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Transit Impacts on Jobs, People and Real Estate

Volume 1: Orientation, Executive Summary, Context and Place Typologies

Arthur C. Nelson, Ph.D.
Robert Hibberd
Kristina Currans, Ph.D.
Nicole Iroz-Elardo, Ph.D.

THE UNIVERSITY OF ARIZONA

TRANSIT IMPACTS ON JOBS, PEOPLE AND REAL ESTATE

Final Report
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Orientation, Executive Summary, Context and Place Typologies

by
Arthur C. Nelson
Robert Hibberd
Kristina Currans
with Nicole Iroz-Elardo

University of Arizona

for
National Institute for Transportation and Communities (NITC)
P.O. Box 751
Portland, OR 97207

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16. Abstract This is the first volume of a five-volume set of publications comprising the report titled "Transit Impacts on Jobs, People and Real Estate." It is the culmination of four research projects funded by the the National Institute of Transportation and Communities (NITC), a US DOT funded National University Transportation Center. This volume includes a preface that review key findings of the prior four research grants, an executive summary that reviews key findings of all five volumes of the current report, the context that reviews the context of the present research including details on more than 50 fixed route transit systems in more than 30 metropolitan areas that were studied, and Chapter 1 on Developing Place Typologies for Transit Analysis. It presents a method to create a typology of places reflecting such factors as population and employment density, land use mix, centrality to downtowns, among others. This allows us to analyze transit station area outcomes with respect to the milieu within which those stations are located being high-, moderate-, low- and poor-mixed use/accessibility.		
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DISCLAIMER

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PREFACE

Transit Impacts on Jobs, People, and Real Estate is the fourth report in a series that started with funding from the National Institute of Transportation and Communities (NITC), a US DOT funded National University Transportation Center. While it completes the "quadrilogy" of work comprising a unique genre of transit and land use planning research it is by no means the last work—it is more likely the foundation for future work.

This document is Volume 1 of five volumes from the full report *Transit Impacts on Jobs, People, and Real Estate*:

- **Volume 1: Orientation, Executive Summary, Context and Place Typologies**
- Volume 2: Impact on Job Location Over Time with Respect to Transit Station Proximity Considering Economic Groups by Transit Mode and Place Typology with Implications for Transit and Land Use Planning
- Volume 3: Impact on Where People Live Over Time with Respect to Transit Station Proximity Considering Race/Ethnicity and Household Type and Household Budget by Transit Mode and Place Typology with Implications for Transit and Land Use Planning
- Volume 4: Impact on Real Estate Rents with Respect to Transit Station Proximity Considering Type of Real Estate by Transit Mode and Place with Implications for Transit and Land Use Planning
- Volume 5: Improving Transit Impacts by Reconsidering Design and Broadening Investment Resources

Each of these volumes, and the full report, can be found at https://nitc.trec.pdx.edu/research/project/1253

The genre of research within which four research projects call is grounded in trend that is common throughout all reports: That America is becoming increasingly focused on the need for transit to meet a growing number of social, economic and environmental objectives. But it is also rooted is simple market dynamics.

America will add at least 100 million new residents, 40 million new households, and 60 million new jobs by 2050. We know from demographic analysis and consumer preference surveys that at least a third of America's 150 million households (50+ million) in 2050 will want to live in locations providing them with transit options, in addition to mixed-use and mixed-housing options. We also know from research on firm location behavior that up to 100 million jobs will be attracted to locations with transit options. Indeed, some research has estimated that even if all new development to 2050 occurred within one-half mile of existing and planned transit stations—such as transit oriented development (TOD) planning areas—the market demand for such development would not be met.

Our prior research outlines the extent to which fixed route transit (FRT) systems can meet future demand. But each system has its own niche. Light rail transit (LRT) systems serve metropolitan wide markets, connecting multiple nodes to each other. Bus rapid transit (BRT) systems can accomplish many of the same objectives as LRT systems at lower cost per mile but also lower capacity—which is fine for the Eugene-Springfield metropolitan area though not necessarily the Portland metropolitan area which, being four times larger and more densely settled, relies on LRT. At the lowest scale of operations are street car transit (SCT) systems that serve mostly downtowns such as Seattle or connect employment centers near downtown to downtown such as Portland, Tucson and Dallas. At the other end of the spectrum are commuter rail transit

(CRT) systems that are intercity systems that connect cities within a metropolitan area to downtown such as San Diego's Coaster, or multiple metropolitan areas such as the Seattle-Tacoma Sounder or the Albuquerque-Santa Fe Rail Runner or the Utah Transit Authority's FrontRunner connecting three metropolitan areas.

Here we will summarize the purpose and key findings of each of the three prior reports and then frame the role of the fourth report.

(2015) Do TODs Make a Difference?

The first report in the Quadrilogy was *Do TODs Make a Difference?* (Nelson et al. 2015). NITC contracts 547 and 650 were used to build station area databases for 12 light rail transit (LRT) systems, nine bus rapid transit (BRT) systems, four streetcar transit (SCT), and five commuter rail transit (CRT) systems. In this report, we presented research that measures the outcomes of TOD areas in relation to their metropolitan area controls with respect to:

- Jobs by sector;
- Housing choice for household types based on key demographic characteristics;
- Housing affordability based on transportation costs; and
- Job-worker balance as a measure of accessibility.

Prior literature has not systematically evaluated TOD outcomes in these respects with respect to light rail transit (LRT), commuter rail transit (CRT), bus rapid transit (BRT), and streetcar transit (SCT) systems. Our analysis helps close some of these gaps. We applied our analysis to 23 fixed guideway transit systems operating in 17 metropolitan areas in the South and West that have one or more of those systems. We found:

- Most TOD areas gained jobs in the office, knowledge, education, health care and entertainment sectors, adding more than $100 billion in wages capitalized over time;
- In assessing economic resilience associated with LRT systems, jobs continued to shift away from TOD areas before the Great Recession, the pace slowed during the Recession, but reversed during recovery leading us to speculate that LRT TOD areas may have transformed metropolitan economies served by LRT systems;
- Rents for offices, retail stores and apartments were higher when closer to SCT systems, had mixed results with respect LRT systems, but were mostly lower with respect to CRT systems (our earlier BRT sample size was too small to evaluate);
- SCT systems performed best in terms of increasing their TOD area shares of metropolitan population, households and householders by age, housing units, and renters with BRT systems performing less well while LRT and CRT systems experienced a much smaller shift in the share of growth;
- Household transportation costs as a share of budgets increase with respect to distance from LRT transit stations to seven miles suggesting the proximity to LRT stations reduces total household transportation costs;
- Emerging trends that may favor higher-wage jobs locating in transit TOD areas over time than lower or middle wage jobs perhaps because TOD areas attract more investment which requires more productive, higher-paid labor to justify the investment; and
- The share of workers who commute 10 minutes or less to work increases nearly one-half of one percent for each half-mile their resident block group is to an LRT transit station, capping at a gain of 1.3 percent, which is not a trivial gain.

This work identified a missing element of research relating to one of the fastest growing modes of fixed route transit systems: Bus rapid transit (BRT). That led to a second NITC-funded project.

(2016) National Study of BRT Development Outcomes
The second report was the nation’s largest and most comprehensive assessment of the influence of bus rapid transit (BRT) systems on jobs, people and households, and real estate rents (Nelson and Ganning 2016).

Public transit systems are often promoted as offering a plethora of social, economic and environmental benefits to urban populations by transforming urban forms from auto-centric designs into more sustainable ones. The “next big thing” in public transit is bus rapid transit (BRT) systems. From virtually no systems a generation ago, there are now nearly 20 lines operating with at least seven under construction and more than 20 in the planning stages. Part of this recent popularity in BRT stems from its more affordable capital investment costs and its potential to be utilized by municipal planning organizations as an economic development tool. Yet, research into development outcomes associated with BRT station/stop proximity is small. This study found:

- For metropolitan counties with BRT systems, (0.50-mile) transit corridors increased their share of new office space by a third, from 11.4 percent to 15.2 percent and although new multifamily apartment construction was small, its share more than doubled since 2008;
- BRT station areas gained share of central county jobs at a faster pace or even at the expense of the rest of the central county and that more technologically advanced BRT systems may contribute to positive economic development outcomes;
- However, when disaggregating data to sectors, BRT is found to influence employment change in only one sector—manufacturing though that sector is broad and includes such activities as assembly, food processing (think beer making) and fashion design;
- Evidence of an office rent premium for location within a BRT corridor for most albeit not all of the metropolitan areas studied;
- Household transportation costs as a share of budgets increase with respect to CBD distance to about 19 miles and about eight miles with respect to BRT stations;
- Before the recession, the shift in jobs for all wage groups was about the same between BRT station areas and counterfactual locations but during recovery, BRT station areas saw larger shifts compared to counter-factual locations for lower-wage but upper-wage jobs had the largest change share in BRT station areas during recovery while the share of lower-wage jobs in BRT station areas fell; and
- There is little difference in BRT study area performance compared to their metropolitan areas in terms of influencing population and residential patterns though we did find indirect evidence that BRT systems choosing higher-quality design and technology options tended to enjoy better population and housing outcomes than those that chose lesser options.

We conclude that, on the whole, BRT systems are associated with positive development and job location outcomes, though not necessarily population or housing outcomes. By the time this study was completed more robust data had become available allowing for updates and expansions of prior work, which led to the third grant in this genre.

(2019) The Link between Transit Station Proximity and Real Estate Rents, Jobs, People and Housing with Transit and Land Use Planning Implications

This report updates and expands prior research in the genre of research that has used economic base analysis (especially shift-share) and CoStar commercial rent data to estimate the development outcomes to transit (Nelson and Hibberd 2019). The study period for prior economic base analysis was 2002-2011 and census data for 2000 and 2010, as well as CoStar data for 2013. This report expands the number of systems used in analysis to 17 LRT systems, 14 BRT systems, nine SCT systems and 12 CRT systems. It also expands the period of analysis to 2015 for jobs-related data, 2016 for census data, and 2018 for CoStar data. The expanded and updated databases allow for more comprehensive assessment of their outcomes. Key findings include:

- Market rents increase with respect to Fixed Guideway Transit (FGT) station proximity for nearly all commercial types and for all modes, except there no rent premium for BRT in the closet (0.125 mile) distance band and office responds positively only within the closets (0.125 mile) distance band from LRT stations, with rent premiums extend one to two miles away from FGT stations for many commercial types;
- On the whole, more mature Fixed Guideway Transit (FGT) system saw gains in regional share of jobs in closer in (0.25 mile and 0.50 mile) distance bands if not up to the 1.00 mile distance band from transit stations—BRT being an exception in gaining share only in the nearest (0.25 mile) distance band— while ones build during and since the Great Recession saw small or negative shifts in regional share;
- There are only modest gains in the regional share of population and housing before/during the Great Recession (2000-2009) bit somewhat more gains afterward (2010-2016) for all transit types except BRT with larger gains associated with households without children and early/middle aged households (35-49); and
- For the most part for all transit modes saw reductions in regional share of driving alone and carpooling, and increases in regional share of transit, biking, walking, and working at home with respect to FGT station proximity.

The report also featured illustrations of “good, bad and ugly” transit station/stop planning and design, suggesting that systems may be underperforming because of these limitations.

A missing element of prior work was the milieu or type of place within which transit stations are located. Addressing this is the key purpose of this report (Nelson, Hibberd and Currans 2021).

(2021) Transit Impacts on Jobs, People and Real Estate

This is the fourth report in the genre of research supported by NITC. This project entailed updating data and disaggregating it to assess outcomes based on station area types or what we call Place Typologies. This research is guided by two overarching questions and analytic contexts:

> ***How do Transit Development Outcomes Vary by Mode and Place Typology?*** This analysis includes each transit system for each metropolitan area studied during appropriate time periods for that system, as well as systems combined across metros. Trends that are assessed include: (1) Changes in the number and share of jobs by sector with respect to type of system and distance from stations, by type of station based on Place Typology; (2) Changes in the number and share of jobs by wage category with respect to transit mode and station proximity by Place Typology; and (3) Changes in number and share of population, households, householders by age, and housing by tenure with respect to transit mode, station proximity, and Place Typology.
>
> ***How does the real estate market for office, retail and apartment properties respond to proximity to transit stations by mode and Place Typology****?* Our prior work pioneered the use of CoStar commercial rental data for very broad assessments of real estate market responsiveness to transit by type but not really by location except for corridor distance bands. The new research conducts more refined relationships in those metropolitan areas based on mode and Place Typology where CoStar data are sufficient for analysis.

In addition, we updated our complete database with a codebook for anyone to access through NITC.

References

Nelson, Arthur C., Matt Miller, Dejan Eskic, Keuntae Kim, Joanna P. Ganning, Reid Ewing, Jenny Liu, Matt Berggren, Zakari Mumuni (2015). *Do TODs Make a Difference?* Portland OR: Portland State University, National Institute for Transportation and Communities Final Report NITC-RR-547 and NITC-RR-763. Available along with related materials at https://nitc.trec.pdx.edu/research/project/547/

Nelson, Arthur C. and Joanna P. Ganning (2016). *National Study of BRT Development Outcomes*. Portland OR: Portland State University, National Institute for Transportation and Communities Final Report 650. Available along with related materials at http://nitc.trec.pdx.edu/research/project/650

Nelson, Arthur C. and Robert Hibberd (2019). *The Link between Transit Station Proximity and Real Estate Rents, Jobs, People and Housing with Transit and Land Use Planning Implications*. Portland OR: Portland State University, National Institute for Transportation and Communities Final Report 1103.
Available along with related materials at https://nitc.trec.pdx.edu/research/project/1103

Nelson, Arthur C., Robert Hibberd and Kristian Currans with Nicole Iroz-Elardo (2021). *Transit Impacts on Jobs, People and Real Estate*, five volumes. Portland OR: Portland State University, National Institute for Transportation and Communities Final Report 1253.
Available along with related materials at https://nitc.trec.pdx.edu/research/project/1253

EXECUTIVE SUMMARY

What follows is an overall summary of the entire five-volume report. The overall report itself is comprised of five substantive elements. The first is crafting a scientifically sound framework for identifying landscapes within the metropolitan areas we studied. The second is applying those Place Typologies and spatial analysis to economic and demographic change for the transit system in each metropolitan area. The third is analyzing how real estate markets respond to transit system proximity with special reference to the Place Typologies. Fourth, this is followed by specialized studies into how urban form and society are shaped by transit systems. The fifth is providing an overall perspective of our research as well as a framework for unlocking the potential to leverage economic benefits of transit to advance social well-being. What follows are key products or findings from each chapter.

Chapter 1: Developing Place Typologies for Transit Analysis

Ours is the first study to create typologies of urban development patterns for national-scale research. To expand on the analyses explored in prior studies, we begin by exploring how the literature and practice identifies different types of transit-based development. For the purposes of this report, we are focusing mainly on fixed-route transit (FRT) systems and corresponding place typologies. In this project, we aim to capture differing built environment contexts that might be more-or-less resilient or responsive to economic development (jobs, housing, populations, or real estate values). We orient our analyses towards the neighborhood-level—instead of station-level—so that we might compare and quantify the relative impacts of FRT on economic outcomes, compared with areas without FRT access. And finally, we aim to develop place types that might more readily align with planning practice.

We then explore the academic and white paper literatures to identify the purposes of place and transit station typologies. We then synthesize a framework and corresponding measurements for delineating different dimensions of transit-oriented development. From there, we describe the different quantitative methods for categorization of place types so that we might expand a consistent approach to compare-and-contrast similar development patterns across vastly different regions. In the last section, we explore the guiding principles for place-type development, and we describe the data and methods used to develop the place typologies used throughout this project.

At the outset, we advise readers that an extensive annotated bibliography of materials used to create the Place Typology is provided in **Appendix A.**

Our scientific analysis generates four Place Typologies: High-, Moderate-, Low- and Poor-Mixed Use/Accessibility places and areas. Table ES.1 summarizes the results of this analysis. Figure ES.1 illustrates how these Place Typologies are used to frame spatial analysis.

While these place types enable us to compare similar built environments across sometimes drastically different metropolitan areas, they are driven largely by the distribution of environments included in our study areas. And the built environment measures included in this study were limited to those generally available and consistent throughout the US at a block-group level. In future work, more robust transit and walkability accessibility measures within each block group could provide an improved representation of local and regional accessibility in a measurable way for comparing across metropolitan areas.

Table ES.1
Average Built Environment Characteristics Across Mix/Accessible Place Types

	Place Types			
	High Mix/Accessible Centers	Moderate Mix/Accessible Areas	Low Mix/Accessible Areas	Poor Mix/Accessible Areas
	(High MA)	(Mod MA)	(Low MA)	(Poor MA)
Scores	Greater than 2.5	2-2.5	1.5-2	0-1.5
Built Environment Variables	Average Values by Place Types			
Jobs per acre	0.42	1.38	3.26	8.11
Proportion of jobs that are retail and arts	0.06	0.17	0.25	0.27
Total population per acre	4.45	10.97	28.33	72.85
Total households per acre	1.71	4.19	11.04	26.96
Percent of households with no kids	0.71	0.66	0.63	0.51
Percent of owner-occupied housing	0.83	0.63	0.40	0.22
Intersections per square mile	45.78	78.98	112.58	149.81
Proportion of intersections with 3 to 4 vertices	0.10	0.26	0.45	0.70

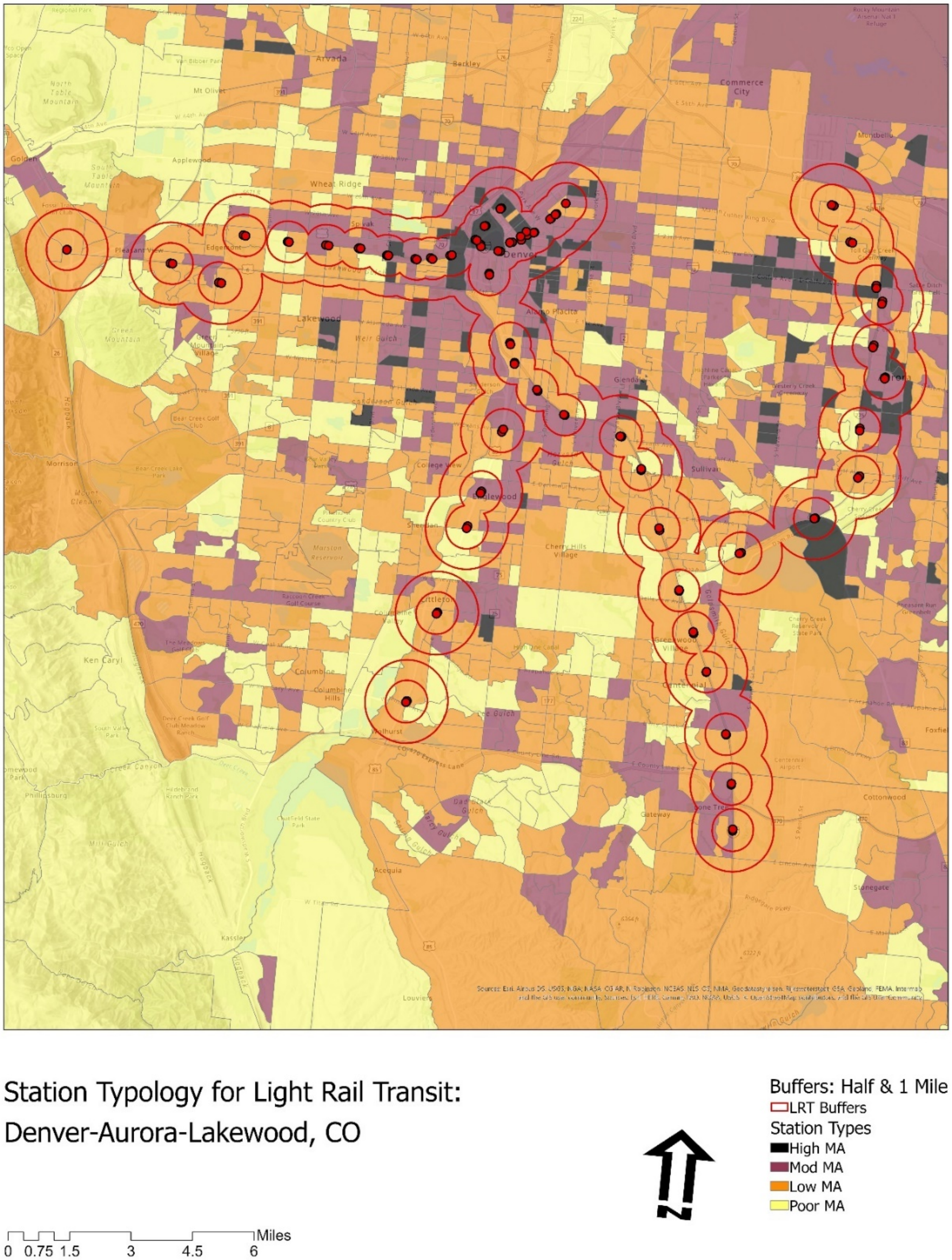


***Figure ES.1*. Light Rail Transit in Denver, Colorado show a wide variety of station place types.** A brief visual inspection of the map implies that Low MA and Mod MA are the most prevalent station place types. Further, the map demonstrates the wide variety of place types at each individual transit station. Competition for revenue-generating land uses may be drawn into those higher-intensity areas, with a concomitant loss of land uses in less intense locations.

Chapter 2: The Link between Transit Station Proximity and Typology and Change in Jobs Over Time

The research reported in this chapter expands upon previous work by assessing the extent to which jobs by sector are attracted to transit stations over time and across a range of station area intensities. Analysis is given of the land area encompassed by transit systems by mode and station type. Using economic base theory and relying upon shift-share and location quotient analyses, the economic development outcomes of station areas are assessed by transit mode, such as light rail, and by station typology. Transit modes include light rail transit, commuter rail transit, streetcar transit, and bus rapid transit systems. The station area types are characterized as lying somewhere along a continuum of land use mix, intensity, and accessibility. These types are based upon the relative intensity of a combination of characteristics of jobs, households, and the built environment. The analysis will advance the understanding of how transit stations by type effect the economy in a multimodal transportation system context. Case studies comprise metropolitan areas across the United States, in the Urbanized Area of the counties served by the transit systems under study. Each station area is analyzed by distance from the station in eighth-mile distance bands.

For each transit mode:

- BRT proved to be quite flexible to the variations of each place type, showing robust growth across three four place types, shining in the two mid-range classes, while losing share slightly in the lowest-mix areas. This indicates, first, that BRT stations and technology need to adapt to the context of the outlying areas to better attract firms to these station areas. Second, it also may indicate that the challenges from low-density dispersed land use impede the efficient use of these stations, just as is the case for most other transit modes.

- CRT showed mostly modest gains in job share for the Low MA place type stations, to the first half mile. It had flat share gains or slight declines in three of the four place type stations. This might indicate that in these stations the firms are opting for locations farther from the station due to the disamenities involved in this large-scale transit mode, such as noise and air pollution. Newer systems such as that in Salt Lake City, Utah use quieter, less polluting train technology for these commuter-oriented stations. This update may be necessary in other metropolitan areas to attract further job share gain near these stations.

- LRT saw modest growth at the Poor MA station areas but saw great share gains in the Low MA and Mod MA place type areas, with acceptable gains in the High MA areas. This seems reasonable given the scale of the trains, the competition from SCT systems for the most urban land, and the low response to transit proximity in all of the transit mode stations. A great deal of focus could shift to the Poor MA station areas, to increase accessibility in the most outlying areas. This will provide gains across all segments of the transit network. The challenge of cost structures for providing greater-quality LRT may impede gains for the lowest-intensity place type. One option is to consider ways to increase integration of LRT and BRT systems to provide higher-quality transit connections to outlying areas.

- SCT did best in the context for which it was designed, the High MA and Mod MA areas. It did reasonably well in Low MA areas, which may include the streetcar suburbs of New Orleans. It saw a slight loss of job share in the Poor MA place type areas, for reasons that are likely to be similar to the other transit modes. However, the scale of the streetcar transit system, and the capacity of the trains may impact its utility in the most outlying areas. SCT, like LRT, may benefit from efforts at greater integration of BRT and other transport mode to increase the utility of the system for all place types.

We will apply shift share analysis by Place Typology to economic sectors and workers by wage groups in the next chapter.

Chapter 3: The Link between Transit Station Proximity and Typology and Change in Jobs by Economic Groups and Wage Categories Over Time

Our research expands upon previous work by assessing the extent to which jobs by wage and economic group are attracted to transit stations over time. Station areas are assessed by transit mode, such as light rail, and by station typology. The types are characterized as lying somewhere along a continuum from low to high land use mix and accessibility. These types are based upon the relative intensity a combination of jobs, households, and the built environment. The analysis will advance the understanding of how transit stations effect the economy in a multimodal transportation system context. It will highlight these trends by wage and economic group stratifications. We allocate jobs by economic sector groups based upon NAICS classifications, and group jobs by wage based upon the salary levels of each sector. This chapter focuses on economic development outcomes first by job sector groups, then by job wage groupings. It follows up with summary findings, implications and recommendations. Analysis is based on Place Typologies developed on Chapter 1 with a spatial dimension based on 0.125-mile distance bands (DB) from transit stations.

Competition between economic sector groups and wage groups is evident at stations for many transit mode-place type combinations. Also very evident is a trend away from the DB closest to the station, or the station area itself, for many transit modes at many station place types. In highly competitive station areas, land use policy may be of help in improving the utility of under-utilized land parcels, to bring them into alignment with the most productive level of mix and intensity for the context. Also true is that many stations repelled firms away from the first DB, at the station itself.

In many station areas, upper and lower-income jobs are partners in growth trends, co-locating in the same DB or nearby. This has left many stations with relatively low growth rates in the middle-income jobs. This is also in part due to the nature of those sector groups, which include such occupations as transport and warehousing. They often require an inordinate land area for the first mile from a station.
For BRT, CRT and LRT, transit share of job shift in this time period was most pronounced at the Low MA and Mod MA place types. For SCT, that trend was most pronounced at the Mod MA and High MA place types. This highlights the urban orientation of the SCT systems.

For SCT, job growth and concentration at the station (the 0.125-mile DB) was the highest at the Low MA place type, possibly due to the built-out nature of the more intensely developed locations. For CRT and LRT, growth at the station was highest at the Poor MA place type. For BRT, growth was quite pronounced at all stations *for the upper-income jobs.* The rest mostly declined at the BRT station. CRT saw upper-income jobs grow at the Mod MA type, while both upper and lower-income jobs grew at the High MA type. This indicates that upper-income jobs pushed away other jobs at the Mod MA level while lower-income jobs supported upper-income jobs at the High MA level where low-income jobs can support upper-income jobs. This phenomenon is present at the Mod MA LRT, as well, with middle-income jobs declining seemingly as a result of significant growth of the upper and lower-income jobs in the same locations.

For some place types, industries gained spatial concentration at a lower rate than the region as a whole, which resulted in negative LQ trends at the station. This occurred for Education, Office and Light Industry at the High MA LRT stations. This may point to these industries losing the competition for transit-proximate land to those who gained in concentration such as Retail and the Arts-Entertainment-Recreation groups. This also happened in the Poor MA SCT stations, as Health and Knowledge outcompeted Retail and Light Industry.

These results indicate the market responses to transit proximity across a range of place types and transit modes. Various policy approaches could be taken in these areas, including 1) encouraging the most competitive land uses to increase their presence at a given station place type and transit mode, 2) increasing the land use mix, intensity and accessibility at specific stations by place type and transit mode by encouraging target land uses to the stations to fill the gaps needed for mixed-use development, and 3) make modifications to the local built environment and zoning code that will support the desired targets.

Chapter 4: Toward an Index of Employment-Worker Balance by Transit Station Mode

An "Employment-Worker Balance" (EWB) is created. It is viewed as a key to economic growth through agglomeration economies is also a key to social equity. This is due to its ability to both increase workers' access to employment and firms' access to a strong, diverse, and resilient workforce. Smart Growth advocates frequently identify Employment-Worker Balance as a key metric in compact urban design. Because of its potential synergistic effects with EWB, another key element of Smart Growth, Fixed-Rail Transit systems (FRT), needs to be studied for its effects on EWB: is the latter improved by the former, and for which job sectors and which workers? Principle Component Analysis will be used to produce a EWB Index that is able to map EWB across multifarious spatial contexts across the U.S., taking into its scope the multiple types of transit system modes, real estate types, and the many sectors of the economy that surround FRT stations. The EWB Index will provide a tool for practitioners and researchers to utilize in regression analysis, and policy and decision support. The paper will follow up on this significant increase of available evidence to work towards further theoretical refinement of EWB.

Theoretical implications of the employment-worker balance phenomenon are drawn from the spatial and attribute clusters revealed by the EWBI. A more accessible workplace translates to a more productive and resilient workforce through potential improvements in work-life balance and overall cost of living, which in turn benefits the firm through higher output. Additionally, existing discrepancies in EWB near transit stations reveal low-hanging fruit for planners who wish to increase economic and housing resiliency. The employment-worker spatial regimes identified in this study through PCA may require targeted solutions to increase EWB. This may reveal some significant patterns of outcomes to transit development. One main implication is that there is a great deal of potential to develop spatial balance between employment and worker residence. The built environment in Eugene far better supports walkability than in the other larger cities of the study. The built environment also plays a role in a positive response to transit proximity. Road and intersection densities seem to correlate well with a positive response to transit.

Workers remain separated from their workplaces. This may be seen by a portion of the population as a significant benefit, but many are paying excessive transportation costs, spending excessive time to commute, and high municipal taxes to support this separation of land uses. These results have significant workforce as well as workplace implications, as accessibility outcomes provide agglomeration economies. The regions in which workers have greater TOD-driven access to firms also provide a more business-friendly environment with increased *situs* via a more accessible, active workforce. When appropriate housing is provided for workers of all sectors of the economy, greater economic diversification is possible.

The results indicate a modestly positive response to TOD. The political implications of increasing employment-worker balance depend upon the local typology of imbalance needing correction. In neighborhoods that are job-rich and housing poor for a lower- to moderate-income worker, challenges may include potential for local opposition from businesses that benefit from larger numbers of workers than residents, businesses seeking to protect their market share from newcomer firms, or from residents who fear negative externalities of lower or moderate-income housing development in their neighborhoods. Neighborhoods with upper-income jobs that seek to improve EWB may face gentrification pressures. Bedroom communities for blue-collar workers needing more jobs may face challenges from industrial externalities.

Chapter 5: The Link between Transit Station Proximity and Typology and Change in Households, Housing tenure and commuting choice Over Time

Our research expands upon previous work by assessing the extent to which households are attracted to transit stations over time. Households are classified by several salient characteristics, including household type, householder age, and housing tenure. Station areas are assessed by transit mode, such as light rail, and by station typology. The types are characterized as lying somewhere along a continuum from urban core to suburban. These types are based upon the relative intensity a combination of jobs, households, and the built environment. The analysis will advance the understanding of how transit stations effect the pattern of household residence in a multimodal transportation system context, how commuters respond to transit proximity, what transportation modes seem to complement each other, and what demographics may be in competition for transit station proximity. Also evident from the study will be which transit modes in which place types (from low to high land use intensity, mix, and accessibility) are repelling or attracting population to the transit station and beyond to 1 mile.

The shifts in the regional populations of this study were measured in terms of household by age, type, tenure, and commuting choice. Variations in demographic response to transit proximity are broad across transit modes (e.g., LRT or SCT) and place types from low to high degrees of land use mix, intensity and accessibility.

There are results that hold true across most of the mode-place type categories. For example, walking, biking, transit use, and working from home gained share in most of these locations and categories, in the aggregate. On the other hand, some categories repelled certain groups while others attracted them. Further, some categories attracted people to the station while other categories repelled them.

At the station, the market was attracted or repelled dependent upon the transit mode as well as the place type. For most transit modes, the Poor MA place type repelled the market, in varying degrees, from the direct vicinity of the station. In many cases, growth was evident just beyond the station, mostly within the first half-mile radius of distance from the station. In many cases, growth occurred at the station while the regional figures declined, or vice-versa. Those demographic segments that grew faster than the regional trend, or faster than the station area total population highlight important market responses to transit proximity and help policy makers determine the relative change in importance over time of being connected to transit stations for those specific segments of the population.

One important takeaway from this study for planners is the classification of the stations into attractors and repellants, by what transit mode and place type, and for whom, and at what distance from the transit station. There are indications of competition and synergy between the measured households by size and age, housing tenure and commuting choice. It also increases the evidence that households with children are being attracted to many transit stations by mode and place type. This is contrary to the traditional wisdom. It gives evidence as well of the consistent increases in positive market response to the presence of transit, but the ongoing concurrent problem of many households being repelled from the station at the first distance band (0.125-mile) away.

For Household by type and age, Poor MA BRT stations lost total population both at the station and cumulatively at the half-mile distance away. These losses occurred for virtually all population segments, but were of particular strength among households with children. This is of further importance when the numbers of households involved in the rates of change are considered. Far more householders of age 45 to 64 left the station area than did householders under age 25, for example. For Mod MA LRT stations, households with children were attracted to the direct station area at a 3% increase over the whole region while this change represented a full 30% of the overall population change. The cumulative half-mile DB captured 5% of that same demographic. Householders under 25 actually left these LRT stations at roughly 6% at the cumulative half-mile DB. This occurred at the same time these younger householders were attracted to the Poor MA BRT stations.

Implications for planners from these results mainly consist of a clear set of evidence of which transit mode and place type needs to address challenges or unfavorable characteristics of station areas, the larger neighborhood context, or transit systems that need to be overcome in order to increase the favorable response of target demographic groups, such as a certain segment of the worker population that is needed in greater numbers along CRT lines.

An unexpected trend in these data include the rising popularity of “other” transportation modes at the stations. This indicates that the market is indeed responding in significant ways to these new forms of transport that may include bike shares and e-scooters.

Chapter 6: The Link between Transit Station Proximity and Typology and Change in People by Demographic Groups Over Time

Our research in this chapter expands upon previous work by assessing the extent to which jobs by sector are attracted to transit stations over time and across a range of station area intensities. Analysis is given of the land area encompassed by transit systems by mode and station type. Using economic base theory and relying upon shift-share and location quotient analyses, the demographic dynamics of station areas are assessed by transit mode, such as light rail, and by station area "place" typology. Transit modes include light rail transit, commuter rail transit, streetcar transit, and bus rapid transit systems. The station area place types are characterized as lying somewhere along a continuum of land use mix, intensity, and accessibility. These types are based upon the relative intensity of a combination of characteristics of jobs, households, and the built environment. The analysis will advance the understanding of how transit stations by type effect the spatial dynamics in a multimodal transportation system context. Demographic change is evaluated as an important result of the makeup of the transportation system, and particularly the effects of transit stations on the changing aspects of demographic concentrations across the landscape. Case studies comprise aggregations of multiple metropolitan areas across the United States, in the Urbanized Area of the counties served by the transit systems under study, grouped by place type. Each station area is analyzed by distance from the station in eighth-mile distance bands.

We find that a good deal of sorting occurs across the various place type-transit mode combinations. However, some basic trends are evident: White populations increased presence at varying rates: modest for BRT, and mostly at the higher-intensity places. Whites saw modest increases at CRT stations in lower-intensity land uses; and declines in growth at higher-intensity stations. For LRT, Whites declined at low intensities, then gradually increased growth at the stations, ending finally with robust growth at the High MA stations. For SCT, Whites saw moderate growth rates at all land use intensities.

For Hispanics, growth was present but mostly modest, with the strongest rates at Mod MA place types. For CRT, Hispanics experienced strong growth rates at Poor and Low MA place type stations but declines at the Mod and High MA station areas. Hispanics grew at the first DB, at the station, and then declined in growth thereafter. For SCT, Hispanics grew at modest to moderate rates at the station, with the exception of the High MA station areas, at which they saw very strong growth.

Blacks at BRT stations had negligible growth at the Poor and Low MA station areas, with robust growth at the station for Mod MA place types, and then mostly declined at High MA stations. Blacks at CRT stations saw modest to moderate growth at the first DB of the station, but mostly declines between a quarter and half-mile DB from the stations. Blacks at LRT stations saw declines at the Poor and Low MA stations, experienced modest gains at the Mod MA stations while seeing decline at subsequent DB's, and then saw robust growth at the half-mile DB. Blacks at SCT stations saw, surprisingly, declines at all place types.

These results strongly suggest further research to determine the impetus for such consistent rates of decline, overall, for Black populations near most stations by transit mode and place type. White populations saw mostly modest to robust growth in most stations by mode and place type. Hispanics saw a range of growth and decline, with many examples of growth being confined mainly to the station area. There appear to be some hints at competitive sorting between these population segments, but perhaps the strongest influence on these patterns is the underlying locations of jobs most held by each group, the part of the city most inhabited by each group, and the kind of housing each group usually occupies. These elements vary greatly between metropolitan areas.

These findings may be considered a preliminary search of these patterns, with some important hints at policy directions to improve these patterns, such as zoning for a wider range of housing across the metropolitan area, and provision of transit system extensions into less-served areas of regions.
Regression and spatial regression may improve the clarity of these outcomes through hypothesis testing and significance levels.

Chapter 7: The Link between Transit Station Proximity, Place Typology and Transportation Costs Incurred by Household Types

It seems an article of faith that transportation costs as a share of household income increase with respect to distance from downtowns, freeway interchanges, and light rail transit stations. Considerable literature reports price effects of these points on residential property values but none measure explicitly differences in household transportation costs as a share of household budgets. Our study helps close this gap in literature. Using the U.S. Department of Housing and Urban Development's (HUD) Location Affordability Index (LAI) database, which estimates the share of household budgets consumed by transportation at the block group level based on the 2012 5-year American Community Survey (ACS) and census tracts based on the 2016 5-year ACS. We evaluate the association between median household transportation costs and distance from light rail transit (LRT) stations using both ACS data sets. We find clear associations between transit station proximity and lower household transportations for both periods, with what appears to be increasing savings over time. We also find important differences in transportation costs incurred by different households with respect to the type of urban place in which they live and proximity to LRT stations. While not surprising intuitively, social equity issues arise. Insights are offered for specific types of households.

Median-Income Household

These households enjoy lower VMT and lower transportation costs the closer they are to LRT stations. And their savings has increased between the two time periods with savings accelerating near LRT stations.

Working Individual @ 50% MHHI

These households have gained considerable transportation cost savings between ACS 2008-2012 and ACS 2012-2016 in the first three distance bands, to 0.375-mile from LRT stations. Thereafter, the gain in savings between the two study periods is modest though not trivial. (We cannot explain the anomalous dip at the 0.175-mile distance band.) Combined with being in High MA places, these households save the most in transportation costs being close to LRT stations. It is also remarkable that this is the lowest income group studied. It is also likely they are predominantly renters occupying small units close to transit and high activity centers.

Single Professionals @ 135% MHHI

In a sense, these are households with the most choices because of their higher incomes and presumably fewer household obligations than other household types. Then would be expected to gravitate to transit stations as well as locate in High MAS areas. Although ostensibly their transportation costs savings might be the most modest because such accounts for only 12.1 percent of their total budget, in the ACS 2012-2016 period, they still realize more than 60 percent savings when living in the first (0.125-mile) distance band and High MA places. Given their higher incomes, total household savings would be in the range of $11,000, the most of any household group. Allocating one third of that to a mortgaged based on 2020 rates could increase the mortgage by nearly $150,000.

Single Parent Family @ 50% MHHI
These are perhaps the most challenged households as they have the lowest budgets with the highest transportation cost share at $31,829 and 31.2 percent in the ACS 2012-2016, respectively. Our analysis shows that their VMT has also increased between the study periods. Moreover, there appears to be a trend where transportation cost savings with respect to LRT station proximity has eroded compared to the first three groups. We surmise that these households are being displaced from locations with lower transportation costs.

Moderate-Income Family @ 80% MHHI
With the second lowest income of the household types included in this study, these households may be nearly as challenged as single parent households, although their transportation cost share is about in the middle of the five other groups. Nonetheless, our analysis shows they are similar to single parent households. It would seem that perhaps moderate income households are also being displaced from locations near LRT transit as well as in High MA areas.

Dual-Professional Family @ 150% MHHI
While these households have the highest incomes of the types we used in this analysis, their transportation costs are nearly the highest as well. One challenge these households may face is finding a location that meets the needs of both professionals. Although our analysis shows that their annual VMT increased between the study periods, they also gain considerable savings when locating near LRT transit stations, and especially if they also live in High MA areas.

Our analysis reveals that there can be considerable transportation cost savings when locating near LRT stations and especially when also locating in High MA areas but only to some households and notably not to others. We offer implications for transit and land use planning and housing, as well as for future research.

Chapter 8: The Variation in Real Estate Rents with Respect to Place Typology and Transit Station Proximity

There is a dearth of systematic research into the relationship between fixed route transit (FRT) systems such as light rail transit (LRT), bus rapid transit (BRT), streetcar transit (SCT) and commuter rail transit (CRT) with respect to real estate rents and transit station proximity. Though there are numerous case studies of individual systems in individual metropolitan areas, they focus mostly on a single property type. Those studies also vary in the type of data used, methodologies, and functional form specifications. In other words, research lacks a consistent cross-section approach to estimate variation in real estate rents between FGT systems and different types of real estate. This chapter seeks to close this gap in the literature.

This chapter presents cross-section regression analysis that uses CoStar, census and GIS-derived location data in a common methodology to estimate the association between FGT station proximity and office, retail and multifamily rents. In all, nearly 60 FRT systems serving more than 30 metropolitan areas are studied, which includes about 300,000 cases. Numerous variables are used to control for structural attributes, occupancy, socioeconomic characteristics, land use, location and other influences.
For the most part—with some surprising exceptions—real estate rents tend to rise the closer the property is to transit stations. There also appears to be a sorting that occurs between real estate types and transit station proximity, which is to be expected in the competition for locations nearest to transportation services.

A sample of key findings is illustrated in Figure ES.2 with respect to multifamily rents as a function of distance from rail transit stations. With the exception of streetcar transit (SCT) station proximity, multifamily rent generally increases with respect to distance from transit stations indicating the presence of externalities at and near those stations.

Implications for fixed guideway transit system and land use planning are offered.

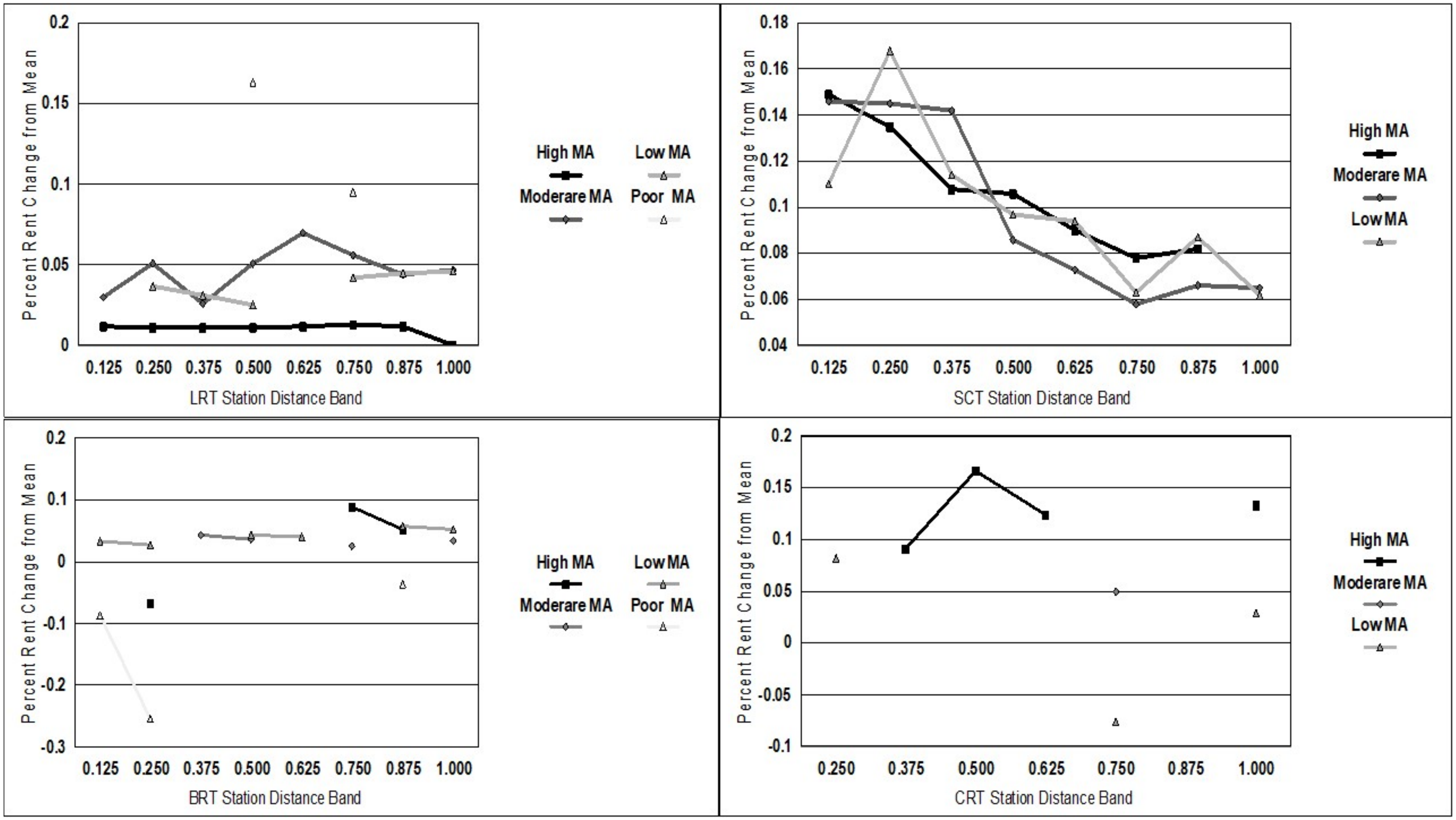


Figure ES.2
Plot of significant and contingent significant LRT, SCT, BRT and CRT multifamily rent coefficients with lines connecting respective points with respect to Place Typology

Chapter 9: The (Overlooked) Association between Express Bus Station/Stop Proximity and Multifamily Rents with Implications for Transit and Land Use Planning

Despite hundreds of studies into the association between real estate value and proximity to fixed route transit (FRT) systems, none has assessed the association with respect to express bus transit (XBT) stations/stops. Ours is the first to do so. Using a static, cross-section quasi-experimental research design, we evaluate CoStar multifamily (MF) rent per square foot to estimate the difference in rent with respect to proximity to (XBT) stations/stops. However, we are also interested in knowing whether there are synergistic price effects at the intersection of XBT and other FRT systems such as light rail transit (LRT). In this article, we estimate the MF rent premium with respect to XBT and LRT (XBT+LRT) station/stop proximity separately, rent premiums for combined XBT and LRT stations/stops, and for those MF cases that are more than 1.0 mile beyond the nearest LRT station. In all cases, whether separately or combined with LRT stations or away from LRT stations, with find positive associations between MF rent and proximity to XBT stations/stops. However, we also find evidence of negative externalities at or near XBT, LRT, and XBT+LRT stations/stops. Express bus transit and land use planning implications are offered.

The research and modeling used in this chapter is essentially a "proof of concept" in creating a simple yet robust method of measuring interactive effects of two different transit modes intersecting at or near the same location. As the proof of concept appears successful, we expand it in Chapter 9 to include Place Typologies and extend the interactive construct to evaluate differential rent outcomes associated with light rail transit systems intersecting streetcar transit (SCT) systems, bus rapid transit (BRT) systems, and commuter rail transit (CRT) systems.

Our over-arching perspective is that future economic returns to local economies and local government resources may be maximized by increasing development opportunities near XBT stations/stops. For instance, while there has been a concerted effort to create transit oriented developments (TODs) across the nation, they tend to focus on rail systems, and recently bus rapid transit systems. We are not aware of any express bus TODs—maybe the time has come. In any event, transit and land use planners would be advised to assess the development potential for multifamily investment and other land uses near XBT stations/stops. Transit and land use planners might also consider rethinking drop-off/park-and-ride lots for their development potential while retaining those options.

Our analysis suggests that because of positive market responsiveness to XBT station/stop proximity, transit agencies may consider expanding XBT services as well as creating more synergies between XBT systems and other transit modes. Though our analysis was of XBT stations/stops within metropolitan areas served by LRT systems, our research suggests that more US metropolitan areas may benefit from them, and those with XBT systems may consider adding to their inventory.

As noted earlier, the research and modeling reported here is a "proof of concept" showing how one may create measures of interactive effects where two transit modes intersect. We will extend this proof of concept to Chapter 9, which will also incorporate the Place Typologies created in Chapter 1.

Chapter 10: How the Intersection of Light Rail Transit Stations with other Transit Modes Influences Real Estate Rent

Using lessons of the “proof of concept” developed in Chapter 8, we extend the analysis of the interactive effects of light rail transit (LRT) stations shared with streetcar transit *SCT), bus rapid transit (BRT) and commuter rail transit (CRT) on office, multifamily and retail real estate rents.

For the most part, we found that where a metropolitan area includes more than just an LRT system—in our case being one or more of SCT, BRT and CRT systems—it may be important to evaluate interactive effects between them. In nearly all comparisons between the original model in Chapter 7 and the expanded model here for office and retail estate, the combined LRT+SCT, LRT+BRT and LRT+CRT coefficients were higher meaning interactive effects were greater than just for LRT alone. This is reasonable, *a priori*.

However, less impressive are comparisons with respect to multifamily real estate where relevant coefficients for only the LRT+SCT expanded model were larger than the original model. For LRT+BRT and LRT+CRT, results were less impressive for the first 0.50-mile distance bands. But this begs the question. In these cases, it is important to know that combined LRT+BRT and LRT+CRT stations actually result in multifamily rents falling below the mean in the first 0.50-mile DBs. Perhaps it is also important that the relevant coefficients of the combined LRT+CRT stations exceed those of the original LRT model in distance bands from 0.50-mile to the end of the 1.00-mile study area. Indeed, these particular results suggest that multifamily real estate is more sensitive to potential externalities associated with BRT and CRT stations which is also reasonable, *a priori*.

Through this chapter and in Chapter 7 as well, we counsel for improved transit and land use planning, and urban design to help overcome externality effects of transit station proximity, and improve rent premiums with respect to transit station proximity. A framework for this is outlined in Chapter 12.

Chapter 11: Regional Differences in the U.S. Real Estate Market Response towards Proximity of Fixed Route Transit Systems

Fixed-route transit (FRT) systems have operated in the US for more than one hundred years with the majority developed during the last half a century. While many single-system studies exist, there has not been rigorous, systematic cross-section analysis of whether and the extent to which these systems influence the real estate market. This article helps close the gap in research. In particular, in this article we apply hedonic regression to estimate the association between FRT station proximity and office, retail and multifamily rents and extend the analysis to compare the structural differences of these responses across metropolitan areas and markets.

In this chapter, we explored the structural differences between associations of proximity to Fixed-Route Transit and real estate rents across regions. The summaries of this analysis explored in the paper (and documented further in the supplementary material) indicate some clear patterns of market responses to light-rail transit and bus-rapid transit, mostly when considering associations with multifamily and office land uses. For streetcar, we were generally limited by small sample sizes in the distance band buffers across regions. While the overall interpretation of streetcar indicates generally positive associations with rent and proximity, this may be conflated by the fact that most streetcar systems are circulators in central city areas where rents are generally high anyway. A larger sample size of developments in proximity to streetcar may help parse out the implications across different cities.

For cities planning FRT expansions or additions in their region, these results help inform other cities that may be useful case comparisons to set expectations. These findings also hint at the contexts in which new FRT additions or expansions might pressure low-income residents. In many cases, access to high-quality transit can elevate travel opportunities low-income households towards lower cost choices. If FRT systems and corresponding land use development are expected to add competition associated with increases in rent, this information can help inform mitigation strategies near FRT to reduce gentrification pressures and avoid pushing out low-income residents in the name of higher rents. These are areas in need of research.

Chapter 12: The Need for Good Transit and Land Use Planning, and Design

In this chapter we assert that fixed route transit (FRT) station planning (the process leading to locations) and design (how stations are integrated with transport systems and nearby land uses) can dictate (a) use of the system by passengers, (b) development outcomes around the station, sometimes to a few miles away, and (c) real estate markets. The vast literature on FRT station planning and design may boil down to these over-arching principles that FRT systems and their stations can:

- Reduce adverse impacts of transit stations on surrounding land uses;
- Facilitate positive interactions between land uses near stations; and
- Maximize accessibility of passengers to transit stations and nearby land uses.

Unfortunately, the statistical evidence presented throughout our study indicates that poor station planning and design can undermine the very purposes and promises of transit in America. Indeed, beyond scope, we undertook a remote visual reconnaissance of what we call "good" and "bad" and even "ugly" station locations and design. This reported in **Appendix G.** Some "good" station locations and design have low to modest WBT scores while others that in our opinion are "bad" locations and design have modest to high WBT scores. We conclude that there does not appear to be an easy way to predict transit station development outcomes based on transit station planning and design. This is an area where new research is needed. This is the theme of the first section of this chapter. The second section identifies the need for future research and includes an overall perspective on the role of transit in meeting America's market demand for mixed-use communities that are accessible to transit.

Epilogue

Transit Funding Options, Assessments, and Approach to Capturing Regional and Spatially-Related Value

Toward A Proportionate-Share, Spatially-Related Value Capture Funding Scheme for Transit

As our research demonstrates, fixed-route transit (FRT) systems confer both regional and local benefits. Regionally, they elevate overall economic performance as well as provide a wide range of public goods such as lower levels of greenhouse gas emissions and more mobility options. Locally, they generate value to private property that is spatially related to transit station proximity. Based on economic development, real estate value added, and fiscal benefits, there is much to be said for expanding existing systems and launching new ones.

However, in these days of declining federal support for fixed-guideway transit capital investments, new sources of funding are needed. The inventory is surprisingly large but largely untapped. In some cases, state enabling legislation may be needed but in others local popular and political support needs to be generated. The choice of funding option can make a difference. In this report, we introduce the role of fixed-guideway transit in creating value, identify numerous transit funding options, review criteria that may be used to choose those options that maximize key public finance objectives including capturing part of the value created by transit investments, and posing a funding approach that captures part of the value-added to regions and to areas around transit stations in relation to the distance of benefiting property from those stations.

The epilogue is comprised of four sections:

Section 1 reviews how transit can improve property values and it includes the proposition that a portion of the value-added can be captured to help finance transit.

In **Section 2,** we present a large list of transit funding options including how they operate and the extent Appendix D
Supplemental tables for Chapter 2
repair-rehabilitation-replacement costs.

Section 3 identifies public finance criteria that should be used to guide the selection of funding options to best meet planning, efficiency, equity, administrative and other objectives.

We conclude the epilogue with **Section 4** that poses an approach to fairly apportion the burdens of financing transit across a region that broadly benefits from its services and within areas around transit stations based on spatially-related benefits.

The nation will add about 100 million people between now and mid-century. One of us (Nelson 2013) has estimated that about a quarter of American households want to live near fixed guideway transit opportunities though less than 10 percent have those options now. Perhaps one reason is that Americans understand the cost savings associated with living near transit stations. Yet, even if all new homes built between now and mid-century were located near existing or planned fixed-guideway transit stations the demand for living near those stations would still not be met.

The report includes seven appendices:

Appendix A
Graphic and statistical inventory of transit systems used in the study

Appendix B
Annotated literature review of materials used to create the Place Typologies in Chapter 1

Appendix C
Place Typology figures for each transit system of each metropolitan area

Appendix D
Supplemental tables for Chapter 3

Appendix E
Supplemental tables for Chapter 4

Appendix F
Supplemental tables for Chapter 5

Appendix G
Good-Bad-Ugly framework and application for Chapter 12

In addition, the National Institute for Transportation and Communities has archived our public data, though not data from CoStar because of licensing agreements.

CONTEXT

This report is the culmination of a genre of research into the relationship between various modes of fixed route transit (FRT) systems and development outcomes. Those modes include light rail transit (LRT), bus rapid transit (BRT), streetcar transit (SCT), and commuter rail transit (CRT). We have pioneered methods to evaluate development outcomes using simple-to-understand economic base methods applied to jobs by sector, wages, population, households, and housing tenure. Shift-share analysis in particular has been used to assess the extent to which FGT systems were associated with increasing or decreasing shares of jobs, people and housing not only over time but with respect to pre-recession, recession, and post-recession periods. We have also become leaders in using commercial real estate data—CoStar—to evaluate the relationship between proximity to FGT systems and commercial rents, controlling for the usual suspects. But our prior work has been limited to assessing outcomes based only on systems as a whole.

This report decomposes our systemwide studies into categories or types of FGT stations including individual stations. In many ways this would have been difficult if not impossible in our prior work because of the sheer amount of processing needs across FGT systems in more than 30 metropolitan areas studied. Because of prior work, what had been impractical is now possible because we have already collected, cleaned, and refined the data, and developed and refined our analytic techniques so they can be applied to disaggregated analysis for individual FGT systems in individual metropolitan areas. This report applies statistical techniques, such as factor/cluster analyses, to identify station areas typologies and then assess the extent to which station types influence economic development (based on LEHD data), people (using census data), and real estate values (based on CoStar data) during each study period for each system and mode.

Completing a Genre of Research

Our work helps fill gaps in research, much of which we actually pioneered. LRT, BRT, SCT and CRT systems are growing in number and expanding where they exist. Until our work, there was no systematic assessment about how they influence the location of jobs by type of sector and wages, people and their housing choices and tenure, and real estate market values (Nelson 2015; Nelson et al. 2015). Key among findings, our prior research found:

> Before the Great Recession (GR), transit station areas lost share of jobs relative to their regions. During the GR and early recovery years they gained share though there were variations by type of transit system; distance from stations (BRT for instance gained job share only within the first one-quarter mile [see Nelson et al. 2013] while LRT and SCT stations gained share up to a mile away and CRT stations lost share during both time periods [see Nelson 2017a]); and sector. Since recovery LRT and SCT systems have continued to gain share while BRT and CRT systems have not (Nelson et al. 2018),
>
> Before the GR, transit station areas lost share of higher-wage jobs relative to their regions. During the GR and early recovery years, LRT station areas gained upper and middle wage job share though lost lower wage ones, SCT station areas gained upper and lower wage job share but lost middle wage jobs, and BRT station areas lost share of all jobs by wage category (though there were exceptions for individual systems) (Nelson 2018).

As expected, LRT and SCT station areas gained small shares of their region's population between the pre-GR and GR-recovery periods. Surprisingly the effect was roughly equal between those under 35 ("Millennials") and those 35-64 while declining shares occurred at 65 and older. In contrast, BRT station areas lost share across all age groups. These trends continued after the recession (Hinners, Nelson & Buchert 2018; Nelson et al 2018).

Market rents for office, retail and apartment properties with respect to distance from different kinds of transit systems varied considerably; LRT and SCT showed the most robust positive effects, BRT modest and limited positive effects, and CRT mixed effects (Nelson et al. 2015; Nelson and Hibberd 2018a, 2018b).

Using keywords relating to station area development for published works in the past five years, we find no studies that disaggregate the influence of transit by mode on jobs, wages, people, housing, tenure and commercial rent by or between metropolitan areas by type of station. That is the purpose of this study and final in a genre of work that we pioneered.

Advancing NITC Themes

Our sponsor for this research, the National Institute for Transportation and Communities (NITC) is one of five US DOT-funded National University Transportation Centers. NIIT sponsors research that advances three themes around which our work has been organized.

Increasing access to opportunities
Well-connected regions and communities can improve social equity by providing access to jobs, services, recreation, and social opportunities.
Our research expands on prior related work, including much of our own, to assess the extent to which jobs and people are attracted to transit station areas with respect to jobs by wage level and households by income; station distance; and type of FGT station by mode. Analyzing both jobs and households concurrently improves upon the understanding of the spatial mismatch that often occurs for low-income households.

Improving multi-modal planning and shared use of infrastructure
Improved mobility requires a range of options for moving people and goods.
As will be seen, our analysis improves understanding of how cities and regions vary in the performance of development outcomes associated with transit through estimations of rent premiums, or the willingness of the market to pay for transit station proximity. It is thus a much more refined analysis compared to our prior work. Our analysis advances evidence needed by planners to demonstrate the benefits of transit systems in the context of multi-modal transportation systems.

Developing data, models, and tools
Our complex transportation system demands better data and tools for decision-making.
Our planned factor/cluster analysis helps describe types of station development patterns, supporting practitioners in identifying the specific characteristics needed for their particular situation and development goals. Additionally, a key feature of our work is updating and expanding the databases and making them open source through NITC. New data generated from our work is now available at no cost to researchers through NITC. This democratization of data enhances examination of the implications of changes to transit system on a range of outcomes relating to mobility, economic equity, the environment, and health at a variety of

scales (from the station area to the nation) by researchers, policy analysts and students everywhere.

These themes help shape the problems addressed in our research in analysis that is guided by our research questions, reviewed next.

Problems Addressed and Research Questions

Our prior research has established that development outcomes to LRT/BRT/SCT/CRT systems vary by type of system and station distance, among other things. Our earlier work was limited to the period before the GR (2000-2007) and during the GR/recovery years (2008-2011). It was further limited because many BRT systems emerged late in the 2000s while many LRT, BRT and SCT systems have been added or expanded since then. Our current work expands the number of systems and updates data through 2018, with commercial rent data through 2019. In all, our report considers 18 LRT systems, 16 BRT systems, 12 SCT systems and seven CRT systems serving 36 metropolitan areas.

In particular, the report disaggregates data used to assess systemwide outcomes to outcomes based on types of stations by mode. Our analysis is guided by two overarching research questions:

Q1: How do Transit Outcomes Vary by Mode and Type of Transit Station?

This analysis includes each transit system for each metropolitan area studied during appropriate time periods for that system, as well as systems combined across metros. Trends tested include:

- Changes in the number and share of jobs by sector with respect to type of system and distance from stations, by type of station based on factor/cluster analysis;
- Changes in the number and share of jobs by wage category with respect to type of system and distance from stations by type of station based on factor/cluster analysis; and
- Changes in number and share of population, households, householders by age, and housing by tenure with respect to type of system and distance from stations by type of station based on factor/cluster analysis.

Q2: How does the real estate market for office, retail and apartment properties respond to proximity to transit stations by mode and type of station?

- Our prior work pioneered the use of CoStar commercial rental data for very broad assessments of real estate market responsiveness to transit by type but not really by location except for corridor distance bands. The report presents results of more refined, continuously measured relationships in those metropolitan areas based on mode and type of transit station where CoStar data are sufficient for analysis.

How the research questions are addressed is guided by our overall research plan and design.

RESEARCH PLAN AND DESIGN

Because of the nature of data, our research establishes only associations and not causality. That said, our overall research design is comprised of these elements:

> ***Quasi-experimental design*** wherein controls and treatments are used albeit not in the way in which rigorous testing is conducted in physics, chemistry, medicine and the lile.
>
> ***Pre-Post (before-and-after) analysis*** to establish associations over time with the introduction or expansion of transit systems.
>
> ***Interrupted time-series analysis*** to establish trends before a major event such as the Great Recession, trends during the event, and trends afterward.

Our research plan is multifaceted in using different kinds of data to address the two research questions.

Transit Station Typology
We start by creating a typology of transit stations. Using factor/cluster analysis, we create a typology of stations based on these dimensions:

- Land use mix (an entropy measure);
- Jobs-population balance (a measure of jobs versus population concentration);
- Distance to downtown and other major activity centers (a centrality measure);
- Employment sector composition (a measure of economic concentration); and
- Socioeconomic composition (a measure of demographic concentration)

These dimensions are used to create station typologies based on their spatial characteristics (downtown, suburban center, isolated), economic features (high-middle-low wage corresponding to relative education and skill levels), and social attributes (age-income-race/ethnicity-tenure). As will be seen, we settled on a typology that assigns transit stations to relatively few types.

Economic Base Analysis
Our prior going research used quasi-experimental, economic base methods to assess change in concentration in:

- Jobs by sector (using Location Employment-Household Dynamics [LEHD] data),
- Jobs by wage category (also using LEHD),
- Population and households by age and other demographic features (Census), and
- Residential units and tenure (Census)

in distance-band based station areas relative to transit regions by transit mode over different time periods. Shift-share analysis is used mostly but so are variations of location quotient analysis. We continue this tradition using updated data but also applying our station typology to the analysis.

Hedonic Analysis
We pioneered the use of CoStar rent data to assess the association between transit station distance and rent with respect to different system types and metropolitan areas. In this report, we disaggregated transit stations into types to show that difference types of station have different outcomes—albeit not as much as we expected.

BROAD IMPACTS

NITC seeks research that: can achieve long-lasting impacts; leverage prior research into new research that may also leverage future research; is groundbreaking; can advance the state of the art or practice of a genre of research; and distinguish NITC. Although only time will tell whether all of these impacts will be achieved from research presented in this report, we are hopeful.

What long-lasting impact might this research have?
America will add at least 100 million new residents, 40 million new households, and 60 million new jobs by 2050. We know from demographic analysis and consumer preference surveys that at least a third of America's 150 million households (50+ million) in 2050 will want to live in locations providing them with transit options, in addition to mixed-use and mixed-housing options. We also know from research on firm location behavior that up to 100 million jobs will be attracted to locations with transit options. Our prior research outlines the extent to which LRT/BRT/SCT/CRT systems can meet future demand. The current research expands our on our prior work to include types of stations which will likely help guide LTR/BRT/SCT/CRT planning, design, investment, and implementation for many years if not decades to come.

Are there any opportunities for leveraging of the research results for future research or practice?
Our prior work included several partners whose contributions have helped create the robust database were used in the current work. A key product of our work is an updated database allowing researchers to explore detailed development outcomes to transit stations that prior research only introduces.

Is the research groundbreaking?
We have pioneered the genre of research that associates development outcomes with respect to different transit systems across the nation. Our report expands our genre of research by addressing outcomes to different types of transit stations for each mode and each transit system over time with special reference to pre-recession, recession and post-recession periods.

Will it advance the state of the art or practice?
As will be shown, our report advances the state of the art of research by: updating and expanding our prior work, much if it pioneering; expanding analysis to include types of stations by mode; and making our expanded database available freely through NITC.

How might this project distinguish NITC?
NITC's prior support allowed our research to make NITC reasonably synonymous with this genre of research among policy-makers, researchers, students, and the informed public when it comes to learning how fixed-guideway transit systems can improve mobility of people to build strong communities. In this report, we elevate NITC's distinction through disaggregated analysis of outcomes based on the types of stations overall and with respect to pre-recession, recession and post-recession periods.

FIXED ROUTE TRANSIT SYSTEMS STUDIED

In this section we first characterize the types of fixed route transit (FRT) systems studied in this report these systems so readers can differentiate between them. We then summarize what and where those systems are.

Types of Fixed Route Transit Systems

FRT systems include rail and bus rolling stock. Consider rail transit systems. While CRT may seem different obviously from LRT and SCT, differences between those two systems may not be so obvious. Table 1 compares key design features of these systems. Visual differences between these types of rail transit rolling stock are noted in figures 1 through 3.

Perhaps even more subtle are differences between local bus transit (LBT), bus rapid transit (BRT), and express bus transit (XBT). Although we address only BRT outcomes in this report, ongoing work is also addressing XBT systems. Box 1 is an edited description of differences between these systems provided by the Greater Richmond Transit Company. Figure 2 illustrates visually what those types of busses look like. Table 2 lists the FRT systems studied and when they commenced operations while Figure 3 illustrates their location.

Table 1
Key Design Differences between LRT, SCT and CRT Systems

Key Differences	Light Rail Transit (LRT)	Street Car Transit (SCT)	Commuter Rail Transit (CRT)
Right-of-way	Primarily exclusive	Primarily mixed flow	Primarily with freight rail
Trains / Capacity	1 to 4 cars / 125 to 500	1 to 2 cars /120-240	1 to 4 cars / 170 to 680
Station Spacing	1/2 to 1 mile or more	2-3 blocks to 1/2 mile	Multiple miles (~5-10+)
Peak Passengers	1,000-7,500 per hour	1,440-5,760 per hour	2,000-8,000 per day
Seats / Standees	64/61 ~125 per car	30/90 ~120 per car	91/79 ~170 per car
Speed	~1+ mile ~50-60 mph	close spacing ~25-35 mph	Multi-mile ~<80 mph

Sources:
LRT and SCT adapted from https://nacto.org/wp-content/uploads/2016/04/4_RTD-Streetcar-and-Light-Rail-Characteristics_2012.pdf
CRT adapted from http://www.rtd-fastracks.com/main_398.

Figure 1
Light Rail Transit example
This is an image of the Portland light rail transit system, MAX.
Source: TriMet, https://www.flickr.com/photos/trimet/4518340197

Figure 2
Street Car Transit example
This is an image of the Tucson street car transit system, SunLink.
Source: Regional Transit Authority, https://www.sunlinkstreetcar.com/history

Figure 3
Commuter Rail Transit example
This is an image of the Utah Transit Authority’s commuter rail transit system, FrontRunner.
Source: Utah Transit Authority, http://www.rideuta.com/uploads/commuterRailHighRes.jpg

Box 1
Differences between LBT, BRT and XBT Systems

What is Local Bus Transit (LBT)?
Local bus transit (LBT) runs on-street, stopping every few blocks, with only a sign marking a stop location. As a result, a local route trip time is much longer than a BRT or XBT trip. Stops with heavier usage may feature a bench or a shelter. A few, very heavily used stops may have information kiosks with bus arrival information. The frequency of local bus service and the time of day that local bus service is available can vary substantially by route. With these features, local bus service typically serves local riders who are not traveling far.

What is Bus Rapid Transit (BRT)?
Bus rapid transit (BRT) is a high quality, high capacity rapid transit system that offers many of the advantages of rail transit but at a lower and more affordable cost. BRT buses typically operate on local streets, with stops about every half-mile, run every 10 to 15 minutes and serve both local and regional riders. BRT buses may travel in dedicated lanes and often use signal priority systems to reduce delays from traffic congestion. In typical BRT systems, passengers wait for the bus at higher-quality stations and pay before they board using ticket vending machines at the station. These qualities add up to an efficient, reliable, frequent and convenient transit service that meets the needs of many types of travelers.

Instead of trains/trolleys and tracks, BRT invests in improvements to vehicles, stations, operations, roadways, rights-of-way, intersections and traffic signals to speed up bus transit service. BRT is not a uniform, turn-key transit technology, but represents a spectrum of service enhancements. BRT systems are constructed by choosing and integrating various BRT elements, such as dedicated lanes, signal priority for buses, branded vehicles and enhanced station amenities. An example of a BRT system is shown in Figure 4.

How is Express Bus Transit (XBT?)
Express bus transit (XBT) service generally pick up passengers at one or multiple park and ride locations in suburban communities and then travel, non-stop, via freeways or other high speed corridors to the central downtown district or other major employment centers where passengers disembark. Where available, they will use dedicated high occupancy vehicle lanes on freeways and in some cases they use specially designed shoulder lanes on local streets. These buses tend to operate only during peak commute times and mainly serve regional riders providing increased pedestrian traffic to local businesses, retail, restaurants and healthcare, but during limited times. Some XBT services are made available during off-peak and weekends for special events such as major sporting events, concerts, and fairs.

Source: Adapted for purposes this report from Greater Richmond Transit Company, http://www.ridegrtc.com/media/annual_reports/BRT_FAQ_7-20-2015.pdf.

Figure 4
Bus Rapid Transit system example
This is an image of the Eugene-Springfield Emerald Express.
Source: The Institute for Policy Research and Engagement, University of Oregon, https://cpb-us-e1.wpmucdn.com/blogs.uoregon.edu/dist/2/1652/files/2014/05/Eugene-BRT-2743795-e1400605109615.jpeg.

Table 2
Fixed Route Transit Systems Studied

Light Rail Transit	Year	Bus Rapid Transit	Year	Streetcar Transit	Year	Commuter Rail Transit	Year
Buffalo	1984	Cleveland	2008	Atlanta	2014	Albuquerque-Santa Fe	2006
Charlotte	2007	Eugene-Springfield	2007	Dallas	2015	Austin	2010
Cleveland	1980	Kansas City	2005	Little Rock	2004	Dallas-Fort Worth	1996
Dallas	1996	Nashville	2009	Portland	2001	Miami Tri-Rail	1989
Denver	1994	Pittsburgh	1977	Salt Lake City	2013	Minneapolis	1997
Houston	2004	Reno	2010	Seattle	2007	Nashville	2006
Minneapolis-St. Paul	2004	Salt Lake City	2008	Tacoma	2003	Orlando-Daytona	2014
Virginia Beach	2011	San Antonio	2012	Tampa	2002	Portland	2009
Phoenix	2008	San Diego	2014	Tucson	2014	Salt Lake City	2008
Pittsburgh	1984	Seattle	2010			San Diego	1995
Portland	1986	Stockton	2007			San Jose-Bay Area	1988
Sacramento	1987	Washington DC	2014			San Jose-Stockton	1998
Salt Lake City	1999					Seattle-Tacoma	2000
San Diego	1981					Washington, DC	1980s-90s
San Jose	1987						
Seattle	2003						
St. Louis	1993						

Figure 5
Metropolitan Areas with Transit Systems Studied

REFERENCES

Hinners, Sarah Jack, Arthur C. Nelson and Martin Buchert, 2018. Streetcars and Equity. *Transportation Research Record.*

Nelson, Arthur C. 2018. Transit and Wages: The Association between Wages and Transit Station Proximity over Time. Transportation Research Board annual meetings.

Nelson, Arthur C. and Robert Hibberd, 2018a. Analysis of the Variation in Apartment and Office Market Rents with Respect to 1 Commuter Rail Transit Station Distance in Metropolitan San Diego and Salt Lake City. Transportation Research Board annual meetings.

Nelson, Arthur C. and Robert Hibberd, 2018a. Using the Real Estate Market to Estimate Streetcar Catchment Areas in Tucson. Transportation Research Board annual meetings.

Nelson, Arthur C. et al. 2018. Transit and Demographic Outcomes Before, During and After the Great Recession. In progress.

Nelson, Arthur C. 2017a. The Effect of TODs on Jobs, Wages, People and Housing*. Fordham Law Review.*

Nelson, Arthur C. 2017b. Transit and Real Estate Rents. *Transportation Research Record.*

Nelson, Arthur C. et al. 2015. Do TODs Make a Difference? Portland, OR: National Institute for Transportation and Communities.

Nelson, Arthur C. 2015. National Study of BRT Development Outcomes. Portland, OR: National Institute for Transportation and Communities.

Nelson, Arthur C. et al. 2015. Office Rent Premiums with Respect to Distance from Light Rail Transit Stations in Dallas. *Transportation Research Record.*

Nelson, Arthur C. et al. 2013. Bus Rapid Transit and Economic Development. *Journal of Public Transportation.*

Petheram, Susan J., Arthur C. Nelson et al. 2014. Using the Real Estate Market to Establish Light Rail Station Catchment Areas: Case Study of Attached Residential Property Values in Salt Lake County with Respect to Light Rail Station Distance, *Transportation Research Record.*

CHAPTER 1: Developing Place Typologies for Transit Analysis[1]

OVERVIEW

Ours is the first study to create typologies of urban development patterns for national-scale research. To expand on the analyses explored in prior studies, we begin by exploring how the literature and practice identifies different types of transit-based development. For the purpose of this report, we are focusing mainly on fixed-route transit (FRT) systems and corresponding place typologies. In this project, we aim to capture differing built environment contexts that might be more or less resilient or responsive to economic development (jobs, housing, populations, or real estate values). We orient our analyses towards the neighborhood-level—instead of station-level—so that we might compare and quantify the relative impacts of FRT on economic outcomes, compared with areas without FRT access. And finally, we aim to develop place types that might more readily align with planning practice.

In the following section, we first explore the academic and white paper literatures to identify the purposes of place and transit station typologies. We then synthesize a framework and corresponding measurements for delineating different dimensions of transit-oriented development. From there, we describe the different quantitative methods for categorization of place types so that we might expand a consistent approach to compare and contrast similar development patterns across vastly different regions. In the last section, we explore the guiding principles for place types development, and we describe the data and methods used to develop the place typologies used throughout this project.
At the outset, we advise readers that an extensive annotated bibliography of materials used to create the Place Typology is provided in **Appendix B.**

Typologies of Transit Stations in Planning, Design, and Analysis

Typologies, in the context of transit design and evaluation, are the categorization of contexts that distinguish across areas or locations based on characteristics determined to impact the outcomes of interest in the analysis. For behavioral studies that focus on transit ridership, for example, typologies would consider characteristics that distinguish across built environments that enable (or inhibit) more (or less) ridership or demographic markets indicative of higher (or lower) propensities to ride. For economic strategy development, typologies would need to be sensitive to both measures that describe current economic situations (such as jobs and wage levels) as well as metrics that might indicate responsiveness to various strategic initiatives (such as race/ethnicity or propensity to gentrify). Through performance-driven evaluations, typologies can align known correlates of success for a number of outcomes to provide a relative basis for understanding how any one station or system functions today or has the potential to function in the future.

For agencies and practitioners, the typing of transit areas is driven by the realization that not all transit-oriented development (or transit-adjacent development or transit neighborhoods) are the same. The categorization of different contexts provides a means for distinguishing between different design guidelines, different evaluative frameworks, or the identification and

[1] We are pleased to acknowledge invaluable assistance in preparing this chapter as well as Appendix B by Nicole Iroz-Elardo.

implementation of different strategies that improve economic, sustainable, or equitable situations.

Throughout our initial literature and background review, we identified three main types of applications of transit typologies. First, typologies can be used as **conceptual design guides for conceptual planning** and discussion. The main goal of these applications is to align a common vocabulary for ‘current’ or ‘target’ built environment or transportation infrastructure locations. To develop these typologies, practitioners and agencies often rely on previously developed typologies, local knowledge of the area(s), and manual development of definitions. These typologies are usually based on an urban intensity hierarchy—moving up and down in intensity level, like from central business district to urban neighborhood to suburban neighborhood—with special considerations for ‘special attractor’ neighborhoods—such as stadiums or concert halls. The metrics embedded in these definitions most commonly rely on land use measures (like employment or population densities, floor-to-area ratios or height of buildings) or supportive transportation infrastructure (like walkability or intersection density) defined within some close proximity to specific types of transit stations (most often defined within 0.5-miles of the station). These definitions are commonly used for the development of overlay zones that define, describe, and sometimes encourage what ‘appropriate development’ might look like for different transit areas or contexts.

Second, typologies may be developed specifically to **evaluate the performance** of transit or transit areas on economic, sustainability, or social outcomes, sometimes called performance-driven or performance-based typologies. These typologies may incorporate measures that define the land use contexts, but often also include additional characteristics that correspond with the market area demographics and/or other performance-based measures (like estimated vehicle miles traveled). The methods commonly used these applications include compiling ‘indices’ calculated using weighted averages of scaled variables selected to represent various dimensions. Indices may be broken into categories using statistical breaks techniques (such as Jenks) and adjusted based on local knowledge or the areas. A subset of the evaluation-use applications include typologies used for **the identification and implementations of planning or policy strategies** to improve planning or policy outcomes. In this application, an outcome variable (such as vehicle miles traveled) is used predictively as a function of the location typology and/or additional policy-sensitive variables to provide guidance that identifies the ‘levers’ which may improve the outcome.

Third, typologies may be developed specifically to allow for analysts to **controlling for urban contexts or the bundle of environmental or locational characteristics.** In this type of application, the analyst uses typologies to distill various inputs (mainly built environment measures) into a handful of dummy variables to aide in controlling for different types of contexts. These types of approaches are sometimes data-driven using more statistically onerous techniques with little-to-no manual specification of categories (e.g., density thresholds). Sometimes, this application uses a simple ‘decision-tree’ definition—categorizing sites based on a short series of ‘yes or no’ responses to questions about the location, transit availability, or land use situation. More complicated methods or performance measures may limit the ease of transferability of research findings to practice.

In this section of the chapter, we explore the use and development of typologies related to developing and/or evaluating transit neighborhoods. This chapter aims to understand the relationship between place and different economic outcomes (changes in jobs, housing, population, and real estate).

Dimensions of Transit-Oriented Development

While there are dozens of different examples that type transit areas and neighborhoods, we utilize Bertonlini's node-place framework (Bertolini 1999; Lyu, Bertolini, and Pfeffer 2016) to organize the academic and white paper literature reviewed in this study to frame our discussion of typologies. Bertolini's framework aligns transport node (e.g., transit stations) with land use places (e.g., urban development characteristics) to discuss and interpret the 'balance' of values of node and place. In the 1999 framework (Bertolini 1999), dimensions of transit and urban development characteristics were graphically related to explore areas of balance (see Figure 1.1). Locations were the node and place are out of balance are 'unsustained'. In the 2016 expansion of Bertolini's node-place framework, a third dimension 'orientation' is added. In this dimension, the proximity of place (land use, development) relative to node (transit) is considered. Together, the node-place-orientation framework brings into practice the alignment of transit system design, land use policies, and orientation, making it useful to discuss the common correlates of success with fixed-guideway transit-oriented development.

The first dimension is the **'node' dimension representing transit (**or, more broadly, transportation). The primary way to distinguish across transit accessibility, quality, and availability is in differentiating between transit systems. In this current study, we focus on fixed-guideway transit (FGT) systems, including: heavy rail, commuter rail, light rail, street car, express bus, and bus rapid transit. Additionally, several agencies incorporate 'supportive transportation infrastructure', which includes access to local bus systems or circulation shuttles, high-quality walkability and other alternative access/egress modes. For some agencies, parking supply and types (e.g., surface parking) is an important way to distinguish the ways in which higher-quality transit may be accessed (or constrained) by car. Measure of the 'node' dimension may also include transit 'quality' measures as well. For example, measures of transit quality could be defined as the frequency or headways of service, the number of lines or stops within a service area, the number and hierarchy of the types of transit within a service area.

The second dimension represents **'place' or land development.** These measures can broadly be defined as descriptors of the built and/or social environment, either at the present moment or capturing recent changes in either. Measures of population, household, or job densities segmented by housing types, demographics (e.g., income, wages, ages, children or household size), or industries are common measures. Descriptors of development, including intensities (floor-to-area ratio, stories, dwelling units, square footage, business establishment), real estate and land values (land, rent, residential sales, vacancies), or land use mix (e.g., entropy, balance, adjacent nature).

For several of these characteristics, the recent (10-15 year) change in characteristics are also seen in the literature aimed at capturing the acceleration and direction of growth and change, including displacement of vulnerable populations. In more than one agency report, measures capturing 'change of demographics' (e.g., income, wages, household size, education levels) were treated as a separate, but related, dimension labeled 'displacement risk' (Puget Sound Regional Council; City of Bellevue; King County Metro 2014) or 'neighborhood change' (Central Maryland Transportation Alliance and Center for Transit-Oriented Development 2009) or 'market opportunity' (Center for Transit-Oriented Development and Nelson/Nygaard 2011). This 'market or neighborhood change' dimension is often intended to capture recent movement in demographics that might indicate the need for policy intervention.

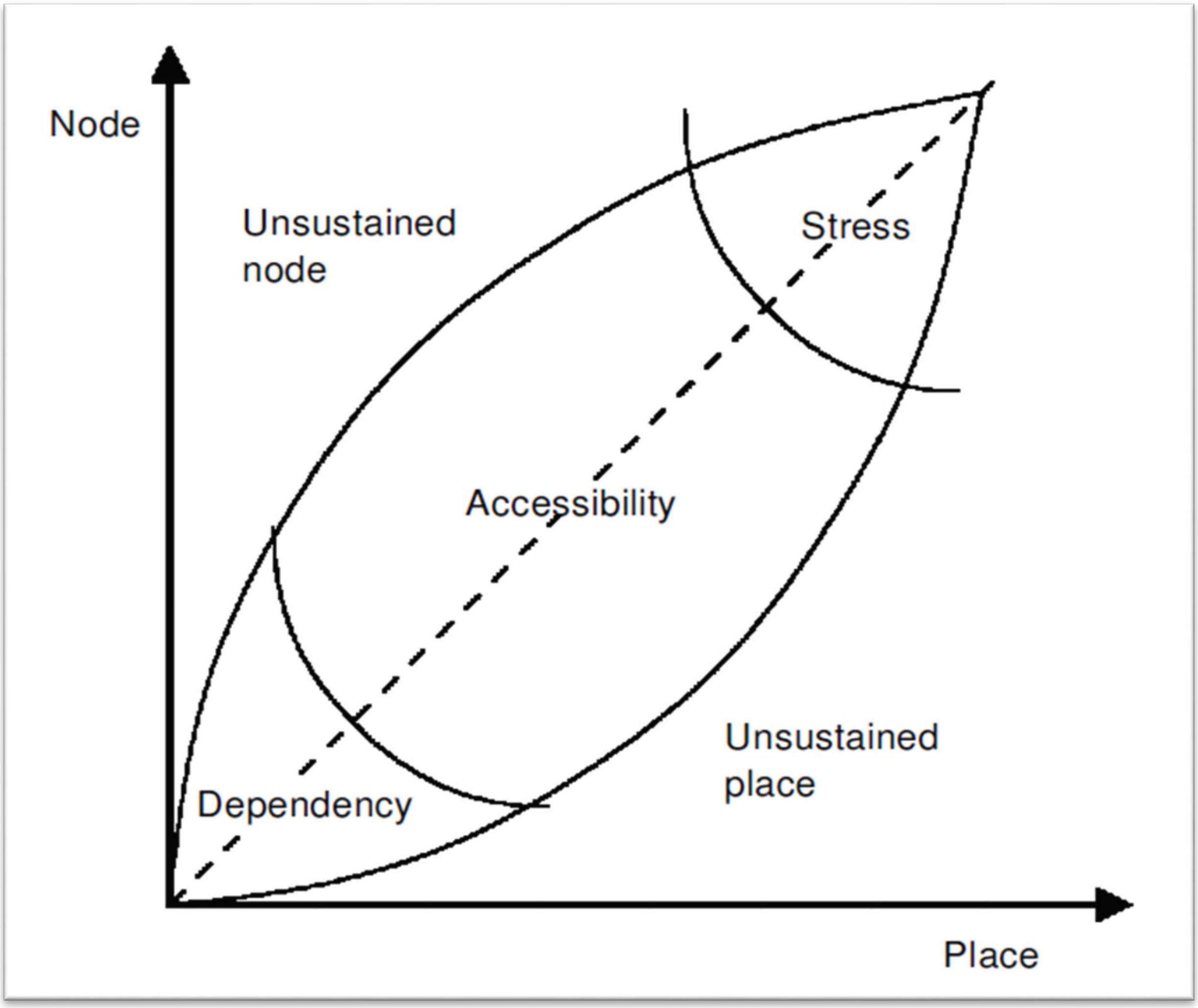


Figure 1.1
Bertolini's (1999) node-place framework

In Lyu et al (2016), the authors also identify several characteristics of place that capture the process of development (e.g., presence of redevelopment authorities) and qualitative evaluations of planning initiatives related to station area planning or zoning, recent development activity, or securing funding/financing for projects. These measures aim to capture the ease or incentives of the development process and may be ranked similarly in places that look drastically different in terms of the built environment. These characteristics were not determined to be the most valuable based on presence in the literature and a review of practitioners by Lyu et al (2016), and they were not the focus on this current national study, but future analyses that examine systems and districts along these dimensions may determine these characteristics important in distinguishing economically successful locations.

The third dimension is **'orientation' representing scales and proximity.** In this dimension, measures aim to align the node and development dimensions through distance. Many of these measures capture proximity of populations or destinations to transit (or vice versa). Additionally, this dimension captures the means by which transit is accessed, such as connectivity of street networks that might facilitate easier access/egress (e.g., walking or biking). For many agency reports, typologies distinguish site or station area scales based on the 'scale' of supporting area. Figure 1.2 is a common example from Renaissance Planning Group (2011), similar examples or descriptions are found in other reports such as the Arizona Department of Transportation (2012). For most agencies, characteristics of the area are often defined by 0.5-mile buffer areas, but some focus on the likely transition of intensities aimed to orient the majority of the development in closer proximity to the stations or 'transit core'. These measures are sometimes embedded in node or place dimensions—specifically because many of the measures from the former dimensions are calculated at a 0.5-mile buffer.

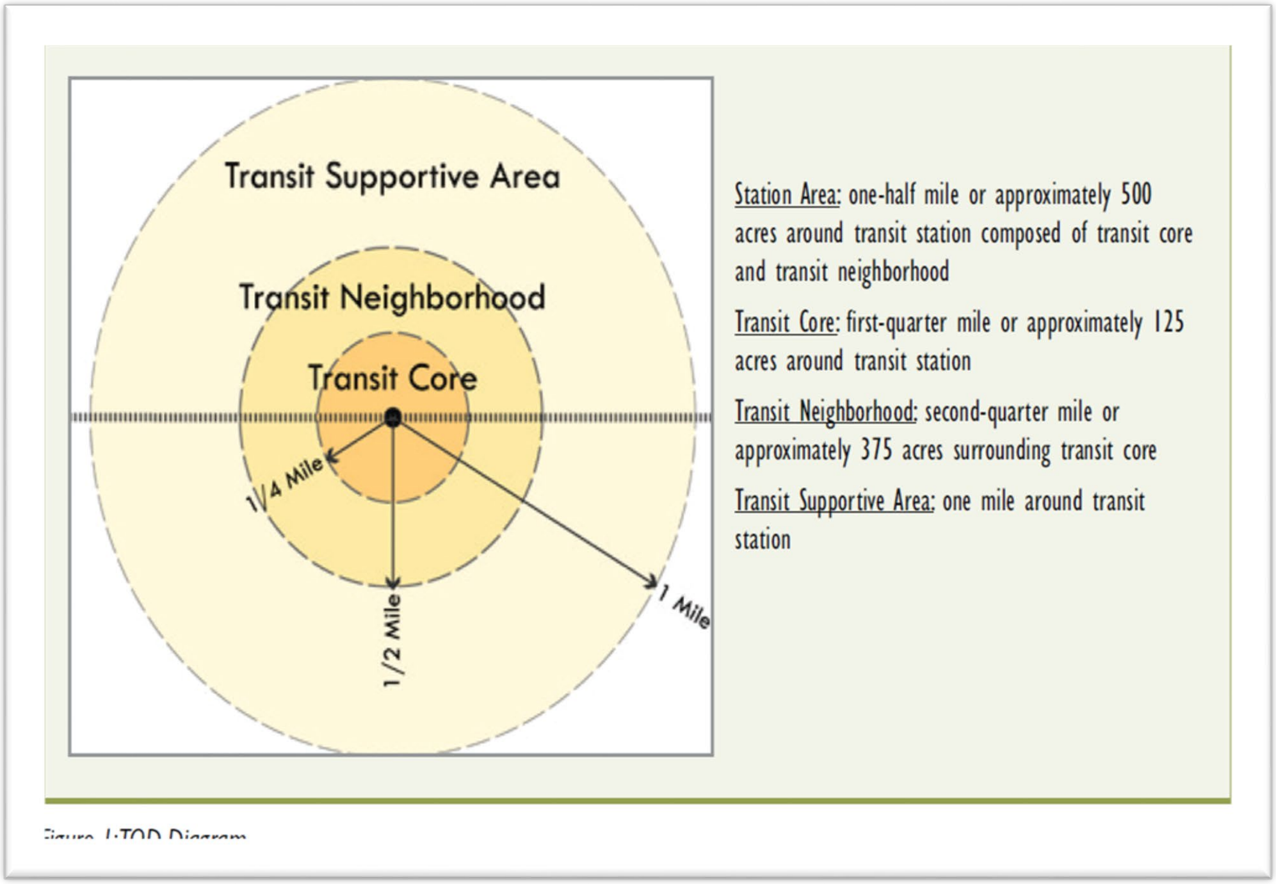


Figure 1.2
Station Service Area Proximities Source: (Renaissance Planning Group 2011)

TABLE 1.1
Transit-Oriented Development Indicators

Transit/Node	Orientation/Proximity	Development/Place	
Number of directions served by Metro or bus Number of metros stations in one TOD Number of bus stops in one TOD *Daily frequency of metro services* Number of other public transport modes (bus, tram) departing on a workday Public transport accessibility level (calculated by scheduled waiting time, walk access time to station) Number of passengers per day by metro Changing rate of Metro passengers in 10 years Number of stations within 45 min. travel by metro *Number of stations within 20 min. travel by metro* Geographic distance to CBD Travel time to CBD by metro *Travel times to major employment and activity centers by metro* Type of metro service (old, new, slow, rapid) Whether station connects to airport directly (no transfer) Whether station is a terminal *Car parking capacity* Bicycle parking capacity	*Average distance from station to jobs* *Average distance from station to residents* Percentage of housing units owner-occupied Percentage of households with access to one or more private vehicles Percentage workers who use non-automobile commuting Percentage of households with low income Percentage of income spent on transportation Walking time to a metro station from the center of each block *Length of paved foot-path per acre* Length of sidewalks and low-stress bike ways Number of cul-de-sacs *Intersection density* Number of entry points into the neighborhood *Average block size* Closeness index of urban street networks (space-syntax, network structure index) Between-ness index of urban street networks (space-	*Number of residents* Percentage of working-age population Percentage of elderly population (above 65) Changing rate of residential population or working-age population in 10 years Changing rate of elderly population (above 5) in 10 years *Numbers of jobs* Jobs per resident *Number of workers in retail/hotel and catering* *Number of workers in education/health/culture* *Number of workers in public administration and services* Number of workers in industry Housing density (units/acre), flats Percentage of public housing above 6 floors; private housing Total gross floor area of development Building floor area by use Floor area ratio; height of buildings Height of buildings Number of neighborhood retail and service establishments Size of built-up area for housing and services Areas with commercial urban amenities Number of massive commercial facilities (>1000 square meter in areas) Number of public facilities	Land-use mix Proportion of similar adjacent land use types Mixed-use attributes (Building floor area) Housing types (e.g., multifamily, single family) Dispersion of different income groups Geographic position of station area (e.g., urban downtown, urban neighborhood) Percentage of TOD-(in)compatible land use (neither residential nor vacant, allowed in future development in overlay zoning) Percentage of vacant land use Areas of green or open space Changing rate of public facility in 15 years Changing rate of floor area ratio in 10 years Changing rate of office jobs in 10 years Qualitative rating of planning initiatives (e.g., station area planning/zoning) Presence of redevelopment authority Qualitative rating of recent development activity Qualitative rating of securing funding and financing for projects Private investment in the area Percentage of people with bachelor's degree Household income

Distance to the closest motorway access by car Number of free-standing bicycle paths (separated bicycle paths) Total bike path length within 2km around metro stations Number of staff in the station	syntax, network structure index) *Walk Scores (calculated based on distance to amenities weighted equally and summed)*	Arriving tourists per 1000 residents of the district Average real estate sales per square foot, average residential rents, or land prices per square meter *Degree of functional mix (workers by economic sections and residents)*	Unemployment levels Rate of unemployed with basic education Tax earnings of district
Note: *Bold and Italic* text represents measures determined to have the highest importance by (Lyu, Bertolini, and Pfeffer 2016).			

Source: Adapted from Lyu, Bertolini, and Pfeffer (2016) (see also Chapter 1 Addenum.)

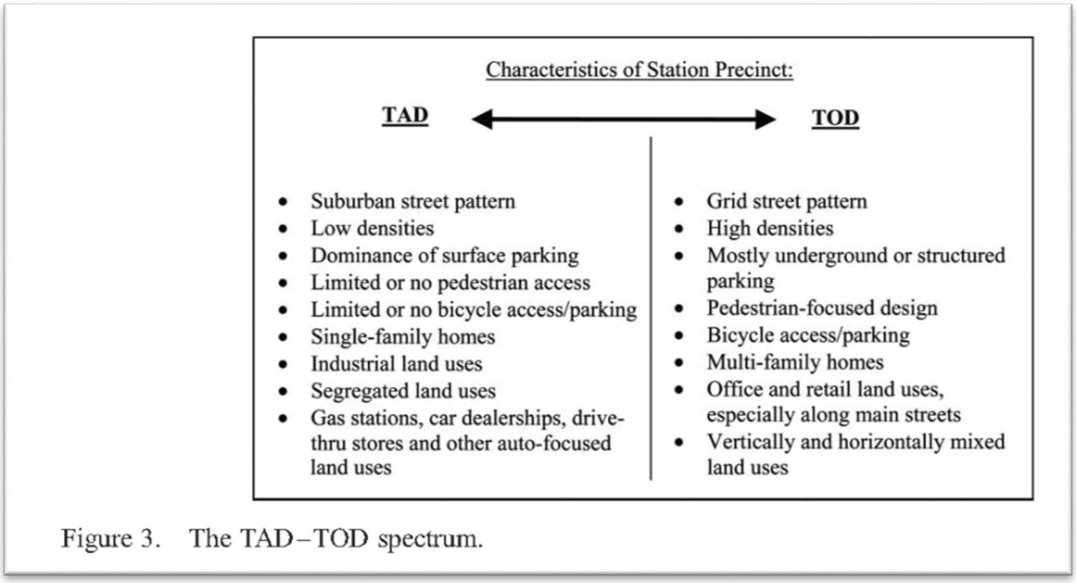
Categorization Methods Used in Previous Studies

We considered four types of methods for categorization that show up in the academic and white literature related to transit neighborhood classification: (1) manual classification; (2) thresholds or qualifying criteria; (3) scaling and weighting measures and breaking them along statistical breaks; and (4) factor and/or cluster analysis. In this section, we first define and describe each approach with examples and then we compare the features of each of these methods for the application of typologies for a large national dataset.

The first method broadly considered was **(1) manual classification**, which relies on quantitative data (such as thresholds or any of the previously described metrics) and/or qualitative rankings or evaluations using local expertise to group similar stations into categories. Ewing et al (2017) provides one example of the TOD qualifications that rely on a combination of quantitative data, site (or google earth) visits, and local expertise to categorize sites based on the following criteria:

- Dense (mid-rise or higher multifamily housing);
- Mixed use (residential, retail, entertainment, and sometimes office uses within one development);
- Pedestrian friendly (streets built for pedestrian as well as cars/transit);
- Adjacent to transit (literally abutting related);
- Built after transit was constructed/proposed (indicates parking supply decisions that took transit access into consideration);
- Fully developed (or near so); and
- Self-contained/dedicated parking.

The second method for categorization we consider in this study uses **(2) thresholds or qualifying criteria.** A threshold-based approach is typically data-driven, but the qualifying thresholds are typically determined by the analyst (not a statistical approach). The most commonly known threshold-based transit neighborhood definition would be the transit-oriented and -adjacent development (TOD and TAD, respectively) area types. (See Figure 1.3 for Renne's (2009) qualitative spectrum for developments that are near high-quality transit but may not be 'oriented' towards the transit.)



Characteristics of Station Precinct:

TAD	TOD
• Suburban street pattern • Low densities • Dominance of surface parking • Limited or no pedestrian access • Limited or no bicycle access/parking • Single-family homes • Industrial land uses • Segregated land uses • Gas stations, car dealerships, drive-thru stores and other auto-focused land uses	• Grid street pattern • High densities • Mostly underground or structured parking • Pedestrian-focused design • Bicycle access/parking • Multi-family homes • Office and retail land uses, especially along main streets • Vertically and horizontally mixed land uses

Figure 3. The TAD–TOD spectrum.

Figure 1.3
Transit-Oriented to Transit-Adjacent Development Spectrum Source: (Renne 2009, 3)

Cervero and Guerra (2011) use thresholds to qualify cost-effective systems based on an analysis of the investments and ridership; they qualify any light rail station area with 30 people per gross acre or more and any heavy rail station area with 45 people per cross acre as cost-effective systems. In Renne and Ewing (2013), the authors define quantitative qualifying criteria and rank the site based on how many criteria the development area meets. Developments that have all three criteria determined to be 'transit-oriented', while those with two criteria are 'TOD-TAD Hybrid', and those that have zero to one points are 'transit-adjacent'.

- Greater than 30 jobs or residents per gross acre;
- Not having 100% of land uses either residential or commercial; and
- Average block size less than 6.5 acres.

For Jeihani and Zhang (2013), the authors use an 'all or nothing' approach to incorporate a "TOD" definition at a traffic analysis zone level (TAZ) into a regional travel demand model, assigning areas to the definition based on their relative performance across the region using the following criteria:

- Residential density OR employment density higher than the regional average;
- Average block size for each TAZ (square miles) should be less than the regional average;
- Land use entropy falls within the top 30% regional entropy scores;
- Housing and transportation affordability (% of housing/transportation cost of household income) is less than 45%; and
- The area within a ½ mile of the transit station location.

The third methods we considered for this analysis includes some combination of **(3) scaling and weighting measures and breaking them along statistical breaks** (e.g., natural breaks, Jenks breaks, or quartiles). In this approach, the user selects multiple measures that capture various dimensions and scales them so that each site is ranked relative to all other sites in the sample dataset. Similar metrics can be average (or weighted, depending on importance) to distill the metrics into a one dimensional index. Using natural breaks along this index provides a means for categorizing high/low performers on any one dimension.

In Puget Sound, the analysts develop two aspects of their transit evaluation: People and Place. The Place aspect is a two-dimensional set of measures that aim to capture Physical Form + Activity/Transit-Orientation (lower or higher) and Change/Market Strength (weaker or stronger); the People aspect is a two dimensional set of measures aimed to capture Social Infrastructure & Access to Opportunity (limited or good) and Change & Displacement Risk (low, potential, immediate). In this approach, the analysts started with dozens of measures describing characteristics of each of these four dimensions. Measures were scaled relative to the entire sample, averaged together to develop an index for each dimension, and then the dimension was 'broken' into categories. In this application, the analysts tweak the location of each statistical break according to local expertise that may identify locations near the break lines as being inaccurately categorized (Puget Sound Regional Council; City of Bellevue; King County Metro 2014).

The fourth method we considered was **(4) factor and/or cluster analysis.** Most broadly used in the academic literature, this approach is similar in concept to the previous 'scaling and breaking' technique with more advanced multivariate dimensional reduction techniques. In this approach, multiple measures selected to represent different dimensions are distilled into indices (or factors) using factor analysis. Similar metrics, however, might contribute in large and small ways cross different measures. Once indices are identified, the index scores (also called ‘factor scores’) are inputted into a cluster analysis that groups each observation based on their multidimensional distance between their index scores and each cluster’s index scores. Similar to the ‘breaks’ approach, the number of clusters can be determined in part by quantitative observations and distributions and examination of how much variation is explained by N number of clusters. The cluster analysis process is an iterative estimation technique that refines clusters assignment over and over again until the error between each site and clusters is minimized, explaining the maximum about of variation across all dimensions (index or factor scores). Similar factor/cluster methods have been used to identify existing ‘neighborhoods’ by aligning measures in multiple dimensions of the built environment (Cervero and Kockelman 1997), studying the development patterns of new single-family home neighborhoods (Song and Knaap 2007), estimating automobile ownership (Shay and Khattak 2007), incorporating aspects of behavior in neighborhood definitions (Jacques and El-Geneidy 2014) or social environments to study physical activity and obesity (Nelson et al. 2006), exploring residential decision on household travel (Lin and Long 2008; Gehrke, Currans, and Clifton 2014), and estimating development-level travel impacts (Clifton et al. 2012).

The following Table 1.2 summarizes the features of methods (2) through (4) described above. Given the national focus on this study and the burden of categorizing hundreds of stations across dozens of systems and regions, (1) manual classification falls outside of our initial scope of work in this project. In general, there are benefits and costs to any of these methods. On the simpler end of applications, typologies can often be easily implemented in practice but may lack the nuances of contextual assignment into categories. These ‘qualifying criteria’ typologies are often reduced to a few supporting measures for a couple of categories. On the more complex end of the spectrum, factor/cluster analysis is a commonly used academic technique, but the translation of these typologies into practice may be problematic, particularly when expanding the application of the typology to a large set of new locations. However, methods (3) and (4) are more readily able to capture a variety of measures to describe and aggregate multiple dimensions, making both of the methods more nuanced to patterns of development.

Table 1.2
Comparison of Methods Used in Previous Studies

Method Features:	(2) Thresholds or Qualifying Characteristics	(3) Scaled Variables with Natural Breaks	(4) Factor and/or Cluster
Complexity	Low	Medium	High
Common Application	Practice or practice-oriented academic exercises. Defining typology for design and/or planning considerations.	Practice or practice-oriented academic exercises. Defining typology for design and/or planning considerations. Identifying and Implementing Strategic Policies.	Academic exercises. Defining typology for design and/or planning considerations. Identifying and Implementing Strategic Policies.
Selection of measures across dimensions	Subjective process of the analyst. Method does not compensate for problematic selection of measures.	Subjective process of the analyst. Method does not compensate for problematic selection of measures.	Subjective process of the analyst. Method does not compensate for problematic selection of measures.
Number of measures allowed	Fewer is likely better, but a ‘scoring’ criteria rubric is a possible way to increase measures included.	Many measures for each dimension is encouraged to capture a broader narrative of the context of each site.	Many measures for each dimension is encouraged to capture a broader narrative of the context of each site.
Definition of thresholds between categories	May be based on other metrics of success (e.g., minimum densities for cost effectiveness) May be relative to other sites (e.g., more than the average for the region)	Relative to other sites in the sample (scaled & statistically broken).	Relative to other sites in the sample (scaled & statistically clustered).
Estimation process (once data for each site is compiled	Simple (possible in excel)	Moderate (possible in excel with more complex functions)	Hard (specialty software is needed)
Replication of results	Static thresholds will not change. If regional averages are used, replication depends on the distribution of the ‘universe’ of observations.	Depends on the distribution of the ‘universe’ of observations.	Depends on the distribution of the ‘universe’ of observations.
Classification of new sites into clusters	Simple	Moderate, requires new sites be scaled according	Moderate to hard, requires new sites be scaled according to the

		to the distribution of all existing sites. May be problematic if new sites fall outside of the range of observations or many new sites are introduced.	distribution of all existing sites. May be problematic if new sites fall outside of the range of observations or many new sites are introduced.

Creating Typologies: Methods and Data

Guiding principals

Based on the review of academic and practice-based TOD place typologies, we identify three guiding principles for developing typologies in our own work. First, the typologies must capture existing variation in the built environments using similar dimensions of development, as studied in academia and applied in practice before us. Second, the categories must be mutually exclusive and collectively exhaustive so that potential systems outside of our study might be able to classify their contexts within our framework, making the place types more readily available for practitioners.

Third, the typologies must enable comparison of similar built environment patterns across metropolitan areas. Not all central business districts look the same, for example, but there may exist similar patterns of density, design, and access across different city that allows us to compare relative market-responses to transit. This third guiding principal added a level of complexity to the development of place types not commonly observed in other studies. Most place type development occurs within a single region, which ground the analysis in local knowledge and expertise. As part of our research question, we desire to explore the role of place type in market response *across* regions, which require our typology to be transferable.

Differences Between Station Area and Block Group Analysis

Before the proposed analysis plan is explored, this section briefly touches on the differences between the transit-oriented development literature and this approach. One of our research questions in this study is whether varying area types are more responsive to development goals (e.g., increasing jobs, housing opportunities or real estate values) with greater proximity to FGT systems. Our hypothesis is that different outcomes may respond differently for different area types and regional contexts depending on the FGT systems. The literature explored in the previous section focuses on station-level development, but the economic analyses implemented in this study are not easily implemented at a station-level analysis. For example, hedonic price analyses are implemented at a development-level, with some sites in close proximity to transit and others farther away. For economic base analyses, the unit of analysis is typically a region or type of neighborhood.

The main limitation of applying the station-level literature to a neighborhood-level analysis is reconfiguring the interpretation and development of the variable from stations to neighborhoods. For example, the station area interpretation of the Place dimension describes job accessibility as ‘Job Density within a 0.5-mile’. But the interpretation of the same indicator may take into account job density of the neighborhood and whether the neighborhood is within 0.5-miles of transit. In this change, a TOD-station analysis may combine descriptors of Place or Node with measures of Orientation, while a neighborhood analysis will likely separate the Place and Node descriptions of the neighborhood with measures that capture the Orientation (specifically, proximity) of the neighborhood to transit.

Existing Variables from Prior NITC Projects

The usable data immediately available for this study was collected in prior NITC studies, compiled at a block-group level using the Longitudinal Employer-Household Data (LEHD) and the American Community Survey (see Table 1.1). The data were collected for 39 U.S. metropolitan areas, including 4 heavy rail systems (HRT), 19 light rail systems, 21 bus rapid transit systems, 11 express bus systems, 12 streetcar systems, and 8 commuter rail systems. In general, the type of data compiled for these studies captures jobs (by income and sector) and population (by race, worker status, commute mode, household composition, tenure). The distance of each block (group) to the nearest transit station (by transit system type) was computed in GIS to categorize the access of that geography to transit. All variables were compiled for each of the three years of analysis: 2002, 2009, and 2017.

Considering these available variables and the dimensions of transit-oriented development described previously, we are largely missing one type of variable. The Oriented dimension has two main components: proximity to high-quality transit and walkability or supportive access/egress street network. The former is represented in the transit variables calculated for each type of FRT system (all of which fall into the 'higher quality transit' category, but with varying degrees of regional accessibility and mobility). The latter may be missing from our existing datasets. 'Walkability' by definition is the ability to access to destinations—generally retail, service, transit stations—by walking. This, in some ways, may be represented by proxy using the block-level (smallest geography) retail or service jobs or something similar. However, even areas with higher retail and service jobs may have lower walkability if the street network design is not conducive—this means higher intersection density and lower block sizes. Fortunately, even when land is re-developed, it is not all that common for existing street networks to change substantially. To incorporate a proxy for street network design in the Oriented dimension, we will append our existing data with the EPA Smart Location Database measures for intersection density[2]. These variables were calculated using the 2011 street network, while all other variables calculated using the LEHD, ACS, or geographic location were calculated using their given year of analysis (2002, 2009, or 2017). Future analysis should include the processing of archived street networks to capture potential changes in the supportive street network design.

The data are therefore organized at a block (group) level, meaning we are examining the block or block group's access to transit and not any one transit station's access to jobs or population (etc). This is an important distinction for this research as many studies of transit-oriented development focus on any one station's built environment and social demographics even if that station's service area overlaps with other stations on the same line. In this work, we consider the typology of neighborhoods at a block or block group level with respect to its access to transit. We will discuss this distinction later in this chapter.

[2] EPA Smart Location Database Documentation User Guide, page 7 (2014); Accessed on May 30th, 2019 from here: https://www.epa.gov/sites/production/files/2014-03/documents/sld_userguide.pdf

TABLE 1.3
Variable Compiled in Previous NITC study

LEHD variables (unit of analysis: census block)
Jobs by income level: Upper (>$3333/month); Middle ($1251-3333/month); and Lower (<$1250/month). Jobs by sector: Manufacturing; Light Industry; Retail/ Lodging/ Food; Knowledge; Office; Education; Health; and Arts/Entertainment/Recreation.
ACS data (unit of analysis: census block group)
Population Population by Race/Ethnicity (counts): Not Hispanic or Latino - White alone; Not Hispanic or Latino - Black or African American alone; Not Hispanic or Latino - American Indian and Alaska Native alone; Not Hispanic or Latino - Asian alone; Not Hispanic or Latino - Native Hawaiian and Other Pacific Islander alone; Not Hispanic or Latino - Some other race alone Total Workers Commute Mode Car, truck, or van (Drove alone or Carpooled); Public transportation (excluding taxicab); Bicycle; Walked; Other means; Worked at home Households with and without children (<18 years) present by family type: Total with and total without; With/without by family households (general, male householder—no wife present, female householder—no husband present); married-couple family; family households; nonfamily households (1-person households). Households by age of householder <25; 25-44; 45-64; >65 years. Households by tenure Owner Occupied; Renter Occupied Households by tenure and vehicles available: Owner/renter occupied and (0, 1, 2, 3, 4, 5+) vehicles available.
Processed Transit Variables (unit of analysis: census block for LEHD and census block group for ACS)
Euclidean distance (miles) of edge of block (group) to the nearest transit station by transit system type. Categorization of distances into 'distance buffer' bands.
Notes: Variables should be available for stations across all years (2002, 2009, 2015). Densities can be calculated by dividing the counts by the gross area of the block group.

Data

To represent the built environment measures relevant to understand the market-response towards transit-oriented development, we identified eight measures described in Table 1.4. While additional measures were tested, for any cases where variables were highly correlated, we simplified by selecting the one more commonly referenced in the literature. Job and population densities are among the most commonly referenced TOD built environment measures. For one measure of land use diversity, we use the proportion of job densities from retail also provides a sense of the mix or diversity of land uses. We also consider the percent of owner-occupied housing—a proxy that largely represents the proportion of single-family housing in the area—and the proportion of households without kids—a proxy for the size of dwelling units. Lastly, we consider the street network design, and therefore connectivity, by including the intersection density and proportion of intersections that are four-way. It is worth noting that the measures of street network design are built from slightly older data; however, unlike development which can change from year to year, once the street network is in place, it is not readily changed.

Table 1.4
Descriptive Statistics of Built Environment Variables

Variables	Calculated from Source	Average	Minimum	Maximum
Jobs per acre	Longitudinal Employer-Household Dynamics	1.94	0	851
Proportion of jobs that are retail and entertainment	Longitudinal Employer-Household Dynamics	0.16	0	1.00
Total population per acre	American Community Survey	16.8	0	1027.1
Total households per acre	American Community Survey	6.4	0	619.0
Percent of households with no kids	American Community Survey	0.66	0	1.00
Percent of owner occupied housing	American Community Survey	0.61	0	1.00
Intersections per square mile	Smart Location Database, 2014, Variable: D3b	82.0	0	5175
Proportion of intersections with four approaching streets	Smart Location Database, 2014, Variable: D3bmm4, and D3bmm3	0.28	0	1.00

Notes:
All data are measured at the block-group level.

Method
Considering the above guiding principles, we utilize a typology methodology by Gehrke and Clifton (2016) that allows for easily classifiable place types that are both transferable in comparisons across regions and customizable to common TOD-related built environment characteristics. In this process, each built environment measure is first segmented into five categories using a Jenks natural breaks classification method, which groups observations into categories that minimize the deviation from each group's mean value. This also orders the data into low to high values for each variable—effectively representing a five-tier degree of urban access and/or land use mix.
For each variable, the groupings are given a score from 1 (least accessible or mixed-use) to 5 (most accessible or mixed use). These scores are then added up for each block group, and the block groups are then cut into groups that represent high to low mix and accessibility. We start by cutting the areas into eight equal groups. However, those considered the most exurban or the most densely urban had little variation across the average built environment characteristics and were aggregated. The result is four place types, as described in Table 1.5.

While these place types enable us to compare similar built environments across sometimes drastically different metropolitan areas, they are driven largely by the distribution of environments included in our study areas. And the built environment measures included in this study were limited to those generally available and consistent throughout the US at a block-group level. In future work, more robust transit and walkability accessibility measures within each block group could provide an improved representation of local and regional accessibility in a measurable way for comparing across metropolitan areas (see Table 1.6).

As mentioned earlier, an extensive annotated bibliography of materials used to create the Place Typology is provided in Appendix B. Appendix C includes images of the Place Typology applied to many transit regions used in our study. Examples are also shown below for NITC member metropolitan areas, being Dallas-Fort Worth, Eugene, Portland, Salt Lake City, and Tucson, respectively.

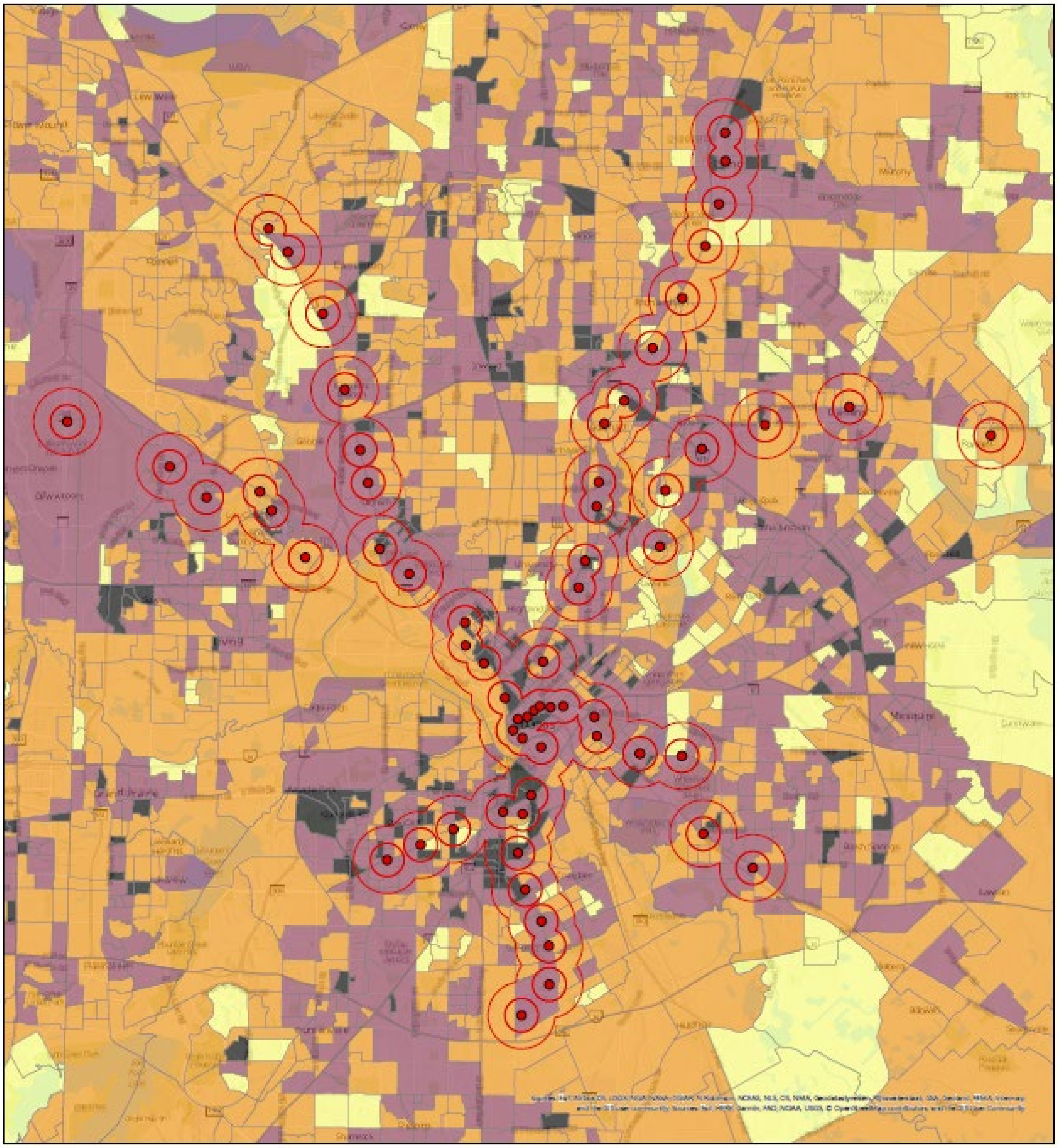
Table 1.5
Average Built Environment Characteristic by Jenks Natural Break Classification Grouping

	Average Built Environment Characteristics by Jenks Grouping				
Score:	5	4	3	2	1
Built Environment Metric:					
Jobs per acre	851	414.4	158.7	52.7	10.8
Proportion of jobs that are retail and arts	1.00	0.71	0.47	0.27	0.09
Total population per acre	1027.1	252.9	131.00	58.5	19.4
Total households per acre	619.0	131.6	65.3	28.1	8.6
Percent of households with no kids[1]	0.00	0.38	0.56	0.69	0.81
Percent of owner occupied housing[1]	0.00	0.21	0.44	0.65	0.83
Intersections per square mile	5175	456	196	111	53
Proportion of intersections with 3 to 4 vertices	1.00	0.82	0.54	0.31	0.12

Notes:
[1] This is reverse coded.

