

Equity Impacts of Central Link Light Rail in Seattle, WA

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Abstract

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Central Link Light Rail has unexplored equity impacts to nearby communities. Large-scale infrastructure projects, often with equitable intentions, end up displacing vulnerable communities or aiding in their detriment—the same communities that paid for and sponsored the infrastructure. Sound Transit was recently granted a 53.8 billion dollar voter-approved tax levy to fund their latest iteration of transportation projects. These projects have great promise in impacting communities positively throughout the region, but also significant potential to displace and harm existing communities of low-income and minority residents. Despite these impacts, there has been no post-equity analysis of the impacts of Central Link Light Rail—the existing light rail alignment. Through the use of Lorenz Curves, Gini Coefficients, descriptive statistics and geospatial analyses, this study has measured many of the quantifiable impacts to communities within a ¼ mile and ½ mile of Central Link in 2009—when the stations opened for service—and 2017. The results uncover nuanced trends in the land use, demographic and bus service outcomes for these communities. There are

noteworthy demographic shifts of vulnerable populations and decreased prioritization of bus service in South Seattle station areas. Conversely, Downtown station areas experienced the lion's share of benefits in bus service, land use changes and retention of vulnerable communities. The direct causes of these observations deserve further investigation for future research.

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1.0 Introduction

The distribution of transportation infrastructure investments is vital to the socio-economic well-being of a community. Mobility through transportation creates access to economic opportunity, recreation, education, health services, institutional services and much more. The mobility granted through these investments has been historically skewed to disadvantage people of color and low income communities. The ways by which these disadvantages detriment vulnerable communities has morphed throughout history with various levels of transparency. However, the most recent rendition of transportation inequity is realized through seemingly objective decision-making that contributes to displacement and inequitable distributions of benefit and detriment (Bullard, 2004; Lo & Rein, 2017). This objective decision-making often includes equity as a significant or primary consideration in the planning process. Even with these considerations in play, inequitable outcomes arise frequently. A potential pitfall of the planning process is that equity considerations are made before a project is made, but there is no period of reflexivity after the project is complete and the impacts are experienced. This phenomenon has played out for the development of Central Link Light Rail, the current alignment of light rail through King County, WA.

Sound Transit's current budget—for the 2018 fiscal year—is approximately 2 billion dollars (Sound Transit, 2018). Their budget was recently expanded significantly to this level due to a 53.8 billion dollar voter-approved taxpayer funded levy. This expansion of Sound Transit's budget is for a package of transportation projects titled Sound Transit 3 (ST3). These projects will radiate from Seattle's downtown core and throughout the region to the North, East and South. These transit expansions, the majority of which are Link Light Rail extensions, will have tremendous impacts on the lives of residents throughout the region. It is the hope of Sound Transit, as well as the voters

who approved ST3, that this new set of transportation infrastructure will increase mobility in the region and improve people's standard of living in the process. Despite these high hopes and optimistic projections, there has been no equity analysis auditing the impacts of the existing Link system—Central Link. It is incredibly important to audit these impacts in order to have informed discussions about ST3. Best practices need to be identified and implemented where it is appropriate to do so. Similarly, detrimental outcomes need to be highlighted and avoided if possible, of not, the detriments need to be mitigated as effectively as possible. The following research will explore the aforementioned transportation infrastructure projects and seek quantifiable trends in communities adjacent to Link stations

The main research question attributed for this thesis is: What have been the equity impacts of Central Link Light Rail? The following sub-research-questions will be utilized: How have the demographics changed in the station areas? How does the quality of King County Metro bus service now compare to service before the construction of Central Link? How have the areas around Central Link stations developed differently economically? This research will investigate the aforementioned questions in the order that they are listed.

2.0 Literature Review

To better understand the equity impacts of Central Link Light Rail, it is important that this research is first contextualized within the greater body of literature. Infrastructure, transportation and equity are all highly contentious fields that have been explored in a myriad of different ways with disparate goals and metrics employed. The following section will help develop the backdrop for my research and provide readers with a sense of place within an otherwise ambiguous and cavernous subject matter. Equity is an unclear term that can have entirely different meanings depending how it is applied. Subsequently, the application of this term affects policies, methodology and metrics for evaluation. The following subsections will cover the history of inequity in transportation, the evolution of transit justice issues, philosophical underpinnings of equity and existing methodologies that measure the impacts of infrastructure projects. Lastly, the literature review includes the expectations and forecasts of Sound Transit during the planning process leading up to Central Link via the Final Environmental Impact Statement.

2.1 Transportation and a History of Inequity

America has a robust history of unfairly distributing the benefits and detriments of transportation—especially along lines of socio-economic and racial demographics. Every major development or evolution of transportation and transit has been coupled with a disdain for fairness and equity. Inequities in transportation are so deeply ingrained in American history, an entire anthology can be written to simply describe them without analysis. In UCLA's PhD candidate Mark Garrett's 1,000 page dissertation, he details and analyzes the history and struggle for transportation justice in Los Angeles alone, from initial segregation within services to analyzing Metro Transit Authority's (MTA) 2001 transportation plan (Garret, 2006). From his analysis of Los Angeles transportation justice, readers can better understand how transit injustice can vary and transform

over the decades. Many other researchers have also explored the complexity and nuanced nature of inequity and transportation.

Transportation justice issues have evolved with the ever-changing American socio-political landscape as well as the equally malleable built form. Robert D Bullard, often cited as the “Father of Environmental Justice,” has published several books and journal articles cataloging significant moments in transportation justice. Within his works, he differentiates between the widely recognized forms of transportation injustice: segregation within services (i.e. Rosa Parks, Plessy v, Furgeson), and the more nuanced disparities in how transportation benefits are distributed across different communities (Bullard, 2004). These disparities are more important in the contemporary setting within Seattle because de jure segregation has ceased to exist; however de facto and implicit discrimination is a pervasive trend that is often harder to identify and prevent. Implicit discrimination can be identified in transportation investment strategies.

Investments in different types of transportation are traditionally linked to the hierarchies of race and income in America; people of color and low-income are significantly more likely to be “captive users” of transit. Researchers such as Inwood et al., highlight the symbolic importance of public transit during the Montgomery Bus Boycotts in the Civil Rights Era (Inwood, Alderman, & Williams, 2015). Ultimately, when public dollars are invested in different transportation systems, the explicit modal preference is motivated by an implicit socio-economic and racial bias. Municipal transportation agencies must make prudent decisions in the allocation of limited funding across the many services and communities they are responsible for serving. Puck and Marcy Lein (2017) highlight the nature of this dilemma—and often problematic outcome—within the San Francisco Bay Area. In Oakland, CA residents rallied against the Oakland Airport Connector due its lack of benefits for nearby residents—most of whom are low-income and people of color—as well the recent cuts to much-needed bus service that preceded it (Lo & Rein, 2017). Ultimately, the residents advocating for

the termination of the project were dismissed and are now burdened with an underperforming light rail extension that fails to benefit them and drains funds that could have been used for services they actually needed. The recent example of the Oakland Airport Connector highlights a core consideration of my research—whether or not Central Link serves the best interests of vulnerable communities near the station areas.

This research is centered on exploring the quantifiable impacts of transportation infrastructure. Transportation planning is often practiced with neutral, or even laudable intentions. Despite this, there are often unexpected or unintended detriments to equity. To frame it within the existing literature, this research will rely on Rawls-Utilitarianism—the distribution of benefits should favor the most disadvantaged members of a society the most (Tierra Suzan Bills, 2013). This form of transit injustice will be used as a lens with the background consideration introduced by Inwood et al: the relatively greater importance of quality transit for vulnerable communities. Utilizing these two facets of transit justice, I will seek to identify potential inequitable and equitable outcomes of Central Link through quantifiable metrics. In addition to understanding historical context of transportation equity, I will also consider the analysis and critique of transportation philosophical considerations concerning transportation as a right, the different forms of equity and the theories that researchers apply to their studies.

2.2 Theoretical Considerations

Philosophical and theoretical considerations of the semantics of equity and the dynamics that it encapsulates is important to discuss in order to triangulate the position of this research. There has been significant research aimed at addressing equity from numerous perspectives with plentiful and diverse objectives. Despite the nuances that separate the following literature, transportation impacts are widely recognized for their significant importance.

Transportation is unequivocally an immensely important influencer in individuals' as well as communities' opportunities and experiences. In a chapter of her book titled "Transit Justice, author Margaret Kohn takes this truism one step further by drawing from Kantian theory to declare mobility through transportation as a right that all people are entitled to (Kohn, 2016). This is an important distinction to make in order to fight for greater universal access to quality transportation. Other researchers have applied different theoretical frameworks to transportation equity and justice in their analyses. As previously mentioned, Rawls' Theory of Justice (1971) is often used as a lens by which equity can be evaluated, especially in terms of infrastructure service; the greatest equity is achieved when the gap in distribution between the most and the least well-off communities is minimized (Calderón & Servén, 2014). This lens is one way to evaluate the value of a transportation project or investment in terms of equity.

Although Rawls provides a compelling argument of what equity is and how it should be pursued, the term "equity" can be utilized in an array of varying contexts with different purposes, groups and meanings. For example, equity can be and has been measured by contribution, need, desire, socio-economic, racial, temporal and much more (Calderón & Servén, 2014). These are important considerations to make during the decision-making process as well as during auditing because the desired outcome and definition of equity steers the conversation. However, for the purpose of this research, the equity impacts of Central Link Light Rail will be evaluated using Rawls' Theory of Justice to focus on low-income and minority communities and how the distribution of benefits relates to them as well as more privileged communities. In addition to the different theoretical and semantic considerations to be made in transportation justice, the methodology by which equity is measured is at least as varied and expansive.

2.3 Existing Methodologies

Transportation justice and equity in distribution of transportation infrastructure and service is a topic that flows unfettered through the spheres of philosophical exploration and critical theory analyses. However, it becomes significantly more splintered and contentious when researchers try to quantitatively evaluate and enumerate the equity impacts of infrastructure and transportation services. Despite this, many researchers have embarked on journeys to measure distribution equity impacts through a wide array of different methodologies. Many researchers attempt to explore the issue through mathematically complex methods: travel demand modeling (Tierra S. Bills & Walker, 2017), Lorenz Curves (Delbosc & Currie, 2011; Welch & Mishra, 2013), Gini coefficients (Welch & Mishra, 2013), and Network Design Problems (Caggiani, Camporeale, & Ottomanelli, 2017) to name a few. These methodologies are plausible in their own right and offer a more rigid analysis of impacts with impressive detail. Beyond their mathematical prowess, these methods are also important to highlight because they are frequently used by transportation agencies within their decision-making process.

A major flaw in using modeling in particular is that models are overly dependent on the assumptions that can significantly skew results. For example, A commonly highlighted issue is with the ways by which models aggregate populations at a level that undermines the true impacts of infrastructure (Tierra Suzan Bills, 2013). The level by which to aggregate populations is a non-objective decision with highly deterministic outcomes. Furthermore, the use of modeling is often seen as a “Black Box” for the general public due to the complexity of the models that are employed (Beimborn, Kennedy, & Schaefer, 1996). Another avenue of equity analysis, that is typically less rigorous and more accessible, is the use of indexes. Indexes are compilations of different indicators—measures that researchers use that they believe are indicative of a trend or pattern. In Seattle’s 2015 “Growth and Equity” Report, they use indexes to highlight different areas that are ripe

for opportunity, rife with the threat of displacement and the different permutations of the two (City of Seattle Department of Planning & Development, 2015). Indicators are an excellent way of conglomerating specific data to craft a more illustrative understanding of different phenomena. Lastly, Geographic Information Systems (ArcGIS) is an important geospatial tool that can and should be employed in transportation justice research. Many researchers have effectively filtered their research through GIS to create a more accessible and visually telling story that showcases patterns important to the research (Lei & Church, 2010; Lovell, 2012; Manaugh, Badami, & El-Geneidy, 2015; Monzón, Ortega, & López, 2013; Osmonson, 2017). The use of GIS and the maps it produces is effective because it gets to the core of what these issues are centered on—spatial distributions of resources, benefits and detriments.

Reviewing the literature to glean trends in equity analysis methodology is important because it creates a directory of different methodological considerations to make. Moreover, agencies, including Sound Transit, utilize these methodologies for the impact analysis reports that guide their decision-making. For this research, a combination of Gini Coefficients, Lorenz Curves, Geospatial analysis (via ArcGIS) and descriptive statistics will be used to quantify impacts to communities adjacent to Central Link Light Rail stations.

2.4 Sound Transit Final Environmental Impact Statement

Due to the varied nature of equity impact analyses, it is important to first narrow the scope of this research to an appropriate field. The field that has been chosen is rooted in the statements and claims made in Sound Transit's Final Environmental Impact Statement (FEIS) (Sound Transit & US Department of Transportation Federal Transit Administration, 1999). Their FEIS is a nearly 1,000 page, legally required document that Sound Transit and the United States Federal Department of Transportation (USDOT) Federal Transit Administration (FTA) created to assess and address the vast

array of impacts the project may have, as well as the potential impacts of previously considered alternative alignments. This project was required to remain "...in accordance with Executive Order 12898, on whether the project is likely to cause disproportionately high and adverse impacts on low-income and minority populations, and the distribution of benefits to these populations" (Sound Transit & US Department of Transportation's Federal Transit Administration, 1999). In their report, Sound Transit acknowledged that minority and low income communities would experience disproportionate detriment stemming from implementation of light rail when compared to other communities—this was mainly stemming from the immediate residential and commercial displacements the project would cause. However, they also noted that these communities would also gain considerably more than whiter wealthier residents in benefits in through increased system-facilitated accessibility as well as economic development (Sound Transit & US Department of Transportation Federal Transit Administration, 1999). This research will seek to address these two proposed benefits through an accessibility analysis of service over time as well as a comparison of land use development near different stations over time; the latter of which will proxy a more comprehensive economic development analysis. Additionally, the methods will seek to understand if there was any significant demographic shifts near these station areas. The FEIS for Central Link only mentioned immediate displacement in terms of physical property for the construction of light rail—there is no mention of potential long-term demographic displacement. This is an important avenue to explore because the two aforementioned benefits are not felt by communities that can longer afford to live in the station areas.

3.0 Research Questions

The primary question for this research is: what are the equity impacts of Central Link Light Rail? A major public transportation infrastructure project of this scale has major influence on the region and potential for tipping the scales of equity. This is an important question that was studied considerably at the time Central Link was planned—despite the relatively underdeveloped concept of equity in planning practiced. The same question needs to be asked after enough time has passed for some of the long-term equity impacts to have materialized. To narrow the scope of this question, several sub-questions have been formulated.

3.1 How Have the Areas around Stations Evolved Differently?

The first sub question is: how have the areas around stations evolved differently? Before the more specific questions are explored, the reference points of equity need to be determined. First, the impacts to each station area will be compared against one another. How have the station areas transformed in the years after Central Link opened? The areas around the different stations are diverse in their composition of people, urban form and existing transit networks and will likely have experienced different changes. These changes also need to be anchored to nearby areas that do not fall within the immediate proximity of the stations.

The second part of this question is: how did the station areas develop in comparison to the surrounding cities? There have been incredibly changes in the region since the construction of light rail that reach far beyond the rail itself. Rapid growth, housing unaffordability, congestion, increased development and increased transit service are among a few of these changes. In this light, the changes in the stations will be weighed against the trends of Seattle, Tukwila and/or SeaTac. Next, the actual parameters for equity need to be unearthed.

3.2 How Have the Demographics of the Station Areas Changed?

This is an important question that will have important implications in itself as well as for the equity questions to follow. First, the demographic makeup of each station area helps uncover which areas that have the greatest equity concerns, especially at the beginning of Central Link service. Furthermore, the character of the neighborhoods involved in this study will undoubtedly have changed through the intervention of Central Link, regional growth trends or, more likely both. If the demographics have changed through displacement or have been diluted by newcomers, who are the purported benefits serving? Also, it is possible that different station areas have experienced these demographic shifts at different magnitudes. This is why changing demographics is a concern in itself, as well as a factor that will affect the following questions regarding bus service and land use changes.

3.3 How Has the Relative Quality of Bus Service Changed for the Station Areas?

In the advent of Central Link, it is possible that King County Metro diverted service priority from these areas to be reinvested in other markets. This is an understandable strategy to pursue; these areas have received a huge investment of high-quality transit, why should bus service continue to serve these areas. Many of the areas in the light rail alignment are home to the most disadvantaged communities in the region. However, through the lens of Rawls' Theory of Justice, bus service should continue to serve these communities the most. There also marked differences between the qualities of bus service and light rail that preclude them for being strict replacements from one another. Flexibility, transit priority, capacity and differences in fare to use transit are all worthy considerations to make. Lastly, the destinations available to Link riders is limited to mainly the downtown core, whereas bus service reaches a significantly greater number of areas throughout King County.

3.4 How Have Economic Benefits been distributed Across Station Areas?

One of the unexplored purported benefits of Central Link is the distribution of economic benefits. The FEIS stated that Sound Transit did not investigate the potential economic benefits of light rail, but predicted there would be benefits for all station areas. To explore this question, the following supporting questions are asked in this research: How have appraised land values changed over time? How have the appraised improvement values changed over time? Lastly, how have the land uses of the station areas changed? The first supporting question is a direct reflection of how the station areas have increased in value in the years following the introduction of Central Link. The second two supporting questions are more concerned with the distribution of development near Link stations.

The ways in which the station areas have developed differently is important for assessing the equity impacts of Central Link. The appraised improvement value of a parcel refers to anything of value beyond the value of the land the parcel contains. Increased improvement values is indicative of increased development and investment from the private sector. Similarly, changing land uses reflects the development of the station areas. Lastly, the types of the land uses affects communities differently and deserves attention.

4.0 Methodologies and Data

4.1 Study Areas

The primary study areas for this analysis were the Central Link Light Rail station areas in King County, Washington. For each station an area of comprised of the ¼ mile and ½ mile radius of each station is used. The stations included in this analysis, shown in Figure 1, are the following: Westlake, University Street, Pioneer Square, International District / Chinatown, Stadium, SODO, Beacon Hill, Mount Baker, Columbia City, Othello, Rainier Beach, Tukwila International Boulevard and Airport / SeaTac. At the time of this study University Link, University of Washington, Capitol Hill and Angle Lake stations, are also operational. However, these stations will not be included due to their relatively recent implementation in 2016.

The two aforementioned study area sizes are used for this study for two reasons. First, using comparing the two sizes highlights the proximal strength of the observed changes. Tobler's First Law of Geography (1970) states: "everything is related to everything else, but near things are more related than distant things" (Griffin & Sener, 2016). It is the assumption of this researcher that changes will be more pronounced at the ¼ mile radius. However, it is important to test this assumption with actual analysis. The second reason is that Sound Transit used these areas intermittingly throughout their Final Environmental Impact Statement. In their 1999 report, they stated forecasted impacts were expected to occur at the ¼ mile and ½ mile radius areas around the stations. (Sound Transit & US Department of Transportation Federal Transit Administration, 1999). The geographic study areas are shown below in Figure 1. The station areas are used for the following analyses for 2009 and 2017. Throughout this paper, there commonalities found across station areas that can be generally be grouped in geographic clusters. The station groupings are shown below in

Table 1. Although commonalities are not strictly found within station groupings, it will be helpful for future discussion of this research.

Station Grouping	Stations
Downtown	Westlake, University Street, Pioneer Square, International / Chinatown
Industrial	Stadium, SODO
South Seattle	Beacon Hill, Mount Baker, Columbia City, Othello, Rainier Beach
South King County	Tukwila, Airport / SeaTac

Table 1: Station Groupings of the Central Link Light Rail

2009 and 2017 are used as the temporal parameters for this research. The former date is used because Central Link opened in July 2009—the purpose is to create a snapshot of the area at the time of introduction of service. Earlier dates were not chosen due to the limited availability of data as well as the relatively immediate nature of bus service changes—King County Metro implemented changes to their service concerning Central Link Light Rail as close to its opening date as possible. The latter time frame (2017) was chosen because at the time of this study, the 2013-2017 estimates are the latest available 5-year estimates available from the American Community Survey.

Study Areas: 1/4 Mile and 1/2 Mile Central Link Station Areas

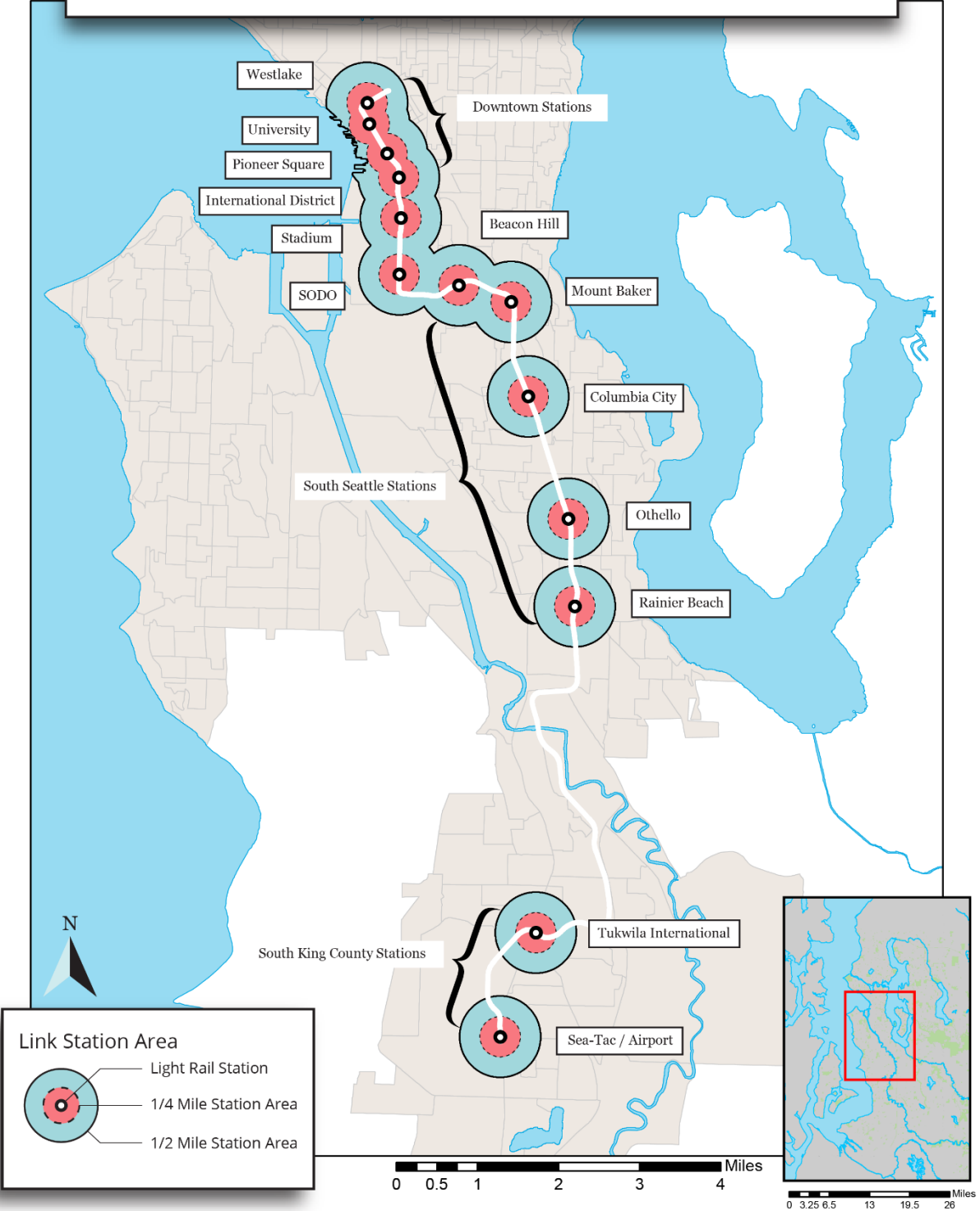


Figure 1: Study Areas: 1/4 Mile and 1/2 Mile Central Link Station Areas

4.2 Demographic Analysis

Before the potential impacts to bus service and economic development are investigated, it is pertinent to study the populations around the Link light rail stations over time. Race, income and education are examined as primary qualifiers for equity concerns. American Community Survey data containing Median Household Income, Race, Household Income Bracket Distributions, Education level, and Poverty rates for 2010 and 2017 are joined to Census Block Group shapefiles. In ArcGIS, ¼ mile and ½ mile buffers are created around Link light rail stations. These buffers are then joined, using the Intersect function, to the Block Group shapefiles. These shapefiles then have the individual counts of individuals in each of the aforementioned categories linked to the block groups that fall within the ¼ mile and ½ mile radius of light rail stations. For the scope of this study, it is assumed that the residents are evenly distributed throughout their respective block groups.

In Microsoft Excel, an Area Ratio for each portion of a block group that falls within the bounds of the station area buffers is created to reapportion the demographic counts that are shown for the entire block group. Once these new demographic counts are calculated, they are summed by station area. Finally, each demographic is reorganized, cleaned and visualized according to thresholds of significance and interpretive usefulness.

4.2.1 Household Income: Lorenz Curves and Gini Coefficients

Gini Coefficients and Lorenz Curves are used to represent the unequal distribution of a service, in this case household income, over a population (Delbosc & Currie, 2011). Shown below in Figure 2, is an example of a typical Lorenz Curve. The straight 45 degree line represents a theoretical, perfect equal distribution of income. A perfectly unequal distribution of income would be a right angle; this would be akin to one individual in a population earning all of the income, and the remainder of the population earning none of it. The blue line shown in the chart is an example

of an actual distribution. In an actual distribution, incomes are not equally distributed across the population—some households are making more annually and have a greater share of the income. The greater the inequity of income is, the greater the space is between the two lines. It is also important to note the curvature of the actual distribution. In the example below in Figure 2, if the x-axis is followed to .400, or 40% of all households, you can see that the corresponding Y-axis value is under .100, or 10%. This means, for this group of households, the bottom 40% constitute less than 10% of the total income generated in the observed population. The measured area between the equal distribution and actual distribution is called the Gini Coefficient.

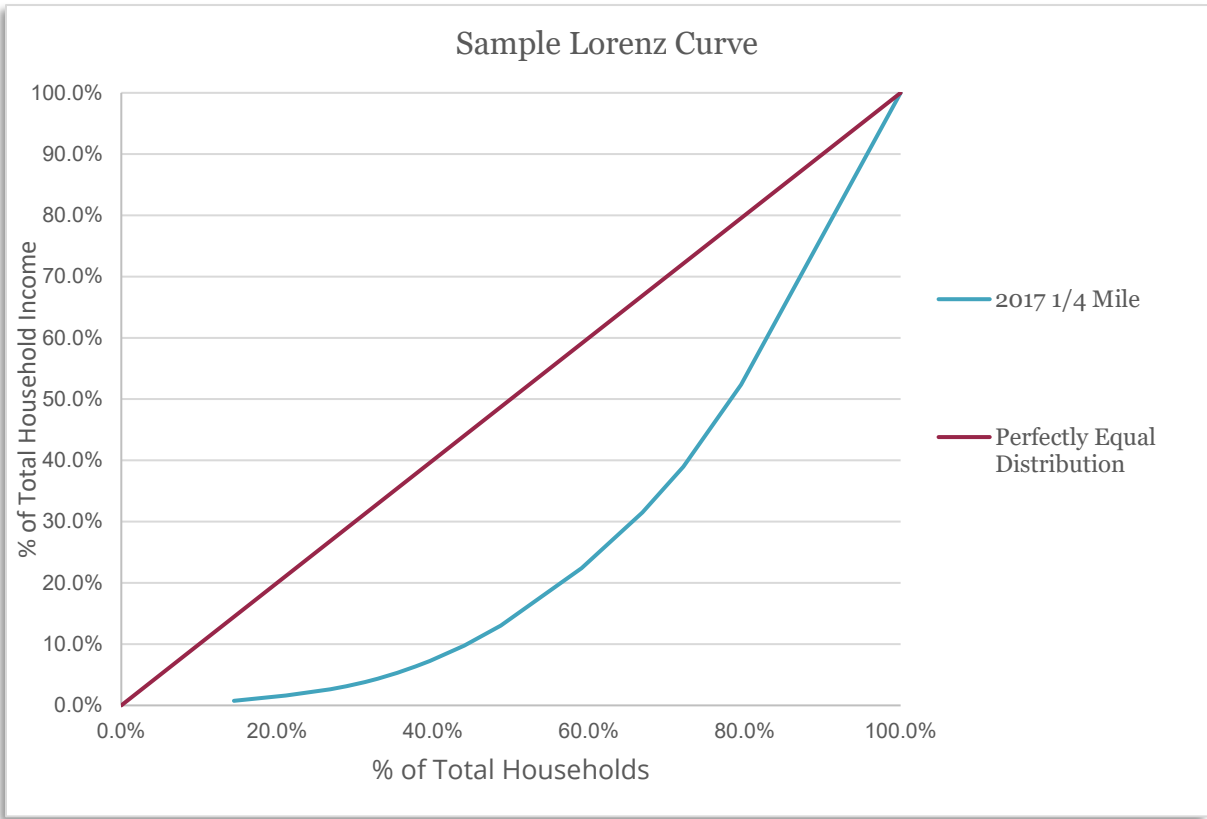


Figure 2: Sample Lorenz Curve

Gini Coefficients (or indexes) are numerical representations of the space between the theoretically perfect distribution and the actual distribution. These numbers are calculated based on the area between the two lines and help to clarify changes in a distribution that may be hard to view

graphically. A greater Gini Coefficient is interpreted as more unequal and a lower one the opposite. It is important to view both measures together in order to better understand the nature of a distribution. It is also important to note that Lorenz Curves and Gini Coefficients are limited to the quality of the data utilized in the analysis and are not suited for in-depth economic analysis; many other factors: including unrecorded income, senior citizenship and unilateral income shifts are not captured through these tools (Welch & Mishra, 2013). Despite these limitations, the tools are good indicators to general shifts in inequality.

For median household income distribution, the 16 income brackets originally provided in the American Community Survey Household data are retained: Less than \$10,000, \$10,000 - \$15,000...\$150,000 - \$200,000, over \$200,000. After the individuals within each bracket are counted based on the aforementioned area ratio, the cumulative population and cumulative population percentage are calculated to be used for the X axis (see Table 2: Sample Chart for Calculating Lorenz Curve, Westlake Station) of the Lorenz Curve. To calculate the Y-axis—which represents the cumulative ratio of total household income—the middle point of the income bracket is multiplied by the number of households in the bracket. For example, the bracket including households that make between \$10,000 and \$15,000 is used in calculations as \$12,500. The ratio of cumulative income is then calculated, creating the Y-axis of the Lorenz Curve. For the lowest income bracket—Households making less than \$10,000 a year—\$5,000 was chosen as the midway point. For the highest income bracket—Households making more than \$200,000 a year—a conservative number of \$225,000 was used. This methodology is then created for each ¼ mile and ½ mile station area in 2009 and 2017. Similarly, the Lorenz curve is calculated for the combined aggregate ¼ mile and ½ mile area for all stations as well as the tri-city area of Seattle, Sea-Tac and Tukwila combined.

Name	Income Brackets	Population	Cumulative Population	Cumulative Population %	Income x Population	Cumulative Income	Cumulative Income %
Westlake Station	5000	234	234	20.20%	1167816.489	1167816.489	01.68%
Westlake Station	12500	118	351	30.39%	1471988.086	2639804.575	03.79%
Westlake Station	17500	81	432	37.36%	1409279.831	4049084.406	05.82%
Westlake Station	22500	61	493	42.62%	1369753.032	5418837.438	07.79%
Westlake Station	27500	67	560	48.41%	1838515.705	7257353.143	10.43%
Westlake Station	32500	36	595	51.49%	1157767.563	8415120.707	12.10%
Westlake Station	37500	44	639	55.25%	1631678.142	10046798.85	14.43%
Westlake Station	42500	51	689	59.63%	2150162.645	12196961.49	17.52%
Westlake Station	47500	61	750	64.91%	2903034.021	15099995.51	21.69%
Westlake Station	55000	46	796	68.86%	2508002.089	17607997.6	25.30%
Westlake Station	67500	28	824	71.27%	1878840.138	19486837.74	28.00%
Westlake Station	87500	64	887	76.76%	5559843.217	25046680.96	35.98%
Westlake Station	112500	81	969	83.80%	9149241.225	34195922.18	49.13%
Westlake Station	137500	67	1036	89.57%	9181302.734	43377224.92	62.31%
Westlake Station	175000	18	1053	91.12%	3122841.82	46500066.74	66.80%
Westlake Station	225000	103	1156	100.00%	23105526.31	69605593.05	100.00%

Table 2: Sample Chart for Calculating Lorenz Curve, Westlake Station

4.2.2 Race Demographics

To identify People of Color (POC) in this analysis, the number of White Alone, from ACS table A04001, individuals was subtracted from the total number of people within each block group prior to the ArcGIS operations completed for all demographic analyses. After the area ratio was applied to the intersecting block groups within each station area, distribution charts are made using Excel to show the change in racial composition between 2009 and 2017 for ¼ mile and ½ mile station areas as well as the combined Seattle/Sea-Tac/Tukwila area.

