Preliminary Gold & Northwest Corridors Service Plan

June 2015

Contents

Tables

Figures

Maps

1 Introduction

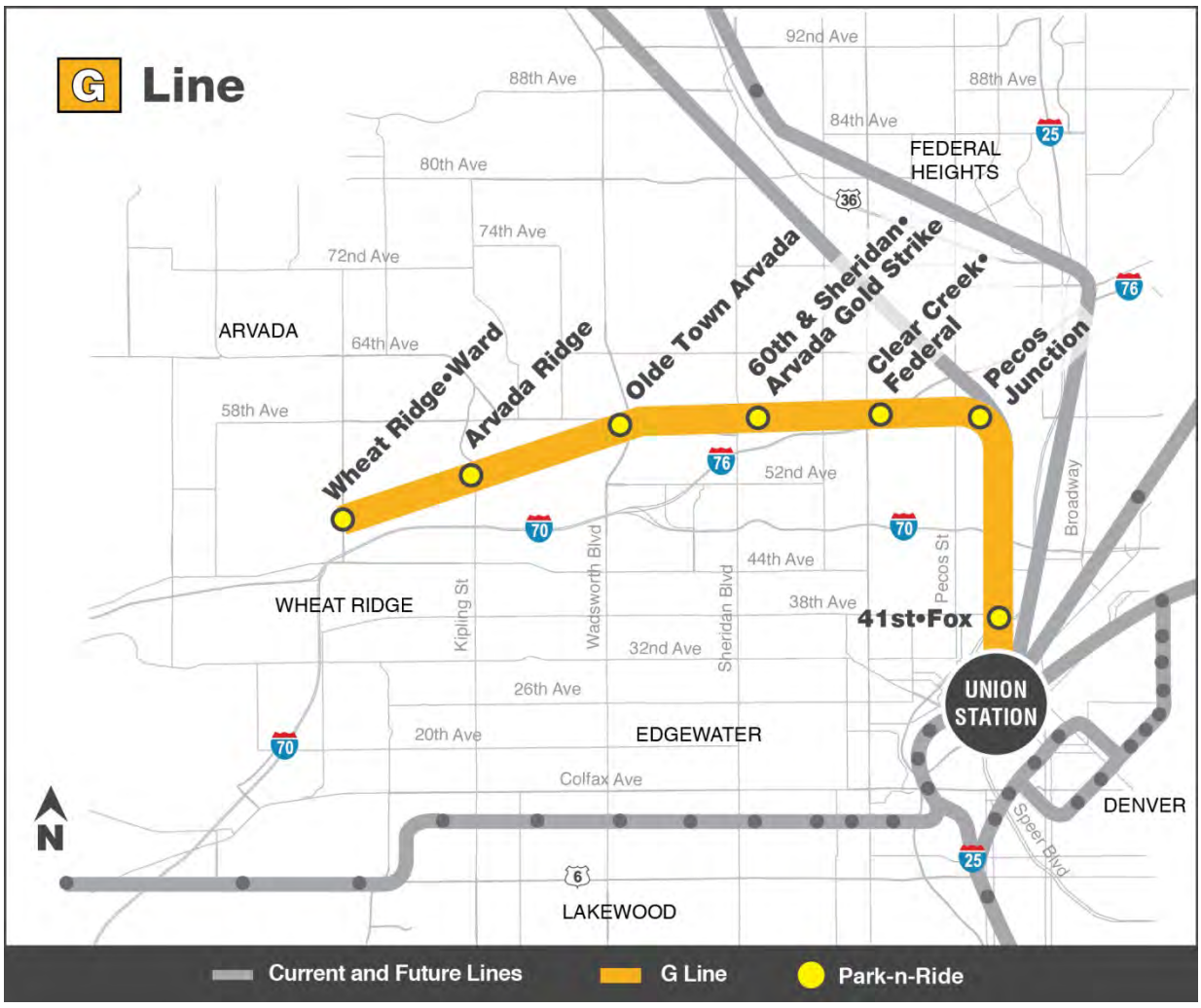
1.1 Background and Focus

As part of the overall FasTracks program to enhance rail service in the Denver region, the upcoming Gold Line and Northwest Line also known as the G-Line and B-Line respectively will represent significant milestones in achieving improved connectivity and travel times for RTD customers. Both projects are likely to stimulate residential, retail, and commercial growth and contribute to increases in ridership within the corridors. The Gold and Northwest Corridor Service Plan contains recommendations for developing a restructured bus network capable of meeting the demand and mobility needs generated by the expansion of commuter rail and light rail services. Recommendations in this study were formulated based on a comprehensive assessment of existing conditions, service area demographics, transit market research, route performance and analysis, and stakeholder input. Data collection activities included both on-site field work and stakeholder meetings held with RTD and FasTracks personnel.

1.2 Study Area

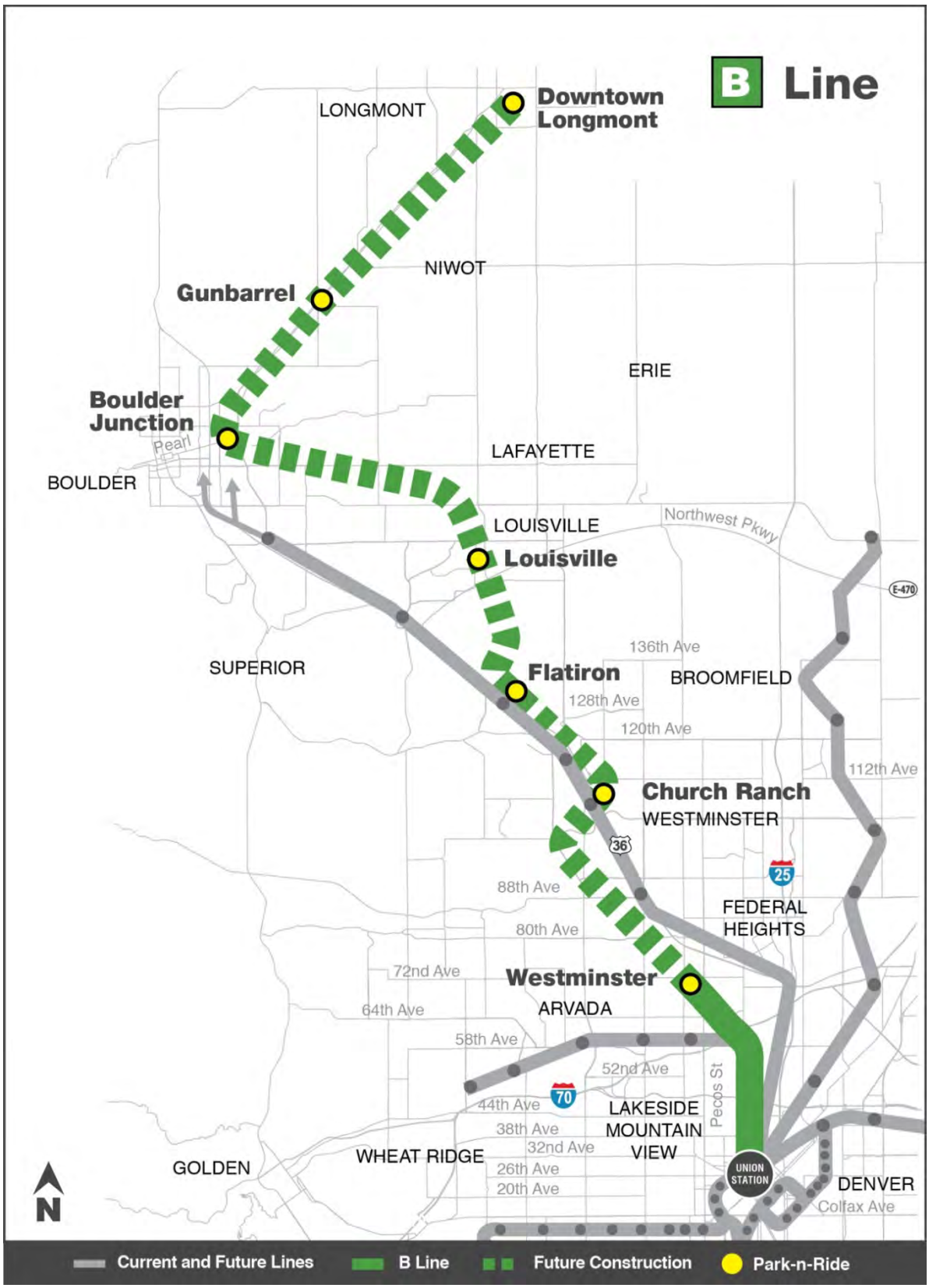
The study area of this project is defined by the RTD West Line to the south, the US 36 & Broomfield Park-n-Ride to the north, Interstate 25 and downtown Denver to the east, and the City of Golden to the west. The study area includes the cities of Arvada, Denver, Thornton, Westminster, and Wheat Ridge, as well as unincorporated areas in Denver and Jefferson Counties.

Map 1 - G-Line Alignment



The G-Line is a future 11.2-mile commuter rail line that will run along the BNSF Railway and Union Pacific Railroad right of way from Denver Union Station (DUS) to the City of Wheat Ridge. The G-Line will serve eight stations, including DUS, 41st/Fox, Pecos Junction, Clear Creek/Federal, 60th & Sheridan/Arvada Gold Strike, Olde Town Arvada, Arvada Ridge, and Wheat Ridge/Ward. The G-Line is expected to open in 2016. Total travel time between DUS and the Wheat Ridge/Ward terminal station is approximately 25 minutes.

Map 2 - B Line Alignment



The B-Line is a future 41-mile commuter rail line from Denver Union Station (DUS) to Longmont, passing through the Cities of Westminster, Broomfield, Louisville, Boulder, and Gunbarrel. Portions of the B-Line are adjacent to the US 36 BRT project. The first 6.2-mile segment from DUS to south Westminster is expected to be completed in 2016 and will be the focus area of this study. This segment will serve two stations including Denver Union Station and Westminster/71st Ave. The remaining segment of the project, from Westminster north to Longmont, will require additional funding before construction can begin.

1.3 Relevant Studies

The following review highlights the key findings from previous planning studies and publications relevant to the study area, which include:

- Gold Line Corridor Transit Operations Plan (2009)
- Northwest Rail Corridor Final Environmental Evaluation (2010)
- West Corridor Service Plan (2013)
- Downtown Denver Commuter Survey (2013)
- Arvada Transit Station Framework Plan (2007)
- Westminster Station Transit Oriented Development
- Wheat Ridge Northwest Subarea Plan (2013)

Arvada Transit Station Framework Plan (2007)

The Arvada Transit Station Plan envisions the development of a transit oriented district surrounding the station of Olde Town Arvada on the G-Line. The plan creates two distinct downtown mixed-use development districts: Olde Town and New Town. New Town would include an increased mix of land uses, including medium density housing and commercial/office space, while the historic character of Olde Town would be preserved by maintaining the existing scale of development.

Gold Line Corridor Transit Operations Plan (2009)

The Gold Line Corridor Transit Operations Plan contains bus and rail operations plans related to the environmental benefits, costs, and impacts of the proposed service alternatives. Existing transit service descriptions and characteristics of the corridor and corresponding routes are provided. Two alternatives for transit service are presented within the bus operations plan, including the "No Action" and "Baseline" alternatives. The "No Action" alternative assumes no new major transit investments with only the existing plus committed facility and operating improvements assumed. The "Baseline" alternative contains operating improvements designed to improve transit access, circulation, and travel time within the study area.

The rail operations service plan includes the following proposed service levels on the G-Line:

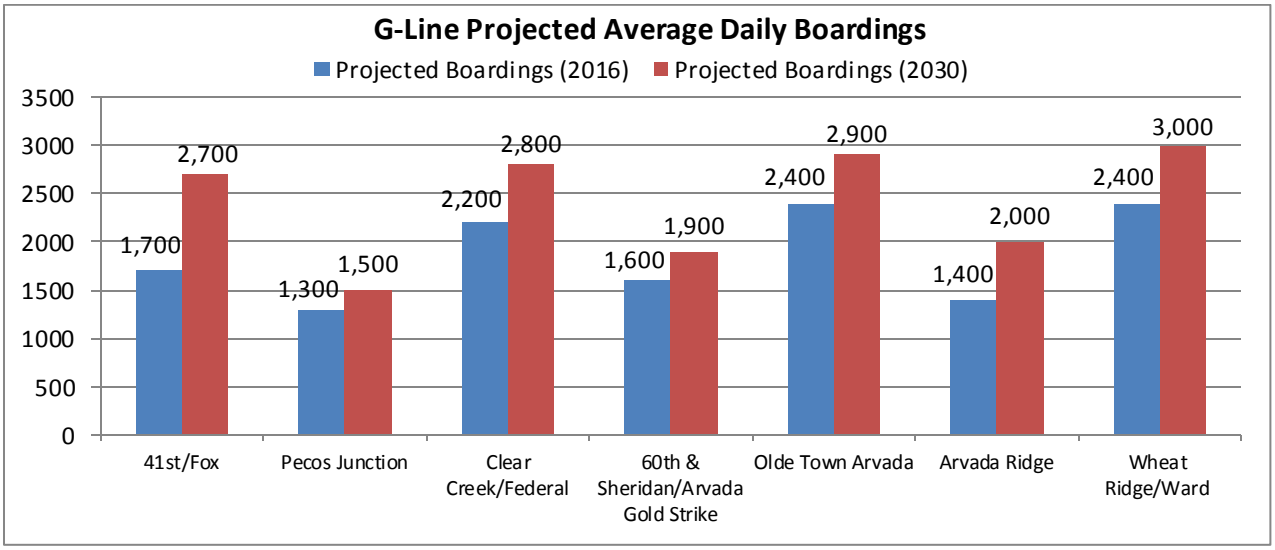
Table 1 - G-Line Planned Operations

G-Line			
Weekday	4:00 AM to 1:30 AM	Peak Periods	15 minutes
		Midday	15 minutes
		Evening	15 minutes
		Late Evening/Early Morning	30 minutes
Saturday	4:00 AM to 1:30 AM	Midday	15 minutes
		Late Evening/Early Morning	30 minutes
Sunday/Holiday	4:00 AM to 1:30 AM	Midday	15 minutes
		Late Evening/Early Morning	30 minutes

G-Line vehicles will be electric multiple unit (EMU) commuter rail cars with maximum operating speeds of 70 miles per hour. Travel time simulations resulted in an average one-way trip time of 19.5 minutes; however, this time is likely to change based on the final track alignment and implementation.

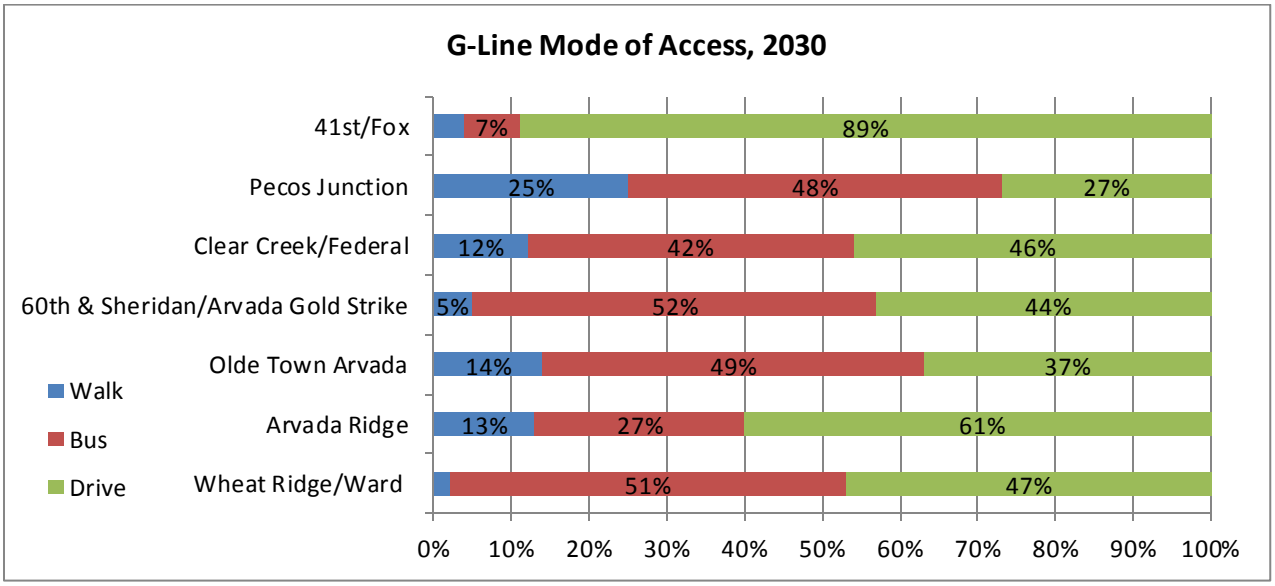
Ridership estimates were developed for the G-Line based on DRCOG modeling scenarios that accounted for various transit investments and incorporated the factors of land use, development, parking, fare structure, and vehicle load standards. Other inputs included demographic information such as projected population, employment, and income. The model projected average daily boardings by station for the initial year of operation in 2016 and for the future year of 2030. The stations of Olde Town Arvada, Wheat Ridge & Ward, and Clear Creek & Federal are expected to generate the greatest ridership.

