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GIS Analysis of Population and Employment Centers in Metro Denver Served by RTD's FasTracks

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Abstract

The Denver regional transit provider, RTD is involved in one of the most ambitious passenger rail expansion projects in the country. Known as FasTracks, the project will add 122 miles of rail and 18 miles of BRT to Metro Denver. Given the scrutiny RTD has faced over budget shortfalls and the likelihood of raising taxes to complete the project on time, this paper used a GIS analysis to determine just how well Metro Denver residents and employees would be served by FasTracks. GIS was also used to determine which corridors and stations would serve the most people, and which high density areas will not be served by FasTracks. Using population data from transportation analysis zones and half mile and one mile buffers around each station, it was found that 30% of residents and 69% of employees within Metro Denver will be within one mile of a FasTracks station, while only 9% of land area falls within a mile of a station. These results indicate that FasTracks will serve residents relatively well and employees very well. Additionally it was found that of the unfunded corridors, the Northwest Corridor to Boulder and Longmont would serve the most residents and employees. A more anecdotal approach was used to identify four high density corridors that will not be served by FasTracks. Future studies could use this same GIS analysis to determine how significantly rail transit along each of these four corridors would improve resident and employee access to high quality transit in Metro Denver.

Introduction

The Regional Transportation District (RTD), the Metro Denver transit provider, is currently in the process of adding 122 miles of light- and commuter rail service, and 18 miles of Bus Rapid Transit (BRT) service to the Denver area. The ambitious project known as FasTracks is one of the largest passenger rail expansion projects in the country. With billions of dollars of public infrastructure money being invested over a fifteen plus year planning and construction process, the question this paper will attempt to answer is how well the new rail and BRT service proposed will serve the people of Metro Denver.

To answer this question, GIS was used to analyze the proximity of residents and employees to the proposed and existing transit stations. Using this analysis the percent of the population within the transit district served by FasTracks as well as which stations and corridors will serve the most people was determined. As a secondary question, this research provided insight into the best location for future corridors or high density areas not served by FasTracks. In addition to measuring the success of FasTracks, data from this research can be used to identify which corridors should have funding priority and where future planning projects should be concentrated.

Background & Context

FasTracks is funded largely through a voter approved 0.4% sales tax, but has recently faced some scrutiny after RTD revealed in 2009 that because of rising construction costs and the loss of sales tax revenue from the recession an additional 2.2 billion dollars is needed to complete the system on time by 2019 (Regional Transportation District 2010). Although TIFA loans, other federal sources, local contributions, and the establishment of public-private

partnerships have help make-up funding for some of the corridors, several corridors have yet to identify funding that will see the system completed on time (See table 1 and figure 1).

Corridor	Completion Date	Funded
Southeast	Mostly Complete	Mostly*
Southwest	Mostly Complete	Mostly*
Central	Mostly Complete	Mostly*
West	2013	Yes
East	2016	Yes
Gold	2016	Yes
Northwest	2016 (Westminster)	Partially**
North Metro	2019?	No
I-225	2019?	No
US 36 BRT	2019?	No

Table 1 Completed, funded, and unfunded corridors. *Only small sections of the Southeast, Southwest, and Central Corridors are unfunded, with most of these corridors already in service. **Only a fraction of the Northwest Corridor is funded (to Westminster) with construction of that portion to begin in 2011.