4.2.3 Educational Attainment Demographics

Within the American Community Survey, Educational Attainment for Population 25 Years and over (A12001 is used for the following analysis. This table contains a distribution of individuals by highest educational attainment at the block group level. The following categories are available in

the distribution: Less than High School, High School Graduate, Some College, Bachelor's Degree, Master's Degree, Professional School Degree and Doctorate Degree. The target population for this study is individuals who fall within the first two categories—High School Graduate and Less than High School.

After the ArcGIS analysis is completed to properly apportion the number of individuals within each station area by the area of the block group that falls within the station buffers, a ratio of the target population is calculated. Individuals within High School Graduate and Less than High School categories is summed by station area and divided by the total number of people over the age 25 within those areas. Afterwards, the ratios of the target population are calculated by station area buffer size and year for comparison.

4.3 Quality of Bus Service

The purpose of the Quality of Bus Service methodology is to evaluate the changes in the quality of bus service in areas surrounding Link Light Rail Stations, before and after the construction of Central Link—relative to the entire network. For this analysis, three main variables are used to evaluate quality of bus service; the first variable is service hours. One of King County Metro's primary methods of investment in different communities is through the number of hours they assign to routes that serve those communities. Subsequently, a hierarchy of investment and prioritization can be somewhat developed from comparing service hours that different communities receive. The second variable used to evaluate level of bus service is ridership. In this research, ridership is used as a proxy for utility of a route. The baseline assumption is that routes that are more useful to communities are going to be utilized more frequently. Finally, the number of routes per bus stop is used as a stand-in for system-facilitated access. Stops with a greater number of routes increase the level of transit-facilitated access for individuals who can access them. These

three variables are imperfect substitutes for factors that can and have each been studied individually for research articles of their own. However, for the purposes of this research, they will be used to represent the relative changes in bus service in station areas over time. All data used for this analysis was provided by King County Metro.

4.3.1 Service Hours

The number of annual service hours by route are not directly recorded by King County Metro. Instead, for every *service change*, the county creates a Microsoft Access database table that includes detailed information for every planned trip for every route in the network. Among other things, the table includes the route making the trip, the *service change*, the *day code* and the number of hours is required to complete that trip. The aforementioned *day code* is used to reference the number of days that trip is made during that *service change*. *Service changes* refer to a period following when King County Metro makes changes to their services through changes in frequency, changes in the pathway of their buses, or even entire additions or removals of routes. These changes occur three times a year. In order to assess the service hours assigned to a route for the year, the following data extraction and cleaning was completed for each service change for 2009 and 2017 then aggregated appropriately.

To count the service hours for each route by service change, the SUMIFS Excel function was used to add up the total number of hours by route and day code. SUMIFS is an operation that totals a table's numerical values based on a criteria defined by the user. In this case, the route and service change are used as the criteria. Once the summed hours were categorized by route and day code, the hours were multiplied by the number of days that day code represented. The total hours for each day code are then summed by route. After repeating this process for each service change and combining results by year (2009 & 2017), quintiles are created for each year. Scores 1- 5 are

assigned to routes based on their quintile; routes in the top quintile scoring 5, the second highest quintile 4, etc. This is the first score that the routes are assigned in this analysis.

4.3.2 Ridership

Ridership is calculated similarly to Service Hours. Within the same previously mentioned Microsoft Access database tables King County Metro maintains, there is a column for number of boarding passengers. The number of boarding passengers is counted through Automatic Passenger Count (APC) technology employed on most buses. This technology counts boarding and alighting bus passengers daily and creates averages over time. In the Access table, this average count is assigned to trips. In order to extract this, the same exact process described above is done for number boarding in place of service hours. Quintiles and scores are assigned the same way as well. These scores are then added to the service hour scores by route and year.

4.3.3 Number of Routes

Currently, scores are assigned to routes in 2009 and 2017 based on their relative rankings of ridership and service hours. However, customers cannot jump on a route at any location—they need to access routes through bus stops. From this point, ArcMap becomes the primary tool for analysis. Route score tables for each year are imported to ArcMap and joined to the route shapefile for their respective year. Once the routes have scores assigned to them, they needed to be attached to stops. Due to the nature of ArcGIS, lines and points do not intersect well with one another. To circumvent this, 35 foot buffers (not dissolved) are created around bus stops. The buffers are then merged with routes using the Intersect Tool. The result of this operation is a shapefile with polygons representing every stop/route pair in the City of Seattle. Tukwila and Sea-Tac are not included in this analysis because they would drastically skew the results. Bus service in Tukwila and Sea-Tac has significantly fewer hours, and lower ridership than Seattle service. There are many reasons for this, including

sprawling urban development patterns, Seattle’s self-imposed tax to increase service and more. The underlying Access database table is exported to Excel for further analysis.

To calculate the number of routes per stop, the Excel function COUNTIFs is used. This function counts the number of occurrences within a table based on criteria defined by the user. In this case, the Stop ID was used as the criteria Afterwards, the IF function is utilized to create scores based on the number of routes the stop possesses. The following ranges are used to assign scores to stops:

Number of Routes	Assigned Score
1	0
2 - 4	1
5 - 9	2
10 or more	3

Table 3: Scoring Rubric for Number of Routes per Stop

These score ranges were created in order to minimize the impact of this variable. If each score for every route a stop serves were added together, stops with multiple routes would always outrank stops with fewer, even if this did not reflect the true utility or relative service investment of that stop. Similarly, adding the count of routes to the score would dwarf the other variables, especially considering many downtown stops serve over 30 routes. After scores are assigned, the highest scoring route for each stop is recorded and attached to that stop. This score is then added to the number of routes score to create a final route score. This route score is then used to create quintiles one final time. These quintiles are used to create 1 – 5 scores similar previous calculations.

4.4 Land Use Analysis

In order to better understand the context of the changes within the Central Link Light Rail station areas, the land use mix of the area must be understood. This analysis will be partitioned into

three parts. The first part is the Land Use Mix. The land use mix will compare the differences in uses around the stations to contextualize the station areas and observe the changes after the advent of Link. The second is a measure of the changing appraised land and improvement values over time. Lastly, the number of multi-family housing units per station area over time is observed. The development of new land uses, change in land values and change in improvement values will be used as a proxy of economic development—station areas that have developed more uses with a greater total improvement value have, in many ways, received more of the purported benefits of Link’s proximity. The appraised land value is also a significant factor to consider how the economic benefits of the Link are distributed over time.

4.4.1 Land Use Mix

The land use mix for each geo-temporal study area is calculated for this analysis. King County maintains present land use data at the county level with 120 categories. For this analysis, the 120 categories were reclassified into 20 categories. The groupings for the original land use classes can be found in the Appendix in 9.3.1 . The analysis itself will include all 20 categories in the calculations, but will only feature 7: Single-family Residential, Multi-family Residential, Retail, Auto-related Use, Mixed Use, Office and Industrial. These 7 categories are selected due to their prominence in the chosen study areas as well as their significance to the neighborhood character of the station areas.

The analysis begins with parcel polygons in ArcMap that have present use data in their attribute tables. To narrow the scope to station areas, un-dissolved buffers are generated around each station area with a radius of ¼ mile and ½ mile. The land use polygons are then joined to the buffers through the Intersect operation in ArcMap; all parcels that intersect the parcel boundaries were included in this analysis. If buffers overlapped one another, they were counted once per

associated station. After parcels were tied to station area buffers, the attribute tables were then exported into excel for further analysis. First, the land uses were reclassified into the aforementioned categories. Next, tables and charts were created comparing each of the station area sizes and time periods.

4.4.2 Appraised Land and Improvement Values

The appraised land and improvement value analysis is based on data from the King County Assessors' Office. Appraised land value refers to the value that assessors from King County assigns to the land of a parcel. Improvement value refers to the value that the assessor assigns to what is sited at the property, in most cases this is residential or commercial development.

For this analysis, the appraised land value and improvement values are calculated the same way as the land uses. The data is partitioned into individual station areas by size and year, then calculated in excel to be aggregated by station. This analysis includes all parcels that intersect the buffers generated around Link stations.

4.4.3 Multi-family Residential

Within King County parcel data, the number of multi-family units is included for each property. To count the number of units by station area, the parcels were chosen using the same methodology as for Land Use Mix and Land and Improvement Value analyses. The data was then sorted by station area in excel for final delivery of results

5.0 Results of Analysis

5.1 Demographic Analysis

5.1.1 Lorenz Curves

The following findings will represent the changes in the distribution of income within each station area between 2009 and 2017. This analysis is completed for both a buffer created from a ¼ mile radius of each station area as well as a ½ mile station area buffer. The following figures (Figure 3, Figure 4, Figure 5 and Figure 6) show each station area Lorenz curve by station area and year. By organizing the data in this way, it is easier to look at trends across the station areas in the same geographic and temporal frame.

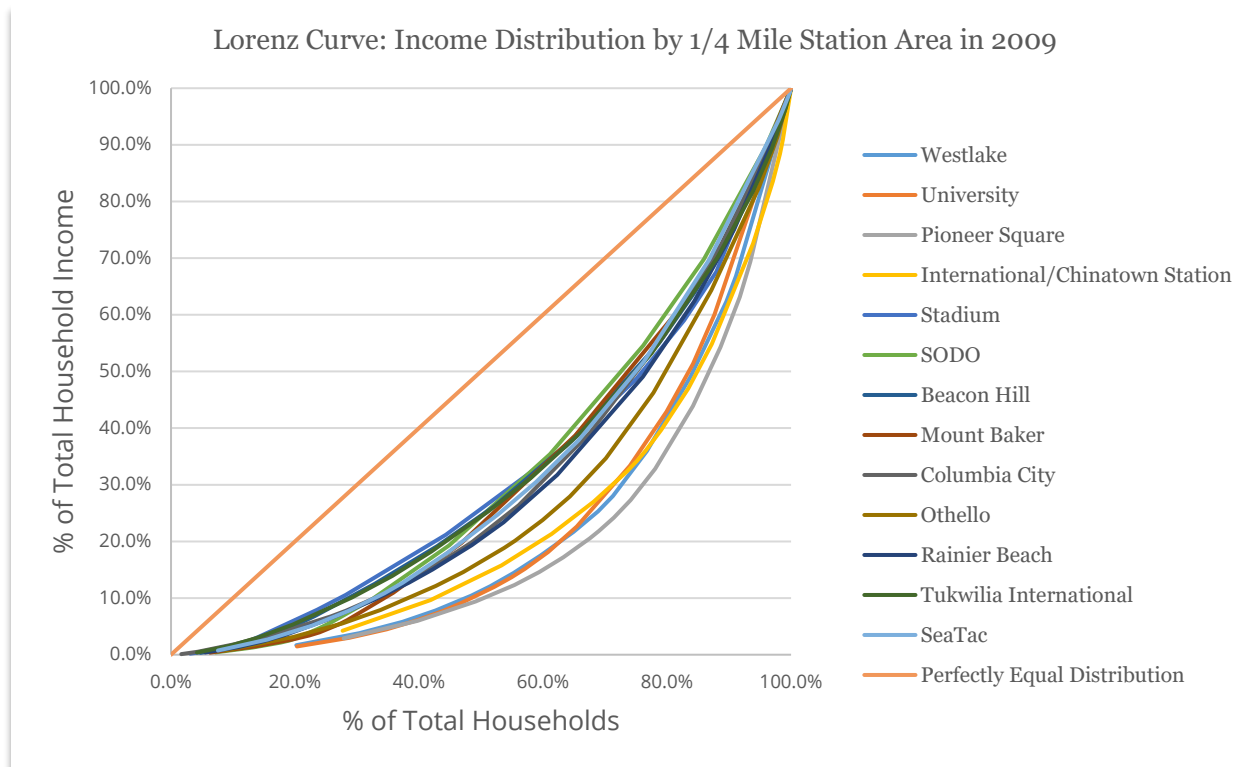


Figure 3: Lorenz Curve: Income Distribution by ¼ Mile Station Area in 2009

In the above figures (Figure 3 and Figure 4) there is a notable difference across station areas in the household income inequity. Furthermore, there is a greater gap across station areas in 2009 when

compared to 2017. Station areas in the downtown area—Pioneer Square, International/Chinatown, Westlake and University Stations—constitute the areas with the greatest levels of income inequality. This trend continues in 2017, but to a lesser degree. This trend is found the following figures for ½ mile station areas (Figure 5 and Figure 6). Similar to the equalizing trend between 2009 and 2017 across station areas, increasing the scale of the analysis from ¼ mile to ½ mile diminishes the differences between station areas’ Lorenz curves. Relationships across temporal and geographic scale by station area can be found in the Appendix: 9.1 Lorenz Curves by Station Area.

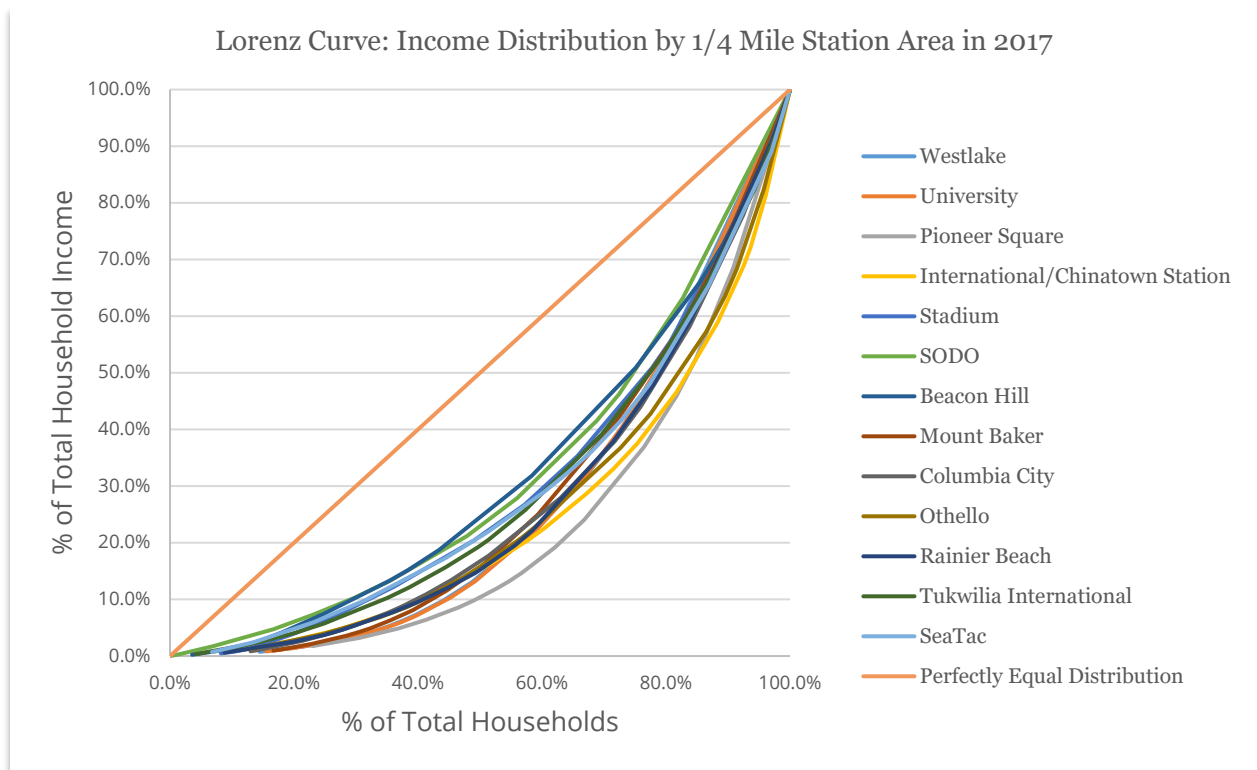


Figure 4: Lorenz Curve: Income Distribution by 1/4 Mile Station Area in 2017

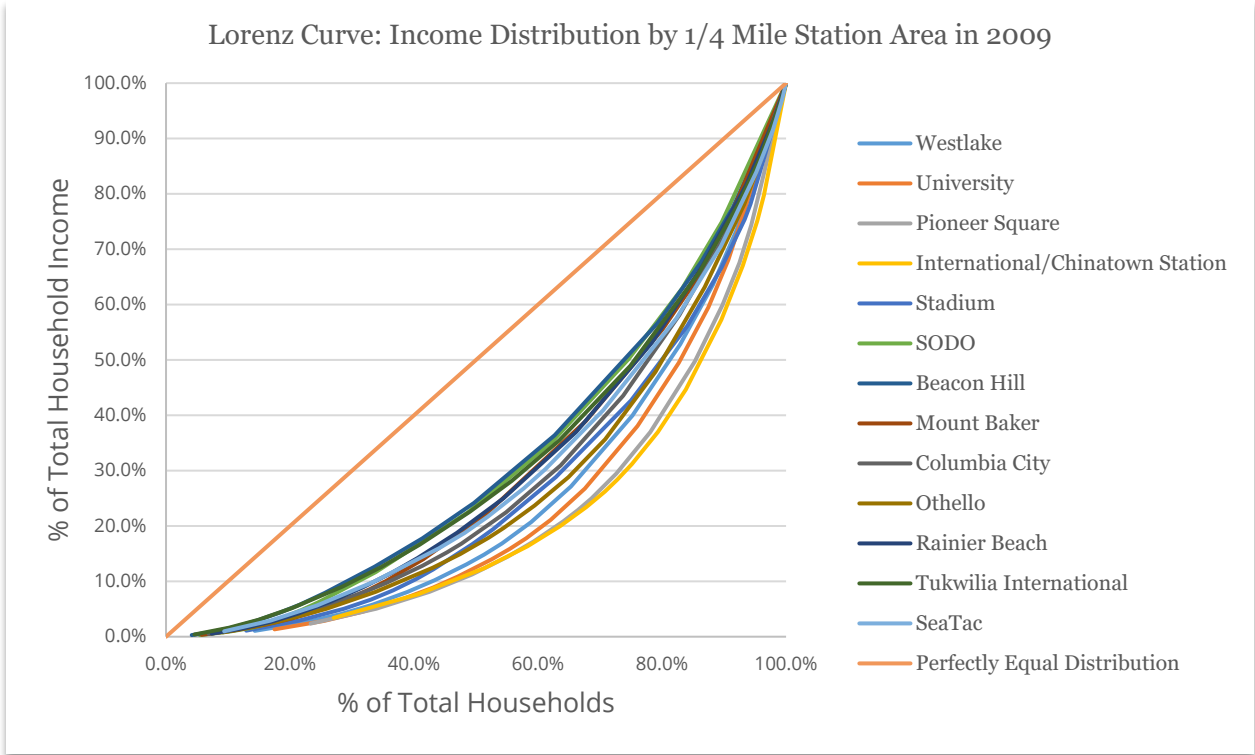


Figure 5: Lorenz Curve: Income Distribution by 1/2 Mile Station Area in 2009

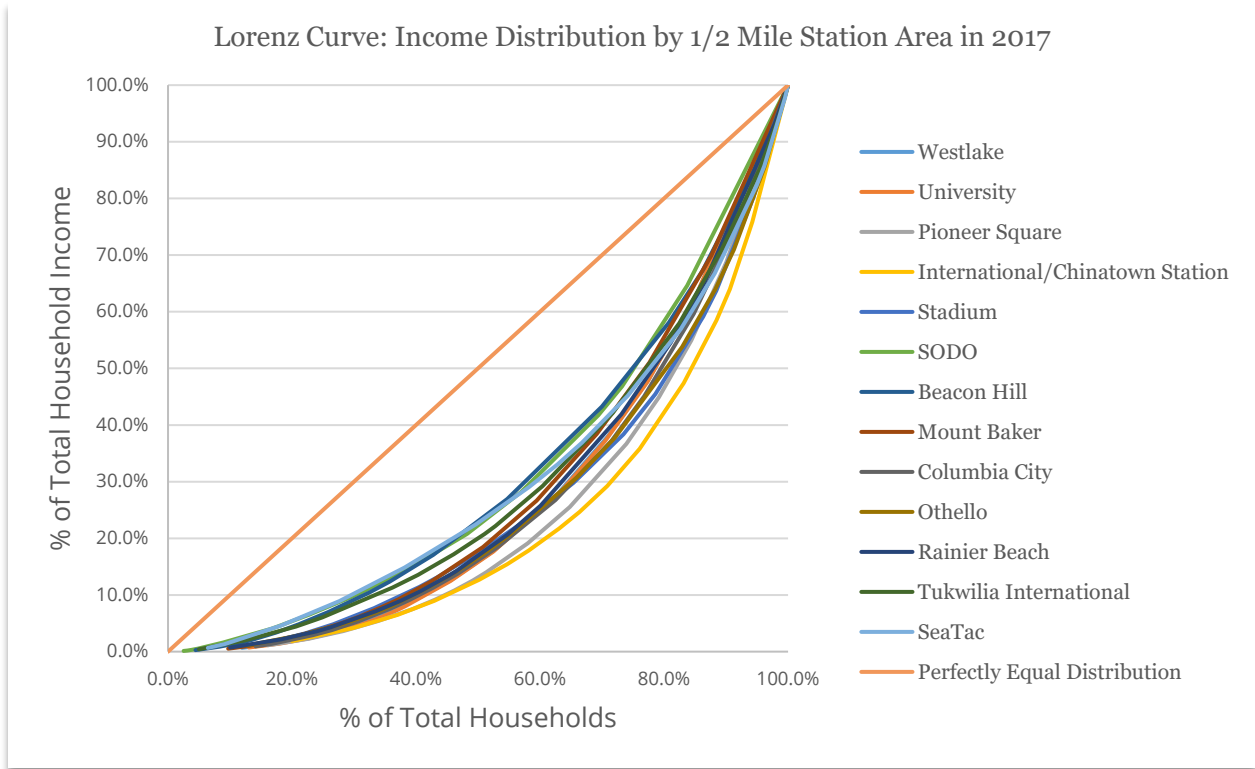


Figure 6: Lorenz Curve: Income Distribution by 1/2 Mile Station Area in 2017

5.1.2 Gini Coefficients

The Gini Coefficient (or Index) is the area between the perfectly equal distribution (the straight 45 degree line) and the Lorenz curve of a distribution. The Gini coefficient represents the inequality in the distribution of income across a population—the greater the coefficient, the more unequal the distribution of income. In this study, it is the distribution of household income across households by station area. In Figure 7, the Gini coefficient for each 1/4 mile station area is shown for 2009, 2017 and the change between the two. The aggregate Gini Coefficient for all of the station areas (overlapping areas in downtown are not double counted) and for the combined Seattle/Sea-Tac/Tukwila areas are calculated and shown for context and as a control. From this data and analysis, a pattern emerges; station areas in the central downtown area of Seattle have markedly lower Gini Coefficients a decade following the introduction of Link Light Rail in 2009 and station

areas south of Beacon Hill possess a higher Gini coefficient in 2017 than 2009. The most significant decrease in Gini Coefficient for ¼ mile station areas, shown in Figure 7, is in the Westlake Station area, where the coefficient decreased by 15% from .556 in 2009 to .469 in 2017. Conversely, Columbia City's coefficient increased 18% from .390 in 2009 to .464 in 2017. This changes can be contrasted to the slight decrease in Gini coefficient (.010) for aggregate city areas where these stations reside. Furthermore, the aggregate station area of all station areas is on average .100 higher than the Tri-city area for both time points. Finally it is also worthy reiterating that these changes had a somewhat “equalizing” effect across station areas—driving station area coefficients towards the average.

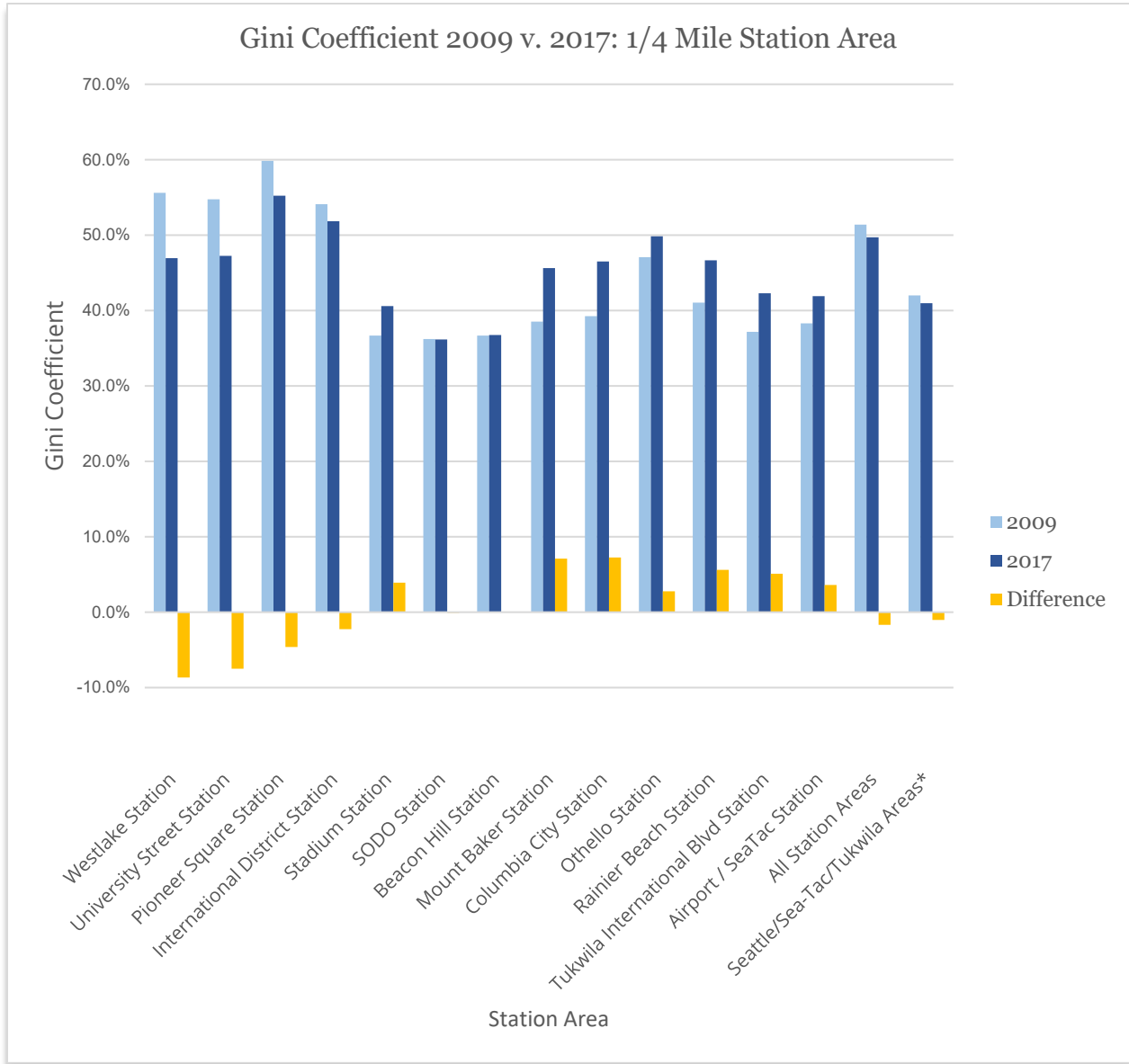


Figure 7: Gini Coefficient 2009 v. 2017: 1/4 Mile Station Area

For the 1/2 mile station areas, shown in Figure 8, a similar trend arose, but to a lesser degree for most areas. However, there were some other notable differences including an increase of the aggregate station area Gini coefficient of .028 from 2009 to 2017 rather than the decrease of .0167 shown for the 1/4 mile analysis during that same period. Furthermore, the Westlake Station area had a significantly higher Gini in 2009 for the 1/4 mile buffer (.556) than for the 1/2 mile station buffer (.503) in 2009.

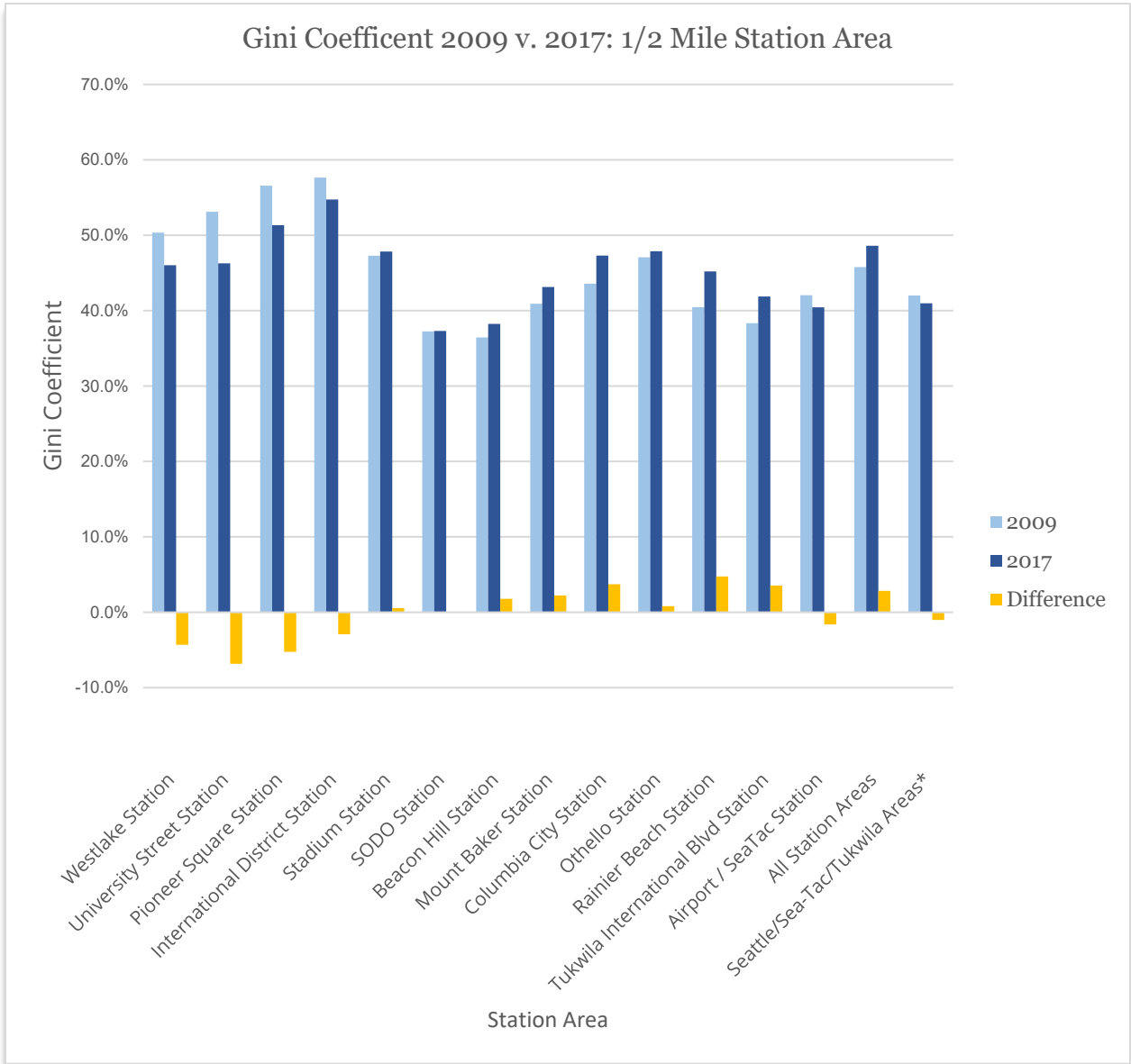


Figure 8: Gini Coefficients 2009 v. 2017: 1/2 Mile Station Area

Station Name	Quarter Mile				Half Mile			
	2009	2017	Difference	Tricity Difference*	2009	2017	Difference	Tricity Difference*
Westlake Station	0.556124187	0.46949944	-0.08662475	-0.07641272	0.503389741	0.460300859	-0.0430889	-0.0328768
University Street Station	0.547415386	0.47246285	-0.07495254	-0.06474051	0.531062542	0.46264562	-0.0684169	-0.0582049
Pioneer Square Station	0.59846064	0.55221946	-0.04624118	-0.03602915	0.565813129	0.51338999	-0.0524231	-0.0422111
International District Station	0.540886061	0.51844711	-0.02243895	-0.01222692	0.576383434	0.547316506	-0.0290669	-0.0188549
Stadium Station	0.366722913	0.40591107	0.03918816	0.04940019	0.472816179	0.478294992	0.00547881	0.01569085
SODO Station	0.362202685	0.36151603	-0.00068666	0.00952537	0.37242848	0.373015986	0.00058751	0.01079954
Beacon Hill Station	0.366737234	0.36759211	0.00085488	0.01106691	0.36447601	0.382336588	0.01786058	0.02807261
Mount Baker Station	0.385274652	0.45622337	0.07094872	0.08116075	0.409159974	0.43134554	0.02218557	0.0323976
Columbia City Station	0.39248347	0.46496235	0.07247888	0.08269092	0.435733943	0.47300864	0.0372747	0.04748673
Othello Station	0.470762341	0.49847247	0.02771013	0.03792216	0.470686036	0.478723698	0.00803766	0.01824969
Rainier Beach Station	0.410397121	0.46652871	0.05613159	0.06634362	0.404528533	0.452007863	0.04747933	0.05769136
Tukwila International Blvd Station	0.371808977	0.42284031	0.05103133	0.06124337	0.383399218	0.418818687	0.03541947	0.0456315
Airport / SeaTac Station	0.38291844	0.41902774	0.0361093	0.04632133	0.420544655	0.404462344	-0.0160823	-0.0058703
All Station Areas	0.513813076	0.49709663	-0.01671645		0.457678298	0.486059815	0.02838152	
Seattle/Sea-Tac/Tukwila Areas	0.419991692	0.40977966	-0.01021203		0.419991692	0.409779659	-0.010212	

Figure 9: Gini Coefficients by Station Area, Year and Station Area Size.

