Leveraging Existing Transit Infrastructure for Equitable Vaccine Distribution

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Advanced Geospatial Methods
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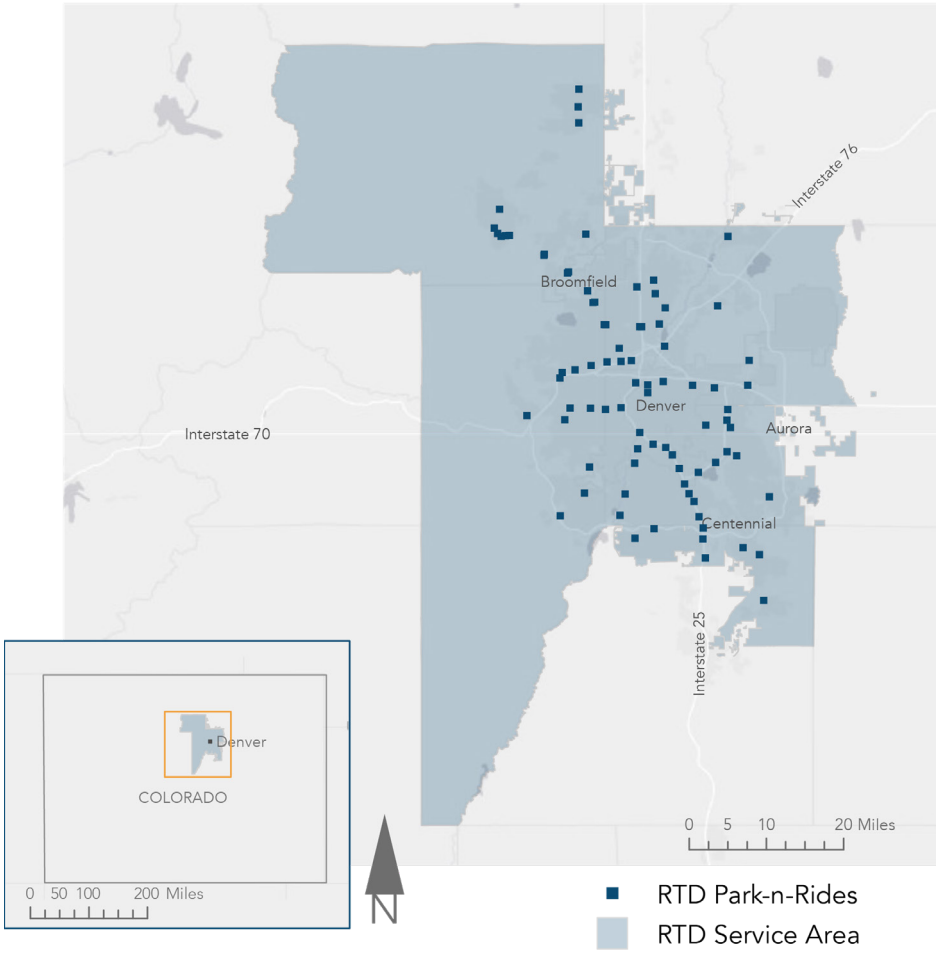
Client: Mile High Connects

FIGURE 1. RTD SERVICE AREA AND PARK-N-RIDE LOCATIONS



BACKGROUND

Mile High Connects is a Denver-based non-profit organization that aims to increase access to housing choices, good jobs, quality schools and essential services via public transit in the Denver Metro region. COVID Check Colorado launched in May 2020 in response to the COVID-19 pandemic and has provided COVID-19 testing. The organization is now working to ensure provision of COVID-19 vaccines to all Colorado residents.

When the COVID-19 pandemic began, Mile High Connects engaged with COVID Check Colorado to identify areas of inequity around COVID-related services, primarily testing and vaccines. Because Mile High Connects prioritizes vulnerable populations who often rely on public transit, they are pursuing a partnership with the Regional Transportation District (RTD), in which RTD would provide the land and infrastructure for semi-permanent vaccine distribution sites in underserved areas. After review of existing RTD facilities and in conjunction with the client, it was determined that RTD Park-n-Ride locations are suited for semi-permanent vaccine distribution sites because of their established infrastructure such as protected areas, utility connections, and existing waste management services.

