Volume 1: Detailed Definition of Alternatives Technical Report

Durham-Orange County Corridor Alternatives Analysis

Triangle Regional Transit Program
our transit future

JULY 2011

Prepared for: Triangle Transit

Prepared by: URS Team

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Executive Summary

The 2035 Long Range Transportation Plan adopted by the Durham-Chapel Hill-Carrboro and Capital Area Metropolitan Planning Organizations in April 2009 identified corridors for major investments in fixed guideway transit over the next 30 years. Through a Transitional Analysis, the first step in the Alternatives Analysis (AA) process which was begun in March 2010, three priority corridors were selected for further consideration: the Durham-Orange Corridor; the Durham-Wake Corridor and the Wake Corridor. In order to identify the most appropriate initial investment or Locally Preferred Alternative (LPA) for each corridor, a broad range of transit technology and alignment alternatives were examined through the Conceptual Evaluation of Alternatives.

This Detailed Definition of Alternatives Technical Report presents the results of the Conceptual Evaluation of Alternatives and a recommendation for the Locally Preferred Alternative (LPA) which includes the preferred alignment, transit technology and station locations for the Durham-Orange Corridor.

Alternatives Considered

In addition to the No-Build and Transportation System Management (TSM) Alternatives automatically advanced from the conceptual alternatives screening, the transit technologies and alignment options remaining after the conceptual alternatives were combined into three fixed-guideway alternatives for detailed evaluation:

Light Rail Transit (LRT) Alternative This alternative would operate light rail vehicles between University of North Carolina (UNC) Hospitals and east Durham and includes alignment options in UNC Chapel Hill (A1 – UNC Hibbard Drive and A3 – UNC Southern), Meadowmont/Woodmont (C1 – Meadowmont Lane and C2 – George King Road), and South Square (D1 – Westgate Drive and D3 – Shannon Road). A total of 17 station locations are proposed.

Bus Rapid Transit (BRT)-High Alternative This alternative would operate BRT between UNC Hospitals and east Durham, generally following the same alignment as LRT and including the same station locations. The only deviation would occur through downtown Durham to the end-of-line at Alston Avenue in east Durham where the BRT-High option would utilize Pettigrew Street, while the LRT would run in the rail corridor. During the Special Transit Advisory Commission's (STAC) deliberations representatives of CSX Transportation (CSX) and Norfolk Southern Corporation (NS) stated that they would not accept the operation of busway/high occupancy vehicle (HOV) lanes in any railroad corridor in which they operated. North Carolina Railroad (NCRR) advised the STAC that they too would not support busway/HOV lanes in the NCRR corridor. Existing Pettigrew Street is technically within the 200-foot railroad right-of-way but is currently utilized by vehicular and bus traffic. The BRT-High would operate similar to conventional bus in mixed traffic along Pettigrew Street, but would transition to exclusive running along a new Pettigrew Street connection to be constructed as part of this project between Campus Drive and Duke Street. Should BRT be selected as the Locally Preferred Alternative, the new guideway connection between these intersections would require coordination with the operating railroads and, potentially, further engineering and design analysis.

BRT-Low Alternative A second BRT alternative was developed in consideration of the greater flexibility offered by BRT operations. The BRT-Low Alternative alignment more closely follows existing roadways with less aerial structures and more mixed-traffic segments. The BRT-Low alignment is similar to the BRT-High alignment but would deviate from the BRT-High alignment in the following three segments: Hamilton Road Station to Leigh Village Station (BRT-Low Alternative 1), Gateway

Station to MLK Jr. Parkway Station (BRT-Low Alternative 2), and Shannon Drive to Pickett Road (BRT-Low Alternative 3). A total of 18 station locations are proposed.

Evaluation Results

The alternatives were evaluated based on seven evaluation criteria directly related to the project goals. These criteria were Ridership, Transportation Operations, Expansion Potential, Economic Development Potential, Public and Agency Support, and Environmental Impacts. Table ES-1 summarizes the evaluation results.[1] A discussion of how well the alternatives performed relative to the project goals follows the table.

[1] Public and agency support is excluded from the summary table because of the limited amount of data available for evaluation. See Section 3.2.4 of the Detailed Definition of Alternatives Technical Report for more information.

Table ES-1 Summary of Evaluation Results for LRT, BRT-High, and BRT-Low Alternatives

<table>
<tr><th>Goals</th><th>Evaluation Criteria (Corresponding Report Section)*</th><th>LRT</th><th>BRT-High</th><th>BRT-Low</th></tr>
<tr><td rowspan="5">Goal 1: Improve mobility through and within the study corridor.
Goal 2: Increase transit efficiency and quality of service.
Goal 3: Improve transit connections.</td><td>Ridership: Daily Project Boardings (Section 3.2.1)</td><td>12,000</td><td>BRT route: 5,700**
Interlined Buses: 11,900
Total: 17,600</td><td>BRT route: 4,600**
Interlined Buses: 11,700
Total: 16,300</td></tr>
<tr><td>Ridership: System-wide Trips*** (Section 3.2.1)</td><td>140,500-141,600</td><td>142,800</td><td>141,100</td></tr>
<tr><td>Transportation Operations: Traffic Impacts (Section 3.2.2)</td><td>Low</td><td>Low</td><td>Moderate</td></tr>
<tr><td>Transportation Operations: Travel Time (Section 3.2.2)</td><td>35 minutes</td><td>39 minutes</td><td>44 minutes</td></tr>
<tr><td>Expansion Potential (Section 3.2.3)</td><td>No engineering constraints & consistent with regional plans</td><td>Could be inconsistent with regional connectivity goals</td><td>Could be inconsistent with regional connectivity goals</td></tr>
<tr><td>Goal 4: Support local and regional economic development and planned growth management initiatives</td><td>Economic Development Potential (Section 3.2.5)</td><td>Demonstrated ability to influence development</td><td>Unproven ability to influence development</td><td>Unproven ability to influence development</td></tr>
<tr><td>Goal 5: Foster environmental stewardship</td><td>Environmental Impacts (Section 3.2.6)</td><td>Moderate property acquisitions, high visual impacts, moderate stream/wetland & construction impacts, no air quality impacts</td><td>Moderate property acquisitions, visual impacts, stream/wetland & construction impacts, low air quality impacts</td><td>High property acquisitions, low visual impacts, low stream/wetland impacts, moderate construction & low air quality impacts</td></tr>
<tr><td rowspan="2">Goal 6: Provide a cost-effective transit investment.</td><td>Estimated Cost (2011 $) – Capital (Section 3.2.7)</td><td>$1.37B</td><td>$960M</td><td>$810M</td></tr>
<tr><td>Estimated Cost (2011 $) – O&M Cost (based on offered peak hour capacity of 800 and 1500 pax/hr - Section 3.2.7)</td><td>800 pax/hr: $14M
1500 pax/hr: $15M</td><td>800 pax/hr: $11M
1500 pax/hr: $13M</td><td>800 pax/hr: $11M
1500 pax/hr: $13M</td></tr>
</table>

**Evaluation criteria include references to sections of the report where more information can be found. | **Daily boardings for BRT-High and BRT-Low routes without interlined buses could potentially be higher as the model estimated the ridership assuming interlined buses. Interlining refers to the ability of local bus routes to use of the guideway in addition to the exclusive BRT service. The BRT numbers thus do not account for passengers that would transfer from feeder buses to BRT if the feeder buses were not sharing the BRT guideway | ***System-wide trips refer to total transit trips in the three county Triangle Region (Durham, Orange, and Wake Counties).*

Based on the information presented in Table ES-1, the BRT-High and BRT-Low Alternatives clearly rate well in their ability to meet Goal 1: Improve mobility through and within the study corridor, Goal 2: Increase transit efficiency and quality of service, and Goal 3: Improve transit connections. In terms of ridership, a significant difference between LRT and BRT is that local bus routes can make use of the guideway in addition to the exclusive bus rapid transit service. This is termed interlining. The interlined buses include not only feeder buses, but also additional bus routes that could make use of portions of the bus guideway (busway). Riders could opt for a one-seat ride along the guideway onboard the feeder buses or could transfer to another route at one of the busway stations, thus potentially double-counting the boardings for BRT where the LRT would only see one boarding. It is not surprising that the sum of the ridership from the interlined bus routes and the BRT exceeds the LRT ridership. When looking at total transit trips in the region, however, this phenomenon is equalized between LRT and the BRT Alternatives. All three alternatives would increase system-wide transit trips in the region by a comparable amount.

The end-to-end travel time for the BRT Alternatives is slightly longer than the LRT Alternative; however, travel time does not seem to be a major differentiator with regard to passenger preference, as ridership on the BRT-High and BRT-Low Alternatives exceeds that of the LRT Alternative, even with a longer travel time. It should be noted that the travel time estimate for the BRT-High and BRT-Low Alternatives assume that the BRT-High Alternative will be permitted to run along the existing and proposed Pettigrew Street, which is within the NCRR corridor. If the alignment is not permitted to operate within the rail corridor, alternate alignment options could increase travel times by 3 to 4 minutes. Additionally, while BRT-Low would result in marginally worse traffic impacts than LRT and BRT-High, traffic impacts are also not a major differentiator among the Build Alternatives.

Each of the three alternatives – LRT, BRT-High, and BRT-Low – meets Goal 5: Foster environmental stewardship; however, the use of fossil fuels by buses makes LRT a more sustainable and desirable technology over the long term. And, while each would result in limited impacts to the natural and built environments, environmental impacts have not proven to be a major differentiator between the alternatives.

From a cost perspective, the BRT-High and BRT-Low Alternatives best meet Goal 6: Provide a cost-effective transit investment by providing a lower capital cost investment and O&M costs within the planning horizon for the proposed project. In terms of capital costs, while LRT presents substantially higher costs than BRT, the cost of the LRT Alternative is still within the range of affordability as detailed in the Financial Plan being prepared for Durham, Orange, and Wake Counties. For O&M costs, as noted in Section 3.2.7, decision-makers must also consider that long-term, the O&M costs of the BRT Alternatives will likely escalate higher than those of the LRT Alternative due to the shorter life span of buses compared to trains, operations (driver) costs, and, potentially, fuel costs.

Ultimately the decision of whether BRT or LRT is a cost-effective technology choice will depend largely on ridership. Currently, the BRT Alternatives do have slightly higher forecasted boardings but, as discussed in Section 3.2.7, as peak hourly volumes reach the range more comparable to existing LRT and BRT systems, LRT can meet the increased demand at a lower capital and O&M investment than BRT.

While the BRT Alternatives have demonstrated ability to be competitive regarding most project goals, the LRT Alternative clearly surpasses the BRT Alternatives under Goal 4: Support local and regional economic development and planned growth management initiatives. The LRT Alternative has demonstrated public support and a proven record of producing local and regional economic development benefits by enhancing and focusing growth within LRT corridors. LRT enhances opportunities for transit oriented development (TOD), and the resulting development can achieve rental rate premiums and higher land values over non-light rail served properties. Impressive levels of development have been constructed along LRT lines in many examples across the nation. As demonstrated by the dollars of investment with LRT corridors such as the Charlotte Blue Line, developers are interested in constructing TOD at LRT stations, as they see the value in the transportation advantage afforded by LRT. Further, in support of planned growth management initiatives, LRT's proven ability to focus growth would, in the long run, have a more substantial impact on mobility because the land use impacts will result in more choices.

Locally Preferred Alternative (LPA) Recommendation

Local and regional stakeholders place a high level of importance on economic development potential and focusing growth within the proposed transit corridor through TOD. LRT has consistently been proven to bolster economic development and focus growth. These potential development dollars are not insignificant. The LRT Alternative alone can fully address the stated Purpose and Need for a fixed-guideway investment in the Durham-Orange Corridor; it can enhance mobility, expand transit options between Durham and Chapel Hill, serve populations with high propensity for transit use, and foster compact development. For these reasons, the project team's recommendation is to carry forward the LRT Alternative as the LPA. The LRT Alternative is recommended for advancement with alignment options A3, C1 and C2, and D3 and the associated station locations for the following reasons:

- *Alignment option A3:* As the preferred alignment option, supported by Town of Chapel staff and UNC & UNC Hospitals, this alignment and a future extension of the A3 option would mitigate the constraint of the extended walking distances to existing major employment and student centers.

- *Alignment options C1 and C2:* Alignment option C1 is the preferred alignment because it serves Meadowmont Village, an existing community that was designed to be a TOD. Long-term plans for fixed-guideway service within Meadowmont Village are also evidenced by the dedication of right-of-way, which would result in fewer private property acquisitions for alignment option C1 relative to alignment option C2. In addition, it should be noted that the ridership potential of Woodmont relies on potential development rather than on an existing community as in the case of Meadowmont. Although the alignment option C1 is recommended, the crossing of wetlands and US Army Corps of Engineer (USACE) owned property to the east of Meadowmont Village warrants additional coordination with the USACE and continued dialogue with community stakeholders to fully vet this issue. Therefore, the project team also recommends advancing alignment option C2 through to the Preliminary Engineering (PE)/National Environmental Policy Act (NEPA) phase in order to provide an opportunity for continued study.

- *Alignment option D3:* The potential for development for alignment option D3 and the surrounding land uses is, in the opinion of the project team, a very significant factor for the recommendation of D3 above and beyond the constraints cited in Table 3-24 of the Detailed Evaluation of Alternatives Technical Report.

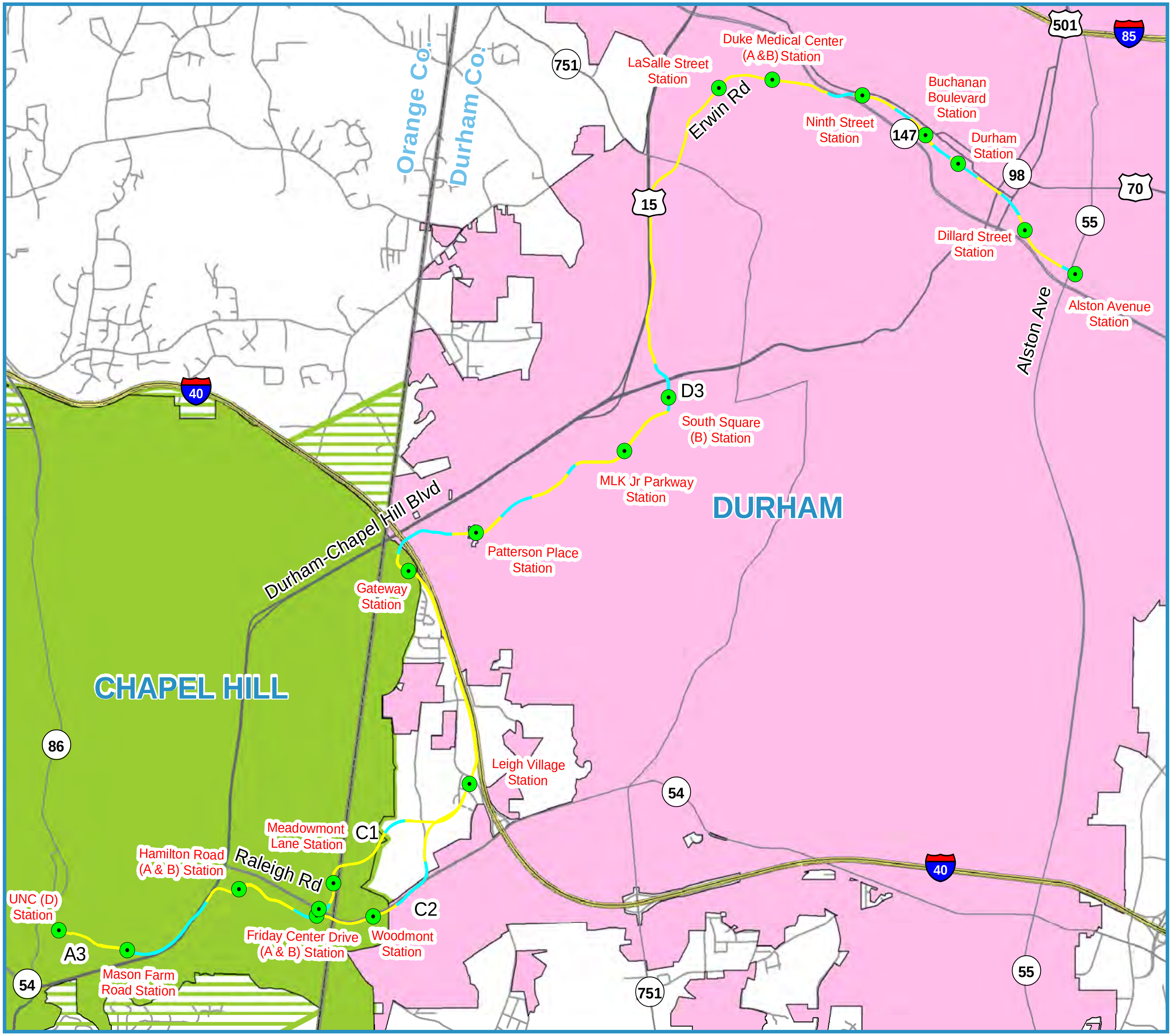
Figure ES-1 illustrates the recommended LPA.

FIGURE ES-1

DURHAM-ORANGE LOCALLY PREFERRED ALTERNATIVE (LRT)

LEGEND

- Aerial Segment
- At-Grade
- Interstate
- US Route
- NC Route
- Railroad
- County Boundary
- Town of Chapel Hill
- Chapel Hill ETJ
- City of Durham
- Conceptual Station



NORTH

0 0.3 0.6 1.2 Miles

JUNE 2011

Triangle Regional Transit Program

Durham-Orange County Corridor Alternatives Analysis

1. Introduction

The purpose of this report is to define the detailed alternatives carried forward from the conceptual alternatives screening, document the evaluation of the detailed alternatives, and recommend a Locally Preferred Alternative that includes a preferred alignment, transit technology, and station locations.

In addition to the No-Build and Transportation System Management (TSM) Alternatives, the following Build Alternatives are considered in the detailed evaluation:

- LRT Alternative
- BRT-High Alternative
- BRT-Low Alternative

Two BRT alternatives were developed to take advantage of the flexibility offered by BRT operations. The BRT-High Alternative generally follows the same fixed-guideway alignment and operations as the LRT Alternative, while the BRT-Low Alternative alignment more closely follows existing roadways with less aerial structures. The BRT-High Alternative is primarily exclusive running while the BRT-Low Alternative includes more mixed-traffic segments.

2. Definition of Alternatives

This section defines the alternatives considered as part of the detailed evaluation. Alignments and transit technologies advanced from the conceptual evaluation are defined in a greater level of detail. The definition of each Build alternative also includes station locations and operating characteristics.

2.1. No-Build Alternative

The No-Build Alternative includes all highway and transit facilities identified in the fiscally constrained 2035 Long-Range Transportation Plan (LRTP), with the exception of the comprehensive system-wide rail transit network, part of which is the subject of this Alternatives Analysis (AA). The No-Build Alternative is used as a starting point to provide a comparison of all Build Alternatives in terms of costs, benefits, and impacts.

2.1.1. Roadway Improvements

Table 2-1 summarizes the programmed roadway improvement projects in the current fiscally constrained 2035 LRTP that are located within the Durham-Orange Corridor Study Area.

Table 2-1 2035 LRTP Roadway Projects in Durham-Orange Corridor

Road Name	Project Limits	Completion Year
Project Type: Add Lanes		
I-40	US 15-501 to NC 86	2035
US 15-501 Bypass	Pickett Rd to Moreene Rd	2035
NC 54	I-40 Interchange to NC 55	2025
NC 55 (Alston Ave)	NC 147 to NC 98	2017
NC 54	I-40 to Barbee Chapel Rd	2025
Garrett Rd	NC 751 to US 15-501	2025
Weaver Dairy Rd	NC 86 to Erwin Rd	2017
Hillandale Rd	I-85 to Carver St	2011
SW Durham Pkwy	Watkins Rd (Old Chapel Hill Rd) to US 15-501	2017
Smith Level Rd	Rock Haven Rd to NC 54 Bypass	2017
Project Type: Upgrade (Freeway Conversion)		
US 15-501	Bypass to I-40	2035
Project Type: Upgrade (Bicycle Lanes)		
South Columbia St	NC 54 to Manning Dr	2017
Project Type: New Roadway		
I-40 HOV	Wake County Line to US 15-501	2035
East End Connector (EEC)	NC 147 to US70 E; US 70: EEC to NC 98	2017
Alston Ave Extension	Holloway St to Old Oxford/Roxboro	2035
MLK Pkwy (NC 55 interchange)	NC 55 to Cornwallis Rd connector	2035
SW Durham Dr	Meadowmont Dr to I-40	2025
SW Durham Pkwy	US 15-501 to Mt Moriah Rd	2025
Woodcroft Pkwy Extension	Garrett Rd to Hope Valley Rd	2025

Source: 2035 Long Range Transportation Plan, CAMPO and DCHC-MPO

2.1.2. Bus Network

The No-Build Alternative includes all fixed-route bus service (BRT, regional, express, and local) that is currently programmed in the 2035 LRTP. BRT routes in the No-Build network refer to planned Chapel Hill Transit (CHT) services. Table 2-2 identifies the routes within the Durham-Orange Corridor Study Area and includes a description of each route and headway.

Table 2-2 No-Build Alternative Bus Network

Route Number	Description	Programmed Headway	
		Peak	Off-Peak
BRT*/Express Bus/Regional Bus			
CHT BRT-1*	CHT BRT-1 I40-Rsmry-UNC	10	20
CHT BRT-3A*	CHT BRT-3A I40-US15-UNC	15	30
CHT BRT-3B*	CHT BRT-3B I40-Elzbth-UNC	15	30
CHT BRT-3C*	CHT BRT-3C I40-Carolina N	15	30
CHT BRT-5*	CHT BRT-5 I40 to UNC	15	30
CHT 8	CHT Base 8 UNC Exp	10	20
CHT 9	CHT Base 9 Mason Farm Exp	15	30
CHT BRT-6	CHT BRT-6 from Carolina N	15	30
CHT BRT-7	CHT BRT-7 to UNC	15	30
CHT BRT-7A	CHT BRT-7a from Carolina N	15	30
CHT BRT-8	CHT BRT-8 to UNC	15	30
CHT BRT-8A	CHT BRT-8a from Carolina N	15	30
CHT CPX	CHT CPX:UNC-CarrboroP&R	15	30
CHT FCX	CHT FCX:Pttsbor-FridayCntr	15	30
CHT HUX	CHT HUX:HedrckBldg-UNCHosp	15	30
CHT JFX	CHT JFX:JonesFerry-Ptsboro	15	30
CHT PX	CHT MOD 20 Pitt. Exp	15	N/A
CHT NUX	CHT NUX: PRLot-UNCHosp	15	30
N/A	DCHC B1 Roxboro to Durham	30	60
N/A	TTA Butner-Durham	30	N/A
N/A	DCHC B10 Durham-Capital Blvd	30	60
N/A	DCHC B2 Butner-Durham	30	60
N/A	DCHC B3 Mebane-Duke	30	60
N/A	DCHC B6 Alamance to CH	30	N/A
N/A	Durham-NorthDurham	30	N/A
TTA 500	TTA 500 EB:Chap Hill-Raleigh	15	30
TTA 550	TTA 550 WB:Raleigh-Chapel; Hill	15	30
N/A	TTA Burlington-Duke	30	N/A
N/A	TTA Butner-Durham	30	N/A
N/A	TTA PersonCo-Durham	30	N/A
TTA 420	TTA 420:Hillsb-Chap Hill	15	30
TTA 402/403	TTA ChapelHill-RTP-402-403	30	60
TTA 412/413	TTA ChapelHill-RTP-412/413	30	60
Feeder/Local			
N/A	Chapel Hill Circulator	10	20
CHT A	CHT A:MLKBlvd-Weiner	15	30
CHT 1	CHT Base 1 Carr N	15	30
CHT 3	CHT Base 3 Estes-Carrboro	15	30
CHT 4	CHT Base 4 Laurel Hills	15	30
N/A	CHT Carr 1A Feeder	15	30
CHT CL	CHT CL: WldnGrnfld-UNCHosp	15	30
CHT CM	CHT CM:FamPrac-JonesFerry	15	30
CHT CW	CHT CW:Ptsboro-JonesFerry	15	30
CHT D	CHT D:Prvdnce-SmithLevel	15	30
N/A	CHT Eubanks Station 1A Feeder	15	30
CHT F	CHT F:ColonyWds-McDougle	15	30

Route Number	Description	Programmed Headway	
		Peak	Off-Peak
CHT G	CHT G:Briarcliff-BookerCrk	15	30
N/A	CHT Gateway Feeder 1	15	30
N/A	CHT Gateway Feeder 2	15	30
N/A	CHT Gateway Feeder 3	15	30
CHT HS	CHT HS:VarsityTh-Hghsch	15	30
N/A	CHT HW 1A Feeder	15	30
CHT J	CHT J:SGrnsboro-RockCrkApt	15	30
CHT M	CHT M:CrestCole-UnivMall	15	30
N/A	CHT Meadowmont Feeder 2	15	30
N/A	CHT Meadowmont Feeder 3	15	30
N/A	CHT Meadowmont Feeder	15	30
N/A	CHT MOD 8-1	15	30
N/A	CHT MODV	30	60
CHT N	CHT N:FamPract-EstsPrkApt	15	30
CHT NS	CHT NS:Eubanks-SVillage	15	30
CHT RU	CHT RU LP:counter clock loop	15	30
CHT S	CHT S:HedrickBldg-UNCHosp	15	30
CHT T	CHT T:UNCHosp-ECHHghSch	15	30
CHT U	CHT U LP:clockwise loop	15	30
CHT V	CHT V:SVillage-Meadowmont	15	30
DATA 10-8	DATA 10-8:NewHopeCmn-DrhmTech	30	60
DATA 10-8	DATA 10-8:Woodcroft-DrhmTech	30	60
DATA 11-9	DATA 11-9:Bennett-DRHosp	15	30
DATA 12	DATA 12:TTATerm-Downtown	30	N/A
DATA 13	DATA 13:Fayette-Birchwood	30	60
DATA 1-3	DATA 1-3:Hillndal-Guess-Mdlnd	30	60
DATA 1-3	DATA 1-3:Hillndal-Point-Mdlnd	30	60
DATA 14	DATA 14 LP:NCCUShuttle	15	30
DATA 15	DATA 15:BrierCreek-Dtn	15	N/A
DATA 15	DATA 15 Willowdale	60	60
DATA 16	DATA 16:Dtn-MineralSprng	30	60
DATA 17	DATA 17 Feeder Eno Loop	60	60
DATA 17	DATA 17 Feeder	60	60
DATA 17	DATA 17 Horton-Davinci SEB	30	60
DATA 17	DATA 17:Horton-Treyburn	15	30
DATA 17	DATA 17 Roxboro-Davinci SB	30	N/A
DATA 18	DATA 18 Feeder	30	60
DATA 19	DATA 19 Feeder	30	60
DATA 20	DATA 20 UniDr-RTP	15	30
DATA 2-4	DATA 2-4:Angier-Horton	15	30
DATA 25	DATA 25 DurReg-DukeMed	30	60
DATA 27	DATA 27 Ngate-RTP W	30	60
DATA 30	DATA 30 Duke Hospital	30	60
DATA 3-1	DATA 3-1:Mdlnd-Point-Hillndal	15	30
DATA 4-2	DATA 4-2:Horton-Angier	15	30
DATA 5-6	DATA 5-6:Emerald-HV-Cameron	15	30
DATA 6-5	DATA 6-5:Cnstitutn-Crnw-Emrld	15	30
DATA 7	DATA 7:Downtown-Southpoint	15	30
DATA 7SP	DATA 7SP Southpoint Mall	60	60
DATA 8-10	DATA 8-10:DrhmTech-NewHopeCmn	15	30
DATA 8-10	DATA 8-10:DrhmTech-Woodcroft	15	30
DATA 9-11	DATA 9-11:DRHosp-Bennett	15	30
N/A	DATA Bethesda	30	60
N/A	DATA Dtech-Snow	30	60

Route Number	Description	Programmed Headway	
		Peak	Off-Peak
N/A	DATA Dtown Terminal Feeder	30	60
N/A	DATA Dtown Terminal Shuttle	15	30
N/A	DATA Durham XT SEB	30	60
N/A	DATA Holoway/The Village	30	60
N/A	DATA Joyner-Club-Duke	30	60
L1	DATA L1 NDP: Carver to RDU SB	60	60
L5	DATA L5 Mt Moraih-NC 54 WB	60	60
L6	DATA L6 Morehead-Cornwallis SB	30	60
L7	DATA L7 Avondale-Chapel Hill St WB	30	60
L8	DATA L8 Hillsboro N-Hillsboro S SB	30	60
L9	DATA L9 Renaissance-Hopson WB	30	60
N/A	DATA Meridian Pkwy Feeder	30	60
N/A	DATA NC98 - US70 - Miami	30	60
N/A	DATA Riddle Station Feeder	30	60
N/A	DATA S Square Feeder	30	60
N/A	DATA S Square Shuttle	60	60
N/A	DATA Treyburn SB	60	60
N/A	DATA Treyburn Station Feeder	30	60
N/A	DATA Woodcroft Feeder	30	60
N/A	DCHC B9 Old Farrington to CH	10	20
N/A	DCHC B11 N Raleigh to Duke WB	30	60
N/A	DCHC B12 W Wake fwy to Duke	30	60
N/A	DCHC B13 Apex to Durham	30	60
N/A	DCHC B14 US70 to W Wake pkwy	30	60
N/A	DCHC B8 Pittsboro to UNC NB	30	60
DUKE C1	DUKE C1:WCampus-ECampus	10	20
DUKE C2	DUKE C2:ECampus-WCampus	10	20
DUKE C3	DUKE C3:EastCampus-SciDr	10	20
DUKE C6	DUKE C6:Ecampus-Chapel	30	60
DUKE EW via Central	Duke E/Cent./W	10	N/A
DUKE H1	DUKE H1:Entry11-PG3	10	20
DUKE H2	DUKE H2:HospNorth-PG3	10	20
DUKE H3	DUKE H3:HillsbghRd-HospN	10	20
DUKE H5	DUKE H5:HockPlaza-MillBldg	10	20
DUKE H6	DUKE H6:Ent11-LaSalleLot	10	20
DUKE M1	Duke Med 1	60	60
DUKE M3	Duke Med 3	10	N/A
DUKE M4	Duke Med 4	30	60
DUKE PR1	DUKE PR1:Bassett Dr-Ent11	10	20
N/A	Duke Science Loop CCW	15	30
N/A	Duke Student Park	15	30
N/A	Duke Villa	10	20

Source: Triangle Regional Model v4 enhanced. | *BRT routes in the No-Build bus network refer to services planned by Chapel Hill Transit (CHT).

