ASSESSING DISTRIBUTION OF BUS TRANSIT SERVICE FOR EQUITY DURING COVID-19 PANDEMIC

White Paper

September 2021 (Final)

National Capital Region
Transportation Planning Board

ASSESSING DISTRIBUTION OF BUS TRANSIT SERVICE FOR EQUITY DURING COVID-19 PANDEMIC
July 2021

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CREDITS
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INTRODUCTION

In March 2020, transit agencies across the region drastically cut service in response to the coronavirus pandemic and over time they have been gradually restoring service. This white paper will inform regional decision makers about equity-related factors to consider when restoring service.

Throughout the pandemic, the region has leaned on its essential workers, such as those in the food service and healthcare industries. Not only do many essential workers depend on transit to reach their jobs, but many are also from population groups and communities that face historical disadvantage and marginalization (people of color, low-income households, non-native English speakers), which have been dramatically exacerbated by the pandemic's health and economic impacts.

Over a year after the pandemic reached us, the region looks forward to recovery from the pandemic as the population is vaccinated, infection rates are anticipated to decrease, and businesses look to resume normal operations. The region's transit agencies are restoring service in the face of extreme fiscal constraint. Can these service restorations improve transportation equity in the region? This white paper recommends criteria for agencies to consider.

Interactive Online Map

The Interactive Online Map, available **here**, contains all the map layers shown in this report plus additional detailed data that can be used for other analyses.

The analysis assesses bus service (route coverage, frequency, time of day, and span of service) during the pandemic for those living in Equity Emphasis Areas (EEAs), historically disadvantaged populations, and low-wage workers. It also compares current service to pre-pandemic service. The analysis examines how equitably service is distributed and identifies gaps in that service that could be filled to improve equity.

ANALYSIS OF COVID-19 ERA BUS SERVICE

Level of Service

Currently most transit agencies in the region are operating more service than they were during earlier periods during the pandemic when service had been cut more drastically. However, many agencies are not yet back to full pre-pandemic levels of service. The online map contains multiple data layers described below that depict the current state of bus transit in the region. These layers are all underneath the "Current Transit Service" tab on the online map. See **Table 2** in the appendix for details about each agency's GTFS data which were used as the sources for these layers.

- The **hours of service** layers depict how many hours of service each route operates by day of week. The three layers are: Hours of Service - Weekday, Hours of Service - Saturday, and Hours of Service - Sunday.
- The **headway** layers depict how frequently routes operate. There are three layers for weekday service and one for weekend service: Headway - Weekday AM Peak, Headway - Weekday Midday, Headway - Weekday Late Night, and Headway - Saturday Core.

Distribution of Transit Service

POPULATION

The distribution of transit service by population group analysis sheds light on how well current service is providing coverage to various population groups. The map layers listed below symbolize census block groups by their relative density within the various groups as described; block groups shown on the blue spectrum are currently within one-quarter mile of a bus stop, and block groups shown on the red spectrum are currently beyond one-quarter mile of a bus stop. Darker red areas that were covered by pre-pandemic service, especially those that appear in multiple layers, could be high priorities for service restoration.

Maps with the following layers, utilized for the Transit Equity Need Index later in this paper, are shown below (and are also available in the online map):

- Persons of color population density (**Figure 1**)
- Persons with disabilities density (**Figure 2**)
- Low-income household density (**Figure 3**)
- Zero/one-car household density (**Figure 4**)
- Low-wage workers home location (**Figure 5**)

In addition, the following layers are available on the online map:

- Total population density
- Total household density
- All workers home location density
- Language other than English (LOTE) population density
- Veteran population density

