

RTD **FasTracks**

Central Rail Extension Mobility Study
Final Report

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Regional Transportation District
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Prepared by:



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EXECUTIVE SUMMARY

INTRODUCTION

What is the Central Rail Extension Project?

The Central Rail Extension (CRE) is a part of the FasTracks program, RTD's comprehensive plan approved by voters in 2004 to expand transit service in the Denver metro region. The purpose of the CRE is to provide high-quality, fixed-guideway rail transit service that improves access between and among the northeast Denver neighborhoods, the downtown transit network, and the full RTD transit system.

What did the Original FasTracks Plan assume for the Central Rail Line and what did subsequent studies show?

The original FasTracks plan assumed that service for the CRE would be provided by extending the three-car D Line light rail service (in operation since 1994) from its current terminus at 30th and Downing to the new East Rail line at 38th and Blake. In 2010, the RTD Board of Directors adopted the Central Rail Extension Environmental Evaluation (EE), with that study's preferred alternative being the use of one-car light rail consists operating from 38th and Blake to the 30th and Downing station (operating in mixed traffic on Downing Street), continuing on existing light rail infrastructure on Welton Street into downtown Denver and the downtown light rail loop, with the assumption that the existing D Line would truncate in the downtown loop instead of continuing to 30th and Downing. However, subsequent to the approval of the EE, the City and County of Denver revised its downtown traffic signal timing to accommodate four-car light rail trains in the downtown loop, limiting the viability of adding the extra CRE trains into the loop, which could potentially result in operational delays

and inefficiencies for the entire loop and other portions of the RTD light rail system.

What did additional studies show?

In 2012, RTD staff conducted additional internal analysis of CRE options, which included limited community stakeholder outreach. The staff's analysis at that time cast doubt on the ability of existing downtown and Welton Street light rail infrastructure and traffic signal network to accommodate the new CRE service. In addition, based on stakeholder comments, the option of forcing a passenger transfer from the CRE line to the existing D Line before entering downtown was not seen as a desirable option. Concurrently, stakeholder comments and other ongoing studies indicated that low-floor streetcar-type technology was also viewed as an option that should be studied further on the CRE corridor for its mobility and economic development benefits.

These three issues – the desire for a one-seat ride from the East Rail line into downtown, the use of the downtown light rail loop, and the potential use of streetcar-type vehicle technology – became the impetus for the Central Rail Extension Mobility Study.

What was the study area for this project?

The study area for this project encompasses Downtown Denver (including Lower Downtown), Five Points, Whittier, Cole and a portion of Elyria Swansea.



Project Study Area

How were stakeholders and the public involved?

The Central Rail Extension Mobility Study project team met with a number of key stakeholders and the general public to develop a vision statement and a set of goals for this project. In addition to public meetings held in February, July, and October 2014, key stakeholders who were consulted included:

- Study area elected officials, focused on RTD Board members and City and County of Denver council members from districts included in the study area. An initial briefing was conducted in January 2014, with a followup meeting in October 2014.
- A Project Task Force, consisting of representatives from neighborhood groups and other community interest groups. This

Task Force initially met in February 2014, with a followup meeting in July 2014.

- A Project Oversight Committee (POC), comprised of representatives of key stakeholders from the project study area. In addition to RTD staff, this Committee consisted of representation from the City and County of Denver, the Downtown Denver Partnership, and the Five Points Business District. This group met roughly monthly throughout the course of the project.

What was the overall purpose of this project?

The primary purpose of the Central Rail Extension Mobility Study was to determine the best way to provide a direct rail transit trip between the 38th/Blake Station and downtown Denver without a transfer. This includes the re-examination of the use of the downtown light rail loop for CRE service, including an analysis of traffic signal timing and other infrastructure requirements to determine the true feasibility of providing a one-seat ride for passengers from the 38th/Blake station into the downtown loop without requiring a transfer.

What goals were established for the project?

Based on input from elected officials, stakeholders, and the public, the project team developed three primary goals for the project to complement and fulfill the purpose of the project:

Goal 1: Open the Central Rail Extension as close to the opening of the East Rail line as possible. This means that RTD and the community will pursue all potential funding and implementation options to construct and open

the CRE extension from 30th/Downing to 38th/Blake as close to the opening of the East Rail line in 2016 as possible. This includes applying for any and all grant funding that might be available in the short term to facilitate the construction, and working with potential project partners from both the public and private sectors to develop a funding package to allow short-term implementation of the extension. Based on this goal, the primary short-term aims of the project are:

- To provide maximum convenience and access for rail transit riders to and from central downtown by way of the East Rail line;
- To improve access to and from downtown for Northeast Denver residents, employees, and visitors; and
- To improve overall downtown rail transit circulation.

Goal 2: Work toward introducing neighborhood-friendly low-floor vehicle technology as soon as practicable. This means that RTD will utilize the vehicle technology readily available at the time of initial opening of the CRE (light rail). However, to help fulfill the community vision and desires expressed in numerous previous studies, RTD will continue to examine and evaluate introducing streetcar-type vehicles in the Central Rail corridor and potentially other corridors as soon as is practicable given future vehicle replacement and procurement schedules and funding availability.

Goal 3: Establish a long-term vision for future potential expansion of the CRE and other rail transit services in downtown Denver. This study will examine a number of potential long-range expansion options for CRE and other RTD

services that can provide additional passenger capacity for RTD in the future. It will also examine other long-term implementation issues related to the future of passenger rail service and its interaction with the community downtown and in other nearby neighborhoods, including Five Points and the Auraria campus, as expressed by other previous and ongoing studies.

GOAL 1: THE ONE-SEAT RIDE

What did stakeholders and the public say about the one-seat ride?

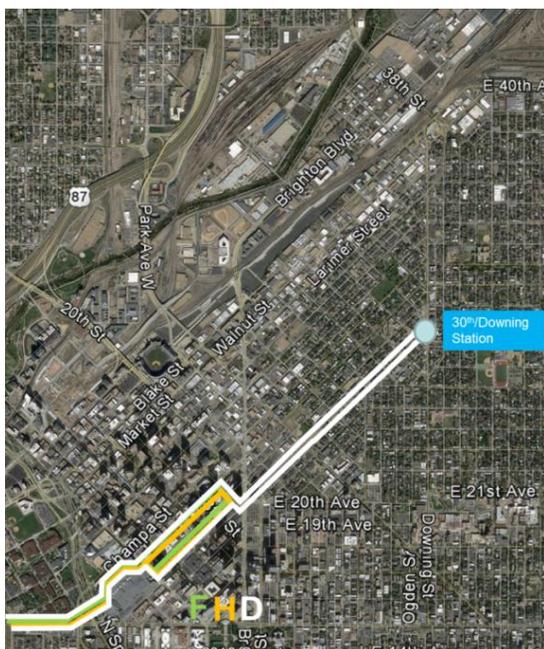
91% of all public comments received as of the end of August 2014 said that providing a one-seat ride from the 38th/Blake Station to downtown was “very important” (82%) or “somewhat important” (9%).

How would the CRE line operate differently from today?

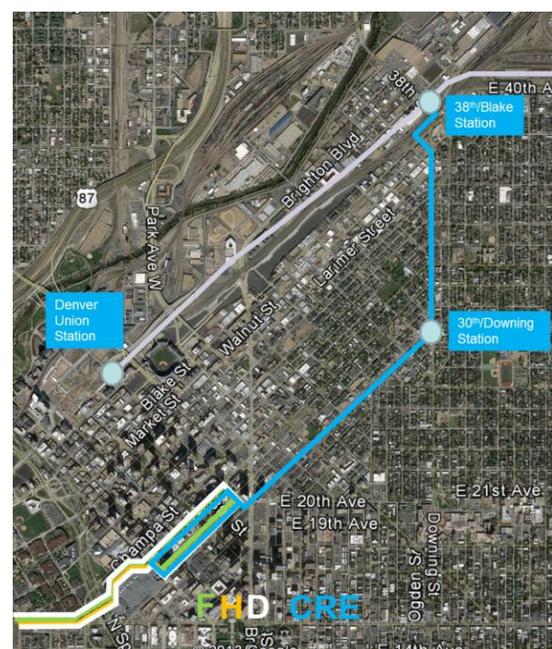
The goal of providing a one-seat ride from the East Rail 38th/Blake station into downtown Denver is predicated on a revision to RTD’s current light rail operating plan. Currently, the F and H light rail lines enter downtown from the Southeast corridor, circling through the downtown loop and returning to the Southeast. The D Line enters the downtown loop from the Southwest corridor, continuing up Welton Street to its terminus at the 30th/Downing

station. From that point, it returns down Welton Street and re-enters the downtown loop on the northeast side of downtown to return to the Southwest corridor.

The new operating plan for the Central Rail line is envisioned to operate in coordination with the other existing rail lines. In this case, the F and H lines would continue to operate as they have in the past, entering downtown at 14th and Stout and cycling through the downtown loop and returning to the Southeast corridor. However, the D Line’s operations would change; instead of continuing up Welton Street to the 30th/Downing station, it would cycle through the downtown loop similar to the F and H lines and return to the Southwest corridor. The new CRE line would run from the 38th/Blake station on the East Rail line south on Downing Street, turning southwest on Welton Street at the 30th/Downing station, and enter the downtown loop on the northeast side of downtown and cycle through the loop,



Current Downtown LRT Operating Plan



Proposed Downtown Operating Plan With CRE

returning up Welton and Downing Streets and back to the 38th/Blake station. It would provide passenger access to existing downtown light rail stations, with the potential for a new station at the Convention Center on the south end of the loop that would be served only by CRE trains.

What did stakeholders and the public say about the importance of a station at the Convention Center?

87% of all public comments received as of the end of August 2014 said that a station at the Convention Center on the south end of the downtown loop was “very important” (61%) or “somewhat important” (26%).

How did the project team evaluate the potential of adding CRE service to the downtown loop?

The project team worked with RTD to test the addition of a CRE train to the downtown loop during the evening peak hour in September 2013. The test showed that while the addition of a train to the loop was feasible, additional track infrastructure (specifically, a pocket track) was needed to ensure overall system reliability in the downtown street network.

What is a pocket track?

A pocket track is an extra piece of rail track that would allow CRE trains to “get out of the way” of other trains entering and existing downtown, ideally located at the light rail “throat” or pinch point at 14th and Stout.

What alternatives were evaluated?

The project team evaluated three groups of alternatives related to the integration of the CRE line with the downtown rail system:

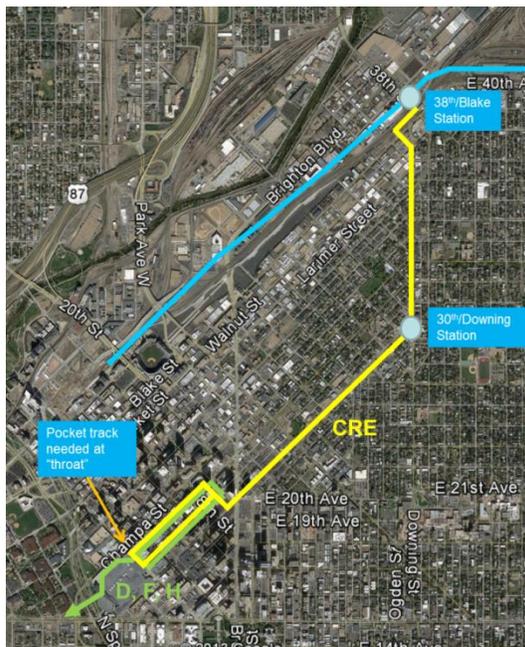
- **Alternative 1** would require a transfer to the existing D Line at either the

30th/Downing station or the 20th/Welton station. This option would implement the implications of the conclusions of the post-EE analysis, which determined that the downtown loop could not accommodate additional trains due to the changes in signal timing downtown implemented by the City and County of Denver. This option would require transit riders to transfer from the CRE line to the D Line at either the 30th/Downing station or the 20th/Welton station. It was rejected by the project team (after consultation with stakeholders) because it causes significant rider inconvenience (by requiring two transfers to travel from the East Rail line at 38th/Blake to downtown) and does not provide an opportunity for a new station at the Convention Center or for new development on the downtown loop.

- **Alternative 2** would use the downtown loop with no infrastructure improvements such as a pocket track. This option would introduce new CRE service as an “overlay” onto the downtown loop using current infrastructure. It would add new one- or two-car trains every 15 minutes into the downtown loop, using available scheduling and timing. This option was also rejected by the project team (after consultation with stakeholders) because it would result in delays and operational inefficiencies in the downtown loop since there is no pocket track for CRE operations, which also affects user convenience and impacts the downtown traffic signal network. It would reduce system reliability and passenger convenience and could result in delays not only in the CRE system but also in the existing D,F, and H Line operations. It also

provides little or no opportunity for redevelopment on the south end of the downtown loop since it uses the existing track and pedestrian plaza on 14th Street between Stout and California.

- **Alternative 3** would use the downtown loop with new rail infrastructure. This category of options assumes the construction of new track infrastructure in the downtown loop to promote operational reliability, combined with other improvements such as traffic/pedestrian signal modification or coordination. While a number of options were explored, the primary focus of the study was at on 14th Street between Stout and California, where trains both enter and exit downtown.



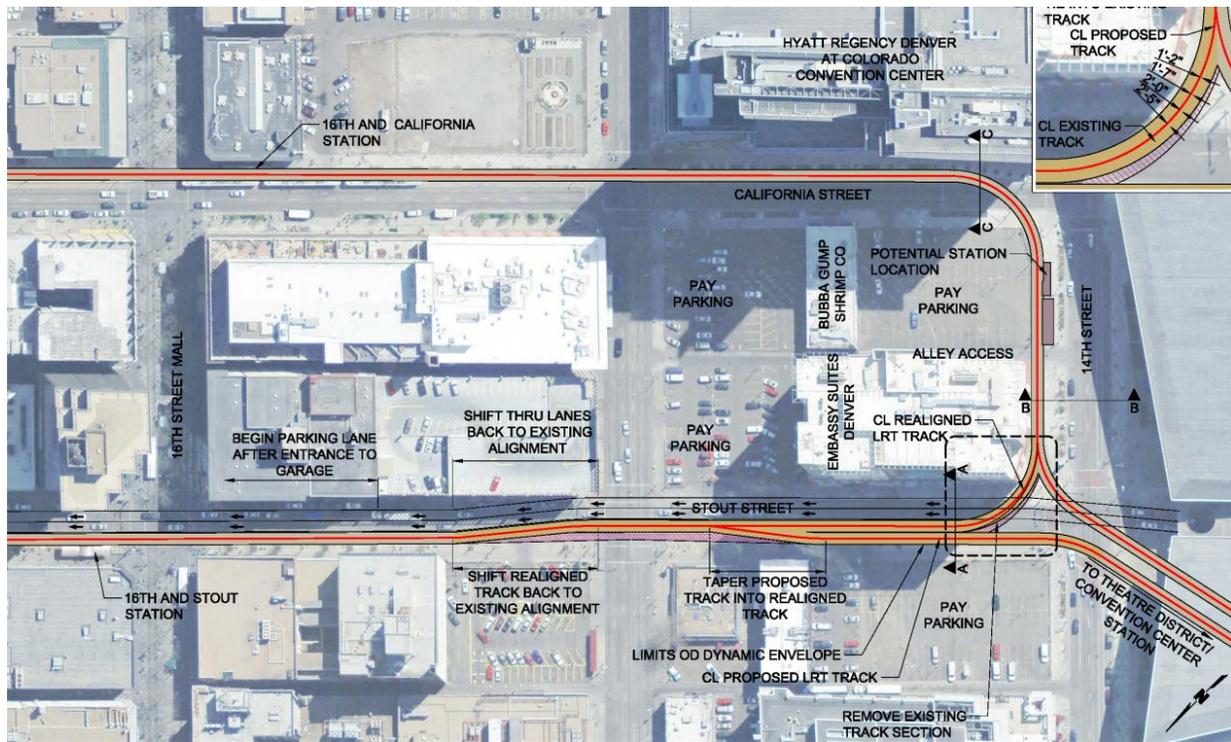
Preferred Location of New Infrastructure

What were the final alternatives evaluated?

Seven alternatives for adding track infrastructure were evaluated by the project team and discussed with stakeholders and the public. After an evaluation process, two primary alternatives were recommended for further consideration.

Alternative 3A: Use Existing Track on 14th Street

This alternative proposes the construction of a pocket track along the west side of Stout Street just north of 14th Street to accommodate a potential two-car CRE consist. It uses existing track infrastructure along 14th Street to the extent possible. It assumes the location of a passenger stop/platform along the existing pedestrian plaza on 14th Street to provide CRE access to the Convention Center. It requires minor deviations to northbound traffic lanes at 14th/Stout to accommodate the pocket track in the street right-of-way, and the loss of two to three parking spaces on northbound Stout north of 15th Street and minor relocation of the existing southbound light rail track on Stout to accommodate the pocket track.



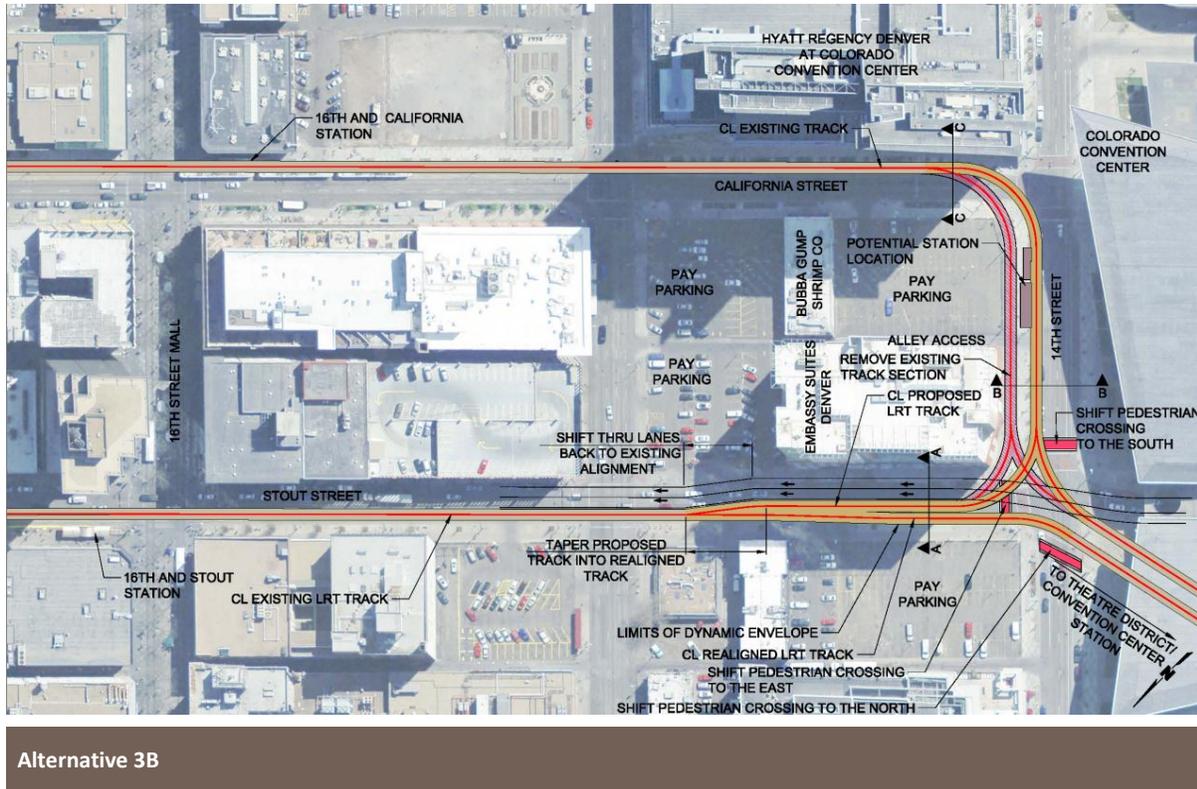
Alternative 3A

This option was carried forward because it provides good mobility benefits (system reliability, user convenience, a new station at the Convention Center) with no negative impacts to signals, autos, pedestrians, or bicyclists. It requires no new property or right-of-way and has no impact on the existing streetscape on 14th Street.

Alternative 3B: New Track on 14th Street in Parking Lane

This option assumes the removal of the existing track on 14th Street and construction of a new track in the existing parking lane on 14th Street (requiring the elimination of nine parking spaces). By removing the existing track, this option creates a wider pedestrian plaza on 14th Street and provides more room for a passenger stop/platform on the plaza. Similar to option 3A, this option maintains two through

northbound traffic lanes on Stout through a minor deviation of the existing lanes to accommodate the pocket track on Stout, but since the new track on 14th Street is located farther south than the existing track, it no longer impacts Stout Street north of 15th Street. This option was also carried forward because, like Alternative 3A, it provides good mobility benefits, though its impact on pedestrian crossings (particularly the crossing of Stout on the side side of 14th) will need additional investigation to ensure pedestrian safety. However, it does eliminate the existing pedestrian island on the northeast corner of 14th/Stout and provides the opportunity to improve overall pedestrian safety at this corner.



How long would the CRE trains need to be?

The ridership forecasts developed for this project showed that two-car trains would be needed to accommodate passenger demand on the CRE in the long term (2035 and after), but RTD would start service in the short-term with one-car trains.

What would the stations look like?

The CRE trains would use the existing light rail stations in the downtown loop, but new stations on Downing Street and at the Convention Center in 14th Street could have a less-costly and less-complex design, similar to the new stations being used by the Free Metro Ride. In addition, the stations would use new modular ramps for access by persons with

disabilities and others needing special access as needed for high-floor rail vehicles. These new ramps are being introduced throughout the RTD system and can be easily installed and removed.





New modular ramps being used at RTD stations

How would the alternatives affect the existing streetscape on 14th Street?

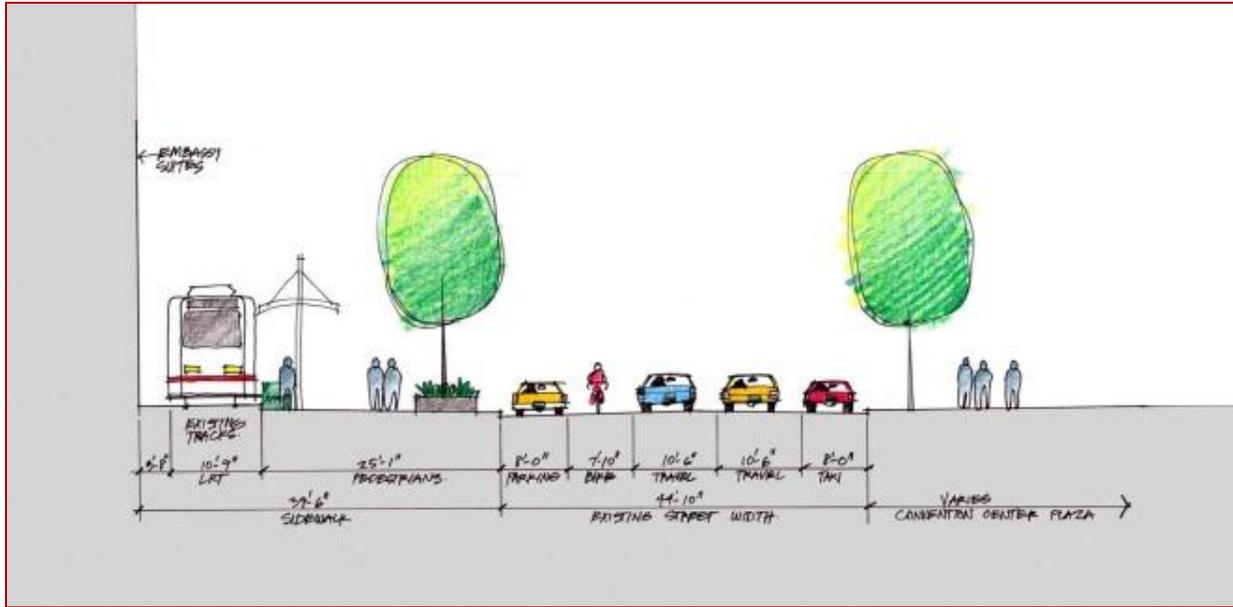
The alternatives were developed with the intent of minimizing the impact to the existing streetscape on 14th Street.

Alternative 3A: While the introduction of a platform on the plaza could possibly reduce the width of the pedestrian plaza along 14th, the use of modular ramps and low-impact canopies,

coupled with curbside boarding, should still provide sufficient clearance for pedestrian flow along 14th. In addition, most of the existing streetscape currently in place along 14th would not be disturbed under alternative 3A.



Urban design plan view sketch of Alternative 3A



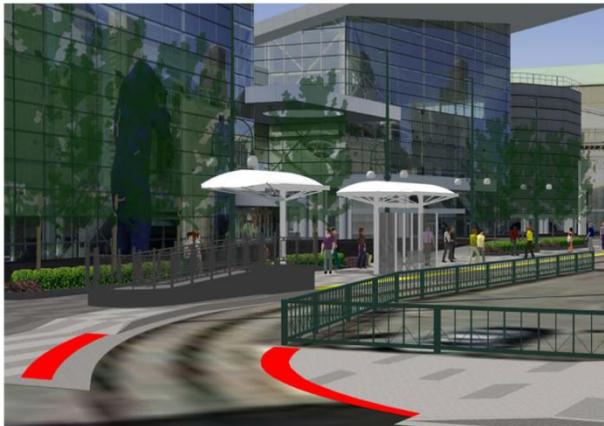
Urban design cross section sketch of Alternative 3A



Aerial View Looking East



View From The Convention Center Looking Northeast



View From California Street Looking Southwest



View From Pedestrian Median Looking East

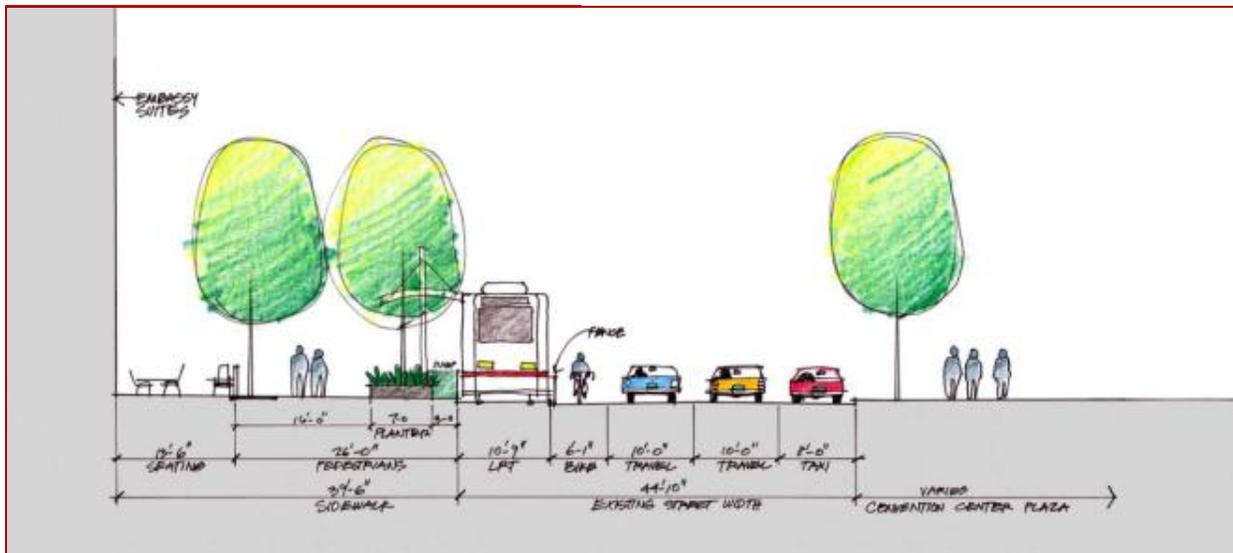
Urban design visualizations of Alternative 3A

Alternative 3B: Under this alternative, the new track would be adjacent to the existing plaza and interact with the future bicycle lane proposed for the north side of 14th Street; the existing street right-of-way should be sufficient to provide any number of “buffering”

treatments to segregate the bicycle lane from the rail track. The use of the parking lane for the track also frees up considerable space for pedestrians along the 14th Street plaza, including the possibility of new sidewalk development (such as café seating).



Urban design plan view sketch of Alternative 3B



Urban design cross section sketch of Alternative 3B



Urban design visualizations of Alternative 3B

How long would it take to travel from 38th/Blake to the Convention Center?

The traffic and travel modeling conducted for this project estimated that a one-way trip from the 38th/Blake station to the Convention Center would take approximately 24 minutes.

How many riders would the CRE line carry?

A ridership forecast developed for this project showed that the CRE line would carry between 6,300 and 6,400 daily riders in 2020 (estimated as a potential opening year), and approximately 8,200 riders in 2035. When a forced transfer at 30th/Downing or 20th/Welton was introduced into the ridership forecasting, overall ridership on the CRE line dropped by more than 15%

How many vehicles would be needed for CRE service?

Given the round-trip travel time forecast (approximately 48 minutes round trip), and given the requirement for two-car trains to meet future ridership capacity requirements, eight vehicles (operating in four two-car trains) ultimately would be needed for the CRE in the long term (2035 and after), though RTD can start service with one-car trains. Including spare vehicles, this means the CRE fleet ultimately would be ten vehicles.

What about the station at 29th and Welton?

RTD recently closed the 29th/Welton Street station due to low ridership and to improve operational reliability on the existing D Line. The ridership forecasts conducted for this study showed that the addition of the 29th/Welton station made little impact on overall system ridership (it added 80 riders to the system in 2020 and 240 in 2035).

How could the CRE's construction and potential expansion be funded or financed?

There is a wide variety of potential options for funding or financing the CRE project and its expansion alternatives. The range of federal, state, and local options – and the projects where those options have been used around the country – point out the need for RTD to potentially develop a menu of funding and financing options appropriate to the scale and impact of the CRE and its potential extensions. In particular, RTD should continue to pursue TIGER funding when those grant programs are again available in the future. Alternatively, RTD should consult with FTA about the potential for including part or all of the CRE (both its short-

term extension to the East Rail line and potentially its longer-term expansion options) into a Small Starts grant application, with the financial and political support of the local community. The projects that have been most successful in securing federal funding have been those that showed a significant amount of local support and a wide variety of local funding as matching funds. RTD should also continue to work with the private sector to determine the potential for establishing public-private partnerships to implement the CRE and its longer-term expansions.

What happens next?

Based on the results of this analysis, this study recommends that RTD continue to move forward with consideration of both alternatives 3A and 3B to further evaluate and decide on the best solution for the infrastructure improvements on the south end of the downtown loop, including:

- Continuing to consult with downtown stakeholders, including the City and County of Denver, the Downtown Denver Partnership, the Colorado Convention Center, Visit Denver, and adjacent property owners (including hotel properties) to further refine the design details of the alternatives and come to consensus on a final solution. This should include an analysis of trade-offs and benefits of each alternative related to issues such as safety, transit operations, on-street parking, business access and associated economic development, conformity with community values, turning movements and turn lanes, pedestrian and bicycle mobility and safety, impacts to and conflicts with major utilities (including maintenance and potential relocations, capital and operating costs, and additional traffic and technical analyses as needed).
- Continuing to coordinate with City and County of Denver traffic engineering and other staff to ensure CRE operations integration with the downtown traffic signal system and to develop appropriate mitigations (including additional pedestrian infrastructure improvements) to ensure that the CRE system can operate safely and efficiently with pedestrian and auto movements, particularly on the southern end of the downtown loop (on 14th Street between Stout and California).
- Continuing RTD staff work on engineering design of the trackwork and other transit-related infrastructure of the alternatives.
- Continuing RTD coordination with other potential project partners on funding options for the improvements to allow the implementation of the CRE as soon as possible and to meet the overall project goal of its opening as close to the opening of the East Rail line as possible.

GOAL 2: POTENTIAL USE OF LOW-FLOOR STREETCAR-TYPE VEHICLES

What did previous studies say about using streetcar-type vehicles in the Central Rail corridor?

- The 2010 *Environmental Evaluation* conducted by RTD examined the potential for using streetcars on the CRE line, and a streetcar alternative was actually recommended as an initial Preferred Alternative for the segment of Downing Street between 38th/Blake and 30th/Downing because it would have fewer impacts and would be within the corridor's FasTracks budget. However, due to systemwide budget constraints, the final recommended alternative proposed using single-vehicle light rail trains on the segment and into the downtown loop.
- The 2009 *Five Points Marketplace Initiative* recommended the development of strategies to improve multi-modal access and to create "a street that is more accessible to transit riders, pedestrians, and bicycles," including an exploration of transit alternatives and an investigation of "an alternative to the existing light rail configuration." The report noted, "The Welton Stakeholder Group [established for the study] has expressed great interest in exploring streetcar and other transit alternatives to better serve the corridor."
- The 2011 *Five Points Sustainable Main Streets Initiative Vision Plan* included a recommendation on pursuing the "feasibility for converting the current rail system to streetcar."
- The 2011 *Northeast Denver Neighborhoods Plan* highlighted a streetcar system as a way to enhance transit service and economic development opportunities in the Welton and Downing corridors.
- The 2012 *Five Points/Welton Corridor Technical Assistance Program Project* recommended examining streetcar as an alternative to light rail to replace the "currently inadequate" light rail corridor that terminates at 30th and Downing. It also encouraged the use of Welton Street as a "streetcar pilot" project for Denver, including seeking alternative funding from the US Department of Transportation and encouraging the use of Welton "as a streetcar pilot to address emerging difficulties of light rail access in to the Central Business District."
- The 2013 *Five Points Welton Street Marketplace Vision Plan Implementation & Revitalization Strategy* recommended that the community "continue to pursue streetcar as a solution that mitigates the challenges light rail created for safety, economic development and the rising cost of light rail for planned connections between the East corridor and downtown."
- The 2013 *Five Points Streetcar Coordination Plan* identified the key issues surrounding the potential for constructing and operating a streetcar system in the Five Points neighborhood, including potential conversion of Welton Street to two-way operations and reconstruction of the existing light rail infrastructure to accommodate a streetcar operations in mixed-flow traffic.

What did stakeholders and the public say about using streetcar-type vehicle technology?

84% of all public comments received as of the end of August 2014 said the use of low-floor streetcar-type technology was “very important” (56%) or “somewhat important” (28%).

How Does a Streetcar Differ from Light Rail?

The term “streetcar” can be defined as an **operational condition**, with rail operations in an urban environment, generally as a local circulator, in one-vehicle or (at most) two-vehicle consists, and primarily in a street-running situation that usually (but not always) shares existing traffic lanes with autos. It can also be defined as a **specific type of vehicle**,

sometimes differing from traditional light rail by providing a more neighborhood-friendly vehicle that can be of a different design profile, with low-floor boarding and other amenities that make it more conducive to a congested urban environment.

However, these two definitions are not mutually exclusive. For example, traditional light rail can operate in streetcar-type conditions (for example, in mixed traffic) in one- or two-car consists and can serve as urban circulators. This was the exact condition foreseen by the 2010 Environmental Evaluation, which proposed using existing light rail vehicles in mixed traffic on Downing Street before transitioning into the existing semi-exclusive light rail tracks on Welton Street and on into downtown Denver.

Key typical differences between light rail and streetcar-type vehicles

Issue	Current RTD Light Rail Vehicles	Modern Streetcar-Type Vehicles
Vehicle fleet	Consistent with existing RTD vehicle fleet	Would introduce new vehicle into RTD fleet
Vehicle type	Generally larger profile in multi-car consists	Generally lower profile in one- or (at most) two-car consists
Operating environment	Typically does not share lanes with traffic (though it can in some limited circumstances)	Can share lanes with traffic
Per-vehicle cost	Generally higher than streetcar	Generally slightly lower than light rail
Construction cost	Generally higher per mile than streetcar	Generally lower per mile than light rail
Station infrastructure	Usually more expensive and more extensive station infrastructure	Generally less expensive and less extensive station infrastructure
Maintenance facilities	Can use existing maintenance facilities	Could require new maintenance infrastructure at existing facilities or entirely new facilities

On the other hand, rail vehicle technology around the world is transitioning to more neighborhood-friendly low-floor vehicles regardless of their operational applications. All modern streetcar systems in North America are using low-floor vehicles in a variety of sizes and styles, and most new light rail systems in the US are using low-floor vehicles in a variety of consist lengths, as are most urban tramway systems around the world. And vehicle types and applications are merging and blurring. For example, new modern streetcar systems in Salt Lake City and Atlanta are using low-floor light rail vehicles in one-car consists in urban circulator and/or street-running applications.

Can low-floor vehicles use existing light rail infrastructure?

Low-floor vehicles can use existing rail infrastructure, including rails, stations, and overhead power lines. Regarding stations, the CRE line is proposed as a maximum of two-car consists, so that they can use existing light rail stations in the downtown loop (since their length would not interfere with the existing ramps on either ends of the light rail platforms). No modification is needed to curb heights at existing stations given the low-floor boarding of the vehicles, though stations not serving RTD’s current light rail fleet (for example, those proposed on Downing Street) could potentially have slightly higher curb heights to facilitate low-floor boarding.



Low-floor vehicles in Tacoma (upper left), Toronto (upper right), Salt Lake City (lower left), and Atlanta (lower right)

What about vehicle maintenance?

RTD will need to determine if its existing Mariposa or Elati light rail maintenance facilities can accommodate future streetcar-type vehicles or if a new facility is needed specifically for the new vehicles. Two major factors will need to be examined in more detail:

- First, a determination will need to be made as to whether one or both of the existing facilities could serve the new vehicles from a technical maintenance standpoint. In other words, RTD will need to determine if the existing facilities' layouts, track configuration, and equipment are compatible with the new vehicles. For example, if Siemens low-floor vehicles (such as the S70, being used in Salt Lake City and Atlanta) were procured, RTD will need to determine if existing maintenance procedures, staffing, and equipment were compatible with the new vehicles (given that RTD currently uses Siemens light rail vehicles).
- Second, a determination will need to be made as to whether one or both of the existing facilities could accommodate the new vehicles from a capacity standpoint. In other words, RTD will need to conduct a fleet analysis to determine if the existing facilities can accommodate the anticipated CRE fleet (currently estimated at ten vehicles) or if an entirely new facility is needed.

What happens next?

This review of vehicle options presents a variety of choices for the local community as it considers using streetcar-type vehicles on the CRE line and on other parts of the RTD system. Overall concluding observations related to streetcar issues and choices include:

- The CRE project is, first and foremost, a mobility project (connecting the RTD East Rail line with downtown Denver). Therefore, its vehicle should be capable of providing relatively rapid and efficient movement for people to and through the corridor.
- Based on RTD's preliminary ridership forecasts for the corridor, a streetcar vehicle's ultimate size (if used on the corridor) should likely be longer than the 66-foot Czech-style vehicle currently used in Portland and Seattle to ensure it can meet passenger capacity. The ridership forecasts assumed a vehicle that could accommodate roughly 125 passengers per vehicle during peak periods, which would require a vehicle in the 85-90 foot range or longer.
- While alternative propulsion systems are becoming more readily available, a streetcar system on the CRE should focus on using overhead electric power, as that is a traditional source of power already used in Denver for its light rail system.
- To promote efficient passenger loading and unloading, off-vehicle ticketing and multi-door boarding is recommended, similar to RTD's existing light rail system.
- Vehicle maintenance will be a key consideration in the implementation of a new streetcar-type vehicle. If existing RTD

facilities cannot accommodate a new vehicle type (either because of radically differing technology and maintenance needs, or if existing facilities are not large enough to accommodate a new CRE fleet), a streetcar maintenance facility will need to be planned, sited, and constructed to provide storage and maintenance space for the streetcar fleet. This issue should be addressed early in any system planning, and every effort should be made to make a maintenance facility a community asset by integrating it into the community (such as providing a maintenance public viewing facility, a streetcar museum, integration with an education facility, or other strategies to increase a facility's community integration).

- Based on this analysis, and taking into consideration past and current community support for a streetcar-type vehicle, this report recommends that RTD continue to examine and evaluate the issues related to implementing use of a low-floor neighborhood-friendly streetcar-type vehicle on the CRE line and potentially other parts of the RTD system.

GOAL 3: SYSTEM EXPANSION

Why is an examination of system expansion needed?

Two issues related to long-range expansion of the CRE and related RTD system were explored in this study:

- Expansion of operational capacity of the CRE system itself to meet future ridership needs, in the core CRE system (including the downtown loop), in non-downtown portions of the system in Five Points and adjacent northeast Denver neighborhoods, and in the overall RTD system to accommodate increasing ridership transferring from the East Rail line to the CRE.
- Expansion of RTD's overall rail capacity in the downtown core to meet future ridership needs as downtown employment and population continue to grow in the years ahead.

How much capacity is in the downtown loop and other parts of the system?

The proposed introduction of CRE trains into the downtown loop at 15-minute headways utilizes all available capacity of the loop. However, the portion of the CRE outside of the downtown loop – primarily on Welton Street through Five Points and on Downing Street – has no such limitations from a purely operational standpoint, but the existing track infrastructure on Welton Street (which transitions from double-track to a single-track configuration at Welton/24th) introduces potential long-range operational capacity issues on Welton from that point to 38th/Blake. Without double-tracking on Welton northeast of 24th Street, that segment also is limited to 15-

minute headways. As future employment and population increase in downtown, Five Points, and throughout the study area, there will likely be a growing need to both improve overall system reliability and expand passenger capacity on the CRE line.

Irrespective of CRE capacity needs, there will likely be a continuing desire on the part of the Five Points neighborhood to implement the community vision for Welton Street. This community vision consists of two major elements, all with the intention of promoting walkability, calming traffic, creating a more user-friendly urban neighborhood, and promoting economic development. Those two major elements are:

- Changing the existing light rail vehicle to a neighborhood-friendly low-floor streetcar-type vehicle, ultimately with in-street tracks operating in mixed traffic on both sides of Welton Street; and
- Converting Welton Street from one-way outbound traffic operations to two-way traffic.

How could rail transit capacity be increased on Welton Street?

This community vision for Welton Street could be accomplished in several ways: adding a track to existing infrastructure, utilizing a portion of the existing infrastructure combined with a new track as part of a partial re-build of Welton Street, and complete removal of existing infrastructure with totally new track construction.

Option 1: Adding a Track to Existing

Infrastructure: This option would merely add a second track in close proximity to the existing one-track section along Welton Street from 24th to 30th Streets. This option has a number of advantages, including relatively low capital cost and the ability to be implemented in a short time frame. However its drawbacks include the elimination of parking along Welton adjacent to the existing tracks, no opportunity for widening sidewalks adjacent to the tracks to promote walkability, and continued segregation of the rail tracks in a semi-exclusive guideway, reinforcing the perception of rail as a “barrier” along Welton Street.

Option 2: Continue to Use Northbound Track but Construct New Southbound Track: This option would remove the existing southbound track from Welton street between 24th Street and 20th Street and construct a new southbound track on the west side of Welton Street as an initial or partial step toward Welton Street redevelopment. It would continue the use of the existing northbound track on the southeast side of Welton Street as either a semi-exclusive guideway or a mixed-traffic guideway (with some street reconstruction to provide a smooth street grade and crown). Advantages seen for this option include the potential for urban design improvements including sidewalk widening and parking on the northwest side of Welton Street in conjunction with the construction of the new southbound track, and moderate capital cost. The major challenge for this option is that (similar to Option 1) there would be no opportunity for urban design improvements such as sidewalk widening on the southeast side of Welton Street.

Option 3: Remove Northbound Track, Extend Existing Southbound Track and Convert to Northbound, and Construct New Southbound Track:

This option would remove the existing northbound track but convert the existing southbound track to a new northbound track, extending it from its current transition point at 24th Street to the 30th/Downing station. Concurrently, a new southbound track would be constructed on the northwest side of Welton Street as an initial or partial step toward Welton Street redevelopment. In essence, it takes advantage of existing track infrastructure to the extent possible while implementing most if not all of the community vision for Welton Street. It would require some reconstruction of Welton Street to accommodate the “new” northbound track to provide a smooth street grade and crown for mixed-traffic operations. Opportunities for this option include its high potential for urban design improvements including sidewalk widening and parking on both sides of Welton Street. Challenges for this option include its relatively high construction cost given the large amount of new track construction and the removal of the existing northbound track.

Option 4: Complete Reconstruction of Welton Street and Track Infrastructure: This option most closely resembles previously-established community visions for the segment of Welton Street between the 20th/Welton and 30th/Downing stations by completely reconstructing the street. Advantages of this option include maximum flexibility for complete street redesign including urban design improvements such as widened sidewalks, and maximum ability to implement two-way traffic operations on Welton Street and retain parking on both sides of the street. Disadvantages of this

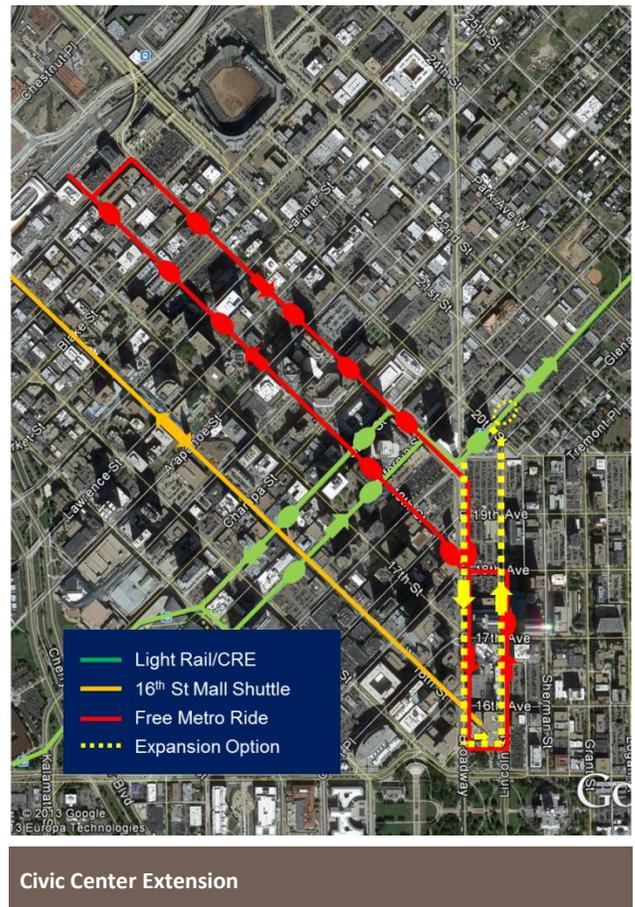
option include its high capital cost (it is the highest cost option, estimated at least at \$60 million, not including additional improvements such as sidewalk reconstruction or widening).

What other system expansion options were studied?

With potential two-track improvements on Welton Street, headways on the CRE line between 38th/Blake and 20th/Welton (at the northern end of the downtown loop) could be increased significantly, allowing additional trains to operate in alternative alignments in downtown. For example, trains on the segment between 38th/Blake and 20th/Welton could operate at 7.5-minute headways, splitting at the “pivot point” near the 20th/Welton station and the intersection of Welton with Broadway and Lincoln, with one train entering the downtown loop at 15-minute headways and the next train entering an alternative alignment, also at 15-minute headways. Conceivably, headways could continue to be increased on the segment between 38th/Blake and 20th/Welton to allow additional trains on one or more alternative alignments in addition to the downtown loop. With those operational concepts in mind, the project team developed a number of potential additional alignments in the downtown area for consideration by project stakeholders, most of which pivoted off the CRE line at the area near the 20th/Welton station. After review by stakeholders and the public, the project team recommended four high-priority expansion options and several other lower-priority options.

What high priority expansion options were recommended?

Civic Center (Broadway/Lincoln) Extension: This option would provide a southbound one-way track extending from the CRE at 20th Street down Broadway to the Civic Center, returning northward in a one-way track on Lincoln Street to re-connect with the CRE at 20th/Welton. The option would provide good connections to the southeast end of downtown and the 16th Street Mall Shuttle and Free Metro Ride circulator systems. It would also provide good connections to future potential high-capacity transit investments on Colfax Avenue.



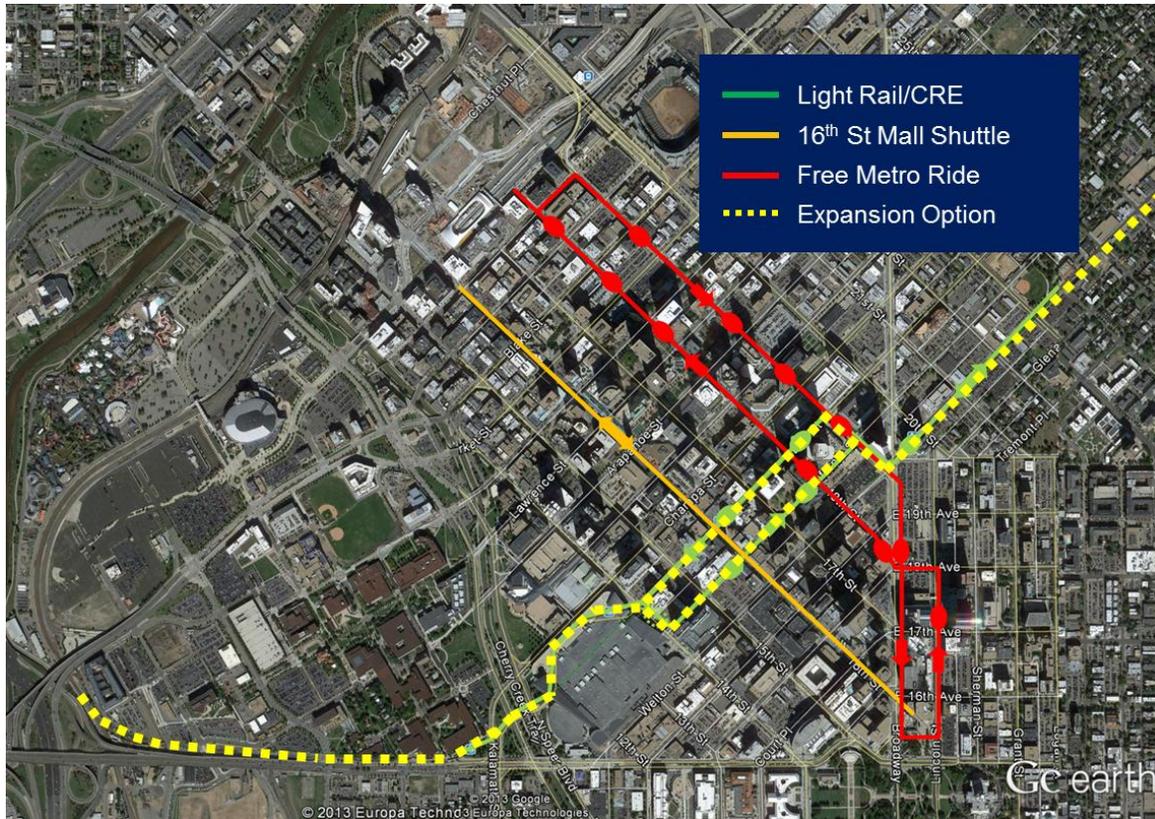
Welton Street Extension to Convention Center:

This option would continue the future two-way track from Welton Street proposed for northeast of Broadway southwestward along Welton through the heart of southeast downtown to the southeast side of the Convention Center. It would provide an additional connection to the 16th Street Mall Shuttle, the Free Metro Ride, and the Convention Center, with potential connections to a future high-capacity transit investment on Colfax Avenue.

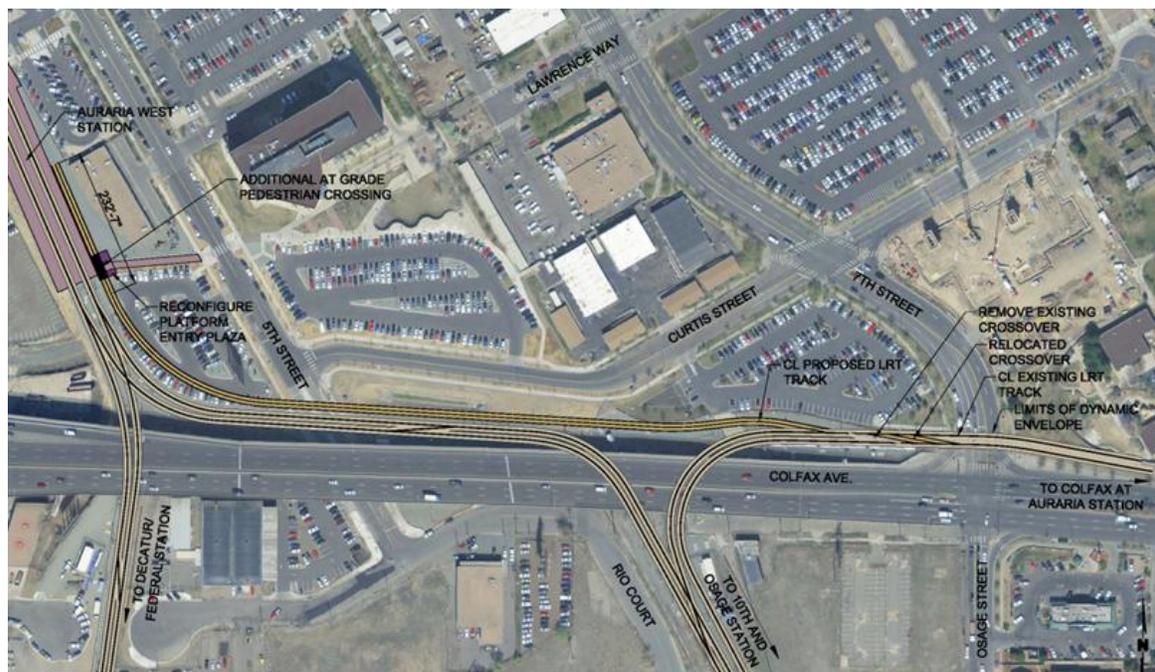


Connection to Auraria Campus:

This option would extend the proposed CRE line westward past the downtown loop to the Auraria campus. Currently, the D Line provides service to Auraria from Five Points and northeast Denver. Under the proposed initial CRE operating plan, the D Line would no longer serve Five Points but would circulate through the downtown loop before proceeding back to the southwest corridor. In addition, the CRE line would operate from the 38th/Blake station through Five Points and into the downtown loop and back to the 38th/Blake station. Under that scenario, direct service to the Auraria campus would no longer be available to residents of Five Points and northeast Denver without a transfer to the D Line in downtown Denver. This proposed option would extend the CRE line past the downtown loop and to the Auraria campus, again providing direct access to Auraria for residents of Five Points and northeast Denver.



Auraria Extension/Expansion



Track Infrastructure Proposed for Auraria Extension/Expansion

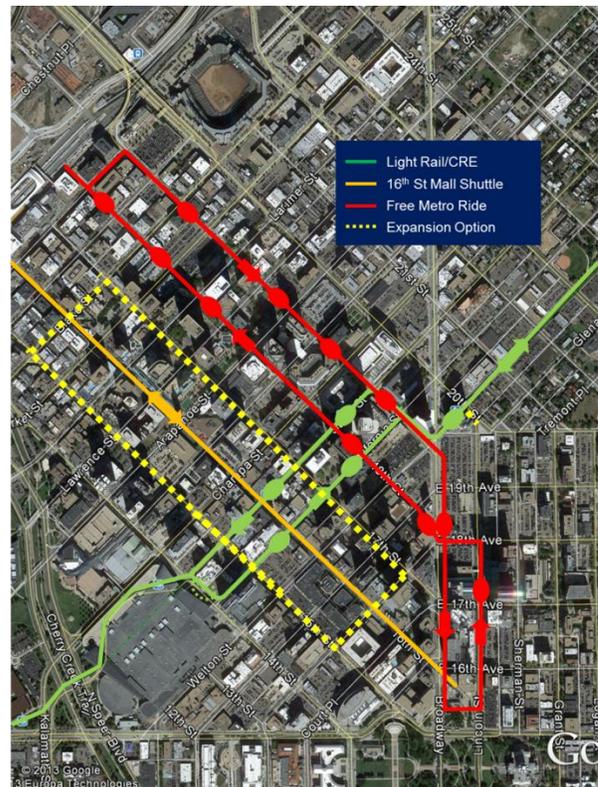
Connection to National Western Complex: This option has been raised by stakeholders who are interested in using the CRE to provide a direct connection between downtown Denver (and major activity centers such as the Convention Center and Five Points) and the National Western Complex to the north. The Complex is currently undergoing a master redevelopment plan that could result in major upgrades and reconstruction at the facility. The North Metro commuter rail line, currently under construction, will provide a station on the west side of the complex. This option could use 38th Street to Brighton Boulevard to reach the east side of the National Western complex (a distance of approximately 1.25 miles)



National Western Complex Extension

What were the lower-priority expansion options that were studied?

15th/17th Streets Circulator: This option emerged from task force and public meeting discussions. It would provide an alternative circulator for downtown to supplement the 16th Street Mall shuttle and the Free Metro Ride to meet future downtown capacity needs.



15th/17th St. Circulator

21st Street Circulator: This option would provide a two-way circulator northwest along 21st Street from Welton Street. This option was discussed by stakeholders and the general public and is related to a proposal being considered by the City and County of Denver and the local neighborhood to transform 21st Street into a “pedestrian boulevard” connecting Five Points and Arapahoe Square with Coors Field and the ballpark neighborhood.

New Downtown Loop: This option consists of a new “outer loop” circulator alignment bordering the existing downtown loop that could operate either as a stand-alone CRE expansion option in the existing downtown loop for future light rail operations. It could be a new route for the light rail system that could replace or supplement the existing downtown light rail operations to provide additional downtown light rail passenger capacity. Or it could be a combined operation for both the CRE and the current light rail system, to provide significant additional operational capacity downtown.



How could these and other options be funded or financed?

A number of potential funding and financing sources could be utilized to implement these expansion options in addition to shorter-term options. Some of those options include:

- Federal funding, including continued pursuit of TIGER grants (despite the project's initial inability to secure funding from the TIGER VI program), potentially packaging improvements into a Federal Transit Administration New Starts or Small Starts application, or exploring the potential use of a Transportation Infrastructure Finance and Innovation Act (TIFIA) loan.
- State funding opportunities, including utilizing Congestion Mitigation and Air Quality (CMAQ) or Surface Transportation (STP) flexible funding programs administered by the Colorado Department of Transportation and coordinated by the Denver Regional Council of Governments.
- A local funding partnership with the City and County of Denver, including possible bonding for related infrastructure improvements, coordination of utility relocation and other potential in-kind contributions, or the use of Tax Increment Financing (TIF) for improvements.
- Partnerships with local groups such as the Five Points Business District, the Downtown Denver Partnership, and other key stakeholders to consider benefit assessment districts or other means of providing local private financial support for improvements.

What happens next?

In addition to the specific options for expansions discussed here, local stakeholders and the general public discussed a number of additional options for improving and expanding rail transit operations downtown and in adjacent neighborhoods. These additional options ranged from specific routing and station suggestions to larger-scale suggestions related to completely re-thinking how light rail and other future rail services (including streetcar-type service) operate downtown. The City and County of Denver will be undertaking a new downtown transportation master plan and a strategic transit plan in the near future, and it is recommended by this project that the future master plan examine, in coordination with RTD and downtown stakeholders, the long-range expansion options listed in this report as potential candidates for additional analysis.

1 Introduction

Introduction and Background

The Central Rail Extension (CRE) is a part of the FasTracks program, RTD's comprehensive plan approved by voters in 2004 to expand transit service in the Denver metro region. The purpose of the CRE is to provide high-quality, fixed-guideway rail transit service that improves access between and among the northeast Denver neighborhoods, the downtown transit network, and the full RTD transit system.

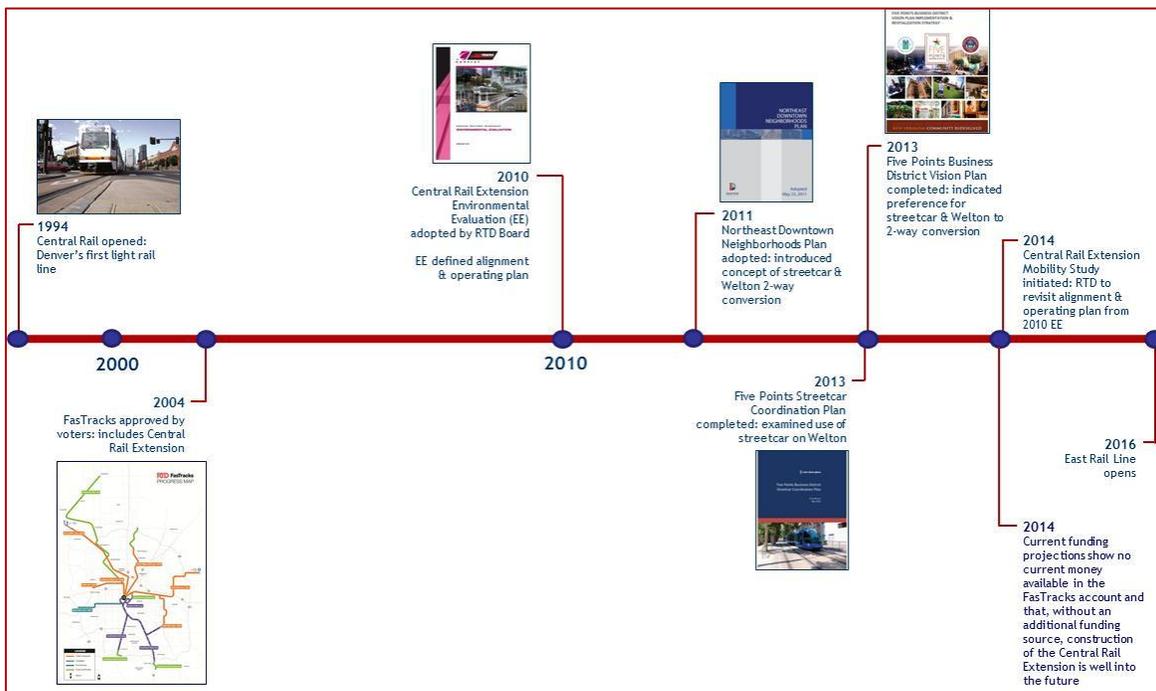
The original FasTracks plan assumed that service for the CRE would be provided by extending the three-car D Line light rail service (in operation since 1994) from its current terminus at 30th and Downing to the new East Rail line at 38th and Blake. In 2010, the RTD Board of Directors adopted the Central Rail Extension Environmental Evaluation (EE), with that study's preferred alternative being the use of one-car light rail consists operating from 38th and Blake to the 30th and Downing station (operating in mixed traffic on Downing Street), continuing on existing light rail infrastructure on Welton Street into downtown Denver and the downtown light rail loop, with the assumption that the existing D Line would truncate in the downtown loop instead of continuing to 30th and Downing. However, subsequent to the approval of the EE, the City and County of Denver revised its downtown traffic signal timing (and related pedestrian crossing signal timing) to accommodate four-car light rail trains in the downtown loop, limiting the possibility of adding the CRE service into the loop that could potentially result in operational delays and inefficiencies for the entire loop.

In 2012, RTD staff conducted additional internal analysis of CRE options, which included limited community stakeholder outreach. The staff's analysis at that time cast doubt on the ability of existing downtown and Welton Street light rail infrastructure and traffic and pedestrian signal network to accommodate the new CRE service. In addition, based on stakeholder comments, the option of forcing a passenger transfer from the CRE line to the existing D Line before entering downtown was not seen as a desirable option. Concurrently, stakeholder comments and other ongoing studies indicated that low-floor streetcar-type technology was also viewed as something that should be studied further on the CRE corridor for its mobility and economic development benefits.

These three issues – the desire for a one-seat ride from the East Rail line into downtown, the use of the downtown light rail loop, and the potential use of streetcar-type vehicle technology – became the impetus for the Central Rail Extension Mobility Study.

Figure 1-1 shows a brief history of the Central Rail Extension and its related projects and activities, many of which are summarized later in this document.

Figure 1-1: Chronology of Activities Related to the Central Rail Extension



Source: Project Team

Purpose of This Study

This study was focused on identifying the most feasible rail transit route and operating plan to provide a direct rail transit ride with no transfers from the future 38th/Blake Station into downtown Denver to improve access, safety, and economic development opportunities for downtown and northeast Denver residents, employees, and visitors. Stakeholders and the community were involved in creating a consensus on the implementation of the Central Rail Extension. The study gathered information to measure and evaluate potential alternatives, screen those alternatives, and provide a detailed description of the most feasible alternatives for short-term implementation. This study also examined how the Central Rail Line should interface with the downtown Denver transportation system with minimal impact to vehicular traffic, transit, bicyclists, and pedestrians. It examined potential long-range expansion options to improve the coverage and operations of the CRE line and other passenger rail lines in downtown Denver. And it examined the potential for neighborhood-friendly, low-floor, streetcar-type vehicle technology for possible use on the CRE line and other alignments in downtown Denver and its surrounding neighborhoods. Specific issues covered in this analysis include:

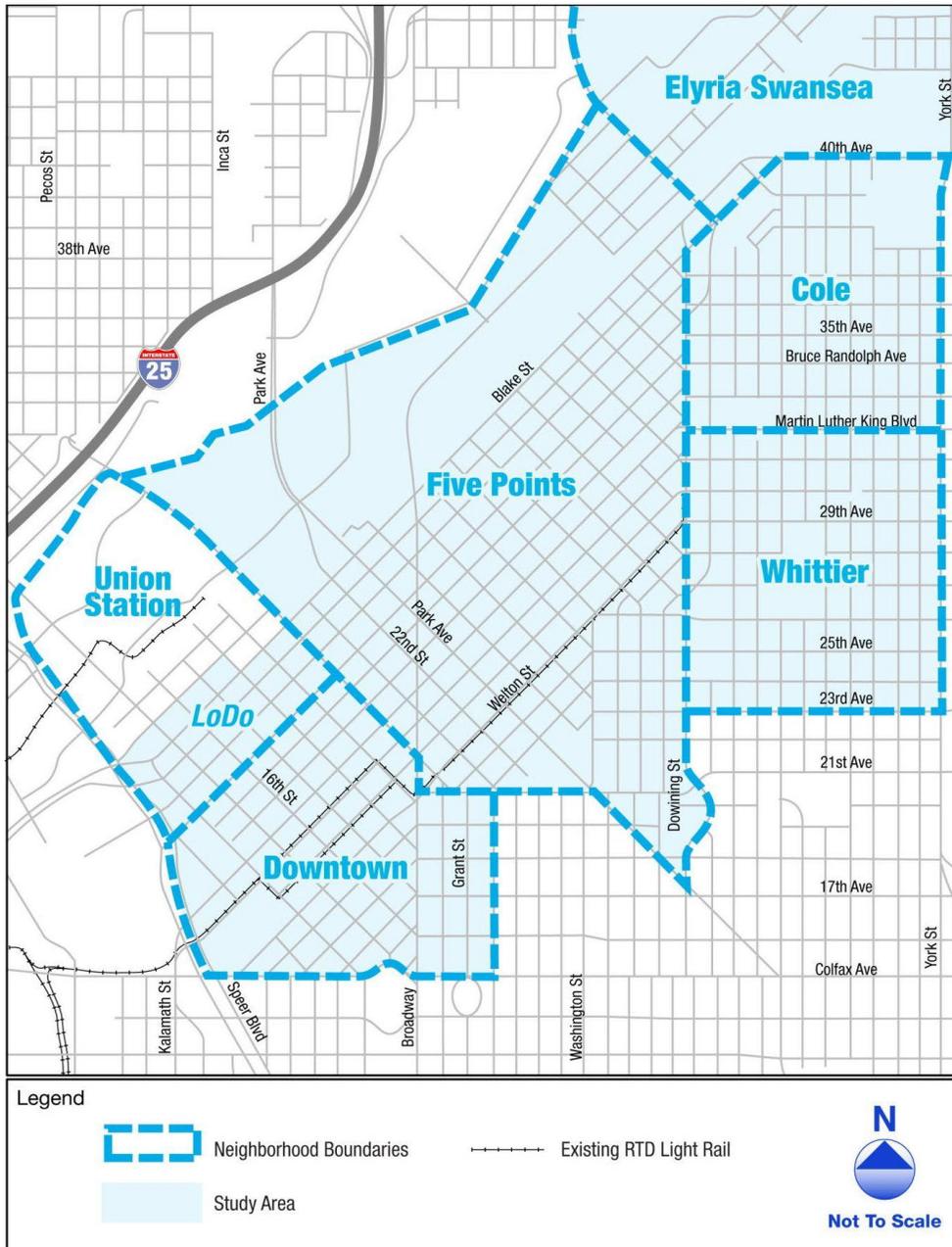
- Determining the issues associated with potentially re-defining the FasTracks plan approved by the voters in 2004 to meet current operational and fiscal realities.

- Conducting an operational analysis to determine the impacts of integrating a CRE investment into the existing downtown LRT loop or on other downtown alignments, including performance impacts on the existing Southeast and Southwest LRT lines.
- Analyzing the physical, operational, and financial/political issues associated with potential new alignments in downtown Denver and the Welton/Downing corridor to the 38th/Blake station, including the disposition of the existing D Line operations.
- Analyzing the physical, operational, and financial/political issues associated with a potential new rail technology (low-floor streetcar-type technology) in downtown Denver and the Welton/Downing corridor to the 38th/Blake station.
- Determining the ultimate destinations of one or more long-range new downtown alignments, including the Convention Center/performing arts complex, Civic Center Station, or others to be determined.
- Determining the potential to interact with and/or influence the construction and financing plan developed by the ultimate contractor for the North Metro design-build project.
- Determining the issues associated with implementation of a new alignment and/or vehicle technology, including financial issues (including potential federal funding leverage and/or public/private partnerships), and the formal and informal partnerships needed between and among RTD, the City, and other entities to move forward with implementation.
- Determining and documenting all issues associated with either re-using all or part of the existing LRT infrastructure on Welton Street or constructing new rail infrastructure, including issues related to two-way auto operation on Welton and other issues.
- Determining how any potential new alignment or technology would interact with auto, transit, pedestrian, and bicycle mobility and connectivity in downtown.
- Using a public process (including stakeholders and key decision-makers) to define the ultimate goals, purposes, and findings of the project.

Study Area

The study area for this project encompasses Downtown Denver (including Lower Downtown), Five Points, Whittier, Cole and a portion of Elyria Swansea, as shown in Figure 1-2.

Figure 1-2: Project Study Area



Source: RTD

Previous RTD Plans and Projects

Environmental Evaluation

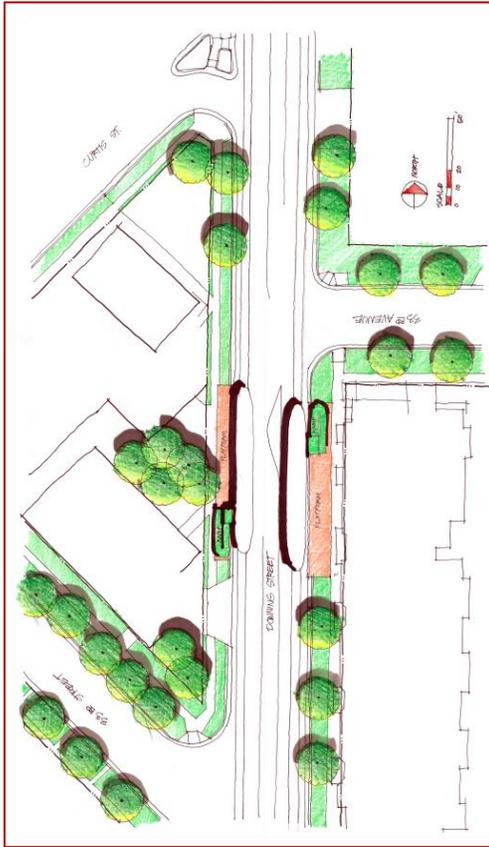
In 2010, RTD completed the Central Corridor Extension Environmental Evaluation (EE), the aim of which was to complete an environmental and operational analysis for the proposed Central Corridor Extension from the existing 30th/Downing light rail station to the East Rail station proposed for 38th/Blake as part of the FasTracks program. The study examined several alternative alignment options for rail transit in Downing Street, including both light rail and streetcar alternatives. A variety of single-track and double-track light rail extension options were examined during the study, with the preferred alternative being a two-track rail extension from 30th/Downing to 38th/Blake, with the trains operating in traffic on Downing Street, and with the northbound light rail vehicle in the northbound travel lane and the southbound light rail vehicle in the southbound travel lane between the two stations. New passenger stations were proposed on Welton Street at 35th and 33rd Avenues. Light rail trains would then travel along the existing tracks on Welton Street and into the downtown light rail loop, as shown in Figure 1-3a. Figure 1-3b shows a plan view of the CRE line operating in Downing Street in mixed traffic, and Figure 1-3c shows a typical cross section on Downing Street.