The study area for this analysis is the RTD service area (see Figure 1). By responding to the following research question, this analysis is intended to help initiate a conversation between Mile High Connects and RTD to explore how RTD can provide resources in the vaccination effort.

RESEARCH QUESTION

Which RTD Park-n-Ride locations are eligible for installation of semi-permanent vaccine distribution sites?

Eligibility is based on the lack of existing vaccine distribution sites in Park-n-Ride walksheds with a 20-minute walking time (1600 meters). Further, eligible sites will be ranked based on demographic data of vehicle availability and income.

METHODS

Collect data within the RTD service area relevant to the analysis.

Dataset: Vaccine Distribution Sites

Due to the fast-moving landscape of COVID-19 vaccine provision in the United States today, there are many sources of vaccine distribution site data. However, due to its availability for analysis, VaccineSpotter.org was selected as the source of vaccine distribution site data for Colorado. First, the data source is not limited to a particular municipality or county, and as the RTD region spans several counties but holds its own unique boundaries, state-wide data was required. Additionally, out of the surveyed sources, VaccineSpotter.org alone provided open-source spatial data which dramatically increased the simplicity of creating this analysis. The data was available in .json format via the vaccinespotter.org/api endpoint and contained point features for the entire United States. The data was imported into ArcGIS Pro and the "JSON to Features" tool was utilized to convert the file type. Then, the layer was clipped to the RTD service area. It must be acknowledged that this data was retrieved on April 11, 2021, and this is the only vaccine distribution site data used in this analysis. Because of the evolving nature of vaccine distribution, it is likely this analysis would change if data were accessed at any other time.

Datasets: RTD Boundary and RTD Park-N-Rides

RTD provides open geospatial data available for download at gis-rtd-denver.opendata.arcgis.com. Due to the determined study area and RTD facilities chosen for assessment, these two datasets were collected for this analysis.

Dataset: Sidewalks

The Denver Regional Council of Governments (DRCOG) provides open geospatial data available for download at data.drcog.org. As a walkable network is utilized for this analysis, sidewalk data from DRCOG was collected and utilized to determine walksheds (see below for further detail.)

Datasets: ACS Median Household Income Variables – Boundaries and ACS Vehicle Availability Variables - Boundaries

These datasets were collected from Living Atlas within the ArcGIS Pro interface. These two demographic variables – median income and vehicle availability – are used to assess potential impact of semi-permanent vaccine distribution sites as they represent characteristics of typically vulnerable populations. The data are available for the entire United States at various boundary levels. The census tract level was used for this analysis.

Determine which RTD Park-n-Rides are suitable for analysis.

RTD refers to Park-n-Rides (PNRs) in two categories – those that serve bus lines and those that serve light rail stations. There was no discernible difference between these two categories that was relevant to this analysis, so both categories are considered. As this analysis considers all PNRs for walkability, PNRs that are outside the available sidewalk data were not considered for eligibility. This is first due to the impossibility of providing a walkshed analysis, and second because these PNRs are generally further from municipal centers and are therefore likely to serve a more car-centric population, which is not the target of this analysis. The list of 84 RTD Park-n-Rides suitable for analysis is found in Appendix 1.

Identify 20-minute walksheds around all RTD Park-n-Ride locations.

Walksheds are approximated to a mile (1600 meters), or an approximately 20-minute walk. A 10- to 15-minute walk is generally accepted as a "walkable distance" for access to most services (Duany, 2021.) This fact was used as the basis for the walkshed distance. However, people are generally willing to travel further for health care than other services (Yen, 2013), and vaccine access is infrequent (maximum twice a year for a two-dose vaccine.) Therefore, a mile was recognized as a suitable walkshed as it increases the Park-n-Ride catchment area. The author recognizes this parameter could be changed in further analysis to accommodate different scenarios and reasoning.