Figure 1: Persons of Color Population Density

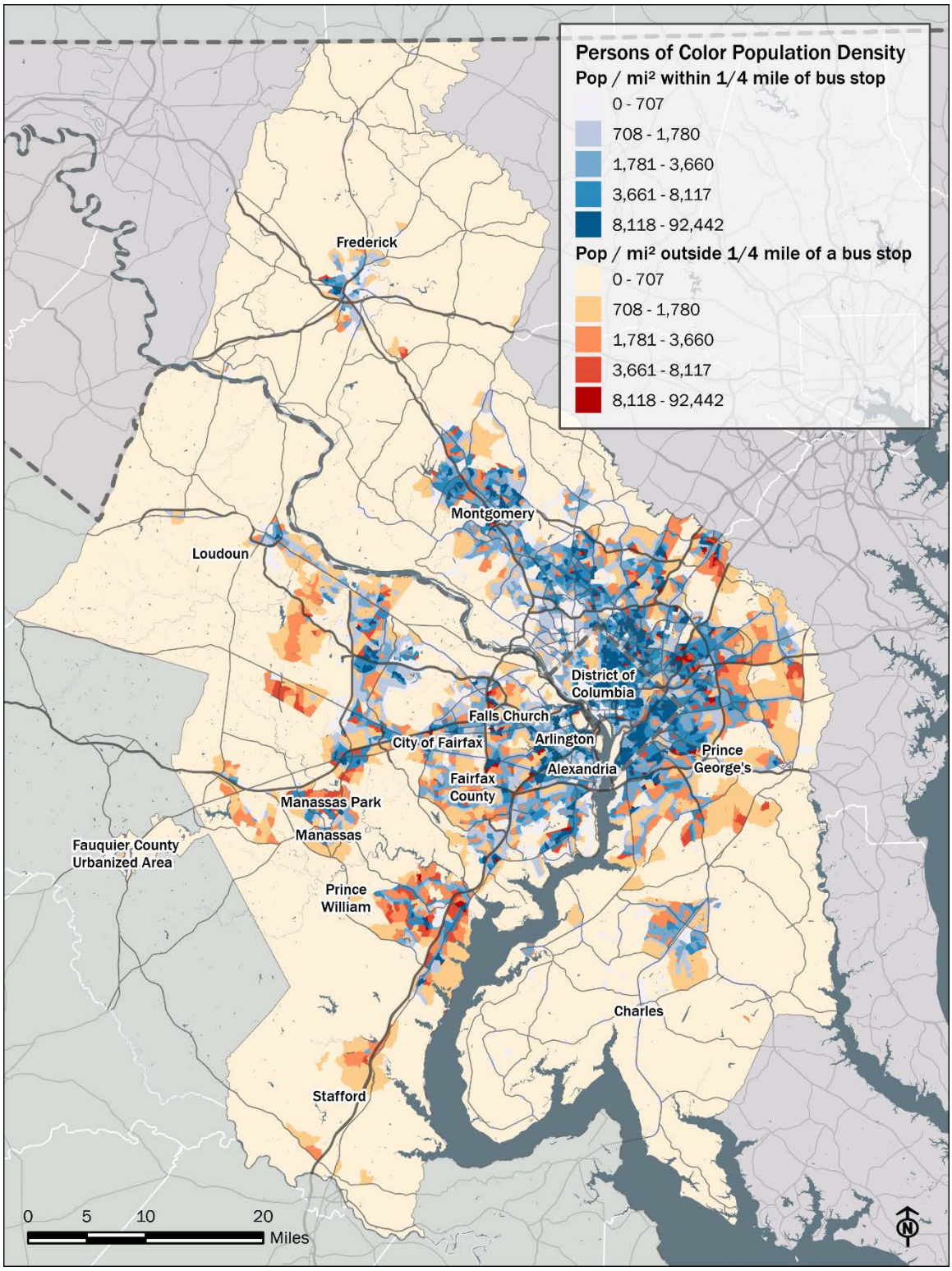


Figure 2: Persons with Disabilities Population Density

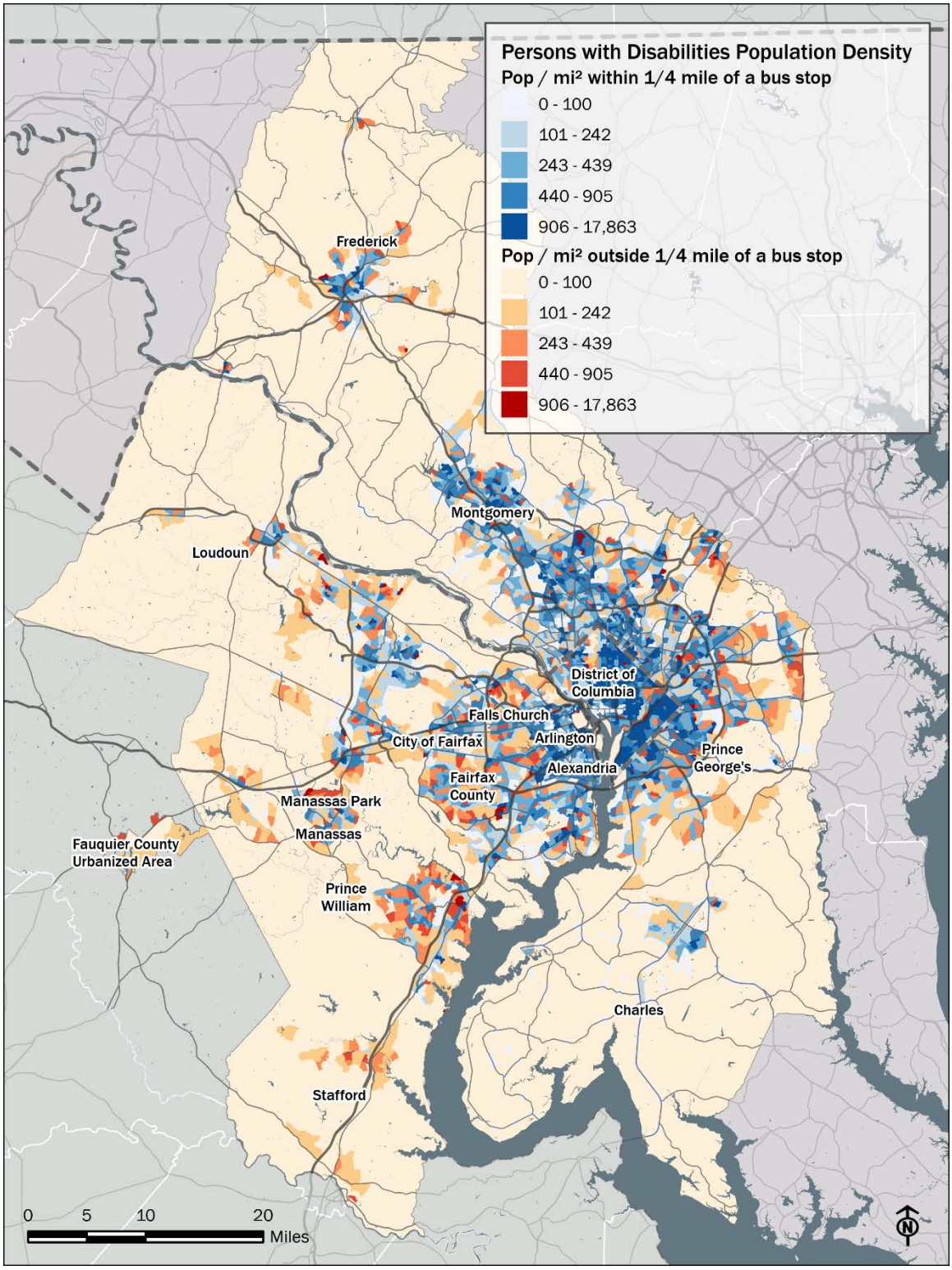


Figure 3: Low-Income Household Density

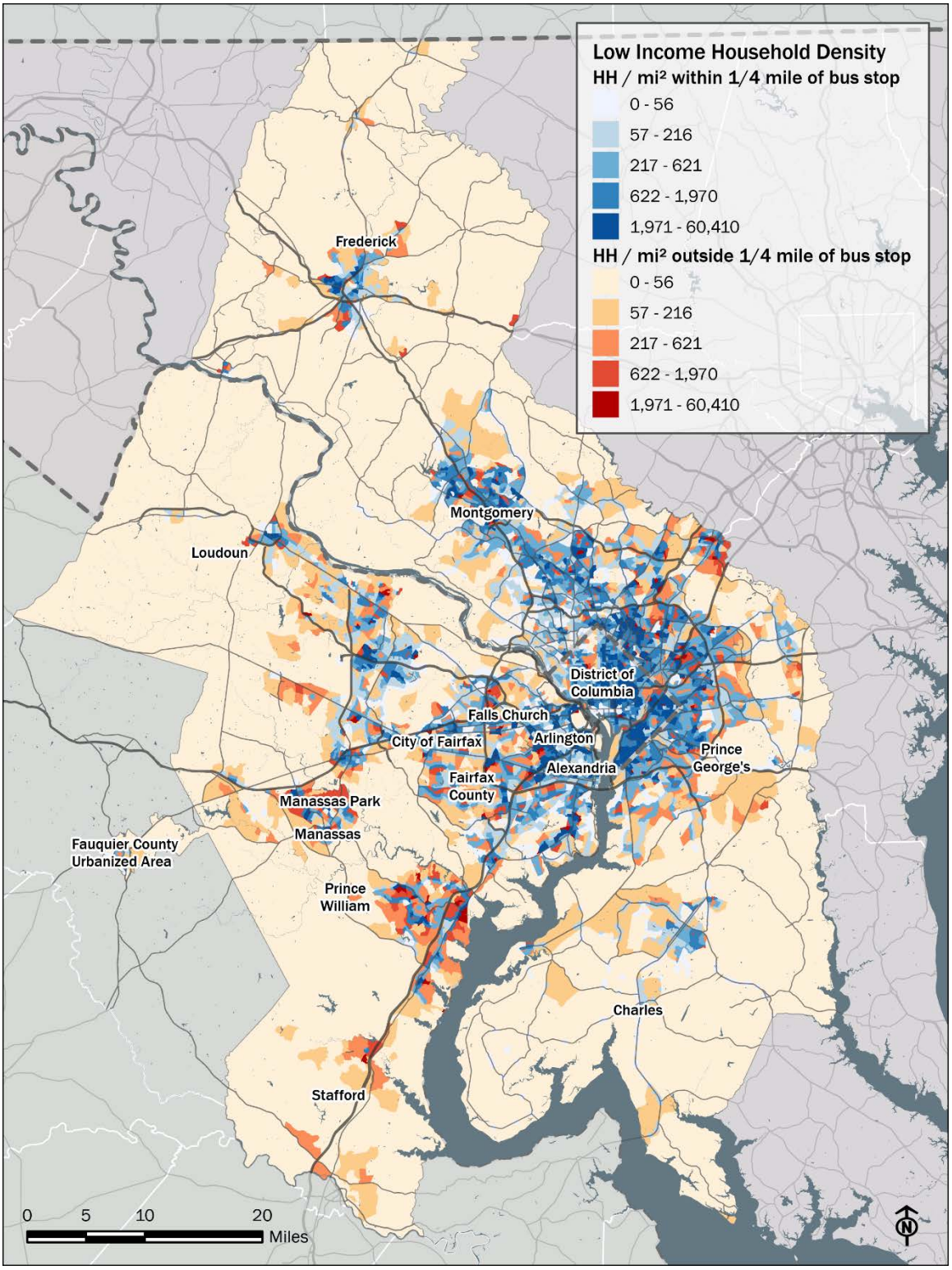


Figure 4: Zero and One Car Household Density

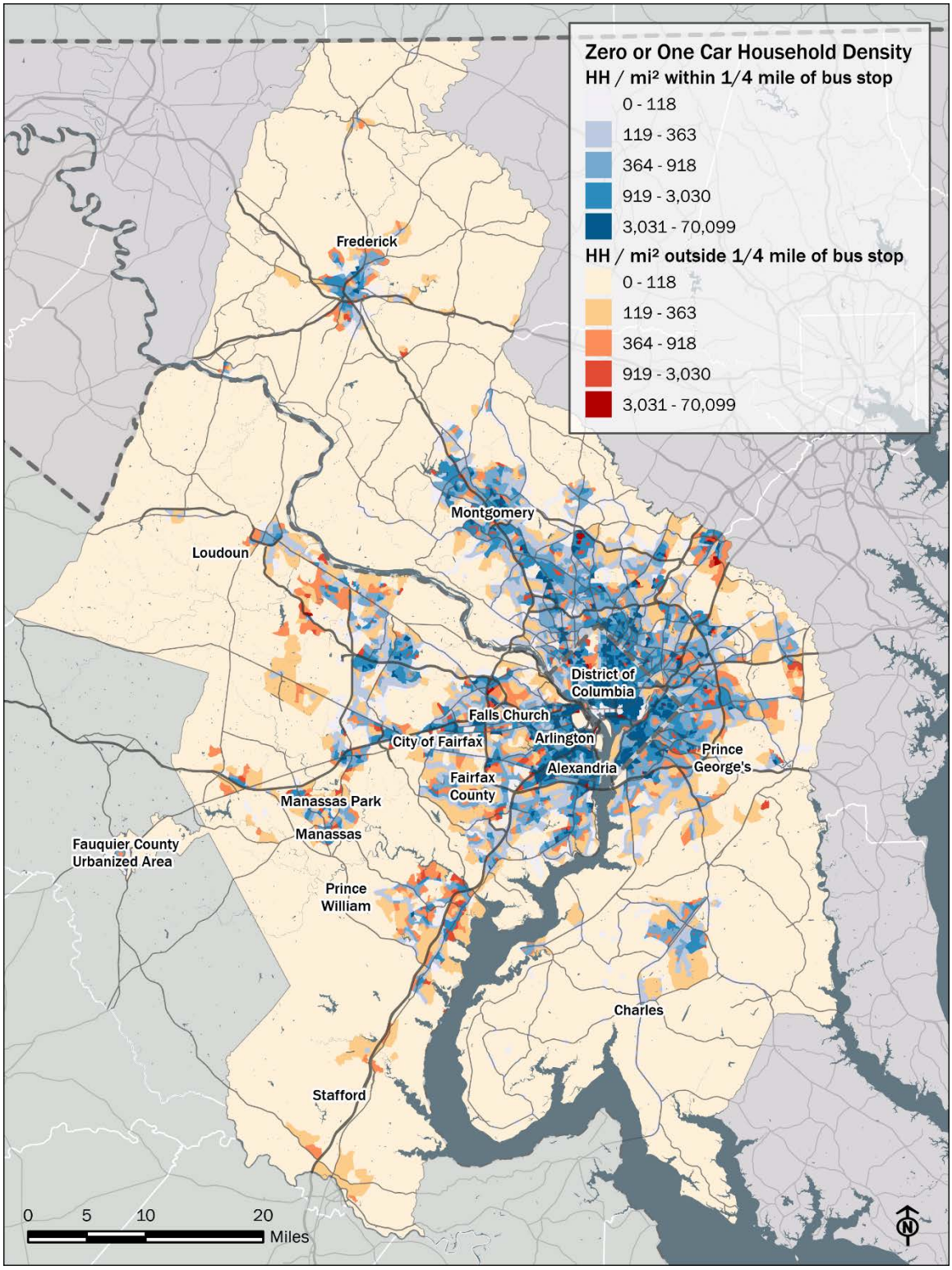
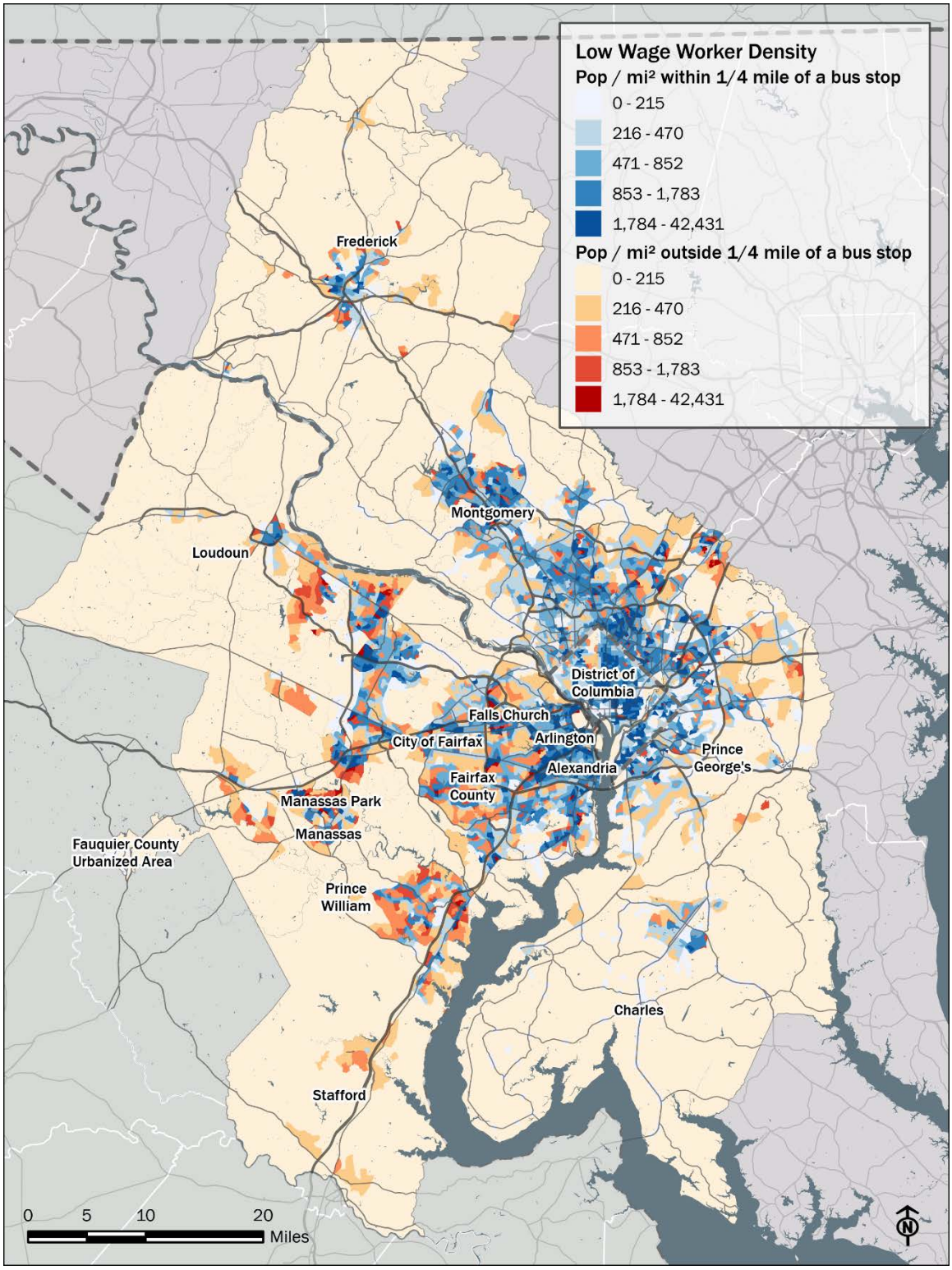


Figure 5: Low-Wage Worker Density



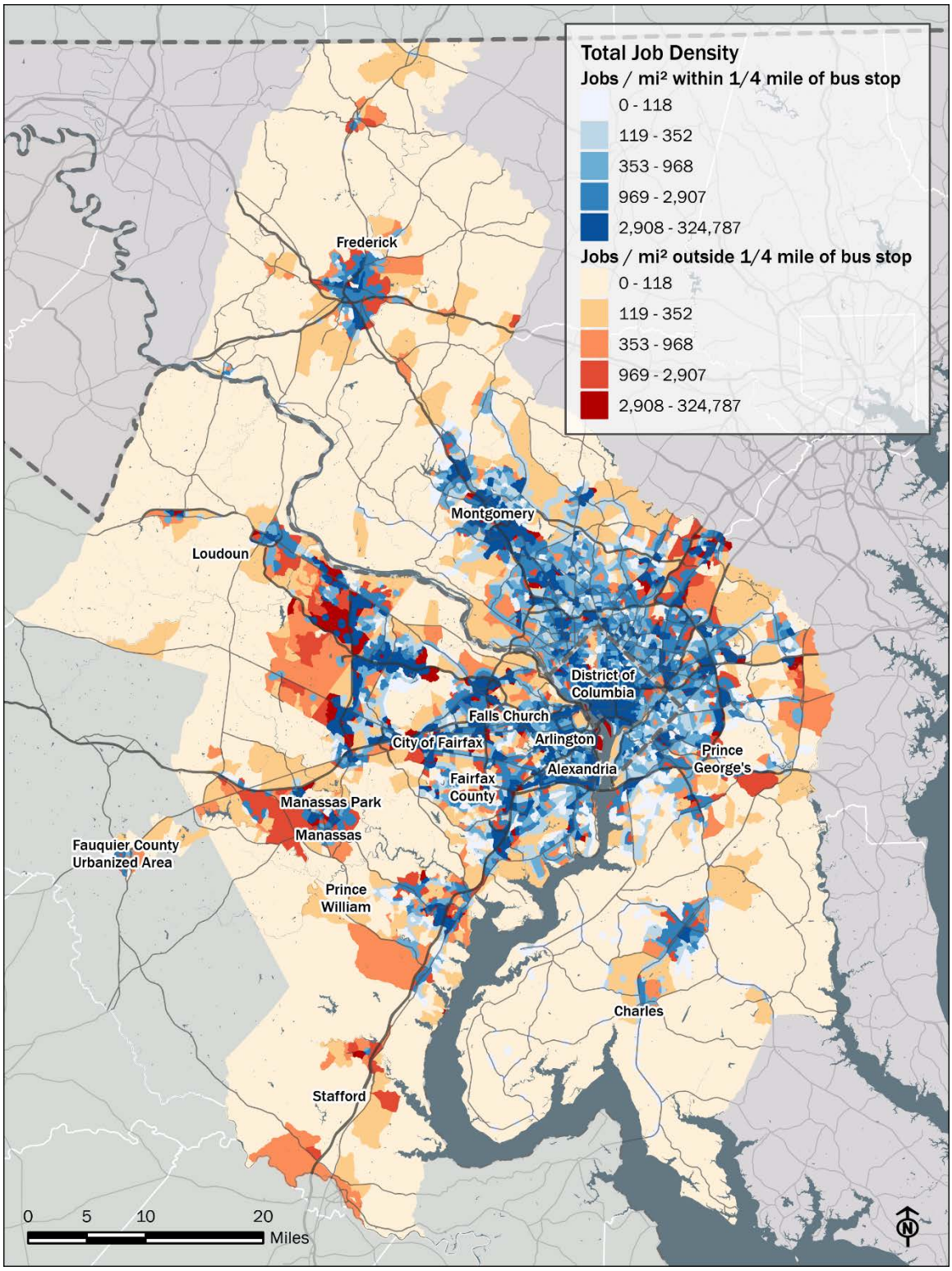
JOBS

The distribution of transit service by job category analysis sheds light on how well current service is providing access to jobs throughout the region. The map layers for this analysis symbolize census block groups by their relative density within the various job categories as described; block groups shown on the blue spectrum are currently within one-quarter mile of a bus stop, and block groups shown on the red spectrum are currently beyond one-quarter mile of a bus stop. Darker red areas that were covered by pre-pandemic service, and especially those that appear in multiple layers, could be high priorities for service restoration.

Total job density is shown below in **Figure 6** and is available for viewing on the online map. Density of low-wage jobs and density of essential service jobs[1] are shown later in **Figure 19** and **Figure 20**, respectively, and are also available for viewing on the online map.

[1] See "Essential Job Identification" in the appendix for more information.

Figure 6: Total Job Density



Disparities in Access to Bus Transit

To understand differences in access to transit between groups, population and jobs were counted within a one-quarter mile buffer around stops with weekday AM and PM peak period 15-minute or better service and around stops with Saturday midday 30-minute or better service. Tabulations included:

- Total population, percent of regional non-Hispanic white population, and percent of regional people of color population
- People with disabilities
- Total households
- Low-income households
- Zero/one-car households
- Two or more car households
- Total jobs, low-wage jobs, low-wage workers, and essential jobs (work location)

Full results for this analysis are in **Table 3** in the Appendix.

While 60 percent of the total population in the TPB region is within one-quarter mile of fixed route bus service, only 68 percent of that group have access to 15-minute or better service in the AM peak period. This figure falls slightly to 62 percent in the PM peak period. Marginalized groups have more access to transit when compared to the region as a whole:

- 65 percent of people of color and 74 percent of low-income households are within a ¼ mile of bus stops, compared to 60 percent of the region as a whole.
- 44 percent of people of color and 54 percent of low-income households have access to 15-minute or better service in the AM peak period, compared to 41 percent of the region as a whole.
- 58 percent of zero or one-car households are within one-quarter mile of a bus stop and 55 percent of these households have access to 15-minute or better service in the AM and PM peak periods, compared to 37 percent of the region as a whole.
- Sixty-one percent of low-wage workers are within one-quarter mile of a bus stop, but only 41 percent have access to frequent service in the peak periods.

These data points illustrate that while marginalized population groups overall have more access to transit service compared to the general population, a smaller share (41 to 55 percent) have access to high-frequency service (15 minutes or better than the AM Peak) compared to the 62 to 68 percent of the transit-accessible population overall.

An additional analysis that examines disparities between Equity Emphasis Areas and the region as a whole can be found in **Table 4** in the Appendix.

Network Job Accessibility Analysis

Disparities in access to jobs were analyzed on several dimensions:

- Jobs accessible for all workers compared to low-wage workers.

- Jobs accessible for people living within Equity Emphasis Areas (EEAs) compared to those living outside of EEAs.
- Access to essential jobs compared to all jobs.
- Comparisons between four main service periods: Weekday AM peak (6:00 AM - 9:00 AM); Weekday midday (9:00 AM - 3:00 PM); Weekday late night (11:00 PM - 4:00 AM); and Saturday core (9:00 AM - 3:00 PM).