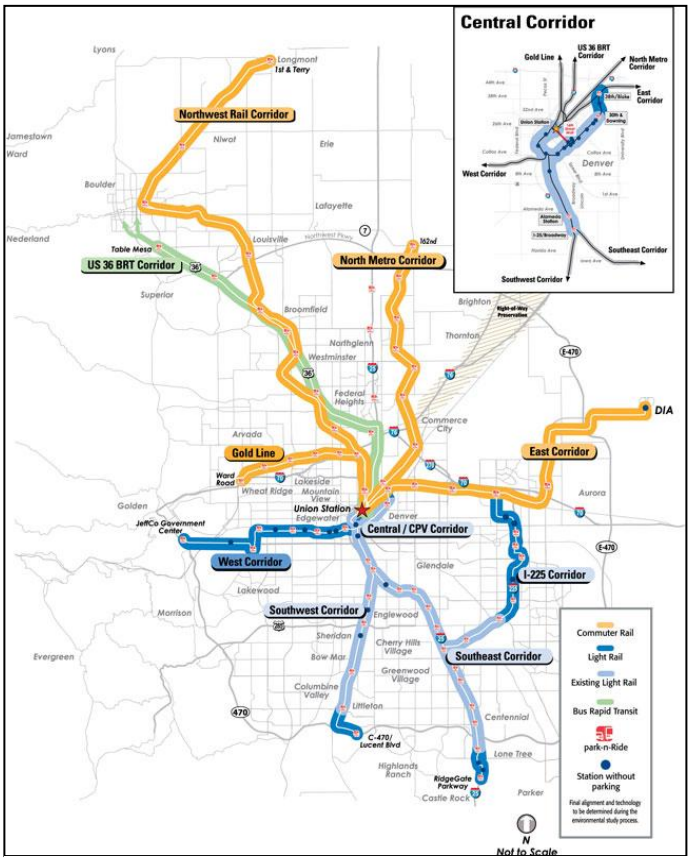

Figure 1 Map of FasTracks corridors (source: www.rtd-fastracks.com)

RTD has recently proposed several short and long term options for funding these remaining corridors, including raising the sales tax 0.1-0.4%, building one corridor at a time, while delaying others, or building part of each corridor over a longer time-frame, possibly to 2040 (Regional Transportation District 2010). Understanding how well the FasTracks system will serve Denver area residents and employees can help garner the needed political support to fund the project. In addition, understanding which corridors will serve the most people can be useful if it becomes necessary to decide which of the remaining unfunded corridors should be built first.

A number of past research studies have used GIS to assess transit accessibility. Lei and Church (2010) identified six different types of methodologies used to measure transit accessibility from using simple distance buffers around transit stations to factoring in street configuration, travel time, schedule, transfers, etc. This project incorporates the most simple of these types of analyses, *System Accessibility*, which measures the distance or time a given location is from a transit station. Nyerges (1995) used this type of analysis by mapping ¼ mile buffers around transit stops in Seattle to determine what areas had good transit access.

It has been shown that distance to transit stop is a strong indicator of use, and is inversely related in particular to pedestrian accessibility (Liu, Hueng and Peng 2008). Although the system accessibility measurement used for this project incorporates one of the most important factors in measuring transit accessibility, distance to transit stop, it fails to incorporate other factors such as total travel time, transit schedule, routes, and physical barriers around the station such as disconnected streets or lacks of pedestrian infrastructure that may inhibit accessibility. Unfortunately this is one of the limitations of this project and results should be interpreted with these unaccounted factors in mind. Instead this project will provide a good understanding of how well destinations with high population and job densities will be proximal to a FasTracks station.

Methodology

To perform the analysis, two basic types of data were mapped using GIS, including FasTracks data and population and employment data. The planned FasTracks rail lines and stations, and RTD boundary were gathered from RTD, while population and employment data was gathered using Transportation Analysis Zones (TAZ's) provided by the Denver Regional Council of Governments (DRCOG). The TAZ's are composed of relatively small blocks that

vary in size depending on population density and contain data on the current and projected populations of residents and employees. For this project DRCOG population and employment projections for 2020 were used, at which time FasTracks would ideally be completed.