Walksheds were identified by first creating a network dataset with sidewalk data provided by the Denver Regional Council of Governments (DRCOG). As mentioned above, sidewalk data was not available around several more remote Park-n-Rides, which were removed from the analysis. After the network dataset was created, the walkshed parameters were specified, and the Service Area analysis was run, creating walkshed polygons for the available Park-n-Rides.

Determine eligible Park-n-Rides.

For this analysis, "eligibility" is determined by the absence of existing vaccine distribution sites within a walkable distance as defined above. In order to identify eligible PNR walksheds, the vaccine distribution site point layer and the walkshed polygon layer were compared using ArcGIS Pro's "Summarize Within" tool, searching for the number of vaccine distribution sites in each walkshed. The walksheds with zero vaccine distribution sites are considered eligible.

Rank eligible walksheds based on two demographic variables.

Given resource constraints and to provide a more actionable result, eligible Park-n-Rides were ranked based on two demographic variables. These variables were selected based on availability and in collaboration with the client. The first demographic variable is median household income, and the second is percent of households with no vehicles available. Both datasets provide polygon layer data at the census tract level.

These datasets are intended to provide information about an area's vulnerability to lack of access to COVID-19 vaccines – low income and a high percentage of no vehicle access indicates a vulnerable area compared to a neighborhood with the opposite statistics.

After the demographic data was obtained and clipped to the RTD service boundary, the feature layer was rasterized, using the "Feature to Raster" tool (cell size=100). Once the layer was rasterized, the mean of the rasterized data within each walkshed polygon was calculated using the "Zonal Statistics as a Table" tool. In the dataset representing median income, the mean is represented in US dollars. For the dataset representing vehicle availability, the mean is represented in the number of households without access to a vehicle and subsequently calculated as the percentage of total households without vehicle access.

Demographic data was classed into categories and an integer score was assigned to each category, as described in Tables 1 and 2. The author recognizes that the threshold dividing categories is somewhat arbitrary, and that different category boundaries could alter the outcome. The potential drawbacks of this method are acknowledged, and further analysis could select different classes to verify if the rankings of this method hold true.

Table 1. Percent of Households with No Vehicle Available Class Breakdown and Score

