



SH7

BUS RAPID TRANSIT FEASIBILITY STUDY

FINAL REPORT 2018



Prepared for: BOULDER COUNTY
in association with:

- HDR
- Rocky Mountain
- Transit & Urban Planning
- EPS
- Logan Simpson Design
- Felsburg Holt & Ulliveg

Contents

A Corridor Vision of Local Livability and Regional Accessibility.....	5
BRT Operations Concepts	7
BRT Feasibility Findings	10
Development Thresholds for Base Bus Service & Future BRT.....	11
Why is BRT Feasibility Being Explored on State Highway 7?	16
Increased Regional Travel:.....	16
Efficient Use of Existing Roadway Infrastructure:	16
Recent Planning Efforts for the SH 7 Corridor:.....	17
What is BRT?.....	20
Typical Features of BRT:	20
What makes BRT successful?.....	21
Supportive Transit Services:	21
Land Use & Density:.....	24
SH 7 Corridor Characteristics and BRT Feasibility	26
Corridor Land Use Characteristics and Conditions:.....	26
Proposed Station Locations:	34
Corridor Trips:.....	36
BRT Routing and Running Way:.....	40
Service Frequency and Service Span:	44
Costs:	44
Capital Costs	45
Operating Costs	46

SH 7 BRT Concept Evaluation:	48
Modeling:.....	48
Ridership and Ridership Evaluation:.....	49
Travel Time Evaluation:	50
Station Usage:.....	52
Key Findings & Considerations	55
Phasing:	58
Funding	60
Funding Options	60
Direct System Revenues	61
Other Funding Sources	62
Innovative Funding Sources.....	64
Financing Options	65
Traditional Financing Mechanisms	65
Innovative Financing Mechanisms	65
Funding and Financing Summary	67

Executive Summary

A Corridor Vision of Local Livability and Regional Accessibility

Best of Both: Land Use Opportunities and Regional Connectivity

The State Highway 7 (SH 7) corridor between Brighton and Boulder is well positioned to develop as a corridor of local livability and multimodal regional access. This is due in large part to the attraction of the well-established downtown areas of Brighton, Lafayette and Boulder coupled with large areas of undeveloped parcels in unincorporated areas of Adams and Boulder Counties, Lafayette, Erie, Broomfield, Thornton and the east side of Brighton.

Combine these land use opportunities with the strategic location of SH 7 in the regional transportation network, and regional Bus Rapid Transit (BRT) has been deemed an effective mobility solution to serve local and regional transportation needs. SH 7 corridor communities are intentionally planning for BRT to enhance quality of life and connect communities with a safe, fast, and reliable transit system on a vibrant multimodal corridor.

Building an Intentional Vision with Deliberate Planning

BRT & Transit-Supportive Development

Bus Rapid Transit

BRT is a high-quality bus-based transit system. It is intended to bring travel time competitive, comfortable, and cost-effective transit service to the public with a feel that is similar to light rail. It shares many similarities to light rail in the way it operates in that it provides frequent service, it inherently has travel time advantages over driving through use of exclusive or shared/managed lanes, and other transit priority features. BRT has off-board fare collection to accelerate the boarding and alighting process at stations, and enhanced transit stations that are branded, provide weather protection and offer high quality passenger amenities. Stations are also spaced further apart to limit the total number of stops, thereby saving travel time and improving reliability. While similar in these ways to light rail, BRT has some advantages that allow it to be implemented and operate at a lower cost with more flexibility. One primary advantage is that BRT is not a fixed guideway system and can offer more routing flexibility. This allows BRT to potentially provide access to more people by including route variations.

Due to the rapid population and employment growth in the Denver Metro region, the relative affordability of housing throughout much

of the SH 7 corridor and the availability of large swaths of undeveloped land, development pressures in the SH 7 corridor are increasing. This trend is a contributing factor to SH 7's current and projected growth further exacerbating travel demands along the corridor through 2040.

A 2017 study by the Transportation Research Board titled *Closing the Induced Vehicle Travel Gap Between Research and Practice* reviews a number of previous studies about induced traffic demand resulting from the construction of additional highway capacity. This study aggregates the findings of previous studies and finds that building more highway capacity induces additional driving rather than resolving congestion, leading to increased traffic, pollution, and safety issues.

With deliberate planning, communities along SH 7 have an opportunity to create vibrant communities where longer trips are reduced by providing a variety of land use and travel options along the entire corridor. Providing a mix of uses, with a focus on appropriate density and amenities at BRT station areas, will support local livability and high quality transportation options for people to travel safely and efficiently through the corridor.

As local jurisdictions strategically plan for transit-supportive development, it is crucial to integrate future access to stations via Park-N-Ride, local bus service, connected bikeways, trails and walkable neighborhoods. These efforts will complement the existing

downtown areas and help to construct the crucial multimodal transportation networks necessary to build a transit ridership base.

The opportunity to create a more sustainable multimodal vision for SH 7 is now. If proactive measures are not implemented as the corridor develops, the quality of life and transportation options for existing and future residents and businesses along SH 7 will be limited. Investing in multi-modal infrastructure concurrent with new development, infill and redevelopment, is the most cost-effective strategy to achieve this vision.

Collaborative Planning for BRT

In 2015, a Coalition of elected officials was organized under the leadership of the City and County of Broomfield. Later formalized as the SH 7 Coalition, this group meets quarterly and provides a forum to coordinate and advocate for the planning and implementation of multimodal transportation improvements and transit supportive development in the SH 7 corridor between Brighton and Boulder. The SH7 Coalition support multimodal projects and programs that are consistent with plans and studies conducted in the corridor, as described here:

- ▶ RTD's 2014 *Northwest Area Mobility Study* (NAMS) – This study identifies six corridors that would be potentially viable Bus Rapid Transit (BRT) routes, including SH 7. SH 7 was one of the corridors that the NAMS found most likely to be able to support future BRT.
- ▶ CDOT's 2014 *SH 7 Planning and Environmental Linkages* (SH 7 PEL) Study – This study collected data, performed traffic analysis,

and made recommendations for transportation improvements on SH 7 from US 85 on the east to US 287 on the west. The study identified “both a desire and a need for transit service along the SH 7 corridor in the future,” and recommended transit priority and queue jumps at select signalized intersections, along with highway cross sections that included full depth, full width shoulders for bus-on-shoulder operation where feasible.

- ▶ RTD’s 2015 *North Area Transportation Evaluation* (NATE) – Documented fatal flaw analyses for commuter rail transit (CRT), light rail transit (LRT), and certain BRT alternatives and to allow RTD, Commerce City, City of Brighton, and adjacent jurisdictions to implement strategies and funding for transit within Denver’s northeast metropolitan area. The focus area for this study is generally located between US 85 and I-76, north and east of Commerce City to the Weld County line, with a future connection to the SH 7 transit service.
- ▶ Boulder County’s 2017 *SH 7 PEL Study* (Boulder SH 7 PEL) – This study collected data, performed traffic analysis, and made recommendations for transportation improvements on SH 7 from US 287 to 75th Street. It also recommended infrastructure improvements to accommodate premium transit service that would tie into the City of Boulder’s *East Arapahoe Transportation Plan* recommendations.
- ▶ City of Boulder’s 2018 *East Arapahoe Transportation Plan* – This study collected data, performed traffic analysis and BRT ridership forecasting, and made recommendations for multimodal transportation improvements on SH 7 between Folsom Street on the west and 75th Street on the east. The vision plan is a complete street design that includes repurposing the existing curbside general-purpose travel lanes to accommodate a combination of BRT, High Occupancy Vehicles (HOVs), right-turning vehicles, and

new shared technologies such as autonomous/connected vehicles.

One of the first collaborative efforts of the SH 7 Coalition was to bring together the local jurisdictions to build on these previous studies that have considered and recommended BRT on SH 7 and further assess the feasibility of BRT service. As a result, the communities partnered, and in 2016, Boulder and Adams Counties worked in conjunction with the communities of Brighton, Thornton, Broomfield, Lafayette, Erie and Boulder to conduct the SH 7 Bus Rapid Transit Feasibility Study (Study) to evaluate the viability of BRT service along SH 7. Boulder County managed the Study, with federal funding support through DRCOG and a local match from Adams County.

This Study further evaluates the feasibility of BRT, as well as identified key strategies for future evaluation and implementation. The SH BRT concept and key findings are described in the following pages.

SH 7 BRT Concept & Findings

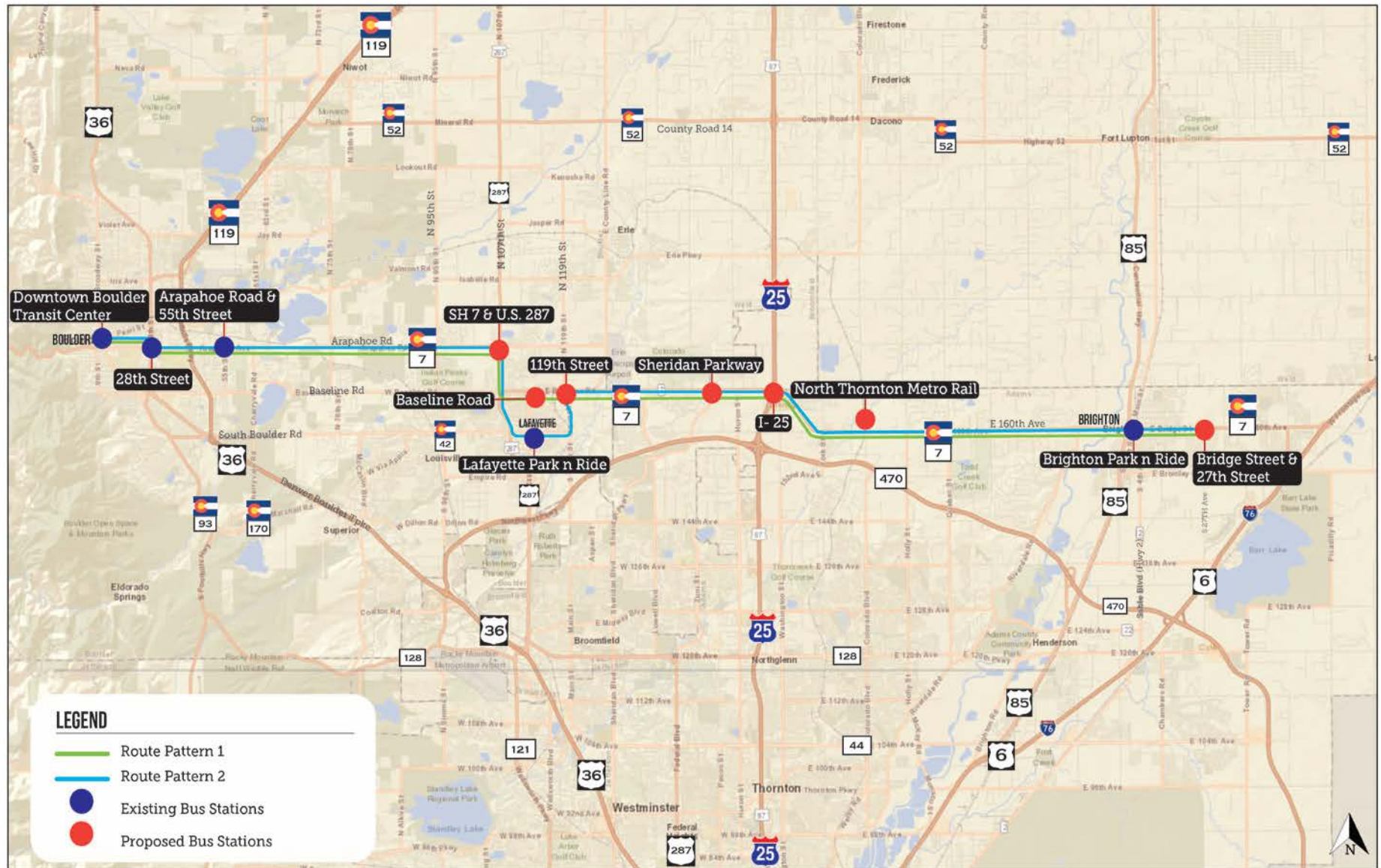
BRT Operations Concepts

Figure ES-1 illustrates the two primary BRT concepts analyzed in this study. Along the SH 7 corridor, the primary BRT scenarios modeled included two route patterns serving 12 stations. A variety of operating scenarios were tested to evaluate alternative station locations and to provide information about how BRT would perform in a mixed traffic scenario and in an exclusive or semi-exclusive right-of-way scenario. One route (Route Pattern 1) travels between Brighton and Boulder along SH 7. Another route (Route Pattern 2)

travels between Brighton and Boulder with a deviation from SH 7 to stop at the Lafayette Park-N-Ride.

It is possible for the two route patterns to operate concurrently 18 hours per day, providing 7.5 and 15-minute frequencies along SH 7 with the intent to complement RTD's existing and future bus services. The operating scenarios will be further refined with future studies that will finalize operating patterns.

Figure ES-1: SH7 BRT Route Patterns 1 & 2



BRT Feasibility Findings

Travel Time

In 2040, travel time between Brighton and Boulder for SH 7 BRT, operating in a dedicated lane, would be approximately 60 minutes. Contrastingly, 2040 travel time for a personal vehicle from Brighton to Boulder is projected to be 80 minutes – 20 minutes longer than travelling by BRT. If BRT were to operate in mixed traffic, travel time between Brighton and Boulder for the SH 7 BRT would be approximately 76 minutes, or 16 minutes more than if BRT operates in a dedicated lane, and comparable to travel in a personal vehicle.

This contrast highlights how BRT operating in dedicated lanes provides superior travel time savings over travel in a personal vehicle and significantly increases the competitive travel time of transit.

Ridership

Ridership in 2040 is projected to be between 7,350- 9,800 boardings per day (variation in ridership is based on the alternative station locations selection), with the assumptions of dedicated running way, queue jump, and transit signal priority.

The projected ridership is an encouraging factor given the current threshold for competing for federal funding. One of the primary funding sources for implementing BRT is the FTA's Small Starts program. To be competitive for the Small Starts program, the transit route should demonstrate existing transit ridership of over 6,000 boardings per day to meet Small Starts warrants.

Currently, there is limited transit service on SH 7 and ridership does not meet the federal funding thresholds. However, as development occurs on the corridor in areas east of Lafayette, and local transit services are implemented on that stretch of corridor, there is a high likelihood that these ridership thresholds will be achieved within the

timeline of this study and will make the corridor competitive to receive federal funding.

Annual Operating & Capital Costs

The estimated general annual operating costs for SH 7 BRT is \$11.3 million per year and capital costs are \$37.0 million, which include stations, Park-N-Rides, and BRT vehicles. Total investments for the multimodal roadway improvements identified in the respective SH 7 PELs and East Arapahoe Transportation Plan are \$302 million (**Table ES 1: Cost Estimates**).

Table ES 1: Cost Estimates

Travel Way	Capital Cost (Millions of \$)
US 85 to US 287	\$155
US 287 to 75 th Street	\$30
75 th Street to Folsom Street	\$90
Shared Use Path	
US 85 to US 287	\$26
US 287 to 75 th Street	\$4
Transit	
Stations	\$5
Park-N-Rides	\$6
Vehicles	\$26
Total	\$342

It is important to note that the roadway improvements on SH 7 are planned to occur even without BRT, and the mobility hub at I-25 is not included in the above costs. It is also valuable to note that a portion of capital improvements have, are, and will be constructed by private development, using the SH 7 PEL as a guide for right-of-way and infrastructure requirements. Cost estimates provided in Table ES 1 include the cost of all improvements regardless of who is responsible for project construction.

