

BRT

Regional BRT Network Feasibility Study

Prepared for:



Regional Transportation District
1560 Broadway, Suite 700, FAS-71
Denver, CO 80202

Prepared By:



Felsburg Holt & Ullevig
6300 Syracuse Way, Suite 600
Centennial, CO 80111
(303) 721-1440

FHU Project No. 116408-01

January 2020



TABLE OF CONTENTS

| | <u>Page</u> |
|---|-------------|
| 1. Introduction..... | 1 |
| 1.1 Regional Bus Rapid Transit Feasibility Study | 2 |
| 1.2 Evolution of Transit in the Region | 4 |
| 1.3 RTD Family of Services | 7 |
| 1.4 Bus Rapid Transit..... | 10 |
| 1.5 Regional Benefits of Bus Rapid Transit | 11 |
| 2. Stakeholder & Public Engagement .. | 13 |
| 2.1 Stakeholder Engagement..... | 14 |
| 2.2 Public Engagement..... | 16 |
| 3. Evaluating the Region’s Potential for BRT | 17 |
| 3.1 Regional BRT Study Process..... | 18 |
| 3.2 Goals, Outcomes, and Guiding Principles..... | 20 |
| 3.3 Tiered Evaluation..... | 23 |
| 3.4 Tier 1 – High Demand Travel Corridors | 26 |
| 3.5 Tier 2 – Congestion and/or Delay..... | 32 |
| 3.6 Tier 3 – Viability of Capital Investment | 39 |
| 3.7 Tier 4 – Final Evaluation | 47 |
| 4. Building a Regional BRT Network..... | 77 |
| 4.1 Regional BRT Network..... | 78 |
| 4.2 Implementation Considerations..... | 80 |
| 4.3 Conclusion | 87 |

Appendices

| | |
|------------|---|
| Appendix A | Stakeholder and Public Engagement |
| Appendix B | Existing Conditions Report |
| Appendix C | Tier 2 Route Evaluation Summaries |
| Appendix D | Community Policy Summaries |
| Appendix E | Tier 3 Route Evaluation Summaries |
| Appendix F | Tier 4 Corridor Service Plan Profiles |
| Appendix G | Tier 4 Modeling |
| Appendix H | Tier 4 Cost Estimates |
| Appendix I | BRT Route Next Generation Technology Readiness Evaluation |
| Appendix J | RTD Bus Rapid Transit Equity Analysis |
| Appendix K | Tier 4 Analysis Economic Development Metric |
| Appendix L | FTA Competitiveness Analysis |
| Appendix M | BRT Funding Opportunities |

List of Figures

| | <u>Page</u> |
|---|-------------|
| Figure 1 Annual and Projected Ridership Growth | 2 |
| Figure 2 2019 Regional Transit Network.... | 5 |
| Figure 3 Benefits of Bus Rapid Transit..... | 12 |
| Figure 4 Tiered Evaluation Process | 24 |
| Figure 5 Routes with more than 1 Million Annual Boardings | 26 |
| Figure 6 Tier 1 Candidate Corridors for Evaluation..... | 28 |
| Figure 7 Tier 1 Evaluation Results by Corridor Segment..... | 31 |
| Figure 8 Tier 2 Routes for Evaluation..... | 33 |
| Figure 9 Tier 2 Route Scoring | 37 |
| Figure 10 Tier 2 Route Performance | 38 |
| Figure 11 Tier 3 Routes for Evaluation..... | 40 |
| Figure 12. Physical Viability for Dedicated Transit Lane by Route | 42 |
| Figure 13 Community Support for BRT – Summary of Findings | 43 |
| Figure 14 Tier 4 Routes for Evaluation..... | 48 |
| Figure 15 Estimated 2040 Travel Time Savings | 59 |
| Figure 16 Tier 4 Modeling Results | 60 |
| Figure 17 Facility Capital Costs..... | 61 |
| Figure 18 Fleet Capital Costs..... | 61 |
| Figure 19 Next Generation Technology Readiness..... | 62 |
| Figure 20 Households in Poverty | 63 |
| Figure 21 Economic Development Potential | 64 |
| Figure 22 2019 Bus Incident Map | 65 |
| Figure 23 Small Starts Competitive Analysis Summary Score | 67 |
| Figure 24 Regional BRT Network | 79 |
| Figure 25 2040 Jobs and Population Density | 83 |

List of Tables

| | <u>Page</u> |
|--|-------------|
| Table 1 RTD Minimum Service Frequency | 9 |
| Table 2 BRT Feasibility Metrics | 21 |
| Table 3 Metrics for Candidate Corridor Identification | 26 |
| Table 4 Corridors Identified for BRT by Other Studies | 27 |
| Table 5 Tier 1 Evaluation Criteria and Guiding Principles | 29 |
| Table 6 Tier 2 Route Descriptions | 34 |
| Table 7 Tier 2 Evaluation Criteria and Guiding Principles | 36 |
| Table 8 Tier 3 Evaluation Criteria and Guiding Principles | 39 |
| Table 9 Community Policy Support for Tier 3 Routes | 45 |
| Table 10 Tier 3 Route Evaluation Summary | 46 |
| Table 11 Tier 4 Evaluation Criteria and Guiding Principles | 49 |
| Table 12 Implementation Considerations | 81 |

Acknowledgements

Project Technical Advisory Committee

- Brian Welch, RTD—Project Manager
- Doug Monroe, RTD
- Jeff Becker, RTD
- David Krutsinger, CDOT
- Matthew Helfant, DRCOG

Consultant Team

- FHU, Prime Consultant
- CTG, Transit Planning
- APEX, Technology Assessment
- Parsons, Small Starts Assessment
- EPS, Economic Analysis
- Headwaters Economics, Social Equity Analysis
- Peter Koonce, Technology Assessment



1.1 Regional Bus Rapid Transit Feasibility Study

As the Denver metropolitan area continues to experience rapid population growth, the transportation system's ability to adequately satisfy the needs of the traveling public is being tested. More and more travel demand is being placed on a largely built-out regional roadway network, residents and visitors are increasingly desirous of alternatives to the personal automobile, and competition for funding is intense. Demand for transit in the region, illustrated in **Figure 1**, may double by 2040. With this projection in mind, coincident with the transportation challenges facing jurisdictions throughout the region, the Regional Transportation District (RTD) recognizes the need to explore opportunities for new services. Bus Rapid Transit (BRT) stands out among the array of existing and envisioned transportation options as a practical, equitable, and sustainable solution for enhancing regional mobility.

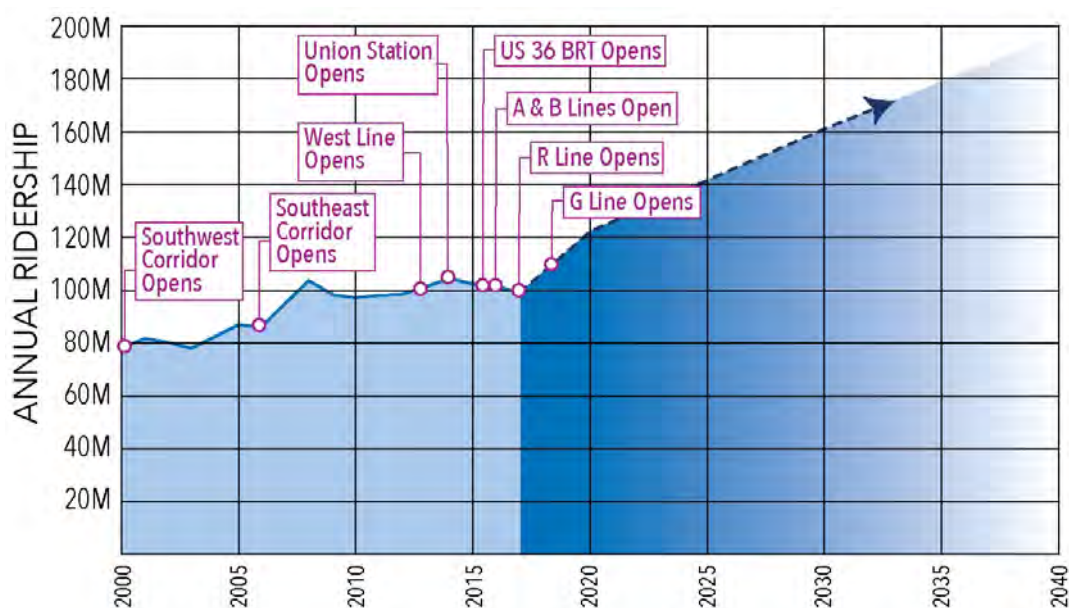
BRT offers benefits that well complement the mobility, economic, and quality of life goals of

PURPOSE OF REGIONAL BRT FEASIBILITY STUDY

- ◆ Understand increases in regional travel demand
- ◆ Assess the viability of pursuing Small Starts funding to support the region's transportation demands
- ◆ Identify opportunities to leverage existing investments
- ◆ Identify BRT investments that complement local and regional planning goals

many communities. Combining many of the amenities and operational advantages of intensive, capital-heavy transit investment with a footprint that often fits within existing curb lines, BRT is both an effective and efficient option for enhancing traditional fixed-route bus service – reduced travel times and congestion levels, higher person-carrying capacity of the transportation system, and economic catalyzation can all be realized from BRT investment.

Figure 1. Annual and Projected Ridership Growth



A regionwide strategy for establishing a BRT network can help integrate and enlist the support of the communities which RTD serves to build the partnerships necessary to capture funding opportunities for the region.

This Regional BRT Feasibility Study developed and followed a data-driven evaluation process that combined the desire to develop an integrated network of BRT routes for the region with a specific objective to identify opportunities for pursuing

federal funds. Those routes identified as most likely to compete for Small Starts funding were further evaluated using performance metrics provided in the Small Starts process to understand the strengths and opportunities of each one. However, these routes are not necessarily the most ready to progress. Stakeholder and community partnerships that can help leverage state and local funding opportunities are key to the successful implementation of any route.

The two primary tasks of this effort involve:

1. Development of a long-term regional BRT network vision that enhances regional mobility and acts as a roadmap for implementation of BRT improvements through partnerships between local agencies and RTD.
2. Identification of the most promising BRT projects that RTD and local partners can move into project development with Federal Transit Administration (FTA) in pursuit of Small Starts grant funding .

1.2 Evolution of Transit in the Region

For most of the 20th century, public transportation in the metro area was provided by an amalgam of private tramway and bus operators. In 1969, recognizing the need for a more coordinated, efficient, and regional authority of transit, the Colorado General Assembly created RTD; voters approved a 0.5 percent sales tax increase four years later to provide a dedicated funding stream for transit improvements and expansion; the RTD sales tax was subsequently increased to 0.6 percent in 1983. RTD expanded services throughout the region over the following decades, including initiation of 16th Street Mall service in 1982. Rail transit returned to the region with the opening of the Central Corridor light rail line connecting 30th & Downing to I-25 & Broadway in 1994. Expansion of rail service continued throughout the 1990s and into the millennium, with the Southwest Corridor line opening in 1999 and the Central Platte Valley Line in 2002.

T-REX

The Transportation Expansion (T-REX) Project was a \$1.67 billion venture to implement a host of transportation infrastructure improvements, including the Southeast light rail line, to the I-25 corridor between downtown Denver and Lone Tree. RTD partnered with the Colorado Department of Transportation (CDOT), federal agencies, and affected municipalities to develop two voter-approved bond measures to fund the project, which was completed in 2006. Transit elements included 19 miles of new light rail track, 13 new stations, and 34 new light rail vehicles.

FasTracks

In 2004, voters approved the FasTracks ballot measure. This multibillion-dollar transit expansion plan included an ambitious list of projects aimed at substantially enhancing the connectivity, convenience, and comfort of RTD's network.

Much progress has been made in building out the FasTracks vision. The past five years have seen the grand reopening of Union Station, now a central multimodal hub for the region, the debut of Flatiron Flyer and University of Colorado A Line services, and the opening of new rail connections to Lone Tree, Aurora, Golden, and Arvada. **Figure 2** shows the 2019 regional transit network.

While there is still work to be done to complete FasTracks, it is also time for RTD to look ahead toward opportunities to capitalize on this significant investment and further enhance transit service in the region. With few practical locations for additional fixed-guideway service remaining in the metro area, BRT offers a promising and proven alternative for expanding the reach of the high-frequency transit network beyond the existing and planned rail lines. Providing seamless connections of potential BRT routes to existing and planned rail stations was a point of emphasis.

NOTABLE FASTRACKS PLAN ELEMENTS

- ◆ Light rail service to Golden and Aurora
- ◆ Commuter rail service between downtown Denver and the Denver International Airport
- ◆ Commuter rail service to the metro area's northern communities
- ◆ Renovation of Union Station
- ◆ Bus Rapid Transit service along US 36

Legend

- Existing Bus Network
- Existing and Funded RTD High Capacity Transit Line
- Future RTD High Capacity Transit Line
- High Capacity Transit Station

0 5 Miles

NORTH

5

The Future of Transit

Given the breakneck pace of technological innovation in the transportation industry, the role of transit is sure to evolve in the coming years. Autonomous vehicle technology and micro-mobility services are among the still emerging technologies with potentially great ramifications for the future of transit. As RTD works to build out a network of BRT routes, it is closely monitoring the continued development of these technologies and remains diligent in identifying how they can best be integrated with its services to benefit the region.

Predictions about when autonomous vehicles will establish a significant market presence and how they will integrate with other modes run the gamut; it will be years before some clarity is brought to their role in transportation. Nevertheless, it is judicious to consider the impacts they may have on a regional BRT network. While autonomous vehicles have the potential to result in substantial operational efficiency improvements compared to human-operated

personal vehicles, they still cannot match the person-carrying capacity of transit. As such, by removing human drivers from the roadway and boosting overall efficiency of the transportation system, autonomous vehicles may help make high-quality, frequent transit service more convenient, reliable, and attractive. Autonomous bus technology is also actively being developed and tested, offering the potential to further enhance transit operations and reduce operating costs.

Micro-mobility services, such as shared e-scooter and e-bike programs, which have exploded in popularity in the past few years, represent a major opportunity for solving the “first and last mile” problem of closing the gap between transit stops and a person’s origin and/or destination. As new BRT routes are planned and developed, considerations for how to efficiently integrate these services at station locations may result in a more accessible and successful route.



Source: RTD

1.3 RTD Family of Services

2019 Transit Network Characteristics

RTD is the primary transit operator in the metro area, with a 2,300-square-mile service area now spanning eight counties and 40 municipalities and covering a population of more than three million people. The region is diverse in terms of population densities, land uses, and transportation commute flows.

RTD services include 8 light rail lines, 3 commuter rail lines, 1 BRT corridor, and more than 100 local and regional bus routes. RTD also offers special FlexRide, Access-a-Ride, SportsRide, SkyRide, and SeniorRide services. The network operates as a hybrid hub-and-spoke system, with downtown Denver acting as the central hub to which surrounding communities are linked via bus and rail. The existing rail lines primarily run parallel to interstates and other major highways. Bus routes are provided on arterials, collectors, and local streets. Outside downtown, the bus routes are typically spaced every one-half to one mile. Annual boardings across all RTD services were over 95 million in 2018, with approximately 335,000 boardings on an average weekday.

RTD's bus routes generally run at least every 30 minutes throughout the day, with several routes along major arterials running every 10 or 15 minutes. Most all-day service begins between 4:00 AM and 6:00 AM and operates until between 10:00 PM and 12:00 AM. Route 15 on East Colfax Avenue operates 24 hours a day. The light rail lines operate on 15- to 30-minute frequencies from approximately 5:00 AM until 12:00 AM. Sections of the light rail system shared by multiple lines offer service as frequent as every 5 to 7 minutes during peak operating hours. The Flatiron Flyer regional BRT routes primarily operate every 15 to 30 minutes, with increased frequencies of 10 minutes or less during peak commute hours. In 2018, the total operating budget to manage all services was approximately \$675 million.

RTD Service Standards

RTD maintains a set of standards to ensure consistency in the evaluation of services and to optimize the use of RTD resources. The standards and criteria are reviewed and revised as needed in response to changes in resources or agency goals. Specific productivity standard values are updated every year with the latest available data.

RTD defines service and context-specific standards for the following service classes:

CBD Local – Local routes serving downtown Denver

Urban Local – Local routes with 35 percent or more of length within a one-quarter mile buffer of areas with population + employment density of 12 or more per acre

Suburban Local – All other local routes

Regional – High-speed routes on limited access highways with distances of 6 or more miles

FlexRide – General public demand-responsive service within a defined geographic service area, characterized by passengers arranging for pick-up in advance

Rail – High-capacity rail service typically operating within exclusive right-of-way

Mall – Free, high-frequency route along the 16th Street Mall between Union Station and Civic Center Station

Access-a-Ride – Americans with Disabilities Act (ADA) complementary paratransit service for passengers with disabilities

Vanpool – Service allowing geographically clustered commuters to ride together to and from work in a van driven by one of the commuters

The annual review identifies those routes most in need of service changes, frequency changes, and/or additional marketing. Route elimination is a last resort if other cost-effective solutions for improvement are not available. The standards are not meant to prevent the implementation of improvements to routes. Proposed new services are evaluated with the same criteria but are not expected to meet productivity standards for at least 12 months after operation commences.

Service standards include ridership and economic measures. The primary values used to assess effectiveness and productivity are passenger boardings per hour, passenger boardings per trip, and subsidy per passenger boardings. Routes generally operate according to the frequency standards defined in **Table 1**. Additional standards are provided for demand-responsive service, reliability, geometric design, shelter placement, accessibility, shuttles, and service of vulnerable and protected populations.

Table 1. RTD Minimum Service Frequency

| Service Type | Span of Service | Minimum Frequency |
|--|---|-------------------|
| Local – Peak period | Mon – Fri 6:00 AM to 9:00 AM and 3:00 PM to 6:00 PM | 30 minutes |
| Local – Off peak below 25% boardings per hour | Weekday midday (9:00 AM to 3:00 PM) | 60 minutes |
| Local – Off peak above 25% boardings per hour | Weekday midday (9:00 AM to 3:00 PM) | 30 minutes |
| Local | Evenings and weekends | 60 minutes |
| Regional to CBD | 3 peak trips, Mon – Fri. Trips target 7:00, 7:30, 8:00 AM shift work start times and 4:00, 4:30, 5:00 PM shift end times. | |
| Rail & Enhanced Bus—Weekday | Weekday 6:00 AM to 6:00 PM | 15 minutes |
| Rail & Enhanced Bus—Weekday evenings and Saturdays | Weekday evenings 6:00 PM to 11:00 PM and Saturday | 30 minutes |
| Rail & Enhanced Bus—Late night | Night after 11:00 PM | 60 minutes |
| Rail & Enhanced Bus—Sundays and holidays | Sunday and holidays | 60 minutes |
| SkyRide | 3:00 AM to 1:00 AM daily | 60 minutes |

Source: RTD Transit Service Policies and Standards, 2016

BRT Services

RTD’s service standards do not currently include BRT but rather group BRT into Enhanced Bus services. However, BRT and Enhanced Bus are not equal when pursuing Small Starts funding. FTA defines two categories of BRT service: Corridor-Based and Fixed Guideway. Due to its higher potential for substantial travel time savings, RTD has a preference for investing in Fixed Guideway BRT. RTD is likely to include a BRT-specific service type in future service standard updates.

CORRIDOR-BASED BRT

- Separated right-of-way not required for the entire corridor
- Bidirectional services for a substantial part of weekdays
- Substantial investment in a single route within a defined corridor
- Defined stations
- Transit signal priority for buses
- Short headway times

FIXED GUIDEWAY BRT

- Majority of project operating in a separated right-of-way dedicated for public transportation use
- Bidirectional services for a substantial part of weekdays and weekend days
- Substantial investment in a single route within a defined corridor
- Defined stations
- Transit signal priority for buses
- Short headway times

1.4 Bus Rapid Transit

bus rapid transit (BRT)

/bəs 'rapəd 'tranzət/

noun



a high-quality bus-based transit system that delivers fast and efficient service that may include dedicated lanes, busways, transit signal priority, off-board fare collection, elevated platforms and enhanced stations (*Federal Transit Administration, 2017*).

BRT yields greater ridership than traditional bus transit services with similar frequencies at a fraction of the cost of light rail, heavy rail, streetcar, subways, and other high-end transit services. BRT offers many of the benefits of these high-end transit services by avoiding travel delays associated with being stuck in traffic that slow regular bus services. BRT also boasts many of the amenities of high-end transit by providing patrons with enhanced stations, innovative vehicles, state-of-the-art technologies, and modern branding and marketing.

Transit Cooperative Research Program (TCRP) Report 118 notes that BRT costs between \$10 and \$27 million per mile in comparison to light rail, which is approximately \$50 million per mile. BRT is also more flexible than fixed-guideway service because buses can travel anywhere a roadway network exists and routing can be readily modified to adapt to new and changing land uses.

Capital investment options for BRT include a combination of treatments intended to reduce transit vehicle delay, such as:

- ◆ Dedicated bus travel lanes to allow transit vehicles to move along busy corridors without experiencing delays associated with traditional vehicular congestion,
- ◆ Transit bypass lanes in segments of a corridor to allow buses to move around

traffic congestion,

- ◆ Queue jumps at intersections to allow buses to move around queueing traffic at congested intersections,
- ◆ Transit signal priority (TSP) to give transit vehicles priority through signalized intersections,
- ◆ Pre-signal bypass lanes to allow buses to move around traffic congestion in areas where space prohibits use of queue jumps or transit bypass lanes, and
- ◆ In-line transit stations to limit transit vehicle delays associated with merging into traffic.

Operationally, BRT services have faster travel times when compared to typical bus services because of reduced travel delays along the route due to the facilities described above, as well as lengthier stop spacing. Passenger drop-off and pick-up are streamlined with the creation of enhanced transit stops with level boarding and pre-purchased tickets. Together these ensure that BRT services are competitive with private automobile travel and that service is reliable and convenient for the traveling public.

1.5 Regional Benefits of Bus Rapid Transit

Investment in BRT services along key travel corridors will expand high-quality transit options that are competitive with private automobile travel. New BRT corridors will provide all-day, high-frequency transit service designed to serve a significant portion of residents' trip patterns, including commuting, shopping, and recreational trip purposes. These improvements can help to expand the share of people using transit, resulting in environmental, social, and economic benefits to the region. **Figure 3** shows how BRT contributes to improved personal and community health.

Environmental Benefits

BRT systems can have positive environmental impacts through their potential to reduce greenhouse gas emissions and local air pollutants by reducing the demand for single-occupancy vehicle trips, leading to improved regional air quality. The 2040 Denver Regional Council of Governments (DRCOG) Regional Transportation Plan cites that more than 14.4 million total person trips (all modes) are made each day in the metro area. The average transit rider produces half as many pounds of carbon dioxide per passenger mile as a private automobile driver/rider according to the FTA (0.45 vs. 0.96, respectively). Additionally, BRT buses are incorporating modern fuel efficiency technologies, including electric power, and better driver training to contribute to lower fuel consumption and emissions.

Social Benefits of BRT

PRODUCTIVITY

Within one year of being enhanced from a standard transit corridor, the Woodhaven-Cross Bay Boulevards Select Bus Service route in Queens, New York saw a 5-8% increase in ridership and 9-10% reduction in bus travel times.

HEALTH

Health benefits include those related to better air quality and increased physical activity afforded by taking public transit. Transit users average about three times as much walking as compared to private automobile users (Litmann, 2019).

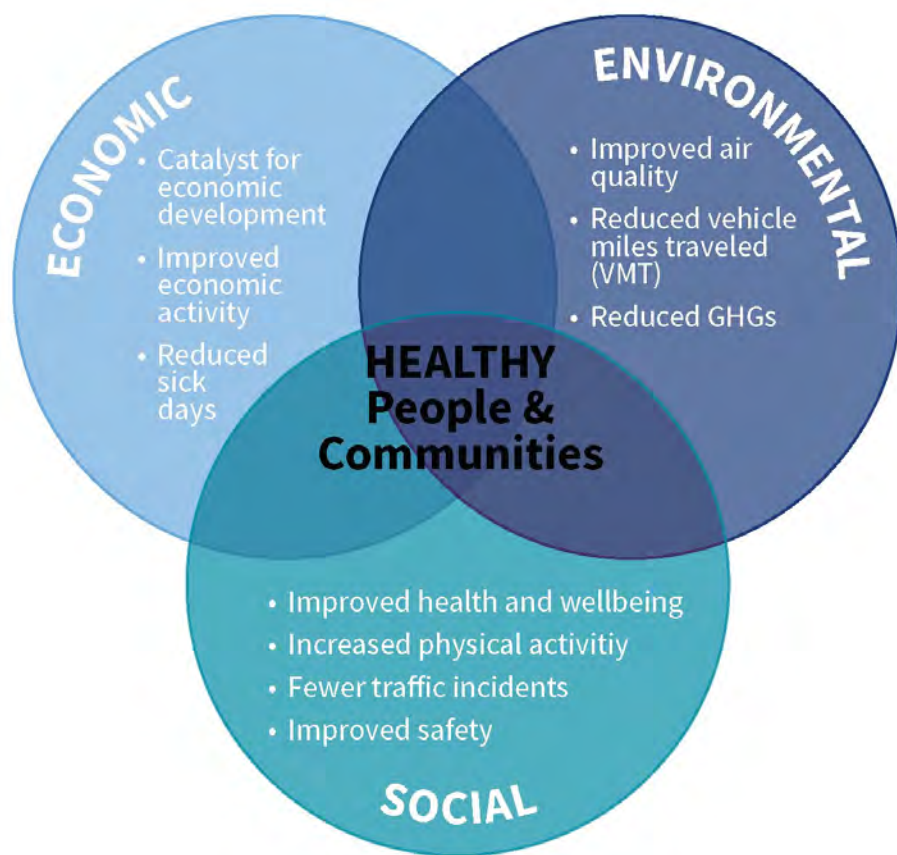
SAFETY

There was a 6% reduction in injury crashes corridor-wide one year after implementation of the Woodhaven-Cross Bay Boulevards Select Bus Service route in Queens.

Economic Benefits

Many studies have linked the relationship between economic development and investment in BRT. This has led to BRT being a catalyst for economic development for many global communities that have implemented BRT systems. BRT systems are being used globally as a focal point or “backbone” to guide urban growth and economic development according to Cervero and Dai (2014). In the National Study of BRT Development Outcomes, Nelson and Ganning (2015) analyzed development within one-half mile of 12 BRT corridors in the United States between 2000 and 2007 and between 2008 and 2015 and found that BRT corridors observed a statistically significant increase in the share of new development in comparison to non-BRT corridors .

Figure 3. Benefits of Bus Rapid Transit





2.0

STAKEHOLDER &
PUBLIC ENGAGEMENT

2.1 Stakeholder Engagement

A multi-pronged stakeholder engagement effort supported development of the Regional BRT Feasibility Study. Given the geographic spread of RTD, it was imperative that stakeholders representing the perspectives and needs of the entire metropolitan area were represented during the process.

A Technical Advisory Committee (TAC) led the study process and included staff members from RTD, CDOT, and DRCOG. The TAC met bi-monthly and guided overall project direction, gave input on the development of project goals and guiding principles, and steered all technical evaluation elements of the study.