Figure 1-3a: Preferred Alternative for the RTD Central Corridor Extension



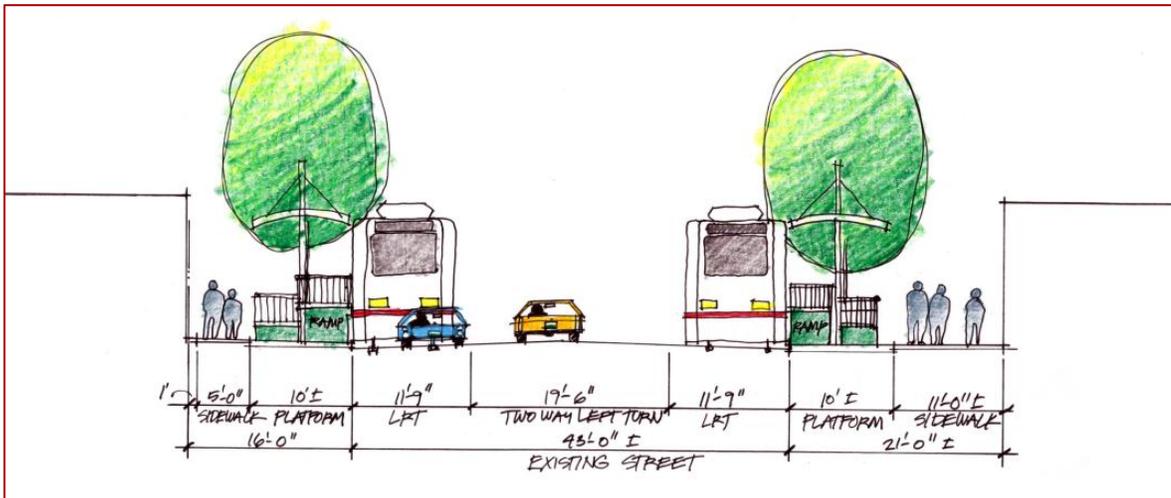
Source: RTD

Figure 1-3b: Preferred Alternative for the RTD Central Corridor Extension on Downing Street: Plan View



Source: Project Team/Leese & Associates

Figure 1-3c: Preferred Alternative for the RTD Central Corridor Extension on Downing Street: Typical Section



Source: Project Team/Leese & Associates

Streetcar Alternative

In response to community requests, RTD included a streetcar alternative in its analysis, primarily focused on the connection between 30th/Downing and 38th/Blake (then called 40th/40th), with a three-lane typical section on Downing selected for further study (as shown in Figure 1-4). This option was initially designed to require a transfer to the existing light rail station at 30th/Downing. Because of the relatively short segment between 38th/Blake and 30th/Downing, the alternative’s design was extended to operate on the existing Welton Street light rail tracks, terminating (and requiring a transfer) at the existing 20th/Welton light rail station on the east side of downtown, as shown in Figure 1-5.

Figure 1-4: Initial Streetcar Alternative Alignment in RTD Central Corridor EE



Source: RTD

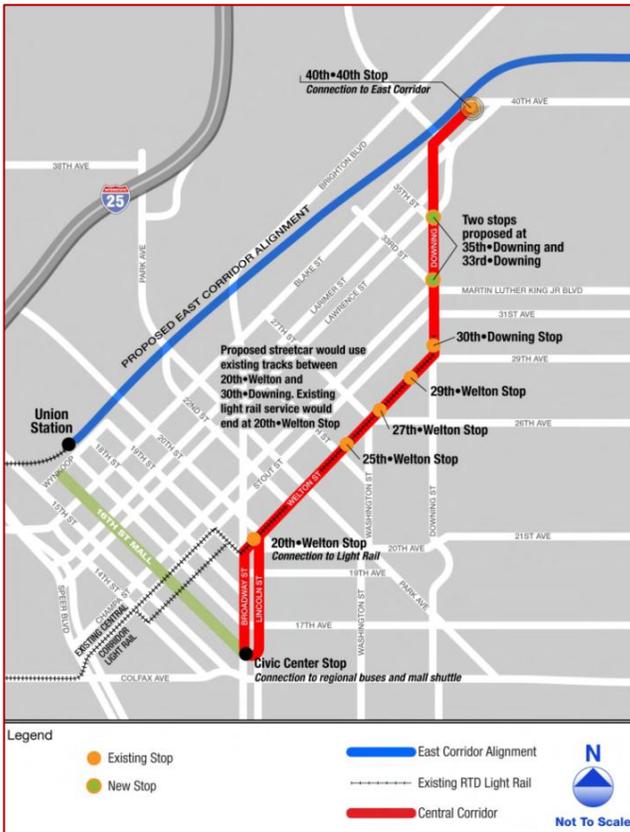
Figure 1-5: Revised Streetcar Alternative in RTD Central Corridor EE



Source: RTD

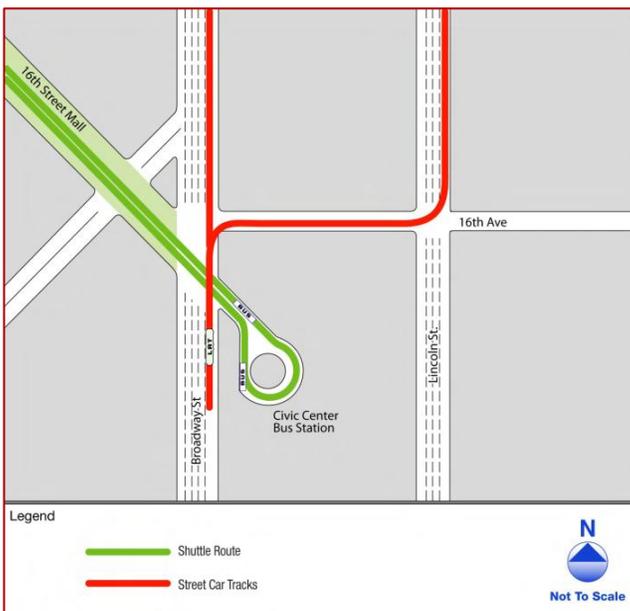
Additional concepts were considered, including the potential of extending the streetcar alignment to Civic Center station in Broadway and Lincoln as shown in Figures 1-6a and 1-6b, providing a convenient connection to the 16th Street Mall Shuttle at Civic Center. The “streetcar” alternative to Civic Center was initially considered as the study’s preferred alternative because it would have fewer impacts and would be within the corridor’s FasTracks budget. The EE noted that the streetcar alternative could be served by either a light rail vehicle or a modern streetcar vehicle. However, during RTD’s Annual Program Evaluation in 2007, program budget issues eliminated the proposed extension to Civic Center and focused on interaction with the downtown light rail loop. In addition, light rail vehicles (rather than streetcar vehicles) were recommended for use on the service to promote consistency of fleet operations and maintenance. The final recommended alternative proposed using single-vehicle light rail consists on the segment, with integration into the downtown loop. Capital construction costs for the segment between 30th/Downing and 38th/Blake were estimated at \$67 million (in 2009 dollars), with annual operating costs estimated at \$3 million.

Figure 1-6a: Central Corridor Streetcar Extension Option to Civic Center



Source: RTD

Figure 1-6b: Potential Streetcar Connection at Civic Center



Source: RTD

Post-EE Issues and Analysis

After completion of the EE, the traffic and pedestrian signal cycle in Downtown Denver increased from 75 to 90 seconds to accommodate four-car light rail trains. This resulted in the loss of available openings for additional light rail trains in the Downtown loop, reducing the number of slots from 24 to 20. The current RTD light rail operations require 14 of the 20 slots per peak hour, and the Central Rail Extension would require an additional four slots per hour on top of the existing 14, leaving only two slots open for help with delays. Additionally, transit simulations showed that the movement of these additional trains looping around at 14th and Stout did not fit within the existing schedule. Consequently, the operating plan envisioned in the EE was considered problematic if not entirely infeasible.

In addition, since the conclusion of the EE, RTD in 2012 continued to examine the potential for streetcar use in the Central Rail corridor as an alternative to light rail on alternative alignments. Two options in particular were analyzed in some detail:

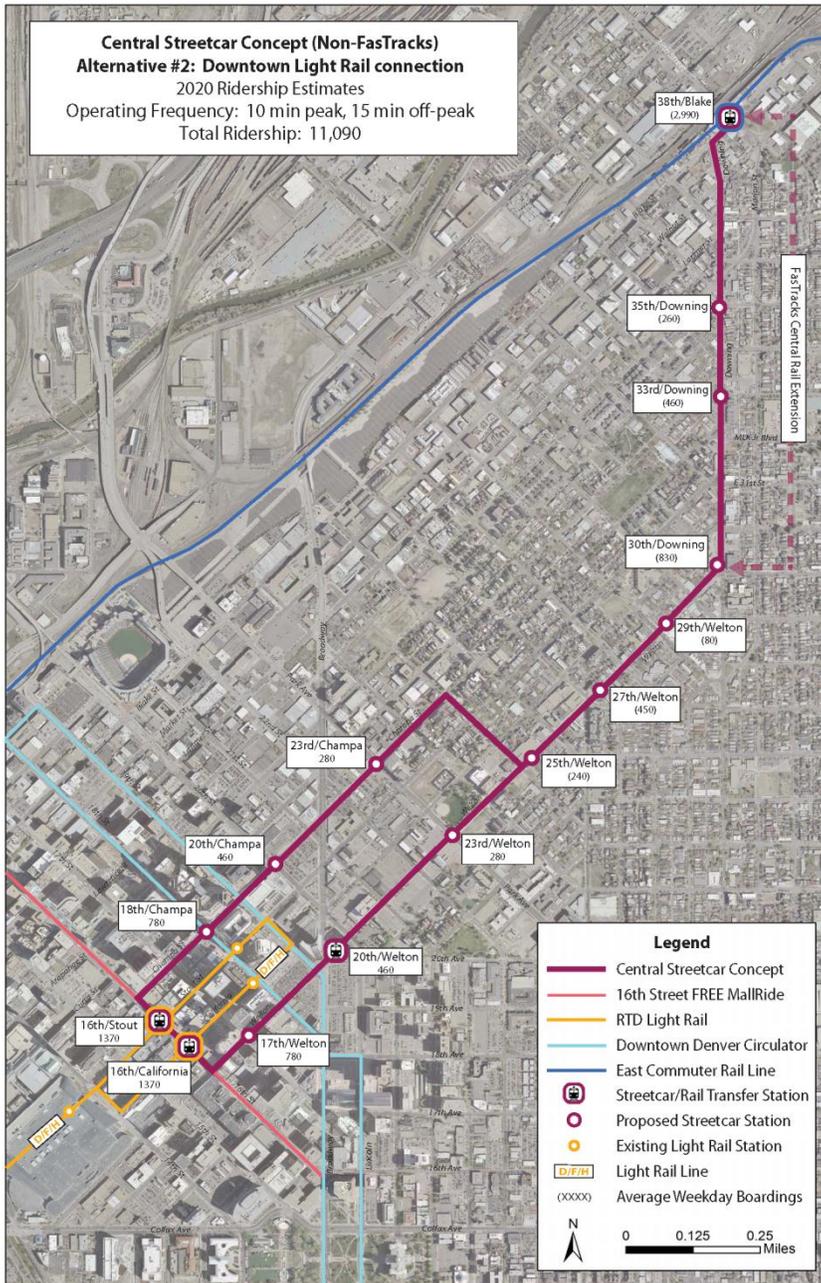
- Alternative 1 (shown in Figure 1-7) again examined the option of extending streetcar service from 38th/Blake through Five Points and on to the Civic Center Station. This option proposed a split southward from 24th, with southbound tracks running on California to Broadway. This option was tested at 10-minute peak service and 15-minute off-peak service and resulted in total daily 2020 ridership of approximately 11,000 riders.
- Alternative 2 (shown in Figure 1-8) examined the option of extending a streetcar alignment through downtown on a new downtown loop that focused on Champa and Welton, with a southern connection assumed on the 16th Street Mall (additional options that used 14th, 15th, and 18th Streets in varying combinations were also examined). That option resulted in daily 2020 ridership projections of just over 11,000 riders.

Figure 1-7: RTD Downtown Streetcar Option Analysis Alternative 1: Civic Center Connection



Source: RTD

Figure 1-8: RTD Downtown Streetcar Option Analysis Alternative 2: Downtown Connection



Source: RTD

Current Design and Implementation Assumptions

38th/Blake Station and Interface with East Rail Line

The Central Rail Extension is planned to end on its northern leg with a cross-platform transfer to the East Rail line at the 38th/Blake Station, on the southeastern side of the station. Passengers will be able to transfer easily between the East Rail line and the Central Rail line. The CRE will run along 36th Street to Downing Street, and then run south along Downing Street until it turns onto Welton Street. Figure 1-9 is a schematic of the planned station and rail lines connection at 38th/Blake.

Figure 1-9: 38th/Blake Street Station Connections



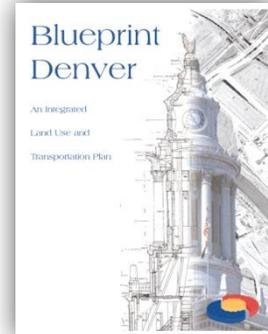
Source: RTD Environmental Evaluation, 2010

Other Plans and Projects

City and County of Denver Studies

Blueprint Denver

The City and County of Denver developed Blueprint Denver in 2002 as an outgrowth of its 2002 Comprehensive Plan. That plan designated several areas of change and areas of stability related to future land use decisions, including downtown and the Five Points area. In particular, the area along Welton was designated as a pedestrian shopping district surrounded by mixed-use and urban residential uses.



Strategic Transportation Plan

As a followup to Blueprint Denver, the 2008 Strategic Transportation Plan developed specific strategies for improving multimodal transportation throughout Denver. The report listed several strategies for downtown Denver, including converting downtown circulators to fixed guideway systems and developing station master plans for the Welton/Downing corridor. Transportation strategies recommended for the River North area (including Five Points) included an operational study for the 38th/Blake station and the encouragement of high-density mixed-use developments around the station. It also recommended Welton Street signal improvements (in conjunction with implementation of the East Rail line).



Northeast Downtown Neighborhoods Plan

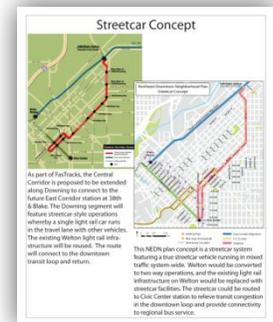
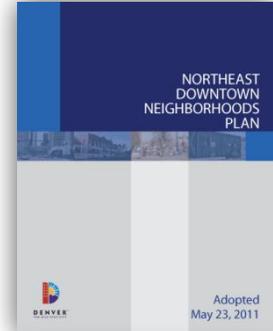
This report, adopted by the City and County of Denver in 2011, was aimed at improving the land use, transportation, and urban form of the northeast Denver neighborhoods (those directly adjacent to downtown). Key findings included:

- It was clear from the previous experience of introducing rail transit onto Welton in the 1990s that the investment of transit infrastructure alone will not result in development.
- Two-way operations on Welton may help support the main street character of this corridor. Conversion of Welton would be necessary to support any future two-way streetcar operations and is contingent on that project and the associated removal of the current light rail infrastructure.

In particular, the report highlighted a streetcar system as a way to enhance transit service and economic development opportunities in the Welton and Downing corridors “while improving the walkable character” of the corridor. As the report noted, “The vision for the Northeast Downtown Neighborhood Plan’s streetcar concept is a streetcar system featuring a modern streetcar vehicle operating on rails in mixed traffic for the length of the [Welton-Downing] route. The conversion of Welton to two-way operations between 24th Street and Downing Street is likely required, with the existing light rail infrastructure being removed or modified to allow streetcar vehicles to run in mixed traffic. This would include removal of the high platforms for boarding at existing stations and could provide more right of way for wider sidewalks.”

The report further noted, “A thorough analysis of the streetcar concept, including an inclusive public engagement process, is necessary to understand the impact on adjacent neighborhoods and historic properties, city-wide transit services, pedestrian access, automobile traffic, and side street movements as well as overall feasibility and cost. The options for a streetcar maintenance facility location, either in the corridor or elsewhere, would also need further exploration. The location would greatly depend on the potential streetcar vehicle compatibility with existing RTD light rail vehicles and future potential streetcar service in other urban corridors.”

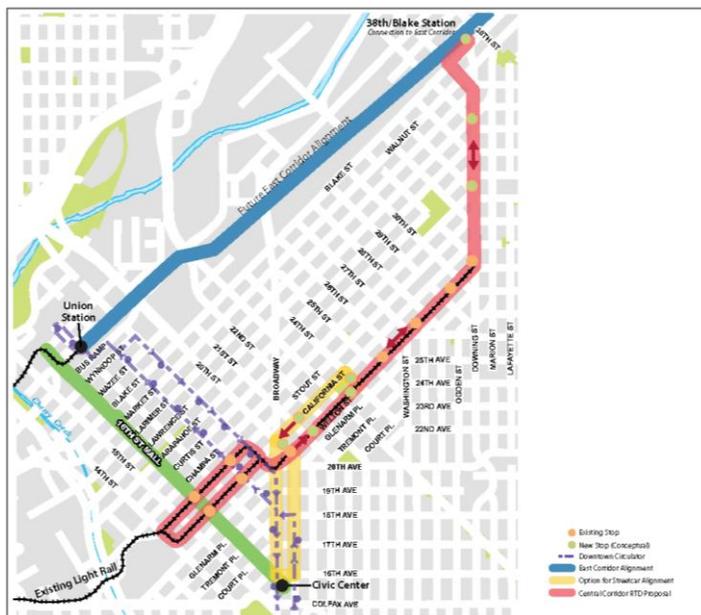
The report specified several areas where a streetcar investment could benefit the neighborhood, including improving neighborhoods connection and character, mobility, development opportunities, and livability and the public realm. It further recommended:



- The use of modern streetcar vehicles (shorter and narrower, with shorter turning radii and low floors) in place of the existing light rail vehicles.
- Further study to help determine if a potential streetcar couplet on Welton and California between 24th and Broadway is “feasible or advisable.”
- Examination of the feasibility of alignment options to interact with downtown circulation, including the potential of accessing the downtown light rail loop.
- Development of a “streetcar concept plan” to establish a long-range vision for streetcar service in other Denver neighborhoods.

Figure 1-10 is a conceptual streetcar alignment options map developed for the report to outline alternatives for further study in the future.

Figure 1-10: Northeast Neighborhood Plan Streetcar Concept



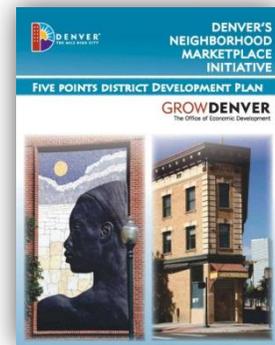
Source: Northeast Downtown Neighborhoods Plan, City and County of Denver

In 2013, the City and County of Denver undertook the Northeast Downtown Neighborhoods Plan Next Steps Study to prioritize the transportation infrastructure projects recommended in the earlier study and identify implementation strategies for projects that are feasible and/or appropriate. Its recommendations are planned for release at the end of 2014.

Five Points/Welton Street Studies

Five Points Marketplace Initiative

This 2009 report was commissioned by Denver’s Office of Economic Development as a pilot project for the City’s Neighborhood Marketplace Initiative. Its aims were to provide guidance on the economic strengthening of the Welton Street Corridor by helping to create a “more accessible and relevant” business district along the corridor; responding to land use and business challenges faced by the corridor; strengthening relationships between businesses, property owners, and residents; and attracting new development and investment to the corridor.



Some of its key recommendations related to a potential streetcar project include:

- Establishing the “optimum” zoning for the corridor to maximize development potential.
- Development of strategies to improve multi-modal access and to create “a street that is more accessible to transit riders, pedestrians, and bicycles,” including an exploration of transit alternatives and an investigation of “an alternative to the existing light rail configuration.” The report noted, “The Welton Stakeholder Group [established for the study] has expressed great interest in exploring streetcar and other transit alternatives to better serve the corridor.”

Five Points Sustainable Main Streets Initiative Vision Plan

This 2011 project, a collaboration between the Five Points Community and the Colorado Department of Local Affairs, was focused on working with community stakeholders in developing priorities for the corridor, including a vision and goal plan, a business revitalization strategy, a visitors center, a community health plan, and a sustainability plan. It had as a part of its overall outcome the aim of improving pedestrian friendliness and increasing transportation choices for the corridor. A major goal established for the process included transforming Welton Street “into a neighborhood commercial street scaled to achieve a balance of cars, pedestrians and transit...”



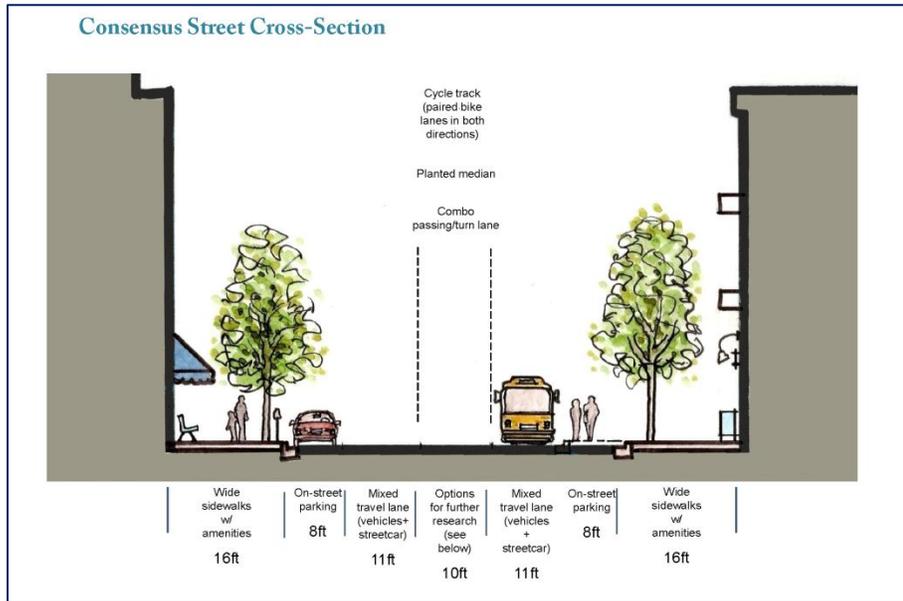
A major recommendation related to business development and marketplace identity was pursuing the “feasibility for converting the current rail system to streetcar.” A recommendation under land use and parking was to support “transit oriented uses” and create “transit supportive strategies that support an accessible and vibrant commercial neighborhood marketplace.”

More specific ideas related to transit were included in the project’s “transportation, streets, and sidewalks” recommendations. The study noted, “A streetcar was frequently identified as a

solution more in scale with the desired neighborhood,” and a specific recommendation was to convert Welton Street to two-way operations and replace the existing light rail system with a “two-way streetcar.” Study participants developed a “consensus vision” for Welton Street in relation to the “positive impacts that streetcar could achieve for Welton, specifically slowing traffic, activating sidewalks with amenities and improving pedestrian safety on Welton Street.”

Figure 1-11 illustrates the study participants’ consensus vision for Welton Street, which includes wider sidewalks, mixed streetcar/auto lanes, and two-way traffic operations.

Figure 1-11: Consensus Vision for Welton Streetcar



Source: Five Points Sustainable Main Streets Initiative

Final recommendations related to transportation include:

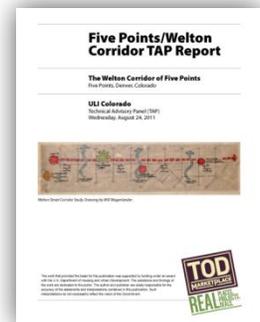
- Working with the City of Denver to plan for a Welton Street corridor that balances “access and safety for cars, bikes, transit and pedestrians” by advocating for the conversion of Welton to two-way operations “to improve business access, slow traffic and to allow for future two-way transit.”
- Working with the City to “pursue plans consistent with the community Vision Plan’s preferred street cross-section” including consideration of “a streetcar as more in scale with the proposed RTD Central Corridor circulator and with a neighborhood commercial district,” urban design features that provide safe separation from transit and autos, and preventing a “transit investment or reconfiguration that does not support the community vision and economic development.”
- Working with the City, RTD, the Downtown Denver Partnership, and the community to “discuss and study support for the potential of a streetcar” on Welton and Downing,

including identifying “the community's vision for streetcar to improve pedestrian mobility, fuel economic development and extend tourism and business from downtown through Five Points to the East Corridor,” and pursuing “funding for alternatives analysis, regional system feasibility and operation/maintenance planning” for a streetcar. The study noted that the Five Points Business District Office will continue to seek grants, partners, and funding “to study the concept of streetcar on Downing and Welton Street through Arapahoe Square and into downtown Denver.” The report further notes, “Built initially around horse-drawn streetcar, the Welton corridor is well-suited and located to serve as a streetcar demonstration project.”

The plan established a number of “next steps,” including working with RTD and the City to “identify benefits of streetcar, cost of the streetcar alternative, how it ties into downtown and to project the potential economic benefit.” It also recommended evaluating federal “small starts criteria and funding sources” for potential future streetcar design, construction, and operation on Welton.

Five Points/Welton Corridor TAP Project

This 2012 report was produced by a Technical Advisory Panel of the Colorado chapter of the Urban Land Institute. Its purpose was to produce strategies and practical ideas to revitalize the Welton Street corridor. The report identified several issues as top priorities to facilitate that redevelopment, including a more diverse mix of uses for commercial development and redevelopment in the corridor (including office uses), an improved public realm, and improved pedestrian safety and transit. Its recommendations included the pursuit of reconfiguring the Welton Street cross-section and “repositioning” light rail as a solution to support commercial revitalization of the area. The report’s panel “strongly supports developing a new street cross section that places transit in the middle of the street.” Key elements of the recommendation included:



- Examining streetcar as an alternative to light rail to replace the “currently inadequate” light rail corridor that terminates at 30th and Downing.
- Encouraging the use of Welton Street as a “streetcar pilot” project for Denver, including seeking alternative funding from the US Department of Transportation and encouraging the use of Welton “as a streetcar pilot to address emerging difficulties of light rail access in to the Central Business District.”

Five Points Welton Street Marketplace Vision Plan Implementation & Revitalization Strategy

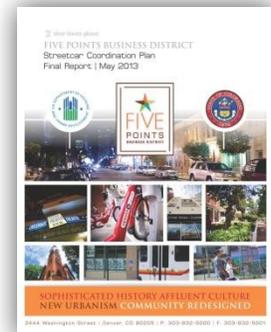
This 2013 report was an outgrowth of the 2011 Sustainable Main Streets Initiative Vision Plan and was focused on examining how the vision could be implemented. It examined the mixed-use development potential for the area, the market potential for redevelopment, the potential of the existing public infrastructure (primarily utilities) to support additional development,

potential zoning changes for the area to implement the vision, and financing options for new development. The report noted, “Though light rail and one-way traffic were created for regional mobility, they are not designed to best support a pedestrian friendly neighborhood business district. Together the street and alleys are 32% of land in the study area, more than enough area to rebalance cars, pedestrians and transit thereby improving safety and activating sidewalks. The community vision for a mixed-use neighborhood commercial district requires a safe pedestrian environment, business visibility and accessibility to redevelopment sites. Efforts, both public and private, must jointly work to create a safer pedestrian environment and a street that supports business access in the short and long term including the potential of a two-way Welton.” One of its major recommendations was: “Continue to pursue streetcar as a solution that mitigates the challenges light rail created for safety, economic development and the rising cost of light rail for planned connections between the East corridor and downtown. The community has long supported transit on Welton and the light rail, originally identified as a pilot project in 1996, has provided important connectivity into downtown, but the rising cost of light rail and the need for a more pedestrian friendly solution means that streetcar may be a refinement and solution to better weave Downing, Welton and Arapahoe Square with downtown Denver. Do not compromise on the need for a safe and vibrant pedestrian environment along Welton that supports access and visibility for a strong business environment.”

Five Points Streetcar Coordination Plan

In 2013, the Five Points Business District worked with the Colorado Department of Local Affairs, the City and County of Denver, and other entities to undertake a transportation, planning, and funding options analysis for the potential implementation of a streetcar in the Welton Street corridor.

The Five Points Streetcar Coordination Plan was conducted as a response to the goals and desires of local stakeholders and the Five Points business community regarding the future of the Welton Street corridor as embodied by the Northeast Denver Neighborhoods Plan, the Five Points Sustainable Main Streets Initiative Vision Plan, and other plans. The project identified the key issues surrounding the potential for constructing and operating a streetcar system in the Five Points neighborhood, including potential conversion of Welton Street to two-way operations and options for the reconstruction of the existing light rail infrastructure to accommodate a streetcar operations in mixed-flow traffic.



Central Rail Extension Mobility Study Purpose and Goals

With these and other projects and activities as background, the Central Rail Extension Mobility Study project team met with a number of key stakeholders and the general public to develop a vision statement and a set of goals for this project. In addition to public meetings held in February and July 2014, key stakeholders who were consulted included:

- Study area elected officials, focused on RTD Board members and City and County of Denver council members from districts included in the study area. An initial briefing was conducted in January 2014.
- A Project Task Force, consisting of representatives from neighborhood groups and other community interest groups. This Task Force initially met in February 2014, with followup meetings later in the project.
- A Project Oversight Committee (POC), comprised of representatives of key stakeholders from the project study area. In addition to RTD staff, this Committee consisted of representation from the City and County of Denver, the Downtown Denver Partnership, and the Five Points Business District. This group met roughly monthly throughout the course of the project.

Based on guidance received from these groups and others, the project team developed the overall purpose statement for the project:

The primary purpose of the Central Rail Extension Mobility Study is to determine the best way to provide a direct rail transit trip between the 38th/Blake Station and downtown Denver without a transfer. This includes the re-examination of the use of the downtown light rail loop for CRE service, including an analysis of traffic and pedestrian signal timing and other infrastructure requirements to determine the true feasibility of providing a one-seat ride for passengers from the 38th/Blake station into the downtown loop without requiring a transfer.

To supplement the overall purpose statement, the project team developed (in consultation with the public and project stakeholders) three primary goals for the project:

Goal 1: Open the Central Rail Extension as close to the opening of the East Rail line as possible. This means that RTD and the community will pursue all potential funding and implementation options to construct and open the CRE extension from 30th/Downing to 38th/Blake as close to the opening of the East Rail line in 2016 as possible. This includes applying for any and all grant funding that might be available in the short term to facilitate the construction and working with potential project partners from both the public and private sectors to develop a funding package to allow short-term implementation of the extension. Based on this goal, the primary short-term aims of the project are:

- To provide maximum convenience and access for rail transit riders to and from central downtown by way of the East Rail line;
- To improve access to and from downtown for Northeast Denver residents, employees, and visitors; and
- To improve overall downtown rail transit circulation.

Goal 2: Work toward introducing neighborhood-friendly low-floor vehicle technology as soon as practicable. This means that RTD will utilize the vehicle technology readily available at the time of initial opening of the CRE (light rail vehicles). However, to help fulfill the community vision and desires expressed in numerous previous studies, RTD will continue to examine the option of introducing streetcar-type vehicles in the Central Rail corridor and potentially other corridors as soon as is practicable given future vehicle replacement and procurement schedules and funding availability.

Goal 3: Establish a long-term vision for future potential expansion of the CRE and other rail transit services in downtown Denver. This study will examine a number of potential long-range expansion options for CRE and other RTD services that can provide additional passenger capacity for RTD in the future. It will also examine other long-term implementation issues related to the future of passenger rail service and its interaction with the community downtown and in other nearby neighborhoods, including Five Points and the Auraria campus, as expressed by other previous and ongoing studies.

Each of these three major goals is discussed in more detail in the following chapters.

2 Goal 1: The One-Seat Ride

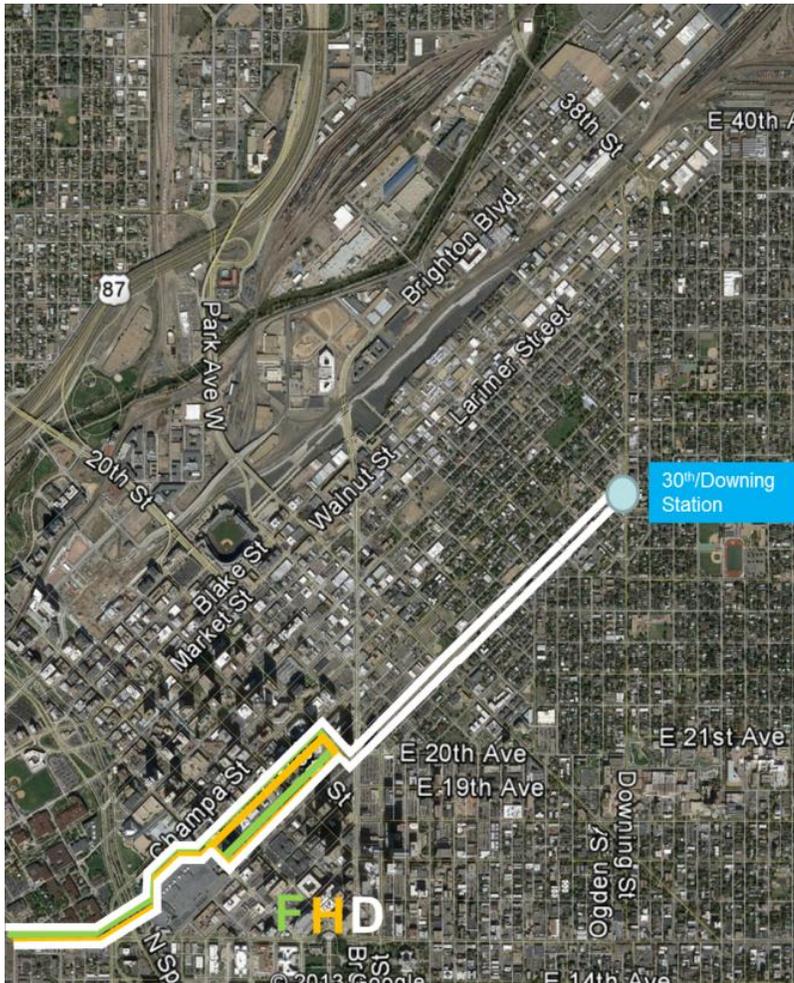
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- To provide maximum convenience and access for rail transit riders to and from central downtown by way of the East Rail line;
- To improve access to and from downtown for Northeast Denver residents, employees, and visitors; and
- To improve overall downtown rail transit circulation.

Introduction

The goal of providing a one-seat ride from the East Rail 38th/Blake station into downtown Denver is predicated on a revision to RTD's current light rail operating plan. Currently, as shown in Figure 2-1, the F and H light rail lines enter downtown from the Southeast corridor, circling through the downtown loop and returning to the Southeast. The D Line enters the downtown loop from the Southwest corridor, continuing up Welton Street to its terminus at the 30th/Downing station. From that point, it returns down Welton Street and re-enters the downtown loop on the northeast side of downtown to return to the Southwest corridor.

Figure 2-1: Current Downtown Light Rail Operating Plan

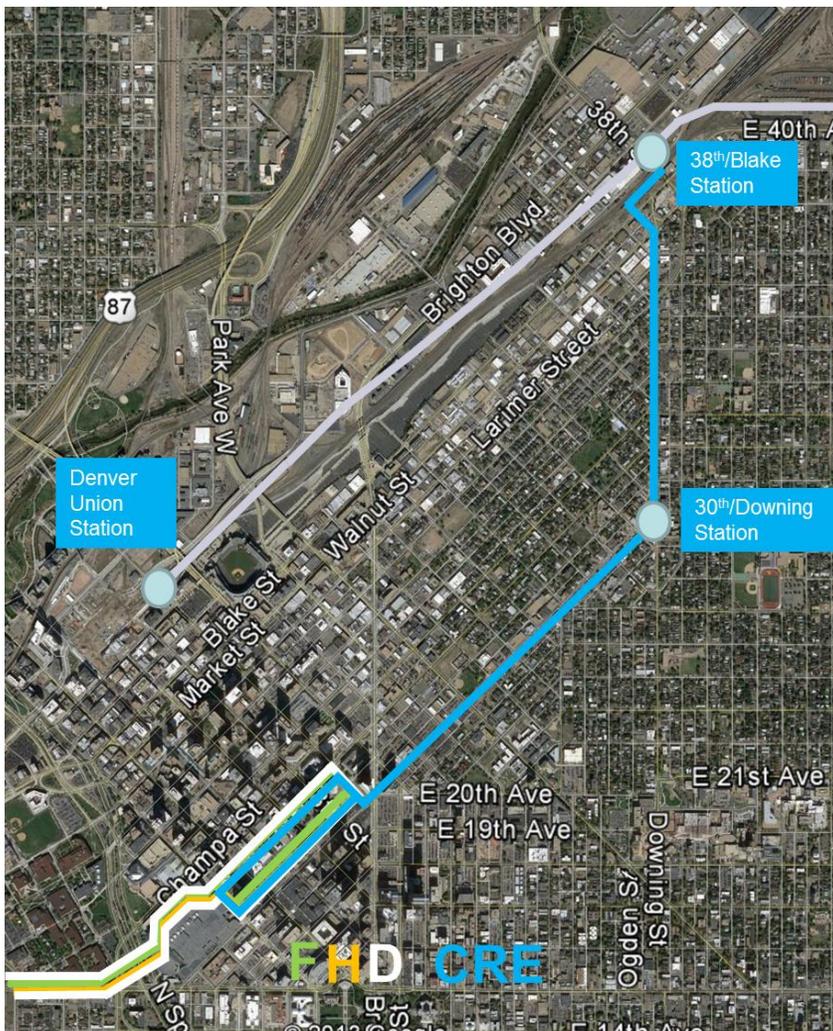


Source: Project Team

How Important is the one-seat ride? 91% of all public comments received as of the end of August 2014 said it was “very important” (82%) or “somewhat important” (9%).

Figure 2-2 shows how the Central Rail line is envisioned to operate in coordination with the other existing rail lines. In this case, the F and H lines would continue to operate as they have in the past, entering downtown at 14th and Stout and cycling through the downtown loop and returning to the Southeast corridor. However, the D Line's operations would change; instead of continuing up Welton Street to the 30th/Downing station, it would cycle through the downtown loop similar to the F and H lines and return to the Southwest corridor. The new CRE line would run from the 38th/Blake station on the East Rail line south on Downing Street, turning southwest on Welton Street at the 30th/Downing station, and enter the downtown loop on the northeast side of downtown and cycle through the loop, returning up Welton and Downing Streets and back to the 38th/Blake station. It would provide passenger access to existing downtown light rail stations, with the potential for a new station at the Convention Center on the south end of the loop that would be served only by CRE trains.

Figure 2-2: Proposed Light Rail Operating Plan with Introduction of CRE Line



Source: Project Team

As noted in Chapter 1, the preferred alternative developed in the 2010 Central Rail Extension Environmental Evaluation (EE) recommended using single-vehicle light rail vehicles running in the traffic lanes on Downing Street from the 38th/Blake East Rail station, then running on the original D-line track on Welton and cycling into the downtown loop every 15 minutes. According to the EE, “the addition of four trains each hour would not adversely affect loop operations of the Southwest Corridor D Line and the Southeast Corridor F and H Lines. Even though D, F, and H Lines operate with relatively short spacing, adequate time gaps exist for introduction of Central Corridor Extension light rail vehicles into the downtown loop. Future service would operate in a scheduled sequence on a first in, first out basis within parameters of the downtown traffic signal network.”

However, subsequent to the approval of the EE, the City and County of Denver revised its standard downtown traffic and pedestrian signal timing from 75 to 90 seconds to accommodate four-car light rail trains in the downtown loop. This resulted in the loss of available openings for additional light rail trains in the loop, reducing the number of slots from 24 to 20. Current RTD light rail operations require 14 of the 20 slots per peak hour, and the Central Rail Extension EE preferred alternative would require an additional four slots per hour on top of the existing 14, leaving only two slots open for help with operational delays or disruptions in the downtown loop. Additionally, initial transit simulations showed that the movement of these additional CRE trains looping around at 14th and Stout (the location of the “throat” for trains entering and exiting the downtown loop) did not fit within the existing light rail schedule. Consequently, the operating plan envisioned in the EE was considered potentially infeasible as it would likely cause severe negative impacts to on-time performance on the existing lines.

Initial On-the-Ground Analysis

To help test and analyze the issues associated with adding new CRE service into the downtown loop, RTD operated a test train at the end of the afternoon peak period on a weekday in September 2013 to better understand the obstacles encountered with running trains through the downtown light rail loop around 14th Street. As noted earlier, the Central Rail Corridor Extension Environmental Evaluation recommended a new train “overlay” operating from the downtown loop to 38th and Blake in addition to existing trains. This requires an additional train running through the loop every 15 minutes, turning at 14th Street to head back north. It was assumed that the existing D Line to 30th and Downing would terminate at the downtown loop, turning around at 19th Street.

According to the RTD staff memo prepared as a result of the test:

The train started from the Mariposa Division and used an extraboard operator and LRV 298, operating as block 80. The train started northbound from Mariposa at 5:52 PM, after the northbound D-Line passed. It then followed that train northbound, looping back at 19th Street, and ran two loops around 14th Street, effectively simulating a train coming from 38th & Blake every 15 minutes. The test train was scheduled to operate after the D-Line to/from 30th & Downing and Mineral and before the H-Line to/from 18th

Street and Nine Mile, where there is a six minute gap in the schedule due to the open slots that the C-Line and E-Line fill south of CPV Junction. This would be the best way to schedule the extra trains that would operate from 38th & Blake.

The test train provided mixed results and helped confirm information that was analyzed before and also brought up new information. Overall, the operation was conducted smoothly and seemed to work fairly well.

One positive result is that the traffic signals cooperated well. Near 14th Street, the test train only had to wait about 15-20 seconds for traffic to clear and proceed along 14th Street, which also gave enough time for control to throw the switch. After that, the test train proceeded similar to a northbound train along California and received favorable signals crossing California and crossing 15th Street before stopping at the 16th & California Station.

A negative result, as was also determined during previous simulation analysis, is that the additional train held up in-service trains in both directions. This is largely caused by the train creating a new loop at the other end and not matching the even headways of those trains coming from the other direction; in principle, a conflict. This conflict was first seen when the test train ran ahead of a northbound D-Line, which it had followed 15 minutes prior. Waiting for the southbound D-Line at 18th & California delayed this northbound D-Line by about 5 minutes. Conversely, waiting at 14th & Stout for the D-Line would have delayed the southbound H-Line by one or two signal cycles.

The test was able to show how the operation proposed in the Environmental Evaluation interacts with the existing operations. As a result of the analysis, RTD staff recommended two options that should be examined in order for utilization of the downtown loop by CRE trains to be considered a viable alternative:

- Modifications to the downtown traffic and pedestrian signals to allow for dynamic phasing to better serve the LRT and minimize delays in the downtown loop; and/or
- Capital infrastructure for the RTD light rail system including but not limited to:
 - The construction of a pocket or staging track somewhere in or adjacent to the downtown loop to allow CRE trains to “get out of the way” of other trains to maintain schedule reliability.
 - Train signal improvements along the LRT line outside of downtown and/or a grade separation of the light rail tracks at the Central Platte Valley junction west of downtown.

Development of Alternatives

As a result of the on-the-ground analysis and through consultation with key project stakeholders, the CRE project team developed a series of alternatives related to facilitating

implementation of the Central Rail Extension. Each option was evaluated according to a series of criteria organized into three major categories:

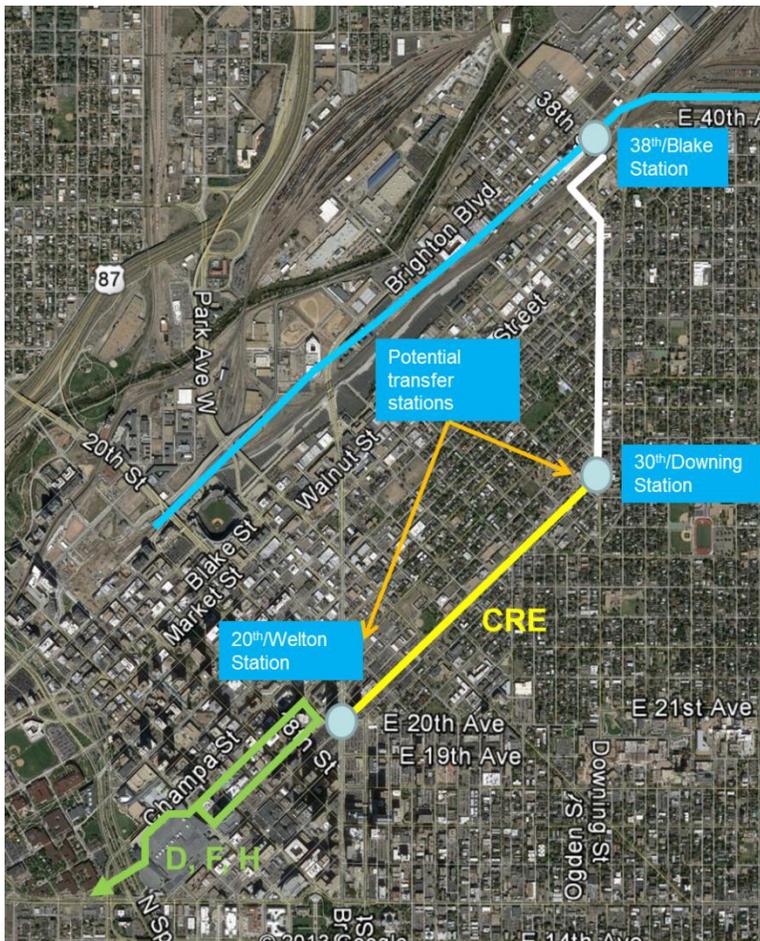
- **Mobility criteria**, including rail operations reliability, new passenger station opportunities (particularly at the Convention Center at the south end of the downtown loop), rider convenience, bicycle facility impacts, auto impacts, pedestrian impacts, and sidewalk impacts.
- **Urban character criteria**, including property impacts and streetscape/urban design impacts.
- **Deliverability criteria**, including infrastructure costs and constructability.

How Important is it to have a CRE station at the Convention Center? 87% of all public comments received as of the end of August 2014 said it was “very important” (61%) or “somewhat important” (26%).

Alternative 1: Transfer to the Existing D Line

This option would implement the implications of the conclusions of the post-EE analysis, which determined that the downtown loop could not accommodate additional trains due to the changes in signal timing downtown implemented by the City and County of Denver. In lieu of developing completely new alignment alternatives (such as a new connection to the Civic Center station as shown in Chapter 1 in Figure 1-7, or a new downtown loop as shown in Figure 1-8), this option would require transit riders to transfer from the CRE line to the D Line at either the 30th/Downing station or the 20th/Welton station, as shown in Figure 2-3.

Figure 2-3: Alternative 1 – Transfer to the Existing D Line



Source: Project Team

Key Opportunities

- Relatively low capital cost and infrastructure requirements (it would require some new station and track infrastructure at either the 20th/Welton or 30th/Downing stations to facilitate cross-platform transfer).

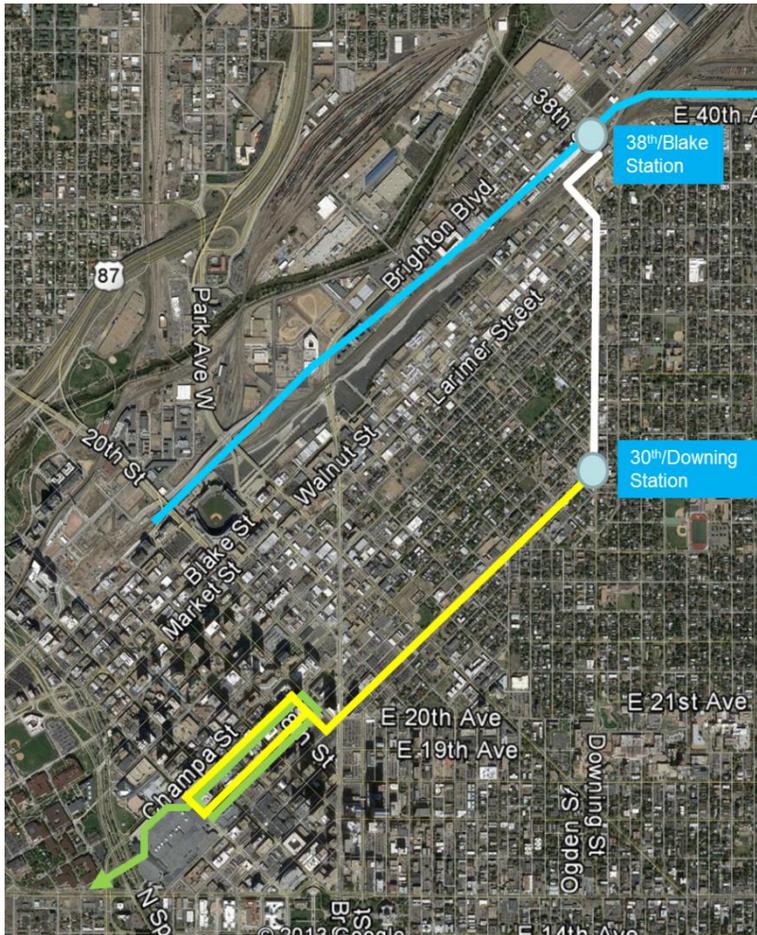
Key Challenges

- No new station or redevelopment opportunities.
- Does not provide a one-seat ride for passengers coming from East Rail line. It would require users from East Line to make two transfers to reach downtown (at 38th/Blake and at the junction of the CRE and D lines at either 20th/Welton or 30th/Downing).

Alternative 2: Use the Downtown Loop with No Infrastructure Improvements

This option would introduce new CRE service as an “overlay” onto the downtown loop using current infrastructure (see Figure 2-4). It would add new one- or two-car trains every 15 minutes into the downtown loop, using available scheduling and timing.

Figure 2-4: Alternative 2 – New CRE Line in Downtown Loop with No Improvements



Source: Project Team

Key Opportunities:

- Minimal capital cost – it does not require new track construction or additional infrastructure.

Key Challenges:

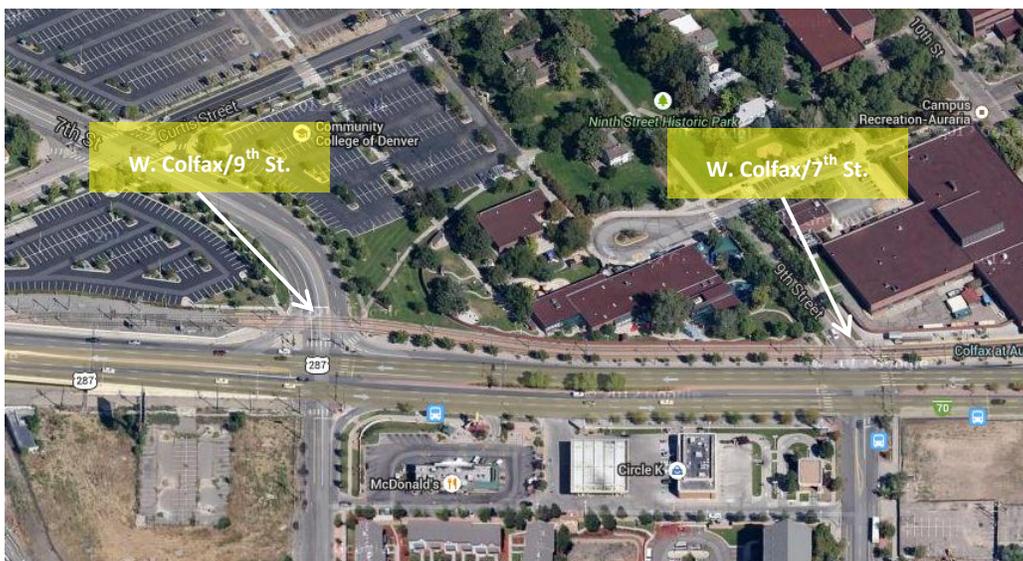
- The addition of new service into the downtown loop without new track infrastructure would result in significant operational delays and inefficiencies. It would reduce system reliability and passenger convenience and could result in delays not only in the CRE system but also in the existing D,F, and H Line operations. Therefore, the option is fatally flawed.

Alternative 3: Use the Downtown Loop with New Infrastructure

This category of options assumes the construction of new track infrastructure in the downtown loop to promote operational reliability. As noted in the staff investigation of train movements in the downtown loop in September 2013, two types of infrastructure improvements were recommended for investigation to help integrate the CRE into the downtown loop and maximize operational reliability:

- **Traffic and pedestrian signal improvements** to improve operations of all trains in the downtown environment. This could include examination of potential revisions to signals both within downtown and outside of downtown to improve train operations. After reviewing this issue with staff from the City and County of Denver, the possibility of modifying downtown signals is limited due to the previous re-timing of those signals to facilitate movement of four-car trains through downtown. However, RTD staff was able to work with Denver staff to modify and improve signalization at 7th and 9th Streets west of downtown (south of the Auraria campus – see Figure 2-5) to improve light rail interaction and movement at those locations, which also improves operations of trains as they enter and exit downtown.

Figure 2-5: Location of Traffic Signal Revisions to Improve Light Rail Train Movements West of Downtown



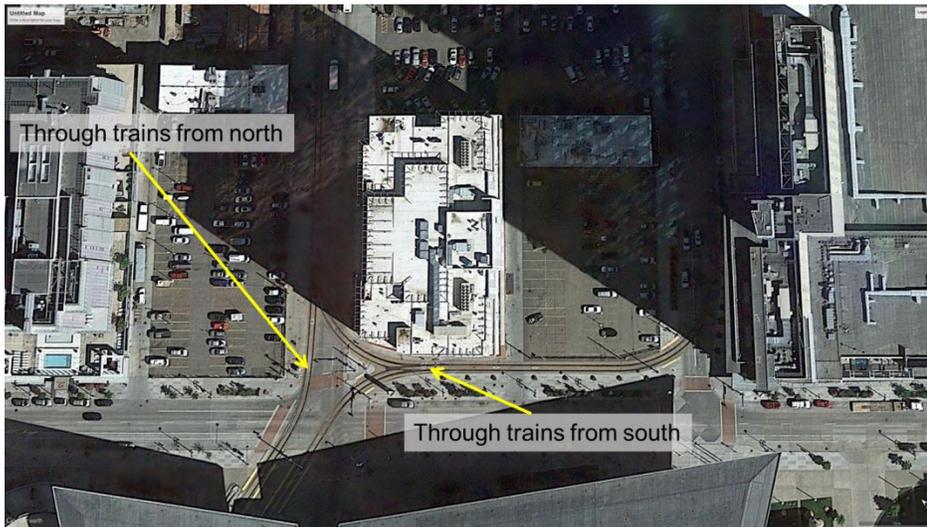
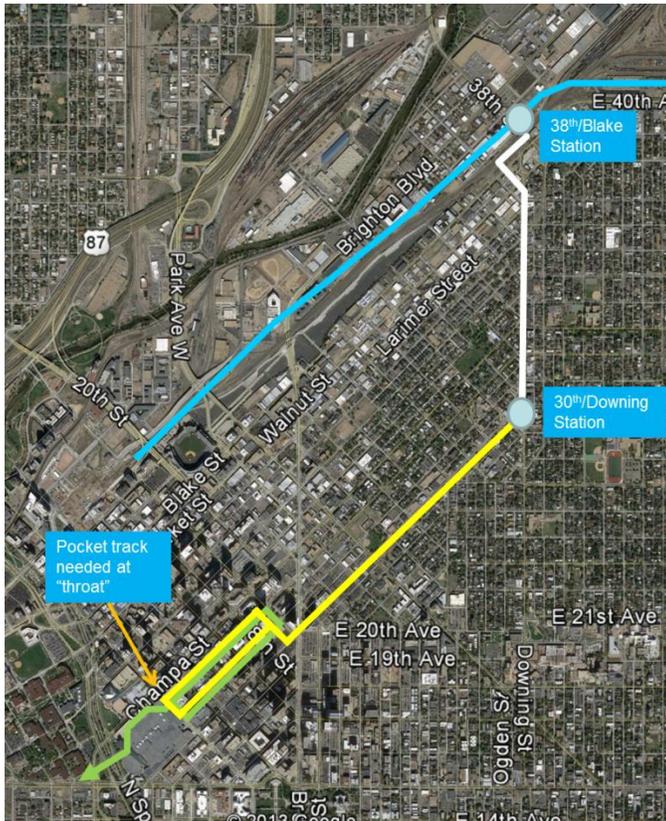
Source: Project Team

- **Rail infrastructure improvements**, including light rail signal improvements, a grade separation at the Central Platte valley light rail junction south and west of the Colfax/Auraria station, and/or a pocket track, preferably on the southern end of the loop near the “throat” at 14th and Stout.
 - Partly as a result of this analysis, RTD staff re-examined train signalization along the light rail segment west of downtown between the 10th/Osage station and the

Central Platte Valley Junction to determine if operational reliability could be improved for trains entering downtown, and subsequently made adjustments to signal location to improve overall train operations.

- The potential for a grade separation at the Central Platte Valley junction (where trains coming from the southeast and southwest split northbound to serve the Central Platte Valley/Denver Union Station and the downtown loop, with southbound trains merging at this same location) had previously been investigated by RTD. While such a grade separation has the potential to significantly improve operations and reliability for trains moving into and out of downtown, the cost and right-of-way requirements make it a less desirable option.
- Finally, the option of establishing a pocket or extra track downtown to improve overall downtown loop operations while facilitating the integration of CRE operations was deemed to be a logical option. A pocket track is a short piece of extra track that would be added to the downtown system to allow CRE trains to move out of the stream of traffic of other trains so as not impede their operations and to allow the entire system to operate more efficiently. The project team considered two potential locations for this pocket track: at or near the north end of the loop along 19th Street, and at the southern end of the loop near 14th/Stout. While there was likely right-of-way available at the northern end on 19th Street, further examination of light rail movements (including the field visit in September 2013) confirmed that the most significant operational bottleneck occurs at the southern end of the loop at 14th/Stout (see Figure 2-6), where trains both enter and exit downtown. Therefore, the remaining alternatives all included some type of new infrastructure near 14th/Stout to accommodate CRE operations in the downtown loop. Those alternatives are each described in more detail below.

Figure 2-6: Preferred Location of New Track Infrastructure at Downtown Throat at 14th/Stout

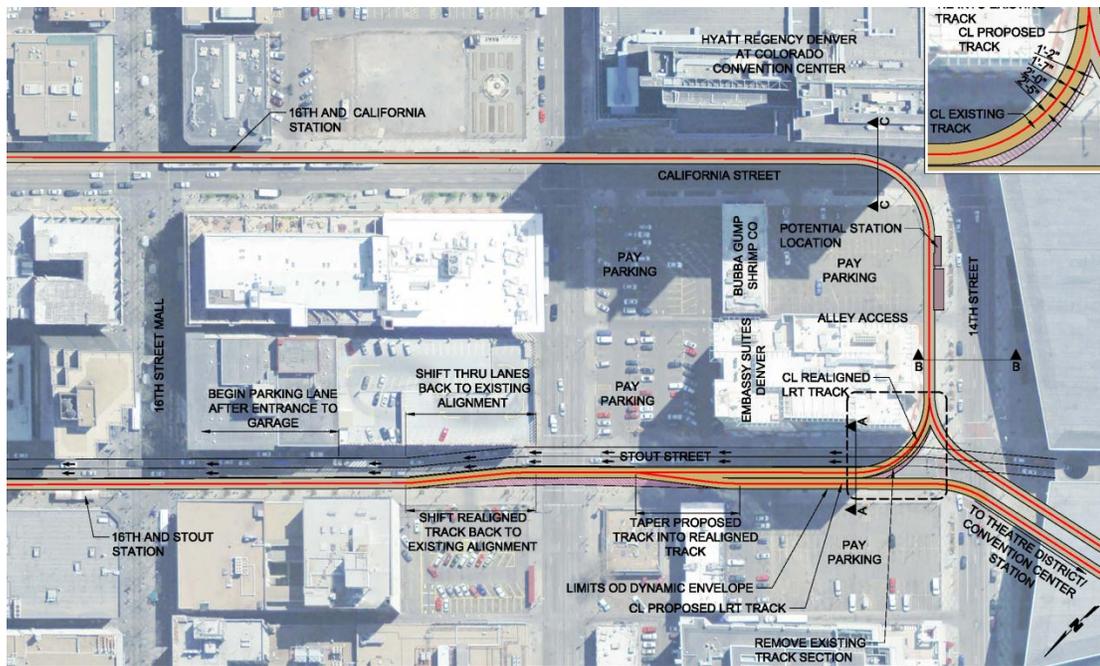


Source: Project Team

Alternative 3A: Use Existing Track on 14th Street

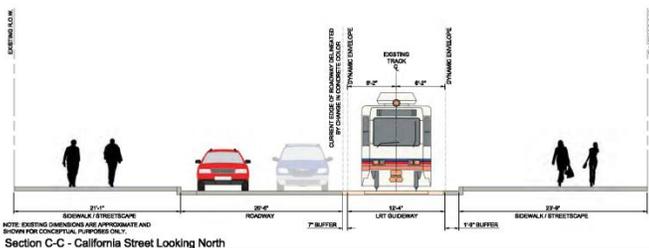
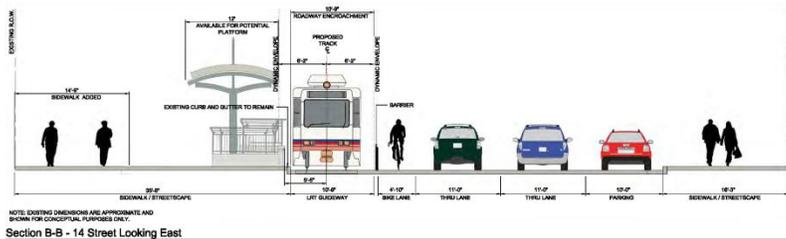
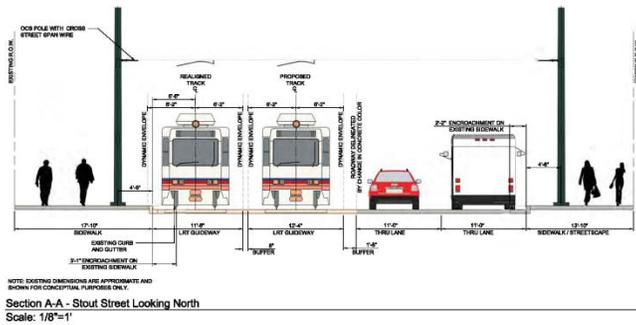
This alternative (see Figures 2-7a and 2-7b) proposes the construction of a pocket track along the west side of Stout Street just north of 14th Street to accommodate a potential future maximum two-car CRE consist. It uses existing track infrastructure along 14th Street to the extent possible. It assumes the location of a passenger stop/platform along the existing pedestrian plaza on 14th Street to provide CRE access to the Convention Center. It requires minor deviations to northbound traffic lanes at 14th/Stout to accommodate the pocket track in the street right-of-way, and the loss of two to three parking spaces on northbound Stout north of 15th Street and minor relocation of the existing southbound light rail track on Stout to accommodate the pocket track.

Figure 2-7a: CRE Alternative 3A Plan View



Source: RTD

Figure 2-7b: Alternative 3A Typical Sections



Source: RTD

Key Opportunities:

- Minimal impact to sidewalk on Stout
- Maintains two through lanes northbound on Stout and will therefore not impact vehicular operations along Stout Street
- Minimal cost option (utilizes existing light rail track on 14th)
- Does not impact parking or the proposed future bicycle lane on 14th
- No need to revise traffic or pedestrian signals at 14th/Stout; existing signal timing can be maintained.

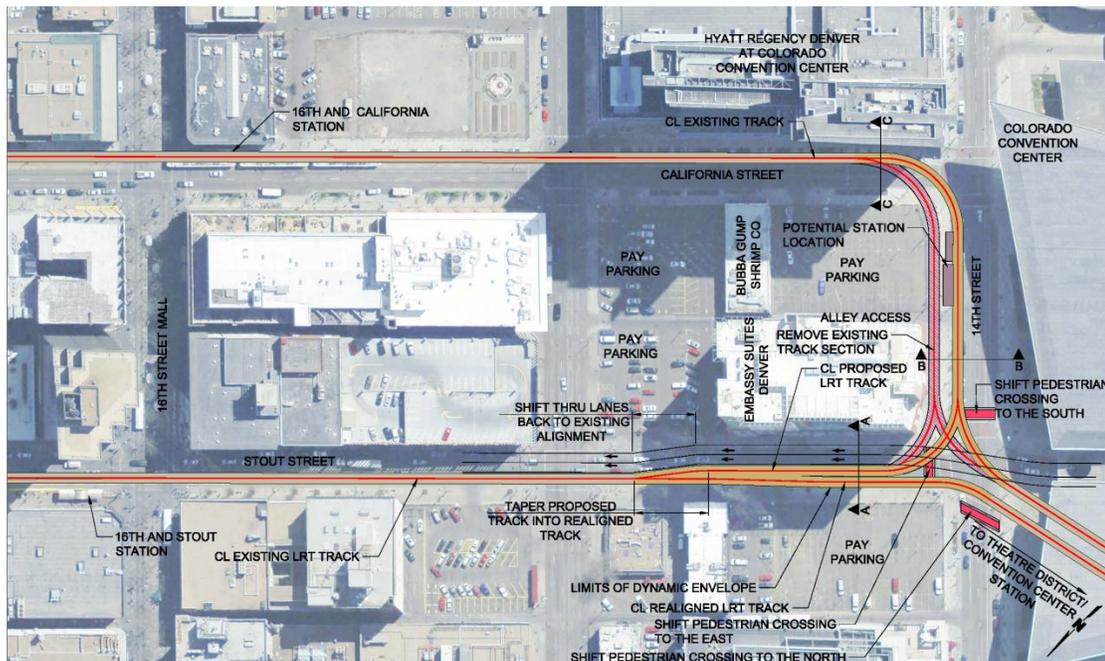
Key Challenges:

- Locates passenger stop in existing (relatively narrow) plaza on 14th
- Maintains existing confusing (and sometimes dangerous) pedestrian island at 14th/Stout

Alternative 3B: New Track on 14th Street in Parking Lane

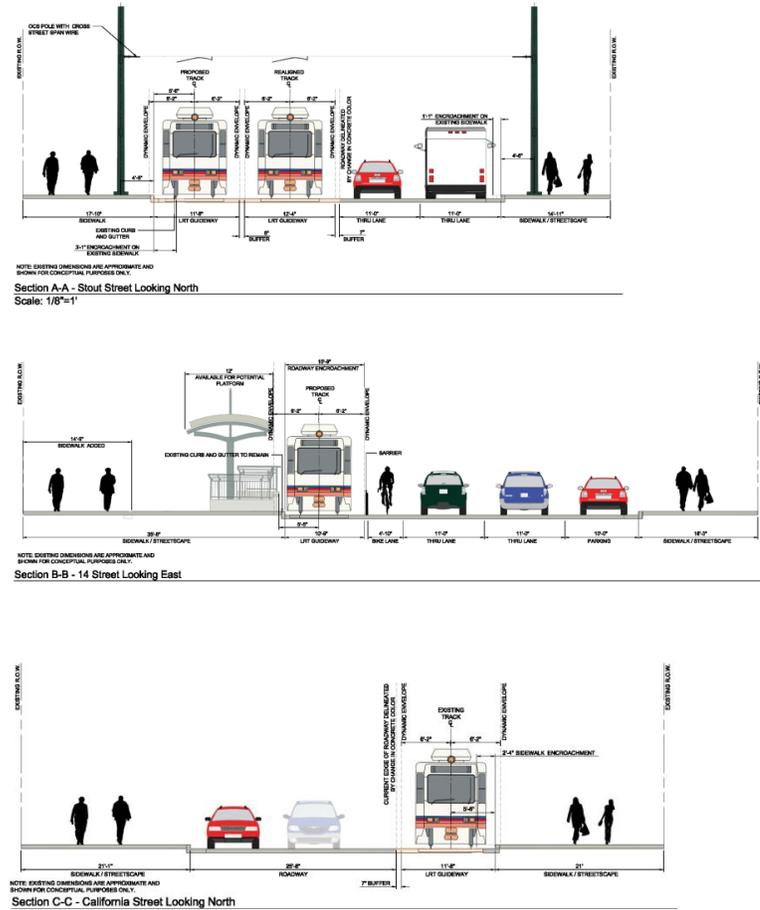
This option (see Figures 2-8a and 2-8b) assumes the removal of the existing track on 14th Street and construction of a new track in the existing parking lane on 14th Street (requiring the elimination of nine parking spaces). By removing the existing track, this option creates a wider pedestrian plaza on 14th Street and provides more room for a passenger stop/platform on the plaza. Similar to option 3A, this option maintains two through northbound traffic lanes on Stout through a minor deviation of the existing lanes to accommodate the pocket track on Stout, but since the new track on 14th Street is located farther south than the existing track, it no longer impacts Stout Street north of 15th Street.

Figure 2-8a: Alternative 3B Plan View



Source: RTD

Figure 2-8b: Alternative 3B Typical Sections



Source: RTD

Key Opportunities:

- Improved pedestrian crossing environment at 14th/Stout by eliminating existing island
- No impact to proposed bicycle lane on 14th
- Wider pedestrian plaza on 14th, opportunity for “storefront” or sidewalk café development on 14th
- Moves southbound traffic stopbar on California farther south, reducing the length of the traffic signal clearance interval.

Key Challenges:

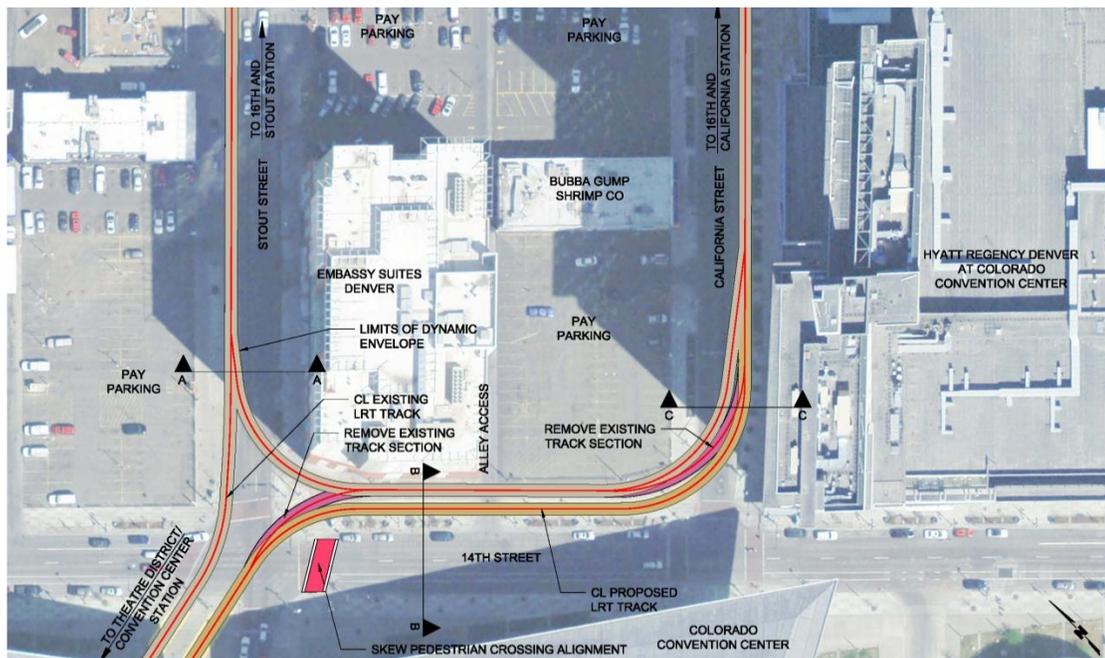
- Higher cost (removal of existing track and construction of new track)
- Requires new pedestrian crosswalks at 14th/Stout

- Possible impact to pedestrian signal timing at 14th/Stout due to the elimination of the all-walk pedestrian phase, which would now be used to accommodate the train movement. Pedestrian movements would now occur concurrently with the vehicular phases, introducing potential pedestrian conflicts with right-turning vehicles. This may negatively impact pedestrian safety and vehicular operations.
- Eliminates nine parking spaces on 14th Street

Alternative 3C: New Track on 14th Street on North Sidewalk

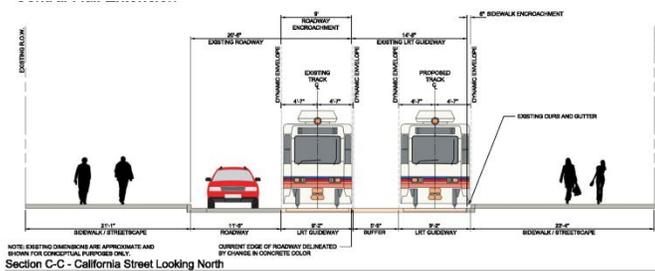
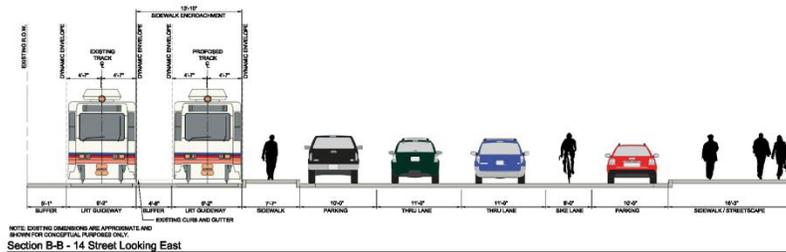
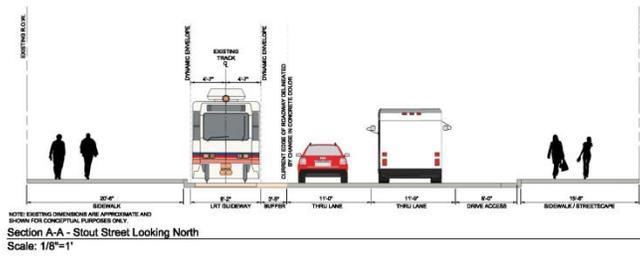
This option (see Figures 2-9a and 2-9b) assumes the retention of the existing track on 14th Street for use of the CRE and construction of a new track on the sidewalk on the north side of 14th Street for use by through trains from the south. This extra track on 14th Street eliminates the need for a pocket track on Stout Street. It requires a new track segment on northbound California Street to accommodate the new track on 14th.