2.2. Transportation System Management Alternative

The TSM Alternative is required for inclusion in the AA by the Federal Transit Administration (FTA) when federal funds are sought for capital improvements. The primary purpose of the TSM Alternative is to develop an enhanced and robust bus network in the Durham-Orange Corridor that provides a level of transit service and capacity roughly equivalent to that of a fixed-guideway improvement. The intention is to compare the efficiency and cost-effectiveness of a significant bus network in the corridor with fixed-guideway improvements to determine the impact on transit ridership, travel time, and other measures.

The TSM Alternative includes enhanced bus service within the corridor along with improved local bus service feeding the express routes and transportation demand management (TDM) strategies that encourage a reduction in total trips (in particular drive-alone trips) and trip delays compared to the No-Build Alternative. The highway network for the TSM Alternative is assumed to be the same as the No-Build Alternative, which is taken from the 2035 LRTP and previously listed in Table 2-1. However, the TSM Alternative also includes minor, low-cost improvements to roadways as they relate to the bolstered bus transit system.

The backbone of the TSM Alternative would be a new bus route operating between UNC Hospitals and east Durham, covering a distance of approximately 19 miles from Chapel Hill to Durham and approximately 19.5 miles from Durham to Chapel Hill and including 17 stops. Buses would operate at 10-minute headways in the peak periods and 20-minute headways in the off-peak periods. Travel time between the UNC Hospitals in Chapel Hill and Alston Avenue in Durham is estimated to be 57 minutes. The high-frequency bus route would closely follow that of the other Build Alternatives, as described below.

2.2.1. Technology

The TSM Alternative assumes operation of articulated buses.

2.2.2. Alignment

As illustrated in Figure 2-1, the TSM Alternative begins at the same western terminus as the LRT and BRT alternatives, UNC Hospitals, and ends at Alston Avenue in East Durham. The buses would use Manning Drive on the UNC campus from the Hospitals complex and southern part of Main Campus to the Fordham Boulevard intersection (NC 54/US 15-501 Bypass) and then follow Fordham Boulevard to the interchange with NC 54. The route would then use NC 54 in an easterly direction to the intersection of NC 54 and Farrington Road where it would then head north on Farrington Road, serving the Leigh Village location. It would continue north on Farrington Road to the intersection with Ephesus Church Road where it would turn left on Ephesus Church Road continuing to the intersection with Pope Road, turning right on Pope Road and continuing north to Old Chapel Hill Road. The route would proceed in a westerly direction on Old Chapel Hill Road to East Lakeview Drive (serving the Gateway area) where it would then head north to Durham-Chapel Hill Boulevard (US 15-501).

At this point the route would continue northeasterly on Durham-Chapel Hill Boulevard to the South Square commercial area of Durham. In the South Square area, the route would use Martin Luther King Jr. Parkway, University Drive, Shannon Road, and Tower Boulevard to serve the South Square activity center. From Tower Boulevard, the route would continue north on US 15-501 to the interchange with Cameron Boulevard where it would head easterly to the intersection with Erwin Road. From here the route would follow Erwin Road through the Duke and VA Hospital medical center area. It would continue on Erwin Road to the intersection with Main Street in the Ninth Street area.

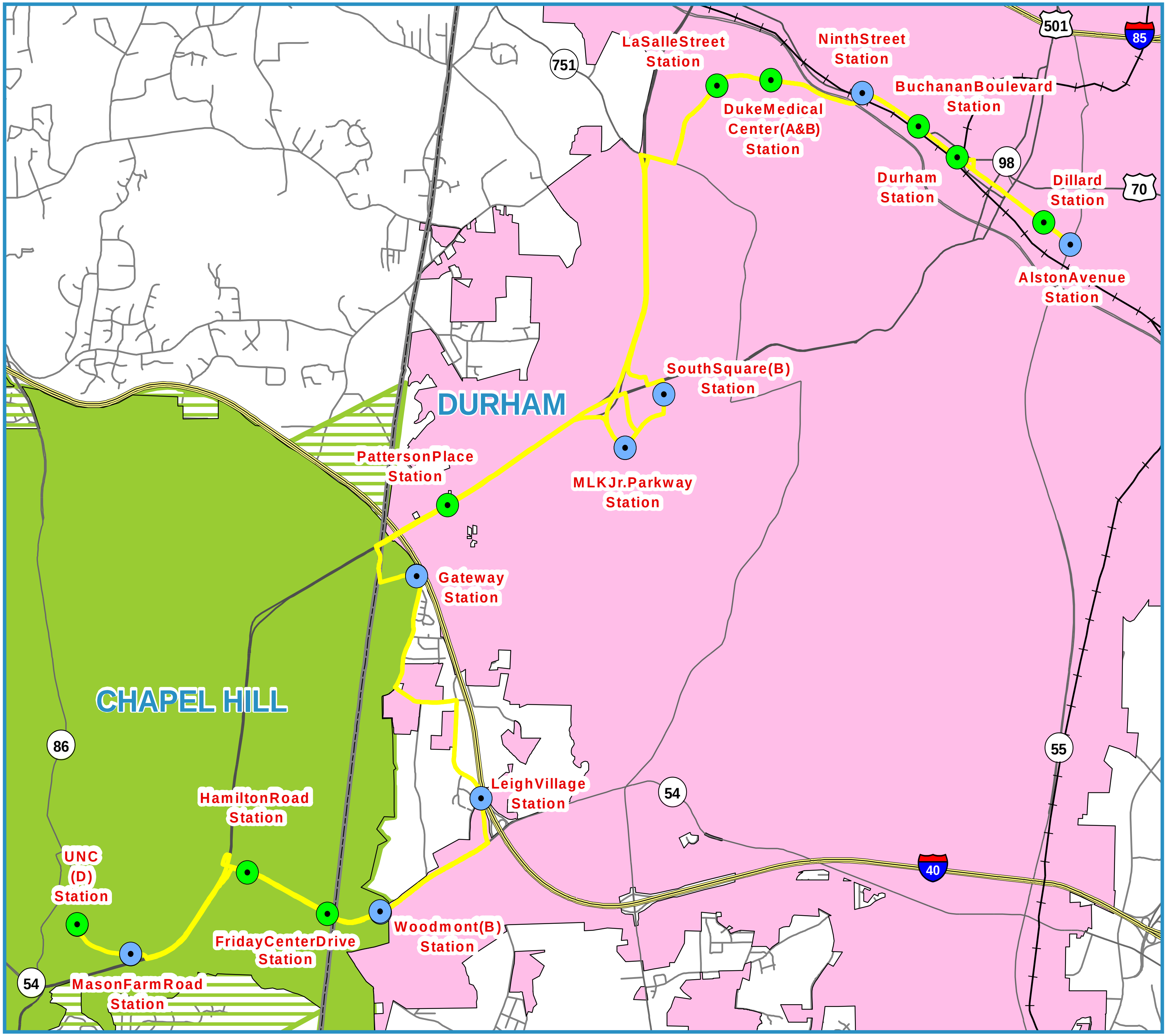
From the intersection of Erwin Road, Ninth Street, and Main Street, the route follows Main Street through downtown Durham to the east side of Durham, terminating at Alston Avenue in east Durham.

The proposed TSM route through Durham and Orange counties would serve similar activity centers as the Build Alternatives, as shown on Figure 2-1. These would include Chapel Hill, UNC and UNC Hospitals, Friday Center and the NC 54 Corridor, Leigh Village, Gateway (I-40/US 15/501), South Square, Duke University and Duke Hospitals, Downtown Durham, and NCCU and Durham Technical Community College.

FIGURE 2-1
TSM ALIGNMENT

LEGEND

- TSM Alignment
- Interstate
- US Route
- NC Route
- Railroad
- County Boundary
- Town of Chapel Hill
- Chapel Hill ETJ
- City of Durham
- Conceptual Bus Stop
- Conceptual Bus Stop with Park and Ride



NORTH

0 0.3 0.6 1.2 Miles

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2.2.3. Bus Stops and Park and Ride Locations

The TSM Alternative includes a total of 17 bus stops, with feeder bus connections available at all stops. Eight of these bus stops would have park-and-ride lots to manage travel demand and enhance access to transit in the corridor. These park-and-ride lots would be located at:

- Mason Farm, on UNC South Campus
- Woodmont (limited number of spaces)
- Leigh Village
- Gateway
- Martin Luther King, Jr. Parkway (limited number of spaces)
- South Square (limited number of spaces)
- Ninth Street (limited number of spaces)
- Alston Avenue

2.2.4. Bus Network

The TSM Alternative includes improvements and enhancements to bus transit service within the Durham-Orange Corridor, including local feeder bus routes to major activity centers and bus terminals from the surrounding areas. While the cost of the bus improvements is modest compared to a fixed-guideway transit system, the TSM Alternative could involve substantial capital and operations cost increases. The proposed bus transit improvements under the TSM Alternative include the following general improvements:

- Restructuring bus routes to address transportation needs and better serve travel markets in the corridor
- Providing both express and local bus service within the study corridor
- Increasing the use of higher-capacity buses, e.g., articulated buses
- Adding park-and-ride facilities and expanding existing facilities
- Traffic signalization improvements including signal timing, synchronization, and bus prioritization
- Timed bus transfers

Modifications to the programmed 2035 LRTP (or the No-Build Alternative) bus network were identified by station travel shed along the TSM alignment. If a route would duplicate or compete with the TSM service, then it was removed from the bus network. For each travel shed, a set of feeder bus routes was identified that provides access to the bus stop from the various activity centers in the travel shed that are beyond the acceptable walking distance from the bus stop (usually about one-third of a mile). The feeder buses serve both residential activities and commercial/employment centers. These routes were then compared to the programmed bus network contained in the 2035 LRTP. If no route in the LRTP provided the same service as the proposed feeder route then a new route was added. If an existing route provided essentially the same service as the feeder route, then the existing route was modified as necessary to match the proposed feeder route. Table 2-3 reflects these changes from the No-Build Alternative.

Table 2-3 TSM Alternative Bus Network Changes from the No-Build Alternative

Route Number	Description	TSM Headway		Change from No-Build Alternative
		Peak	Off-Peak	
BRT/Express Bus/Regional Bus				
TTA 420	TTA 420:Hillsb-Chap Hill	N/A	N/A	Route removed
Feeder/Local				
N/A	Mason Farm Road to 15-501	20	40	Route added
N/A	Mason Farm Road to Jones Ferry Park N Ride	20	40	Route added
N/A	Seawall School to UNC Hospital	20	40	Route added
N/A	Leigh Village Circulator	20	40	Route added
N/A	Gateway to Pinehurst / Burning Tree	20	40	Route added
N/A	Gateway to Legion to Estes / Willow	20	40	Route added
N/A	Gateway to Whitfield / Turkey Farm	20	40	Route added
N/A	Gateway to Farrington	20	40	Route added
N/A	Leigh Village to 751 / Fayetteville	20	40	Route added
N/A	Leigh Village to Renaissance to Fayetteville / Chancellors Ridge	20	40	Route added
N/A	Leigh Village to NC 54 / Revere	20	40	Route added
N/A	Leigh Village to MLK via Garrett	20	40	Route added
N/A	Leigh Village to MLK via Roxboro and MLK Blvd	20	40	Route added
N/A	MLK to Garrett / Pickett	20	40	Route added
N/A	South Square to Erwin / Randolph	20	40	Route added
N/A	South Square to James / Nation	20	40	Route added
N/A	South Square to Durham Station	20	40	Route added
N/A	South Square to La Salle	20	40	Route added
N/A	Alston Circulator via Fayetteville and Riddle	20	40	Route added
N/A	Alston to Briggs / Lawson	20	40	Route added
N/A	Alston to US 70	20	40	Route added
N/A	Durham Station to La Salle	20	40	Route added
N/A	Ninth to Broad / Carver	20	40	Route added
N/A	Ninth to Guess / Horton	20	40	Route added
N/A	Alston to Clayton / Freeman	20	40	Route added
N/A	Alston to Club / Geer (Wal-Mart)	20	40	Route added
CHT 4	CHT Base 4 Laurel Hills	N/A	N/A	Route removed
CHT NS	CHT NS:Eubanks-SVillage	N/A	N/A	Route removed
CHT S	CHT S:HedrickBldg-UNCHosp	N/A	N/A	Route removed
CHT V	CHT V:SVillage-Meadowmont	N/A	N/A	Route removed
DUKE C6	DUKE C6:Ecampus-Chapel	N/A	N/A	Route removed

Source: URS Corporation Consultant Team, 2011.

2.2.5. Roadway Improvements

The TSM Alternative includes all of the "committed" roadway projects as contained in the 2035 LRTP and included in the No-Build Alternative. These improvements were previously listed in Table 2-1 in Section 2.1. In addition, the TSM Alternative includes a variety of low-cost improvements to roadways specifically aimed at improving bus travel times and minimizing time in congestion. These low-cost improvements include:

- Bus-only shoulder on both sides of Fordham Boulevard between Manning Drive and NC 54
- Capacity improvements along NC 54, between Fordham Boulevard and I-40, consistent with an ongoing study and planning for that corridor; improvements may include superstreet configurations, additional travel lanes, and other intersection improvements
- Signal improvements for the intersection of NC 54 and Farrington Road, including signal phasing improvements and additional dedicated turn lanes
- Signal improvements for the intersection of US 15-501 and East Lakeview Drive/Easton Drive, including signal phasing improvements and additional dedicated turn lanes

2.2.6. Transportation Demand Management (TDM)

The TSM Alternative also assumes further developed TDM strategies to encourage transit use, discourage drive-alone commuting, reduce the number of daily trips, and reduce trip delay. Triangle Transit in cooperation with other transit providers, the North Carolina Department of Transportation, the two regional MPOs, and the Triangle J Council of Government managed the preparation of the *Triangle Region 7-Year Long Range TDM Plan* in 2007. The Plan provides a framework and strategies to achieve a 25 percent reduction in the growth of vehicle miles traveled in the Triangle Region by 2015, encouraging commuters to use different modes of travel such as mass transit, carpooling, biking, telecommuting, and vanpooling. This goal was achieved in 2009. The Plan also outlines a TDM program that includes an emphasis on TDM marketing, branding, and outreach which is designed to maximize the efficiency of numerous existing TDM programs and encourage new alternative mode users. TDM action items include enhancements to existing programs as well as the creation of new programs which may be augmented as additional funding becomes available. While it is assumed that these changes would occur as part of the TSM Alternative, they are not incorporated into the travel demand model.

The TDM programs, which have been implemented, include the following:

- The Share the Ride NC Ridematch Service (STRNC), which provides referrals to possible rideshare partners. There are 14,337 registered commuters in the STRNC program in the Triangle alone.
- The GoTriangle.org door-to-door Trip Planner, which provides advice on the best public transportation connection to destinations within the Triangle region. Durham Area Transit Authority (DATA), Capital Area Transit (CAT), CHT, North Carolina State University (NCSU) Wolfline, Cary Transit (C-Tran), and Triangle Transit regional services are included. In 2011, all trip planning information was added to Google for *on-the-go* trip planning.
- The Triangle Transit Vanpool Program includes 86, 12- and 7-passenger vans which are owned and serviced by Triangle Transit and leased to groups of commuters who pay a low monthly fare based on the shared cost of their commute. Currently there are 75 active vanpools in the Triangle.

- The Emergency Ride Home program, which is a service designed to encourage the use of alternative transportation to the worksite by providing employees with a free back-up taxi ride home in the event of an emergency or unplanned schedule change.
- The GoTriangle TDM Financial Incentives Program, which is designed to (1) motivate single occupancy vehicle (SOV) travelers to try an alternative mode of transportation and reward them for doing so; (2) motivate existing non-SOV travelers to continue using their mode of transportation and reward them for doing so; and (3) establish a tool to track region-wide participation in alternative modes of transportation that are often difficult to otherwise track.

2.3. LRT Alternative

The LRT Alternative would operate light rail vehicles between UNC Hospitals and east Durham, covering a distance of approximately 17.1 miles. The LRT would operate at 10-minute frequencies during peak hours and 20-minute frequencies during off-peak hours. LRT travel time is estimated to be 35 minutes between the UNC Hospitals Station in Chapel Hill and the Alston Avenue Station in east Durham.

The alignment would be double-tracked throughout, with one track for each direction. The alignment would primarily run at-grade in a dedicated right-of-way parallel to existing roadways, with elevated sections throughout to mitigate potential traffic impacts or impacts to environmental features as needed. As illustrated in Appendix A, a total of 17 stations are proposed for the LRT Alternative. Conceptual plans and typical sections of the LRT Alternative are provided in Volume 2: Detailed Definition of Alternatives, Conceptual Plan, and Profile Drawings.

2.3.1. Technology

The proposed transit technology for the LRT Alternative is modern 70% low-floor light rail vehicles, with a seating capacity of 228 (3-car train with 76 seats per car), operating on dedicated tracks with power supplied from an overhead catenary system. The image to the right is an example of a 70% low floor light rail vehicle from Phoenix.

2.3.2. Alignment

A description of the LRT Alternative alignment is provided by subarea—beginning at the westerly end in Chapel Hill at UNC Hospitals and moving east through Meadowmont/Woodmont, South Square, western Durham, and terminating in east Durham (Figure 2-2) at Alston Avenue. The LRT Alternative includes the "base alignment" and alignment alternatives advanced from the Evaluation of Conceptual Alternatives in the UNC Chapel Hill, Meadowmont/Woodmont, and South Square subareas. Alignment alternatives advanced from the Conceptual Evaluation of Alternatives are herein referred to as "alignment options."

UNC Chapel Hill The LRT alignment begins in Chapel Hill at UNC Hospitals on the southern portion of the UNC campus, with a possible extension north into downtown Chapel Hill and the Town of Carrboro. There are two alignment options under consideration for the UNC Hospitals area – UNC Hibbard Drive and UNC Southern Alignment.

UNC Hibbard Drive Alignment Option (A1) The UNC Hibbard alignment option (A1) begins at-grade adjacent to the UNC Hospitals Jackson Parking Deck, southwest of the intersection of Manning and Hibbard Drives. The alignment travels south through an existing developed site, transitioning to an aerial structure due to a steep decrease in grade, and continuing through Odum Village before turning southeast and dropping back to grade north of Mason Farm Road. Alignment option A1 continues heading eastward, parallel to Mason Farm Road, and rejoins the base LRT alignment near the Mason Farm Road and Fordham Boulevard intersection.

UNC Southern Alignment Option (A3) The UNC Southern alignment option (A3) begins on the south side of the Genetic Medicine Research Building, located south of the Dogwood Parking Deck, and continues eastward, running at-grade along a new east-west roadway to be constructed (by others) south of the Genetic Medicine Research facility and adjacent to an existing chiller plant. The alignment option continues east, leaving the new roadway and crossing the Mason Farm Road and Hibbard Drive intersection and traversing Odum Village on a new alignment through developed land. The alignment option then heads eastward, joining the base LRT alignment near the Mason Farm Road and Fordham Boulevard intersection.

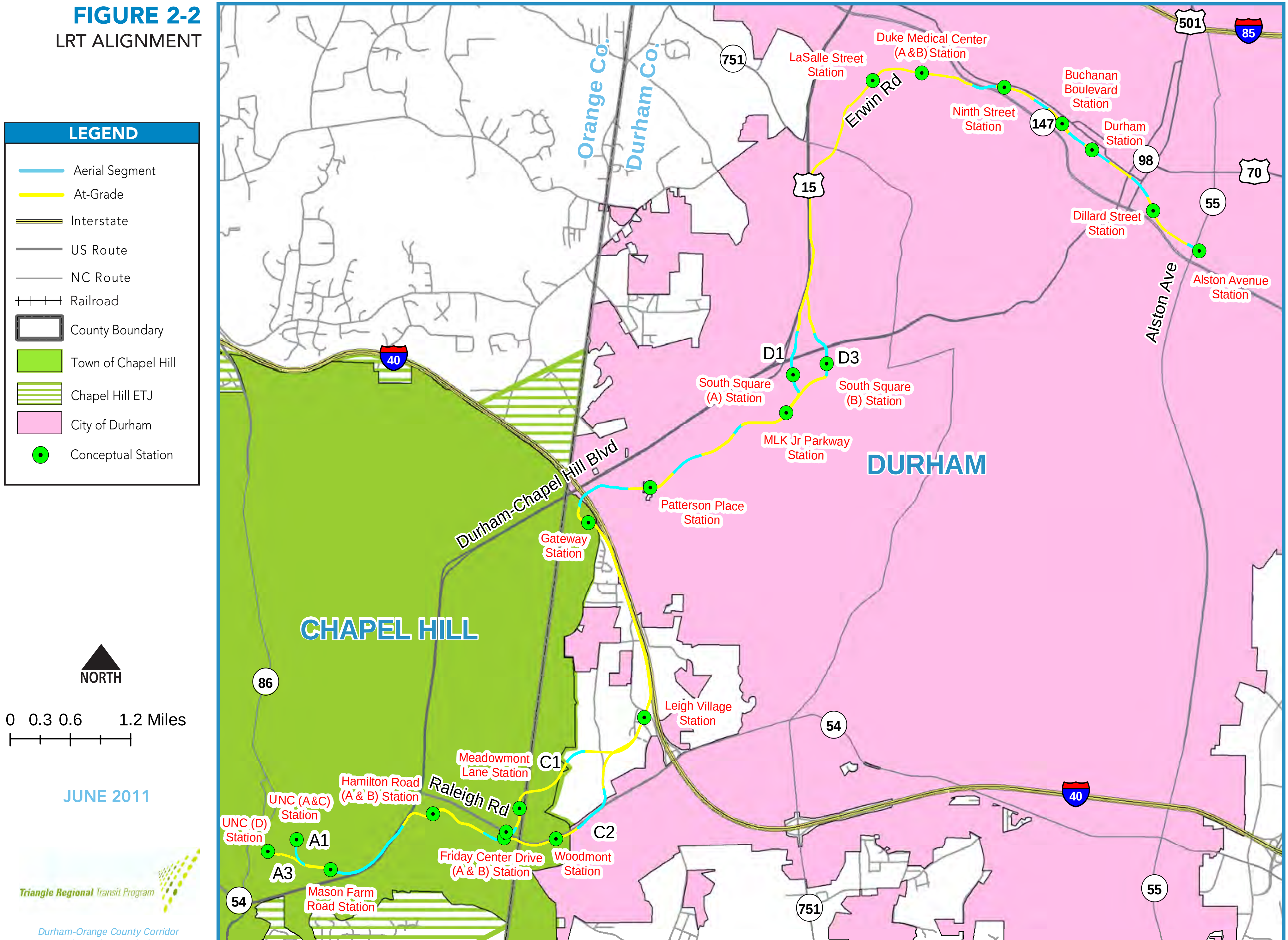
Friday Center From the UNC Chapel Hill subarea, the LRT Alternative runs east along the edge of the sidewalk north of, and roughly parallel to, Mason Farm Road. Just east of Baity Hill Drive, the LRT Alternative transitions to an aerial structure, turning slightly to run just north of and adjacent to Fordham Boulevard. The aerial structure continues past the Fordham Boulevard and Manning Drive intersection, crossing Fordham Boulevard after the Old Mason Farm Road intersection at a skew and continuing east along an undeveloped area that is south of and parallel to Fordham Boulevard. The alignment then returns to grade, running adjacent Fordham Boulevard along the south side of the roadway.

The alignment turns east behind Glenwood Elementary School, moving away from Fordham Boulevard and running parallel with Prestwick Road, south of NC 54. The alignment continues around the north side of the Finley Golf Course, heading east to UNC’s Friday Center.

Meadowmont/Woodmont From Friday Center, the LRT alignment enters the Meadowmont/ Woodmont subarea, where there are two alignment options.

Meadowmont Lane Alignment Option (C1) The Meadowmont Lane alignment option (C1) heads north, crossing NC 54 on aerial structure, entering Meadowmont Village and transitioning to at-grade, crossing Barbee Chapel Road, Sprunt Street, and Meadowmont Lane. The alignment then follows Meadowmont Lane north along the Durham/Orange County Line, before transitioning to an aerial structure and turning northeast across wetlands associated with Little Creek (about 500 feet in length) and skirting Federally-owned property associated with the Lake Jordan water supply watershed (the 500 feet of wetlands plus another 500 feet). The alignment returns to grade, heading east and crossing George King Road before turning north and connecting with Farrington Road and joining the LRT base alignment.

FIGURE 2-2
LRT ALIGNMENT



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George King Road Alignment Option (C2) The George King Road alignment option (C2) continues the alignment south of and parallel to NC 54, crossing Friday Center Drive either at-grade or on an aerial structure and paralleling NC 54 to the south of the roadway. Future traffic studies and additional coordination with NCDOT will determine the necessary profile. The alignment returns to grade before crossing Barbee Chapel Road and continues following NC 54 before transitioning back to an aerial structure. The alignment turns north and crosses NC 54 at George King Road. After crossing NC 54, the alignment returns to grade along George King Road before turning northeast and rejoining the base LRT alignment at Farrington Road slightly north of Rutgers Place.

Leigh Village and Patterson Place Leaving the Meadowmont/Woodmont subarea, the LRT alignment moves into the proposed Leigh Village development in southwest Durham at-grade. From Leigh Village, the alignment runs north on the west side of, and parallel to, I-40. The design allows for approximately 29 feet between the I-40 shoulder and eastern rail centerline, allowing for future widening of traffic lanes if necessary. The alignment continues north along I-40 to serve the Gateway development before turning eastward and transitioning to an aerial structure to cross I-40 just west of the interchange of I-40 and US 15-501. The alignment continues northeast, crossing Mt. Moriah Road and transitioning to an at-grade alignment just west of the McFarland Drive and Witherspoon Boulevard intersection. The alignment continues northeast, serving the Patterson Place development.

South Square From Patterson Place, the alignment continues northeast, transitioning to an aerial structure to cross New Hope Creek. The alignment returns to street level, crossing Garrett Road and running aerial for a short segment to cross Sandy Creek and then returning to grade, running north, adjacent to the west side of University Drive. The alignment crosses Martin Luther King, Jr. Parkway and there are two alignment options for serving the South Square commercial area. The alignment options serve the west or east side of South Square on an aerial structure.

Westgate Drive Alignment Option (D1) One alignment option, the Westgate Drive alignment option (D1), travels along the west side of the South Square development. The alignment travels east along University Drive before turning north to run along a developed area that runs parallel to Westgate Drive along the east side of the roadway, immediately transitioning to an aerial structure. The alignment travels north on the aerial structure through the South Square development, crossing Durham Chapel Hill Boulevard and the US 15/501 access ramps before returning to grade. The alignment continues north, paralleling US 15/501 along Petty Road/Western Bypass, which would be realigned as part of this alternative, before rejoining the LRT base alignment just north of Pickett Road.

