KITTELSON & ASSOCIATES

WAXHAW ORIGIN-DESTINATION STUDY

TOWN OF WAXHAW, NC

April 28, 2023

Waxhaw Origin-Destination Study

Town of Waxhaw, NC

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Section 1
Introduction

EXECUTIVE SUMMARY

The purpose of the Waxhaw Origin-Destination (O-D) Study is to support the Town of Waxhaw's evaluation of committed and conceptual road projects through:

- Determining origin and destination travel patterns in and around Waxhaw,
- Evaluating local versus regional pass-through trips, and
- Analyzing the impacts of the planned Waxhaw Parkway on future travel patterns:
  - What impact will the Waxhaw Parkway have on downtown traffic?
  - How might incremental Parkway implementation impact travel patterns with consideration of other programmed improvements?

Technical work activities were completed in two parts. The first part covers analysis of existing vehicle O-D travel patterns through the Waxhaw downtown core as well as identification of broader regional travel patterns. Other topics explored include the distribution of vehicle trips across the three railroad crossings in downtown Waxhaw, comparison of travel patterns by time of day and day of the week, and travel pattern changes due to the COVID-19 pandemic.

Key findings of the O-D analysis include:

- Non-local trips comprised 67.5% of vehicles traveling through the downtown core in 2021.
  - Top travel patterns through the downtown core included north to south from NC 16 to Old Providence, east to west along NC 75, and north to east from NC 16 to NC 75.
- Regional trips were evaluated based upon cardinal directions of origins.
  - **From the south**, 72% of trips were destined to the north along NC 16, 20% were destined towards the west, and 8% were destined towards the east.
  - **From the north**, 55% of trips were destined to south of downtown Waxhaw. 24% were destined toward the west and 21% were destined toward the east.
  - **From the west**, 39% of trips were destined to the east, 36% towards the north, and 25% towards the south of downtown Waxhaw. For regional trips between the west and north, over 50% of vehicles currently use Jim Wilson Road, 25% traveled through downtown, and the remainder used Waxhaw-Marvin Road and/or Pine Oak Road to bypass downtown.
  - **From the east**, 53% of trips were destined to the west along NC 75, 36% were destined towards the north, and 11% were destined towards the south.

The second part of the study involved network scenario analyses for incremental construction of the Waxhaw Parkway and analyses of selected intersections. This included development of estimates for 2045 daily traffic conditions for five network scenarios that considered various combinations of implementation for three Parkway segments. Figure 1 depicts preliminary alignments for these segments.

The regional travel demand model was utilized to account for future growth patterns along with consideration of existing travel patterns from the O-D analysis. Forecasts from prior NCDOT roadway projects and traffic impact studies from local development projects were also considered. The network analyses allow for a comparison of how various scenarios of Parkway construction may influence rerouting of traffic within the roadway network around downtown Waxhaw, with particular focus on the changes in volume through the downtown core under each scenario.

Intersection analyses were also completed for the 2045 AM and PM peak hours at four intersections. Peak-hour analyses were conducted for each of the applicable network scenarios to allow for comparison of potential impacts of modified route selection on intersection operations. Analyses were completed at the intersections of NC 16 and NC 75, NC 16 and Waxhaw Parkway, NC 75 and Old Providence Road, and the northeast Waxhaw Parkway and Waxhaw Indian Trail Road.

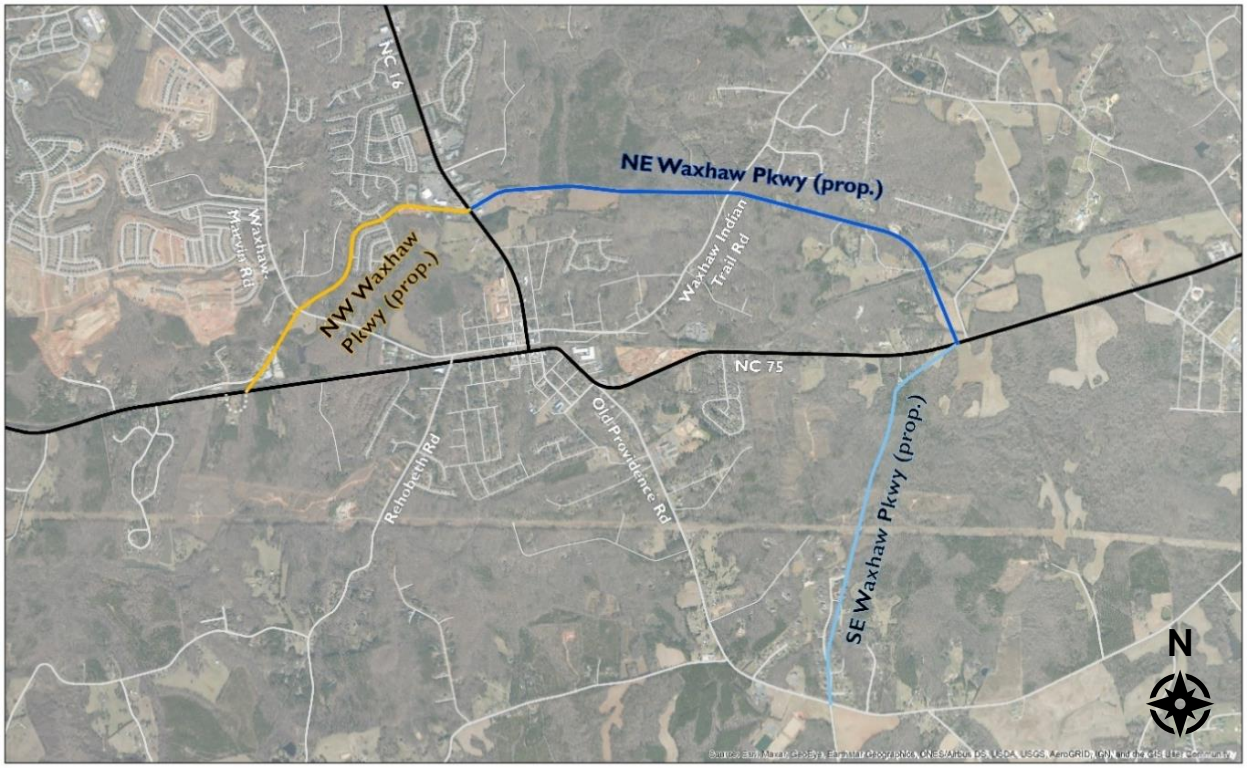


Figure 1. Planned segments of the Waxhaw Parkway.

Key findings of the network analysis include:

- Waxhaw Parkway provides important infrastructure to support longer-term growth for local circulation and regional trips.
- Even with construction of the northwest, northeast, and southeast Parkway segments, volume levels in the downtown core are expected to remain near 2018 levels.
  - Volume levels in downtown will continue to rise until Parkway segments are constructed.
  - Improvements to the NC 16/NC 75 intersection are expected to be needed even with Parkway implementation.
- Some network re-routing is expected without the Waxhaw Parkway with increased use of Waxhaw-Marvin Road and Pine Oak Road to bypass congestion in downtown Waxhaw. However, limited alternative routes are available for some other key O-D patterns.
- Implementation of the northeast segment of the Parkway is expected to have the largest influence on reducing vehicle trips through downtown Waxhaw. However, implementation of the northeast segment alone is still estimated to result in 2045 traffic volumes through downtown that are exceeding prior counts from 2018.
- Incremental additional reductions in vehicles through downtown are expected with construction of both the northwest and northeast segments of the Parkway as well as if the Parkway is extended to the southeast.
- Consideration of alternative alignments for the northeast and southeast Parkway segments that are shifted closer to downtown Waxhaw are suggested to better support north-south travel patterns.

Key findings of the intersection analysis include:

- **NC 16 and NC 75:** Intersection improvement alternatives currently under consideration (from the Union County Critical Intersection project) provide incremental benefit. However, dual exclusive southbound left turn lanes and dual eastbound right turn lanes may be needed for some network scenarios.
- **NC 16 and Waxhaw Parkway:** Traffic signal and roundabout alternatives were evaluated. Minimum lane configuration needs for each control type vary depending on incremental Parkway construction. In general, the roundabout alternative is estimated to result in lower intersection delay utilizing fewer lanes compared to the signal alternative.
- **NC 75 and Old Providence Road:** The proposed STIP project, which includes a single-lane roundabout with an eastbound right turn bypass lane, is expected to operate adequately through year 2045 with the construction of the northeast Waxhaw Parkway. Without construction of the northeast Parkway segment, the roundabout may require expansion prior to year 2045.
- **NE Waxhaw Parkway and Waxhaw Indian Trail Road:** A single-lane roundabout was evaluated at the future intersection, as proposed as part of an NCDOT express design project. The roundabout is expected to operate acceptably through year 2045 with spare capacity to accommodate volumes 50% higher than those evaluated in this study.

Results from this O-D study inform Town staff regarding vehicle travel patterns to support a variety of local and regional topics including:

- Decision making about improvements within downtown Waxhaw,
- Prioritization of Waxhaw Parkway improvements,
- Coordination with NCDOT regarding Waxhaw Parkway alignments that best meet the needs of regional travel patterns,
- Review of private development traffic impact analyses,
- Coordination with CRTPO regarding ongoing refinement to the regional model in the Waxhaw area, and
- Other future transportation planning.

Section 2
Origin-Destination Analysis

ORIGIN-DESTINATION ANALYSIS

The O-D analysis examined existing traffic volumes in and around Waxhaw to inform local and regional travel patterns. Key questions evaluated as part of the O-D analysis included:

- What vehicles traveling in the downtown core are local vs. regional through trips?
  - What are the corresponding travel patterns?
  - How are downtown core trips distributed across the three railroad crossings?
  - How do travel patterns compare across times of day and days of the week?
- What are the major O-D patterns and trip routes at a regional level?
- Have travel patterns changed between 2019 and 2021due to the COVID-19 pandemic?

The data used for the analysis were obtained through StreetLight Data, which aggregates anonymous location data from smartphones, connected cars, and smart devices to inform origin-destination patterns and travel times, and sells analytics to transportation professionals. Data from StreetLight allows for the acquisition of more data and network coverage at reduced cost compared to traditional data collection methods. The data can be obtained for entire years to enable analysis of trends by day-of-week, month, or year and provides flexibility for dynamic analyses.

The StreetLight data for the O-D analysis was collected based on three types of location points, including origins, destinations, and middle filters. Origins and destinations define the locations where trips originate from or end at. Each origin can also serve as a destination for a trip in the opposite direction. Middle filters are zones through which a trip must travel between its origin and destination in order to be counted.

The preliminary alignment of the planned Waxhaw Parkway influenced the locations of the selected StreetLight zones and the decision to divide the O-D analysis into two phases: Phase 1 would be primarily focused on the intersection of NC 16 and 75 and Phase 2 would be geared toward how the Parkway would impact broader regional trips.

PHASE 1 (CORE) O-D ANALYSIS

The first phase of the O-D analysis involved an evaluation of travel patterns with origins and destinations within or just outside of Waxhaw's downtown, or "local trip area," to capture a core set of trips that pass through local intersections.

The following definitions were developed to apply to this phase of the analysis:

- **Local Trip Area**: The area encompassed by the downtown Waxhaw core where local trips start and/or end
- **Study Area**: The area encompassed by the local trip area along with the external gates
- **External Gate**: Point outside the local trip area where trip data is collected
- **Local Trip**: Trip with an origin and/or destination in the local trip area
- **Non-Local Trip**: Trip with both its origin and destination at an external gate (pass-through trip with start and end points outside the local trip area)
- **Top Trip**: Trip with an average daily volume of over 500 vehicles per day
- **Middle Filter**: Point within the local trip area where trips may pass through

Figure 2 illustrates the StreetLight zones (external gates, labeled in blue, and middle filters, labeled in red) as well as the study area, which includes the local trip area.

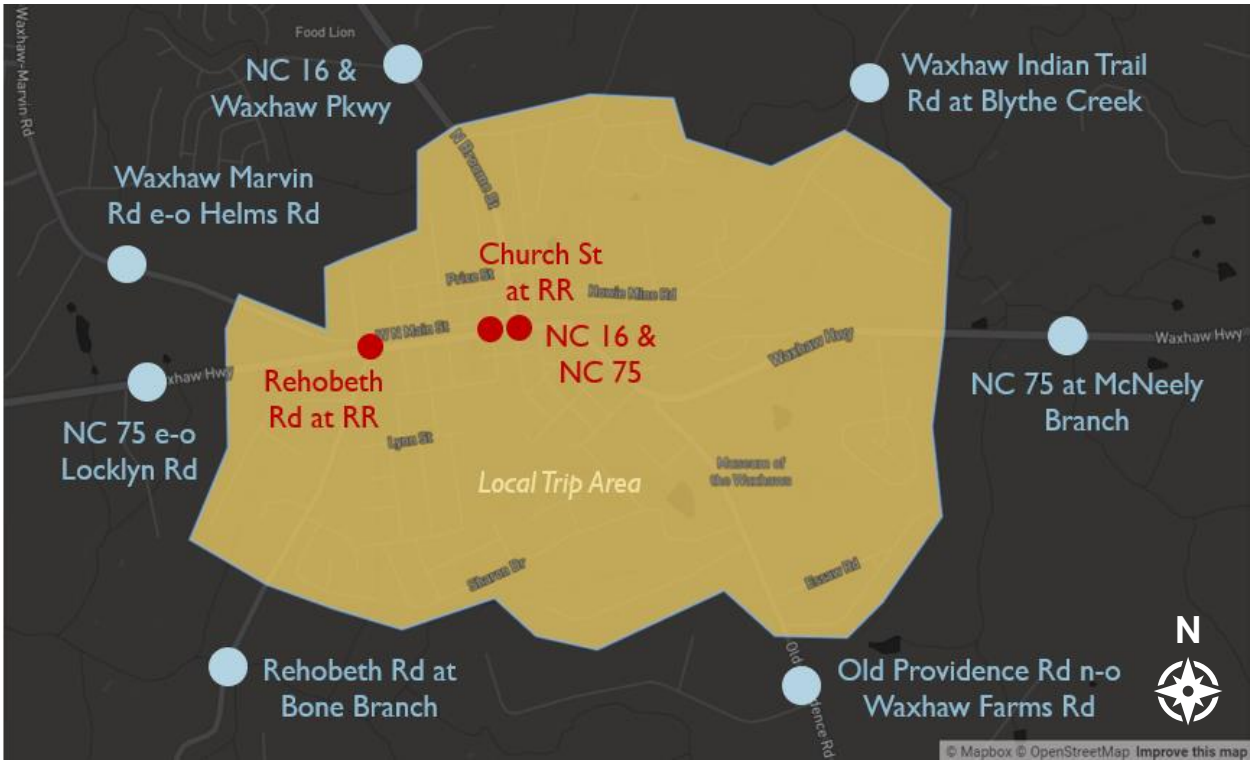


Figure 2. StreetLight zones and study area for Phase 1 (core) analysis.

Table 1 provides an overview of average daily volumes for the StreetLight data collected in 2021, with external gates and the local trip area serving as origins and destinations.

Table 1. Average Daily Volumes by Origin and Destination in 2021

	DESTINATION								
ORIGIN	***Local Trip Area***	***Indian Trail Rd at Blythe Creek (NE of Downtown)***	***NC 16 & Waxhaw Pkwy (N of Downtown)***	***NC 75 at McNeely Branch (E of Downtown)***	***NC 75 e-o Locklyn Rd (W of Downtown)***	***Old Providence Rd n-o Waxhaw Farms Rd (SE of Downtown)***	***Rehobeth Rd at Rone Branch (SW of Downtown)***	***Waxhaw Marvin Rd e-o Helms Rd (NW of Downtown)***	**Grand Total**
Local Trip Area	388	165	1,443	474	368	414	90	879	4,221
Indian Trail Rd at Blythe Creek (NE of Downtown)	207		26	24	211	72	42	67	649
NC 16 & Waxhaw Pkwy (N of Downtown)	1,520	19		945	512	2,384	335	176	5,891
NC 75 at McNeely Branch (E of Downtown)	535	25	1,103		1,183	35	87	1,028	3,996
NC 75 e-o Locklyn Rd (W of Downtown)	406	211	621	1,175		524	5	61	3,003
Old Providence Rd n-o Waxhaw Farms Rd (SE of Downtown)	339	63	2,325	27	423		17	677	3,871
Rehobeth Rd at Rone Branch (SW of Downtown)	86	40	302	90	3	10		153	684
Waxhaw Marvin Rd e-o Helms Rd (NW of Downtown)	1,128	78	231	1,138	82	868	170		3,695
Grand Total	4,609	601	6,051	3,873	2,782	4,307	746	3,041	26,010

OVERALL ORIGIN AND DESTINATION TRENDS

Of the average daily volumes collected in the study area in 2021, 32.5% of trips were local trips, with a least one trip end in Downtown Waxhaw. Local trips with both trip ends in Downtown (the local trip area) encompassed 1.5% of the daily volumes.

Non-local trips encompassed 67.5% of the total trips, with the movement to and from the north along NC 16, or to and from the *NC 16 & Waxhaw Parkway* external gate, representing the most common trip origin and destination. This location encompasses 22.6% of trip origins and 23.3% of trip destinations.

For a comparison of yearly trip patterns (before and after the start of the COVID-19 pandemic), StreetLight volumes were also collected from 2019. Patterns were similar between the two years as the most common non-local O-D trip pattern for both years was the north-south movement between NC 16 & Waxhaw Parkway and Old Providence Road n-o Waxhaw Farms Rd.

Figure 3 and Figure 4 depict the non-local daily trip volumes based on origin and destination for 2019 and 2021, respectively.

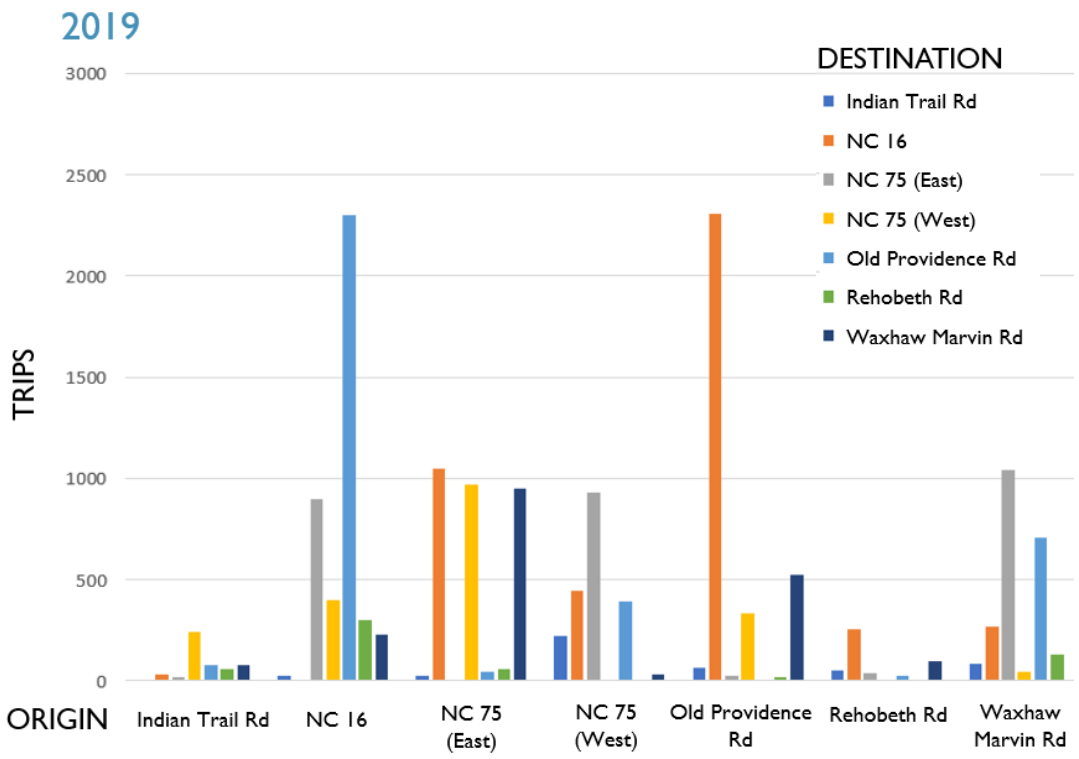


Figure 3. Origins and destinations for daily non-local trips in 2019.