Table 1.6
Average Built Environment Characteristics Across Mix/Accessible Place Types

	Place Types			
	High Mix/Accessible	Moderate Mix/Accessible	Low Mix/Accessible	Poor Mix/Accessible
	(High MA)	(Mod MA)	(Low MA)	(Poor MA)
Scores	Greater than 2.5	2-2.5	1.5-2	0-1.5
Built Environment Variables	Average Values by Place Types			
Jobs per acre	0.42	1.38	3.26	8.11
Proportion of jobs that are retail and arts	0.06	0.17	0.25	0.27
Total population per acre	4.45	10.97	28.33	72.85
Total households per acre	1.71	4.19	11.04	26.96
Percent of households with no kids	0.71	0.66	0.63	0.51
Percent of owner-occupied housing	0.83	0.63	0.40	0.22
Intersections per square mile	45.78	78.98	112.58	149.81
Proportion of intersections with 3 to 4 vertices	0.10	0.26	0.45	0.70



Station Typology for Light Rail Transit:
Dallas-Fort Worth-Arlington, TX

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

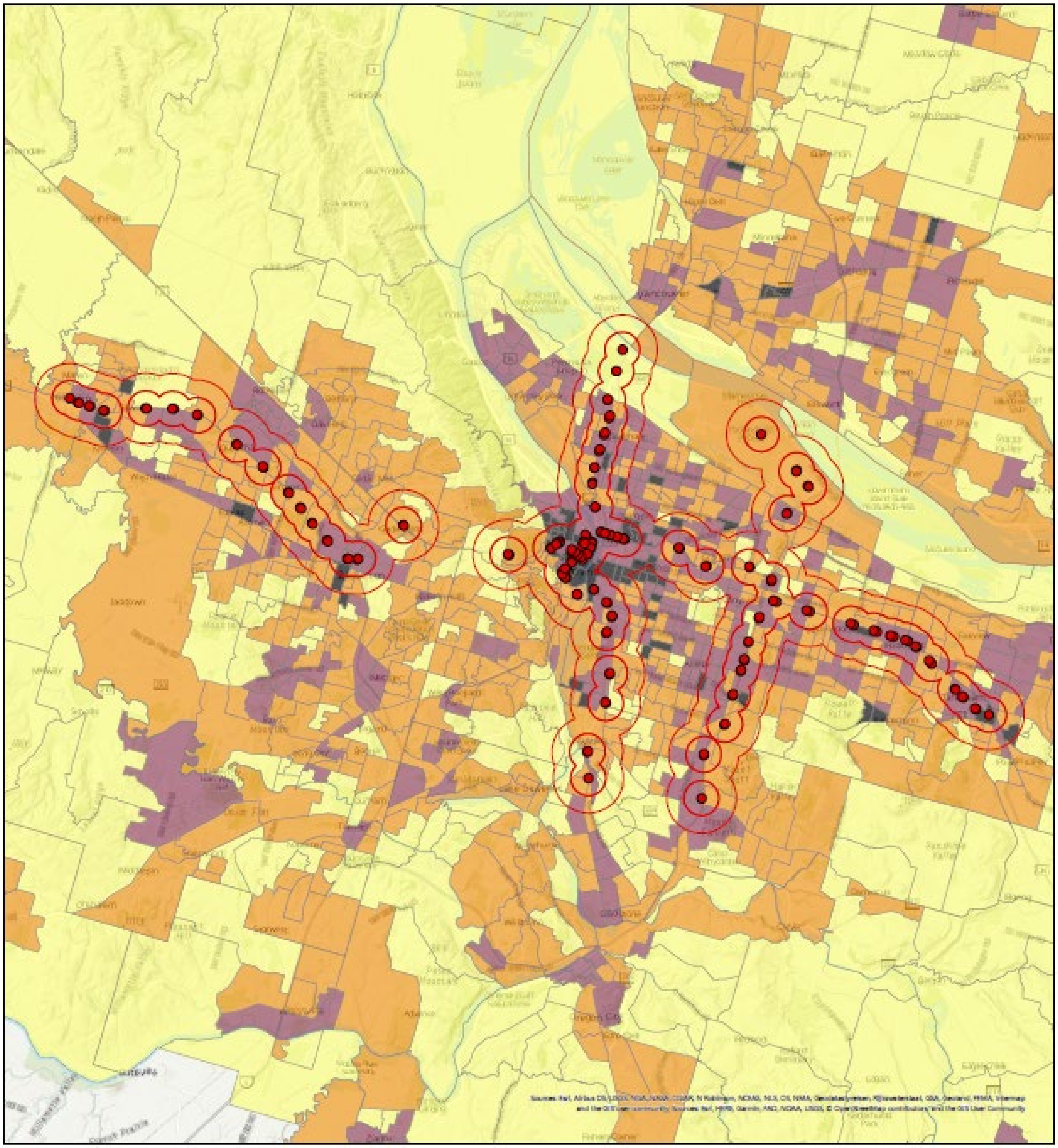
N

0 1 2 4 6 8 Miles

Station Typology for Bus Rapid Transit:
Eugene, OR

Buffers: Half & 1 Mile
BRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

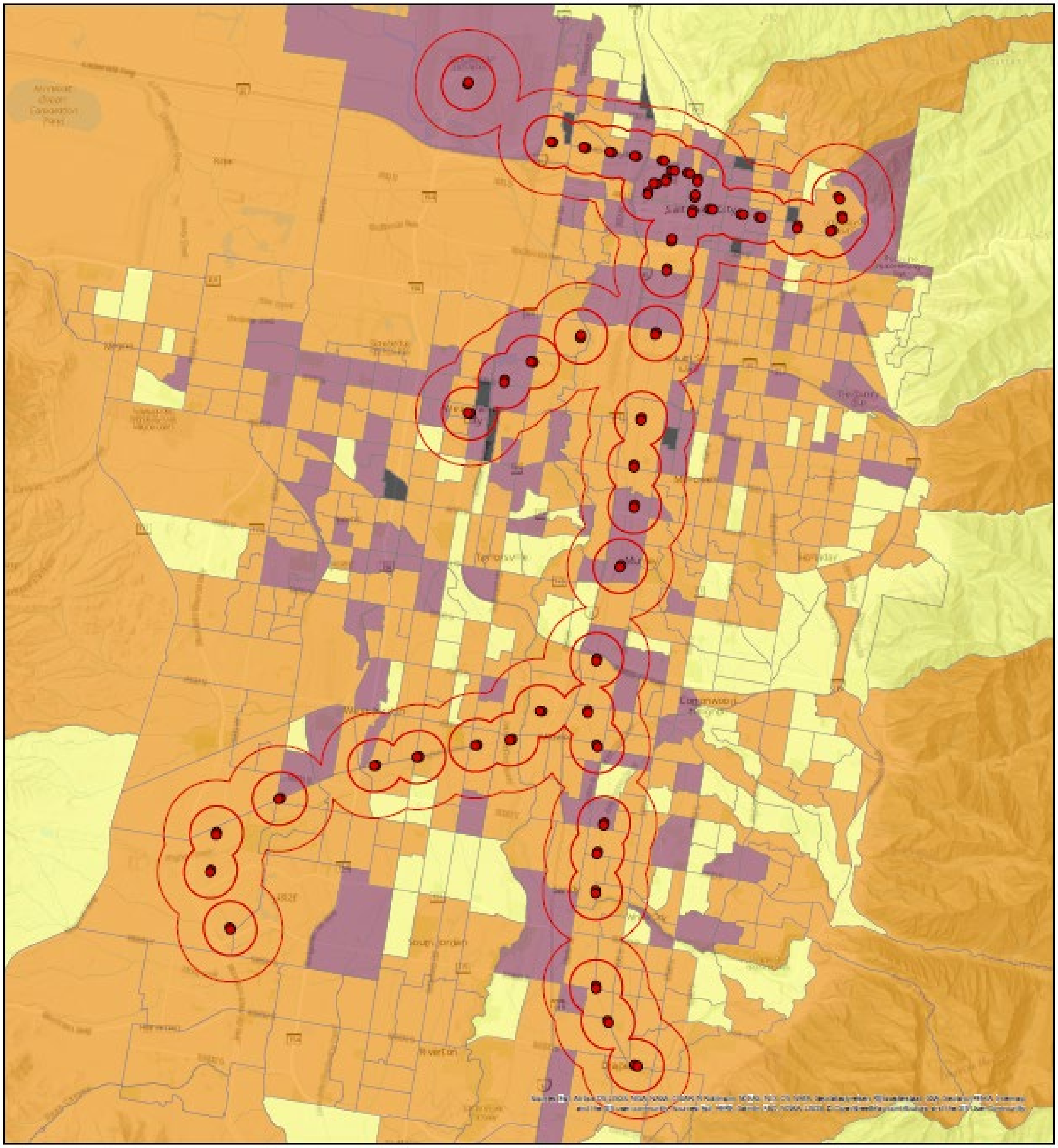
0 0.17 0.35 0.7 1.05 1.4 Miles



Station Typology for Light Rail Transit:
Portland-Vancouver-Hillsboro, OR-WA

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

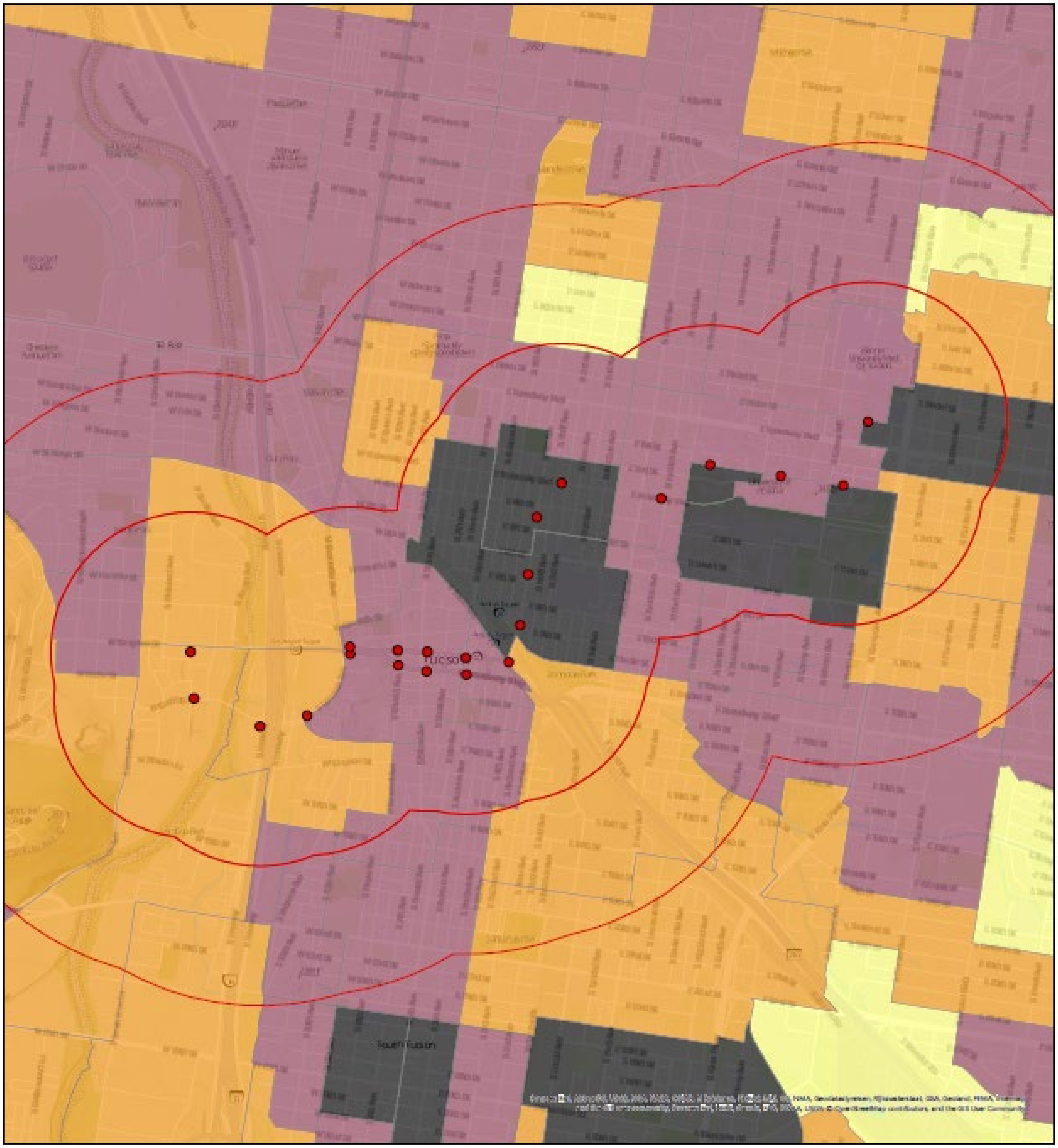
0 1 2 4 6 8 Miles



Station Typology for Light Rail Transit:
Salt Lake City, UT

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

0 0.5 1 2 3 4 Miles



Station Typology for Streetcar Transit:
Tucson, AZ

References

Arizona Department of Transportation. 2012. “Station Area Typology Definitions.” Passenger Rail Corridor Study: Tucson to Phoenix. Phoenix, Arizona: Federal Transit Administration.

Bertolini, L. 1999. “Spatial Development Patterns and Public Transport: The Application of an Analytical Model in the Netherlands.” Planning Practice and Research 14 (2): 199–210. https://doi.org/10.1080/02697459915724.

Center for Transit-Oriented Development, and Nelson/Nygaard. 2011. “Transit-Oriented Development Strategic Plan.” Portland, Oregon: Metro. http://ctod.org/pdfs/2011PortlandTODweb.pdf.

Central Maryland Transportation Alliance, and Center for Transit-Oriented Development. 2009. “Central Maryland TOD Strategy: A Regional Action Plan for Transit-Centered Communities.” http://ctod.org/pdfs/2009CentralMarylandTODStrategy.pdf.

Cervero, Robert, and Erick Guerra. 2011. “Urban Densities and Transit: A Multi-Dimensional Perspective.” Working Paper UCB-ITS-VWP-2011-6. Institute of Transportation Studies: University of California, Davis.

Cervero, Robert, and Kara Kockelman. 1997. “Travel Demand and the 3Ds: Density, Diversity, and Design.” Transportation Research Part D 2 (3): 199–219.

Clifton, Kelly J., Kristina M. Currans, April Cutter, and Robert Schneider. 2012. “Household Travel Surveys in a Context-Based Approach for Adjusting ITE Trip Generation Rates in Urban Contexts.” Transportation Research Record: Journal of the Transportation Research Board 2307: 108–19.

Clifton, Kelly J., and Steven Gehrke. Memo. 2016. “Technical Memorandum: Place Typology Data Sources and Development Procedure,” August 23, 2016.

Ewing, Reid, Guang Tian, Torrey Lyons, Preston Stinger, Rachel Weinberger, Ben Kaufman, and Kevin Shivley. 2017. “Trip and Parking Generation at Transit-Oriented Developments.” Research Report NITC-RR-767. http://nitc.trec.pdx.edu/research/project/767/Trip_and_Parking_Generation_at_Transit-Oriented_Developments.

Gehrke, Steven R., Kristina M. Currans, and Kelly J. Clifton. 2014. “The Impact of Residential Location Decisions on Miles Traveled, Trip Frequency, and Automobile Ownership for Households in the Portland Metropolitan Region.” In https://trid.trb.org/view/1289730.

Jacques, Cynthia, and Ahmed El-Geneidy. 2014. “Does Travel Behavior Matter in Defining Urban Form? A Quantitative Analysis Characterizing Distinct Areas within a Region.” Journal of Transport and Land Use 7 (1): 1. https://doi.org/10.5198/jtlu.v7i1.377.

Jeihani, Mansoureh, and Lei Zhang. 2013. “Development of a Framework for Transit-Oriented Development.” Final Report SP209B4N. State Highway Administration; Maryland Department of Transportation.

Lin, Jie, and Liang Long. 2008. “What Neighborhood Are You in? Empirical Findings of Relationships between Household Travel and Neighborhood Characteristics.” Transportation 35 (6): 739–58. https://doi.org/10.1007/s11116-008-9167-7.

Lyu, Guowei, Luca Bertolini, and Karin Pfeffer. 2016. “Developing a TOD Typology for Beijing Metro Station Areas.” Journal of Transport Geography 55 (July): 40–50. https://doi.org/10.1016/j.jtrangeo.2016.07.002.

Nelson, Melissa C., Penny Gordon-Larsen, Yan Song, and Barry M. Popkin. 2006. "Built and Social Environments." American Journal of Preventive Medicine 31 (2): 109–17. https://doi.org/10.1016/j.amepre.2006.03.026.

Puget Sound Regional Council; City of Bellevue; King County Metro. 2014. "Appendix D. Growing Transit Communities Strategy People + Place Implementation Typology Methods and Results." Puget Sound, Washington. https://www.nap.edu/read/23630/chapter/11.

Renaissance Planning Group. 2011. "A Framework for Transit Oriented Development in Florida." Florida Department of Transportation and Department of Community Affairs. http://www.fltod.com/renaissance/docs/Products/FrameworkTOD_0715.pdf.

Renne, John L. 2009. "From Transit-Adjacent to Transit-Oriented Development." Local Environment 14 (1): 1–15. https://doi.org/10.1080/13549830802522376.

Renne, John L., and Reid Ewing. 2013. "Transit-Oriented Development: An Examination of America's Transit Precincts in 2000 & 2010." New Orleans, LA: University of New Orleans Transportation Institute. https://scholarworks.uno.edu/cgi/viewcontent.cgi?article=1016&context=unoti_pubs.

Shay, Elizabeth, and Asad J. Khattak. 2007. "Automobiles, Trips, and Neighborhood Type: Comparing Environmental Measures." Transportation Research Record: Journal of the Transportation Research Board 2010 (1): 73–82. https://doi.org/10.3141/2010-09.

Song, Yan, and Gerrit-Jan Knaap. 2007. "Quantitative Classification of Neighbourhoods: The Neighbourhoods of New Single-Family Homes in the Portland Metropolitan Area." Journal of Urban Design 12 (1): 1–24. https://doi.org/10.1080/13574800601072640.

APPENDIX A: Summary of Fixed Guideway Systems used in Analysis[3]

Light Rail Transit (LRT)
Bus Rapid Transit (BRT)
Streetcar Transit (SCT)
Commuter Rail Transit (CRT)
Express Bus Transit (XBT)
Heavy Rail Transit (HRT) *[reserved for future analysis]*

[3] We are pleased to acknowledge invaluable assistance in preparing this appendix by Matt Dixon.

APPENDIX A – LRT
LIGHT RAIL SYSTEMS USED IN ANALYSIS

Light Rail Transit Systems Metro Area & Name	Year	Miles	Stations	Riders (Daily)
Buffalo: Metro Rail	1984	6.4	13	18,500
Charlotte: Lynx Blue Line	2007	19.3	26	16,900
Cleveland: Blue Line, Green Line, and Waterfront Line	1980	15.3	35	7,671
Dallas: DART Light Rail	1996	93	64	82,466
Denver: RTD Rail	1994	47	53	200,000
Houston: METRORail	2004	22.7	39	50,137
Minneapolis-St. Paul: Metro Blue Line	2004	12	19	29,041
Norfolk: The Tide	2011	7.4	11	4,900
Phoenix: Valley Metro	2008	26.3	35	50,000
Pittsburgh: The T	1984	26.2	52	27,700
Portland: MAX Rail	1986	86	97	121,000
Sacramento: RT	1987	42.9	54	40,000
Salt Lake City: Transit Express / TRAX	1999	44.8	50	67,300
San Diego: Trolley	1981	53.5	55	119,800
San Jose: VTA Light Rail	1987	42.2	62	30,219
Seattle: Link Light Rail	2003	21.95	22	65,753
St. Louis: Metrolink	1993	46	38	53,123

BUFFALO LIGHT RAIL SYSTEM

Figure LRT Buffalo 1
Buffalo Metro
Source: https://buffalonews.com/2017/04/18/plan-metro-rail-extension-amherst-coming-focus/
Running from downtown Buffalo to the University at Buffalo, the Buffalo Metro Rail is a single-line, 6.4-mile light rail system. Between 2008 and 2009 during the Great Recession, the line saw an increase of 1.2 million passengers annually. Currently, the daily ridership is about 18,500. The line launched in October of 1984.[4]

[4] Adapted from: https://en.wikipedia.org/wiki/Buffalo_Metro_Rail.

Figure LRT Buffalo 2
Buffalo Metro Service Map
Source: http://metro.nfta.com/img/Rail.jpg

CHARLOTTE LIGHT RAIL SYSTEM

Figure LRT Charlotte 1
Charlotte Light Rail System
Source: https://www.charlotteagenda.com/81876/inside-john-lewiss-6-billion-vision-bring-light-rail-across-city/

The Lynx Blue Line in Charlotte, North Carolina was the first transit system of its kind in the entire state. The 19.3-mile line goes from the University of North Carolina Charlotte to a northern suburb called Pineville. The system has 26 stations along its route. It first opened in November of 2007, and an extension was unveiled in March of 2018.[5]

[5] Adapted from: https://en.wikipedia.org/wiki/Lynx_Blue_Line.

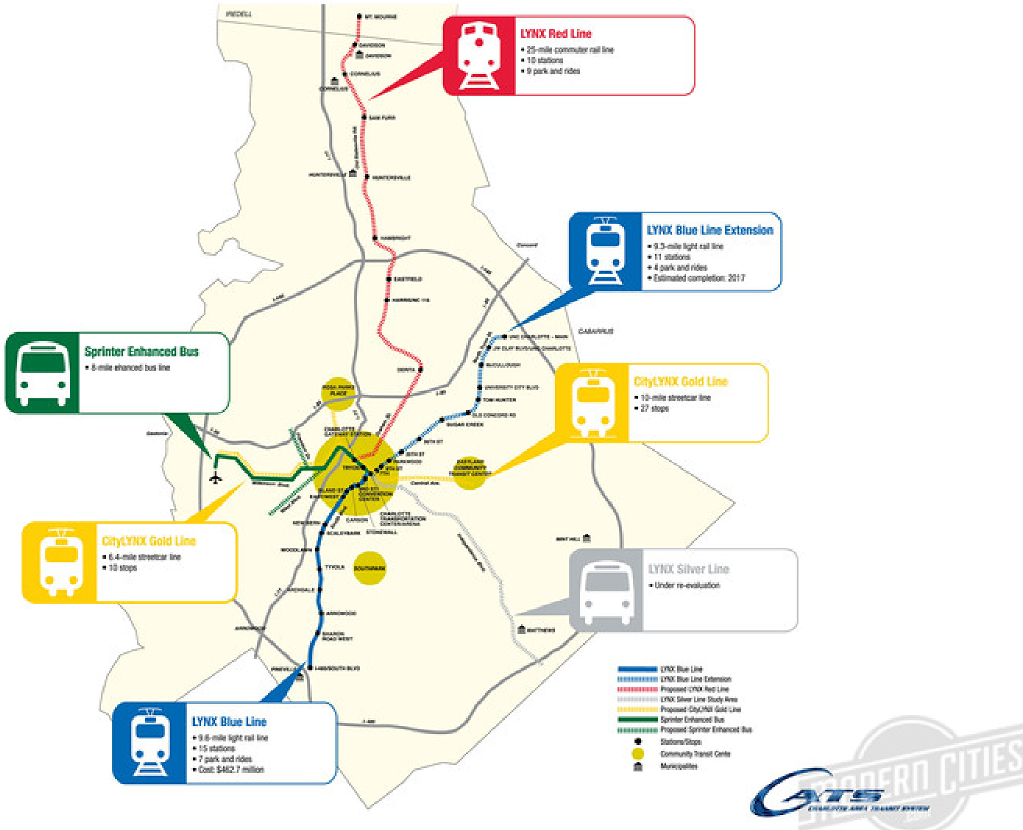


Figure LRT Charlotte 2
Lynx Blue Line Service Map
Source: https://www.moderncities.com/article/2017-apr-aerial-video-of-charlottes-new-light-rail-line

CLEVELAND LIGHT RAIL SYSTEM

Figure LRT Cleveland 1
Cleveland Light Rail Line
Source: https://en.wikipedia.org/wiki/Blue,_Green,_and_Waterfront_Lines_(Cleveland)
The light rail system serving metro Cleveland, Ohio is the Blue Line, Green Line, and Waterfront Line. The line is 15.3 miles in total length and carries more than 2,800,000 passengers annually. The line was originally a streetcar system that opened in 1913. The system has, in total, 35 stations.[6]

[6] Adapted from: https://en.wikipedia.org/wiki/Blue,_Green,_and_Waterfront_Lines_(Cleveland).

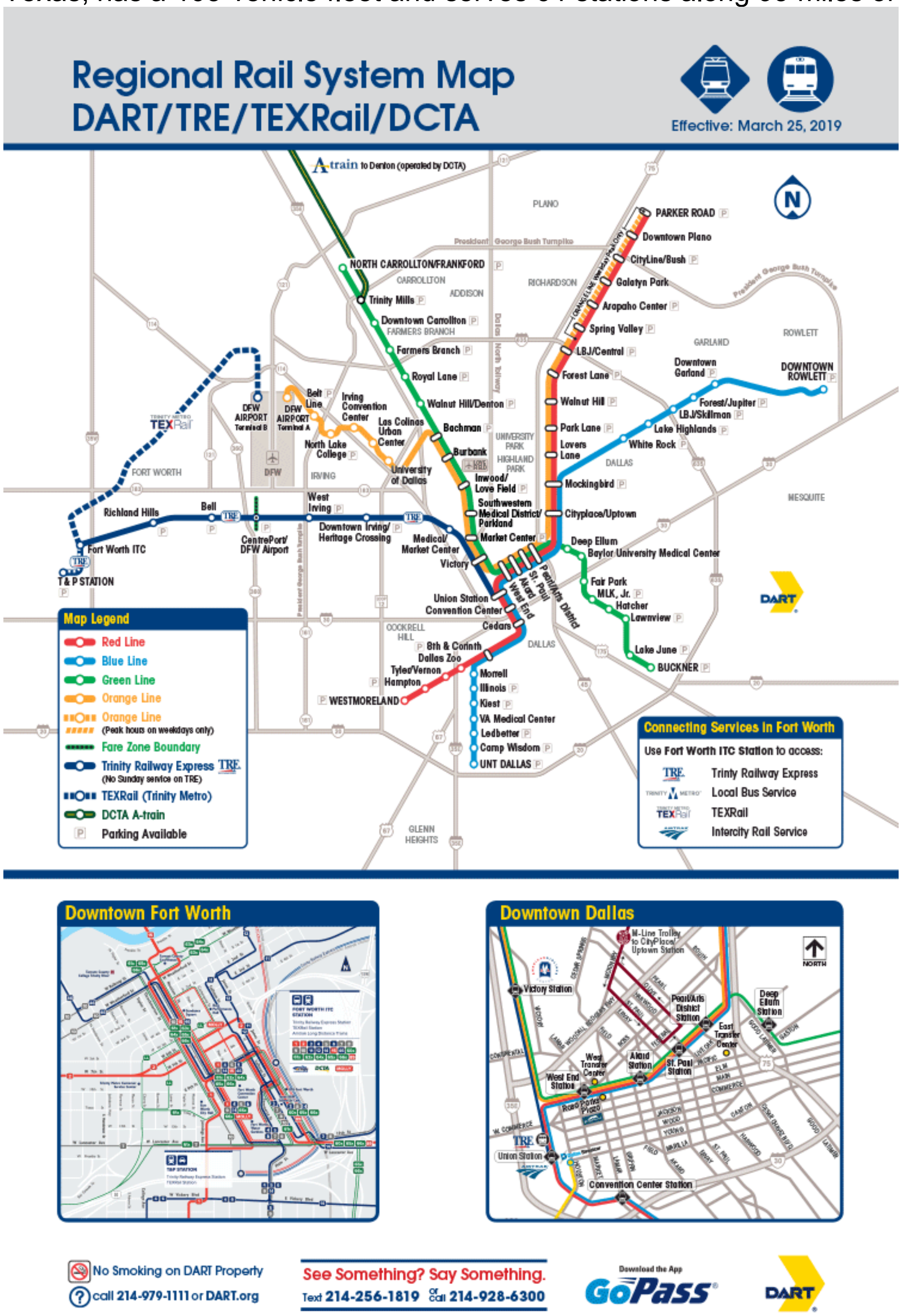
Figure LRT Cleveland 2
Cleveland Metro Service Map
Source: http://mapa-metro.com/mapas/Cleveland/mapa-metro-cleveland.png

DALLAS LIGHT RAIL SYSTEM

Figure LRT Dallas 1
Dallas Light Rail Rolling Stock

Source: https://ggwash.org/view/37371/would-you-have-guessed-dallas-has-the-countrys-biggest-light-rail-system

Operated by the Dallas Area Rapid Transit (DART), the DART Light Rail system had a ridership rate of 30.1 million as of the 2017 fiscal year. The system, serving the second largest city in Texas, has a 163-vehicle fleet and serves 64 stations along 93 miles of track.[7]



[7] Adapted from: https://www.dart.org/newsroom/dartrailfacts.asp.

Figure LRT Dallas 2
DART Light Rail System Map
Source: https://www.dart.org/maps/printrailmap.asp

DENVER LIGHT RAIL SYSTEM

Figure LRT Denver 1
RTD Light Rail Rolling Stock
Source: https://www.bizjournals.com/denver/blog/earth_to_power/2015/10/rtd-returns-to-the-well-to-bolster-its-light-rail.html
The Regional Transportation District (RTD) of Denver, Colorado operates the RTD Rail Line. The system serves nine rail lines and 53 stations in the greater Denver area.[8]

[8] Adapted from: http://www.rtd-denver.com/lightrail.shtml.

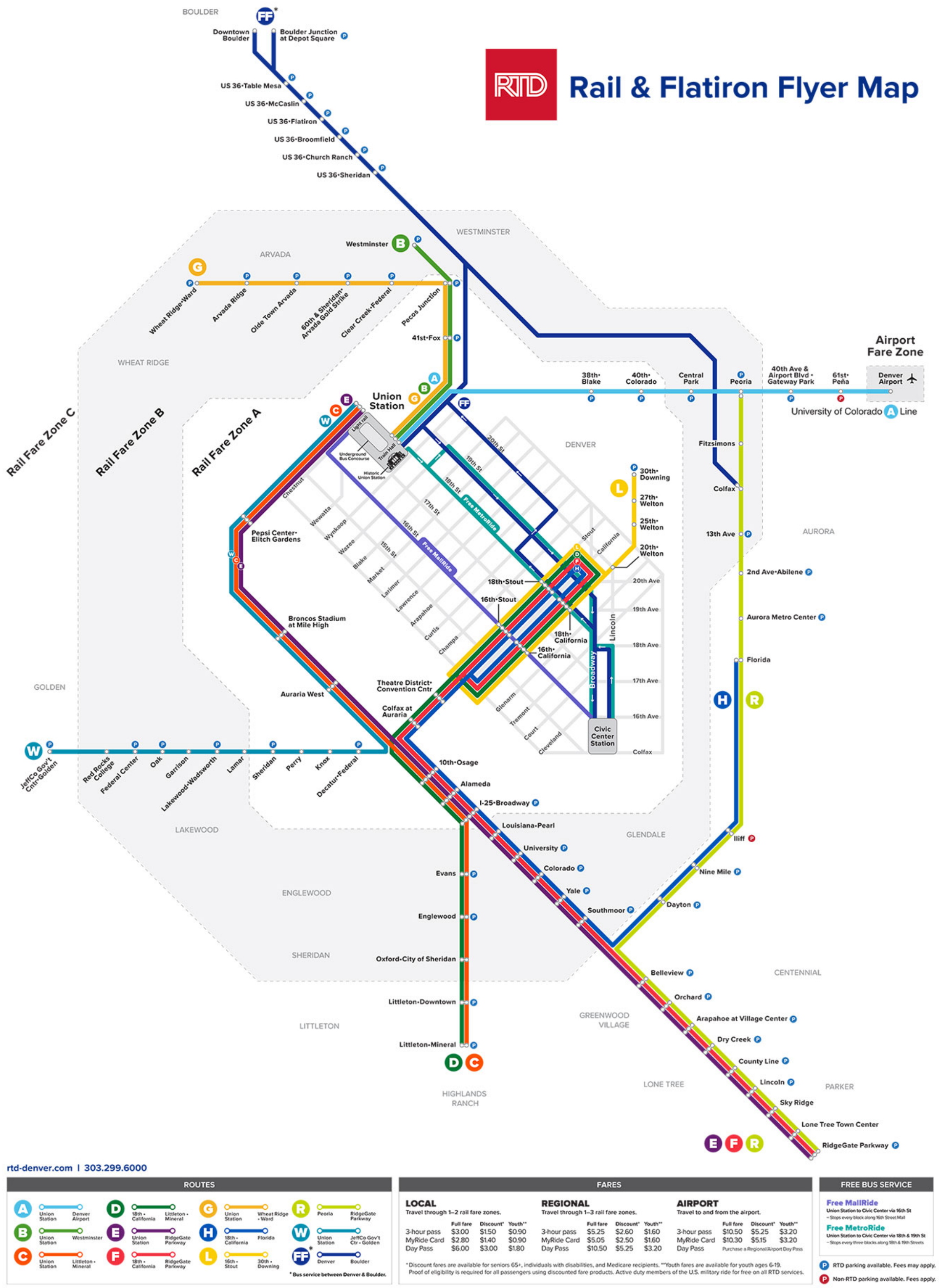


Figure LRT Denver 2
RTD Light Rail Map
Source: http://www.rtd-denver.com/img/map/rail-fare-map.jpg?v=1.2

HOUSTON LIGHT RAIL SYSTEM

Figure LRT Houston 1
Houston METRORail
Source:
http://media.culturemap.com/crop/35/e9/600x600/METRO_Houston_skyline_light_rail_CVB.jpg

With three lines in operation and an additional two in the works, Houston, Texas' METRORail serves over 18,300,000 passengers on a yearly basis. The system began operation on January 1, 2004. METRORail serves 39 stations along a 22.7-mile route in total. There are 76 cars in total, with each train being two cars long.[9]

[9] Adapted from: https://en.wikipedia.org/wiki/METRORail.

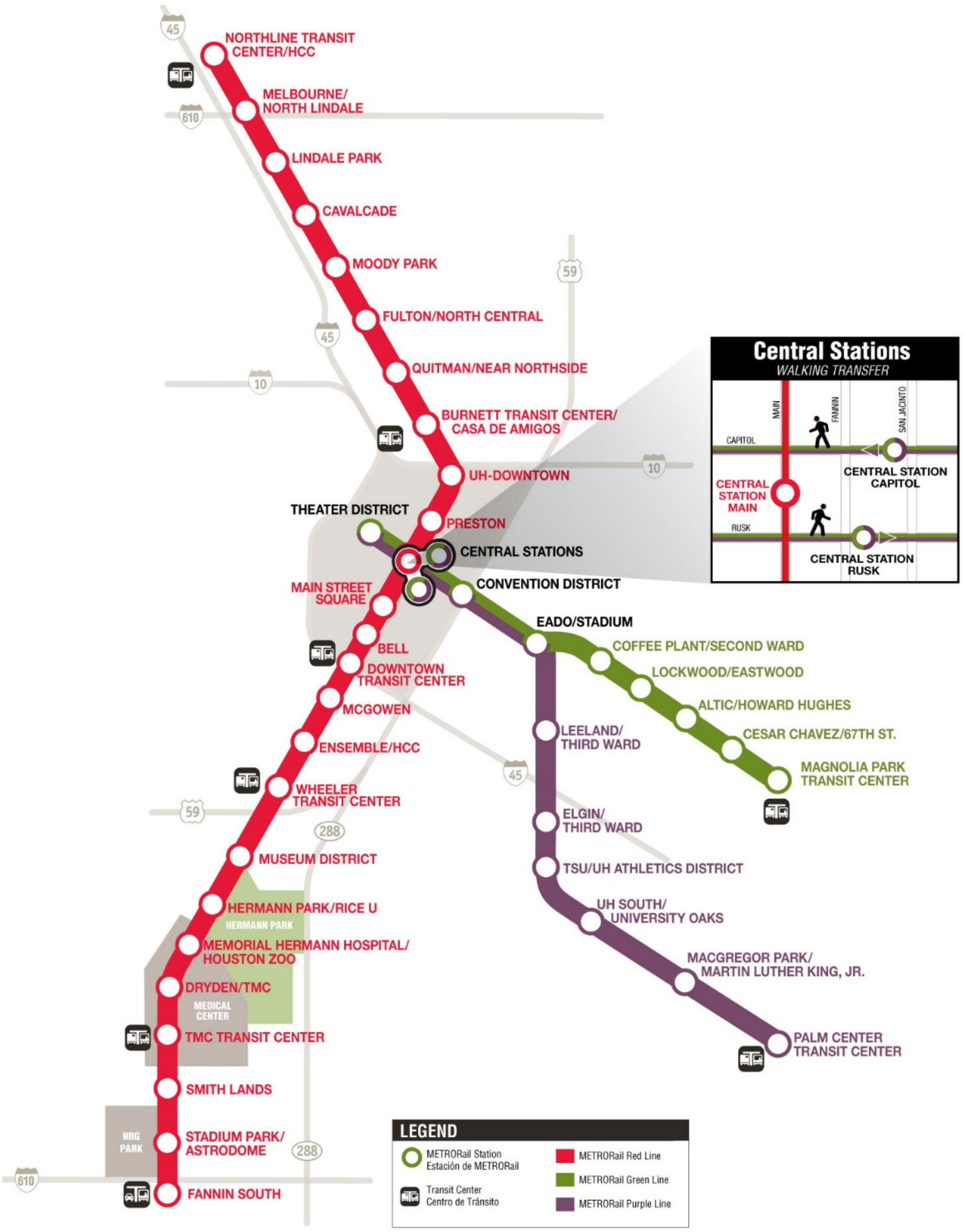


Figure X
Houston Metro System Service Map
Source: https://www.ridemetro.org/SiteImage/SchedulesAndMaps/METRORail-LinesMap.jpg

MINNEAPOLIS – ST. PAUL LIGHT RAIL SYSTEM

Figure LRT Minneapolis 1
Minneapolis Metro
Source:
https://www.tripsavvy.com/thmb/xCUG_EY8EtlDAAiy8kObdQEEX1o=/1024x665/filters:no_upscale():fill(transparent,1)/GettyImages-476036388-5a578d79da27150037b36fbd.jpg
The Metro Blue Line serves the Minneapolis – St. Paul metro area along its 12-mile route. It runs between the Mall of America to the south and Target Field (Minnesota Twins MLB stadium) to the north. There are 19 stations along the route, and it opened in June of 2004. There were 10.6 million riders in 2015.[10]

[10] Adapted from: https://en.wikipedia.org/wiki/Metro_Blue_Line_(Minnesota).

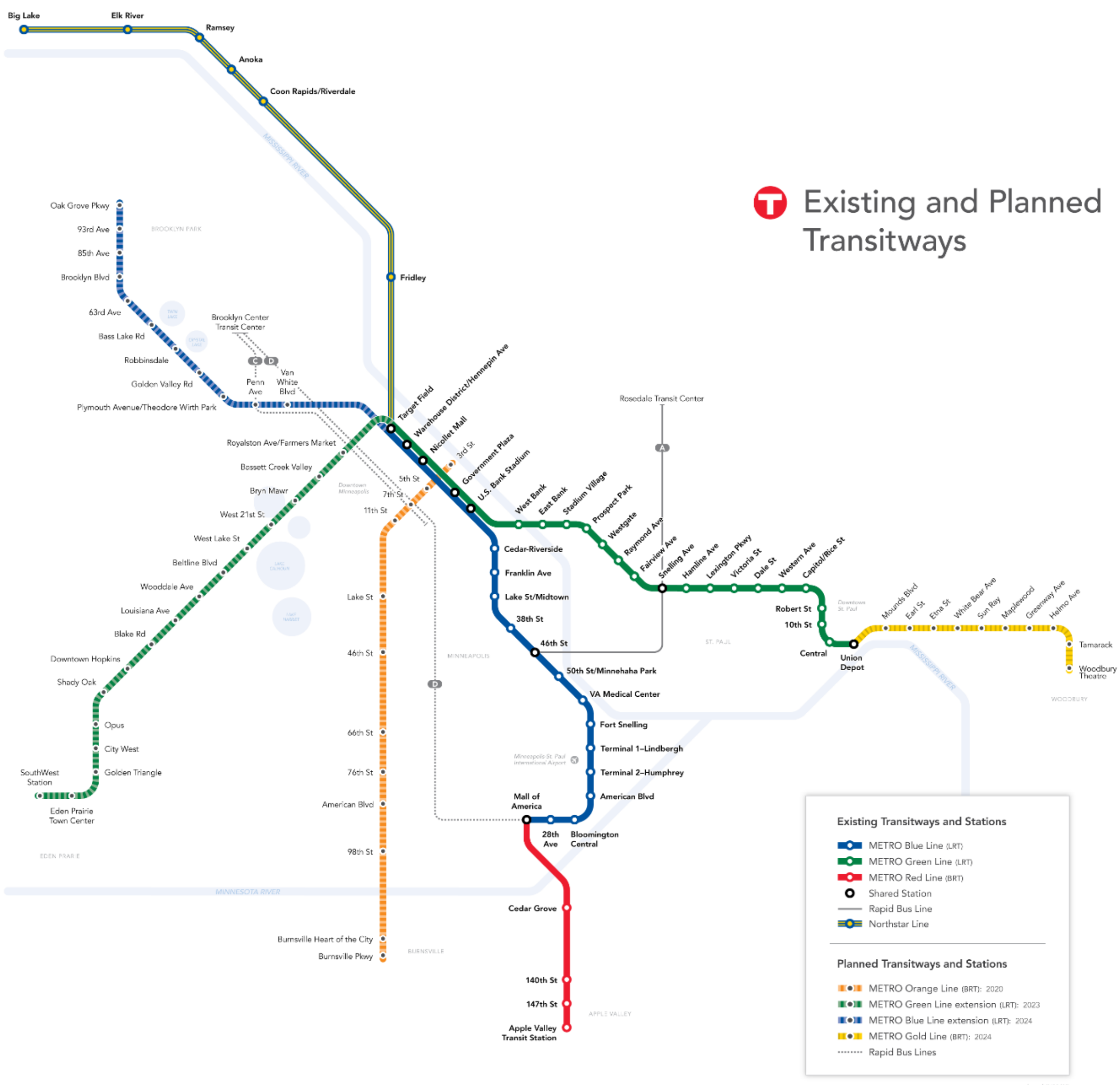


Figure LRT Minneapolis 2
Minneapolis Light Rail Service Map
Source:
https://www.metrotransit.org/Data/Sites/1/media/metro/transitways_diagrammap_2x_11-14-2018.png

NORFOLK LIGHT RAIL SYSTEM

Figure LRT Norfolk 1
The Tide Light Rail System
Source: https://upload.wikimedia.org/wikipedia/commons/b/b6/Tidelrt_01142011.JPG

With 11 stations along one 7.4-mile route, The Tide is a light rail line serving Norfolk, Virginia. It was the first light rail system in Virginia opening on August 19, 2011. As of April 2012, the line was carrying 4,900 passengers per day.[11]

[11] Adapted from: https://en.wikipedia.org/wiki/Tide_Light_Rail.

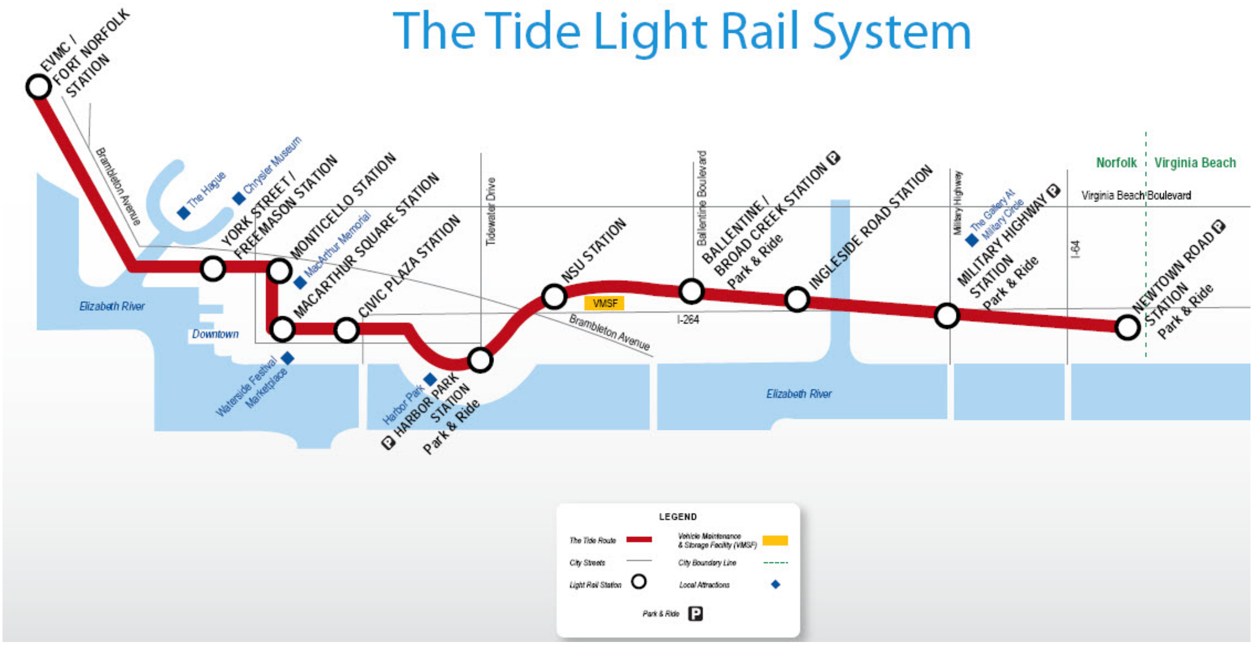


Figure LRT Norfolk 2
The Tide Light Rail Service Map
Source: http://www.railfanguides.us/va/tide/index.htm

PHOENIX LIGHT RAIL SYSTEM

Figure LRT Phoenix 1
Phoenix Valley Metro
Source: https://www.visitphoenix.com/learn-plan/getting-around/public-transportation/
Going between Mesa, Tempe, and Phoenix, the Valley Metro Rail opened in late December of 2008. Valley Metro carries just over 50,000 people per day along a 26.3-mile, 35-station route. It is the 14^{th} busiest light rail system in the nation.[12]

[12] Adapted from: https://en.wikipedia.org/wiki/Valley_Metro_Rail.

Figure LRT Phoenix 2
Phoenix Valley Metro Rail Service Map
Source: http://azmag.gov/Programs/Transportation/Transit

PITTSBURGH LIGHT RAIL SYSTEM

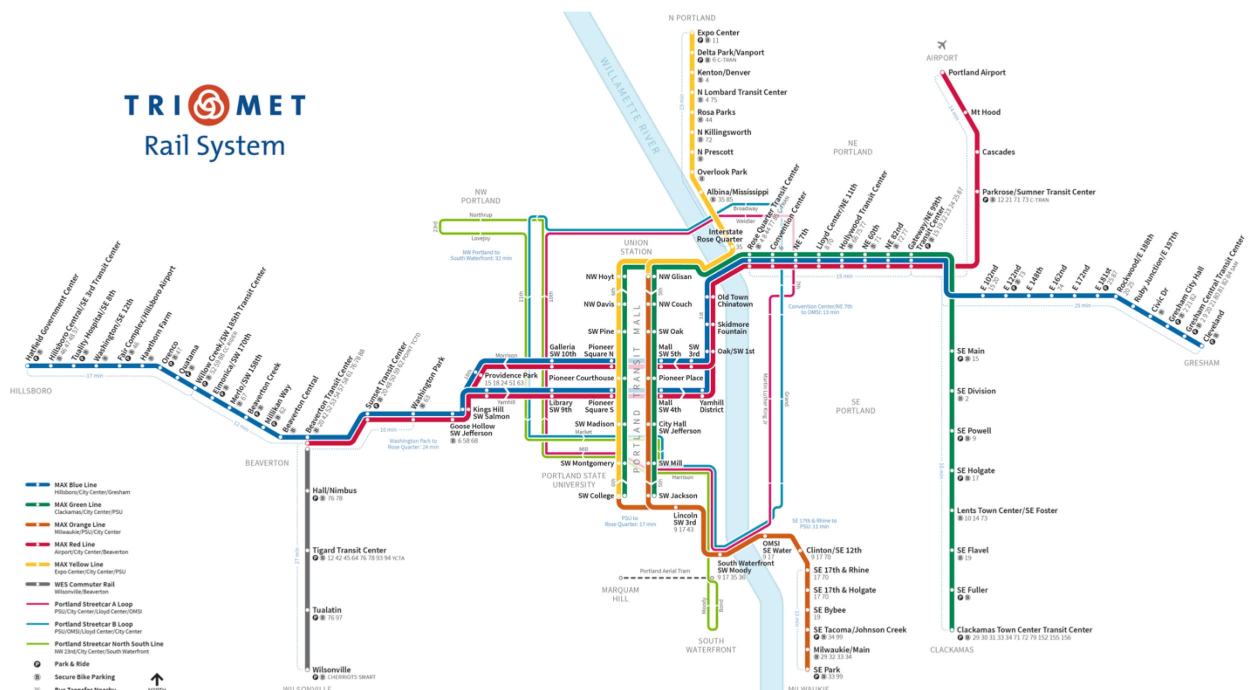
Figure LRT Pittsburgh 1
Pittsburgh Metro
Source: https://www.post-gazette.com/news/transportation/2018/08/23/Port-Authority-Station-Square-light-rail-vehicles-closed-two-hours/stories/201808230159
With 52 stations and a 26.2-mile route, the Pittsburgh Light Rail, commonly known as The T, began operation in 1984. 27,700 passengers ride the system per day, and it operates on lines that date back to 1903. [13]

[13] Adapted from: https://ipfs.io/ipfs/QmXoypizjW3WknFiJnKLwHCnL72vedxjQkDDP1mXWo6uco/wiki/Pittsburgh_light_rail.html.

Figure LRT Pittsburgh 2
Pittsburgh Metro Service Map
Source:
https://ipfs.io/ipfs/QmXoypizjW3WknFiJnKLwHCnL72vedxjQkDDP1mXWo6uco/wiki/Pittsburgh_light_rail.html

PORTLAND LIGHT RAIL SYSTEM

Figure LRT Portland 1
Portland MAX Light Rail System
Source: https://trimet.org/max/
Serving Portland, Oregon, the MAX light rail system has over 121,000 passengers per day. There are five lines stretching to suburbs in all directions with 97 stations. MAX began operation in 1986. There are 86 miles of track in total.[14]



[14] Adapted from: https://en.wikipedia.org/wiki/MAX_Light_Rail.

Figure LRT Portland 2
MAX Service Map
Source: https://trimet.org/max/

SACRAMENTO LIGHT RAIL SYSTEM

Figure LRT Sacramento 1
Sacramento Light Rail
Source: http://ktransit.com/transit/NAmerica/uscalifornia/sacramento/lightrail/Photos/sac-lr-meadowview-041404-05.jpg
The sixteenth busiest light rail system in the nation, Sacramento’s RT system has an average of just under 40,000 passengers riding every weekday. It has 3 lines along 54 stations. All lines, though serving separate suburban areas, go through downtown Sacramento. The line opened on March 12, 1987.

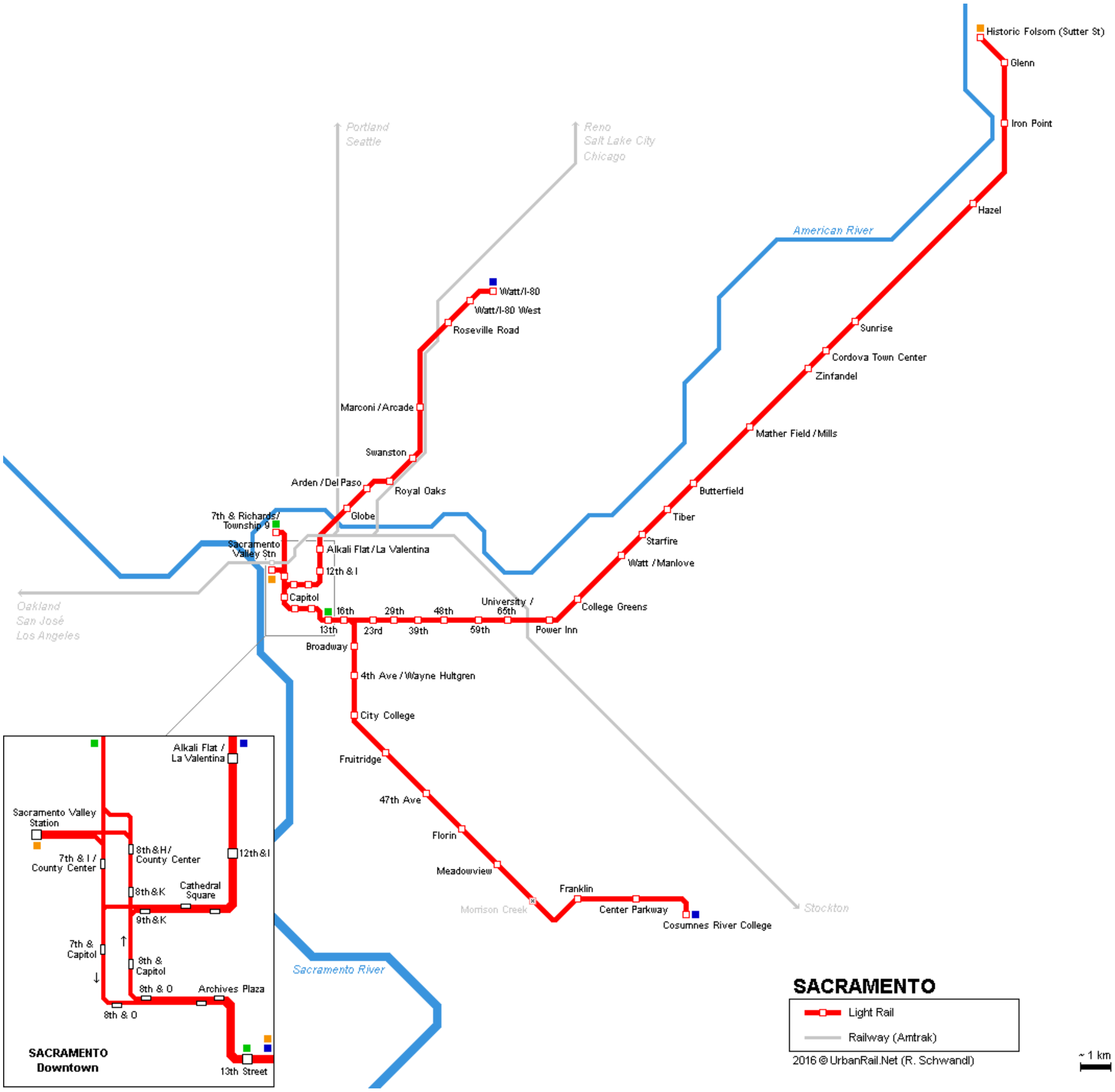


Figure LRT Sacramento 2
Sacramento Light Rail Service Map
Source: http://www.urbanrail.net/am/sacr/sacramento-map.gif

SALT LAKE CITY LIGHT RAIL SYSTEM

Figure LRT Salt Lake City 1
Salt Lake City Light Rail
Source: https://en.wikipedia.org/wiki/TRAX_(light_rail)

There are three lines which the Transit Express, or TRAX, light rail system serves in the Salt Lake City, Utah metro area. TRAX has a daily ridership of approximately 67,300 people with 50 stations in total. The line was open for operation on December 4, 1999 and has 146 vehicles in total. The system's length is 44.8 miles.[15]

[15] Adapted from: https://en.wikipedia.org/wiki/TRAX_(light_rail).

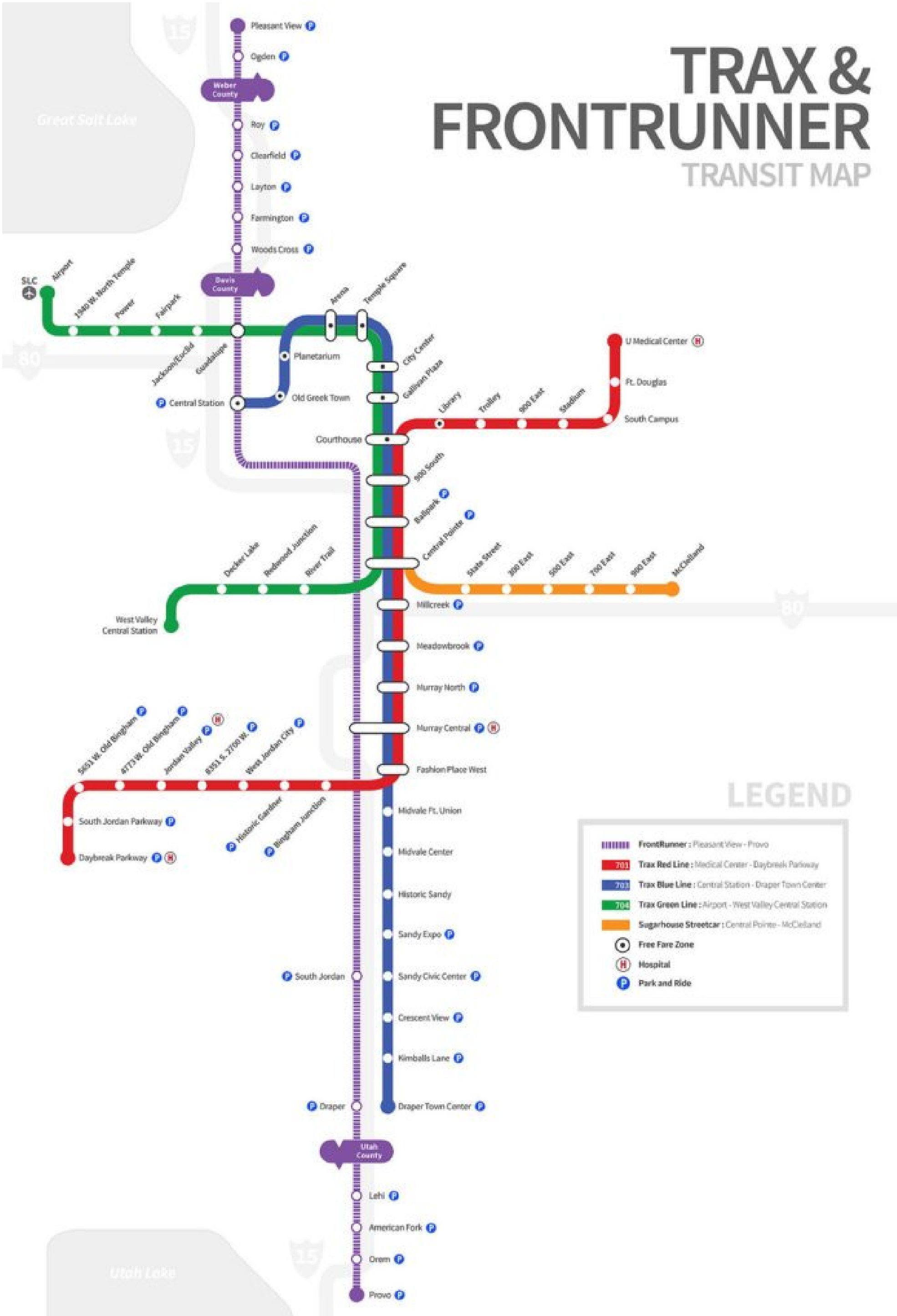


Figure LRT Salt Lake City 2
Salt Lake City Light Rail Service Map
Source: https://i1.wp.com/www.transitmap.net/wp-content/uploads/2012/12/tumblr_meu9utRQeV1r54c4oo1_1280-699x1024.jpg?ssl=1

SAN DIEGO LIGHT RAIL SYSTEM

Figure LRT San Diego 1
San Diego Trolley
Source: https://en.wikipedia.org/wiki/San_Diego_Trolley
The San Diego Trolley has 55 stations for its 3 daily lines and serves 119,800 passengers daily. It began operation in 1981, with the system as a whole dating back to the 1880s. The line is 53.5 miles long and brings passengers from suburbs into the downtown area.[16]

[16] Adapted from: https://en.wikipedia.org/wiki/San_Diego_Trolley.

Figure LRT San Diego 2
San Diego Trolley Service Map
Source:
https://upload.wikimedia.org/wikipedia/commons/thumb/8/8a/San_Diego_Trolley_September_2012.svg/350px-San_Diego_Trolley_September_2012.svg.png

SAN JOSE LIGHT RAIL SYSTEM

Figure LRT San Jose 1
San Jose Light Rail
Source: https://i2.wp.com/www.sanjoseinside.com/wp-content/uploads/2017/09/VTA-Light-Rail-Wikimedia.jpg?resize=772%2C350

Serving the Silicon Valley and San Jose, the VTA Light Rail consists of 3 lines serving 62 stations with an additional four stations planned for development. On an annual basis, the VTA Light Rail carries 11.03 million passengers as of 2015. The system began operation on December 11, 1987, and has 42.2 miles of track.[17]

[17] Adapted from: https://en.wikipedia.org/wiki/Santa_Clara_Valley_Transportation_Authority_light_rail.

Figure LRT San Jose 2
San Jose VTA Service Map (Denoted in light blue)
Source: https://rsnous.com/posts/my-favorite-regional-transit-maps/

SEATTLE LIGHT RAIL SYSTEM

Figure LRT Seattle 1
Link Light Rail
Source: https://www.bizjournals.com/seattle/news/2015/06/05/ballard-to-seattle-heres-what-may-be-next-for.html
With an annual ridership of over 24 million, the Link Light Rail system began operation in August of 2003. The line consists of two disconnected lines formed by a partnership between regional transit partners – the Central Link in King County and the Tacoma Link in Pierce County. There are 22 stations in total along 21.95 miles of track. The line opened on August 22, 2003.[18]

[18] Adapted from: https://en.wikipedia.org/wiki/Link_light_rail.

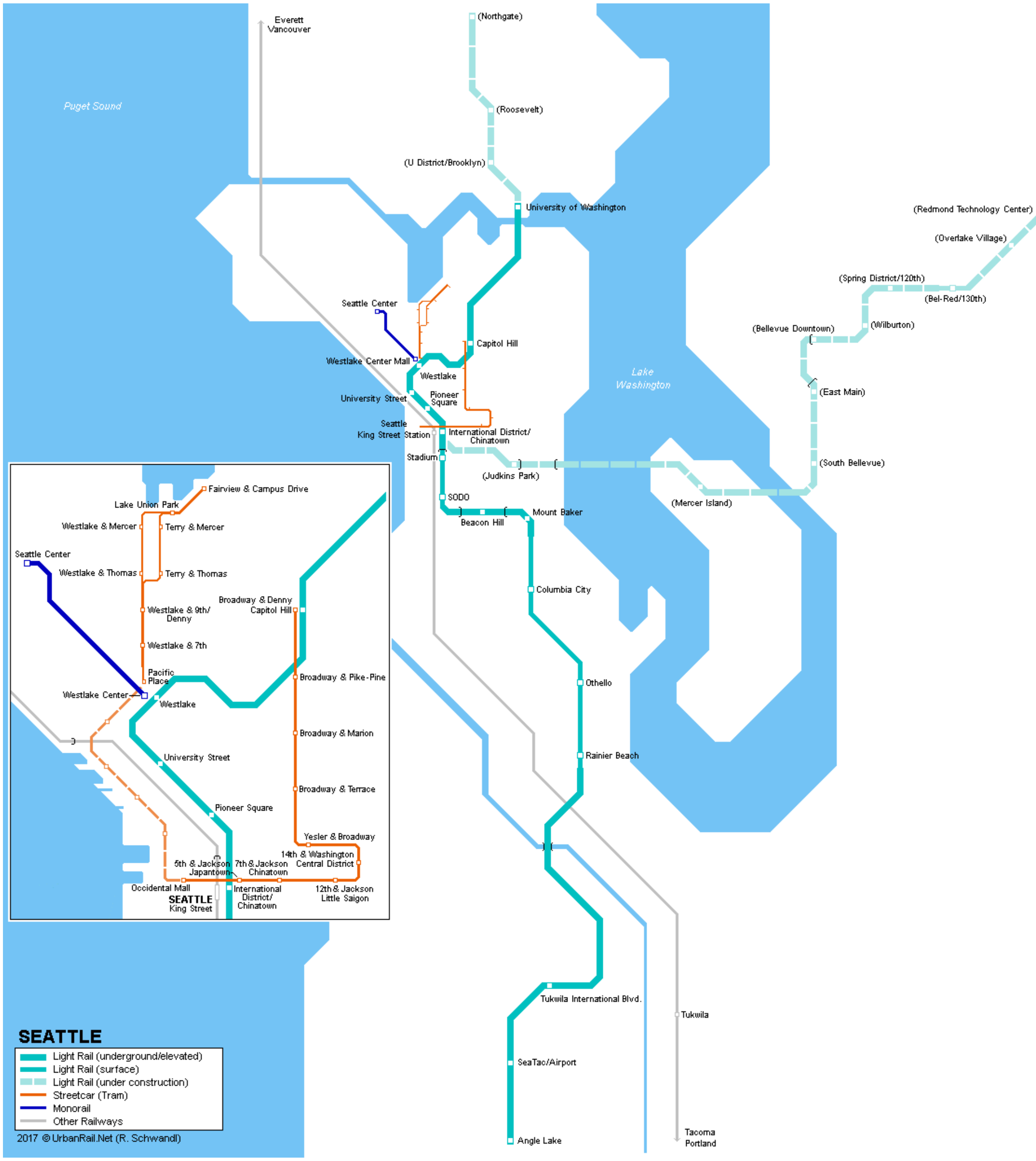


Figure LRT Seattle 2
Seattle Light Rail Service Map
Source: http://www.urbanrail.net/am/seat/seattle-map.png

ST. LOUIS LIGHT RAIL SYSTEM

Figure LRT St. Louis 1
St. Louis Metrolink
Source: https://farm1.staticflickr.com/450/18645452774_308f375b90_b.jpg
With two lines, St. Louis' Metrolink opened on July 31, 1993. The system has 38 stations and carries on average 53,123 people per day. The system extends into the suburbs of St. Louis in Missouri and Illinois as well as the airport and the Scott Air Force Base. The line is 46 miles in total length.[19]

[19] Adapted from: https://en.wikipedia.org/wiki/MetroLink_(St._Louis).

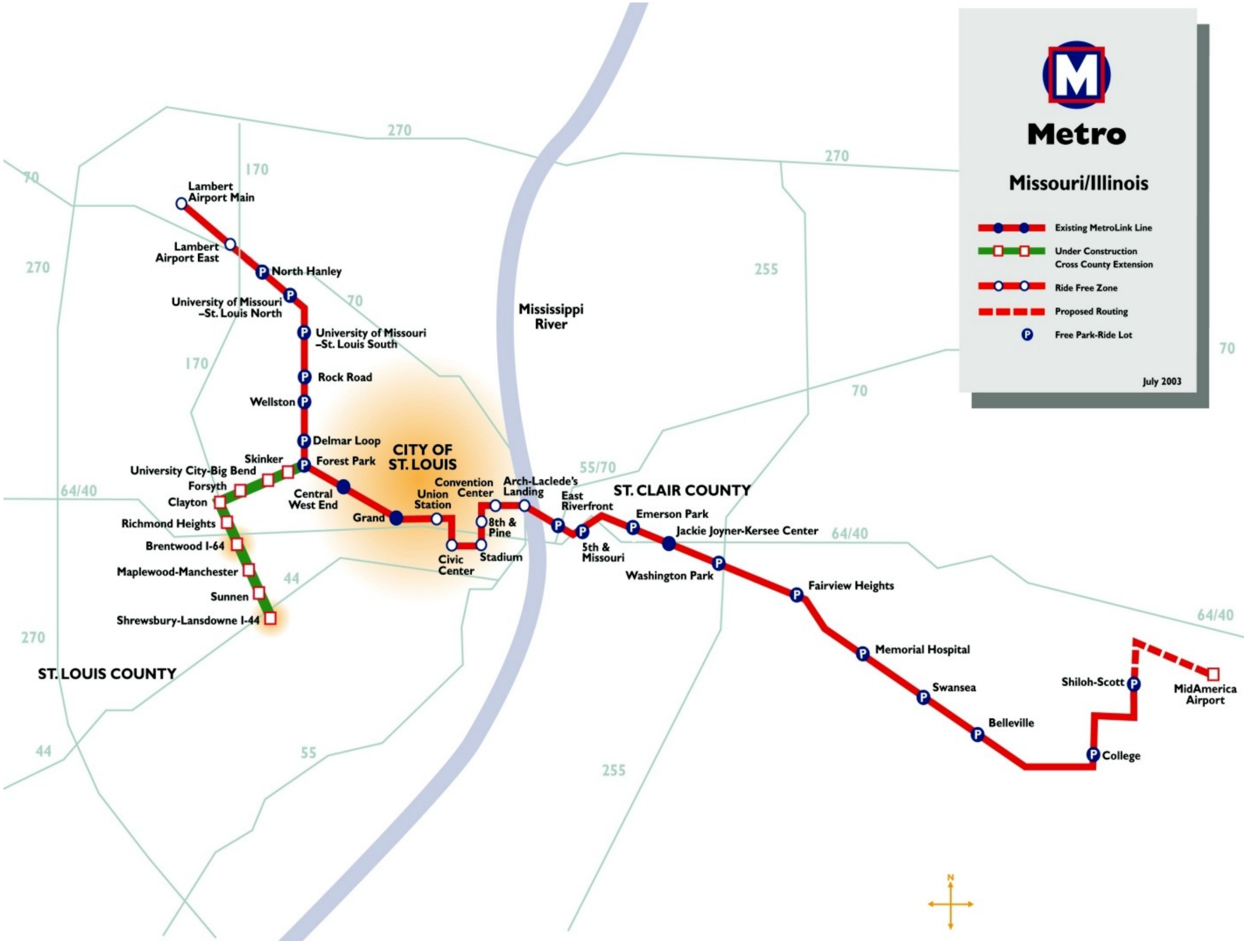


Figure LRT St. Louis 2
St. Louis Metro Service Map
Source: https://www.lightrailnow.org/images/stl-lrt-map-system_cross-county-metro.jpg

APPENDIX A – BRT
BUS RAPID TRANSIT SYSTEMS USED IN ANALYSIS

Bus Rapid Transit Systems Metro Area & Name	Year	Miles	Stations	Riders (Daily)
Albuquerque: Albuquerque Rapid Transit / ART	2019		27	15,750
Cleveland: HealthLine	2008	6.8	59	14,367
Eugene - Springfield: Emerald Express / EMX	2007	13	25	
Kansas City: MAX BRT	2005	32	87	
Las Vegas: Metropolitan Area Express / MAX	2004-16	7	22	
Minneapolis: A Line	2016		20	
Nashville: BRT	2009	24		
Phoenix: BRT	2009			
Pittsburgh: BRT	1977			220,000
Reno: Rapid	2010			
Salt Lake City: UTA MAX Bus	2008			4,100
San Antonio: Primo	2012			
San Diego: Rapid	2014		30	
San Jose: Rapid	2017	7		
Seattle: RAPIDRIDE	2010	64		65,000
Stockton: Bus Rapid Transit	2007			
Washington, DC: Metroway	2014	6.8	16	2,067

ALBUQUERQUE BUS RAPID TRANSIT SYSTEM

Figure BRT Albuquerque 1
ART Rolling Stock
[Source: https://www.abqjournal.com/815792/court-hearing-begins-on-suit-that-could-halt-abq-rapid-transit.html](https://www.abqjournal.com/815792/court-hearing-begins-on-suit-that-could-halt-abq-rapid-transit.html)

Albuquerque Rapid Transit, abbreviated ART, is a rapid transit line slated to open in 2019. Its route is set to revive parts of historic Route 66 and features 27 stops.[20]

[20] Adapted from: http://www.cabq.gov/transit/art-information.

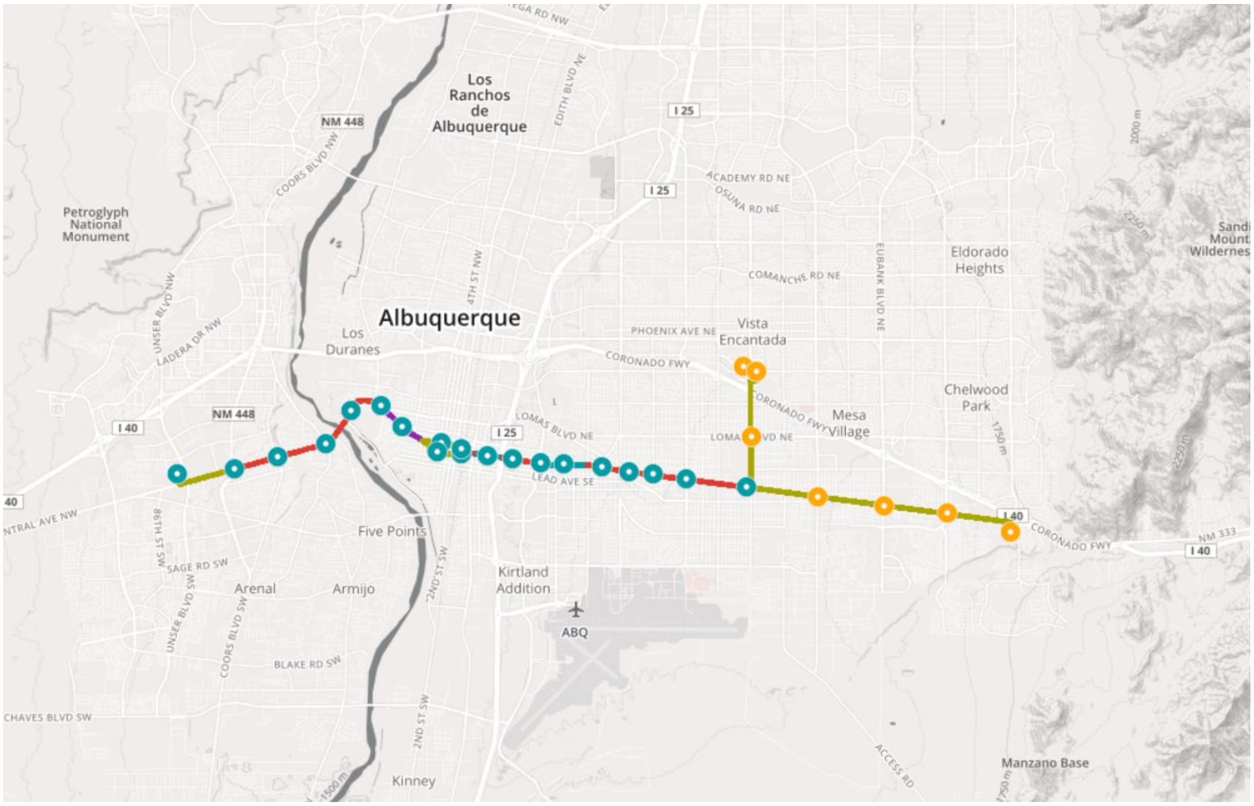


Figure BRT Albuquerque 2
ART System Map
[Source: https://www.brtabq.com/Map](https://www.brtabq.com/Map)

CLEVELAND BUS RAPID TRANSIT SYSTEM

Figure BRT Cleveland 1
HealthLine BRT System
Source: https://en.wikipedia.org/wiki/File:HealthLine_1.jpg
The HealthLine is the bus rapid transit system in Cleveland, Ohio. It is operated by the Greater Cleveland Regional Transit Authority. The line has 59 stations along a 6.8-mile route. Daily, it serves 14,367 passengers. It is a top-rated BRT system according to the BRT Standard.[21]

[21] Adapted from: https://en.wikipedia.org/wiki/HealthLine.

Figure BRT Cleveland 2
HealthLine Map
Source: https://moovitapp.com/index/en/public_transit-line-HEALTHLINE-Cleveland_OH-1362-775392-239205-0

EUGENE – SPRINGFIELD BUS RAPID TRANSIT SYSTEM

Figure BRT Eugene – Springfield 1
Emerald Express
Source: http://www.bcx.news/photos/transport/public/ltd/emx/bus/

Serving the Eugene-Springfield metro area of Oregon, the Emerald Express (EMX) line was one of the first BRT systems in the country. EMX began service on January 14, 2007 with 25 stations serving a single line. The line received an honorable mention in the Sustainable Transportation Awards in 2008 since ridership had doubled in the year since it opened.[22]

[22] Adapted from: https://en.wikipedia.org/wiki/Emerald_Express.

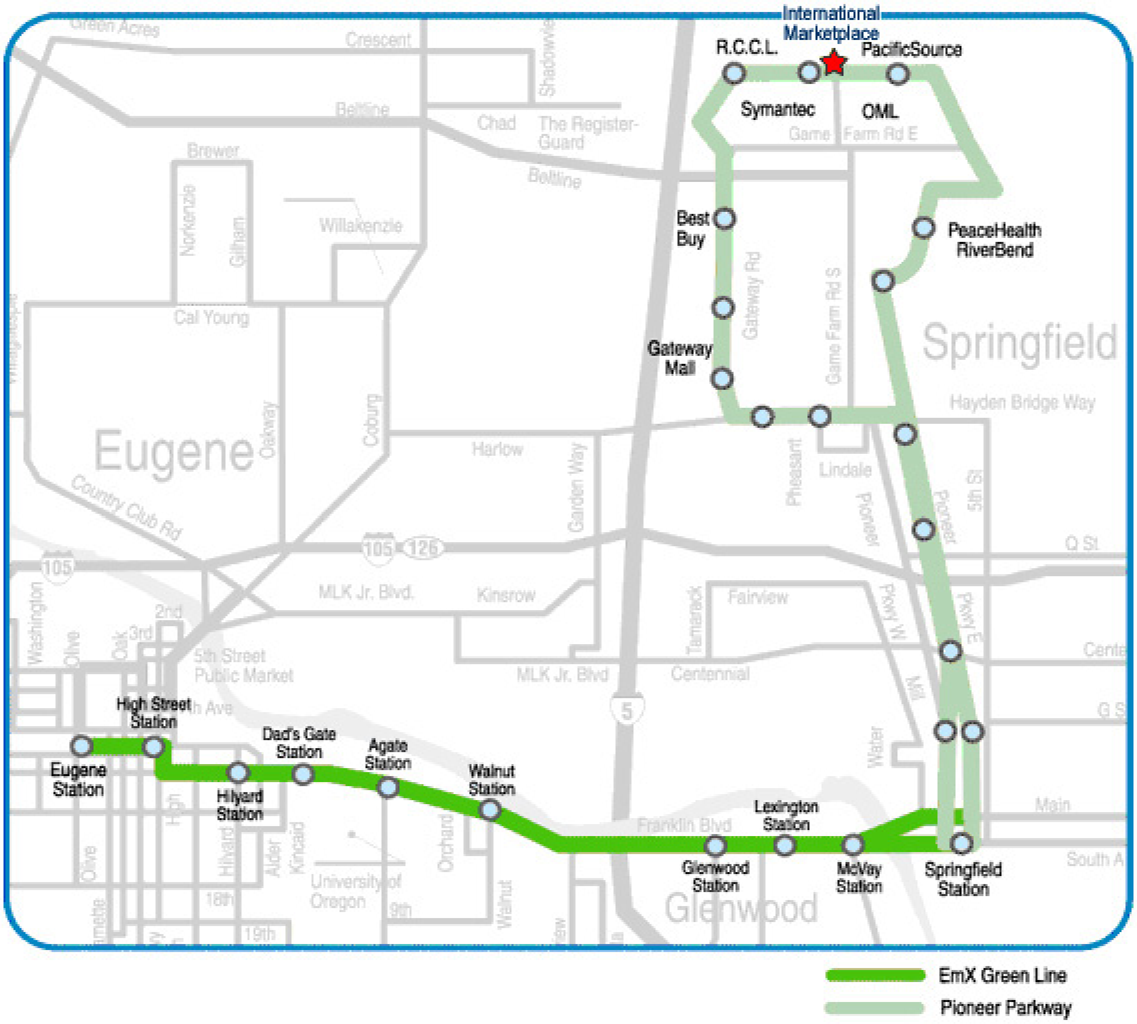


Figure BRT Eugene – Springfield 2
EmX Service Map
Source: http://www.voyentcapital.com/images/emx_map.jpg

KANSAS CITY BUS RAPID TRANSIT SYSTEM

Figure BRT Kansas City 1
Kansas City MAX System
Source: https://www.bizjournals.com/kansascity/news/2016/02/10/kcata-federal-transit-administration-grant.html
Serving areas of concentrated residential and business activity, Kansas City's MAX BRT system debuted in 2005. There are currently 87 stations that are served by MAX. With two routes currently in operation, there are an addition four planned with one now under construction. According to the Federal Transit Administration, it is a model bus rapid transit line.[23]

[23] Adapted from: https://en.wikipedia.org/wiki/Metro_Area_Express.

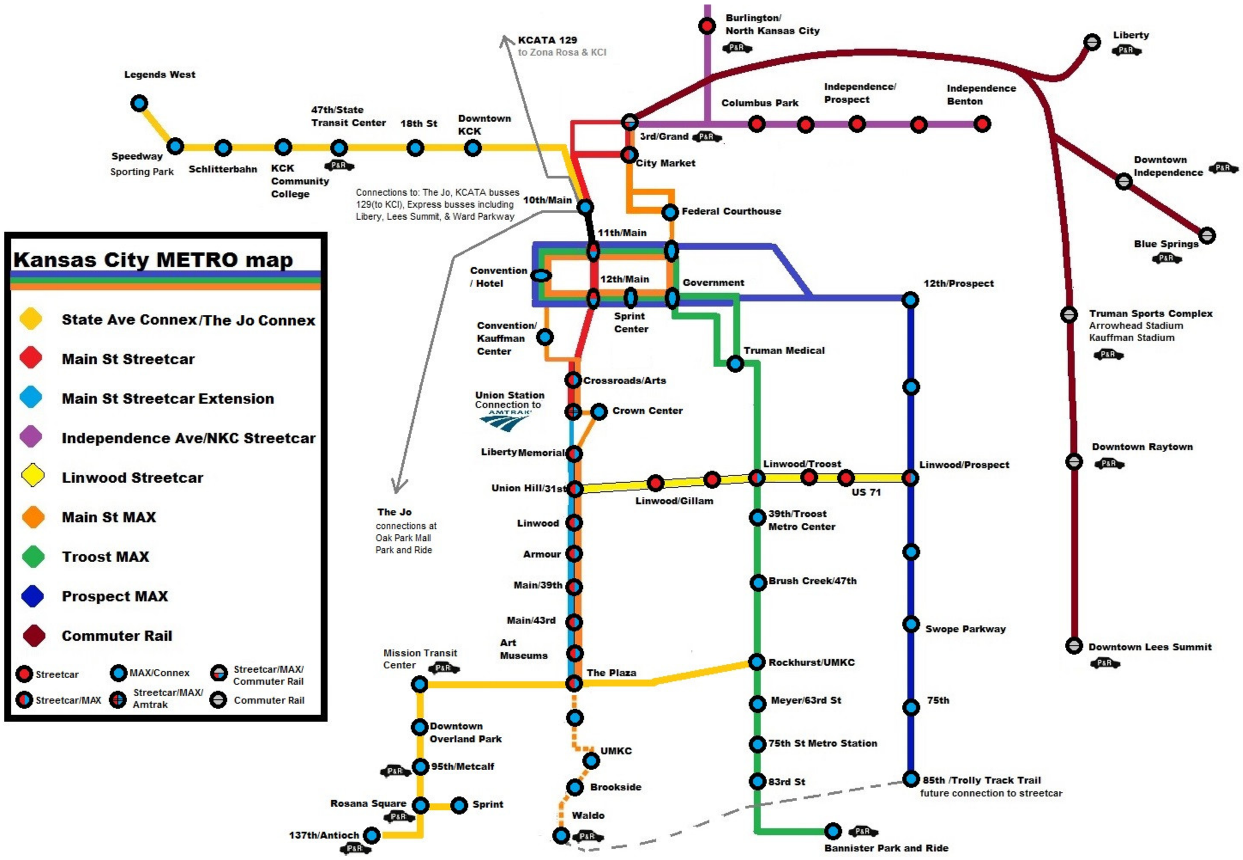


Figure BRT Kansas City 2
Kansas City Transit Service Map
Source: http://kcrag.com/viewtopic.php?t=19518

LAS VEGAS BUS RAPID TRANSIT SYSTEM

Figure BRT Las Vegas 1
Las Vegas Bus Rapid Transit
Source: https://en.wikipedia.org/wiki/File:CAT_Irisbus_Civis.jpg
The Metropolitan Area Express (MAX) was Las Vegas' bus rapid transit system which operated from June 30, 2004 until February 20, 2016. It ran in 12-minute intervals during the day and 20 minute intervals at night. There were 22 stations along its 7-mile route.[24]

[24] Adapted from: https://en.wikipedia.org/wiki/Metropolitan_Area_Express_(Las_Vegas).

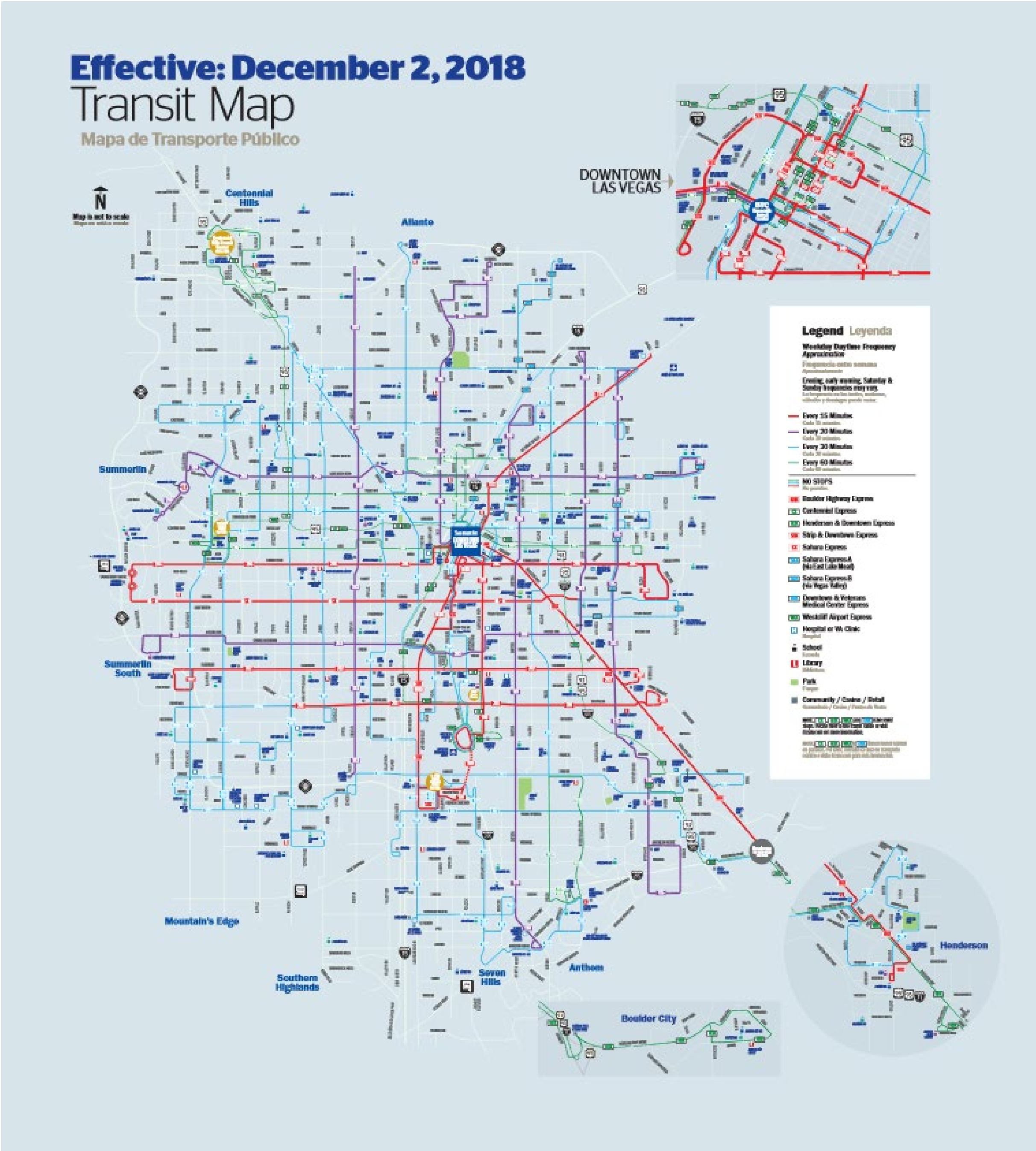


Figure BRT Las Vegas 2
Las Vegas Transit Map (Express Lines)
[Source: https://www.rtcsnv.com/wp-content/uploads/2018/11/SystemMap-Dec2018.pdf](https://www.rtcsnv.com/wp-content/uploads/2018/11/SystemMap-Dec2018.pdf)

MINNEAPOLIS BUS RAPID TRANSIT SYSTEM

Figure BRT Minneapolis 1
A Line Bus
Source: https://minnesota.cbslocal.com/2016/06/08/brt/
Called the A Line, the Twin Cities' rapid bus service is like conventional buses but operates much quicker and more efficient. Service on the A Line is every ten minutes, and all A Line buses have free onboard Wi-Fi. It connects passengers from suburbs to the rail station on to Downtown Minneapolis.[25]

[25]Adapted from: https://www.metrotransit.org/a-line-now-open.

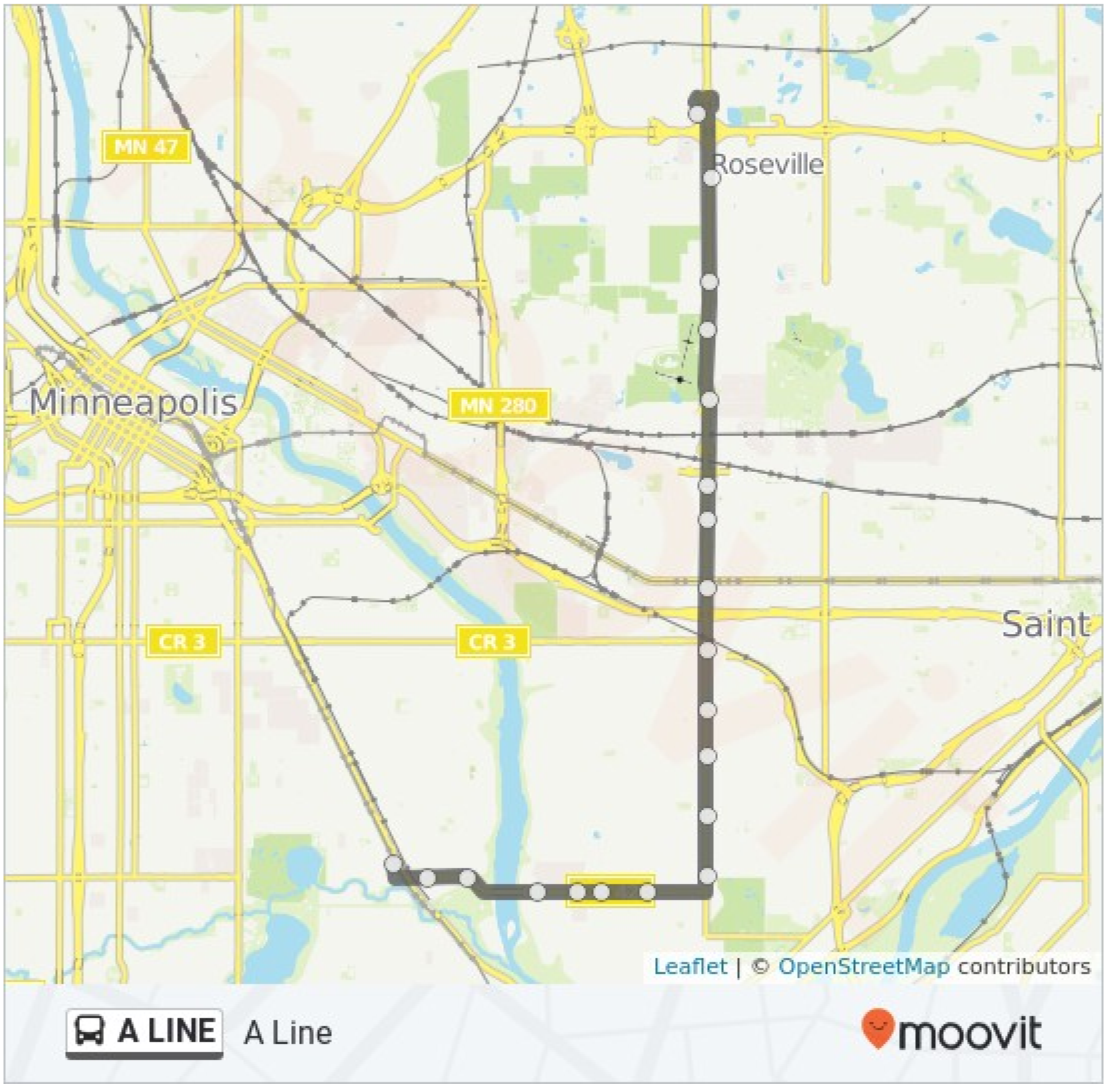


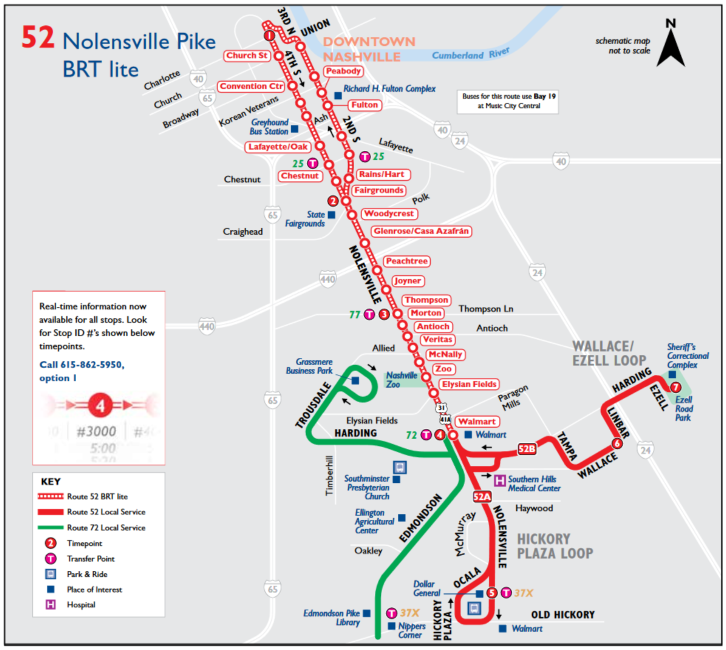
Figure BRT Minneapolis 2
A Line Service Map
Source: https://moovitapp.com/index/en/public_transit-line-A_LINE-MinneapolisSt_Paul_MN-1143-10734-455984-0

NASHVILLE BUS RAPID TRANSIT SYSTEM

Figure BRT Nashville 1
Nashville BRT
Source: https://www.alamy.com/stock-photo/nashville-mta.html

Operating as lines 50 and 52, Nashville’s BRT lines connect Hillwood and Old Hickory with Downtown Nashville. They are called BRT Lite lines since they don’t technically fall into a traditional BRT realm, but operate as one for all intents and purposes.[26]

[26] Adapted from: https://en.wikipedia.org/wiki/Nashville_Metropolitan_Transit_Authority#BRT_(Bus_Rapid_Transit)_Lite.



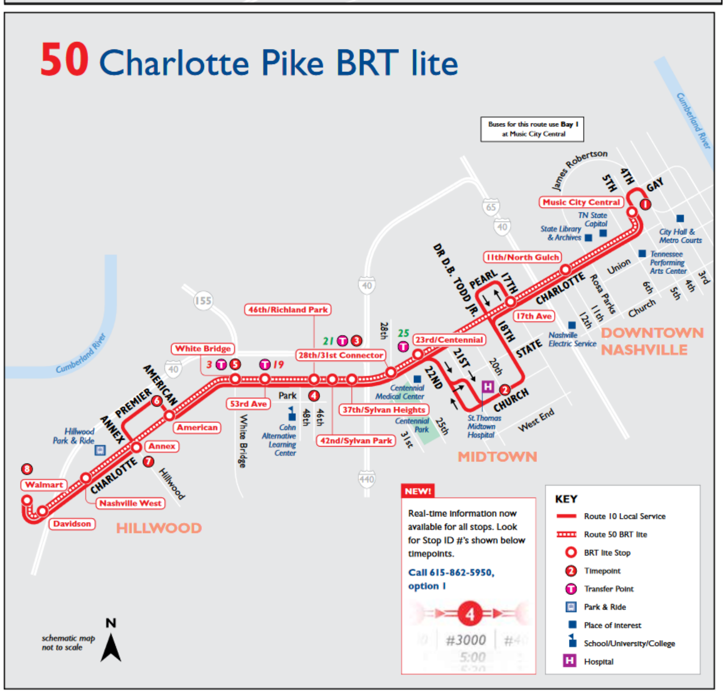


Figure BRT Nashville 2
Nashville BRT Lite Service Maps
Source: http://www.nashvillemta.org/Nashville-MTA-Maps-and-Schedules.asp

PHOENIX BUS RAPID TRANSIT SYSTEM

Figure BRT Phoenix 1
Phoenix BRT Rolling Stock
Source: https://www.stvinc.com/project/phoenix-bus-rapid-transit

Valley Metro Transportation Authority operates six rapid bus lines in the Phoenix, Arizona metro area. These lines travel along Interstate 10, Arizona State Road 51, and South Mountain.[27]

[27] Adapted from: https://www.valleymetro.org/maps-schedules.

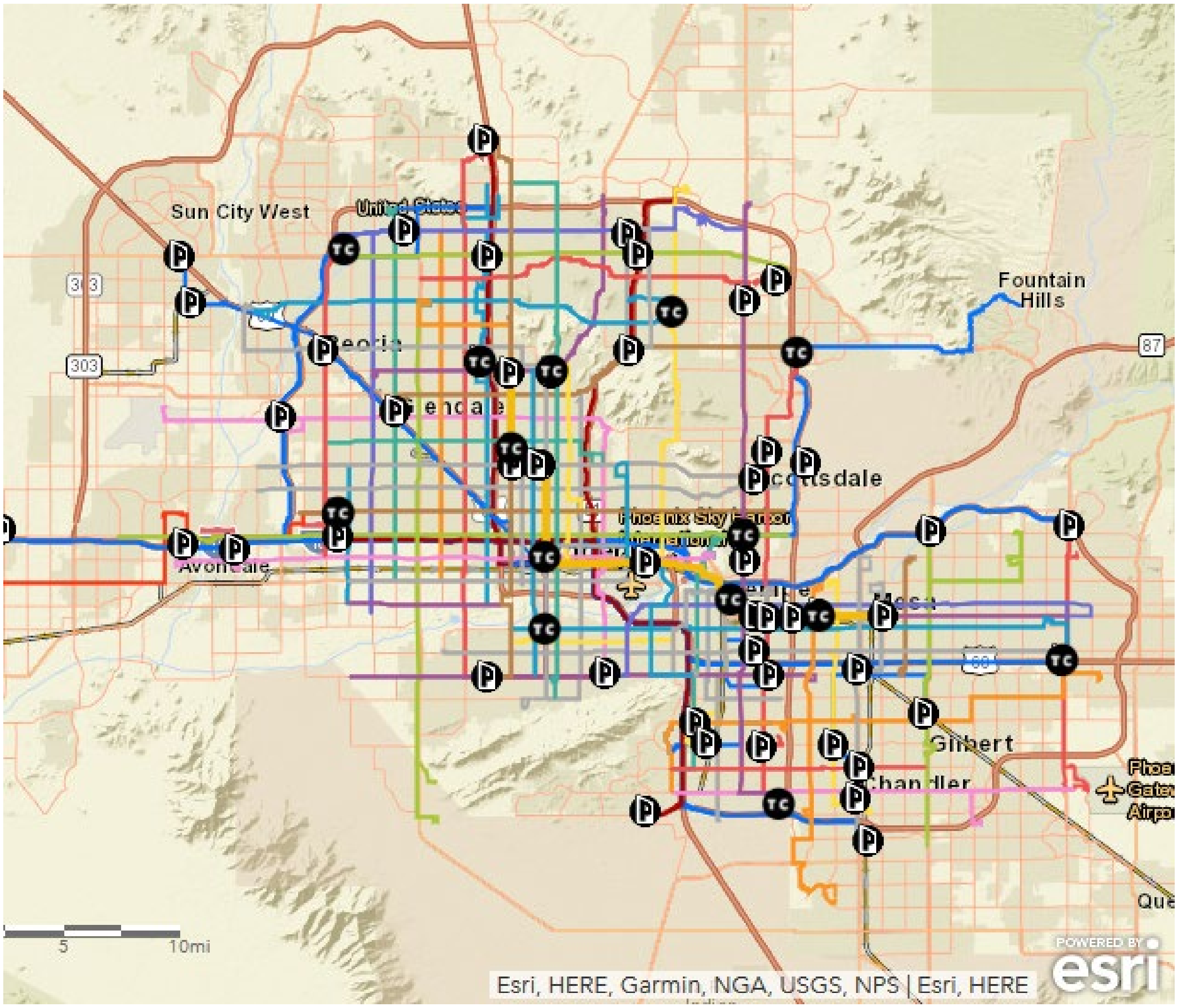


Figure BRT Phoenix 2
Valley Metro Bus Service Map (RAPID lines denoted in deep red)
Source: https://www.valleymetro.org/system-map

PITTSBURGH BUS RAPID TRANSIT SYSTEM

Figure BRT Pittsburgh 1
Pittsburgh Bus Rolling Stock
Source: [Source: http://gcapgh.org/wp-content/uploads/2017/03/GCA_BRT_photo.jpg](http://gcapgh.org/wp-content/uploads/2017/03/GCA_BRT_photo.jpg)
The Pittsburgh Bus system has a fleet of over 700 buses and averages 220,000 rides every weekday for all public transit services.[28]

[28] Adapted from: https://www.portauthority.org/inside-Port-Authority/about-us/.

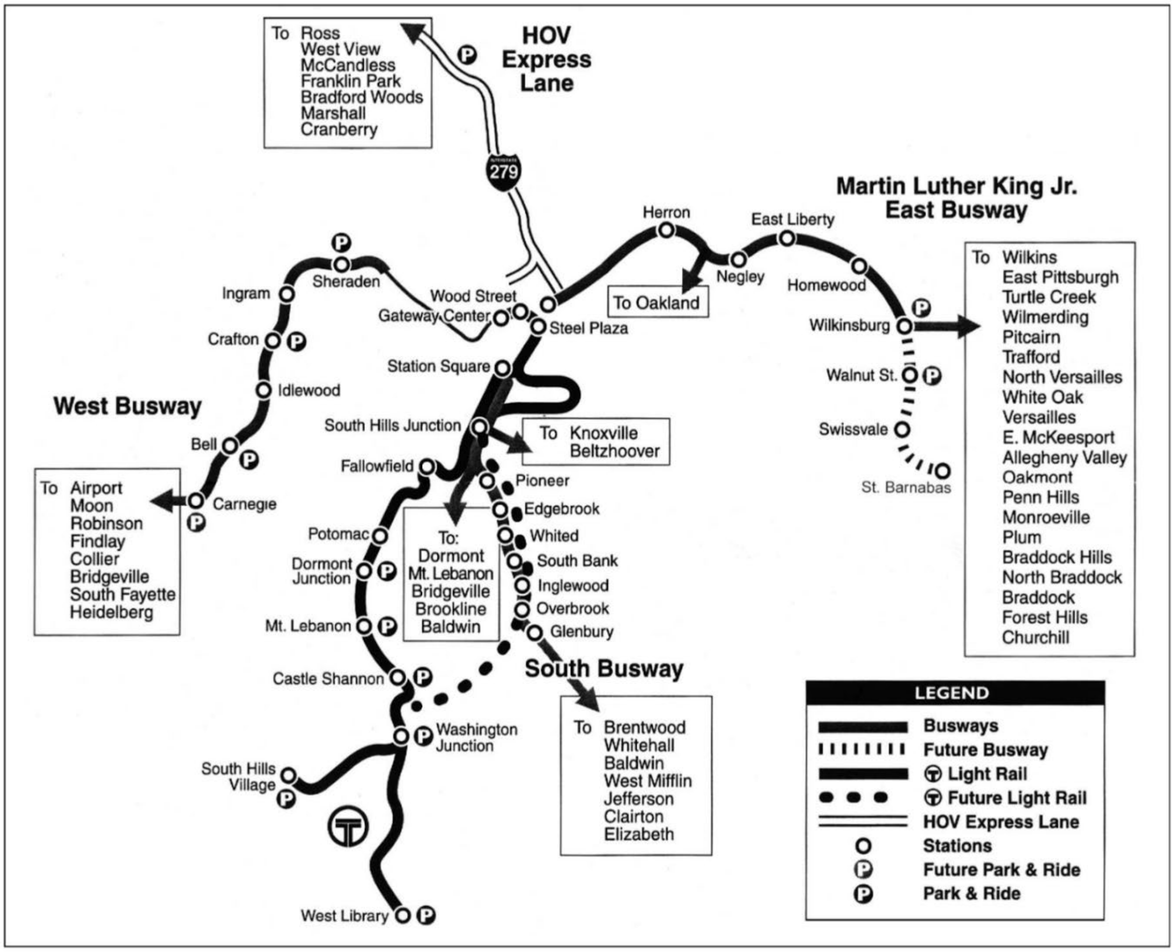


Figure 1: Busway System Map

Figure BRT Pittsburgh 2
Source: https://cdn-images-1.medium.com/max/2600/0*2ni_pbZgl8K_ttba.

RENO BUS RAPID TRANSIT SYSTEM

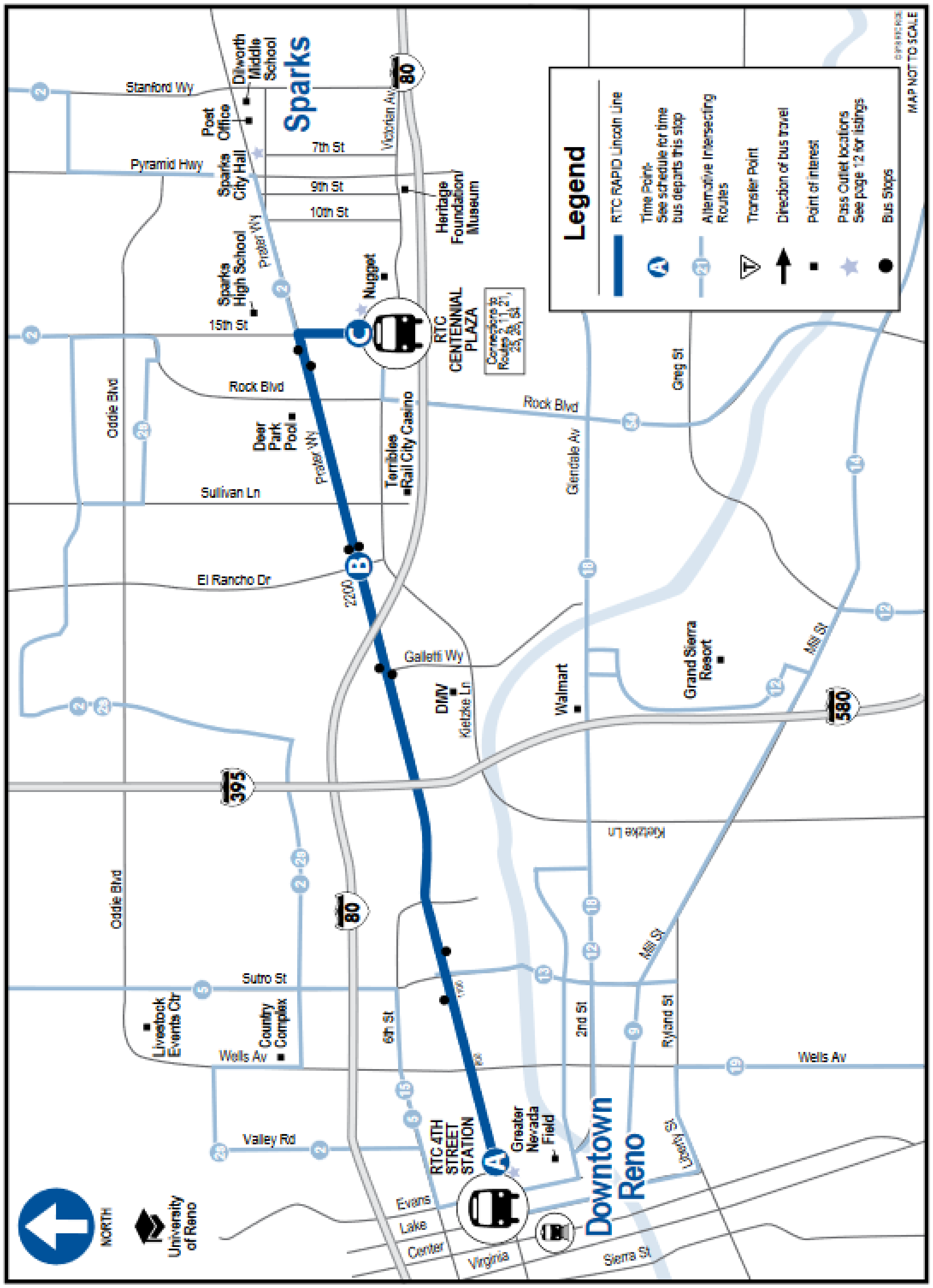
Figure BRT Reno 1
Reno Rapid Bus
Source: http://www.imagemag.org/rtc-bus-reno/
Reno, Nevada's rapid transit bus system operates during most of the day with two separate lines, with reliable and quick transportation between suburban areas and downtown Reno. [29]

[29] Adapted from: https://www.rtcwashoe.com/routes/.

RTC RAPID Lincoln Line

RTC 4TH STREET STATION
Middle Island

Fourth/Prater



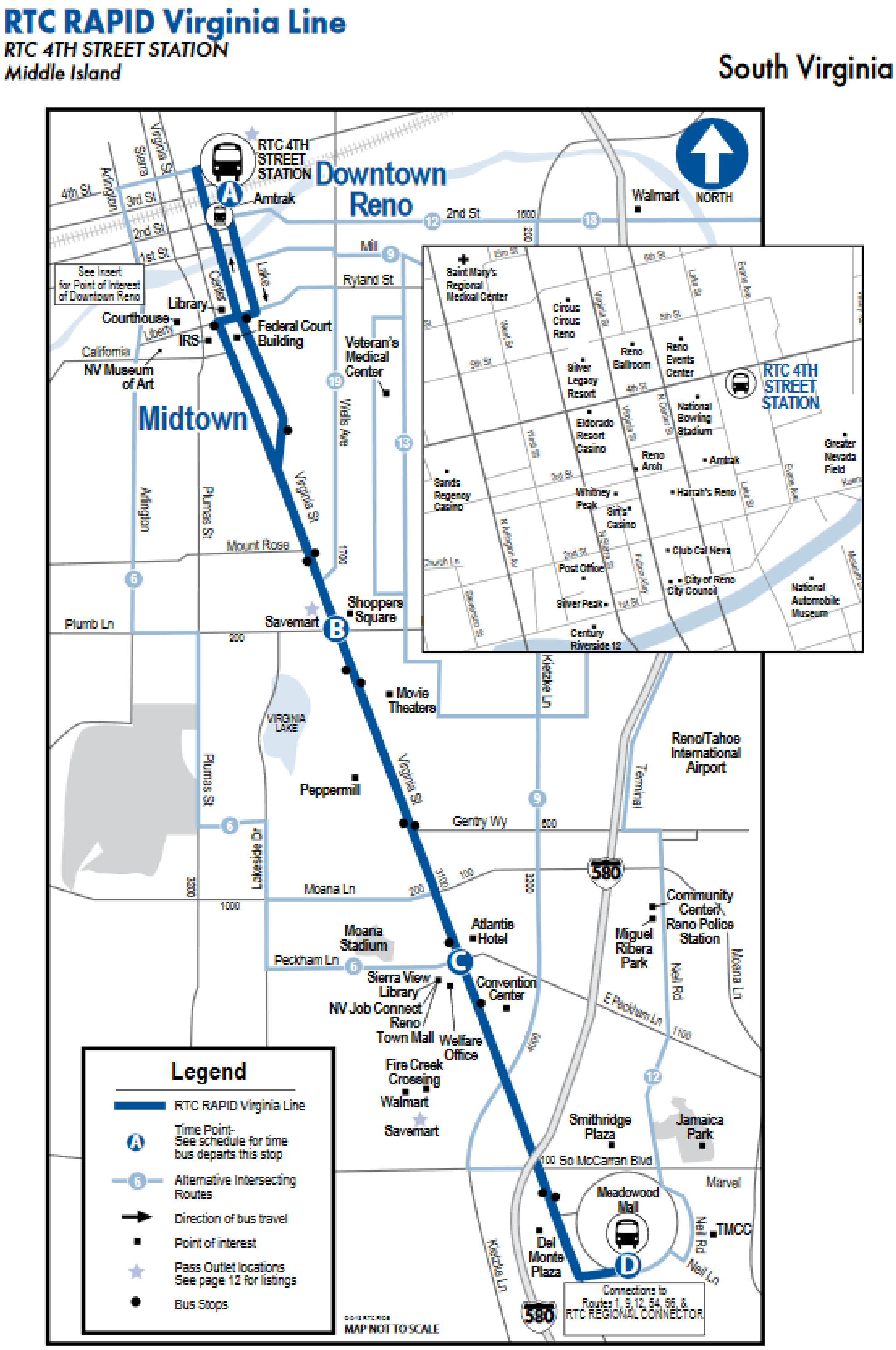


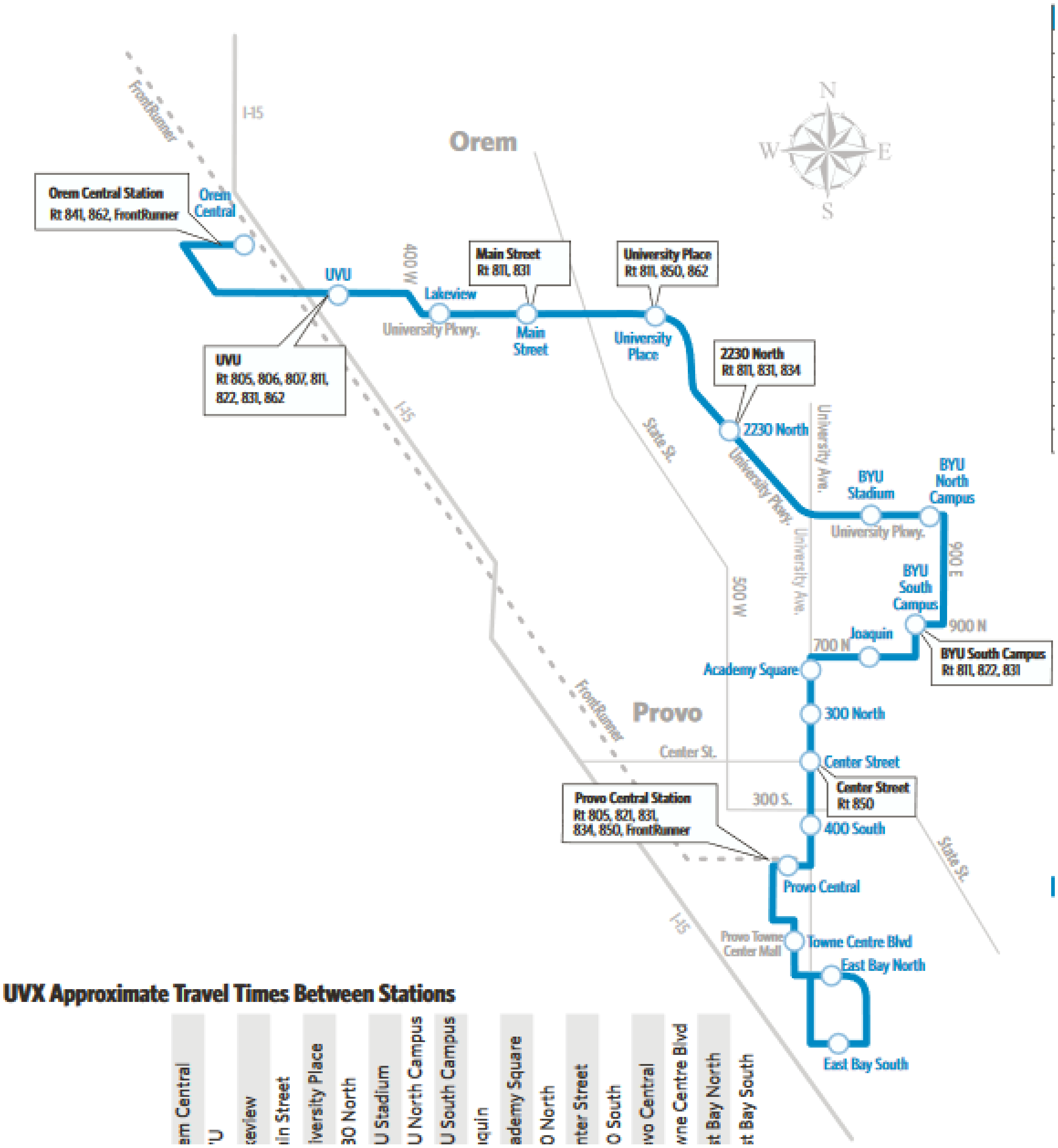
Figure BRT Reno 2 & 3
Rapid Transit Reno Service Map
Source: https://www.rtcwashoe.com/routes/
SALT LAKE CITY BUS RAPID TRANSIT SYSTEM

Figure BRT Salt Lake City 1
UTA Bus
Source: https://www.deseretnews.com/article/900053005/uta-offers-extra-service-to-capitol-for-legislative-session.html

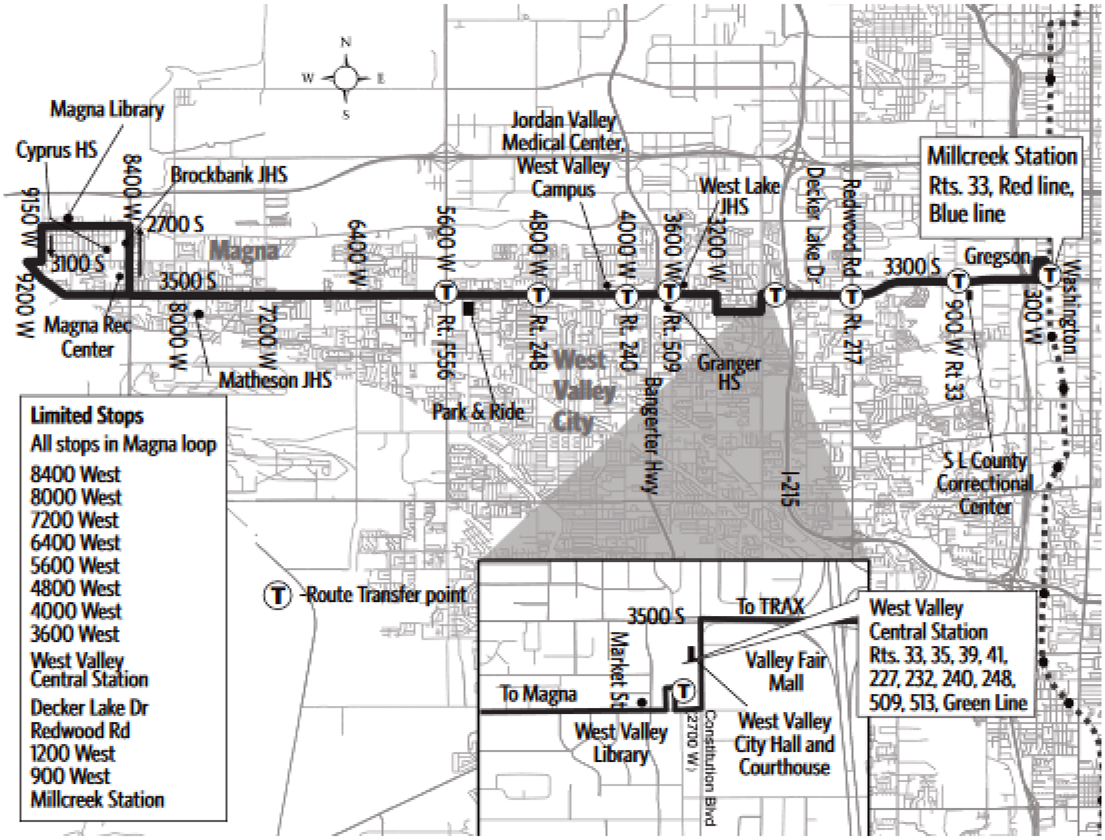
The Utah Transit Authority (UTA) operates two bus rapid transit lines – the MAX 3500 South and the Utah Valley Express. The 3500 Line serves the areas just south of Salt Lake City running east and west, and the Valley Express line goes between Orem and Provo with connections to the light rail.[30]

[30] Adapted from: https://www.rideuta.com/Services/Bus-Rapid-Transit.