Development Thresholds for Base Bus Service & Future BRT

Timing of BRT implementation on SH 7 largely depends on growth and its resulting travel demand. When average development density is between 3-12 residents plus employees per acre, RTD will consider implementing limited local bus service. Introducing local bus service to establish baseline ridership in the corridor is an important interim step to implementing future BRT service. This study envisions local bus service to interline with BRT along SH 7 even once BRT is implemented. This will allow for local service to accommodate for lower density areas.

An important initial opportunity will be to capitalize on Brighton, Lafayette and Boulder's unique downtown environments as transit anchors where existing transit service can be extended from, while at the same time, looking at the undeveloped areas and focusing on appropriate land uses and densities that support connectivity to the future mobility hubs. These anchors, hubs, and Park-N-Rides will extend the reach of transit throughout the corridor, and in turn

connect SH 7 to other key existing and future regional multimodal facilities.

To plan specifically for BRT, the local jurisdictions can use a minimum density of 17 combined residents and employment per acre within ½ mile of station areas as a guide for initiating BRT service. Higher densities, in excess of 42 combined residents and employment per acre, can be supported at major BRT stations like the future I-25 Multimodal Hub, and are ideal for creating highly successful BRT. These higher densities should be allowed for in planning documents and zoning or overlay requirements and can be phased in over time. For initial phases of land use development, the local jurisdictions can explore developing surface lot Park-N-Rides to help offset density requirements that may later transition into structured parking as density increases.

Figure ES 2: Examples of Dwelling Unit Density



Next Steps

Table ES-2 summarizes suggested conceptual implementation steps for project enactment, along with an estimated timeline and an estimated cost of these conceptual implementation steps. These milestones are conceptual in nature and depend on local jurisdictions in the corridor continuing to work together to move this project forward in the months and years ahead.

Table ES-2: Implementation Steps

Task	Projected Timeframe to Implement Task	Status
Agreement for Jurisdictional Cooperation on Implementation	2017-2018	Completed "Statement of Purpose" to Formalize the SH 7 Coalition. This agreement should be revisited annually to ensure it meets the group needs.
Undertake the SH 7 Station Area Master Plan) Study (STAMP	2018-2019	\$200K in funding has been awarded for this study. Contracting is complete and the study is set to be initiated in the spring of 2018.
Ensure SH 7 BRT & Transportation Improvements are incorporated into the Metro Vision Fiscally Constrained Regional Transportation Plan (MV FC-RTP)	2018-2021	DRCOG staff has indicated a full call for projects to be added to the MV FC-RTP will take place in the 2018-2019 timeframe.
Conduct NEPA/30% design to evaluate widening, safety and operational improvements for general traffic, bike/ped, and Bus Rapid Transit	2018-2021	Funding for this planning effort must be identified.
Initiate enabling legislation to allow for shoulder running BRT on principal rural and urban arterials	2019-2021	Monitor SH 119 BRT agreements and discussions, as well as future legislative activity.
Incorporate design, maintenance and operational needs for shoulder running BRT	2019-2021	Monitor SH 119 BRT agreements and discussions. Start initial SH 7 BRT discussion during NEPA.
Implement compatible land use policies to support high quality, high frequency transit	Ongoing	Recommendations from STAMP study – ongoing.
Build transportation improvements from the SH 7 PEL Studies and East Arapahoe Transportation Plan (EATP)	Ongoing	\$302 million (FY17)

Implement new phased-BRT as density thresholds are met. Also incorporate new local transit service to increase ridership	Ongoing	
Establish policies to encourage Transportation Demand Management (TDM) strategies, for example parking management and rideshare services	Ongoing	Ongoing
Continue local route service planning coordination with RTD, including mobility hubs, right-of-entry to private development for buses, design standards required for transit access and station areas	2018-2021	
Identify and pursue local, regional, state and federal funding sources	Ongoing	
Incorporate ROW preservation through the development review process for transit improvements. Encourage private sector capital improvements in development proposals (i.e., shared parking strategies with RTD, etc.)	Ongoing	

Introduction

The State Highway 7 (SH 7) corridor serves as an east-west connection for the north Denver metro area between Brighton and Boulder. It functions primarily as a vehicle corridor with major north-south highway connections to United States Highway 287 (US 287), Interstate 25 (I-25), and US 85.

Why is BRT Feasibility Being Explored on State Highway 7?

Increased Regional Travel:

The SH 7 corridor has long been a primary regional corridor for travel into Boulder. The residential growth of Broomfield, Thornton, Erie, and Lafayette is directly related to the ongoing job growth in Boulder and the Denver metro area and the lack of available and affordable housing in Boulder and Denver. The lack of desirable and affordable housing close to employment areas forces many people working in these areas to move further from employment centers. This pressure has led to rapid expansion of the suburban areas surrounding Denver and, in this situation, in undeveloped areas along the SH 7 corridor east of Lafayette.

As people move to the SH 7 corridor, increased trips will be generated on the corridor. Trip purposes will range from access to existing and new employment centers in the city centers and in the areas surrounding the major north/south commuting corridors like I-25 along with people using the corridor to access services,

healthcare, and recreational opportunities to meet their personal needs. The transportation impacts to this recently rural area will be dramatic, resulting in increasing volumes of traffic on SH 7 and the need for transportation improvements on the corridor to safely and efficiently meet the growing mobility demands.

This study addresses the increased trip demand on SH 7 by assessing the feasibility of BRT on the corridor. BRT can provide a cost effective and travel time competitive alternative to driving a personal vehicle, while carrying more people. BRT can increase the carrying capacity of the corridor while minimizing the need to add new costly and inefficient capacity improvements on the corridor. BRT operating in an exclusive or managed lane, as is planned for in the respective PELs and studies for the SH 7 corridor, can also have travel time benefits over driving, making this mode of transportation more attractive to people that do not want to drive or wait in traffic.

Efficient Use of Existing Roadway Infrastructure:

Land is a finite resource and in desirable areas to live like Colorado's Front Range, land is a valuable commodity. Recent planning efforts on the SH 7 corridor that include CDOT's 2014 SH 7 Planning and Environmental Linkages (PEL) study (US 85 – US 287), Boulder County's 2017 PEL Study (US 285-75th St.), and Boulder's 2018 East Arapahoe Transportation Plan identify the right of way (ROW) needed along the SH 7 corridor to allow for necessary transportation improvements that meet travel demands for 2040 and beyond. These plans make recommendations for

transportation improvements that seek to avoid natural resource impacts and create improvements within the right of way that is currently available on the corridor to more efficiently use the space that is available for transportation improvements. Part of this strategy includes planning for BRT on the corridor to increase corridor person carrying capacity, while limiting the amount of new ROW that would be required.

The recommendations from the plans listed above add some new highway capacity where land is available, and/or to improve traffic operations, but envision BRT to help limit the total land requirements needed to facilitate transportation on the corridor. BRT will also allow for more people to travel through areas of the corridor that are already built out and where land is not available to expand the corridor like in the downtowns of Brighton, Lafayette, and Boulder, and along areas with land adjacent to the corridor that has conservations easements or is dedicated open space.

Recent Planning Efforts for the SH 7 Corridor:

Since 2013, the corridor communities have embarked on thorough corridor planning efforts in partnership with the Colorado Department of Transportation (CDOT) and the Regional Transportation District (RTD) that have set the foundations for a more sustainable multimodal vision for SH 7. These efforts include the development of:

RTD's 2014 *Northwest Area Mobility Study* (NAMS) – This study identifies six corridors that would be potentially viable Bus Rapid Transit (BRT) routes, including SH 7. SH 7 was one of the corridors that the NAMS found most likely to be able to support future BRT.

CDOT's 2014 *SH 7 Planning and Environmental Linkages* (PEL) Study – This study collected data, performed traffic analysis, and made recommendations for transportation improvements on SH 7 from US 85 on the east to US 287 on the west. The study identified “both a desire and a need for transit service along the SH 7 corridor in the future,” and recommended transit priority and queue jumps at select signalized intersections, along with highway cross sections that included full depth, full width shoulders for bus-on-shoulder operation where feasible.

Boulder County's 2017 *SH 7 PEL Study* – This study collected data, performed traffic analysis, and made recommendations for transportation improvements on SH 7 from US 287 to 75th Street. It also recommended infrastructure improvements to accommodate premium transit service that would tie into the City of Boulder's *East Arapahoe Transportation Plan* recommendations.

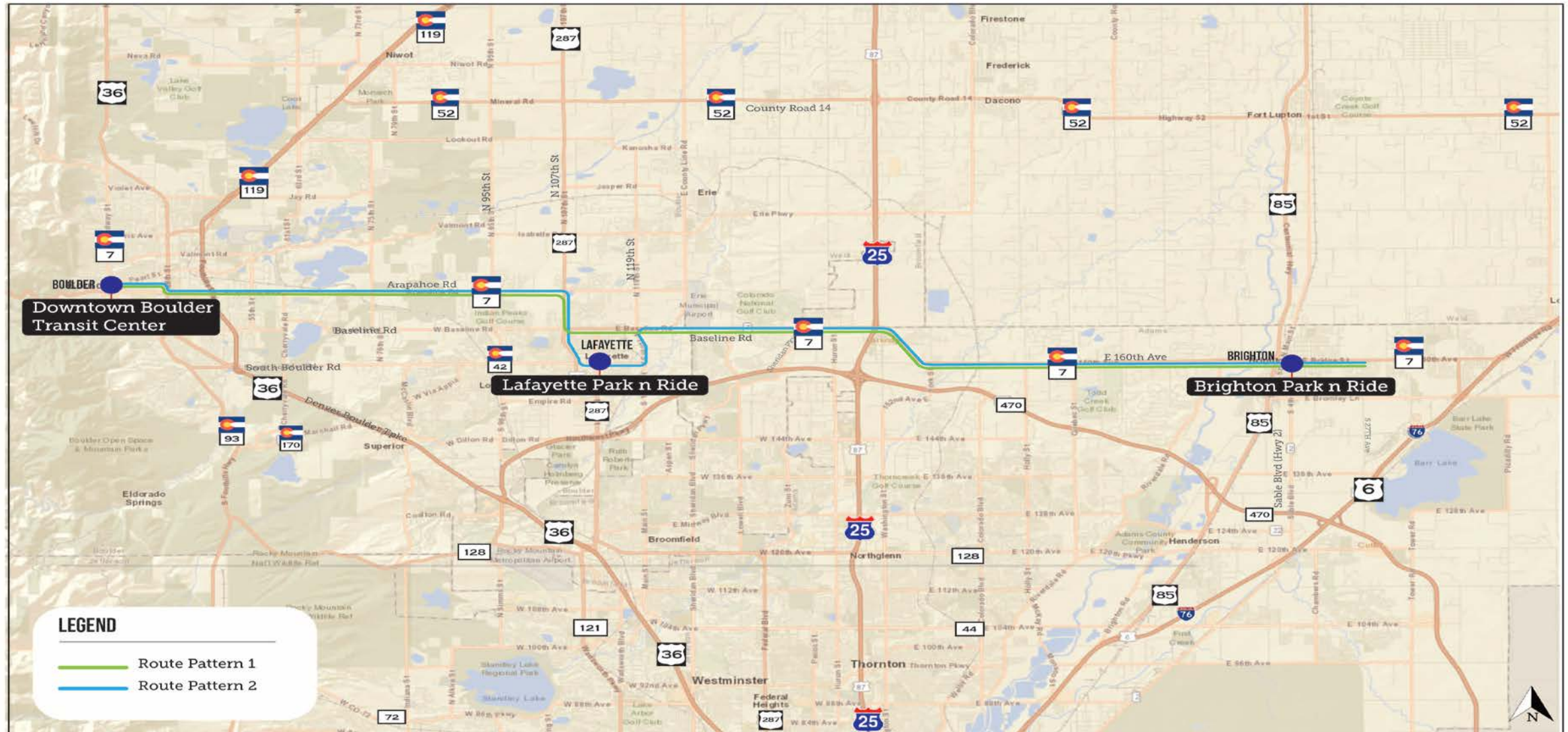
City of Boulder's *East Arapahoe Transportation Plan* – This study collected data, performed traffic analysis and BRT ridership forecasting, and made recommendations for multimodal transportation improvements on SH 7 between Folsom Street on the west and 75th Street on the east. The vision plan is a complete street design that includes repurposing the existing curbside general-purpose travel lanes to accommodate a combination of BRT, High Occupancy Vehicles (HOVs), right-turning vehicles, and new shared technologies such as autonomous/connected vehicles.

The **SH 7 BRT Feasibility Study** is a continuation of these previous efforts. This Study seeks to add an additional level of refinement to the feasibility analysis performed in the NAMS and attempts to take

a proactive approach to making suggestions to municipalities focused on land use and zoning policies that support the successful implementation BRT along the SH 7 corridor. Boulder and Adams counties initiated this study and sought to address the increasing travel demands, support livable development on and around the corridor, and investigate cost effective solutions to travel demands on the corridor. Through these studies, corridor communities have expressed support for implementation of BRT along SH 7.

Error! Reference source not found. depicts the 28-mile corridor that includes the cities of Brighton, Thornton, Broomfield, Erie, Lafayette, and Boulder. The corridor lies within Adams, Broomfield, and Boulder counties.

Figure 1: State Highway 7 BRT Corridor



What is BRT?

BRT is a high-quality bus-based transit system, covering a wide spectrum of infrastructure designs and operating scenarios. Although BRT systems vary greatly from one to the next, BRT's specialized design, frequent service, station amenities, branded shelters with weather protection, seating and real-time information set it apart from a standard city bus while remaining less expensive to implement than rail service. The Institute for Transportation and Development Policy (<https://www.itdp.org/>) has further information on BRT definitions and features.

For SH 7, BRT is a flexible and affordable transit solution compared to other fixed guideway systems. Foremost, BRT provides the flexibility to deviate and change route patterns to reflect travel needs over time and increase access to more people. BRT is also comparable to fixed guideway systems in terms of travel time predictability and savings and increased carrying capacity.

Typical Features of BRT:

The exact features of BRT systems vary widely on a case by case basis, but some elements are common among many BRT systems. The features listed below are common to most successful BRT systems:

- Stations need to be more than a bus stop; they need to offer a host of benefits and services to accommodate riders, including:

- The stations should be designed and built as safe environments with permanent raised platforms, art work, adequate lighting, and creature comforts that show the long-term investment by the local jurisdiction and transit agency.
- Amenities such as real-time passenger information systems, trash cans, benches, and fully enclosed shelters to protect riders from Colorado's inclement weather are necessities for a successful BRT.
- Accessibility for all users is a crucial element for stations as ease of access for individuals with diverse sets of needs should be a priority. This includes making sure there are good sidewalks and crosswalks leading to the station to improve accessibility.
- Increased speed and efficiency for customers by reducing boarding times using ticket vending machines to allow customers to purchase tickets ahead of boarding. Less wait time means less travel time for customers.
- Station locations are typically 2,000–7,000 feet apart. More distance between stations provides more efficient and faster BRT operations and provides increased reliability of on-time service. The BRT corridor requires certain elements to distinguish it from an ordinary bus route, including:
- A separate, dedicated lane along the entire route provides the best environment for high quality, high frequency BRT.
- Service operates with short headways for a substantial part of weekdays and weekends.
- Unique BRT vehicles with high-quality features including WiFi, monitors with route/targeting advertising

information, better lighting, and climate control to optimize passenger comfort.