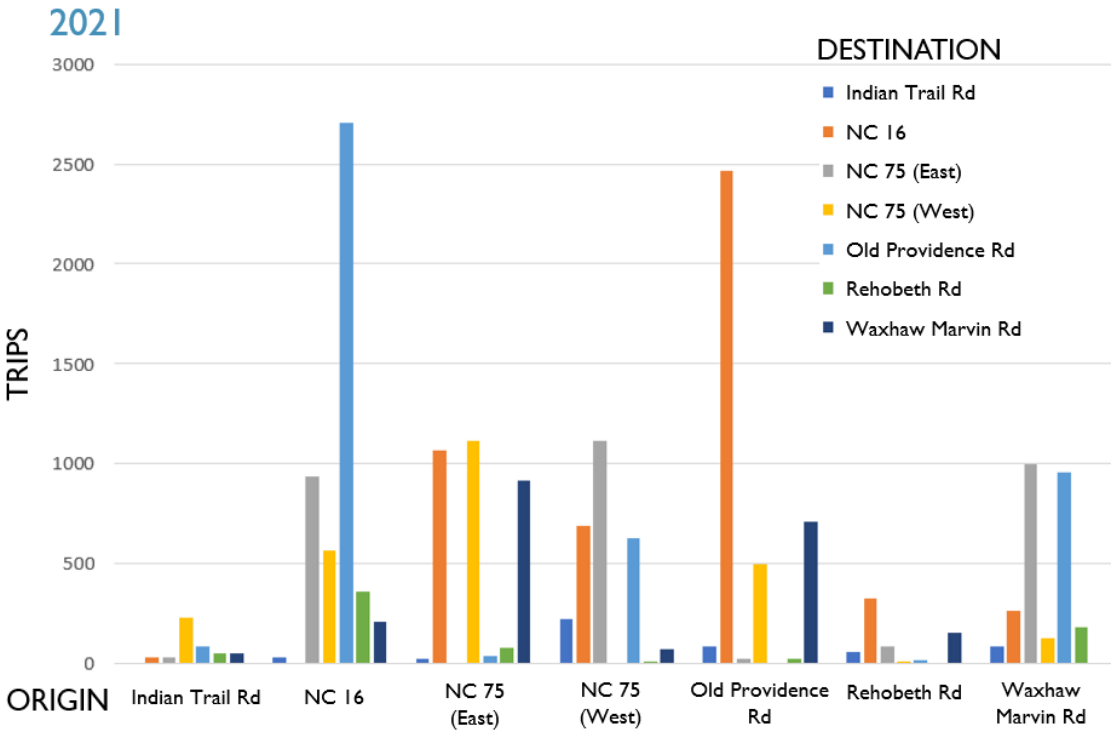


Figure 4. Origins and destinations for daily non-local trips in 2021.

MIDDLE FILTER TRENDS

Of the daily volumes in 2021, 100% of trips passed through at least one of the three middle filters in the local trip area, with the distribution as follows:

- 14.3% of trips passed through Rehobeth Road at Railroad Crossing (RR),
- 7.5% of trips passed through Church St at RR, and
- 78.2% of trips passed through NC 16 & NC 75.

In other words, out of 26,010 total daily trips,

- 3,724 trips passed through *Rehobeth Road at RR*,
- 1,940 trips passed through *Church St at RR*, and
- 20,346 trips passed through *NC 16 & NC 75*.

Figure 5 graphs the daily non-local trip patterns by middle filter. In addition, Figure 6 and Figure 7 graph the weekday (average Tuesday to Thursday daily volumes) non-local trip patterns by middle filter during the AM and PM peak hours (7 am to 9 AM and 5 PM to 7 PM, respectively).

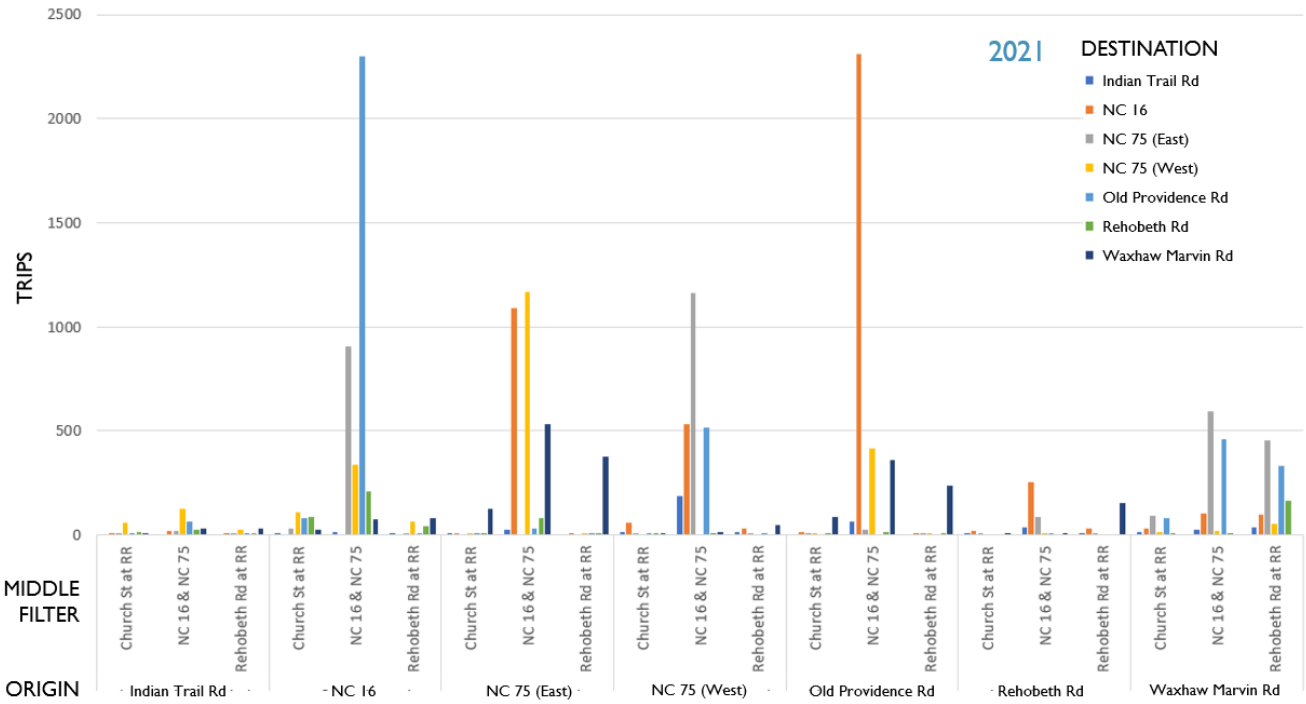


Figure 5. Origins, middle filters, and destinations for daily non-local trips in 2021.

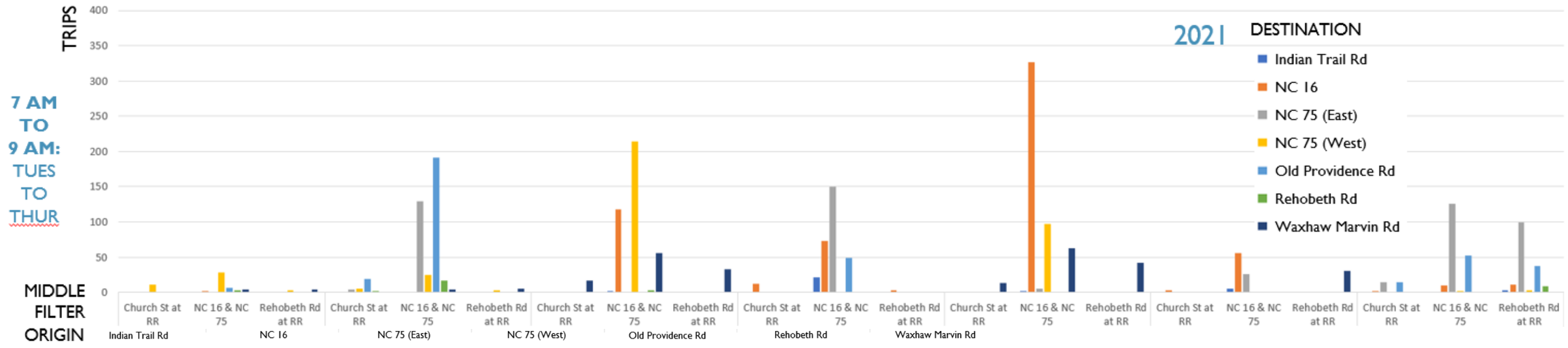


Figure 6. Origins, middle filters, and destinations for weekday *AM* non-local trips in 2021.

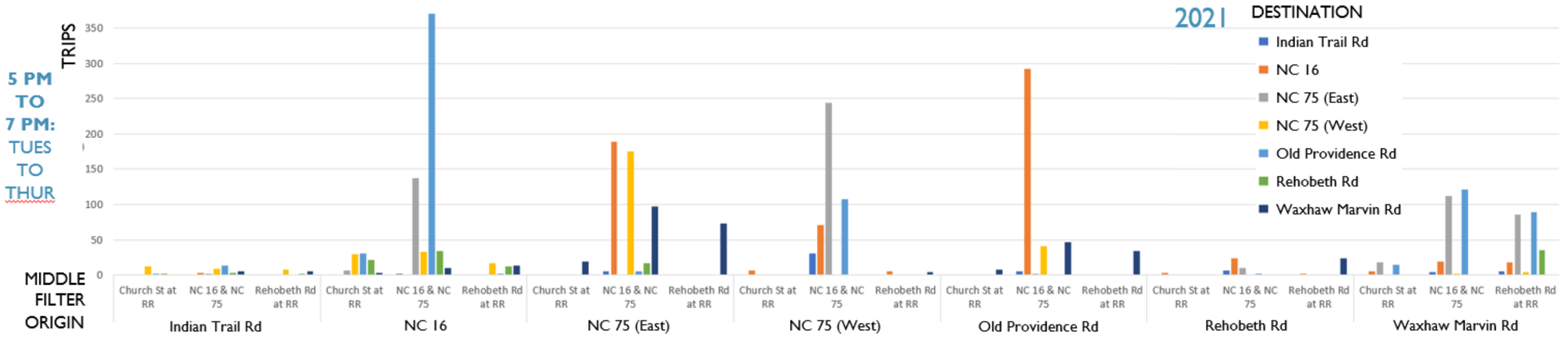


Figure 7. Origins, middle filters, and destinations for weekday *PM* non-local trips in 2021.

When compared to overall daily trips, trips during the weekday AM and PM peak hours followed similar travel patterns. However, there were some directional trends for north-south and east-west trips through the NC 16 & NC 75 middle filter. A higher number of trips originated from south of Downtown (at Old Providence Road), passing through NC 16 and NC 75 and heading north, in the AM, and a higher number of trips originated from north of Downtown (at NC 16), passing through NC 16 and NC 75 and heading south, in the PM. Similarly, a higher number of trips originated from east of Downtown (at NC 75 (East)), heading west, in the AM, and a higher number of trips originated from west of Downtown (at NC 75 (West)), heading east, in the PM.

TRIPS THROUGH NC 16 AND NC 75

As almost 80% of trips in the study area for the core analysis passed the NC 16 & NC 75 middle filter, the trips that utilized this intersection were analyzed in greater detail. Figure 8, below, depicts the top trip patterns (including local trips) that passed through NC 16 and NC 75, with the percentages of total daily volumes going through the intersection shown. For comparison, Figure 8 also depicts the percentage of local trips with both trip ends in Downtown.

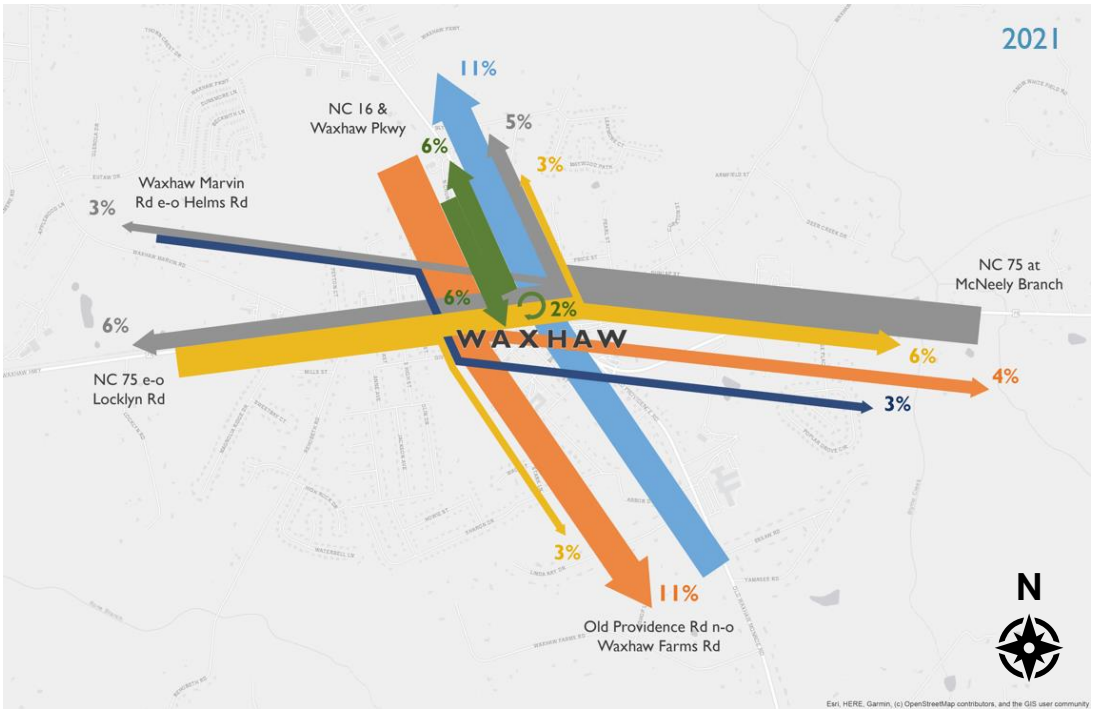


Figure 8. Graphical depiction of top trips through NC 16 and NC 75 in 2021.

Figure 9 depicts the top *non-local* trip patterns that passed through the NC 16 and NC 75 intersection, which includes ten O-D pairs, with the percentages of total non-local daily volumes going through the intersection shown. Non-local trips encompassed 67.5% of total trips through the downtown core in 2021.

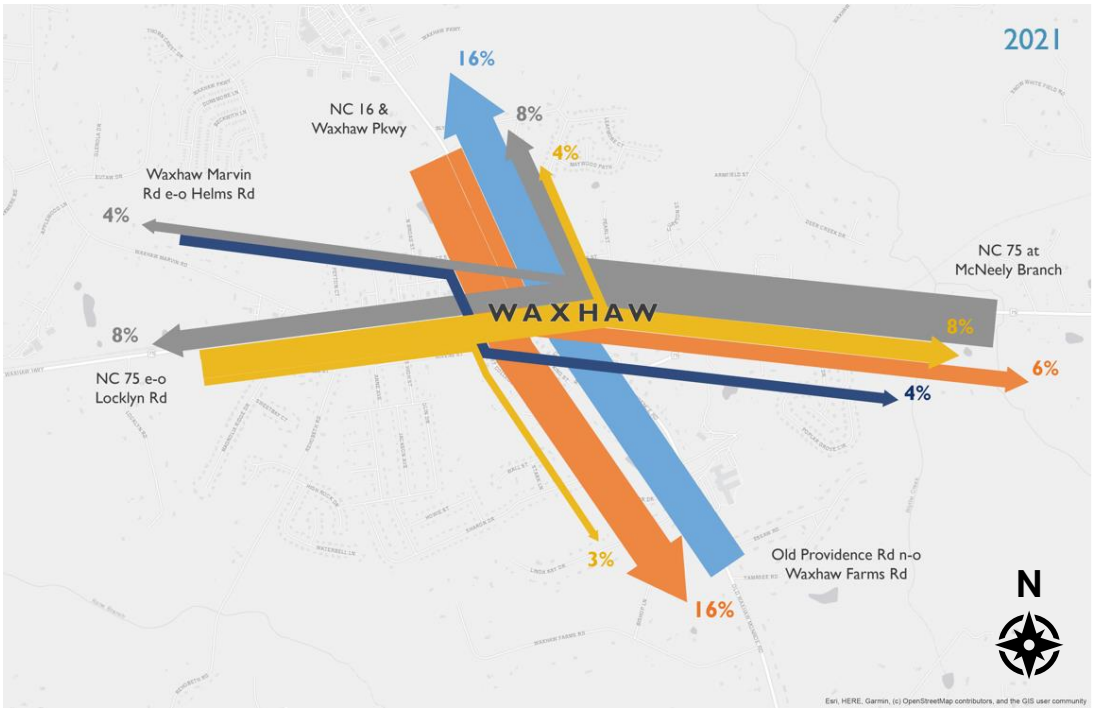


Figure 9. Graphical depiction of top non-local trips through NC 16 and NC 75 in 2021.

At the intersection of NC 16 and NC 75, the top ten O-D trip patterns shown in Figure 9 comprise 77% of non-local trips. Top travel patterns include:

- North-south trips from NC 16 to Old Providence Road
- East-west trips along NC 75
- North to east travel from NC 16 to NC 75

The origins and destinations of all non-local trips through NC 16 and NC 75 are depicted in Figure 10 and Figure 11, comparing between weekday (Tuesday to Thursday) daily trips and weekend (Saturday) daily trips. As seen in the figures, patterns are similar between weekday and Saturday travel, with only minor variations between the two graphs.

A comparison of the morning (AM) peak and evening (PM) peak time-of-day travel patterns for non-local trips through NC 16 and NC 75 is provided in Figure 12 and Figure 13. During the AM peak, there was a large distribution of trips from the south to the north, with a higher number of trips originating from Old Providence Road, south of Downtown, and ending on NC 16, north of Downtown. In contrast, during the PM peak, more trips originated from the north and ended in the south, with trips from NC 16 to Old Providence Road being the most common.

