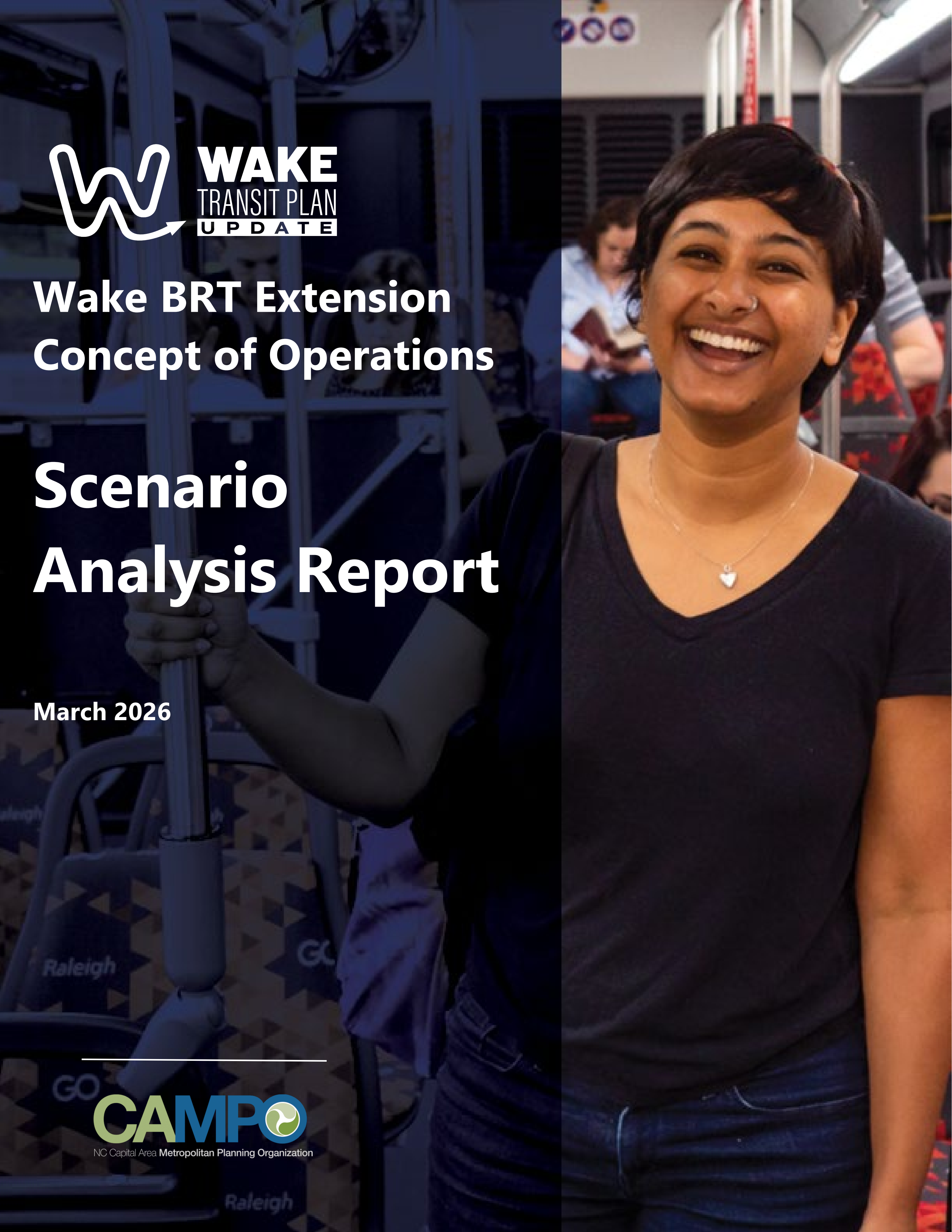

WAKE TRANSIT PLAN UPDATE

Wake BRT Extension Concept of Operations

Scenario Analysis Report

March 2026

CAMPO
NC Capital Area Metropolitan Planning Organization

Contents

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1 PROJECT BACKGROUND

BUS RAPID TRANSIT IN WAKE COUNTY

The Wake County Transit Plan, originally published and approved by voters in 2016, called for approximately 20 miles of bus rapid transit (BRT) corridors centered around Downtown Raleigh. A Major Investment Study (MIS) was developed in 2018 that defined four "core" BRT corridors: New Bern, Southern, Western, and Capital (Northern).

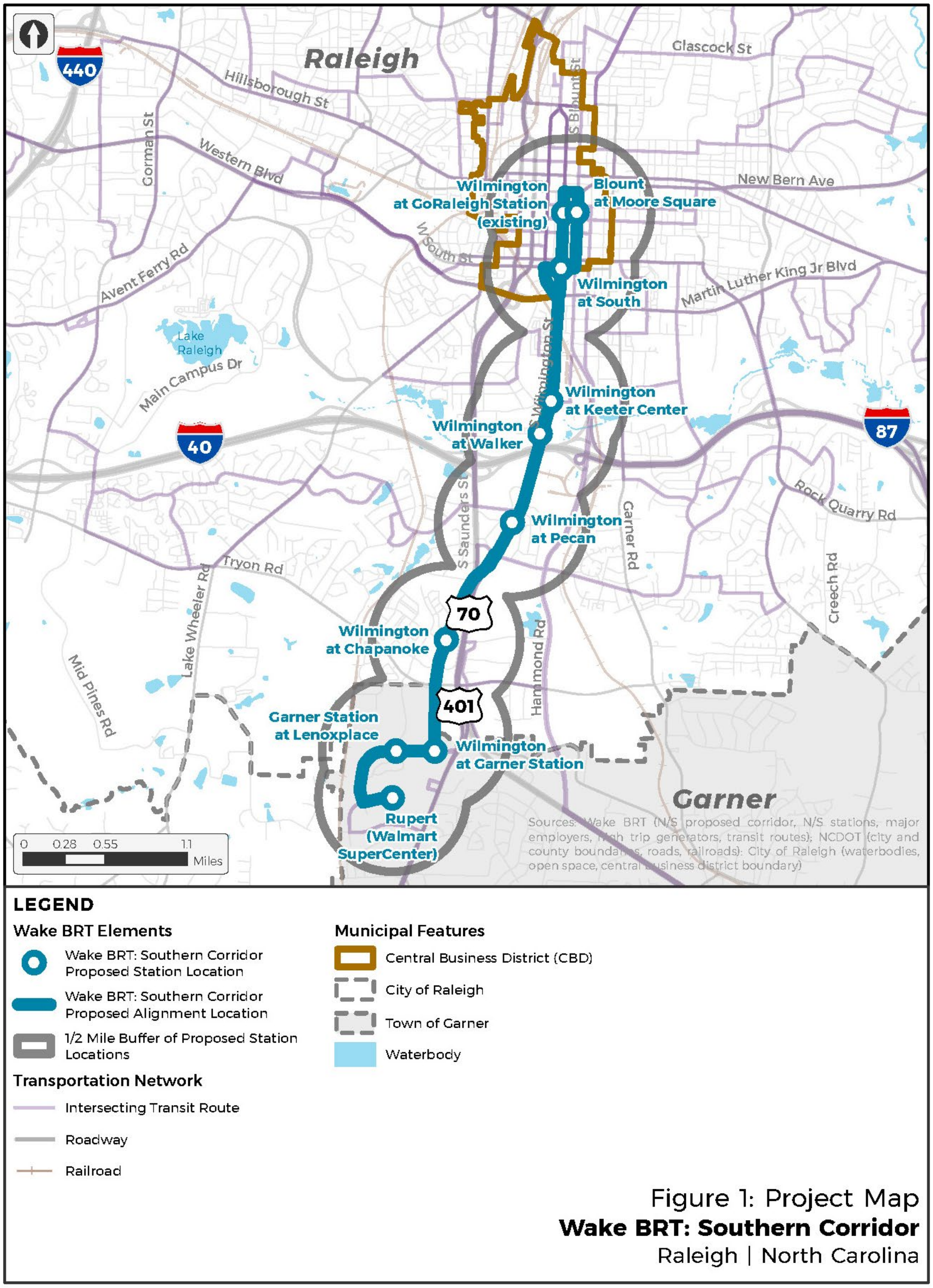
After this original MIS was published, anticipated growth in the region suggested that extensions to the original core BRT corridors would expand the number of jobs and residents in the region served by high quality transit and build upon the capital investments made in the original corridors. CAMPO conducted an additional MIS, published in 2023, to extend the Southern corridor from its core route terminus in Garner to Clayton and the Western corridor from its core route terminus in Cary to Research Triangle Park (RTP). This study identified the preferred alternative for the two extension corridors, but the unique nature of the extensions left unanswered operational questions before the projects could move into design and engineering.

The purpose of this present study, the Wake BRT Extensions Concept of Operations, is to further define the operations of the Southern and Western Extension corridors, including identifying how these extensions would interact with the core BRT and a project sponsor to continue moving the projects into implementation. The first phase of the study, detailed in this memo, defines a series of operational scenarios for each corridor, evaluates these scenarios, and recommends a preferred scenario to further develop detailed operating and capital plans in the next phase of the study.

CORE BRT CORRIDORS

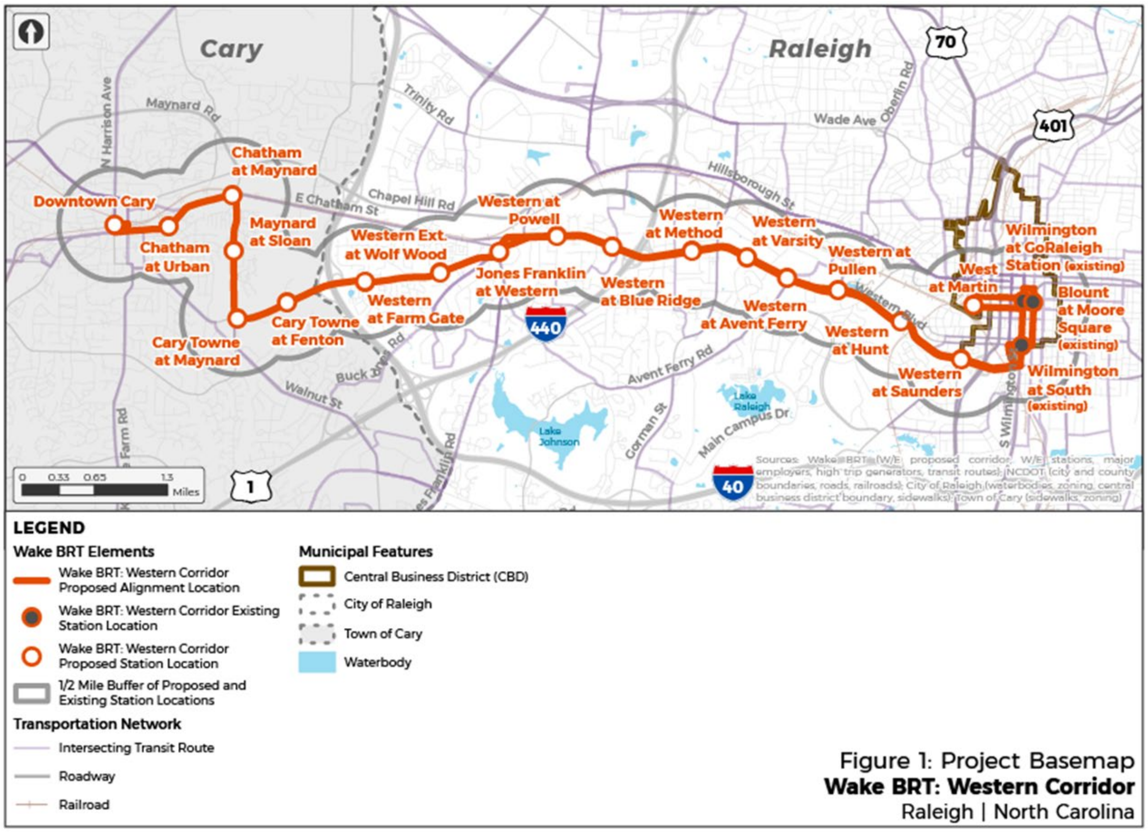
The BRT Extensions build off of the core Southern and Western BRT corridors. The core Southern BRT runs between downtown Raleigh and Garner, with the stations shown in Figure 1. The Western BRT runs between downtown Raleigh and Cary, with the stations shown in Figure 2.

Figure 1 Proposed Wake BRT Southern Corridor Map



Source: Wake BRT Southern Corridor Operations Plan

Figure 2 Proposed Wake BRT Western Corridor Map



Source: Wake BRT Western Corridor Operations Plan

Assumptions for the core BRT operating characteristics, including route alignments, hours of operation, headways, and station locations are sourced from GoRaleigh, primarily the Operations Plan documents for each corridor project. Figure 3 lists the anticipated spans and frequencies for each service. The extension services examined in this project build upon these core services.

Figure 3 Core BRT Spans & Frequencies

Day and Time	Span of Service	Southern BRT Frequency	Western BRT Frequency
Weekday Early AM	4 AM – 6 AM	15 minutes	15 minutes
Weekday AM Peak	6 AM – 9 AM	10 minutes	10 minutes
Weekday Mid-Day	9 AM – 3 PM	15 minutes	15 minutes
Weekday PM Peak	3 PM – 6 PM	10 minutes	10 minutes
Weekday Evening	6 PM – 12 AM	15 minutes	15 minutes
Saturday All Day	5:30 AM – 12 AM	20 minutes	15 minutes
Sunday All Day	5:30 AM – 12 AM	20 minutes	15 minutes

BRT EXTENSION CORRIDORS

This Concept of Operations study will build upon the locally preferred alternatives defined in the previous MIS. The Southern BRT Extension will run from Garner to Powhatan, past Clayton, as shown in Figure 4. The Western BRT Extension will run from downtown Cary to RTP, as shown in Figure 5.

Figure 4 Southern Extension Corridor Map, MIS Preferred Alignment

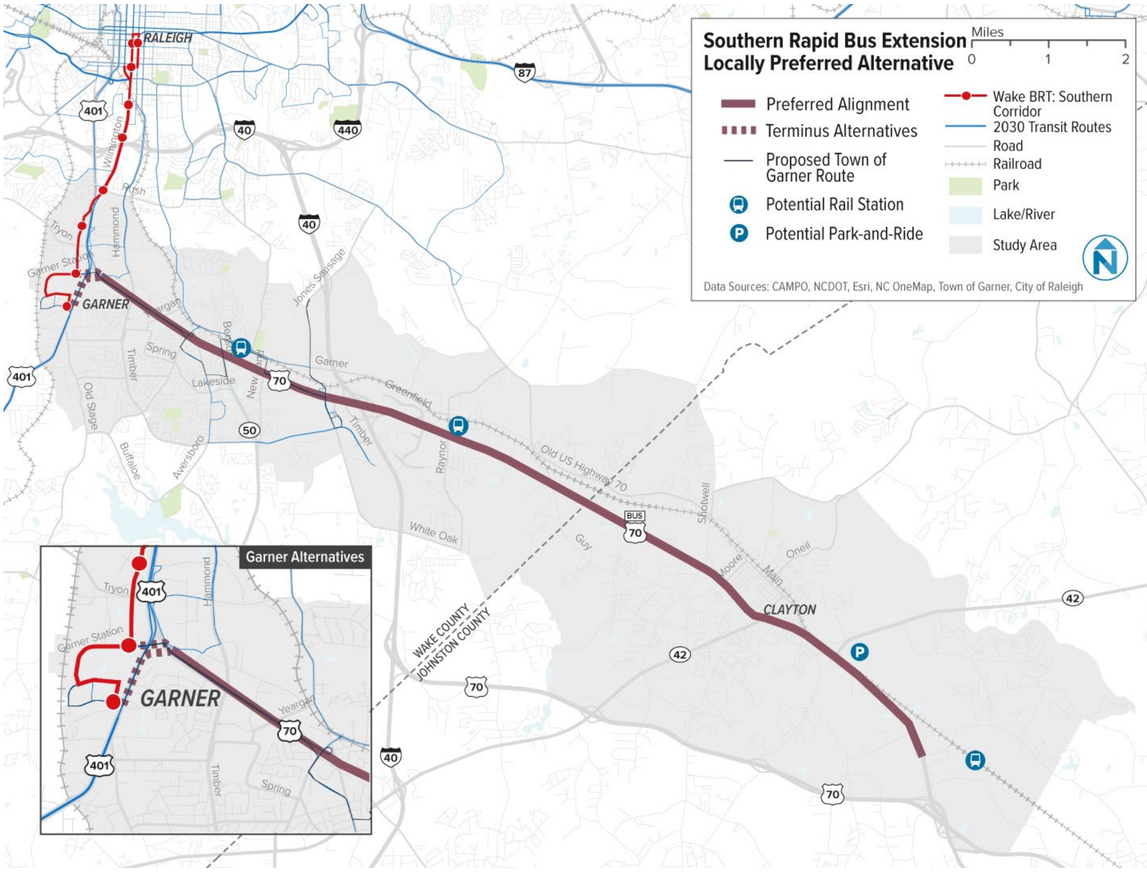
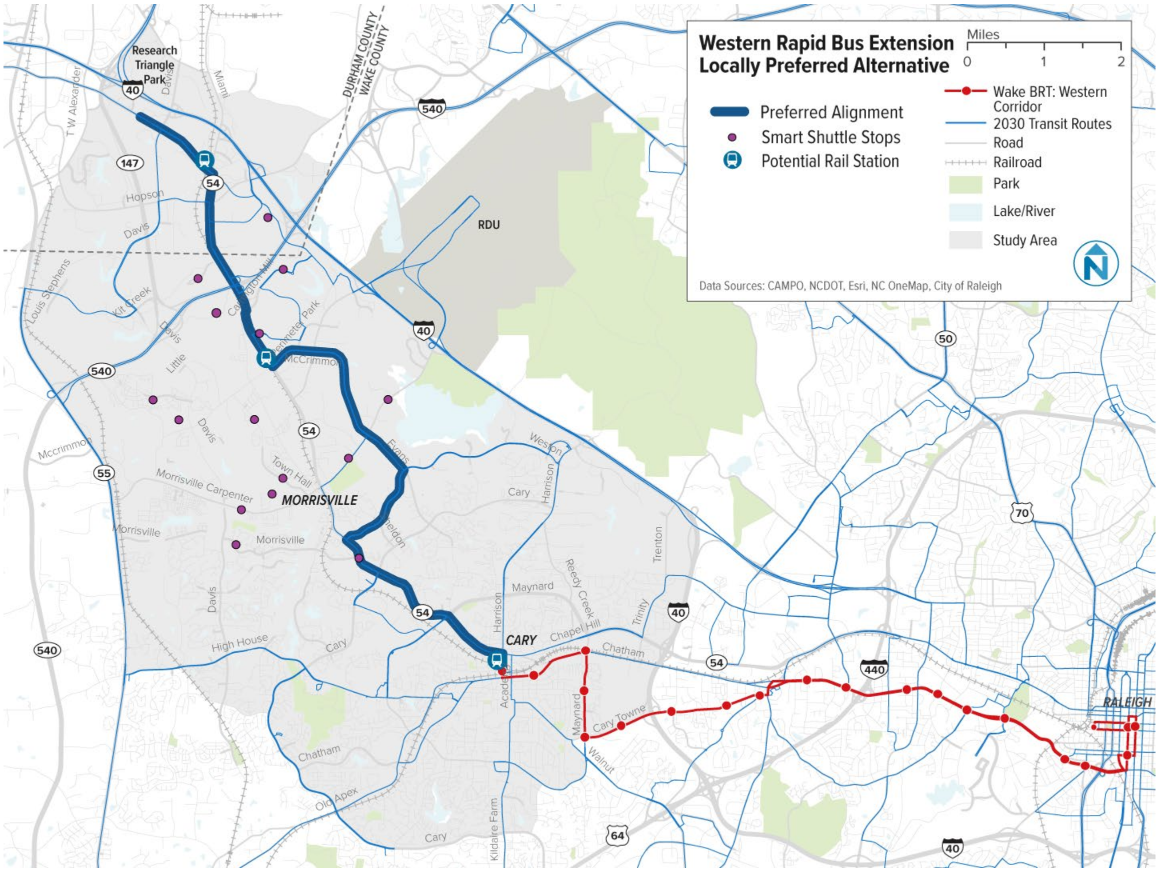