Figure 1 - G-Line Projected Average Daily Boardings



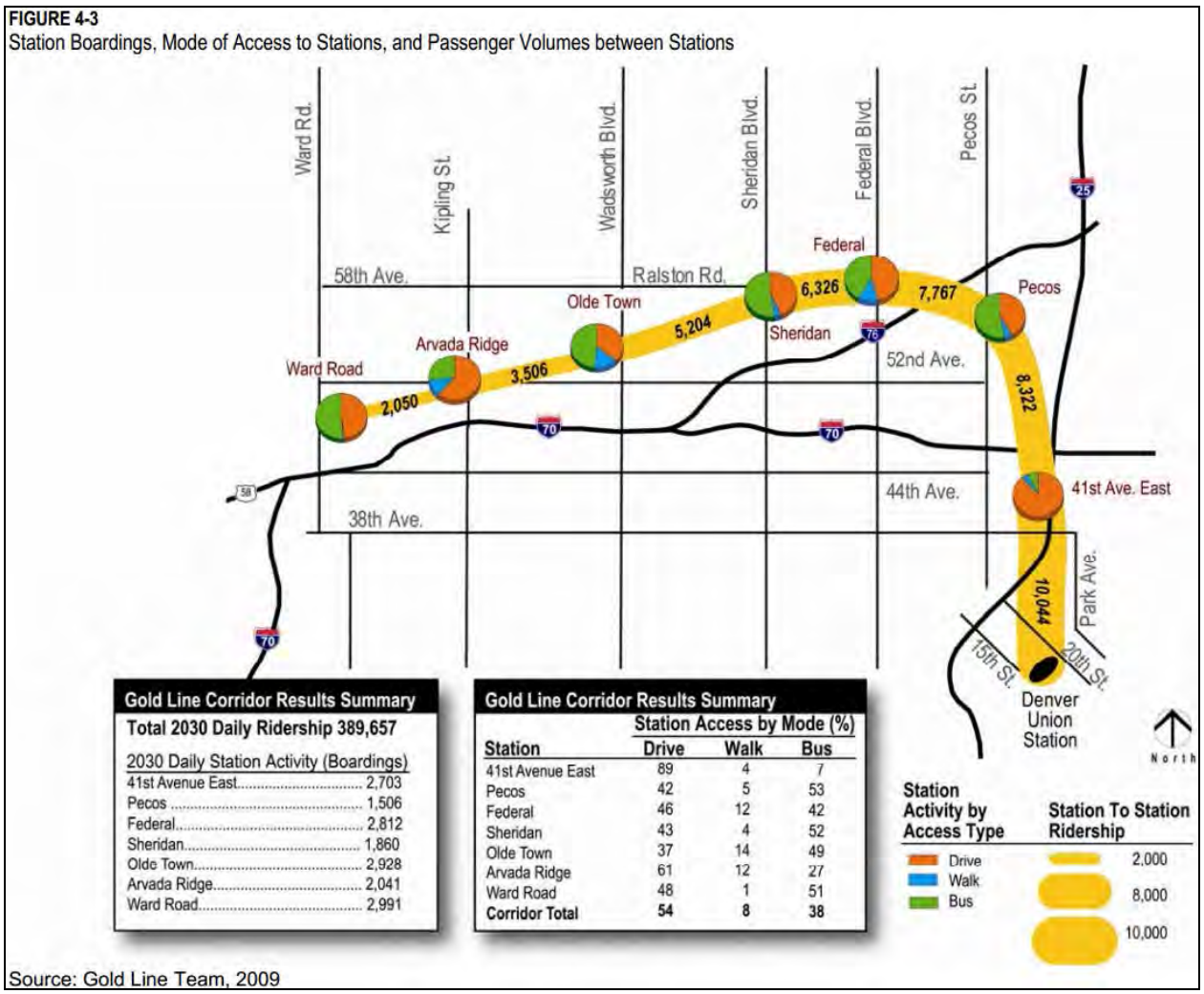
Additionally, mode of access to each station was projected to determine the method by which rail passengers are expected to arrive at the station. 41st & Fox and Arvada Ridge stations are the only stations projected to have more the 50% of passengers accessing the station via automobile, while passengers at all other stations access the station by walking or taking transit.

Figure 2 - G-Line Mode of Access, 2030



Projected 2016 daily boardings for the G-Line are estimated to be approximately 13,000 and are subsequently projected to increase to 16,800 by 2030. Station ridership is projected to be highest at Clear Creek/Federal, Olde Town Arvada, and Wheat Ridge/Ward, where average daily boardings are expected to exceed 2,000. Ridership is expected to grow by an average of approximately 550 boardings per station between 2016 and 2030.

Map 3- Station Boardings, Mode of Access to Stations, Passenger Volumes Between Stations



Northwest Rail Corridor Final Environmental Evaluation (2010)

The Northwest Rail Corridor Environmental Evaluation contains bus and rail operations plans related to the environmental benefits, costs, and impacts of the proposed service alternatives. The bus operations plan summarizes the existing transit service in the corridor including current routes, service frequencies and facilities, while the rail operations plan provides a description of the proposed service including of hours of operation, service frequency, and stations served.

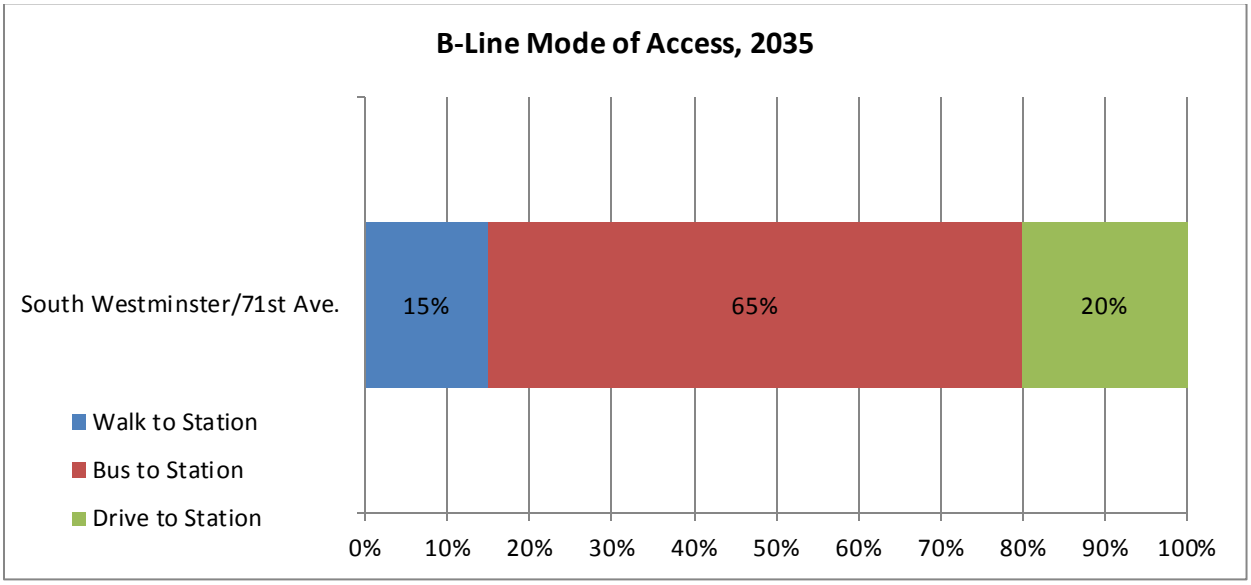
The Northwest Corridor is envisioned to serve a potential of eleven total stations when fully constructed; however, only seven of these stations have received FasTracks funding. Of these seven stations, Westminster/71st Avenue is the only station that will be operational when the line opens for service in 2016 as part of Phase 1 of the project. Future phases constructed beyond Westminster/71st Avenue would share a Right-Of-Way (ROW) with freight operations and would therefore require an operating agreement with BNSF Railway Company. Due to the interaction with freight trains, the B-Line will be operated with diesel multiple unit (DMU) commuter rail cars that have the flexibility to operate on a shared ROW.

Table 2 - B-Line Planned Operations

B-Line			
Weekday	4:00 AM to 12:00 AM	Peak Periods	30 minutes
		Midday	50 minutes
Saturday	4:00 AM to 12:00 AM	All Day	60 minutes
		Late Evening	120 minutes
Sunday/Holiday	4:00 AM to 12:00 AM	All Day	60 minutes
		Late Evening	120 minutes

Projected 2035 daily boardings for the Westminster/71st Avenue station are estimated to be 795 when all FasTracks funded stations are included in the ridership model. Of these average daily boardings, 65% are expected to access the station by bus route identified as either Routes 31 or 72 in the evaluation report. There will be a total of 925 parking spaces at Westminster/71st Avenue station, which is more than any other FasTracks funded station in the corridor.

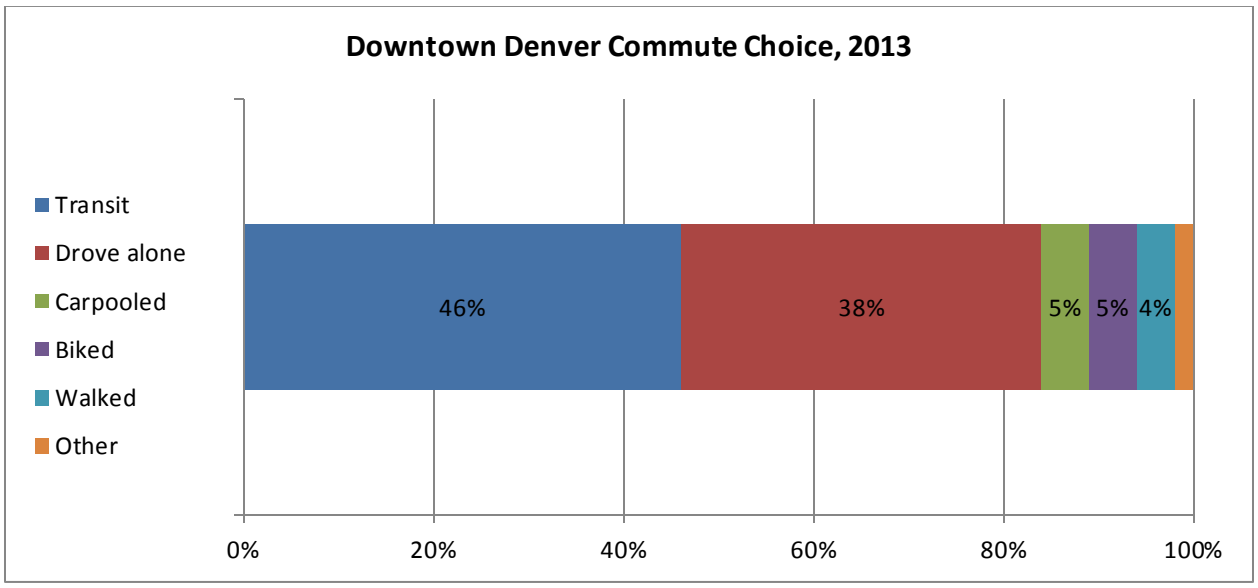
Figure 3 - B-Line Mode of Access, 2035



Downtown Denver Commuter Survey (2013)

Each year, the Downtown Denver Partnership surveys employees working in downtown Denver to examine the commuting patterns and trends of downtown commuters. The survey found that transit and driving alone are the two most commonly used ways that commuters travel to work.

Figure 4- Downtown Denver Commute Choice, 2013



Survey respondents have an average one-way commute of 14 miles with the majority working in the Commercial Core neighborhood of downtown. Other findings conclude that employer-provided transportation benefits, age, office location, and commute length all play a role in determining commute choice. Note that this survey predates the opening of the new Denver Union Station.

West Corridor Service Plan (2013)

The West Corridor Service Plan was developed to restructure the bus network prior to the implementation of the West Rail Line, which provides light rail service from downtown Denver to the City of Golden. Lessons learned from this report will help inform the design of the Service Plans for the Gold and Northwest Corridors. Key findings in this report include the discovery that the majority of the West Corridor boarding activity occurs within the inner and middle segments of the corridor, with the outer segment showing a significant decrease in activity. The final bus service plan recommended alternative service delivery methods in the outer segment and a reinvestment of resources in the core grid network, where they could benefit a higher number of riders. Additionally, an out of direction model was run to determine whether bus routes should be deviated to serve rail stations off the main corridor. This will be an issue that has to be addressed in preparation for the opening of the Gold and Northwest Rail project. The chart in the following page relates to routes studied in the West Corridor.

Table 3 - West Corridor Service Plan Recommendations and Straegies

Service Type		Recommendations and Strategies
North-South		- Reinvest available resources in service improvements on the strongest core grid routes - Preserve high frequencies to promote spontanous use - Provide high capacity connections to LRT - Introduce new Limited service to facilitate LRT-based travel *See Routes 31, 51, and 76Ltd*
East-West	Downtown to Wadsworth Blvd	- Preserve frequencies to promote spontaneous use - Maintain the core grid network to preserve strong network connectivity - Focus line haul travel on LRT
	West of Wadsworth Blvd	- Rationalize low-performing route segments - Introduce alternative service delivery options in limited demand markets *See Routes 20, 28, and 32*
Express		- Replace routes duplicative of LRT - Restructure into first mile/last mile LRT feeder services - Focus line haul travel on LRT *See Routes 2X, 5X, 87X, 93X, and 100X*
Regional		- Leave as is to avoid transfers for very long distance trips *See Routes GS, EV, and CV*
call-n-Ride		- Introduce in low demand markets - Allow for flexible demand-based trip making - Fulfill role for first mile/last mile LRT feeder with scheduled LRT station timepoints *See Golden cnR, Wadsworth cnR, Green Mountain cnR, and Applewood cnR*

Wheat Ridge Northwest Subarea Plan (2013)

The purpose of the Northwest Sub-area Plan is to establish a vision that will guide future development around the G-Line station of Ward Road in the City of Wheat Ridge. The plan establishes the need for higher density, mixed-use development around the transit station with a focus on employment-supporting land uses in the area. Wheat Ridge voters exempted the area from the height and density restrictions in the City Charter, which creates an opportunity for high density development along the Interstate 70 corridor.

Westminster Station Transit Oriented Development

The Westminster Station Transit Oriented Development project is envisioned by the City of Westminster as a vibrant, mixed-use, high intensity development district, which will include a community park and open space amenities. The district will be anchored by the station of Westminster/71st Avenue on the B-Line. A policy framework plan is in development for land use, urban design, and circulation that will support transit ridership and revitalization around the station is expected to be adopted in late 2014.

Map 4- Westminster Station Transit Oriented Development

2 Existing Conditions

2.1 Market Assessment

The Denver region is growing rapidly. In order to provide the best possible service, the Regional Transportation District (RTD) must continually adjust and keep pace with those changes. The purpose of this market assessment is to examine the underlying conditions in the communities that will be served by the Gold Line and Northwest Line corridors and assess the trends as they relate to the demand for transit service and the types of services that best match the demand.