- BRT buses are typically lower-floor vehicles that allow for lever boarding for Americans with Disabilities Act accessibility and faster boarding.
- Using advanced technologies strategically along the corridor to disseminate real-time information and integrate traffic signal optimization for buses. Plan for a future of buses communicating directly with traffic signals to allow for bus priority operations.
- Branding the BRT sets the service apart from other transit services within the broader transit system. Opportunities to brand stations, buses, and other infrastructure elements help to connect the corridor and service into a common vision that allows users to easily identify the service.

BRT concepts in this study were developed based on the best practices described above, information presented in NAMS, the CDOT SH 7 PEL, municipal input, and existing and planned land use. This section describes the BRT concepts and the subsequent section describes the evaluation of these concepts to test feasibility.

In addition to seeking a better understanding of BRT feasibility on the SH 7 corridor, this study begins to define some of the key features corridor communities should expect to see included if BRT is eventually implemented. It also suggests land use and zoning policies that support BRT along the corridor for each community. The Study also documents community engagement, key corridor characteristics, concept development and evaluation, and a plan to

move forward, including cost estimates, funding options, phasing, and implementation.

Finally, the report seeks to communicate how, through thoughtful planning, intentional implementation of BRT service, and development of supporting land uses, the corridor can realize mobility and economic benefits.

What makes BRT successful?

It is important to understand key corridor characteristics when evaluating the feasibility of BRT. These characteristics play a significant role in determining whether BRT can be successful on a corridor and can help local decision makers implement policies to that can encourage BRT supportive development. This includes factors that create an environment conducive to successful BRT.

Supportive Transit Services:

Development along SH 7, particularly in areas east of Lafayette, will generate significant new trips on the corridor. However, BRT on SH 7 alone will not provide access to all the locations residents of this area will need to access. Many people in this area will work in Denver, Fort Collins, or other areas that today are only accessible by driving. In these cases, BRT on SH 7 will provide access to other transit services like the Bustang or the future North Metro

Commuter Rail Line that will allow users to make connections to these and other major destinations. Providing convenient and travel time competitive one and two seat transit rides to popular destinations is essential for people to choose transit over other modes of transportation. These routes will also provide access to BRT on SH 7.

Additionally, for areas in the mid and eastern portion of SH 7 where a large concentration of development is primarily detached single family homes, such as Todd Creek and locations in Erie, it will be important to develop complementary circulator transit services to provide access to transit stations from lower density residential areas. In the coming years these services may be less expensive to operate and may be able to run more frequently due to autonomous vehicle technology and transportation network company services.

Error! Reference source not found. shows the existing and planned transit operating along or connecting to SH 7. As shown, these transit services provide important connections between SH 7 communities as well as to the Denver metropolitan area and Fort Collins. Transit service along all of SH 7 would improve regional mobility and provide transit options for the communities. These existing and planned routes provide the basis for development and evaluation of BRT operating scenarios and route patterns.

Figure 2: Existing and Planned Transit Intersecting SH 7



Land Use & Density:

The SH 7 corridor is a unique opportunity because the areas east of Lafayette are emerging and allow for greater planning and shaping of development to ensure outcomes that are supportive of BRT. Being largely undeveloped also presents challenges due to uncertainties in the timing of development and the lack of existing transit on the corridor to establish a baseline of transit ridership. Great care and forethought need to be taken with the development of the corridor to ensure land uses are transit supportive and BRT can be successful. With the proper planning, BRT can help mitigate the need for costly highway expansion capital and associated on-going maintenance costs on the eastern extent of the corridor and provide convenient, high-capacity mobility options that offers travel time savings over driving.

Ensuring transit supportive densities on the corridor will be one of the challenges for municipalities as development occurs. It will be critical when development is occurring for municipalities to have a plan in place for how infill and redevelopment can take place in areas surrounding transit stations when BRT comes online. It will also be critical for first and final mile connections to be established around station areas during the initial land use development. This will eliminate the need for costly right-of-way (ROW) acquisition and multiuse path construction to be retrofitted into already established land uses. *The Effects of Densities on Fixed-Guideway Transit Ridership and Capital Costs* (Guerra/Cervero, 2010) suggests that mixed-use developments with composite densities more than 17 employees and people per acre are typically considered supportive for implementation of BRT service. However, more

recent guidance encourages much higher densities in areas around BRT stations and corridor communities should be striving for composite densities in excess of 42 employees and people per acre. This higher figure is also supported by RTD as it will ensure the success and sustainability of BRT on SH 7.

Once BRT is implemented, land surrounding a station area becomes attractive to developers for infill and redevelopment and BRT can be attractive to businesses that want to provide their employees transportation options. This can lead to beneficial development outcomes for communities.

Further, around station areas zoning should be compatible with a BRT system. This often requires the use of zoning overlays that allow for higher maximum density around stations areas. A zoning overlay can often include reduced parking requirements for these areas and/or the addition of park-n-rides.

SH 7 Corridor Characteristics and BRT Operating Scenarios

SH 7 Corridor Characteristics and BRT Feasibility

Corridor Land Use Characteristics and Conditions:

Dense mixed development within a roughly 0.5-mile radius of station and stop areas is ideal for supporting transit use. The best developments around transit areas offer safe access to stations for active modes of transportation. Land uses around station areas also include a mix of uses so residents can shop, work, access services, and recreate without needing a personal vehicle. These factors can help lead to much higher transit usage. Additionally, density around station areas offers a number of other important benefits ranging from higher average tax revenue per acre for municipalities, to better average health of the population due to more frequent use of active modes of transportation.

For this study the project team met with corridor communities to understand their existing land use and plans for future land use. These meetings included land use planning staff, economic development staff, and other relevant staff to help inform the project team's understanding of the corridor. This section provides a brief description of the existing and planned land uses around major proposed station areas along the corridor.

Brighton – Brighton is largely built out along the SH 7 corridor. Their comprehensive plan does, however, call for infill and redevelopment

of parcels on the corridor and encourages the construction of complete streets with high quality facilities for people using all modes. These strategies will help in supporting BRT and will ensure high quality access to BRT stations in Brighton.

Thornton and Adams County – The area of the corridor between Colorado Road and US 85 is experiencing significant change over recent years and is projected to continue this trend moving into the future. Historically this stretch of SH 7 was agricultural land, but more recently much of the area is transitioning to suburban residential development that is largely single family. These land uses do not have the density to support a transit station but, provided there are high quality multiuse paths in place, residents of these areas will be able to conveniently access BRT stations without needing to use a personal vehicle. This trend of development is expected to continue into the future.

Erie, Broomfield, and Thornton – Areas from the Lafayette municipal boundary to Colorado Boulevard were historically agricultural land, but have already undergone significant changes and are planned to continue changing at a rapid pace. Substantial housing has already been constructed both North and South of SH 7, and new housing and commercial development are rapidly occurring. Just west of the I-25 and SH 7 intersection the CU system owns significant land and is planning to construct a new CU medical facility. The Children's Hospital just to the north of SH 7 is currently being expanded.

Broomfield and Thornton have plans for millions of square feet of new office, research, and commercial development, along with new

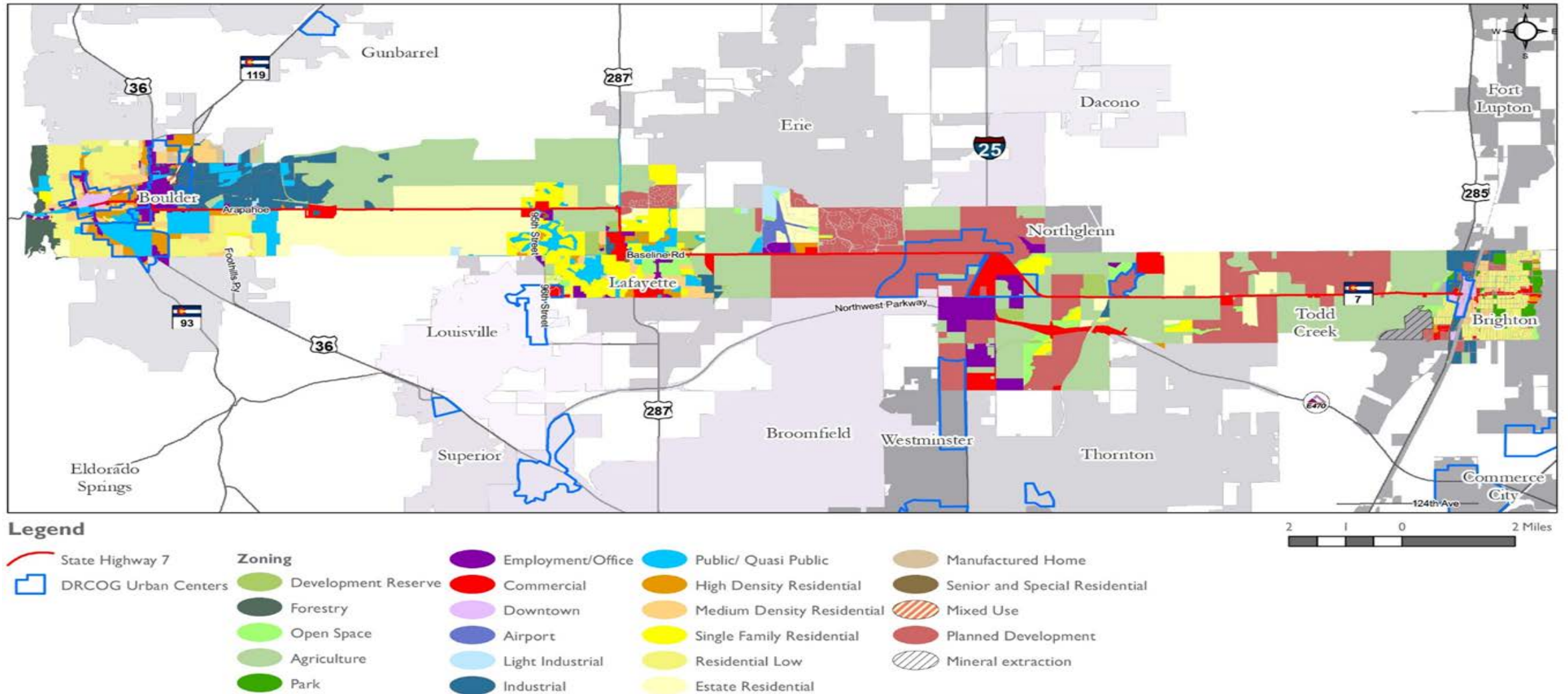
single- and multi-family residential development around the I-25 and SH 7 intersection. Just east of the SH 7 and I-25 intersection, RTD has plans to extend the North Metro Rail Line to 164th Street and create the northern terminus of the line, which will be a major station area.

Boulder, Lafayette, and Erie (in Boulder County) – Boulder is largely built out. The City is poised for significant redevelopment and infill on the SH 7 corridor in the coming years including the development of the Colorado University East Campus. However, changes will likely not have a major impact on the available affordable housing in the City. This is one of the primary drivers of employees working in Boulder moving to more affordable locations east of the City. Lafayette and Erie have room for some new development, but the area along the SH 7 corridor is largely built out.

Today, there is a mix of land uses of various stages of development along the SH 7 corridor among the six cities and three counties and this will continue to be the case into the future. The Team largely based the proposed BRT stations around areas with major planned or existing highway or transit connections and that are expected to see major land use changes over the coming years. Below, Error! Reference source not found. depicts current zoning within 1 mile of the SH 7 corridor, conveying the opportunities for the type of development permissible along the largely undeveloped corridor. Error! Reference source not found. shows future planned land use. Error! Reference source not found. and Error! Reference source not found. illustrate how significantly the corridor is expected to change over the coming years. Station areas proposed in this project

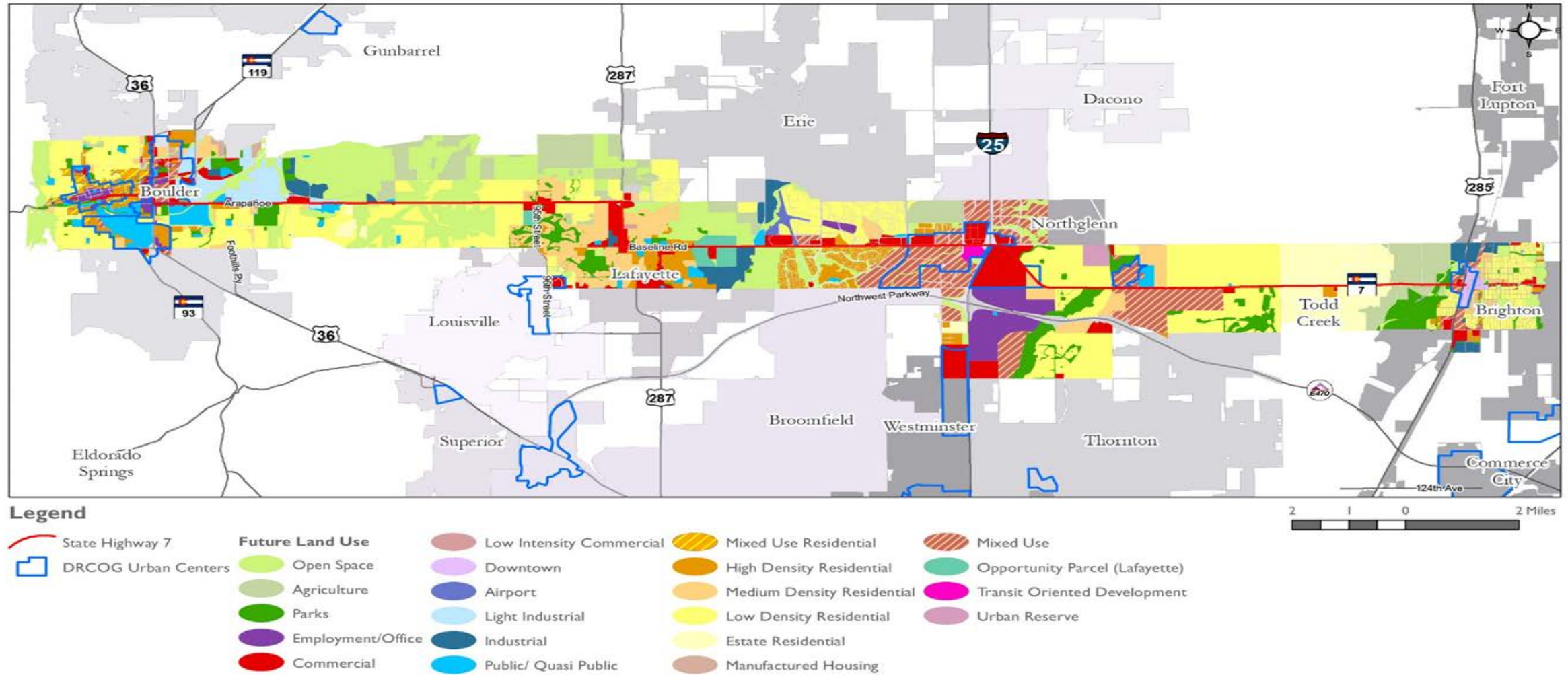
correlate closely with areas that have the most planned change or new development.