Figure 14 through Figure 19 show the weekday AM peak, weekday PM peak, and Saturday midday peak trip patterns for non-local trips through NC 16 and NC 75, with a comparison of 2019 and 2021 volumes. For all peak periods, patterns were generally consistent between the two years

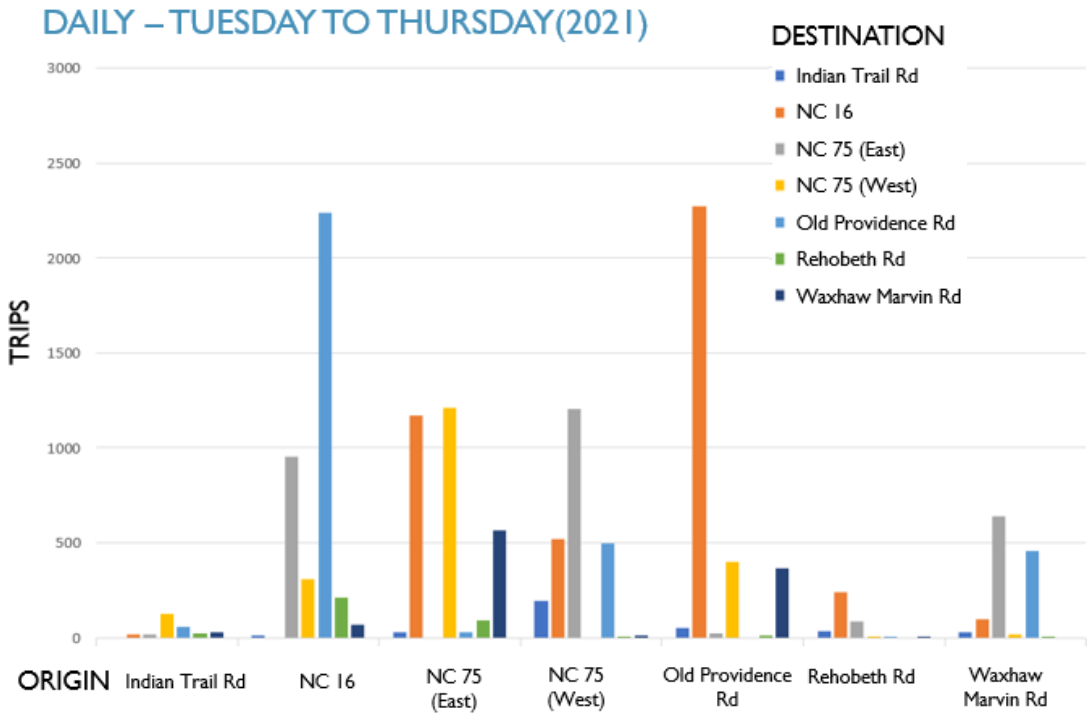


Figure 10. Origins and destinations for *weekday* non-local trips through NC 16 and NC 75 in 2021.

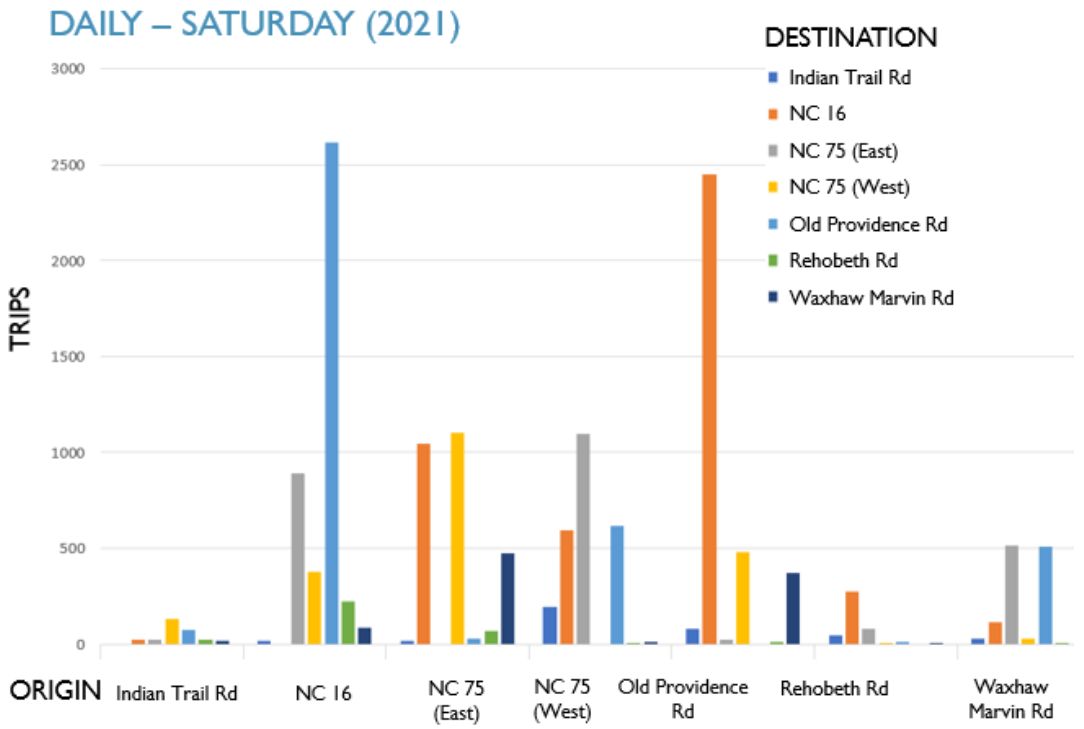


Figure 11. Origins and destinations for *Saturday* non-local trips through NC 16 and NC 75 in 2021.

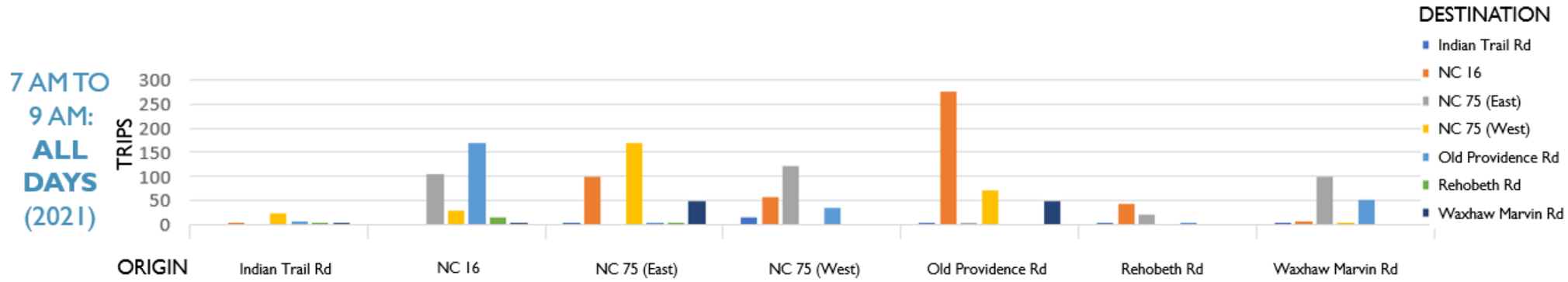


Figure 12. Origins and destinations for non-local trips through NC 16 and NC 75 from 7-9 *am* in 2021.

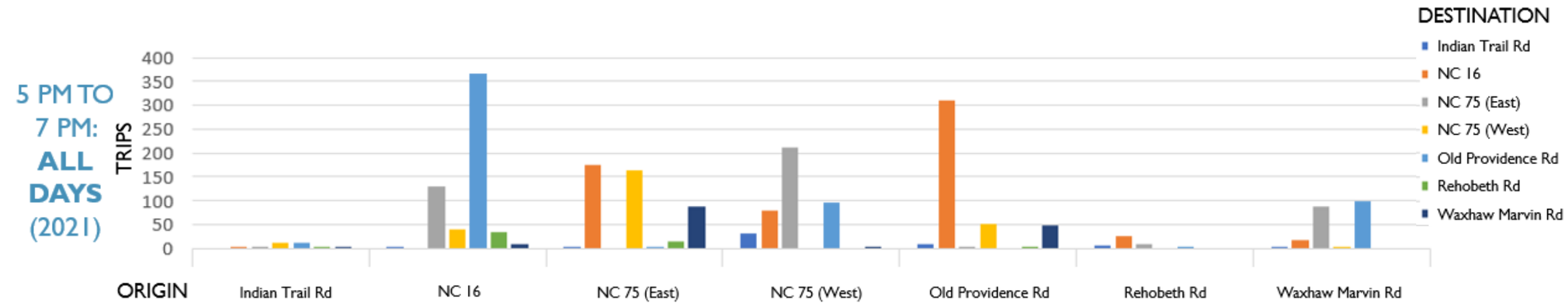


Figure 13. Origins and destinations for non-local trips through NC 16 and NC 75 from *5-7 pm* in 2021.

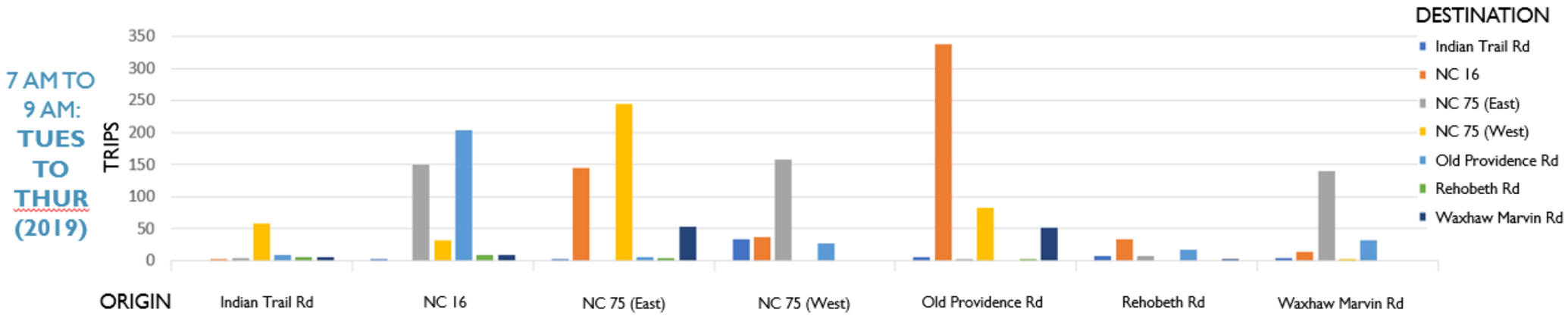


Figure 14. Origins and destinations for weekday AM peak (7-9 am) non-local trips through NC 16 and NC 75 in *2019*.

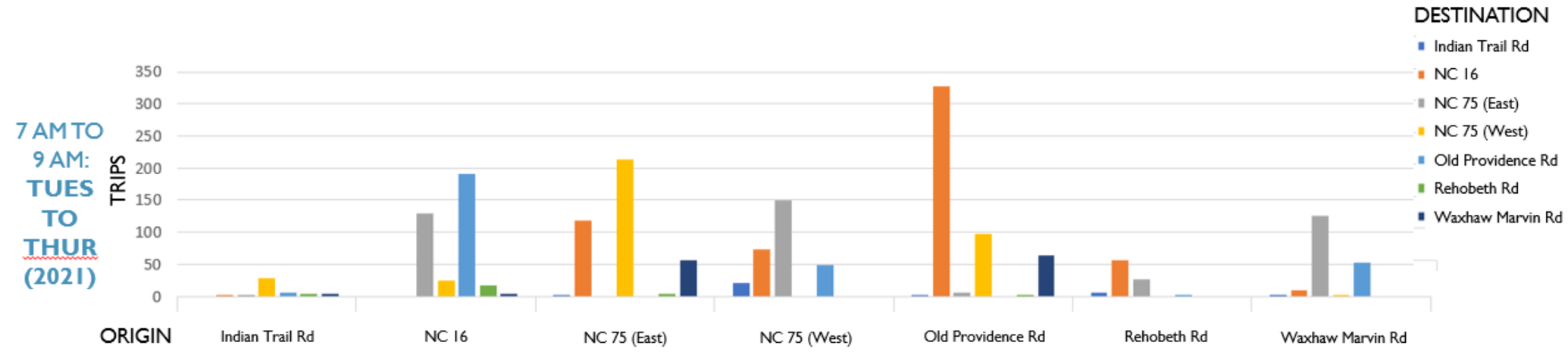


Figure 15. Origins and destinations for weekday AM peak (7-9 am) non-local trips through NC 16 and NC 75 in *2021*.

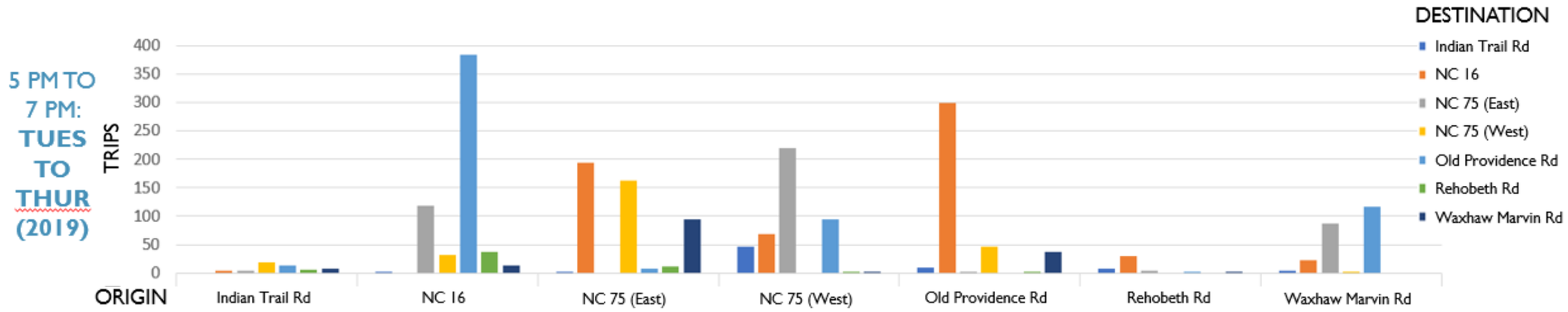


Figure 16. Origins and destinations for weekday PM peak (5-7 pm) non-local trips through NC 16 and NC 75 in *2019*.

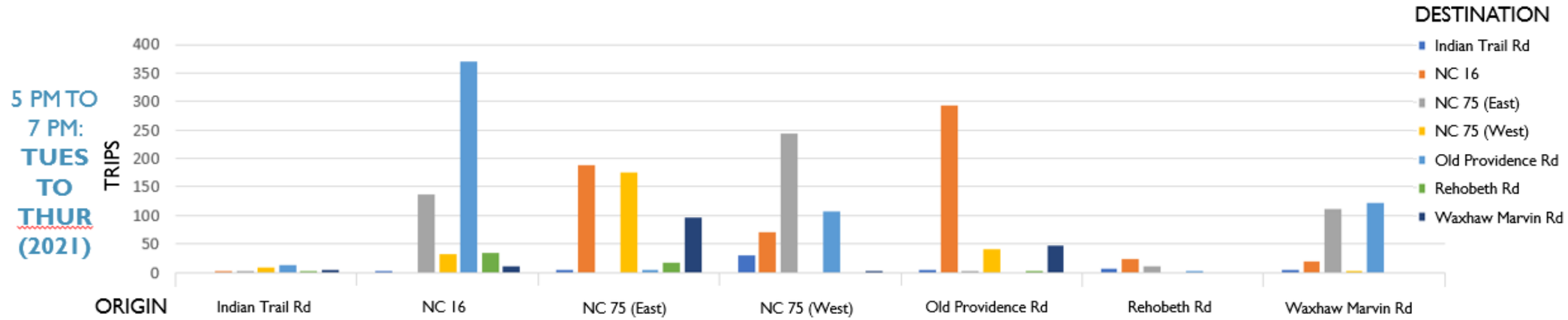


Figure 17. Origins and destinations for weekday PM peak (5-7 pm) non-local trips through NC 16 and NC 75 in *2021*.

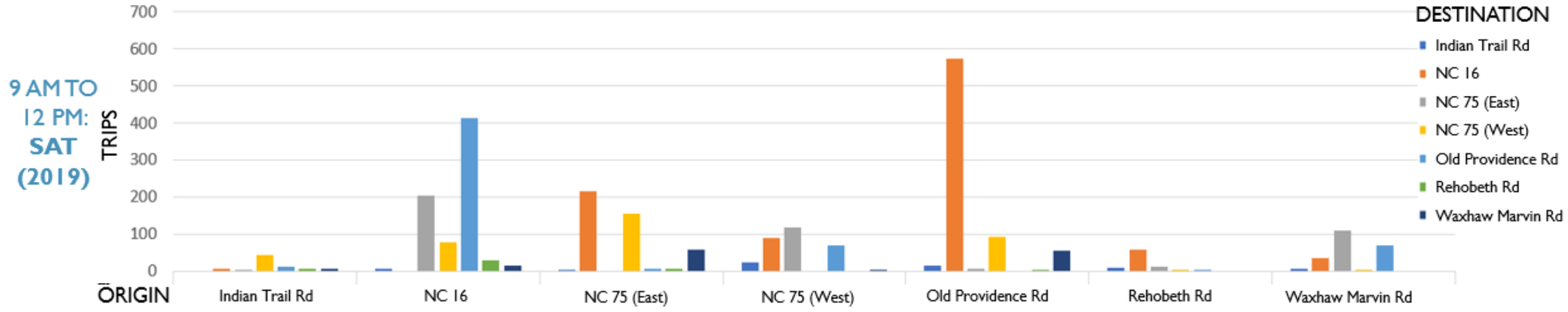


Figure 18. Origins and destinations for Saturday midday peak (9 am-12 pm) non-local trips through NC 16 and NC 75 in *2019*.

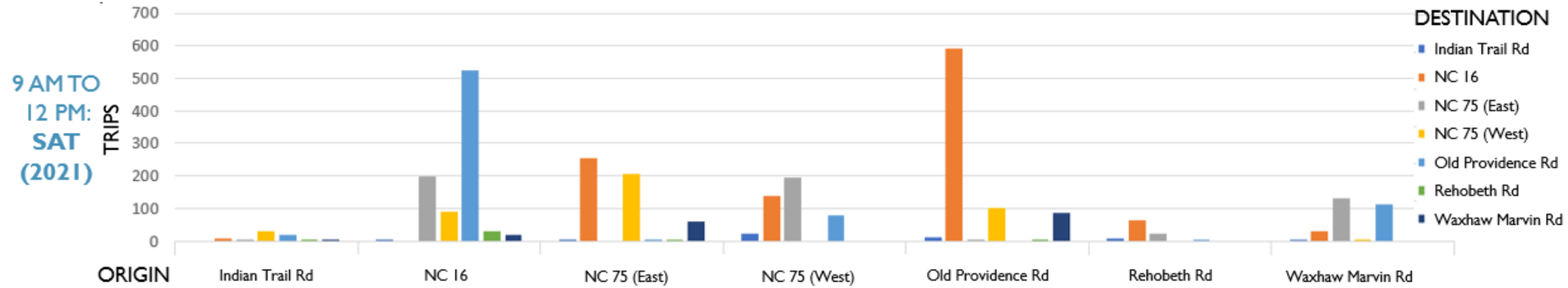


Figure 19. Origins and destinations for Saturday midday peak (9 am-12 pm) non-local trips through NC 16 and NC 75 in *2021*.

KEY FINDINGS

Key findings from the core O-D analysis are as follows:

- Travels patterns were similar in 2019 and 2021, although overall volumes increased slightly in 2021.
- O-D trends were similar during different days of the week (weekday vs. Saturday) and during different times of day (AM vs. midday vs. PM).
- In 2021, 32.5% of trips were local (1.5% with both trip ends in downtown and 31.0% with one trip end in downtown) and 67.5% of trips were non-local.
- For non-local trips, the most common O-D trip pair was between NC 16 & Waxhaw Pkwy and Old Providence Rd north of Waxhaw Farms Rd, representing those traveling between north and south of Downtown Waxhaw.
- Most trips (both local and non-local) passed through the intersection of NC 16 and NC 75.
- For all trips that passed through NC 16 & NC 75, the top local trips were between NC 16 & Waxhaw Pkwy and Downtown.
- For non-local trips that passed through NC 16 & NC 75, trips between east and west of Downtown increased between 2019 and 2021. However, overall trends by time-of-day remained similar between the two years.