The following market characteristics are key factors that influence the demand for transit and are critical elements of a market-based approach to transit planning:

- Population and Employment Density
- Customer Demographics
- Development Patterns
- Street Patterns
- Market Typologies

This information will be used in subsequent phases of the development of the bus operations performance analysis to inform the design of transit service improvements.

Market Fundamentals for Transit Planning

The aforementioned market fundamentals are key factors that affect the demand for transit and are critical elements of a market-based approach to transit planning. Transit success cannot be attributed to one market factor alone; rather, these fundamentals combine to form a series of push and pull factors that act as incentives or disincentives for transit use. Together they identify what is necessary for transit to succeed within a market context and will be used to create a composite picture of where service is most likely to generate ridership. Use of the market-based indicators serves to inform decisions about transit service location and supply.

Population and Employment Density

Population and employment density identifies the location and concentration of residents and jobs within an area. The distribution of people and jobs significantly influences the effectiveness of transit. A community with a concentrated mix of uses will allow transit to serve more customers and trip purposes than an area with a more dispersed pattern of development. In addition, transit agencies should view local residents and employees as a base of prospective customers. Higher densities are positive market indicators for transit, assuming that the preference for riding transit is consistent across a service area; routes in low-density areas will be limited in their ability to generate a substantial level of ridership given the smaller base of customers from which to draw.

Customer Demographics

In practice, customer preferences are not static across a service area. Preferences vary from community to community based on local mobility needs. Demographic data such as income or personal vehicle access provides additional information about the population that can be used to further identify where the strongest market opportunities for transit exist. In a market-based approach, understanding different

rider market segments will help transit agencies better match transit service products to serve a particular customer market segment. In addition, a market analysis of customer characteristics supports RTD's responsibility to comply with Title VI federal regulations which aim to identify and mitigate disproportionate and disparate service impacts to low-income and minority households respectively.

Development Patterns

In evaluating the market for transit, agencies must consider how the configuration of a community will influence service design. Higher density developments with varied land uses are typically indicators of more sustainable developments where active modes of travel (i.e., walking and biking) together with transit, become viable alternatives in completing for all types of trips. Transit-oriented developments promote multimodal travel and maximize access to public transportation through features such as enhanced pedestrian and bicycle facilities, as well as pedestrian-scaled street design. The multimodal amenities, mix of land uses, and closer proximity of activity centers entices residents and visitors to complete more of their trips via transit, foregoing the use of private vehicles.

Street Patterns

The shape and design of the street network profoundly impacts transit opportunity and success. It is important to remember that the majority of transit trips begin and end as pedestrian trips, making strong pedestrian connections vital for transit success. Areas that prioritize pedestrian access are characterized by multiple points of entry, functional sidewalks, good lighting, a grid-like street pattern, short blocks, and direct alignments between destinations. Street design factors such as street width and alignment influence pedestrian and vehicle access, travel time, and safety. Areas with discontinuous and non-linear streets present barriers to pedestrian circulation and provide a disincentive to use transit.

Market Typologies

Market typologies serve as generalized characterizations of the varying market conditions within the region. Each typology incorporates findings from population and employment densities as well as development and land use patterns. Each market typology presents different opportunities and challenges for transit and serves as a guide to inform transit service decisions. Utilizing typologies ultimately offers an efficient method for categorizing community mobility needs and identifying the best-fit solutions.

2.2 Existing Market Conditions

The following market assessment presents an overview of the population demographics and characteristics of each corridor and was used to identify areas that are more prone to transit use. Demographic characteristics incorporated into this assessment include income, race, car ownership, and senior populations. Additionally, the population and employment densities within the corridors were used to determine the location of high density trip generators and potential ridership patterns.

Population and Employment Density

Generally, higher population and employment densities are more conducive to transit usage. In the Gold and Northwest Corridor service areas, high population densities are found in the neighborhoods immediately surrounding downtown Denver, Westminster and the area between Olde Town Arvada and Arvada Ridge. Areas located immediately north of the West Line show particularly strong population densities, which can be attributed to their proximity to Colfax Avenue, a major arterial road with strong retail and residential developments that have resulted in higher densities. Heading north from the West Line and away from the City of Denver, population densities begin to diminish. The City of Wheat Ridge is a low density community with a small concentration of higher density development located just south of Interstate 70. Between Interstate 70 and the G-Line, population densities are reduced as the land use transitions to commercial and industrial developments with fewer residential areas. The City of Arvada, which possesses two stations on the G-Line, exhibits higher densities in areas along the G-Line between Wadsworth Blvd. and Kipling Street. Population densities begin to diminish upon heading north away from Olde Town Arvada until reaching the City of Westminster. Westminster maintains two medium density corridors along 88th Avenue and 92nd Avenue that lead east to US 36 and the planned Bus Rapid Transit (BRT) corridor. East of US 36, population densities substantially increase in the City of Thornton, especially between 84th Ave and 104th Ave to the west of Interstate 25. This area exhibits some of the highest densities outside of downtown Denver.

Similar to population densities, employment densities in the Gold and Northwest Corridors are highest in downtown Denver and the immediate surrounding areas. Outside of downtown, employment densities are highest along the arterial roadways including the east-west roads of 44th Ave., 84th Ave., 88th Ave., and the north-south roads of Federal Blvd., Sheridan Blvd., and Wadsworth Blvd.

- **44th Avenue** is characterized by various strip retail centers located along the western portion of the study area, as well as a Walmart that sits adjacent to the Lakeside Amusement Park. Development along this corridor often changes from residential to retail with a distribution of retail centers scattered throughout the residential areas.

- **84th Avenue** is characterized by higher density residential development, including some three story apartment buildings, and several employment centers, which include St. Anthony North Hospital and the North Valley Tech Center. The concentration of apartments would be expected to generate above average ridership on routes serving this segment.

- **88th Avenue** contains several large employment centers including the seasonal Waterworld Water Park, North Suburban Medical Center, and numerous big box retail stores. In addition, there is a connection with the US 36/Sheridan BRT Station and the Thornton Park-n-Ride, with each providing several transit connections to the greater RTD network. The mix of residential and retail development should make this corridor a strong market for transit.

- **Federal Boulevard** is characterized by varied land uses with portions of residential, strip retail, commercial and industrial developments along the corridor. Residential

development remains the most dominant form of land use with limited commercial and strip retail developments spread out through the corridor. Major attractions along this corridor include the Denver Bronco's stadium, which generates strong seasonal ridership.

- **Sheridan Boulevard** is similar to Federal Blvd. with a mixture of varied land uses but its employment densities are also supplemented by big box retail locations and a greater intensity of industrial development.

- **Wadsworth Boulevard** is characterized by dense, mixed-use development with retail nodes located at major intersections. Big box retail stores contribute significantly to the employment density in this corridor and anchor other retail stores nearby. Additionally, Wadsworth Blvd. passes through Olde Town Arvada, which is comprised of retail developments in the historic district. See Map 3 for population and employment densities.

Customer Demographics

Income

In order to comply with the Federal Department of Transportation's Title VI regulations under the Civil Rights Act of 1964, the Federal Transit Administration (FTA) under C4702.1B requires transit service providers to conduct a service equity analysis with minority and low income populations when a major service change has been proposed. As established by RTD, this analysis includes provisions that an adverse impact, as a result of the proposed changes, may not be borne by low-income persons by more than 10% above non-low income populations. Care must be taken to ensure that the proposed recommendations do not result in a disproportionate burden on low income populations.

Low-income persons are defined by the US Census as persons living in households with a total family income of less than or equal to its poverty threshold. This threshold is calculated based on the size of the family and how many children under the age of 18 live in the household. These families are more likely to use transit of necessity, being less able to afford other forms of transport with some or all of the household using transit as their primary mobility mode.

Downtown Denver has the greatest concentration of low-income persons in the study area. Outside of downtown, there is a significant low-income population adjacent to the G-Line station of 41st & Fox, as well as north of the Westminster/71st Ave station on the B-Line. Excluding these areas, there is not a significant concentration of low-income persons in either corridor. See Map 4: Population in Poverty.

Minorities

Similar to the low-income population, Title VI recognizes areas with a high concentration of minority populations, as care must be taken to ensure that an adverse impact, as a result of a major change, is not disproportionally borne by minority

communities. The proposed recommendations should not result in an impact greater than 10% above majority populations.

Downtown Denver and the surrounding areas possess the greatest concentration of minority persons in the study area. In the Gold Corridor, the minority population is lower with the greatest population near the stations of 41st & Fox and 60th & Sheridan. Alternatively, the Northwest Corridor possesses a considerably larger minority population, particularly in the area between US 36 and Interstate 25, which falls within the market capture of the service. It is important that these communities are recognized and taken into account when developing major changes in the transit network. See Map 5: Minority Populations.

Vehicle Access

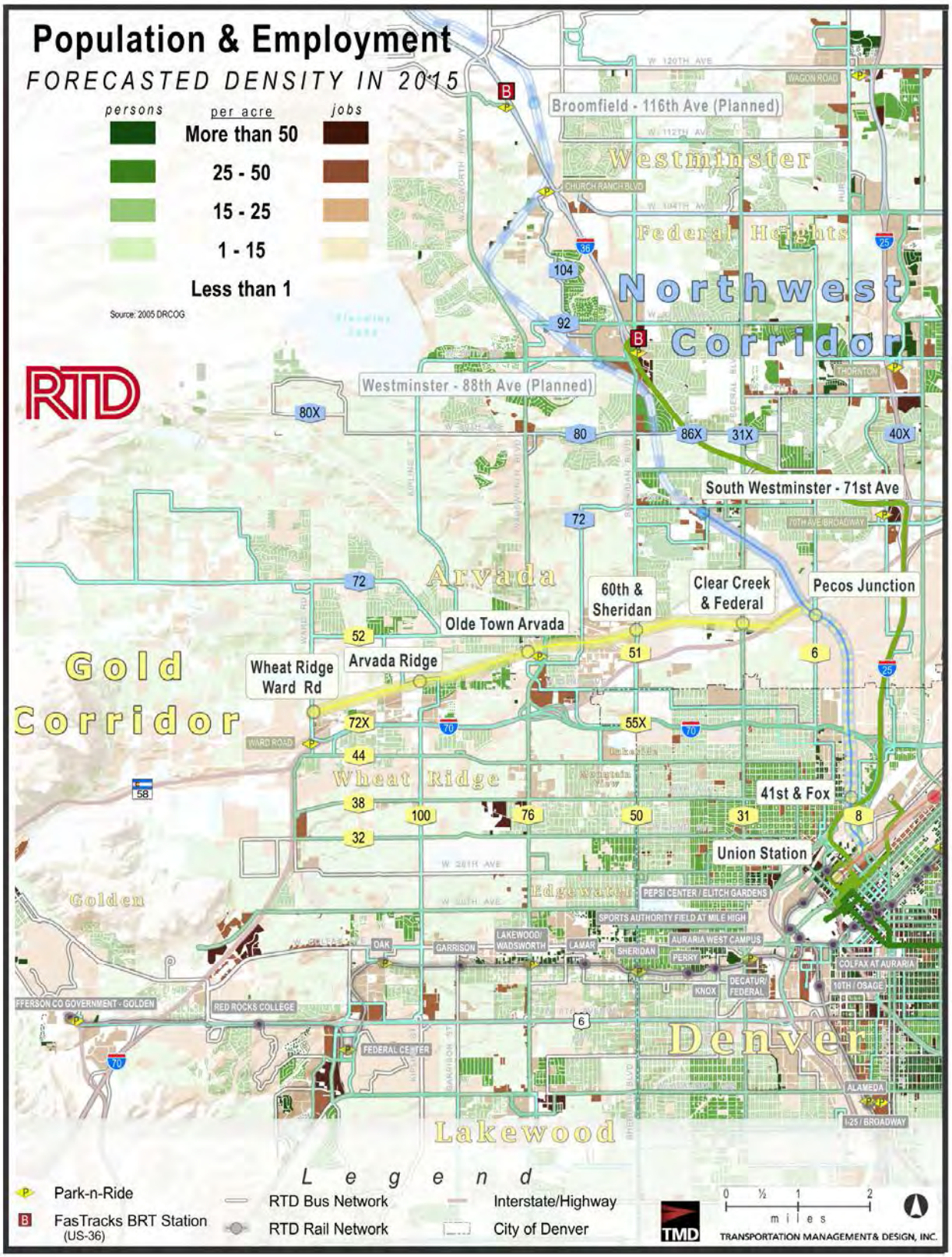
Persons with limited access to a vehicle for work-based or personal trips are more likely to account for a higher share of transit use. Typically, an area has a vehicle access deficient population if there are two or more persons (of driving age) per vehicle or four or more households per acre without access to a car. Neighborhoods with deficient automobile access generally lie within areas of concentrated low income, senior, or college-aged populations, where car ownership is either unnecessary or results in financial burden.

Similar to the other demographic findings, reduced vehicle availability is concentrated in downtown Denver and adjacent to the station of 41st & Fox. The remaining study area population does not have a high concentration of persons with limited access to a vehicle suggesting that the majority of the population will have a competitive means other than transit to complete their trips. See Map 6: Zero Vehicle Households.

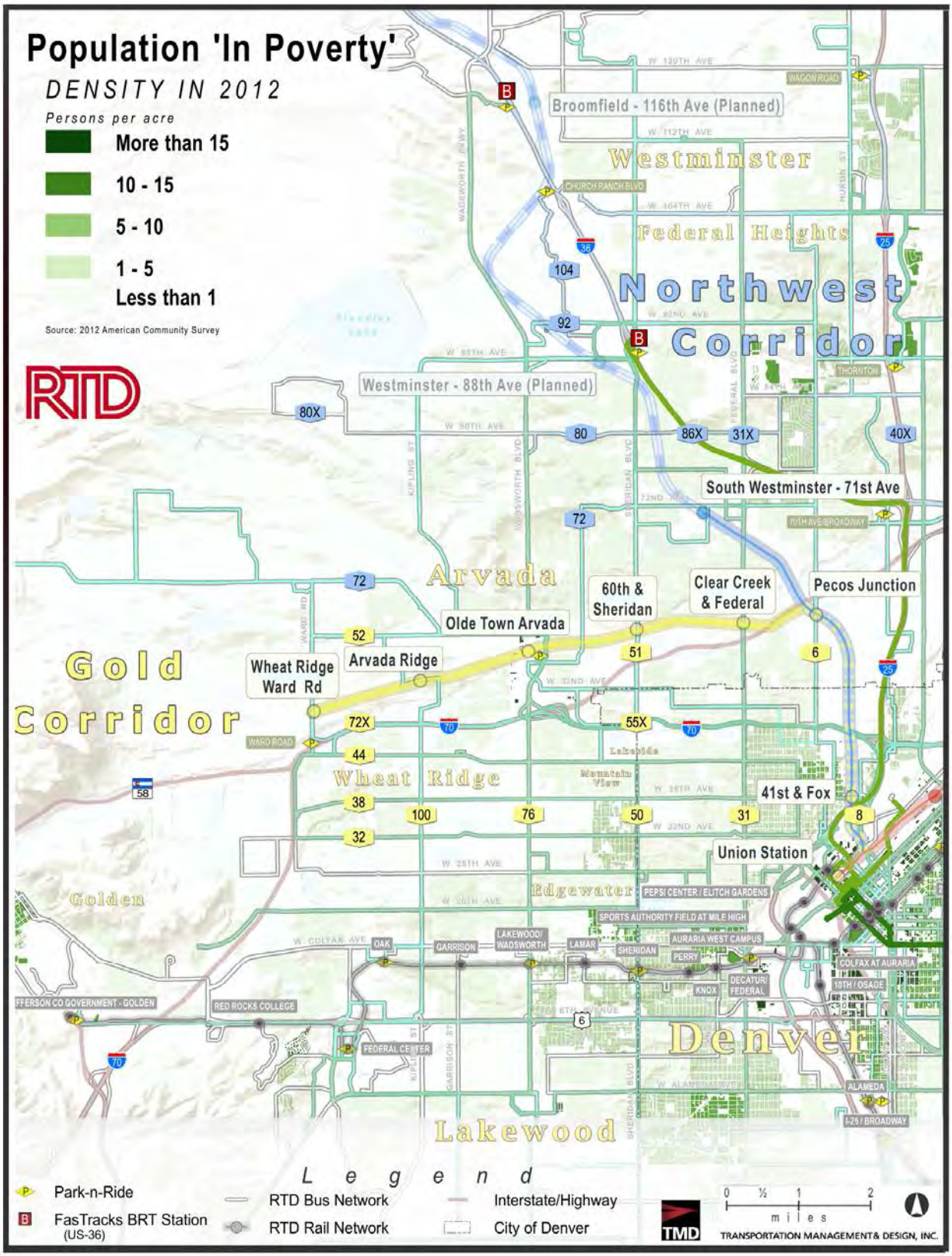
Senior Population

When older adults lose their ability to drive, they also risk losing their connections with their community and to vital services and activities. The senior population, defined as persons age 65 and older, is generally more dependent on transit for shopping, medical, and other personal trips when compared with other age groups. The study area does not contain any notable concentration of seniors which will need special mobility consideration. See Map 7: Senior Citizens.