Shannon Road Alignment Option (D3) The other alignment option, the Shannon Road alignment option (D3), serves South Square from the east. The alignment travels east along University Drive, past Westgate Drive, and turns north at Shannon Road, immediately transitioning to an aerial structure to run along a developed area, parallel to Shannon Road along the east side of the roadway. The alignment travels north on the elevated alignment through the South Square development, crossing Durham Chapel Hill Boulevard and returning to grade before crossing Pickett Road and rejoining the base LRT alignment north of Pickett Road.

Downtown Durham to East Durham North of Pickett Road, the LRT alignment parallels US 15/501 to a point north of Cornwallis Road where it then turns east to cross Cameron Boulevard at-grade and transition into the median of Erwin Road. Erwin Road would be reconstructed from a 5-lane section to 4-lane section as part of this alternative. The continuous dual left turn lane between Cameron Boulevard and 15th Street/Anderson Street would be removed and replaced by dedicated left turn lanes at the intersections. The LRT alignment runs along Erwin Road, serving Duke University and Duke Medical Center. East of Duke Medical Center, the alignment exits the median of Erwin Road, moving to the north of the roadway and transitioning to an aerial structure to cross NC 147. The LRT alignment enters the North Carolina Railroad (NCRR) rail corridor at-grade. A new set of parallel tracks would be constructed in the rail corridor 26 feet from the existing freight rail tracks for the light rail service. The LRT alignment remains in the rail corridor until the eastern end-of-line at Alston Avenue.

2.3.3. Station Locations

The LRT Alternative includes 17 station locations. The development and full evaluation of stations are documented in the Station Evaluation (Appendix A). The average spacing of the LRT stations is approximately one mile. At the southeasterly end of the corridor and in the downtown Durham area, the stations are more densely spaced, whereas in some of the less densely developed segments, the stations are located much further apart. This variance in station spacing is a reflection of the existing general land development patterns and densities.

The UNC, Meadowmont/Woodmont, and South Square stations have two distinct station options to be evaluated in the Detailed Evaluation of Alternatives. The options correspond to alignment options in these subareas. Remaining stations may have design configuration options that will be discussed in more detail for the Final Definition of Alternatives.

Table 2-4 summarizes the proposed station locations for the LRT Alternative. Station locations along the LRT alignment are shown in Section 4 of Appendix A includes the conceptual LRT station layouts.

Summary of Station Selection Process

Station locations were developed through stakeholder involvement and parallel engineering and planning studies. Intensive workshops were held in October and December 2010 and January 2011. Participants included staff from the municipal and county governments within the study area, as well as the MPOs and other organizations with an interest or responsibility for planning in those areas. The public also provided input on station locations at the March 2011 public workshops.

The initial and alternative locations were based primarily on previous studies, including the *Phase 1 Regional Rail FEIS* (2002) and the *US 15-501 MIS* (2001), as well as changes, additions, or deletions made by local governments subsequent to those studies or in the early phases of the AA prior to the initiation of station workshops.

See the Station Evaluation (Appendix A) for more information.

Table 2-4 Proposed LRT Station Locations

Station Name	Location	Features	Service Area	Long Walk, P/R, and Bus Transfer Markets
UNC Station	*Alignment Option A1 – UNC (A) / UNC (C)* - SW of the Manning Drive & Hibbard Drive intersection on fully developed area.	▪ Walk-up ▪ 4 feeder bus routes (curbside) ▪ At-grade platform	▪ UNC Hospital complex ▪ UNC South Campus	▪ UNC North Campus ▪ Town of Chapel Hill (Bus) ▪ Town of Carrboro (Bus)
	Alignment Option A3 – UNC (D) – Along a new east-west roadway to be constructed south of the Genetic Medicine Research facility.	▪ Walk-up ▪ 4 feeder bus routes (curbside) ▪ At-grade platform	▪ UNC Hospital complex ▪ Purefoy Rd Neighborhood	▪ UNC South Campus ▪ UNC North Campus ▪ Town of Chapel Hill (Bus) ▪ Town of Carrboro (Bus)
Mason Farm Road Station	NW of the Mason Farm Road and Baity Hill Drive intersection, at the south end of the UNC campus	▪ 300-space park-and-ride ▪ 2 feeder bus bays (curbside) ▪ At-grade platform	▪ Dean E. Smith Center ▪ Ernie Williamson Athletic Center ▪ UNC Housing along Mason Farm Rd	▪ UNC South Campus ▪ Town of Carrboro (Bus) ▪ Chatham County Residents (Park/Riders)
Hamilton Road Station	*Hamilton Road (A)* - SW of the Hamilton Road and Prestwick Road intersection at the NW corner of the UNC Finley Golf Course	▪ Walk-up ▪ At-grade platform	▪ East 54 development ▪ Fresh Market Shopping Center ▪ Glen Lennox Neighborhood	▪ Oaks neighborhood ▪ NC Botanical Garden ▪ Greenwood Neighborhood
	Hamilton Road (B) - East of the Hamilton Road and Prestwick Road intersection between the Prestwick Road and the UNC Finley Golf Course	▪ Walk-up ▪ At-grade platform	▪ East 54 development ▪ Fresh Market Shopping Center ▪ Glen Lennox Neighborhood	▪ Oaks neighborhood ▪ NC Botanical Garden ▪ Greenwood Neighborhood
Friday Center Drive Station	*Options A and B* – SW of the Raleigh Road and Friday Center Drive intersection on a fully developed site. The station would be a walk-up station. Option A aligns with Alignment Option C1 to Meadowmont. Option B Aligns with Alignment Option C1 to Woodmont (Hillmont).	▪ Walk-up ▪ Option A – Aerial platform ▪ Option B - At-grade platform or aerial platform	▪ Friday Center Complex ▪ Commercial Development south of NC 54 ▪ Finley Forest Neighborhood	▪ Meadowmont Village
Meadowmont Lane (A) / Woodmont (B) Station	*Alignment Option C1- Meadowmont Lane* West side of Meadowmont Lane, between Barbee Chapel Road and Sprunt Street.	▪ Walk-up ▪ At-grade platform	▪ Meadowmont Village	▪ The Oaks neighborhood ▪ Friday Center

Station Name	Location	Features	Service Area	Long Walk, P/R, and Bus Transfer Markets
	Alignment Option C2- George King Road Between NC 54 and Stancel Drive, east of Barbee Chapel Road.	▪ 200-space park-and-ride ▪ At-grade platform	▪ Proposed commercial and office development adjacent to station	▪ South Chapel Hill Park/Riders ▪ Chatham County Park/Riders
Leigh Village Station	SE of the Farrington Road and Wendell Road intersection, west of I-40.	▪ 1,000-space park-and-ride ▪ 7 feeder bus bays ▪ At-grade platform	▪ Proposed Leigh Village TOD	▪ Morrisville Park/Riders ▪ Cary Park/Riders ▪ Raleigh Park/Riders ▪ Durham Park/Riders
Gateway Station	NE of the Old Chapel Hill Road and White Oak Drive intersection.	▪ 500-space park-and-ride ▪ 7 feeder bus bays ▪ At-grade platform	▪ Proposed Gateway TOD	▪ North Chapel Hill (Bus) ▪ Downtown Chapel Hill (Bus) ▪ Town of Carrboro (Bus)
Patterson Place Station	East of the McFarland Road and Sayward Drive intersection.	▪ Walk-up ▪ At-grade platform	▪ Existing and Future Commercial Developments to West ▪ Sayward Drive neighborhood	▪ Five Oaks neighborhood ▪ Northwest Durham County Park/Riders
MLK Jr. Parkway Station	North side of University Drive between MLK Jr. and Lyckan Parkways.	▪ 300-space park-and-ride ▪ 5 feeder bus bays ▪ At-grade platform	▪ Larchmont Apts ▪ Area Commercial/Retail Development	▪ Knollwood neighborhood ▪ Valley Run neighborhood ▪ South Durham Park/Riders
South Square Station	*South Square (A) - Alignment Option D3* Along east side of Shannon Road, directly NE of Shannon Road and Auto Drive intersection.	▪ 300-space park-and-ride ▪ 6 feeder bus bays ▪ Elevated platform	▪ Existing and Future redeveloped commercial uses	▪ South Durham Park/Riders
	South Square (B) - Alignment Option D1 Along east side of Westgate Drive, south of Durham Chapel Hill Boulevard	▪ 300-space park-and-ride ▪ 6 feeder bus bays ▪ Elevated platform	▪ Existing and Future redeveloped commercial uses	▪ South Durham Park/Riders
LaSalle Street Station	Median of Erwin Road at LaSalle Street.	▪ Walk-up ▪ 5 feeder bus bays (curbside) ▪ At-grade platforms	▪ Duke University campus ▪ Campus Walk apartments ▪ Area Commercial and Residential buildings	▪ American Village (Bus)

Station Name	Location	Features	Service Area	Long Walk, P/R, and Bus Transfer Markets
Duke Medical Center Station – Option A and B	*Option A* - Median of Erwin Road on the west side of Fulton Street *Option B* - West side of Flowers Drive and east side of Trent Drive	▪ Walk-up ▪ At-grade platforms	▪ Duke Hospital ▪ VA Hospital ▪ Adjacent medical office and commercial uses	▪ Duke West Campus
Ninth Street Station	In the railroad ROW, west of Ninth Street, directly south of the freight and commuter rail tracks.	▪ 200-space park-and-ride ▪ 4 feeder bus bays ▪ Elevated platform	▪ Old West Durham ▪ Duke East Campus ▪ Trinity Height ▪ 9th St Business District	▪ Walltown neighborhood ▪ Watts/Hillandale (Bus, Park and Ride)
Buchanan Boulevard Station	In the railroad right-of-way, east of Buchanan Boulevard, directly south of the existing rail tracks.	▪ Walk-up ▪ At-grade platform	▪ Trinity Park ▪ Duke East Campus ▪ Brightleaf Square	▪ West End neighborhood ▪ Morehead Hill neighborhood ▪ Lakewood Park neighborhood (Bus)
Durham Station	In the railroad right-of-way between Duke Street and Chapel Hill Street, directly south of the existing rail corridor. Adjacent to the Amtrak and across the street from the Durham Station Transportation Center.	▪ 300-space park-and-ride (shared) ▪ Intermodal facility ▪ At-grade platform	▪ Durham Station Transportation Center ▪ Amtrak Station ▪ Downtown Loop ▪ Bulls Ballpark ▪ American Tobacco District ▪ Future redevelopment areas	▪ Old North Durham ▪ Duke Park (Bus, Park/Ride)
Dillard Street Station	In the railroad ROW, east of Dillard Street, directly south of the existing rail corridor.	▪ Walk-up ▪ At-grade platform	▪ East Downtown ▪ DPAC ▪ Cleveland-Holloway neighborhood ▪ Future redevelopment areas	▪ East Durham ▪ Albright neighborhoods (Bus)
Alston Avenue Station	In the railroad ROW, east of Alston Avenue, directly south of the existing rail corridor.	▪ 500-space park-and-ride ▪ 4 feeder bus bays ▪ At-grade platform	▪ NE Central Durham ▪ NCCU	▪ North Durham ▪ Durham Technical Community College ▪ North Raleigh Park/ Riders

Source: Station Evaluation Technical Report, URS Corporation Consultant Team, 2011.

2.3.4. Bus Network

The feeder bus service network is a key component of the LRT Alternative. Modifications to the programmed 2035 LRTP (or the No-Build Alternative) bus network were identified by station travel shed along the LRT alignment. If a route would duplicate or compete with the LRT service, then it was removed from the bus network. For each travel shed, a set of feeder bus routes was identified that provides access to the station from the various activity centers in the travel shed that are beyond the acceptable walking distance from the station (usually about one-third of a mile). The feeder buses serve both residential activities and commercial/employment centers. These routes were then compared to the programmed bus network contained in the 2035 LRTP. If no route in the LRTP provided the same service as the proposed feeder route then a new route was added. If an existing route provided essentially the same service as the feeder route, then the existing route was modified as necessary to match the proposed feeder route. Table 2-5 reflects these changes from the No-Build Alternative.

Table 2-5 LRT Bus Network Changes from the No-Build Alternative

Route Number	Description	LRT Headway		Change from No-Build Alternative
		Peak	Off-Peak	
BRT*/Express Bus/Regional Bus				
CHT BRT-5*	CHT BRT-5 I40 to UNC	N/A	N/A	Removed
CHT FCX	CHT FCX:Pttsbor-FridayCntr	N/A	N/A	Removed
CHT HUX	CHT HUX:HedrckBldg-UNCHosp	N/A	N/A	Removed
TTA 550	TTA 550 WB:Raleigh-Chap Hill	15	30	Terminates at Friday Center instead of Downtown Chapel Hill
N/A	TTA Burlington-Duke	30	N/A	Terminates at Duke Medical Center instead of Durham Station
TTA 402/403	TTA ChapelHill-RTP-402/403	30	60	Terminates at Leigh Village instead of Downtown Chapel Hill
TTA 412/413	TTA ChapelHill-RTP-412/413	30	60	Terminates at Leigh Village instead of Downtown Chapel Hill
Feeder/Local				
N/A	Mason Farm Road to 15-501	20	40	Added
N/A	Mason Farm Road to Jones Ferry Park N Ride	20	40	Added
N/A	Seawell School to UNC Hospital	20	40	Added
N/A	Leigh Village Circulator	20	40	Added
N/A	Gateway to Pinehurst / Burning Tree	20	40	Added
N/A	Gateway to Legion to Estes / Willow	20	40	Added
N/A	Gateway to Whitfield / Turkey Farm	20	40	Added
N/A	Gateway to Farrington	20	40	Added
N/A	Leigh Village to 751 / Fayetteville	20	40	Added
N/A	Leigh Village to Renaissance to Fayetteville / Chancellors Ridge	20	40	Added
N/A	Leigh Village to NC 54 / Revere	20	40	Added

Route Number	Description	LRT Headway		Change from No-Build Alternative
		Peak	Off-Peak	
N/A	Leigh Village to MLK via Garrett	20	40	Added
N/A	Leigh Village to MLK via Roxboro and MLK Blvd	20	40	Added
N/A	MLK to Garrett / Picket	20	40	Added
N/A	South Square to Erwin / Randolph	20	40	Added
N/A	South Square to James / Nation	20	40	Added
N/A	South Square to Durham Station	20	40	Added
N/A	South Square to La Salle	20	40	Added
N/A	Alston Circulator via Fayetteville and Riddle	20	40	Added
N/A	Alston to Briggs / Lawson	20	40	Added
N/A	Alston to US 70	20	40	Added
N/A	Durham Station to La Salle	20	40	Added
N/A	Ninth to Broad / Carver	20	40	Added
N/A	Ninth to Guess / Horton	20	40	Added
N/A	Alston to Clayton / Freeman	20	40	Added
N/A	Alston to Club / Geer (Wal-Mart)	20	40	Added
CHT 4	CHT Base 4 Laurel Hills	N/A	N/A	Removed
CHT S	CHT S:HedrickBldg-UNCHosp	N/A	N/A	Removed
CHT V	CHT V:SVillage-Meadowmont	N/A	N/A	Removed
DATA 10-8	DATA 10-8:NewHopeCmn-DrhmTech	N/A	N/A	Removed
L5	DATA L5 Mt Moriah-NC 54 WB	N/A	N/A	Removed
N/A	DCHC B11 N Raleigh to Duke WB	N/A	N/A	Terminates at Alston Ave instead of Duke Medical Center

Source: URS Corporation Consultant Team, 2011. | *BRT routes in the LRT bus network refer to services planned by Chapel Hill Transit (CHT).

2.4. BRT-High Alternative

The BRT-High Alternative would operate BRT service between UNC Hospitals and east Durham, covering a distance of approximately 17.1 miles. The BRT would operate at 10-minute frequencies during peak hours and 20-minute frequencies during off-peak hours. Travel time is estimated to be 39 minutes between the UNC Station in Chapel Hill and the Alston Avenue Station in Durham.

The alignment would primarily run at-grade in a dedicated running way, parallel to existing roadways, with elevated sections throughout to mitigate potential traffic impacts or impacts to environmental features as needed. Similar to LRT, a total of 17 stations are proposed.

2.4.1. Technology

The BRT-High Alternative assumes low-floor, articulated BRT vehicles with a capacity (seated and standing) of 100.

2.4.2. Alignment

The BRT-High generally follows the LRT Alternative from UNC Hospitals in Chapel Hill to Ninth Street in Durham with minor differences in width (Figure 2-3). The alignment assumes elevated structure and capital improvements in many of the same locations as LRT.

> The Special Transit Advisory Commissions (STAC) is a 38-member broad-based citizen group appointed by the Triangle Region's two Metropolitan Planning Organizations (MPOs) to assist in joint development of a plan for a regional transit system and draft the transit element of the 2035 LRTP. The STAC's recommendations are documented in the Regional Transit Vision Plan.

Downtown Durham to East Durham The BRT-High alignment enters downtown Durham similarly to the LRT Alternative; however, between Ninth Street and the end-of-line at Alston Avenue, the BRT-High alignment deviates from the LRT alignment which runs in the NCRR corridor. BRT-High would not operate in the NCRR corridor because during the Special Transit Advisory Commission's (STAC) deliberations, representatives of CSX Transportation (CSX) and Norfolk Southern Corporation (NS) stated that they would not accept the operation of busway/HOV lanes in any railroad corridor in which they operated. NCRR advised the STAC that they too would not support busway/HOV lanes in the NCRR corridor. Therefore, the BRT-High alignment is proposed to run along Pettigrew Street. Existing Pettigrew Street is technically within the 200-foot railroad right-of-way but is currently utilized by vehicular and bus traffic. The BRT-High would operate similar to conventional bus in mixed traffic along Pettigrew Street, but would transition to exclusive running along a new Pettigrew Street connection to be constructed as part of this project between Campus Drive and Duke Street. More research is needed to ascertain if the City has easements and/or rights to make this connection versus whether NS would allow its construction since this connection is located within the railroad right-of-way (as is most of the existing Pettigrew Street).

This section, termed BRT Alternative 4, would have stations at Ninth Street, Buchanan Boulevard, the Durham Station Transportation Center, Dillard Street, and Alston Street. The route from Pettigrew Street to the Durham Transportation Center would be via a one-way couplet in mixed traffic. The eastbound direction would follow S. Gregson Street south to E. Chapel Hill Street and north back to Pettigrew Street. The westbound direction would follow W. Chapel Hill Street to Duke Street. From the Durham Station Transportation Center, the BRT-High alignment follows Pettigrew Street in mixed traffic to Alston Avenue.

2.4.3. Station Locations

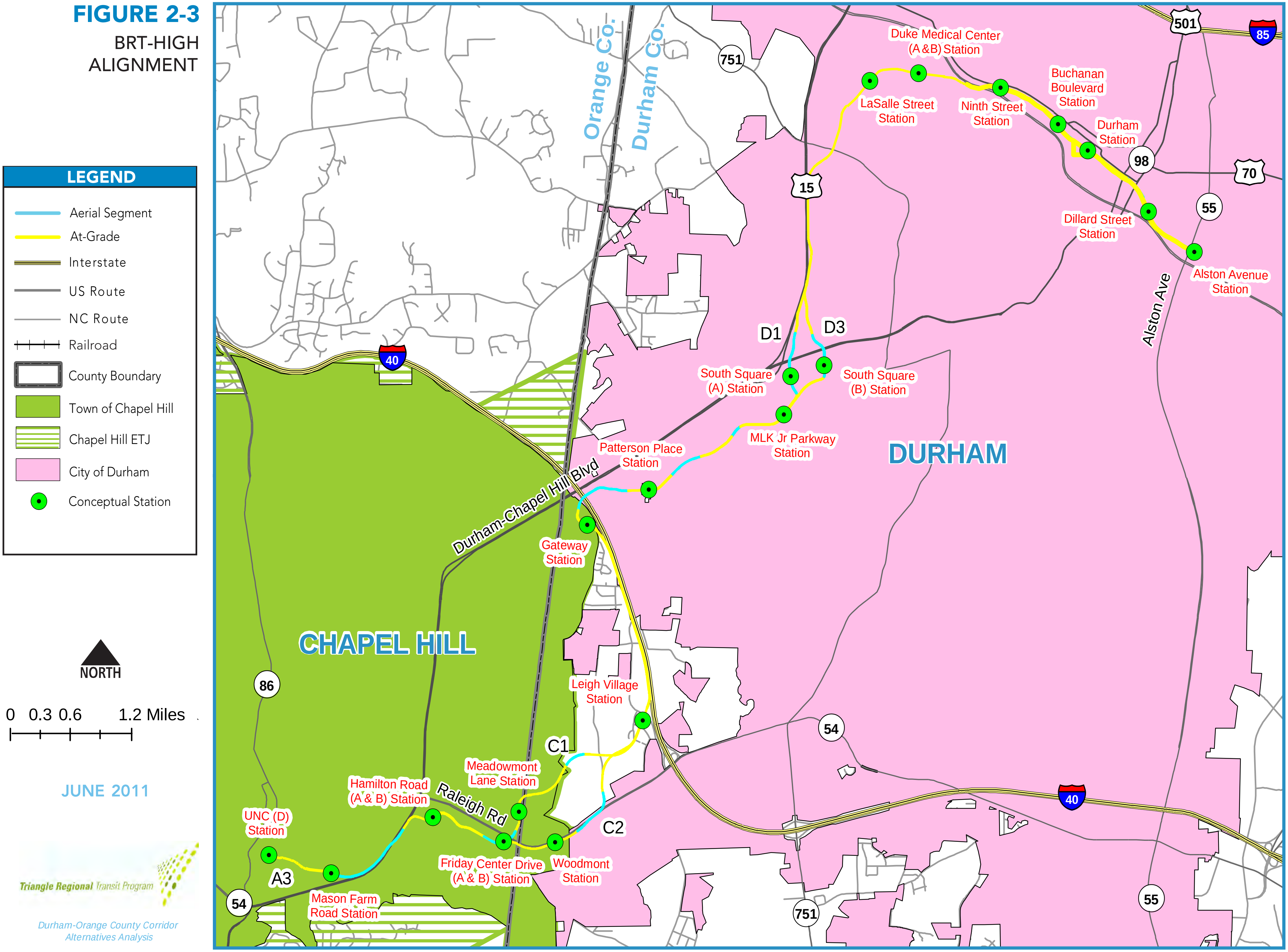
BRT-High would generally have the same station locations and features described under LRT.

2.4.4. Bus Network

Bus service modifications from the No-Build Alternative are identical to those changes described for the LRT Alternative, as previously listed in Table 2-5.

FIGURE 2-3

BRT-HIGH ALIGNMENT



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2.5. BRT-Low Alternative

The BRT-Low Alternative would operate BRT service between UNC Hospitals and east Durham, covering a distance of 17.7 miles. BRT-Low would operate at 10-minute frequencies during peak hours and 20-minute frequencies during off-peak hours. Travel time between is estimated to be 44 minutes between the UNC Hospitals in Chapel Hill and Alston Avenue in Durham.

Similar to the BRT-High Alternative, the BRT-Low Alternative would operate primarily in an exclusive running way from Chapel Hill through west Durham and operate in mixed-traffic in downtown Durham to east Durham. However, the alternative is designed to be a lower cost alternative and thus includes additional alignment segments following existing roadways. A total of 18 stations are proposed for the BRT-Low Alternative. Conceptual plans and typical sections of the BRT-Low Alternative are provided in Volume 2: Detailed Definition of Alternatives, Conceptual Plan, and Profile Drawings.

2.5.1. Technology

The BRT-Low Alternative would use the same vehicle technology as the BRT-High: low-floor, articulated BRT vehicles with a capacity (seated and standing) of 100.

2.5.2. Alignment

The BRT-Low alignment is similar to the BRT-High alignment but would deviate from the BRT-High alignment in the following three segments: Hamilton Road Station to Leigh Village Station (BRT-Low Alternative 1), Gateway Station to MLK Jr. Parkway Station (BRT-Low Alternative 2), and Shannon Drive to Pickett Road (BRT-Low Alternative 3). Figure 2-4 shows the BRT-Low alignment. These BRT-Low alignments are described below.

BRT-Low Alternative 1 - Hamilton Road Station to Leigh Village Station (including Meadowmont/ Woodmont Subarea)

The BRT-Low alignment would use new lanes in each direction along NC 54 from Hamilton Street to George King Road. Current planning studies for NC 54 are likely to recommend adding capacity to the roadway. BRT-Low, along with local and regional bus operations, could make use of these added bus-only lanes. The BRT-Low guideway would leave Hamilton Road Station and join with Hamilton Street running in mixed traffic for this short block. The eastbound lane would be built on the south side of NC 54 and the westbound lane on the north side. The southbound movement at the intersection of Hamilton Street and NC 54 would be a controlled at-grade movement through a modified signal control system.

For the westbound lane, additional at-grade crossings would occur at Barbee Chapel Road, Friday Center Drive, and George King Road. The eastbound lane would transition to aerial structure for the crossing of NC 54 and return to grade on the north side of NC 54 where it would rejoin the south/westbound guideway and continue on to Leigh Village as with the LRT and BRT-High Alternatives.

There would be two side platforms on each side of NC 54. The Friday Center Drive Station would be aligned with the pedestrian underpass to allow for grade-separated pedestrian movements across NC 54. The other station (replicating the Woodmont LRT stop) would be at the Little John Road intersection. A new traffic signal would be introduced at Little John Road to allow for pedestrian movements associated with the two split platforms.

FIGURE 2-4
BRT-LOW ALIGNMENT

LEGEND

- Aerial Segment
- At-Grade
- Interstate
- US Route
- NC Route
- Railroad
- County Boundary
- Town of Chapel Hill
- Chapel Hill ETJ
- City of Durham
- Conceptual Station

NORTH

0 0.3 0.6 1.2 Miles

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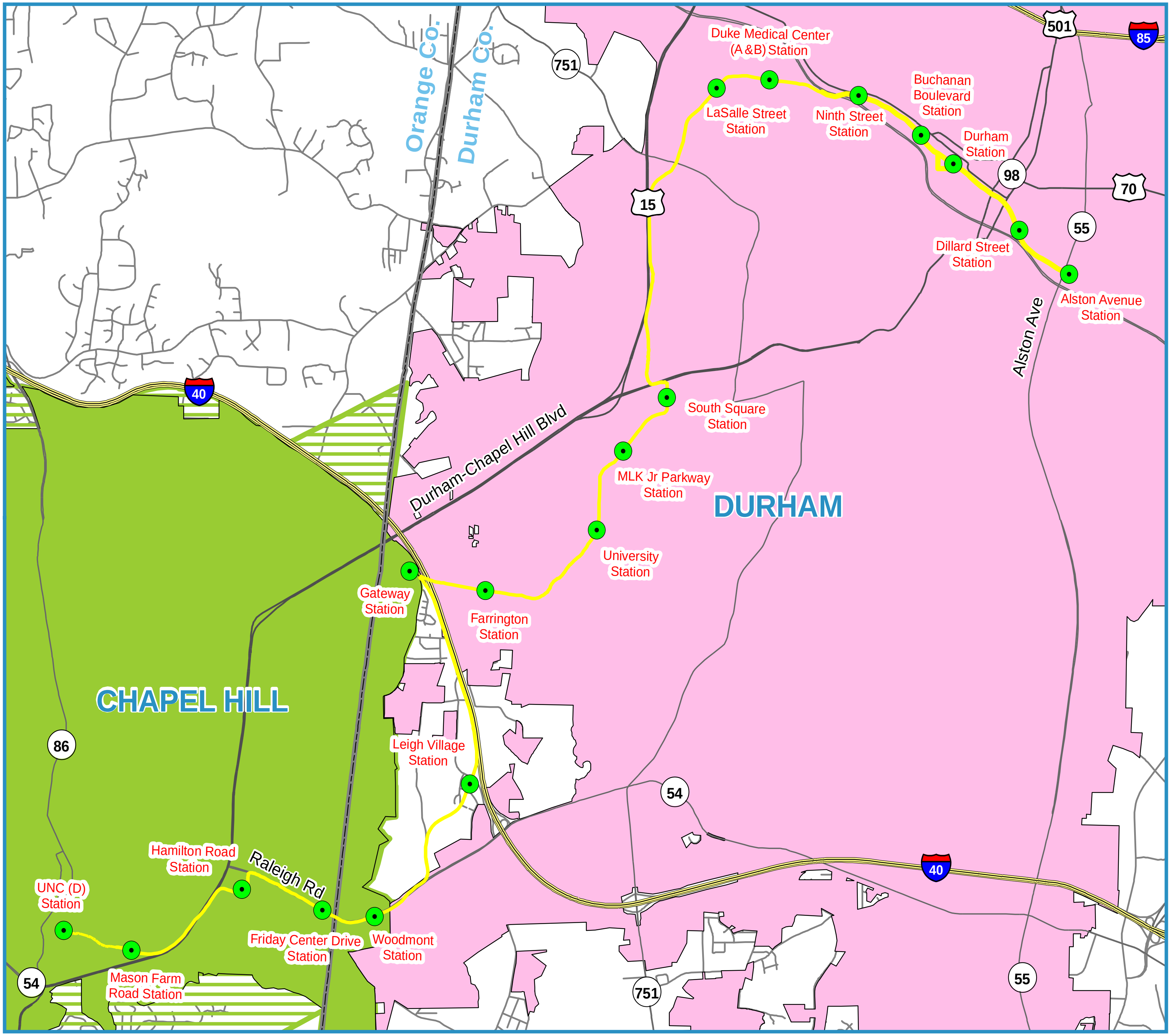

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BRT-Low Alternative 2 - Gateway Station to MLK Jr. Parkway Station

The BRT-Low alignment would follow Old Chapel Hill Road and University Drive for its entire length between the Gateway Station and MLK Jr. Parkway Station. Like NC 54, one lane would be built on each side of Old Chapel Hill Road and University Drive. The existing Old Chapel Hill Street Bridge over I-40 would be widened to accommodate the added lanes.