PHASE 2 (REGIONAL) O-D ANALYSIS

The second phase of O-D analysis involved examining regional travel patterns around Waxhaw, moving away from the downtown core.

The following definitions were developed to apply to this phase of the analysis:

- **Study Area**: The regional area surrounding Waxhaw, encompassing approximately a two- to three-mile radius outside of the NC 16 & NC 75 intersection
- **External Gate**: Point within the study area where regional trip data is collected
- **Middle Filter**: Point within the study area where trips may pass through
- **Top Trip**: Trip with an average daily volume of over 500 vehicles per day

Figure 20, below, shows the StreetLight zones (external gates, labeled in blue, and middle filters, labeled in red) within the study area.

Figure 20. StreetLight zones and study area for Phase 2 (regional) analysis.

The regional study area was selected to capture regional pass-through trips crossing two analysis points to support evaluation of network routing for planning of the Waxhaw Parkway.

REGIONAL TRIPS: AGGREGATE TRIP ORIGINS

Figure 21 shows the four trip origins identified for purposes of the regional O-D analysis. Trips originating from within these four areas (north, south, east, and west) were aggregated together. Figure 21 also shows the total average daily trips originating from each of the four quadrants and ending in one of the other three quadrants.

Figure 21. Regional trip origins and number of trips originating from each quadrant.

REGIONAL TRIPS FROM THE NORTH AND SOUTH

Figure 22 shows the trip patterns through the regional study area originating from the north and ending in the east, south and west, with volumes aggregated from the northern external gates including:

- NC 16 north of Gray Byrum Road
- Cuthbertson Road east of NC 16
- Waxhaw Marvin Road north of Gray Byrum Road
- Kensington Drive west of Waxhaw Marvin Road

The number and percentage (out of total average daily trips from the north) for each destination is shown.

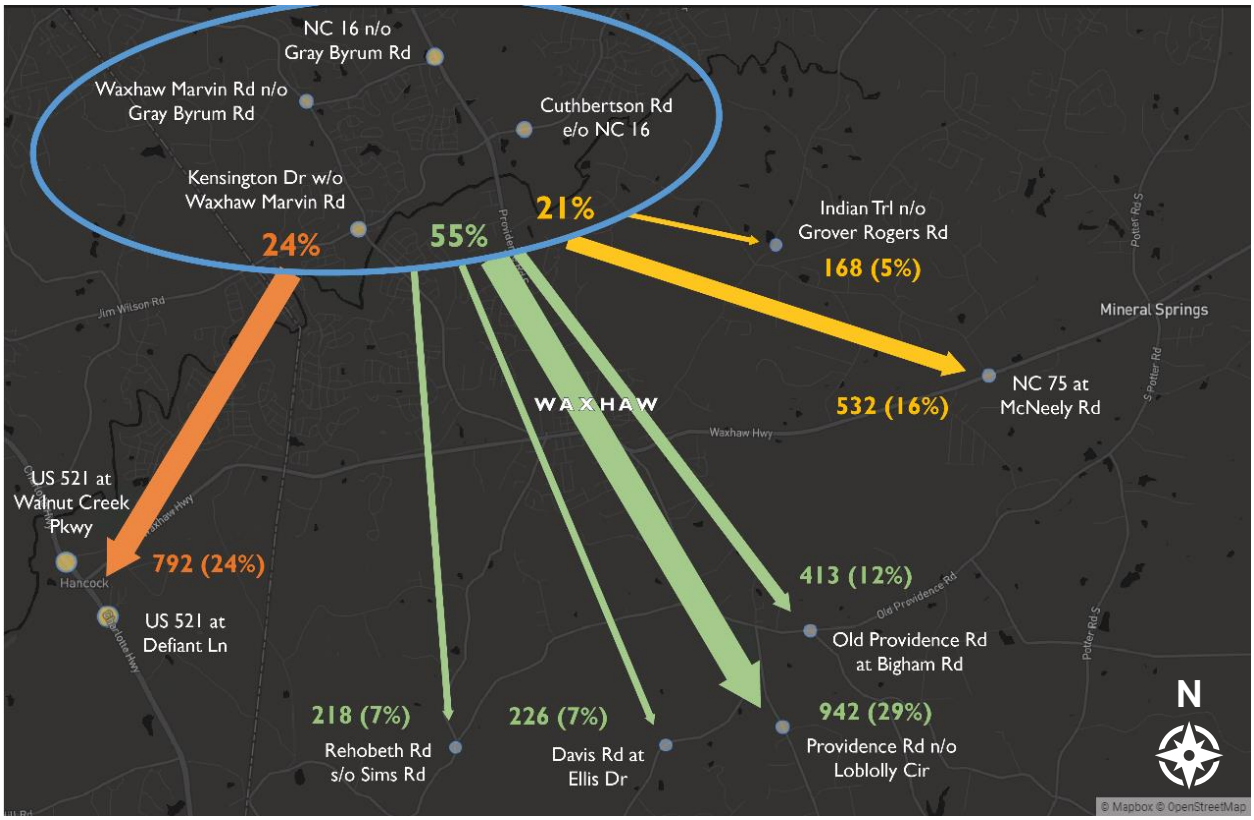


Figure 22. Distribution of regional trips originating from the north quadrant.

Figure 23 shows the trip patterns through the regional study area originating from the south and ending in the north, east, and west, with volumes aggregated from the southern external gates including:

- Old Providence Road at Bigham Road
- Providence Road north of Loblolly Circle
- Davis Road at Ellis Drive
- Rehobeth Road south of Sims Road

The number and percentage (out of total average daily trips from the south) for each destination is shown.

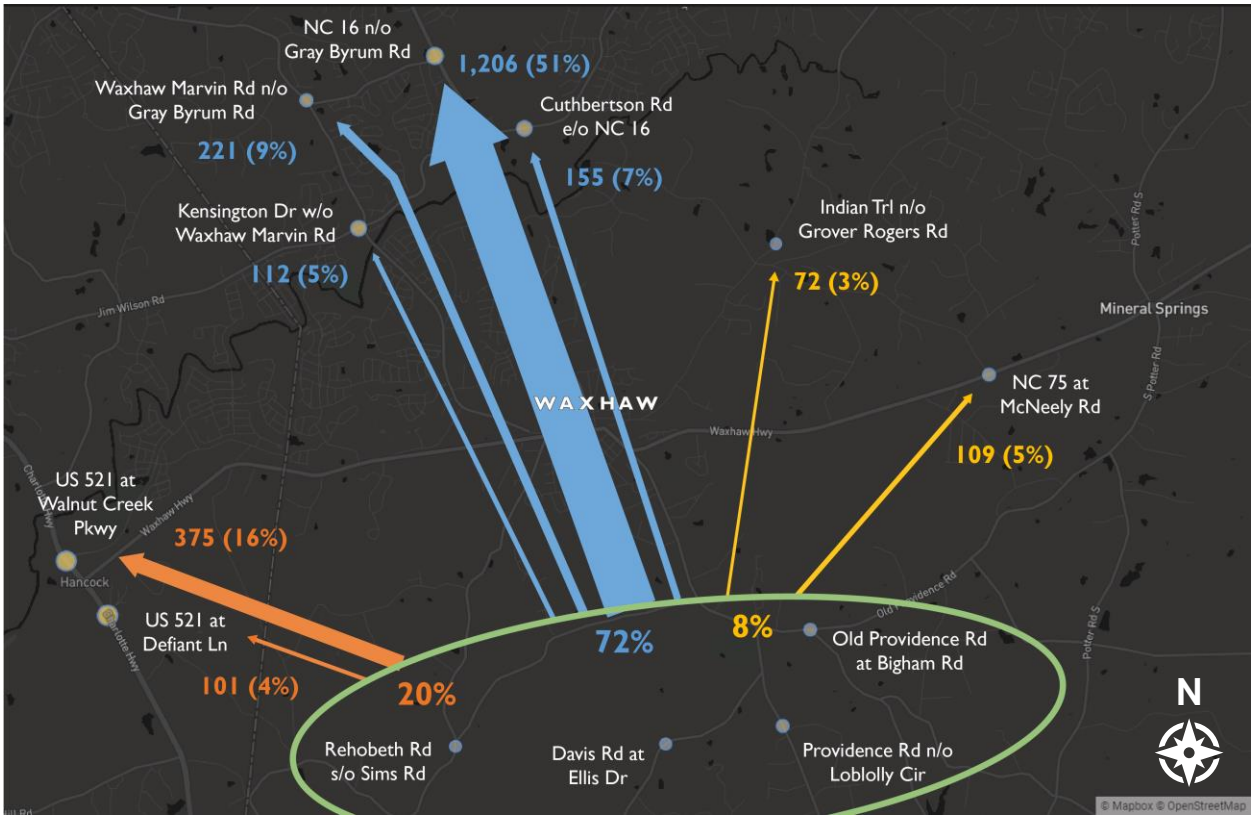


Figure 23. Distribution of regional trips originating from the south quadrant.

REGIONAL TRIPS FROM THE EAST AND WEST

Figure 24 shows the trip patterns through the regional study area originating from the east and ending in the north, south and west, with volumes aggregated from the eastern external gates including:

- Indian Trail north of Grover Rogers Road
- NC 75 at McNeely Road

The number and percentage (out of total average daily trips from the east) for each destination is shown.

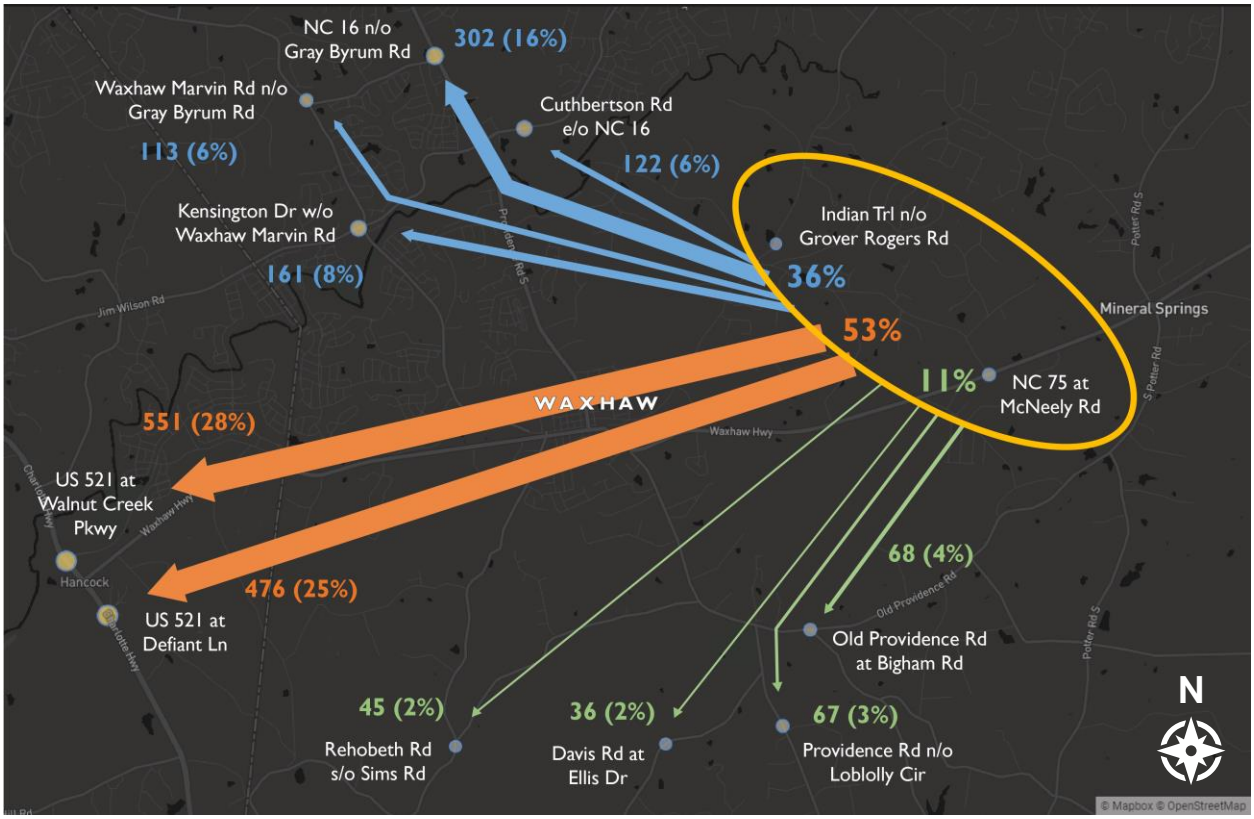


Figure 24. Distribution of regional trips originating from the east quadrant.

Figure 25 shows the trip patterns through the regional study area originating from the west, and ending in the north, east, and south, with volumes aggregated from the western external gates including:

- US 521 at Walnut Creek Pkwy
- US 521 at Defiant Ln

The number and percentage (out of total average daily trips from the west) for each destination is shown.

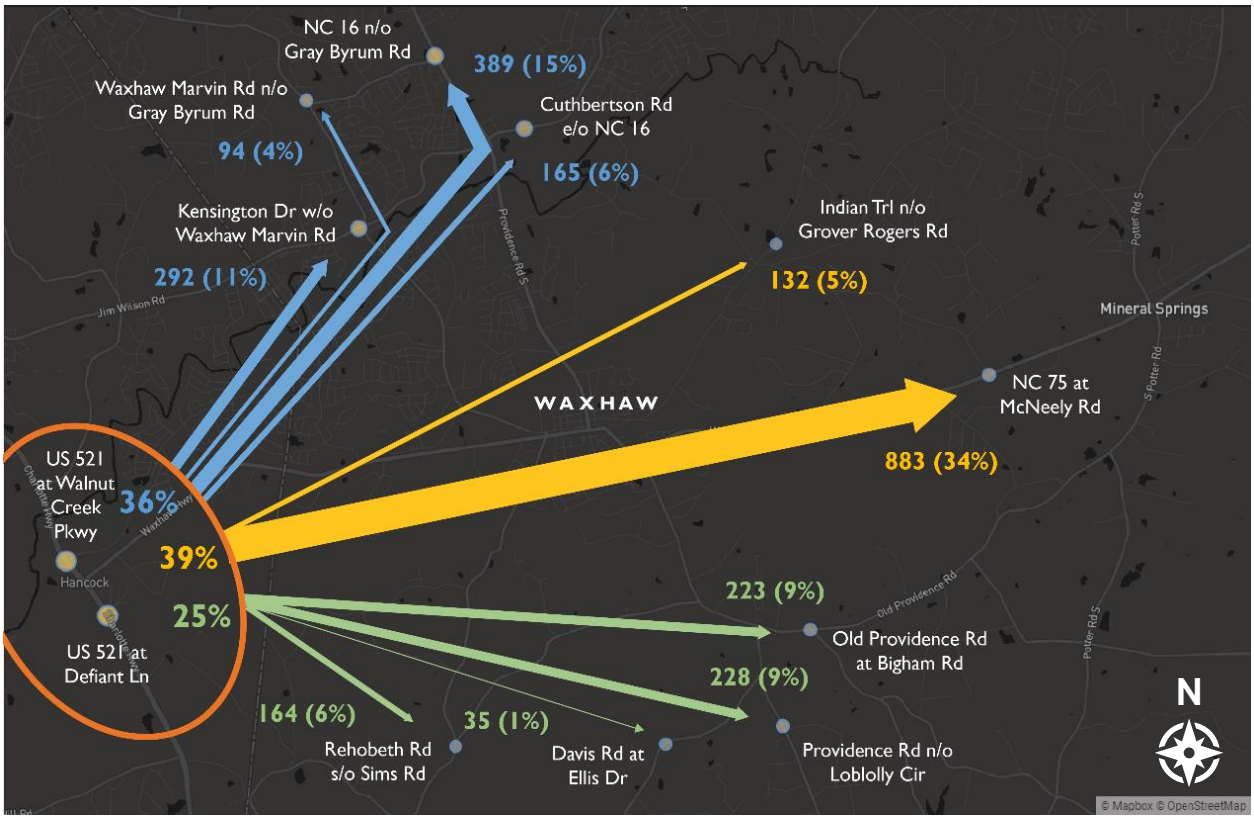


Figure 25. Distribution of regional trips originating from the west quadrant.

ROUTE CHOICE BY MIDDLE FILTER

North-West (Northwest Quadrant) Trips

Figure 26 shows the trips between the *Kensington Drive west of Waxhaw Marvin Road* and *US 521 at Walnut Creek Parkway* external gates as well as the trips within the northwest quadrant that pass through one of three middle filters in the quadrant, encompassing a majority of trips between the north and west. For trips through a middle filter, volumes have been aggregated for all trips from the northern external gates and all trips from the western external gates. Middle filters include:

- Waxhaw Marvin Road over Twelve Mile Creek
- Pine Oak Road
- NC 16 south of Pine Oak Road

The number and percentage (out of total average daily trips between the north and west) for each middle filter is shown.

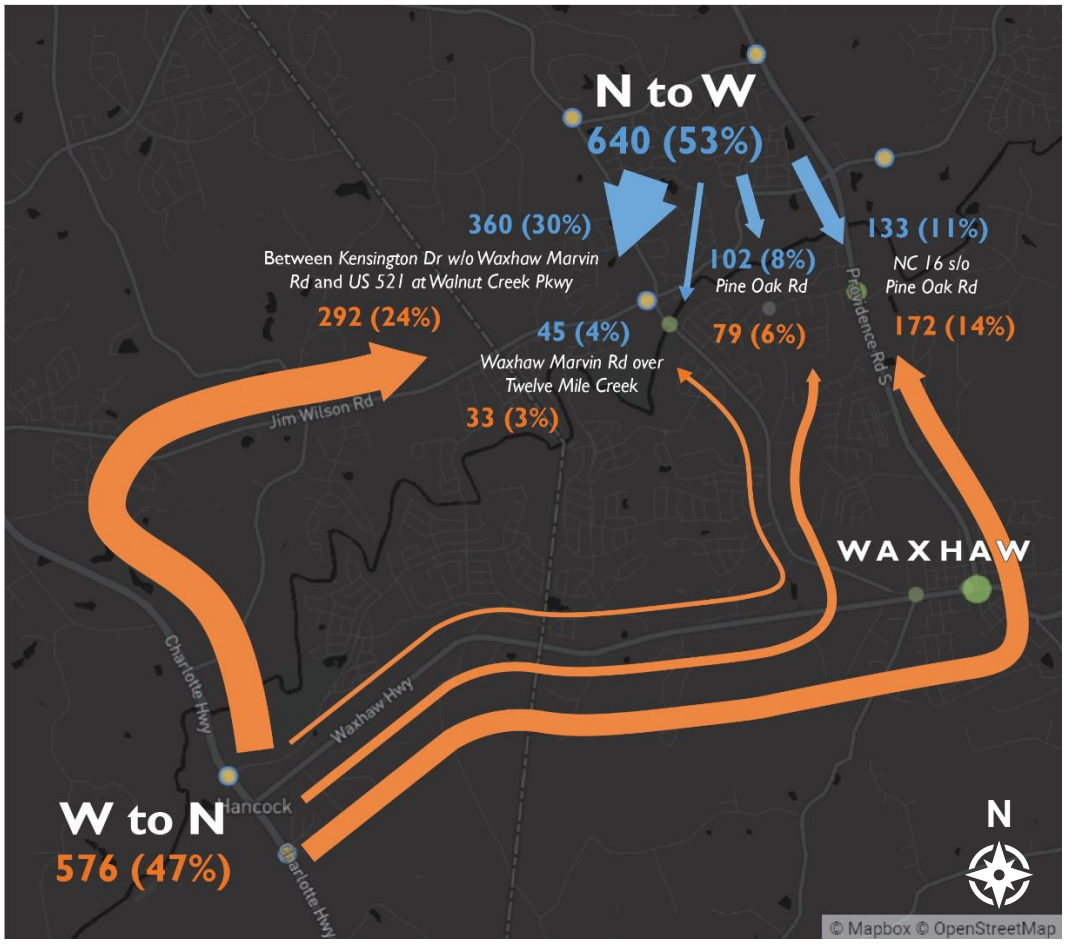


Figure 26. Distribution of trips by middle filter within the northwest quadrant.