Figure 2-9a: Alternative 3C Plan View



Source: RTD

Figure 2-9b: Alternative 3C Typical Sections



Source: RTD

Key Opportunities:

- No impact to parking or future bike lane on 14th
- Minimal traffic signal impacts at 14th/Stout and 14th/California since train movements would continue to be accommodated as they are today during the all-walk pedestrian phase

Key Challenges:

- No station or redevelopment opportunity
- Impacts pedestrian plaza on 14th
- Could require relocation or removal of existing streetscaping
- Potential pedestrian crossing impacts at 14th/Stout. The existing sidewalk crossing on 14th Street west of Stout Street would need to be re-aligned to provide sufficient pedestrian refuge. If this cannot be accommodated, this crossing may need to be removed from the all-walk pedestrian phase when the train movements occur and run concurrently with the Stout Street vehicular phase. Concurrent operations may introduce additional pedestrian

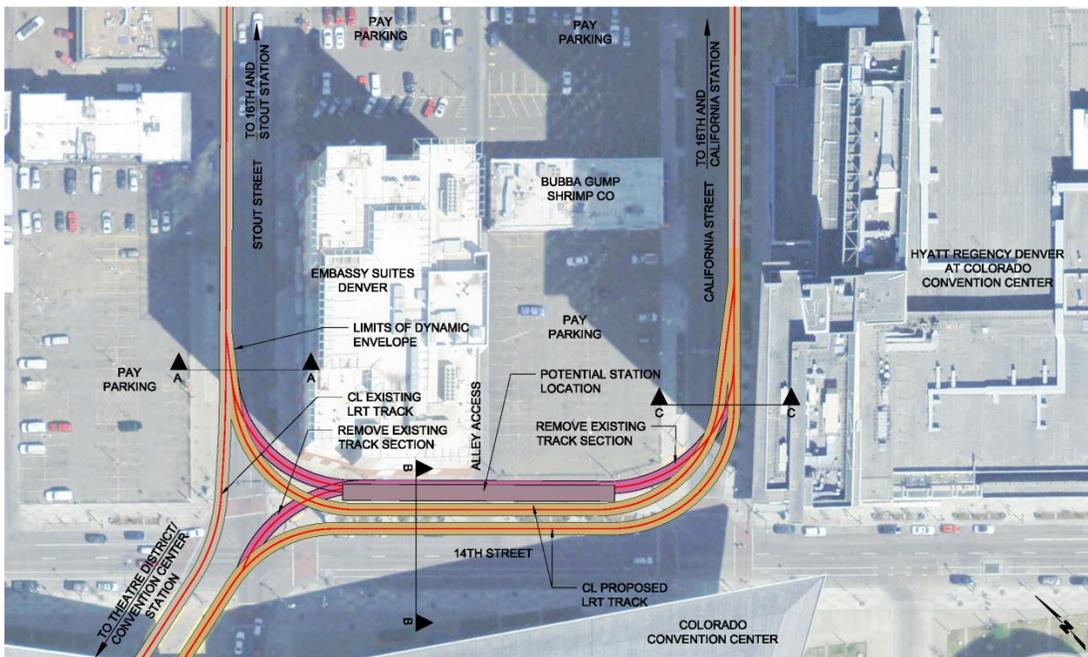
conflicts with right-turning vehicles, potentially negatively impacting pedestrian safety and vehicular operations.

- Potential right-of-way impacts at 14th/Stout
- Potential relocation of stopbar on California farther north, which would require extension of the clearance interval and would result in negative impacts to the efficiency of the traffic signal.

Alternative 3D: Two New Tracks on North Side of 14th Street

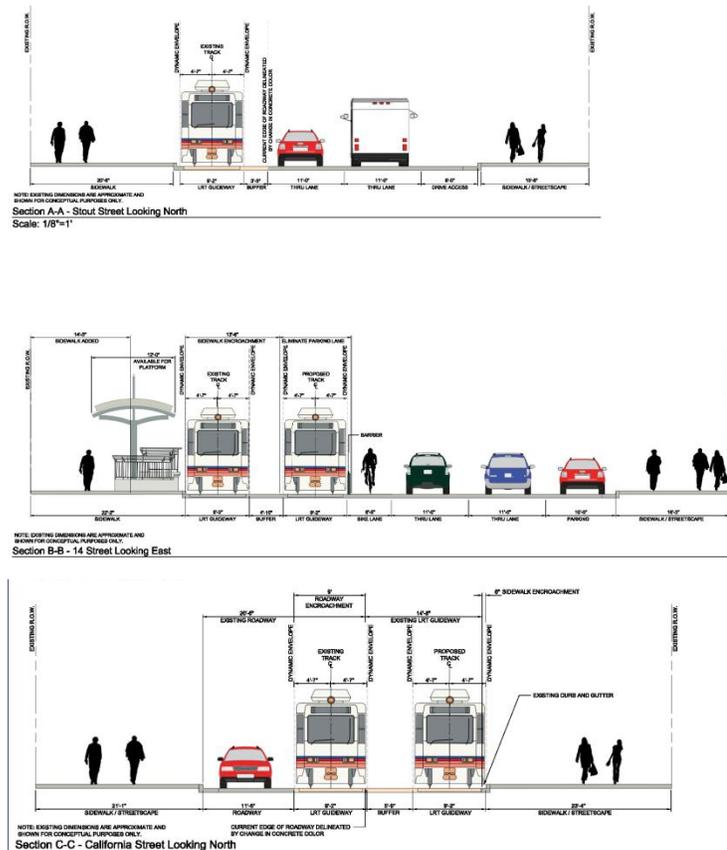
This alternative (see Figures 2-10a and 2-10b) would remove the existing track on 14th Street and replace it with two new tracks, one in the southern edge of the 14th Street pedestrian plaza for use by the CRE line and one in the parking lane of 14th Street for use by through northbound trains. Removal of the existing track frees up some space for placement of a passenger stop/platform.

Figure 2-10a: Alternative 3D Plan View



Source: RTD

Figure 2-10b: Alternative 3D Typical Sections



Source: RTD

Key Opportunities:

- Opportunity for station
- Potential for new urban development on plaza
- Minimal traffic signal impacts at 14th/Stout, since train movements would continue to be accommodated as they are today during the all-walk pedestrian phase.
- No impact to future bike lane on 14th

Key Challenges:

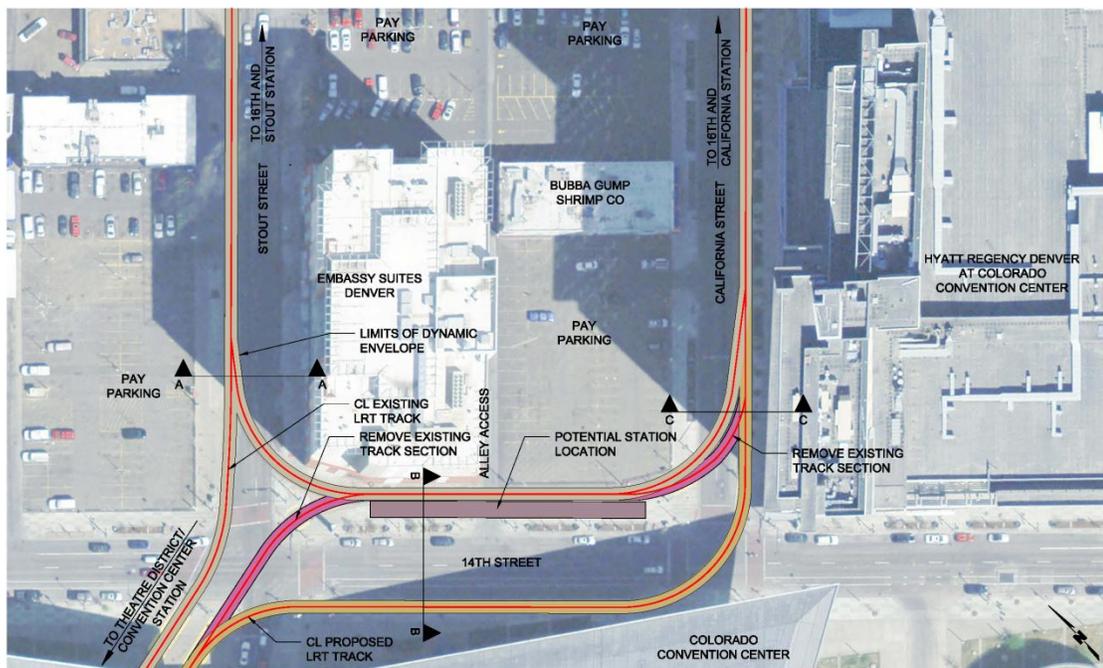
- High cost for track removal and replacement
- Pedestrian crossing impacts at 14th/Stout, specifically the 14th Street crossing east of Stout Street. Since train tracks would be located in the crosswalk, this pedestrian phase would need to be removed from the existing all-walk pedestrian phase and run concurrently with the Stout Street vehicular phase. Concurrent operations may introduce additional pedestrian conflicts with right-turning vehicles, potentially negatively impacting pedestrian safety and vehicular operations.

- Removes nine parking spaces on 14th
- Could require removal or relocation of existing streetscape on 14th
- Potential relocation of southbound traffic stopbar on California farther north, increasing the length of the signal interval

Alternative 3E: New Through Track on South Side of 14th Street (Sidewalk)

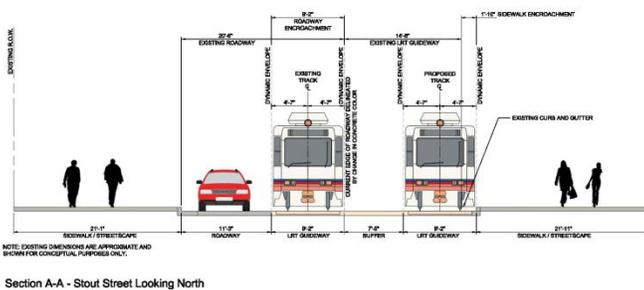
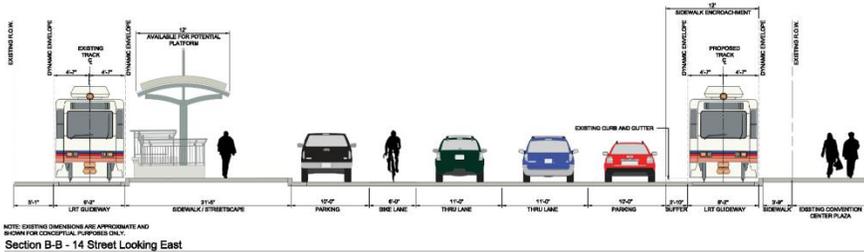
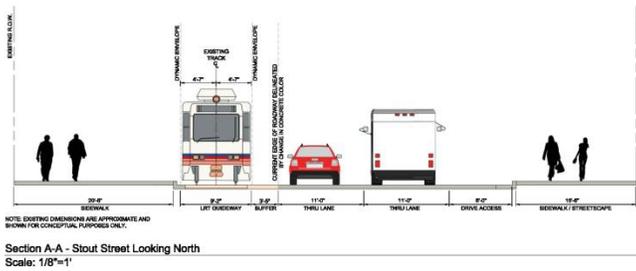
This option (see Figures 2-11a and 2-11b) would construct a new track for through light rail trains on the south side of 14th Street on the sidewalk in front of the Convention Center, with CRE trains using the existing track on the north side of 14th. It would eliminate the track crossing northbound at 14th/Stout but require a new track northbound at 14th/California.

Figure 2-11a: Alternative 3E Plan View



Source: RTD

Figure 2-11b: Alternative 3E Typical Sections



Source: RTD

Key Opportunities:

- Provides station opportunity on 14th Street
- Eliminates existing pedestrian island at 14th/Stout
- No impact to parking on either side of 14th or future bike lane on north side of 14th

Key Challenges:

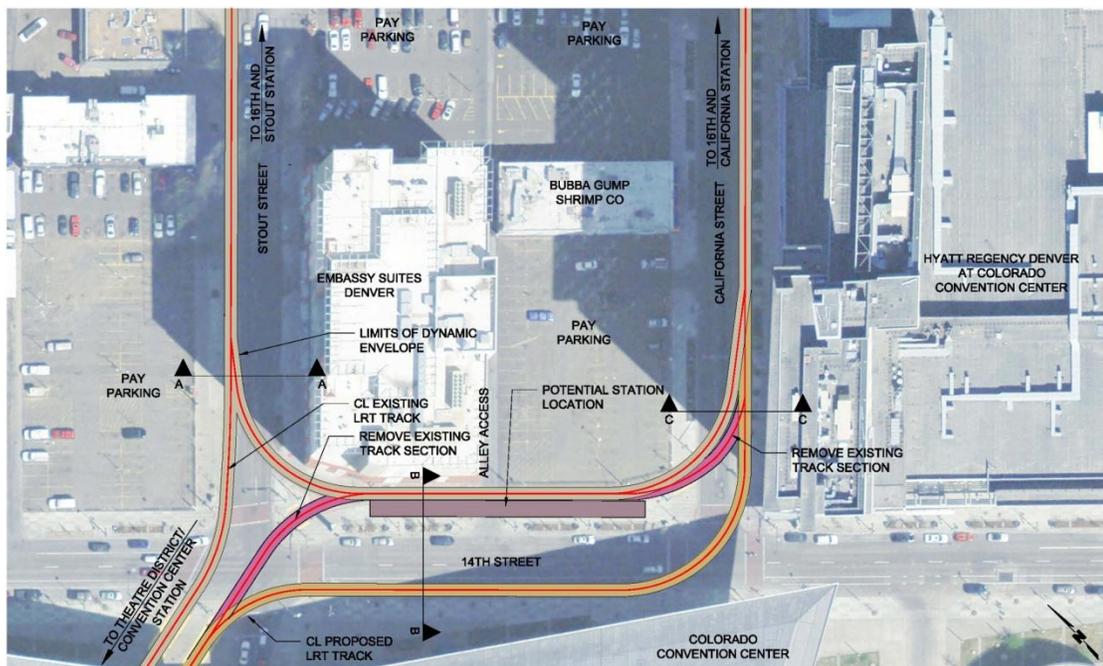
- Impacts to traffic and pedestrian signals at 14th/Stout and 14th/California due to train movements crossing several crosswalks. Currently, train movements are accommodated during the all-walk phase since trains do not impact existing crosswalks. Since the tracks would be crossing several crosswalks under this alternative, pedestrians and trains could not be accommodated at the same time. This would require that the pedestrian phases at these crosswalk locations run concurrently with the adjacent vehicular phase. Concurrent operations may introduce additional pedestrian conflicts with right- and left-turning vehicles, potentially negatively impacting pedestrian safety and vehicular operations.

- Potential property impacts at 14th/California
- Removes portion of sidewalk in front of Convention Center
- Relatively high cost (requires partial track removal and new track construction)

Alternative 3F: New Through Track on South Side of 14th Street (Parking/Taxi Lane)

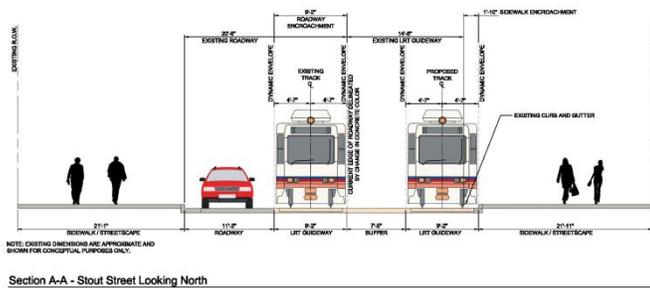
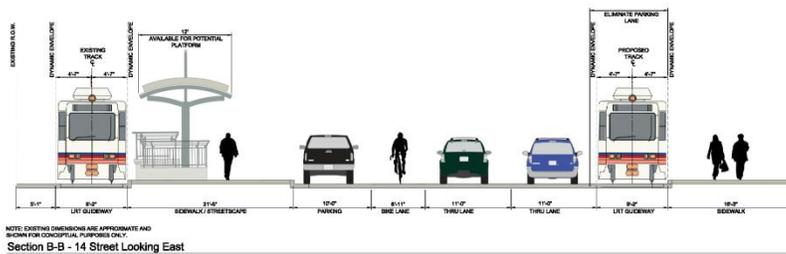
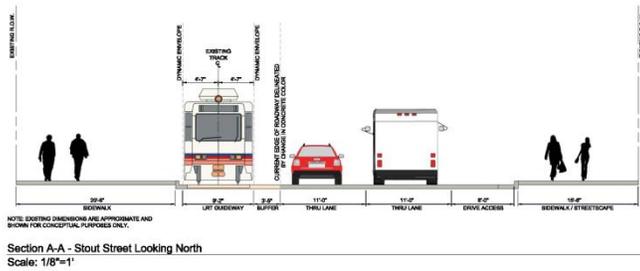
This alternative (Figures 2-12a and 2-12b) would also create a new northbound through track on the south side of 14th Street, but would use the parking/taxi loading lane in front of the Convention Center. As with the previous option, this new track would be for northbound through trains, with CRE trains using the existing track on the north side of 14th Street.

Figure 2-12a: Alternative 3F Plan View



Source: RTD

Figure 2-12b: Alternative 3F Typical Sections



Source: RTD

Key Opportunities:

- Provides station opportunity on 14th Street
- Eliminates existing pedestrian island at 14th/Stout
- No impact to parking or future bike lane on north side of 14th

Key Challenges:

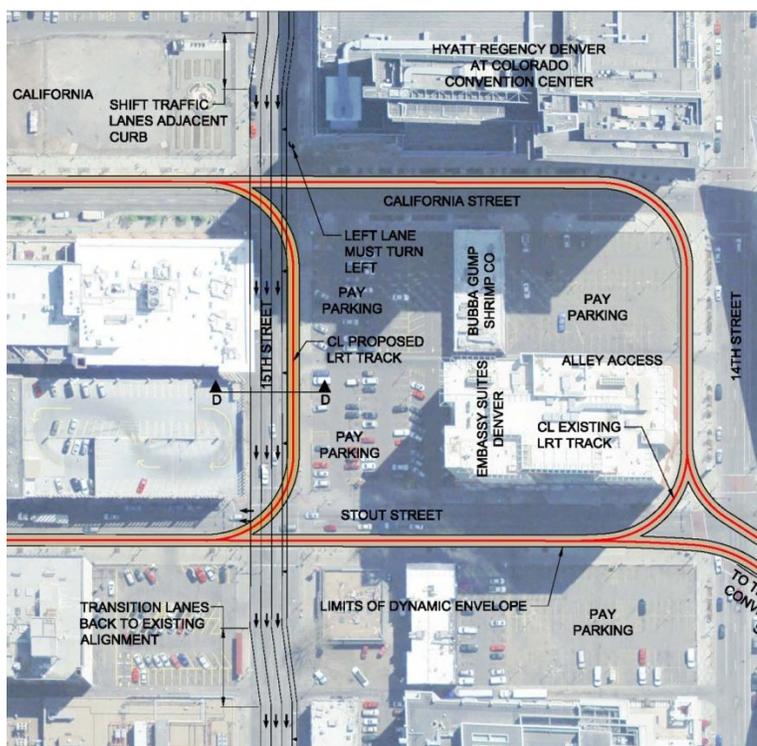
- Impacts to traffic and pedestrian signals at 14th/Stout and 14th/California due to train movements crossing several crosswalks. Currently, train movements are accommodated during the all-walk phase since trains do not impact existing crosswalks. Since the tracks would be crossing several crosswalks under this alternative, pedestrians and trains could not be accommodated at the same time. This would require that the pedestrian phases at these crosswalk locations run concurrently with the adjacent vehicular phase. Concurrent operations may introduce additional pedestrian conflicts with right- and left-turning vehicles, potentially negatively impacting pedestrian safety and vehicular operations.

- Eliminates parking/taxi lane on south side of 14th
- Potential property impacts at 14th/California
- Relatively high cost (requires partial track removal and new track construction)

Alternative 3G: New CRE Track on 15th Street

This option (see Figure 2-13) was suggested by downtown stakeholders and would require the construction of a new track on 15th Street (one block north of the southern end of the downtown loop) for exclusive use of the CRE train.

Figure 2-13: Alternative 3G Plan View



Source: RTD

Key Opportunities:

- No impact to light rail, auto/parking, pedestrian, or bicycle activity on 14th Street
- No requirement for pocket track in Stout Street

Key Challenges:

- Adds new rail movement to the traffic signal on 15th/Stout and 15th/California, which would require new train-only phases at these locations. Providing such phases within the existing cycle length may be infeasible or, if implemented, could have negative impacts on vehicular and pedestrian operations at both locations.

- Requires relocation of existing bicycle lane on south side of 15th
- Requires relocation of through traffic lanes to accommodate contraflow rail guideway on south side of 14th Street
- Relatively high cost (new track construction)

Evaluation of Alternatives

Table 2-1 summarizes the evaluation of the long list of alternatives for the CRE. The evaluation was conducted at a “pass/fail” level, meaning that any alternative that receives a “fail” rating in any criterion is eliminated from consideration, as a “fail” rating is considered a “fatal flaw.”

Table 2-1: CRE Alternatives Evaluation

	1: Transfer to Existing D Line	2: Use Downtown Loop with No New Infrastructure	3: Use Downtown Loop with New Infrastructure						
			3A Use Existing Track on 14 th St	3B New Track on 14 th in Parking Lane	3C Existing Track Plus New Track on 14 th (North Sidewalk)	3D Two New Tracks on North Side of 14th	3E New Thru Track on South Side of 14 th (Sidewalk)	3F New Thru Track on South Side of 14 th (Parking/Taxi Lane)	3G New CRE Track on 15 th St
MOBILITY									
Reliability	PASS	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	PASS
Station	FAIL	PASS	PASS	PASS	FAIL	PASS	PASS	PASS	NA
User Convenience	FAIL	FAIL	PASS	PASS	PASS	PASS	PASS	PASS	PASS
Traffic	PASS	PASS	PASS	PASS	?	?	FAIL	FAIL	FAIL
Signals	PASS	FAIL	PASS	PASS	?	?	FAIL	FAIL	FAIL
Bicycle	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	FAIL
Pedestrians	PASS	PASS	PASS	?	FAIL	FAIL	FAIL	FAIL	PASS
Sidewalks	PASS	PASS	PASS	PASS	FAIL	PASS	FAIL	PASS	PASS
URBAN CHARACTER									
Property	PASS	PASS	PASS	PASS	PASS	PASS	FAIL	PASS	PASS
Streetscape/urban design	PASS	PASS	PASS	PASS	FAIL	FAIL	PASS	PASS	PASS
DELIVERABILITY									
Costs	PASS	PASS	PASS	PASS	PASS	FAIL	PASS	PASS	PASS
Constructability	PASS	PASS	PASS	PASS	PASS	FAIL	FAIL	FAIL	FAIL
SUMMARY	FAIL	FAIL	PASS	PASS	FAIL	FAIL	FAIL	FAIL	FAIL
COMMENTS	Two transfers reduces rider convenience; no opp. for new station	No new infrastructure eliminates reliability			No opp. for new station, impacts existing streetscape	Significant construction costs, impacts existing streetscape	Adds new LRT crossing at California; eliminates parking/taxi lane, significant construction costs	Adds new LRT crossing on 14 th and at California	New rail crossings and signal impacts; relocate 15 th St. bike lane

Source: Project Team

Evaluation Summary

The pass/fail evaluation resulted in the following conclusions:

- Alternative 1 (transferring from the CRE line to the D line) did not meet the “pass/fail” test because it causes significant rider inconvenience (by requiring two transfers to travel from the East Rail line at 38th/Blake to downtown) and does not provide an opportunity for a new station at the Convention Center or for new development on the downtown loop.
- Alternative 2 (using the downtown loop for the CRE with no new infrastructure) did not meet the “pass/fail” test in a number of areas. It likely results in delays and operational inefficiencies in the downtown loop since there is no pocket track for CRE operations, which also affects user convenience and impacts the downtown traffic and pedestrian signal network.
- Alternative 3A (combining a new pocket track on Stout with the existing track on 14th) did not receive any “fail” ratings in this analysis. It provides good mobility benefits (system reliability, user convenience, a new station at the Convention Center) with no negative impacts to signals, autos, pedestrians, or bicyclists. It requires no new property or right-of-way and has no impact on the existing streetscape on 14th.
- Similarly, Alternative 3B (a new pocket track on 14th with a new track in the parking lane of the north side of 14th) did not receive any “fail” ratings, though its impact on pedestrian crossings (particularly the crossing of Stout on the side side of 14th) will need additional investigation to ensure pedestrian safety. However, it does eliminate the existing pedestrian island on the northeast corner of 14th/Stout and provides the opportunity to improve overall pedestrian safety at this corner.
- Alternative 3C (adding a second track on the 14th Street plaza) received a “fail” rating because it would not allow a Convention Center station and could negatively impact the existing sidewalk and streetscape and pedestrian crossings.
- Alternative 3D (removing existing tracks and placing new tracks on the 14th Street plaza and in the parking lane of 14th Street) received a “fail” rating because it would considerably complicate pedestrian movements at 14th and Stout, would negatively impact the existing streetscape on 14th Street, and is prohibitively expensive (requiring removal of existing tracks and construction of two new tracks).
- Alternative 3E (construction of a new through track on the south side of 14th Street on the sidewalk in front of the Convention Center) received a “fail” rating because it would considerably complicate traffic signalization at the south side of the 14th/Stout intersection, would negatively impact the sidewalk in front of the Convention Center (also creating safety issues for pedestrians and for taxi loading on 14th Street), and would require taking Convention Center property to construct.

- Alternative 3F (construction of a new through track on the south side of 14th Street in the taxi/parking lane in front of the Convention Center) received a “fail” rating because it would considerably complicate traffic signalization at the south side of the 14th/Stout intersection (also creating safety issues for pedestrians at the intersection), and it would eliminate taxi loading on 14th Street in front of the Convention Center.
- Alternative 3G (a new CRE track on 15th Street) received a “fail” rating because it would create a new rail crossing in two intersections (considerably complicating traffic flow and signalization for both autos and pedestrians), and would interfere with the relatively new bicycle lane on 15th Street (causing it to be either relocated or eliminated).

Based on the results of this screening process, two alternatives are recommended for continued consideration:

- Alternative 3A, which combines a new pocket track on Stout Street with the existing through track on 14th Street; and
- Alternative 3B, which combines a new pocket track on Stout Street with a new through track in the parking lane of 14th Street.

Additional Analysis of Remaining Alternatives

The two remaining alternatives were examined in more detail by the project team to determine a number of operational and design issues, including:

- Capital costs, to understand the fiscal implications of the remaining alternatives;
- A VISSIM analysis to determine how the alternatives interact with traffic and pedestrian movement and signalization, particularly at the southern end of the downtown loop;
- Urban design issues, including passenger stop/platform placement and design and interaction with the existing 14th Street pedestrian plaza and streetscape; and
- Ridership forecasting, to help determine how to accommodate anticipated passenger loads, with the resulting impact on fleet size and costs.

Capital Costs and Utilities

LS Gallegos and Associates (LSG), a member of the project team, met with RTD cost estimators to obtain existing RTD unit costs and design criteria that could be applied to the various CRE improvements under consideration. In most cases, LSG was able to use RTD unit costs and design criteria for preparing its cost estimates. For many of the cost elements where no design detail was available, LSG made assumptions about potential scopes of work and provided unit price or lump sum allowances in the estimates. For soft costs and contingency elements, LSG utilized percentages as applied in an RTD cost estimate prepared for the Welton Street light rail

reconstruction project dated March 14, 2012. These percentages are in line with other industry standards for conceptual cost estimating.

In order to determine quantities for construction elements, LSG utilized alignment and cross section sketches and diagrams provided by SDG. Additionally, LSG utilized satellite images obtained from Google Earth. We have not included the cost of additional vehicles that may be needed. LSG’s cost estimates presented in this report are summarized in the Standard Cost Categories (SCC) format developed by the Federal Transit Administration (FTA). The results of this analysis for the two remaining short-term alternatives are:

- The estimated cost of Alternative 3A is approximately **\$4.4 million**. Unit costs for this alternative were derived primarily from a cost estimate prepared in this vicinity by RTD dated April 10, 2014. The cost estimate assumes minor modifications to the existing track paralleling 14th Street. The pocket track would be constructed on Stout Street with existing traffic lanes remaining in place and provide a station on 14th Street.
- The estimated cost of Alternative 3B is approximately **\$5.6 million**. This alternative removes all existing track paralleling 14th Street and reconstructs it at the inside curb line of 14th Street. The primary difference in cost between Alternatives 3A and 3B lies in the additional track work, site work and signal modifications necessary to move the track onto 14th Street.

In addition, the project team conducted a high-level analysis of potential major utilities along Stout Street between 14th and 15th Streets to determine potential utility conflicts that could affect capital costs and constructability of the pocket track, as shown in Table 2-2.

Table 2-2: Major Utilities Noted on Stout Street Between 14th and 15th Streets

Major Utility Type	Location/Details
Communications	Denver traffic has fiber lines on the northwest side of Stout St.
Electric transmission/network electric lines	No electric transmission lines meeting the major utility criteria are present in this area based on the available information.
Storm sewers	There is a 90-inch RCP storm sewer on the southeast side of Stout St., possibly under the sidewalk.
Sanitary sewers	No sanitary sewers meeting the criteria for major utilities were identified in this area.
Steam lines	Xcel Energy has two low-pressure steam pipelines near the centerline of Stout St.
Water lines	No water lines meeting the criteria for major utilities were identified in this area.
Gas lines	No gas lines meeting the major utility criteria are present in this area based on the available information.

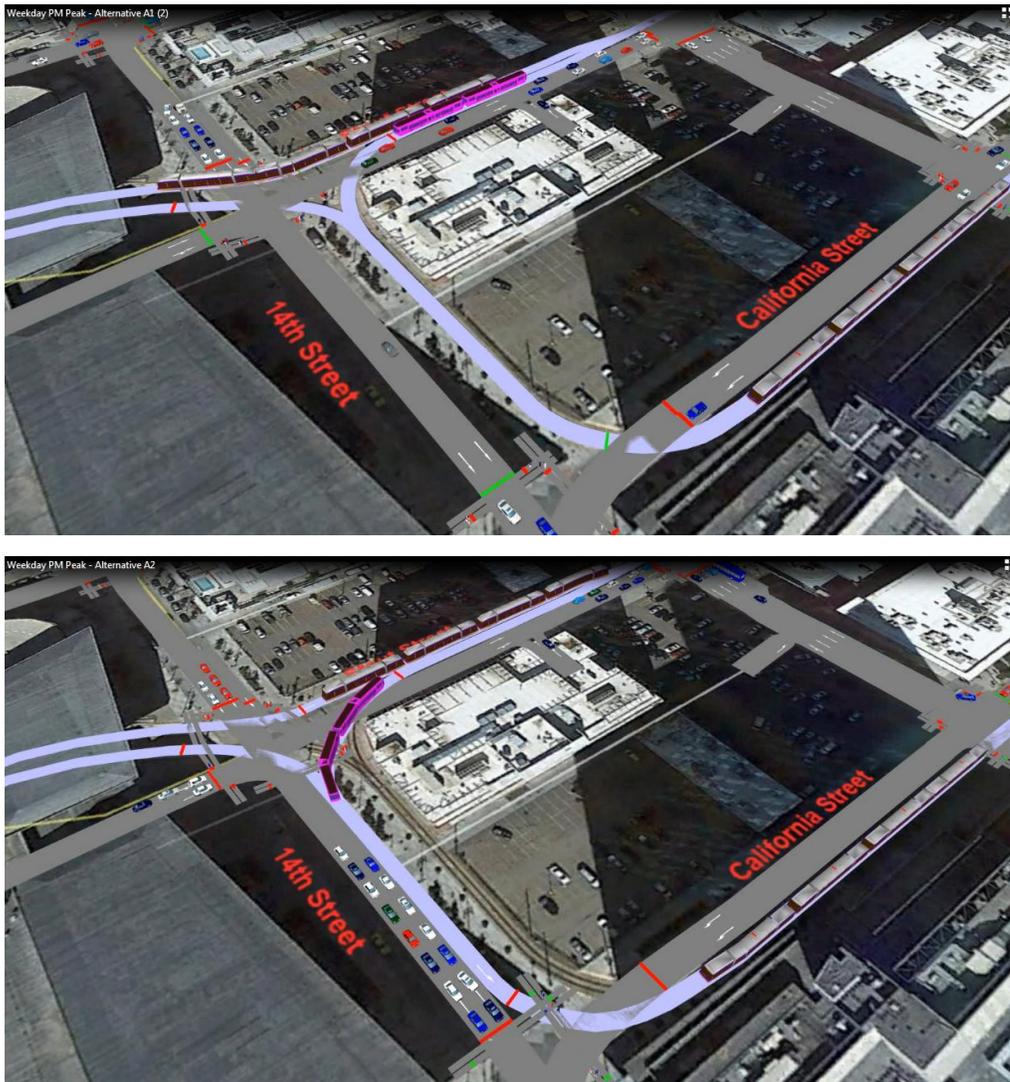
Source: Project Team/Goodbee & Associates

These utility-related issues will need to be explored on more depth as design proceeds to more advanced stages for the two alternatives.

VISSIM Analysis

The project team conducted a VISSIM micro-simulation analysis for alternatives 3A and 3B in June 2014 to help determine a number of key factors related to their operations, including travel times, intersection impacts, and transit waiting times. Various parameters specific to each alternative were input into the VISSIM models, including geometrics, train schedules, and signal timing. The models were then run ten times to allow a more statistically significant result and to account for the significant variations that can occur in the downtown loop and the mixed-flow segment along Downing Street. Figure 2-14 shows screen shots of the VISSIM models for the two alternatives. The results were extracted from the models and are discussed below.

Figure 2-14: Screen Shot of the VISSIM Models for Alternatives 3A and 3B



Top: Simulation for Alternative 3A
Bottom: Simulation for Alternative 3B
Source: Project Team/Apex Design

Travel Times

Table 2-3 summarizes the transit travel times that were obtained from the VISSIM models for the two CRE alternatives. These travel times are for round trips on the entire CRE line from 38th/Blake to downtown and back.

Table 2-3: Transit Travel Times for Remaining Alternatives

	Alternative 3A – Existing Track with New Pocket Track on Stout	Alternative 3B – New Track in Parking Lane on 14 th St with New Pocket Track on Stout
Minimum time (minutes)	45.5	45.4
Maximum time (minutes)	50.6	49.3
Average time (minutes)	48.0	47.7

Source: Project Team/Apex Design

The table shows that both alternatives have roughly the same round trip travel times – approximately 48 minutes. This means that a one-way trip from 38th/Blake to the proposed passenger stop/platform at the Convention Center would take approximately half that – roughly 24 minutes. The difference between the minimum and maximum travel times (also shown in Table 2-2) provides some idea of the variability of travel times, which are approximately 4-5 minutes depending on alternative. **This also means that, when combining 15-minute headways with the forecast travel time and end-of-line layover times, four train consists are needed to meet this schedule.**

Train Waiting Times

Table 2-4 summarizes the VISSIM results for train waiting times (the time each train spends at stations or intersections or other locations along its route waiting for signals to move forward, not including passenger loading dwell times). This comparison is a good indicator of how well each alternative moves in traffic through the signal system along its route and how it impacts other trains using the downtown loop. These waiting times are included in each option’s total run time.

The table shows that the implementation of alternative 3A actually improves the operation of the existing light rail trains in the downtown loop, dropping the average light rail waiting time in the loop from 5.6 minutes to 5.1 minutes. However, alternative 3B increases waiting times for other downtown loop trains to 7.5 minutes. This is likely caused by the traffic signal timing changes necessary for alternative 3B. With the trains traversing through the 14th & Stout and 14th & California at different points in the cycle, the train progression through the rest of the loop is negatively affected.

Table 2-4: VISSIM Analysis of Train Waiting Times

	Existing Conditions	Alternative 3A – Existing Track with New Pocket Track on Stout	Alternative 3B – New Track in Parking Lane on 14 th St with New Pocket Track on Stout
LRT Trains in Downtown Loop			
Minimum time (min.)	5.3	5.2	7.1
Maximum time (min.)	5.8	5.9	7.8
Average time (min.)	5.6	5.1	7.5
CRE Trains			
Minimum time (min.)	--	17.0	13.1
Maximum time (min.)	--	20.1	19.1
Average time (min.)	--	18.6	17.2

Source: Project Team/Apex Design

The table also shows that alternative 3B is slightly better than alternative 3A when comparing train waiting times over the length of the entire CRE alignment (from 38th/Blake through the downtown loop and back again). Alternative 3B has average waiting times of 17.2 minutes, while alternative 3A has average waiting times of 18.6 minutes. This is consistent with the overall travel time results, which also show that alternative 3B performs slightly better than alternative 3A when only looking at the CRE trains.

Intersection Delays

Table 2-5 summarizes the VISSIM intersection level of service and delays at the southern end of the downtown loop. Data was only reported for the 14th & Stout and 14th & California intersections since the difference between the two remaining alternatives was limited to these two locations.

The table shows that, in most cases, the implementation of the two options has minimal impacts on intersection performance – with one exception. At the 14th/Stout intersection, both alternatives 3A and 3B cause very few changes in intersection performance compared with existing conditions. Intersection delay is similar (44.5 seconds under existing conditions, 46.4 seconds for alternative 3A, and 48.9 seconds for alternative 3B). Level of service (LOS) does not change (LOS D under existing conditions and for both alternatives). And maximum vehicular queues improve in several movements (for example, queues for northbound through traffic decrease from 203 feet under existing conditions to 160 feet under alternative 3B).

Table 2-5: VISSIM Analysis of Intersection Level of Service

Intersection/ Movement	Existing Conditions			Alternative 3A			Alternative 3B		
	Delay (sec.)	Level of Service	Max. Queue (ft.)	Delay (sec.)	Level of Service	Max Queue (ft.)	Delay (sec.)	Level of Service	Max Queue (ft.)
14th/Stout									
N'Bound Through	32.1	C	203	31.9	C	205	33.9	C	160
N'Bound Right Turn	27.6	C	203	26.2	C	205	35.3	D	160
E'Bound Left Turn	13.7	B	174	10.0	B	32	65.5	E	151
E'Bound Through	62.3	E	227	64.4	E	261	62.1	E	207
Intersection Total	44.5	D		46.4	D		48.9	D	
14th/California									
S'Bound Left Turn	31.8	C	134	31.0	C	146	33.6	C	128
E'Bound Through	13.4	B	201	13.2	B	202	35.9	D	219
Intersection Total	20.1	C		19.7	B		35.0	D	

Source: Project Team/Apex Design

However, alternative 3B does have some impacts to traffic at the 14th/California intersection, primarily due to the new track geometry. With the new tracks crossing the southwest and northwest crosswalks, the train movements for alternative 3A would require a separate train-only phase, as opposed to the existing condition where the train movements are made during the all-walk phase. Total intersection delay increase from 20.1 seconds under existing conditions to 35 seconds under alternative 3B (note that delay actually decreases slightly under alternative 3A). In addition, total LOS worsens from B for eastbound through traffic under existing conditions to D under alternative 3B. However, maximum vehicle queues are relatively unchanged for either alternative compared with existing conditions.

Overall Conclusions

This VISSIM analysis was aimed at determining if there were any fatal flaws related to transit and traffic operations for either of the remaining alternatives. No fatal flaws were noted for either alternative, though some minor negative impacts were noted in certain circumstances. For example, alternative 3B appears to have some impacts to traffic movements at the 14th & California intersection (especially eastbound through traffic). In addition, alternative 3B has a slightly negative impact on waiting times for other light rail trains using the downtown loop. Any negative observations noted for either alternative will need to be explored further in a future, more detailed traffic study to determine if additional mitigations are warranted as the project moves toward implementation.

Urban Design Analysis

The project team and RTD conducted additional urban design analyses of the two remaining alternatives to help stakeholders and the public understand and visualize how the alternatives would fit into the downtown urban landscape, primarily on 14th Street between Stout and California Streets (the southern end of the downtown loop). Three major elements affect how the CRE will fit into the downtown streetscape from an urban design standpoint: vehicle type and consists, passenger stops/platform design, and accessibility ramps.

Vehicle Type and Consists

The type of rail vehicle used on the CRE and the number of vehicles per train will affect the design of the CRE system in the downtown landscape. As noted earlier, one of the goals of this project is to examine the issues related to the potential use of low-floor neighborhood friendly streetcar-type vehicles as soon as practicable (this issue is discussed in more detail in the following chapter). The type of vehicle being used on the system will affect the overall passenger platform design, primarily related to the ADA accessibility ramps at the platforms (see discussion below). In addition, the number of vehicles used on the CRE also will affect the streetscape. The 2010 Environmental Evaluation assumed single-vehicle consists, which would accommodate 2030 ridership projections at the time of the EE, with passenger platforms of 100 feet (with the potential to expand as needed in the future). Given the desire to construct a CRE station at the south end of the downtown loop across the street from the Convention Center along 14th Street, CRE trains will have a practical limit of two-vehicle consists, since the block width in this area is approximately 300 feet (with the maximum length of tangent track possible in this area being approximately 200 feet, roughly the length of two-car light rail or similar low-floor vehicle consists).

Passenger Stops/Platforms

Given the potential for a new operating environment and potentially new vehicle for the CRE system (not only in downtown Denver but elsewhere in northeast Denver along Welton and Downing Streets), the potential also exists for a new type of passenger platform, significantly different from those traditionally used by RTD on its light rail system. To promote integration into the urban landscape, the platform could be lower-cost and less infrastructure intensive, similar to the boarding platforms and canopies currently being used by the Free Metro Ride bus system in downtown Denver (as shown in Figure 2-15). Platforms envisioned for the CRE could, in almost all cases, use existing curbs and sidewalks for passenger boarding without requiring major construction or right-of-way.

Figure 2-15: Passenger Platform and Canopy Used on Free Metro Ride



Source: Project Team

ADA Accessibility

A major requirement for any transit investment is accessibility for persons with disabilities and other mobility issues. Initially, RTD chose to use concrete ramps to provide access to its high-level-boarding light rail stations. However, in recent years, RTD has transitioned to a new modular ramp that can easily be installed and removed (as shown in Figure 2-16).

Figure 2-16: Modular Accessibility Ramps

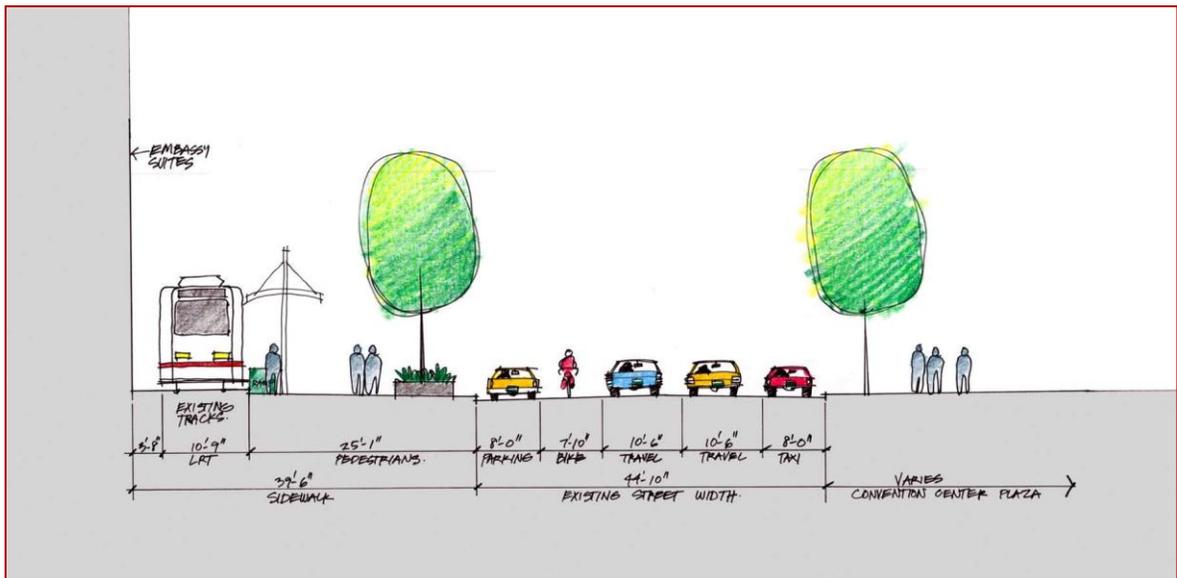


Source: Project Team

Urban Design Concepts

With those factors in mind, RTD and the project team developed a number of urban design treatments and visualizations for the two remaining alternatives. Figure 2-17 shows a sketch of alternative 3A and how it could potentially be designed to maximize integration into the downtown landscape

Figure 2-17: Urban Design Sketches of Alternative 3A on 14th Street



Source: Project Team/Leese & Associates

The sketches show the estimated dimensions for the rail guideway and passenger platform on the 14th Street plaza. While the introduction of a platform on the plaza could possibly reduce the width of the pedestrian plaza along 14th, the use of modular ramps and low-impact canopies, coupled with curbside boarding, should still provide sufficient clearance for pedestrian flow along 14th. In addition, most of the existing streetscape currently in place along 14th would likely not be disturbed under alternative 3A.

RTD staff also developed SketchUp visualizations of alternative 3A, providing more detail on how it could fit into the urban landscape along 14th Street (see Figure 2-18).

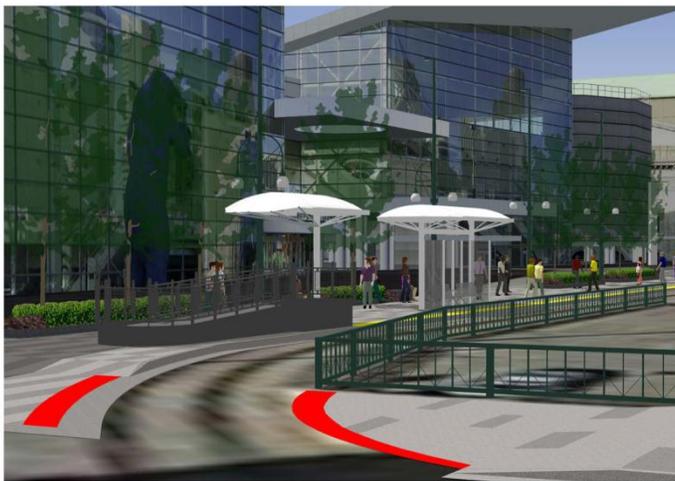
Figure 2-18: SketchUp Visualizations of Alternative 3A on 14th Street



Aerial View Looking East



View From The Convention Center Looking Northeast



View From California Street Looking Southwest

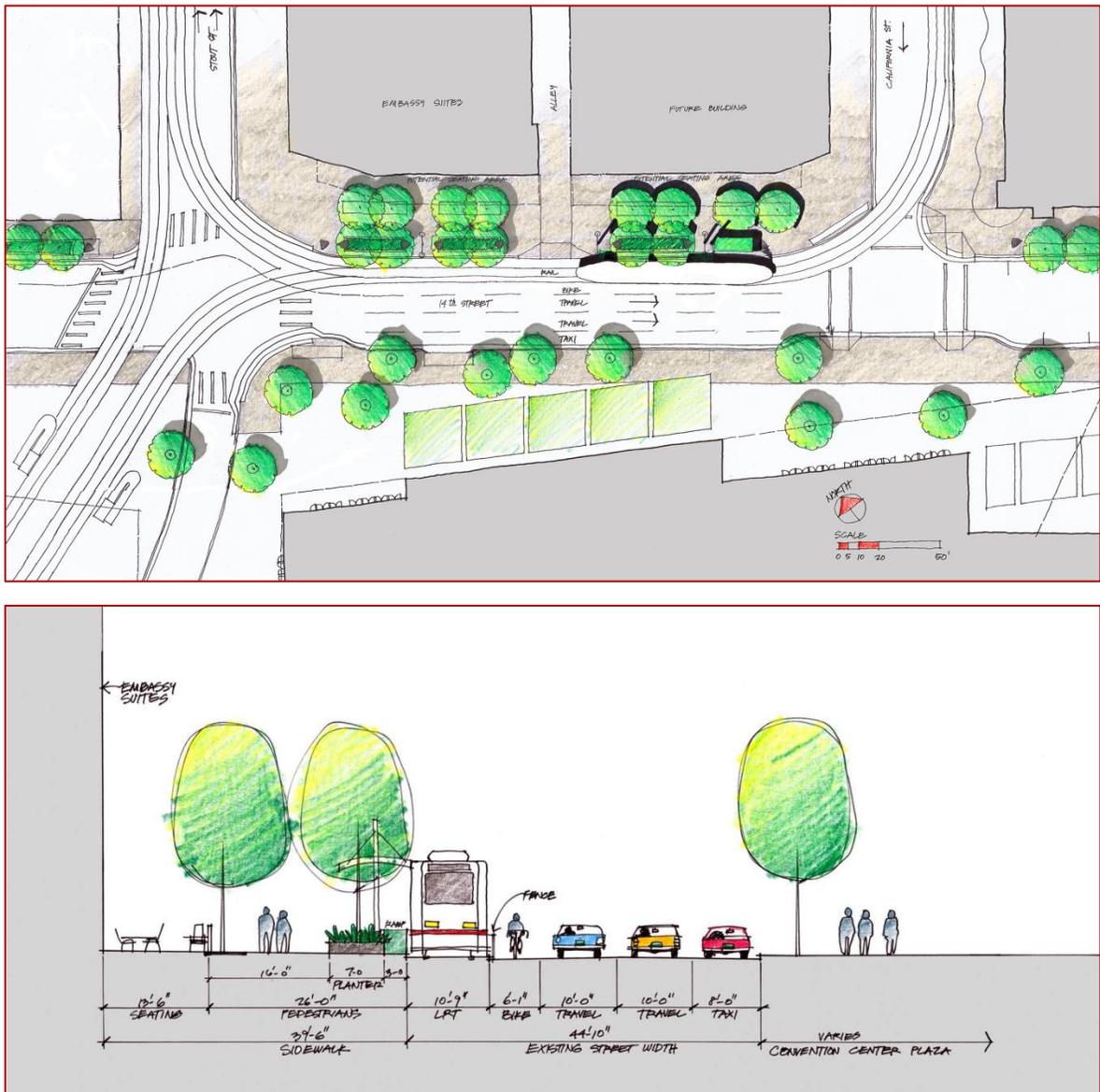


View From Pedestrian Median Looking East

Source: RTD

Similar urban design treatments were developed for alternative 3B. Figure 2-19 shows preliminary sketches of the alternative, showing how the new CRE track would fit into the existing parking lane on 14th Street. This alternative shows how the new track could interact with the plaza and with the future bicycle lane proposed for the north side of 14th Street; the existing street right-of-way should be sufficient to provide any number of “buffering” treatments to segregate the bicycle lane from the rail track. The use of the parking lane for the track also frees up considerable space for pedestrians along the 14th Street plaza, including the possibility of new sidewalk development (such as café seating).

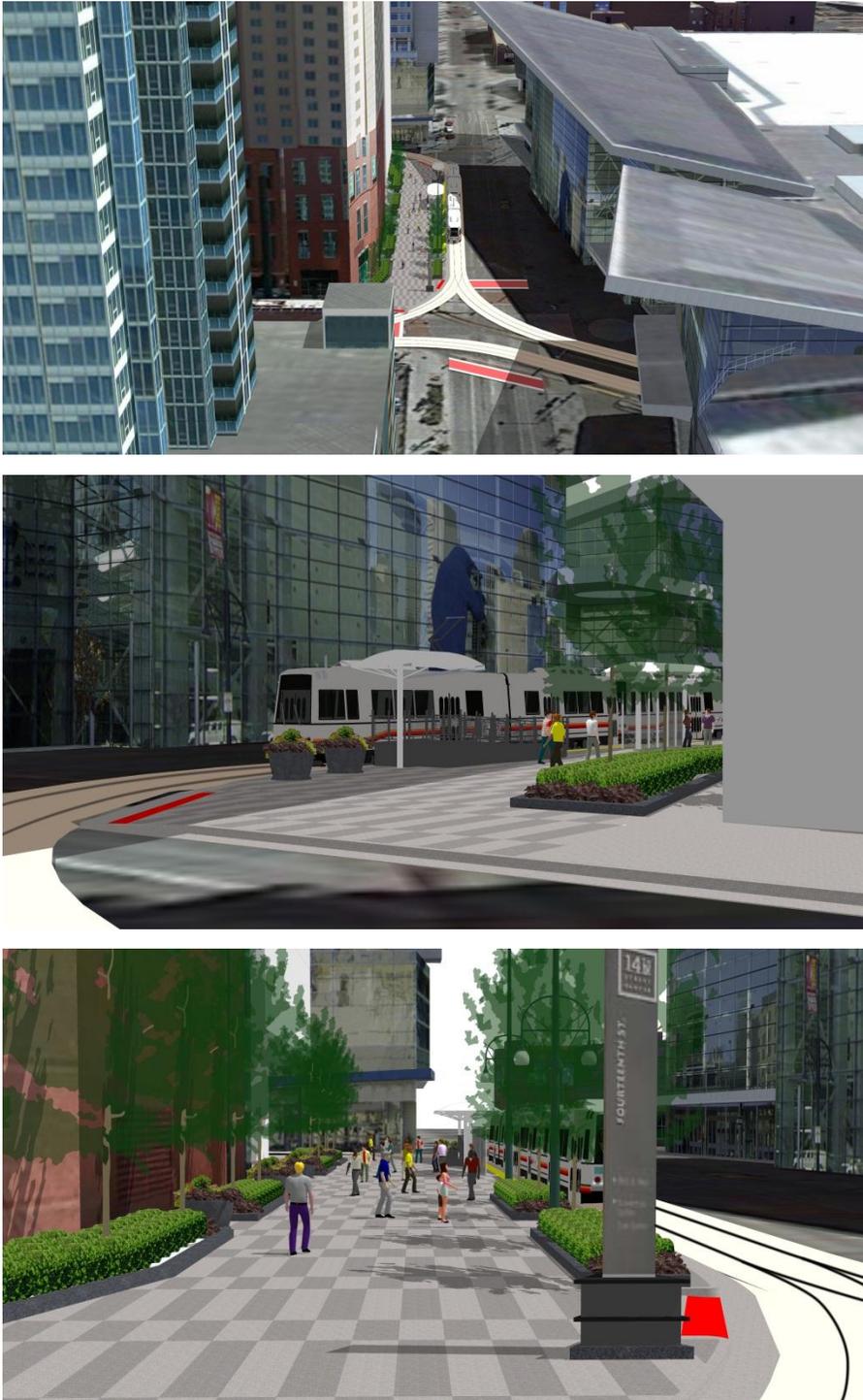
Figure 2-19: Urban Design Sketches of Alternative 3B on 14th Street



Source: Project Team/Leese & Associates

Figure 2-20 shows more detailed SketchUp visualizations of alternative 3B.

Figure 2-20: SketchUp Visualizations of Alternative 3B on 14th Street



Source: RTD

Ridership Forecasting

In August 2014, RTD staff used the DRCOG Compass 5.0 regional ridership model to conduct an updated ridership forecast for the CRE line to help with the understanding of a number of factors, including:

- The number of vehicles needed per consist to serve peak hour ridership, both short-term and in 2035, and the resulting fleet size; and
- The ability of the CRE system and its proposed headways to accommodate transfers from the East Rail line.

Ridership forecasts were developed for a number of scenarios for both 2020 (roughly an anticipated opening year) and 2035 (the current DRCOG horizon forecast year) to analyze ridership differences and impacts to the RTD system. The scenarios developed for both 2020 and 2035 included:

- With the current D Line to 30th/Downing, with a transfer at that station for the CRE line continuation to 38th/Blake (with and without the 29th/Welton station); and
- With the CRE line using the downtown loop as a one-seat ride into downtown, with the D Line truncated in the downtown loop (with and without the 29th/Welton station).

These eight total scenarios were chosen to provide the widest potential range of analysis of ridership. The options using a transfer at 30th/Downing were tested to determine the impact of forcing a transfer at 30th/Downing in case funding limitations prevented the addition of infrastructure in the downtown loop that would allow CRE use of the loop in the short term. The testing of options with and without the 29th/Welton station is important to determine the ridership impact of that station on the CRE and entire RTD system. RTD has closed that existing station on an interim basis due to low ridership and due to its proximity to the 30th/Downing station (see Figure 2-21). This study was charged with determining the short-term and long-term passenger demand at that station to help RTD determine if it should remain closed.

How Important is a stop at 29th/Welton? Only 19% of all public comments received as of the end of August 2014 said it was “very important” or “somewhat important.” 26% were neutral on the subject, and 55% said it was “somewhat unimportant” (9%) or “not important” (46%).

Figure 2-21: Proximity of 29th/Welton and 30th/Downing Stations



Source: Project Team

Tables 2-6a and 2-6b summarize the ridership information developed for the project.

Table 2-6a: CRE Ridership Summary for Forecast Year 2020

Option	Description	29 th / Welton Station?	Total Ridership (CRE only)	Total Ridership (CRE + D Line)	CRE Peak Hour Load	CRE Vehicles Required at 15-min. headways (1 car = 125 psgrs)
2020 1A	CRE line in downtown loop; D Line truncated in loop	Yes	6,370	26,300	540	2
2020 2A	CRE line in downtown loop; D Line truncated in loop	No	6,290	26,200	530	2
2020 3A	CRE transfer to current D Line at 30 th /Downing	Yes	5,360	25,000	60	1
2020 4A	CRE transfer to current D Line at 30 th /Downing	No	5,280	24,900	60	1

Source: RTD

Table 2-6b: CRE Ridership Summary for Forecast Year 2035

Option	Description	29 th / Welton Station?	Total Ridership (CRE only)	Total Ridership (CRE + D Line)	CRE Peak Hour Load	CRE Vehicles Required at 15-min. headways (1 car = 125 psgrs)
2035 1A	CRE line in downtown loop; D Line truncated in loop	Yes	8,160	35,500	680	2
2035 2A	CRE line in downtown loop; D Line truncated in loop	No	8,060	35,400	670	2
2035 3A	CRE transfer to current D Line at 30 th /Downing	Yes	6,880	33,000	70	1
2035 4A	CRE transfer to current D Line at 30 th /Downing	No	6,640	32,900	70	1

Source: RTD

The tables show a number of key metrics for the CRE line:

- The issue of a forced transfer from the CRE line to the D line at 30th/Downing made a considerable difference in CRE ridership. Options with a forced transfer resulted in a CRE ridership approximately 16% lower than those with a one-seat ride on the CRE into downtown. Total combined CRE and D Line ridership dropped from 5 to 7% with the transfer at 30th/Downing compared with the one-seat ride.
- The addition or deletion of the 29th/Welton station made relatively minor differences in total ridership. The addition of the station added 80 riders to the CRE line in 2020 and 100-240 riders in 2035.
- The anticipated peak hour passenger loads on the CRE line with the one-seat ride into downtown (530-540 in 2020, 670-680 in 2035) resulted in the need for two-vehicle consists to meet peak hour passenger demand in the long term (2035 and after).

Conclusions and Next Steps

Based on the results of this analysis, this study recommends that RTD continue to move forward with consideration of both alternatives 3A and 3B to further evaluate and decide on the best solution for the infrastructure improvements on the south end of the downtown loop, including:

- Continuing to consult with downtown stakeholders, including the City and County of Denver, the Downtown Denver Partnership, the Colorado Convention Center, Visit Denver, and adjacent property owners (including hotel properties) to further refine the design details of the alternatives and come to consensus on a final solution. This should include an analysis of trade-offs and benefits of each alternative related to issues such as safety, transit operations, on-street parking, business access and associated economic development, conformity with community values, turning movements and turn lanes, pedestrian and bicycle mobility and safety, impacts to and conflicts with major utilities (including maintenance and potential relocations, capital and operating costs, and additional traffic and technical analyses as needed.
- Continuing to coordinate with City and County of Denver traffic engineering and other staff to ensure CRE operations integration with the downtown traffic signal system and to develop appropriate mitigations (including additional pedestrian infrastructure improvements) to ensure that the CRE system can operate safely and efficiently with pedestrian and auto movements, particularly on the southern end of the downtown loop (on 14th Street between Stout and California).
- Continuing RTD staff work on engineering design of the trackwork and other transit-related infrastructure of the alternatives.
- Continuing RTD coordination with other potential project partners on funding options for the improvements to allow the implementation of the CRE as soon as possible and to meet the overall project goal of its opening as close to the opening of the East Rail line as possible.

Other conclusions to be drawn from this analysis include:

- The one-seat ride using the downtown loop is a major attractor of additional ridership for the CRE line in both 2020 and 2035.
- The addition of the 29th/Welton station made relatively little difference in system ridership. While station access at any point along the line promotes user convenience, the proximity of the 29th/Welton station to the 30th/Downing station (and the downstream 27th/Welton station) appears to limit its usefulness to the overall system. Therefore, it does not appear to provide much benefit to RTD or the community to retain the station in the short term. This issue should be re-visited, however, if and when the community vision on Welton Street is implemented, including the conversion of Welton Street from one-way to two-way operations, and the construction of two shared-lane tracks for the CRE line in Welton Street.

- Ridership and travel time forecasts show that four two-vehicle consists ultimately will be needed on the CRE line to meet peak-period ridership demand in the long term (2035 and after), though RTD can meet short-term opening day ridership with four one-vehicle consists. When including spares, this means that, over the long term (2035 and after), ten rail vehicles (four two-car train consists and two spares) ultimately will be needed to meet headways and passenger demands on the CRE line.

3 Goal 2: Potential Use of Low-Floor Vehicles

Goal 2: Work toward introducing neighborhood-friendly low-floor vehicle technology as soon as practicable. This means that RTD will utilize the vehicle technology readily available at the time of initial opening of the CRE (light rail vehicles). However, to help fulfill the community vision and desires expressed in numerous previous studies, RTD will continue to examine the option of introducing streetcar-type vehicles in the Central Rail corridor and potentially other corridors as soon as is practicable given future vehicle replacement and procurement schedules and funding availability.

Introduction

As mentioned earlier, numerous previous reports and studies have examined the potential and desirability for using a new type of rail vehicle on the CRE system and potentially on other future RTD rail lines – a low-floor neighborhood-friendly streetcar-type vehicle. As noted in Chapter 1, the 2010 Environmental Evaluation conducted by RTD examined the potential for using streetcars on the CRE line, and a streetcar alternative was actually recommended as an initial Preferred Alternative for the segment of Downing Street between 38th/Blake and 30th/Downing because it would have fewer impacts and would be within the corridor’s FasTracks budget. Additional concepts were considered, including the potential of extending the streetcar alignment to Civic Center station in Broadway and Lincoln, providing a convenient connection to the 16th Street Mall Shuttle at Civic Center. The EE noted that the “streetcar” (street-running) alternative could be served by either a light rail vehicle or a modern streetcar vehicle. However, during RTD’s Annual Program Evaluation in 2007, program budget issues eliminated the proposed extension to Civic Center and focused on interaction with the downtown light rail loop. In addition, light rail vehicles (rather than streetcar vehicles) were recommended for use on the service to promote consistency of fleet operations and maintenance. The final recommended alternative proposed using single-vehicle light rail consists on the segment, with integration into the downtown loop.

Since that time, the idea of the use of a streetcar-type vehicle has continued to be a major component of other studies, including the Northeast Downtown Neighborhoods Plan, the Five Points Marketplace Initiative, the Five Points Sustainable Main Streets Initiative Vision Plan, the Five Points/Welton Corridor TAP Project, Five Points Welton Street Marketplace Vision Plan Implementation & Revitalization Strategy, and the Five Points Streetcar Coordination Plan. During the course of the CRE Mobility Study, considerable public support was also expressed for using a new streetcar-type vehicle on the CRE and potentially other RTD lines in the future.

How Important is it for RTD to transition to low-floor vehicle technology? 84% of all public comments received as of the end of August 2014 said it was “very important” (56%) or “somewhat important” (28%).

What is a Streetcar and How Does it Differ from a Traditional Light Rail Vehicle?

The term “streetcar” has many different meanings in a variety of applications in North America and around the world. Its definition has two major connotations:

- It can be defined as an **operational condition**, with rail operations in an urban environment, generally as a local circulator, in one-vehicle or (at most) two-vehicle consists, and primarily in a street-running situation that usually (but not always) shares existing traffic lanes with autos.
- It can also be defined as a **specific type of vehicle**, sometimes differing from traditional light rail by providing a more neighborhood-friendly or less-impactful vehicle that can be of a different design profile, with low-floor boarding and other amenities that make it more conducive to a congested urban environment.

However, these two definitions are not mutually exclusive. For example, traditional light rail can operate in streetcar-type conditions (for example, in mixed traffic) in one- or two-car consists and can serve as urban circulators. This was the exact condition foreseen by the 2010 Environmental Evaluation, which proposed using existing light rail vehicles in mixed traffic on Downing Street before transitioning into the existing semi-exclusive light rail tracks on Welton Street and on into downtown Denver.

On the other hand, rail vehicle technology around the world is transitioning to more neighborhood-friendly low-floor vehicles regardless of their operational applications. All modern streetcar systems in North America are using low-floor vehicles in a variety of sizes and styles, and most new light rail systems in the US are using low-floor vehicles in a variety of consist lengths, as are most urban tramway systems around the world. And vehicle types and applications are merging and blurring. For example, new modern streetcar systems in Salt Lake City and Atlanta are using low-floor light rail vehicles in one-car consists in urban circulator and/or street-running applications.

Table 3-1 summarizes some of the major issues associated with the potential use of low-floor streetcar-type vehicles compared with RTD’s current light rail vehicle fleet.

Table 3-1: Key Issues – RTD Light Rail Vehicles Compared with Streetcar-Type Vehicles

Issue	Current RTD Light Rail Vehicles	Modern Streetcar-Type Vehicles
Vehicle fleet	Consistent with existing RTD vehicle fleet	Would introduce new vehicle into RTD fleet
Vehicle type	Generally larger profile in multi-car consists	Generally lower profile in one- or (at most) two-car consists
Operating environment	Typically does not share lanes with traffic (though it can in some limited circumstances)	Can share lanes with traffic
Per-vehicle cost	Generally higher than streetcar	Generally slightly lower than light rail
Construction cost	Generally higher per mile than streetcar	Generally lower per mile than light rail
Station infrastructure	Usually more expensive and more extensive station infrastructure	Generally less expensive and less extensive station infrastructure
Maintenance facilities	Can use existing maintenance facilities	Could require new maintenance infrastructure at existing facilities or entirely new facilities

Source: Project Team

Modern Streetcars: Key Issues

Vehicle Options

There are typically three types of streetcar vehicles available for use in the US: vintage restored (historic vehicles that are refurbished and rehabilitated to operate in modern conditions); vintage replica (new vehicles designed to resemble vintage or historic vehicles); and modern. This analysis will focus on modern streetcar vehicles, as those provide the types of capacity needed for an urban circulator system such as that proposed for the CRE system.

Vehicle Overview

Modern streetcar systems typically operate in dense urban corridors and are aimed at providing supplemental capacity to existing transit networks, filling “gaps” that are not being served by existing transit networks, and providing both short-distance and long-distance trips in urban corridors. Recent examples in Portland, Seattle, and Tacoma have served as urban circulators, connecting key activity centers in relatively short corridors. Newly emerging applications may include a European-style combination urban circulator and longer-distance trip provider; the Austin Urban Rail project, for example, is ultimately planned as a downtown circulator in addition to a long-haul, higher-speed, limited-stop connection to Austin-Bergstrom International Airport. Modern streetcars (defined as such to distinguish “modern” vehicles from smaller “vintage replica” vehicles seen in cities such as Little Rock) can operate in a shared-traffic roadway environment (as is often the case in downtown circulators) or semi-exclusive or exclusive guideway environments for higher speeds and better travel times. Modern streetcars typically operate in single-car consists though can be coupled if needed (and if the cars are constructed for coupling). Streetcars have similar features to those of light rail, but are typically operated with slightly smaller vehicles with slightly lower capacity, operate at lower speeds within general traffic, and with lower levels of segregation and traffic priority. They can sometimes be classified as local “pedestrian accelerators.”

The most common recent modern streetcar systems in the US use a vehicle design that originated in Czechoslovakia (and is now being manufactured in the US). This vehicle is approximately 66 feet long and accommodates 30 seated passengers and approximately 90 standing passengers. Another option being considered by some cities is a longer, European tramway-type design that features a vehicle that is 100 to 120 feet long with multiple articulations. A moderate-sized option is being built for the US market by Siemens and is a shortened version of its low-floor light rail car at approximately 80-90 feet; this vehicle is being used in Salt Lake City and Atlanta (see Figure 3-1).

Figure 3-1: Siemens S70 Light Rail Vehicle Being Used in Streetcar Service in Salt Lake City and Proposed for Atlanta



Source: Project Team

The key components of modern streetcars are:

- They are steel wheel on steel rail, with track flush with the road surface.
- They operate generally on-street in lanes usually shared with autos, often in downtowns and destination neighborhoods, but may also include segregated (semi-exclusive or exclusive) sections where needed or available.
- Their flexible alignment design criteria allow the track guideway to be well-integrated into the existing urban fabric.
- They include low-floor multi-door boarding.
- They are typically electrically powered via overhead wires supported by poles or building fittings; however, some systems operate on battery or ground-level power strips for short segments.
- They use simple curb-height or raised-curb platforms to provide low-floor access for easy boarding and alighting.
- Passenger stops can range from bus-system-type stops with simple shelter with static information to more complex shelters and canopies with real-time passenger information and other amenities.

Vehicles Currently Available

The APTA *Carbuilder Survey: North American Application of Modern Streetcar Vehicles* provides significant details on the range of streetcar vehicle types available for use in North America.

Table 3-2 summarizes the key characteristics of those vehicles.

Table 3-2: Streetcar Vehicles Available in North America

Manufacturer/ Name	Partial or 100% low-floor?	Floor height	Width	Length/ modules	Passenger capacity (seated + standing)	Turning radius	Where in use
Alstom Citadis X02 	100%	13"	7'10"-8'8"	106.6'-143.7'/ 5-7 modules	216-296	66'	Bordeaux
Alstom Citadis X04 	100%	13"	7'10"-8'8"	110'-140.4'/ 3-5 modules	213-295	59'	Istanbul
AnsaldoBreda Sirio 	100%	13.8"	7'6"-8'8"	68.9'-141'/ 3-7 modules	120-290	59'-66'	Naples
AnsaldoBreda Sirio Tram-Train 	100%	13.8"	7'10"-8'8"	108.3'-144'/5-7 modules	200-300	66'	Milan
Bombardier Flexity Outlook 	100%	12.8"	8'8"	98.4'-147.6'/ 5-7 modules	190-262	82'	Just ordered for Toronto

Table 3-2: Streetcar Vehicles Available in North America (cont.)

Manufacturer/ Name	Partial or 100% low-floor?	Floor height	Width	Length/ modules	Passenger capacity (seated + standing)	Turning radius	Where in use
Brookville Liberty 	Partial (71%)	13.75"	8'-8'8"	66'5"	41-47	59'	Proposed for Dallas
CAF Urbos 	100%	14"	7'10"-8'8"	77.4'-146'	148-317	59'	Just ordered for Cincinnati
Kinkisharyo ameriTram 	100%	13.8"	8'-8'8"	65.6'-131.2' / 3-7 modules	115-190	59'	Not yet in service
Siemens Avenue 	100%	14"	8'8"	91'	202	59'	Not yet in service
Siemens S70 Streetcar 	Partial (68%)	14"	8'8"	79'	149	82'	Salt Lake, ordered for Atlanta
United Streetcar USC 100 	Partial (50%)	13.8"	8"	66'	115	59'	Portland, ordered for Tucson and Washington DC

Source: American Public Transportation Association; photos courtesy modernstreetcar.org

Maintenance Facilities

A streetcar system, like other passenger rail systems, requires one or more maintenance and storage facilities. The exact number and location will depend on the specific alignment and length of the system. Traditionally, streetcar maintenance facilities can be located on parcels from two to five acres in size depending on the number of vehicles in the fleet.

Activities that could be performed at such a facility include:

- Vehicle storage and layover;
- Operator reporting and dispatching;
- System operations supervision;
- Daily maintenance, such as interior and exterior cleaning;
- Inspections, including daily safety inspections, and long-term cyclical inspections;
- Running repairs or light maintenance such as replacing broken glass or indicator lights, door malfunctions, and similar activities;
- Component change-out, including major components such as motors;
- Vehicle unscheduled and daily repairs; and
- Parts and materials storage.

