

Title: Service and Fare Equity Analysis: *CTrail* Hartford Line
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Introduction

The Connecticut Department of Transportation (CTDOT) plans to initiate a new *CTrail* rail passenger service called the “Hartford Line” in 2018. The Hartford Line rail passenger service will provide eight roundtrip trains between New Haven and Hartford with three of the roundtrip trains continuing north to Springfield, MA. This new service will augment the Amtrak service that operates today between New Haven and Springfield, MA. When the Hartford Line service launches in 2018, 17 roundtrips between New Haven and Hartford will operate each weekday; 12 of these 17 roundtrips trains will continue north to Springfield. Travelers in New Haven, Wallingford, Meriden, Berlin, and Hartford will board trains every 45 minutes during the morning and evening peak hours, and approximately every 90 minutes during off-peak periods. Weekday service will begin as early as 6 AM and run as late as 11 PM, providing a convenient alternative to driving for people traveling to work, school, or for leisure throughout this corridor.

The proposed schedule was memorialized by a three-party agreement between Connecticut Department of Transportation, Amtrak, and the Federal Railroad Administration. With the exception of State Street in New Haven *CTrail* and Amtrak trains will serve the same stations. There will be no differentiation of service such as local and express service or premium and economy service. The proposed fares for the new service are patterned on the fares for Shore Line East, an existing commuter train service between New London, New Haven and Stamford.

CTDOT, as a recipient of FTA funding and in accordance with the CTDOT Title VI program and the Federal Transit Administration (FTA) Circular 4702.1B, has commissioned the University of Connecticut to conduct a Service and Fare Equity analysis for the proposed service along the Hartford Line corridor. Disparate Impact and Disproportionate Burden analyses are presented in this document. Disparate Impact analysis refers to potentially disproportionately affected population groups based on their race, color, or national origin. Disproportionate Burden refers to a facially neutral policy or practice that disproportionately affects low-income populations more than non-low-income populations. (CTDOT Title VI 2015 p.186). Disparate Impact and Disproportionate Burden analyses are conducted for the demographic groups residing within *CTrail* system service area. The service area is defined as the 2.5 mile buffer around each station along the rail line.

Data Sources and Basic Variables

The demographic data used for this report was extracted from census tract level American Community Survey (ACS) estimates published by the U.S. Census Bureau. The most recent five-year release provides survey results sampled in 2011-2015. Compared to one-year and three-year ACS estimates, five-year estimates are reported as more accurate by the U.S. Census as they are based on a larger sample size and result in a lower margin of error for demographic variables (<https://www.census.gov>). The is a new service, there is currently no ridership data available, the analyses was completed using census tract data.

To determine minority and low-income status, two ACS tables are utilized (Table 1). Table B03002

(Hispanic or Latino Origin by Race) contains population counts by race broken down by Hispanic or Latino origin. Table B06012 (Place of Birth by Poverty Status in the Past 12 Months in the United States) reports poverty status by place of birth. Although the place of birth is not relevant in definition of low-income populations, this table contains poverty status for total count estimates as well. The counts are reported for groups below 100%, 100-149% and above 150% of poverty level. The Census Bureau uses total income thresholds to determine whether a family or an individual lives in poverty. The application of this dataset gives greater detail, as the counts of persons living in poverty takes into account their household size and the associated poverty line.

Minority population counts are computed as total population minus counts for “not Hispanic or Latino” variable (one race: white alone). The proportion of minority population group is derived by dividing minority counts by total population counts for each census tract.

Low-income population counts are those who live below 150% of the poverty level. Therefore, the low-income population count per tract is a sum of those below 100% and between 100 to 149% of the poverty level. The proportion of low-income per tract is the ratio of low-income population counts to the total tract population counts.

Table 1. List of ACS datasets used for demographic data processing

ACS Table	Description	Derived Demographic Groups	Variables Used
B03002	HISPANIC OR LATINO ORIGIN BY RACE	Minority Population	HD01_VD01 – Total HD01_VD03 – Not Hispanic or Latino: White alone
B06012	PLACE OF BIRTH BY POVERTY STATUS IN THE PAST 12 MONTHS IN THE UNITED STATES	Low-Income Population	HD01_VD01 –Total HD01_VD03 – Total: Below 100 percent of the poverty level HD01_VD03 - Total: 100 to 149 percent of the poverty level

To support spatial components of the analysis, the 2016 release of TIGER/Line Shapefiles of census tracts by the U.S. Census Bureau for the states of Connecticut and Massachusetts were joined with the demographic variables. Transit system configuration shapefiles of transit station locations and lines representing the Hartford line are used within a GIS environment.

System and Route Service Area Construction

Route service areas are defined by the specified radius (or buffer distance) around station locations along the route. The CTDOT uses a 2.5 mile radius buffer from each station as the criterion for analysis of rail services in the CTDOT Title VI Program. The same 2.5 mile station buffer is used here in this SAFE analysis. The station buffer was selected because it accounts for the likelihood of potential customers who may access the service by walking, bus, or by automobile and park modes since populations within 2.5 miles of a station are those more likely to utilize the service than those who reside further distances from the station.

The cumulative service areas around all stations on the Hartford Line defines is referred to as the “system

service area.” The system service area is used to evaluate the total population size served by the Hartford Line. The service area is then used for querying census tracts in order to gather the aggregate demographic characteristics of the population living within the specified distance of all transit stations. However, it is worth noting that the census tract boundaries do not fit precisely within a transit service area, most often spreading beyond its boundary. Collection of the demographic variables for the Hartford Line service area is performed by intersecting the service area, i.e., the 2.5 mile buffer around the stations in a Geographical Information System (GIS), with the underlying census tracts. If any portion of a tract is intersected by the buffer, it is considered part of the service area. This naturally results in the potential for overestimation of the population counts for a given service area, but is a reasonable estimate for the analysis. Figure 1 depicts the Hartford line, its eight station buffers and the underlying census tracts.

Low-Income and Minority Designations of Census Tracts

The dataset described above was used to identify census tracts that are predominately minority and/or low-income within the service areas. Census tracts are considered predominately low income or minority if the percentage of low-income or minority populations is higher than the service area average. This census tract designation is in accordance with the 2015 CTDOT Title VI Program. **Table 2** provides summary demographic variables for the Hartford Line system service area. The population totals for the system are different between minority and low-income households. This is caused by the nature of ACS estimates, and the inherent error attributable to using only a sample of households rather than comprehensive decennial census totals. This error is considered acceptable as the ACS provides a better estimate of Connecticut demographics in 2017 than the 2010 census data.. Each of the total population estimates has a margin of error of approximately 9%. This means that if the tract has total population of 1,000 people reported in the ACS table, then on average the error term is ± 90 people. This error can affect low-income and minority true estimates, but is an inherent part of the ACS data uncertainty.