Figure 5 Western Extension Corridor Map, MIS Preferred Alignment



2 SCENARIO OVERVIEW

SCENARIO DEVELOPMENT

To evaluate different concepts of operations for the two BRT Extension corridors, the project team developed three scenarios for the Southern Extension and four for the Western Extension. Scenarios were developed around a set of scenario levers and fixed considerations, both built upon recommendations from the previous MIS.

Scenario levers are the key differentiators and are primarily operational considerations. These include the project sponsor and agency that will operate the service, how the extension coordinates with the Core BRT service, and the service frequency. Related considerations that are downstream of these levers include the fleet requirements, impact on existing services for the Western Extension, and the termini location for the Southern Extension. Fixed considerations are the same across all scenarios and primarily constitute capital considerations. These include stop spacing and locations, transit priority infrastructure, and BRT station design and amenities.

Southern Extension Scenarios

Three scenarios were developed for the Southern Extension corridor based on the scenario levers and local context, listed in Figure 6.

Figure 6 Summary of Southern Extension Scenarios

	Operator	Core BRT Coordination	Frequency on Extension Corridor
Scenario 1	GoRaleigh	Extend alternating trips of Southern BRT along extension corridor	Half the core BRT frequency
Scenario 2	GoRaleigh	Separate bus serving extension corridor with timed transfer to Southern BRT	Half the core BRT frequency
Scenario 3	GoTriangle	Separate bus serving extension corridor with timed transfer to Southern BRT	Half the core BRT frequency

Scenarios that were considered but ultimately excluded from further development included:

- Every BRT Extension trip, operating with a 40’ transit bus, continues to Raleigh along the Southern BRT corridor rather than terminating at Garner, but does not serve any stations along the core BRT alignment. This was ruled out as it would create duplicative service along the Core BRT alignment, and skip-stop service could be confusing from rider perspective.
- Extending every Southern BRT trip along the extension corridor. This was ruled out as the demand along the Southern BRT Extension alignment does not justify the same level of frequency as Core BRT service.

Southern Extension Scenario 1

Scenario 1 would operate in two alternating patterns:

- Pattern A: Core BRT alignment only, Raleigh to Garner
- Pattern B: Full extension from Raleigh to Powhatan

The service would be operated by **GoRaleigh** using a **60' articulated bus.** Figure 7 shows the hours of operation and frequencies for Scenario 1, with the alternating patterns creating double the frequency on the core corridor compared to the extension portion from Garner to Powhatan.

Figure 7 Southern Extension Scenario 1 Spans and Frequencies

Day and Time	Span of Service	Operating Pattern	Frequency on Core Corridor	Frequency on Extension Corridor
Weekday Very Early	4 AM – 5 AM	Pattern A	20 minutes	-
Weekday Early AM	5 AM – 6 AM	Alternating Patterns A & B	20 minutes	40 minutes
Weekday Peak	6 AM – 7:30 PM	Alternating Patterns A & B	10 minutes	20 minutes
Weekday Night	7:30 PM – 12 AM	Alternating Patterns A & B	20 minutes	40 minutes
Saturday Early AM	5 AM – 6 AM	Pattern A	20 minutes	-
Saturday Day	6 AM – 7:30 PM	Alternating Patterns A & B	15 minutes	30 minutes
Saturday Night	7:30 PM – 12 AM	Alternating Patterns A & B	20 minutes	40 minutes
Sunday Early AM	5 AM – 6 AM	Pattern A	20 minutes	-
Sunday Day	6 AM – 7:30 PM	Alternating Patterns A & B	15 minutes	30 minutes
Sunday Evening	7:30 PM – 10 PM	Alternating Patterns A & B	20 minutes	40 minutes
Sunday Late Night	10 PM – 12 AM	Pattern A	20 minutes	-

Southern Extension Scenario 2

Scenario 2 would operate a separate bus on the extension corridor only. The service would be operated by **GoRaleigh** using a **40' transit bus**. The core Southern BRT would continue operating as shown in Chapter 1, with timed transfers to the extension corridor route. Figure 8 shows the proposed spans and frequencies of the separate extension bus.

Figure 8 Southern Extension Scenario 2 Spans and Frequencies

Day and Time	Span of Service	Operating Pattern	Frequency on Extension Corridor
Weekday Morning	5 AM – 6 AM	Separate extension bus	40 minutes
Weekday Peak	6 AM – 7:30 PM	Separate extension bus	20 minutes
Weekday Night	7:30 PM – 12 AM	Separate extension bus	40 minutes
Saturday Day	6 AM – 7:30 PM	Separate extension bus	30 minutes
Saturday Night	7:30 PM – 12 AM	Separate extension bus	40 minutes
Sunday Day	6 AM – 7:30 PM	Separate extension bus	30 minutes
Sunday Evening	7:30 PM – 10 PM	Separate extension bus	40 minutes

Southern Extension Scenario 3

Scenario 3 would operate a separate bus on the extension corridor only. The service would be operated by **GoTriangle** using a **40' transit bus**. This scenario is identical to Scenario 2, except that the service would be operated by GoTriangle instead of GoRaleigh. Figure 9 details the spans and frequencies for Scenario 3.

Figure 9 Southern Extension Scenario 3 Spans and Frequencies

Day and Time	Span of Service	Operating Pattern	Frequency on Extension Corridor
Weekday Morning	5 AM – 6 AM	Separate extension bus	40 minutes
Weekday Peak	6 AM – 7:30 PM	Separate extension bus	20 minutes
Weekday Night	7:30 PM – 12 AM	Separate extension bus	40 minutes
Saturday Day	6 AM – 7:30 PM	Separate extension bus	30 minutes
Saturday Night	7:30 PM – 12 AM	Separate extension bus	40 minutes
Sunday Day	6 AM – 7:30 PM	Separate extension bus	30 minutes
Sunday Evening	7:30 PM – 10 PM	Separate extension bus	40 minutes

Western Extension Scenarios

Four scenarios were developed for the Western Extension corridor based on the scenario levers and local context, listed in Figure 10.

Figure 10 Summary of Western Extension Scenarios

	Operator	Core BRT Coordination	Frequency on Extension Corridor
Scenario 1	GoRaleigh	Extend every trip of Western BRT along extension corridor	Same as core BRT frequency
Scenario 2	GoRaleigh	Extend alternating trips of Western BRT along extension corridor	Half the core BRT frequency
Scenario 3	GoTriangle	Separate bus serving extension corridor with timed transfer to Western BRT	Half the core BRT frequency
Scenario 4	GoCary	Separate bus serving extension corridor with timed transfer to Western BRT	Half the core BRT frequency

One scenario that was considered but ultimately excluded from further development included the same skip-stop extension service considered but excluded from the Southern Extension as discussed previously.

Western Extension Scenario 1

Scenario 1 would extend every trip of the Western BRT to RTP. The service would be operated by **GoRaleigh** using a **60' articulated bus**. Figure 11 shows the hours of operation and frequencies for Scenario 1, with the same route and frequency along both the core and extension portions of the corridor.

Figure 11 Western Extension Scenario 1 Spans and Frequencies

Day and Time	Span of Service	Operating Pattern	Frequency on Core Corridor	Frequency on Extension Corridor
Weekday Morning	4 AM – 6 AM	Full extension	20 minutes	20 minutes
Weekday Peak	6 AM – 7:30 PM	Full extension	10 minutes	10 minutes
Weekday Night	7:30 PM – 12 AM	Full extension	20 minutes	20 minutes
Saturday Morning	5 AM – 6 AM	Full extension	20 minutes	20 minutes
Saturday Day	6 AM – 7:30 PM	Full extension	15 minutes	15 minutes
Saturday Night	7:30 PM – 12 AM	Full extension	20 minutes	20 minutes
Sunday Morning	5 AM – 6 AM	Full extension	20 minutes	20 minutes
Sunday Day	6 AM – 7:30 PM	Full extension	15 minutes	15 minutes
Sunday Evening	7:30 PM – 12 AM	Full extension	20 minutes	20 minutes

Western Extension Scenario 2

Scenario 2 would operate in two alternating patterns:

- Pattern A: Core BRT alignment only, Raleigh to Cary
- Pattern B: Full extension from Raleigh to RTP

The service would be operated by **GoRaleigh** using a **60' articulated bus.** Figure 12 shows the hours of operation and frequencies for Scenario 2, with the alternating patterns creating double the frequency on the core corridor compared to the extension portion from Cary to RTP.

Figure 12 Western Extension Scenario 2 Spans and Frequencies

Day and Time	Span of Service	Operating Pattern	Frequency	Frequency on Extension Corridor
Weekday Very Early	4 AM – 5 AM	Pattern A	20 minutes	-
Weekday Early AM	5 AM – 6 AM	Alternating Patterns A & B	20 minutes	40 minutes
Weekday Peak	6 AM – 7:30 PM	Alternating Patterns A & B	10 minutes	20 minutes
Weekday Night	7:30 PM – 12 AM	Alternating Patterns A & B	20 minutes	40 minutes
Saturday Early AM	5 AM – 6 AM	Pattern A	20 minutes	-
Saturday Day	6 AM – 7:30 PM	Alternating Patterns A & B	15 minutes	30 minutes
Saturday Night	7:30 PM – 12 AM	Alternating Patterns A & B	20 minutes	40 minutes
Sunday Early AM	5 AM – 6 AM	Pattern A	20 minutes	-
Sunday Day	6 AM – 7:30 PM	Alternating Patterns A & B	15 minutes	30 minutes
Sunday Evening	7:30 PM – 10 PM	Alternating Patterns A & B	20 minutes	40 minutes
Sunday Late Night	10 PM – 12 AM	Pattern A	20 minutes	-

Western Extension Scenario 3

Scenario 3 operates as a separate bus on the extension corridor only. The service would be operated by **GoTriangle** using a **40' transit bus**. The Western BRT would continue operating as shown previously in Chapter 1 with timed transfers to the extension corridor route. Figure 13 shows the proposed spans and frequencies on the extension route between Cary and RTP.

Figure 13 Western Extension Scenario 3 Spans and Frequencies

Day and Time	Span of Service	Operating Pattern	Frequency on Extension Corridor
Weekday Morning	5 AM – 6 AM	Separate extension bus	40 minutes
Weekday Peak	6 AM – 7:30 PM	Separate extension bus	20 minutes
Weekday Night	7:30 PM – 12 AM	Separate extension bus	40 minutes
Saturday Day	6 AM – 7:30 PM	Separate extension bus	30 minutes
Saturday Night	7:30 PM – 12 AM	Separate extension bus	40 minutes
Sunday Day	6 AM – 7:30 PM	Separate extension bus	30 minutes
Sunday Evening	7:30 PM – 10 PM	Separate extension bus	40 minutes

Western Extension Scenario 4

Scenario 4 operates as a separate bus on the extension corridor only. The service would be operated by **GoCary** using a **40' transit bus**. This scenario is identical to Scenario 3, except that the service would be operated by GoCary instead of GoTriangle. Figure 14 details the spans and frequencies for Scenario 3.

Figure 14 Southern Extension Scenario 3 Spans and Frequencies

Day and Time	Span of Service	Operating Pattern	Frequency on Extension Corridor
Weekday Morning	5 AM – 6 AM	Separate extension bus	40 minutes
Weekday Peak	6 AM – 7:30 PM	Separate extension bus	20 minutes
Weekday Night	7:30 PM – 12 AM	Separate extension bus	40 minutes
Saturday Day	6 AM – 7:30 PM	Separate extension bus	30 minutes
Saturday Night	7:30 PM – 12 AM	Separate extension bus	40 minutes
Sunday Day	6 AM – 7:30 PM	Separate extension bus	30 minutes
Sunday Evening	7:30 PM – 10 PM	Separate extension bus	40 minutes

STATION DESIGN & LOCATIONS

Considerations

Final station designs and locations were selected for the two extensions and presumed to vary as little as possible between scenarios in order to make the clearest operational comparisons. Considerations for stop locations included agency and municipality input, overall stop spacing along the alignment, and remaining consistent with the Metropolitan Transportation Plan (MTP) by limiting changes from the MIS.

Stations along the extension alignments fall into the following four categories:

- **Core BRT station**: These stations will be constructed as part of the core BRT corridor projects and can be utilized by the extension services without additional capital investment. For both the Southern and Western BRT corridors, stations are currently at 30% design and will be further refined as needed to support both core and Extension BRT operations.
- **Transit facility**: Only applicable to the Western Extension, the Cary Multimodal Center is a planned transit facility that will not require capital investment as part of the extension project.
- **Opening day station**: These stops constitute the majority of planned stations for both extension corridors, with varying capital costs and operating considerations that will be evaluated and compared across scenarios. With the exception of the Southern Extension terminus station (Powhatan) all opening day stations are planned to include canopies, station

lighting, benches, and signage. In selecting precise locations, far-side stops were preferred over midblock or near-side stops when possible.

- **Future infill station:** These locations will not have the development to support a station on opening day but may be suitable for a station in the future as the region continues to grow. These stations are not taken into consideration when calculating travel times, ridership, or capital costs, and are listed here solely to inform future development and planning decisions.

Southern Extension Stations

The Southern Extension consists of 11 stations in all scenarios, with the order of the two northernmost extension stations dependent upon the operating scenario. Figure 15 lists the proposed stations in Scenario 1. Figure 16 illustrates the scenario's alignment and station locations.