Streetcar systems around the U.S. have dealt with maintenance facilities in several different ways:

- The Portland streetcar system conducts its maintenance in a facility tucked under an interstate highway (I-405 at 16th Street).
- Seattle’s facility is approximately one block off the current alignment on a parcel in a semi-industrial area approximately 32,500 square feet in size.
- Tacoma’s facility is directly adjacent to the alignment in a semi-industrial area.
- Little Rock’s facility is a simple facility directly on the alignment in North Little Rock.
- Tampa’s maintenance facility is located on the line in a quasi-industrial area and is integrated with the HART bus and administrative offices.



- Washington DC’s new proposed streetcar maintenance facility is proposed to be located on the campus of a neighborhood high school and to provide job training opportunities for local students.

In the case of the CRE, RTD will need to determine if its existing Mariposa or Elati light rail maintenance facilities can accommodate future streetcar-type vehicles or if a new facility is needed specifically for the new vehicles. Two major factors will need to be examined in more detail:

- First, a determination will need to be made as to whether one or both of the existing facilities could serve the new vehicles from a technical maintenance standpoint. In other words, RTD will need to determine if the existing facilities’ layouts, track configuration, and equipment are compatible with the new vehicles. For example, if Siemens low-floor vehicles (such as the S70, being used in Salt Lake City and Atlanta) were procured, RTD will need to determine if existing maintenance procedures, staffing, and equipment were compatible with the new vehicles (given that RTD currently uses Siemens light rail vehicles).
- Second, a determination will need to be made as to whether one or both of the existing facilities could accommodate the new vehicles from a capacity standpoint. In other words, RTD will need to conduct a fleet analysis to determine if the existing facilities can accommodate the anticipated CRE fleet or if an entirely new facility is needed.

Conclusions and Next Steps

This review of vehicle options presented a variety of choices for the local community to consider as it considers using low-floor streetcar-type vehicles on the CRE line and on other parts of the RTD system, while recognizing that current plans for short-term implementation of the CRE include using light rail vehicles on opening day. Overall concluding observations related to streetcar-related issues and choices include:

- The CRE project is, first and foremost, a mobility project (connecting the RTD East Rail line with downtown Denver). Therefore, its vehicle should be capable of providing relatively rapid and efficient movement for people to and through the corridor.
- Based on RTD’s preliminary ridership forecasts for the corridor, a streetcar vehicle’s ultimate size (if used on the corridor) should likely be longer than the 66-foot Czech-style vehicle currently used in Portland and Seattle to ensure it can meet passenger capacity. The ridership forecasts described in Chapter 2 assumed a vehicle that could accommodate roughly 125 passengers per vehicle during peak periods, which would require a vehicle in the 85-90 feet range or longer.
- While alternative propulsion systems are becoming more readily available, a streetcar system on the CRE should focus on using overhead electric power, as that is a traditional source of power already used in Denver for its light rail system.
- To promote efficient passenger loading and unloading, off-vehicle ticketing and multi-door boarding is recommended, similar to RTD’s existing light rail system.
- Vehicle maintenance will be a key consideration in the implementation of a new streetcar-type vehicle. If existing RTD facilities cannot accommodate a new vehicle type (either because of radically differing technology and maintenance needs, or if existing facilities are not large enough to accommodate a new CRE fleet), a streetcar maintenance facility will need to be planned, sited, and constructed to provide storage and maintenance space for the streetcar fleet. This issue should be addressed early in any system planning, and every effort should be made to make a maintenance facility a community asset by integrating it into the community (such as providing a maintenance public viewing facility, a streetcar museum, integration with an education facility, or other strategies to increase a facility’s community integration).

Based on this analysis, and taking into consideration past and current community support for a streetcar-type vehicle, this report recommends that RTD should continue to examine and evaluate the option of implementing use of a low-floor neighborhood-friendly streetcar-type vehicle on the CRE line and potentially other parts of the RTD system.

4 Goal 3: System Expansion

Goal 3: Establish a long-term vision for future potential expansion of the CRE and other rail transit services in downtown Denver. This study will examine a number of potential long-range expansion options for CRE and other RTD services that can provide additional passenger capacity for RTD in the future. It will also examine other long-term implementation issues related to the future of passenger rail service and its interaction with the community downtown and in other nearby neighborhoods, including Five Points and the Auraria campus, as expressed by other previous and ongoing studies.

Introduction

A major issue related to this study – and to future RTD operations – is system capacity expansion. This issue has two major components:

- Expansion of operational capacity of the CRE system itself to meet future ridership needs, in the core CRE system (including the downtown loop), in non-downtown portions of the system in Five Points and adjacent northeast Denver neighborhoods, and in the overall system to accommodate increasing ridership transferring from the East Rail line to the CRE.
- Expansion of RTD’s overall rail capacity in the downtown core to meet future ridership needs as downtown employment and population continue to grow in the years ahead.

Core System Capacity Expansion

The first prerequisite for operational capacity expansion is improvement of the operational capability of the core CRE system itself. As noted earlier, the introduction of CRE trains into the downtown loop at 15-minute headways utilizes all available capacity of the loop. However, the portion of the CRE outside of the downtown loop – primarily on Welton Street through Five Points and on Downing Street – has no such limitations from a purely operational standpoint, but the existing track infrastructure on Welton Street does introduce potential long-range operational issues.

Existing Conditions on Welton Street

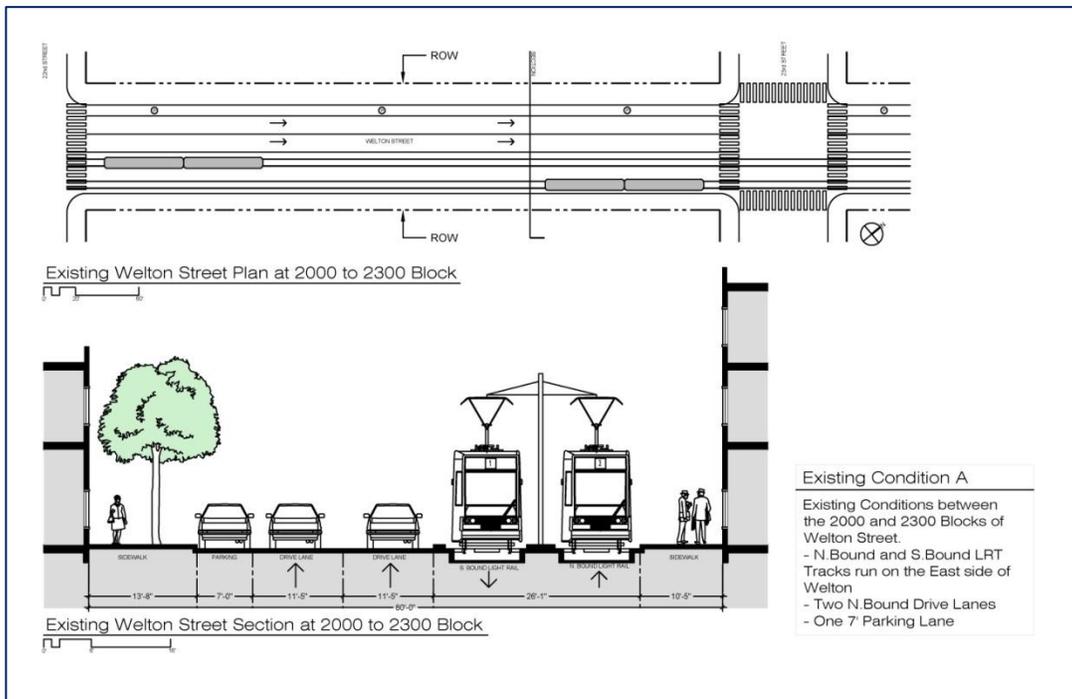
Currently, the LRT D line runs on Welton Street operates in a double-track configuration from 20th Street to 24th Street. However, continuing northeastward on Welton Street, the line is a single-track configuration to the station at 30th and Downing Streets. Figure 4-1a shows an aerial view of the transition from two tracks to one track at Welton and 24th Streets, and Figures 4-1b and 4-1c show general existing conditions on Welton on either side of 24th Street (note that parking varies from block to block).

Figure 4-1a: Aerial View of Transition from Two-Track to One-Track Infrastructure on Welton Street



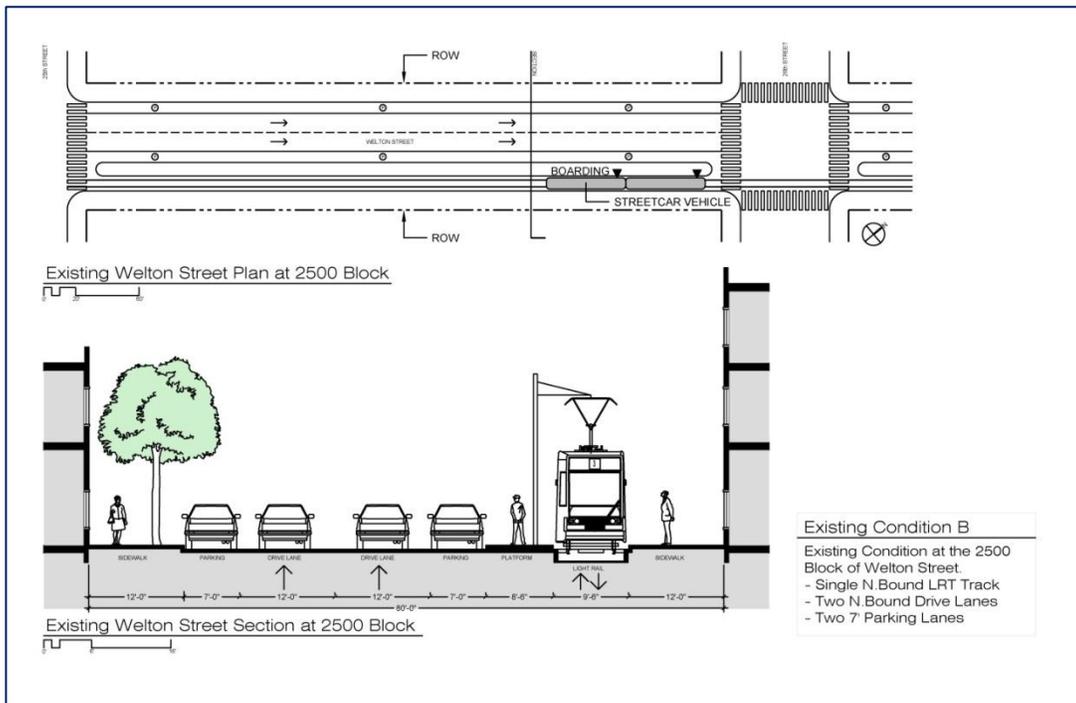
Source: Project Team

Figure 4-1b: Current General Conditions on Welton Street from 20th to 24th Streets



Source: Five Points Streetcar Coordination Plan, 2013

Figure 4-1c: General Current Conditions on Welton Street from 25th to 29th Streets

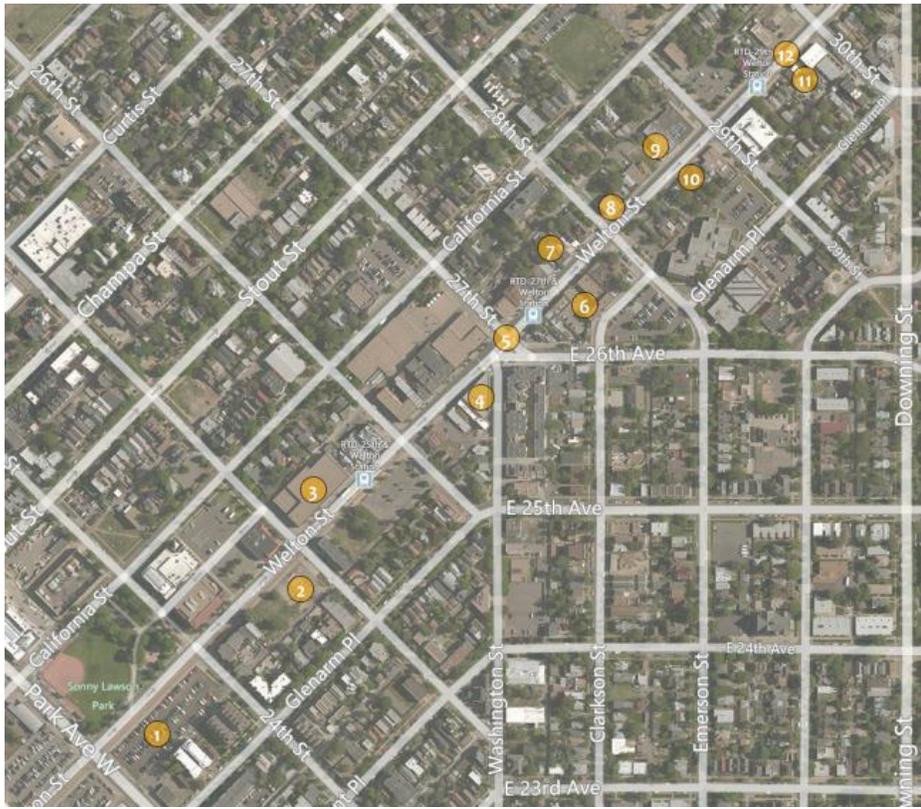


Source: Five Points Streetcar Coordination Plan, 2013

How is the Welton Street Corridor Changing?

Over the years, there have been a number of planning efforts focused on Welton Street revitalization. The City of Denver has played a critical role, as have State and Federal investments and grants. These efforts, combined with a demographic, development, and investment environment favoring downtown revitalization, have helped spark a number of potential development projects along the Welton Street Corridor that could result in increasing demand on the CRE line. These projects vary in size; however, many of them tend to be mixed-use, and some of them include redevelopment of existing structures. **All will play an important role in contributing to the future vibrancy of this neighborhood corridor and potentially increasing rideship pressures on the CRE line.** These projects are depicted in Figure 4-2 and described in Table 4-1.

Figure 4-2: Welton Street Development Projects as of August 2014



Source: Five Points Business District, Project Team/ArLand Land Use Economics

Table 4-1: Developments Planned for the Welton Street Corridor as of August 2014

Map Key	Address	Program	Proposed Date	Developer
1	2300 Welton St	223 workforce rental units; total development planned for 268,500 sq ft	2014	Century Real Estate
2	2422-2469 Welton St	82 market-rate apartment unites and 14 for-sale 3-story townhomes	2014	Palisade Partners
3	2501 Welton St	Renovation of 30,000 sq ft into mixed-use retail/office	2014	NA
4	2650 Welton St	200,000 sq ft of restaurant, residential, hotel, and office	2015	Rossonian Partners
5	2714 Welton St	Renovation of historic 2-story bldg. with 2,400 sq ft of restaurant/deli space with 2-4 market-rate apartments above	Opened July 2014	Empire Bagels LLC/Cousins Properties
6	2736 Welton St	22,040 sq ft of restaurants and retail	2016	NA
7	2741 Welton St	3,700 sq ft of restaurant	2014	Randalls at Pierre's
8	2801 Welton St	Renovation of historic 5,000-sq ft 2-story bldg. into restaurant/retail and office	NA	NA
9	2821-2843 Welton St	5-story mixed-use project with retail and 66 units of market-rate residential	2015	Markel Homes
10	2844 Welton St	Renovation of 2-story bldg. to include 4,700 sq ft Duncan's Kitchen and Tap Room	2014	Ayre WP, LLC
11	2942-2944 Welton St	3-story mixed-use restaurant and office bldg	2015	SID, LLC
12	2950 Welton St	3-story mixed-use retail and apartments	2014	St. Bernard Properties, LLC

Source: Five Points Business District, Project Team/ArLand Land Use Economics

Future Rail Operations and the Community Vision on Welton Street

The current D Line operates on 15-minute headways throughout most of the day, including on this stretch of Welton Street. The single-track segment is not ideal since it can cause operational delays if the schedule is slightly disrupted (primarily when northbound trains are forced to wait for southbound trains to clear the single-track segment). However, in general, the single-track segment is able to accommodate 15-minute headways throughout most of the day without significant problems. This also means that the CRE line, also proposed for 15-minute headways, should be accommodated in the single-track segment without major problems. In addition, the VISSIM analysis described in Chapter 2 utilized a tentative schedule for the CRE line developed by RTD staff for that purpose; the VISSIM analysis indicated that the single-track segment did not present any major problems for the CRE line (operating in its entirety from the 38th/Blake station through the downtown loop and back again) other than occasional delays resulting from “downstream” schedule delays or disruptions. However, as future employment and population increase in downtown, Five Points, and throughout the study area, there will likely be a growing need to both improve overall system reliability and expand passenger capacity on the CRE line.

Irrespective of CRE capacity needs, there will likely be a continuing desire on the part of the Five Points neighborhood to implement the community vision for Welton Street described in Chapter 1. This community vision consists of two major elements, all with the intention of promoting walkability, calming traffic, creating a more user-friendly urban neighborhood, and promoting economic development. Those two major elements are:

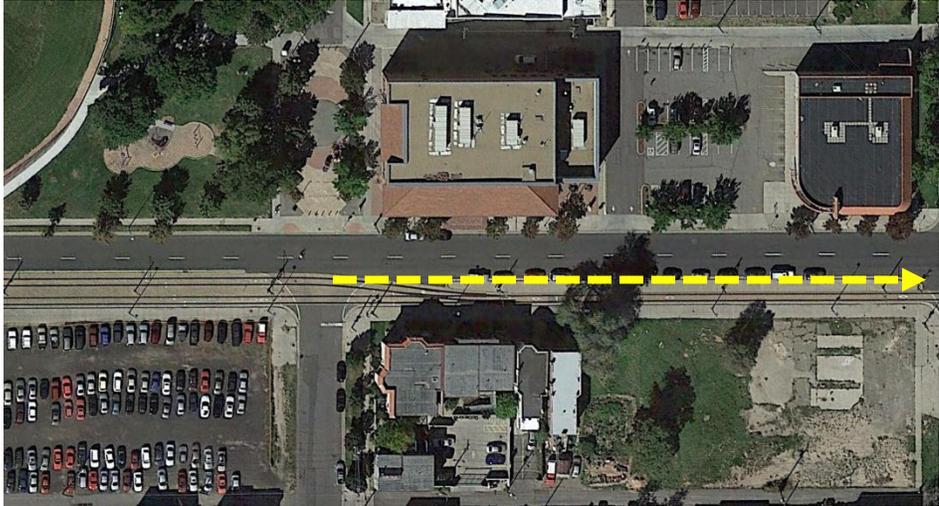
- Changing the existing light rail vehicle to a neighborhood-friendly low-floor streetcar-type vehicle, ultimately with in-street tracks operating in mixed traffic on both sides of Welton Street; and
- Converting Welton Street from one-way outbound traffic operations to two-way traffic.

This community vision for Welton Street could be accomplished in several ways: adding a track to existing infrastructure, utilizing a portion of the existing infrastructure combined with a new track as part of a partial re-build of Welton Street, and complete removal of existing infrastructure with totally new track construction. The options below describe how that conversion could take place.

Option 1: Adding a Track to Existing Infrastructure

This option would merely add a second track in close proximity to the existing one-track section along Welton Street, as illustrated in Figure 4-3.

Figure 4-3: Conceptual Addition of Second Track to Existing Single-Track Alignment on Welton St.



Source: Project Team

Opportunities for this option include:

- **Relatively low cost.** At a distance of approximately 0.6 miles from the transition point at 24th Street to the 30th/Downing station, a single track could cost in the range of \$15-\$25 million given recent streetcar-type track-slab construction costs of approximately \$25-35 million per track mile.
- **Short-term implementation.** This option could be implemented in a relatively short time frame pending funding availability, allowing for relatively rapid capacity expansion and reliability improvement.

Challenges for this option include:

- **Elimination of parking** along the guideway that exists for most of the route from 24th Street to the 30th/Downing station.
- **No opportunity for urban design improvements along Welton Street** such as widening of sidewalks to promote walkability and improve pedestrian safety.
- **Continued segregation of the rail tracks** in the Welton Street right-of-way, as the use of a semi-exclusive guideway for the new southbound track would continue the perception of the rail infrastructure as a “barrier” or impediment to walkability and economic development.

Option 2: Continue to Use Northbound Track but Construct New Southbound Track

This option would remove the existing southbound track from Welton street between 24th Street and 20th Street and construct a new southbound track on the west side of Welton Street as an initial or partial step toward Welton Street redevelopment. It would continue the use of the existing northbound track on the east side of Welton Street as either a semi-exclusive guideway or a mixed-traffic guideway (with some street reconstruction to provide a smooth street grade and crown).

Opportunities for this option include:

- **Potential for urban design improvements** including sidewalk widening and parking on the northwest side of Welton Street in conjunction with the construction of the new southbound track.
- **Moderate cost**, as the construction of the new track on the northwest side of Welton is estimated to cost \$25-\$35 million using streetcar-type track slab construction. In addition, the removal of the existing southbound track and reconstruction of Welton Street from 24th Street to 20th Street could conceivably be accomplished for \$15-\$25 million.

Challenges for this option include:

- **No opportunity for urban design improvements** such as sidewalk widening on the southeast side of Welton Street.

Option 3: Remove Northbound Track, Extend Existing Southbound Track and Convert to Northbound, and Construct New Southbound Track

This option is a variation of Options 1 and 2. It would remove the existing northbound track but convert the existing southbound track to a new northbound track, extending it from its current transition point at 24th Street to the 30th/Downing station. Concurrently, a new southbound track would be constructed on the west side of Welton Street as an initial or partial step toward Welton Street redevelopment. In essence, it takes advantage of existing track infrastructure to the extent possible while implementing most if not all of the community vision for Welton Street. It would require some reconstruction of Welton Street to accommodate the “new” northbound track to provide a smooth street grade and crown for mixed-traffic operations.

Opportunities for this option include:

- **High potential for urban design improvements** including sidewalk widening and parking on both sides of Welton Street.

Challenges for this option include:

- **Relatively high construction cost** with the removal of the existing northbound track, extension of the existing southbound track and conversion to the new northbound track, and construction of the new southbound track on the west side of Welton Street, for a total conceptual cost of approximately \$55-\$65 million.

Option 4: Complete Reconstruction of Welton Street and Track Infrastructure

This option most closely resembles previously-established community visions for the segment of Welton Street between the 20th/Welton and 30th/Downing stations by completely reconstructing the street.

Opportunities for this option include:

- **Maximum flexibility for complete street redesign**, including urban design improvements such as widened sidewalks.
- **Maximum ability to implement two-way traffic operations** on Welton Street and retain parking on both sides of the street.

Challenges for this option include:

- **Highest cost option.** RTD estimates that removal of existing track infrastructure and replacement with new in-street tracks could cost as much as \$60-\$70 million, not including additional improvements such as sidewalk reconstruction or widening.

Interaction with 30th/Downing Station

Regardless of the option chosen, a two-track alignment on Welton Street could have implications on the design and operations of the existing station at 30th/Downing. The 2010 Environmental Evaluation included a concept showing how the transition could occur from the 30th/Downing station northward into the Downing Street right-of-way, as shown in Figure 4-4.

Figure 4-4: CRE Environmental Evaluation Concept for Track Extension at 30th/Downing Station



Source: RTD

However, if and when a two-track operation is implemented in Welton Street, with tracks on either side of the right-of-way in mixed-traffic lanes, an additional configuration could be considered. Two options are shown in Figures 4-5a and 4-5b, which show how the two tracks

on either side of Welton Street could transition into the station from the south and then move into the Downing Street right-of-way to the north. Both options propose elimination of the existing 30th/Downing station and plaza configuration on the west side of Downing, replacing the station with curbside loading in the Downing Street right-of-way, potentially freeing up the existing RTD station footprint (and the adjacent park-and-ride) for development. Figure 4-5a shows an example configuration using “bump-out” curbside stations for both rail and bus loading on either side of Downing Street, with optional parking spaces also provided along Downing.

Figure 4-5a: Example Track Configuration on Downing Street with “Bump-Out” Platforms on Both Sides



Source: Project Team/Perspective-3

Figure 4-5b shows a second example concept with “bump-out” curbside loading platforms for rail and bus on the west side of Downing Street, but with loading platforms using existing curbs on the east side of Downing. This option provides more flexibility in traffic operations and traffic/transit interaction on the northbound rail track. Both of these options, along with additional concepts, should be explored in more detail in future phases as the two-track alignment on Welton Street moves forward.

Figure 4-5b: Example Track Configuration on Downing Street with “Bump-Out” Platforms on East Side



Source: Project Team/Perspective-3

Figure 4-5c is an example of how the current RTD park-and-ride at the 30th/Downing station could be converted to new development in conjunction with the redesign of the station, and Figure 4-5d shows SketchUp models of how this development could look in relation to the redesigned station. These ideas are purely theoretical but do show the potential for redevelopment of this entire area concurrently with the implementation of the community vision on Welton Street and the completion of the CRE line north to 38th/Blake.

Figure 4-5c: Plan View of Potential Redesign of Existing RTD Park-and-Ride at 30th/Downing



Source: Project Team/Perspective-3 and Leese Associates

Figure 4-5d: SketchUp Visualizations of Potential Redevelopment of 30th/Downing Park-and-Ride

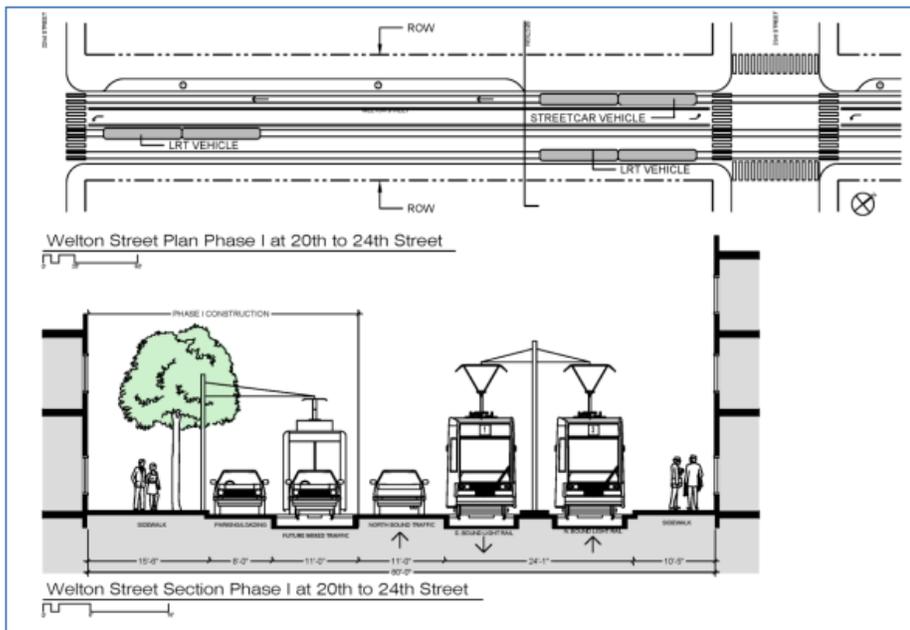


Source: Project Team/Perspective-3

How Could the Welton Street Conversion be Accomplished?

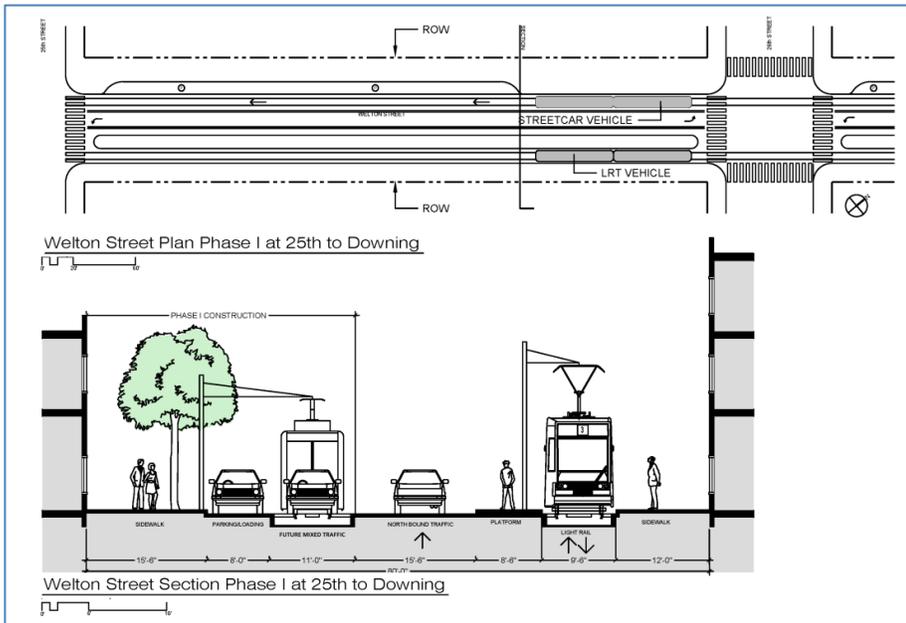
According to the *Five Points Streetcar Coordination Plan* (Steer Davies Gleave for the Colorado Department of Local Affairs and the Five Points Business District, 2013), changing Welton Street from one-way operation to two-way operation could be completed in phases so as to cause minimal disruption to traffic along Welton. With the construction first on the west side of the street, northbound traffic would continue in one lane and the existing passenger rail service (irrespective of vehicle type) would continue on the east side of the street. The construction of the track on the west side would also include the widening of the sidewalk from its current width to its desired or ultimate width of 15'6", while installing a parking lane for future southbound auto traffic. Figures 4-6a and 4-6b show an example of how Phase I could be accomplished.

Figure 4-6a: Example Phase I Construction from 20th to 24th



Source: Five Points Streetcar Coordination Plan, 2013

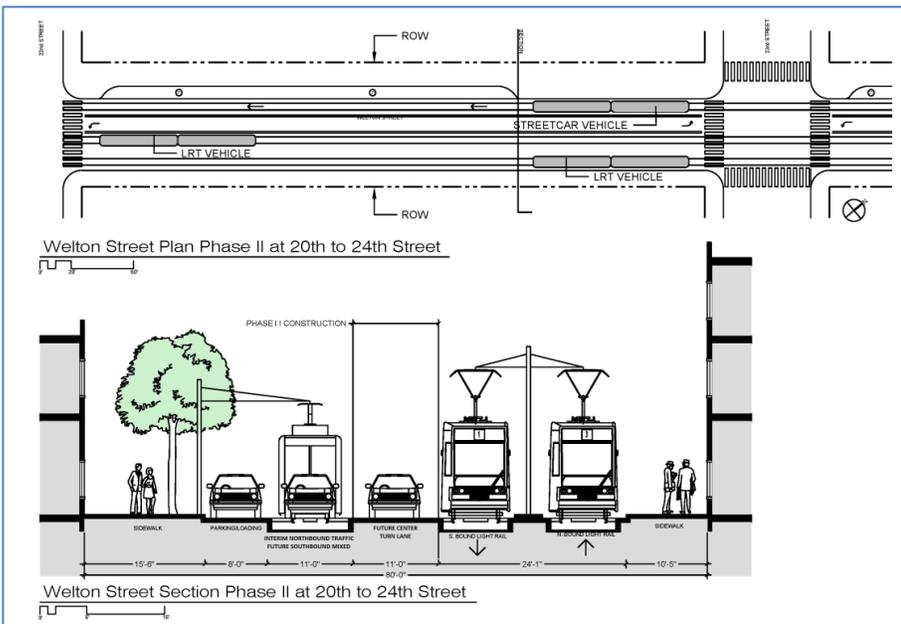
Figure 4-6b: Example Phase I Construction from 25th to 30th



Source: Five Points Streetcar Coordination Plan, 2013

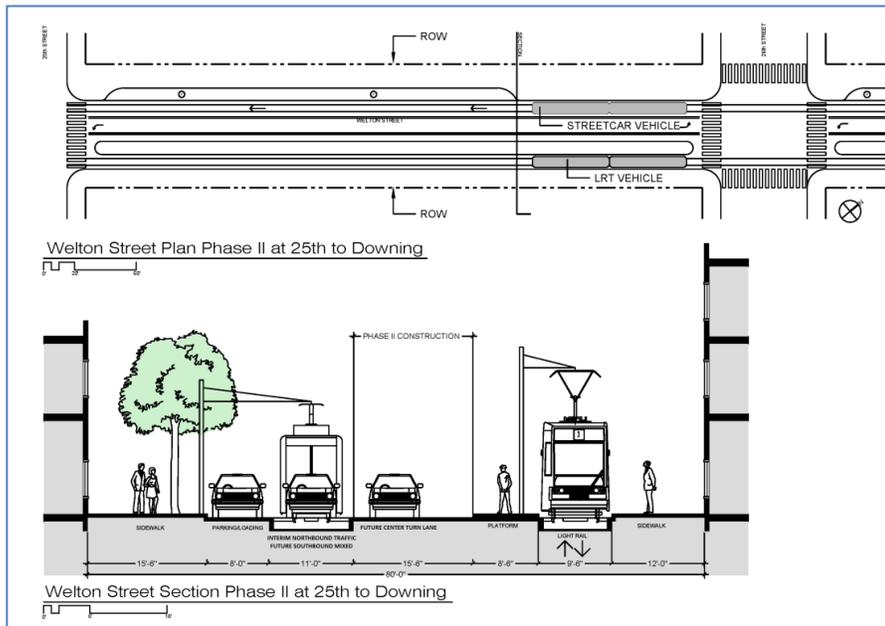
Phase II would reconstruct the center of Welton Street with a new two-way center turn lane adjacent to the existing rail tracks while maintaining one lane of interim northbound auto traffic and the existing rail service on the east side of Welton. Figures 4-7a and 4-7b show example Phase II construction diagrams.

Figure 4-7a: Example Phase II Construction from 20th to 24th



Source: Five Points Streetcar Coordination Plan, 2013

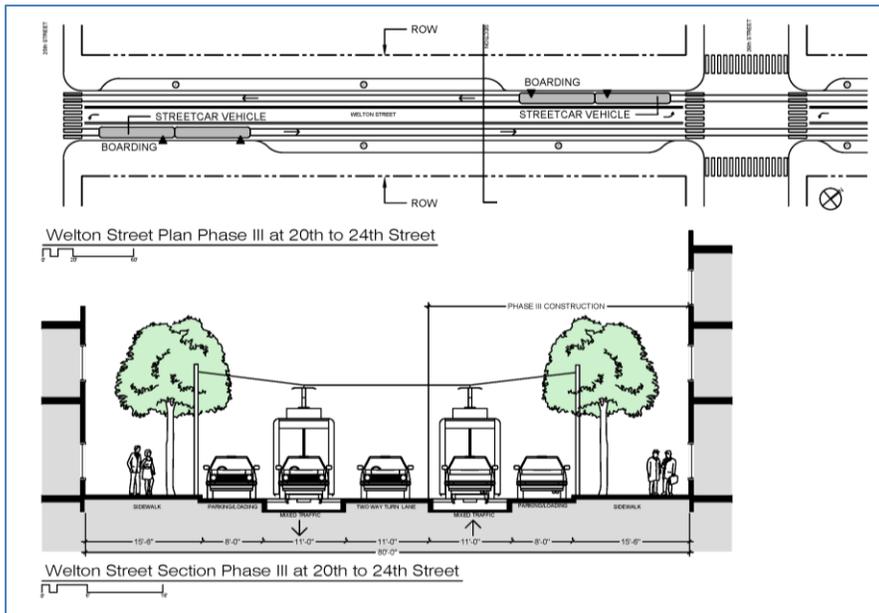
Figure 4-7b: Example Phase II Construction from 25th to 30th



Source: Five Points Streetcar Coordination Plan, 2013

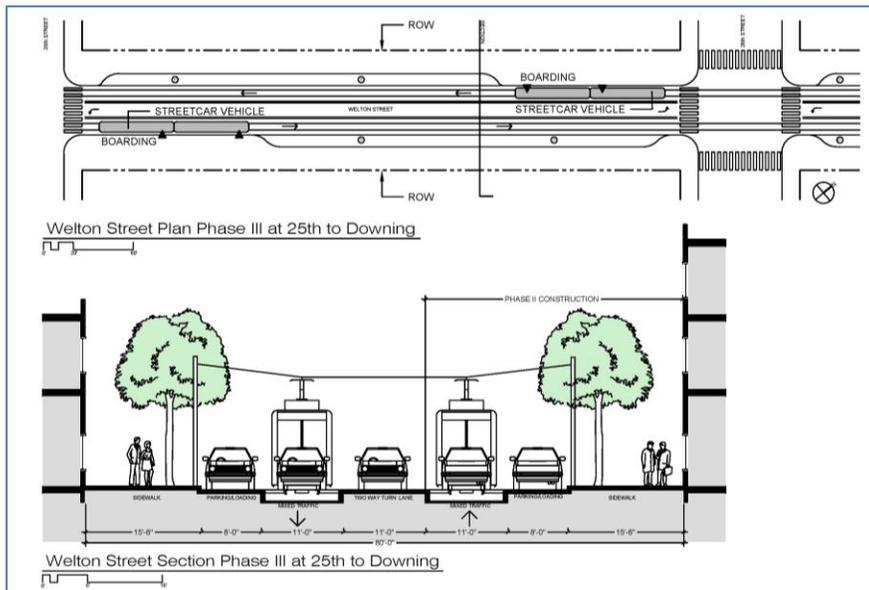
Implementation of Phase III (the final phase), would remove the existing RTD light rail infrastructure and install a new parking lane and new northbound track in the east side of Welton. This would allow conversion of Welton to two-way auto traffic during construction and also would allow initiation of bi-directional rail service in the shared southbound lane. The sidewalks would also be widened on the east side of Welton for better pedestrian connections and flow. Figures 4-8a and 4-8b show example Phase III construction.

Figure 4-8a: Example Phase III Construction from 20th to 24th



Source: Five Points Streetcar Coordination Plan, 2013

Figure 4-8b: Example Phase III Construction from 25th to 30th



Source: Five Points Streetcar Coordination Plan, 2013

These example implementation phases are conceptual recommendations subject to additional design and constructability reviews. However, they can provide good first steps in helping local project partners, including RTD, the City and County of Denver, the Five Points Business District, and others understand the issues associated with implementing the community vision for Welton Street.

Utilities

An issue related to track relocation or reconstruction in Welton Street and potentially other alignments – regardless of the vehicle option selected – is utilities. Traditionally, utility relocation for streetcar construction is not as extensive as that for light rail (primarily through the usual use of a shallow track slab construction method). However, RTD is proposing the less-costly track slab construction for its new tracks on Downing Street between 38th/Blake and 30th/Downing regardless of technology. Whatever rail technology is used, the exact location of utilities and a program for dealing with potential relocations should be a top priority of future phases on Welton Street and all potential expansion routes.



The publication *Streetsmart 2: Streetcars and Cities in the Twenty-First Century* (published by Reconnecting America in 2009) discusses issues surrounding utilities in relation to streetcar (and other track slab) construction and operations. It defines several types of potential utility conflicts for streetcar construction in particular:

- Direct conflicts – when “streetcar infrastructure needs to occupy the same space as an existing (or proposed) utility or access structure.”
- Longitudinal (or maintenance or access) conflicts – when “streetcar improvements are located directly above” a utility or “within a specified distance” of a utility that runs parallel to a streetcar alignment.
- Crossings – when utilities cross under or over a streetcar line.

The analysis notes that, “The greatest flexibility a streetcar operation can offer to the utility is the ability to shut down service when necessary to accommodate” utility repair or maintenance. That determination – if service can be stopped for short times and potentially replaced by bus service in the interim – can often help determine whether or not a utility needs to be relocated. The document notes that the best course is to “accommodate access and maintenance requirements into the design of the streetcar project where by possible by including offset manholes; by servicing utilities during hours when the streetcar is not in service; by installing structural track slab capable of spanning utility trenches; and by providing for limited relocations at critical service points.”

Detailed documentation on utilities in the corridor was included in the 2013 Five Points Welton Street Marketplace Vision Plan Implementation and Revitalization Strategy report. In addition, a member of this study’s project team – Goodbee and Associates – conducted a subsequent high-

level inventory of potential utility conflicts in Welton Street between 20th and 30th Streets. Table 4-2 summarizes the major utilities inventoried in this stretch of Welton Street.

Table 4-2: Major Utilities Noted on Welton Street Between 20th and 30th Streets

Major Utility Type	Location/Details
Communications	No communication lines meeting the major utility criteria are present in this area based on the available information.
Electric transmission/network electric lines	No electric transmission lines meeting the major utility criteria are present in this area based on the available information. This area is beyond the limits of Xcel Energy’s network electric facilities.
Storm sewers	There are 12-inch to 18-inch clay storm sewers crossing Welton St. in 20 th St., 22 nd St., 23 rd St., 24 th St., 25 th St., 26 th St., 28 th St. and 29 th St. There is a 75-inch clay storm sewer crossing Welton St. in 27 th St. There is a 15-inch clay storm pipe near the southeast curb in Welton St. between 27 th St. and 29 th St.
Sanitary sewers	There is a 10-inch to 15-inch clay sanitary in Welton St. west of the existing light rail tracks between 20 th St. and Park Avenue West. There is a 24-inch PVC sanitary in Welton St. northwest of the existing light rail tracks between 27 th St. and 30 th St. that crosses Welton St. and continues northwest in 30 th St. There is a 12-inch clay sanitary pipe that crosses Welton St. along 20 th St
Steam lines	This area is beyond the limits of Xcel Energy’s steam, chilled water and network electric facilities.
Water lines	Denver Water has a 20-inch waterline on the southeast side of Welton St. between Broadway and 20 th St., changing to a 12-inch line on the northwestern side of Welton between 20 th and 30 th Denver Water’s 24-inch Conduit 33 crosses Welton St. in 30 th St.
Gas lines	No gas lines meeting the major utility criteria are present in this area based on the available information.

Source: Project Team/Goodbee & Associates

Obviously, the location (and potential relocation) of utilities is a major factor in the construction of a new rail line (regardless of specific technology), so extensive analysis of those utilities should be undertaken in future, more detailed design phases. In addition, the potential reconstruction of Welton Street presents the opportunity for RTD to work with the City and County of Denver to upgrade and/or replace aging utility infrastructure within Welton Street in conjunction with any potential removal or new construction of rail tracks.

What are the Issues Related to Converting Welton Street from One-Way to Two-Way Traffic Operations?

The project team, led by Arland Land Use Economics, examined a number of key issues related to the potential conversion of Welton Street from one-way to two-way operations, both for its potential impact on the local neighborhood and for its potential integration of a two-track rail transit alignment as part of the community vision. The results of that examination are summarized below; the entire analysis is included in the Appendix.

Literature Review

Many factors combine to make a street economically successful. Converting a one-way street into a two-way street can sometimes help an area's revitalization effort if conditions are conducive, such as redevelopment activities that are already occurring. A growing number of communities are converting one-way streets to two-way streets citing potential economic benefits, such as reduced vacancy rates, increased retail sales and employment, increased pedestrian activity, and/or increased property tax assessments.

Some of the economic development benefits cited in the literature discussing the conversion of one-way streets to two-way streets included the following:

- **Two-way streets make the area more navigable.** One-way streets networks are often confusing and more difficult to navigate than two-way street networks. Streets that are two-way improve circulation in ways that allow patrons to reach their destinations quickly and easily because most one-way systems do not allow motorists to travel directly to every destination. One-way streets, with rapid and efficient traffic flows, often cause drivers to pass their destination, turn back on to another block after some distance, and drive back via the original block to complete their trip. Two-way streets can provide more direct access by giving more directional options and creating slower traffic conditions, which makes for easier lane changes.
- **Two-way streets also slow traffic down**, which makes the area more pedestrian-friendly. It makes it safer due to lower speed limits (15 to 30 miles per hour) and invites pedestrians to come and enjoy the street more often and for longer periods of time, which can increase impulse buys and can generally have a positive effect on businesses. Slowing traffic down and allowing a certain level of traffic congestion can also help to create the perception that a commercial area is exciting and lively, as it appears busy, which can make the area desirable to businesses and patrons alike. One-way streets, on the other hand, tend to encourage higher speeds at 35 to 40 mph, which are often too high for retail districts to be enjoyable and safe for pedestrians. One-way streets are often so efficient at moving traffic that they may feel empty in terms of activity and unsafe due to high speeds.
- **Two-way streets can have a positive impact on storefront visibility**, partially because traffic moves more slowly and allows drivers time to absorb their surroundings. Additionally, as a vehicle stops at or enters an intersection, the driver has excellent visibility of the storefronts

on the far side of the cross street. District businesses that greatly rely on pass-by traffic will also benefit from the pedestrian-friendly (and thus pedestrian-rich) atmosphere of two-way streets.

- **Two-way streets can result in a reduction in crime in retail districts.** A study in West Palm Beach, Florida, showed a reduction in crime after two-way directional changes were made. This was likely due to more positive activity at the street level as a result of increased and activated ground floor retail activities. Increased movement and more eyes on the street reduces crime by making it a less-favorable environment for criminal activity that does not like to be seen.

More communities are opting for two-way traffic along retail districts and there is significant anecdotal evidence that positive changes occur after most street conversions. For example, in 2000, the Hyannis Main Street Business Improvement District (in Cape Cod, Massachusetts) surveyed 22 towns and cities that had converted streets from one-way to two-way traffic. In general, the results were positive, including significant reductions in vacant floor space after the conversion, improved business, improved livability and substantial private investments stimulated by conversions.

General findings indicate that if the area in question is predominantly a retail district that is regenerating, a conversion may help to boost the economy of the area by contributing to an atmosphere conducive to increased pedestrian activity. If, however, the land uses adjacent to the one-way street are primarily office, warehousing, or industrial, with high peak-hour traffic and little in the way of pedestrian interest, then a conversion may not produce sufficient effects. This is because most significant benefits to a district come with existing and increased pedestrian traffic on its sidewalks. Areas in which existing pedestrian traffic volume is less than 200 to 300 people an hour have been found to produce minimal benefits when converted .

All of these aspects are potential benefits of two-way streets, but it is important to note that the potential of converting the street network from one-way to two-way will most likely not, by itself, guarantee an immediate resurgence of growth and activity, but rather should be considered an important piece of the overall redevelopment strategy. Most communities have included one-way to two-way conversions as a part of a greater vision or plan for their retail districts, such as streetscape improvements, beautification measures, traffic-calming measures, improved design and other improvements.

Local Case Study

In 2011, the City of Denver converted Larimer Street from Broadway to Downing Street from a one-way to two-way street. Larimer Street is close to downtown Denver and was historically an industrial and warehouse district. It is, however, in the midst of an area that has experienced some residential revitalization with a mix of new and renovated lofts, townhomes and apartments. Zoning in the area is predominantly industrial and commercial mixed use.

Prior to conversion, the area experienced a moderate amount of traffic. The Average Daily Traffic (ADT) pre-conversion was 10,700 based on a count that the City of Denver conducted in 2005. Streets parallel to Larimer Street include Walnut Street and Lawrence Street. Walnut Street in this area is a redeveloping mix of industrial and residential while Lawrence Street is predominantly residential. Larimer Street, closer to the downtown area, remains a one-way street. The area between Broadway and 30th Streets on Larimer Street area has experienced commercial revitalization with new offices, retail stores, restaurants, and coffee shops.

An examination of property values before and after the conversion showed the potential benefits of the change. Between 2010 and 2014, property values on the section of Larimer Street examined grew by an average annual growth rate of 5.5% and an overall growth rate of 23.7%. Denver and Walnut Street saw value declines during this period, while the greater Northeast Downtown area grew, but at a lower rate. While the conversion of Larimer Street to a two-way street was not the only factor in the area's growing economic vitality, its contribution should not be underestimated.

What are the Transit and Traffic Implications of Converting Welton to Two-Way Operations?

The project team conducted a preliminary analysis to determine if the two-way conversion of Welton Street to allow a mixed-flow operation of the CRE would create any negative traffic impacts. The analysis was once again conducted using the VISSIM micro-simulation model and various measures were used. These included the transit travel time and waiting time, which measure transit operations, and the intersection operations to determine traffic impacts. To achieve the two-way conversion, various parameters were changed from the base model. In this case, the base model was the CRE model for Alternative 3B as discussed in Chapter 2. The following describe the changes:

- **Geometry** – Welton Street was converted from a two-lane, one-way northbound cross-section with dual/single rail tracks on the right side of the road to a four-lane two-way cross-section with two through lanes mixed with trains as well as vehicles. This change was made north of 20th Street. South of 20th Street, the existing configuration was assumed.
- **Traffic Volumes** – It was assumed that the existing northbound traffic volume along Welton Street would remain unchanged. The southbound traffic demand was estimated based on the existing demand along California Street. Specifically, it was assumed that approximately one-third of the traffic along California Street would divert to Welton Street.
- **Traffic Signal Timing** – The traffic signal timing at Welton Street at Park Avenue, 26th Avenue/27th Street, and Downing Street were modified to accommodate two-way operation, however changes in phase splits were minimal.

The resulting models were then run ten times in order to get a more statistically significant result and to account for the significant variations that can occur in the downtown loop and the mixed-flow segment along Downing Street. The results were extracted from the models and are discussed below.

Transit Travel Times and Waiting Times

Table 4-3 summarizes the transit travel times that were obtained from the VISSIM models for the two-way Welton Street alternative. These travel times are for round trips on the entire CRE line from 38th/Blake to downtown and back. The results are compared to the base model (Alternative 3B) which assumes the existing one-way Welton Street configuration.

Table 4-3: Transit Travel Times for Two-Way Welton Street

	Alternative 3B – New Track in Parking Lane on 14 th St with New Pocket Track on Stout	Alternative 3B with Two-Way Welton Street Conversion
Minimum time (minutes)	45.4	39.4
Maximum time (minutes)	49.3	45.7
Average time (minutes)	47.7	42.7

Source: Project Team/Apex Design

The results show that that the two-way conversion of Welton Street will improve the total rail transit round trip travel time by roughly five minutes. The difference is primarily due to the elimination of delays at the single-track section as well as the fact that southbound trains do not have to cross Welton Street near both Downing Street and 20th Avenue. Similar results apply to the transit waiting times, which measure the amount of time that transit vehicles are delayed at traffic signals, etc., but does not include the transit stop dwell time. The transit waiting time results are shown in Table 4-4.

Table 4-4: Transit Waiting Times for Two-Way Welton Street

	Alternative 3B – New Track in Parking Lane on 14 th St with New Pocket Track on Stout	Alternative 3B with Two-Way Welton Street Conversion
Minimum time (minutes)	16.4	13.9
Maximum time (minutes)	19.1	16.5
Average time (minutes)	17.2	14.9

Source: Project Team

Intersection Operations

To determine if the proposed Welton Street two-way conversion will result in poor traffic operations, the intersection delay and level of service was extracted from the VISSIM model. Table 4-5 summarizes the results along Welton Street in the area that will be affected by the two-way conversion.

Table 4-5: VISSIM Analysis of Intersection Level of Service

Intersection	Two-Way Welton Street	
	Delay (sec.)	Level of Service
Welton Street / 19 th Street / Broadway	34.5	C
Welton Street / 20 th Street	16.3	B
Welton Street / Park Avenue	16.2	B
Welton Street / Washington Street / 26 th Avenue / 27 th Street	17.2	B
Welton Street / Downing Street / 29 th Avenue	23.8	C

Source: Project Team

As shown, all five signalized intersection to be affected by the conversion are anticipated to operate well with a level of service of “C” or better. This is not surprising considering that the two-way conversion will continue to maintain two travel lanes in the northbound direction while adding two additional lanes in the southbound direction. The four-lane cross-section will also allow vehicles to easily pass trains stopped at stations.

Overall Conclusions

This VISSIM analysis of the Welton Street two-way conversion was aimed at making a preliminary determination of the potential impacts of the conversion. Based on the results, the change would have significant positive impacts to rail transit operations while not worsening traffic operations. Future design will require special attention at certain areas, such as the track crossings area near Downing Street and 20th Street, but no operational issues are anticipated.

Other Expansion Opportunities

As noted above, the reconfiguration of Welton Street to a two-track rail operation is essential to increasing passenger capacity on the CRE line and, ultimately, additional potential routes in the downtown area. Previous and recent analysis indicates that the introduction of the CRE line into the downtown loop at 15-minute headways utilizes all available capacity in the loop. However, with potential two-track improvements on Welton Street, headways on the CRE line between 38th/Blake and 20th/Welton (at the northern end of the downtown loop) could be increased significantly, allowing additional trains to operate in alternative alignments in downtown. For example, trains on the segment between 38th/Blake and 20th/Welton could operate at 7.5-minute headways, splitting at the “pivot point” near the 20th/Welton station and the intersection of Welton with Broadway and Lincoln, with one train entering the downtown loop at 15-minute headways and the next train entering an alternative alignment, also at 15-minute headways. Conceivably, headways could continue to be increased on the segment between 38th/Blake and 20th/Welton to allow additional trains on one or more alternative alignments in addition to the downtown loop.

With those operational concepts in mind, the project team developed a number of potential additional alignments in the downtown area for consideration by project stakeholders, most of which pivoted off the CRE line at the area near the 20th/Welton station. After review by stakeholders and the public, the project team recommended four high-priority expansion options and several other lower-priority options.

High-priority expansion options included:

- An alignment along Broadway and Lincoln to and from the Civic Center station;
- An extension along Welton Street southwest of Broadway to the southeast east side of the Convention Center near 12th Street;
- A connection to the Auraria campus; and
- A connection to the National Western Complex from the 38th/Blake station.

Lower-priority expansion options included:

- A new downtown circulator focused on 15th and 17th Streets;
- A circulator along 21st Street from Welton Street to Coors Field; and
- A new “outer loop” circulator alignment bordering the existing downtown loop.

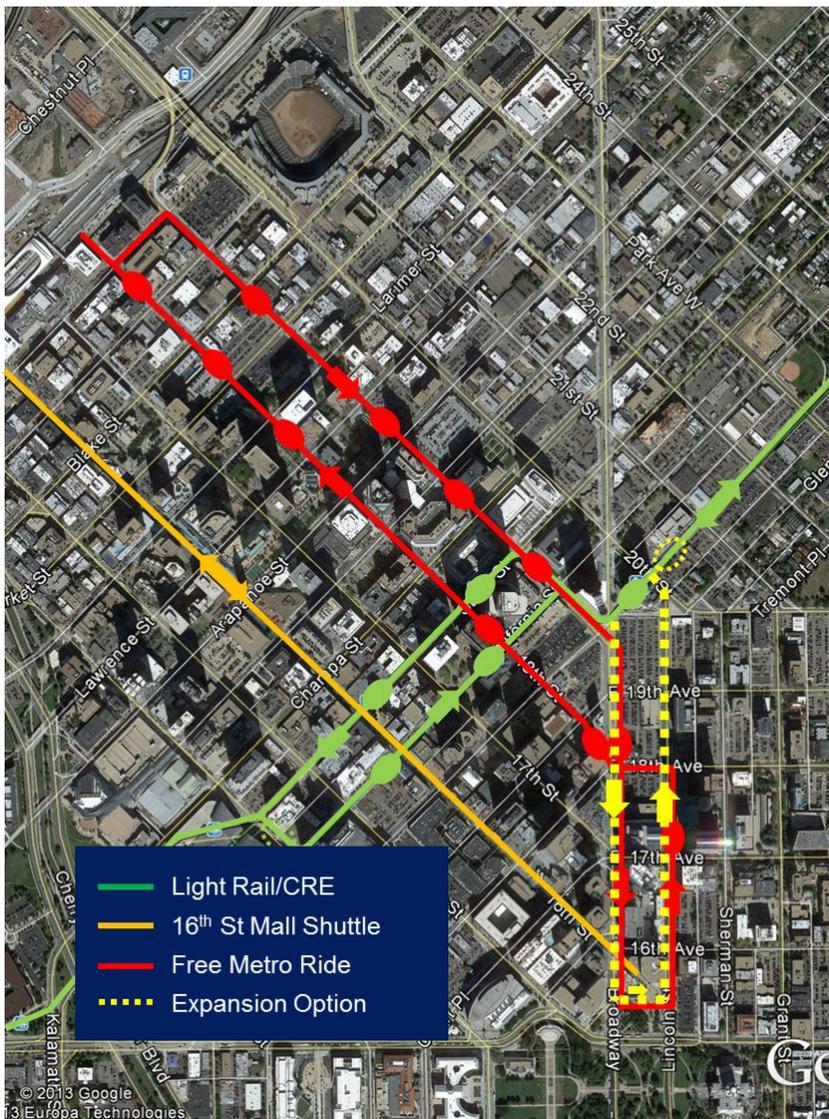
These options are explored in more detail in the following sections.

High-Priority Expansion Options

Civic Center (Broadway/Lincoln) Extension

This option (as shown in Figure 4-9) would provide a southbound one-way track extending from the CRE at 20th Street down Broadway to the Civic Center, returning northward in a one-way track on Lincoln Street to re-connect with the CRE at 20th/Welton. The option would provide good connections to the southeast end of downtown and the 16th Street Mall Shuttle and Free Metro Ride circulator systems. It would also provide good connections to future potential high-capacity transit investments on Colfax Avenue.

Figure 4-9: Conceptual Civic Center (Broadway/Lincoln) Extension

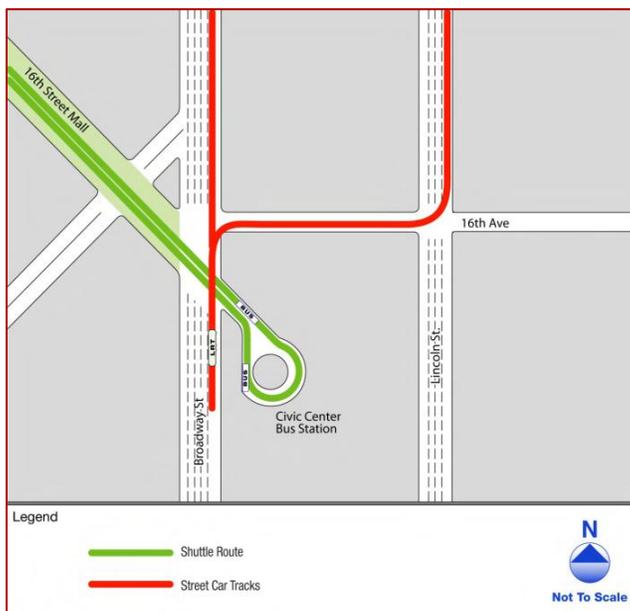


Source: Project Team

Key issues related to this option include:

- Capital cost: this option would encompass approximately 1.06 miles of one-way track at a cost ranging from approximately \$30 million using unit cost estimates of recent streetcar construction projects in the US, to approximately \$42 million using an estimate developed by LS Gallegos and Associates for this project using current RTD unit cost estimates.
- Track placement/utilities constraints: The 2010 Environmental Evaluation assumed potential track placement on the east sides of both Broadway and Lincoln as shown in Figure 4-10. For this study, a high-level examination of utilities in Broadway and Lincoln documented potential utility conflicts as shown in Tables 4-3a and 4-3b. The tables show that there are potentially significant utilities on the east and west sides of both Broadway and Lincoln, meaning that construction could be expensive and problematic, with extensive utility relocation required on both streets to accommodate rail track construction. More detailed analysis and cost estimates will be needed in future design and construction phases to determine specific cost and engineering implications.

Figure 4-10: CRE Environmental Evaluation Assumption of Track Location at Civic Center Station



Source: CRE Environmental Evaluation, RTD

Table 4-3a: Major Utilities Noted in Broadway

Major Utility Type	Location/Details
Communications	During the field survey, old locator markings showed communication lines owned by AT&T, CenturyLink, Comcast, Denver Traffic, Level 3, NextLink and XO in and crossing Broadway, although the full extent and size/importance of the facilities could not be determined based on the field markings.
	CenturyLink has facilities on the west side of Broadway between Cheyenne Pl. and south of Court Pl. and on the east side of Broadway between W. Colfax Ave. and 16 th Ave.
	Denver Traffic has fiber on the east side of Broadway between 18 th Ave. and 18 th St. and on the west side of Broadway between 18 th St. and Glenarm Pl. Denver Traffic also has conduit in Level 3's facilities in Broadway.
	Comcast has facilities on the east side of Broadway between 16 th Ave. and 17 th Ave. and between 18 th Ave. and 20 th St.
	Level 3 and NextLink are on the west side of Broadway between 16 th Ave. and 17 th St. and between 18 th Ave. and 19 th Ave.
	XO and Zayo have a facility on the west side of Broadway between 16 th Ave. and 17 th St.
	MCI has facilities on the west side of the street from north of W. Colfax Ave. to 17 th Ave. and from 18 th Ave. to north of 19 th Ave.
	TW Telecom has facilities on the east side of Broadway from Cleveland Pl. to 17 th Ave. and near the curb on the west side of the street between 19 th Ave. and 20 th Ave.
	Numerous communication lines cross Broadway at 16 th Ave., 17 th Ave., 18 th Ave. and 19 th Ave.
Electric transmission/network electric lines	Xcel Energy has buried network electric on the west side of Broadway for half a block north and south of 16 th Ave. and between 18 th Ave. and California St.
	Xcel Energy may have network electric on the east side of Broadway between Welton St. and 20 th Ave.
	There are buried network electric crossings at 16 th Ave., 17 th Ave., 18 th Ave., and Welton St.
Storm sewers	There is an 18-inch clay storm sewer near the curb on the east side of Broadway between W. Colfax Ave. and 16 th St. and smaller clay storm sewers connecting to storm mains in Broadway from the east at 16 th Ave., 17 th Ave., 18 th Ave. and 19 th Ave.
	There is 21-inch clay storm sewer along Broadway between 19 th Ave. and 20 th Ave.
	There is a 12-inch clay storm sewer on the east side of Broadway between 16 th Ave. and 17 th Ave.
Sanitary sewers	There is a sanitary sewer on the east side of Broadway from W. Colfax Ave. to north of 20 th Ave. ranging in size from 18 inches to 27 inches. South of 16 th Ave. it is clay pipe and is particularly close to the east curb between W. Colfax Ave. and 16 th Ave. North of 16 th Ave. it is PVC pipe.
Steam lines	Xcel Energy has low pressure steam pipelines on the west side of Broadway between 17 th Ave. and 18 th Ave. and on the east side of Broadway between 17 th Ave. and 19 th Ave.
	Low pressure steam pipelines cross Broadway in 16 th Ave., Court Pl., 18 th St. and 19 th Ave
Water lines	Denver Water's 24-inch Conduit 31 is on the east side of Broadway between W. Colfax Ave. and 16 th St., where it continues northwest in 16 th St.
Gas lines	No gas pipelines meeting the criteria for major utilities were identified in Broadway.

Source: Project Team/Goodbee & Associates

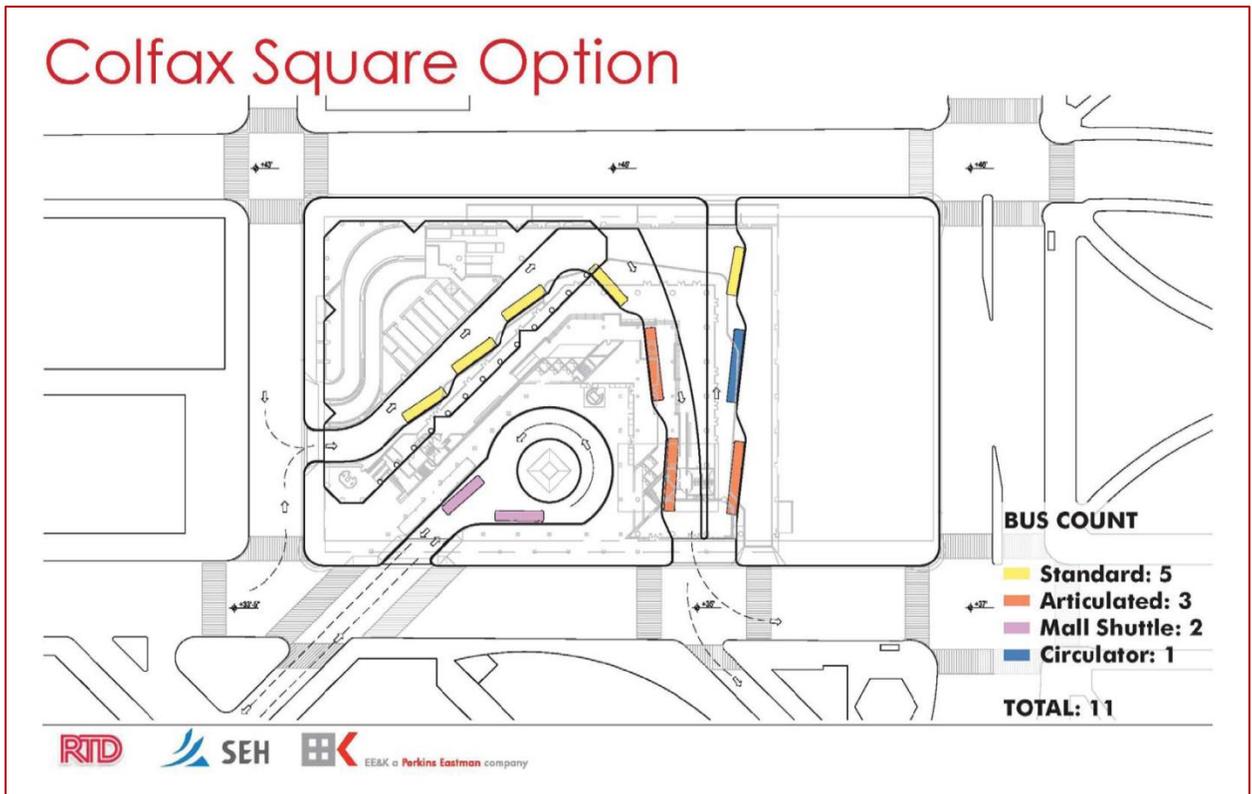
Table 4-3b: Major Utilities Noted in Lincoln Street

Major Utility Type	Location/Details
Communications	During the field survey, old locator markings showed communication lines owned by CenturyLink, Comcast, Level 3, NextLink XO and Zayo in and/or crossing Lincoln St., although the full extent and size/importance of the facilities could not be determined based on the field markings.
	CenturyLink has facilities crossing Lincoln under the north sidewalk of W. Colfax Ave. and 17 th Ave.
	CenturyLink long distance has facilities on the east side of Lincoln St. south of 17 th Ave.
	Level 3 and NextLink have facilities on the east side of Lincoln St. at 20 th Ave.
	MCI has facilities in Lincoln St. from north of 16 th Ave. to 20 th Ave.; it is unclear where in the street it is located.
	Zayo has facilities on the west side of Lincoln St. from south of 16 th Ave. to 20 th Ave.
	Numerous communication lines cross Lincoln St. at 16 th Ave., 17 th Ave., 18 th Ave. and 19 th Ave.
Electric transmission/network electric lines	Xcel Energy's buried network electric runs on the east side of Lincoln St. between 17 th Ave. and 18 th Ave. and crosses Lincoln St. in 16 th Ave., 17 th Ave. and 18 th Ave.
Storm sewers	An 18-inch clay storm sewer runs in Lincoln St. east of the centerline between 16 th Ave. and 17 th Ave.
	Clay storm sewers 12 to 18 inches in diameter cross Lincoln St. near the centerline of W. Colfax Ave., 16 th Ave., 17 th Ave., 18 th Ave., 19 th Ave. and 20 th Ave.
Sanitary sewers	A 9-inch clay sanitary sewer runs east of the centerline in Lincoln St. from W. Colfax Ave. to 20 th Ave.
	Clay sanitary sewers in 16 th Ave. and 19 th Ave. cross Lincoln St. south of the centerline and near the centerline in 17 th Ave.
Steam lines	Xcel Energy has low pressure steam pipelines crossing Lincoln St. south of the centerline in 16 th Ave. and 19 th Ave.
Water lines	No water lines meeting the major utility criteria in or crossing Lincoln St. were identified.
Gas lines	No gas lines meeting the major utility criteria in or crossing Lincoln St. were identified.

Source: Project Team/Goodbee & Associates

- Interaction with Civic Center station: As shown in Figure 4-8 above, the 2010 Environmental Evaluation assumed the use of 16th Avenue on the north side of Civic Center Station as the route for the southbound Broadway track alignment to move into northbound Lincoln. Since that time, RTD has initiated the design for the reconstruction of the entire Civic Center station; one initial design concept is shown in Figure 4-11, showing the potential interaction between the 16th Street Mall shuttles, downtown circulators (including the Free Metro Ride) and other buses. In particular, local circulator service is shown as using the southernmost cut-through between Broadway and Lincoln, north of Colfax Avenue. Under this configuration, a rail alignment serving Broadway and Lincoln could conceivably use the same cut-through, though the requirement for a maximum of two-vehicle consists (and the use of staggered angled bus bays) could be problematic at this location. Future design studies will need to examine this issue further to determine the specific location of the rail turnaround in this vicinity.

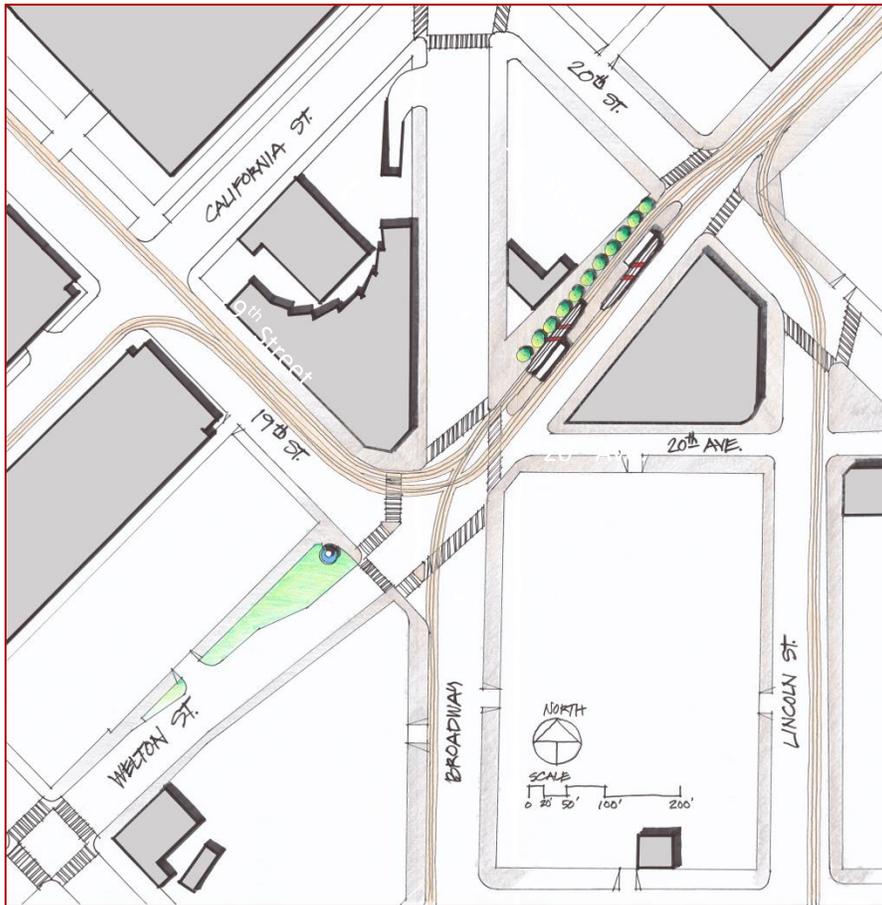
Figure 4-11: Potential Conceptual Redesign of Civic Center Station



Source: RTD and SHE Engineering

- Interaction with 20th/Welton/Broadway area: Figure 4-12 shows conceptual track locations for the junction of the Civic Center extension with the CRE line near the 20th/Welton station area. Key issues associated with this junction include:
 - A rail track intersection/crossing at 20th Ave./Broadway as the southbound CRE extension onto southbound Broadway crosses the existing downtown loop tracks.
 - The need for an eastbound platform along Welton Street for the northbound CRE extension coming from Lincoln (since this northbound track bypasses the existing 20th/Welton station).
 - The need for traffic and pedestrian signal coordination to allow the northbound and southbound CRE extension trains to move through the complicated intersections at Lincoln and 20th Avenue and 20th Street and at Broadway and 19th St.

Figure 4-12: Potential Track Interactions at 20th/Welton/Broadway Junction



Source: Project Team/Perspective-3 and Leese Associates

Welton Street Extension to Convention Center

This option would continue the future two-way track from Welton Street proposed for northeast of Broadway southwestward along Welton through the heart of southeast downtown to the southeast side of the Convention Center, as shown in Figure 4-13. It would provide an additional connection to the 16th Street Mall Shuttle, the Free Metro Ride, and the Convention Center, with potential connections to a future high-capacity transit investment on Colfax Avenue.