BRT-Low Alternative 3 - Shannon Drive to Pickett Road (includes South Square Subarea)

The BRT-Low alignment through this segment continues the proposed guideway along the west and north side of University Drive to Shannon Drive. The option places a lane in each direction on Shannon Drive to Durham Chapel Hill Boulevard running at-grade instead of elevated as with the BRT-High option. From Shannon Drive, the lanes would turn west along Durham Chapel Hill Boulevard, with one lane on each side of the street. The alignment would then turn north, entering Tower Road and would operate in mixed traffic for the short length of Tower Road.

2.5.3. Station Locations

The station locations would be the same as BRT-High except along Old Chapel Hill Road, where the BRT-Low would have two alternate stations in place of a Patterson Place Station. Table 2-6 describes station locations for BRT-Low along the BRT-Low Alternative segments. Appendix A includes the conceptual BRT station layouts.

Table 2-6 BRT-Low Station Locations

Station Name	Location	Features	Service Area	Long Walk, P/R, and Bus Transfer Markets
Friday Center Drive	West of the Friday Center Drive/Meadowmont Lane intersection with NC 54	▪ Walk-up station ▪ At-grade, side platform on either each side of Old Chapel Hill Road ▪ Bus pullouts	▪ Friday Center Complex ▪ Commercial Development south of NC 54 ▪ Finley Forest Neighborhood	▪ Meadowmont Village
Woodmont	Vicinity of Downing Creek Parkway	▪ 200-space park-and-ride ▪ At-grade, side platform on either each side of Old Chapel Hill Road	▪ Proposed commercial and office development adjacent to station	▪ South Chapel Hill Park/Riders
Farrington Road Station	West of the Old Chapel Hill Road and Farrington Drive intersection	▪ Walk-up station ▪ At-grade, side platform on either each side of Old Chapel Hill Road ▪ Bus pullouts	▪ Multi-family residential north and south of Old Chapel Hill Rd ▪ Middle School on north side of Old Chapel Hill Rd east of SW Durham Rd	▪ Five Oaks ▪ Rose Garden
University Place Station	At the University Drive and University Place intersection	▪ Walk-up station ▪ At-grade, side platform on either each side of Old Chapel Hill Road ▪ Bus pullouts	▪ Multi-family residential west of University Drive ▪ Office buildings in University Place on east side of University Drive	▪ University Place Apartments ▪ University Place Office Complex
South Square Station	*South Square (A)* Along east side of Shannon Road, directly NE of Shannon Road and Auto Drive intersection.	▪ 300-space park-and-ride ▪ 6 feeder bus bays ▪ At-grade platform	▪ Existing and Future redeveloped commercial uses	▪ South Durham Park/Riders

2.5.4. Bus Network

Bus service modifications from the No-Build Alternative are identical to those changes described for the LRT and BRT-High Alternative, as previously listed in Table 2-5. Minor feeder bus route modifications would also be made to accommodate the alignment variations for the BRT-Low Alternative.

2.6. Operating Plans

Operating plans were developed for the purpose of developing ridership forecasts and cost estimates for the Build Alternatives. The final operating plan will be developed for the Build Alternative advanced as the LPA.

2.6.1. Service Levels

Table 2-7 summarizes the operating statistics for the Build Alternatives as assumed in the ridership forecasts and cost estimates for the Detailed Evaluation of Alternatives. The operating hours and days for the Build Alternatives would be 18 hours per day, seven days per week, and 365 days per year. Service hours could be extended later into the evening or early morning hours for special events as needed.

Table 2-7 Summary of Service Characteristics for Build Alternatives

Period	Hours	TSM Headway	LRT Headway	BRT-High BRT-Low Headway
AM Peak	6:00 AM – 9:00 AM	10 minutes	10 minutes	10 minutes
Mid-day	9:00 AM – 3:30 PM	20 minutes	20 minutes	20 minutes
PM Peak	3:30 PM – 7:00 PM	10 minutes	10 minutes	10 minutes
Evening	7:00 PM – 12:00 AM	20 minutes	20 minutes	20 minutes
Off-Peak	6:00 AM – 12:00 AM	20 minutes	20 minutes	20 minutes

Source: URS Corporation Consultant Team, 2011.

2.6.2. End-to-End Operating Characteristics

Table 2-8 summarizes the route miles, average speed, and trip time for the Build Alternatives from end-to-end.

Table 2-8 End-to-End Operating Characteristics

Alternative	Route Miles	Average Speed	Travel Time
TSM	18.9 EB /19.4 WB	20.0 mph	57 minutes
LRT	17.1 miles	29.6 mph	35 minutes
BRT-High	17.1 miles	26.7 mph	39 minutes
BRT-Low	17.8 miles	24.5 mph	44 minutes

Source: URS Corporation Consultant Team, 2011.

2.6.3. Station-to-Station Distance, Speed, and Travel Time

Table 2-9 shows the route miles, average speed, and total trip time between stations for LRT and BRT Alternatives.

Table 2-9 Station-to-Station Operating Characteristics

Segment (Station to Station)	LRT Alternative			BRT-High Alternative			BRT-Low Alternative		
	Route Miles	Avg.Speed (mph)	Trip Time (mins)	Route Miles	Avg.Speed (mph)	Trip Time (mins)	Route Miles	Avg. Speed (mph)	Trip Time (mins)
UNC – Mason Farm Road									
Alignment Option A1									
UNC – Mason Farm Road	0.5	22.2	1.4	0.5	20.6	1.5	0.5	20.6	1.5
Alignment Option A3									
UNC – Mason Farm Road	0.6	20.6	1.8	0.6	19.5	1.9	0.6	19.5	1.9
Mason Farm Road – Hamilton Road	1.3	31.7	2.5	1.3	30.2	2.6	1.3	30.2	2.6
Hamilton Road – Friday Center Drive	0.8	21.9	2.2	0.8	20.9	2.3	0.8	20.9	2.3
Friday Center Drive – Leigh Village									
Alignment Option C1									
Friday Center Drive – Meadowmont Lane	0.3	17.9	1.1	0.3	16.5	1.2	--	--	--
Meadowmont Lane – Leigh Village	1.7	38.1	2.7	1.7	36.2	2.8	--	--	--
Alignment Option C2									
Friday Center Drive – Woodmont	0.5	24.5	1.2	0.5	21.4	1.3	0.5	21.4	1.3
Woodmont – Leigh Village	1.7	35.4	2.8	1.7	33.3	3.0	1.7	33.3	3.0
Leigh Village – Gateway	2.1	41.7	2.9	2.1	39.9	3.1	2.1	39.9	3.1
Gateway – Patterson Place	1.0	25.6	2.3	1.0	24.6	2.4	--	--	--
Patterson Place – MLK Jr. Parkway	1.7	36.6	2.8	1.7	35.1	2.9	--	--	--
Gateway – Farrington Drive	--	--	--	--	--	--	0.9	21.4	2.5
Farrington Drive – University Place	--	--	--	--	--	--	0.8	21.4	2.2
University Place – MLK Jr. Parkway	--	--	--	--	--	--	1.4	22.0	3.8
MLK Jr. Parkway – LaSalle Street									
Alignment Option D1									
MLK Jr. Parkway – South Square (B)	0.4	14.5	1.6	0.4	14.0	1.7	--	--	--
South Square (B) – LaSalle Street	3.0	36.4	5.0	3.0	35.5	5.1	--	--	--
Alignment Option D3									
MLK Jr. Parkway – South Square (A)	0.6	20.3	1.9	0.6	19.4	2.0	0.6	19.4	2.0
South Square (A) – LaSalle Street	3.0	36.2	4.9	3.0	35.3	5.0	3.2	28.0	6.9
LaSalle Street – Duke Medical Center	0.5	19.6	1.4	0.5	18.6	1.5	0.5	18.6	1.5
Duke Medical Center – Ninth Street	0.9	20.6	2.6	0.9	19.9	2.7	0.9	19.9	2.7
Ninth Street – Buchanan Boulevard	0.7	29.9	1.4	0.7	19.5	2.1	0.7	19.5	2.1
Buchanan Boulevard – Durham Station	0.4	27.9	1.1	0.4	16.7	1.3	0.4	16.7	1.3
Durham Station – Dillard Street	0.7	31.0	1.6	0.7	20.1	2.2	0.7	20.1	2.2
Dillard Street – Alston Avenue	0.8	22.2	1.6	0.8	22.3	2.3	0.8	22.3	2.3

Source: URS Corporation Consultant Team, 2011, Volume 3, Section C Travel Times and Distance Calculations

2.6.4. Fleet Size

Two sets of cost estimates were developed for LRT, BRT-High, and BRT-Low to provide an understanding of the differences in scale of operations and maintenance (O&M) costs related to operating the fixed-guideway alternatives with a peak hour passenger capacity of 1,500 passengers (Scenario 1) and service with a peak hour passenger capacity of 800 passengers (Scenario 2). Table 2-10 summarizes the fleet characteristics for the Build Alternatives based on both operating scenarios.

Table 2-10 Build Alternatives Fleet Characteristics

	LRT		BRT-High and BRT-Low		TSM
	1500 pax/hr	800 pax/hr	1500 pax/hr	800 pax/hr	
Total Number of Vehicles in Fleet	15 cars	10 cars	27 buses	15 buses	16 buses
Total Number of Vehicle in Peak Service	12 cars	8 cars	22 buses	12 buses	13 buses
Peak Service Consist Size	1-and 2-car trains	1-car trains	10 buses	NA buses	NA
Off-Peak Service Train Consist Size	1-car trains	1-car trains	8 buses	NA	NA

Source: URS Corporation Consultant Team, 2011.

2.7. Storage Yard and Maintenance Facility

An important infrastructure component of a fixed-guideway transit investment in the Durham-Orange Corridor is a rail operations and maintenance facility (ROMF) to accommodate LRT and BRT vehicles and repairs for all transit system wayside equipment.

For the TSM, BRT-High, and BRT-Low Alternatives, vehicles would be stored, serviced, and repaired at one or more existing CHT, DATA, and/or Triangle Transit bus storage and maintenance facilities that would be expanded. Any necessary expansions would be funded as part of the capital costs for the proposed project. The CHT facility is located on Eubanks Road. The DATA bus maintenance facility is located northeast of downtown Durham in the vicinity of Fay Street and East Greer Street. The Triangle Transit facility is located along I-540, west of RDU Airport on Nelson Road in Durham.

For the LRT Alternative, the Project Team assessed potential LRT storage yard and maintenance facility sites within the Durham-Orange Corridor. Four sites were chosen for evaluation: Leigh Village, Farrington, Patterson, and Cornwallis (Figure 2-5). These sites were chosen because they have sufficient acreage and length to accommodate the required functions, grading that could accommodate a rail yard, and adjacent land uses and access that could be compatible with a LRT yard and maintenance facility operation. The following basic functions were identified as requirements for each of the sites:

- Storage of 15 LRT cars which includes 3 spares. Each LRT car was assumed to be a low-floor articulated unit between 90 and 95 feet in length and up to 9 feet in width.
- Storage tracks to be double ended and capable of storing trains in one, two or three car lengths.
- Storage tracks will have paved access areas between alternating storage tracks for access to vehicles for cleaning and inspection. Designs are based on 20-foot track centers where access

areas are provided allowing 11-foot clearance between vehicles and 15-foot track centers in unpaved areas where catenary poles would be placed between tracks.

- Rail access to and from the mainline in either direction with crossovers between the mainline tracks located on the mainline at either end of the yards.
- Maintenance of Equipment (MOE) activities.
- Transportation Employee (TE) activities to be provided for:
  - Maintenance of Way (MOW) and Signals, Power, and Communications functions
  - Traction power Substation (TPSS)

Conceptual layouts developed for each site are provided in Volume 2: Detailed Definition of Alternatives, Conceptual Plan and Profile Drawings. The conceptual layouts have only been prepared to the level sufficient to identify the basic ability of the site to accommodate the required functions.

Evaluation of the four sites is based on size, access (rail and roadway), land use compatibility, and potential for adverse environmental effects. Table 2-11 summarizes the results of this preliminary evaluation.

Since the most productive and affordable segment of the Durham-Orange corridor has yet to be identified, all of the storage yard and maintenance facility alternatives are recommended to be carried forward and reviewed after selection of the LPA. It is likely that more than one alternative will be advanced with the LPA for more rigorous study in the PE/National Environmental Policy Act (NEPA) phase of the project.

FIGURE 2-5
LRT RAIL OPERATIONS AND MAINTENANCE FACILITY SITES

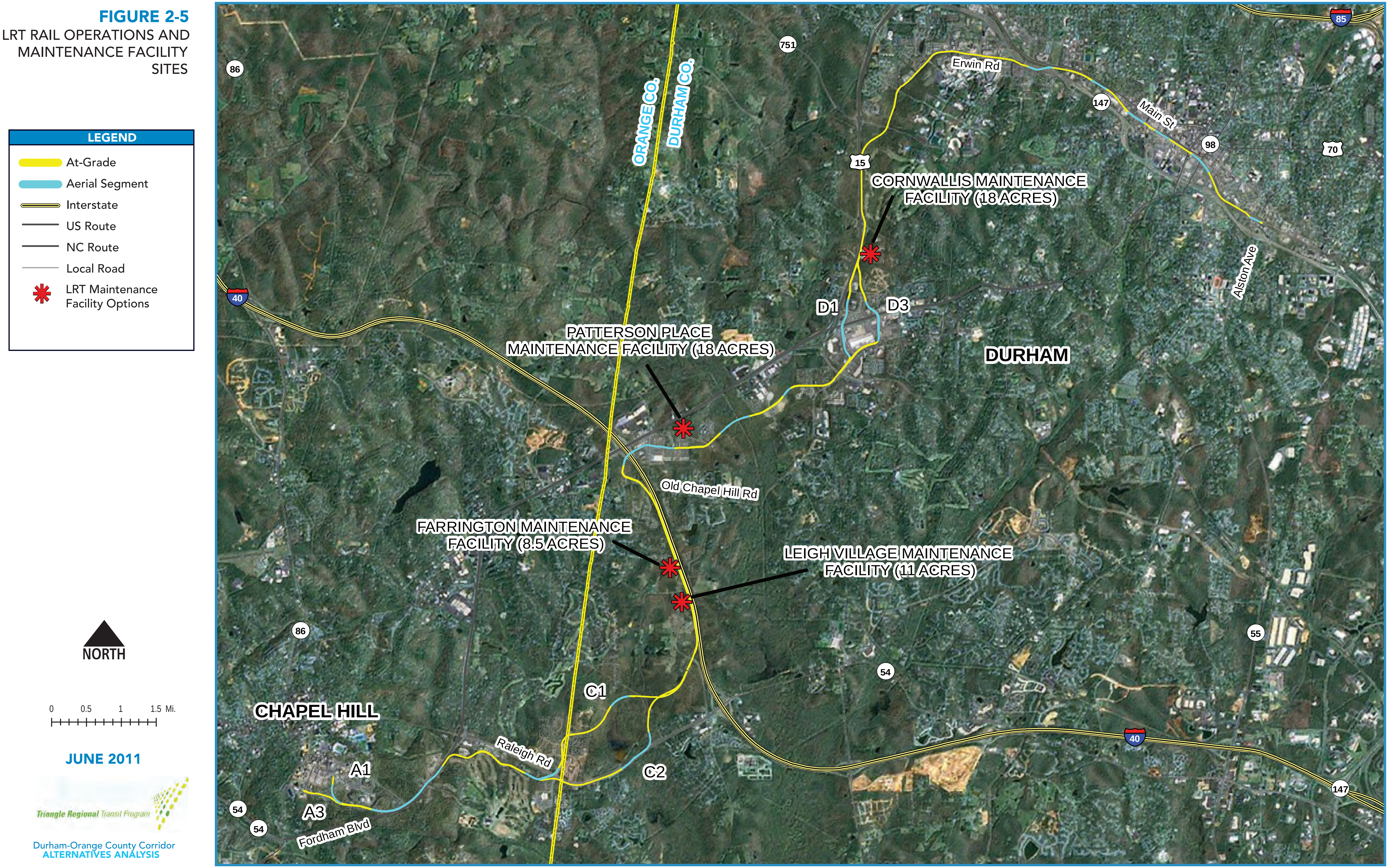

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Table 2-11 Summary of LRT Maintenance Sites

Candidate Site	Size	Access	Land Use Compatibility	Environmental Effects
Leigh Village	Adequate size (approximately 13.5 acres)	▪ Good roadway access ▪ Excellent bidirectional access	▪ Bound on one side by I-40 ▪ Adjacent rural residential land uses; acquisition of multiple residences would be required ▪ Opportunity for natural buffers to screen site from view	▪ Potential noise impacts to surrounding residences
Farrington	Adequate size (approximately 12.4 acres)	▪ Good roadway access ▪ Excellent bidirectional access	▪ Bound on one side by I-40 and Farrington Road on the other providing for separation of land uses ▪ Adjacent rural residential land uses; acquisition of multiple residences would be required ▪ Opportunity for natural buffers to screen site from view	▪ Potential noise impacts to surrounding residences
Patterson	Adequate size (approximately 12 acres)	▪ Good roadway access ▪ Off-line site requiring approximately 1,400 feet of access track ▪ Excellent bidirectional access	▪ Bound on one side by I-40 and Farrington Road on the other providing for separation of land uses ▪ Undeveloped land and well-buffered from adjacent land uses ▪ Opportunity for natural buffers to screen site from view	▪ Potential impacts to 2 possible Section 4(f) resources ▪ Potential visual impacts from the New Hope Creek trail
Cornwallis	Adequate size (approximately 14 acres)	▪ Good roadway access ▪ Excellent bidirectional access	▪ Bound on one side by US 15/501 and on the other providing for separation of land uses ▪ Consistent with existing industrial use of site. ▪ Adjacent to institutional land uses (schools, church) ▪ Opportunity for natural buffers to screen site from view	▪ Potential noise impacts to adjacent institutional land uses

Source: LRT Maintenance & Storage Yard Facility Assessment, URS Corporation Consultant Team, May 2011.

3. Evaluation of Alternatives

This section presents the screening criteria and process used to evaluate the fixed-guideway Build Alternatives described in Chapter 2.

3.1. Detailed Evaluation Criteria

Like the Conceptual Alternative evaluation process, detailed evaluation criteria relate to the six project goals. Table 3-1 presents all six goals and their related evaluation criteria and measures used to screen the detailed alternatives.

Table 3-1 Build Alternatives Evaluation Criteria

Goals	Evaluation Criteria	Measure
Goal 1: Improve mobility through and within the study corridor. Goal 2: Increase transit efficiency and quality of service. Goal 3: Improve transit connections.	Ridership	Evaluates alternatives based on the ability to serve potential transit riders and major activity centers within the Study Area. ▪ Ridership Forecasts: Estimates 2035 end-to-end boardings for LRT, BRT-High, and BRT-Low. ▪ System-wide Transit Trips: Estimates 2035 daily transit trips within the Triangle region.
	Transportation Operations	Evaluates alternatives based on the ease of operating LRT or BRT service. ▪ Traffic Impacts: Measures impacts to roadway and intersection conditions ▪ Travel Times: Measures overall end-to-end travel times.
	Expansion Potential	Evaluates ability of alternatives to serve travel markets beyond the existing termini of the corridor with future extensions.
Goal 4: Support local and regional economic development and planned growth management initiatives.	Economic Development Potential	Evaluates ability of the alternatives to positively impact economic development. Also considers transit oriented development (TOD) potential.
	Public and Agency Support	Evaluates alternatives based on results of public and agency stakeholder meetings.
Goal 5: Foster environmental stewardship.	Environmental Impacts	Considers environmental impacts associated with constructing and operating BRT or LRT service. Includes: ▪ Property Acquisitions ▪ Visual Impacts ▪ Wetland and Stream Impacts ▪ Section 4(f) Resources Impacts ▪ Air Quality Impacts ▪ Construction Impacts
Goal 6: Provide a cost-effective transit investment.	Cost	Considers costs associated with the construction of the Build Alternatives. ▪ Capital Costs ▪ Operating & Maintenance Costs

Source: URS Corporation Consultant Team, 2011

3.2. Evaluation Results

This section summarizes the evaluation of the three fixed-guideway alternatives by evaluation criterion. A full summary table (Table 3-25) is presented at the end of this section. Solid, half-filled, and open circles are used to rate the performance of alternatives relative to one another. The ratings for the circles are as follows:

● = High Performing ◓ = Medium Performing ○ = Low Performing

Ridership, travel time, and costs for the TSM are included for informational purposes. The TSM will be evaluated against the LPA in the Final Definition of Alternatives.

3.2.1. Ridership

The measure of total daily riders reflects the usefulness and attractiveness of the high capacity transit system as a primary mode choice on a daily basis.

Summary of Ridership Forecasting Methodology

Alternatives Modeled The LRT, BRT-High, and BRT-Low Alternatives were modeled using the TRM Version 4 Enhanced (TRM4E.2) model. Four alternatives were modeled for LRT, based on combinations of the alignment options at UNC Chapel Hill (A1 and A3), Meadowmont/Woodmont (C1 and C2), and South Square (D1 and D3). These combinations were developed to illustrate the relative difference of the alignment options on LRT ridership. It is expected that the relative difference in ridership for the alignment options for LRT would be proportional to the relative differences under BRT-High, and BRT-Low. Therefore, modeling one alternative combination for both the BRT-High and BRT-Low was deemed sufficient to provide information to decision-makers for the selection of the preferred technology and alignment. BRT-High and BRT-Low were modeled using the combination of alignment options A3, C2, and D3.

The TSM Alternative is considered primarily against the modeled LRT, BRT-High, and BRT-Low Alternatives that combine alignment options A3, C2, and D3. Ultimately, once an LPA is selected for carrying forward, a refined TSM Alternative (Baseline Alternative) can be developed specifically to serve the same markets as the LPA. It is anticipated that the performance of this Baseline Alternative relative to the LPA will be comparable to the performance of the TSM Alternative presented in this report relative to the modeled LRT, BRT-High, and BRT-Low Alternatives that combine alignment options A3, C2, and D3.

Fixed-Guideway Bonus There are a number of attributes of mode choice that are not incorporated into the ridership forecasting model because they are qualitative in nature and/or difficult to quantify ("unincluded attributes"). These unincluded attributes can impact potential user perceptions of transit modes and include such factors as service reliability, station and vehicle amenities, and passenger comfort and convenience. The ridership forecasting model is sensitive to changes in travel time—which is divided into out-of-vehicle travel time (OVTT) and in-vehicle travel time (IVTT). OVTT represents time to access the LRT or BRT mode, which can include walking, driving, waiting, and bus transfers. IVTT represents time spent onboard the LRT or BRT vehicle. Therefore, to account for the unincluded attributes, a fixed-guideway bonus was applied to the IVTT for the LRT, BRT-High, and BRT-Low Alternatives. For the LRT and BRT-High Alternatives, both of which are assumed to provide the highest quality and level of service, a 15-minute travel time savings bonus was assumed. A high-investment BRT differs substantially from other types of bus service in that it provides almost all of the amenities of a rail-based service including a fixed-guideway, substantial stations, and other passenger amenities. These characteristics provide the same level of benefit on a BRT service as in an LRT system. BRT-Low features more sections operating in mixed-traffic and cross-traffic, potentially lowering the attraction of the service. To account for this difference in the design of the BRT-Low Alternative, an 8-minute travel time bonus was used.

Interlining In addition to the alignment difference between the BRT-High and the BRT-Low Alternatives, the BRT-High and BRT-Low projections also account for the interlining of local bus routes. Interlining refers to the ability of local bus routes, including feeder bus services to utilize the BRT running way for a portion of their trip. It is an accepted practice for BRT systems and allows more transit users to benefit from the guideway investment. The following should be noted about the ridership forecasts involving the interlining routes:

- Every interlined route stops at every BRT station when on the BRT busway.
- The combination of routes running on the guideway results in a higher frequency of service at guideway stations.
- While most of the interlining bus passengers would take advantage of the one-seat interlined bus ride through the BRT guideway, a small number would transfer at the BRT stations and is a part of the BRT route ridership as well.
- If a passenger is on the bus on the busway, it is counted in the interline ridership number, even if that passenger does not get off the bus on the busway. The same is true for those who transfer from one interlined route to another.

Figure 3-1 and Figure 3-2 depict the feeder bus routes for LRT and the feeder bus routes together with interlining bus routes for BRT.

Uncertainties in Forecasts

In discussions throughout the model calibration and validation process, the FTA has emphasized the importance of considering sources of uncertainty in performing the forecasting. It is desirable to avoid internalizing uncertainties within the forecasts. Rather than produce a single forecast that assumes the answer is known to every potential uncertainty, ideally a series or range of forecasts could be produced that can communicate the uncertainties to the decision-makers for consideration.

To that end, as part of the study, descriptions of a variety of potential sources of uncertainty in the forecasts and discussions about those uncertainties and their potential effects on the ridership forecasts were developed. Table 3-2 presents a listing of these uncertainties as present in the forecasts developed using the TRM4E.2.