Figure 3: 2017 Zoning



Sources: City of Boulder, Boulder County, City and County of Broomfield, Town of Erie, City of Lafayette, City of Thornton, City of Brighton, DRCOG, Weld County, and Adams County, 2016

Figure 4: Future Planned Land Use



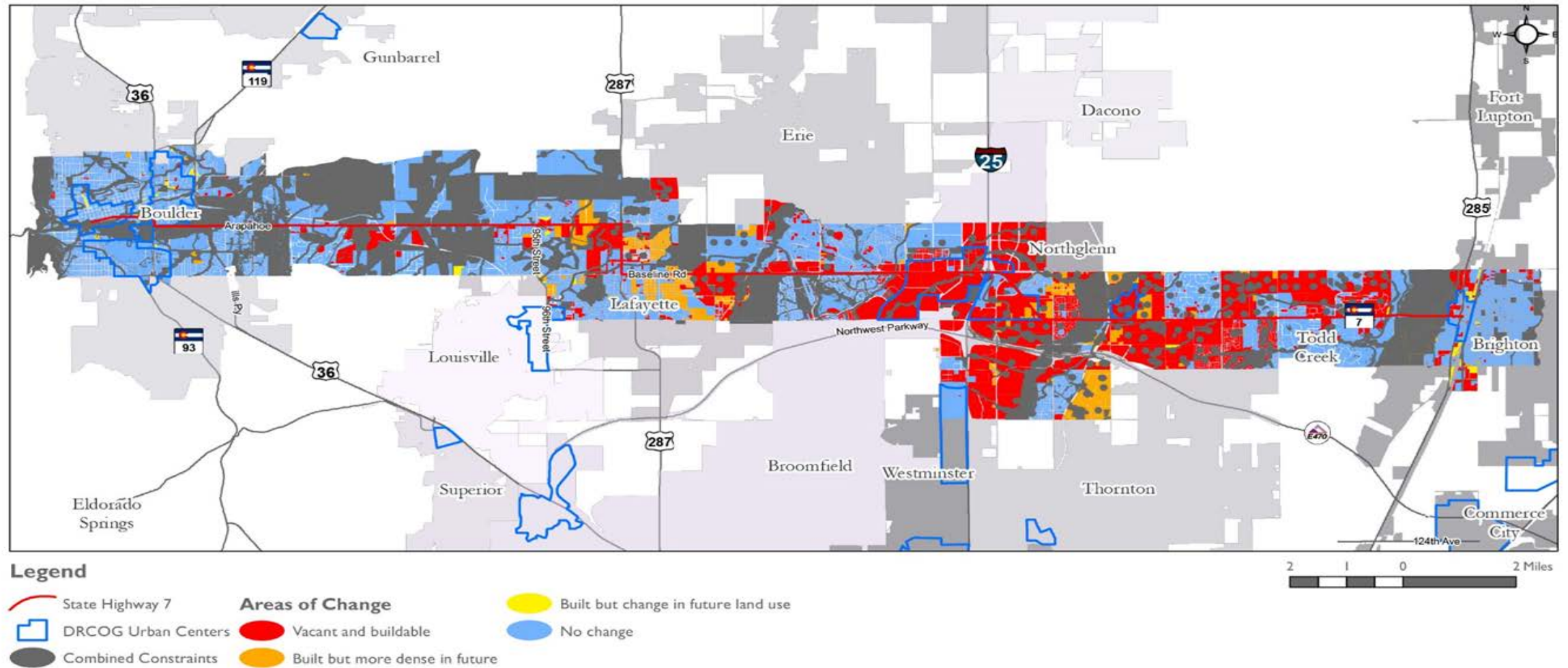
Sources: City of Boulder, Boulder County, City and County of Broomfield, Town of Erie, City of Lafayette, City of Thornton, City of Brighton, DRCOG, Weld County, and Adams County, 2016

Error! Reference source not found. shows areas on the corridor that are likely to experience significant change and that are or will likely be supportive of BRT. The station areas identified by the Team correlate closely with areas highlighted in these figures. The areas shown in orange are built, but a change in future land use will increase density. Areas highlighted in yellow are currently built and have a change in land use, but will not increase in density. The areas shown in blue will not have any significant changes. The gray areas are constrained by features including dedicated open space and parks, 100-year floodplain, wetlands, and stream buffers. As can be seen, the corridor will experience growth and densification and has the potential to support BRT service in the future.

Error! Reference source not found. and Error! Reference source not found. highlight areas on the corridor that are expected to achieve BRT supportive employment and residential densities by year 2040 based on allowed zoning by corridor municipalities. The target, as noted in *The Effects of Densities on Fixed-Guideway Transit Ridership and Capital Costs* (Guerra/Cervero, 2010), for employment and residential density combined is greater than 17 employees plus residents per acre, with higher densities being more transit supportive. Newer best practices and FTA funding requirements suggest densities of residents and employees that are in excess of 42 per acre around station areas to ensure a strong, sustainable BRT service that will experience optimal ridership. Park-n-ride lots at BRT stations can offset a portion of the recommended densities at station areas. Park-n-rides collect potential transit riders from a larger travelshed and can increase the effective density around station areas without necessitating a more dense built environment. The

station locations proposed by municipalities correlate closely with areas that either meet transit supportive densities, are expected to meet transit supportive densities in the near future, or have existing or planned park-n-rides that increase the effective density to transit supportive levels.

Figure 5: Areas of Change



Sources: City of Boulder, Boulder County, City and County of Broomfield, Town of Erie, City of Lafayette, City of Thornton, City of Brighton, Adams County, Weld County, DRCOG, United States Geological Survey, Federal Emergency Management Agency, and Colorado Oil and Gas Conservation Commission, 2016

Figure 6: Areas Projected to have Future Population and Density Supportive of BRT (West Corridor)

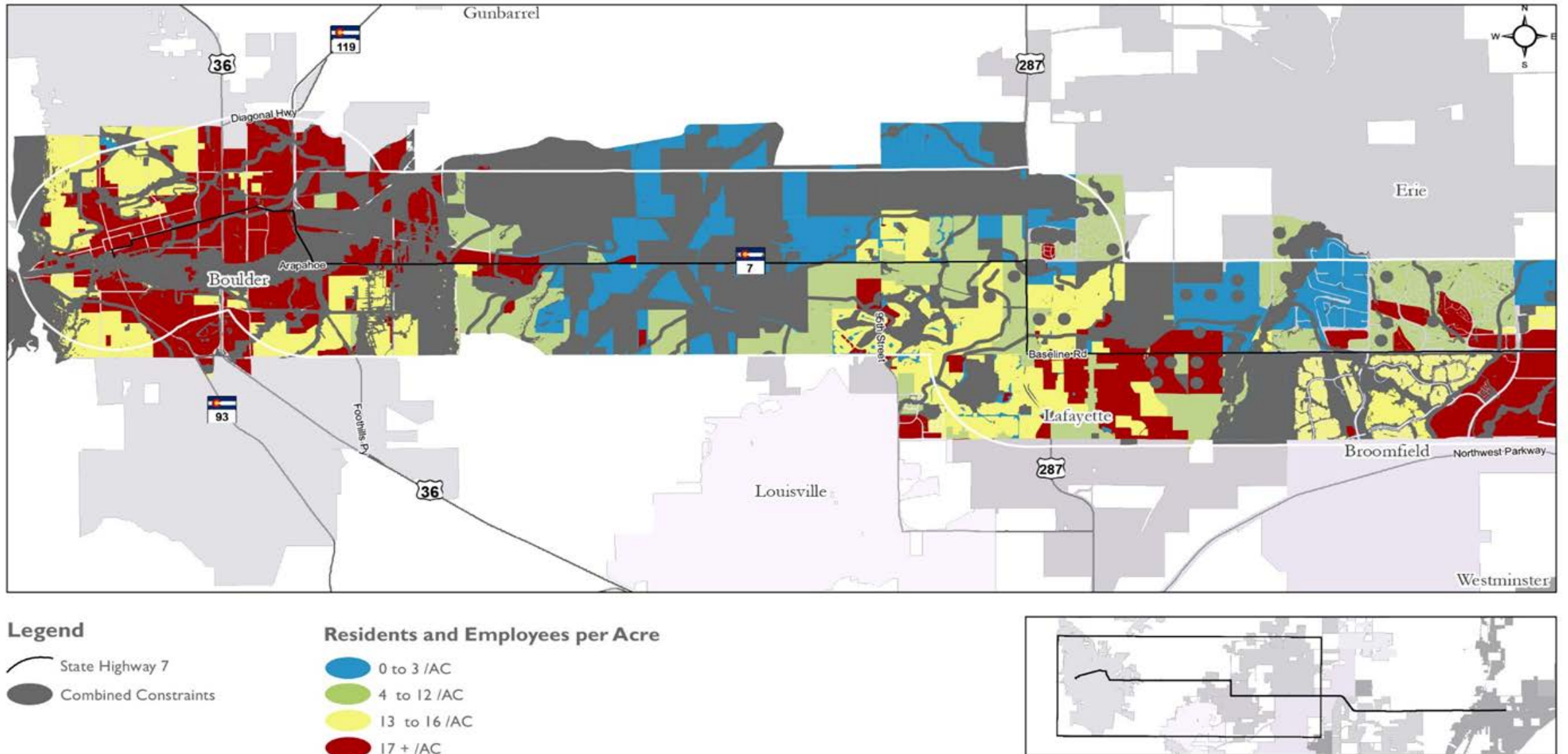
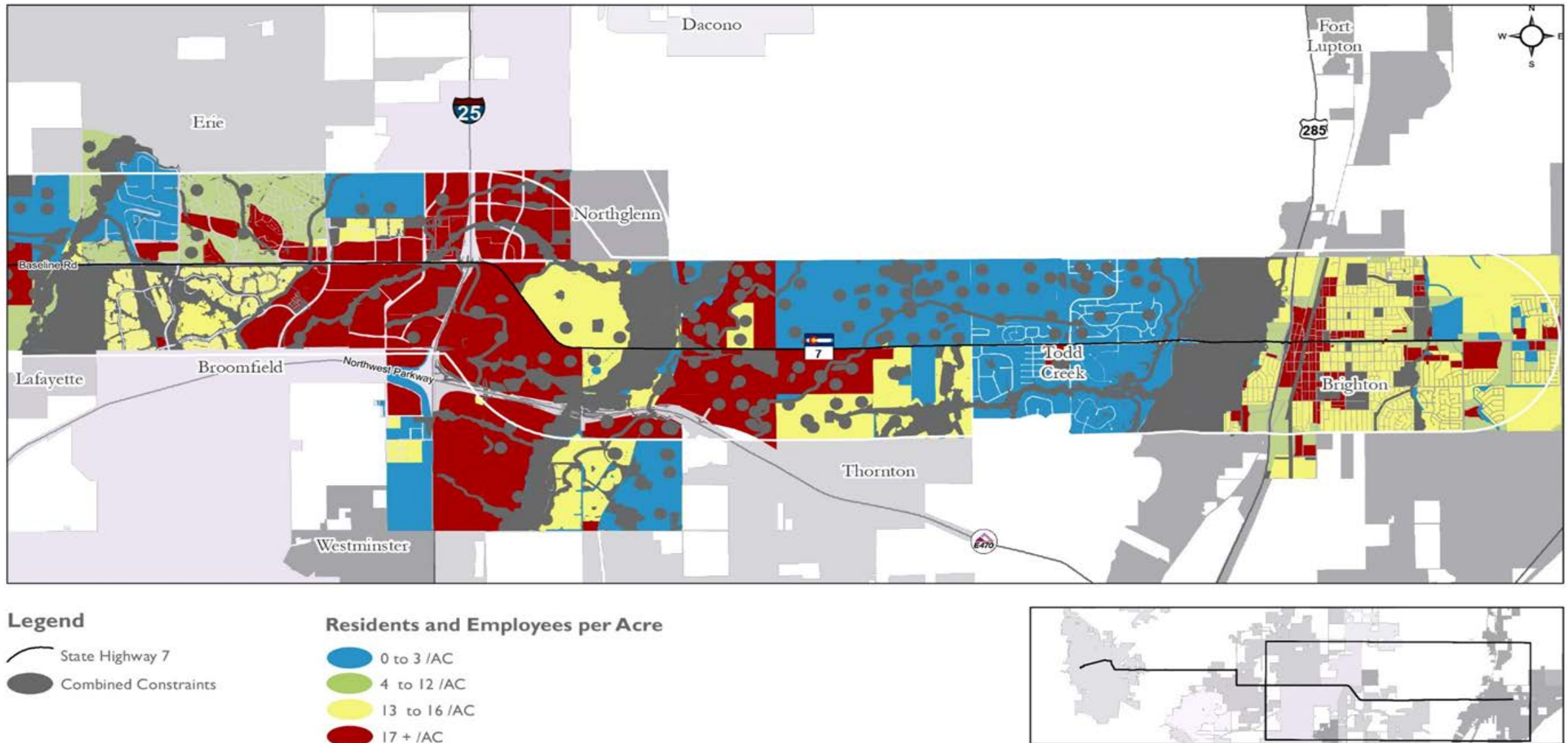


Figure 7: Areas Projected to have Future Population and Density Supportive of BRT (East Corridor)



Proposed Station Locations:

A primary difference between BRT and traditional transit are the travel times. For local or regional transit, stops and stations are typically spaced relatively close together, sometimes only a few hundred feet apart. This is a significant contributor to longer travel times and the passenger perception that transit is “slow.” BRT seeks to limit the total number of stops and stations to limit travel delays caused by stopping, boarding, and alighting. Arterial BRT best practices suggest a minimum of 2 miles between stops to limit travel delay, and urban BRT recommends a minimum stop spacing of ½ mile.

The base BRT station set was developed to provide high-quality BRT service to each community along the corridor. In the interest of meeting the stated goal of providing rapid transit service, a minimal number of stations were identified and station locations included larger spacing than is seen on a local or express transit route to maximize speed and reliability of the BRT service. This means locating stations in areas that are dense and have a mix of uses including residential, employment, and services. BRT also benefits when stations provide high quality connections to other modes of transportation. Multimodal hubs that provide opportunities to connect with other transit services, rail, car share, bike share, and have safe facilities for active modes of transportation help ensure BRT is successful.

Previous work looking at BRT on SH 7, including the NAMS and Northeast Area Transit Evaluation (NATE) studies, helped inform station locations for this study. The NAMS study used members from its TAC and other community officials to help identify potential

station locations for the SH 7 corridor between downtown Boulder and I-25. Similarly, the NATE study identified potential stations in Brighton that could serve BRT along SH 7 and US 85/SH 2. The study group used this information as a basis for initiating discussions about station locations. The locations were further identified in this study using planning assumptions from corridor municipalities land use plans and through coordination with municipal representatives.

Error! Reference source not found.⁸ illustrates the base station set and the stations are listed in **Table 1**. Twelve stations are included in the base station set, resulting in station spacing of approximately 2 to 2.5 miles. Stations in dense urban areas enable riders to access BRT service on foot, by bike, or from another connecting transit line. In areas of lower density, PnRs will be provided (where land is available). The major stations outlined in this study would be designed as mobility hubs to optimize multimodal transfers and provide convenient access to bicycle parking, bicycle sharing, other bus routes (where applicable), real-time passenger information, and other mobility amenities. The BRT stations identified in this study that are expected to be located in less developed areas are still envisioned to include branded shelters and other passenger amenities associated with BRT. They would also include high quality first and final mile connections to adjacent land uses to support the use of active modes of transportation but would likely not be fully built out multimodal hubs.