To maximize participation in the study process, the TAC recommended that results and findings from the evaluation process be presented to stakeholder groups that represent different needs and perspectives of existing and potential transit users in the metro area. As a result, the findings from the evaluations were presented to the following stakeholder groups:

- RTD Board of Directors
- DRCOG Board of Directors
- DRCOG Technical Advisory Committee
- DRCOG Regional Transportation Committee

Another critical component to the stakeholder engagement effort was the participation of staff and representatives from local communities throughout the District. To maximize efficiency, the BRT study leveraged RTD's existing Local Government Planning meetings to provide ongoing updates about the BRT study and to obtain input from agency representatives. The BRT team attended three meetings with this group throughout the planning process.

As the study progressed and candidate BRT corridors were identified, the project team conducted additional outreach with local agencies to further understand overall community support for BRT. The project team developed Community Policy Support profiles for 20 local agencies – each of which would be served by one or more of the BRT routes in the Tier 3 evaluation. The Community Policy Support profiles were sent to the

STAKEHOLDER INPUT RESPONSES

- Added all Northwest Area Mobility Study (NAMS) corridors to Candidate Corridor and Tier 1 evaluations
- Tested corridor evaluation methodology utilized on proposed BRT routes against Colfax, US 36, and SH 119 for accuracy
- Extended Federal Boulevard route to 120th Avenue
- Added passenger miles traveled to Tier 2 evaluation metrics
- Added Sheridan Boulevard to Tier 3 evaluation
- Developed a comprehensive regional BRT network
- Included Colorado Boulevard in Tier 4 evaluation

TIER 4 ROUTE BUS TOUR

Project team members led a bus tour of the final BRT routes under evaluation in Tier 4. This allowed RTD staff and key stakeholders to further refine routes and to understand the context of the recommendations, identify physical viability issues and opportunities, and observe existing and proposed land use.



planning director and/or planning staff at each agency for review and were revised and edited as needed based on agency comments.

The project team also developed an online survey that was distributed to all communities that would be impacted by a Tier 3 corridor. Survey questions asked about a community's transit policies and planning and willingness to implement transit supportive investments. Follow up phone calls and meetings were held with agencies as needed to further discuss community support and the physical viability of BRT on the identified Tier 3 BRT corridors. A one-day corridor bus tour of Tier 4 BRT corridors was conducted to engage local communities in the process and to understand issues and opportunities related to design, land use, and public sentiment.



WHAT WE DID

4 Local government planning meetings

3 RTD board meetings

3 DRCOG board meetings

3 DRCOG Regional Transportation Committee (RTC) meetings

3 DRCOG Technical Advisory Committee (TAC) meetings

1 North Area Transportation Alliance (NATA) meeting

1 Tour (8 routes, 11 communities)

1 Survey (25 community responses)

24 Interviews (in person and phone)

1 Social media campaign

1 CDOT coordination meeting

1 Northwest/US 36 RTD general manager/elected officials meeting

2.2 Public Engagement

RTD's Local Government Planning meetings provided an opportune venue for the project team to meaningfully engage with agency representatives of citizens throughout the District. Furthering the reach of the project, a dedicated webpage was created on RTD's website to serve as a landing page for overall study information and to provide an opportunity for the public to provide comments related to the BRT study. The outcomes of the evaluations were posted to the webpage for public review and comment.

All stakeholder and public comments submitted via the project website, directly to RTD staff or the consultant team were documented and responded to throughout the study process. All comments were documented in a tracking spreadsheet with all associated responses.

Early in the planning process, the project team also crafted a three-week social media campaign to promote the project to the general public and drive traffic to the project webpage. Social media posts were created for Facebook, Instagram, Twitter, and blogs and the campaign materials were distributed to RTD and local agency Public Information Officers for distribution.

RTD SCHEDULES SERVICES RIDER INFO FARES & PASSES PROJECTS search

TOOLS

REGIONAL BUS RAPID TRANSIT FEASIBILITY STUDY

As the metro area becomes more congested, RTD has partnered with the Colorado Department of Transportation (CDOT) and the Denver Regional Council of Governments (DRCOG) to conduct the Regional Bus Rapid Transit Feasibility Study. The study will explore opportunities to implement bus rapid transit service throughout the region to address growing travel demand and support current and future RTD FasTracks projects. The study will identify and prioritize BRT projects based on analysis of ridership demands, transit operational needs, corridor feasibility, cost and benefit considerations.

Bus rapid transit (BRT) service is high-frequency bus service that emulates rail transit, and provides fast and reliable service on a dedicated route. For the purpose of the study, BRT service will be consistent with the Federal Transit

Please provide your questions or comments below concerning the Regional Bus Rapid Transit Feasibility Study. *

First Name * Last Name *

<http://www.rtd-denver.com/BRT-study.shtml>

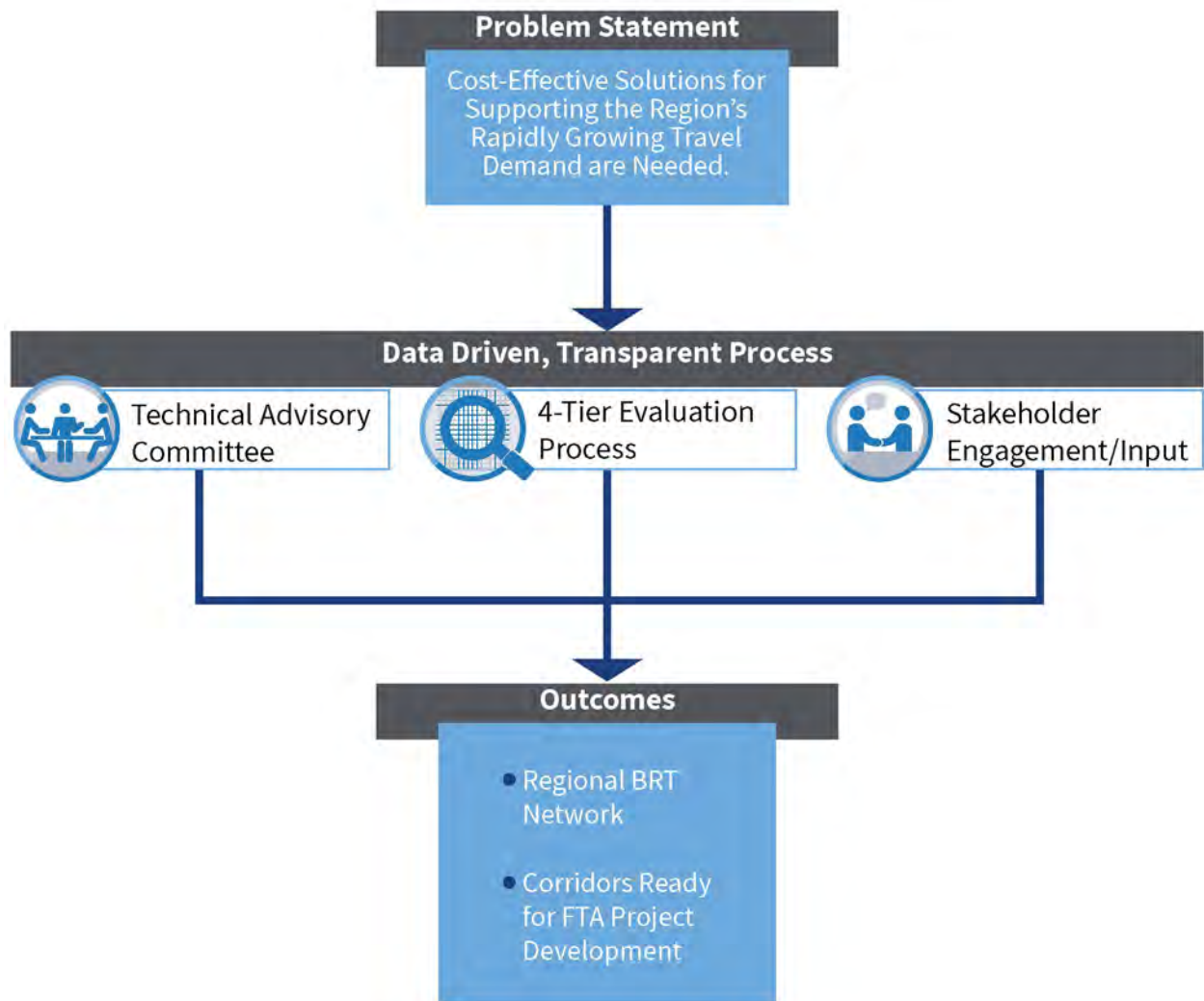




Evaluating the Region's Potential for BRT

The Regional BRT Feasibility Study followed an inherently data-driven process to analyze and assess the suitability of corridors throughout the District for BRT implementation. Four progressively more intensive and focused tiers of evaluation, supplemented with robust stakeholder engagement and structured to align with a set of guiding principles for the study, were conducted to establish a complete and comprehensive understanding of relative strengths, opportunities, and constraints along each potential route. From projected ridership to potential travel time savings to estimated capital and maintenance costs, a diverse array of factors was investigated to inform the ultimate outcomes: an envisioned regional BRT network, and identification of specific routes ready for FTA project development.

3.1 Regional BRT Study Process

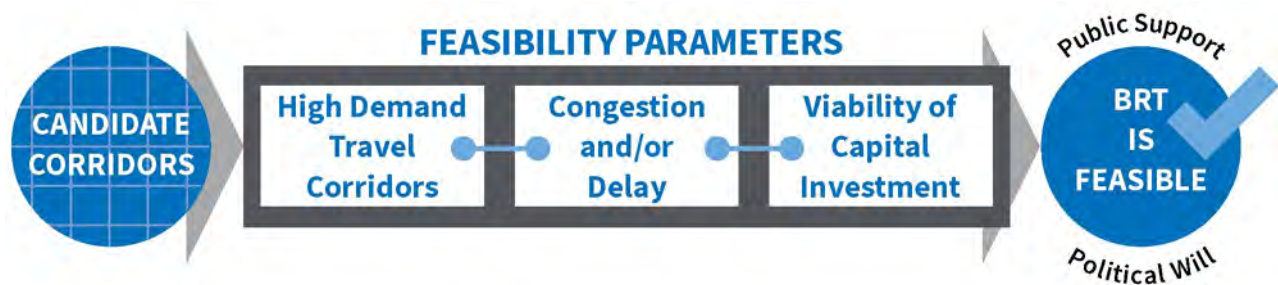


Note: BRT routes along Colfax Avenue and SH 119 are already included in DRCOG's 2040 Metro Vision Regional Transportation Plan. As such, they were assumed to already be part of the regional BRT network and did not receive further evaluation during this study.

To understand the potential for BRT, the project team considered many data points. The process was initiated by detailing the multitude of available data and the key feasibility parameters that have shown a positive correlation toward the development of successful BRT services.

The first step was to identify all potential Candidate BRT Corridors throughout the region. This inclusive process considered all corridors that demonstrated some potential to support BRT services, now and in the future. To narrow down the Candidate Corridors, the project team used feasibility parameters intended to identify routes with high demand, the presence of traffic congestion and/or delay, and those with high viability for capital investment. Ultimately, the regional network and the routes with the most promise to move into project development will require public support and political will, a process presented in the diagram below.

Table 2 identifies the metrics used in the four-tiered evaluation process to identify the feasibility of implementing BRT. The checkmarks indicate the metrics that were analyzed during each phase of the study.



Note: BRT routes along Colfax Avenue and SH 119 are already included in DRCOG's 2040 Metro Vision Regional Transportation Plan. As such, they were assumed to already be part of the regional BRT network and did not receive further evaluation during this study.

3.2 Goals, Outcomes, and Guiding Principles

To guide the process, a framework of project goals and desired outcomes was developed with the TAC. This framework included a set of principles to guide the TAC in developing strategies and making decisions.

The evaluation process was designed to reflect the guiding principles through specific evaluation criteria in a four-tiered process. Each guiding principle was substantiated through a progressively more rigorous evaluation of potential corridors in each tier, resulting in a focus on BRT routes with the most opportunity for successful implementation.

PROJECT GOALS

1. Development of a regional BRT network that enhances mobility and acts as a roadmap for implementation of BRT improvements through partnerships between local agencies and RTD.
2. Identification of the most promising Fixed-Guideway BRT projects that RTD and local partners can move into project development and initiate discussions with Federal Transit Administration (FTA) in pursuit of Small Starts grant funding.

Guiding Principles for BRT Development

1. Provides connectivity and access
2. Increases ridership
3. Enhances expandability, equity, and sustainability
4. Ensures cost-effectiveness
5. Aligns with state and local agency recommendations
6. Considers technological innovation/Smart Cities
7. Adheres to FAST Act BRT definition
8. Integrates engineering/operational feasibility/safety
9. Acknowledges potential environmental impacts
10. Capitalizes on financial resources

Table 2. BRT Feasibility Metrics

| | TIER 1  CANDIDATE CORRIDORS | TIER 1  HIGH DEMAND TRAVEL CORRIDOR | TIER 2  CONGESTION AND/OR DELAY | TIER 3  VIABILITY OF CAPITAL & OPERATIONAL IMPROVEMENTS | TIER 4  DETAILED EVALUATION |
|--|---|---|--|---|---|
| GUIDING PRINCIPLES | | | | | |
| Connectivity & Access | | | | | |
| Physical and/or operational connections | | | | ✓ | |
| Connectivity to other transportation modes | | ✓ | | | |
| Equitable access | | | | | ✓ |
| Highest ridership compared to most congestion | | | ✓ | | |
| Ridership Metrics | | | | | |
| Daily/annual boardings | ✓ | | | | |
| Travel time comparison | | | ✓ | | |
| Reliability | | | ✓ | | |
| Passenger safety | | | | ✓ | |
| Boardings/revenue vehicle hour | | ✓ | | | ✓ |
| Most congestion with most passengers | | | ✓ | | ✓ |
| Greatest impact in near-term | | ✓ | | | ✓ |
| Expandability, Equity & Sustainability | | | | | |
| Ridership growth/future ridership potential | ✓ | ✓ | | | ✓ |
| Integration with TOD | | ✓ | | | ✓ |
| Consistency with corridor character | | | | ✓ | |
| Station area population & employment | | ✓ | | | ✓ |
| Service to underserved communities | | ✓ | | | ✓ |
| Cost Effectiveness | | | | | |
| Annualized cost per rider | | | | | ✓ |
| Route productivity | | ✓ | | | ✓ |
| Eligibility for funding | | | | | ✓ |
| Annualized capital & O&M | | | | | ✓ |
| State & Local Agency Compatibility | | | | | |
| Receptiveness of stakeholder agencies | | | | ✓ | |
| Cohesion with local land use plans | ✓ | ✓ | | | |
| Technological Innovation/Smart Cities | | | | | |
| Opportunities for advanced technologies | | | | ✓ | ✓ |
| Adherence to FAST Act BRT Definition/ Capitalize on Financial Resources | | | | | |
| Project Characteristics | | | | ✓ | |
| Engineering/Operation Feasibility/Environmental Impacts | | | | | |
| Traffic impacts | | | | ✓ | ✓ |
| Parking impacts | | | | ✓ | ✓ |
| ROW impacts | | | | ✓ | ✓ |
| Bicycle & pedestrian impacts | | | | ✓ | ✓ |
| Congestion relief | | ✓ | ✓ | | ✓ |
| Corridor safety | | | | | ✓ |
| Drainage impacts | | | | | ✓ |
| Noise impacts | | | | | ✓ |
| Environmental benefits | | | | | ✓ |
| Neighborhood impacts | | | | | ✓ |

This page intentionally left blank.

3.3 Tiered Evaluation

A tiered evaluation methodology guided route development and analysis and provided a data-driven approach to developing the regional BRT network vision. The tiered evaluation methodology was also structured to identify the most promising BRT projects for RTD and local partners to move into project development in pursuit of FTA Small Starts funding grants. The evaluation process was designed with the understanding that BRT feasibility depends on:

1. Demonstrated and potential corridor travel demand,
2. The presence of congestion or delays in corridors with demonstrated demand,
3. The ability to mitigate bus delays through a capital and/or operating investment, and
4. Community support for BRT investment and the trade-offs associated with the project.

Tiered Evaluation Steps

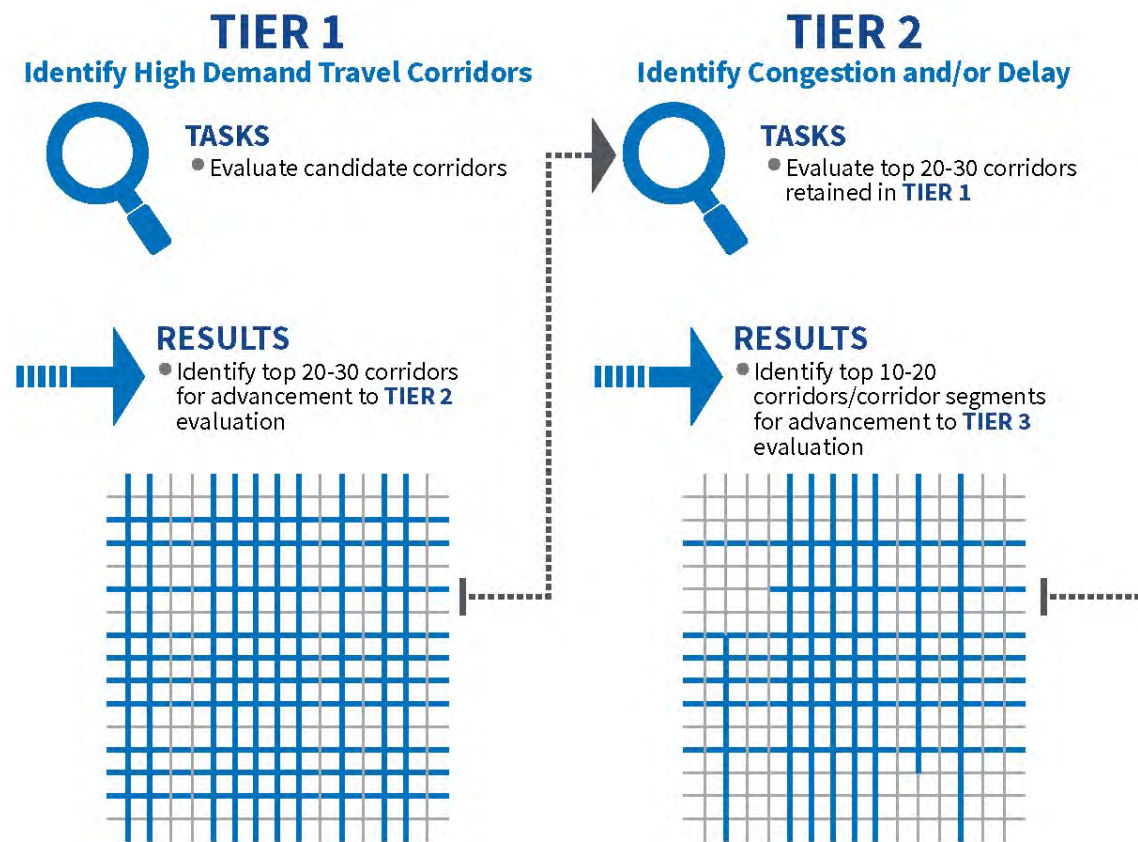
- ◆ Tier 1 – Identify High Demand Travel Corridors
- ◆ Tier 2 – Identify Locations with Congestion and/or Delay
- ◆ Tier 3 – Identify the Viability of Capital Investment
- ◆ Tier 4 – Final Evaluation

TIERED EVALUATION SUMMARY SHEETS

Evaluation summary sheets for Tiers 2, 3, and 4 provide route-specific summaries of the evaluation. **Appendix C** and **Appendix E** provide Tier 2 and Tier 3 summary sheets, respectively, while Tier 4 summary sheets are provided in **Section 3.7**.

The project team established evaluation criteria in each tier that built off the project guiding principles. **Figure 4** illustrates the evaluation process, and **Table 3** summarizes how the criteria within each tier link to the project guiding principles.

Figure 4. Tiered Evaluation Process



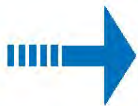
TIER 3

Identify Viability of Capital Investment



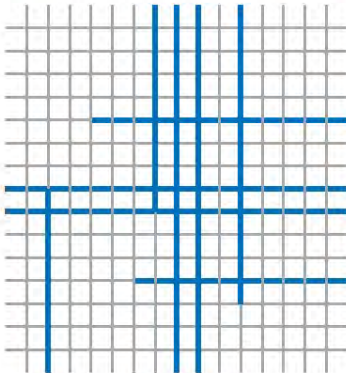
TASKS

- Evaluate top 10-20 corridors/corridor segments retained in **TIER 2**



RESULTS

- Identify top 5-10 corridors/corridor segments for advancement to **TIER 4** evaluation



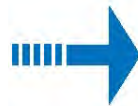
TIER 4

Conduct Final Evaluation



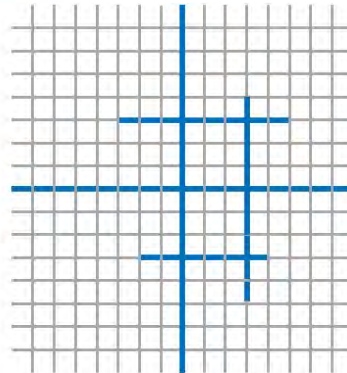
TASKS

- Evaluate 5-10 corridors/corridor segments retained in **TIER 3**



RESULTS

- Identify multiple corridors for near-term BRT investment



3.4 Tier 1 – High Demand Travel Corridors

Tier 1 Candidate Corridor Identification

The first step in the feasibility study was to identify a set of Candidate Corridors for consideration. This step was inclusive and considered all corridors that demonstrated some potential to support BRT. **Table 3** identifies the three metrics and the associated guiding principles used to develop a comprehensive list of potential corridors to be evaluated. Corridors meeting one or more of these three criteria were included.

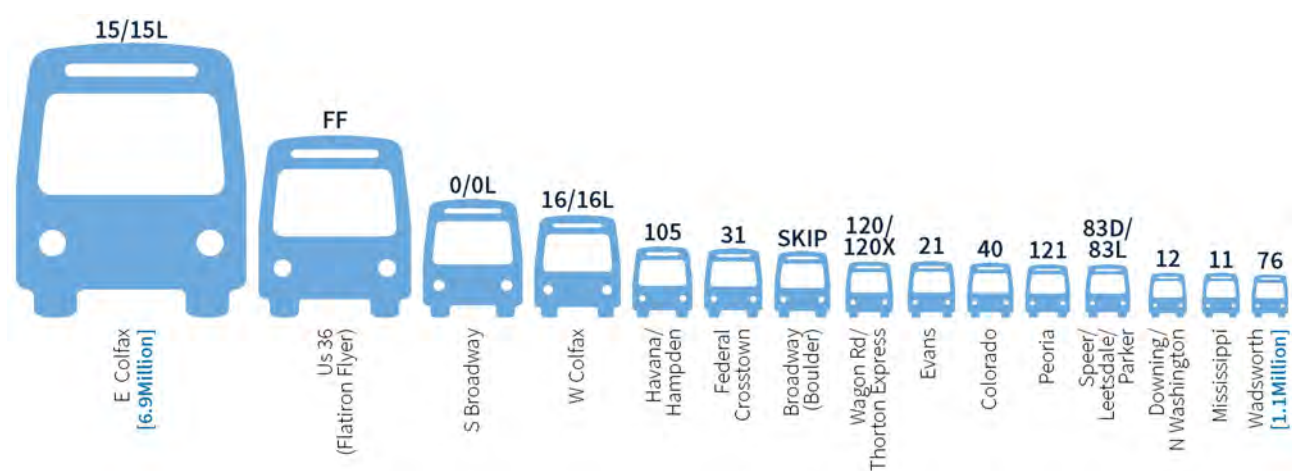
Existing RTD Route Ridership

The project team used RTD's 2016 annual route ridership to identify all routes with more than 1 million annual boardings. This included the top 10 to 15 percent of RTD's fixed-route bus services when measured by boardings. **Figure 5** illustrates the routes included in this analysis.

Table 3. Metrics for Candidate Corridor Identification

| Evaluation Criteria | Associated Guiding Principles |
|---|--|
| Existing RTD Bus Routes with 1 Million or More Boardings Annually in 2016 | ⇒ Provides connectivity and access |
| Corridors Identified for BRT in Other Studies | ⇒ Increases ridership |
| Roadways Projected to Carry 40,000 Vehicles per Day or More in 2040 | ⇒ Aligns with state and local agency recommendations |

Figure 5. Routes with more than 1 Million Annual Boardings



Corridors Identified for BRT by Local Studies

The team reviewed transportation studies throughout the region as part of the Existing Conditions Report documentation (**Appendix B**). **Table 4** identifies studies recommending BRT-like service throughout the region. Inclusion in community plans indicates the potential for the corridor to support BRT and that local community support exists. **Figure 6** shows the identified Candidate Corridors.

2040 Vehicle Volumes

The team used raw travel demand model volumes to identify roads projected to carry 40,000 vehicles per day or more in 2040. High-quality BRT service along these roadways may capture 5 percent of the travel demand and, therefore, could support BRT.

Figure 6 also provides a map of all three metrics combined, which was the basis for the Tier 1 evaluation. As shown in the figure, SH 119 and Colfax Avenue BRT routes are already included in DRCOG's fiscally constrained plan; as such, they did not receive further analysis in this study.

Table 4 Corridors Identified for BRT by Other Studies

| Corridor | Study |
|------------------|---|
| SH 119 | SH 119 BRT Study, Northwest Area Mobility Study |
| US 287 | Northwest Area Mobility Study |
| SH 7 | Northwest Area Mobility Study, SH 7 BRT Study |
| South Boulder Rd | Northwest Area Mobility Study |
| 120th Ave | Northwest Area Mobility Study |
| SH 42 | Northwest Area Mobility Study |
| Park Ave | Denver Moves: Transit |
| Colfax Ave | Denver Moves: Transit |
| Speer/Leetsdale | Go Speer Leetsdale |
| Federal Blvd | Denver Moves: Transit |
| Broadway/Lincoln | Denver Moves: Transit |
| Colorado Blvd | Denver Moves: Transit |
| SH 2 | Northeast Area Transit Evaluation, 2040 Metro Vision Regional Transportation Plan |
| Arapahoe Rd | Centennial Transportation Master Plan |
| RidgeGate Pkwy | Mainstreet Fixed Guideway Study |

Tier 1 Evaluation

In Tier 1, we evaluated the Candidate Corridors to identify the segments of corridors that have the potential to serve the most users and, therefore, would have the highest ridership potential. **Table 5** identifies the criteria used to assess ridership potential.

Table 5 Tier 1 Evaluation Criteria and Guiding Principles

| Criteria | Associated Guiding Principles |
|--|---|
| 1. 2040 Population | ⇒ Provides connectivity and access ⇒ Ensures cost-effectiveness ⇒ Increases ridership |
| 2. 2020–2040 Population Growth | |
| 3. 2040 Employment | |
| 4. 2020–2040 Employment Growth | |
| 5. Regional Destinations | |
| 6. 2040 Population plus Employment Density | |
| 7. Tolled or Managed Lanes | |

The project team obtained 2020 and 2040 population and employment data from the DRCOG Focus 2.1 Model. Regional destinations were identified through a combination of existing spatial data sources, including RTD's Quality of Life Study, which uses DRCOG 2017 InfoGroup point data, as well as DRCOG education data. The data for the first five criteria were divided into quartiles indicating the lowest 25 percent to the highest 25 percent within ½ mile of the Candidate Corridor segments.