Figure 15 Southern Extension Stations, Scenario 1

Station	Street	Cross Street	Direction	Station Type
Garner Station Blvd at Lennox Place	Garner Station Blvd	Lenoxplace Circle	NB/SB	Core BRT
Walmart - Garner	Rupert Rd	Walmart Supercenter	NB/SB	Core BRT
Garner Towne Square	US 70	Garner Towne Square	NB/SB	Opening day
US 70 at Yeargan Rd	US 70	Yeargan Rd	NB/SB	Opening day
Forest Hills Shopping Center	US 70	Vandora Springs Rd	NB/SB	Opening day
White Oak Crossing	US 70	Jones Sausage Rd	NB/SB	Opening day
Auburn	US 70	Auburn Knightdale Rd	NB/SB	Future infill
Walmart - Clayton	US 70	Town Centre Blvd	NB/SB	Opening day
Clayton Blvd at Shotwell Rd	US 70 (Clayton Blvd)	Shotwell Rd	NB/SB	Opening day
Clayton Blvd at Robertson St	US 70 (Clayton Blvd)	Robertson St	NB/SB	Opening day
Clayton Blvd at Main St	US 70 (Clayton Blvd)	Main St	NB/SB	Opening day
NC 42	US 70 (Clayton Blvd)	NC42	NB/SB	Future infill
Powhatan	N Tech Dr	Best Wood Dr	Southern Endpoint	Opening day

Figure 16 Southern Extension, Scenario 1

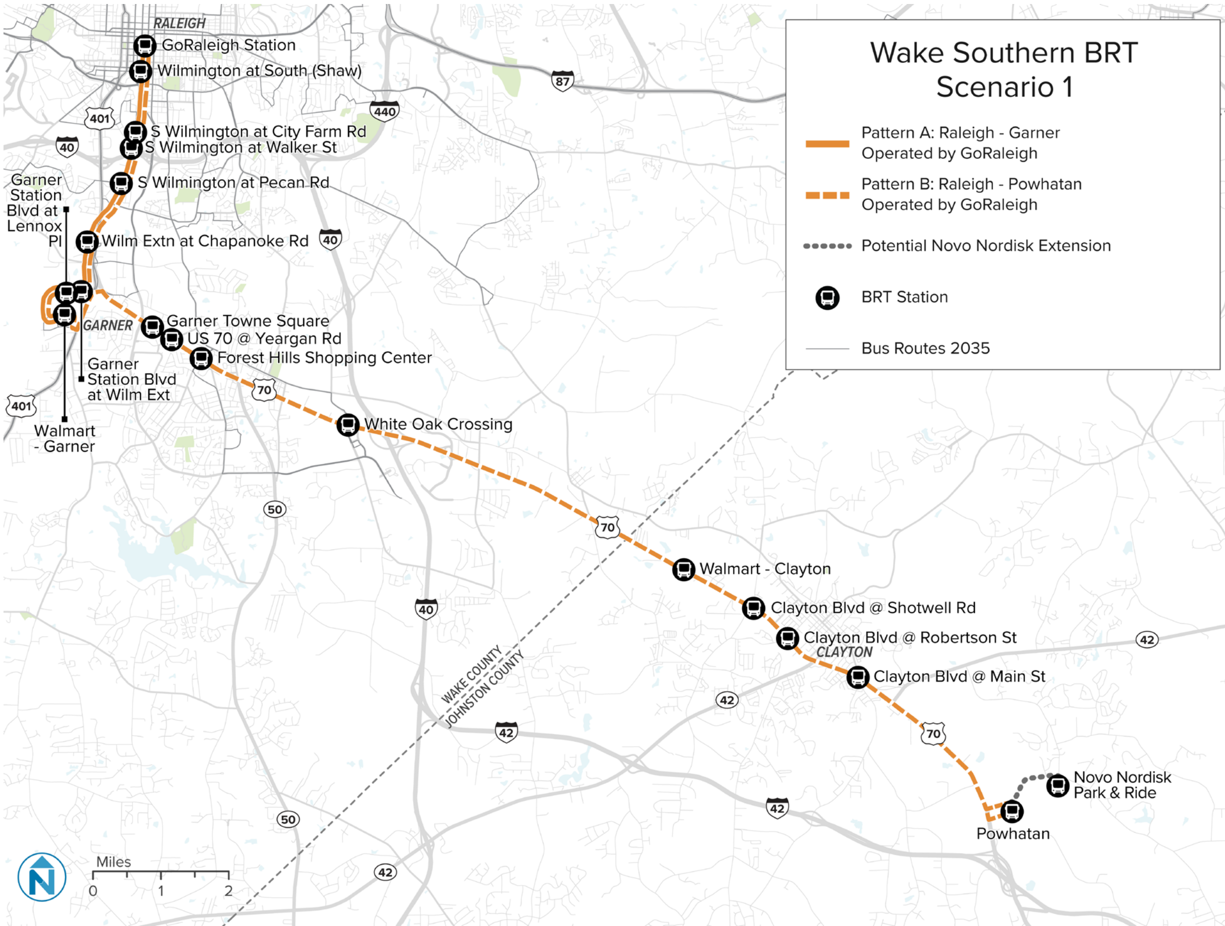


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Figure 17 lists the proposed stations in Scenarios 2 and 3, while Figure 18 and Figure 19 illustrate the stations and alignment of Scenarios 2 and 3, respectively.

Figure 17 Southern Extension Stations, Scenarios 2 and 3

Station	Street	Cross Street	Direction	Station Type
Walmart - Garner	Rupert Rd	Walmart Supercenter	Northern Endpoint	Core BRT
Garner Station Blvd at Lennox Place	Garner Station Blvd	Lenoxplace Circle	NB/SB	Core BRT
Garner Towne Square	US 70	Garner Towne Square	NB/SB	Opening day
US 70 at Yeargan Rd	US 70	Yeargan Rd	NB/SB	Opening day
Forest Hills Shopping Center	US 70	Vandora Springs Rd	NB/SB	Opening day
White Oak Crossing	US 70	Jones Sausage Rd	NB/SB	Opening day
Auburn	US 70	Auburn Knightdale Rd	NB/SB	Future infill
Walmart - Clayton	US 70	Town Centre Blvd	NB/SB	Opening day
Clayton Blvd at Shotwell Rd	US 70 (Clayton Blvd)	Shotwell Rd	NB/SB	Opening day
Clayton Blvd at Robertson St	US 70 (Clayton Blvd)	Robertson St	NB/SB	Opening day
Clayton Blvd at Main St	US 70 (Clayton Blvd)	Main St	NB/SB	Opening day
NC 42	US 70 (Clayton Blvd)	NC42	NB/SB	Future infill
Powhatan	N Tech Dr	Best Wood Dr	Southern Endpoint	Opening day

Figure 18 Southern Extension, Scenario 2

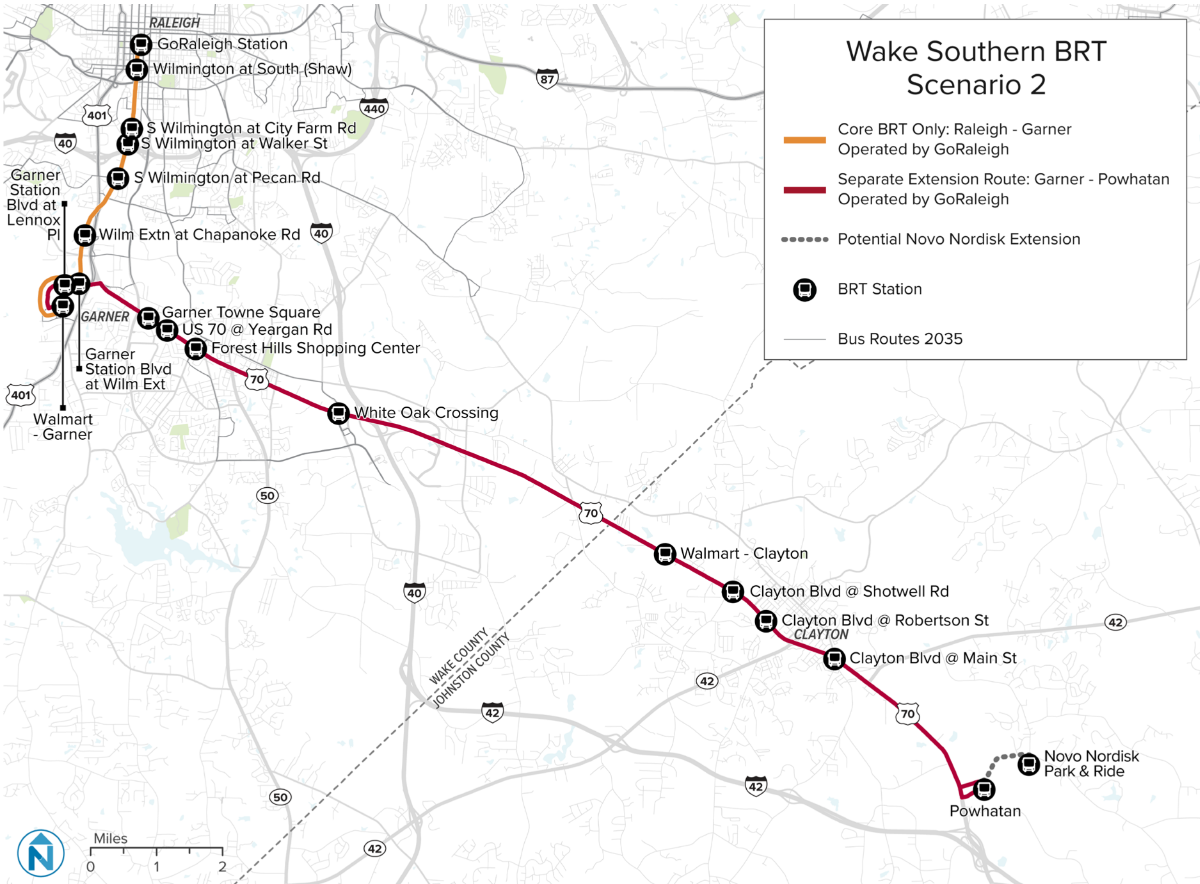
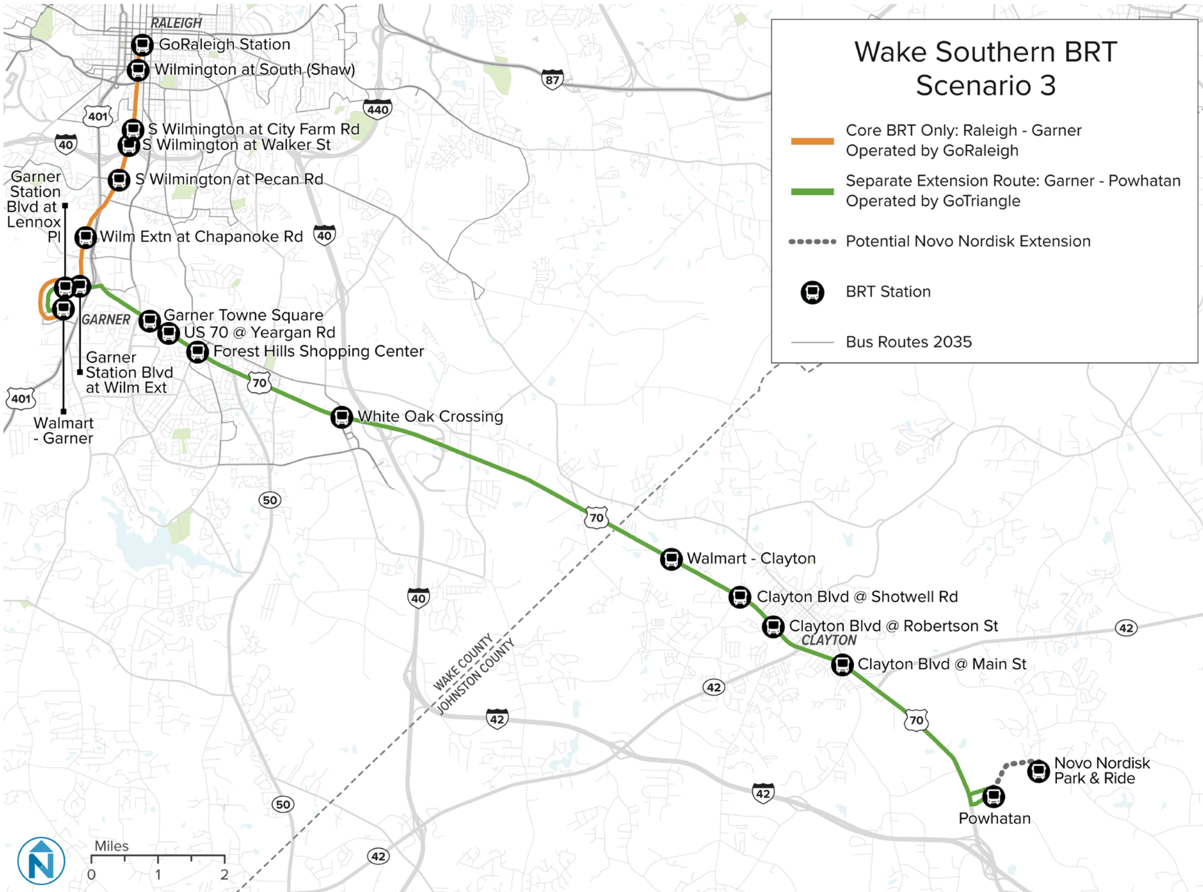


Figure 19 Southern Extension, Scenario 3



Two stations in the Southern Extension corridor in all scenarios have additional considerations:

- Forest Hills Shopping Center: This station is dependent upon the redesign of the Vandora Springs Rd Bridge to facilitate pedestrian access
- Powhatan: Additional facilities will need to be constructed for operator layover comfort, and further conversations may be held with the largest nearby employer, Novo Nordisk.

Western Extension Stations

The Western Extension consists of 14 stations in all scenarios. In Scenarios 1 and 2 the easternmost extension station is the last station on the core Western BRT, and in Scenarios 3 and 4 the easternmost station is the Cary Multimodal Center. Figure 20 lists the proposed stations in Scenarios 1 and 2, and Figure 21 and Figure 22 illustrate the stations and alignments in Scenarios 1 and 2, respectively.

Figure 20 Western Extension Stations, Scenarios 1 and 2

Station	Street	Cross Street	Direction	Station Type
Harrison Ave at Hillsboro St	Harrison Ave	Hillsboro St	EB/WB	Core BRT
Chapel Hill Rd at Maynard Rd	Chapel Hill Rd	Maynard Rd	EB/WB	Opening day
Park West Village	Chapel Hill Rd	Market Center Dr	EB/WB	Opening day
Weston Pkwy & Evans Rd	Weston Pkwy	Evans Rd	EB/WB	Opening day
McCrimmon Pkwy at Aviation Pkwy	Evans Rd – McCrimmon Pkwy	Aviation Pkwy	EB/WB	Opening day
Wake Competition Center	McCrimmon Pkwy	Strand St	EB/WB	Opening day
McCrimmon Pkwy at Airport Blvd	McCrimmon Pkwy	Airport Blvd	EB/WB	Opening day
McCrimmon Pkwy at Chapel Hill Rd	McCrimmon Pkwy	Chapel Hill Rd	EB/WB	Opening day
Wake Tech	Chapel Hill Rd	Watkins Rd	EB/WB	Opening day
Perimeter Park	Chapel Hill Rd	Carrington Mill	EB/WB	Future infill
Walmart - Morrisville	Chapel Hill Rd	Surles Ct	EB/WB	Opening day
Miami Blvd at Page Rd	Miami Blvd	Page Rd	EB/WB	Opening day
Triangle Mobility Hub	NC 54	Select Dr	EB/WB	Opening day
NC 54 at Rodbell St	NC 54	Rodbell St	EB/WB	Opening day
Hub RTP – Park Offices Dr	Park Offices Dr	NC 54	Western Endpoint	Opening day

Figure 21 Western Extension, Scenario 1

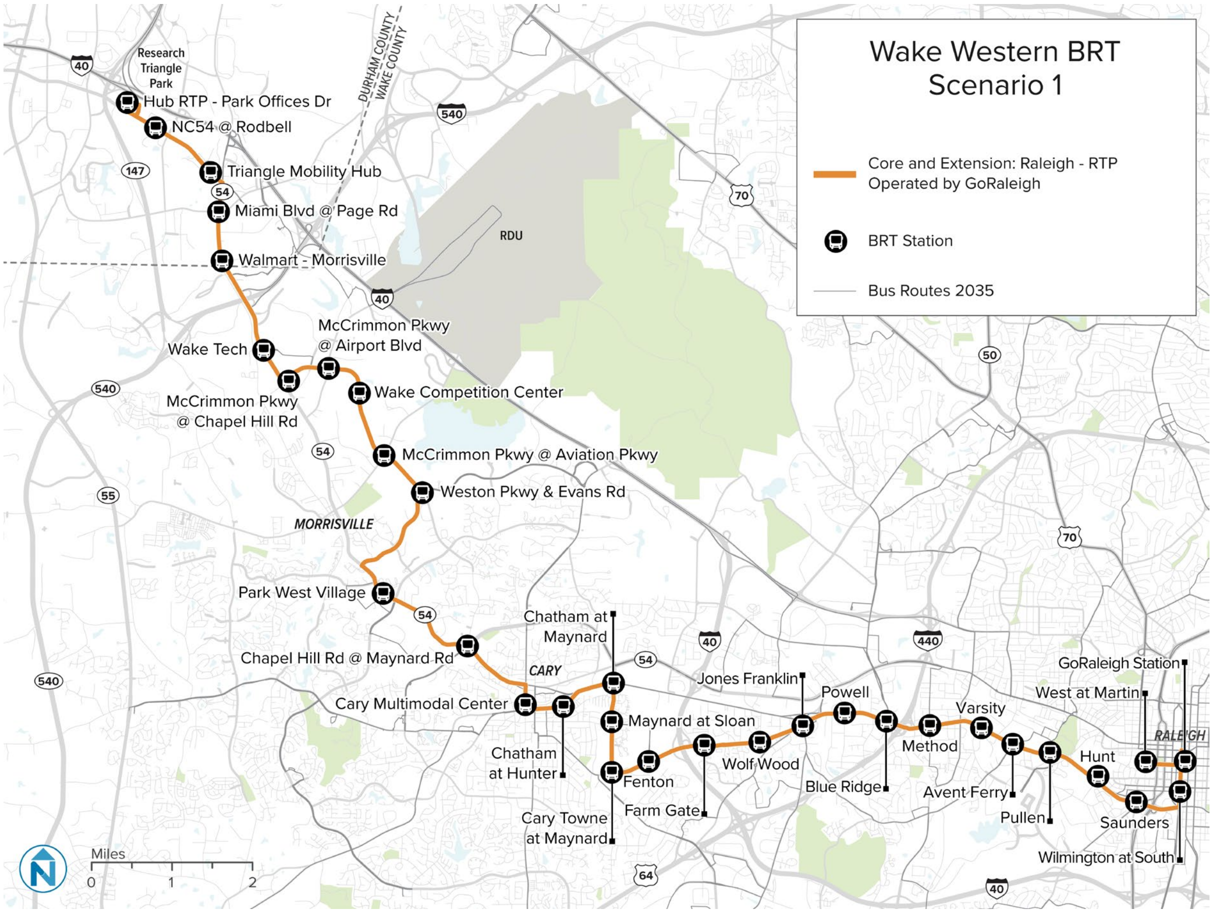


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Figure 22 Western Extension, Scenario 2