Figure 8: BRT Station/Stop Set

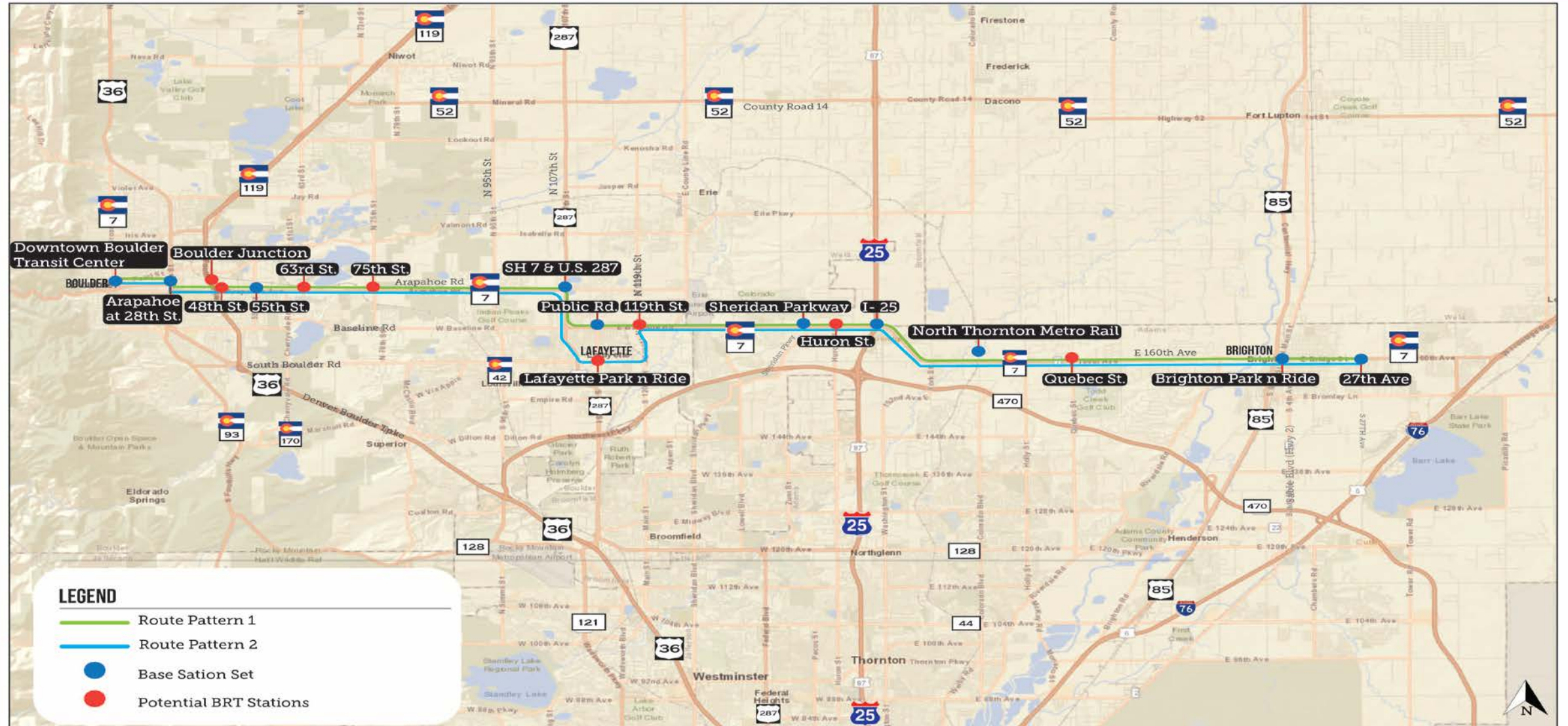


Table 1: SH 7 BRT Stations (Base Station Set)

Station Location	Community	Station Type
Downtown Boulder Transit Center	Boulder	Urban
Arapahoe Road & 28 th Street	Boulder	Urban
Arapahoe Road & 55 th Street	Boulder	Urban
Arapahoe Road & US 287	Lafayette/Erie	PNR
SH 7 & Public Road	Lafayette	Urban
South Boulder Road & Public Road	Lafayette	PnR
119 th Street	Lafayette	Urban
Sheridan Parkway	Broomfield	PnR
I-25	Broomfield/Thornton	PnR
North Metro End of Line	Thornton	PnR
Bridge Street & Main Street	Brighton	PnR
Bridge Street & 27 th Street	Brighton	PnR

Through municipal input, six additional station locations were identified for consideration in the BRT ridership modeling. The six

additional stations could be implemented as development occurs, but for this study they were tested to assess their impact on travel time and ridership. The addition of each individual station to the base station set is considered a new concept. Testing each station as a unique concept provides an understanding of the amount of additional ridership that each location would attract. **Table** lists these potential additional stations.

Table 2: SH 7 BRT Potential Additional Stations

Potential Additional Station	Community	Station Type
Boulder Junction	Boulder	Urban
48 th Street	Boulder	Urban
63 rd Street	Boulder	Urban
75 th Street	Boulder County	PnR
Huron Street	Broomfield	PnR
Quebec Street	Thornton	PnR

Corridor Trips:

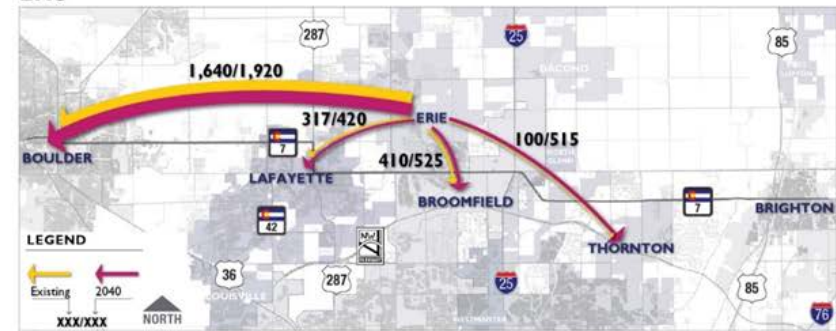
As people move to the SH 7 corridor, increased trips will be generated on the corridor. Trip purposes will range from accessing existing and new employment centers to accessing services, healthcare, and recreational opportunities to meet their personal needs. Data from the U.S. Census Bureau Longitudinal Employer-Household Dynamics was combined with DRCOG 2040 projections to estimate current and future home-to-work trips among the SH 7 communities in **Figures 9 and Figure 10**.

Figure 9: SH 7 Community Commuting Patterns

Brighton



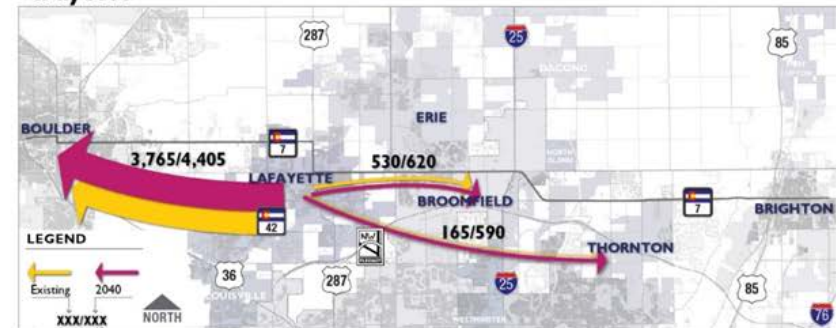
Erie



Thornton



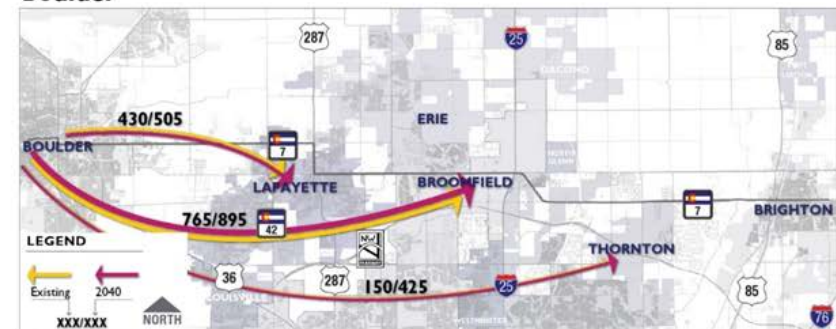
Lafayette



Broomfield



Boulder



SOURCE: U.S. Census Bureau Longitudinal Employer-Household Dynamic (LEHD), 2014; and HDR, 2016

Figure 10: 2014 Origin and Destination Travel Patterns, 2040 Origin and Destination Travel Patterns, & Change from 2014-2040 in Origin and Destination Travel Patterns

2014 Total Inter-Community Trips		Destination					
		Brighton	Thornton	Broomfield	Dacono	Lafayette	Boulder
Origin	Brighton	N/A	285	230	125	No Data	230
	Thornton	145	N/A	370	285	No Data	345
	Broomfield	No Data	70	N/A	No Data	No Data	405
	Erie	No Data	100	410	N/A	317	1640
	Lafayette	No Data	165	530	No Data	N/A	3765
	Boulder	No Data	150	765	No Data	430	N/A

Projected 2040 Total Inter-Community Trips		Destination					
		Brighton	Thornton	Broomfield	Dacono	Lafayette	Boulder
Origin	Brighton	N/A	895	270	215	No Data	270
	Thornton	405	N/A	585	450	No Data	445
	Broomfield	No Data	485	N/A	No Data	No Data	485
	Erie	No Data	515	525	N/A	420	1920
	Lafayette	No Data	590	620	No Data	N/A	4405
	Boulder	No Data	425	895	No Data	505	N/A

Change in Inter-Community Trips (2014-2040)		Destination					
		Brighton	Thornton	Broomfield	Dacono	Lafayette	Boulder
Origin	Brighton	N/A	610	40	90	No Data	40
	Thornton	260	N/A	215	165	No Data	100
	Broomfield	No Data	415	N/A	No Data	No Data	80
	Erie	No Data	415	115	N/A	103	280
	Lafayette	No Data	425	90	No Data	N/A	640
	Boulder	No Data	275	130	No Data	75	N/A

These illustrations and matrices depict daily one-way trips from residences along SH 7 to places of employment along SH 7. It should be noted that these figures do not account for trips generated on the corridor where destinations are to the north or south of the corridor. For example, residents traveling on SH 7 to reach employment destinations in Denver or Fort Collins are not accounted for in Figures 9 and 10.

As shown, commuting to adjacent communities is more common than longer corridor trips, and that pattern will continue. However, in the future, more people will be forced to live further from their place of employment due to the jobs/ housing imbalance and this will likely generate longer trips for employment.

Interpreting the figures are critical to understanding how commuting will change on the corridor as we approach 2040. In 2017 the majority of corridor trips are to Boulder for employment. By 2040 the total jobs in Boulder are expected to increase, but they will not increase at the same rate as in areas east of Lafayette. Many of the new 2040 trips will take place between locations on the eastern part of the corridor due to the additional housing and jobs that are expected to be generated in those areas. The change in total number of trips between 2017 and 2040 are illustrated in the third matrices from Figure 10 and the magnitude of new trips to communities on the eastern part of the corridor are generally greater than the new trips going to Boulder.

BRT Routing and Running Way:

BRT routing is a key aspect of understanding BRT feasibility. Routing can impact the number of people that can conveniently access BRT

by running through more populated areas or areas with park & rides. A primary advantage of BRT over rail is that BRT is not a fixed guideway system and can offer more routing flexibility. This allows BRT to potentially provide access to more people by including route variations. In this study routing variations were tested in Boulder and Lafayette, two communities with areas along SH 7 that are in large part, built out. The intent of testing alternative routing was to establish an understand of how these changes would impact ridership and access to the service.

Several potential route alignments exist through the City of Lafayette. The route patterns reviewed evaluate opportunities to maintain a SH 7 alignment and/or continue to serve the Lafayette PnR. The City feels strongly that the existing PnR located on South Public Road will be the focus of redevelopment over the next several decades and should continue to act as a hub for transit routes serving the city.

Route Pattern 1 – On the eastern end of the corridor, this route would begin in Brighton. In Brighton it would travel along Bridge Street to SH 7 (160th Avenue). It would follow SH 7 through Lafayette along Baseline Road and then turn north onto US 287. It would continue following SH 7 as it turns west along Arapahoe Road and follow that route into the City of Boulder.

This pattern provides the most direct connection between each of the communities along SH 7 and serves the Lafayette Library and Recreation Center. However, it does not serve the Lafayette PnR and transit station on South Public Road and therefore misses the opportunity to connect to routes at that existing station.

Route Pattern 2 – This route directly serves the PnR and transit hub located on South Public Road. It is identical to Route Pattern 1 for the beginning of its journey. When the BRT reaches the intersection with 119th Street/120th Street on the eastern side of Lafayette, the routing would deviate from SH 7 and head south before turning west onto South Boulder Road and continuing on to the Lafayette PnR. From the PnR it would continue west on South Boulder Road before turning north on US 287. The remainder of the route would be identical to Route Pattern 1.

This pattern is less direct than Route Pattern 1 (30 miles end to end compared to 28 miles) but serves the City Center and would facilitate transfers to other RTD bus routes at the Lafayette PnR. This route pattern would include a station at 119th Street and Baseline Road.

The two route patterns are depicted in **Figure 11**.



BRT running way is another factor that can play a major role in determining the success of BRT. The running way plays a primary role in determining travel time savings over driving, on time transit reliability, perceived speed of the trip for passengers, and it impacts overall ridership. BRT provides the fastest and most reliable travel times when it operates in an exclusive lane. When an exclusive lane is not possible, a semi-exclusive lane (managed lane) or intersection treatments such as transit queue jumps and transit priority can also provide benefits to travel times.

Transit operations through intersections are a major cause of delay, particularly on corridors that are not limited access like SH 7. Due to its length, SH 7 has numerous major intersections along the corridor that can contribute significantly to travel times in the absence of transit focused operational intersection improvements.

Queue jump lanes and transit signal priority (TSP) are the two primary ways BRT can reduce delay caused at intersections. Queue jump lanes provide a space for transit vehicles to bypass normal traffic queues and continue through an intersection unimpeded by traffic. This solution is relatively simple to implement with shoulder running transit because the transit vehicle is already in the correct operating space and the only change is that the shoulder lane must be carried through the intersection while allowing the right turning vehicles to share the lane at the intersection approach.

TSP is a technology-based solution to transit operations through intersections. With this solution the transit vehicle communicates with the traffic signal as it is approaching an intersection. The traffic signal timing will be alerted to the transit vehicle's presence and can

extend a green light temporarily to prevent the bus from having to wait a full signal cycle length. TSP can have some drawbacks for intersecting highway facilities by creating marginal additional delay on intersecting facilities to allow for buses to pass through the intersection, but the impact is measured in seconds of delay.

Understanding the viability of these physical improvements along the corridor is key to the evaluation of feasibility for BRT. The project team tested a mixed traffic running way to help provide a baseline for travel time and ridership and utilized a number of studies to help define an enhanced running way for BRT on SH 7, which was also tested. For the enhanced running way the team drew from a number of studies.

Between US 85 and US 287 highway cross sections were developed in the SH 7 PEL (2014). These cross sections range from two to six travel lanes throughout the corridor, with a shared-use bicycle and pedestrian path on both sides of SH 7, as well as an unmarked bicycle lane on the shoulder. Once bus service is in operation, the plan assumes transit would operate on the shoulder. The shoulder is shown in the SH 7 PEL (2014) to be 12' wide (full width) and build to withstand the weight of a transit vehicle (full depth). The highway cross section would be reconfigured to provide a separate bicycle lane to avoid conflicts between cyclists and shoulder running transit. The SH 7 PEL (2014) also recommended intersection treatments, transit signal priority (TSP), and transit amenities. More detailed ROW information is included in the SH 7 PEL (2014).

Transportation and transit improvements for the segment of SH 7 between 75th Street and US 287 are outlined in the SH 7 PEL (2017).