*This is the comparison of the station area difference from 2009 v. 2017 and the difference for the entire Seattle/Sea-Tac/Tukwila areas during the same time

Gini Coefficient by Station Area: 2009

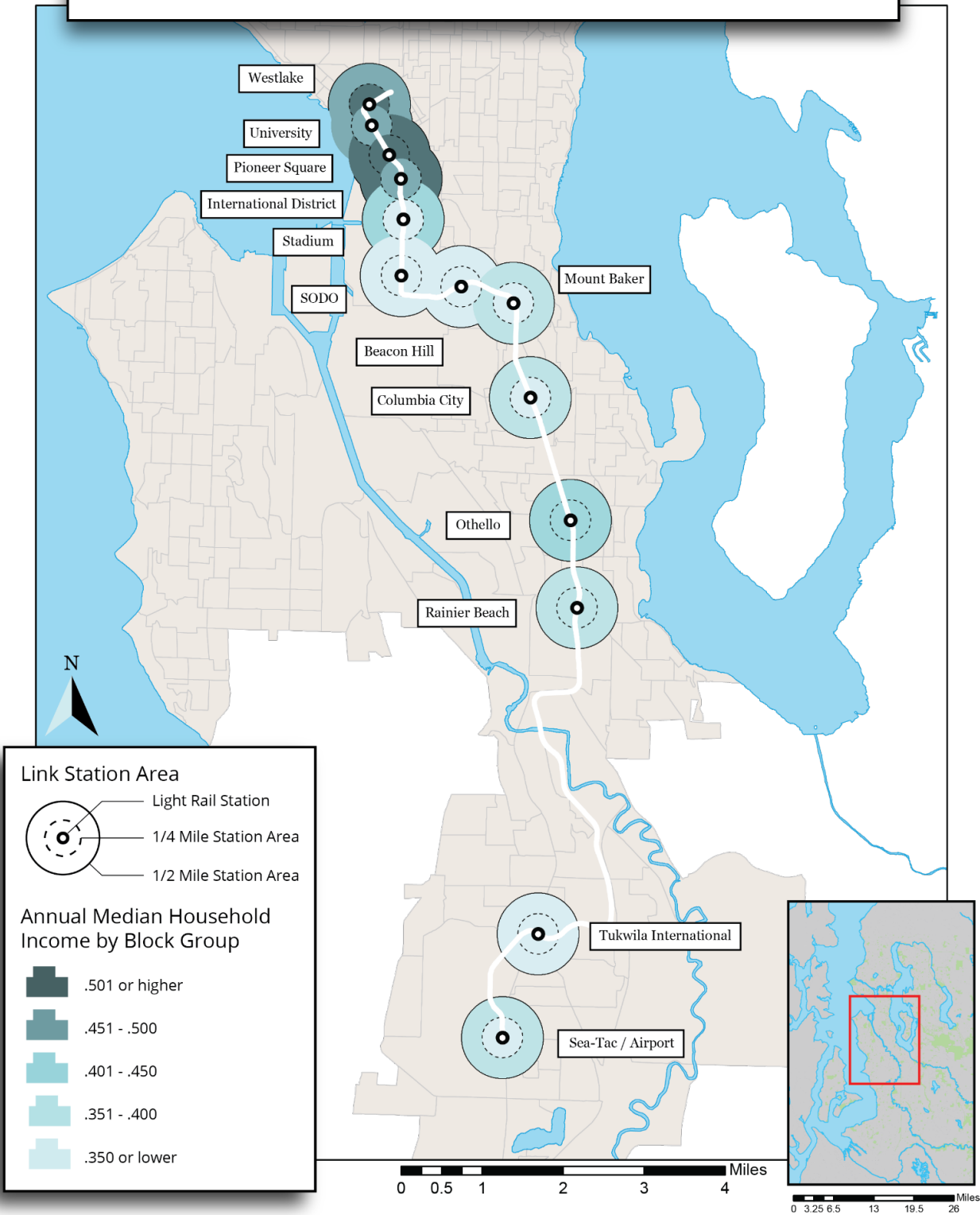


Figure 10: Map of Gini Coefficient of Income Groups by Station Area: 2009

Gini Coefficient by Station Area: 2017

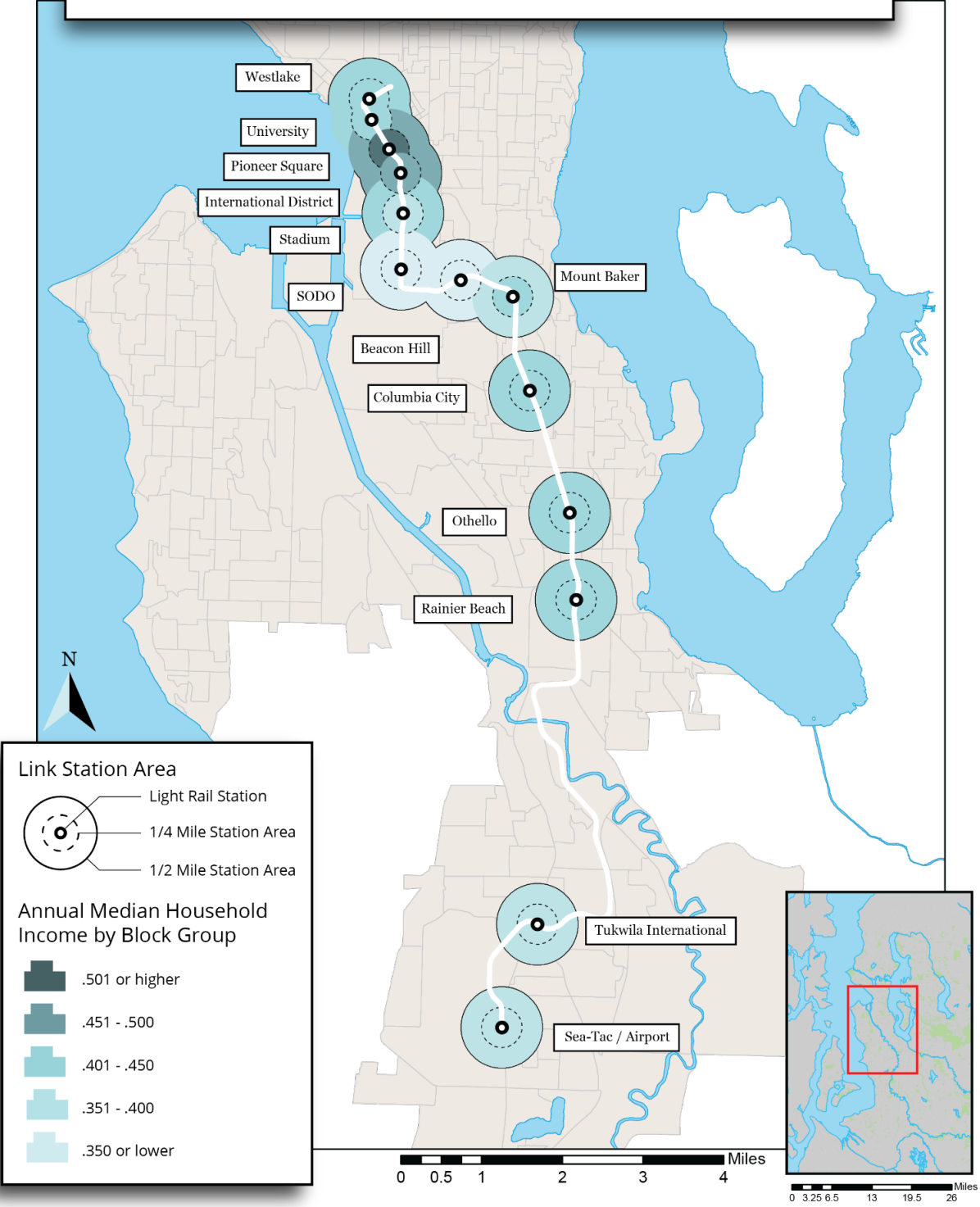


Figure 11: Map of Gini Coefficient of Income Groups by Station Area: 2017

5.1.3 Descriptive Statistics

5.1.3.1 Median Household Income

Shown below in Figure 12 is the distribution of Household incomes by ¼ mile station area in 2009. The results show that there is a high concentration of households making less than \$25,000 a year in the Westlake, University Street, Pioneer Square and International District station areas—with over 50% in the latter two areas. These results help add further clarity to the results from the previous section; there are significantly more equal distributions of incomes in the South Seattle stations areas. The tri-city area of Seattle/Tukwila/Sea-Tac boasts the most even distribution of household incomes, with all five income groups representing about 15%-20% of the total population of households.

Figure 13 shows the percent change of the number of households in each income bracket. The most significant change in the distribution is the increase of households making \$150,000 or more. The tri-city area saw a greater increase than the ¼ mile station areas with an increase of over 60% of this population. The next highest increase of households making \$150,000 or more was around 50% in Westlake station. Another notable change between 2009 and 2017 was the increase of households making less than \$25,000 a year. There were increases of this population in station areas south of Beacon Hill station. The greatest increase was 50% in Rainier Beach.

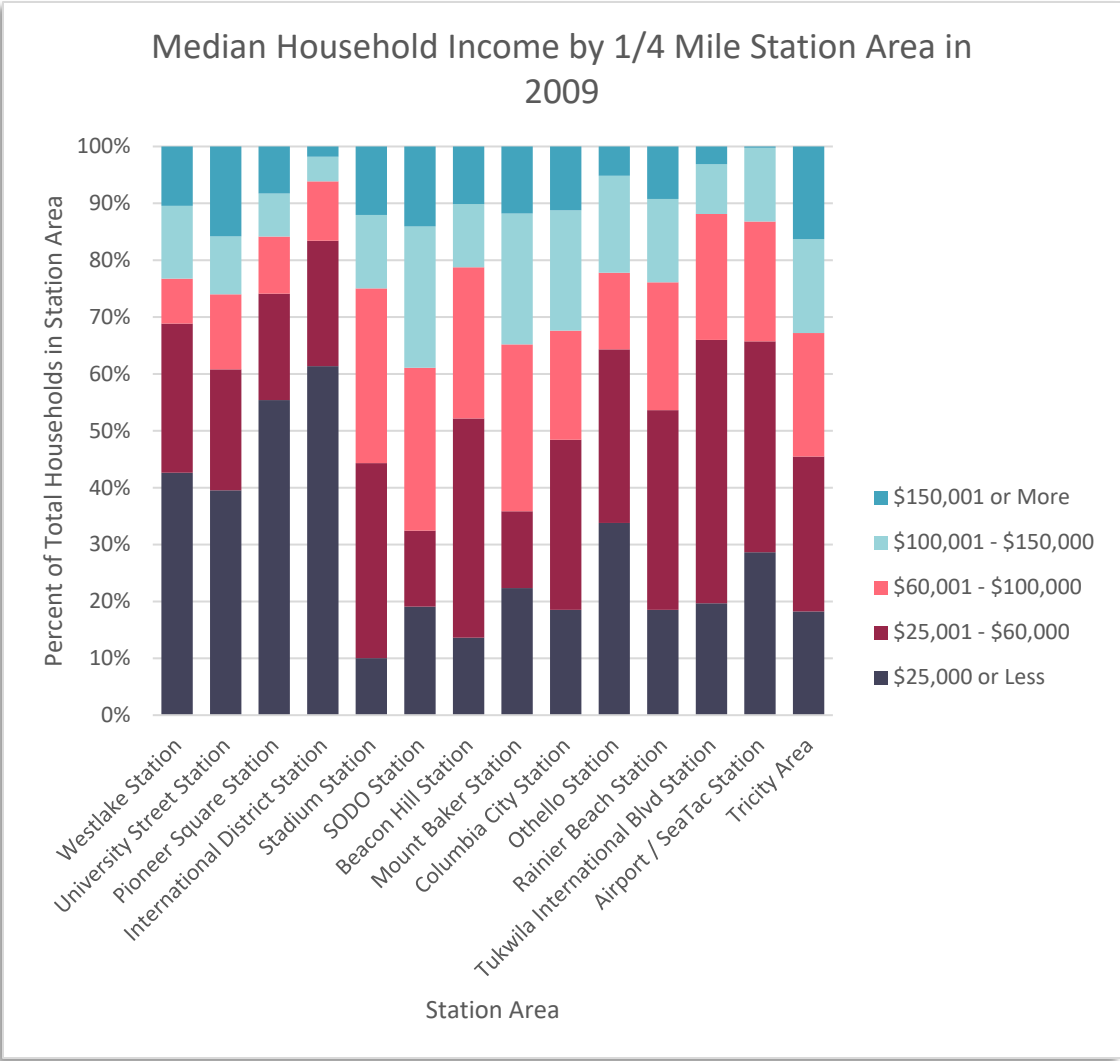


Figure 12: Median Household Income by 1/4 Mile Station Area in 2009

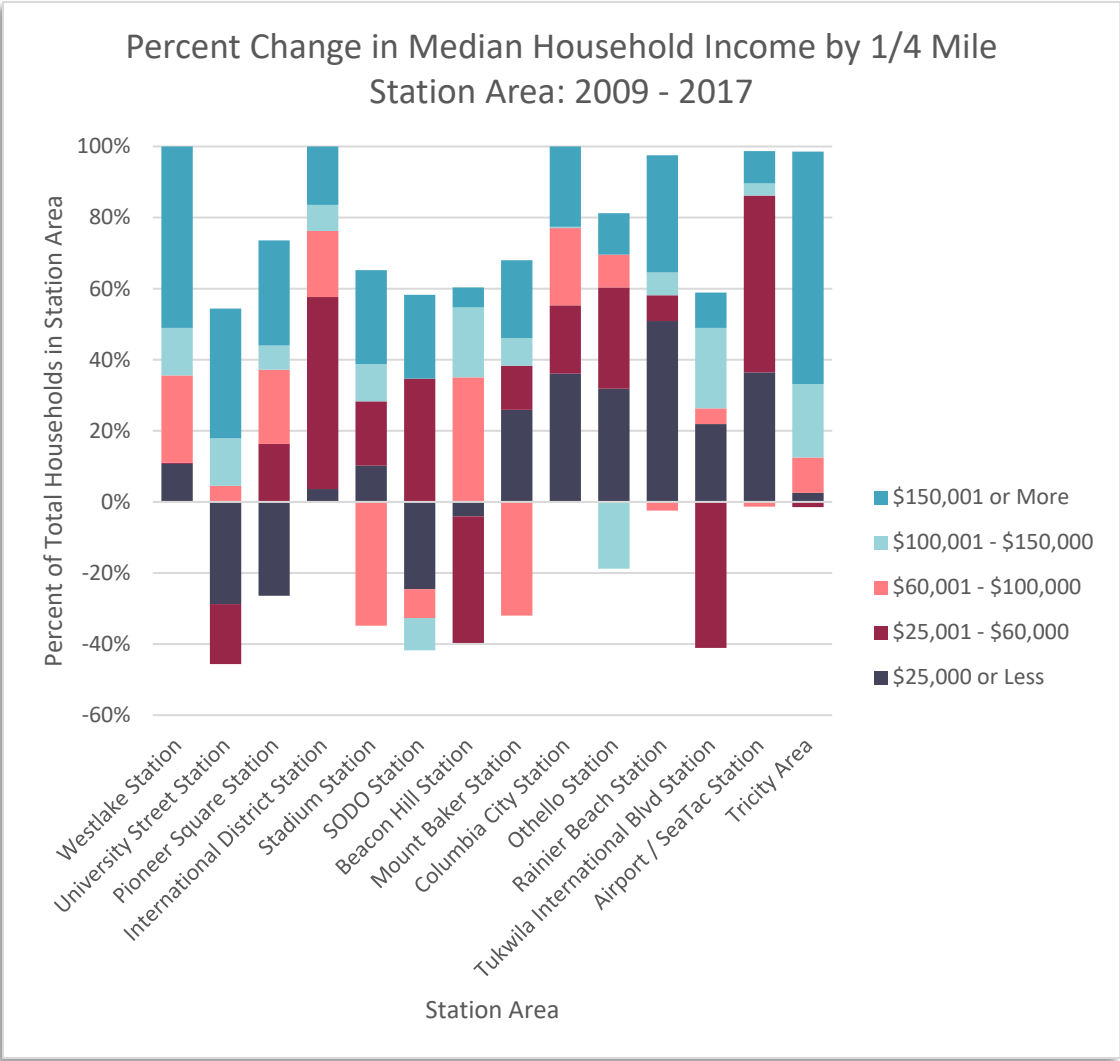


Figure 13: Percent Change in Median Household Income by 1/4 Mile Station Area: 2009 - 2017

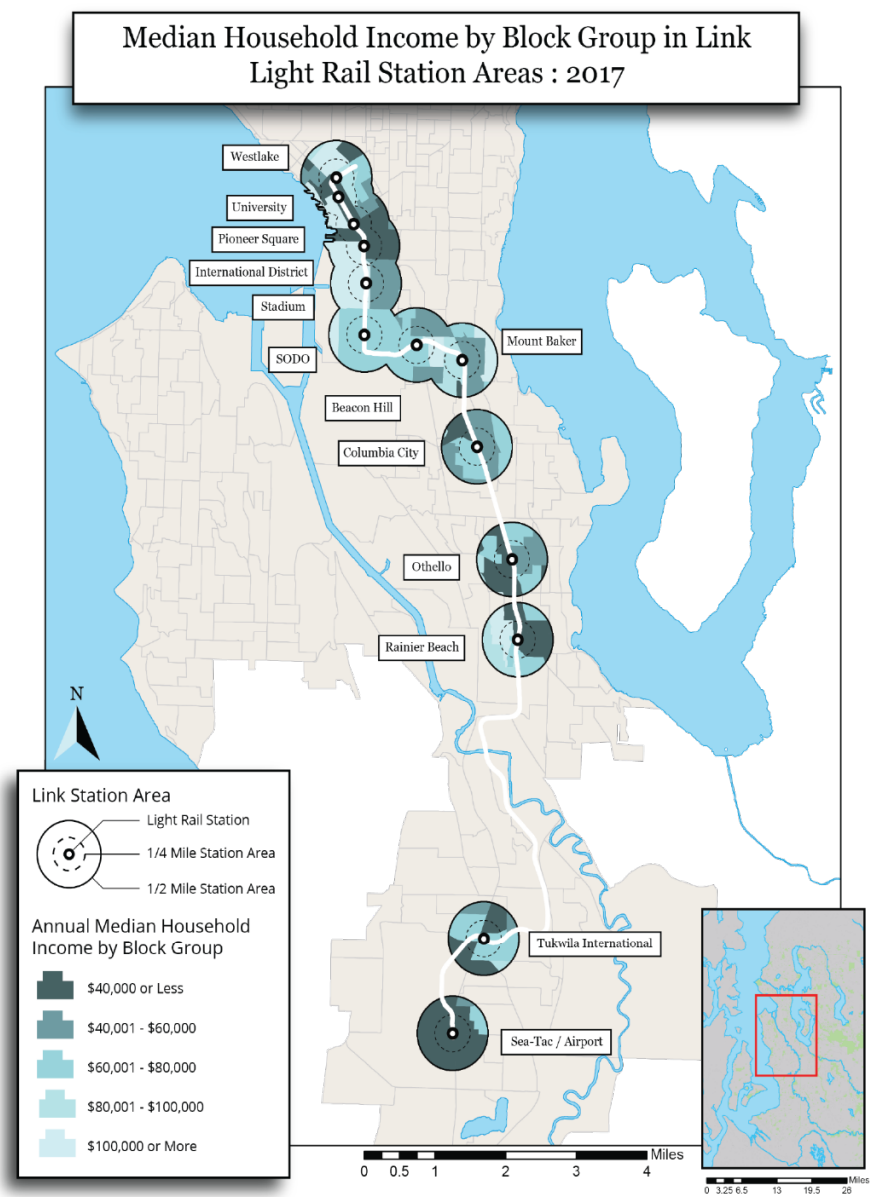
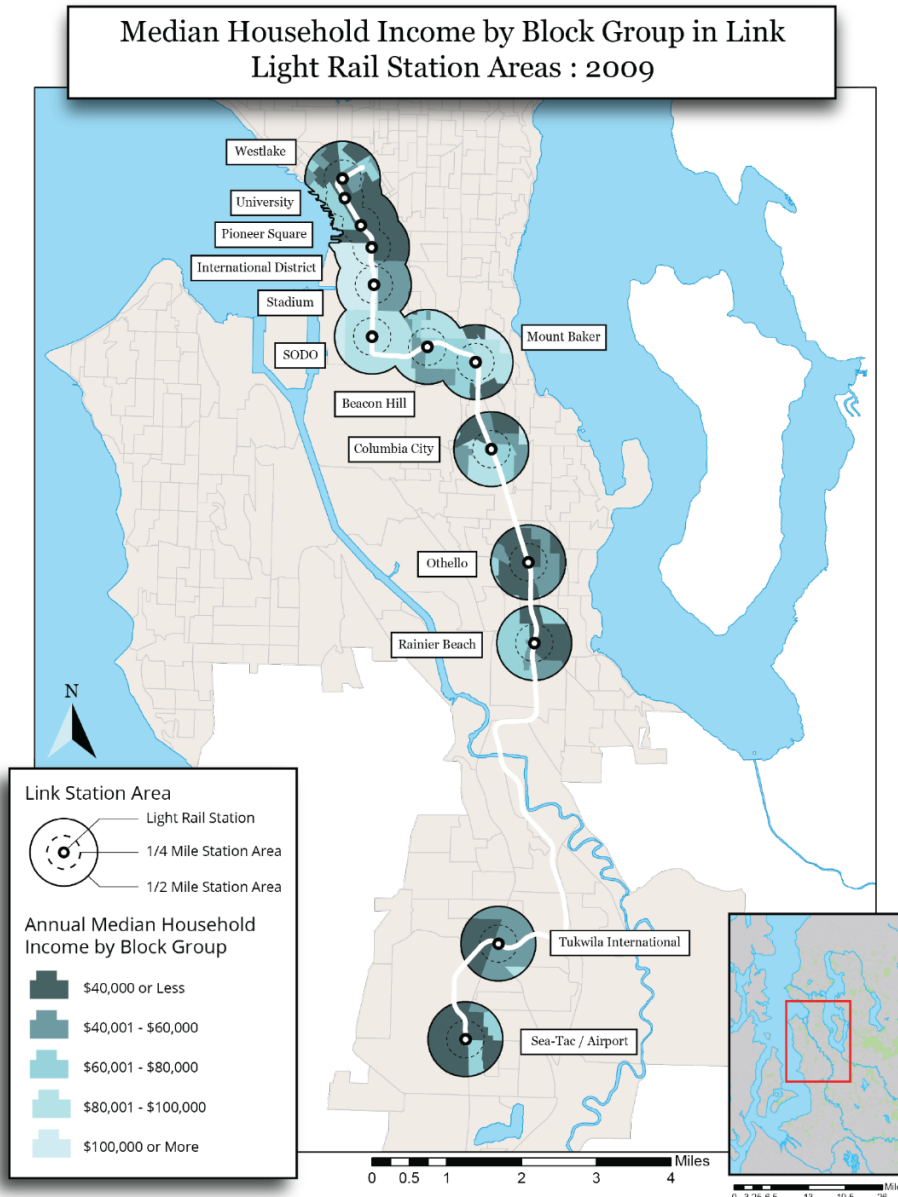


Figure 14: Median Household Income by Block Group in Link Light Rail Station Areas: 2009 & 2017

5.1.3.2 Race Demographics

The results of the descriptive statistics analysis show significant representation of non-white, people of color (POC) in the station areas. In most station areas, before and after the construction of light rail, there is a significantly higher proportion of POC than in the surrounding Seattle/Sea-Tac/Tukwila cities. As shown in Figure 15 & Figure 16 the average aggregate composition of POC in the station areas is between 59% - 66% across station area size and study year. In contrast, the combined tri-city area is between 33% - 37% during 2009 and 2017 respectively.

The most significant results of the descriptive statistics in this section are the yellow bars shown in Figure 15 & Figure 16 that represent the change in demographic composition since Link Light Rail was constructed. First, POC in the tri-city aggregate increased compositionally by 4% from 33% in 2009 to 37% in 2017. Across station areas there is a loose geographic trend; most of the station areas in the downtown area of Seattle (Westlake, University and Pioneer Square stations) and South King County (Sea-Tac/Airport and Tukwila) experienced a shift towards a greater proportion of POC, shifting by 8.5% to 28.3% in the ¼ mile study areas. Conversely, stations south of Pioneer Square and north of Tukwila changed anywhere from +2% to -10.5%. It is important to note that these changes over time in the ratio of POC to the total population of each station area. Subsequently, station areas with relatively small populations—SODO, Stadium & Sea-Tac/Airport stations—are more susceptible to large proportional swings in representation of POC than higher population areas.

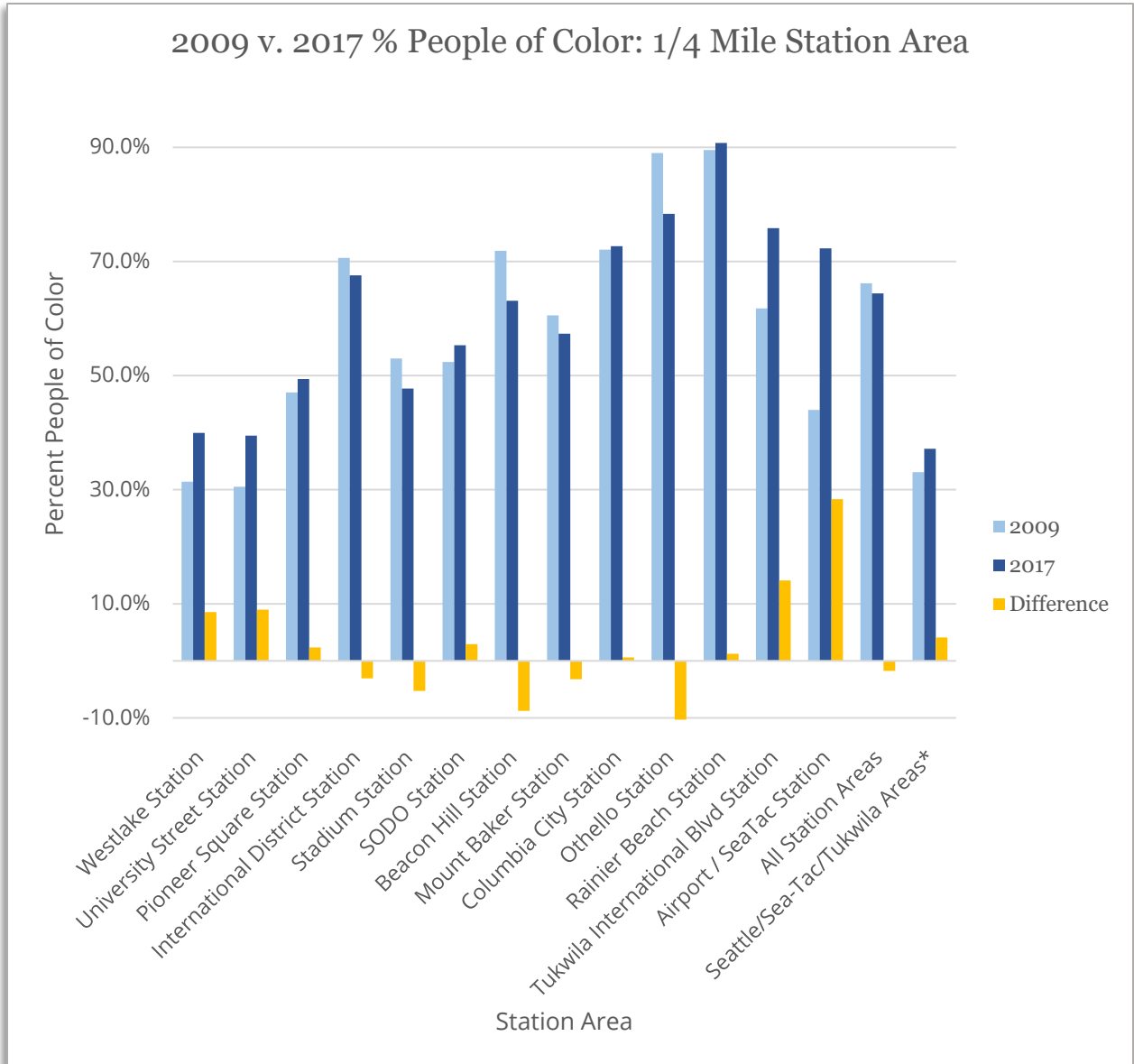


Figure 15: 2009 v. 2017 Percent People of Color: 1/4 Mile Station Area

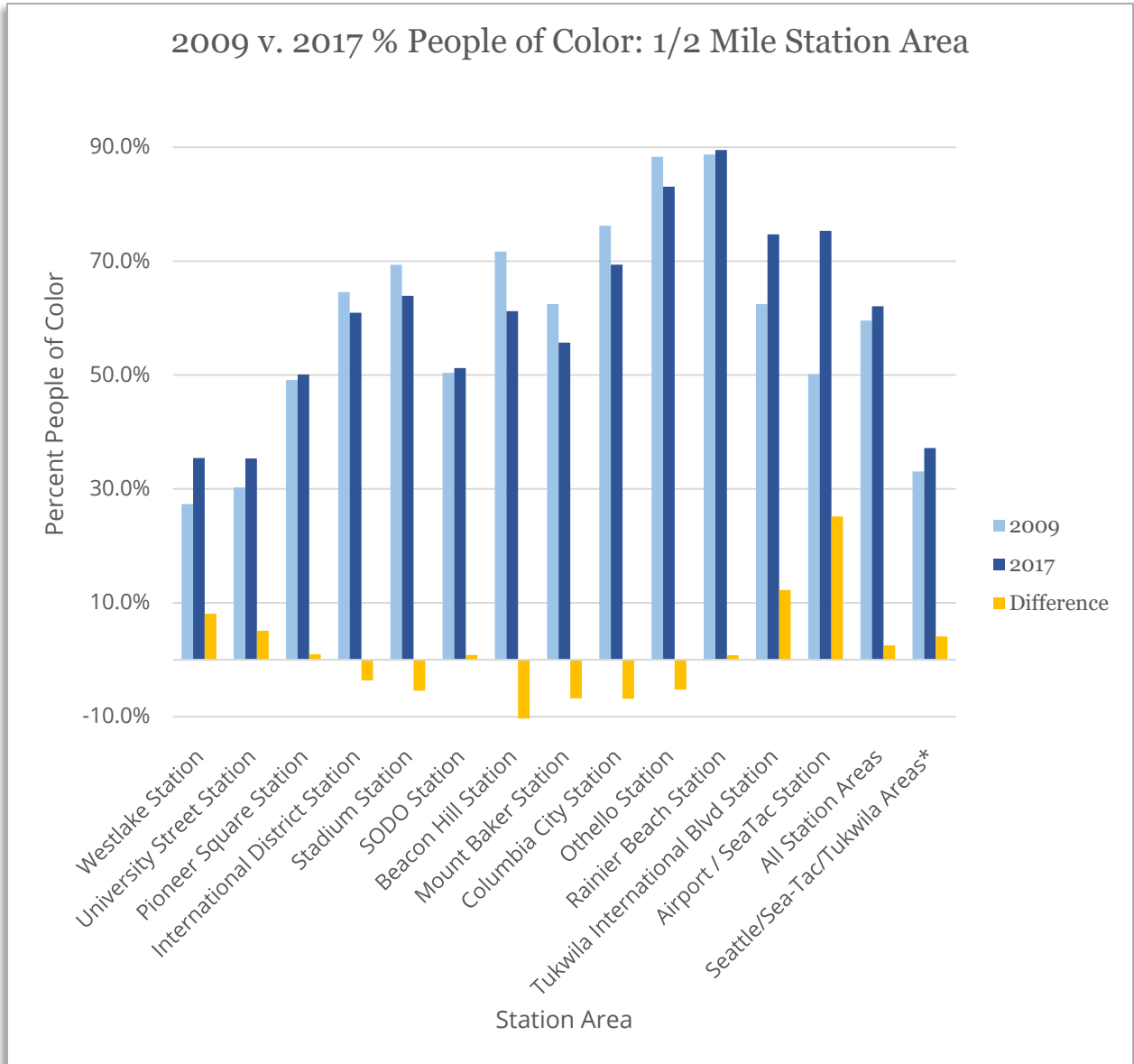


Figure 16: 2009 v. 2017 Percent People of Color: 1/2 Mile Station Area

The raw count of individuals in each station area are shown in Figure 17 & Figure 18— population counts for the All Station and Tri-city aggregate are not shown due to differences in scale. In the aggregate for all 1/4 mile station areas, the population of POC increased from 37,100 in 2009 to 47,880 in 2017 and 63,617 to 76,749 for the aggregate 1/2 mile station area during the same period. Based on this analysis, the vast majority—10,700 of the 13,100—of the net increase in POC occurred

in the immediate ¼ mile area of the light rail stations. The tables supporting the aforementioned figures as well as all of the counts for POC counts can be found in the Appendix.