	Score
<4%	1
4 – 8%	2
8 – 12%	3
12 – 16%	4
20 – 24%	5

Table 2. Median Household Income Class Breakdown and Score

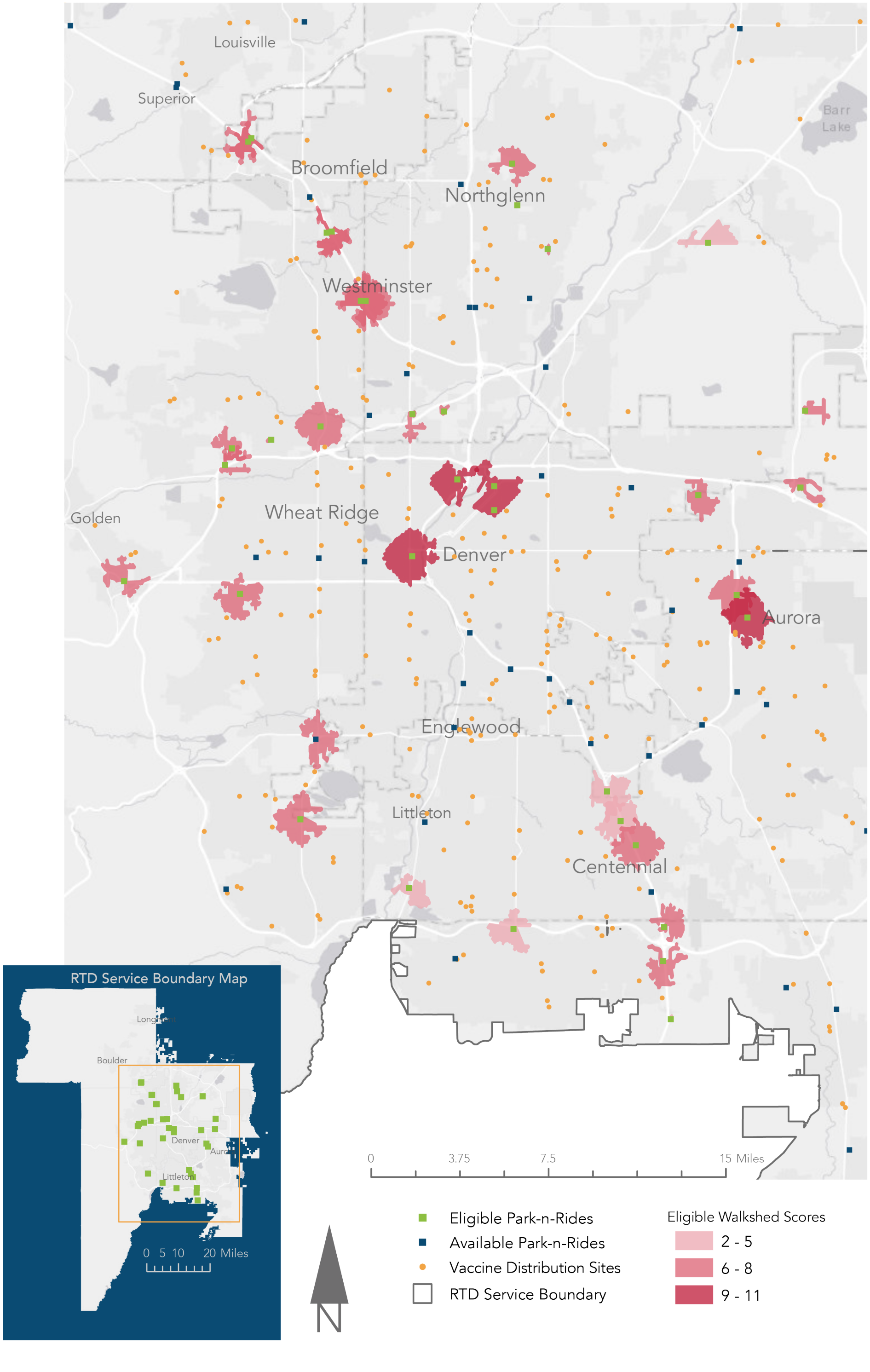
	Score
$42,600 – 67,600	1
$67,600 – 92,600	2
$92,600 – 117,600	3
$117,600 – 142,600	4
$142,600 – 167,600	5
$167,600 – 192,600	6

Figure 2. represents each eligible PNR walkshed's location and score.

Identify 3-5 most eligible RTD park-n-rides for semi-permanent vaccine distribution sites.

To identify the eligible Park-n-Rides located in the most vulnerable areas, the vulnerability score for each PNR walkshed was calculated by computing the sum of each variable. Scores for each eligible Park-n-Ride walkshed can be found in Appendix 2.

FIGURE 2. ELIGIBLE WALKSHEDS



RESULTS AND CONCLUSION

Based on the analysis described above, 36 of 84 assessed RTD Park-n-Rides are eligible for semi-permanent vaccine distribution sites. This means they are outside of a 20-minute walking range from an existing vaccine distribution site. These Park-n-Rides and their infrastructure could be leveraged to fill a gap in vaccine distribution.

Further analysis reviewed demographic data to suggest which Park-n-Rides could be most impactful as semi-permanent vaccine distribution sites. The four most vulnerable eligible Park-n-Rides are the Decatur-Federal Station (Figure 3), 38th and Blake Station (Figure 4), 41st and Fox Station (Figure 5) and Aurora Metro Center Station (Figure 6).

RTD has the opportunity to utilize existing infrastructure within its service boundary to fill a gap in vaccine distribution. Leveraging Park-n-Rides as secure spaces for vaccine distribution aimed at vulnerable, transit-dependent populations could fill a crucial gap in the effort to control COVID-19 in the Colorado population. As mentioned, the landscape of vaccine distribution sites is changing rapidly. This analysis shows gaps in vaccine site distribution at a snapshot in time, so further research should be done to determine if these gaps have been filled in the specified vulnerable areas.