Table 2. Minority and Low-Income Counts and Percentages for the System Area

Demographic Group	Total People in Demographic Group	Total People in System	System % in Demographic Group
Minority	436,272	829,913	52.57 %
Low-Income	234,851	792,741	29.63 %

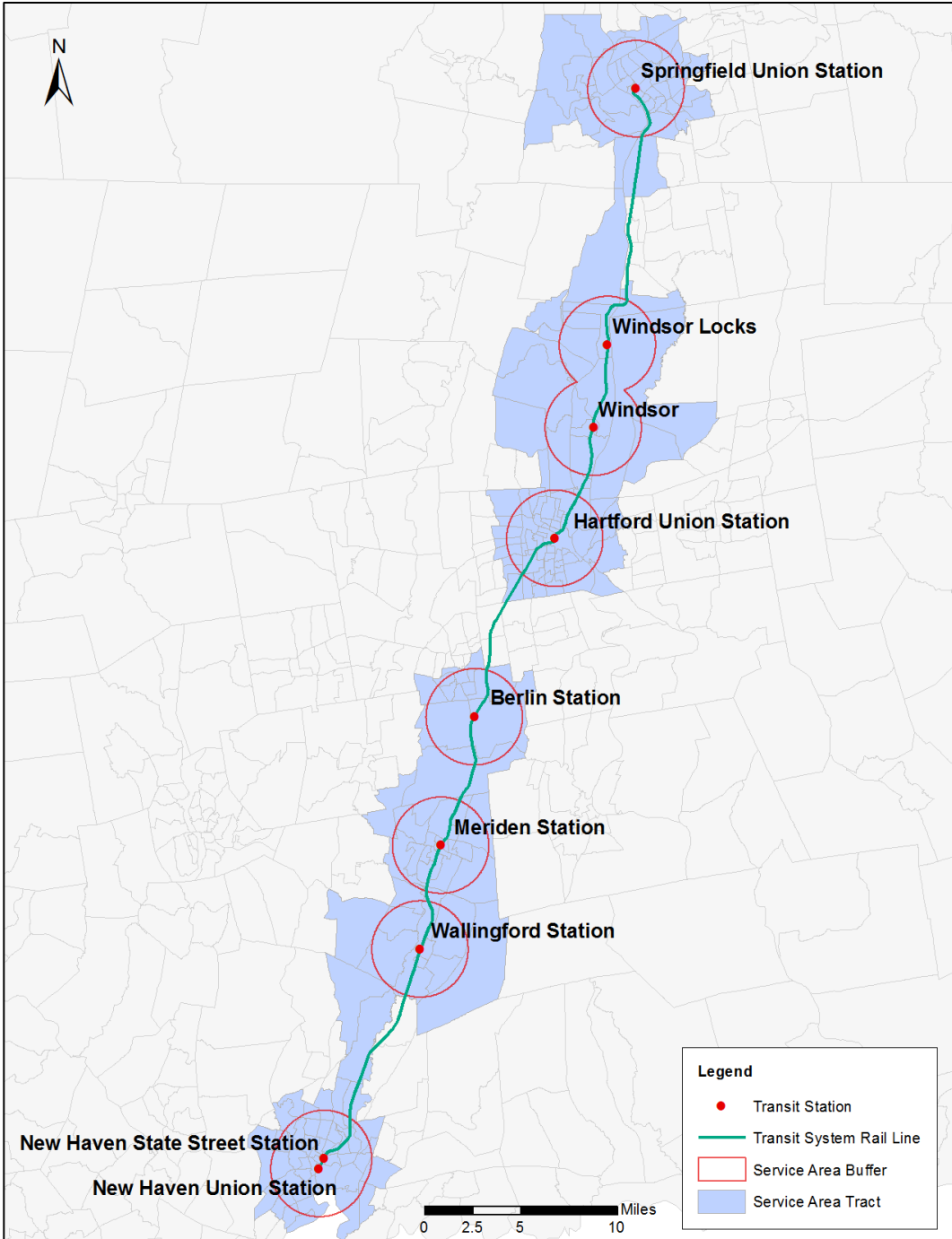


Figure 1. Hartford Line System Service Area

Based on the system percentage of each demographic group in Table 2 each census tract was labeled a “minority”, “low-income”, both “minority and low-income” or “non-minority, non-low income” tract. Table 3 lists the number of tracts found in each category and the associated percentage of the system service area that these tracts occupy.

Table 3. Minority and Low-Income Tract Designations Summary

Tract Designation	Number Tracts	Percent System Area
Minority	114 of 206	23.87%
Low-Income	97 of 206	15.67%
Minority and Low-Income	92 of 206	14.62%
Non-Minority, Non-Low Income	87 of 206	75.07%

Appendices A through D provide comprehensive maps of station areas and surrounding census tracts that meet minority and/or low-income designation as described above.

Service Provision Equity Analysis

The evaluation of service provision proceeded using some of the system characteristics defined above. For clarity, the method is summarized below:

1. Based on the definition of the service area (using 2.5 mile buffers around rail station), the system proportions of minority and low-income (LI) populations were established.
2. The proportion of minority and LI populations within each station area was then tabulated individually. If a station area's proportion of minority and/or LI residents exceeded the system average, it was designated a minority and/or LI station area accordingly.
3. The number of weekly stops at each station was then calculated based on the proposed schedule and compared between minority, minority and LI, and non-minority/LI station areas.

Service provision data was generated using the existing and proposed Amtrak and *CTrail* schedules. Unless otherwise noted, weekday service was assumed to repeat on all five days of the week and weekend service on both weekend days. **Table 4** presents the total number of trips serving each station for the existing service, proposed expansion and the sum total of existing and new service. Cells are highlighted to indicate minority or LI status for a particular station.

Table 4. Number of weekly stops at each station (pink = both minority and low-income)

	Total Weekday Stops	Total Weekend Stops	% Minority	% LI	Total Minority Population	Total LI Population
New Haven	80	24	62.2	32.0	123,732	59,670
Wallingford	80	24	15.9	7.6	10,696	4,777
Meriden	80	24	32.3	17.9	26,014	14,288
Berlin	80	24	36.6	23.3	21,891	13,816
Hartford	80	24	73.9	39.0	141,550	70,920
Windsor	30	8	43.2	10.0	21,045	4,811
Windsor Locks	30	8	26.2	9.0	10,646	3,380
Springfield MA	30	8	51.4	37.6	94,239	66,792
Mean Minority and LI	63	19	Total Minority and LI		359,521	197,382
Mean Non-minority/LI	60	18	Total Non-minority/LI		90,292	41,072

Stations were then classified according to minority and low-income designation criterion described above – creating two sets of data: the number of trips per week for minority and LI stations, and for non-

minority/non-LI stations. It is important to note that all low-income stations are also minority designated and vice versa, so any reference to minority or low-income is “Low-income and minority”. Minority/LI stations include New Haven, Hartford, and Springfield. Non-minority/non-LI stations are Wallingford, Meriden, Berlin, Windsor and Windsor Locks. A cutoff value of 50% for minority and 25% for LI were used (based on Table 2 above), acknowledging the slightly higher error associated with these population estimates.

Minority station-pair analysis

Because the sample size of minority/LI and non-minority/non-LI stations is so small (3 and 5, respectively), a meaningful statistical analysis cannot be performed. The average number of weekday stops at minority/LI stations is 63, whereas it is 60 for non-minority stations. Also, nearly 80% of minority and LI residents live in the three station areas designated minority/LI, which are experiencing more weekly trips both on weekdays and weekends. As minority/LI stations have on average more weekly weekday trips, **there is no finding of a disparate impact or a disproportionate burden evident in this comparison.** The same can be said for weekend stops, as the minority/LI value of 19 weekend stops per week exceeds the 18 weekly weekend stops of non-minority/non-LI stations.