In nearly all of the ½ mile station areas, there is a marked increase in the number of POC. The exception to this trend is present at the Beacon Hill and Mount Baker stations that experienced net loss of 1,030 and 180 POC respectively. The largest increase of People of Color was experienced in the Westlake station area, which increased by a net total of 2,750 people in the ½ mile station area between 2009 and 2017. Strikingly, the Beacon Hill ½ mile station area lost 1,000 people of color from 2009 to 2017. This is even more surprising when all of the other areas experienced an increase (except the ¼ mile Othello and ½ mile Mount Baker areas), including the entire tri-city area.

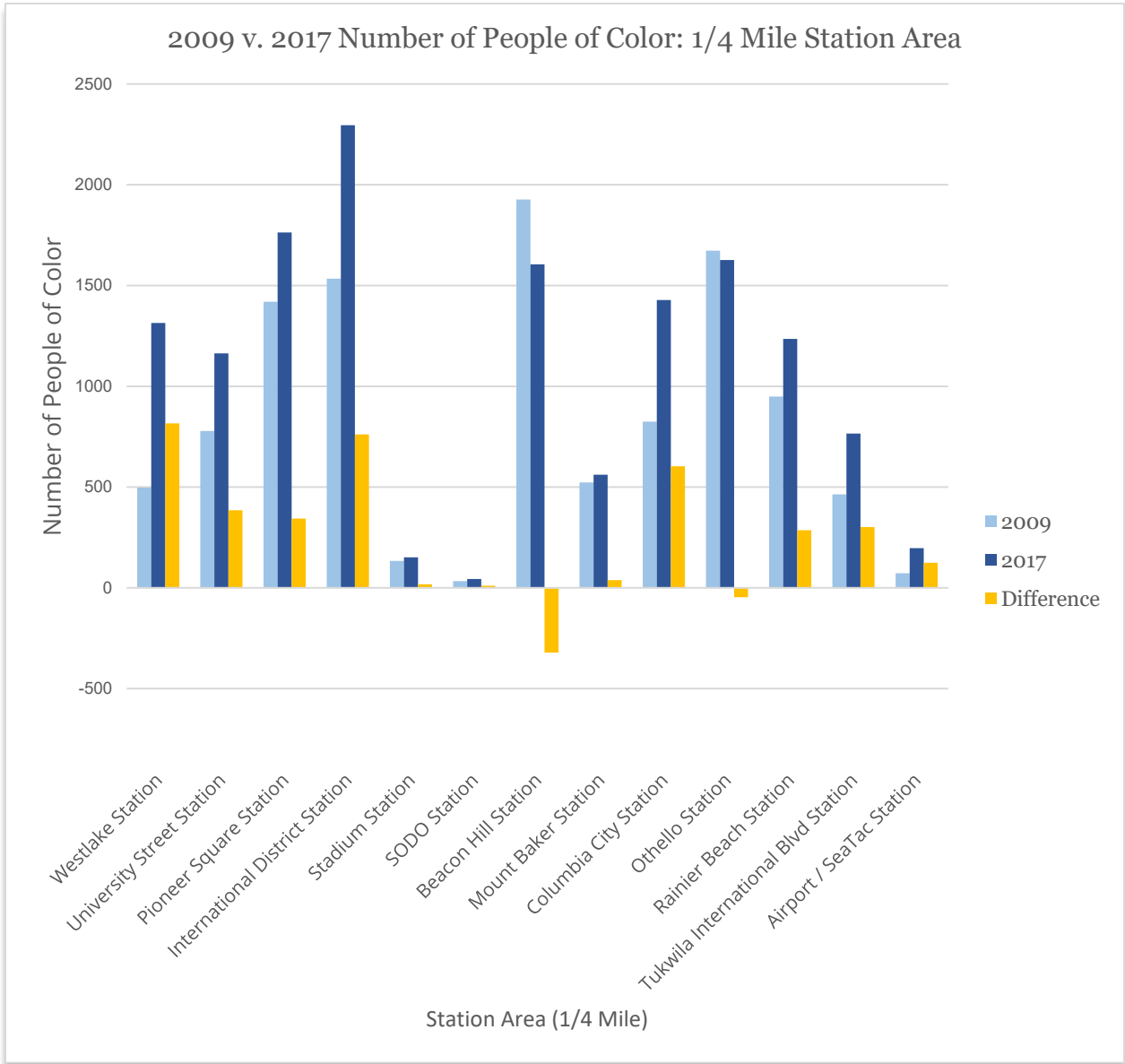


Figure 17: 2009 v. 2017 Number of People of Color: 1/4 Mile Station Area

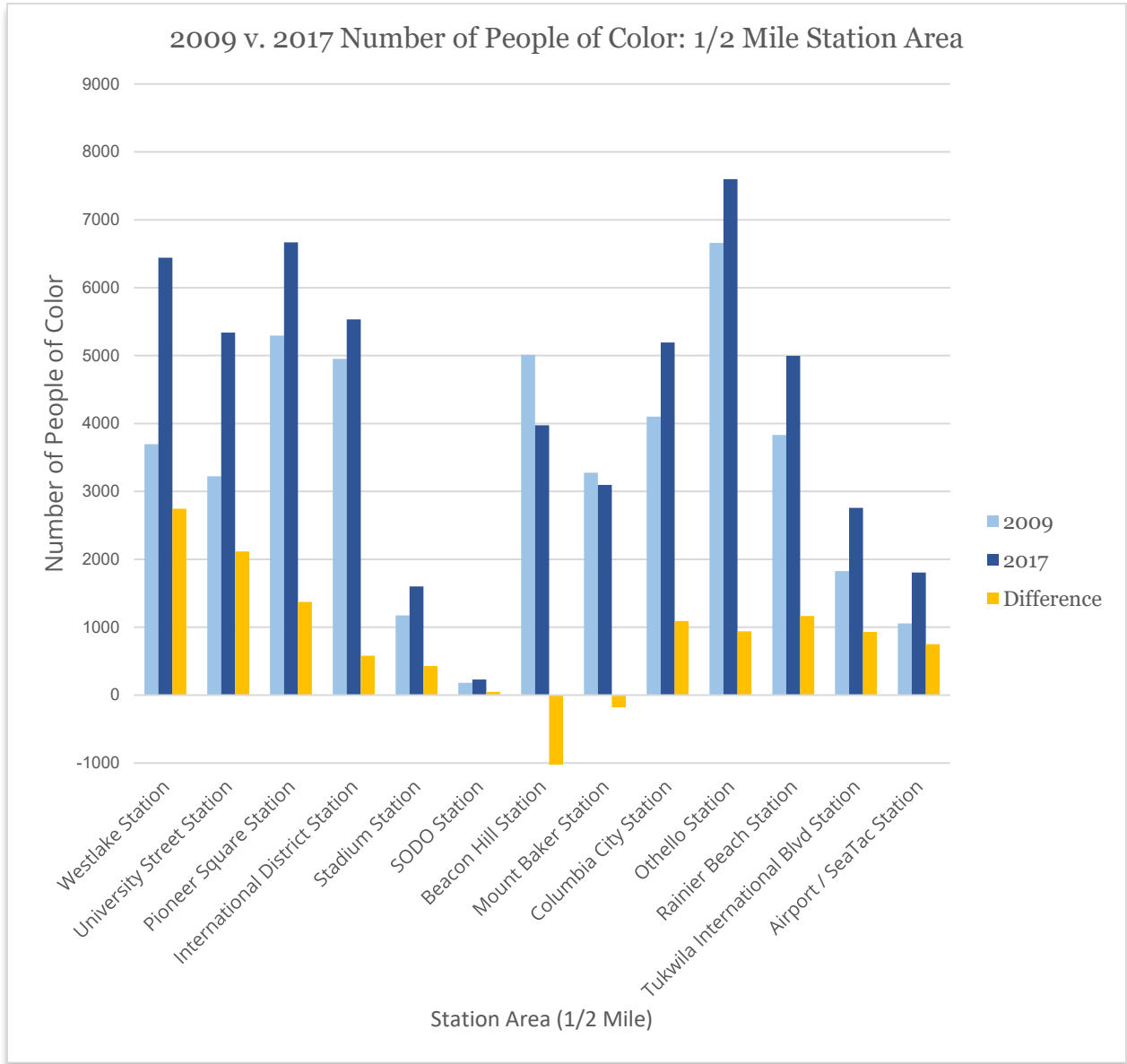


Figure 18: 2009 v. 2017 Number of People of Color: 1/2 Mile Station Area

5.1.3.3 Education Demographics

Shown below in Figure 19 & Figure 20, show the percent of individuals over the age of 25 in each station area who have a high school degree or less. At nearly all stations, the share of individuals with less than some college decreased significantly—with exception to the areas surrounding Tukwila International and Stadium stations. The most significant decrease is found in the Beacon Hill station area, where the share of individuals without any college education dropped by nearly 24%. This trend was also found in the aggregate tri-city area of Seattle/Sea-Tac/Tukwila, but to a lesser degree. In this area, the share decreased 5 percentage points from 23% in 2009 to 18% in 2017. Also notable, is that the majority of the station areas hosted a higher rate of people without any college than the surrounding cities; many ¼ mile station areas—including International District, Othello and Airport—had communities where over 50% of the population had a high school degree or less.

Comparing the results from the ¼ mile buffer and ½ mile buffer of each station, there are some notable differences. The most apparent difference is the strength of the change in proportion of individuals with a high school degree or less—the demographic shift in the ½ mile is generally more pronounced when the analysis is expanded to a ½ mile buffer. For example, the ½ mile Beacon Hill station area lost 10 percentage points more of the target population than the ¼ mile area at the same station. The most notable inverse of this trend was found for Columbia City. For the area within a ¼ mile radius of Columbia City station, the proportion of people over the age of 25 with a high school degree or less dropped by 7.6%; in the ½ mile station area of Columbia City, the composition stayed relatively the same between 2009 and 2017.

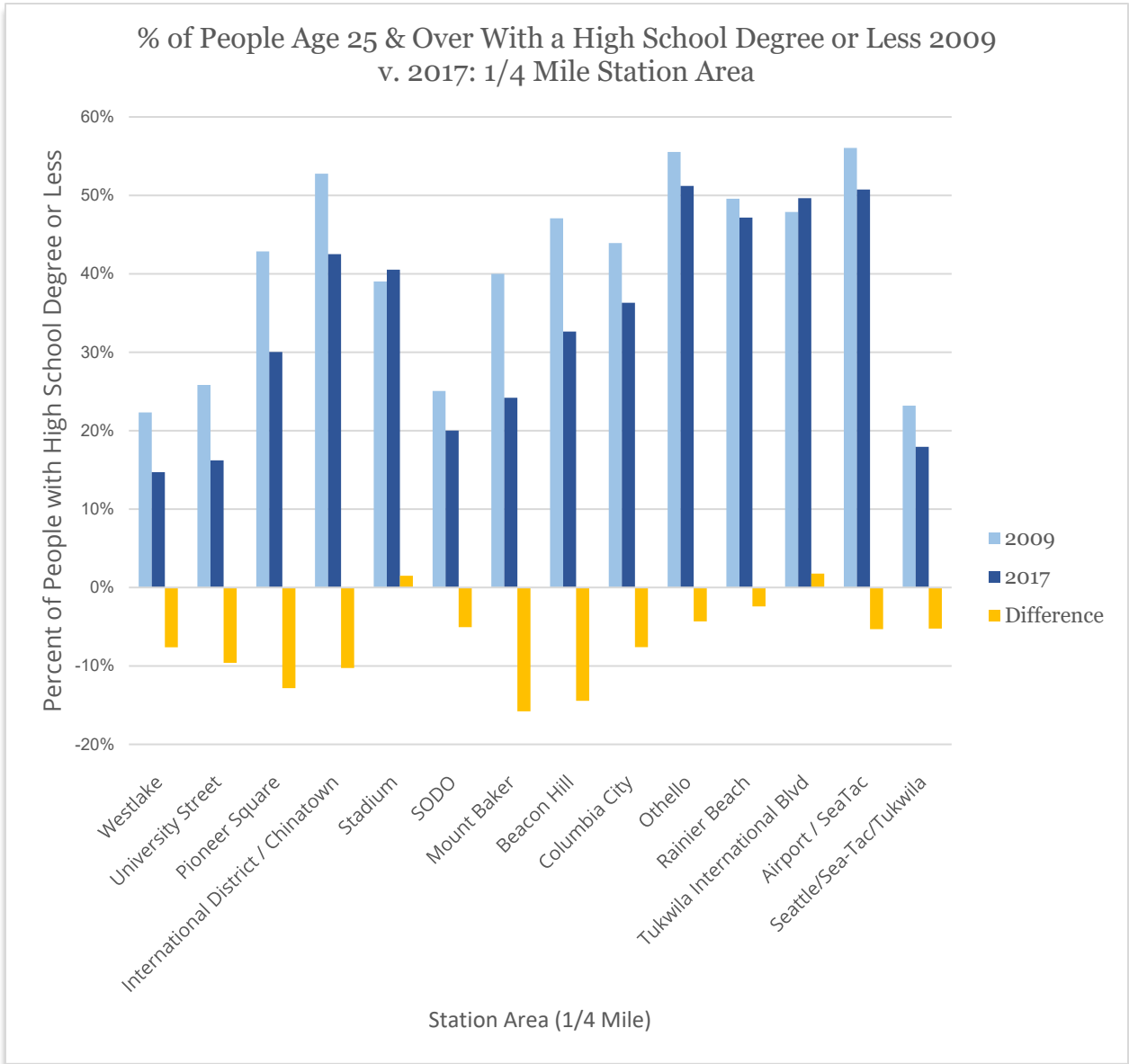


Figure 19: Percent of People Age 25 & Over with a High School Degree or Less 2009 v. 2017: 1/4 Mile Station Area

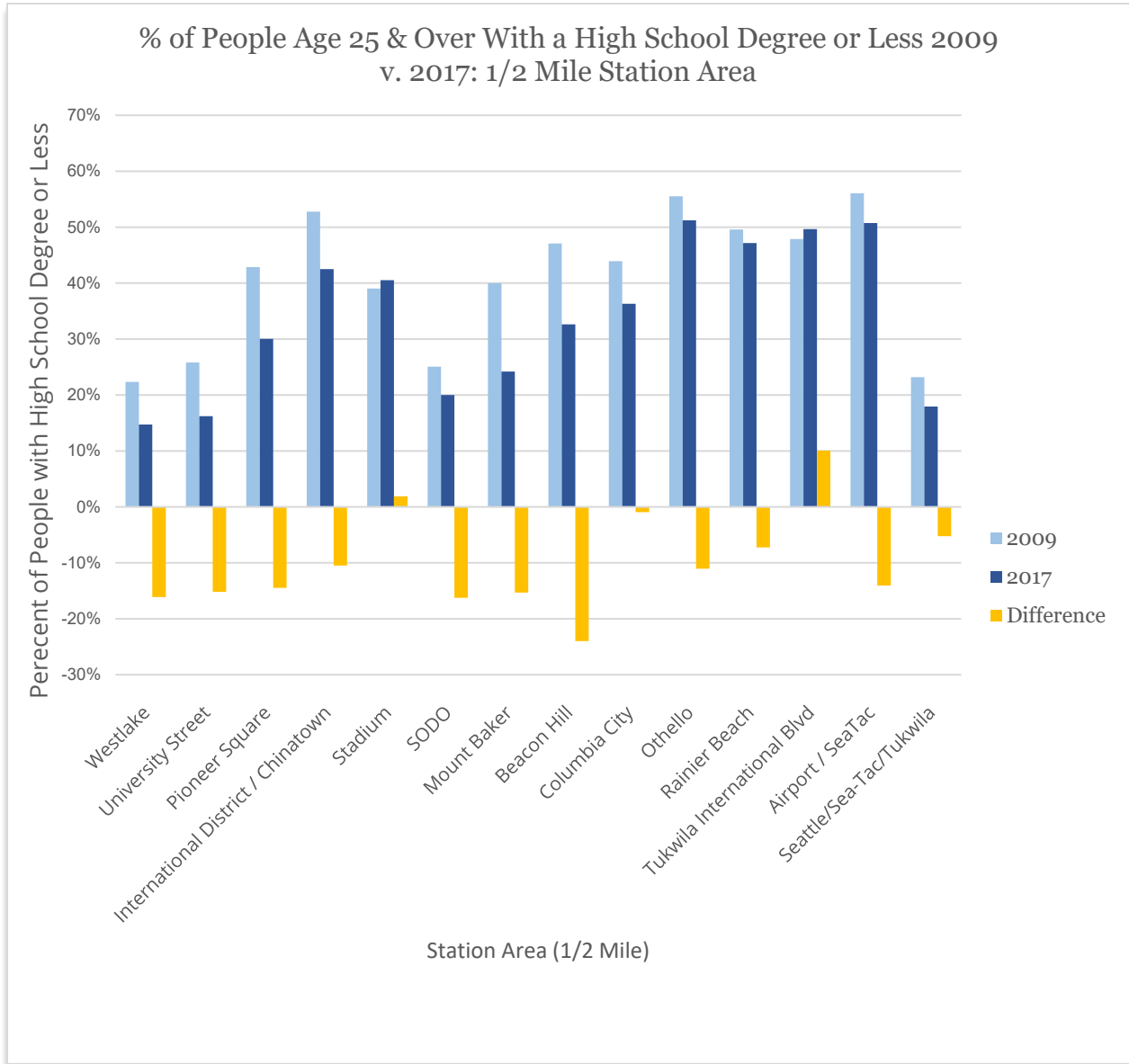


Figure 20: Percent of People Age 25 & Over with a High School Degree or Less 2009 v. 2017: 1/2 Mile Station Area

5.2 Bus Service Analysis

The main purpose of this analysis is to better understand how the quality of bus service near station areas in 2017 compares to 2009 before the stations were opened. Furthermore, this study seeks to understand these changes in terms of equity. Subsequently, there are several ways to present this matrix of variables. First, shown in Figure 21 and Figure 22 are the different levels of bus

service that different areas through Seattle have access to. One of the cursory observations that should be made from looking at this map is the high level of access the city enjoys during both time periods. Nearly all parts of the city are within a ¼ mile of bus service and much of that service is at least of Medium rank by this research's standards. Many of the black spots of the maps that represent areas that are not within a ¼ mile of bus service are parks, such as Discovery Park to the west and Magnuson Park to the east. Conversely, there are still areas that do not have service in far north Seattle as well as the southern neighborhoods of the city. These gaps in service shown in 2009 increase in geographic area in 2017.

At this point it is worthwhile to repeat that the quality of the service shown in these two figures as well as the ones to follow is relative to the service network of Seattle during each respective year. If quintiles were created from an aggregate of the two years, 2017 service would constitute the majority of the upper quintiles. Service hours and ridership in particular have increased significantly. Annual network-wide ridership average was about 700,000 boarding per route in 2017 and 334,000 in 2009. Similarly, the average number of service hours per route was 13,300 in 2009 and 15,500 in 2017.

Access to Bus Service by Quality: 2009

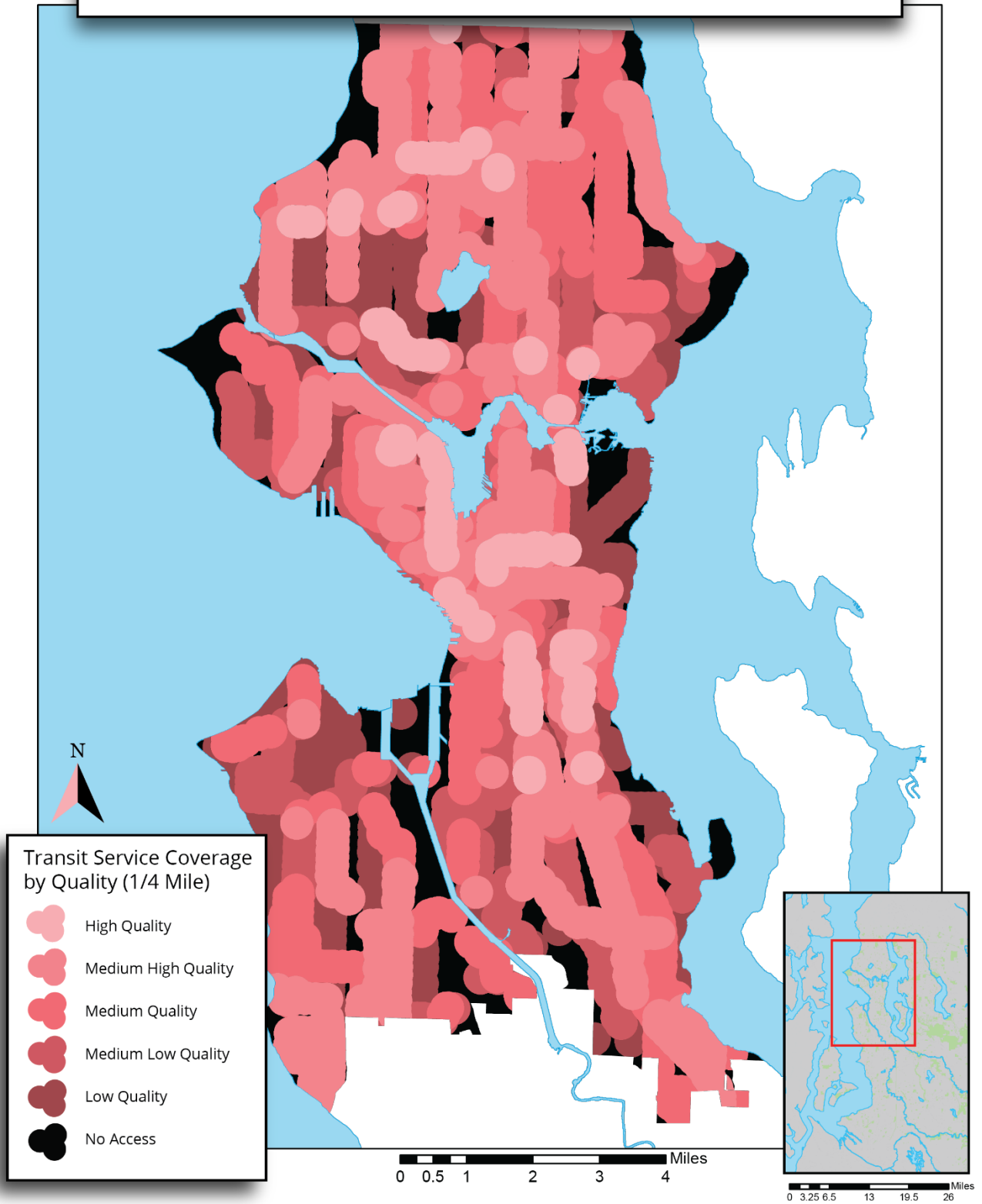


Figure 21: Access to Bus Service by Quality in Seattle: 2009

Access to Bus Service by Quality: 2017

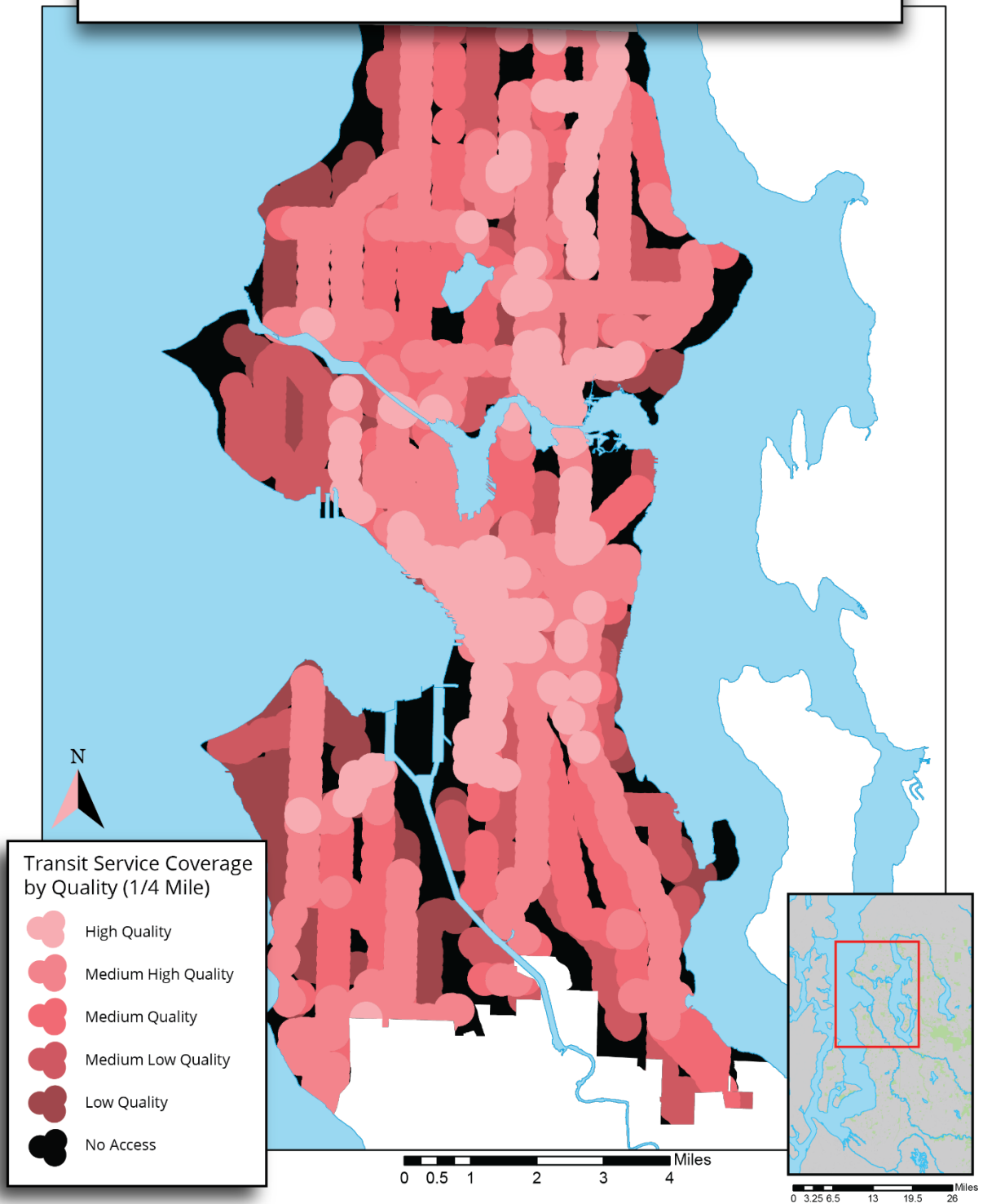


Figure 22: Access to Bus Service by Quality in Seattle: 2017

The following maps, Figure 23 and Figure 24, show the service within the station areas separate from the surrounding city. The most significant changes are: the quality of accessible stops in the downtown area increased and the gaps in transit service to the south of downtown increased. The quality of service in downtown in 2009 was high in the areas within a ¼ mile of where the Westlake, University Street and Pioneer Squares are now located. In 2017, nearly all of the ½ mile area of all downtown stations, as well as SODO and Stadium stations, is encapsulated in high quality service. The increases in no access to bus service are found in the area falling within both Mount Baker and Beacon Hill ½ mile station areas as well as the southern part of Rainier Beach.

Access to Bus Service by Quality within Seattle Link Light Rail Station Areas: 2009

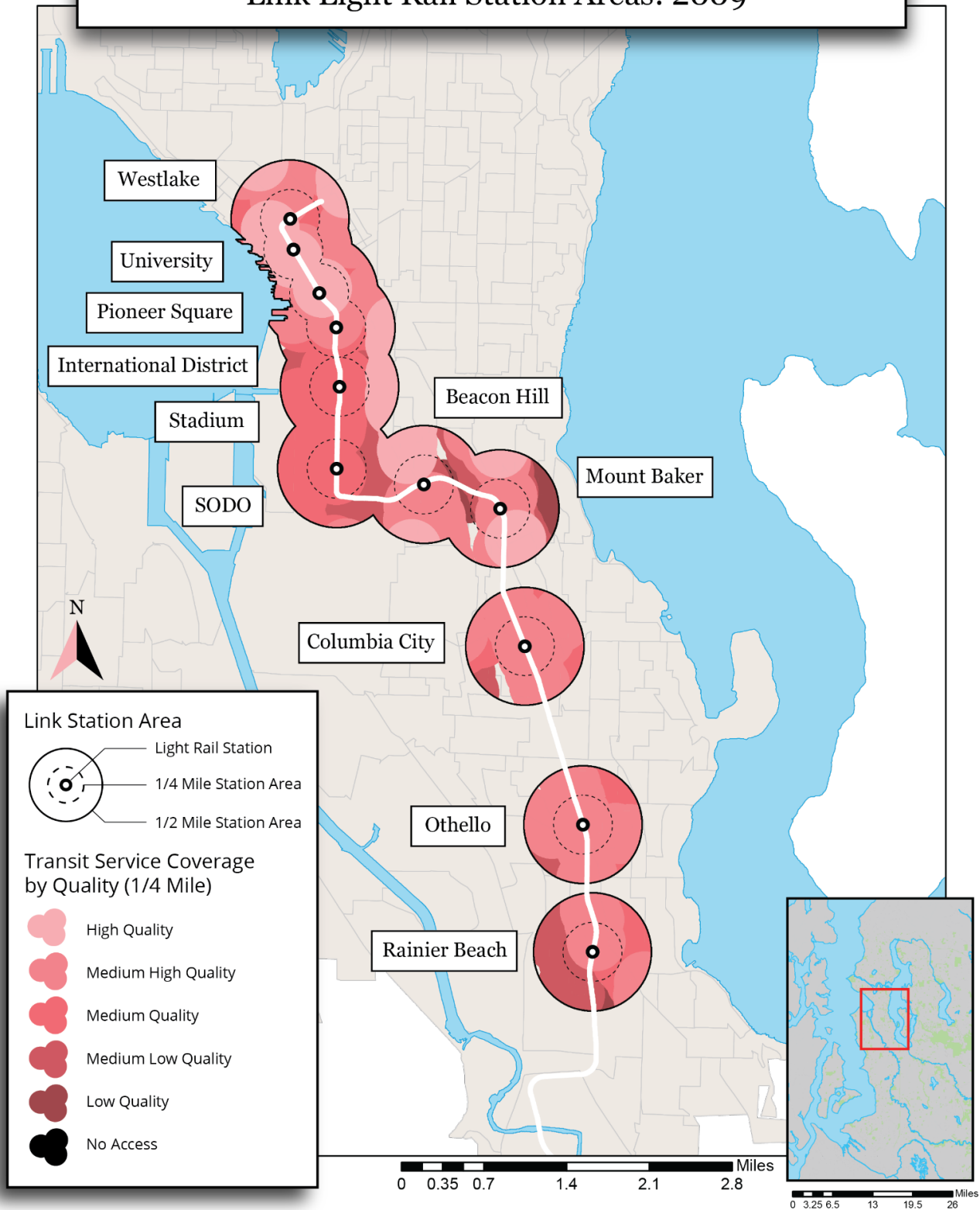


Figure 23: Access to Bus Service by Quality within Seattle Link Light Rail Station Areas: 2009

Access to Bus Service by Quality within Seattle Link Light Rail Station Areas: 2017

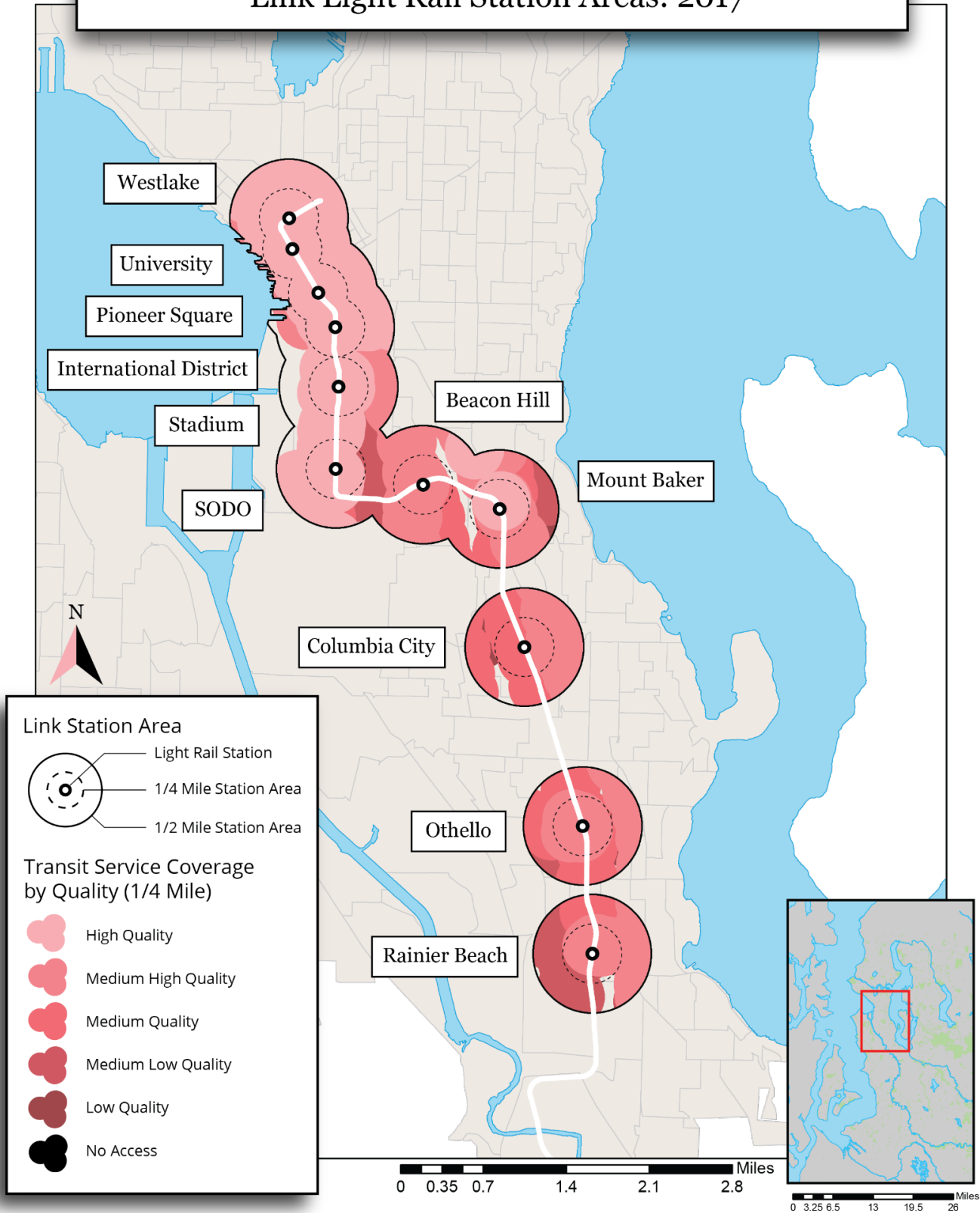


Figure 24: Access to Bus Service by Quality within Seattle Link Light Rail Station Areas: 2017

5.2.1 Bus Service Ranking

Shown below in Figure 25 and Figure 26, are the distributions of bus service coverage within each ½ mile station area in 2009 and 2017 for people living within a ¼ mile of a bus stop; these individuals will be considered as the population that has access to bus service. Between 2009 and 2017, nearly all of the people in the downtown stations had a shift in the relative ranking of their bus service from a mix of medium-high and high ranking stops to entirely high ranking stops. These changes also happened in the largely industrial areas of the SODO and Stadium station areas. Within the ½ mile station areas south of SODO there is a marked decrease in the ranking of bus service.