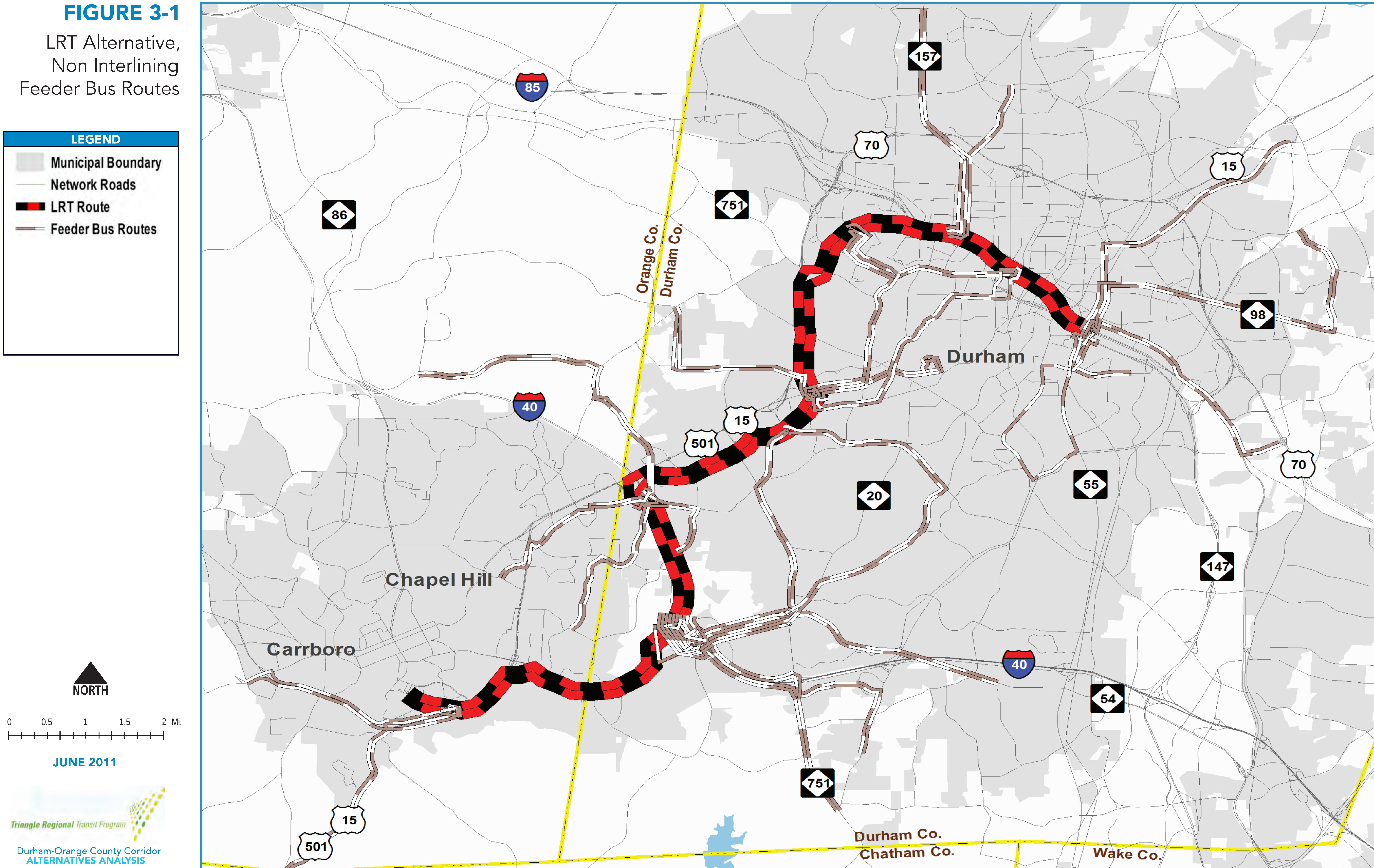
Table 3-2 Potential Forecasting Uncertainties with Triangle Regional Model

Uncertainties	Discussion	Potential Impact
1. Gasoline price (long-term effects of increasing gasoline price on transit ridership)	Studies have shown a positive relationship between increases in gasoline prices and transit ridership levels. Rail ridership tends to be more sensitive to changes in gasoline prices than bus ridership. Based on the literature review, the long-term elasticity of transit ridership was suggested to be in the range 0.2 to 0.4 (Litman 2011), meaning that a 10% increase in gasoline price could result in a 2% to 4% increase in transit ridership. Over very long periods of time, technology and spatial distribution patterns may adjust to account for price changes and these potential effects are not incorporated.	Significant increases in gasoline prices could result in considerable increase in the estimated rail ridership. For example, doubling the gasoline price could potentially lead to a 20% to 40% increase in rail ridership.
2. University trips (fare-free transit services in three major universities in the region)	Fare-free bus services for Chapel Hill, Duke, and NCSU are in the corridors today. University-related trips account for close to 60% of all transit trips in the region. Home-based university trips were currently estimated to be around 10% of rail trips, with below 10% for the Durham-Orange corridor. University-related trips can also be part of the non-home-based trips. Due to model limitations, in this preliminary Alternatives Analysis, it was assumed that rail trips are all paid trips, including student trips. This could tend to understate usage of the guideway services by this market. Based on the literature review, the long-term ridership elasticity with respect to fare was suggested to be -0.6 to -0.9 (Litman 2011), meaning that 10% decrease in fare could result in a 6% to 9% increase in transit ridership.	Provision of (fare-free or discounted) student rail passes could potentially increase the rail ridership versus what the model reports.
3. Representation of fixed-guideway ridership	Fixed-guideways tend to attract proportionally more riders than standard buses. As typical of a region without an operating fixed-guideway, the region's travel demand model was developed and calibrated on transit surveys of the current bus users, potentially under-representing the attractiveness of a fixed-guideway service to riders if one were introduced to the market. As one aspect of this, the model, as currently calibrated, represents a traveler's drive access behavior to local and express buses, but fixed-guideway services typically attract more riders using drive access. Therefore, the model likely inadequately accounts for attractiveness of drive access to the fixed-guideways. For example, light rail systems used to calibrate the FTA Aggregate Rail Ridership Forecasting II model show the percentage of	The fixed-guideway bonuses employed in this study have been asserted to help account for attributes of attractiveness of these modes that are otherwise unaccounted for in the model. However, if these bonuses overstate the actual attractiveness, the resulting ridership could be lower than what is forecast. (See Section Ridership Forecasting Methodology – Fixed-Guideway Bonus discussion on page 3-2 for more information on the fixed-guideway bonus) An experimental model approach, based on a study of rail ridership in Charlotte, was tested and

Uncertainties	Discussion	Potential Impact
	park and ride access ranging from 19% to 48%, averaging around 30%. In this phase of study, drive access was estimated to be around 20% for the Durham-Orange Corridor (at the low end of the range). As indicated in the report, a 15 minute fixed-guideway bonus has been applied to the LRT and BRT-High options and a 8-minute fixed-guideway bonus has been applied to the BRT-Low option to help account for the attractiveness attributes of LRT or BRT that are otherwise not included in the model. The actual attractiveness of the fixed-guideway option may be different from what is represented by the bonus used.	calibrated as part of a sensitivity analysis to help explore the potential contribution of "choice riders" to ridership of fixed-guideway services. Using the experimental approach increased the forecast share of choice riders in the rail ridership composition and the proportion of drive access to rail. If more choice riders are attracted to the fixed-guideway services, higher ridership and higher park-and-ride-based ridership could result than what is forecast by the TRM V4E.2
4. Integration of feeder buses with background bus system and bus transfers to rail	Efforts have been made to integrate the transit system in the long-range plan transportation with a potential feeder bus system. However, the eventual transit system with a proposed guideway could be different from what was assumed in the model, because of changes in cost and other factors. Bus transfers to the rail were projected to play an important role in the rail ridership composition, accounting for nearly one third of the total ridership.	Reductions in the feeder buses that are assumed in the model, in terms of service frequencies and service areas, would decrease the bus transfers to the proposed rail.
5. Socioeconomic growth over the next 25 years along the corridor	A high growth of population and employment was assumed in the region's LRTP over the next 25 years, and thus in this preliminary Alternatives Analysis. The Triangle region is currently projected to double its 2005 population and employment by 2035. The 30-year growth was projected to be lower in the proposed rail corridors, with 70-80% employment growth and 30-40% population growth in the Durham-Orange Corridor.	Too optimistic socioeconomic forecasts are often cited as a major reason for over-estimation of rail ridership in the US rail program. Lower growth could lead to lower ridership.
6. Representation of parking constraints	There is a lack of parking constraints in the region's model, although an auto-intercept component was used to represent park-and-ride behavior around the UNC-Chapel Hill campus. Lack of parking capacity constraints may lead to more auto access transit trips forecast than could be accommodated.	Without sensitivity to parking pricing and demand-supply relationship, the model estimates may result in biased estimates for drive access trips, either upward or downward.
7. Historical ridership forecasts	FTA studies (2003, 2007) indicate systematic over-estimation of ridership for New Starts projects, but recent projects are significantly more accurate than earlier projects.	"New" New Starts projects are shown to have higher uncertainties in the ridership forecasts than those projects extending the existing fixed-guideway services.
8. Model sensitivity to walk access	Representation of walk access from a transportation analysis zone (TAZ) is affected by the TAZ size. When a TAZ is big, the distance from a TAZ centroid to a proposed station may be too large to walk. However, a part of the big TAZ may be walkable to the station.	Given the refinements, the model could still underestimate walk access to proposed rail stations, where adjacent TAZs are big and especially transit-oriented developments are planned near the proposed stations.

FIGURE 3-1

LRT Alternative, Non Interlining Feeder Bus Routes



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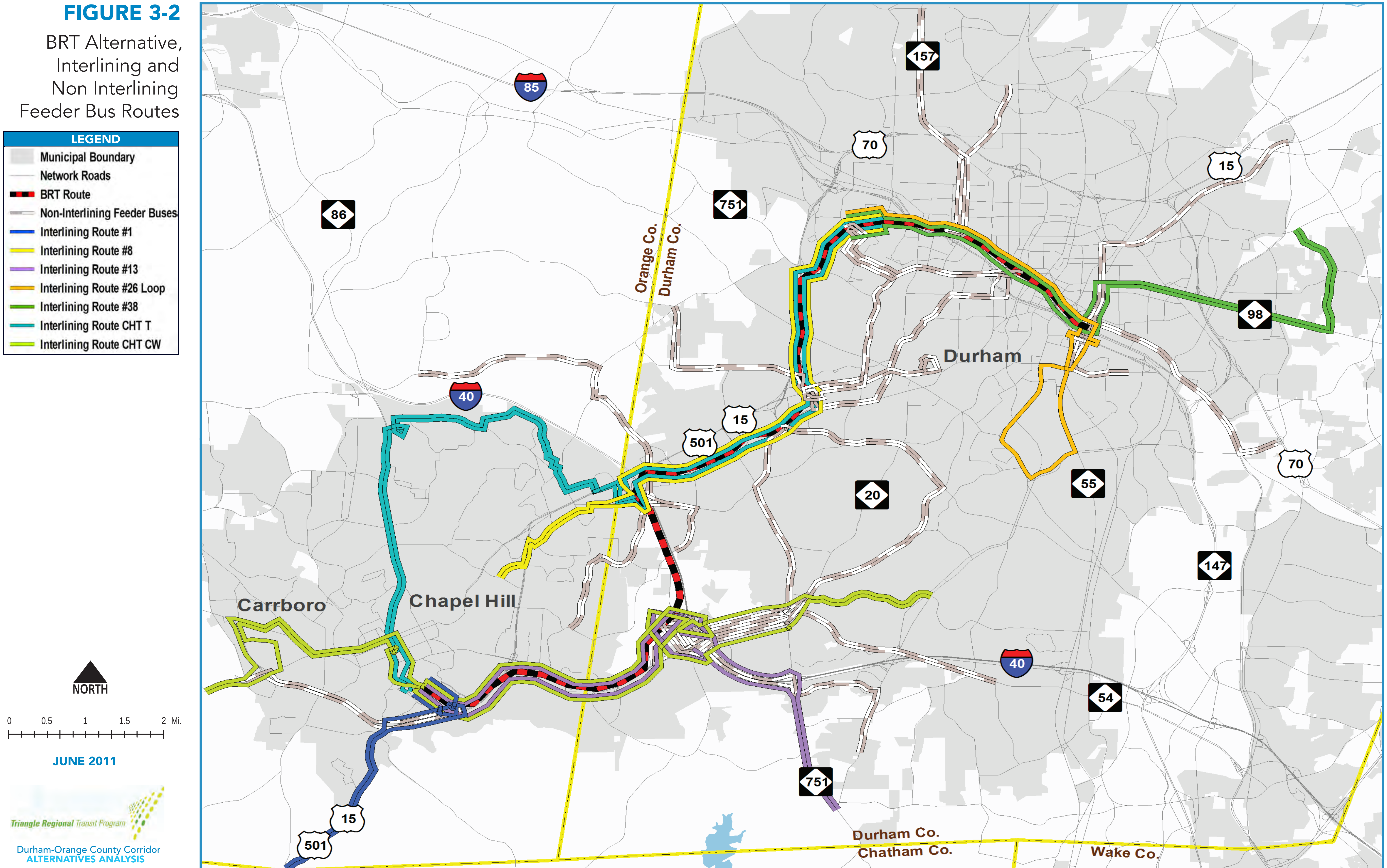
Durham-Orange County Corridor
ALTERNATIVES ANALYSIS

FIGURE 3-2

BRT Alternative, Interlining and Non Interlining Feeder Bus Routes



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LRT 2035 daily boardings for LRT vary between 11,000 and 12,800 boardings per day depending on the combination of alignment options used. Ridership is affected by a number of factors including destinations served, travel time, and cost. The relatively small variation in ridership between the LRT alternatives modeled is expected given that the alignment options generally serve the same primary activity centers within the corridor. The modeled alternative that combines alignment options A1 (UNC Hibbard Drive), C2 (George King Road), and D3 (Shannon Road), is forecast to have the highest ridership of the LRT alternatives. The lowest ridership combination is expected to be A3 (UNC Southern), C1 (Meadowmont Lane), and D1 (Westgate Drive).

Ridership variations between the alignment options under consideration in UNC Chapel Hill, Meadowmont/Woodmont, and South Square are discussed below.

- *UNC Chapel Hill:* A station level ridership comparison of the alternatives modeled shows that alignment option A1 could attract up to an additional 800 daily riders over alignment option A3. Alignment option A1, UNC Hibbard Drive, is closer to the center of UNC Main Campus and Hospitals as well as major employment and student centers than alignment option A3. While the station on alignment option A3 could still attract riders through transfers from feeder bus service, the additional distance between the proposed station locations on alignment option A1 and alignment option A3 substantially increases the walk distance from UNC area activity centers, thereby significantly reducing the number of walking trips.
- *Meadowmont/Woodmont:* A station level ridership comparison of the modeled LRT Alternatives shows that alignment option C2 has up to 300 additional boardings over alignment option C1. This difference in station level ridership is a result of the differences between Meadowmont and Woodmont station areas and the model's sensitivity to these differences. First, projected 2035 number of households and employment in the traffic analysis zones (TAZ) served by the stations is larger in the TAZ serving the Woodmont station (1189 households and 1486 employment) than for the Meadowmont station (587 households and 763 employment). Second, the Woodmont station area has about 500 more students than the Meadowmont station area; Woodmont also has a non-student population of similar magnitude as Meadowmont, but with smaller household sizes. Being modeled as a part of no-car and low-income groups, students are more likely to take transit than higher-income residents with cars.

  The travel demand model may underestimate walk access to stations from nearby transit-oriented developments. While the Woodmont Station, which would serve the proposed Hillmont development and adjacent area by means of walk access, is also accessible by park-and-ride and bus transfers, the Meadowmont Station relies heavily on walk-to-transit trips without a park-and-ride access. Meadowmont Village was conceived as a TOD and offers a well-developed urban street grid, a highly walkable landscape, mixed-use developments, and multifamily housing within the one-half mile station catchment area. A recent study completed by leading TOD scholars (Reid Ewing and Robert Cervero) indicates that urban form and connectivity have a considerably more powerful influence on transit usage than land use mix or even density. Meadowmont's higher intersection density per square mile and sidewalk coverage per mile of roadway further substantiates its potential for attracting a substantial number of walk-to-transit trips. Due to these similar characteristics, the Meadowmont Station ridership is potentially underrepresented.

  Recent experience from Charlotte, NC sheds light on the extent to which ridership forecasting models could underestimate walk-access-to-transit trips. Of the approximately 6,000 daily rail trips that were under-predicted by the model used to forecast ridership for the Charlotte LYNX Blue Line, more than 4,000 were walk-to-transit trips.

- *South Square:* A station level ridership comparison of the modeled LRT alternatives shows that alignment option D3 can attract up to 650 additional boardings over alignment option D1. Alignment option D3, Shannon Road, presents higher ridership than alignment option D1, Westgate Drive, because it is not constrained by US 15/501 and is more centrally located to serve existing developments and the planned University Marketplace development southeast of the station location.

For the purpose of comparing ridership between Build Alternatives, the LRT ridership forecast that combines alignment options A3, C2, and D3 is used. As previously noted, variations in ridership projections for the alignment options modeled in LRT would be expected to be proportional to the variations between these options (when applicable) for BRT-High and BRT-Low.

BRT-High For the BRT-High Alternative, the guideway users include riders on the proposed BRT route operating exclusively on the guideway and riders traveling on interlined buses that use the BRT guideway (See Page 3-3 for more information on interlining). It should be noted that the combination of routes thus running on the guideway results in a very high perceived frequency of service at guideway stations. The BRT route is forecast to have 5,700 daily boardings, while the interlined buses using the BRT guideway are estimated to have 11,900 boardings per day (includes only boardings and alightings within the guideway). As noted under the Ridership Forecasting Methodology, while most of the 11,900 bus passengers would take advantage of the one-seat interlined bus ride through the BRT guideway, a small number (less than 10%) would transfer at the BRT stations and is a part of the BRT route ridership as well. With interlined buses included, the total daily boardings are 17,600.

BRT-Low Similarly for the BRT-Low Alternative, the guideway users include riders on the proposed BRT route operating exclusively on the guideway, which is forecast to have 4,600 daily boardings, and riders traveling on interlined buses using the BRT guideway, which is estimated to be 11,700 boardings per day (includes only boardings and alightings within the guideway). Like BRT-High, while most of the 11,700 bus passengers would take advantage of the one-seat interlined bus ride through the BRT guideway, a small number (less than 10%) would take transfers at the BRT stations and is a part of the BRT route ridership as well. Again, guideway stations would see a very high perceived frequency of service due to the combination of routes running on the guideway. With interlined buses included, the total daily boardings are 16,300.

TSM The ridership forecast for TSM Alternative is 3,200 boardings per day.

Summary of Daily Boardings

Table 3-3 provides the forecast daily boardings for 2035.

Table 3-3 Forecast 2035 Daily Boardings

Alternative	Daily Boardings	Rating (not including interlined buses for BRT)**	Rating (including interlined buses for BRT)
TSM	3,200	-	-
LRT	12,000	●	◒
BRT-High	BRT route: 5,700 Interlined buses: 11,900*	○	●
BRT-Low	BRT route: 4,600 Interlined buses: 11,700*	○	●

*Source: Triangle Regional Model v4 enhanced. |*Boardings on interlined buses include bus routes using the BRT guideway.|**Daily boardings for BRT-High and BRT-Low routes without interlined buses could potentially be higher as the model estimated the ridership assuming interlined buses. The BRT numbers thus do not account for passengers that would transfer from feeder buses to BRT if the feeder buses were not sharing the BRT guideway.*

As shown in Table 3-3, the total transit boardings (inclusive of interlined buses) for the BRT alternatives are significantly higher than those for the LRT alternatives. This is a direct result of the ability of the BRT Alternatives to accommodate the interlining of local and feeder routes onto the BRT fixed-guideway. Riders arriving at guideway stations see an effective frequency of service under the BRT Alternatives that is much higher than what equivalent riders see under the LRT Alternatives. One of the reasons that the boardings for the BRT routes that only use the guideway is lower than the LRT alternatives, despite having the same basic level of service (10 minute headways during the peak period and 20 minute during the off peak), is that some of the trips that under the LRT alternative would have transferred from the feeder bus routes to the LRT routes would now make the trip using the interlined feeder bus routes. In fact, the number of bus transfers for the LRT routes (5,500) is roughly double the bus transfers to the BRT only routes (2,400).

The BRT-High route itself is forecast to attract more ridership than the BRT-Low route primarily due to the combination of a faster end-to-end running time and a higher assumed fixed-guideway bonus. All three proposed fixed-guideway projects resulted in a substantial increase in ridership over the TSM Alternative.

Summary of System-wide Transit Ridership

Measures used by FTA to rate a project's justification—including mobility improvements and cost effectiveness—take into account the ridership increases and travel time savings enjoyed by the system as a whole as a result of the project's implementation, not only those benefits for the project alone. Therefore, another output of the ridership modeling process was the measurement of each alternative's impact on the total future regional or system-wide transit ridership that is expected to be operational in 2035, as shown in Table 3-4.

Table 3-4 Forecast 2035 Daily System-Wide Transit Trips

Alternative	Daily Transit Trips (System-wide)	Increase in Daily Transit Trips over No-Build (System-wide)	Rating
TSM	133,300	+8,300	-
LRT	140,500-141,600	+15,500	●
BRT-High	142,800	+17,800	●
BRT-Low	141,100	+16,100	●

Source: Triangle Regional Model v4 enhanced.

Since there were multiple alignment options modeled for the LRT alternative, the total transit trips is shown as a range from 140,500 to 141,600 daily trips. The BRT-High Alternative is expected to have between 1,200 to 2,300 more daily transit trips than the LRT alternatives and 9,500 more daily transit trips than the TSM Alternative. The BRT-Low alternative has approximately the same number of daily transit trips as the LRT alternatives and 7,800 more daily transit trips than the TSM Alternative. Results also indicate that the LRT, BRT-High, and BRT-Low Alternatives would add between 15,500 and 17,800 new riders to the regional transit system.

3.2.2. Transportation Operations

The evaluation of transportation operations is divided into two parts: Traffic Impacts and Travel Times.

Traffic Impacts

A detailed traffic operations analysis was conducted for the LRT Alternative (Triangle Transit Durham-Orange Corridor Traffic Results Report, January 2011, appended by reference). A total of 86 intersections along the corridor were evaluated for the 2035 No-Build and Build analysis. A third scenario was included to evaluate mitigation, at a conceptual level, for the intersections with increased delay. Traffic impacts of the BRT-High and BRT-Low Alternatives were assessed relative to the results of the LRT evaluation.

LRT The results of the traffic analysis showed that the LRT Alternative could be implemented without substantial effects on corridor traffic operations. In general, the implementation of LRT would result in minor increases in delay, which could be minimized or eliminated through design and minor mitigation measures.

Specific considerations for the alignment options under consideration are summarized by subarea.

- *UNC Chapel Hill* Neither alignment option A1 nor alignment option A3 is projected to degrade significantly traffic operations within the southern portions of the UNC campus. As the Durham-Orange Corridor Traffic Results Report details, alignment option A1 results in no change in the levels of service along the campus intersections studied along Manning Drive and Mason Farm Road. Similarly, alignment option A3 is expected to have a negligible traffic impact at these intersections. Alignment options A3 and A1 require a new at-grade crossing near or through the Mason Farm Road and Hibbard Drive intersection. Based on the projected volumes at that intersection, LRT could be sufficiently accommodated at that intersection. Access to existing and future land uses must be maintained and would be accommodated by LRT. Alignment option A3 also would not significantly impact the future street network and building layout proposed in the most recent UNC Master Plan.

- *Meadowmont/Woodmont:* Alignment option C1 would have a lesser effect on traffic operations than alignment option C2. Alignment option C1 would include a grade separated crossing of NC 54 and four new at-grade LRT crossings along Meadowmont Lane, while alignment option C2 would include two new at-grade LRT crossings along NC 54 at Friday Center Drive and East Barbee Chapel Hill Road, both of which are high volume intersections. Based on an evaluation of the overall NC 54 corridor, including 17 intersections, alignment option C1 resulted in 11 intersections in the subarea experiencing an increase in delay; while the remaining six intersections are predicted to either remain the same or see decreases in delay. Under alignment option C2, delays are expected to increase at 15 of the 17 intersections in the subarea; the remaining two intersections are predicted to either remain the same or see decreases in delay. The delays associated with alignment option C2 at the intersections of NC 54 with Friday Center Drive and East Barbee Chapel Road show potential substantial increases in delay depending on assumptions made for roadway configurations and land uses post implementation. The analysis will need to be evaluated during a future stage of the project development process once there is more certainty regarding the future configuration along the NC 54 corridor.
- *South Square:* Alignment options D1 and D3 are projected to have similar effects on traffic. Under alignment option D1, 10 of the 15 intersections in the subarea would experience an increase in delay; the remaining five would remain the same. Alignment option D3 would result in an increase in delay for 13 of the 15 intersections. Alignment option D1 would affect fewer intersections and would likely result in slightly better traffic operations; however, neither alignment option would significantly impact the future street network.

A detailed evaluation of the section of the LRT alignment that is proposed to run along Erwin Road was undertaken due to Erwin Road being a high volume roadway with existing congestion and substantial right-of-way constraints. The implementation of LRT along the corridor would require the reconstruction of the roadway from NC 751 (Cameron Boulevard) to east of Anderson Street with numerous specific design features to optimize the traffic operations along the corridor. Based on the detailed traffic and design evaluation, the configuration along the Erwin Road corridor would include the following elements.

- The two-way center turn lane along the corridor from NC 751 (Cameron Boulevard) to east of Anderson Street would be replaced by a raised median where the trackbed would be located to improve safety and traffic operations along the corridor.

- The Erwin Road/Emergency Drive intersection would be converted to a signalized intersection.

- The Erwin Road/Trent Drive intersection would be expanded to include exclusive right turn lanes on the eastbound and westbound approaches to the intersection as well as dual left turn lanes from northbound Trent Drive to Erwin Road.

- The Erwin Road/Flowers Drive intersection would be converted to a right-in/right-out intersection on both the north and south sides of Erwin Road.

- The Erwin Road/Anderson Street intersection would be expanded to include dual left turn lanes from eastbound Erwin Road to Anderson Street and an exclusive right turn lane from northbound Anderson Street to Erwin Road.

- In addition, to mitigate the potential effects of eliminating the westbound Erwin Road right turn lane to Fulton Street, consideration should be given during future stages of the project development process to modifying the Trent Drive/Elba Street intersection to allow for improved connectivity by allowing northbound left turns onto Elba Street.

The following improvements to the Erwin Road area are based on the Duke University Health Systems Improvement Plans. These improvements are assumed to be in place by 2035 regardless of the implementation of the LRT, and are not included in the cost estimation calculations for the LRT project.

- The Erwin Road/LaSalle Street intersection would be modified to include a southbound right turn lane from LaSalle Street to Erwin Drive.

- The Erwin Road intersection at the Eye Care Center/VA Medical Center would be converted to a signalized intersection, with the northbound and southbound Eye Care Center/VA Medical Center approaches receiving exclusive left turn lanes.

- The Erwin Road/Fulton Street would be modified to include dual left turn lanes from eastbound Erwin Road to northbound Fulton Street and the elimination of the westbound Erwin Road right turn lane to Fulton Street due to the right-of-way constraints at the intersection.

- The Erwin Road/Trent Drive intersection would be expanded to include dual left turn lanes from northbound Trent Drive to Erwin Road

Based on the configuration detailed above, none of the intersections studied within the Erwin Road corridor would result in a significant degradation in the level of service.

BRT-High The BRT-High Alternative follows the same alignment as LRT from Chapel Hill through west Durham. In general, the operations of the BRT are assumed to result in comparable traffic impacts as LRT.

The design approach to traffic signal operation is to try to achieve a timed progression for the predominate movement in each of the AM and PM peak service hours. The reason for this is to have the LRT wait at a station and then proceed on the normal green phase to the next station with the knowledge that it will hit all green signals between the two stations (i.e. LaSalle Station to Fulton Station or Fulton Station to the Ninth St. Station). With BRT, there could be delay in the operations if there is bunching of the buses, especially when considering the interlining of buses with the dedicated service. More studies would be needed to ascertain if this is an issue.

For parallel street running, like along NC 54, it is preferable that the control of the cross street be managed with crossing gate protection for LRT. Whereas for BRT, the cross streets are assumed to be signalized. This is necessary to control the right-turn movements along NC 54 so that automobiles do not cross in front of buses on the parallel roadway operating in both directions. Whereas the LRT controls the right-turn lane movements with crossing gates, the BRT system would control this movement either by an additional dedicated signal for the existing right-turn pockets (which exist at each intersection along the NC 54 route alignment) or by a second set of signals for the busway itself, which would be operated in conjunction with the NC 54 traffic signal. The latter is considered a safer means of controlling this movement. Again, the timing of the crossing gates or the timing of the traffic signals should be coordinated with the transit operations so that a vehicle leaving Woodmont Station, for instance, would hit all green/crossing gate down phases l as it proceeds to Friday Center or to Leigh Village. The transit vehicle would use the station to dwell until the next green phase of the nearby intersection occurs, thereby avoiding the need for preemption. Again, this would be the predominant movement since it is recognized that it is difficult to have progressive signal timing occur in both directions. Since crossing gates have longer advance down time requirements than the stopping distance of a BRT vehicle, the timing of the LRT operation needs to be closely adhered to or delay in LRT operations could occur. With bus bunching, similar delays could also occur. In either case, the through movements of the parallel street are unaffected since the normal signal operation is not affected because no preemption is assumed.

In downtown Durham, the alignment for the BRT-High Alternative differs from the LRT Alternative. For BRT, every street crossing would be at-grade, whereas LRT has grade separation occurring at Erwin Road, Campus Drive, Gregson Street, Chapel Hill Street., Roxboro Street, and Alston Avenue With more grade separations, there are fewer chances of traffic impact for LRT than BRT if more green time is needed along Pettigrew Street than exists today. A more detailed analysis would be needed to fully evaluate the specific impacts of BRT operations in the downtown area.

Therefore, the BRT-High Alternative could be implemented with no worse traffic impacts than with the LRT Alternative. However, as expansion occurs, there is a higher potential to have more travel time impacts to BRT operation than the LRT operation given the nature of more random vehicle movements over standard headway movements for LRT. With the current ridership projections, single car LRT trains are all that is needed. Hence, the LRT system can triple in capacity to three vehicle train sets, without a decrease in headway time. This is not the case for BRT and this could be considered an impact.

BRT-Low The BRT-Low Alternative largely follows the same alignment as BRT-High. Where the alignment is common to the BRT-High Alternative, traffic impacts are anticipated to be the same.

The BRT-Low Alternative travels along Old Chapel Hill Road through signalized intersections with Farrington Road/Southwest Durham Drive and Garrett Road and then continues along University Drive passing through signals at Old Chapel Hill Road at University Place before rejoining the BRT-High alignment in the South Square subarea. Since the BRT-Low Alternative includes widening of the existing cross-section to provide a single exclusive BRT lane in each direction, capacity is provided for the movement of individual buses with only a minor impact to the general purpose traffic as a result of transit priority signal phasing.

In addition, prior traffic analyses indicate that University Avenue has adequate capacity with downstream signalized intersections (Snowcrest Trail, Martin Luther King, Jr. Parkway, Lyckan Parkway, Westgate Drive, and Shannon Road) all operating at an acceptable level of service in 2035. Although detailed analysis is necessary to determine the specific impacts, the Old Chapel Hill Road and University Place, signals are expected to operate at similarly acceptable levels of service in the future given the comparable volumes and lane configurations. Adjacent intersections studied along Old Chapel Hill Road were generally operating at an acceptable level of service in 2035, with the exception of Garrett Road, which was projected to operate at a decreased level of service during both peak periods. Given the modest impact of BRT to normal signal operations, a substantial degradation of operations at this location is not expected.