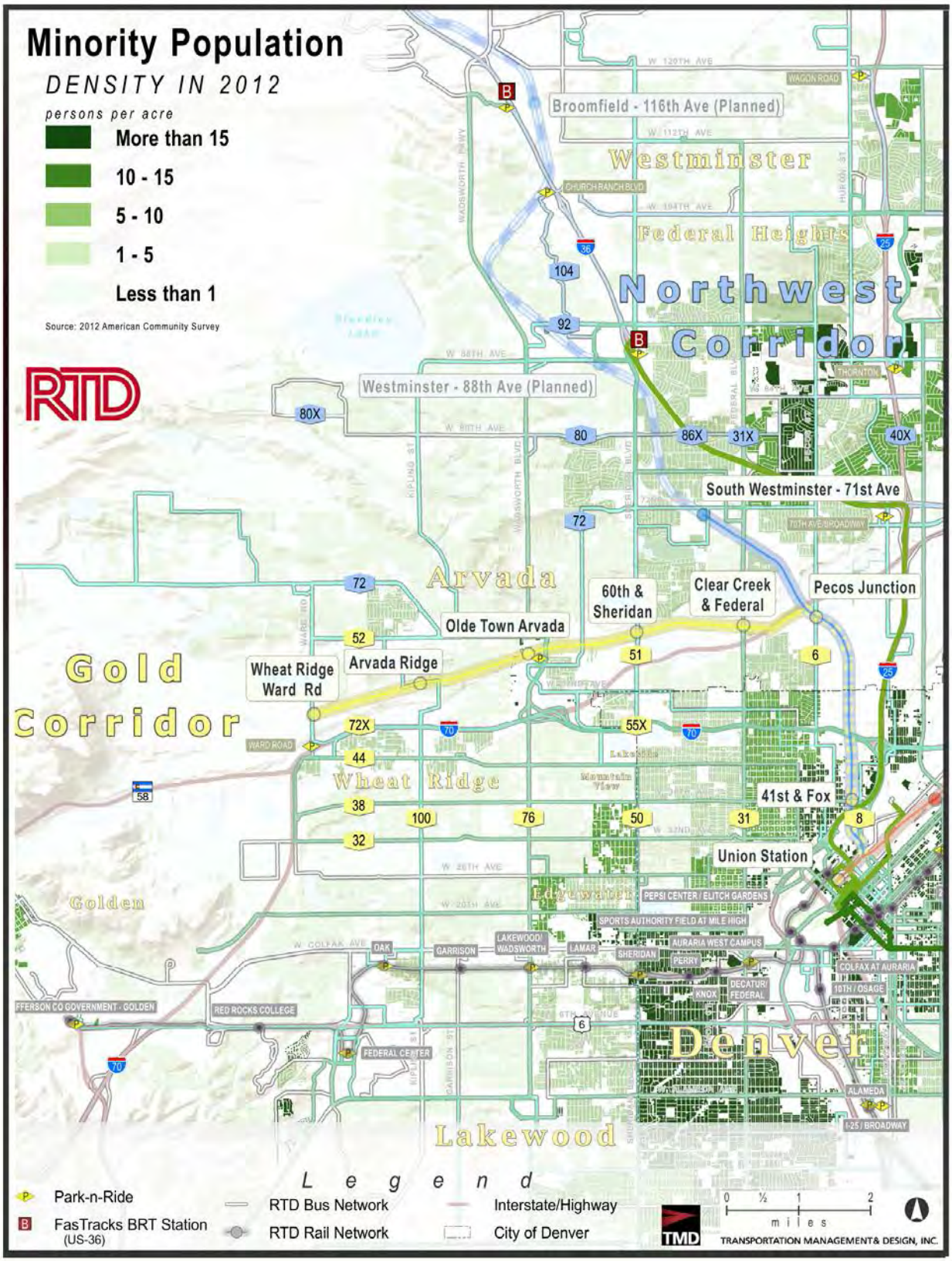
Map 5 - Population & Employment Density in 2015



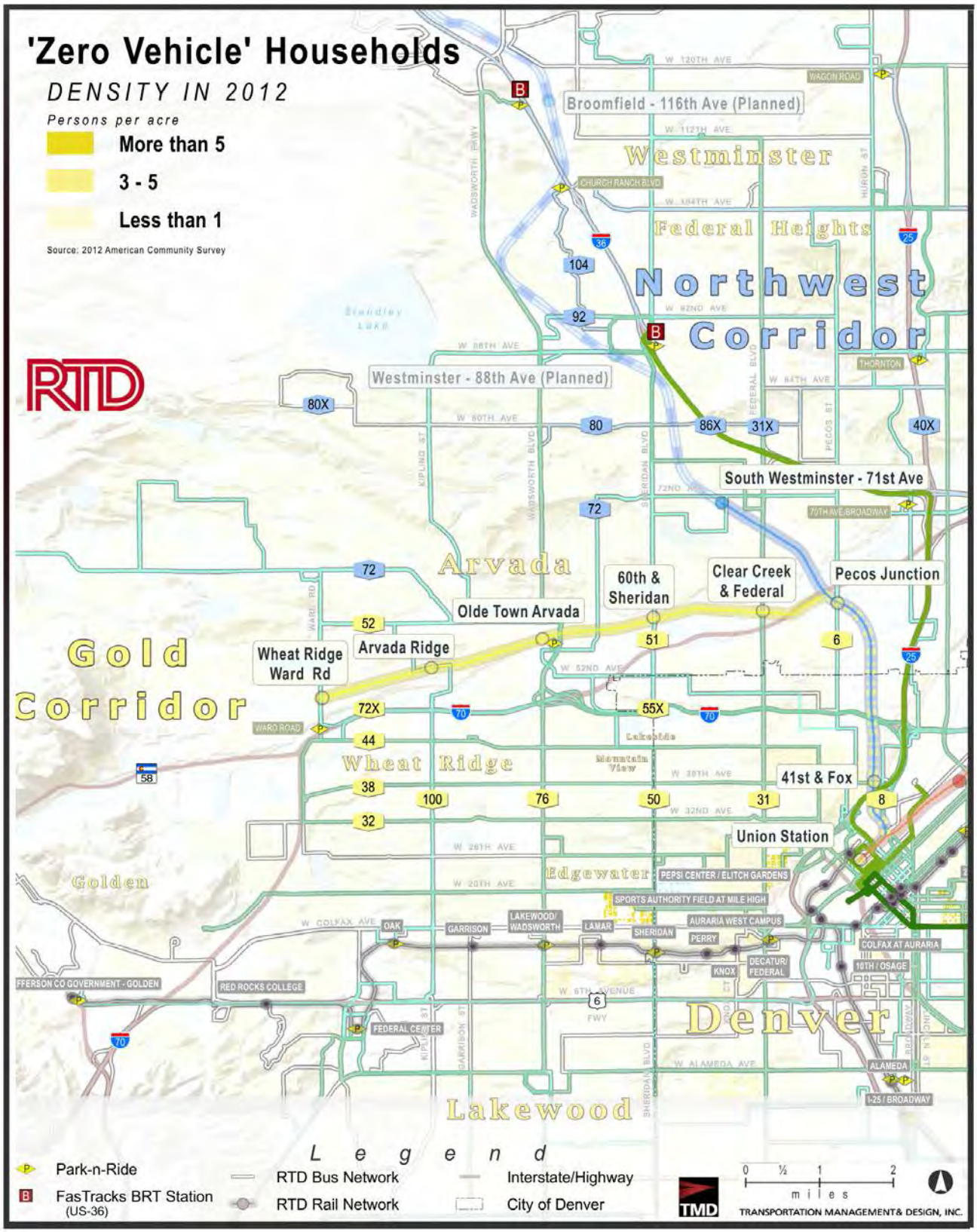
Map 6 - Minority Population Density in 2012



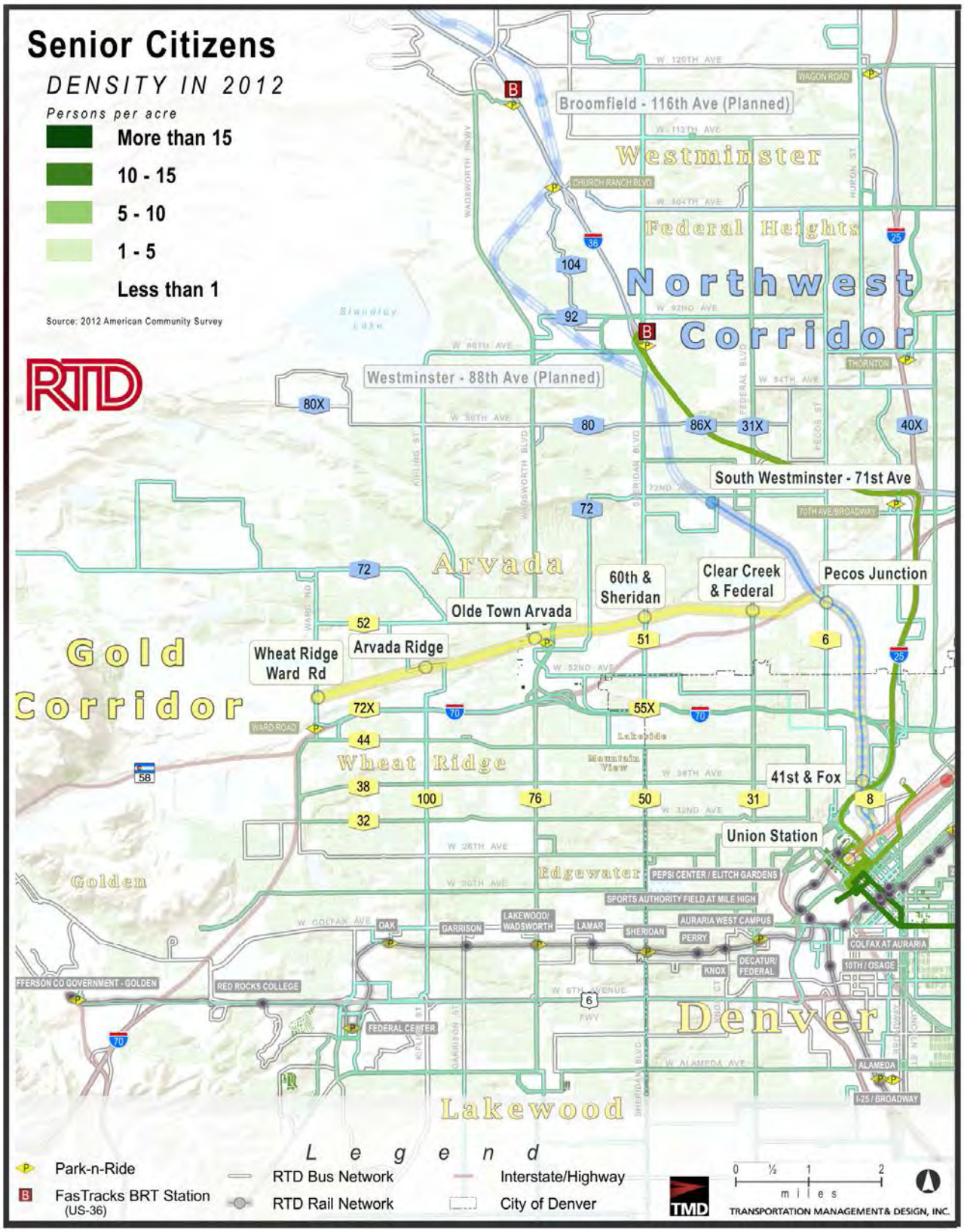
Map 7 - Minority Population - Density in 2012



Map 8 - Zero Vehicle Households, Density in 2012



Map 9 - Senior Citizens Density in 2012



Development Patterns

Single-family residential housing is the dominant land use in the study area. While often associated with urban sprawl and automobile centered development, single family residential land uses can vary from low to medium densities depending on the street pattern. A more compact street network often contributes to higher densities of housing, which are more supportive of transit use. Some multi-family residential housing exists in the study area but is typically centered around downtown Denver where higher density condominiums, apartments, and townhomes are more prevalent. Outside of downtown, multi-family residential land uses are scattered throughout the study area and often located along major roadways. Commercial and industrial land uses are concentrated along the existing rail lines, particularly in the area immediately north of downtown Denver. Retail development is typically confined to shopping centers located throughout the study area at major intersections. No single retail location is significantly more influential than the others. However, the presence of large value oriented retailers will make some locations better candidates for supporting transit use.

Street Patterns

The Denver region was established with a grid street plan characterized by intersecting perpendicular roadways oriented to the four cardinal directions, excepting downtown. Major roadways intersect every one-half mile which is more or less a ten minute walk. Closer to downtown Denver, the street network is more compact, with block distances less than 300 feet, allowing for higher densities of residential development. A strong grid network is maintained heading west until Wadsworth Blvd. After Wadsworth Blvd., non-linear streets become more prevalent with greater distances between blocks. The non-linear and cul-de-sac street types found in this area are the result of subdivision developments and are naturally prohibitive to transit use due to their minimal access and lack of focus on the pedestrian environment. Even greater barriers to transit exist continuing northwest to the outskirts of Standley Lake where the presence of parks, lakes, golf courses, and subdivisions have further disrupted the street pattern.

Market Typologies

Market typologies in this study area include urban core, core, suburban, and industrial. The urban core market constitutes downtown Denver and surrounding areas heading west to Wadsworth Blvd. and north to Interstate 70. As shown in the population/employment density and the demographic maps, the higher densities of the urban core and close proximity to key destinations make transit more effective in this area.

North of Interstate 70, the study area transitions into a core market with medium densities and several Park-n-Rides, which signify more auto-centric developments. The core market lends itself to peak oriented commuters traveling further distances to employment centers. The ability to attract ridership depends upon the ability to compete with automobile travel times.

The suburban market is defined as the area west of Ward Rd. where development is characterized by non-linear street patterns, minimal pedestrian facilities, and low density single family housing. Suburban markets tend to have high concentrations of

car ownership and a limited market for transit as travel distances are greater to and from the population and employment centers making transit less competitive compared with the automobile.

An industrial market currently surrounds portions of the G-Line alignment from downtown Denver to Arvada with various facilities occupying large areas of land limiting the diversity of land uses. The industrial market often requires transit service during non-traditional hours with demand to these areas depending on parking availability and transit access. Limited residential development and retail opportunities are likely to affect potential immediate ridership gains in this area.

3 Service Evaluation

An assessment of the existing transit service is essential for understanding a route's role within the larger transit network and for analyzing individual route performance against the service standard metrics. Included in this assessment is a ridership review that helped to identify boarding activity and ridership trends.

3.1 Service Fundamentals for Transit Design

Service fundamentals provide a framework for evaluating transit performance and identifying opportunities for improvement. Service fundamentals are divided into two categories: Service Design Decisions and Performance Metrics. Performance metrics show how a route performs while service design decisions provide explanations for why a route performs the way it does. When analyzing market demand for transit and service performance no one metric or design decision provides a complete story of a route's performance; but when considered as a whole, a clear picture of existing performance is generated.

Service Design Decisions

Transit agencies can make a number of important service design decisions that positively influence a customer's decision to ride transit. This section details the impact that decisions such as service frequency, span, speed, reliability, approachability, route alignment, and network role have on ridership levels.