The final criterion, Tolled or Managed Lanes, includes all Candidate Corridor segments classified as a toll or a managed road according to the DRCOG 2040 Metro Vision Regional Transportation Plan. This parameter was prioritized during Tier 1 to capitalize on managed lanes that future BRT may be able to use, ultimately resulting in higher travel time reliability.

CORRIDOR SEGMENT ANALYSIS

For evaluation purposes, Candidate Corridors were broken into segments at intersecting Candidate Corridors. A ½ -mile buffer was then created around all Candidate Corridor segments to assess data within a reasonable walking distance of all potential future BRT services. The area of influence for interstate facilities was extended to one mile to account for the wide width of the interstate. All data was equalized on a per mile basis.

Each Candidate Corridor segment was scored across all seven evaluation criteria. Segments were scored as follows:

- ♦ For Criteria 1-5, a segment “scored” if it ranked in the top quartile.
- ♦ For Criterion 6, a segment “scored” if it met the desired combined population and employment density of greater than 17 per acre.
- ♦ For Criterion 7, a segment “scored” if it had a toll and/or managed lane facility.

Figure 7 shows the number of criteria (Categories) for which each segment “scored” according to the methodology outlined above.

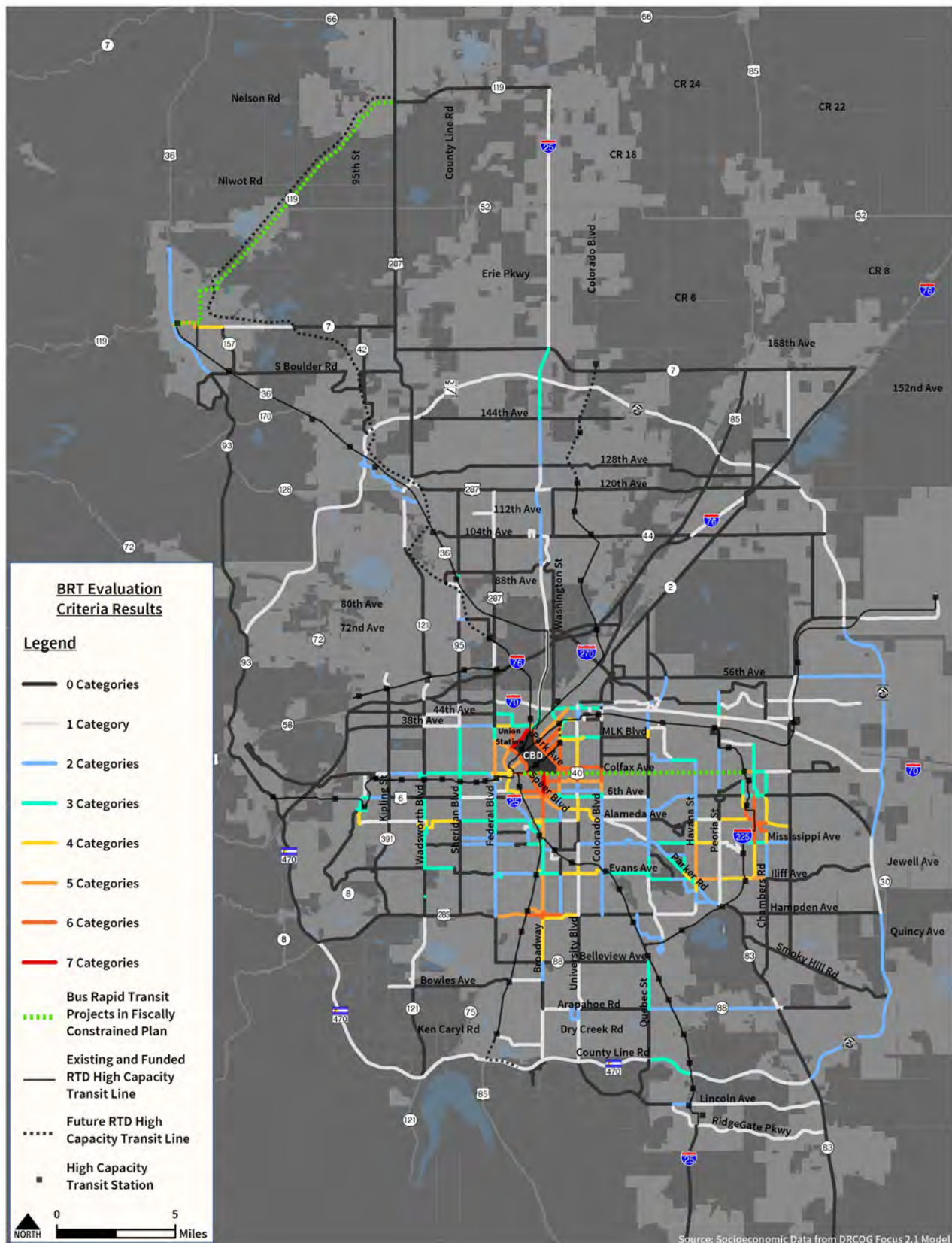
VALIDATION OF METHODOLOGY

Figure 6 and **Figure 7** include two BRT routes included in DRCOG’s 2040 Metro Vision Regional Transportation Plan: SH 119 BRT and Colfax BRT. To substantiate the study’s evaluation methodology, the Tier 1 evaluation was performed on these routes to determine if they would be identified as having the potential for BRT. Both routes met one or more of the Tier 1 evaluation criteria and would have been retained using this study’s methodology.



Source: RTD

Figure 7. Tier 1 Evaluation Results by Corridor Segment



3.5 Tier 2 – Congestion and/or Delay

Tier 2 Route Development

Corridor segments that performed the best during the Tier 1 analysis served as the starting point for creating potential BRT routes for Tier 2 evaluation. Other considerations during BRT Tier 2 route creation included:

- ◆ Supporting and connecting existing regional rapid transit investments (e.g., FasTracks and other Rapid Transit services)
- ◆ Supporting regional park-n-ride facilities by providing BRT service to existing users where significant travel densities occur
- ◆ Facilitating regional origin-destination travel patterns

Twenty-nine routes were developed to progress into the Tier 2 evaluation (**Figure 8**). Routes were numbered, generally, from the northwest to southeast across the region, starting with north-south oriented routes, then east-west oriented routes (Tier 2 – Route 1 (T2-1)). **Table 6** describes the routes and the existing and planned investment and key destinations they serve.

LEVERAGING EXISTING INVESTMENTS

Leveraging existing and planned investments was a focus in Tier 2 route development. This included connecting to existing and planned rapid transit investments, stations, park-n-rides, and community activity centers throughout the region. Each route was designed to originate at, terminate at, and travel through stations to the maximum extent feasible along the identified alignment.

Figure 8. Tier 2 Routes for Evaluation

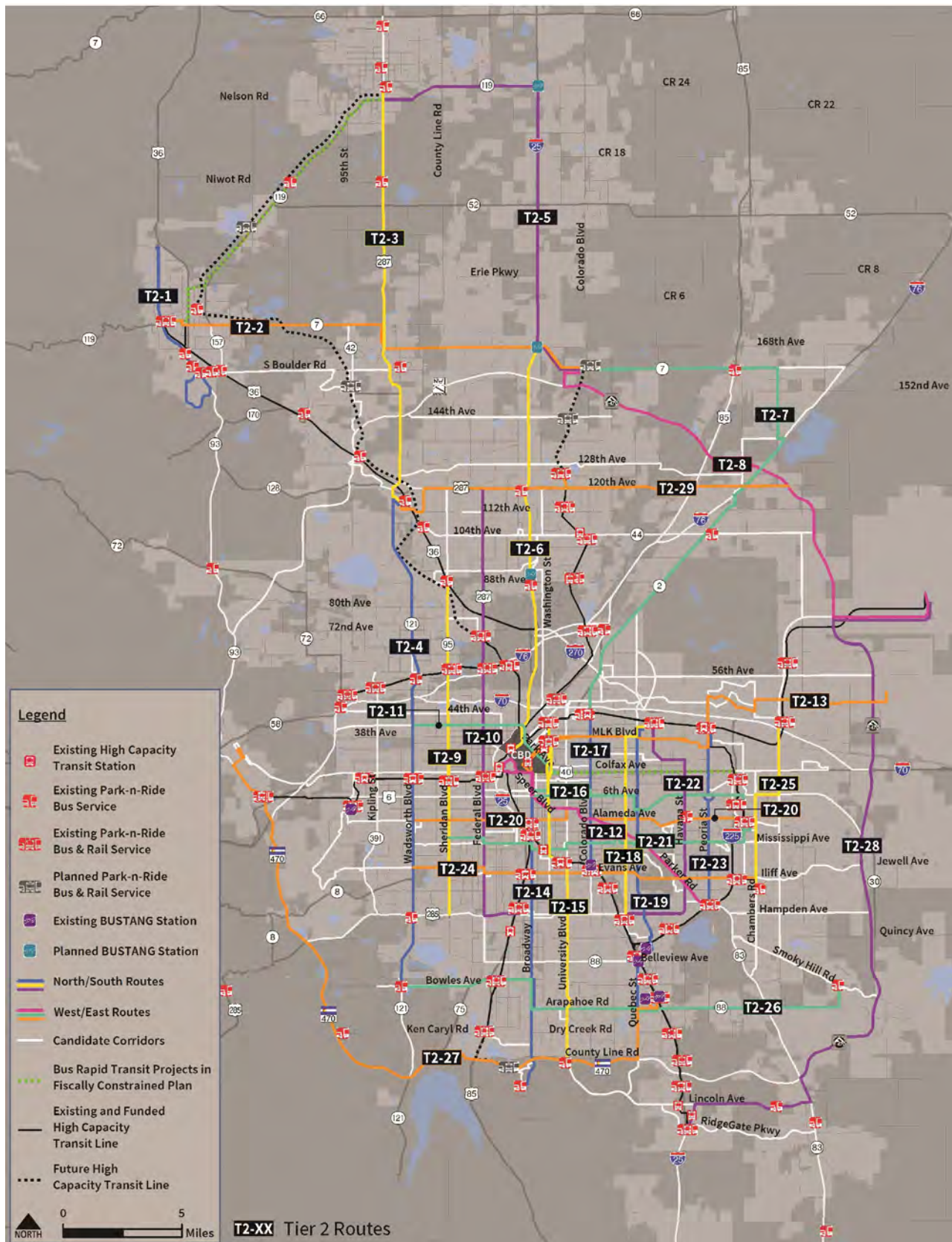


Table 6. Tier 2 Route Descriptions

| No. | Route Name | Existing and Planned Investments | Key Destinations Served |
|-------|---------------------------|--|---|
| T2-1 | Broadway (Boulder) | <ul style="list-style-type: none"> ◆ Flatiron Flyer connections at the Boulder Station ◆ Planned SH 119 route ◆ 27th Way/Broadway, Boulder Church of Nazarene, 39th Street/Table Mesa, US 36/Table Mesa Park-n-Rides in Boulder | North Boulder, downtown Boulder, and south Boulder |
| T2-2 | State Highway 7 (SH 7) | <ul style="list-style-type: none"> ◆ CDOT's Bustang at I-25/SH 7 ◆ RTD's planned N-line at the route's northern terminus | Boulder, Lafayette, Erie, and Thornton |
| T2-3 | US 287 | <ul style="list-style-type: none"> ◆ Flatiron Flyer at US 36 & Church Ranch Station ◆ Planned SH 119 BRT route in south Longmont ◆ US 287/Niwot Park-n-Ride | Longmont, Lafayette, and Broomfield |
| T2-4 | Wadsworth Boulevard | <ul style="list-style-type: none"> ◆ Flatiron Flyer at Wadsworth & US 36 ◆ G-line in Downtown Arvada ◆ W-line at the Wadsworth Station ◆ Park-n-Rides at Hampden Ave and Bowles Ave | Broomfield, Westminster, Arvada, Wheat Ridge, Lakewood, and west Denver |
| T2-5 | North I-25 (Longmont) | <ul style="list-style-type: none"> ◆ Longmont US 287/SH 119 Park-n-Ride ◆ CDOT's Bustang at I-25/SH 119 and I-25/SH 7 | South Longmont and the north metro area |
| T2-6 | North I-25 (Thornton) | <ul style="list-style-type: none"> ◆ Wagon Road and Thornton Park-n-Rides ◆ CDOT's Bustang at I-25/SH 7, I-25/Thornton Parkway and Union Station | North metro area and downtown Denver |
| T2-7 | State Highway 2 (SH 2) | <ul style="list-style-type: none"> ◆ Planned N-line's north terminus at SH 7 & Colorado Blvd ◆ A-line at the 40th & Colorado Station ◆ US 85/Bridge Street and 104th/Revere Park-n-Rides | Brighton, Commerce City, and Denver |
| T2-8 | North E-470 | <ul style="list-style-type: none"> ◆ Planned N-line's north terminus at SH 7 & Colorado Boulevard | North metro area and Denver International Airport |
| T2-9 | Sheridan Boulevard | <ul style="list-style-type: none"> ◆ Flatiron Flyer at Sheridan & US 36 ◆ G-line at 60th & Sheridan at the Arvada Gold Strike Station ◆ W-line at the Sheridan Station | Westminster, Arvada, Denver, and Lakewood |
| T2-10 | Federal Boulevard | <ul style="list-style-type: none"> ◆ B-line at the Westminster Station ◆ G-line at the Clear Creek & Federal Station ◆ W-line at the Decatur & Federal Station ◆ Southwest Line at the Southmoor Station | Westminster, Federal Heights, and Denver |
| T2-11 | 38th / Park | <ul style="list-style-type: none"> ◆ Planned Colfax BRT route | Northwest and downtown Denver |
| T2-12 | Speer / Leetsdale/ Parker | <ul style="list-style-type: none"> ◆ H- and R-lines and Park-n-Ride at the Nine Mile Station | Denver, Cherry Creek, southeast Denver, and Aurora |
| T2-13 | MLK / Green Valley Ranch | <ul style="list-style-type: none"> ◆ A-line at the Peoria Station | Downtown and northeast Denver |
| T2-14 | Broadway / Lincoln | <ul style="list-style-type: none"> ◆ I-25 & Broadway Station ◆ Highlands Ranch Town Center Park-n-Ride | Denver, Englewood, Centennial, Littleton, and Highlands Ranch |

Table 6. Tier 2 Route Descriptions (continued)

| No. | Route Name | Existing and Planned Investments | Key Destinations Served |
|-------|--------------------------|---|---|
| T2-15 | University Boulevard | <ul style="list-style-type: none"> ◆ A-line at the 38th & Blake Station ◆ Planned Colfax BRT route at Colfax/Downing ◆ Southeast line at the University of Denver Station ◆ E-470/University Park-n-Ride | Denver, Englewood, Cherry Hills Village, Greenwood Village, Centennial, and Highlands Ranch |
| T2-16 | 6 th Avenue | <ul style="list-style-type: none"> ◆ W-line at the Decatur & Federal Station ◆ R-line at the 2nd Avenue & Abilene Station | Denver and Aurora |
| T2-17 | Colorado Boulevard | <ul style="list-style-type: none"> ◆ A-line at the 40th & Colorado Station ◆ Southeast line's Colorado and Southmoor Stations ◆ CDOT's Bustang at Colorado Station | Denver, Cherry Creek, Glendale, and Cherry Hills Village |
| T2-18 | Monaco Parkway | <ul style="list-style-type: none"> ◆ A-line at the Central Park Station ◆ Southeast line at the Southmoor Station | North and south Denver |
| T2-19 | Quebec Street | <ul style="list-style-type: none"> ◆ A-line at the Central Park Station ◆ Southeast line at the Bellevue Station | North Denver and the Denver Tech Center (DTC) |
| T2-20 | Alameda Avenue | <ul style="list-style-type: none"> ◆ Southeast/Southwest line at the Alameda Station and the R-line at the Aurora Metro Center Station | Lakewood, Denver, Cherry Creek, Glendale, and Aurora |
| T2-21 | Mississippi Avenue | <ul style="list-style-type: none"> ◆ Southeast line at the Louisiana & Pearl Station ◆ R-line at the Aurora Metro Center Station | Lakewood, Denver, and Aurora |
| T2-22 | Havana Street | <ul style="list-style-type: none"> ◆ A-line at the Central Park Station ◆ Southeast line at the Southmoor Station ◆ Alameda/Havana Park-n-Ride | Denver's Stapleton neighborhoods, Denver, and Aurora |
| T2-23 | Peoria Street | <ul style="list-style-type: none"> ◆ A-line at the Peoria Station ◆ R- and H-lines at the Nine Mile Station | North and south Aurora |
| T2-24 | Evans Avenue | <ul style="list-style-type: none"> ◆ Southwest line at the Evans Station ◆ Southeast line at the Colorado Station ◆ R-line at the Iliff Station ◆ Olympic Park Park-n-Ride | Lakewood, Denver, and Aurora |
| T2-25 | Chambers Road | <ul style="list-style-type: none"> ◆ A-line at the 40th & Airport Boulevard Station ◆ Olympic Park Park-n-Ride | North and south Aurora |
| T2-26 | Arapahoe Road | <ul style="list-style-type: none"> ◆ Southwest line at the Littleton Downtown Station ◆ Southeast line at the Arapahoe at Village Center Station ◆ Southwest Plaza and Smoky Hill/Picadilly Park-n-Rides | Littleton, Centennial, and Aurora |
| T2-27 | C-470 | <ul style="list-style-type: none"> ◆ W-line at the Jeffco Government Center Station in Golden ◆ Southeast line at the Arapahoe at Village Center Station ◆ Ken Caryl/C-470 and C-470/University Park-n-Rides | Golden, Centennial, and Greenwood Village |
| T2-28 | South E-470 | <ul style="list-style-type: none"> ◆ Southeast line at RidgeGate Parkway Station ◆ A-line at Denver International Airport ◆ Lincoln/Jordan Park-n-Ride | South metro area and Denver International Airport |
| T2-29 | 120 th Avenue | <ul style="list-style-type: none"> ◆ Flatiron Flyer at US 36 & Broomfield Station ◆ N-line at SH 7 & Colorado Blvd ◆ Wagon Road Park-n-Ride | Broomfield, Westminster, Northglenn, Thornton, Henderson, Brighton, and Commerce City |

Tier 2 Evaluation

In Tier 2, we analyzed the routes detailed in **Table 7** to determine those with high ridership potential and those that experience substantive delays or congestion or are projected to in the future. High ridership potential, delays, and congestion were evaluated using the metrics and associated project guiding principles identified.

EVALUATION SUMMARY SHEETS

Summary sheets were prepared for each of the 29 Tier 2 routes. **Appendix C** contains the route summary sheets.

Table 7. Tier 2 Evaluation Criteria and Guiding Principles

| Evaluation Criteria | Associated Guiding Principles |
|---|---|
| BRT Boardings per Revenue-Mile | ⇒ Increases ridership |
| BRT Passenger-Miles Traveled per Revenue-Mile | ⇒ Ensures cost-effectiveness |
| Percent of Route that is Severely Congested | ⇒ Integrates engineering/operational feasibility/safety |

Each Tier 2 route was evaluated using the 2040 RTD Travel Demand Model (model) to identify routes with the highest potential to support BRT-type service. Each Tier 2 route was run independently with the 2040 underlying transit network in the model using a universal set of operating characteristics (e.g., 10-minute headways operating 20 hours per day and stops located at all intersecting routes to ensure transferability). If a Tier 2 Route's alignment replicated or was similar to that of a route in the 2040 underlying network, that route was removed from the 2040 underlying network to ensure that ridership projections were optimized for potential BRT service.

Three metrics in alignment with the Federal Small Starts application criteria were used to score each Tier 2 Route:

- ♦ **BRT Boardings per Revenue-Mile** – Indicates the potential for a route to attract riders
- ♦ **BRT Passenger-Miles Traveled per Revenue-Mile** – Indicates the potential to serve longer trips
- ♦ **Percent of Corridor that is Severely Congested** – Identifies routes where congestion is prevalent and fixed guideway BRT would provide travel times more competitive with those of private autos

To compare each route, the evaluation results for each of these metrics were divided into quartiles. The top 25 percent of boardings per revenue-mile received a score of 4 and the lowest 25 percent received a score of 1. The same procedure was followed using passenger-miles traveled per revenue-mile and percent of route that is severely congested. The individual metric scores were then totaled.

Figure 9 displays the results of the scoring methodology. The relative score of each route is indicated after aggregating the quartile scores for each of the three-performance metrics. The lowest possible score is 3 (bottom quartiles for all three metrics), and the best possible score is 12 (top quartiles for all three metrics).

Figure 9. Tier 2 Route Scoring

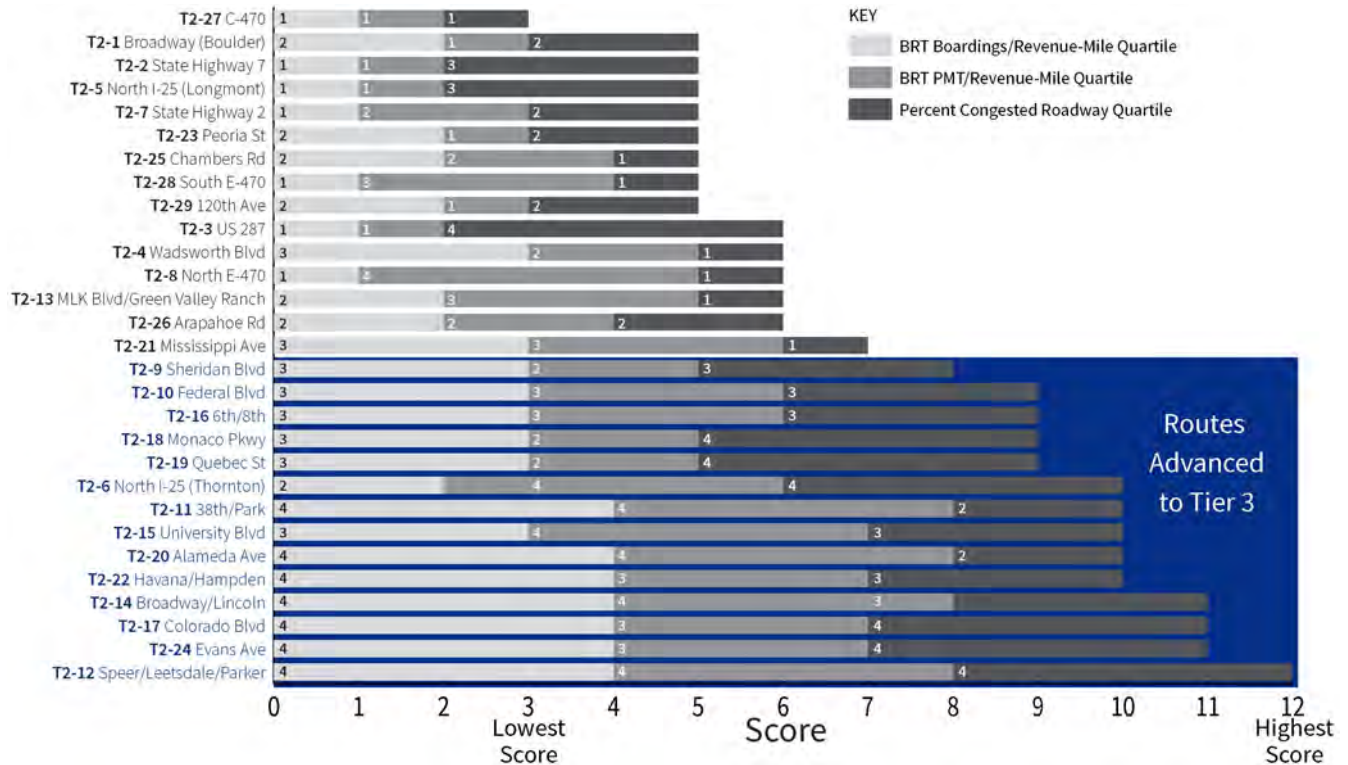
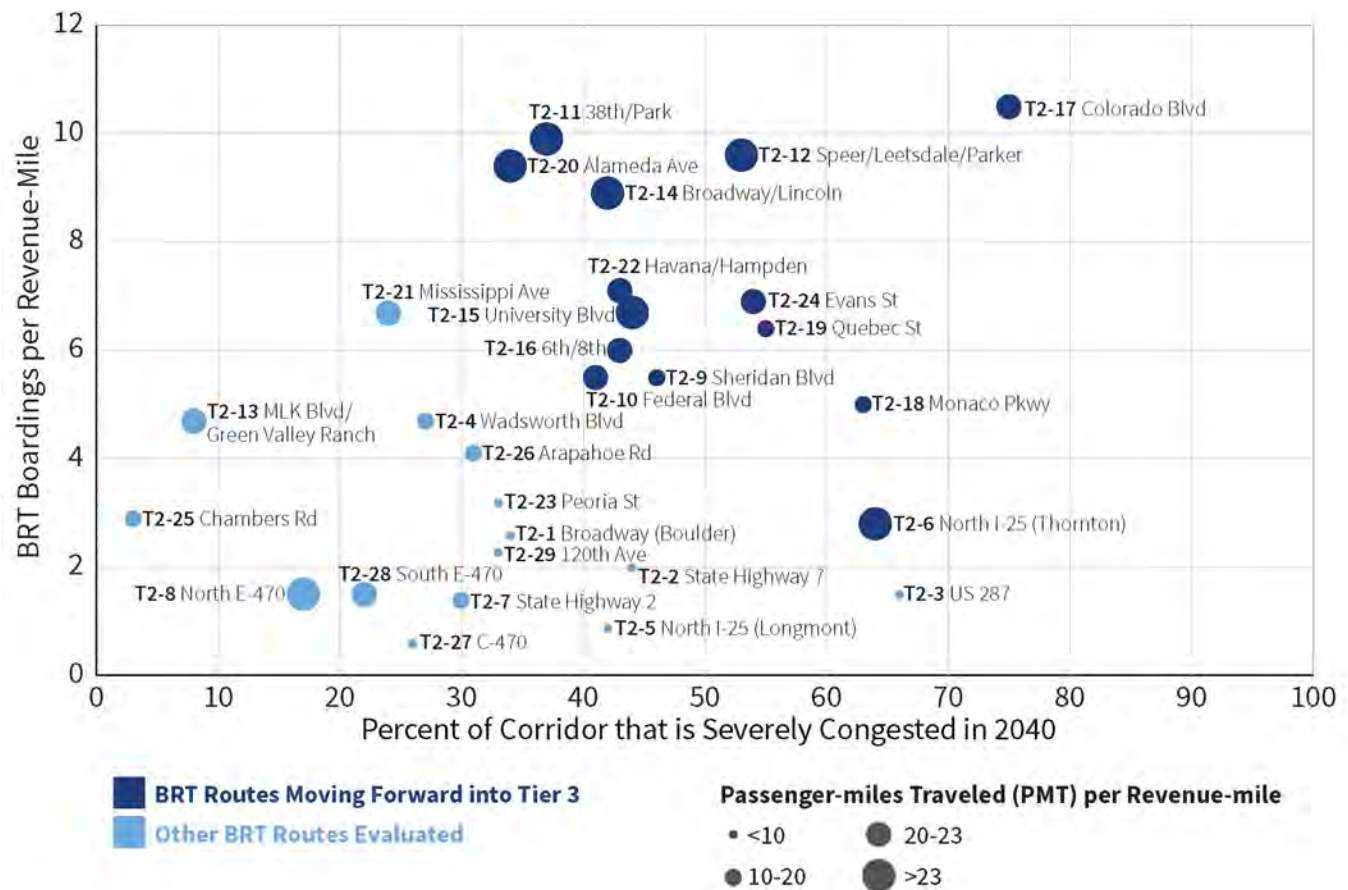


Figure 10 is a plot showing the relative performance of each of the 29 routes. This plot displays the three performance metrics, with routes moving forward to Tier 3 indicated in dark blue. Routes with high boardings per revenue-mile, high passenger-miles traveled per revenue-mile, and more congestion generally scored the highest.