The analysis was conducted using the Conveyal accessibility analysis platform, which calculates network-based travel patterns from many origins to many destinations. More details about the methodology can be found in the "Network Job Accessibility Analysis" section of the Appendix.

Figure 7 depicts the average jobs accessible via local bus for all workers, while **Figure 8** is limited to the average jobs accessible via local bus for low-wage workers only. Both analyses demonstrate that many more jobs are accessible via local bus for people living in Equity Emphasis Areas (EEAs) compared to those not living in EEAs. The service period with the highest quantity of jobs accessible is the weekday peak period, followed by weekday midday, Saturday, and weekday late night. For all time periods, low-wage workers have access to fewer jobs compared to all workers.

For all time periods, low-wage workers have access to fewer jobs compared to all workers.

Trendlines in both figures show the percent change from the weekday peak period to the weekday midday period, and again from the weekday midday period to the weekday late period. There are similar rates of decrease between the weekday peak period and weekday midday period across all analysis categories in both figures, ranging from eight to ten percent. There are sharper rates of decrease when comparing jobs accessible in the weekday midday period to the weekday late night period, especially for access to essential jobs compared to all jobs.

Figure 7: Average Jobs Available via Local Bus for All Workers

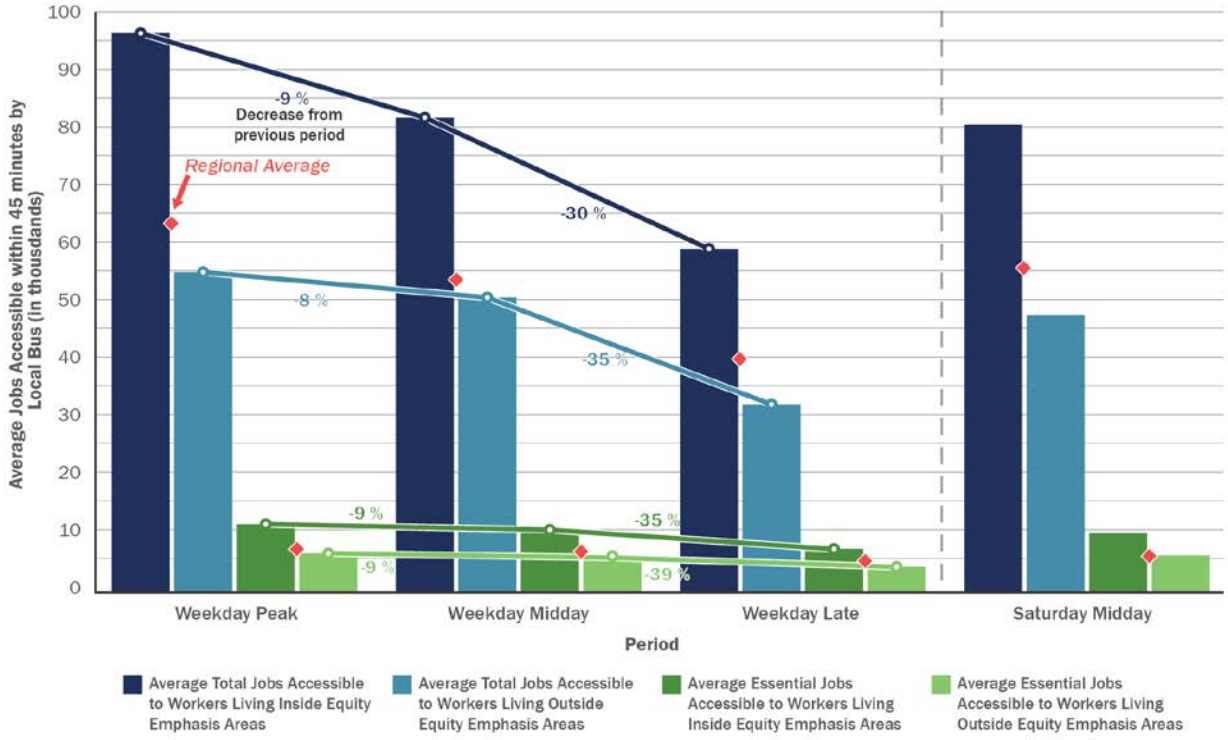
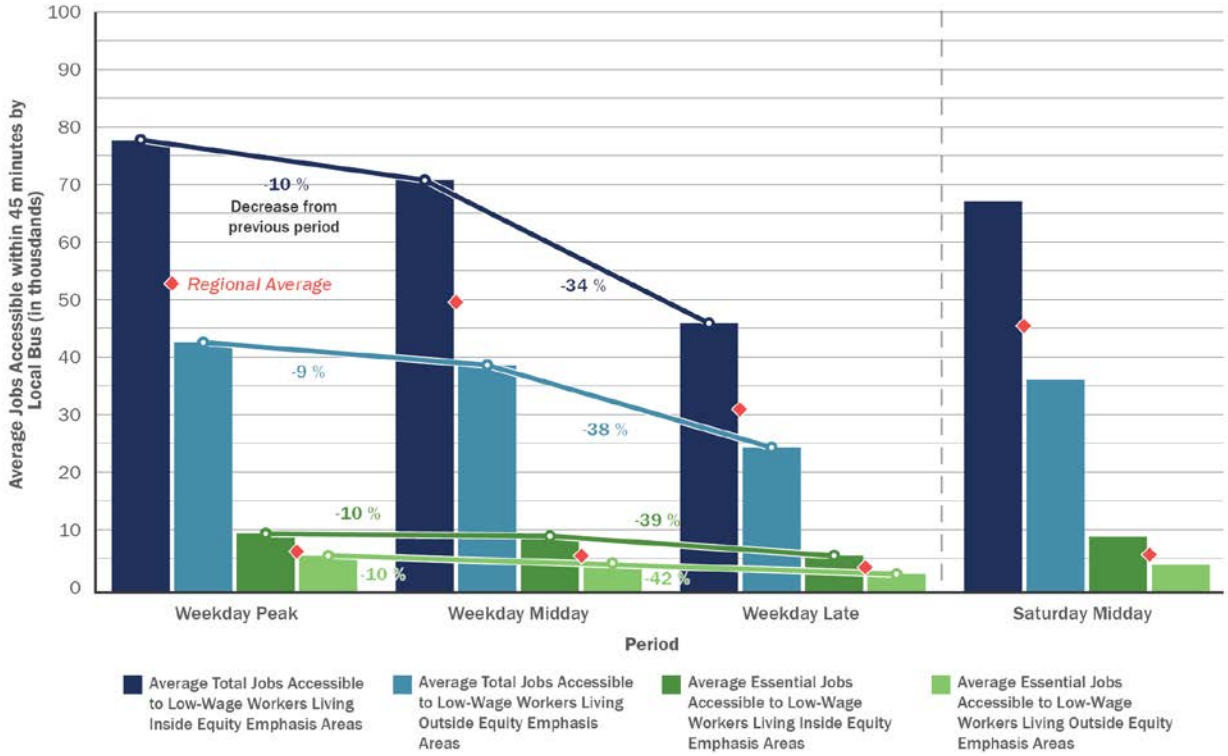


Figure 8: Average Jobs Accessible via Local Bus for Low-Wage Workers



A portion of the region's total jobs are classified as essential service jobs for the purpose of this analysis: 12.5 percent of regional jobs are considered essential (2,954,567 total jobs and 370,317 essential jobs—see the "Essential Job Identification" section of the Appendix for more information about how essential jobs were identified). In the late-night period, only 11.2 percent of jobs that are accessible via local bus are essential jobs, which is lower than what would be expected from the share of essential jobs regionwide.

As transit agencies continue to ramp up service and look to provide service in a more equitable manner, late night access to essential jobs for low-wage workers should be of particular concern and priority.

Figure 9 depicts total jobs accessible during the AM peak period (**Figure 10** shows the same thing zoomed in). The color band ranges from yellow to purple, with yellow representing the most jobs accessible from that location, and purple representing the fewest jobs accessible from that location. Map layers for jobs accessible during the other three service periods are available in the online map along with the AM peak period map layer.

Figure 9: Jobs Accessible Within 45 Minutes by Local Bus in Weekday AM Peak

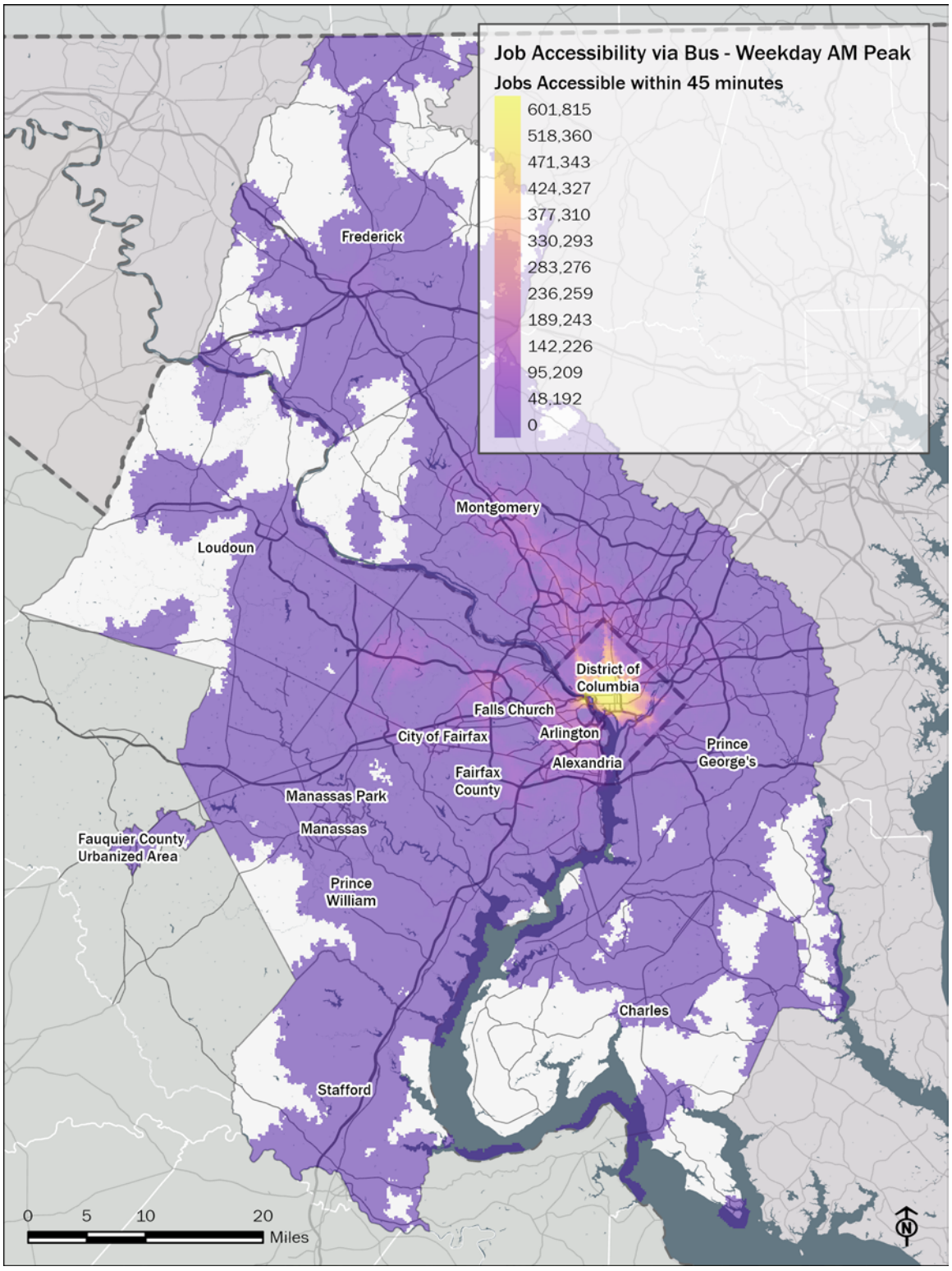
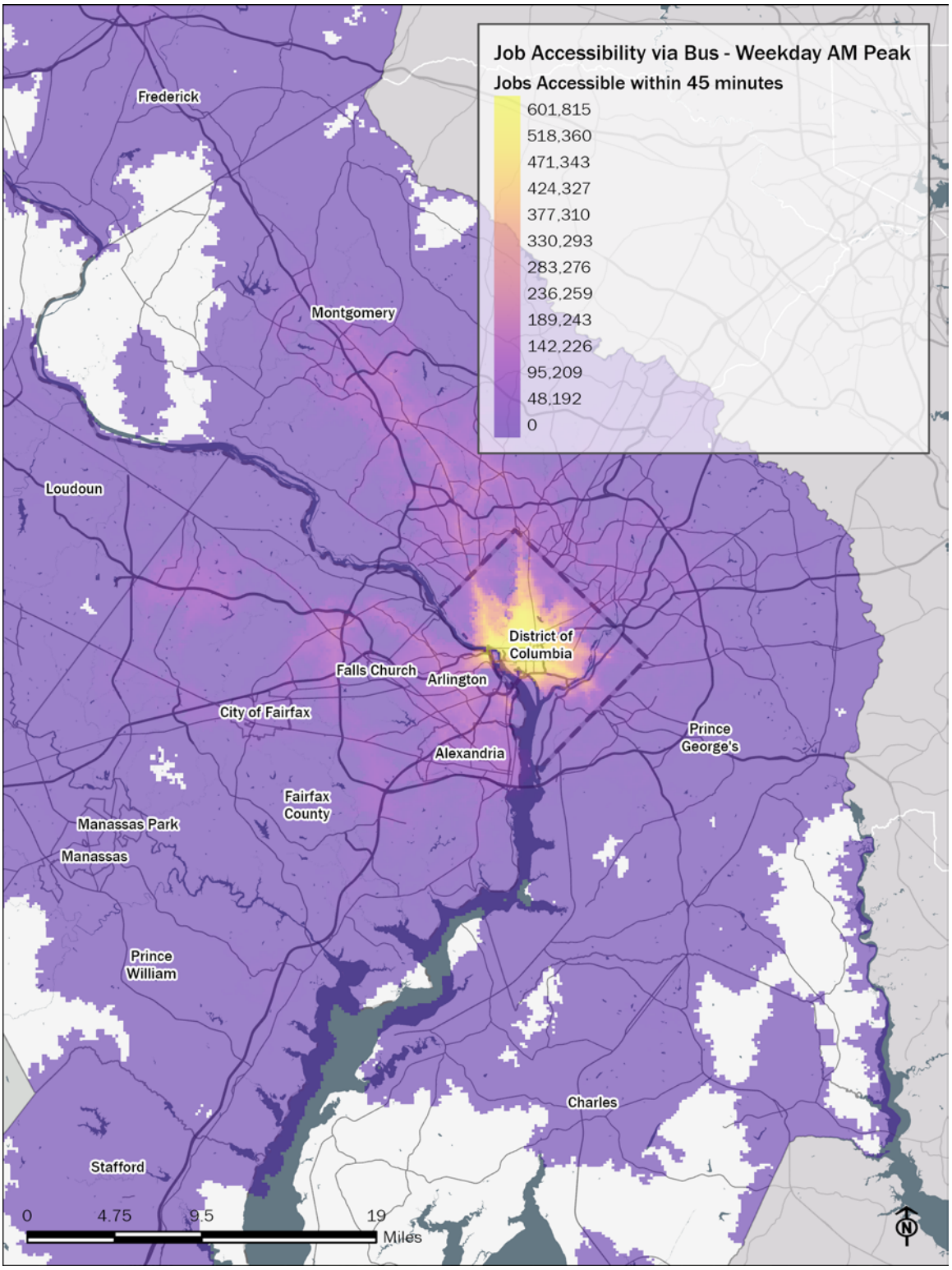


Figure 10: Jobs Accessible Within 45 Minutes by Local Bus in Weekday AM Peak (Zoomed In)



BUS SERVICE COMPARISON BETWEEN PRE-PANDEMIC AND COVID-19 ERA

Level of Service

CHANGE IN LEVEL OF SERVICE

The levels of service from the pre-pandemic and recent GTFS feeds were compared to understand how service has changed for these four time periods:

- Weekday AM peak (6:00 AM - 9:00 AM)
- Weekday midday (9:00 AM - 3:00 PM)
- Weekday late night (11:00 PM - 4:00 AM)
- Saturday core (9:00 AM - 3:00 PM)

The analysis involved calculating the change in average number of trips by block group within each service period, which were then summarized into the percent change in number of trips by block group (**Figure 12** shows the results of this analysis for the AM peak period). The online map contains this same layer (called "Weekday AM Peak Change in Trips") plus the layers for the three other service periods. By clicking on a block group, a user can view the following data: the number of trips that served the block group in that service period pre-pandemic, the current number of trips, and the change between those two, as well as the percentage change. Within each time period's data layer, block groups only appear if they currently have transit service or used to have transit service pre-pandemic. Because of this, there are many more block groups shown on the weekday AM peak layer than there are on the Saturday core layer, because there is more expansive service in the former compared to the latter. More detail about the analysis can be found in the "Change in Level of Service (LOS) and LOS Index" section of the Appendix. **Figure 11** depicts how the change in trips was calculated.