FIGURE 3. DECATUR-FEDERAL STATION

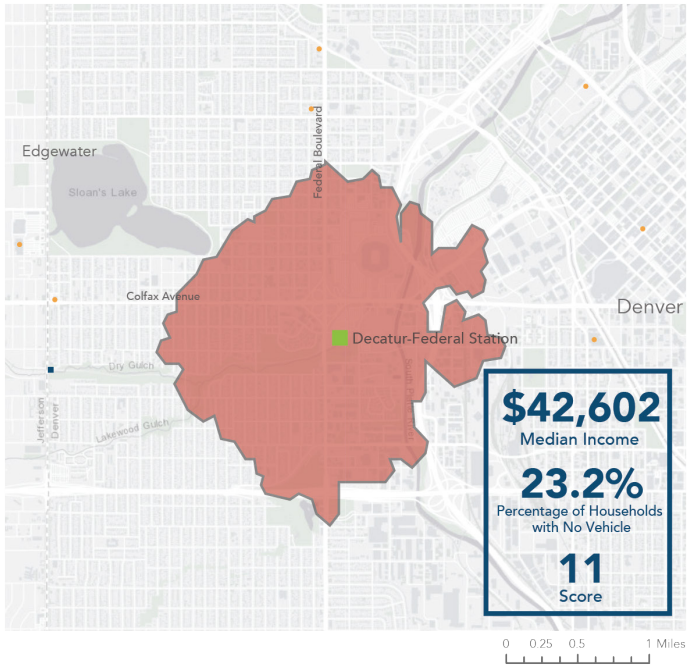
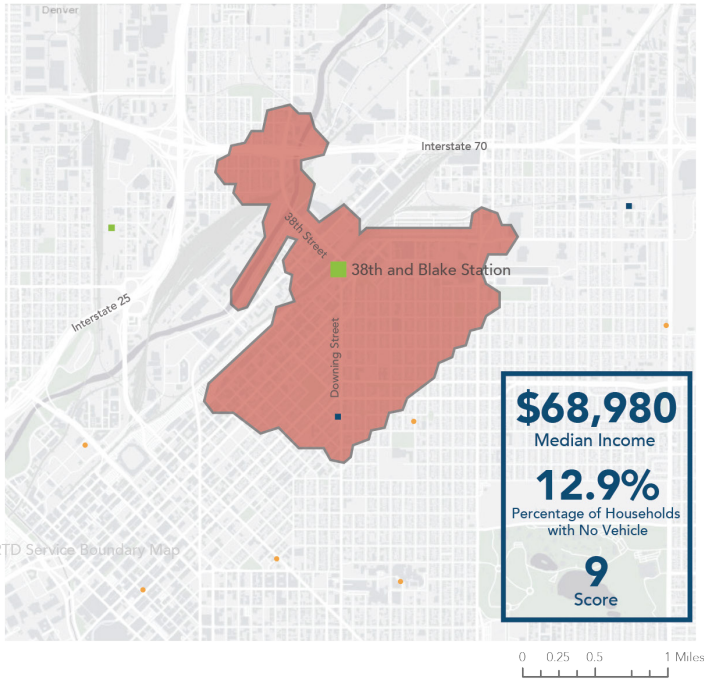


FIGURE 4. 38TH AND BLAKE STATION



20 minute walkshed
Eligible Park-n-Rides
Available Park-n-Rides
Vaccine Distribution Sites

