peninsula Development TIA* (J.M. Teague, May 2014) and the *Riverside TIA* (Kimley-Horn, June 2017), respectively. The site trip distribution used for the Worrells River residential development, discussed in **Section 5.3**, was used to carry and assign volumes appropriately at study area intersections that were not included in the approved TIAs.

It should be noted that the improvement required of the McLean development (listed in both the MOU and **Table 4.1**) was not included as a modification between 2018 existing and 2024 background conditions as this has already been constructed since the time the respective TIA was approved and is reflected as existing laneage in this study.

Figure 4.1 illustrates the location of both approved developments. Site trip figures from both approved TIAs are included in the **Appendix**. **Figures 4.2** and **4.3** show the breakdown of AM and PM peak-hour approved development trips, respectively. **Figures 4.4** and **4.5** show the 2024 background AM and PM peak-hour traffic volumes, respectively, that include the historical growth traffic and approved development trips.

4.3 PLANNED TRANSPORTATION PROJECTS

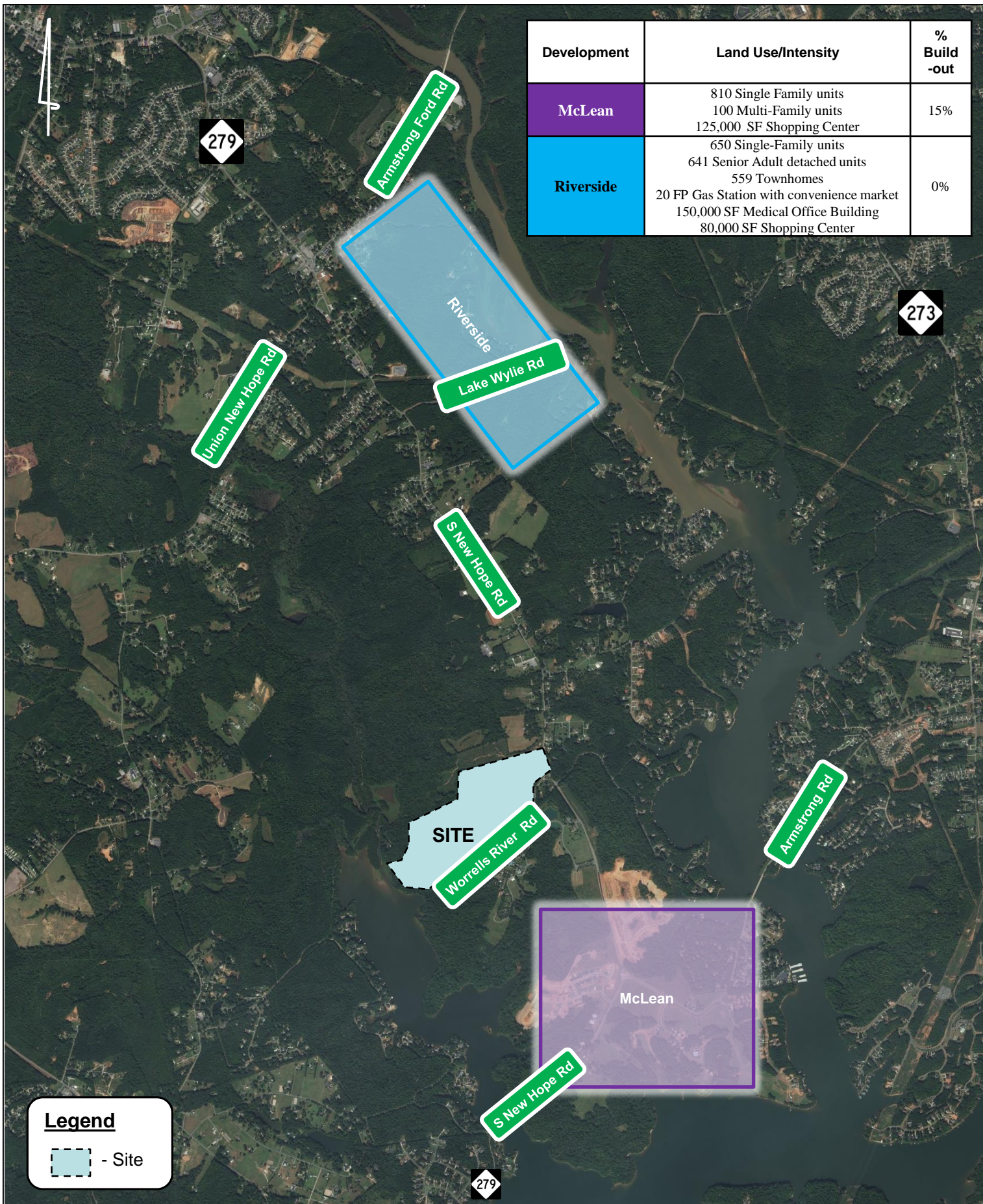
Transportation Improvement Program (TIP) project U-5821 is currently funded to widen S New Hope Road (NC 279) to a four-lane divided section between Titman Road and Union New Hope Road, overlapping with only the Union New Hope Road intersection in this TIA study area. According to NCDOT's STIP, U-5821 is currently scheduled for right-of-way in fiscal year (FY) 2019, and construction in FY 2021-2022. Given that this project is expected to be complete prior to the assumed build-out year for the Worrells River development, U-5821 was included in the analysis of all future-year conditions. Based on the current concept plans provided by NCDOT and included in the **Appendix**, the following improvements are planned at the intersection of S New Hope Road (NC 279) at Union New Hope Road:

- A northbound left-turn lane along S New Hope Road (NC 279) with 350 feet of storage
- An additional northbound through lane along S New Hope Road (NC 279) that begins approximately 500 feet south of the intersection
- A southbound right-turn lane along S New Hope Road (NC 279) that serves as a drop lane from the four-lane cross-section being installed north of this intersection as a part of U-5821

The Catawba Crossings project proposes to construct a new boulevard connecting I-485 in Mecklenburg County to NC 279 in Gaston County via a bridge crossing over the Catawba River. The Gaston-Cleveland-Lincoln Metropolitan Planning Organization (GCLMPO) Comprehensive Transportation Plan (CTP) shows the future alignment of the Catawba Crossings project along with a new interchange at S New Hope Road (NC 279) north of the proposed Worrells River site. The Catawba Crossings project has also been identified in Belmont's 2018 Comprehensive Land Use Plan (CLUP), and GCLMPO's 2045 Draft Metropolitan Transportation Plan (MTP); however, since this project is currently not funded, it was not included in this analysis.

As shown in GCLMPO's CTP, Armstrong Ford Road is planned to be realigned to create the fourth leg (westbound approach) of the S New Hope Road (NC 279) at Union New Hope Road intersection. Since this project is currently not funded, it was not included in this analysis.

Additionally, Belmont's 2018 CLUP, 2012 Bicycle Plan, and GCLMPO's CTP each identify a multi-use path or greenway along the riverfront and through the proposed site, in addition to a bike lane or paved shoulder along S New Hope Road (NC 279) that would be part of the Metric Century Route.