Figure 11: Change in Trips Calculation

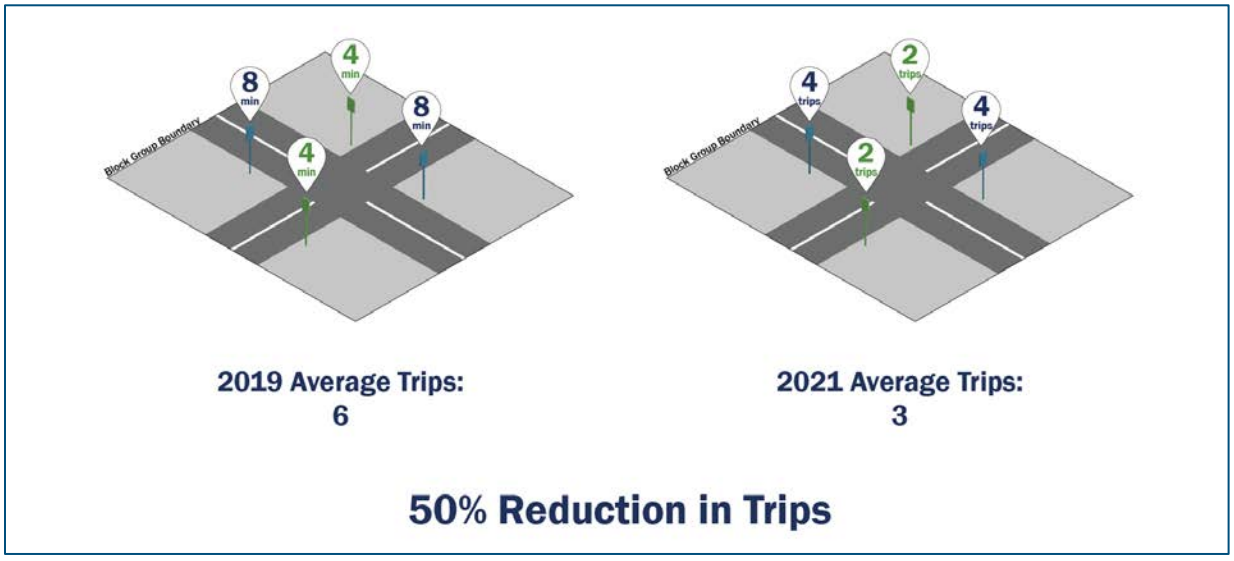
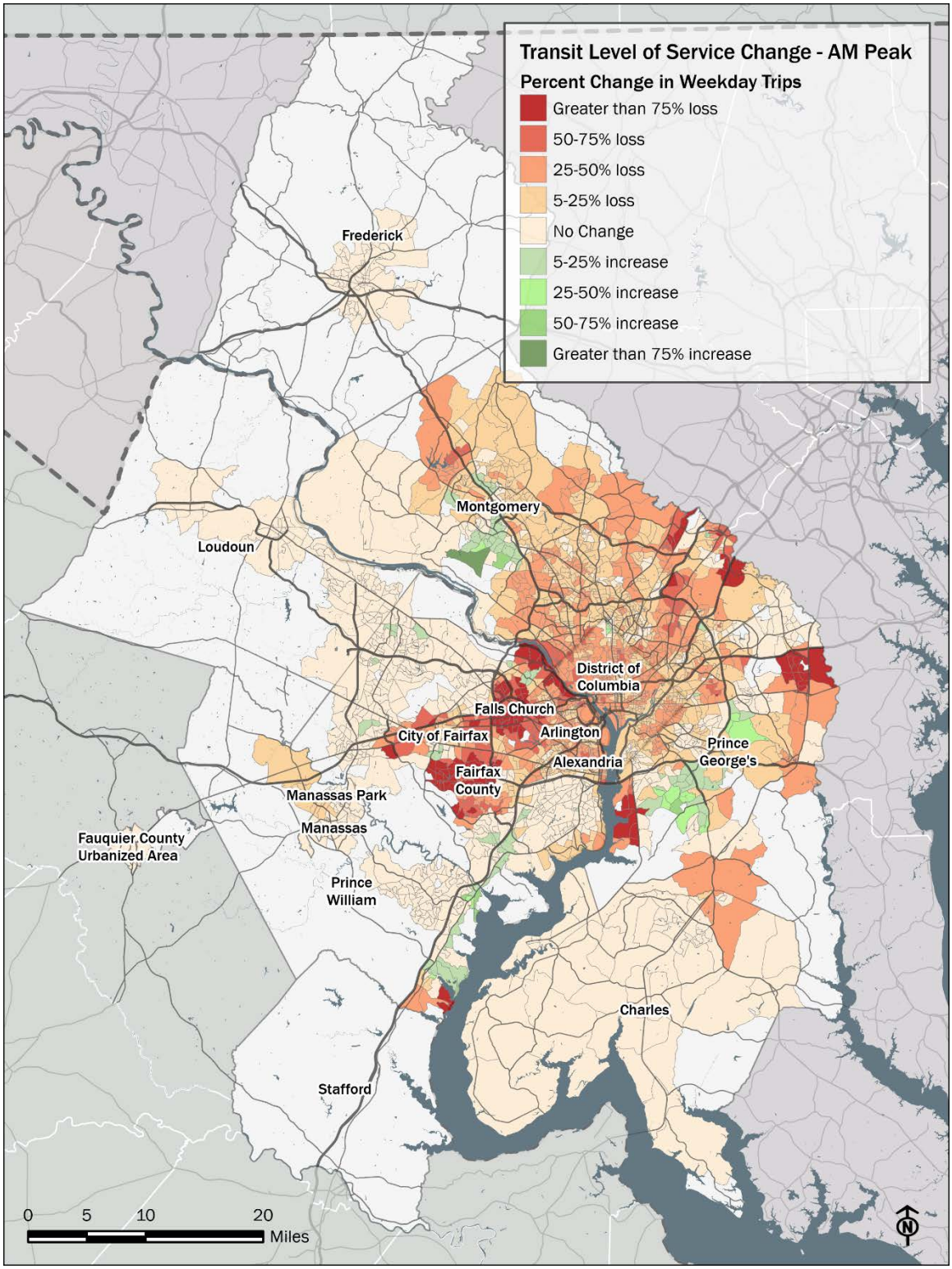


Figure 12: Level of Service Change Between Pre-Pandemic and Current (Weekday AM Peak)



Areas that lost the greatest amount of service in the AM peak period include Burke in Fairfax County, which lost service due to WMATA Routes 16L, 17L, and 17K, and Fairfax Connector Route 306 being discontinued; Falls Church, which lost service due to WMATA Routes 1A, 2A, , 3T, and 15K being discontinued; McLean, which lost service due to WMATA Route 15K being discontinued; Fort Washington, which lost service due to WMATA Route P19 and TheBus Route 35S being discontinued; and Mitchellville, which lost service due to WMATA Routes C28 and B29 being discontinued. Part of the impacted areas in Falls Church and Fort Washington fall within Equity Emphasis Areas. Block groups that are shown to have gained service in Montgomery County are due to new service from Ride On Route 301. This route was not included in the pre-pandemic GTFS feed, which may be a GTFS error rather than a result of new service being added more recently. Block groups that are shown to have gained service in Prince George's County are due to additional trips and longer span of service on TheBus Route 30.

The percent change in level of service for each block group were transformed into an index score so that it could be examined alongside the Transit Equity Need Index. Both of these indices are described in the Gap Analysis section of the report.

AREAS WHICH LOST HIGH-FREQUENCY SERVICE

Examining the change in availability of high-frequency service is another way to understand how service has changed since the pandemic began. To do this, first the bus stops that were served every 15 minutes or more[2] (considered high-frequency for the purpose of this study) before the pandemic were identified. Then, bus stops that are served every 15 minutes or more currently were identified. Stops that previously had high-frequency service but no longer do were identified. Block group average headway was found by averaging stop headways that fall within one-quarter mile of the block group. Block groups which lost high-frequency service are shown in **Figure 13** (and **Figure 14** shows a more zoomed-in version). This layer is available for viewing in the online map.

[2] Effective headway using all routes that serve the stop.

Figure 13: Loss of High-Frequency Service in AM Peak Period from Pre-Pandemic to Current

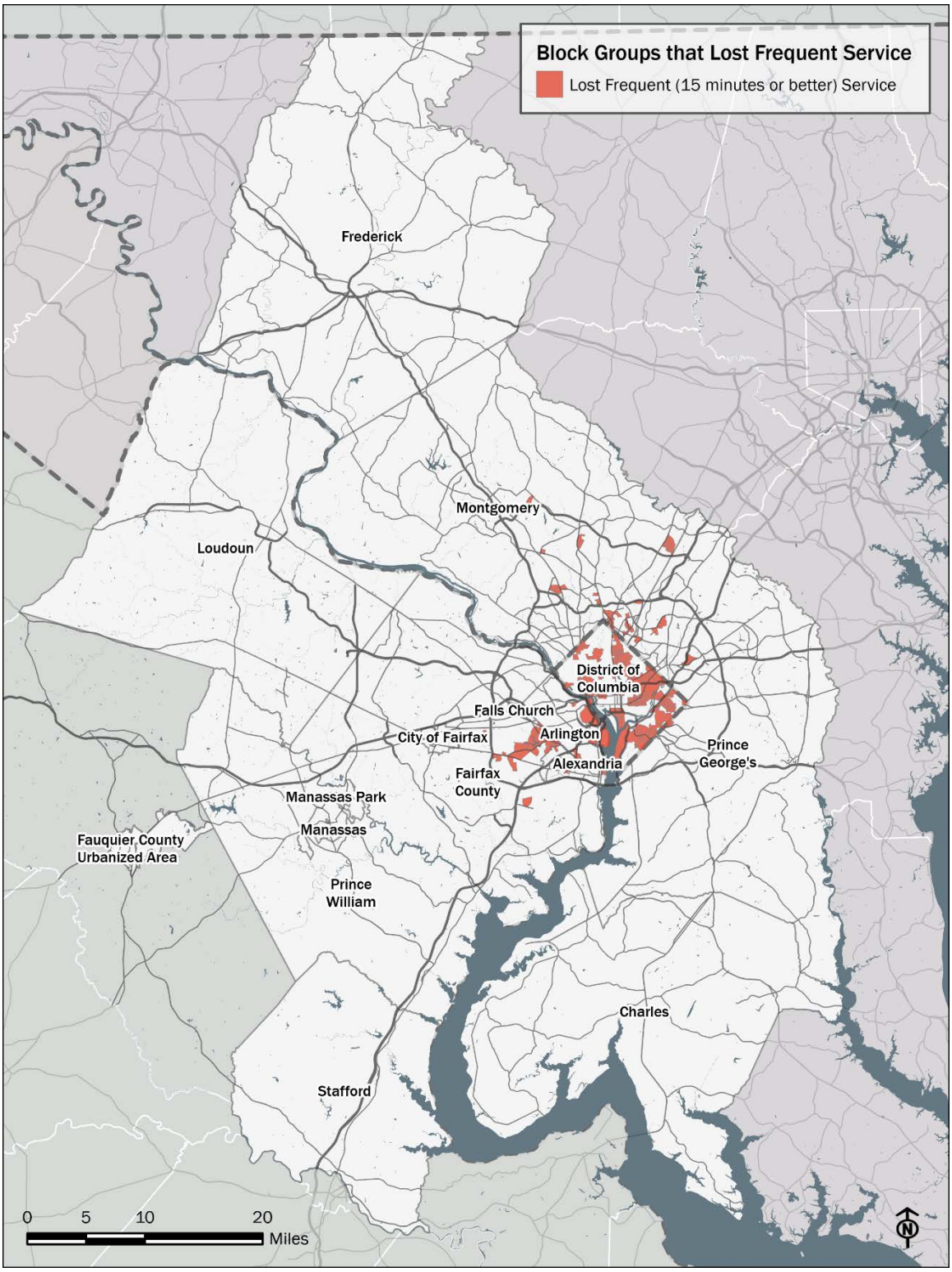
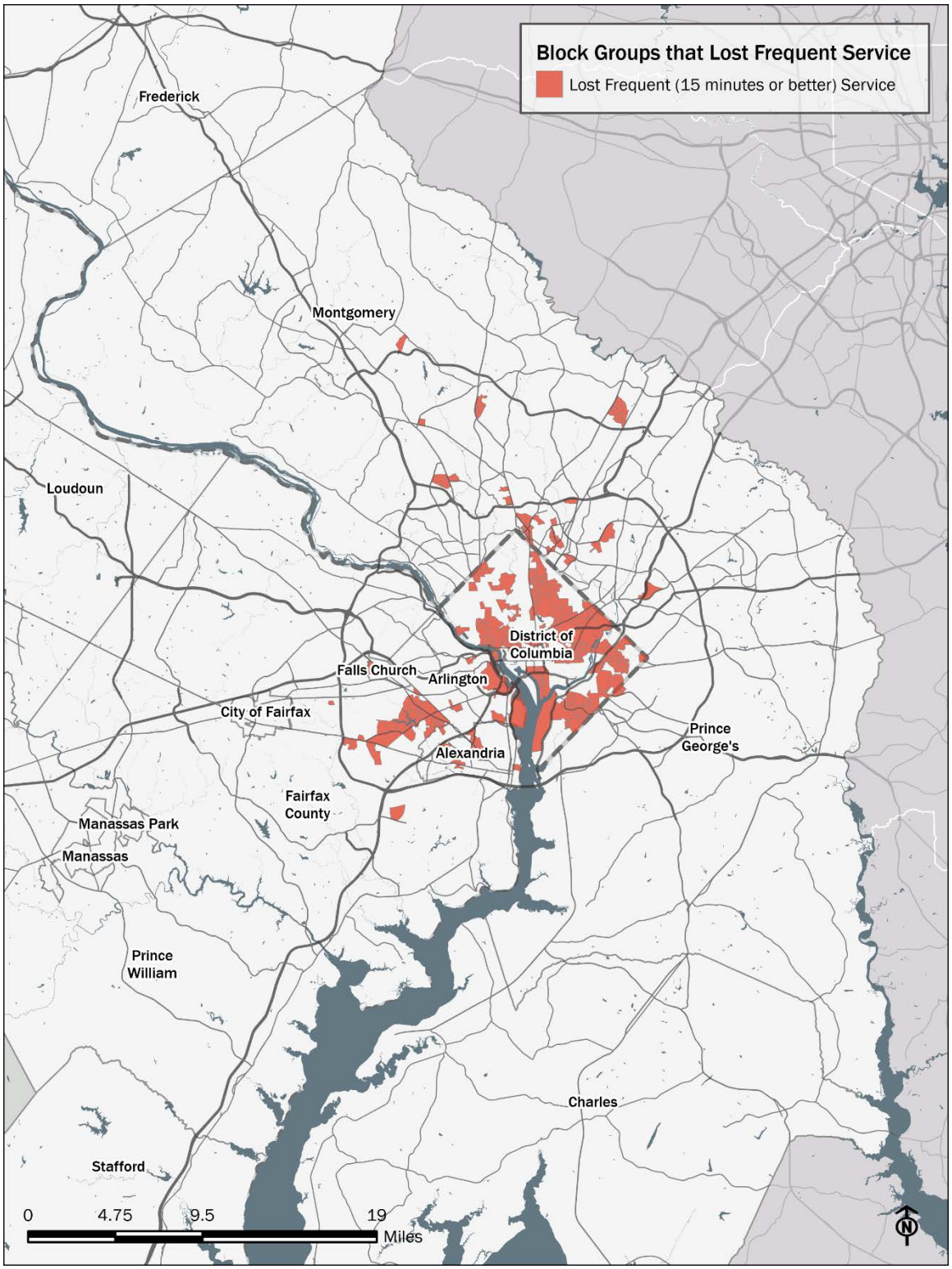