Figure 10. Tier 2 Route Performance



3.6 Tier 3 – Viability of Capital Investment

Tier 3 Routes

The following 14 routes progressed from Tier 2 into Tier 3:

- ◆ 6th Avenue
- ◆ 38th/Park
- ◆ Alameda Avenue
- ◆ Broadway/Lincoln
- ◆ Colorado Boulevard
- ◆ Evans Avenue
- ◆ Federal Boulevard
- ◆ Havana/Hampden
- ◆ Monaco Parkway
- ◆ North I-25 (Thornton)
- ◆ Quebec Street
- ◆ Sheridan Boulevard
- ◆ Speer/Leetsdale/Parker
- ◆ University Boulevard

Figure 11 provides the Tier 3 routes in dark blue. Yellow and green routes on this map indicate existing and planned rapid transit projects throughout the region. The 14 Tier 3 routes travel through 24 communities.

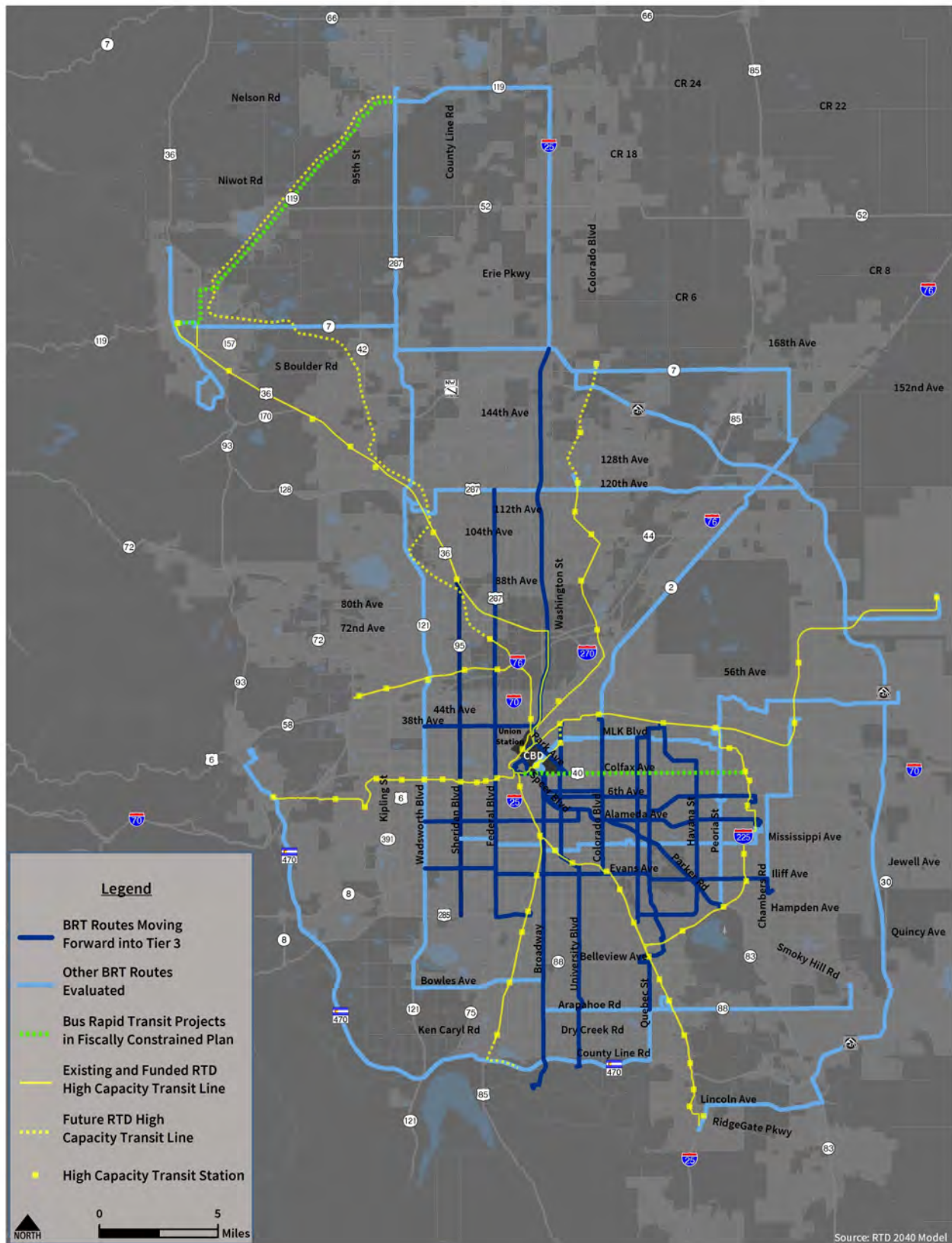
Tier 3 Evaluation

In Tier 3, we evaluated the physical viability and public support for BRT service on Tier 3 Routes to determine which routes have greater near-term BRT implementation potential. Physical viability and public support were evaluated using the following metrics and associated project guiding principles identified in **Table 8**.

Table 8. Tier 3 Evaluation Criteria and Guiding Principles

| Evaluation Criteria | Associated Guiding Principles |
|--|---|
| Right-of-way Availability | ⇒ Increases ridership |
| Viability of Lane Repurposing | ⇒ Aligns with state and local agency recommendations |
| Viability of Exclusive or Semi-exclusive Lanes | ⇒ Adheres to FAST Act BRT definition |
| Potential for Competitive Travel Time to General Traffic | ⇒ Integrates engineering/operational feasibility/safety |
| Agency Support and Alignment with Plans/Policies | |

Figure 11. Tier 3 Routes for Evaluation



Tier 3 evaluated whether or not transit-only lanes were viable to support BRT service. While BRT service can exist in mixed-traffic travel lanes, FTA Small Starts eligible projects must be either a “Corridor-Based” or a “Fixed Guideway BRT” service, with dedicated facilities required on a portion of the project corridor.

Fixed Guideway service is more likely to see substantial travel time savings compared to traditional fixed-route bus service, so RTD is most interested in identifying corridors where it would be feasible. Therefore, the critical step in assessing each route’s viability in Tier 3 was to determine where separation of buses from general traffic would be practical. A physical viability assessment was completed, paired with an assessment of the community support for dedicated facilities along each Tier 3 route.

Findings were used to evaluate what percentage of each Tier 3 route’s length presents an opportunity for implementing dedicated transit lanes.

Assessment of Physical Viability

The Tier 3 evaluation focused on understanding the physical space along all routes. Tier 3 was initiated with the documentation of the existing and planned infrastructure along the 14 Tier 3 routes and focused on the availability of sufficient space within the existing right-of-way to accommodate dedicated transit facilities, such as transit-only lanes, business access transit lanes, and/or other transit supportive infrastructure. For this evaluation, it was assumed that dedicated transit lanes in both directions would require at least 24 feet of roadway width (i.e., one 12-foot lane in each direction).

Quantitative Metrics

The project team used many quantitative factors to determine the physical viability of BRT, including existing and planned elements along each route. The presence of quantitative data associated with each of the following features was gathered at approximately half-mile increments (analysis points):

- ◆ Right-of-way width
- ◆ Curb-curb width
- ◆ Through travel lanes
- ◆ Turn lanes
- ◆ Median types
- ◆ Parking lanes and widths
- ◆ Bike lanes and widths
- ◆ Sidewalks and widths
- ◆ Existing traffic volumes
- ◆ 2040 traffic forecasts

FIXED GUIDEWAY BRT*

Majority of project operating in a separated right-of-way dedicated for public transportation use

Bidirectional services for a substantial part of weekdays and weekend days

Substantial investment in a single route within a defined corridor

Defined stations

Transit signal priority for buses

** FTA also defines Corridor-Based BRT service; RTD has a preference for investing in Fixed-Guideway service due to its higher likelihood of reduced travel times*

Qualitative Considerations

Qualitative factors considered along each route included access control, location of dedicated park land (which would limit the likelihood of repurposing), truck route designations, and any programmed changes from DRCOG's Regional Transportation Plan and other plans.

Physical Viability Parameters

A series of parameters were used to determine which components of the existing cross sections, or right-of-way, present opportunities for repurposing lanes into dedicated transit facilities. These parameters established an order of preference (from most to least preferred):

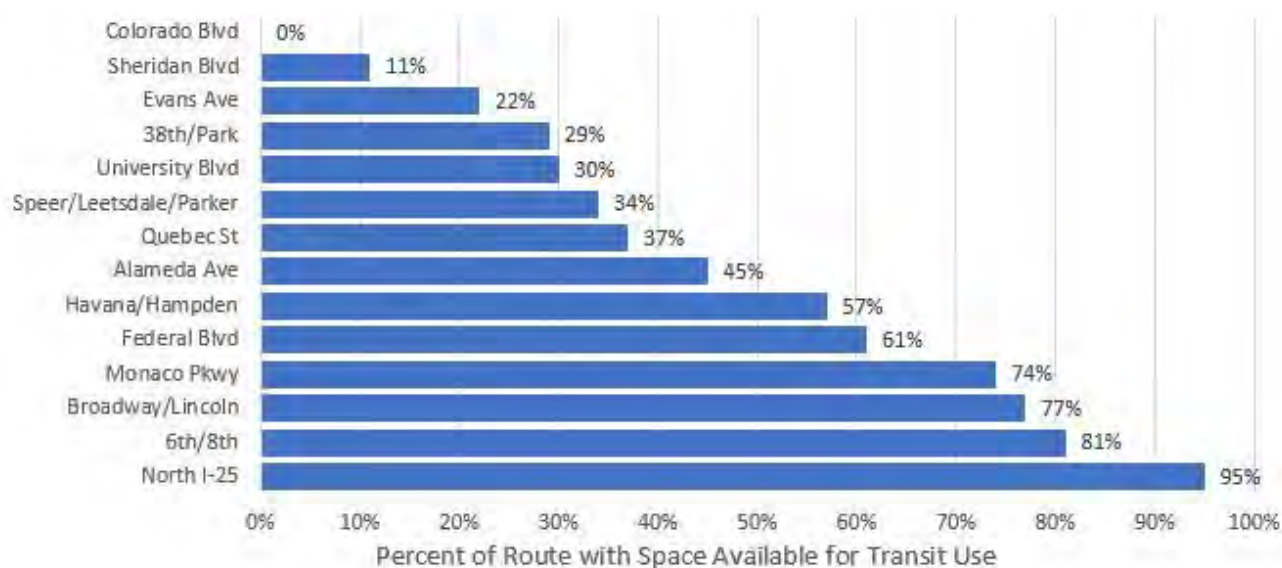
1. Existing vehicular through lanes, parking, medians, turn lanes, and/or shoulders
 - ♦ The existing and 2040 volume/capacity ratio could not exceed 1.2 as a result of repurposing through lanes (assuming a capacity of 12,000 vehicles per lane per day)
 - ♦ Existing left-turn lanes could not be repurposed except in situations with dual left-turn lanes
2. Existing right-of-way outside the street
3. Acquiring additional right-of-way

A cumulative process identified opportunities to repurpose vehicular through lanes (and how much space that would yield), followed by other street space (within the curb-to-curb space), other right-of-way (space outside the curb, such as a grass strip between the sidewalk and curb), and finally the potential for new right-of-way. This assessment sought to identify locations where repurposing 24 feet for transit use was viable at each analysis point. **Figure 12** provides the percent of each Tier 3 route that the assessment identified as having at least 24 feet of space available to repurpose for transit use.

EVALUATION SUMMARY SHEETS

Evaluation summary sheets were prepared for each of the 14 Tier 3 Routes, depicting the locations thought to have high, medium, and low likelihood to be repurposed for transit lane use (high likelihood areas have at least 24 feet, medium likelihood areas have between 12 and 23 feet, and low likelihood areas have less than 11 feet available for potential repurposing). Refer to **Appendix E** for the summary sheets and full technical details from the Tier 3 physical viability analysis.

Figure 12. Physical Viability for Dedicated Transit Lane by Route



Community Support Analysis

The second stage of the Tier 3 evaluation determined community support for BRT investment. This included a survey and policy review for the following communities, all of which contained a Tier 3 route:

- ◆ Arvada
- ◆ Aurora
- ◆ Broomfield
- ◆ Centennial
- ◆ Cherry Hills Village
- ◆ Denver
- ◆ Edgewater
- ◆ Englewood
- ◆ Federal Heights
- ◆ Glendale
- ◆ Greenwood Village
- ◆ Lakeside
- ◆ Lakewood
- ◆ Littleton
- ◆ Mountain View
- ◆ Northglenn
- ◆ Sheridan
- ◆ Thornton
- ◆ Westminster
- ◆ Wheat Ridge
- ◆ Adams County
- ◆ Arapahoe County
- ◆ Douglas County
- ◆ Jefferson County

Local Agency Survey

The project team developed an online survey to gather input from communities where one or more of the 14 Tier 3 routes would operate within their jurisdiction. The purpose of the survey was to gain input from a variety of perspectives at each agency, including planning, public works, and administration. The survey was sent to staff at all of the communities listed above.

The survey began with high-level questions about transportation/transit policy, complete streets plans, and general support for BRT through policy, planning, implementation, and/or funding.

Figure 13 shows the agencies that completed the survey and their corresponding responses about their community's overall support for BRT.

Figure 13. Community Support for BRT – Summary of Findings

| | DOES YOUR COMMUNITY HAVE AN: | | WHAT IS YOUR COMMUNITY'S LIKELIHOOD OF: | | | | | |
|--------------------------|------------------------------|---|---|------------------------|---------------|--|---|--|
| | Adopted Transportation Plan | Adopted Complete Streets Plans, Policies, and/or Guidelines | Policy Level Support | Planning Level Support | Staff Support | Financial Support for Capital Improvements | Financial Support for Annual Operations & Maintenance Costs | Elected Officials Prioritizing Transit Improvements on Candidate Corridors |
| Arvada | | ✓ | ○ | ● | ○ | ● | ● | ○ |
| Aurora | ✓ | ✓ | ○ | ● | ○ | ○ | ○ | ○ |
| Broomfield | ✓ | ✓ | ● | ● | ● | ● | ○ | ● |
| Centennial | ✓ | | ○ | ○ | ○ | ○ | ○ | ○ |
| Denver | ✓ | ✓ | ● | ● | ● | ● | ○ | ● |
| Greenwood Village | ✓ | | ○ | ○ | ● | ● | ● | ○ |
| Mountain View | | | ○ | ○ | ○ | ○ | ○ | ○ |
| Northglenn | | ✓ | ○ | ○ | ○ | ○ | ● | ○ |
| Sheridan | | | ○ | ○ | ○ | ○ | ○ | ● |
| Westminster | | ✓ | ● | ● | ● | ○ | ○ | ● |
| Wheat Ridge | | ✓ | ○ | ○ | ○ | ○ | ● | ○ |
| Adams County | ✓ | | ● | ● | ○ | ○ | ○ | ○ |

Source: RTD Regional BRT Local Agency Community Support Survey, February 2019

Survey responses not received from Cherry Hills Village, Edgewater, Englewood, Federal Heights, Glendale, Lakeside, Lakewood, Littleton, Thornton, Arapahoe County, Douglas County, Jefferson County

After providing general input on their community's overall support for BRT, each agency was asked to provide specific input on each BRT route that would operate in their community. For each route, the community was asked how likely they are to support:

- ◆ Converting general-purpose lanes for BRT
- ◆ Acquiring right-of-way
- ◆ Implementing queue jumps/bypass lanes
- ◆ Implementing transit signal priority (TSP)

NEIGHBORHOOD PLANNING INITIATIVES

The City and County of Denver has in-process or upcoming Neighborhood Planning Initiatives for the East, East Central, Far Southeast, Far Southwest, Near Northwest, Near Southeast, Southwest, and West regions. Since most of the envisioned BRT routes pass through at least one of these regions, transit considerations will be an important component of those plans.

Community Policy Review

In addition to the local agency survey, the project team reviewed community plans and policies to understand policy level support of BRT. Policy and planning documents were studied, and policies relating to the following questions from FTA's Small Starts Grant Program documentation requirements were identified:

1. Do **land use policies** promote transit supportive development?
2. Do **parking policies** promote transit supportive development?
3. Do **financial incentives** promote transit supportive development?
4. Do **affordable housing policies** promote transit supportive development?
5. Do **transportation policies** support BRT? (not an FTA Small Starts Grant documentation requirement)

The following documents were reviewed, as available, for each community:

- ◆ Zoning codes
- ◆ Comprehensive plans
- ◆ Corridor-specific plans
- ◆ Affordable housing plans
- ◆ Draft plans in progress
- ◆ Municipal codes
- ◆ Transportation/mobility master plans
- ◆ Climate action plans
- ◆ Policy statements

A community policy summary was developed for all communities that contain a Tier 3 route. Each community's policy summary included a list of specific routes that would travel through the community and any specific policy support for BRT type service on that route. **Table 9** presents the community support across all Tier 3 routes, and **Appendix D** provides policy summaries.

Table 9. Community Policy Support for Tier 3 Routes

| KEY | | CORRIDOR | | | | | | | | | | | | | |
|-------------|----------------------|-------------|-------------|------------------|---------------|-------------|--------------|-----------------|-------------|-----------------------|-------------|-------------|---------------|----------------------------|-----------------|
| COMMUNITIES | | 6th/8th | Alameda Ave | Broadway/Lincoln | Colorado Blvd | Evans Ave | Federal Blvd | Havana /Hampden | Monaco Pkwy | North I-25 (Thornton) | 38th/Park | Quebec St | Sheridan Blvd | Speer/Leetsdale/ Parker | University Blvd |
| | Arvada | | | | | | | | | | | | <div></div> | | |
| | Aurora | <div></div> | <div></div> | | | <div></div> | | <div></div> | | | | | | <div></div> | |
| | Broomfield | | | | | | | | | <div></div> | | | | | |
| | Centennial | | | <div></div> | | | | | | | | <div></div> | | | <div></div> |
| | Cherry Hills Village | | | | <div></div> | | | | | | | | | | <div></div> |
| | Denver | <div></div> | <div></div> | <div></div> | <div></div> | <div></div> | <div></div> | <div></div> | <div></div> | <div></div> | <div></div> | <div></div> | <div></div> | <div></div> | <div></div> |
| | Edgewater | | | | | | | | | | | | <div></div> | | |
| | Englewood | | | <div></div> | | <div></div> | <div></div> | <div></div> | | | | | | | <div></div> |
| | Federal Heights | | | | | | <div></div> | | | | | | | | |
| | Glendale | | | | <div></div> | | | | | | | | | <div></div> | |
| | Greenwood Village | | | | | | | | | | | <div></div> | | | <div></div> |
| | Lakeside | | | | | | | | | | | | <div></div> | | |
| | Lakewood | | <div></div> | | | <div></div> | | | | | | | <div></div> | | |
| | Littleton | | | <div></div> | | | | | | | | | | | |
| | Mountain View | | | | | | | | | | | | <div></div> | | |
| | Northglenn | | | | | | | | | <div></div> | | | | | |
| | Sheridan | | | | | | <div></div> | | | | | | | | |
| | Thornton | | | | | | | | | <div></div> | | | | | |
| | Westminster | | | | | | <div></div> | | | <div></div> | | | <div></div> | | |
| | Wheat Ridge | | | | | | | | | | <div></div> | | <div></div> | | |
| | Adams County | | | | | | <div></div> | <div></div> | | <div></div> | | | <div></div> | | |
| | Arapahoe County | <div></div> | <div></div> | <div></div> | <div></div> | <div></div> | <div></div> | <div></div> | <div></div> | | | <div></div> | | <div></div> | <div></div> |
| | Douglas County | | | <div></div> | | | | | | | | | | | <div></div> |
| | Jefferson County | | <div></div> | | | <div></div> | | | | | <div></div> | | <div></div> | | |








Tier 3 Scoring Methodology and Results

The physical viability analysis and community support for transit along each route formed the basis for developing recommendations for routes to move forward to the Tier 4 evaluation. In some instances, the results of the physical viability assessment (**Figure 12**) were offset by local support for implementing BRT, even in situations where right-of-way challenges exist. For example, Colorado Boulevard had low viability for transit-only lanes based on this study's analysis, but City and County of Denver community and policy support was high for BRT-type service in this corridor. **Table 10** summarizes the three Tier 3 evaluation criteria results and those highlighted in yellow were the eight routes that moved into Tier 4.

EVALUATION SUMMARY SHEETS

Evaluation summary sheets in **Appendix E** summarize route-specific support. **Appendix A** provides a full summary of the survey results, and **Appendix D** includes policy support summaries.

Table 10. Tier 3 Route Evaluation Summary

| KEY | CORRIDOR | | | | | | | | | | | | | |
|--------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 6th/8th | Alameda Ave | Broadway/Lincoln | Colorado Blvd | Evans Ave | Federal Blvd | Havana/Hampden | Monaco Pkwy | North I-25 (Thornton) | 38th/Park | Quebec St | Sheridan Blvd | Speer/Leetsdale / Parker |
| CRITERIA | | | | | | | | | | | | | | |
| Physical Viability |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Community Support |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Policy Support |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Note: Speer/Leetsdale/Parker was given a moderate ranking for physical viability because reversible transit-only lanes have been evaluated for the corridor through a corridor-specific study (Go Speer Leetsdale). However, the analysis completed for this effort identifies low viability for two-way transit-only facilities.

3.7 Tier 4—Final Evaluation

Tier 4 Routes

The following eight routes were progressed from Tier 3 into Tier 4:

- ◆ 38th/Park
- ◆ Alameda Avenue
- ◆ Broadway/Lincoln
- ◆ Colorado Boulevard
- ◆ Federal Boulevard
- ◆ Havana/Hampden
- ◆ North I-25
- ◆ Speer/Leetsdale/Parker

Figure 14 shows the Tier 4 routes. The eight Tier 4 routes travel through 18 communities.

Tier 4 Recommendations

Through the first three tiers of analysis and evaluation, the eight Tier 4 routes stand out as the most promising for FTA Small Starts funding. To support potential federal funding applications, specific recommendations for how BRT could be implemented effectively along each route were developed. The evaluation summary sheets on the following pages detail proposed infrastructure improvements and peak hour operating plans. These recommendations were also used to inform several of the Tier 4 analyses.



Source: RTD

[illegible]

Tier 4 Evaluation

Tier 4 evaluated the eight routes progressed from Tier 3 (shown on **Figure 14**) on a range of metrics to both exhibit their relative strengths and assess their anticipated eligibility for FTA Small Starts funding. **Table 11** identifies specific metrics analyzed.

The Tier 4 evaluation had several separate but related components:

- ◆ Identification of proposed BRT-supportive improvements (dedicated lanes, TSP, etc.) along each route
- ◆ Development of route-specific service plans
- ◆ Detailed modeling to assess projected ridership and VMT reduction in 2020 and 2040
- ◆ Capital and operating cost estimates
- ◆ Equity analysis
- ◆ Safety analysis

Each component helped to inform an assessment of each route's eligibility and competitiveness for Small Starts funding. Additionally, this helped to understand and inform the appropriate next steps for each route. Section 4 of this report provides more information on potential next steps.

Proposed BRT-Supportive Improvements

Tier 4 was initiated with the development of a set of proposed infrastructure improvements along each route that would support BRT service. The types of improvements considered include:

- ◆ Dedicated transit lanes
- ◆ Transit signal priority
- ◆ Queue jumps
- ◆ Mobility hubs

The findings from the Tier 3 physical viability assessment were used as a basis for developing these recommendations. With cost-effectiveness in mind, an attempt was made to keep recommended improvements within existing curb lines and to limit necessary roadway widening as much as possible. Reconfiguring the streetscape to provide dedicated transit lanes was proposed wherever feasible based on projected future traffic volumes and local jurisdiction feedback.

Table 11. Tier 4 Evaluation Criteria and Guiding Principles

| Evaluation Criteria | Associated Guiding Principles |
|---|--|
| Travel Time Savings by Route (No Action vs. Proposed) | ⇒ Provides connectivity and access |
| Capital and Operating Costs | ⇒ Increases ridership |
| Ridership Projections (Boardings) | ⇒ Enhances equity |
| Boardings per Service Hour and Mile | ⇒ Ensures cost-effectiveness |
| Annualized Cost per Rider (Capital and Operating) | ⇒ Aligns with state and local agency recommendations |
| Transit Dependent Populations Served (Census Data) | ⇒ Adheres to FAST Act BRT definition |
| Jobs and Households Served (¼- and ½-mile buffer) | ⇒ Integrates operation feasibility |
| Potential to Address Community-identified Safety Concerns | ⇒ Integrates safety |
| Daily Vehicle Miles Traveled (VMT) Reduction | ⇒ Capitalizes on financial resources |
| Suitability for Small Starts Funding | |

NORTH I-25

The North I-25 route between downtown Denver and SH 7 differs in its proposed BRT accommodations from the other seven Tier 4 routes given its higher roadway classification and the presence of managed lanes. Between US 36 and SH 7, CDOT is constructing managed lanes. This study assumes that BRT service will operate in the managed lanes once completed. Between US 36 and downtown, the 120X and 122X routes already use an existing peak-hour managed lane; buses traveling in the off-peak direction use general-purpose lanes. Future BRT service would likely follow this pattern. Past studies of the feasibility of bus-on-shoulder operation or converting the peak-hour managed lane to bi-directional through this stretch of I-25 concluded that both configurations would be difficult and cost-prohibitive to implement.

Service Plans

An integral part of Tier 4 was the development of route-specific service plans for each Tier 4 route. This was used to inform more detailed modeling of BRT along each route. The profiles contain the following information:

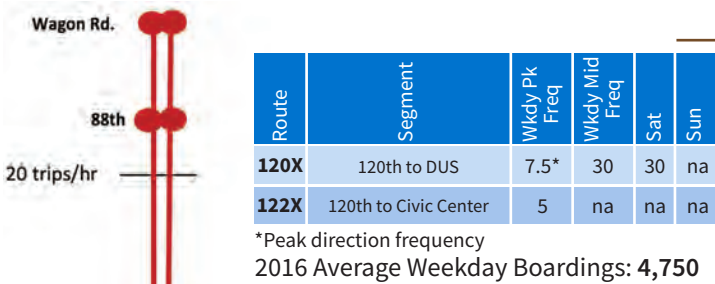
- ◆ Station location assumptions
- ◆ Proposed service plan route schematic and frequencies
- ◆ Estimated transit speeds and travel time
- ◆ Service requirements and operations and maintenance (O&M) costs

In general, proposed station spacing averaged $\frac{1}{2}$ to $\frac{3}{4}$ miles for most routes. Existing high ridership stops, intersections with other RTD routes, and major destinations were used as a basis for identifying station locations. Both the station spacing and the proposed BRT-supportive infrastructure along each route was used to determine estimated speeds and travel times, with specific assumptions made for acceleration and deceleration rates, dwell times, and potential savings realized from TSP, queue jumps, and dedicated transit lanes. The average expected travel time savings along each Tier 4 route with the recommended improvements in the horizon year (2040), relative to buses traveling in general-purpose lanes for the duration, is shown on **Figure 15**. The North I-25 route shows minimal savings because managed lanes are already planned to exist along the entire route by the horizon year of 2040.