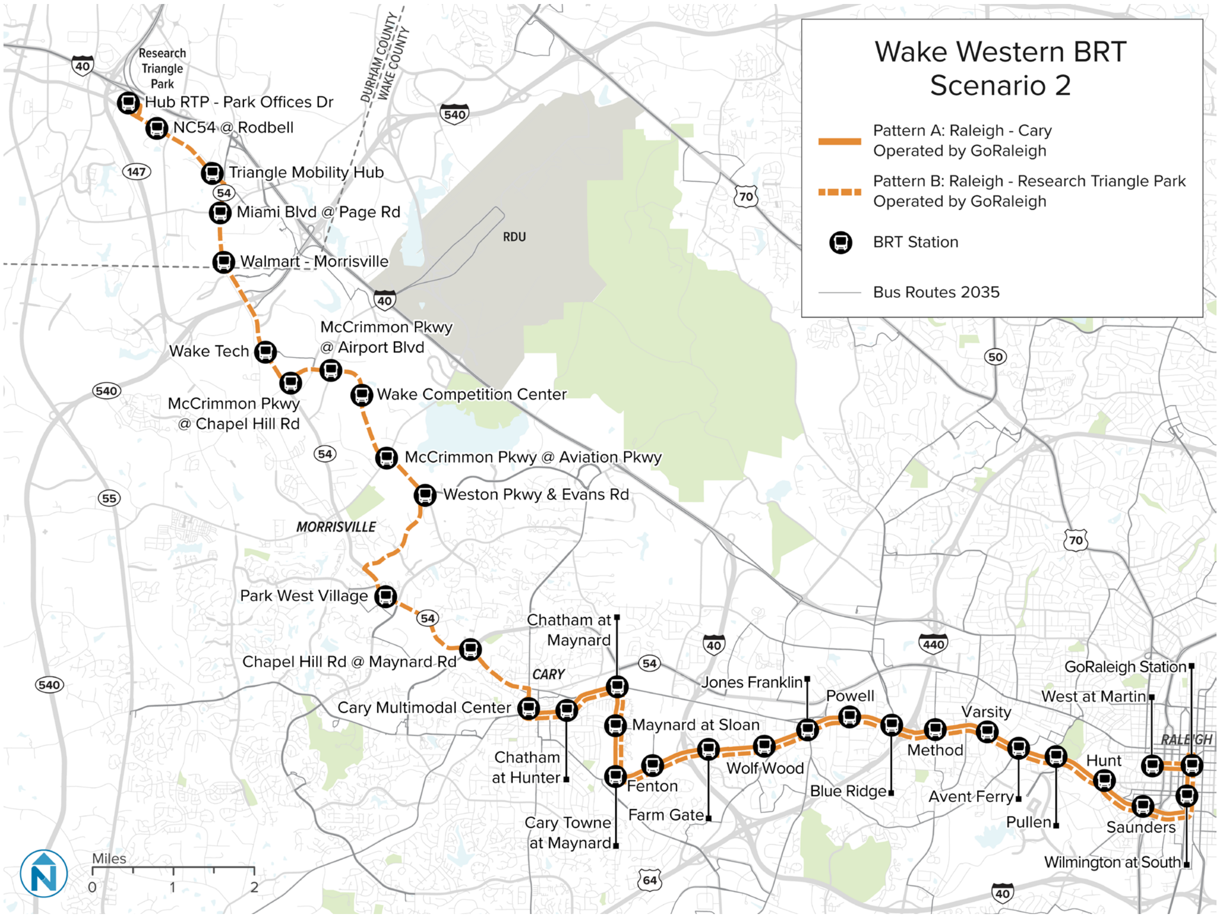

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Figure 23 lists the proposed stations in Scenarios 3 and 4. Figure 24 and Figure 25 illustrate the stations and alignments in Scenarios 3 and 4, respectively.

Figure 23 Western Extension Stations Scenarios 3 and 4

Station	Street	Cross Street	Direction	Station Type
Cary Multimodal Center	Hillsboro St	Harrison Ave	Eastern Endpoint	Transit facility
Chapel Hill Rd at Maynard Rd	Chapel Hill Rd	Maynard Rd	EB/WB	Opening day
Park West Village	Chapel Hill Rd	Market Center Dr	EB/WB	Opening day
Weston Pkwy & Evans Rd	Weston Pkwy	Evans Rd	EB/WB	Opening day
McCrimmon Pkwy at Aviation Pkwy	Evans Rd/ McCrimmon Pkwy	Aviation Pkwy	EB/WB	Opening day
Wake Competition Center	McCrimmon Pkwy	Strand St	EB/WB	Opening day
McCrimmon Pkwy at Airport Blvd	McCrimmon Pkwy	Airport Blvd	EB/WB	Opening day
McCrimmon Pkwy at Chapel Hill Rd	McCrimmon Pkwy	Chapel Hill Rd	EB/WB	Opening day
Wake Tech	Chapel Hill Rd	Watkins Rd	EB/WB	Opening day
Perimeter Park	Chapel Hill Rd	Carrington Mill	EB/WB	Future infill
Walmart - Morrisville	Chapel Hill Rd	Surles Ct	EB/WB	Opening day
Miami Blvd at Page Rd	Miami Blvd	Page Rd	EB/WB	Opening day
Triangle Mobility Hub	NC 54	Select Dr	EB/WB	Opening day
NC 54 at Rodbell St	NC 54	Rodbell St	EB/WB	Opening day
Hub RTP – Park Offices Dr	Park Offices Dr	NC 54	Western Endpoint	Opening day

Figure 24 Western Extension, Scenario 3

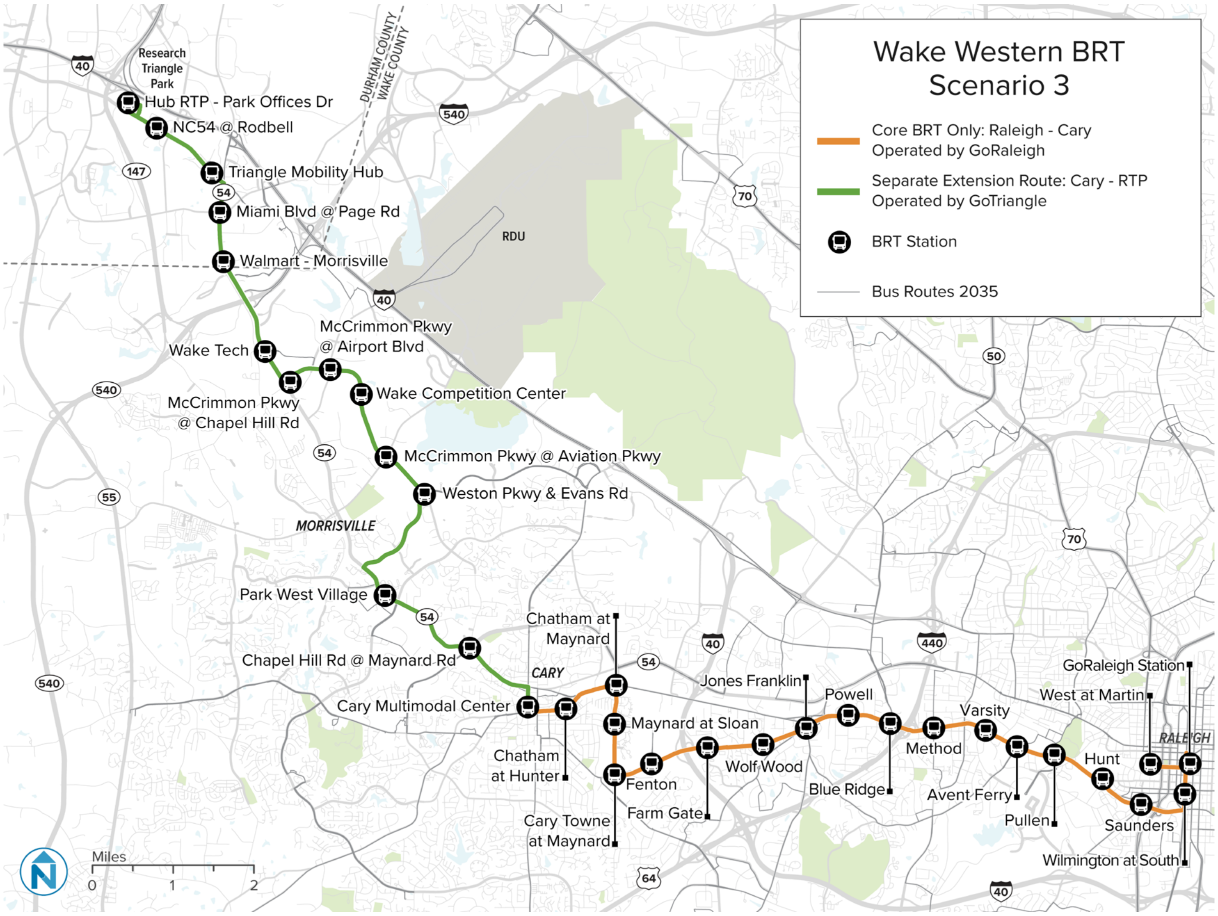

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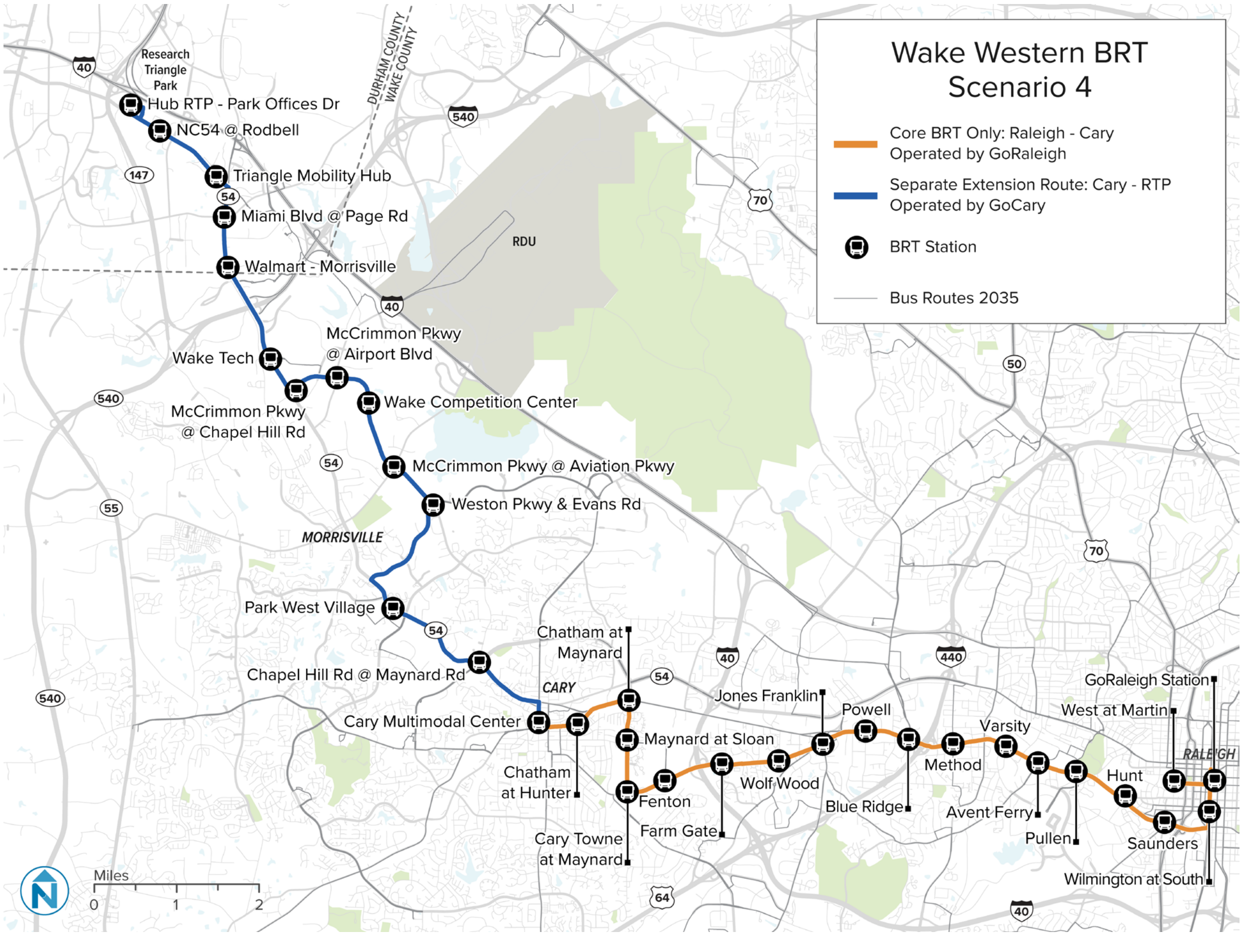
Figure 25 Western Extension, Scenario 4



One station in the Western Extension corridor in all scenarios has additional considerations:

- McCrimmon at Chapel Hill Rd – This station will need to be sited at a temporary location at grade before further development on western quadrants of the McCrimmon/Chapel Hill Rd intersection. Current rail right-of-way and grade separation limits walkability across the corridor.

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3 TRANSIT PRIORITY TREATMENTS

Transit priority treatments are infrastructure investments that improve bus speed and reliability. Three treatments were analyzed for implementation on the Southern and Western Extension BRT corridors: transit signal priority, queue jump lanes, and bus on shoulder systems. Transit signal priority (TSP) is a set of tools and traffic management systems that detect transit vehicles and modify traffic signals to prioritize transit movements. Queue jump lanes provide buses with an early signal phase, allowing them to bypass congestion and re-enter the main traffic flow ahead of general traffic. Bus on shoulder systems (BOSS) allow operators to drive on the shoulder when certain conditions are met.

In 2023, CAMPO's BRT Extension MIS assumed all signalized intersections along the proposed Southern and Western Extension corridors would receive transit signal priority treatment and evaluated these intersections to identify potential locations for additional transit priority improvements, such as queue jumps, that could further improve BRT operational efficiencies.

Since then, some of the existing roadways, surrounding land uses, and transit conditions have changed, such as new roadway configurations, grade separations, and signalized intersections. In addition, existing transit routes and bus stops and planned BRT alignments and station locations have been adjusted for the changed conditions. Accordingly, the prior analysis was revisited as part of this Concept of Operations study to provide up-to-date recommendations on transit priority treatment locations and implementation timeframes.

For all scenarios, this study recommends signal priority and queue jump treatments when service is planned to begin in 2035 and recommends bus on shoulder systems after service has been initiated and its performance is evaluated, in 2040 in accordance with several MTP projects. The following chapter details the analysis process and recommended priority treatments and locations.

SIGNAL PRIORITY

Overview

Transit signal priority (TSP) is a set of tools and traffic management systems that detect transit vehicles and modify traffic signals to prioritize transit movements. Signal prioritization can be given to all buses or exclusively to buses that are running behind schedule. TSP can be implemented throughout an entire corridor or at specific intersections. The proper treatment depends on the conditions at an intersection or corridor, such as traffic volume and direction, cycle length, and distance between signals. TSP is most effective at intersections or corridors where signal cycles are long, causing large delays and frequent, lengthy queues, because longer cycles allow for greater flexibility in prioritizing transit. TSP strategies can be reinforced with complementary transit priority measures like far-side stops and an appropriate degree of dedicated lanes. Signal delays can be a significant impediment to transit reliability and service. By prioritizing transit at intersections, TSP can reduce signal delays, improving travel time and reliability.

This study reviewed and analyzed the 2023 MIS recommendations for the proposed Southern BRT Extension and the proposed Western BRT Extension to:

- **Assess** the existing and planned roadway and transit networks and operations.
- **Identify** new intersections or conditions requiring updated analyses.
- **Analyze** the intersections.
- **Determine** the type of intersection for the runtime calculations.

The transit signal priority analysis reviewed signalized intersections along the proposed BRT extensions, identified feasible transit signal priority locations, and categorized each feasible location by intersection type.

As a result of this transit signal priority analysis:

- **Southern BRT Extension**: 55 turns at signalized intersections were identified as feasible for transit signal priority along the proposed round trip for all the Southern BRT Extension scenarios.
- **Western BRT Extension**: 66 turns at signalized intersections were identified as feasible for transit signal priority along the proposed round trip for all the Western BRT Extension scenarios.

Methodology

Identical to how intersections were identified in the MIS, newly identified intersections were classified into one of three delay types: High, Medium, and Low, based on the type of intersecting roads. **High-delay intersections** include two major arterials crossing each other with full LT lane phases on all approaches. **Medium-delay intersections** include arterial/major collectors. **Low-delay intersections** include arterials that cross a minor collector. Time savings by each intersection type is shown in Figure 26 below.