Figure 14: Loss of High-Frequency Service in AM Peak Period from Pre-Pandemic to Current (Zoomed In)



REVENUE HOUR CHANGE BY ROUTE

This analysis sheds light on routes which serve high transit need populations and that lost significant amounts of service during the pandemic. The GTFS data was used to calculate the revenue hours per route pre-pandemic and during the pandemic. **Table 1** lists the routes which had a reduction in revenue hours by at least 10 percent and operate at least 33 percent of their alignment within block groups that score high on the Transit Equity Need Index (scores of 20-25; described in the next section of this paper). This analysis could be used to prioritize routes for restoration of service. In the online map, the layer for the Transit Equity Need Index and the layer for Percent Change in Revenue Hours by Route can be turned on simultaneously to visually analyze the data further.

Table 1: Routes with Reduced Revenue Hours Serving Areas with High Transit Equity Need Index Scores

Agency	Route Number	Route Name	% Change in Weekday Revenue Hours
DASH	AT1+	Van Dorn Metro – Seminary Plaza	-100% (-19 hours)
RideOn	100	Shady Grove Station – Germantown Transit Center	-100% (-19 hours)
WMATA	34	Naylor Road Station – Archives	-100% (-17 hours)
TheBus	11	Greenbelt Station – Greenbelt Shopping Center	-100% (-15 hours)
TheBus	23	Seat Pleasant	-100% (-15 hours)
WMATA	S80	Metro Park – Franconia Springfield	-100% (-14 hours)
TheBus	12	Chillum / Mt. Rainier / Brentwood	-100% (-13 hours)
TheBus	27	Landover Metro / Dodge Park	-100% (-13 hours)
TheBus	25	Capitol Heights	-100% (-13 hours)
TheBus	14	Plaza Metrorail Station – College Park Station	-100% (-12 hours)
TheBus	21X	PGCC / New Carrollton Express	-100% (-11 hours)
WMATA	60	Fort Totten – Georgia Ave/Petworth Station	-100% (-10 hours)
TheBus	22	Morgan Blvd Metro Station - PG Sports Complex	-100% (-10 hours)
WMATA	J4	College Park Station – Bethesda Station	-100% (-9 hours)
WMATA	V1	Benning Heights – Bureau of Engraving	-100% (-9 hours)
TheBus	15X	New Carrollton Station – Greenbelt Metro Station	-100% (-9 hours)
WMATA	A9	McPherson Square – Livingston South Capitol	-100% (-8 hours)
WMATA	G9	Rhode Island Ave/Eastern Ave – Franklin Square	-100% (-8 hours)
WMATA	K9	Hillandale FDA/FRC – Fort Totten	-100% (-8 hours)
WMATA	V7	Minnesota Ave Station to Congress Heights Station	-100% (-8 hours)
WMATA	B8	Fort Lincoln – Rhode Island Station	-100% (-7 hours)

Agency	Route Number	Route Name	% Change in Weekday Revenue Hours
WMATA	H11	Naylor Rd Station to Temple Hills	-100% (-7 hours)
WMATA	P19	Southern Avenue Station	-100% (-7 hours)
WMATA	21A	Pentagon - Landmark	-100% (-7 hours)
WMATA	7W	Pentagon – Lincolnia	-100% (-6 hours)
WMATA	B9	Colmar Manor – Rhode Island Avenue Station	-100% (-6 hours)
WMATA	S91	Franconia/Springfield – Springfield Town Center	-100% (-4 hours)
WMATA	C14	Branch Ave Station to Naylor Rd Station	-43.5% (-6 hours)
WMATA	C12	Branch Ave Station to Naylor Rd Station	-35.3% (-4 hours)
TheBus	17	Mt. Rainier Terminal - Ikea	-32.0% (-5 hours)
TheBus	13	Hyattsville – Prince George's Plaza Metrorail Stations	-32.0% (-4 hours)
WMATA	86	Calverton – Rhode Island Station	-28.3% (-5 hours)
WMATA	E2	Fort Totten – Ivy City	-22.2% (-4 hours)
WMATA	74	Convention Center – Nationals Park	-16.6% (-3 hours)
WMATA	U5	Marshall Heights – Lincoln Heights, Minnesota Avenue Station	-16.1% (-3 hours)
WMATA	X2	Lafayette Square – Minnesota Ave Station	-13.6% (-3 hours)
WMATA	P6	Anacostia Station – Rhode Island Ave Station	-13.1% (-3 hours)

Gap Analysis

TRANSIT EQUITY NEED INDEX

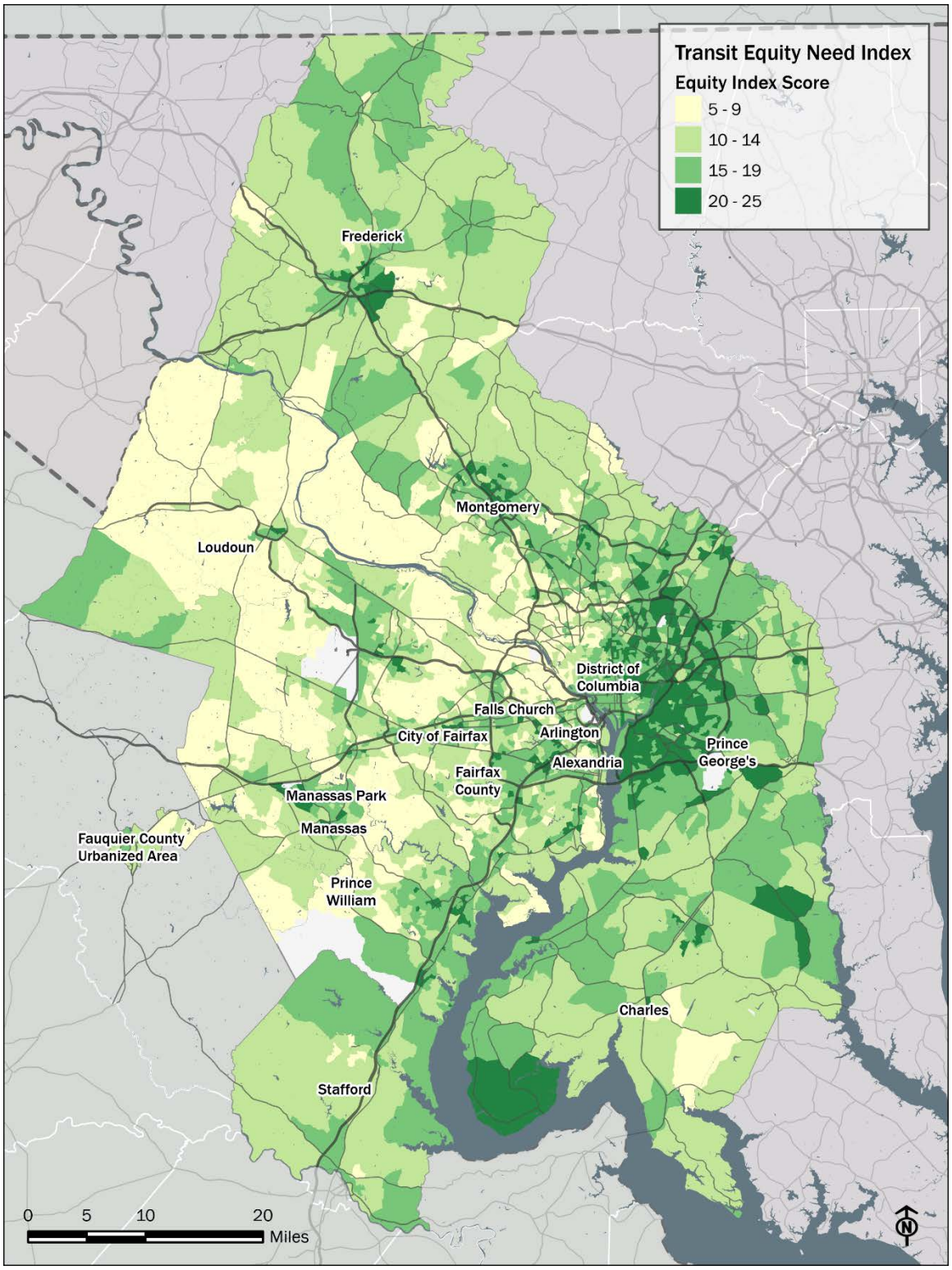
The Transit Need Equity Index measures demographic characteristics at the block group level which are known to indicate likelihood of transit use and/or transit dependency. The Transit Need Equity Index is made up of the following variables:

- People of color population (as a percentage of the total population)
- Low-wage workers (as a percentage of total workers)
- Low-income households (as a percentage of total households)
- Zero- and one-car households (as a percentage of total households)
- Persons with disabilities (as a percentage of the total population)

These variables measure population and households at their home location and are therefore indicators for access on the origin side (a separate analysis in the section called "Results from Employment Transit Gap Analysis" will look at destination-based transit equity). More detail about the creation of the index can be found in the "Transit Equity Need Index" section of the Appendix.

The Transit Equity Need Index is displayed in **Figure 15**. There is a large degree of overlap between the highest-scoring areas (the darkest shade of green) and Equity Emphasis Areas (EEAs): The eastern and southwest portions of the District of Columbia; the inner beltway regions of Prince George's County and Montgomery County; adjacent to major corridors in Northern Virginia; and, the densest areas of the region's satellite communities such as Rockville, Frederick, and Manassas. The index also highlighted high-scoring areas outside of the EEAs, including certain block groups in Prince George's County and Charles County. The index, as well as the component demographic parts, are available for viewing in the online map.

Figure 15: Transit Equity Need Index

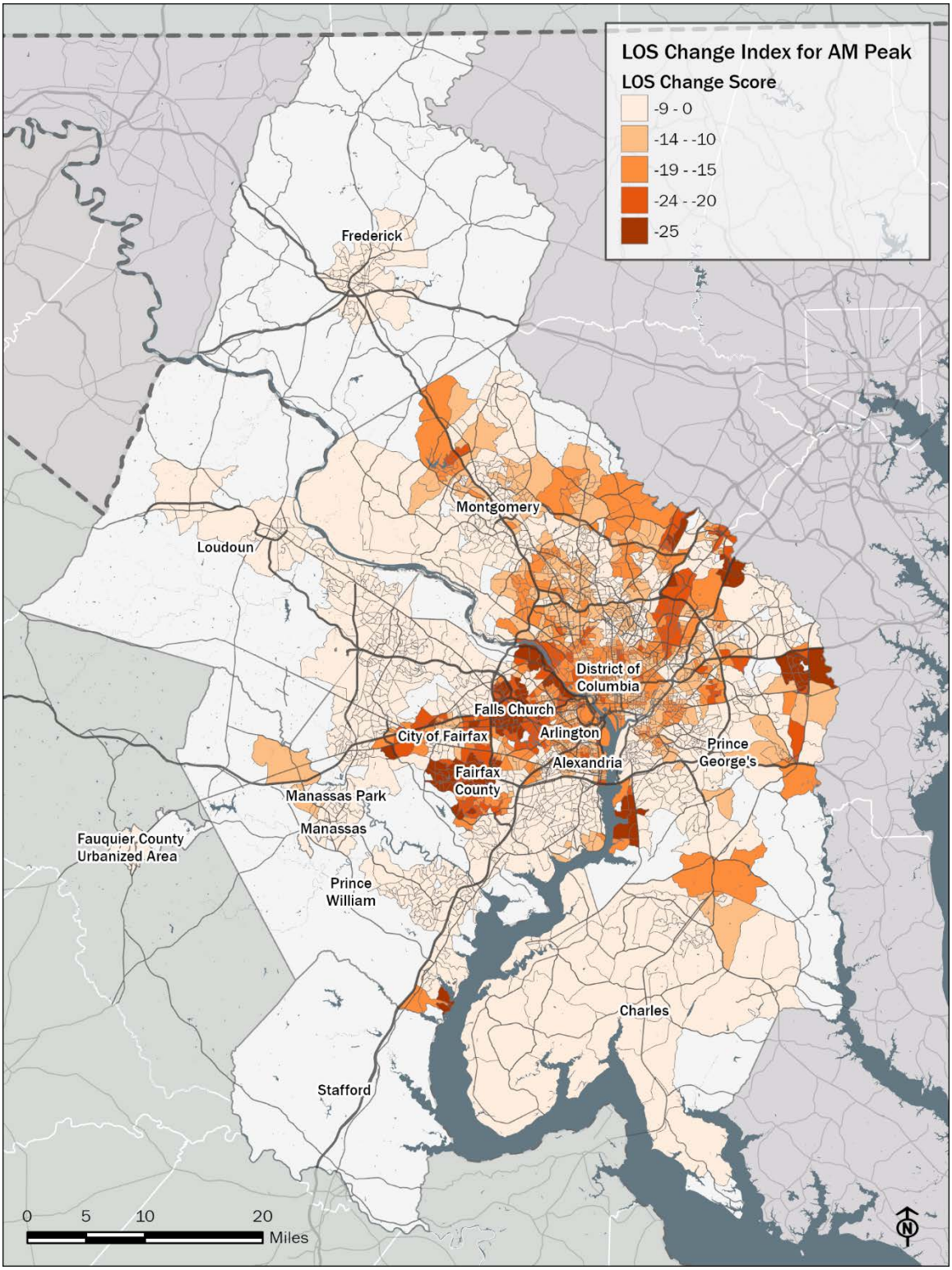


LEVEL OF SERVICE (LOS) CHANGE INDEX

The Level of Service (LOS) Change Index measures how much service changed in each block group from before the pandemic until now. The change in number of trips per period calculations were used to create the LOS Change Index. Lower negative numbers represent higher losses of service. More detail about the creation of the index can be found in the "Change in Level of Service (LOS) and LOS Index" section of the Appendix.