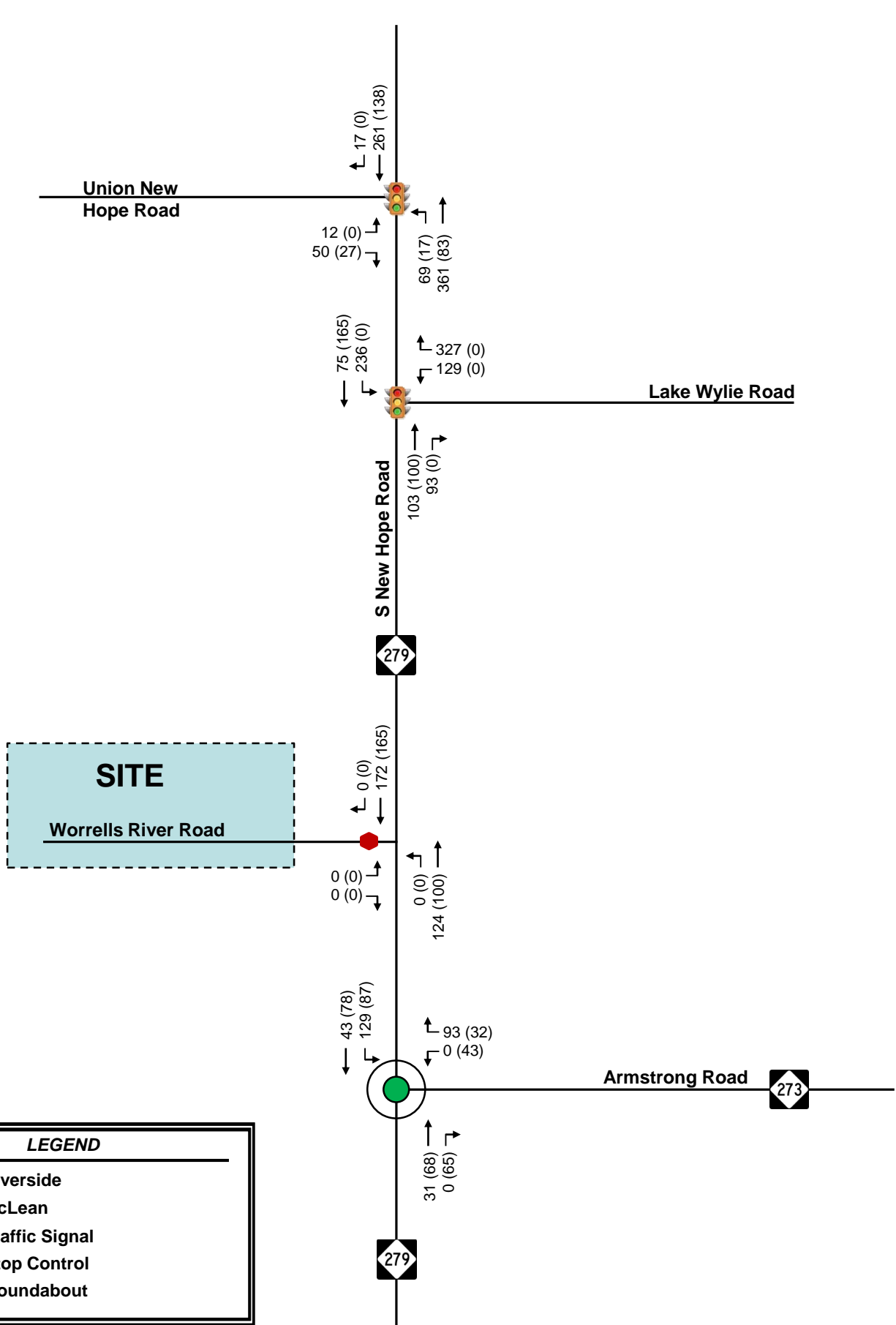


Development	Land Use/Intensity	% Build-out
McLean	810 Single Family units 100 Multi-Family units 125,000 SF Shopping Center	15%
Riverside	650 Single-Family units 641 Senior Adult detached units 559 Townhomes 20 FP Gas Station with convenience market 150,000 SF Medical Office Building 80,000 SF Shopping Center	0%

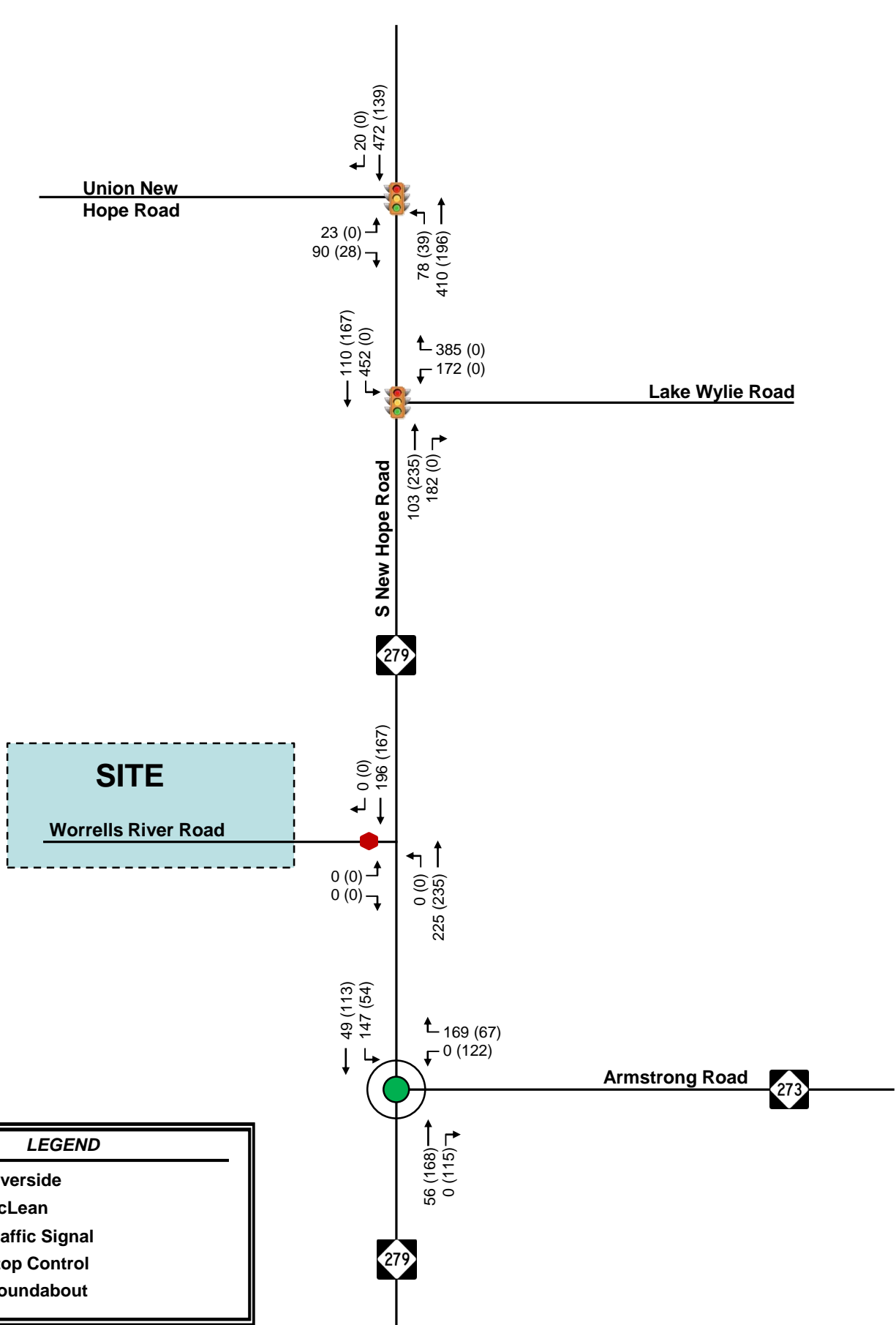
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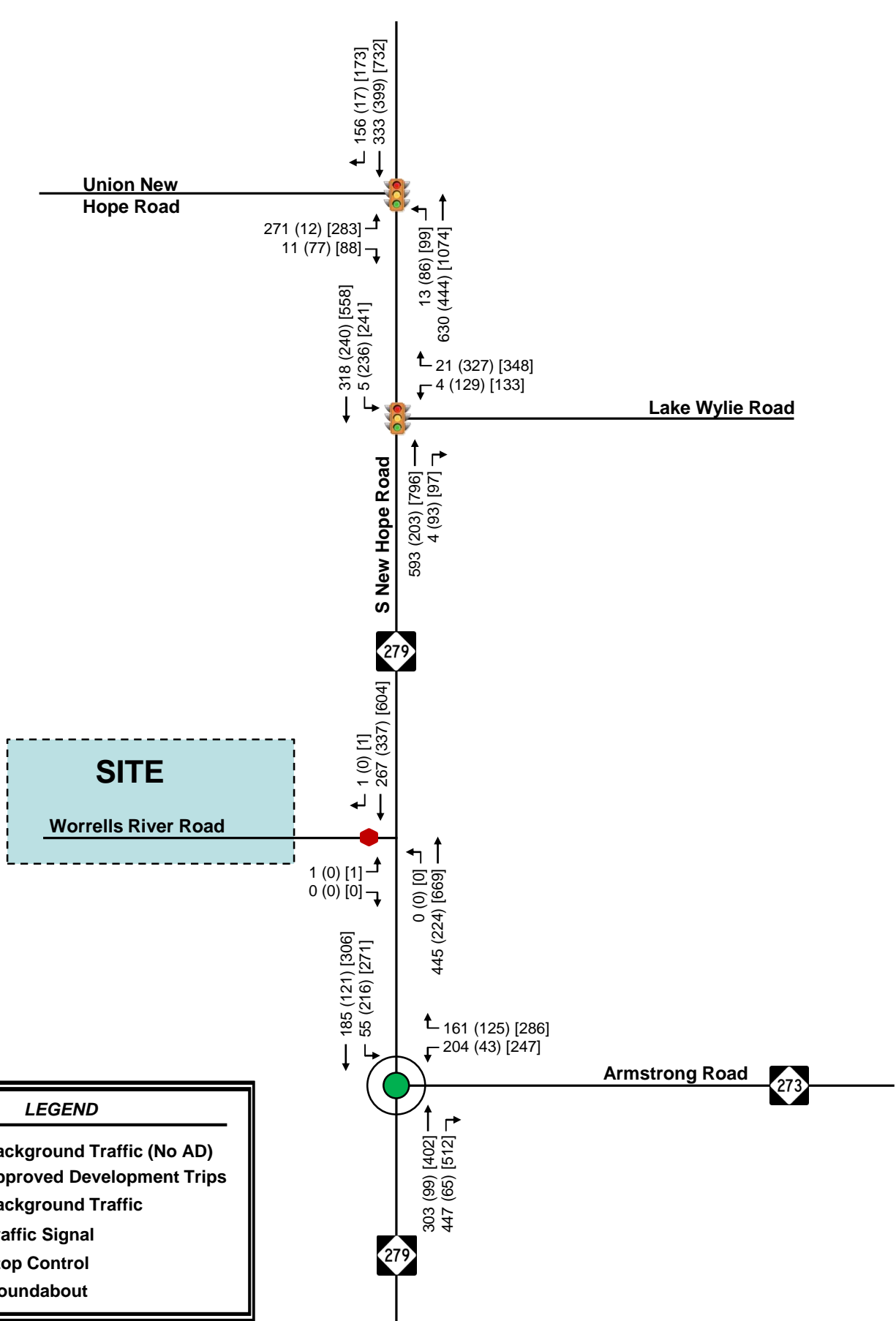
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LEGEND