- **Service Frequency** – Frequency is one of the most effective service design characteristics that influence transit trial and ongoing use. Routes with spontaneous-use frequencies (service every 15 minutes or better) benefit passengers by reducing their out-of-vehicle wait times. At these service levels, passengers typically do not need to consult schedules nor time their arrival at bus stops. Higher bus frequencies also provide a better connection to more frequent rail services which maximizes network benefits by facilitating the transfer experience.
- **Service Span** – Service span is the hours and days of operation of a route. It affects ridership by limiting when passengers can travel and often affects both ends of a trip even though half of the trip occurs during regular service hours. Greater service span provides more travel flexibility and improves the customer experience, but excessive time span coverage like geographic coverage can be excessively unproductive.
- **Service Speed** – Faster operating speeds benefit both the customer and the transit agency by reducing in-vehicle travel times for passengers and resource

requirements for the agency. Out-of-direction travel (deviations), excessive stop dwell time (stops too closely spaced or long delays at stops), unsynchronized travel signal delay, and traffic congestion will be identified for possible mitigation.

- **Reliability** – On time performance impacts a passenger's ability to rely on a service to get them to their destination in a timely and consistent manner. Service reliability (daily delivery of service as scheduled) is the most important metric in retaining existing transit customers.
- **Alignment** – The alignment refers to the operating path of the transit route. Alignment design should balance customer access (walk distances) with service directness (fast travel). Direct service normally results in higher ridership (deviations deter upstream customer use) and lower operating costs (shorter round trip travel times often require fewer resources). One typical impact of introducing bus connections to rail stations occurs when the bus must leave the natural direct alignment to reach the station. The number of patrons riding through the station on the bus versus the potential ridership at the station must both be considered and are influenced by the length of the deviation (impact on through riders per new station rider) [1].
- **Round Trip Cycle Time** – The cycle time's relationship to the frequency is the principal factor in service design efficiency. For instance, a round trip cycle time of 56 minutes[2] can be easily rounded to 60 minutes, which efficiently divides into 60, 30, 20, 15, 12, and 10 minute frequencies. One of 65 minutes presents major efficiency issues, where operation of any of the preceding frequencies would require the inefficient use of one extra bus. Consequently, the route alignment and operating speed should be both considered in assuring that routes have efficient round trip cycle times whenever possible.
- **Route Spacing** – Routes should be spaced to maximize effective network access. Services placed too close together or too far apart become issues in network cost effectiveness (unproductive competition) and synergy. Typical spacing is no closer than ½ mile and no farther apart than one mile where the necessary densities are present. These distances are heavily influenced by the street network and the mode and service level (consumer research has found that customers will walk further to better service).[3]
- **Network Role** – While the design of individual routes is important, how they come together into an efficient and effective network is critical to attracting transit use for a variety of trip-making purposes by a broad cross-section of the community (transit lifestyle design: "live-work-play" mobility).
- **Approachability** – The approachability of a system refers to how easy it is for a passenger to navigate and understand a system. Systems that are approachable

---

[1] The industry best practice out-of-direction model measures the minutes of out-of-direction travel for the deviation times the number of through-riders divided by the number of new station riders. A ratio of 2 to 5 minutes is the acceptable range of impacts with 2 minutes a good trade-off and 5 minutes as the highest acceptable impact.

[2] The round trip cycle time is also known as revenue time and includes the in-service running time plus terminal recovery time to ensure the on-time departure of the next trip.

[3] Typical consumer walk distances are ¼ mile for regular bus transit (80% of the riders travel ¼ mile or less – 5 minute walks), while the 80% consumer walk shed for rail and enhanced bus is ½ mile (10-minute walk).

make customers comfortable with using public transit and reduce uncertainty. Excess complexity can negatively affect both route and more importantly network attractiveness. This is a qualitative assessment that considers issues such as line branching, short/long lines, trippers, deviations, corridor alignments, and service frequencies.

Performance Metrics

Performance indicators provide a way of quantifying the strength of a route's performance and comparing it with others in the system. The magnitude of a performance indicator is directly related to the number of passengers who ride a given route or service unit. Performance indicators are an important route evaluation tool because they allow routes that vary greatly in boardings, service levels, and costs to be compared directly to one another and are part of RTD's Service Standards program. The performance metric inputs are defined as:

- **Boardings** – Unlinked passenger trips; includes transfers as boardings.
- **Revenue Hours** – In-service plus recovery time, but not including non-revenue time (deadheading movements and pull-time to/from service garage).
- **Operating Revenues** – Cash, ticket, electronic fare media, and tokens allocated by route by farebox recorded boardings plus other revenue directly attributable to service operation (e.g., vehicle and shelter advertising).
- **Operating Cost** – All operating, maintenance and administrative costs for providing current service. RTD's cost allocation model allocates costs to each route based on its miles, hours, and peak vehicles and varies between in-house and contracted operations. Individual accounting line items are assigned to the most relevant service unit variable by the model.
- **Subsidy** – Operating revenue minus operating cost minus fare revenues.

4 Existing Service Conditions

4.1 Transit Route Network

RTD services are divided into various service classes depending on service type, route alignment, and frequency. Each service class has its own service standards derived from the performance of all routes within each class. RTD conducts an annual route review using the performance indicators of subsidy per boarding and boardings per hour.

Routes in the Gold and Northwest corridors fall into one of the following service class categories: Central Business District (CBD) Local, Urban Local, Suburban Local, or Express. The majority of routes in the study area provide local service, characterized by frequent stops to allow convenient access to destinations along major and minor streets. Local service routes are categorized as CBD Local, Urban Local, or Suburban Local. CBD local routes operate to and from downtown Denver. Urban Local routes predominantly serve urban areas which have higher residential and/or employment densities. Suburban Local routes predominantly serve suburban areas which have low to medium residential densities, offering transit coverage to less developed communities in the far reaches of the service area. Limited routes supplement local routes during peak periods of travel demand or throughout the day but are not

operating within the study area at this time. Express routes provide commute-oriented service primarily during peak periods between major origins and destinations in the region. Express routes make fewer stops, can operate on highways, and provide faster service to destinations compared with local or limited routes. Express routes represent a premium service with fares that are generally higher than local or limited routes.

Gold Corridor Bus Routes

Table 4- Current Gold Corridor Bus Routes

Service Class	Routes
CBD Local	6-8-32-38-44-52
Urban Local	31-50-51-76
Suburban Local	72-100
Express	55X-72X

Northwest Corridor Bus Routes

Table 5- Current Northwest Corridor Bus Routes

Service Class	Routes
Urban Local	31
Suburban Local	72-80-92-100-104
Express	31X-40X-80X-86X

Transit Service Levels

Transit service levels include frequency and span. Frequency refers to how often a route runs and span refers to the hours and days of operation. Transit service levels are often dictated by a number of factors, the most important being actual usage, i.e. market demand. Increased demand for transit often translates into an increased supply of service with better frequencies, longer spans, and multiple days of operation. Similarly, less demand usually translates into less service. Other contributing factors that influence transit service levels include connections to key destinations, historical precedent, regional significance, and operating agreements.

Frequency

In the RTD route network, frequency is broken down into three categories: spontaneous-use (15 minutes or less), coordinated (30 minutes), and lifeline (60 minutes or more).

- Spontaneous-use frequencies minimize passenger wait times and eliminate the need for passengers to plan their trips in advance around the schedule which ultimately attracts more riders making routes more cost-effective. CBD Local and Urban Local routes often possess frequencies that facilitate spontaneous use.
- Coordinated frequencies require passengers to coordinate their trips in advance to arrive and depart in a fashion that will minimize wait times and reduce their overall travel time. Coordinated frequencies are often found on routes that cannot support spontaneous-use frequencies but have enough demand to support greater service levels than the lifeline frequencies.

- Lifeline frequencies provide transit coverage to areas that cannot support higher frequencies. These services are often used to expand the transit service area to provide access to outlying communities. Focusing efforts on lifeline coverage does not typically grow ridership but can provide critical mobility for many passengers located in low density markets. Suburban Local routes often have lifeline frequencies. Routes that provide "trips" rather than a regular frequency are often the result of commute oriented travel patterns where transit demand is not sufficient enough to warrant midday service or regular service frequencies.

Gold Corridor

In the Gold Corridor, spontaneous use frequencies are found south of Interstate 70 on three east-west CBD Local routes. These are Routes 32, 38 and 44 which serve the City of Wheat Ridge and downtown Denver. Other spontaneous use frequencies are found on the two major north-south arterial roadways of Federal Blvd. and Wadsworth Blvd. All other routes in the Gold Corridor possess coordinated frequencies and are concentrated in the areas north of Interstate 70 and on the remaining north-south arterial roadways.

Gold Corridor Frequency and Span of Service

Table 6 - Current Gold Corridor Transit Route Network

Route	Description	Weekday Frequency			Weekend Frequency		Span of Service		
		AM Peak	PM Peak	Off-Peak	Saturday	Sunday	Weekday	Saturday	Sunday
CBD Local Routes									
6	East 6th Avenue / North Pecos	15/30	15/30	30	30	30	4:46a-11:29p	5:42a-11:30p	6:12a-11:04p
8	North Broadway / Huron	30	30	60	60	60	4:57a-10:06p	6:02a-8:04p	8:02p-8:05p
32	West 32nd Avenue / City Park	15/30	15/30	30/60	60	60	5:02a-8:17p	7:05a-8:07p	7:05a-8:07p
38	38th Avenue	15/30	15/30	30	30	30	4:39a-1:51a	4:49a-1:48a	4:49a-1:48a
44	44th Avenue	15	15	30	30	60	4:40a-12:44a	4:52a-12:43a	4:53a-12:43a
52	W 52nd Avenue / South Bannock	15/30	15/30	30	30	60	4:37a-12:14a	4:50a-12:14a	5:55a-8:47p
Urban Local Routes									
31	Federal Blvd	15	15	30	15	30	4:13a-2:04a	4:17a-1:58a	4:17a-2:00a
50	Lakes Crosstown	30	30	30	–	–	5:45a-7:15p	–	–
51	Sheridan Blvd	30	30	30	30	30	4:43a-1:15a	5:15a-1:15a	6:18a-1:15a
76	Wadsworth Blvd	15	15	30	30	60	4:26a-2:00a	5:57a-1:58a	5:56a-2:02a
Suburban Local Routes									
72	72nd Avenue	30	30	30	60	–	5:28a-9:09p	8:39a-6:38p	–
100	Kipling Street	30	30	30	60	–	5:02a-11:13p	6:39a-8:39p	–
Express Routes									
55X	Olde Town Arvada	15	15	–	–	–	6:11a-8:16a / 3:55p-6:17p	–	–
72X	Quaker St. via Ward	30	30	–	–	–	5:22a-8:51a / 3:01p-7:10p	–	–

Northwest Corridor

In the Northwest Corridor, routes generally provide either coordinated or lifeline frequency services as a result of operating at a greater distance from the urban core where population and employment densities are lower and ridership demand is less.

Route 86X provides a spontaneous use 10-minute frequency but only operates during the peak hours, while other Express routes provide service on a per trip basis.

Northwest Corridor Frequency and Span of Service

Table 7 - Current Northwest Corridor Transit Route Network

Route	Description	Weekday Frequency			Weekend Frequency		Span of Service		
		AM Peak	PM Peak	Off-Peak	Saturday	Sunday	Weekday	Saturday	Sunday
Urban Local Routes									
31	Federal Blvd	15/30	15/30	15/30	15/60	30/60	4:13a-2:04a	4:17a-1:58a	4:16a-1:14a
Suburban Local Routes									
72	72nd Avenue	30	30	30	60	–	5:28a-9:09p	8:39a-6:38p	–
80	80th Avenue	60	60	60	–	–	5:47a-7:10p	–	–
92	92nd Avenue	30	30	30	30	60	4:52a-11:14p	7:15a-11:12p	8:14a-8:12p
100	Kipling Street	30	30	30	60	–	5:02a-11:13p	6:39a-8:39p	–
104	West 104th Avenue	60	60	60	–	–	5:50a-7:43p	–	–
Express Routes									
31X	North Federal Express	3 trips	3 trips	–	–	–	5:54a-7:36a / 4:15p-5:55p	–	–
40X	North Colorado Express	4 trips	4 trips	–	–	–	5:54a-8:20a / 3:47p-5:57p	–	–
80X	West 80th Express	2 trips	2 trips	–	–	–	6:18a-7:35a / 4:57p-6:10p	–	–
86X	Westminster Center Express	10 min	10 min	–	–	–	6:10a-9:16a / 3:49p-7:19p	–	–

Span

Span of service in the RTD network often varies by service class and is based on service policy and ridership demand. A wider service span gives passengers greater flexibility when planning their trips and encourages ridership at different hours of the day to meet varying passenger needs, but conversely increases cost.

- CBD Local and Urban Local routes typically begin weekday service between 4:00 AM to 5:00 AM. The end of service, however, varies greatly with some routes ending service around 8:00 PM and others ending service at 2:00 AM the next day.
- Suburban Local routes typically begin weekday service between 5:00 AM and 6:00 AM with service ending between 7:00 PM and 11:00 PM.
- Express routes provide peak-only service typically between 6:00 AM and 9:00 AM and again at 3:00 PM to 7:00 PM to meet the demand of commuters traveling to and from large employment centers.

The Gold Line Corridor is served primarily by CBD and Urban Local routes with greater frequencies and spans. The corridor is intersected with Routes 31, 51, 76, and 100 which travel north-south and provide service along the major arterial roads of Federal Boulevard, Sheridan Boulevard, Wadsworth Boulevard, and Kipling Street. None of these routes serve downtown Denver but they do connect with the West Rail Line further south of the G-Line. The Gold Line corridor is also served by two Express routes, 55X and 72X, operating on Interstate 70, which do provide service to downtown Denver from the Olde Town Arvada and Ward Road Park-n-Ride facilities. These routes have 15 to 30 minute frequencies during the peak periods and 30 to 60 minute frequencies in the off-peak periods. They serve primarily as commute supply for workers travelling to downtown Denver.

The Northwest Corridor is served predominately by Suburban Local routes and Express routes. Express routes operating on US Highway 36 and Interstate 25 provide peak-only service to and from downtown Denver. Suburban Local routes in this corridor typically operate at frequencies of 30 or 60 minutes throughout the day. This corridor is also served by Urban Local Route 31 which travels on Federal Blvd. and serves the US 36/Sheridan BRT Station.

Performance

Route performance is essential in developing appropriate service plan recommendations as resources need to be invested to optimize performance and maximize ridership. Performance is measured in productivity; how efficient the service is provided in regards to expenditure and how effective the service is at accomplishing its intended objectives. Productivity increases as market demand begins to match the current supply of service and productivity decreases when the supply of service exceeds the market demand. Although the market for transit cannot be controlled[4], poor market conditions can be mitigated through service and network design choices. Matching transit service levels, including frequency and span, with the transit market demand is one way to strengthen service productivity.

RTD Service Class Service Standards

[4] RTD through collaboration with its member cities and counties can support changes that influence mobility choice. For instance, current RTD support of sustainable community Smart Growth initiatives that foster transit oriented development develop "transit lifestyle" markets where transit, biking, and walking play stronger roles in public mobility.