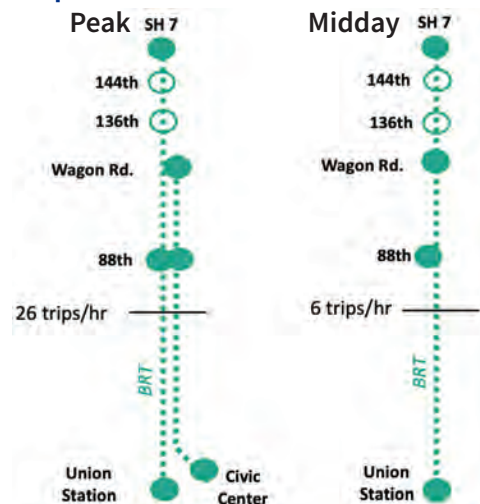
EVALUATION SUMMARY SHEETS

Evaluation summary sheets that summarize the recommended BRT-supportive improvements, as well as their proposed service plans, were developed for all Tier 4 routes and are presented on the next eight pages.

Existing Peak Service Plan



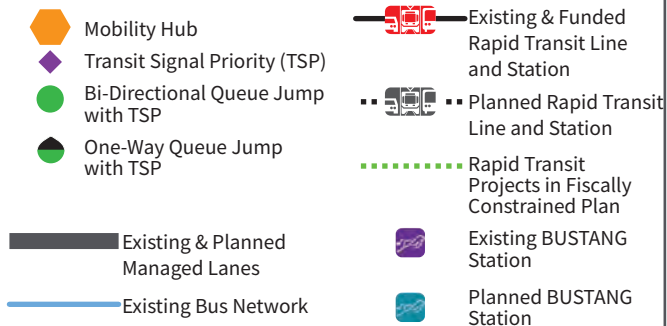
Proposed Service Plan



| Route | Segment | Wkdy Pk Freq | Wkdy Mid Freq | Sat | Sun |
|----------|-----------------------|--------------|---------------|-----|-----|
| N I-25 1 | SH 7 to DUS | 10 | 10 | 15 | 30 |
| N I-25 2 | 120th to Civic Center | 3 | na | na | na |

1. In peak period, long pattern from SH 7 operates at 10-min frequency and short pattern operates at 3-min frequency
2. 136th and 144th are on-line and walk-up stations
3. Peak period short pattern from Wagon Rd makes same stops downtown as 122X

LEGEND

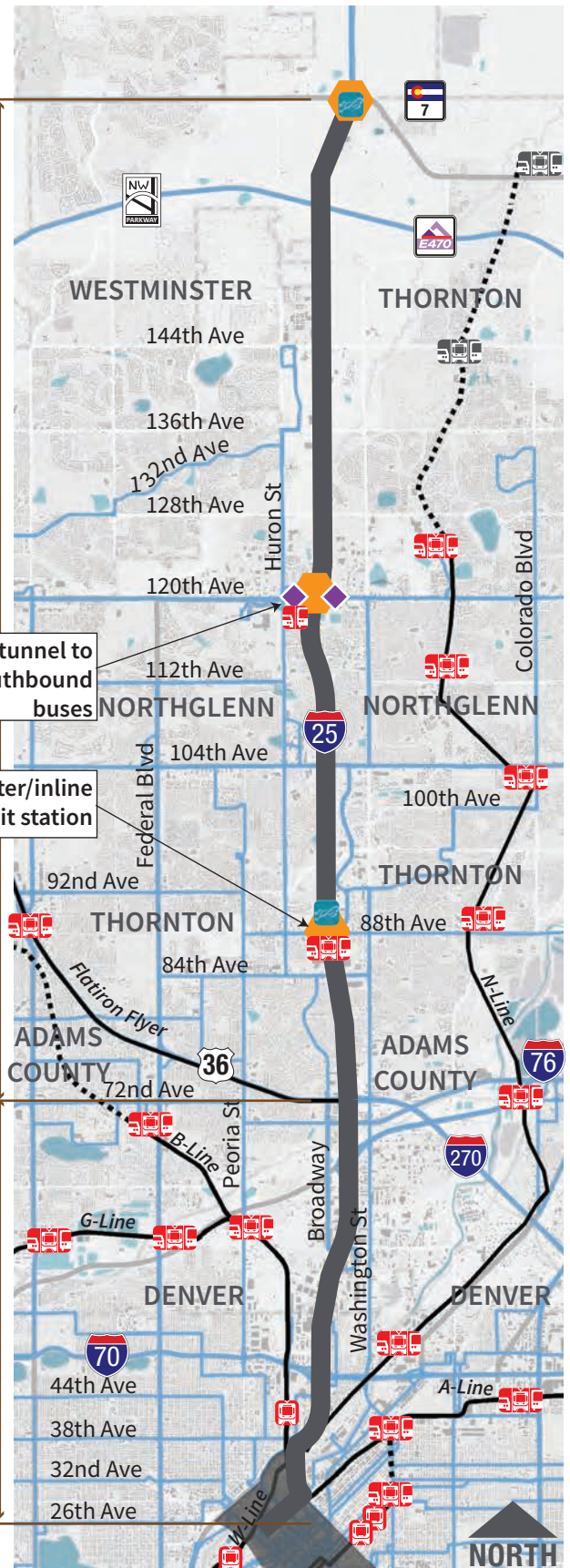


12 miles
Use planned managed lane

Modify tunnel to I-25 for southbound buses

Center/inline transit station

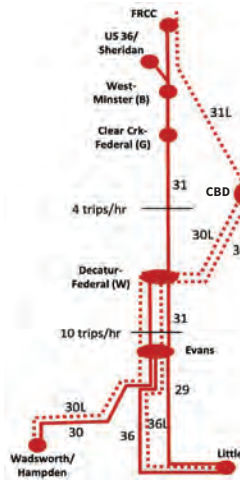
5.8 miles
Use existing toll lane in peak travel direction/ use existing general purpose in off-peak travel direction



Federal Blvd

TIER 4 Evaluation

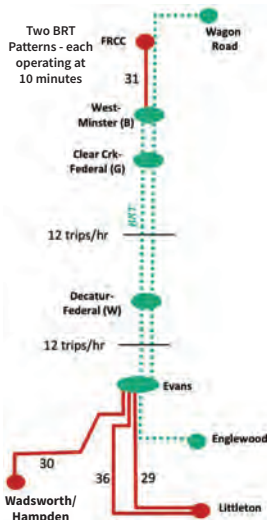
Existing Peak Service Plan



| Route | Segment | Wkdy Pk Freq | Wkdy Mid Freq | Sat | Sun |
|-------|---|--------------|---------------|----------|----------|
| 29 | Evans to Littleton | 30 | 60 | 60 | 60 |
| 30 | Colfax to Evans Evans to Wadsworth/ Hampden | 15 na | 30 60 | 30 60 | 30 na |
| 30L | Wadsworth/Hampden to CBD | 30 | na | na | na |
| 31 | FRCC to Evans US 36/Sheridan to Evans | 30 30 | 30 30 | 30 30 | 60 60 |
| 31L | 104th to CBD | 30 | na | na | na |
| 36 | Federal/Evans to Littleton | 60 | 60 | 60 | 60 |
| 36L | Littleton to CBD | 30 | na | na | na |

2017 Average Weekday Boardings: 10,025

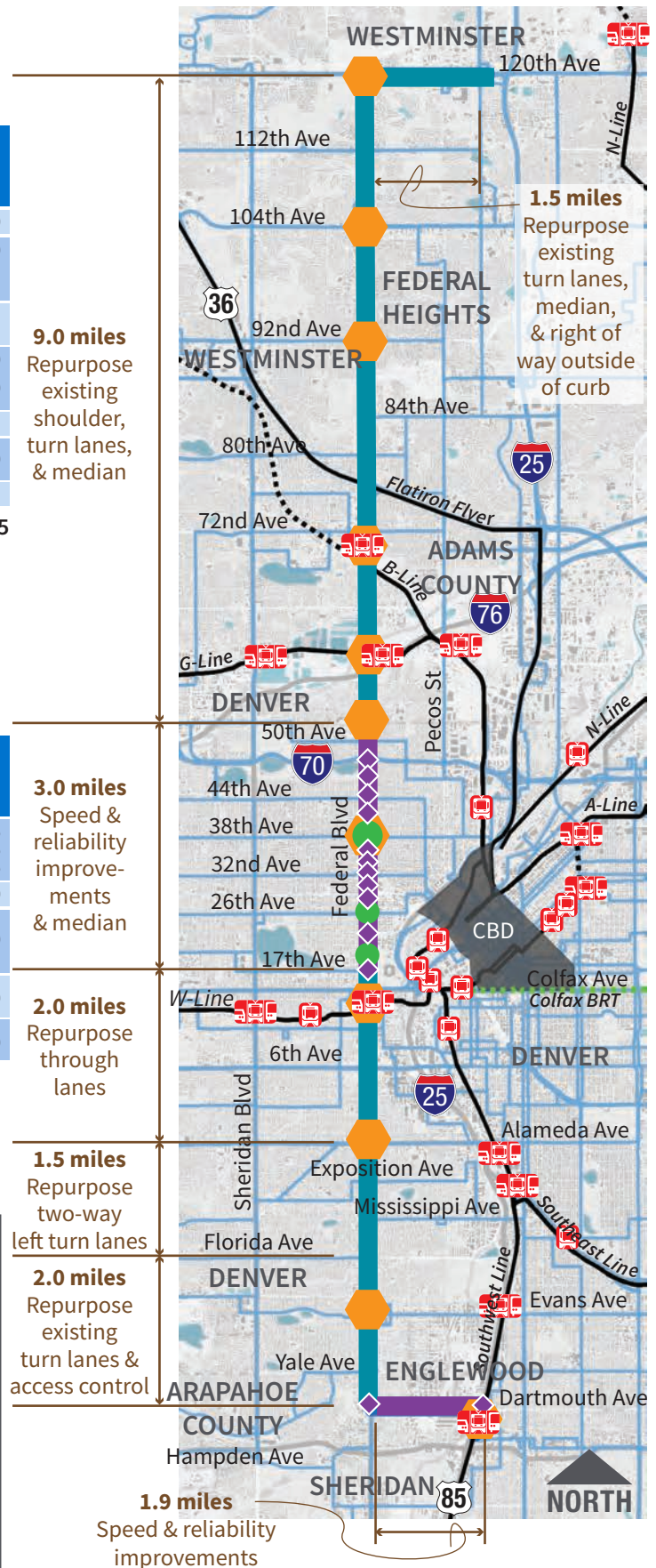
Proposed Peak Service Plan

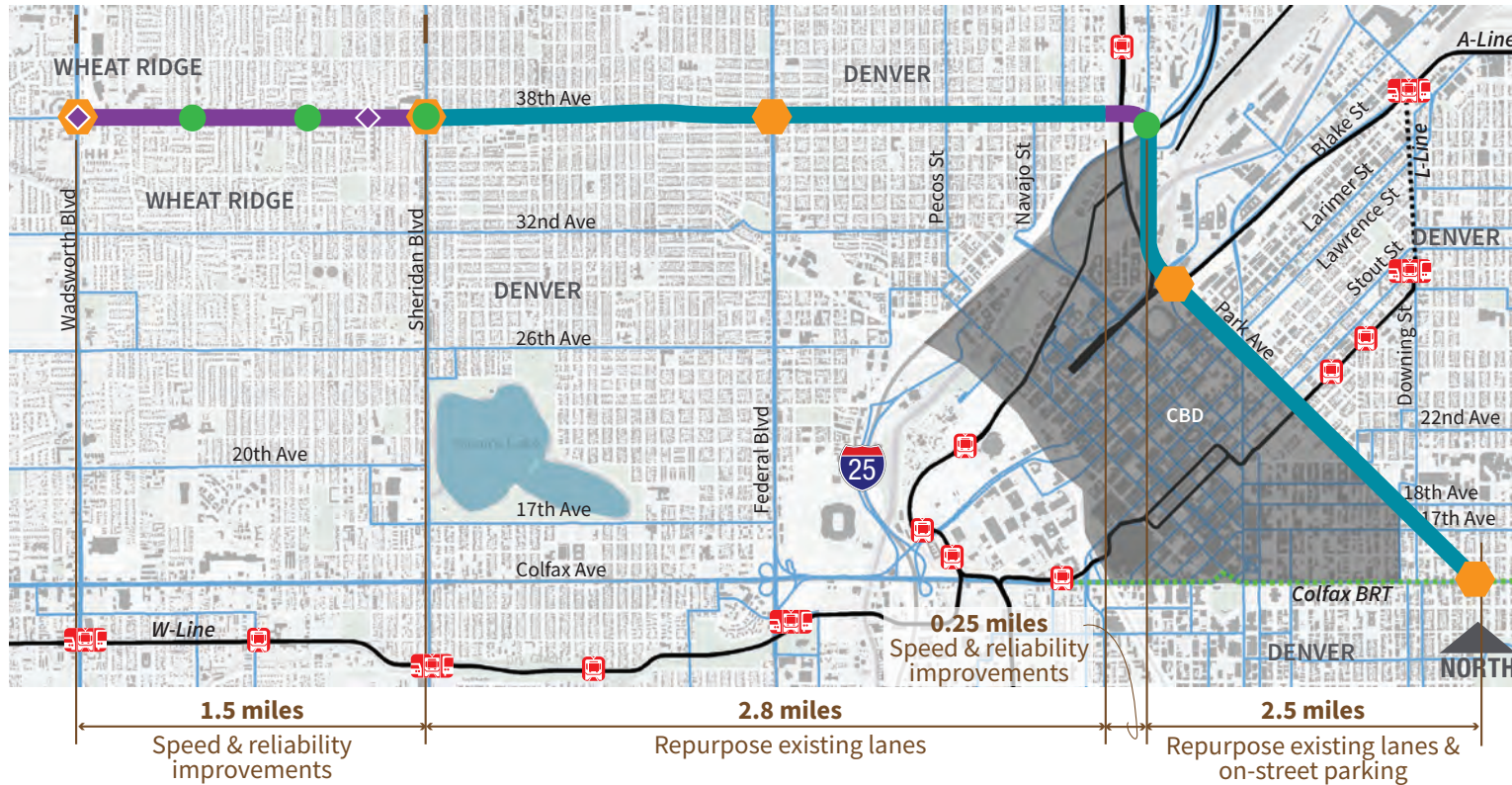


| Route | Segment | Wkdy Pk Freq | Wkdy Mid Freq | Sat | Sun |
|-------|---|---------------|---------------|-----------------|----------------|
| BRT | Wagon Rd to B-Line B-Line to Federal/Evans Evans to Englewood | 10 5 10 | 10 5 10 | 15 7.5 15 | 15 15 15 |
| 29 | Evans to Littleton | 30 | 30 | 60 | 60 |
| 30 | Federal/Evans to Wadsworth/ Hampden | 30 | 30 | 30 | 30 |
| 31 | US 36/Sheridan to FRCC via B-Line | 30 | 30 | 30 | 30 |
| 36 | Federal/Evans to Littleton | 30 | 30 | 60 | 60 |

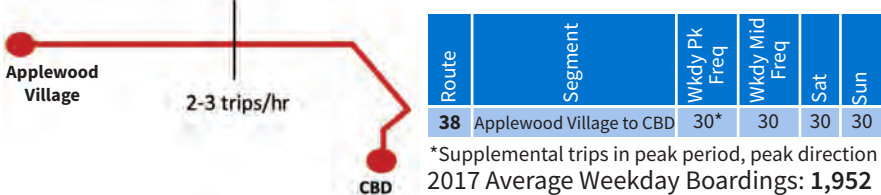
LEGEND

- Mobility Hub
- Transit Signal Priority (TSP)
- Bi-Directional Queue Jump with TSP
- One-Way Queue Jump with TSP
- Speed & Reliability Improvements
- Dedicated Transit Lane with TSP
- Existing Bus Network
- Existing & Funded Rapid Transit Line and Station
- Planned Rapid Transit Line and Station
- Rapid Transit Projects in Fiscally Constrained Plan
- Existing BUSTANG Station
- Planned BUSTANG Station

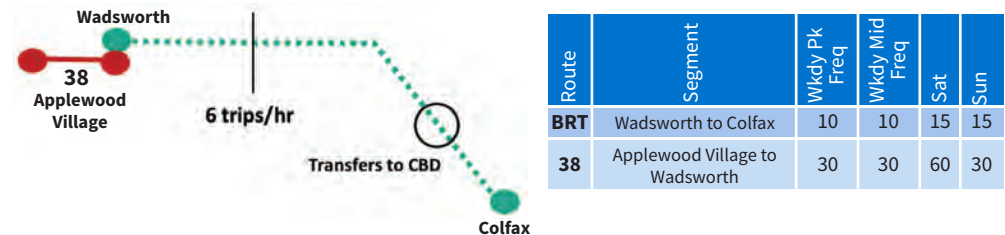




Existing Peak Service Plan



Proposed Peak Service Plan

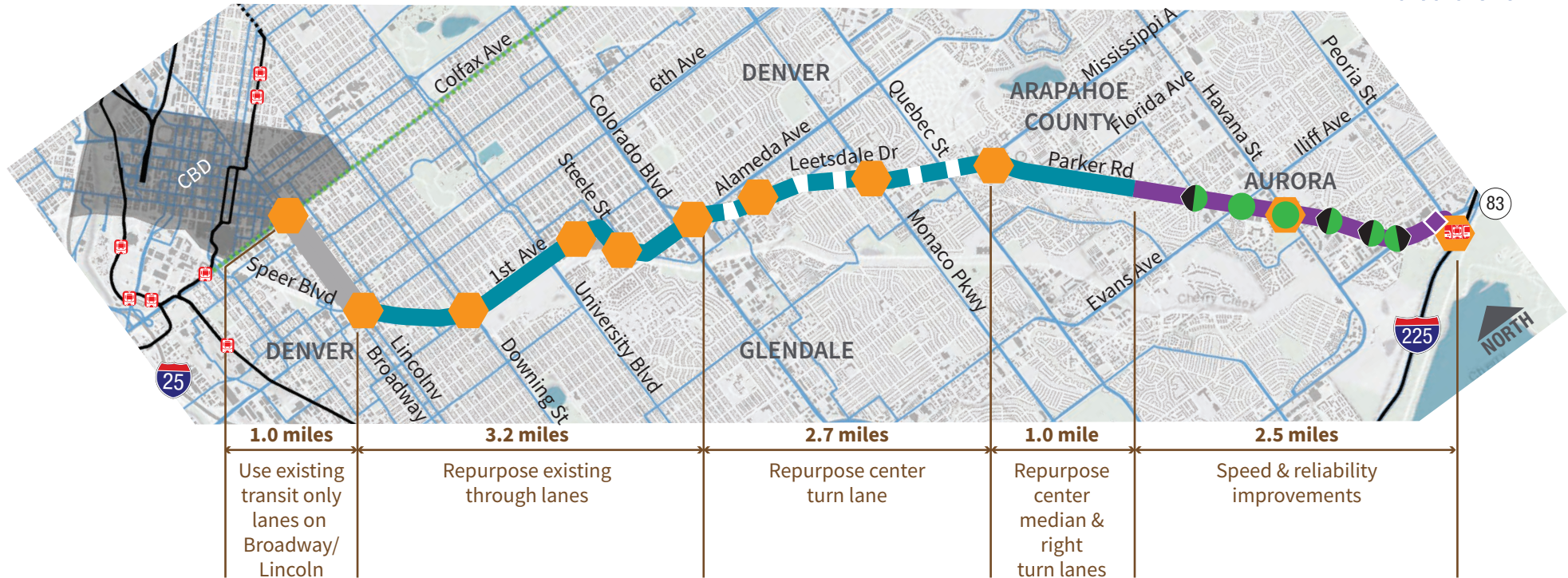


LEGEND

- Mobility Hub
- Transit Signal Priority (TSP)
- Queue Jump with TSP
- Speed & Reliability Improvements
- Dedicated Transit Lane with TSP
- Existing Bus Network
- Existing & Funded Rapid Transit Line and Station
- Planned Rapid Transit Line and Station
- Rapid Transit Projects in Fiscally Constrained Plan
- Existing BUSTANG Station
- Planned BUSTANG Station

Speer/Leetsdale/Parker

TIER 4 Evaluation



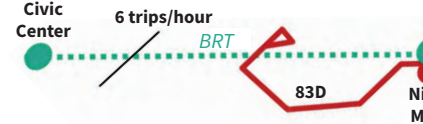
Existing Peak Service Plan



| Route | Segment | Wkdy Pk Freq | Wkdy Mid Freq | Sat | Sun |
|-------|---------------------------|--------------|---------------|-----|-----|
| 83L | Civic Center to Nine Mile | 20 | 30 | 20 | 30 |
| 83D | Civic Center to Nine Mile | 30 | 30 | 60 | na |

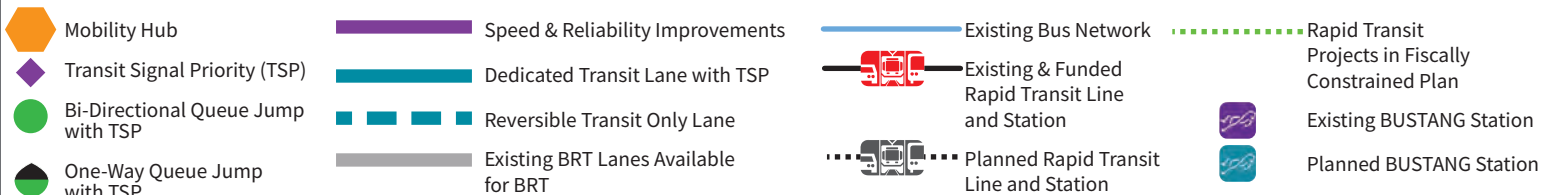
2017 Average Weekday Boardings: 4,133

Proposed Peak Service Plan



| Route | Segment | Wkdy Pk Freq | Wkdy Mid Freq | Sat | Sun |
|-------|---------------------------|--------------|---------------|-----|-----|
| BRT | Civic Center to Nine Mile | 10 | 10 | 15 | 15 |
| 83D | Nine Mile to Florida | 30 | 30 | 60 | na |

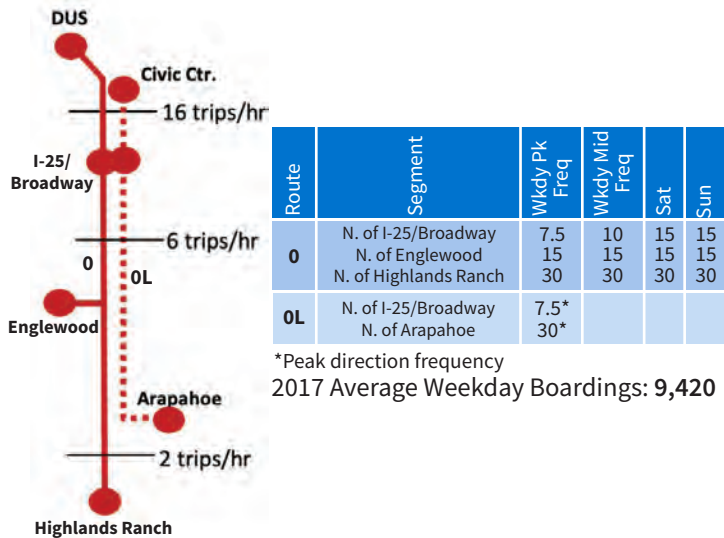
LEGEND



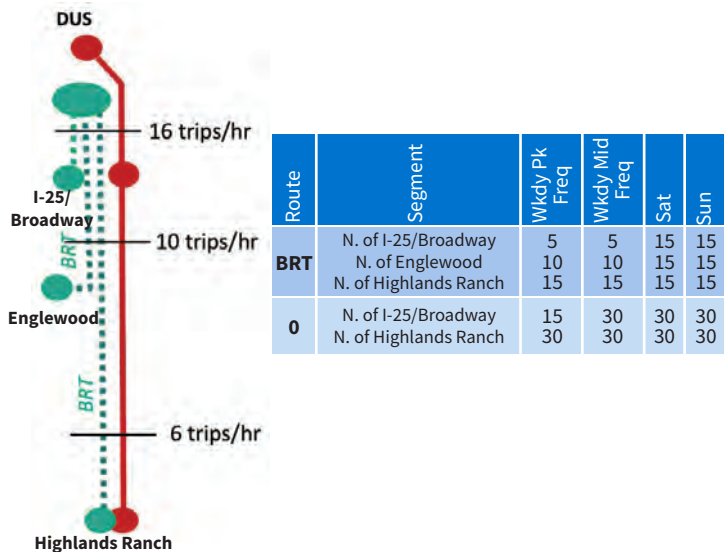
Broadway/Lincoln

TIER 4 Evaluation

Existing Peak Service Plan

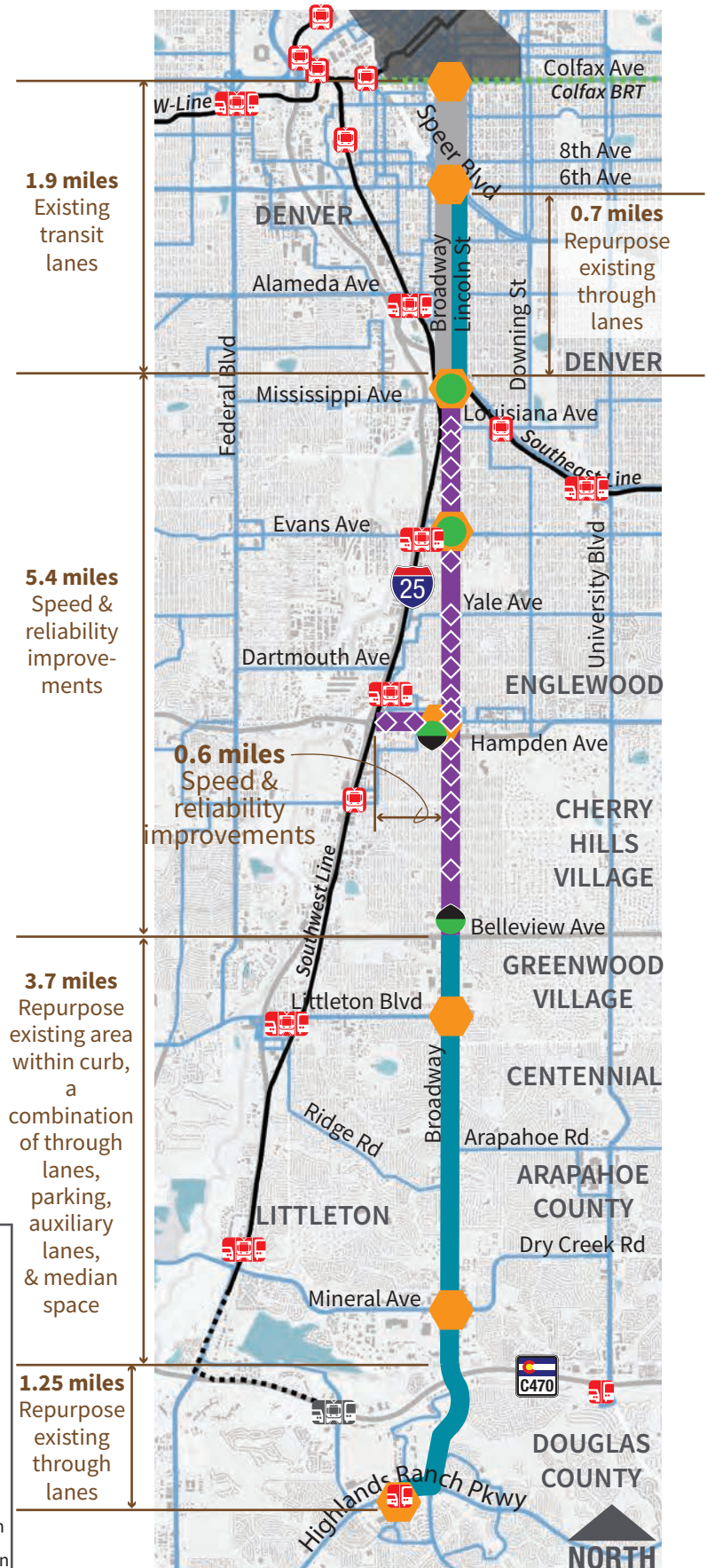


Proposed Peak Service Plan



LEGEND

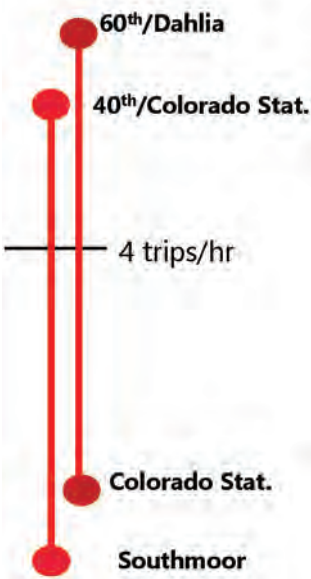
- Mobility Hub
- Transit Signal Priority (TSP)
- Bi-Directional Queue Jump with TSP
- One-Way Queue Jump with TSP
- Speed & Reliability Improvements
- Dedicated Transit Lane with TSP
- Existing Bus Network
- Existing BRT Lanes Available for BRT
- Existing & Funded Rapid Transit Line and Station
- Planned Rapid Transit Line and Station
- Rapid Transit Projects in Fiscally Constrained Plan
- Existing BUSTANG Station
- Planned BUSTANG Station