Figure 4-13: Conceptual Welton Street Extension to Convention Center

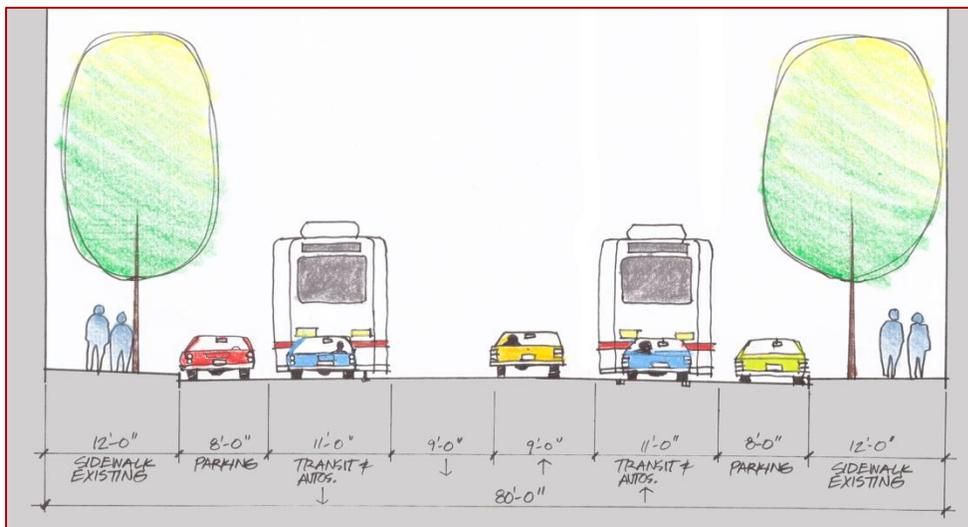


Source: Project Team

Key issues associated with this option include:

- **Welton Street configuration:** Currently, Welton Street in this area is one-way northeastbound. For this option to operate without the need for semi-exclusive contraflow track construction (to eliminate auto conflicts), which could also reduce the number of traffic lanes (and related auto capacity), Welton Street would need to be converted to two-way operations, an issue currently under consideration for some segments of the street. Two-way operation of Welton also would allow placement of tracks in shared auto lanes. Figure 4-14 shows a conceptual typical section with two-way operations combined with rail tracks.
- **Capital cost:** This option would require approximately 0.65 miles of two-way track (or 1.3 miles of one-way track) for a conceptual capital cost ranging from approximately \$40 million using unit cost estimates of recent streetcar construction projects in the US, to approximately \$50 million using an estimate developed by LS Gallegos and Associates for this project using RTD unit cost estimates.
- **Track placement/utility constraints:** The project team conducted a high-level analysis of potential major utility conflicts in this portion of Welton Street, as shown in Table 4-4. The table shows that there are potentially significant utilities on both the southeast and northwest sides of Welton Street, meaning that construction could be expensive and problematic with extensive utility relocation required to accommodate rail track construction. More detailed analysis and cost estimates will be needed in future design and construction phases to determine specific cost and engineering implications, including the potential for track placement either in the center or on the sides of Welton Street.

Figure 4-14: Conceptual Two-Way Welton St. Configuration



Source: Project Team/Leese and Associates

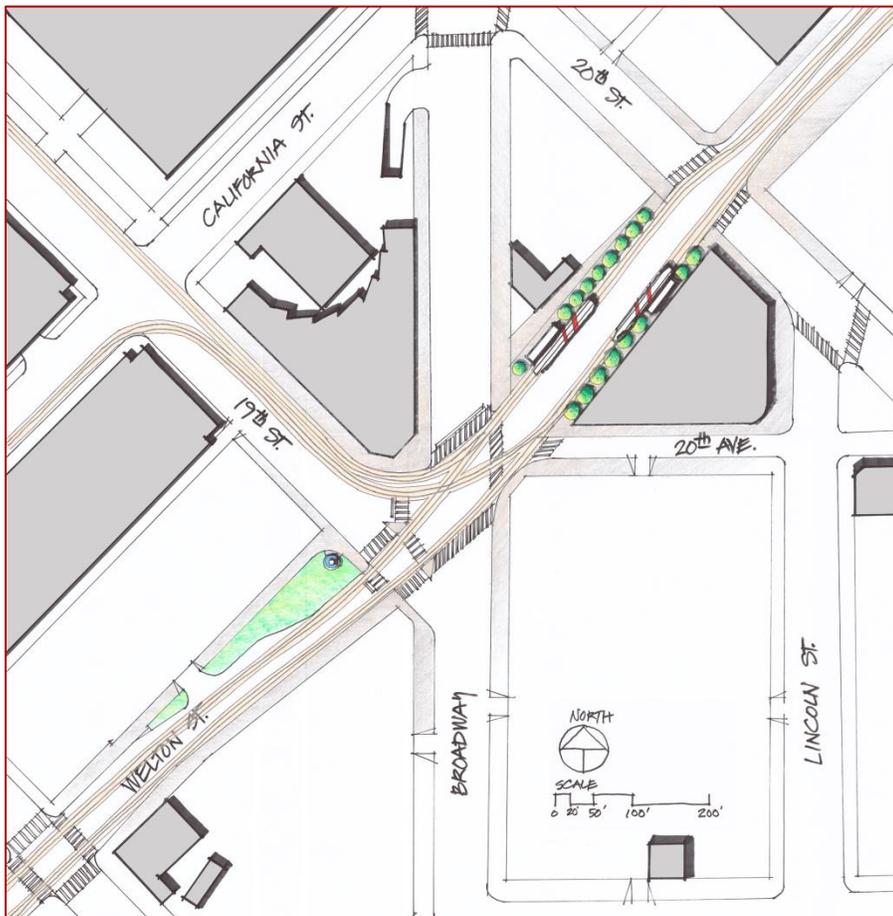
Table 4-4: Major Utilities Noted in Welton Street Between 20th and 12th Streets

Major Utility Type	Location/Details
Communications	MCI has several buried fiber runs in Welton St. including between 12 th St. and 16 th St. and on the southeast side of the street between 17 th St. and 18 th St.
	New Century Energy has fiber in Welton St. between 12 th St. and 14 th St.
	XO, NextLink and Level 3 have buried fiber runs on the northwest side of Welton St., between 14 th St. and 15 th St., although no key maps were received from NextLink or Level 3 and information was limited to field observations.
Electric transmission/network electric lines	There are numerous buried communication lines crossing Welton St., including MCI and Sprint in 14 th St., XO and Zayo in 15 th St., MCI and TW in 17 th St., Zayo in 18 th St. and TW Telecom in 19 th St.
	Xcel's buried network electric in Welton St. is near the middle of Welton St. between 12 th St. and 14 th St. and between 15 th St. and 16 th St. It also crosses Welton St. in 14 th St., 15 th St., 16 th St., 17 th St. and 18 th St.
Storm sewers	There are 12-inch clay storm sewer laterals crossing Welton St. in 15 th St., 17 th St. and 18 th St.
Sanitary sewers	There is a 21-26-inch sanitary sewer crossing Welton St. near the center of 16 th St.
Steam lines	Xcel Energy has a low pressure steam pipeline on the southeast side of Welton St. from south of 14 th St. to 18 th St. Low pressure steam pipelines also cross Welton St. at 17 th St. and 18 th St. and an intermediate pressure steam pipe crosses Welton St. at 14 th St.
Water lines	Xcel Energy's chilled water system consists of two 24-inch steel water lines (for supply and return) and six 4-inch conduits containing fiber optic cable ranging in depth from 3-20 feet deep. The water lines are located in front of the southeast curb from north of 16 th St. to 17 th St. and cross Welton in 15 th St. and 17 th St.
	Denver Water has a 20-inch water line on the southeast side of Welton from Broadway to 20 th St. that crosses Welton St. and continues northwest on 20 th St.
	Denver Water Conduit 31 is a 24-inch waterline crossing Welton St. in 16 th St.
Gas lines	No gas lines were noted

Source: Project Team/Goodbee & Associates

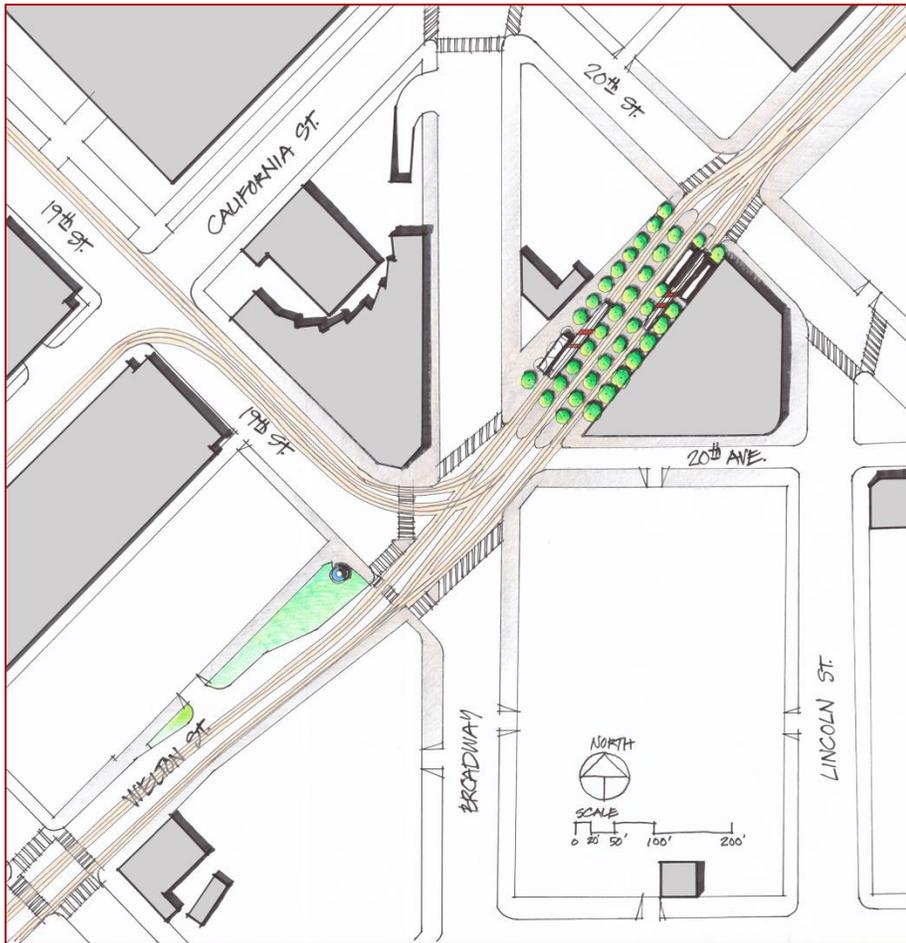
- Interaction with 20th/Welton/Broadway area: Figure 4-15a shows conceptual track locations for the junction of the Welton Street extension with the CRE line near the 20th/Welton station area. Figure 4-15b shows an alternative approach that considers a transit/pedestrian plaza on Welton between Broadway and 20th Street that could supplement the two-way conversion of Welton on either side of the station. Key issues associated with this junction include:
 - The potential for a new northbound track on the southeast side of Welton Street to replace the existing northbound track that currently runs through the 20th/Welton station on the northwest side of Welton.
 - A rail track intersection/crossing at 20th Ave./Broadway as the southbound CRE extension onto Welton crosses the existing downtown loop tracks.
 - The need for traffic and pedestrian signal coordination to allow the northbound and southbound CRE extension trains to move through the complicated intersections in the Broadway/Lincoln/19th/20th area.

Figure 4-15a: Potential Track Interactions at 20th/Welton/Broadway Junction



Source: Project Team/Perspective-3 and Leese Associates

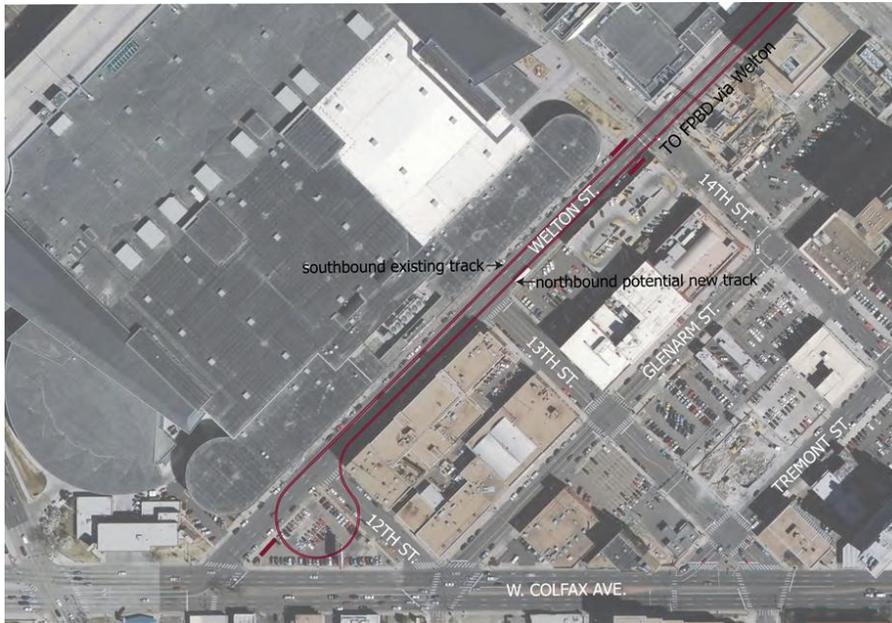
Figure 4-15b: Potential Track Interactions at 20th/Welton/Broadway Junction with Transit/Pedestrian Plaza



Source: Project Team/Perspective-3 and Leese Associates

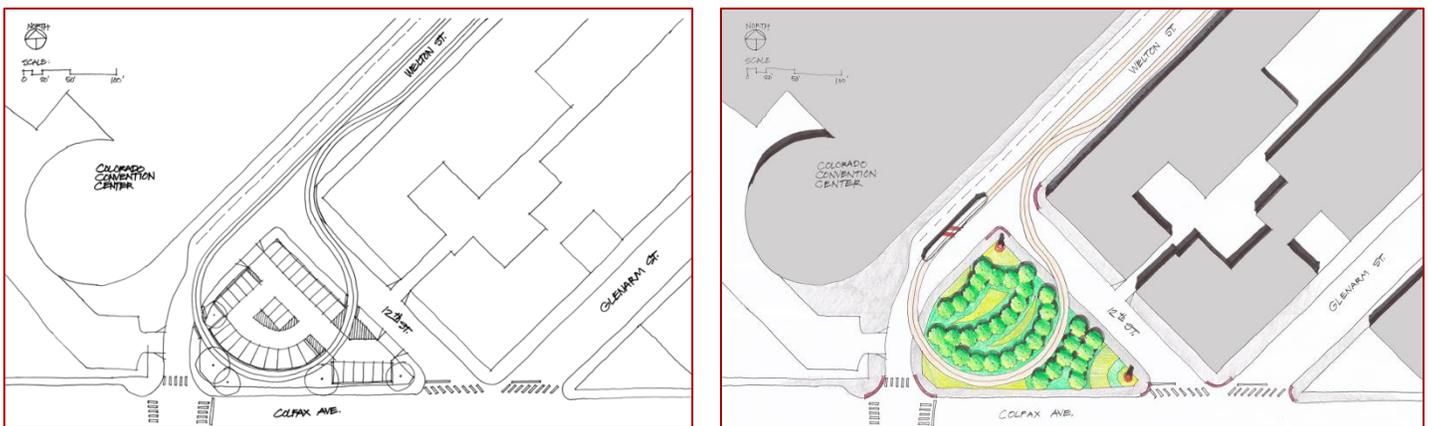
- Southern end turnaround/interaction with Convention Center: At the southern end of the line adjacent to the Convention Center, the extension will need a facility or system to “turn around” so that southbound trains can reverse course and head back north. Figure 4-16a shows a high-level schematic of one potential option; Figure 4-16b shows a more detailed sketch of how the turnaround could transform the existing parking lot along 12th Street and Colfax Avenue into a new parking configuration and/or public plaza or a park/greenspace.

Figure 4-16a: Schematic of Rail “Turnaround” at Southern End of Extension



Source: Project Team/Perspective-3

Figure 4-16b: Sketches of South End “Turnaround” Options

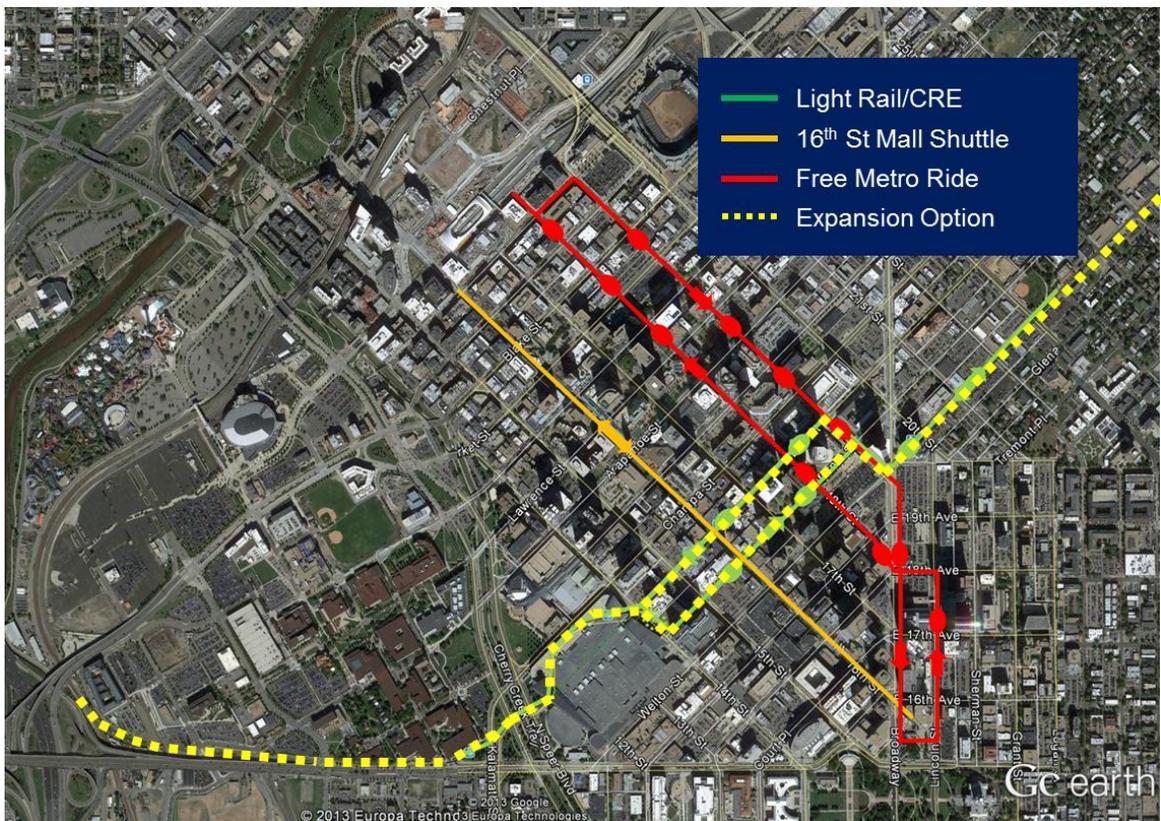


Source: Project Team/Leese & Associates

Connection to Auraria Campus

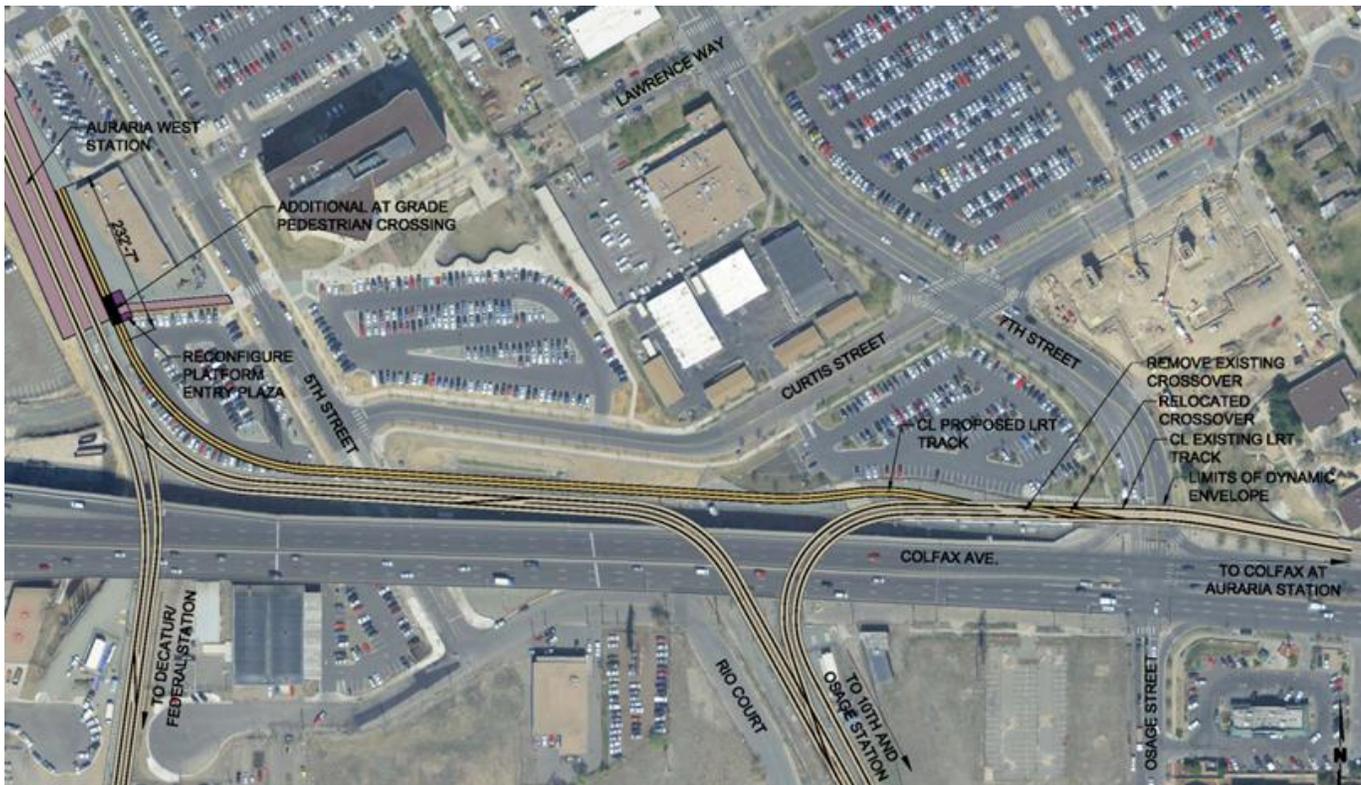
This option would extend the proposed CRE line westward past the downtown loop to the Auraria campus. Currently, the D Line provides service to Auraria from Five Points and northeast Denver. Under the proposed initial CRE operating plan, the D Line would no longer serve Five Points but would circulate through the downtown loop before proceeding back to the southwest corridor; in addition, the CRE line would operate from the 38th/Blake station through Five Points and into the downtown loop and back to the 38th/Blake station. Under that scenario, direct service to the Auraria campus would no longer be available to residents of Five Points and northeast Denver without a transfer to the D Line in downtown Denver. This proposed option would extend the CRE line past the downtown loop and to the Auraria campus, again providing direct access to Auraria for residents of Five Points and northeast Denver. Figure 4-17a shows a conceptual diagram for the extension, and Figure 4-17b is a conceptual design drawing from RTD showing the track infrastructure needed to connect the CRE line with the Auraria West light rail station on the west side of the Auraria campus.

Figure 4-17a: Conceptual CRE Extension to Auraria Campus



Source: Project Team

Figure 4-17b: Conceptual Track Infrastructure for Auraria Extension



Source: RTD

Key issues associated with this option include:

- Right-of-way/property requirements: While much of the proposed new infrastructure parallels existing RTD light rail tracks and is in RTD right-of-way, a portion of the alignment likely would impact parking lots or other property of the Auraria campus.
- Capital costs: The option would require between 0.4 and 0.5 miles of two-way track, resulting in a conceptual capital cost of approximately \$25-\$30 million. In addition, a VISSIM analysis conducted for this alternative shows that total round trip transit travel time from 38th/Blake to the Auraria West station is approximately 61 minutes, resulting in the need for at least five vehicle consists (one more than required for the CRE using only the downtown loop).
- Engineering challenges: The option would require complicated trackwork with crossover tracks and junctions with the light rail tracks required west of 7th Street to allow the extension to proceed westerly toward the Auraria West station. It would also require new trackwork and platform construction at the Auraria West stations.
- Operational issues: The option would require close schedule and operational interaction with southeast and southwest corridor trains operating between the Colfax/Auraria station and the downtown loop. The separate track for CRE trains west of 7th Street should provide

- an operational “cushion” for eastbound CRE trains to interact with light rail trains approaching from the south, but train movements between 7th Street and the downtown loop could be subject to conflicts and delays with the introduction of the CRE trains into the system before reaching the downtown loop. However, a VISSIM analysis conducted for this alternative shows that it would result in lower transit waiting times for both the CRE trains and the other LRT trains in the downtown loop. This is likely due to the much simpler configuration at 14th Street, where a pocket track is not necessary and where the CRE trains utilize the existing track configuration. The other added benefit of this alternative is the layover at the Auraria West station, which will allow for CRE trains to wait and enter the downtown loop at the optimal time. The transit waiting time results indicate that although the Auraria West alternative will have the longest transit travel times for a round trip, it will result in the most efficient operations with the least amount of delay.
- Construction timing related to downtown pocket track: As noted earlier, the preferred short-term solution for the CRE system is the construction of a pocket track near the south end of the downtown loop to improve operational reliability for both CRE and light rail trains. If and when the extension to the Auraria campus is implemented, it could potentially eliminate the need for a pocket track in downtown Denver, potentially making the pocket track a “throwaway” investment that might no longer be needed with the introduction of the Auraria extension. Additional operational and traffic analysis will be needed at that time to determine if the downtown pocket track is still needed; if so, it will no longer provide a direct connection to the Convention Center station (since CRE tracks would proceed southwestward towards Auraria instead of turning onto 14th Street), but could potentially need to be reconfigured to continue to provide operational flexibility throughout the entire CRE system.

Connection to National Western Complex

This option was raised by stakeholders who were interested in using the CRE to provide a direct connection between downtown Denver (and major activity centers such as the Convention Center and Five Points) and the National Western Complex to the north. The Complex is currently undergoing a master redevelopment plan that could result in major upgrades and reconstruction at the facility. The North Metro commuter rail line, currently under construction, will provide a station on the west side of the complex as shown in Figure 4-18a, with the station concept as developed during the North Metro Environmental Impact Statement (EIS) shown in Figure 4-18b.

Figure 4-18a: Location of Proposed North Metro National Western Complex Station



Source: RTD North Metro EIS

Figure 4-18b: Proposed Station Layout for National Western Complex Station on North Metro Line



Source: RTD North Metro EIS

Figure 4-19 shows the relative locations of the end of the currently planned CRE line at the 38th/Blake station and the National Western Complex, a distance of approximately 1.25 miles using 38th St. to Brighton Boulevard.

Figure 4-19: Relative Locations of CRE End-of-Line and National Western Complex

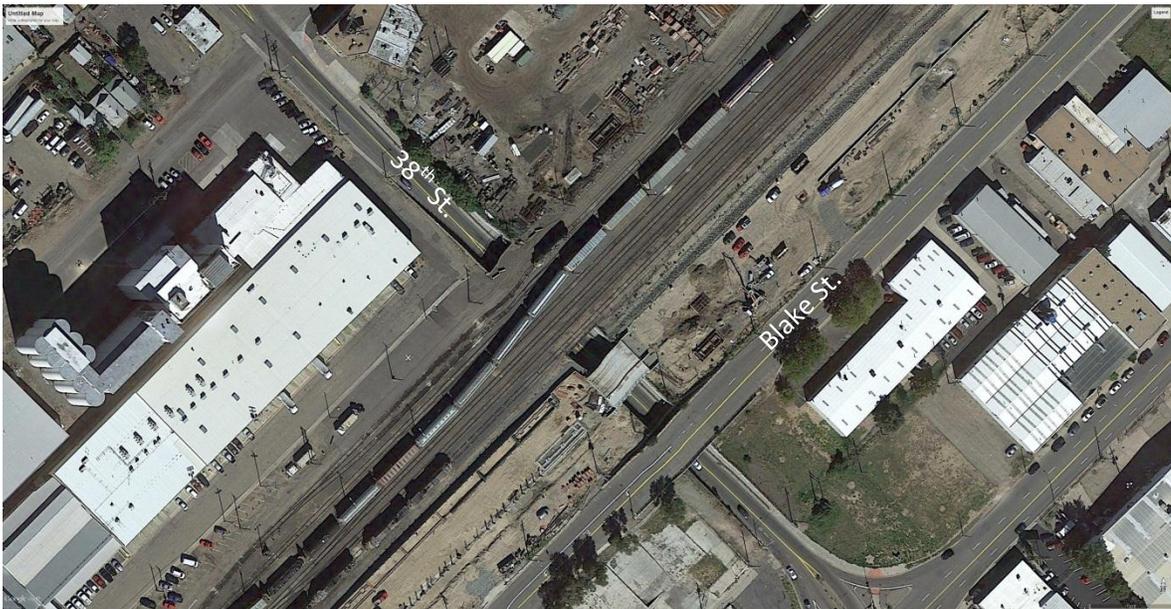


Source: Project Team

Key issues for this option include:

- **Capital cost:** At a distance of approximately 1.25 miles (or 2.5 track miles), the cost for this option would be approximately \$55-\$80 million depending on the type of construction and extent of engineering challenges.
- **Connectivity:** A logical connection to the 38th/Blake station and its connectivity to the East Rail Line and CRE line would be on 38th Street from the north. However, 38th Street in this area is in a narrow two-lane underpass (see Figure 4-20) that crosses under Blake Street and the rail line, leaving little room (and a relatively steep grade) for construction of a rail line on the roadway right-of-way. Any widening or other reconfiguration of 38th St. to accommodate a rail connection in this area would be challenging and expensive, as would an aerial connection over the East Rail Line. Additional engineering studies will be needed to determine the viability of a direct connection with the station or an indirect connection on the west side of the East Rail line.

Figure 4-20: 38th Street Underpass at Rail Line



Source: Project Team

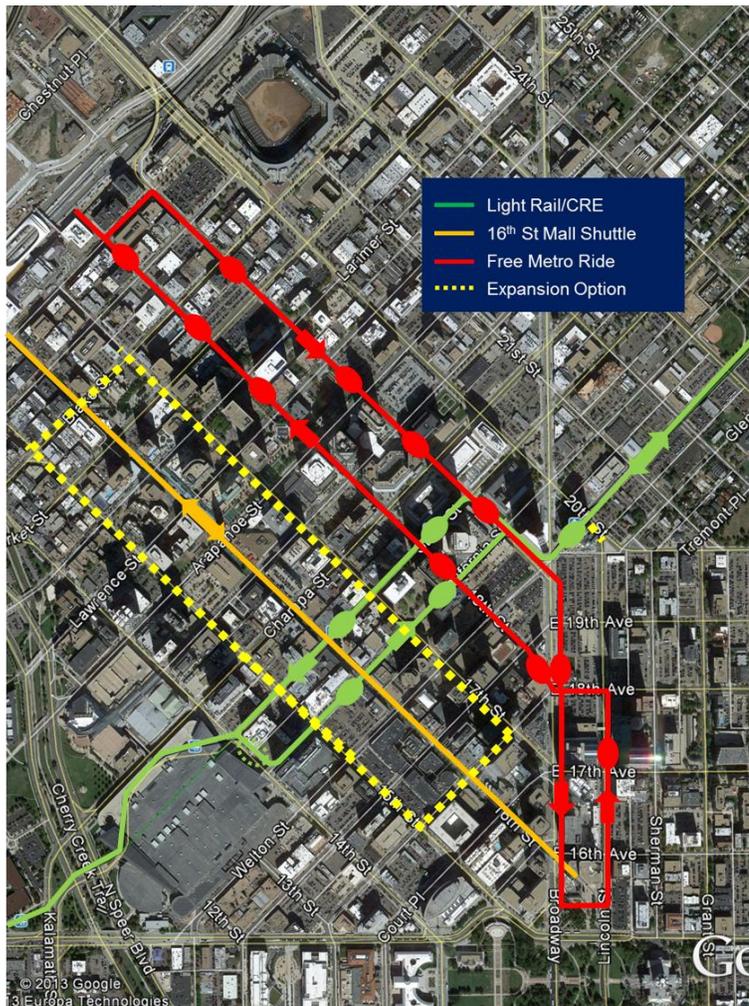
- **Northern Terminus:** The interaction of the CRE extension with the National Western Complex has not been examined to this point. The City and County of Denver is currently sponsoring a master plan study for the Complex, so consideration should be given to a future multimodal connection point for the CRE line on Brighton Boulevard so as not to preclude CRE interconnectivity in the future.

Lower-Priority Expansion Options

15th/17th Streets Circulator

This option emerged from task force and public meeting discussions and is illustrated in Figure 4-21.

Figure 4-21: 15th/17th Streets Circulator Concept



Source: Project Team

Key issues related to this option include:

- **Capital cost:** This option would consist of approximately 1.8 miles of one-way track and would cost approximately \$40-\$60 million to construct depending on the type of construction and the extent of engineering challenges.
- **Operations:** This option would operate on 15th and 17th Streets, with a northwest connecting leg on Blake Street, and a southeast connecting leg on Tremont (though other streets could serve as connecting legs instead). This alternative would provide one-way rail

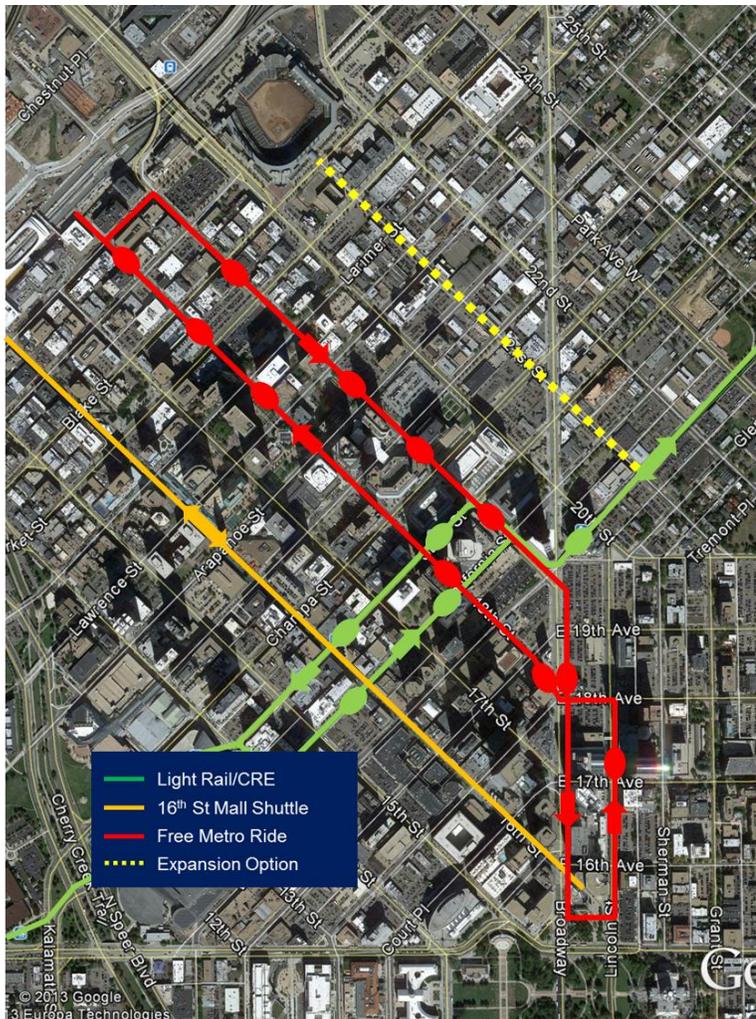
circulation connecting to the downtown loop that could circulate in one of two operational plans:

- As concurrent flow, potentially operating in shared traffic lanes, operating southeastward on 17th Street and northwestward on 15th Street.
 - As a contraflow system in semi-exclusive lanes (similar to the way light rail operates on California and Stout Streets currently), operating northwestward on 17th Street and southeastward on 15th Street.
- Rail capacity: This option could operate either as an integrated system that is connected to the downtown loop and CRE operations, or as a stand-alone circulator with no operational integration with the loop. If integrated with the loop, it would be subject to the 15-minute headway limits that govern the operations of the CRE. If operated as a stand-alone circulator, it could potentially have greater frequencies. Regardless of the operating plan, it would need to be closely integrated with the downtown signal system to provide reliable operations.
 - Interaction with other modes: Both 15th and 17th Streets are streets with high volumes of auto, bus, pedestrian, and bicycle traffic. No assumptions have been made as to how future tracks would be located within the streets, as much more detailed analysis would need to be conducted in the future to determine the optimum track location.
 - Parallel circulators: This option would provide additional circulator service that is parallel to existing service (the 16th Street Mall Shuttle and the Free Metro Ride on 18th/19th Streets). This option could have viability if and when the existing circulator services see high ridership that impacts their operational reliability.

21st Street Circulator

This option would provide a two-way circulator northwest along 21st Street from Welton Street, as shown in Figure 4-22. This option was discussed by stakeholders and the general public and is related to a proposal being considered by the City and County of Denver and the local neighborhood to transform 21st Street to a “pedestrian boulevard” connecting Five Points and Arapahoe Square with Coors Field and the ballpark neighborhood.

Figure 4-22: 21st Street Circulator



Source: Project Team

Key issues associated with this option include:

- Capital costs: This option would consist of approximately 1.2 miles of one-way track (0.6 route miles) between Welton Street and Coors Field, with a conceptual capital cost of approximately \$30-\$40 million depending on the type of construction and extent of engineering challenges.

- Track placement: No assumption is made related to track placement in 21st Street. However, this issue could be part of a larger re-design of 21st Street to develop a “complete streets” approach providing effective placement of autos, bicycles, pedestrians, and transit.
- Interaction with Welton Street tracks: This option would provide new track connections from the existing (or future) tracks in Welton Street. More detailed design will be needed to ensure that the rail connections could be made efficiently at this location to promote reliable train operations and to limit negative traffic impacts.

New Downtown Loop

This option consists of a new “outer loop” circulator alignment bordering the existing downtown loop, as illustrated in Figure 4-23.

Figure 4-23: New Downtown Loop Option



Source: Project Team

Key issues associated with this option include:

- **Operational integration:** This option could operate in a number of ways. It could be a stand-alone option for the CRE that could free up capacity in the existing downtown loop for future light rail operations. It could be a new route for the light rail system that could replace or supplement the existing downtown light rail operations to provide additional downtown light rail passenger capacity. Or it could be a combined operation for both the CRE and the current light rail system, to provide significant additional operational capacity downtown.
- **Alignments:** A number of options exist for potential alignments. The illustration shown features an outer loop operating on Welton, 14th, Champa, and 24th Streets, with options on 23rd Street on the northeast and 15th Street on the southwest. No significant analysis has yet been conducted of the pros and cons of any of these streets, though adding significant rail capacity on 14th Street could be problematic given the recent urban design improvements on that street and the potential interaction with the light rail “throat” at 14th/Stout that limited options for CRE circulation in this area.
- **Capital cost:** The “worst case” alignment shown in Figure 4-19 consists of approximately 2.4 miles of one-way track, resulting on a conceptual capital cost of approximately \$50-\$80 million depending on the type of construction and extent of engineering challenges.
- **Traffic/pedestrian signal interaction:** The addition of a new rail alignment in downtown could add significant complexity to downtown traffic and pedestrian signal operations. If and when this type of option was considered, close consultation will need to occur with the City and County of Denver to ensure smooth integration into the signal system to ensure auto, pedestrian, bicycle, and transit safety and efficient operations.

Additional Options and Next Steps

In addition to these specific options, local stakeholders and the general public discussed a number of additional options for improving and expanding rail transit operations downtown and in adjacent neighborhoods. These additional options ranged from specific routing and station suggestions to larger-scale suggestions related to completely re-thinking how light rail and other future rail services (including streetcar-type service) operate downtown. The City and County of Denver will be undertaking a new downtown transportation master plan in the near future, and it is recommended by this project that the future master plan examine, in coordination with RTD and downtown stakeholders, the long-range expansion options listed in this report as potential candidates for additional analysis.

Funding and Financing Options

Summary of Recent Federal Funding Opportunities

There are three main types of federal funding and financing programs that could be used for the CRE project:

- The Transportation Investments Generating Economic Recovery (TIGER) Discretionary Grants;
- The Small Starts (or Very Small Starts) program of the Federal Transit Administration (FTA); and
- The Transportation Infrastructure Finance and Innovation Act (TIFIA) loan program.

The Transportation Investments Generating Economic Recovery (TIGER) Program

The TIGER program was created in 2009 as part of the federal stimulus program, and has to date provided \$4.1 billion in six rounds of projects. TIGER grants range from \$10 million to \$200 million in size and may be used to fund up to 80 percent of the funds for a project. RTD applied for a TIGER VI grant in 2014 to construct the CRE extension from 30th/Downing to 38th/Blake (and potentially other enhancements) but was unsuccessful. However, future TIGER grant programs are likely, and RTD should continue its pursuit of such grants.

In recent years, TIGER grants have been the predominant federal funding source for streetcar projects across the country, including:

- Tucson Sun Link (\$63 million TIGER grant out of an overall project cost of \$196.5 million);
- Kansas City Downtown Streetcar (\$20 million TIGER grant out of an overall project cost of \$102.5 million);
- Detroit M-1 Rail Streetcar Project (\$25 million TIGER grant out of an overall project cost of \$137 million);
- Dallas Downtown Streetcar Project (\$26 million TIGER grant out of a total project cost of \$56.8 million);
- Cincinnati Streetcar (\$15.9 million TIGER grant out of a total project cost of \$148 million); and
- Atlanta Streetcar (\$47.6 million TIGER grant out of an overall project cost of \$92 million).

There are several key characteristics common to successful TIGER grant applications:

- **TIGER applications must be outcome-based and should ideally demonstrate the use of innovation and partnerships.** Long-term outcomes are the primary selection criteria for evaluating TIGER applicants. In order to compete effectively for TIGER funds, proposed projects should demonstrate strength in at least two or three of the following five long-term outcomes: (1) safety, (2) economic competitiveness, (3) state of good repair, (4) livability

- (“quality of life”) and (5) environmental sustainability. Secondary selection criteria include the use of innovative strategies to achieve long-term outcomes as well as the promotion of partnerships. The TIGER program was one of the first federal funding programs to require an economic analysis (specifically, a cost-benefit analysis) as part of its application process, demonstrating its emphasis on showing positive, long-term societal benefits. A project must also clearly fit within a long-term strategic vision for the community or region.
- **TIGER applications must demonstrate strong political and community support.** In general, TIGER applications are more likely to be approved if they can demonstrate strong support from local communities and from local, state and federal politicians. For example, the Atlanta Streetcar’s TIGER application included over 30 letters of support from the Atlanta business community, as well as metro area economic development, environmental and transportation organizations, and congressmen and senators. Similarly, Rochester County’s Inner Loop East project included letters of support from US senators, New York senators, County legislators, real estate developers, regional associations and other stakeholders such as businesses and neighborhoods.
 - **TIGER grants are intended for multi-modal projects that are difficult to fund via other mechanisms.** The TIGER program aims to fund projects that are difficult to fund via traditional formula funding, as well as those that incorporate different modes of transit (or include more than one mode of transit) and will improve connectivity between transit systems. Applications benefit from being able to show higher matches as well as leverage other federal funds from partner agencies such as the US Environmental Protection Agency (EPA) or the US Department of Housing and Urban Development (HUD).
 - **TIGER funds granted in FY 2014 differed from funds granted in previous fiscal years by their longer obligation period, and a reduced emphasis on “project readiness.”** Because previous rounds of TIGER funds had a very short obligation period, a key consideration in the approval of projects was “project readiness”—a project needed to be far along in the National Environmental Policy Act (NEPA) schedule, have a substantial local match, and have high status in terms of design and engineering. By extending the obligation period to almost two years (through 30 September 2016 in the FY 2014 round), TIGER funds are now able to accommodate more complex and innovative projects with longer schedules.
 - **TIGER funds granted in FY 2014 prioritized projects that aligned with the Administration’s “Ladders of Opportunity” program.** The focus of the TIGER program in FY 2014 was to improve access to “reliable, safe and affordable transportation” for “disconnected communities in urban, suburban, and rural areas.” The Department of Transportation (DOT) therefore prioritized applications for projects that would connect communities to employment and training centers, remove barriers to transit access, and strengthen communities through neighborhood development.

TIGER funds granted in FY 2014 differed from funds granted in previous fiscal years by their longer obligation period, and a reduced emphasis on ‘project readiness.’ Because previous TIGER funds had a very short obligation period, a key consideration in the approval of projects was ‘project readiness’—a project needed to be far along in the National Environmental Policy Act (NEPA) schedule, have a substantial local match, and have high status in terms of design and engineering. By extending the obligation period (through 30 September 2016 in the FY 2014 round), TIGER funds are now able to accommodate more complex projects with longer schedules.

TIGER grants remain highly competitive and eligible project applications far exceed available funding. Over the first five rounds of TIGER funds, only about 5 percent of applications were awarded. In FY 2014, applications for TIGER grants totaled \$9.5 billion, 15 times more than the \$600 million in available funding. The U.S. Department of Transportation (US DOT) received 797 eligible applications, compared to 585 in 2013. Michigan’s M-1 Fixed Rail Streetcar Project and Rhode Island’s Providence Streetcar are two examples of streetcar projects that received TIGER grants in FY 2014.

The FTA Small Starts Program

The Federal Transit Administration’s (FTA) discretionary “New Starts” program provides grants for locally planned, implemented and operated transit systems, including (but not limited to) commuter rail, light rail, and rapid rail. Funding allocated to the program was \$1.855 billion in FY2013 and \$1.943 billion in FY2014. Subsets of the New Starts program are the “Small Starts” and “Very Small Starts” programs. FTA’s New Starts program – generally focused on larger projects (those of \$250 million or more) has been used successfully in the Denver area on projects such as the East Rail line and Gold Line and the Southeast Corridor Extension. However, no local projects have utilized the Small Starts or Very Small Starts program, though BRT projects in Fort Collins and the Roaring Fork Valley have used Small Starts funding for their implementation.

To be eligible for Small Starts grants, projects must meet the following general criteria:

- The total project cost must be less than \$250 million, of which no more than \$75 million may be obtained from federal sources including Small Starts grants;
- The project must be either a new fixed guideway project, or an extension to an existing fixed guideway, and must contain significant transit improvements.

FTA created the Very Small Starts program in order to streamline requirements for projects that were simple and low-risk. In order to be eligible for Very Small Starts grants, projects must meet the same requirements as for Small Starts, as well as three additional ones:

- Existing corridor ridership must exceed 3,000 existing riders per average weekday;
- The total project cost must be less than \$50 million; and

- The per-mile cost of the project must be less than \$3 million, excluding rolling stock (e.g., train cars).

Small Starts and Very Small Starts funding applications are evaluated based on two categories of criteria: (1) the justification for the project; and (2) the level of local financial commitment. The FTA gives equal weight to the two categories of criteria and similarly equal weight to the various criteria within these categories. In its evaluation of the justification for the project, the FTA examines six factors: mobility improvements; economic development effects; environmental benefits; cost effectiveness; land use; and congestion relief.

In its evaluation of the level of local financial commitment, the FTA quantitatively assesses the ability of the local agency to build, maintain, and operate the new transit system without causing deterioration in other services. It also examines the agency's financial plan and cash flow statements. Three specific criteria are used: (1) availability of reasonable contingency amounts; (2) availability of stable and dependable capital and operating funding sources; and (3) availability of local resources to recapitalize, maintain, and operate the overall existing and proposed public transportation system without requiring a reduction in existing services.

Since the 2012 MAP-21 reforms, the three main steps of the Small Starts process are: (1) project development, (2) engineering, and (3) the full funding grant agreement. Once the FTA has approved a project for the "project development" phase, the local project sponsor has a two-year period within which to: conclude the review required under NEPA; select a locally preferred alternative (LPA); adopt the LPA into the regional long range transportation plan; and develop sufficient information for FTA to evaluate and rate the project. Upon completion of the "project development" phase, if the project meets the criteria for advancement, the project will then enter the "engineering" phase. Upon completion of "engineering" phase, the project will be eligible for a construction funding commitment.

Transportation Infrastructure Finance and Innovation Act (TIFIA)

The TIFIA loan program provides credit assistance to eligible surface transportation projects, including highways and transit. It should be seen as distinct from the TIGER and Small Starts federal funding programs, as the latter are funding mechanisms (which can assist with upfront investments costs), whereas the TIFIA program is a financing tool. The TIFIA program, which was expanded to \$1 billion in fiscal year 2014, provides three types of financing:

- *Secured (Direct) Loans*: direct federal loans to project sponsors which offer flexible repayment terms and provide combined construction and permanent financing of the capital costs (up to 49% of project costs)
- *Loan Guarantees*: credit guarantees by the government to institutional investors that provide loans for the project (up to 49% of project costs)

- *Standby Lines of Credit*: contingent sources of funding in form of federal loans that may be used to supplement the revenues of the project during the first ten years of construction (up to 33% of project costs)

TIFIA loans tend to be used for larger projects such as roads and major transit projects; although TIFIA loans have been used for light rail in the past, they have yet to be used for a streetcar project. This is in large part because expected project costs must equal or exceed \$50 million and must have dedicated revenues associated with them to be eligible. This tends to be easier in a toll road than in a streetcar project, the latter of which may rely on sales taxes or other funding mechanisms rather than direct revenues.

TIFIA loans must be repaid through dedicated funding sources that secure the obligation, such as tolls, user fees or tax increment financing. The maximum maturity of all TIFIA financing is the lesser of 35 years after a project's substantial completion or the useful life of the project being financed by TIFIA. The best local examples of TIFIA use are on the US 36 Managed Lane/Bus Rapid Transit project, which received two TIFIA loans of \$54 and \$60 million, RTD's Eagle P3 rail project, which received a \$280 million TIFIA loan, and Denver Union Station, which received a \$146 million TIFIA loan. In the case of the RTD's Eagle P3 rail project, the TIFIA loan was secured by a (senior) gross revenue pledge of RTD's 0.4 percent sales tax revenues and a (subordinate) pledge of RTD's 0.6 percent sales tax revenues. Only the 0.4 percent sales tax could be used for construction and operation of the transit system.

Alternative Funding and Financing Options

Traditionally, transit agencies have relied on both system-based and non-system based mechanisms to fund capital improvements and annual operating costs. System-based revenue sources include both farebox and non-farebox revenues—such as advertising, air rights, station or system naming rights—and station revenues such as parking and concessions. Non-system based revenues include grants from state, local, and federal governments. The financing for these revenue streams has typically been derived from issuing revenue bonds, often backed by the local government sponsor. However, as a result of increasing limitations of federal funding sources, transit agencies are increasingly relying on innovative funding mechanisms. These may include joint development districts, assessment districts (ADs), or tax increment financing (TIF). These innovative sources of funds can be leveraged through financing mechanisms such as traditional debt issuance; innovative loans and credit programs (TIFIA, SIB loans, EB-5); or possible equity contributions through a Public-Private Partnership (P3) delivery model. Table 4-5 summarizes the traditional and innovative revenues, funding sources, and financing mechanisms typically available.

Table 4-5: Potential Funding Sources and Financing Mechanisms

	Funding Mechanisms		Financing Mechanisms
	Direct System Revenues	Other Funding Sources	
Traditional	<ol style="list-style-type: none"> 1) Farebox 2) Non-Farebox: <ul style="list-style-type: none"> • Traditional advertising • Parking 	<ol style="list-style-type: none"> 1) State/Local: <ul style="list-style-type: none"> • Appropriations • Sales taxes • Other local taxes 2) Federal grants 	<ol style="list-style-type: none"> 1) Tax-exempt and taxable debt
Innovative	<ol style="list-style-type: none"> 1) Station-Related: <ul style="list-style-type: none"> • Concessions • Parking innovations • Innovative Advertising • Air rights • Station or system naming rights 2) ROW sharing with other transportation users 3) Contractual fare payments 	<ol style="list-style-type: none"> 1) Real estate-related: <ul style="list-style-type: none"> • TOD/Joint Development • Benefit assessment districts • Tax increment finance • Asset monetization 2) Parking increment 	<ol style="list-style-type: none"> 1) Innovative finance: <ul style="list-style-type: none"> • SIB loans • Tax credit loans • TIFIA • EB-5 2) Via a P3 delivery mechanism: <ul style="list-style-type: none"> • Private activity bonds • Private equity • Availability payments

Source: Project Team/IMG Rebel Group

Funding Mechanisms

As federal funding for transit projects has become increasingly competitive and difficult to obtain, transit agencies have increasingly relied on other sources to help raise the upfront investments costs in transit projects. This section will examine some of these options in greater detail.

Direct System Revenues:

Farebox Revenues: Typically, farebox revenues do not cover the long-term operations and maintenance of a transit system. A streetcar or light rail system is no exception. Transit operators can traditionally anticipate a roughly 30 percent farebox recovery ratio for light rail and streetcar operations, but it may be even lower. In the case of the Kansas City Downtown Streetcar in Kansas City, Missouri, which entered the construction phase in May 2014 and is expected to start operations in late 2015, passengers will ride free of cost.

Non-farebox Revenues: Non-farebox revenues include system revenues not generated by ticket sales, including:

- *Advertising:* Transit agencies typically enter into contracts to provide advertising space on shelters, stations, and transit vehicles, which can amount to up to three percent of operating revenue. Innovative advertising concepts may include such as fare collection media, floor space, and wrapping transit vehicles. Typically, this funding source can provide some additional revenue but it is subject to market conditions and may not yield significant increases in revenue.

- *Air rights:* Many agencies have been successful in selling the right to build above transit stations to private developers. Air rights may have some limited applications in the Central Rail Extension (CRE) project, perhaps above a maintenance facility.
- *Naming rights:* A familiar concept for sports venues, naming rights involve an upfront and/or ongoing payment from a private entity to a transit agency or operator in return for naming a station or other assets for the private firm. For example, Cleveland's Health Line was so named because of a naming rights purchase by two competing local hospitals for \$6.25 million over a 25 year period. In the case of the TECO Line Streetcar System in Tampa, Florida, naming rights were sold for \$1 million to Tampa Electric Company (TECO) over a 10 year period. The value of the asset to be named could be assessed for potential advertising value (such as the number of times the line is mentioned on the radio, on TV, on the sides of trains themselves, etc). The project could explore selling naming rights for stations at schools, shopping centers, specific local businesses or venues, or for entire segments of the system.
- *Station revenues (including concessions/commercialization):* Providing space for food and retail vendors at transit stations is 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.

Non-System Based Funding Sources

Traditional Funding Sources: Funding sources differ from system revenues in that they provide revenue targeted to a single station or project, most often to support capital projects (although some grants, of course, are used to fund operating expenses). State or local funding sources could include:

- *Local government* appropriations or allocations of funding specifically for a project, though those are usually subject to an annual approval process and do not necessarily provide long-term funding stability.
- *State funding* including SB 228 funding, which requires that at least 10% of all transfers to the state Highway Users Trust Fund be used by CDOT for transit purposes or transit capital improvements, and the FASTER program (funded by motor vehicle registration fees) , which provides grants to local governments for transit projects, such as new bus stops, bike parking, maintenance facilities or multi-modal transportation centers.
- *Sales taxes* are very common funding sources for transit. In the case of the CRE project, the RTD already assesses a regional sales tax of 1% in the areas within which the RTD applies. As a result, it is unlikely that a sales tax specifically for the CRE project could be established. However, if RTD goes to the voters to expand its sales tax percentage, a portion of that new tax could be allocated to the CRE project.

- *Lodging or rental car taxes* could be expanded above their current levels in Denver or with appropriate legislative approval, those taxes could be expanded to provide a specific allocation for the CRE project.
- Federal funding opportunities, which were discussed in Section 1, include: the Small Starts (or Very Small Starts) program of the Federal Transit Administration (FTA) and the Transportation Investments Generating Economic Recovery (TIGER) program. Other potential federal funding opportunities could include:
 - *The Congestion Mitigation and Air Quality (CMAQ) Improvement Program:* A program jointly administered by the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA), its grants fund state transportation programs that meet the National Ambient Air Quality Standards (NAAQS). The 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. The Providence, Rhode Island, Streetcar funded 5% of its project costs through the CMAQ program, and the Kansas City Streetcar project obtained \$1.1 million through the CMAQ program.
 - *Surface Transportation Program:* Of all of the FTA's grants, the Surface Transportation Program (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. The Kansas City Streetcar obtained \$16 million in funding to purchase new vehicles through the STP program.
 - *Livable Community Grants:* The FTA started the Livable Community Initiative (LCI) to improve mobility and quality of services available to residents of neighborhoods by, among others, strengthening transit links. 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.

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:* Transit-Oriented Development (TOD) is a well-known planning concept whereby zoning, tax, and development regulations are set up to encourage compact, high-density development near transit stations. Typical TODs consist of a mix of use including residential, commercial, and retail, are pedestrian- and cycle-friendly, may

offer public and civic spaces near stations, and the stations may serve as community hubs. For example, the Five Points area has already explored TOD opportunities, and those efforts should continue and expand to provide the largest potential development opportunities possible. Joint Development occurs when private (or public) entities other than the transit operator provide land, assets, or funding to support TODs near a station. For example, a real estate developer may provide parking in return for development rights near a station or alignment. Transit agencies can take direct equity stakes in projects through direct cash investments or as is more usual, investing land in the project. Care must be taken to determine whether the transit agencies investment is paid back based on “gross” or “net” revenues of the project, since the risk and return levels in either scheme can differ widely.

- *Parking increment revenue:* An increase in parking rates in the area could create additional revenue. The City could then choose to dedicate those revenues from the parking increment, which could be used to directly fund a transportation project or used to back revenue bonds.
- *Assessment Districts:* Assessment districts are special tax assessment areas that may be created to support the construction, maintenance and operation of a new transit project. A typical assessment district creates a zone around a station or alignment, often up to a half a mile, with all businesses within the zone paying a tax based on real estate valuation (either ad valorem or per square footage). 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 rail corridor. Because businesses must pay higher taxes in a BAD, 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. They usually require approval by at minimum a majority of the property owners. In the case of the New York Avenue Washington Metropolitan Area Transit Authority (WMATA) Metro station in Washington, DC, a not-for-profit entity worked with property owners to advocate for the implementation of the assessment district. Strong local property owner support helped to facilitate project delivery. Los Angeles, Kansas City, Tampa, Portland and Seattle have also used assessment districts successfully; in the latter two cases, the assessment districts paid for 17 and 50 percent respectively of the capital costs of the streetcar project.

The City of Denver already has numerous special districts in place that perform various different functions, from financing public infrastructure to providing services. The benefit of a special district is that it allows an area to undertake improvements without using general funds or debt issuances by the City of Denver. To date, there are some 145 special districts in the City or County of Denver, including:

- General Improvement Districts (GIDs);

- Business Improvement Districts (BIDs);
- Local Maintenance Districts (LMDs);
- Local Improvement Districts (LIDs); and
- Metropolitan Districts.

Most special districts are created by the electors within the district area, who may choose to pay an additional tax in order to attain localized benefits, such as improved infrastructure or economic development. Metropolitan districts, however, are usually created by the developers of the project.

Each type of special district is permitted to conduct a range of different public improvements. The improvements permitted under a GID, for example, are very broad and include any kind of public improvements (with the exception of solid waste). The improvements permitted under a BID, on the other hand, are intended to benefit the commercial properties of the area and are therefore explicitly confined to a range of smaller improvements. LIDs and LMDs have a smaller range of powers, namely to construct public improvements and to maintain and operate public improvements, respectively.

Metropolitan districts are the only type of special district for which “transportation” is explicitly listed as one of the powers. Table 4-6 presents overview of the powers, formation and governance of GIDs, BIDs and Metropolitan Districts. Metropolitan Districts may be preferable for transportation projects since they have substantially greater powers, autonomy, and flexibility than the other types of districts. Developers have often favored establishing Metropolitan Districts for the construction of public improvements because they have been able to exercise greater control. Metropolitan Districts have the authority to impose fees and charges, to issue general obligation bonds and revenue bonds, and to levy and collect ad valorem taxes. In some rare cases, Metropolitan Districts may also establish special assessment districts.

Revenues from a special district could be used to cover part of the CRE’s project costs. The Atlanta Streetcar, for example, generated \$6 million out of a total capital cost of \$92 million from its Atlanta Downtown Improvement District (ADID). Depending on a district’s particular powers and purposes, revenues from a special district could be used to retire bonds used to finance the construction costs or to fund the regular maintenance and/or operating costs of the project. There are several ways in which such a district could be structured:

- Create a *new* special district with specific powers to use the collected revenues to fund a portion of the CRE’s project costs (as mentioned above);
- Expand the functional powers (and geographical scope) of an *existing* district to divert a portion of the district’s revenues to the CRE project.

Because there are restrictions on overlapping special districts, current districts must be taken into consideration. Existing districts in the area include the Five Points Business

District and the Downtown Denver Partnership / Downtown Denver Business Improvement District (BID). BIDs are not allowed to overlap with one another, which could present an obstacle to the establishment of a BID for the CRE project. However, BIDs are allowed to overlap with GIDs or Metropolitan districts. For example, the 14th Street Corridor GID is located within the Denver Downtown Partnership (a BID). Metropolitan districts are also allowed to overlap with one another. It is often challenging to obtain the political support required to establish a new district. For example, in order to establish a Metropolitan District, a service plan must be prepared and adopted by the City Council; a petition must be signed by at least 30% (or 200) taxpaying electors; a public hearing must be held; and approval must be acquired from district electors.

It is likely to be challenging to obtain the political support required to expand an existing district to accommodate the CRE project. Expanding an existing BID, for example, requires approval by 100% of the electors within the district area. Although Metropolitan districts would be somewhat easier to expand, it remains a challenge to obtain the necessary political support. In Kansas City, for example, voters rejected plans to expand an existing assessment district for a second phase of the project in August 2014.

There are three financing mechanisms for raising funds through a district: (1) An assessment district with an ad valorem tax; (2) An assessment district with an additional tax per square footage; and (3) a tax increment financing (TIF) district. The first two mechanisms could be levied through the creation of a special district. However, only BIDs, GIDs, and Metropolitan Districts have the authority to levy ad valorem taxes or to establish assessment districts. An ad valorem tax takes into consideration the location and quality of the development, whereas a tax per square footage treats every property in the same way, regardless of location. Tax Increment Financing (TIF) districts remain under the authority of the Denver Urban Renewal Authority (DURA) or the Downtown Development Authority (DDA). Because a TIF does not increase out-of-pocket costs to private property owners, it is likely to be more political palatable than an assessment district, in particular in a less-developed area. However, a TIF district does reduce the funds potentially additionally available to the County for other uses. In addition, a TIF district generates revenue only as property values increase, whereas assessment districts generate funds as soon as they are implemented. RTD's Denver Union Station Transit Center created a Metropolitan District combined with a Tax Increment Financing (TIF) district. The RTD's new Union Station Transit Center, which opened in May 2014, is financed by two federal loan programs repaid with TIF revenues, as well as a public-private partnership (P3). In 2004, voters in the eight counties of the RTD approved a 0.4 percent sales tax increase to finance the FasTracks transit project. In 2008, the Denver City Council approved a 30-year TIF district, which included the entire Union Station and surrounding 20 acres. The property tax revenues from the TIF district will help pay for debt service on two federal loans: a \$145.6 million TIFIA loan and a \$155 million Railroad Rehabilitation and Improvement Financing (RRIF) Loan. Certain entities were

excluded the payment of the TIF, such as Central Platte Valley Metropolitan District and Cherry Creek Subarea Business Improvement District.

Table 4-6: Overview of General Improvement Districts, Business Improvement Districts and Metropolitan Districts

Type of Special District	Permitted Improvements	Powers	Formation	Governance
General Improvement District (GID)	GIDs are allowed to construct any public improvement except solid waste disposal services.	<ul style="list-style-type: none"> A. May assess ad valorem taxes and charge rates, tolls and charges for services or facilities. B. May issue general obligation and revenue bonds. C. Debt in excess of \$5,000 must be approved by the electors within the district 	<ul style="list-style-type: none"> 1. Initiated by a petition filed with the City Clerk, signed by the lesser of 30% or 200 electors owning taxable real or personal property within the district. 2. Subareas within the district may be formed. 	The City Council is the board of directors of the district. By ordinance, an advisory board may be created to oversee the GID.
Business Improvement District (BID)	BIDs are allowed to acquire, construct, finance, install, and operate smaller improvements. They are organized for the benefit of commercial properties only.	<ul style="list-style-type: none"> A. May borrow money, incur indebtedness and issue negotiable bonds. B. May fix rates, tolls, or charges for any services or improvements. The revenue may be pledged to pay district bonds. C. May levy and collect ad valorem taxes on commercial property within the district. 	<ul style="list-style-type: none"> 1. A petition must be signed by persons who own real or personal property in the service area. 2. The City Council must approve the petition by ordinance. 	The BID is governed either by a board of directors of not fewer than five electors appointed by City Council or by the mayor.
Metropolitan District	The most common form of special district, they may be used for services such as sanitation, street improvements, transportation, etc.	<ul style="list-style-type: none"> A. May fix, charge and collect fees, rates, tolls, penalties or charges for services, programs or facilities; B. May levy and collect ad valorem taxes on and against all taxable property within the special district; C. May issue general obligation and revenue bonds of the special district; D. May use the taxes and other revenue to pay off bonds and for maintenance and operating costs; and E. May issue revenue bonds. 	<ul style="list-style-type: none"> 1. The City Council must approve the district's service plan. 2. A petition must be signed by 30% or 200 of the electors of the District, whichever is less. 3. Approval of the District by the electors within the District. 	A metropolitan district is governed by a five-member board of directors.

Source: City and County of Denver and IMG Rebel Group

Financing Mechanisms

A number of financial tools, both traditional and innovative, can be used to leverage transportation revenue sources, allowing transportation agencies to raise the upfront costs required for the construction phases of a project. Financing mechanisms are used to access either debt or equity capital.

Traditional Financing Mechanisms: Traditionally, public infrastructure projects have used tax-exempt debt to fund capital costs. The benefits of tax-exempt debt include low interest rates, long maturities, and the ability to sculpt principal repayment to match the cash flows of the project. Tax-exempt debt however, restricts potential private investors. Taxable debt could also be a source of financing for a project, and would provide Denver with flexibility in utilizing a P3 approach. Typically, taxable debt has higher interest rates and a shorter maturity date. The size of a project may limit the taxable financing mechanisms that Denver can utilize. Typically, the minimum issuance size threshold is \$100 million in order to generate sufficient lender/bondholder interest.

Innovative Financing Mechanisms: There are several innovative financing mechanisms that could be considered for a streetcar or light rail system:

- *The Colorado State Infrastructure Bank (SIB)* is a Colorado DOT program that provides funding to transportation projects in the state. SIB loans are subordinate to senior debt, so long as senior debt has a BBB credit rating or better. 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 a number of 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.
- *Tax Credit Bonds (TCBs)* are a type of bond that offers the holder a federal tax credit instead of interest. This provides a major benefit to bond issuers, as they are responsible only for principal repayments, rather than full principal and interest payments under typical municipal bonds.
- *The Transportation Infrastructure Finance and Innovation Act (TIFIA)*, as noted earlier, is a federal loan program sponsored by the U.S. Department of Transportation. TIFIA loans must be repaid through dedicated funding sources that secure the obligation, such as tolls, user fees, or tax increment financing in terms of up to 35-years. The best local examples of TIFIA use are on the US 36 Bus Rapid Transit project, which received two TIFIA loans of \$54 million and \$60 million, RTD's Eagle P3 rail project, which received a \$280 million TIFIA loan, and Denver Union Station, which received a \$146 million TIFIA loan. TIFIA loans have generally been used for roadway projects and for major transit projects. They have not yet been used for a streetcar project. TIFIA loans are seen as financing tools with attractive rates and

terms, as they are flexible and low cost—they can finance a major portion of a project at US Treasury rates.

- *EB-5 Funds:* In the aftermath of the 2008 financial crisis, an increasing number of companies and developers are turning towards EB-5 funds to raise capital for projects. The EB-5 Regional Center investor visa program is designed to use immigrant investor capital to promote economic growth in a particular geographic area. The minimum amount required to invest is \$1 million, although if the investment can be reduced to \$500,000 if it is made in a rural or high unemployment (+150%) area. The capital is then pooled into a new commercial enterprise that creates employment for 10 U.S. workers for each \$1 million invested. EB-5 funds can be seen as an attractive source of financing for two reasons: (1) it has inexpensive borrowing costs (3 to 5 percent); and (2) there is no pressure to produce high rates of return, as EB-5 investors are more concerned with obtaining green cards than the returns on their investments.
- *A Public-Private Partnership (P3s) delivery model* could also bring with it several other tools to reduce the cost of borrowing or speed project delivery, including availability payments or private equity contributions. With an availability payment mechanism, a concessionaire receives periodic payments based solely on the condition and/or performance of the facility. Availability payments allow public sponsors to share risk with private contractors. A typical availability payment deal would involve a private firm (or consortium of firms) being responsible for the construction of the asset, including planning, design, and engineering, as well as operations, maintenance, and enforcement. In return, the consortium is paid fixed, pre-agreed availability payments on certain milestone dates. The availability payment is conditional upon the asset being operational, safe, and meeting all standards set by 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. Availability payments are attractive to private developers, since they are not asked to take on risks that are difficult to manage, such as the level of ridership.

Table 4-7 provides a summary of where the innovative funding and financing tools described above have been used by other cities and systems, as well as the advantages and disadvantages of each tool.

Table 4-7: Summary of Innovative Funding and Financing Tools

Funding/Financing Tool	Example	Advantages	Disadvantages
Non-Farebox Revenue			
Advertising	Washington Metropolitan Area Transit Authority (WMATA)	Easy to implement	Limited revenues
Air rights	WMATA	Provides TOD benefits in addition to revenue source	Works best for underground/at-grade stations in high-density areas
Naming rights	Cleveland, Little Rock	No cost to implement	Private sector may not be interested; public resistance
Concessions/commercialization	Chicago Transit Authority (CTA)	Easy to implement; could provide a good opportunity for vendors and other retail outlets	Could clutter station area and compete with other local retail
Innovative Funding Sources			
TOD/Joint Development	Metropolitan Atlanta Rapid Transit Authority (MARTA)	Increases ridership by focusing density around stations or alignment	Lengthy development period (10-20 years)
Benefit Assessment Districts	Portland Streetcar, WMATA	Major, ongoing revenue source that can be leveraged	Difficult to implement as a result of land owner approvals and other legal obstacles
Tax increment financing	Portland Streetcar, Bay Area Rapid Transit (BART), Charlotte	No cost to implement, ongoing revenue source	Uncertainty of pace of development; requires blight designation in Colorado
Parking increments	Portland, San Francisco	No cost to implement	Can reduce activity in area and reduce ridership
Lodging and rental car tax	Numerous	Upfront revenue, taxing non-residents	Can impact tourism and local activity and ridership
Financing Mechanisms			
SIB Loans	Lee County, Southwest Florida	Highly subsidized loan without federal strings attached	Competitive; funding may not be available
Availability payments	London Underground, Miami Port Tunnel	Transfers risk to private sector; spreads out payments	Must allow for developer profit; still needs funding source
TIFIA loans	Denver Union Station, US 36	Subsidized long-term loan that works well with both public and private projects	Extremely competitive
EB-5	EB-5 funding has been used for numerous hotel investments, and was attempted in Seattle's Highway 520 Project.	Inexpensive borrowing costs (3 to 5 percent); no pressure to produce high rates of return for EB-5 investors	Complex process that includes various actors and procedures, discouraging investment

Source: Project Team/IMG Rebel Group

Summary and Conclusions

This summary shows the wide variety of potential options for funding or financing the CRE project and its expansion alternatives. The range of federal, state, and local options – and the projects where those options have been used around the country – point out the need for RTD to potentially develop a menu of funding and financing options appropriate to the scale and impact of the CRE and its potential extensions. In particular, RTD should continue to pursue TIGER funding when those grant programs are again available in the future. Alternatively, RTD should consult with FTA about the potential for including part or all of the CRE (both its short-term extension to the East Rail line and potentially its longer-term expansion options) into a Small Starts grant application, with the financial and political support of the local community. The projects that have been most successful in securing federal funding have been those that showed a significant amount of local support and a wide variety of local funding as matching funds. RTD should also continue to work with the private sector to determine the potential for establishing public-private partnerships to implement the CRE and its longer-term expansions.

5 Overall Conclusions, Recommendations, and Next Steps

This report has come to a number of conclusions and recommendations related to the potential implementation of the Central Rail Extension project and the focus on providing a one-seat ride from the East Rail Line and the 38th/Blake station through northeast Denver and into downtown while fulfilling the community vision for rail service on Welton Street and throughout downtown and northeast Denver.

Goal 1: The One-Seat Ride

Major Recommendation: RTD should continue to move forward with consideration of both alternatives 3A and 3B related to rail and urban streetscape improvements on 14th Street to further evaluate and decide on the best solution for the infrastructure improvements on the south end of the downtown loop, including:

- Continuing to consult with downtown stakeholders, including the City and County of Denver, the Downtown Denver Partnership, the Colorado Convention Center, Visit Denver, and adjacent property owners (including hotel properties) to further refine the design details of the alternatives and come to consensus on a final solution. This should include an analysis of trade-offs and benefits of each alternative related to issues such as safety, transit operations, on-street parking, business access and associated economic development, conformity with community values, turning movements and turn lanes, pedestrian and bicycle mobility and safety, impacts to and conflicts with major utilities (including maintenance and potential relocations, capital and operating costs, and additional traffic and technical analyses as needed.
- Continuing to coordinate with City and County of Denver traffic engineering and other staff to ensure CRE operations integration with the downtown traffic and pedestrian signal system and to develop appropriate mitigations (including additional pedestrian infrastructure improvements) to ensure that the CRE system can operate safely and efficiently with pedestrian and auto movements, particularly on the southern end of the downtown loop (on 14th Street between Stout and California).
- Continuing RTD staff work on engineering design of the trackwork and other transit-related infrastructure of the alternatives.
- Continuing RTD coordination with other potential project partners on funding options for the improvements to allow the implementation of the CRE as soon as possible and to meet the overall project goal of its opening as close to the opening of the East Rail line as possible.