UVX Route 830X

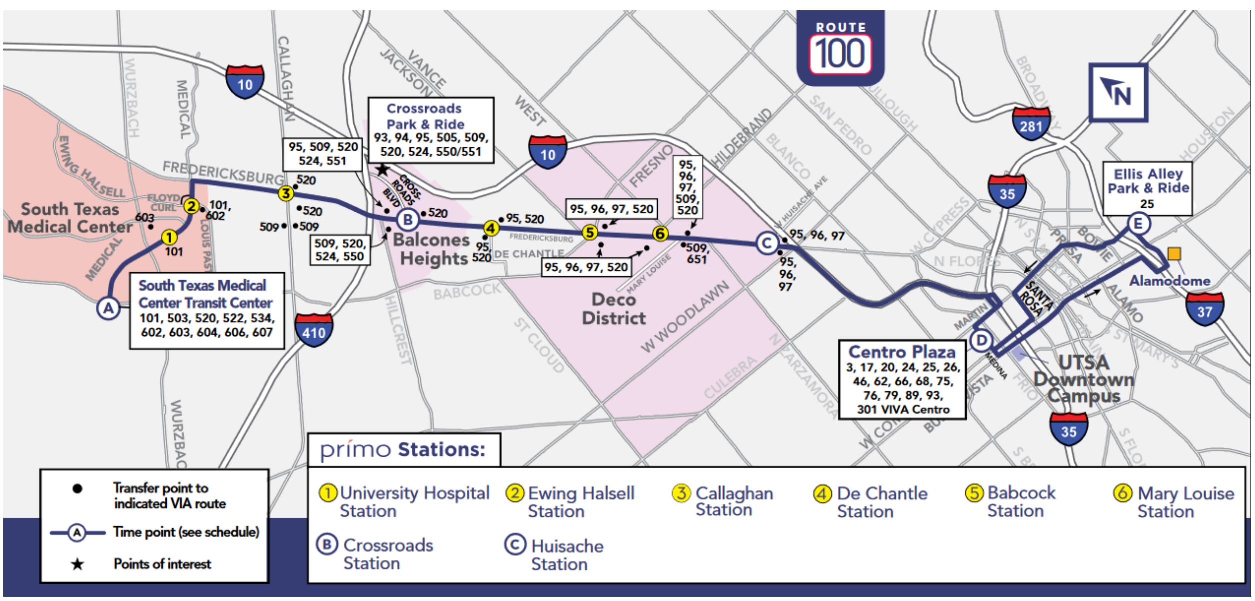


UVX Approximate Travel Times Between Stations



SAN ANTONIO BUS RAPID TRANSIT SYSTEM

Figure BRT San Antonio 1
San Antonio Primo Bus
Source: https://www.viainfo.net/primo_service/
San Antonio's bus rapid transit system is called Primo. Primo buses get traffic signal priority and free high-speed wifi among others. Buses run every 12 minutes along two lines, the 100 and 103, with 102 opening late 2019.[31]



[31] Adapted from: https://www.viainfo.net/primo_service/.

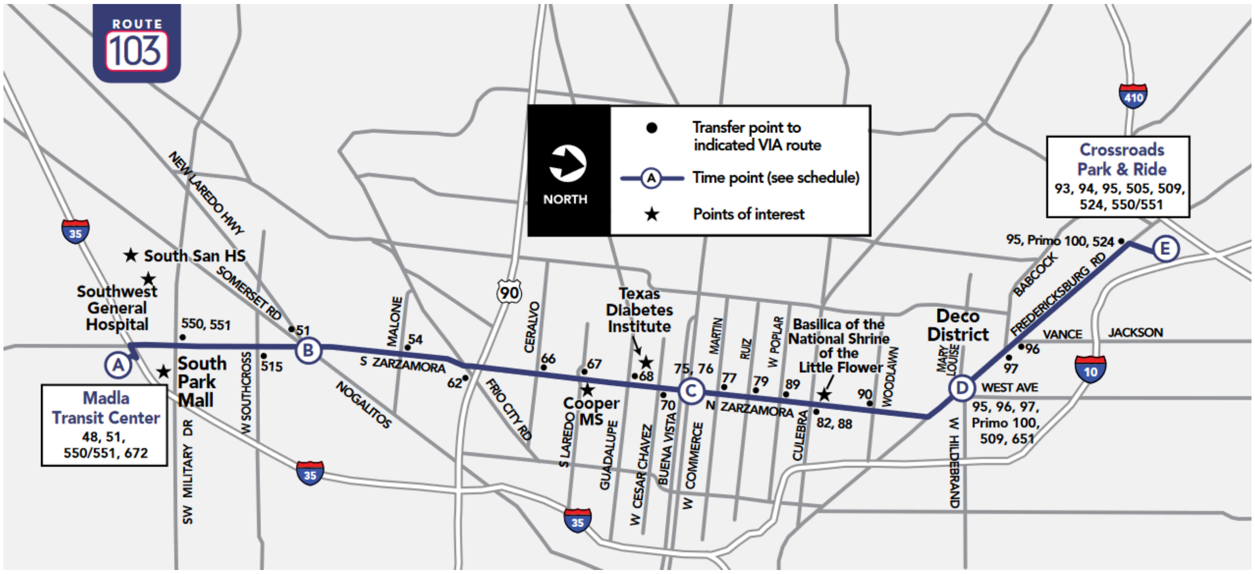


Figure BRT San Antonio 2 & 3
Primo Routes 100 and 103 Map
Source: [Source: https://www.viainfo.net/primo_service/](https://www.viainfo.net/primo_service/)

SAN DIEGO BUS RAPID TRANSIT

Figure X
San Diego Rapid BRT System
Source: https://keepsandiegomoving.com/i-15-corridor/I-15-transit-services.aspx

Called Rapid, San Diego's bus rapid transit system operated mainly in the HOV lanes of Interstate 15 and Interstate 805. The system was founded in 2014 with 30 stops along 9 routes. Rapid has 34 stations and runs mainly on compressed natural gas.[32]

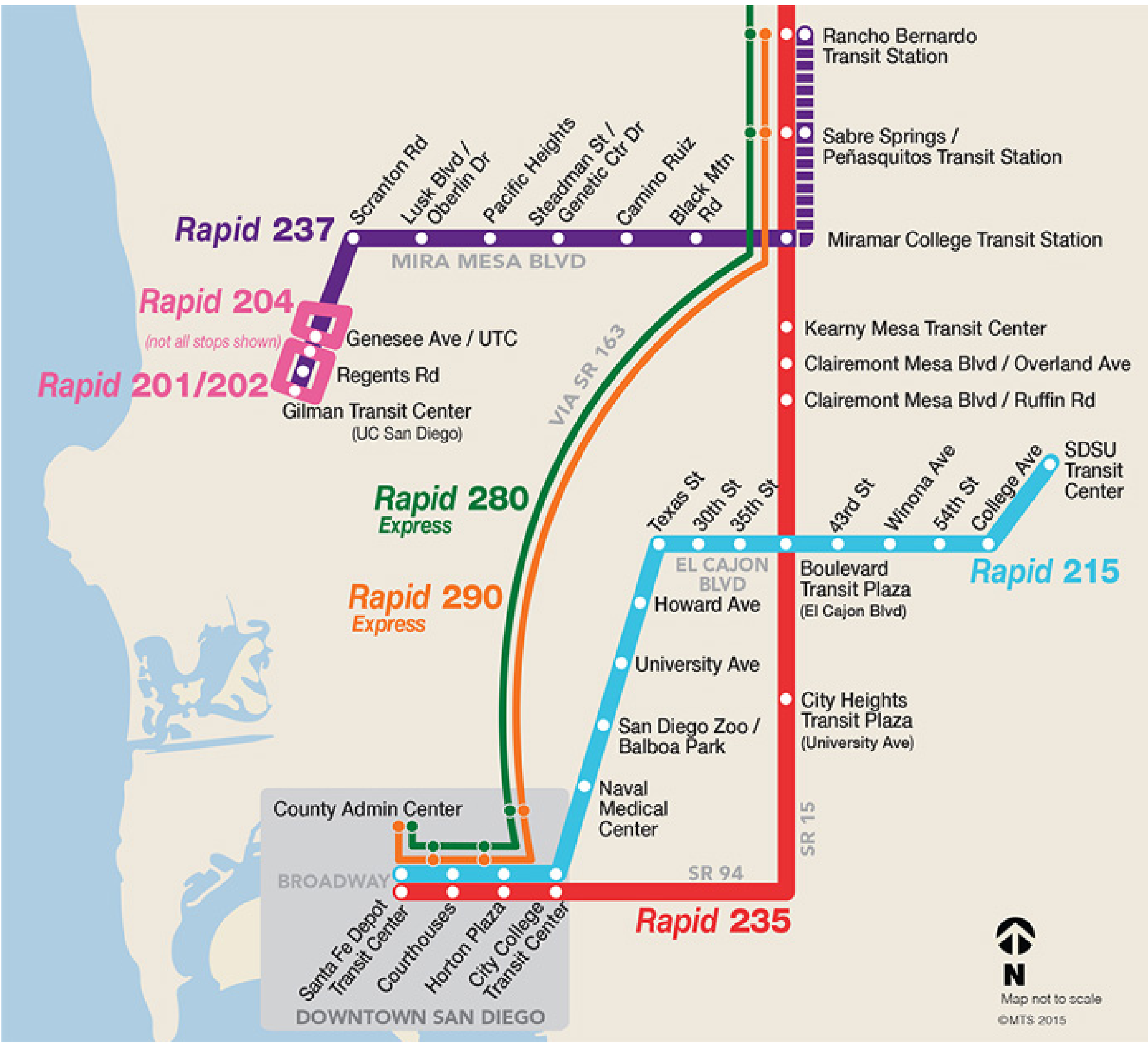


Figure X
San Diego Rapid Service Map
Source: http://theboulevard.org/wp-content/uploads/2017/06/Transit-Mid-City-BRT.jpg

[32] Adapted from: https://en.wikipedia.org/wiki/Rapid_(San_Diego).

SAN JOSE BUS RAPID TRANSIT

Figure X
San Jose BRT
Source: http://www.vta.org/projects-and-programs/transit/alum-rock-santa-clara
The Santa Clara Valley Transportation Authority (VTA) opened the first line of San Jose's bus rapid transit system on May 2, 2017. There are three lines planned in total, and the fleet is hybrid electric. The line is 7 miles in length with limited stops and traffic signal priority.[33]

[33] Adapted from: http://www.vta.org/projects-and-programs/transit/alum-rock-santa-clara.

Figure X
VTA Alum Rock BRT Route Map
Source: http://www.vta.org/News-and-Media/Connect-with-VTA/Taking-Shape-Alum-RockSanta-Clara-Bus-Rapid-Transit-Corridor#.XJFyhbh7IPY

SEATTLE BUS RAPID TRANSIT SYSTEM

Figure BRT Seattle 1
Seattle RAPIDRIDE BRT
Source:
https://commons.wikimedia.org/wiki/File:King_County_Metro_Rapid_Ride_New_Flyer_DE60LFR_6060.JPG

Operated by King County Metro, RAPIDRIDE is Seattle's transit system with bus rapid transit (BRT) features. This system has six lines totaling 64 miles in and around downtown Seattle. With over 150 buses in the fleet, the RAPIDRIDE system carries nearly 65,000 riders per day. It opened October 2, 2010.[34]

[34] Adapted from: https://en.wikipedia.org/wiki/RapidRide.

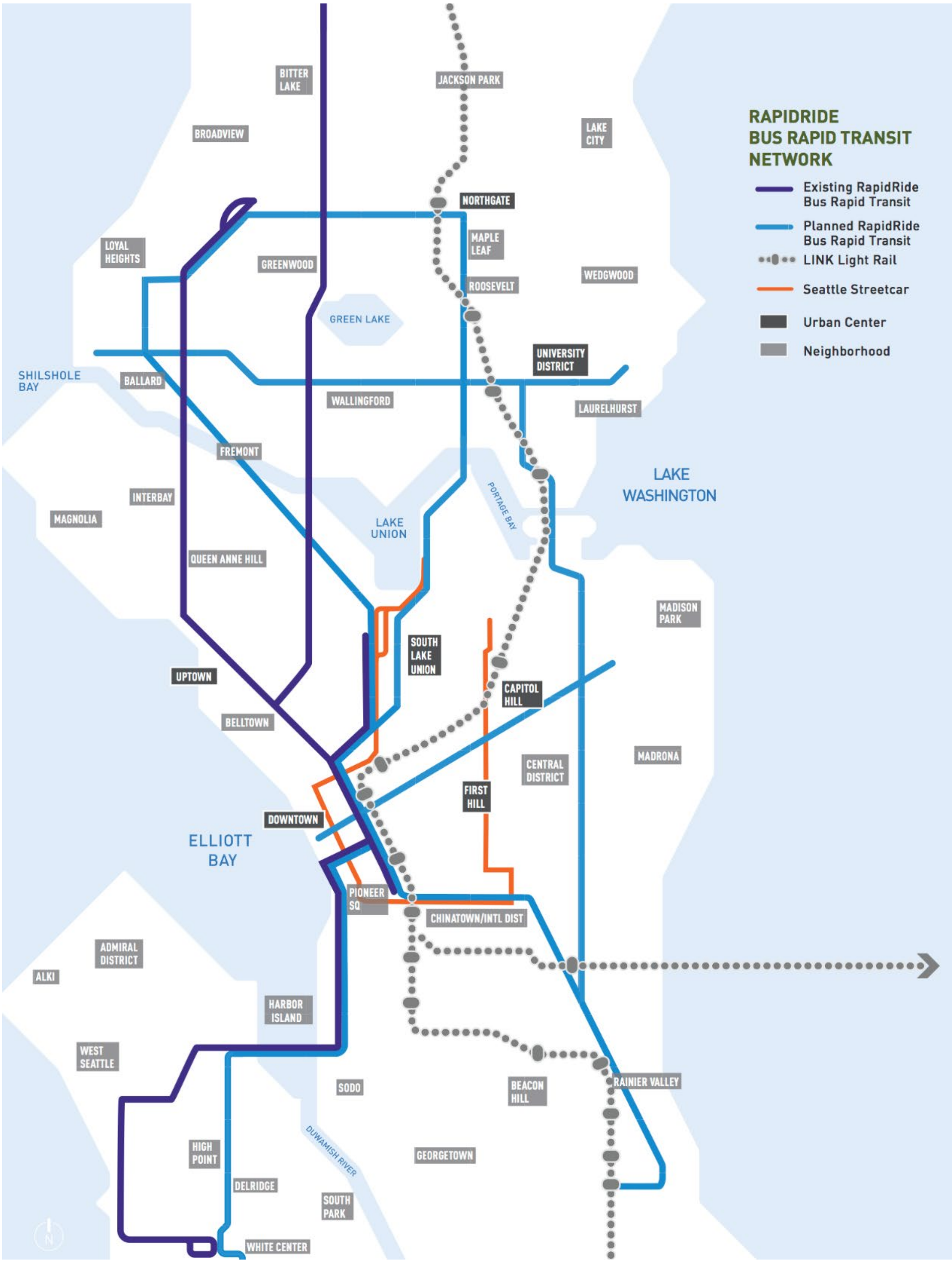


Figure BRT Seattle 1
Current (violet) and Proposed (blue) RAPIDRIDE Map
Source: https://seattletransitblog.com/2015/12/18/an-introduction-to-rapidride/

STOCKTON BUS RAPID TRANSIT SYSTEM

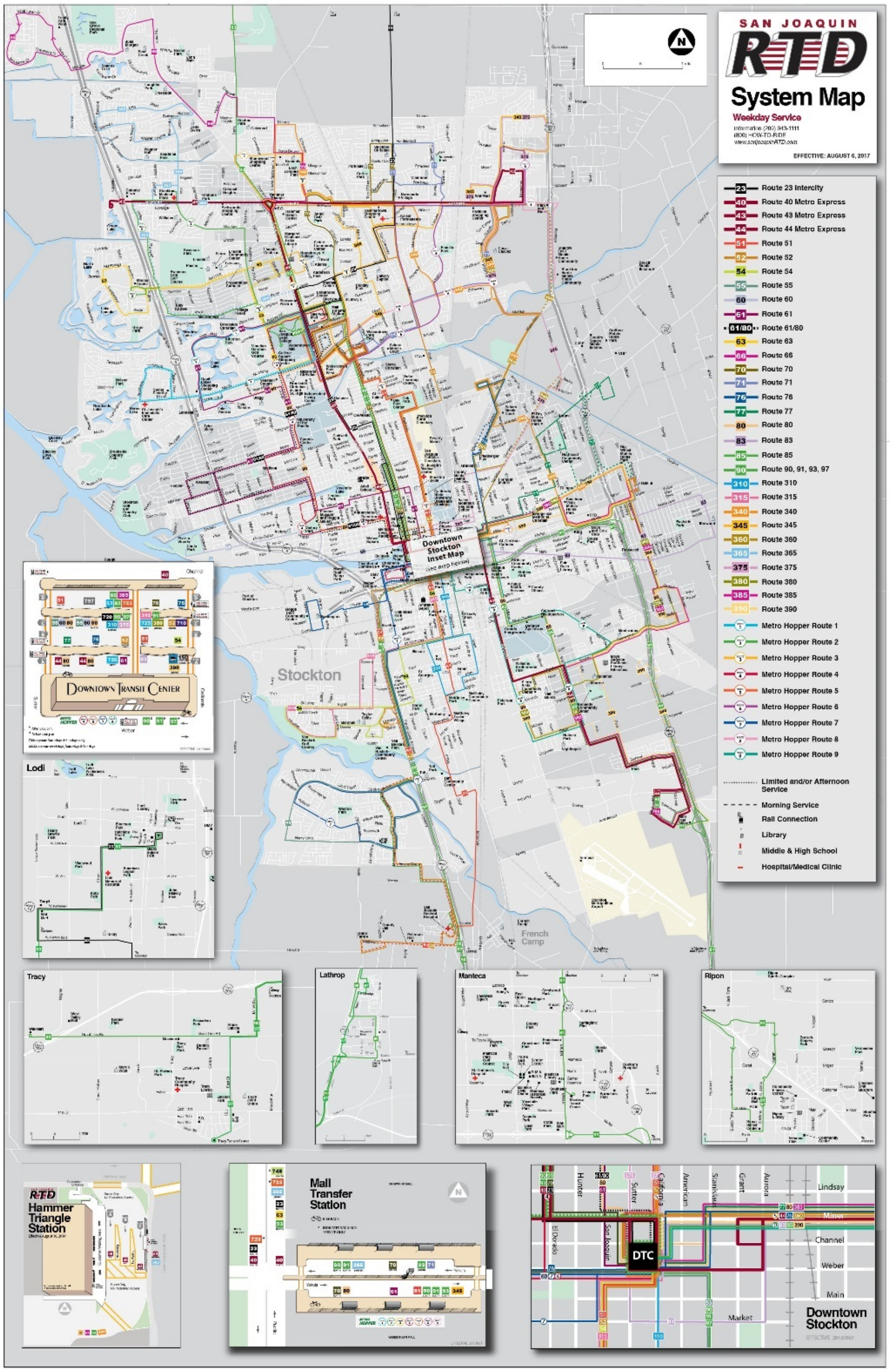
Figure BRT Stockton 1
San Joaquin RTD Bus Rapid Transit Stock
Source: [Source: http://sanjoaquinrtd.com/first-in-the-nation-1/](http://sanjoaquinrtd.com/first-in-the-nation-1/)
Operated by the San Joaquin Regional Transit District, there are five bus rapid transit lines serving the greater Stockton, California area.[35]

[35] Adapted from: http://sanjoaquinrtd.com/bus-maps-schedules/.

SAN JOAQUIN RTD

WEEKDAY **SYSTEM MAP**

EFFECTIVE: AUGUST 6, 2017



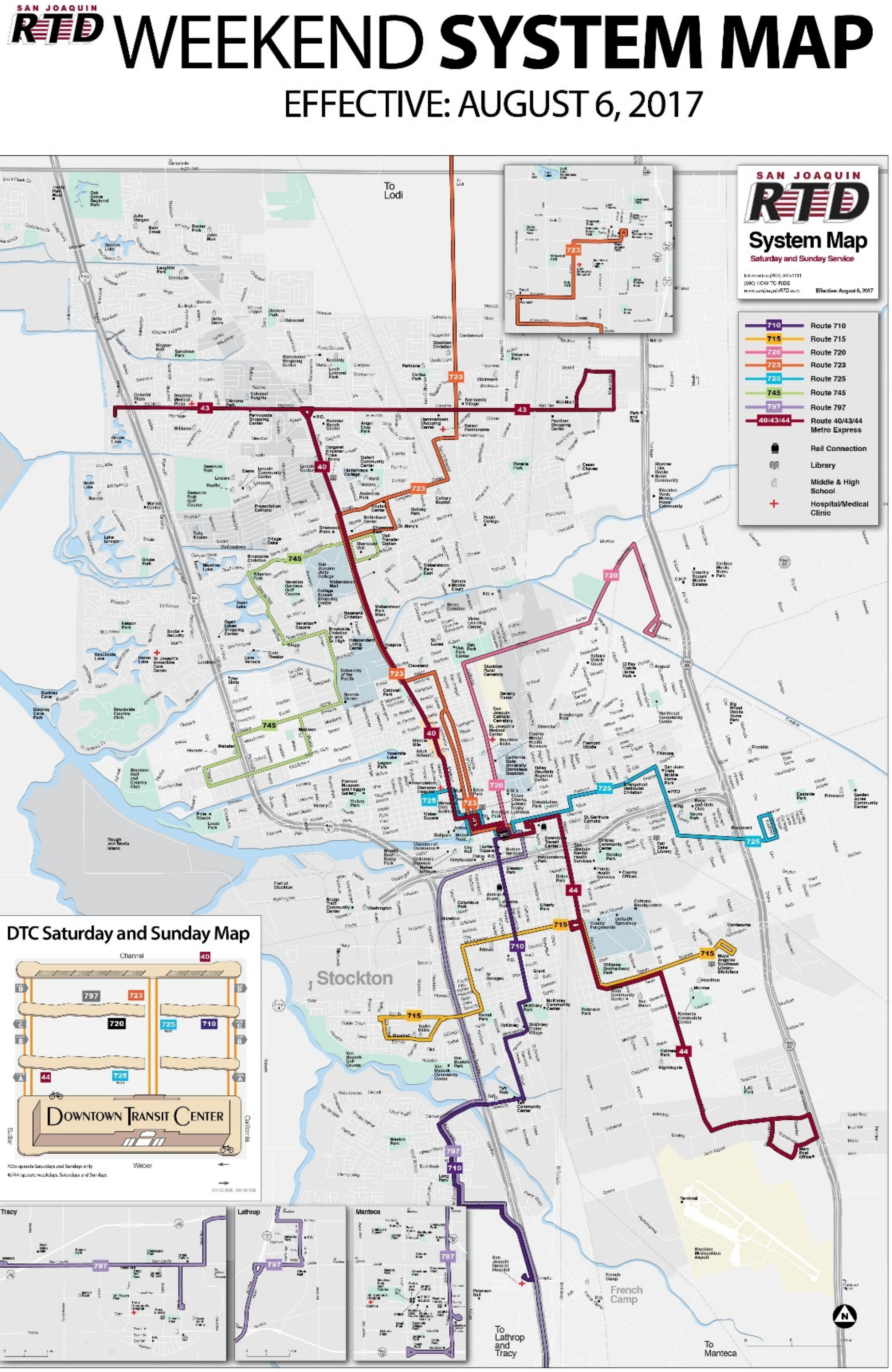


Figure BRT Stockton 2 & 3
San Joaquin RTD Transit Map
Source: http://sanjoaquinrtd.com/maps_and_schedules/system_maps.php
WASHINGTON, DC BUS RAPID TRANSIT SYSTEM

Figure BRT Washington, DC 1
Metroway Rolling Stock
Source: [Source: http://www.wikiwand.com/en/Metroway](http://www.wikiwand.com/en/Metroway)
Operated by the Washington Metro Area Transit Authority, the Metroway is the DC area's first bus rapid transit system. It opened in August 2014, and it has one line in Arlington and Alexandria, Virginia. The line is 6.8 miles long and has 16 stations.[36]

[36] Adapted from: https://en.wikipedia.org/wiki/Metroway.

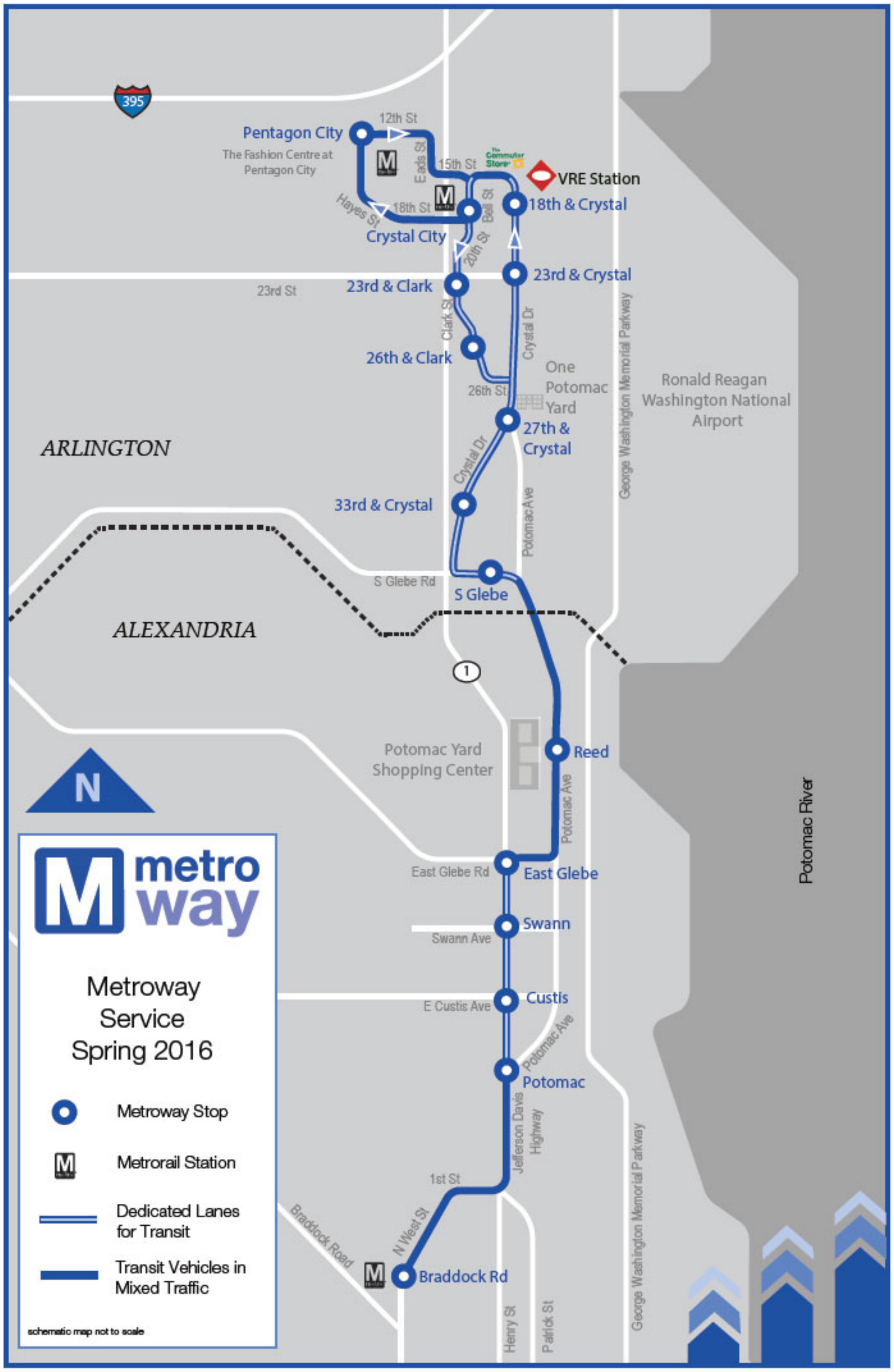


Figure BRT Washington, DC 2
Metroway Map
Source: http://metrowayva.com/route/

APPENDIX A – SCT

STREETCAR TRANSIT SYSTEMS USED IN ANALYSIS

Streetcar Transit Systems Metro Area & Name	Year	Miles	Stations	Riders (Daily)
Atlanta: Downtown Loop	2014	2.7	12	1,500
Cincinnati: Bell Connector	2016	3.6	18	1,750
Dallas: Streetcar	2015	2.45	6	1,000
Kansas City: Streetcar	2016	2.2	16	6,000
Little Rock: Metro Streetcar	2004	2.4	15	274
New Orleans: Streetcar	1835	22.3	22.3	21,600
Portland: Streetcar	2001	8.3	72	16,000
Salt Lake City: S Line	2013	2	7	1,000
Seattle: Streetcar	2007	3.8	17	5,000
Tacoma: Link	2003	1.6	6	2,663
Tampa: TECO	2002	2.7	11	783
Tucson: Sun Link	2014	3.9	21	3,000
Washington, DC: Streetcar	2016	2.2	8	3,014

ATLANTA STREETCAR SYSTEM

Figure X
Atlanta Streetcar
Source: https://upload.wikimedia.org/wikipedia/commons/3/3f/Atlanta_Streetcar.JPG

The Atlanta Streetcar, also known as the Downtown Loop, is a streetcar line serving downtown and nearby areas in Atlanta, Georgia. The Downtown Loop is the Phase 1 of the Atlanta Streetcar project, which is planning to expand onto the Beltline surrounding central Atlanta. The project is the first regular passenger streetcar service in Atlanta since the original Atlanta streetcars were phased out in 1949. [37]

The streetcar is operated by the Metropolitan Atlanta Rapid Transit Authority (MARTA) and is comprised of one line serving 12 stations, as of 2018. Its average daily ridership ranges about 1,500.

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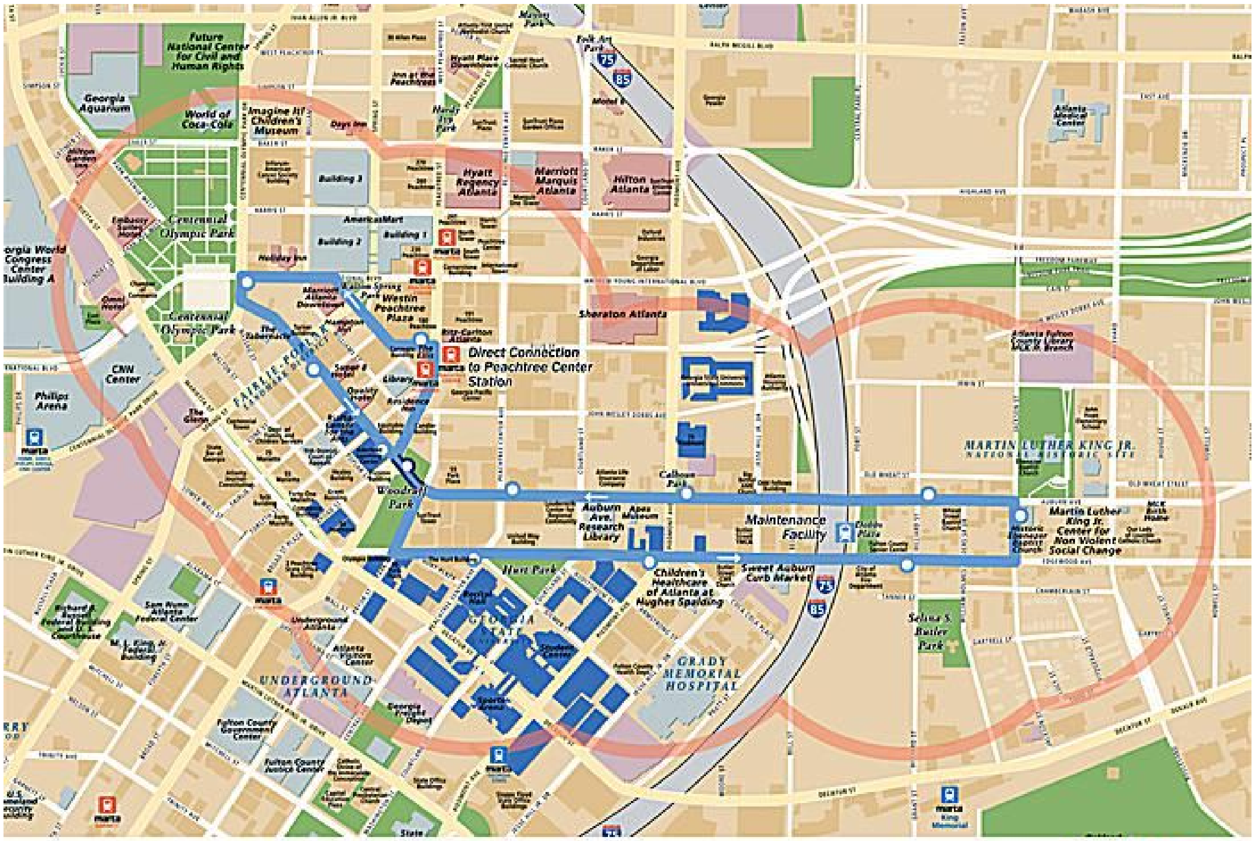
[37] Adapted from: https://en.wikipedia.org/wiki/Atlanta_Streetcar



ATLANTA STREETCAR

Figure X
Atlanta Streetcar route
Source: https://www.tripsavvy.com/thmb/7IV_JpoSPQzbyaEjTvkdkB0y-3s=/700x515/filters:fill(auto,1)/Streetcar-2-57a9fb273df78cf4594c0510.jpg

CINCINNATI STREETCAR SYSTEM

Figure X
Cincinnati Bell Connector
Source: https://upload.wikimedia.org/wikipedia/commons/thumb/e/ec/Cincinnati-bell-connector_station-12-findlay-market-race_09-11-2016.jpg/1920px-Cincinnati-bell-connector_station-12-findlay-market-race_09-11-2016.jpg

The Cincinnati Bell Connector, previously known as the Cincinnati Streetcar, started operations in September 2016. The streetcar operates along on a 3.6-mile (5.8 km) loop north of downtown through the Over-the-Rhine neighborhood into downtown. As of this report, it serves 18 stations. Ridership ranges from about 1,500 to 2,000 passengers per day.[38]

[38] Adapted from: https://en.wikipedia.org/wiki/Cincinnati_Bell_Connector.

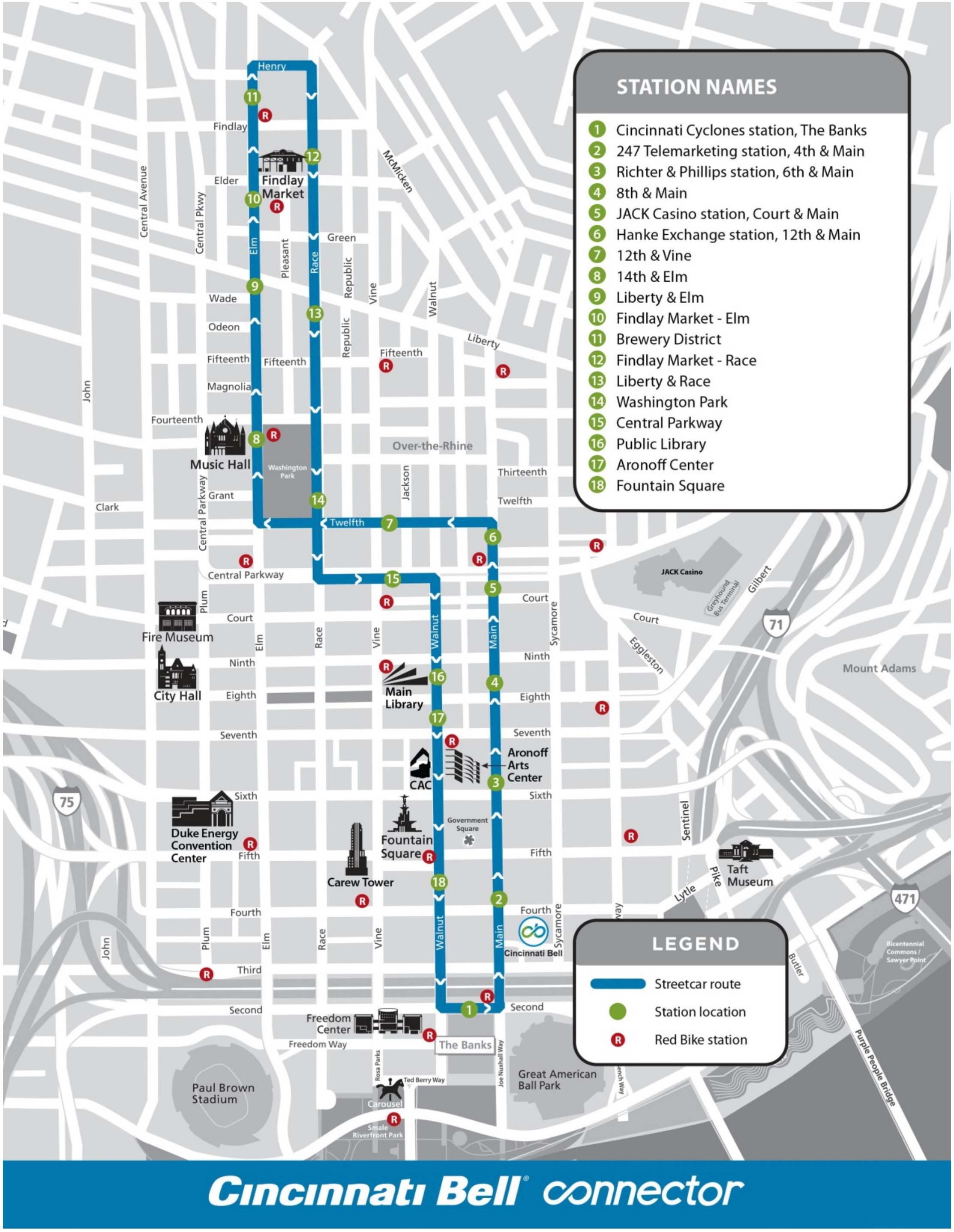


Figure X
Cincinnati Bell Connector route
Source: https://www.cincinnati-oh.gov/streetcar/assets/File/streetcar%20map_Decal_OnTVMs_lettersize.jpg

DALLAS STREETCAR SYSTEM

Figure X
Dallas Streetcar
Source:
https://upload.wikimedia.org/wikipedia/commons/thumb/4/44/Oak_Cliff_September_2016_51_%28Dallas_Streetcar%29.jpg/1920px-Oak_Cliff_September_2016_51_%28Dallas_Streetcar%29.jpg

The Dallas Streetcar is a 2.45-mile (3.94 km) modern streetcar that has operated connecting downtown Dallas to the medical and arts district south, across the Trinity River. It has been operating since 2015. It serves six stations.[39] Fewer than 1,000 people use the streetcar on an average daily basis.[40]

[39] Adapted from: https://en.wikipedia.org/wiki/Dallas_Streetcar.
[40] Source: https://www.dallasnews.com/opinion/editorials/2018/04/23/city-keep-eye-ridership-weighs-adding-1-fare-streetcar.

Figure X
Dallas streetcar route
Source: https://www.dart.org/riding/dallasstreetcar.asp

KANSAS CITY STREETCAR SYSTEM

Figure X
Kansas City streetcar
Source:
https://upload.wikimedia.org/wikipedia/commons/thumb/6/6a/KC_Streetcar_%2826813012241%29.jpg/1920px-KC_Streetcar_%2826813012241%29.jpg

The Kansas City Streetcar, formally known as the RideKC Streetcar, serves downtown Kansas City, Missouri. It started operations in May 2016. Unlike most streetcars, the KC Streetcar is free to ride as costs are borne by a downtown based Transportation Development District. By late fall of 2018, ridership was averaging nearly 6,000 riders daily. The streetcar line's 2.2 mile route serves 16 stops connecting downtown to the convention center district and Union Station.[41]

[41] Adapted from: https://en.wikipedia.org/wiki/KC_Streetcar.

Figure X
Kansas City streetcar route
Source: https://cdn.archpaper.com/wp-content/uploads/2014/01/kc_streetcar_03.jpg

LITTLE ROCK STREETCAR SYSTEM

Figure X
Little Rock streetcar
Source: https://en.wikipedia.org/wiki/Metro_Streetcar#/media/File:River_Rail_streetcars.jpg

The Metro Streetcar as it's known in metro Little Rock, Arkansas is a streetcar system which has been in operation since November 1, 2004. Spanning between the cities of Little Rock and North Little Rock, the 3.4-mile system serves 100,000 riders annually and covers 1,080 miles every week. Adults can ride the Metro starting at $1.35 for a one-way, one-time ride or pay $36 for a 31-day pass. There are discounts for students, senior citizens, and others. The Metro has been expanded once in 2007.[42]

[42] Adapted from: https://rrmetro.org/services/streetcar/ and Source: https://en.wikipedia.org/wiki/Metro_Streetcar.

Figure X
Little Rock streetcar map
Source: https://www.transitmap.net/little-rock-dovak/

NEW ORLEANS STREETCAR SYSTEM

Figure X
New Orleans Canal Line streetcar
Source:
https://en.wikipedia.org/wiki/Canal_Streetcar_Line#/media/File:Canal_Streetcar_in_New_Orleans,_Louisiana,_USA.jpg

The New Orleans Regional Transit Authority out of New Orleans, Louisiana operates four streetcar lines in the downtown region all serving different areas and purposes – the historic St. Charles Avenue line, the Canal Street line, the Riverfront line, and the Rampart-St. Claude Avenue line, which is the newest installment.

The oldest continuously operating streetcar line in the world, the St. Charles streetcar line has been running since 1835. Its main passengers are commuters and tourists, making it also the busiest line in the New Orleans System. The St. Charles line is 13.2 miles long with one route.

The Canal Street line originally operated between 1861 and 1964, and between 2000 and 2004, the line was redesigned and rebuilt primarily running along its namesake street. The Canal line is 5.5 miles in length and has two routes.

Opened in 1988, the Riverfront streetcar line was the first new line in 62 years. It was opened after a need was identified for tourist transportation, operating along a stretch of the Mississippi River which has plentiful amenities for visitors. It travels 2 miles along an exclusive right of way between the French Quarter and the convention center and has one route.

The newest line, the Rampart-St. Claude streetcar line, opened on October 2, 2016. It serves as a connection between a large national and regional bus terminal and the rest of the city. The Rampart-St. Claude line is one route at 1.6 miles long.[43]

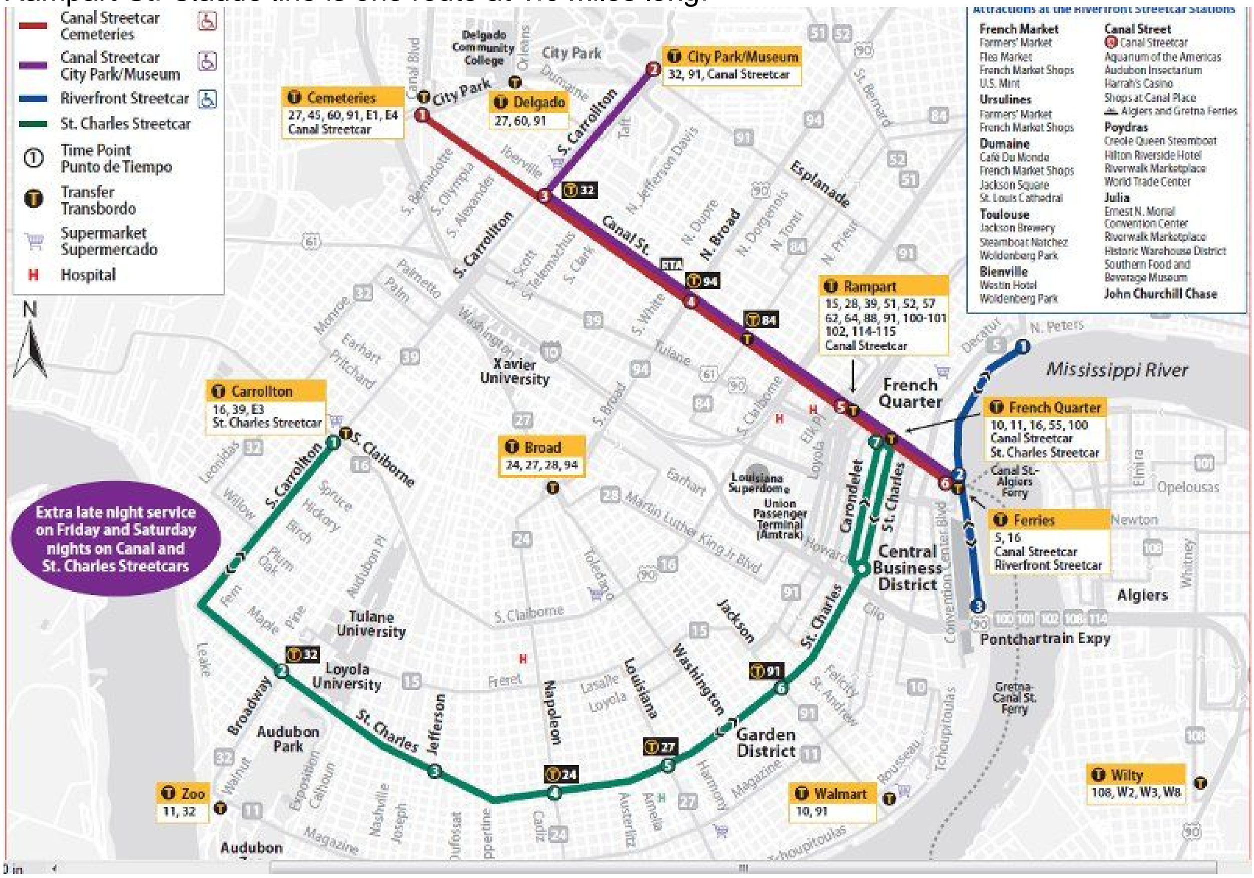


Figure X
New Orleans Streetcar Map
Source: https://www.pinterest.com/pin/461267186813387397/

PORTLAND STREETCAR SYSTEM

[43] Adapted from: https://en.wikipedia.org/wiki/St._Charles_Streetcar_Line; Source: https://en.wikipedia.org/wiki/Canal_Streetcar_Line; Source: https://en.wikipedia.org/wiki/Riverfront_Streetcar_Line; and Source: https://en.wikipedia.org/wiki/Rampart%E2%80%93St._Claude_Streetcar_Line.

The Portland Streetcar in Portland, Oregon has two lines, a central loop a north-south line, and serves much of the downtown and surrounding areas. The system debuted in 2001 and has a daily ridership of over 16,000 and nearly 5,000,000 passengers on a yearly basis. The loop line is 4.4 miles long and the north-south line is 3.9 miles long.[44]

[44] Adapted from: https://en.wikipedia.org/wiki/Portland_Streetcar.

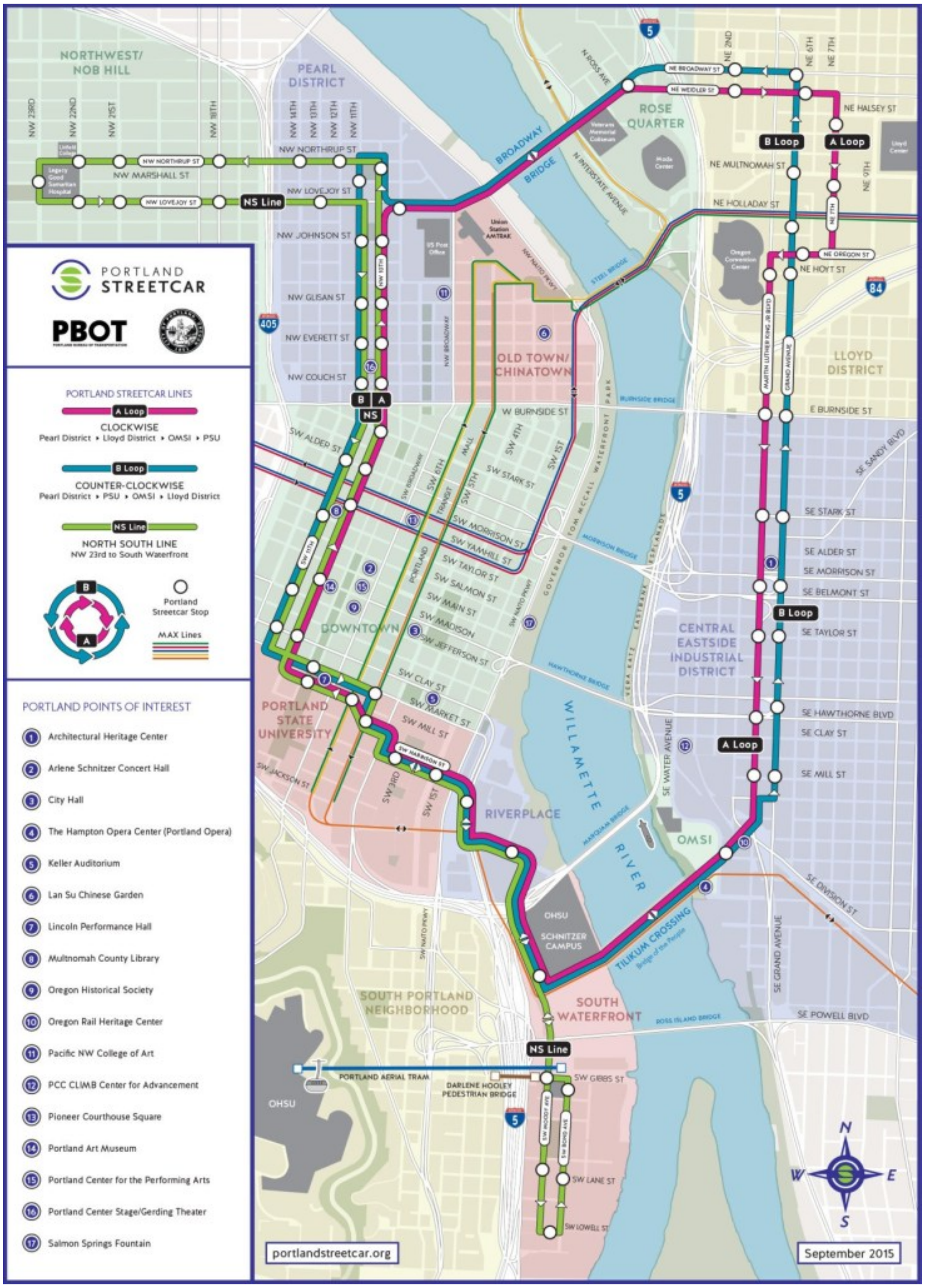


Figure X
Portland Streetcar map
Source: https://www.transitmap.net/portland-streetcar-2015/

SALT LAKE CITY STREETCAR SYSTEM

Figure X
Salt Lake City S Line Streetcars
Source:
https://en.wikipedia.org/wiki/S_Line_(Utah_Transit_Authority)#/media/File:UTA_S_Line_streetcars_at_500_East.jpg
Connecting the business district with the city of South Salt Lake and the area light rail system, the S Line is a streetcar system in Salt Lake City, Utah. It opened on December 8, 2013 and has 7 stops along one route. It carries just over 1,000 people per day along the 2-mile-long line. An extension of the line beyond the southernmost stop is in the works, but nothing is finalized at this time.[45]

[45] Adapted from: https://en.wikipedia.org/wiki/S_Line_(Utah_Transit_Authority).

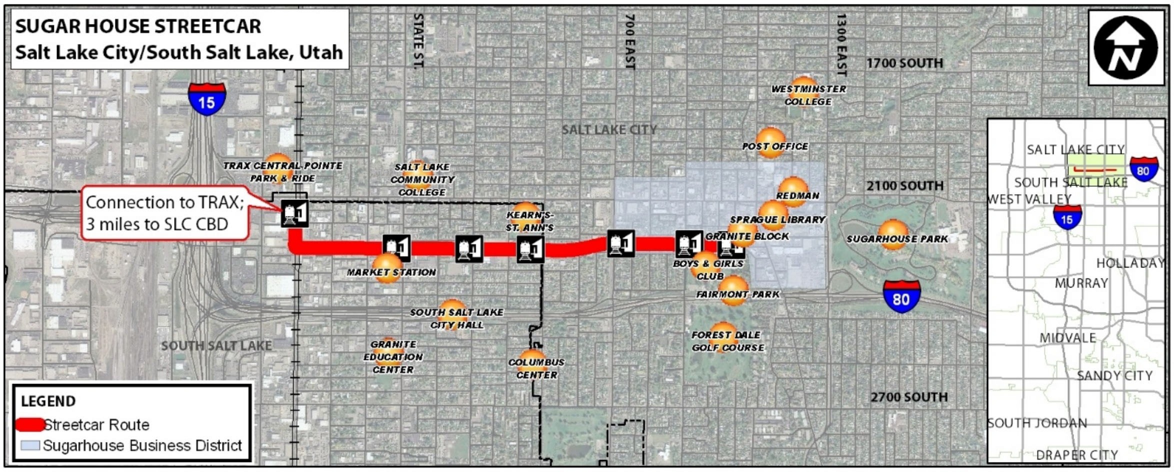


Figure X
S Line streetcar map
Source: https://www.ksl.com/article/12896889

SEATTLE STREETCAR SYSTEM

Figure X
Seattle South Lake Union Streetcar
Source: https://commons.wikimedia.org/wiki/File:Seattle_streetcar.jpg

First opened in 2007, the Seattle Streetcar is a two-line system serving the downtown area of Seattle, Washington. The South Lake Union line was the first route followed by the addition of the First Hill line in 2016, and, respectively, the lines are 1.3 miles and 2.5 miles in length. The two lines are not connected but share many hardware components and operate similarly. The lines serve approximately 5,000 people daily.[46]

[46] Adapted from: https://en.wikipedia.org/wiki/Seattle_Streetcar

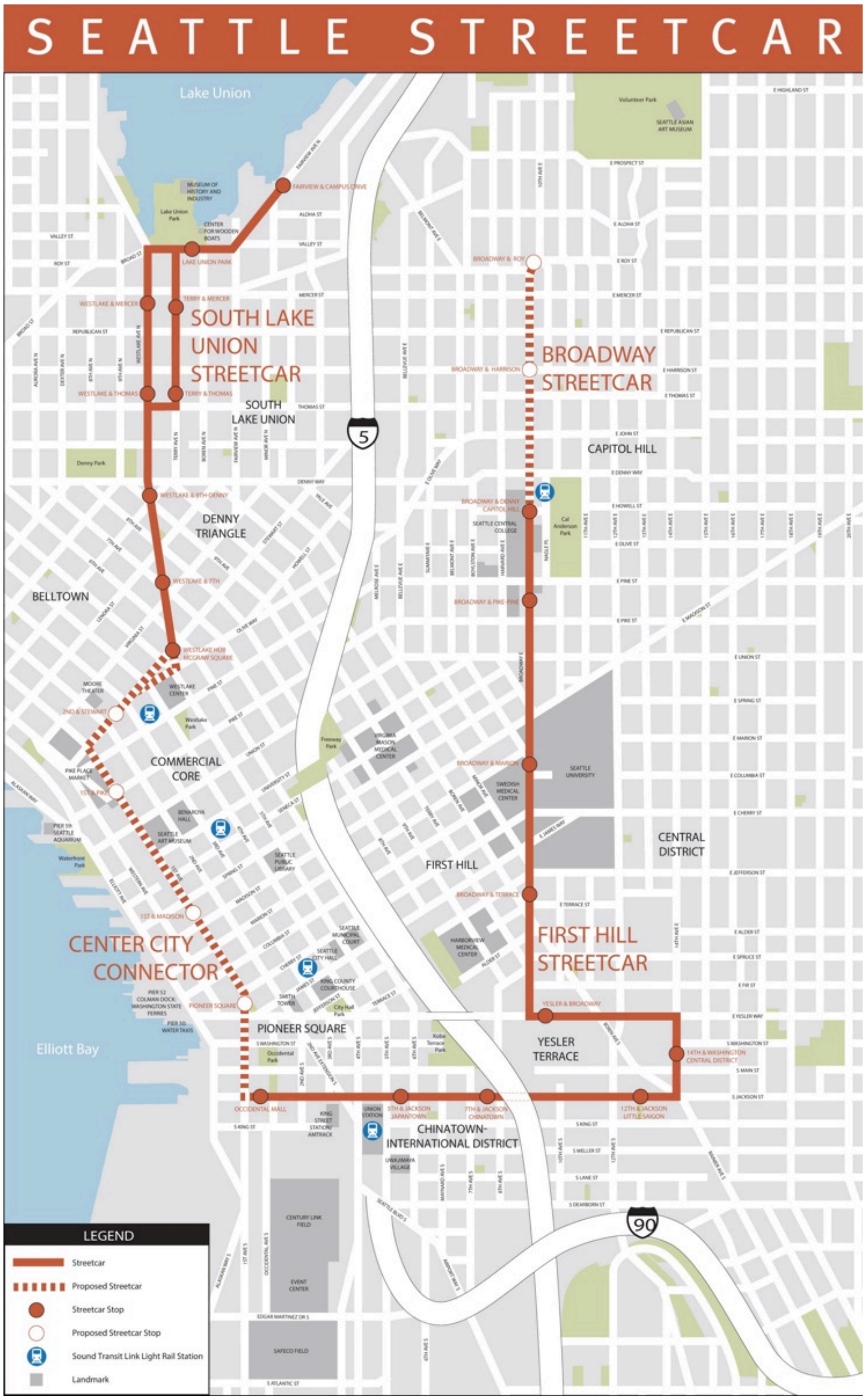


Figure X
Seattle Streetcar Map
Source: http://ontheworldmap.com/usa/city/seattle/seattle-streetcar-map.html

TACOMA STREETCAR SYSTEM

Figure X
Tacoma Streetcar
Source:
https://en.wikipedia.org/wiki/Tacoma_Link#/media/File:Skoda_10T_car_1003_of_Tacoma_Link_on_Pacific_Ave_(2008).jpg

First approved by a ballot measure in 1996 but opened in 2003, the Tacoma Link serves Tacoma, Washington between the Tacoma Dome and Downtown Tacoma. The line carried approximately 972,000 passengers in 2016 along its 1.6-mile track. Tacoma Link runs for between 8 and 14 hours a day and is free of charge for passengers.[47]

[47] Adapted from: https://en.wikipedia.org/wiki/Tacoma_Link.

Figure X
Tacoma Link Map
Source: http://sized.us/tacoma-transport-map.html

TAMPA STREETCAR SYSTEM

Figure X
TECO Streetcar
Source: https://patch.com/florida/southtampa/all-aboard-tampa-trolley-will-soon-be-free
The TECO Line Streetcar system in Tampa, Florida connects the downtown area to the historic Ybor City district. A three-year grant from the Florida Department of Transportation has allowed the streetcar to be free starting October of 2018. However, a mere 783 people ride the streetcar daily along the 2.7-mile, 11-stop track. [48]

[48] Source: https://en.wikipedia.org/wiki/TECO_Line_Streetcar_System

Figure X
TECO Streetcar Map
[Source: https://www.lightrailnow.org/news/n_tam001.htm](https://www.lightrailnow.org/news/n_tam001.htm)

TUCSON STREETCAR SYSTEM

Figure X
Sun Link Streetcar
Source: https://www.tucsontopia.com/tucson-streetcar/

Opening in 2014, the Sun Link streetcar system serves a 3.9-mile stretch of Tucson, Arizona between the Health Sciences Center at the University of Arizona to an area known as Mercado west of downtown. The Sun Link runs between 7am and 2am depending on the day of the week. Nearly 3,000 passengers are served by the Sun Link daily along the 21-stop line. [49]

[49] Adapted from: https://en.wikipedia.org/wiki/Sun_Link.

Figure X
Sun Link Map
Source: https://www.sunlinkstreetcar.com/schedule/route

WASHINGTON, DC STREETCAR SYSTEM

Figure X
DC Streetcar
Source: https://washington.org/dc-guide-to/dc-streetcar
Beginning operation in February 2016, the DC Streetcar consists of a single 2.2-mile line. Ridership is up nearly 21% between 2016 and 2017 with an annual ridership of almost 1,100,000. Washington, D.C. previously had a streetcar system which was dismantled in 1962. Though other lines are proposed, the only line operating runs along H Street and Benning Road in the city's northeastern quadrant. [50]

[50] Adapted from: https://en.wikipedia.org/wiki/DC_Streetcar.

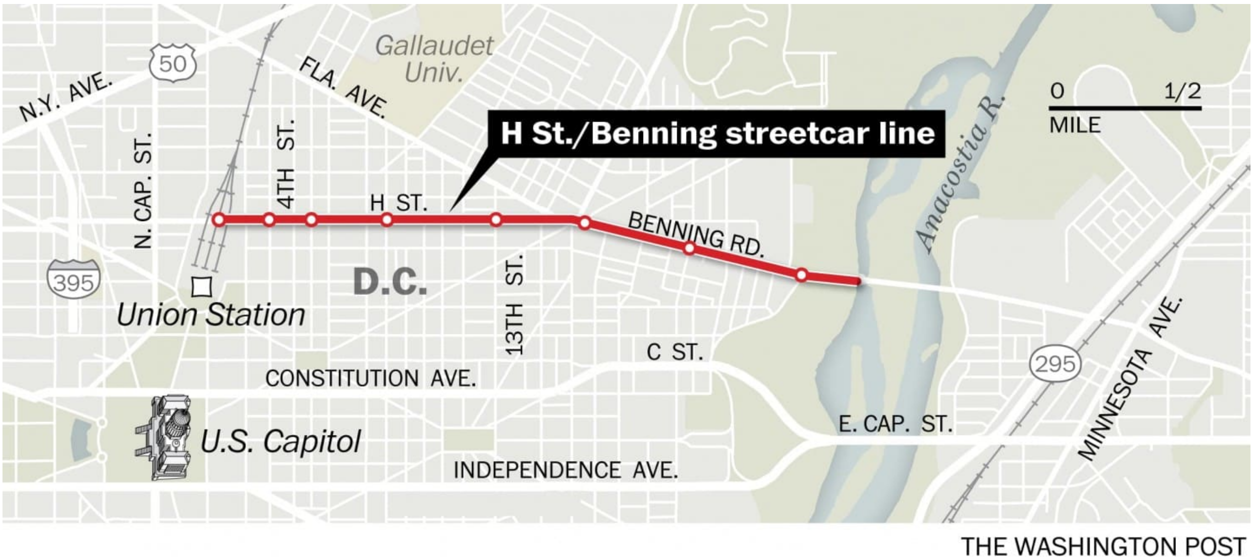


Figure X
DC Streetcar Map
Source: https://www.washingtonpost.com/news/dr-gridlock/wp/2016/02/27/want-to-ride-ride-the-d-c-streetcar-heres-a-handy-faq/?utm_term=.bb9f6a5caa4b

APPENDIX A – CRT
COMMUTER RAIL TRANSIT SYSTEMS USED IN ANALYSIS

Commuter Rail Transit Systems Metro Area & Name	Year	Miles	Stations	Riders (Daily)
Albuquerque - Santa Fe: New Mexico Rail Runner	2006	97	15	2,983
Austin: Metrorail	2010	32	9	2,900
Dallas - Fort Worth: Trinity Railway Express	1996	34	10	8,200
Miami: Tri Rail	1989	71.2	18	14,800
Minneapolis: Northstar	1997	40	7	2,700
Nashville: Music City Star	2006	32	7	1,225
Orlando: Sunrail	2014	49	16	3,400
Portland: TriMet WES	2009	14.7	5	1,600
Salt Lake City: FrontRunner	2008	88	17	17,600
San Diego: Coaster	1995	41	8	4,384
San Jose - Stockton - San Francisco: Altamont Corridor Express	1998	85	10	5,900
Seattle - Tacoma: Sounder Commuter Rail	2000	83	12	18,314
Washington, DC - Baltimore: MARC	1984	187	42	40,000
Washington, DC - Northern Virginia: VRE	1992	90	19	12,830

ALBUQUERQUE – SANTA FE COMMUTER RAIL SYSTEM

Figure X
New Mexico Rail Runner
Source: https://www.riometro.org/395/New-Mexico-Rail-Runner-Express

Opened on July 14, 2006, the New Mexico Rail Runner is a commuter rail which serves the Albuquerque and Santa Fe areas of New Mexico. The line is 97 miles in length and has a maximum operating speed of 79 miles per hour. There are 15 operational stations along the single line from Belen in the south to Santa Fe in the north.[51]

[51] Adapted from: https://en.wikipedia.org/wiki/New_Mexico_Rail_Runner_Express.

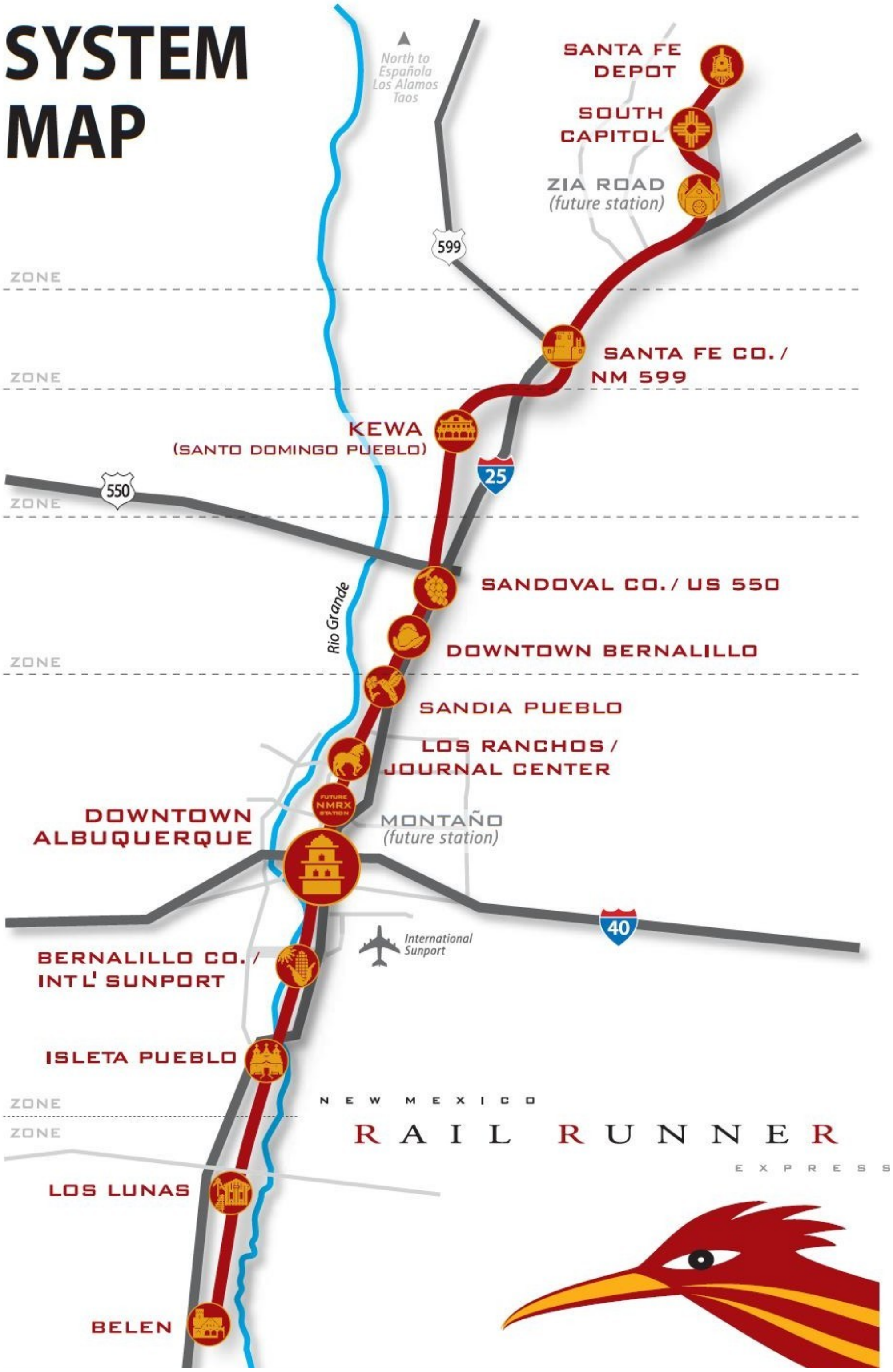


Figure X
New Mexico Rail Runner Service Map
Source: http://www.santafedia.org/wiki/images/b/b7/Rail_runner_system_map.JPG

AUSTIN COMMUTER RAIL SYSTEM

Figure X
Austin MetroRail
Source:
https://en.wikipedia.org/wiki/Capital_MetroRail#/media/File:Lakeline_metrorail_station_2014.jpg

Connecting downtown Austin with its Northern Suburbs, MetroRail is the only rail line in Texas' capital city. As of 2014, the line served about 2,900 commuters each weekday, with an annual ridership of approximately 820,000. The singular 32-mile line is filled through 9 stations from Leander all the way to downtown Austin. [52]

[52] Adapted from: https://en.wikipedia.org/wiki/Capital_MetroRail.

Figure X
MetroRail Map
Source: http://ecohomesaustin.homestead.com/SearchHomesMetroRailStations.html

DALLAS – FORT WORTH COMMUTER RAIL SYSTEM

Figure X
Trinity Railway Express
Source: http://trainweb.org/tony/eagletripreport09.htm
The fifteenth most-ridden commuter rail in the country, the Trinity Railway Express (TRE) is the commuter rail system in the Dallas-Fort Worth metro area. The line began operating in late 1996 with 10 stations along its 34-mile route. The TRE goes between Union Station in Dallas and T&P Station in Fort Worth.[53]

[53] Adapted from: https://en.wikipedia.org/wiki/Trinity_Railway_Express.

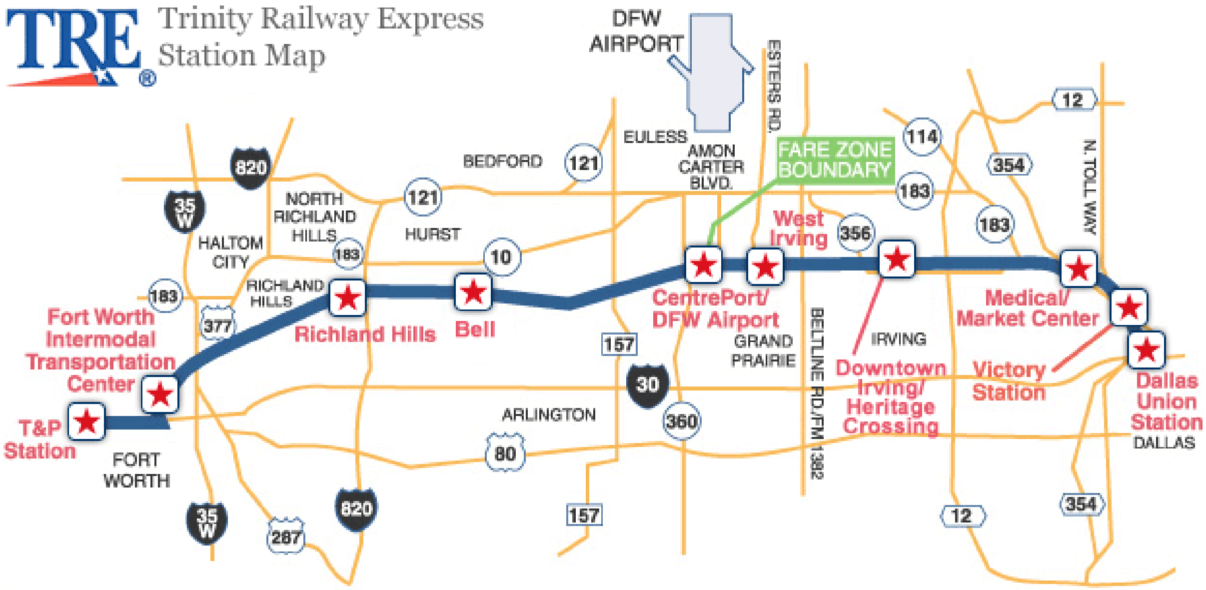


Figure X
TRE Service Map
Source: https://trinityrailwayexpress.org/stations/

MIAMI COMMUTER RAIL SYSTEM

Figure X
Tri-Rail
Source: https://www.miamitodaynews.com/2017/02/21/tri-rail-roll-commuter-rail-downtown-miami-years-end/

Traveling at speeds of up to 79 miles per hour, the Tri-Rail line in Greater Miami, Florida connects the cities of Miami, Fort Lauderdale, and West Palm Beach. 14,800 passengers ride the line per day and get on and off at 18 stations along the way. The line on which Tri-Rail currently operates was originally built in the 1920s with some of the original stations being utilized as well. [54]

[54] Adapted from: https://en.wikipedia.org/wiki/Tri-Rail.

Figure X
Tri-Rail Service Map
Source: https://www.transitmap.net/floida-tri-rail/

MINNEAPOLIS COMMUTER RAIL SYSTEM

Figure X
Northstar Commuter Rail
Source: https://www.youtube.com/watch?reload=9&v=ocV_U3kwU6g
With free Wi-Fi, work stations, and onboard restrooms and bike storage, amenity-rich Northstar Commuter Rail Line serves the capital region of Minnesota between Big Lake and downtown Minneapolis. The line has 7 stations in operation, with another 4 proposed, along its 40-mile route. Planning for the line began in 1997 with the inaugural run commencing November 16, 2009. [55]

[55] Adapted from [Source: https://www.metrotransit.org/northstar](https://www.metrotransit.org/northstar) and Source: https://en.wikipedia.org/wiki/Northstar_Line#Route.

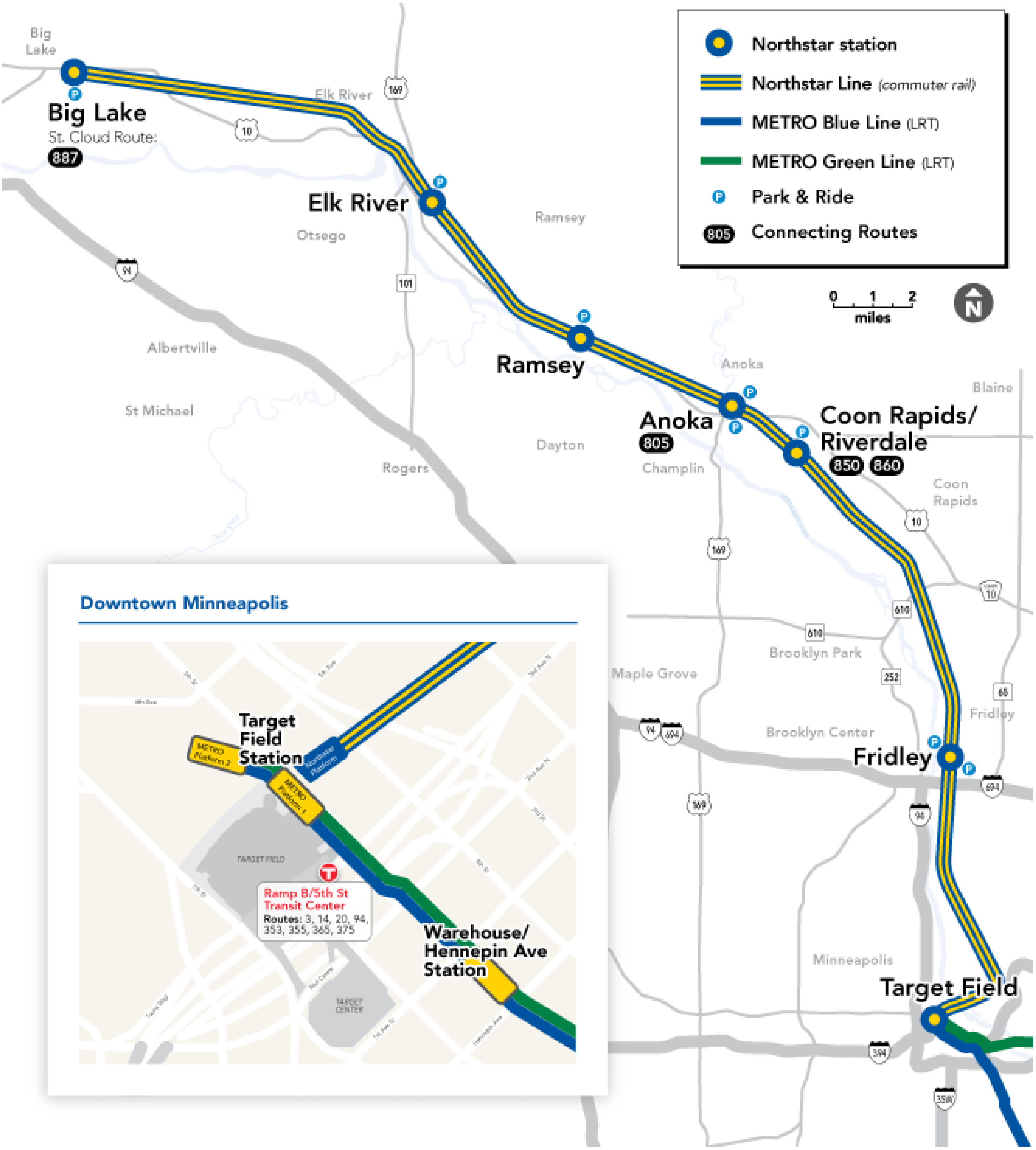


Figure X
Northstar Service Map
Source: https://www.metrotransit.org/northstar

NASHVILLE COMMUTER RAIL SYSTEM

Figure X
Music City Star
Source: https://www.youtube.com/watch?v=u8ggFKFOvOc
The Music City Star serves commuters in between Lebanon and Nashville, Tennessee. The line is 32 miles long with stops at seven stations. There is only one operational line now, but there are six more planned to serve other suburbs of Nashville. The line cost just under $1,300,000 per mile, which means it is the most cost-efficient development of a commuter line in the nation. [56]

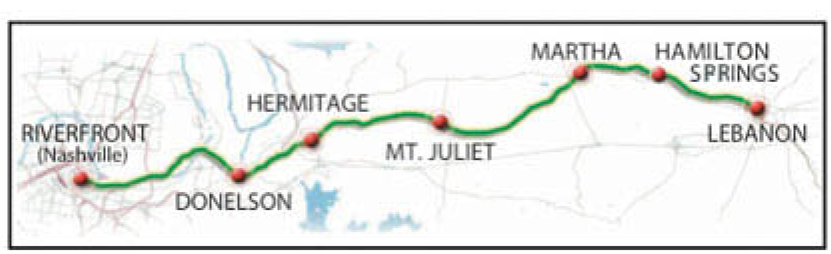


Figure X
Music City Star Service Map
Source: http://www.musiccitystar.org/Middle-TN-RTA-stations.asp

[56] Adapted from: https://en.wikipedia.org/wiki/Music_City_Star

ORLANDO COMMUTER RAIL SYSTEM

Figure X
SunRail
Source: https://www.tampabay.com/news/Hooper-Wondering-what-could-have-been-for-Tampa-Orlando_166496888

Service commenced on May 1, 2014 for the Sunrail commuter rail system in the Orlando, Florida area. Operating along a former CSX Transportation line, SunRail serves the counties of Orange, Volusia, and Osceola. The single line system has 16 stations and has about 3,400 riders per day. It travels at an average speed of 30 miles per hour along its nearly 49-mile-long route.

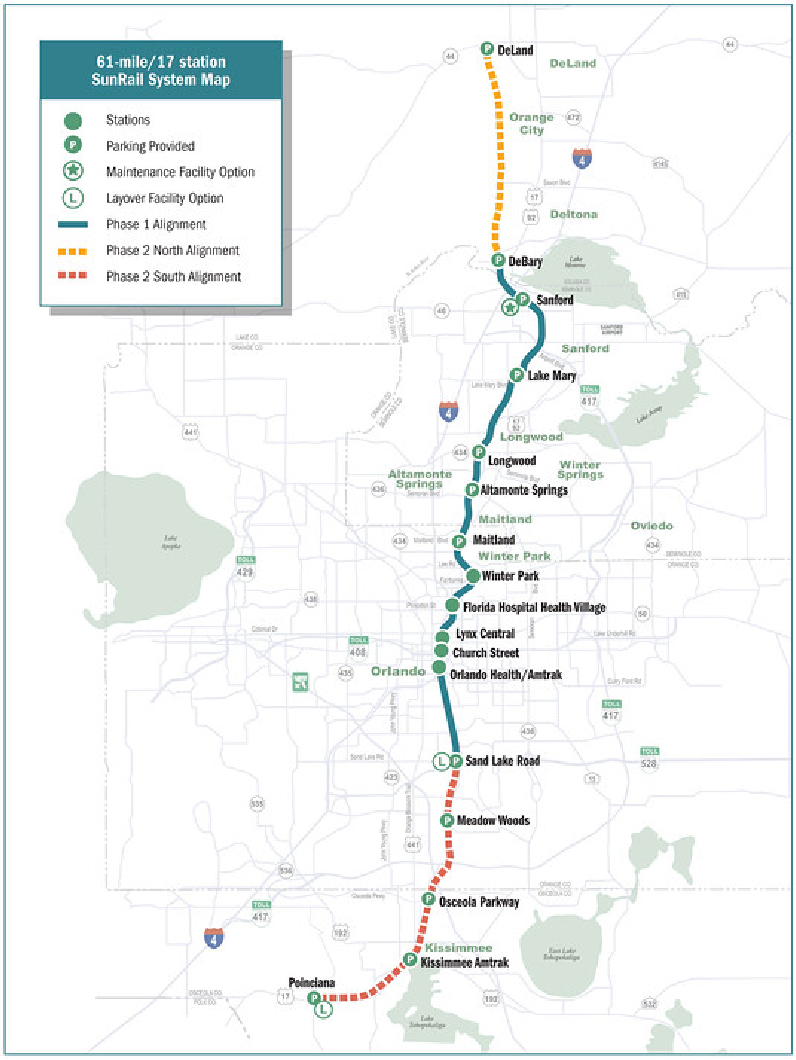


Figure X
Sunrail Service Map
Source: https://www.metrojacksonville.com/article/2012-oct-sunrail-redefining-orlando-

ORTLAND COMMUTER RAIL SYSTEM

Figure X
TriMet WES Commuter Rail
Source: https://trimet.org/wes/index.htm
The commuter rail serving the Portland, Oregon area is called the WES, or Westside Express Service. The line serves Beaverton, Tigard, Tualatin, and Wilsonville, connecting commuters to the light rail line which goes directly downtown. The WES runs every 30 minutes on workdays during morning and evening rush hours. The single-line route has 5 stations and serves approximately 1,600 people per day. [57]

[57] Adapted from: https://trimet.org/wes/index.htm and Source: https://en.wikipedia.org/wiki/WES_Commuter_Rail.

Figure X
Trimet WES Service Map
Source: http://www.railfanguides.us/or/trimet/map3/TrimetWESmap2011.jpg

SALT LAKE CITY COMMUTER RAIL SYSTEM

Figure X
FrontRunner Commuter Rail
Source: https://en.wikipedia.org/wiki/FrontRunner
The 88-mile system known as the FrontRunner in central Utah began operation in April of 2008. Daily, 17,600 passengers ride the line which goes from Ogden through Salt Lake City to Provo. Annually, the line carries nearly 5,000,000 passengers operating Monday through Saturday along 16 stations every half-hour.[58]

[58] Adapted from Source: https://www.rideuta.com/Services/FrontRunner and Source: https://en.wikipedia.org/wiki/FrontRunner.

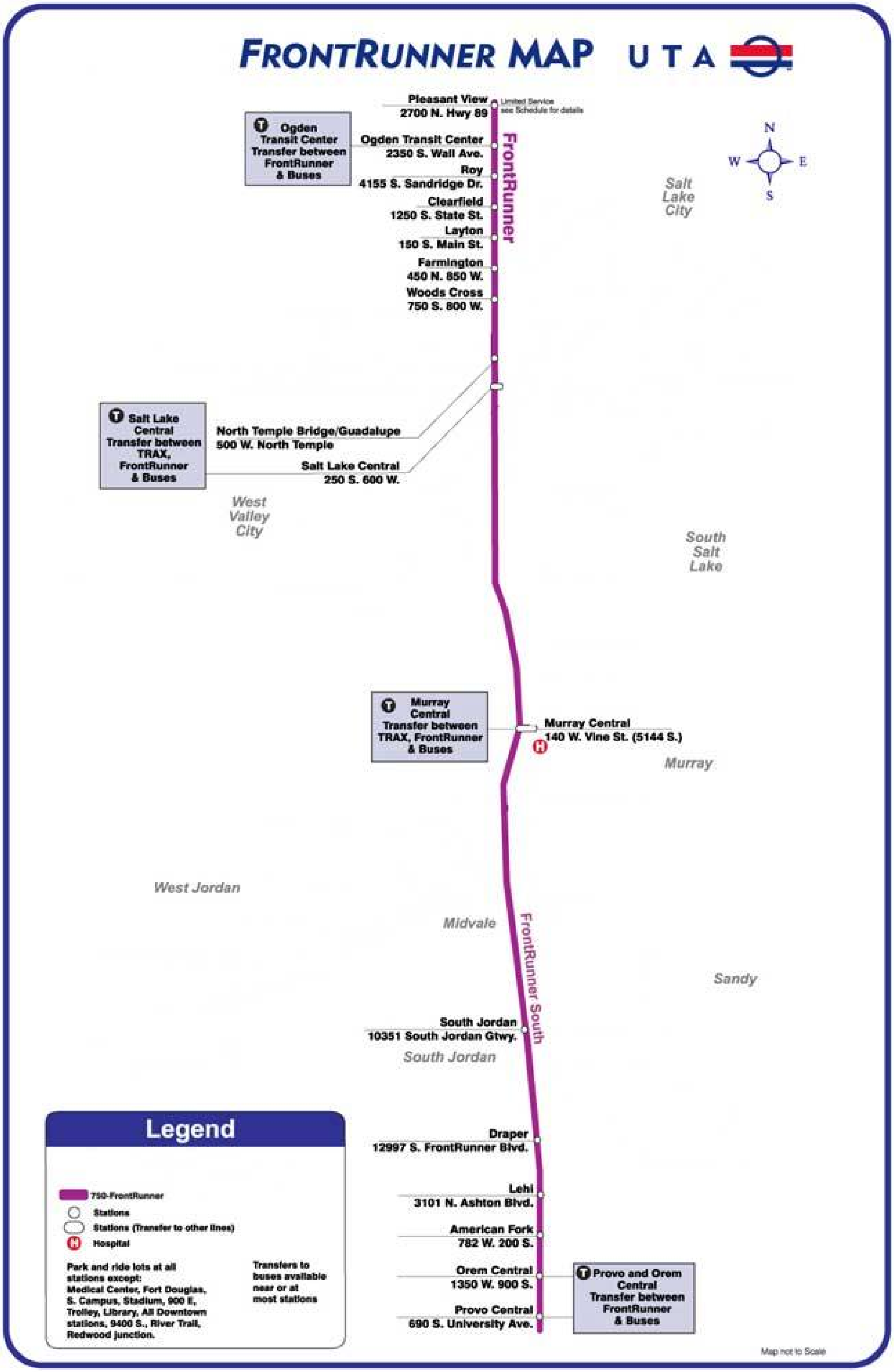


Figure X
FrontRunner Service Map
Source:
https://66.media.tumblr.com/7cc4cd6d5b4b3eddb8537361e056deed/tumblr_mlczfqedvs1r54c4o
o2_1280.jpg

SAN DIEGO COMMUTER RAIL SYSTEM

Figure X
San Diego Commuter Train
Source: https://chapterscapistrano.com/alcohol-banned-san-diego-coaster-train-step-right-direction/

The San Diego Coaster commuter train operates mainly on weekdays with limited service on weekends and holidays. The train has eight stops along its 41-mile route between Oceanside and San Diego, California. The operating speed for the rolling stock is 90 miles per hour, and the entire route can be ridden (including stops) in about 55 minutes. On a yearly basis, the ridership is 1,600,000.[59]

[59] Adapted from: https://en.wikipedia.org/wiki/Coaster_(commuter_rail).

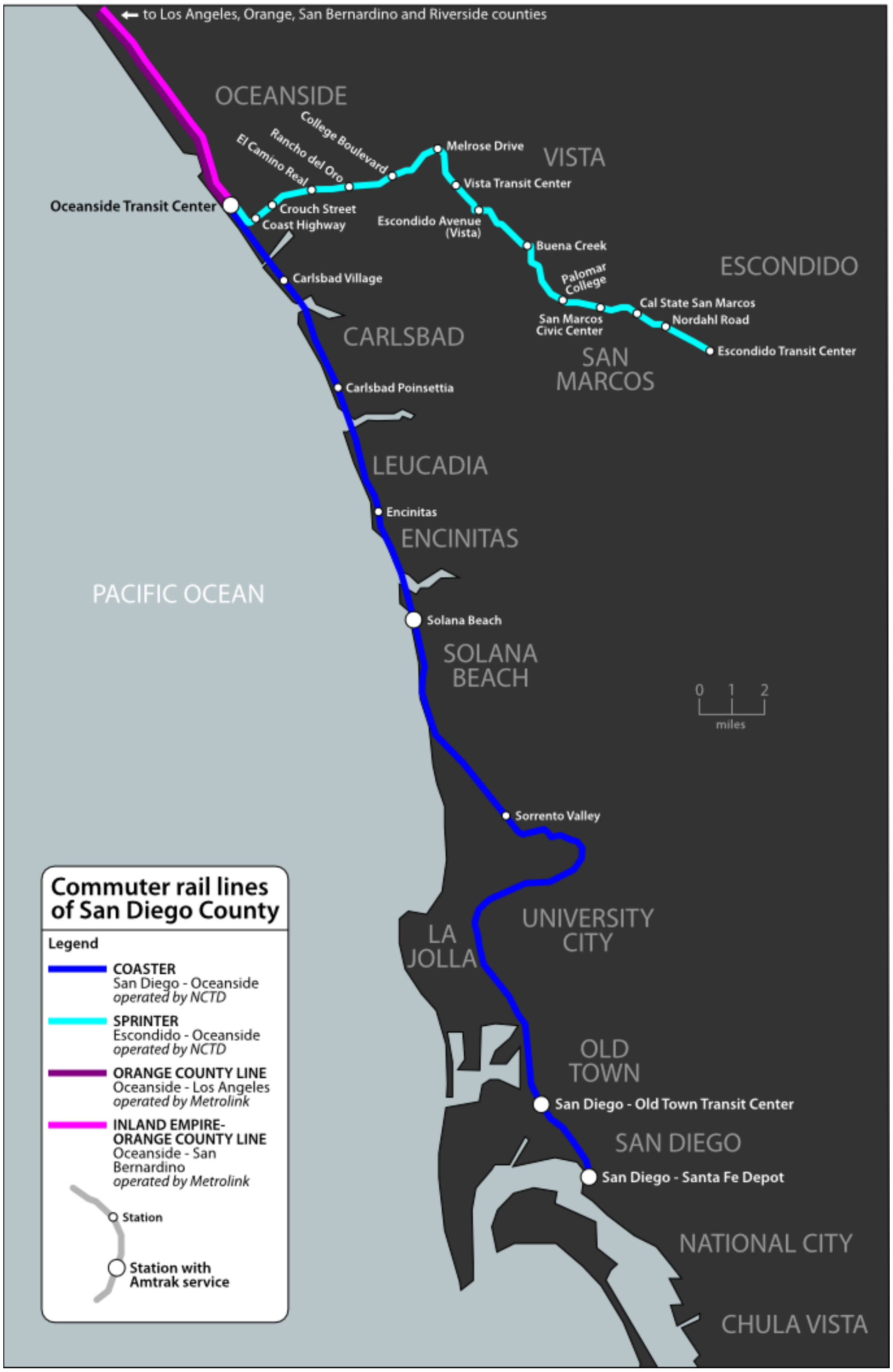


Figure X
Coaster Service Map
Source: http://www.sandiegoasap.com/gfx/san-diego-commuter-rail-map.png

SAN JOSE – STOCKTON – SAN FRANCISCO COMMUTER RAIL SYSTEM

Figure X
Altamont Corridor Express
Source:
https://en.wikipedia.org/wiki/Altamont_Corridor_Express#/media/File:ACE_Altamont_Pass.jpg
The commuter rail linking Stockton and San Jose, California is called the Altamont Corridor Express (ACE). Named after Altamont Pass through which it runs, there is one line with ten stations. The line is 85 miles long and it moves at an average pace of 39 miles per hour. Including stops, the line end-to-end takes about 2.5 hours to ride. Service on the ACE began October 19, 1998. [60]

[60] Adapted from: https://en.wikipedia.org/wiki/Altamont_Corridor_Express.

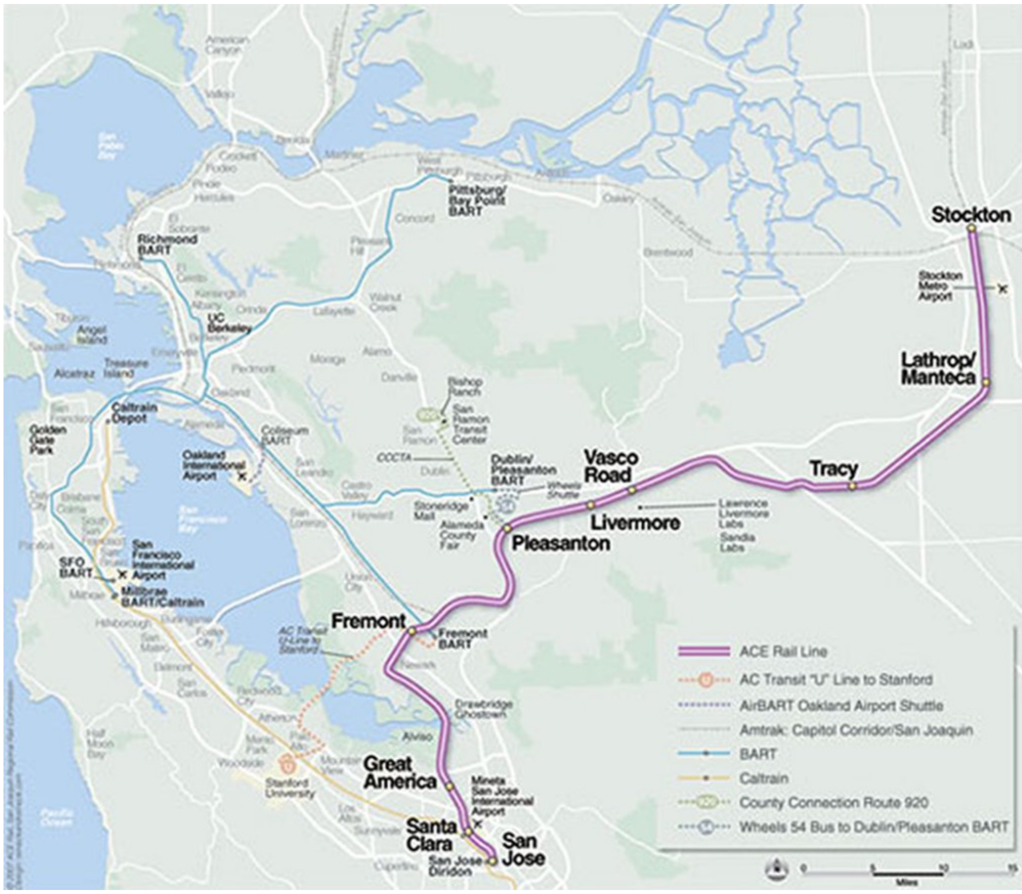


Figure X
Altamont Corridor Express Service Map
Source: https://www.mobilemaplets.com/showplace/6393

SEATTLE – TACOMA COMMUTER RAIL LINE SYSTEM

Figure X
Sounder Commuter Rail
Source: https://www.nycsubway.org/wiki/Seattle_Sounder_Commuter_Rail
Operating Monday through Friday during peak commute times, the Sounder Commuter Rail has two lines and twelve stations between southern suburbs of Tacoma and northern suburbs of Seattle, Washington. Daily ridership for Sounder is 18,314, and it opened on September 18, 2000. [61]

[61] Adapted from: https://en.wikipedia.org/wiki/Sounder_commuter_rail.

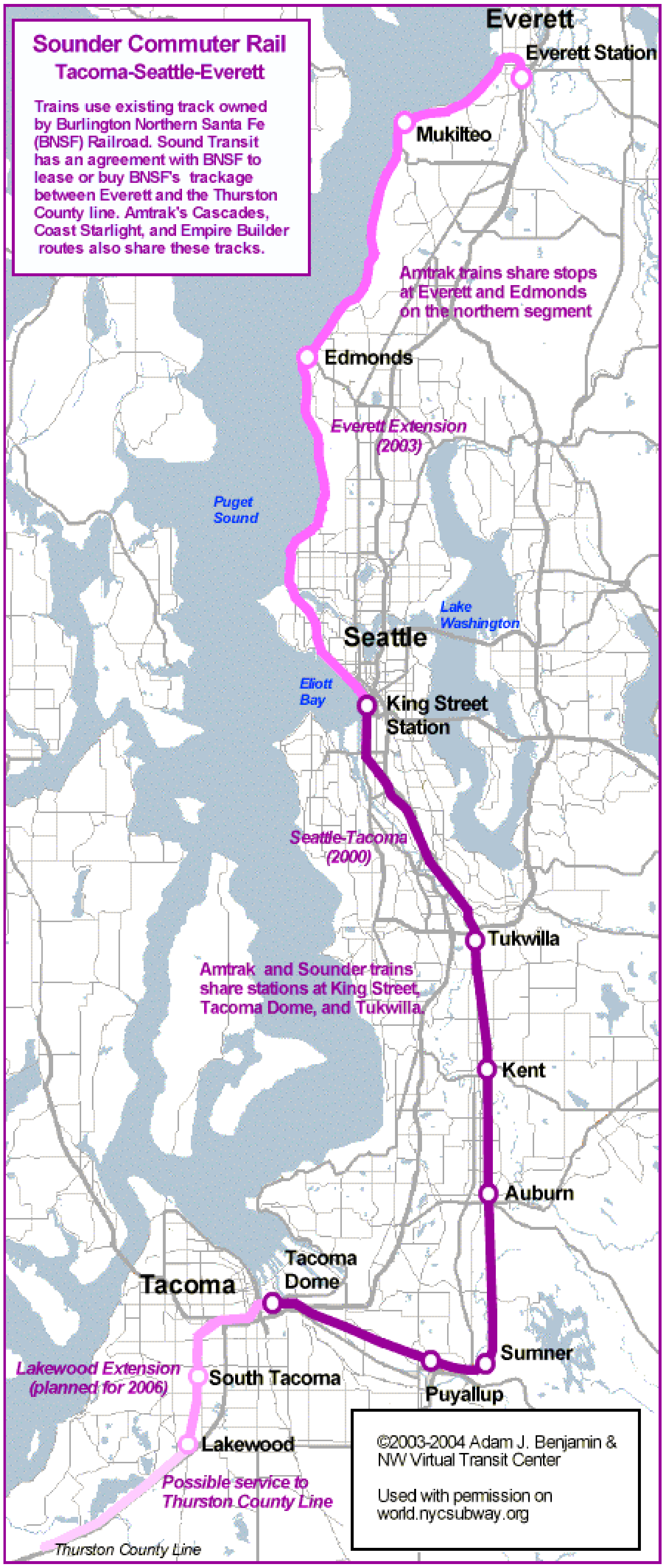


Figure X
Sounder Service Map (shown in deep purple)
Source: https://www.nycsubway.org/wiki/Seattle_Sounder_Commuter_Rail

WASHINGTON, DC – BALTIMORE COMMUTER RAIL SYSTEM: MARC

Figure X
MARC Commuter Rail
Source: https://en.wikipedia.org/wiki/MARC_Train#/media/File:MARC_438_(14833026066).jpg
The MARC Commuter Rail is one of two commuter train lines that has service to D.C., and its modern-day operation began in 1984. Dating back to the 1800s, the line serves primarily as a connection between Baltimore and D.C. with a daily ridership of over 40,000. The rail system has three lines: Martinsburg, WV to D.C.; Perryville, MD via Baltimore to D.C.; and Baltimore to D.C.[62]

[62] Adapted from: https://en.wikipedia.org/wiki/MARC_Train and Source: https://www.mta.maryland.gov/schedule/11080.

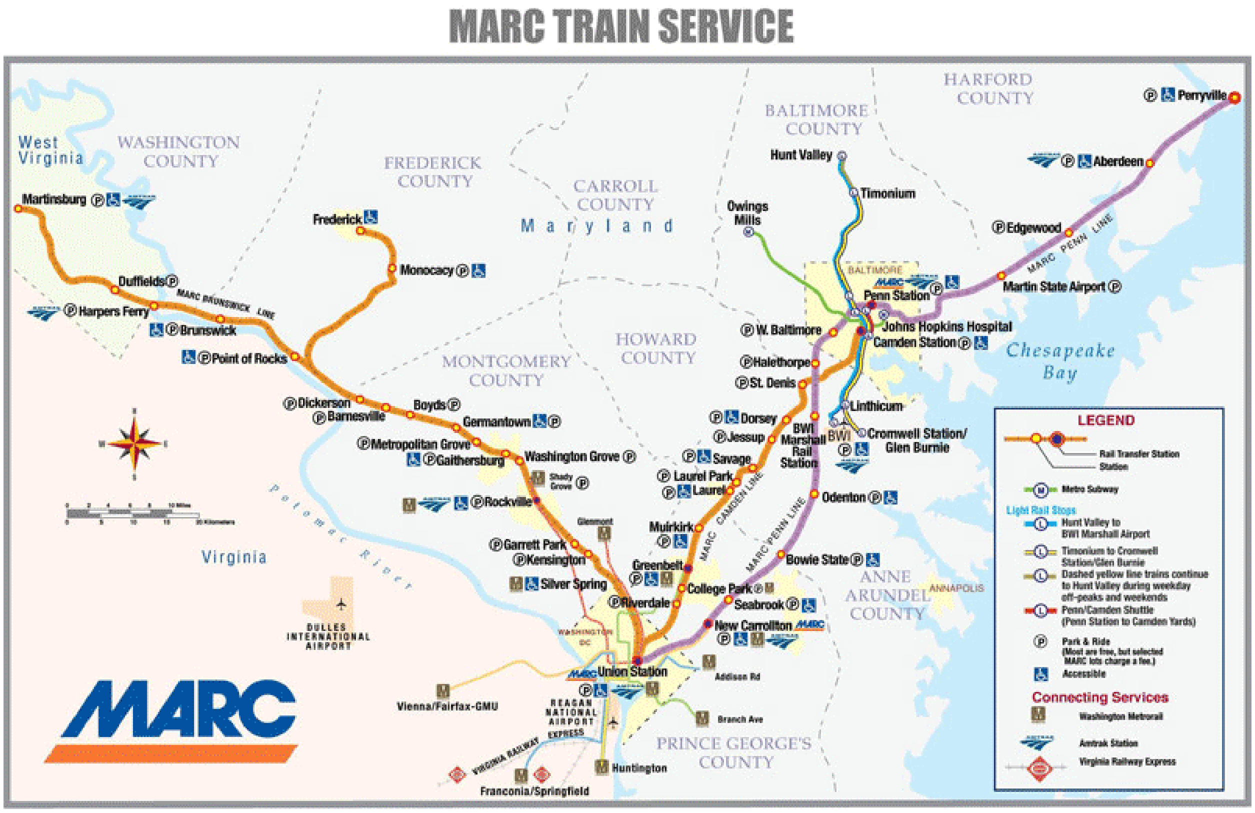


Figure X
MARC Service Map
Source: http://www.perryvillemd.org/transportation/pages/marc-train-station

WASHINGTON, DC – NORTHERN VIRGINIA COMMUTER RAIL SYSTEM: VRE

Figure X
Virginia Railway Express
Source: https://www.vre.org/development/
Connecting the Northern Virginia suburbs to Union Station in Washington, D.C., the Virginia Railway Express (VRE) operates two lines during peak hours. One line starts from Fredericksburg, Virginia and the other from Bristow, Virginia. The VRE began operations in summer of 1992 with 19 stations serving the two lines. [63]

[63] Adapted from: https://en.wikipedia.org/wiki/Virginia_Railway_Express and Source: https://www.vre.org/.

Figure X
VRE Service Map
Source: https://map.vre.org/vremap/app?action=ovmap

APPENDIX A – XBT
EXPRESS BUS TRANSIT SYSTEMS USED IN ANALYSIS

Express Bus Transit Systems Metro Area & Name	Year	Miles	Stations	Riders (Daily)
Albuquerque: Express Lines				
Atlanta: Xpress				4,932
Austin: MetroExpress				
Buffalo: Enhanced Express Bus Service				
Charlotte: Express Bus				
Cincinnati: Metro Bus Express Lines				
Dallas - Fort Worth: DART Express				
Denver: Express Bus Lines				
Houston: Park and Ride				
Kansas City: KC MAX	2005	32	87	
Little Rock: Express Routes				
Miami: Express Routes				
Minneapolis: Express Bus System				
Nashville: Express Bus System				
New Orleans: Express Lines				
Norfolk: Metro Area Express (MAX)				
Orlando: Fastlink				
Phoenix: MetroExpress				
Pittsburgh: Flyer				
Portland: Express Lines				
Reno: RTC Regional Connector				
Sacramento: Express Bus Lines				
Salt Lake City: Utah Express Bus Transit				
San Antonio: VIA Express				
San Jose: VTA Express Bus				
Seattle - Tacoma: SoundTransit Express Line				
St. Louis: Express Transit Lines				
Tacoma: Express Bus Transit				
Tucson: SunExpress				
Washington, DC: Metrobus Express				

ALBUQUERQUE EXPRESS BUS TRANSIT SYSTEM

Figure XBT Albuquerque 1
Albuquerque Bus Stock
Source: [Source: https://www.cabq.gov/student-guide](https://www.cabq.gov/student-guide)

The City of Albuquerque, New Mexico operates three express lines. The Taylor Ranch Express line runs from south of Rio Rancho to the University of New Mexico. The Jefferson / Paseo del Norte Express runs from north of Rio Rancho to the University of New Mexico, and there is an additional express line running between the airport and downtown.[64]

[64] Adapted from: https://www.cabq.gov/transit/routes-and-schedules.

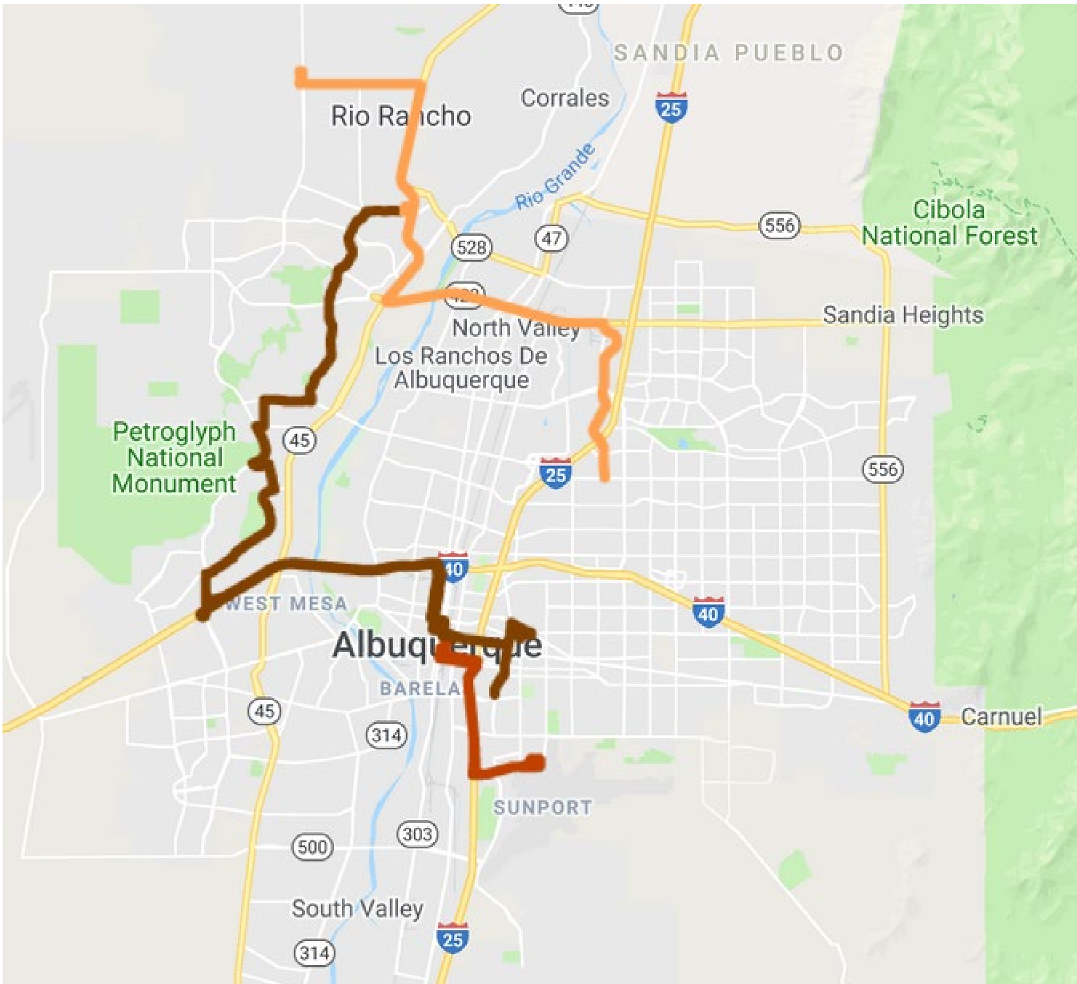


Figure XBT Albuquerque 2
Albuquerque Express Bus Lines
Source: [Source: http://wmb.unm.edu/?busid=92](http://wmb.unm.edu/?busid=92)

ATLANTA EXPRESS BUS TRANSIT SYSTEM

Figure XBT Atlanta 1
Atlanta Xpress
Source: https://dilemma-x.net/2013/02/18/fight-over-atlanta-mass-transit-marta-system-raises-race-issues/

Operated by the State Road & Tollway Authority (SRTA), Xpress gives commuters in the metro Atlanta, Georgia area an alternative transportation option to the automobile. The system has 27 routes in 12 metro Atlanta counties, carrying around 1,800,000 passengers on a yearly basis. Annually, Xpress removes 55 million miles of congestion from Atlanta metro highways and interstates.[65]

[65] Adapted from: https://www.xpressga.com/about/.

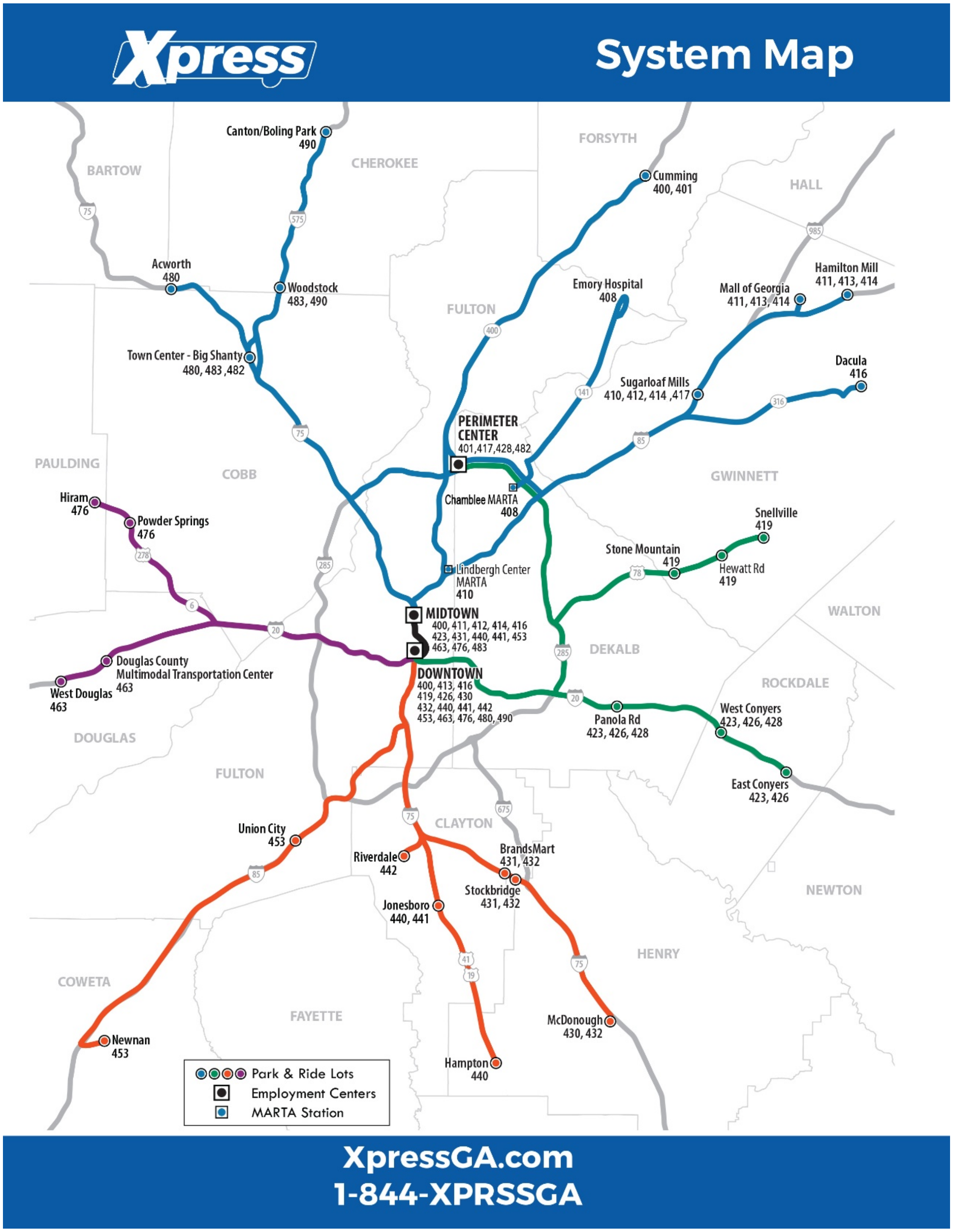


Figure XBT Atlanta 2
Atlanta Xpress Map
Source: https://www.xpressga.com/commutertools/#maps

AUSTIN EXPRESS BUS TRANSIT SYSTEM

Figure XBT Austin 1
MetroExpress
Source: https://www.flickr.com/photSource:
https://www.flickr.com/photos/27884592@N07/22971129740os/27884592@N07/22971129740
Called MetroExpress, Austin, Texas' express bus transit line operates seven lines directly to downtown and other major employment hubs in Austin from outer suburbs. A monthly pass can be purchased for less than $100, and gives riders flexibility with three different departure times each morning. [66]

AUSTIN EXPRESS BUS TRANSIT MAP

[66] Adapted from: https://capmetro.org/metroexpress/#!.

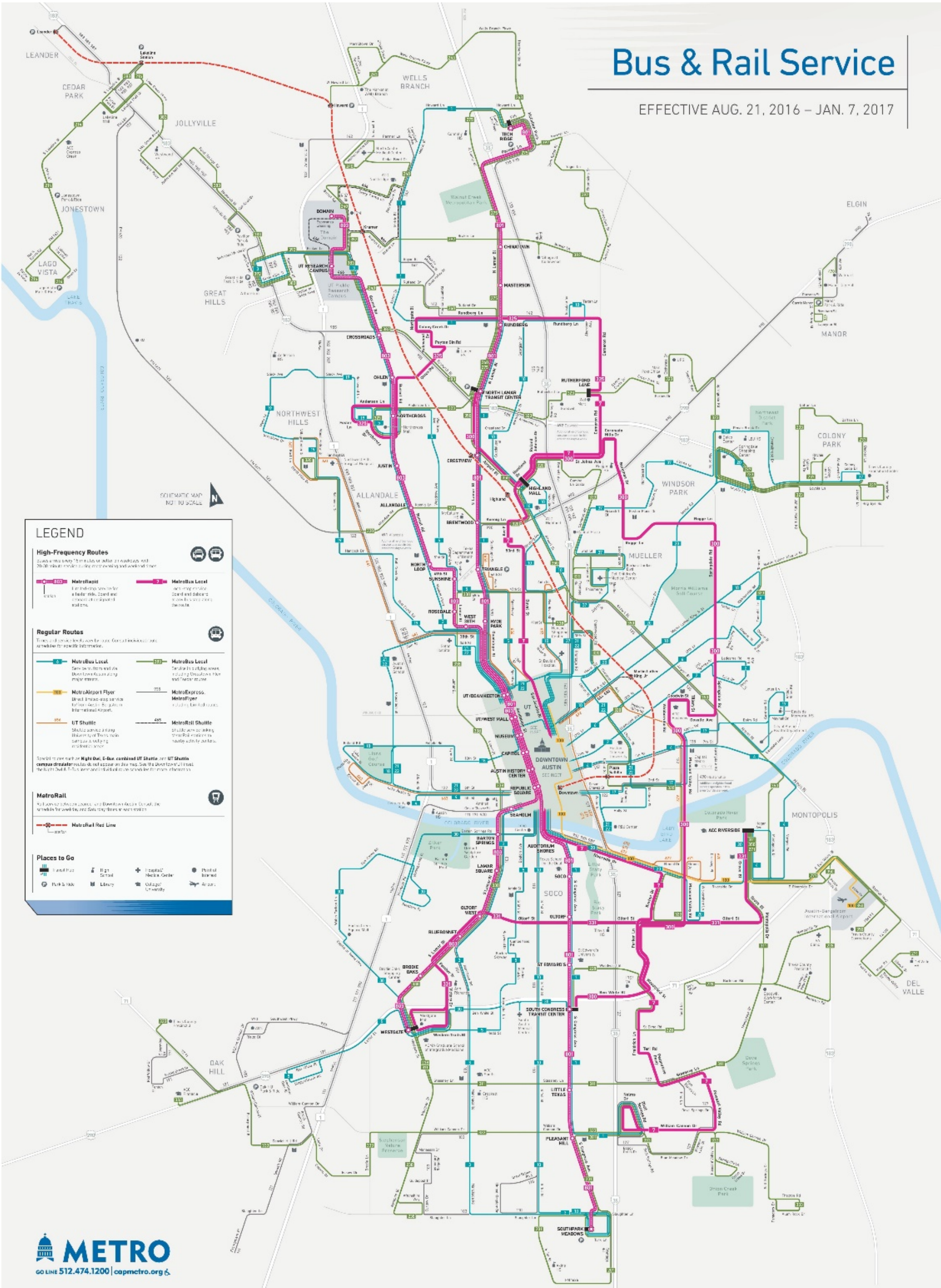


Figure XBT Austin 2
Austin Bus & Rail Map (Express line denoted in solid gray)
Source: http://ontheworldmap.com/usa/city/austin/austin-bus-and-rail-map.jpg

BUFFALO EXPRESS BUS TRANSIT SYSTEM

Figure XBT Buffalo 1
Enhanced Express Bus Service
Source: https://en.wikipedia.org/wiki/Niagara_Frontier_Transportation_Authority
Operated by the Niagara Frontier Transportation Authority (NFTA), the Enhanced Express Bus serves the metro area of Buffalo, New York. The line operates three routes: a direct route to downtown from the airport, a direct route from downtown Buffalo to Niagara Falls, and a route to downtown from a far suburb called Lockport with stops in other suburbs along the way. These express lines also offer onboard Wi-Fi to enhance rider experience. [67]

[67] Adapted from: http://metro.nfta.com/Routes/express.aspx.