Minority and Low-Income Designations of Routes for the Fare Equity Analysis

The Hartford Line (see Figure 1) is a single corridor comprised of 9 stations (see Table 5 for station names and station abbreviations) being served by four variations of a single route. The corridor’s length of 62 miles covers a broad population with a diverse range of demographic characteristics; however, if the Hartford Line were treated as a single route, its population characteristics by area would be lost in the analysis, and potential impacts obscured. Therefore, in this analysis the Hartford Line is broken down into 28 pairs of stations, representing potential origin-destination combinations for trips generated using this service. In this way, each of these station pairs is treated as a “route” in this analysis. This breakdown also allows for a direct comparison with the origin-destination pair-based fare structure. All 28 origin-destination pairs are abbreviated for use in data tables and figures below. New Haven State Street Station (NHVSS) is not utilized in the reporting analysis results, but rather merged with New Haven Union Station as a single station service area due to their close proximity and nearly complete service area overlap.

Utilizing all of the possible origin-destination pairings for trips beginning and ending on this new rail service, the demographic profiles, income attributes and the associated impacts and burdens can be compared across pairs of stations for service levels and fare levels. Thus one can distinguish between an origin-destination pairing that has a high proportion of minority residents within the service area (e.g., Hartford – Windsor in Figure 3) and one with a small proportion (e.g., Wallingford – Meriden in Figure 4) and make meaningful comparisons within the proposed service plan and fare structure.

Table 5. Stations and abbreviations in the Hartford Line

Station ID	Station Name
NHV	New Haven Union Station
NHVSS	New Haven State Street Station
WFD	Wallingford Station
MDN	Meriden Station
BER	Berlin Station
HFD	Hartford Union Station
WND	Windsor
WNL	Windsor Locks
SPG	Springfield Union Station

In accordance with FTA Circular 4702.1B§I-4(s), a minority-serving transit route is defined in this analysis as one with greater than one-third of its route miles traversing minority designated census tracts. The system averages presented in Table 2 were used as the means of designating census tracts, and the route miles of the Hartford Line traversing these tracts (within the service areas) calculated accordingly. The calculations of route-miles for both the numerator (those traversing minority or LI tracts) and the denominator (total route-miles within service area) use only the pieces of the Hartford line that fall within the service area. For each station pair only the service areas of origin and destination stations were used to determine percentage of route miles, ignoring the stations between the pair. Table 6 provides the results of the analysis.

For example, the station pair with the highest percentage of route miles crossing minority tracts is the Hartford – Springfield station pair (See Figure 3). With 92% of the service area portion of the route traversing tracts with high percentages of minority residents, this meets the threshold and is considered a minority-serving route. In contrast, Wallingford – Meriden traverses only 13.4% of its route miles through tracts with a higher than system average minority population, and therefore is not classified as such (Figure 4).

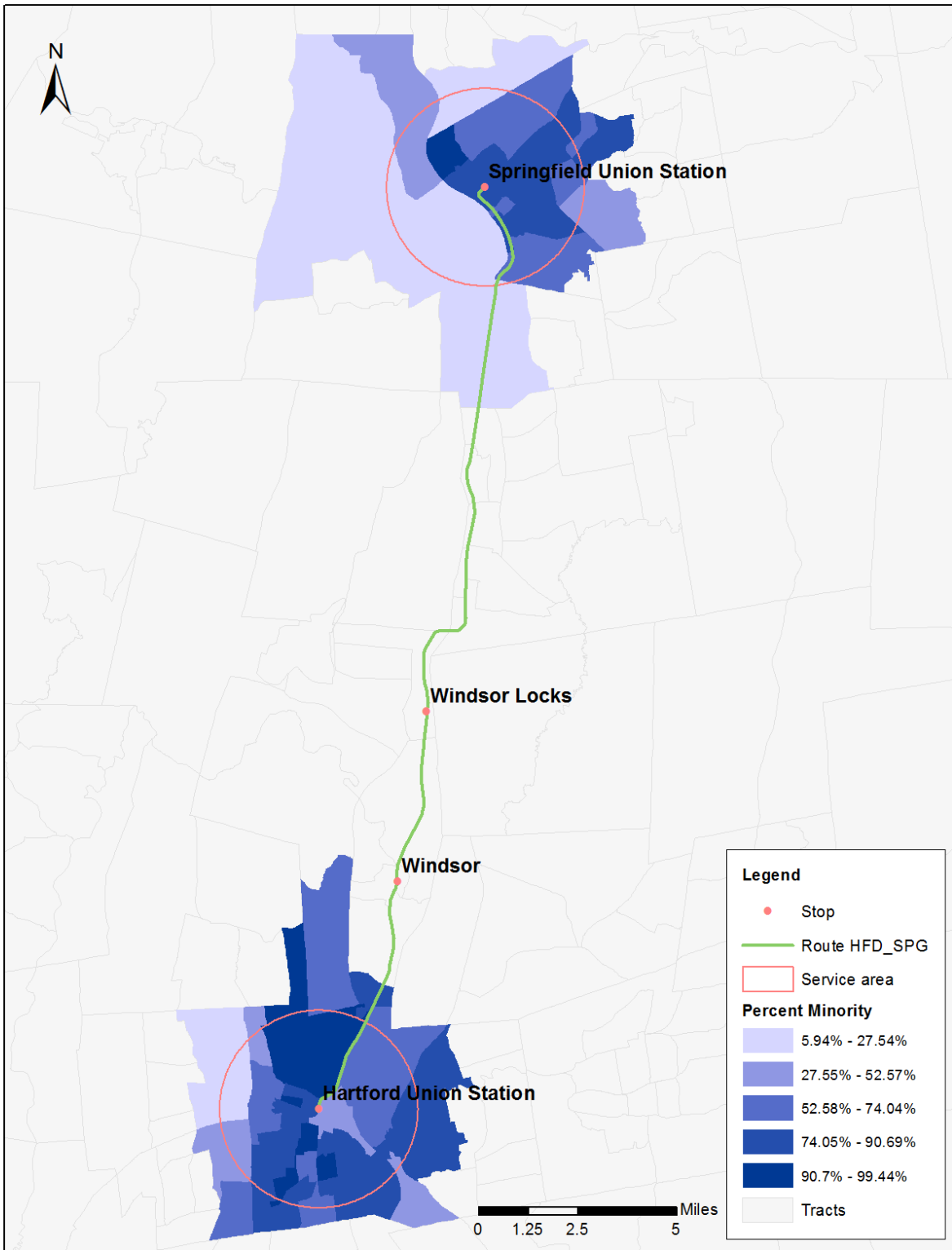


Figure 3. Hartford – Springfield *CTrail* station pair, buffers and minority population percentages