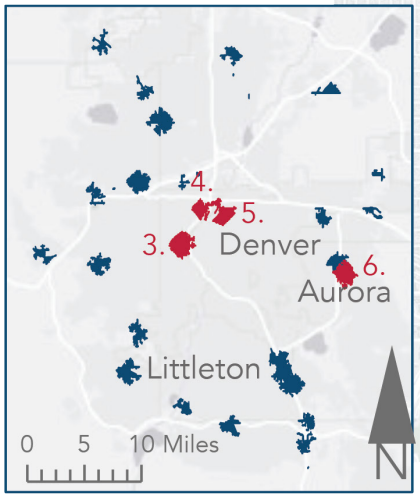


FIGURE 5. 41ST AND FOX STATION

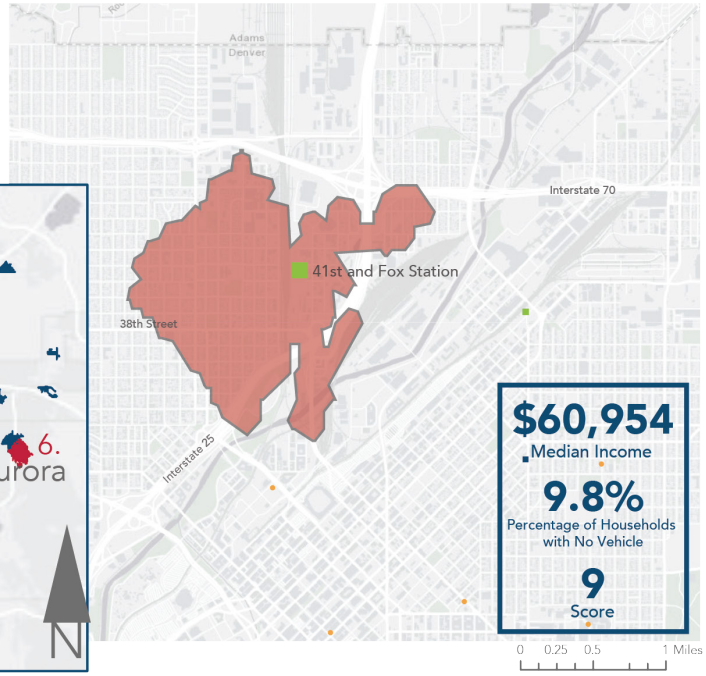
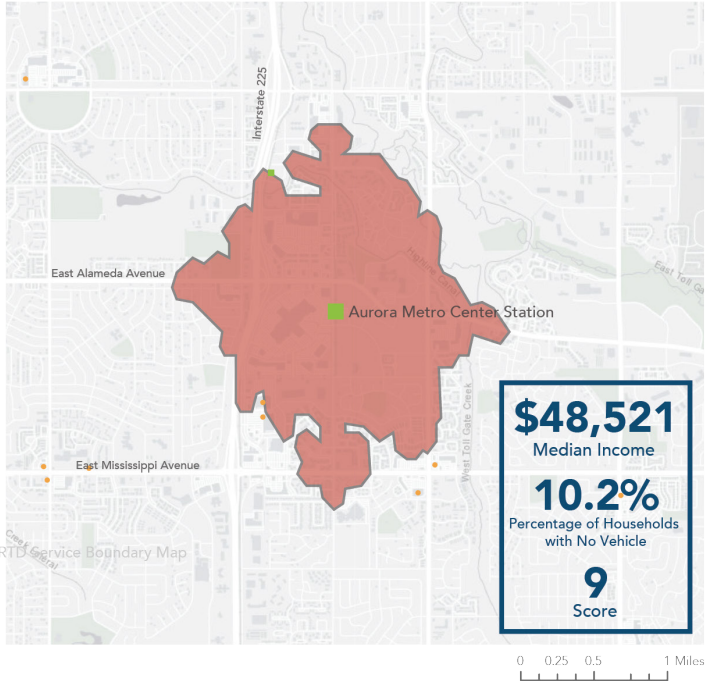