Figure 26 Signal Priority Time Savings by Intersection Type

Intersection Type	Time Savings
High-delay	6 seconds
Medium-delay	3 seconds
Low-delay	2 seconds

QUEUE JUMP LANES

Overview

Queue jump lanes are a targeted traffic management strategy designed to improve bus travel time and reliability at signalized intersections without requiring a fully dedicated lane along the entire corridor. A queue jump provides buses with an early signal phase, allowing them to bypass congestion and re-enter the main traffic flow ahead of general traffic.

This study reviewed and analyzed the 2023 MIS queue jump recommendations for the proposed Southern BRT Extension and the proposed Western BRT Extension to:

- **Confirm** the validity of the prior MIS recommendations.
- **Assess** the existing and planned roadway and transit networks and operations.
- **Identify** new intersections or conditions requiring updated analyses.
- **Analyze** the intersections.
- **Determine** the feasibility of queue jump lanes for the proposed BRT extension operations scenarios.

The queue jump analysis reviewed signalized intersections along the proposed BRT extensions, identified feasible queue jump locations, and categorized each feasible location by a rough order-of-magnitude implementation cost. The recommendations focused on intersections where queue jumps could be implemented with minor improvements at a lower cost.

As a result of this queue jump analysis:

- **Southern BRT Extension:** 21 intersections were identified as feasible for queue jumps along the proposed Southern BRT Extension.
- **Western BRT Extension:** 18 intersections were identified as feasible for queue jumps along the proposed Western BRT Extension.

Methodology

The queue jump analysis included the following steps:

1. **Reviewed** field notes and observations and aerial/street-level imagery.
2. **Evaluated** current traffic volumes [Average Annual Daily Traffic (AADT)].
3. **Assessed** intersection geometry and lane configurations (e.g., is there available lane width to incorporate a queue jump lane, or could a lane be added at a low cost?)
4. **Checked** existing bus stop locations and transit operations and planned BRT station locations and alignments using Remix software to assess compatibility for queue jumps.
5. **Considered** recent changes in roadway operations and nearby land use development that could affect the feasibility of the 2023 MIS queue jump recommendations.

6. **Reviewed** planned roadway projects from the 2055 Metropolitan Transportation Plan (MTP) for the 2035 horizon year.
7. **Identified** feasible queue jump intersections.
8. **Categorized** intersections by a rough order-of-magnitude capital cost tier based on the level of infrastructure modification required to implementing queue jumps.

Identification Process

The queue jump identification process began with a comprehensive review of each existing and planned signalized intersection using a combination of field observation data, aerial and street-level imagery, and Remix software to confirm existing lane configurations, intersection geometry, AADT, and surrounding roadway, transit, and land use conditions. Each intersection was examined for the presence of an existing right-turn lane or channelized area could potentially serve as a queue jump lane for buses.

The intersections were then examined for the presence of a receiving lane or usable shoulder area on the far side of the intersection to allow buses to merge back into traffic after the queue jump phase. This receiving lane did not need to be a through lane; a striped shoulder or auxiliary lane was considered acceptable if it was determined that enough usable pavement was present. In cases where an existing lane or additional pavement was not present, an assessment was conducted to determine if a lane could be created through minor capital improvements, such as minor widening or restriping.

Capital Cost Categorization

A high-level, rough order-of-magnitude capital cost for implementing queue jumps at each identified intersection was assessed and categorized into three tiers based on the anticipated level of infrastructure modification required:

- **The lowest-cost category ($)** applied to improvements that could be implemented within the existing right-of-way, such as pavement striping, signage, and minor signal adjustments. These measures typically involve minimal construction and no significant utility work.
- **The moderate-cost category ($$)** included minor geometric changes, such as adding curb cuts or adjusting sidewalks, and that may require limited utility relocation, such as moving a light pole or drainage structure. These improvements are typically more complex than simple restriping but do not involve full intersection reconstruction.
- **The highest-cost category ($$$)** encompassed major geometric modifications, such as roadway widening or intersection reconfiguration, and would likely require significant utility relocation. These projects typically involve extensive design, permitting, and construction efforts, resulting in substantially higher costs compared to the other categories. Due to the cost-prohibitive nature of the improvements, these intersections were not advanced as feasible queue jump candidates.

It should be noted that all capital cost classifications at the intersections were evaluated based on the data obtained from the field notes and desktop review using aerial and street-level imagery. Further investigation of existing conditions are recommended during design and may result in different capital cost assignments.

Future Roadway Network Assessment

Future roadway projects were also assessed as part of the analysis. Queue jump recommendations took into account the projects identified in the 2055 Metropolitan Transportation Plan (MTP) for the 2035 horizon year. Projects with horizon years beyond 2035, such as those planned for 2045 or 2055, were excluded from feasibility assumptions due to the proposed BRT implementation timeframes.

Additional Considerations

Additional considerations included reviewing current traffic volumes (AADT) to estimate congestion levels, assessing intersection geometry and lane configuration for potential modifications, and reviewing existing bus stop locations and transit operations to ensure compatibility with queue jump treatments. The analysis also accounted for any recent changes in roadway operations or nearby development that could affect feasibility.

Recommendations

Figure 27 and Figure 28 list the proposed queue jump (QJ) intersections and estimated capital cost range for the Southern and Western BRT Extension corridors, respectively.

Figure 27 Recommended Queue Jump Locations, Southern Extension (2035)

On Street	Intersecting Street	1st QJ Direction?	1st Receiving Lane?	2nd QJ Direction?	2nd Receiving Lane?	Capital Cost Range
Fayetteville Rd/US-401	Mechanical Blvd/Garner Station Blvd	WB	No	EB	No	$
US-70	Mechanical Blvd	WB	No			$$
US-70	Jessup Dr			EB	No	$
US-70	Timber Dr	WB	No	EB	No	$
US-70	Garner Town Square	WB	No	EB	No	$
US-70	Yeargan Rd	WB	No	EB	No	$
US-70	New Rand Rd	WB	No	EB	No	$
US-70	Medical Park Ct	WB	No	EB	Yes	$
US-70	Jones Sausage Rd/White Oak Rd	WB	No	EB	No	$
US-70	I-40 WB Ramps (WB Only)	WB	Yes			$
US-70	Raynor Rd	WB	No	EB	Yes*	$
US-70	TV Tower Rd	WB	Yes	EB	No	$
US-70	Guy Rd	WB	No	EB	No	$$
US-70	Town Centre Blvd	WB	Yes	EB	Yes	$
US-70	Shotwell Rd	WB	No	EB	Yes	$
US-70	S Moore St	WB	No	EB	Yes	$$
US-70	S Robertson St	WB	No	EB	Yes	$
US-70	Champion St	WB	No			$
US-70	Cutter Lab Access Rd	WB	No			$
US-70	Pony Farm Rd	WB	Yes	EB	No	$
US-70	Powhatan Rd			EB	No	$

*With minor curb and gutter changes

Source: Three Oaks Engineering for Nelson\Nygaard on behalf of CAMPO, 2025.

Figure 28 Recommended Queue Jump Locations, Western Extension (2035)

On Street	Intersecting Street	1st QJ Direction?	1st Receiving Lane?	2nd QJ Direction?	2nd Receiving Lane?	Capital Cost Range
Chapel Hill Rd/NC-54	NW Cary Pkwy			EB	No	$$
Chapel Hill Rd/NC-54	Market Ctr Dr			EB	No	$$
Chapel Hill Rd/NC-54	Morrisville Pkwy			EB	Yes	$
Chapel Hill Rd/NC-54	Weston Pkwy	WB	Yes			$
Evans Rd	Aviation Pkwy	NB	No	SB	No	$$
McCrimmon Pkwy	Strand St Future Signal	NB	No	SB	No	$
McCrimmon Pkwy	Future Odyssey Dr Extension, Future Signal			SB	No	$
McCrimmon Pkwy	Perimeter Park Dr	NB	Yes	SB	Yes	$
Chapel Hill Rd/NC-54	McCrimmon Pkwy	NB	Yes	SB	Yes	$
Chapel Hill Rd/NC-54	Watkins Rd	SB	Yes			$
Chapel Hill Rd/NC-54	Carrington Mill Blvd	NB	No			$
Chapel Hill Rd/NC-54	Shiloh Glenn Dr			NB	No	$
Chapel Hill Rd/NC-54	Surles Ct			NB	No	$
S Miami Blvd/NC-54	Emperor Blvd			NB	No	$
S Miami Blvd/NC-54	Hopson Rd/Page Rd			NB	No	$
NC-54	New Millennium Wy	WB	No	EB	No	$
NC-54	Davis Dr	WB	No	EB	No	$$
NC-54	Rodbell St	WB	No			$$

Source: Three Oaks Engineering for Nelson\Nygaard on behalf of CAMPO, 2025.

BUS ON SHOULDER SYSTEMS

Overview

Bus on Shoulder System (BOSS) is a cost-effective and comparatively easy-to-implement solution to improve bus service performance on limited access facilities. With BOSS, buses are allowed to drive on the shoulder when certain conditions are met. As detailed in the Triangle Bus on Shoulder Study, BOSS may operate when traffic in the general-purpose lanes slows below 35 mph due to traffic congestion. Buses may operate no more than 15 mph faster than the free flow of general-purpose traffic when using BOSS. In addition to these operating criteria, shoulders must meet minimum design criteria to be considered for BOSS such as a minimum 10-foot width without a barrier or 11 feet with a barrier. Additional requirements related to pavement depth, pavement condition, signage, and access control can be found in the Triangle Bus on Shoulder Study. BOSS was primarily evaluated for the Southern BRT Extension. The Western BRT Extension has insubstantial limited access for much of the corridor and does not have existing shoulders sufficient for BOSS.

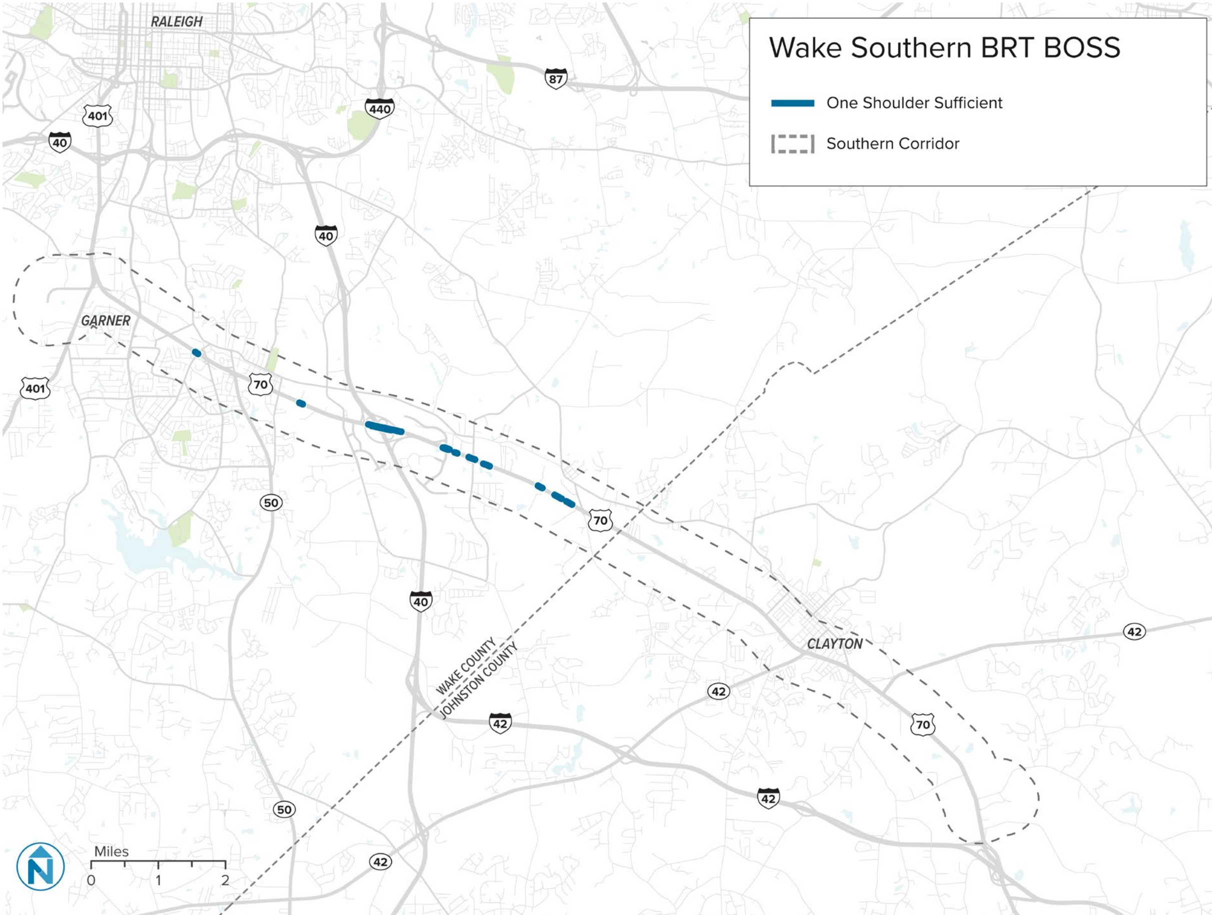
Methodology

BOSS was evaluated by considering existing shoulders along the corridor and forecasted travel speeds as an indicator of congestion where BOSS could be applicable and beneficial for future BRT service. Planned projects by CAMPO and NCDOT were also considered in this analysis.

Existing Shoulders

The Southern BRT Extension corridor was first reviewed for existing shoulders that meet the minimum pavement widths for BOSS as defined in the Triangle Bus on Shoulder Study. This analysis was a desktop review in GIS using the NCDOT Roadway Characteristics ArcGIS layer (2025 Quarter 2 release). The corridor was then visually reviewed using satellite imagery to confirm the shoulders from the GIS layer (Figure 29).

Figure 29 Existing Shoulders Sufficient for BOSS in the Southern BRT Extension Corridor



There are limited portions of the corridor with short segments of existing shoulders that are at least 10 feet wide. The longest shoulder is approximately only 2,000 feet long and is located at the I-40 and US-70 interchange. BOSS is not ideal at this location, given the potential conflicts with the interchange on and off ramps. Out of the 35.1 miles of shoulder along the corridor, only 1.6 miles have shoulders that meet the width requirements for BOSS.

Planned Transportation Projects

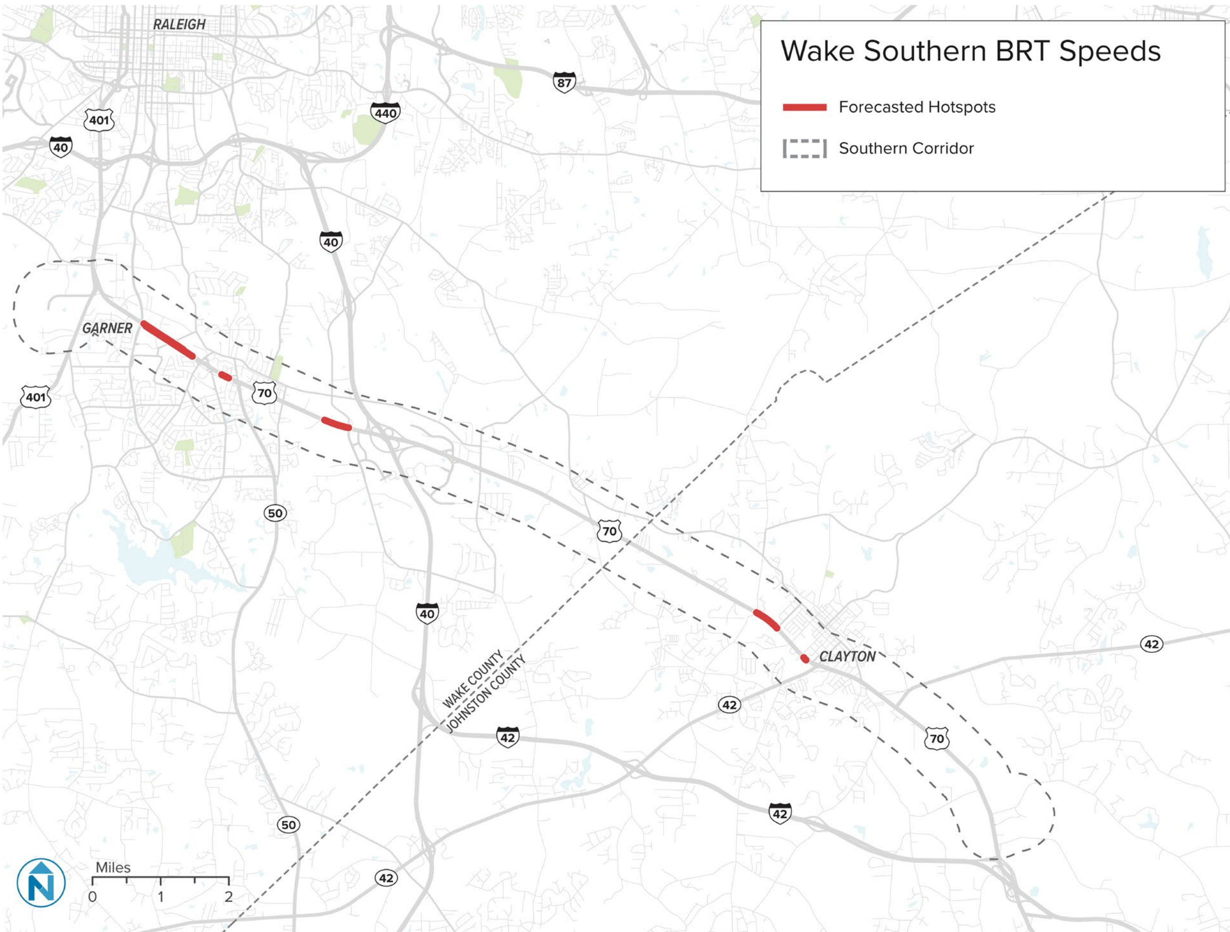
The current 2026-2035 Statewide Transportation Improvement Program (STIP) does not include any projects that would construct shoulders in the Southern or Western BRT Extension corridors. Previously, STIP Project U-6113 was included but unfunded in the 2020-2029 STIP. This project would have converted US-70 to a superstreet between Greenfield Parkway and NC 42 and may have provided an opportunity for constructing additional shoulders.