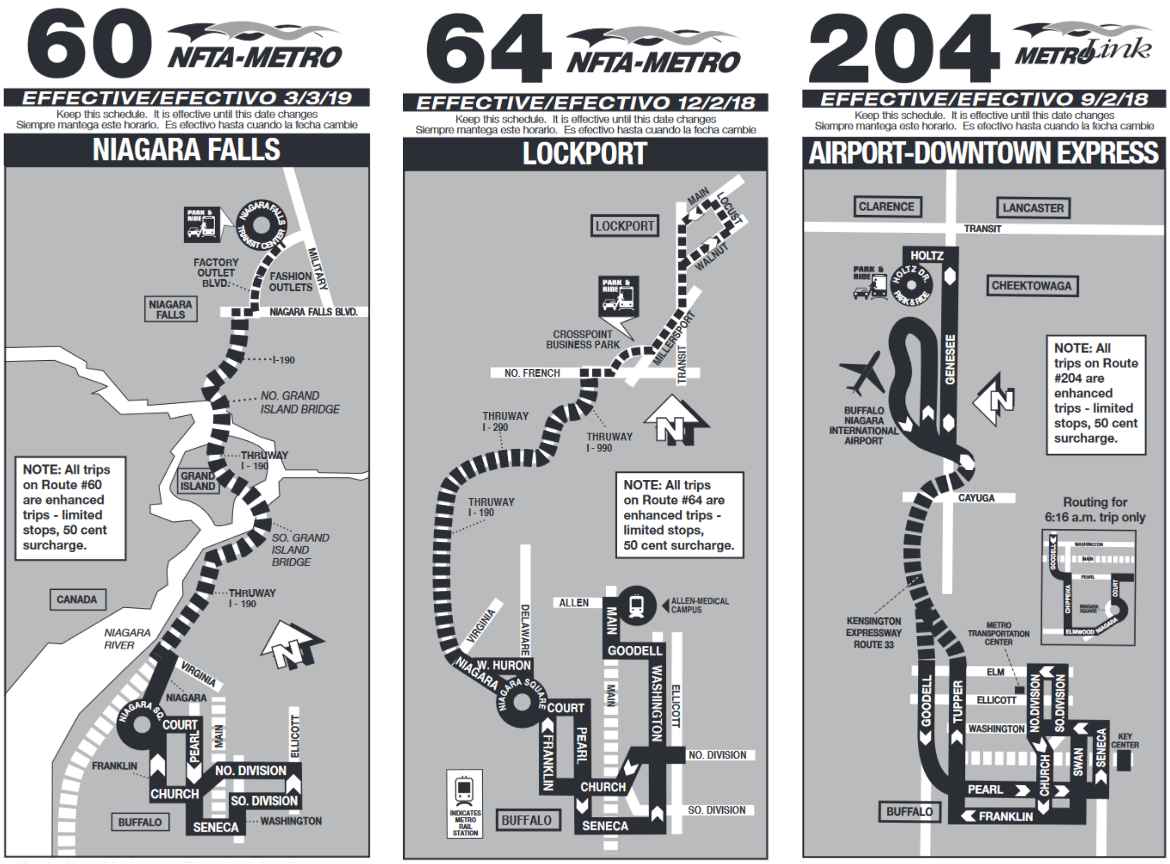


Figure XBT Buffalo 2
NFTA Enhanced Bus Service maps
Source: http://metro.nfta.com/Routes/express.aspx

CHARLOTTE EXPRESS BUS TRANSIT SYSTEM

Figure XBT Charlotte 1
Charlotte Express Bus
Source: https://www.youtube.com/watch?v=SpeXLLu6HA8
The Charlotte Area Transit System (CATS) operates 16 express lines, denoted with an 'X' after the route number. The express systems serve Union, Concord, and Gastonia Counties in North Carolina and Rock Hill County in South Carolina. As a whole, the CATS bus systems transport over 80,000 passengers weekly. [68]

[68] Adapted from: https://en.wikipedia.org/wiki/Charlotte_Area_Transit_System and Source: https://charlottenc.gov/cats/bus/routes/Pages/default.aspx.

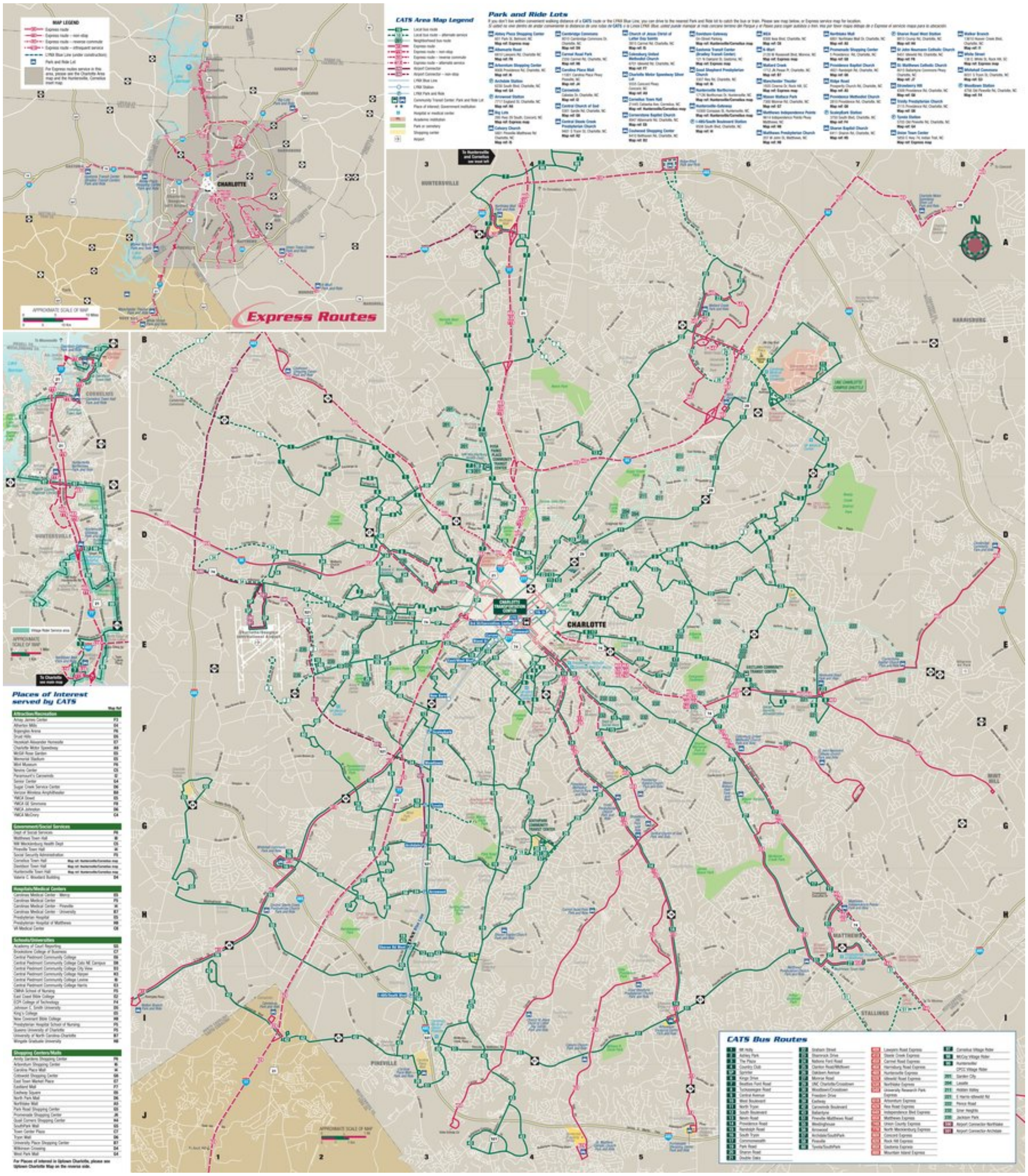


Figure XBT Charlotte 2
Charlotte Bus Map
Source: http://www.mobilemaplets.com/showplace/4331

CINCINNATI EXPRESS BUS TRANSIT SYSTEM

Figure XBT Cincinnati 1
Cincinnati Metro Bus
Source: https://www.urbancincy.com/2016/06/running-time-adjustments-go-into-effect-for-9-express-metro-routes-on-monday/cincinnati-metro-bus-10/
The Metro Bus Line has 20 express lines that serve the greater Cincinnati, Ohio metro area. Around 10% of all daily riders utilize the express lines. The express lines only operate inbound and outbound during rush hour. [69]

[69] Adapted from: https://en.wikipedia.org/wiki/Southwest_Ohio_Regional_Transit_Authority.

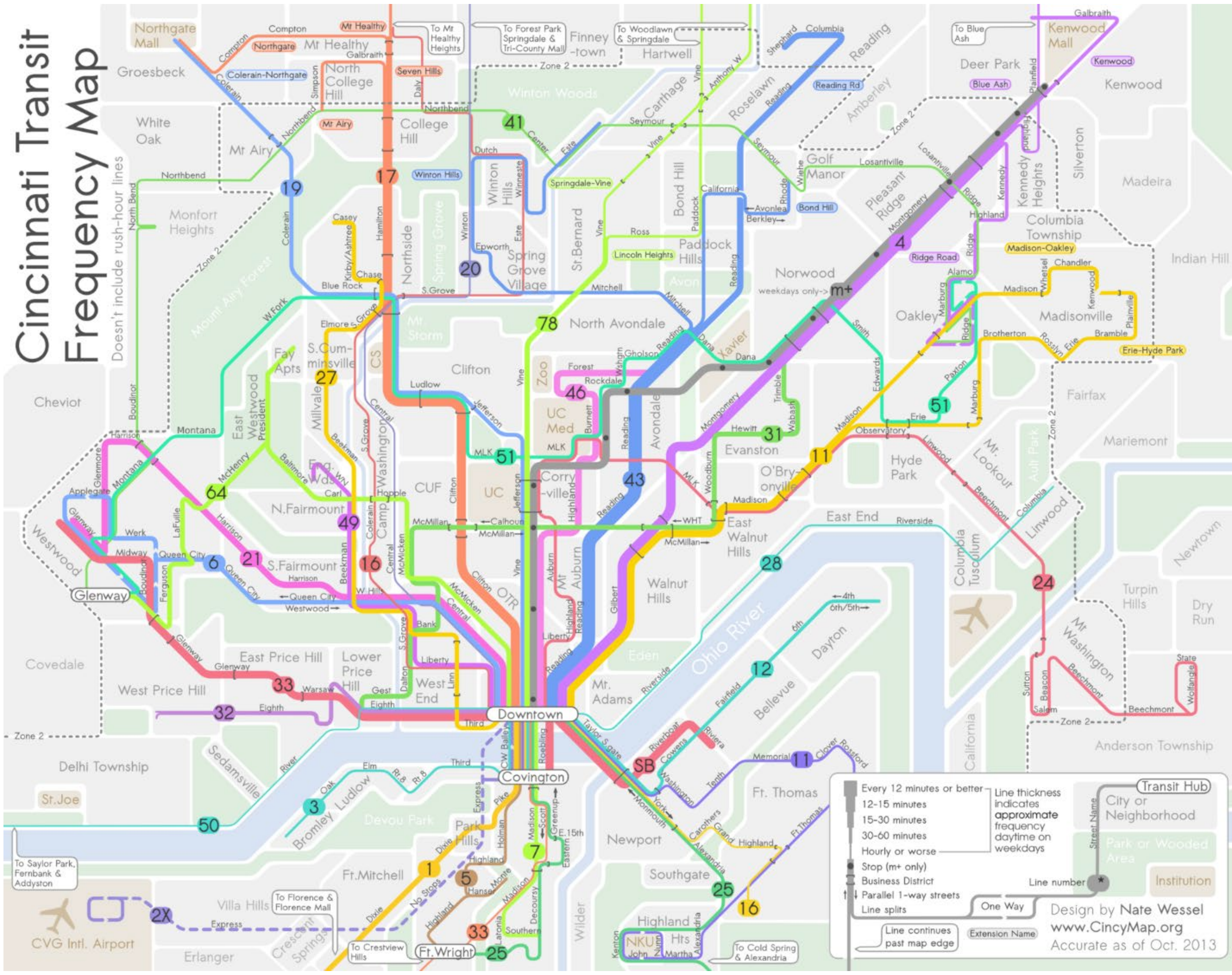


Figure XBT Cincinnati 2
Cincinnati Transit Map
Source:
https://en.wikipedia.org/wiki/Transportation_in_Cincinnati#/media/File:Cincinnati_Transit_Frequency_Map.png

DALLAS – FORT WORTH EXPRESS BUS TRANSIT SYSTEM

Figure XBT Dallas 1
Dallas Express Bus
Source: [Source: https://i.ytimg.com/vi/ws9YFPHs-Ck/maxresdefault.jpg](https://i.ytimg.com/vi/ws9YFPHs-Ck/maxresdefault.jpg)
Operated by Dallas Area Regional Transit (DART), there are eight DART Express lines serving the greater Dallas area.[70]

[70] Adapted from: https://www.dart.org/schedules/busschedules.asp?quicksched=999.

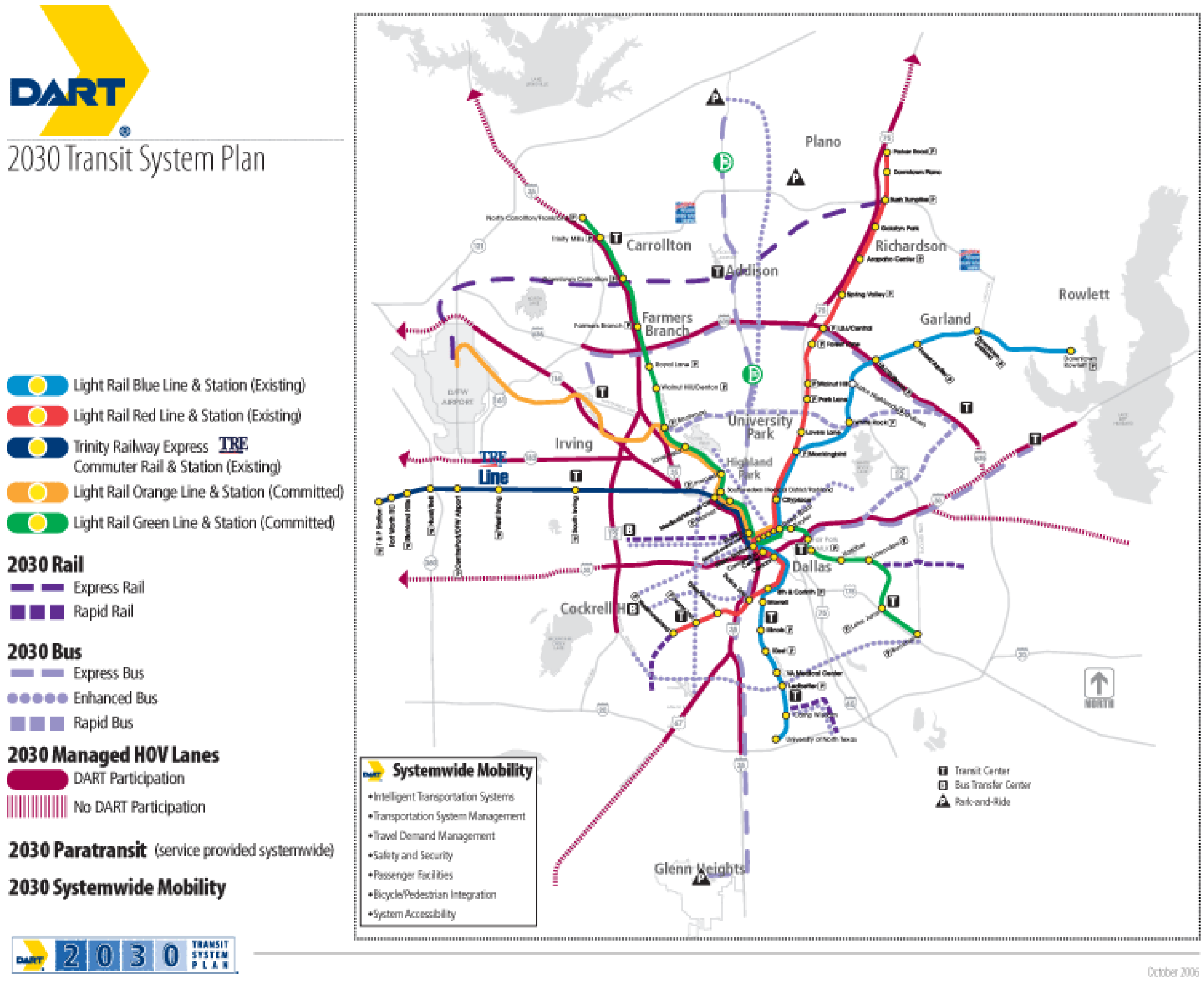


Figure XBT Dallas 2
Dallas Area Regional Transit Plan 2030 (Express in long dash)
Source: https://www.dart.org/maps/DART2030planmap.asp

DENVER EXPRESS BUS TRANSIT SYSTEM

Figure XBT Denver 1
Denver Express Bus
Source: https://www.flickr.com/photos/raythetrain/5843779934
Denoted by an “X” in the route name, Denver has five express bus transit routes.[71]

[71] Adapted from: http://www.rtd-denver.com/Schedules.shtml.

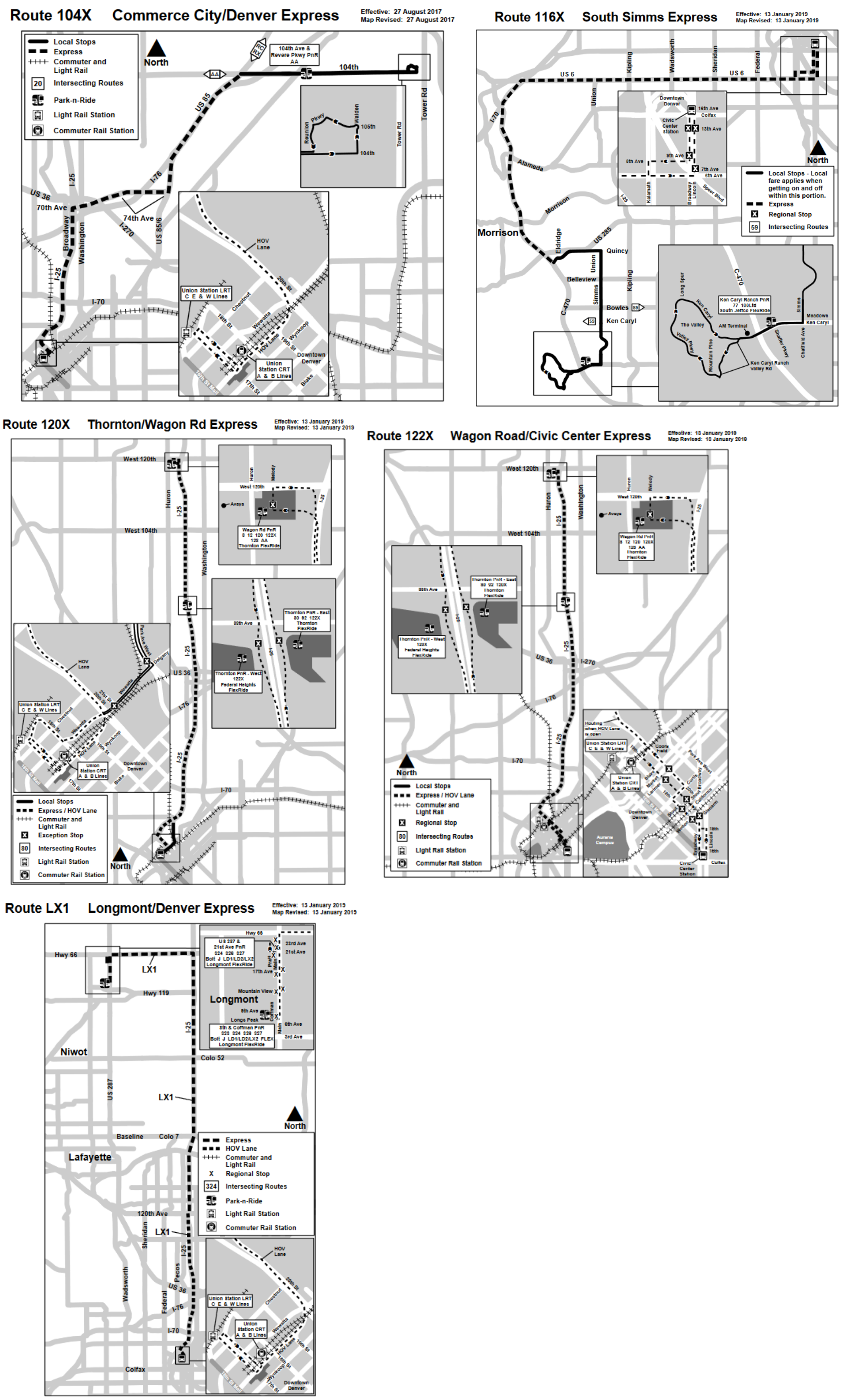


Figure XBT Denver 2-6
Express Bus Maps
Source: http://www.rtd-denver.com/Schedules.shtml
HOUSTON EXPRESS BUS TRANSIT SYSTEM

Figure XBT Houston 1
Houston Commuter Bus
Source: https://lastrow.wordpress.com/tag/commuting/
With service at morning, midday, and evening, Houston's Park and Ride commuter bus service serves outlying suburbs with direct routes to downtown, the Texas Medical Center, and other large employment centers in Houston. The system is operated by the Metropolitan Transit Authority of Harris County, and offers discounts to students.[72]

[72] Adapted from: https://www.ridemetro.org/Pages/ParkRide.aspx and Source: https://www.ridemetro.org/Pages/PR-BayArea.aspx.

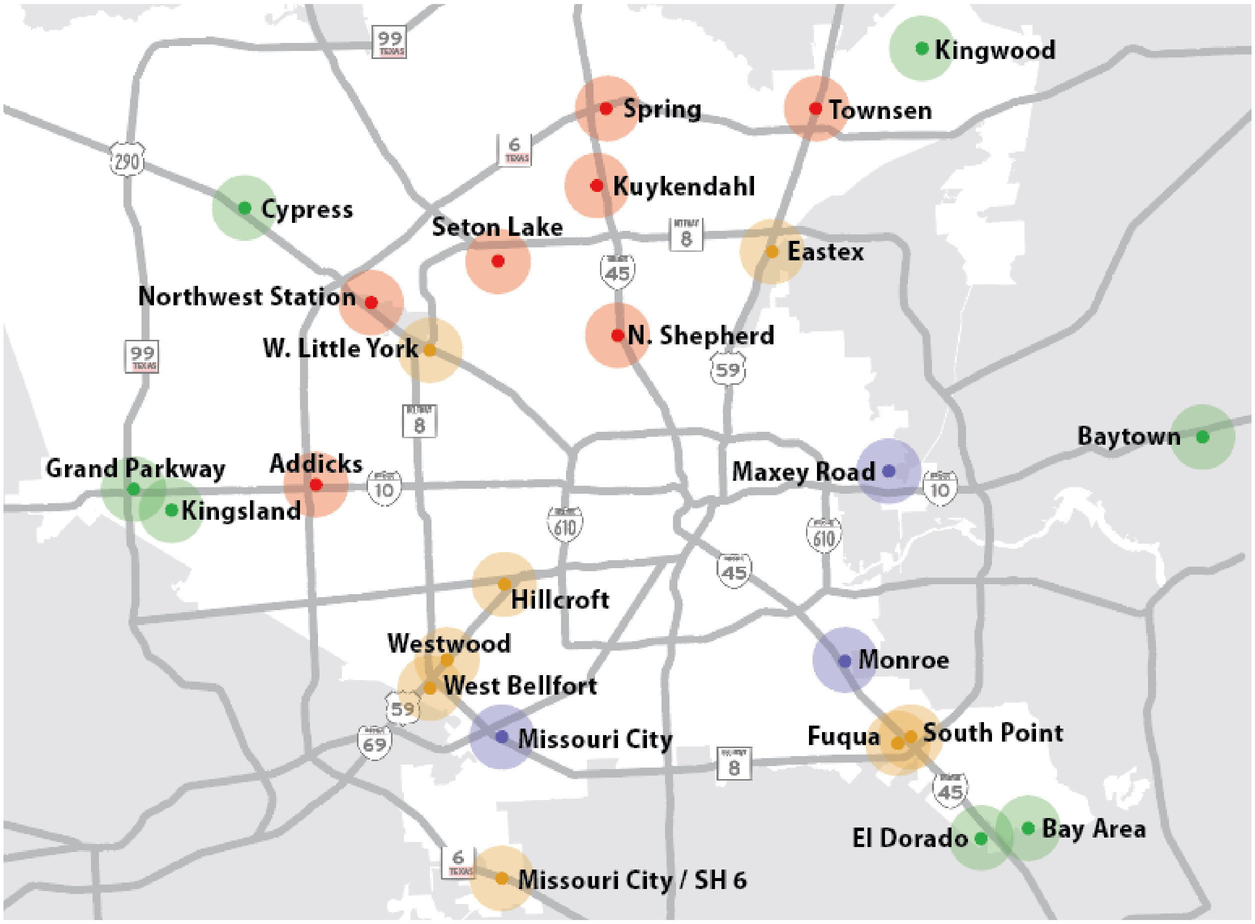


Figure XBT Houston 2
Houston Commuter Bus Service Map
Source: https://www.ridemetro.org/Pages/PR-BayArea.aspx

KANSAS CITY EXPRESS BUS TRANSIT SYSTEM

Figure XBT Kansas City 1
KC MAX Express Bus Transit
Source: http://www.kcata.org/transit-initiatives/max_and_bus_rapid_transit
With the first service beginning in July of 2005, the Metro Area Express (MAX) serves Kansas City, Missouri. The line is 32 miles in length with 87 stations. The line was an "instant success," with ridership 50% more than expected upon launch. The Federal Transit Administration holds Kansas City's MAX line as a model for other rapid transit services.[73]

[73] Adapted from: https://en.wikipedia.org/wiki/Metro_Area_Express.

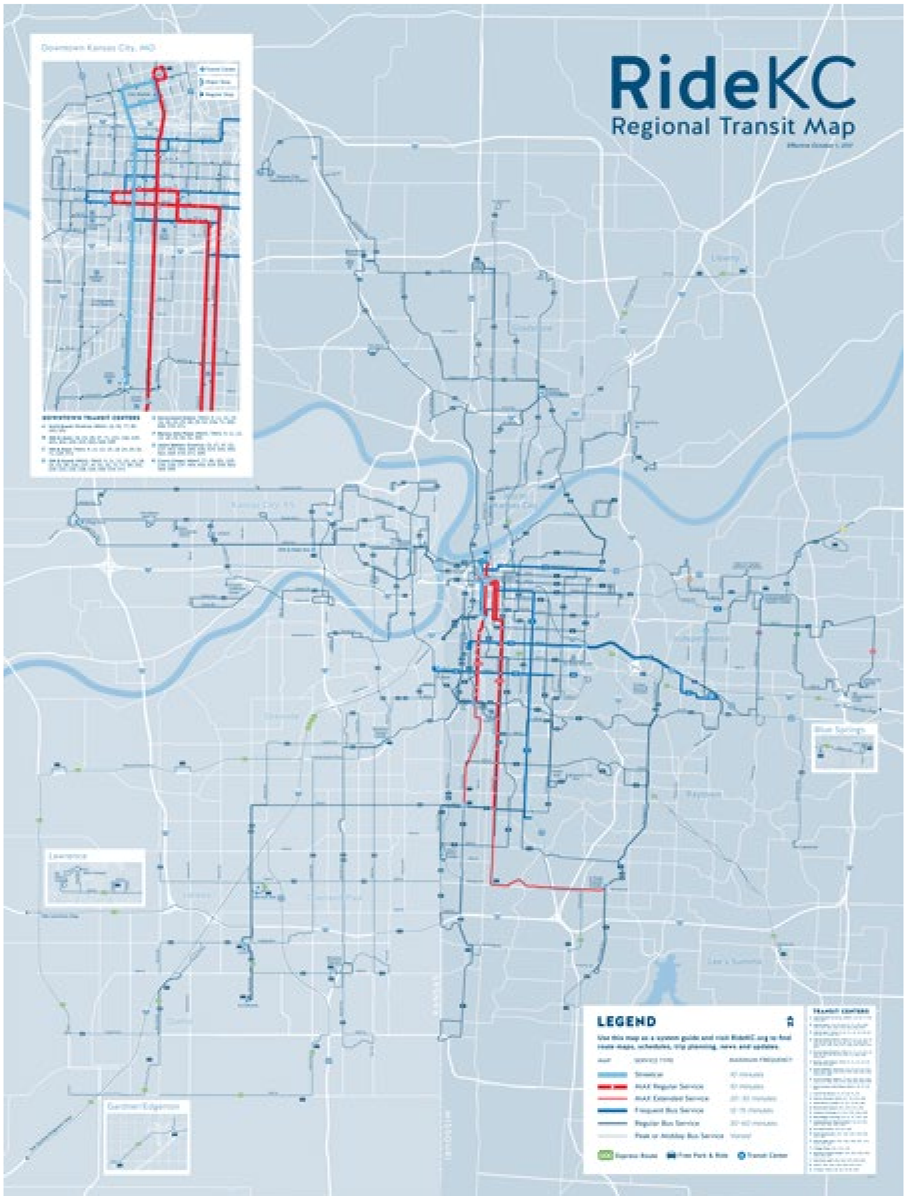


Figure XBT Kansas City 2
MAX Service Map
Source: http://ridekc.org/rider-guide/system-map

LITTLE ROCK EXPRESS BUS TRANSIT SYSTEM

Figure XBT Little Rock 1
Little Rock Express Bus Transit
Source: https://m.arktimes.com/ArkansasBlog/archives/2018/05/15/rock-region-metro-local-and-express-buses-will-be-fare-free-on-election-day

Rock Region Metro operates four express routes serving the Little Rock, Arkansas region. These four routes serve Hensley, Pinnacle Mountain, Maumelle/Oak, and Jacksonville/Sherwood all with service to downtown Little Rock. The purpose of these express lanes is to connect far commuters with downtown employment centers.[74]

[74] Adapted from: https://rrmetro.org/services/local/maps-schedules/.

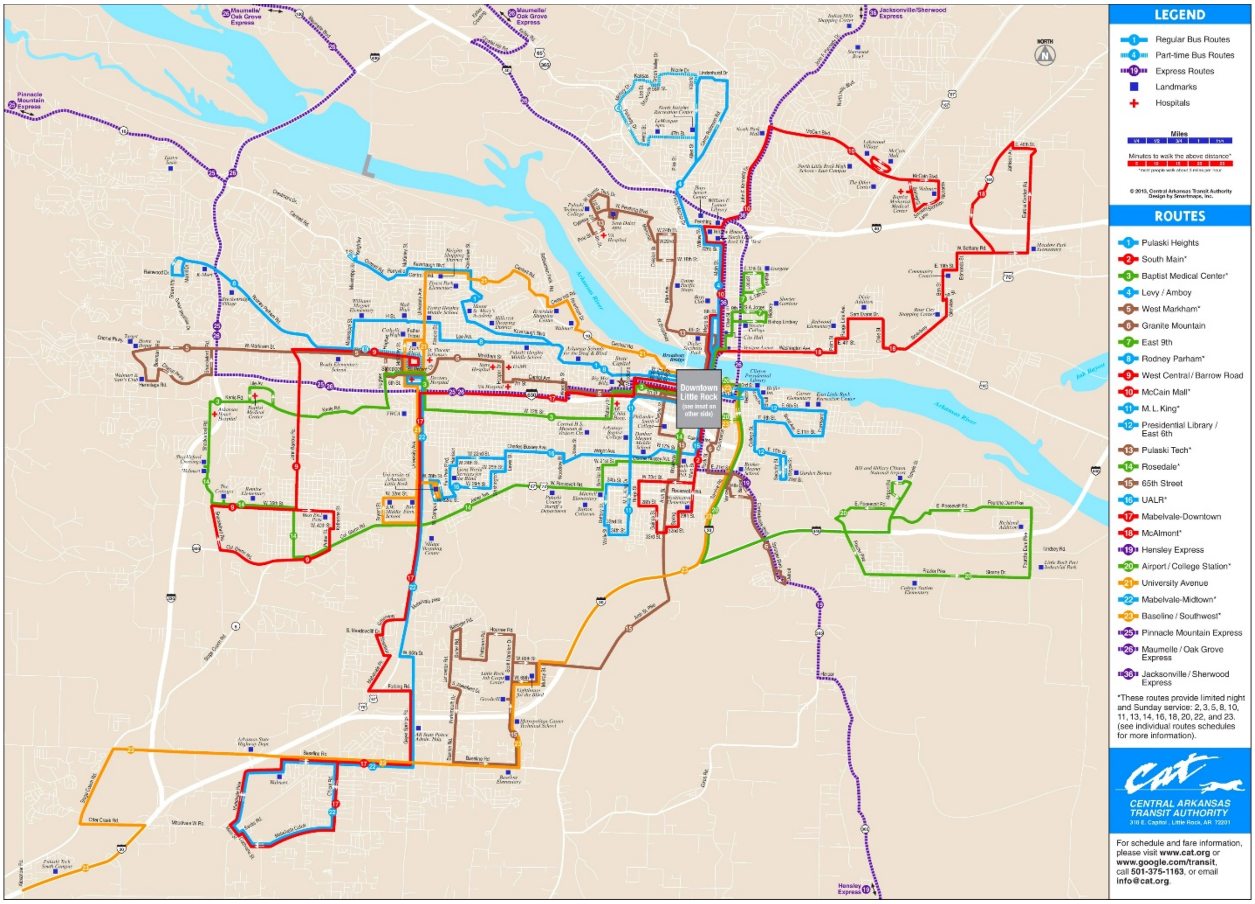


Figure XBT Little Rock 2
Little Rock Transit Service Map (Express lines in violet)
Source: http://ontheworldmap.com/usa/city/little-rock/little-rock-bus-map.html

MIAMI EXPRESS BUS TRANSIT SYSTEM

Figure XBT Miami 1
Miami Express Bus
Source: https://www.miamidade.gov/beta/easyperks/attractions.asp

Miami offers two express bus transit lines, the 95 Express and the Miami Beach Airport Express. The 95 Express offers service during peak weekday travel times. It serves downtown Miami, the Miami Civic center, the Miami Health District, and Doral from many locations in Broward County and the Golden Glades Interchange. The Miami Beach Airport Express runs between 6:00 AM and 11:40 PM every day of the week. Service is every 30 minutes between Miami Beach and the Miami International Airport Metrorail Station.[75]

[75] Adapted from: https://www8.miamidade.gov/global/transportation/metrobus.page.

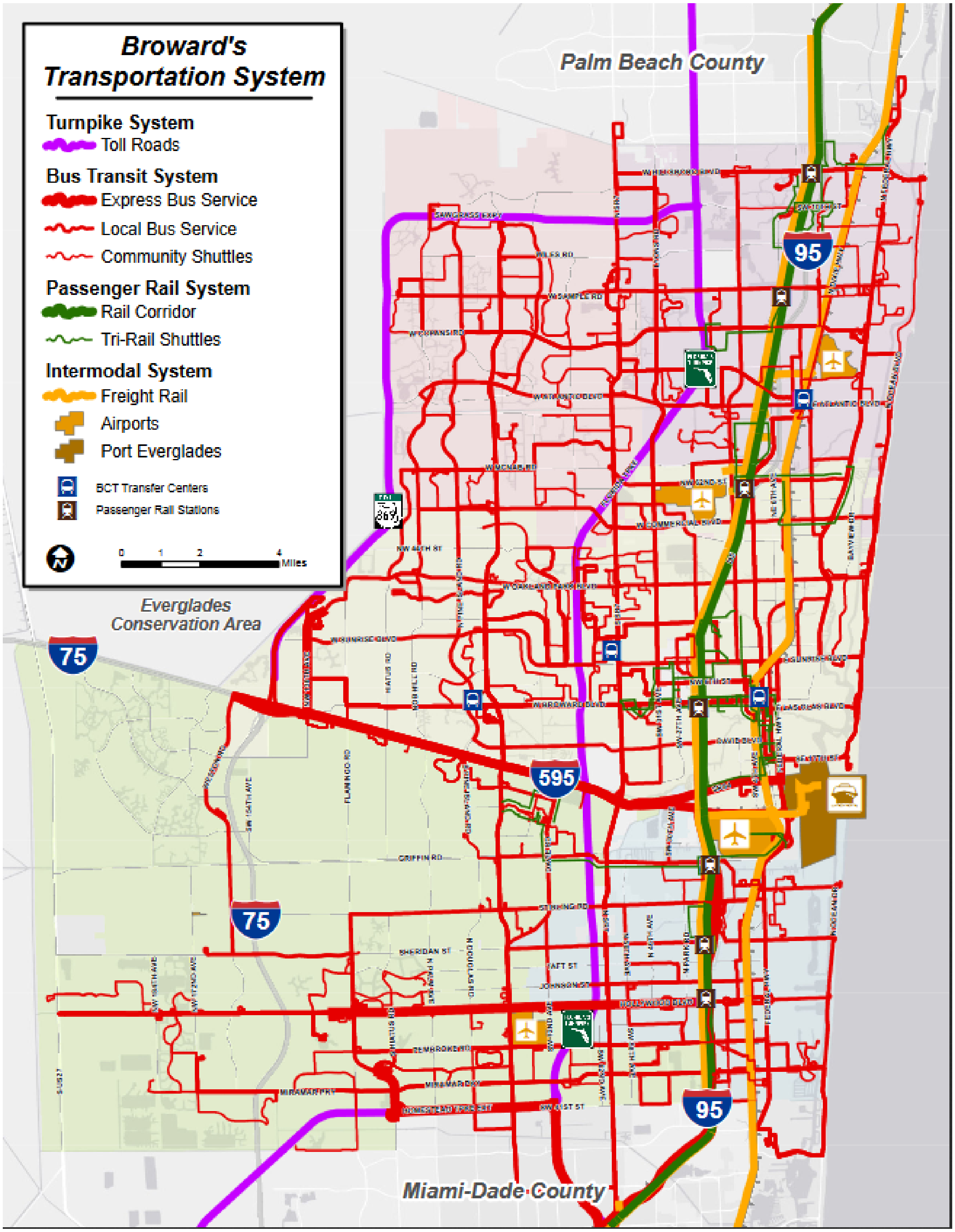


Figure XBT Miami 2
Miami Transit Map
Source: http://www.browardmpo.org/images/SpeakUpBroward/systemmap2.pdf
MINNEAPOLIS EXPRESS BUS TRANSIT SYSTEM

Figure XBT Minneapolis 1
MVTA Bus
Source: https://www.flickr.com/photos/mspdude/8956466254
Operated by the Minnesota Valley Transit Authority, the Express Bus System offers 16 express routes from far-reaching suburbs into the Minneapolis – St. Paul metro area. This system gives commuters an option other than vehicular transit to get to work. Operation is usually confined to commute times and midday during weekdays. [76]

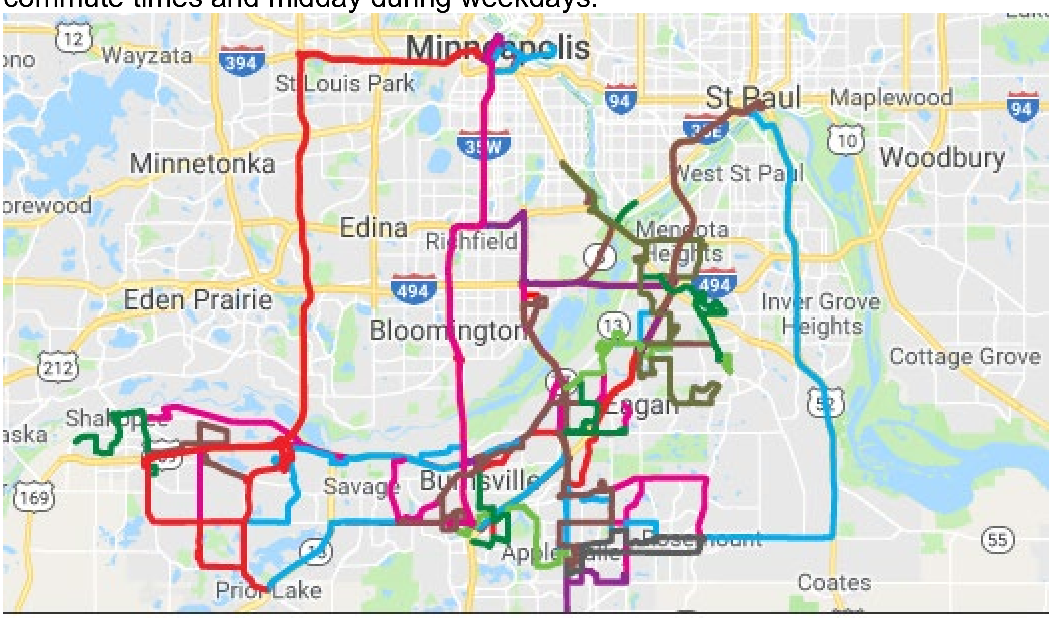


Figure XBT Minneapolis 2
MVTA Bus & Express Line System Map
Source: https://www.mvta.com/routes/

[76] Adapted from: https://www.mvta.com/routes/491/.

NASHVILLE EXPRESS BUS TRANSIT SYSTEM

Figure XBT Nashville 1
Nashville MTA Express Bus
Source: https://www.thetravelmentor.com/2016/03/how-to-get-from-bna-airport-to-downtown-nashville-on-bus-18/

The Nashville MTA operates 16 express bus services from outer suburbs to downtown Nashville. These lines give commuters an option to avoid driving through traffic and operate during the morning and evening rush as well as midday during weekdays only.[77]

[77] Adapted from: http://www.nashvillemta.org/Nashville-MTA-Maps-and-Schedules.asp.

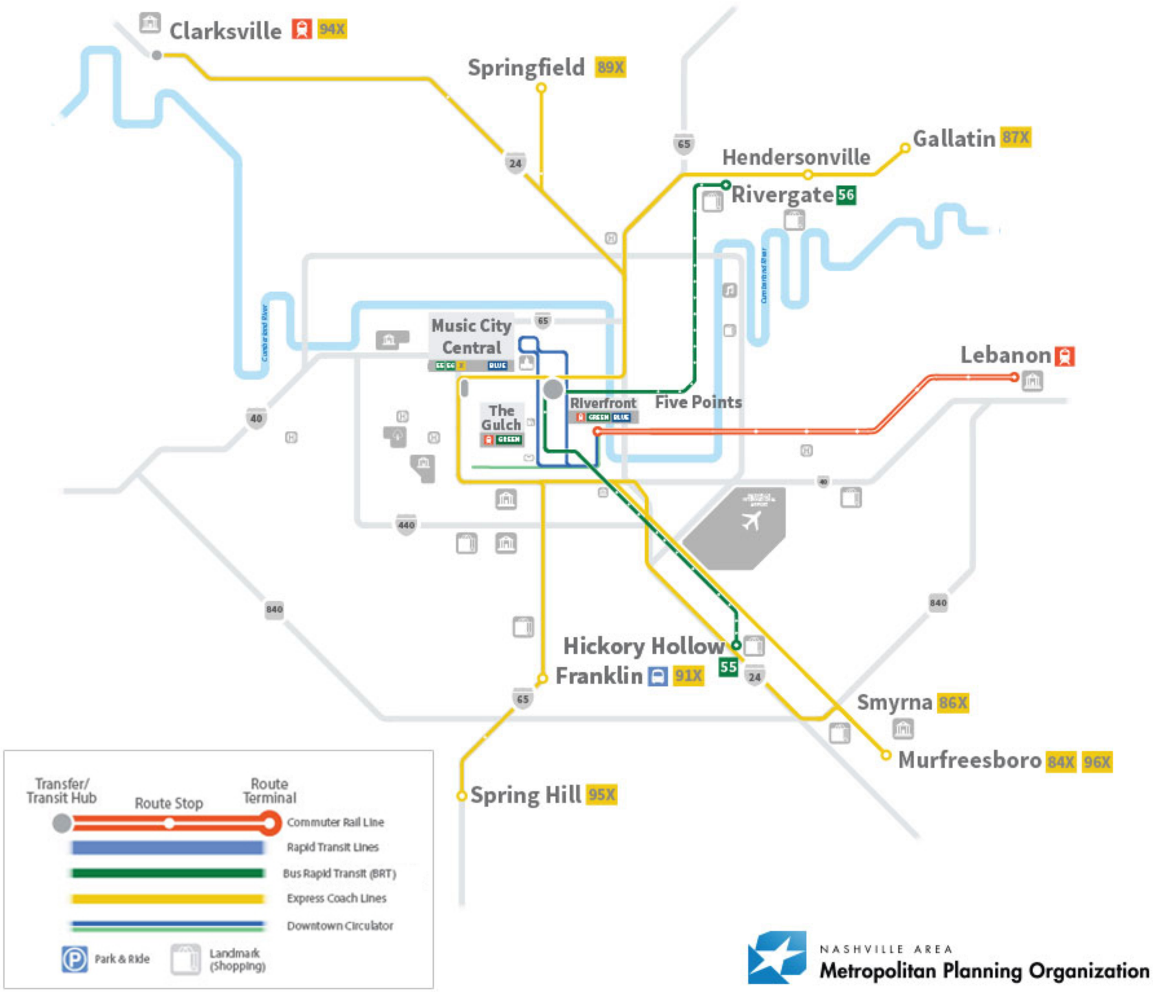


Figure XBT Nashville 2
Nashville Bus Service Map (Express Lines in yellow)
Source: http://www.nashvillempo.org/plans_programs/rtp/transit_existing.aspx

NEW ORLEANS EXPRESS BUS TRANSIT SYSTEM

Figure XBT New Orleans 1
NORTA Express Bus
Source: https://www.norta.com/Maps-Schedules/System-Map
The New Orleans Regional Transit Authority operates four express lines serving downtown New Orleans from outer suburbs and the airport. These lines have varying times of operation, but will reliably serve passengers during peak commuting times and midday.[78]

[78] Adapted from: https://www.norta.com/Maps-Schedules/System-Map.

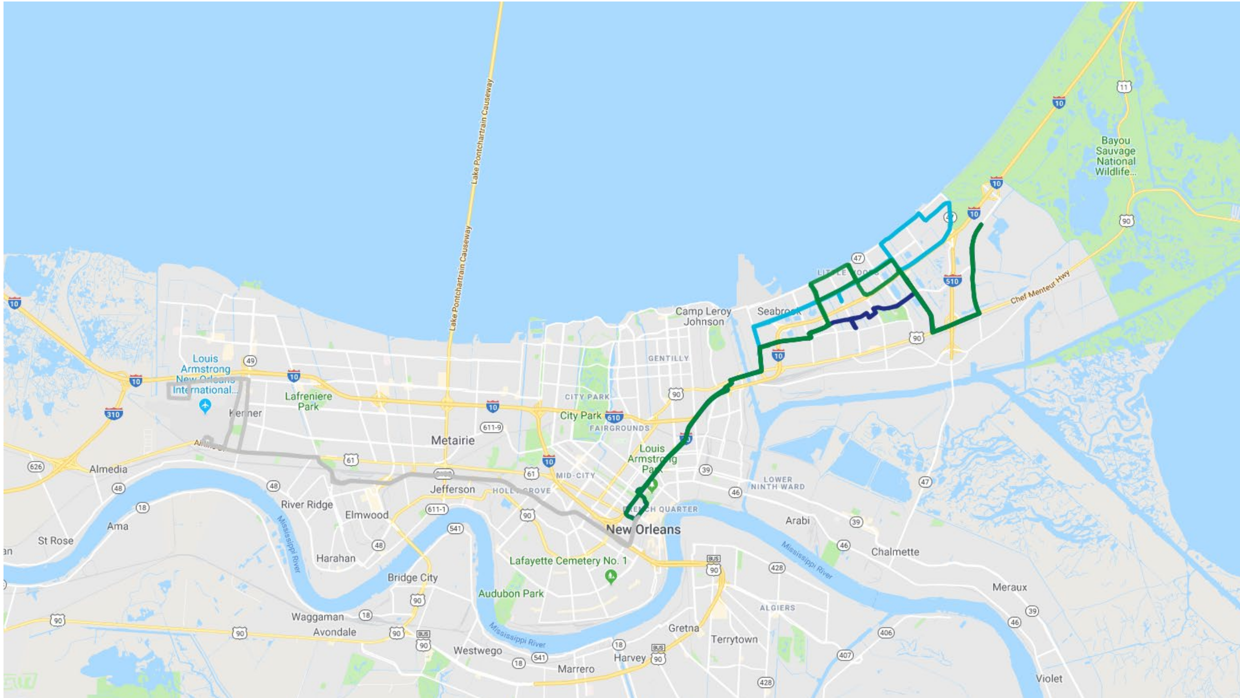


Figure XBT New Orleans 2
NORTA Express Bus Line Service Map (shown in gray, green, navy, and blue)
[Source: https://www.norta.com/Maps-Schedules/System-Map](https://www.norta.com/Maps-Schedules/System-Map)

NORFOLK EXPRESS BUS TRANSIT SYSTEM

Figure XBT Norfolk 1
HRT Bus
Source: http://thechasfoundation.org/mental-health-awareness-campaigns/
Known as the MAX, Norfolk's metro area express bus system is operated by Hampton Roads Transit (HRT). There are many park-and-ride facilities giving many options to commuters. The buses on this express system offer onboard Wi-Fi to ensure productivity even on the way to work. This system has nine lines.[79]

Maps for all nine routes can be found here: Source: https://gohrt.com/routes/max/
Figures XBT Norfolk 2-10
Metro Area Express Maps
Source: https://gohrt.com/routes/max/

ORLANDO EXPRESS BUS TRANSIT SYSTEM

[79] Adapted from: https://gohrt.com/2019/01/the-max-park-less-text-more/.

Figure XBT Orlando 1
FastLink Bus
Source: https://www.flickr.com/photos/126261518@N03/21458290146/

Called FastLink, Orlando's express commuter bus system operates similarly to its conventional bus lines only with fewer stops. This saves time for commuters going in and out of Orlando. FastLink has three lines serving Kissimmee, downtown Orlando, Orlando International Airport, the VA Hospital, Lake Nona, Meadow Woods, and Florida Mall. [80]

[80] Adapted from: https://www.golynx.com/plan-trip/riding-lynx/fastlink.stml.

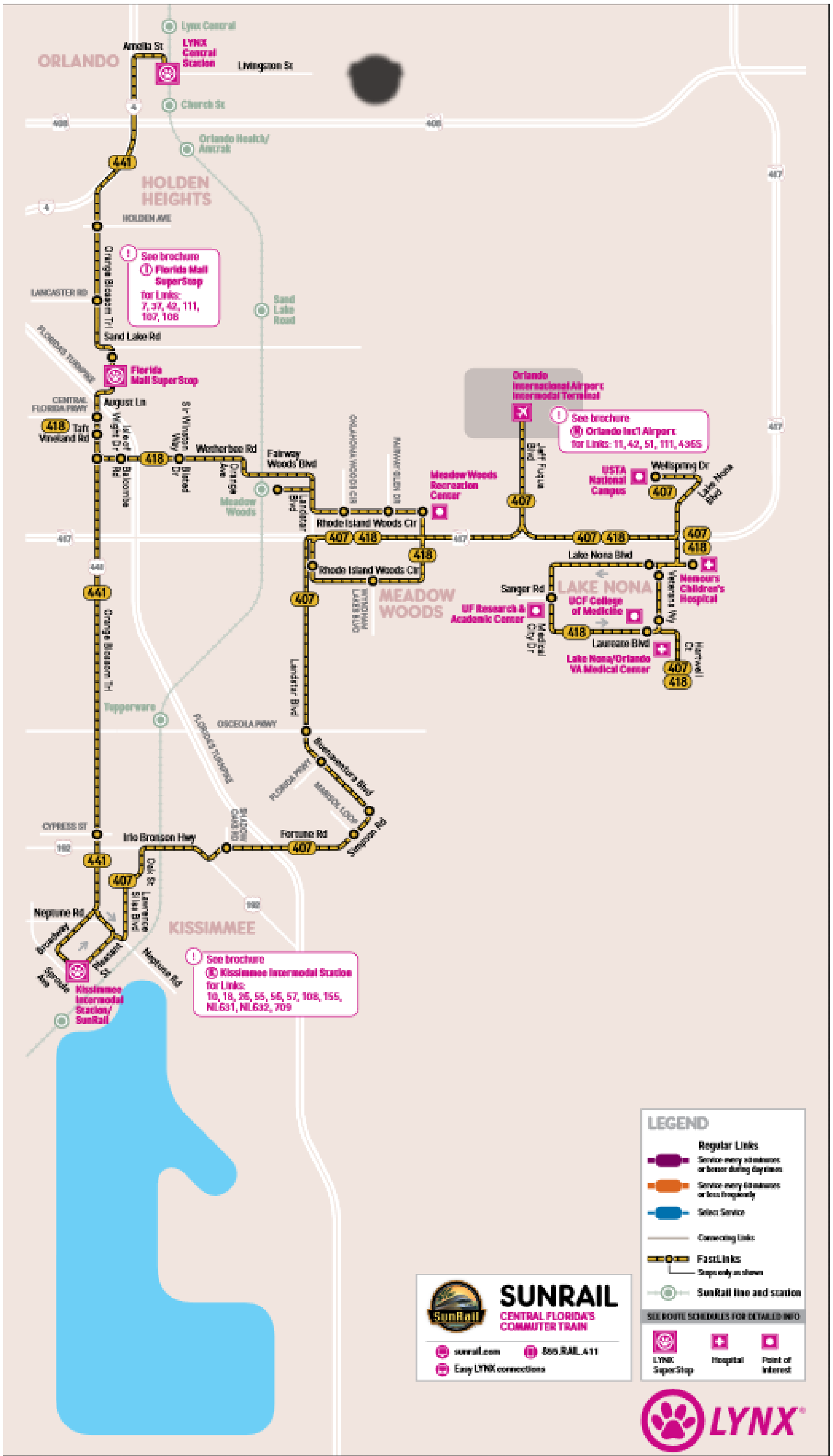


Figure XBT Orlando 2
FastLink Service Map
Source: https://www.golynx.com/core/fileparse.php/97362/urlt/LNX_Lft_FastLink_WEB.pdf
PHOENIX EXPRESS BUS TRANSIT SYSTEM

Figure XBT Phoenix 1
MetroExpress Bus
Source: https://www.youtube.com/watch?reload=9&v=qrCMTaPFKoI
Operated by Valley Metro, MetroExpress buses serve Phoenix employment hubs from far-reaching suburbs. There are 14 express lines serving Scottsdale, Tempe, Mesa, Gilbert, Chandler, Goodyear, Avondale, Buckeye, Surprise, and Glendale.[81]

[81] Adapted from: https://www.valleymetro.org/maps-schedules.

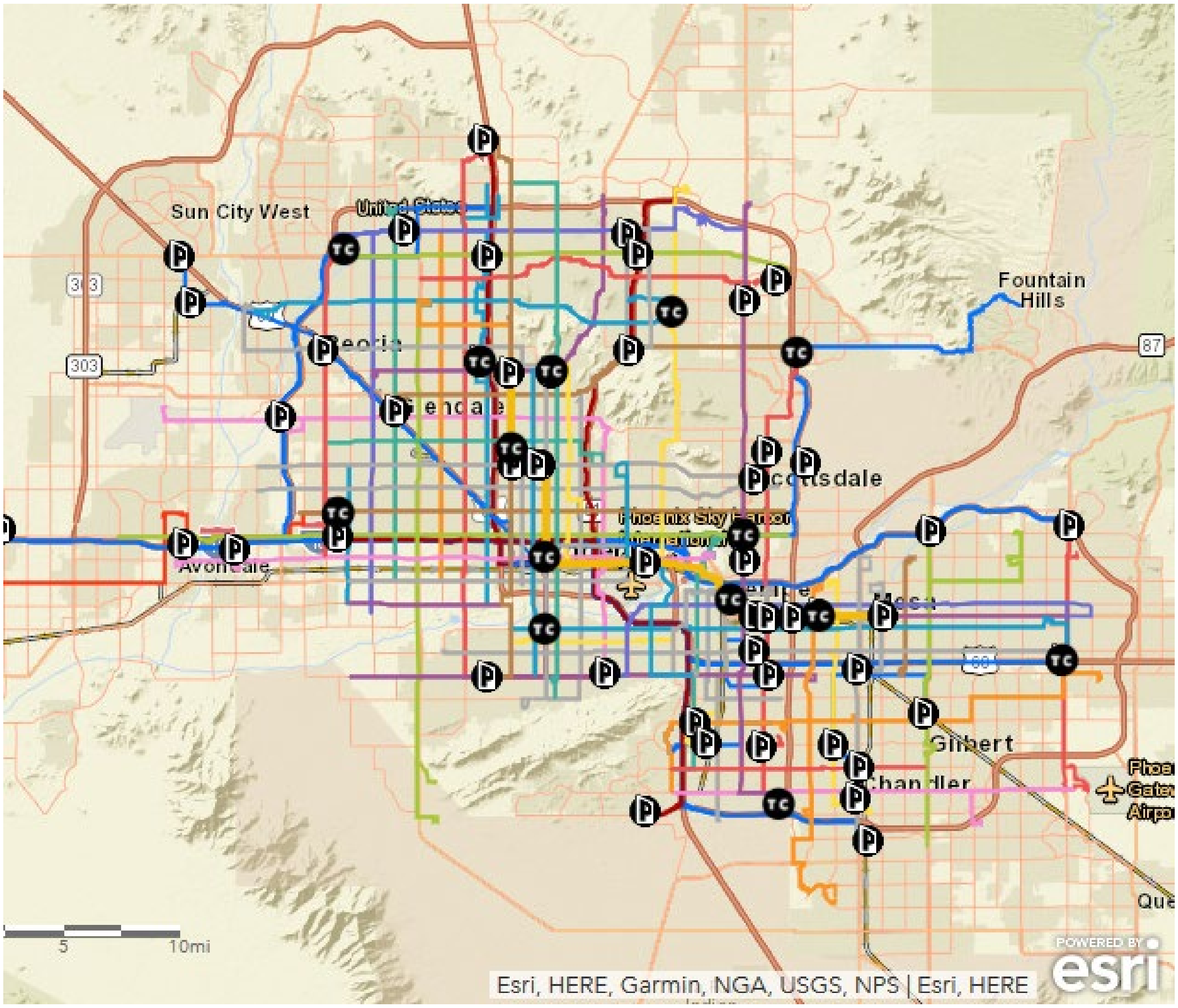


Figure XBT Phoenix 2
Valley Metro Bus System Map (express lines in royal blue)
Source: https://www.valleymetro.org/system-map

PITTSBURGH EXPRESS BUS TRANSIT SYSTEM

Figure XBT Pittsburgh 1
Flyer
Source: https://sites.google.com/site/patransit/Home
The Flyer lines operated by Pittsburgh’s Port Authority give commuters access to downtown Pittsburgh and other employment centers.[82]

[82] Adapted from: https://en.wikipedia.org/wiki/List_of_bus_routes_in_Pittsburgh.

Figure XBT Pittsburgh 2
Flyer Map
Source: http://www.portauthority.org/PAAC/Apps/maps/SystemMap.pdf

PORTLAND EXPRESS BUS TRANSIT SYSTEM

Figure XBT Portland 1
Portland Bus Rolling Stock
Source: [Source: https://trimet.org/bus/img/header.jpg](https://trimet.org/bus/img/header.jpg)
Offering rush hour service between suburban and downtown Portland, the 92-South Beaverton Express bus line offers commuters an alternative way to get to employment hubs in the downtown area.[83]

[83] Adapted from: https://trimet.org/schedules/r092.htm.

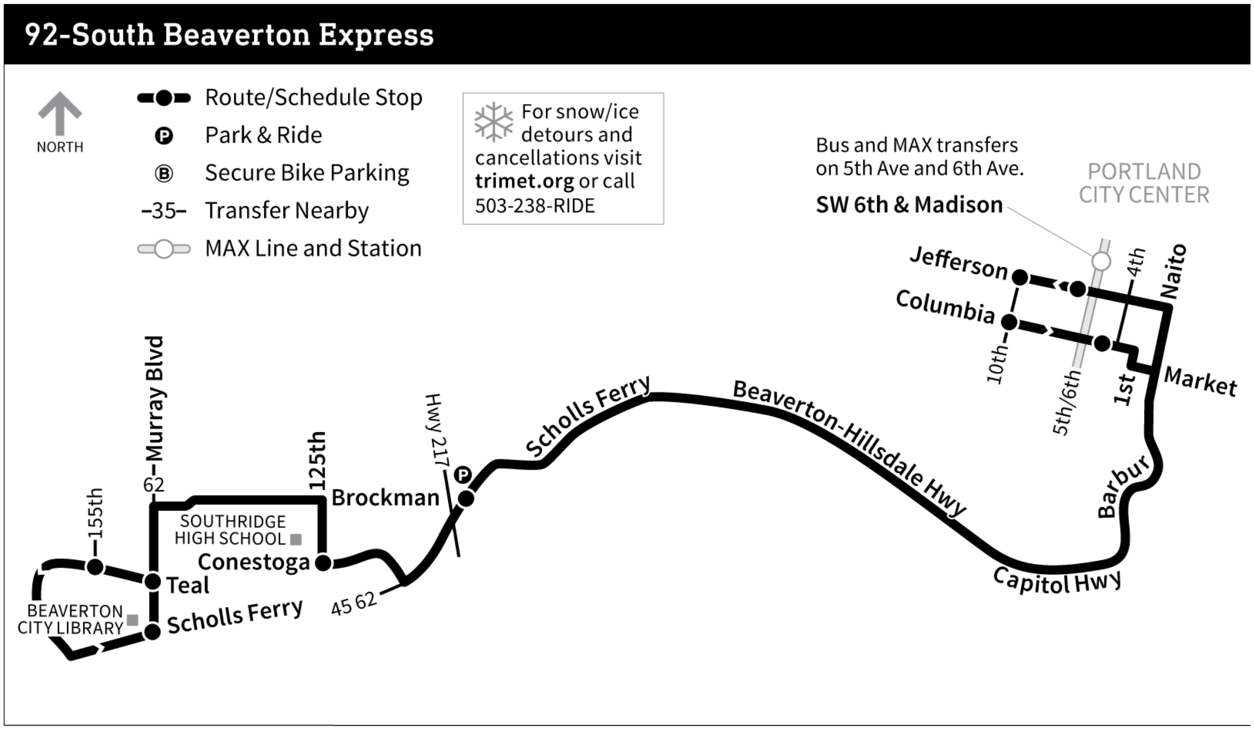


Figure XBT Portland 2
92-South Beaverton Express Map
Source: https://trimet.org/schedules/img/092.png

RENO EXPRESS BUS TRANSIT SYSTEM

Figure XBT Reno 1
Reno RTC Bus
Source: Source: https://www.flickr.com/photos/southerncalifornian/5507640309
Operating between Reno and Carson City, Nevada, the RTC Regional Connector is operated by the Regional Transportation Commission of Washoe County.[84]

[84] Adapted from: https://www.rtcwashoe.com/public-transportation/.

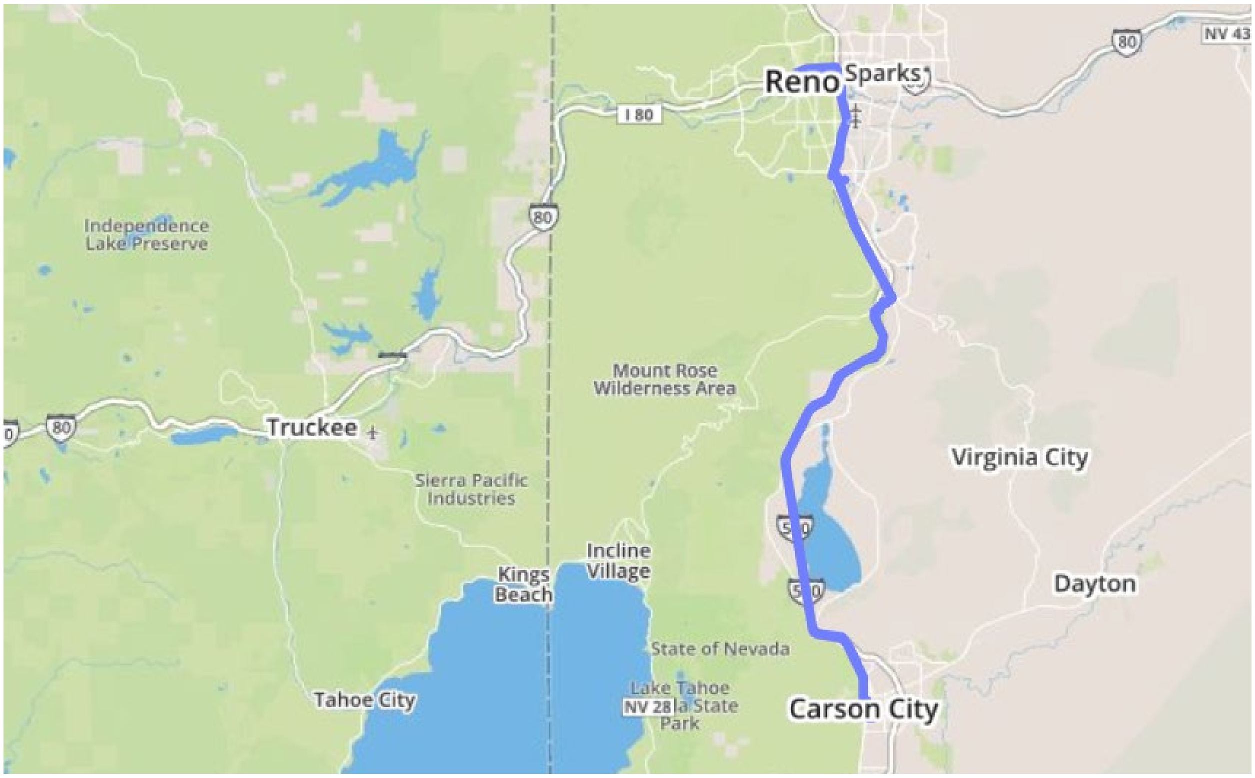


Figure XBT Reno 2
RTC Regional Connector Bus Route
Source: [Source: https://www.rtcwashoe.com/routes/rtc-intercity/](https://www.rtcwashoe.com/routes/rtc-intercity/)

SACRAMENTO EXPRESS BUS TRANSIT SYSTEM

Figure XBT Sacramento 1
SRT Bus
Source: http://www.sacrt.com/services/
Sacramento Regional Transit operates seven express bus lines. Numbered 3, 7, 109, 170, 171, 172, and 174, this system gives passengers quicker options when commuting.[85]

[85] Adapted from: http://www.sacrt.com/services/.

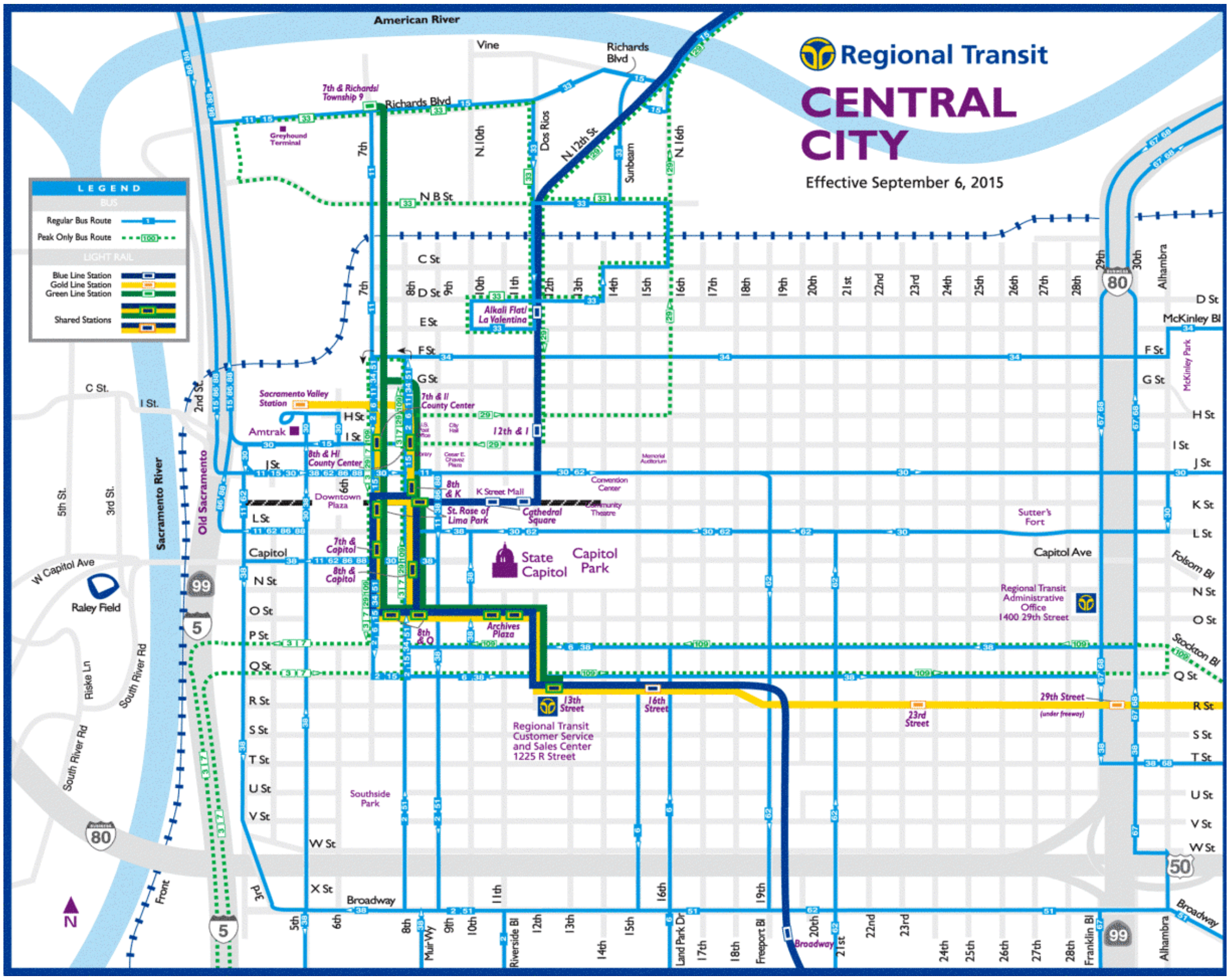


Figure XBT Sacramento 2
Sacramento Regional Transit Bus Service Map (excluding XBT lines 170, 171, and 172)
Source: http://www.sacrt.com/systemmap/central.stm

SALT LAKE CITY EXPRESS BUS TRANSIT SYSTEM

Figure XBT Salt Lake City 1
Utah Express Bus Transit
Source: https://en.wikipedia.org/wiki/MAX_(Utah_Transit_Authority)
Designed specifically for commuters, Utah Transit Authority's express bus transit service operates nine lines. The fleet is comprised of diesel, hybrid electric, and compressed natural gas buses.[86]

[86] Adapted from: http://www.rideuta.com/Services/Bus.

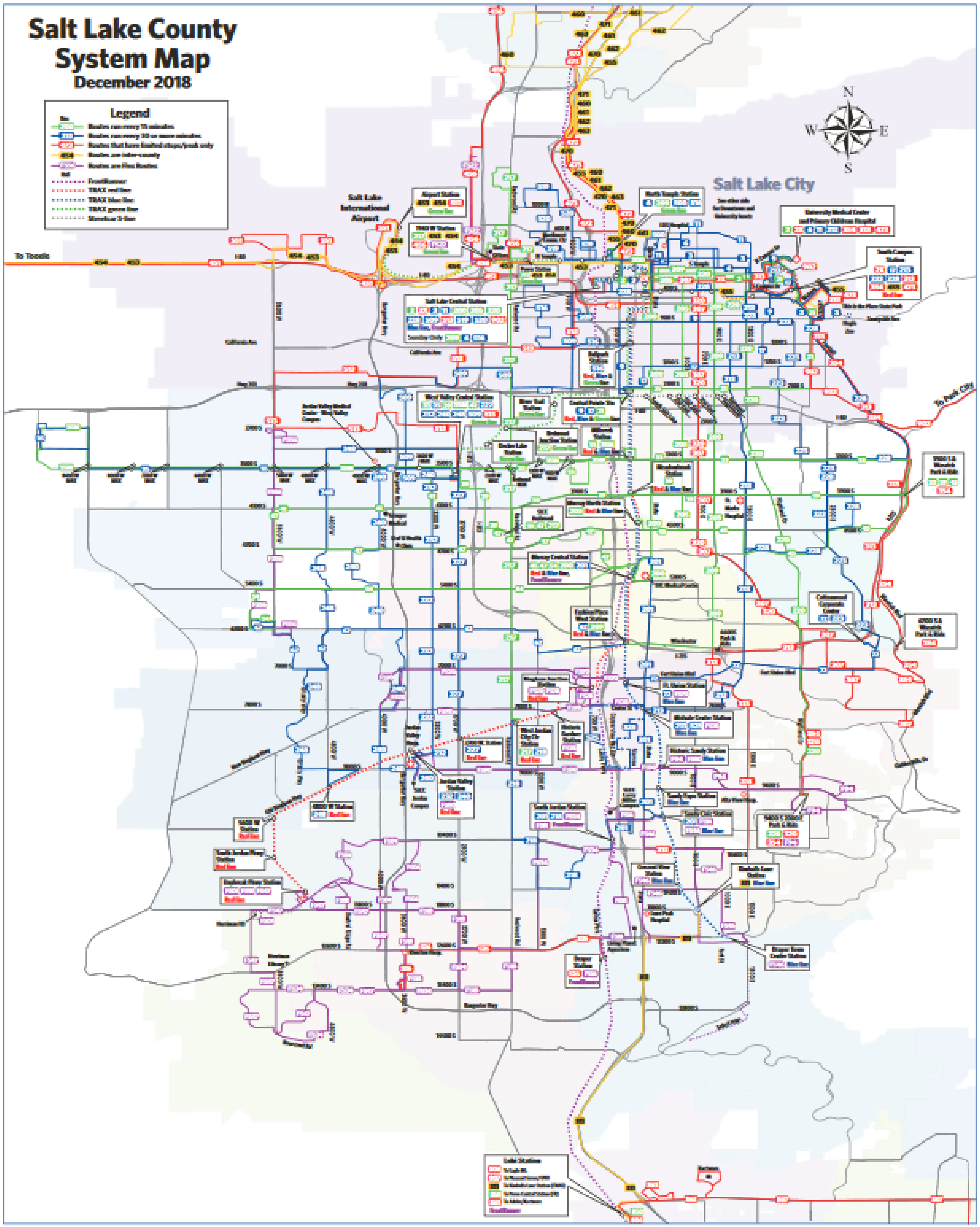


Figure XBT Salt Lake City 2
Salt Lake City Transit Service Map
Source: https://www.rideuta.com/-/media/Files/System-Maps/2018/Salt-Lake-County/Dec_2018_SL_System_Map.ashx
SAN ANTONIO EXPRESS BUS TRANSIT SYSTEM

Figure XBT San Antonio 1
VIA Express Bus
Source: [Source: https://www.viainfo.net/express/](https://www.viainfo.net/express/)
The VIA Express bus lines cater service direct to downtown with minimal stops in the San Antonio area. The suburban stations offer Park-and-Ride and there are six express bus lines.[87]

[87] Adapted from: https://www.viainfo.net/express/.

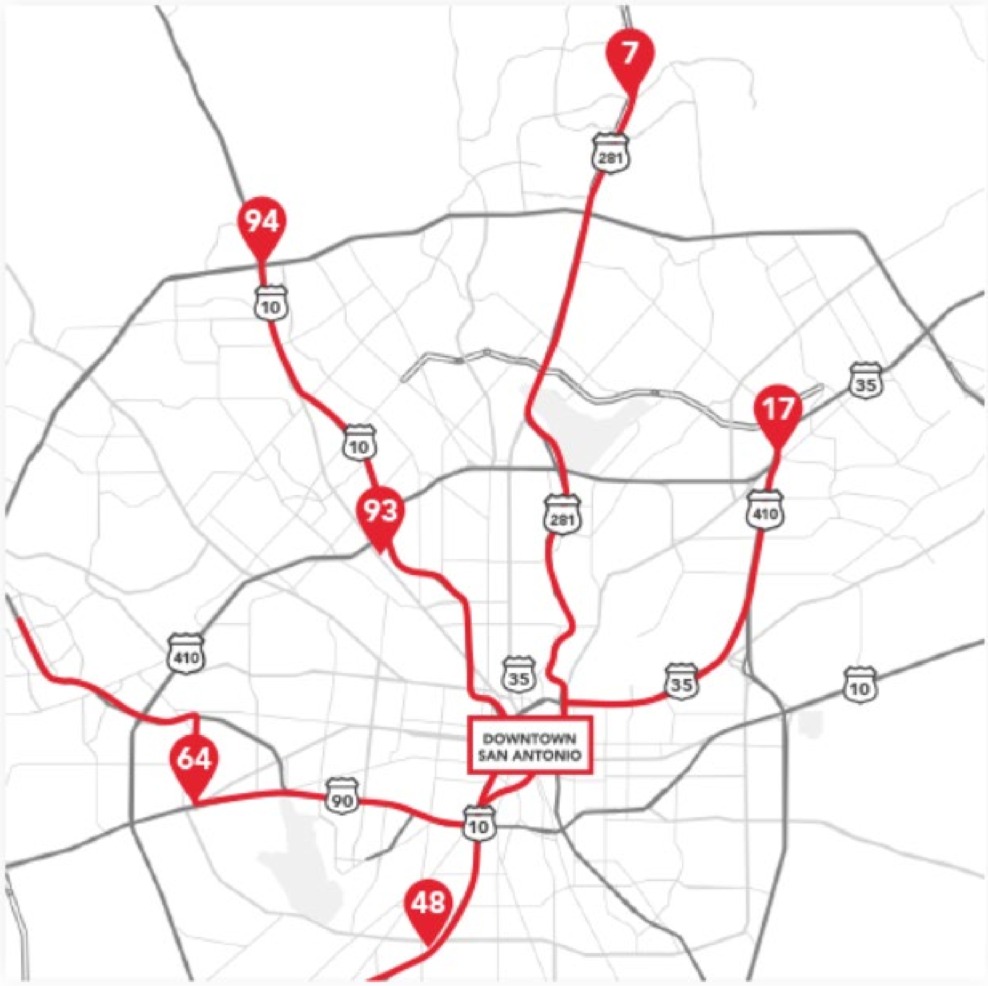


Figure XBT San Antonio 2
Express Bus Service Map
Source: [Source: https://www.viainfo.net/express/](https://www.viainfo.net/express/)

SAN JOSE EXPRESS BUS TRANSIT SYSTEM

Figure XBT San Jose 1
VTA Express Bus
Source: [Source: http://www.vta.org/Getting-Around/Riders-Tips/VTA-Express-Bus-Service](http://www.vta.org/Getting-Around/Riders-Tips/VTA-Express-Bus-Service)
Offering free Wi-Fi, reading lights, reclining seats, and footrests, Santa Clara Valley Transit Authority's Express Bus Lines are rapidly expanding to offer alternative commute transportation to many people in the San Jose area.[88]

[88] Adapted from: http://www.vta.org/Getting-Around/Riders-Tips/VTA-Express-Bus-Service.

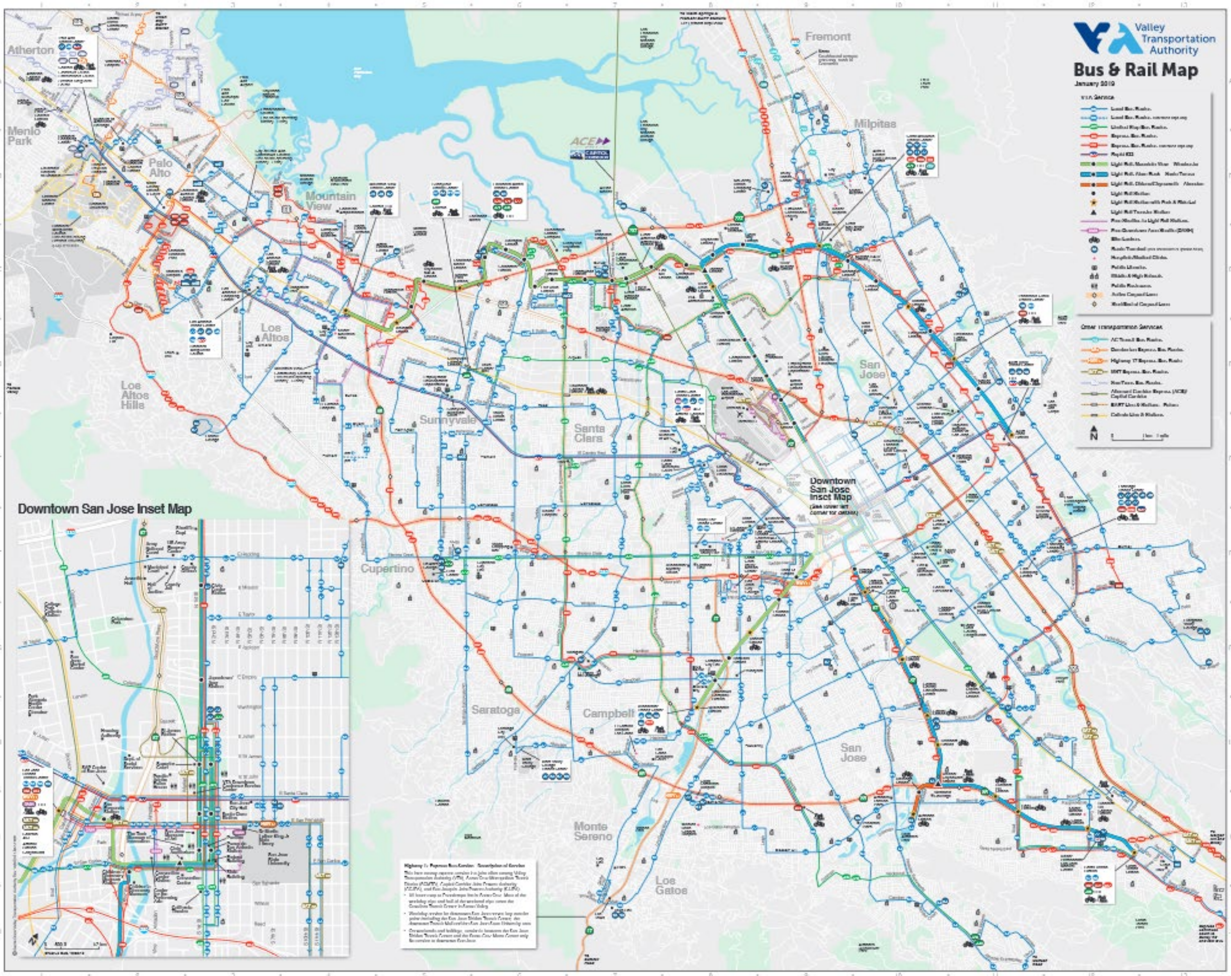


Figure XBT San Jose 2
VTA Bus and Rail Map
Source: http://www.vta.org/sfc/servlet.shepherd/document/download/069A0000001cwcWIAQ

SEATTLE – TACOMA EXPRESS BUS TRANSIT SYSTEM

Figure XBT Seattle 1
Seattle – Tacoma XBT
Source: https://seattle.curbed.com/2018/1/17/16902734/sound-transit-express-bus-fare-changes

Called route 590, SoundTransit operates an express bus transit line between Seattle and Tacoma. With several stops, it takes approximately 2 hours to travel the entire distance from the north end of Seattle to Tacoma, Washington. [89]

[89] Adapted from: https://www.soundtransit.org/schedules/route/40_590/at/1552945344721/direction/0/from/null.

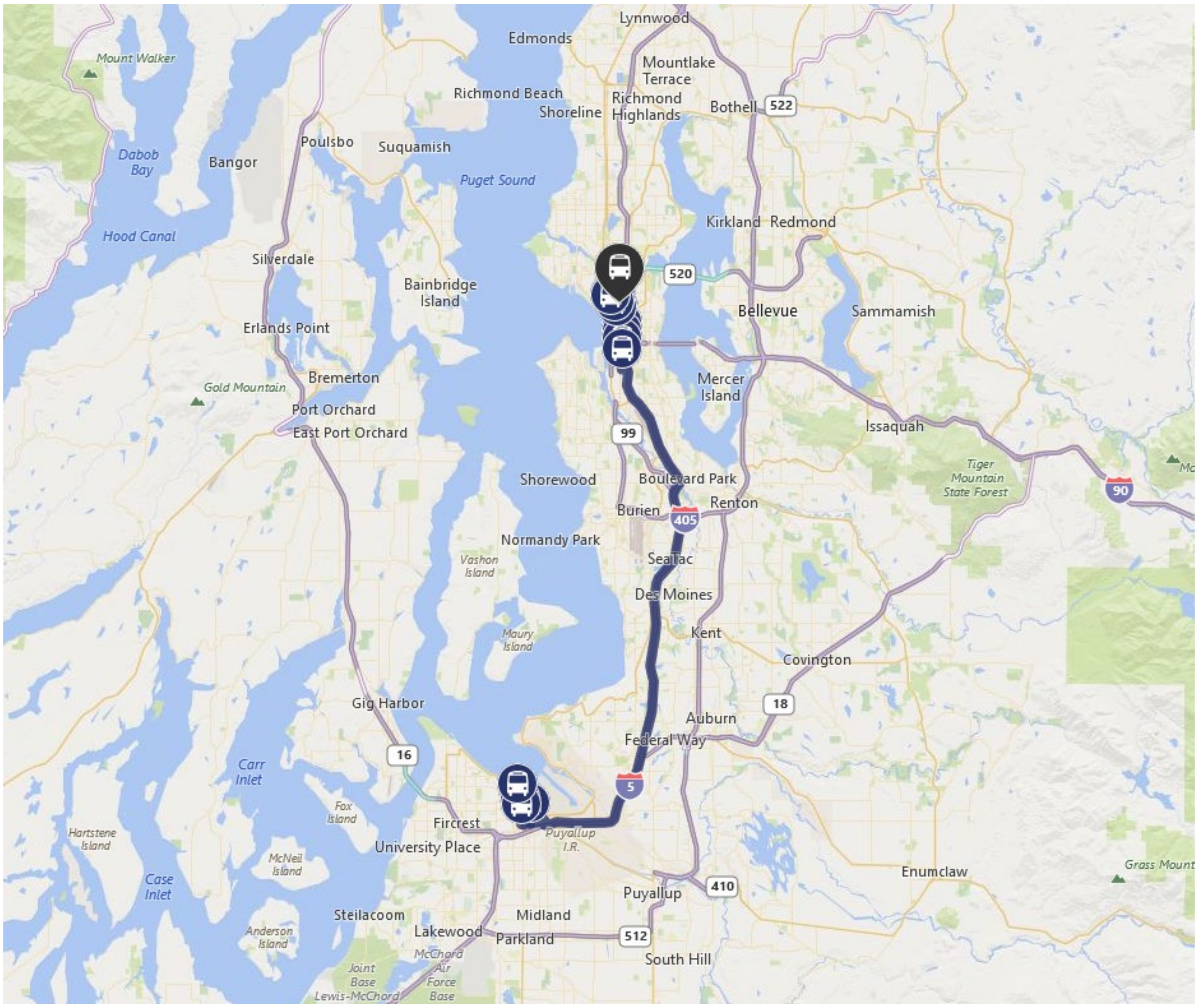


Figure XBT Seattle 2
Route 590 Map
Source:
https://www.soundtransit.org/schedules/route/40_590/at/1552945344721/direction/0/from/null

ST. LOUIS EXPRESS BUS TRANSIT SYSTEM

Figure XBT St. Louis 1
St. Louis XBT
Source: https://www.metrostlouis.org/nextstop/metro-transit-records-biggest-bus-ridership-increase-in-the-nation-among-large-bus-systems/
Metro St. Louis operates four express transit lines in the region: the Interstate 55 Express, Twin Oaks Express, North Express, and Eureka Express. [90]

[90] Adapted from: https://www.metrostlouis.org/metrobus/.

Figure XBT St. Louis 2
St. Louis Transit System Map
Source: https://www.metrostlouis.org/wp-content/uploads/2016/02/SystemMap2017.jpg

TACOMA EXPRESS BUS TRANSIT SYSTEM

Figure XBT Tacoma 1
Pierce Transit Bus
Source: Source: https://en.wikipedia.org/wiki/Pierce_Transit
Serving Pierce County, Washington, which includes the cities of Tacoma and Lakewood, Pierce Transit operates three Express Bus Transit lines.[91]

[91] Adapted from: https://www.piercetransit.org/pierce-transit-routes/.

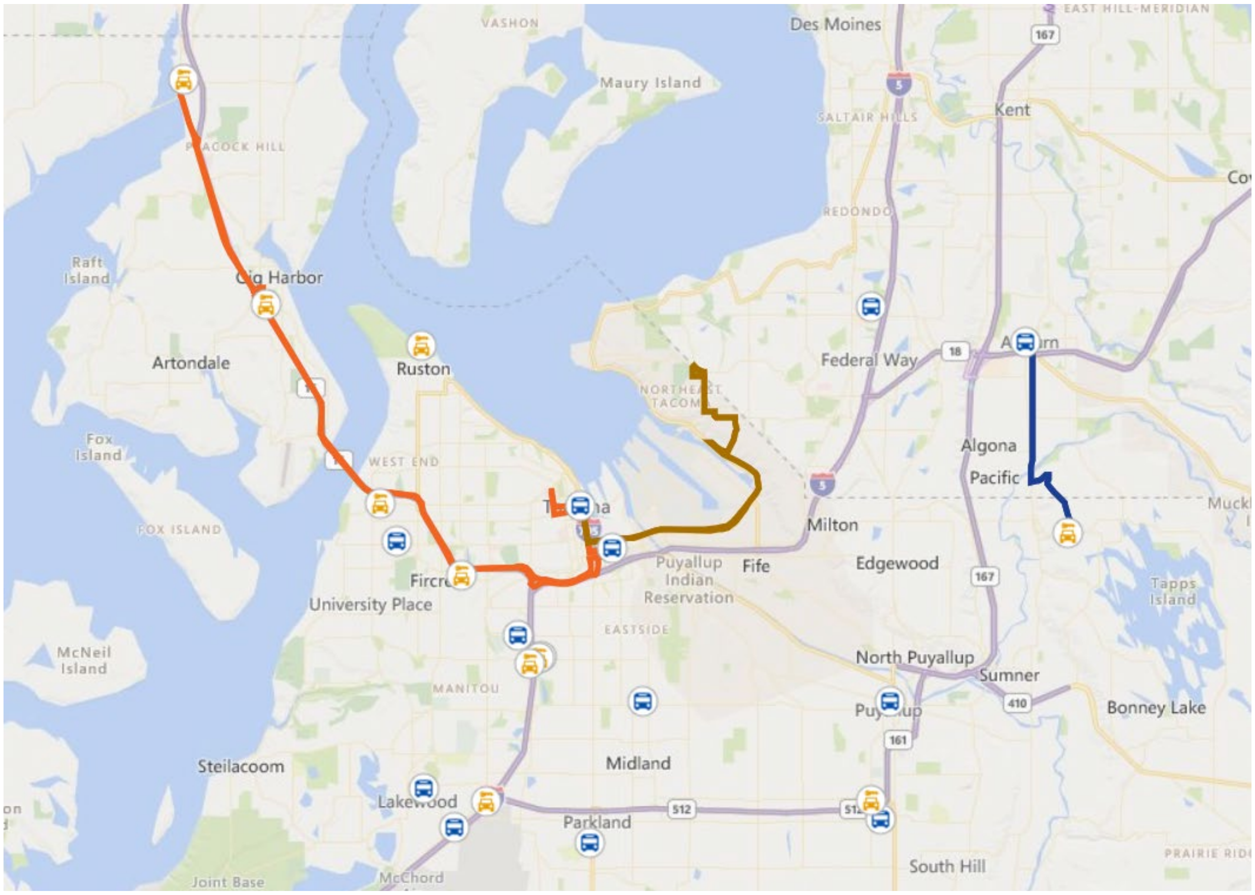


Figure XBT Tacoma 2
Pierce Transit Express Bus Lines
Source: [Source: https://piercetransit.maps.arcgis.com/apps/webappviewer/index.html?id=5e122c82aab449f9acf4ce14b596d394](https://piercetransit.maps.arcgis.com/apps/webappviewer/index.html?id=5e122c82aab449f9acf4ce14b596d394)

TUCSON EXPRESS BUS TRANSIT SYSTEM

Figure XBT Tucson 1
SunExpress XBT Service
Source: https://tucson.com/news/local/govt-and-politics/sun-tran-introduces-new-look-strategies-to-make-travel-easier/article_d8ea6d7a-c16d-5b22-b005-dc40fdc79882.html
With limited stops from outlying suburbs, SunTran's SunExpress line makes commuting hassle-free for many riders each day. The line has 12 routes with differing destinations and originations. It operates Monday through Friday during peak hours only.[92]

[92] Adapted from: https://www.suntran.com/commuter_express.php.

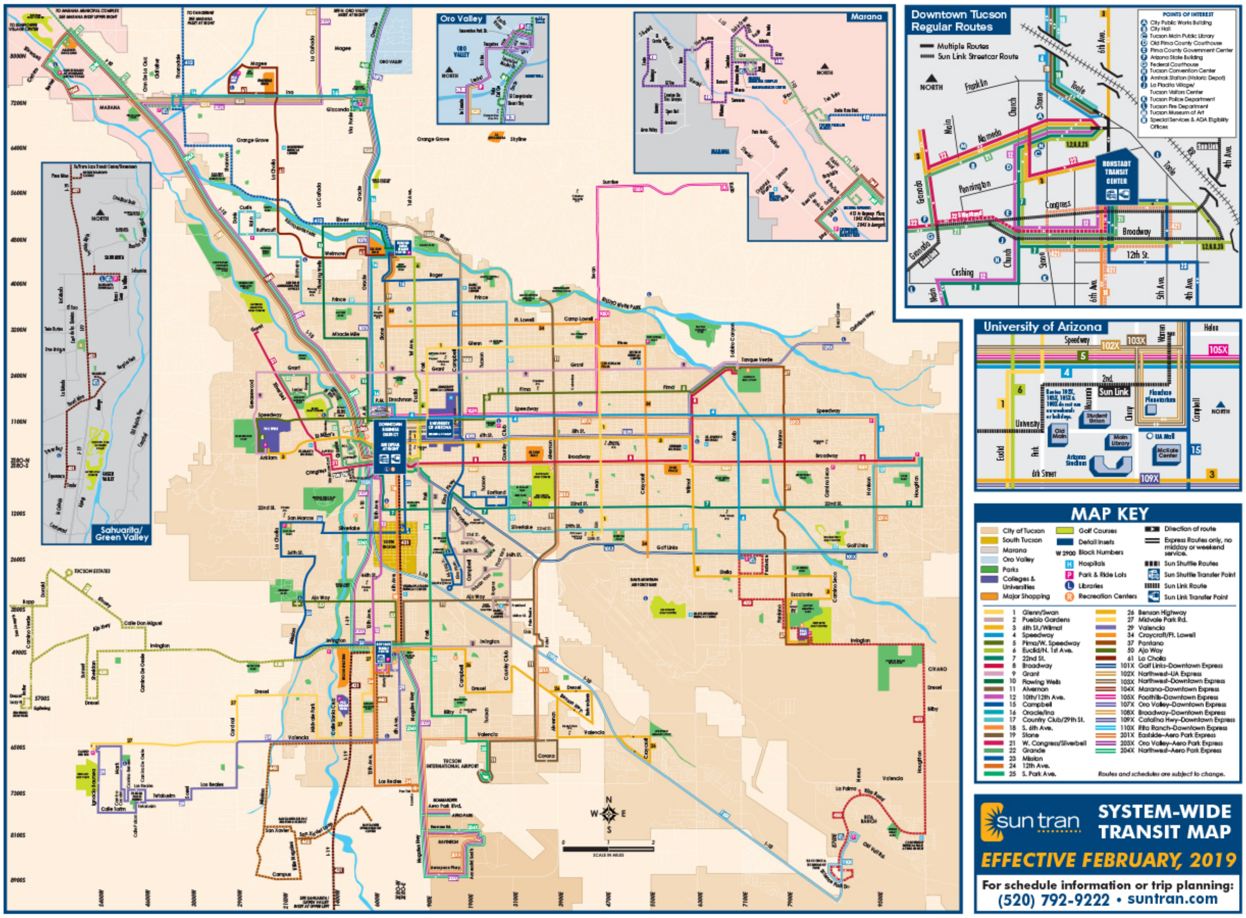


Figure XBT Tucson 2
Tucson Bus Service Map
Source:
https://infoweb.suntran.com/FILE/Apps/FixedRoute/CustomerInfo/images/systemmap.jpg

WASHINGTON, D.C. EXPRESS BUS TRANSIT SYSTEM

Figure XBT Washington, DC 1
Metro Express XBT
Source: https://www.metro-magazine.com/sustainability/news/411615/d-c-metro-debuts-cng-buses-for-the-holidays

The Metrobus Express service is Washington, D.C.'s express bus system. It provides an estimated time savings of 15-20% for all riders. Limited stops on the line mean less time spent in traffic. [93]

[93] Adapted from: https://ddot.dc.gov/page/metrobus-express-service.

Figure XBT Washington, DC 2
Metro Express Bus Service Map
Source: https://www.wmata.com/service/bus/metroextra.cfm

APPENDIX A – HRT

HEAVY RAIL TRANSIT SYSTEMS (reserved for future analysis)

Heavy Rail Transit Systems Metro Area & Name	Year	Miles	Stations	Riders (Daily)
Atlanta: MARTA Heavy Rail	1975	48	38	231,700
Miami: Metrorail	1984	24.4	23	67,000
Washington, DC: Washington Metro	1976	117	91	612,652

ATLANTA HEAVY RAIL SYSTEM

Figure X
Atlanta Heavy Rail
Source: https://www.wabe.org/unprecedented-gwinnett-transit-plan-includes-heavy-rail/

The heavy rail system in Atlanta, Georgia consists of 48 miles of track, a fleet of 338 rail cars, and service to 38 stations within Fulton, Dekalb, and Clay counties including the city of Atlanta. The heavy rail system in Atlanta operates at less than or equal to 10 minutes between trains during peak travel times and can take up to 576 passengers in one six-car train. The heavy rail service operates for 21 hours a day every day of the week. [94]

[94] Adapted from: https://www.itsmarta.com/uploadedfiles/10.04.18_ServiceStandardsFY19_BoardApproved.pdf

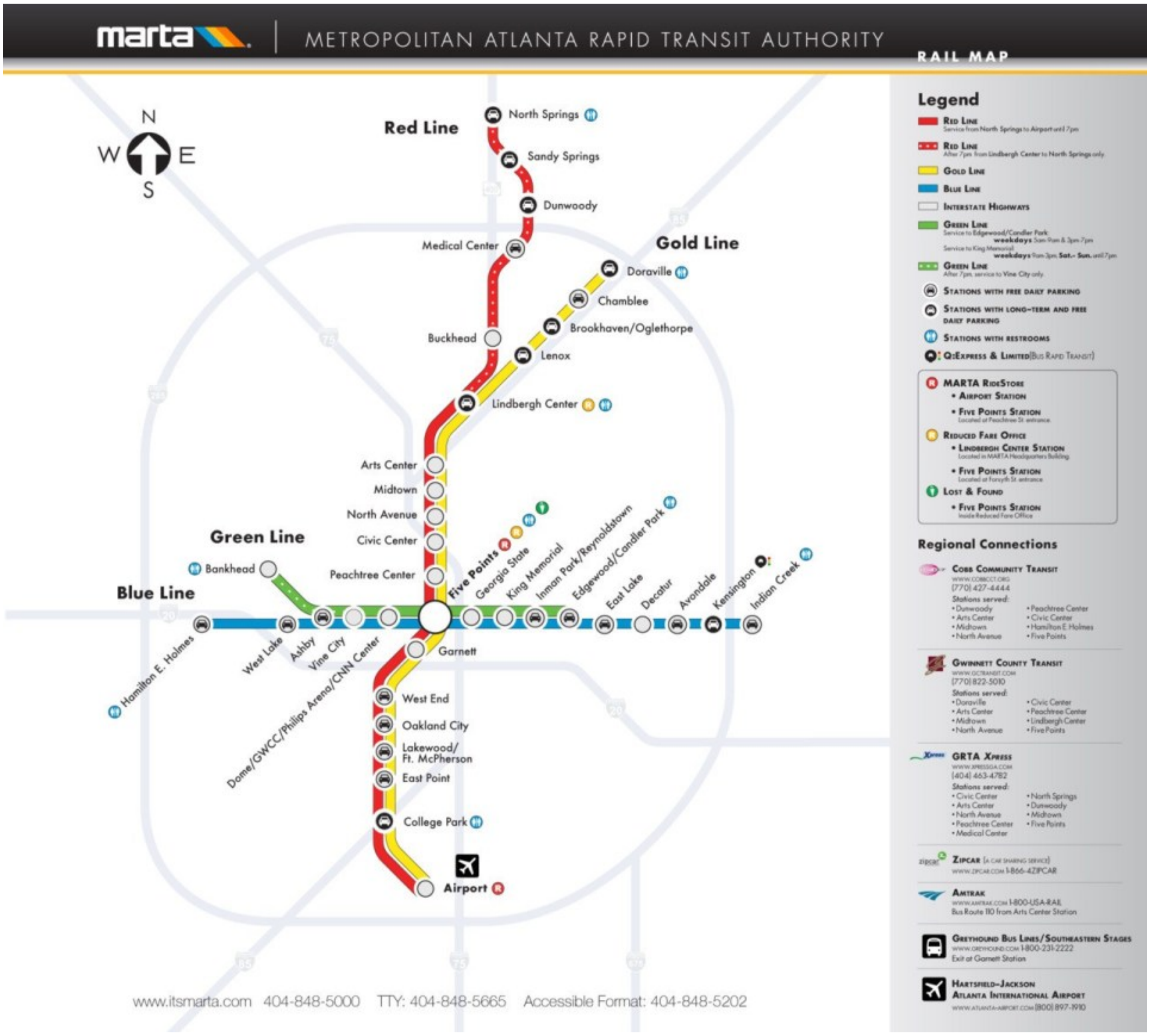


Figure X
Atlanta Heavy Rail Service Map
Source: https://www.transitmap.net/marta-atlanta/

MIAMI HEAVY RAIL SYSTEM

Figure X
Miami Metrorail
Source: http://www.subways.net/usa/florida/miami.html
The Metrorail, opened in 1984, is Florida’s only heavy rail system, and its only rapid rail commuter system. In its 24.4 miles of track, it has 23 stations and serves approximately 67,000 people per day. Metrorail links the Miami International Airport, the Miami Civic Center, Downtown Miami, and Brickell with extensions to northern and southern neighborhoods. With a top speed of 58 miles per hour, the Metrorail typically travels at about 27-31 miles per hour.[95]

[95] Source: https://en.wikipedia.org/wiki/Metrorail_(Miami-Dade_County)

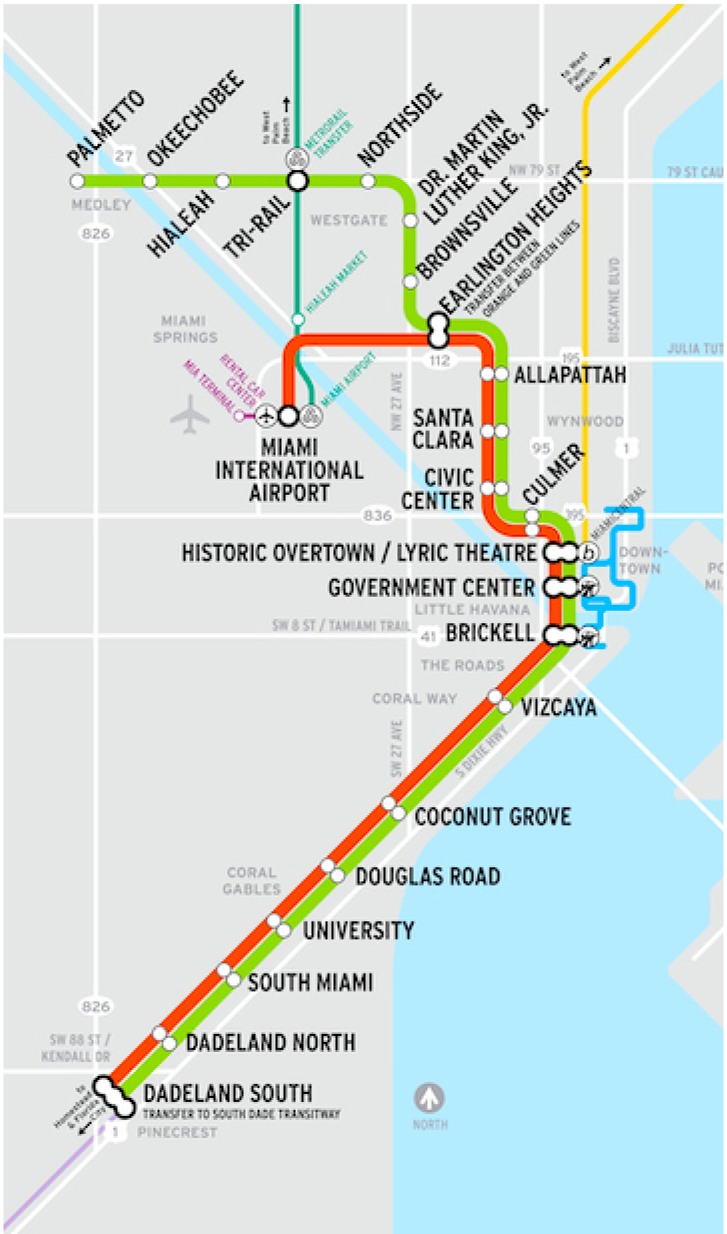


Figure X
Metrorail Service Map
Source: https://www8.miamidade.gov/transportation-publicworks/metrorail-stations.asp

WASHINGTON, D.C. HEAVY RAIL SYSTEM

Figure X
Washington Metro
Source: https://washington.org/find-dc-listings/washington-metropolitan-area-transit-authority
Cocooned in a series of brutalist stations, Washington D.C.'s Metro serves the D.C. metro area in Maryland, Virginia, and within Washington, D.C. This system carries a staggering 612,652 people on a daily basis, with service from 5:00 AM to 1:00 AM depending on the day. Metro has 6 lines serving 91 stations in the tri-state area, with seven additional stops under construction. Metro began operation in 1976.[96]

[96] Adapted from: https://en.wikipedia.org/wiki/Washington_Metro#Hours_and_headways.

Figure X
Washington Metro Service Map
Source: https://washington.org/navigating-dc-met

APPENDIX B: Developing Place Typologies for Transit Analysis[97]

Annotated Bibliography

The studies included here incorporate the designation of TOD typologies (or complimentary TOD studies). References from additional studies may be incorporated in the main text even if they are not included in this bibliography. The references are at the end of this appendix.

Agencies

Puget Sound Regional Council, Washington (2013-2014)

References: (Puget Sound Regional Council; City of Bellevue; King County Metro, 2013, 2014; Sound Transit, 2014)

Transit System: 74 transit communities in Puget Sound including (aggregated) light rail, bus rapid transit and commuter rail (both existing and planned).

Purpose of Typology:

Types of Use: Agency; Strategy Identification & Implementation; Prioritization; Evaluation;

Findings & Outcomes:

Strategy development using place and people 'screens'

Established to support various 'implementation approaches'—bundled strategies depending on the context of place and people. This approach was developed in recognition of unique needs across different transit communities. The 'toolkit' of strategies that support each of the 8 implementation approaches provide a range of complementary options based on the unique needs and situation of the communities.

Place is a two-dimensional set of categories expressing the Physical Form + Activity/Transit-Orientation (lower or higher) and change/market strength (weaker or stronger).

People is a two-dimensional set of categories expressing the social infrastructure/access to opportunity (limited or good) and change/displacement risk (low, potential, immediate).

Note:

The white paper from October 2014 completed for Sound Transit provided an issue paper on regional land use and transit planning. This document did not specify any Puget Sound analysis on station typologies, and in fact referenced the TCRP paper that included such. Instead, this document provides guidance for the ways in which high-capacity transit planning might be integrated with other forms of land use planning at a variety of scales.

[97] We are pleased to acknowledge invaluable assistance in preparing this appendix as well as Chapter 1 by Nicole Iroz-Elardo.

Method for Aggregating Typology:
The authors developed an equally weighted index for the supporting variables within each category. The index was then split into subcategories (such as 'lower or higher' or 'weaker or stronger') based on a combination of (a) natural breaks in the data distribution and (b) discussions with technical committees and decision-makers who are more familiar with the specific stations and locations. Minor adjustments were made for stations at the border of category thresholds.
Categories & Supporting Variables or Definitions:
The authors and technical teams recognized that typologies that rely on place alone ignore the broader context of the locations and markets. That's why a 'people' screening was included. The following tables and graphics were pulled from the Appendix D document (Puget Sound Regional Council; City of Bellevue; King County Metro, 2014).
Page 7

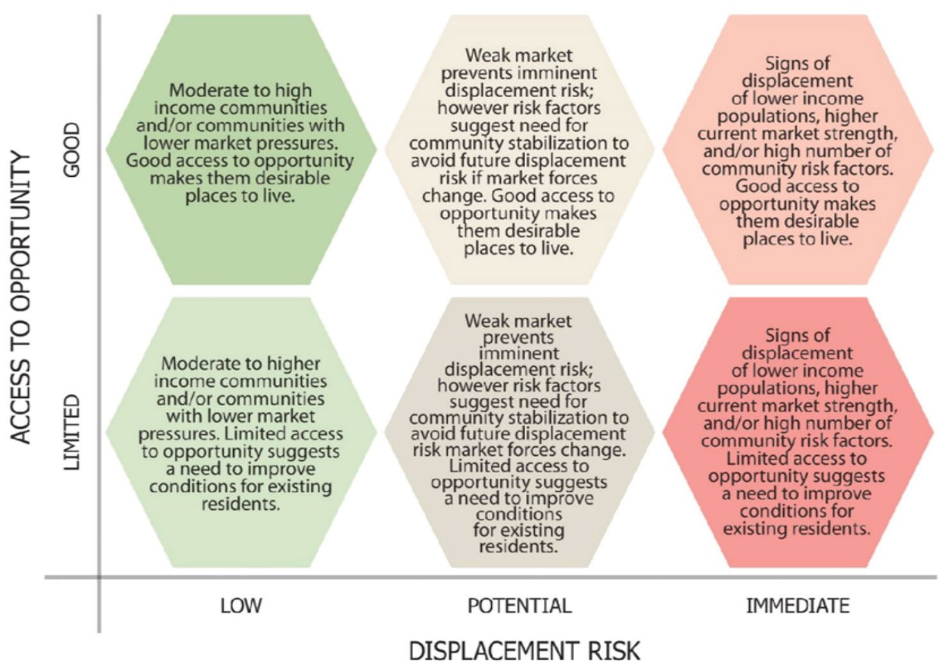


Figure 4: People Profile Community Descriptions

Page 15

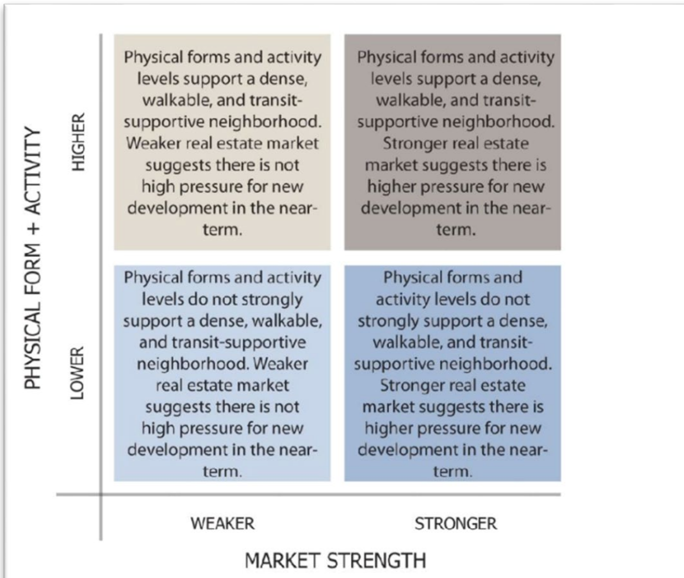


Figure 8: Place Profile Community Descriptions

Page 8 access to opportunity

INDICES	INDICATORS	DATA SOURCES
Access to quality education measures the quality of the elementary and high school resources within, or in close proximity of the study area	• Fourth grade WASL scores for math • Fourth grade WASL scores for reading • Percentage of elementary school students receiving free or reduced lunch • Percentage of elementary school teachers with a master's degree or higher • High school graduation rate	Washington State Report Card, Office of Superintendent of Public Instruction (OSPI), 2010-2011 school year (Data comes from the 3 schools closest to the census tract)
Economic health measures the access to employment opportunities for residents of the study area	• Number of living wage jobs within a 15-minute auto commute or 30-minute transit commute of the study area • Unemployment rate	Puget Sound Regional Council Travel Model (Traffic Analysis Zone (TAZ)) and Covered Employment Estimates. "Searching For Work That Pays", Report from Alliance for a Just Society, 2008-2010; American Community Survey, 2010
Housing and neighborhood quality measures the condition of housing and neighborhood attributes that contribute to a sense of safety and security	• Housing vacancy rate • Estimated housing foreclosure rate • Estimated rate of subprime mortgages • Housing conditions regarding overcrowding and presence of plumbing facilities • Estimated crime rate based on personal and property crimes relative to total population	US Census, 2010; HUD, 2010; Tetrad Computer Applications, Inc. 2010
Mobility and transportation measures the access and availability of affordable transportation choices	• Cost of the average auto commute to work from study area at $0.50 per mile • Percentage of study area within ¼ mile of express bus stops (15 min headways, peak hours) • Average transit fare for commute to work from study area • Percentage of commute trips by walking	Puget Sound Regional Council Travel Model, 2010; PSRC data collected from Transit Agencies, 2008-2010; American Community Survey, 2010
Health and environment measures the degree to which the community's attributes promote or diminish physical health	• Number of acres of parks or open space within the study area • Proximity of study area to toxic waste emitting location • Percentage of the study area that is in a 'food desert' without access to retail selling fresh and healthy groceries	PSRC, 2006; EPA, 2010; PSRC Food Policy Council & UW Report 2011

Page 11 displacement risk data

MEASURES	INDICATORS	DATA SOURCES
Community risk factors suggest whether or not a community may be at risk for displacement in the future	• Current median income • Percentage of renters • Percentage minority • Percentage of cost-burden households (>30% of income toward housing)	• ACS (2006-2010) • ACS (2006-2010) • U.S. Census 2010 • ACS (2006-2010)
Residential real estate **market strength** may predict near term growth pressure	• Residential market strength index	• Strategic Economics (2012)
Indicators of **recent change** measure the extent to which displacement is or is not already occurring	• Change in median income (2000-2010) • Change in percentage with BA (2000-2010) • Change in percentage of non-family households (2000-2010)	• U.S. Census 2000 and ACS (2006-10) • U.S. Census 2000 and ACS (2006-10) • U.S. Census 2000 and 2010
Additional information about the community may provide important understanding of why change may be occurring	• 2010 population • 2000-2010 new housing units permitted • Light rail planning and development status	• U.S. Census 2010 • PSRC, 2000-2010

Notes: Recent trends in income, educational attainment, and household status are derived from a comparison of data for selected blocks and block groups that approximate the 74 study areas. Minor differences in geography exist between the 2000 and 2010 Census, most recent American Community Survey (ACS) data, and block groups. All ACS data represents an average over the 2006-2010 reporting period. Income figures have been controlled to 2010 dollars.

Page 16 physical form + activity data

INDICES	INDICATORS	DATA SOURCES
Pedestrian connectivity measures the degree to which the community has the infrastructure to support high pedestrian activity	• Estimated percentage of existing road network with sidewalk coverage on at least one side of the road.	PSRC, WSDOT, Community Transit, Cities of Bellevue, Lynnwood, Mountlake Terrace, Shoreline, Seattle, Mercer Island, Bellevue, Redmond, Tacoma, and Tukwila.
Transit **performance** measures the availability of core and high capacity transit service within the community	• Total number of weekday daily core and high capacity transit runs through the study area • Total number of non-peak (midday, after 7pm, all day Saturday and all day Sunday) runs through the study area	PSRC, Metro, Community Transit, Everett Transit, Sound Transit, and Pierce Transit.
Physical form measures the degree the physical structure of the street grid supports smaller scale land-uses, and walking and biking activity	• Average block size in acres • Percentage of study area within the half-mile walkshed	PSRC, U.S. Census
Population measures the level of activity of people in the study area	• Total number of people living in the study area • Total number of covered jobs in the study area • Total number of full-time students enrolled at colleges or universities within the study area	2010 Census; PSRC; Washington State Employment Security Dept.; PSRC
Proximity measures the availability of a mix of uses that support a vibrant, walkable community	• Total number of retail and food service workplaces within study area	PSRC; Washington State Employment Security Dept.

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Table 6: Market Strength Data Measures

MEASURES	INDICATORS	DATA SOURCES
Real Estate Market measures provide insight into existing and future market strength.	• Planned and proposed new housing units • Home sales • Apartment rents and vacancy rates • Condominium sales price	Units in pipeline: 2012 – 2014 Dupre and Scott; Gardner Economics Home sales: 2005-2012 Dupre and Scott; Gardner Economics Rental data: 2012 Dupre and Scott; Gardner Economics
Employment patterns measures of proximity to employment as a major factor influencing residential demand.	• Commute distance to major employment centers • Employment density (current and change over time)	U.S. Census Longitudinal Employer-Household Dynamics Data (2009) 2000, 2010 State of Washington; PSRC
Density measures indicate market strength for and community acceptance of multifamily or compact housing.	• Household density • Current inventory housing unit density	2010 U.S. Census; PSRC 2012 Dupre and Scott; Gardner Economics
Several **household characteristics** are correlated with stronger demand for new residential development, especially around transit.	• Household income • Household size	American Community Survey (2005-2009); PSRC

Other Notes:
Page 51 “Many station area typologies developed in other regions have described the current or aspirational physical characteristics of different transit communities. An implementation typology, on the other hand, classifies transit communities according to the types of strategies that will be most meaningful to help achieve desired outcomes.”
Implementation approach categories
Emerging or strong real estate demand, capitalize on potential in investing in housing, employment and public amenities, increase equity and opportunity
Protect and grow
Expand housing choices
Improve access
Transform and diversify
Medium- to long-term growth potential based on current market demand, focus on the market catalysts, long-range planning, economic/community development
Stimulate demand
Build urban places
Enhance community
Regional job centers where residential growth is limited, but access for jobs is important
Preserve and connect

St. Louis, Missouri (2013)
References: (Design Workshop, 2013)
Transit System: considers full set of modes from ‘high-capacity regional rail and bus’, to BRT and local-serving bus. Distinguishes between local and regional; high-capacity; high/low frequency.
Purpose of Typology:
Types of Use: Agency; Design or Land Use; Common Vocabulary; Strategy Identification & Implementation
Findings & Outcomes: categories are used to recognize how TODs vary across a region, partially used to categorize design typologies
Method for Aggregating Typology:
Notes: No methodology was discussed. It appears these general descriptions may have been pulled from other network design typologies elsewhere.
Categories & Supporting Variables or Definitions:
Notes: Categories from top to bottom of the table generally indicate the intensity level from high to low. The following table is from Chapter 4 in the plan (Design Workshop, 2013, p. 63). All serve transit types “Special, LRT, BRT, Commuter rail, express and local bus hub” at varying levels.