There was a decrease in the ranking of service of all South Seattle station areas from 2009 to 2017, with significant shifts from medium-high quality service to medium service. For example—in the ¼ mile Columbia City station area—83.3% of the people of color had access to Medium-High ranking bus service. In 2017, only 45% had access to Medium-High ranking bus service; this shift was made almost entirely towards Medium ranking service, where the majority of people of color (54.1%, up from 11.4%) now reside. This trend is found to be true, in varying degrees, at all ½ mile station areas in South Seattle.

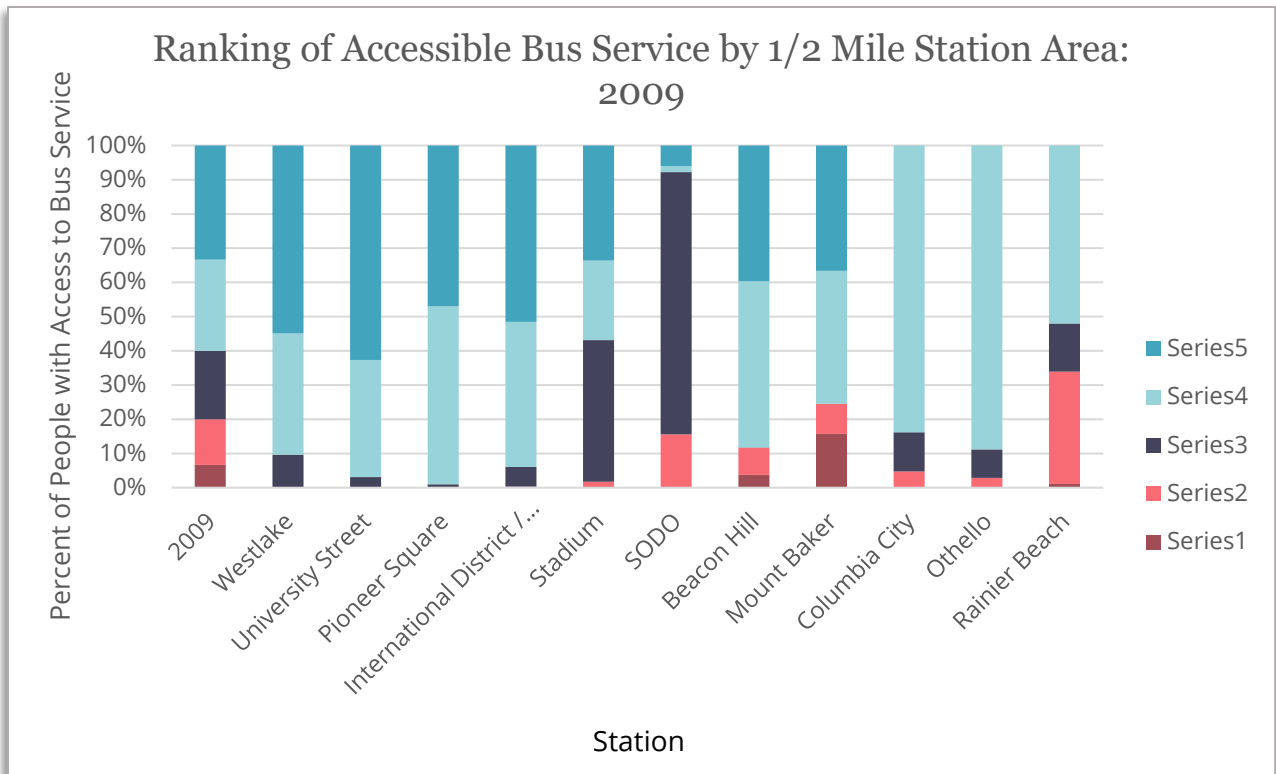


Figure 25: Quality of Accessible Bus Service by 1/2 Mile Station Area: 2009

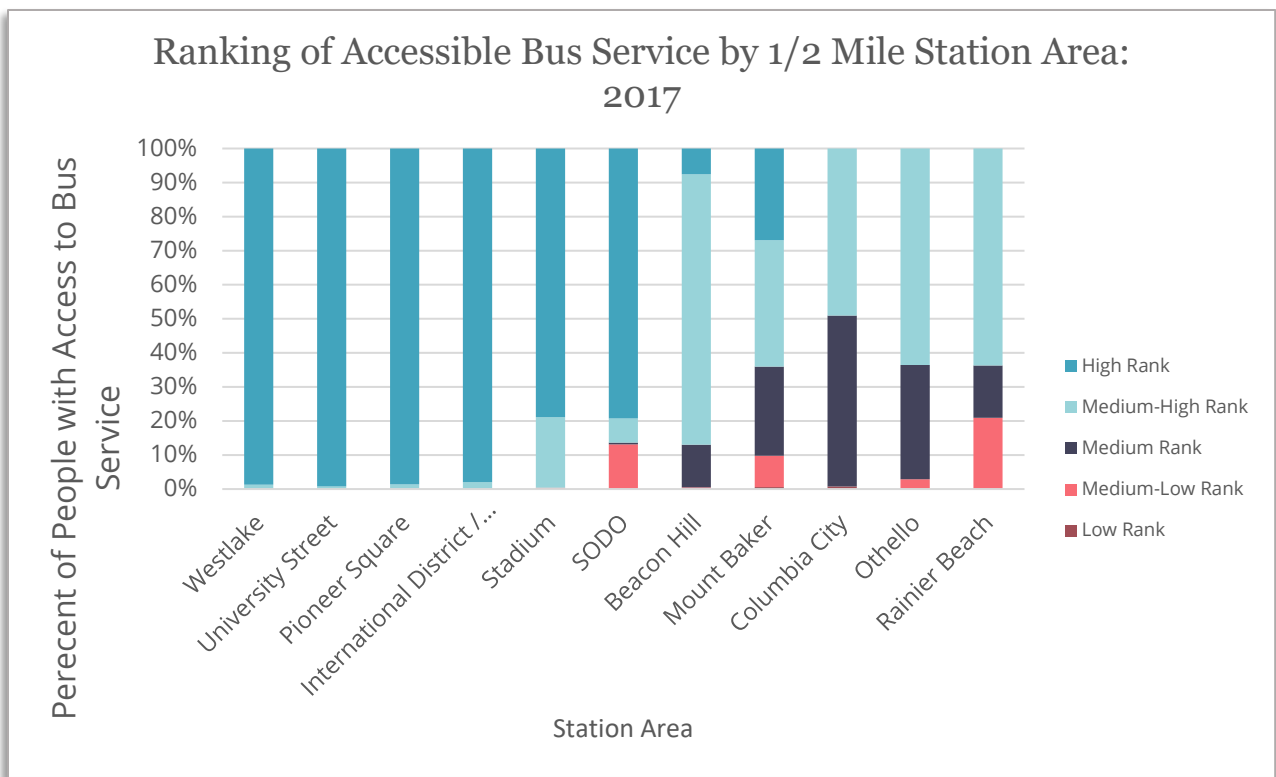


Figure 26: Quality of Accessible Bus Service by 1/2 Mile Station Area: 2017

The following charts, Figure 27 and Figure 28, show the distributions of bus service coverage within each ¼ mile station area in 2009 and 2017). Due to the relatively small area of analysis for these chart, many of the station areas are completely covered by one quality of service coverage. In the Westlake, University Street and Pioneer Square station areas, people of color have the same access to high quality transit in 2017 as they did in 2009. International District was the only station area where people had a more mixed quality coverage in 2009 (70% access to Medium-High). In 2017, nearly all people in this station area had access to high quality transit. SODO and Stadium station areas saw significant shifts from Medium quality to High quality. There were more nuanced changes in the southern Seattle station areas.

South Seattle station areas saw varied changes in terms of the quality of transit people have access to. Columbia City saw the largest decrease: 100% of people had access to Medium-High service in 2009 and 51.6% had the same access in 2017; the remaining 48.4% have access to Medium service in 2017. Conversely, Mount Baker saw the greatest increase in quality of accessible service: 33% of all individuals had access to high quality bus service in 2009 and 86% in 2017.

Overall, comparing the ½ to ¼ mile station areas, people in the latter have access to higher quality transit: nearly all people within the immediate ¼ mile area of Link stations have access to Medium-High or High quality bus service in 2009 and 2017 (except for SODO and Stadium in 2009). On the other hand, people had access to varying levels of service in 2009 and 2017 in the expanded ½ mile station areas.

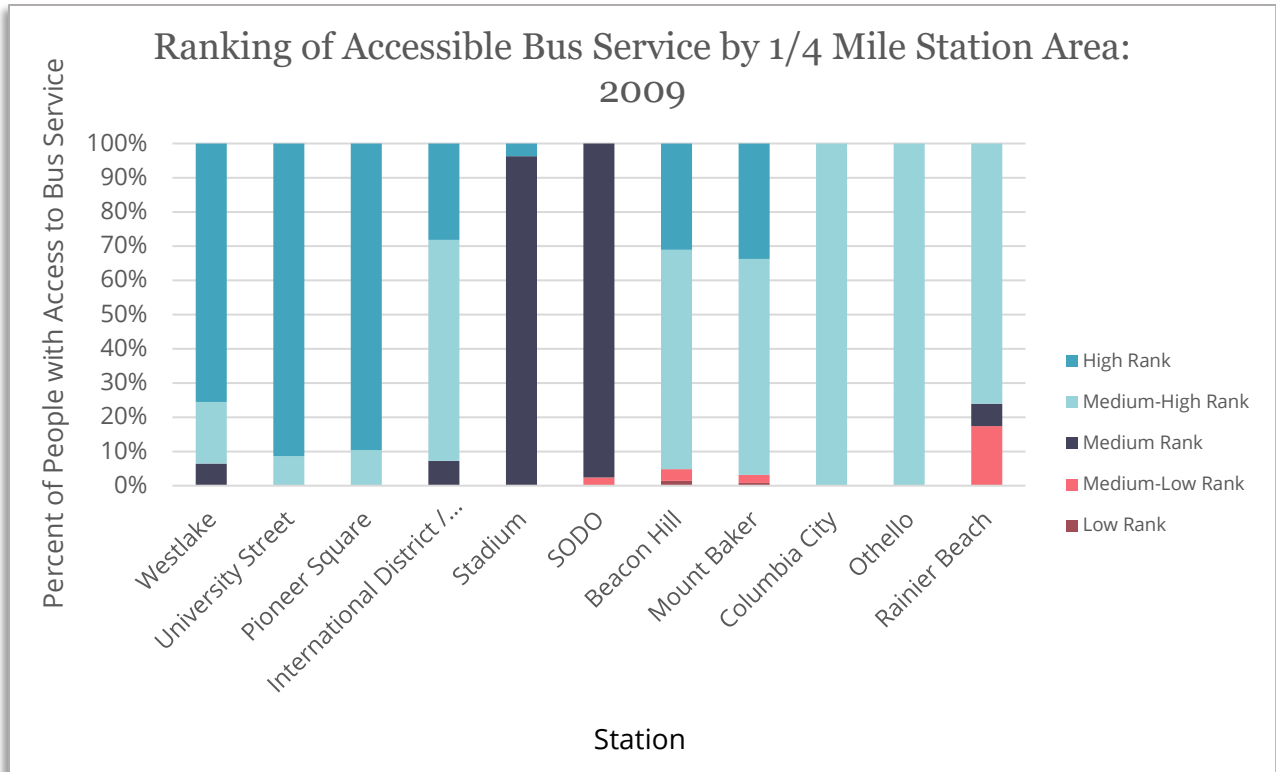


Figure 27: Ranking of Accessible Bus Service by 1/4 Mile Station Area: 2009

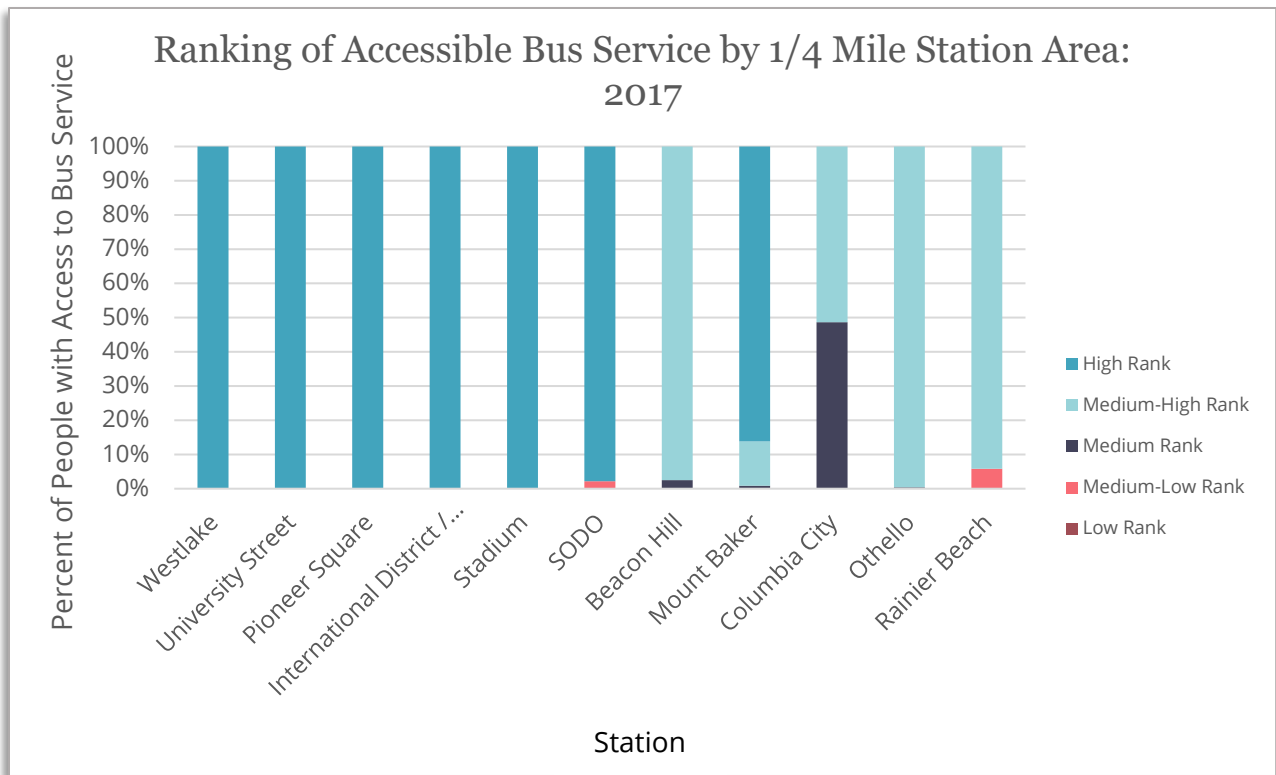


Figure 28: Ranking of Accessible Bus Service by 1/4 Mile Station Area: 2017

5.3 Land Use Analysis

5.3.1 Land Use Mix

The following charts, Figure 29: Land Use Mix by 1/4 Mile Station Area: 2009 and Figure 30, show the land use mix for the ¼ mile radius area of each Central Link station in 2009, then 2017. Note: Industrial was removed from both the ¼ mile and ½ mile analysis for Airport/SeaTac and Tukwila International Boulevard station areas because it severely skewed the charts Y axis values; the block group where the SeaTac Airport is located intersects both station areas and is incredibly large. From these charts you can see general patterns across the station areas; the area measured for these figures is based on the lot size of each use. Most of the office space is, unsurprisingly, located near the downtown core of Seattle, but there is also significant office space near the Airport/SeaTac station. Industrial is mainly found nearby SODO and Stadium stations—as well as Tukwila International Boulevard and Airport / SeaTac stations. Single Family Residential housing is found near South Seattle stations, with Beacon Hill boasting nearly 2.5 million square feet in both years. Multi-Family housing was found at most station areas at varying but significant levels. The greatest concentration of Multi-Family housing by lot size was in the Tukwila International Boulevard station area, with 1.6 million square feet in both years. Despite the greatest concentration of Multi-Family housing by lot size in Tukwila, downtown has greater numbers of units—this will be shown later in the housing section.

One of the most striking observations of the general station versus station comparisons of land use composition is the amount of vacant space that exists in many south Seattle station areas. In particular, Rainier Beach has the greatest amount of vacant land with over 2 million square feet. Also significant is the amount of retail by square feet that is found in the Mount Baker station area, with nearly 950,000 square feet in 2009 and 875,000 in 2017. The following chart, Figure 31, shows

the changes in total area by land use between 2009 and 2017. The changes shown below only reflect the parcel footprint, not square footage by floor.

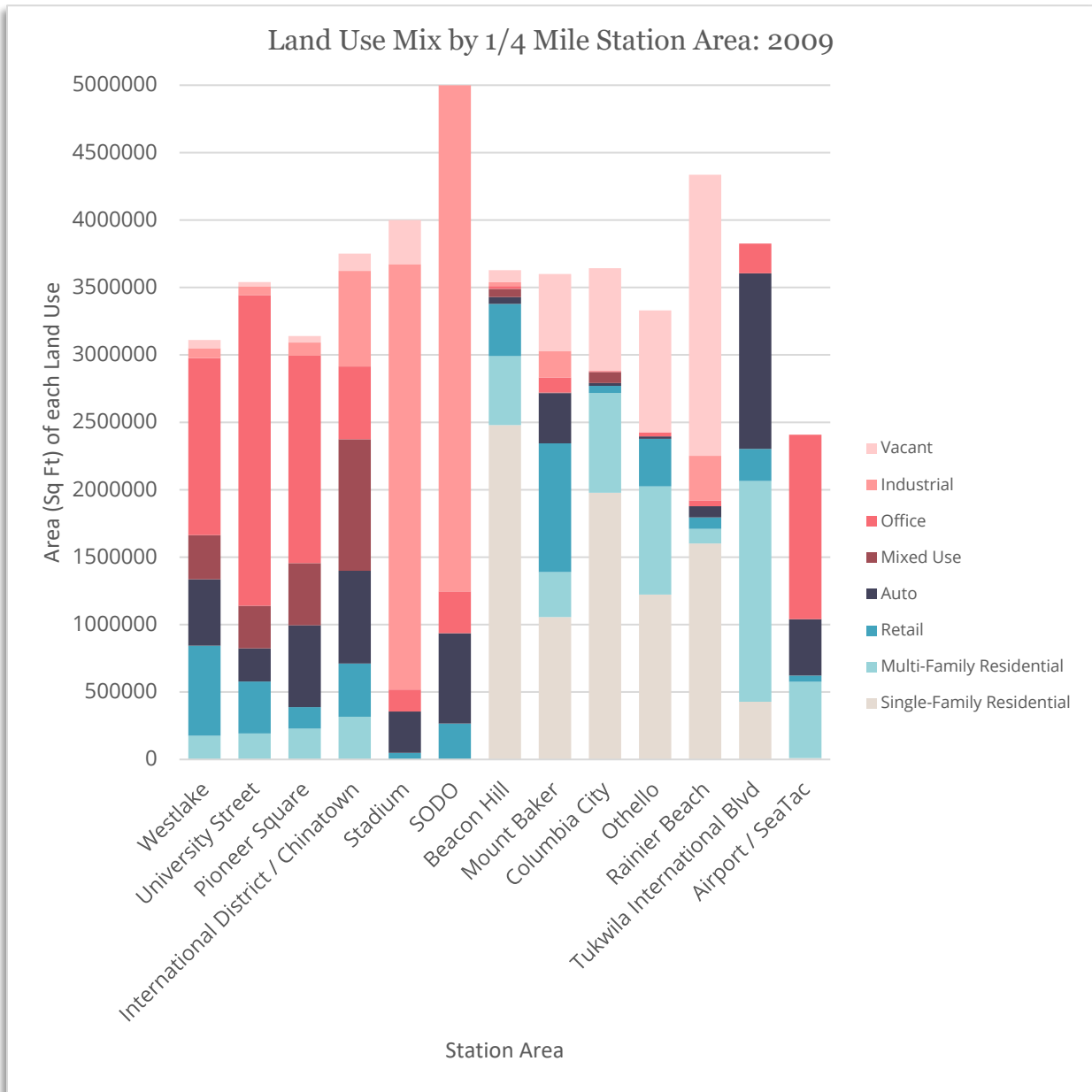


Figure 29: Land Use Mix by 1/4 Mile Station Area: 2009

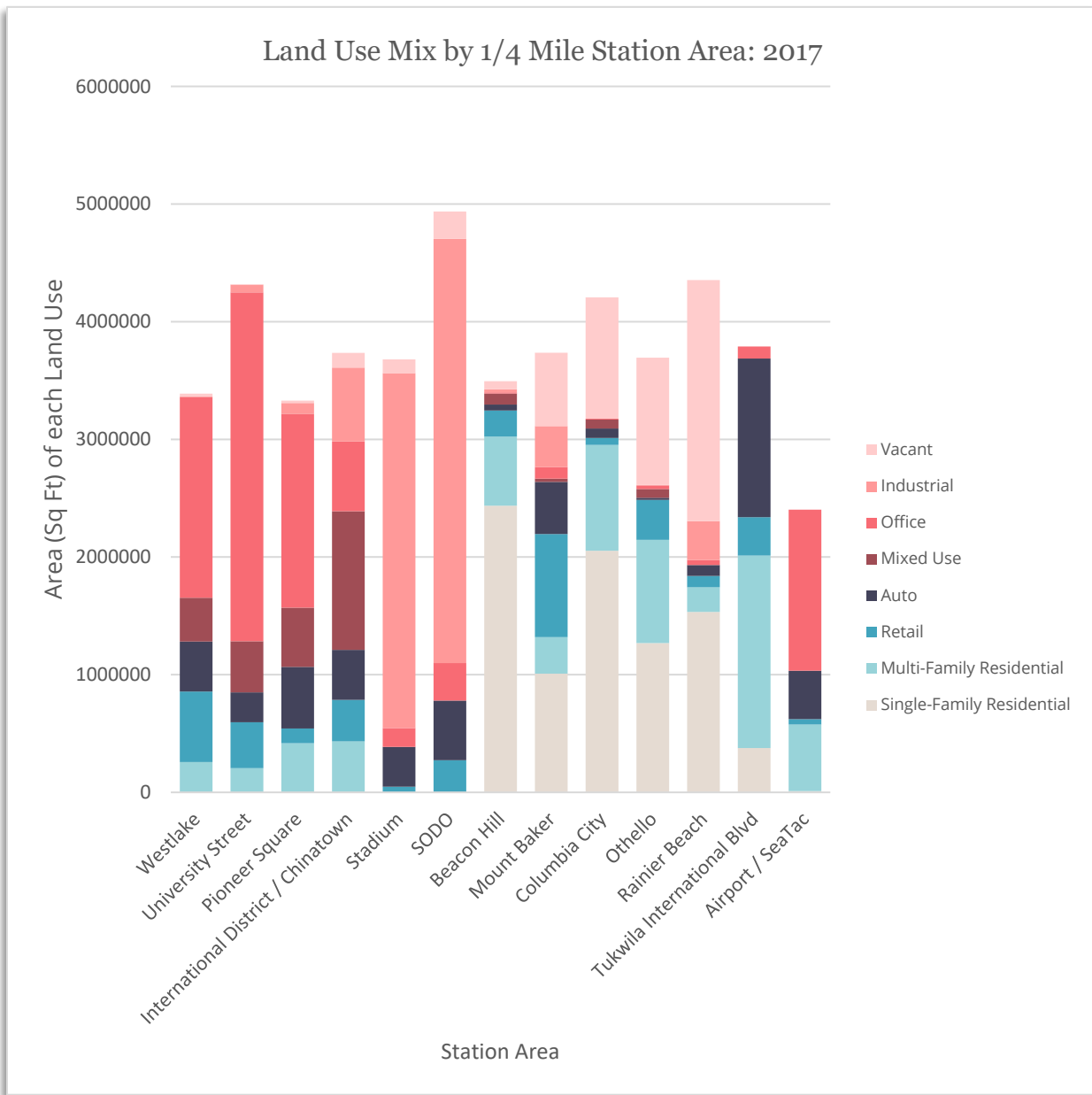


Figure 30: Land Use Mix by 1/4 Mile Station Area: 2017

For the downtown station areas, there was significant increases in office space near Westlake and University Street: over 650,000 additional square feet was dedicated for office uses within a ¼ mile of University Street station. In the Pioneer Square and International District /

Chinatown station (CID) areas there were significant increases of Multi-Family Residential, with 230,000 and 310,000 additional square feet respectively. In International District, there was also a decrease of over 250,000 square feet dedicated to auto-related uses (car repairs, parking, gas stations, etc). Westlake and Pioneer Square, to a lesser degree, also saw decreases in auto uses.

Within the South Seattle station areas, there were also considerable increases in square footage dedicated to multi-family residential. The greatest increase was found in the Columbia City station area with an additional 200,000 square feet dedicated to Multi-Family. Another significant change found in the South Seattle stations was the increase in vacant square footage in Rainier Beach and Columbia City, the latter increasing vacant land by over 250,000. Lastly, there were notable increases in Mixed-Use developments in International District, University Street and Othello station areas.

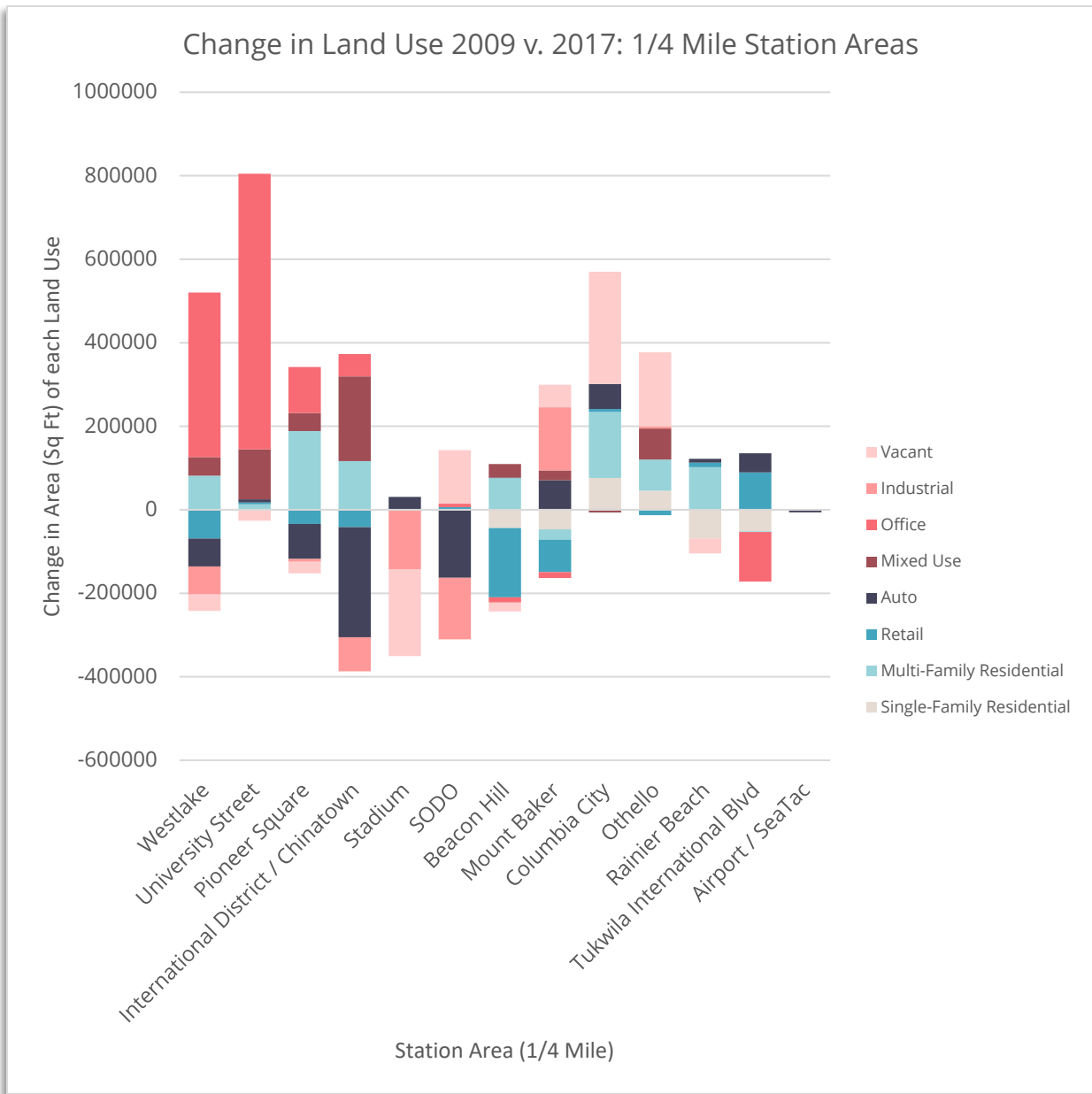


Figure 31: Change in Land Use 2009 v. 2017: 1/4 Mile Station Areas

5.3.2 Land Value and Improvement Value

The chart shown below, Figure 32, shows the ratio of changed value by station area from 2009 to 2017 as well as the city-wide change in appraised land value in Seattle. Other than the Tukwila International Boulevard and Airport/SeaTac areas, station areas saw an increase in appraised land value, many higher than the city-wide average. The most significant increases in total

appraised land value were in the Stadium, SODO and Mount Baker station areas, which all experienced a 100% increase. Notably, the only station within the Seattle city limits that increased at a rate lower than the city-wide average was Rainier Beach. Rainier Beach saw a 34% increase, 6% less than the average land value in the City of Seattle.