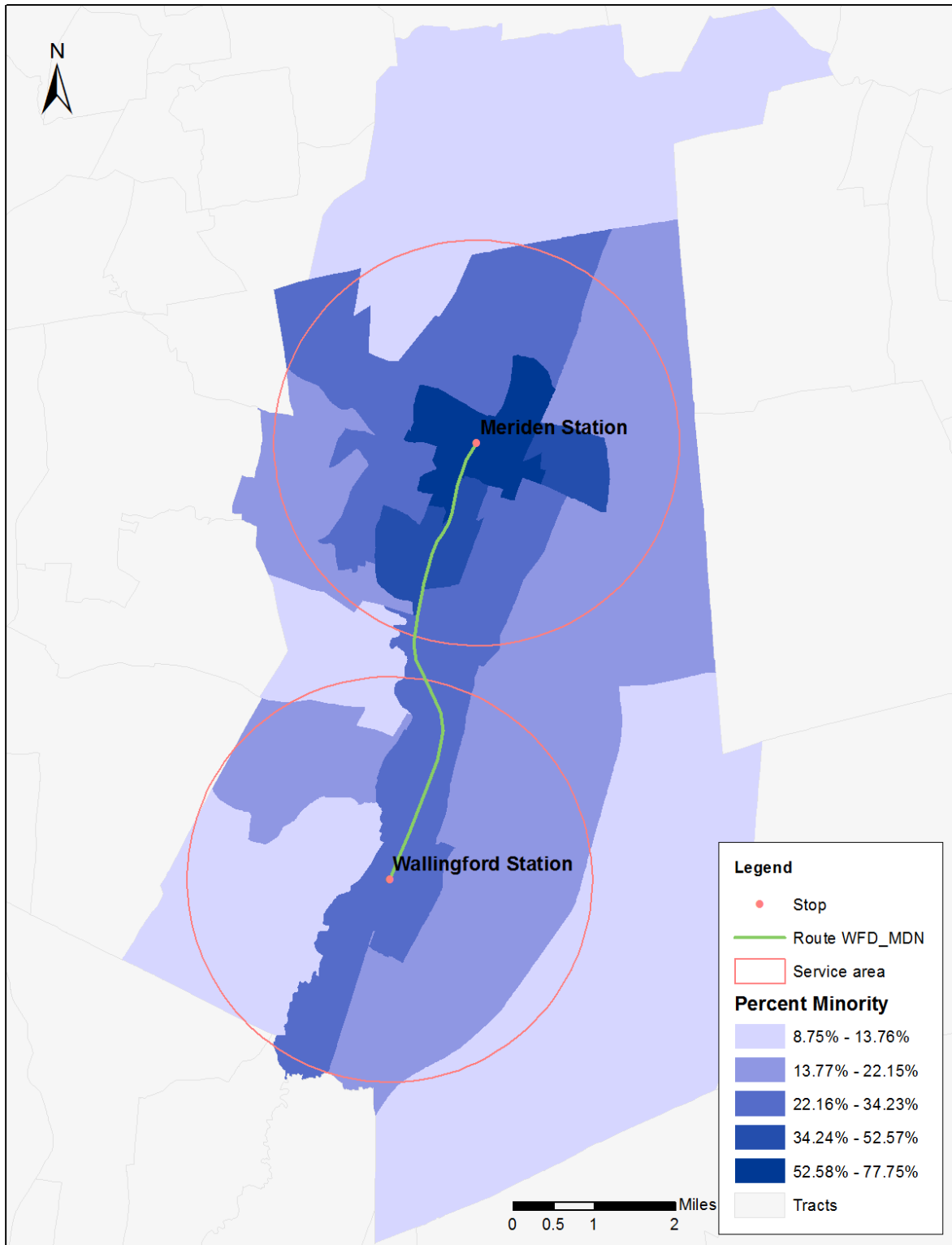


Figure 4. Wallingford - Meriden *CTrail* station pair, buffers and minority population percentages

Table 6. Percent Route Miles that Traverse Minority and Low-Income Designated Tracts

Route ID	% Minority Route Miles	% Low-Income Route Miles	Minority Status	Low-Income Route	Total travel Distance (Miles)
HFD_SPG	92.37%	66.33%	1	1	25.36
HFD_WND	81.92%	16.76%	1	0	6.33
NHV_HFD	81.09%	81.09%	1	1	36.67
NHV_SPG	80.79%	80.79%	1	1	62.02
BER_SPG	72.14%	72.14%	1	1	36.10
BER_HFD	72.00%	72.00%	1	1	10.74
NHV_WND	70.90%	38.71%	1	1	42.99
MDN_SPG	70.29%	58.49%	1	1	43.26
MDN_HFD	70.04%	57.57%	1	1	17.90
BER_WND	60.14%	23.34%	1	0	17.07
MDN_WND	57.95%	7.82%	1	0	24.23
WND_SPG	50.84%	50.84%	1	1	19.03
NHV_MDN	50.64%	41.79%	1	1	18.77
WFD_SPG	50.44%	50.44%	1	1	48.98
WFD_HFD	49.08%	49.08%	1	1	23.62
WNL_SPG	47.22%	47.22%	1	1	14.57
HFD_WNL	45.28%	16.90%	1	0	10.79
NHV_WFD	39.07%	39.07%	1	1	13.04
NHV_WNL	39.01%	39.01%	1	1	47.45
NHV_BER	38.50%	38.50%	1	1	25.93
WFD_WND	36.73%	0.00%	1	0	29.95
BER_WNL	23.54%	23.54%	0	0	21.52
MDN_WNL	20.75%	7.89%	0	0	28.68
MDN_BER	20.43%	7.77%	0	0	7.16
WFD_MDN	13.41%	3.30%	0	0	5.72
WFD_BER	0.00%	0.00%	0	0	12.88
WFD_WNL	0.00%	0.00%	0	0	34.41
WND_WNL	0.00%	0.00%	0	0	4.46

Figures 5 and 6 depict the percentage of route miles that traverse target Census tracts for each station pair in the Hartford Line along with the FTA threshold of 33.33% for both minority and low-income designation. As is evident, most station pairs qualify as minority serving routes with 21 classified as minority serving and seven not being classified as minority serving. The situation is somewhat different for low-income pairs, as 16 of the 28 meet the FTA threshold.