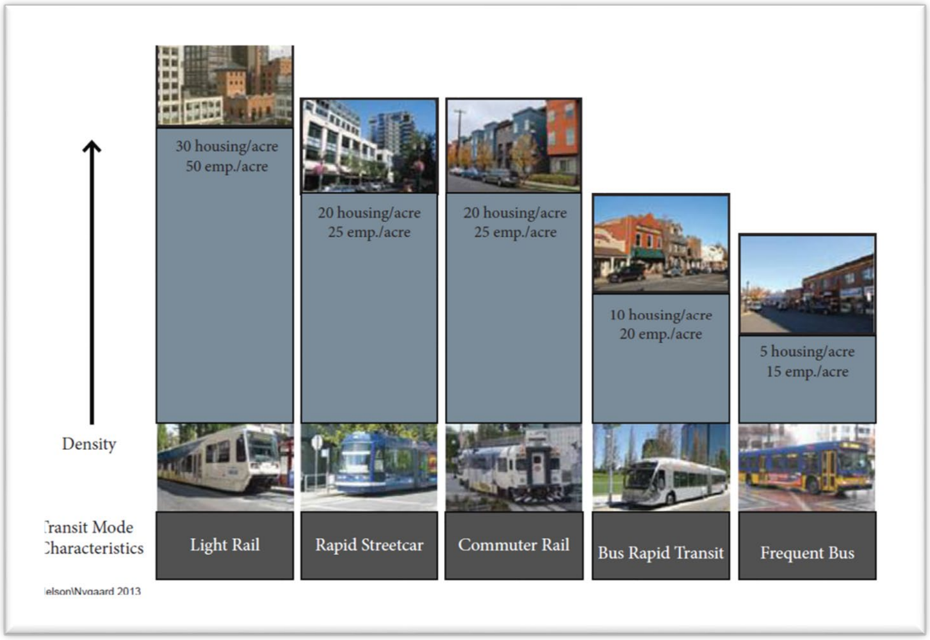
DESIGN GUIDELINES MATRIX

	1	2	3	4	5
	Downtown	Major Urban Center	Suburban Town Center	Neighborhood	Campus/ Special Event
	Commuter Rail/LRT/BRT	Local Bus Hub	Commuter Rail/LRT/BRT	Local Bus Hub	LRT/BRT
DENSITY					
Residential Density Dwelling Units per Acre	25-45 Dwelling Units/Acre	30-60 Dwelling Units/Acre	30-40 Dwelling Units/Acre	20-30 Dwelling Units/Acre	30-40 Dwelling Units/Acre
Employment Density- Employees per Acre	260-435 Jobs/Acre	125-250 Jobs/Acre	40-80 Jobs/Acre	20-30 Jobs/Acre	40-60 Jobs/Acre
Gross Population Density	325-545 Persons/Acre	200-395 Persons/Acre	100-200 Persons/Acre	50-90 Persons/Acre	100-200 Persons/Acre
INTENSITY OF USE					
Average Floor Area Ratio (FAR)	3.0-5.0	2.0-4.0	2.0-3.0	1.0	1.0
Average Building Height	4 or more stories	3 or more stories	2.5 or more stories	2 stories	3 stories
Minimum Lot Coverage	70%-80%	70%	60%	50%	70%
Minimum Street Coverage	100% primary, 80% secondary	80%	70%	60%	60%
PARKING					
Maximum Residential Parking (Spaces per Unit)	1 Space/Unit	1.5 Spaces/Unit	2 Spaces/Unit	2 Spaces/Unit	1.5 Spaces/Unit
Maximum Office/ Retail/ (Spaces per 1,000 Sq. ft.)	2 Spaces/1000 SF	3 Spaces/1000 SF	3 Spaces/1000 SF	3 Spaces/1000 SF	3 Spaces/1000 SF
Maximum Surface Parking (% of Total Spaces)	10%	15%	25%	50%	20%
Shared vs. Single-Use Parking Facility	Shared	Shared	Shared	Mix of Shared/Single	Shared
Park & Ride and Other Considerations	No	No	Yes	Yes	No
MIXED USE & DIVERSITY					
Minimum Hours of 'Significant' Activity	18 Hours	16 Hours	14 Hours	12 Hours	14 Hours
Average Jobs/ Housing ratio	10 jobs/1 Dwelling Unit	5 jobs/1 Dwelling Unit	1 job/1 Dwelling Unit	1 job/1 Dwelling Unit	1 job/1 Dwelling Unit
Mix of Uses (% Residential, % Non-Residential)	30% Residential/ 70% Non-Residential	50% Residential/ 50% Non-Residential	70% Residential/ 30% Non-Residential	80% Residential/ 20% Non-Residential	50% Residential/ 50% Non-Residential
STREET NETWORK					
Grid Density (Polygons per sq. mile) Bicycle, Pedestrian & Street Network	Minimum of 150	Minimum of 75	Minimum of 50	Minimum of 40	Minimum of 75
Average Block Size (in Feet)	200' x 400'	200' x 600'	200' x 800'	200' x 600'	200' x 600'

DESIGNWORKSHOP ST. LOUIS TOD FRAMEWORK PLAN | St. Louis, Missouri TOD Toolbox | 63

Other Notes:
This document provides simple descriptions of the typologies and then classifies example stations and provides some similar stations external to St. Louis.
The document also cites Nelson/Nygaard (2013) in ‘minimum supportive density thresholds’, which may be useful in evaluation.
Maybe this citation? Years don’t line up: Nelson\Nygaard Consulting Associates. “Rhode Island Avenue Parking Analysis, Technical Memorandum #1,” prepared for the US EPA and DC Office of Planning. 2003.

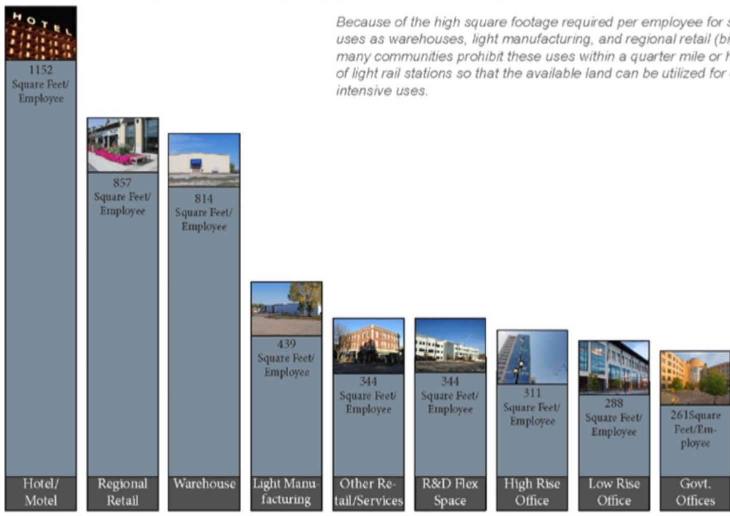
(Design Workshop, 2013, p. 57) Chapter 4



They also include some crosswalks that describe square feet/FAR/acre per employee based on a report by Southern California Council of Governments. This can be used to link employee density with SQFT or acreage per land use type. (Ch. 4; page 58-59)
Reference: Southern California Council of Governments. Employment Density Study. October 2001

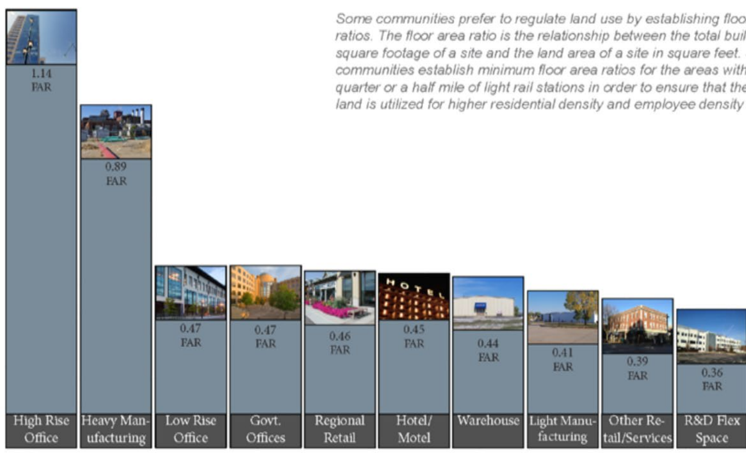
Square Feet Per Employee Based on: Average Employees Per Acre and Average FAR

Because of the high square footage required per employee for such land uses as warehouses, light manufacturing, and regional retail (big box), many communities prohibit these uses within a quarter mile or half mile of light rail stations so that the available land can be utilized for employee intensive uses.

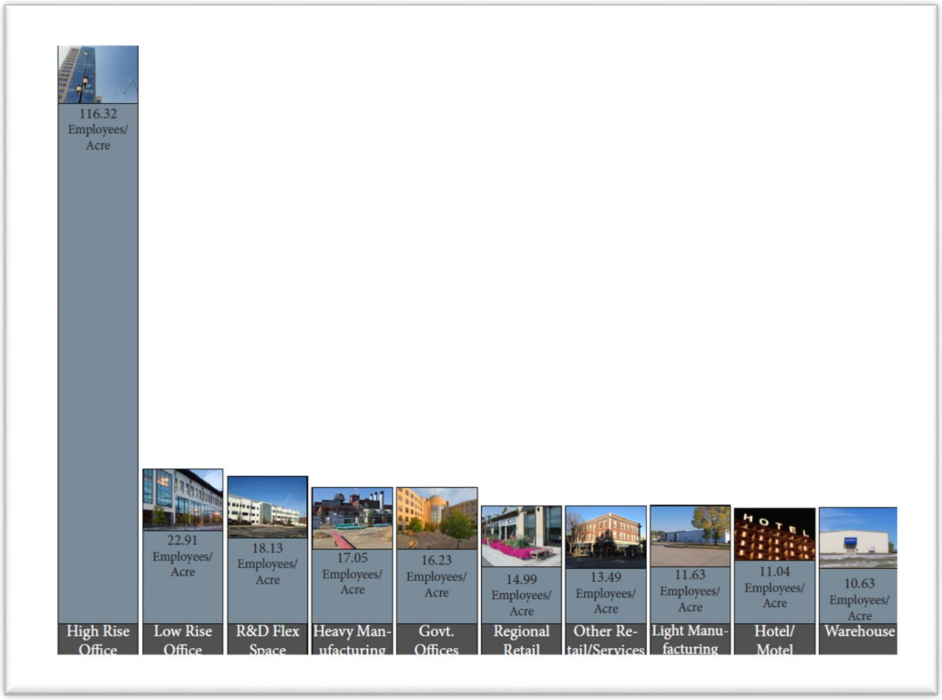


Square Feet Per Employee Based on: Floor Area Ratio

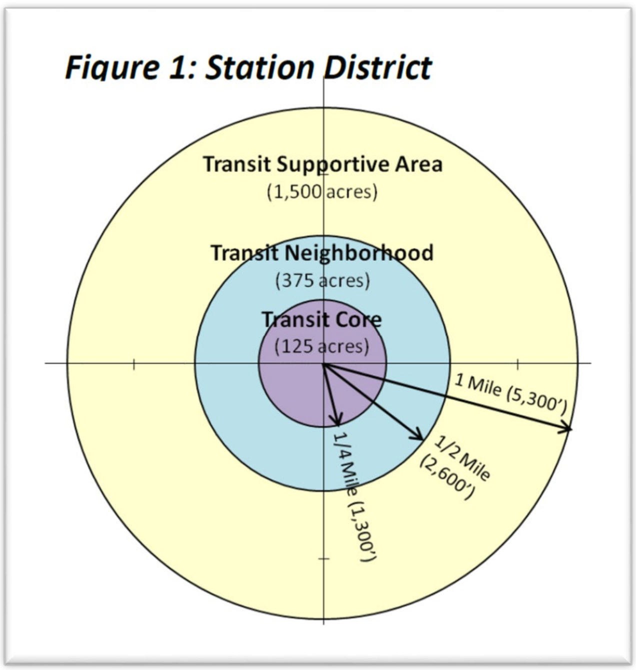
Some communities prefer to regulate land use by establishing floor area ratios. The floor area ratio is the relationship between the total building square footage of a site and the land area of a site in square feet. Some communities establish minimum floor area ratios for the areas within a quarter or a half mile of light rail stations in order to ensure that the available land is utilized for higher residential density and employee density uses.



Source: Employment Density Study, Southern California Council of Governments, October 31, 2001


116.32 Employees/ Acre
22.91 Employees/ Acre
18.13 Employees/ Acre
17.05 Employees/ Acre
16.23 Employees/ Acre
14.99 Employees/ Acre
13.49 Employees/ Acre
11.63 Employees/ Acre
11.04 Employees/ Acre
10.63 Employees/ Acre
HOTEL
High Rise Office
Low Rise Office
R&D Flex Space
Heavy Manufacturing
Govt. Offices
Regional Retail
Other Retail/Services
Light Manufacturing
Hotel/ Motel
Warehouse

Arizona Department of Transportation (2012)
References: (Arizona Department of Transportation, 2012)
Transit System: Mostly commuter and intercity rail planning with discussion about multimodal supportive infrastructure.
Purpose of Typology:
Types of Use: Agency; Design or Land Use; Common Vocabulary;
Findings & Outcomes: This is an early-stage typology used for developing and collecting attitudes, concerns, and other initial planning approaches. No existing or planned sites were identified (in general and using this typology).
Method for Aggregating Typology:
Notes: No clear method for distinguishing typology. This appears to be the outcome of a longer process for distinguishing regional passenger rail opportunities/potential (see: https://www.azdot.gov/planning/transportation-studies/PassengerRail/library).
Categories & Supporting Variables or Definitions:
Notes: This report identifies the scale of station area orientation as follows (page 1)



Top to bottom reflects general intensity level spectrum. Below is the general description of each of the four area types in the ADOT report (page 3):

PASSENGER RAIL CORRIDOR STUDY
Tucson to Phoenix

Table 1: Station Area Typology Overview

Station Type	Typical Urban Setting	Employment/ Commercial Land Use Types	Residential Land Use Types	Transit Patronage Area	Typical Transportation Modes and Parking Types
System Hub	Downtown/ center of metropolitan area	Primary office, government, and cultural/sports/ entertainment center with supportive retail and services	High-density, multi-family housing	15 to 25 miles	Intermodal facility/transit hub; Major regional destination with high- quality feeder transit (light rail, streetcar, bus, circulator); Potential park-and-ride location with structured parking integrated into mixed use development.
Regional Station	Subregional downtown or major employment center	Regional employment hub and major activity center (retail, services, education, medical, entertainment)	Mid- to high-density residential, often as part of mixed-use developments	10 to 15 miles	May be a subregional destination on fixed-guideway transit corridor, or subregional transit center with high quality feeder bus service, including local activity center circulator; Potential park-and-ride location with structured parking.
Local Station	Suburban town center, master planned community commercial core, or historic downtown of rural community	Office/service/retail economic activity center, potential regional government service center	Mid-density multi-family, and higher density single family (e.g., townhouses, row houses)	5 to 20 miles (Suburban) 20 to 40 miles (Rural)	Local activity center linked with high quality feeder bus services (e.g., express bus, regional fixed-route bus routes); Potential park-and-ride location with decked parking or surface lots.
Transit Emergent Station	Center of a small town outside a major metropolitan area with significant surrounding growth potential	Office/service/retail center, potential civic service center; often a historic "Main Street" activity node	Medium-density multi-family, possibly single family (e.g., row houses, patio homes)	20 to 40 miles	Transit station with future connections to local feeder bus service, and regional bus transit with service to adjacent towns/cities; Potential park-and-ride location with surface parking.

3

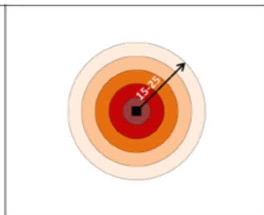
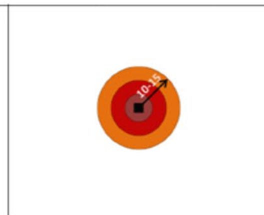
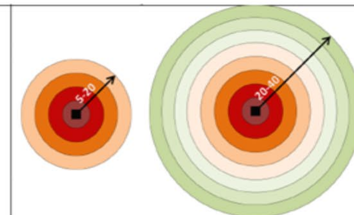
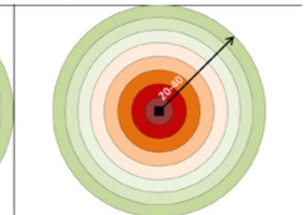
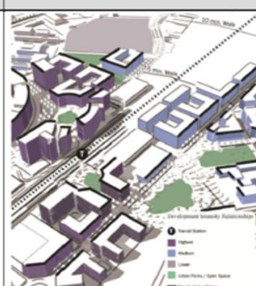
Each category is further segmented by the station district categories:
Transit Core (<1/4 mile and 125 acres): 20-min. walk or 5-min. drive
Transit Neighborhoods (1/4-1/2 miles and 375 acres): 10 min. walk
Transit Supportive Area (1/2-1 miles and 1500 acres): 5 min. walk

	System Hub	Regional Station	Local Station	Transit Emergent Station
Desired Land Use Mix				
Transit Core	<75% emp <35% res <10% other	<70% emp <50% res <15% other	<60% emp <50% res >15% other	<40% emp >60% res >10% other
Transit Neighborhoods	<60% emp <50% res <15% other	<60% emp >50% res >15% other	<40% emp >50% res <15% other	<30% emp <80% res >5% other
Transit Supportive Area	<40 emp >60% res >15% other	<40% emp >60% res >15% other	<303% emp >70% res >10% toher	<20% emp >80% res >5% other
Typical Land Use Mix				
Transit Core	Corporate offices; gov. offices; regional sports/ entertainment; convention/conference facilities; high-rise res.	Mid-high rise office or residential; gov/educational/ employment/	Lofts/condo; mid-rise res; apart./ townhouse complex; 'main street'	'main street' commercial/ mixed use dev.; apart/ townhomes; row houses; gov.

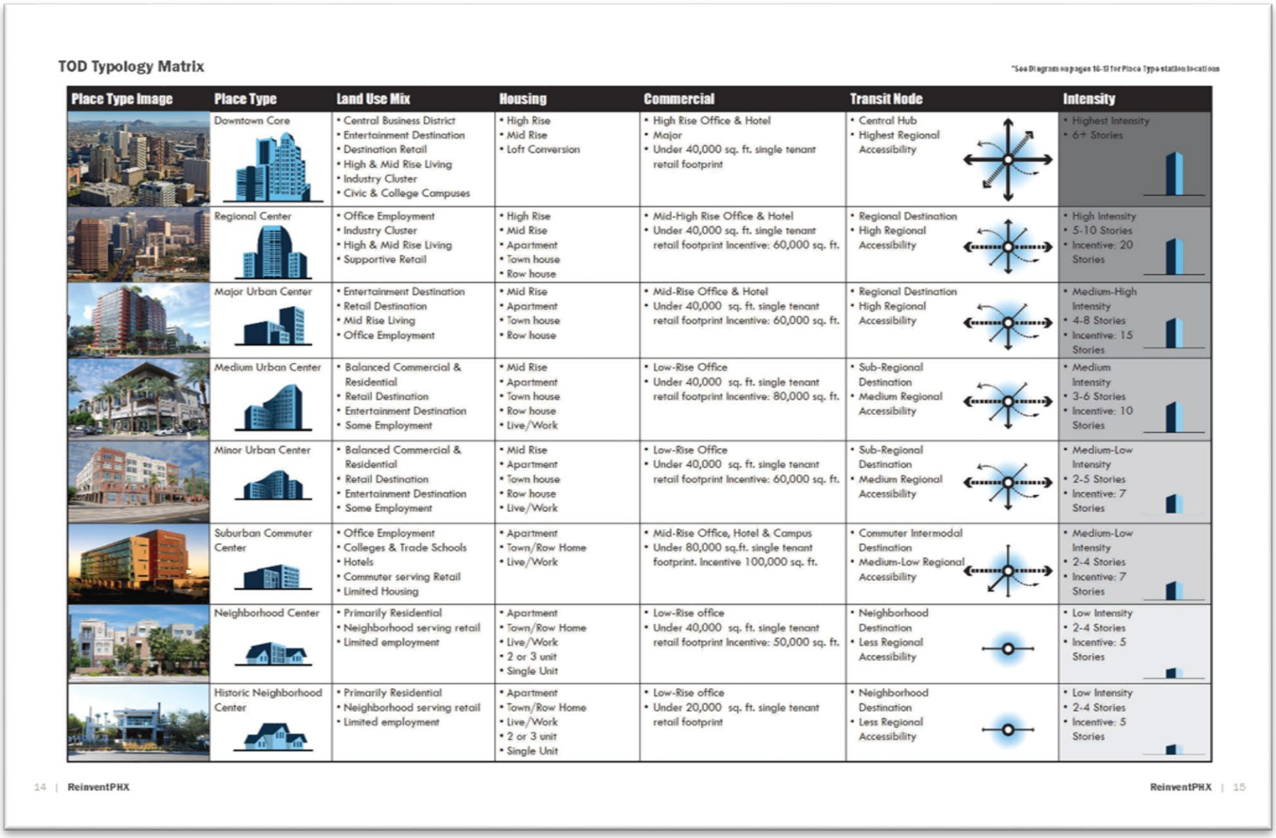
		research campuses	commercial/ mixed-use dev.; government service center; office/research park	service center; garden office buildings
Transit Neighborhoods	Mid-high rise office towers; mid-high rise res.; gov/educational/ employment/ research campuses	ofts/ condos; mid-rise res towers; apart/townhomes; office/research park; med. Facilities; lifestyle retail; mixed-use dev.	Apart/townhomes; row houses; garden office buildings; multi-use developments	Apart/townhomes; row houses; garden office buildings; multi-use dev.
Transit Supportive Area	Lofts/ condos; mid-rise res towers; apart/townhomes; office/research park; med. Facilities; lifestyle retail; mixed-use dev.	Apartments/ townhomes; row houses; office/research park; garden office buildings; mixed-use dev.	Apart/townhomes; patio home/ zero lot line residential; garden office buildings; multi-use dev.	Patio home/zero lot line res.; row houses; garden office buildings; multi-use dev.
Typical Building Heights (stories				
Transit Core	10+	5+	4+	2+
Transit Neighborhoods	6+	4+	3+	2+
Transit Supportive Area	4+	2+	2+	1
Average Employment Density (Floor to Area Ratio; FAR)				
Transit Core	3.0-5.0	1.0-3.0	0.5-1.0	0.5-1.0
Transit Neighborhoods	1.5-3.0	0.5-1.0	0.35-0.5	0.25-0.5
Transit Supportive Area	0.5-1.5	0.35-0.5	0.25-0.35	0.15-0.25
Average Residential Density (Dwelling units per acre)				
Transit Core	100+	50-100	25-50	15-35
Transit Neighborhoods	50-100	25-50	18-25	10-25
Transit Supportive Area	25-50	18-25	8-18	8-12
Parking Types				
Transit Core	Multi-story	Multi-story	Multi-story or parking deck	Surface lot with plans for structured parking deck
Transit Neighborhoods	Multi-story	Multi-story or parking deck	Surface Lot	Surface Lot
Transit Supportive Area	Short term: surface lot Long term: parking deck	Short term: surface lot Long term: parking deck	Surface Lot	Surface Lot

This document also includes some fairly extensive descriptions of ‘supportive transit’ networks (see image of table below, from page 11 of (Arizona Department of Transportation, 2012)).

Table 6: Supportive Transportation Infrastructure

Passenger Patronage Area				
	15-25 miles	10-15 miles	5-20 miles (Suburban) 20-40 miles (Rural)	20-40 miles
Transit Modes	**System Hub Station**	**Regional Station**	**Local Station**	**Transit Emergent Station**
Light Rail Transit (LRT)	▪ Fixed-guideway rail transit in exclusive right-of-way with stops averaging every 1 mile ▪ Multiple routes serving regionally-significant activity and employment centers, high-density residential nodes	▪ Fixed-guideway rail transit in exclusive right-of-way with stops averaging every 1 mile ▪ Located along a route serving regionally-significant activity and employment centers, high-density residential nodes		
Modern Streetcar/ Hybrid	▪ "Lighter light rail" operating in mixed traffic with stops averaging 1/2 to 1 mile ▪ May provide local circulation as well as commuting	▪ "Lighter light rail" operating in mixed traffic with stops averaging 1/2 to 1 mile ▪ May provide local circulation as well as commuting		
Bus Rapid Transit (BRT)/Express Bus	▪ Fixed routes operating in major transportation corridors with stops averaging 1 to 3 miles ▪ May operate in semi-exclusive right-of-way or mixed traffic ▪ Typically operates during peak periods only	▪ Fixed routes operating in major transportation corridors with stops averaging 1 to 3 miles ▪ May operate in semi-exclusive right-of-way or mixed traffic ▪ Typically operates during peak periods only	▪ Fixed route operating along major highways ▪ Limited stop express service between communities ▪ Schedule coordination with intercity and commuter rail	▪ Fixed route operating along major highways ▪ Limited stop express service between communities ▪ Schedule coordination with commuter rail
Local Bus	▪ All-day, fixed-route local arterial bus service with stops averaging 1/4 to 1/2 miles ▪ May offer higher frequency during peak periods ▪ Accessible buses; articulated where necessary	▪ All-day, fixed-route local arterial bus service with stops averaging 1/4 to 1/2 miles ▪ May offer higher frequency during peak periods ▪ Accessible buses; articulated where necessary	▪ All-day, fixed-route bus service along main roads with stops averaging 1/4 to 1/2 miles ▪ May offer higher frequency during peak periods ▪ Accessible buses	▪ All-day, fixed-route bus service along main roads with stops averaging 1/4 to 1/2 miles ▪ May offer higher frequency during peak periods ▪ Accessible buses
Shuttle/Circulator Bus	▪ Circulates within activity center and to adjacent neighborhoods ▪ Frequent stops (averaging 1/4-mile) ▪ Provides feeder or distribution service to and from transit centers, activity centers, or rail stations ▪ May have multiple routes connecting local activity nodes, parking and rental car facilities in the station district	▪ Circulates within activity center and to adjacent neighborhoods and communities ▪ Frequent stops (averaging 1/4-mile) ▪ Provides feeder or distribution service to and from transit centers, activity centers, or rail stations ▪ May have multiple routes connecting local activity nodes, parking and rental car facilities in the station district	▪ Circulates within activity center and to adjacent neighborhoods ▪ Frequent stops averaging 1/4-mile or less (or flag-down service ▪ Provides feeder or distribution service to and from transit center/rail station	▪ Circulates within activity center and to adjacent neighborhoods ▪ Frequent stops averaging 1/4-mile or less (or flag-down service ▪ Provides feeder or distribution service to and from transit center/rail station
Bikeways	▪ Bike lanes and/or paths throughout the station district ▪ Provide access to transit hubs from within a moderate (1-5 mile) distance ▪ May be on-street, off-street or a combination	▪ Bike lanes and/or paths throughout the station district ▪ Provide access to transit hubs from within a moderate (1-5 mile) distance ▪ May be on-street, off-street or a combination	▪ Bike lanes and/or paths throughout the station district ▪ Provide access to transit hubs from within a moderate (1-5 mile) distance ▪ May be on-street, off-street or a combination	▪ Bike lanes and/or paths throughout the station district ▪ Provide access to transit hubs from within a moderate (1-5 mile) distance ▪ May be on-street, off-street or a combination
Pedestrian Pathways	▪ Pedestrian pathways along all streets with shaded sidewalks, buffered from vehicular traffic by landscaping ▪ Mid-block plazas with pedestrian linkage to streets ▪ Provide access to transit hubs from within a short (0-1 mile) distance	▪ Pedestrian pathways along all streets with shaded sidewalks, buffered from vehicular traffic by landscaping ▪ Mid-block plazas with pedestrian linkage to streets ▪ Provide access to transit hubs from within a short (0-1 mile) distance	▪ Pedestrian-oriented streets with shaded sidewalks, buffered from vehicular traffic by landscaping ▪ Provide mid-block pedestrian linkage ▪ Provide access to transit hubs from within a short (0-1 mile) distance	▪ Pedestrian-oriented streets with shaded sidewalks, buffered from vehicular traffic by landscaping ▪ Provide mid-block pedestrian linkage ▪ Provide access to transit hubs from within a short (0-1 mile) distance
Vehicular Parking Facilities	▪ Multi-story parking structures/decks integrated into mixed use developments	▪ Multi-story parking structures/decks	▪ Decked parking/surface parking lot	▪ Surface parking lot
Typical Station Area Surrounding Density				
Typical Block Size	200' – 400' with pedestrian penetration every 200' Max. block perimeter: 1200' Study Area Reference: Phoenix CBD – 340' X 340'	200' – 400' with pedestrian penetration every 200' Max. block perimeter: 1200' Study Area Reference: Tempe CBD – 340' X 370'	200' – 400' with pedestrian penetration every 200' Max. block perimeter: 1200' Study Area Ref.: Casa Grande Downtown – 300' X 300'	200' – 400' with pedestrian penetration every 200' Max. block perimeter: 1200' Study Area Reference: Coolidge Downtown – 600' X 300'

Phoenix, Arizona (2018)
References: (City of Phoenix, 2018; General Plan Amendment, 2018)
Transit System: Mainly light-rail, but conscious of supportive transportation alternatives
Purpose of Typology:
Types of Use: Agency; Agency; Design or Land Use; Common Vocabulary; Conceptual Planning;
Findings & Outcomes: The larger purpose of the report was to describe the outcomes (including benefits) and market for various TOD design, identifying potential opportunities. The area types were mainly used for planning purposes, considered a 'starting point' for plans and interim guidance for rezoning decisions and coordinating T&LU before any TOD plans can be developed (page 15). The provide some example policies for one example typology, linking the policies (often zoning-specific) with the supporting metrics used to distinguish typologies. As this provides some interim guidance, individual typology plans should be developed following to supplement this document/guidance.
Method for Aggregating Typology:
Notes: The analysts in 'ReInventPHX' worked with the city's Village Planning Committees (VPCs). They analyzed 'land use, zoning, entitlements, destinations, demographics, housing, employment, walkability, market research studies, and existing plans to assess the existing context and susceptibility to future change within ¼ mile of light-rail stations" (page 14-15). The VPCs then voted to recommend area types for each existing or planned light rail station.
The planning model uses a 'connected centers' approach by identifying each area type 'center or core' and linking those areas together. "Center" is a common term they use, defined as "concentration of activities within a city" (page 14).
Categories & Supporting Variables or Definitions:
Notes: The descriptions here may be pulled directly from the language of the document; for image screenshots (marked with an image shadow), page numbers are either left on the image or embedded in the text directly before the image. The table below from top to bottom represents the spectrum of intensity of development from high to low. These area types apply to all properties within a ¼ mile with the following exceptions (from page 15):
Historic or historic-eligible (as determined by historic preservation officer);
Single-family zoned;
VPC specifying actions exclusions;
Existing entitlements greater than allowed in each area type;
Incompatible through TOC district planning or rezoning processes.
People is the copied table which describes the quantitative land use and transportation aspects of each area type (page 16):



TOD Typology Matrix

*See Diagram on pages 16-19 for Place Type station locations

Place Type Image	Place Type	Land Use Mix	Housing	Commercial	Transit Node	Intensity
	Downtown Core	• Central Business District • Entertainment Destination • Destination Retail • High & Mid Rise Living • Industry Cluster • Civic & College Campuses	• High Rise • Mid Rise • Loft Conversion	• High Rise Office & Hotel • Major • Under 40,000 sq. ft. single tenant retail footprint	• Central Hub • Highest Regional Accessibility	• Highest Intensity • 6+ Stories
	Regional Center	• Office Employment • Industry Cluster • High & Mid Rise Living • Supportive Retail	• High Rise • Mid Rise • Apartment • Town house • Row house	• Mid-High Rise Office & Hotel • Under 40,000 sq. ft. single tenant retail footprint Incentive: 60,000 sq. ft.	• Regional Destination • High Regional Accessibility	• High Intensity • 5-10 Stories • Incentive: 20 Stories
	Major Urban Center	• Entertainment Destination • Retail Destination • Mid Rise Living • Office Employment	• Mid Rise • Apartment • Town house • Row house	• Mid-Rise Office & Hotel • Under 40,000 sq. ft. single tenant retail footprint Incentive: 60,000 sq. ft.	• Regional Destination • High Regional Accessibility	• Medium-High Intensity • 4-8 Stories • Incentive: 15 Stories
	Medium Urban Center	• Balanced Commercial & Residential • Retail Destination • Entertainment Destination • Some Employment	• Mid Rise • Apartment • Town house • Row house • Live/Work	• Low-Rise Office • Under 40,000 sq. ft. single tenant retail footprint Incentive: 80,000 sq. ft.	• Sub-Regional Destination • Medium Regional Accessibility	• Medium Intensity • 3-6 Stories • Incentive: 10 Stories
	Minor Urban Center	• Balanced Commercial & Residential • Retail Destination • Entertainment Destination • Some Employment	• Mid Rise • Apartment • Town house • Row house • Live/Work	• Low-Rise Office • Under 40,000 sq. ft. single tenant retail footprint Incentive: 60,000 sq. ft.	• Sub-Regional Destination • Medium Regional Accessibility	• Medium-Low Intensity • 2-5 Stories • Incentive: 7 Stories
	Suburban Commuter Center	• Office Employment • Colleges & Trade Schools • Hotels • Commuter serving Retail • Limited Housing	• Apartment • Town/Row Home • Live/Work	• Mid-Rise Office, Hotel & Campus • Under 80,000 sq.ft. single tenant footprint. Incentive 100,000 sq. ft.	• Commuter Intermodal Destination • Medium-Low Regional Accessibility	• Medium-Low Intensity • 2-4 Stories • Incentive: 7 Stories
	Neighborhood Center	• Primarily Residential • Neighborhood serving retail • Limited employment	• Apartment • Town/Row Home • Live/Work • 2 or 3 unit • Single Unit	• Low-Rise office • Under 40,000 sq. ft. single tenant retail footprint Incentive: 50,000 sq. ft.	• Neighborhood Destination • Less Regional Accessibility	• Low Intensity • 2-4 Stories • Incentive: 5 Stories
	Historic Neighborhood Center	• Primarily Residential • Neighborhood serving retail • Limited employment	• Apartment • Town/Row Home • Live/Work • 2 or 3 unit • Single Unit	• Low-Rise office • Under 20,000 sq. ft. single tenant retail footprint	• Neighborhood Destination • Less Regional Accessibility	• Low Intensity • 2-4 Stories • Incentive: 5 Stories

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Portland Metro, Oregon (2011)
References: (Center for Transit-Oriented Development & Nelson/Nygaard, 2011)
Transit System: Considers metro-wide transit, but ‘categories’ LRT stations specifically.
Purpose of Typology:
Types of Use: Agency; Agency; Strategy Identification & Implementation; Prioritization; Evaluation;
Findings & Outcomes: Similar to the Puget Sound example, these area types were used to develop a sense of variation in transit typology across the region and to package strategies aimed at addressing concerns, growth or funding mechanisms across each typology.
Method for Aggregating Typology:
Notes: The typology separates station areas into 9 categories along two dimensions (each dimension having three sub-categories). For the ‘market strength’ dimension (one variables), the data were split based on natural breaks in the data (excluding downtown Portland, which tends to skew the data). For ‘transit orientation scores’, the ‘5 Ps’ were each standardized and summed together. The resulting index was then split based on natural breaks into three categories, similar to ‘market strength’. This means that the definition of the categories are relative to what is currently available across the region.
Question: It’s not clear if the ‘natural breaks’ were used across station scores or across the region (based on the raster grid ‘context tool’. The ‘context tool’ supportive 5Ps data pulled into this study was reflective of Portland Metro’s larger ‘context tool’ that we used for the site selection and analysis of our 2012 Contextual Influence on Trip Generation study. I’m thinking the market strength may have been ‘broken’ on the station area information, which the transit orientation data may have been ‘broken’ at a regional level.
Categories & Supporting Variables or Definitions:
Notes: The descriptions here may be pulled directly from the language of the document; for image screenshots (marked with an image shadow), page numbers are either left on the image or embedded in the text directly before the image.

Dimensions	Category	Description	Supporting variables
Market Strength (page 33)	Limited	“these areas have weaker market conditions and lack the sales values necessary to support new compact and/or mixed use development. TOD Program investments in these areas, thus, are less likely to catalyze additional private development and should be used only on a limited basis. Emphasis on visioning and planning is more appropriate to begin to develop physical and regulatory conditions that could influence future private development interest.”	Residential (including mixed use) and commercial real estate sales by square foot (2000-2010); split by natural breaks in the data
	Emerging	“these are areas that have limited to moderate real estate market conditions and where intensive building types are generally not supported in the near-term. Although they may lack immediate market support for TOD, emerging areas may be ideally suited for catalytic TOD Program investments to enhance local market strength. These areas represent a “sweet spot” for TOD program investment, since land and development costs are not elevated (as in Stronger market areas) and small investments	

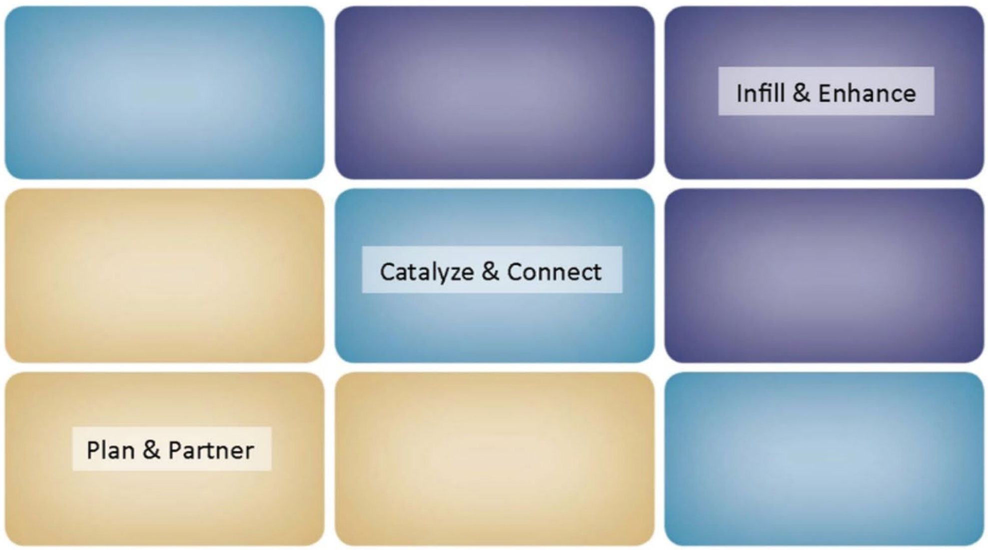
		may catalyze further market investment by creating market comparables."	
	Stronger	"these are areas where market conditions are beginning to support higher density mixed use development and infill. Since the markets of these areas are already ripe or ripening, TOD Program investments should focus on improving urban living infrastructure (amenities), developing prototype developments for the region and funding more "aggressive" (e.g. more significant increase in density compared to recent development in the area) TOD projects. Low- to moderate-income housing development in these areas may be more challenging due to high land prices, so strong market areas may be an appropriate place for Metro TOD program to support affordable and workforce housing projects."	
Transit-Orientation (page 35)	Transit-oriented	"Areas that are most likely to support a transit lifestyle. Describes more densely populated areas served by high quality rail and/or bus transit, good to excellent pedestrian/bicycle connections, a finer grain of blocks, and a supportive mix of retail and service amenities."	Typology uses the following '5 Ps of Transit-Orientation' (page 34): People: number of residents and workers in an area ("direct correlation with reduced auto trips") Places: areas with commercial urban amenities such as restaurants, grocers, specialty retail ("allow residents to complete daily activities without using a car; improve the likelihood of higher density development by increasing residential land values") Physical form: small block sizes ("promote more compact development and walkability") Performance: high quality, frequently bus and rail service ("makes public transportation a more reliable means of getting around and can be correlated to less driving") Ped/bike connectivity: access to sidewalks and low stress bikeways ("encourages many more people to walk or cycle to transit and neighborhood destinations")
	Transit-related	"Areas that possess some, but not all, of the components of TOD. Generally describes moderately populated areas served by higher quality transit, a good or improving pedestrian/bicycle network, and some mix of neighborhood supportive retail and service amenities."	
	Transit-adjacent	"Non-transit areas or areas proximate to quality transit without possessing the urban character that would best support it. Generally describes low to moderately populated areas perhaps within walking distances of higher quality rail stations or bus stops, but lack a combination of the street connectivity, pedestrian and bicycle facilities, and urban amenities to more fully support the level of transit service."	

Page 40 – Clustering typologies to define TOD program investments and strategies

Using the Typology to Define TOD Program Investments

The nine place types provide the first step in an investment strategy for the Metro TOD Program. However, many of the place types face similar challenges, and clusters of place types would benefit from similar investment strategies. To address this, the place types are grouped in three clusters that are commonly positioned for investments and implementation actions that could be administered by the TOD Program. The place type clusters are described in Figure 22. Each of the clusters is described below and illustrated with case examples from existing stations and corridors in the Portland region.

Figure 22: TOD Place Type Clusters



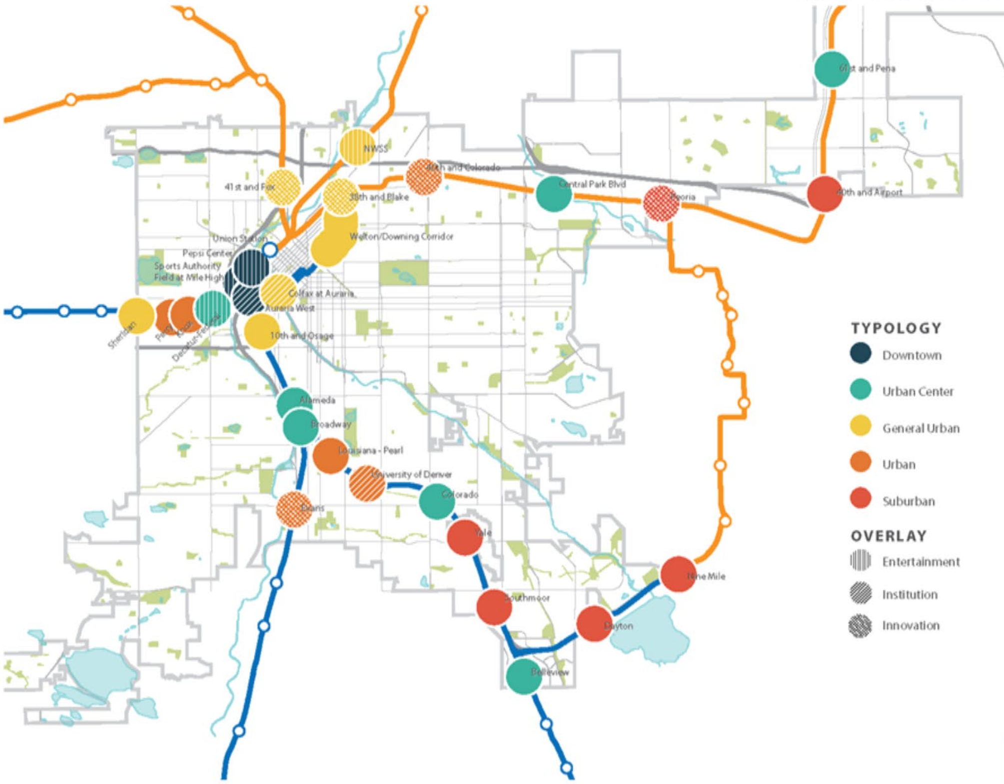
Denver, Colorado (2014)
References: (Buchanan et al., 2014)
Transit System: The focus of this report is at rail stations (possibly LRT and commuter), but the study recognizes the need to consider supportive transit/transportation infrastructure.
Purpose of Typology:
Types of Use: Agency; Design or Land Use; Common Vocabulary; Strategy Identification & Implementation; Prioritization;
Findings & Outcomes: There is a major purpose for both typologies. The area type + functional overlay provides guidance for the designation and direction of each station in terms of the built environment. The "TOD Continuum" (market readiness, development potential, and transit readiness) segments stations into areas that help the agency, practitioner, and developer align strategies and mitigations across the stations. It's important to note that some of the information that informs the area types may also inform the Continuum, but the Continuum is designed to align the *needs* of each station types while the area types are intended to organize the goal built environment or design.
Additional Definitions:
Transit community (page 9): "Denver's transit communities are walkable places that provide destinations like shopping, dining, jobs, parks, and schools — most of ones daily activities — easily accessed from home by foot, bicycle, and transit. These communities tend to have a variety of housing types, provide the opportunity for a healthy lifestyle, and are designed to maximize resident access to public transportation by focusing activities on a major transit stop."
Transit-oriented development (page 9): "Transit-oriented development in Denver generally describes a development in an existing or planned transit community that adds to the walkable, vibrant, mixed-use environment and is oriented towards frequent, high-quality transit service that connects the community to the rest of the region."
TOD Principles (page 10-11):
Connect: "entry point-access to the regional economy; first/last mile – walk, bike, bus to the station; access to all – connect to new and existing neighborhoods"
Innovate: "sustainable – economic, social, environmental; equitable – opportunities for all; global economy – compete on the world stage"
Efficient: "Location – one place to live, work, and play decreases need for regional trips; Shared Resources – reduce cost of infrastructure per household; Balance – jobs and homes nearby reduce travel times and long commutes"
Place: "Active – promote safety and visual interest; Vibrant – bring together people and activities; Destination – public life happens in the streets and open space"
Mix: "Choice – housing, jobs, shopping, transit options; Diversity – mix of incomes and age groups; Resilient – stands up through changing economic conditions"
Shift: "Car Free/Car Lite – becoming non-/less car dependent for most trips; Public Space – more room for pedestrians and bikes, less for cars; Reduce and Energize – carbon emissions go down, healthy living goes up"
Method for Aggregating Typology:
Notes: It is not clear how the five built environment place typologies were created, but five categories of characteristics were included: land use mix; street and block patterns; building placement and location; building heights; mobility. The functional overlays appear to be identified based on major generators (institutional and/or entertainment districts) or anecdotal experiences/expertise. Given the qualitative description of the categories, it appears that this approach was more 'manual' than quantitative.
In addition to the built environment area types, the report considers categorizing 'market readiness' and 'development potential' of each station area called the 'TOD Continuum". The team considered a 10-minute walkshed around the area. This approach is based on three prior resources (Central Maryland; Portland, Metro; and Los Angeles). The 34 stations (not including

downtown) were plotted on a graph with ‘transit readiness’ informing the policy implications and recommendations. The outcomes of both market readiness and development potential appear to be standardized on a scale from 1 to 5. It is likely that this scale is an indication of natural breaks as they cite Portland, LA, and Baltimore.

Categories & Supporting Variables or Definitions:

Notes: The descriptions here may be pulled directly from the language of the document; for image screenshots (marked with an image shadow), page numbers are either left on the image or embedded in the text directly before the image. Below are tables and descriptions for each of the five main place typologies and overlays. The overlays indicate the aspirational qualities of the given station, which can occur in any typology.

CITYWIDE TYPOLOGY



STATION TYPOLOGY

- **Downtown** – Mixed use, highest density, tallest buildings, high pedestrian activity, transit hub, and historic areas
- **Urban Center** – Mixed use, high density, grid and alley block pattern, high pedestrian activity, and multi-modal
- **General Urban** – Multi-family residential, grid and alley block pattern, main streets , corner stores, and multi-modal
- **Urban** – Grid and alley block pattern, predominantly single family residential, main streets, corner stores, and multi-modal
- **Suburban** – Town centers, community open spaces and residential neighborhoods

Functional Overlays:

- **Innovation** – Allowing a wide range and diversity of TOD land uses, activities and building forms to accommodate new types of development such as advanced manufacturing, research and development, creative design studios, and more.
- **Institutional** – Academic campuses, medical and government centers with a significant amount of jobs
- **Entertainment** – Major destinations – typically evenings and weekends

downtown

Mixed use, highest density, tallest buildings, high pedestrian activity, transit hub, historic areas

Downtown rail stations are unique as they are located in the most intensely used land in the region, with civic, institutional and entertainment uses sharing the same spaces as high density residential, office and commercial uses. Buildings are mostly mid- to high-rise structures located in a consistent pattern of small blocks and linear streets. Downtown stations have the highest level of use due to downtown being the center of the regional transit system. Downtown streets have the most pedestrian activity and extensive set of bicycle facilities of all station types. All downtown rail stations are walk-up stations, but a few stations have specific functions – Pepsi Center and Mile High Station serve as entertainment stations, and Auraria West Station serves as an institutional station.

Land Use Mix	Street and Block Pattern	Building Placement	Building Height	Mobility
Strong mix of uses Mid to high-rise buildings with a mix of multi-family, commercial, office, civic, institutional and entertainment uses	Regular, smaller blocks Regular pattern of pedestrian/vehicle connections Unique triangular blocks where grids meet Linear streets Consistent alleys	Buildings built-to sidewalks Continuous street wall Consistent orientation Parking at rear/side or structured	Context-sensitive heights in historic districts Consistent mid to high-rise in other districts	Highest priority to pedestrian High level of bicycle facilities Center of multi-modal transit system

urban center

mixed use, high density, grid & alley block pattern, high pedestrian activity, multi-modal

Urban Center rail stations typically serve or are planned to serve as a destination for surrounding neighborhoods with strong transit use and a high level of pedestrian and bicycle activity. Urban Centers have a mix of uses, with mid- to high-rise multi-family residential integrated with mixed-use commercial buildings. The intended high intensity nature of urban centers positions these stations as regional employment hubs. Buildings front sidewalks with consistent pedestrian entrances and are located within a pattern of regular, smaller blocks and linear streets. Many urban center stations have one or more major land owners.

Land Use Mix

Strong mix of uses

Mid-high rise

Multi-family

Mixed-use commercial

Destination for surrounding neighborhoods

Potential job center

Street and Block Pattern

Regular, smaller blocks

Regular pattern of ped/vehicle connections

Linear streets

Mostly alleys

Building Placement

Buildings built to sidewalk or very shallow setbacks

Consistent orientation

Parking at rear/side or structured

Building Height

Consistent mid- to high-rise residential, mixed-use, and commercial structures;

Maximum height at the core is typically 20 stories with transitions

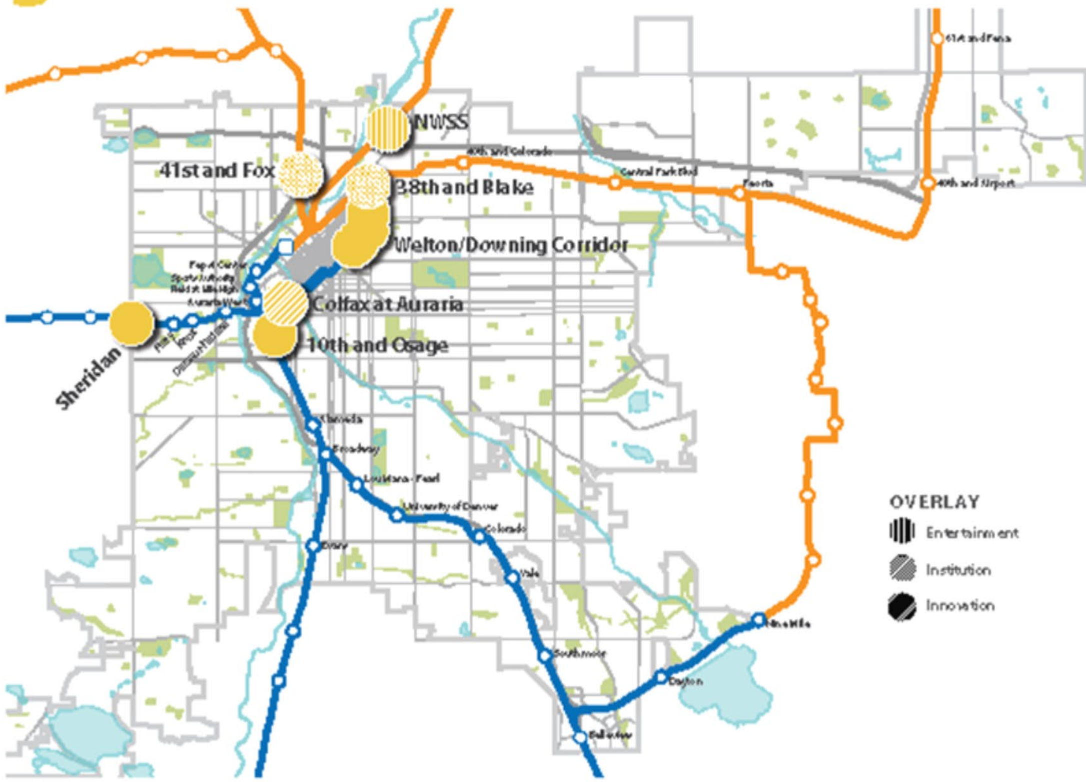
Mobility

Strong transit use

High level of ped/bike use

general urban

multi-family residential, grid & alley block pattern, main streets, corner stores, and multi-modal



General Urban rail stations are characterized by their significant amount of mid to high-density multifamily residential areas. These areas have a variety of building forms, such as urban houses, rowhouses, and mid to high-rise apartment and/or condominium buildings, as well as some limited single family and two family residential uses. Commercial areas, generally consisting of low to mid rise structures, are both embedded in the neighborhood and located along busier, mixed-use arterials. Buildings have shallow or moderate setbacks, with consistent pedestrian orientation and parking located behind or to the side. Areas around general urban stations have a regular, smaller block pattern with linear streets and alleys. Due to the higher residential densities, transit use is strong, especially along high capacity transit corridors. There is a general balance of pedestrian, bicycle and vehicle travel modes.

Land Use Mix

Mix of uses with heavy emphasis on higher density multi-family residential areas with rowhouses and apartment buildings

Commercial uses located on key mixed-use and main streets

Street and Block Pattern

Regular, smaller blocks

Regular pattern of pedestrian/vehicle connections

Linear streets

Mostly alleys

Building Placement

Consistent shallow to moderate setbacks

Consistent entrance orientation to the street

Parking accessed from the alley or side yard

Building Height

Mid- to high-rise residential structures

Low- to mid-rise commercial structures at appropriate locations

Mobility

Strong transit use, especially along high capacity transit corridors

Balance of ped/bike/ vehicle use

urban multi-family residential, grid & alley block pattern, main streets, corner stores, and multi-modal

Urban rail stations are lower-scale "walk-up" stations, providing transit access to existing neighborhoods primarily characterized by single-unit and two-unit residential uses, small-scale multi-unit residential uses and embedded commercial areas. Buildings have shallow or moderate setbacks, with consistent pedestrian orientation and parking located behind or to the side.

Areas around urban stations have a regular, smaller block pattern with linear streets and alleys. Due to the lower residential densities but strong street grid, transit use is moderate, with higher use along high capacity transit corridors during peak commuting periods. There is a general balance of pedestrian, bicycle and vehicle travel modes.

Land Use Mix

Primary single-unit and two-unit residential uses on small lots

Small-scale multi-family residential such as rowhouses and garden court apartments

Embedded commercial

Street and Block Pattern

Regular, smaller blocks

Linear streets

Mostly alleys

Building Placement

Consistent, moderate setbacks

Consistent entrance orientation to the street

Parking from the alley or side yard

Building Height

Low-scale structures

Some mid-rise at nodes or along arterials

Mobility

Moderate transit use, greater along high capacity transit corridors and peak hour commuting times

Balance of pedestrian/bike/vehicle use

suburban town centers, community open spaces and residential neighborhoods

Suburban rail stations are characterized by their higher level of transit service and pedestrian orientation than the surrounding, auto-oriented context. These stations may take on the qualities of a town center, having a mix of uses with some mid-to-high-rise buildings oriented towards the transit station, but with significant amounts of surface or structured parking for commuters. A public plaza or open space serving as a community gathering place is a desired amenity. Residential neighborhoods consisting of single-unit and two-unit residential uses and small-scale multi-unit residential uses are found further from the station. Other commercial uses are found along major arterial streets. Block sizes and street types vary greatly, but smaller blocks and pedestrian friendly streets are found near the station, with larger blocks that provide development flexibility further away. Buildings with shallow setbacks are placed in front of parking lots near the station, with deeper setbacks on arterials and parking in front of buildings further from the station.

Land Use Mix

Mixed of uses oriented to the station

Public plaza or open space as central gathering place

Primarily 1-unit, 2-unit, and small-scale mf residential further from station

Commercial uses along arterials

Street and Block Pattern

Mix of block sizes, smaller blocks and pedestrian streets near station, larger blocks further from station

Best connectivity near the station

Large blocks have mid-block pedestrian passages

Building Placement

Deep setbacks

Parking in front of building

Building Height

Low-rise structures

Some mid/high-rise structures

Mobility

Auto-oriented

Regional bike trails

FUNCTIONAL OVERLAYS

These designations are applied to stations that have a key functional aspect on top of their context type that provides additional context and clarifies future expectations.

INNOVATION


River North


Granville Island, Vancouver

Innovation stations are characterized by their high degree of mixed use, adaptive reuse of existing structures, and creative approach to business. These stations typically are found in existing industrial areas, but may have experienced new housing and retail arriving with the rail station. Under-utilized warehouses are being reused by young companies looking for space, often seeking synergy and cooperation with other like-minded companies. Many of these businesses have corporate cultures that emphasize sustainable building design, green technology, and high-quality of life employee amenities like transit passes, car-sharing, and bicycle parking. Businesses may include advanced manufacturing, research and development, and creative design studios.

INSTITUTIONAL


Auraria Campus

Houston, TX

Institutional stations have specific uses that bring unique attributes to station areas. This overlay typically applies to stations with one or more large land owners that have multiple buildings located in a campus setting. Universities, government centers, and medical campuses are typical uses. Stations have a large concentration of jobs and a significant amount of daily visitors, resulting in a high level of transit ridership and internal trip capture via walking and biking.

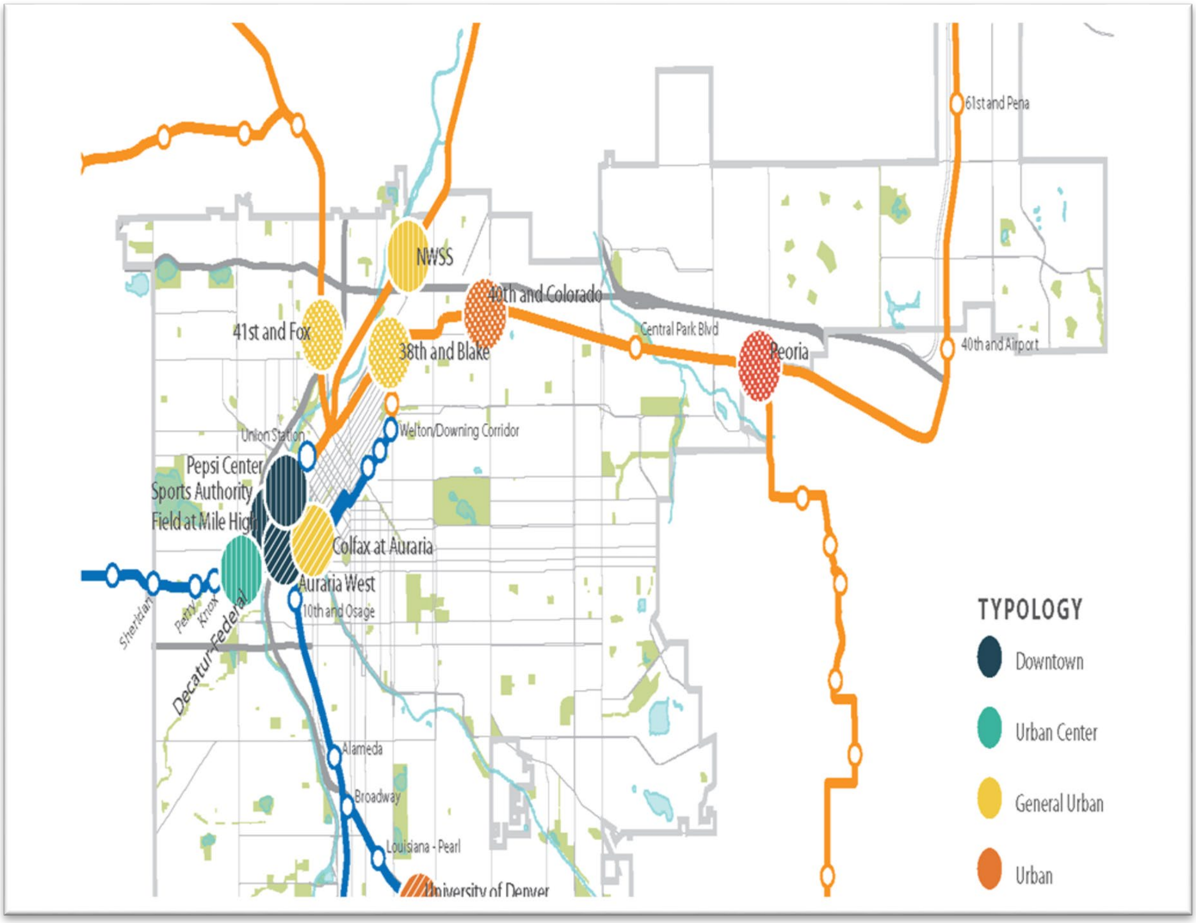
ENTERTAINMENT


Sports Authority Field


LA Live, Los Angeles

Entertainment stations are designed for accommodating major events when a large amount of passengers arrive and depart during a limited period of time. Ample surface parking is typically located at these sites to serve non-transit users. As the region continues to grow, market demand for reuse of this surface parking into commercial and residential development may present itself.

Page 31



In addition to the area types described above, the following three criteria categories for their continued evaluation of TODs on the 'TOD Continuum' (page 38), evaluating based on a standard '1/2 radius station area or a ½ mile walk-shed (10-minute walk)'. See table following from page 39 for specific variables.

Type	Description	Supporting variables
Market Readiness	"helps determine whether the station area real estate market is capable of supporting new development by evaluating the strength of market demand and market timing."	"population density, employment density, TOD demographics, land values, residential price appreciation, commercial rents, and market activity (permit values)."
Development Potential	"evaluates whether the legal, physical, and infrastructure framework of the station area is ready to support new development, and determines the potential capacity for new development"	"plan in place, transit-supportive zoning, developable land (vacant + underutilized), ownership fragmentation, special district (in place), and cost of infrastructure needed."
Transit-Oriented Characteristics	"evaluates how likely it is that station area development will be transit-oriented; that is, are the quantity and quality of access, amenities, and services in and near a station area sufficient to support TOD?"	"physical form (block size), pedestrian access (walk score), bicycle access, number of parks, and transit service frequency."

METHODOLOGY

DATA ANALYSIS

MARKET READINES

Measure	Variable
Household Growth (2000 - 2010)	Annual Percent Change
Employment Growth (2000-2010)	Percent of Area with Transit Supportive Zoning
TOD Demographics (Non-Family Households, Households with no Kids, Householders 25-34 and 55 to 64)	Location Quotient
Property Values	Dollar Amount of Actual Value (Assessor)
Residential Sales Price App. (2000 - 2010)	Annual Percentage Change
Office Rents	Average Commercial Rents - Dollar per square foot (Co-Star)
Retail Rents	Avgerage Commercial Rents - Dollar per square foot (Co-Star)
Commercial Development To Date	Dollar Amount of Permit Value
Residential Development To Date	Dollar Amount of Permit Value

DEVELOPMENT POTENTIAL

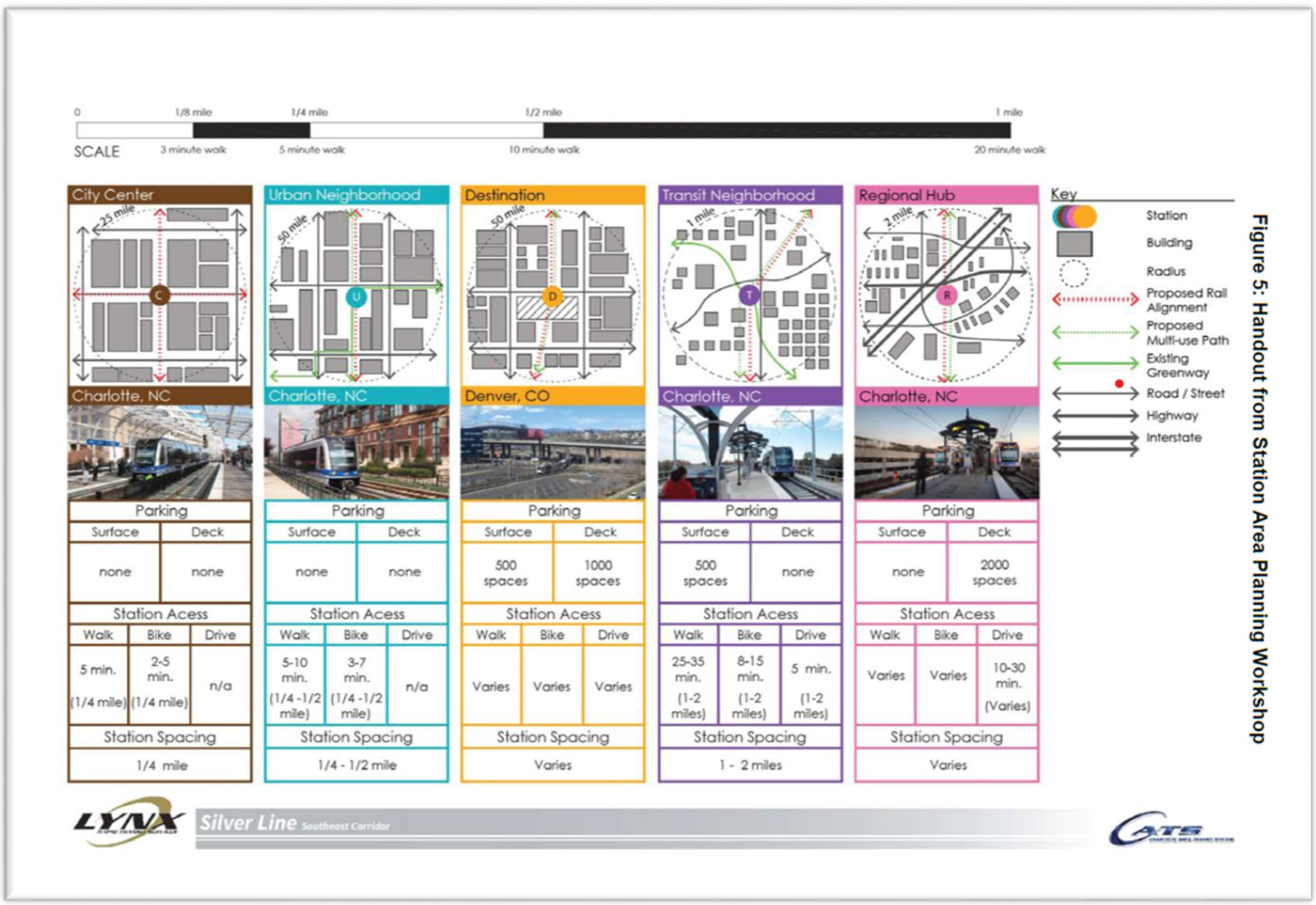
Planning Completed to Date	None/ Station Area Plan / GDP
Zoning	Percentage of Area with transit supportive zoning
Parcelization	Number of Parcels per Acre
Vacant Land	Acres of Vacant Land
Redevelopment Land	Acres of Improved Value/Land Value <1.0
Ownership	Number of Owners/ (Acres of Vacant + Acres of Redevelopable Land)
Urban Renewal Area or Special District	Yes/No
Infrastructure Investment	Dollars of TOD Infrastructure Investment to Date
Infrastructure Needs	Dollars of TOD Infrastructure Investment Needed

TOD CHARACTERISTICS

Employment Density	Jobs/ Acre
Population Density	Population/Acre
Physical Form	Percentage of Blocks =< 4.0 acres
Community Amenity Access	Walk Score
Park Access	Number of Parks
Transit Service	Number of Bus Stops and Peak Hour Train Frequency Combined Location Quotient
Bicycle Access	Linear Feet of Dedicated Bicycle Routes
Bike Share	B-Cycle Station
Automobile Ownership	Number of Vehicle Households Location Quotient

Note: Location quotient is a way of quantifying how concentrated a particular industry, cluster, occupation, or demographic group is in a region as compared to the nation. It can reveal what makes a particular region "unique" in comparison to the national average.

Charlotte Area, North Carolina (2016)
References: (Lynx Rapid Transit Services, 2016)
Transit System: FGT (BRT and LRT)
Purpose of Typology:
Types of Use: Agency; Design or Land Use; Conceptual Planning;
Findings & Outcomes: The purpose of this typology is to help assist in early-stage planning for an expansion of LRT. The area types were used to develop conceptual station locations and types for the hypothetical expanded line.
Method for Aggregating Typology:
Notes: Supporting variables include factors such as scale, density, population, and land uses. It is not clear how the metrics considered across the five Area types were categorized. It is likely it was ‘manual’ based on anecdotal variation and local expertise. The typologies are only applied to the conceptual station locations of the hypothetical new rail alignment.
Categories & Supporting Variables or Definitions:
Notes: The descriptions here may be pulled directly from the language of the document; for image screenshots (marked with an image shadow), page numbers are either left on the image or embedded in the text directly before the image.



2.1 Center City

The Center City station area typology is applicable for stations located within the I-277 Loop. Faced with urban conditions, established infrastructure, and the highest density along the rail alignment, Center City stations are unique and must fit within existing conditions.

Station Area:

1. Urban
2. High density
3. High to mid-rise development
4. Connectivity to existing pedestrian systems

Station Character:

1. Architecture: Walk-up
2. Ridership Area: Walking distance (5-10 minutes, ¼ - ½ mile)
3. Parking: None
4. Surrounding Uses: High-rise Office, Commercial, Residential
5. Associated Uses: Mixed-use
6. Rail alignment: Based on city's grid
7. Rail Type: Light Rail, low speed
8. Station spacing: ½ mile or less, frequent stops
9. Other: Connections to all modes of transit

Figure 7: Typical Center City Station Area

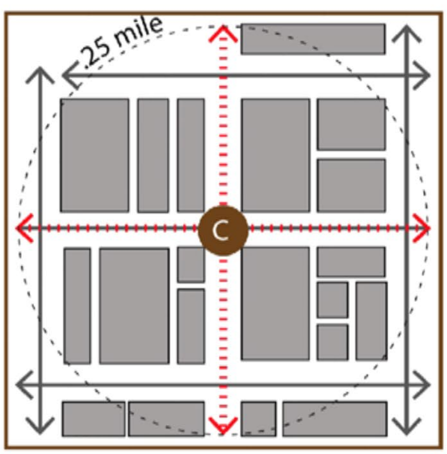


Figure 6: Center City Station Precedents

Charlotte, NC (7th Street)

San Diego, CA

Houston, TX

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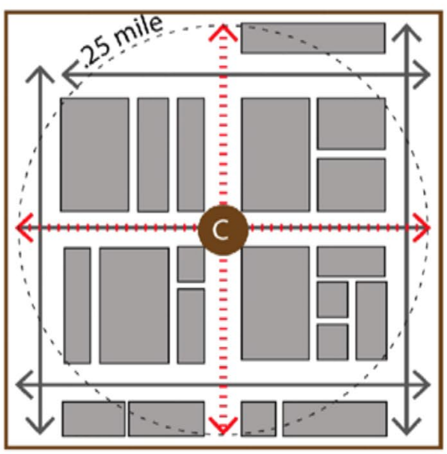

Figure 6: Center City Station Precedents

Charlotte, NC (7th Street)

San Diego, CA

Houston, TX

2.2 Urban Neighborhood

The Urban Neighborhood station area typology is applicable for stations planned for urban, inner-ring neighborhoods. These neighborhoods are typically dense, walkable, and have considerable existing infrastructure.

Station Area:

1. Urban
2. High density
3. High to mid-rise development
4. Connectivity to existing pedestrian systems

Station Character:

1. Architecture: Walk-up
2. Ridership Area: Walking distance (10-15 minutes)
3. Parking: None
4. Surrounding Uses: Mixed-use, Commercial, Multi-family, Single family
5. Associated Uses: None
6. Rail Type: Light Rail, low speed
7. Station Spacing: 1 mile or less, frequent stops
8. Other: Streetcar, bus, and greenway connections

Figure 9: Typical Urban Neighborhood Station Area

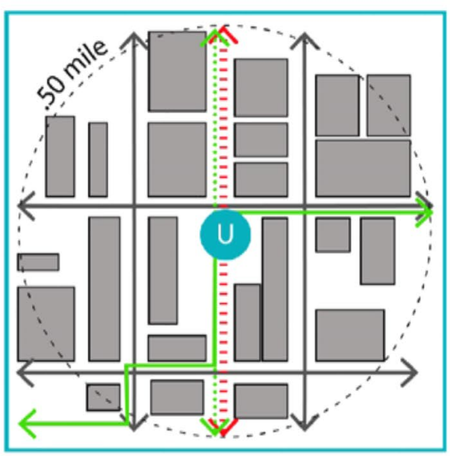

Figure 8: Urban Neighborhood Station Precedents

Charlotte, NC (Bland)

San Diego, CA

Portland, OR

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The Urban Neighborhood station area typology is applicable for stations planned for urban, inner-ring neighborhoods. These neighborhoods are typically dense, walkable, and have considerable existing infrastructure.

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1. Architecture: Walk-up
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3. Parking: None
4. Surrounding Uses: Mixed-use, Commercial, Multi-family, Single family
5. Associated Uses: None
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8. Other: Streetcar, bus, and greenway connections

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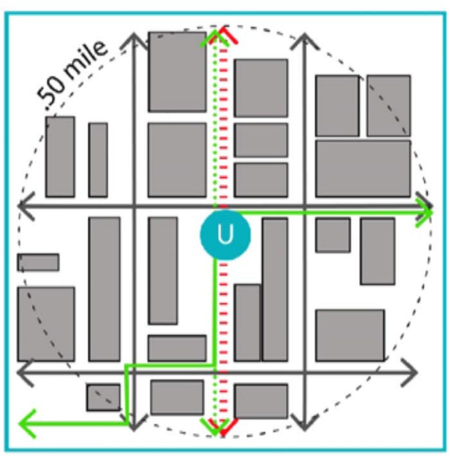


Figure 8: Urban Neighborhood Station Precedents

Charlotte, NC (Bland)

San Diego, CA

Portland, OR

2.3 Transit Neighborhood

The Transit Neighborhood station area typology is applicable for stations planned for suburban areas along the corridor. These neighborhoods typically consist of suburban single family developments, dedicated retail centers, and large arterial roads.

Station Area:

1. Suburban
2. Medium density
3. Low rise to single story development
4. Connectivity to existing/proposed pedestrian systems

Station Character:

1. Architecture: Commuter
2. Ridership Area: Neighborhood/Local (1-3 miles)
3. Parking: Surface or Deck
4. Surrounding Uses: Small Commercial, Multi-family, Single family
5. Associated Uses: None
6. Rail Type: Light Rail, higher speed
7. Station Spacing: 1-3 miles, infrequent stops
8. Other: Possible express service, connections to bus and greenway

Figure 11: Typical Transit Neighborhood Station Area

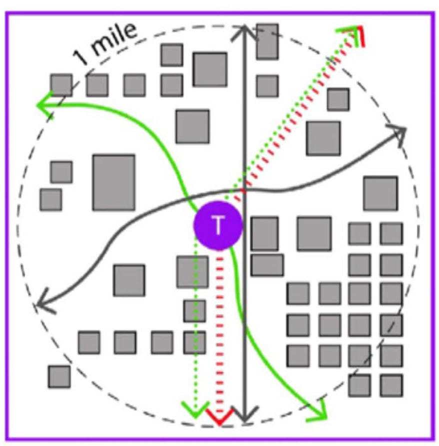


Figure 10: Transit Neighborhood Station Precedents

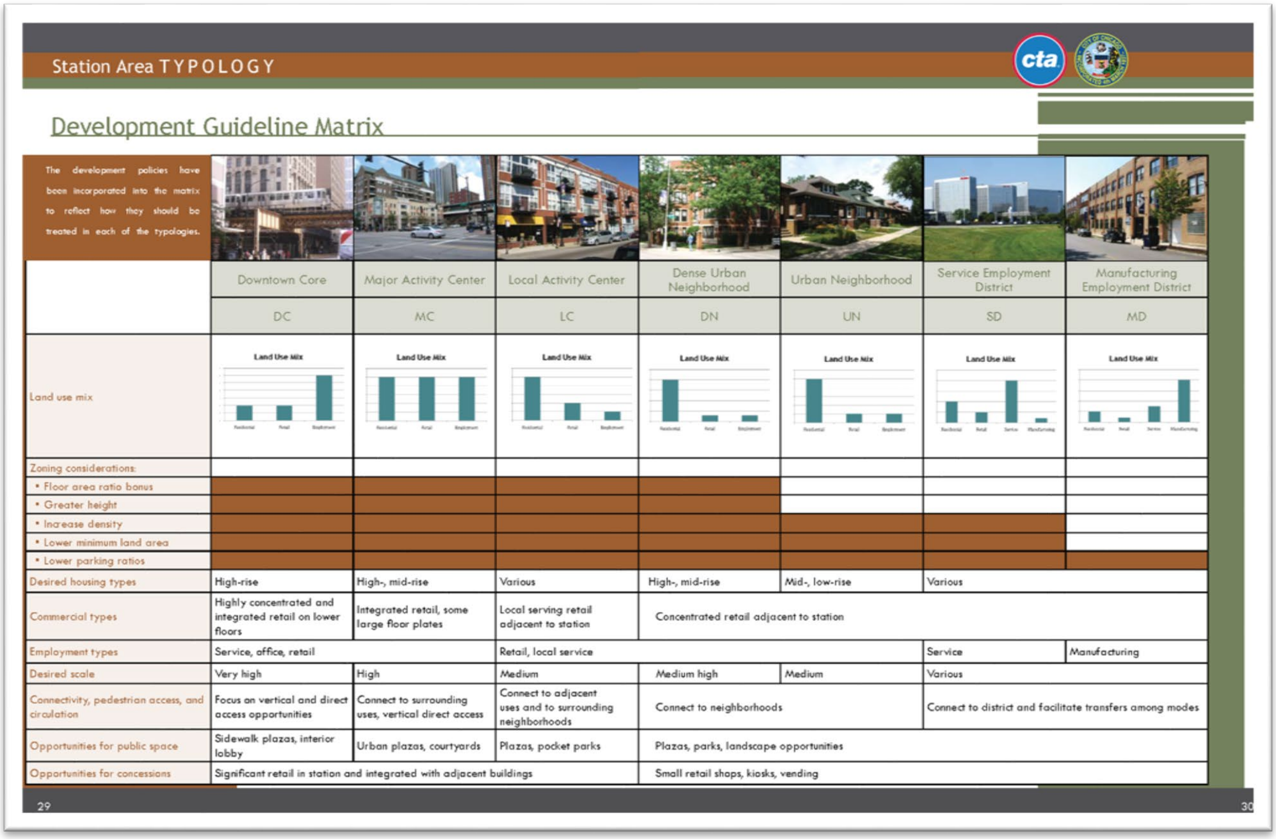
Charlotte, NC (Scaleybark)

Baltimore, MD

Portland, OR

Chicago, Illinois (2009; 2014)
References: (Jones Lang LaSalle et al., 2009; Teska Associates, Inc. et al., 2014)
Note: The information and images come from the 2014 update, unless otherwise noted. The development of the area types was more detailed in the 2009 edition; the 2014 built upon the 2009 version, but they added two new typologies.
Transit System: 77 existing and 2 planned Metra stations, defined as 'commuter rail'. Identifies 11 lines with about a third of the stations (77/241) within the City of Chicago, the focus of this study.
Purpose of Typology:
Types of Use: Agency; Design or Land Use; Strategy Identification & Implementation (light);
Findings & Outcomes: Among other purposes, these documents aim to differentiating across TOD types in the region. While both reports provide some guidance and recommendations for encouraging development and transitioning TODs into their 'realized' potential, these documents fall short of providing a detailed 'toolkit' of strategies for economic and social development.
Definitions:
"Transit oriented development (TOD) is generally defined as development that is oriented towards and integrated with a nearby transit facility, such as a rail station or bus line. TOD is typically perceived as a means to improve access to the transit facility by building up the station area as a compact, mixed use district that is intended to encourage increased transit ridership." (2014, page 3)
Transit friendly development (TFD): "focuses on multimodal connectivity, appropriately scaled development, and station area improvements that create better access to transit facilities and encourage greater transit ridership." (2014, page 3)
Method for Aggregating Typology:
Notes: The 2014 study uses the prior (2009) 7 CTA typologies and adds 2 new ones. It is still not clear how the typologies were categorized, but it is likely it was a combination of quantitative analysis and local expertise.
Supporting data included: "land use; zoning; density; neighborhood character; Metra ridership data, frequency of service, and fare zones; commuter parking; access to CTA bus and rail; walkability and bikeability scores; nearby employers and business districts; local institutions; and opportunities for development and station area improvements." (Teska Associates, Inc. et al., 2014, p. 3)
Categories & Supporting Variables or Definitions:
Notes: The descriptions here may be pulled directly from the language of the document; for image screenshots (marked with an image shadow), page numbers are either left on the image or embedded in the text directly before the image.

(Jones Lang LaSalle et al., 2009, pp. 29–30)



Station Area TYPOLOGY

Development Guideline Matrix

The development policies have been incorporated into the matrix to reflect how they should be treated in each of the typologies.

	Downtown Core	Major Activity Center	Local Activity Center	Dense Urban Neighborhood	Urban Neighborhood	Service Employment District	Manufacturing Employment District
	DC	MC	LC	DN	UN	SD	MD
Land use mix	Land Use Mix	Land Use Mix	Land Use Mix	Land Use Mix	Land Use Mix	Land Use Mix	Land Use Mix
Zoning considerations:							
• Floor area ratio bonus							
• Greater height							
• Increase density							
• Lower minimum land area							
• Lower parking ratios							
Desired housing types	High-rise	High-, mid-rise	Various	High-, mid-rise	Mid-, low-rise	Various	
Commercial types	Highly concentrated and integrated retail on lower floors	Integrated retail, some large floor plates	Local serving retail adjacent to station	Concentrated retail adjacent to station			
Employment types	Service, office, retail		Retail, local service			Service	Manufacturing
Desired scale	Very high	High	Medium	Medium high	Medium	Various	
Connectivity, pedestrian access, and circulation	Focus on vertical and direct access opportunities	Connect to surrounding uses, vertical direct access	Connect to adjacent uses and to surrounding neighborhoods	Connect to neighborhoods		Connect to district and facilitate transfers among modes	
Opportunities for public space	Sidewalk plazas, interior lobby	Urban plazas, courtyards	Plazas, pocket parks	Plazas, parks, landscape opportunities			
Opportunities for concessions	Significant retail in station and integrated with adjacent buildings			Small retail shops, kiosks, vending			

29 30

(Teska Associates, Inc. et al., 2014, p. 2)– LN and RI are new; more detailed descriptions of each of these 2014 area types to follow.

Chicago Plan Commission Meeting - October 16, 2014

DC **DOWNTOWN CORE**
Located in the Loop and adjacent high density areas, Metra service generates highest ridership counts in the system within the City of Chicago. Land uses are primarily employment-generating uses within the central business district, with a mix of retail and residential. Residential primarily in high-rise buildings. Superior access to CTA rail and bus.

26,667 AVERAGE WEEKDAY AM BOARDINGS

MC **MAJOR ACTIVITY CENTER**
An MC is a major node of activity generally located outside of the downtown core. Metra ridership at the MCs varies, but all station areas are served by CTA rail and bus. They typically have a balanced mix of residential, commercial, and employment-generating uses, with residential development typically provided in mid- to high-rise buildings.

616 AVERAGE WEEKDAY AM BOARDINGS

LC **LOCAL ACTIVITY CENTER**
An LC is primarily characterized by the Metra station being the central focus of a built-up and identifiable neighborhood. An LC typically has the highest density and greatest mix of uses around the station. Infill development and adaptive reuse present opportunities to enhance the vitality of the LC.

785 AVERAGE WEEKDAY AM BOARDINGS

DN **DENSE URBAN NEIGHBORHOOD**
A DN serves Chicago neighborhoods with a high concentration of development and a high level of riders who walk to the station. While all stations have access to CTA bus, only Rogers Park has nearby CTA rail access. Land use is composed of a mix of commercial development near the stations surrounded by residential development.

440 AVERAGE WEEKDAY AM BOARDINGS

UN **URBAN NEIGHBORHOOD**
A UN serves an established neighborhood, but ridership varies in intensity and about half of riders walk, bike or take transit to the station. Land use is primarily residential, but many UNs have commercial districts. UN stations generally have CTA or Pace buses with only a few having CTA rail stations nearby.

302 AVERAGE WEEKDAY AM BOARDINGS

LN **LOW DENSITY NEIGHBORHOOD**
An LN is predominantly residential in nature with modest Metra ridership. LN is one of two new typologies that has been created for Metra stations. With more than three-quarters of the land use devoted to residential, an LN has a strong residential character with minimal retail and employment uses located around the station areas.

194 AVERAGE WEEKDAY AM BOARDINGS

SD **SERVICE EMPLOYMENT DISTRICT**
An SD is typically identified by a major service use with high employment, such as a university or airport. Two of the four SD stations are located next to major universities: Chicago State University and the University of Chicago. The other two serve O'Hare Airport, which is a major multimodal transportation hub with access to various employers.

174 AVERAGE WEEKDAY AM BOARDINGS

MD **MANUFACTURING EMPLOYMENT DISTRICT**
An MD is generally characterized by a significant amount of manufacturing land uses. Over one-quarter of the total land use is devoted to industrial, warehouse, or wholesale trading. Another quarter are for railways and freight use. Residential uses still comprise less than one-third, which contributes to about half of all commuters accessing the MD stations.

335 AVERAGE WEEKDAY AM BOARDINGS

RI **MIXED RESIDENTIAL/INDUSTRIAL NEIGHBORHOOD**
An RI is an area in which the Metra station serves both residential and industrial uses. The train tracks often separate these uses which have evolved over time.

234 AVERAGE WEEKDAY AM BOARDINGS

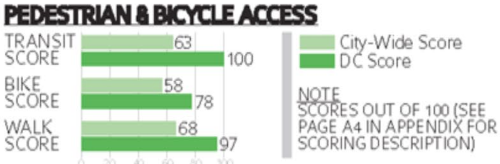
2 CITY OF CHICAGO & METRA STATION TYPOLOGY STUDY

DC DOWNTOWN CORE

METRA RIDERSHIP
Weekday ridership averages more than 26,000 riders, which is the highest in the system.

CTA ACCESS
All five DC station areas have adequate CTA bus and rail access.

PEDESTRIAN & BICYCLE ACCESS



COMMUTER PARKING
None of the DCs have access to commuter parking facilities.

The Downtown Core (DC) is located around the Loop and adjacent to high density areas, with stations generating the highest ridership counts in the system.

Metra weekday ridership averages 26,000+ riders for the five DCs, with all station areas served by CTA rail and bus. A majority of commuters arrive to the DC stations on foot or via CTA. Consistent with the Loop, the average land use makeup of a DC station area is predominantly commercial and service uses, with residential, institutional, and open space components as well. DCs also have the highest walk, bike, and transit scores in the entire system.

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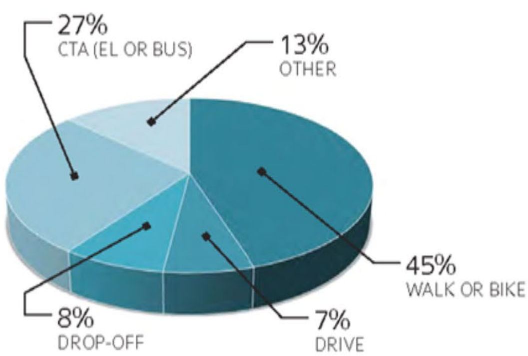
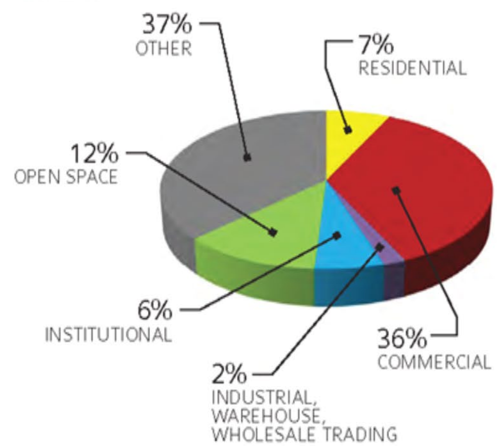
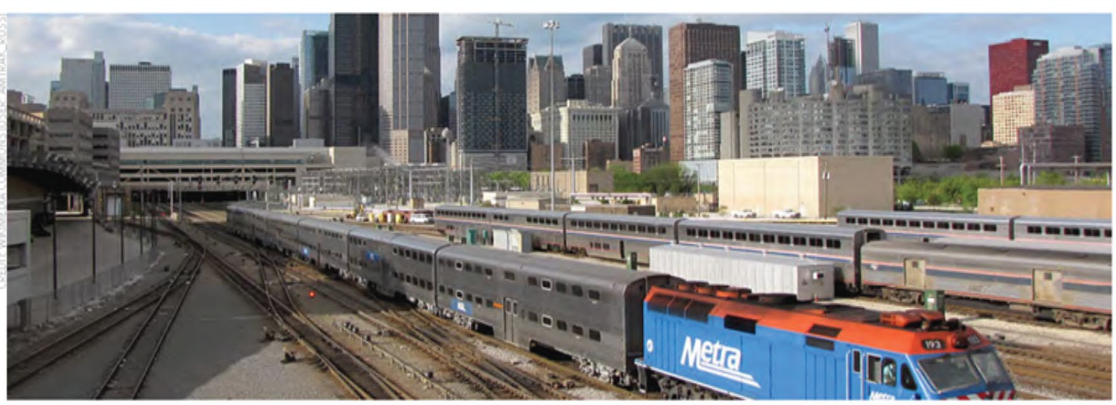


[A] Data refer to typology averages within ½-mile radius of DC stations.

LAND USE [A]



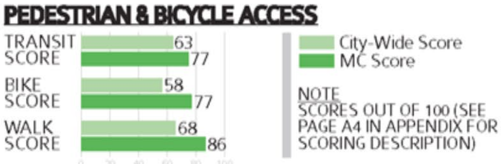


MC MAJOR ACTIVITY CENTER

METRA RIDERSHIP
Weekday ridership is a strong attribute of MC. Four of the 7 MC stations attract 500+ riders.

CTA ACCESS
While 3 of the 7 MC stations have nearby CTA rail access, all MCs have strong CTA bus access.

PEDESTRIAN & BICYCLE ACCESS



COMMUTER PARKING
Two of the 7 MC stations have access to commuter parking, with an average of 95% of available parking spaces being utilized.

A Major Activity Center (MC) is a major node of activity generally located outside of the downtown core.

Metra weekday ridership at the MCs varies, but all station areas are served by CTA rail and bus. They typically have a balanced mix of residential, commercial, and employment-generating uses, with residential development typically provided in mid- to high-rise buildings. Some have major cultural attractions or institutional uses, such as a university, sports facility, convention center, or museum. In addition, the Metra station area at Jefferson Park is one of the City's more prominent transit hubs located beyond the downtown core.

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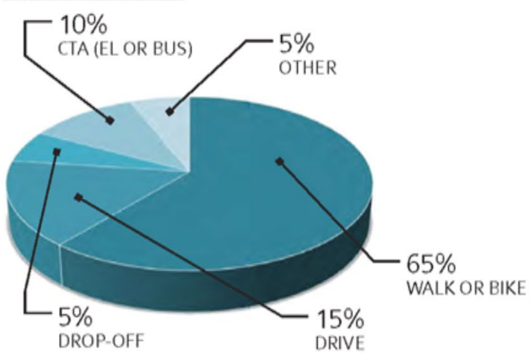

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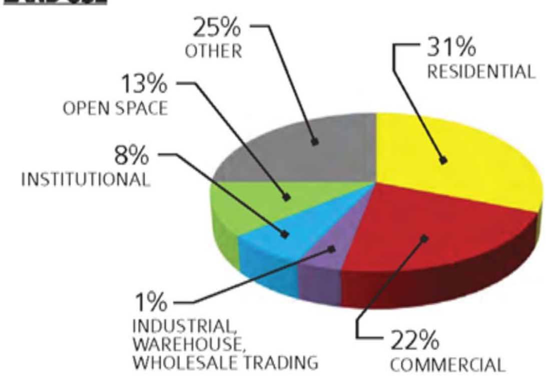
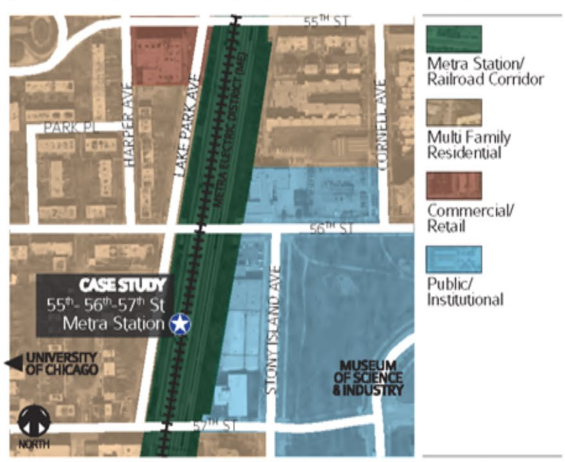


[A] Data refer to typology averages within ½-mile radius of MC stations.



CASE STUDY

55th-56th-57th Street

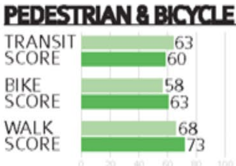
The 55th-56th-57th Street Metra Station, serving Hyde Park, the University of Chicago, and the Museum of Science and Industry, is at the center of a large built-up neighborhood with a mix of land uses, from high rise residential to large retailers and university-related buildings. The station is located above a viaduct with a small retail space at ground level. With 1,500+ riders per day, the station is one of the most heavily used stations -- ranking 8th of all 77 existing Metra stations within the City of Chicago – in a neighborhood setting. The pedestrian environment, signage, and linkages to nearby amenities are important aspects of this station area.

LC LOCAL ACTIVITY CENTER

METRA RIDERSHIP
Weekday ridership is a strong attribute of LC. Seven of the 11 LC stations attract 500+ riders.

CTA ACCESS
Each LC is defined by a Metra station as its focal point with strong CTA bus access.

PEDESTRIAN & BICYCLE ACCESS



COMMUTER PARKING
Seven of the 11 LC stations have access to commuter parking, with an average of 67% of available parking spaces being utilized.

A Local Activity Center (LC) is primarily characterized by the Metra station being the central focus of a built-up and identifiable neighborhood.

An LC is primarily built up with the highest density and greatest mix of uses around the station. Residential also varies with single- and multi-family uses. Infill development and adaptive reuse present opportunities to enhance the vitality of the LC. Redevelopment opportunities, as well as enhanced connectivity and amenities for pedestrians and bicyclists, will help attract Metra riders. The Metra station will continue to be the central focus of the LC, while also maintaining the pedestrian scale of the surrounding area and providing opportunities for local shopping, dining, and employment.

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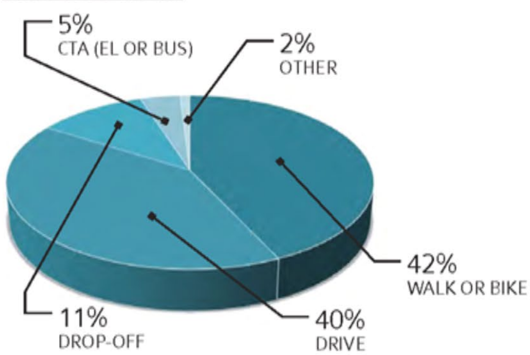

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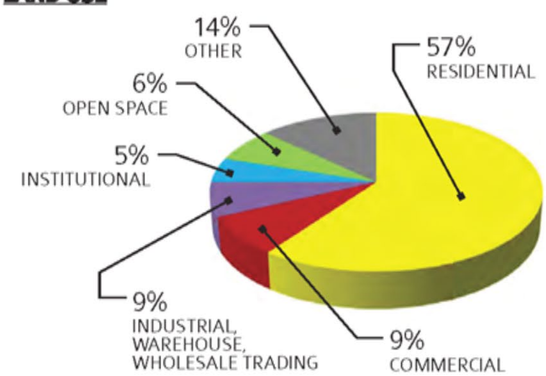
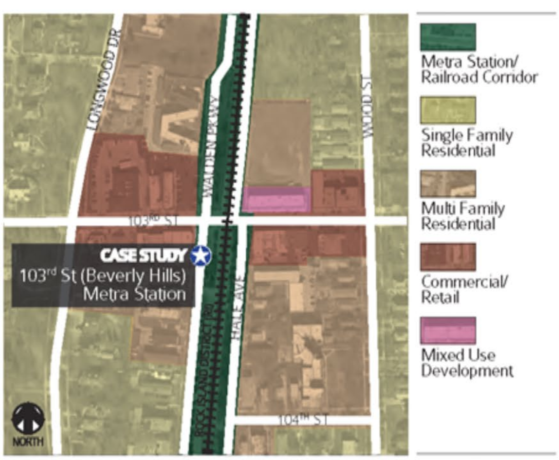


[A] Data refer to typology averages within ½-mile radius of LC stations.



CASE STUDY
103rd Street (Beverly Hills)

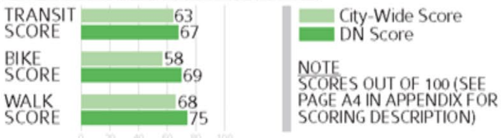
The 103rd Street Metra Station is the focal point of the portion of the Beverly Hills community along the 103rd Street corridor. The corridor is presently defined by a strong streetwall of businesses and mixed use buildings that create a pedestrian-oriented streetscape that leads to the Metra station. While recent mixed use and residential development have appeared on the north side of 103rd Street across from the station, opportunities exist for infill development and adaptive reuse of a former funeral parlor. As outlined in the case study on the next page, a mix of transit, streetscape, and site improvements are intended to build upon the existing transit friendly elements for this LC.

DN DENSE URBAN NEIGHBORHOOD

METRA RIDERSHIP
Weekday ridership for DN is moderate, averaging 440 riders. Rogers Park attracts 1,176 riders.

CTA ACCESS
Each DN has adequate CTA bus access, with only Rogers Park having nearby CTA rail.

PEDESTRIAN & BICYCLE ACCESS



COMMUTER PARKING
Three-fourths of existing DN stations have access to commuter parking, with an average of 80% of available parking spaces being utilized.

A Dense Urban Neighborhood (DN) serve Chicago neighborhoods with a high concentration of development.

Four existing Metra station are designated as DN, with the proposed Peterson/Ridge station being the fifth. While all stations have access to CTA bus, only Rogers Park has nearby CTA rail access. The Metra station is not the focal point of a DN like it is for most LCs, despite their similar land use characteristics. For example, the Rogers Park station sits west of the bustling Clark Street corridor. Land use is composed of a mix of commercial development near the stations, surrounded by residential development. Residential uses may include mid-to high-density buildings, although some areas may be primarily composed of single-family two- and three-flats on small lots located near the station.

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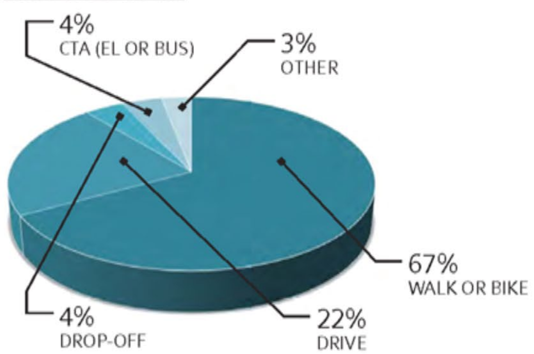

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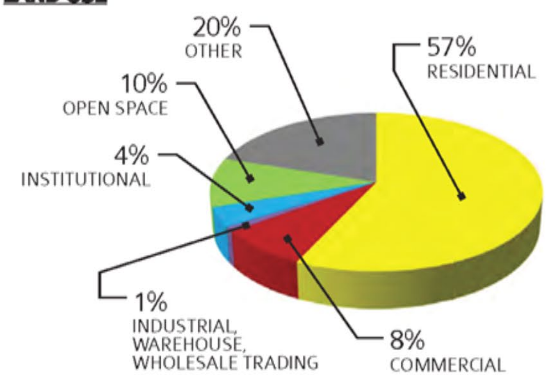
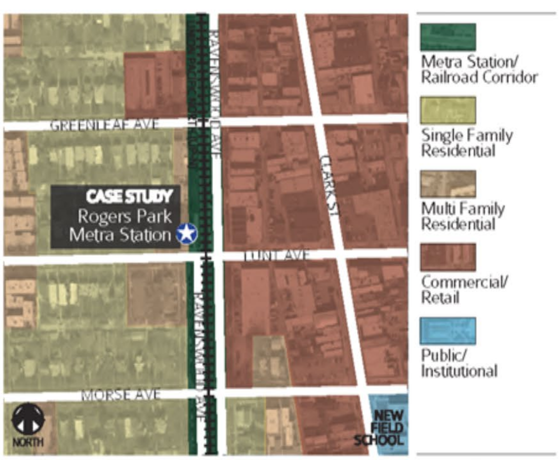


[A] Data refer to typology averages within ½-mile radius of DN stations.



CASE STUDY
Rogers Park

The Rogers Park Metra Station serves a vibrant neighborhood with a strong mix of uses, smaller industrial buildings near the railroad tracks to the east, and a major commercial corridor one block to the east. On the west side, most of the neighborhood is residential. With over 1,100 riders per day, the station ranks 11th of all 77 existing Metra stations within the City of Chicago. In addition to having 137 available parking spaces that have a 90% utilization rate, nearly three-quarters of riders access the station by walking. The station serves both residents and employees who live and work nearby in the neighborhood.

UN URBAN NEIGHBORHOOD

METRA RIDERSHIP

Weekday ridership is moderate with an average of 302 riders. Five of the existing 28 UN stations attract 500+ riders.

CTA ACCESS

While only a few UN stations have CTA rail access, all have CTA or Pace bus access.

PEDESTRIAN & BICYCLE ACCESS

COMMUTER PARKING

Twenty-three of 28 existing UN stations have access to commuter parking, which average a 49% utilization rate of available spaces.

An Urban Neighborhood (UN) serves an established neighborhood, but ridership varies in intensity.

The UN typology designation is applied to 28 existing Metra stations, with the proposed Auburn Park (79th Street) station bringing the total up to 29. Of all nine Metra typologies, the UN designation is applied to the most stations in the City of Chicago (29 out of 79). A UN neighborhood is generally served by CTA or Pace bus, with only a few UNs having CTA rail stations nearby. Land use is primarily residential, but many UNs have commercial districts. About half of riders either walk, bike, or take transit to Metra and the other half drive to the station. Density around a UN station is moderate, then tapers off away from the station, generally to low-density residential.

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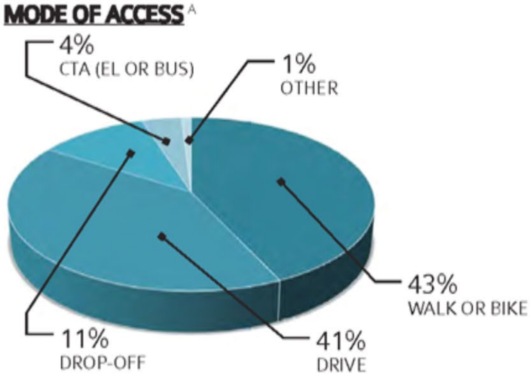

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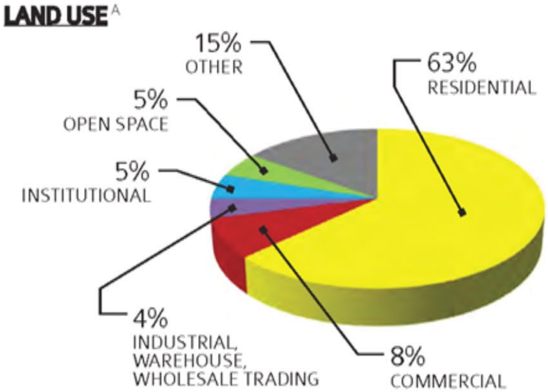


[A] Data refer to typology averages within ½-mile radius of UN stations.

CASE STUDY
Brainerd

The Brainerd Metra Station serves a primarily residential area on both sides of the railroad tracks, which run east-west through the neighborhood at surface level. A large senior building was recently built south of the tracks, and additional vacant land could be developed for residential or commercial purposes. Parking lots around the station area make it convenient to drive to the station, but the area is also generally pedestrian-friendly. Additional landscaping and pedestrian improvements could make the station area more attractive to Metra users.

UN URBAN NEIGHBORHOOD

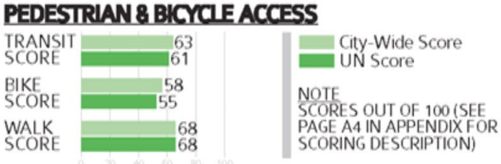
METRA RIDERSHIP

Weekday ridership is moderate with an average of 302 riders. Five of the existing 28 UN stations attract 500+ riders.

CTA ACCESS

While only a few UN stations have CTA rail access, all have CTA or Pace bus access.

PEDESTRIAN & BICYCLE ACCESS



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Twenty-three of 28 existing UN stations have access to commuter parking, which average a 49% utilization rate of available spaces.

An Urban Neighborhood (UN) serves an established neighborhood, but ridership varies in intensity.

The UN typology designation is applied to 28 existing Metra stations, with the proposed Auburn Park (79th Street) station bringing the total up to 29. Of all nine Metra typologies, the UN designation is applied to the most stations in the City of Chicago (29 out of 79). A UN neighborhood is generally served by CTA or Pace bus, with only a few UNs having CTA rail stations nearby. Land use is primarily residential, but many UNs have commercial districts. About half of riders either walk, bike, or take transit to Metra and the other half drive to the station. Density around a UN station is moderate, then tapers off away from the station, generally to low-density residential.

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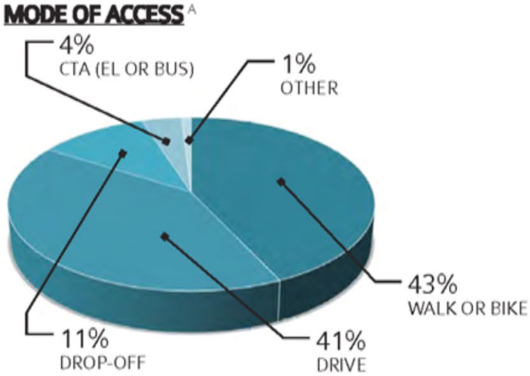

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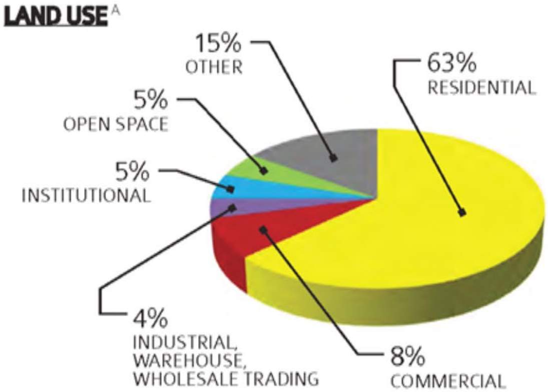

[A] Data refer to typology averages within ½-mile radius of UN stations.

CASE STUDY
Forest Glen

The Forest Glen Metra Station serves a residential neighborhood east and south of the station and a commercial district along N. Elston Avenue west of the station. A new grocery store that recently opened on Elston will be a major retail anchor for the area. Just north of the station, Forest Glen Woods is owned by the Cook County Forest Preserve District. The station serves both riders walking to the station from nearby homes, as well as passengers who drive to the station who either park or are dropped off. While the station is generally favorable to pedestrians and bikes, modest improvements could make the area more pedestrian- and bike-friendly.

LN LOW DENSITY NEIGHBORHOOD

METRA RIDERSHIP
Two of the 3 LN stations attract an average of 85 riders or less on weekdays. The third station at 91st Street (Beverly Hills) attracts 437 riders.

CTA ACCESS
None of the LNs have nearby CTA rail access, but all three have CTA or Pace bus access.

PEDESTRIAN & BICYCLE ACCESS


COMMUTER PARKING
Only one of the three LNs has access to commuter parking. The 91st Street (Beverly Hills) Station has 189 parking spaces with a 64% utilization rate.

A Low Density Neighborhood (LN) is predominantly residential in nature with modest Metra ridership.

LN is one of two new typologies that has been created for Metra stations. With more than three-quarters of the land use devoted to residential, an LN has a strong residential character with minimal retail and employment uses located around the station areas. Metra is often the most visible form of transit, as few station areas have proximate CTA rail, although most are served by CTA or Pace bus. Approximately half of riders walk or bike to the station, with the other half driving or being dropped off at the station. Metra serves to stabilize the LN areas and is a significant amenity for the local housing stock.

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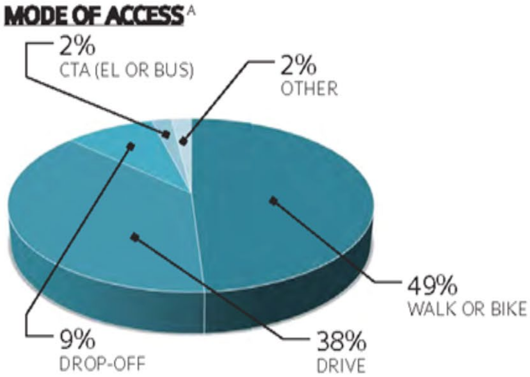

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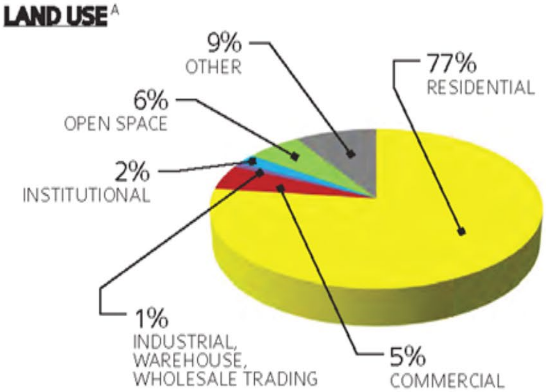

[A] Data refer to typology averages within ½-mile radius of LN stations.

CASE STUDY
State Street
The State Street Metra Station, which is located in the West Pullman neighborhood, serves a low density residential base that generally walks to the station. Although some parking is available, none of the parking is designated commuter parking. The station is located on the single-track Blue Island Branch, which is not elevated and has less frequent Metra service than stations on the Main Line of the Metra Electric District. Pedestrian and bike friendliness is due to generally low traffic counts on local streets and the low-density residential nature around the station area.

SD SERVICE EMPLOYMENT DISTRICT

METRA RIDERSHIP
Weekday ridership is moderate with an average of 174 riders. The 59th Street Station at the University of Chicago attracts 500+ riders.

CTA ACCESS
All 4 SDs are accessible via CTA or Pace bus; however, none have nearby CTA rail stations.

PEDESTRIAN & BICYCLE ACCESS

COMMUTER PARKING
Two of the 4 SD station areas have access to commuter parking, which average a 71% utilization rate of available spaces.

A Service Employment District (SD) is typically identified by a major service use with high employment, such as a university or O'Hare Airport.

Two of the four SD stations are located next to major universities: 59th Street next to the University of Chicago and 95th Street adjacent to Chicago State University. The other two serve the O'Hare Airport area, which is a major multimodal transportation hub with access to various employers. An SD also has significantly more riders that view the station as their AM destination, due to employment in the area. Land use distribution is diverse, particularly noting the high percentage of institutional (e.g., schools) and other (e.g., transportation-related) uses. About an even amount of commuters walk or bike to an SD as arrive by car. Another 15% arrive by other means, including employer or university shuttles.

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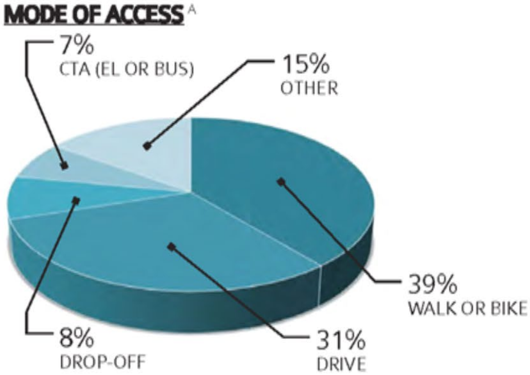

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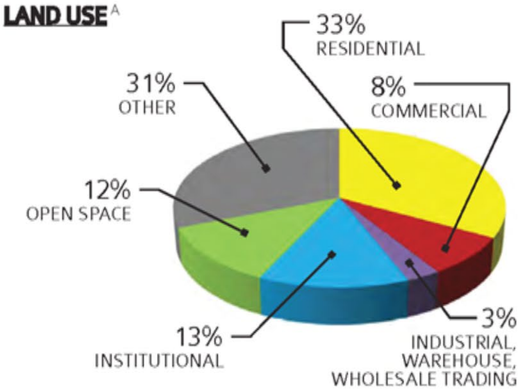
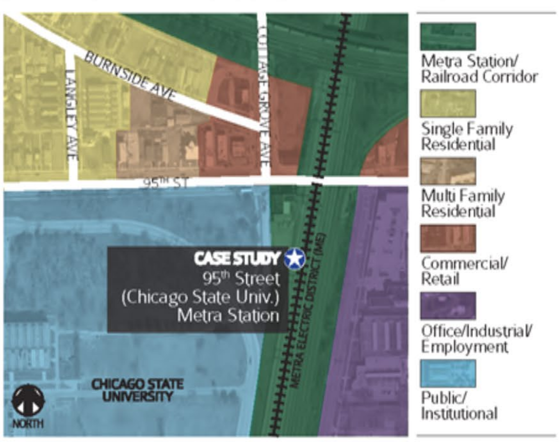


[A] Data refer to typology averages within ½-mile radius of SD stations.



CASE STUDY

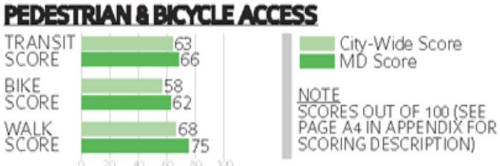
95th Street (Chicago State University)

The 95th Street (Chicago State University) Metra Station is located just east of the Chicago State University campus. The CTA 95th Street bus route provides significant connectivity for the campus and Metra station, since the route links to the CTA 95th/Dan Ryan Red Line Station -- one of the busiest rail stations in the CTA system and a key CTA/Pace bus terminal. While there are preliminary plans to establish additional commuter parking near the campus, the City, Metra, and university will continue to work together on other mutually beneficial projects to encourage ridership and create improved connectivity between the station and the campus.

MD MANUFACTURING EMPLOYMENT DISTRICT

METRA RIDERSHIP
Weekday ridership averages 335 riders. The Western Avenue station along the MD-N, MD-W, and NCS Lines attracts 800+ riders.

CTA ACCESS
Two of the three MD stations have nearby CTA rail access. All three have CTA bus access.

PEDESTRIAN & BICYCLE ACCESS


COMMUTER PARKING
Two of the three MD stations have access to commuter parking, which average a 94% utilization rate of available spaces.

A Manufacturing Employment District (MD) is generally characterized by a significant amount of manufacturing related land uses.

About 28% of the total land use in a typical MD station area is devoted to industrial, warehouse, or wholesale trading. Another 27% are for other uses, which typically include railways and freight uses relating to manufacturing. Residential uses still comprise a significant amount at 31%, which contributes to a quarter of all commuters accessing the MD stations by walking or biking, and another quarter by CTA rail or bus. Commuters arriving by car utilize almost all available parking spaces. Similar to SD, an MD has significantly more riders than other typologies that view the station as their AM destination, due to employment in the area.

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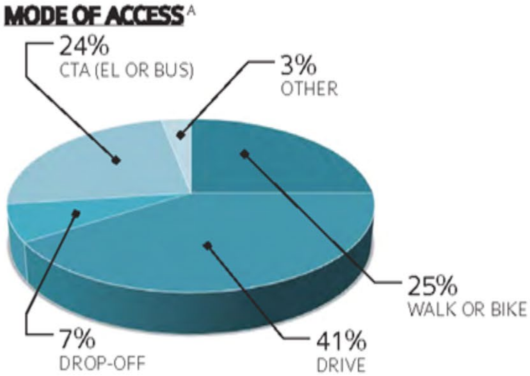

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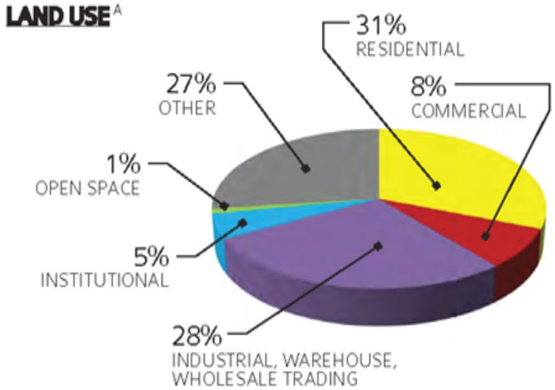

[A] Data refer to typology averages within ½-mile radius of MD stations.

CASE STUDY
Western Avenue
Serving the Milwaukee District North and West Lines, the Western Avenue Metra Station attracts 800+ daily riders, ranking 14 of 77 existing Metra stations within the City of Chicago. Surrounded by railyards and industrial uses, the station area generates significant employment. Established neighborhoods north of the station enable commuters to access the station conveniently on foot or by bike. The station is accessible via CTA bus, with the CTA California Green Line Station located within a ½-mile radius (less than a 1-mile walk/bike ride). Infill development is encouraged to continue building up the proximity of industrial and commercial uses near the station.

RI MIXED RESIDENTIAL / INDUSTRIAL NEIGHBORHOOD

METRA RIDERSHIP
Weekday ridership is moderate with an average of 234 riders. One-quarter of the 12 RI stations have about 300+ riders.

CTA ACCESS
Only one RI station has nearby CTA rail access, but all 12 RIs have CTA or Pace bus access.

PEDESTRIAN & BICYCLE ACCESS

COMMUTER PARKING
Two-thirds of the RI stations have access to commuter parking, which average a 52% utilization rate of available spaces.

A Mixed Residential / Industrial Neighborhood (RI) is an area in which the Metra station serves both residential and industrial uses.

RI is one of two new typologies that has been created for Metra stations. While residential use is usually the predominant land use, industrial related uses are also a significant component of the neighborhood. In particular, about 16% is devoted to industrial, warehouse, and wholesale trading, with another 19% covering other uses, which is often railyards or other industrial related uses. The residential aspect plays a major role in the fact that almost half of commuters access RI stations on foot or by bike. The high walk/bike percentage may also be an influential factor on the 52% utilization rate of available commuter parking spaces.

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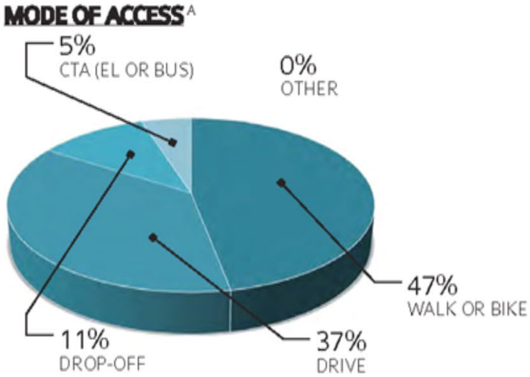

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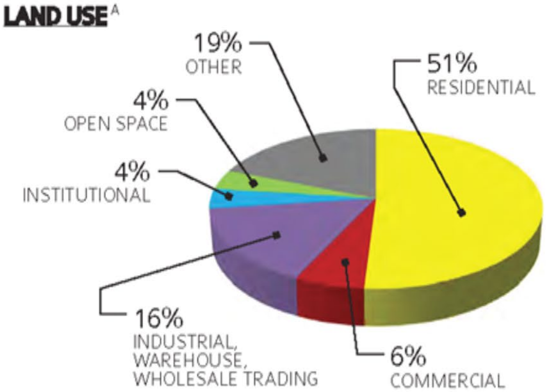
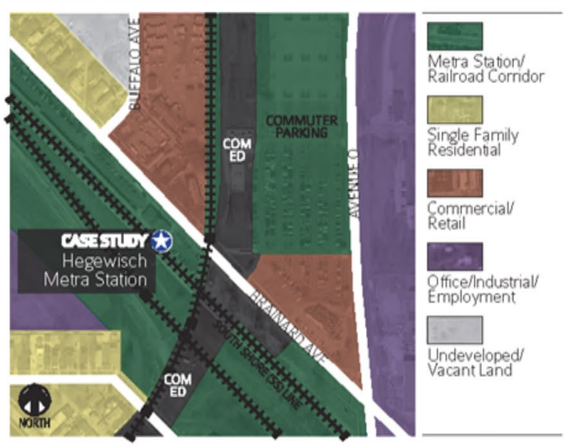


[A] Data refer to typology averages within ½-mile radius of RI stations.