It recommends transit priority through the use of an exclusive lane or managed/bus lane and it included intersection focused transit priority treatments comprised of TSP and queue jump lanes.

The City of Boulder's *East Arapahoe Transportation Plan* describes the transit running way between 75th Street and Folsom. It recommends repurposing the existing curbside general-purpose travel lanes to accommodate a combination of BRT and right-turning vehicles, with the possibility of allowing HOV and new shared technologies such as autonomous/connected vehicles in the future.

Together these plans outline the running way that was modeled in addition to a mixed traffic scenario. Ultimately the second running way option that was modeled was modeled as an exclusive lane because this would be possible for the majority of the corridor. In practice it is more likely that transit would operate on the shoulder or a shoulder/managed lane and would operate through areas with limited available ROW, like downtown Brighton and Lafayette. Additional information about the modeling and scenarios that were modeled can be found in **Appendices B and C**.

Service Frequency and Service Span:

Two major elements of BRT service that separate it from other transit services are the service frequency, or how often a bus is available for passengers to board, and the total number of hours over the course of the day that service is available. BRT service frequency is much higher than local transit, particularly during peak traffic hours in the AM and PM, and BRT is expected to be available

for more of the day than other transit services. To access FTA funding for BRT (Small Starts) the service must operate at a minimum of 10-minute peak hour frequency and 20-minute off peak frequency, or it must maintain 15-minute frequency for the entire service span. FTA also requires BRT to operate for 18 hours over the course of the day.

All BRT concepts that were modeled for this study included a service frequency of 7.5-minute headways during peak periods and 15-minute headways during off-peak periods and a service span of 18 hours. The service frequency assumptions were established by considering the frequency of service offered on RTD's Flatiron Flyer BRT and through discussions with the group about what reasonable BRT frequency could be expected.

Costs:

Implementation of BRT service requires both capital investment and ongoing operating costs. This section summarizes the operating cost estimates for the semi-exclusive lane operations concept as well as the capital cost investment needed for construction of stations, the running way, and purchase of fleet. Additionally, this section looks at the total cost for corridor transportation improvements that are called for in the respective PEL and corridor plans. Many of the transportation improvements such as highway widening, intersection operations improvements, multiuse paths, station areas, etc. will be constructed regardless of whether or not BRT is implemented on the corridor. These are costs are being shown in

this section, but they are not necessarily a component of the BRT cost of implementation and operation.

Capital Costs

Capital cost estimates were developed for the recommended concept and are based on three sections along SH 7: US 85 to US 287, US 287 to 75th Street, and 75th Street to Folsom Street.

Travel way cost estimates between US 85 and US 287 were based on costs prepared in the SH 7 PEL (2014) and escalated from 2014 to 2017 dollars. Costs were developed using CDOT's 2013 Cost Data Book and assume reconstruction of the full cross section with a full width, full depth shoulder (where feasible) for bus-on-shoulder operation, and intersection reconstruction. A modest estimate is included for ROW acquisition as well but will require additional design to help finalize estimates. Estimates also include signing and striping, traffic signals, utilities, landscaping, drainage, engineering, and contingency. The capital cost of SH 7 improvements already implemented in Thornton were removed from the estimate. Travel way cost estimates between US 287 and 75th Street are based on the per mile cost estimates developed for section 1 (US 85 to US 287) and include full reconstruction (with a narrower cross section). Cost estimates for the third section (75th Street to Folsom Street) were developed as part of the City of Boulder's *East Arapahoe Transportation Plan* and include ROW acquisition, extensive new multiuse paths and sidewalks, new and enhanced transit station areas, and streetscaping.

Shared use path cost estimates were developed using CDOT's 2017 Cost Data Book and include excavation, aggregate base, concrete,

signage, landscaping, drainage, utility adjustments, and contingency. Along section 1 (US 85 to US 287), a shared use path is included on both the north and south sides of SH 7. Along section 2, cost estimates include a shared use path along one side of SH 7.

Capital investments in the travel way and shared use path between US 85 and 75th Street are expected to occur independent of BRT implementation. Additionally, it is anticipated that the travel way and shared use path could be constructed in phases as development along the corridor occurs and as the local agencies and CDOT identify funds to implement sections of the recommended cross section.

BRT specific capital investments include stations, PnRs, and BRT vehicles (including spare vehicles). Cost estimates assume construction of new stations or station upgrades at 10 stations along the corridor with the cost of approximately \$500,000 each. The cost includes shelters, platforms, benches, off-board fare collection, and passenger information. Cost of the larger and more complex features associated with connecting regional transit investments such as the updated SH 7 PEL costs for SH 7/I-25 interchange (I-25 & SH 7 Mobility Hub) and the North Metro Mobility Hub are not included in the SH 7 BRT. Estimates also include construction of 1,200 new parking spaces for BRT users and a new BRT fleet of 26 vehicles. **BRT specific capital costs total approximately \$37 million.**

Table 3 provides the recommended concept capital cost. This figure includes all transportation improvements called for in the respective PELs and corridor studies, except costs for the I-25 mobility hub.

The total capital costs are projected to be approximately \$342 million.

Table 3: Capital Cost Estimates

Travel Way	Capital Cost (Millions of \$)
US 85 to US 287	\$155
US 287 to 75 th Street	\$30
75 th Street to Folsom Street	\$90
Shared Use Path	
US 85 to US 287	\$26
US 287 to 75 th Street	\$4
Transit	
Stations	\$5
Park-N-Rides	\$6
Vehicles	\$26
Total	\$342

Sources:
 SH 7 Planning Environmental Linkages Study, 2014
 SH 7 Planning Environmental Linkages Study US 287 to 75th, 2018
 East Arapahoe Transportation Plan
 CDOT Cost Data Book

Operating Costs

Operating costs were calculated for the recommended concept based on annual operating hours. Trip time was calculated by round trip end-to-end travel times and adding a factor for operator layover at the end of the run. Operator layover was assumed to be 20 minutes. The operating cost calculation assumes an 18-hour operating day on weekdays, with 3 hours of peak service during both the morning and evening peak periods (with headways of 7.5 minutes), and 12 hours of off-peak service throughout the remainder of the day (with 15-minute headways). Weekend service was assumed to be 18 hours of off-peak service (15-minute headways) per day. An additional factor of 20 percent was added to account for operator travel time to and from the route termini.

These factors determined that the recommended concept would have approximately 91,000 annual operating hours. The operating cost per hour was conservatively assumed to be \$125 per operating hour. By way of comparison, RTD's latest operating cost calculation was \$114 per bus operating hour in 2015. The recommended concept is a "maximum" service concept during future years when demand is high based on land use patterns. It is likely that service would be implemented gradually over time, with operating costs proportionately lower as each service component is introduced.

The operations cost for the scenario that would operate primarily on the shoulder, with 7.5 minute peak and 15 minute off peak service frequency, and an 18 hour span of service is projected to cost approximately \$11.3 million per year.

Appendix D contains conceptual operating cost calculations for all operating scenarios considered in this study.

SH 7 BRT Feasibility Findings

SH 7 BRT Concept Evaluation:

BRT Concepts were evaluated using the DRCOG/RTD 2040 regional travel demand model known as Compass, which is calibrated for transit forecasting suitable to meet FTA approval. The model includes transportation infrastructure included in the 2040 *Fiscally Constrained Regional Transportation Plan*. For these modeling runs, the land use projections were reviewed and modified to reflect each community's future plans. The model projects transit travel time and ridership in 2040, two key metrics for determining feasibility and for evaluating concepts. This section summarizes the results of the evaluation used to determine feasibility of providing BRT service along SH 7.

Modeling:

The travel demand model is a tool used to help planners, regulators, and funders evaluate changes in the transportation network. The model incorporates employment projections, population projections, and assumptions about how the transportation network will look in the future. It is used for estimating air pollution generated by travel, total vehicle miles traveled, transit ridership, and the benefits or drawbacks of implementing transportation system improvements like BRT, intersection improvements, road widening, or other changes to the system. Federal agencies require modeling to make projections for impacts of transportation improvements on the transportation system, along with helping funders determine if a transportation project is feasible and worthy of investment.

In this study an array of BRT scenarios were coded and run with the travel demand model. These scenarios included the two routing patterns discussed in the previous section. These essentially differed in their operations through the City of Lafayette, one staying on Baseline Rd. through Lafayette, and the other deviating to South Boulder Road and the Lafayette Park and Ride before reconnecting with SH 7. The different scenarios tested varied the stations that were included for the two routing patterns. All but one modeling run assumed the Short JUMP continued operations, and one modeling run included the ongoing operations of the Long JUMP. The model was coded with each scenario's unique configurations of BRT route patterns, service frequency, running way, and station set. Local circulator routes were also included in the travel model in each community. This envisions new future local transit routes within communities to collect and distribute riders to and from the BRT service. By 2040 it is possible that circulator routes would be operated using autonomous transit vehicles by public agencies or transportation network companies like Uber or Lyft, and would be practical first and final mile solutions to provide access to BRT stations.

Appendices B provide additional information about the travel demand model, and provide information about the travel forecasting methodology and assumptions.

Ridership and Ridership Evaluation:

Successful BRT requires sufficient ridership to justify the additional expense of its implementation and operations costs. Additionally, to receive funding from FTA and other funders to assist in the implementation of BRT, certain ridership thresholds must be projected to be achievable. One of the primary funding sources for implementing BRT is the FTA's Small Starts program. To be competitive for the Small Starts program, the transit route needs to demonstrate existing transit ridership of over 6,000 boardings per day to meet warrants outlined in Small Starts guidance. The warrants allow a proposed Small Starts project to receive automatic Medium ratings on some Small Starts criteria. In 2017 there is limited transit service on SH 7 and current ridership does not meet the warrant thresholds outlined in the Small Starts program. However, as development occurs on the corridor in areas east of Lafayette, and local transit services are implemented on that stretch of corridor, there is a high likelihood that these ridership thresholds will be achieved within the planning horizon for this study and will make the corridor competitive to receive funding from the Small Starts program.

Error! Reference source not found.4 shows the range of projected total daily ridership results in 2040 for the BRT concepts tested with the model. Results are shown for both mixed traffic and dedicated lane (bus-on-shoulder) conditions. The base BRT operating concept that includes a dedicated running way is estimated to attract over 8,600 riders per day in 2040. In mixed traffic this projection would drop to approximately 6,500 boardings. This disparity between

transit operating in mixed traffic vs. in a managed lane scenario is expected due to differences in travel times and is comparable to the increase in ridership RTD saw with the introductions of the Flatiron Flyer route, where operations were shifted from mixed traffic to managed lanes and shoulder running.

This study's modeling outputs project ridership in mixed traffic conditions being approximately 33 percent lower than operating within a dedicated lane. The results indicate that all of the BRT operations scenarios tested would likely have adequate ridership to support successful BRT routes using FTA Small Starts ridership requirement as a benchmark.

Table 4: Projected 2040 BRT Ridership

BRT Concept	2040 Daily Ridership	
	Dedicated Lane (Bus on Shoulder)	Mixed Traffic
BRT Route Pattern 1	8,650	6,500
BRT Route Pattern 1 with Additional Stations	8,500 - 9,100	6,400 - 6,850
BRT Route Pattern 2	8,700	6,550
BRT Route Pattern 1 with Long JUMP	9,800	7,350

Travel Time Evaluation:

Travel time is one of the fundamental reasons transit is often not a competitive mode of travel when compared to a personal vehicle. Trips of the same length on the same corridor typically take longer using transit than driving a personal vehicle. The reason for this is because the typical transit running way is in mixed traffic so it suffers from the same congestions and intersection related delay as a personal automobile, and accrues additional delay due to frequent stops for boarding, alighting, and fare collection. The goal of BRT is to provide rapid transit services that are travel time competitive with driving a personal vehicle. BRT enjoys travel time benefits because of its limited stops, off-board fare collection, exclusive/semi-exclusive running way advantages, and priority treatments at intersections. These BRT elements combine in an effort to make BRT a faster mode choice than driving in a personal vehicle and it results in much higher ridership than typical transit running in mixed traffic with frequent stops.

Travel times for this study were determined for each BRT concept under mixed traffic and dedicated lane (bus-on-shoulder) operations scenarios. As an informative comparison, travel times were also projected for personal vehicles and standard transit that would operate without BRT amenities. **Appendix C** contains the technical memorandum outlining the full methodology of travel time calculations and assumptions.

Table 5 shows the modeling outputs from the travel time analysis. The Route Pattern 1 BRT operating scenario shows the AM/PM peak period travel times between Brighton and Boulder in 2040 to be approximately 59 minutes from end-to-end with a dedicated lane,

and 76 minutes from end-to-end when operating in mixed traffic. For comparison, the projected travel time for a personal vehicle from Brighton to Boulder on the corridor in 2040 is roughly 80 minutes. Both BRT scenarios offer travel time benefits over driving, but there is a significant benefit of BRT operating primarily in a dedicated lane. The travel time projections also show why riding BRT on SH 7 could be an attractive alternative to driving a personal vehicle. For the other transit operations scenarios modeled for the study, the travel times are similar. For the Route Pattern 2 which would provide service to the Lafayette PnR, the travel times are 3 or 4 minutes longer. Projected off-peak BRT travel times in 2040 show less variation, with a range of 50 to 54 minutes depending on the BRT concept.