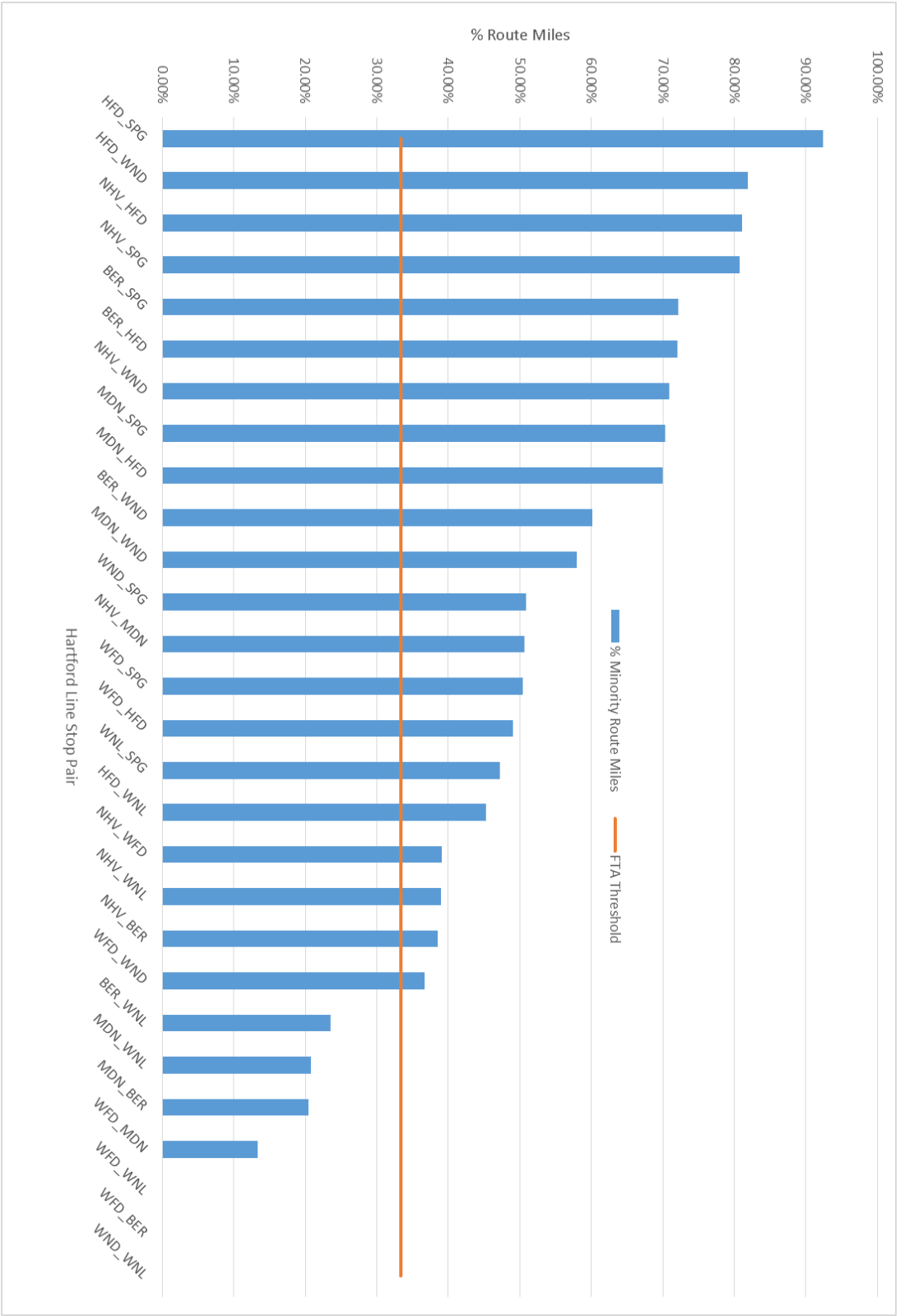


Figure 5. % Route Miles Traversing Minority Tracts

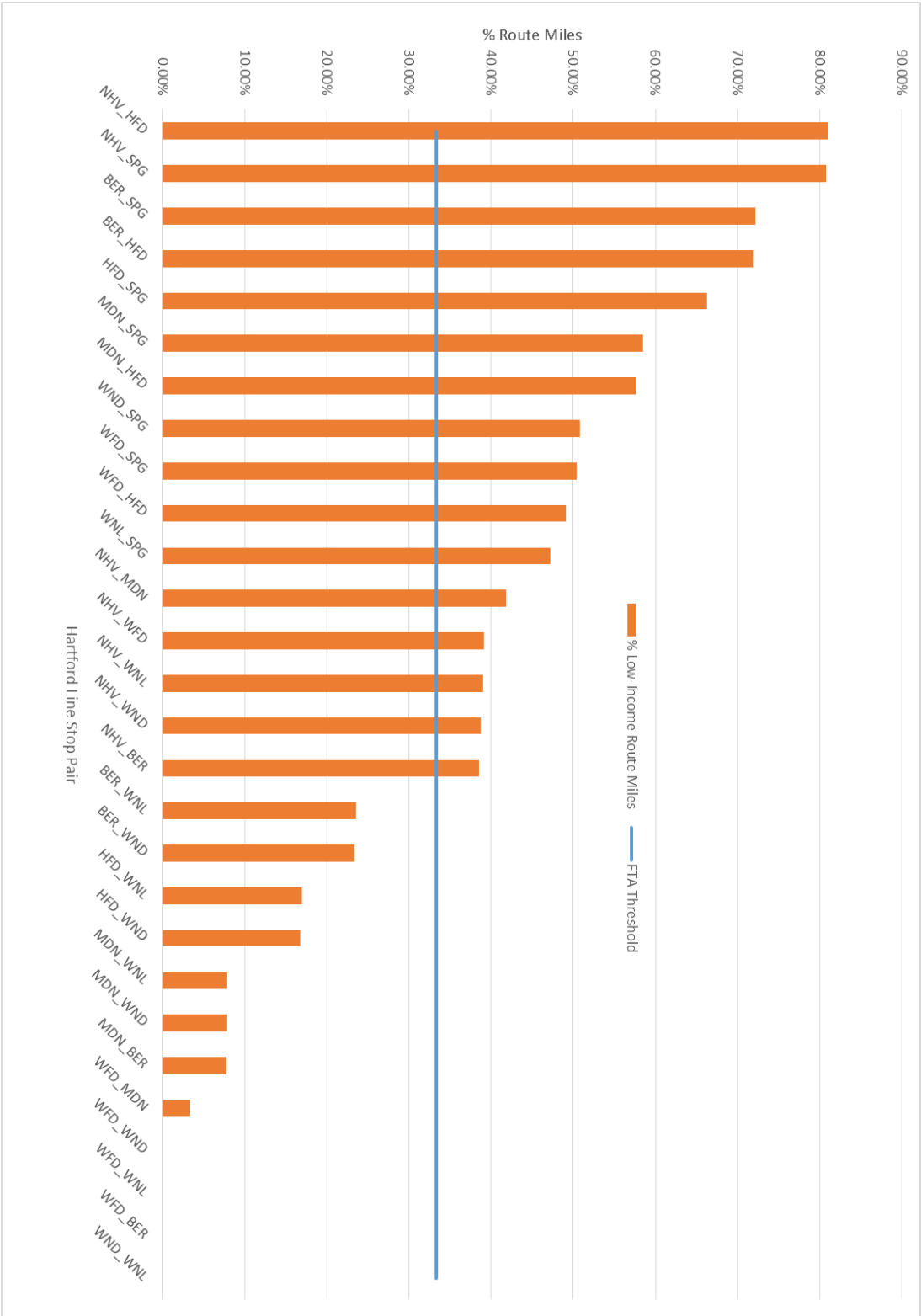


Figure 6. % Route Miles Traversing Low Income Tracts

Fare Equity Analysis

The fare equity analysis builds on the earlier system characteristics and classification scheme detailed earlier in the report. For clarity a summary of the method used for fare equity analysis is provided below:

1. Based on the definition of the service area using 2.5 mile buffers around each rail station, system proportions of minority and LI populations were established.
2. Individual census tract minority and LI proportions were then compared to the system values to establish whether a particular tract had a high minority or LI population. If a census tract had a higher proportion of either than the system as a whole, it was designated a minority and/or LI tract as appropriate.
3. Station-pairs were then classified as minority or LI serving based on the route miles (within the station buffer areas) that traverse minority or LI designated census tracts. As per FTA guidelines, if a station pair had greater than 1/3 of its route miles traversing minority and/or LI tracts, it was classified accordingly.
4. Costs per mile for each station pair were then compared between minority/non-minority and low income/non-low income station pairs. The entire length of the route between stations was used to calculate this value.