CASE STUDY
Hegewisch

The Hegewisch Metra Station, which is located along the South Shore Line managed by NICTD, is a prime example of the RI typology. In particular, major industrial users are located on the eastern and western sections of the ½-mile station area, and residential neighborhoods set on the northern and southern sections. Commercial uses are also located near the Metra station and along the Baltimore Avenue corridor. Residential development is encouraged in close proximity to the station. Improvements to pedestrian and bike access and circulation are also recommended.

Atlanta, Georgia (2014)
References: (Reconnecting America, 2014) - Note: This is a working document and may not reflect the final typologies or strategies.
Transit System: Heavy rail stations, but they consider overlap with alternative/supportive transportation modes.
Purpose of Typology:
Types of Use: Agency; Strategy Identification & Implementation; Prioritization;
Findings & Outcomes: The purpose of this typology is to evaluate existing transit with an ‘social equity lens’ to identify strategies and investments.
Key Findings:
“There is a disconnect between where low-income and communities of color live and where the jobs are.” (page 8)
“The real estate market and TOD demand is stronger in more affluent areas, which is also where most jobs are.” (page 11)
“The real estate market is weakest in low-income communities to the west and south.” (page 12)
“Emerging real estate markets in communities proximate to downtown presents a risk of displacement.” (page 12)
“The western and southern communities need better regional access to employment centers via transit.” (page 14)
Recommendations:
System wide
“The strength of the market will dictate TOD in certain station areas.” (page 15)
“Vulnerability concerns will require equitable TOD strategies in certain station areas.” (page 15)
“The region needs to continue pushing for affordable housing strategies for major job centers on the MARTA system and move forward with transportation strategies for those employment centers that are not on the MARTA system.” (page 15)
Area type recommendations (page 19)

Figure 11: Recommendations by Place Type

Type	Affordable Housing Strategies	Diversify Housing Stock	Improve Job Access	Infrastructure Improvements	Strengthen Community Assets	Planning/ Visioning
A	Short-Term	X	Within station areas	X	X	
B	Short-Term	X	Within station areas		X	
C	Immediate	X	Within station areas		X	X
D	Immediate	X	To other station areas	X	X	X
E	Long-Term		To other station areas	X	X	

Method for Aggregating Typology:
Notes: Two dimensions (vulnerability and market strength) are developed based relative supporting variables. The variables are ‘scored and indexed’ into categories. The ‘scoring system’ is unknown for each variable, but it possible that this is either a ‘scaling’ or a manual approach.
Categories & Supporting Variables or Definitions:
Notes: The descriptions here may be pulled directly from the language of the document; for image screenshots (marked with an image shadow), page numbers are either left on the image or embedded in the text directly before the image.

Category	Definitions (page 2 and 3)	Supporting Variables (verbatim list, page 2-3)

Vulnerability	High ("high percentage of low-income and transit oriented vulnerable populations") Moderate ("mix of incomes and a moderate percentage of transit oriented vulnerable populations") Low ("low percentage of low-income and transit oriented vulnerable populations")	Median Household Income Percentage of Zero-Car Households Percent Renters Percent Walk, Bike, and Transit Commuters (combined)
Market Strength & TOD Suitability	Mature: ("most urban locations, with a wide range of high-density uses over the decades. Transit adds to development potential but is not necessarily a catalyst.") Emerging: ("developed urban attributes, and future real estate development will capitalize on transit access to further aid in urban infill.") Emerging Potential: ("positioned to benefit from TOD but are lacking attributes to attract large amounts of mixed-uses to date.") Lagging: ("lack the attributes that are likely to attract developers looking for acceptable returns in a market-rate environment.")	TOD Demographics Housing Density per Acre Percent Population Change, 2000-2012 Percent of Population aged 18-34 (Generation Y/Millennial) Percent of Singles Population Median Household Income Employment Characteristics Employment Density (Jobs per Acre) Percent of Employees Earning More Than $3,333 Per Month Commercial Characteristics Total Office Square Feet (Office Inventory) Average Office Rents ($) Total Retail Square Feet (Retail Inventory) Average Retail Rents ($) Residential Characteristics Percentage of Housing Built Since 2000 Average Apartment Rents (within 1 mile) ($) 2012 Number of New Homes Sold (within 1 mile) 2012 New Average Sales Price (within 1 mile) ($) Physical Characteristics Walk Score Nearby Barriers MARTA TOD Land Nearby Development Land

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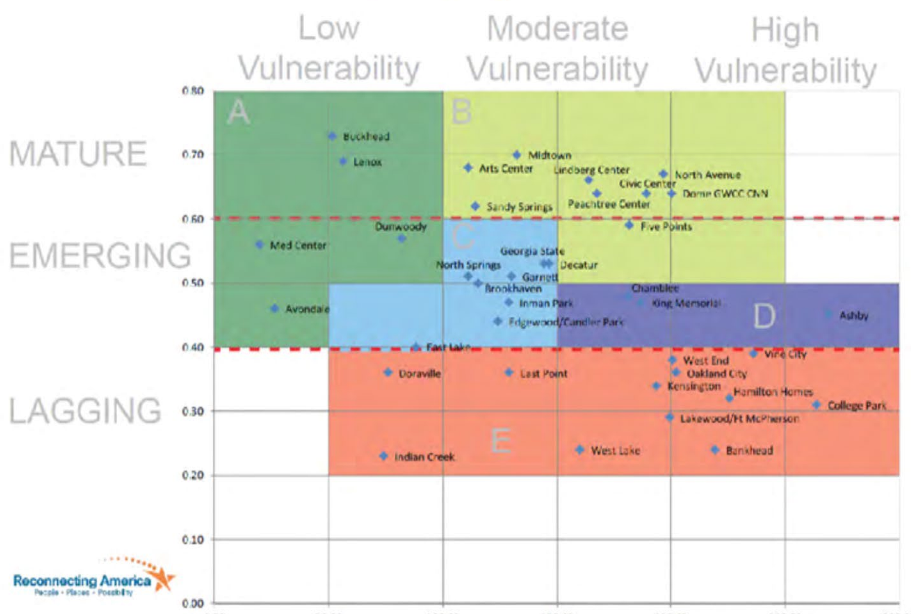
Typology Groupings/Place Types

Figure 3 shows the combined vulnerability and market data on one graph. The station areas are grouped into five place types based on where they fall on the graph:

- **Type A: Affluent + Emerging/Strong Market (dark green):** These stations score low on vulnerability and emerging/high on market strength. They are mostly concentrated in the northern suburbs, which are relatively affluent areas with strong real estate markets.
- **Type B: Mixed-Income + Strong Market (olive green):** These station areas score moderate or high on vulnerability and high on market strength. These station areas are concentrated just north of downtown Atlanta and its northern neighborhoods.
- **Type C: Mixed-Income + Emerging Market (light blue):** These areas score moderately on vulnerability and have emerging real estate markets. They are primarily to the east and north of downtown Atlanta.
- **Type D: Low-Income + Emerging Market (dark blue):** These station areas score towards the high side on vulnerability and have emerging markets for TOD. Two of these stations are near downtown Atlanta, while the other one (Chamblee) is in the far north.
- **Type E: Low-Income + Weak Market (red):** These station areas score moderate to high on vulnerability but are lagging in market strength. They are concentrated to the west and south.

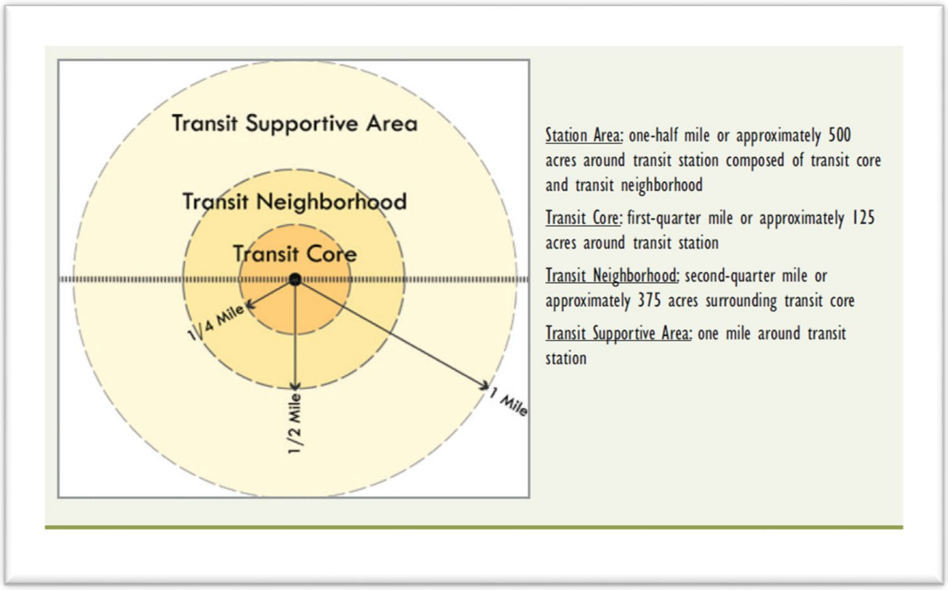
Figure 3: Typology Matrix



Atlanta Typology Memo
DRAFT *April 22, 2014* 5

Florida Department of Transportation (2011)

References: (Renaissance Planning Group, 2011)
Transit System: heavy rail (commuter); light rail; BRT/bus;
Purpose of Typology:
Types of Use: Agency; Design or Land Use;
Findings & Outcomes: The purpose of this typology is to provide both quantitative and qualitative information to help planners and developers "asses how transit-ready existing development patterns are and help guide decision making in the direction of creating more compact and transit supportive development patterns in the future." (page 2)
Method for Aggregating Typology:
Notes: This report defines station area scales, similar to other reports (page 3)



This method uses some initial assumptions about 'target' typology characteristics and relies on a series of assumption to estimate the target indicators for the project. This means that they developed the 'goal' typologies (but did not elaborate) and then 'reverse engineered' target indicators. The following four images (pages 56-59) summarize the process and assumptions linking the inputs and outputs.

Station Area Measures

GROSS INTENSITY AND DENSITY MEASURES (FIGURE 25)

The gross intensity and density measures address population, employment, and the jobs to housing ratio. Mix of uses is a related measure. The targets set for each TOD place type apply to the whole station area and are derived from estimating the residential and employment densities most likely to support specific transit ridership goals at the station and corridor levels.

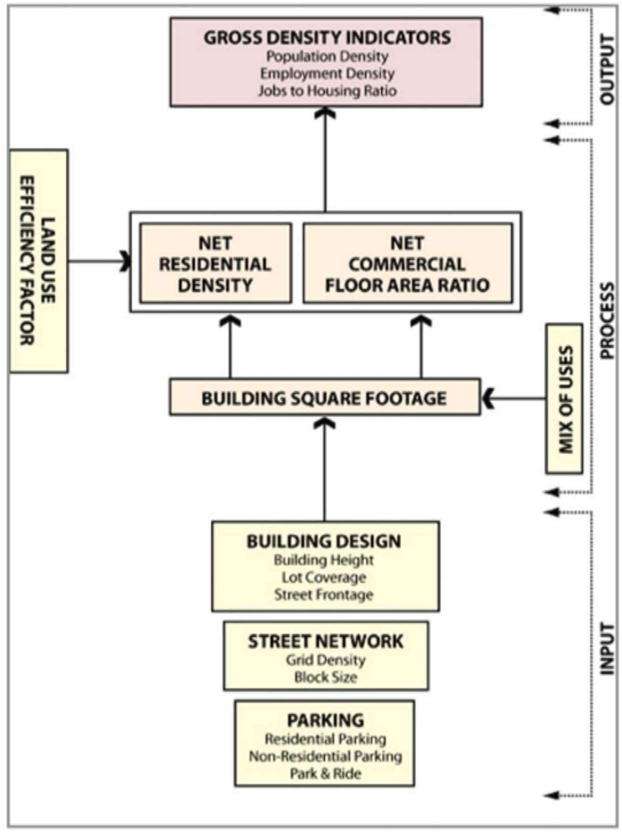


Figure 25: Gross Intensity and Density

<u>Station Area Residential and Employment Densities</u>

These measures identify the targeted number of residential units and jobs for a station area. The assumptions used to derive the values for total residential units and total employment are described below.

- **Station Area Total Residential Units and Gross Residential Density** - Total residential units are measured as the total number of dwelling units in the station area, and gross residential density is measured as dwelling units per acre. Residential units are computed based on total FAR (gross) and percent of mix of uses allocated to residential. Dwelling unit square footage is assumed to be 1,200 square feet in Regional Centers, 1,500 square feet in Community Centers, and 1,800 square feet in Neighborhood Centers.
- **Station Area Total Employment and Gross Employment Density** - Total employment is measured as the total number of jobs in the station area, and gross employment density is measured as jobs/employees per acre. Employment is derived from total FAR (gross) and percent mix of uses allocated to non-residential. Employment is calculated based on Planners Estimating Guide standards for square feet per employee for office, retail/services, and industrial uses (350 square feet for Regional Centers, 500 square feet for Community Centers, and 750 square feet for Neighborhood Centers).

Station Area Jobs to Housing Ratio

The jobs to housing ratio is a measure of the proportion of total employees and total dwelling units within a station area. The jobs to housing ratio helps to estimate the number of trips that can be produced by or attracted to each station area. More jobs rich station areas serve as trip destinations, whereas more housing rich stations serve as trip origins. A balanced jobs to housing ratio within a station area creates efficiencies for transit service and increases the likelihood of people being able to access a range of destinations (retail, employment, cultural facilities, and the like) within the station area walking shed.

Mix of Uses

Mix of uses is measured as the percentage of residential and non-residential uses. The mix of uses ranges from 35% residential and 65% non-residential in Regional Centers to 75% residential and 25% non-residential in Neighborhood Centers. Best practices research indicates that optimal TODs should contain a minimum of 30% residential uses.

Site Level Measures

NET INTENSITY AND DENSITY MEASURES (FIGURE 26)

Net intensity and density measures address site-level design considerations for development or redevelopment within a station area. The targets set for each TOD place type are intended to encourage context appropriate building massing/ form and a transit supportive mix of uses. Pedestrian-scaled building massing and form, complemented by the appropriate mix of uses (horizontal and vertical), encourage walkability, reduce vehicle trips per person, and enhance transit ridership potential. Intensity (measured by FAR) and density (measured by dwelling units per acre) are critical measures that need to be well coordinated with building design measures such as building height, lot coverage, and street frontage. Optimal TODs contain the highest intensity and density within the transit core (first-quarter mile). As minimums, it is likely that sites within the transit core could well exceed the targets and thereby reduce the intensities or densities needed in the transit neighborhood (second-quarter mile) to achieve the same transit ridership goals. Therefore, planning at the site level for TOD requires consideration of each site relative to meeting targets for the station area as a whole.

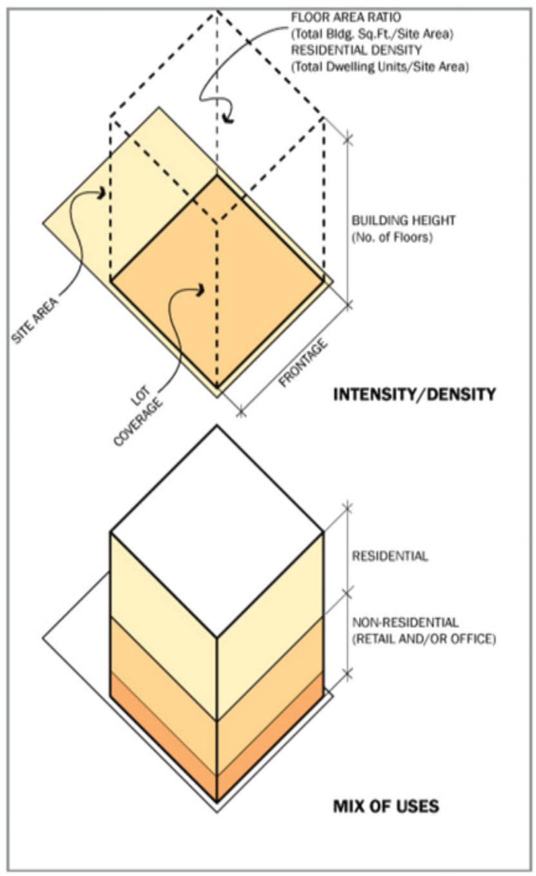


Figure 26: Net Density and Intensity

- **Net Non-Residential Floor Area Ratio** - Net Non-residential FAR includes all non-residential building square footage. Distinct from the Gross FAR measure for the station area, it excludes land utilization features (e.g., roadways, open space, stormwater management).
- **Net Residential Density** - Residential density is measured as dwelling units per net acres and is computed based on net total FAR and percent mix of uses allocated to residential. Dwelling unit square footage is assumed to be 1,200 square feet in Regional Centers, 1,500 square feet in Community Centers, and 1,800 square feet in Neighborhood Centers.

NET TO GROSS CONVERSION FACTORS

The gross intensity and density and mix of use measures for each TOD place type serve as a guide for determining the net intensity and density needed at the site level given existing land use efficiency within station areas. Land use efficiency is the percentage of land available for building square footage after excluding roadways, open space, stormwater management, and so forth. Since the gross measures for the TOD place types do not exclude land utilization features, the net intensity and density targets need to be calibrated to local conditions. This calibration could result in even higher site level targets within the station area. This conversion factor is best addressed by analyzing local conditions.

STREET NETWORK AND BUILDING DESIGN (FIGURE 27)

Street networks and building design help define the pattern of urban form within each TOD place type. For TOD, the goal is to create the 'bones' of urban form that will support a high concentration of vertically and horizontally mixed uses and walkable public spaces within the station area. Higher street grid density and smaller block sizes, combined with appropriately scaled and permeable building frontages, improve street-level activity, pedestrian connectivity and accessibility.

- **Grid Density** - Grid density is measured as the number of blocks (polygons) per square mile. A block is defined as a contiguous piece of land bounded by street network connections that include vehicle, bicycle, and pedestrian pathways. Grid density is a proxy measure for connectivity (links/nodes or intersection density) and accessibility (intersection spacing). Grid density ranges from 350 blocks per square mile in Regional Centers to 150 blocks per square mile in Neighborhood Centers.

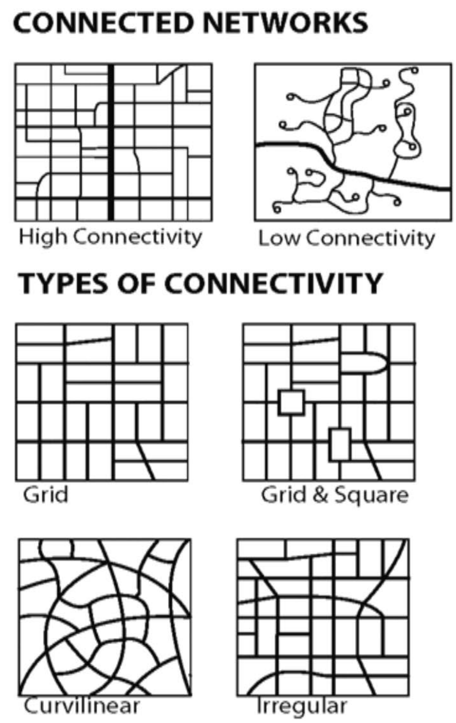


Figure 27: Street Networks and Connectivity

- **Building Height** - Building height is measured as the number of floors in a building. Total FAR is a calculated by looking at total building height to lot coverage. Building heights range from four or more floors in Regional Centers to one or more floors in Neighborhood Centers.
- **Lot Coverage** - Lot coverage is measured as the percentage of a site that can be built on. Computation of lot coverage includes structured parking and other accessory structures, but it does not include open stormwater management or surface parking. Lot coverage targets range from 80 to 90% in Regional Centers to 40 to 50% in Neighborhood Centers.
- **Street Frontage** - Street frontage is measured as the percentage of primary building frontages built to the lot-line or sidewalk. The targets for street frontage within the TOD place types assume a small percentage (25-30%) of the frontage set back no more than 5'-10' from the parcel line. However, this factor should be calibrated to reflect existing building massing/form and development character. Street frontages range from 80-90% in Regional Centers to 60-70% in Neighborhood Centers.

PARKING

Generally, parking within TODs should be limited. Parking targets by TOD place type establish parking caps for sites within station areas with the intention of discouraging vehicle trips and encouraging walking or transit trips. However, phasing in the parking caps over time should be considered based on the type of transit system implementation and connectivity to more regional systems. Other strategies such as shared parking facilities or utilization of surface parking lots as land banks for future redevelopment should also be considered. Parking caps are limited to on-site parking and public/private parking facilities (surface or structured) and exclude on-street parking.

- **Residential Parking** - Residential parking is defined as the maximum number of parking spaces per dwelling unit. This number represents an average for single-family and multi-family dwelling units. Residential parking caps range from one space per dwelling unit in Regional Centers to two spaces per dwelling unit in Neighborhood Centers.
- **Non-Residential Parking** - Non-residential parking is defined as the maximum number of parking spaces per 1,000 square feet of office, retail, or industrial space. Non-residential parking caps range from one space per 1,000 square feet in Regional Centers to three spaces per 1,000 square feet in Neighborhood Centers.
- **Park and Ride** - Station areas that include park-and-ride lots to allow for greater drive access to transit will require exemptions from parking caps. Park-and-ride lots are typically located in less densely developed areas where TOD potential is not as strong, or in areas where they can serve as a temporary land bank until development conditions are more conducive to TOD. Generally, park-and-ride lots are not desirable for use in a Regional Center or a Community Center. However, transit system and corridor level planning often involves some level of tradeoff analysis to determine which stations are appropriate for park-and-ride lots and which ones are not. This analysis involves consideration of factors such as the auto-trip and walk-trip access ridership catchment potential, parking fee revenue potential, adjacent development and market conditions, and travel markets to determine the best location for park-and-ride facilities within a larger transit system.

Categories & Supporting Variables or Definitions:

Notes: The descriptions here may be pulled directly from the language of the document; for image screenshots (marked with an image shadow), page numbers are either left on the image or embedded in the text directly before the image.
Using the same definitions as (Arizona Department of Transportation, 2012), this study distinguishes each station as having a transit core (<1/4); Transit neighborhood (1/4-1/2 mile) and transit supportive area (<1 mile). The transit station makes up both the core and neighborhood (<1/2 mile).
Station Area Targets:
Gross intensity and Density: combined employment/residential units; total residential units; gross residential density (dwelling units per acre); total employment; gross employment density (jobs per acre), and jobs to housing ratio.
Mix of Uses: percentages of residential and non-residential uses.
Site Level Targets:
Net Intensity and Density: net total FAR for non-residential uses and residential density (dwelling units per acre)
Street Network and Building Design: grid density, building height (in floors), maximum lot coverage, and minimum street frontage
Parking: Maximum residential parking, maximum non-residential parking, and park-and-ride
The following three images (page 39, 41, 43) visually describe the differences in each area types typical ‘urban form’.

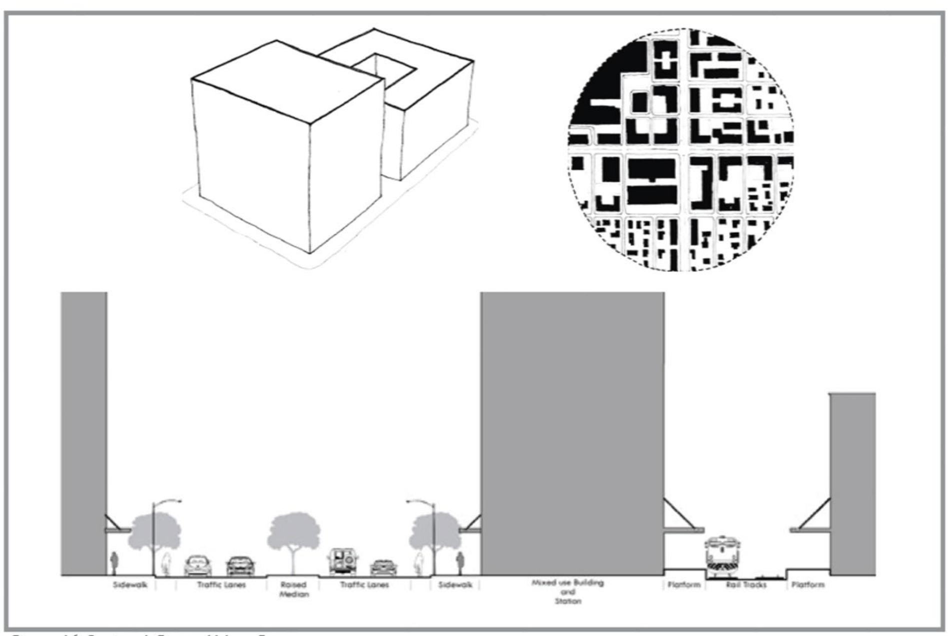
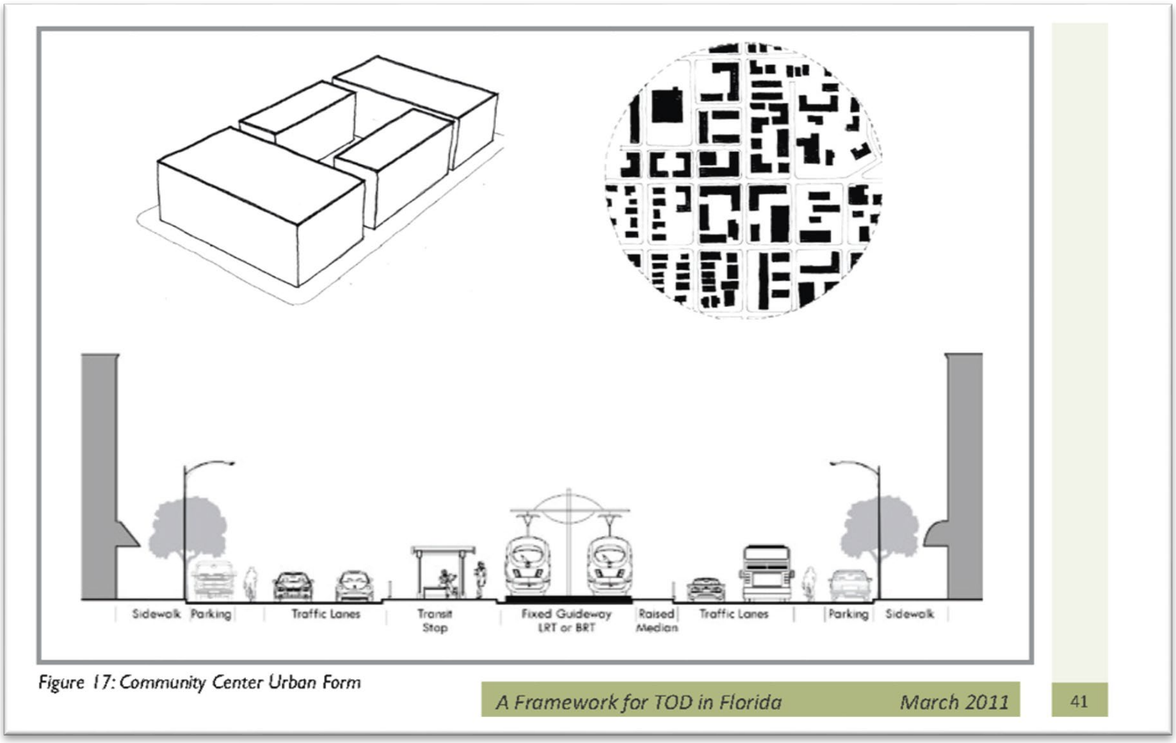
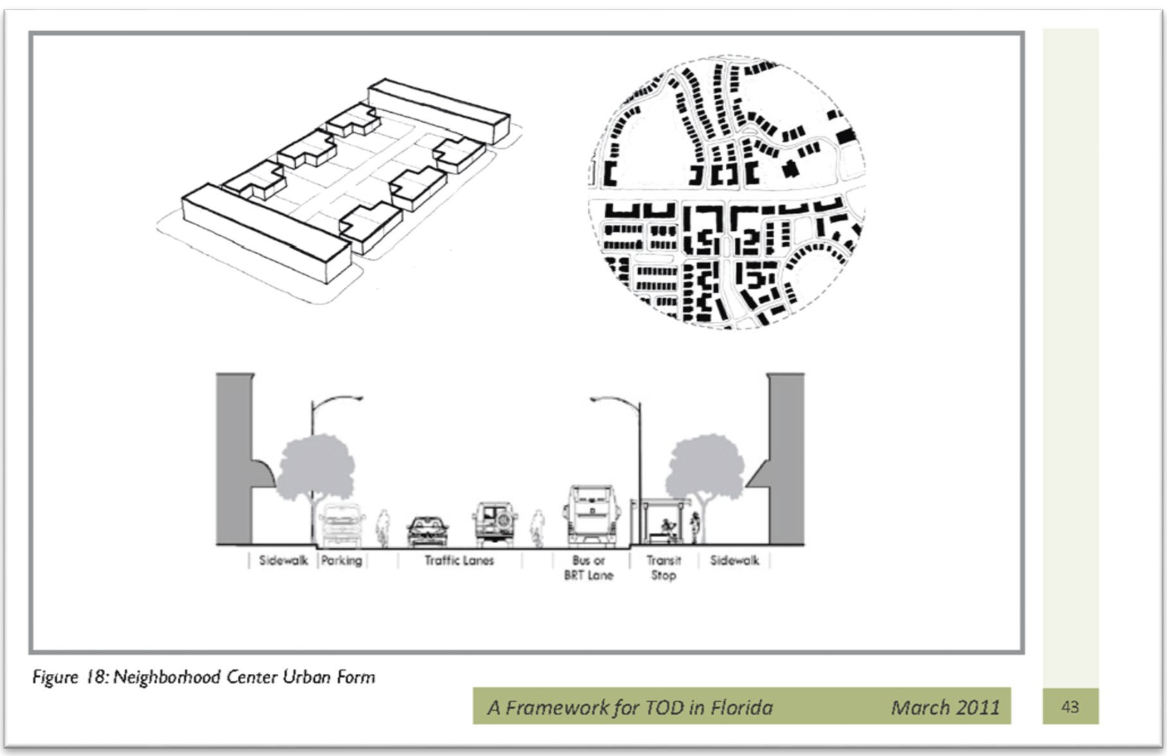


Figure 16: Regional Center Urban Form

A Framework for TOD in Florida March 2011 39





The following three images (page 38, 40, 42) describe the quantitative descriptors for the station and site area measures.

REGIONAL CENTER

Regional Centers are centers of economic and cultural significance, including downtowns and central business districts, which serve a regional travel market and are served by a rich mix of transit types ranging from high speed, heavy or commuter rail to BRT to local bus service. Usually emphasizing employment uses, Regional Centers increasingly are being sought out for residential uses in response to changing demographics and housing preferences. Regional Centers are larger in size than Community Centers or Neighborhood Centers and tend to contain more than one transit station and multiple bus stops. Small block sizes, more lot coverage, higher intensities and densities of development, civic open spaces, and minimal surface parking result in a highly urban development pattern in Regional Centers. Figure 16 illustrates a prototypical Regional Center urban form that reflects application of the station area and site level targets identified for the Regional Center TOD place type (Table 3).

		1	2	3
		Regional Center		
		Heavy Rail	Commuter/Light Rail	Bus Rapid Transit/Bus
STATION AREA MEASURES	**Gross Intensity/Density**			
	Station Area Employment and Residential Units	70,000 - 95,000	45,000 - 70,000	23,000 - 45,000
	Station Area Total Residential Units	10,000 - 15,000	5,000 - 10,000	3,000 - 5,000
	Gross Residential Density (Dus/Acre)	55 - 75	35 - 55	20 - 35
	Station Area Total Employment	60,000 - 80,000	40,000 - 60,000	20,000 - 40,000
	Gross Employment Density (Jobs/Acre)	200 - 250	100 - 200	50 - 125
	Jobs/Housing Ratio (Jobs:Residential Units)	6 : 1		
	Mix of Uses			
	Mix of Uses - % Residential / % Non-Residential	35% / 65%		
SITE LEVEL MEASURES	**Net Intensity/Density**			
	Net Commercial Floor Area Ratio (FAR)	4.0 - 6.0	2.0 - 4.0	1.5 - 3.0
	Net Residential Density (Dwelling Units per Acre)	85 - 115	55 - 85	30 - 55
	Street Network and Building Design			
	Grid Density - Blocks per Square Mile for Vehicular, Bicycle, and Pedestrian Street Network	> 350	> 350	>230
	Building Height (in Floors)	> 4	> 3	> 2
	Maximum Lot Coverage	80% - 90%	80% - 90%	60% - 70%
	Minimum Street Frontage	80% - 90%	80% - 90%	70% - 80%
	Parking			
	Maximum Residential Parking - Spaces per Residential Unit	1	1	1.5
	Maximum Non-Residential Parking - Spaces per 1,000 square feet	1	1	2
	Park & Ride	No	No	No

Table 3: TOD Place Type Targets - Regional Center

COMMUNITY CENTERS

Community Centers function as sub-regional or local centers of economic and community activity and include urban and town centers served by one or more transit types. Residential densities in Community Centers are typically lower than residential densities in Regional Centers, but the mix of uses in them is more balanced between residential and employment uses. More intense or dense development in Community Centers tends to be concentrated within walking distance of the transit station. The pattern of development in Community Centers ranges from urban to suburban. Block sizes, lot coverage, and development intensities and densities all tend to be moderate. Parking is typically structured and located close to the transit station. Figure 17 illustrates a prototypical Community Center urban form that reflects application of the station area and site level targets identified for the Community Center TOD place type (Table 4).

		4	5	6
		Community Center		
		Heavy Rail	Commuter/Light Rail	Bus Rapid Transit/Bus
STATION AREA MEASURES	**Gross Intensity/Density**			
	Station Area Employment and Residential Units	23,000 - 30,000	15,000 - 23,000	7,000 - 15,000
	Station Area Total Residential Units	5,000 - 6,000	3,000 - 5,000	1,000 - 3,000
	Gross Residential Density (Dus/Acre)	35 - 65	25 - 35	10 - 20
	Station Area Total Employment	18,000 - 24,000	12,000 - 18,000	6,000 - 12,000
	Gross Employment Density (Jobs/Acre)	65 - 90	45 - 65	20 - 45
	Jobs/Housing Ratio (Jobs:Residential Units)	3 : 1		
	Mix of Uses			
	Mix of Uses - % Residential / % Non-Residential	45% / 55%		
SITE LEVEL MEASURES	**Net Intensity/Density**			
	Net Commercial Floor Area Ratio (FAR)	4.0 - 6.0	2.0 - 4.0	1.0 - 2.0
	Net Residential Density (Dwelling Units per Acre)	60 - 80	40 - 60	20 - 40
	Street Network and Building Design			
	Grid Density - Blocks per Square Mile for Vehicular, Bicycle, and Pedestrian Street Network	> 350	>230	>150
	Building Height (in Floors)	> 3	> 2	> 2
	Maximum Lot Coverage	80% - 90%	60% - 70%	40% - 50%
	Minimum Street Frontage	80% - 90%	70% - 80%	60% - 70%
	Parking			
	Maximum Residential Parking - Spaces per Residential Unit	1	1.5	2
	Maximum Non-Residential Parking - Spaces per 1,000 square feet	1	2	3
	Park & Ride	No	No	No

Table 4:TOD Place Type Targets - Community Center

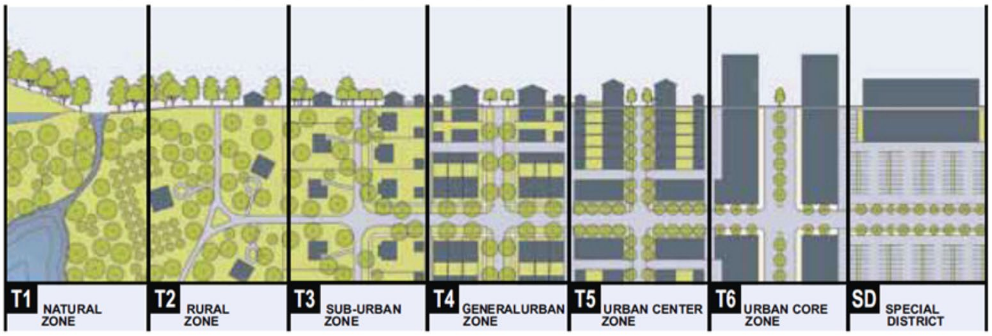
NEIGHBORHOOD CENTERS

Neighborhood Centers are dominated by residential uses and are served by some type of premium transit. Non-residential uses in them are limited to local-serving retail and services. Residential densities in Neighborhood Centers tend to be lower than in Community Centers and at their highest within walking distance of the transit station. Neighborhood Centers are found in older urban areas and newer suburban developments. Open space is usually abundant in them, and parking is mostly in surface lots. Figure 18 illustrates a prototypical Neighborhood Center urban form that reflects application of the station area and site level targets identified for the Neighborhood Center TOD place type (Table 5).

		7	8	9
		Neighborhood Center		
		Heavy Rail	Commuter/Light Rail	Bus Rapid Transit/Bus
STATION AREA MEASURES	**Gross Intensity/Density**			
	Station Area Employment and Residential Units	5,000 - 8,000	4,000 - 6,000	2,000 - 4,000
	Station Area Total Residential Units	3,000 - 4,500	2,000 - 3,000	1,000 - 2,000
	Gross Residential Density (Dus/Acre)	12 - 15	9 - 12	7 - 9
	Station Area Total Employment	2,000 - 3,500	2,000 - 3,000	1,000 - 2,000
	Gross Employment Density (Jobs/Acre)	20 - 30	15 - 20	10 - 15
	Jobs/Housing Ratio (Jobs:Residential Units)	1 : 1		
	Mix of Uses			
	Mix of Uses - % Residential / % Non-Residential	75% / 25%		
SITE LEVEL MEASURES	**Net Intensity/Density**			
	Net Commercial Floor Area Ratio (FAR)	1.5 - 2.0	1.0 - 1.5	0.5 - 1.0
	Net Residential Density (Dwelling Units per Acre)	15 - 20	12 - 15	10 - 12
	Street Network and Building Design			
	Grid Density - Blocks per Square Mile for Vehicular, Bicycle, and Pedestrian Street Network	> 230	> 150	> 150
	Building Height (in Floors)	> 2	> 2	> 1
	Maximum Lot Coverage	60% - 70%	40% - 50%	40% - 50%
	Minimum Street Frontage	70% - 80%	60% - 70%	60% - 70%
	Parking			
	Maximum Residential Parking - Spaces per Residential Unit	1.5	2	2
	Maximum Non-Residential Parking - Spaces per 1,000 square feet	2	3	3
	Park & Ride	Yes	Yes	Yes

Table 5:TOD Place Type Targets - Neighborhood Center

Each of the three area types and transit modes are compared with the Smartcode Transect and the Context Sensitive Solutions (CSS) Zones. (Page 34 & 35)



A Typical Rural-Urban Transect, with Transect Zones

Context Zone	Distinguishing Characteristics	General Character
C-1 Natural	Natural landscape	Natural features
C-2 Rural	Agricultural with scattered development	Agricultural activity and natural features
C-3 Suburban	Primarily single family residential with walkable development pattern and pedestrian facilities, dominant landscape character	Detached buildings with landscaped yards
C-4 General Urban	Mix of housing types including attached units, with a range of commercial and civic activity at the neighborhood and community scale	Predominantly detached buildings, balance between landscape and buildings, presence of pedestrians
C-5 Urban Center	Attached housing types such as townhouses and apartments mixed with retail, workplace and civic activities at the community or sub-regional scale.	Predominantly attached buildings landscaping within the public right of way substantial pedestrian activity
C-6 Urban Core	Highest-intensity areas in sub-region or region, with high-density residential and workplace uses, entertainment, civic and cultural uses	Attached buildings forming sense of enclosure and continuous street wall landscaping within the public right of way, highest pedestrian and transit activity
Districts	To be designated and described locally, districts are areas that are single-use or multi-use with low-density development pattern. These may be large facilities such as airports, business parks and industrial areas.	

The illustration above demonstrates the transect as defined by the Congress for New Urbanism. The table to the left illustrates the general descriptions and characteristics of context zones from the Institute of Transportation Engineers.

Figure 14: Smartcode Transect and CSS Context Zones

TOD PLACE TYPES	COMMUNITY CONTEXT	SMARTCODE TRANSECT ZONE	CSS CONTEXT ZONES
Regional Center – Heavy Rail	Urban	Urban Core (T6) Urban Center (T5)	Urban Core (C6) Urban Center (C5)
Regional Center – Light Rail			
Community Center – Heavy Rail			
Regional Center – BRT/Bus	Transitional	Urban General (T4)	General Urban (C4)
Community Center – Light Rail			
Neighborhood Center – Heavy Rail			
Community Center – BRT/Bus	Suburban	Suburban (T3)	Suburban (C3)
Neighborhood Center – Light Rail			
Neighborhood Center – BRT/Bus			

Table 2:TOD Place Types, Smartcode Transect Zones, and CSS Context Zones

Central Maryland (2009)
References: (Central Maryland Transportation Alliance & Center for Transit-Oriented Development, 2009)
Transit System: Light rail, heavy rail, commuter rail
Purpose of Typology:
Types of Use: Agency; Strategy Identification & Implementation; Prioritization;
Findings & Outcomes: This study aimed at identifying market potential and corresponding strategies for stations in the Central Maryland area. The goal here was to develop a station-level prioritization of infrastructure needs (including supportive infrastructure) and to encourage partnerships and development based on both market potential AND market need.
Strategies:
Complete existing projects to demonstrate high-quality TOD in the region
Develop new corridor-level initiatives in key regional locations for TOD
Modify local, regional, and state policies to support TOD
Construct transit and multi-modal transportation systems to support TOD
Foster cross-sector partnerships and build local capacity for TOD implementation
Notes:
There was a prior study by University of Maryland and Baltimore identifying built environment ‘area types’. The map of station areas and definitions was included in the location-specific file.
Method for Aggregating Typology:
Notes: The authors consider two dimensions: market opportunity and demographic need/stability. In both dimensions, several performance indicators are identified (see images of tables in the next subsection’. The ‘market opportunity’ indicator captures housing markets and land opportunities, including existing activity and existing transit infrastructure. The ‘demographic change’ dimension considers the change in home values, incomes (compared with median incomes), and a composite ‘drilldown update’ (jobs/housing balance, housing type, median income, etc). It is not clear how the ‘drilldown’ composite factor was developed. Each composite indicator is given a ranking, and each station falls within a set of four tiers for each dimension based on the frequency of ‘mid to high’ priorities for each of four categories (as well as severity). This was a somewhat manual process. Areas with ‘high to mid’ categorization on some indicators, but ‘low or NA’ on others may still fall into ‘tier 2’. Priorities fall within tiers 1 and 2, with tiers 3 and 4 indicating low short-term priorities.
Categories & Supporting Variables or Definitions:
Notes: The descriptions here may be pulled directly from the language of the document; for image screenshots (marked with an image shadow), page numbers are either left on the image or embedded in the text directly before the image.
Factors influencing “Market Opportunity”, related to housing, land opportunity, region’s employment and whether transit and transportation infrastructure is ‘conducive’ to supporting a walkable TOD. Factors are summarized on the following image (page 41):

Central Maryland Transit-Oriented Development Strategy / Chapter 2: Priority TOD Investment Locations 41

Factor	Indicator	Importance	Priority Thresholds
Housing Market Condition	Baltimore Housing Market Typology	Helps determine the potential that an investment will have a positive impact on the ability to attract new investment in the short term; investments should be focused on "Stabilization" and "Reinvestment" Neighborhoods	• High: Emerging and Stable • Mid: Transitional • Low: Competitive • None: Distressed
Land Opportunity	Number and Size of Vacant and Underutilized Parcels	Helps determine the extent to which market interest in neighborhood investments can be translated into new development.	• High: > 100 acres or 400 units • Mid: 20-100 acres or 100-400 units • Low: < 20 acres or 100 units
Proximity to Activity Centers	Type of Activity Center (Density, Dominant Activity, etc.)	The type of activity center will determine the frequency and timing of trips from residential neighborhoods. Dense daytime employment centers are the most likely to be accessed by public transit; thus, transit will have the greatest impact on land values in residential areas closely linked to these centers. This is true to a lesser extent of entertainment districts, which may have a lesser employment base, but still lend themselves to non-automobile-based trips. Those areas in which this impact is greatest will have the potential response to TOD investments.	• High: Downtown, Education, or Entertainment employment clusters • Mid: Other employment clusters • Low: Non-employment clusters
Proximity to Activity Centers	Distance from Activity Center	The land value/TOD potential associated with activity centers (described above) diminishes with distance. After a certain distance in the transit network, these connections cease to have an appreciable impact.	• Mid: Adjacent to Downtown, Education, or Entertainment employment clusters • High/Low: N.A.
Proximity to Activity Centers	Employment Dynamics of Activity Center	The extent to which activity centers have a positive overall rate of jobs growth and/or include sectors/employers that are growing, plays an important role in whether households will move to improve their accessibility. This will influence the attractiveness of new TOD opportunities and, in turn, investment potential.	• Mid: High employment growth rate in cluster. • High/Low: N.A.
Transit Infrastructure	Accessibility of Transit Station and Connection to Neighborhood	Transit infrastructure can have a large impact on the potential market for TOD. Stations that are part of an interconnected street grid provide access from multiple directions and to many destinations. Elevated transit stations or stations with limited or poor pedestrian connectivity can dampen the catalytic potential of investments.	• High: At grade or sub-grade with highly walkable street pattern • Mid: At grade or sub-grade with connected street pattern • Low: At grade or grade separate d with disconnected street pattern • None: Grade separated with limited access or freeway median.

Figure 16: Factors and indicators of the potential for catalyzing market momentum for TOD.

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Factors related to 'Demographic Change' were also considered. While 'market potential' looks at TODs with the greatest potential, this dimension considers those areas with the greatest need. The four factors in this dimension include: median income; income diversity; family structure; and educational attainment. Station areas were categories as changing or stable, and again within the following subcategories (page 45-46):

Changing neighborhoods

Gentrifying ("increasing number of residents in higher income and educational attainment categories as there are fewer residents in lower income and educational attainment categories." The result of existing patterns or displacement.)

Disinvesting ("increasing number of residents in lower income and education categories as there are fewer residents in higher income and education categories." May be a result of wealthy households leaving or shrinkage of major employers of the residents.)

Polarizing ("increasing number of residents at each end of the income and education spectrum, at the expense of middle class residents." Sensitive to sudden "upward shifts in housing costs or to rapid disinvestment")

Stable Neighborhoods ("may not require short-term intervention")

Higher Income ("the median income and educational attainment exceeds the city regional average and has not been shifting significantly")

Middle Income ("median income and educational attainment is near the city regional average and has not been shifting significantly")

Lower Income (“median income and educational attainment is below the city and/or regional average and has not shifted significantly”)
Stably Mixed-Income (“median income and educational attainment is not far from the regional average, but there is a high degree of variability.”)

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Factor	Indicator	Importance	Priority Thresholds
Jobs/Housing Balance	Ratio of workers to residents within ½-mile of station	Places that are predominantly job locations are of less significance. Predominantly housing locations are places of higher importance in addressing this goal.	• High: Housing (>0.5 workers/residents) • Mid: Mixed (0.5-3.0 workers/ residents) • Low: Jobs (>3.0 workers/residents)
Household Structure	Change in share of households that are not families	Change in the share of households that are in families can be indicative of neighborhood change. In gentrifying neighborhoods, young non-family households may be replacing families; in disinvesting neighborhoods, family households may be leaving for more desirable neighborhoods. While rapid decreases in this indicator show the potential for gentrification and displacement, rapid decreases show more neighborhood stability.	• High: Rapid Increase (> +10%) • Mid: Increase (+2.5% - +10%) • Low: No change (-2.5% - +2.5%) or decrease (-10% - -2.5%) • None: Rapid Decrease (< -10%)
Education	Change in % of households earning a bachelor's degree or higher	Whereas income reflects *current* buying power, education is a powerful indicator of *potential* buying power. Thus, even if incomes remain stable, a significant increase or decrease in educational attainment can be important indicator of neighborhood change.	• High: Rapid Increase (> +10%) or Rapid Decrease (< -10%) • Mid: Increase (+2.5% - +10%) • Low: No change (-2.5% – +2.5%) or decrease (-10% - -2.5%)
Median Income	Change in median household income	This reflects the overall change in the wealth of a neighborhood. While rapid changes in either direction are the most important indicator, decreases of median income can show signs of disinvestment, while modest increases show more signs of underlying stability, and may not signal gentrification.	• High: Rapid increase (> +15%) or decrease (< -15%) • Mid: Decrease (-15% - -5%) • Low: Increase (+5% - +15%) • None: No change (-5% - +5%)
Change in Income Distribution	Change in distribution of household Incomes, including overall diversity and change within income categories	While median income provides a simple measure of the wealth of residents, the distribution of incomes provides greater insights into the dynamics of neighborhood change. Specifically, the change in the relative shares of households in the lower, middle, and higher income ranges can indicate whether a neighborhood is stable, gentrifying, disinvesting, or polarizing. When there is stability in income distribution, there is not a priority on addressing neighborhood change.	• High: Gentrifying or Disinvesting (rapid increases or decreases in high and low incomes) • Mid: Polarizing (rapid decline in middle incomes) • Low: Stable Diverse or Middle-Income • None: Stable High-Income

Figure 17: Factors and indicators of neighborhood change.

	Factor	Indicator	Importance	Priority Thresholds
	Neighborhood Trend	Composite of DrillDown Comparisons	Because the economic landscape in Central Maryland has shifted since the 2000 US Census, the DrillDown report indicators can be used to update the other neighborhood indicators and confirm or refute trends between 1990 and 2006. Rapid increases between 2000 and 2006 indicate gentrification, while decreases or small increases indicate disinvestment. Moderate increases indicate general stability. This analysis is used to flag potential changes in neighborhood trend since 2000.	• High: Confirmation of previous trend • Mid: Stable or confirmation of previous trend • Low: Stable or refutation of previous trend • None: Continued stability
Combined indicators of Neighborhood Trend	*Change in Home Values*	*Change in value of housing units*	*This reflects the change in a neighborhood real estate market from 2000-2006. This period captures a booming real estate market nationwide, but very large change in home value is a signal of gentrification and potential displacement. Small increases in home values can be a sign of economic distress because of the overall price appreciation during this period.*	• *Very large increase = > 200 %* • *Large increase = 100-199%* • *Moderate increase = 50-99%* • *Small increase = 0-50%* • *Decrease = < 0%*
	Change in Median Income	*Change in median household income (DrillDown vs Census)*	*This reflects the overall change in the wealth of a neighborhood from 2000-2006. While rapid changes in either direction are the most important indicator, decreases of median income can show signs of disinvestment, while modest increases show more signs of underlying stability, and may not signal gentrification.*	• *High: Rapid increase (> +15%) or decrease (< -15%)* • *Mid: Decrease (-15% - -5%)* • *Low: Increase (+5% - +15%)* • *None: No change (-5% - +5%)*
	Change in Homebuyer Income	*Income of Homebuyers (HMDA) vs. Overall Income (Census)*	*This reflects the change in the income of new residents moving to a neighborhood. Rapid increases signal gentrification, while declines or small increases signal economic distress. Moderate increases indicate general stability.*	• *Very large increase = > 400 %* • *Large increase = 200-399%* • *Moderate increase = 100-199%* • *Small increase = 50-99%* • *Very small increase = 0-49%*

Figure 18: DrillDown indicators and analysis of 2000-2006 trends.

Catalyze Momentum for Market-Driven TOD	Direct Trajectory of Neighborhood Change: Tier 1	Tier 2	Tier 3	Tier 4
Tier 1	• N.A.	• U of B/Mount Royal • Centre Street • Lexington Market • University Center • Pratt Street/ Convention Center/ Howard Street • State Center/Cultural Center • Shot Tower/Market Place/Gov't Center • Harlem Park/Poppleton	• Pepper Road • McCormick Road • Charles Center Metro • Canton Crossing	• N.A.
Tier 2	• Woodberry • Camden Yards • Westport • Mondawmin Metro • Penn North Metro • Allendale • West Baltimore MARC • Edmondson Village • Inner Harbor East • Fells Point • Canton • Highlandtown	• North Avenue • Owings Mills • Reisterstown Plaza • Rogers Avenue • Johns Hopkins Medical Center • Penn Station • Rosemont	• Hunt Valley • Warren Road • Ferndale • Cromwell/Glen Burnie • Upton Metro • Odenton • CMS • Security Square Mall • Social Security Administration • Bayview Campus	• N.A.
Tier 3	• Hamburg Street • Patapsco • I-70 East	• Cold Spring Lane • Baltimore Highlands • BWI Business District • Old Court • Milford Mill • W. Cold Spring • Edgewood	• Gilroy Road • Timonium • Timonium Business Park • Lutherville • Nursery Road • North Linthicum • BWI Amtrak • Martin State Airport • Halethorpe • Dorsey	• St. Denis • Bayview MARC
Tier 4	• Cherry Hill	• N.A.	• N.A.	• Falls Road • Mount Washington • BWI Airport

= Critical TOD Priority Stations

= Regionally important TOD Stations

= Non-Priority TOD locations

Regional TOD Priority Locations

Other Notes:

This report also provided ‘performance metrics’ (shown in the image below) that can be used to monitor the successful implementation of any of the strategies.

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ppendix D: Performance Metrics for Monitoring Implementation

Performance Metrics for Measuring the Outcomes of TOD Efforts

	Indicator	Metrics	Source
Housing and Development Indicators	Increased housing values in inner-city transit-centered neighborhoods	Sales data for transit zones compared to city and regional data	Baltimore City, Baltimore County, BNIA
	Continued presence of a mix of housing stock around transit, affordable and market, rental and homeownership	Transit zone data on unit typ, permit data for rehabilitation, subsidized developments.	Baltimore City, Baltimore County, US Census, MDP, DHCD
	Increased income diversity in transit-centered neighborhoods	Composite indicator of income diversity developed by BNIA.	BNIA
	Improved housing market stability in transit-centered neighborhoods	Improved HMVA for TOD areas.	BNIA
	Expanded homeownership in transit-centered neighborhoods.	Housing tenure	US Census and/or BNIA
	Increased regional awareness of transit as an asset	Q3 , Q14, and Q21 of the CMTA Culture of Transit telephone survey	CMTA
	Improved development capacity for local and state officials around TOD projects	Programs and policies that target capital funds, development incentives and other resources toward TOD projects.	MDOT, Baltimore County, Baltimore City, CMTA
	Increased residential and commercial development near Central Maryland transit stations	Permit data for builting permits > $50,000	Baltimore County, Baltimore City
Transit and Transportation Indicators	Improved transportation savings for residents living in proximity to transit	The Housing plus Transportation (H + T) Affordability Index	Center for Neighborhood Technology
	Funds appropriated by state, federal, and local governments for public transit and transit-oriented development	Maryland Capital Transportation Program (CTP), Local Capital Improvement Programs (CIP)	MDOT, Baltimore County, Baltimore City
	Increases in ridership on the MARC line, light rail and bus lines serving Central Maryland, especially walk-access trips	APTA quarterly ridership reports (not broken out for Central Maryland); MTA	APTA, MTA
	Poll results through regularly conducted consumer polls on transportation and transit issues	Improvement on "no transit near where I live" and "transit doesn't go where I need it to go" reponses to Q13 of Culture of Transit telephone survey	CMTA
	Reduction in road congestion per capita	"Annual hours of delay per traveler" from the Texas Transportation Institute's Annual Urban Mobility Report	Texas Transportation Institute
	Reduction of carbon emissions in the region	Vehicle Miles Traveled, emissions modeling	Baltimore Metropolitan Council

Los Angeles, California (2011)
References: (Office of the Mayor, City of Los Angeles, 2011)
Transit System: 49 stations
Purpose of Typology:
Types of Use: Agency; Prioritization;
Findings & Outcomes: The purpose of this study was to priority opportunities for developing/expanding upon 10 stations, as the mayor promised. The prioritization was partially based on whether sites were suitable for new development, but also whether they are 'Sustainable Transit Community' (STC) ready. The 'STC Readiness analysis' was only performed on the top 20 stations using the Development Potential analysis. The goal was not just TOD development, but achieving sustainable transit community goals (related to smart growth efforts) related to both market potential and multimodal use.
Method for Aggregating Typology:
Notes: The authors analyzed most of the stations using the following criteria. Definitions and scorecard criteria of all *used* performance indicators are described in the rubrics from following section. Additional information was collected (such as the *quality* in addition to the quantity of parks and recreation within the area), but not all information as used to prioritize development. Information collected from the urban design, walkability, multimodal transportation system, and sustainability categories were sometimes collected using site visits.
First, the 'Development Potential Analysis' (DPA) included only performance indicators from the Development Opportunity category. The average 'score' of the opportunity site indicators (public/quasi-public sites; total sites'; incentivized sites; large sizes) was averaged and weighted by 40%. The employment potential (high-wage) was scored and weighted by 10%. The sum of these two composite indicators was calculated, and all 49 sites were ranked in order of this score.
Second, for the top 20 sites the DPA process, the Sustainable Transit Communities (STC) Readiness analysis was computed. The analysis was based on the composite average score within each of the following categories: mix and vitality of land use total score (weighted 15%); urban design total score (weighted 5%); walkability total score (weighted 10%); multimodal transportation system total score (weighted 15%); sustainability total score (weighted 5%).
Third, for the top 20 DPA sites, each of the composite average scores from the DPA and STC were averaged together (with the corresponding weights). A rank was assigned to each site based on the relative total weighted readiness score. This ranking provides prioritization of the sites.
Categories & Supporting Variables or Definitions:
Notes: The descriptions here may be pulled directly from the language of the document; for image screenshots (marked with an image shadow), page numbers are either left on the image or embedded in the text directly before the image.
The following images the dimensions, performance indicators, and corresponding scoring rubrics.

(Office of the Mayor, City of Los Angeles, 2011, p. A-1 to A-9)

ABLE A-1 SCORING DESCRIPTIONS

:riteria	Scoring Ranges	Scoring Explanation	Data Source
)EVELOPMENT OPPORTUNITY			
'otal Opportunity Site ıcreage	Opportunity site acreage: Value / Score / Value / Score 0-20 / 1 / 100-120 / 6 20-40 / 2 / 120-140 / 7 40-60 / 3 / 140-160 / 8 60-80 / 4 / 160-180 / 9 80-100 / 5 / 180-200 / 10	Range of acreages divided into 10 equal intervals.	Acreages represent acreages of specific opportunity sites within ½ mile of the station. Opportunity sites were identified on a parcel basis by CTOD for the Los Angeles Transit-Oriented Development Typology project, and were refined by DC&E based on Los Angeles County Assessor data for use in this project. A more detailed description is included in Appendix B. For stations where the ½-mile buffer includes areas outside the city, opportunity site acreage has been divided by the percentage of the station area within the city.
'ublic and Quasi-'ublic Opportunity ite Acreage	Public and quasi-public opportunity site acreage: Value / Score / Value / Score 0-14 / 1 / 70-84 / 6 14-28 / 2 / 84-98 / 7 28-42 / 3 / 98-112 / 8 42-56 / 4 / 112-126 / 9 56-70 / 5 / 126-140 / 10	Range of values divided into 10 equal intervals.	Acreages represent acreages of specific opportunity sites within ½ mile of the station that are owned by public or quasi-public entities. Opportunity sites were identified on a parcel basis by CTOD for the Los Angeles Transit-Oriented Development Typology project, and were refined by DC&E based on Los Angeles County Assessor data for use in this project. A more detailed description is included in Appendix B. For stations where the ½-mile buffer includes areas outside the city, opportunity site acreage has been divided by the percentage of the station area within the city.
ıcentivized Site ıcreage	Incentivized site acreage: Value / Score / Value / Score 0-20 / 1 / 100-120 / 6 20-40 / 2 / 120-140 / 7 40-60 / 3 / 140-160 / 8 60-80 / 4 / 160-180 / 9 80-100 / 5 / 180-200 / 10	Range of values divided into 10 equal intervals.	Acreages represent acreages of specific opportunity sites within ½ mile of the station that are within a State Enterprise Zone, Community Redevelopment Agency Project Area, or a Federal Empowerment Zone. Opportunity sites were identified on a parcel basis by CTOD for the Los Angeles Transit-Oriented Development Typology project, and were refined by DC&E based on Los Angeles County Assessor data for use in this project. A more detailed description is included in Appendix B. For stations where the ½-mile buffer includes areas outside the city, opportunity site acreage has been divided by the percentage of the station area within the city.

:riteria	Scoring Ranges	Scoring Explanation	Data Source
arge Opportunity ites	Number of large opportunity sites: Value / Score / Value / Score 1 / 1 / 6 / 6 2 / 2 / 7 / 7 3 / 3 / 8 / 8 4 / 4 / 9 / 9 5 / 5	Range of values divided into 9 equal intervals.	Number represents the number of opportunity site areas that are greater than 5 acres within a ½ mile of the station. Opportunity sites may include more than one parcel if they are adjacent and have the same owner.
ligh-Wage Employ-nent Potential	Weak = 0 Weak/Moderate = 2.5 Moderate = 5 Moderate/Strong = 7.5 Strong = 10	Bay Area Economics evaluated the percentage of employment growth or contraction occurring in each market area in high-wage sectors. Based on how this percentage compared to the County average, and on local knowledge of the market area, BAE classified each market area between weak and strong potential for high-wage employment growth.	Provided by Bay Area Economics.
:ONCENTRATION, DENSITY AND BALANCE OF USES			
lousing:			
:esidential Density	Dwelling units per acre: Value / Score / Value / Score 0-4 / 0 / 20-24 / 5 4-8 / 1 / 24-28 / 6 8-12 / 2 / 28-32 / 7 12-16 / 3 / 32-36 / 8 16-20 / 4 / 36-40 / 9	Range of densities divided into 10 equal intervals.	County Assessor data indicates number of units on each parcel. The total Number of units is divided by the total acreage within ½ mile of the station to obtain density.
ffordable Housing leed	Percent household income spent on housing: Value / Score / Value / Score 25-28% / 1 / 40-43% / 6 28-31% / 2 / 43-46% / 7 31-34% / 3 / 46-49% / 8 34-37% / 4 / 49-52% / 9 37-40% / 5 / 52-55% / 10	Range of values divided into 10 equal intervals.	Affordable housing need is measured by the "housing cost burden", which is the relationship between the amount a household pays for rent or mortgage costs compared to the household's income. A household paying more that 30 percent of their income for housing is considered "cost-burdened." Bay Area Economics determined the percentage of households within each station area that are cost-burdened and scores were assigned based on these percentages.

Criteria	Scoring Ranges	Scoring Explanation	Data Source
Everyday Uses:			
Schools	Number of schools within ½ mile of station: Value / Score / Value / Score 0 / 0 / 6 / 6 1 / 1 / 7 / 7 2 / 2 / 8 / 8 3 / 3 / 9 / 9 4 / 4 / 10 + / 10 5 / 5	Range of values divided into 10 equal intervals.	Public school sites have been geocoded from the Los Angeles School District's "Guide to Schools," accessed online on January 13, 2010. Private school sites have been geocoded from a list of private schools in Los Angeles generated by the California Nutrition Network GIS Map Viewer, March 16, 2010. For stations where the ½-mile buffer includes areas outside the city, the number of schools has been divided by the percentage of the station area within the city.
Colleges and Vocational Schools	Poor = 0 Good = 5 Excellent = 10	Poor: Few or no vocational schools, and no colleges or universities, are located near the station. Good: A cluster of vocational schools is located near the station. Excellent: At least one major city college, four-year college, or university is located near the station.	Google Earth, accessed May 14, 2010.
Civic Buildings	Number of civic buildings within ½-mile of station: Value / Score / Value / Score 0 / 0 / 6 / 6 1 / 1 / 7 / 7 2 / 2 / 8 / 8 3 / 3 / 9 / 9 4 / 4 / 10 + / 10 5 / 5	Range of values divided into 10 equal intervals.	GIS data from Los Angeles Community Redevelopment Agency. Includes government buildings, libraries, police stations, post offices, libraries and fire stations.
Grocery Stores	Grocery stores within ½ mile of station: Value / Score / Value / Score 0-4 / 0 / 20-24 / 5 4-8 / 1 / 24-28 / 6 8-12 / 2 / 28-32 / 7 12-16 / 3 / 32-36 / 8 16-20 / 4 / 36-40 / 9	Range of values divided into 10 equal intervals.	Grocery store sites have been geocoded from a list of both grocery stores and fruit and vegetable markets in Los Angeles generated by the California Nutrition Network GIS Map Viewer, January 7, 2010.

Criteria	Scoring Ranges	Scoring Explanation	Data Source
Convenience Stores	Convenience stores within ½ mile of the station: Value / Score / Value / Score 0 / 0 / 6 / 6 1 / 1 / 7 / 7 2 / 2 / 8 / 8 3 / 3 / 9 / 9 4 / 4 / 10 + / 10 5 / 5	Range of values divided into 10 equal intervals.	Convenience store sites have been geocoded from a list for Los Angeles generated by the California Nutrition Network GIS Map Viewer, January 7, 2010.
Restaurants	Number of restaurants within ½ mile of station: Value / Score / Value / Score 0-15 / 1 / 75-90 / 6 15-30 / 2 / 90-105 / 7 30-45 / 3 / 105-120 / 8 45-60 / 4 / 120-135 / 9 60-75 / 5 / 135-150 / 10	Range of values divided into 10 equal intervals.	Restaurant sites have been geocoded from a list for Los Angeles generated by the California Nutrition Network GIS Map Viewer, April 29, 2010.
Banks and Financial Services	Present = 10 Absent = 0	Presence/absence	Google Earth, accessed May 5, 2010.
Parks and Recreation Facilities	Acres of parks within ½ mile of station: Value / Score / Value / Score 0-5 / 1 / 25-30 / 6 5-10 / 2 / 30-35 / 7 10-15 / 3 / 35-40 / 8 15-20 / 4 / 40-45 / 9 20-25 / 5 / 45+ / 10	Range of values divided into 10 equal intervals.	GIS data from Los Angeles Community Redevelopment Agency. Includes neighborhood and community park acreages only.
Attractions:			
Entertainment Venues	Present = 10 Absent = 0	Presence/absence	Google Earth, accessed May 5, 2010.
Market Outlook:			
Retail Occupancy Trend	Poor = 0 Good = 5 Excellent = 10	Poor: Higher vacancy rate and lower rents than LA County. Good: Lower vacancy rate and higher rents than LA County, or higher vacancy rate and lower rents than LA County. Excellent: Lower vacancy rate and higher rents than LA County.	Data provided by Bay Area Economics for 4th Quarter of 2009.

riteria	Scoring Ranges	Scoring Explanation	Data Source
ffice Occupancy rend	Change in office vacancy: Value / Score / Value / Score < 30% 10 / 55-60% 4 30-35% 9 / 60-65% 3 35-40% 8 / 65-70% 2 40-45% 7 / 70-75% 1 45-50% 6 / +75% 0 50-55% 5	Range of values divided into 10 equal intervals.	Change in office vacancy rates between 4th Quarter 2008 and 4th Quarter 2009 provided by Bay Area Economics.
ndustrial Occupancy rend	Change in industrial vacancy: Value / Score / Value / Score 0.0-0.1% 10 / 0.6-0.7% 4 0.1-0.2% 9 / 0.7-0.8% 3 0.2-0.3% 8 / 0.8-0.9% 2 0.3-0.4% 7 / 0.9-1.0% 1 0.4-0.5% 6 / + 1.0% 0 0.5-0.6% 5	Range of values divided into 10 equal intervals.	Change in industrial vacancy rates between 4th Quarter 2008 and 4th Quarter 2009 provided by Bay Area Economics.
RBAN DESIGN			
rban Form:			
enters and Landmarks	Poor = 0 Good = 5 Excellent = 10	Poor: The area has no discernable center. There are no notable landmarks to help people orient themselves. Good: The area has a fairly well-defined center. There are a few landmarks that help people orient themselves. Excellent: The area has a strongly defined, easily recognizable center. There are several landmarks to help people orient themselves, including at least one highly visible landmark.	Site visit conducted by DC&E.
orridors	Poor = 0 Good = 5 Excellent = 10	Poor: The area has no discernable commercial corridors or the corridors have few pedestrian-friendly retail businesses on the ground floor. Good: The area has a fairly well-defined commercial corridor or a few different corridors knit together, with some pedestrian-oriented retail businesses on the ground floor. Excellent: The area has at least one very well-defined commercial corridor that almost always has pedestrian-oriented retail businesses on the ground floor.	Site visit conducted by DC&E.
dges and Seams	Poor = 0 Good = 5 Excellent = 10	Poor: Numerous edges create a sense that the area itself is divided into pieces. Edges also divide the area from its surroundings. Good: To some extent, seams connect different parts of the area to one another, and to the area's surroundings. Excellent: Almost all connections within the area, and to the area's	Site visit conducted by DC&E.

Criteria	Scoring Ranges	Scoring Explanation	Data Source
edestrian-Oriented Architecture:			
uilt Edge	Poor = 0 Good = 5 Excellent = 10	Poor: buildings are not oriented toward the street, and widely varying setbacks create an inconsistent street edge. Frontages are dominated by parking and/or driveways. Good: buildings are oriented toward the street, and consistent or appropriately varied setbacks create a sense of a street edge. Most parking is located behind buildings. Excellent: buildings are oriented toward the street, consistent or appropriately varied setbacks create a sense of a street edge. Nearly all parking is located behind buildings. The typical height of buildings is at least 50 percent of the street's width.	Site visit conducted by DC&E.
cale of Development	Poor = 0 Good = 5 Excellent = 10	Poor: Most development consists of large-scaled buildings with long, undifferentiated horizontal surfaces near street level. Good: Some small-scale development is present. Some large-scale development uses changes in massing and architectural details to divide façades into smaller horizontal components. Excellent: Almost all buildings are either small in scale or incorporate architectural features that divide their façades into smaller horizontal components.	Site visit conducted by DC&E.
treet Frontages	Poor = 0 Good = 5 Excellent = 10	Poor: building frontages are visually monotonous, dominated by opaque materials, with minimal views into the building. Good: transparent window openings are provided at the street level. Excellent: building entrances and frontages provide awnings, canopies or arcades that offer shade and weather protection for pedestrians. Transparent window opening are provided at the street level. Some ground-floor frontages allow for outdoor seating.	Site visit conducted by DC&E.
treet Trees and andscaping	Poor = 0 Good = 5 Excellent = 10	Poor: Street trees are sparsely planted, poorly maintained and do not provide shade for pedestrians. Landscaping is poorly maintained or consists largely of turf, and it creates little aesthetic benefit. Good: Street trees are present but could be more consistently planted or more closely spaced. Trees may provide some shade for pedestrians. Landscaping enhances the site aesthetically. Excellent: Consistently planted, well-maintained street trees provide shade for pedestrians. Landscaping enhances the site aesthetically and includes an appropriately varied plant palette.	Site visit conducted by DC&E.
WALKABILITY			
inear Feet of Walkable Streets	Linear feet of street that are within a ½-mile walk of the station: Value Score	Range of values divided into 10 equal intervals.	Developed by DC&E using GIS data from the Los Angeles Community Redevelopment Agency.

Criteria	Scoring Ranges	Scoring Explanation	Data Source
	20,000-28,000 1 28,001-36,000 2 36,001-44,000 3 44,001-52,000 4 52,001-60,000 5 60,001-68,000 6 68,001-76,000 7 76,001-84,000 8 84,001-92,000 9 92,001-100,000 10		
Intersection Density	Number of intersections within ½ mile of station: Value / Score / Value / Score 0-18 1 90.1-108 6 18.1-36 2 108.1-126 7 36.1-54 3 126.1-144 8 54.1-72 4 144.1-162 9 72.1-90 5 +162 10	Range of values divided into 10 equal intervals.	Developed by DC&E using GIS data from the Los Angeles Community Redevelopment Agency.
Quality of Sidewalks	Poor = 0 Good = 5 Excellent = 10	Poor: Sidewalks are narrow, and some sections are missing or require significant repair. It is difficult for all users to navigate sidewalks. Good: There is a mix of wide and narrow sidewalks, with some sections in need of minor repair. Accessibility to all users is generally adequate but could be improved in some areas. Excellent: Sidewalks are generally wide and are in good repair. Sidewalks are readily accessible to all users.	Site visit conducted by DC&E.
Quality of Crosswalks	Poor = 0 Good = 5 Excellent = 10	Poor: Many intersections lack marked crosswalks, or crosswalk markings are worn and difficult to see. Good: Major intersections have marked crosswalks that are clearly visible. Excellent: Major intersections have crosswalks with distinctive markings, such as unit pavers and/or bricks, scored decorative concrete, thermoplastic markers, or zebra stripes. Pedestrian refuges are sometimes provided on wide street crossings. Mid-block crossings may be present.	Site visit conducted by DC&E.
Average Speed Limits	Average speed limit on streets within ½ mile of station (mph): Value / Score / Value / Score	Range of values divided into 10 equal intervals.	DC&E calculation based on GIS data from Los Angeles Community Redevelopment Agency.

Criteria	Scoring Ranges	Scoring Explanation	Data Source
	25-25.5 10 28.1-28.5 4 25.6-26.0 9 28.6-29.0 3 26.1-26.5 8 29.1-29.5 2 26.6-27.0 7 29.6-30.0 1 27.1-27.5 6 + 30.0 0 27.6-28.0 5		
MULTIMODAL TRANSPORTATION SYSTEM			
Public Transit:			
Transit Ridership	Daily riders using station: Value / Score 400-4,090 1 4,091-7,780 2 7,781-11,470 3 11,471-15,160 4 15,161-18,850 5 18,851-22,540 6 22,541-26,230 7 26,231-29,920 8 29,921-33,610 9 33,611-37,300 10	Range of values divided into 10 equal intervals.	Provided in the CTOD report: *Creating Successful Transit-Oriented Districts in Los Angeles.*
Transit Headways	Average morning and evening commute headway at station (minutes): Value / Score / Value / Score 4.0-4.9 10 10.0-10.9 4 5.0-5.9 9 11.0-11.9 3 6.0-6.9 8 12.0-12.9 2 7.0-7.9 7 13.0-13.9 1 8.0-8.9 6 + 14.0 0 9.0-9.9 5	Range of values divided into 10 equal intervals.	DC&E calculation based on Metro schedules.
Transit Connections	Number of bus lines traveling within ½ mile of the station: Value / Score / Value / Score 0-5 1 26-30 6 6-10 2 31-35 7 11-15 3 36-40 8 16-20 4 41-45 9 21-25 5 +46 10	Range of values divided into 10 equal intervals.	DC&E calculation based on GIS data from MTA.

Criteria	Scoring Ranges	Scoring Explanation	Data Source
Separation from Vehicle Traffic	Poor = 0 Good = 5 Excellent = 10	Poor: The transit line shares the right-of-way with vehicle traffic. Good: The transit line has a dedicated right-of-way, but is required to stop for vehicle traffic at intersections. Excellent: The transit line has a dedicated right-of-way that is entirely separated from vehicle traffic.	Site visit conducted by DC&E.
Bicycles:			
Bicycle Network	Poor = 0 Good = 5 Excellent = 10	Poor: Very few safe and visible bicycle facilities. Poor connectivity between bicycle facilities and destinations. Good: A partial network of safe and visible bicycle facilities. Some areas may lack safe and visible facilities, limiting connectivity between destinations. Excellent: A comprehensive network of safe and visible bicycle facilities that allow bicyclists to travel safely to most destinations that can be reached by vehicle.	Site visit conducted by DC&E.
Bicycle Parking	Poor = 0 Good = 5 Excellent = 10	Poor: few no bicycle parking facilities within ½ mile. Good: bicycle parking facilities provided in key locations such as transit stations within ½ mile. Excellent: an abundance of bicycle parking facilities and covered bicycle parking provided within ½ mile.	Site visit conducted by DC&E.
Vehicles:			
On-Street Parking	Poor = 0 Good = 5 Excellent = 10	Poor: Few or no streets allow on-street parking within ½ mile. Good: On-street parking is allowed on some streets within ½ mile. Excellent: On-street parking is provided on most streets within ½ mile.	Site visit conducted by DC&E.
SUSTAINABILITY			
Sustainability of Landscaping	Poor = 0 Good = 5 Excellent = 10	Poor: Landscaping has not been well-maintained and/or largely includes plants that are not climate-appropriate, such as turf grass. Good: Landscaping is well maintained, requires a moderate amount of watering, and does not generate large amounts of green waste. Excellent: Landscaping is well-maintained, requires little or no watering, does not generate large amounts of green waste, and helps to reduce the rate and improve the quality of stormwater runoff.	Site visit conducted by DC&E.

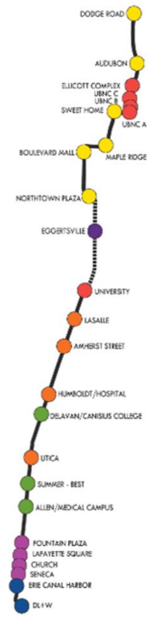
Buffalo, New York (2014)
References: (WSP, 2017) – Note: The document under review was a draft interim report made public in June 2017. Updated guidance or outcomes may vary from the provided summary.
Transit System: Metro Rail
Purpose of Typology:
Types of Use: Agency; Design or Land Use;
Findings & Outcomes: It is also too early to tell the full use of this typology. This is an interim report, which means that the full potential of these typologies may not have been realized just yet. The types appear to represent mostly area types, not capturing the demographic shifts or market potential of studies aimed at developing strategies that strengthen these neighborhoods or evaluating the success of different policies. However, the interim report does acknowledge the potential for typologies to be used in this way. It's currently too early to tell how these typologies will be used and applied in practice.
Method for Aggregating Typology:
Notes: There is no mention of the methodology that was used to develop the place-type based typology for this report. It was mentioned early in the document that this came out of a workshop, which means that it may have been more anecdotal or manual than quantitative. These typologies communicate area type/land use
Categories & Supporting Variables or Definitions:
Notes: The descriptions here may be pulled directly from the language of the document; for image screenshots (marked with an image shadow), page numbers are either left on the image or embedded in the text directly before the image.
The following images describe the typologies and the supporting high-level variables. The dimensions of these typologies include: character (such as major attractions or activities); density; mix of uses; pedestrian environments; multimodal connectivity; and parking.

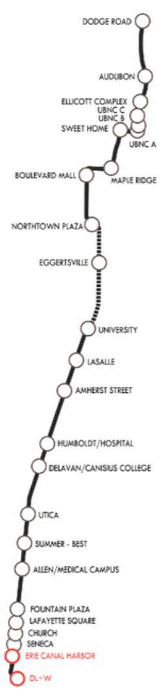
5. STATION AREA TOD TYPOLOGIES

TOD should not be viewed as a one-size-fits-all approach. Because station areas vary significantly in function, character, physical form, and market potential, and are driven by a number of factors that vary throughout a corridor, planning goals and future development objectives for station areas should be flexible to accommodate the differences in situations at various station areas.

Station typologies are a way to think about the function, character, physical form, and market potential of station areas in the larger context of the Metro Rail study corridor, and provides a way to group station areas that share similar attributes. Station typologies are developed based on the current character of the neighborhood, a reasonable expectation of what character the station area will take on and how the station area will function, how the physical form will be shaped, and what the market potential is for TOD. Seven station typologies are identified in the Metro Rail study corridor, shown below with the stations that fit within each typology. Map X portrays the station typologies along the Metro Rail corridor and an explanation of each of the station typologies is provided on the following pages.

- Sports & Entertainment District
  - DL&W Terminal
  - Erie Canal Harbor
- Urban Core
  - Seneca
  - Church
  - Lafayette Square
  - Fountain Plaza
- Urban Campus
  - Allen/ Medical Campus
  - Summer – Best
  - Delavan/Canisius College
- Urban Neighborhood
  - Utica
  - Humboldt/Hospital
  - Amherst Street
  - LaSalle
- Suburban Neighborhood
  - Eggertsville
- Mixed Use Center
  - Northtown Plaza
  - Boulevard Mall
  - Maple Ridge
  - Sweet Home
  - Audubon
  - Dodge Road
- University Campus
  - University
  - UB North Campus A
  - UB North Campus B
  - UB North Campus C
  - Ellicott Complex

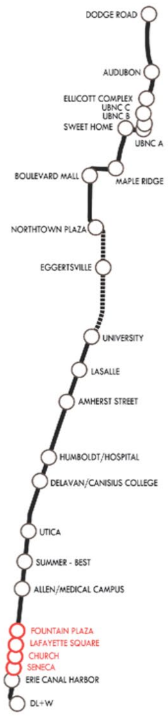




5.1. SPORTS & ENTERTAINMENT DISTRICT

Key Characteristics

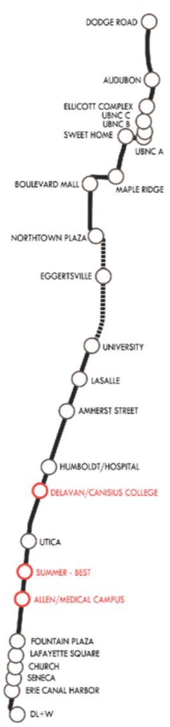
- Metro Rail Stations: The DL&W Terminal and Erie Canal Harbor Stations are included in the Sports & Entertainment District station typology.
- Character: The attractions throughout the Sports & Entertainment District draw large crowds as events take place. Key Bank Center holds events nearly 80 days per year, Canalside attracts upwards of a million visitors a year, and events at HARBORCenter and Riverworks attract visitors, many from out of town. The Seneca Buffalo Creek Casino brings a steady crowd of residents to the area at all times of the day.
- Density: As a whole, the Sports & Entertainment District contains vast amounts vacant or underutilized land. Much of this vacant and underutilized land is reserved for parking for the foreseeable future, some of the land is reserved as future development parcels. As the Canalside and Cobblestone areas build out, density will increase and more importantly begin to create continuous building frontages.
- Mix of Uses: While the Sports & Entertainment District used to be solely focused on large scale sports and entertainment type venues, recent projects have introduced mixed uses and have begun to reactivate street frontages and generate activity even when events are not occuring. Proposals for the continued build out of Canalside and redevelopment of Cobblestone will add to this mix of uses.
- Pedestrian Environment: Where improvements associated with Canalside or around development projects (i.e., HARBORCenter, One Canalside, Ohio Street, and Buffalo Seneca Creek Casino) have been undertaken, pedestrian and bicycle accommodations have been upgraded. However, large sections of the area contain poor pedestrian and bicycle conditions due to lack of building frontage activity and overall outdated facilities. The redevelopment of Canalside has brought about new and revived public spaces that continue to attract visitors and connect people to the waterfront.
- Multi-Modal Connectivity: Metro Rail is highly visible as it operates on the surface along Main Street through the Sports & Entertainment District. Metro Rail currently has exclusive use of portions of Main Street but, an upcoming Cars on Main Street project will open up Main Street to shared Metro Rail and vehicle space. NFTA is pursuing a project to locate a new Metro Rail station within the ground floor of DL&W Terminal, with possible connections to the south side of Key Bank Center, opening up portions of DL&W Terminal for redevelopment.
- Parking: Off-street parking is plentiful in the Sports & Entertainment District to accommodate large events. Numerous surface parking lots and parking structures frequently interrupt the urban landscape and result in large areas of inactivity during non-event times. On-street parking is available on some streets.



5.2. URBAN CORE

Key Characteristics

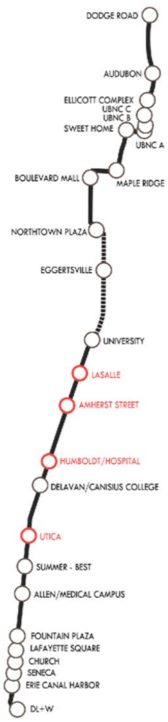
- Metro Rail Stations: The Seneca, Church, Lafayette Square, and Fountain Plaza Stations are included in the Urban Core station typology.
- Character: The Urban Core is the region's center for employment and government and contains the tallest buildings in Buffalo, including the tallest- Seneca One Tower that spans Main Street, and has traditionally been the center of commerce for the region. Much of the original radial street pattern is still in place and provides good connectivity and manageable block sizes that support transit use.
- Density: Distinctively higher density along the Metro Rail line (Main Street), with progressively less density east of Main Street towards Michigan Avenue, but still high density west of Main Street towards the government center.
- Mix of Uses: While the Urban Core is traditionally the commercial and government center of the region, there have been an increasing number of redevelopment and infill projects that have reestablished a vibrant mix of uses, with several projects redeveloping older building stock with upper floor residential and office with active ground floor uses.
- High Quality Pedestrian Environment: Wide sidewalks are prevalent along most urban core streets. Recent Cars on Main Street projects have introduced updated pedestrian amenities to the section of Main Street between Mohawk Street and Goodell Street. There are a mix of blocks that contain larger projects from an urban renewal era that have broken up the street connectivity and/or have long spans of inactive building frontages. Buffalo's historical street pattern allows for numerous public plazas and parks that open up viewsheds across the Urban Core and offer opportunity for public gathering. The Metro Rail transit plaza which remains along portions of Mail Street provides a vehicle-less transit and pedestrian linear plaza.
- Multi-Modal Connectivity: Metro Rail is highly visible, as it operates on the surface along Main Street through the Urban Core. Metro Rail has exclusive use of portions of Main Street; other portions that have been improved under the Cars on Main Street projects contain shared Metro Rail and vehicle space. NFTA's busiest Metro Bus transfer area is located adjacent to Church Station, and numerous Metro Bus routes in the Urban Core provide access to the greater transit network. Bicycle facilities continue to be added as transportation and other improvement projects are undertaken.
- Parking: Off-street parking is available in both surface lots and structures in the Urban Core, with surface parking lots frequently interrupting the urban landscape. On-street parking is available on most streets, including along portions of Main Street.



5.3. URBAN CAMPUS

Key Characteristics

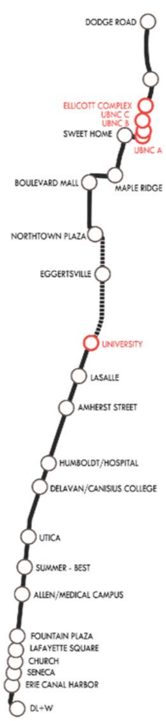
- Metro Rail Stations: The Allen/ Medical Campus, Summer – Best, and Delavan/Canisius College Stations are included in the Urban Campus station typology.
- Character: The Urban Campus consists of medical/ hospital uses as well as college institutional uses clustered in a campus type setting within an urban setting. The Buffalo Niagara Medical Campus (BNMC) houses the region's most dense cluster of hospitals and medical related uses. Canisius College is an expanding college campus at Main Street and Jefferson Avenue. While much of the development that has occurred is non-taxable, the development has spurred associated commercial and residential development that offers a greater mix of uses.
- Density: The BNMC is home to the highest concentration of hospitals and medical uses in the region, and has been developed in a dense urban campus setting that takes advantage of the existing city street grid. The new University at Buffalo Medical School was built in the air space above the Allen/ Medical Campus Station, offering the region's first TOD joint development project. The Canisius College campus is constrained by its existing neighborhood and is currently expanding into existing buildings along Main Street near the Delavan/Canisius College Station and Humboldt/Hospital Station.
- Mix of Uses: While many of the hospitals, medical offices, and college institutional buildings are single use buildings, associated commercial and residential development has increased the mix and diversity of uses and has added street activity. Adaptive reuse of buildings along Main Street has helped to revitalize that corridor and has helped to reconnect the Buffalo Niagara Medical Campus and Allentown.
- Pedestrian Environment: Numerous streetscape projects throughout BNMC have brought enhanced pedestrian, bicycle, and transit facilities. Along with the UB Medical School project will come additional public space and a new connection between Allentown and Buffalo Niagara Medical Campus. The BNMC and grass roots organizations are actively involved in promoting alternative transportation options as a way to reduce single-occupant vehicle travel and the amount of parking. The pedestrian environment on the Canisius College campus is high quality, but Main Street in this area is a wide 6-lane automobile dominated roadway that impacts the comfortability of walking and biking.
- Multi-Modal Connectivity: The BNMC is looking into developing a mobility hub near the Allen/ Medical Campus Station in order to promote alternative transportation options. Metro Bus routes provide major east-west bus connectivity to Metro Rail stations.
- Parking: Off-street parking in the Urban Campus mostly exists in parking structures. On-street parking is available on most streets. Parking is at a premium in the Urban Campus, thus making it easier to promote transit options.



5.4. URBAN NEIGHBORHOOD

Key Characteristics

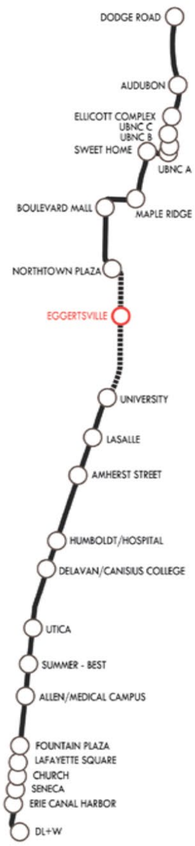
- Metro Rail Stations: The Utica, Humboldt/Hospital, Amherst Street, and LaSalle Stations are included in the Urban Neighborhood station typology.
- Character: The Urban Neighborhood is dominated by smaller parcels, medium density (2-5 stories), and predominately shallow commercial properties fronting major roadways.
- Density: The area scales down in density and it transitions from the Urban Campus areas. The area is dominated by smaller parcels, medium density (generally 2-5 story buildings), and a mix of uses. Major roadways are fronted by shallow lot commercial and residential buildings, Main Street being the most predominant. Adjacent neighborhoods are characterized by medium density single and two family residential, with occasional multi-family development.
- Mix of Uses: The area offers a general mix of uses, ranging from commercial, office, retail, and residential fronting Main Street and many east-west cross streets. Adjacent neighborhoods are primarily single and two-family residential with occasional multi-family or commercial uses mixed in. The neighborhoods east of Main Street experience much higher vacancy.
- Pedestrian Environment: The traditional street grid layout in this area offers smaller lot sizes, smaller block sizes, and numerous street connections. This provides for a very manageable walking environment that provides numerous opportunities for connectivity to stations. In many cases, the actual walking environment is poor and is in need of upgrades. There are limited public spaces and plazas in the Urban Neighborhood.
- Multi-Modal Connectivity: The numerous street connections provide opportunity for abundant east-west connectivity via Metro Bus routes. All streets have sidewalks, although many are in poor condition. While bicycle facilities are lacking on many major roadways, a contra-flow bicycle lane exists on Linwood Avenue, offering an alternative to Main Street between Delaware Park and Downtown.
- Parking: Off-street parking in the Urban Neighborhood is accommodated on a site-by-site basis, with several properties providing some off-street parking. On-street parking is available along Main Street and side streets.



5.5. UNIVERSITY CAMPUS

Key Characteristics

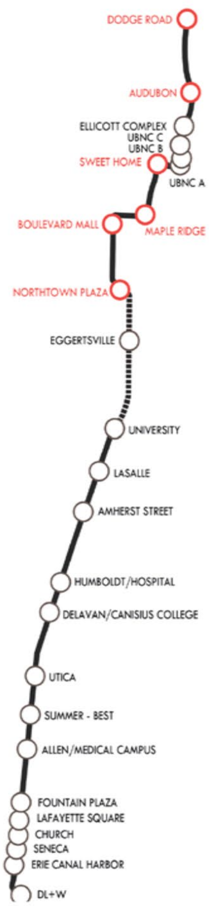
- Metro Rail Stations: The University Campus typology includes University, UB North Campus A, UB North Campus B, UB North Campus C, and Ellicott Complex Stations.
- Character: Numerous educational buildings spread out in a campus atmosphere, with abundant green space. The University Campus is a stand-alone area and is generally not well tied into adjacent neighborhoods, but greatly impact the economy and drive the character of the surrounding neighborhoods.
- Density: While the University Campus area can have pockets of higher density and higher intensity, it is generally low density, with several educational buildings of varying heights spread out across a campus type setting.
- Mix of Uses: There isn't a great deal of mixed uses in the University Campus. Most buildings are educational buildings or buildings to support the University. There are some residential dormitories and small retail and restaurant establishments within educational and residential dormitories. Most commercial, retail, and other services are found off campus in the surrounding areas.
- Pedestrian Environment: The University Campus environment offers a highly comfortable walking and biking environment, with good connections between campus destinations. Walking and biking corridors are generally well lit and active. Connections to adjacent neighborhoods outside of the campus are somewhat limited and less comfortable. The layout of the university campus lends itself to numerous public plazas and open space that create connections between educational facilities and allow for social and gathering places on the campuses. The vast open space at South Campus actually works to somewhat separate the University and University Station from the University Heights neighborhood.
- Multi-Modal Connectivity: Metro Rail and Metro Bus serve the University South Campus well, with a major multi-modal node located at University Station. The University at Buffalo operates the Stampede bus service to supplement NFTA service and connect the University's three campuses. Future Metro Rail expansion will supplant the Stampede and offer Metro Rail service between all three University at Buffalo campuses.
- Parking: Both the North and South Campuses offer abundant faculty, staff, and student parking areas. At South Campus, the parking areas along Main Street are also used for Metro Rail commuter park-and-ride lots, which are heavily used.



5.6. SUBURBAN NEIGHBORHOOD

Key Characteristics

- Metro Rail Stations: The Eggertsville Station is included in the Suburban Neighborhood station typology.
- Character: The Suburban Neighborhood is characterized by medium-density residential neighborhoods with intermixed, small-lot commercial and retail uses fronting major roadways or at major intersections. The residential neighborhoods are predominantly single-family, however, some multi-family residential is intermixed.
- Density: Medium-density residential, mainly single-family detached residential. Commercial and retail uses are small and typically no taller than 2 stories.
- Mix of Uses: While the neighborhoods themselves contain mixed uses, individual properties are mainly dedicated to a single use. Along major roadways and at major intersections, commercial and retail uses are prevalent and are often adjacent to residential with little buffer.
- Pedestrian Environment: The walking environment is very good, with all streets containing sidewalks and block sizes very manageable. Multiple connections are available between neighborhood commercial areas and residences.
- Multi-Modal Connectivity: Metro Bus operates on major streets. The layout of the street pattern and medium-density makeup of the neighborhood make transit very accessible by a large population. The Inter-Campus bikeway connects the University at Buffalo South and North Campuses.
- Parking: Most commercial and residential properties contain their own off-street parking. On-street parking is available on most streets and supplements off-street parking, especially where commercial properties do not have sufficient off-street parking.



5.7. MIXED USE CENTER

Key Characteristics

- Metro Rail Stations: The Northtown Plaza, Boulevard Mall, Maple Ridge, Sweet Home, Audubon, and Dodge Road Stations are included in the Mixed Use Center station typology.
- Character: The Mixed-Use Center is currently representative of auto-oriented, suburban type development consisting of large lot, single-use properties in a low-density setting. There are several big box retailers along Sheridan Drive, Niagara Falls Boulevard, Maple Road, and Sweet Home Road; office parks along Maple Road, Sweet Home Road, and Audubon Parkway; and intermixed smaller businesses. The commercial areas are surrounded by both single-family and multi-family residential. The area is a major retail destination for UB students. This area represents an opportunity to recreate auto-oriented, suburban type development into live, work, play mixed use centers built around transit.
- Density: The Mixed-Use Center contains mainly low-density commercial, with pockets of medium density commercial clustered within commercial parks, and low to medium density residential development.
- Mix of Uses: Properties are mainly dedicated to a single use, either commercial or residential. The distances and character between uses is generally such that walking between uses is not comfortable and driving is encouraged.
- Pedestrian Environment: The walking environment is fairly uncomfortable in the area due to auto-dominated uses, wide streets and high traffic volumes, and limited pedestrian amenities. Public areas are generally limited to the public realm along streets and at parks. There are limited gathering areas along roadways.
- Multi-Modal Connectivity: Metro Bus operates on major streets and handles a high volume of riders, especially along Niagara Falls Boulevard. Transit amenities and accessibility between transit stops and destinations are not great.
- Parking: All commercial properties have their own off-street parking, typically located at the front of the site. There is limited on-street parking on major streets, on-street parking is available on side streets.

Federal Guidebooks or Reports Directly Related
CTOD - Performance-Based Transit-Oriented Development Typology Guidebook (2010)
Reference: (Center for Transit-Oriented Development, 2010)
Transit System: Any (potentially)
Purpose of Typology:
Types of Use: Agency; Design or Land Use; Evaluation;
Findings & Outcomes: This typology is for evaluative purposes based on the performance measure: vehicle-miles traveled (VMT) considering land use measures as an input. VMT, however, is a proxy for many other outcomes that correspond with multimodal and livable community goes—such as walkability, transit use, accessibility (and trip length), active travel, or reduced car ownership and use rates. The output of VMT is not a function of only use mix (workers/(workers + residents)), but rather a host of factors related to the built environment, socio-economic demographics and accessibility opportunities. Instead, mixed use is a way of distinguishing the built environment and regional context of the stations, recognizing that the VMT produced of that area is a means of evaluating the status of the area and identifying strategies that may help further achieve performance goals.
Other Notes:
Page 4: "The characteristics that define a typology can differ depending on what outcomes the typology is meant to accomplish, and not every station area in one area type will be exactly the same."
In this study, the users produce a typology to evaluate the sustainability of TODs. Similar types of typologies could be generated to accommodate evaluation of goals on economic or social outcomes.
Method and Outcomes:
Notes: Recognizing that many built environment measures correlate with each other, this study relies on one set of measures—the proximity and mix of residents and workers—to demonstrate the evaluation. VMT is estimated based on a host of social and environmental factors and normalized across national averages based on the VMT-intensity thresholds (page 10, below).
Page 10:

Table 1. VMT Types

Household VMT Type	VMT Range
1 – Low	< 9,100
2 – Low-Moderate	9,100 to 11,600
3 – Moderate	11,600 to 14,300
4 – High-Moderate	14,300 to 17,200
5 - High	> 17,200

mix, or the balance between residential and non-residential uses is a critical determinant of the qualities and characteristics of a place.

Table 2. Use Mix Types

Use Mix Type	Percentage of workers relative to workers and residents
1 primarily residential	33.3% or less
2 balanced	33.3% to 66.7%
3 primarily employment	66.7% or more

Figure 4: Performance-Based Place Types

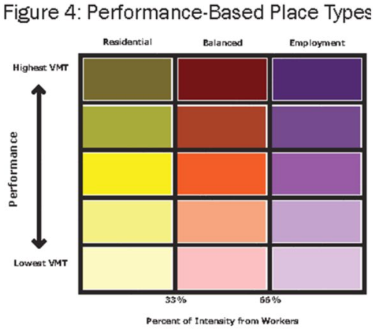


Table 4. Normative Metrics

Place Types	Residential Places					Balanced Places					Employment Places				
	Low VMT	Low-Mod VMT	Mod VMT	High-Mod VMT	High VMT	Low VMT	Low-Mod VMT	Mod VMT	High-Mod VMT	High VMT	Low VMT	Low-Mod VMT	Mod VMT	High-Mod VMT	High VMT
Total Intensity (residents + workers)	54,216	24,718	12,580	7,708	3,429	64,155	21,763	11,600	6,867	3,242	109,306	34,914	13,009	5,969	2,325
Residents	44,293	20,106	10,229	6,292	2,716	29,875	10,732	5,884	3,695	1,764	12,581	5,103	2,065	1,154	321
Workers	9,923	4,612	2,351	1,416	713	34,280	11,031	5,716	3,172	1,478	96,725	29,811	10,944	4,815	2,004
Workers/Residents	18.3%	19.5%	19.6%	20.3%	19.6%	51.6%	49.7%	48.2%	46.0%	46.2%	86.5%	83.9%	84.2%	83.0%	87.1%
Households	16,214	7,684	3,906	2,253	974	15,466	4,646	2,429	1,467	670	6,828	2,524	861	467	120
Household Size	2.71	2.61	2.62	2.71	2.68	1.95	2.21	2.41	2.43	2.60	1.58	1.67	2.22	2.28	2.64
Gross Density (units/acre)	50.0	21.6	10.3	5.7	2.2	48.7	16.4	7.6	4.0	1.9	28.5	10.3	4.6	2.2	0.9
Residential Density (units/acre)	53.2	23.6	12.1	6.7	3.4	55.6	20.9	10.5	5.8	3.5	51.4	20.6	10.8	6.0	2.9
Block Size (acres)	4.2	4.1	5.7	7.7	18.8	3.7	5.8	8.5	9.9	23.7	3.7	6.4	14.2	69.9	86.7
Monthly T Cost	$422	$563	$688	$781	$906	$394	$597	$721	$794	$900	$463	$613	$713	$793	$920
Yearly T Cost	$5,064	$6,756	$8,256	$9,372	$10,872	$4,728	$7,164	$8,652	$9,528	$10,800	$5,556	$7,356	$8,556	$9,516	$11,040
Average Median Income (1999)	$31,713	$35,643	$41,344	$53,492	$62,06t9	$43,997	$37,364	$43,395	$51,138	$65,544	$41,875	$34,183	$43,935	$40,985	$57,562
Travel Time to Work (minutes)	35.6	31.4	27.4	25.5	24.7	23.5	22.1	21.4	21.6	22.9	18.0	17.1	18.7	19.0	21.5
Employment Proximity	233,890	127,448	65,640	42,260	20,788	451,725	152,310	73,393	41,335	27,131	396,277	159,118	99,648	58,747	32,167
Transit Access Index	31	19	13	10	3	56	28	11	9	4	85	45	19	10	4
Autos/Household	0.45	0.82	1.18	1.47	1.71	0.52	0.87	1.22	1.41	1.68	0.48	0.74	1.11	1.18	1.61
Home Journey to Work Transit	58%	39%	23%	15%	8%	43%	25%	14%	10%	8%	25%	16%	13%	9%	5%
Home Journey to Work Walk/Bike/ Transit	68%	47%	27%	18%	10%	64%	40%	23%	15%	11%	58%	37%	24%	18%	9%
Workplace Journey to Work Transit	33%	20%	11%	7%	2%	38%	17%	8%	5%	3%	38%	16%	9%	5%	3%
Workplace Journey to Work Walk/Bike/ Transit	47%	30%	18%	12%	6%	48%	23%	12%	8%	5%	43%	19%	11%	7%	5%

Performance-Based Transit-Oriented Development Typology Guidebook

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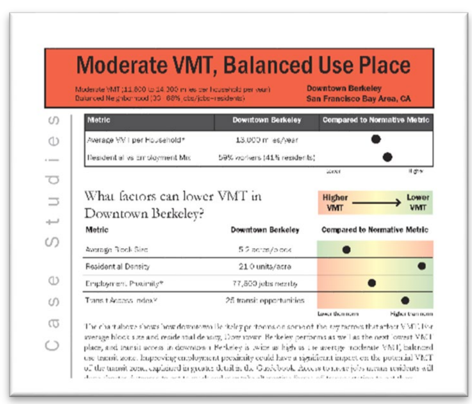
Any one station's location on this typology is a function of not just the mixed-use variable, but the host of variables that go into estimating VMT (see page 15 table above with the normative metrics for each of the VMT threshold categories). The normative metrics allow stations across systems to be compared relative to the national 'universe' on any one variable. When considering strategies to lower VMT, it is the comparison with a station's metrics within any of the 15 VMT/MXD types that provides a direction for which inputs might impact lowering VMT (and increasing active travel or lowering vehicle ownership rates, etc.).

For example, for any one station, one can consider its location relative to the normative metrics to get a sense for which variables might contribute most to VMT, and therefore strategies aimed at improving that corresponding variable/metric. (See right example from page 3 of the appendix; page 60 of the PDF document.)



Similarly, the typology/VMT setup, can be used to assess potential impacts of policies that increase housing (a factor that impacts the mixed-use metric) or any of the VMT inputs to examine the 'direction and scale' of impacts. For examples, Figure 24 (page 31) for example of increasing households (which changes the Use Mix) or see Figure 22 (page 27) for a scenario of another VMT input (which does not change the Use Mix).

Figure 24: Increase Households by 2,000

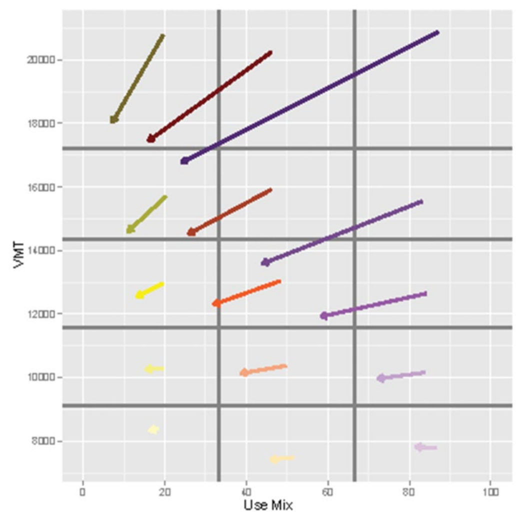
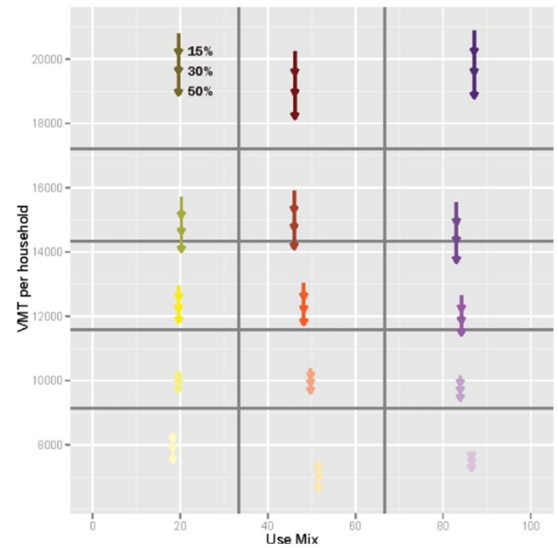
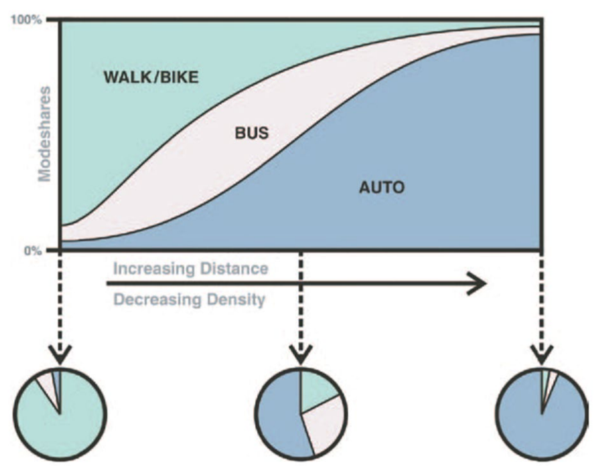


Figure 22: Scenarios A, B, C - Increased Employment Access & Households by 15, 30, and 50 Percent



TCRP Report 153: Providing Access to Transit Stations (2012)
Reference: (Levinson et al., 2012)
Transit System: commuter rail, heavy rail, light rail, and BRT lines.
Purpose of Typology:
Types of Use: Design or Land Use; Common Vocabulary; Conceptual Planning; Evaluation;
Findings & Outcomes:
This report had several purposes. Overall, this report aims to provide comprehensive guidance on the planning of station access—from problem identification to partnerships to solutions. Part of this process includes classifying TODs into different categories or typologies, recognizing that the varying contexts captures the variation in the roles of different types of stations. It also provides a means for understanding, evaluating, and aiming to improve access to and use of stations across different contexts.
The typology might be simplified into five basic types: CBD; urban-medium to high density; suburban low-density; terminal stations; and special conditions.
The typology as proposed was based on the following conceptual illustration, recognizing that as the built environment (here depicted by density) becomes less urban, the typical travel distances increase (making trip length and VMT increase) resulting in more frequent use (and higher proportions) of automobile mode shares (page 34):

Exhibit 4-2. Conceptual illustration of density's effect on access mode choice.



Other Notes:
Method and Outcomes:
Notes:
There is no clear methodology for deriving a 'station access' typology from the following inputs, but the authors provide the typology as an example. The inputs to the typology include the following metrics, indicating that these metrics corresponding with 'station access' performance (in terms of ridership and multimodal access/use): (page 35)

Stations were reviewed according to eight categories:

- **Housing density**—a characterization of the housing density in the area around the station. This attribute provides insight into the potential riders that live within walking distance of the station.
- **Scale**—average building height in the area surrounding the station. Building scale relates to walkability, density, and activity levels, and helps to illustrate the feel of the station area when combined with some of the other categories.
- **Distance from CBD**—a measure of the typical station type's location within the metro area. Stations further from downtown will tend to serve a different market than those closer to the CBD. Stations closer to the urban core tend to emphasize pedestrian connections while commuter stations focus on providing enough parking to meet demand. These locational attributes will vary according to transit mode and other land use considerations.
- **Supporting Transit Network**—the level of transit connectivity to other transit services available at the station. This measure identifies how the station operates in the context of the overall transit network and indicates the station's ability to serve a wide-ranging area.
- **Pedestrian/Bike Access**—a measure of the completeness and attractiveness of the pedestrian and bicycle networks around the station. Well-formed connections for pedestrians and bicycles are important for assuring successful station access.
- **Surrounding Land Uses**—description of the land use mix in the station area. Stations adjacent to different land use types serve different functions.
- **Parking Facilities**—the level of off-street parking accommodation provided at the station type.
- **Access/Egress**—simple classification (Access/Egress/Both) describing the *primary* role of the station in the transportation system. Some stations are located at the "home" end of the journey for most passengers, while others represent the destination. This distinction is important because passengers are more likely to have access to a private vehicle at the "home," or access station.

Page 36 & 37 – The following typologies were provided. Although not explicitly mentioned, these appear to be partially developed based manual categorization based on actual stations and contexts. The authors list this as a 'suggested station access typology' (page 35). The table is in two parts and has been aggregated here into one page.

Exhibit 4-3. Station access typology.

Station Area Type	Housing Density	Scale (# of stories)	Distance from CBD	Supporting Transit Network	Ped/Bike Access	Surrounding Land Use	Access/ Egress	Parking Facilities	Example Stations	Rapid Transit Modes
Urban Commercial	High	>5	0-10 miles	Intermodal facility/transit hub	High-quality network; good connectivity	Office, residential, institutional, retail, entertainment, and civic uses	Both	No off-street parking	16th Street/Mission (BART) Lloyd Center (TriMet) East Liberty (Port Authority)	Heavy Rail Light Rail BRT
High-Density Urban Neighborhood	High	>5	0-10 miles	Subregional hub	High-quality network; good connectivity	Residential, neighborhood retail, limited office	Access	No/limited off-street parking	Kingsbridge Road (NYCT)	Heavy Rail
Medium-Density Urban Neighborhood	Medium	2-5	5-10 miles	Some local bus connections	High-quality network; good connectivity	Residential, neighborhood retails	Access	No/limited off-street parking	Western – Pink Line (CTA) West Baltimore (MARC) Othello Station (Sound Transit) Euclid Ave/71st St (Cleveland RTA) Hoboken – 14th Street (NY Waterway)	Heavy Rail Commuter Rail Light Rail BRT Ferry
Urban Neighborhood with Parking	Medium	2-5	5-10 miles	Subregional hub	High-quality network; high-volume roadways may limit connectivity	Residential, neighborhood retail	Access	Off-street parking available	Anacostia (WMATA)	Heavy Rail
Historic Transit Village	Medium-High	2-5	10-40 miles	Some local bus connections	High-quality network; good connectivity	Residential, neighborhood retail, limited office	Access	Some off-street parking	Greenwich Station (Metro North)	Commuter Rail
Suburban TOD	Medium-High	2-8	5-15 miles	Some local bus connections	Good network within station area, some high-volume roadways	Residential, neighborhood retail	Both	Some off-street parking	Bethesda (WMATA) Davis Street (Metra) Orenco Station (TriMet) Tunney's Pasture (OC Transpo)	Heavy Rail Commuter Rail Light Rail BRT
Suburban Village Center	Medium-High	2 – 5	5-15 miles	Subregional hub	Limited connectivity, some high-volume roadways	Residential, neighborhood retail, commercial	Access	Some off-street parking available	Downtown Littleton (RTD) Van Nuys (LA Metro)	Light Rail BRT
Suburban Neighborhood	Low-Medium	1 – 3	5-15 miles	Some local bus connections	Limited connectivity, some high-volume roadways	Residential, retail, limited office	Access	Some off-street parking available	South Bank (PAT) Pleasant Park (OC Transpo) Route 915 - Columbia (MTA) Quincy (MBTA)	Light Rail BRT Commuter Bus Ferry
Suburban (Freeway)	Low	0-2	10-20 miles	Employer shuttles, limited bus connections	Isolated, difficult connections	Varies	Both	Park-and-ride prioritized	Owings Mills (MTA)	Heavy Rail
Suburban Employment Center	Low	1 – 3	5-15 miles	Some local bus connections, employer shuttles	Poor connectivity, high-volume roadways	Office, retail and limited residential	Egress	Park-and-ride prioritized	McCormick Road (MTA) Maple Island (Lane Transit)	Light Rail BRT
Suburban Retail Center	Low	1 – 3	5-15 miles	Some local bus connections	Poor connectivity, high-volume roadways	Retail, limited office	Egress	Park-and-ride prioritized	Great Mall Transit Center (VTA) Warner Center (LA Metro)	Light Rail BRT
Intermodal Transit Center	Low-Medium	1-3	5-15 miles	Intermodal facility/transit hub	Good connections between systems; isolated	Varies	Both	Park-and-ride often prioritized	Forest Hills (MBTA) Mukilteo (Sound Transit) Bellevue Transit Center (Sound Transit) Hoboken Transit Terminal (NY Waterway)	Heavy Rail Commuter Rail Commuter Bus Ferry
Freeway/ Highway Park & Ride	Low	0-2	15-40 miles	Employer shuttles, limited bus connections	Isolated, difficult connections	Varies	Both	Park-and-ride prioritized	Golden Glades (TriRail) I-485/South Blvd (CATS) Eagleson (OC Transpo) Sammamish Park & Ride (Sound Transit)	Commuter Rail Light Rail BRT Commuter Bus
Busway	Varies	Varies	10 – 30 miles	Subregional hub	High-volume roadways, difficult connections	Varies	Access	Park-and-ride prioritized	El Monte Bus Station (LA Metro)	Commuter Bus
Special Event/ Campus	Low-Medium	1 – 3	Varies	Some local bus connections	Limited connectivity with emphasis on special facility	Entertainment, airport, and/or civic uses	Egress	Limited off-street parking available	Hartsfield Airport (MARTA) Hamburg Street (MTA) Airport Station (MBTA)	Heavy Rail Light Rail BRT
Shuttle Station	Low	0-2	15 – 40 miles	Employer, airport, special event shuttles	Isolated, difficult connections	Varies	Egress	Some off-street parking	Great America (ACE)	Commuter Rail
Satellite City	Low-Medium	1-3	>30 miles	Subregional hub	High-quality network; good connectivity	Residential, retail, limited office	Both	Park-and-ride prioritized	Elgin (Metra) Port Townsend (WSDOT Ferry)	Commuter Rail Ferry
Legacy	Low	0-2	Varies	Limited connections	Isolated, difficult connections	Varies	Access	Some off-street parking	St. Denis (MARC)	Commuter Rail

In an analysis of more than 450 rail stations across eight systems, the authors also provide the 'weekday daily average percentage of station users (for all trips) arriving by a particular mode' (page 35, figure on page 38) to demonstrate the relationship between mode share and urban context in the form of their proposed area types.

Exhibit 4-4. Average station access mode share by station type.

Station Type	Average Access Mode Percentage				
	Walk (%)	Bicycle (%)	Feeder Bus (%)	Auto (Drop-off) (%)	Auto (Park-and-Ride) (%)
Urban Commercial	82	1	10	2	5
High-Density Urban Neighborhood	72	2	14	4	10
Medium-Density Urban Neighborhood	80	1	9	4	7
Urban Neighborhood with Parking	35	3	21	10	31
Historic Transit Village	25	1	3	17	53
Suburban TOD	32	2	13	14	39
Suburban Village Center	30	2	16	12	40
Suburban Neighborhood	29	1	11	13	46
Suburban Freeway	10	1	12	12	65
Suburban Employment Center	29	3	25	9	36
Suburban Retail Center	30	2	19	11	39
Intermodal Transit Center	27	1	36	6	30
Special Event/Campus	55	2	24	6	13
Satellite City	7	6	12	16	59

TCRP Report 167: Making Effective FGT Investments (2014)
Reference: (Chatman et al., 2014, p.)
Transit System: 55 projects primarily heavy rail and light rail with some commuter rail and bus rapid transit.
Purpose of Typology:
Types of Use: NA
Findings & Outcomes:
Other Notes:
Page 2-14 "Suggesting that a one-size-fits-all approach does not match the diversity of local goals and project types, some participants said that projects with different goals and characteristics should be categorized and evaluated under different criteria. One participant suggested that the evaluation process should "put a project into one of a number of categories" (a typology of projects)."
Page 2-24 "The research team deliberately did not establish a typology of indicators according to fixed-guideway transit type (e.g., initial versus expansion project), transit mode (e.g., LRT, HRT, CR, BRT) or by urban setting (e.g., based on surrounding densities or whether location is a CBD, central city, inner suburb, or outer suburb). The approach was instead to run analyses that included appropriate measures to render variables representing type and mode statistically insignificant, given that such measures are imprecise. Other indicators were sufficient to predict ridership according to the statistical tests used, enabling the method to avoid relying on somewhat arbitrary definitions of HRT, LRT, and BRT—categories that have large overlaps in service quality and capital cost."
Method and Outcomes:
Notes: This study considers 55 TOD projects and estimates two measures of 'success' in terms of ridership and use as a function of the built and transportation environment based on factors known for impacting the use of TOD (e.g., densities, congestion, parking).
The measurements of 'success' were based on ridership, not secondary impacts. The metrics include the average weekday ridership measured at a project-level and the change in annual passenger miles traveled (PMT) measured at a metro-area level.
The relevant predictors for ridership were jobs, population, CBD parking rate, percent at-grade, and an interaction between jobs, population, and parking.
The relevant predictors for PMT were high-earning jobs, leisure jobs, congestion score, population, and jobs, and the interaction between jobs, population, and congestion.
All indicators were measured within a ½ mile of the station.
This study relies on the 'indicator' method, which associates measures of success (like ridership) with elements that are more readily controlled for in the planned environment (like zoned or actual density). In other words, ridership is taken as a function of the built and transportation environment to provide a means for estimating demand. Other options may include identifying minimum/maximum thresholds for the environmental variables (like densities, floor space requirements, households, parking ratios) for specific transit modes (and or area types) to provide a simple means for ensuring a high-likelihood of success based on previous studies and analysis. The following Table 4 (from page 1-14) describes the criterion indicators that correlate with specific measures of success. Table 5 (below, from page 1-16) describes the main indicators of ridership.