Table 5: 2040 Peak and Off-Peak Travel Times

	BRT Route Pattern 1		Route Pattern 1 with Alternate Stops		BRT Route Pattern 2		Lafayette to Boulder Underlying Transit Service	
	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Private Auto	80	54	80	54	80	54	46	32
BRT in Mixed Traffic	76	54	77	54	80	54	43	30
BRT in Dedicated Lanes	59	52	59	51	62	52	27	24
Standard Bus in Mixed Traffic	85	61	86	62	89	62	49	35

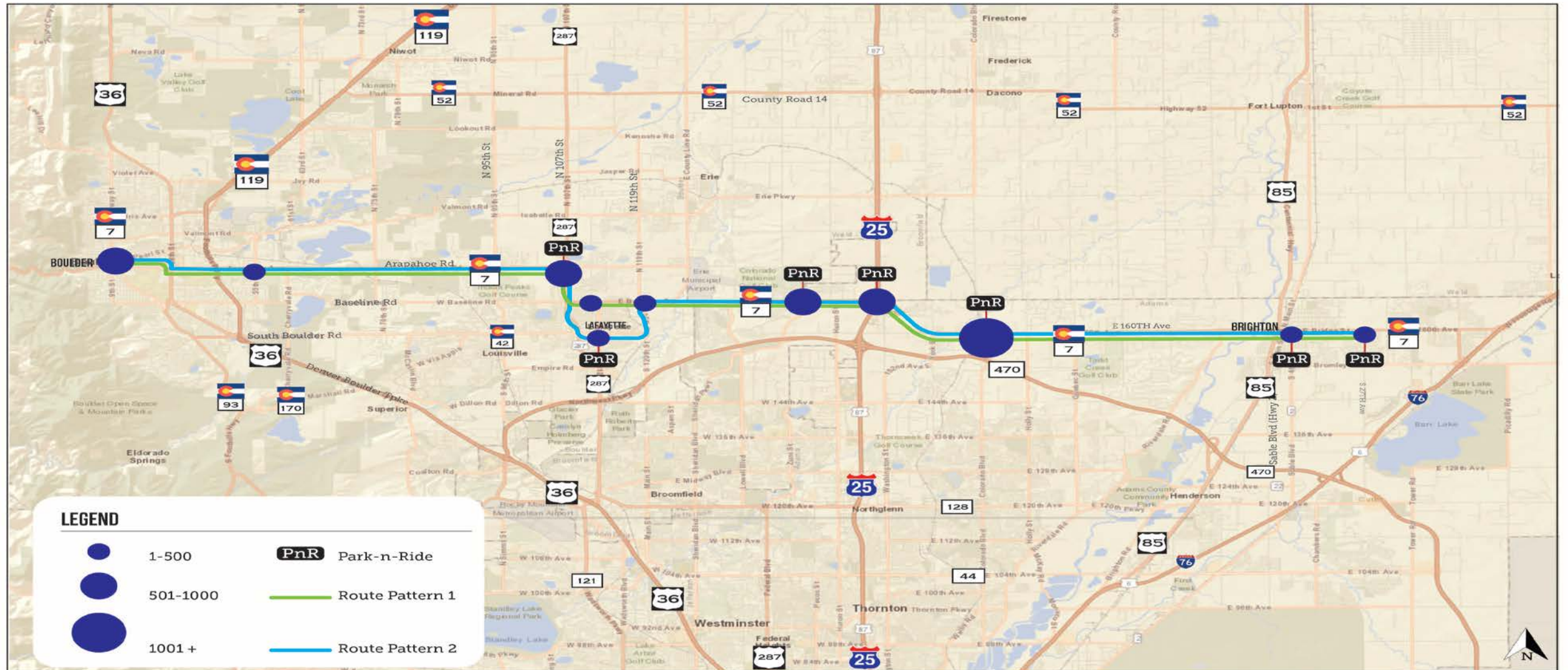
Station Usage:

BRT stations are typically more developed than stations and stops for local transit. BRT stations are often branded to help identify and promote the BRT service; include high quality weather protected shelters for waiting passengers; include off-board fare collection; have real time information displays; are well lit; and include other passenger amenities that increase comfort and establish a light rail feel. BRT stations are often better connected to the surrounding land uses with multiuse paths, ensuring high quality and safe access to stations. Station usage rates help determine the amenities that should be present at stations to ensure passenger safety and comfort. For example, high use stations could including amenities such as restrooms, enhanced modal connections like bike and car share, parking, etc. Understanding projected station usage is critical in planning for station design.

Error! Reference source not found.2 shows the comparative station usage results from the 2040 travel demand model. It should be noted that the following model outputs only indicate station usage generated by SH 7 BRT, and not usage from other transit routes. Thus, some stations that serve numerous transit routes are likely to see much higher total usage than are captured in these projections.

Alternative station locations were also tested as part of this study for Route Patterns 1 and 2 to determine if varying station locations had a significant impact on overall BRT ridership. The results showed that including alternate station location had little impact on overall transit ridership, and in most cases only had a minor impact on the usage at nearby station locations. Further study will be necessary to determine the optimal station location set.

Figure 12: Station Usage



Key Findings, Phasing, Next Steps, & Funding Options

Key Findings & Considerations

The process of setting up the transportation and socioeconomic assumptions in the model and running the BRT operations scenarios through the model were the two key elements for this study to evaluate the feasibility of BRT on the SH 7 corridor. The results built off the initial findings from the NAMS and further confirmed showed once again that **BRT along SH 7 is feasible**. Ridership in 2040 is projected to be sufficiently high and BRT, particularly if operating on the shoulder, will likely offer significant travel time savings when compared to expected 2040 vehicular travel times. **Table 6** highlights the findings from the study.

Table 6: Key Findings & Considerations

Ridership Projections for 2040 support that BRT is feasible on the corridor	Depending on the operating scenario, BRT ridership forecasts vary from 8,500-9,800 daily boardings with a dedicated lane (bus on shoulder) and from 6,400-7,350 daily boardings in mixed traffic. These figures are an increase over projections from the NAMS study and are comparable to Flatiron Flyer ridership. This bodes well for future BRT being a successful and attractive transportation alternative on the SH 7 Corridor.
Travel Time Projections for 2040 for bus-on-shoulder and mixed traffic operations both offer travel time savings over driving	In 2040 during AM and PM peak periods, travel times for BRT from end to end on the corridor are approximately 60 minutes in a dedicated lane (bus-on-shoulder), and 76 minutes in mixed traffic. The vehicular travel time for peak periods in 2040 for the extent of the corridor is expected to be approximately 80 minutes. The travel time differential between vehicles and transit would likely induce transit usage on the corridor.
BRT Running Way – Dedicated Lanes (Bus-On-Shoulder) provides the maximum ridership and minimal travel times	The transportation planning documents that outline preferred transportation enhancements for the SH 7 corridor—The <i>2014 CDOT PEL</i> , the <i>Boulder County SH 7 PEL</i> , and the <i>East Arapahoe Transportation Plan</i> —make provisions for shoulder running transit. This would provide a dedicated lane for nearly the extent of the corridor between Brighton and Boulder. However, certain high-density areas like in downtown Lafayette and downtown Brighton with constrained ROW would not be able to allow BRT to operate in dedicated lanes or on the shoulder. While this will result in slightly increased BRT travel times over what has been modeled for dedicated lanes, BRT on SH 7 will still have travel times during AM and PM peak traffic periods that is less than what it would take to drive a personal vehicle. Where possible, bus-on-shoulder operation should be pursued to ensure BRT on SH7 is viable.
Station locations work under the scenarios tested, but development around station areas will help support BRT success	Twelve stations demonstrate a strong potential for high ridership volumes. To achieve this, potential station areas will need to be developed with sufficient density and connectivity to other modes. Funding for a follow up station area study has been secured and will identify parcels for station development, recommend locations first and final mile connectivity, and help establish phased development plans for station areas.
Multiple route patterns are feasible and may be included in a final operations plan	Lafayette has expressed a continued desire for the BRT system to serve the existing Lafayette PnR. This will be an important consideration when defining the recommended route pattern(s), but due to BRT's inherent flexibility, it may be viable to operate BRT on SH 7 with multiple routing variations. The City of Boulder may also want to explore route deviations within City limits to provide access to major activity centers like CU campus and Boulder Junction. Final operations scenarios and route patterns will need to be determined in a future NEPA study, but findings from this study indicate that multiple routing options are viable.

Land use around station areas and station access must be planned

For BRT to be successful it is essential that corridor communities intentionally plan around station areas. Communities should consider zoning overlays to help promote density within ½ mile of major stations. 17 residents + employees/acre is the minimum density recommended for transit supportive development to support BRT implementation, but 42 or more residents + employees/acre in strategic locations along the corridor should be sought to support BRT ridership and should be allowed for in zoning. In these areas, surface parking may be a suitable interim solution while development is coming online, but a phased plan should be in place for structured parking when predetermined density thresholds are achieved. Provisions for high quality first and final mile connections should be included in planning requirements for development in major station areas to make it possible for transit users to use active modes to access transit station.

Phasing:

Implementing BRT on the SH 7 corridor between Brighton and Boulder will depend primarily on development growth and the resulting travel demand. As with BRT systems in other parts of the country, a certain level of development density along with park-n-rides at the major station nodes will support investment in high-quality BRT service. While RTD does not have BRT specific service standards, when the average development density within a corridor segment is between 3 and 12 residents plus employees per acre, RTD will consider initiating limited local peak period service within the segment that meets that density, per its service standards. As noted in *The Effects of Densities on Fixed-Guideway Transit Ridership and Capital Costs* (Guerra/Cervero, 2010), development of an average of approximately 17 residents plus employees per acre within a corridor segment creates a threshold for viable and robust BRT service and higher densities are encouraged. **Appendix E** offers information about existing conditions at planned station areas on the corridor and makes suggestions for how land use policies in these areas can change to be more supportive of BRT. The expected growth of development along the SH 7 corridor will follow natural economic cycles of upturns and downturns but is expected to have an overall positive trajectory into the future. **Appendix F**, SH 7 BRT Economic Development Assessment Report, provides information on economic development potential along the corridor.

Introducing service on SH 7 will depend on the location of the initial segments with sufficient development density. It is likely initial

service will be implemented in phases as demand warrants, in some order of the following possibilities:

- Introduction of peak period service for commuters on the eastern link between Brighton and I-25
- Initiation of BRT/enhanced bus service on the JUMP service between Boulder and Lafayette (including increasing frequencies, intersection operational transit improvements, enhanced stations, and exclusive lanes where appropriate and feasible)
- Extension of the JUMP service beyond Lafayette to I-25 as BRT/enhanced bus service
- An additional layer of peak-period service for commuters between Boulder and I-25
- Corridor-long BRT/enhanced all day bus service between Boulder and Brighton
- Incremental corridor-wide highway improvements using the standards in the CDOT SH 7 PEL, the Boulder County SH 7 PEL, and the East Arapahoe Transportation Plan as guidance for improvements.

Implementation of brand new transit service on the segments of SH 7 that currently are not served with transit will likely require time to develop a ridership base. However, ridership will grow over time and help induce BRT supportive development.

Next Steps:

The successful implementation of a high quality, high frequency BRT vision on SH 7 will require more than constructing new facilities and implementation of local transit service. It will require an ongoing and coordinated effort from the corridor communities, the development community, RTD, CDOT and other groups. This section provides an overview of the additional planning efforts, advocacy, engineering, and other efforts that will be necessary for realizing BRT on SH 7.

Table summarizes suggested conceptual implementation steps for project enactment, with assumptions for both federal and local funding (in case federal funding is not available), along with an estimated timeline. These milestones are conceptual in nature and represent the Team's best ideas on potential recommendations and their related timelines; they depend on the ability of local jurisdictions in the corridor to work together to continue moving this project forward in the months and years ahead.

Table 7: Suggested Conceptual Implementation Steps

Task	Timeline
Conduct Preliminary Engineering and NEPA for corridor improvements	2020-2024 (TIP Cycle)
Conduct final BRT Alternative Analysis including: BRT Operations Plan, refined Operations & Maintenance Cost Projections, and Project Financing Plan.	Following Preliminary Engineering & NEPA Study

In support of the conceptual implementation steps identified above, the TAC brainstormed and identified a variety of actions that the local communities can instigate to further the corridor plans for BRT on SH 7. These actions are not necessarily listed in sequential order, and have been grouped for readability.

Garner Support

- Identify champions among corridor agency staff and elected officials on the SH 7 Coalition who will support a coordinated land use and mobility plan for the corridor.

Guide Development

- Establish land use and zoning policies at the major station areas (including the development of TOD districts or overlay districts where appropriate) to promote development densities needed to support high-capacity transit and to ensure the creation of walkable neighborhoods with good access to those stations. Specifically, reserved land within 0.125 to 0.25 mile of the BRT stations for the highest development densities.
- Broadcast SH 7 BRT plans to prospective developers.
- Design medium- to high-density single and multi-family development at BRT stations in a transit supportive manner.
- Build office, healthcare, education, and research and development facilities at transit supportive densities (one and one-half Floor Area Ratio or greater).

Plan Proactively

- Update municipal and county comprehensive plans and transportation plans to specify planned BRT on SH 7.
- Develop and adopt station area plans to inform developers of specific strategies.
- Enact first and final mile connection strategies at stations to extend the distance from a station in which the increased real estate values can be leveraged for transit.
- Identify parcels for stations, including PnR areas and mobility hubs, at major nodes.
- Work with all participating jurisdictions to ensure that bicycle and pedestrian facilities planning coincides with potential corridor stops to provide essential first and final mile connections.

Monitor Designs

- Work with CDOT to ensure that SH 7 construction projects follow the PEL cross section, including at major intersections for inclusion of transit bypass lanes.
- Review the layout for the I-25 and SH 7 interchange complex to be certain that it is designed to efficiently accommodate east-west transit service with cross-platform connectivity to north-south transit service.

Develop Funds

- Seek opportunities to leverage funds with partner agencies to implement BRT.
- Initiate discussions among the Coalition agencies to establish a funding plan for BRT service implementation as demand warrants.

Introduce Transit

- Continue to work with RTD to monitor development progress in the corridor and to begin providing short-term service enhancements to existing RTD services.
- Solicit input from private transportation network companies on the potential for using non-traditional transit services to possibly provide enhanced service in the corridor and/or provide first and final mile connections to major nodes.

BRT service is feasible, can lead to vibrant community development, and provide an effective multimodal option for travelers on the growing SH 7 corridor. Implementation of BRT on SH 7 will require adherence to the above steps in the near term and long term, and application of sound specific land use policies at each station area. The Land Use Analysis report, conducted concurrently with this Feasibility Study, identifies specific policy suggestions for each major station area.

Funding

Funding Options

Transit agencies and other public entities that have introduced transit improvements to communities have traditionally relied on several funding options for capital and operating expenses. Primary revenue sources are traditional and well known, including farebox revenues and grants from state, local, and federal governments. However, to leverage these revenue streams for capital and operating needs, agencies must focus on additional strategies.

Several sources provide good information on transit funding options and were used in this compilation, including:

“Thinking Outside the Farebox” by Transportation for America

“Innovative Funding Sources for Transit” by American Public Transit Association

“Evaluating Public Transportation Local Funding Options” by Victoria Transport Policy Institute

Summaries provided by IMG-Rebel to Rocky Mountain West Transit & Urban Planning

Direct System Revenues

Farebox Revenues

Typically, farebox revenues do not cover the long-term operations and maintenance of a transit system. A BRT system is no exception. Transit operators can traditionally anticipate roughly a 30 percent farebox recovery ratio for most transit operations. For example, according to the National Transit Database, RTD’s overall farebox recovery rate in 2015 was 25.7 percent; for bus service alone, it was 25.2 percent. **Potential Impact for SH 7 BRT: High. Sustainability Potential: Long-term.**

Non-Farebox Revenues

Non-farebox revenues include system revenues not generated by the farebox, including items such as:

Advertising: Transit agencies often work with local advertising agencies to provide ads on transit shelters, stations, vehicles, fare media, and larger facilities (such as intermodal transit centers). Typically, ad revenue can provide 3 to 5 percent of operating revenue depending on local market conditions. **Potential Impact for SH 7 BRT: Moderate. Sustainability Potential: Long-term.**

Air Rights: As part of a larger development, transit agencies often sell air rights above existing PnRs or other facilities to provide additional revenue. Given the existing nature of the SH 7 corridor, not many significant opportunities for air rights are foreseen in the near future, although as development occurs in the corridor, opportunities might exist at major transfer nodes. **Potential Impact for SH 7 BRT: Low. Sustainability Potential: Long-term.**

Naming Rights: Naming rights involve a one-time and/or ongoing payment from a private business to an agency or an operator in return for naming a station or other assets for the business. The best local example was the naming of RTD’s commuter rail line between downtown Denver and Denver International Airport as “The University of Colorado A Line,” with a \$5 million payment from CU to RTD for 5 years. This project could explore selling naming rights for stations at key activity centers, developments, or employers, or for entire segments of the system. **Potential Impact for SH 7 BRT: Moderate. Sustainability Potential: Long-term.**

Station or Stop Revenues (including concessions): Many agencies provide space for food and other retail vendors at major transit stations as a potential revenue source. Similar to concessions, but on a larger scale, commercialization involves generating revenue from

public space through development of retail, restaurant, and office space. This option could have viability at major transfer points and stops along the route as development occurs in the future. **Potential Impact for SH 7 BRT: Low to Moderate. Sustainability Potential: Long-term.**

Other Funding Sources

Traditional Funding Sources

Funding sources are different from revenues in that they provide revenue targeted to a single station or project, most often to support capital projects, with some grants providing operating support.