North-South Trips

Figure 27 shows the downtown middle filter choices for trips between the north and south that pass through the downtown core in the regional study area. Volumes have been aggregated for all trips from the northern external gates and all trips from the southern external gates. Middle filters include:

- Rehobeth Rd at RR
- Church St at RR
- NC 16 & NC 75

The number and percentage (out of total average daily trips between the north south) for each middle filter is shown.

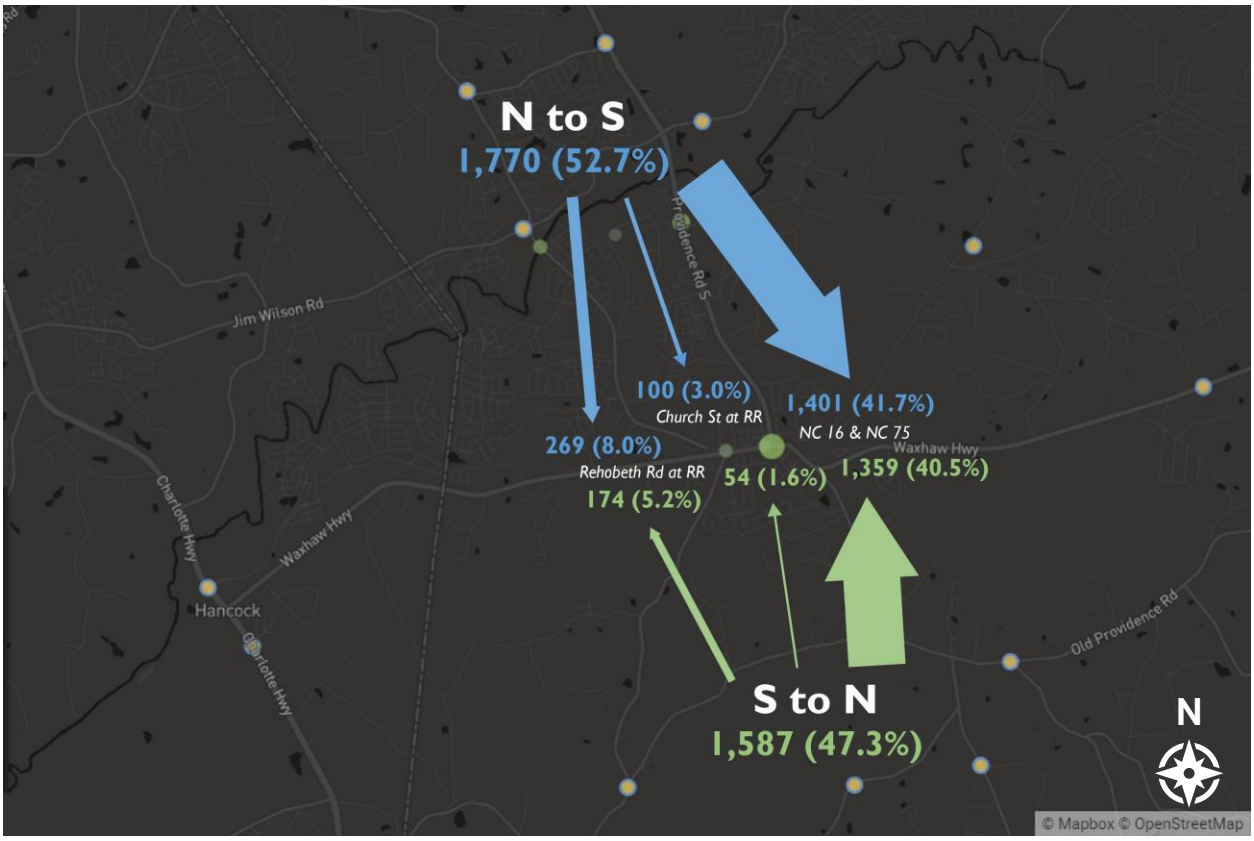


Figure 27. Distribution of trips through each downtown middle filter between the north and south.

REGIONAL TRIPS: NORTH-SOUTH AND EAST-WEST COMPARISON

Figure 28 shows the total average daily trips between the north and south as well as between the east and west from the regional study area. For comparison, the volumes of trips between these directions from the core study area are also depicted. The external gates from the core analysis were aggregated as follows:

- North
  - NC 16 & Waxhaw Parkway
- South
  - Old Providence Road north of Waxhaw Farms Road
  - Rehobeth Road at Bone Branch
- East
  - NC 75 at McNeely Branch
  - Waxhaw Indian Trail Road at Blythe Creek
- West
  - NC 75 east of Locklyn Road
  - Waxhaw Marvin Road east of Helms Road

Note that the trips between the north and south shown in Figure 28 are higher than those shown in Figure 27 since a small number of north-south trips did not pass through one of the three downtown middle filters.

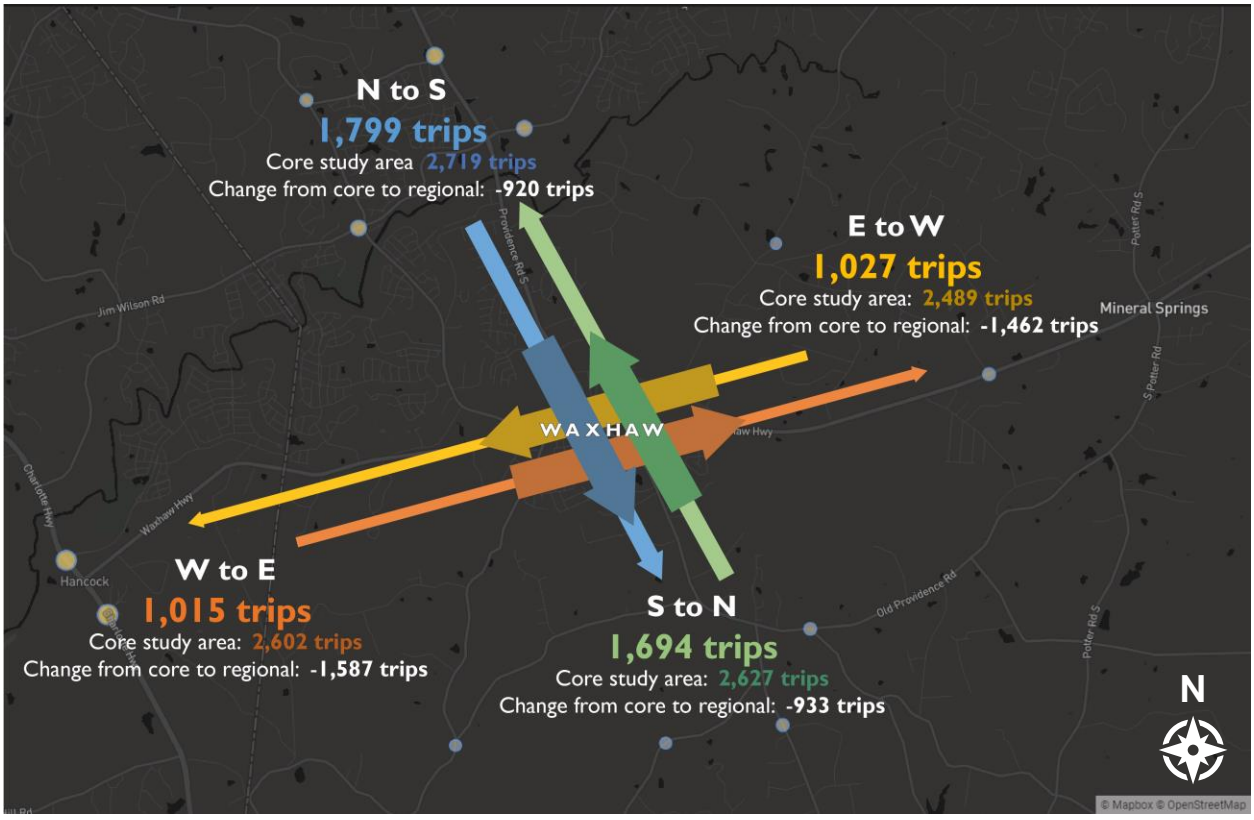


Figure 28. North-south and east-west trips within the regional and core study areas.

KEY FINDINGS

Key findings from the regional O-D analysis are as follows:

- Regional trips were evaluated based upon cardinal direction of origins.
  - From the south, 72% of trips were destined to the north along NC 16. These trips are less likely to be served by the northwest or northeast segments of the Parkway. In addition, 20% of trips from the south were destined towards the west and 8% were destined towards the east.
  - From the north, 55% of trips were destined to south of downtown Waxhaw. 24% were destined toward the west and 21% were destined toward the east.
  - From the west, 39% of trips were destined to the east, 36% towards the north, and 25% towards the south of downtown Waxhaw.
  - From the east, 53% of trips were destined to the west along NC 75, 36% were destined towards the north, and 11% were destined towards the south.
- For regional trips originating from the north and south, the strongest travels patterns are those continuing in the north and south directions. These trips are less likely to divert to utilize the northwest or northeast Parkway segments alone. Construction of both the northeast and southeast segments could provide a reasonable alternate route depending upon the final Parkway alignment. Alignment options closer to downtown are expected to be more attractive as an alternative route for regional vehicles traveling north-south. Trips originating from the north and traveling to the east and west have a greater potential to divert to the northwest and northeast Parkway segments.
- For regional trips originating from the east and west, the strongest travels patterns are those directly between the east and west as well as trips towards the north. Regional trips destined toward the north are candidates for possible diversion to the northwest and northeast Parkway segments. Completion of both the northwest and northeast Waxhaw Parkway would be needed to support potential east-west trip diversions. East-west through trips diverting to the Parkway are also expected to be impacted by levels of congestion at the NC 16 & NC 75 intersection since use of the parkway would result in a longer trip length.
- For regional trips between the west and north, over 50% of vehicles currently use Jim Wilson Road, 25% traveled through downtown, and the remainder used Waxhaw-Marvin Road and/or Pine Oak Road to bypass downtown. Diverting to northwest Waxhaw Parkway would become more attractive with the completion of programmed improvements, including the widening of NC 16 and the railroad overcrossing at Helms Road.

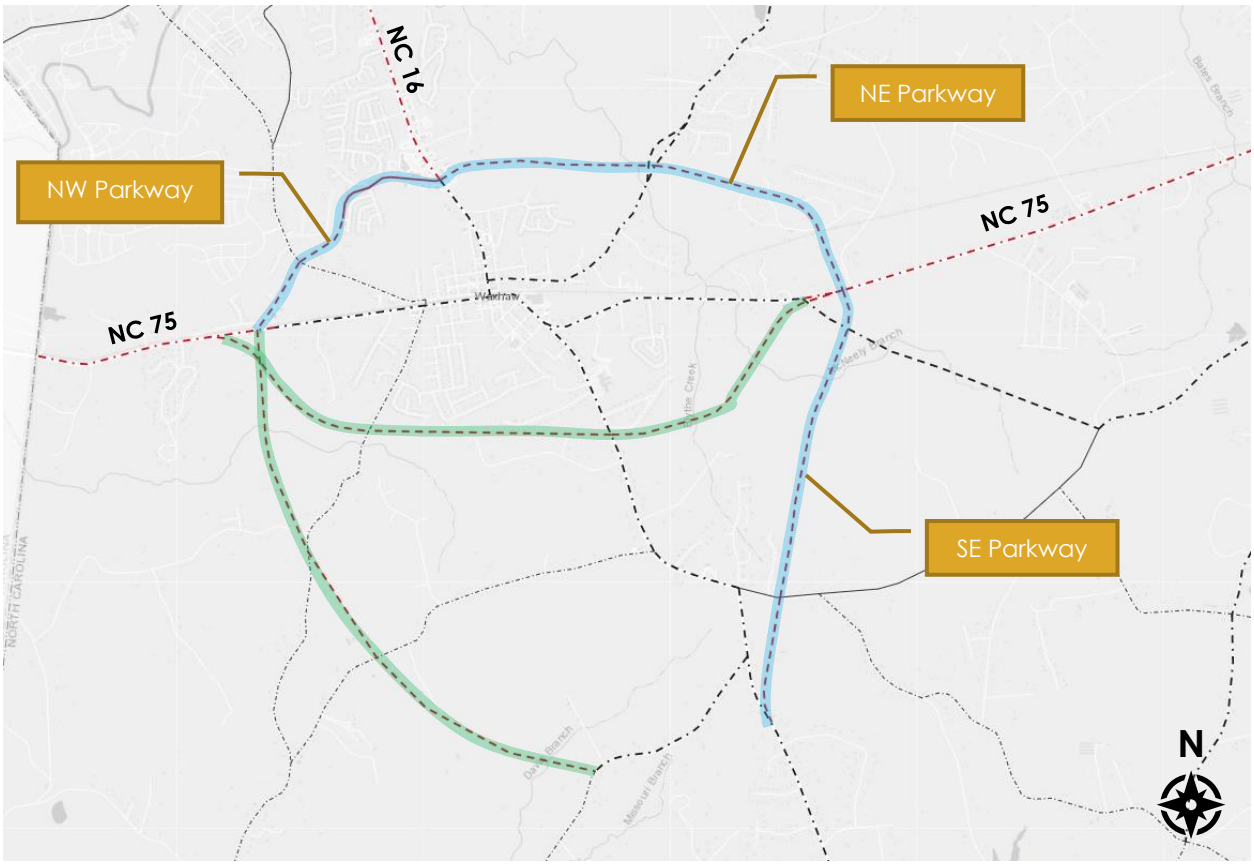
Section 3

Waxhaw Parkway Scenario Analysis

WAXHAW PARKWAY NETWORK SCENARIO ANALYSIS

The origin-destination evaluation, summarized in the previous section, highlights the existing traffic patterns in and around downtown Waxhaw. These patterns are heavily influenced by the existing roadway network, which offers limited network alternatives to avoid travel through the congested intersection of NC 16 and NC 75. As part of long-range planning, several new roadway facilities have been identified by the Town and other agency partners to expand the roadway network around downtown Waxhaw. Referred to as the Waxhaw Parkway, these new facilities are expected to support redistribution of traffic and reduce the volume of regional trips traveling through the historical downtown core. The analyses contained in this section presents an estimate of how Annual Average Daily Traffic (AADT) volumes may change on key roadway segments around downtown Waxhaw with incremental implementation of selected segments of the Waxhaw Parkway.

Figure 29 illustrates the proposed Waxhaw Parkway segments in blue and green. Blue highlighted lines reflect the northwest, northeast, and southeast segments of the Waxhaw Parkway that were evaluated as part of this study. Additional potential future segments of the Waxhaw Parkway are highlighted in green.



Note: Study Waxhaw Parkway segments highlighted in blue. Other potential future Waxhaw Parkway segments in green.

Figure 29. Conceptual Waxhaw Parkway alignments
(Source: CRTPO Comprehensive Transportation Plan Online Story Map).

Kittelson developed network volumes estimates based upon consideration of the existing origin-destination traffic patterns, application of the regional travel demand model, NCDOT traffic forecasts, and Traffic Impact Analysis studies from local development projects. Volume estimates were developed for design year 2045, which corresponds to the horizon year for the regional travel demand model. Kittelson estimated 2045 AADT volumes for the following network scenarios:

1. No-Build (No Waxhaw Parkway. Existing network plus funded roadway improvements only)
2. With implementation of NW Waxhaw Parkway
3. With implementation of NE Waxhaw Parkway
4. With implementation of NW and NE Waxhaw Parkway
5. With implementation of NW, NE, and SE Waxhaw Parkway

At four study intersections, Kittelson also developed 2045 AM and PM peak hour turning movement volume estimates and performed operational analyses. The intersection analyses are intended to provide an estimate of possible intersection performance and lane configuration needs. The analyses also allow for a relative comparison of how incremental Waxhaw Parkway construction may impact study intersection performance.

2045 NETWORK AADT VOLUME ESTIMATES

The origin-destination analyses in the previous section of this report provide insights into current travel patterns. However, continued regional development may result in shifts to these patterns over time. To account for future changes in population and employment within the Town of Waxhaw, as well as broader regional development, the Metrolina Regional Model (MRM) was applied with a horizon year of 2045.

Staff from the Charlotte Regional Transportation Planning Organization (CRTPO) completed all travel demand modeling for this project. Initial model development was completed by CRTPO for the northwest and northeast portions of the Waxhaw Parkway in 2020 to support prior investigations by Town staff. This served as the basis for developing model permutations for the remaining network scenarios considered in this study. The modeling was completed using model version MRM2001. At that time of this study, the latest MRM22v1.0 model version had not yet been released and MRM2001served as an interim build that applied utilized a 2018 based year, updated socioeconomic data, and updated funded roadway projects. Centroid connectors were also adjusted for scenarios that included the new Waxhaw Parkway segments.

The travel demand modeling was completed based upon the conceptual Parkway alignment illustrated in the CRTPO Comprehensive Transportation Plan. Alternative alignments for the northeast segments of the Waxhaw Parkway are being investigated in conjunction with NCDOT, which have the potential to influence the travel distance and attractiveness for some routes (such as vehicles traveling northbound and southbound from NC 16 to Old Providence Road). Similarly, the final alignment of the southeast segment of the Parkway may be subject to further adjustment which may impact future driver route selection.

All travel demand model scenarios included the widening of NC 16 (STIP project U-5796), the Helms Rd railroad grade separation (STIP project P-5749), and the connector roadway between NC 16 and Waxhaw-Marvin Road to be completed by a developer as part of the Howie Property project.

Model plots for each scenario are provided in Appendix A. Development of volume estimates for each network scenario utilized the model as a starting point with manual adjustments made based upon engineering judgment with consideration of localized traffic forecasts previously completed for the U-5796, P-5749, and more recent NCDOT Express Design Traffic Volume (EDTV) report prepared to support conceptual design for the northeast segments of the Waxhaw Parkway. Traffic volume diagrams for each of these previous studies are provided in Appendix B.

2018 AADT TRAFFIC VOLUMES

Figure 30 depicts 2018 AADT traffic volumes obtained from NCDOT in the area around downtown Waxhaw to provide a baseline of measured volumes under pre-COVID conditions. The year 2018 also reflects the base validation year for the MRM travel demand model for comparison purposes. Note that with these 2018 volume levels, existing congestion is present at the critical NC 16 and NC 75 intersection during multiple hours throughout the day.