Fare data was provided by *CTrail*, including the number of discounting and pass options for each station pair. The analysis below compares the proposed fare and pass options to determine whether there is a Disproportionate Burden or Disparate Impact imposed by any of the proposed fares.. The eight proposed fare options range from one-way single fare to 10-trip to monthly passes (Table 7). A cost per mile per trip is calculated for each fare class using the total distance traveled between stations as the denominator for this measure. Weekly and monthly passes assumed 9 and 42 trips, respectively.

Table 7. Fare and pass options for each station pairing

Station Pair	One-Way	Senior/Disabled	Onboard	Weekly	10-Trip	Disc. 10-Trip	Monthly	School Monthly
NHV_WFD	3.50	1.75	6.50	22.75	31.50	17.50	73.50	52.50
NHV_MDN	4.75	2.25	7.75	31.00	42.75	22.50	99.75	71.25
NHV_BER	6.00	3.00	9.00	39.00	54.00	30.00	126.00	90.00
NHV_HFD	8.00	4.00	11.00	52.00	72.00	40.00	168.00	120.00
NHV_WND	9.25	4.50	12.25	60.25	83.25	45.00	194.25	138.75
NHV_WNL	10.00	5.00	13.00	65.00	90.00	50.00	210.00	150.00
NHV_SPG	12.75	6.25	15.75	83.00	114.75	62.50	267.75	191.25
WFD_MDN	3.00	1.50	6.00	19.50	27.00	15.00	63.00	45.00
WFD_BER	3.50	1.75	6.50	22.75	31.50	17.50	73.50	52.50
WFD_HFD	5.50	2.75	8.50	35.75	49.50	27.50	115.50	82.50
WFD_WND	6.75	3.25	9.75	44.00	60.75	32.50	141.75	101.25
WFD_WNL	7.50	3.75	10.50	48.75	67.50	37.50	157.50	112.50
WFD_SPG	10.25	5.00	13.25	66.75	92.25	50.00	215.25	153.75
MDN_BER	3.00	1.50	6.00	19.50	27.00	15.00	63.00	45.00
MDN_HFD	4.50	2.25	7.50	29.25	40.50	22.50	94.50	67.50
MDN_WND	5.75	2.75	8.75	37.50	51.75	27.50	120.75	86.25
MDN_WNL	6.50	3.25	9.50	42.25	58.50	32.50	136.50	97.50
MDN_SPG	9.25	4.50	12.25	60.25	83.25	45.00	194.25	138.75
BER_HFD	3.25	1.50	6.25	21.25	29.25	15.00	68.25	48.75
BER_WND	4.50	2.25	7.50	29.25	40.50	22.50	94.50	67.50
BER_WNL	5.25	2.50	8.25	34.25	47.25	25.00	110.25	78.75
BER_SPG	8.00	4.00	11.00	52.00	72.00	40.00	168.00	120.00
HFD_WND	3.00	1.50	6.00	19.50	27.00	15.00	63.00	45.00
HFD_WNL	3.25	1.50	6.25	21.25	29.25	15.00	68.25	48.75
HFD_SPG	6.00	3.00	9.00	39.00	54.00	30.00	126.00	90.00
WND_WNL	3.00	1.50	6.00	19.50	27.00	15.00	63.00	45.00
WND_SPG	4.75	2.25	7.75	31.00	42.75	22.50	99.75	71.25
WNL_SPG	4.00	2.00	7.00	26.00	36.00	20.00	84.00	60.00

Station pairs were then classified according to the minority and low-income designation criteria described above – creating two sets of data: costs per mile per trip for minority and non-minority routes, and for low- and non-low-income labelled routes (see Tables 12 and 13 for the full dataset). It is important to note that all low-income tracts are also minority designated tracts, so any reference to low-income is “Low-income and minority”.

Minority station-pair analysis

A one-tailed t-test was performed to compare the average fare per mile for minority versus non-minority station pairs. There are 21 station pairs classified as minority-serving. Table 8 provides p-values and

descriptive statistics of maximum, mean and median for each fare option. A positive difference between mean values for minority serving and non-minority serving fares indicates that the observed average cost per mile on minority routes is lower than that on non-minority serving station pairs. The p-values associated with all pass types are over 0.05 (though are very close), indicating that while there is no statistically significant difference between the various fare options between minority and non-minority station pairs at the 5% significance level, minority classified routes tend to have lower costs per mile with this fare structure.

To summarize, non-minority pairs on average tend to have higher fares per mile per trip than minority pairs. This difference is consistent across all fare types. **This result suggests that there is no finding of a disparate impact of this fare structure on minority populations.** It is worth noting that one minority serving station pair, HFD-WND, has a significantly higher cost per mile per trip than all other trip pairs with a minority designation (See Table 10). This is a minority station-pair that is an outlier in the analysis and may need to be treated as such in fare structure implementation. The higher cost is due to the close proximity of the two stations and the nature of the fare determination equation which includes the first ten miles in the minimum fare. Please note the HFD-WND fare is already the minimum fare.

Table 8. Statistics of the Ridership Cost Per Mile for Minority and Non-Minority Population Groups (Based on **Table 12**)

Statistic	Group	One-Way	Disc. One-Way	Onboard	Weekly	10-Trip	Disc. 10-Trip	Monthly	School Monthly
T-test (p-value)		0.0678	0.0640	0.0626	0.0681	0.0678	0.0640	0.0678	0.0678
Maximum	Minority	0.47	0.24	0.95	0.34	0.43	0.24	0.24	0.17
	Non-Minority	0.67	0.34	1.35	0.49	0.61	0.34	0.34	0.24
	<i>Difference</i>	<i>0.20</i>	<i>0.10</i>	<i>0.40</i>	<i>0.14</i>	<i>0.18</i>	<i>0.10</i>	<i>0.10</i>	<i>0.07</i>
Mean	Minority	0.25	0.12	0.40	0.18	0.23	0.12	0.13	0.09
	Non-Minority	0.37	0.18	0.68	0.27	0.33	0.18	0.18	0.13
	<i>Difference</i>	<i>0.12</i>	<i>0.06</i>	<i>0.28</i>	<i>0.08</i>	<i>0.10</i>	<i>0.06</i>	<i>0.06</i>	<i>0.04</i>
Median	Minority	0.24	0.12	0.36	0.17	0.21	0.12	0.12	0.08
	Non-Minority	0.27	0.14	0.50	0.20	0.24	0.14	0.14	0.10
	<i>Difference</i>	<i>0.04</i>	<i>0.02</i>	<i>0.14</i>	<i>0.03</i>	<i>0.03</i>	<i>0.02</i>	<i>0.02</i>	<i>0.01</i>

Low-Income station-pair analysis

Sixteen station pairs met the low-income classification of 33.33% of route miles threshold for classification as a low-income station pair. Similar to minority station pairs an analysis was conducted for the low-income and non-low-income serving station pairs. Figure 6 and Table 9 depict the percent of route miles that traverse low-income tracts and statistics on associated fares.