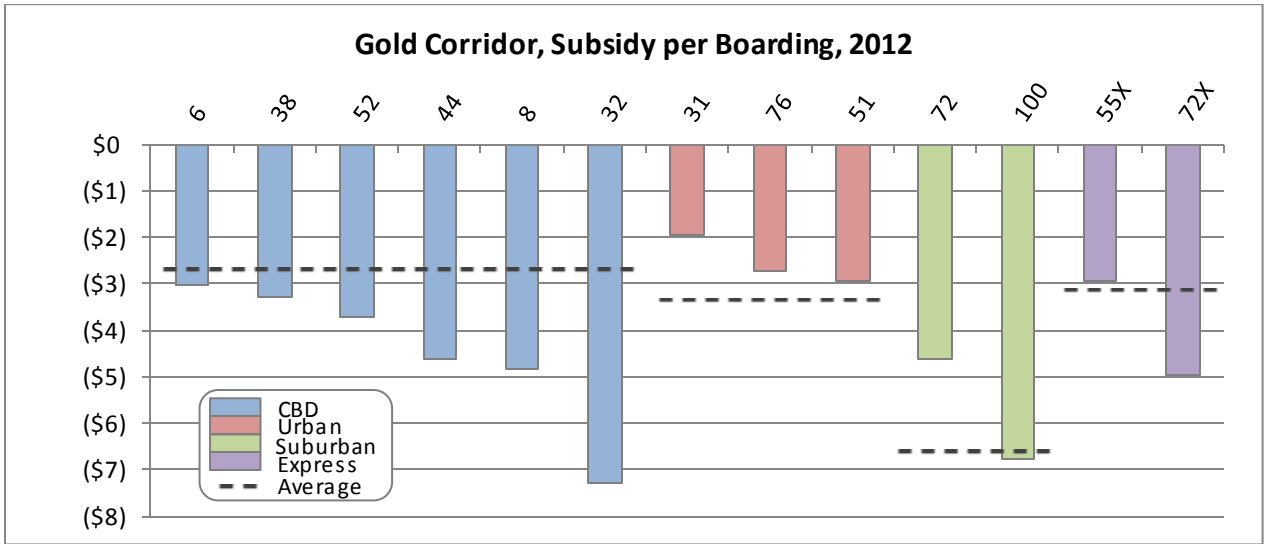
Table 8 - RTD Service Standards

Service Class	Subsidy per Boarding		Boardings per Revenue Hour	
	Average	10% Cutoff[5]	Average	10% Cutoff
CBD Local	($2.88)	($5.31)	34.6	23.55
Urban Local	($3.27)	(8.21)	29.5	19.17
Suburban Local	($6.61)	($11.76)	17.7	10.77
Express	($3.11)	($7.06)	47.8	13.13

Subsidy per Boarding

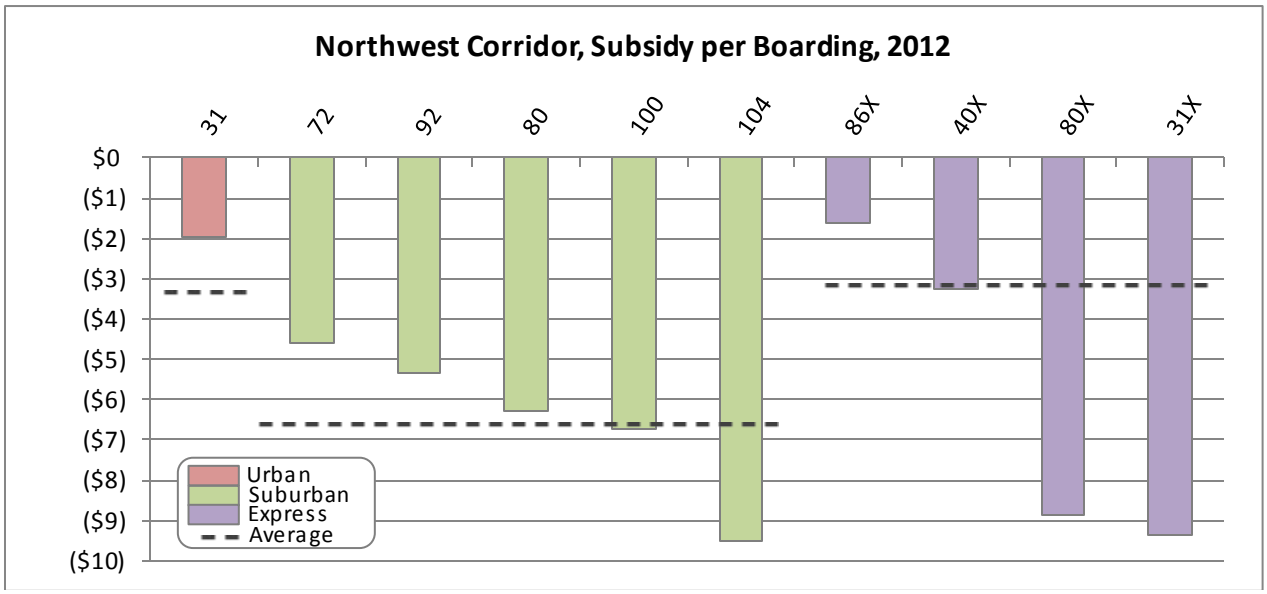
RTD conducts an annual route review using performance indicators such as subsidy per boarding. The subsidy per boarding measurement determines the portion of the operating cost, after subtracting fare revenues, that RTD pays on a per passenger boarding basis. Routes with a higher subsidy per boarding cost more to operate and therefore, perform worse than routes with a lower subsidy per boarding. Potential methods to improve subsidy per boarding include lowering operating costs by reducing route frequency and span. This will decrease the number of buses, drivers, pay hours, and service miles required to operate a route but can also reduce ridership. Another method to improve subsidy per boarding is to increase ridership and revenue through route realignment, route consolidation, or route deviation. Additional ridership and revenue can also be generated by marketing the service, improving operating characteristics such as on-time-performance, safety, reliability, and route network integration with other transit services. Improvements in scheduling can often result in reduced operating costs, improved service efficiency and reliability.

Figure 5- Gold Corridor Bus Routes, Subsidy per Boarding, 2012



[5] Based on RTD Service Standards, the bottom 10% performing routes by each service class are evaluated for possible consolidation, realignment or improved marketing.

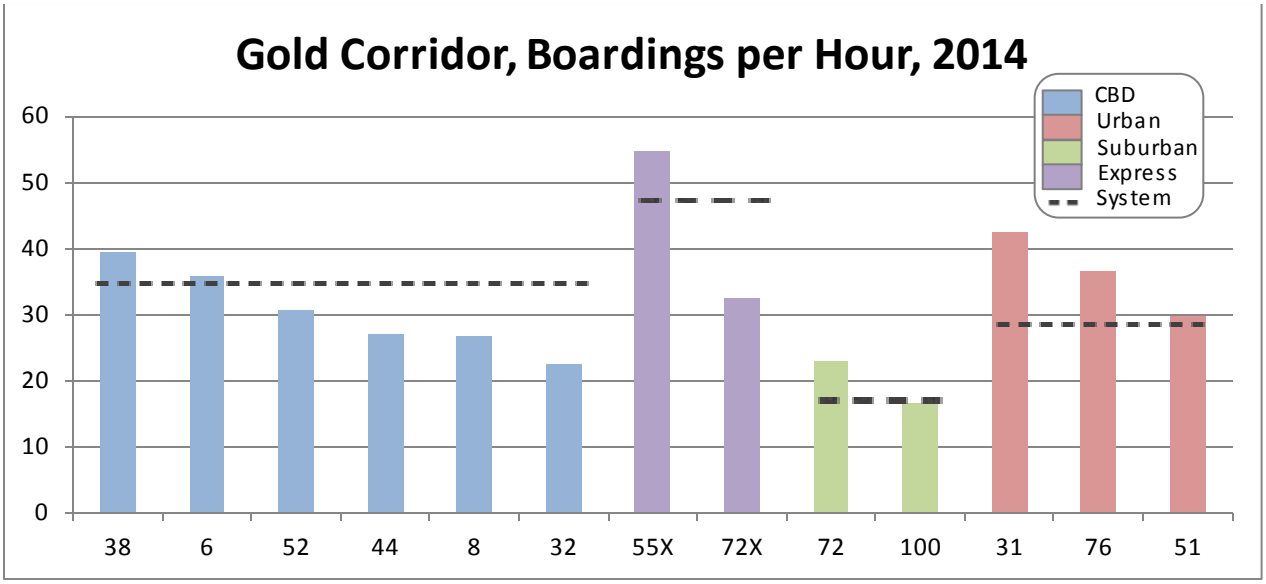
Figure 6 - Northwest Corrdor Bus Routes, Subsidy perBoarding 2012



Boardings per Hour

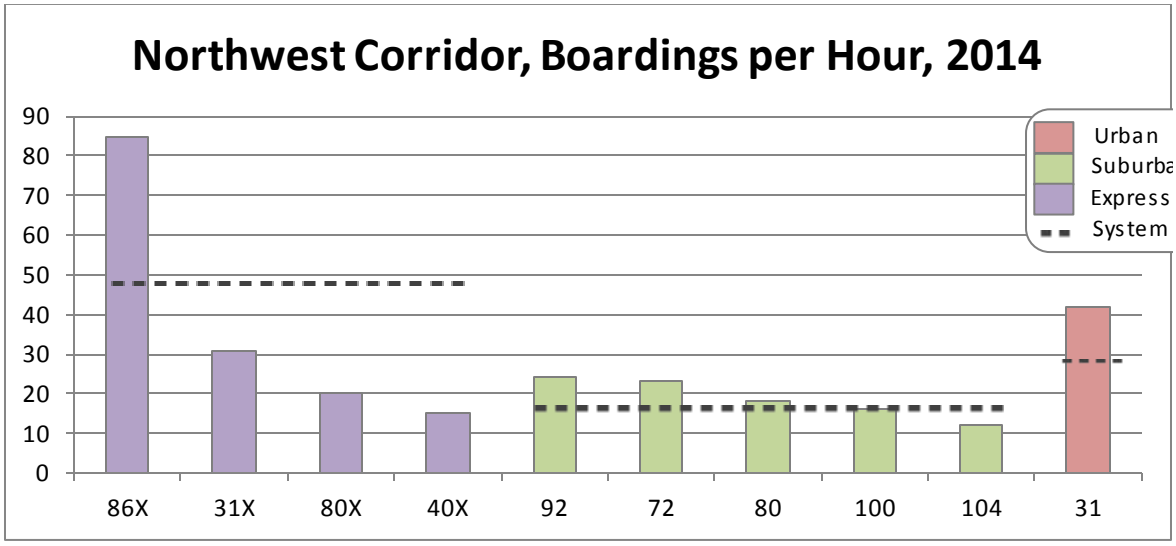
RTD also uses the boardings per revenue hour metric to measure route performance. The boardings per revenue hour calculation measures the average number of passenger boardings per hour of revenue service. Routes that generate higher boardings per hour represent more productive routes where market demand (boardings) is balanced with the supply of service (revenue hours). If demand increases, but supply remains the same, then productivity will increase. If supply increases, but demand remains the same, then productivity will decrease. By balancing the supply of service with the market demand, transit providers can generate the greatest return on their investment by reducing operating costs and associated subsidies – RTD has service standards policies that address both high and low performing routes. Following is service productivity for bus routes within the Gold Line and Northwest Line corridors.

Figure 7 - Gold Corridor Bus Routes, Boardings per Hours, 2014



Within the Gold Line Corridor, CBD Local bus routes have below average boardings per revenue hour of service. The CBD Local transit routes average 42 boardings per hour in the entire RTD Service Area, while CBD Local buses average only 31 boardings per hour in the Gold Line Corridor. Route 32 is the worst performing CBD Local line in the study area with just 23 boardings per revenue hour. Route 32 travels south of the Gold Rail Line primarily in low density residential neighborhoods. The Express services within the Gold Corridor also underperform compared to the RTD average. While the 55X Express line performs well with 55 boardings per hour, the 72X Express Line only has 33 boardings per hour. The RTD system wide average for an Express line is 54 boardings per hour. The variance between the two lines may have to do with the fact that the 55X line is mostly express and has a short spur into Olde Towne Arvada as a local route whereas the 72X line has a longer spur into residential and commercial neighborhoods Arvada which would decrease route productivity. The Urban Local and Suburban Local routes in the Gold Line Corridor are more in line with the averages for overall service area.

Figure 8 - Northwest Corridor Bus Routes, Boardings per Hours, 2014



Within the Northwest Corridor, the Express lines and Suburban Local lines have about average productivity for their service type in the region while the Urban Local Route 31 performs above the RTD average for Urban Local services. There is significant variation between the Express lines in the corridor however. For example, the 86X Express line which travels from Sheridan/US-36 in Westminster to DUS has an average of 85 boardings per revenue hour which is much higher than the system-wide average of 54 boardings per revenue hour for Express services. This is likely due to the 86X Express line having very little locally running service (park-n-rider access) while the 31X, 40X, and 80X all have significant local walk-up access which would bring down their averages.[6]

Farebox Recovery

Farebox recovery is the ratio of fare revenue to operating costs. It indicates the percentage of operating costs covered by passenger boarding revenue. The higher the farebox recovery, the lower the subsidy a route requires to operate, leaving more funding available to operate more service. Routes with a high farebox recovery ratio have the greatest share of the operating cost paid by passengers. Express routes represent the most productive service class in terms of farebox recovery in this category due to the strong ridership, higher fare of $4.00 instead of the local fare of $2.25, and focused operating costs as a result of providing peak-only service. Farebox recovery for the entire RTD system was 23.8% in 2012.

[6] RTD conducted a test over a decade ago regarding whether park-n-ride or community walk-up access would provide better mobility and attract more riders, more productively. The test conclusively found that park-n-ride express service performed significantly better than the local running alternative and could deliver more service for the same operating cost.

Table 9 - RTD Average Farebox Recovery by Service Class

Service Class	Average Farebox Recovery
CBD Local	27.1%
Urban Local	25.6%
Suburban Local	14.7%
Express	44.6%