The CAMPO 2050 Metropolitan Transportation Plan (MTP) includes two US-70 widening projects, A300 from US-401 to I-40 and A301 from I-40 to NC 42. Both projects have a 2040 horizon year, and neither are currently committed. Although the horizon year of these projects is beyond the assumed opening year of 2035 for the Southern BRT Extension, these projects may provide opportunities for additional shoulders to address forecasted congestion in the corridor.

Forecasted Congestion

Given that BOSS may only operate when traffic in the general purpose lanes slows below 35 mph, the forecasted speeds during the AM and PM peak periods in 2050 from the Triangle Regional Model (TRM) were analyzed throughout the corridor (Figure 30).

Figure 30 Forecasted Speeds Below 35 MPH in 2050



For most of the corridor, speeds are not forecasted to be less than 35 mph. However, there are three segments in particular where congestion is anticipated to occur and could negatively impact future BRT operations:

- US-70 from Timber Dr to Garner Town Square
- US 70 from Medical Park Ct to Jones Sausage Rd/White Oak Rd
- US-70 from Shotwell Rd to South Moore St

There are no existing shoulders meeting the criteria for BOSS in these three segments. The current 2026-2035 STIP does not include projects that would add shoulders. However, the 2050 MTP includes two US-70 widening projects that have the potential to construct shoulder infrastructure after the planned opening year of the Southern BRT Extension.

Recommendations

The three US-70 corridor segments identified above where congestion is anticipated to occur include intersections where TSP and queue jumps are recommended. In these locations, there may be opportunities to extend queue jumps to address congestion particularly to connect intersections with stations to avoid the bus having to reenter general traffic.

BOSS should continue to be considered as MTP projects with IDs A300 and A301 are advanced in planning, design, and funding. Southern BRT Extension service is planned to begin in 2035, five years ahead of the 2040 horizon for A300 and A301. This timing provides an opportunity to evaluate the actual on-time performance and reliability of Southern BRT Extension to determine specific locations where BOSS and queue jumps would be beneficial and then incorporate those improvements into projects A300 and A301. Additional projects in future MTPs and STIPs should similarly be reviewed for opportunities to enhance BRT service.

4 SCENARIO EVALUATION

EVALUATION FRAMEWORK

The following goals were carried through from the MIS to inform the evaluation of the scenarios:

- Access to Local or Regional Destinations and Major Activity Centers
- Access to Transit Services
- Productive and Sustainable Service
- Safety and Compatibility with the Surrounding Environment

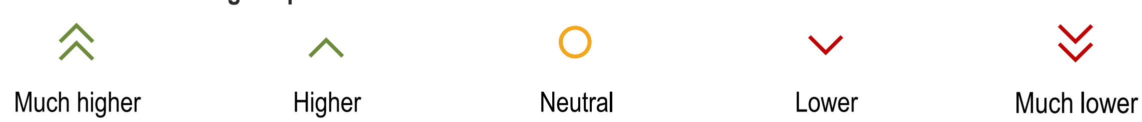
Metrics were developed to evaluate how well each scenario supported the achievement of the goals, incorporating feedback from Core Technical Team members. Final metrics are shown in Figure 31.

Figure 31 Evaluation Metrics

Goal	Metric
Access to Local or Regional Destinations and Major Activity Centers	End-to-end and interim travel times on extension corridors, to downtown Raleigh, and between RTP and Clayton
Access to Transit Services	Average rider transfer and wait times
Productive and Sustainable service	Annual operating cost per rider
	Annualized capital cost per rider
	Operational considerations
Safety and Compatibility with the Surrounding Environment	Comparison between expected future transit demand and proposed service levels

For each metric, the scenarios were compared and assigned a relative score that was vetted by the Core Technical Team. Relative rankings (Figure 32) were made through comparisons between scenarios within the same extension corridor and are presented in a summary table in the following chapter.

Figure 32 Relative Scoring Graphics



KEY ASSUMPTIONS & METHODS

Travel Time

This section provides an overview of the assumptions used for estimating peak and off-peak period travel times. Along with the travel time metrics in the evaluation framework, segment-level travel times are necessary inputs for estimating ridership, operational costs, and capital costs.

Inputs

Travel times at the segment level are calculated based on three areas: **stations**, **intersections**, and **road segments**. Once calculated, additional travel time can be added for transfers and estimated wait time.

Station timing is characterized by **dwell timing**, or the time the bus remains at the station, as passengers board and alight, and **congestion level**, as delay from other buses at the same stop.

- **Dwell timing** is assumed to be seven seconds per stop, with the bus stopping at every stop. This assumption is based on a moderate level of boardings per stop throughout the day, which will be further refined in the next stage of this study.
- **Congestion level** is a qualitative measure that assigns high, medium, or low level of congestion based on congestion at stops with other buses pulling in and out. Low congestion adds zero seconds to the total station timing, medium congestion increases dwell time by 20%, and high congestion increases dwell time by 40%.

Intersection timing is characterized by the **road intersection type**, including the type of road and how the bus operates at the intersection, and the intersection infrastructure, which includes **transit signal priority** and **queue jumps**. Total delay at an intersection is a combination of these factors.

- **Road intersection type** can be major, medium, or minor, informing the signal's cycle time delay. Major intersections include two major arterials crossing each other with full left-turn lane phases on all approaches, medium intersections involve arterials or major collectors, and minor intersections involve arterials that cross a minor collector.
- **Transit signal priority** allows buses to pass through an intersection quickly and reliably. It involves whether an intersection is signalized, and if so, the presence of signal priority. Signal priority has been assumed at most signals and is assumed to reduce the red time that buses incur. Reductions in delay are based on information from the Transit Cooperative Research Program (TCRP) Report 118.
- **Queue jumps** have been assumed where there are right-turn only lanes or lane drops with space across the intersection that would allow buses to merge into general purpose through lanes. Some assumptions have also been made based on future roadway configurations based on input from local stakeholders. Some queue jumps are assumed to be longer, further reducing delay time.

Road segment timing is characterized by the **distance, posted and level of service (LOS) speed**, and their corresponding **acceleration constraints**.

- **Distance** is measured between every intersection and station using geographic information systems (GIS) analysis. Distances were measured on roadway centerlines and from the center of each station or intersection to negate differences of station placement by direction.
- **Posted speed** limits have been sourced from field work and Google Street View.
- **Level of service (LOS) speed** is the posted road speed, reduced by roadway capacity during peak hours. For more details, refer to the Level of Service section below. There is no assumption for bus lanes or BOSS. In addition, we assume off-peak runtimes allow the entire route to approach the posted speed.
- **Acceleration constraints** limit the actual segment speed based on whether a bus can realistically reach the LOS speed within the segment's distance. Rates used for this analysis for acceleration are a constant 1.5 miles per hour per second (mphps) from 0 to 25 mph with a decreasing rate until maximum speeds, and a constant 2.0 mphps for deceleration. Though specific rates for articulated and standard-length CNG vehicles planned for Wake BRT Program were not yet available, these rates generally fall in line with bus procurement guidelines.

Estimating travel times involves applying a reasonable set of assumptions regarding traffic flow to approximate (as best as possible) for both current and forecasted conditions. For this analysis, travel times were estimated for the peak period (generally 6 a.m. to 9 a.m. and 3 p.m. to 7 p.m.) and for off-peak periods. Peak periods will represent times of the day when traffic congestion is highest and subsequent travel times are longest, requiring additional service requirements, such as additional buses, to provide the same level of service as in off-peak periods.

Peak period congestion factors were based on traffic volume to roadway capacity (v/c) ratios from the TRM. For current conditions, the Triangle Regional Model's 2020-baseline v/c ratios were used and its 2055 forecasted v/c ratios were used for future conditions. Level of service was projected for 2035 using straight-line interpolation between existing LOS data from 2020 and projected LOS data for 2055.

Volume-to-capacity ratios were available at the segment level and assumptions were made as to the level of service (LOS) at subsequent intersections along conceptual alignments. These LOS values were then used to adjust the potential maximum speed a bus would be able to travel. For both years, v/c data fit into three categories of capacity: below, at, or above capacity. These categories roughly correspond to three LOS categories that generally describe roadway congestion conditions.

Off-peak travel times assumed free-flow conditions with roadways "below capacity" and roadway segments were assigned a LOS of A throughout to approximate free-flow conditions for buses encountering minor amounts of traffic "friction."

Outputs

Segment-level outputs from the Southern Extension scenarios travel time model are listed in Figure 33. The full extension runtimes on Scenarios 2 and 3 are marginally faster than Scenario 1 during peak hours, but marginally slower during off-peak.

Figure 33 Southern BRT Extension Segment Travel Times

Segment	Scenarios	Direction	Start	End	Peak	Off-Peak
Core BRT	1, 2, 3	SB	Raleigh	Walmart - Garner	0:16:25	0:16:25
Core BRT	1, 2, 3	NB	Walmart - Garner	Raleigh	0:16:20	0:16:20
BRT Extension	1	SB	Walmart - Garner	Powhatan	0:35:34	0:34:38
BRT Extension	1	NB	Powhatan	Walmart - Garner	0:35:34	0:34:26
BRT Extension	2 & 3	SB	Walmart - Garner	Powhatan	0:35:39	0:34:45
BRT Extension	2 & 3	NB	Powhatan	Walmart - Garner	0:35:21	0:34:23
BRT Extension Midpoint	1	SB	Walmart - Garner	White Oak Crossing	0:13:26	0:13:16
BRT Extension Midpoint	1	NB	White Oak Crossing	Walmart - Garner	0:13:08	0:12:59
BRT Extension Midpoint	2 & 3	SB	Walmart - Garner	White Oak Crossing	0:13:30	0:13:22
BRT Extension Midpoint	2 & 3	NB	White Oak Crossing	Walmart - Garner	0:12:55	0:12:55

Segment-level outputs from the Western Extension scenarios travel time model are listed in Figure 34. The extension runtimes on Scenarios 1 and 2 are marginally faster compared to Scenarios 3 and 4 during both peak and off-peak hours due to assumptions surrounding turning movements within Cary.

Figure 34 Western BRT Extension Segment Travel Times

Segment	Scenarios	Direction	Start	End	Peak	Off-Peak
Core BRT	1, 2, 3, 4	WB	Raleigh	Harrison Ave	0:40:16	0:40:16
Core BRT	1, 2, 3, 4	EB	Harrison Ave	Raleigh	0:42:44	0:42:44
BRT Extension	1 & 2	WB	Harrison Ave	Hub RTP	0:30:29	0:29:44
BRT Extension	1 & 2	EB	Hub RTP	Harrison Ave	0:30:51	0:30:05
BRT Extension	3 & 4	WB	Cary Multimodal Center	Hub RTP	0:30:42	0:29:57
BRT Extension	3 & 4	EB	Hub RTP	Cary Multimodal Center	0:31:03	0:30:18
BRT Extension Midpoint	1 & 2	WB	Harrison Ave	McCrimmon Pkwy at Chapel Hill Rd	0:17:39	0:17:05
BRT Extension Midpoint	1 & 2	EB	McCrimmon Pkwy at Chapel Hill Rd	Harrison Ave	0:17:50	0:17:09
BRT Extension Midpoint	3 & 4	WB	Cary Multimodal Center	McCrimmon Pkwy at Chapel Hill Rd	0:17:52	0:17:18
BRT Extension Midpoint	3 & 4	EB	McCrimmon Pkwy at Chapel Hill Rd	Cary Multimodal Center	0:18:02	0:17:29

Operating Model

This section provides an overview of the operating model that estimates the vehicle requirements and costs by using the travel time analysis and other service level assumptions. The outputs from the operating model inform both operating and capital costs.

The operating model requires several inputs (assumptions) to produce the estimated operating requirements and costs for each alternative. These inputs are variables that either describe operating conditions (e.g., travel time) or the desired level of service (e.g., headways) associated with the alternative. The inputs are used to calculate the outputs that either describe the operating requirements (e.g., peak vehicles), costs, and other service statistics (e.g. trips) that would be needed for each alternative.

Inputs

- **Travel time** is the estimated time in route to complete a trip (excluding layovers) and are derived from the travel time analysis for each alternative. As determined in the travel time analysis, travel times vary between the peak and off-peak period. These inputs are used to calculate the cycle time.

- **Service span** represents the hours within a 24-hour period that a route is in operation, and defines when service starts and ends. Service spans are further divided into service periods, often with distinct headways and are used to estimate revenue hours.
- **Headway** is the time interval between trip departures and can vary by service period. Headways are used to derive cycle times, trips, and vehicle requirements.
- **Revenue hour cost factor** is the most recent available operating cost per revenue hour and varies by agency. This is used to calculate the operating cost.
- **Days of service** consist of 255 weekdays, 52 Saturdays, and 58 Sundays for all alternatives. These are used to calculate the annual operating cost.

Outputs

- **Cycle time** is the time required to complete one roundtrip, including the layover, and can vary depending on the travel time and headway for the service period. The cycle time must both be a multiple of the headway and include a minimum of an additional 10% of the travel time for the layover time. The cycle time is used to calculate the vehicle requirement output.
- **Layover** is the time allocated for the trip to absorb any travel delays and help the subsequent trip stay on schedule. The layover is derived by subtracting the roundtrip travel time from the cycle time. The conditions placed on deriving the cycle time will create a layover that will always be at least 10% of the travel time.
- **Trips** are calculated for each service period by dividing the total number of minutes in the period by the headway for the period. Summing all trips from each service period creates the total number of trips for a route and are used to calculate revenue miles.
- **Vehicle requirement** is the number of vehicles needed to provide the service at a proposed headway and varies by service period. This is derived from dividing the cycle time of a service period by the headway for the same period, rounded up to the next whole number (i.e., vehicle). The peak vehicle requirement is the highest value across all service periods and is the number of vehicles needed to operate the service.
- **Revenue hours** are the hours of revenue service operated by each vehicle dedicated to the route. This is derived from multiplying the vehicle requirement for each period by the service span hours for the same period.
- **Revenue miles** are the distances traveled by the route, excluding deadhead miles. This is derived from multiplying the trips of a service period by the round-trip distance of the route.
- **Operating cost** is the amount of money it requires to operate the alternative at the proposed service levels at a daily and annual figure. This is derived from multiplying the revenue hour cost factor of a particular agency by the total number of revenue hours for the alignment.

Outputs from the operating model for the Southern and Western Extension scenarios are listed in Figure 35 and Figure 36. In the Southern BRT Extension scenarios, Scenario 2 has the lowest total operating cost across all agencies, followed by Scenarios 1 and 3, respectively.

Figure 35 Southern BRT Extension Operating Requirements and Costs by Scenario

	Scenario 1	Scenario 2	Scenario 3
Weekday Max Vehicles 60’	10	5	5
Weekday Max Vehicles 40’	0	4	4
GoRaleigh Annual Core BRT Cost	$4,761,360	$4,761,360	$4,761,360
GoRaleigh Annual Extension Cost	$4,233,480	$3,820,380	-
GoTriangle Annual Extension Cost	-	-	$5,475,878

In the Western BRT Extension scenarios, Scenario 4 has the lowest total operating cost across all agencies, followed by Scenarios 2, 3, and 1, respectively.

Figure 36 Western BRT Extension Operating Requirements and Costs by Scenario

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Weekday Max Vehicles 60’	17	14	10	10
Weekday Max Vehicles 40’	0	0	4	4
GoRaleigh Annual Core BRT Cost	$9,638,220	$9,638,220	$9,638,220	$9,638,220
GoRaleigh Annual Extension Cost	$6,094,620	$3,820,380	-	-
GoTriangle Annual Extension Cost	-	-	$5,475,878	-
GoCary Annual Extension Cost	-	-	-	$3,488,325

Ridership Estimates

To calculate the costs per rider, annual ridership along the extension corridors had to be projected for each scenario. Ridership projections can be modeled in multiple ways, with different tools for different contexts. The FTA’s **Simplified Trips-on-Project Software (STOPS)** is the preferred method for many projects seeking federal funding, and was utilized for the initial core Western BRT and Southern BRT ridership estimates. To maintain consistency, the GoRaleigh team shared the inputs for the core BRT model to use for the extensions. However, given the Southern Extension corridor’s service to Johnson County outside the service area of the current transit network and the STOPS model’s reliance on existing transit ridership as a baseline, the model could not provide reliable estimates for the Southern Extension scenarios. Instead, the Southern Extension scenarios were programmed into the **Triangle Regional Model (TRM)** for future-year ridership estimates. While both methods have merit and are useful for comparing scenarios within each extension, the Southern and Western scenario ridership estimates should not be considered comparable across corridors due to the different baseline inputs. Regional travel models such as the TRM often overestimate ridership but are useful for order of magnitude comparisons between scenarios.