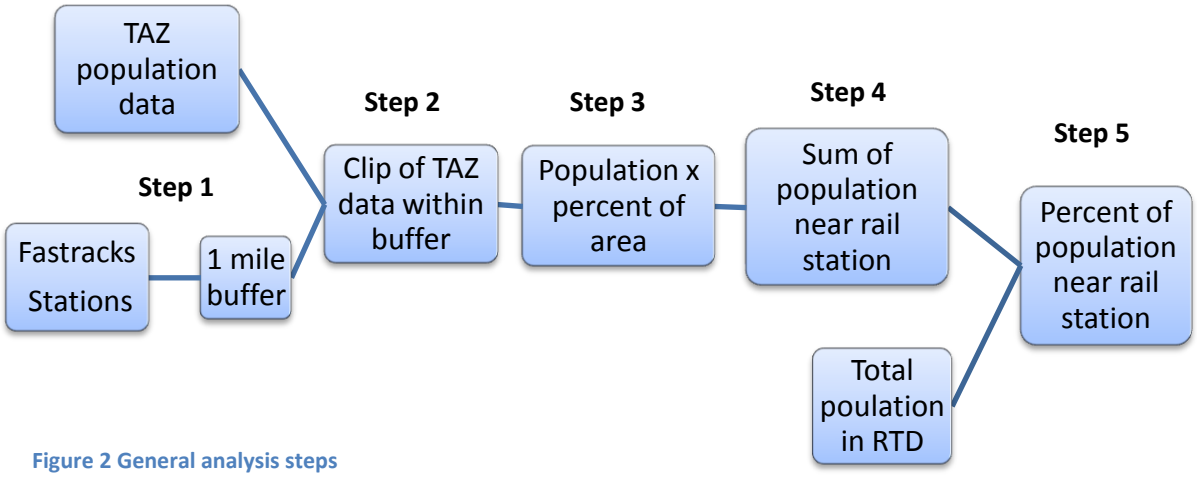

Figure 2 General analysis steps

After mapping this data (figure 3 & 4) the analysis was performed as outlined by the steps in figure 2. Two types of buffers were created around each of the FasTracks stations, half mile and one mile buffers (figure 5). Half mile distance buffers represents walking distance (about ten minutes, assuming average walk speed is three miles per hour), while the one mile buffers represents an area in which people have relatively convenient access by several modes including via bus, car, bicycle or walking in some cases. A 1996 survey of 22 transit agencies in North America found that a light-rail station was considered within in walking distance if it was within a quarter to a half mile (Transportation Research Board 1996). It is also well recognized that far less people will walk one mile than half mile or a quarter mile to a transit stop (see table 2) (Hoback, Anderson and Dutta 2008). However, as has been noted past studies, people are generally willing to walk farther to a rail stop than a bus stop (Transportation Research Board 1996) (Alshalalfah and Shalaby 2007), meaning the catchment area for pedestrians in this study will be at the higher end of what is generally considered walking distance to transit.

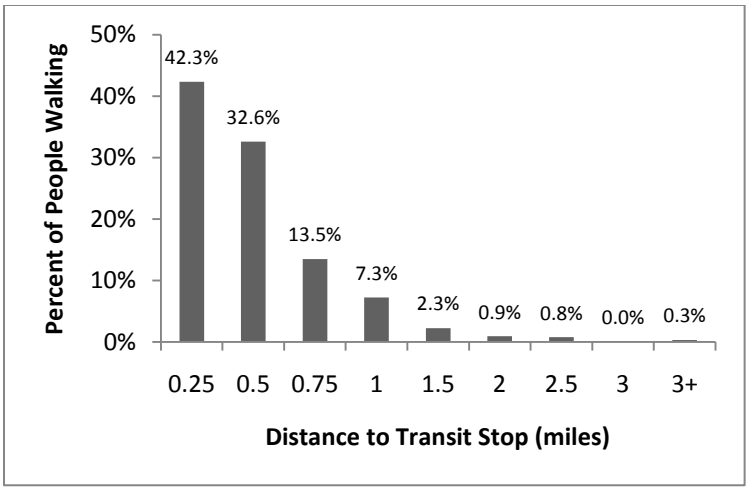

Table 2 Approximate distance people walk based off National Household Transportation Survey of time it takes for people to walk to transit stop, assuming walk time of 3mph (Hoback, Anderson and Dutta 2008).

In Step 2 the TAZ population data was clipped using the station buffer. When measuring the system as a whole, all fields were dissolved to produce one polygon (Figure 5). For the analysis of each corridor, only corridor data was dissolved to produce a polygon for each corridor, and in the station level analysis, the data was not dissolved during the clipping process producing a separate polygon for each station.