- XX Riverside
- (XX) McLean
- Traffic Signal
- Stop Control
- Roundabout

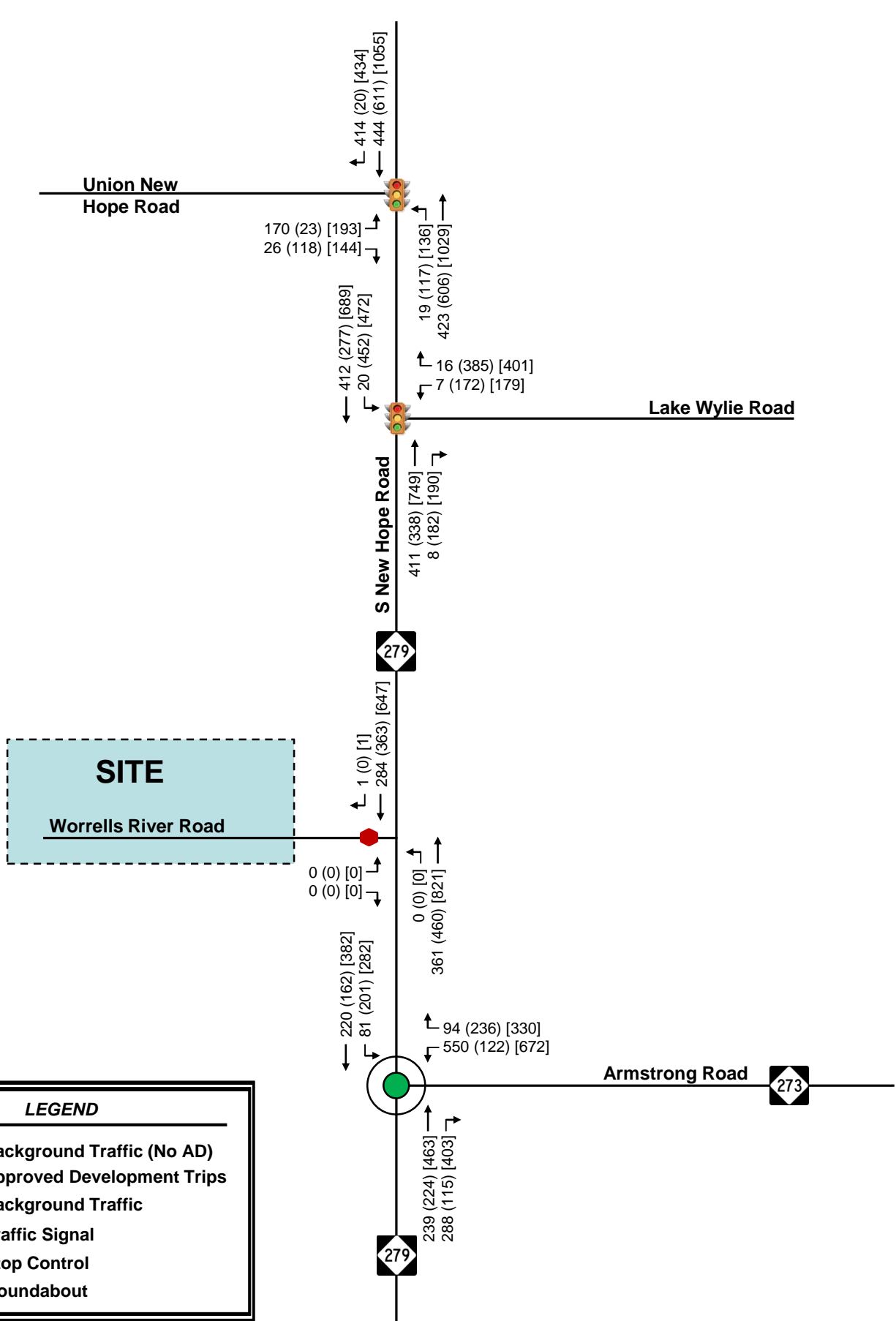
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LEGEND

- XX Background Traffic (No AD)
- (XX) Approved Development Trips
- [XX] Background Traffic
- Traffic Signal
- Stop Control
- Roundabout

NOT TO SCALE



LEGEND

- XX Background Traffic (No AD)
- (XX) Approved Development Trips
- [XX] Background Traffic
- Traffic Signal
- Stop Control
- Roundabout

5.0 Site Traffic Volume Development

Site traffic developed for this TIA is defined as the vehicle trips expected to be generated and added to the study area by construction of the proposed development, and the distribution and assignment of that traffic throughout the surrounding network.

5.1 SITE ACCESS

Based on the provided site plan and information provided by the applicant, the proposed development will realign the existing Worrells River Road to connect to S New Hope Road (NC 279) at the existing construction delivery driveway for the Daniel Stowe Botanical Garden. The realigned Worrells River Road will provide direct access to the proposed development. The existing construction delivery driveway will be relocated to the existing Worrells River Road (separating access between the proposed development and Daniel Stowe Botanical Garden property).

5.2 TRAFFIC GENERATION

The traffic generation potential of the proposed development was determined using the trip generation rates published in *Trip Generation* (Institute of Transportation Engineers, Ninth Edition, 2012) for all land uses.

Based on the site plan provided by the applicant, the proposed development is envisioned to include 209 single-family homes.

Table 5.1 summarizes the projected trip generation for the proposed residential development. During a typical weekday, the proposed development has the potential to generate 157 and 209 net new external trips during the AM and PM peak hours, respectively.

Land Use	Intensity	Daily	AM Peak Hour			PM Peak Hour		
			Total	In	Out	Total	In	Out
			Single-Family Homes	209 DU	1,990	157	39	118
Net New External Trips		1,990	157	39	118	209	132	77

5.3 SITE TRAFFIC DISTRIBUTION AND ASSIGNMENT

The proposed development's trips were assigned to the surrounding network based on existing peak-hour turning movements, surrounding land uses, locations of similar land use and population densities in the area. The following site traffic distribution was reviewed and approved as part of the MOU by the City of Belmont, NCDOT and the applicant:

- 50% to/from the north along S New Hope Road (NC 279)
- 10% to/from the west along Union New Hope Road
- 30% to/from the east along Armstrong Road (NC 273)
- 10% to/from the south along S New Hope Road (NC 279)

The overall site traffic distribution and assignment are shown in **Figure 5.1**.

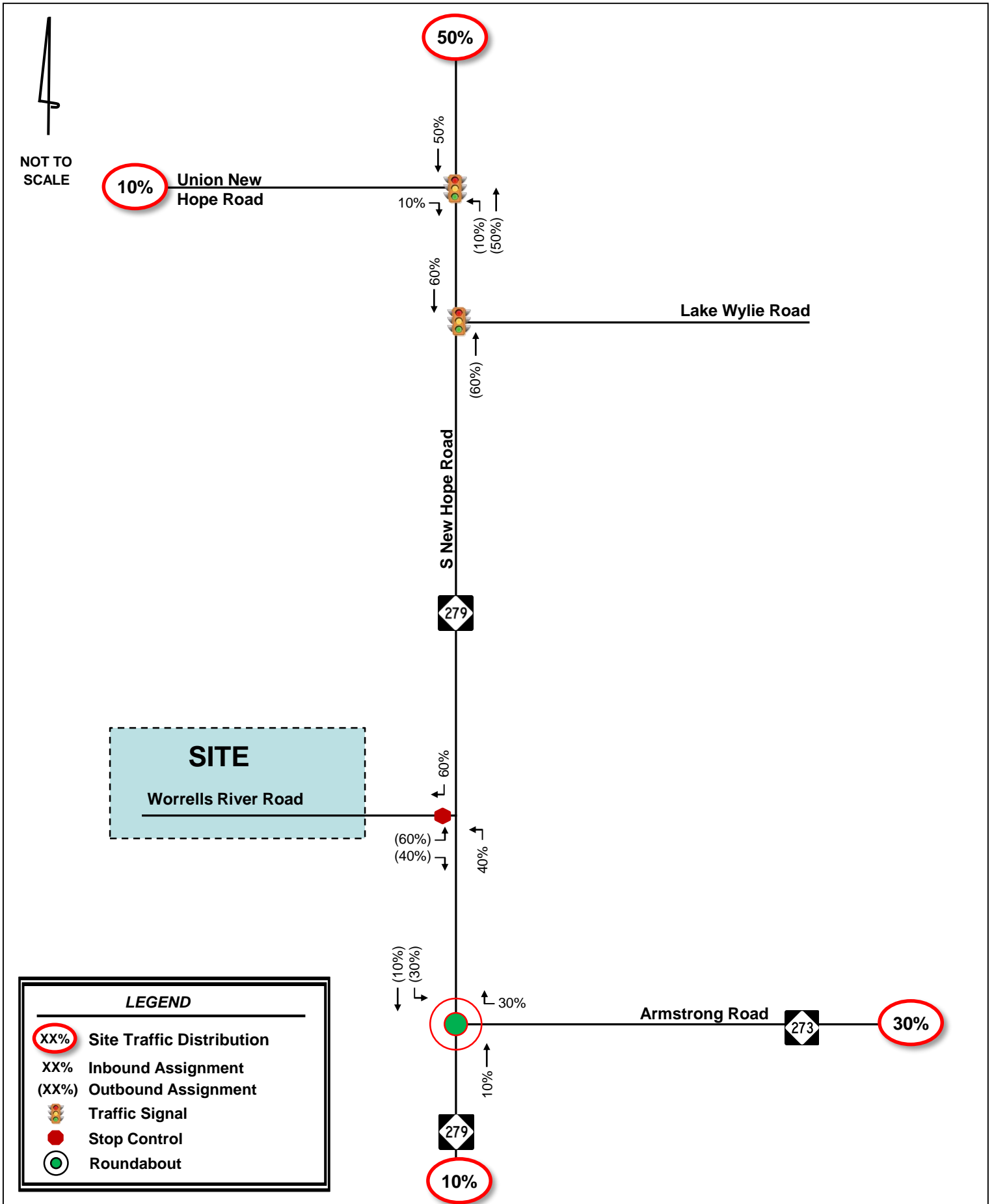
5.4 2024 BUILD-OUT TRAFFIC VOLUMES

The 2024 build-out traffic volumes include the assignment of the projected site traffic generation added to the 2024 background traffic volumes. **Figures 5.2** and **5.3** show the projected 2024 build-out traffic volumes for the AM and PM peak hours, respectively.