Comparing the ¼ mile to ½ mile study areas, there was generally a greater increase in land value within the ¼ mile area. Despite this, some stations, including SODO, Westlake and Pioneer Square had a slightly greater increase when the area was expanded to a ½ mile radius. The greatest difference of land values between the ¼ mile and 1/2 mile radiuses for station area was at Othello station. At Othello, the ¼ mile station area increased in total land value by 75%, when the analysis is expanded to ½ mile, it was only 41%, close to the city average 40%.

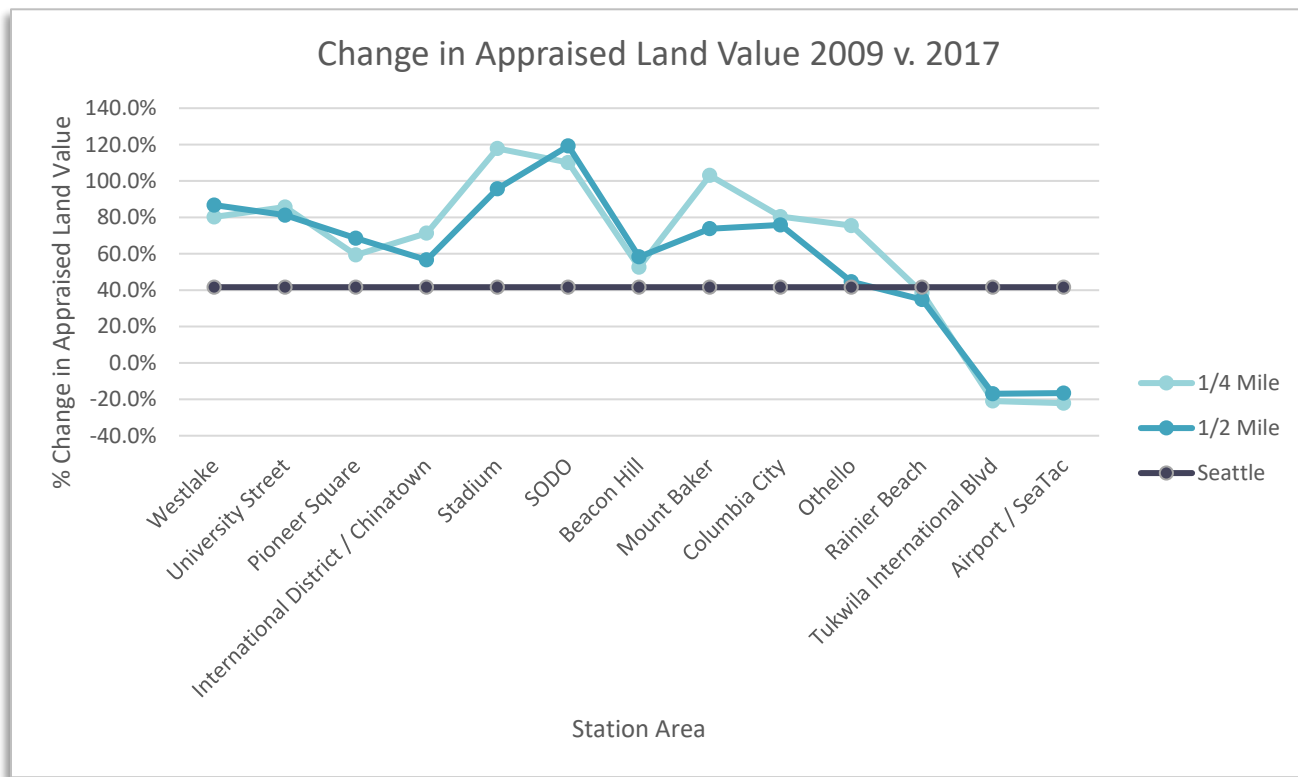


Figure 32: Change in Appraised Land Value 2009 v. 2017

Shown below in Figure 33 is the percent change in total value of all improvements within each station area from 2009 to 2017. Change in value is shown as a ratio of the original value in 2009 for each station area. The darkest line shows the total percent increase of all improvements in

the City of Seattle from 2009 to 2017—which is 64.8%. According to these results, the majority of the stations did not have their total improvements increase more than the city-wide average during the same period. The only station areas that increased in value at a significantly greater rate was the ½ mile Westlake area and the ¼ mile Columbia City and Othello areas. The aggregate improvement value increased by 102.9% for Columbia City and 101.3% for Othello. Three station areas did not experience an increase in their aggregated appraised improvement value: Stadium, SODO and Mount Baker. The latter station area even decreased by 6.5%.

When the ¼ mile and ½ mile station areas are compared to one another, there is no clear pattern that emerges. In some areas—Columbia City, Othello, and Chinatown / International District for example—the ¼ mile station area increased in value at a greater rate than the expanded ½ mile area. For other areas—like Mount Baker, Westlake and University Street—the greater ½ mile area outperformed its smaller counterpart. Lastly, many stations experienced the same, or nearly the same, rate of change in aggregate improvement value; this is true for the Rainier Beach, Airport / SeaTac, Tukwila International, and Beacon Hill station areas.

Similar to many aforementioned results, the results shown below are ratios based on the change from 2009 values of each station area. If the increases are judged based on raw dollar totals, downtown Seattle station areas (Westlake, University Street, Pioneer Square and CID) gained the most value in all categories by a significant margin. The area within a ½ mile radius of Westlake station increased in land value by 3.2 billion and in improvement value by 8.6 billion from 2009 to 2017. The tables with the raw totals in dollars that were used to calculate the above charts can be found in the

Appendi.

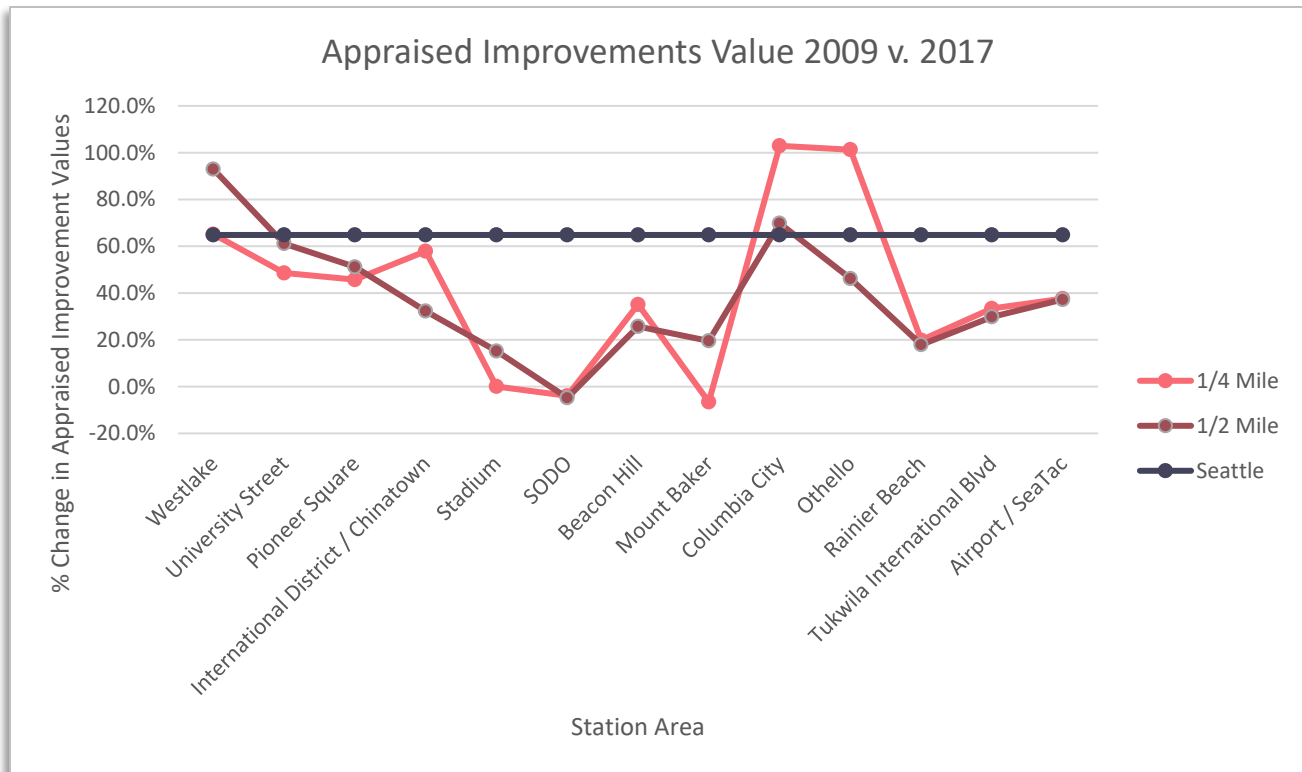


Figure 33: Appraised Improvements Value 2009 v. 2017

5.3.3 Housing

The following charts show the number of Multi-Family residential units by station area. Included in these counts are any residential properties that are not classified as single-family residential. In the first chart, Figure 34, the number of units are shown for each ¼ mile station area. For all station areas—except Rainier Beach, the number of units increased or stayed the same. Westlake station area increased the most, adding 1,424 additional units to their housing supply. The remaining downtown stations saw increases ranging from 500 to 720 additional units. South Seattle station areas also increased their multi-family supply considerably in Othello, Columbia City and Mount Baker. SODO, Stadium, Airport, and Tukwila all saw little to no change in their total supply of multi-family units within a ¼ mile of their light rail stations. Rainier Beach experienced a small decrease of 10 units.

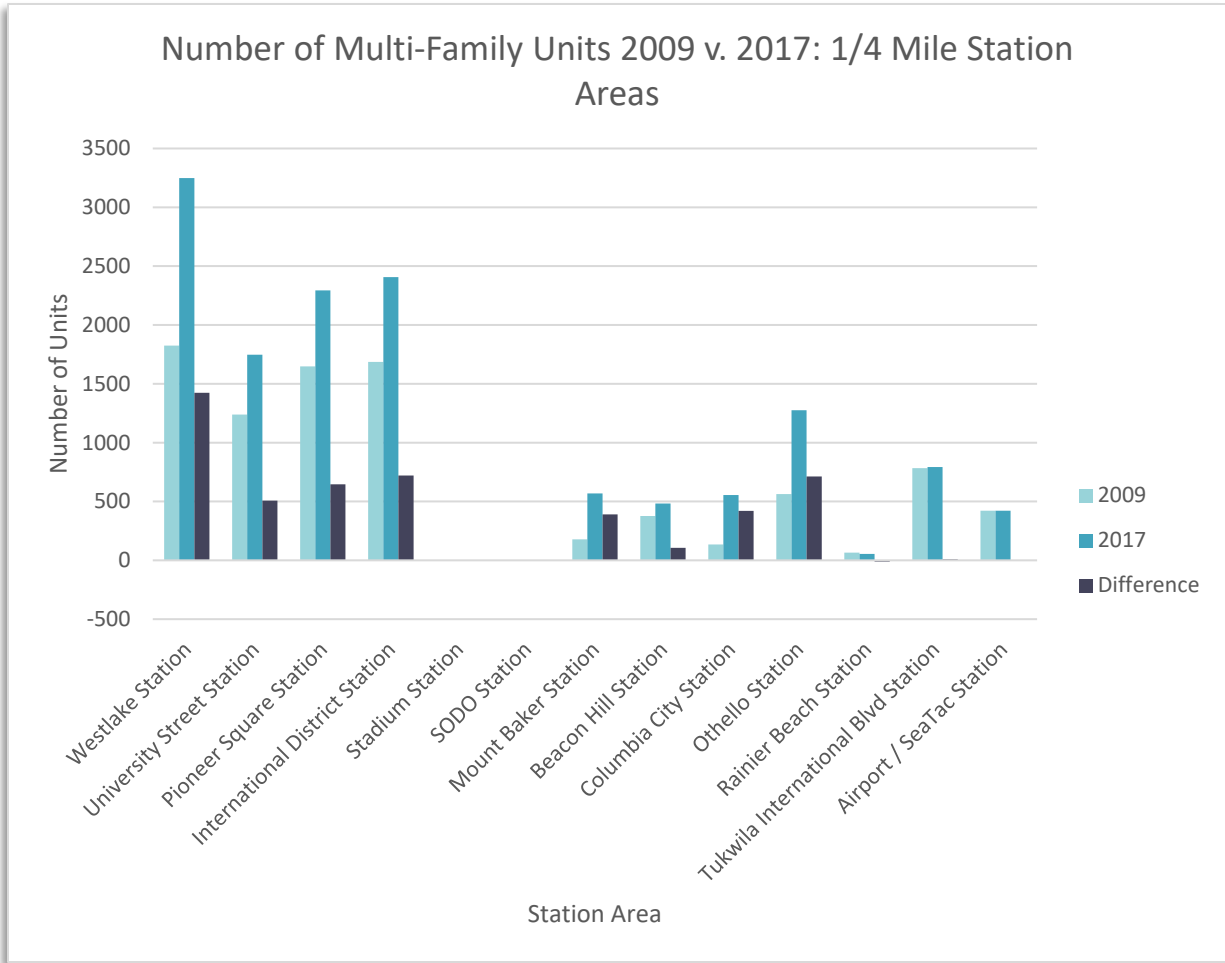


Figure 34: Number of Multi-Family Units 2009 v 2017: 1/4 Mile Station Areas

In the chart shown below, Figure 35, the total number of multi-family units are shown for each 1/2 mile station area. In this comparison, the increases in the downtown area, dwarf the remaining station areas. Westlake in particular shows an increase of 9,800 multi-family units between 2009 and 2017. The increase for the Westlake station 1/2 mile area is 6 time greater than that for the 1/4 mile analysis, suggesting that proximity did not play as important role for the development of multi-family residential units in the first two downtown station areas. Conversely, the results for 1/2 mile area around South Seattle stations had insignificant gains compared to their 1/4 mile counterparts, suggesting proximity to the station areas was significant to the development of multi-family units.

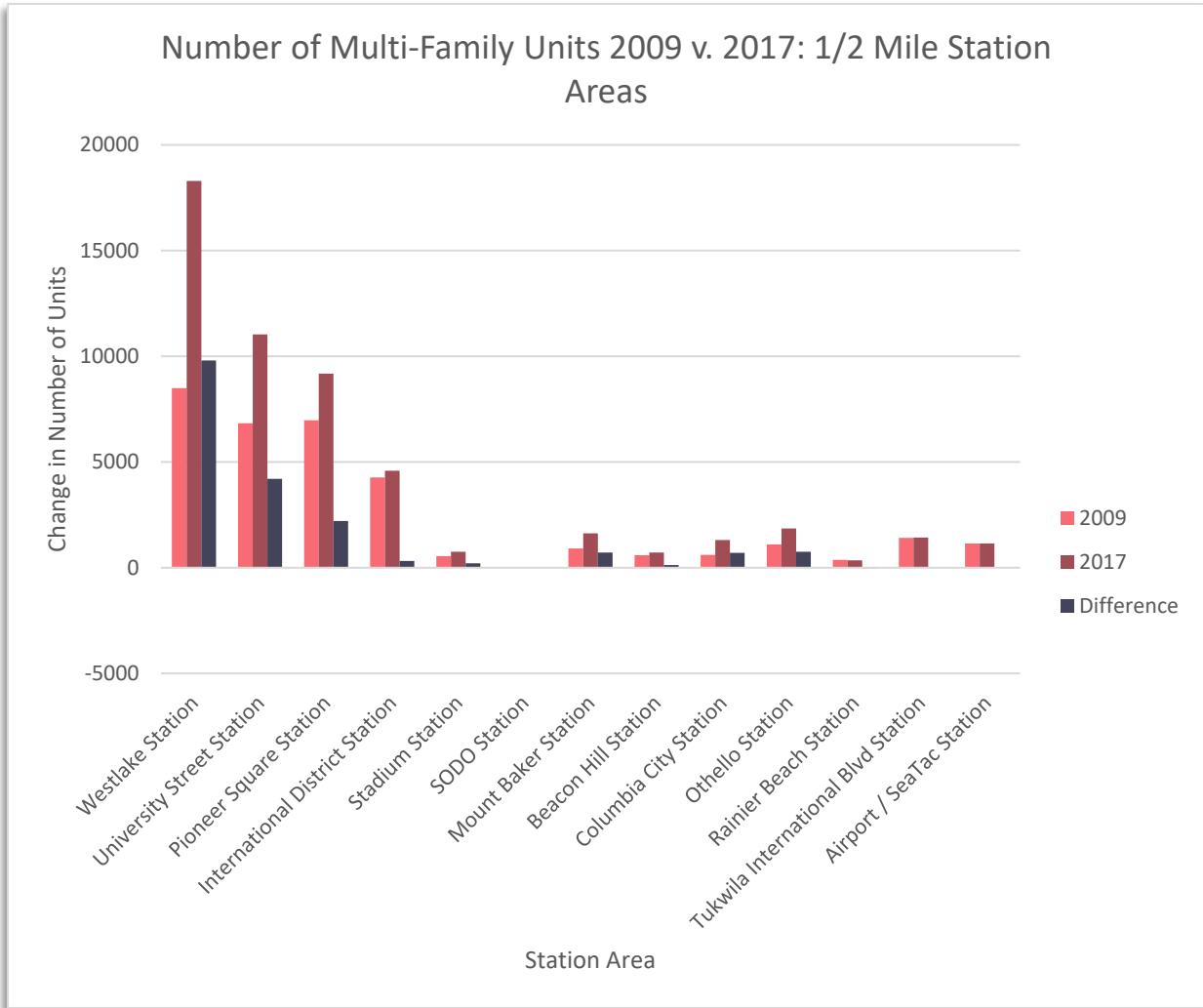


Figure 35: Number of Multi-Family Units 2009 v. 2017: 1/2 Mile Station Areas

The chart shown below, Figure 36, shows the percent change in number of multi-family units between 2009 and 2017 for each of the station areas. The ratio is based on the original amount in 2009 for that station area. Based on these proportional changes, Columbia City had the greatest change for the immediate station area (1/4 mile): over 300% additional multi-family units. The relationship to proximity to station area and development of units can be clearly observed in this chart; Mount Baker, Columbia City, International District and Othello station areas experienced a greater rate of increase in their 1/4 mile areas compared to their 1/2 mile counterparts. Conversely, Westlake and University Street experienced a greater rate of increase in their 1/2 mile station areas.

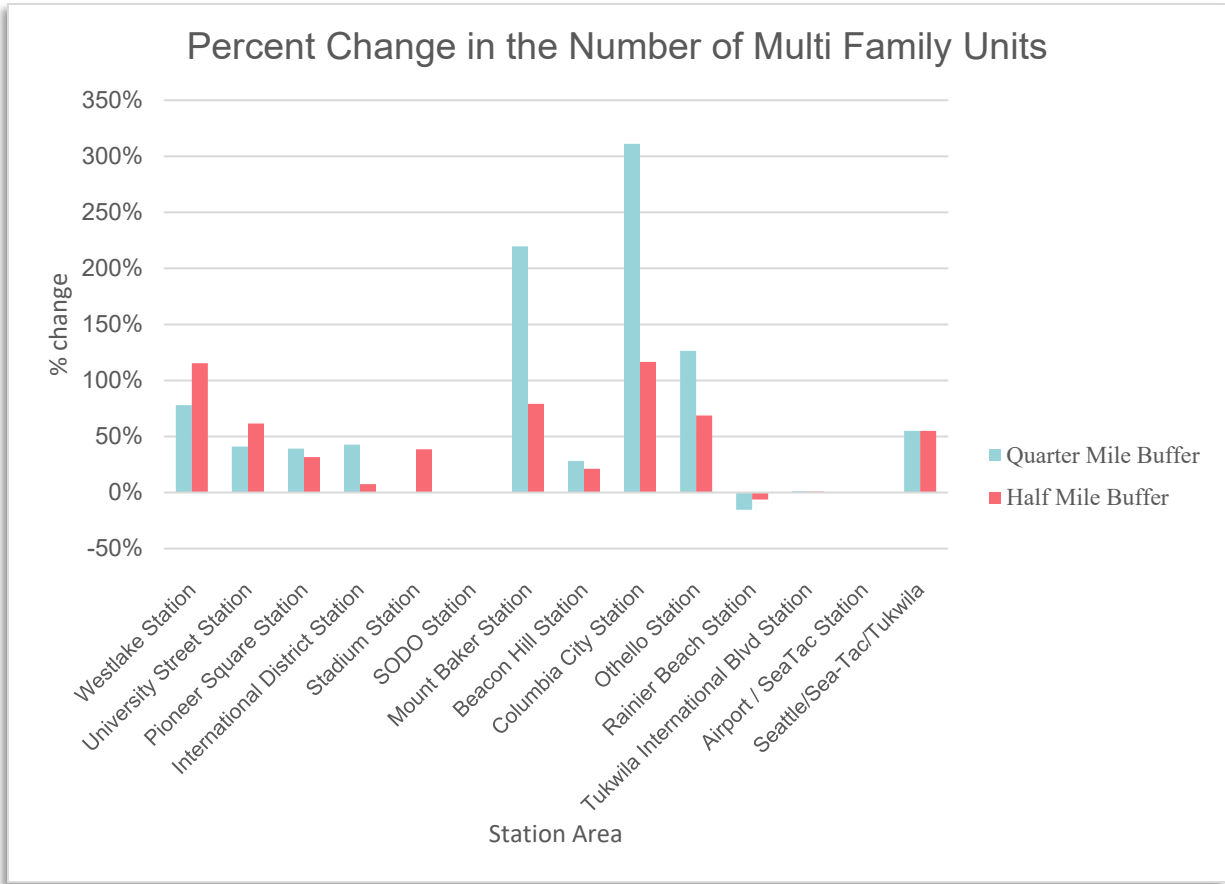


Figure 36: Percent Change in the Number of Multi-Family Units

6.0 Findings

6.1 Demographics

The purpose of the demographic analysis was to better understand how the communities nearby Central Link light rail stations have evolved in the years following the opening of service. Each area experienced nuanced changes that are unique to their area—this information is communicated in the results section through charts, tables and written interpretations of the

analysis. Despite this, there are trends station areas experienced based on the geographic groupings discussed in the beginning of this research and shown in Table 1: Station Groupings.

The distribution of negative inequitable outcomes are primarily found in International District and South Seattle station areas. These are areas in 2009 that boasted high populations of people of color, lower education and lower Gini coefficients. After the introduction of Central Link Light Rail, these areas shifted more towards being whiter, more highly educated and with greater inequitable income distributions than the other station areas along the alignment as well as the aggregate Seattle/Tukwila/SeaTac area. These findings suggest that there is a relationship between decreased representation of vulnerable communities within the International District and South Seattle Station Areas of Central Link Light Rail. For many of the aforementioned trends, dilution of representation is the assigned term because all station areas experienced growth in total population—including people of color and people with a high school degree or less.

Contrary to the above trend, there are some station areas that experienced a net loss individuals from the targeted populations; this can be translated more directly into displacement. Beacon Hill is a notable station area that lost people of color and individuals over the age of 25 with a high school degree or less between 2009 and 2017. This is poor outcome in terms of extending equity and has important implications for the distribution of bus service and economic changes to Beacon Hill's community. Even if laudable intentions are behind planning for this station area, any forecasted benefits for the existing community fail to serve them. This trend is more pronounced for education demographics. Several station areas experienced displacement of individuals over the age of 25 who had completed a high school degree or less, including: Downtown Stations, Beacon Hill and Mount Baker. This group experienced the greatest displacement of all tested populations. Subsequently, this suggests that they suffered the most from the implementation of Central Link.

Despite the aforementioned trend towards inequitable outcomes in South Seattle stations, especially compared to Downtown stations, the relationship is the inverse for low-income households. Downtown station areas all experienced a loss of households with an annual median household income of \$25,000 or less. Conversely, Columbia City, Othello and Rainier Beach areas gained households in this income bracket. This suggests that there is a relationship between the implementation of light rail and displacement of low-income families in Downtown.

6.2 Bus Service

The bus service analysis was aimed at understanding how bus service is prioritized differently after the introduction of Central Link. The conventional assumption would be that King County Metro shifted service away from areas now served by light rail. This runs counter to the Rawlsian framework that directs benefits to be disproportionately distributed to disadvantaged populations. Applied to this dynamic, the distribution of bus service should continue to prioritize disadvantaged communities. Under this framework and based on the results of the analysis, the shift in prioritization can be argued to be inequitable.

Prioritization of service decreased in many South Seattle station areas and increased for Downtown and Industrial station areas. This is an inequitable shift under Rawlsian principles, especially considering the concentration of disadvantaged populations in South Seattle station areas. The distribution of quality of bus service exists in tandem with light rail service, but it is not equivalent in quality or typology of mobility. Light rail is not a sufficient substitute for bus service due to the flexibility, affordability and range of the latter. The issue of shifting priorities away from South Seattle stations is further compounded by the relatively higher concentrations of target populations. Despite this trend in de-prioritization of South Seattle station area residents, it is

important to reiterate that—by the metrics of this research—transit service has increased substantially for everyone between 2009 and 2017.

6.3 Land Use Changes

For the purposes of this study, land use, land and improvement value and multi-family units were used as proxies for economic development. The purpose of utilizing these factors was to understand the context of the areas, the typology of development, where wealth is generated through increased land value as well as the levels of investment found in each station area following the implementation of Central Link.

The findings of this research found that there is a relationship to the proximity to station areas and increased land value. Nearly all of the station areas increased in land value at a greater rate than the City of Seattle. Furthermore, the ¼ mile areas largely experienced increased rates higher than that of their ½ mile counterparts. The exception to this trend is found at the Tukwila International Boulevard and Airport / SeaTac station areas, where land value decreased by 15%-20%. This is an incredibly inequitable outcome, especially considering those areas have some of the highest rates of people of color, people without a college education and greater proportions of low-income households. This issue is further compounded by the regional aspect of Sound Transit service. The establishment of inter-city transportation infrastructure is predicated on the assumption that the municipalities involved will all benefit from its construction. Although there are many factors to consider when weighing the benefits of light rail, land valuation is a significant economic metric. Another significant factor to consider is the level of investment that follows light rail's implementation.

Based on the findings from the land improvement analysis, the proportional rate of increased value was found in Columbia City, Othello and Westlake station areas. Surprisingly, the

appraised improvement values for the remaining station areas increased at a lower rate than that of the City of Seattle. For some station areas, Mount Baker, SODO and Stadium, the aggregate improvement values decreased between 2009 and 2017. This is an interesting trend that deserves additional research to better understand. The implications of this finding is crucial to understanding the development value that light rail infrastructure brings to an area. There is a clear inequity of the findings of changing improvement values across station areas. Furthermore, investment into these communities is markedly different.

The increased vacancy in a number of South Seattle station areas including Rainier Beach Othello and Mount Baker is a particularly problematic trend that runs counter to the idea that light rail is a strict progenitor of development. This phenomenon deserves further study to fully understand and potentially mitigate for communities nearby future Link stations.

7.0 Directions for Future Research

This research is largely aimed at uncovering quantifiable measures of inequity in the communities directly adjacent to Central Link stations. From the findings, it is clear that there is a variety of demographic, economic and service-based changes that have affected station areas differently. However, the research does not delve deeper into the potential individual causes for many of these changes. It would be particularly difficult (and ill-advised) to assign causation to trends that need additional investigation to vet. Future research should aim to further investigate individual strains of changes to station areas that have been uncovered in this research. For example, a handful station areas had increases in the area of vacant land in 2017 than 2009. These trends are not uniform across geographic areas and not readily understood. This is a limitation that permeates this paper and further investigation goes beyond the scope of this work.

8.0 Conclusions

Central Link is a major investment of public dollars that was constructed with the purpose of Promoting better transit service and spurring economic development. The locations Sound Transit chose to site stations were disproportionately people of color, low-income and with less education than the surrounding city. From Rawlsian perspective, the decision to develop significant transportation infrastructure in communities that have the greatest disadvantage is a strategy that fosters greater equity outcomes. Despite this, it was still important to audit the forecasted benefits to these communities and compare them to the city as well as one another.

Many of the outcomes from this analysis showed that station areas fared better than the surrounding city of Seattle. For example, the appraised land value increased significantly around station areas and at a higher rate than that of Seattle. There was also greater retention of low-income households in station areas and greater development of multi-family residential housing. In terms of the priority of bus service, the station areas maintained, on average, a higher ranking of bus service before and after the opening of light rail than most other areas throughout the city. Despite these positive changes, there were some issues that affected station area communities to a greater degree than the city as a whole.

Station areas saw decreases in proportionate levels of people of color (POC), individuals without college experience as well lower improvement values. In terms of demographics, the city on average saw an increase in the ratio of POC. Despite this, many station areas saw a decrease in the representation of these groups. Education was more severe, with significant decreases of individuals with a high school degree or less that outpaced Seattle's own decreases. Land improvement values in the station areas also lagged behind Seattle's—suggesting that station areas are underdeveloped.

This suggestion is supported by the high levels of vacancies in some South Seattle station areas.

Related to this, there was disparities across the station areas in the benefits received.

Although station areas in general saw benefits that outpaced city-wide trends, the distribution of these benefits were not equal across station areas; Downtown station areas saw the lion's share of benefits. Land and Improvement values, greater income equality, fewer vacancies and greater retention of low income and people of color all characterize the Downtown stations in comparison to the South Seattle stations. These differences are even more pronounced when the raw counts are observed instead of ratios tied to each station area. Many of these differences are tied to the context of Downtown station areas that have markedly more intense land uses.

Ultimately, the communities near Central Link stations enjoyed disproportionate benefits compared to the entirety of the City of Seattle. Despite this, these changes were experienced differently across geographic segments along Link's alignment. It is arguable whether or not greater equity was achieved through Central Link's implementation as well as what scale the benefits should be examined at. The position of this research is that the communities near each station area should be considered as the primary unit of equity evaluation. It is likely that these differences in outcomes are linked to the disparate contexts of each station area. When planning for future Sound Transit light rail stations, the context of each station areas should be brought to the forefront of any discussion concerning equity. Future light rail stations should be evaluated based on their individual characteristics that will undoubtedly play a role in the change that light rail will foster.