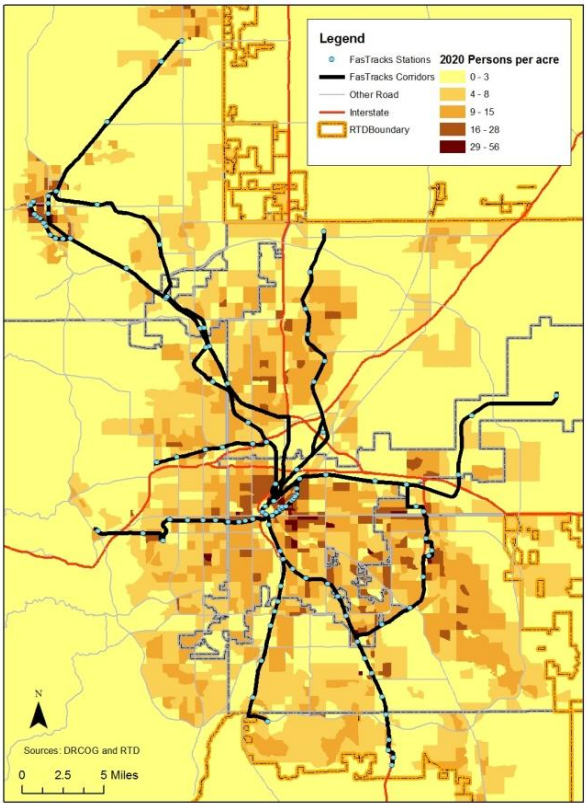

Figure 4 Population Density

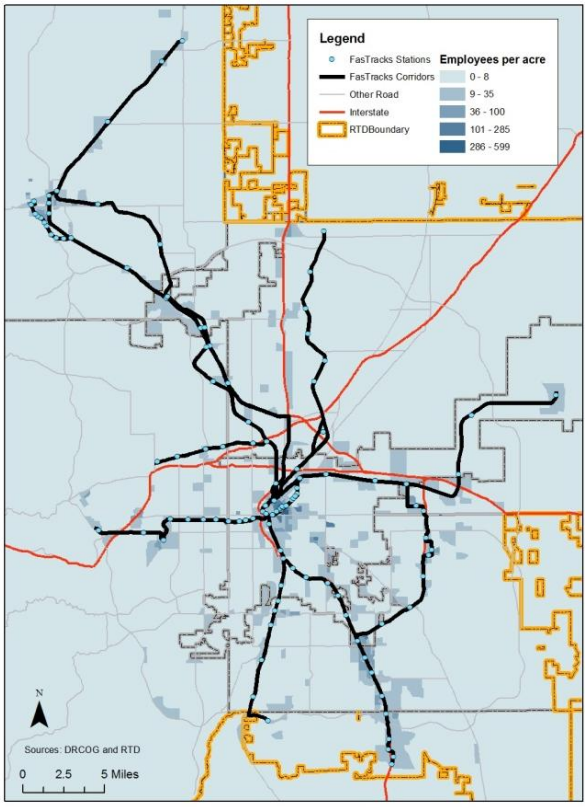

Figure 3 Employee Density

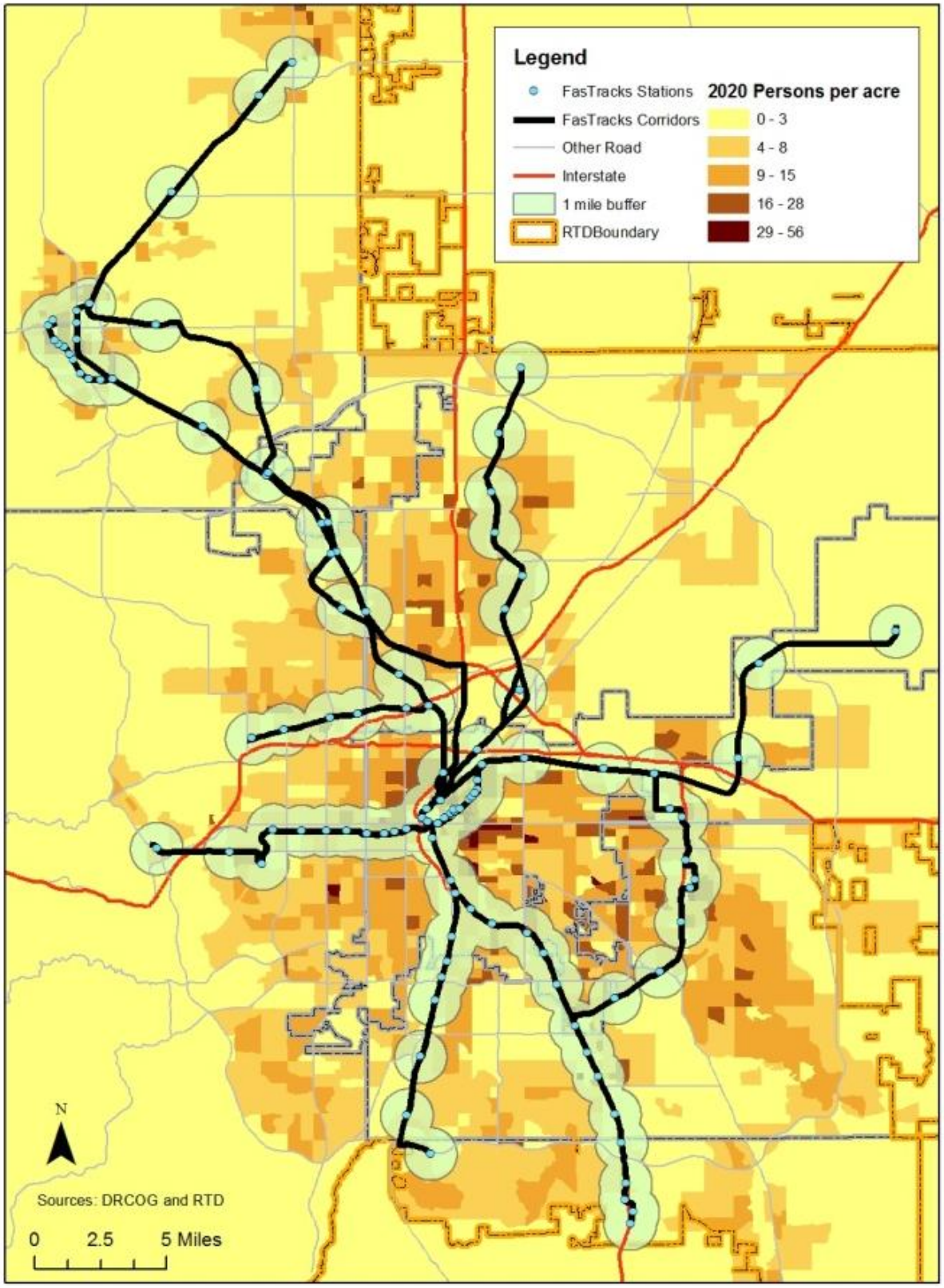

Figure 5 One mile buffer around stations (dissolved)

In step 3, population or employment within the given distance of a station was calculated by multiplying the population or employment data by the proportion of the geographic area of the TAZ within the buffer. This calculation therefore assumes that population is evenly distributed throughout the TAZ. Although this is an unlikely assumption in most cases, the error caused by this assumption is negligible because most of the TAZ's are geographically small in area. In step 4 the population /employees of each TAZ are summed allowing the percentage of people served by FasTracks within the RTD boundary to be calculated in step 5.

To determine if there are any obvious missing corridors, a more anecdotal approach was used. This was done through a simple analysis of the population and employee density maps to determine areas of high population or employee density not within a mile of a FasTracks station.

Results and Discussion

The calculated percentage of residents and employees within RTD's boundary that will be served by FasTracks in 2020 are displayed in table 3. The analysis shows that 30% of the population and nearly 70% of employees within RTD will be within one mile of a station, even though only 9% of the land area is within one mile of a station. Additionally, 11% of residents and 37% of employees will be within walking distance (half mile) of a station. These results show that FasTracks will serve employees very well and residents relatively well in the Denver region.

Distance	1 mile	1/2 mile
2020 Population	30%	11%
2020 Employees	69%	37%
2020 Population & Employees	44%	20%
Total Land Area (Acres)	9%	3%

Table 3 Percent of residents and employees within 1 mile and 1/2 mile of a FasTracks station in 2020

Although the numbers indicate that employees will be much better served than residents, being within walking distance from a rail station to one's job is more important in terms of access than being within walking distance of a rail station from one's home. This means the one mile buffer better represents access for residents, while the half mile buffer better represents access for employees. This is because people are much more likely to drive or bike to get to the station from their home, than using these modes to get to one's job from a station, where they typically no longer have access to a car or bike. A 1996 study of the Calgary light rail found that people walked nearly twice as far to suburban stations, where most riders lived, than those in the CBD, where most riders worked (Transportation Research Board 1996). That report also recommended that the pedestrian catchment area for residential stops be about twice that of office stops.