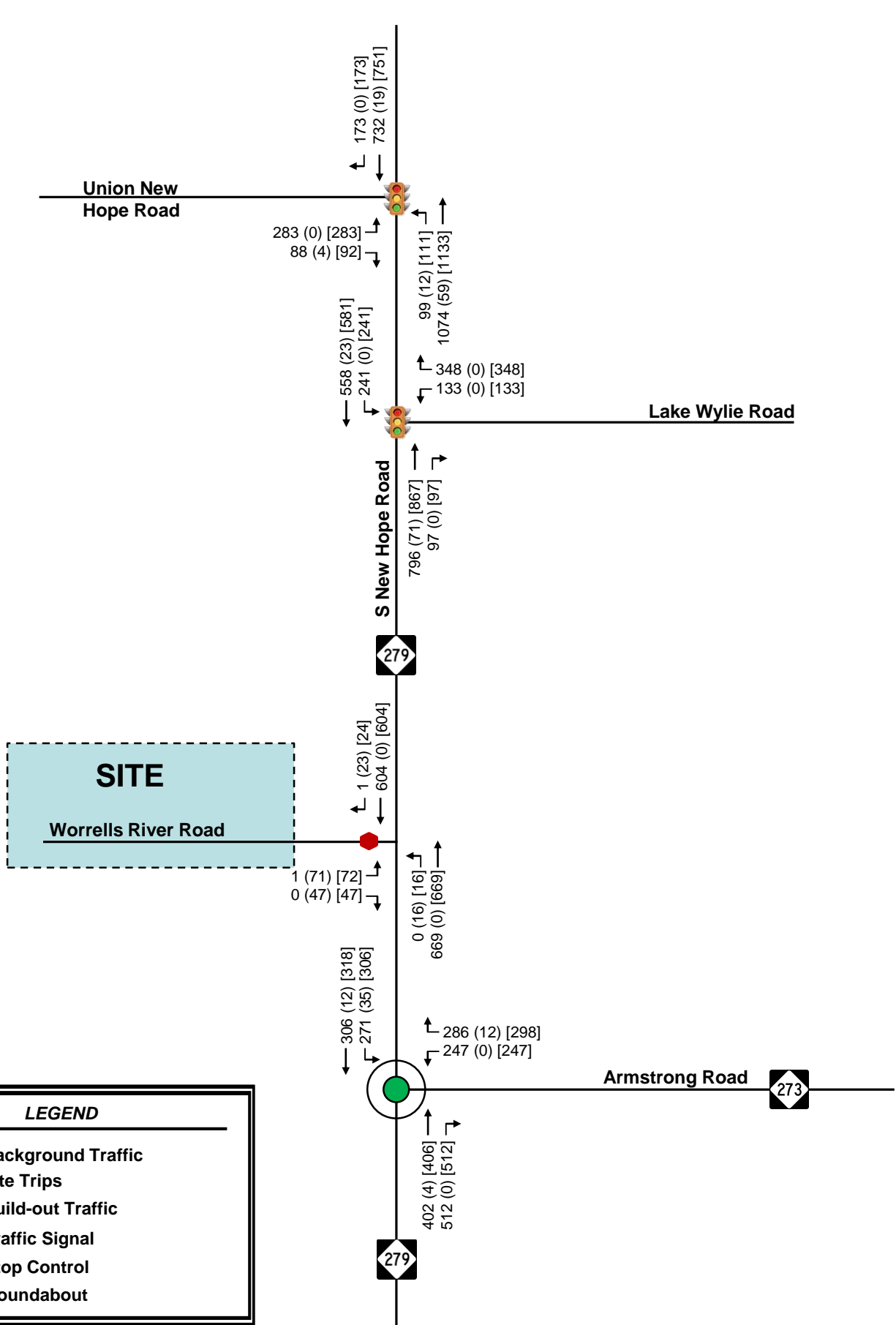
5.5 2029 BUILD-OUT TRAFFIC VOLUMES

As required by the *City of Belmont Land Development Code – Section 16.14 Traffic Impact Analysis*, an analysis scenario of five years after the build-out year was performed. The 2029 build-out traffic volumes include the approved development traffic and the assignment of the proposed site traffic generation added to the 2029 base background traffic volumes. **Figure 5.4** shows the projected 2029 AM and PM peak-hour build-out traffic volumes.

Intersection volume development worksheets for all intersections and driveways within the study network are provided in the **Appendix**.



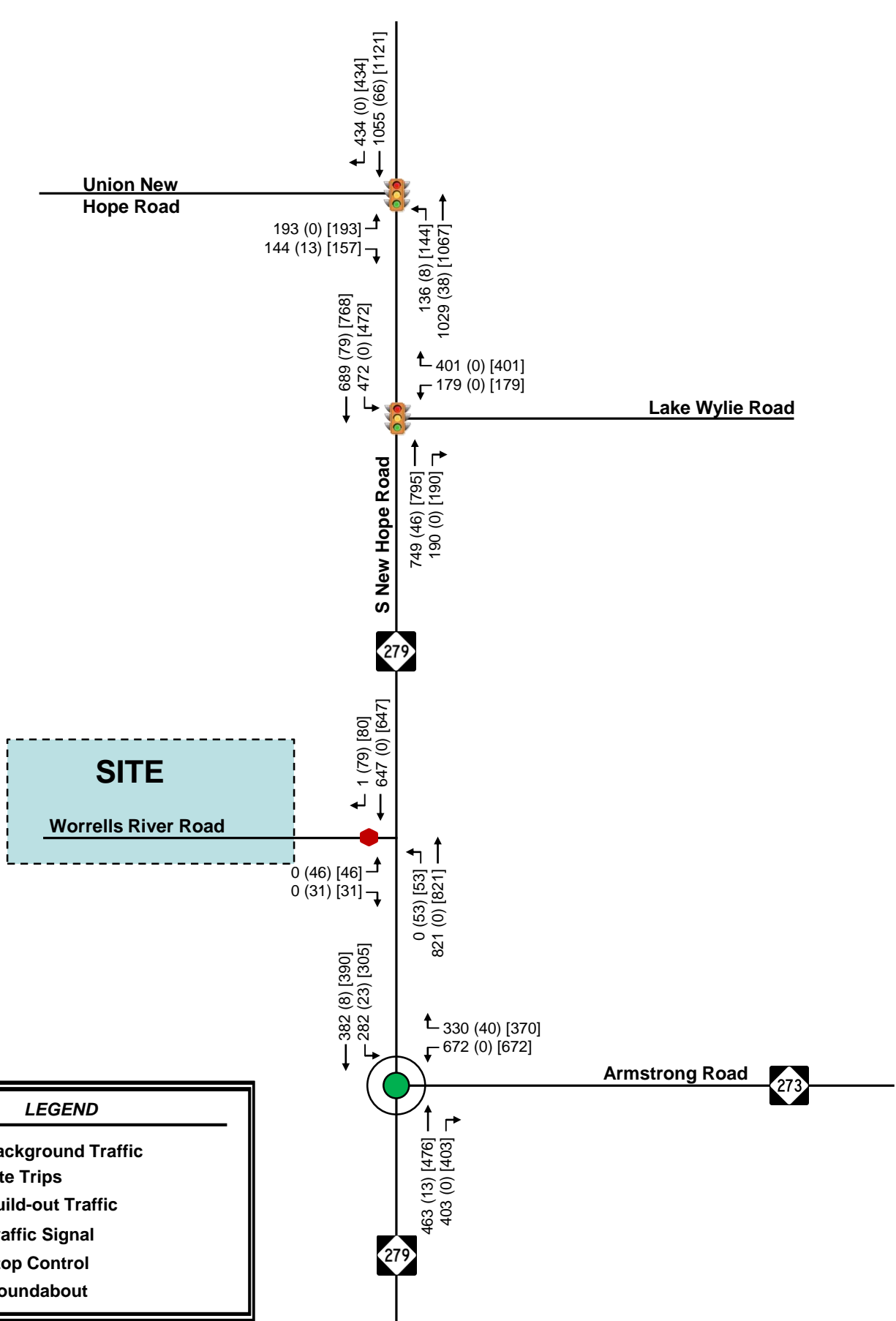
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LEGEND

- XX Background Traffic
- (XX) Site Trips
- [XX] Build-out Traffic
- Traffic Signal
- Stop Control
- Roundabout