There are four versions of the LOS Change Index, one for each of the four service periods within this study. The map of the LOS Change Index for the AM peak period is shown in **Figure 16**. This layer, as well as the layers for the other three time periods, are available for viewing in the online map. The results of the index indicate the highest scoring areas (those that experienced the most significant losses in service) are in Northern Virginia (including Fairfax County, Falls Church, McLean, and Burke) and Prince George's County (around Fort Washington, Bowie, and Laurel), shown in the darkest shade of orange.

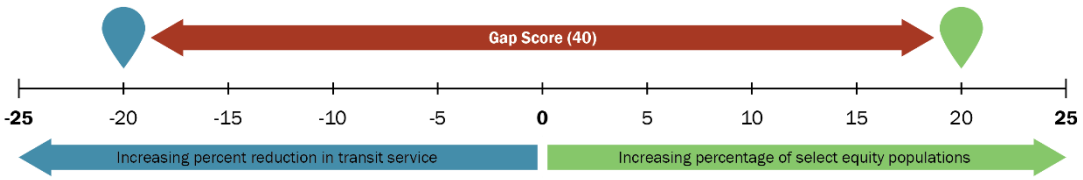
Figure 16: Level of Service (LOS) Change Index



GAP ANALYSIS INDEX

The Gap Analysis Index determines the areas within the region that have high transit need and experienced notable reductions in or losses of service during the pandemic. This index is calculated by taking the Transit Equity Need Index and LOS Change Index and calculating the size of the gap between them. Block groups with higher Transit Need Equity scores that experienced a larger decrease in trips resulted in larger Gap Analysis Index scores, while block groups with lower Transit Need Equity scores with a similar service reduction would yield a smaller gap. **Figure 17** shows the method by which the gap between the two component scores is calculated to find the Gap Analysis Index score. Higher Gap Analysis Index scores indicate areas that have high need for equitable distribution of transit and also experienced a notable loss of service during the pandemic; these areas may be prioritized for service restoration.

Figure 17: Gap Analysis Index Scoring Diagram



Because there are four versions of the LOS Change Index, one for each of the four service periods within this study, there are also four resulting Gap Analysis Indices. The map of the Gap Analysis Index results is shown in **Figure 17** for the AM peak period. While the index was calculated for all block groups that have or had service in the AM peak period, the mapped data are filtered to only show the resulting scores for block groups which have above average scores on the Transit Equity Need Index in order to focus more specifically on them. Block groups which have darker orange colors experienced higher losses of service and scored higher on the Transit Equity Need Index.

Figure 18 and **Figure 19** show highest-scoring gaps across the region. The District of Columbia has fewer highest-scoring gaps (the darkest orange shade) compared to the suburban counties. The largest gaps in Maryland are in College Park, Laurel, Bowie, and the National Harbor/Fort Washington area. In Virginia, major gaps exist around Falls Church, Annandale, Burke, and Quantico. High-scoring gaps can be found both within and outside of COG's Equity Emphasis Areas. While the District does not have a high concentration of the highest-scoring gaps, much of its area is covered by block groups with moderate scores (17 or higher) compared to the suburban jurisdictions. These notable gaps are likely a result of the District having the highest density of transit service.

One limitation of this index is that it considers changes in transit service and not absolute levels of service. There may be areas that were underserved before the pandemic but saw minimal service cuts that would not be emphasized in these results. Future analyses can explore transit need and equitable provision of transit service more fully to understand gaps that pre-existed before pandemic-related service cuts.

Figure 18: Transit Gap Score for AM Peak Period

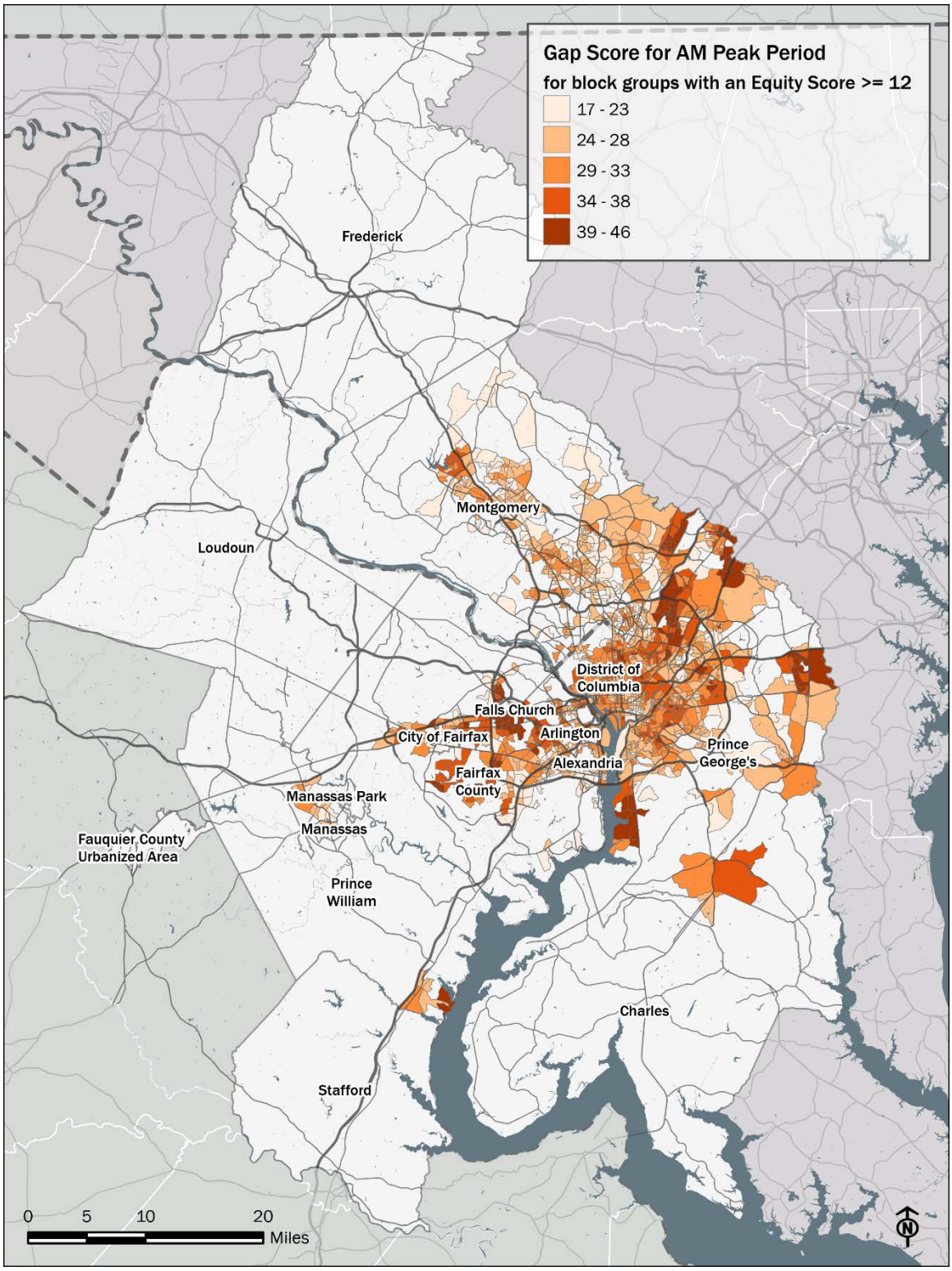
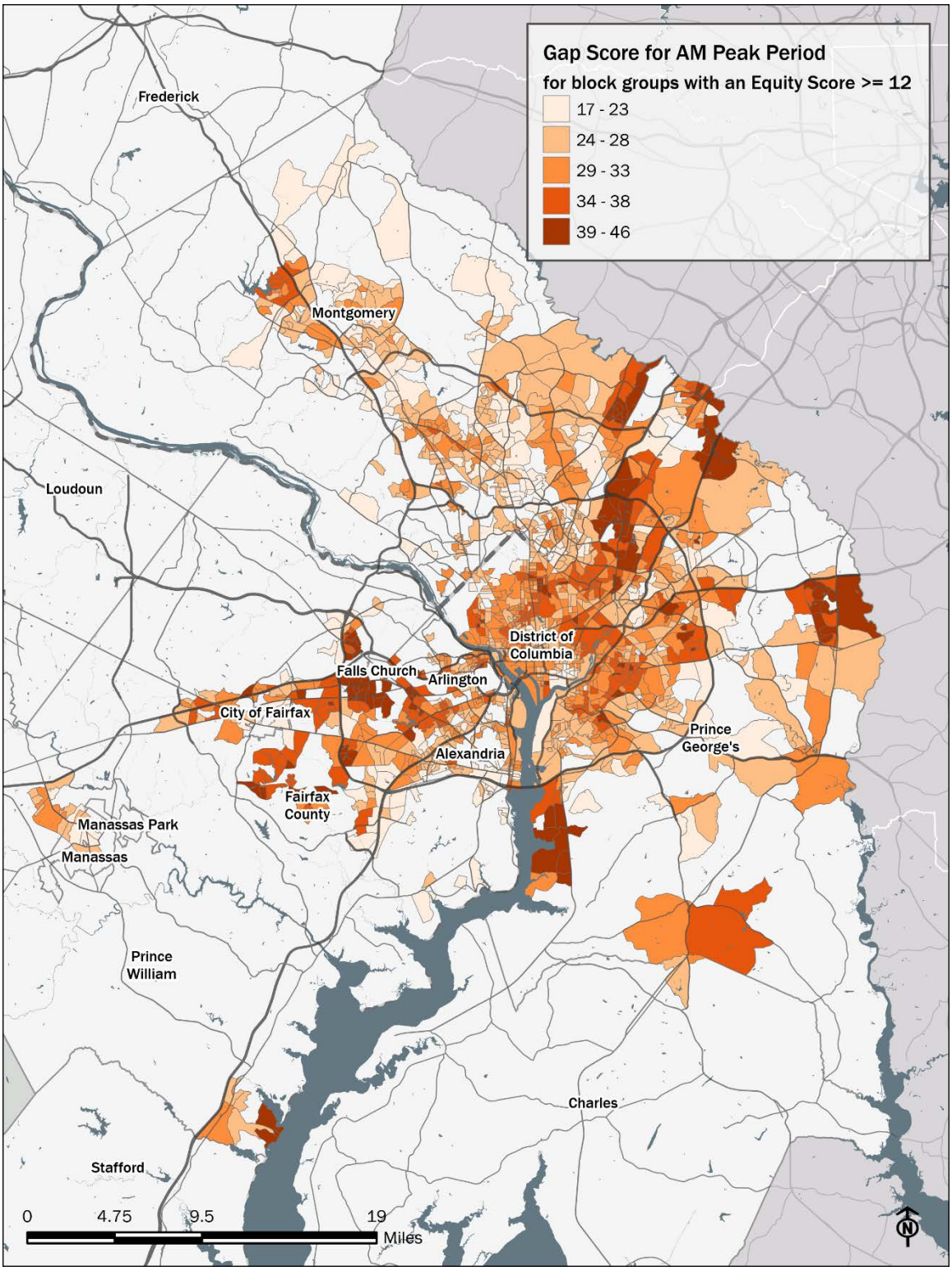


Figure 19: Transit Gap Score for AM Peak Period (Zoomed In)



RESULTS FROM EMPLOYMENT TRANSIT GAP ANALYSIS

This analysis examines employment density and its spatial relationship to current transit service (active bus stops). The analysis focuses on low-wage jobs and essential jobs—the former for their inclusion in this report's Transit Equity Need Index, the latter because people who work in these jobs needed reliable transit during the pandemic.

Figure 20 shows a higher density of low-wage jobs with no transit access primarily in Northern Virginia; in Loudoun County around Dulles Airport; and large areas in and around Manassas and Manassas Park. Other high-density pockets with not transit service can be seen along the I-95 and US-1 corridors in suburban Maryland; the edges of the City of Frederick; and in Stafford County.

Figure 21 shows that essential jobs without access to transit largely follow the same spaital distribution as low-wage jobs without transit access in **Figure 20**, but with additional underserved essential job hotspots in Fairfax County and along the eastern boundary of Prince George's County.