Part of the discrepancy between employee and resident access has to do with the fact that job centers in the Denver region are much more clustered than residences. Residential dispersion in the Denver area, as in most metropolitan regions in the U.S., stems from years of car-oriented development. The result is a transit system that can be more easily built to serve more employees than residences. One of the hopes behind FasTracks is that its implementation will spur transit-oriented development so that future residential (and office) development will be more clustered around stations. The more this happens, the higher the ratio of people in the Denver Region that will be served by FasTracks.

The results of the corridor analysis which represent the corridors that will serve the most people are are displayed in figure 6 (residents), figure 7(employees), and figure 8 (residents plus employees). In all three comparisons, the Southeast corridor (which has been in service several years) would serve the most people. Of the lines currently under construction, the West corridor

will serve the most people. The most interesting result of the corridor level analysis is that, excluding the Central corridor and Union Station branch downtown (which include all the corridors), the Northwest corridor to Boulder and Longmont, which is currently unfunded, would serve the second most people of any corridor in the system. Based on this data the Northwest corridor would be the obvious choice if a decision was needed to determine which of the currently unfunded corridors should be built next. This is followed by I-225, North Metro, and finally the US 36 BRT (Figure 8). Under current plans, the Northwest Corridor would be the last segment of FasTracks to be constructed (Regional Transportation District 2010).

Figure 6 Population with 1 mile of each corridor

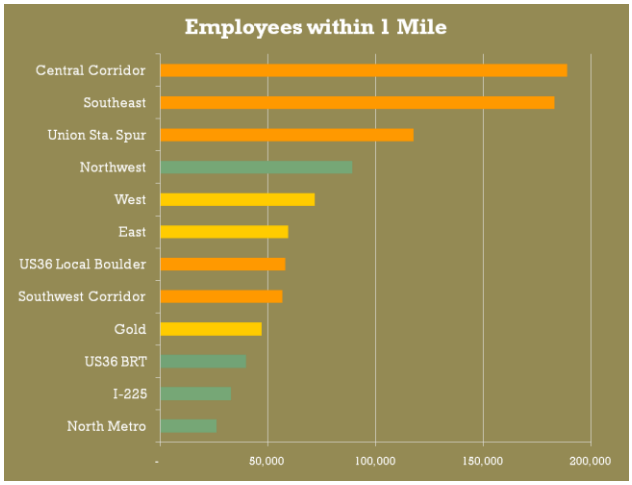

Figure 7 Employees with 1 mile of each corridor

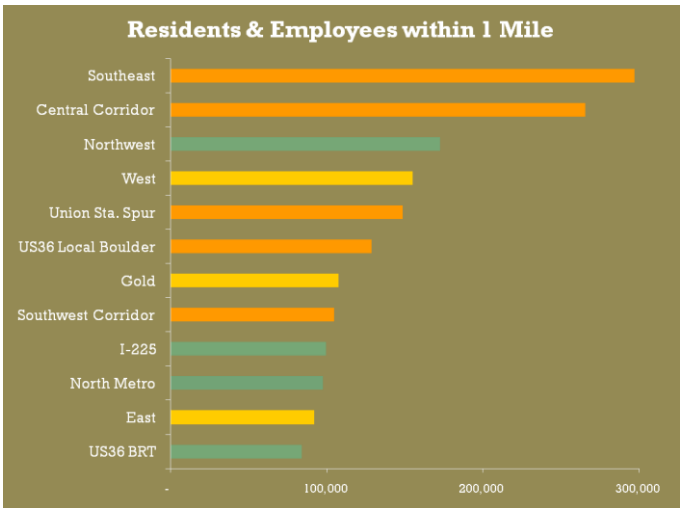

Figure 8 Residents and employees within 1 mile of each corridor

It is also interesting to note that the East corridor to Denver International Airport (DIA) currently under construction is low to moderate in terms of residents and employees served compared to the other corridors. However this corridor will definitely be highly used because it serves the airport, something not accounted for in this analysis. Future analysis of this kind may want to consider incorporating other land uses that serve the population including airports, entertainment venues, shopping centers, civic centers, museums, etc.