Other conclusions to be drawn from this analysis include:

- The one-seat ride using the downtown loop is a major attractor of additional ridership for the CRE line in both 2020 and 2035.

- The addition of the 29th/Welton station made relatively little difference in system ridership. While station access at any point along the line promotes user convenience, the proximity of the 29th/Welton station to the 30th/Downing station (and the downstream 27th/Welton station) appears to limit its usefulness to the overall system. Therefore, it does not appear to provide much benefit to RTD or the community to retain the station in the short term. This issue should be re-visited, however, if and when the community vision on Welton Street is implemented, including the conversion of Welton Street from one-way to two-way operations, and the construction of two shared-lane tracks for the CRE line in Welton Street.
- Ridership and travel time forecasts show that four two-vehicle trains ultimately will be needed on the CRE line to meet peak-period ridership demand in the long term (2035 and after), though RTD can meet short-term opening day ridership with four one-vehicle consists. When including spares, this means that, over the long term (2035 and after), ten rail cars ultimately will be needed to meet headways and passenger demands on the CRE line.

Goal 2: Use of Low-Floor Vehicles

This review of vehicle options presented a variety of choices for the local community to consider as it considers using low-floor streetcar-type vehicles on the CRE line and on other parts of the RTD system, while recognizing that current plans for short-term implementation of the CRE include using light rail vehicles on opening day. Overall concluding observations related to streetcar-related issues and choices include:

- The CRE project is, first and foremost, a mobility project (connecting the RTD East Rail line with downtown Denver). Therefore, its vehicle should be capable of providing relatively rapid and efficient movement for people to and through the corridor.
- Based on RTD's preliminary ridership forecasts for the corridor, a streetcar vehicle's ultimate size (if used on the corridor) should likely be longer than the 66-foot Czech-style vehicle currently used in Portland and Seattle to ensure it can meet passenger capacity. The ridership forecasts described in Chapter 2 assumed a vehicle that could accommodate roughly 125 passengers per vehicle during peak periods, which would require a vehicle in the 85-90 feet range or longer.
- While alternative propulsion systems are becoming more readily available, a streetcar system on the CRE should focus on using overhead electric power, as that is a traditional source of power already used in Denver for its light rail system.
- To promote efficient passenger loading and unloading, off-vehicle ticketing and multi-door boarding is recommended, similar to RTD's existing light rail system.
- Vehicle maintenance will be a key consideration in the implementation of a new streetcar-type vehicle. If existing RTD facilities cannot accommodate a new vehicle type (either because of radically differing technology and maintenance needs, or if existing facilities are not large enough to accommodate a new CRE fleet), a streetcar maintenance facility will

need to be planned, sited, and constructed to provide storage and maintenance space for the streetcar fleet. This issue should be addressed early in any system planning, and every effort should be made to make a maintenance facility a community asset by integrating it into the community (such as providing a maintenance public viewing facility, a streetcar museum, integration with an education facility, or other strategies to increase a facility's community integration).

- Based on this analysis, and taking into consideration past and current community support for a streetcar-type vehicle, this report recommends that RTD should continue to examine and evaluate the option of implementing use of a low-floor neighborhood-friendly streetcar-type vehicle on the CRE line and potentially other parts of the RTD system.

Goal 3: System Expansion

This study examined a number of potential options for providing future rail system capacity in downtown Denver and adjacent neighborhoods. The primary conclusions and recommendations include:

- RTD should continue to work with the City and County of Denver, the Five Points Business Association, and other project partners to identify funding choices to implement the community vision for Welton Street between 20th and 30th Streets, including moving toward conversion to two-way traffic operations and in-street rail track construction in shared lanes, promoting walkability, safety, and economic development on Welton Street.
- RTD should continue to work with its project partners – including the City and County of Denver in coordination with the City's future revision of its downtown transportation plan – to further study viable options for rail service expansion in downtown and the funding and financing mechanisms to pay for them.

Funding and Financing

There is a wide variety of potential options for funding or financing the CRE project and its expansion alternatives. The range of federal, state, and local options – and the projects where those options have been used around the country – point out the need for RTD to potentially develop a menu of funding and financing options appropriate to the scale and impact of the CRE and its potential extensions. In particular, RTD should continue to pursue TIGER funding when those grant programs are again available in the future. Alternatively, RTD should consult with FTA about the potential for including part or all of the CRE (both its short-term extension to the East Rail line and potentially its longer-term expansion options) into a Small Starts grant application, with the financial and political support of the local community, as the projects that have been most successful in securing federal funding (particularly Small Starts projects) have been those that showed a significant amount of local support and a wide variety of local funding as matching funds. RTD should also continue to work with the private sector to determine the potential for establishing public-private partnerships to implement the CRE and its longer-term expansions.

Appendices

- Apex Design memo on results of VISSIM analysis for two-way Welton Street conversion and Auraria West Connection
- ArLand Land Use and Economics memo on Welton Street conversion and the economic benefits of streetcars and two-way conversions
- Goodbee & Associates memo on major utility evaluation
- IMG Rebel Group memo on funding and financing mechanisms
- LS Gallegos and Associates memo on cost estimating
- Summary of outreach activities



Welton Street Two-Way Conversion Analysis

The project team conducted a preliminary analysis to determine if the two-way conversion of Welton Street to allow a mixed-flow operation of the CRE would create any negative traffic impacts. The analysis was once again conducted using the VISSIM micro-simulation model and various measures were used. These included the transit travel time and waiting time, which measure transit operations, and the intersection operations to determine traffic impacts. To achieve the two-way conversion, various parameters were changed from the base model. In this case, the base model was the CRE model for Alternative 3B as discussed in Chapter 2. The following describe the changes:

- **Geometry** – Welton Street was converted from a two-lane, one-way northbound cross-section with dual/single LRT tracks on the right side of the road to a four-lane two-way cross-section with two through lanes and the two outside lanes accommodating both LRT trains as well as vehicles. This change was made north of 20th Street.
- **Traffic Volumes** – It was assumed that the existing northbound traffic volume along Welton Street would remain unchanged. The southbound traffic demand was estimated based on the existing demand along California Street. Specifically, it was assumed that approximately one-third of the traffic along California Street would divert to Welton Street.
- **Traffic Signal Timing** – The traffic signal timing at Welton Street at Park Avenue, 26th Avenue/27th Street, and Downing Street were modified to accommodate two-way operation, however changes in phase splits were minimal.

The resulting models were then run 10 times in order to get a more statistically significant result and to account for the significant variations that can occur in the downtown loop and the mixed-flow segment along Downing Street. The results were extracted from the models and are discussed below.



Transit Travel Times and Waiting Times

Table 1 summarizes the transit travel times that were obtained from the VISSIM models for the two-way Welton Street alternative. These travel times are for round trips on the entire CRE line from 38th/Blake to downtown and back. The results are compared to the base model (Alternative 3B) which assumes the existing one-way Welton Street configuration.

Table 1: Transit Travel Times for Two-Way Welton Street

	Alternative 3B – New Track in Parking Lane on 14 th St with New Pocket Track on Stout	Alternative 3B with Two-Way Welton Street Conversion
Minimum time (minutes)	45.4	39.4
Maximum time (minutes)	49.3	45.7
Average time (minutes)	47.7	42.7

Source: Project Team

The results show that that the two-way conversion of Welton Street will improve the total round trip travel time by roughly 5 minutes. The difference is primarily due to the elimination of delays at the single-track section as well as the fact that southbound trains do not have to cross Welton Street near both Downing Street and 20th Avenue. Similar results apply to the transit waiting times, which measure the amount of time that transit vehicles are delayed at traffic signals, etc. but does not include the transit stop dwell time. The transit waiting time results are shown in Table 2.

Table 2: Transit Waiting Times for Two-Way Welton Street

	Alternative 3B – New Track in Parking Lane on 14 th St with New Pocket Track on Stout	Alternative 3B with Two-Way Welton Street Conversion
Minimum time (minutes)	16.4	13.9
Maximum time (minutes)	19.1	16.5
Average time (minutes)	17.2	14.9

Source: Project Team

Intersection Operations

To determine if the proposed Welton Street two-way conversion will result in poor traffic operations, the intersection delay and level of service was extracted from the VISSIM model. Table 3 summarizes the results along Welton Street in the area that will be affected by the two-way conversion.



Table 3: VISSIM Analysis of Intersection Level of Service

Intersection	Two-Way Welton Street	
	Delay (sec.)	Level of Service
Welton Street / 19 th Street / Broadway	34.5	C
Welton Street / 20 th Street	16.3	B
Welton Street / Park Avenue	16.2	B
Welton Street / Washington Street / 26 th Avenue / 27 th Street	17.2	B
Welton Street / Downing Street / 29 th Avenue	23.8	C

Source: Project Team

As shown, all five signalized intersection to be affected by the conversion are anticipated to operate well with a level of service of “C” or better. This is not surprising considering that the two-way conversion will continue to maintain two travel lanes in the northbound direction while adding two additional lanes in the southbound direction. The four-lane cross-section will also allow vehicles to easily pass LRT trains stopped at stations.

Overall Conclusions

This VISSIM analysis of the Welton Street two-way conversion was aimed at making a preliminary determination of the potential impacts of the conversion. Based on the results, the change would have significant positive impacts to transit operations while not creating poor traffic operations. Future design will require special attention at certain areas, such as the track crossings area near Downing Street and 20th Street, but no operational issues are anticipated.



Auraria West Alternative VISSIM Analysis

The project team conducted a VISSIM micro-simulation analysis for the Auraria West alternative to help determine a number of key factors related to the operation, including transit travel times and waiting times, and intersection impacts. Various parameters specific to the alternative were input into the VISSIM models, including geometrics, train schedules, and signal timing. The models were then run 10 times in order to get a more statistically significant result and to account for the significant variations that can occur in the downtown loop and the mixed-flow segment along Downing Street. The results were extracted from the models and are discussed below.

Travel Times

Table 1 summarizes the transit travel times that were obtained from the VISSIM models for the Auraria West alternative. The results for Alternatives 3A and 3B are also shown for comparison purposes. These travel times are for round trips on the entire CRE line from 38th/Blake to downtown and back. However, since the Auraria West alternative is essentially two one-way segments between the 38th/Blake station and the Auraria West station, the travel times include a four minute layover at the Auraria West Station.

Table 1: Transit Travel Times for Remaining Alternatives

	Alternative 3A – Existing Track with New Pocket Track on Stout	Alternative 3B – New Track in Parking Lane on 14 th St with New Pocket Track on Stout	Auraria West Alternative
Minimum time (minutes)	45.5	45.4	59.0
Maximum time (minutes)	50.6	49.3	63.2
Average time (minutes)	48.0	47.7	61.0

Source: Project Team

The table shows that the Auraria West alternative will have significantly longer round trip travel times than Alternatives 3A and 3B – approximately 61 minutes. This is due to the additional distance of the route and the fact that a layover time at the Auraria West station is required. The additional travel time will likely mean that the alternative will require a larger fleet size for the CRE.

Train Waiting Times

Table 2 summarizes the VISSIM results for train waiting times (the time each train spends at stations or intersections or other locations along its route waiting for signals to move forward, not including passenger loading dwell times). This comparison is a good indicator of how well each alternative moves in traffic through the signal system along its route and how it impacts other trains using the downtown loop. These waiting times are included in each option's total run time.



Figure 2: VISSIM Analysis of Train Waiting Times

	Alternative 3A – Existing Track with New Pocket Track on Stout	Alternative 3B – New Track in Parking Lane on 14 th St with New Pocket Track on Stout	Alternative 3B – New Track in Parking Lane on 14 th St with New Pocket Track on Stout
LRT Trains in Downtown Loop			
Minimum time (min.)	5.2	7.1	4.9
Maximum time (min.)	5.9	7.8	6.1
Average time (min.)	5.1	7.5	5.6
CRE Trains			
Minimum time (min.)	17.0	16.4	13.1
Maximum time (min.)	20.1	19.1	15.6
Average time (min.)	18.6	17.2	14.3

Source: Project Team

The table shows that the Auraria West alternative will result in lower transit waiting times for both the CRE trains and the other LRT trains in the downtown loop. This is likely due to the much simpler configuration at 14th Street, where a pocket track is not necessary and the CRE trains utilize the existing track configuration. The other added benefit of this alternative is the layover at the Auraria West station, which will allow for CRE trains to wait and enter the downtown loop at the optimal time. The transit waiting time results indicate that although the Auraria West alternative will have the longest transit travel times for a round trip, it will result in the most efficient operations with the least amount of delay.

Intersection Delays

Table 3 summarizes the VISSIM intersection level of service and delays at the southern end of the downtown loop. Data was only reported for the 14th & Stout and 14th & California intersection since the difference between the Auraria West alternative and the other two remaining alternatives was limited to these two locations.



Table 3: VISSIM Analysis of Intersection Level of Service

Intersection/ Movement	Alternative 3A			Alternative 3B			Auraria West		
	Delay (sec.)	Level of Service	Max. Queue (ft.)	Delay (sec.)	Level of Service	Max Queue (ft.)	Delay (sec.)	Level of Service	Max Queue (ft.)
14th/Stout									
N'Bound Through	31.9	C	205	33.9	C	160	32.5	C	208
N'Bound Right Turn	26.2	C	205	35.3	D	160	27.0	C	208
E'Bound Left Turn	10.0	B	32	65.5	E	151	10.2	B	29
E'Bound Through	64.4	E	261	62.1	E	207	64.1	E	231
Intersection Total	46.4	D		48.9	D		46.5	D	
14th/California									
S'Bound Left Turn	31.0	C	146	33.6	C	128	31.8	C	138
E'Bound Through	13.2	B	202	35.9	D	219	13.2	B	204
Intersection Total	19.7	B		35.0	D		20.0	C	

Source: Project Team

The table shows that traffic operations under the Auraria West alternative will be very similar to those under Alternative 3A. This is expected since both alternatives do not change the existing signal configuration at the two signalized intersections. As a result, both alternatives will have negligible impacts on the traffic operations.

Overall Conclusions

This VISSIM analysis was aimed at determining how the Auraria West alternative will operate related to transit and traffic operations. The analysis also compared the results to the other two remaining alternatives 3A and 3B. Overall, the Auraria West alternative will result in good transit operations with the least amount of transit delay of the remaining alternatives. In addition, no significant traffic impacts are anticipated since the track configuration near 14th Street will not change. However, the round trip travel time for the Auraria West alternative will increase to over 60 minutes due to the length of the route, which could have negative implications for fleet size requirements.

August 29, 2014

To: Tim Baldwin, Steer Davies Gleave

From: Arleen Taniwaki and Ryann Anderson, ArLand Land Use Economics

Subject: Welton Street Corridor, Potential Economic Benefits of Streetcars and Two-Way Conversions

While the Central Rail Extension (CRE) Mobility Study has focused primarily on transit and connectivity issues, economic revitalization of this corridor has been a longstanding goal for neighborhood and City leaders for a number of years. The corridor once known as “the hippest strip between St. Louis and San Francisco” is, after years of planning, poised for revitalization with a number of development projects in the pipeline. Redevelopment and planning efforts in the area, whether it’s the improvement of transit options or greater connectivity, are enhanced when combined with public-private development efforts focused on the goal of revitalization.

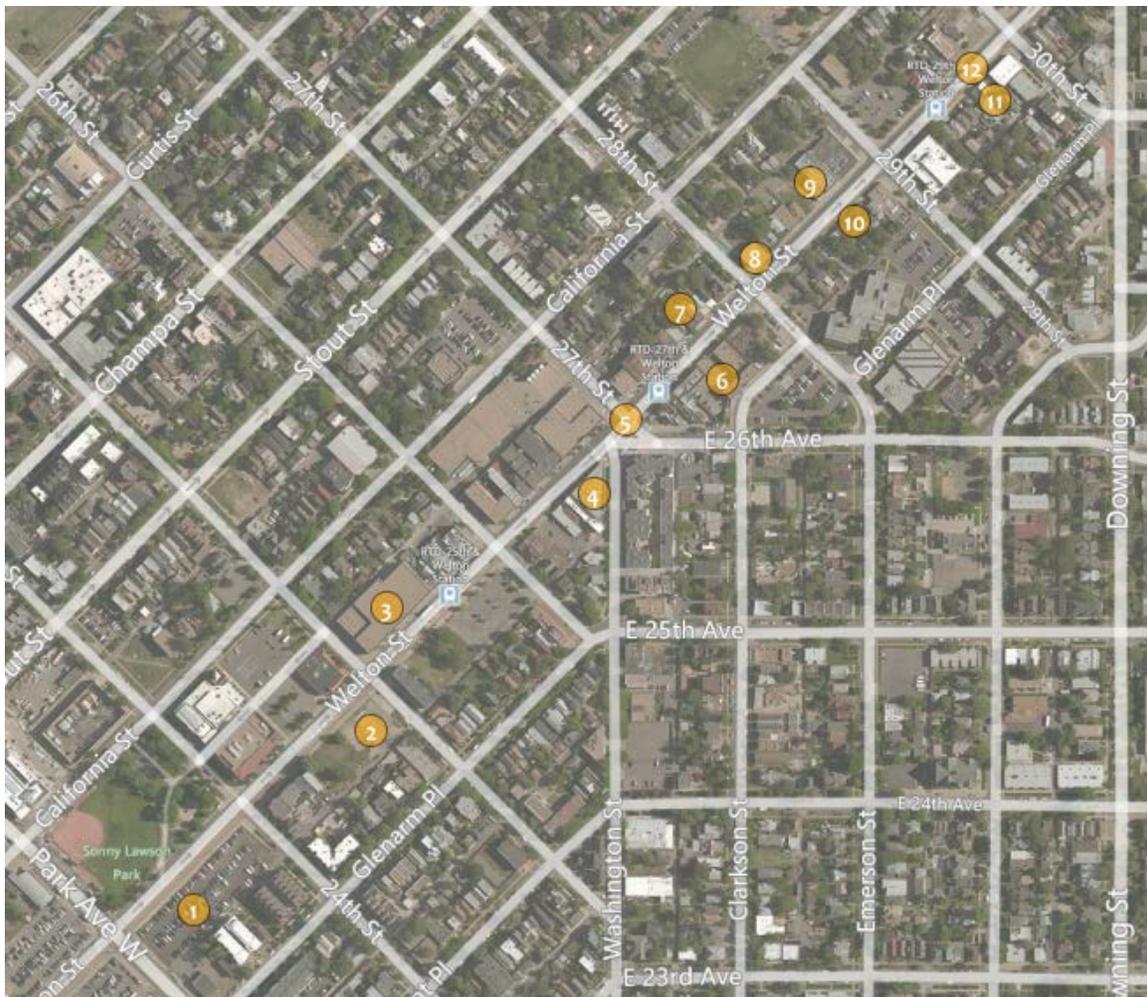
This memo will focus on:

- 1) **Current Development Efforts on the Welton Street Corridor:** After years of visioning and planning, the corridor is seeing a number of plans for redevelopment and new development.
- 2) **Potential Benefits of Converting Welton to a Two-Way Street:** There has been longstanding support in the neighborhood for the conversion of Welton Street from a one-way street to a two-way street. The conversion of streets from one-way streets to two-way streets is a trend that has occurred throughout the country, particularly in downtown areas, in an attempt to slow traffic and provide for an enhanced pedestrian experience. This memo will summarize some of the available literature and provide a brief case study of Larimer Street between Broadway and 30th Streets. This roadway underwent a conversion to a two-way street in 2011 and has seen new development and redevelopment since that time. Although the success of the street is attributable to a number of factors, the street environment has played a strong role.
- 3) **Potential Street Car Benefits:** The CRE team has focused on a number of different transit options for the corridor, including the potential for streetcars and other options for light rail in a format friendlier to a commercial district. The memo will highlight the potential differences between streetcar and light rail systems. It will also provide a brief summary of the benefits of streetcars.

I. Current Development Efforts in the Welton Street Corridor Area

Over the years, there have been a number of planning efforts focused on Welton Street revitalization. The City of Denver has played a critical role, as well as State and Federal investments. These efforts, combined with a demographic, development, and investment environment favoring downtown revitalization, has helped spark a number of potential development projects along the Welton Street Corridor. These projects vary in size, however, many of them tend to be mixed-use, and some of them include redevelopment of existing structures. All play an important role in contributing to the future vibrancy of this neighborhood corridor. These projects are depicted in Figure 1 and described in the following table.

Figure 1
Welton Street Development Projects, August 2014



Source: FPBDO, ArLand

**Table 1
Planned Development along the Welton Street Corridor, 2014**

Key	Address	Program	Proposed Date	Developer
1	2300 Welton St.	223 workforce rental housing units. Total development planned for 268,500 square feet	2014	Century Real Estate
2	2422-2469 Welton St.	82 market rate apartment units and 14 for sale three story townhomes	2014	Palisade Partners
3	2501 Welton St.	Renovation of 30,000 square feet into mixed use retail / office space	2014	
4	2650 Welton St.	200,000 square feet of restaurant, residential, hotel, and office space	2015	Rossonian Partners
5	2714 Welton St.	Renovation of historic two story building with 2,400 sf of restaurant space (deli) with 2-4 market rate apartments above	Opened July 2014	Empire Bagels LLC / Cousins Properties
6	2736 Welton St.	22,040 square feet of restaurants and retail	2016	
7	2741 Welton St.	3,700 sf Restaurant	2014	Randalls at Pierre's
8	2801 Welton St.	Renovation of historic 5,000 sf 2 story building into restaurant / retail and office		
9	2821-2843 Welton St.	Five story mixed use project with retail and 66 units of market rate residential	2015	Markel Homes
10	2844 Welton St.	Renovation of two story building to include, 4,700 square foot Duncan's Kitchen and Tap	2014	Ayre WP, LLC
11	2942-2944 Welton St.	Three story mixed use restaurant and office building	2015	SID, LLC
12	2950 Welton St.	Three story mixed use retail, and apartments	2014	St. Bernard Properties, LLC

Source: FPBDO

II. Benefits of Two-Way Streets

Literature Review

Many factors combine to make a street economically successful. Converting a one-way street into a two-way street can sometimes help an area's revitalization effort if conditions are conducive, ie redevelopment activities are already occurring. A growing number of communities are converting one-way streets to two-way streets citing potential economic benefits, such as reduced vacancy rates, increased retail sales and employment, increased pedestrian activity, and/or increased property tax assessments.

Economic development benefits cited in the literature discussing the conversion of one-way streets to two-way streets include the following:

- **Two-way streets make the district more navigable.** One-way streets networks are often confusing and more difficult to navigate than two-way street networks. Streets that are two-way improve circulation in ways that allow patrons to reach their destinations quickly and easily because most one-way systems do not allow motorists to travel directly to every destination. One-way streets, with rapid and efficient traffic flows, often cause drivers to pass their destination, turn back on to another block after some distance, and drive back via the original block to complete their trip; two-way streets can provide more direct access by giving more directional options and creating slower traffic conditions, which makes for easier lane changes.
- **Two-way streets also slow traffic down**, which makes the area more pedestrian friendly. It makes it safer due to low speed limits (15 to 30 miles per hour) and invites pedestrians to come and enjoy the street more often and for longer periods of time, which can increase impulse buys and can generally have a positive effect on businesses. Slowing traffic down and allowing a certain level of traffic congestion can also help to create the perception that a commercial area is exciting and lively, as it appears busy, which can make the area desirable to businesses and patrons alike. One-way streets, on the other hand, tend to encourage higher speeds at 35 to 40 mph, which are often too high for retail districts to be enjoyable and safe for pedestrians. One-way streets are often so efficient at moving traffic that they may feel empty in terms of activity and unsafe due to high speeds (Edwards).
- **Two-way streets can have a positive impact on storefront visibility**, partially because traffic moves more slowly and allows drivers time to absorb their surroundings. Additionally, as a vehicle stops at or enters an intersection, the driver has excellent visibility of the storefronts on the far side of the cross street (Transportation Coordinating Committee). District businesses that greatly rely on pass-by traffic will also benefit from the pedestrian-friendly (and thus pedestrian-rich) atmosphere of two-way streets.
- **Two-way streets can result in a reduction in crime in retail districts.** A study in West Palm Beach, Florida, showed a reduction in crime after two-way directional changes were made. This was likely due to more positive activity at the street level as a result

of increased and activated ground floor retail activities. Increased movement and more eyes on the street reduces crime by making it a less-favorable environment for criminal activity that does not like to be seen (Chinapen).

More communities are opting for two-way traffic along retail districts and there is significant anecdotal evidence that positive changes occur after most street conversions.

- In 2000, the Hyannis Main Street Business Improvement District (in Cape Cod, Massachusetts) surveyed 22 towns and cities that had converted streets from one-way to two-way traffic. In general, the results were positive, including significant reductions in vacant floor space after the conversion, improved business, improved livability and substantial private investments stimulated by conversions (Edwards; Wayland). The survey included:
 - West Palm Beach, Florida (pop: 85,000) reported \$300 million in private investment following local public investment of \$10 million for two-way conversion, streetscaping and renovations of historic buildings. It reported a dramatic increase in new retail shops, restaurants, and residential use and attributed the positive changes to the decrease in mobility (i.e., vehicle speed) and increase in access brought about by the two-way circulation as well as livability through streetscape design. Property values also increased. (Transportation Coordinating Committee).
 - Toledo, Ohio (pop: 323,000) reported that developers are buying up properties that stood vacant for many years and turning them in to successful new shops and restaurants.
 - Lafayette, Indiana (pop: 50,000) was concerned that they would lose vehicle and pedestrian traffic after converting their street, but found instead that business patronage improved, even with some parking loss due to the installation of left-turn lanes. The city's Economic Development Officer insists that, "No one would want to go back to one-way traffic..."
 - Charleston, South Carolina (pop: 95,000) experienced a dramatic increase in new retail and service businesses in the two-way conversion area.
 - Lubbock, Texas (pop: 200,000) reports that no negative feedback has been received and that sentiments have consistently conveyed that the conversion has been beneficial to the central business district, which is experiencing growth after several years of decline (Transportation Coordinating Committee).

General findings indicate that if the area in question is predominantly a retail district that is regenerating, then a conversion may help to boost the economy of the area by contributing to an atmosphere conducive to increased pedestrian activity. If, however, the land uses adjacent to the one-way street are primarily office, warehousing, or industrial, with high peak-hour traffic and little in the way of pedestrian interest, then a conversion may not produce sufficient effects. This is because most significant benefits to a district come with

existing and increased pedestrian traffic on its sidewalks. Areas in which existing pedestrian traffic volume is less than 200 to 300 people an hour have been found to produce minimal benefits when converted (Edwards).

All of these aspects are potential benefits of two-way streets, but it is important to note that the potential of converting the street network from one-way to two-way will most likely not, by itself, guarantee an immediate resurgence of growth and activity, but rather should be considered an important piece of the overall redevelopment strategy. Most communities have included one-way to two-way conversions as a part of a greater vision or plan for their retail districts, such as streetscape improvements, beautification measures, traffic-calming measures, improved design and other improvements (Transportation Coordinating Committee).

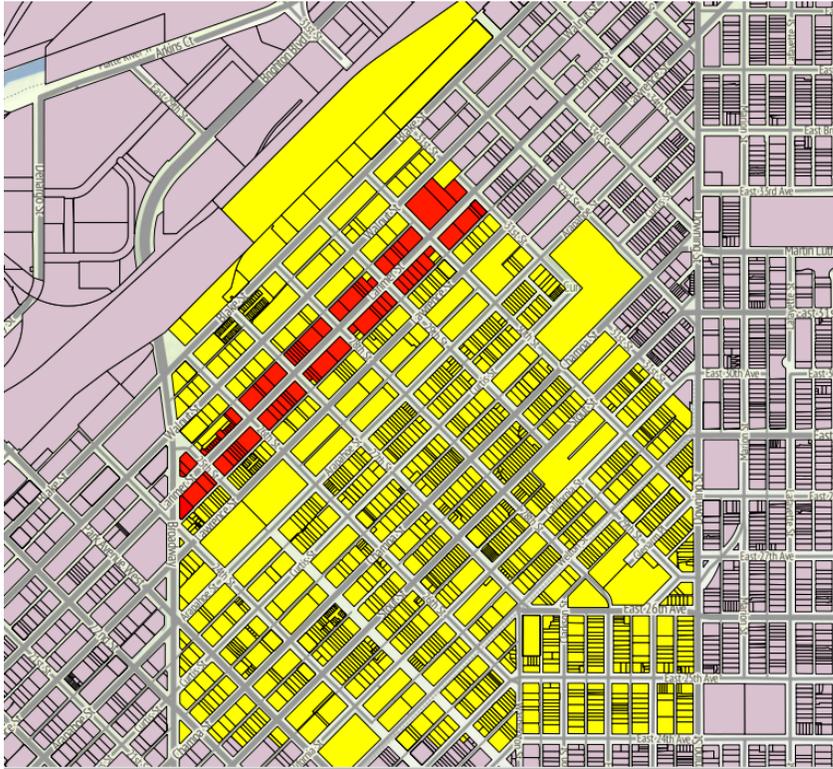
Case Study

In 2011, the City of Denver converted Larimer Street from Broadway to Downing Street from a one-way to two-way street. Larimer Street is close to downtown Denver and was historically an industrial and warehouse district. It is, however, in the midst of an area that has experienced some residential revitalization with a mix of new and renovated lofts, townhomes and apartments. Zoning in the area is predominantly industrial and commercial mixed use.

Prior to conversion, the area experienced a moderate amount of traffic. The Average Daily Traffic (ADT) pre-conversion was 10,700 based on a count that the City of Denver conducted in 2005. Streets parallel to Larimer Street include Walnut Street and Lawrence Street. Walnut Street in this area is a redeveloping mix of industrial and residential while Lawrence Street is predominantly residential. Larimer Street, closer to the downtown area, remains a one-way street.

The area between Broadway and 30th Streets on Larimer Street area has experienced commercial revitalization with new offices, retail stores, restaurants, and coffee shops.

Figure 2
Larimer Street Case Study



Source: Denver County Assessors' Office, ArLand

Table 2
Property Values

Property Values	Total Value (\$ millions)				
	Larimer Street (Bway to 31st)	Lawrence Street (Bway to 31st)	Walnut Street (Bway to 31st)	NE Downtown (tract 1600)	City of Denver
2010	\$45.7	\$46.7	\$52.7	\$1,645	\$91,617
2014	\$56.5	\$50.2	\$50.6	\$1,956	\$90,687
CAGR	5.5%	1.8%	-1.0%	4.4%	-0.3%
overall Pct.	23.7%	7.5%	-4.0%	18.9%	-1.0%

Source: Denver County Assessors Office, ArLand

Table 2 shows property values in 2010 and 2014 before and after conversion. The 2010 row shows values across different neighborhoods including Larimer Street, Lawrence Street, Walnut Street, and the Northeast Downtown Neighborhoods (Ballpark and Curtis Park neighborhoods encompassing Census Tract 1600). It also shows the City of Denver. By 2014, the conversion of Larimer to a two-way street was complete. Between 2010 and 2014, property values on the section of Larimer Street examined grew by an average annual growth rate (CAGR) of 5.5% and an overall growth rate of 23.7%. Denver and Walnut Street

saw value declines during this period, while the greater Northeast Downtown area grew, but at a lower rate.

While the conversion of Larimer Street to a two-way street was not the only factor in the area's growing economic vitality, its contribution should not be underestimated.

III. Benefits of Street Cars

The goals of the CRE Mobility Study include the following:

- Determine the best way to provide a direct rail transit trip between the 38th and Blake Station and downtown Denver without a transfer
- Explore the use of transitioning from the current light rail system to a low floor vehicle particularly along the Welton Corridor

Additional plans in place for the system include eventually linking the 30th and Downing station to 38th and Blake along the East Corridor which would provide the Welton Corridor a direct link to downtown as well as the Denver International Airport.

This section of the memo discusses potential economic benefits of a low floor or a streetcar type of vehicle. The discussion is a bit challenging because the Welton situation is contemplating converting the existing light rail infrastructure to low floor or streetcar infrastructure. There is no body of research exploring this exact situation. The literature examining the impacts of fixed guideway transit systems acknowledges that methodologies vary widely and that value premiums can vary by land use and range from minimal (1% to 2%) to substantial (100% plus). The studies also acknowledge that one of the challenges in evaluating value premiums is controlling for changes in zoning or other policies permitting greater density in conjunction with fixed guideway transit, because these alone can increase the value of land and existing properties, separate from any direct transit impacts (Transportation Research Board).

However, it should be acknowledged that the CRE study contemplates the low floor vehicle technology in concert with the conversion of Welton Street into a two-way street and creating a potential street environment with appropriate enhancements that would contribute greatly to the economic revitalization already being seen in the area.

Case Studies

Streetcars have become a more popular transportation alternative, with more than 45 systems built or in various stages of planning or construction. Their popularity has resulted from a range of factors, including relatively lower cost of construction than other forms of rail transit and their relative ease of integration into the existing urban fabric (Transportation Research Board).

While streetcars have some similarities to light rail, there are notable differences, from a land use and economic development perspective, including the following:

- **More frequent service** - While streetcar vehicles run on fixed rail guideways as do light rail vehicles, they differ from light rail vehicles in that they would potentially have more frequent headways, relatively short distances between stops and lower operating speeds.
- **Shorter distance circulation** - They are designed for shorter distance circulation whereas light rail lines may operate at higher speeds over greater distances.
- **Ease of boarding** - Streetcar stations are not as developed as light rail stations and allow for level boarding platforms. They are typically low-floor compared to light rail systems. Both offer boarding through multiple doors.
- **Potentially different land use patterns** – Different land use development studies have shown that streetcars promote a “ribbon of development” instead of the nodal development that occurs around and light and heavy rail stations, primarily because of slower speeds, tighter spacing, and visibility of streetcars.

There are similarities, however, in their economic development benefits. Like light rail, streetcars have the ability to catalyze and organize development. Throughout history, streetcars have been an “organizing principle” around which development occurred. Streetcars can help create dense pedestrian environments where access to streetcar stops is accessible by foot. These benefits have been demonstrated in the literature, primarily in case studies. A few of the more recent relevant studies are summarized below.

Case Studies

- Kansas City Streetcar** - One of the most recent studies explored the development impact of the downtown streetcar in Kansas City as of January 2014. The study describes the various projects and their degree of connection to the streetcar as the impetus for the project (Figure 4 next page). Eleven projects with a value of \$256 million, including the addition of 451 housing units cited the streetcar as the key reason for development. Ten projects with a value of \$367 million including the addition of 411 housing units cited the streetcar as impacting the decision to develop. Eighteen projects with a value of \$214 million including the addition of 1,115 housing units are in development in the Transportation Development District. In sum, a total of \$879 million in projects in the completed, construction, or planning phases that will add a total of 1,997 new housing units have been connected to the streetcar so far (NextRailKC).
- Portland Streetcar** – (Figure 3) Portland is one of the only communities that has conducted extensive formal research regarding its streetcar system. In 2005, a study of the impact of the streetcar on development in the areas around the system compared development prior to and after the 1997 announcement of the streetcar. Prior to the announcement, development ranged from 30% of the allowable density within one block of the line to 40% in areas three blocks and further away. Eight years after the announcement, billions of dollars in investment had been generated, as developers had built at 90% of allowable density within one block of the line, 75% within two blocks of the line, and 40% in areas three blocks and further away (Vredevelt et al.).

According to Reconnecting America in examining the Portland streetcar system, “...While it was tempting to say the streetcar was responsible for leveraging all this development, that would not be entirely accurate. Rather the streetcar was said to be part of a ‘perfect storm’ of planning and policy, development opportunities, and public-private investment.” (Poticha and Ohland)

**Figure 3
Portland Streetcar System**

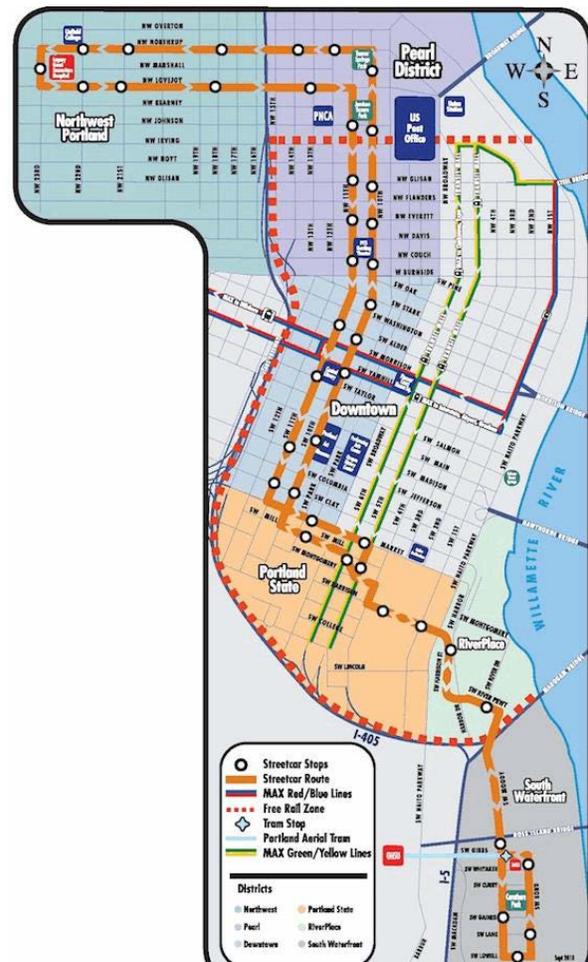
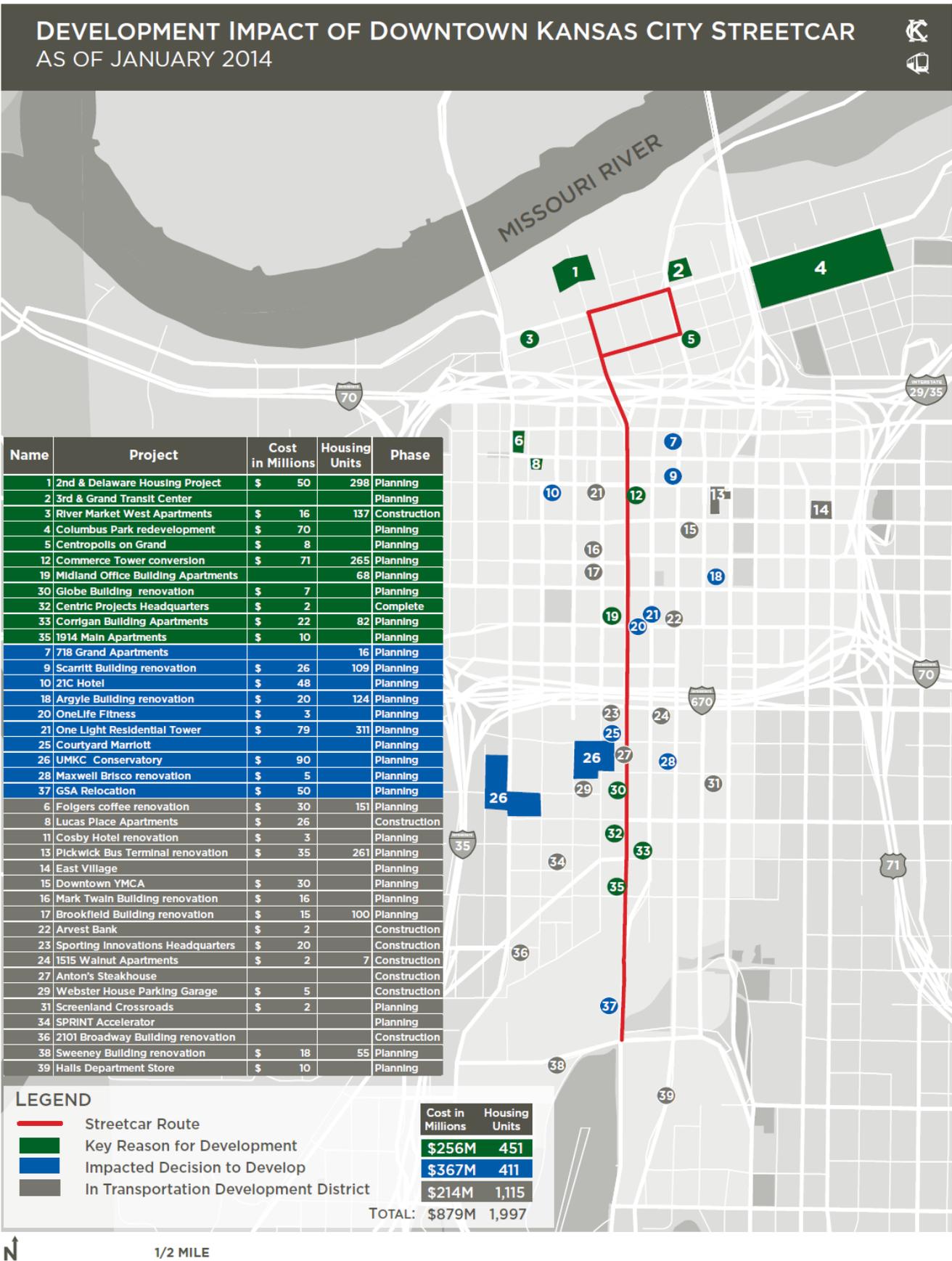


Figure 4
Development Impact of Downtown Kansas City Streetcar, as of January 2014



- **Cincinnati Streetcar** - Cincinnati is in the construction phase of a 3.5-mile loop streetcar line. A feasibility study conducted a benefit-cost analysis and determined that the system is expected to bring substantial economic benefit to downtown and Over the Rhine. Substantial residential and commercial private investment is expected, which would result in property value appreciation and increases in the density of development. These development benefits are estimated to constitute 85 to 90 percent of the total benefits of the system (the rest would be attributed to ridership benefits). According to the study, the present value of total benefits from the streetcar project is expected to be \$431.6 million. After deducting total costs, the present value of the average net benefits figure is expected to be \$315.8 million. The average expected benefit-cost ratio is 2.7. This means that the economic return over 35 years is expected to be 2.7 times greater than the original investment in the system (Vredeveld et al.).

Summary

Additional potential benefits cited by streetcar proponents include:

- Ridership often increases on streetcar systems over time, which increases mobility and access for those nearby
- More people use their personal vehicles less, generating savings by reducing vehicle operating costs, accidents, emissions, parking and traffic congestion
- Proponents also say that streetcars will attract more of the “creative class,” reduce carbon footprints, and stimulate private investment in the urban core (Vredeveld et al.)
- Anecdotally, streetcars attract new development or enhance revitalization, although the impacts vary
- There is a strong belief that people are attracted to streetcars, and that they help to meet the goals of revitalization and visitor attraction. (Transportation Research Board)

Development appears to account for most of the economic benefits of a streetcar system. The fixed rail aspect of a streetcar stimulates economic development along its line and in its vicinity, and can be substantial. The case studies examined indicate that an increase in property values and in land use density is likely to increase for both commercial and residential uses that are within three blocks of the line through new development creation (Vredeveld et al.).

IV. Benefits of Street Cars and Two-Way Conversions

The literature acknowledges that actions such as converting the street network from one-way to two-way, or the inclusion of streetcars, in and of themselves, do not guarantee an immediate resurgence of growth and activity but are important parts of an overall redevelopment strategy. Because the Welton Corridor has a vision plan in place and redevelopment is occurring, the activities recommended in the CRE Mobility Study help

support revitalization in the area through improvements to the streetscape, traffic-calming measures, and other activities to improve the street environment.

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TECHNICAL MEMORANDUM

TO: Tim Baldwin/Steer Davies Gleave
FROM: Elissa Roselyn/Goodbee and Associates, Inc.
DATE: October 31, 2014
SUBJECT: Major Utility Evaluation
Central Rail Extension Project

1.0 INTRODUCTION

This technical memorandum documents Goodbee & Associates' evaluation of major utilities for RTD's Central Rail Extension Mobility Study. The purpose of this work is to provide RTD with a comparison of major utility impacts that would affect track placement along several corridors:

- Potential streetcar route along Welton St. between 12th St. and 20th St.
- Potential streetcar route on a loop consisting of Broadway and Lincoln St. between W. Colfax Ave. and 20th/Downing.
- Changing Welton St. between 20th St. and 30th St. to two-way and having light rail on either side of the roadway rather than just on the northwest side.; and
- Potential pocket track in Stout St from 14th St. to 15th St.

Methodology:

Major utilities are defined as electric transmission lines and substations, network electric (downtown electric feed), high pressure gas lines, petroleum pipelines, waterlines at least 20 inches in diameter, sanitary sewers at least 18 inches in diameter, storm sewers at least 36 inches in diameter, brick and clay sanitary and storm sewers, sewer and water pump stations, force main sanitary sewers, steam pipelines, and communication trunk lines.

The project area was defined as the existing roadway along Welton St. between 12th St. and 30th St., Broadway and Lincoln St. from W. Colfax Ave. to 20th/Downing, W. Colfax Ave. from Broadway to Lincoln, and Stout St. between 14th St. and 15th St. To identify owners of major utilities in the project area, Goodbee & Associates conducted a search of the Utility Notification Center of Colorado (UNCC) database. Utility owners were contacted to confirm the presence or absence of facilities in the project area and to obtain key maps. Information from utility owners was confirmed and supplemented by a field survey during which locator markings, pedestals, marked manholes and vaults were observed. There was additional coordination with utility owners following the field survey to clarify discrepancies and field observations.

Limitations:

It should be noted that several assumptions were made for this work effort:

- Information received from utility owners was assumed to be accurate and complete.

- Buried utility locations were estimated based on schematic maps that were provided and field observations of surface features such as manholes, vaults, pedestals and old locator markings.
- Some utility owners did not provide maps or information about their facilities or provided maps that did not cover the entire project area.
- Major utilities running parallel to and within the project corridors were considered more significant than utilities crossing the corridors in cross-streets. While utilities crossing beneath the tracks may need to be lowered to accommodate the tracks, this would be a much smaller effort and expense compared to relocating extended lengths of a utility to a parallel location in an often already crowded right of way.
- All communication lines running parallel to or in roadways were assumed to be trunk lines.

2.0 FINDINGS

The UNCC database identified a total of 21 utility owners with facilities in or near the project corridors; of these, three do not have facilities that meet the criteria for major utilities. No electric transmission lines or substations, high pressure gas lines, petroleum pipelines, pump stations, or force main sanitary sewers were identified in the project area. In addition, field observations indicated that NextLink Communications, who was not listed by UNCC, has facilities in the project area. It is possible that NextLink was not listed by UNCC because they may lease conduits owned by another company which was listed by UNCC. The follow table lists the utility owners identified for each corridor:

Utility Owner	Welton 12 th -20 th St.	Welton St. 20 th – 30 th St.	Broadway-Lincoln	Stout St. 14 th - 15 th St.
AT&T***	x		x	x
CenturyLink – local***	x	x	x	x
CenturyLink– long distance	x		x	x
Cogent Communications	x	x	x	
Comcast*	x	x	x	x
Deep Rock Water**		x		
Denver Parks Department**	x	x	x	x
Denver Traffic*	x	x	x	x
Denver Water *	x	x	x	x
Denver Wastewater*	x	x	x	
Downtown Denver Partnership**	x		x	x
Level 3 *	x	x	x	x
MCI-Verizon*	x		x	x
Metro Wastewater*			x	
New Century Energy***	x	x	x	x
NextLink Communications	x		x	
Reliance Global	x	x		x
Sprint	x		x	x
TW Telecom*	x	x	x	x
Windstream (Paetec)***		x		x
Xcel Energy – electric/gas*	x	x	x	x
Xcel Energy – steam***	x	x	x	x
Xcel Energy – chilled water	x			x
XO*	x	x	x	x
Zayo (360)*	x	x	x	x

* Key maps obtained from utility owners for this project

** No major utilities owned

*** Key maps from previous work used when no maps were provided to supplement maps obtained for this project.

Welton St. between 12th St. and 20th St.

The proposed improvements along this segment of Welton St. would include converting traffic flow from one-way to two-way and installing a single set of tracks near the curb on both sides of the street.

Based on information from utility owners and field observations, major utilities in this segment of Welton St. include:

- Communication Trunk Lines
 - MCI has several buried fiber runs in Welton St. including between 12th St. and 16th St. and on the southeast side of the street between 17th St. and 18th St.
 - New Century Energy has fiber in Welton St. between 12th St. and 14th St.
 - Level 3 has fiber in Welton St. between 17th and 18th St.
 - XO, NextLink and Level 3 have buried fiber runs on the northwest side of Welton St., between 14th St. and 15th St., although no key maps were received from NextLink and information was limited to field observations.
 - There are numerous buried communication lines crossing Welton St., including Comcast, MCI and Sprint in 14th St.; XO and Zayo in 15th St.; MCI, Comcast and TW in 17th St.; Zayo in 18th St. and TW Telecom in 19th St.
- Network Electric
 - Xcel's buried network electric in Welton St. is near the middle of Welton St. between 12th St. and 14th St. and between 15th St. and 16th St. It also crosses Welton St. in 14th St., 15th St., 16th St., 17th St. and 18th St.
- Sanitary Sewers
 - There is a 21-26-inch sanitary sewer crossing Welton St. near the center of 16th St.
- Steam
 - Xcel Energy has a low pressure steam pipeline on the southeast side of Welton St. from south of 14th St. to 18th St. Low pressure steam pipelines also cross Welton St. at 17th St. and 18th St. and an intermediate pressure steam pipe crosses Welton St. at 14th St.
- Storm Sewers
 - There are 12-inch clay storm sewer laterals crossing Welton St. in 15th St., 17th St. and 18th St.
- Water Lines
 - Xcel Energy's chilled water system consisting of two 24-inch steel water lines and six 4-inch conduits containing fiber optic cable ranging in depth from 3-20 feet deep. The water lines are located in front of the southeast curb from north of 16th St. to 17th St. and cross Welton in 15th St. and 17th St.
 - Denver Water has a 20-inch water line on the southeast side of Welton from Broadway to 20th St. that crosses Welton St. and continues northwest on 20th St.
 - Denver Water Conduit 31 is a 24-inch waterline crossing Welton St. in 16th St.

Welton St. between 20th St. and 30th St.

The proposed improvements along this segment of Welton St. would include converting traffic flow from one-way to two-way and replacing the double track currently on the southeast side of the street with a single set of tracks on either side of the street near the curb.

Major utilities in this segment of Welton St. include:

- Sanitary Sewer
 - There is a 10-inch to 15-inch clay sanitary in Welton St. west of the existing light rail tracks between 20th St. and Park Avenue West.

- There is a 24-inch PVC sanitary in Welton St. northwest of the existing light rail tracks between 27th St. and 30th St. that crosses Welton St. and continues northwest in 30th St.
- There is a 12-inch clay sanitary pipe that crosses Welton St. along 20th St.
- Storm Sewer
 - There are 12-inch to 18-inch clay storm sewers crossing Welton St. in 20th St., 22nd St., 23rd St., 24th St., 25th St., 26th St., 28th St. and 29th St.
 - There is a 75-inch clay storm sewer crossing Welton St. in 27th St.
 - There is a 15-inch clay storm pipe near the southeast curb in Welton St. between 27th St. and 29th St.
- Water Lines
 - Denver Water has a 20-inch waterline on the southeast side of Welton St. between Broadway and 20th St.
 - Denver Water's 24-inch Conduit 33 crosses Welton St. in 30th St.
- No electric transmission, gas or communication lines meeting the major utility criteria are present in this area based on the available information. This area is beyond the limits of Xcel Energy's steam, chilled water and network electric facilities.

Broadway-Lincoln Loop between W. Colfax Ave. and 20th/Downing St.

The proposed improvements for the Broadway-Lincoln Loop would include installing a set of single tracks on the one side of Broadway, the middle of Colfax Ave., and one side of Lincoln.

Major utilities identified along Broadway include:

- Communication Trunk Lines
 - During the field survey, old locator markings showed communication lines owned by AT&T, CenturyLink, Comcast, Denver Traffic, Level 3, NextLink and XO in and crossing Broadway, although the full extent and size/importance of the facilities could not be determined based on the field markings.
 - CenturyLink has facilities on the west side of Broadway between Cheyenne Pl. and south of Court Pl. and on the east side of Broadway between W. Colfax Ave. and 16th Ave.
 - Denver Traffic has fiber on the east side of Broadway between 18th Ave. and 18th St. and on the west side of Broadway between 18th St. and Glenarm Pl. Denver Traffic also has conduit in Level 3's facilities in Broadway.
 - Comcast has facilities on the east side of Broadway between 16th Ave. and 17th Ave. and between 18th Ave. and 20th St.
 - Level 3 and NextLink are on the west side of Broadway between 16th Ave. and 17th St. and between 18th Ave. and 19th Ave.
 - XO and Zayo have a facility on the west side of Broadway between 16th Ave. and 17th St.
 - MCI has facilities on the west side of the street from north of W. Colfax Ave. to 17th Ave. and from 18th Ave. to north of 19th Ave.
 - TW Telecom has facilities on the east side of Broadway from Cleveland Pl. to 17th Ave. and near the curb on the west side of the street between 19th Ave. and 20th Ave.
 - Numerous communication lines cross Broadway at 16th Ave., 17th Ave., 18th Ave. and 19th Ave.
- Electric Transmission/Network Electric
 - Xcel Energy has buried network electric on the west side of Broadway for half a block north and south of 16th Ave. and between 18th Ave. and California St.
 - Xcel Energy may have network electric on the east side of Broadway between Welton St. and 20th Ave.

- There are buried network electric crossings at 16th Ave., 17th Ave., 18th Ave. and Welton St.
- Sanitary Sewers
 - There is a sanitary sewer on the east side of Broadway from W. Colfax Ave. to north of 20th Ave. ranging in size from 18 inches to 27 inches. South of 16th Ave. it is clay pipe and is particularly close to the east curb between W. Colfax Ave. and 16th Ave. North of 16th Ave. it is PVC pipe.
- Steam
 - Xcel Energy has low pressure steam pipelines on the west side of Broadway between 17th Ave. and 18th Ave. and on the east side of Broadway between 17th Ave. and 19th Ave.
 - Low pressure steam pipelines cross Broadway in 16th Ave., Court Pl., 18th St. and 19th Ave.
- Storm Sewers
 - There is an 18-inch clay storm sewer near the curb on the east side of Broadway between W. Colfax Ave. and 16th St. and smaller clay storm sewers connecting to storm mains in Broadway from the east at 16th Ave., 17th Ave., 18th Ave. and 19th Ave.
 - There is 21-inch clay storm sewer along Broadway between 19th Ave. and 20th Ave.
 - There is a 12-inch clay storm sewer on the east side of Broadway between 16th Ave. and 17th Ave.
- Water lines
 - Denver Water's 24-inch Conduit 31 is on the east side of Broadway between W. Colfax Ave. and 16th St., where it continues northwest in 16th St.
- No gas pipelines meeting the criteria for major utilities were identified in Broadway.

Major utilities in Lincoln St. include:

- Communication Trunk Lines
 - During the field survey, old locator markings showed communication lines owned by CenturyLink, Comcast, Level 3, NextLink XO and Zayo in and/or crossing Lincoln St., although the full extent and size/importance of the facilities could not be determined based on the field markings.
 - CenturyLink has facilities crossing Lincoln under the north sidewalk of W. Colfax Ave. and 17th Ave.
 - CenturyLink long distance has facilities on the east side of Lincoln St. south of 17th Ave.
 - NextLink has facilities on the east side of Lincoln St. at 20th Ave.
 - Level 3 has facilities in Lincoln between 16th Ave. and 20th St, including the east side of the street at 20th Ave.
 - Comcast has facilities in Lincoln St. between 16th Ave. and 18th Ave.
 - MCI has facilities in Lincoln St. from north of 16th Ave. to 20th Ave.; it is unclear where in the street it is located.
 - Zayo has facilities on the west side of Lincoln St. from south of 16th Ave. to 20th Ave.
 - Numerous communication lines cross Lincoln St. at 16th Ave., 17th Ave., 18th Ave. and 19th Ave.
- Electric Transmission/Network Electric
 - Xcel Energy's buried network electric runs on the east side of Lincoln St. between 17th Ave. and 18th Ave. and crosses Lincoln St. in 16th Ave., 17th Ave. and 18th Ave.
- Sanitary Sewers
 - A 9-inch clay sanitary sewer runs east of the centerline in Lincoln St. from W. Colfax Ave. to 20th Ave.
 - Clay sanitary sewers in 16th Ave. and 19th Ave. cross Lincoln St. south of the centerline and near the centerline in 17th Ave.

- Steam
 - Xcel Energy has low pressure steam pipelines crossing Lincoln St. south of the centerline in 16th Ave. and 19th Ave.
- Storm Sewers
 - An 18-inch clay storm sewer runs in Lincoln St. east of the centerline between 16th Ave. and 17th Ave.
 - Clay storm sewers 12 to 18 inches in diameter cross Lincoln St. near the centerline of W. Colfax Ave., 16th Ave., 17th Ave., 18th Ave., 19th Ave. and 20th Ave.
- No gas or water lines meeting the major utility criteria in or crossing Lincoln St. were identified.

Major utilities in W. Colfax Ave. include:

- Communication Trunk Lines
 - During the field survey, old locator markings showing CenturyLink's facilities were observed.
 - AT&T has a fiber duct in W. Colfax Ave.
 - CenturyLink has facilities on the north side of W. Colfax Ave.
- Storm Sewers
 - There is a 15-inch clay storm sewer in the middle of W. Colfax Ave.
- No electric, gas pipelines, water lines, steam pipelines, or sanitary sewers meeting the criteria for major utilities in West Colfax Ave. were identified.

Stout St. between 14th St. and 15th St.

The proposed improvements along this segment of Stout St. would include realigning the existing track and installing a pocket track on the northwest side of the street.

Major utilities identified in Stout St. include:

- Communication Trunk Lines
 - Denver Traffic has fiber on the northwest side of Stout St.
- Steam
 - Xcel Energy has two low pressure steam pipelines near the centerline of Stout St.
- Storm Sewers
 - There is a 90-inch RCP storm sewer on the southeast side of Stout St. possibly under the sidewalk.
- No electric, gas pipelines, sanitary sewers or water lines meeting the criteria for major utilities were identified in Stout St.

Major utilities identifies along 14th St. include:

- Communication Trunk Lines
 - During the field survey, old locator marking for CenturyLink Long Distance, CenturyLink, Level 3, XO, Zayo and MCI were observed, although the full extent and size/importance of the facilities could not be determined based on the field markings.
 - Level 3, XO and Zayo are located under the sidewalk on the southwest side of 14th St.
 - CenturyLink, MCI and Sprint are located under the sidewalk on the northeast side of 14th St.
 - CenturyLink, CenturyLink Long Distance, Comcast, MCI, AT&T and Zayo have facilities in the roadway along 14th St.
 - Windstream, Denver Traffic, and New Century Energy have fiber in 14th St.
- Network Electric
 - Xcel's buried network electric is in 14th St. on the southwest side.

- Steam
 - Xcel Energy has two low pressure steam pipelines near the centerline of 14th St.
- No gas pipelines, sanitary sewers, storm sewers or waterlines meeting the criteria for major utilities in 14th St. were identified.

Major utilities identified along 15th St. include:

- Communication Trunk Lines
 - During the field survey, old locator marking for two CenturyLink ducts on the southwest side of 15th St. were observed, although the full extent and size/importance of the facilities could not be determined based on the field markings.
 - AT&T, Zayo, and Level 3 have facilities located in 15th St.
- Network Electric
 - Xcel's buried network electric is located on the northeast side of 15th St.
- Water Lines
 - Xcel Energy's chilled water system consisting of two 24-inch steel water lines and six 4-inch conduits containing fiber optic cable ranging in depth from 3-20 feet deep are located near the centerline of 15th St.
- No gas pipelines, sanitary sewers or storm sewers meeting the criteria for major utilities were identified in 15th St.

3.0 CONCLUSIONS AND RECOMMENDATIONS

All of the track alignments under consideration will likely result in multiple utility impacts. It is recommended that the following actions be taken after a preferred alternative is selected to better identify and resolve these potential conflicts:

- Coordinate with utility owners to obtain key maps which were not provided for this study and to investigate if future utility installations are planned;
- Have the location of buried utilities marked and surveyed; and
- Determine the depth of utilities which may conflict with the track alignment by potholing.

Funding and Financing the Central Rail Extension (CRE)

The purpose of this memorandum is to review the options available to the Regional Transportation District of Denver (RTD) to fund and finance the Denver Central Rail Extension (CRE).

This aim is to provide an update on the current status of federal funding opportunities, as well as present a range of alternative funding and financing options. Section I will examine the main federal funding opportunities available for the CRE project. Section II will examine a range of alternative funding and financing options, with a particular emphasis on value capture mechanisms such as assessment districts. Section III will present an overview of various transit projects across the United States where value capture mechanisms have successfully been used to generate project regular revenue streams. Finally, Section IV will present conclusions for funding and financing the CRE project, and discuss the potential for using value capture mechanisms in the Denver downtown area.

1. Summary of Recent Federal Funding Opportunities

Three main types of federal funding and financing programs could be used for the Denver Central Rail Extension (CRE) project:

- The Transportation Investments Generating Economic Recovery (TIGER) Discretionary Grants;
- The Small Starts (or Very Small Starts) program of the Federal Transit Administration (FTA); and
- The Transportation Infrastructure Finance and Innovation Act (TIFIA) loan program.

The following section will examine these three programs in more detail and discuss the extent to which they have been successfully used to fund light rail and/or streetcar projects in the past. It is our understanding that the RTD submitted an application for a \$20 million grant from the TIGER program in 2014, but was unsuccessful. Nevertheless, this report will begin with a brief overview of the TIGER program, as the RTD could choose to reapply for this grant in future fiscal years.

1.1. The Transportation Investments Generating Economic Recovery (TIGER) Program

The TIGER program was created in 2009 as part of the federal stimulus program, and has to date provided \$4.1 billion in six rounds of projects. TIGER grants range from \$10 million to \$200 million in size and may be used to fund up to 80 percent of the funds for a project. Unlike other funding programs, TIGER funds are open to any governmental entity or any sub-entity, including cities and regional transportation departments.

In recent years, TIGER grants have been the predominant federal funding source for streetcars across the country. Streetcar projects funded by TIGER grants have included:

- **Sun Link Streetcar line, Tucson, Arizona** (2014) - \$63 million TIGER grant out of an overall project cost of \$196.5 million;
- **Kansas City Downtown Street Car** (2013) - \$20 million TIGER grant out of an overall project cost of \$102.5 million;
- **M-1 Rail Streetcar project, Detroit** (2013) - \$25 million TIGER grant out of an overall project cost of \$137 million;

- **Downtown Streetcar Project, Dallas, Texas (2012)** - \$26 million TIGER grant out of an overall project cost of \$56.8 million;
- **Cincinnati Streetcar (2012-13)**- \$15.92 million TIGER III grant out of an overall project cost of \$148 million; and
- **Atlanta Streetcar (2010)** - \$47.6 million TIGER II grant out of an overall project cost of \$92 million.

TIGER applications must be outcome-based and should ideally demonstrate the use of innovation and partnerships. Long-term outcomes are the primary selection criteria for evaluating TIGER applicants. In order to compete effectively for TIGER funds, proposed projects should demonstrate strength in at least two or three of the following five long-term outcomes: (1) safety, (2) economic competitiveness, (3) state of good repair, (4) livability (“quality of life”) and (5) environmental sustainability. Secondary selection criteria include the use of innovative strategies to achieve long-term outcomes as well as the promotion of partnerships. The TIGER program was one of the first federal funding programs to require an economic analysis (specifically, a cost-benefit analysis) as part of its application process, demonstrating its emphasis on showing positive, long-term societal benefits. A project must also clearly fit within a long-term strategic vision for the community or region.

TIGER applications must demonstrate strong political and community support. In general, TIGER applications are more likely to be approved if they can demonstrate strong support from local communities and from local, state and federal politicians. For example, the Atlanta Streetcar’s TIGER application included over 30 letters of support from the Atlanta business community, as well as metro area economic development, environmental and transportation organizations, and congressmen and senators.¹ Similarly, Rochester County’s Inner Loop East project included letters of support from US senators, New York senators, County legislators, real estate developers, regional associations and other stakeholders such as businesses and neighborhoods.²

TIGER grants are intended for multi-modal projects that are difficult to fund via other mechanisms. The TIGER program aims to fund projects that are difficult to fund via traditional formula funding, as well as those that incorporate different modes of transit (or include more than one mode of transit) and will improve connectivity between transit systems. Applications benefit from being able to show higher matches as well as leverage other federal funds from partner agencies such as the US Environmental Protection Agency (EPA) or the US Department of Housing and Urban Development (HUD).

TIGER funds granted in FY 2014 differed from funds granted in previous fiscal years by their longer obligation period, and a reduced emphasis on “project readiness.” Because previous rounds of TIGER funds had a very short obligation period, a key consideration in the approval of projects was “project readiness”—a project needed to be far along in the National Environmental Policy Act (NEPA) schedule, have a substantial local match, and have high status in terms of design and engineering. By extending the obligation period to almost two years (through 30 September 2016 in the FY 2014 round), TIGER funds are now able to accommodate more complex and innovative projects with longer schedules.

TIGER funds granted in FY 2014 prioritized projects that aligned with President Obama’s “Ladders of Opportunity” program. The focus of the TIGER program in FY 2014 was to improve access to “reliable,

¹ Website of the Atlanta Streetcar, Accessible at: <http://www.theatlantastreetcar.com/>

² Website of the Inner Loop East Project, Rochester County, New York, Accessible at: <http://www.cityofrochester.gov/innerloopsupport/>

safe and affordable transportation” for “disconnected communities in urban, suburban, and rural areas.” The Department of Transportation (DOT) therefore prioritized applications for projects that would connect communities to employment and training centers, remove barriers to transit access, and strengthen communities through neighborhood development.³

TIGER grants remain highly competitive and eligible project applications far exceed available funding. Over the first five rounds of TIGER funds, only about 5 percent of applications were awarded. In FY 2014, applications for TIGER grants totaled \$9.5 billion, 15 times more than the \$600 million in available funding. The U.S. Department of Transportation (US DOT) received 797 eligible applications, compared to 585 in 2013. Michigan’s M-1 Fixed Rail Streetcar Project and Rhode Island’s Providence Streetcar are two examples of streetcar projects that received TIGER grants in FY 2014.

1.2. The FTA Small Starts Program

The Federal Transit Administration’s (FTA) discretionary “New Starts” program provides grants for locally planned, implemented and operated transit systems, including (but not limited to) commuter rail, light rail, and rapid rail. Funding allocated to the program was \$1.855 billion in FY2013 and \$1.943 billion in FY2014. Subsets of the New Starts program are the “Small Starts” and “Very Small Starts” programs.

In order to be eligible for Small Starts grants, projects must meet the following general criteria:

- The total project cost must be less than \$250 million, of which no more than \$75 million may be obtained from federal sources including Small Starts grants;
- The project must be either a new fixed guideway project, or an extension to an existing fixed guideway, and must contain significant transit improvements.

FTA created the Very Small Starts program in order to streamline requirements for projects that were simple and low-risk. In order to be eligible for Very Small Starts grants, projects must meet the same requirements as for Small Starts, as well as three additional ones:

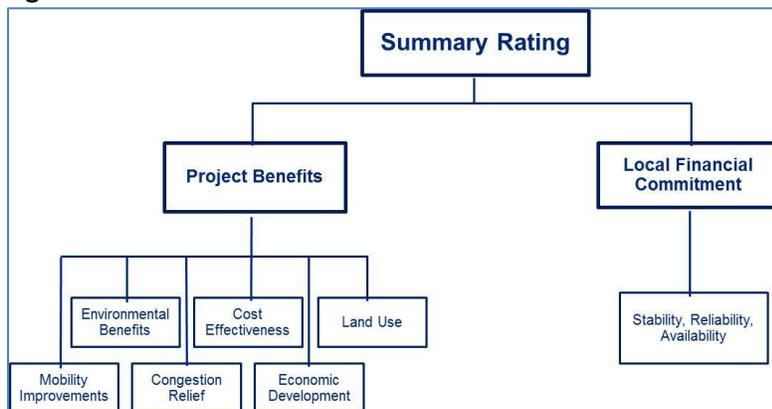
- Existing corridor ridership must exceed 3,000 existing riders per average weekday;
- The total project cost must be less than \$50 million; and
- The per-mile cost of the project must be less than \$3 million, excluding rolling stock (e.g., train cars).

Small Starts and Very Small Starts funding applications are evaluated based on two categories of criteria: (1) the justification for the project; and (2) the level of local financial commitment. The FTA gives equal weight to the two categories of criteria and similarly equal weight to the various criteria within these categories. In its evaluation of the justification for the project, the FTA examines six factors: mobility improvements; economic development effects; environmental benefits; cost effectiveness; land use; and congestion relief. Figure 1-1 summarizes the evaluation process used by FTA for Small Starts projects. The individual categories are described in more detail below.

³ “Note of Funding Availability for the Department of Transportation’s National Infrastructure Investments under the Consolidated Appropriations Act, 2014,” Department of Transportation (DOT). Accessible at: http://www.dot.gov/sites/dot.gov/files/docs/TIGER%202014%20NOFA_FINAL.pdf

In its evaluation of the level of local financial commitment, the FTA quantitatively assesses the ability of the local agency to build, maintain, and operate the new transit system without causing deterioration in other services. It also examines the agency’s financial plan and cash flow statements. Three specific criteria are used: (1) availability of reasonable contingency amounts; (2) availability of stable and dependable capital and operating funding sources; and (3) availability of local resources to recapitalize, maintain, and operate the overall existing and proposed public transportation system without requiring a reduction in existing services.

Figure 1-1: Small Starts Evaluation Process



Source: Federal Transit Administration

- **Land Use Criteria:** This measure includes a qualitative and quantitative analysis of corridor and station areas. It uses current criteria (including transit-supportive land use policies) in addition to measuring existing “legally binding affordability restricted” housing in the corridor.
- **Mobility Improvements:** This measure includes a quantitative analysis of the total number of linked trips that will use the proposed transit. Extra weight is given to trips made by transit dependent persons—each trip by a transit dependent person is equivalent to two trips by a non-transit dependent person.
- **Economic Development Effects:** This measure includes a qualitative analysis of existing local plans and policies to support economic development near the transit project. An optional methodology is to use a scenario-based estimate that considers the impact of the project on development/redevelopment, changes in population, and availability of land for development/redevelopment. This category also examines the estimated change in vehicles miles travelled (VMT) and then monetizes the environmental benefits that result.
- **Environmental Benefits:** This measure includes a process to monetize the direct and indirect benefits to human health, safety, energy, and air quality compared to the current system; those benefits are as compared to the annualized Federal share of project. This category also measures reductions in auto emissions, changes in air quality, changes in energy use, changes in greenhouse gases, and reductions in injuries and fatalities.
- **Cost Effectiveness:** This measure formerly evaluated the cost per user benefit (travel time savings) of a build alternative compared with a baseline (or “best bus”) alternative. The new regulations merely calculate the annualized federal share of the project per trip, a much simpler (and probably more meaningful) criterion. Project sponsors are encouraged to use the current year as the base year, which compares the project’s cost effectiveness to the current system. If the project sponsor uses a horizon year as the evaluation year, the proposed project is

compared against investments funded in a ten-year regional Transportation Improvement Program or a fiscally constrained twenty-year Long-Range Transportation Plan.

- **Congestion Relief:** The FTA has yet to determine a measurement system for rating this criterion.

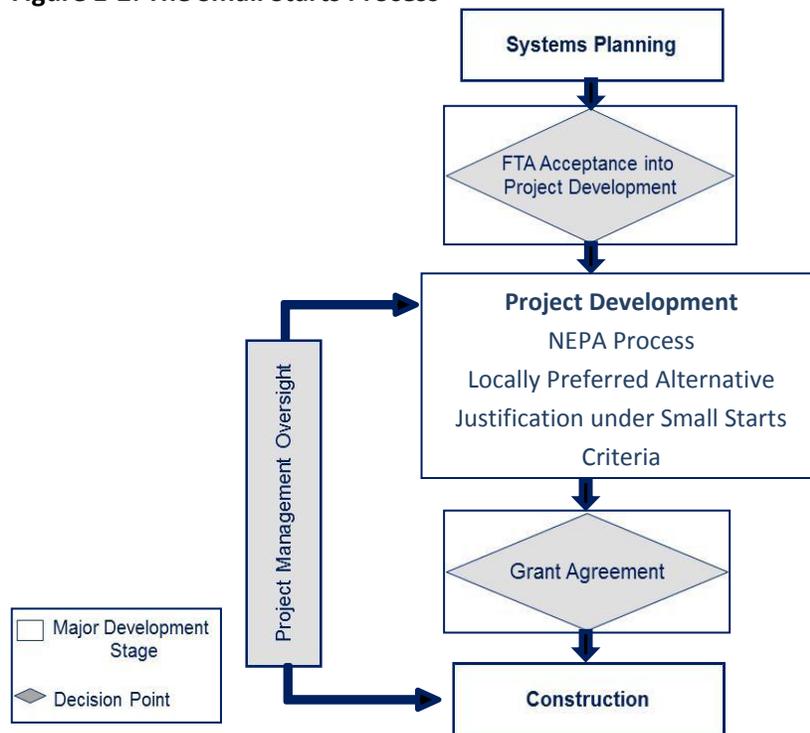
Since the 2012 MAP-21 reforms, the three main steps of the Small Starts process are: (1) project development, (2) engineering, and (3) the full funding grant agreement. Once the FTA has approved a project for the “project development” phase, the local project sponsor has a two-year period within which to: conclude the review required under NEPA; select a locally preferred alternative (LPA); adopt the LPA into the regional long range transportation plan; and develop sufficient information for FTA to evaluate and rate the project. Upon completion of the “project development” phase, if the project meets the criteria for advancement, the project will then enter the “engineering” phase. Upon completion of “engineering” phase, the project will be eligible for a construction funding commitment.