Figure 9- Gold Corridor Bus Routes, Farebox Recovery 2012

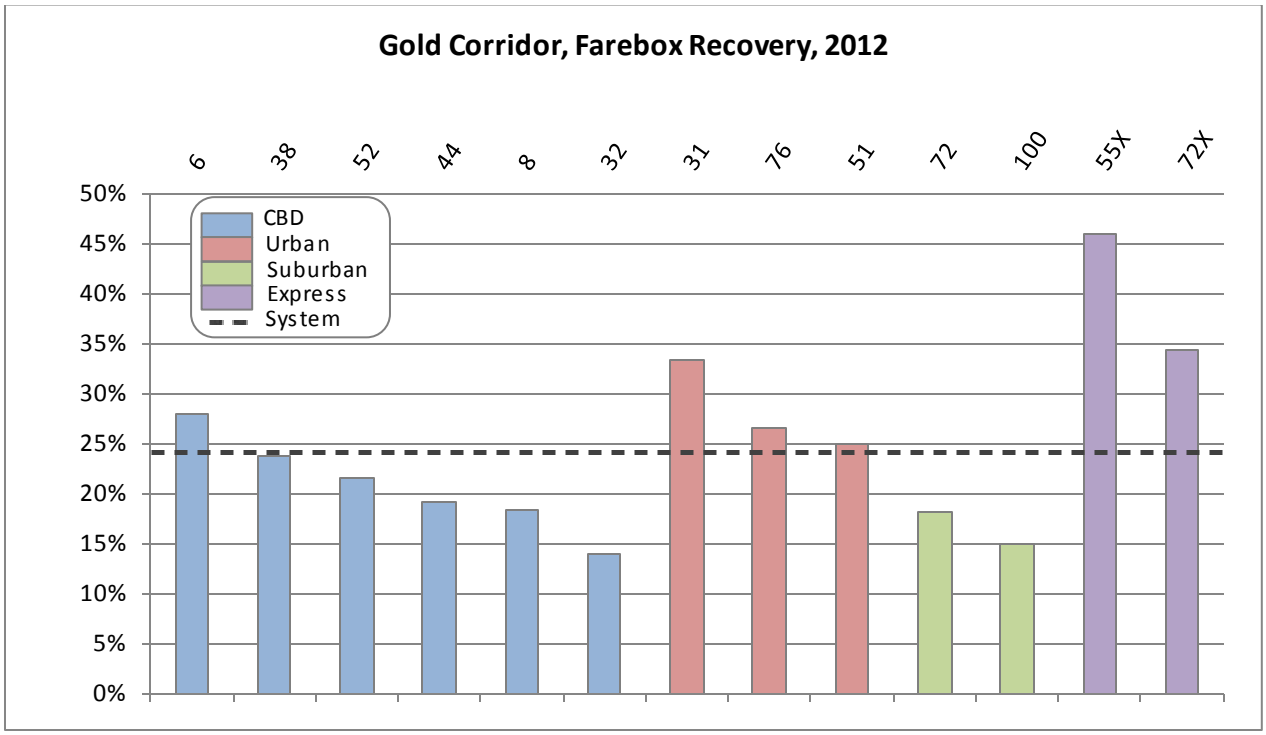
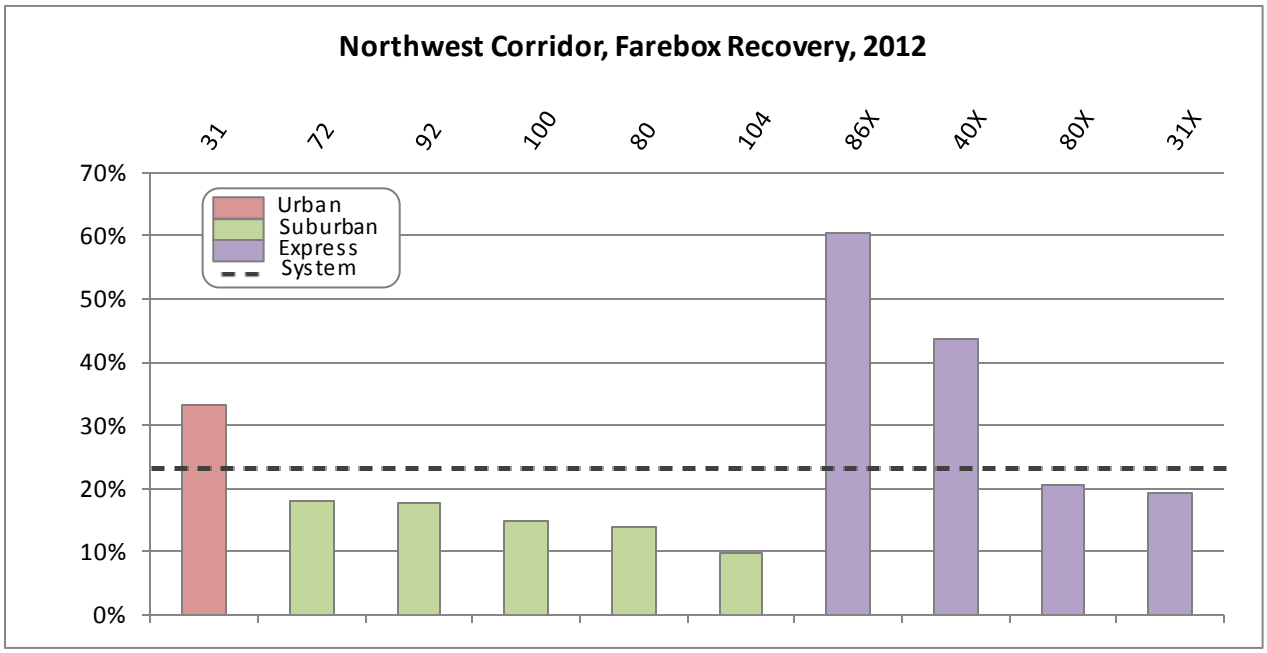


Figure 10- Northwest Corridor Bus Routes, Farebox Recovery 2012



Productivity Analysis

CBD Local and Express routes generate the best performance statistics due to the number of people carried on these services. The performance of Urban Local routes is next, while Suburban Local routes generate the weakest performance of all the route types. Identifying which routes are the most costly to run can help result in a more efficient allocation of resources. Routes with strong financial effectiveness are candidates for additional investment, while routes with weak financial effectiveness may be candidates for service reduction or realignment.

RTD service standards state "the least productive 10% of routes based on either subsidy per boarding or boardings per revenue hour need to be evaluated for marketing, revision, or elimination." These are noted below in Red.

Gold Rail Line Corridor

Table 10 - Gold Line Corridor Bus Route Performance Metrics

Route	Subsidy per Boarding		Boardings per Hour	
	Average	10% Cutoff	Average	10% Cutoff
CBD Local Routes				
6	($3.03)	($5.31)	35.84	23.55
8	($4.83)	($5.31)	26.82	23.55
32	($7.26)	($5.31)	22.63	23.55
38	($3.30)	($5.31)	39.37	23.55
44	($4.62)	($5.31)	27.05	23.55
52	($3.71)	($5.31)	30.72	23.55
Urban Local Routes				
31	($1.96)	($8.21)	42.37	19.17
51	($2.95)	($8.21)	29.82	19.17
76	($2.74)	($8.21)	36.50	19.17
Suburban Local Routes				
72	($4.60)	($11.76)	22.87	10.77
100	($6.75)	($11.76)	16.41	10.77
Express Routes				
55X	($2.95)	($7.06)	54.62	13.13
72X	($4.96)	($7.06)	32.53	13.13

Northwest Rail Line Corridor

Table 11 - Northwest Corridor Bus Route Performance Metrics

Route	Subsidy per Boarding		Boardings per Hour	
	Average	10% Cutoff	Average	10% Cutoff
Urban Local Routes				
31	($1.96)	($8.21)	42.37	19.17
Suburban Local Routes				
72	($4.60)	($9.30)	22.87	10.77
80	($6.30)	($9.30)	18.10	10.77
92	($5.34)	($9.30)	24.02	10.77
100	($6.75)	($9.30)	16.41	10.77
104	($9.49)	($9.30)	11.57	10.77
Express Routes				
31X	($9.38)	($7.06)	30.79	13.13
40X	($3.24)	($7.06)	15.31	13.13
80X	($8.89)	($7.06)	19.71	13.13
86X	($1.63)	($7.06)	85.00	13.13

Gold Corridor Route Performance

The Gold Corridor is primarily served by CBD Local and Urban Local routes, which are typically more productive due to their high frequencies and strong ridership. In the corridor, Routes 6, 31, 38, 76, 51, 52, and 55X each have a subsidy per boarding of less than $4.00. The system wide subsidy per boarding is $3.31 for Year 2012. Routes 32, 100, and 72X require a subsidy greater than the group average. Routes 32 and 100 exceed $6.00 subsidy per boarding and will require further analysis. All routes generate more than 15 boardings per hour.

Of all the routes in the Gold Corridor, only Route 32 fails the subsidy per boarding 10% service class standard. Route 32 currently operates on a 15 minute peak frequency and a 30-minute off-peak frequency and serves downtown Denver and the VA Medical Center located east of downtown. This medical center is expected to be replaced by a new VA Hospital in Aurora in May 2015. When this happens, this route's performance is expected to decline further requiring additional marketing, revision, or elimination.

Northwest Corridor Route Performance

The Northwest Corridor is served mainly by Suburban and Express routes, which often require a greater subsidy to operate. Five routes exceed the $6.00 subsidy per boarding figure compared to two in the Gold Corridor. The higher subsidies are a result of the less productive suburban market ridership as compared with Urban Local routes. All Suburban routes in this corridor exceed 10 boardings per hour with the exception of Route 104, and all Express routes exceed 20 boardings per hour.

Of all the routes in the Northwest Corridor, only Routes 31X and 80X fail the subsidy per boarding 10% service class standard. Route 31X operates express from downtown Denver to the 70th & Broadway Park-n-Ride, with service continuing on to Federal Blvd. Service operates weekday only with three AM trips and three PM trips. Route 80X operates express from downtown Denver to West 80th Ave. Service operates weekday only with two AM trips and two PM trips.

5 Gold and Northwest Corridor Service Plan

Building upon RTD's significant investments in transit, the addition of rail service in the Gold and Northwest corridors is another major step forward in developing a comprehensive and seamless transit network for the people of the greater Denver area. However, rail service is only part of the overall transit improvements envisioned for these corridors. The bus network which carries the vast majority of transit riders was evaluated and recommendations were made to complement the additional rail service with direct and convenient access to the new rail stations. Recommendations were also made to the bus network to enhance intra-corridor mobility and to strengthen connectivity to urban and suburban regional destinations while improving operational efficiency and the rider's experience.

Plan Framework and Strategies

To fully ensure that the transit network makes the most effective use of limited operating resources, it was imperative that the recommendations were congruent with RTD's vision for a regionally integrated transit network that will improve mobility, enhance economic competitiveness, reduce congestion and pollution, and will ultimately retain existing riders while continuing to attract new ones. The service recommendations not only focus on enhancing operating efficiency and improving transit network effectiveness, but also aim to make transit the region's mode of choice.

The Existing Conditions findings from the ridership analysis, service performance, and market conditions also informed the development of guiding principles which served as the framework for the service plan. The framework and strategies guided the development of the plan recommendations from both a "top-down" network-level perspective as well as a route-level "bottom-up" perspective.

Network Design Strategies

Transit system success is built over a network, not by individual bus route or rail line. The critical goal for the Gold and Northwest Corridor Service Plan is to build a simple, easy-to-use network that is comprised of a family of bus and rail service tiers, all focusing on delivering the overall network experience desired by existing and potential customers.

Leverage Rail Investment

RTD has made a significant investment in new rail alignments to improve regional mobility. These investments will help shape land use patterns, enhance the competitive advantage of the region, reduce congestion and pollution, and improve the livability and vibrancy of the area. However, new rail infrastructure alone can't accomplish these goals. Investments in rail infrastructure must be leveraged and seamlessly integrated into RTD's larger network of transit services. By serving as the transit corridor backbones, rail service offers several advantages over other modes of travel to include larger carrying capacities, and faster and more reliable service. To leverage these advantages, many of the adjacent or intersecting bus routes were realigned to serve the new rail stations, resources of duplicative bus service were reallocated, and bus route alignment changes were made to refocus network coverage. Through these

actions, an integrated transit network is proposed that will attract riders, reduce operating costs, and strengthen regional and community mobility.

Strengthen Bus Service Tiers

RTD has a number of bus tiers which are defined by their target markets and service characteristics. The Gold and Northwest Corridor Service Plan further differentiates the network and corridor target markets between "transit lifestyle" and "coverage" markets. Service designed for sustainable lifestyle consumers focuses on spontaneous-use frequencies of 10-15 minutes throughout the day and week that allow consumers to walk-up and catch the next trip without planning their arrival at the stop. These spontaneous use corridors will form the top tier of arterial bus transit and are good candidates for future infrastructure investment to enhance the wait (upgraded stops) and travel experience (reduced delay; improved reliability) for customers.

Lifestyle areas require development densities high enough to sustain these service levels productively (meeting RTD standards) together with community orientation that facilitates transit, walking, and biking active mobility. Coverage transit markets are those where densities and community design are focused on automobile travel, which makes significant transit mode penetration not possible and/or cost-effective. The proposed plan focuses increased service frequency investment to network areas and corridors that support lifestyle transit while tailoring transit options for coverage service areas.

Route Spacing and Prioritization

Where multiple routes operate along shared or parallel corridors, route consolidation or prioritizing was evaluated in order to create a more robust transit service with greater frequency that adds value to riders and supports spontaneous network use. Routes operating along the same or adjacent corridors usually compete for the same riders, reducing the effectiveness and increasing the net cost of service of each route. By consolidating or prioritizing routes, limited resources can be reinvested within the transit network to provide more direct, faster, and reliable service. For example, instead of operating three 20 minute service routes in parallel, the plan looks to operate one at 10 or 15 minutes with the other two at 30 or 60 minutes.[7] In many instances, the middle route operates on a major arterial and can be a candidate for infrastructure enhancement to reduce delay and improve the customer experience - this investment has more ridership and performance return on streamlined corridors with higher service levels.

Alternative First/Last Mile Transit

In most cases, network transit mobility is best served using regular fixed route bus service. In some cases where the mobility needs are more limited (e.g., work or school commuting; senior mobility) or where development intensity is too low to productively support regular fixed route bus service, alternative mobility options are appropriate. The Gold and Northwest Corridor Service Plan considered more cost-effective

[7] Research in many cities has documented that corridor prioritizing generates more overall ridership for the same resource cost because more consumers are attracted. They walk further to better bus transit with the average access for basic local bus at ¼ mile (80% of riders) while for enhanced frequent bus this walk shed increases to ½ mile attracting more riders.

alternatives in such instances including Call-n-Rides, station-based vanpools or car-sharing, home-to-work vanpools, or private shuttles. Existing express services should be reconfigured as first-mile connectors to the nearest rail station where current ridership is low or where the rail connection offers improved service frequency and/or travel time. RTD should consider remote PnRs rather than walk-up access to improve performance of these first-mile replacement services.

Route Design Strategies

To fully ensure that the transit network makes the most effective use of its operating resources, it is important to ensure that not only is there a coherent vision for a complete transit network, but that individual routes can attract ridership as well. The following route design strategies focus not only maintaining high operating efficiency, but providing an improved customer experience that will attract more riders and operating revenue, thus improving effectiveness as well.

Route Streamlining

Deviating routes from the main transit corridors reduces the walking distance and makes transit more attractive to small numbers of riders but makes it significantly less attractive to large numbers of riders using the main corridor. The result is fewer total riders at higher operating cost.[8] The Gold and Northwest Corridor Service Plan calls for limiting deviations to just areas that can justify the additional travel time and costs by high ridership on the deviation – areas such as rail stations, transit hubs, and major destinations in order make individual routes, as well as the transit network, more productive and attractive to riders. In cases where the deviation was providing needed lifeline coverage, alternative service was proposed while also proposing streamlined corridor bus transit.

Short-Lining

Routes often vary in terms of ridership and performance along the length of their alignments. Generally, areas with higher population and employment densities generate more ridership than areas with lower densities. For example, Route 76 serves the Wadsworth Boulevard corridor where ridership is much stronger between the Olde Town Arvada and Lakewood City Commons. Cost-effective short-lining has been proposed in such instances using either an interior short-list (long-line running the full length with the short-line between Olde Town and Lakewood) or a pattern overlap (north terminal to Lakewood and south terminal to Olde Town) depending on the off-peak ridership pattern and customer through-riding.

Stop Consolidation

One of the greatest sources of operating delay and on-time performance impacts is dwell time at bus stops. While closely-spaced bus stops increase the ease in which riders can access the transit system that convenience comes at the expense of operating speed and service reliability. Closely spaced stops not only impact route

[8] RTD's out-of-direction standard calls for deviations to have less than 3 minutes increased travel time impact to through-passengers for each rider served on the deviation to avoid total route ridership loss. Also, deviations typically cost more to operate due to increased mileage and slower off-route operating speeds.

performance, increase stop maintenance costs, and accelerate bus maintenance costs, but they can significantly reduce the competitiveness of the service. By finding an optimal balance of stop spacing to maintain convenient access to transit service while reducing potential for delay, the efficiency and effectiveness of transit can be increased significantly. While stop consolidation is not proposed per se as part of the Gold and Northwest Corridor Service Plan, it is recommended that RTD continue is stop consolidation program throughout the bus network.

Corridor Segment Consolidation

In some instances where multiple routes serve the same corridor at different points, it is more intuitive for the customer to have one streamlined route that serves the corridor continuously. If general travel patterns on the corridor show a higher degree of through travel relative to local mobility, routes that link complimentary origins and destinations together were consolidated to increase rider convenience by eliminating or reducing transfers required to complete their trip along a natural transit corridor. In some cases this results in restructuring the corridor into routes with consistent roles: one is streamlined to serve the main arterial with frequent service while one or more are designed to serve the neighborhood interior with less direct service where walk access to the main corridor is not feasible.

Route Segmentation

In contrast to the segment consolidation strategy, where routes exhibited a very high proportion of rider transfer activity at a single point, the benefits of separating those routes into two distinct routes at that point to improve schedule adherence or scheduling efficiency were evaluated. This was primarily due to the low number of riders remaining on the bus and traveling through the point in question. These actions also resulted in routes with more balanced service levels on either side of this midpoint based on demand.

Low Performing Service Replacement

If a route or route segment performed poorly and the potential to improve performance appeared to be limited within the existing configuration, then alternatives to fixed route service were considered. These alternative mobility options included Call-n-Rides, special shuttles (destination), service routes (tailored for specific trip-making, e.g., seniors), or commute oriented programs (e.g., station vans, car/bike sharing). These options maintain service coverage mobility while reducing RTD's net subsidy.