State or local funding sources include items such as:

Local City or County Government Appropriations specifically for a project, although those are usually subject to an annual approval process and do not necessarily provide long-term funding stability. For example, the City of Boulder “buys up” service from RTD by providing local funds in support of additional bus routes within Boulder. This could be a viable option for local governments in the corridor if they make this project a high priority. **Potential Impact for SH 7 BRT: High. Sustainability Potential: Long-term.**

Local Sales Taxes. In this case, since RTD already assesses a regional sales tax totaling 1 percent for its programs, it is unlikely that a sales tax specifically for a BRT project in this corridor could be established. However, if RTD or other local governments go to the voters to expand their sales tax percentage, a portion of those new taxes could

be allocated to this project. **Potential Impact for SH 7 BRT: Low to Moderate. Sustainability Potential: Long-term.**

Lodging or Rental Car Taxes could be expanded above their current levels in jurisdictions along the corridor; or with appropriate legislative approval, those taxes could be expanded to provide a specific allocation for a BRT project. **Potential Impact for SH 7 BRT: Low. Sustainability Potential: Long-term.**

Federal grant programs are common funding sources for major transit investments, although the federal funding situation in Washington, DC, is currently unknown due to the beginning of a new administration in 2017. Pending no major changes in legislation in the next few years, options include:

The Small Starts program of the FTA, the most likely federal funding source for a BRT project of this type. The Small Starts program funds projects of \$300 million or less, with a maximum federal share of \$100 million or 80 percent of the project’s cost, whichever is smaller. Small Starts funding for BRT relies in good cost-effectiveness (annualized capital and operating cost per annualized rider). Small Starts regulations define two types of BRT projects:

Exclusive Lane Focused, defined as “a bus system in which the majority of each line operates in a separated, dedicated, right-of-way for transit during peak periods and includes features that emulate the services provided by rail transit, including— defined stations; traffic signal priority; short headways for a substantial part of weekdays and weekend days; and any other features necessary to produce high-quality transit services that emulate the services provided by rail transit.”

Corridor-Based, defined as a bus capital project not in an exclusive guideway for most of the alignment and that “represents a substantial investment in a defined corridor as demonstrated by features such as park-and-ride lots, transit stations, bus arrival and departure signage, intelligent transportation systems technology, traffic signal priority, off-board fare collection, advanced bus technology, and other features that support the long-term corridor investment.”

Small Starts funding could be a viable option for funding this project if it has good cost-effectiveness (defined as total annualized capital and operating costs per rider). However, local governments would need to work closely with RTD, the agency responsible for administering and “passing through” federal grants to other entities, if this is to be a good funding option for this project. **Potential Impact for SH 7 BRT: High if Good Cost-Effectiveness. Sustainability Potential: One-time, for capital expenditures only.**

Better Utilizing Investments to Leverage Development (BUILD) is the discretionary grant program that replaced the *Transportation Investment Generating Economic Recovery (TIGER)* program in 2018. This program is similar to TIGER in the types of projects it is allowed to fund. It is likely that this program will be similar to TIGER in its popularity, TIGER has typically been extremely competitive and significantly oversubscribed. It is unclear if funding will be awarded to similar projects - TIGER was often awarded to projects where it comprised the final funding component necessary to ensure transformational projects could be constructed. The new guidance suggests more BUILD funding will be directed toward rural areas than

the TIGER project. **Potential Impact for SH 7 BRT: Low to Moderate. Sustainability Potential: One-time.**

Other potential federal funding opportunities could include:

The Congestion Mitigation and Air Quality (CMAQ) Improvement Program and the Surface Transportation Program (STP) are grant programs administered locally by CDOT and DRCOG. The CMAQ program, jointly administered by the Federal Highway Administration (FHWA) and FTA, funds state transportation programs that meet the National Ambient Air Quality Standards. FHWA requires states to give priority CMAQ funds to diesel engine retrofit and other cost-effective emission reduction and congestion mitigation activities that provide air quality benefits. Of all the FTA’s grants, the STP provides the greatest flexibility in the use of funds. Funds from the STP may be used (as capital funding) for public transportation capital improvements, car and vanpool projects, fringe and corridor parking facilities, intercity or intracity bus terminals and bus facilities, and bicycle and pedestrian facilities. STP funds, however, are apportioned to each state and are distributed among various population and programmatic categories. Local governments would need to work with CDOT and DRCOG to apply for funding under these programs, and overall funding totals are limited. **Potential Impact for SH 7 BRT: Moderate. Sustainability Potential: One-time.**

Livable Community Grants: FTA started the Livable Community Initiative (LCI) to improve mobility and quality of services available to residents of neighborhoods by strengthening transit links among others. Eligible recipients of the LCI funds are transit operators, metropolitan planning organizations, city and county governments,

state planning agencies, and other public bodies with the authority to plan or construct transit projects. However, funding for this program, like other transit programs, is in jeopardy given the current climate in Washington, DC. **Potential Impact for SH 7 BRT: Low. Sustainability Potential: One-time.**

Innovative Funding Sources

Transit agencies across the country have increased the use of innovative funding sources to supplement traditional grants in developing capital projects. Key innovative funding sources include:

TOD/Joint Development: TOD can be leveraged to help fund local transit improvements. This can take many forms including:

Developer Contributions, where landowners or developers directly contribute to help fund transit improvements that enhance access to their properties. This could take the form of property dedications, one-time payments, or development impact fees. Given the proposed level of development at key nodes in the corridor, this could provide some funding for a BRT project. **Potential Impact for SH 7 BRT: Moderate to High. Sustainability Potential: One-time.**

Joint Development occurs when private developers partner with public entities to provide development on public assets, such as land (often a PnR or transit station). Revenues can be used for the capital or operating costs of a new project. Given the few existing and planned major transit facilities in the corridor, this may not be a viable option unless and until major transit stations are constructed at key nodes. **Potential Impact for SH 7 BRT: Low to Moderate. Sustainability Potential: Long-term.**

Special Assessment or Benefit Assessment Districts: These districts are special tax assessment areas that may be created to support the construction and operation of new transit service. A typical district creates a zone around a station or a corridor, often up to 0.5 mile, with all businesses within the zone paying a tax based on real estate valuation per square foot. Frequently, residential property is exempted. Sometimes assessments are “tiered,” reflecting the fact that properties nearer to the station have higher benefit. In special cases, as with the Dulles Metrorail extension in Fairfax County, a benefit assessment district may cover an entire corridor. Because businesses must pay higher taxes in an assessment district, they can be controversial and are only appropriate under certain conditions. Assessment districts are most successful where new transit service can be shown to correlate strongly with increased sales at local businesses. These districts often need a majority or more of property owner approval before going into effect. For example, both Los Angeles and Kansas City have recently established benefit assessment districts in their downtown areas to help fund those cities’ new streetcar projects. This option would be viable when major developments occur in this corridor. **Potential Impact for SH 7 BRT: Moderate. Sustainability Potential: Long-term.**

Impact Fees as a Subset of an Assessment District: An impact fee is assessed on new development within a jurisdiction to defray the cost to the jurisdiction of expanding and extending public services to the development. Because it is a one-time fee, it has less benefit for transit, which needs funding for both capital and operating costs. **Potential Impact for SH 7 BRT: Low to Moderate. Sustainability Potential: One-time.**

Tax Increment Financing: Like an assessment district, a tax increment financing (TIF) district is a special assessment zone. However, unlike an assessment district, property owners in the TIF district pay no surcharge on their property taxes. Rather, the TIF district retains any increases in real estate (or income) taxes as property values rise due to the new transit service. Because they do not involve additional taxes, TIFs are generally more politically palatable than assessment districts. However, they are not without controversy since they will eventually result in subsidizing development by creating tax-privileged districts. TIF is available in Colorado in areas that have been designated as “blighted” (generally defined as underdeveloped or in economic distress), which could potentially apply to some areas of the SH 7 corridor. **Potential Impact for SH 7 BRT: Moderate.**

Sustainability Potential: Long-term.

Parking Increment Revenue: An increase in parking rates in study area jurisdictions could potentially create additional revenue that could be applied to this project. Local jurisdictions could then dedicate those revenues from the parking increment to directly fund a transportation project or use them to back revenue bonds. However, given the limited urban nature of the corridor, this option may not have much viability. **Potential Impact for SH 7 BRT: Low.**

Sustainability Potential: Long-term.

Financing Options

Traditional Financing Mechanisms

Financing mechanisms are used to provide public agencies with access to either debt or equity capital. Options include:

General Obligation (GO) Bonds are secured by and repaid from the general tax revenues of a local government. The major advantage of GO bonds is their low cost compared to other financing options since GO bonds are backed by the full faith and credit of the government entity. However, local tax revenues must keep pace with payments because GO bonds represent a promise to repay investors before making any other budgetary expenditure. Local governments in the corridor could include portions of their project in the regular GO bond issuances, although competition is usually strong for projects at the local government level for GO funding. **Potential Impact for SH 7 BRT: Moderate to High. Sustainability Potential: Long-term.**

Revenue Bonds are repaid by local governments from a specific funding source. Bondholders have a claim only to those revenues pledged to retire the bond and are slightly riskier than GO bonds; for example, issuing revenue bonds to fund a municipal parking garage, with parking fees generated by the facility earmarked to pay off the bonds. Given the nature of the BRT project and its low revenue generation potential, this may not be a viable option. **Potential Impact for SH 7 BRT: Low to Moderate. Sustainability Potential: Long-term.**

Innovative Financing Mechanisms

In addition to traditional financing mechanisms, several innovative financing mechanisms could be considered for a BRT system.

Grant Anticipation Notes: Transit agencies in metropolitan areas with a population of more than 200,000 receive funds from the federal government each year based on a formula. Transit agencies are permitted to borrow against those future formula funds. Grant

Anticipation Notes (GANs) are a form of municipal security that pledges future federal funds to make debt service payments. In addition, transit agencies may also issue bonds known as Grant Anticipation Revenue Vehicles (GARVEE) bonds, supported by CMAQ or STP flexible funds allocated to federal highway programs, to help construct a transit project. This involves concurrence by either the state or DRCOG. RTD has occasionally used GARVEEs as part of its FasTracks funding program. However, the decision to obligate future federal formula funds means that a portion of those revenues will not be available to carry out other capital projects, such as replacing aging vehicles. RTD would need to initiate the use of GANs in this corridor. However, given RTD's focus on completing FasTracks, it is unlikely that GANs or GARVEE bonds would be allocated to this project. **Potential Impact for SH 7 BRT: Low. Sustainability Potential: One-time.**

Infrastructure Bank Loans: The Colorado State Infrastructure Bank (SIB) is a CDOT program that provides funding to transportation projects in the state. When funds are available to the SIB program, there is an annual application process. Applicants provide a proposed drawdown and repayment schedule, which may include several years with no interest accrual and/or no principal repayment. The applicant also selects the interest rate it would like to pay. However, the SIB program is competitive, and applicants requiring a smaller subsidy (whether from low interest rates or repayment holidays) are more likely to receive funding. **Potential Impact for SH 7 BRT: Moderate. Sustainability Potential: One-time.**

The Transportation Infrastructure Finance and Innovation Act (TIFIA) is a federal loan program sponsored by the US Department of

Transportation. TIFIA loans must be repaid through dedicated funding sources that secure the obligation, such as tolls, user fees or TIF, and are for up to 35-year terms. Local examples of TIFIA use include the US 36 BRT project, which received a \$54 million TIFIA loan for construction; RTD's Eagle *Public-Private Partnerships* (P3) rail project, which received a \$280 million TIFIA loan; and Denver Union Station, which received a \$146 million TIFIA loan. TIFIA loans have been used for roadway and major transit projects (for example, to accelerate the Los Angeles region's major transit expansion project). TIFIA loans are financing tools with attractive rates and terms. TIFIA loans are flexible, are low cost, and can finance a major portion of a project at US Treasury rates. However, given the uncertainty for federal funding in Washington, DC, its application to this project is uncertain. **Potential Impact for SH 7 BRT: Low to Moderate. Sustainability Potential: One-time.**

In addition to innovative financing mechanisms, other tools associated with P3s could provide additional opportunities to reduce the cost of borrowing or speed project delivery. An availability payment is a rent-like payment where a concessionaire receives periodic payments based solely on the condition and/or performance of the facility. A typical availability payment deal would involve construction of the asset by a private firm or a consortium of firms. The consortium may be responsible for any or all the planning, design, engineering, ROW acquisition, construction, operations, maintenance, and enforcement. In return, the consortium is paid fixed, pre-agreed availability payments on certain milestone dates. The availability payments are subject to the asset being operational, safe, and meeting all standards of the public sponsor. Availability

payments are attractive because they shift construction risk, financing risk, and operational risk to the private consortium, while retaining public oversight over the development process. Private developers like availability payments because they are not asked to take on risks that are difficult to predict or manage, such as the level of ridership. RTD has successfully used P3 financing for its A and G Line commuter rail projects. Given the relatively small budgetary nature of the project and its potential to generate revenue, a P3

approach to this project could be viable if combined with other infrastructure projects to make it more attractive over the long term to potential partners and investors. **Potential Impact for SH 7 BRT: Moderate. Sustainability Potential: Long-term.**

Funding and Financing Summary

Table 10 summarizes the potential funding mechanisms described previously, and summarizes the financing mechanisms, along with a notation on each mechanism's potential for long-term sustainability.

Table 10: Summary of Potential Financing Mechanisms

		Potential Impact for SH 7	Potential as a Sustainable Funding Source
Direct System Revenues	Farebox	High	Long-Term
	Non-Farebox		
	➤ Advertising	Moderate	Long-Term
	➤ Air Rights	Low	Long-Term
	➤ Naming Rights	Moderate	Long-Term
Other Sources	➤ Station/Stop Revenues	Low to Moderate	Long-Term
	State or Local		
	➤ Local Appropriations	High	Long-Term
	➤ Local Sales Tax	Low to Moderate	Long-Term
	➤ Lodging or Rental Car Taxes	Low	Long-Term
	Federal		
	➤ Small Starts	High, is good cost-effectiveness	One-Time
	➤ TIGER (BUILD) Grants	Low to Moderate	One-Time
	➤ CMAQ or STP Grants	Moderate	One-Time
	➤ Livable Community Grants	Low	One-Time
	TOD/Joint Development		
	➤ Developer Contributions	Moderate to High	One-Time
	➤ Joint Development Revenues	Low to Moderate	Long-Term
	Special Assessment or Benefit Districts	Moderate	Long-Term
	Impact Fees	Low to Moderate	One-Time
	Tax-Increment Financing	Moderate	Long-Term
	Parking Increment Revenues	Low	Long-Term
	General Obligation Bonds	Moderate to High	Long-Term
	Revenue Bonds	Low to Moderate	Long-Term
	Grant Anticipation Notes	Low	One-Time
	Infrastructure Bank Loans	Moderate	One-Time

	Federal TIFIA Loan	Low to Moderate	One-Time
	Public-Private Partnerships	Moderate	Long Term

Based on this summary, potential funding or financing for a BRT project on SH 7 should focus on those mechanisms with a moderate to high potential for success and/or long-term sustainability to provide the potential for continued financial support after implementation. Using those criteria, the most likely funding and financing options for this project could include:

- Farebox revenues
- Advertising revenues
- Naming rights
- Station/stop revenues
- Public-Private Partnerships
- Local appropriations
- FTA Small Starts funding
- CMAQ or STP grants (from DRCOG or CDOT)
- Developer contributions
- Special assessment or benefits districts
- Tax-Increment Financing
- General obligation bonds