9.0 Appendix

9.1 Lorenz Curves by Station Area

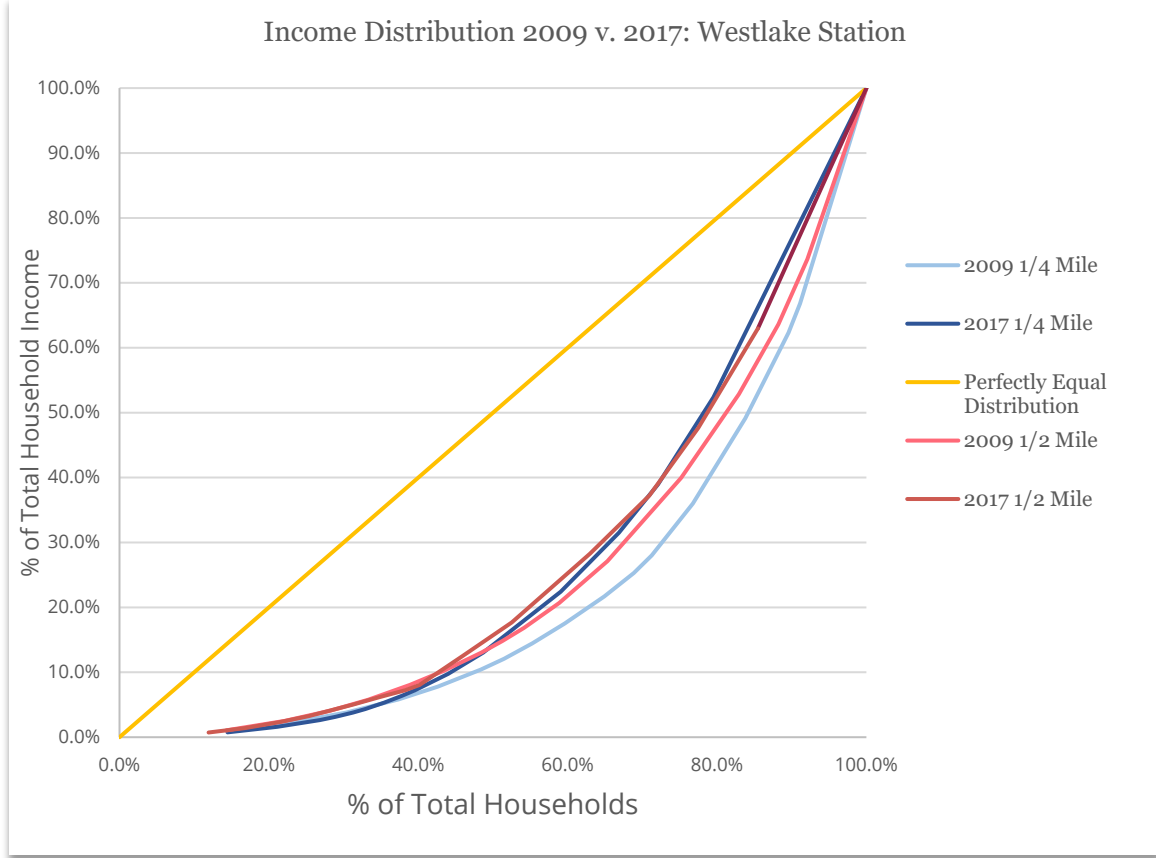


Figure 37: Income Distribution 2009 v. 2017: Westlake Station

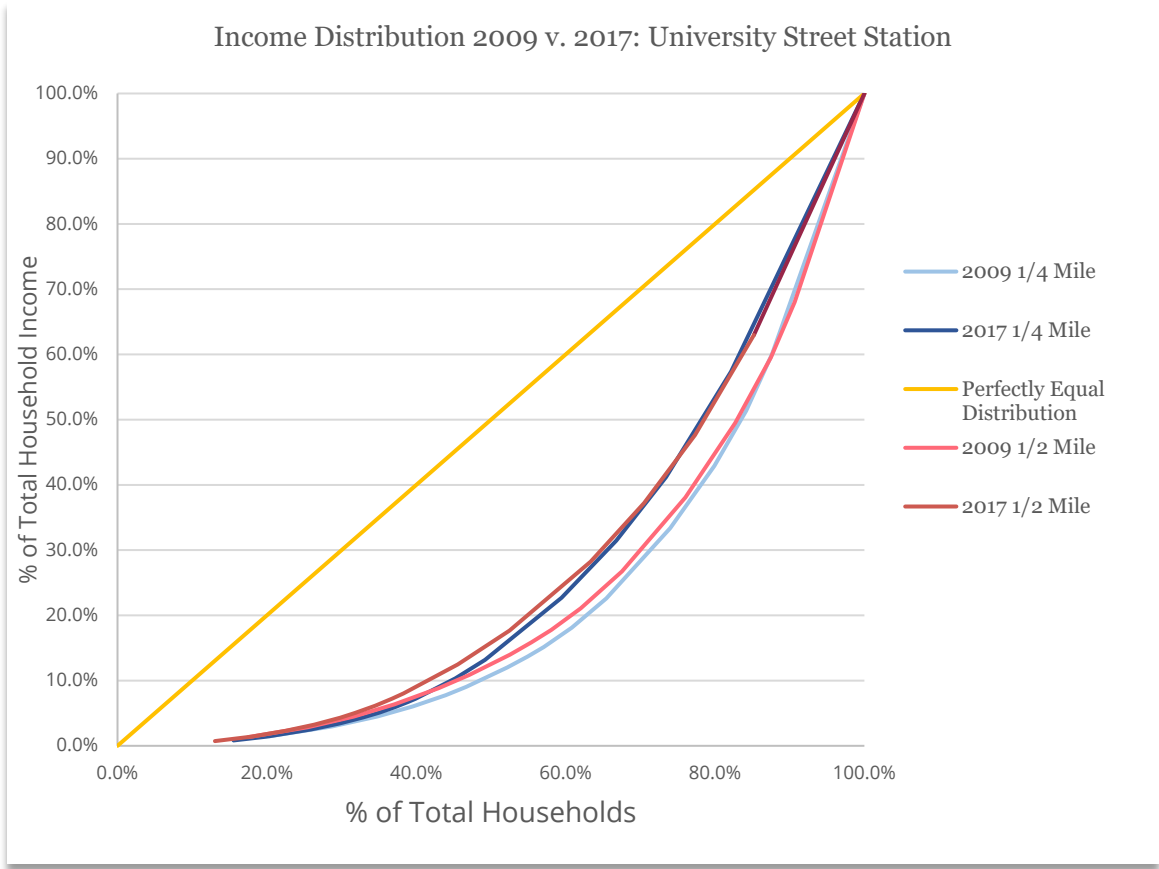


Figure 38: Income Distribution 2009 v. 2017: University Street Station

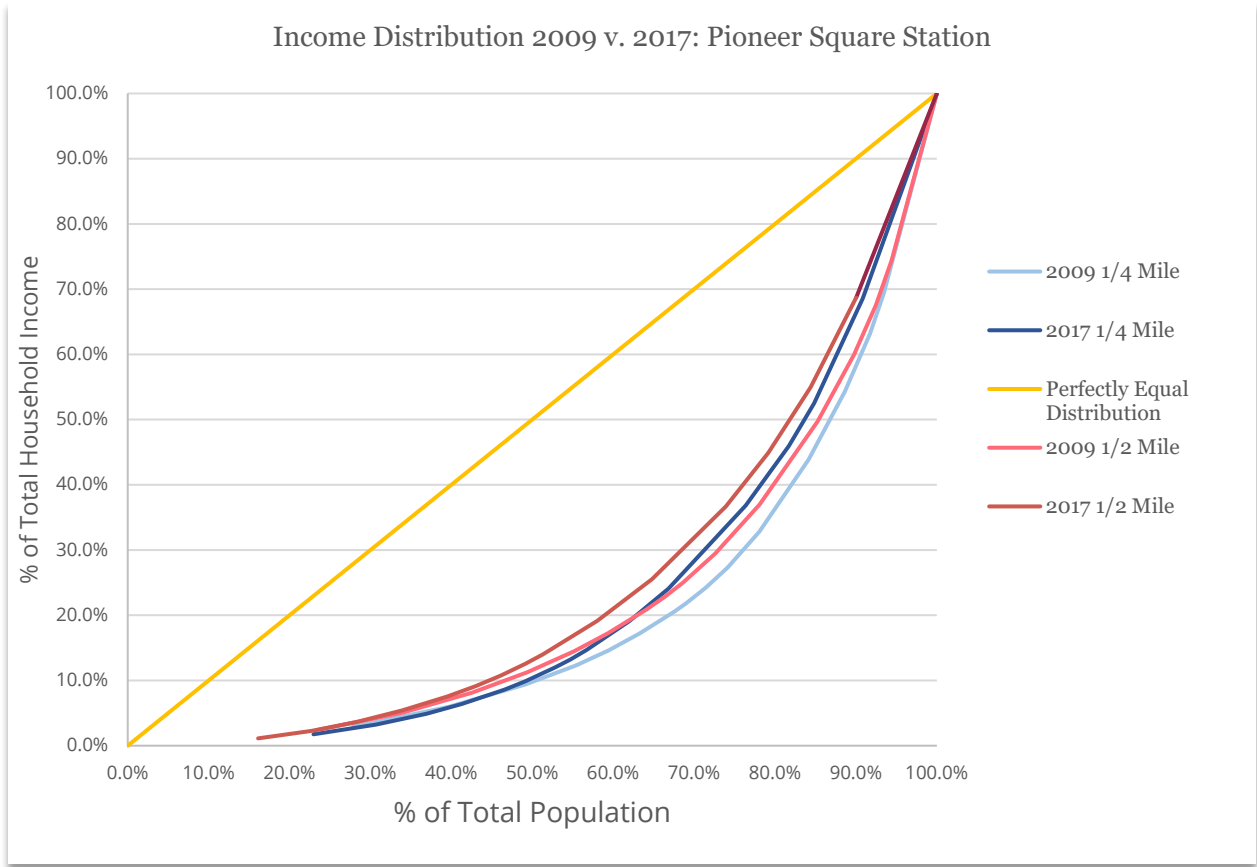


Figure 39: Income Distribution 2009 v. 2017: Pioneer Square

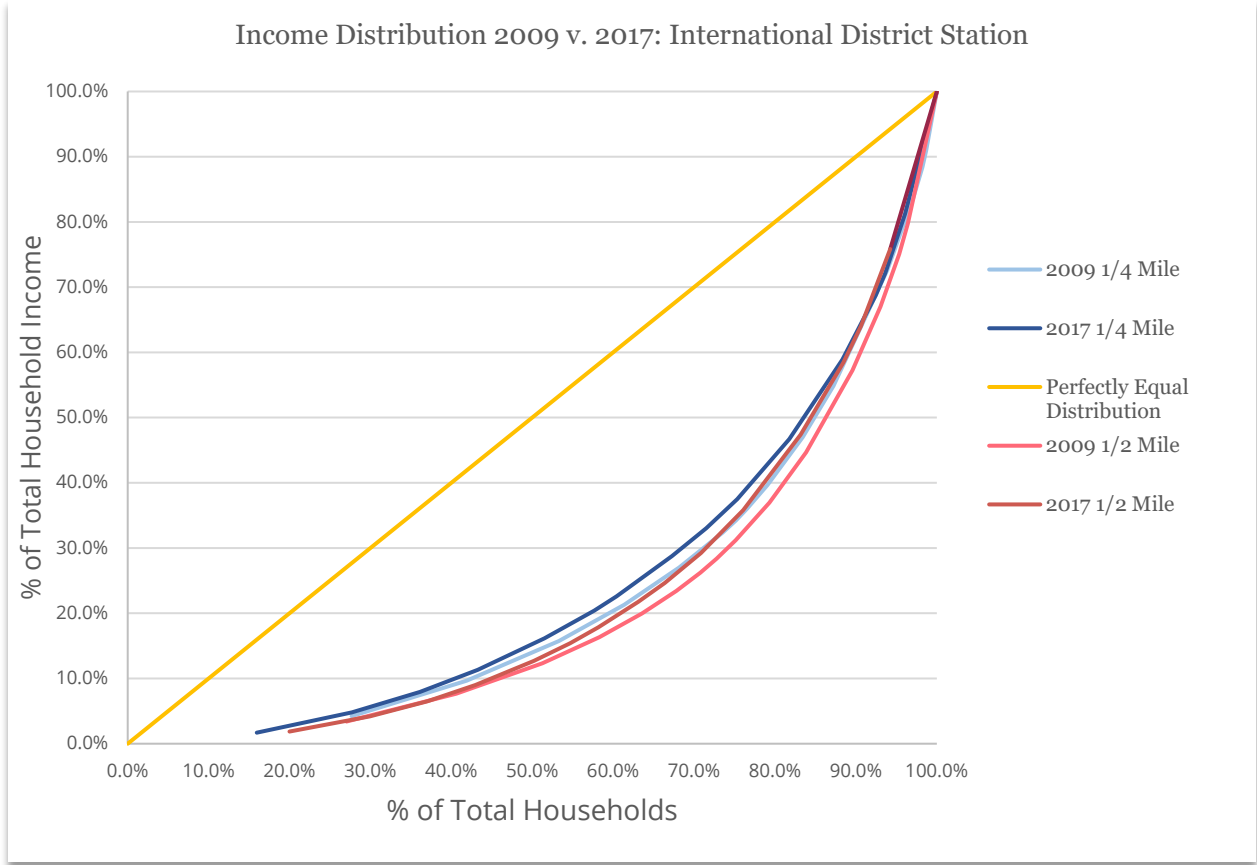


Figure 40: Income Distribution 2009 v. 2017: International District Station

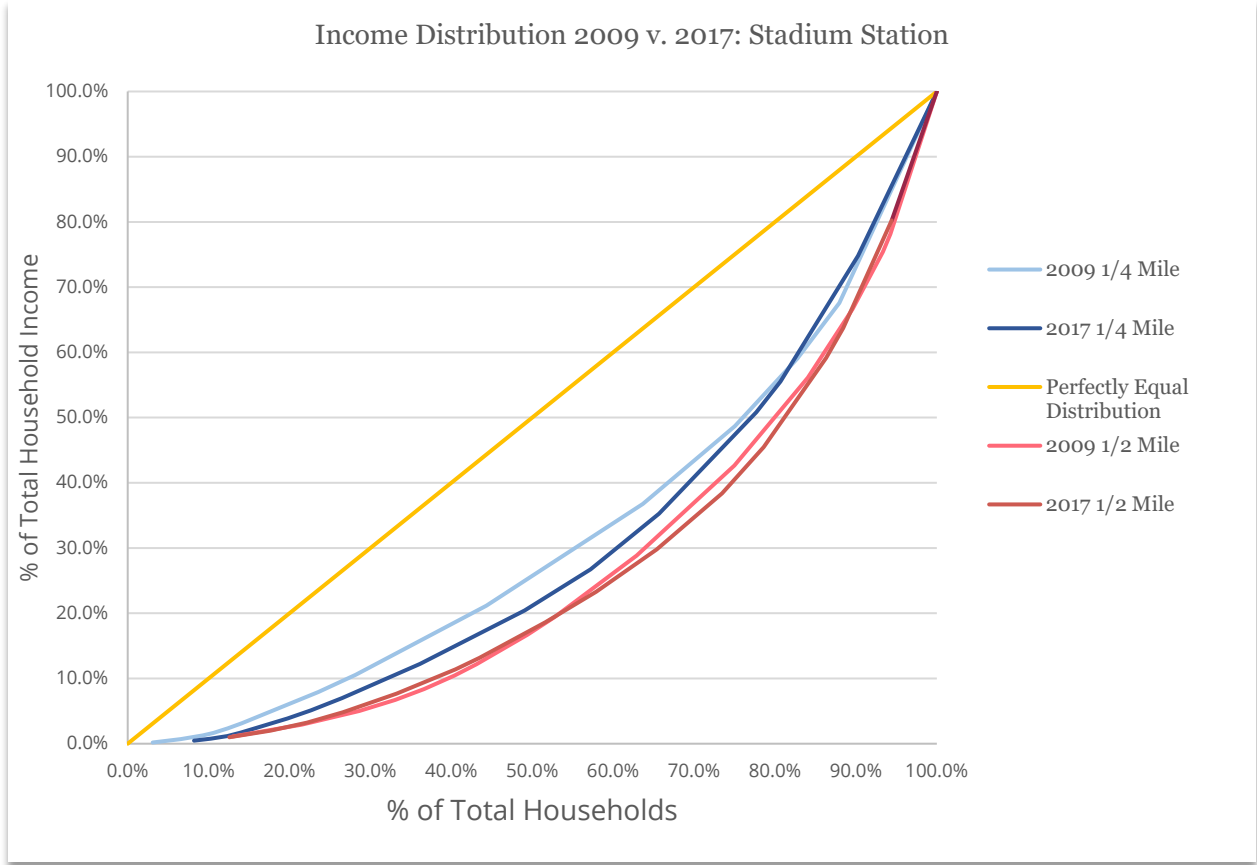


Figure 41: Income Distribution 2009 v. 2017: Stadium Station

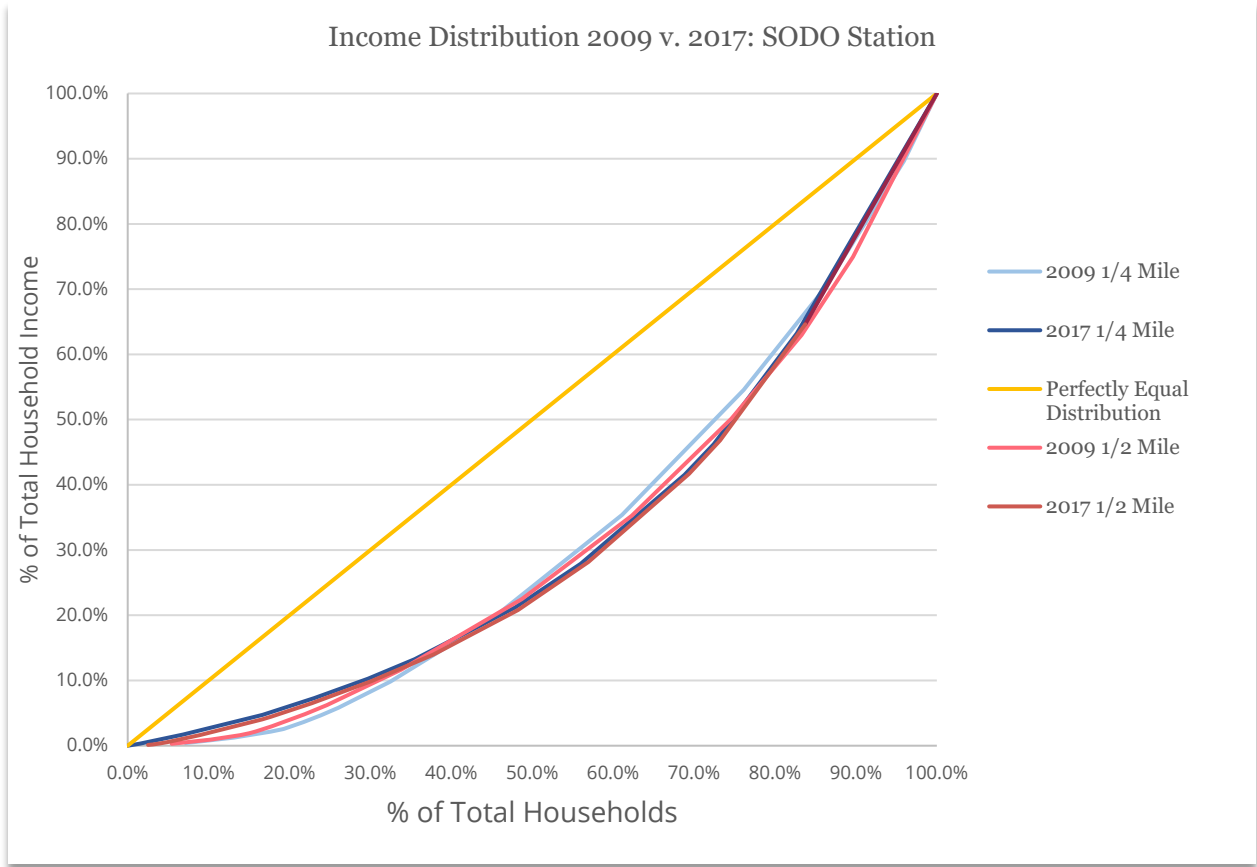


Figure 42: Income Distribution 2009 v. 2017: SODO Station

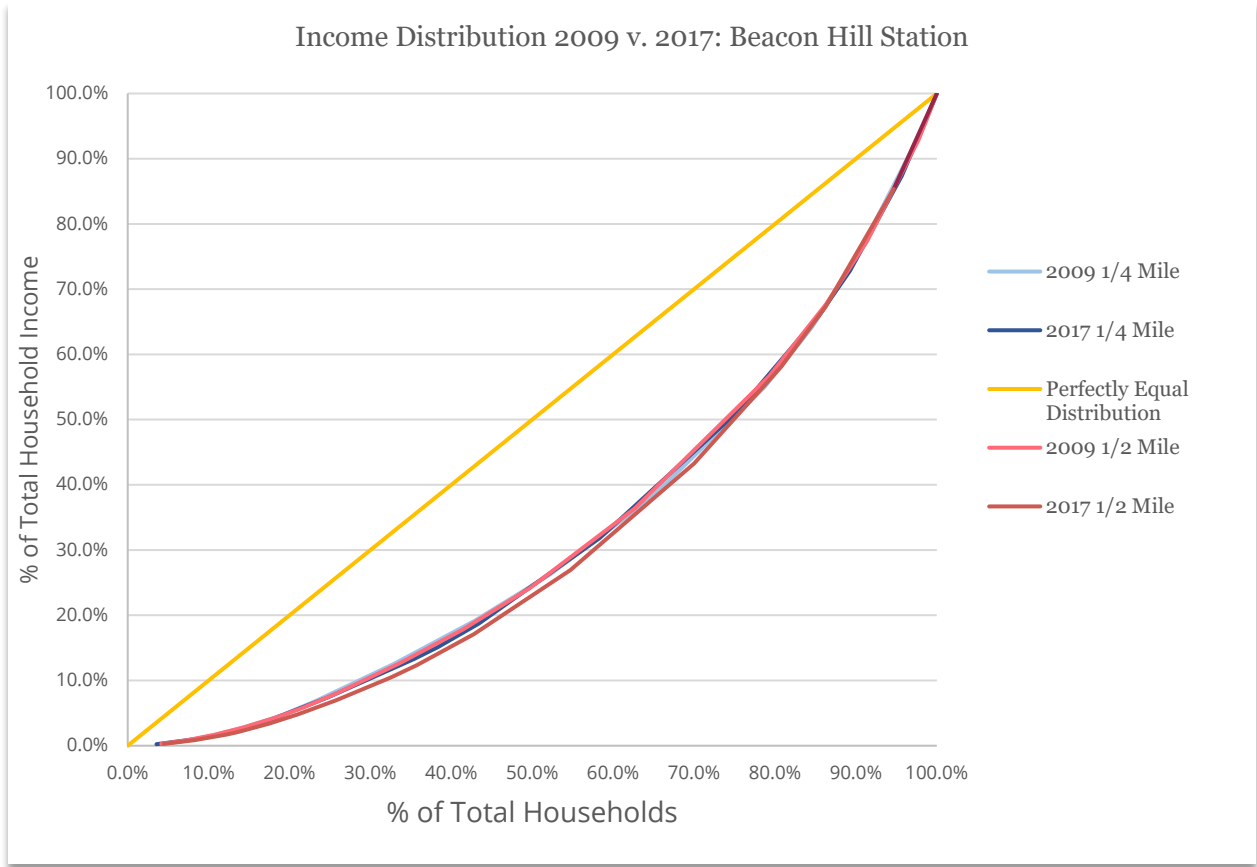


Figure 43: Income Distribution 2009 v. 2017: Beacon Hill Station

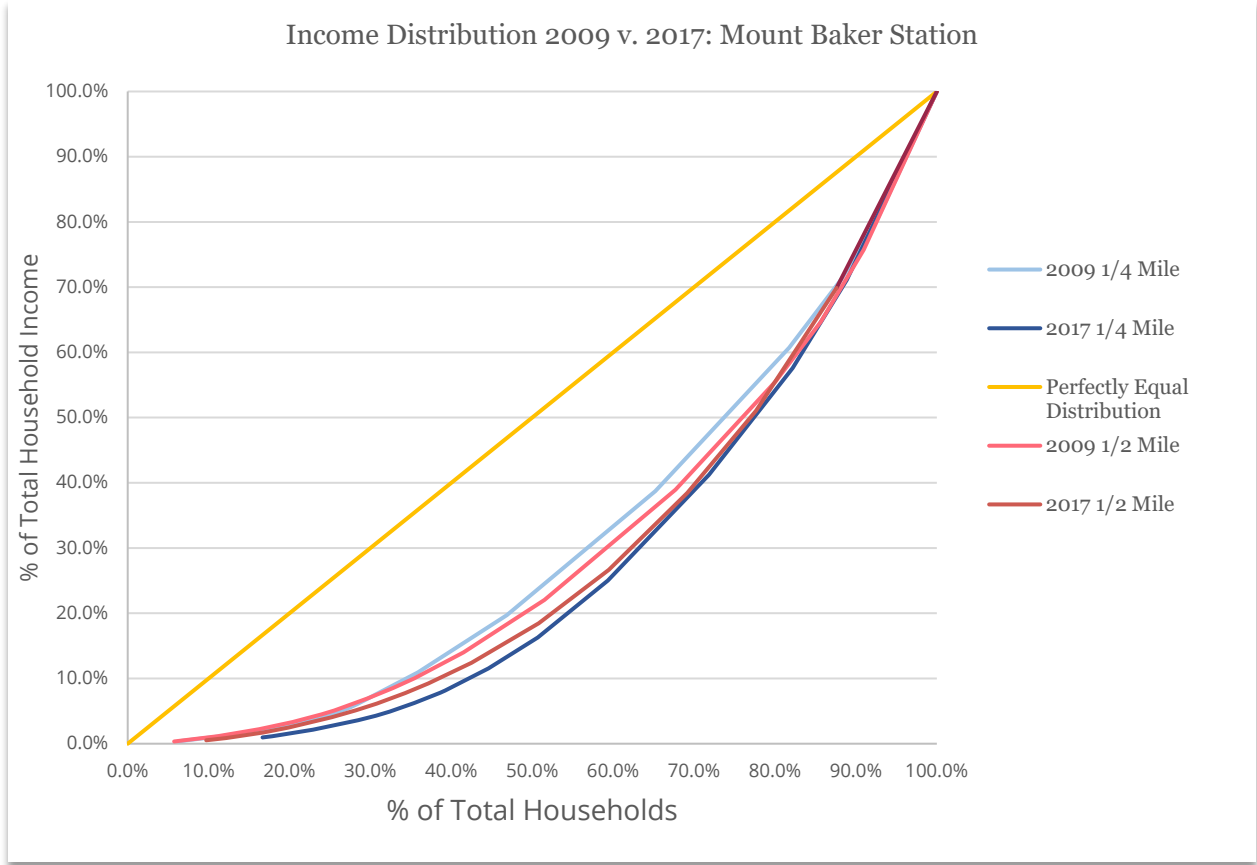


Figure 44: Income Distribution 2009 v. 2017: Mount Baker Station

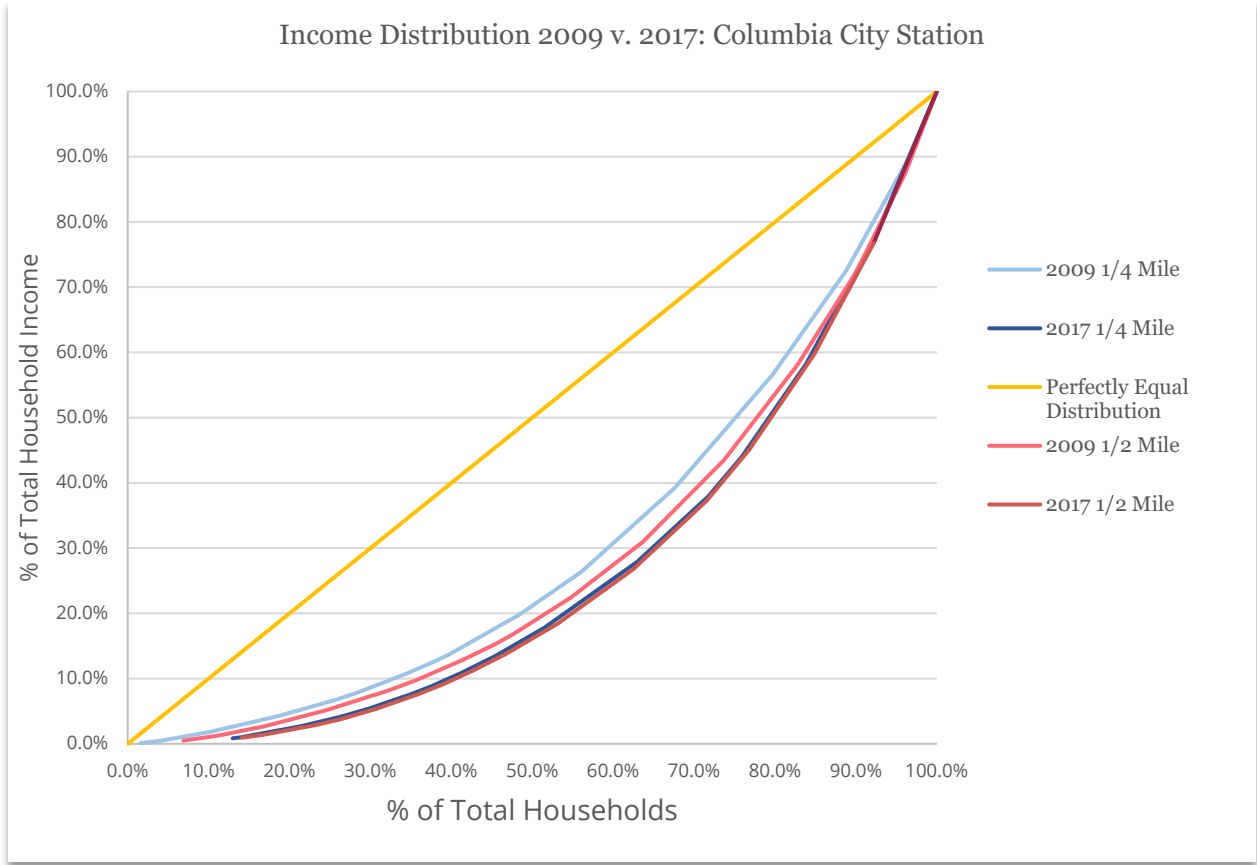


Figure 45: Income Distribution 2009 v. 2017 Columbia City Station

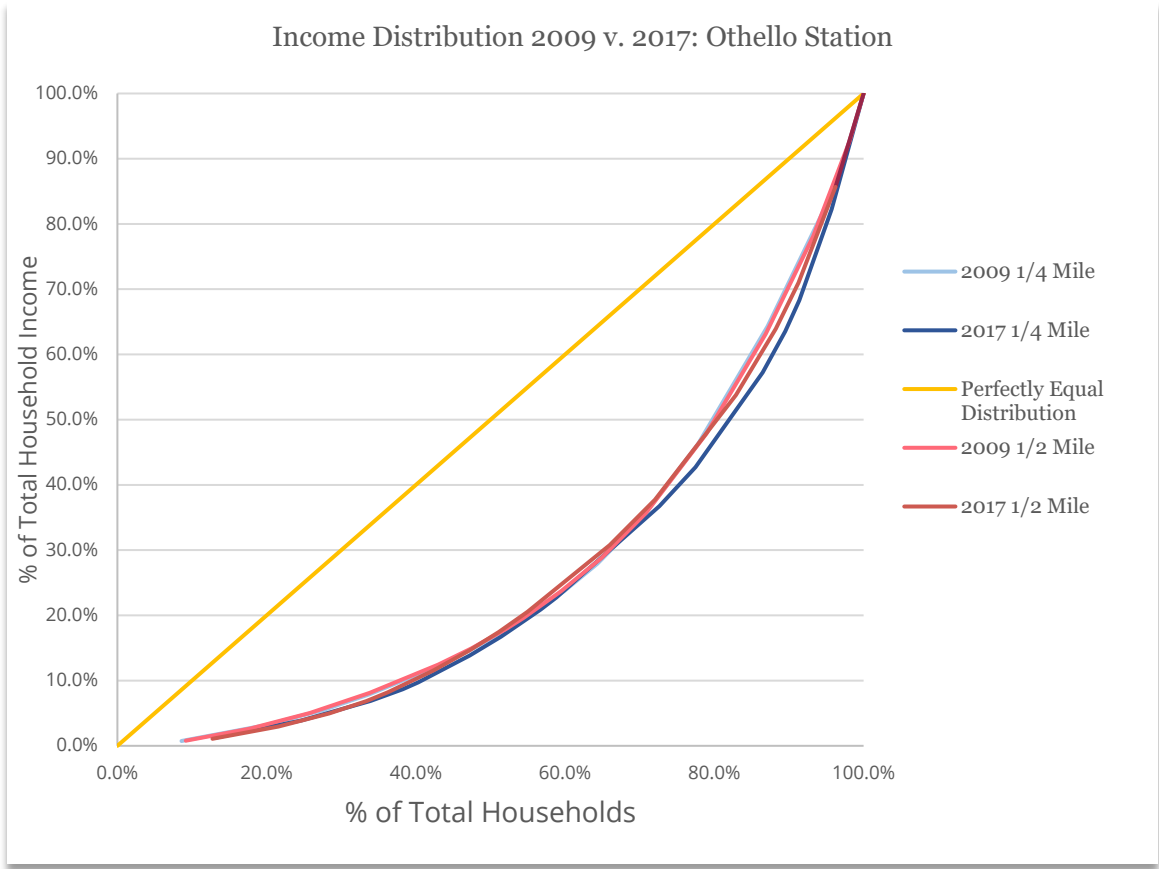


Figure 46: Income Distribution 2009 v. 2017: Othello Station

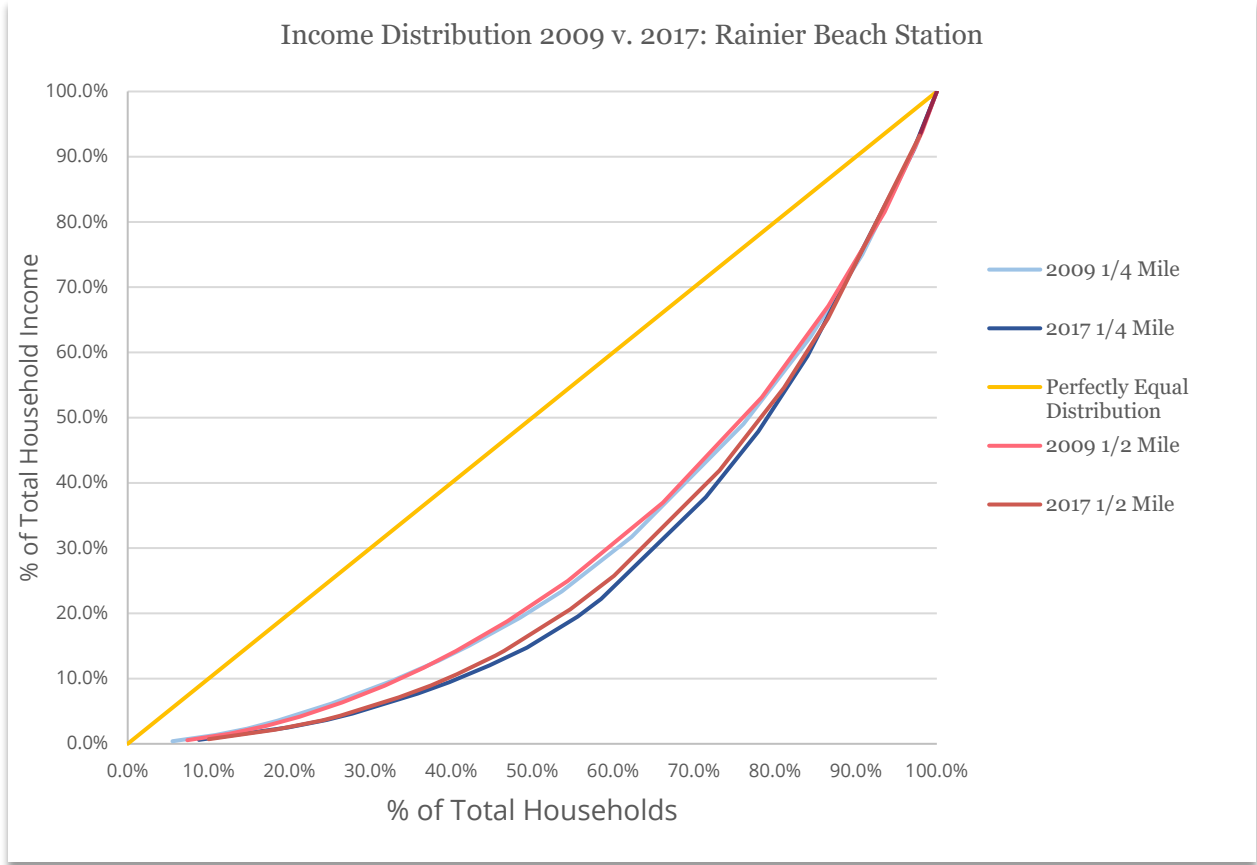


Figure 47: Income Distribution 2009 v. 2017: Rainier Beach Station

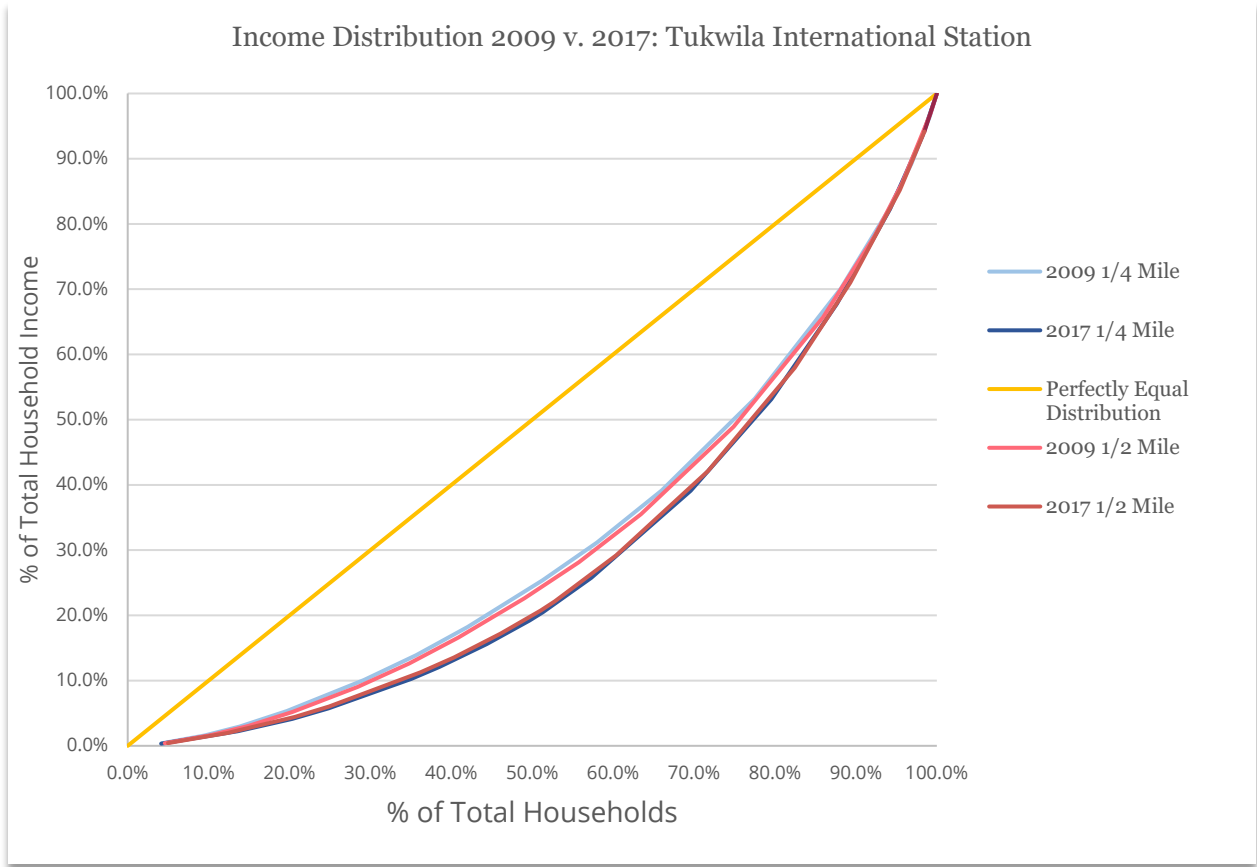


Figure 48: Income Distribution 2009 v. 2017: Tukwila International Station

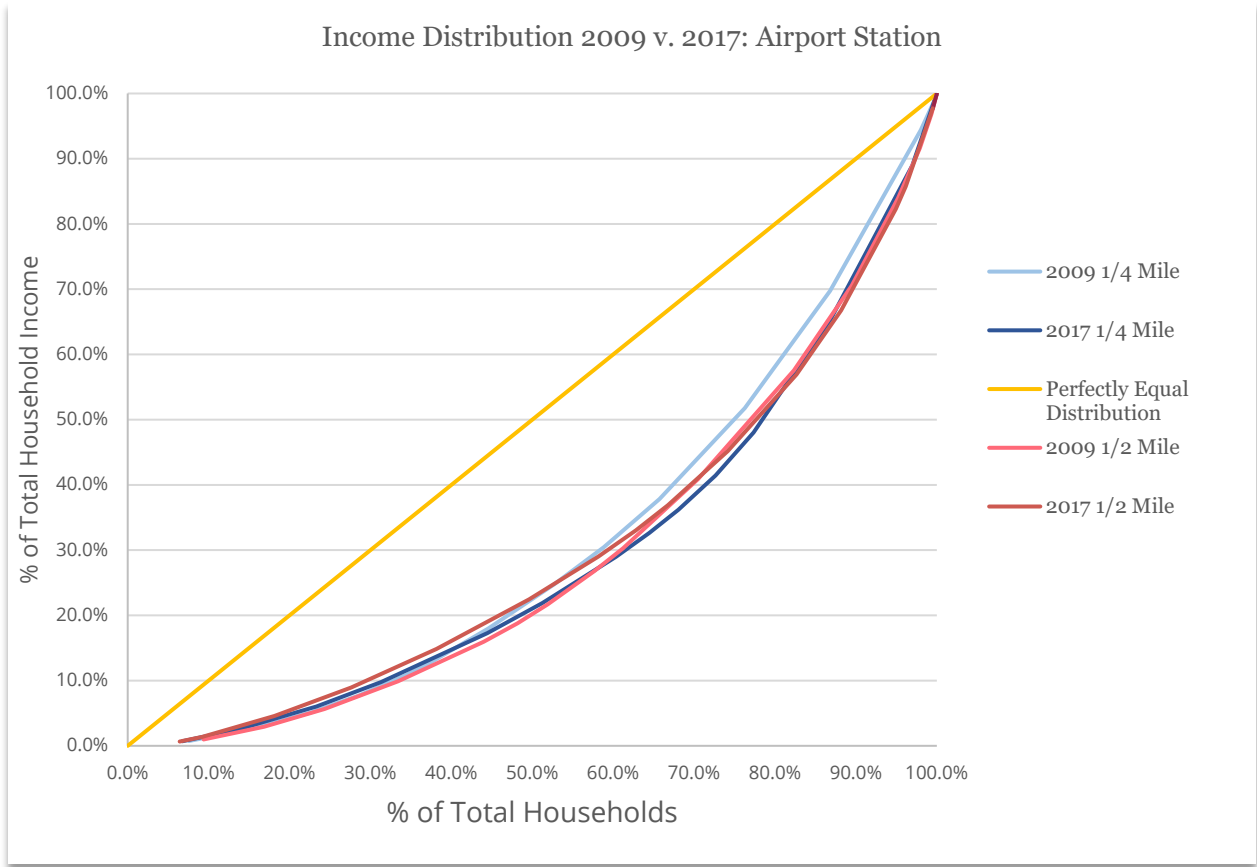


Figure 49: Income Distribution 2009 v. 2017: Airport Station

9.2 Descriptive Statistics

9.2.1 Race Demographic Tables

Station Name	Quarter Mile				Half Mile			
	2009	2017	Difference	Tri-city Difference*	2009	2017	Difference	Tri-city Difference*
Westlake Station	0.314090754	0.39947645	0.0853857	0.04436639	0.273309749	0.354343896	0.08103415	0.04001484
University Street Station	0.305113643	0.39486696	0.08975332	0.04873402	0.302536021	0.353647815	0.05111179	0.01009249
Pioneer Square Station	0.470326535	0.49389774	0.0235712	-0.0174481	0.491138204	0.500771826	0.00963362	-0.0313857
International District Station	0.706375752	0.67563927	-0.03073648	-0.07175579	0.64564479	0.60941868	-0.0362261	-0.0772454
Stadium Station	0.52999511	0.47730927	-0.05268584	-0.09370515	0.693475419	0.639196954	-0.0542785	-0.0952978
SODO Station	0.523809524	0.55323383	0.02942431	-0.011595	0.504034353	0.5123663	0.00833195	-0.0326874
Beacon Hill Station	0.718788999	0.63107835	-0.08771065	-0.12872996	0.716887704	0.612246357	-0.1046413	-0.1456607
Mount Baker Station	0.605538127	0.57346218	-0.03207595	-0.07309525	0.624547434	0.556812911	-0.0677345	-0.1087538
Columbia City Station	0.720637489	0.72673357	0.00609609	-0.03492322	0.762330779	0.693952035	-0.0683787	-0.109398
Othello Station	0.890111714	0.78356624	-0.10654548	-0.14756478	0.883212258	0.830686107	-0.0525262	-0.0935455
Rainier Beach Station	0.89545691	0.90776432	0.01230741	-0.02871189	0.887364673	0.89529435	0.00792968	-0.0330896
Tukwila International Blvd Station	0.617698127	0.7585496	0.14085147	0.09983217	0.62455462	0.746998177	0.12244356	0.08142425
Airport / SeaTac Station	0.439813406	0.72313652	0.28332311	0.24230381	0.501542263	0.753114152	0.25157189	0.21055258
All Station Areas	0.661655878	0.64401582	-0.01764006		0.595636908	0.620846141	0.02520923	-0.0158101
Seattle/Sea-Tac/Tukwila Areas*	0.330675786	0.37169509	0.04101931	0	0.330675786	0.371695091	0.04101931	0

Table 4: Net Changes in Percent of People of Color: 2009 v. 2017

Station Name	Quarter Mile			Half Mile		
	2009	2017	Difference	2009	2017	Difference
Westlake Station	497.5996324	1313.9011	816.301471	3695.540003	6440.996194	2745.45619
University Street Station	778.455761	1163.60686	385.151097	3223.514449	5338.978993	2115.46454
Pioneer Square Station	1419.597766	1763.17914	343.581371	5293.754573	6667.114289	1373.35972
International District Station	1533.984517	2295.1714	761.186882	4953.223999	5532.623377	579.399378
Stadium Station	133.8860413	151.596807	17.710766	1173.767281	1601.561714	427.794433
SODO Station	32.98934557	43.8858773	10.8965317	181.6367018	230.495489	48.8587872
Beacon Hill Station	1926.524336	1605.19175	-321.332584	5012.464769	3974.031848	-1038.4329
Mount Baker Station	522.9736256	561.552082	38.5784561	3276.026989	3096.900179	-179.12681
Columbia City Station	824.5274475	1427.95811	603.430663	4102.218544	5193.000222	1090.78168
Othello Station	1673.128609	1626.78148	-46.3471331	6659.71006	7598.157404	938.447343
Rainier Beach Station	949.2796999	1235.03132	285.751624	3830.116349	4995.815227	1165.69888
Tukwila International Blvd Station	463.6969417	765.584978	301.888036	1825.834738	2757.209189	931.374452
Airport / SeaTac Station	72.32703744	196.898281	124.571244	1056.402598	1805.871093	749.468495
All Station Areas	37105	47880	10775	63617	76749	13132
Seattle/Sea-Tac/Tukwila Areas*	211861	276853	64992	211861	276853	64992

Table 5: Net Changes in Number of People of Color: 2009 v. 2017

9.2.2 Educational Attainment Demographic Charts

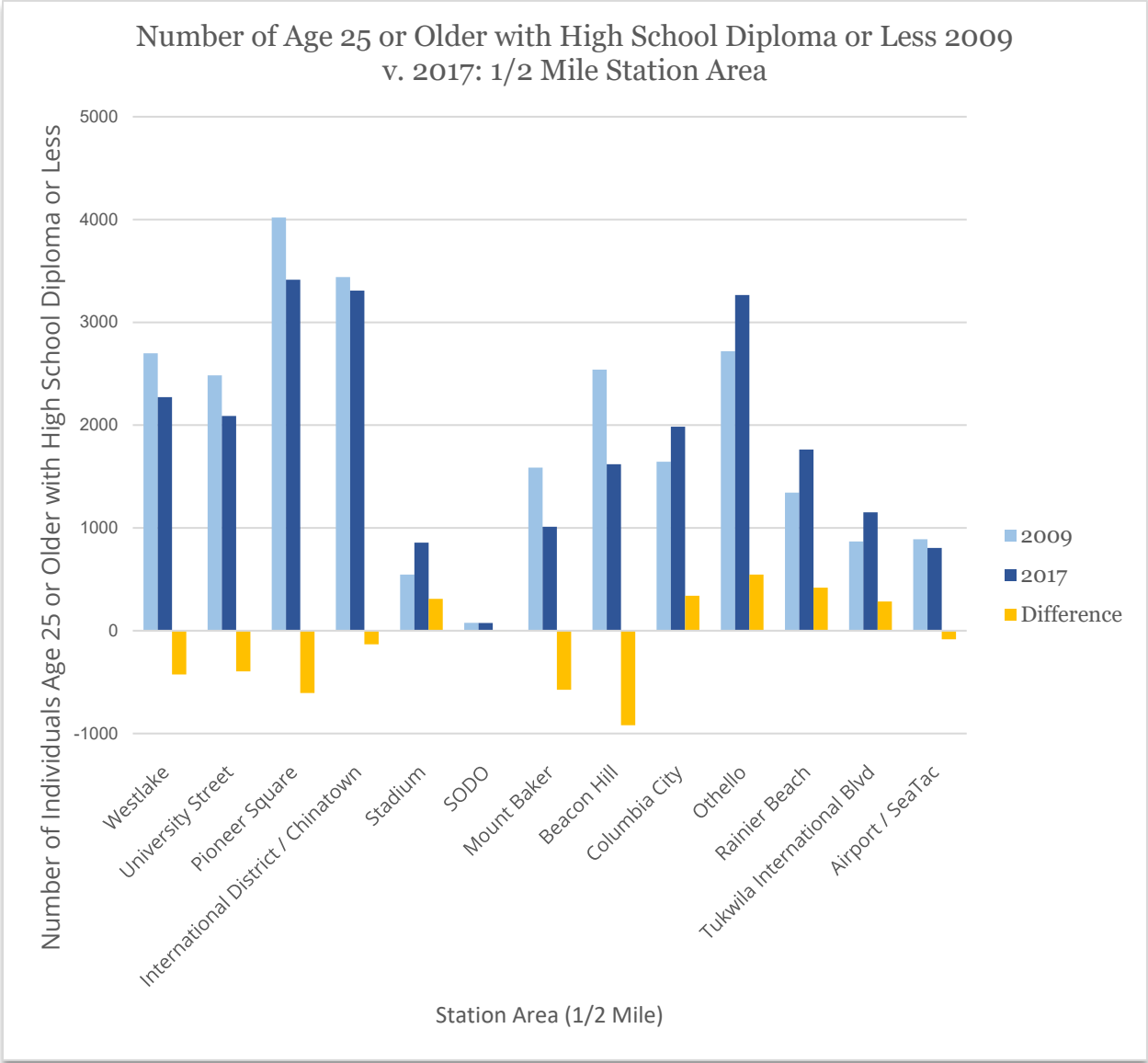


Figure 50: Number of Age 25 or Older with High School Diploma or Less 2009 v. 2017: 1/2 Mile Station Area

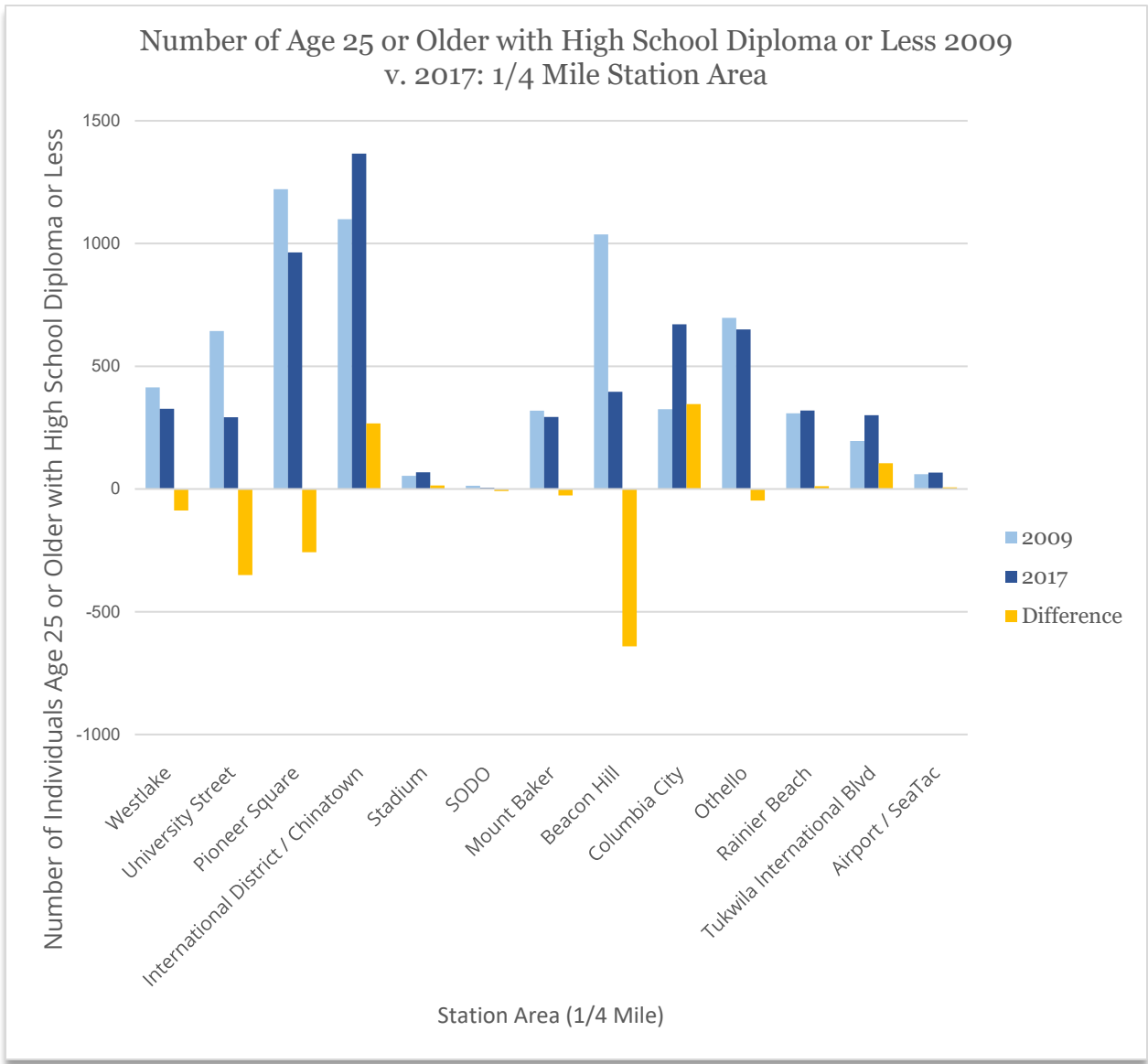


Figure 51: Number of Age 25 or Older with High School Diploma or Less 2009 v. 2017: 1/4 Mile Station Area

9.3 Land Use

9.3.1 Simplified Station Area Land Use Groupings

Station Area Land Use Classification	Detailed Land Use
Auto	Parking (Assoc), Parking(Garage), Parking(Commercial Lot), Gas Station, Conv Store with Gas, Auto Showroom and lot, Service Building, Service Station, Shell Structure, Car Wash, Mini Lube
Civic	Governmental Service, Post Office/Post Service
Education	School(Public), School(Private), Residence Hall/Dorm, Fraternity/Sorority House
Greenhouse	Greenhse/Nrsry/Hort Srvc
Health Facility	Medical/Dental Office, Nursing Home, Rehabilitation Center, Hospital
Historic	Historic Prop(Office), Historic Prop(Retail), Historic Prop(Misc), Historic Prop(Rec/Entertain), Historic Prop(Residence), Historic Prop(Park/Billbrd), Historic Prop(Eat/Drink), Historic Prop(Vacant Land), Historic Prop(Loft/Warehse)
Industrial	Industrial(Gen Purpose), Marina, Air Terminal and Hangers, Industrial(Heavy), Warehouse, Utility Public, Terminal(Marine/Comm Fish), Industrial(Light), Terminal(Rail), Terminal(Auto/Bus/Other), Utility Private(Radio/T.V.), Industrial Park, Mini Warehouse, Terminal(Marine), High Tec/High Flex)
Mixed Use	Condominium(Mixed Use), Apartment(Mixed Use)
Multi-Family Residential	Townhouse Plat, Duplex, Apartment, Triplex, 4-Plex, Group Home, Condominium(Residential), Mobile Home, Mobile Home Park, Rooming House, Apartment(Subsidized), Apartment(Co-op), Retirement Facility
Office	Office Building, Office Park, Condominium(Office)
Open Space	Right of Way/Utility Road, Easement, Park Public(Zoo/Arbor), Reserve/Wilderness Area, Open Space Tmbr Land/Greenbelt, Park Private (Amuse Ctr), Open Space(Curr Use-RCW 84.34), Open Space (Agric-RCW 84.34)