One area of concern along Old Chapel Hill Road is at the intersections of cross streets that are not currently signalized such as Pin Oak Drive, Five Oaks Drive, Buchanan Drive, Everwood Drive, Jean Avenue, Grapevine Trail, and Scottish Lane along with over a dozen driveways to homes and residential communities. The single BRT lane is comprised of a 4-foot buffer/landscaped area, then a 2 foot shoulder, a 12 foot lane and another 4 foot shoulder (total paved width of 18 feet as seen in the cross sections in Volume 2) for a total distance of 22 feet. This is a significant setback from the edge of the shoulder on Old Chapel Hill Road. Thus, safety is a concern if the cross traffic stop bar was merely moved back to outside of the BRT lane. Signals are also considered necessary to control the right-turn movements from Chapel Hill Road. Unrestricted cross traffic automobiles could encroach upon the BRT lane in their approach to turning left or right onto Old Chapel Hill Boulevard. This would interfere the BRT movement and potentially require stop signs be placed at each of these intersections. This would significantly impact the BRT operations. Or, each of these low volume intersections would be signalized to allow for efficient safe operations. Most parallel frontage road type street crossings do treat such cross traffic as two movements versus a single cross traffic movement. Unless new right-hand drop lanes are added at intersections, the restricted right hand turn movements when BRT vehicles are present would impact traffic on Old Chapel Hill Road.

Therefore, based on this planning level assessment, the BRT-Low Alternative is expected to have a substantial impact to traffic operations along the Old Chapel Hill Road/University Drive corridor associated with traffic movements either for the BRT or for through traffic movements on Old Chapel Hill Road given the multitude of these occurrences. Table 3-6 provides a relative rating for traffic impacts for each of the fixed-guideway Build Alternatives.

Table 3-5 Traffic Impacts Rating

Alternative	Rating
LRT	●
BRT-High	●
BRT-Low	◓

Source: URS Corporation Consultant Team, 2011

Travel Time

The total travel time from one end of the high-capacity transit route to the other should be competitive with automobile travel. The greater the travel time savings, the greater the benefit to passengers and the more riders the transit system is likely to attract. Travel times were developed for all Build Alternatives under consideration. Table 3-6 summarizes the end-to-end travel times for the Build Alternatives and assigns a relative rating for each alternative.

LRT The total end-to-end travel time for the LRT Alternative ranges from 34.6 to 34.8 minutes. This indicates that the alignment options under consideration at UNC Chapel Hill (A1, A3), Meadowmont/Woodmont (C1, C2), and South Square (D1, D3) do not present differences in travel time sufficient enough to affect the overall attractiveness of the service. Therefore, travel time is not a differentiating criterion for the alignment options.

For purposes of comparing the LRT Alternative to the BRT-High, BRT-Low, and TSM Alternatives at the corridor level, the LRT travel time range is averaged to 35 minutes. The LRT Alternative is the most time-competitive of the Build Alternatives under consideration, providing travel time savings of 22 minutes over the TSM Alternative and up to 5 minutes over the BRT Alternatives.

BRT-High The BRT-High Alternative would have the second lowest travel time at 39 minutes, providing a 19-minute improvement in travel time over the TSM Alternative and 5 minutes over the BRT-Low Alternative. This travel time estimate assumes that BRT-High will be permitted to run along the existing and proposed Pettigrew Street which is within the NCRR corridor. If the alignment is not permitted to operate within the rail corridor, alternate alignment options could increase travel times by 3 to 4 minutes.

BRT-Low At 44 minutes, BRT-Low provides the least competitive travel time, yet provides a 14-minute improvement over the TSM Alternative. Similar to BRT-High, the BRT-Low travel time could increase 3 to 4 minutes if the alternative is not permitted to operate within the NCRR corridor from downtown Durham to east Durham.

Table 3-6 End-to-End Travel Times for Build Alternatives

Alternative	End-to-End Travel Time	Rating
TSM	57 minutes	-
LRT	35 minutes	●
BRT-High	39 minutes	◓
BRT-Low	44 minutes	◓

Source: URS Corporation Consultant Team, 2011.

3.2.3. Expansion Potential

The Project Team analyzed expansion potential of each alternative by assessing the ease of future extensions beyond the proposed termini at UNC Hospitals and Alston Avenue. At the western end of the Durham-Orange Corridor (UNC Chapel Hill), all three fixed-guideway alternatives (LRT, BRT, and BRT-High) have two dedicated alignment options: A1 or A3. At the eastern end (downtown Durham to east Durham), LRT runs on exclusive track within the NCRR rail corridor and BRT-High and BRT-Low operate in mixed-traffic along Pettigrew Street.

LRT For LRT at the UNC Chapel Hill terminus, future expansion potential for alignment option A1 would be difficult because of concerns over emergency access to the UNC hospitals and concerns over impacts to existing utility infrastructure. Extending LRT beyond the alignment option A1 terminus is possible based on a review of the infrastructure location and based on traffic and train signaling operations that could be employed on Manning Drive. The station option for alignment option A1 (UNC Station – Option A, per the UNC campus master plan) precludes extension of the corridor north and west into downtown Chapel Hill and beyond to Carrboro due to physical constraints. Accommodating a future extension would require the station location to be shifted to station location Option C. This station location would require new buildings that are proposed in the UNC Master Plan be constructed west of the LRT station. This is not acceptable to the Town of Chapel Hill staff and to the UNC at Chapel Hill (per an email to Triangle Transit dated January 24, 2011). As noted in the conceptual evaluation of alternatives, alignment option A3, and the corresponding station option (UNC Station – Option D), was developed as an alternative to alignment option A1 as it would allow for the future extension of both LRT and BRT (High and Low) service on Columbia Street. No substantial engineering challenges would prohibit future extensions of the LRT alignment. Therefore, for LRT, alignment option A3 presents the more favorable option for future extensions at the UNC Chapel Hill end-of-line.

For LRT in east Durham, there are no major engineering issues that preclude future extensions either within or outside of the rail corridor.

BRT-High and BRT-Low Future extensions for BRT-High and BRT-Low for both alignment options at UNC Chapel Hill (A1 and A3) and in east Durham are substantially less expensive since there is no need to electrify the line. The cost to implement either BRT or LRT in an exclusive alignment is considerable for either LRT or BRT technology given the right-of-way required.

Since the extension to downtown Chapel Hill and the Town of Carrboro is envisioned to be a mixed traffic operation, both technologies are suited for such an expansion.

For the eastern end-of-line in Durham, this is a different scenario. Expansion of LRT in the rail corridor is straightforward, but expansion of BRT is not. Pettigrew Street does not continue past Ellis Road, and the alignment would most likely involve the use of NC 147, with the BRT entering at Briggs Avenue. It is recognized that the LRT alignment extension could utilize the NCRR rail corridor or new location alignment, pending additional land use planning and coordination with decision-makers. However, considering that the Wake Corridor Alternatives Analysis study has determined that BRT is not a competitive technology choice, the expansion of BRT to the Wake Corridor LRT system would require systems connectivity planning and a seat exchange between the two systems.

For these reasons, the BRT options are rated lower than the LRT option since ultimate regional connectivity and compatibility is desired. However, an expanded BRT system could ultimately connect to an expanded Wake County LRT system with a required transfer at a common station area. If this is deemed an acceptable solution to decision-makers, then the ratings for Expansion Potential would become similar.

Table 3-7 summarizes the ratings for expansion potential at end-of-line.

Table 3-7 Expansion Potential Ratings

Alternative	Rating
LRT	●
BRT-High	⊖
BRT-Low	⊖

Source: URS Corporation Consultant Team, 2011

3.2.4. Public and Agency Support

Public Support Between June 2010 and March 2011, 19 public workshops were held supporting work of the Project Kickoff, Transitional Analysis, and Alternatives Analysis. Over 1,100 people attended the workshops. In the first round of six workshops, in June 2010, the public was introduced to the corridors under study. In the second round of six workshops, in September 2010, the public was introduced to a further look at the study corridors, including technologies under consideration and maps of initial alignment alternatives.

The detailed alternatives in this document were presented for public comments at the third round of workshops in March 2011:

March 22, 2011	Triangle Town Center	Raleigh
March 23, 2011	Durham Station Transportation Center	Durham
March 24, 2011	William and Ida Friday Center	Chapel Hill
March 28, 2011	Mt. Peace Baptist Church	Raleigh
March 29, 2011	Cary Senior Center	Cary
March 30, 2011	McKimmon Center @ NCSU	Raleigh
March 31, 2011	The Research Triangle Park Foundation	Research Triangle Park

A Public Involvement Plan was prepared defining goals for outreach, strategies, and ways to communicate project information and meetings. The intensive public outreach included print and broadcast ads, the use of Facebook and Twitter, the project web site at www.ourtransitfuture.com, e-mail notifications, interior bus ads, news stories, and blog posts.

In the third round of public workshops, 205 comments were received from the public workshops, web site, e-mail, mail and telephone. A small percentage of these comment forms related directly to the Durham-Orange Corridor and the alternatives under consideration. Comments summarized in this section may not fully capture public sentiments regarding the Build Alternatives.

At the corridor level, comments received reflected general support for the LRT Alternative over both the BRT-High and BRT-Low options. The Meadowmont/Woodmont subarea generated the most interest among attendees. The majority of comments received for the subarea expressed or implied support for alignment option C1 Meadowmont Lane. However, it should be noted that there were a very limited number of specific comments on the C1 versus C2 alternatives (15 total). The comments did not indicate a clear preference for the alignment options in UNC Chapel Hill and South Square.

Agency Support Input from agency representatives and officials will be determined after LPA discussions among agency stakeholders.

Table 3-8 Public and Stakeholder Support Rating

Alternative	Public Support Rating	Agency Support Rating
LRT	●	To be determined.
BRT-High	◒	To be determined.
BRT-Low	◒	To be determined.

Source: URS Corporation Consultant Team, 2011

3.2.5. Economic Development Potential

The Project Team evaluated economic development potential by alternative, addressing bigger picture land use, economic development, and job issues. These issues include supporting and enhancing employment and household growth and economic activity to the region.

LRT Significant evidence exists regarding LRT's ability to support transit oriented development (TOD) and provide economic benefits. North Carolina's first LRT line, the Blue Line, has been a catalyst for almost $1.5 billion of new or planned development along Charlotte's South Corridor, a formerly underutilized railroad corridor. Within less than three years of operation, daily transit ridership exceeded 2020 forecast levels and now averages about 15,000 trips per day. The Blue Line corridor has also experienced 10 million square feet of new development since 2007, when the line opened. While much of the development has been concentrated in Center City Charlotte, a considerable amount of new development has also occurred in the South End area, where the Blue Line's connection to downtown has spurred condominium and apartment development. The City of Charlotte set the stage for TOD through targeted infrastructure investments in streets, streetscape, and sidewalks.

Communities outside of North Carolina and similar in makeup to the Triangle Region that have also experienced such positive economic benefits include the following:

- Dallas, Texas: office and retail space in some light rail station areas rent for 40 percent more than market rates; studies found land values for retail and office properties near DART stops rose faster than comparable properties without transit[2]. Dallas is similar to the Triangle Region in terms of its polycentric spatial orientation with respect to Fort Worth, strong population growth, and public policy support for TOD (public investment in infrastructure and financial and regulatory incentives). Some of the successful TODs that have been built in the Dallas region include Eastside Village in Plano, South Side on Lamar, and Mockingbird Station.

  Portland, Oregon: More than $8 billion of new development has occurred in light rail station areas. A study of MAX Blue Line light rail station areas found that development occurring after light rail investment has an average development density or Floor Area Ratio (FAR) of 0.65 more than the average FAR for development outside of station areas. This means that for every 1,000 square feet of land area developed, station area parcels realized an additional 650 square feet of building area. The rate of development within Blue Line station areas was 69 percent higher than elsewhere within a one-mile corridor extending along the light rail alignment. Low and moderate value lots within Blue Line station areas redeveloped at twice the redevelopment rate reported for low value lots outside of station areas[3].

  Similarities to the Triangle Region include: Portland's higher education institutions, growing population, and supportive policies for TOD. Support from the public sector has included tax abatements for development at station area sites as well as regulations that favor TOD, such as minimum densities, parking maximums, design requirements, and rezoning to allow only TOD-appropriate uses. It should be noted that the Portland metropolitan area has implemented some of the most supportive TOD policies in the country, which has played an important role in achieving these outcomes. Examples of the successful TOD projects that have been constructed in the Portland region include Center Commons, The Round, and Orenco Station.

- Santa Clara County, California: premiums were found for commercial properties near light rail stations of over 20%[4]. The Santa Clara County area is similar to the Triangle Region in terms of its strong university presence (University of San Jose, Stanford, and UC Santa Cruz), research and development based economy (Silicon Valley), growing population, and public policy support for TOD.

[2] TCRP Report 102: Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects. Transportation Research Board

[3] Livable Portland, Land Use Transportation Initiatives, Tri-Met, November 2010

[4] Reference: TCRP Report 102: Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects. Transportation Research Board

- St. Paul-Minneapolis, Minnesota: the Hiawatha Light Rail Line supported an estimated 6.7 million square feet of new development since the line opened in 2004. Much of the development is concentrated in the downtown, where public policies support revitalizing the downtown riverfront and warehouse district.

- Denver, Colorado: A total of 7.8 million square feet of new development has occurred along the Southeast Corridor since its opening in 2006. Properties near light rail stations have experienced faster absorption and higher occupancy rates than properties not located at transit stations.

The preceding case studies show that light rail transit enhances opportunities for TOD, and that the resulting TOD can achieve rental rate premiums and higher land values over non light-rail served properties. Impressive levels of development have been constructed along many light rail lines across the nation. Developers have exhibited documented interest in constructing TOD at light rail stations, as they see the value in the transportation advantage afforded by light rail.

BRT-High and BRT-Low Few case studies are available to quantify the economic development potential for BRT systems in the United States. Therefore, the Project Team has reviewed the emerging literature on this mode to gain some qualitative understanding of how BRT might relate to transit supportive development. According to the Transportation Research Board, full-featured BRT systems can experience a level of TOD similar to that of LRT[5]. Full-featured systems are those with “dedicated running ways, attractive stations and bus stops, distinctive easy-to-board vehicles, off-vehicle fare collection, use of ITS technologies, and frequent all-day service” with midday headways of 15 minutes or less and peak headways of 10 minutes or less. The economic experiences of the following communities that have most of the features described above are described here:

- Pittsburgh, Pennsylvania: The Port Authority of Allegheny County reports $302 million in new development along the East Busway. Opened in 1983, this dedicated busway links downtown Pittsburgh with eastern communities. Pittsburgh’s similarities to the Triangle Region include: university presence and supportive public policies for TOD. It is noteworthy, however, that this development has occurred over a nearly 30 year timeframe, whereas the development impacts of light rail have included larger amounts of development with higher value in a significantly shorter (years, not decades) period of time. This could be in part due to the relatively slow to stable economic growth of the Pittsburgh region, but also in part due to the reduced ability of bus rapid transit to attract economic development around stations as compared to light rail.

- Cleveland, Ohio: The Euclid Corridor BRT is expected to experience increased residential and non-residential investment over the next three decades, and development is already occurring. The Euclid Corridor contains mostly high-density development in downtown, University Circle and East Cleveland. Since opening in 2008, the $87.3 million in investment has occurred in Midtown. The price of land is rising as developers purchase land in Midtown. Cleveland is similar to the Triangle Region in terms of its universities (Case Western, Cleveland State University), its health care facilities (the Cleveland Clinic) and supportive public policies for TOD.

The Transportation Research Board’s findings highlight the need for a full-featured system to optimize economic development potential. This means that to the degree that BRT can mimic light rail transit in

[5] Reference: TCRP Report 90: Bus Rapid Transit – Volume 1: Case Studies in Bus Rapid Transit Transportation Research Board.

terms of attractive design, positive image, operating speed, and reliability (and surpass LRT in flexibility) the more likely BRT will mimic LRT's ability to support TOD. Thus, the ability of BRT to yield economic benefits hinges on the ability of the system to meet the more robust performance standards of the advanced, top quality, highly successful BRT systems found in South America, which come closer to mimicking LRT in operation. Unfortunately, most BRT systems in the United States include significant compromises in design that reduce the performance, speed, and efficiency of the service.

On May 26, 2011, the Institute for Transportation and Development Policy released a report titled "Recapturing Global Leadership in Bus Rapid Transit: A Survey of Select U.S. Cities." Using a 100-point system to score the various components of BRT, from speed-supporting improvements such as off-board fare collection and dedicated running ways, to cosmetic improvements such as better branding and bus station amenities, the ITDP found that there was no significant project in the US that their system rated above a grade of 63, in this case, the Cleveland project mentioned above. This compares with a score of 93 for Bogota, Columbia's "Transmilenio" system or a score of 89 for Guangzhou, China's BRT system. In short, there has not been a BRT system in the United States built that approaches a top-level standard in terms of performance. Without such a system in the United States to assess, statements about the ability of high-quality BRT to help focus economic development similar to LRT remain speculative from either a positive or negative point of view.

Additionally, there is a perceived mode bias for rail in the United States, and the degree to which this bias can be compensated for by BRT that is more like LRT (i.e., reduced headways, potential "one seat" travel, branding, and time savings) is not known.

Table 3-9 compares LRT and BRT modes and ranks them in terms of their ability to offer various economic benefits. While there is less research on the economic effects of BRT, available research and recent case studies indicate that the magnitude of its impacts in the Durham-Orange Corridor will likely not reach those of LRT. Because of the limited, documented evidence available for BRT systems to influence development, developer interest, and enhance regional competitiveness and potentially attract significant amounts of regional growth, LRT is given the most favorable rating of the three alternatives. In addition, LRT is rated more favorably because available case studies show that it has stimulated development in a shorter time span than the documented cases of BRT.

Table 3-9 Summary of Potential Economic Benefits

Economic Benefits	Alternative		
	LRT	BRT-High	BRT-Low
Documented Ability to Influence Compact Development*	High	Moderate	Low
Proven Developer Interest	High	Low	Low
Ability to Stimulate Capital Infusion of Dollars from Outside Region	High	Moderate	Low
Rating	●	◒	○

**LRT has a robust history of influencing compact development in the United States, while recent BRT systems in the U.S. have demonstrated some ability to be a modest catalyst for compact development.*

BRT-Low is generally assigned the lowest rating of the three alternatives since the system is designed to balance exclusive running operations similar to an LRT with increased segments of the corridor operating in mixed traffic or semi-exclusive rights-of-way in configurations more closely aligned with conventional bus operations. These design changes are likely to reduce further the economic potential of the system.

TOD Potential at Stations A TOD Assessment Report was conducted to supplement the AA primarily as both a primer and an interactive, analytical planning tool focusing on the assessment of existing conditions influencing performance trends for TOD development potential surrounding each of the proposed station sites (Draft TOD Assessment Report, May, 2011, Volume 4). A total of 19 qualitative criteria were assessed. Criteria included land area, vicinity land use compatibility, site development density and diversity, market conditions and developer interest, access and connection to adjacent vicinity, ability to phase development, and community support. Stakeholder input for the TOD assessment was coordinated with the Station Planning Process described Section 2.3.3. The highest performing stations included Leigh Village, Gateway, Patterson Place, Ninth Street, Durham Station, and Dillard Street Station. Additional detail may be found in the Durham-Orange Corridor TOD Assessment Report. For this analysis, TOD potential was not found to be a differentiator between alignment options based on the location of proposed stations relative to existing and planned development.

Initially, as shown on Exhibit 1, stations were divided into the following 5 different categories or typologies, based on their location and characteristics: Urban Center, Urban Neighborhood, Suburban Center, Suburban Neighborhood and Institutional. The performance levels for each typology included densities and floor area ratio (FAR), form and scale of buildings, parking strategies, types of land uses and activities. Stations were ranked based on expected TOD capacity and potential for improvement using a total of 19 qualitative criteria which included: land availability and ownership structure; compatibility with surrounding land uses; community support; market and developer interest; ability to phase development; access to parks and open space; grid street network, walkability and accessibility; traffic volumes and transit services within station areas; access and connectivity beyond station areas; public policies supporting TOD; mixed-use; parking reduction and growth in employment and households. Stakeholder input for the TOD Assessment was coordinated with the Station Planning Process described in Section 2.3.3. As shown on Exhibit 2, the highest performing stations included Leigh Village, Ninth Street, Buchanan, Downtown Durham, and Dillard. Additional details may be found in the Durham-Orange Corridor TOD Assessment Report.

For this analysis, TOD potential was not found to be a differentiator among alignment options based on the location of proposed stations relative to existing and planned development.

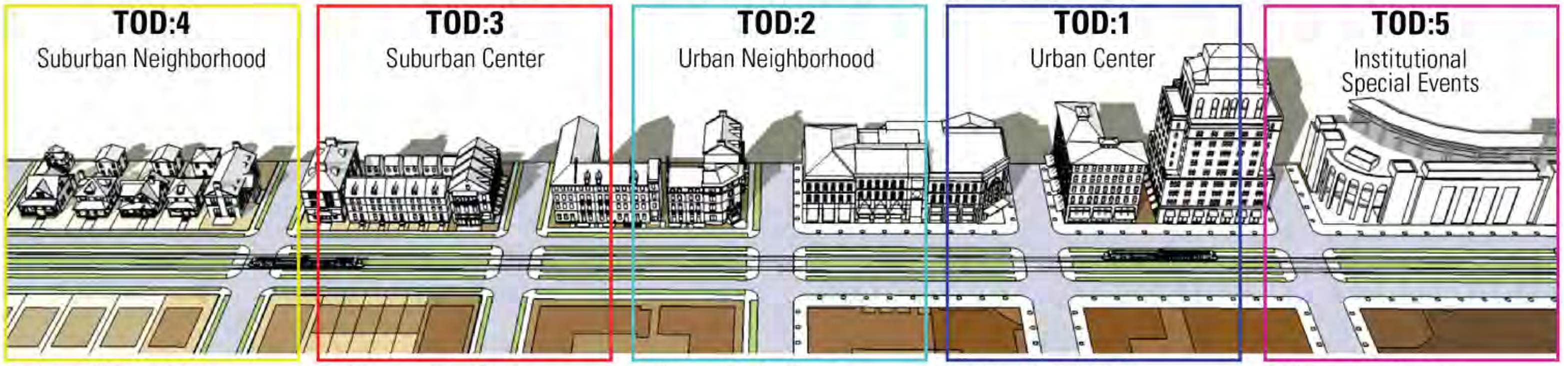
Exhibit 1
Composite TOD Station Typology

TOD Assessments

Preliminary Transit Station Area TOD Typology Designations

Figure 1.1 TOD Typology Transect

Station Area TOD Typology Designations representing each TOD Typology are identified along with TOD Correlation Zone(s) **(CZ)** & Predominant Site Development Typology **(PSDT)**.



TOD:4 – Designated Station Areas & CZ / PSDT Characteristics

TOD: 4 Suburban Neighborhood Typology is not currently represented within the corridor. However, it is expected that either the Hamilton, Woodmont, and Patterson Station Areas, or portions of, may trend toward the Suburban Neighborhood Typology as dictated by additional Station Area planning and engineering analysis along with evolving growth patterns and market conditions within the corridor.

TOD:3 – Designated Station Areas & CZ / PSDT Characteristics

Hamilton Station (CZ:2)
PSDT: Infill / Redevelopment

Meadowmont Station (CZ:2/3)
PSDT: Infill

Woodmont Station (CZ:2/3)
PSDT: Redevelopment / Greenfield

Gateway Station (CZ:3/4)
PSDT: Infill / Redevelopment / Greenfield

Patterson Place Station (CZ:4)
PSDT: Greenfield

MLK Station (CZ:5)
PSDT: Infill / Redevelopment

South Square Station(s) (CZ:5)
PSDT: Infill / Redevelopment

TOD:2 – Designated Station Areas & CZ / PSDT Characteristics

LaSalle Station (CZ:6)
PSDT: Infill / Redevelopment / Greenfield

Ninth Street Station (CZ:6/7)
PSDT: Infill / Redevelopment

Buchanan Station (CZ:7)
PSDT: Infill / Redevelopment / Brownfield

Alston Station (CZ:7)
PSDT: Redevelopment / Brownfield

TOD:1 – Designated Station Areas & CZ / PSDT Characteristics

Leigh Village Station (CZ:3)
PSDT: Greenfield

Durham Station (CZ:7)
PSDT: Infill / Redevelopment / Brownfield

TOD:5 – Designated Station Areas & CZ / PSDT Characteristics

UNC Hospitals Station (CZ:1)
PSDT: Infill / Redevelopment

Mason Farm Station (CZ:1)
PSDT: Infill / Redevelopment

Friday Center Station (CZ:2)
PSDT: Infill / Redevelopment

Duke Medical Center Station (CZ:6)
PSDT: Infill/Redevelopment

Dillard Station (CZ:7)
PSDT: Infill / Redevelopment / Brownfield

Durham-Orange County **Corridor Alternatives Analysis**

TOD Assessments

Preliminary TOD Corridor Assessment

Key Findings

Corridor Trend

The Composite Corridor trend of the Durham-Orange County Corridor - AA is characterized as "Medium/High" with median rating of 2.5 based upon resulting composite of site assessments for Station Areas with all-inclusive rating analysis.

Corridor Characteristics

Solid moderate to high combined performance ratings for TOD development potential are expected in a relatively even distribution pattern west to east along the Corridor.

The highest ratings are clustered around the downtown Durham Station within the eastern end of the Corridor, and include the adjacent sequence of Station Areas including Ninth Street, Buchanan, and Dillard.

The Leigh Village Station Area, located toward the western end of the Corridor, is also highly rated for TOD development potential.

The remaining majority of Station Areas exhibit strong trends for certain moderate and possible high performance for TOD development potential.

MLK is the only Station Area within the Corridor rated low in performance for TOD development potential.

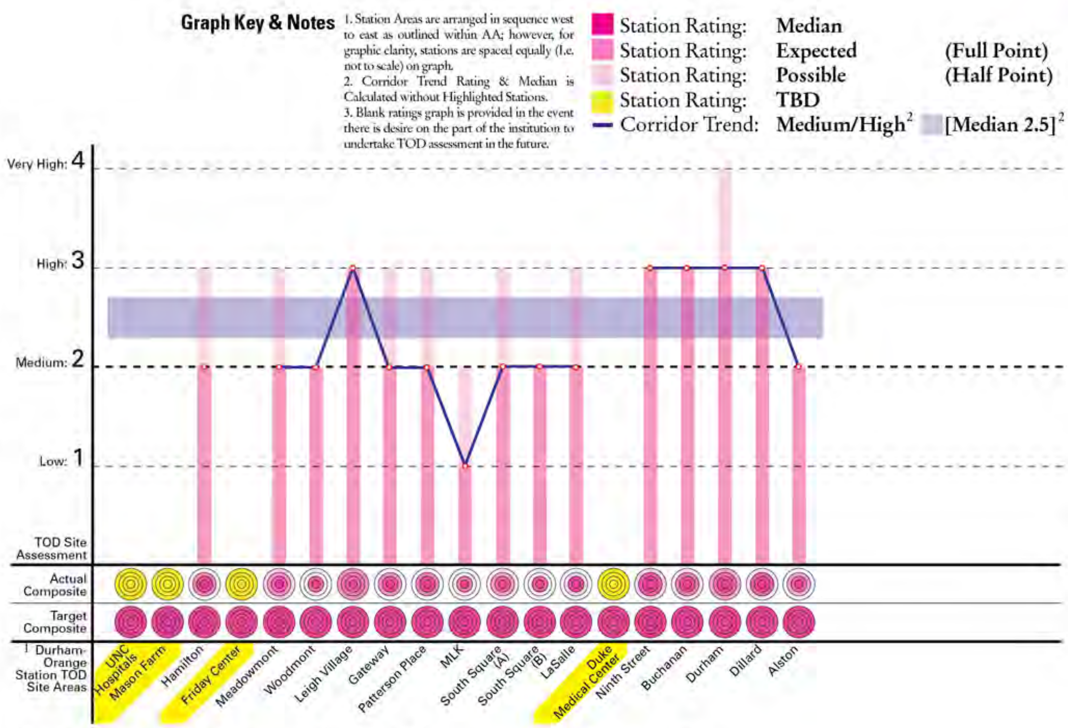
Although not included within this report, both the Duke Medical Center Station toward the east and the UNC Hospitals Station in the western end of the Corridor are expected to contain potential for TOD development opportunities defined by respective campus and institutional district plans for enrollment and expansion.

Summary

The Station Areas identified with greater combined performance ratings relative to their context are expected to stimulate and sustain TOD development potential within the Corridor.