STATION	CORRIDOR	POPULATION (1 mi.)
20th & Welton Station	Central Corridor	28,850
25th & Welton Station	Central Corridor	28,422
27th & Welton Station	Central Corridor	28,152
Regent	US36 Local	27,842
Euclid	US36 Local	27,575
18th & California Station	Central Corridor	27,464
29th & Welton Station	Central Corridor	26,641
College	US36 Local	26,375
Boulder Transit Center	US36 Local	26,309
28th/Colorado	US36 Local	26,267

Table 4 Top 10 stations that serve the most residents

STATION	CORRIDOR	POPULATION (1 mi.)
County Line	Southeast	2,406
US36/96th St Rail	Northwest	2,126
Niwot	Northwest	1,624
63rd/Arapahoe	Northwest	1,323
Central Park Blvd	East	1,274
Lone Tree Town Center	Southeast	1,262
Ridge Gate Parkway	Southeast	1,133
160th	North Metro	717
Pena/Tower	East	29
DIA	East	-

Table 5 Bottom 10 stations that serve the fewest residents

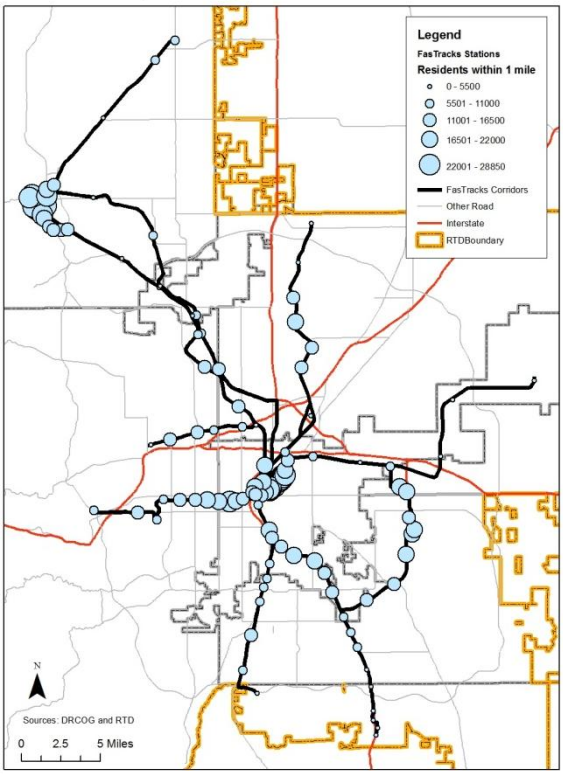

Figure 9 Residents within 1 mile of a FasTracks station

Figure 9 and tables 4 and 5 demonstrate the results of the station level analysis, showing which FasTracks stations would serve the most and fewest people in the Denver Region. This type of data can be used to determine which stations would likely be most used and help identify the appropriate end of line stations if budget constraints forced corridors to be completed in segments. The planned stations that would serve the most residents are located in the high

density areas of Boulder and Central Denver, while the stations serving the fewest residents are scattered around the Metro area, mostly at or near the end of each line. Several of the planned stations in the bottom ten will likely serve many more people than this analysis indicates because they will be located at planned development sites such as Stapleton and Lone Tree. One aspect not captured by this analysis is that the end of the line stations will serve more people than the data indicates because these stations capture riders from a greater area.