Table 5: Most Significant Indicators of Project Ridership and System-Wide PMT

Indicators of Project Ridership	Indicators of Change in PMT on System
• Employment within one-half-mile of project stations • Population within one-half-mile of project stations • Combination of employment and population within one-half-mile of stations and daily parking rate in the CBD • Percent of the project alignment at grade	• Metropolitan area population • Employment density within one-half-mile of fixed-guideway stations in the metropolitan area • Population density within one-half-mile of fixed-guideway stations in the metropolitan area • Higher wage jobs within one-half-mile of fixed-guideway stations in the metropolitan area • Average congestion in the metropolitan area (daily vehicle-miles traveled (VMT) per freeway lane-mile) • Retail, entertainment, and food jobs within one-half-mile of fixed-guideway stations in the metropolitan area • Interaction of jobs and population within one-half-mile of fixed-guideway stations in the metropolitan area

Table 4: Success Indicators from TCRP Project H-42 Case Studies

Criterion (Rule of Thumb)	Measure of Project Success	Charlotte	Dallas	Eugene	Portland	Salt Lake City	D.C./MD
Provide fixed-guideway transit where bus ridership is already high	Ridership / Consolidated bus operations		●	●	●	●	●
Select high-visibility corridors where patrons will feel safe	Ridership				●		
Connect CBD with suburban park-and-rides near a congested belt loop	Ridership / Sustainability / Congestion relief / Consolidated bus operations	●	●				●
Minimize stations to maximize speed	Ridership / Sustainability / Congestion relief	●		●			
Minimize grade crossings and in-street operations to maximize speed	Ridership / Sustainability / Congestion relief	●	●	●	●		●
Provide fixed-guideway transit in corridors where parallel highway infra-structure is heavily congested	Ridership / Sustainability / Congestion relief	●	●		●		
Connect multiple employment centers	Ridership / Sustainability / Congestion relief		●	●		●	●
Connect major regional destinations	Ridership / Economic development			●	●	●	
Place alignment in close proximity to commercial property	Ridership / Economic development				●	●	
Place stations in busy locations where "eyes on the street" provide sense of safety	Ridership				●		
Provide service that has average travel speeds greater than existing bus routes	Ridership / Consolidated bus operations	●	●			●	●
Provide transit in high-demand travel corridors where alternative capacity is prohibitively expensive	Economic development	●	●		●	●	
Maximize the number of stations	Economic development / Real estate values	●		●	●		●
Place alignment along corridors with ample development potential to fa-cilitate urban growth as described by local land use plans or regional plans	Real estate values	●		●	●	●	
Provide fixed-guideway transit in corridors where inexpensive right-of-way can be easily accessed	Construction completion / Minimized impacts	●	●	●	●	●	●
Maximize distance between alignment and single family neighborhoods; Minimize taking of residential property	Minimized impacts / Public support	●		●	●		●
Identify corridors that can help garner local political support for further transit system investment	Public support	●		●			●
Select corridors that garner congressional support	Public support	●			●		●
Locate stations in low income areas or in communities of color	Dependent riders / Economic development			●	●		●
Provide substantial bus layover facilities at stations	Consolidated bus operations		●			●	●

FTA Report no. 0057: Local Planning and Transit-Supportive Development (2014)
Reference: (Santasieri, 2014)
Transit System: commuter, light rail, streetcar, heavy rail, bus
Purpose of Typology:
Types of Use: Design or Land Use; Conceptual Planning; Strategy Identification & Implementation;
Findings & Outcomes:
This study develops a typology that considers the concurrency of planning and zoned land use as part of the TOD type. This means that this type of typology would not likely be integrated into the kind of analysis we are conducting. However, the success of any one TOD is likely to be driven by the planned efforts in achieving transit-friendly and -supportive environments. At a system level, this type of classification might be an interesting way to assess economic impacts. However, the typology must at least partially be developed with the discussion of local developers and planners to identify the level of 'planned' environment (versus coincidental).
The separation within each typology of urban/suburban designation is a recognition of the variation of inputs and outcomes of TOD across a region. There is no clear designation/definition of how 'urban/suburban' were classified.
Although the use of the typology was not to drive the identification of future strategies, instead the use of the typology as a means for qualitatively considering the mechanisms for which the case studies were developed. In other words, patterns and themes in successes/failures across the case studies were organized based on the typologies.
Other Notes:
TOD (page 5-3): "a pedestrian-friendly community that extends for ¼ to ½ mile from a public transit station and includes mixed uses, higher densities, and compact design."
Method and Outcomes:
Notes:
The authors studied a sample (initially 60 and then 25) which met the criteria "contained within a connected, comfortable walking distance of transit, generally ¼ to ½ mile" and "includes a mix of at least three different land uses, including retail, housing, office, entertainment, transit facilities, and/or transit-facility parking". For the filtered 25 sites, addition information was collected for classification and case-study analysis purposes, including the location, transit orientation, land use, density and massing, site and building design, and funding and process.
The authors analyzed the data based on quantitative (mean/median calculations) and qualitative observations, which include interviews (developers and planners) and discussion.
In addition to the following typologies, sites were separated by the (community context defined) urban and suburban nature of the location as well as the 'transit-supportive' nature of the development, which includes type and extent of linking the access of rail from development.

Typology	Description
Transit-ready development	"…a mixed-use development that is planned and implemented in concert with, and in anticipation of, future rail stations and implemented before the station is constructed … occur[ing] in conjunction with adopted corridor plans. They have the advantage of being built early into the planning process, which means that zoning and design guidelines or codes can be developed in advance to accommodate the type of project envisioned." (page 5-3)
Transit-integral development	"…a mixed-use or single-use development that is implemented in concert with station and corridor implementation… [with] significant connectivity with the proposed stations and have no access barriers to surrounding land uses. They have the advantage of early planning and are encouraged by zoning, code, and design controls that support their development." (page 5-4)
Transit-adjacent development	"… a single-use or mixed-use development that has or is being implemented adjacent to rail stations and corridors where significant barriers (e.g., surface highways, arterial or freight rail corridors, park-and-rides, industrial or big block retail) separate stations from less intense land use …[and are] indicative of a lack of coordinated planning and/or coordinated agency decision making. While such developments can be made more user-friendly, the linkages and infrastructure costs are more expensive later in the development process." (page 5-6)
Transit-coincidental development	"… a mixed-use or single-use development that builds on the success of previous developments surrounding stations and corridors … [which] benefits from the place-making features that exist in typically successful urban areas, where zone and code adjustments and financial investments have already been made." (page 5-6)

Other Studies about TOD (with typologies)
LSU/UNO UTC: Examination of America's TOD 2000 & 2010 (2013)
Reference: (J. L. Renne & Ewing, 2013)
Transit System: appears to be entirely rail, including heavy and light systems
Purpose of Typology:
Types of Use: Conceptual Planning; Prioritization; Evaluation;
Findings & Outcomes:
TAD-TOD Typology: This study aggregates 1,325 TODS in 2000 and 1,640 TODs in 2010 (about a third of all stations) to categorize sites into adjacent/oriented/hybrid typology using the density, land use diversity, and walkable design. The difference between TADs and TODs in terms of built environment is explored. The typology was then correlated with commute mode share, vehicle ownership, transportation + housing costs, and housing tenure.
Other Notes:
Peter Calthrope in *Next American Metropolis* (1993) on page 56*:* "a mixed-use community within an average 2,000-foot walking distance of a transit stop and a core commercial area. TODs mix residential, retail, office, open space, and public uses in a walkable environment, making it convenient for residents and employees to travel by transit, bicycle, foot or car"
Belzer and Autler (2002) *Transit Oriented Development: Moving from Rhetoric to Reality* on page 3 indicate that definitions should focus on outcomes (not just physical environments), recognize the 'continuum of success', and adapt to different contexts.
Method and Outcomes:
Notes:
The typology for this study uses a point-based system (page 6). Where the points are allocated based on the following criteria:
"Greater than 30 jobs or residents per gross acre = 1 point"
"Not having 100% of land uses as either residential or commercial = 1 point"
"Average block size less than 6.5 acres = 1 point" (footnote: "This threshold was recommended by Reid Ewing based on his knowledge of many studies of which is the minimum average block size for being walkable")
Each station was then assigned according to the following rubric:
TAD = 0 or 1 points
Hybrid = 2 points
TOD = 3 points.
The authors then conducted two types of analysis: Descriptive statistics of transportation, economic (e.g., housing income), and built environment variables across their typology and multivariate statistical analyses of community and built environment variables.
The authors also consider a 'conceptual framework' that estimates transit commute mode share by characteristics of the region (e.g., sprawl, regional jobs within railway stations) and neighborhood (densities, mix, etc.).

TCRP Report 128: Effects of TOD (2008)
Reference: (Arrington & Cervero, 2008)
Transit System: light rail
Purpose of Typology:
Types of Use: Design or Land Use; Evaluation;
Findings & Outcomes:
This study focuses on the travel behavior of employees, employers, and residents of TOD areas. The outcome of this analysis is related to trip and parking generation, factors that play a part in transportation impact analyses. The unit of analysis was behavior measured at a (housing) site level (not a station level). No clear outcomes from this study relate directly to the work proposed in this project.
Other Notes:
Method and Outcomes:
Notes:
This analysis does not consider the TOD type within the analysis of travel behavior outcomes. They are mentioned however throughout the literature review in reference to prior works. The key emphasis here is that the mode share is partly related to the regional location, and typologies tend to capture the hierarchy of locations across a region (basically a proxy for distance to the CBD and/or accessibilities/densities). In the final analyses, densities (such as retail densities) and parking are inputs into the estimates of vehicle trip and parking generation models, suggesting these indicators are the strongest predictors of automobile/non-automobile travel at housing locations with close proximity to light-rail transit.

NITC: Trip and Parking Generation at TOD (2017)
Reference: (Ewing et al., 2017)
Transit System: light rail
Purpose of Typology:
Types of Use: Study site selection threshold criteria
Findings & Outcomes:
Seven criteria:
Align with ITE's definition
Dense (mid-rise or higher multifamily housing)
Mixed use (residential, retail, entertainment, and sometimes office uses within one development)
Pedestrian friendly (streets built for peds as well as cars/transit)
Additional:
Adjacent to transit (literally abutting related)
Built after transit was constructed/proposed (indicates parking supply decisions that took transit access into consideration)
Full developed (or near so)
Self-contained/dedicated parking
Other Notes:
ITE (2004, page 5-7) define TODs as "compact, mixed-use developments with high-quality walking environments near transit facilities" (quote Ewing et al).
Method and Outcomes:
Notes:
Sites were selected first through a professional and local survey administered over the phone with local professions dealing with TODs (often located in public agencies). Following, google street view and secondary (ACS, Census) data analysis were completed to narrow down to 10 study sites, ranging from 2 to 50 gross acres (development only, not including dedicated transit parking, etc.). Five TODs were then studied for the report.
Person trip generation counts (entering/existing developments); intercept surveys (peak periods only); and parking inventory and occupancy (off-street, development dedicated only, but for each 2 hour period) were collected.

Cervero & Guerra (2011) - Urban Densities and Transit: A Multi-Dimensional Perspective
Reference: (Cervero & Guerra, 2011)
Transit System: Mainly LRT and HR, but with some BRT.
Purpose of Typology:
Types of Use: Conceptual Planning; Evaluation;
Findings & Outcomes:
LRT need 30 people per gross acre and HR needs 45 people per gross acre to remain in the top-quartile of cost-effective systems.
The authors are not relying on a typology as much as they are working to define minimum job/residential thresholds around LRT and HR. They also aim to establish guidelines about the catchment areas. All of this analysis is based on providing more cost-effective systems in terms of costs per passenger mile and per passenger.
Other Notes:
Methods and Outcomes:
Notes:
Additional analysis of photo simulation reactions of densities and design were considered, but were determined not to be directly relevant for this analysis.
Minimum density thresholds:
The authors collected information on 33 LRT investments and 23 heavy rail (and 4 BRT). This includes 768 stations and 740 'bidirectional route miles of fixed-guideway service' built for $68 billion 2009-USD. The information included investment data, fare revenues, operating costs, passenger trips, and jobs/population in station catchment areas. [full methods are cited as being presented in the Guerra & Cervero JAPA article "Cost of a Ride".]
Costs were annualized to calculate the cost per passenger mile and per passenger of each system. Costs against densities were considered to establish a review of Pushkarev and Zupan's 1977 and re-consider an updated 'recommended minimum threshold'.
When comparing with Pushkarev and Zupan's thresholds, only 26% of HR and 19% of LRT meet the recommended thresholds (HR: 12 households per acre for areas with CBD of >50-million non-residential square feet; LRT: 9 households per acre with access to a CBD with 20-50-million non-residential square feet).
Defining 'cost-effectiveness' as costing less than $0.58 per passenger mile (based on average estimated marginal costs, just above the top-quartile of investments), the authors the "minimum threshold population density that an average light-rail and heavy-rail city need in order to achieve a high cost-effectiveness rating at different capital costs per passenger mile".

TABLE IV. POPULATION DENSITY THRESHOLDS FOR TOP QUARTILE COST-EFFECTIVENESS AT A RANGE OF CAPITAL COSTS FOR AVERAGE LIGHT- AND HEAVY-RAIL CITIES.

Large city (HR) job catchment of 350,000		Medium city (LRT) job catchment of 100,000	
Capital Cost[a]	PPA[b]	Capital Cost[a]	PPA[b]
$100	9	$25	14
$150	22	$50	32
$200	36	$75	50
$250	50	$100	67
$500	119	-	-

Notes: a. Average capital cost per mile in millions (2009).
b. Population per gross acre.

The authors also found that light-rail is more cost effective than heavy rail up to approximately 28 people and jobs per gross acre. This analysis included modeling 'the variation inn cost per passenger mile while adjusting capital costs, based on increasing densities.' By varying jobs/populations by 1%, the authors derived the following relationship between costs and densities:

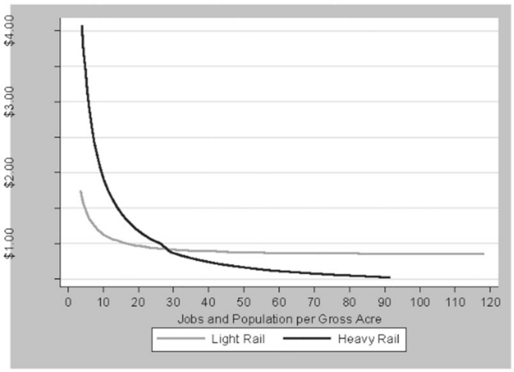


Figure 5. Net cost per passenger mile by jobs and population in average light- and heavy-rail cities.

The authors also note that high-cost systems require more densities, needing approximately 45 and 30 people per gross acre to achieve their high 'cost-effectiveness' for HR and LRT, respectively.

Catchment areas:

Using data from 832 HR, 589 LRT, and 36 BRT, the author estimates a direct demand model of stations and transit ridership as a function of population within different catchment areas. Each coefficient provides an estimate of the contribution of boardings/alightings based on population for that buffer area. The multivariate analysis parses out the impacts of population from a distance. Although not as robust as a full travel demand model, a direct demand approach can be useful for establishing guidance based on existing contexts at a station (not human) level. The authors found little variation in prediction power when using jobs/population densities for different catchment areas, suggesting catchment areas are irrelevant for ridership. Slight improvements in models using the 0.5 to 0.75 buffer population counts and the 0 to 0.25 buffer for job counts:

lation within miles	0.338***					
	(6.02)					
lation within miles		0.249***				
		(4.62)				
lation within miles			0.183**			
			(3.52)			
lation within miles				0.146**		
				(3.00)		
lation within miles					0.122*	
					(2.67)	
lation within miles						0.104*
						(2.38)
rvations	1449	1449	1449	1449	1449	1449
sted R-squared	0.7402	0.7463	0.7463	0.7454	0.7445	0.7436

(a) For a list of the included control variables, see Table VII, Model 1. The regression also includes six job count es in quarter-mile bands out to 1.5 miles.
ust clustered t statistics in parentheses; (c) * p<0.05, ** p<0.01, *** p<0.001

LE VI. ORDINARY LEAST SQUARES REGRESSIONS OF THE INFLUENCE OF CATCHMENT-AREA JOBS ON THE AVERAGE OF WEEKDAY B ALIGHTINGS[A]

	(1)	(2)	(3)	(4)	(5)	(6)
within 0.25	0.685***					
;	(4.25)					
within 0.50		0.421***				
;		(4.88)				
within 0.75			0.342***			
;			(4.80)			
within 1.00				0.317***		
;				(4.29)		
within 1.25					0.301***	

Lastly, the authors also found that population and jobs were significant in contributing to ridership, when controlling for other various contextual information.

TABLE VII. LOG-LOG ORDINARY LEAST SQUARES DIRECT MODELS OF U.S. TRANSIT RIDERSHIP

	(1)	(2)	(3)	(4)	(5)
Population within 0.50 miles	0.0922* (2.27)	0.140** (2.99)	0.137** (3.15)	0.147** (3.00)	0.345*** (5.18)
Jobs within 0.25 miles	0.198*** (3.88)	0.257*** (3.89)	0.374** (3.73)	0.370** (3.78)	0.466*** (4.61)
Park-and-ride spaces	0.0136*** (4.20)	0.0137*** (4.06)	0.0145** (3.09)	-	-
Regional Rail Connection Dummy	0.296** (3.37)	0.292* (2.67)	0.446** (3.62)	-	-
Bus lines servings station area	0.0375*** (7.79)	0.0401*** (5.68)	0.0479*** (8.60)	-	-
Terminal station dummy	0.340** (3.59)	0.359*** (3.96)	0.322*** (4.26)	-	-
Airport station dummy	0.755*** (3.98)	0.788*** (3.90)	0.753** (3.31)	-	-
Linear distance (yards) to central business district	-0.0204* (-2.74)	-0.0256* (-2.46)	-0.0343* (-2.16)	-	-
Linear distance (yards) to nearest station	0.00971 (0.40)	0.0932* (2.47)	0.0589 (1.22)	-	-
Frequency (trains during AM peak hour)	0.875*** (17.70)	0.817*** (13.24)	-	-	-
Light rail dummy (1=LRT)	-1.098*** (-9.69)	-	-	-	-
BRT dummy (1=BRT)	-1.876*** (-13.13)	-	-	-	-
City-level dummy variables					
Baltimore	-0.203*	-0.922***	-1.197***	-1.383***	-
Boston	-0.0115	-0.629***	-0.367***	-0.730***	-
Buffalo	0.388**	-0.689***	-1.044***	-1.191***	-
Chicago	-0.506***	-0.491***	-0.347***	-0.605***	-
Dallas	0.279*	-0.814***	-0.908***	-0.961***	-
Denver	-0.0396	-1.113***	-1.211***	-1.271***	-
Los Angeles	0.303**	-0.785***	-0.695***	-0.776***	-
Miami	-0.765***	-0.792***	-0.835***	-0.747***	-
Minneapolis	0.432**	-0.607***	-0.733***	-1.071***	-
New York	0.0935	-0.0107	0.289*	-0.106	-
Newark/Jersey City	-0.914***	-1.965***	-1.970***	-2.197***	-
Phoenix	-0.0278	-1.115***	-1.303***	-1.443***	-
Portland	0.327*	-0.675***	-0.702***	-1.066***	-
Sacramento	0.635***	-0.403***	-0.879***	-1.352***	-
San Diego	0.295*	-0.788***	-1.004***	-1.308***	-
San Francisco	0.0560	-0.0151	0.157*	0.330***	-
San Jose	-0.681***	-1.751***	-2.188***	-2.440***	-
St. Louis	0.557**	-0.481***	-0.737***	-0.879***	-
Trenton	-0.503**	-1.546***	-1.977***	-2.156***	-
Washington D.C.	0.459***	0.500***	1.026***	0.300***	-
Constant	3.907***	2.750**	4.606***	4.778***	1.812
Observations	1449	1449	1449	1449	1449
Adjusted R-squared	0.798	0.734	0.667	0.577	0.334

Notes: (a)Robust clustered t statistics in parentheses; (b) * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Lyu, Bertolini, and Pfeffer (2016) – TOD Typology for Beijing
Reference: (Lyu et al., 2016)
Transit System: Beijing 'metro' (I am assuming this is more like heavy rail, but I'm not sure.)
Purpose of Typology:
Types of Use: Agency; Design or Land Use; Common Vocabulary; Strategy Identification & Implementation; Conceptual Planning; Prioritization; Evaluation;
Findings & Outcomes:
The authors based their analysis on the node-place theoretical framework. This specific paper extends the node-place framework (applied here as the transit-development relationship) to include 'orientation' which describes the catchment area. Although the authors do not provide enough descriptive information to identify the actual TOD characteristics/indicators, this approach and framing provides support for a T-O-D analysis, at the very least through the selection of important indicators for our 'place typology' based approach.
Other Notes:
The area types were developed in this paper, but no additional analysis was considered. The authors described the ways in which a typology can be useful. In this case, for cost-benefit analysis, cost-effectiveness analysis, and other evaluative approaches for grouping 'similar' stations for evaluation.
The authors reference Bertolini's 1999 node-place model (below, page 41), which aligns transport-note and urban development-place characteristics of location and relationships.
Page 41: "Bertolini distinguishes five ideal typical situations in the node-place model (Bertolini, 1999, 2005; see Fig. 1). Along the middle diagonal line are areas in 'Balance' where the node and the place values are equally strong, indicating that the development potential of both has been realized. At the upper right corner of the line are areas under 'Stress',which indicates that the potential for land use development is highest (strong node) and that it has been realized (strong place). The same can be said about the potential for transport development. However, competition for scarce space between node and place functions also produces tensions. At the bottom of the middle line are areas characterized by 'Dependency'. There is no tension here, but demand for both land use and transport development is insufficient to generate an autonomous development dynamics. Areas where transportation facilities are more developed than urban activities are labeled 'Unsustained Nodes' (upper left area of Fig. 1). Conversely, in 'Unsustained Places', at the bottom right of Fig. 1, urban activities are much more developed than transportation facilities. The latter two are the situations where the most development dynamics is to be expected, either positive (upgrading) or negative downgrading)."

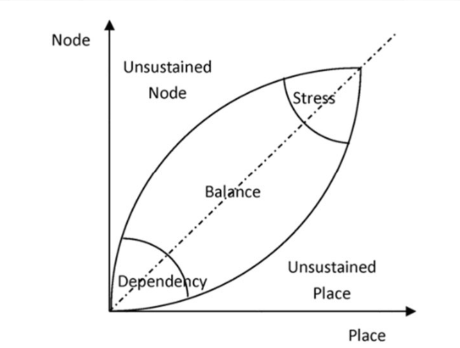


Fig. 1. The node-place model and five ideal-typical situations for a location
Source: (Bertolini, 1999).

By further elaborating the relationship between the pedestrian catchment area of the surrounding location, analysts can establish a difference between 'adjacent' and 'oriented' development. This further establishes the relationships between place and node, but brings in a third dimension or ‘functional proximity’ of entities to node.

Methods and Outcomes:
Notes:
The authors: (1) identified transit, oriented, and development indicators’; (2) selected indicators; (3) measured indicators for the study area; and (4) applied procedures to identify a typology, including:
Standardized metrics; principal component analysis; hierarchical cluster analysis; duda test (to ‘define optimal number of clusters’).
Identified 94 indicators (24 on transit dimension, 53 on development, and 17 on oriented).
Two filters were used to reduce the number of metrics: local experts from Beijing and a ranking of indicators based on their presence in the literature. The following five rules were used (quote from page 42):
“(1) For each of the three TOD dimensions, indicators elected in the top five by both local experts and international studies should be selected first.
(2) The remaining indicators in the top five of both rankings should be selected according to their ranked place.
(3) When indicators describe similar characteristics of a location, the lower scoring ones should be removed from the final selection (see details below).
(4) Indicators should be measurable with publicly accessible data (allowing for transparency and applicability in other contexts).
(5) Each TOD dimension should have the same number of indicators.”
Selected the following indicators:
Transit: T1 – number of directions service by metro; T5 – daily frequency of metro services; T12 – number of stations within 20 min. of travel by metro; T2 – number of directions served by bus; T15 – travel times to major employment and activity centers by metro; T19 – car parking capacity.
T8 – number of passengers per day by metro – was determined to be important, but unavailable due to lack of data.
Development: D1 – number of residents; D29 – degree of functional mix; D7 – number of jobs; D9 – number of workers in retail/hotel and catering; D10 – number of workers in education/health/culture; D11 – number of workers in public administration and services.
D30 – land-use mix – was determined to be important, but unavailable due to lack of data.
Oriented: O14 – average block size; O1 – average distance from station to jobs; O9 – length of paved foot-path per acre; O12 – intersection density;)2 – average distance from station to resident; O17 – walk scores.
Three dimensions were established (transit, development, oriented), and from that 6 types of metro stations were identified (page 45):

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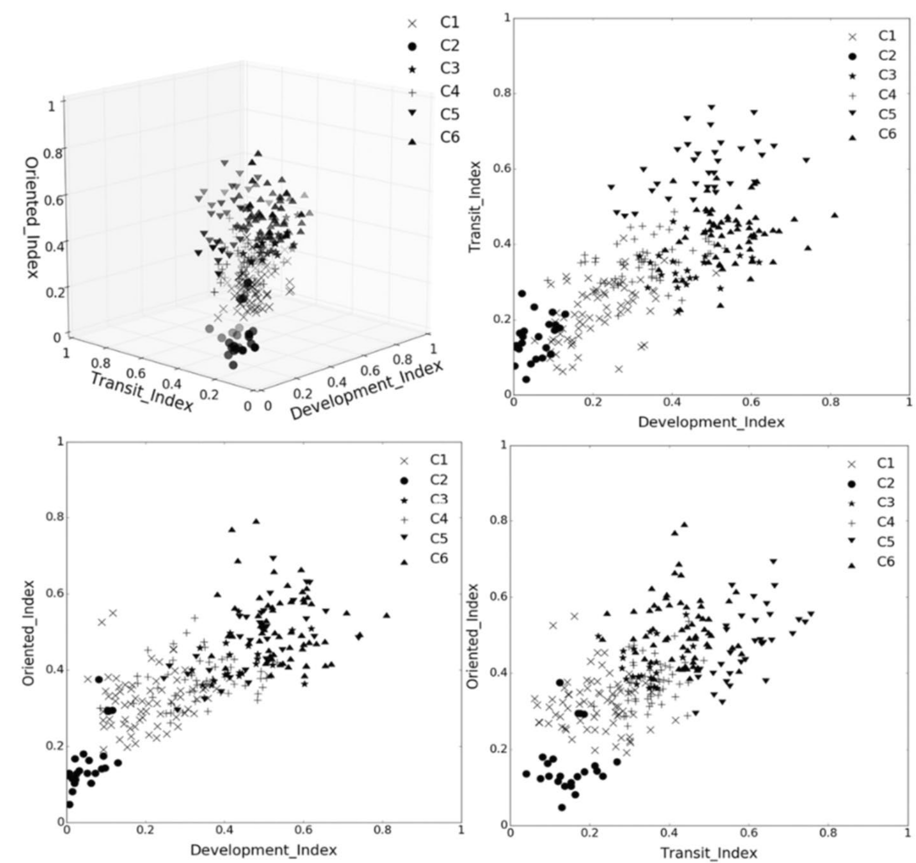


ig. 2. Scatter plot of all station areas and the six clusters in the extended node-place model, representing the indexes for the 'Transit', 'Oriented', and 'Development' dimen
ynthetic and three paired perspectives.

The following table (page 46) depicts the summary of rescaled TOD indicators. Unfortunately, the summary of each indicator used to scale the values was not provided.

Table 3
Cluster description and summary means on rescaled TOD indicators[a] and the T, D, and O index[b].

Rescaled	C1 (N = 72)	C2 (N = 23)	C3 (N = 22)	C4 (N = 55)	C5 (N = 33)	C6 (N = 63)	All (N = 268)
T1	0.222	0.217	0.284	0.250	0.750	0.250	0.304
T2	0.136	0.055	0.348	0.191	0.258	0.277	0.206
T5	0.180	0.120	0.280	0.280	0.604	0.249	0.272
T12	0.137	0.067	0.202	0.314	0.591	0.444	0.301
T15	0.553	0.414	0.683	0.842	0.920	0.910	0.740
T19	0.078	0.024	0.258	0.240	0.462	0.463	0.259
D1	0.162	0.058	0.259	0.381	0.518	0.585	0.349
D7	0.189	0.048	0.531	0.266	0.482	0.557	0.343
D9	0.199	0.045	0.572	0.209	0.351	0.434	0.292
D10	0.101	0.015	0.342	0.225	0.408	0.520	0.275
D11	0.156	0.037	0.394	0.273	0.505	0.616	0.340
D29	0.459	0.131	0.564	0.650	0.588	0.560	0.518
O1	0.336	0.172	0.440	0.245	0.274	0.320	0.300
O2	0.586	0.246	0.610	0.498	0.521	0.540	0.522
O9	0.131	0.101	0.229	0.250	0.382	0.450	0.267
O12	0.093	0.056	0.152	0.170	0.311	0.381	0.205
O14	0.249	0.186	0.362	0.357	0.508	0.570	0.382
O17	0.530	0.208	0.769	0.729	0.833	0.861	0.678
T_Index	0.217	0.150	0.343	0.353	0.598	0.432	0.347
D_Index	0.211	0.056	0.444	0.334	0.475	0.545	0.353
O_Index	0.321	0.162	0.427	0.375	0.472	0.520	0.392

[a] TOD indicators see Table 2 for descriptions.
[b] T_Index, D_Index and O_Index are the average of T, D, and O rescaled indicators.

Attached below is the list of indicators identified in the literature (page 48-49):

TOD indicator	Literature source
T1 Number of directions served by Metro	Bertolini (1999), Reusser et al. (2008), Chorus and Bertolini (2011), Zemp et al. (2011), Song and Deguchi (2013), Vale (2015)
T2 Number of directions served by bus	Bertolini (1999), Reusser et al. (2008), Chorus and Bertolini (2011), Zemp et al. (2011), Song and Deguchi (2013), Vale (2015)
T3 Number of metro stations in one TOD	Song and Deguchi (2013)
T4 Number of bus stops in one TOD	Song and Deguchi (2013)
T5 Daily frequency of Metro services	Bertolini (1999), Dittmar and Ohland (2004), Reusser et al. (2008), Center for Transit-Oriented Development (2011), Zemp et al. (2011), Song and Deguchi (2013), Monajem and Nosratian (2015), Vale (2015)
T6 Number of other public transport modes (Bus, Tram) departing on a working day	Bertolini (1999), Reusser et al. (2008), Center for Transit-Oriented Development (2011), Zemp et al. (2011), Ivan et al. (2012), Vale (2015)
T7 Public Transport Accessibility Level (It is calculated by schedule waiting time of bus and metro, and access (walk) time to stops/stations)	Kamruzzaman et al. (2014)
T8 Number of passengers per day by Metro	Reusser et al. (2008), Monajem and Nosratian (2015)
T9 Ratio of metro passengers on weekends to ones on weekdays	Zemp et al. (2011)
T10 Changing rate of Metro passengers in 10 years	Song and Deguchi (2013)
T11 Number of stations within 45 min of travel by Metro	Bertolini (1999), Monajem and Nosratian (2015)
T12 Number of stations within 20 min of travel by metro	Reusser et al. (2008), Zemp et al. (2011), Vale (2015)
T13 Geographic distance to CBD	Reusser et al. (2008), Chorus and Bertolini (2011), Monajem and Nosratian (2015)
T14 Travel time to CBD by Metro	Center for Transit-Oriented Development (2013)
T15 Travel times to major employment and activity centres by Metro	Center for Transit-Oriented Development (2013)
T16 Type of metro service (e.g. old, new, slow, rapid)	Reusser et al. (2008), Chorus and Bertolini (2011)
T17 Whether station connects to airport directly (no transfer)	Atkinson-Palombo and Kuby (2011)
T18 Whether station is a terminal	Atkinson-Palombo and Kuby (2011)
T19 Car parking capacity	Bertolini (1999), Atkinson-Palombo and Kuby (2011), Ivan et al. (2012), Vale (2015)
T20 Bicycle Parking capacity	Bertolini (1999), Atkinson-Palombo and Kuby (2011)
T21 Distance to the closest motorway access by car	Bertolini (1999), Reusser et al. (2008), Vale (2015)
T22 Number of free-standing bicycle paths (separated bicycle paths)	Bertolini (1999)
T23 Total bike path length within 2 km around metro station	Reusser et al. (2008)
T24 Number of staff in the station	Reusser et al. (2008)
D1 Number of residents	Bertolini (1999), Reusser et al. (2008), Shastry (2010), Atkinson-Palombo and Kuby (2011), Chorus and Bertolini (2011), Center for Transit-Oriented Development (2011), Zemp et al. (2011), Ivan et al. (2012), Center for Transit-Oriented Development (2013), Song and Deguchi (2013), Kamruzzaman et al. (2014), Singh et al. (2014), Monajem and Nosratian (2015), Vale (2015)
D2 Percentage of working-age population	Center for Transit-Oriented Development (2011), Center for Transit-Oriented Development (2013)
D3 Percentage of elderly population (above 65)	Song and Deguchi (2013)
D4 Changing rate of residential population in 10 years	Song and Deguchi (2013)
D5 Changing rate of working-age population in 10 years	Song and Deguchi (2013)
D6 Changing rate of elderly population (above 65) in 10 years	Song and Deguchi (2013)
D7 Number of jobs	Shastry (2010), Atkinson-Palombo and Kuby (2011), Zemp et al. (2011), Kamruzzaman et al. (2014), Pollack et al. (2014), Singh et al. (2014)
D8 Number of jobs per resident	Shastry (2010)
D9 Number of workers in retail/hotel and catering	Bertolini (1999), Reusser et al. (2008), Chorus and Bertolini (2011), Ivan et al. (2012), Singh et al. (2014), Monajem and Nosratian (2015), Vale (2015)
D10 Number of workers in education/health/culture	Bertolini (1999), Reusser et al. (2008), Chorus and Bertolini (2011), Ivan et al. (2012), Monajem and Nosratian (2015), Vale (2015)
D11 Number of workers in public administration and services	Bertolini (1999), Reusser et al. (2008), Chorus and Bertolini (2011), Ivan et al. (2012), Monajem and Nosratian (2015), Vale (2015)
D12 Number of workers in industry	Bertolini (1999), Reusser et al. (2008), Chorus and Bertolini (2011), Ivan et al. (2012), Singh et al. (2014), Monajem and Nosratian (2015), Vale (2015)
D13 Housing density (units/acre)	Dittmar and Ohland (2004), Pollack et al. (2014)
D14 Number of flats	Ivan et al. (2012)
D15 The percentage of public housing above 6 floor	Song and Deguchi (2013)
D16 The percentage of private housing	Song and Deguchi (2013)
D17 Total gross floor area of development	Cervero and Murakami (2009)
D18 Building floor area by use (residential, office, retail shopping, hotel/service apartments and other)	Cervero and Murakami (2009), Ivan et al. (2012)
D19 Floor area ratio	Cervero and Murakami (2009), Song and Deguchi (2013)
D20 Height of buildings	Cervero and Murakami (2009)
D21 The number of neighbourhood retail and service establishments	Center for Transit-Oriented Development (2011)
D22 The size of built-up area for housing and services	Ivan et al. (2012)
D23 Areas with commercial urban amenities	Shastry (2010), Center for Transit-Oriented Development (2013)
D24 Number of massive commercial facilities (above 1000 square meter in areas)	Song and Deguchi (2013)
D25 Number of public facilities	Reusser et al. (2008), Song and Deguchi (2013)
D26 Average real estate sales per square foot	Center for Transit-Oriented Development (2011), Center for Transit-Oriented Development (2013)
D27 Land prices per square meter	Ivan et al. (2012)
D28 Average residential rents	Center for Transit-Oriented Development (2013)
D29 Degree of functional mix (Calculated by numbers of workers from different economic sections and residents)	Bertolini (1999), Reusser et al. (2008), Chorus and Bertolini (2011), Monajem and Nosratian (2015), Vale (2015)
D30 Land-use Mix	Dittmar and Ohland (2004), Kamruzzaman et al. (2014), Singh et al. (2014)
D31 The proportion of similar adjacent land use types	Shastry (2010)
D32 Mixed-use attributes (Building floor area Mix)	Cervero and Murakami (2009)

Appendix A (*continued*)

TOD indicator	Literature source
D33 Housing types (e.g. multifamily, single family, loft, town-home)	Dittmar and Ohland (2004)
D34 Statistical dispersion of different income groups	Shastry (2010)
D35 Geographic position of station area (e.g. urban downtown, urban neighbourhood, suburban centre, suburban neighbourhood, commuter town centre)	Dittmar and Ohland (2004)
D36 Percentage of TOD-compatible land use (A parcel was defined as being TOD-compatible if it is neither residential nor vacant and its property use code would be allowed for future development in the overlay zoning ordinances)	Atkinson-Palombo and Kuby (2011)
D37 Percentage of TOD-incompatible land use (see the definition above (D36))	Atkinson-Palombo and Kuby (2011)
D38 Percentage of vacant land use	Atkinson-Palombo and Kuby (2011), Center for Transit-Oriented Development (2013)
D39 Areas of green or open space	Shastry (2010)
D40 Changing rate of public facility in 15 years	Song and Deguchi (2013)
D41 Changing rate of floor area ratio in 10 years	Song and Deguchi (2013)
D42 Changing rate of office jobs in 10 years	Song and Deguchi (2013)
D43 Qualitative rating of planning initiatives (e.g. station area planning or zoning)	Center for Transit-Oriented Development (2013)
D44 The Presence of a redevelopment authority	Center for Transit-Oriented Development (2013)
D45 Qualitative rating of recent development activity	Center for Transit-Oriented Development (2013)
D46 Qualitative rating of securing funding and financing for projects	Center for Transit-Oriented Development (2013)
D47 Private investment in the area	Singh et al. (2014)
D48 Percentage of people with bachelor's degree	Atkinson-Palombo and Kuby (2011)
D49 Household income	Atkinson-Palombo and Kuby (2011)
D50 Unemployment levels	Singh et al. (2014)
D51 Rate of unemployed with basic education	Ivan et al. (2012)
D52 Tax earnings of district	Singh et al. (2014)
D53 Arriving tourists per 1000 residents of the district	Zemp et al. (2011)
O1 Average distance from station to jobs	Zemp et al. (2011)
O2 Average distance from station to residents	Zemp et al. (2011)
O3 Percentage of housing units owner-occupied	Atkinson-Palombo and Kuby (2011), Pollack et al. (2014)
O4 Percentage of households with access to one or more private vehicles	Center for Transit-Oriented Development (2013), Pollack et al. (2014)
O5 Percentage workers who use non-automobile commuting	Pollack et al. (2014)
O6 Percentage of households with low income	Pollack et al. (2014)
O7 Percentage of income spent on transportation	Pollack et al. (2014)
O8 Walking time to a Metro Station from the centre of each block	Shastry (2010)
O9 Length of paved foot-path per acre	Shastry (2010), Pollack et al. (2014), Singh et al. (2014)
O10 Length of sidewalks and low-stress bike ways	Center for Transit-Oriented Development (2011)
O11 Number of cul-de-sac (dead end road)	Kamruzzaman et al. (2014)
O12 Intersection density	Shastry (2010), Kamruzzaman et al. (2014), Singh et al. (2014)
O13 Number of entry points into the neighbourhood	Shastry (2010)
O14 Average block size	Center for Transit-Oriented Development (2011), Center for Transit-Oriented Development (2013)
O15 Closeness index of urban street networks (space-syntax, network structure index)	Monajem and Nosratian (2015)
O16 Betweenness index of urban street networks (space-syntax, network structure index)	Monajem and Nosratian (2015)
O17 Walk Scores (It is calculated based on distance to various categories of amenities (e.g., schools, stores, parks and libraries) that are weighted equally and summed)	Pollack et al. (2014)

Pojani et al (2016) – Critical Deconstruction of the Concept of TOD
Reference: (Pojani & Stead, 2016)
Methods and Outcomes: This article is a white paper that focuses on three European case studies. Building from the culturized planning model which considers how culture shapes planning systems), this paper describes some context of the three case studies to reflect the relevancy of TOD development, even in areas where the term TOD doesn't come into play. There is no clear information in this paper that corresponds to the delineation of TOD types. For more information about the 'culturized planning model', see KNIELING, Joerg and Frank Othengrafen. 2015. "Planning Culture: A Concept to Explain the Evolution of Planning Policies and Processes in Europe?" European Planning Studies 23(11):2133-2147.

Rayle (2015) – Connection b/t TOD and Displacement: Four Hypotheses
Reference: (Rayle, 2015)
Methods and Outcomes:
The authors provide only a broad category definition of TOD—"typically a cluster of relatively dense buildings oriented toward a rail transit station, supported by pedestrian-friendly design" (page 534, referencing Bernick & Cervero 1997 and Calthorpe 1993). They also note the modern definition is usually within the context of institutionalized practices. The author uses the "term t*ransit-oriented development* rather than the more general *transit-adjacent development* or *transit-rich neighborhood* (Pollack et al., 2010) so as to focus on the TOD package—that is, the set of policies and the development" (page 534). [Pollack et al: Pollack, S., Bluestone, B., & Billingham, C. (2010). Maintaining diversity in America's transit-rich neighborhoods: Tools for equitable neighborhood change. Retrieved from http://nuweb9.neu.edu/dukakiscenter/wp-content/uploads/TRN_Equity_final.pdf]
While the definition of gentrification remains debated, it generally contains the following aspects (quoted from page 532): "transformation in class and, often, racial composition of a neighborhood; an influx of investment to a neighborhood that has previously experienced disinvestment; a process of rehabilitating structures and the built environment; class- or race-based conflict over territory; displacement of original residents".
The authors note that TOD is an effective tool for urban redevelopment in part because it facilitates investment in fixed capital, making it less risky or uncertain for potential real estate investors. The infrastructure is also more concentrated, making it more likely that accessibility will be increased (thus increasing land value). FGT, specifically LRT, has been defined as serving more high-income and white riders, with buses contributing to lower-class and minority connotations. Redevelopment with transit often incurs more political support including support from coalitions aimed at equity (or sustainability) concerns. Additionally, funds for redevelopment in the transportation realm has continued, tying funding more closely to plans that include transportation elements.
Many of the studies examined have found little to no displacement, contradicting more disaggregate, qualitative, or anecdotal evidence of such. The author presents four points/explanation aiming to explain TODs as a form of gentrification leading to displacement.
"methodological shortcomings of existing studies may mask the actual extent of displacement caused by gentrification" (quoted from page 532)
Meaning areas of analysis larger than the neighborhood scale or measuring too short a temporal period (displacement or out-migration per year instead of per five year or 10 year). Taking into account government intervention (subsidized public housing) allows many residents to stay, which should be controlled for in an analysis. In general, the data used were not intended to measure displacement (too aggregated in space, not enough aggregation across time, no information about household-level reasons for moving).
"even if physical displacement rates are small, social and psychological displacement may have greater effects on residents" (quoted from page 532)
"Empirical studies have operationally defined displacement as the physical movement of households into or out of a neighborhood. According to Wyly et al. (2010), processes of displacement have shifted from direct, visible forms like tenant evictions to more diffuse, less obvious forms, such as gradual economic pressure or the slow erosion of residents' sense of belonging in their neighborhood." (quoted from page 539)
Our study will not consider 'indirect' forms of displacement.
"while TOD may raise housing prices, reduced transportation costs may allow households to remain in place" (quoted from page 532)
"in the face of uncertain outcomes, advocacy groups may use political openings created by TOD plans to claim development benefits for low-income communities" (quoted from page 532)

Renne (2009) – From TAD to TOD
Reference: (J. L. Renne, 2009)
Methods and Outcomes:
Page 1:
"Both concepts refer to the area within a 10-min walk, or half-mile radius, around a major transit station. While a TOD describes a station-area precinct that is compact, mixed-use, and facilitates transit connectivity through urban design, a TAD is "physically near transit [but] fails to capitalize upon this proximity. . . [It] lacks any functional connectivity to transit – whether in terms of land-use composition, means of station access, or site design" (Cervero et al. 2002, p. 6)."
"A national study here in the USA found that about 100 of the nation's 3300 fixed rail stations are TODs (Cervero et al. 2004). Even many of these may be TAD-like because "TOD designations, of course, are quite subjective: one person's TOD may be viewed by others as little more than an office building with suburban parking ratios that happens to be near a train stop" (Cervero et al. 2004). Based on these numbers, even if all of these stations were TODs, nearly 97% of rail stations in the USA would be underdeveloped or in other words – a TAD."
TOD-TAD Spectrum (page 3):

Characteristics of Station Precinct:

TAD ⟷ TOD

TAD	TOD
• Suburban street pattern • Low densities • Dominance of surface parking • Limited or no pedestrian access • Limited or no bicycle access/parking • Single-family homes • Industrial land uses • Segregated land uses • Gas stations, car dealerships, drive-thru stores and other auto-focused land uses	• Grid street pattern • High densities • Mostly underground or structured parking • Pedestrian-focused design • Bicycle access/parking • Multi-family homes • Office and retail land uses, especially along main streets • Vertically and horizontally mixed land uses

Figure 3. The TAD–TOD spectrum.

The authors consider the characteristics of three case studies in the San Francisco area: Downtown Berkeley (TOD); Hayward (more TAD); and Fremont (TAD). The following characteristics are provided as TAD/TOD indicators (page 8):

Table 3. Built environment indicators.

Station area	Number of street links	Number of nodes (three-way or more intersections)	Typical block dimensions (in ft)	Station design rating	Pedestrian accessibility rating	Bicycle accessibility rating
Downtown Berkeley	184	102	350×700 or less	6 of 8	3 of 4	3 of 4
Hayward	144	80	350×700 or more	5 of 8	3 of 4	2 of 4
Fremont	120	58	No clear pattern suburban street design	5 of 8	1 of 4	2 of 4

Note: Calculations are based on the half-mile station area taken from the street maps available from the California TOD Database.

Renne & Wells (2002) – State of the Literature: TOD
Reference: (J. Renne & Wells, 2002)
Methods and Outcomes:
This report provides a selected summary of three reports:
Transit Oriented Development: Moving from Rhetoric to Reality (Brookings report: Belzer and Autler 2002)
Transit Oriented Development and Joint Development in the US: A literature review (TCRP report: Cervero, Ferrell, and Murphy 2002).
Statewide Transit Oriented Development Study: Factors for Success in California (Caltrans 2002a)
Although the majority of this report summarizes existing reports, they provide a few conclusions that are relevant to this study (quoted on page 28):
"Collaboration is key — In order to successfully build a TOD, it is vital that not only do public and private sectors need to work together, but also different levels of government and different agencies across government."
"Public policies are lacking— The TCRP report discusses case studies in a best practice manner, but the Brookings report begins to outline necessary goals and objectives for a coherent public vision. The California report takes the Brookings report's recommendations and develops a model of state policy to promote TOD."
"It is necessary to develop a typology and guidelines for success— Although TOD is subject to local market constraints, it is necessary to develop a system for classifying different places and then creating guidelines for success. Future TODs should learn from the successes and/or failures of the past — it is necessary to define obstacles to success, especially in a local context."
"Housing, parking, and financing need special attention— All three of these reports identify the importance of housing, parking, and financing for TODs. These issues need to be worked on in a general sense, again to develop guidelines for success, but they also need to be addressed in a local context for each new project."
"Measuring and evaluating success is necessary— To ensure that TODs are successful, a process of evaluation is important to ensure that goals are being realized. As stated in the TCRP report, most TODs in the United States are so new that adequate data have not yet been collected to evaluate their success."

Dittmar & Poticha (2004) – Ch. 2 – Defining TOD: New Regional Building Block
Reference: (Dittmar & Poticha, 2004)
Methods and Outcomes:
Notes:
This chapter describes the efforts defining a typology of TOD that aligns with planned goals providing elements of livability using performance-based definitions that include:
Location efficiency: “Conscious placement of homes” (page 23)
Density within walking/biking distance
Transit accessibility: stations located with efficiency within the station area to make other destinations accessible
Pedestrian friendliness: interconnected/scaled network of streets for human convenience
Rich mix of choices: “many activities within walking distance for those that do not drive…, people who cannot afford cars, and people who choose not to rely on cars to get around” (page 25). This is about providing options.
Value capture: reducing transportation costs can provide economic value capture, but requires the following: “frequent, high-quality transit service; good connections between transit and the community; community amenities and a dedication to place making; scorekeeping and attention to financial returns” (page 26). Potential stakeholders are denoted in the following table (Bartlett School of Planning 2001, page 29 qtd. In Dittmar and Poticha 2004, page 27).

TABLE 2.1—THE BENEFICIARIES OF VALUE IN GOOD URBAN DESIGN

STAKEHOLDERS	SHORT-TERM VALUE	LONG-TERM VALUE
Landowners	Potential for increased land values	
Funders (short-term)	Potential for greater security of investment	
Developers	Quicker approvals (reduced cost and uncertainty) Increased public support Higher sales values (profitability) Distinctiveness (greater product differentiation) Increased funding potential (public/private partnering) Allows difficult sites to be tackled	Better reputation Future collaborations more likely
Design Professionals	Increased workload and repeat commissions from high-quality, stable clients	Enhanced professional reputation
Investors (long-term)	Higher rental returns Increased asset value Reduced running costs Competitive investment edge	Maintenance of value/income Reduced life cycle maintenance costs Better resale value Higher quality long-term tenants
Management Agents	Easy maintenance if high-quality materials	
Occupiers (tenants)		Happier workforce Better productivity Increased client confidence Reduced running costs
Public Interests	Regenerative potential (encouraging other development) Reduced public/private discord	Reduced public expenditure (on crime prevention/urban management/ urban maintenance/health) More time for positive planning Increased economic viability for neighboring uses Increased local tax revenue More sustainable environment
Community Interests		Better security and less crime Increased cultural viability Better quality of life More inclusive public space A more equitable/accessible environment Greater civic pride (sense of community) Reinforced sense of place Higher property prices

Place making: "places for people… enrich the existing… make connections… work with the landscape… mix uses and forms… manage the investment… design for change" (page 31-32). Resolution of the tension between node and place: The corresponds with some of Bertonlini's node-place work. Bertolini and Spit (Cities on Rails text) are quoted "the unique challenge of the development of node-places is the need to deal, at the same time, with both transport and urban development issues" (Bertolini and Spit (1998) qtd in Dittmar and Poticha (2004) page 32). The authors then present a typology of six types of stations, with the caution that evaluating TODs and expecting the same returns and observations is exactly why typologies were originally created. Typologies allow for similar sites to be compared. The following is Dittmar and Poticha's typology (page 38):

TABLE 2.3—TOD TYPOLOGY

TOD TYPE	LAND-USE MIX	MINIMUM HOUSING DENSITY	HOUSING TYPES	SCALE	REGIONAL CONNECTIVITY	TRANSIT MODES	FREQUENCIES	EXAMPLES
Urban Downtown	Primary office center Urban entertainment Multifamily housing Retail	>60 units/acre	Multifamily Loft	High	High Hub of radial system	All modes	<10 minutes	Printers Row (Chicago) LoDo (Denver) South Beach (San Francisco)
Urban Neighborhood	Residential Retail Class B commercial	>20 units/acre	Multifamily Loft Townhome Single family	Medium	Medium access to downtown Subregional circulation	Light-rail Streetcar Rapid bus Local bus	10 minutes peak 20 minutes offpeak	Mockingbird (Dallas) Fullerton (Chicago) Barrio Logan (San Diego
Suburban Center	Primary office center Urban entertainment Multifamily housing Retail	>50 units/acre	Multifamily Loft Townhome	High	High access to downtown Subregional hub	Rail Streetcar Rapid bus Local bus Paratransit	10 minutes peak 10–15 minutes offpeak	Arlington County (Virginia) Addison Circle (Dallas) Evanston (Illinois)
Suburban Neighborhood	Residential Neighborhood retail Local office	>12 units/acre	Multifamily Townhome Single family	Moderate	Medium access to suburban center Access to downtown	Light-rail Rapid bus Local bus Paratransit	20 minutes peak 30 minutes offpeak	Crossings (Mountain View, CA) Ohlone-Chynoweth (San Jose, CA)
Neighborhood Transit Zone	Residential Neighborhood retail	>7 units/acre	Townhome Single family	Low access to a center	Low	Local bus Paratransit	25–30 minutes Demand responsive	
Commuter Town Center	Retail center Residential	>12 units/acre	Multifamily Townhome Single family	Low	Low access to downtown	Commuter rail Rapid bus	Peak service Demand responsive	Prairie Crossing (Illinois) Suisun City (California)

Jeihani & Zhang (2013) – Development of a Framework for TOD
Reference: (Jeihani & Zhang, 2013)
Methods and Outcomes:
Notes:
The goal of this study was to define a measure of TOD to be incorporated into a four-step transportation demand model (trip generation, distribution, mode choice steps) at a transportation analysis zone (TAZ) level.
The methodology for defining TOD areas is as follows (page 26) at a TAZ level for Washington DC and Baltimore areas separately:
Walkability and high-density; Walking distance to transit station; Collaboration of mixed uses and transit; and Affordable housing available around transit.
The methods of classifying a TAZ as a TOD must meet the following conditions (written originally in math, translated to meaning here):
Residential density (population per acre) must be greater than the average residential density for the entire metro area (DC and Baltimore considered separately OR employment density (employment population per acre) must be greater than the average employment density for the entire metro area.
Average block size for each TAZ (square miles) should be less than the average block size for the entire metro area.
The entropy of the TAZ (mixed-use measure) falls within the top 30% (when ranked in decreasing order, meaning it meets the highest entropy/mixed-use scores).
The Housing and transportation affordability (% of housing/transportation cost of household income) is less than 45%.
The TAZ's "U" (undefined and/or ill-defined in the math, but I'm assuming it's either the centroid of the TAZ or the majority of the area) is within a ½ mile of the transit station location.
The authors (page 28) continue to disaggregate the TODs by the following built environment/area type categories by activity density (household + employment + retail employment and divided by area). The thresholds of activity density across the three area types was unclear (rural, suburban, urban), but it relied on existing regional models (MSTM). After aggregating rural and suburban TOD observations, the six categories (TOD/non-TOD across rural/suburban/urban) become five.
Household travel survey data were then geocoded and disaggregated into typical travel purposes, aligned with TAZs, and then modeled to derive typical four-step outcomes and approaches (e.g., trips f(SES + TOD)… or discrete choice models). TDM outcomes were not discussed in this summary of the paper as typology was the focus on this review.
This approach is more aggregated and simplified for application in a regional or statewide model. It relies on data available at more aggregated levels, but may classify appropriate 'high-quality' TOD locations according to the standards derived from the literature. When modeled, using the thresholds for higher-quality TOD may more accurately reflect travel demand outcomes. Conflating affordability with TOD definitions may make modeling transportation outcomes for affordable-transportation/housing policies more difficult.

References

Arizona Department of Transportation. (2012). Station Area Typology Definitions (Passenger Rail Corridor Study: Tucson to Phoenix). Federal Transit Administration.

Arrington, G. B., & Cervero, R. (2008). Effects of TOD on Housing, Parking, and Travel. TCRP Report, 128. https://trid.trb.org/view/870956

Buchanan, B., Gordon, S., Champine, C., Gaspers, D., Chester, S., Santoro, A., Oss, D., Burns, A., Kennedy, C., Mayor, D., Hollrah, G., Johnston, A., Hambidge, T., Washington, P., Romine, J., Cornejo, J., Fanganello, C., Dannemiller, L., Robertson, G., … Consulting, O. (2014). Transit-Oriented Denver: Transit Oriented Development Strategic Plan (p. 83).

Center for Transit-Oriented Development. (2010). Performance-Based Transit-Oriented Development Typology Guidebook. Center for Transit-Oriented Development. http://reconnectingamerica.org/assets/Uploads/2010_performancebasedtodtypologyguidebook.pdf

Center for Transit-Oriented Development, & Nelson/Nygaard. (2011). Transit-Oriented Development Strategic Plan. Metro. http://ctod.org/pdfs/2011PortlandTODweb.pdf

Central Maryland Transportation Alliance, & Center for Transit-Oriented Development. (2009). Central Maryland TOD Strategy: A Regional Action Plan for Transit-Centered Communities. http://ctod.org/pdfs/2009CentralMarylandTODStrategy.pdf

Cervero, R., & Guerra, E. (2011). Urban Densities and Transit: A Multi-dimensional Perspective (Working Paper UCB-ITS-VWP-2011-6; p. 15). Institute of Transportation Studies: University of California, Davis.

Chatman, D. G., Cervero, R., Moylan, E., Carlton, I., Weissman, D., Zissman, J., Guerra, E., Murakami, J., Ikezoe, P., Emerson, D., Tischler, D., Means, D., Winkler, S., Sheu, K., Kwon, S. Y., Transit Cooperative Research Program, Transportation Research Board, & National Academies of Sciences, Engineering, and Medicine. (2014). Making Effective Fixed-Guideway Transit Investments: Indicators of Success (TCRP No. 167). Transportation Research Board. https://doi.org/10.17226/22355

City of Phoenix. (2018). Reinvent PHX: Transit Oriented Development Strategic Policy Framework. City of Phoenix. https://www.phoenix.gov/villagessite/Documents/pdd_pz_pdf_00380.pdf

Design Workshop. (2013). St. Louis TOD Framework Plan. East-West Gateway Council of Governments. http://www.onestl.org/resources/reports/transit-oriented-development/119-tod-framework-master-plan

Dittmar, H., & Poticha, S. (2004). Ch. 2 Defining Transit-Oriented Development: The New Regional Building Block. In The New Transit Town: Best Practices in Transit-Oriented Development (pp. 18–39). Island Press.

Ewing, R., Tian, G., Lyons, T., Stinger, P., Weinberger, R., Kaufman, B., & Shivley, K. (2017). Trip and Parking Generation at Transit-Oriented Developments (Research Report NITC-RR-767). http://nitc.trec.pdx.edu/research/project/767/Trip_and_Parking_Generation_at_Transit-Oriented_Developments

Jeihani, M., & Zhang, L. (2013). Development of a Framework for Transit-Oriented Development (Final Report SP209B4N; p. 100). State Highway Administration; Maryland Department of Transportation.

Jones Lang LaSalle, TRA TR Advisors, & Kimley-Horn and Associates, Inc. (2009). Transit Friendly Development Guide: Station Area Typology. CTA; City of Chicago. https://www.chicago.gov/content/dam/city/depts/zlup/Planning_and_Policy/Publications/Transit_Friendly_Development_Guide/CTA_Typology_Study.pdf

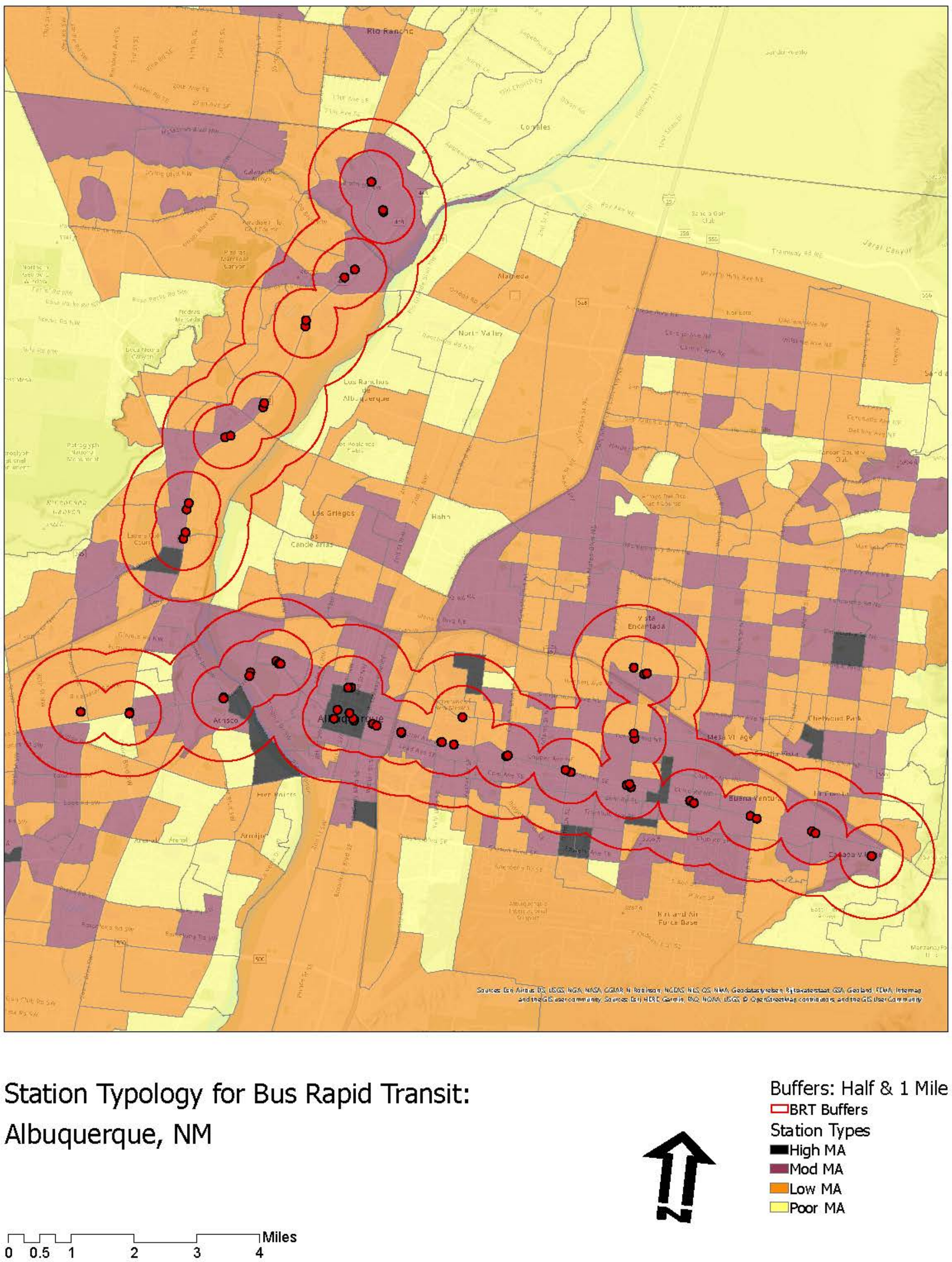
Levinson, H. S., Ryus, P., Schofer, J. L., Semler, C., Parks, J., Coffel, K., Sampson, D., Kachadoorian, C., Transportation Research Board, Transit Cooperative Research Program, & Transportation Research Board. (2012). Guidelines for Providing Access to Public

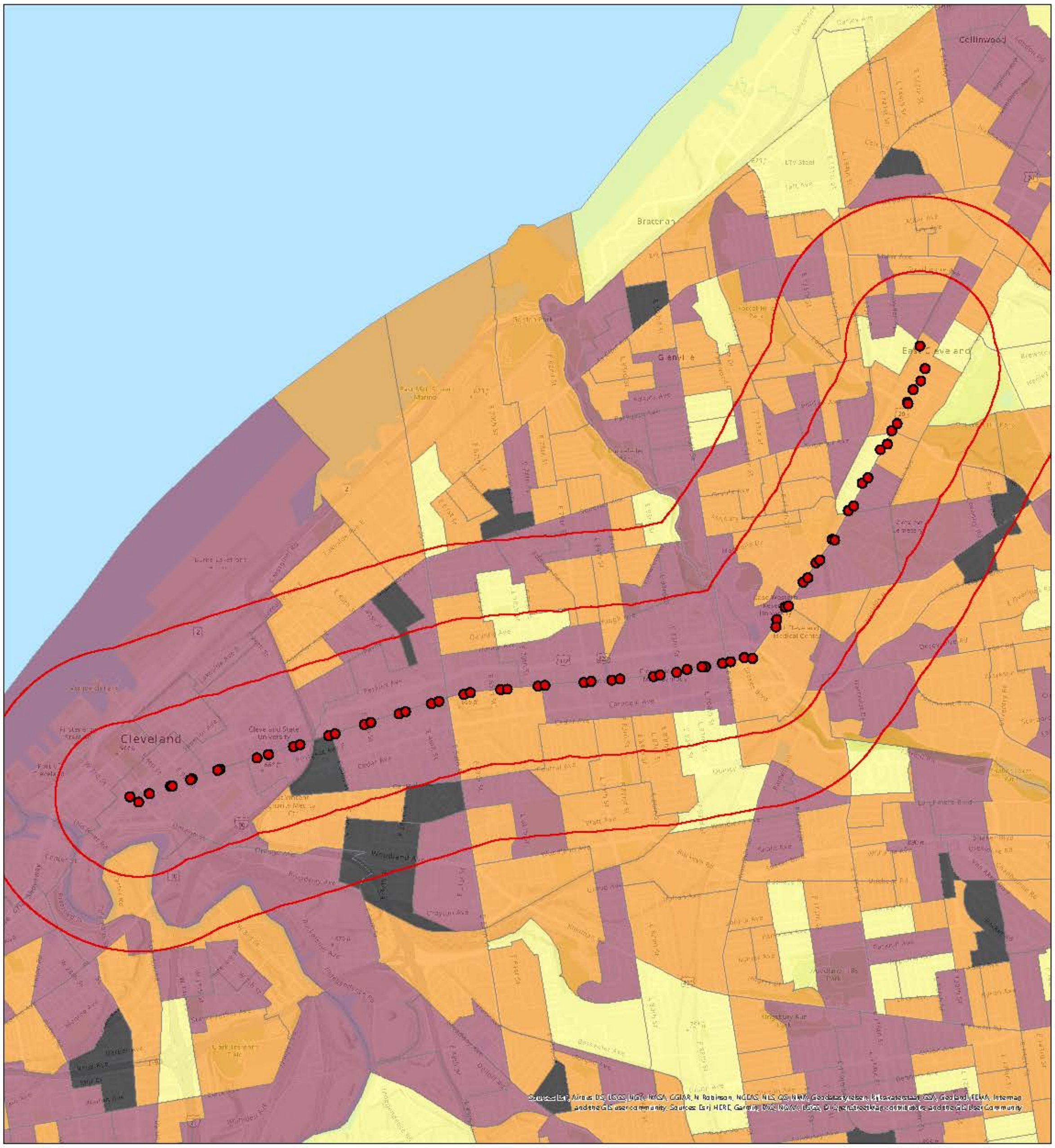
Transportation Stations (Research Report TCRP Report 153; Transit Cooperative Research Program (TCRP)). National Academies Press. https://doi.org/10.17226/14614
Lynx Rapid Transit Services. (2016). Southeast Corridor Transit Study: Rail Station Locations and Typologies. Charlotte Area Transit System.
Lyu, G., Bertolini, L., & Pfeffer, K. (2016). Developing a TOD typology for Beijing metro station areas. Journal of Transport Geography, 55, 40–50. https://doi.org/10.1016/j.jtrangeo.2016.07.002
Office of the Mayor, City of Los Angeles. (2011). Sustainable Transit Communities Study: Scorecard Analysis Summary (p. 54).
General Plan Amendment, no. GPA-3-17, 28 (2018).
Pojani, D., & Stead, D. (2016). A Critical Deconstruction of the Concept of Transit Oriented Development (TOD). In M. Schenk, V. V. Popovich, P. Zelle, P. Elisei, & C. Beyer (Eds.), REAL CORP 2016 (pp. 829–833). http://pure.tudelft.nl/ws/files/10056669/CORP2016_33.pdf
Puget Sound Regional Council; City of Bellevue; King County Metro. (2013). People + Place Implementation Typology. https://www.psrc.org/sites/default/files/strategytypology.pdf
Puget Sound Regional Council; City of Bellevue; King County Metro. (2014). Appendix D. Growing Transit Communities Strategy People + Place Implementation Typology Methods and Results. https://www.nap.edu/read/23630/chapter/11
Rayle, L. (2015). Investigating the Connection Between Transit-Oriented Development and Displacement: Four Hypotheses. Housing Policy Debate, 25(3), 531–548. https://doi.org/10.1080/10511482.2014.951674
Reconnecting America. (2014). An Equitable TOD Typology for the Atlanta Region (DRAFT MEMO).
Renaissance Planning Group. (2011). A Framework for Transit Oriented Development in Florida. Florida Department of Transportation and Department of Community Affairs. http://www.fltod.com/renaissance/docs/Products/FrameworkTOD_0715.pdf
Renne, J. L. (2009). From transit-adjacent to transit-oriented development. Local Environment, 14(1), 1–15. https://doi.org/10.1080/13549830802522376
Renne, J. L., & Ewing, R. (2013). Transit-Oriented Development: An Examination of America's Transit Precincts in 2000 & 2010. University of New Orleans Transportation Institute. https://scholarworks.uno.edu/cgi/viewcontent.cgi?article=1016&context=unoti_pubs
Renne, J., & Wells, J. (2002). State of the literature: Transit-oriented development. Vorhees Transportation Policy Institute.
Santasieri, C. (2014). Section 5: Local Planning and Transit-Supportive Development (FTA Report No. 0057; Planning for Transit-Supportive Development: A Practitioner's Guide, p. 106). Federal Transit Administration Research. https://www.transit.dot.gov/funding/funding-finance-resources/transit-oriented-development/planning-transit-supportive
Sound Transit. (2014). Regional Transit Long-Range Plan Update: Issue Paper on Regional Land Use and Transit Planning (DRAFT). Sound Transit.
Teska Associates, Inc., Fish Transportation Group, & OKW Architects. (2014). City of Chicago & Metra Station Typology Study. City of Chicago Plan Commission.
WSP. (2017). NFTA Comprehensive Transit-Oriented Development Planning: Interim Report Part 1 (DRAFT).

APPENDIX C: Place Typology Maps

APPENDIX C.1

This section contains maps of Bus Rapid Transit systems for the study.



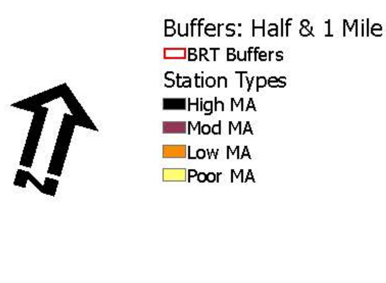


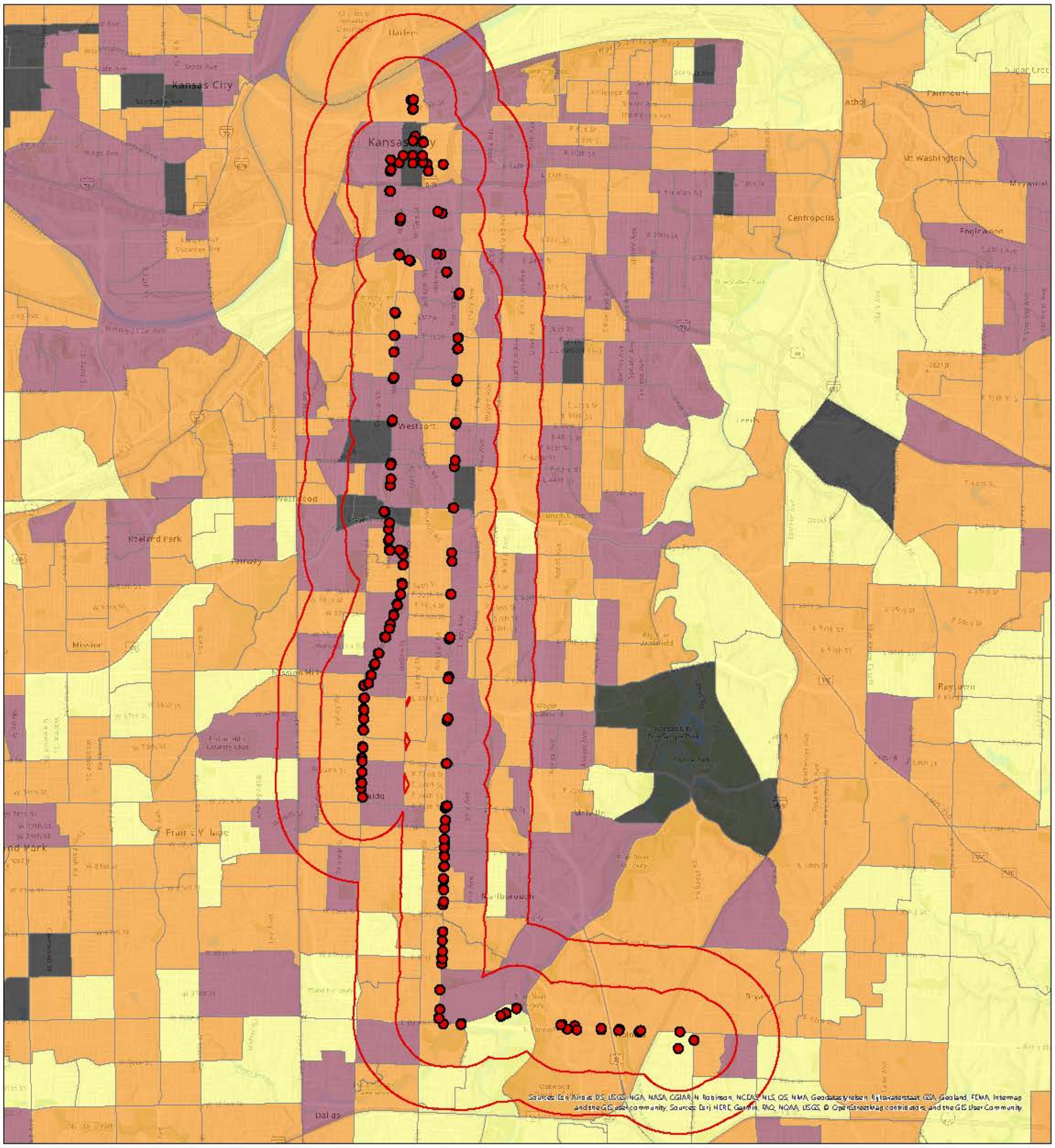
Station Typology for Bus Rapid Transit:
Cleveland-Elyria, OH

Buffers: Half & 1 Mile
BRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

Miles
0 0.230.45 0.9 1.35 1.8

Station Typology for Bus Rapid Transit:
Eugene, OR

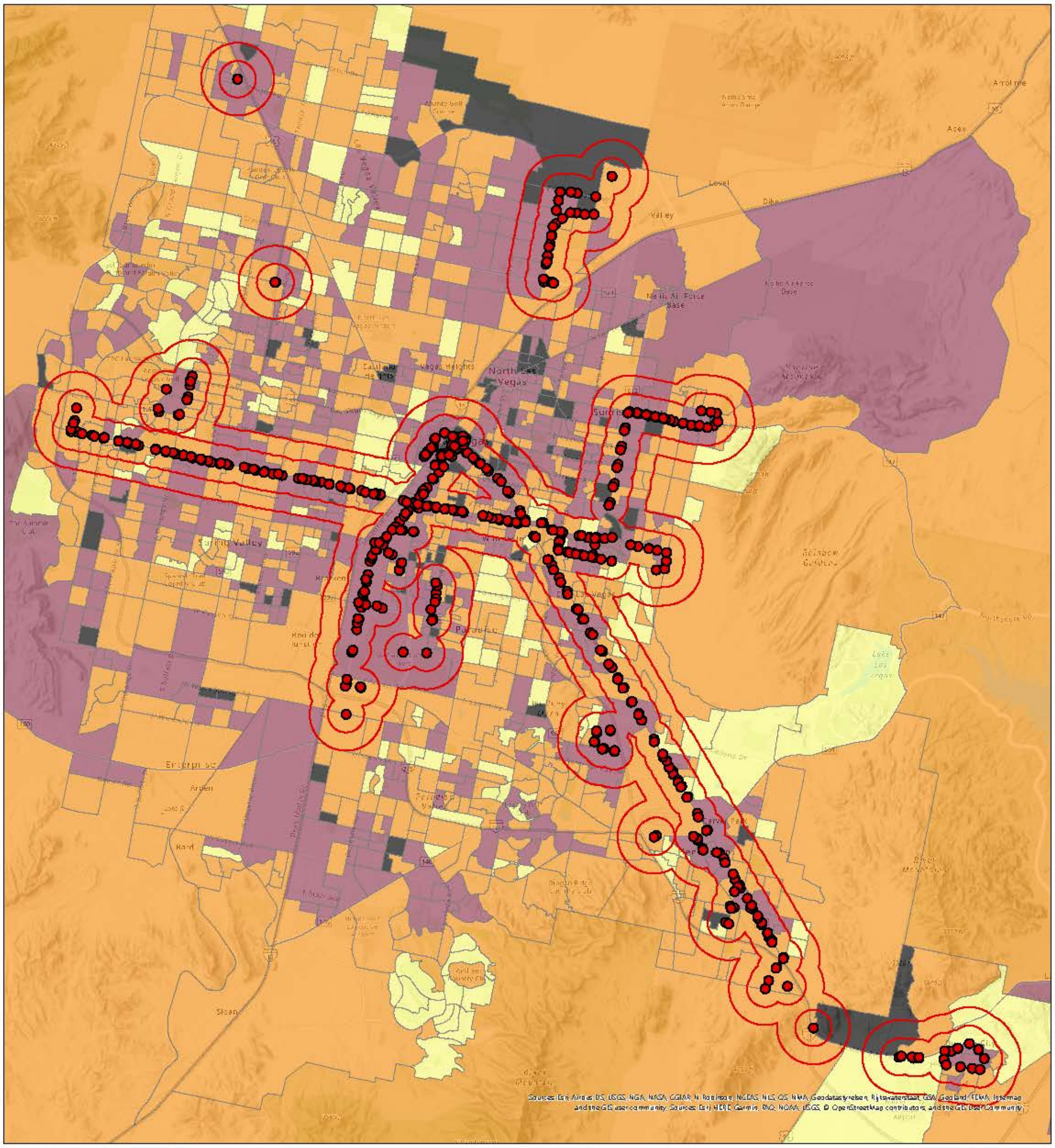




Station Typology for Bus Rapid Transit:
Kansas City, MO-KS

Buffers: Half & 1 Mile
BRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

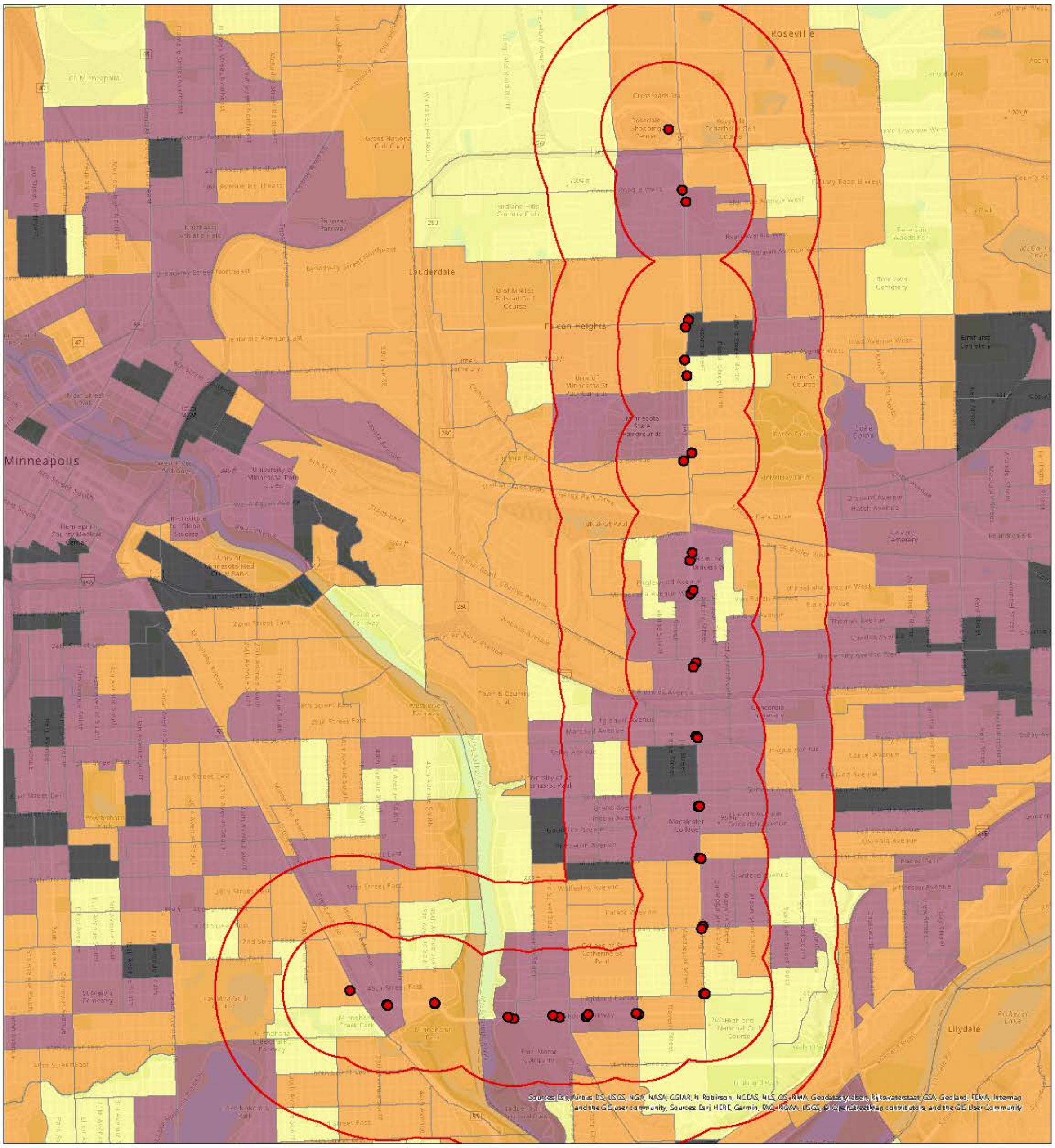
Miles
0 0.4 0.8 1.6 2.4 3.2



Station Typology for Bus Rapid Transit:
Las Vegas-Henderson-Paradise, NV

Buffers: Half & 1 Mile
BRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

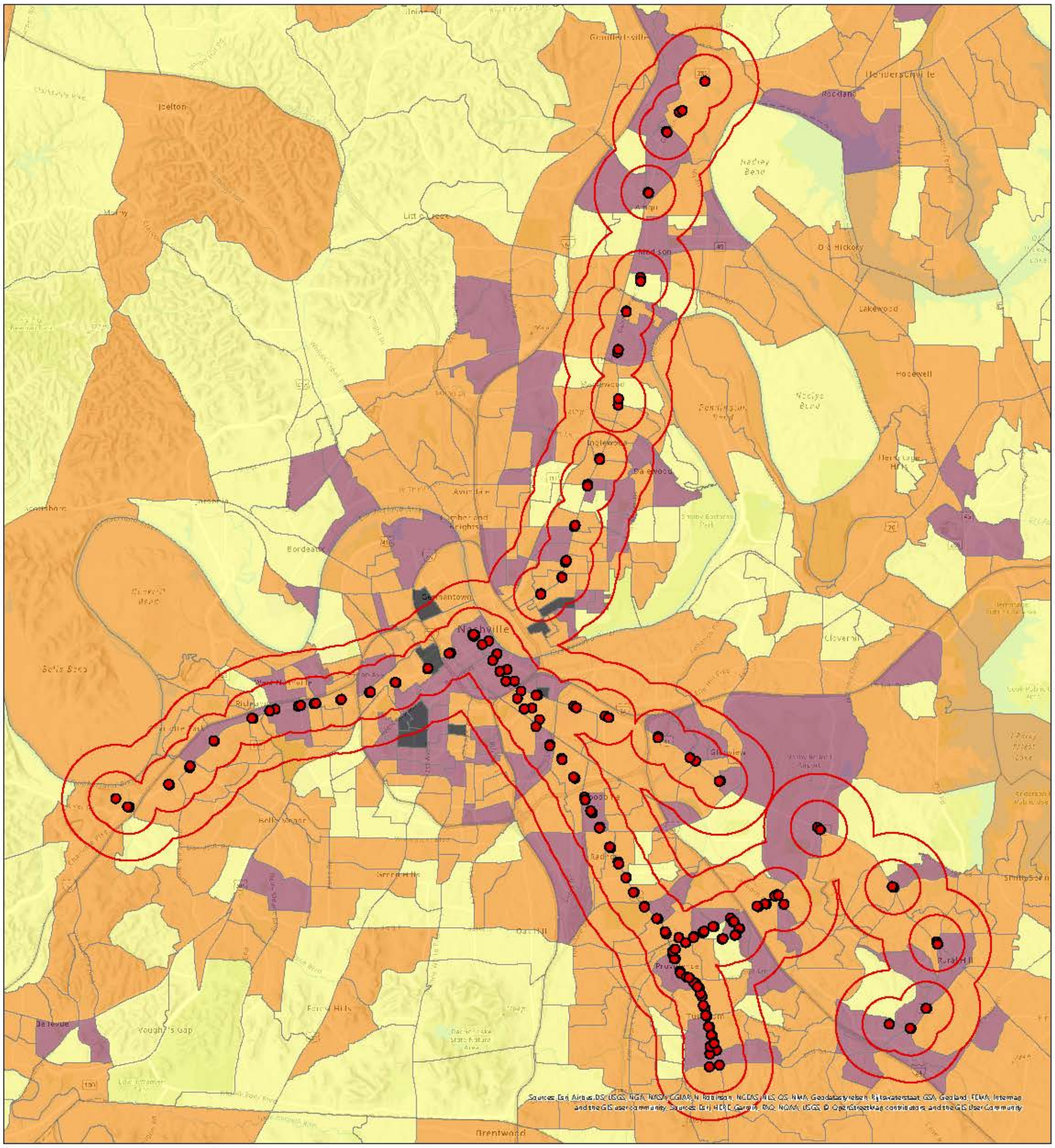
0 0.75 1.5 3 4.5 6 Miles



Station Typology for Bus Rapid Transit:
Minneapolis-St. Paul-Bloomington, MN-WI

Buffers: Half & 1 Mile
BRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

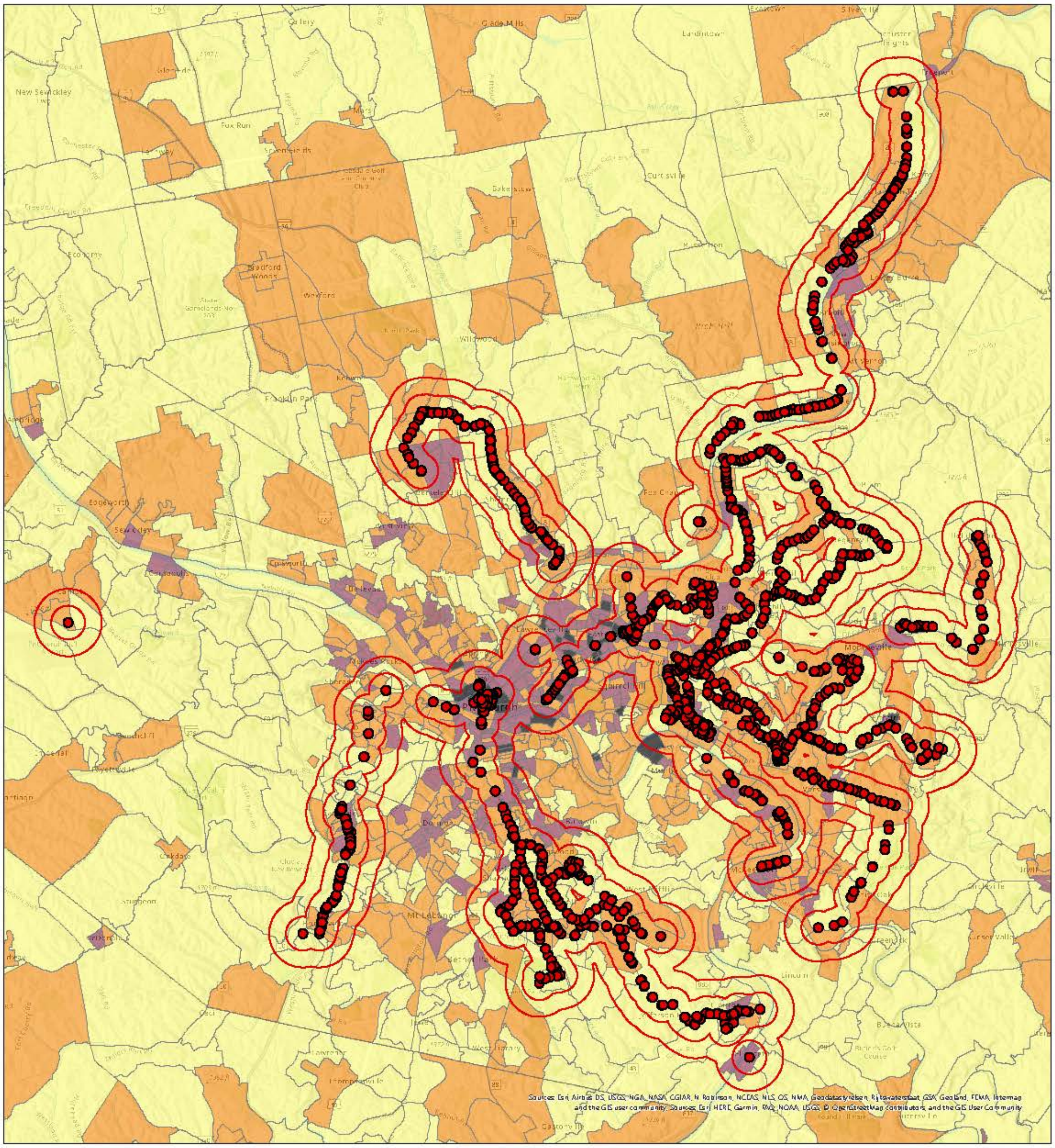
0 0.25 0.5 1 1.5 2 Miles



Station Typology for Bus Rapid Transit:
Nashville-Davidson--Murfreesboro--Franklin, TN

Buffers: Half & 1 Mile
BRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

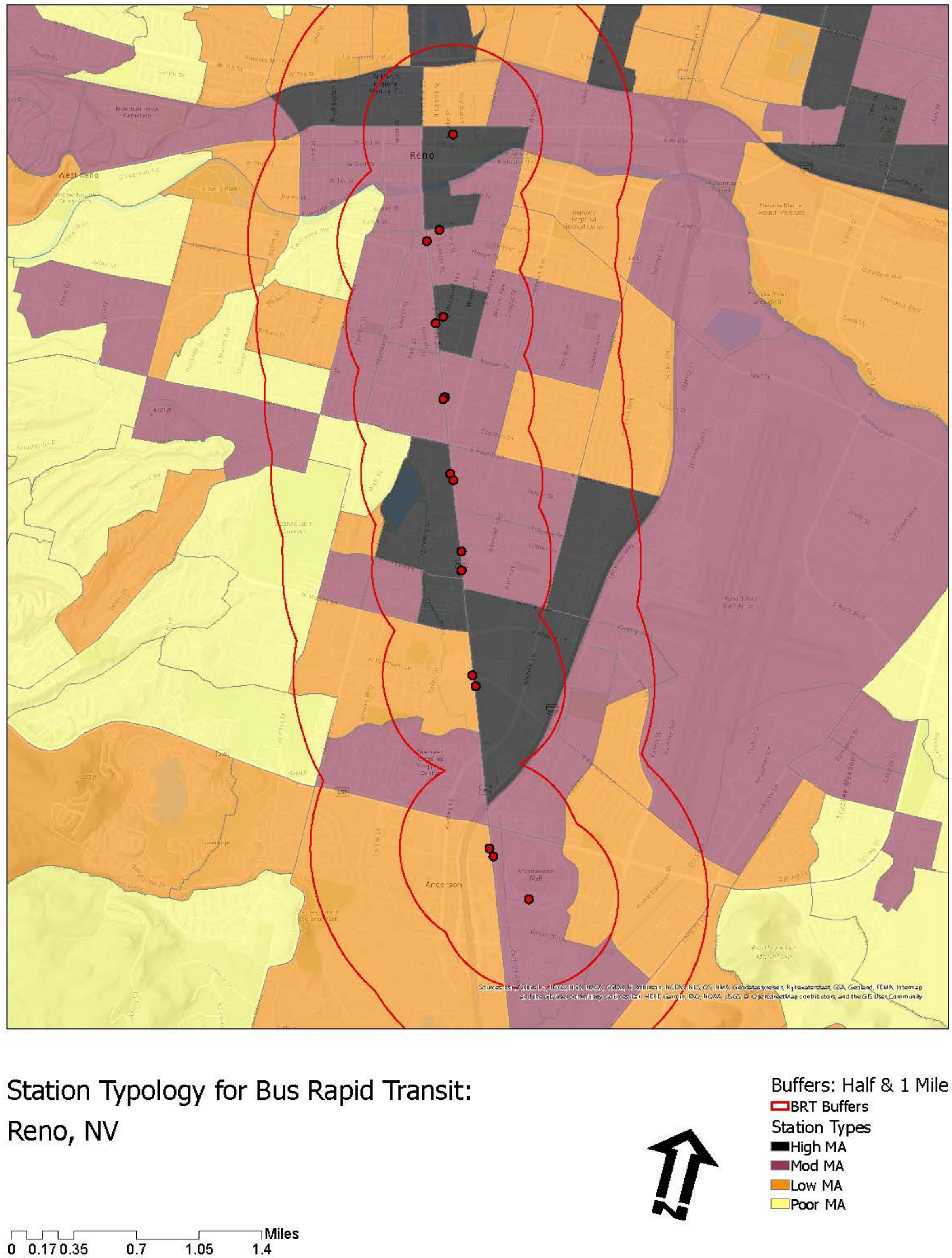
0 0.5 1 2 3 4 Miles

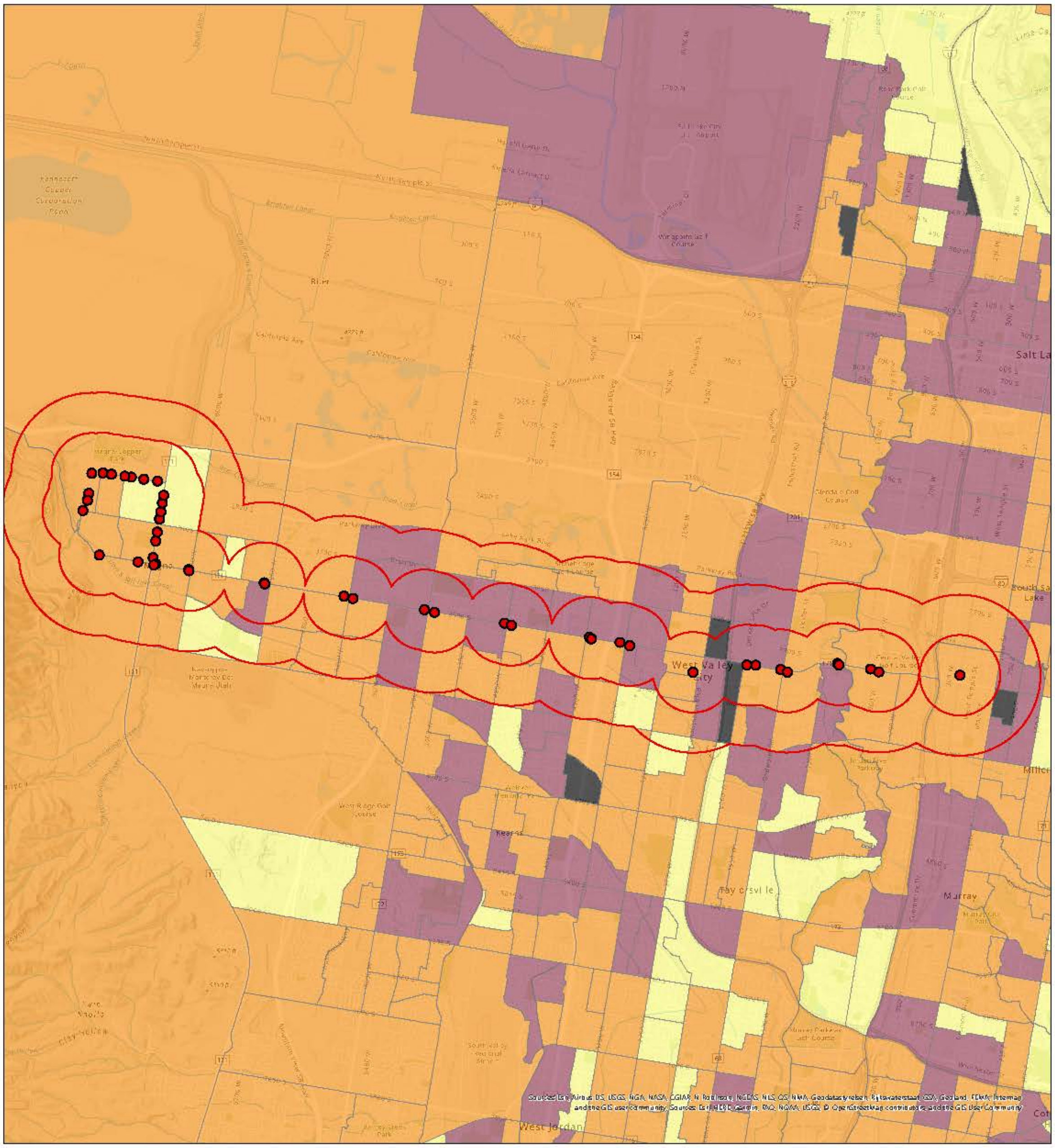


Station Typology for Bus Rapid Transit:
Pittsburgh, PA

Buffers: Half & 1 Mile
BRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

0 1 2 4 6 8 Miles


Station Typology for Bus Rapid Transit:
Reno, NV
Buffers: Half & 1 Mile
BRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA
0
0.17
0.35
0.7
1.05
1.4
Miles



Station Typology for Bus Rapid Transit:
Salt Lake City, UT

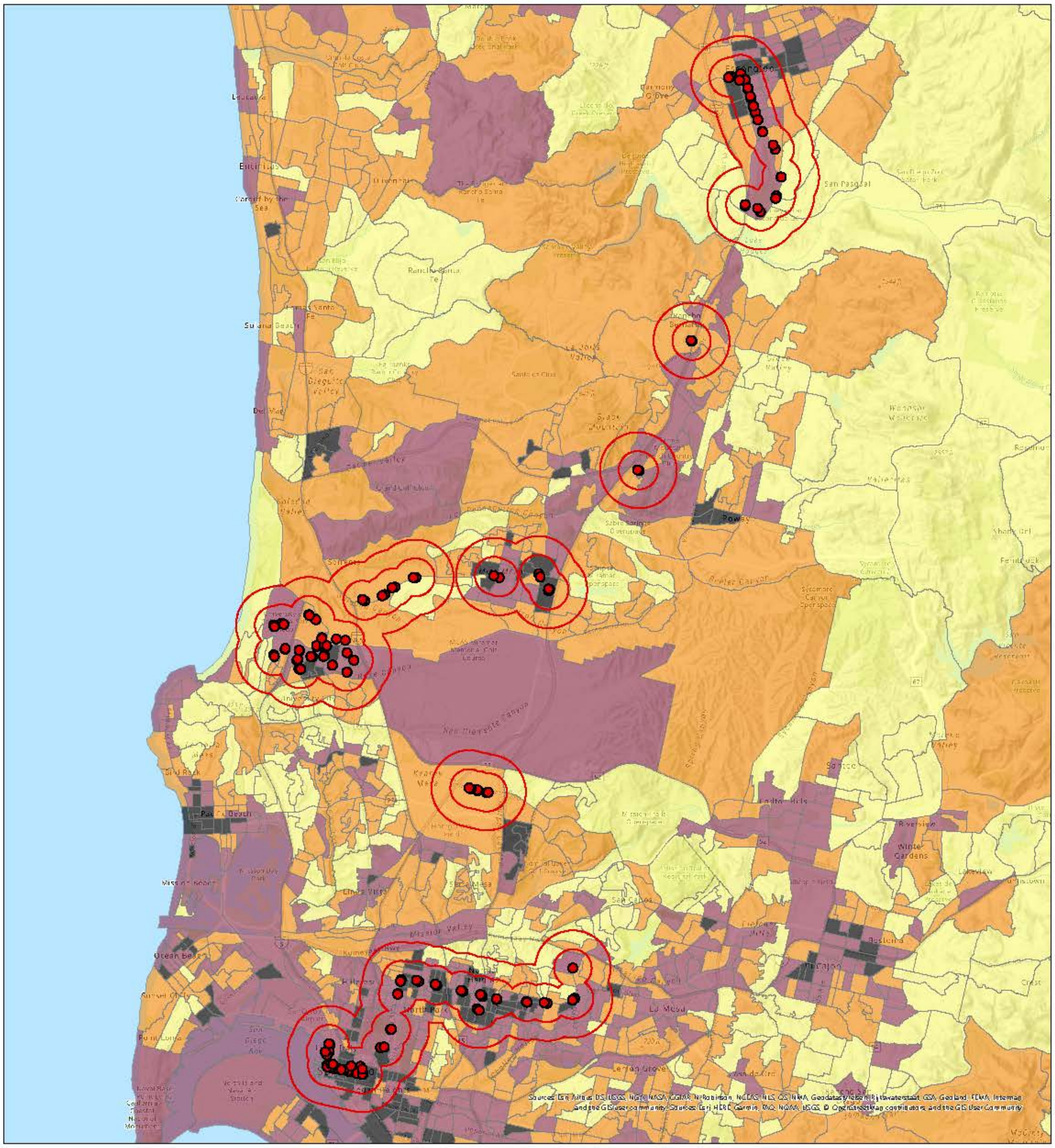
Buffers: Half & 1 Mile
BRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

0 0.42 0.85 1.7 2.55 3.4 Miles

Station Typology for Bus Rapid Transit:
San Antonio-New Braunfels, TX

Buffers: Half & 1 Mile
BRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

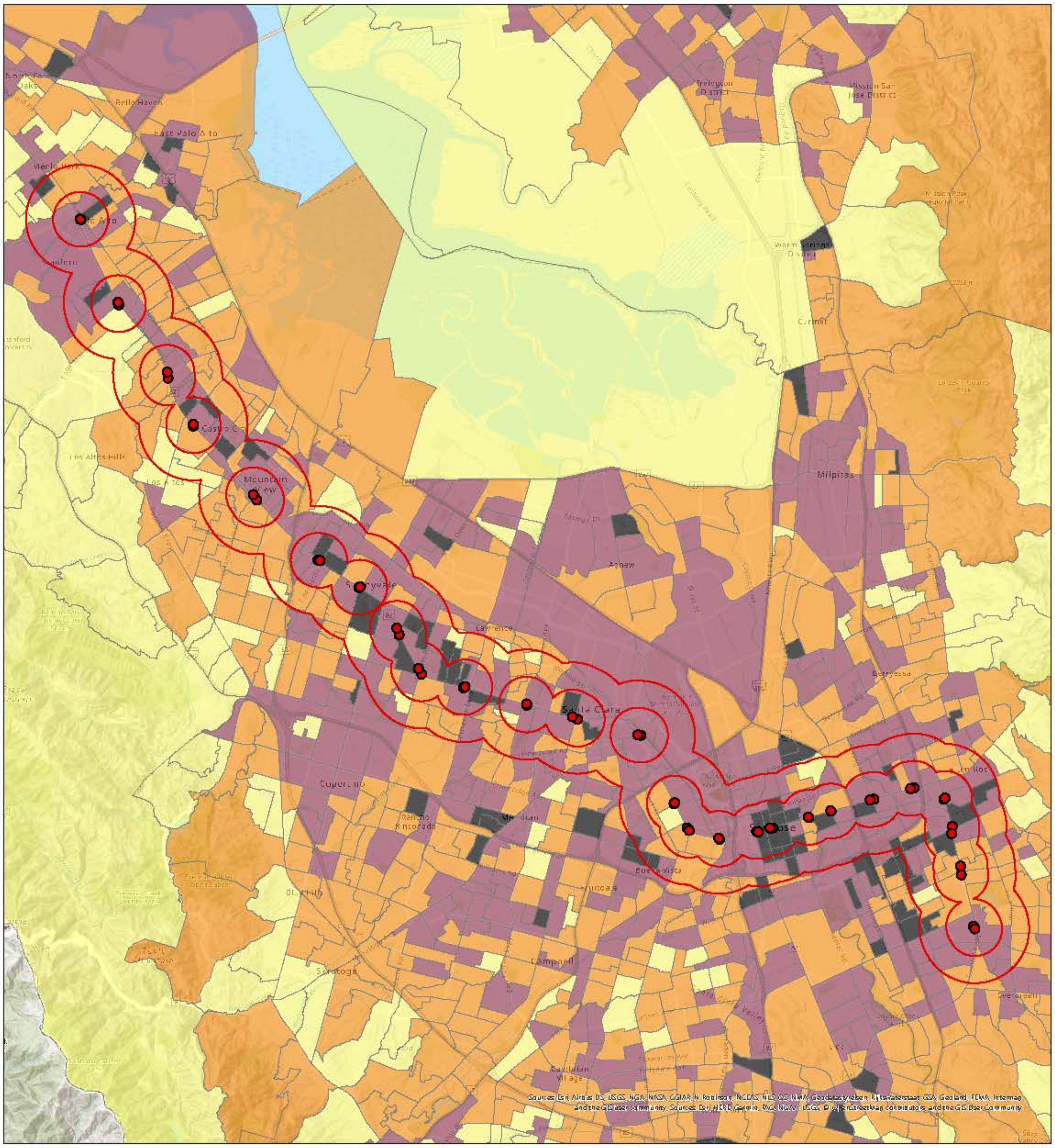
0 0.42 0.85 1.7 2.55 3.4 Miles



Station Typology for Bus Rapid Transit:
San Diego-Carlsbad, CA

Buffers: Half & 1 Mile
BRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

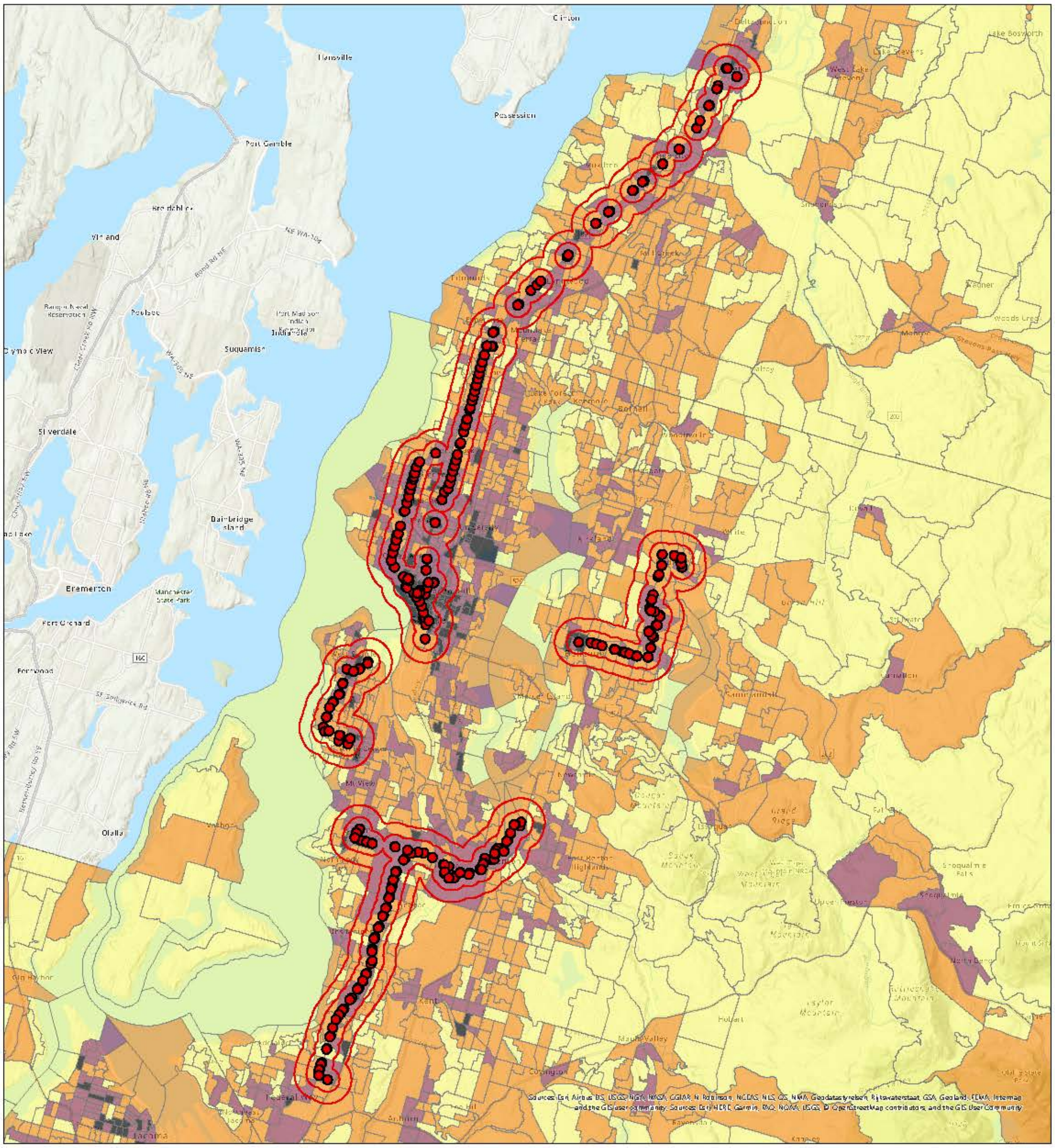
Miles
0 0.75 1.5 3 4.5 6



Station Typology for Bus Rapid Transit:
San Jose-Sunnyvale-Santa Clara, CA

Buffers: Half & 1 Mile
BRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

0 0.5 1 2 3 4 Miles



Station Typology for Bus Rapid Transit:
Seattle-Tacoma-Bellevue, WA

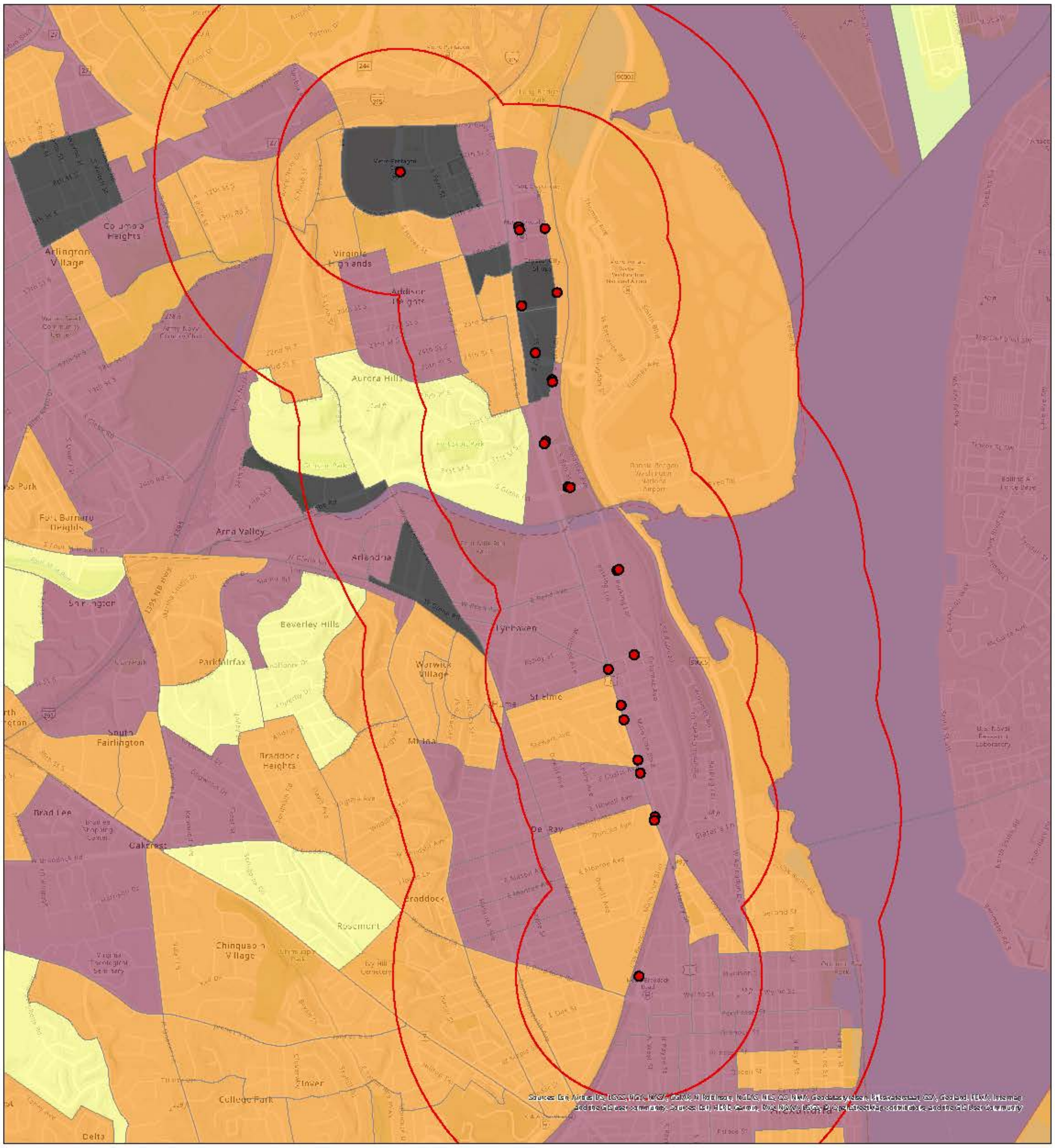
Buffers: Half & 1 Mile
BRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

0 1.25 2.5 5 7.5 10 Miles

Station Typology for Bus Rapid Transit:
Stockton-Lodi, CA

Buffers: Half & 1 Mile
BRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

0 0.3 0.6 1.2 1.8 2.4 Miles

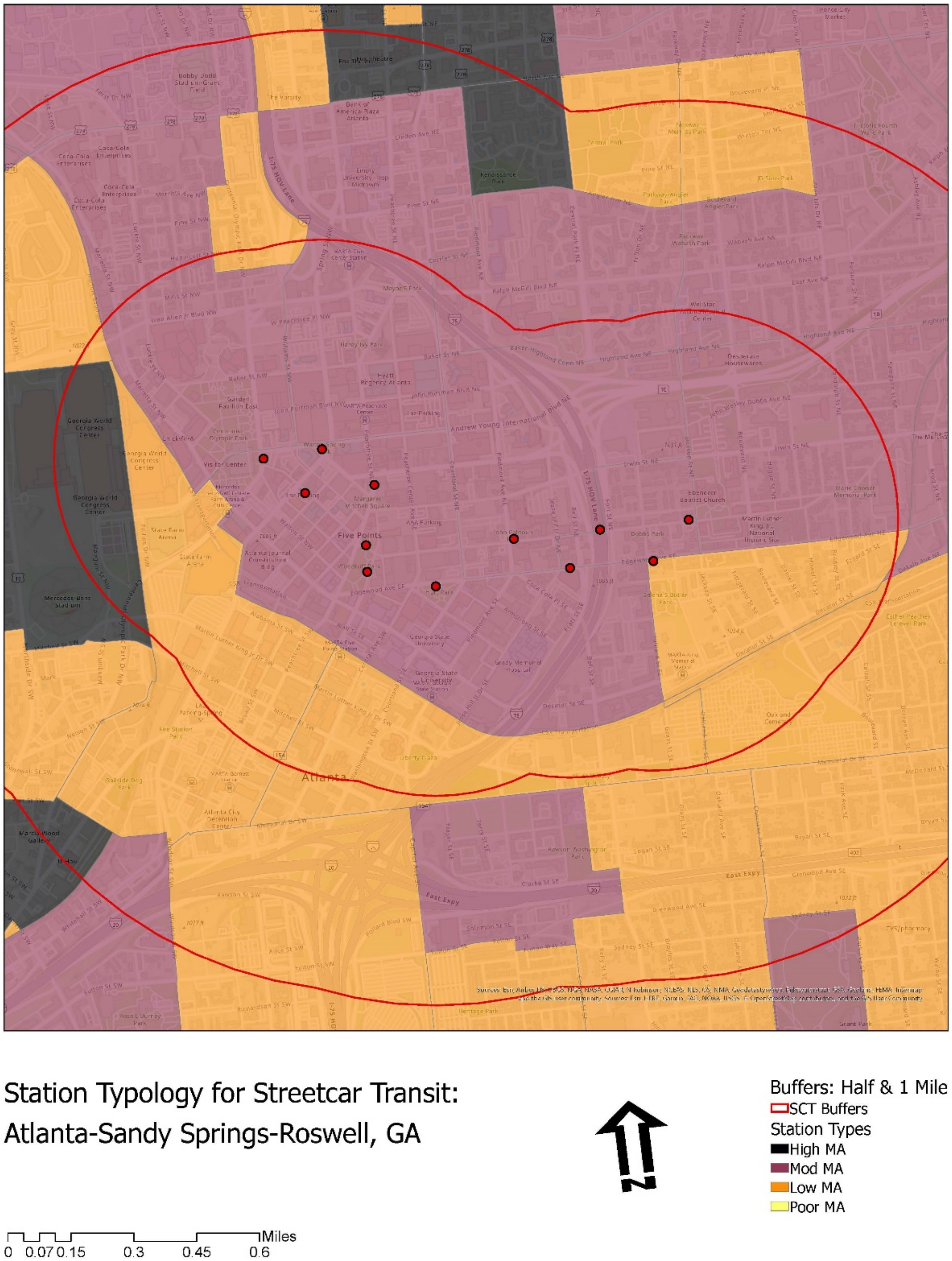


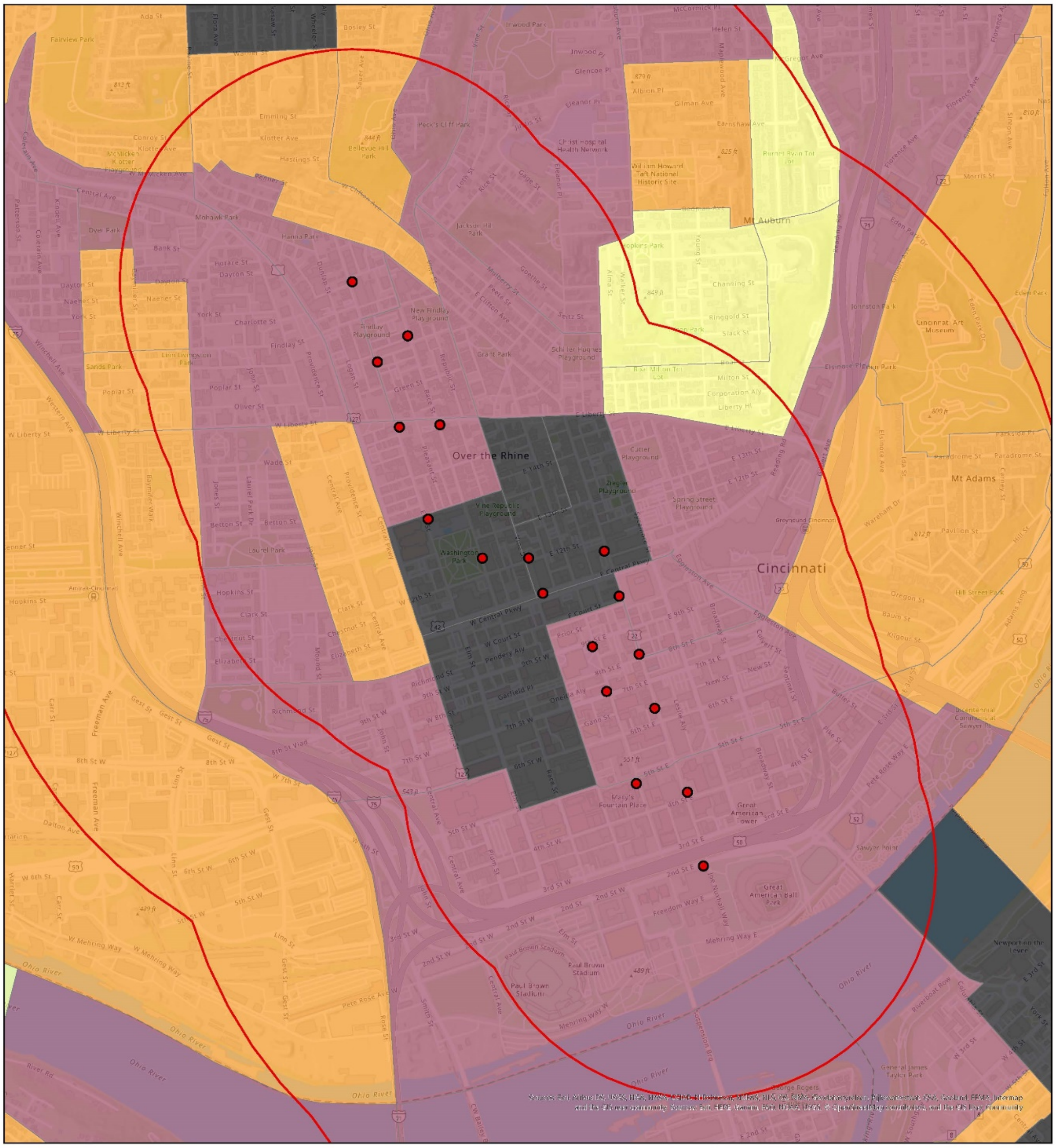
Station Typology for Bus Rapid Transit: Washington-Arlington-Alexandria, DC-VA-MD-WV

Buffers: Half & 1 Mile
BRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

0 0.130.25 0.5 0.75 1 Miles

APPENDIX C.2
This section contains maps for all Streetcar Transit systems in the study.