Colorado Blvd

TIER 4 Evaluation

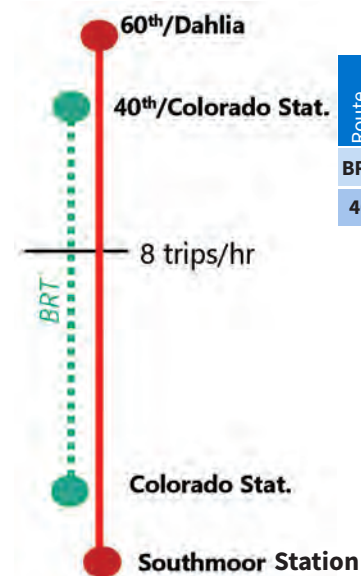
Existing Peak Service Plan



| Route | Segment | Wkdy Pk Freq | Wkdy Mid Freq | Sat | Sun |
|-------|-----------------------------------|--------------|---------------|-----|-----|
| 40 | 60th/Dahlia to 40th/Colorado | 30 | 30 | 30 | 30 |
| | 40th/Colorado to Colorado Station | 15 | 15 | 30 | 30 |
| | Colorado Station to Southmoor | 30 | 30 | 30 | 30 |

2017 Average Weekday Boardings: 4,856

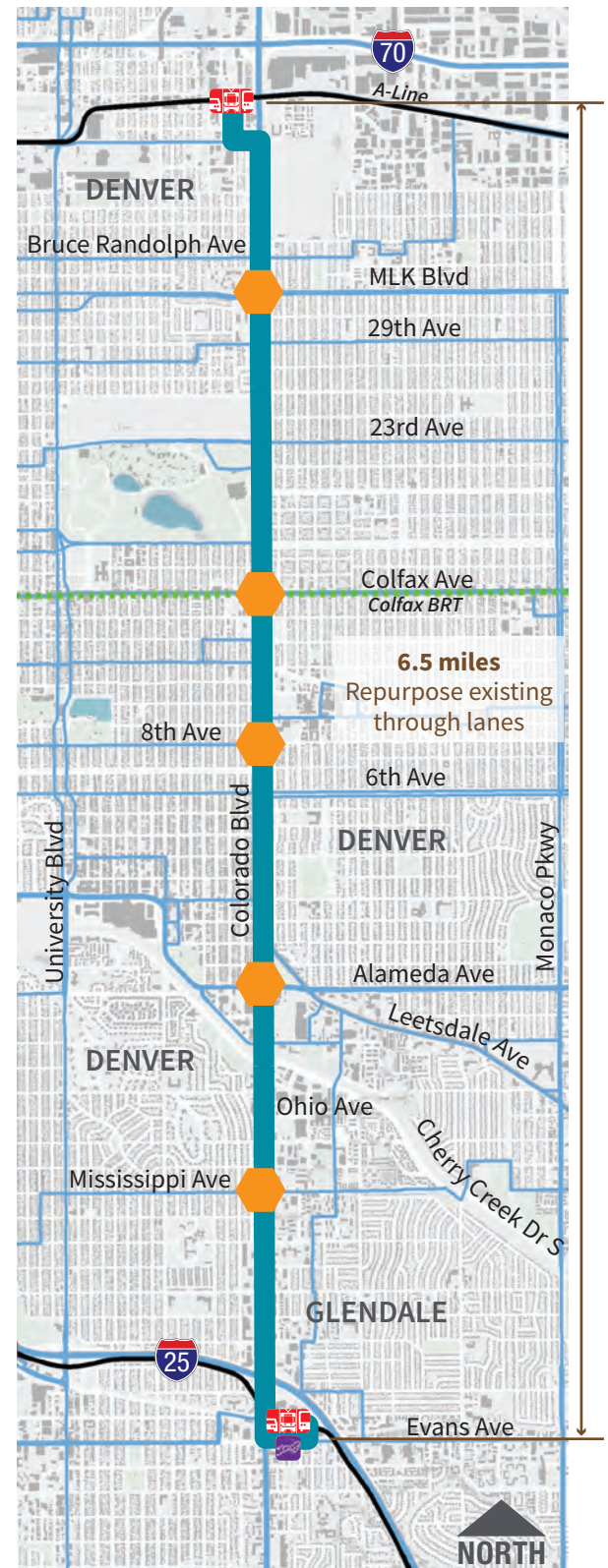
Proposed Peak Service Plan



| Route | Segment | Wkdy Pk Freq | Wkdy Mid Freq | Sat | Sun |
|-------|---------|--------------|---------------|-----|-----|
| BRT | Full | 10 | 10 | 15 | 15 |
| 40 | Full | 30 | 30 | 30 | 30 |

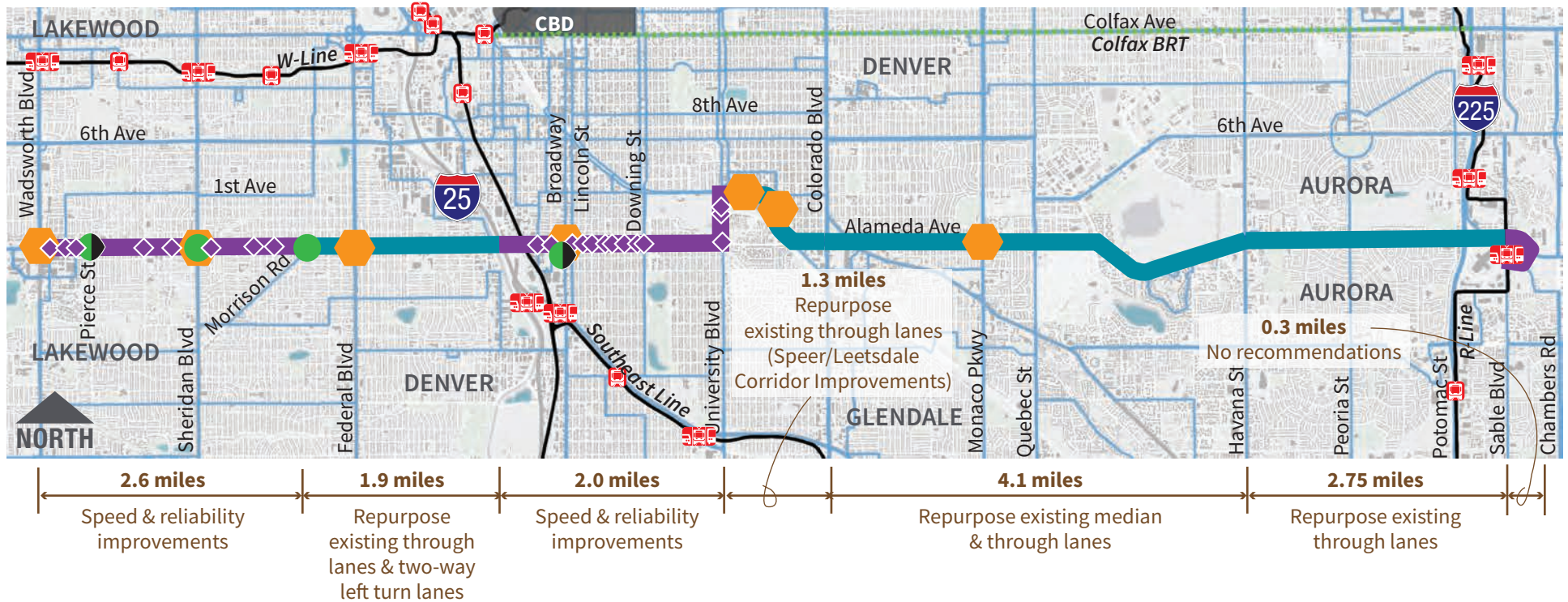
LEGEND

- Mobility Hub
- Transit Signal Priority (TSP)
- Bi-Directional Queue Jump with TSP
- One-Way Queue Jump with TSP
- Speed & Reliability Improvements
- Dedicated Transit Lane with TSP
- Existing Bus Network
- Existing & Funded Rapid Transit Line and Station
- Planned Rapid Transit Line and Station
- Rapid Transit Projects in Fiscally Constrained Plan
- Existing BUSTANG Station
- Planned BUSTANG Station



Alameda Ave

TIER 4 Evaluation



Existing Peak Service Plan



| Route | Segment | Wkdy Pk Freq | Wkdy Mid Freq | Sat | Sun |
|-------|-----------------|--------------|---------------|-----|-----|
| 3 | West of Alameda | 15 | 30 | 30 | 30 |
| 3 | East of Alameda | 30 | 60 | 60 | 60 |
| 3L | na | 15* | | | |

*Peak direction frequency
2017 Average Weekday Boardings: 3,878

Proposed Peak Service Plan



| Route | Segment | Wkdy Pk Freq | Wkdy Mid Freq | Sat | Sun |
|-------|---------|--------------|---------------|-----|-----|
| BRT | Full | 10 | 10 | 15 | 15 |
| 3 | Full | 30 | 30 | 30 | 30 |

LEGEND

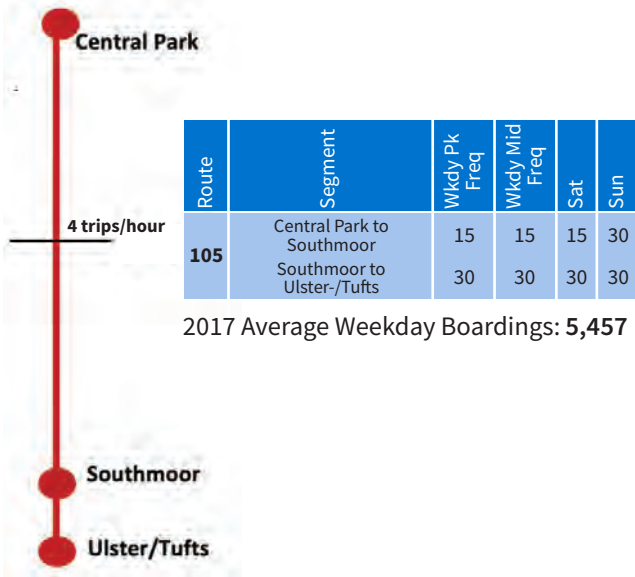
- Mobility Hub
- Transit Signal Priority (TSP)
- Bi-Directional Queue Jump with TSP
- One-Way Queue Jump with TSP
- Speed & Reliability Improvements
- Dedicated Transit Lane with TSP
- Existing Bus Network

- Existing & Funded Rapid Transit Line and Station
- Planned Rapid Transit Line and Station
- Rapid Transit Projects in Fiscally Constrained Plan
- Existing BUSTANG Station
- Planned BUSTANG Station

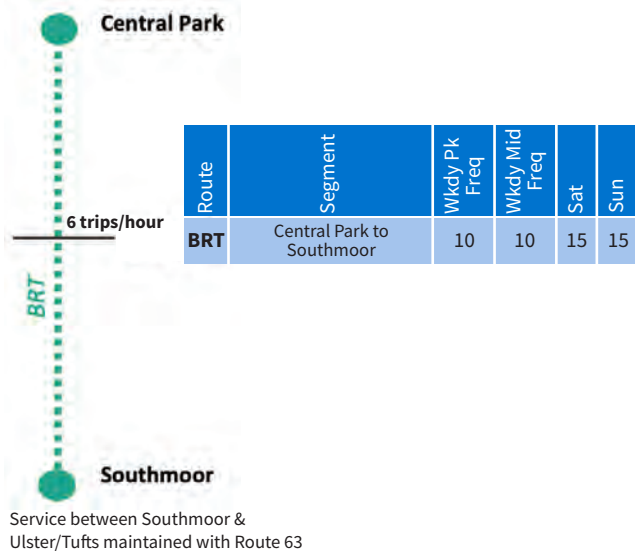
Havana/Hampden

TIER 4 Evaluation

Existing Peak Service Plan



Proposed Peak Service Plan



LEGEND

- Mobility Hub
- Transit Signal Priority (TSP)
- Bi-Directional Queue Jump with TSP
- One-Way Queue Jump with TSP
- Funded Project
- Existing Bus Network
- Existing & Funded Rapid Transit Line and Station
- Planned Rapid Transit Line and Station
- Rapid Transit Projects in Fiscally Constrained Plan
- Existing BUSTANG Station
- Planned BUSTANG Station
- Speed & Reliability Improvements
- Dedicated Transit Lane with TSP

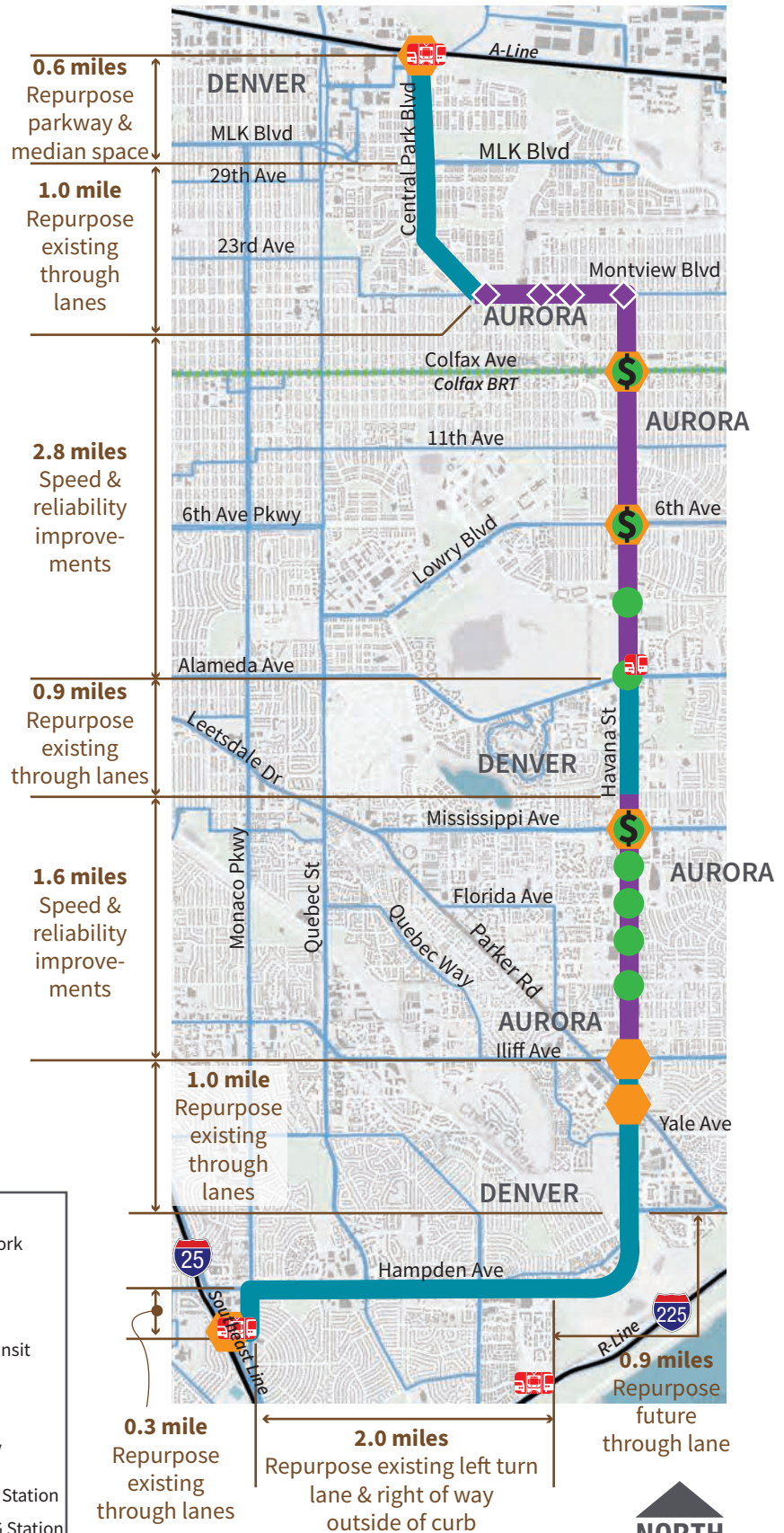
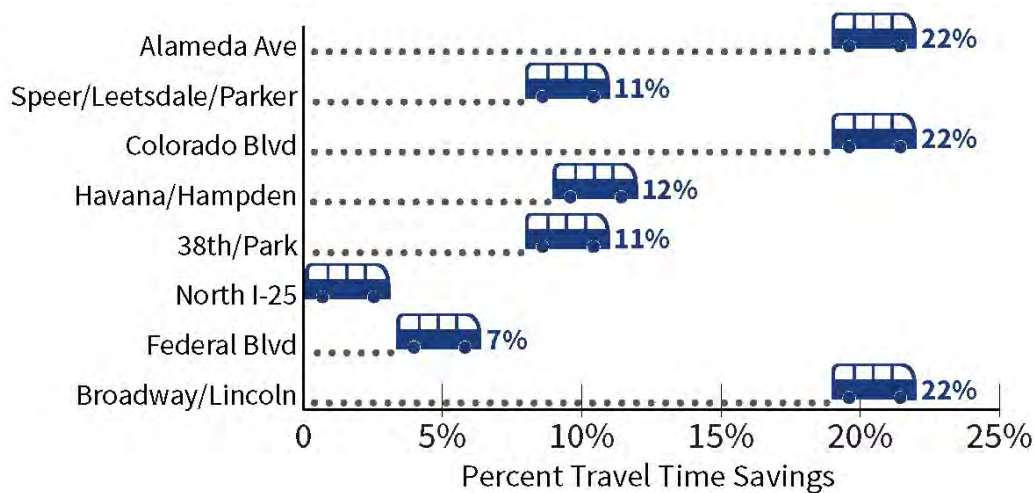


Figure 15. Estimated 2040 Travel Time Savings



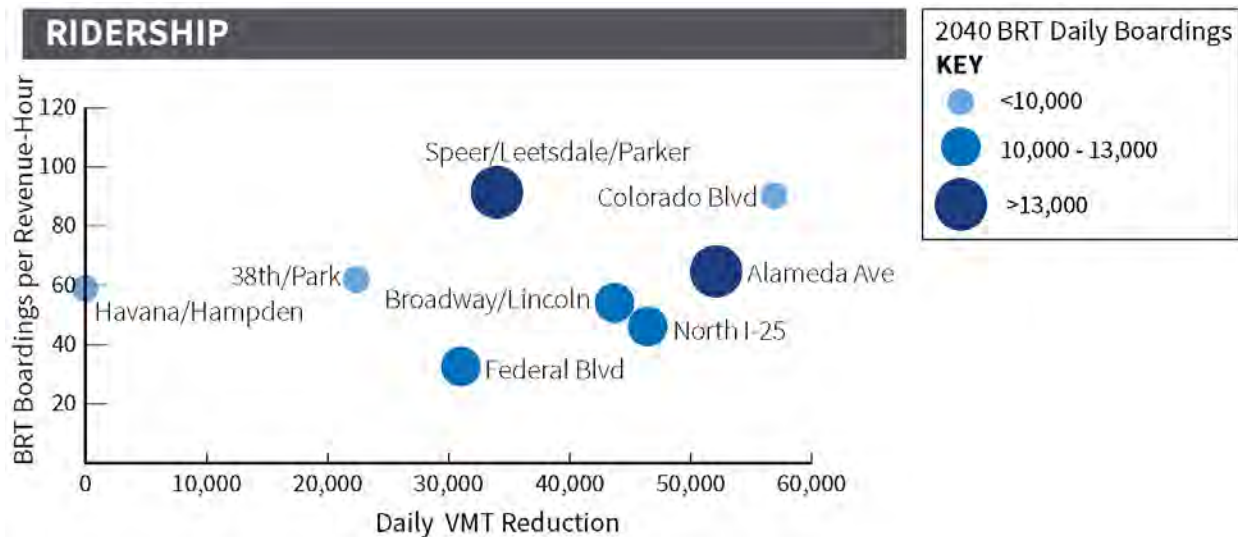
Unique transit service plans were tailored for each Tier 4 route. BRT service was generally assumed to operate at 10-minute frequencies on weekdays, 15-minute frequencies on weekends, and 30-minute frequencies during late evening hours. Exceptions were made for routes with existing high levels of service (Broadway/Lincoln & Federal Boulevard). The service plans include recommended modifications to existing bus service along the routes; for example, elimination of existing service was assumed along some, and retention along others. The proposed BRT frequencies and underlying local service recommendations factored into the estimation of annual operating and maintenance costs using a marginal cost per bus-hour of \$119 (BRT service) and \$103 (local service).

Appendix F includes the full-service plan profiles for each Tier 4 route and a more detailed summary of the methodology behind them.

Tier 4 Modeling

After service plans for each Tier 4 route were developed, the plans were incorporated into the 2040 RTD Travel Demand Model to assess the expected performance of each route. The routes were modeled individually with detailed coding of stop locations, operating speeds, headway, and service hours to more closely study potential ridership along each route. **Figure 16** provides a plot showing the relative performance of each of the eight Tier 4 routes. The plot displays the three performance metrics: projected daily vehicle miles traveled (VMT) reduction, projected daily BRT boardings, and BRT boardings per revenue-hour. Routes plotted toward the top right corner of the figure, and those with larger dot sizes, were the strongest performers in this round of modeling. More detailed information about the Tier 4 modeling process is presented in **Appendix G**.

Figure 16. Tier 4 Modeling Results



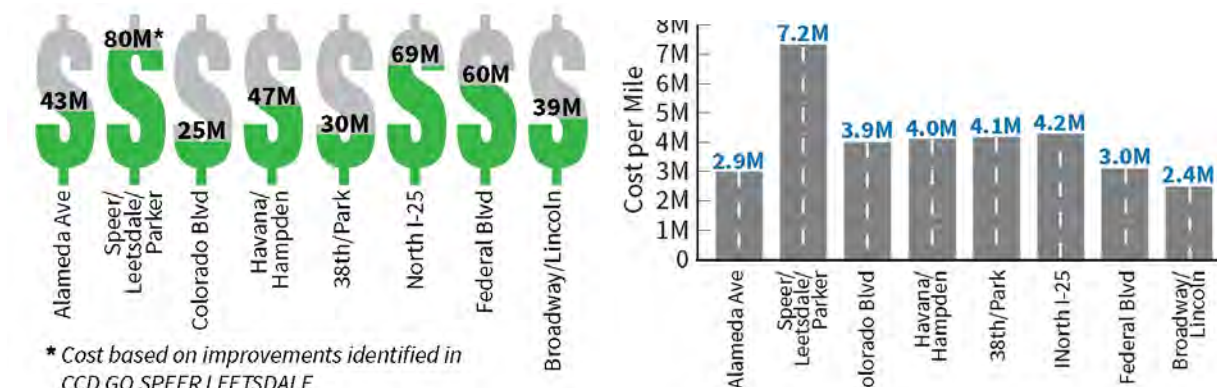
Capital Cost Estimates

Another element of Tier 4 was the development of planning-level capital cost estimates for each route. Based on the recommended improvements, specific line items were quantified for three general types of transit elements: mobility hubs and stations, exclusive transit lanes, and intersection improvements. Specific items quantified include:

- ◆ **Mobility Hubs & Stations** (mobility hubs at major intersections and activity centers, with stations assumed at every other identified stop except existing rail stations) – Canopy, ticket kiosk, variable message sign board, bike racks, trash cans, benches, branding, security camera, route sign, platform, bus pads
- ◆ **Exclusive Transit Lanes** – Signage, striping, sidewalk improvements, pavement widening
- ◆ **Intersection Improvements** – Transit signal priority, queue jumps

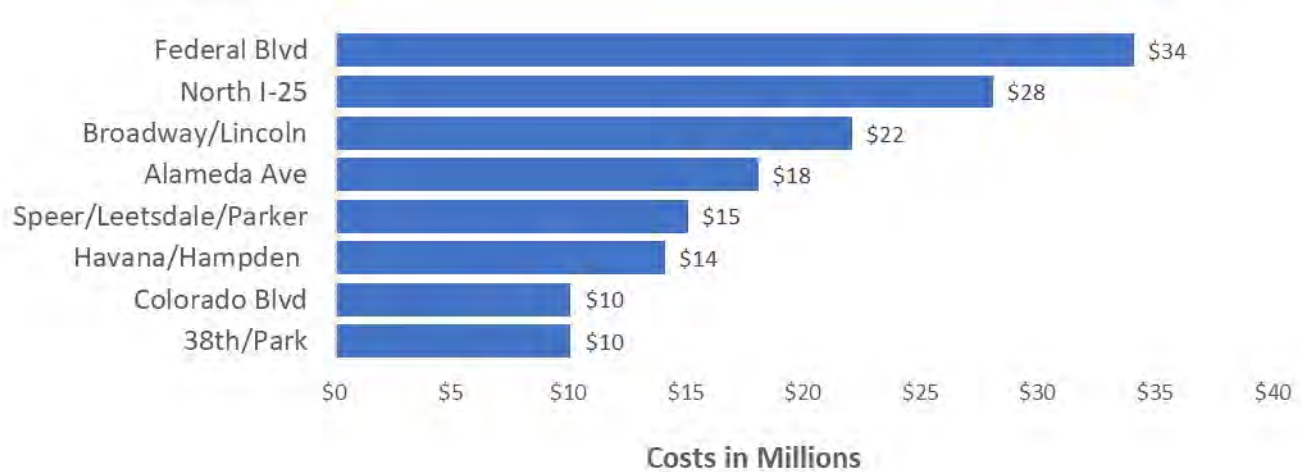
Figure 17 presents the total estimated cost for each Tier 4 route, not including fleet costs. The bar chart on the right shows the costs normalized by route length. The Speer/Leetsdale/Parker route has a higher cost per mile than the others because the City and County of Denver has already completed extensive planning for a capital-intensive center running reversible transit lane on a portion of Leetsdale Drive, while recommendations for the other Tier 4 routes were developed to limit significant infrastructure changes. More detailed cost estimate information for each Tier 4 route is in **Appendix H**.