Southern Extension: Triangle Regional Model

Using CAMPO’s Metropolitan Transportation Plan (MTP 2055) and regional land use forecasts, the CAMPO modeling team built the Southern BRT Extension scenarios into the Triangle Regional Model and produced estimated daily boardings for all stations on the extension corridor under each scenario based on projected 2035 socioeconomic data and transportation networks.

Figure 37 lists the projected ridership by scenario for the Southern BRT Extension. The TRM outputs average daily boardings which were annualized using a standard factor. Scenario 1 is projected to have higher ridership than Scenarios 2 and 3 due to the benefits of a one-seat ride for the full corridor.

Figure 37 Southern BRT Extension Projected Ridership by Scenario

	Scenario 1	Scenario 2	Scenario 3
Extension Daily Ridership	3,578	3,157	3,157
Extension Annual Ridership	**1,173,694**	**1,035,394**	**1,035,394**

Western Extension: STOPS Model

Using the planned 2035 transit network, projected population and jobs estimates, and the calibration settings from the Western Core BRT, station-level ridership was projected for all core and extension stops across the four scenarios. Fares are an additional input in the STOPS model, typically based on the operating agency. As the Wake BRT fare structure has not yet been determined, for this exercise the same fare was used across all four scenarios. For scenarios 1 and 2, daily extension ridership was estimated by combining the boardings at extension stations with the on-board bus load passing through the Harrison Avenue Station to capture riders who board at core BRT stations but are alighting at extension stations. These riders are captured in scenarios 3 and 4 as boardings at Cary Multimodal Center. Figure 38 lists the projected ridership by scenario for the Southern BRT Extension, using a standard annualization factor.

Figure 38 Western BRT Extension Projected Ridership by Scenario

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Extension boardings	1,220	1,109	1,026	1,026
Pass-through load from core	543	479	-	-
Extension Daily Ridership	**1,763**	**1,588**	**1,026**	**1,026**
Extension Annual Ridership	**578,284**	**520,766**	**336,489**	**336,489**

Scenario 1, as a one-seat ride with high frequency, has the highest projected ridership of the four scenarios. Despite having half the frequency of Scenario 1, Scenario 2 has only slightly lower annual ridership with the convenience of a one-seat ride to downtown Raleigh. Scenarios 3 and 4 have the same projected ridership, lower than Scenario 2 due to the impact of the transfer requirement at Cary Multimodal Center.

Capital Model

A capital model was developed as part of this study to estimate capital costs by scenario and was largely adapted from the capital model developed as part of the 2023 MIS. Outputs of the model represent rough order of magnitude costs and are primarily for comparative purposes to inform the scenario evaluation.

The capital model uses the Federal Transit Administration's Standard Cost Categories (SCC) for the Capital Investment Grants (CIG) program. There are ten categories that were grouped into four subtotals for this evaluation.

- Five categories make up the **Construction** subtotal:
  - SCC 10: Guideway & Track Elements
  - SCC 20: Stations, Stops, Terminals, Intermodal
  - SCC 30: Support Facilities: Yards, Shops, Admin. Buildings
  - SCC 40: Sitework & Special Conditions
  - SCC 50: Systems
- The **Vehicles**, **Professional Services**, and **Additional Contingency** subtotals correspond to the following three SCC categories respectively:
  - SCC 70: Vehicles
  - SCC 80: Professional Services
  - SCC 90: Unallocated Contingency
- Two categories are excluded from cost estimates:
  - SCC 60: Right-of-way (ROW), Land, Existing Improvements
  - SCC 100: Financial Charges

2025 is the base year for all unit costs, and any historic unit costs were escalated to the 2025 base year. The main data sources used to develop unit costs include New Bern Avenue 100% engineering estimates (provided by the City of Raleigh) and the 2023 MIS capital model.

Outputs

Outputs from the capital model for the Southern and Western Extension scenarios are listed in Figure 39 and Figure 40, respectively. Costs across the four categories were calculated as follows:

- **Construction** is the total across five Standard Cost Categories (SCC 10, 20, 30, 40, and 50). It also includes 25% sitework allocation (utilities, temporary facilities and other indirect construction costs) and 30% overall contingency.
- **Vehicles** is the cost of vehicles, including the 20% minimum spare requirement, a 5% allocation for spare parts, and a 10% overall contingency.
- **Professional services** is inclusive of services like project management, design, engineering, construction administration, and legal and is calculated as 20% of the Construction total.
- **Additional contingency** is calculated as 10% of the total Construction, Vehicles, and Professional Services costs.

For the Southern Extension, Scenarios 2 and 3 have a lower cost than Scenario 1. For the Western Extension, Scenarios 3 and 4 have the lowest costs, followed by Scenario 2 then 1.

Figure 39 Southern BRT Extension Capital Costs by Scenario

	Scenario 1	Scenario 2	Scenario 3
Construction	$28,487,000	$28,047,000	$28,047,000
Vehicles	$8,117,800	$3,612,300	$3,612,300
Professional Services	$5,697,400	$5,609,400	$5,609,400
Additional Contingency	$4,230,200	$3,726,900	$3,726,900
Total Capital Cost	**$46,532,400**	**$40,995,600**	**$40,995,600**
Annualized Capital Cost	**$2,443,300**	**$1,945,100**	**$1,945,100**

Figure 40 Western BRT Extension Capital Costs by Scenario

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Construction	$28,809,200	$28,809,200	$28,812,200	$28,812,200
Vehicles	$12,176,700	$6,764,800	$3,612,300	$3,612,300
Professional Services	$5,761,800	$5,761,800	$5,762,400	$5,762,400
Additional Contingency	$4,674,800	$4,133,600	$3,818,700	$3,818,700
Total Capital Cost	**$51,422,500**	**45,469,400**	**$42,005,600**	**$42,005,600**
Annualized Capital Cost	**$2,781,000**	**$2,217,900**	**$1,890,000**	**$1,890,000**

EVALUATION RESULTS

Goal 1: Access to Destinations

Using the peak-period travel time outputs and assuming a scheduled 5-minute transfer between the extension routes and Core BRT routes where applicable, the following travel times were calculated averaging inbound and outbound travel:

- **Extension Corridor Only**, either the Extension BRT segment or Separate Extension Bus
- **Terminus to Downtown Raleigh**, adding the extension corridor time, the Core BRT time, and the average transfer time
- **Midpoint to Downtown Raleigh**, adding the extension midpoint travel time, the Core BRT time, and the average transfer time
- **RTP to Clayton**, adding the extensions and Core BRT with the assumption that the transfer between BRT services in Raleigh is half the frequency of the route being transferred to, pairing the Western and Southern Scenarios by extension type and operator:
  - GoRaleigh full extension: Western Scenario 1 and Southern Scenario 1 (used for Western Scenario 1 only)

- GoRaleigh alternating extensions: Southern Scenario 1 and Western Scenario 2
- GoRaleigh and GoCary separate extension bus: Southern Scenario 2 and Western Scenario 4
- GoTriangle separate extension bus: Southern Scenario 3 and Western Scenario 3.

Figure 41 lists the final end-to-end travel time metrics, rounded to the nearest minute. Within the Southern Extension scenarios, Scenario 1 has the shortest end-to-end travel time, followed by Scenarios 2 and 3, which have the same travel time. Within the Western Extension scenarios, Scenario 1 has the shortest end-to-end travel time, followed by Scenarios 2, 3, and 4. Scenarios 3 and 4 have the same travel time.

Figure 41 Evaluation Metrics: Travel Times, All Scenarios

	Extension Corridor Only	Terminus to Downtown Raleigh	Midpoint to Downtown Raleigh	RTP to Clayton
Southern Scenario 1	36 minutes	52 minutes	30 minutes	2 hours 14 minutes
Southern Scenario 2	36 minutes	57 minutes	35 minutes	2 hours 24 minutes
Southern Scenario 3	36 minutes	57 minutes	35 minutes	2 hours 24 minutes
Western Scenario 1	31 minutes	1 hour 12 minutes	59 minutes	2 hours 12 minutes
Western Scenario 2	31 minutes	1 hour 12 minutes	59 minutes	2 hours 14 minutes
Western Scenario 3	31 minutes	1 hour 17 minutes	1 hour 4 minutes	2 hours 24 minutes
Western Scenario 4	31 minutes	1 hour 17 minutes	1 hour 4 minutes	2 hours 24 minutes

Goal 2: Access to Transit

For the evaluation metric Average Rider Transfer and Wait Time, Wait Time is calculated as a weighted average based on daily trips, with Average Wait Time assumed to be half the frequency of the service. The transfer time between buses is scheduled at the transfer point for 5 minutes, allowing for some buffer and walk time. Figure 42 lists the average transfer and wait times across all scenarios for both Southern and Western BRT Extensions. Southern Scenario 1 and Western Scenario 2 have no average transfer time because it is assumed that a rider would only board a bus that will operate the full extension. Western Scenario 1 has no average transfer time because all trips operate the full extension. In the Southern Scenarios, Scenario 1 has the shortest total transfer and wait time, followed by Scenarios 2 and 3, which have the same total time. In the Western Scenarios, Scenario 1 has the shortest total transfer and wait time, followed by Scenarios 2, 3, and 4. Scenarios 3 and 4 have the same total time.

Figure 42 Evaluation Metric: Average Rider Transfer and Wait Times, All Scenarios

	Average Transfer	Average Wait Time	Total
Southern Scenario 1	-	12 minutes	12 minutes
Southern Scenario 2	5 minutes	12 minutes	17 minutes

Southern Scenario 3	5 minutes	12 minutes	17 minutes
Western Scenario 1	-	6 minutes	6 minutes
Western Scenario 2	-	12 minutes	12 minutes
Western Scenario 3	5 minutes	12 minutes	17 minutes
Western Scenario 4	5 minutes	12 minutes	17 minutes

Goal 3: Productive and Sustainable Service

Operating Cost Per Rider

Figure 43 describes the total and incremental operating costs and requirements by scenario for the Southern BRT Extension. Scenario 2 has the lowest cost, followed by Scenarios 1 and 3, respectively. Scenario 1 has a higher cost than Scenario 2 despite the same frequency and operator due to the additional bus required for the alternating extension pattern to work in the schedule.

Figure 43 Southern BRT Extension Operating Requirements and Costs by Scenario

	Scenario 1	Scenario 2	Scenario 3
GoRaleigh Annual Operating Cost	$8,994,840	$8,581,740	$4,761,360
GoTriangle Annual Operating Cost	-	-	$5,475,878
Total Annual Operating Cost	**$8,994,840**	**$8,581,740**	**$10,237,238**
Incremental Cost of Extension	**$4,233,480**	**$3,820,380**	**$5,475,878**

Figure 44 describes the total and incremental operating costs and requirements by scenario for the Western BRT Extension. Scenario 4 has the lowest cost, followed by Scenarios 2, 3, and 1, respectively.

Figure 44 Western BRT Extension Operating Requirements and Costs by Scenario

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
GoRaleigh Annual Operating Cost	$15,732,840	$13,458,600	$9,638,220	$9,638,220
GoTriangle Annual Operating Cost	-	-	$5,475,878	-
GoCary Annual Operating Cost	-	-	-	$3,488,325
Total Annual Operating Cost	**$15,732,840**	**$13,458,600**	**$15,114,098**	**$13,126,545**
Incremental Cost of Extension	**$6,094,620**	**$3,820,380**	**$5,475,878**	**$3,488,325**

To fairly compare across scenarios, the final evaluation metric looks at operating cost per rider for each extension scenario, or the approximate annual price of each additional rider above the Core BRT. At this stage, differences in fares across providers were not considered in either operating cost or ridership estimates. Figure 45 describes the annual incremental operating costs per rider for the Southern BRT Extension scenarios. Scenario 1 has the lowest operating cost per rider, with the higher ridership from the one-seat ride offsetting the higher operating cost, while the higher operating cost of Scenario 3 is not offset to the same degree.

Figure 45 Evaluation Metric: Annual Operating Costs per Rider, Southern Extension Scenarios

	Incremental Operating Cost (nearest 1000)	Projected Annual Ridership* (nearest 1000)	Operating Cost per Rider
Southern Scenario 1	$4,233,000	1,174,000	**$3.61**
Southern Scenario 2	$3,820,000	1,035,000	**$3.69**
Southern Scenario 3	$5,476,000	1,035,000	**$5.29**

*Ridership projections cannot be compared between the Southern and Western Scenarios due to differing modeling approaches and differences in the baseline inputs.

Figure 46 describes the annual incremental operating costs per rider for the Western BRT Extension scenarios. Scenario 2 has the lowest operating cost per rider, with both lower operating costs than Scenarios 1 and 3 as well as higher ridership than Scenarios 3 and 4 due to the one-seat ride. The higher frequency in Scenario 1 results in both higher operating costs and higher ridership, but the ridership is not enough to fully offset the higher operating costs.

Figure 46 Evaluation Metric: Annual Operating Costs per Rider, Western Extension Scenarios

	Incremental Operating Cost (nearest 1000)	Projected Annual Ridership* (nearest 1000)	Operating Cost per Rider
Western Scenario 1	$6,095,000	578,000	**$10.54**
Western Scenario 2	$3,820,000	521,000	**$7.34**
Western Scenario 3	$5,476,000	336,000	**$16.27**
Western Scenario 4	$3,488,000	336,000	**$10.37**

*Ridership projections cannot be compared between the Southern and Western Scenarios due to differing modeling approaches and differences in the baseline inputs.

Capital Cost per Rider

Similar to the operating cost per rider metric, the annualized incremental capital costs of each extension scenario were divided by the projected annual ridership to estimate the capital cost per rider. Figure 47 shows the results for the Southern Extension scenarios, with Scenario 1 costing slightly more per rider than Scenarios 2 and 3, with the higher ridership not fully offsetting the higher cost of articulated buses and higher number of buses needed.

Figure 47 Evaluation Metric: Annual Capital Costs per Rider, Southern Extension Scenarios

	Annualized Capital Costs	Projected Annual Ridership* (nearest 1000)	Capital Cost per Rider
Southern Scenario 1	$2,443,300	1,174,000	**$2.08**
Southern Scenario 2	$1,945,100	1,035,000	**$1.88**
Southern Scenario 3	$1,945,100	1,035,000	**$1.88**

*Ridership projections cannot be compared between the Southern and Western Scenarios due to differing modeling approaches and differences in the baseline inputs.

As shown in Figure 48, Western Scenario 2 has the lowest annual capital cost per rider of the Western BRT Extension scenarios, followed closely by Scenario 1. Scenarios 3 and 4 have lower capital costs but lower overall ridership due to the transfer requirement.

Figure 48 Evaluation Metric: Annual Capital Costs per Rider, Western Extension Scenarios

	Annualized Capital Costs	Projected Annual Ridership* (nearest 1000)	Capital Cost per Rider
Western Scenario 1	$2,781,000	578,000	**$4.81**
Western Scenario 2	$2,217,900	521,000	**$4.26**
Western Scenario 3	$1,890,000	336,000	**$5.62**
Western Scenario 4	$1,890,000	336,000	**$5.62**

*Ridership projections cannot be compared between the Southern and Western Scenarios due to differing modeling approaches and differences in the baseline inputs.

Operational Considerations

Travel time and cost alone do not tell the whole story of transit operations, and additional considerations that do not fit easily into clear numeric outputs must also be considered when evaluating potential transit services. Operational concerns that were reviewed for this evaluation metric included turnaround movements, layover needs, deadhead distances, and facility capacity.

All three operators have planned expansions or relocations of their bus operation and maintenance facilities (BOMFs) expected to be completed by the opening year of the extensions. Figure 49 and Figure 50 detail the facility locations, deadhead distance, and vehicle capacity needs and constraints for the Southern and Western scenarios, respectively.

Figure 49 Opening Year Bus Facility Considerations, Southern Extension Scenarios

	Scenario 1	Scenario 2	Scenario 3
Facility Location	4104 Poole Rd	4104 Poole Rd	5201 Nelson Rd
Nearest Terminus	Wilmington St at Hargett St	Walmart – Garner	Walmart – Garner
Deadhead Distance	**5.3 miles**	**8.9 miles**	**18 miles**
Peak Vehicles	5 60' buses	4 40' buses	4 40' buses
Spare Vehicles	1 60' bus	1 40' bus	1 40' bus
Total New Vehicles	**6 60' buses**	**5 40' buses**	**5 40' buses**
Available Facility Capacity	**6 60' buses**	**>5 40' buses**	**>5 40' buses**

Figure 50 Opening Year Bus Facility Considerations, Western Extension Scenarios

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Facility Location	4104 Poole Rd	4104 Poole Rd	5201 Nelson Rd	160 Towerview Ct
Nearest Terminus	GoRaleigh Station	GoRaleigh Station	Park Offices Drive at RTP	Cary Multimodal Facility
Deadhead Distance	**4.8 miles**	**4.8 miles**	**5.2 miles**	**2.2 miles**
Peak Vehicles	7 60' buses	4 60' buses	4 40' buses	4 40' buses
Spare Vehicles	2 60' buses	1 60' bus	1 40' bus	1 40' bus
Total New Vehicles	**9 60' buses**	**5 60' buses**	**5 40' buses**	**5 40' buses**
Available Facility Capacity	**6 60' buses**	**6 60' buses**	**>5 40' buses**	**>5 40' buses**

The GoRaleigh facility at Poole Rd will have capacity for 50 articulated buses, with 44 of those slots reserved for Core BRT vehicles, and significant capacity for 40' transit buses. The facility could accommodate Southern Scenario 2 with no concerns, and could accommodate the vehicles for either Southern Scenario 1 or Western Scenario 2, but not both. There would not be capacity for the 9 articulated 60' buses required by Western Scenario 1.