Religion	Church/Welfare/Relig Srvc
Retail	Retail Store, Retail(Line/Strip), Restaurant(Fast Food), Restaurant/Lounge, Bank, Retil(Discount), Conv Store without Gas, Grocery Store, Vet/Animal Control Srvc, Bowling Alley, Health Club, Retail(Big Box), Shopping Ctr(Nghbrhood), Tavern/Lounge, Movie Theatre, Auditorium//Assembly Bldg, Art Gallery/Museum/Soc Srvc, Shopping Ctr(Community), Shopping Ctr(Maj Retail), Daycare Center, Shopping Ctr(Regional)
Short-Term Lodging	Hotel/Motel, Bed & Breakfast
Single-Family Residential	Single Family(Res Use/Zone), Single Family (C/I Zone), Single Family(C/I Use)
Sports Facility	Sport Facility, Golf Course, Driving Range
Vacant	Vacant(Industrial),Vacant(Single-Family, Vacant(Commercial), Vacant(Multi-Family)
Water	Water Body Fresh, Tideland 1st class, Tideland 2nd Class, River/Creek/Stream

Table 6: Simplified Station Area Land Use Groupings

9.3.2 Land & Improvement Value Tables

Station (1/4 Mile)	2009	2017	Change	Change %	Difference from All Stations
Westlake	\$ 1,330,979,400.00	\$ 2,398,780,506.00	\$ 1,067,801,106.00	80.2%	28.3%
University Street	\$ 1,592,149,600.00	\$ 2,956,216,813.00	\$ 1,364,067,213.00	85.7%	33.8%
Pioneer Square	\$ 973,072,600.00	\$ 1,550,454,859.00	\$ 577,382,259.00	59.3%	7.4%
CID	\$ 430,487,300.00	\$ 737,449,400.00	\$ 306,962,100.00	71.3%	19.4%
Stadium	\$ 281,541,200.00	\$ 613,362,100.00	\$ 331,820,900.00	117.9%	66.0%
SODO	\$ 151,859,200.00	\$ 319,129,900.00	\$ 167,270,700.00	110.1%	58.2%
Beacon Hill	\$ 99,904,900.00	\$ 152,412,800.00	\$ 52,507,900.00	52.6%	0.7%
Mount Baker	\$ 128,874,500.00	\$ 261,706,400.00	\$ 132,831,900.00	103.1%	51.2%
Columbia City	\$ 83,618,925.00	\$ 150,840,900.00	\$ 67,221,975.00	80.4%	28.5%
Othello	\$ 95,675,400.00	\$ 167,886,300.00	\$ 72,210,900.00	75.5%	23.6%
Rainier Beach	\$ 49,455,200.00	\$ 68,524,550.00	\$ 19,069,350.00	38.6%	-13.3%
Tukwila International	\$ 691,170,600.00	\$ 546,358,500.00	\$ (144,812,100.00)	-21.0%	-72.9%
Airport / SeaTac	\$ 741,565,300.00	\$ 577,515,600.00	\$ (164,049,700.00)	-22.1%	-74.0%
All Stations	\$ 4,299,829,825.00	\$ 6,531,504,902.00	\$ 2,231,675,077.00	51.9%	
Seattle	\$ 65,319,816,097.00	\$ 92,509,406,631.00	\$ 27,189,590,534.00	41.6%	

Table 7: Reference Table for Aggregate Land Value by 1/4 Mile Station Area

Station (1/2 Mile)	2009	2017	Change	Change %	Difference from All Stations
Westlake	\$ 3,835,356,700.00	\$ 7,161,770,495.00	\$ 3,326,413,795.00	86.7%	34.8%
University Street	\$ 3,447,253,500.00	\$ 6,245,772,038.00	\$ 2,798,518,538.00	81.2%	29.3%
Pioneer Square	\$ 3,243,651,200.00	\$ 5,466,043,873.00	\$ 2,222,392,673.00	68.5%	16.6%
CID	\$ 2,305,947,700.00	\$ 3,611,171,155.00	\$ 1,305,223,455.00	56.6%	4.7%
Stadium	\$ 1,218,274,800.00	\$ 2,384,154,800.00	\$ 1,165,880,000.00	95.7%	43.8%
SODO	\$ 506,670,700.00	\$ 1,110,903,400.00	\$ 604,232,700.00	119.3%	67.4%
Beacon Hill	\$ 380,774,900.00	\$ 602,765,900.00	\$ 221,991,000.00	58.3%	6.4%
Mount Baker	\$ 464,833,000.00	\$ 807,685,300.00	\$ 342,852,300.00	73.8%	21.9%
Columbia City	\$ 336,950,525.00	\$ 592,442,800.00	\$ 255,492,275.00	75.8%	23.9%
Othello	\$ 317,624,500.00	\$ 459,348,400.00	\$ 141,723,900.00	44.6%	-7.3%
Rainier Beach	\$ 226,745,225.00	\$ 305,726,092.00	\$ 78,980,867.00	34.8%	-17.1%
Tukwila International	\$ 831,627,400.00	\$ 690,784,400.00	\$ (140,843,000.00)	-16.9%	-68.8%
Airport / SeaTac	\$ 851,626,100.00	\$ 710,391,200.00	\$ (141,234,900.00)	-16.6%	-68.5%
All Stations	\$ 4,299,829,825.00	\$ 6,531,504,902.00	\$ 2,231,675,077.00	51.9%	
Seattle	\$ 65,319,816,097.00	\$ 92,509,406,631.00	\$ 27,189,590,534.00	41.6%	

Table 8: Reference Table for Aggregate Land Value by 1/2 Mile Station Area

Station	2009	2017	Seattle	Change	Change %	Difference from All Stations
Westlake	\$ 4,321,859,255.00	\$ 7,137,013,200.00	64.8%	\$ 2,815,153,945.00	65.1%	13.2%
University Street	\$ 5,740,488,555.00	\$ 8,530,779,236.00	64.8%	\$ 2,790,290,681.00	48.6%	-3.3%
Pioneer Square	\$ 2,973,498,179.00	\$ 4,332,781,725.00	64.8%	\$ 1,359,283,546.00	45.7%	-6.2%
International District / Chinatown	\$ 999,877,479.00	\$ 1,578,686,150.00	64.8%	\$ 578,808,671.00	57.9%	6.0%
Stadium	\$ 932,488,250.00	\$ 933,146,300.00	64.8%	\$ 658,050.00	0.1%	-51.8%
SODO	\$ 148,212,300.00	\$ 142,389,900.00	64.8%	\$ (5,822,400.00)	-3.9%	-55.8%
Beacon Hill	\$ 156,506,200.00	\$ 211,485,200.00	64.8%	\$ 54,979,000.00	35.1%	-16.8%
Mount Baker	\$ 108,706,760.00	\$ 101,596,800.00	64.8%	\$ (7,109,960.00)	-6.5%	-58.4%
Columbia City	\$ 90,449,738.00	\$ 183,558,045.00	64.8%	\$ 93,108,307.00	102.9%	51.0%
Othello	\$ 88,505,600.00	\$ 178,151,683.00	64.8%	\$ 89,646,083.00	101.3%	49.4%
Rainier Beach	\$ 65,112,897.00	\$ 78,054,200.00	64.8%	\$ 12,941,303.00	19.9%	-32.0%
Tukwila International Blvd	\$ 734,953,900.00	\$ 980,422,200.00	64.8%	\$ 245,468,300.00	33.4%	-18.5%
Airport / SeaTac	\$ 775,396,900.00	\$ 1,067,058,900.00	64.8%	\$ 291,662,000.00	37.6%	-14.3%
All Stations	\$ 10,616,886,979.00	\$ 15,148,282,325.00		\$ 4,531,395,346.00	42.7%	
Seattle/Tukwila/Airport	\$ 69,330,575,565.00	\$ 112,461,724,815.00		\$ 43,131,149,250.00	62.2%	
Seattle	\$ 64,516,143,722.00	\$ 106,340,489,348.00		\$ 41,824,345,626.00	64.8%	

Table 9: Reference Table for Aggregate Improvement Value by 1/4 Mile Station Area

Station	2009	2017	Change	Change %	Difference from All Stations
Westlake	\$ 9,295,221,460.00	\$ 17,934,668,877.00	\$ 8,639,447,417.00	92.9%	41.0%
University Street	\$ 10,260,987,290.00	\$ 16,534,261,772.00	\$ 6,273,274,482.00	61.1%	9.2%
Pioneer Square	\$ 8,241,253,814.00	\$ 12,459,954,261.00	\$ 4,218,700,447.00	51.2%	-0.7%
CID	\$ 4,525,451,539.00	\$ 5,986,714,785.00	\$ 1,461,263,246.00	32.3%	-19.6%
Stadium	\$ 2,144,515,250.00	\$ 2,470,460,800.00	\$ 325,945,550.00	15.2%	-36.7%
SODO	\$ 502,677,150.00	\$ 478,660,600.00	\$ (24,016,550.00)	-4.8%	-56.7%
Beacon Hill	\$ 548,829,500.00	\$ 689,874,400.00	\$ 141,044,900.00	25.7%	-26.2%
Mount Baker	\$ 572,009,260.00	\$ 683,951,100.00	\$ 111,941,840.00	19.6%	-32.3%
Columbia City	\$ 404,666,565.00	\$ 687,275,495.00	\$ 282,608,930.00	69.8%	17.9%
Othello	\$ 382,041,000.00	\$ 558,570,555.00	\$ 176,529,555.00	46.2%	-5.7%
Rainier Beach	\$ 321,758,122.00	\$ 379,353,277.00	\$ 57,595,155.00	17.9%	-34.0%
Tukwila International	\$ 883,050,800.00	\$ 1,146,242,700.00	\$ 263,191,900.00	29.8%	-22.1%
Airport / SeaTac	\$ 874,583,200.00	\$ 1,200,151,900.00	\$ 325,568,700.00	37.2%	-14.7%
All Stations	\$ 10,616,886,979.00	\$ 15,148,282,325.00	\$ 4,531,395,346.00	42.7%	
Seattle/Tukwila/Airport	\$ 69,330,575,565.00	\$ 112,461,724,815.00	\$ 43,131,149,250.00	62.2%	
Seattle	\$ 64,516,143,722.00	\$ 106,340,489,348.00	\$ 41,824,345,626.00	64.8%	

Table 10: Reference Table for Aggregate Improvement Value by 1/2 Mile Station Area

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