Figure 30. 2018 AADT traffic volumes around Downtown Waxhaw (Source: NCDOT).

2045 NO-BUILD AADT VOLUME ESTIMATES

The estimated "no-build" volumes for horizon year 2045 are shown in Figure 31. This scenario assumes no segments of the Waxhaw Parkway are completed prior to year 2045. However, it does assume implementation of other regional projects that are currently programmed and funded by NCDOT, including widening of NC 16 north of Waxhaw Parkway (STIP project U-5796) and the Helms Rd railroad grade separation (STIP project P-5749).

Under this scenario, the existing capacity bottlenecks at the intersection of NC 16 and NC 75 are expected to impact vehicle route selection for north-south travel through the network. In particular, the new railroad grade separation and enhanced connection between Waxhaw-Marvin Road and NC 75 to the west of downtown is expected to result in higher growth along Pine Oak Road and Waxhaw Marvin Road as a parallel option to use of NC 16. Engineering judgement was applied to manually adjust forecasts from the MRM regional model under this scenario. Volume estimates reflect a balance between the MRM results (which reflect lower volumes on NC 16 and higher volumes on Waxhaw-Marvin Road) and the forecast for the NC 16 widening (STIP project U-5796). Volume estimates illustrated in Figure 31assume approximately 5,000 AADT will divert to Pine Oak Road and Waxhaw Marvin Road until the northwest portion of the Waxhaw Parkway is completed.

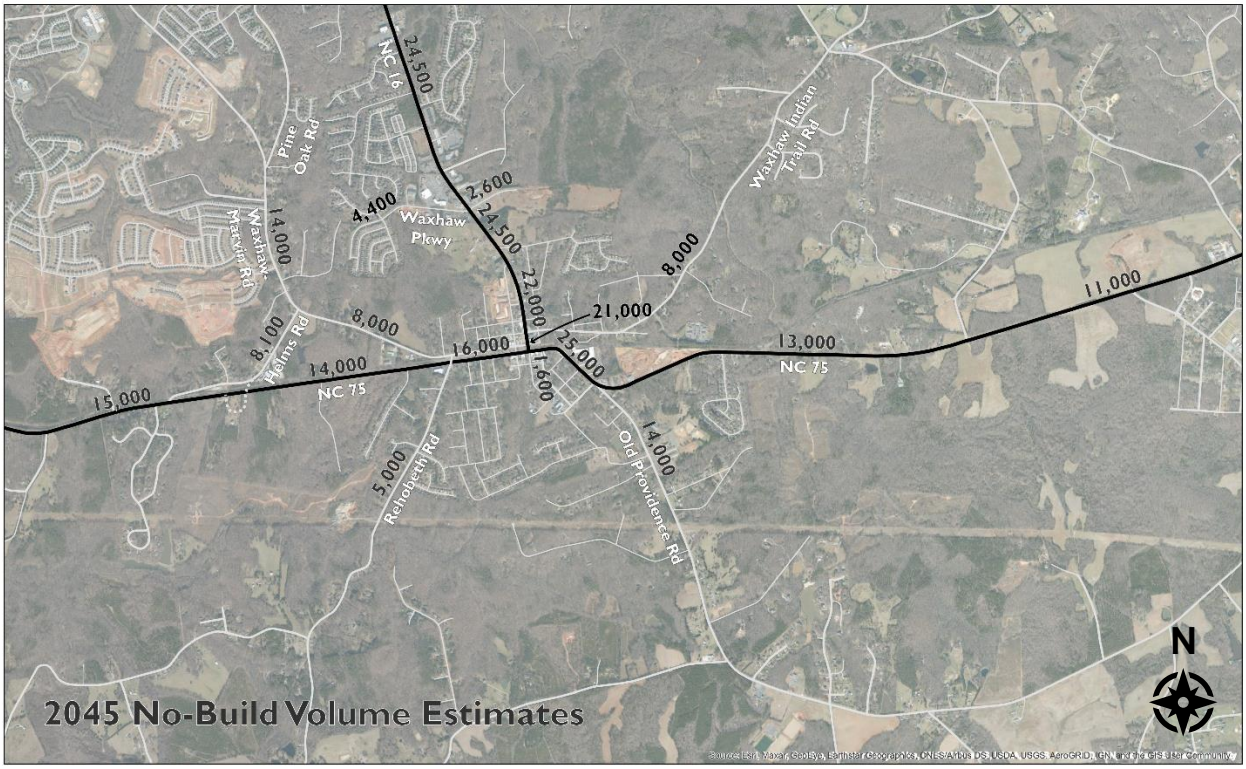


Figure 31. Estimated 2045 AADT volumes with no segments of the Waxhaw Parkway completed.

2045 BUILD AADT VOLUME ESTIMATES WITH NW PARKWAY

Figure 32 illustrates estimated 2045 AADT volumes with the implementation of the northwest portion of the Waxhaw Parkway, which would provide an alternate route for regional trips between the west and north along with enhanced network route choices for local circulation. Volume estimates for this scenario are grounded in the previously developed NCDOT forecast for the Helms Road grade separation project (STIP project P-5749) with refinement based upon consideration of the regional MRM model results, previous forecast for the NC 16 widening (STIP project U-5796), and EDTV for the northeast Waxhaw Parkway.

When compared to the 2045 no-build scenario, construction of the northwest portion of the Waxhaw Parkway is estimated to result in a shift of approximately 5,000 daily vehicles from Pine Oak Road and Waxhaw-Marvin Road back to NC 16. This is due to the widened NC 16 and new northwest Waxhaw Parkway providing a more direct route for regional travel between the north and west. Daily vehicular volume along NC 75 and NC 16 are estimated to be reduced by approximately 1,000 AADT to the west and north of downtown when compared to the no-build scenario. However, volumes through the NC 16 and NC 75 intersection are expected to still exceed 2018 levels.

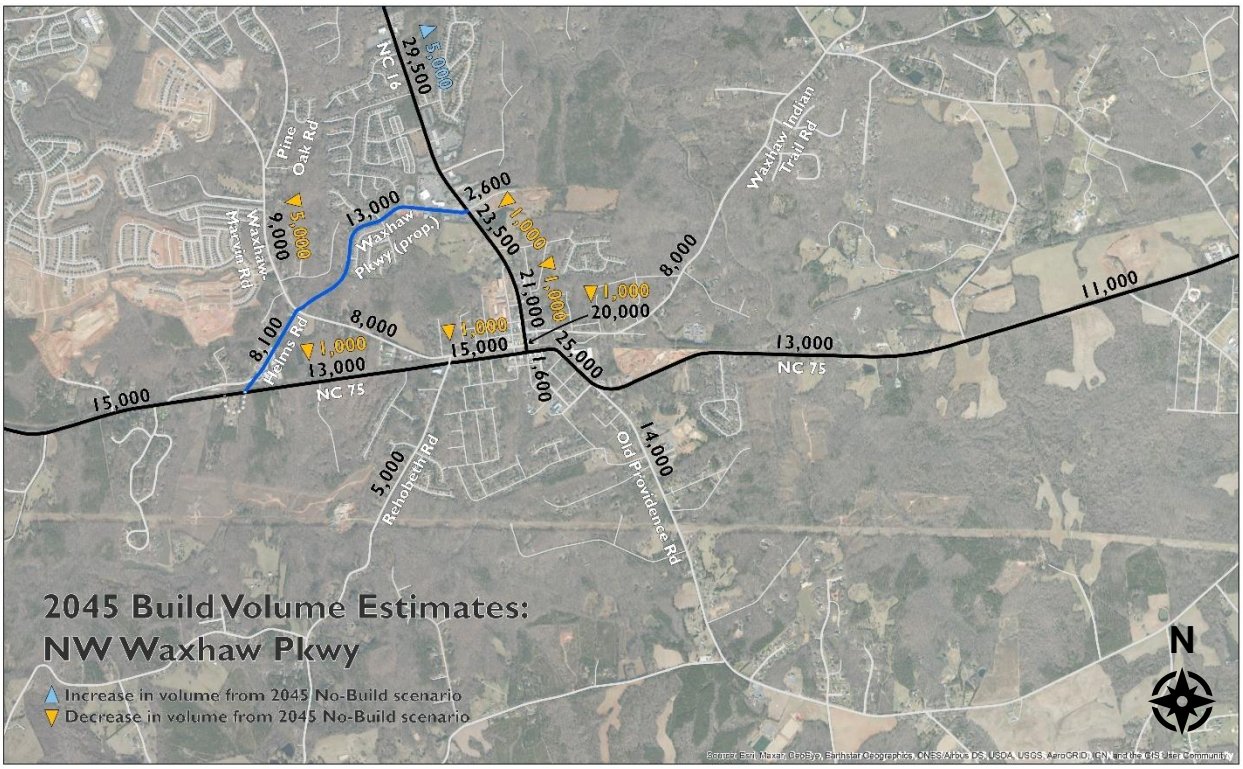


Figure 32. Estimated 2045 AADT volumes with the northwest segment of the Waxhaw Parkway.

2045 BUILD AADT VOLUME ESTIMATES WITH NE PARKWAY

Figure 33 illustrates the estimated 2045 volumes with the implementation of the northeast portion of the Waxhaw Parkway, which would provide an alternate route for regional trips between the east and north. The northeast segments of the Waxhaw Parkway also provide enhanced network connectivity for local circulation to support new development northeast of downtown Waxhaw.

Vehicular volume estimates along the northeast Waxhaw Parkway segments are based upon consideration of the MRM model and recent NCDOT EDTV forecast for the northeast Waxhaw Parkway. The addition of the northeast segment of the Parkway is expected to divert 4,000 to 6,000 AADT from segments of NC 16 and NC 75 to the north and east of downtown. Resulting daily vehicle volumes along NC 16, between NC 75 and Waxhaw Parkway, would be similar to 2018 volume levels. Volumes along NC 75 continue to exhibit growth compared to 2018 conditions.

Vehicles anticipated to utilize the northeast Waxhaw Parkway include diverted regional trips with O-D pairs traveling between the north (along NC 16) and east (along NC 75), vehicles currently traveling along Waxhaw Indian Trail, and new development directly accessing the parkway segments. Depending upon the final alignment, some vehicles making regional trips between the south (along Old Providence Road) and north (along NC 16) may also divert to use the northeast Waxhaw Parkway instead of traveling through downtown Waxhaw. For modeling purposes, the alignment of the northeast Waxhaw Parkway is assumed to be consistent with information contained in the CRTPO Comprehensive Transportation Plan. This alignment connects with NC 75 near Collins Road, as illustrated in Figure 33. Alternative alignments are being explored in conjunction with NCDOT that are shifted closer to downtown. Based upon the results of the Origin-Destination Study, presented in the first section of this report, strong north-south regional travel patterns are present between NC 16 and Old Providence Road. Alignment options closer to the downtown core are expected to better serve as a viable alternative for regional north-south trips and could result in greater diversions than those predicted in the MRM model and estimated in Figure 33.

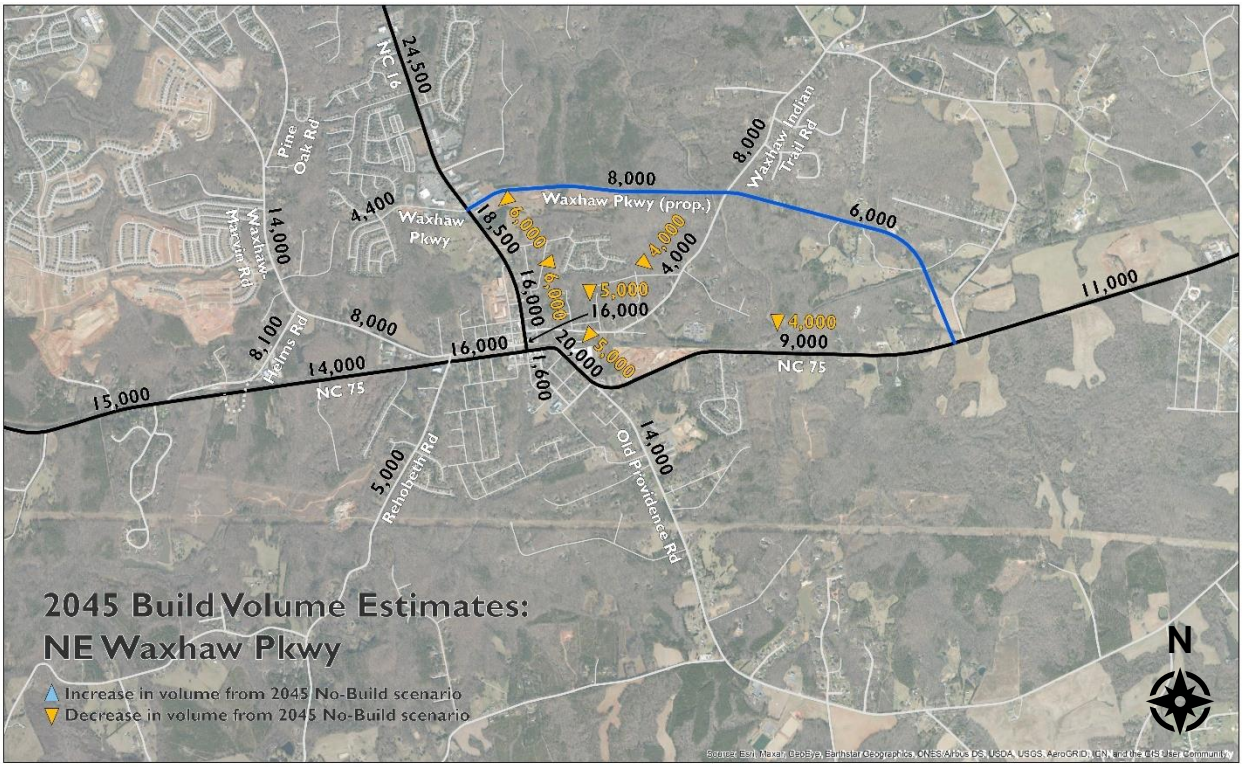


Figure 33. Estimated 2045 AADT volumes with the northeast segment of the Waxhaw Parkway.

2045 BUILD AADT VOLUME ESTIMATES WITH NW AND NE PARKWAY

The estimated 2045 AADT volumes with the construction of both the northwest and northeast portions of the Waxhaw Parkway are illustrated in Figure 34. Completion of both segments provides an alternative route for regional east-west travel to avoid the critical intersection at NC 16 and NC 75. Due to a longer travel distance, use of the Parkway for east-west regional travel would likely be attractive primarily during peak-hour conditions when there is increased potential for congestion in downtown Waxhaw. Therefore, limited re-assignment of east-west vehicle trips from NC 75 to the Parkway was assumed. However, the completion of both parkway segments does provide further enhancement of network connectivity for local trips.

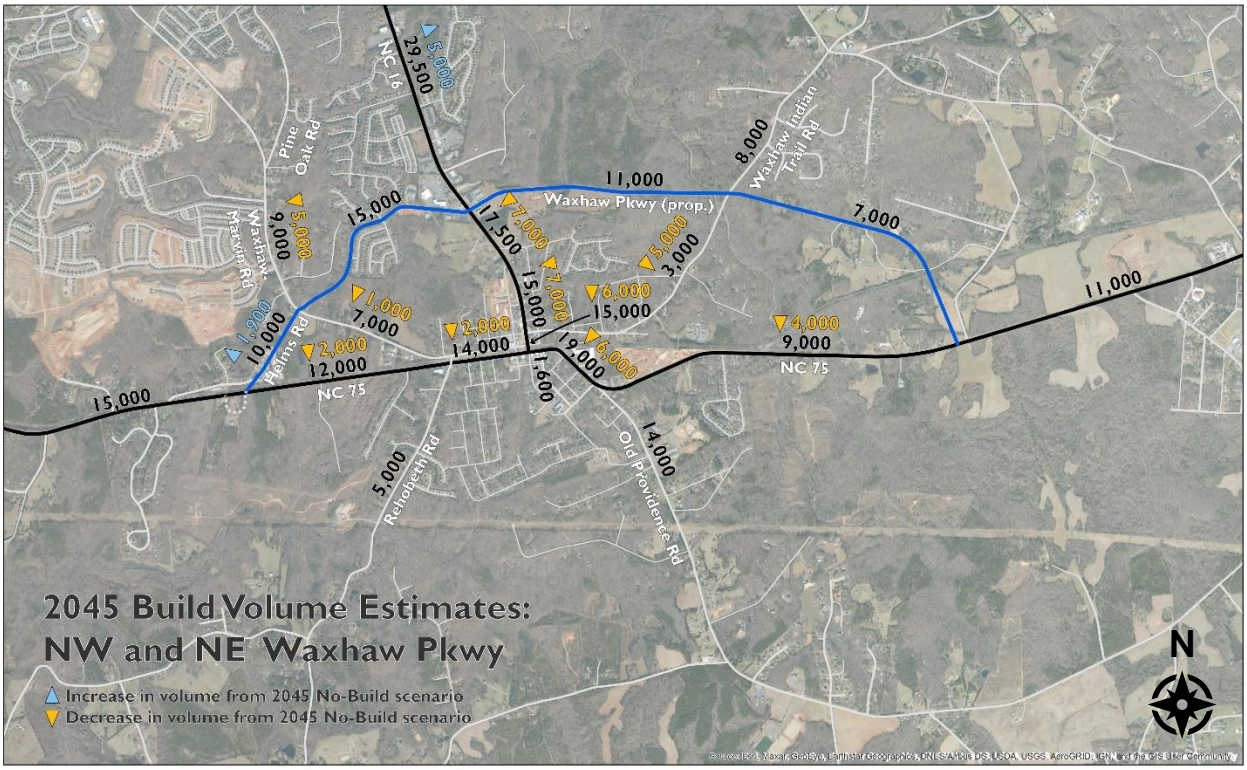


Figure 34. Estimated 2045 AADT volumes with the northwest and northeast segments of the Waxhaw Parkway.

2045 BUILD AADT VOLUME ESTIMATES WITH NW, NE, AND SE PARKWAY

Figure 35 illustrates the estimated 2045 volumes with the implementation of the northwest, northeast, and southeast portions of the Parkway. Extension of the Waxhaw Parkway into the area southeast of downtown Waxhaw would provide an alternate route for north-south trips currently utilizing Old Providence Road as well as new development projected in the area between Old Providence Road and NC 75. Under this scenario, further reductions in north-south regional trips through downtown Waxhaw are expected, which is estimated to result in AADTs at the NC 16/NC 75 intersection returning to levels near existing conditions.

For modeling purposes, the alignment of the northeast Waxhaw Parkway is assumed to be consistent with information contained in the CRTPO Comprehensive Transportation Plan. For vehicles traveling regionally north-south between NC 16 and Old Providence Road, this alignment does increase travel distance compared to the existing route through downtown Waxhaw. This may impact the attractiveness of the alternate Waxhaw Parkway route. Shifting the alignment of the northeast and southeast segments further west, to be closer to downtown, would result in a shorter travel distance and could encourage higher usage of the Waxhaw Parkway compared to AADT estimates illustrated in Figure 35.