Although few streetcar projects have received Small Starts funding in recent years, the 2012 MAP-21 reforms have made it more likely that streetcar projects may receive Small Starts funding. Examples of streetcar projects that have either received Small Starts funding or are in the project development phase include:

- **The River Rail, Little Rock, Arkansas** – The River Rail is a 3.4 mile fixed guideway streetcar system operated by the Central Arkansas Transit Authority (CATA). Phase I (2.5 miles of track) opened in 2004 and Phase II (an additional 0.9 miles) opened in 2007. The \$30 million project was 80% funded through a Small Starts grant of \$24 million, with the remaining 20 percent obtained from the state.
- **Tempe Streetcar, Tempe, Arizona:** In the project development phase as of April 2013, the project proposal includes a \$56 million Small Starts grant out of a total project cost of \$130 million (43% of project cost).
- **Wave Streetcar Fort Lauderdale, Florida:** In the project development phase since April 2013, Florida applied for a \$50 million Small Starts grant out of a total project cost of \$143 million (35% of total project cost). The 2.7-mile streetcar is expected to serve as a local circulator in Downtown Fort Lauderdale.

Figure 1-2 illustrates the stages in the development of a Small Starts project under the new MAP-21 regulations.

Figure 1-2: The Small Starts Process



[Source: Federal Transit Administration]

1.3. Transportation Infrastructure Finance and Innovation Act (TIFIA)

The TIFIA loan program provides credit assistance to eligible surface transportation projects, including highways and transit. It should be seen as distinct from the TIGER and Small Starts federal funding programs, as the latter are funding mechanisms (which can assist with upfront investments costs), whereas the TIFIA program is a financing tool. The TIFIA program, which was expanded to \$1 billion in fiscal year 2014, provides three types of financing:

- *Secured (Direct) Loans*: direct federal loans to project sponsors which offer flexible repayment terms and provide combined construction and permanent financing of the capital costs (up to 49% of project costs)
- *Loan Guarantees*: credit guarantees by the government to institutional investors that provide loans for the project (up to 49% of project costs)
- *Standby Lines of Credit*: contingent sources of funding in form of federal loans that may be used to supplement the revenues of the project during the first ten years of construction (up to 33% of project costs)

TIFIA loans tend to be used for larger projects such as roads and major transit projects; although TIFIA loans have been used for light rail in the past, they have yet to be used for a streetcar project. This is in large part because expected project costs must equal or exceed \$50 million⁴ and must have dedicated

⁴ The exceptions to the \$50 million project cost requirement include rural projects (may be \$25 million or less), intelligent transportation system (ITS) projects or projects for which the costs exceed one-third of the recently-completed fiscal year's formula apportionments for the state in which the project is located.

revenues associated with them to be eligible. This tends to be easier in a toll road than in a streetcar project, the latter of which may rely on sales taxes or other funding mechanisms rather than direct revenues.

TIFIA loans must be repaid through dedicated funding sources that secure the obligation, such as tolls, user fees or tax increment financing. The maximum maturity of all TIFIA financing is the lesser of 35 years after a project's substantial completion or the useful life of the project being financed by TIFIA. The best local examples of TIFIA use are on the US 36 Managed Lane/Bus Rapid Transit project, which received two TIFIA loans of \$54 and \$60 million, RTD's Eagle P3 rail project, which received a \$280 million TIFIA loan, and Denver Union Station, which received a \$146 million TIFIA loan. In the case of the RTD's Eagle P3 rail project, the TIFIA loan was secured by a (senior) gross revenue pledge of RTD's 0.4 percent sales tax revenues and a (subordinate) pledge of RTD's 0.6 percent sales tax revenues. Only the 0.4 percent sales tax could be used for construction and operation of the transit system.

2. Alternative Funding and Financing Options

The purpose of Section II is to present an overview of funding and financing options that could be used for the CRE project. The first section will include a review of *funding* sources that could cover the upfront investment costs of the CRE project. The second section will examine *financing* tools—both traditional and innovative—that could be used to leverage transportation funding and revenue sources. Using financing mechanisms such as bonds, credit, and/or loan programs would allow the RTD to raise the required capital costs upfront, and thus expedite the implementation of the project.

Traditionally, transit agencies have relied on both system- based revenues and grants to fund transit projects. System-based revenue sources have included both farebox revenues and non-farebox revenues—such as advertising, air rights, station or system naming rights—as well as station revenues such as parking and concessions. These sources have been traditionally been complemented with grants from state, local, and federal governments. The financing for these revenue streams has typically been derived from revenue bonds, often backed by the local government sponsor.

However, as a result of increasing limitations of federal funding sources, transit agencies are increasingly relying on innovative funding mechanisms. These may include joint development districts, assessment districts, or tax increment financing (TIF) mechanisms. These innovative sources of funds can be leveraged through financing mechanisms such as traditional debt issuance; innovative loans and credit programs (TIFIA, SIB loans, EB-5); or possible equity contributions through a Public-Private Partnership (P3) delivery model.

Table 2-1 summarizes the traditional and innovative revenues, funding sources, and financing mechanisms typically available.

Table 1-1: Potential Funding Sources and Financing Mechanisms

	Funding Mechanisms		Financing Mechanisms
	Direct System Revenues	Other Funding Sources	
TRADITIONAL	1) Farebox 2) Non-Farebox: <ul style="list-style-type: none"> • Traditional advertising • Parking 	1) State/Local: <ul style="list-style-type: none"> • Appropriations • Sales taxes • Other local taxes 2) Federal grants	1) Tax-exempt and taxable debt
INNOVATIVE	1) Station-Related: <ul style="list-style-type: none"> • Concessions • Parking innovations • Innovative Advertising • Air rights • Station or system naming rights 2) ROW sharing with other transportation users 3) Contractual fare payments	1) Real estate-related: <ul style="list-style-type: none"> • TOD/Joint Development • Benefit assessment districts • Tax increment finance • Asset monetization 2) Parking increment	1) Innovative finance: <ul style="list-style-type: none"> • SIB loans • Tax credit loans • TIFIA • EB-5 2) Via a P3 delivery mechanism: <ul style="list-style-type: none"> • Private activity bonds • Private equity • Availability payments

Source: IMG Rebel Group

2.1. Funding Mechanisms

As federal funding for transit projects has become increasingly competitive and difficult to obtain, transit agencies have increasingly relied on other sources to help raise the upfront investments costs in transit projects. This section will examine some of these options in greater detail.

2.1.1. Direct System Revenues

Farebox Revenues: Typically, farebox revenues do not cover the long-term operations and maintenance of a transit system. A streetcar or light rail system is no exception. Transit operators can traditionally anticipate a roughly 30 percent farebox recovery ratio⁵ for light rail and streetcar operations, but it may be even lower. In the case of the Kansas City Downtown Streetcar in Kansas, Missouri, which entered the construction phase in May 2014 and is expected to start operations in late 2015, passengers will ride free of cost.

Non-farebox Revenues: Non-farebox revenues include system revenues not generated by ticket sales, including:

- *Advertising:* Transit agencies typically enter into contracts to provide advertising space on shelters, stations, and transit vehicles, which can amount to up to three percent of operating revenue. Innovative advertising concepts may include such as fare collection media, floor space, and wrapping transit vehicles. Typically, this funding source can provide some additional revenue but it is subject to market conditions and may not yield significant increases in revenue.

⁵ The farebox recovery ratio (also known as the “fare recovery ratio”) of a passenger transit system is the fraction of operating expenses covered by the fares paid by passengers. It is calculated by dividing the system's total fare revenue by its total operating expenses.

- *Air rights:* Many agencies have been successful in selling the right to build above transit stations to private developers. Air rights may have some limited applications in the Central Rail Extension (CRE) project, perhaps above a maintenance facility.
- *Naming rights:* A familiar concept for sports venues, naming rights involve an upfront and/or ongoing payment from a private entity to a transit agency or operator in return for naming a station or other assets for the private firm. For example, Cleveland's Health Line was so named because of a naming rights purchase by two competing local hospitals for \$6.25 million over a 25 year period. In the case of the TECO Line Streetcar System in Tampa, Florida, naming rights were sold for \$1 million to Tampa Electric Company (TECO) over a 10 year period. The value of the asset to be named could be assessed for potential advertising value (such as the number of times the line is mentioned on the radio, on TV, on the sides of trains themselves, etc). The project could explore selling naming rights for stations at schools, shopping centers, specific local businesses or venues, or for entire segments of the system.
- *Station revenues (including concessions/commercialization):* Providing space for food and retail vendors at transit stations is 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.

2.1.2. Non-System Based Revenues

Traditional Funding Sources: Funding sources differ from system revenues in that they provide revenue targeted to a single station or project, most often to support capital projects (although some grants may be used to fund operating expenses).

State or local funding sources could include:

- *Local government* appropriations or allocations of funding specifically for a project, though those are usually subject to an annual approval process and do not necessarily provide long-term funding stability.
- *Sales taxes* are very common funding sources for transit. Because the RTD already assesses a regional sales tax of 1% in the areas within which the RTD applies, it is unlikely that a sales tax specifically for the CRE project could be established. However, if RTD goes to the voters to expand its sales tax percentage, a portion of that new tax could be allocated to the CRE project.
- *Lodging or rental car taxes* could be expanded above their current levels in Denver or with appropriate legislative approval, those taxes could be expanded to provide a specific allocation for the CRE project.

Federal funding opportunities discussed in Section I included the Small Starts (or Very Small Starts) program of the Federal Transit Administration (FTA) and the Transportation Investments Generating Economic Recovery (TIGER) program. Other potential federal funding opportunities include:

- *The Congestion Mitigation and Air Quality (CMAQ) Improvement Program:* A program jointly administered by the Federal Highway Administration (FHWA) and the Federal Transit

Administration (FTA), its grants fund state transportation programs that meet the National Ambient Air Quality Standards (NAAQS). The 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. The Providence Streetcar in Rhode Island, for example, funded 5 percent of its project costs through the CMAQ program.⁶ The Kansas City Streetcar also obtained \$1.1 million through the CMAQ program.⁷

- *Surface Transportation Program:* Of all of the FTA's grants, the Surface Transportation Program (STP) provides the greatest flexibility in the use of funds. Funds from the STP may be used 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. For example, the Kansas City Streetcar obtained \$16 million in funding to purchase new vehicles through the STP program.⁸
- *Livable Community Grants:* The FTA started the Livable Community Initiative (LCI) to improve mobility and quality of services available to residents of neighborhoods by, among others, strengthening transit links. 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.

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:* Transit-Oriented Development (TOD) is a well-known planning concept whereby zoning, tax, and development regulations are set up to encourage compact, high-density development near transit stations. Typical TODs consist of a mix of use including residential, commercial, and retail, are pedestrian- and cycle-friendly, may offer public and civic spaces near stations, and the stations may serve as community hubs. For example, the Five Points area has already explored TOD opportunities, and those efforts should continue and expand to provide the largest potential development opportunities possible. Joint Development occurs when private (or public) entities other than the transit operator provide land, assets, or funding to support TODs near a station. For example, a real estate developer may provide parking in return for development rights near a station or alignment. Transit agencies can take direct equity stakes in projects through direct cash investments or as is more usual, investing land in the project. Care must be taken to determine whether the transit agencies investment is paid back based on "gross" or "net" revenues of the project, since the risk and return levels in either scheme can differ widely.

⁶ Website of the City of Providence, Rhode Island, "Providence Streetcar," Accessible at: <http://www.providenceri.com/efile/5439>

⁷ "MARC approves \$17.7 million for Downtown streetcar," Downtown Council of Kansas City, 25 October 2012, Accessible at: <http://www.downtownkc.org/2012/10/25/marc-approves-17-7-million-for-downtown-streetcar/>

⁸ "MARC approves \$17.7 million for Downtown streetcar," Downtown Council of Kansas City, 25 October 2012, Accessible at: <http://www.downtownkc.org/2012/10/25/marc-approves-17-7-million-for-downtown-streetcar/>

- *Assessment Districts:* Assessment districts are special tax assessment areas that may be created to support the construction, maintenance and operation of a new transit project. A typical assessment district creates a zone around a station or alignment, often up to a half a mile, with all businesses within the zone paying a tax based on real estate valuation (either ad valorem or per square footage). 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 rail corridor. Because businesses must pay higher taxes in a BAD, 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. They usually require approval by at minimum a majority of the property owners. In the case of the New York Avenue Washington Metropolitan Area Transit Authority (WMATA) Metro station in Washington, DC, a not-for-profit entity worked with property owners to advocate for the implementation of the assessment district. Strong local property owner support helped to facilitate project delivery. Los Angeles, Kansas City, Tampa, Portland and Seattle have also used assessment districts successfully; in the latter two cases, the assessment districts paid for 17 and 50 percent respectively of the capital costs of the streetcar project.

The City of Denver already has experience with various different types of assessment districts, including Local Maintenance Districts (LMDs); Local Improvement Districts (LIDs); Business Improvement Districts (BIDs); General Improvement Districts (GIDs); and Metropolitan districts.⁹ Section IV will present more detail on the possible establishment of assessment districts to support the CRE project.

- *Tax increment financing (TIF):* Similar to an assessment district, a TIF district is a special assessment area. However, unlike an assessment district, property owners in the TIF pay no surcharge on their property taxes. Rather, the TIF district retains any increases in real estate (or income) taxes as property values rise as a result of the new transit service. Because they do not involve additional taxes, TIFs are more politically acceptable than assessment districts. However, they are not without controversy since they will eventually result in subsidizing development by creating tax-privileged districts. A TIF district may be appropriate in an economically disadvantaged neighborhood that will enjoy growth due to transit. In Denver, TIF districts are established and managed by the Denver Urban Renewal Authority (DURA) or the Downtown Development Authority (DDA).
- *Parking increment revenue:* An increase in parking rates in the area could create additional revenue. Denver could then choose to dedicate those revenues from the parking increment, which could be used to directly fund a transportation project or used to back revenue bonds.

⁹ Examples include the 5-Points Area Local Maintenance Districts (LMDs); the 14th Street General Improvement District (GID); and the East and West Colfax Business Improvement Districts (BIDs). Examples of public improvement districts include the Skyline Park Improvement District; South Broadway Streetscape Improvements; and Delgany Street Improvements.

2.2. Financing Mechanisms

A number of financial tools, both traditional and innovative, can be used to leverage transportation revenue sources, allowing transportation agencies to raise the upfront costs required for the construction phases of a project. Financing mechanisms are used to access either debt or equity capital.

Traditional Financing Mechanisms: Traditionally, public infrastructure projects have used tax-exempt debt to fund capital costs. The benefits of tax-exempt debt include low interest rates, long maturities, and the ability to sculpt principal repayment to match the cash flows of the project. Tax-exempt debt however, restricts potential private investors.

Taxable debt could also be a source of financing for a project, and would provide Denver with flexibility in utilizing a P3 approach. Typically, taxable debt has higher interest rates and a shorter maturity date. The size of a project may limit the taxable financing mechanisms that Denver can utilize. Typically, the minimum issuance size threshold is \$100 million in order to generate sufficient lender/bondholder interest.

Innovative Financing Mechanisms: There are several innovative financing mechanisms that could be considered for a streetcar or light rail system:

- *The Colorado State Infrastructure Bank (SIB)* is a Colorado DOT program that provides funding to transportation projects in the state. SIB loans are subordinate to senior debt, so long as senior debt has a BBB credit rating or better. 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 a number of 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.
- *Tax Credit Bonds (TCBs)* are a type of bond that offers the holder a federal tax credit instead of interest. This provides a major benefit to bond issuers, as they are responsible only for principal repayments, rather than full principal and interest payments under typical municipal bonds
- *The Transportation Infrastructure Finance and Innovation Act (TIFIA)* is a federal loan program sponsored by the U.S. Department of Transportation. TIFIA loans must be repaid through dedicated funding sources that secure the obligation, such as tolls, user fees, or tax increment financing in terms of up to 35-years. The best local examples of TIFIA use are on the US 36 Bus Rapid Transit project, which received two TIFIA loans of \$54 million and \$60 million, RTD's Eagle P3 rail project, which received a \$280 million TIFIA loan, and Denver Union Station, which received a \$146 million TIFIA loan. TIFIA loans have generally been used for roadway projects and for major transit projects; they have not yet been used for a streetcar project. TIFIA loans are seen as financing tools with attractive rates and terms, as they are flexible and low cost—they can finance a major portion of a project at US Treasury rates.
- *EB-5 Funds:* In the aftermath of the 2008 financial crisis, an increasing number of companies and developers are turning towards EB-5 funds to raise capital for projects. The EB-5 Regional Center investor visa program is designed to use immigrant investor capital to promote economic growth in a particular geographic area. The minimum amount required to invest is \$1 million,

although if the investment can be reduced to \$500,000 if it is made in a rural or high unemployment (+150%) area. The capital is then pooled into a new commercial enterprise that creates employment for 10 U.S. workers for each \$1 million invested. EB-5 funds can be seen as an attractive source of financing for two reasons: (1) it has inexpensive borrowing costs (3 to 5 percent); and (2) there is no pressure to produce high rates of return, as EB-5 investors are more concerned with obtaining green cards than the returns on their investments.

- A *Public-Private Partnership* (P3s) delivery model could also bring with it several other tools to reduce the cost of borrowing or speed project delivery, including availability payments or private equity contributions.

With an availability payment mechanism, a concessionaire receives periodic payments based solely on the condition and/or performance of the facility. Availability payments allow public sponsors to share risk with private contractors. A typical availability payment deal would involve a private firm (or consortium of firms) being responsible for the construction of the asset, including planning, design, and engineering, as well as operations, maintenance, and enforcement. In return, the consortium is paid fixed, pre-agreed availability payments on certain milestone dates. The availability payment is conditional upon the asset being operational, safe, and meeting all standards set by 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. Availability payments are attractive to private developers, since they are not asked to take on risks that are difficult to manage, such as the level of ridership.

Table 1-2 provides a summary of where the innovative funding and financing tools described above have been used by other cities and systems, as well as the advantages and disadvantages of each tool.

Table 1-2: Summary of Innovative Funding and Financing Tools

Source: IMG Rebel Group

Funding/Financing Tool	Example	Advantages	Disadvantages
Non-Farebox Revenue			
Advertising	Washington Metropolitan Area Transit Authority (WMATA)	Easy to implement	Limited revenues
Air rights	WMATA	Provides TOD benefits in addition to revenue source	Works best for underground/at-grade stations in high-density areas
Naming rights	Cleveland, Little Rock	No cost to implement	Private sector may not be interested; public resistance
Concessions/commercialization	Chicago Transit Authority (CTA)	Easy to implement; could provide a good opportunity for vendors and other retail outlets	Could clutter station area and compete with other local retail
Innovative Funding Sources			
TOD/Joint Development	Metropolitan Atlanta Rapid Transit Authority (MARTA)	Increases ridership by focusing density around stations or alignment	Lengthy development period (10-20 years)
Assessment Districts	Portland Streetcar, WMATA	Major, ongoing revenue source that can be leveraged	Difficult to implement as a result of land owner approvals and other legal obstacles
Tax increment financing	Portland Streetcar, Bay Area Rapid Transit (BART), Charlotte, Denver Union Station	No cost to implement, ongoing revenue source	Uncertainty of pace of development; requires blight designation in Colorado
Parking increments	Portland, San Francisco	No cost to implement	Can reduce activity in area and reduce ridership
Lodging and rental car tax	Numerous	Upfront revenue, taxing non-residents	Can impact tourism and local activity and ridership
Financing Mechanisms			
SIB Loans	Lee County, Southwest Florida	Highly subsidized loan without federal strings attached	Competitive; funding may not be available
Availability payments	London Underground, Miami Port Tunnel	Transfers risk to private sector; spreads out payments	Must allow for developer profit; still needs funding source
TIFIA loans	Denver Union Station, US 36	Subsidized long-term loan that works well with both public and private projects	Extremely competitive
EB-5	EB-5 funding has been used for numerous hotel investments, and was attempted in Seattle's Highway 520 Project.	Inexpensive borrowing costs (3 to 5 percent); no pressure to produce high rates of return for EB-5 investors	Complex process that includes various actors and procedures, discouraging investment

3. Case Studies

Several streetcar or rail systems across the US have used private funding sources to complement public funding sources. These may include value capture (such as local development or assessment districts and tax increment financing programs), the federal TIFIA loan program (as described above), and other financing means. The following section describes the following cases:

- Downtown Los Angeles Streetcar, Los Angeles, California;
- Kansas City Streetcar, Kansas City;
- Portland Streetcar, Oregon;
- Transbay Transit Centre, San Francisco, California;
- Silver Line Metro, Fairfax County, Virginia.

3.1. Downtown Los Angeles Streetcar

Since 2011, the City of Los Angeles and the LA Metro have been working on a streetcar system for downtown Los Angeles. In 2012, an Alternatives Analysis (AA) process was completed and approved, and a Locally Preferred Alternative (LPA) was designated. The LPA consists of a 3.8 mile loop that serves many Downtown districts and destinations/ attractions. The project, which has since experienced various funding challenges, is now expected to be operational in 2019. According to media reports, cost estimates escalated from \$125 million to \$327 million and were subsequently brought down to \$270 million in September 2014.

The project is expected to be funded through Community Facilities Districts (CFD), local tax assessments, as well an FTA “Small Starts” grant. One of the primary funding sources of funding is the establishment of a Community Facilities District (CFD), the boundaries for which are shown in Figure 7-3. In late 2012, local landowners voted in favor of establishing the CFD and implementing tax assessments. The CFD is expected to fund a \$62.5 million 30-year municipal bond, which was to pay for up to half of the project’s construction costs. The remainder of the project’s funding is anticipated to come from an FTA “Small Starts” grant. Ongoing operations are to be covered by fares and local City appropriations.

Figure 3-1: Los Angeles Streetcar Community Facilities District Boundaries



Source: Los Angeles Streetcar Inc.

The CFD seeks to equitably charge landowners based on property value benefit and distance from the proposed streetcar alignment. Property owners directly on the line are assessed 60 cents per square foot; those one to two blocks away are assessed 42 cents; and those three or more blocks away are assessed 21 cents per square foot. For example, a 10,000-square-foot parcel will be taxed \$4,490 if it is directly on the line; \$3,640 if it is one to two blocks from line; and \$1,730 if located three blocks away. Condominium units will be charged their unit’s proportional share of underlying land or \$100 or less per year with the median rate for a 1,000 square foot property of \$60 per year. The CFD will be in place for up to 40 years.

3.2. Kansas City Streetcar

Construction for the Kansas City Streetcar system began in the spring of 2014, with completion expected in Fall 2015. The total project cost for the 2.2 route-mile (or 4.4 track-mile) system is estimated at approximately \$100 million (\$23 million/track mile). The City of Kansas City is now planning an extension of the streetcar (Streetcar Phase II or NextRail KC).

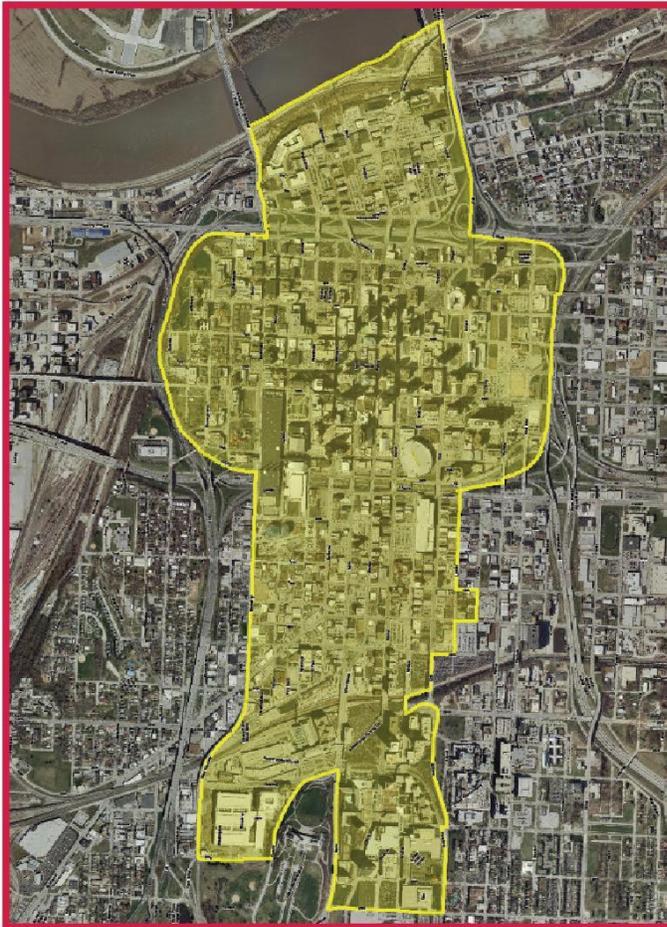
Streetcar Phase I is being funded by a combination of a voter-approved sales tax, parking assessments and a \$20 million federal TIGER grant; passengers will not pay any fare. The sales tax will be collected within a transport development district that was approved by property owners in the Kansas City downtown district in 2012.

Figure 3-2: Kansas City Streetcar



The downtown Transportation Development District (TDD) is shown in Figure 3-2 and covers much of the downtown area, with the river and major highways serving as key boundaries.

Figure 3-3: Kansas City Downtown Phase I Transportation Development District (TDD) Boundaries



Source: Kansas City Transportation Development District

For Phase I of the streetcar, the following revenue sources and maximum rates were approved for the TDD:

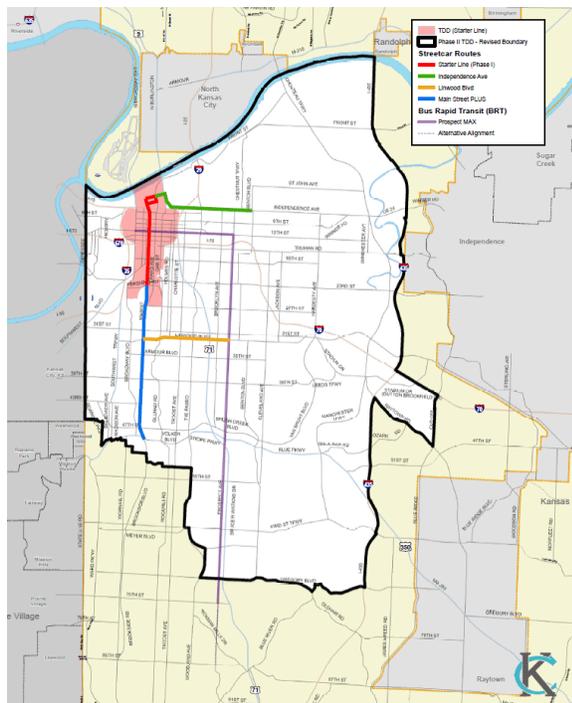
- A sales tax not to exceed 1 percent on sales within the Phase I TDD boundary
- A special assessment on real estate within the Phase I TDD boundary, with maximum annual rates as follows:
 - 48¢ for each \$100 of assessed value for commercial property (\$1,536 for each \$1 million of market value)
 - 70¢ for each \$100 of assessed value for residential property (\$266 for each \$200,000 of market value)
 - \$1.04 for each \$100 of assessed value for property owned by the City (which would mean a total annual City payment of about \$810,000)
 - 40¢ for each \$100 of assessed value for real property exempt from property tax, such as religious, educational, charitable, etc. property, but only on market value more than \$300,000 and less than \$50 Million.

- A supplemental special assessment on surface-pay parking lots within the Phase 1 TDD boundary (not on garages and not on free parking lots). The maximum rate for the supplemental special assessment on surface pay parking lots will be \$54.75 per space per year.

Streetcar Phase II (NextRail KC) was expected to use a funding formula similar to the one used to construct the downtown streetcar line. An expanded TDD (shown in Figure 3-3 below), which was expected to seek voter approval in November 2014, was supposed to replace the “Phase I TDD.” The “Expansion TDD” was expected to pay for annual operating costs and approximately 40-50 percent of construction costs. Federal and state funds and other non-TDD sources, including potential public-private partnerships, would fund the remainder of the costs.

In August 2014, however, voters rejected the proposal to create an expanded TDD in an unofficial poll. An anti-streetcar campaign, called SmartKC, has argued against the streetcar plan, since it would impose a burden on low-income residents. As a result, Kansas City will no longer seek official voter approval in November 2014, casting doubt on whether it will be able to go ahead with Phase II of the streetcar project.

Figure 3-4: Kansas City Downtown Phase II Transportation Development District (TDD) Boundaries



Source: Website of the City of Kansas City

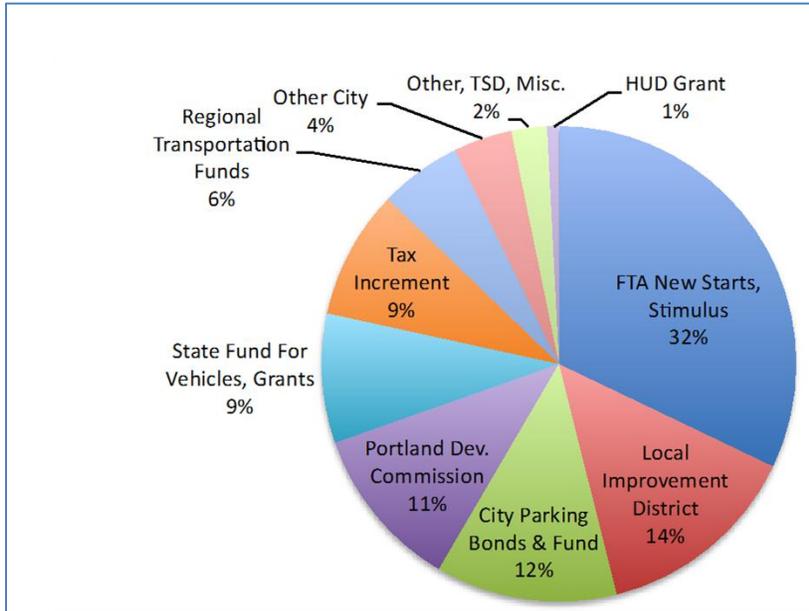
3.3. Portland Streetcar

Portland developed the first modern streetcar system in the US. Its first segment opened in 2001 and five additional extensions have been built since then. Figure 8-5 illustrates the various funding sources that comprise the \$251 million capital cost for the Portland streetcar system thus far.

Figure 3-5: Portland Streetcar



Figure 3-6: Sources of Funding for Portland Streetcar Capital Cost (\$251 Million Total)

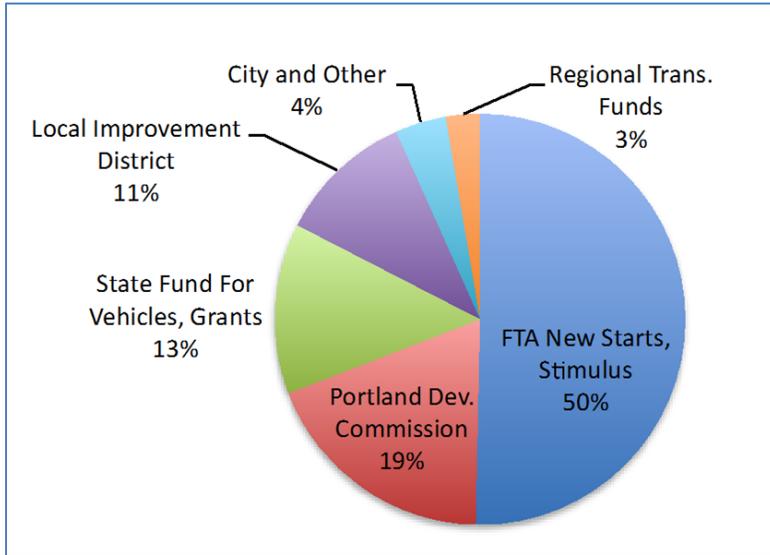


Source: IMG Rebel Group, Portland Streetcar Inc.

The figure shows that the system’s funding came from a variety of sources; grants, parking monies, and value capture are the core to Portland’s funding success. Local improvement district (LID) assessments, parking revenues, and tax increment (TIF) proceeds are major non-grant sources. The value capture sources (LID and TIF) comprise more than 20% of the sources for the system.

The system’s final segment across the Willamette River (known as the Central Loop Line), completed in 2012, effectively doubled the length of the system. This segment benefited from a FTA New Starts grant and LID funding in this segment comprised the lowest percentage of total cost of all of the segments. Figure 3-5 shows the sources of funding for that \$148 million segment.

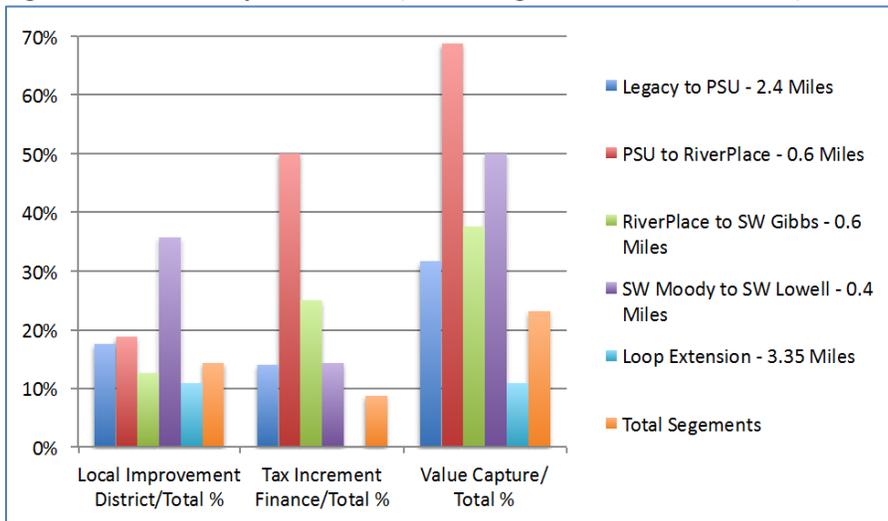
Figure 3-7: Sources of Funding for Portland Streetcar Central Loop Line (\$148 Million Total)



Source: IMG Rebel Group, Portland Streetcar Inc.

However, for earlier segments, however, value capture played an important funding role. Most segments had value capture sources of 30% or more, and LID and TIF portions varied by project. Figure 8-7 illustrates the splits between LID and TIF financing for the four Portland Streetcar segments.

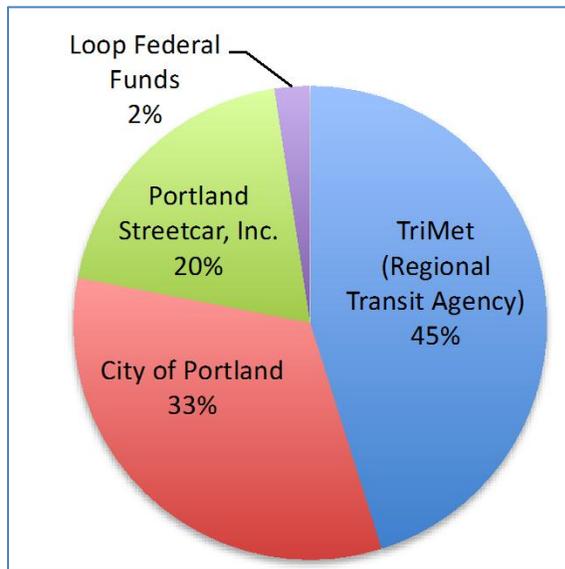
Figure 3-8: Value Capture Totals (Percentage of Construction Cost) for Portland Streetcar Segments



Source: IMG Rebel Group, Portland Streetcar Inc.

On the operations funding side, the operations budget is funded by a variety of regional, city, project-specific, and federal funds. However, with a reliable source of their own funding, the regional transit agency (Tri-Met) and the City of Portland are the primary sources of operating funds. Figure 8-8 shows the sources of funds for annual streetcar operations in Portland.

Figure 3-9: Sources of Funds for Annual Portland Streetcar Operations



Source: IMG Rebel Group, Portland Streetcar Inc.

3.4. Transbay Transit Center – San Francisco

The Transbay Transit Center is a \$4.5 billion transit station and neighborhood development project in downtown San Francisco that will serve the San Francisco Bay Area’s regional transportation system. It is governed by the Transbay Joint Powers Authority (TJPA) and is currently under construction, expected to be completed by late 2017.

The Transbay Transit Center is an example of the use of value capture as a funding mechanism. The project is using Tax Increment Financing (TIF) mechanism to raise \$1.4 billion in property taxes over 45 years, of which \$171 million will be used to repay a federal TIFIA loan used for construction. It is also expected to raise additional funds through special assessments (called a Mello Roos in California) and development impact fees.

3.5. Silver Line (Dulles Metrorail), Fairfax County, Virginia

Washington DC’s new Silver Line is a new 23-mile Metrorail extension connecting the Tysons, Reston, Herndon, and Dulles Airport areas of Fairfax County to the regional Metrorail system. The \$6.8 billion project is to be completed in two phases; the first 11.6 miles of service opened on July 26, 2014, and Phase 2 is scheduled to be completed by 2019.

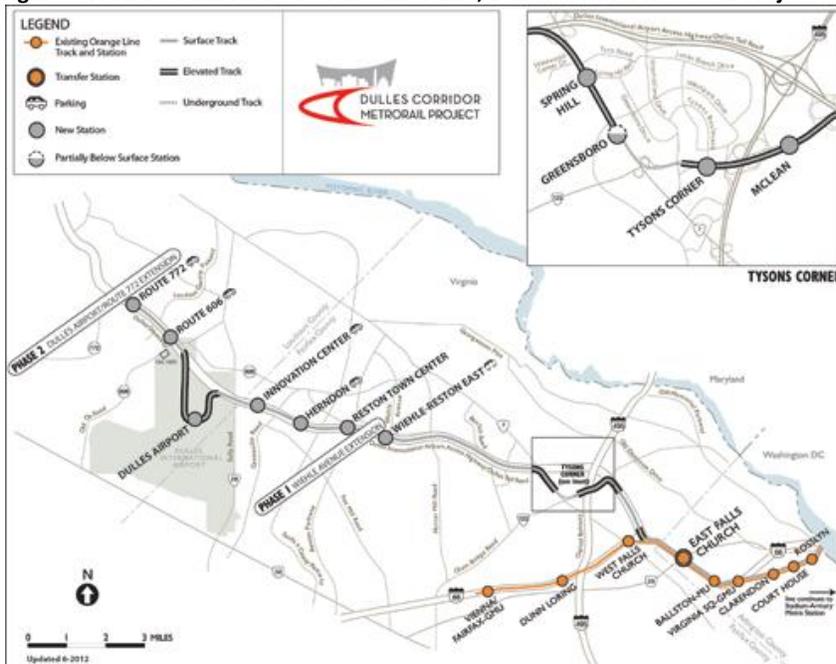
The Silver Line is being funded through a large number of different sources, including federal funding (16.4% of total project cost), Virginia State funding (10.5%), funding from Fairfax County (16.1%) and Loudoun County (4.8%), as well as from Dulles Toll Road Drivers (48.1%) and commercial property tax districts. Fairfax County created two special tax districts to fund the majority of its contribution to the project:

- In the Phase I Tax District, commercial landowners agreed to pay up to 29 cents per \$100 of assessed value of their commercial and industrial properties, up to a total of \$400 million;

- In the Phase II Tax District property owners agreed to pay up to 25 cents per \$100, up to a total of \$330 million.

Similarly, in 2012 Loudoun County established a Dulles Metrorail Service District, a tax district created to help fund construction costs for Phase II of the Metrorail operations (see Figure 3-8). In October 2013, the Loudoun County Board of Supervisors initiated a SilverLine/Metrorail Tax District Comprehensive Plan Amendment (CPAM) to evaluate the development potential of these service districts. The district encompasses 641 parcels and 14,328 acres, including the Washington Dulles International Airport Property. Real property taxes are expected to be assessed on parcels within the district boundaries at a rate not to exceed \$0.20 per \$100 of assessed value.

Figure 3-7: Phase I and Phase II of the Silver Line, Dulles Corridor Metrorail Project



Source: Dulles Metrorail

Figure 3-8: Metrorail Service District, Loudoun County



4. Conclusions: Funding and Financing the CRE project

4.1. Federal Funding Opportunities

Although the RTD was unsuccessful in its application for a TIGER grant in FY 2014, it may consider reapplying for TIGER funds in subsequent rounds. It is common for failed applicants to go back and improve project proposals, reduce costs, and bring in new partners in order to improve chances of obtaining funding in following rounds. The US DOT also offers technical support with TIGER applications. A project can increase its chances of obtaining TIGER funds by, inter alia: (1) Demonstrating contribution towards at least two or three out of the five long-term improvements—including safety, economic competitiveness, state of good repair, quality of life and environmental sustainability; (2) Showcasing the long-term social and economic benefits of the project by presenting a robust cost-benefit analysis; (3) Obtaining widespread support from the local community, including business and political leaders; (4) Demonstrating that the project can meet the TIGER program’s schedule for obligation of funds (“ready to go”); and (5) Ensuring that the proposed project is multimodal and will improve connectivity between different transit systems.

The TIGER program remains the most common federal funding source for streetcar projects. Streetcar projects that have obtained TIGER funding include the Sun Link Streetcar line in Tucson, Arizona (\$63 million grant); the Kansas City Downtown Streetcar (\$20 million grant); the M1 Rail Streetcar project in Detroit (\$25 million grant); and the Atlanta Streetcar (\$47.6 million grant). As a result of the program’s popularity for streetcar projects, it remains a viable (although competitive) funding option should the RTD choose to pursue a streetcar as part of the CRE project.

The CRE project could be eligible for either Small Starts or Very Small Starts funding, depending on the size and scope of the project. The CRE project could be eligible for the more streamlined Very Small Starts funding if the project cost is under \$50 million; the project could qualify for Smart Starts funding if the project cost is above \$50 million. The 2012 MAP-21 regulations made the Small Starts program friendlier to streetcar projects, enhancing the prospect of being able to obtain funding under this mechanism. Planned streetcars in Tempe, Arizona and Fort Lauderdale, Florida are examples of streetcar projects that have advanced to the project development phase under Small Starts.

4.2. Value-Capture Funding Opportunities

To enhance grant competitiveness and to anticipate non-federal grant options, streetcar and light rail projects are increasingly focusing on various forms of value capture, including assessment districts and Tax Increment Financing (TIF). Section III examined several transit systems for which value capture was successful, including the Kansas City and Portland Streetcars, as well as the San Francisco Transbay Transit System, Dulles Metrorail Silver Line and Denver Union Station. This section will examine the different special districts available in the City of Denver, as well as look at the possibility for Tax Increment Financing (TIF) mechanisms.

4.2.1. Overview of Special Districts in the City of Denver

The City of Denver already has numerous special districts in place that perform various different functions, from financing public infrastructure to providing services. The benefit of a special district is that it allows an area to undertake improvements without using general funds or debt issuances by the City of Denver. To date, there are some 145 special districts in the City or County of Denver,¹⁰ including:

- General Improvement Districts (GIDs).
- Business Improvement Districts (BIDs)
- Local Maintenance Districts (LMDs);
- Local Improvement Districts (LIDs); and
- Metropolitan Districts.

Most special districts are created by the electors within the district area, who may choose to pay an additional tax in order to attain localized benefits, such as improved infrastructure or economic development. Metropolitan districts, however, are usually created by the developers of the project.

Each type of special district is permitted to conduct a range of different public improvements. The improvements permitted under a GID, for example, are very broad and include any kind of public improvements (with the exception of solid waste). The improvements permitted under a BID, on the other hand, are intended to benefit the commercial properties of the area and are therefore explicitly confined to a range of smaller improvements.¹¹ LIDs and LMDs have a smaller range of powers, namely

¹⁰ Website of the City and County of Denver, Department of Public Works, Accessible at:

<http://www.denvergov.org/dpw/DepartmentofPublicWorks/OurDivisions/DistrictManagementOffice/tabid/441236/Default.aspx>

¹¹ Specifically, the improvements permitted by a BID are to: “acquire, construct, finance, install, and operate improvements, including streets, sidewalks, curbs, gutters, pedestrian malls, streetlights, utilities, drainage facilities, landscaping, decorative structures, statuary, fountains, identification signs, traffic safety devices, bicycle

to construct public improvements and to maintain and operate public improvements, respectively. Metropolitan districts are the only type of special district for which “transportation” is explicitly listed as one of the powers. Table 4-1 presents overview of the powers, formation and governance of GIDs, BIDs and Metropolitan Districts.

Metropolitan Districts may be preferable for transportation projects since they have substantially greater powers, autonomy, and flexibility than the other types of districts. Developers have often favored establishing Metropolitan Districts for the construction of public improvements because they have been able to exercise greater control. Metropolitan Districts have the authority to impose fees and charges, to issue general obligation bonds and revenue bonds, and to levy and collect ad valorem taxes.¹² In some rare cases, Metropolitan Districts may also establish special assessment districts.

Table 4-1: Overview of General Improvement Districts, Business Improvement Districts and Metropolitan Districts.

Type of Special District	Permitted Improvements	Powers	Formation	Governance
		Funding		
General Improvement District (GID)	GIDs are allowed to construct any public improvement except solid waste disposal services.	<ul style="list-style-type: none"> A. May assess ad valorem taxes and charge rates, tolls and charges for services or facilities. B. May issue general obligation and revenue bonds. C. Debt in excess of \$5,000 must be approved by the electors within the district 	<ul style="list-style-type: none"> 1. Initiated by a petition filed with the City Clerk, signed by the lesser of 30% or 200 electors owning taxable real or personal property within the district. 2. Subareas within the district may be formed. 	The City Council is the board of directors of the district. By ordinance, an advisory board may be created to oversee the GID.
Business Improvement District (BID)	BIDs are allowed to acquire, construct, finance, install, and operate smaller improvements. They are organized for the benefit of commercial properties only.	<ul style="list-style-type: none"> A. May borrow money, incur indebtedness and issue negotiable bonds. B. May fix rates, tolls, or charges for any services or improvements. The revenue may be pledged to pay district bonds. C. May levy and collect ad valorem taxes on commercial property within the district. 	<ul style="list-style-type: none"> 1. A petition must be signed by persons who own real or personal property in the service area. 2. The City Council must approve the petition by ordinance. 	The BID is governed either by a board of directors of not fewer than five electors appointed by City Council or by the mayor.
Metropolitan District	The most common form of special district, they may be used for services such as sanitation, street	<ul style="list-style-type: none"> A. May fix, charge and collect fees, rates, tolls, penalties or charges for services, programs or facilities; B. May levy and collect ad valorem taxes on and 	<ul style="list-style-type: none"> 1. The City Council must approve the district's service plan. 2. A petition must be signed by 30% or 200 of the electors of the District, whichever is less. 3. Approval of the District by the electors within the District. 	A metropolitan district is governed by a five-member board of directors.

paths, off-street parking facilities, benches, rest rooms, information booths, public meeting facilities, and all necessary appurtenances.” Source: Website of the City and County of Denver.

¹²City and County of Denver, Department of Public Works, “District Characteristics Within the City and County of Denver,” Accessible at:

[http://www.denvergov.org/Portals/705/documents/District%20Characteristics%20\(within%20the%20City%20and%20County%20of%20Denver.pdf](http://www.denvergov.org/Portals/705/documents/District%20Characteristics%20(within%20the%20City%20and%20County%20of%20Denver.pdf)

	improvements, transportation, etc.	<p>against all taxable property within the special district;</p> <p>C. May issue general obligation and revenue bonds of the special district;</p> <p>D. May use the taxes and other revenue to pay off bonds and for maintenance and operating costs; and</p> <p>E. May issue revenue bonds.</p>		
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Source: City and County of Denver and IMG Rebel Group

4.2.2. Political, Legal and Technical Considerations of Establishing a Special District

Revenues from a special district could be used to cover part of the CRE’s project costs. The Atlanta Streetcar, for example, generated \$6 million out of a total capital cost of \$92 million from its Atlanta Downtown Improvement District (ADID). Depending on a district’s particular powers and purposes, revenues from a special district could be used to retire bonds used to finance the construction costs or to fund the regular maintenance and/or operating costs of the project. There are several ways in which such a district could be structured:

- Create a *new* special district with specific powers to use the collected revenues to fund a portion of the CRE’s project costs (as mentioned above);
- Expand the functional powers (and geographical scope) of an *existing* district to divert a portion of the district’s revenues to the CRE project.

Because there are restrictions on overlapping special districts, current districts must be taken into consideration. Existing districts in the area include the Five Points Business District and the Downtown Denver Partnership / Downtown Denver Business Improvement District (BID). BIDs are not allowed to overlap with one another, which could present an obstacle to the establishment of a BID for the CRE project. However, BIDs are allowed to overlap with GIDs or Metropolitan districts. For example, the 14th Street Corridor GID is located within the Denver Downtown Partnership (a BID). Metropolitan districts are also allowed to overlap with one another.

It is often challenging to obtain the political support required to establish a new district. For example, in order to establish a Metropolitan District, a service plan must be prepared and adopted by the City Council; a petition must be signed by at least 30% (or 200) taxpaying electors; a public hearing must be held; and approval must be acquired from district electors. Table 4-1 presents an overview of the formation process for GIDs, BIDs and Metropolitan districts. It may be easier to generate strong political support if the revenues are used for general public improvements, and not solely for a transit project.

It is likely to be challenging to obtain the political support required to expand an existing district to accommodate the CRE project. Expanding an existing BID, for example, requires approval by 100% of the electors within the district area. Although Metropolitan districts would be somewhat easier to expand, it remains a challenge to obtain the necessary political support. For the Kansas City Streetcar,

for example, voters rejected plans to expand an existing assessment district for a second phase of the project in August 2014.

There are three financing mechanisms for raising funds through a district: (1) An assessment district with an ad valorem tax; (2) An assessment district with an additional tax per square footage; and (3) a tax increment financing (TIF) district. The first two mechanisms could be levied through the creation of a special district. However, only BIDs, GIDs, and Metropolitan Districts have the authority to levy ad valorem taxes or to establish assessment districts. An ad valorem tax takes into consideration the location and quality of the development, whereas a tax per square footage treats every property in the same way, regardless of location.

Tax Increment Financing (TIF) districts remain under the authority of the Denver Urban Renewal Authority (DURA) or the Downtown Development Authority (DDA). Because a TIF does not increase out-of-pocket costs to private property owners, it is likely to be more political palatable than an assessment district, in particular in a less-developed area. However, a TIF district does reduce the funds potentially additionally available to the County for other uses. In addition, a TIF district generates revenue only as property values increase, whereas assessment districts generate funds as soon as they are implemented.

The RTD's Denver Union Station Transit Center created a Metropolitan District combined with a Tax Increment Financing (TIF) district. The RTD's new Union Station Transit Center, which opened in May 2014, is financed by two federal loan programs repaid with TIF revenues, as well as a public-private partnership (P3). In 2004, voters in the eight counties of the RTD approved a 0.4 percent sales tax increase to finance the FasTracks transit project. In 2008, the Denver City Council approved a 30-year TIF district, which included the entire Union Station and surrounding 20 acres. The property tax revenues from the TIF district will help pay for debt service on two federal loans: a \$145.6 million TIFIA loan and a \$155 million Railroad Rehabilitation and Improvement Financing (RRIF) Loan. Certain entities were excluded the payment of the TIF, such as Central Platte Valley Metropolitan District and Cherry Creek Subarea Business Improvement District.

4.3. Other Financing Options

In addition to traditional tax-exempt debt, innovative forms of financing could also be used to leverage the project's revenue stream, such as TIFIA loans or private equity through public private partnerships (P3s). The RTD is already examining P3s as a possible delivery and financing mechanism for the implementation of FasTracks projects, including the North Metro and I-225 corridors, as well as the East Corridor, Gold Line and commuter rail maintenance facility projects.¹³ A P3 model was also used in the case of the Denver Union Station Transit Center. P3 models can also be used for smaller projects such as streetcars, as the Portland Streetcar demonstrates. However, P3s should be used if they are expected—based on financial assessments and Value for Money analyses—to deliver enhanced value for the public benefit.

A TIFIA loan could be a possible financing mechanism for the CRE project; in practice, however, TIFIA loans tend to be used predominately for road or larger transit projects, and they require a steady and reliable repayment revenue stream. To date, TIFIA loans have never been used for streetcar projects, although Kansas City is in the review process to obtain a TIFIA loan for its streetcar project. In order to

¹³ Website of the Regional Transportation District (RTD), accessible at: http://www.rtd-fastracks.com/main_91



be eligible for a TIFIA loan, the CRE project would need to have a cost of over \$50 million and a dedicated revenue stream, which could derive from tax increment financing (TIF) or sales taxes, for example. The Denver Union Station project is an example of where TIF financing was pledged as debt service for a TIFIA loan.



**REGIONAL TRANSPORTATION DISTRICT
CENTRAL RAIL EXTENSION MOBILITY STUDY
ESTIMATES OF COST
October 6, 2014**

LS Gallegos & Associates Inc (LSG), as a subconsultant member of the Mobility Study Consultant Team led by Steer Davies Gleave (SDG), was responsible for preparing capital cost estimates for various options and alternative alignments for extending and improving the existing Central Corridor Light Rail Transit Lines. The Central Corridor Extension (CCE) Project consists of extending the existing line from 30th Street and Welton Street to 40th Street and Blake Street on the north, reconfiguring the existing tracks along Welton Street and considers alternative alignments to extend the Central Corridor on the south to serve the Civic Center Area along Broadway and Lincoln and the Convention Center on Welton Street. This report presents LSG’s conceptual cost estimates for various alternative improvements.

LSG’s cost estimating scope included:

- Developing conceptual cost estimates for two options of installing pocket tracks along Stout Street at 14th Street,
- Evaluating two long-range extensions from the 20th/Welton Station – one on Broadway/Lincoln operating through the Civic Center Station, and one on Welton Street from 19th Street to 12th Street adjacent to the Convention Center,
- Evaluating potential use of a track construction method referred to as “Track Slab”. Track Slab is a method of constructing track by utilizing a continuous concrete pour as a base for rail installation as opposed to a concrete tie and ballast construction.

Cost Estimating Approach

LSG first met with RTD cost estimators to obtain existing RTD unit costs and design criteria that could be applied to the various CCE improvements under consideration. In most cases LSG was able to use RTD unit costs and design criteria for preparing its cost estimates. For many of the cost elements where no design detail was available, LSG made assumptions about potential scopes of work and provided unit price or lump sum allowances in the estimates. For soft costs and contingency elements, LSG utilized percentages as applied in an RTD cost estimate prepared for the Welton Street light rail reconstruction project dated March 14, 2012. These percentages are in line with other industry standards for conceptual cost estimating.

In order to determine quantities for construction elements, LSG utilized alignment and cross section sketches and diagrams provided by SDG. Additionally, LSG utilized satellite images obtained from Google Earth. We have not included the cost of additional vehicles that may be needed.

LSG’s cost estimates presented in this report are summarized in the Standard Cost Categories (SCC) format developed by the Federal Transit Administration (FTA)

Pocket Track at 14th and Stout

LSG evaluated two options for providing a pocket track at the intersection of 14th Street and Stout Street in downtown Denver. The pocket track will serve as an area for trains to stage and provide for enhanced coordination between trains and improved service. The two options are referred to as Option A1 and Option A2 (see diagrams).

The estimated cost of **Option A1** is approximately **\$4,422,000**. Unit costs for this alternative were derived primarily from a cost estimate prepared in this vicinity by RTD dated 04/10/14. The cost estimate assumes minor modifications to the existing track paralleling 14th Street. The pocket track would be constructed on Stout Street with existing traffic lanes remaining in place and provide a station on 14th Street.

The estimated cost of **Option A2** is approximately **\$5,590,000**. Option A2 removes all existing track paralleling 14th Street and reconstructs it at the inside curb line of 14th Street. The primary difference in cost between Option A1 and Option A2 lies in the additional track work, site work and signal modifications necessary to move the track onto 14th Street.

Broadway/Lincoln Loop to Civic Center

The estimated cost of this potential extension is approximately **\$42,144,000** and the length of single track is estimated at **5760 track feet**. LSG viewed this extension as a single line on Broadway and Lincoln with trains travelling with traffic and utilizing existing intersection signalization where possible. LSG assumes the line will cross the Civic Center Station property near Colfax Avenue but not enter onto Colfax. A currently planned reconstruction of Civic Center will remove the existing station and site landscaping, thus only track costs and associated contingencies for that section were included in this cost estimate. No site costs at Civic Center have been included.

LSG assumes that this Loop will connect into to the existing Welton Street line. Trains on Welton Street travelling either into or out of the Central Business District are assumed to have the ability to enter this extension via Broadway. Likewise, trains exiting the extension via Lincoln will have the ability to go into the Central Business District or travel east toward the Downing Street Station at 30th St. It should be noted that tie-ins to the existing dual lines on Welton Street will be complex due to geometry and dual tracks. It should also be noted that existing parking on both Broadway and Lincoln may have to be removed to provide an exclusive guideway.

This cost estimate includes costs for the potential construction of a substation to provide power for the extension. The estimate also includes a cost for the acquisition of right-of-way at Lincoln and Welton Street to accommodate the directional train movements.

Welton Street Extension to 12th Street

The estimated cost of this potential extension is **\$49,812,000** and the length of single track for this extension is estimated at **7350 track feet**. LSG was asked to estimate this project based upon the assumption track would be constructed on both sides of Welton Street from the existing tracks at 19th Street southwest to 12th Street. Trains would travel with traffic and utilize existing traffic signals where

possible. Welton Street is currently a one-way street but would be made into a two-way street with this alternative. A circular turn-around has been assumed at 12th Street and this cost estimate contains cost assumptions for acquisition of right-of-way and construction of the turnaround. Tie-ins to the track at 19th Street will be complex due to geometry and dual lines.

As with the Broadway/Lincoln Loop, construction of these tracks will probably necessitate a reduction of parking or elimination of travel lane(s) to provide exclusive LRT guideways.

Track Slab Construction

LSG was asked to evaluate costs related to a method of track construction known as Track Slab and determine if this method had been used in a previous cost estimate for the Welton Street track reconstruction project from 20th/Welton to 30th/Welton. Based upon a cursory review, it appears this method was not used within the cost estimate for that project. Tie and ballast construction appears to be the method used and is consistent with RTD's current design standard. However, the Track Slab method does hold promise as an alternative construction method.

Track Slab is a method of constructing track through the use of a continuously reinforced concrete pavement under the track rail. This type of construction can be used with embedded rail and may offer advantages to the current construction method of concrete tie and ballast.

LSG learned that both the City of Seattle and City of Portland Tri Met currently specify Track Slab on their track construction projects. Sound Transit in Seattle has used it recently in the construction of track for street car use. It is unknown whether Seattle also uses it in the construction of LRT rail. Due to the differential in weight between a street car (typically 57,000 lb.) and LRT car (upwards of 97,000 lb.) the structural section of an LRT track has to be greater.

LSG contacted Tri Met to learn more about their design and was provided Tri Met's typical section for embedded rail (enclosed). Tri Met has specified this method of construction on its Portland-Milwaukee construction project.

Some apparent advantages of Track Slab:

1. The construction envelope for Track Slab is typically narrower than with tie and ballast construction. The width of trench that is required per Tri Met's standard drawing is 8' vs. RTD's standard width of 10'-8".
2. The depth of construction on the Tri Met standard is a total of 22" (14" concrete over 8" of aggregate base course). RTD's standard depth is approximately 40".
3. Due to the shallower construction depth, less excavation is necessary and the potential for utility relocation is reduced.

Items that we were not able to fully address in this report based upon the information received:

1. The cost per foot of Track Slab appears to be very close in price to the tie and ballast construction based upon an evaluation of Tri Met's numbers vs. numbers currently being used

by the RTD. There are probable cost savings in time of construction with the Track Slab method due to less excavation and utility relocation effort, however, LSG was not able to ascertain what that time savings would be nor how it would affect project cost.

REGIONAL TRANSPORTATION DISTRICT CENTRAL RAIL EXTENSION MOBILITY CONCEPTUAL ESTIMATE OF COST 14TH AND STOUT STREET LOOP OPTION A1						PREPARED BY: LS GALLEGOS AND ASSOCIATES FOR STEARS DAVIES CLEAVE PROJECT PRINCIPAL: LARRY GALLEGOS PROJECT MANAGER: RANDALL TEAGUE, P.E. DATE: SEPTEMBER 24, 2014
SCC NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	ESTIMATED TOTAL	COMMENTS
	TRACKWORK					
10.10	Track: Embedded	785	TF	\$253.33	\$198,864.05	Unit cost from previous estimate of 04/10/14
10.10	Furnish and Install New Flangeway Filler	4420	LF	\$39.98	\$176,711.60	Unit cost from previous estimate of 04/10/14. Includes quantity for turnouts.
	SPECIAL TRACKWORK					
10.12	Turnout (Standard)	1	EA	\$125,800.00	\$125,800.00	Unit cost from previous estimate of 04/10/2014
10.12	Turnout (Equalateral)	1	EA	\$250,000.00	\$250,000.00	Unit cost higher due to manufacture and installation complexity
	STATIONS/CONNECTIONS					
20.01	At-grade Platform	1	EA	\$250,000.00	\$250,000.00	Unit cost from previous estimate prepared by RTD for Welton St. dated 04/13/14
	REMOVALS/RELOCATION					
40.01	Remove Existing Turnout	1	EA	\$16,160.00	\$16,160.00	Unit cost from previous estimate of 04/10/2014
40.01	Remove Existing Track	845	TF	\$15.09	\$12,751.05	Unit cost from previous estimate of 04/10/2014
40.01	Remove Curb, Gutter, Sidewalk and Pavement	16120	SF	\$2.14	\$34,496.80	Unit cost from previous estimate of 04/10/2014
40.01	Remove Existing OCS/Light Poles/Traffic Poles	10	EA	\$1,100.00	\$11,000.00	Unit cost from previous estimate of 04/10/2014
40.01	Remove Trees and Tree Grates	4	EA	\$324.00	\$1,296.00	Unit cost from previous estimate of 04/10/2014
40.01	Remove/Relocate Control Boxes	2	EA	\$11,542.00	\$23,084.00	Unit cost from previous estimate of 04/10/2014
	UTILITY INSTALLATION/RELOCATION					
40.02	Storm Sewer Inlet Modifications	3	EA	\$17,004.00	\$51,012.00	Unit cost from previous estimate of 04/10/2014
40.02	Sanitary Sewer Line Modifications	1	LS	\$50,300.00	\$50,300.00	Estimated cost from previous estimate of 04/10/2014
40.02	Relocate/Modify Other Utilities	1	LS	\$145,000.00	\$145,000.00	Cost increased from previous estimate due to greater impact
	SITWORK AND SPECIAL CONDITIONS					
40.04	Erosion Control	1	LS	\$6,000.00	\$6,000.00	Cost increased from previous estimate due to greater impact
40.07	Reconstruct Pedestrian Crosswalks	550	SF	\$15.00	\$8,250.00	Required work due to alignment shifts. Unit cost based upon brick paver construction.
40.07	Curb and Gutter	465	LF	\$20.78	\$9,662.70	Unit cost from previous estimate of 04/10/2014
40.07	Pavement (Concrete) (Sidewalk and Street)	16120	SF	\$10.62	\$171,194.40	Unit cost from previous estimate of 04/10/2014
	SYSTEM-WIDE ELEMENTS (INCL. SIGNALS)					
50.02	Traffic Control	1	LS	\$39,062.00	\$39,062.00	Unit cost from previous estimate of 04/10/2014
50.01	Traffic Signal Modifications	1	EA	\$30,000.00	\$30,000.00	Cost increased from previous estimate due to greater impact.
50.03	OCS/Light Poles	6	EA	\$10,965.00	\$65,790.00	Unit cost from previous estimate of 04/10/2014. Quantity increased due to greater impact.

<u>SCC NO.</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>	<u>UNIT</u>	<u>UNIT PRICE</u>	<u>ESTIMATED TOTAL</u>	<u>COMMENTS</u>
50.03	OCS Cable	1220	LF	\$75.00	\$91,500.00	Unit cost from previous estimate of 04/10/2014
50.03	Additional OCS Work	1	LS	\$17,300.00	\$17,300.00	Increased from previous estimate due to greater impact.
	Subtotal =				\$1,785,234.60	
	CONTINGENCIES AND OTHER COSTS					
40.08	Mobilization, Indirects and Profit (22%)	1	LS	\$392,751.61	\$392,751.61	Derived from previous RTD estimate on Welton Street dated 03/14/12
80.01	Preliminary Design/Engineering (15%)	1	LS	\$267,785.19	\$267,785.19	Derived from previous RTD estimate.
80.02	Final Design (15%)	1	LS	\$267,785.19	\$267,785.19	Derived from previous RTD estimate.
80.03	Project Management for Design and Const. (14%)	1	LS	\$249,932.84	\$249,932.84	Derived from previous RTD estimate.
80.04	Construction Management (7%)	1	LS	\$124,966.42	\$124,966.42	Derived from previous RTD estimate.
80.05	Insurance and Legal (5%)	1	LS	\$89,261.73	\$89,261.73	Derived from previous RTD estimate.
80.06	Permits and Review Fees	1	LS	\$173,000.00	\$173,000.00	Derived from previous RTD estimate.
80.07	Owner Verified Testing (5%)	1	LS	\$89,261.73	\$89,261.73	Derived from previous RTD estimate.
80.08	Activation/System Integration (5%)	1	LS	\$89,261.73	\$89,261.73	Derived from previous RTD estimate.
90.00	Contingencies (50%)	1	LS	\$892,617.30	\$892,617.30	Derived from previous RTD estimate.
	Total =				\$4,421,858.35	
Assumptions:						
	1. Costs from previous estimate dated 04/10/14 reviewed and utilized where applicable.					
	2. Widening of 14th Ave. assumed on west side of roadway to obtain needed width for additional track.					
	East side of 14th Ave. to remain.					
	3. Quantities derived from satellite imagery.					
	4. Cost of additional vehicles has not been included in this cost estimate.					

REGIONAL TRANSPORTATION DISTRICT CENTRAL RAIL EXTENSION MOBILITY CONCEPTUAL ESTIMATE OF COST 14TH AND STOUT STREET LOOP OPTION A2						PREPARED BY: LS GALLEGOS AND ASSOCIATES FOR STEARNS DAVIES CLEAVE PROJECT PRINCIPAL: LARRY GALLEGOS PROJECT MANAGER: RANDALL TEAGUE, P.E. DATE: SEPTEMBER 24, 2014
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<u>SCC NO.</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>	<u>UNIT</u>	<u>UNIT PRICE</u>	<u>ESTIMATED TOTAL</u>	<u>COMMENTS</u>
	TRACKWORK					
10.10	Track: Embedded	1030	TF	\$253.33	\$260,929.90	Unit cost from previous estimate of 04/10/2014
10.10	Furnish and Install New Flangeway Filler	5320	LF	\$39.98	\$212,693.60	Unit cost from previous estimate of 04/10/2014. Includes quantity for turnouts.
	SPECIAL TRACKWORK					
10.12	Turnout (Standard)	1	EA	\$125,800.00	\$125,800.00	Unit cost from previous estimate of 04/10/2014
10.12	Turnout (Equalateral)	1	EA	\$250,000.00	\$250,000.00	Unit cost higher due to specialized manufacture and installation complexity.
	STATIONS/CONNECTIONS					
20.01	At-grade Platform	1	EA	\$250,000.00	\$250,000.00	Unit cost from previous estimate for Welton St. Extension dated 03/14/14
	REMOVALS/RELOCATION					
40.01	Remove Existing Crossover	1	EA	\$16,160.00	\$16,160.00	Unit cost from previous estimate of 04/10/2014
40.01	Remove Existing Track	900	TF	\$15.09	\$13,581.00	Unit cost from previous estimate of 04/10/2014
40.01	Remove Curb, Gutter, Sidewalk and Pavement	24540	SF	\$2.14	\$52,515.60	Unit cost from previous estimate of 04/10/2014
40.01	Remove Existing OCS/Light Poles/Traffic Poles	14	EA	\$1,100.00	\$15,400.00	Unit cost from previous estimate of 04/10/2014
40.01	Remove Trees and Tree Grates	4	EA	\$324.00	\$1,296.00	Unit cost from previous estimate of 04/10/2014
40.01	Remove/Relocate Control Boxes	2	EA	\$11,542.00	\$23,084.00	Unit cost from previous estimate of 04/10/2014
	UTILITY INSTALLATION/RELOCATION					
40.02	Storm Sewer Inlet Modifications	3	EA	\$17,004.00	\$51,012.00	Unit cost from previous estimate of 04/10/2014
40.02	Sanitary Sewer Line Modifications	1	LS	\$50,300.00	\$50,300.00	Estimated cost from previous estimate of 04/10/2014
40.02	Relocate/Modify Other Utilities	1	LS	\$190,000.00	\$190,000.00	Cost increased from previous estimate due to greater impact.
	SITEWORK AND SPECIAL CONDITIONS					
40.04	Erosion Control	1	LS	\$13,000.00	\$13,000.00	Cost increased from previous estimate due to greater impact.
40.07	Reconstruct Pedestrian Crosswalks	1400	SF	\$15.00	\$21,000.00	Required work due to alignment shifts. Unit cost based upon brick paver construction.
40.07	Curb and Gutter	920	LF	\$20.78	\$19,117.60	Unit cost from previous estimate of 04/10/2014
40.07	Pavement (Concrete) (Sidewalk and Street)	24540	SF	\$10.62	\$260,614.80	Unit cost from previous estimate of 04/10/2014
40.07	Reconstruct Planter Boxes	1	LS	\$50,000.00	\$50,000.00	Cost roughly estimated due to limited knowledge of reconstruction plans.
	SYSTEM-WIDE ELEMENTS (INCL. SIGNALS)					
50.02	Traffic Control	1	LS	\$45,000.00	\$45,000.00	Cost increased from previous estimate due to greater impact.
50.01	Traffic Signal Modifications	1	EA	\$120,000.00	\$120,000.00	Cost increased from previous estimate due to greater impact.
50.03	OCS/Light Poles	10	EA	\$10,965.00	\$109,650.00	Unit cost from previous estimate of 04/10/2014
50.03	OCS Cable	1400	LF	\$75.00	\$105,000.00	Unit cost from previous estimate of 04/10/2014
50.03	Additional OCS Work	1	LS	\$20,000.00	\$20,000.00	Cost increased from previous estimate due to greater impact.

<u>SCC NO.</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>	<u>UNIT</u>	<u>UNIT PRICE</u>	<u>ESTIMATED TOTAL</u>	<u>COMMENTS</u>
	Subtotal =				\$2,276,154.50	
	CONTINGENCIES AND OTHER COSTS					
40.08	Mobilization, Indirects and Profit (22%)	1	LS	\$500,753.99	\$500,753.99	Derived from previous RTD estimate on Welton St. dated 03/14/12.
80.01	Preliminary Design/Engineering (15%)	1	LS	\$341,423.18	\$341,423.18	Derived from previous RTD estimate on Welton St.
80.02	Final Design (15%)	1	LS	\$341,423.18	\$341,423.18	Derived from previous RTD estimate on Welton St.
80.03	Project Management for Design and Const. (14%)	1	LS	\$318,661.63	\$318,661.63	Derived from previous RTD estimate on Welton St.
80.04	Construction Management (7%)	1	LS	\$159,330.82	\$159,330.82	Derived from previous RTD estimate on Welton St.
80.05	Insurance and Legal (5%)	1	LS	\$113,807.73	\$113,807.73	Derived from previous RTD estimate on Welton St.
80.06	Permits and Review Fees	1	LS	\$173,000.00	\$173,000.00	Derived from previous RTD estimate on Welton St.
80.07	Owner Verified Testing (5%)	1	LS	\$113,807.73	\$113,807.73	Derived from previous RTD estimate on Welton St.
80.08	Activation/System Integration (5%)	1	LS	\$113,807.73	\$113,807.73	Derived from previous RTD estimate on Welton St.
90.00	Contingencies (50%)	1	LS	\$1,138,077.25	\$1,138,077.25	Derived from previous RTD estimate on Welton St.
	Total =				\$5,590,247.71	
Assumptions:						
	1. Costs from previous estimate dated 04/10/14 reviewed and utilized where applicable.					
	2. Widening of 14th Ave. assumed on west side of roadway to obtain needed width for additional track.					
	East side of 14th Ave. to remain.					
	3. Quantities derived from satellite imagery.					
	4. Cost of additional vehicles has not been included in this estimate.					