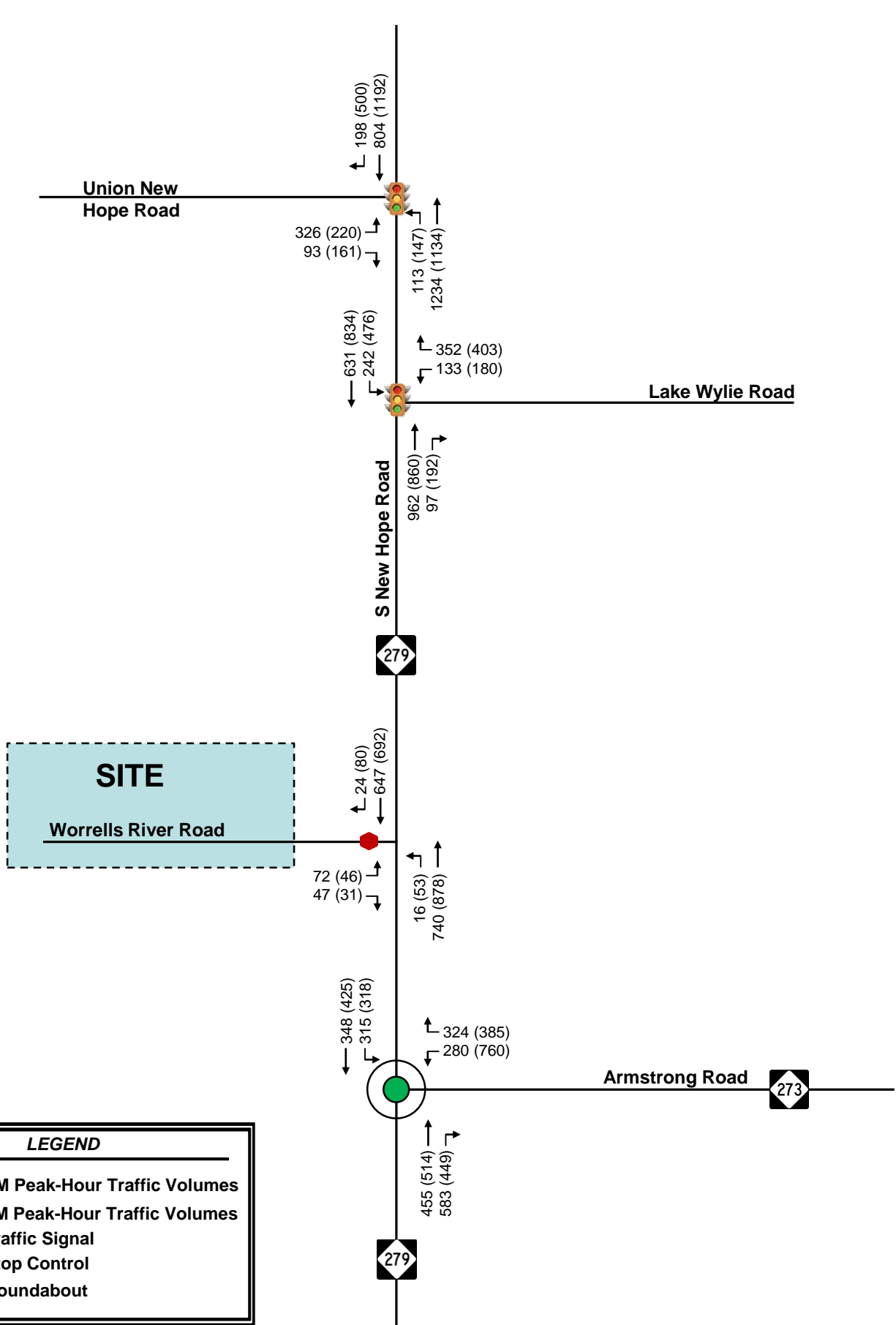
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LEGEND

- XX Background Traffic
- (XX) Site Trips
- [XX] Build-out Traffic
- Traffic Signal
- Stop Control
- Roundabout

NOT TO SCALE



6.0 Capacity Analysis

Based on the requirements set forth by the *City of Belmont Land Development Code – Section 16.14 Traffic Impact Analysis* and in accordance with the traffic study guidelines in the *NC DOT Policy on Street and Driveway Access to North Carolina Highways*, capacity analyses were performed at the study area intersections for each of the following AM and PM peak-hour scenarios:

- 2018 Existing Conditions
- 2024 Background Conditions
- 2024 Build-out Conditions
- 2029 Build-out Conditions + 5 years

Capacity analyses were performed for the AM and PM peak hours using the Synchro Version 9 software to determine the operating characteristics at the signalized and stop-controlled intersections of the adjacent street network and to evaluate the impacts of the proposed development. Capacity is defined as the maximum number of vehicles that can pass over a particular road segment, or through a particular intersection, within a specified period of time under prevailing operational, geometric and controlling conditions within a set time duration. SIDRA Version 7 software was used to determine operating characteristics, level-of-service (LOS) and delay for the existing roundabout at the S New Hope Road (NC 279)/Armstrong Road (NC 273) intersection. SIDRA is typically used to analyze roundabout operations using a macroscopic model that uses gap acceptance and lane utilization to determine capacity, where capacity is based on the size of time gaps between vehicles that motorists choose when entering a roundabout. These software programs use methodologies contained in the *Highway Capacity Manual* (HCM) to determine the operating characteristics of an intersection.

The *Highway Capacity Manual* (HCM) defines LOS as a “quantitative stratification of a performance measure or measures representing quality of service”, and is used to “translate complex numerical performance results into a simple A-F system representative of travelers’ perceptions of the quality of service provided by a facility or service”. The HCM defines six levels of service, LOS A through LOS F, with A having the best operating conditions from the traveler’s perspective and F having the worst. However, it must be understood that “the LOS letter result hides much of the complexity of facility performance”, and that “the appropriate LOS for a given system element in the community is a decision for local policy makers”. According to the HCM, “for cost, environmental impact, and other reasons, roadways are typically designed not to provide LOS A conditions during peak periods but instead to provide some lower LOS that balances individual travelers’ desires against society’s desires and financial resources. Nevertheless, during low-volume periods of the day, a system element may operate at LOS A.”

LOS for a two-way stop-controlled (TWSC) intersection is determined by the control delay at the side-street approaches, typically during the highest volume periods of the day, the AM and PM peak periods. Control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. With respect to field measurements, control delay is defined as the total elapsed time from the time a vehicle stops at the end of the queue to the time the vehicle departs from the stop line. It is typical for stop sign-controlled side streets and driveways intersecting major streets to experience long delays during peak hours, particularly for left-turn movements. The majority of the traffic moving through the intersection on the major street experiences little or no delay.

LOS for signalized intersections is reported for the intersection as a whole, and typically during the highest volume periods of the day, the AM and PM peak periods. One or more movements at an intersection may experience a low level-of-service, while the intersection as a whole may operate acceptably.

LOS for roundabout intersections is also reported for the intersection as a whole, but uses the same control delay thresholds as the stop-controlled intersections. However, if the volume-to-capacity ratio on an approach of the intersection is greater than 1.0, that approach or intersection is reported as LOS F regardless of the reported control delay.

Table 6.0-A and **6.0-B** list the LOS control delay thresholds published in the HCM for unsignalized (TWSC and roundabout) and signalized intersections, respectively, as well as the unsignalized operational descriptions assumed herein.

Table 6.0-A Vehicular LOS Control Delay Thresholds for Unsignalized Intersections		
Level-of-Service	Average Control Delay per Vehicle [sec/veh]	
A	≤ 10	Short Delays
B	> 10 – 15	
C	> 15 – 25	
D	> 25 – 35	Moderate Delays
E	> 35 – 50	
F	> 50	Long Delays

Table 6.0-B Vehicular LOS Control Delay Thresholds for Signalized Intersections	
Level-of-Service	Average Control Delay per Vehicle [sec/veh]
A	≤ 10
B	> 10 – 20
C	> 20 – 35
D	> 35 – 55
E	> 55 – 80
F	> 80

As noted in Section 4.2, traffic signals along S New Hope Road (NC 279) are planned to be installed at the intersections with both Union New Hope Road and Lake Wylie Road, as part of the improvements required for the approved Riverside development. To be consistent with the analysis provided for the Riverside TIA, the southbound left-turn movement on S New Hope Road (NC 279) at Lake Wylie Road was assumed to operate with permitted-protected phasing under background and build-out conditions. Right-turn on red (RTOR) operations were not allowed at these intersections per NCDOT Congestion Management guidelines and consistent with the Riverside TIA.

Also note that zero-volume movements were not changed to four vehicles per hour in the analysis. Given that these movements were only shown under existing and background conditions at the intersection of S New Hope Road (NC 279) at Worrells River Road, which is currently a private

drive serving few residents, these movements were kept at zero to match the counts collected in the field. Based on review of the model, maintaining the zero volumes are not shown to have significant impacts on the analysis.

Mitigation for traffic impacts caused by the proposed development were noted and identified based on City of Belmont and NCDOT mitigation requirements. When determining the proposed development's traffic impact to the study area intersections, the 2024 build-out conditions were compared to the 2024 background conditions. Based on the *City of Belmont Land Development Code*, "the applicant shall be required to identify mitigation improvements to the roadway network if at least one of the following conditions exists when comparing future year background conditions to future year build-out conditions:

- a) the total average delay at an intersection or individual approach increases by 25% or greater, while maintaining the same LOS,
- b) the LOS degrades by at least one level,
- c) or the LOS is "D" or worse in background conditions and the proposed project shows a negative impact on the intersection or approach"

Capacity analysis reports generated by Synchro Version 9 software and SIDRA Version 7 software are included in the **Appendix**. Additionally, queuing and blocking reports generated by the SimTraffic microsimulation model are included in the **Appendix**.