The new GoCary facility at Towerview Court will accommodate 58 transit buses and up to 4 articulated buses, compared to the current facility with 32 spaces, leaving significant spare capacity for Scenario 4.

Similarly, the planned expansion of GoTriangle's Nelson Road facility will accommodate over 50 more fleet vehicles than the current facility, exceeding the required capacity from Southern Scenario 3 and Western Scenario 3. However, the facility is a significant distance from the Southern Extension terminus, which would create additional operational inefficiencies. GoTriangle is exploring an auxiliary BOMF to serve southern Wake County, which would eliminate this concern, but the proposal is not yet funded in the Wake Transit Plan within the opening year timeframe.

Concerns regarding layovers and turnarounds were also discussed, with solutions found for potential operational issues raised by the project team. GoRaleigh Station, the terminus for both core corridors, faces space constraints given its location and the many routes that serve it, limiting the length of any layovers that occur there. For the extension scenarios, this means considering both the length and location of the layovers on the core and extension corridors. The scheduling for alternating scenarios, particularly Southern Scenario 1, is likely to be inefficient and require long layovers that may be difficult to accommodate. Similarly, Western Scenarios 1 and 2 will have limited time and space to layover at GoRaleigh station. For all Western scenarios that require the core BRT to turn around in Cary (2, 3, and 4), layovers would need to be accommodated at Cary Multimodal Station, which does not yet have a finalized design.

Figure 51 summarizes the key operational concerns for each scenario that could not be resolved at this stage.

Figure 51 Evaluation Metric: Summary of Operational Concerns by Scenario

	Operational Concerns
Southern Scenario 1	Potential facility capacity concerns, depending on Western scenario; inefficient scheduling of alternating patterns
Southern Scenario 2	No major concerns
Southern Scenario 3	Long deadhead between BOMF and route terminus
Western Scenario 1	Vehicle requirements exceed facility capacity; limited space for long layovers at GoRaleigh station
Western Scenario 2	Potential facility capacity concerns, depending on Southern scenario; limited space for long layovers at GoRaleigh station
Western Scenario 3	No major concerns
Western Scenario 4	No major concerns

Goal 4: Safety and Compatibility with the Surrounding Environment

More than any other factors, population density and job density are the primary drivers of transit demand. As a result, population density (residents per acre) and job density (jobs per acre) provide a useful indicator of just how much underlying demand there is for transit in a particular area. Urban neighborhoods and mixed-used developments with higher concentrations of residents, jobs, or both can support higher levels of transit service, and suburban and rural areas with lower density of jobs and residents are less suitable for high-capacity, high-frequency transit service. Figure 52 indicates the frequency of transit service that different levels of residential and employment density are likely to support.

Figure 52 Land Use and Appropriate Transit Service

LAND USE	DENSITY		TRANSIT
Land Use Type	Residents per Acre	Jobs per Acre	Frequency of Service
Downtowns & High Density Corridors	>45	>25	10 mins or better
Urban Mixed-Use	30-45	15-25	10-15 minutes
Neighborhood & Surburban Mixed-Use	15-30	10-15	15-30 minutes
Mixed Neighborhoods	10-15	5-10	30-60 minutes
Low Density	2-10	2-5	60 mins or less or On Demand
Rural	<2	<2	On Demand

Source: Nelson\Nygaard national research

Using straight line interpolation between the 2020 Base Year and the 2055 Long Range Horizon, the project team calculated the projected employment and population density within a half-mile of each BRT extension station for both 2035 and 2055 to identify the likely level of transit frequency supported at the station and corridor level for both extensions (Figure 53 and Figure 54).

Figure 53 Southern Extension Station Area Transit Demand

MTP Horizon Year	2035	2035	2055	2055
Station	Station Area Composite Density	Frequency Supported	Station Area Composite Density	Frequency Supported
Garner Station Blvd at Lennox Place	21	15-30 minutes	32	10-15 minutes
Walmart - Garner	18	15-30 minutes	27	15-30 minutes
Garner Towne Square	13	30-60 minutes	15	30-60 minutes
US 70 at Yeargan Rd	12	30-60 minutes	15	30-60 minutes
Forest Hills Shopping Center	13	30-60 minutes	15	30-60 minutes
White Oak Crossing	12	30-60 minutes	27	15-30 minutes
Walmart - Clayton	5	60 minutes or less	9	60 minutes or less
Clayton Blvd at Shotwell Rd	11	30-60 minutes	16	15-30 minutes
Clayton Blvd at Robertson St	12	30-60 minutes	14	30-60 minutes
Clayton Blvd at Main St	8	60 minutes or less	12	30-60 minutes
Powhatan	5	60 minutes or less	7	60 minutes or less
Corridor Average	12	**30-60 minutes**	17	**15-30 minutes**

All Southern Extension scenarios provide the same frequency of transit service along the corridor: every 20 minutes during the peak, 40 minutes off-peak, and 30 minutes on weekends. This is slightly higher frequency than the underlying land use calls for on opening day (2035) but may be justified by expanding the station catchment areas with Park and Rides and the high demand connections available on the Core BRT corridor. In addition, density along the corridor is expected to continue to increase, with higher levels of frequency supported by 2055. While the frequencies are the same across the scenarios, Scenario 1 utilizes 60′ articulated buses, which may be ill-suited to the corridor in the opening year at the proposed frequency compared to the same level of service with more appropriately sized 40′ buses.

Figure 54 Western Extension Station Area Transit Demand

MTP Horizon Year	2035	2035	2055	2055
Station	Station Area Composite Density	Frequency Supported	Station Area Composite Density	Frequency Supported
Cary Multimodal Center	37	10-15 minutes	64	10 minutes or better
Harrison Ave at Hillsboro St	37	10-15 minutes	65	10 minutes or better
Chapel Hill Rd at Maynard Rd	13	30-60 minutes	21	15-30 minutes
Park West Village	24	15-30 minutes	31	10-15 minutes
Weston Pkwy & Evans Rd	22	15-30 minutes	25	15-30 minutes
McCrimmon Pkwy at Aviation Pkwy	17	15-30 minutes	24	15-30 minutes
Wake Competition Center	19	15-30 minutes	30	15-30 minutes
McCrimmon Pkwy at Airport Blvd	25	15-30 minutes	37	10-15 minutes
McCrimmon Pkwy at Chapel Hill Rd	29	15-30 minutes	39	10-15 minutes
Wake Tech	25	15-30 minutes	34	10-15 minutes
Walmart - Morrisville	15	15-30 minutes	19	15-30 minutes
Miami Blvd at Page Rd	29	15-30 minutes	38	10-15 minutes
Triangle Mobility Hub	37	10-15 minutes	58	10 minutes or better
NC 54 at Rodbell St	28	15-30 minutes	50	10 minutes or better
Hub RTP – Park Offices Dr	23	15-30 minutes	41	10-15 minutes
Corridor Average	26	**15-30 minutes**	**38**	**10-15 minutes**

The projected density along the Western Extension corridor is likely to support transit frequency between 15 and 30 minutes in 2035 and between 10 and 15 minutes by 2055. The 10-minute service proposed in Scenario 1 is slightly higher than the frequency supported by the corridor on opening day, while the 20-minute service in Scenarios 2, 3, and 4 is well suited for the land use surrounding the stations on opening day but may be somewhat low by 2055, though the articulated buses of Scenario 2 could prevent crowding.

5 RECOMMENDATIONS

To make the final recommendation, the relative rankings (Figure 32) for each metric brought together to compare holistically across scenarios.

Figure 55 Relative Scoring Graphics

⌃⌃	⌃	○	⌄	⌄⌄
Much higher	Higher	Neutral	Lower	Much lower

SOUTHERN EXTENSION

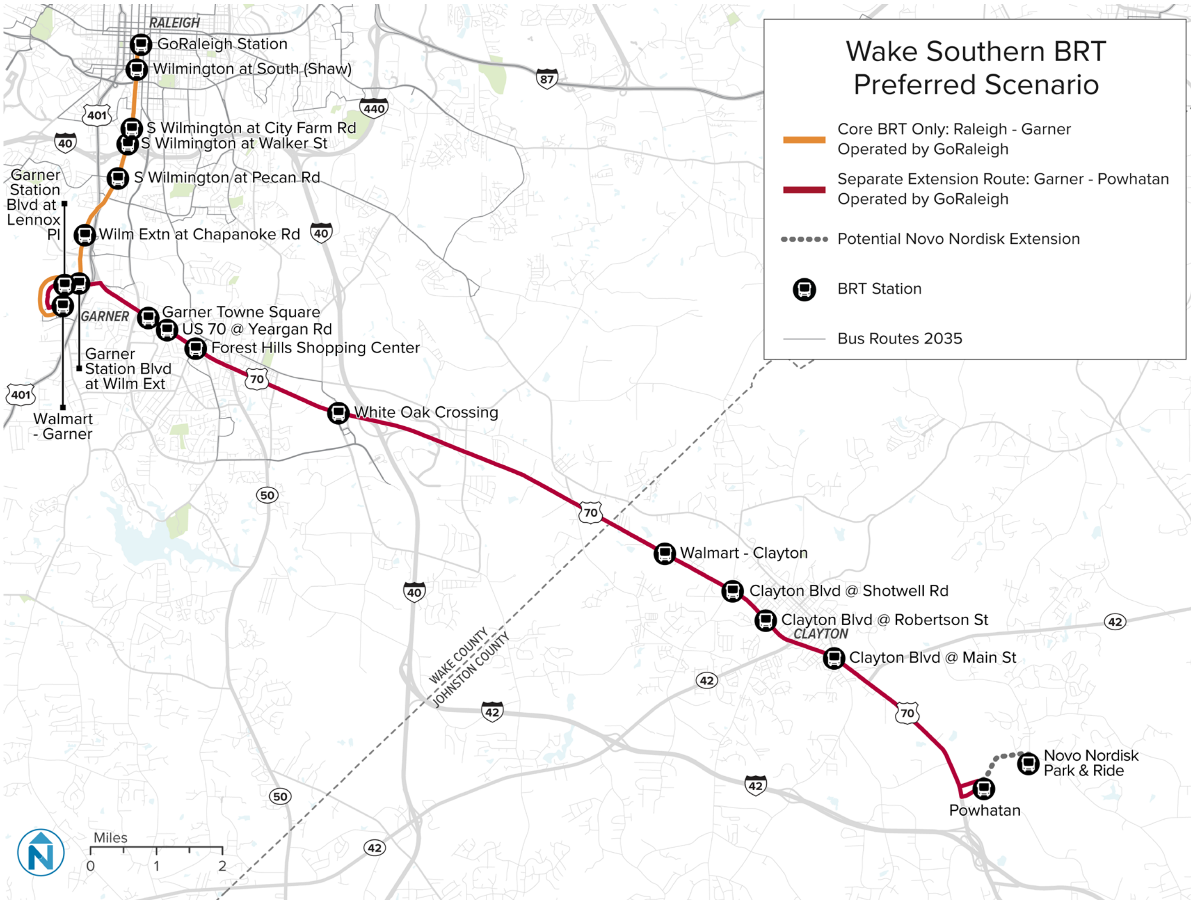
The relative scores by evaluation metric for the Southern Extension scenarios are shown in Figure 55.

Figure 56 Southern Extension Evaluation Results Summary Table

Metric	Scenario 1 GoRaleigh Alternating Extension	Scenario 2 GoRaleigh Separate Bus	Scenario 3 GoTriangle Separate Bus
Travel Time	○ (Neutral)	⌄ (Lower)	⌄ (Lower)
Transfer & Wait Time	○ (Neutral)	⌄ (Lower)	⌄ (Lower)
Operating Cost/Rider	⌃ (Higher)	⌃ (Higher)	○ (Neutral)
Capital Cost/Rider	⌃ (Higher)	⌃ (Higher)	⌃ (Higher)
Operational Concerns	⌄ (Lower)	⌃ (Higher)	⌄ (Lower)
Future Transit Demand	⌄ (Lower)	○ (Neutral)	○ (Neutral)

Based on corridor suitability, operating cost, and operational efficiency, **Scenario 2** was selected as the preferred scenario for the Southern Extension corridor (Figure 56). GoRaleigh would operate a 40' transit bus between Powhatan and Garner at half the frequency of the Core BRT with a timed transfer to the Southern BRT at Walmart – Garner that would provide service to GoRaleigh Station and further connections with the full BRT network. A detailed capital and operating plan will be developed with the operator for this corridor, along with a financial and implementation plan for both extension and core BRT corridors.

Figure 57 Southern Extension Preferred Scenario



WESTERN EXTENSION

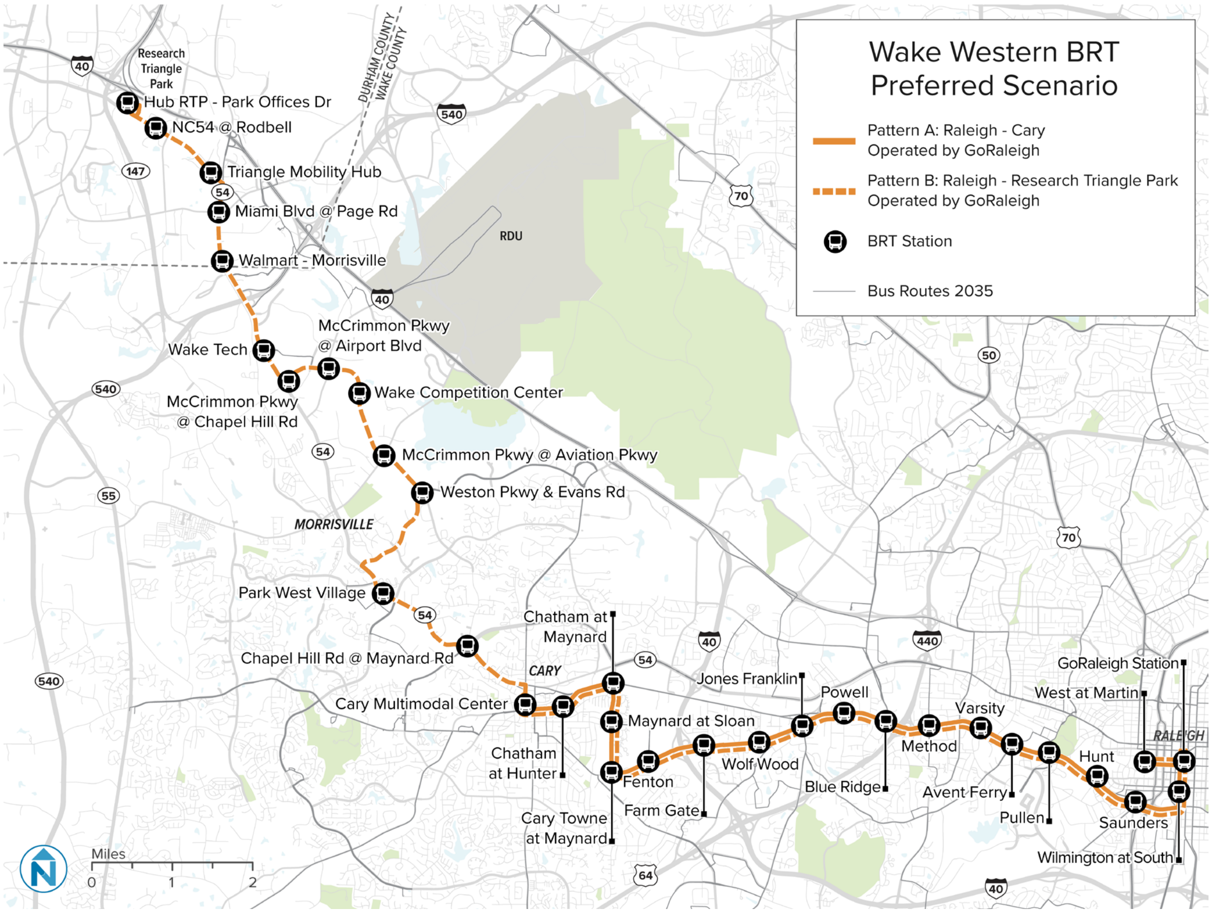
The relative scores by evaluation metric for the Western Extension scenarios are shown in Figure 57.

Figure 58 Western Extension Evaluation Results Summary Table

Metric	Scenario 1 GoRaleigh Full Extension	Scenario 2 GoRaleigh Alternating Extension	Scenario 3 GoTriangle Separate Bus	Scenario 4 GoCary Separate Bus
Travel Time	○	○	⌄	⌄
Transfer & Wait Time	⌃	○	⌄	⌄
Operating Cost/Rider	○	⌃⌃	⌄	○
Capital Cost/Rider	⌃	⌃	○	○
Operational Concerns	⌄	○	⌃	⌃
Future Transit Demand	○	⌃	⌃	⌃

Based on rider experience and cost efficiency, **Scenario 2** was selected as the preferred scenario for the Western Extension corridor (Figure 58). The alternating extension operated by GoRaleigh will allow for future expansion into a full extension of the Core BRT as density increases along the corridor without straining current facility capacity. A detailed capital and operating plan will be developed with the operator for this corridor, along with a financial and implementation plan for the full RTP to Powhatan alignment.

Figure 59 Western Extension Preferred Scenario



NC Capital Area Metropolitan Planning Organization