A *t*-test was performed, comparing the mean fare per mile per trip of those pairs classified as low-income

and non-low-income. Table 13 provides the percent low-income route miles and the fare per mile per trip of each of the 28 station pairs by travel pass option. Again, a positive difference in observed mean values for each pass option suggests that the fares per mile for the low-income serving trips are overall lower than those for the non-low-income serving pairs. Given the resulting *p*-values, **the difference between low-income and non-low-income serving station pairs is statistically significant.**

To summarize, low-income station pairs on average tend to have lower fares per mile per trip. This difference is consistent across all fare types. **This result suggests that there is no finding of a disproportionate burden of this fare structure on low-income populations.**

Table 9. Statistics of the Ridership Cost Per Mile for Low-Income and Non- Low-Income Population Groups (Based on Table 13)

Statistic	Group	One-Way	Disc. One-Way	Onboard	Weekly	10-Trip	Disc. 10-Trip	Monthly	School Monthly
T-test (<i>p</i>-value)		0.0181	0.0194	0.0144	0.0180	0.0181	0.0194	0.0181	0.0181
Maximum	Low-Income	0.30	0.14	0.58	0.22	0.27	0.14	0.15	0.11
	Non-Low-Income	0.67	0.34	1.35	0.49	0.61	0.34	0.34	0.24
	<i>Difference</i>	<i>0.37</i>	<i>0.20</i>	<i>0.76</i>	<i>0.27</i>	<i>0.33</i>	<i>0.20</i>	<i>0.19</i>	<i>0.13</i>
Mean	Low-Income	0.24	0.12	0.36	0.17	0.21	0.12	0.12	0.08
	Non-Low-Income	0.34	0.17	0.62	0.25	0.31	0.17	0.17	0.12
	<i>Difference</i>	<i>0.10</i>	<i>0.05</i>	<i>0.25</i>	<i>0.07</i>	<i>0.09</i>	<i>0.05</i>	<i>0.05</i>	<i>0.04</i>
Median	Low-Income	0.23	0.12	0.35	0.17	0.21	0.12	0.12	0.08
	Non-Low-Income	0.27	0.13	0.47	0.19	0.24	0.13	0.13	0.10
	<i>Difference</i>	<i>0.04</i>	<i>0.02</i>	<i>0.12</i>	<i>0.03</i>	<i>0.03</i>	<i>0.02</i>	<i>0.02</i>	<i>0.01</i>

Table 10 (a-h). Cost per Mile per trip for station pairs

*Blue shaded cells indicate that the station pair is a minority station pair, pink – both minority and low-income.

All low-income station pairs are also minority station pairs.

a) One-Way							
	New Haven	Wallingford	Meriden	Berlin	Hartford	Windsor	Windsor Locks
Wallingford	0.27						
Meriden	0.25	0.52					
Berlin	0.23	0.27	0.42				
Hartford	0.22	0.23	0.25	0.3			
Windsor	0.22	0.23	0.24	0.26	0.47		
Windsor Locks	0.21	0.22	0.23	0.24	0.3	0.67	
Springfield, MA	0.21	0.21	0.21	0.22	0.24	0.25	0.27
b) Discount One-Way							
	New Haven	Wallingford	Meriden	Berlin	Hartford	Windsor	Windsor Locks
Wallingford	0.13						
Meriden	0.12	0.26					
Berlin	0.12	0.14	0.21				
Hartford	0.11	0.12	0.13	0.14			
Windsor	0.1	0.11	0.11	0.13	0.24		
Windsor Locks	0.11	0.11	0.11	0.12	0.14	0.34	
Springfield, MA	0.1	0.1	0.1	0.11	0.12	0.12	0.14
c) Onboard							
	New Haven	Wallingford	Meriden	Berlin	Hartford	Windsor	Windsor Locks
Wallingford	0.5						
Meriden	0.41	1.05					
Berlin	0.35	0.5	0.84				
Hartford	0.3	0.36	0.42	0.58			
Windsor	0.28	0.33	0.36	0.44	0.95		
Windsor Locks	0.27	0.31	0.33	0.38	0.58	1.35	
Springfield, MA	0.25	0.27	0.28	0.3	0.35	0.41	0.48
d) Weekly							
	New Haven	Wallingford	Meriden	Berlin	Hartford	Windsor	Windsor Locks
Wallingford	0.19						
Meriden	0.18	0.38					
Berlin	0.17	0.2	0.3				
Hartford	0.16	0.17	0.18	0.22			
Windsor	0.16	0.16	0.17	0.19	0.34		
Windsor Locks	0.15	0.16	0.16	0.18	0.22	0.49	
Springfield, MA	0.15	0.15	0.15	0.16	0.17	0.18	0.2

e) 10-Trip							
	New Haven	Wallingford	Meriden	Berlin	Hartford	Windsor	Windsor Locks
Wallingford	0.24						
Meriden	0.23	0.47					
Berlin	0.21	0.24	0.38				
Hartford	0.2	0.21	0.23	0.27			
Windsor	0.19	0.2	0.21	0.24	0.43		
Windsor Locks	0.19	0.2	0.2	0.22	0.27	0.61	
Springfield, MA	0.19	0.19	0.19	0.2	0.21	0.22	0.25
f) Discount 10-Trip							
	New Haven	Wallingford	Meriden	Berlin	Hartford	Windsor	Windsor Locks
Wallingford	0.13						
Meriden	0.12	0.26					
Berlin	0.12	0.14	0.21				
Hartford	0.11	0.12	0.13	0.14			
Windsor	0.1	0.11	0.11	0.13	0.24		
Windsor Locks	0.11	0.11	0.11	0.12	0.14	0.34	
Springfield, MA	0.1	0.1	0.1	0.11	0.12	0.12	0.14
g) Monthly							
	New Haven	Wallingford	Meriden	Berlin	Hartford	Windsor	Windsor Locks
Wallingford	0.13						
Meriden	0.13	0.26					
Berlin	0.12	0.14	0.21				
Hartford	0.11	0.12	0.13	0.15			
Windsor	0.11	0.11	0.12	0.13	0.24		
Windsor Locks	0.11	0.11	0.11	0.12	0.15	0.34	
Springfield, MA	0.1	0.1	0.11	0.11	0.12	0.12	0.14
h) School Monthly							
	New Haven	Wallingford	Meriden	Berlin	Hartford	Windsor	Windsor Locks
Wallingford	0.1						
Meriden	0.09	0.19					
Berlin	0.08	0.1	0.15				
Hartford	0.08	0.08	0.09	0.11			
Windsor	0.08	0.08	0.08	0.09	0.17		
Windsor Locks	0.08	0.08	0.08	0.09	0.11	0.24	
Springfield, MA	0.07	0.07	0.08	0.08	0.08	0.09	0.1

Table 11. Total Distance Matrix for Origin-Destination Pairs

	New Haven	Wallingford	Meriden	Berlin	Hartford	Windsor	Windsor Locks
Wallingford	13.04						
Meriden	18.77	5.72					

Berlin	25.93	12.88	7.16				
Hartford	36.67	23.62	17.90	10.74			
Windsor	42.99	29.95	24.23	17.07	6.33		
Windsor Locks	47.45	34.41	28.68	21.52	10.79	4.46	
Springfield, MA	62.02	48.98	43.26	36.10	25.36	19.03	14.57

Table 12. Fare Per Mile by Minority and Non-Minority Station Pairs. Highlighted Cells Indicate the Top Rate Per Mile by Minority Status for Every Pass Option