These results may be used to assist local governments in identifying existing strengths and weaknesses within the Corridor, and to highlight opportunities for future specific and focused TOD planning initiatives and improvements that would enhance the Corridor's TOD potential.

Exhibit 2
Composite Corridor Assessment



Graph 20.1 Corridor Trend for TOD Development Potential[3]

3.2.6. Environmental impacts

Property Acquisitions

Property acquisitions include the potential acquisition of properties and the displacement of owners and tenants that would be associated with the fixed-guideway Build Alternatives. For the purposes of this analysis, property that has been reserved or dedicated as outlined in the Conceptual Alternatives Report has not been included as a property acquisition. In addition, the three parcels owned by Triangle Transit in downtown Durham were not included in property acquisition calculations.

LRT The LRT Alternative would, to some degree, require acquisition of private property outside of the public right-of-way at the Friday Center and in the Meadowmont/Woodmont and South Square subareas. No private property impacts are required for the alignment in the UNC Chapel Hill subarea because land adjacent to both alignment options (A1 and A3) has been dedicated for transit. From downtown Durham to east Durham, the LRT alignment operates within the existing rail corridor and would not require property acquisitions.

In total, full or partial property acquisitions for the LRT Alternative would range from 54 to 73 parcels, depending on the alignment options selected at UNC Chapel Hill, Meadowmont/Woodmont, and South Square. Along the base alignment near the Friday Center, three parcels would require full acquisition. No other full property acquisitions are anticipated for the alignment itself. Property impacts for the station park and ride lots have not been quantified since specific sites have not been determined. Partial property acquisitions along the base alignment are concentrated near Patterson Place (14), Leigh Village (4), and Gateway (7).

Within the Meadowmont/Woodmont subarea, alignment option C1, Meadowmont Lane, would require partial acquisitions of 4 properties as compared to a total of 14 parcels for alignment option C2 George King Road. The partial property acquisition along alignment option C2 also include right-of-way for a new access road to be constructed for the properties adjacent to George King Road as part of the project. Alignment option C1 has fewer impacts due to the reservation of right-of-way for the transit corridor.

In the South Square area, alignment option D3, Shannon Road, is expected to have substantially more impacts than alignment option D1, Westgate Drive.

Table 3-10 summarizes property impacts for the base LRT alignment and the alignment alternatives under consideration in UNC Chapel Hill, Meadowmont/Woodmont, and South Square.

Table 3-10 Summary of LRT Property Impacts

LRT Alignment Alternatives	No. of Private Property Acquisitions* (Full or Partial)
Base Alignment *(see call-out box to right)*	34
UNC Chapel Hill	
Alignment Option A1 – Hibbard Drive	0
Alignment Option A3 – UNC Southern	0
Meadowmont/Woodmont	
Alignment Option C1 - Meadowmont Lane	8
Alignment Option C2 – George King Road	21
South Square	
Alignment Option D1 – Westgate Drive	10
Alignment Option D3 – Shannon Road	19

*Source: URS Corporation Consultant Team, April 2011. | *Property impacts for the station park and ride lots have not been quantified since specific sites have not been determined.*

The Base Alignment generally refers to the recommended transit alignment from the US 15-501 Phase II Major Investment Study (MIS) that was carried forward into the AA. It includes the entire LRT Alternative and excludes the alignment options under consideration at UNC Chapel Hill, Meadowmont/ Woodmont, and South Square.

BRT-High The BRT-High Alternative is expected to have the same property impacts as the LRT Alternative from Chapel Hill to west Durham. In the segment of the corridor from Ninth Street in downtown Durham to Alston Avenues in east Durham, the BRT-High Alternative would impact two buildings between Campus Drive and Duke Street. This impact would result from the construction of the new Pettigrew Street connection between these roadways. Although these buildings have been constructed in the railroad right-of-way, the impacts were included in the number of property acquisitions. The rest of the BRT-High alignment through downtown Durham and onto east Durham would operate in mixed-traffic and any proposed roadway widening would occur within the public right-of-way.

BRT-Low The BRT-Low Alternative would have the same property impacts as the LRT and BRT-High Alternatives in locations where the proposed alignment is the same. Where the BRT-Low deviates from the LRT and BRT-High Alternatives, road widening for the project could impact adjacent properties. Along George King Road the BRT-Low Alternative would require partial acquisition of roughly 14 properties and adjacent to Old Chapel Hill Road, the alignment would include roughly 53 partial acquisitions. The new BRT-Low guideway would require acquisition of 12 properties north of Leigh Village. Total number of full or partial property acquisitions for BRT-Low is 107

Table 3-11 summarizes property acquisitions and provides relative ratings for the build alternatives.

Table 3-11 Summary of Property Acquisitions

Alternative	No. of Private Property Acquisitions (Full or Partial)	Rating
LRT	52 - 74	◒
BRT-High	54 - 76	◒
BRT-Low	107	○

Source: URS Corporation Consultant Team, 2011.

Visual Impacts

Visual resources can include parks, open space, wooded areas, and vegetation. Significant view sheds along the corridor include the UNC campus, Meadowmont Village, Duke University, and downtown Durham. The Build Alternatives primarily utilize or are located adjacent to existing rights-of-way that carry vehicles common to urban environments, including buses. There are some segments of existing right-of-way that are adjacent to open space and wooded areas. The overhead catenary system, including the overhead electrical wires and poles, could be considered visually intrusive but would not be out of character with the largely urban and suburban setting. In addition, the construction of the LRT guideway or BRT running-way may cause the removal of some landscaping but not to an extent that would substantially impact visual resources. The highest visual impact potential occurs where there are elevated structures proposed for the alternatives.

LRT The LRT Alternative would add 15,250 to 17,150 feet of aerial structure to the Durham-Orange Corridor, depending on the alignment option selected at UNC Chapel Hill, Meadowmont/Woodmont, and South Square. The structures could potentially impact view sheds in Chapel Hill and Meadowmont Village. The LRT system will also add an overhead catenary system for the length of the corridor.

Potential visual impacts associated with alignment options under consideration in UNC Chapel Hill, Meadowmont/Woodmont, and South Square are discussed below.

- *UNC Chapel Hill:* The Hibbard Drive alignment option (A1), would create a greater visual impact through this area, as it includes 600-feet of aerial structure as it travels south between the intersection of Manning and Hibbard Drives and Mason Farm Road. The UNC Southern alignment option (A3) is entirely at-grade through this area and would therefore result in fewer visual impacts.
- *Meadowmont/Woodmont:* The Meadowmont Lane alignment option (C1) and George King Road Alignment option (C2) both include aerial structures that would create potential visual impacts. Alignment option C1 includes 2,500 feet of aerial structure, while Alignment option C2 includes 2,100 feet of aerial structure that would be visually prominent along the length of NC 54
- *South Square:* The Westgate Drive alignment option (D1) and the Shannon Road alignment option (D3) both include aerial structures that would create potential visual impacts; however, alignment option D3 includes 900 more feet of aerial structure than alignment option D1 and would therefore create a greater visual impact. Alignment option D1 includes 2,300 feet of aerial structure, while alignment option D3 includes 3,200 feet of aerial structure.

BRT-High The BRT-High Alternative would also add 15,250 to 17,150 feet of aerial structure to the Durham-Orange Corridor, depending on the alignment option selected at UNC Chapel Hill, Meadowmont/Woodmont, and South Square. The structures could potentially impact view sheds in Chapel Hill and Meadowmont Village. No overhead catenary system would be needed.

BRT-Low The BRT-Low Alternative would add +/- 7,000 feet of aerial structure to the Durham-Orange Corridor. This will vary depending on the alignment option selected at UNC Chapel Hill and South Square. No overhead catenary system would be needed.

Table 3-12 summarizes potential visual impacts for the Durham-Orange Corridor.

Table 3-12 Summary of Visual Impacts

Alternative	Aerial Structure (feet)	Overhead Catenary System	Visual Impacts Rating
LRT	15,250 - 17,150	Yes	○
BRT-High	15,250 - 17,150	No	◒
BRT-Low	+/- 7,000	No	●

Source: URS Corporation Consultant Team, 2011

LRT and BRT-High Alternatives will have the highest visual impacts of the Build Alternatives.

Wetland and Stream Impacts

Wetlands and streams that are either directly crossed by the fixed-guideway alternatives or within 50 feet of the alignment were identified using available Geographic Information System (GIS) data. Information on water crossings is important to determine if an alignment would have a potentially adverse impact on a stream or other water crossing during construction or operation. Each alignment crosses several major streams, intermittent streams and unnamed creeks. Wetlands are defined by the U.S. Army Corps of Engineers and US Environmental Protection Agency (EPA) based on the presence of wetland vegetation, wetland hydrology and hydric soils. Wetlands are important biological resources that perform many functions, including groundwater recharge, flood flow attenuation, erosion control, water quality improvement and plant and animal habitat. A review of the National Wetlands Inventory (NWI) Maps, published by the United States Department of the Interior Fish and Wildlife Service, was conducted to determine acreage of wetlands adjacent to the proposed alignments.

LRT The proposed LRT alignment will cross several NWI mapped wetlands and United States Geological Survey (USGS) blue-line streams. These include:

- Little Creek/ Palustrine Forested (PFO) wetland
- Unnamed Tributary (UT) to Little Creek
- New Hope Creek/ PFO wetland
- UT to New Hope Creek (1)
- UT to New Hope Creek (2)
- UT to New Hope Creek (3)
- UT to New Hope Creek (4)
- UT to New Hope Creek (5)
- UT to New Hope Creek (6)
- New Hope Creek/ PFO wetland
- Sandy Creek 1
- Sandy Creek 2
- UT to Sandy Creek

Most of the proposed crossings occur along existing road right-of-ways that have crossing structures in place (e.g., culverts or bridges). The proposed alignment may require an extension of these structures. Two proposed LRT crossings of Little Creek and New Hope Creek would require new crossing structures for these streams and associated PFO wetlands.

Table 3-13 summarizes the estimated linear feet of stream and acreage of wetland impacts for the base alignment and the alignment options at UNC Chapel Hill, Meadowmont/Woodmont, and South Square for the LRT alignment (Figure 3-3). Most of the stream and wetland impacts along the base alignment are expected to occur over New Hope Creek near Patterson Place. The alignment will be bridged over the crossings. There are no anticipated stream or wetland impacts in the UNC Chapel Hill subarea. The South Square alignment options will both impact roughly 300 linear feet of streams but will not affect any wetlands.

Table 3-13 Potential Impacts to Streams and Wetlands for LRT Alignment Options

Alignment Options	Streams (linear feet)	Wetlands (acres)
Base Alignment	2,445	3.0
UNC Chapel Hill		
A1 – Hibbard Drive	0	0
A3 – UNC Southern	0	0
Meadowmont/Woodmont		
C1 - Meadowmont Lane	120	<1
C2 – George King Road*	250	<.25
South Square		
D1 – Westgate Drive	300	0
D3 – Shannon Road	300	0

*Source: URS Corporation Consultant Team, 2011, estimated using GIS NWI mapping USGS stream mapping data | *Avoids having a new crossing and disturbance to the contiguous Little Creek watershed north of NC 54.*

FIGURE 3-3a
DURHAM-ORANGE ENVIRONMENTAL FEATURES

LEGEND

- Federal Land
- National Register Historic Boundaries
- 1 Rocky Ridge Farm Historic District
- 2 Rocky Ridge Farm H.D. Boundary Expansion
- 3 Meadowmont
- Water Bodies
- Significant Natural Heritage Areas
- Floodplains
- Wetlands
- Rivers & Streams
- County Boundary
- Interstate
- US Route
- NC Route
- Local Road
- Railroad

NORTH

0 0.25 0.5 1
Miles

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Triangle Regional Transit Program

Durham-Orange County Cor
Alternatives Analysis

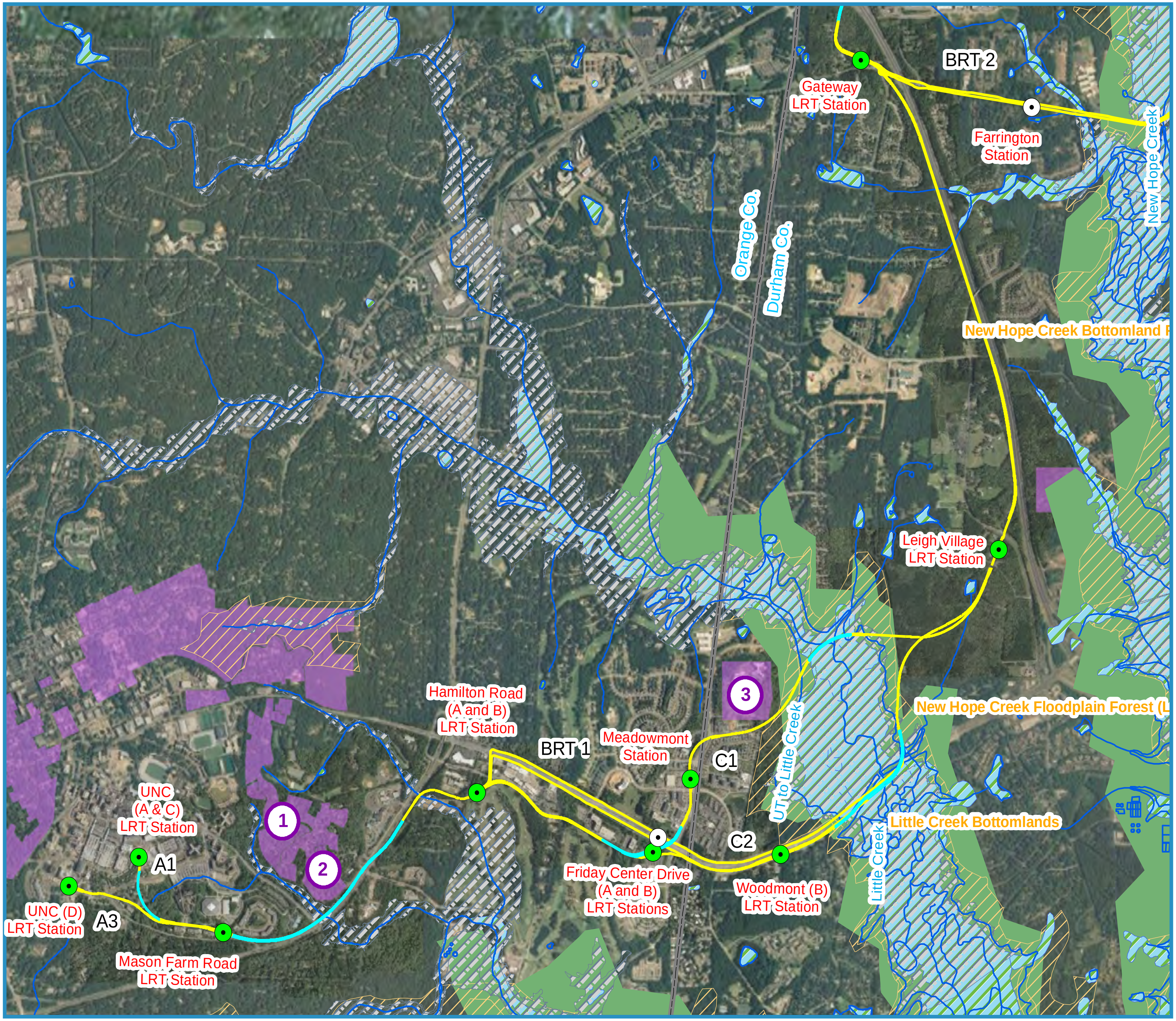
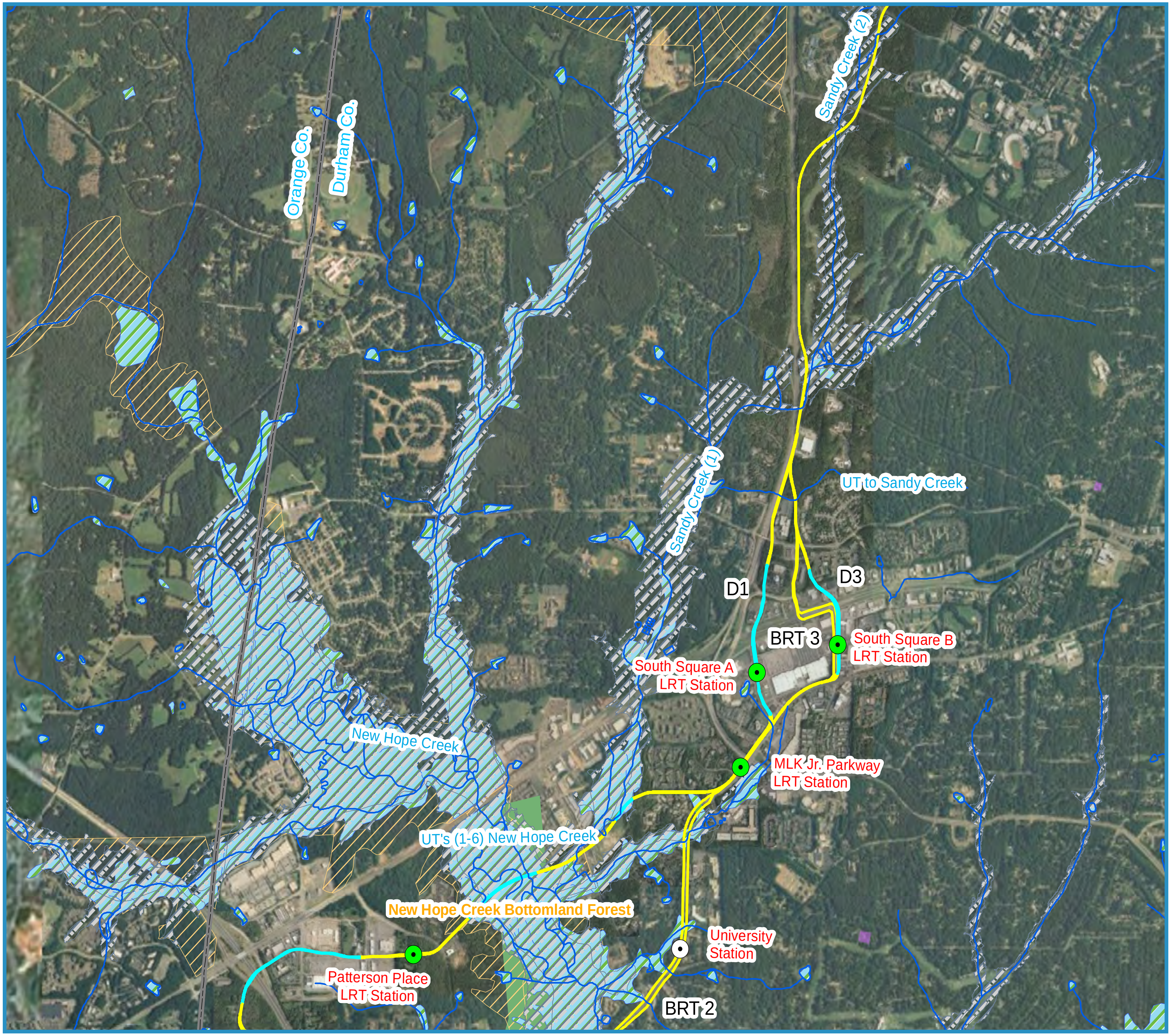


FIGURE 3-3b
DURHAM-ORANGE ENVIRONMENTAL FEATURES



LEGEND

- Federal Land
- National Register Historic Boundaries
- Water Bodies
- Significant Natural Heritage Areas
- Floodplains
- Wetlands
- Rivers & Streams
- County Boundary
- Interstate
- US Route
- NC Route
- Local Road
- Railroad

NORTH

0 0.25 0.5 1

Miles

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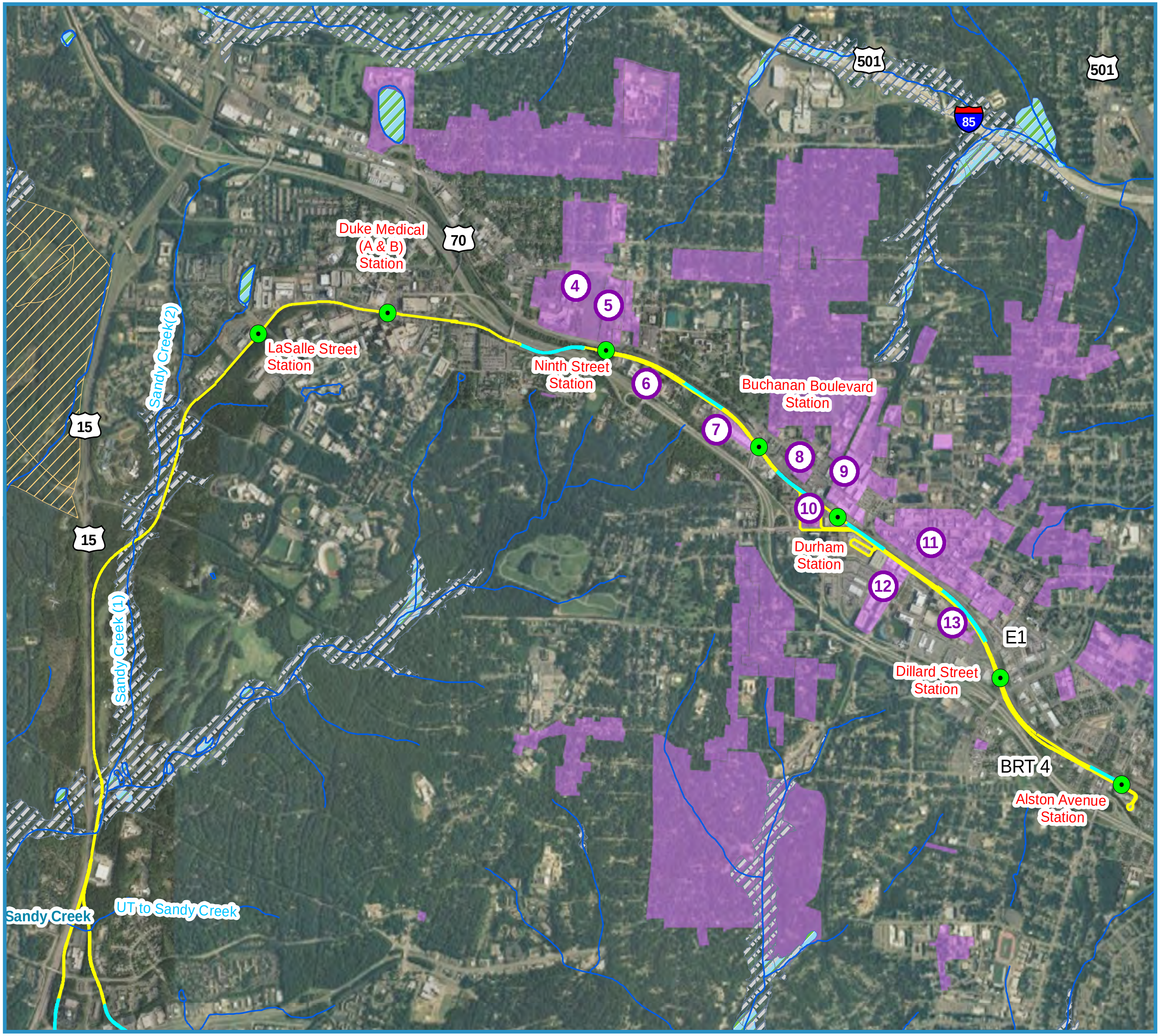
Durham-Orange County Corridor Alternatives Analysis

FIGURE 3-3c
DURHAM-ORANGE ENVIRONMENTAL FEATURES

LEGEND

- Federal Land
- National Register Historic Boundaries
- Water Bodies
- Significant Natural Heritage Areas
- Floodplains
- Wetlands
- Rivers & Streams
- County Boundary
- Interstate
- US Route
- NC Route
- Local Road
- Railroad
- 4 West Durham Historic District
- 5 Erwin Cotton Mills Company
- 6 Powe House
- 7 Smith Warehouse
- 8 Watts & Yuille Warehouses
- 9 Brightleaf Historic District
- 10 Duke Memorial United Methodist Church
- 11 Downtown Durham Historic District
- 12 American Tobacco Company Manufacturing Plant
- 13 Venable Tobacco Company Warehouse and Prizery



NORTH

0 0.25 0.5 1

Miles

JUNE 2011

Triangle Regional Transit Program

Durham-Orange County Corridor Alternatives Analysis

In the Meadowmont/Woodmont subarea, while alignment option C1 would impact less than one acre of wetlands and 120 linear feet of streams, alignment option C2 would impact less than one-quarter acre of wetlands and approximately 250 linear feet of streams. Because LRT would operate in the median of George King Road, which crosses the existing wetland, the LRT avoids having a new crossing and disturbance to the contiguous Little Creek watershed north of NC 54. There is, however, a slight encroachment on the edge of the wetlands associated with Little Creek when the alignment turns onto George King Road from NC 54. Accommodating this turn requires a new crossing of the Little Creek wetland area that accounts for the less than one-quarter acre of impact.

Wetland and stream impacts are shown in Figure 3-3.

BRT-High The proposed BRT-High Alternative alignment crosses the same or adjacent wetland and stream systems as the LRT alignment. There are no major wetlands and streams that could be impacted within 50 feet of the BRT-High corridor in downtown Durham. Wetland and Stream Impacts for the BRT-High Alternative are identical to LRT.

BRT-Low The proposed BRT-Low Alternative alignment also crosses the same or adjacent wetland and stream systems as the LRT alignment. As shown in Table 3-14, within the base alignment, the BRT-Low has fewer impacts because it does not cross the New Hope Creek systems between Gateway and South Square on new structure as it will operate in mixed-traffic. However, the alignment does clip portions of New Hope Creek and the associated wetland along Old Chapel Hill Road, with the total impact to wetlands equating to approximately one acre. Similar to alignment option C2 for the LRT and BRT-High Alternatives, the BRT-Low Alternative will also run along NC 54 where it crosses Little Creek. However, the BRT-Low alignment will require a widening of the existing roadway. The proposed alignment also may require an extension of culvert and bridge structures. The BRT-Low Alternative will thus impact approximately one acre of wetlands in the Little Creek watershed. There are no major wetlands and streams that could be impacted within 50 feet of the BRT-Low corridor in South Square or Downtown Durham subareas. Wetland and Stream Impacts for the BRT-Low are less than the LRT and BRT-High Alternatives.

Table 3-14 Summary of Stream and Wetland Impacts

Alternative	Stream Impacts (linear feet)	Wetlands (acres)	Wetland & Riparian Area Rating
LRT	4,000 – 5,300	3 – 4	◓
BRT-High	4,000 – 5,300	3 – 4	◓
BRT-Low	3,600 – 4,800	2	●

Source: URS Corporation Consultant Team, 2011, estimated using GIS NWI mapping USGS stream mapping data

In total, the LRT and BRT-High alternatives could impact between 4,000 and 5,300 linear feet of streams, depending on the alternatives selected in Meadowmont/Woodmont. Both LRT and BRT-High would also impact approximately 4 acres of wetlands if alignment option C1, Meadowmont Lane, is selected and three acres of wetlands if alignment option C2, George King Road, is selected. BRT-Low would impact approximately 2 acres of wetlands.

BRT-High The proposed BRT-High Alternative alignment crosses the same or adjacent wetland and

Section 4(f) Resources

According to Title 23 USC 138 (Section 4[f]), the USDOT:

…shall not approve any program or project…which requires the use of any publicly owned land from a public park, recreation area, or wildlife and waterfowl refuge of national, State or local significance as determined by the Federal, State, or local officials having jurisdiction thereof, or any land from an historic site of national, State or local significance as so determined by such officials unless (1) there is no feasible and prudent alternative to the use of such land, and (2) such program includes all possible planning to minimize harm to such park, recreational area, wildlife and waterfowl refuge, or historic site resulting from such use.

Thus potential Section 4(f) resources that are within 50 feet of the alignment were identified using available GIS data.

LRT Section 4(f) resources within 50 feet of the LRT alignment include DCS Hospital School in Durham and the US Army Corps of Engineers (USACE) property in the Meadowmont/Woodmont subarea. The LRT alignment crosses adjacent to property owned by Durham County and is preserved as open and recreational space associated with New Hope Creek. Both alignment options C1 and C2 would impact the USACE property and C2 proposes to use existing right of way through the property but may also have impacts. Alignment option C1 passes near the historic Meadowmont Farm property but is outside the 50-foot buffer. There are no Section 4(f) resources within the UNC Chapel Hill or South Square subareas. Numerous historic properties are within the Downtown Durham subarea, four of which are within 50 feet of the LRT alignment.

The Patterson Storage Yard and Maintenance Facility Alternative would directly impact the historic William N. Patterson High School site which is located between SW Durham Road and US 15/501 just north of the North Creek Apartment complex.