Figure 17. Facility Capital Costs



Fleet requirements for BRT service along each Tier 4 route were also estimated. The cost of BRT vehicles can vary significantly based on type (e.g., coach, articulated), size, fuel type, and branding. The US Department of Transportation reports a typical range from \$370,000 to \$1.6 million. Fleet costs were developed using an assumption of \$1 million per each new BRT vehicle and the fleet requirements identified in each Tier 4 route's service plan. The estimated fleet costs are provided in **Figure 18**; these estimates include spare vehicles.

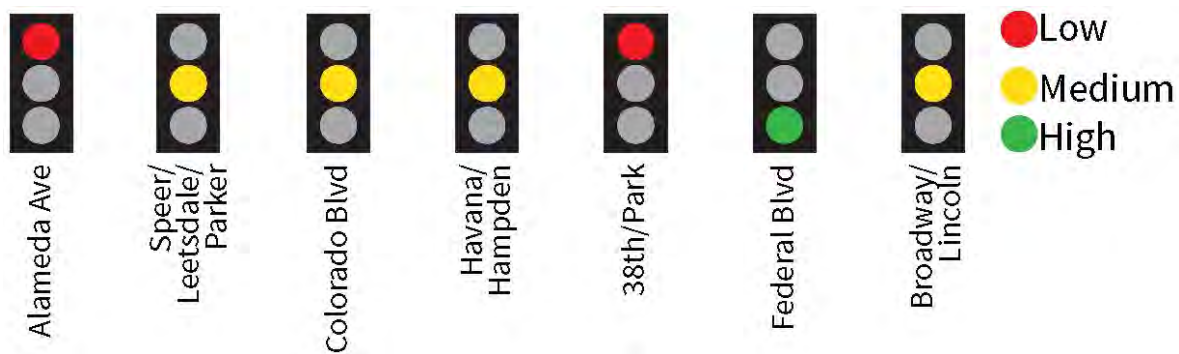
Figure 18. Fleet Capital Costs



Next Generation Technology Readiness

Intersection operations and signal timing can have a substantial effect on the efficiency of transit service. Frequent stops for red lights contribute to increases in both travel time and travel time variability. Numerous technological applications, most notably transit signal priority, are being implemented throughout the world to prioritize the flow of transit vehicles. These typically require fiber optic/wireless communication infrastructure and updated traffic signal controller configurations. As part of the Tier 4 evaluation process, the existence of technology that supports the capability for next generation applications (or plans to introduce it) along each of the eight routes was assessed. Key elements reviewed included Central Traffic Signal Control Systems, controller cabinet types, and the existence of an Uninterruptible Power Supply. The results of this assessment, which categorized the routes with a “Low,” “Medium,” or “High” rating, are presented in **Figure 19**. Federal Boulevard stands out as the only Tier 4 Route to receive a “High” rating due to significant technology upgrades implemented by the City and County of Denver and CDOT in recent years. The North I-25 route was not included in this evaluation as it functions with continuous uninterrupted flow operations. **Appendix I** provides a more detailed summary of the technology assessment .

Figure 19. Next Generation Technology Readiness



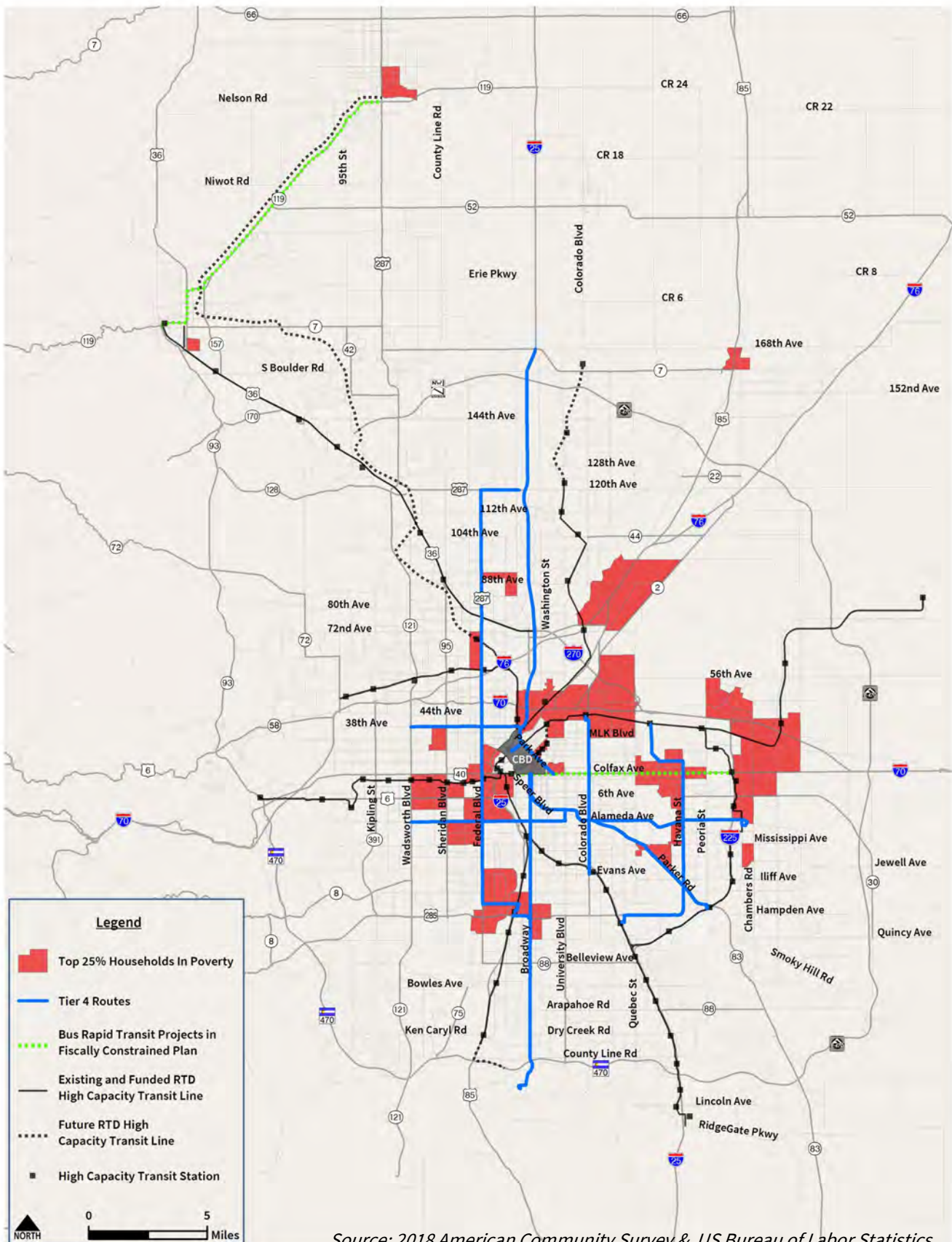
Equity Analysis

Transit serves a vital role in providing mobility and access to underprivileged populations within a community. As such, equity is of paramount importance when evaluating routes and networks. Areas with high concentrations of certain demographics including families in poverty, the elderly, and people with disabilities, all of which are less likely to have other transportation options, have a relatively greater need for convenient and reliable transit service. **Figure 20** shows the census tracts within the District with the highest proportion of households in poverty.

In acknowledgement of the importance of equitable transit service, another component of the Tier 4 evaluation was an assessment of how well each route in the proposed District-wide BRT network would serve the district’s more transit-dependent residents. Using data from the US Census Bureau’s 2017 American Community Survey, a web-based tool (<https://hedevlopment.wpengine.com/tools/denver-rapid-transit-study/>) was developed to estimate and visually depict the several equity metrics within ¼ mile, ½ mile, and ¾ mile of each route:

Appendix J contains a more detailed summary of the equity analysis.

Figure 20. Households in Poverty



Source: 2018 American Community Survey & US Bureau of Labor Statistics

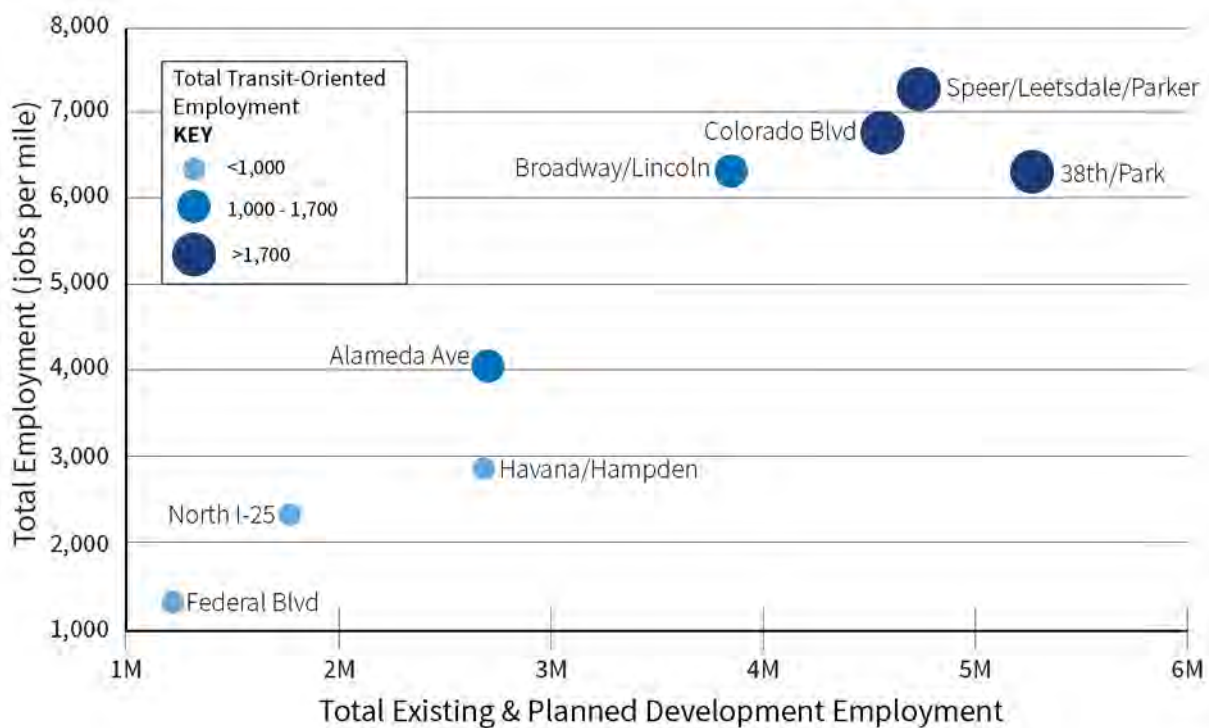
Assessment of Economic Development Potential

Surrounding land uses are a significant determinant to the success of high-frequency transit service. Dense mixed-use development with lots of people, jobs, and/or destinations of interest is more likely to spur sustainable ridership numbers than rural or suburban areas with segregated zoning, large lot sizes, and long blocks. To assess and compare the potential for supportive land use along each Tier 4 route, three metrics relating to existing and planned development were inventoried and analyzed within a ½ mile buffer area (excluding downtown Denver): square footage of commercial space, units of multifamily housing (with an assumption

of 900 square feet per unit), and total employment.

Figure 21 provides a plot showing the relative economic development potential of each Tier 4 route. The size of each dot reflects the percentage of existing jobs along each route categorized as transit-oriented (i.e., retail trade arts/entertainment/recreation, accommodation, and food services sectors). From an economic development potential perspective, Broadway/Lincoln, Colorado Boulevard, Speer/Leetsdale/Parker, and 38th/Park are the most promising future BRT routes. **Appendix K** provides a more detailed summary of the economic development analysis.

Figure 21. Economic Development Potential



Safety Assessment

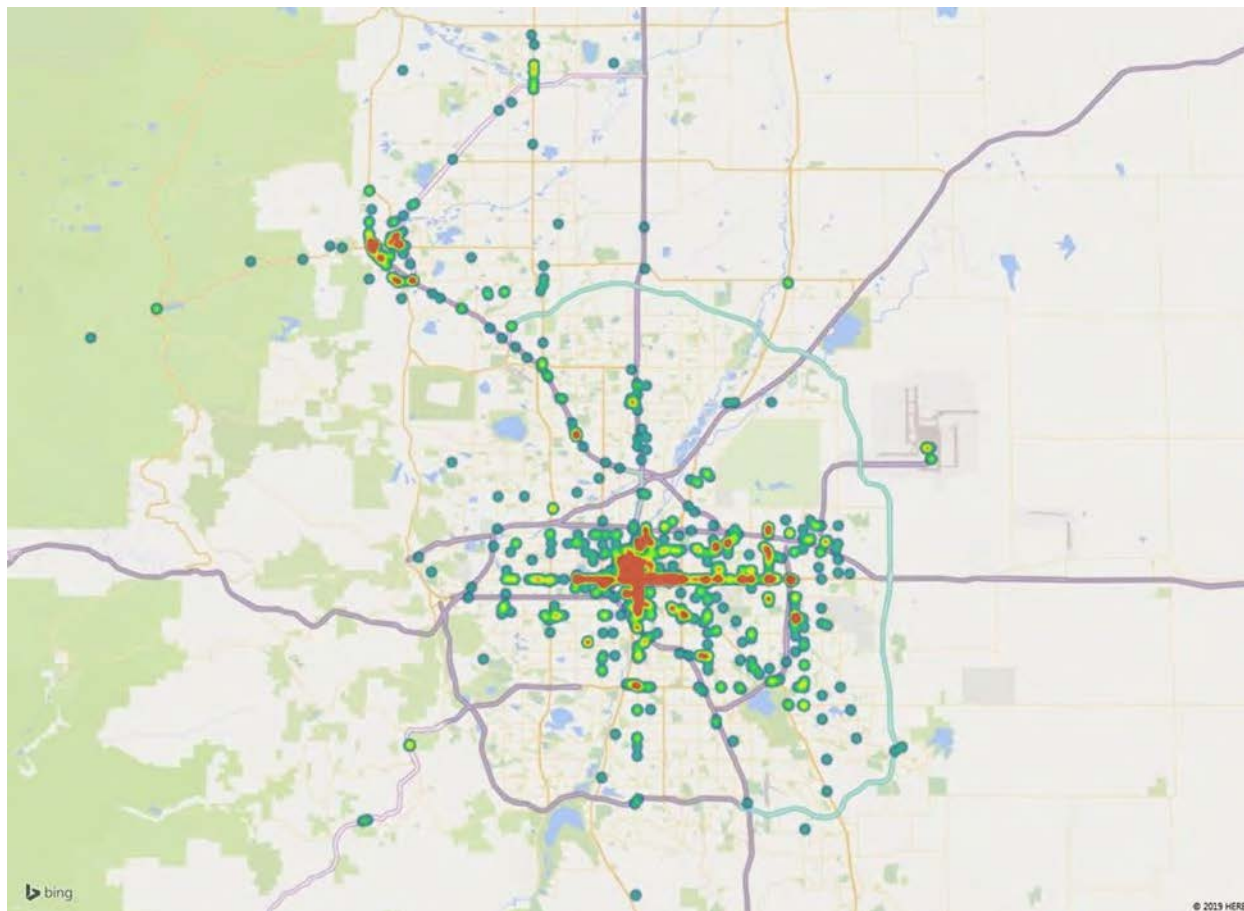
In addition to enhancing mobility, implementation of BRT has the potential to improve safety for all users of the transportation system. Providing an exclusive right-of-way for transit operations reduces conflicts between buses and other vehicles, and the bicycle and pedestrian facility improvements that often accompany BRT implementation make for a safer and more comfortable environment for active users. Investment in BRT aligns well with the emphasis throughout the region on Vision Zero, an effort to eliminate traffic-related fatalities and serious injuries.

As part of the Tier 4 evaluation, transit-involved crashes through the first half of 2019 were analyzed to identify hotspots throughout the

District that could see the largest safety benefit from BRT implementation. **Figure 22** presents the locations of each recorded crash, with the red colors indicating areas with high concentrations of crashes.

An important factor to note with these crash statistics is that they are not normalized; RTD's existing high-frequency transit routes, notably Broadway/Lincoln and Colfax Avenue, have significantly more buses traveling along them than other routes, and thus a higher likelihood of a bus-involved crash due simply to the higher exposure. As such, the relatively high concentrations of crashes along these corridors, and in the downtown areas served by numerous routes, do not necessarily mean they are less safe from a transit perspective than others.

Figure 22. 2019 Bus Incident Map



Source: Regional Transportation District

FTA Small Starts Capital Improvement Program Funding Assessment

The Tier 4 evaluation assessed the likely competitiveness of each of the eight Tier 4 routes for a potential FTA Small Starts Capital Improvement Grant (CIG). This evaluation included quantitative and qualitative methods based on the specific Small Starts criteria, the project team's past experience with similar BRT projects, and FTA's previous ratings of similar projects. Although this evaluation represents a realistic assessment of the likely competitiveness of each BRT alternative for potential funding from the Small Starts program, actual results from an FTA rating of the eight potential BRT route projects could be different given the competitiveness of the FTA CIG program and limited available funding.

Small Starts Evaluation Criteria

All potential Small Starts projects are evaluated and given a rating on a 5-point scale (Low, Medium-Low, Medium, Medium-High, and High) by FTA for each of the following criteria:

◆ Project Justification

- *Land Use* (current) – Population, employment, affordable housing, parking
- *Economic Development* (future) – Transit-supportive development and affordable housing policies
- *Mobility Improvements* – Annual linked transit trips in current year and horizon year

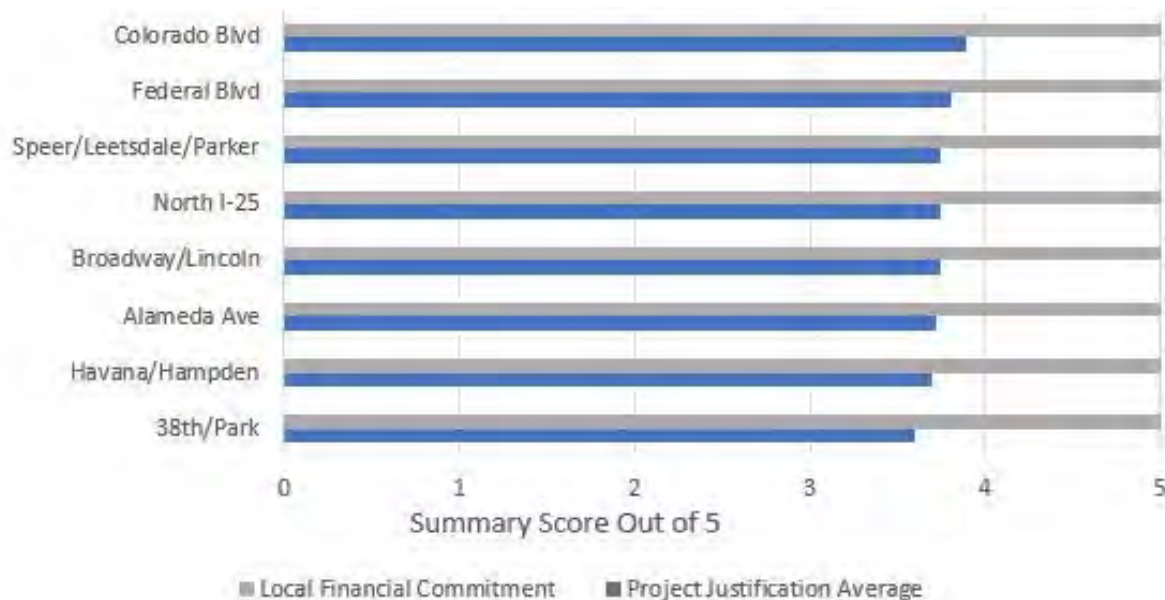
- *Environmental Benefits* – Air quality, energy use, greenhouse gas emissions, and safety, all based on changes in daily VMT
 - *Cost Effectiveness* – Annual linked transit trips divided by annualized Federal share of capital costs
 - *Congestion Relief* – New systemwide linked transit trips per day in current year and horizon year
- ◆ Local Financial Commitment
- *Current Financial Condition*
 - *Commitment to Funds* (for BRT project)
 - *Reasonableness of the Financial Plan*

Figure 23 provides the summary score for each of the Tier 4 routes, all of which average a rating of Medium-High when Project Justification and Local Financial Commitment averages are combined. For analysis purposes, all routes were assigned a High financial commitment score; however, RTD may not be able to achieve that rating based on the agency's current financial status.

The criteria used for Local Financial Commitment were all assumed to be high for this analysis, though actual local financial commitment is yet to be determined for the Tier 4 routes. Small Starts projects are required to have a high level of local financial commitment, and projects that are awarded funding have shown to be most successful when their local funding grant match is at least 50 percent of the project total cost.

Appendix L includes the full FTA Competitive Analysis methodology.

Figure 23. Small Starts Competitive Analysis Summary Score



Scores for criteria listed in the Project Justification section varied across projects. Most rankings are similar, with a few differentiators:

♦ Land Use

- *Federal Boulevard* – Rates High due to speed and reliability work that is already underway (this is only one criterion of many), while most other routes rate Medium
- *38th/Park* – Rates High due to actions the City of Wheat Ridge has been taking to implement plan recommendations along the route (this is only one criterion of many), while most other routes rate Medium

♦ Mobility Improvements

- *38th/Park* – Rates Low on the Mobility criterion because ridership projections are lower when compared to the other routes that rate Low-Medium

♦ Environmental Benefits

- *Colorado Boulevard* – Rates Medium-High for the Environmental Benefits criteria because of high VMT saving projections while the other routes rate Medium

Tier 4 Route Summaries

Each of the Tier 4 routes is unique in its relative strengths and the opportunities it provides for enhancing regional transportation. The following pages detail these considerations.

38th/Park

The 38th/Park Avenue route travels through Wheat Ridge, the City and County of Denver, and Jefferson County. The route provides a link between major destinations in Wheat Ridge, Denver's Highlands and Sunnyside communities, the north Central Business District (CBD), and the planned Colfax BRT route.

Strengths

The 38th/Park route is a short corridor with few partner communities in comparison to other routes—the City and County of Denver and Wheat Ridge. City and County of Denver staff indicated a high likelihood of support, and Wheat Ridge is also likely to support BRT initiatives. A general study has been completed identifying 38th/Park as a transit corridor. *Denver Moves: Transit* (2019) recommends 38th Avenue as a medium-capacity (rapid bus to full BRT) transit corridor and Park Avenue as a high-capacity (BRT to rail) transit corridor. Additionally, land uses and growth projections are supportive of high-frequency transit service.

Opportunities

This study estimates that the 38th/Park route will have over 7,000 daily boardings and lead to a daily reduction in VMT of over 20,000 in 2040. Next steps for advancing BRT on 38th/Park include:

- ◆ A collaboration among all potential partner agencies of Wheat Ridge, City and County of Denver, Jefferson County, and RTD
- ◆ Initiate discussions on how to proceed into the project development stage
 - Identify local funding match
 - Pursue FTA Small Starts grant

Corridor Strengths



**Existing Transit
Supportive Land Use**



**Existing Transit
Supportive Policies**

Alameda Avenue

The Alameda Avenue route travels through Aurora, Glendale, Lakewood, the City and County of Denver, and Jefferson and Arapahoe Counties. The route would be one of the few high-frequency east-west services aside from Colfax Avenue and would connect the Central Corridor light rail lines with the R-line in Aurora.

Strengths

City and County of Denver staff indicated a high likelihood of support for BRT on Alameda Avenue. *Denver Moves: Transit* (2019) identified the corridor as a medium-capacity (rapid transit or BRT) transit corridor, and existing land uses and future land use projections are transit supportive along most of the alignment.

Opportunities

There is a moderate potential for repurposing travel lanes along Alameda Avenue due to relatively low existing and future traffic volumes and available space along the route. A substantial estimated travel time savings of approximately 22 percent could be realized with BRT service and dedicated transit facilities along the route. The route is projected to carry daily boardings of over 13,000 and lead to a daily reduction in VMT of over 50,000 in 2040.

Next steps for advancing BRT on Alameda Avenue include:

- ◆ Initiation of discussions about public, political, and financial support for BRT-type services
- ◆ Bring partners together to understand the long-term vision for Alameda Avenue and its role in connectivity across these communities
- ◆ Complete a route-specific study
- ◆ Initiate discussions on how to proceed into the project development stage
 - Identify local funding match
 - Pursue FTA Small Starts grant

Corridor Strengths



Existing Transit
Supportive Land Use



Right-of-Way
Available



Existing Transit
Supportive Policies

Broadway/Lincoln

The Broadway/Lincoln route travels through Centennial, Englewood, Littleton, the City and County of Denver, and Arapahoe and Douglas Counties. Building on the existing dedicated transit lanes along Broadway and Lincoln just south of Downtown Denver, this route would complement the existing Southwest rail line with an additional high-frequency transit option with transfer opportunities to/from many of RTD's east-west routes in the south metro area.

Strengths

Broadway/Lincoln has existing transit-only lanes north of I-25, and *Denver Moves: Transit* (2019) identifies the entire Denver portion of the route as a high-capacity (BRT to rail) transit corridor. Existing land uses and future land use projections are transit supportive along most of the route. Denver staff is interested in expanding the transit-only lanes along Broadway/Lincoln south of the existing lanes; however, communities south of Denver along the remaining route are either unsure or did not respond to inquiries about the potential for repurposing travel lanes for transit use.

Opportunities

Overall, the route offers good potential for repurposing travel lanes based on existing and future volumes and space along the route. This allows for a significant estimated travel time savings of over 22 percent if dedicated transit facilities were to be extended south along the route. This supports projected daily boardings of nearly 13,000 and a daily reduction in VMT of nearly 45,000 in 2040.

Next steps for advancing BRT on Broadway/Lincoln include:

- ◆ Initiation of discussions about public, political, and financial support for BRT-type services south of the existing BRT route
- ◆ Bringing partners together to understand the long-term vision for Broadway/Lincoln and its role in north-south connectivity
- ◆ Complete a route-specific study
- ◆ Initiate discussions on how to proceed into the project development stage
 - Identify local funding match
 - Pursue FTA Small Starts grant

Corridor Strengths



Colorado Boulevard

The Colorado Boulevard route travels through Glendale, the City and County of Denver, and Arapahoe County. This route links the A-line, planned Colfax BRT, and the Southeast rail line services and provides a high-frequency transit connection through one of the region's busiest commercial areas and to several major destinations.