FIGURE 6. AURORA METRO CENTER STATION



METADATA

Data Layers	Coordinate System	Datum	Publication Date	Data Type	Source
Vaccine distribution sites – Colorado	WGS 1984	D WGS 1984	April 11 2021	.json converted to feature layer	https://www.vaccine-spotter.org/api/
RTD Boundary	WGS 1984	D WGS 1984	Feb 24 2020	Shapefile	https://gis-rtd-denver.opendata.arcgis.com/
RTD Park-n-rides	WGS 1984	D WGS 1984	Jan 12 2021	Shapefile	https://gis-rtd-denver.opendata.arcgis.com/
Sidewalks	WGS 1984	D WGS 1984	2018	Shapefile	https://data.drcog.org/
ACS Median Household Income Variables – Boundaries	WGS 1984	D WGS 1984	Jan 14 2021	Feature Layer	Living Atlas
ACS Vehicle Availability Variables - Boundaries	WGS 1984	D WGS 1984		Feature Layer	Living Atlas

WORKS CITED

Duany, Andres and Robert Steuteville. "Defining the 15-minute City." Public Square. CNU Journal. Accessed on May 4, 2021. Retrieved from https://www.cnu.org/publicsquare/2021/02/08/defining-15-minute-city

Washington State Health Services Research Project. How Long and How Far Do Adults Travel and Will Adults Travel for Primary Care? Research Brief No. 70. Washington State Office of Financial Management. Accessed on May 4, 2021. Retrieved from https://ofm.wa.gov/sites/default/files/public/legacy/research-briefs/2013/brief070.pdf

APPENDIX 1. RTD PARK-N-RIDES SUITABLE FOR ANALYSIS

NAME	LATITUDE	LONGITUDE
104th Ave / Revere	39.884957	-104.842782
13th Avenue Station	39.734968	-104.82381
27th Way / Broadway	39.997249	-105.261081
2nd Ave / Abilene Station	39.71937	-104.825393
30th / Downing Station	39.759352	-104.973639
38th / Blake Station	39.770625	-104.973626
39th St / Table Mesa	39.985563	-105.248412
40th / Airport - Gateway Park Station	39.769949	-104.786354
40th / Colorado Station	39.775473	-104.944662
41st / Fox Station	39.773807	-104.996174
60th/Sheridan-Arvada Gold Strike Station	39.803898	-105.049999
61st / Pena Station	39.806102	-104.783566
8th / Coffman	40.172146	-105.104041
Alameda / Havana	39.712273	-104.864839
Arapahoe at Village Center Station	39.601588	-104.887052
Arvada Ridge Station	39.792432	-105.10994
Aurora Metro Center Station	39.708858	-104.818793
Belleview Station	39.626987	-104.904622
Boulder Church of the Nazarene	39.989361	-105.25497
Boulder Junction at Depot Square Station	40.024472	-105.251361
C470 / University Blvd	39.562152	-104.961823
Central Park Station	39.76991	-104.889796
Clear Creek / Federal Station	39.804488	-105.023651
Colorado Station	39.679943	-104.939863
Commerce City / 72nd Ave	39.826573	-104.942128
County Line Station	39.56304	-104.869718
Dayton Station	39.643697	-104.878933
Decatur-Federal Station	39.737692	-105.023795
Dry Creek Station	39.579533	-104.877581
Eastlake / 124th Ave	39.922082	-104.96269
Englewood Station	39.657056	-104.998175
Evans Station	39.677772	-104.992469
Federal Center Station	39.720005	-105.129126
Highlands Ranch Town Center	39.548138	-104.997465