REGIONAL TRANSPORTATION DISTRICT CENTRAL RAIL EXTENSION MOBILITY CONCEPTUAL ESTIMATE OF COST BROADWAY/LINCOLN LOOP						PREPARED BY: LS GALLEGOS AND ASSOCIATES FOR STEARS DAVIES CLEAVE PROJECT PRINCIPAL: LARRY GALLEGOS PROJECT MANAGER: RANDALL TEAGUE, P.E. DATE: SEPTEMBER 24, 2014
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SCC NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	ESTIMATED TOTAL	COMMENTS
	TRACKWORK					
10.10	Track: Embedded	5760	TF	\$253.33	\$1,459,180.80	Includes excavation and ballast. Unit cost from previous RTD estimate dated 04/10/2014
10.10	Flangeway Filler	23040	LF	\$39.98	\$921,139.20	Unit cost from previous estimate dated 04/10/14. Includes turnout lengths.
	SPECIAL TRACKWORK					
10.12	Turnouts	6	EA	\$300,000.00	\$1,800,000.00	Assumes crossovers each direction onto Broadway and off of Lincoln. Preliminary layout should be done to determine constructability. Cost of turnouts higher than previous estimate due to complexity of tie-ins.
10.12	Diamond Crossings	2	EA	\$30,000.00	\$60,000.00	Allowance provided due to limited information.
	STATIONS/CONNECTIONS					
20.01	At-grade Platform	6	EA	\$250,000.00	\$1,500,000.00	Allowance based upon RTD estimate for Welton Street Extension dated 03/14/12
	REMOVALS/RELOCATION					
40.01	Remove Existing Track	400	TF	\$15.09	\$6,036.00	Unit cost from previous estimate dated 04/10/14. Removal needed to tie into existing trackwork. Quantity estimated from limited information.
40.01	Remove Curb, Gutter, Sidewalk and Pavement	99677	SF	\$2.14	\$213,308.78	Unit cost from previous estimate dated 04/10/14. Assume 75% of existing curb and gutter can remain.
40.01	Remove Existing OCS/Light Poles/Traffic Poles	18	EA	\$1,093.00	\$19,674.00	Unit cost from previous estimate dated 04/10/14
40.01	Remove/Relocate Control Boxes	3	EA	\$11,500.00	\$34,500.00	Unit cost from previous estimate dated 04/10/14
40.01	Modify Sign Bridge	1	EA	\$30,000.00	\$30,000.00	Unit cost estimated based upon limited information.
	UTILITY INSTALLATION/RELOCATION					
40.02	Storm Sewer Inlet/Manhole Modifications	20	EA	\$17,004.00	\$340,080.00	Unit cost from previous RTD estimate.
40.02	Sanitary Sewer Line Modifications	1	LS	\$50,300.00	\$50,300.00	Allowance provided due to limited information.
40.02	Encase Utility and Communication Lines	1	LS	\$900,000.00	\$900,000.00	Allowance provided due to limited information.
40.02	Other Utility Relocations	1	LS	\$400,000.00	\$400,000.00	Allowance provided due to limited information.
	SITWORK AND SPECIAL CONDITIONS					
40.04	Erosion Control	1	LS	\$173,316.00	\$173,316.00	Unit cost based upon a percentage (1%) of construction cost. Lower percentage than that used on RTD Welton St. estimate due to urban construction.
40.07	Curb and Gutter	7200	LF	\$20.78	\$149,616.00	Unit price based upon previous estimate dated 04/10/14. Quantity assumes existing curb and gutter to remain.
40.07	Pavement (Street and Track)	75220	SF	\$10.60	\$797,332.00	Unit cost from previous RTD estimate dated 4/10/14.
40.07	Sidewalk	13587	SF	\$5.36	\$72,826.32	Unit price derived from RTD estimate for Welton St. Quantity assumes 25% of existing SW requires replacement due to condition.
40.07	Pedestrian Ramps	27	EA	\$2,645.00	\$71,415.00	Unit price derived from RTD estimate for Welton St. dated 03/14/12.

<u>SCC NO.</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>	<u>UNIT</u>	<u>UNIT PRICE</u>	<u>ESTIMATED TOTAL</u>	<u>COMMENTS</u>
	SYSTEM-WIDE ELEMENTS (INCL. SIGNALS)					
50.02	Traffic Control	1	LS	\$511,000.00	\$511,000.00	Assumes 1-year construction period.
50.01	Traffic Signal Modifications (Minor per intersection)	10	EA	\$120,000.00	\$1,200,000.00	Allowance provided due to limited information.
50.01	Traffic Signal Modifications (Major)	2	EA	\$500,000.00	\$1,000,000.00	Allowance provided due to limited information.
50.01	Train Control and Signal System	1	LS	\$1,800,000.00	\$1,800,000.00	General cost information provided by RTD.
50.03	OCS/Light Poles	63	EA	\$10,965.00	\$690,795.00	Cost based upon previous estimate dated 4/10/14. Quantity based upon pole/100 LF of track.
50.03	OCS Cable	6336	LF	\$75.02	\$475,326.72	Unit cost based upon previous estimate dated 4/10/14.
50.03	Additional OCS Work	1	LS	\$213,400.00	\$213,400.00	Prorated based upon previous estimate dated 4/10/14.
50.03	Traction Power Substation System	1	EA	\$1,000,000.00	\$1,000,000.00	Cost based upon information provided by RTD. Assumption made that additional substation will be required.
50.03	Duct Bank	1	EA	\$250,000.00	\$250,000.00	Cost based upon information provided by RTD. Assumption made that additional substation will be required.
50.03	Stations Communications	1	EA	\$750,000.00	\$750,000.00	Cost based upon information provided by RTD. Assumption made that additional substation will be required.
50.03	Electrical Supply	1	EA	\$350,000.00	\$350,000.00	Cost based upon information provided by RTD. Assumption made that additional substation will be required.
	ROW, LAND EXISTING IMPROVEMENTS					
60.01	Land Purchase	1	LS	\$250,000.00	\$250,000.00	Partial take of parking lot at Welton - North to East Movement
	Subtotal =				\$17,489,245.82	
	CONTINGENCIES AND OTHER COSTS					
40.08	Mobilization, Indirects and Profit (22%)	1	LS	\$3,847,634.08	\$3,847,634.08	Derived from previous RTD estimate on Welton St.
80.01	Preliminary Design/Engineering (15%)	1	LS	\$2,623,386.87	\$2,623,386.87	Derived from previous RTD estimate on Welton St.
80.02	Final Design (15%)	1	LS	\$2,623,386.87	\$2,623,386.87	Derived from previous RTD estimate on Welton St.
80.03	Project Management for Design and Const. (14%)	1	LS	\$2,448,494.41	\$2,448,494.41	Derived from previous RTD estimate on Welton St.
80.04	Construction Management (7%)	1	LS	\$1,224,247.21	\$1,224,247.21	Derived from previous RTD estimate on Welton St.
80.05	Insurance and Legal (5%)	1	LS	\$874,462.29	\$874,462.29	Derived from previous RTD estimate on Welton St.
80.06	Permits and Review Fees	1	LS	\$519,399.00	\$519,399.00	Prorated from previous estimate dated 04/10/14 based upon anticipated construction period.
80.07	Owner Verified Testing (5%)	1	LS	\$874,462.29	\$874,462.29	Derived from previous RTD estimate on Welton St.
80.08	Activation/System Integration (5%)	1	LS	\$874,462.29	\$874,462.29	Derived from previous RTD estimate on Welton St.
90.00	Contingencies (50%)	1	LS	\$8,744,622.91	\$8,744,622.91	Derived from previous RTD estimate on Welton St.
	Total =				\$42,143,804.05	

<u>SCC NO.</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>	<u>UNIT</u>	<u>UNIT PRICE</u>	<u>ESTIMATED TOTAL</u>	<u>COMMENTS</u>
Assumptions:						
	1. A single track is assumed on Broadway and Lincoln running with traffic.					
	2. In order to obtain adequate width, parking or through lane will be taken. Cost of lost revenue not included.					
	3. No improvements or reconstruction is assumed at Civic Center Park. All work there by others.					
	4. Assumption that existing traffic signals will be used for LRT.					
	5. Assumption that a new traction power substation will be required for extension.					
	6. Assumption that utility lines under LRT will require encasement.					
	7. A one-year construction period is assumed for utility encasement and LRT track improvements.					
	8. Quantity take-offs and measurements taken from satellite imagery.					
	9. The cost of any new vehicles needed for this extension have not been included.					

REGIONAL TRANSPORTATION DISTRICT CENTRAL RAIL EXTENSION MOBILITY CONCEPTUAL ESTIMATE OF COST WELTON EXTENSION FROM 19TH ST. TO 12TH ST.					PREPARED BY: LS GALLEGOS AND ASSOCIATES FOR STEARNS DAVIES CLEAVE PROJECT PRINCIPAL: LARRY GALLEGOS PROJECT MANAGER: RANDALL TEAGUE, P.E. DATE: SEPTEMBER 24, 2014	
<u>SCC NO.</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>	<u>UNIT</u>	<u>UNIT PRICE</u>	<u>ESTIMATED TOTAL</u>	<u>COMMENTS</u>
	TRACKWORK					
10.10	Track: Embedded	7350	TF	\$253.33	\$1,861,975.50	Includes excavation and ballast. Unit cost from previous RTD estimate dated 4/10/14.
10.10	Flangeway Filler	31160	LF	\$39.98	\$1,245,776.80	Unit costs from previous estimate dated 4/10/14. Includes turnout lengths.
	SPECIAL TRACKWORK					
10.12	Turnouts	6	EA	\$400,000.00	\$2,400,000.00	Assumes full connection in all directions. Preliminary layout is recommended to ensure constructibility. Costs are higher than previous estimates due to the complexity of tie-ins.
10.12	Diamond Crossings	2	EA	\$30,000.00	\$60,000.00	Allowance provided due to limited information.
	STATIONS/CONNECTIONS					
20.01	At-grade Platform	6	EA	\$250,000.00	\$1,500,000.00	Unit cost from previous estimate prepared by RTD for the Welton St. Extension project dated 03/14/14.
	REMOVALS/RELOCATION					
40.01	Remove Existing Track	400	TF	\$15.09	\$6,036.00	Unit cost from previous estimate dated 4/10/14. Removal needed to tie into existing track. Quantity based upon limited information regarding configuration.
40.01	Remove Curb, Gutter, Sidewalk and Pavement	166554	SF	\$2.14	\$356,425.56	Unit cost from previous estimate dated 4/10/14. Assume 75% of existing curb and gutter and sidewalk can remain.
40.01	Remove Existing OCS/Light Poles/Traffic Poles	68	EA	\$1,093.00	\$74,324.00	Unit cost from previous estimate dated 4/10/14.
40.01	Remove/Relocate Control Boxes	8	EA	\$11,500.00	\$92,000.00	Unit cost from previous estimate dated 4/10/14.
	UTILITY INSTALLATION/RELOCATION					
40.02	Storm Sewer Inlet/Manhole Modifications	18	EA	\$17,004.00	\$306,072.00	Unit cost from previous estimate dated 4/10/14.
40.02	Sanitary Sewer Line Modifications	1	LS	\$50,300.00	\$50,300.00	Allowance provided due to limited information.
40.02	Encase Utility Lines	1	LS	\$900,000.00	\$900,000.00	Allowance provided due to limited information.
40.02	Other Utility Relocations	1	LS	\$300,000.00	\$300,000.00	Allowance provided due to limited information.
	SITWORK AND SPECIAL CONDITIONS					
40.04	Erosion Control	1	LS	\$207,536.00	\$207,536.00	Allowance provided based upon percentage of construction cost (1%) . Percentage reduced from RTD Welton St. estimate due to urban construction.
40.07	Curb and Gutter	9187	LF	\$20.78	\$190,905.86	Unit price based upon previous estimate dated 4/10/14.
40.07	Pavement (Street and Track)	98200	SF	\$10.60	\$1,040,920.00	Unit price from previous estimate dated 4/10/14.
40.07	Sidewalk	14700	SF	\$5.36	\$78,792.00	Dated 03/14/12. A 15% adjustment made for inflation.
40.07	Pedestrian Ramps	26	EA	\$2,645.00	\$68,770.00	Unit price derived from RTD estimate for Welton St. A 15% adjustment made for inflation.

SCC NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	ESTIMATED TOTAL	COMMENTS
	SYSTEM-WIDE ELEMENTS (INCL. SIGNALS)					
50.02	Traffic Control	1	LS	\$511,000.00	\$511,000.00	Assume 1-year construction period.
50.01	Traffic Signal Modifications (Per Intersection)	5	EA	\$120,000.00	\$600,000.00	Allowance provided due to limited information.
50.01	Traffic Signal Modifications (Major Reconstruction)	2	EA	\$500,000.00	\$1,000,000.00	Allowance provided due to limited information.
50.01	Train Control and Signal System	1	EA	\$1,800,000.00	\$1,800,000.00	General cost information provided by RTD.
50.03	OCS/Light Poles	73	EA	\$11,000.00	\$803,000.00	Cost based upon previous estimate dated 4/10/14. Quantity based upon pole/100 LF track.
50.03	OCS Cable	8570	LF	\$75.00	\$642,750.00	Unit cost based upon previous estimate dated 4/10/14. Quantity increased to provide for radii.
50.03	Additional OCS Work	1	LS	\$264,572.00	\$264,572.00	Prorated based upon previous estimate dated 4/10/14.
50.03	Duct Bank	1	LS	\$250,000.00	\$250,000.00	Cost based upon information provided by RTD.
50.03	Traction Power Substation Systems	1	LS	\$1,000,000.00	\$1,000,000.00	Cost based upon information provided by RTD. Assumption made that additional substation will be required.
50.03	Stations Communications	1	LS	\$750,000.00	\$750,000.00	Cost based upon information provided by RTD.
50.03	Electrical Supply	1	LS	\$350,000.00	\$350,000.00	Cost based upon information provided by RTD.
	ROW, LAND EXISTING IMPROVEMENTS					
60.01	Land Purchase	1	LS	\$2,000,000.00	\$2,000,000.00	Assume parcel take for turn-around at 12th Street and widening from 18th to Broadway
	Subtotal =				\$20,711,155.72	
	CONTINGENCIES AND OTHER COSTS					
40.08	Mobilization, Indirects and Profit (22%)	1	LS	\$4,556,454.26	\$4,556,454.26	Derived from previous RTD estimate on Welton St.
80.01	Preliminary Design/Engineering (15%)	1	LS	\$3,106,673.36	\$3,106,673.36	Derived from previous RTD estimate on Welton St.
80.02	Final Design (15%)	1	LS	\$3,106,673.36	\$3,106,673.36	Derived from previous RTD estimate on Welton St.
80.03	Project Management for Design and Const. (14%)	1	LS	\$2,899,561.80	\$2,899,561.80	Derived from previous RTD estimate on Welton St.
80.04	Construction Management (7%)	1	LS	\$1,449,780.90	\$1,449,780.90	Derived from previous RTD estimate on Welton St.
80.05	Insurance and Legal (5%)	1	LS	\$1,035,557.79	\$1,035,557.79	Derived from previous RTD estimate on Welton St.
80.06	Permits and Review Fees	1	LS	\$519,399.00	\$519,399.00	Prorated from previous estimate dated 4/10/14 based upon anticipated construction period.
80.07	Owner Verified Testing (5%)	1	LS	\$1,035,557.79	\$1,035,557.79	Derived from previous RTD estimate on Welton St.
80.08	Activation/System Integration (5%)	1	LS	\$1,035,557.79	\$1,035,557.79	Derived from previous RTD estimate on Welton St.
90.00	Contingencies (50%)	1	LS	\$10,355,577.86	\$10,355,577.86	Derived from previous RTD estimate on Welton St.
	Total =				\$49,811,949.61	
Assumptions:						
	1. A track in each direction is assumed on Welton St.					
	2. In order to obtain adequate width, parking or through lane(s) will be lost. Loss of parking revenue not included.					
	3. Assumption that current one-way configuration Welton St. will be changed to accommodate 2-way traffic.					
	4. Assumption that a new traction power substation will be required for extension.					
	5. Assumption that utility lines under LRT will require encasement.					
	6. A one-year construction period is assumed for utility encasement and LRT track improvements.					
	7. Assumes ROW acquisition at 12th St. turnaround and widening from 18th to Broadway.					
	8. Quantity take-offs and measurements taken from satellite imagery.					
	9. Cost of additional vehicles has not been included in this estimate.					

Venue	RTD FasTracks Regional Conference Room (7 th Floor)		
Date	Wednesday, January 29, 2014	Time	3:00-5:00 p.m.
Project	Central Rail Extension Mobility Study	Project No.	22567801

Subject Elected Officials Update - Meeting Summary

1. Welcome and Introductions - Andy Mutz (RTD)

Andy Mutz gave a brief overview of the project and discussed the purpose of the meeting. He explained the project team’s goals to develop a clear vision for the project, establish a collaborative effort between all involved parties and to present information about the study progress to date.

2. Agreement on Purpose/Goals of Meeting - Andy Mountain (GBSM)

Andy Mountain presented the agenda for the meeting and requested that the elected officials consider how they’d like to receive updates regarding the project moving forward.

3. Brief Review of Other Projects in the Study Area - Crissy Fanganello (CCD)

Crissy Fanganello gave a brief overview of other City and County of Denver projects in the area, including the 38th/Blake Station, the 35th/36th Pedestrian Bridge Project and the Northeast Downtown Next Steps Study, and the related coordination between the City and RTD.

4. Overview of Central Rail Extension Mobility Study - Tim Baldwin (SDG)

Project History

Tim Baldwin summarized the history of the Central Rail Line from its inception in 1994 to the extension’s inclusion in the FasTracks program. He provided an overview of the 2010 Environmental Evaluation of the Central Rail Extension (CRE) and studies/changes since that time (e.g. changes to downtown traffic signals, Five Points Business District streetcar study, and more) that will influence this study.

Project Basics (schedule, study process, public process)

Tim briefly explained the study process and timing and provided an overview of the study’s public involvement efforts.

Key Issues Review and Discussion

Tim then discussed the key issues that will be analyzed by the Central Rail Extension Mobility Study, including the possible alignments, the interface with the current 30th/Downing Station, and the use of the existing light rail loop to provide service to downtown. He explained the main focus of the study is to provide a one seat rail transit ride with no transfers from the 38th/Blake Station into downtown.

For context, Phil Washington summarized the North Metro contract as it relates to the FasTracks rail extensions (a guaranteed construction price for two years), including the CRE. The group then discussed the impact the contract could have on the pricing and design of the CRE (particularly related to shifts from what was included in the EE) and how that could impact this study.

The group asked about the current capacity of the downtown light rail loop and how the CRE will affect that capacity in the long term. Phasing potential was also discussed given the study's early finding that more detailed analysis of the loop is warranted as it may have adequate short-term capacity to accommodate the additional trains that would serve the extension.

Meeting participants agreed that it will be important for the study to look at both near-term implementable opportunities, but to also develop and maintain a long term vision for this corridor that any near-term improvements are building toward.

Tim Baldwin also presented a comparison of the technology options (light rail as planned in FasTracks and streetcar which has been studied recently by local stakeholders) for the CRE and their respective challenges and benefits for this corridor. Tim emphasized that the majority of the issues this study will need to look at are actually technology neutral.

The group also discussed the importance of identifying the issues the Central Rail line faces on Welton Street (e.g. safety, economic development, one-way vs. two-way).

5. Facilitated Discussion on Project Vision and Goals - Andy Mountain

Andy Mountain summarized the goals of the project and the key considerations to success developed with input from the Policy Oversight Committee. The group provided input on additional themes that should be considered either as key considerations or modifications/additions to the goals:

- Planning for adequate parking
- Safety of the rail on the Welton corridor
- Station security
- Inclusions of a Transportation Demand Management component
- The economic and cultural impact of the extension
- Further expansion of the project's grassroots outreach efforts
- Coordination with other stakeholder organizations (e.g. Bike Denver, Walk Denver)
- Working to develop project champions (e.g. possible federal support)

6. Summary and Next Steps - Tim Baldwin/Andy Mountain

Andy Mountain outlined the upcoming project milestones and encouraged meeting participants to help promote the upcoming public meeting and to reach out to Registered Neighborhood Organizations that may be interested in participating in the project's Task Force.

agenda

The group determined that a mixture of one-on-one and group briefings with them should occur at key project milestones.

agenda

Affiliation	Name	Email
RTD	Michelle Brier	Michelle.brier@rtd-denver.com
	Barbara Deadwyler	Barbara.deadwyler@rtd-denver.com
	Angie Malpiede	Angie.malpiede@rtd-denver.com
	Andy Mutz	Andy.mutz@rtd-denver.com
	Mike Turner	Mike.turner@rtd-denver.com
	Nate Herman	Nathan.herman@rtd-denver.com
	Phil Washington	Phil.washington@rtd-denver.com
CCD	Diane Barrett	Diane.barrett@denvergov.org
	Crissy Fanganello	Crissy.fanganello@denvergov.org
	Robin Kniech	kniechatlarge@denvergov.org
	Judy Montero	Judy.montero@denvergov.org
Five Points Business District	Joel Noble	jnoble@frii.com
	Tracy Winchester	tjwinchester@fivepointsbiz.org
Downtown Denver Partnership	Aylene McCallum	amccallum@downtowndenver.com
Project Team	Suzanne Arkle	suzanne@zanninc.com
	Tim Baldwin	Tim.baldwin@sdgworld.net
	Andrea Cunningham	andreacunningham@gbsm.com
	Hannah Eflin	hannaheflin@gbsm.com
	Andy Mountain	andymountain@gbsm.com

Venue	Five Points Business District Office, 2444 Washington St.		
Date	Wednesday, February 12, 2014	Time	5:30 p.m.
Project	Central Rail Extension Mobility Study	Project No.	22567801

Subject **Community Task Force Meeting No. 1 - Draft Meeting Summary**

I. Welcome and Introductions - Andrea Cunningham (GBSM)/Andy Mutz (RTD)

Andrea Cunningham opened the meeting, led introductions and reviewed the meeting’s agenda and goals.

RTD Project Manager Andy Mutz provided background on the Central Rail Extension since its inclusion in FasTracks and the mobility study’s goal to determine the best way to provide a one-seat rail transit ride with no transfers from the 38th/Blake Station on the East Rail Line to downtown.

II. Role of Task Force - Andrea Cunningham (GBSM)

Andrea outlined the role and composition of the Task Force and asked participants for their help in sharing project information with their communities and the project team.

III. Overview of Project Work Plan, Schedule & Key Issues - Tim Baldwin (SDG)

Consultant Project Manager Tim Baldwin reiterated the overall vision of the Central Rail Extension Mobility Study and provided an overview of the previous studies in the corridor.

For context, Tykus Holloway (City and County of Denver) also outlined the current City and County of Denver projects in the vicinity of the Central Rail Extension study area and explained how they relate. RTD and Denver are working in partnership on this study and others to ensure maximum coordination.

Tim summarized the goals of the project and the key considerations that were developed with input from the study’s Policy Oversight Committee and area elected officials.

Tim also outlined the study process and schedule, and provided an overview of the study’s public involvement program beyond the Task Force, which includes: public meetings, elected official and community leader briefings, media outreach, coordination with project partners through a Policy Oversight Committee and a website.

Tim then broke down the study area into three segments and identified key issues that need to be addressed in each: 38th/Blake to 30th/Downing, 30th/Downing to 20th/Welton and Downtown. A video comparing light rail and streetcar technologies was also shown.

V. Breakout Table Discussions and Report Out

Andrea divided the Task Force members into two facilitated breakout groups to discuss issues that the project team should consider in the development of alternatives as it relates to *Vehicle Technology* and *Alignment*. Afterwards, the facilitators presented the following key themes and takeaways from the discussions.

Vehicle Technology:

- A side-by-side economic comparison of the two technologies is needed, but there appears to be no compelling reason for streetcar over light rail in the short-term if light rail vehicles are indeed available in the short-term.
- The maintenance facility required for streetcar could potentially serve as a community asset as it has in other cities (e.g. tourist attraction, coffee shop, facility tours).
- Federal funding opportunities and challenges for streetcar need to be explored.
- Economic development is a key consideration in the technology discussion, but transit is not the only factor affecting the Welton Street corridor's development.
- Light rail is perceived to have an adverse impact on residential streets.
- It's important to remember that the infrastructure used for light rail trains can also be used for streetcars without significant changes (e.g. they use the same tracks and catenary).

Alignment (additional Task Force considerations noted on attached maps):

- The study needs to understand/consider travel patterns and key destinations in and around downtown.
- Increased transit service in Five Points will be important to balance out the robust service downtown.
- Transit improvement may be able to help Welton Street become more of a destination.
- Providing a connection to Broadway/Colfax/Civic Center is vital.
- The possibility of streetcar technology on Colfax may be key in making an alignment decision.
- Ridership may depend on a connection to the Downtown Loop. Stations and stops on Welton may need to be re-evaluated.
- Use of Downtown Loop should be considered in the short-term.

Other Key Considerations:

- Capacity of both the Downtown Loop and vehicles is a concern, especially given the planned growth/density in neighborhoods like RiNo, LoDo, etc.
- Ridership numbers and travel patterns will be critical in decision making. RTD should work with the local communities to better understand future growth plans so they can be reflected in the ridership modeling.

- Pedestrian crossings should be a key consideration.
- Phasing of technology should be considered. For example, consider the possibility of implementing light rail first (if vehicles are available) and eventually transferring to a streetcar technology once the vehicles need replacement and/or as other potential streetcar routes in Denver are realized.

For clarification, Andy Mutz explained RTD's financial situation as it relates to the Central Rail Extension. RTD has FasTracks funds budgeted for the extension, but there is no current money available in the FasTracks account. According to RTD's most recent cash-flow forecast, FasTracks money for the Central Rail Extension will not be available until well into the future.

There was much discussion about the potential benefits of being able to implement the extension sooner (e.g. before or shortly after the East Rail Line opens, as proposed by the North Metro contractor) and there was resounding support from Task Force members for RTD to collaborate with the City and other local partners to explore creative funding sources that would allow RTD to take advantage of the North Metro contractor's bid, or other opportunities to construct the line sooner. RTD is looking at ways to do this, but without a new funding source, implementation could be many years away.

Given the funding realities, Tim explained that this study will focus on determining the long-term vision for the entire Central Rail corridor, while at the same time prioritizing what elements should be implemented in the event funding becomes available sooner than currently anticipated. Many Task Force members pointed out that the near-term implementation priorities should support and be designed to easily adapt to the long-term vision.

VI. Next Steps

Andrea outlined the upcoming project milestones in the alternatives development process. Meeting participants were encouraged to help promote the upcoming public meeting on February 26 and share project information with their communities.

meeting summary

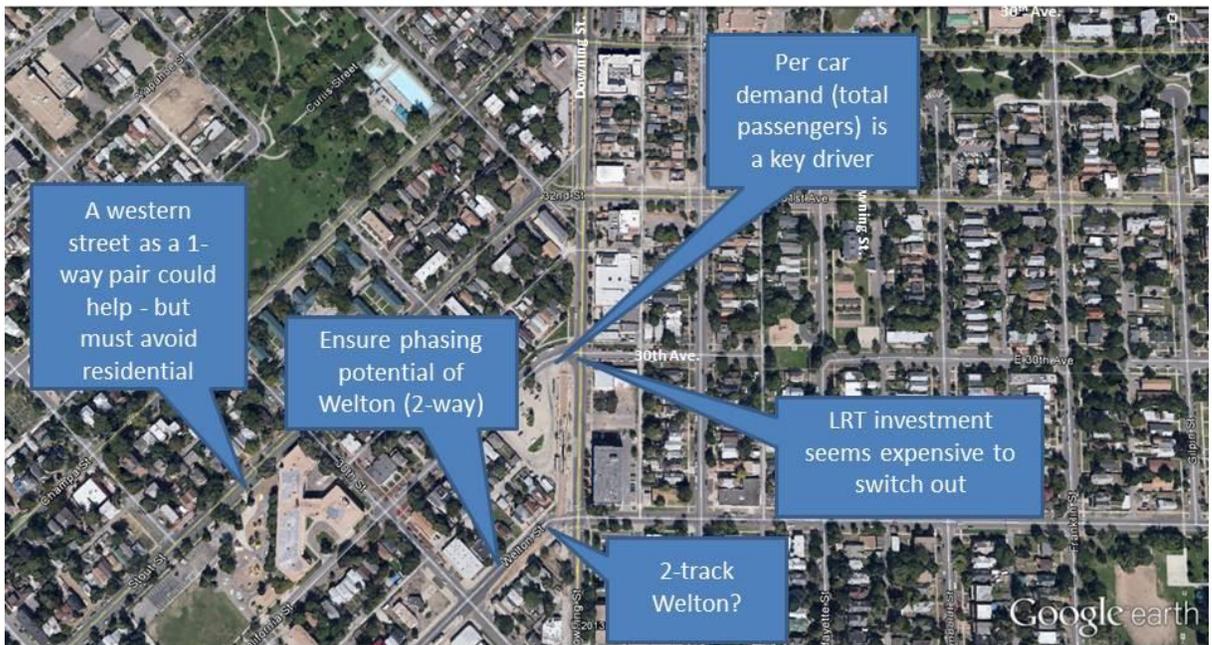
ATTENDEES			
Affiliation	Name	Email	Attended meeting
RTD	Michelle Brier	Michelle.brier@rtd-denver.com	X
	John Elias	john.elias@rtd-denver.com	X
	Andy Mutz	Andy.mutz@rtd-denver.com	X
	Mike Turner	Mike.turner@rtd-denver.com	X
CCD	Tykus Holloway	Tykus.holloway@denvergov.org	X
Project Team	Tim Baldwin	Tim.baldwin@sdgworld.net	X
	Andrea Cunningham	andracunningham@gbsm.com	X
	Hannah Eflin	hannaheflin@gbsm.com	X
	Shari Frank	shari.frank@sdgworld.net	X
	Carlos Hernandez	hernandez@foxtuttle.com	X
	Rene Martinez-Stone	renee@perspective-3.com	X
	Andy Mountain	andymountain@gbsm.com	X
	Jean Sanson	Jean.sanson@sdgworld.net	X
Capitol Hill United Neighborhoods, Inc.	Geneva Hooten*	geneva.hooten@gmail.com	X
Curtis Park Neighbors	Joel Noble*	jnoble@frii.net	X
Denver Police Department	Jim Rose	James.rose@denvergov.org	X
	Jeff Hasner	jeff.hasner@denvergov.org	X
	Mark Rossi	mark.rossi@denvergov.org	X
Elyria Swansea/ Globeville Business Association	Larry Burgess	LBur238057@msn.com	X
	Cliff Lind*	Cliff.Lind@Otak.com	X
Five Points Business District	Tracy Winchester*	tjwinchester@fivepointsbiz.org	X
LoDo District, Inc.	Mike LaMair*	mel@riverbank3030.com	X
River North Art District / RiNo Urban Improvement Committee	Andrew Feinstein*	afeinstein@exdomanagement.com	X
	Robert Paul		X
RTD District C Designee	Linda Dowlen*	lgdowlen@gmail.com	X
San Rafael Neighborhood Association	Mark McClung*	mark@starbuckrealtygroup.com	X
United Community Action Network Inc.	Drew Dutcher*	drewdutcherdirect@gmail.com	X
Whittier Neighborhood Association	Jordan Dietrich*	jordandietrich@hotmail.com	X

*Denotes a designated Task Force Representative

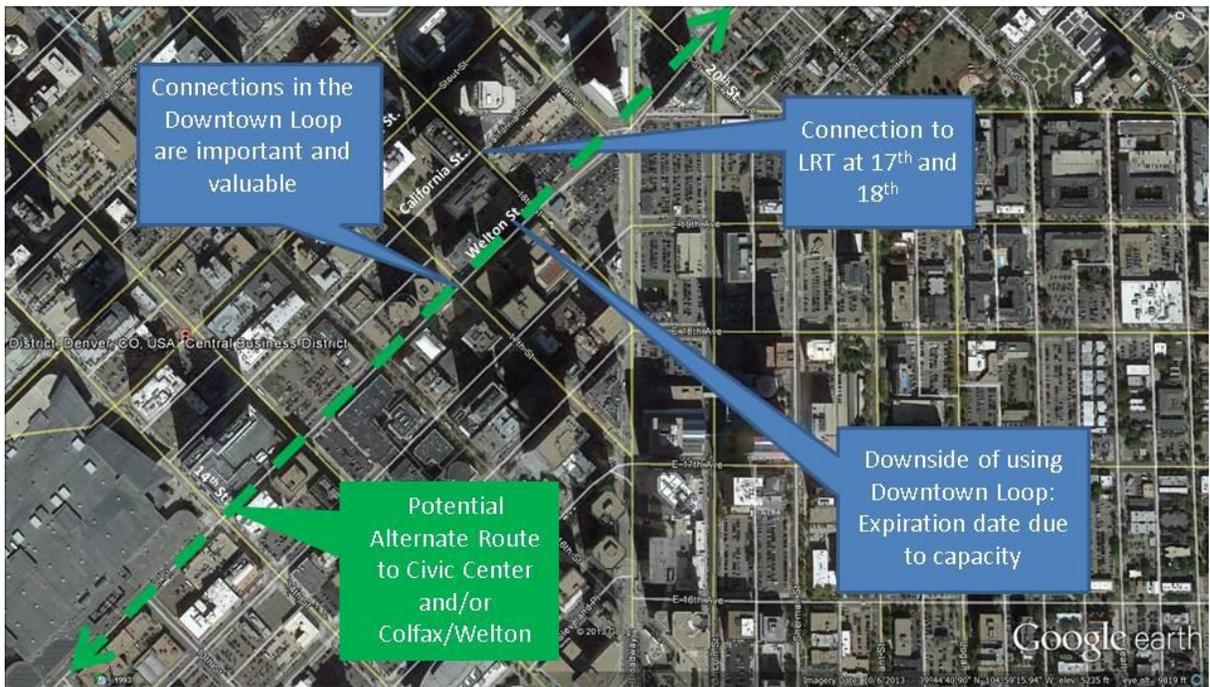
38th/Blake



30th/Downing



Downtown Loop



Civic Center



RTD FaTracks

Central Rail Extension

Issue Maps

The maps below identify the input collected on maps at the public meeting. Attendees were asked to identify specific issues and opportunities that they hoped would inform the analysis completed in this study.

Downing/36th



Welton Corridor



RTD FaTracks

Central Rail Extension

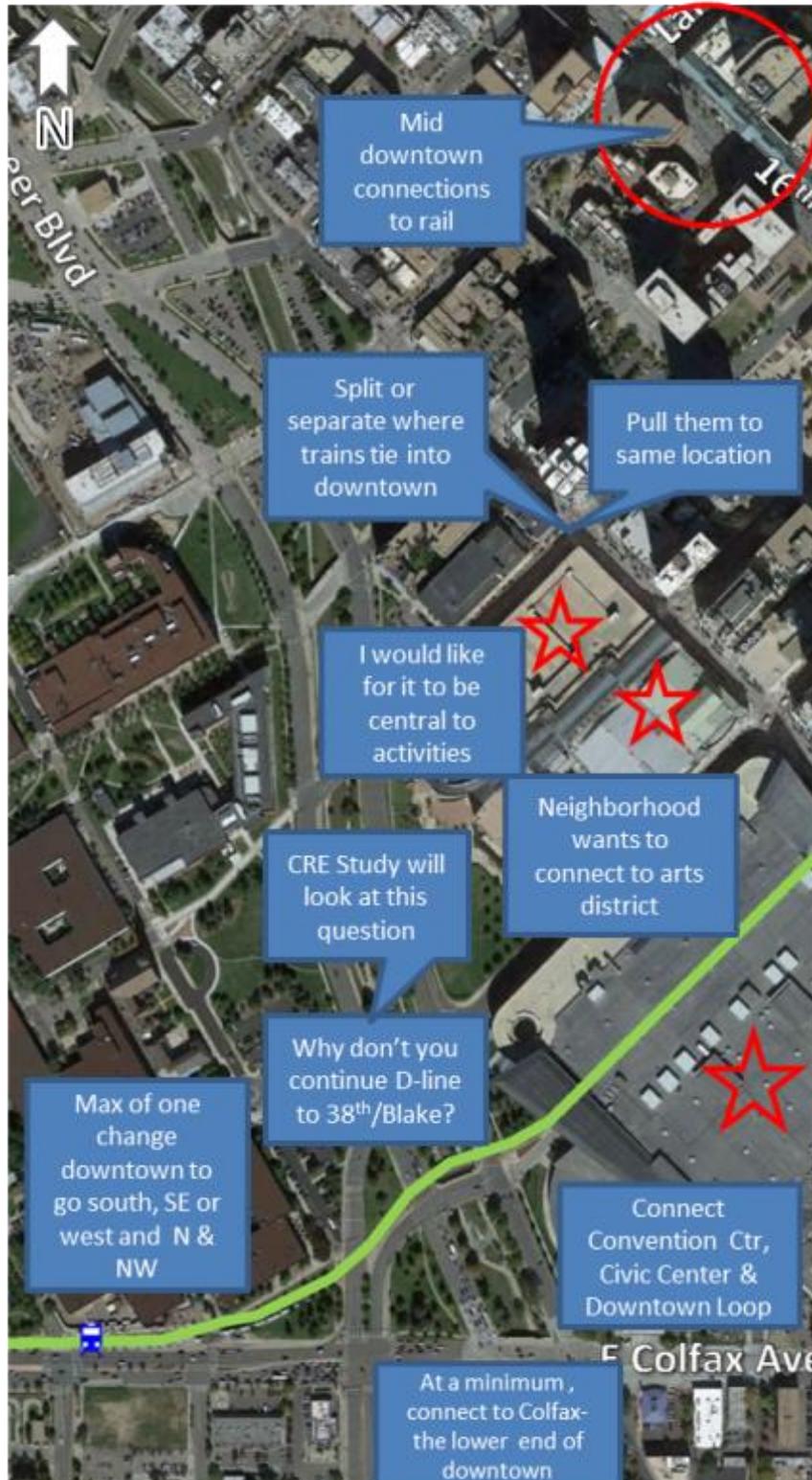
Welton Corridor



RTD FaTracks

Central Rail Extension

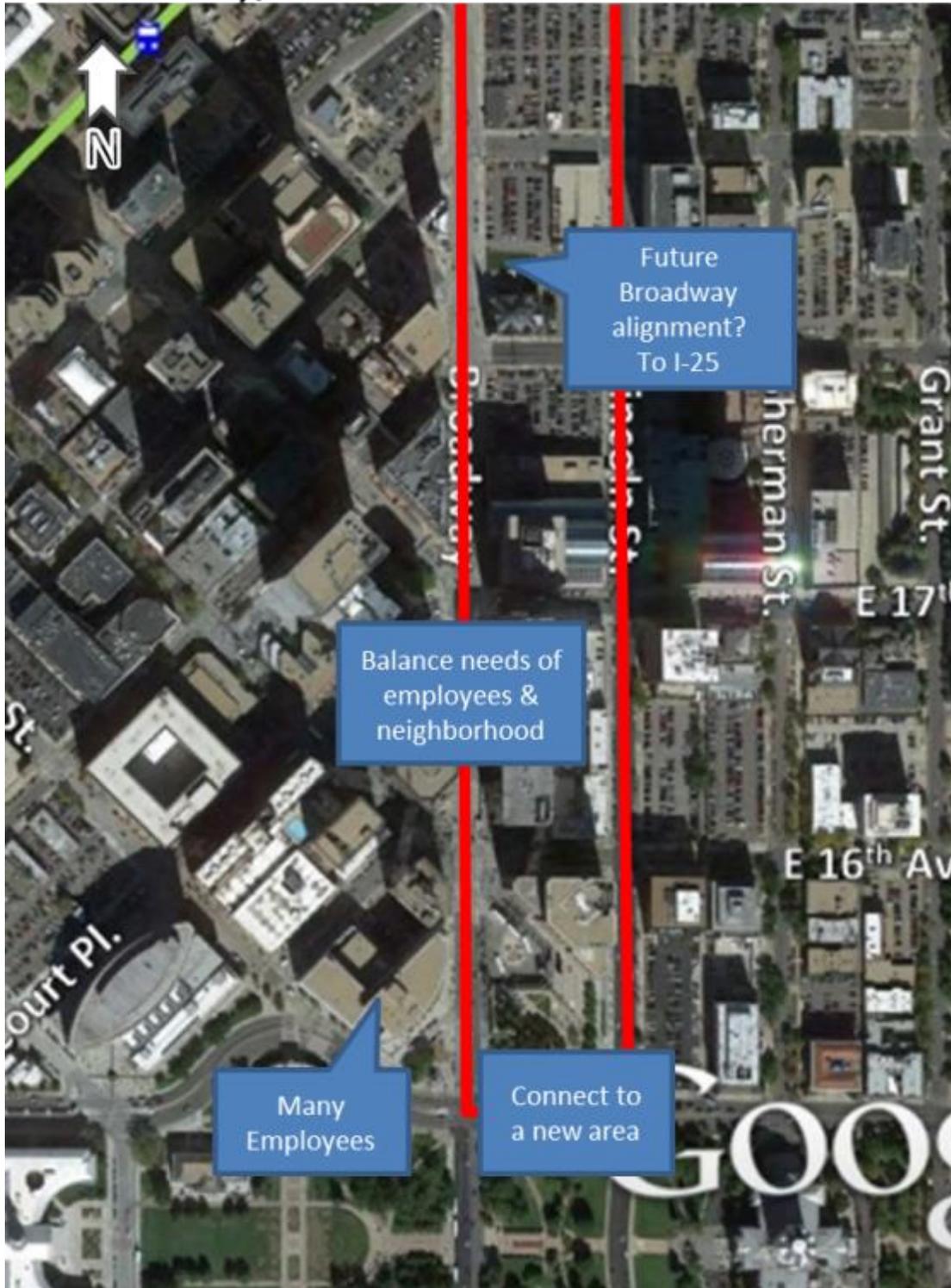
Connections to the Southwest



RTD FaTracks

Central Rail Extension

Broadway/Lincoln



RTD FaTracks

Central Rail Extension

Downtown Loop



Southeast of Welton





Central Rail Extension Mobility Study Kickoff Public Meeting Input Summary

February 26, 2014

The kickoff public meeting for the Central Rail Extension Mobility Study was held on Wednesday, February 26 at the Blair-Caldwell African American Research Library on Welton Street.

The meeting was well attended with good representation from the neighborhood groups and elected officials in the study area – 71 members of the public attended including four elected officials from RTD and the City and County of Denver.

The public was asked to help identify issues that the study team should consider in its development of alternatives as well as provide input on near/long-term priorities for the implementation of the Central Rail Extension.

Comment Themes

Based on the comment forms received and one-on-one discussions with the study team, the following themes emerged:

- **Enthusiasm for the possibility of near-term implementation:** Many stakeholders expressed excitement about the possibility of the extension opening in close conjunction to the opening of the East Rail Line. The overwhelming sentiment was that establishing any rail connection sooner is better than doing nothing until a grander vision can be achieved. Concerns remain about when exactly funding will be available in the near-term and what the definition of “near-term” really means.
- **The one-seat ride is a priority:** There was strong support for the project’s goal of ensuring a transfer-free trip between the 38th/Blake Station and downtown. Given the relatively short distance, a transfer is considered extremely unattractive.
- **Other connections should be considered:** Many people indicated that they would like the Central Rail Line to provide access to other central portions of downtown (see map notes for specifics). A triangular-type loop that could also potentially serve Uptown, Capitol Hill and the Golden Triangle areas was suggested. There was less support for a Lincoln/Broadway alignment due to fewer activity centers in the area. Some concern was also expressed about the plan to have Central Rail Line trains no longer continue south along the D Line.
- **Concerns with existing service and future capacity:** Given the expected growth in and around the study area, there is some concern that the proposed service plan and existing single track section along Welton Street could create capacity issues for the line in the near- and long-term.

RTD **FasTracks**

Central Rail Extension

- **Some concern with mixed-flow operation on Downing Street:** Although this was determined in the EE, a few people expressed concerns about potential delays caused by mixed-flow operations (trains sharing lanes with vehicles) on Downing Street. It was noted that coordinating the connections (traffic, signal timing, etc.) between the Central Rail Extension and the East Rail Line will be important for reliability.
- **General perception that streetcars are more neighborhood-oriented than light rail:** There is a general opinion among many stakeholders that streetcar may be more ideal in the long-term for the neighborhoods it travels through and the surrounding business districts.

Comment Form Responses

The public was asked two multiple choice questions regarding short- and long-term priorities – the results of which are outlined below. This data is representative of those who chose to complete a comment form, not necessarily of all those in attendance. The public comment form will be available on the project website until March 14 in order to gather more input.

Rank	Question 1: What are the three most important priorities to consider in developing the long-term vision for the Central Rail Line?	Total
1	Integration into the downtown transportation system (transit, vehicles, pedestrians, bicycles)	11
2	Enhancing pedestrian connections/access	6
3	Economic development	5
4	Sufficient capacity to meet future demand (e.g. more frequent service, longer trains)	4
4	Security around stations	4
5	Transit vehicle type (light rail, streetcar)	3
6	Enhancing bicycle connections/access	2
7	Community character	1
7	Safety (vehicles, cyclists, pedestrians)	1
7	Stations (location, design, etc.)	1
8	Other	0

RTD FaTracks
Central Rail Extension

Rank	Question 2: If money is identified to implement something sooner that builds toward the long-term vision, what would be your top three priorities?	Total
1	A transfer-free connection from the East Rail Line into downtown	9
2	Pedestrian connections/access	7
3	Stations (location, design, etc.)	3
3	Bicycle connections/access	3
3	Design that reflects the community character	3
4	Other (single-track to double-track)	1
5	No major priorities – getting something implemented is most important	0

Venue	Dominion Towers Conference Room (23 Floor)		
Date	Wednesday, June 18, 2014	Time	9:00 a.m. - 12:00 p.m.
Project	Central Rail Extension Mobility Study	Project No.	22567801

Subject Community Development Workshop - Draft Meeting Summary

Agenda

1. Project Overview
2. Challenges and Opportunities of the Downtown Loop
3. Alternatives Review and Optimization
4. Summary and Next Steps

Option-Specific Comments *(see below for maps)*

Option 3A

- Concern that existing tracks already complicate the pedestrian crossing on 14th Street/Stout Street and make it confusing for pedestrians, especially those that are not familiar with the area (e.g. Convention Center visitors).
- Support for a low impact/small footprint station at the Convention Center, but concerns that the narrow sidewalk in 3A may create a pinch-point for pedestrian traffic.

Option 3B

- Pedestrian crossing was generally viewed as more intuitive — eliminates the “triangle” island at 14th and Stout Street.
- Expanded sidewalk/pedestrian environment on 14th Street provides more opportunity for storefronts and other future development. Some existing streetscape may be impacted, but the benefits of this option seem to justify the impact.
- Signal timing is a concern adding additional conflicts because of the need for longer pedestrian crossing cycles and the elimination of the current all-walk phase (e.g. traffic back-ups at the intersection of Stout Street and Speer Boulevard).
- Concerns with interaction of bikes and other modes (e.g. width of bike lane between trains and vehicles, angle of bikes crossing tracks).

Overall Comments

- A one-seat ride is an important benefit.
- Maintaining and supporting a pedestrian-friendly, urban environment in downtown Denver is paramount.

- General support for a low impact station at the Convention Center.
- Some question of how adding more trains in the loop will work with signal timing. Modeling should attempt to account for existing delays to ensure the Central Rail will integrate well during sub-optimal conditions.
- Ripple effects to the rest of the system (RTD operations and Denver signal timing) must be carefully considered.
- Low-floor vehicles are generally preferred because of their smaller, neighborhood friendly profile.
- Concerns with blocking private property access and increased traffic build-up if a train is stopped in the pocket track on Stout Street. This condition happens now when a southbound train gets stopped on Stout Street at the 14th Street light.

Meeting Participants

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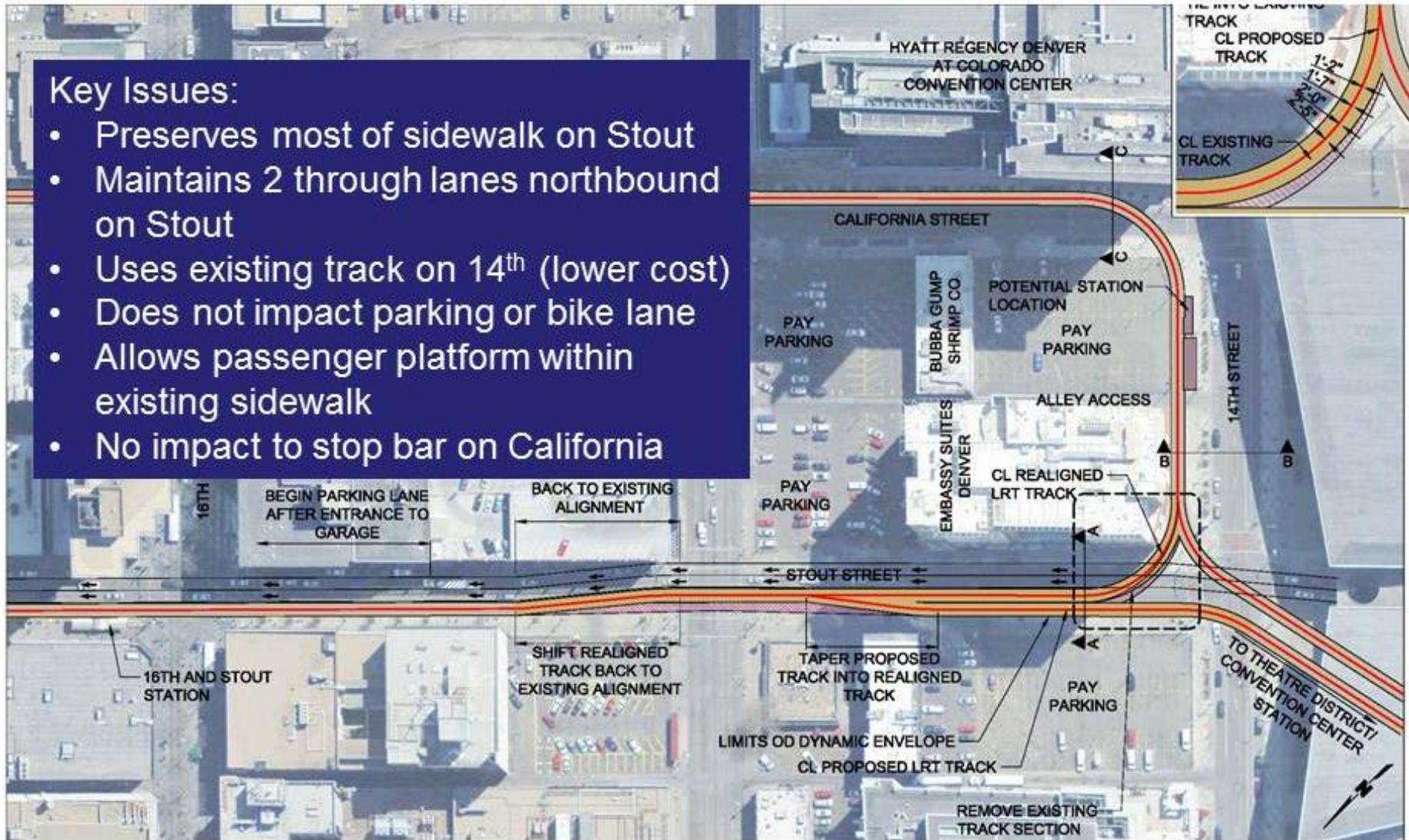
Project Team

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Option 3A

Key Issues:

- Preserves most of sidewalk on Stout
- Maintains 2 through lanes northbound on Stout
- Uses existing track on 14th (lower cost)
- Does not impact parking or bike lane
- Allows passenger platform within existing sidewalk
- No impact to stop bar on California



Option 3B

Key Issues:

- Preserves most of sidewalk on Stout
- Maintains 2 through lanes northbound on Stout
- Eliminates 9 parking spaces
- No impact on bike lane
- New track (higher cost)
- Requires new pedestrian crosswalks
- Provides wider pedestrian plaza on 14th, opportunity for 'storefront development'
- Potentially moves stop bar on California farther south



How important is ensuring a one-seat ride between downtown Denver and the future 38th/Blake Station on the East Rail Line?

Very Important	Somewhat Important	Neutral	Somewhat Unimportant	Not Important
72%	14%	0%	0%	14%

How important is it to you for the Central Rail Line to stop at the Convention Center?

Very Important	Somewhat Important	Neutral	Somewhat Unimportant	Not Important
29%	57%	14%	0%	0%

Note: This information is reflective of input received from the eight stakeholder organizations that participated in the Community Development Workshop. For more detail on the discussion from this workshop refer to the Meeting Summary.

DRAFT
Central Rail Extension Mobility Study
Public Meeting 2 Input Report

Public Meeting Details

Wednesday, July 16
5:30p.m. - 7:30 p.m.
St. Charles Recreation Center
3777 Lafayette Street
Denver, CO 80205

Attendees

46 meeting attendees

Comment Form Responses *(Reflects all comment forms completed at this milestone, not just those at the public meeting)*

Question 1: How important is ensuring a one-seat ride between downtown Denver and the future 38th/Blake Station on the East Rail Line?

	Very Important	Somewhat Important	Neutral	Somewhat Unimportant	Not Important
#	44	5	5	0	0
%	82%	9%	9%	0%	0%

Question 2: How important is it for RTD to transition to low-floor vehicle technology on the Central Rail Line in the future?

	Very Important	Somewhat Important	Neutral	Somewhat Unimportant	Not Important
#	30	15	6	0	3
%	56%	28%	11%	0%	5%

Question 3: How important is it to you for the Central Rail Line to have a station at the Convention Center?

	Very Important	Somewhat Important	Neutral	Somewhat Unimportant	Not Important
#	33	14	3	2	2
%	61%	26%	5%	4%	4%

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Question 4: With stops at 27th/Welton and 30th/Downing, how important is a stop at 29th/Welton?

	Very Important	Somewhat Important	Neutral	Somewhat Unimportant	Not Important
#	6	4	14	5	25
%	11%	8%	26%	9%	46%

Question 5: Rank your order of preference of the three long-term expansion categories (Civic Center, Southeast Downtown/Golden Triangle and New Central Downtown Loops).

Option	Total 1s	Total 2s	Total 3s	Average Rank
Civic Center	18	21	13	1.90
Southeast Downtown/Golden Triangle	17	18	15	1.96
New Central Downtown Loop	20	9	21	2.02

Raw Observations from Project Team Members

- *Option 3A*
 - Concern about this alternatives as it does not appear to resolve multiple pedestrian crossing conflicts with trains
 - Low support for this option based on the close proximity to the building on the north side of tracks (Embassy Hotel)
 - Support the idea as it provides a “one seat’ ride to the Convention Center
 - Concern about the “blank wall” adjacent to the tracks and how this option improves the visual character of the area
 - Need to know how much money this option would really save vs. option 3B
 - Support for the left-side bike lane

- *Option 3B*
 - Support even if there is the potential disadvantage for motor vehicle traffic (within reason)
 - Support for the idea to create a larger station area
 - Support the idea as it provides a “one seat’ ride to the Convention Center
 - No comments regarding the loss of 9 parking spaces
 - Support for the left side bike lane
 - Simulations don’t show how the “blank wall” is different. How does that really happen? Still support the idea and want to know what it could become?

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- Support for the short and direct pedestrian crossings
- Significantly more support for Option 3B than 3A. One resident of the Spire building on Champa/14th said that he talked to a few neighbors and they all like option 3B as well.

- *Long Term Expansion Options*
 - Neighborhood riders have different destination compared to commuters and visitors connecting from the East Line
 - Options that meander in Curtis Park add travel time that could impact ridership by 5-points neighborhood riders
 - 5-points residents like the access to the current downtown loop as it serves 16th Street Mall and DPAC Complex
 - 5-points residents would like to have a “one-seat ride” to LODO
 - What if the current downtown loop was dedicated to the CRE and a new loop was built for the other lines (David Gaspers with CCD)?
 - How about a new downtown loop on 15th and 17th for the other lines? Let the CRE have the current loop
 - CRE connection down Broadway and Lincoln is good for commuters but not sure it serves neighborhood trips to downtown/DPAC Complex
 - Any new loop should allow the headways to get below 5 minutes, but also allow for different destinations. Maybe every other train goes to downtown core?
 - Connect the dots. Make sure this line would connect to the Colfax and AHEC Campus future lines

- *29th St. Station*
 - The 30th Station is vital and should remain a ‘hub’. If schedules can work, the 29th Street station should remain to serve development coming to Welton. (plus 1x - one additional person said put me down for that same statement)
 - The 30th and 29th stations orient to two different areas of the neighborhood. The 30th station serves the northeast part of the neighborhood and has many buses; the 29th station serves the neighborhood and residences to the east and west. (plus 2x - two additional people said put me down for that same statement)
 - The 30th station serves commercial uses and the 29th station serves the neighborhood to the west and the businesses on Welton.
 - The intersection 29th/Downing is a barrier.
 - The 30th station needs to be a better station; it should be a “premier” hub. 29th is a neighborhood station. (plus 2x - two additional people said put me down for that same statement)
 - It is much more important for trains to run on time in the single-track section THAN it is to re-open the 29th station. (plus 2x - two additional people said put me down for that same statement)
 - When/if we double the track on Welton, the 29th station should reopen.
 - Has RTD analyzed the impact of the 29th station on timing? If so, can this be shared? Other solutions to timing?
 - It is not easy for pedestrians to move from the 29th station area to the 30th station. If this situation is permanent, then the connection needs to be improved, especially at the intersection of Downing/Welton/light rail.

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- I don't think closing the 29th station has improved the train timing. I still see it sitting or wait for a late train. (plus 1x - one additional person said put me down for that same statement)
- The immediate vicinity of the 29th station is residential...it is comfortable and visible (to surrounding uses).
- It is safer to access the 29th station because at the 30th station there is congestion of buses, cars, trains and it does not feel safe from a crime standpoint.
- The 30th station is not comfortable and it is not a pedestrian friendly for the people who are trying to access, especially with families with kids.
- I don't see stations as bad as the 30th station in other areas; just here in Five Points.
- Has crime changed at the 30th station since the 29th station closed?
- The 29th station wasn't what created the timing issue; the problems/slowing start further down at 24th and 20th.
- Rail is not integrated into the neighborhood. (reference to more comfortable stations with good neighborhood pedestrian connections).

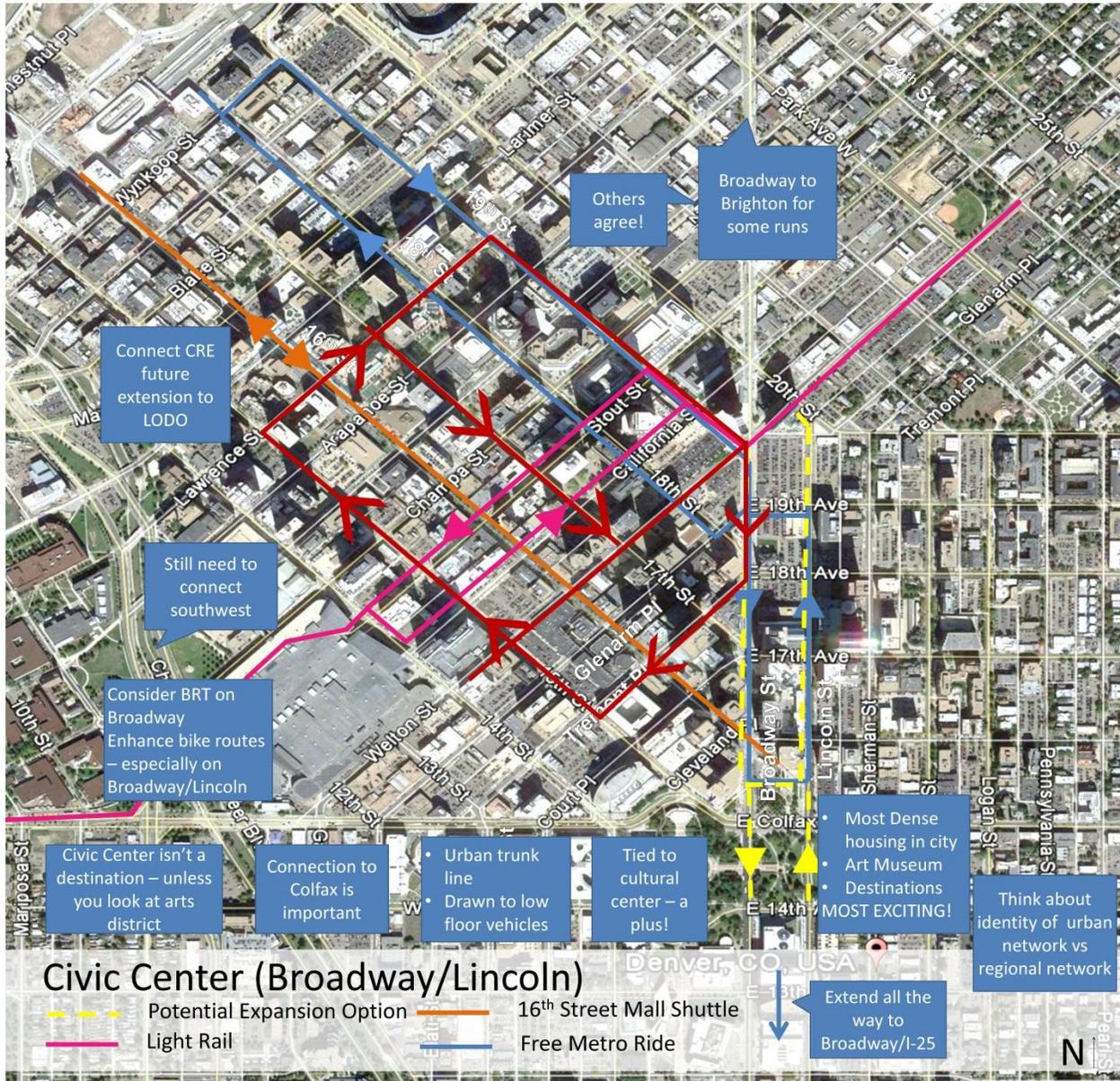
- *Welton Street Corridor*
 - I would like to see a two-way Welton. It would be better for the businesses. It is hard to see the empty storefronts and having people pass more than on their way out of town would be good for business.
 - I really hope that they (RTD) are hearing that the community wants a better long term solution. Yes, we got the first light rail, but we also got many of the issues and difficulties that we can fix now.
 - We need two tracks to handle all of the people who will come off of the east line; it won't be just neighborhood people riding. If not, the timing will be worse.
 - When the street changes and light rail is going two ways...there is going to need to be efforts to prevent accidents because people are real used to the one-way.
 - I am hopeful that RTD is hearing that the community wants and needs something different on Welton. (referred to project goals and short/long term approach to achieve)

- *Other*
 - One person suggested a fence on both sides of the bike lane, but that's really something that Denver would need to address, if there is even room for it.
 - A couple people complained about the long waits at the single-track section.
 - Joel Noble had many good questions about the single-track section. He wanted to know how much room for delays there was before another train was delayed in entering the single-track section. Also, how would priority into the single-track section be done; would it be first-come-first-served or would southbound trains be prioritized as they are today. I offered to look into this further and perhaps try to provide him some info at the next meeting that he'll be attending.

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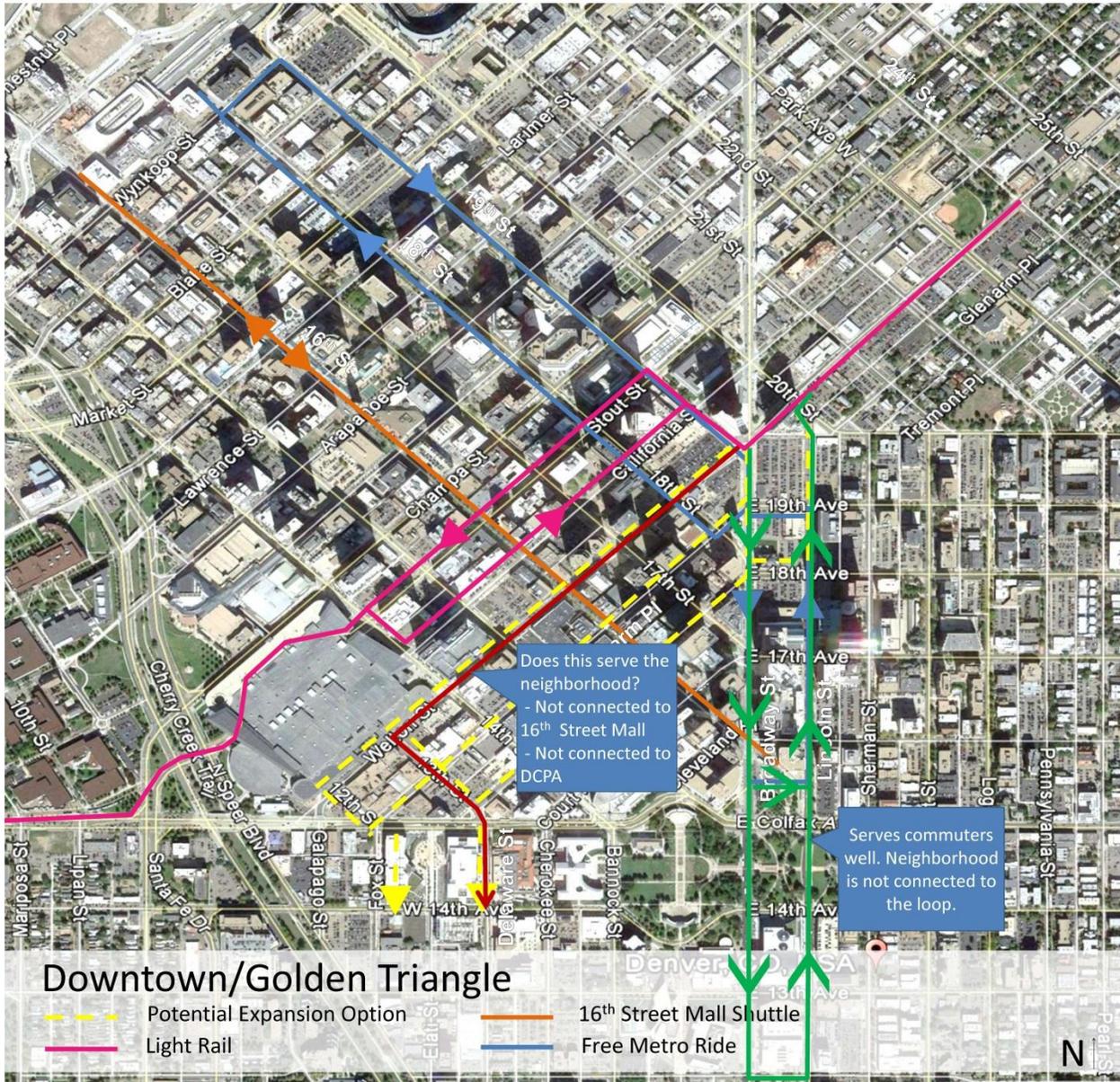
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Long Term Expansion Option Map Comments



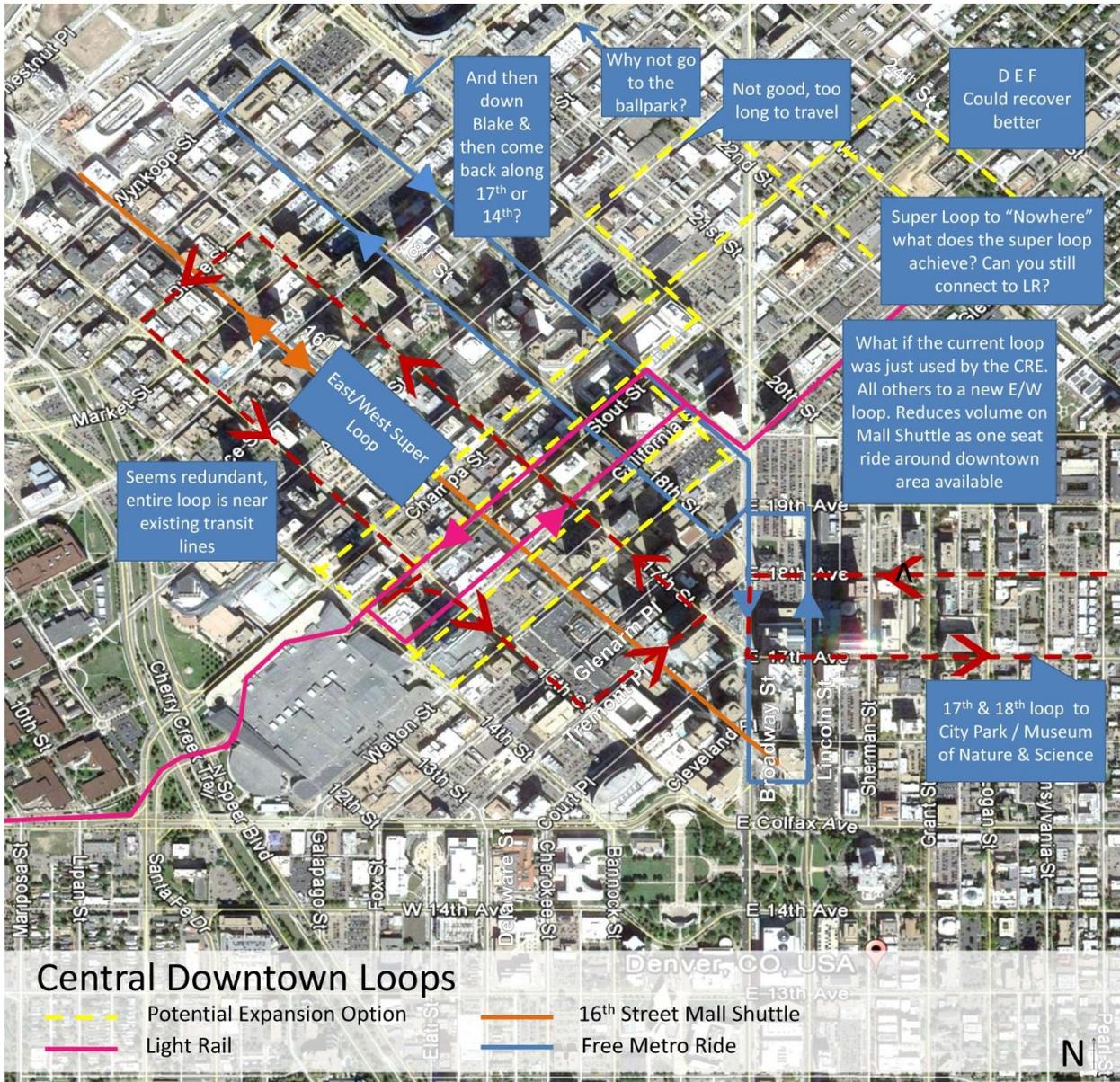
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Central Rail Extension Mobility Study Public Meeting 3 Input Report

Public Meeting Details

Wednesday, November 19, 2014

6:00-7:30 p.m.

RTD 1600 Blake, Rooms T & D

Attendees:

28 meeting attendees

Questions from attendees and responses:

1. **What are the current plans to pursue funding?** Response: RTD was unsuccessful in its attempt to secure Federal (TIGER grant) funding for the project. RTD will continue to work both internally and with potential project partners to find funding for the project.
2. **How much does a corridor like this generally cost?** Response: Current cost estimates for the extension are approximately \$60-\$65 million.
3. **Will you have to do an EA or EIS for any changes to the project such as the downtown pocket track?** Response: RTD will probably need to update and/or amend the previous Environmental Evaluation to clear new elements of the project such as the pocket track, especially if Federal funding is received.
4. **Are the vehicles on the east rail line different from the light rail vehicles?** Response: Yes, the East Rail vehicles are electric commuter rail vehicles that are designed to operate in a freight railroad environment.
5. **Will this allow for a one seat ride to the airport?** Response: No, the one-seat ride refers to the ride from the 38th/Blake station to downtown. A transfer will still be needed at that station.
6. **What will be the frequency of trains arriving to the stations? Will this improve?** Response: Current assumptions are that the system will continue to operate at 15-minute frequencies.
7. **Did you consider BRT for this corridor as an alternative?** Response: This study did not examine BRT as an option. Current FaTracks assumptions are for rail service in

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the corridor. If the community desires BRT as an option, that would need to be considered by the Board in the future.

8. **Are other municipalities contributing towards other projects as the City and County of Denver seems to be expected to contribute funding towards this one?**
Response: Yes, all communities involved in FasTracks are contributing a local share to the overall system.

9. **Would the current configuration of tracks prevent Welton from converting from a one way to a two way street? Will we have to wait for RTD to get funding for this project before the conversion of Welton can take place?**
Response: Based on discussions with the City, current assumptions are that a conversion of Welton Street to two-way would be problematic with the current track configuration, primarily because of signal timing required for two-way operation that would interfere with train operations. This issue will need to be explored in more depth in the future with the City.

10. **The closing of the station at 29th has not improved frequency and connection as it was supposed to. What is the short term resolution for improving frequency, connection and safety at 24th and Welton?**
Response: RTD will continue to try to improve operational reliability on Welton. The closing of the station was both for operational efficiency and cost-effectiveness given that it was generating low ridership. This issue will continue to be explored in the future with the aim of improving overall operational reliability.