6.1 S NEW HOPE ROAD (NC 279) AND UNION NEW HOPE ROAD

Table 6.1 summarizes the LOS, control delay and 95th percentile queue lengths at the currently unsignalized intersection of S New Hope Road (NC 279) and Union New Hope Road. This intersection is assumed to be signalized with laneage improvements under 2024 and 2029 conditions.

Table 6.1 - S New Hope Road (NC 279) and Union New Hope Road								
Condition	Measure	EB		NB		SB		Intersection LOS (Delay)
		EBL	EBR	NBL	NBT	SBT	SBR	
AM Peak Hour								
2018 Existing	LOS (Delay)	F (142.8)		A (0.3)		A (0.0)		-
	Synchro 95th Q	300'	-	1'	-	-	0'	
2024 Background	LOS (Delay)	E (63.6)		B (14.0)		C (32.7)		C (28.4)
	Synchro 95th Q	#405'	-	#130'	227'	#667'	34'	
2024 Build-out	LOS (Delay)	E (64.5)		B (15.1)		D (36.2)		C (30.0)
	Synchro 95th Q	#410'	-	#150'	247'	#694'	34'	
2024 Build-out IMP	LOS (Delay)	D (47.9)		B (12.9)		C (24.9)		C (22.4)
	Synchro 95th Q	#312'	75'	#150'	210'	#644'	34'	
2029 Build-out + 5	LOS (Delay)	E (58.6)		B (13.6)		C (32.5)		C (27.2)
	Synchro 95th Q	#379'	76'	#156'	240'	#720'	39'	
PM Peak Hour								
2018 Existing	LOS (Delay)	F (52.2)		A (1.0)		A (0.0)		-
	Synchro 95th Q	142'	-	3'	-	-	0'	
2024 Background	LOS (Delay)	F (116.7)		C (26.3)		D (46.4)		D (46.5)
	Synchro 95th Q	#577'	-	#301'	242'	#1411'	100'	
2024 Build-out	LOS (Delay)	F (128.8)		C (28.9)		E (63.4)		E (57.3)
	Synchro 95th Q	#606'	-	#320'	255'	#1550'	100'	
2024 Build-out IMP	LOS (Delay)	E (80.0)		B (19.2)		D (35.5)		C (34.2)
	Synchro 95th Q	#356'	208'	#296'	170'	#1437'	114'	
2029 Build-out + 5	LOS (Delay)	F (99.3)		B (19.4)		D (48.0)		D (42.9)
	Synchro 95th Q	#422'	214'	#302'	186'	#1586'	141'	
Existing/Background Storage				350'				

95th percentile volume exceeds capacity, queue may be longer

Table 6.1 shows that the eastbound approach of Union New Hope Road currently operates with long delays during both peak hours under stop-controlled conditions.

As discussed in Section 4, future improvements are planned at this intersection as part of both the approved Riverside development and NCDOT's TIP project U-5821. These improvements were assumed to be installed prior to the 2024 build-out year for the Worrells River site, and include the following improvements:

- Installation of a traffic signal
- A northbound left-turn lane along S New Hope Road (NC 279) with 350 feet of storage
- An additional northbound through lane along S New Hope Road (NC 279) that begins approximately 500 feet south of the intersection
- A southbound right-turn lane along S New Hope Road (NC 279) that serves as a drop lane from the four-lane cross-section being installed north of this intersection as a part of U-5821

With these improvements in place, the overall intersection is expected to operate at LOS C during the AM peak hour and LOS D during the PM peak hour under 2024 background conditions.

When the proposed site traffic is added to the 2024 background volume, both the overall intersection and southbound approach LOS degrades during the PM peak hour from LOS D to LOS E, while the eastbound approach is shown to be negatively impacted while remaining at LOS F. Given the negative impact caused by the project, identification of mitigation improvements is required. The following improvement was identified to mitigate the added delay caused by the addition of site traffic:

- Construction of an eastbound right-turn lane along Union New Hope Road with a minimum of 225' of storage

With this improvement in place, the negative operational impacts to the overall intersection and approaches are mitigated, with the overall intersection expected to operate at LOS C during both the AM and PM peak hours. Note that the minimum of 225 feet of storage was identified based on Synchro's 95th percentile queue length for the eastbound right-turn movement.

6.2 S NEW HOPE ROAD (NC 279) AND LAKE WYLIE ROAD

Table 6.2 summarizes the LOS, control delay and 95th percentile queue lengths at the currently unsignalized intersection of S New Hope Road (NC 279) and Lake Wylie Road. This intersection is assumed to be signalized with laneage improvements under 2024 and 2029 conditions.

Table 6.2 - S New Hope Road (NC 279) and Lake Wylie Road								
Condition	Measure	WB		NB		SB		Intersection LOS (Delay)
		WBL	WBR	NBT	NBR	SBL	SBT	
AM Peak Hour								
2018 Existing	LOS (Delay)	B (13.9)		A (0.0)		A (0.1)		-
	Synchro 95th Q	6'	-	-	0'	0'	-	
2024 Background	LOS (Delay)	D (38.9)		C (26.8)		B (12.8)		C (24.3)
	Synchro 95th Q	#167'	#306'	#665'	28'	#187'	145'	
2024 Build-out	LOS (Delay)	D (41.2)		C (32.9)		B (13.8)		C (27.7)
	Synchro 95th Q	#167'	#306'	#764'	28'	#201'	153'	
2029 Build-out + 5	LOS (Delay)	D (43.4)		D (49.1)		B (14.1)		D (35.3)
	Synchro 95th Q	#167'	#313'	#897'	28'	#208'	175'	
PM Peak Hour								
2018 Existing	LOS (Delay)	B (13.4)		A (0.0)		A (0.7)		-
	Synchro 95th Q	5'	-	-	0'	2'	-	
2024 Background	LOS (Delay)	D (44.6)		D (39.2)		C (31.9)		D (37.2)
	Synchro 95th Q	#242'	308'	#698'	74'	#464'	203'	
2024 Build-out	LOS (Delay)	D (44.9)		D (50.1)		C (31.2)		D (40.7)
	Synchro 95th Q	#242'	308'	#763'	74'	#465'	246'	
2029 Build-out + 5	LOS (Delay)	E (55.3)		E (57.4)		D (35.8)		D (47.4)
	Synchro 95th Q	#255'	323'	#830'	72'	#483'	274'	
Existing/Background Storage		250'		150'		475'		

95th percentile volume exceeds capacity, queue may be longer

Table 6.2 shows that the westbound approach of Lake Wylie Road currently operates with short delays during both peak hours under stop-controlled conditions.

As discussed in Section 4, future improvements are planned at this intersection as part of the approved Riverside development. These improvements were assumed to be installed prior to the 2024 build-out year for the Worrells River site, and include the following improvements:

- Installation of a traffic signal
- A westbound left-turn lane along Lake Wylie Road with 250 feet of storage
- A northbound right-turn lane along S New Hope Road (NC 279) with 150 feet of storage
- A southbound left-turn lane along S New Hope Road (NC 279) with 475 feet of storage

With these improvements in place, the overall intersection is expected to operate at LOS C during the AM peak hour and LOS D during the PM peak hour under both 2024 background and build-out conditions. In addition, each approach is expected to remain at the same LOS during both peak hours when proposed site traffic is added to the background volumes. However, the proposed project is expected to negatively impact the overall intersection during the PM peak hour (along with the westbound approach during the AM peak hour and the northbound approach during the PM peak hour) where it is shown to operate at LOS D under background conditions. Given the negative impact caused by the project that meets the City of Belmont's mitigation criteria, identification of mitigation improvements is required. The following options for laneage improvements were evaluated at this intersection to identify improvements to mitigate the increase in delay and accommodate the added site traffic, while minimizing disruption to the background traffic:

1. Construction of dual southbound left-turn lanes along S New Hope Road (NC 279)
2. Construction of dual westbound right-turn lanes along Lake Wylie Road
3. Construction of dual westbound left-turn lanes along Lake Wylie Road

Option 1 - Construction of Dual Southbound Left-Turn Lanes along S New Hope Road (NC 279)

Based on review of the traffic volumes shown at this intersection in **Figure 5.3**, 472 vehicles are expected to turn southbound left onto Lake Wylie Road from S New Hope Road (NC 279) during the PM peak hour. Since exclusive left-turn lanes are already planned on each approach of this tee-intersection and a high volume of southbound left-turns is expected, dual southbound left-turn lanes were considered. As noted previously, permitted-protected left-turn phasing was assumed on the southbound approach of this intersection consistent with the analysis provided in the approved Riverside TIA. Installation of a second left-turn lane would require the implementation of protected-only phasing for the southbound left-turn movements. With dual southbound left-turn lanes, the overall intersection, along with both the northbound and southbound approaches are expected to operate better than background conditions during the PM peak hour. However, the westbound approach experiences increased delay under this scenario. The dual southbound left-turn lanes are able to process its demand much quicker, reducing the green time for this phase. The westbound right-turn movement is provided additional green time via an overlap phase that runs concurrently with the protected southbound left-turn phase. Therefore, the reduced green time for the southbound left-turn phase also reduces the green time for the westbound right-turn movement, yet this movement would still be processed through a single lane, thus increased delay for this movement and the overall westbound approach (580 vph on the westbound approach during the PM peak hour). See the supplemental analysis section of the **Appendix** for capacity analysis results.