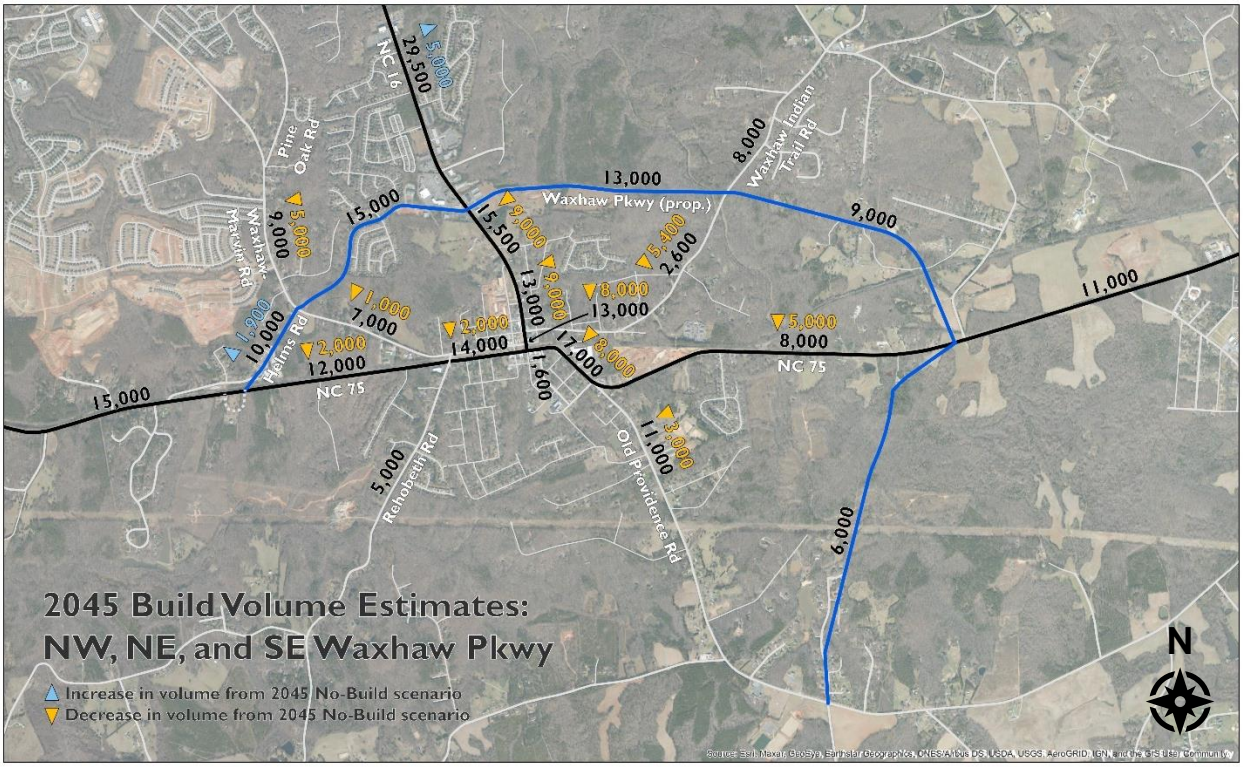


Figure 35. Estimated 2045 AADT volumes with the northwest, northeast, and southeast segments of the Waxhaw Parkway.

KEY FINDINGS

The Waxhaw Parkway would provide important network route alternatives to support growth in both local and regional trips. Buildout of the combined northwest, northeast, and southeast Parkway segments is expected to allow 2045 AADT volumes in downtown Waxhaw (at the intersection of NC 16/NC 75) to return to similar AADTs as 2018 conditions. However, in the years prior to the parkway being constructed, volume levels in downtown Waxhaw are expected to continue to rise, even with individual parkway segment implementation. Improvements to downtown intersections, including at NC 16 and NC 75, are expected to be needed even with the Waxhaw Parkway implementation.

INTERSECTION ANALYSIS

For each Waxhaw Parkway AADT volume scenario presented in the previous section, AM and PM peak hour operational analyses were conducted for the following key intersections.

- NC 16 and NC 75,
- NC 16 and Waxhaw Parkway,
- NC 75 and Old Providence Road, and
- Waxhaw Parkway and Waxhaw Indian Trail Road.

The intersection analyses are intended to provide a planning-level estimate of possible intersection performance and lane configuration needs. The analyses also allow for a relative comparison of how incremental Waxhaw Parkway construction may impact study intersection performance.

Kittelson developed AM and PM peak hour volume estimates utilizing typical NCDOT tools, including the Intersection Analysis Utility, to convert from segment AADTs to hourly intersection turning movement volumes. However, these peak hour volumes are intended for planning-level use only and do not reflect the level of precision typical of an NCDOT forecast for design purposes. This includes planning-level AADT estimates and use of assumed K, D, and T factors from previous NCDOT forecasts instead of collection of new intersection-level turning movement count data. For each network scenario, Kittelson estimated the AM and PM peak hour intersection turning movement volumes utilizing K and D factors from the NCDOT EDTV Report for the northeast Waxhaw Parkway, dated October 14, 2021. This was supplemented by traffic factor data from prior forecasts for the widening of NC 16 north of Waxhaw Parkway (STIP project U-5796) and the Helms Rd railroad grade separation (STIP project P-5749).

Unless stated otherwise, the operational analysis results are based upon the Highway Capacity Manual (HCM) 6th Edition methodologies, as implemented through the Synchro software for signal analysis and the SIDRA Intersection software for roundabout analysis. Operational analyses also adhere to NCDOT Capacity Analysis Guidelines.

The following abbreviations apply to the tables in the remainder of this section summarizing the evaluated lane configurations and corresponding operational analysis results:

- L = left turn lane
- T = through lane
- R = right turn lane
- LT = shared left turn and through lane
- TR = shared through and right turn lane
- LTR = shared left turn, through, and right turn lane
- V/C = Volume to capacity ratio
- LOS = Level of service

NC 16 AND NC 75 INTERSECTION

The intersection of NC 16 and NC 75 is currently traffic signal controlled and influenced by a rail crossing on the north leg in close proximity to the intersection. Even under existing volume conditions, the intersection experiences extensive queuing and delay under various peak hours throughout the day. This important intersection within downtown Waxhaw was previously studied as part of the Union County Critical Intersection project to identify possible improvements within the site constraints. Supplemental analyses by Kittelson, included in this report, cover three different lane configuration options for each of the five network configuration scenarios to estimate 2045 AM and PM peak hour operational performance.

Assumed 2045 Lane Configurations

For the NC 16 and NC 75 intersection, three different lane configuration options were evaluated. These include (1) existing lane configurations, (2) the current preferred improvement alternative (as identified by Town staff) based upon prior Union County Critical Intersection project analyses, and (3) lane configurations anticipated to be needed to support an overall intersection LOS of "D" or better for each individual Waxhaw Parkway build scenario in the 2045 AM and PM peak hours.

Figure 36 illustrates the existing lane configurations at NC 16 and NC 75. Figure 37 illustrates the lane configurations for the preferred alternative from the Union County Critical Intersection project. Lane configurations needed to achieve LOS "D" under each scenario are summarized in Table 4.

Figure 36. Existing lane configurations at NC 16 and NC 75.

Figure 37. Preferred lane configurations at NC 16 and NC 75 from Union County Critical Intersection project.

Operational Analysis Results

For each network scenario, Kittelson estimated the AM and PM peak hour intersection turning movement volumes utilizing K and D factors from the NCDOT EDTV Report for the northeast Waxhaw Parkway, dated October 14, 2021. Analysis of the signal operations was performed utilizing the Synchro software.

Analysis results for the AM and PM peak hour in design year 2045 with *existing* lane configurations are summarized in Table 2. These results reflect overall intersection average conditions. A summary of approach level results is provided in Appendix C.

Under all network scenarios, including construction of the combined northwest, northeast, and southeast Waxhaw Parkway segments, the existing intersection lane configurations are not anticipated to provide the desired operational performance. Overall average intersection conditions are anticipated to be at LOS "F" during at least one peak hour period.

Table 2. NC 16/NC 75 2045 Signal Alternative Results: *Existing Conditions*

	AM Peak Hour			PM Peak Hour		
Network Scenario	**Overall Intersection Average Delay (s)**	**Intersection Level of Service**	**Critical Movement V/C Ratio**	**Overall Intersection Average Delay (s)**	**Intersection Level of Service**	**Critical Movement V/C Ratio**
No-Build	506.9	F	4.32	763.3	F	5.63
NW Pkwy Only	383.3	F	3.76	556.9	F	4.56
NE Pkwy Only	184.2	F	2.25	353.7	F	3.44
NW + NE Pkwy	88.4	F	1.59	293.0	F	3.15
NW + NE + SE Pkwy	58.6	E	1.37	157.6	F	2.21

With modification of the intersection lane configurations to reflect those illustrated in Figure 37, the overall performance of the intersection is estimated to improve under all network scenarios compared to existing lane configurations. Results of the analysis for the preferred alternative from the Union County Critical Intersection project is summarized in Table 3. These results reflect overall intersection average conditions. A summary of approach level results is provided in Appendix C.

For the no-build and northwest Parkway scenarios with application of the Union County Critical Intersection project recommendations illustrated in Figure 37, the improved lane configurations are still expected to result in an overall average intersection LOS of "F" by year 2045 during the AM and PM peak hours. However, the overall intersection LOS is expected to be "D" or better for the remaining three scenarios. Note that the critical movement v/c ratio in the northeast Parkway scenario during the AM and PM peak hours is above 1.0, but drops to below 1.0 in the scenarios with more than one parkway segment constructed. Additional details regarding approach-level delay, level of service and queue lengths are provided in Appendix C.

Table 3. NC 16/NC 75 2045 Signal Alternative Results: *Union County Critical Intersection Alternative*

	AM Peak Hour			PM Peak Hour		
Network Scenario	**Overall Intersection Average Delay (s)**	**Intersection Level of Service**	**Critical Movement V/C Ratio**	**Overall Intersection Average Delay (s)**	**Intersection Level of Service**	**Critical Movement V/C Ratio**
No-Build	171.4	F	1.70	186.4	F	1.82
NW Pkwy Only	89.3	F	1.21	89.6	F	1.20
NE Pkwy Only	48.1	D	1.01	52.2	D	1.10
NW + NE Pkwy	44.7	D	0.98	43.0	D	0.99
NW + NE + SE Pkwy	32.6	C	0.82	31.8	C	0.81

The final scenario for NC 16 and NC 75 included evaluation of the lane configurations needed to achieve an overall intersection LOS of "D" or better and a critical movement v/c ratio of less than 1.0 under each network configuration. Table 4 summarizes the lane configurations assumed for each intersection approach under each network configuration. Table 5 summarizes the corresponding operational analysis results.

The same lane configurations were utilized on the west and south legs for each network scenario. These match those proposed under the Union County Critical Intersection project. However, lane configurations on the north and east legs vary by scenario. Most scenarios were identified to require dedicated dual left turn lanes on the southbound approach. For the no-build (no Waxhaw Parkway segments) and northwest Waxhaw Parkway only scenarios, dual right turns on the east leg are also anticipated to be needed prior to year 2045. Implementation of the northeast Waxhaw Parkway segments is estimated to result in a single westbound right turn lane providing sufficient operations through year 2045.

Table 4. NC 16/NC 75 Signal Alternative Lane Configurations to Achieve LOS "D" and V/C < 1.0

	No-Build	NW Pkwy Only	NE Pkwy Only	NW + NE Pkwy*	NW + NE + SE Pkwy
West Leg: NC 75 (Eastbound Approach)	L | TR	L | TR	L | TR	L | TR	L | TR
East Leg: NC 75 (Westbound Approach)	LT | R | R	LT | R | R	LT | R	LT | R	LT | R
South Leg: NC 16 (Northbound Approach)	LTR	LTR	LTR	LTR	LTR
North Leg: NC 16 (Southbound Approach)	L | L | TR	L | L | TR	L | L | TR	L | LTR	L | TR

*Matches Union County Critical Intersection study lane configurations

Table 5. NC 16/NC 75 2045 Signal Alternative Results: *Lane Configurations to Achieve LOS "D" and V/C < 1.0*

	AM Peak Hour			PM Peak Hour		
Network Scenario	**Overall Intersection Average Delay (s)**	**Intersection Level of Service**	**Critical Movement V/C Ratio**	**Overall Intersection Average Delay (s)**	**Intersection Level of Service**	**Critical Movement V/C Ratio**
No-Build	40.9	D	0.89	40.4	D	0.97
NW Pkwy Only	29.4	C	0.78	29.7	C	0.82
NE Pkwy Only	31.4	C	0.86	31.8	C	0.86
NW + NE Pkwy	44.7	D	0.98	43.0	D	0.99
NW + NE + SE Pkwy	28.5	C	0.80	29.8	C	0.83

Note that, for the scenario with the northwest, northeast, and southeast Parkway segments, a single dedicated southbound left turn lane is estimated to be sufficient in order to achieve an overall intersection LOS "D" and critical v/c ratio of less than 1.0 during the AM and PM peak hours. This would provide an advantage of potentially avoiding impacts to existing on-street parking.

NC 16 AND WAXHAW PARKWAY INTERSECTION

The intersection of NC 16 and Waxhaw Parkway is currently stop controlled. On the NC 16 approaches, a single through lane and a dedicated left turn lane is currently provided. However, STIP project U-5796 will widen NC 16 to two through lanes in each direction. The west leg currently provides a dedicated left turn and shared through/right turn lane. A shared left turn/through/right turn lane is present on the east leg. The NC 16 and Waxhaw Parkway intersection traffic patterns are expected to be substantially impacted by the widening of NC 16 and incremental implementation of the Waxhaw Parkway. Therefore, Kittelson evaluated traffic signal and roundabout control options under each of the five network configuration scenarios to compare potential 2045 AM and PM peak hour operational performance.

For each of the five network scenarios, Kittelson estimated the AM and PM peak hour intersection turning movement volumes utilizing the NCDOT Intersection Analysis Utility. Assumed K and D factors were obtained from the NCDOT EDTV Report for the northeast Waxhaw Parkway dated October 14, 2021. For scenarios without the northeast segment of the Waxhaw Parkway, K and D factors were adjusted based upon engineering judgement for the west leg of the intersection to reflect the change in network connectivity. A summary of inputs and outputs from the NCDOT Intersection Analysis Utility is provided in Appendix D for each network scenario along with the corresponding operational analysis results.

Assumed 2045 Lane Configurations: Signal Alternative

Separate signalized intersection lane configurations were evaluated for each network scenario to provide LOS "D" or better operations. Lane configuration needs identified for each network scenario are summarized in Table 6 based upon the specific intersection turning movement patterns.

Table 6. Assumed NC 16/Waxhaw Parkway Signal Lane Configurations

	No-Build	NW Pkwy Only	NE Pkwy Only	NW + NE Pkwy	NW + NE + SE Pkwy
West Leg: Waxhaw Parkway (Eastbound Approach)	L | TR	L | TR	L | TR	L | L | TR	L | L | TR
East Leg: Waxhaw Parkway (Westbound Approach)	LTR	L | TR	LT | R	L | T | R	L | T | R
South Leg: NC 16 (Northbound Approach)	L | T | TR	L | T | TR	L | T | TR	L | T | TR	L | T | TR
North Leg: NC 16 (Southbound Approach)	L | T | TR	L | T | T | R	L | L | T | TR	L | T | TR	L | L | T | TR

Operational Analysis Results: Signal Alternative

For each network scenario, Table 7 summarizes the analysis results corresponding to the lane configurations from Table 6 for the AM and PM peak hours in design year 2045. These results reflect overall intersection average conditions. A summary of approach level results is provided in Appendix D.

Table 7. NC 16/Waxhaw Parkway 2045 Signal Alternative

	AM Peak Hour			PM Peak Hour		
	Overall Intersection Average Delay (s)	Intersection Level of Service	Critical Movement V/C Ratio	Overall Intersection Average Delay (s)	Intersection Level of Service	Critical Movement V/C Ratio
No-Build	21.4	C	0.76	34.2	C	0.92
NW Pkwy Only	36.9	D	0.87	45.3	D	0.93
NE Pkwy Only	32.4	C	0.83	39.1	D	0.87
NW + NE Pkwy	41.1	D	0.86	55.0	D	0.98
NW + NE + SE Pkwy	39.3	D	0.89	48.4	D	0.92

Assumed 2045 Lane Configurations: Roundabout Alternative

For the roundabout alternative at NC 16 and Waxhaw Parkway, one lane configuration option was evaluated with the intent to provide flexibility for supporting the range of network configuration scenarios. Figure 38 provides a schematic depiction of the evaluated lane configurations from the SIDRA Intersection Software. This is not intended to reflect any geometric recommendations for a roundabout at the study intersection.

Note that for the no-build network scenario, single-lane eastbound and westbound approaches may be sufficient with two-lane northbound and southbound approaches to correspond to the planned widening of NC 16. The separate left turn lane on the eastbound approach is not expected to be needed until the northwest Waxhaw Parkway segment is constructed. Similarly, the additional yield controlled right turn bypass lane on the westbound approach is not expected to be needed until the northeast Waxhaw Parkway segments are constructed. However, any phased implementation of a roundabout should consider the full build-out when establishing the roundabout geometry and required intersection footprint.

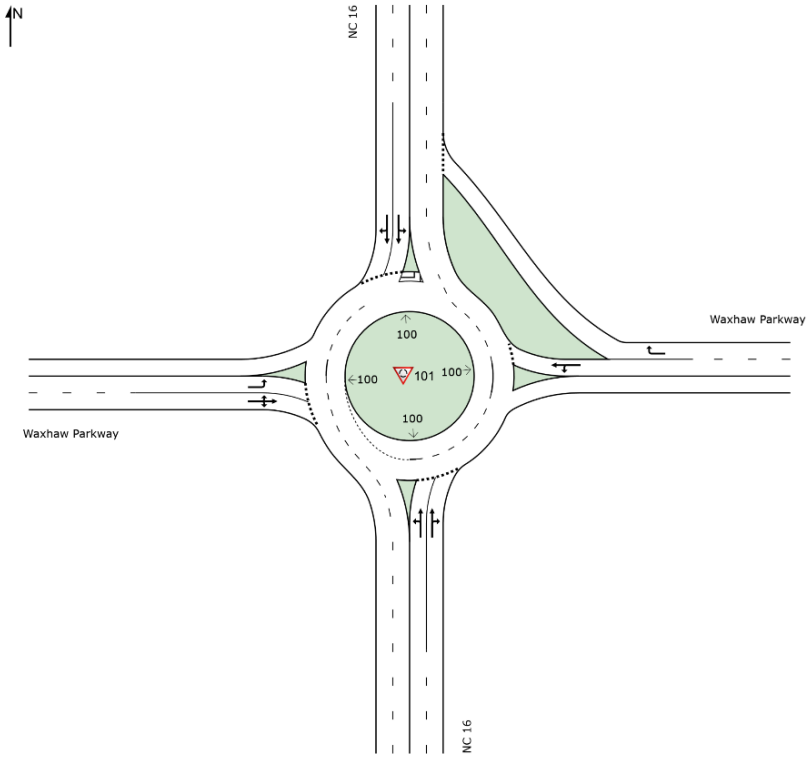


Figure 38. Assumed lane configurations for roundabout alternative at NC 16 and Waxhaw Parkway.

Operational Analysis Results: Roundabout Alternative

Table 8 summarizes roundabout analysis for each network scenario during the design year 2045 AM and PM peak hours based upon HCM 6th Edition methodologies. These results reflect overall intersection average conditions for comparison against the corresponding traffic signal control option. A summary of approach level results is provided in Appendix D.