NAME	LATITUDE	LONGITUDE
I-25 / Broadway Station	39.701628	-104.988542
Iliff Station	39.673839	-104.825101
Jefferson CO Government-Golden Station	39.725968	-105.199976
Ken Caryl / C-470	39.580886	-105.137577
Lafayette	39.988562	-105.089694
Lakewood-Wadsworth Station	39.736757	-105.080905
Lincoln / Jordan	39.534452	-104.79508
Lincoln Station	39.547041	-104.87026
Littleton / Downtown Station	39.612481	-105.016061
Littleton / Mineral Station	39.581467	-105.025704
Longmont	40.148957	-105.102941
Nine Mile Station	39.658294	-104.846534
Northglenn / 112th Ave	39.902561	-104.959497
Oak Station	39.737124	-105.119266
Olde Town Arvada Station	39.798684	-105.079842
Olympic Park	39.667883	-104.807125
Orchard Station	39.613003	-104.896327
Original Thornton / 88th Ave	39.858841	-104.951985
Parker	39.524263	-104.764314
Pecos Junction Station	39.805737	-105.004372
Peoria Station	39.766386	-104.848819
Pinery	39.457851	-104.75638
RidgeGate Parkway Station	39.519558	-104.865658
Sheridan Station	39.735144	-105.052912
Smoky Hill / Picadilly	39.608354	-104.745699
Southmoor Station	39.649472	-104.914597
Southwest Plaza	39.613814	-105.092162
Tantra Dr / Table Mesa	39.986239	-105.239792
Thornton Crossroads / 104th Ave	39.881998	-104.940961
Thornton East Side	39.854584	-104.985144
Thornton West Side	39.854639	-104.988701
University of Denver Station	39.684558	-104.963653
US287 / 21st Ave	40.197466	-105.102734
US36 / Broomfield Station	39.906441	-105.086434
US36 / Church Ranch Blvd East Side	39.890223	-105.073016
US36 / Church Ranch Blvd West Side	39.889708	-105.07605

NAME	LATITUDE	LONGITUDE
US36 / Flatiron Station East Side	39.93395	-105.122136
US36 / Flatiron Station West Side	39.932396	-105.124021
US36 / McCaslin Station East Side	39.959492	-105.167487
US36 / McCaslin Station West Side	39.95785	-105.168087
US36 / Sheridan Station East Side	39.857661	-105.05225
US36 / Sheridan Station West Side	39.857719	-105.055192
US36 / Table Mesa	39.986787	-105.232804
US85 / Bridge St	39.98537	-104.823435
Wadsworth / Hampden	39.651521	-105.082731
Wagon Road	39.912385	-104.994007
Ward Road	39.780587	-105.138261
Westminster Station	39.823494	-105.027078
Wheat Ridge / Ward Road Station	39.788365	-105.133991
Yale Station	39.669005	-104.927515

APPENDIX 2. SCORES OF PARK-N-RIDE WALKSHEDS BASED ON DEMOGRAPHIC VARIABLES

NAME	SCORE (NO VEHICLE)	SCORE (INCOME)	TOTAL SCORE
Decatur-Federal Station	5	6	**11**
38th / Blake Station	4	5	**9**
41st / Fox Station	3	6	**9**
Aurora Metro Center Station	3	6	**9**
2nd Ave / Abilene Station	2	6	**8**
40th / Airport - Gateway Park Station	2	6	**8**
Clear Creek / Federal Station	2	6	**8**
Federal Center Station	2	6	**8**
Jefferson CO Government-Golden Station	2	6	**8**
Olde Town Arvada Station	2	6	**8**
Wadsworth / Hampden	2	6	**8**
61st / Pena Station	1	6	**7**
Arvada Ridge Station	1	6	**7**
Eastlake / 124th Ave	2	5	**7**
Northglenn / 112th Ave	2	5	**7**
Pecos Junction Station	2	5	**7**
Peoria Station	2	5	**7**
US36 / Flatiron Station West Side	2	5	**7**
Ward Road	1	6	**7**
Arapahoe at Village Center Station	2	4	**6**
County Line Station	1	5	**6**
Lincoln Station	2	4	**6**
Southwest Plaza	2	4	**6**
Thornton Crossroads / 104th Ave	1	5	**6**
US36 / Church Ranch Blvd East Side	1	5	**6**
US36 / Church Ranch Blvd West Side	1	5	**6**
US36 / Flatiron Station East Side	1	5	**6**
US36 / Sheridan Station East Side	1	5	**6**
US36 / Sheridan Station West Side	1	5	**6**
Wheat Ridge / Ward Road Station	1	5	**6**
104th Ave / Revere	1	4	**5**
Belleview Station	1	4	**5**
C470 / University Blvd	1	4	**5**
Littleton / Mineral Station	1	4	**5**
Orchard Station	1	3	**4**
RidgeGate Parkway Station	1	3	**4**