Additionally, construction of dual southbound left-turn lanes would require construction of a second receiving lane eastbound along Lake Wylie Road. It would also disallow permitted phasing during

non-peak hours. Given these considerations, along with the relatively minor operational impacts from the proposed site shown in **Table 6.2**, the construction of dual southbound left-turn lanes is not recommended for mitigation of the Worrells River residential development.

Option 2 - Construction of Dual Westbound Right-Turn Lanes along Lake Wylie Road

Based on review of the traffic volumes shown at this intersection in **Figure 5.3**, 401 vehicles are expected to turn westbound right from Lake Wylie Road onto S New Hope Road (NC 279) during the PM peak hour. With turn lanes already planned on each approach of this tee-intersection and a high volume of westbound right turns expected, dual westbound right-turn lanes were considered. With dual westbound right-turn lanes in place, the westbound approach delay is expected to be reduced (and mitigates the AM peak hour increase in delay); however, the northbound approach delay is not mitigated and is still expected to increase by more than 25% during the PM peak hour when compared to background conditions. See the supplemental analysis section of the **Appendix** for capacity analysis results.

Additionally, dual westbound right-turn lanes would require construction of a second receiving lane northbound along S New Hope Road (NC 279). Given these considerations, along with the relatively minor operational impacts from the proposed site shown in **Table 6.2**, the construction of dual westbound right-turn lanes is not recommended for mitigation of the Worrells River residential development.

Option 3 – Construction of Dual Westbound Left-Turn Lanes along Lake Wylie Road

Based on review of Option 2 that showed that dual westbound right-turn lanes would not be expected to provide a significant benefit to the northbound approach, dual westbound left-turn lanes along Lake Wylie Road were considered. With dual westbound left-turn lanes in place, the overall intersection and each approach are expected to operate better than background conditions during the PM peak hour. However, when compared to background conditions, the overall intersection delay is only expected to decrease by 2.5 seconds, while the northbound and southbound approach delays are expected to decrease by less than 1.5 seconds. See the supplemental analysis section of the **Appendix** for capacity analysis results.

Additionally, dual westbound left-turn lanes would require construction of a second receiving lane southbound along S New Hope Road (NC 279). Given these considerations, along with the relatively minor operational impacts from the proposed site shown in **Table 6.2**, the construction of dual westbound left-turn lanes is not recommended for mitigation of the Worrells River residential development.

Based on the evaluation of the three options described above, no improvements are recommended to be constructed to mitigate the added delay caused by the addition of the proposed Worrells River residential site traffic at this intersection.

6.3 S NEW HOPE ROAD (NC 279) AND WORRELLS RIVER ROAD

Table 6.3 summarizes the LOS, control delay and 95th percentile queue lengths at the unsignalized intersection of S New Hope Road (NC 279) and Worrells River Road.

Table 6.3 - S New Hope Road (NC 279) and Worrells River Road							
Condition	Measure	EB		NB		SB	
		EBL	EBR	NBL	NBT	SBT	SBR
AM Peak Hour							
2018 Existing	LOS (Delay)	B (14.7)		A (0.0)		A (0.0)	
	Synchro 95th Q	1'	-	0'	-	0'	-
2024 Background	LOS (Delay)	D (28.9)		A (0.0)		A (0.0)	
	Synchro 95th Q	0'	-	0'	-	0'	-
2024 Build-out	LOS (Delay)	F (58.1)		A (0.5)		A (0.0)	
	Synchro 95th Q	107'	-	2'	-	0'	-
2024 Build-out IMP	LOS (Delay)	E (42.8)		A (0.5)		A (0.0)	
	Synchro 95th Q	73'	10'	2'	-	0'	-
2029 Build-out + 5	LOS (Delay)	F (56.4)		A (0.2)		A (0.0)	
	Synchro 95th Q	90'	10'	2'	0'	0'	0'
PM Peak Hour							
2018 Existing	LOS (Delay)	A (0.0)		A (0.0)		A (0.0)	
	Synchro 95th Q	0'	-	0'	-	0'	-
2024 Background	LOS (Delay)	A (0.0)		A (0.0)		A (0.0)	
	Synchro 95th Q	0'	-	0'	-	0'	-
2024 Build-out	LOS (Delay)	F (86.2)		A (2.0)		A (0.0)	
	Synchro 95th Q	96'	-	6'	-	0'	-
2024 Build-out IMP	LOS (Delay)	F (67.8)		A (2.0)		A (0.0)	
	Synchro 95th Q	71'	7'	6'	-	0'	-
2029 Build-out + 5	LOS (Delay)	F (80.7)		A (0.6)		A (0.0)	
	Synchro 95th Q	79'	7'	6'	0'	0'	0'

Worrells River Road is currently a private drive serving only a few residences. Based on the provided site plan and information provided by the applicant, the proposed development will realign the existing Worrells River Road to connect to S New Hope Road (NC 279) at the existing construction delivery driveway for the Daniel Stowe Botanical Garden. The realigned Worrells River Road will provide direct access to the proposed development. The existing construction delivery driveway will be relocated to the existing Worrells River Road (separating access between the proposed development and Daniel Stowe Botanical Garden property).

As shown in **Table 6.3**, the stop-controlled eastbound approach of Worrells River Road is expected to operate with long delays with added site traffic under 2024 build-out conditions. The eastbound egress lane was assumed to include a single lane based on the width provided in the current site plan. Given the negative impact caused by the project on the eastbound approach, identification of mitigation improvements is required. Note that there is currently little to no traffic on this approach; therefore, with site traffic added, increase and delay and queueing is expected. However, given the expected LOS F on the eastbound approach, the following improvement is recommended to help reduce the long delays expected with the addition of site traffic:

- Construction of an exclusive eastbound right-turn lane along Worrells River Road with a minimum of 100 feet of storage

With the separation of left- and right-turn lanes along Worrells River Road, **Table 6.3** shows that the eastbound approach delay is expected to improve by more than 20% during both peak hours. The right-turn lane would allow the right-turn traffic to bypass the longer-delayed left-turn vehicles to lower the average delay on the approach and limit the longer queues. Further evaluation of the SimTraffic model shows that the maximum eastbound left-turn queue is expected to be 96 feet; therefore, a minimum storage of 100 feet is recommended.

Given that the stop-controlled eastbound approach is still expected to operate at LOS F during both peak hours, the construction of exclusive northbound left- and southbound right-turn lanes along S New Hope Road (NC 279) were also evaluated to determine if these improvements would be warranted for capacity purposes. With the auxiliary turn lanes in place along the mainline, the eastbound approach delay is expected to decrease by approximately 3% during the AM peak hour and 10% during the PM peak hour. Given that these turn lanes are not expected to provide a significant operational benefit, the construction of an exclusive northbound left-turn lane and a southbound right-turn lane along S New Hope Road (NC 279) is not recommended for capacity purposes. However, review of auxiliary turn-lane warrants (for safety purposes) at this intersection can be seen in Section 7.0.

6.4 S NEW HOPE ROAD (NC 279) AND ARMSTRONG RD (NC 273)

Table 6.4 summarizes the LOS, control delay and 95th percentile queue lengths at the roundabout intersection of S New Hope Road (NC 279) and Armstrong Road (NC 273).

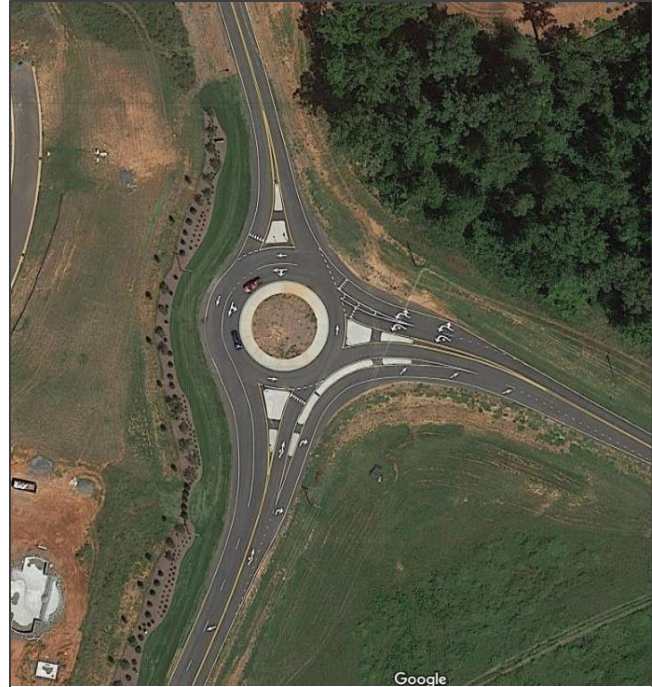
Table 6.4 - S New Hope Road (NC 279) and Armstrong Road								
Condition	Measure	WB		NB		SB		Intersection LOS (Delay)
		WBL	WBLR	NBT	NBR	SBL	SBT	
AM Peak Hour								
2018 Existing	LOS (Delay)	A (6.0)		A (2.3)		A (5.5)		A (4.0)
	SIDRA 95th Q	27'	28'	37'	0'	27'	-	
2024 Background	LOS (Delay)	A (8.3)		A (4.0)		B (10.8)		A (7.1)
	SIDRA 95th Q	40'	48'	68'	0'	103'	-	
2024 Build-out	LOS (Delay)	A (8.5)		A (4.3)		B (11.9)		A (7.7)
	SIDRA 95th Q	40'	51'	75'	0'	124'	-	
2024 Build-out IMP	LOS (Delay)	A (8.5)		A (4.3)		A (6.4)		A (6.0)
	SIDRA 95th Q	40'	51'	75'	0'	37'	38'	
2029 Build-out + 5	LOS (Delay)	A (9.9)		A (4.9)		A (6.9)		A (6.8)
	SIDRA 95th Q	50'	65'	97'	0'	39'	44'	
PM Peak Hour								
2018 Existing	LOS (Delay)	A (6.1)		A (2.1)		A (7.1)		A (4.9)
	SIDRA 95th Q	37'	37'	23'	0'	33'	-	
2024 Background	LOS (Delay)	C (18.1)		A (5.5)		F (56.3)		C (23.8)
	SIDRA 95th Q	160'	160'	91'	0'	529'	-	
2024 Build-out	LOS (Delay)	C (20.3)		A (5.9)		F (68.9)		D (28.4)
	SIDRA 95th Q	182'	182'	99'	0'	715'	-	
2024 Build-out IMP	LOS (Delay)	C (20.3)		A (6.1)		B (13.0)		B (13.6)
	SIDRA 95th Q	182'	182'	102'	0'	58'	89'	
2029 Build-out + 5	LOS (Delay)	D (30.1)		A (6.8)		C (17.2)		C (18.9)
	SIDRA 95th Q	274'	274'	125'	0'	69'	120'	
Existing Storage			120'		200'			