5.1 Gold and Northwest Bus Service Recommendations

Service recommendations were informed by previous Gold and Northwest Corridor planning efforts and additional market and service analyses conducted as part of this study. The following recommendations follow the network and route design principles discussed above and were developed to enhance mobility in both corridors upon the opening of the Gold and Northwest rail lines.

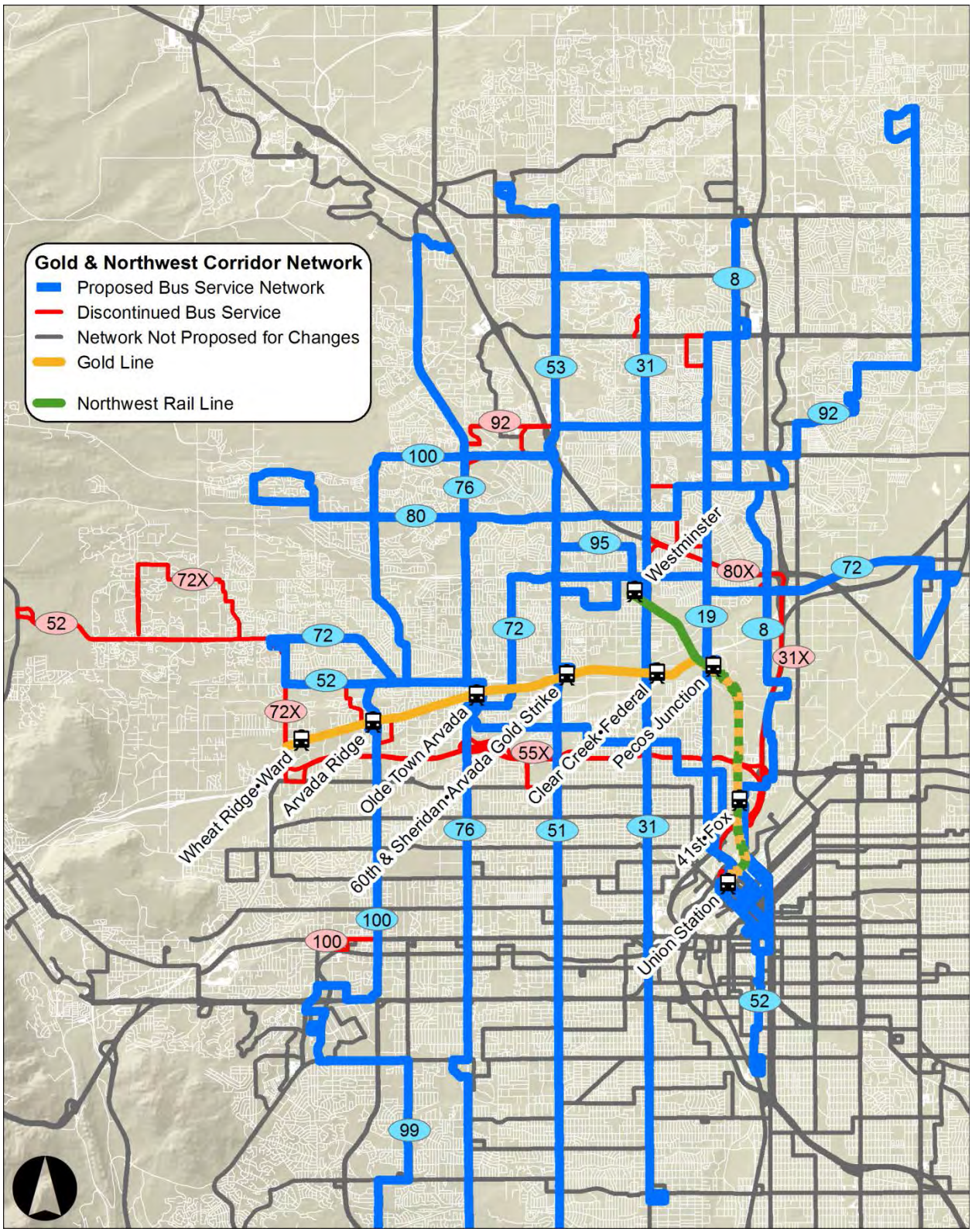
Proposed service frequencies are provided in the table below. Route recommendations are organized by primary cardinal direction (north-south and east-west). The key findings from the market and service analyses are presented together with the specific route alignment, schedule, and operating recommendations.

Table 12 - Proposed Gold and Northwest Corridor Bus Service Levels

Proposed Gold & Northwest Corridor Bus Service Levels								
Route	Route Name	Weekday			Saturday		Sunday	
		Frequency		Span of Service	Frequency	Span of Service	Frequency	Span of Service
		Peak	Off-Peak					
8	North Broadway/ Huron	30	30	5:00-22:00	60	6:00-20:00	60	8:00-20:00
19	North Pecos	30	30	5:00-23:30	60	5:00-23:30	60	8:00-20:00
31	Federal Boulevard	15/30	15/30	4:00-26:00	15/30	4:30-26:00	15/30	4:30-26:00
51	Sheridan Boulevard	15/30	15/30	4:30-25:30	30	5:30-25:00	30	6:30-25:00
52	52nd Avenue/ South Bannock	15/30	30	4:30-24:30	30	5:00-24:30	60	6:00-21:00
53	North Sheridan Boulevard	30	60	6:00-19:00	-	-	-	-
72	72nd Avenue	30	30	5:30-21:00	60	8:30-18:30	-	-
76	Wadsworth Boulevard	15/30	15/30	4:30-26:00	30	6:00-26:00	30/60	6:00-26:00
80	80th Avenue	30	60	5:30-19:30	-	-	-	-
92	92nd Avenue	30	30	5:00-23:30	30	7:00-23:00	60	8:00-20:00
95	South Westminster	30	30	6:00-19:00	-	-	-	-
99	South Kipling Street	30	30	5:30-21:30	60	7:30-20:00	-	-
100	Kipling Street	30	30	5:00-23:30	60	6:30-20:00	-	-

Multiple frequencies in one cell indicate route with shorth and long service patterns with more frequent service on the trunk portion

Map 10- Service Plan Recommended Network Map



With commuter rail serving as the structural spine of the Gold Line and Northwest Rail corridors, connecting north-south routes will provide the underlying support network for the collection and distribution of rail riders through these communities. The performance of the Gold Line and Northwest Rail Line will be directly related to the effectiveness of these intersecting bus routes; as such, the plan utilizes the following service design strategies to ensure strong north-south connections:

- Improve service headhways to foster spontaneous-use travel and improve frequent grid transfer connections to commuter rail service.
- Improve midday service levels to provide additional spontaneous use of transit for all-day trip purposes.
- Transition any east-west route segments to new commuter rail trips where appropriate.

Once completed, the Gold Line will attract the majority of east-west line haul travel into Downtown Denver, deemphasizing the need for high capacity east-west bus routes in the Gold Line and Northwest Rail Corridors. As line haul travel transitions to commuter rail service, east-west bus routes in the Gold Line and Northwest Rail Corridors will function primarily for local trip needs and network completion.

Route 8 – North Broadway/Huron

- Deviate route to serve the new 41st/Fox Station on the Gold Line.
- Eliminate out of direction travel by eliminating deviations to 70th & Broadway Park-n-Ride.
- Increase service to 30 minute frequencies weekday middays.

Route 19 – North Pecos (formerly Route 6)

- Route 6 is proposed to be split into two routes in January 2016. Route 19 will be the new designation for the portion between Downtown Denver and 106th & Melody Transfer Center.
- Deviate from Pecos Street to serve the Pecos Junction station.
- Eliminate out of direction travel to Ura Lane.
- Reroute service to operate on Pecos Street between 33rd Avenue and 46th Avenue.
- Establish southern terminal location in the vicinity of the Colorado Convention Center at 13th/Welton.

Route 31 – Federal Boulevard & Route 31X – North Federal Express

- Operate two service patterns: one terminating at the Westminster Station and another continuing to Front Range Community College.
- Provide service every 15 minutes between 71st Avenue (Westminster (Rail) Station) and Federal/Evans and every 30 minutes between 71st Avenue and Front Range Community College.
- Deviate from Federal Boulevard to serve Clear Creek-Federal Station.
- Discontinue service to US 36 & Sheridan Station. Alternative service proposed on new Route 95.
- Discontinue Route 31X with alternative service provided by Routes 19, 31, 72, and 80 connecting to the Gold Line, Northwest Rail Line, and Thornton Park-n-Ride.

- Close 70th & Broadway Park-n-Ride.

Route 51 – Sheridan Boulevard & Route 50 – Lakes Crosstown

- Merge Routes 50 and 51 between 44th Avenue and Dartmouth Avenue, retaining Route 51 designation. Discontinue portion of Route 50 between Sheridan Boulevard and Olde Town Arvada Park-n-Ride.
- Increase weekday service on Route 51 to every 15 minutes between 60th & Sheridan-Arvada Gold Strike Station and Sheridan/Dartmouth.
- Deviate from Sheridan Boulevard to serve 60th & Sheridan-Arvada Gold Strike Station.
- Discontinue Route 51 service north of US 36 & Sheridan Station; to be replaced with a new Route 53.
- Discontinue deviation to Harlan Street between 44th and 48th Avenues.
- Discontinue deviation around the former Westminster Mall.

Route 52 – West 52nd Avenue/South Bannock

- Discontinue service west of Ward Rd to Hwy 93.

Route 53 – North Sheridan Boulevard – New Route

- New service proposed on the alignment previously served by Route 51 north of US 36 & Sheridan Station.
- Proposed 30 minute peak frequency, 60 minute off-peak. No weekend service.

Route 55X – Olde Town Arvada Express

- Discontinue service; alternative service provided by Gold Line commuter rail.

Route 72 – 72nd Avenue

- Deviate from 72nd Avenue to serve Westminster (Rail) Station
- Discontinue deviation to 70th & Broadway Park-n-Ride remaining on 70th Avenue at this location.
- Retain two weekday Route 72W trips in each direction, one each direction for school start and end time at Westminster High School. Remaining trips would all be Route 72.

Route 72X – Quaker Street via Ward Express

- Discontinue service; alternative service provided by Gold Line commuter rail.

Route 76 – Wadsworth Boulevard

- Provide weekday 15 minute frequency between Lakewood Commons and Olde Town Arvada Station.
- Discontinue Vance Street deviation near Lakewood Commons.
- Extend existing peak hour trips to Southwest Plaza from current terminal at Wadsworth & Hampden Park-n-Ride to provide 15 minute peak hour service between Southwest Plaza and Olde Town Arvada.

Route 80 – 80th Avenue & Route 80X – West 80th Express

- Discontinue service on Route 80X.

- Provide two-peak hour, peak-direction trips on Route 80 between Simms Street and US 36 & Sheridan Station.

Route 92 – 92nd Avenue
- Discontinue service west of Sheridan Boulevard; alternative service available on Route 100.

Route 95 – South Westminster – New Route
- New service proposed on the alignment of the Route 31 branch between Westminster (Rail) Station and US36 & Sheridan Station. Would not service former Westminster Mall loop.
- Proposed 30 minute weekday service. No weekend service.

Route 99 – South Kipling Street – New Route
- New service proposed on the alignment previously served by Route 100 south of Federal Center Station.
- Maintain existing Route 100 span of service and frequency.

Route 100 – Kipling Street
- Split Route 100 into two routes at Federal Center Station. Northern portion to be Route 100, southern portion to be Route 99.
- Deviate from Kipling Street to serve Arvada Ridge Station.
- Discontinue out of direction travel to Ridge Road by remaining on Kipling Street.
- Discontinue out of direction travel to Oak Station by remaining on Kipling Street.

5.2 Resource Impacts

These recommendations encompass 318,000 annual revenue hours, 4.6 million annual revenue miles and 87 peak buses. Tables 13 and 14 summarize the existing and proposed resource impacts of the Gold and Northwest Corridor Bus Service Plan.
The plan includes notable changes in RTD bus operations:
- An increase of 11,200 annual service hours, representing a 3 percent increase.
- An increase of 38,000 annual service miles, representing a 1 percent increase.
- An increase of 3,400 Saturday annual service hours, representing a 9 percent increase.
- An increase of 2,700 Sunday annual service hours, representing a 12 percent increase.
- An increase in overall weekday service hours, but a decrease in the peak bus requirement due to the elimination of peak hour express services with high resource requirements.

Table 13 - Existing Gold and Northwest Corridor Bus Service Requirements

Existing Gold & Northwest Corridor Bus Service Resources										
Route	Description	Hours			Miles			Peak Buses		
		Wk	Sa	Su	Wk	Sa	Su	Wk	Sa	Su
8	North Broadway /Huron	66	27	23	799	403	343	7	3	2
19*	E 6th Avenue/ North Pecos	99	42	35	1,135	426	363	6	3	3
31	Federal Boulevard	208	151	117	2,497	1,840	1,444	13	11	8
31X	North Federal Express	7	-	-	79	-	-	2	-	-
50	Lakes Crosstown	63	-	-	593	-	-	5	-	-
51	Sheridan Boulevard	142	100	78	1,869	1,285	927	9	7	6
52	52nd Avenue/South Bannock	123	88	42	1,310	992	477	11	6	6
55X	Olde Town Arvada Express	12	-	-	135	-	-	4	-	-
72	72nd Avenue	69	20	-	987	318	-	5	2	-
72X	Quaker Street via Ward Express	26	-	-	305	-	-	5	-	-
76	Wadsworth Boulevard	147	104	50	1,998	1,414	725	12	7	4
80	80th Avenue	14	-	-	200	-	-	1	-	-
80X	West 80th Express	4	-	-	69	-	-	2	-	-
92	92nd Avenue	75	59	22	1,065	857	371	5	5	2
100	Kipling Street	121	50	-	1,810	770	-	8	4	-

*Resources for Route 19 reflect splitting Route 6 prior to corridor opening.

Table 14 - Proposed Gold and Northwest Corridor Bus Service Requirements

Proposed Gold & Northwest Corridor Bus Service Resources										
Route	Description	Hours			Miles			Peak Buses		
		Wk	Sa	Su	Wk	Sa	Su	Wk	Sa	Su
8	North Broadway/Huron	99	42	35	1,135	426	363	6	3	3
19	North Pecos	75	50	36	772	328	316	6	3	3
31	Federal Boulevard	165	153	136	2,063	1,948	1,719	10	10	10
51	Sheridan Boulevard	186	110	85	2,293	2,165	1,911	11	7	6
52	52nd Avenue/South Bannock	147	121	50	1,537	1,112	478	12	7	5
53	North Sheridan Boulevard Shuttle	24	-	-	350	-	-	2	-	-
72	72nd Avenue	85	36	-	857	391	-	5	3	-
76	Wadsworth Boulevard	177	121	72	2,362	1,559	892	16	7	5
80	80th Avenue	24	-	-	324	-	-	2	-	-
92	92nd Avenue	78	68	25	1,004	948	433	5	4	2
95	South Westminster	42	-	-	252	-	-	3	-	-
99	South Kipling Street	63	30	-	796	332	-	4	2	-
100	Kipling Street	81	42	-	1,089	424	-	5	3	-

6 Process

RTD is developing this service plan in concert with state, county, municipal and other transportation stakeholders and customer and public input on the following schedule:

- Preliminary Gold & Northwest Lines Service Plan – June 29, 2015
- Stakeholder meetings to review proposed service plan – June 29 – July 24, 2015
- Revise Proposed Gold & Northwest Lines Service Plan – August 4, 2015
- Proposed Gold & Northwest Lines Service Plan to RTD Board Operations Committee – August 11, 2015
- Conduct public meetings on Proposed Gold & Northwest Lines Service Plan – August 2015
- Revise Proposed Service Plan based on input – September 30, 2015
- Board approval of Final Gold & Northwest Lines Service Plan – November 16, 2015
- Implement service plan – Summer 2016 (Northwest Line) and Fall 2016 (Gold Line)

This schedule provides time for substantial review and comment. The plan will be made available on RTD's website for the widest possible access. In addition RTD staff

will be available to make presentations to groups as a forum for detailed discussions. To request a presentation please contact Doug Monroe at douglas.monroe@rtd-denver.com or 303-299-2213. Email comments should be sent to service.changes@rtd-denver.com with subject line "Gold & Northwest Service Plan."