BRT-High Potential Section 4(f) resources under BRT-High are identical to LRT, except in downtown Durham. Numerous historic properties are within the Downtown Durham Subarea, six of which are within 50 feet of the BRT-High alignment.

BRT-Low Section 4(f) resources within 50 feet of the BRT-Low Alternative include the DCS Hospital School in Durham and the USACE property in the Meadowmont/Woodmont subarea, and similar to alignment option C2, proposes to use existing right-of-way on NC 54 through the US Army Corps of Engineers (USACE) property but may also have impacts. There are no Section 4(f) resources within the UNC Chapel Hill or South Square subareas. Numerous historic properties are within the Downtown Durham Subarea, six of which are within 50 feet of the BRT-Low alignment.

Table 3-15 summarizes potential Section 4(f) resource impacts and provides a summary rating.

Table 3-15 Summary of Potential Section 4(f) Resource Impacts

Alternative	Number of Potential 4(f) Impact Locations	Section 4(f) Ratings
LRT	7	◒
BRT-High	7	◒
BRT-Low	8	◒

Source: URS Corporation Consultant Team, 2011

Air Quality Impacts

Air quality is typically assessed at the regional level. None of the alignments is anticipated to affect regional air quality substantially. All of the alternatives, at a minimum, would maintain existing air quality levels. It is, however, generally accepted that electrically powered LRT vehicles are a greener technology that would be more efficient and provide a slight improvement over diesel or alternatively fueled buses in the immediate service area. Ratings for air quality impacts are provided in Table 3-16.

Table 3-16 Air Quality Impacts

Alternative	Air Quality Ratings
LRT	●
BRT-High	◒
BRT-Low	◒

Source: URS Corporation Consultant Team, 2011

Construction Impacts

Impacts to businesses and residents are one of the most challenging elements in the construction of a fixed-guideway transit system. Roadway access, along with services provided for water, sewer, electrical, and communication are vital, and their disruption due to construction should be minimized. Construction impacts, such as noise and vibration, can also occur as a result of the hauling and redistribution of materials and for the delivery of new materials for guideway construction, namely, ballast (LRT), concrete or paving materials (BRT and LRT), rail (LRT), and overhead catenary poles and wiring (for LRT). Other construction materials include drainage pipes and graded materials for base and sub-base for pavements (BRT) and for drainage trenches. This heavy equipment can result in noise and traffic impacts to the surrounding area.

Where the guideway crosses streets at-grade, local automobile traffic can be disrupted and it is common to either close the street and detour the traffic away and around the construction site or to construct the grade crossing in stages without closing the street entirely by detouring traffic locally around the construction zone making use of one-half of the street being crossed. This process is then reversed to build the other half of the street. This necessitates the use of flagman and traffic detour signs. It is a common construction staging requirement that adjacent street crossings cannot be worked on simultaneously to minimize impacts to traffic. Construction detour plans are necessary to be produced and approved by the governing jurisdiction.

Mitigation for construction impacts can be achieved through best management practices and construction phasing. It is common to dictate working hours and limit construction equipment noise levels depending on the sensitivity of the surrounding areas. In some cases, nighttime construction is required to minimize traffic impacts (such as an aerial crossing of an expressway). Other times nighttime construction is prohibited such as in a residential setting. Erosion control and water run-off control during construction is common to all types of guideway construction and is typically mandated by the authority having jurisdiction.

For guideway construction to progress in phases, it is common to make use of the corridor in one area as a staging zone for construction in another and progressing in a linear fashion. A finished guideway zone is a good area for staging construction materials for the next zone thus minimizing the need for additional construction staging areas and for a consistent area for delivery of materials for certain reaches of guideway construction. The materials are then distributed linearly along the guideway corridor as the work progresses. Future station park and ride lots and bus bay areas would also be used for the staging of construction.

LRT, BRT-High, and BRT-Low All three alternatives - LRT, BRT-High, and BRT-Low - would generate construction impacts requiring mitigation. Because each alternative requires the construction of extensive segments of fixed-guideway, and each alignment is roughly the same length, construction impacts are not a differentiating factor between alternatives. See Appendix B for more detail regarding construction impacts for each alternative. Summary ratings for construction impacts are provided in Table 3-17.

Table 3-17 Construction Impacts Ratings

Alternative	Rating
LRT	
BRT-High	
BRT-Low	

Source: URS Corporation Consultant Team, 2011

3.2.7. Cost

Capital Costs

Capital costs include a one-time expenditure to construct the Build Alternatives and purchase vehicles. All of the build alternatives in the Durham-Orange corridor include feeder bus service. The capital costs for the feeder bus service will be calculated upon the selection of the LPA prior to development of the full financial plan, and therefore are not included here. The same basic feeder bus service was used in each alternative and would not materially impact the marginal costs between the alternatives. All capital costs estimates are given in 2011 dollars. More detailed information on the methods and assumption for the development of O&M costs can be found in the Technical Report containing: Durham-Orange Corridor Capital Cost Estimates, Operations and Maintenance Costs Estimates, Travel Time and Distance Calculation, and Ridership Summaries and Station-to-Station Ridership, May 2011.

LRT As shown in Table 3-18, capital costs for the LRT Alternative range from $1.34 Billion to $1.40 Billion, depending on the alignment options selected at UNC Chapel Hill, Meadowmont/Woodmont, and South Square. The highest cost combination includes alignment options A1 Hibbard Drive, C1 Meadowmont Lane, and D3 Shannon Road. The lowest cost combination includes alignment options A3 Hibbard Drive, C2 George King Road, and D1 Westgate Drive.

Table 3-18 Capital Costs for LRT Alignment Alternatives

Alternative Alignment Combination	Capital Cost (2011 dollars)
A1, C1, D1	$1.37M
A3, C1, D1	$1.37M
A1, C2, D1	$1.34M
A3, C2, D1	$1.34M
A1, C1, D3	$1.40M
A3, C1, D3	$1.40M
A1, C2, D3	$1.37M
A3, C2, D3	$1.37M

Source: URS Corporation Consultant Team, 2011

Factors affecting the cost of the alignment options in UNC Chapel Hill, Meadowmont/Woodmont, and South Square are described below. All costs presented are total project costs inclusive of construction, vehicles, maintenance yard and shops, right-of-way, allocated and unallocated contingencies, project administration and engineering costs, and project reserve. The alignment segment comparison costs do not include the system-wide costs associated with vehicles and maintenance yard and shops.

UNC Chapel Hill: Alignment option A1 Hibbard Drive would cost approximately $60 million while alignment option A3 Hibbard Drive would cost approximately $59 million (cost includes tail track). Alignment option A1 is modestly higher in cost because it requires 600 feet of aerial structure while alignment option A3 would be constructed at-grade. Alignment option A3 has over 885 feet more track feet than alignment option A1 which offsets the added cost of the aerial structure.

Meadowmont/Woodmont: Alignment option C1 Meadowmont Lane would cost approximately $212 million while alignment option C2, George King Road, would cost $182million. Meadowmont Lane would cost approximately $30 million more due to the aerial structure required to cross NC 54 between Meadowmont Village and Friday Center. The aerial crossing of NC 54 requires the Friday Center Drive station be aerial for alignment option C1. The station is at-grade with alignment option C2. Alignment option C1 also requires road crossings/gates.

South Square: Alignment option D1, Westgate Drive, would cost approximately $219 million while alignment option D3, Shannon Road, would cost $245.0 million. Alignment option D3 would cost approximately $26 million more than alignment option D1 because it requires more aerial structure, 3,200 feet for alignment option D3 when compared to 2,300 feet for alignment option D1. In addition, alignment option D3 is a circuitous route relative to alignment option D1, requiring slightly more guideway and track elements to cover the additional distance. Alignment option D1, Westgate Drive, requires additional crossing protection at two access roads and Shannon Drive. Alignment option D3 also requires purchase of 1.5 more acres of right-of-way easements than alignment option D1.

BRT-High A capital cost estimate was developed for BRT-High assuming alignment options A3 Hibbard Drive, C2 George King Road, and D3 Shannon Road. BRT-High is estimated to cost $960 million. The cost was derived using the same guideway construction costs as LRT with the following exceptions:

- lower station costs due to less length requirements for the platforms;
- less cost since BRT does not require traction power facilities and overhead distribution system (overhead canopy);
- a train control and signaling system is not required;
- Although included in BRT, there is less cost associated with communications and central control; and
- Different vehicle quantities and costs.

Maintenance yard and shop requirements were assumed to be the same. BRT has more vehicles and storage needs bus less component rebuilding requirements.

BRT-Low A capital cost estimate was developed for BRT-Low assuming alignment options (A3, C2, and D3). BRT-Low is estimated to cost $810 million. The difference in cost from BRT High and BRT-Low is based on the differences in guideway construction and fleet requirements.

TSM The TSM Alternative capital costs would be approximately $85 million, consisting of three miles of single lane pavement, additional left turn lanes and traffic signals, 800 spaces for park and ride lots, 16 bus bays, 16 articulated buses, right-of-way and all associated project administration, engineering, contingencies and project reserves.

Summary Table 3-19 summarizes capital costs for the Build Alternatives. For the purposes of comparison, the costs shown assume alignment options A3, C2, and D3.

Table 3-19 Capital Costs for Build Alternatives

Alternative (Alignments A3, C2, D3)	Capital Cost (2011 dollars)	Rating
TSM	$85M	-
LRT	$1.40B	○
BRT-High	$960M	◒
BRT-Low	$810M	●

Source: URS Corporation Consultant Team, 2011

The costs for the BRT alternatives are substantially less expensive than the LRT Alternative, $414 million less for BRT-High Alternative and $561 million for the BRT-Low Alternative. Although the BRT systems require construction of guideway and aerial structure in many of the same locations as LRT, guideway costs are reduced as described above.

As to be expected, the capital cost of the BRT-Low Alternative is lower than the BRT-High Alternative, approximately $147 million less. BRT-Low includes more sections operating in mixed-traffic, reducing costs for an exclusive running way. The BRT-Low alignment along Old Chapel Hill Road instead of through Patterson Place is estimated to cost approximately $99 million or $112 million less than the LRT alignment and $73 million less than the BRT-High alignment through this segment. BRT-Low costs also include less real estate acquisition for station areas.

While the cost of the bus improvements is modest compared to a fixed-guideway transit system, the TSM Alternative does involve some capital improvements totaling $84 million. These improvements include vehicles and spare parts, roadway facility improvements (such as on both sides of Fordham Boulevard, between Manning Drive and NC 54), bus bays, park and ride lots (including real estate acquisition), pedestrian and bike access as well as links to parking, traffic signal improvements, construction costs, and maintenance facility expansion. Additional information on facility improvements and traffic signal improvements is provided in Section 2.2.5.

O&M Costs

The operating and maintenance (O&M) costs projects the annual cost of running the new service under the Build Alternatives. All operating cost estimates are provided in 2011 dollars. More detailed information on the methods and assumption for the development of O&M costs can be found in the Technical Report containing: Durham-Orange Corridor Capital Cost Estimates, Operations and Maintenance Costs Estimates, Travel Time and Distance Calculation, and Ridership Summaries and Station-to-Station Ridership, May 2011.

LRT Based on the service plans defined for the LRT Alternative, as defined in Section 2.6, the annual O&M costs would be approximately $14 million in 2011 dollars for a peak hour capacity of 800 passengers per hour and $15 million in 2011 dollars for a peak hour capacity of 1500 passengers per hour.

BRT-High Based on the service plans defined for the BRT-High Alternative, as defined in Section 2.6, the annual O&M costs would be approximately $11 million in 2011 dollars for a peak hour capacity of 800 passengers per hour and $13 million in 2011 dollars for a peak hour capacity of 1500 passengers per hour.

BRT-Low Based on the service plans defined for the BRT-Low Alternative, as defined in Section 2.6, the annual O&M costs would be approximately $11 million in 2011 dollars for a peak hour capacity of 800 passengers per hour and $13 million in 2011 dollars for a peak hour capacity of 1500 passengers per hour.

TSM Based on the service plans defined for the TSM Alternative, as defined in Section 2.6, the annual O&M costs would be approximately $9 million in 2011 dollars.

Table 3-20 summarizes the operating costs under the Build Alternatives.

Table 3-20 O&M Cost Estimates for Build Alternatives (2011 Dollars)

Alternative	Annual O&M Cost (800 pax/hr)	Annual O&M Cost (1500 pax/hr)	Rating
TSM	$8.89M		-
LRT	$14M	$15M	◒
BRT-High	$11M	$13M	●
BRT-Low	$11M	$13M	●

Source: URS Corporation Consultant Team, 2011.

While operating costs for the BRT alternatives are estimated to be substantially lower than the LRT Alternative, long-term, the BRT alternatives O&M costs will likely escalate higher than LRT costs due to the shorter life span of buses compared to trains, operations (driver) costs, and, potentially, fuel costs. A comparison of cost estimates for the BRT alternatives and the LRT Alternative at peak hour capacities of 800 and 1500 illustrates the economies of scale that can be seen with LRT. As shown in Table 3-21, if the capacity of the BRT alternatives is increased to 1500, the O&M costs increase from approximately $11 million to $13 million, an approximate difference of $2 million. Conversely, if the LRT Alternative's capacity is increased from 800 to 1500, the operating cost increase from approximately $14 million to $15 million, an incremental change of roughly $1 million. A proportional increase in BRT and LRT service would increase O&M costs for BRT by 18 percent change whereas LRT would only require a 7 percent adjustment. This illustrates that LRT can be expanded to accommodate more passengers at a lower cost. Further, BRT would eventually overtake LRT in O&M costs. Based on the magnitude of change illustrated in Table 3-21, this would likely occur near 2000 passengers per hour. A survey of observed peak hourly volumes for five LRT and three BRT US and Canadian systems revealed volumes ranging from 1700 to 4500 between the years 1997 and 2000.[6] This data shows that it is common for BRT and LRT systems to operate with these passenger volumes.

Table 3-21 Comparison of O&M Costs for LRT & BRT for Alternate Peak Hour Capacities

Alternative	O&M Cost (800 pax/hr)	O&M Cost (1500 pax/hr)	Change in O&M Cost
LRT	$14M	$15M	7%
BRT-High	$11M	$13M	18%
BRT-Low	$11M	$13M	18%

Source: URS Corporation Consultant Team, 2011

Given this information, BRT is still rated higher for O&M costs as is projected to have a lower O&M cost given the initial ridership forecasts. However, decision-makers should weigh the long-term potential for escalated O&M costs as ridership nears the range more typical of US systems.

[6] Demery, Jr., Leroy, "Peak-period Vehicle Occupancy Statistics for U.S. and Canadian Rapid Bus and Rapid Rail Services," 2007

3.2.8. Summary of Evaluation Results

The summary of evaluation results focuses first on narrowing down the alignment options under consideration and second on comparing and screening the Build Alternatives to arrive at a preliminary LPA recommendation.

Alignment Options This section summarizes the primary opportunities and constraints of the alignment options under consideration in the UNC Chapel Hill, Meadowmont/Woodmont, and South Square subareas and includes a preliminary recommendation for each subarea.

UNC Chapel Hill

Table 3-22 UNC Chapel Hill Alignment Options Opportunities & Constraints

Alignment Option	Opportunities	Constraints
A1 UNC Hibbard Drive	▪ Substantially higher ridership (up to 800 more daily boardings over A3) due to better walk access from UNC Main Campus and Hospitals ▪ Closer to major employment and student centers	▪ Potential for more construction impacts due to aerial structure ▪ Aerial structure would also cause more visual impacts ▪ Future expansion potential presents greater engineering challenges. An alternate station location and realignment of Hibbard Drive would be required.
A3 UNC Southern	▪ Consistent with UNC redevelopment and expansion plans ▪ Future extension to Columbia Street less problematic ▪ Alignment is the preferred option of UNC and Town of Chapel Hill staff ▪ At-grade alignment would lead to fewer construction and visual impacts	▪ Lower ridership as it is located further from major employment and student centers ▪ Substantially lower walk access

Source: URS Corporation Consultant Team, 2011

UNC Chapel Hill Alignment Option Recommendation: Based on the opportunities and constraints, carry forward alignment option A3 as the preferred alignment option. The Town of Chapel Hill staff and the UNC & UNC Hospitals support this option and a future extension of the A3 option would resolve the constraint of the extended walking distances to the UNC Campus and downtown Chapel Hill.

Meadowmont/Woodmont

Table 3-23 Meadowmont/Woodmont Alignment Options Opportunities & Constraints

Alignment Option	Opportunities	Constraints
C1 Meadowmont Lane	▪ Right-of-way has been preserved for transit along this alignment ▪ Serves existing transit oriented development ▪ Greater walk access potential that may not be captured in the existing ridership model; actual could equal or exceed the amount forecasted for C2 ▪ Fewer linear feet of stream are likely to be impacted ▪ Would increase delay at 4 fewer intersections than C2	▪ Slightly lower ridership within Meadowmont Village ▪ Traffic impacts would need to be studied in greater detail at the intersection of NC 54 with Friday Center Drive and East Barbee Chapel Road ▪ Alignment crosses USACE property
C2 George King Road	▪ Alignment along NC 54 is placed between NC 54 and the frontage road, Stancel Drive; less impacts during construction ▪ Slightly higher forecast ridership (300 additional passengers) ▪ Potential for less impacts to USACE property as alignment is proposed to use existing right-of-way ▪ Marginally lower capital cost due to the avoidance of the NC 54 aerial crossing at Friday Center ▪ Avoids impacts to existing residential community	▪ Impacts more private properties along George King Road ▪ More linear feet of stream could be impacted ▪ Greater traffic impacts as the option slightly increases delay at 4 additional intersections than C1

Source: URS Corporation Consultant Team, 2011

Meadowmont/Woodmont Alignment Option Recommendation: The project team recommends alignment option C1 be advanced as part of the LPA for the Durham-Orange Corridor. Alignment option C1 serves Meadowmont Village, an existing community that was designed to be a TOD, offering a well-developed urban street grid, a highly walkable landscape, mixed-use developments, and multifamily housing within the one-half mile station catchment area. Long-term plans for fixed-guideway service within Meadowmont Village is also evidenced by the dedication of right-of-way, which results in fewer private property acquisitions for alignment option C1 relative to alignment option C2. In addition, the ridership potential of Woodmont relies on a proposed development rather than on an existing community as in the case of Meadowmont.

Still, the impacts to wetlands are a significant issue that must be explored further. Although there is a mitigation alternative identified for alignment option C1 (See drawing C1-04a in Volume 2: Detailed Definition of Alternatives, Conceptual Plan and Profile Drawings), the mitigation alignment option is very circuitous and would entail sharp turns, thus lengthening travel time and decreasing speed. This circuitous alignment and travel time and speed impact was not considered in the ridership modeling so alignment option C1 could experience a decrease in ridership should wetland avoidance at this location be a condition strictly enforced by the USACE. The crossing of wetlands and USACE owned property will require additional coordination to fully vet this issue with the USACE together with continued dialogue with community stakeholders.

Therefore, although alignment option C1 is the preferred alignment, the project team also recommends advancing alignment option C2 through to the PE/NEPA phase in order to provide an opportunity for continued study of the wetlands issue.

South Square

Table 3-24 South Square Alignment Options Opportunities & Constraints

Alignment Option	Opportunities	Constraints
D1 Westgate Drive	▪ Fewer visual impacts as less aerial structure is required ▪ Lower capital cost due to less aerial structure ▪ Fewer property impacts	▪ Slightly lower ridership as it presents less opportunity to serve existing development ▪ Does not serve surrounding land uses as well as D3 ▪ Development opportunity and non-highway access is constrained by US 15/501 interchange
D3 Shannon Road	▪ Higher ridership (up to 650 additional boardings) due to more central location ▪ Better serves surrounding land uses, including existing development and the planned University Marketplace development	▪ Greater number of property impacts (10 more than D1) ▪ Approximately $26 million higher capital cost due to 1,100 additional feet of aerial structure ▪ Greater potential for visual impacts due to aerial structure

Source: URS Corporation Consultant Team, 2011

South Square Alignment Option Recommendation: Based on the opportunities and constraints, carry forward alignment option D3 as the preferred alignment option. The potential for development for alignment option D3 and the surrounding land uses is, in the opinion of the project team, a very significant factor for the recommendation of D3 above and beyond the constraints cited.

Build Alternatives (Technology Recommendation)

The following observations can be made about each of the detailed alternatives:

- The LRT Alternative has lower ridership (12,000 daily boardings) and higher capital costs ($1.37B) and O&M costs ($15M) than the BRT-High and BRT-Low Alternatives. However, the LRT Alternative has better travel times and economic development potential. Another important consideration is that of the comments received the LRT Alternative has a greater degree of public support.

- The BRT-High Alternative has the highest ridership (5,700 daily boardings on the BRT route and 11,900 boardings on the interlined buses), moderate capital costs ($960M) and the lowest O&M costs ($11M) of the three alternatives. However, economic development potential and degree of public support are not as competitive as the LRT Alternative.

- The BRT-Low Alternative has the second highest ridership (4,600 daily boardings on the BRT route and 11,700 boardings on the interlined buses), lowest capital cost ($810M) and second lowest O&M costs ($11M). Like the BRT-High Alternative however, the economic development potential is not as competitive as the LRT Alternative and public support is lacking.

- The BRT-High and BRT-Low Alternatives have longer end-to-end travel times than the LRT Alternative. The LRT Alternative, with a travel time of 35 minutes, is 3 minutes faster than BRT-High Alternative and 8 minutes faster than BRT-Low Alternative. This travel time difference could increase by 3 to 4 minutes due to the need to pursue other mixed traffic in-street alignments if the BRT Alternatives are not permitted to operate within the NCRR corridor right-of-way (see downtown Durham to East Durham - BRT Alternative 4 under Section 2.4.2.

- All three alternatives would increase system-wide transit trips in the region by a comparable amount. Measures used by the FTA to rate a project's justification—including mobility improvements and cost effectiveness—take into account the ridership increases and travel time savings enjoyed by the system as a whole as a result of the project's implementation, not only those benefits for the project alone. This is significant because it demonstrates that although BRT has higher boardings due to the interlining of feeder bus routes which make it difficult to isolate the performance of BRT alone and likely inflates its ridership potential, LRT ultimately provides a comparable increase in transit ridership for the system as a whole.

- The LRT and BRT-High Alternatives have similar environmental impacts, although LRT fares marginally worse in terms of visual impacts because it requires overhead catenary wire. While the BRT-Low Alternative requires a higher number of property acquisitions, it generally presents fewer visual and construction impacts than LRT and, to a lesser extent, BRT-High because more of the alignment is at-grade and follows existing roadways. In terms of air quality, however, it is generally accepted that electrically powered LRT vehicles are a greener technology that would be more efficient and provide a slight improvement over diesel or alternatively fueled BRT vehicles in the immediate service area, and offer more substantial emission reductions over time as renewable energy sources are increasingly employed by electric utilities in support of power generation needs.

Table 3-25 summarizes the evaluation of detailed alternatives.

Table 3-25 Summary of Detailed Alternatives Evaluation

Evaluation Criteria	Measure	LRT Alternative	BRT-High Alternative	BRT-Low Alternative
Ridership	2035 Ridership forecasts (without interlining on BRT)*	●	○	○
	2035 Ridership forecasts (with interlining on BRT)	◓	●	●
	2035 System-wide transit ridership	●	●	●
Transportation Operations	Traffic impacts	●	●	◓
	Travel times	●	◓	◓
Expansion Potential	Ability for alignment to be extended in future	●	◓	◓
Stakeholder Support	Public and agency support**	●	◓	◓
	Economic development potential	●	◓	○
Environmental Impacts	Property acquisitions	◓	◓	○
	Visual impacts	○	◓	●
	Wetland and stream impacts	◓	◓	●
	Section 4(f) resources impacts	◓	◓	◓
	Air quality impacts	●	◓	◓
	Construction impacts	◓	◓	◓
Cost	Capital costs	○	◓	●
	Operating costs	◓	●	●

**Daily boardings for BRT-High and BRT-Low routes without interlined buses could potentially be higher as the model estimated the ridership assuming interlined buses. The BRT numbers thus do not account for passengers that would transfer from feeder buses to BRT if the feeder buses were not sharing the BRT guideway.| **Note agency support has not been evaluated at the time of this report. Ratings only include public support.*

The BRT-High and BRT-Low Alternatives clearly rate well in their ability to meet the first three project goals. Both BRT Alternatives outperform the LRT Alternative in their ability to meet Goal 1: Improve mobility through and within the study corridor, Goal 2: Increase transit efficiency and quality of service, and Goal 3: Improve transit connections. The end-to-end travel time for the BRT Alternatives is slightly longer than the LRT Alternative; however, travel time does not seem to be a major differentiator with regard to passenger preference, as ridership on the BRT-High and BRT-Low Alternatives exceeds that of the LRT Alternative, even with a longer travel time. Additionally, while BRT-Low would result in marginally worse traffic impacts than LRT and BRT-High, traffic impacts is also not a major differentiator among the Build Alternatives.

Each of the three alternatives – LRT, BRT-High, and BRT-Low also meet Goal 5: Foster environmental stewardship; however, the use of fossil fuels by buses makes LRT a more sustainable and desirable technology over the long term. And, while each would result in limited impacts to the natural and built environments, environmental impacts have not proven to be a major differentiator between the alternatives.

From a cost perspective, the BRT-High and BRT-Low Alternatives best meet Goal 6: Provide a cost-effective transit investment by providing a lower capital cost investment and O&M costs within the planning horizon for the proposed project. In terms of capital costs, while LRT presents substantially higher costs than BRT, the cost of the LRT Alternative is still within the range of affordability as detailed in the Financial Plan being prepared for Durham, Orange, and Wake Counties. For O&M costs, as noted in Section 3.2.7, decision makers must also consider that long-term, the O&M costs of the BRT Alternatives will likely escalate quicker than those of the LRT Alternative due to the shorter life span of buses compared to trains, operations (driver) costs, fuel costs. Ultimately the decision of whether BRT or LRT is a cost-effective technology choice will depend largely on ridership. Currently, the BRT Alternatives do have slightly higher forecasted boardings but, as peak hourly volumes reach the range more comparable to existing LRT and BRT systems, LRT can meet the increased demand at a lower capital and O&M investment than BRT.

While the BRT Alternatives are competitive regarding most project goals, the LRT Alternative clearly surpasses the BRT Alternatives under Goal 4: Support local and regional economic development and planned growth management initiatives. The LRT Alternative has demonstrated public support and LRT technology has a proven record of producing local and regional economic development benefits by enhancing and focusing growth within LRT corridors. LRT enhances opportunities for TOD, and the resulting TOD can achieve rental rate premiums and higher land values over non-light rail served properties. Impressive levels of development have been constructed along LRT lines in many examples across the nation. As evidenced by the dollars of investment with LRT corridors such as the Charlotte Blue Line, developers are interested in constructing TOD at LRT stations, as they see the value in the transportation advantage afforded by LRT. Further, in support of planned growth management initiatives, LRT's proven ability to focus growth would, in the long run, have a more substantial impact on mobility because the land use impacts will result in more transportation choices that can reduce impacts to the highway system.

Build Alternative/Technology Recommendation: The ultimate choice of technology to carry forward is a major decision and could be considered a business decision beyond and above all else. Local and regional stakeholders place a high level of importance on economic development potential and focusing growth within the proposed transit corridor through TOD. LRT can bolster economic development and focus growth and the potential development dollars are not insignificant. The LRT Alternative alone can fully address the stated Purpose and Need for a fixed-guideway investment in the Durham-Orange Corridor; it can enhance mobility, expand transit options between Durham and Chapel Hill, serve populations with high propensity for transit use, and foster compact development. Therefore, the recommended Build Alternative (and technology) is the LRT Alternative.

LPA Recommendation

For the reasons presented in the preceding subsections, the project team's recommendation is to carry forward the LRT Alternative as the LPA with alignment options A3, C1, and D3 and the associated station locations. It is also recommended that the alignment option C2 be carried forward for further study in the PE/DEIS phase based on potential impacts to wetlands and USACE owned property associated with the C1 Alternative.

4. References

Several supporting technical reports are appended by reference. A list of these technical reports is provided below.

- *Durham-Orange Detailed Definition of Alternatives Volume 2: Detailed Definition of Alternatives - Conceptual Plan and Profile Drawings,* URS Team, May 2011.
- *Durham-Orange Detailed Definition of Alternatives Volume 3: Durham-Orange Corridor Capital Cost Estimates, Operations and Maintenance Costs Estimates, Travel Time and Distance Calculation, and Ridership Summaries and Station-to-Station Ridership*, URS Team, May 2011.
- *Durham-Orange Detailed Definition of Alternatives Volume 4: Transit Oriented Development (TOD) Assessment Report,* URS Team, April 2011.
- *Durham-Orange Detailed Definition of Alternatives Volume 5: Traffic Analysis Results Report*, URS Team, February 2011.