Exceeds existing storage

As show in **Table 6.4**, the overall intersection is expected to operate at LOS C during the PM peak hour, while the southbound approach of S New Hope Road (NC 279) is expected to operate at LOS F during the PM peak hour under 2024 background conditions. When the proposed site traffic is added to the 2024 background volume, the LOS degrades from LOS C to LOS D for the overall intersection and the southbound approach delay increases while continuing to operate at LOS F. Given the negative impact caused by the project, identification of mitigation improvements is required. The following improvement was identified to mitigate the added overall intersection and southbound approach delay caused by the addition of site traffic:

- Construction of an additional southbound through lane along S New Hope Road (NC 279) with a minimum of 100 feet of storage

This intersection was recently converted to the three-leg roundabout shown in the image to the right. It currently has ample capacity, but as the two developments discussed in Section 4 (McLean and Riverside) continue to build out along with the proposed Worrells River residential development, the additional capacity will continue to diminish (as shown in **Table 6.4**). Unlike traffic signals that can adjust signal timings to serve changes in demand, roundabouts have less flexibility. Here, two entering lanes on the southbound approach (similar to how the westbound approach is configured) is shown to mitigate the added delay caused by the addition of site traffic.



With this improvement in place, **Table 6.4** shows that the negative operational impacts to the overall intersection and southbound approach are both mitigated to LOS B during the PM peak hour. Based on review of the SIDRA 95th percentile queues, 100 feet of storage is recommended to allow the southbound through traffic to bypass the southbound left-turning traffic.

Note that with this improvement in place, modification of the overall roundabout will also be required to allow the approach lanes to enter the correct circulating lanes within the roundabout. Currently, the southbound approach enters the outside circulating lane; therefore, when an additional southbound lane is added, the new lane will need to enter the outside circulating lane, forcing the current lane to be modified to enter the inside circulating lane.

7.0 Auxiliary Turn Lane Warrants

Warrants for additional turn-lane improvements for unsignalized intersection beyond those necessary for capacity were determined based on a review of the figure titled 'Warrant for Left and Right-Turn Lanes' found on page 80 in the *NC DOT Policy On Street And Driveway Access to North Carolina Highways*. The results of the warrants for left and right-turn lanes under 2024 background and build-out conditions are summarized by intersection below and included in the **Appendix**.

2024 Background Conditions

No auxiliary turn lanes were warranted at stop-controlled intersections under 2024 background conditions.

2024 Build-out Conditions

S New Hope Road (NC 279) and Worrells River Road

- Northbound left-turn lane along S New Hope Road (NC 279) with a minimum storage length of 75'
- Southbound right-turn lane along S New Hope Road (NC 279) with a minimum storage length of 75'

8.0 Crash Data Analysis

Crash data was obtained at study intersections for crashes that occurred between April 1, 2015, and March 31, 2018. Over this three-year period, 23 total crashes were reported at the four existing study intersections. Note that there were no reported crashes at the study intersections of S New Hope Road (NC 279)/Lake Wylie Road and S New Hope Road (NC 279)/Worrells River Road. Therefore, only the summaries below reflect only crash data at the intersections of S New Hope Road (NC 279)/Union New Hope Road and S New Hope Road (NC 279)/Armstrong Road (NC 273). The breakdown of crashes at these study intersections by severity, frequency and accident type can be seen the tables below.

Table 8.1 – Crash Severity Summary

Crash Type	Number of Crashes
Fatal Crashes	0
Class A	0
Class B	0
Class C	4
Property Damage Only	19
Total	23

Table 8.1 above displays the total number of crashes by severity type from most to least severe. As shown, there were no fatal crashes reported in the study area intersections over the past three years. ‘Class A’ incidents are crashes in which serious injury is suspected, which can include significant loss of blood or broken bones, and ‘Class B’ incidents are crashes in which minor injury is suspected, such as bruises or minor cuts. There were no ‘Class A’ or ‘Class B’ crashes reported within the study area over the three-year period. There were 4 ‘Class C’ crashes reported, which are defined as crashes wherein possible injuries occur, which are injuries reported by the person or indicated by his/her behavior, but no wounds or injuries are physically present, such as limping or complaint of neck pain. There were 19 crashes in which only property damage occurred, meaning no injury was reported in 83% of the recorded crashes at the study intersections.

Table 8.2 – Accident Frequency Summary

Location	Crashes/100 MEV
Union New Hope	49.75
Armstrong Road	182.40
Average	107.58

Table 8.2 shows that the crash rates at the S New Hope Road (NC 279) intersections at Union New Hope Road and Armstrong Road (NC 273) resulted in a weighted average crash rate of 107.58 crashes per 100 MEV, with the highest rate occurring at the intersection of S New Hope Road (NC 279) and Armstrong Road (NC 273) intersection. Based on review of the crash types, this appears to be contributed to a number of angle crashes that occurred shortly after the installation of the new roundabout, which can be expected as motorists learn how to traverse the new intersection configuration.

Table 8.3 – Accident Type Summary

Accident Type	Union New Hope Road	Armstrong Road (NC 273)
Angle	0	11
Left-Turn, Different Roadways	3	1
Ran off Road - Right	0	1
Rear End, Slow or Stop	2	2
Rear End, Turn	1	0
Sideswipe Same Direction	0	2
Total	6	17

At the intersection of S New Hope Road (NC 279) and Union New Hope Road, the most common crash type was left-turn collisions caused by vehicles turning from different roadways, with 50% of crashes. As previously noted, a traffic signal is planned to be installed at this intersection. The traffic signal is expected to address this concern as the left turns will have a protected phase to make their turn rather than waiting for a gap in the mainline traffic.

At the intersection of S New Hope Road (NC 279) and Armstrong Road (NC 273), the most common crash type was angle collisions, with over 64% of crashes. The majority of the angle crashes at this intersection occurred in the fall of 2017, shortly after the intersection was converted to a roundabout. As previously noted, angle crashes (which are less severe than head-on or left-turn crashes) can be expected as motorists learn how to traverse the new intersection configuration.

9.0 Mitigation Improvements

Based on the capacity analyses performed at each of the identified study intersections, along with review of auxiliary turn-lane warrants and crash analyses contained herein, the following improvements are identified to mitigate the impact of the proposed development on the adjacent street network:

S New Hope Road (NC 279) and Union New Hope Road

- Construction of an eastbound right-turn lane along Union New Hope Road with a minimum of 225' of storage

S New Hope Road (NC 279) and Worrells River Road

- Construction of an eastbound right-turn lane along Worrells River Road with a minimum of 100' of storage
- Construction of a northbound left-turn lane along S New Hope Road (NC 279) with a minimum of 75' of storage
- Construction of a southbound right-turn lane along S New Hope Road (NC 279) with a minimum of 75' of storage

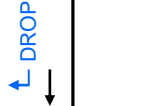
S New Hope Road (NC 279) and Armstrong Road (NC 273)

- Construction of an additional southbound through lane along S New Hope Road (NC 279) with a minimum of 100' of storage (modification of the overall roundabout may be required to allow the two southbound approach lanes to enter the correct circulating lanes within the roundabout)

The mitigation improvements identified within the study area are shown in **Figure 9.1**. The improvements shown on this figure are subject to approval by NCDOT and the City of Belmont. All additions and attachments to the State and City roadway system shall be properly permitted, designed and constructed in conformance to standards maintained by the agencies.

NOT TO SCALE

Union New Hope Road



225' (min)

350' 500'

475'

250'

Lake Wylie Road

150'

S New Hope Road



SITE

Worrells River Road

75' (min)

100' (min)

75' (min)

100' (min)

120'

Modification of the overall roundabout may be required to allow the two southbound approach lanes to enter the correct circulating lanes within the roundabout

Armstrong Road



200'



LEGEND

- Existing Lane
- X' Storage Length
- Stop Control
- Roundabout
- 🚦 Traffic Signal
- 🟦 NCDOT U-5821/Riverside Improvement
- 🟥 Identified Mitigation Improvement

APPENDIX