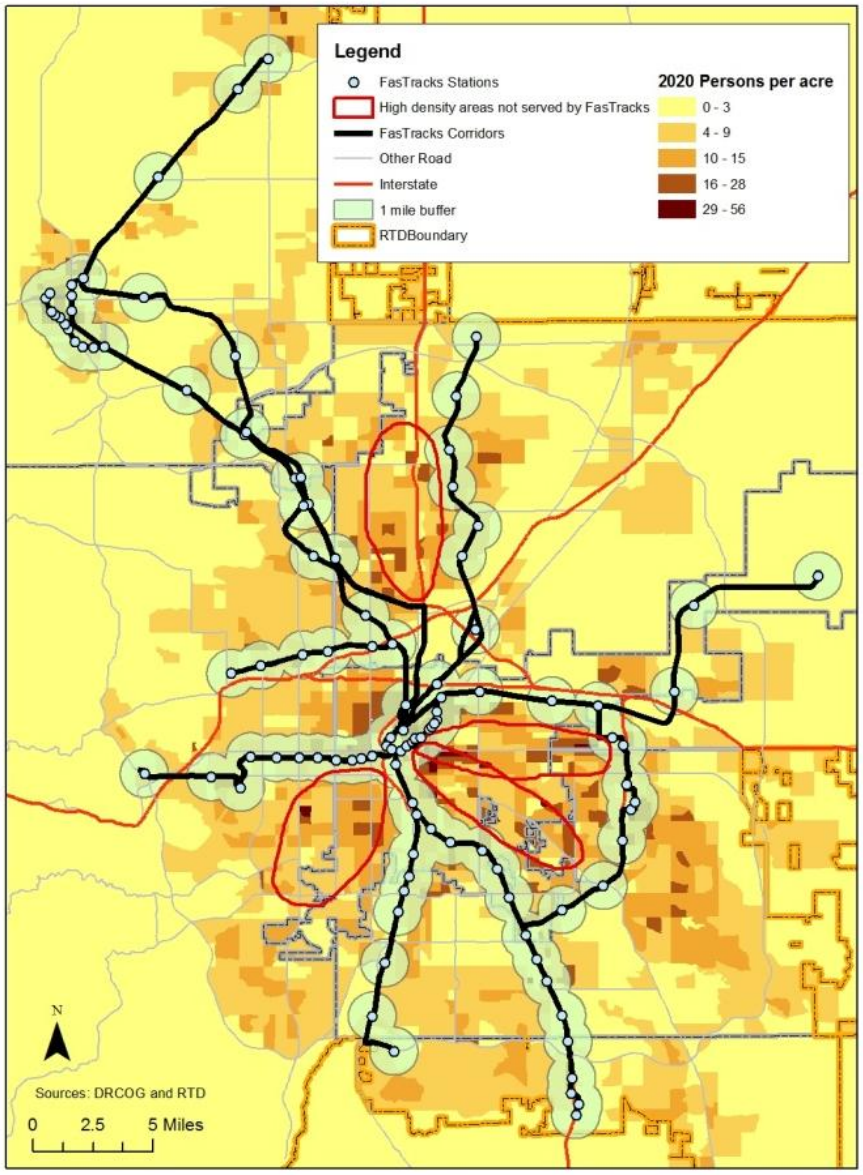

Figure 10 Map showing high density areas not served by FasTracks including East Colfax, Speer Blvd/ Parker Rd, southwest Denver/ west Littleton, and north I-25.

This research also found "missing gaps" or high density places not served by FasTracks. A rough anecdotal analysis of the density maps indicated four primary locations for future corridors (figure 10). These include East Colfax Ave in Denver and Aurora, Speer Blvd and Parker Rd in Denver and Aurora, southwest Denver and Littleton, and along I-25 in Thornton and Westminster. All of the planned FasTracks lines utilize an existing right of way, either a highway or rail corridor. These corridors were chosen not necessarily because they will serve the most people, but often because they are much cheaper and less invasive to private property than building a rail line through existing development. Of the four missing corridors identified in this analysis, only the I-25 line could be built along an existing highway or rail corridor, which is a likely reason these corridors are not part of FasTracks. A more creative approach could be used to provide high quality transit service to these corridors, including a streetcar system. Future analysis addressing these "missing gaps" could use the same analytical approach used in this analysis to reveal which lines would serve the most people.

Conclusion

This study revealed that the planned FasTracks rail expansion will do a reasonably good job at serving Denver area residents, and a very good job at serving employees, although there is much room for improvement. In addition, it was determined that, of the unfunded rail corridors, the Northwest Corridor to Boulder and Longmont would serve the most people, despite the fact that the current plan is to build this corridor last. Data collected in this study was also used to determine which stations will serve the most people and fewest people, which would be helpful RTD ends up building corridors in segments. Finally, future studies could use the same GIS analysis used in this study to determine which of the proposed future corridors would serve the

most people. This type of GIS analysis could also be used when planning transit corridors in other cities to help maximize the number of people served by proposed transit expansions.

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