Route ID	% Minority Miles	Minority Status	\$/Mile							
			One-Way	Disc. One-Way	Onboard	Weekly	10-Trip	Disc. 10-Trip	Monthly	School Monthly
HFD_SPG	92.37%	1	0.24	0.12	0.35	0.17	0.21	0.12	0.12	0.08
HFD_WND	81.92%	1	0.47	0.24	0.95	0.34	0.43	0.24	0.24	0.17
NHV_HFD	81.09%	1	0.22	0.11	0.30	0.16	0.20	0.11	0.11	0.08
NHV_SPG	80.79%	1	0.21	0.10	0.25	0.15	0.19	0.10	0.10	0.07
BER_SPG	72.14%	1	0.22	0.11	0.30	0.16	0.20	0.11	0.11	0.08
BER_HFD	72.00%	1	0.30	0.14	0.58	0.22	0.27	0.14	0.15	0.11
NHV_WND	70.90%	1	0.22	0.10	0.28	0.16	0.19	0.10	0.11	0.08
MDN_SPG	70.29%	1	0.21	0.10	0.28	0.15	0.19	0.10	0.11	0.08
MDN_HFD	70.04%	1	0.25	0.13	0.42	0.18	0.23	0.13	0.13	0.09
BER_WND	60.14%	1	0.26	0.13	0.44	0.19	0.24	0.13	0.13	0.09
MDN_WND	57.95%	1	0.24	0.11	0.36	0.17	0.21	0.11	0.12	0.08
WND_SPG	50.84%	1	0.25	0.12	0.41	0.18	0.22	0.12	0.12	0.09
NHV_MDN	50.64%	1	0.25	0.12	0.41	0.18	0.23	0.12	0.13	0.09
WFD_SPG	50.44%	1	0.21	0.10	0.27	0.15	0.19	0.10	0.10	0.07
WFD_HFD	49.08%	1	0.23	0.12	0.36	0.17	0.21	0.12	0.12	0.08
WNL_SPG	47.22%	1	0.27	0.14	0.48	0.20	0.25	0.14	0.14	0.10
HFD_WNL	45.28%	1	0.30	0.14	0.58	0.22	0.27	0.14	0.15	0.11
NHV_WFD	39.07%	1	0.27	0.13	0.50	0.19	0.24	0.13	0.13	0.10
NHV_WNL	39.01%	1	0.21	0.11	0.27	0.15	0.19	0.11	0.11	0.08
NHV_BER	38.50%	1	0.23	0.12	0.35	0.17	0.21	0.12	0.12	0.08
WFD_WND	36.73%	1	0.23	0.11	0.33	0.16	0.20	0.11	0.11	0.08
BER_WNL	23.54%	0	0.24	0.12	0.38	0.18	0.22	0.12	0.12	0.09
MDN_WNL	20.75%	0	0.23	0.11	0.33	0.16	0.20	0.11	0.11	0.08
MDN_BER	20.43%	0	0.42	0.21	0.84	0.30	0.38	0.21	0.21	0.15
WFD_MDN	13.41%	0	0.52	0.26	1.05	0.38	0.47	0.26	0.26	0.19
WFD_WNL	0.00%	0	0.22	0.11	0.31	0.16	0.20	0.11	0.11	0.08
WFD_BER	0.00%	0	0.27	0.14	0.50	0.20	0.24	0.14	0.14	0.10
WND_WNL	0.00%	0	0.67	0.34	1.35	0.49	0.61	0.34	0.34	0.24

Table 13. Fare Per Mile by Low-Income and Non- Low-Income Station Pairs. Highlighted Cells Indicate the Top Rate Per Mile by Low-Income Status for Every Pass Option

Route ID	% Low-Income Miles	Low-Income Status	\$/Mile							
			One-Way	Disc. One-Way	Onboard	Weekly	10-Trip	Disc. 10-Trip	Monthly	School Monthly
NHV_HFD	81.09%	1	0.22	0.11	0.30	0.16	0.20	0.11	0.11	0.08
NHV_SPG	80.79%	1	0.21	0.10	0.25	0.15	0.19	0.10	0.10	0.07
BER_SPG	72.14%	1	0.22	0.11	0.30	0.16	0.20	0.11	0.11	0.08
BER_HFD	72.00%	1	0.30	0.14	0.58	0.22	0.27	0.14	0.15	0.11
HFD_SPG	66.33%	1	0.24	0.12	0.35	0.17	0.21	0.12	0.12	0.08
MDN_SPG	58.49%	1	0.21	0.10	0.28	0.15	0.19	0.10	0.11	0.08
MDN_HFD	57.57%	1	0.25	0.13	0.42	0.18	0.23	0.13	0.13	0.09
WND_SPG	50.84%	1	0.25	0.12	0.41	0.18	0.22	0.12	0.12	0.09
WFD_SPG	50.44%	1	0.21	0.10	0.27	0.15	0.19	0.10	0.10	0.07
WFD_HFD	49.08%	1	0.23	0.12	0.36	0.17	0.21	0.12	0.12	0.08
WNL_SPG	47.22%	1	0.27	0.14	0.48	0.20	0.25	0.14	0.14	0.10
NHV_MDN	41.79%	1	0.25	0.12	0.41	0.18	0.23	0.12	0.13	0.09
NHV_WFD	39.07%	1	0.27	0.13	0.50	0.19	0.24	0.13	0.13	0.10
NHV_WNL	39.01%	1	0.21	0.11	0.27	0.15	0.19	0.11	0.11	0.08
NHV_WND	38.71%	1	0.22	0.10	0.28	0.16	0.19	0.10	0.11	0.08
NHV_BER	38.50%	1	0.23	0.12	0.35	0.17	0.21	0.12	0.12	0.08
BER_WNL	23.54%	0	0.24	0.12	0.38	0.18	0.22	0.12	0.12	0.09
BER_WND	23.34%	0	0.26	0.13	0.44	0.19	0.24	0.13	0.13	0.09
HFD_WNL	16.90%	0	0.30	0.14	0.58	0.22	0.27	0.14	0.15	0.11
HFD_WND	16.76%	0	0.47	0.24	0.95	0.34	0.43	0.24	0.24	0.17
MDN_WNL	7.89%	0	0.23	0.11	0.33	0.16	0.20	0.11	0.11	0.08
MDN_WND	7.82%	0	0.24	0.11	0.36	0.17	0.21	0.11	0.12	0.08
MDN_BER	7.77%	0	0.42	0.21	0.84	0.30	0.38	0.21	0.21	0.15
WFD_MDN	3.30%	0	0.52	0.26	1.05	0.38	0.47	0.26	0.26	0.19
WFD_WND	0.00%	0	0.23	0.11	0.33	0.16	0.20	0.11	0.11	0.08
WFD_WNL	0.00%	0	0.22	0.11	0.31	0.16	0.20	0.11	0.11	0.08
WFD_BER	0.00%	0	0.27	0.14	0.50	0.20	0.24	0.14	0.14	0.10
WND_WNL	0.00%	0	0.67	0.34	1.35	0.49	0.61	0.34	0.34	0.24

APPENDICES

Appendix A: Maps of Distribution of Population by Minority Status

Appendix B: Maps of Distribution of Population by Poverty Status

Appendix C: Maps of Minority Tract Designation

Appendix D: Maps of Low Income Tract Designation

Appendix E: Maps of Minority and LI Station Designations