Strengths

The Colorado Boulevard route requires few partner communities in comparison to other routes: City and County of Denver, Glendale, and Arapahoe County. *Denver Moves: Transit* (2019) identifies Colorado Boulevard as one of six future high-capacity (full BRT or rail service) transit corridors. Existing land uses and future land use projections are transit supportive along most of the route. Denver staff indicate a high level of support for repurposing travel lanes on Colorado Boulevard for transit use.

Opportunities

The combination of high-traffic volumes and limited space along the route is a challenge, but support from the City and County of Denver is encouraging for transit prioritization. No route-specific planning has evaluated high-frequency transit today, but ridership projections developed as a part of this study estimate high boardings per revenue hour of approximately 90 and a potential reduced daily VMT of nearly 60,000 in 2040 if BRT services were implemented.

Next steps for advancing BRT on Colorado Boulevard include:

- ◆ Initiation of discussions about public, political, and financial support for BRT-type services
- ◆ Bringing partners together to understand the long-term vision for Colorado Boulevard and its role in north-south connectivity
- ◆ Complete a route-specific study
- ◆ Initiate discussions on how to proceed into the project development stage
 - Identify local funding match
 - Pursue FTA Small Starts grant

Corridor Strengths



**Existing Transit
Supportive Land Use**



**Existing Transit
Supportive Policies**

Federal Boulevard

The Federal Boulevard route travels through Englewood, Federal Heights, Sheridan, Westminster, the City and County of Denver, and Adams and Arapahoe Counties. The route connects the Wagon Road Park-n-Ride, Flatiron Flyer, B-line, G-line, W-line, and Southwest rail line.

Strengths

The Denver section of the route is currently being evaluated for multimodal improvements in the Federal Boulevard Corridor Study. Westminster has initiated a planning study for its section of the route and Adams County's *Making Connections* (2016) plan previously identified the need for a BRT study for Federal Boulevard. Existing land uses and future land use projections are transit supportive along most of the route. The staff of both Denver and Adams County indicate that they would support repurposing travel lanes for transit use on Federal Boulevard, while other communities along the route are either unsure or it is unknown if they would support lane conversion/repurposing for transit use along Federal Boulevard.

Opportunities

There is a good potential for repurposing travel lanes on Federal Boulevard based on existing and future traffic volumes and available space along the route. Ridership projections developed as a part of this study estimate nearly 13,000 daily boardings and a potential reduction in daily VMT of over 30,000 in 2040 if BRT services were implemented.

Next steps for advancing BRT on Federal Boulevard include:

- ◆ Complete corridor studies in Denver and Westminster
- ◆ Identify a unified vision for Federal Boulevard's role in north-south connectivity
- ◆ Initiate discussions on how to proceed into the project development stage
 - Identify local funding match
 - Pursue FTA Small Starts grant

Corridor Strengths



Corridor Study/
Evaluation
Complete



Existing Transit
Supportive Land
Use



Right-of-Way
Available



Existing
Partnerships/
Coordination



Existing Transit
Supportive Policies

Havana/Hampden

The Havana/Hampden route includes Havana Street on the north and Hampden Avenue on the south. This route travels through Aurora, the City and County of Denver, and Adams and Arapahoe Counties. The route connects the Southeast rail line, future Colfax BRT, and the A-line along an important commercial corridor.

Strengths

Existing land uses and future land use projections are transit supportive along most of the route. *Aurora Places* (2018) is currently being updated to include Havana Street as a high-frequency transit corridor, and *Denver Moves: Transit* (2019) identifies Hampden Avenue as a speed and reliability (enhanced bus) corridor. City of Aurora staff indicate support for bus bypass lanes/queue jumps, and Denver staff are likely to support general-purpose travel lane conversion for priority bus use. Denver has also initiated route-specific planning along Hampden Avenue with the *Hampden Avenue Corridor Study*, although the study does not recommend transit lanes. Aurora has received DRCOG Transportation Improvement Program (TIP) funding for transit improvements

along Havana Street and will soon initiate a multi-modal study for the corridor.

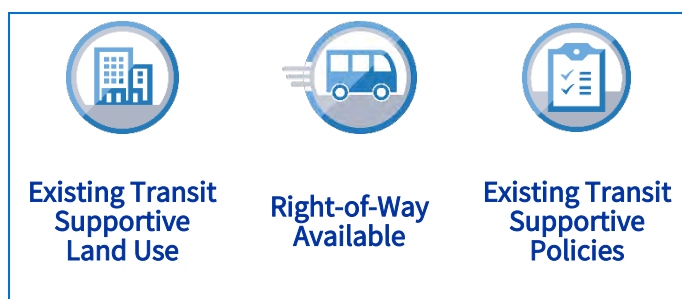
Opportunities

There is a good potential for repurposing travel lanes along Havana/Hampden based on existing and future traffic volumes and available space along the route. Ridership projections developed as a part of this study estimate over 9,000 daily boardings if BRT services were implemented.

Next steps for advancing BRT on Havana/Hampden include:

- ◆ Complete corridor studies in Denver and Aurora
- ◆ Identify a unified vision for Hampden Avenue and Havana Street through continued discussions between Denver and Aurora
- ◆ Initiate discussions on how to proceed into the project development stage
 - Identify local funding match
 - Pursue FTA Small Starts grant

Corridor Strengths



North I-25

The North I-25 route travels through Northglenn, Thornton, Westminster, the City and County of Broomfield, the City and County of Denver, and Adams County.

Strengths

The North I-25 route has been identified for express bus service in the *North I-25 Environmental Impact Statement* (2011) and further evaluated in the *North I-25 Planning and Environmental Linkages Study* (2014). Broomfield also identifies BRT on I-25 in their *Transportation Plan* (2016). Staff across all communities support BRT service in the managed lanes (existing and planned) on north I-25.

Opportunities

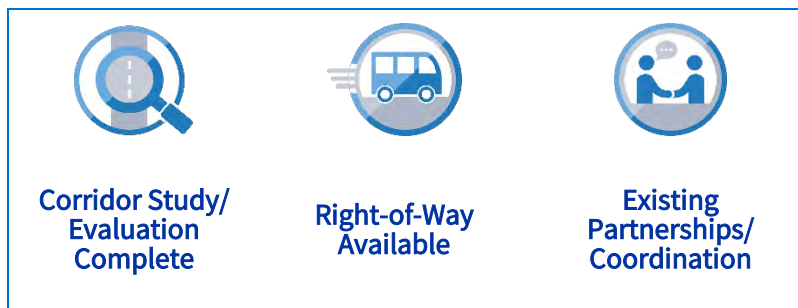
The existing and planned managed lanes offer a unique opportunity to implement service on north I-25 with limited on-route infrastructure

improvements needed; however, stations still need to be planned and financed. Ridership projections developed as a part of this study estimate nearly 11,000 daily boardings and a potential reduced daily VMT of nearly 50,000 in 2040 if BRT services were implemented.

Next steps for advancing BRT on North I-25 include:

- ◆ Complete managed lanes along north I-25 (construction ongoing)
- ◆ Initiate discussions on how to proceed into the project development stage (i.e., station planning and service operations planning and funding)
 - Finalize station locations along north I-25 and build consensus
 - Identify local funding match
 - Pursue FTA Small Starts grant

Corridor Strengths



Speer/Leetsdale/Parker

The Speer/Leetsdale/Parker route travels through Aurora, Glendale, the City and County of Denver, and Arapahoe County. It provides a connection between the R-line's Nine Mile Station and the Planned Colfax BRT route.

Strengths

Existing land uses and future land use projections are transit supportive along most of the route. The section of the route that travels through Denver was evaluated in the *Go Speer/Leetsdale Study* (2017), which recommends BRT service and developed proposed cross sections along the route. Denver staff also support the repurposing of travel lanes for transit use and queue jumps or bus bypass lanes along the route. *Aurora Places* (2018) also identifies the corridor as a high-frequency transit corridor, but staff is unsure if they would support repurposing of travel lanes for transit use along the Aurora section of this route without further analysis.

Opportunities

Ridership projections developed as a part of this study estimate nearly 15,000 daily boardings and a potential reduced daily VMT of nearly 35,000 in 2040 if BRT services were implemented.

Next steps for advancing BRT on Speer/Leetsdale/Parker include:

- ◆ Initiate planning for the Parker Road portion of the route
- ◆ Initiate discussions on how to proceed into the project development stage
 - Identify local funding match
 - Pursue FTA Small Starts grant

Corridor Strengths



This page intentionally left blank.



4.0

BUILDING A REGIONAL BRT NETWORK

The original intent of the Regional BRT Feasibility Study was to identify a small set of routes that have the greatest potential to improve regional mobility and compete for FTA Small Start funds. Based on stakeholder input across the region, it became clear that not only should a short list of potential Small Starts-competitive routes be identified, but a larger regional network should be recommended. RTD supports BRT investment throughout the District where high-quality, high-frequency bus service is expected to meet RTD's minimum service standards and the local agencies demonstrate commitment to project development. As a result, this study developed a regional BRT network that spans the entire region and encompasses 37 partner jurisdictions.

This comprehensive regional BRT network represents a long-term vision of BRT throughout the region that expands regional mobility and leverages existing investments in the transportation system. Furthering the BRT routes into project development will require stakeholder support along the length of the route, the development of strategic partnerships, political support, and ultimately financial buy-in of partners.

The Tier 4 routes represent those that this study identified as being the most competitive for FTA Small Starts funding, but this does not imply that those routes will be implemented sooner than others in the network. Some routes that were not advanced into Tier 4 have a high level of community support (e.g., SH 7). Local champions will be the primary force to move routes into project development. Other influences on timing and the ability to implement BRT services in the near- and long- term include identification of funding sources, community values, and priorities that may vary across the route length and greater region.

4.1 Regional BRT Network

The Regional BRT Feasibility Study developed a proposed BRT network that includes:

- ◆ Routes with the highest potential to support high-quality, high-frequency bus service (Small Starts-competitive routes)
- ◆ Routes in communities that have demonstrated substantial support through study, design, and/or financial commitment
- ◆ Routes with high ridership potential that can operate on an existing semi-exclusive travel way (i.e., toll lanes, managed lanes, high-occupancy vehicle lanes) and can, therefore, be implemented relatively cost-effectively

This approach resulted in a proposed BRT network of 21 routes, which require continued evaluation and development by local agencies with support from RTD, as shown on **Figure 24**. These routes, in conjunction with RTD's existing and planned rapid transit network, provide high-quality service throughout a substantial portion of the District. Though not evaluated further in this study, BRT routes along both Colfax Avenue and SH 119 are part of the regional BRT network based on their previous inclusion in DRCOG's 2040 Metro Vision Regional Transportation Plan.

The map displays the proposed BRT network in Denver, Colorado. The legend identifies the following elements:

- BRT Network Routes:** Solid white lines.
- Bus Rapid Transit Projects in Fiscally Constrained Plan:** Dashed green lines.
- Existing and Funded RTD High Capacity Transit Line:** Solid yellow lines.
- Future RTD High Capacity Transit Line:** Dashed yellow lines.
- High Capacity Transit Station:** Yellow star icons.

The map shows major highways (Interstates 70, 25, 76, 26, 70, 25, 76, 26, 70, 25, 76, 26) and local streets (Nelson Rd, Niwot Rd, 95th St, County Line Rd, Erie Pkwy, Colorado Blvd, 168th Ave, 152nd Ave, 144th Ave, 128th Ave, 120th Ave, 112th Ave, 104th Ave, 88th Ave, 80th Ave, 72nd Ave, 56th Ave, 44th Ave, 38th Ave, 36th Ave, 34th Ave, 32nd Ave, 30th Ave, 28th Ave, 26th Ave, 24th Ave, 22nd Ave, 20th Ave, 18th Ave, 16th Ave, 14th Ave, 12th Ave, 10th Ave, 8th Ave, 6th Ave, 4th Ave, 2nd Ave, Broadway, University Blvd, Arapahoe Rd, Dry Creek Rd, County Line Rd, Lincoln Ave, RidgeGate Pkwy, Smoky Hill Rd, Jewell Ave, Quincy Ave, Chambers Rd, Jiliff Ave, Hampden Ave, Mississippi Ave, Colfax Ave, MLK Blvd, Washington St, Federal Blvd, Sheridan Blvd, Wadsworth Blvd, Kipling St, Bowles Ave, Ken Caryl Rd, Broadway, University Blvd, Arapahoe Rd, Dry Creek Rd, County Line Rd, Lincoln Ave, RidgeGate Pkwy, Smoky Hill Rd, Jewell Ave, Quincy Ave, Chambers Rd, Jiliff Ave, Hampden Ave, Mississippi Ave, Colfax Ave, MLK Blvd, Washington St, Federal Blvd, Sheridan Blvd, Wadsworth Blvd, Kipling St, Bowles Ave, Ken Caryl Rd). The map also shows the locations of major transit stations and the proposed BRT network routes.

4.2 Implementation Considerations

While some BRT routes have a demonstrated need today, other routes are emerging, and need is based on future land use and travel demand. Other factors that influence the implementation of BRT include available right-of-way, existing policies, partnerships and coordination, existing transit supportive policies, and route-specific studies. Another factor evaluated as part of this study is readiness to pursue FTA's Small Starts grant funding.



Table 12 provides a qualitative assessment of each route's readiness for BRT implementation based on these considerations. The routes shaded in blue are those identified as having the most promise to be competitive for Small Starts funding. While this provides a high-level

assessment of "readiness," it is important to remember that routes will progress differently based on current and future conditions, and that local jurisdictions have a significant role to play in advancing their development. Additionally, anticipated boardings and adherence to the RTD Service Standards Policy are important considerations in the further development of these routes. RTD is open to partnering with local communities to deploy BRT along all routes based on financial commitment, updated transit supportive policies, and partnerships.



Source: RTD

Table 12. Implementation Considerations

| Network Routes | Considerations for Implementation | | | | | |
|----------------------------|--|---|---|---|---|--------------------|
| |  Transit Supportive Land Use |  Right-of-Way Available |  Existing Partnerships Coordination |  Existing Transit Supportive Policies |  Corridor Study/Evaluation Complete | Small Starts Ready |
| 6 th Ave | ✓ | ✓ | | ✓ | | |
| 120 th Ave | ✓ | ✓ | | ✓ | | |
| 38th/Park | ✓ | | | ✓ | | ✓ |
| Alameda Ave | ✓ | ✓ | | ✓ | | ✓ |
| Arapahoe Rd | ✓ | | ✓ | ✓ | | |
| Broadway (Boulder) | ✓ | | ✓ | ✓ | | |
| Broadway/Lincoln | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Colorado Blvd | ✓ | | | ✓ | | ✓ |
| Evans Ave | ✓ | | | ✓ | | |
| Federal Blvd | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Havana/Hampden | ✓ | ✓ | | ✓ | | ✓ |
| Monaco/Quebec | ✓ | | | ✓ | | |
| North E-470 | | ✓ | | | | |
| North I-25 | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Sheridan Blvd | ✓ | | | | | |
| South Boulder Rd | | ✓ | ✓ | | | |
| South E-470 | | ✓ | | | | |
| Speer/Leetsdale/Parker | ✓ | | ✓ | ✓ | ✓ | ✓ |
| SH 2 | | ✓ | | | | |
| SH 7 | | ✓ | ✓ | ✓ | ✓ | |
| SH 42/96 th Ave | | ✓ | | ✓ | | |
| University Blvd | ✓ | | | | | |
| US 287 | | ✓ | | ✓ | | |

Note: Blue shaded routes are those identified as having the most promise for FTA Small Starts grant funding.

Transit Supportive Land Uses

Socioeconomic data contained within the DRCOG model was analyzed to understand population and employment patterns and growth within the district. This data helped inform the identification of routes where present and future land use may be supportive of BRT services. To identify transit supportive areas, population and employment density (in units of persons per acre) was combined.

Greater than 17 persons per acre – where 17 persons per acre represents the level of density needed to support BRT service (*Cost of a Ride: The Effects of Densities on Fixed-Guideway Transit Ridership and Capital Costs*, Guerra and Cervero, 2010). **Figure 25** shows areas where 2040 population and employment densities are estimated to be at least 17 persons per acre and are most likely to support BRT investment.

Conversely, this also highlights areas where land use policies could be updated with higher density land uses in an effort to improve the likelihood of a BRT route's implementation. BRT routes with low densities include:

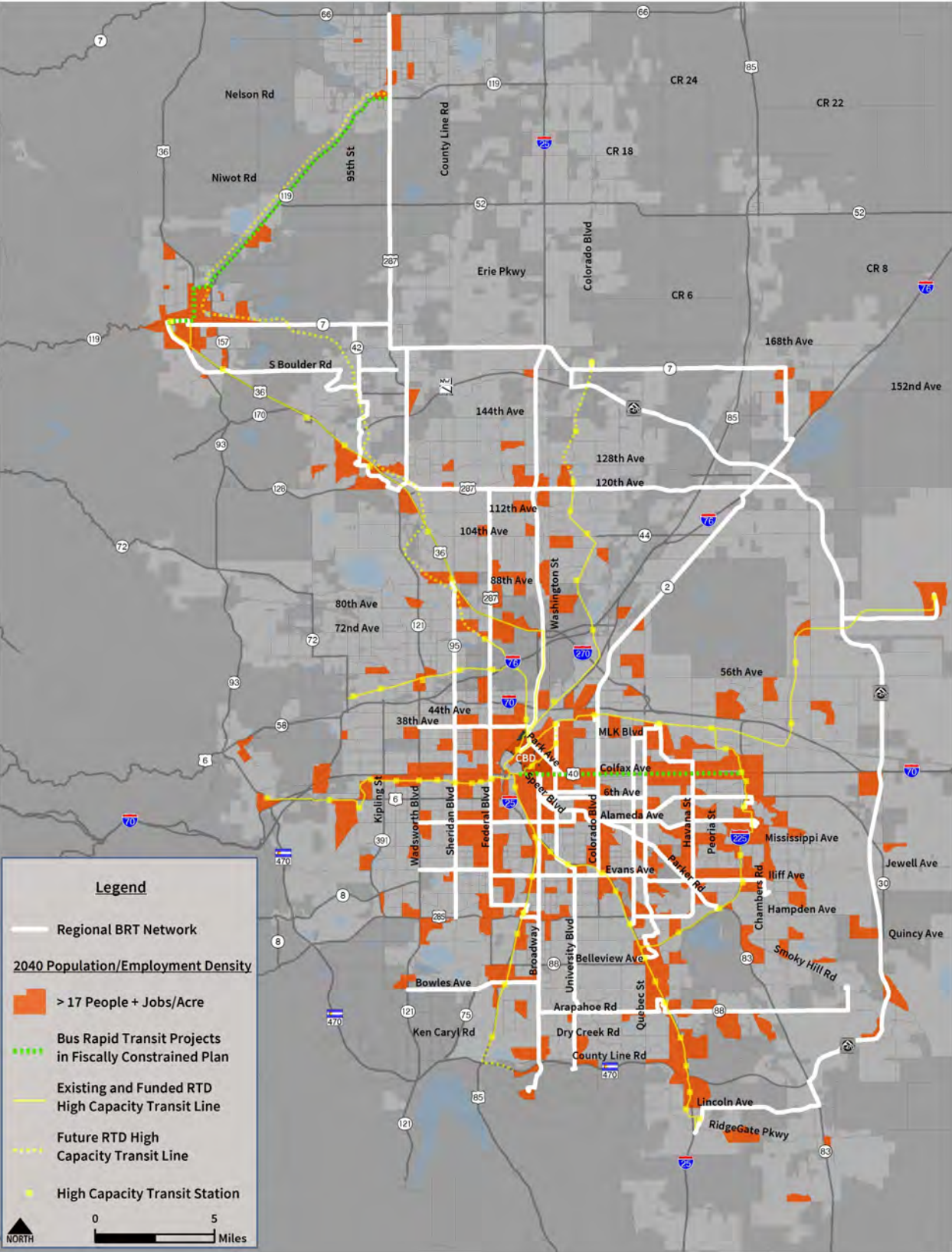
- North E-470
- South Boulder Rd
- South E-470
- SH 2
- SH 7
- US 287

The full *Existing Conditions Report* in **Appendix B** includes additional information on existing and future land uses.



Source: RTD

Figure 25. 2040 Jobs and Population Density



Source: DRCOG Regional Travel Demand Model (Focus 2.1)

Right-of-Way Availability

As discussed previously, the presence of dedicated facilities is the primary identifier for a BRT-type service by the FTA. FTA Small Starts eligible projects must be either a Corridor-Based or a Fixed Guideway BRT system, with dedicated facilities provided along the project corridor.

Fixed guideway service is more likely to see substantial travel time savings compared to traditional fixed-route bus service, so RTD is most interested in identifying corridors where it would be feasible within existing right-of-way. A physical viability assessment, detailed in **Section 3.6**, was completed for each Tier 3 route. The second column in **Table 12** highlights those routes in the BRT network with the most opportunity for dedicated transit facilities due either to existing and future traffic volumes that could be accommodated in fewer general purpose lanes than currently exist or to available right-of-way outside the existing roadway footprint.

Community support for dedicated transit lanes, particularly when repurposing of existing street space would be necessary, is another key consideration. Where efficient transit service is the priority, reduced levels of service for personal vehicles may be acceptable.

It is worth noting that some routes, especially those in more suburban and/or rural parts of the region, have a distinct advantage due to their wide and largely unused existing right-of-way. Preservation of this right-of-way is critical for future implementation of BRT services.

Some routes with large swaths of right-of-way potentially available for future dedicated transit facilities include:

- 120th Avenue
- South Boulder Road
- SH 2
- SH 42/96th Street
- SH 7
- US 287

Partnerships and Coordination

Although RTD is the regional transit provider for the metro area, CDOT, all the communities throughout the region, and private property owners ultimately are the decision-makers for how right-of-way and adjacent space are used within their jurisdictions. Implementing a regional network of BRT routes requires support and buy-in from stakeholders. Support can come in various ways depending on the location and the proposed BRT treatment. Examples include policy support, financial contribution, in-kind land contribution, and willingness for implementation of location-specific site improvements.

The realization of any BRT route will involve many partnerships. Each partnership will transpire differently depending on timing of implementation, local context, and the perceived benefits and impacts along each route. Some partnerships are already formed (e.g., SH 7), and many were initiated through this study and will continue to be refined as projects move through design phases. This study included various touchpoints with the stakeholders along each potential BRT route; for more information refer to **Chapter 2** and **Chapter 3**, which discusses the stakeholder survey and policy reviews completed for this study. **Appendix A** and **Appendix D** provide additional information on the community survey and policy summaries.

In addition to local jurisdictions, CDOT will be a critical partner in furthering the development of the BRT network. Many of the identified routes are entirely or partially state highways. CDOT's participation in the TAC helped to build early consensus on regional transportation priorities and establish a framework for the types of transit-specific accommodations that would be feasible along CDOT-maintained facilities. Continued close coordination between RTD and CDOT will ensure that a consistent vision for regional transit is maintained.

Each route in the regional BRT network has varying levels of public and agency support. Moving a route into the project development stage will require community champions to help build support not only in individual communities but also across all communities and agencies along the route. This study initiated these discussions for the region, but smaller and more focused discussions are required to build momentum for each route.

As an example, the North Area Transportation Alliance (NATA) is a strong supporter and advocate for transportation initiatives in these communities and has been a proponent for moving the following routes into project development:

- Broadway (Boulder)
- Federal Boulevard
- SH 7

BRT Funding Opportunities

As with any infrastructure project, funding considerations are of paramount importance before implementation of BRT. Several potential strategies and tools for financing the 28 routes envisioned as part of the regional BRT network are available. They vary in method of establishment and revenue potential, and some may be more applicable than others to certain routes. Examples include dedicated taxes and fees, federal grants, and special funding districts. Given that all of the envisioned routes cross jurisdictional boundaries, new taxes and fees would require voter approval from multiple cities; this is a potentially challenging obstacle for as narrowly defined of an improvement as a BRT route. Regional initiatives packaging BRT with other mobility improvements, similar to 2018's unsuccessful Proposition 110, would have a higher likelihood of success if scaled down from a statewide focus to the Denver metro area level. **Appendix M** provides a more detailed summary of the funding tools and strategies to consider.

Transit Supportive Policies

Land use and transportation policies vary along each route. Small Starts grant consideration requires that land use and transportation policies be supportive of transit, including having land use densities that support transit ridership, parking policies that support transit usage, financial incentives for transit supportive development, and affordable housing policies that promote transit supportive development.

Tier 3 assessed transit supportive policies as shown on **Table 9**. Analysis was further refined in Tier 4's Small Starts readiness evaluation. All Tier 4 routes have transit supportive policies behind them and most of the Tier 3 routes have some level of policy support. Many of the more rural routes that were analyzed in Tier 2 do not have the policy support behind them to support BRT at this time.

Corridor Studies

Route-specific planning work is necessary to further any route into project development and ultimate BRT service deployment. Some broader studies, such as *Denver Moves: Transit* (2018) and the *Northwest Area Mobility Study* (2014), have recommended a few corridors as BRT routes. Additional corridor studies that emphasize improving transit service have either been completed (e.g., *Go Speer/Leetsdale* (2017)) or are in progress (e.g., *Federal Boulevard Alternatives Analysis*). These corridor studies further evaluate public support, design, and operations and help to identify funding sources, and set the stage for initiating conversations with the FTA about Small Starts grant funding.

Routes that would benefit from policy development include:

- North E-470
- South E-470
- SH 2
- SH 7
- US 287

Small Starts Readiness

The analysis completed in Tier 4 assessing the readiness of the Tier 4 routes to pursue project development showed that all Tier 4 routes have merit and a Medium-High rating using FTA Small Starts criteria. However, based on the analysis of recent and anticipated grant awards, it appears there is no common thread among successful applications for any candidate project to receive a Small Starts grant. The project application process and the results are far more subtle and based on a wide variety of specific project elements, FTA evaluation criteria ratings, regional context and connections with other transit routes, perceived public benefit to be derived, agency history, capability, and success in constructing projects and managing FTA grants, demonstrated local funding match, political will and interagency coordination, and public support.

Identifying why one BRT project is selected for Small Starts funding over another is not intuitively obvious. In fact, it is difficult to accurately gauge the likely competitive success of a given project for funding even from a careful review of its physical characteristics as they relate to FTA's definitions or a quantitative review of the project's evaluation ratings.

That said, it is clear that the Small Starts program will continue to be highly competitive, regardless of future funding levels authorized by the U.S. Congress. The best path forward for all of the regional network routes and potential grantee agencies is:

1. To identify and optimize BRT routes that will garner the highest possible ratings for each of the FTA evaluation criteria;

2. To ensure that all local funding is secured; and
3. Ideally, to request less than 50 percent FTA share of the total capital cost or to obtain a High Local Financial Commitment rating and increase the odds of receiving a CIG.

4.3 Conclusion

The past decade has seen something of a transit renaissance. As concerns about accessibility, equity, safety, and sustainability in transportation continue to grow, high-quality public transit service increasingly stands out as a potential panacea for an array of 21st century mobility challenges. Bus Rapid Transit, in particular, has proliferated throughout the United States. The combination of rail-like frequencies and amenities with the cost efficiencies of traditional rubber-tire service makes it a uniquely promising opportunity for expanding the reach of high-frequency transit. The regional BRT network envisioned herein would greatly enhance the convenience, connectivity, and comfort of transit for the region's rapidly growing population and act as part of the solution for combatting worsening congestion and environmental health. RTD looks forward to working with its partners to bring this vision to fruition.



Source: RTD

This page intentionally left blank.