Figure 20: Low-Wage Job Density and Transit Access

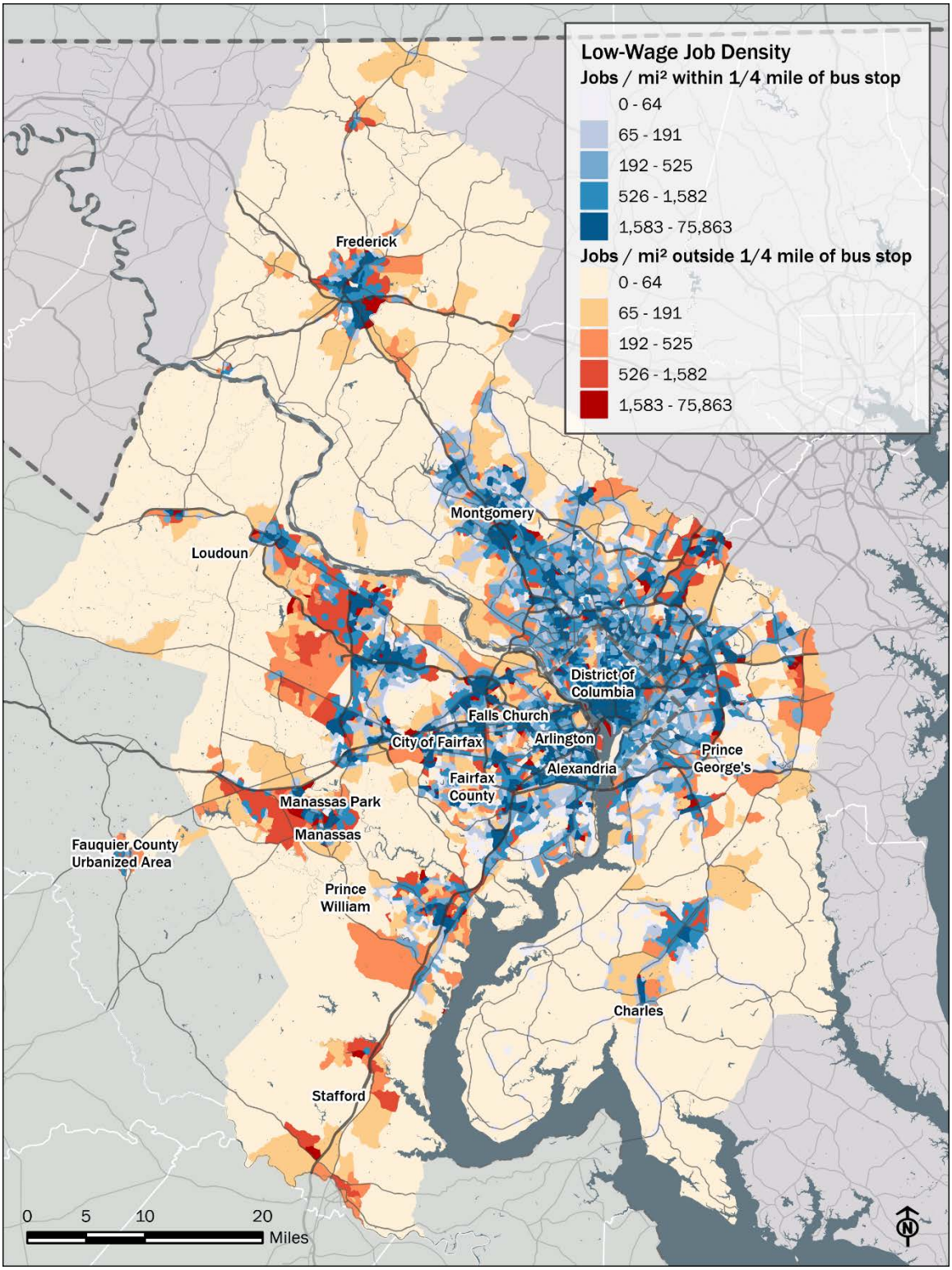
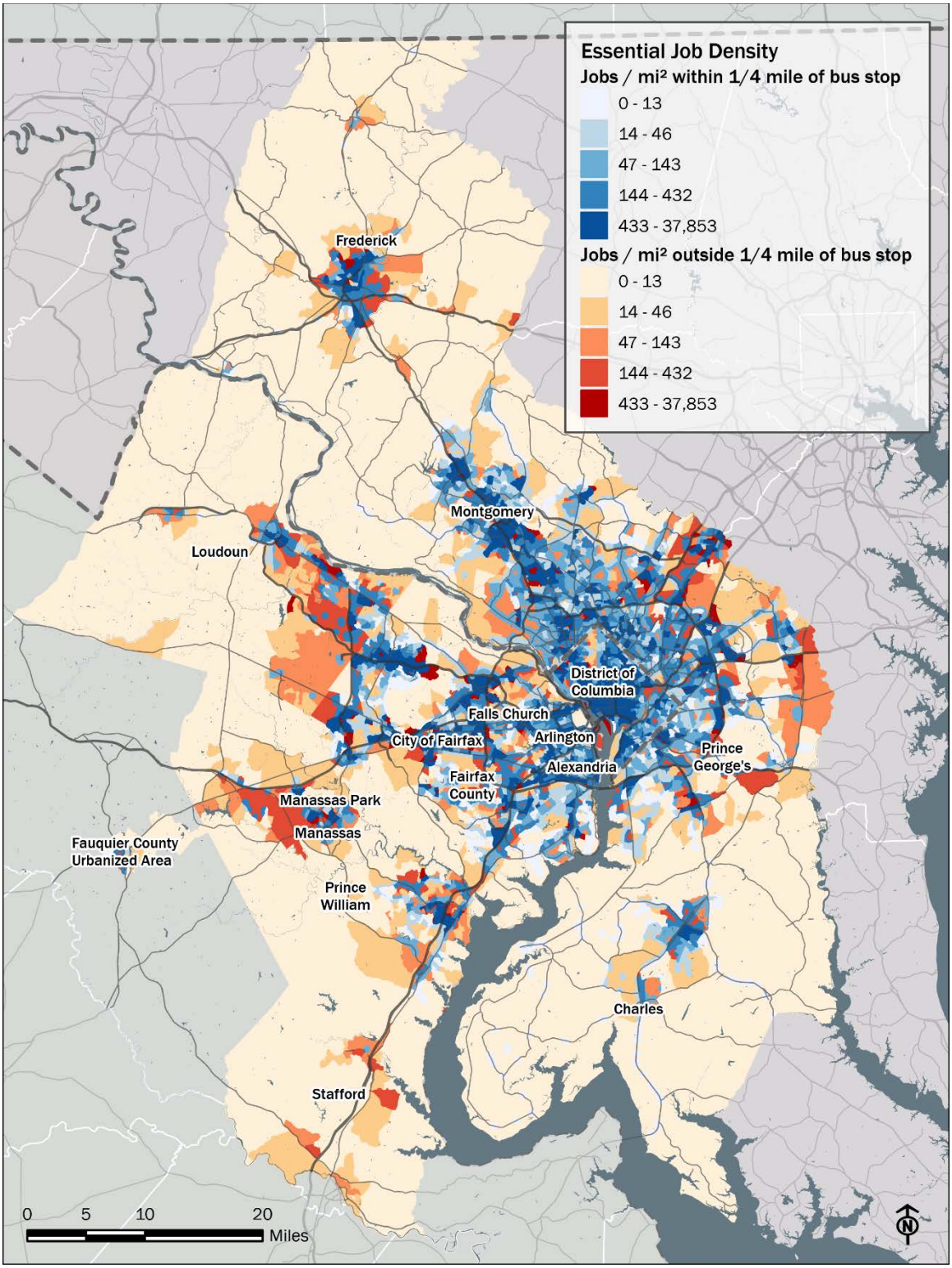


Figure 21: Essential Job Density and Transit Access



KEY TAKEAWAYS

Gaps in Service vs. Population

- While 60 percent of the total population in the TPB region is within one-quarter mile of fixed route bus service, only 68 percent of that group have access to 15-minute or better service in the AM peak period.
- Overall, transit service, major corridors, and population density are generally congruent.
- There are select block groups across the region that are high in population density (both total and specific equity subgroups) that are not within one-quarter mile of a bus stop.
    - Areas with concentrations of these block groups include Prince George's County outside the Beltway (such as in Laurel and Bowie); Prince William County around Dale City and parts of Manassas; and portions of Loudoun County south of Leesburg.

Gaps in Service vs. Employment

- Overall, transit service, major corridors, and job density are generally congruent, particularly in the region's core.
- Overall, 73% of all jobs are within a ¼ mile of a bus stop, reflecting the fact that a significant amount of transit service is directed towards job centers and jobs access.
- A higher density of low-wage jobs with no transit access can be seen primarily in Loudoun County around Dulles Airport and in and around Manassas and Manassas Park.
    - Other significant areas include the edges of the City of Frederick; Stafford County; and Prince George's County outside of the Beltway (such as Laurel, College Park, and Bowie).
        - Essential jobs follow the same patterns, but with additional underserved essential job hotspots in Fairfax County and on the eastern boundary of Prince George's County.

Disparities in Access to Bus Transit

- Overall, most persons of color, people with low incomes, and zero and one-car households have higher access to bus stops than their parent populations (total population and total households).
    - However, many of these percentages fall when looking at frequent bus service in the peak periods (15 minutes or better).
- When looking at low-wage workers, only 61 percent are within one-quarter mile of a bus stop, and this figure drops to 41 percent in the peak periods.
- While marginalized population groups overall have more access to transit service compared to the general population, a smaller share (41 to 55 percent) have access to high-frequency service (15 minutes or better than the AM Peak) compared to the 62 to 68 percent of the transit-accessible population overall.
- The low percentage of access to frequent service for all groups, even in the peak periods, remains a concern, particularly for quality of life and jobs access.
- Equity Emphasis Areas (EEAs) have a higher percentage of residents within one-quarter mile of a bus stop for every analyzed sub-group, often by a factor of 20 percentage points.
    - However, this is compared to the region as a whole, which is overall less dense than the EEAs.
- When looking at low-wage jobs within a quarter mile of transit compared to all jobs, the percentage drops to five percentage points, indicating that those in this higher need category have less slightly less access to their employment location.

    - When looking at essential jobs (work location) the figure rises slightly to 75%
    - When we evaluate the peak periods however the access drops significantly, with only 56% of jobs are within a ¼ mile of 15-minute or better service in the AM peak period, and this rises slightly to 57% during the PM peak period.
        - For low-wage jobs this drops to 41% in the AM peak and 48% in the PM peak.
        - Access to essential jobs (work location) in the AM peak period remains on par with overall access to jobs (56%).
- The access rates for the 12-18 hour weekday span in **Table 3** show the highest percentage of all demographic and job groups, indicating this is the prevalent range of weekday service across the region.

Network Job Accessibility Analysis

- The service period with the highest quantity of jobs accessible is the weekday peak period, followed by weekday midday, Saturday, and weekday late night.
- For all time periods, low-wage workers have access to fewer jobs compared to all workers.
- Job access for all job types and all workers decrease consistently from the peak to the midday to the late periods.
- More jobs are accessible for people living within EEAs compared to those living outside of them.
- The highest levels of job access are found in the dense core of the District of Columbia and radiate out along major corridors. However, Montgomery County shows generally better access along its corridors compared to Prince George's County and Northern Virginia.

Transit Level of Service Change

- Areas that lost the greatest amount of service during the pandemic include:
    - Burke (Fairfax County)
    - McLean (Fairfax County)
    - City of Falls Church
    - Fort Washington, Mitchellville, and Crofton (Prince George's County)

Areas which Lost High-Frequency Service

- The loss of high-frequency service (service that comes every 15 minutes or more) was most prevalent across the District of Columbia and along Columbia Pike in Fairfax County.
- Other smaller pockets saw a loss of high-frequency service in Arlington County, the City of Falls Church, and throughout Montgomery County and the northern end of Prince George's County.

Transit Equity Need Index

- The Transit Need Equity Index measures demographic characteristics at the block group level which are known to indicate likelihood of transit use and/or transit dependency. These variables measure population and households at their home location and are therefore indicators for access on the origin side.
- There is a large degree of overlap between the areas which scored high on this index and Equity Emphasis Areas (EEAs): The eastern and southwest portions of the District of Columbia; the inner beltway regions of Prince George's County and Montgomery County;

adjacent to major corridors in Northern Virginia; and, the densest areas of the region's satellite communities such as Rockville, Frederick, and Manassas.
- Clusters of high-scoring areas outside EEA boundaries can be found primarily in Prince George's and Charles Counties.

Level of Service (LOS) Change Index

- The Level of Service (LOS) Change Index measures how much service changed in each block group from before the pandemic until now. The change in number of trips per period calculations were used to create the LOS Change Index.
- The highest scoring areas (those that experienced the most significant losses in service) are in Northern Virginia (including Fairfax County, Falls Church, McLean, and Burke) and Prince George's County (around Fort Washington, Bowie, and Laurel).

Gap Analysis Index

- The Gap Analysis Index determines the areas within the region that have high transit need and experienced notable reductions in or losses of service during the pandemic. This index is calculated by taking the Transit Equity Need Index and LOS Change Index and calculating the size of the gap between them. Block groups with higher Transit Need Equity scores that experienced a larger decrease in trips resulted in larger Gap Analysis Index scores, while block groups with lower Transit Need Equity scores with a similar service reduction would yield a smaller gap.
- The District of Columbia had many block groups with moderate scores on this index. Most of the largest gaps were found in Maryland and Virginia.
- The largest gaps in Maryland can be found in College Park, Laurel, Bowie, and the National Harbor/Fort Washington area.
- In Virginia, major gaps exist around Falls Church, Annandale, Burke, and Quantico.
- High-scoring gaps can be found both within and outside of COG's Equity Emphasis Areas.

APPENDIX – DATA SOURCES, METHODOLOGY DETAILS, AND DETAILED RESULTS

GTFS Sources

Table 2 contains information about GTFS feeds that were pulled and used for the service analysis. Where available, two different time periods of service were pulled: one before the pandemic, and the most recently available data. The "Notes" column describes three instances where GTFS data were either unavailable or were not used and one instance in which an erroneous feed was updated. Non-local bus routes, including commuter routes and local shuttles (i.e., routes connecting a Metrorail station with an employment campus) were removed from each feed.

Table 2: GTFS Data Sources

Agency	Pre-Pandemic GTFS	More Recent GTFS	Notes
ART	1/31/2020	2/17/2021	
Charles VanGo	8/27/2019	8/27/2019	Service has not changed, so the same GTFS feed was used in both analysis periods.
DASH	1/1/2020	2/17/2021	
DC Circulator	7/14/2019	3/28/2021	
Fairfax Connector	1/24/2020	1/6/2021	
Fairfax CUE	3/14/2019	3/17/2021	
Fauquier County	10/2/2020	10/2/2020	No earlier GTFS feed available.
Frederick Transit	3/27/2019	3/18/2021	
Loudoun County Transit	1/23/2021	1/23/2021	No earlier complete GTFS feed available.
PRTC Omniride	11/29/2019	2/26/2021	
RideOn	1/7/2020	2/17/2021	
TheBus	11/11/2019	2/9/2021	Erroneous Saturday service was removed from the newer feed before analysis.
WMATA	1/31/2020	2/14/2021	

Methodologies and Results

ESSENTIAL JOB IDENTIFICATION

Essential jobs were identified using the Centers for Disease Control's (CDC) *Interim List of Categories of Essential Workers Mapped to Standardized Industry Codes and Titles*.[3] This data source provided job categories by four, five, and six-digit NAICS codes,[4] providing a high degree of fidelity and ease of translation to larger job datasets. Phase 1a and Phase 1b as identified by the CDC include:

Essential Healthcare Workers (1a):
All paid and unpaid persons serving in healthcare settings who have the potential for direct or indirect exposure to patients or infectious materials. This includes persons not directly involved in patient care, but potentially exposed to infectious agents while working in a healthcare setting.