Utilizing the HCM 6th Edition roundabout capacity model, the lane configurations illustrated in Figure 38 provide acceptable operations for all network scenarios during the 2045 AM peak hour with LOS "C" or better and all approach legs with V/C ratios at or below 0.79. However, during the 2045 PM peak hour, the NW + NE Parkway and NW + NE + SE Parkway scenarios are projected to have V/C ratios on the northbound approach (south leg) of 0.94 and 0.92, respectively, which exceed the target maximum range of 0.85. Delay on the northbound approach for each of these two network scenarios is approximately 51

seconds, which slightly exceeds the roundabout LOS "F" threshold of 50 seconds; however, the raw approach delay is comparable to the corresponding traffic signal delay on the northbound approach.

Under the same network scenarios, the desired 0.85 maximum V/C ratio is also slightly exceeded on the southbound approach (V/C ratio = 0.86) and westbound approach (V/C ratio = 0.87). However, for both of these approaches, average delays and queue lengths are estimated to be within a reasonable range. Overall, these HCM 6th Edition analysis results suggest that the roundabout lane configurations illustrated in Figure 38 would be near capacity in the 2045 PM peak hour based upon the estimated network volumes.

Table 8. NC 16/Waxhaw Parkway 2045 Roundabout Alternative: *HCM 6th Results*

	AM Peak Hour			PM Peak Hour		
	Overall Intersection Average Delay (s)	Intersection Level of Service	Critical Movement V/C Ratio	Overall Intersection Average Delay (s)	Intersection Level of Service	Critical Movement V/C Ratio
No-Build	8.4	A	0.52	11.8	B	0.65
NW Pkwy Only	13.7	B	0.68	22.3	C	0.83
NE Pkwy Only	9.1	A	0.51	12.7	B	0.64
NW + NE Pkwy	17.2	C	0.69	33.8	D	0.94
NW + NE + SE Pkwy	17.9	C	0.79	34.3	D	0.92

For comparison purposes, Kittelson evaluated the roundabout alternative utilizing an alternative capacity model—the SIDRA Standard model with a 1.10 environmental factor. The SIDRA Standard model utilizes a slightly different methodology for computing roundabout capacity, which can yield slightly different results particularly where high conflicting flows are present like in the northbound approach under the NW + NE Parkway and NW + NE + SE Parkway scenarios.

Table 9 summarizes the results of the analyses utilizing the SIDRA Standard model and the same lane configurations illustrated in Figure 38. This alternative model provides slightly more optimistic results with all approaches projected to have V/C ratios below 0.85 for all network scenarios.

Table 9. NC 16/Waxhaw Parkway 2045 Roundabout Alternative: *SIDRA Standard Results*

	AM Peak Hour			PM Peak Hour		
	Overall Intersection Average Delay (s)	Intersection Level of Service	Critical Movement V/C Ratio	Overall Intersection Average Delay (s)	Intersection Level of Service	Critical Movement V/C Ratio
No-Build	7.8	A	0.52	10.5	B	0.63
NW Pkwy Only	11.4	B	0.65	18.1	C	0.80
NE Pkwy Only	7.8	A	0.45	10.6	B	0.60
NW + NE Pkwy	12.2	B	0.59	21.7	C	0.81
NW + NE + SE Pkwy	12.1	B	0.57	20.9	C	0.79

The combined results from both roundabout capacity models suggest that the evaluated roundabout lane configurations may operate acceptably through year 2045 for each of the network scenarios. However, the more conservative results from the HCM 6th Edition suggest that for the NW + NE Parkway and NW + NE + SE Parkway scenarios, the roundabout could be near capacity during the 2045 PM peak hour. Additional lanes could be needed for accommodation of volumes beyond the levels analyzed.

Additional feasibility assessment is needed to compare the footprint and potential property impacts for the signal versus roundabout alternatives within the site constraints. However, the operational analysis results suggest that the roundabout alternative offers advantages in terms of lower average vehicle delays utilizing fewer lanes compared to the signal alternative. A roundabout would also allow for U-turn movements along NC 16 to support access management strategies.

NC 75 AND OLD PROVIDENCE ROAD INTERSECTION

The intersection of NC 75 and Old Providence Road is currently stop controlled. However, a roundabout is programmed under NCDOT State Transportation Improvement Plan (STIP) project number U-6248. Kittelson evaluated the planned roundabout configuration under each of the five network configuration scenarios to identify potential 2045 AM and PM peak hour operational performances.

Assumed 2045 Lane Configurations

Figure 39 illustrates the lane configurations for the planned roundabout. This includes a single-lane configuration with one entering, circulating, and exiting lane on all legs except for the eastbound approach. A separate yield-controlled right turn bypass lane is included on the eastbound approach to serve the heavy eastbound to southbound right turn movement.

Figure 39. Planned roundabout at NC 75 and Old Providence Road (Source: NCDOT STIP U-6248).

Operational Analysis Results

For each of the five network scenarios, Kittelson estimated the AM and PM peak hour intersection turning movement volumes utilizing the NCDOT Intersection Analysis Utility. Assumed K and D factors for the NC 75 approaches were extrapolated from the NCDOT EDTV Report for the northeast Waxhaw Parkway, dated October 14, 2021. Along Old Providence Road, a K-factor of 0.09 was assumed for both peak hours and the AM and PM directional factor (D) was estimated based upon historical turning movement count data. A summary of inputs and outputs from the NCDOT Intersection Analysis Utility is provided in Appendix E for each network scenario along with the corresponding operational analysis results.

Analysis of the roundabout operations was performed utilizing HCM 6th Edition procedures, as applied by the SIDRA Intersection software. Analysis results for the AM and PM peak hour in design year 2045 are summarized in Table 10. These results reflect overall intersection average conditions. A summary of approach level results is provided in Appendix E.

Table 10. NC 75/Old Providence Road 2045 Roundabout Alternative						
	AM Peak Hour			PM Peak Hour		
	Overall Intersection Average Delay (s)	Intersection Level of Service	Critical Movement V/C Ratio	Overall Intersection Average Delay (s)	Intersection Level of Service	Critical Movement V/C Ratio
No-Build	44.9	E	1.11	24.6	C	0.96
NW Pkwy Only	44.9	E	1.11	24.6	C	0.96
NE Pkwy Only	16.3	C	0.82	12.3	B	0.69
NW + NE Pkwy	15.3	C	0.80	12.0	B	0.67
NW + NE + SE Pkwy	10.2	B	0.63	8.8	A	0.53

The NC 75 and Old Providence Road intersection is estimated to experience the highest volumes under the no-build (no Waxhaw Parkway implementation) and northwest Parkway only scenarios. Under these scenarios, the intersection is estimated to operate over-capacity in the 2045 AM peak hour with the critical approach at a V/C ratio of 1.11 and near capacity in the 2045 PM peak hour with a critical approach V/C ratio of 0.96. The desired maximum V/C ratio is 0.85 for each individual roundabout entry. With implementation of the northeast segment of the Waxhaw Parkway, volume levels at the NC 75 and Old Providence Road intersection are expected to reduce as some vehicles traveling along NC 75 re-route through the network. As a result, all network scenarios that include the northeast Waxhaw Parkway segment are estimated to operate with each individual roundabout entry at or below a V/C ratio of 0.85.

Based upon the analysis results summarized in Table 10, the planned roundabout project is expected to operate adequately through year 2045 with the construction of the northeast Waxhaw Parkway. Without the northeast Parkway segment, expansion of the roundabout to a partial two-lane configuration with dual lefts on the northbound Old Providence Road entry is expected to be needed.

WAXHAW PARKWAY AND WAXHAW INDIAN TRAIL ROAD

Implementation of the northeast portion of the Waxhaw Parkway will result in a new intersection with Waxhaw Indian Trail in the vicinity of Blythe Creek. This new intersection was analyzed under each of the three roadway network scenarios with the northeast Waxhaw Parkway in place to evaluate potential operations and required intersections lane configurations under each scenario.

Assumed 2045 Lane Configurations

NCDOT explored initial conceptual design alternatives for the northeast portion of the Waxhaw Parkway under SPOT Project H150208. Based upon a concept dated May 4, 2022, a single-lane roundabout was identified at the intersection of Waxhaw Indian Trail Road and the future Waxhaw Parkway, as illustrated in Figure 40. For this intersection, Kittelson evaluated the proposed roundabout alternative to verify the adequacy of the single-lane configuration through the design year 2045.

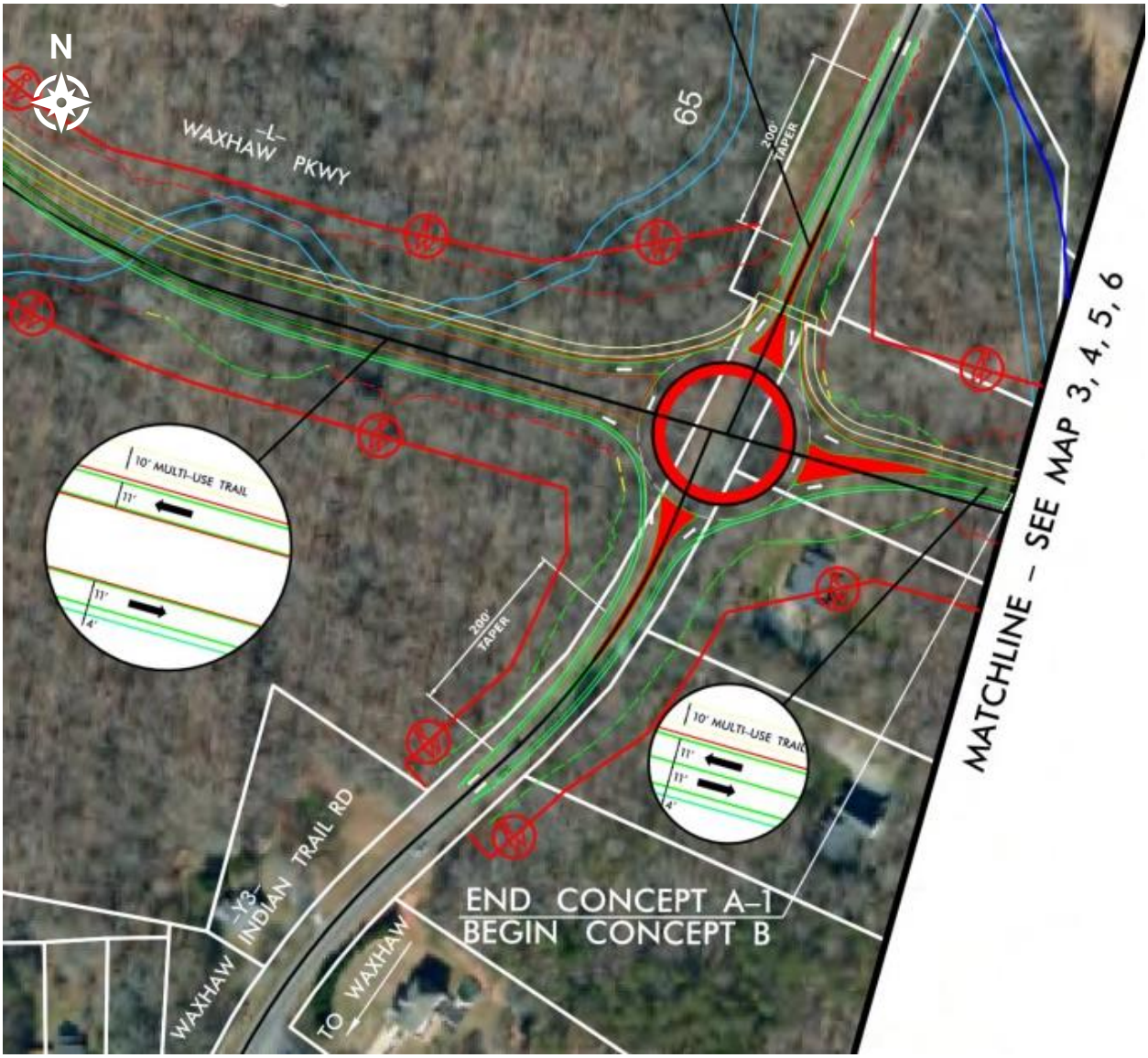


Figure 40. Assumed lane configurations for roundabout alternative at Waxhaw Parkway and Waxhaw Indian Trail Road (Source: NCDOT SPOT Project H150208, concept dated May 4, 2022).

Operational Analysis Results

For each network scenario, Kittelson estimated the AM and PM peak hour intersection turning movement volumes utilizing K and D factors from the NCDOT EDTV Report for the northeast Waxhaw Parkway, dated October 14, 2021. Analysis of the roundabout operations was performed utilizing HCM 6th Edition procedures, as applied by the SIDRA Intersection software. Analysis results for the AM and PM peak hour in design year 2045 are summarized in Table 9. These results reflect overall intersection average conditions. A summary of approach level results is provided in Appendix F.

Table 11. Waxhaw Parkway/Waxhaw Indian Trail Road 2045 Roundabout Alternative

	AM Peak Hour			PM Peak Hour		
	Overall Intersection Average Delay (s)	Intersection Level of Service	Critical Movement V/C Ratio	Overall Intersection Average Delay (s)	Intersection Level of Service	Critical Movement V/C Ratio
NE Pkwy Only	6.4	A	0.38	6.6	A	0.38
NW + NE Pkwy	7.0	A	0.41	7.3	A	0.40
NW + NE + SE Pkwy	7.9	A	0.44	8.4	A	0.44

As summarized in Table 11, a single-lane roundabout is anticipated to operate at an overall intersection LOS "A". Each of the individual intersection approaches is expected to operate with a V/C ratio at or below 0.44. The desirable maximum V/C ratio is 0.85 for each individual roundabout entry. Based upon a sensitivity analysis, a single-lane roundabout is estimated to have spare capacity to accommodate peak hour volumes that are approximately 50% higher prior to reaching a V/C ratio of 0.85 on any individual approach.

Section 4
Findings and Conclusions

FINDINGS AND CONCLUSIONS

The following is a summary of key study findings from the origin-destination analysis, network scenario analysis, and intersection analysis.

ORIGIN-DESTINATION ANALYSES

Key findings from the core O-D analysis for downtown Waxhaw include:

- Travels patterns were similar in 2019 and 2021, although overall volumes increased slightly in 2021.
- O-D trends were similar during different days of the week (weekday vs. Saturday) and during different times of day (AM vs. midday vs. PM).
- In 2021, 32.5% of trips were local (1.5% with both trip ends in downtown and 31.0% with one trip end in downtown) and 67.5% of trips were non-local.
- For non-local trips, the most common O-D trip pair was between NC 16 & Waxhaw Parkway and Old Providence Rd north of Waxhaw Farms Rd, representing those traveling between north and south of downtown Waxhaw.
- Most trips (both local and non-local) passed through the intersection of NC 16 & NC 75.
- For all trips that passed through NC 16 & NC 75, the top local trips were between NC 16 & Waxhaw Pkwy and downtown.
- For non-local trips that passed through NC 16 & NC 75, trips between east and west of downtown increased between 2019 and 2021. However, overall trends by time-of-day remained similar between the two years.

Key findings from the regional O-D analysis include:

- Regional trips were evaluated based upon cardinal directions of origins.
  - From the south, 72% of trips were destined to the north along NC 16. These trips are less likely to be served by the northwest or northeast segments of the Parkway. In addition, 20% of trips from the south were destined towards the west and 8% were destined towards the east.
  - From the north, 55% of trips were destined to south of downtown Waxhaw, 24% were destined toward the west, and 21% were destined toward the east.
  - From the west, 39% of trips were destined to the east, 36% were destined towards the north, and 25% were destined towards the south of downtown Waxhaw.
  - From the east, 53% of trips were destined to the west along NC 75, 36% were destined towards the north, and 11% were destined towards the south.
- For regional trips originating from the north and south, the strongest travels patterns are those continuing in the north and south directions. These trips are less likely to divert to utilize the northwest or northeast Parkway segments alone. Construction of both the northeast and southeast segments could provide a reasonable alternate route depending upon the final Parkway alignment. Alignment options closer to downtown are expected to be more attractive as an alternative route for regional vehicles traveling north-south. Trips originating from the north and traveling to the east and west have a greater potential to divert to the northwest and northeast parkway segments.
- For regional trips originating from the east and west, the strongest travels patterns are those directly between the east and west as well as trips towards the north. Regional trips destined toward the north are candidates for possible diversion to the northwest and northeast parkway segments. Completion of both the northwest and northeast Waxhaw Parkway would be needed to support potential east-west trip diversions. East-west through trips diverting to the Parkway are also expected to be impacted by levels of congestion at the NC 16 & NC 75 intersection since use of the Parkway would result in a longer trip length.

- For regional trips between the west and north, over 50% of vehicles currently use Jim Wilson Road, 25% traveled through downtown, and the remainder used Waxhaw-Marvin Road and/or Pine Oak Road to bypass downtown. Diverting to the northwest Waxhaw Parkway would become more attractive with the completion of programmed improvements, including the widening of NC 16 and the railroad overcrossing at Helms Road.

NETWORK ANALYSES

Key findings of the network analysis include:

- Waxhaw Parkway provides important infrastructure to support longer-term growth for local circulation and regional trips.
- Even with construction of the northwest, northeast, and southeast Parkway segments, volume levels in the downtown core are expected to remain near 2018 levels.
  - Volume levels in downtown will continue to rise until Parkway segments are constructed.
  - Improvements to the NC 16/NC 75 intersection are expected to be needed even with Parkway implementation.
- Some network re-routing is expected without the Waxhaw Parkway with increased use of Waxhaw-Marvin Road and Pine Oak Road to bypass congestion in downtown Waxhaw. However, limited alternative routes are available for some other key O-D patterns.
- Implementation of the northeast segment of the Parkway is expected to have the largest influence in reducing vehicle trips through downtown Waxhaw. However, implementation of the northeast segment alone is still estimated to result in 2045 traffic volumes through downtown that are exceeding prior counts from year 2018.
- Incremental additional reductions in vehicles through downtown are expected with construction of both the northwest and northeast segments of the Parkway as well as if the Parkway is extended to the southeast.
- Consideration of alternative alignments for the northeast and southeast Parkway segments that are shifted closer to downtown Waxhaw are suggested to better support north-south travel patterns.

INTERSECTION ANALYSES

Key findings of the intersection analysis include:

- **NC 16 and NC 75:** Intersection improvement alternatives currently under consideration (from the Union County Critical Intersection project) provide incremental benefit and would be sufficient to meet capacity needs through year 2045 if both the northwest and northeast Parkway segments are constructed, or if all three Parkway segments are constructed. However, dual exclusive southbound left turn lanes and dual westbound right turn lanes may be needed for some network scenarios.
- **NC 16 and Waxhaw Parkway:** Traffic signal and roundabout alternatives were evaluated. Minimum lane configuration needs for each control type vary depending on incremental Parkway construction. In general, the roundabout alternative is estimated to result in lower intersection delay utilizing fewer lanes compared to the signal alternative.
- **NC 75 and Old Providence Road:** The proposed STIP project, which includes a single-lane roundabout with an eastbound right turn bypass lane, is expected to operate adequately through year 2045 with the construction of the northeast Waxhaw Parkway. Without construction of the northeast Parkway segment, the roundabout may require expansion prior to year 2045.

- **NE Waxhaw Parkway and Waxhaw Indian Trail Road:** A single-lane roundabout was evaluated at the future intersection, as proposed as part of an NCDOT express design project. The roundabout is expected to operate acceptably through year 2045 with spare capacity to accommodate volumes 50% higher than those evaluated in this study.