Essential Non-Healthcare Workers – Frontline Essential Workers (1b):
Workers who are essential to maintain critical infrastructure and continue critical services and functions. The subset of essential workers likely at highest risk for work-related exposure to SARS-CoV-2, the virus that causes COVID-19, because their work-related duties must be performed on-site and involve being in close proximity (<6 feet) to the public or to coworkers.

The level of geographic specificity of the NAICS codes used by CDC are identifiable at the ZIP code level. In order to assign essential jobs at the block group level, each block group was assigned a number of essential jobs based on its share of jobs compared to the ZIP code's total.

[3] Centers for Disease Control. "Interim List of Categories of Essential Workers Mapped to Standardized Industry Codes and Titles." https://www.cdc.gov/vaccines/covid-19/categories-essential-workers.html

[4] U.S. Census Bureau. "North American Industry Classification System." https://www.census.gov/naics/

DISPARITIES IN ACCESS TO BUS TRANSIT

Table 3: Transit Access Summary Statistics

	Total Population	White Population	Minority Population	Disabled Population	Language other than English Population	Veteran Population	Households	Low Income Households	Zero or One Car Households	Two or More Car Households	Total Jobs	Low Wage Jobs	Essential Jobs (Work Location)	Total Workers	Low Income Workers
TPB Universe	5,666,099	2,450,005	3,257,385	4,281,114	3,692,476	4,394,607	5,609,480	720,324	899,389	1,130,131	2,954,567	1,186,766	370,317	2,720,069	1,132,737
Within 1/4 Mile Buffer of Bus Stops	3,409,421	1,300,311	2,124,664	2,607,072	2,101,355	2,679,505	3,360,080	531,953	698,835	582,110	2,159,582	831,529	276,941	1,627,029	689,386
Percent of TPB Universe	*60%*	*53%*	*65%*	*61%*	*57%*	*61%*	*60%*	*74%*	*78%*	*52%*	*73%*	*70%*	*75%*	*60%*	*61%*
15 Minute Service - AM Peak Average Weekday	2,307,475	894,381	1,426,995	1,782,813	1,418,017	1,827,017	2,282,400	389,545	521,498	370,307	1,660,566	605,276	207,023	1,106,079	462,261
Percent of Pop./Jobs Near Transit	*68%*	*69%*	*67%*	*68%*	*67%*	*68%*	*68%*	*73%*	*75%*	*64%*	*77%*	*73%*	*75%*	*68%*	*67%*
Percent of TPB Universe	*41%*	*37%*	*44%*	*42%*	*38%*	*42%*	*41%*	*54%*	*58%*	*33%*	*56%*	*51%*	*56%*	*41%*	*41%*
15 Minute Service - PM Peak Average Weekday	2,123,699	826,105	1,310,754	1,643,858	1,303,345	1,690,654	2,094,876	363,275	498,871	330,624	1,594,595	572,357	197,631	1,013,625	418,442
Percent of Pop./Jobs Near Transit	*62%*	*64%*	*62%*	*63%*	*62%*	*63%*	*62%*	*68%*	*71%*	*57%*	*74%*	*69%*	*71%*	*62%*	*61%*
Percent of TPB Universe	*37%*	*34%*	*40%*	*38%*	*35%*	*38%*	*37%*	*50%*	*55%*	*29%*	*54%*	*48%*	*53%*	*37%*	*37%*
30 Minute Service - Saturday Midday	1,855,341	675,589	1,195,053	1,442,090	1,160,876	1,492,002	1,825,126	343,117	479,594	260,387	1,449,793	518,235	177,790	879,684	366,606
Percent of Pop./Jobs Near Transit	*54%*	*52%*	*56%*	*55%*	*55%*	*56%*	*54%*	*65%*	*69%*	*45%*	*67%*	*62%*	*64%*	*54%*	*53%*
Percent of TPB Universe	*33%*	*28%*	*37%*	*34%*	*31%*	*34%*	*33%*	*48%*	*53%*	*23%*	*49%*	*44%*	*48%*	*32%*	*32%*
<6 Hours - Average Weekday Span	623,528	274,349	353,453	481,728	380,305	499,091	612,615	85,901	128,736	110,299	686,608	207,166	73,069	305,113	118,153
Percent of Pop./Jobs Near Transit	*18%*	*21%*	*17%*	*18%*	*18%*	*19%*	*18%*	*16%*	*18%*	*19%*	*32%*	*25%*	*26%*	*19%*	*17%*
Percent of TPB Universe	*11%*	*11%*	*11%*	*11%*	*10%*	*11%*	*11%*	*12%*	*14%*	*10%*	*23%*	*17%*	*20%*	*11%*	*10%*

	Total Population	White Population	Minority Population	Disabled Population	Language other than English Population	Veteran Population	Households	Low Income Households	Zero or One Car Households	Two or More Car Households	Total Jobs	Low Wage Jobs	Essential Jobs (Work Location)	Total Workers	Low Income Workers
6-12 - Average Weekday Span	305,806	124,251	183,539	235,031	190,431	238,684	305,075	44,644	52,780	59,044	231,397	83,772	23,814	151,741	66,592
Percent of Pop./Jobs Near Transit	*9%*	*10%*	*9%*	*9%*	*9%*	*9%*	*9%*	*8%*	*8%*	*10%*	*11%*	*10%*	*9%*	*9%*	*10%*
Percent of TPB Universe	*5%*	*5%*	*6%*	*5%*	*5%*	*5%*	*5%*	*6%*	*6%*	*5%*	*8%*	*7%*	*6%*	*6%*	*6%*
12-18 Hours - Average Weekday Span	2,338,002	897,026	1,447,492	1,786,320	1,438,604	1,835,655	2,301,366	347,933	473,527	413,306	1,649,548	624,953	206,528	1,120,777	473,492
Percent of Pop./Jobs Near Transit	*69%*	*69%*	*68%*	*69%*	*68%*	*69%*	*68%*	*65%*	*68%*	*71%*	*76%*	*75%*	*75%*	*69%*	*69%*
Percent of TPB Universe	*41%*	*37%*	*44%*	*42%*	*39%*	*42%*	*41%*	*48%*	*53%*	*37%*	*56%*	*53%*	*56%*	*41%*	*42%*
18-21 Hours - Average Weekday Span	1,912,198	685,214	1,239,269	1,486,166	1,196,638	1,527,343	1,887,558	353,231	489,637	269,636	1,403,570	500,612	174,195	902,780	379,615
Percent of Pop./Jobs Near Transit	*56%*	*53%*	*58%*	*57%*	*57%*	*57%*	*56%*	*66%*	*70%*	*46%*	*65%*	*60%*	*63%*	*55%*	*55%*
Percent of TPB Universe	*34%*	*28%*	*38%*	*35%*	*32%*	*35%*	*34%*	*49%*	*54%*	*24%*	*48%*	*42%*	*47%*	*33%*	*34%*
21+ Hours - Average Weekday Span	94,597	33,550	62,743	72,862	43,708	74,099	95,726	16,546	17,496	17,407	99,656	36,901	12,307	44,349	19,431
Percent of Pop./Jobs Near Transit	*3%*	*3%*	*3%*	*3%*	*2%*	*3%*	*3%*	*3%*	*3%*	*3%*	*5%*	*4%*	*4%*	*3%*	*3%*
Percent of TPB Universe	*2%*	*1%*	*2%*	*2%*	*1%*	*2%*	*2%*	*2%*	*2%*	*2%*	*3%*	*3%*	*3%*	*2%*	*2%*

Table 4: Equity Emphasis Area Transit Access Summary Statistics

	Total Population	White Population	PoC Population	Disabled Population	Language other than English Population	Veteran Population	Total Households	Low Income Households	Zero / One Car Households	Two or More Car Households	Total Jobs	Low Wage Jobs	Essential Jobs	Total Workers	Low Income Workers
Within All Equity Emphasis Areas (A)	1,548,126	324,097	1,232,959	1,144,050	859,493	1,190,728	1,508,488	369,864	324,728	213,213	707,325	303,135	99,082	700,886	366,360
Within EEAs within 1/4 Mile of Bus Stop (B)	1,293,365	256,482	1,044,430	957,603	722,392	995,650	1,261,313	322,159	291,129	166,843	610,535	256,533	86,436	582,314	303,876
Share of EEA Population/Jobs within 1/4 Mile of Bus Stop (B/A)	84%	79%	85%	84%	84%	84%	84%	87%	90%	78%	86%	85%	87%	83%	83%
Regionwide Share of Population/Jobs within 1/4 Mile of Bus Stop	60%	53%	65%	61%	57%	61%	60%	74%	78%	52%	73%	70%	75%	60%	61%

NETWORK JOB ACCESSIBILITY ANALYSIS

This analysis of job access used Conveyal, a web-based application that produces estimates of accessibility on transit networks. Using the platform, analysts can calculate not only the accessibility to jobs or other destinations from a single point but also aggregate the results of these accessibility measures over an entire region. The platform accepts custom inputs of demographic data (such as job counts), geographic aggregations (such as Equity Emphasis Areas), and GTFS feeds (listed in **Table 2**) that describe transit systems. Parameters that affect accessibility calculations, such as the date and time ranges used, can also be modified. The platform's methodology is described in detail on its user help site.[5]

Using the Conveyal platform, Foursquare ITP conducted the job accessibility analyses for both total workers and low-wage workers, and compared access for workers living in Equity Emphasis Areas (EEAs) to those who live outside of them.

The following time periods were analyzed:

- Weekday AM peak (6:00 AM - 9:00 AM)
- Weekday midday (9:00 AM - 3:00 PM)
- Weekday late night (11:00 PM - 4:00 AM)
- Saturday core (9:00 AM - 3:00 PM)

Table 5 and **Table 6** contain the results from the Conveyal accessibility analysis for jobs accessible within a 45-minute bus trip, which are summarized in the "Network Job Accessibility Analysis" section of the report. Two different statistics are reported for each record. One is the weighted average number of jobs accessible (used throughout the report) and the number of jobs available to workers at the 50th percentile. In both cases, median travel times (including access and egress time, wait time, and in-vehicle travel time) are used.

Table 5: Network Job Accessibility Analysis Results – Total Workers

Time Period	Job Type (Total Jobs or Essential Jobs)	Living in EEA or not Living in EEA	Jobs Accessible (Weighted Average)	Jobs Accessible (50th Percentile)
Weekday AM Peak 6:00 AM - 9:00 AM	Essential Jobs	In EEA	11,014	6,128
	Essential Jobs	Not in EEA	6,315	892
	Total Jobs	In EEA	90,699	38,877
	Total Jobs	Not in EEA	54,277	6,338
Weekday Midday 9:00 AM - 3:00 PM	Essential Jobs	In EEA	9,991	5,306
	Essential Jobs	Not in EEA	5,762	631
	Total Jobs	In EEA	82,827	33,226
	Total Jobs	Not in EEA	50,065	4,400
Weekday Late Night	Essential Jobs	In EEA	6,498	1,687
	Essential Jobs	Not in EEA	3,509	184

[5] Conveyal. *Methodology.* https://docs.analysis.conveyal.com/analysis/methodology

Time Period	Job Type (Total Jobs or Essential Jobs)	Living in EEA or not Living in EEA	Jobs Accessible (Weighted Average)	Jobs Accessible (50th Percentile)
9:00 PM - 2:00 AM	Total Jobs	In EEA	58,234	8,675
	Total Jobs	Not in EEA	32,538	1,365
Weekend Core 9:00 AM - 3:00 PM	Essential Jobs	In EEA	9,490	4,745
	Essential Jobs	Not in EEA	5,353	373
	Total Jobs	In EEA	80,255	29,525
	Total Jobs	Not in EEA	47,239	2,705

Table 6: Network Job Accessibility Analysis Results – Low-Wage Workers

Time Period	Job Type (Total Jobs or Essential Jobs)	Living in EEA or not Living in EEA	Jobs Accessible (Weighted Average)	Jobs Accessible (50th Percentile)
Weekday AM Peak 6:00 AM - 9:00 AM	Essential Jobs	In EEA	9,769	5,751
	Essential Jobs	Not in EEA	5,149	709
	Total Jobs	In EEA	77,720	36,028
	Total Jobs	Not in EEA	42,761	5,081
Weekday Midday 9:00 AM - 3:00 PM	Essential Jobs	In EEA	8,791	4,980
	Essential Jobs	Not in EEA	4,642	493
	Total Jobs	In EEA	70,254	30,828
	Total Jobs	Not in EEA	38,965	3,519
Weekday Late Night 9:00 PM - 2:00 AM	Essential Jobs	In EEA	5,375	1,600
	Essential Jobs	Not in EEA	2,698	166
	Total Jobs	In EEA	46,481	8,248
	Total Jobs	Not in EEA	24,207	1,244
Weekend Core 9:00 AM - 3:00 PM	Essential Jobs	In EEA	8,259	4,408
	Essential Jobs	Not in EEA	4,255	307
	Total Jobs	In EEA	67,465	26,682
	Total Jobs	Not in EEA	36,288	2,214

CHANGE IN LEVEL OF SERVICE (LOS) AND LOS CHANGE INDEX

Trip data from each GTFS feed (pre-pandemic and current) was aggregated to the block group level. Stops were buffered by one-quarter mile; any block groups intersecting a stop's buffer had that stop attributed to it. Some stops were counted by more than one block group, which is accurate to real-life service—a stop can be accessible to users on either side of a block group dividing line—and it does not negatively impact the analysis to have a stop counted more than once. The number of trips that serve each stop was determined and was averaged for all stops serving each block group to find the average number of trips per stop in each block group, for each time period, both pre-pandemic and current.

After the trips per period were assigned and averaged to the block group, the LOS Change Index was constructed. The total range in values was divided into five bins based on natural breaks, with each bin receiving a score between one and five, except multiplied by negative five: the lowest bin receives a score of negative five, the next a score of negative ten, and so on: This is done to ensure

the same scale between the two score sets for the gaps analysis. Any block group that never had service or saw an increase in service from before the pandemic to current was given a score of 0 for the LOS Change Index. The use of negative integers for the LOS Change Score ensures that areas with the greatest loss of service (a score -25) and the highest transit equity need score (a score of 25, as mentioned in the next section) would have the largest gap between them (50).

TRANSIT EQUITY NEED INDEX

The Transit Need Equity Index is made up of the following variables:

- People of color population (as a percentage of the total population)
- Low-wage workers (as a percentage of total workers)
- Low-income households (as a percentage of total households)
- Zero- and one-car households (as a percentage of total households)
- Persons with disabilities (as a percentage of the total population)

The percentages of these variables were measured at the block group level. Each block group was assigned a variable index score based on quintiles for each of the variables, yielding an integer value between one and five: the lowest 20 percent of values were assigned an index score of one, the next 20 percent a score of two, etc. The result were five index scores, one for each variable, which were then summed to give every block group an equity index value between five and 25.