Station Typology for Streetcar Transit:
Cincinnati, OH-KY-IN

Buffers: Half & 1 Mile
SCT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

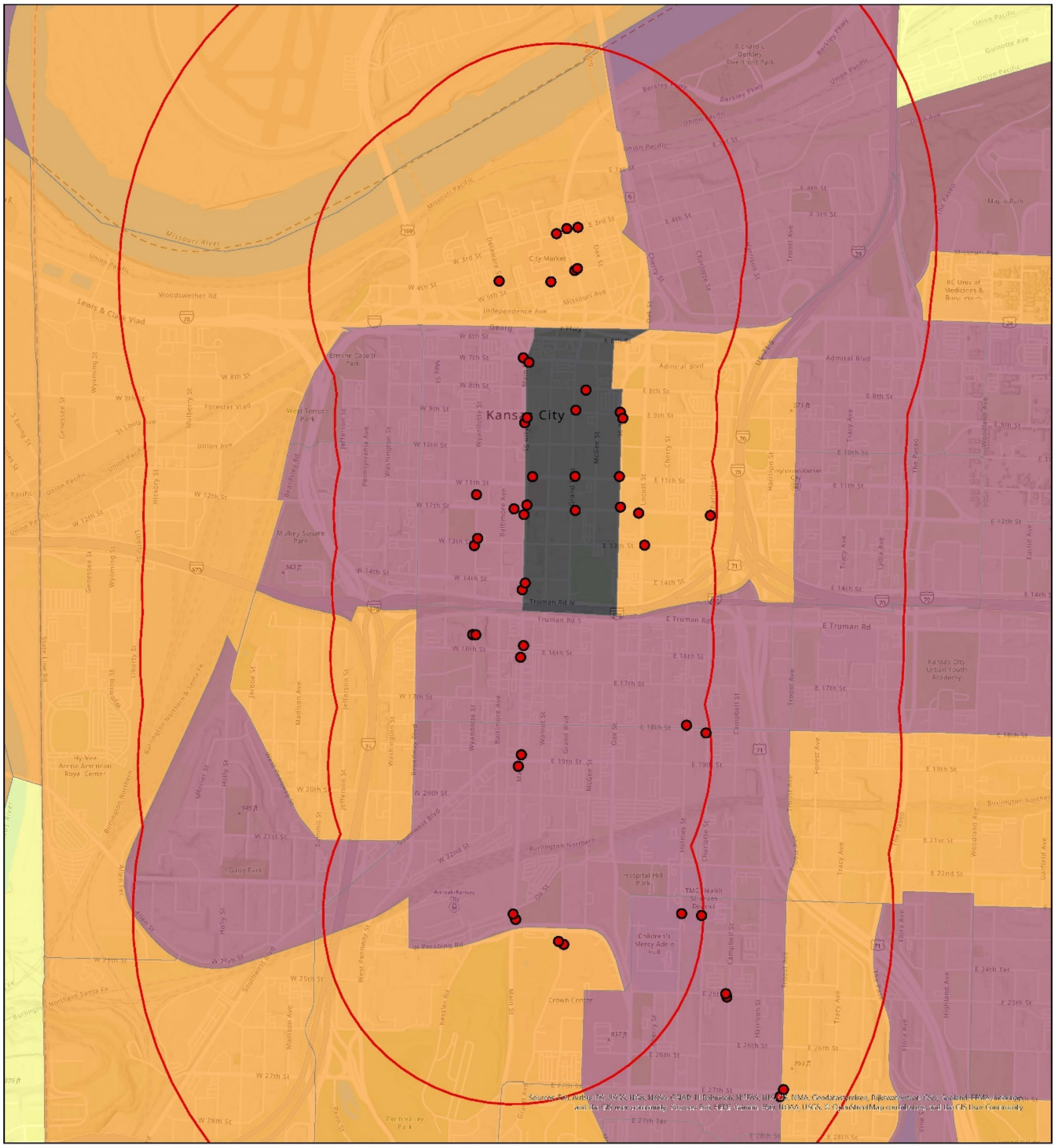
0 0.07 0.15 0.3 0.45 0.6 Miles

Station Typology for Streetcar Transit:
Dallas-Fort Worth-Arlington, TX

Buffers: Half & 1 Mile
SCT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

N

0 0.17 0.35 0.7 1.05 1.4 Miles

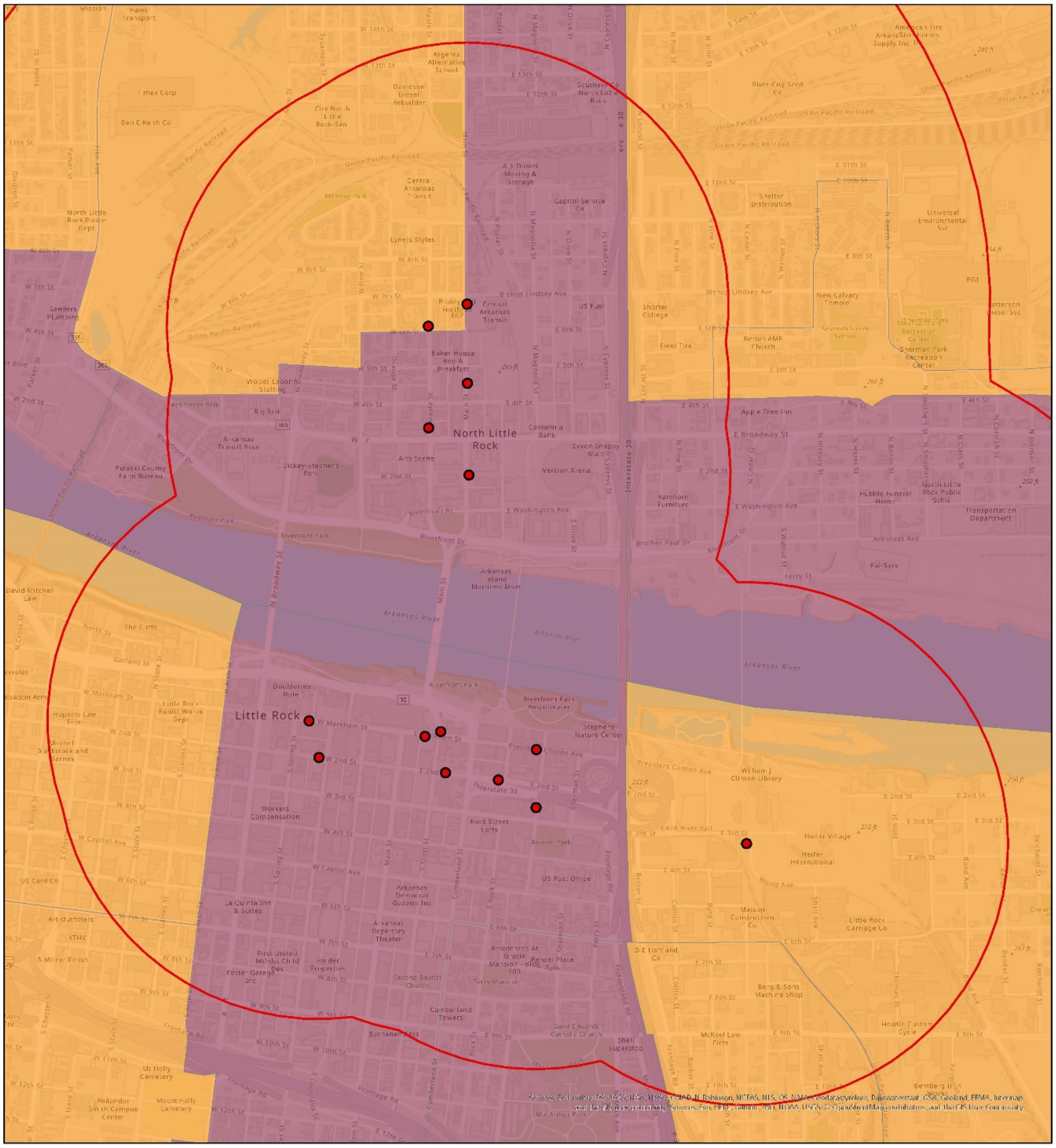


Station Typology for Streetcar Transit:
Kansas City, MO-KS

N

Buffers: Half & 1 Mile
SCT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

0 0.07 0.15 0.3 0.45 0.6 Miles



Station Typology for Streetcar Transit:
Little Rock-North Little Rock-Conway, AR

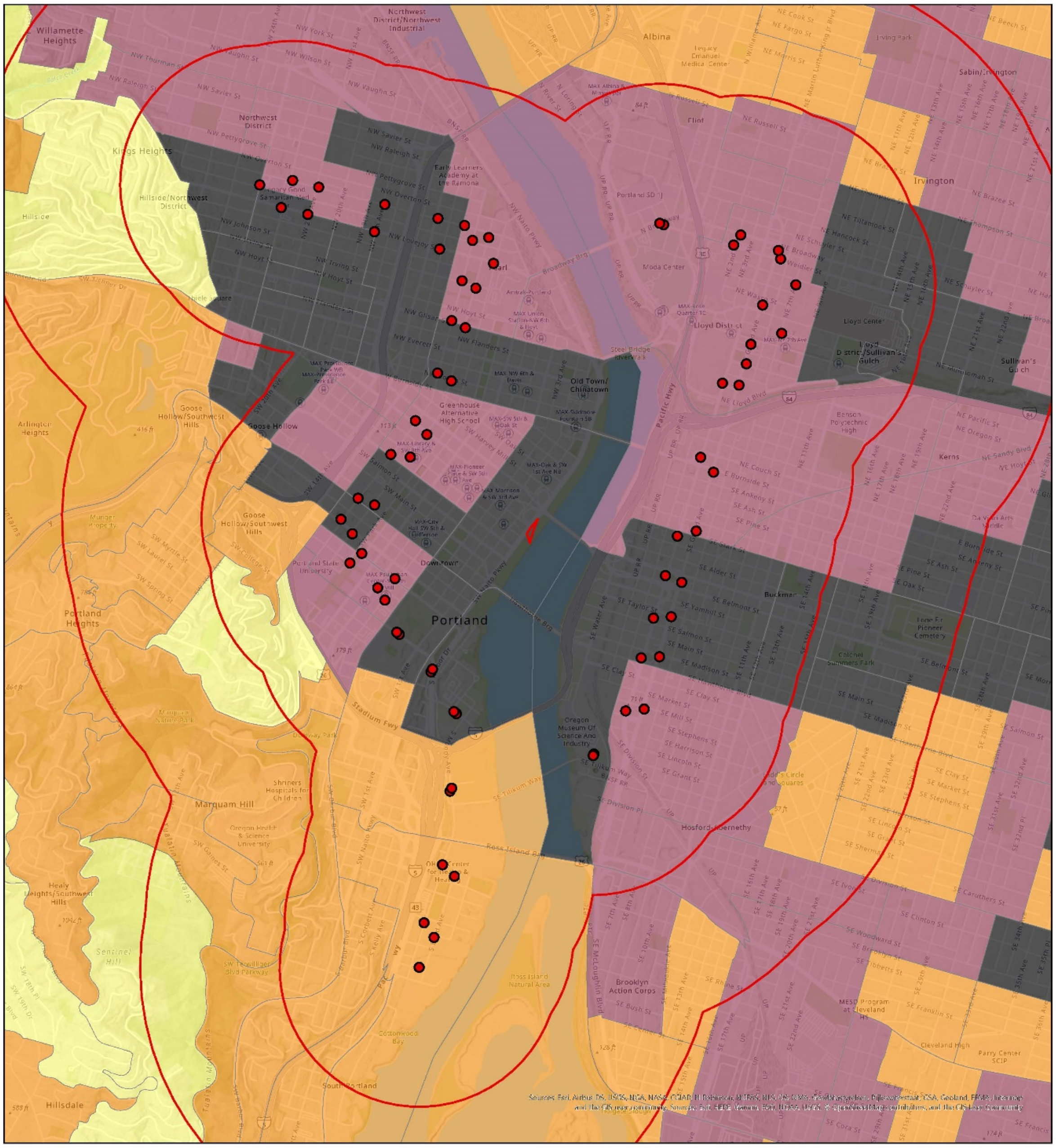
Buffers: Half & 1 Mile
SCT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

0 0.05 0.1 0.2 0.3 0.4 Miles

Station Typology for Streetcar Transit:
New Orleans-Metairie, LA

Buffers: Half & 1 Mile
SCT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

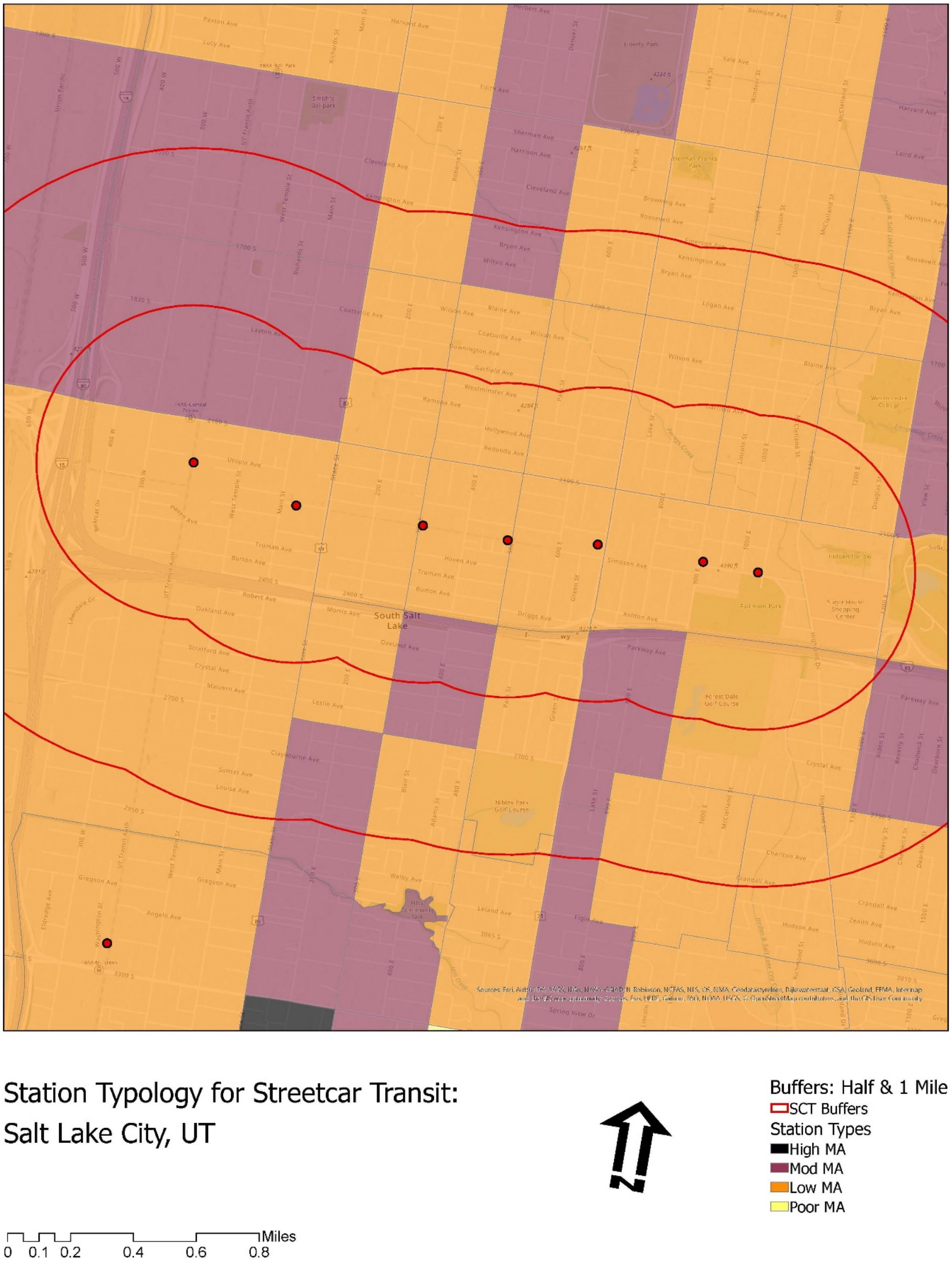
0 0.5 1 2 3 4 Miles

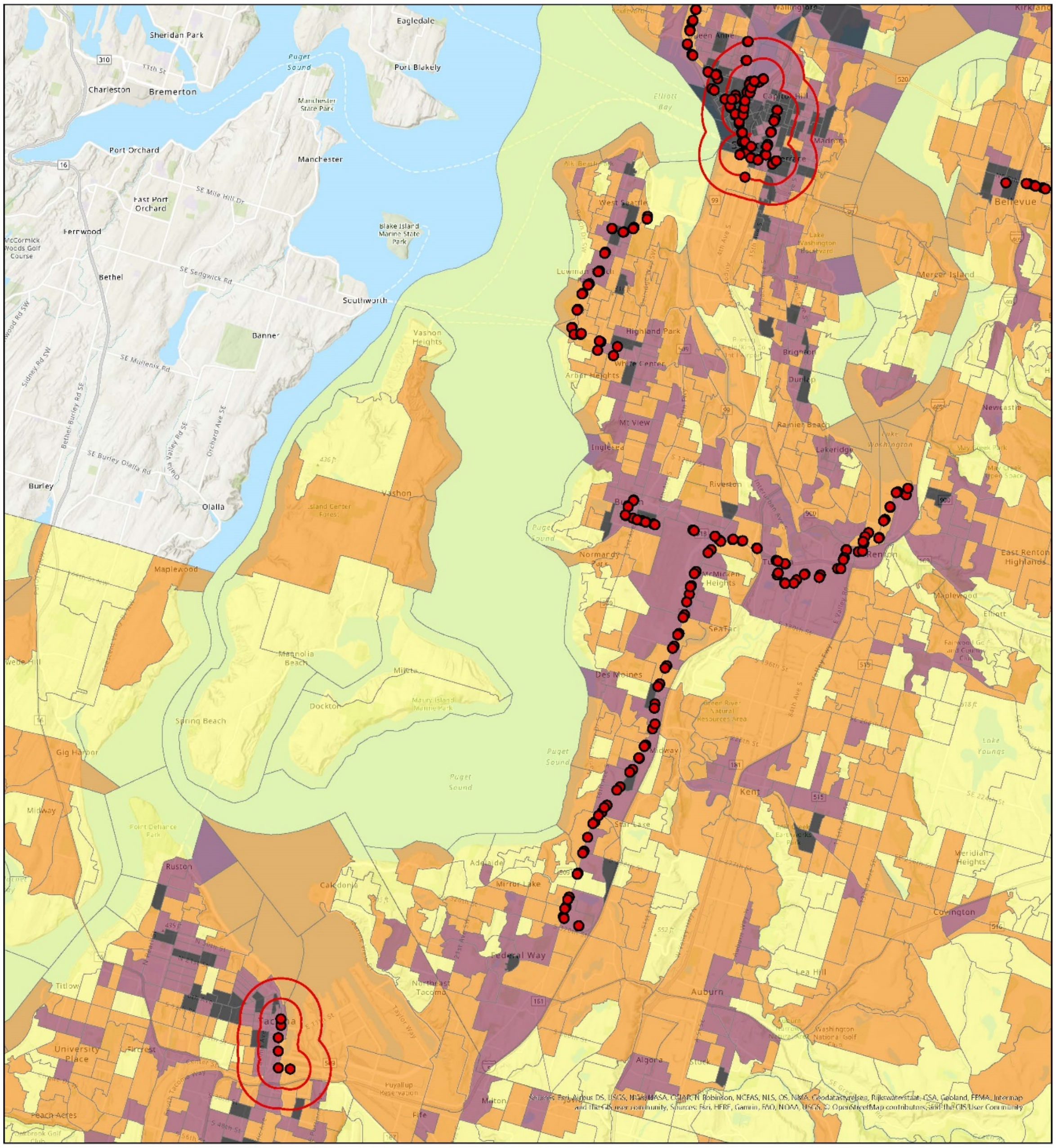


Station Typology for Streetcar Transit:
Portland-Vancouver-Hillsboro, OR-WA

Buffers: Half & 1 Mile
SCT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

0 0.13 0.25 0.5 0.75 1 Miles

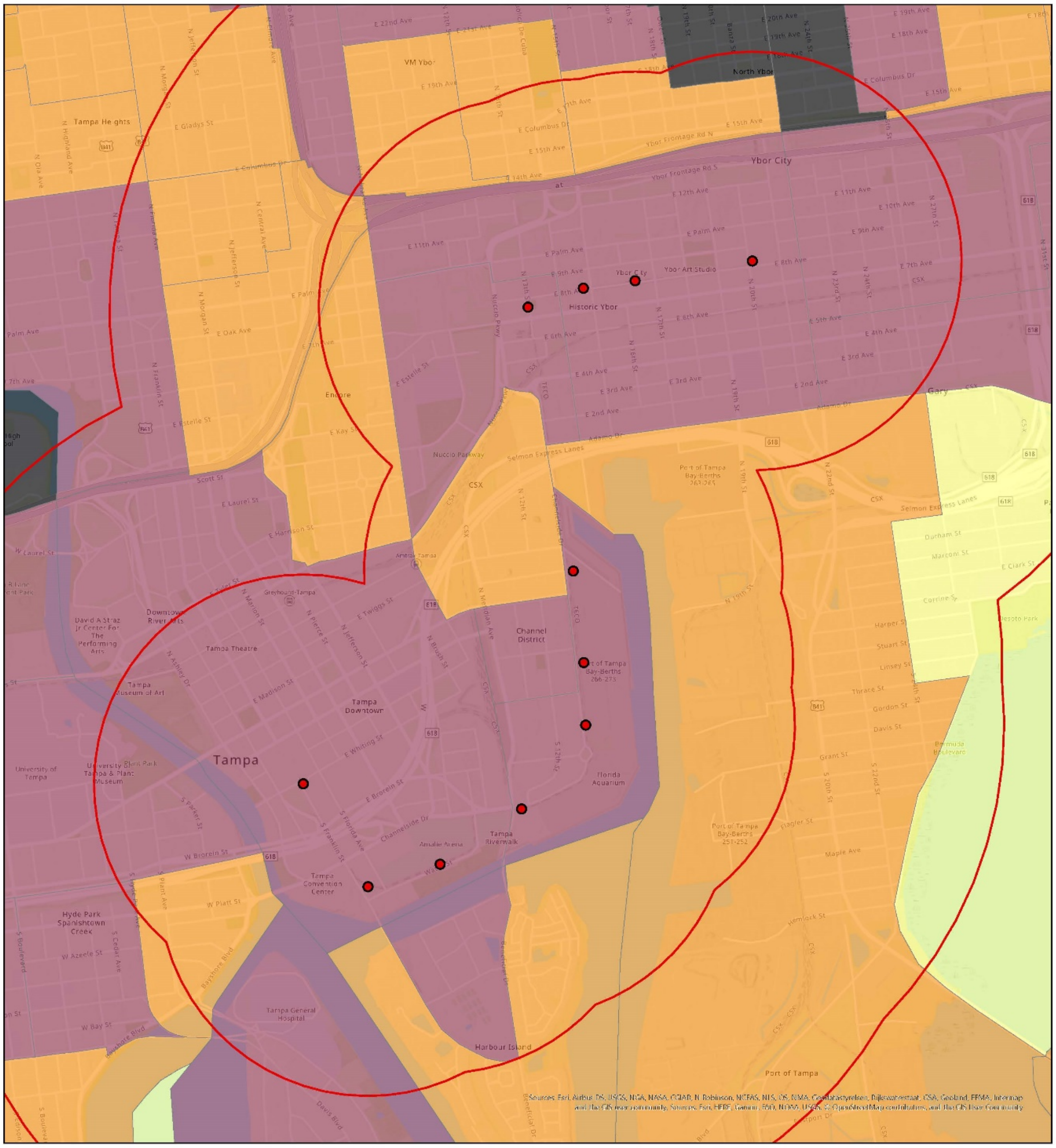

Station Typology for Streetcar Transit:
Salt Lake City, UT
Buffers: Half & 1 Mile
SCT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA
0 0.1 0.2 0.4 0.6 0.8 Miles



Station Typology for Streetcar Transit:
Seattle-Tacoma-Bellevue, WA

Buffers: Half & 1 Mile
SCT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

0 0.75 1.5 3 4.5 6 Miles



Station Typology for Streetcar Transit:
Tampa-St. Petersburg-Clearwater, FL

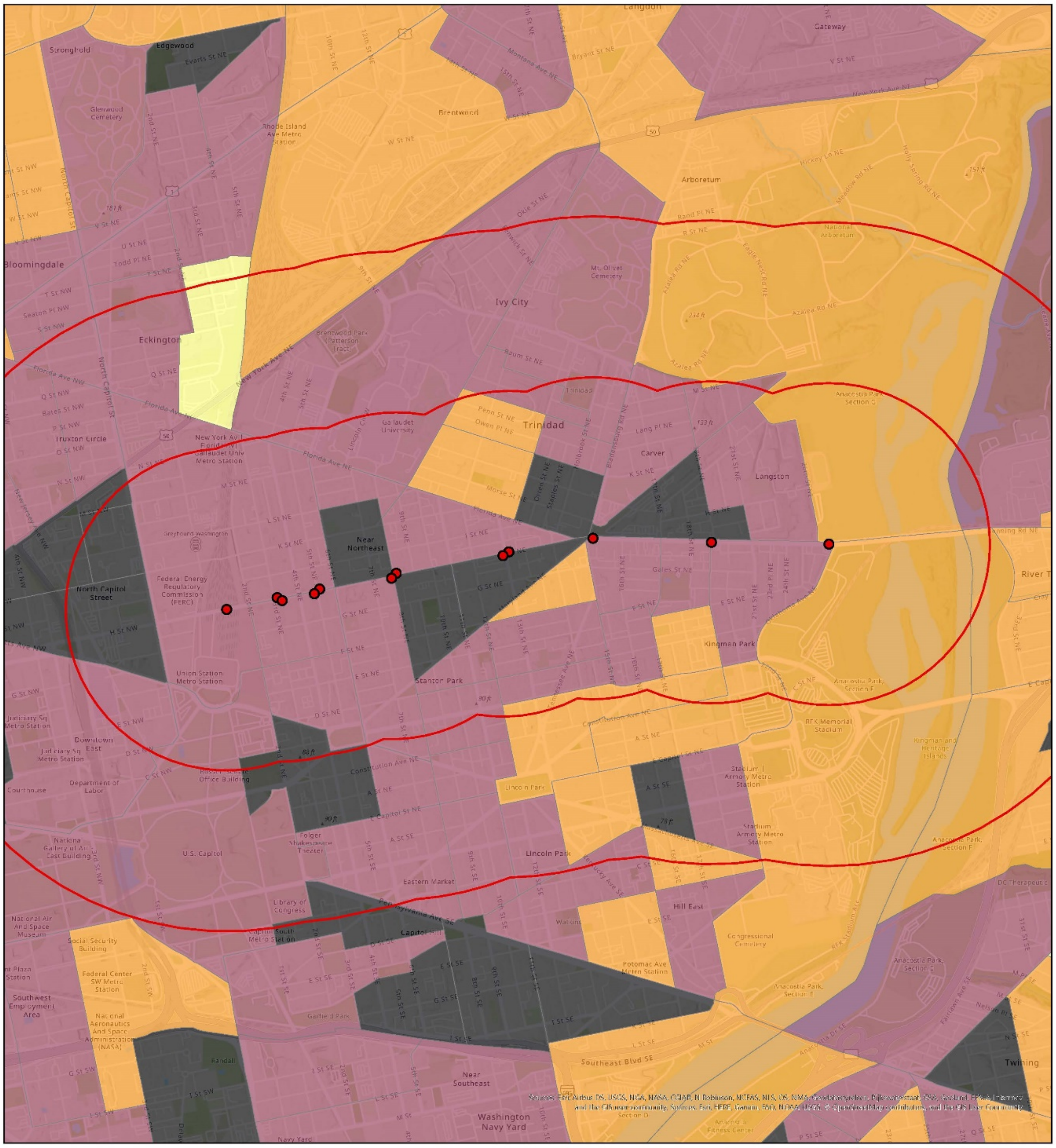
Buffers: Half & 1 Mile
SCT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

0 0.070.15 0.3 0.45 0.6 Miles

Station Typology for Streetcar Transit:
Tucson, AZ

Buffers: Half & 1 Mile
SCT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

0 0.13 0.25 0.5 0.75 1 Miles

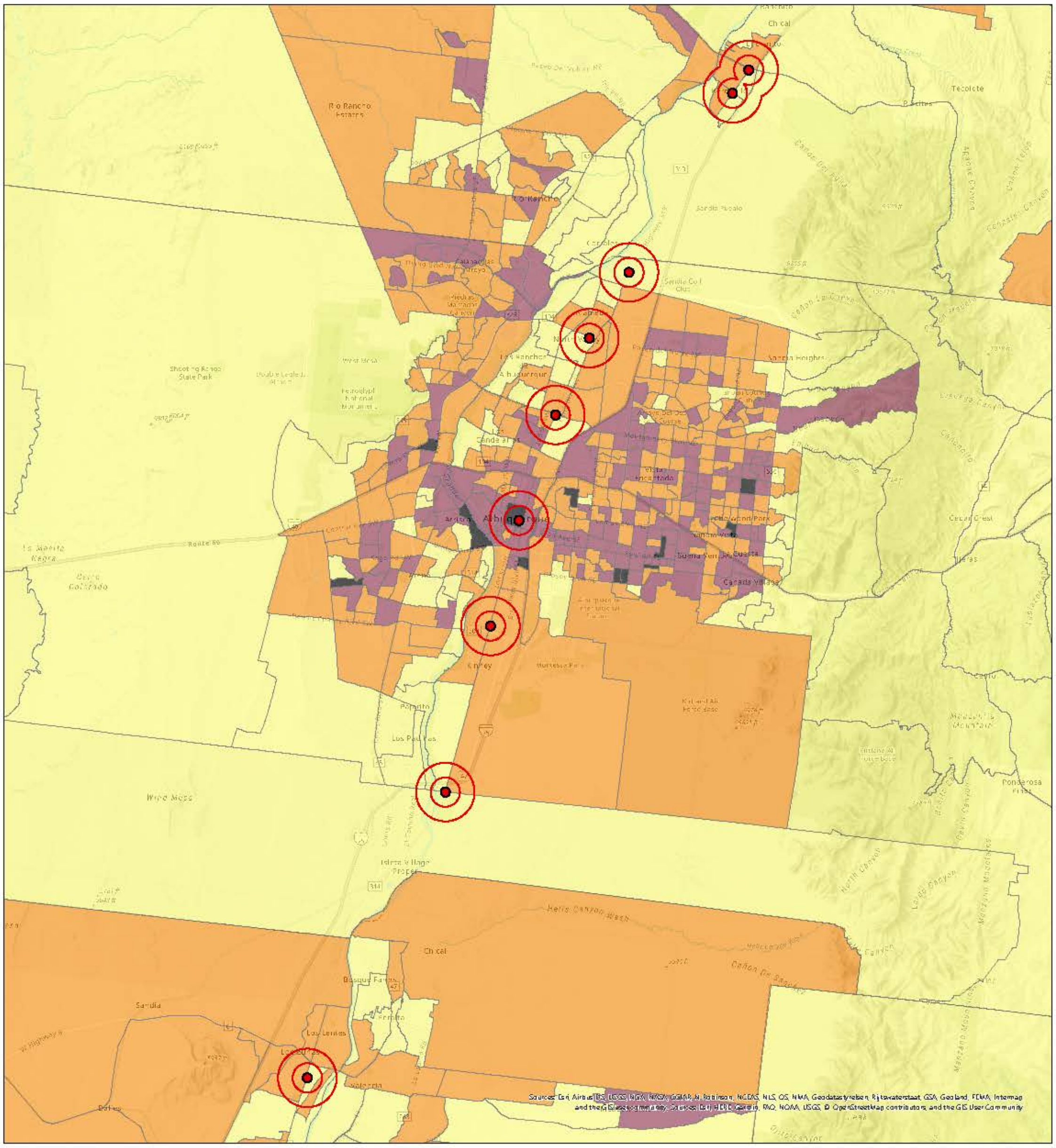


Station Typology for Streetcar Transit: Washington-Arlington-Alexandria, DC-VA-MD-WV

Buffers: Half & 1 Mile
SCT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

0 0.1 0.2 0.4 0.6 0.8 Miles

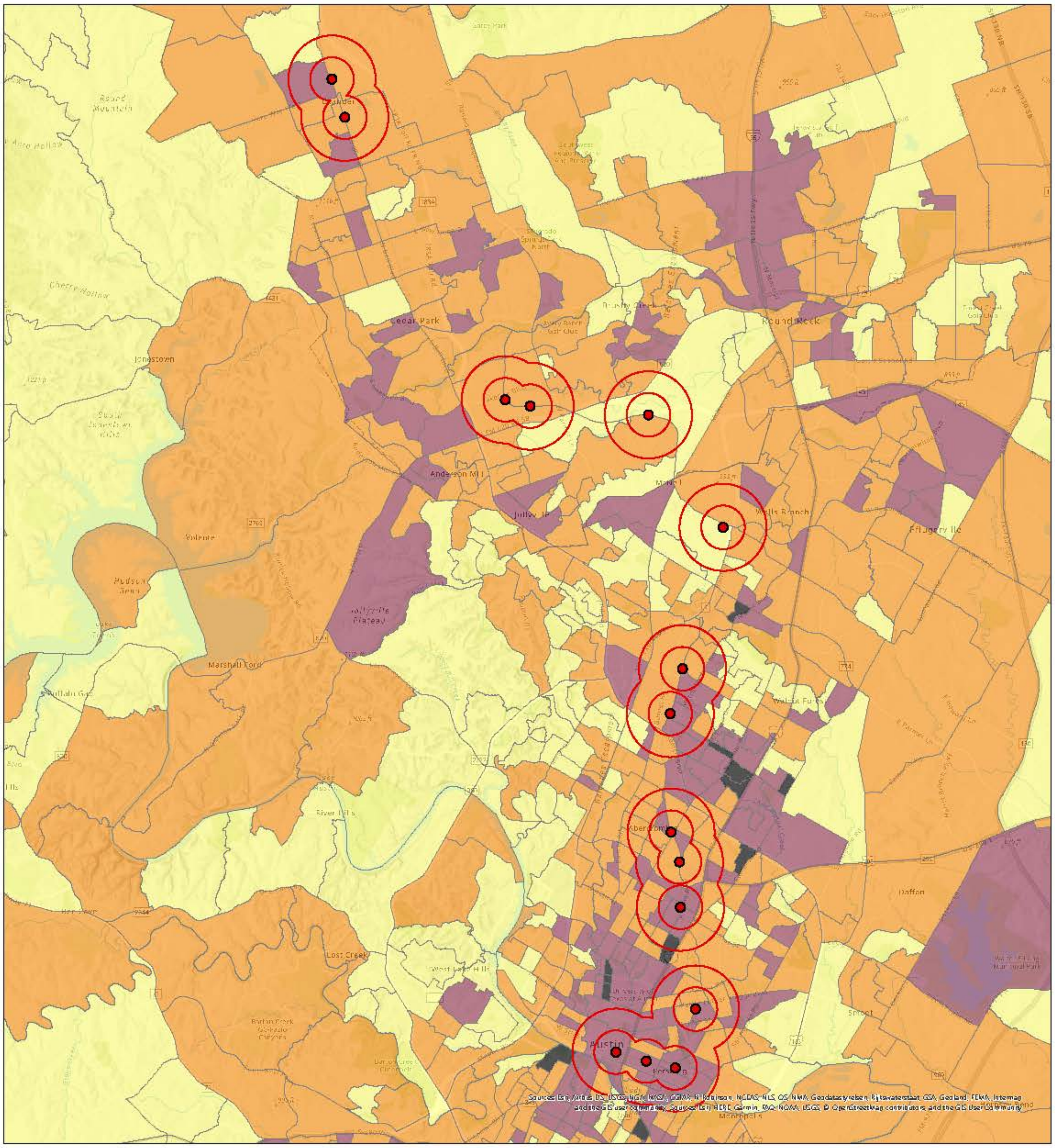
APPENDIX C.3
This section contains maps for all Commuter Rail Transit systems in the study.



Station Typology for Commuter Rail Transit:
Albuquerque, NM

Buffers: Half & 1 Mile
CRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

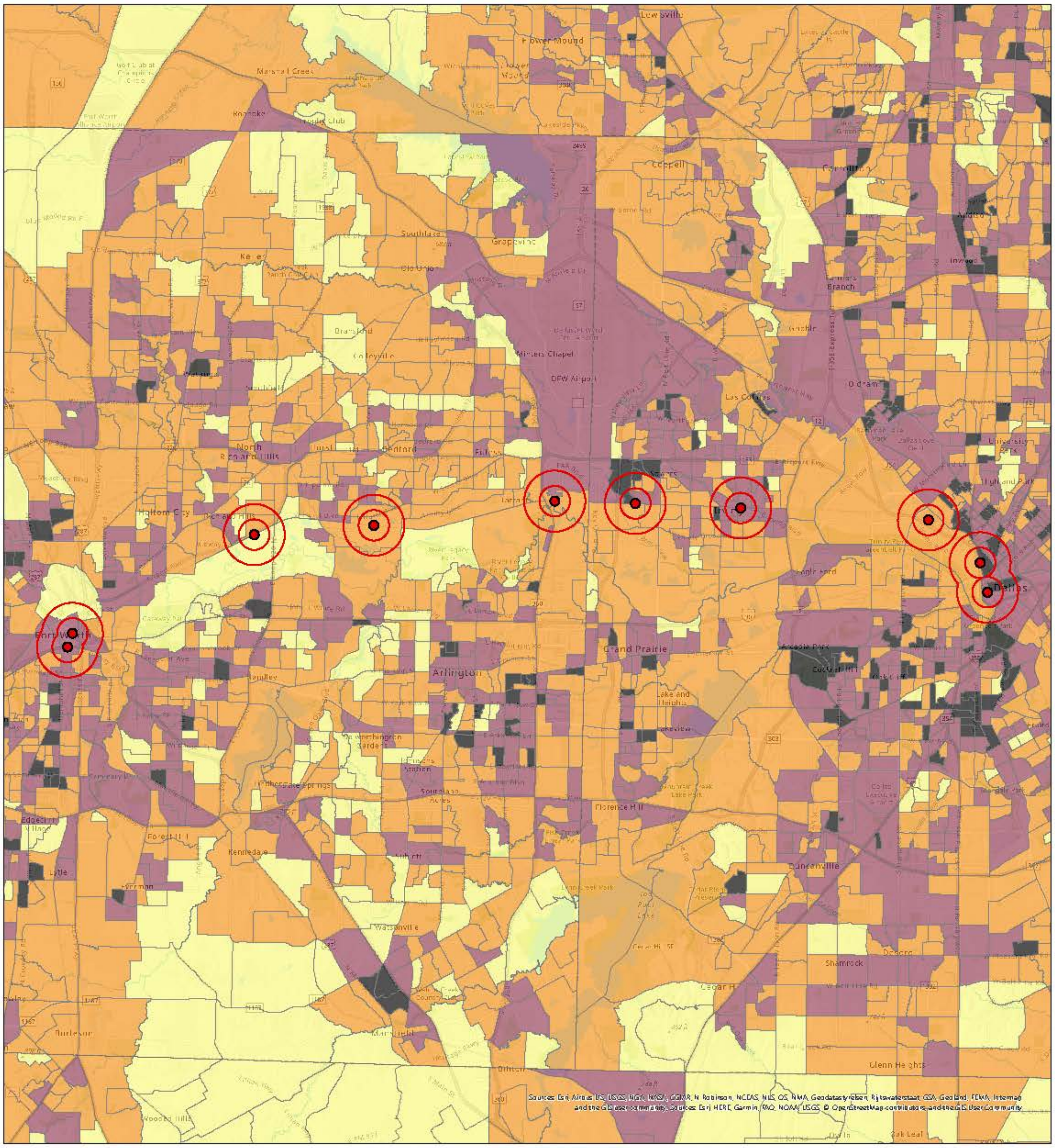
0 1 2 4 6 8 Miles



Station Typology for Commuter Rail Transit:
Austin-Round Rock, TX

Buffers: Half & 1 Mile
CRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

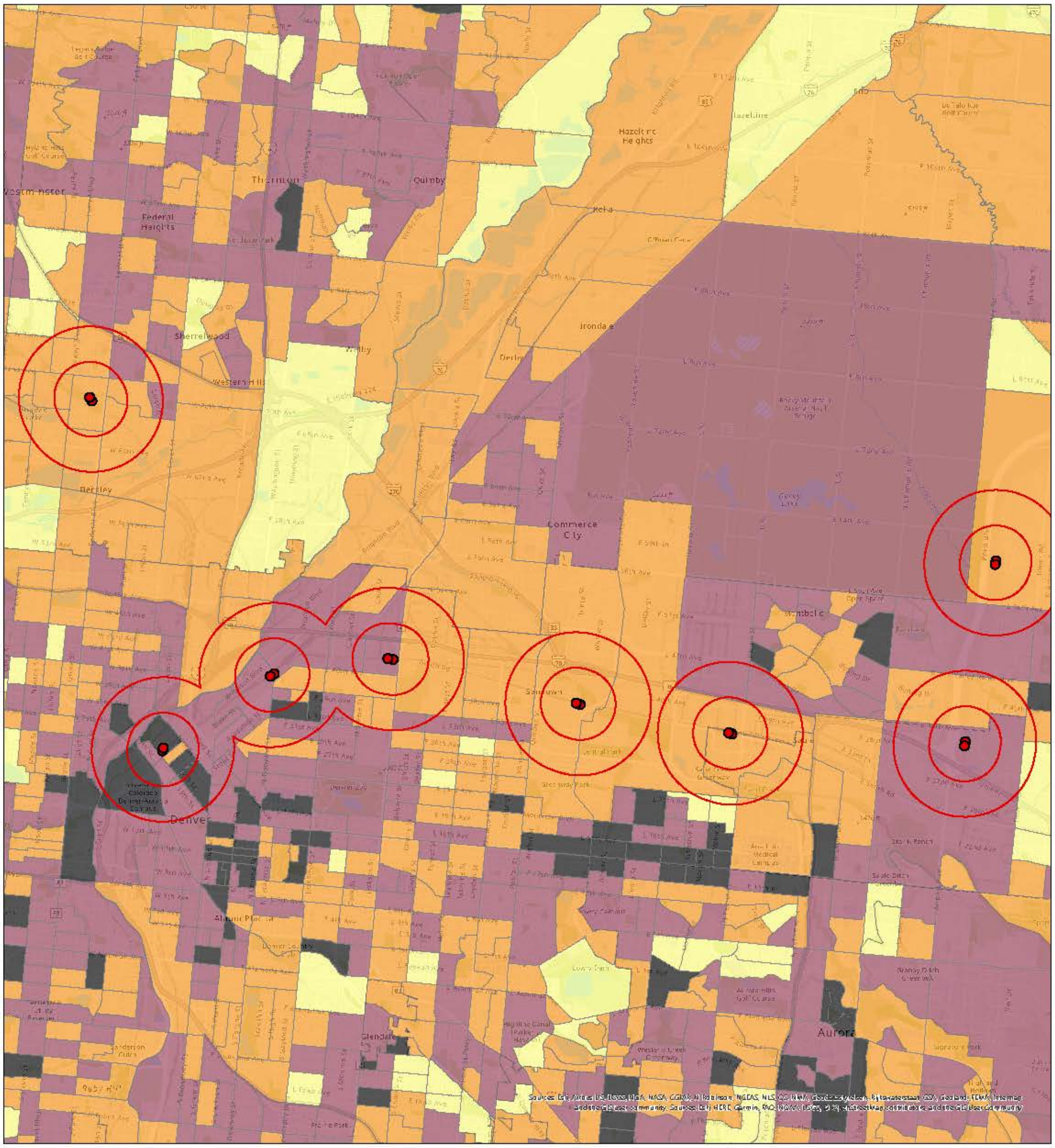
0 0.75 1.5 3 4.5 6 Miles



Station Typology for Commuter Rail Transit:
Dallas-Fort Worth-Arlington, TX

Buffers: Half & 1 Mile
CRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

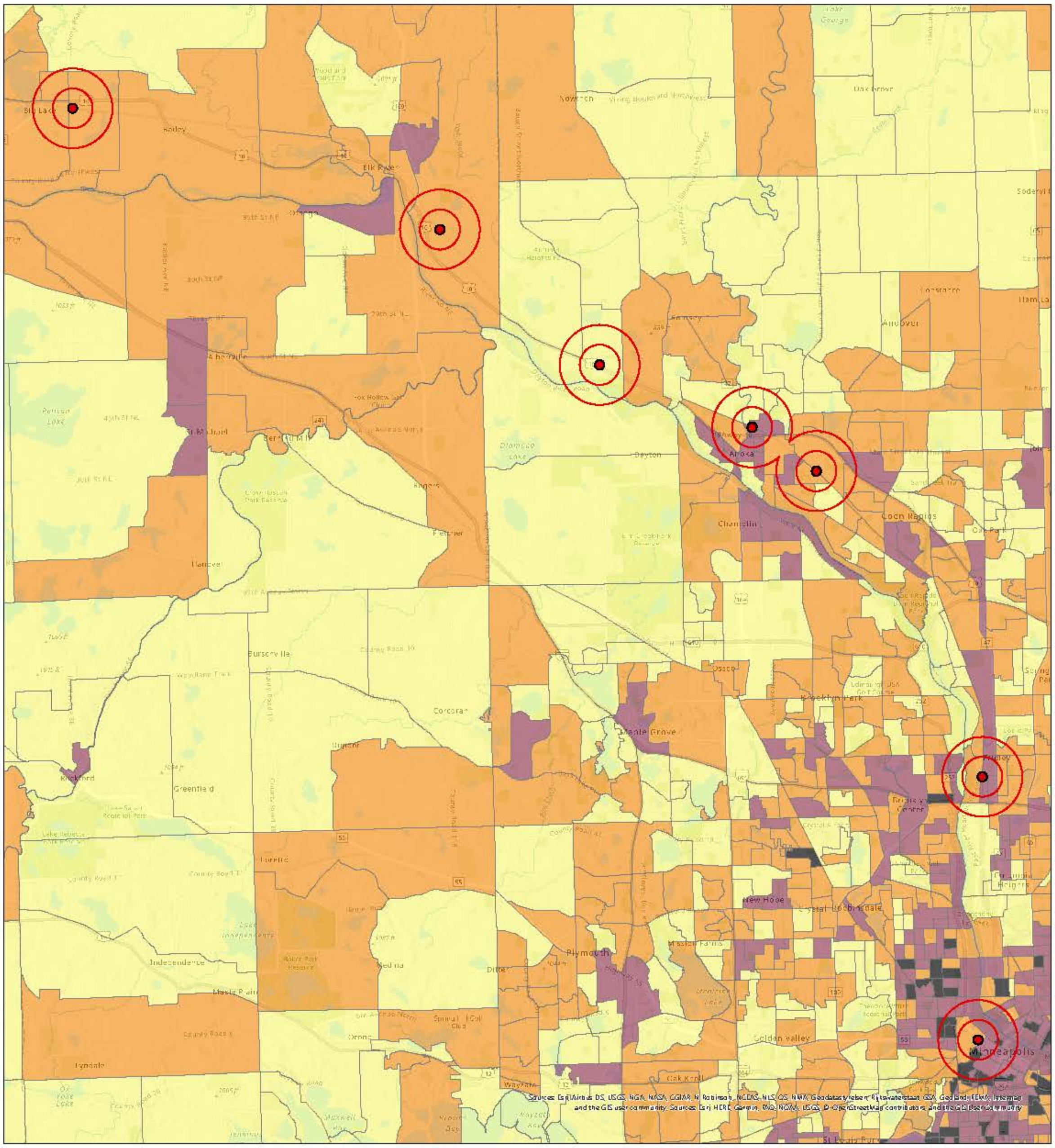
0 1 2 4 6 8 Miles



Station Typology for Commuter Rail Transit:
Denver-Aurora-Lakewood, CO

Buffers: Half & 1 Mile
CRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

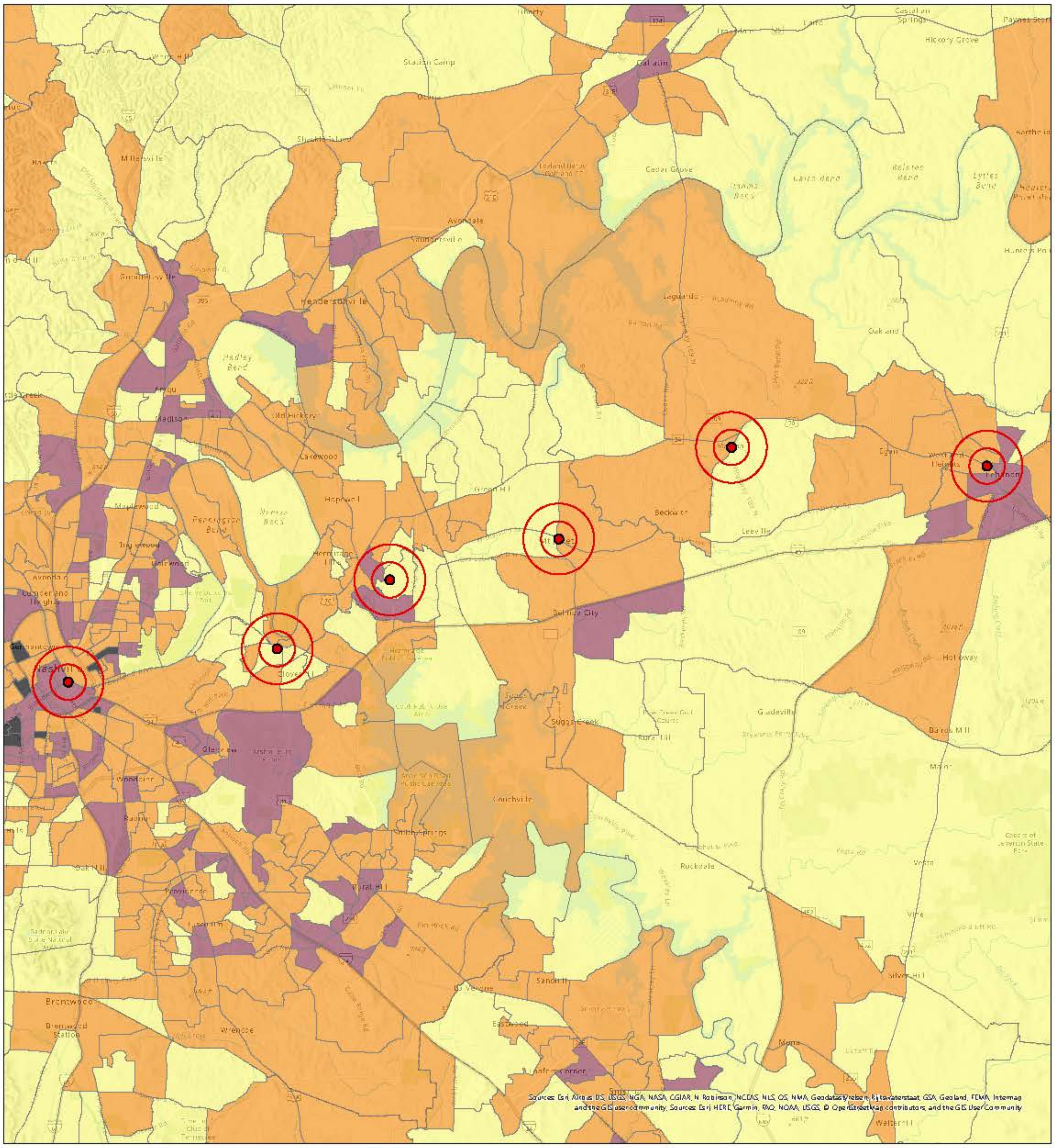
0 0.5 1 2 3 4 Miles



Station Typology for Commuter Rail Transit:
Minneapolis-St. Paul-Bloomington, MN-WI

Buffers: Half & 1 Mile
CRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

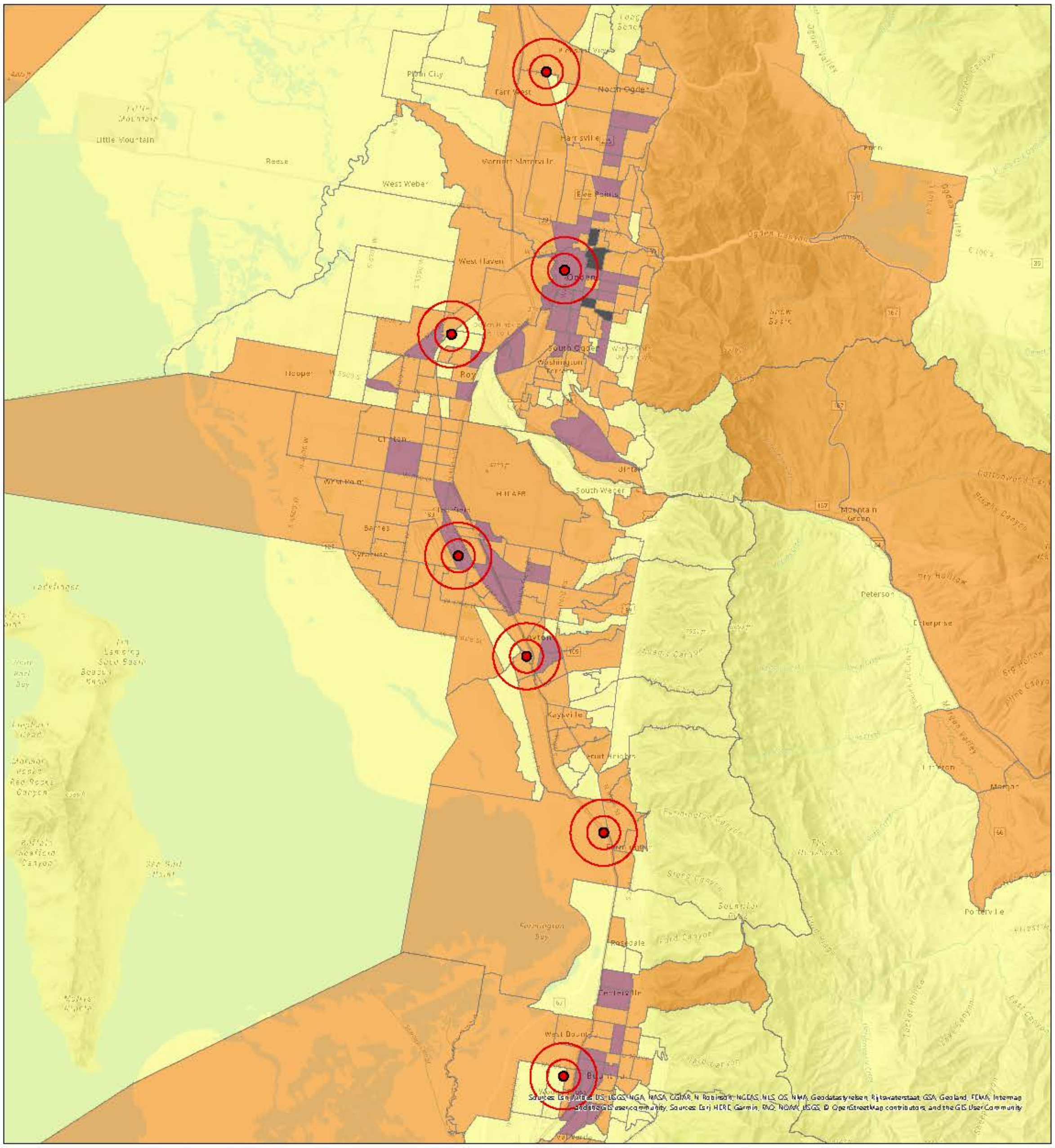
0 0.75 1.5 3 4.5 6 Miles



Station Typology for Commuter Rail Transit:
Nashville-Davidson--Murfreesboro--Franklin, TN

Buffers: Half & 1 Mile
CRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

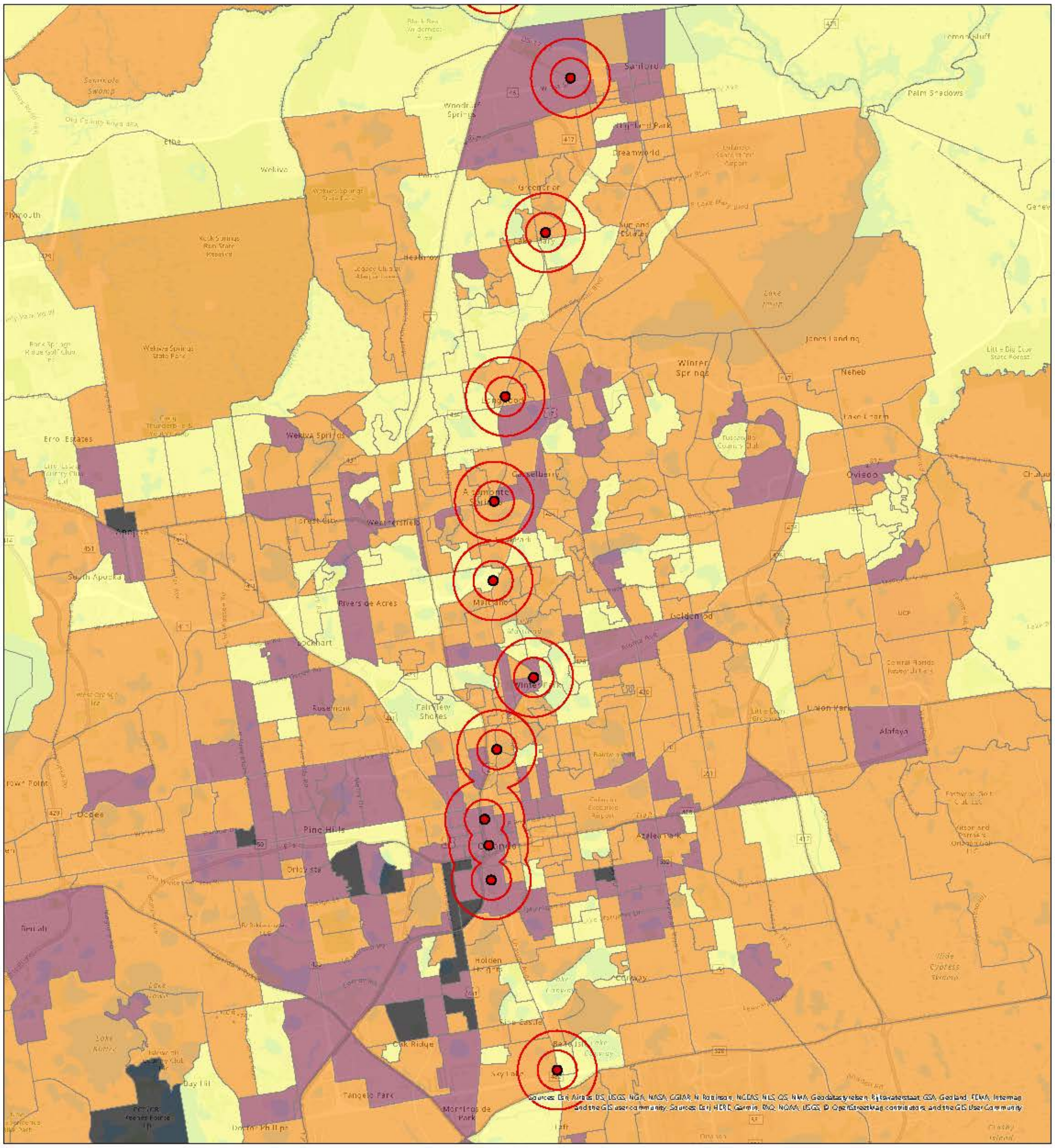
Miles
0 0.751.5 3 4.5 6



Station Typology for Commuter Rail Transit:
Ogden-Clearfield, UT

Buffers: Half & 1 Mile
CRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

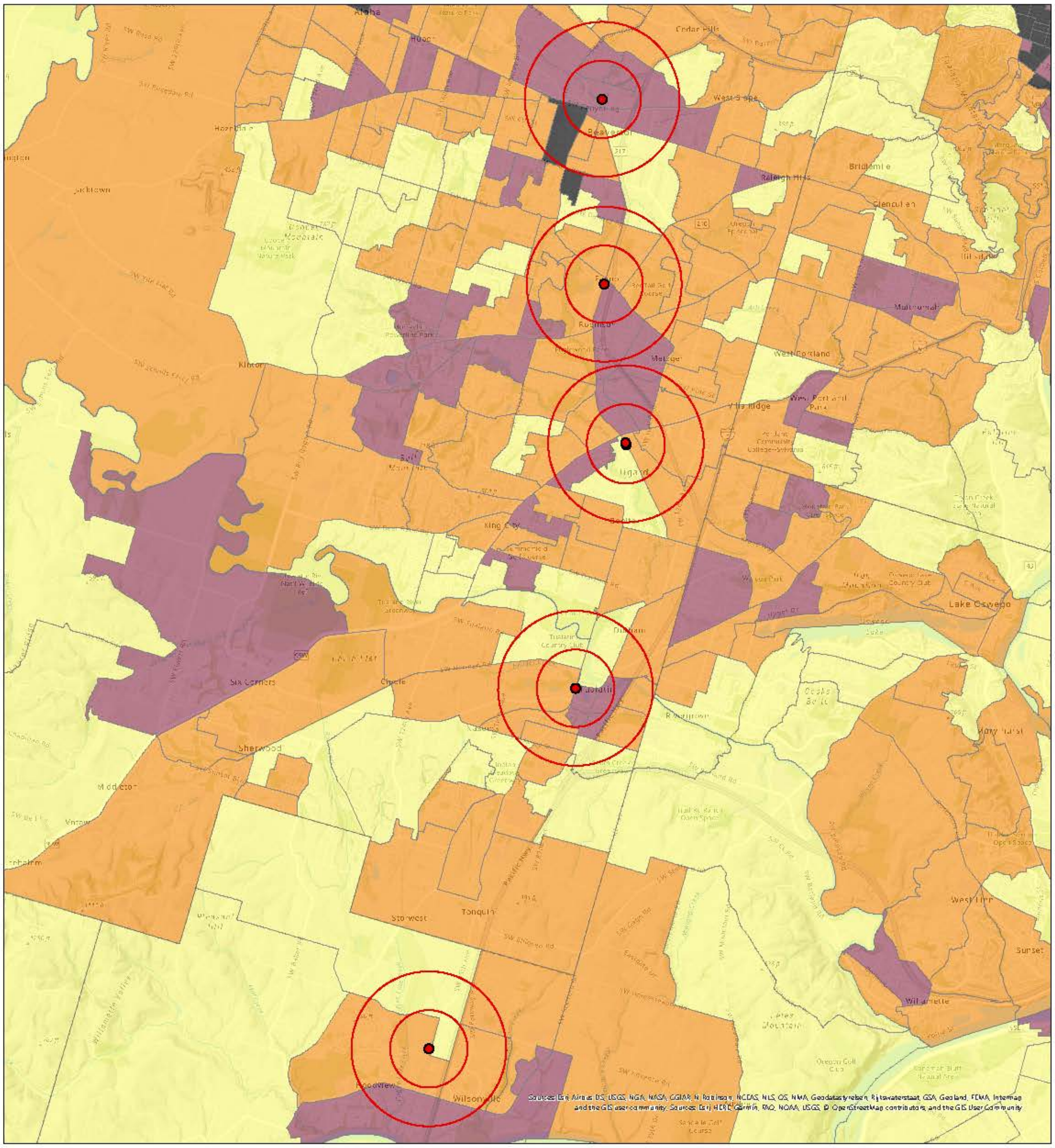
0 1 2 4 6 8 Miles



Station Typology for Commuter Rail Transit:
Orlando-Kissimmee-Sanford, FL

Buffers: Half & 1 Mile
CRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

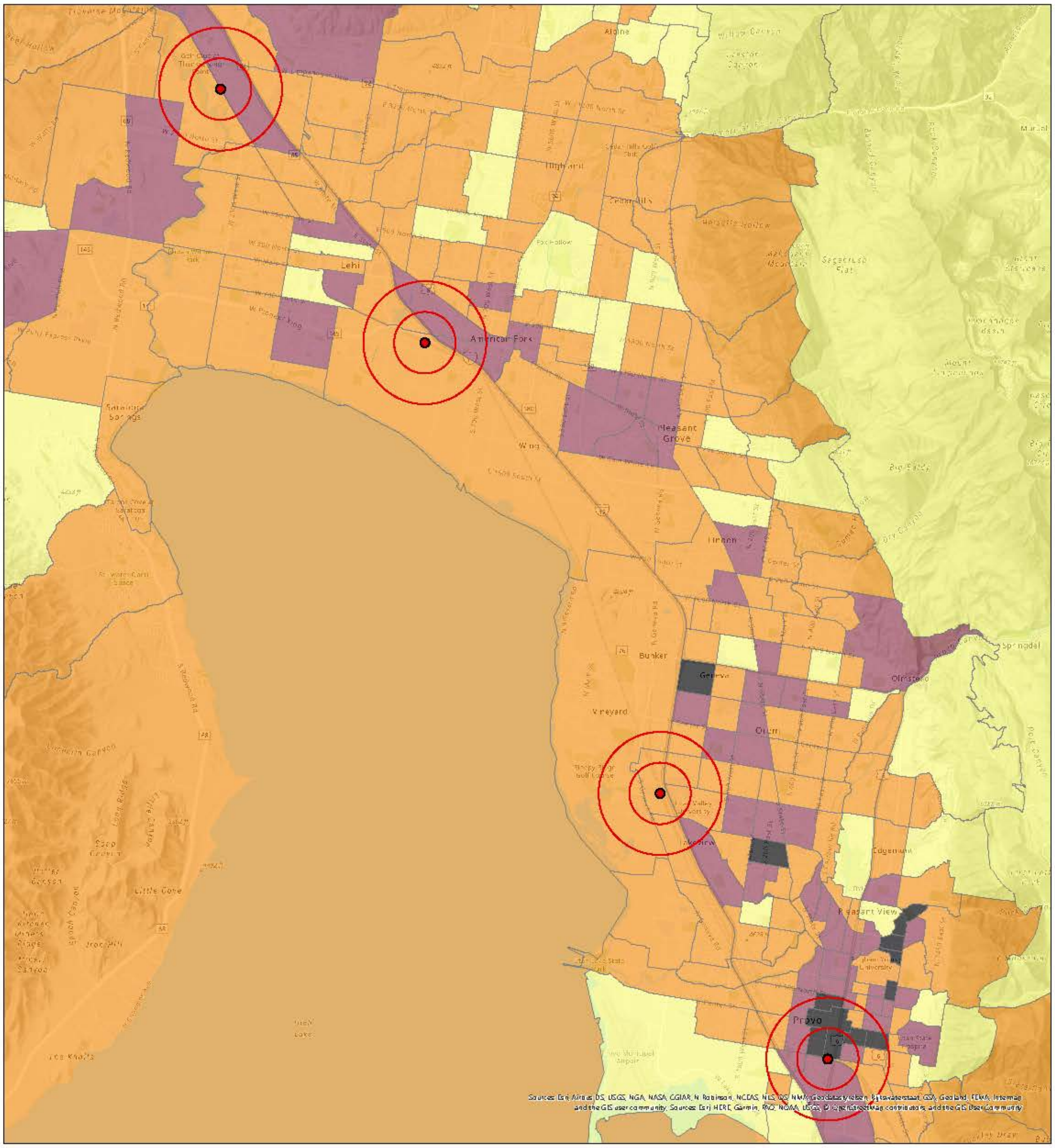
0 0.75 1.5 3 4.5 6 Miles



Station Typology for Commuter Rail Transit:
Portland-Vancouver-Hillsboro, OR-WA

Buffers: Half & 1 Mile
CRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

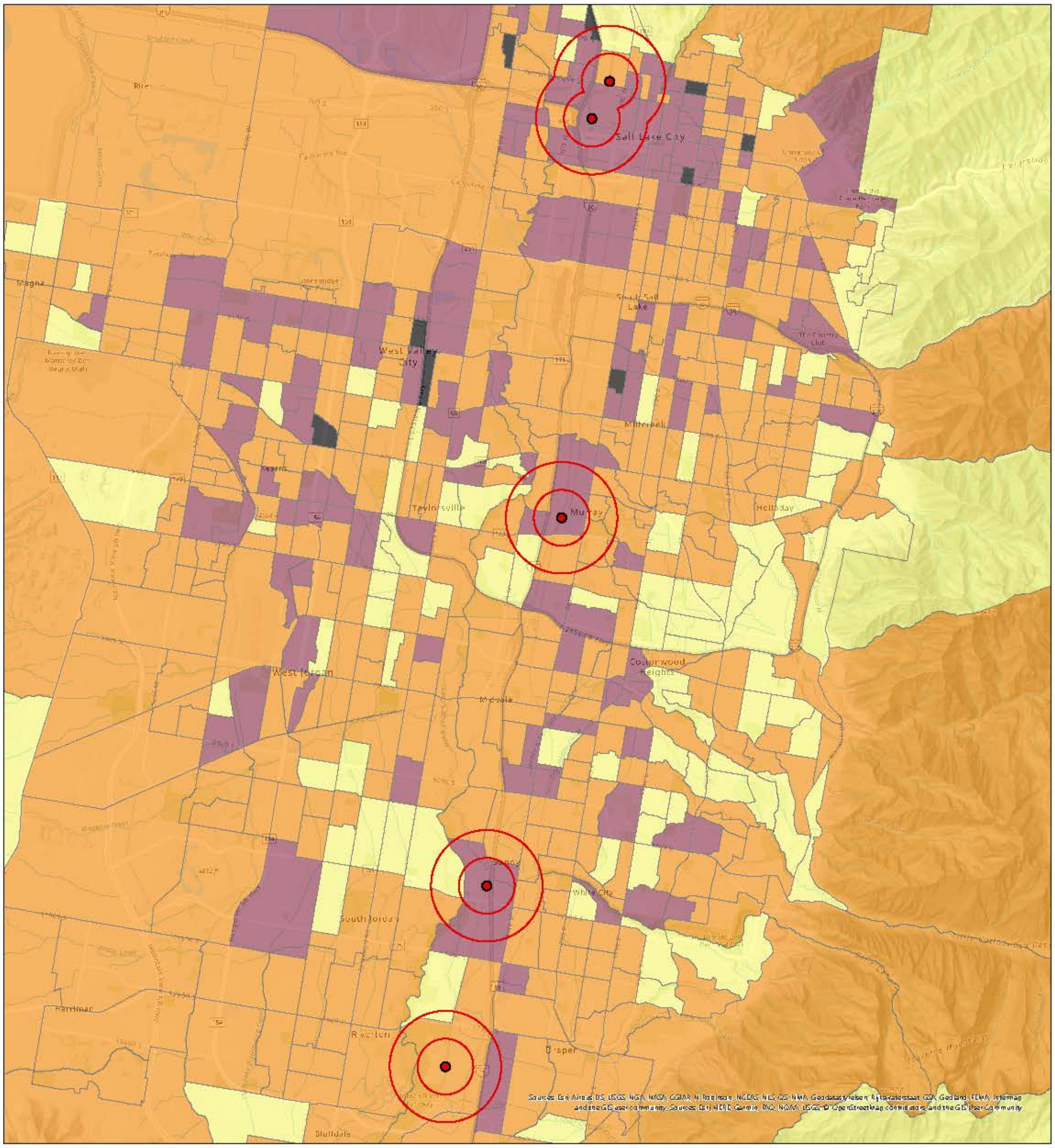
0 0.45 0.9 1.8 2.7 3.6 Miles



Station Typology for Commuter Rail Transit:
Provo-Orem, UT

Buffers: Half & 1 Mile
CRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

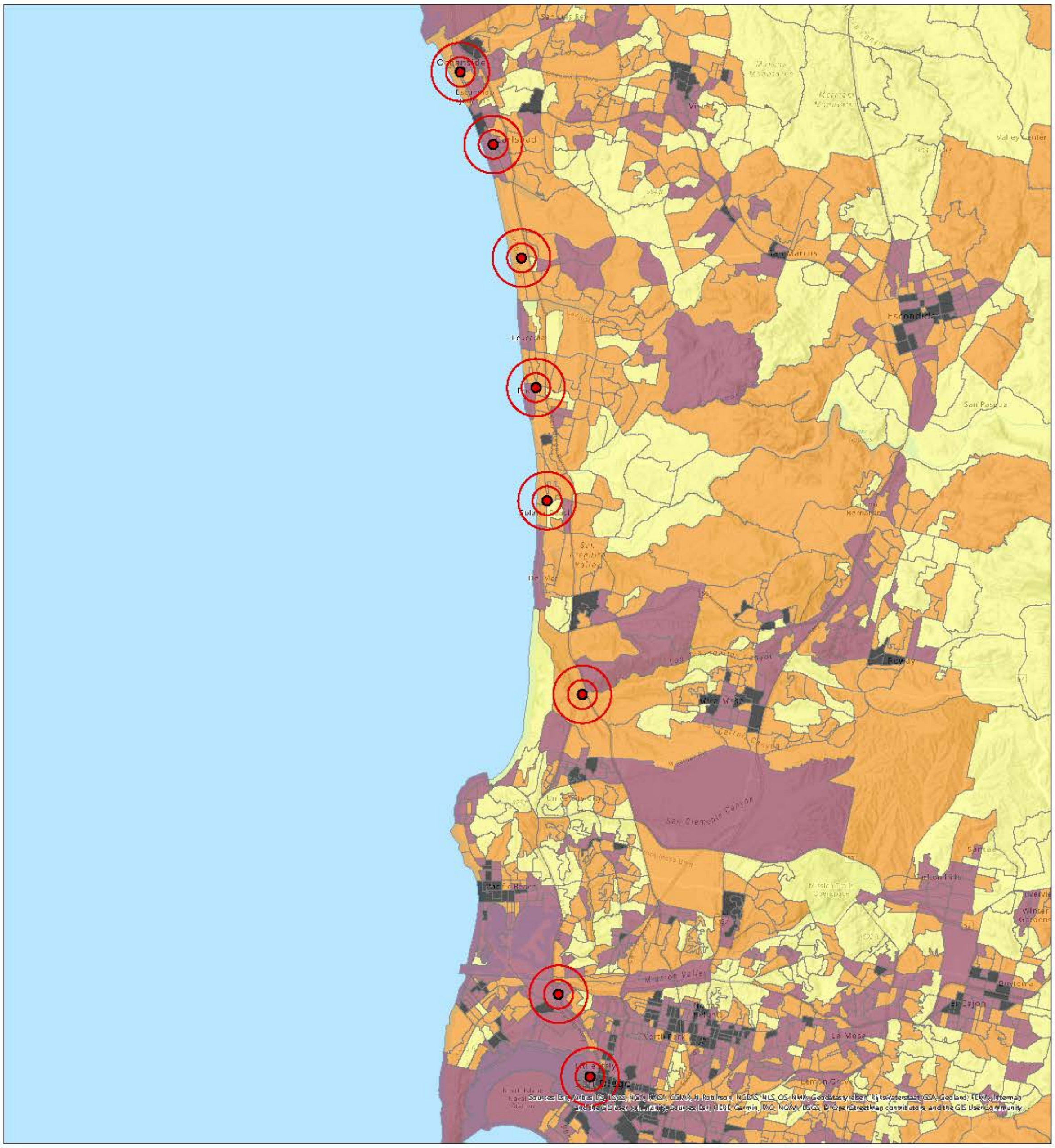
Miles
0 0.5 1 2 3 4



Station Typology for Commuter Rail Transit:
Salt Lake City, UT

Buffers: Half & 1 Mile
CRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

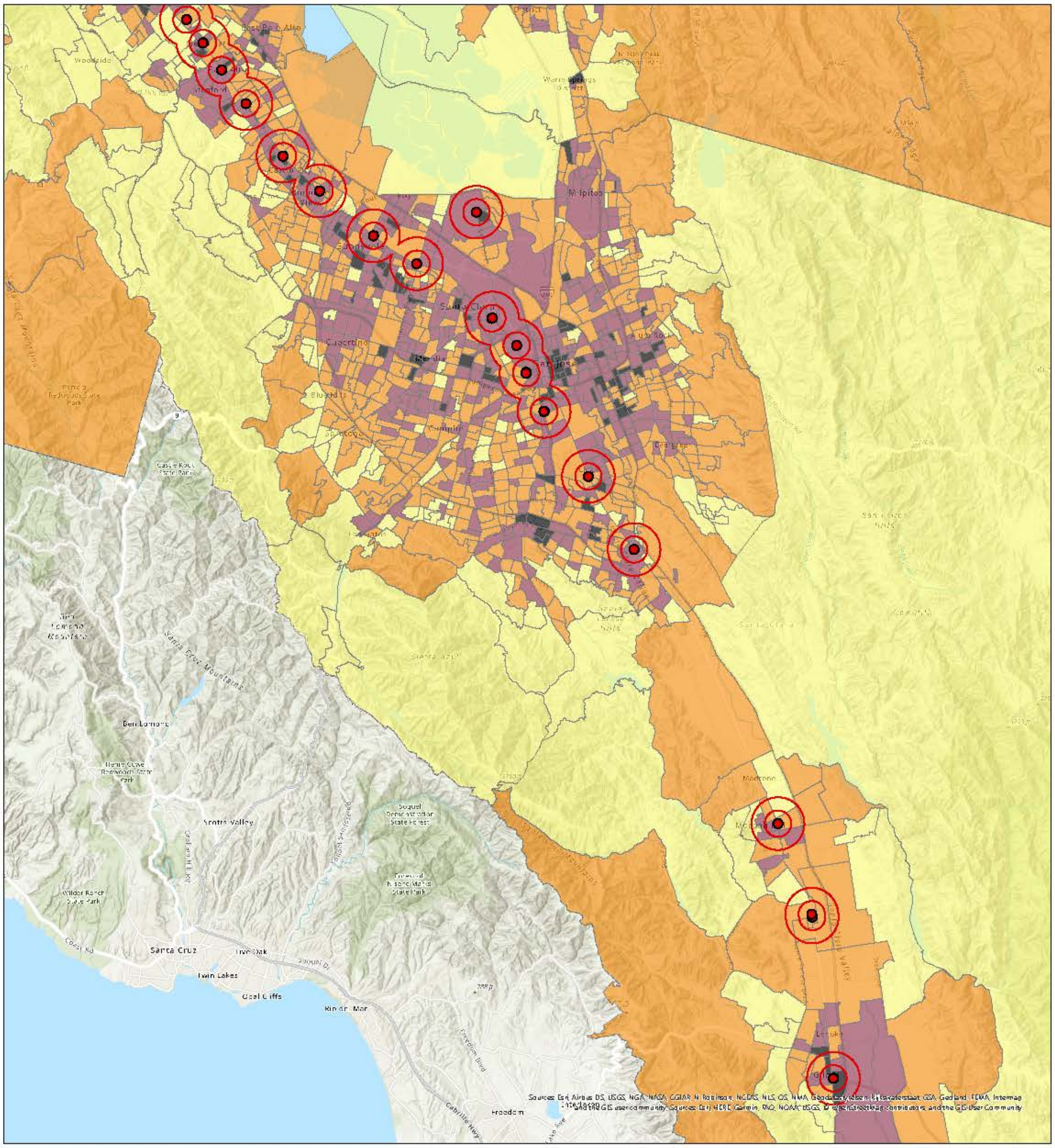
0 0.5 1 2 3 4 Miles



Station Typology for Commuter Rail Transit:
San Diego-Carlsbad, CA

Buffers: Half & 1 Mile
CRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

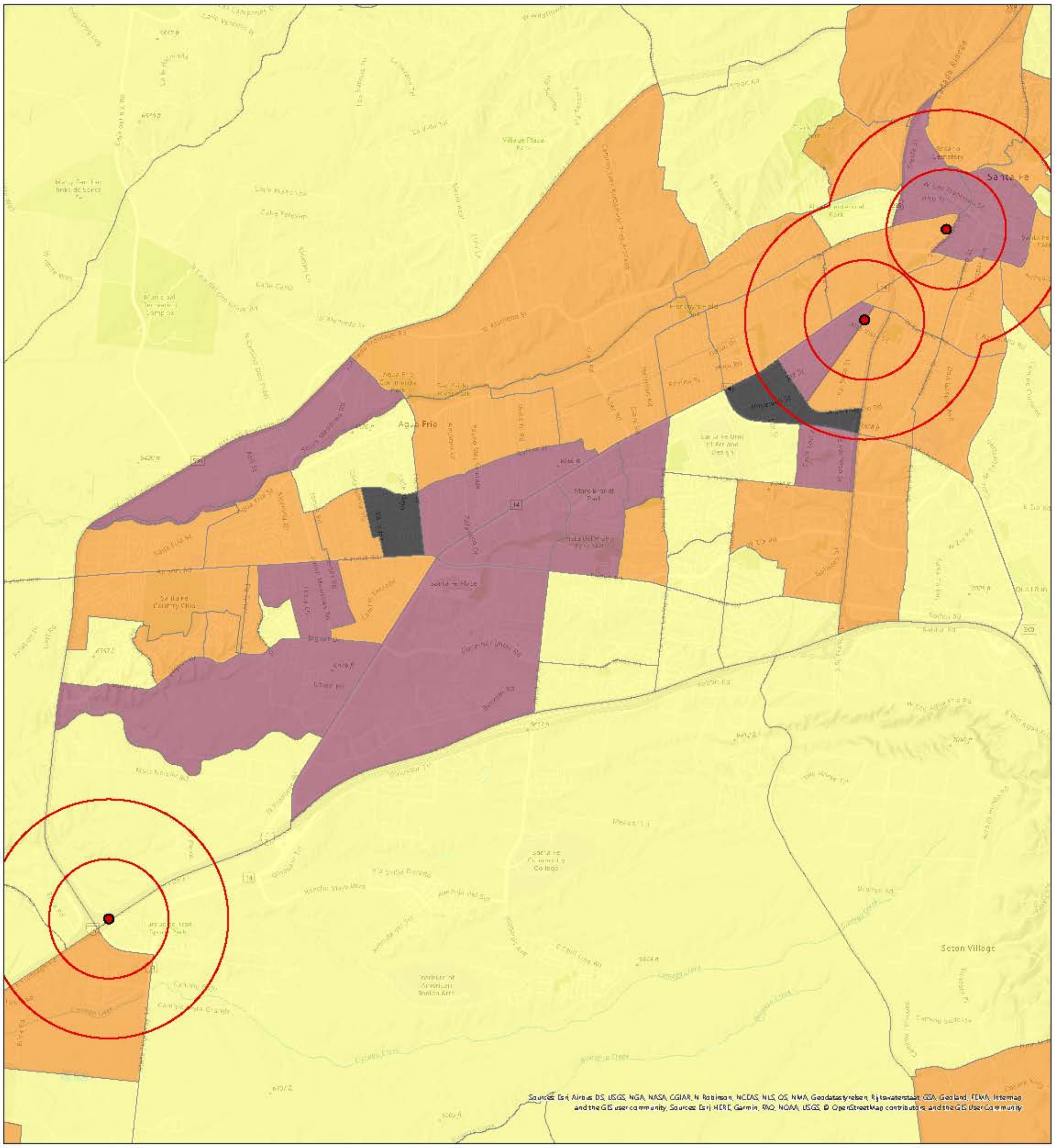
0 1 2 4 6 8 Miles



Station Typology for Commuter Rail Transit:
San Jose-Sunnyvale-Santa Clara, CA

Buffers: Half & 1 Mile
CRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

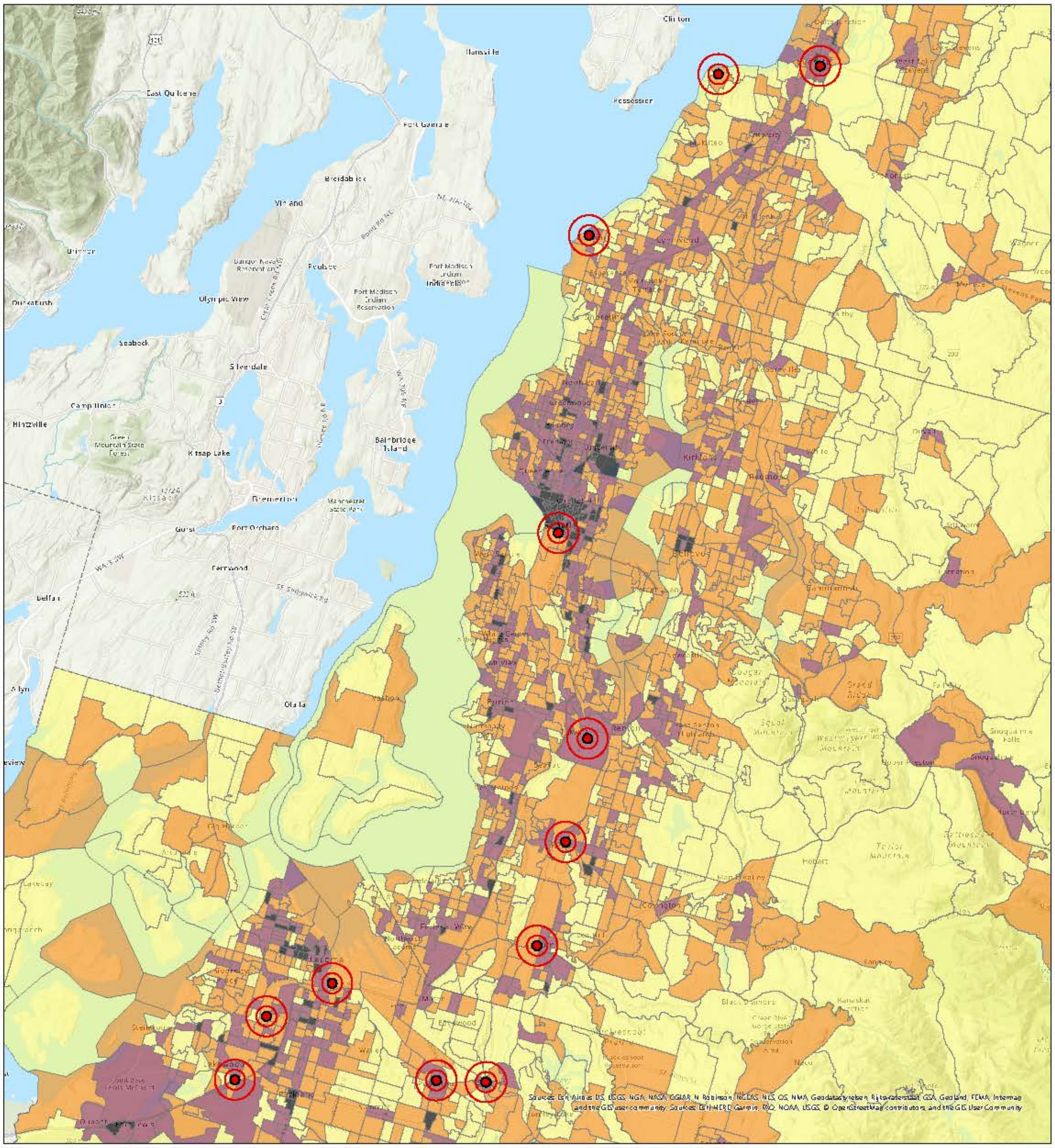
0 1.25 2.5 5 7.5 10 Miles



Station Typology for Commuter Rail Transit:
Santa Fe, NM

Buffers: Half & 1 Mile
CRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

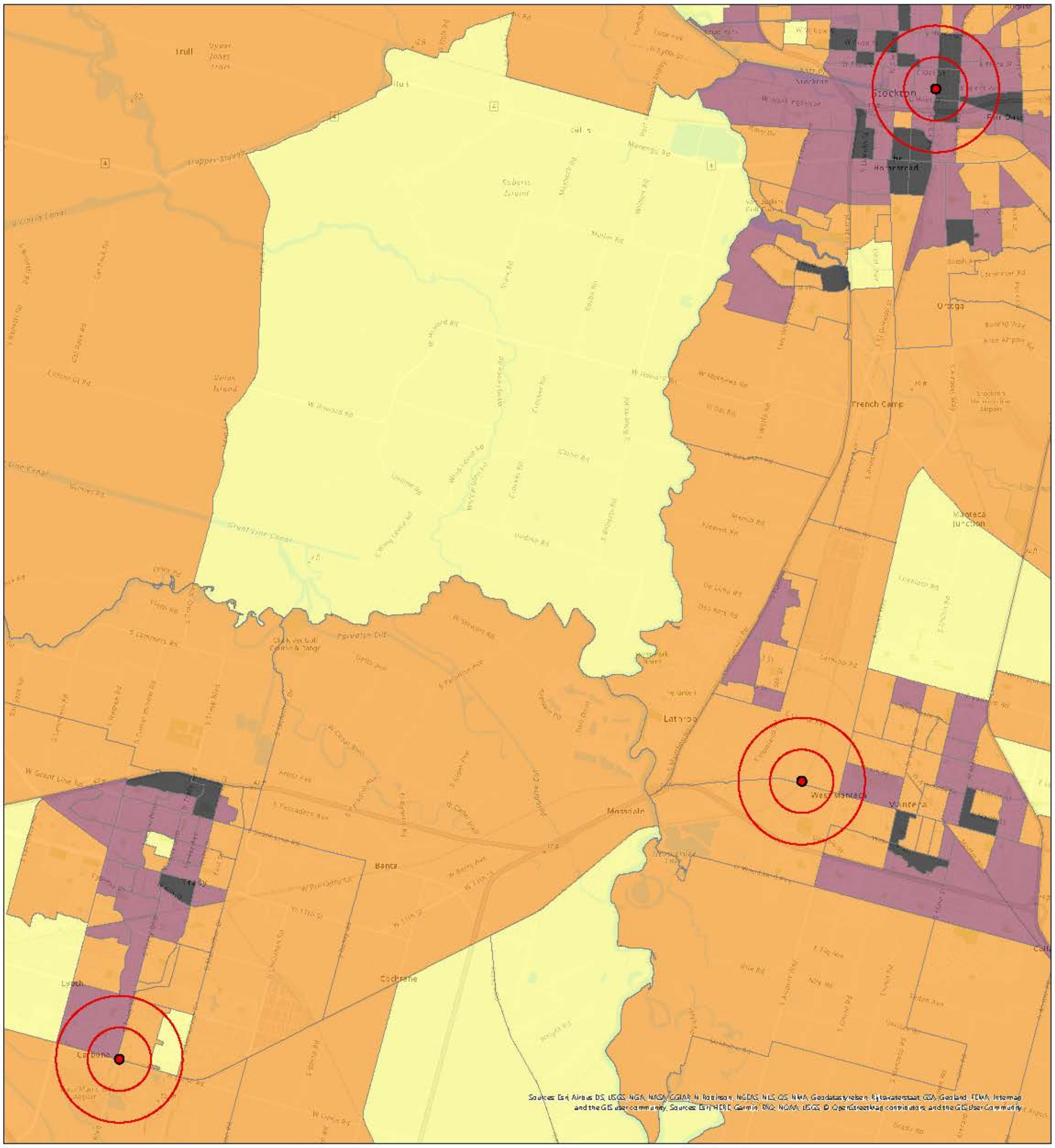
Miles
0 0.28 0.55 1.1 1.65 2.2



Station Typology for Commuter Rail Transit:
Seattle-Tacoma-Bellevue, WA

Buffers: Half & 1 Mile
CRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

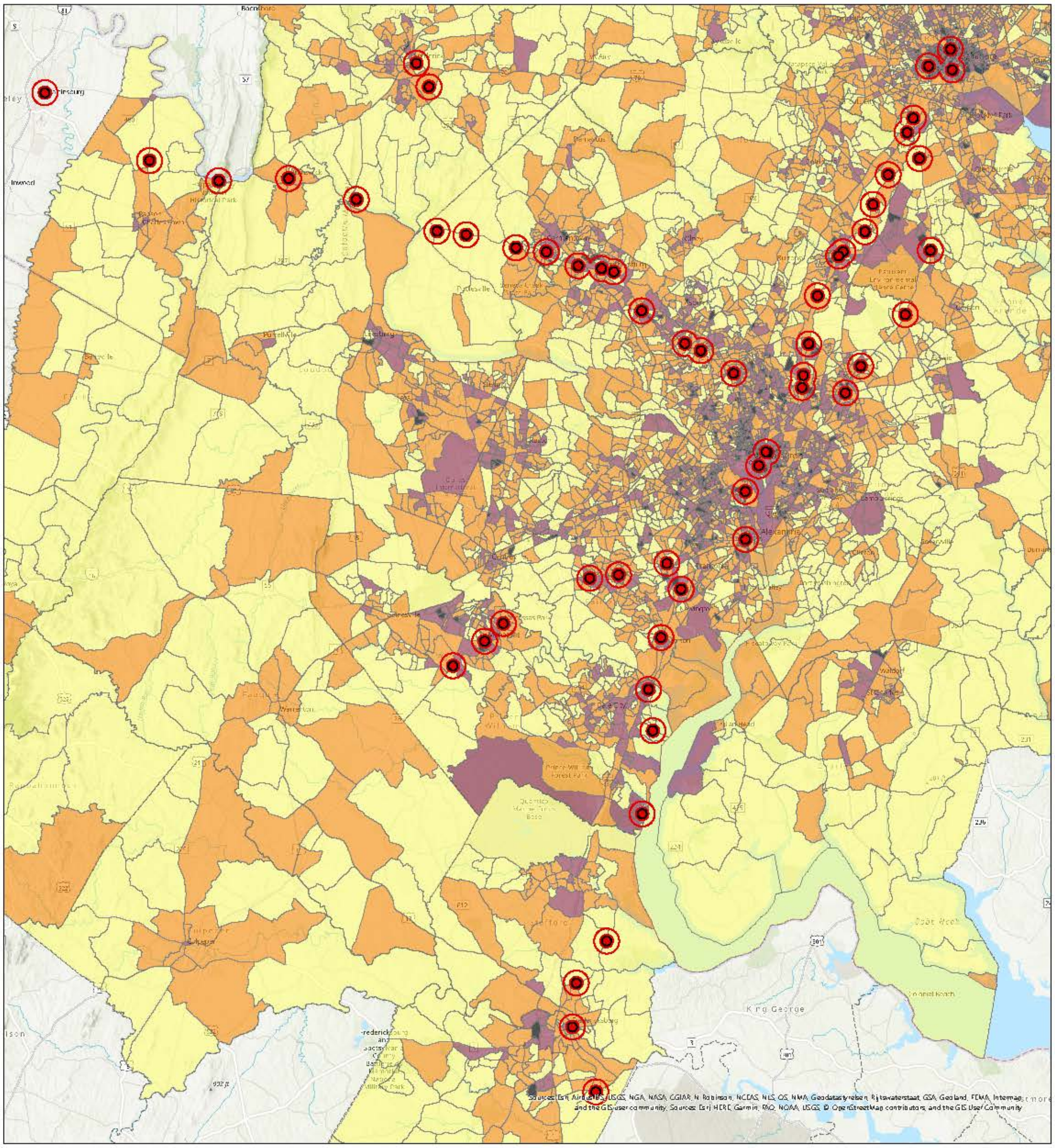
0 1.75 3.5 7 10.5 14 Miles



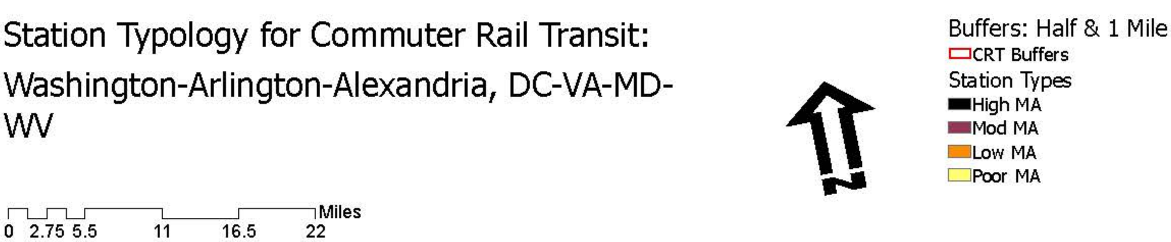
Station Typology for Commuter Rail Transit:
Stockton-Lodi, CA

Buffers: Half & 1 Mile
CRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

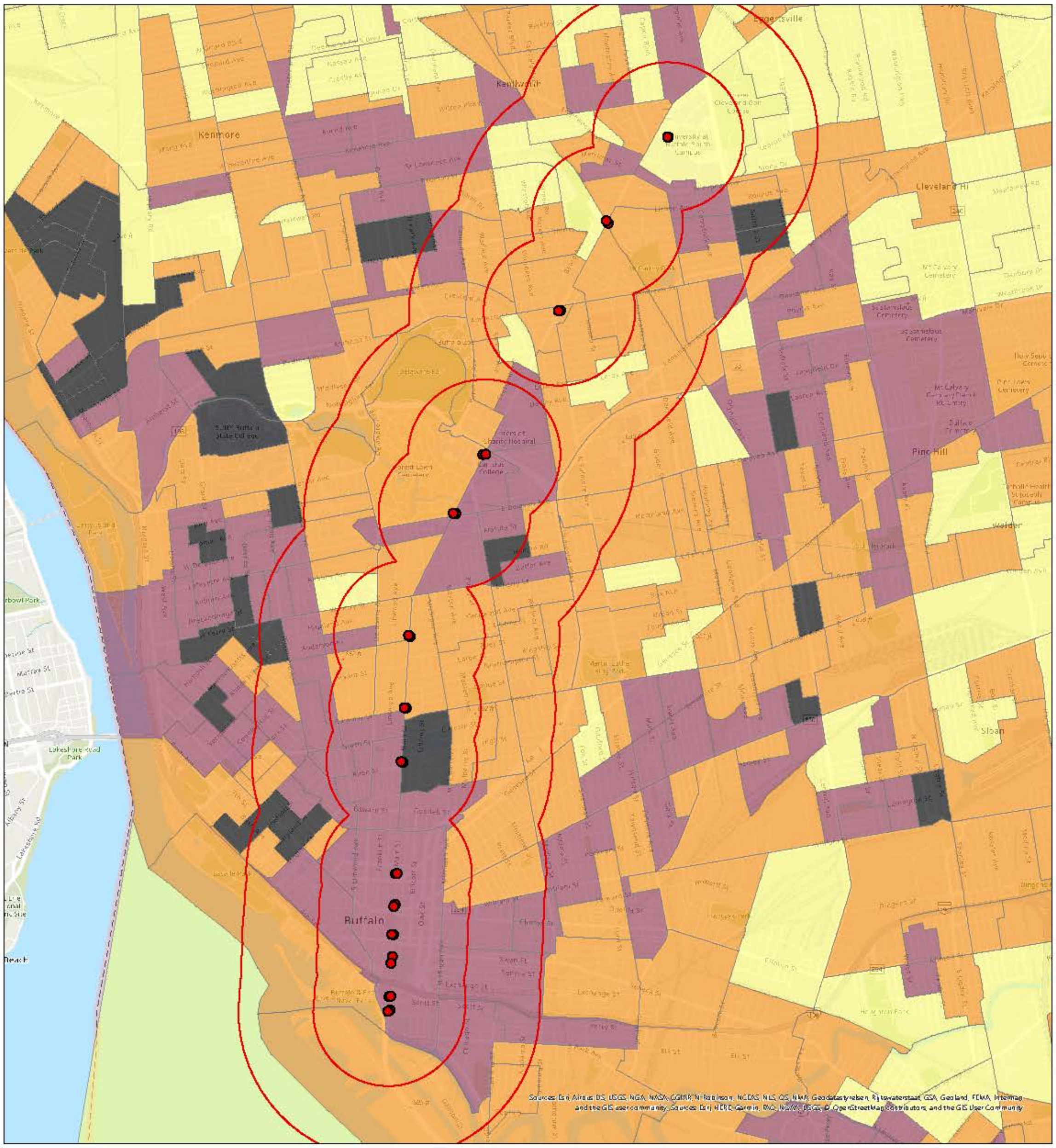
0 0.5 1 2 3 4 Miles



Station Typology for Commuter Rail Transit:
Washington-Arlington-Alexandria, DC-VA-MD-WV



APPENDIX C.4
This section contains maps for all Light Rail Transit systems in the study.



Station Typology for Light Rail Transit:
Buffalo-Cheektowaga-Niagara Falls, NY

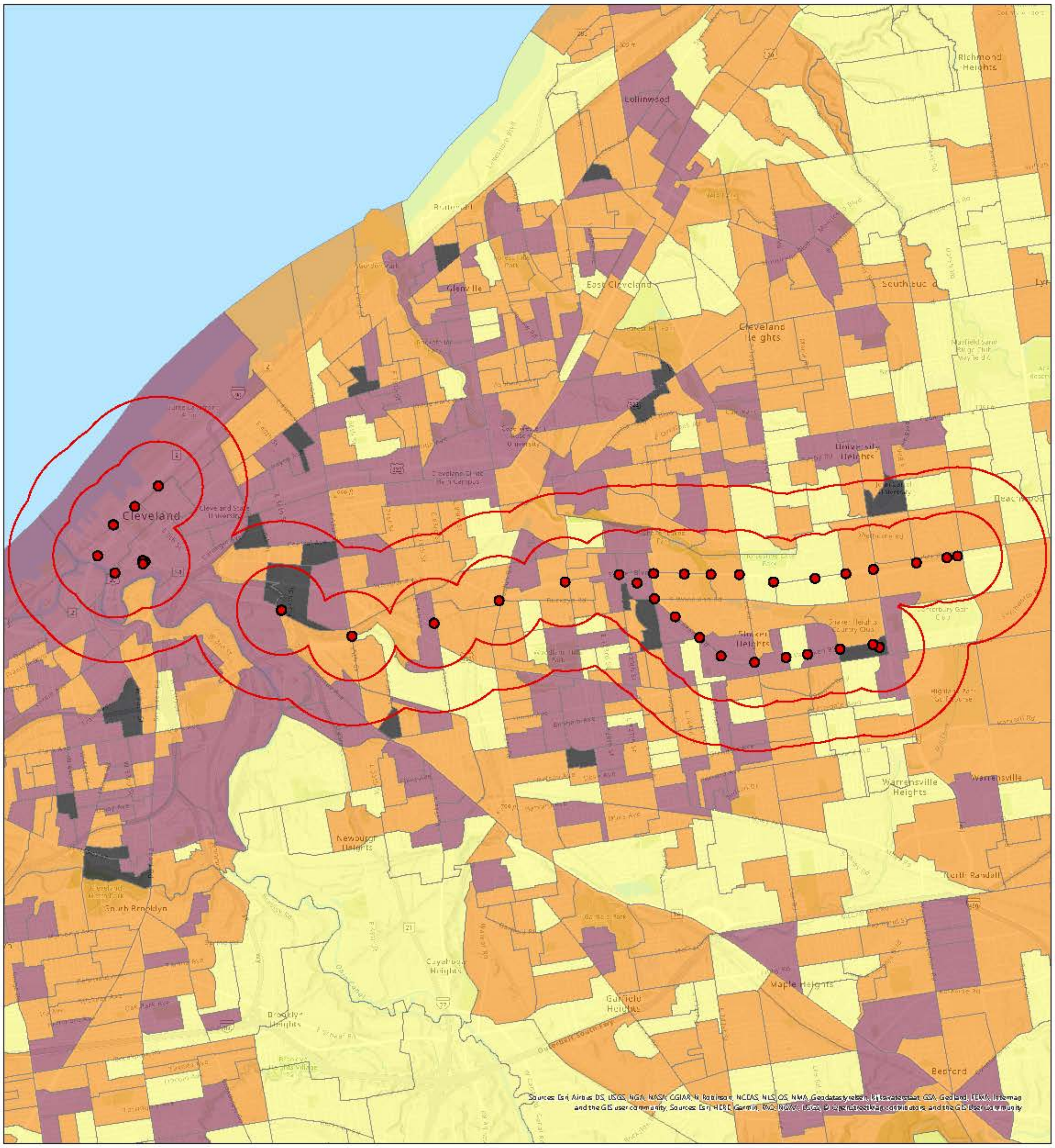
Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

0 0.23 0.45 0.9 1.35 1.8 Miles

Station Typology for Light Rail Transit:
Charlotte-Concord-Gastonia, NC-SC

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

Miles
0 0.33 0.65 1.3 1.95 2.6



Station Typology for Light Rail Transit: Cleveland-Elyria, OH

Buffers: Half & 1 Mile

LRT Buffers

Station Types

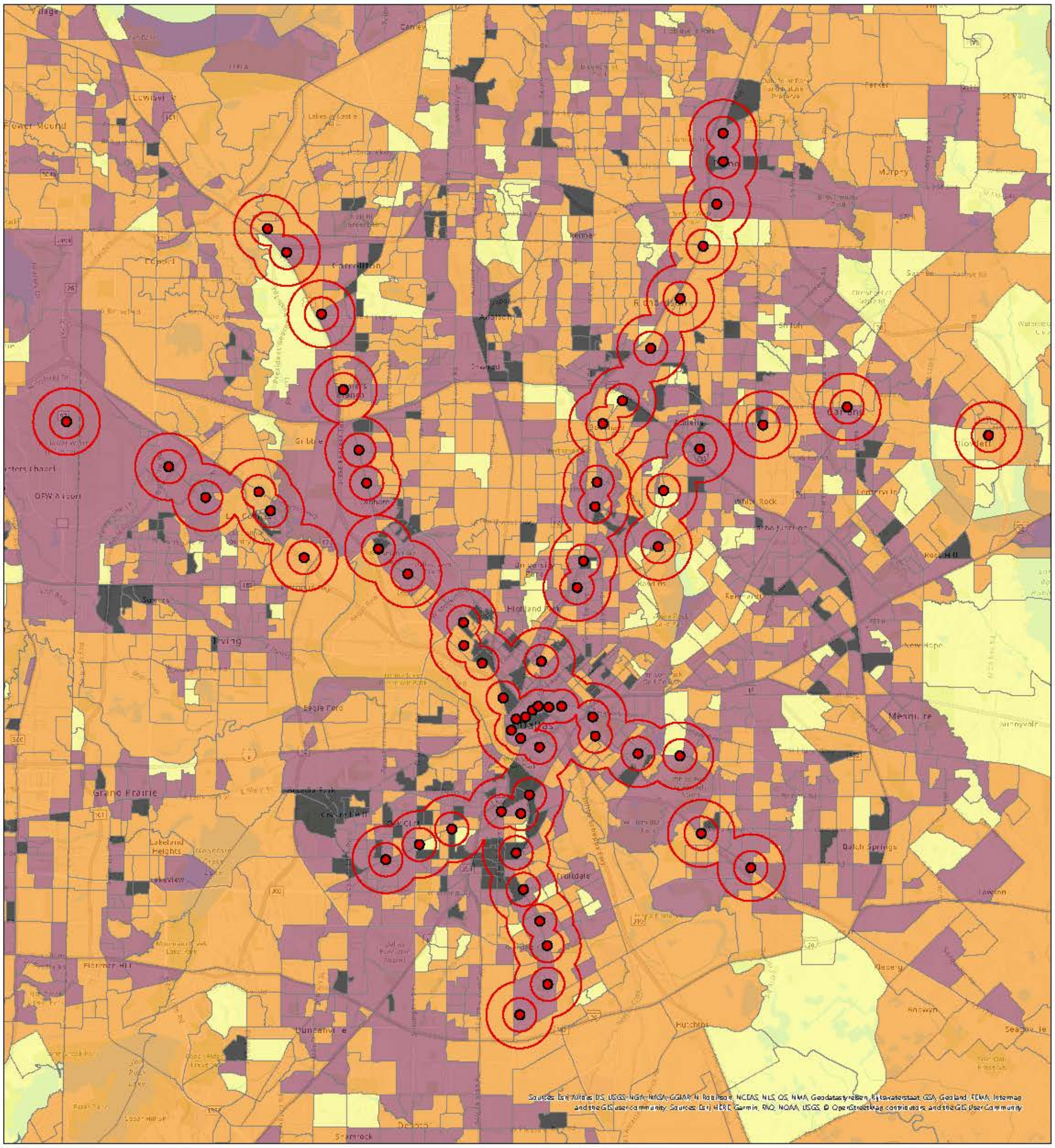
High MA

Mod MA

Low MA

Poor MA

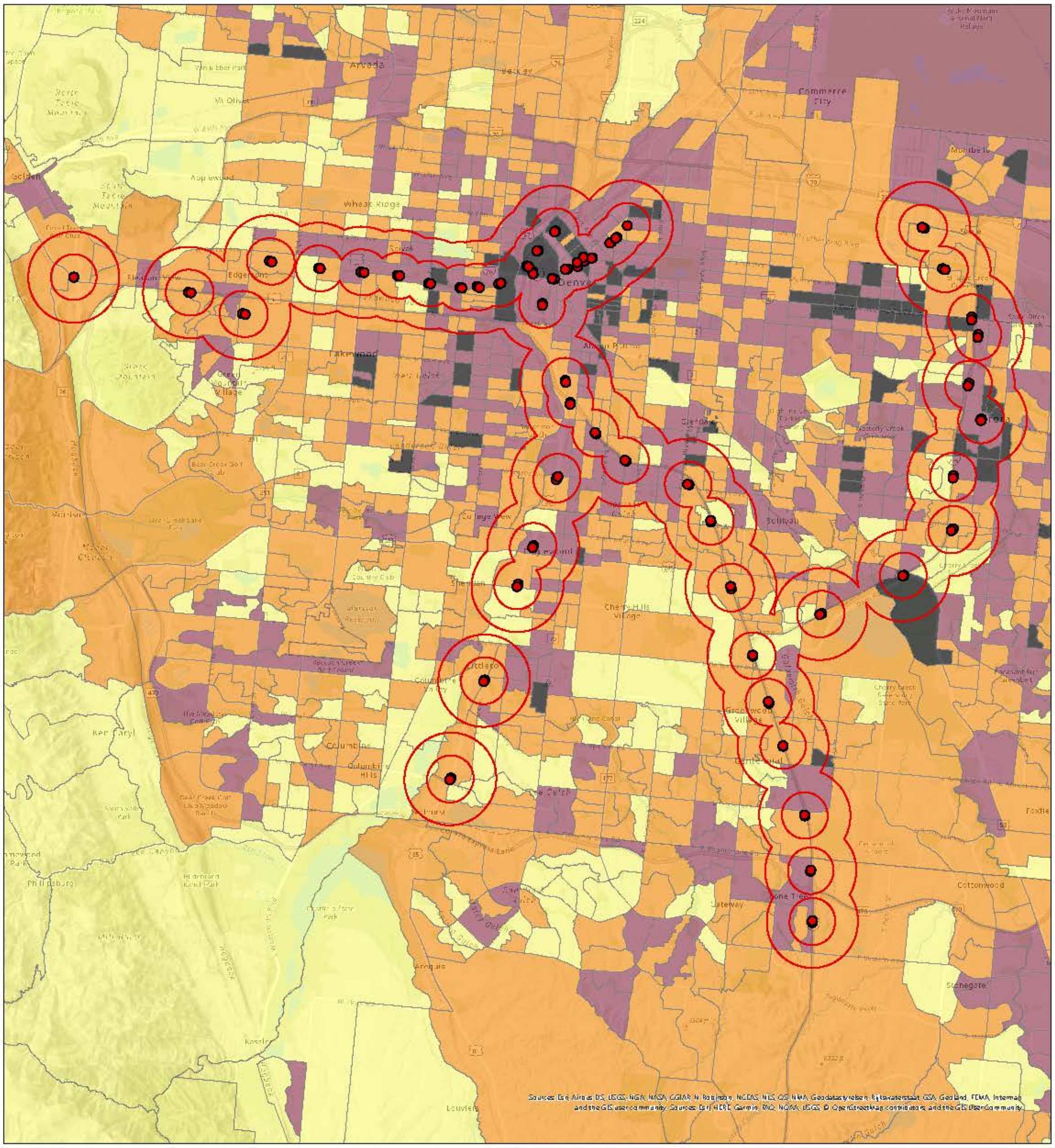
0 0.380.75 1.5 2.25 3 Miles



Station Typology for Light Rail Transit:
Dallas-Fort Worth-Arlington, TX

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

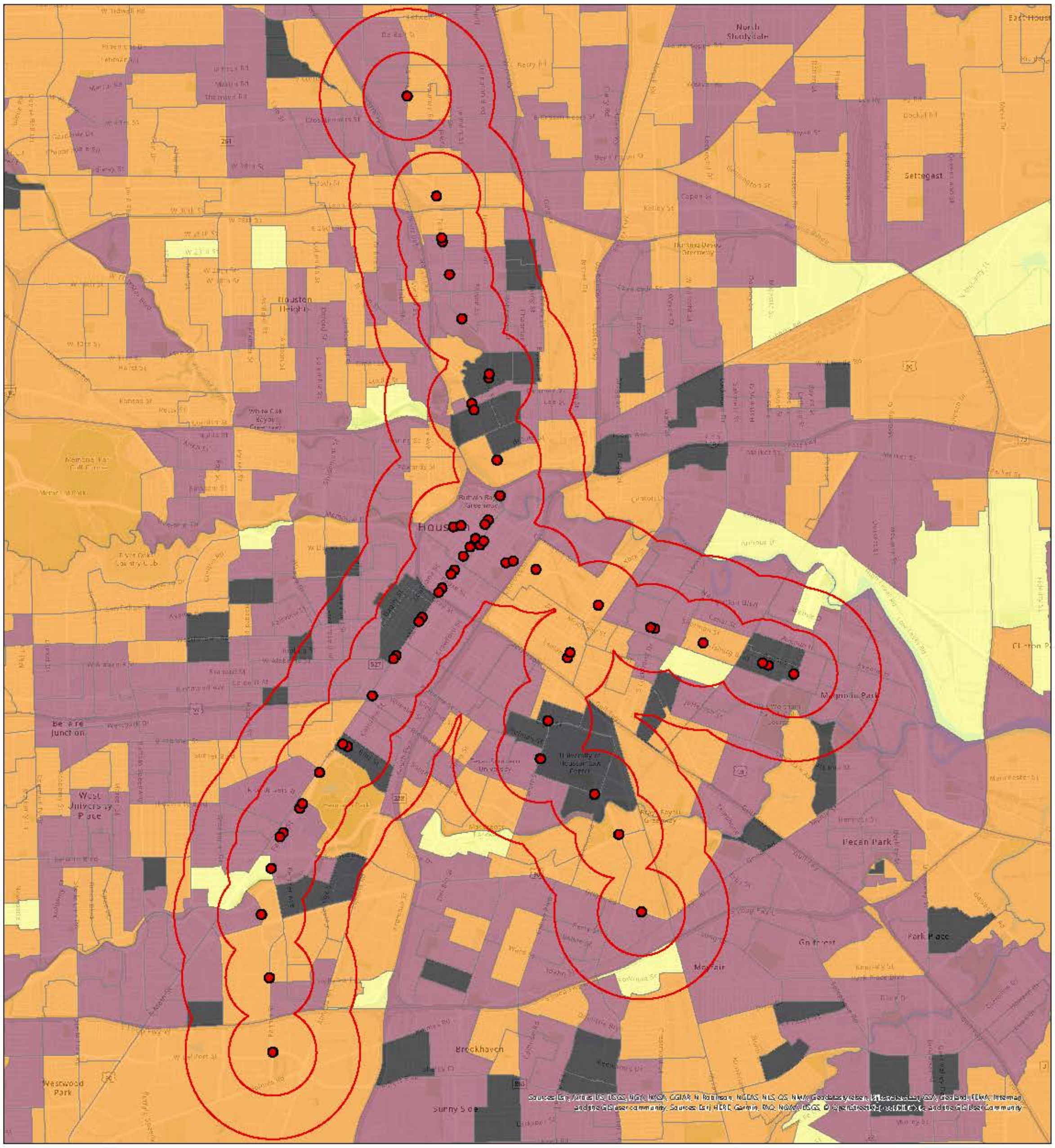
0 1 2 4 6 8 Miles



Station Typology for Light Rail Transit:
Denver-Aurora-Lakewood, CO

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

0 0.75 1.5 3 4.5 6 Miles

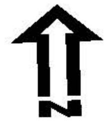


Station Typology for Light Rail Transit:
Houston-The Woodlands-Sugar Land, TX

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

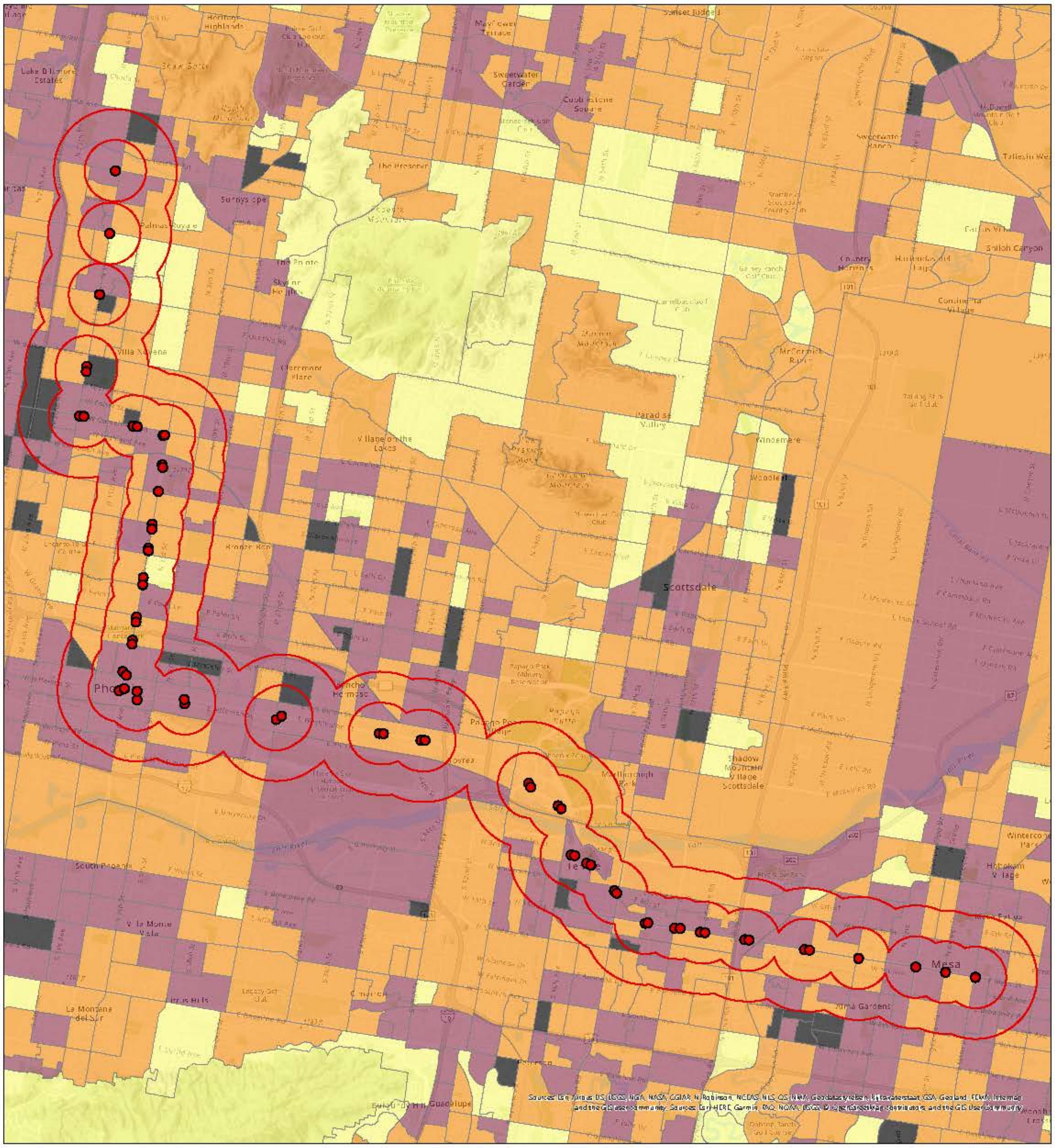
0 0.4 0.8 1.6 2.4 3.2 Miles

Station Typology for Light Rail Transit:
Minneapolis-St. Paul-Bloomington, MN-WI



Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

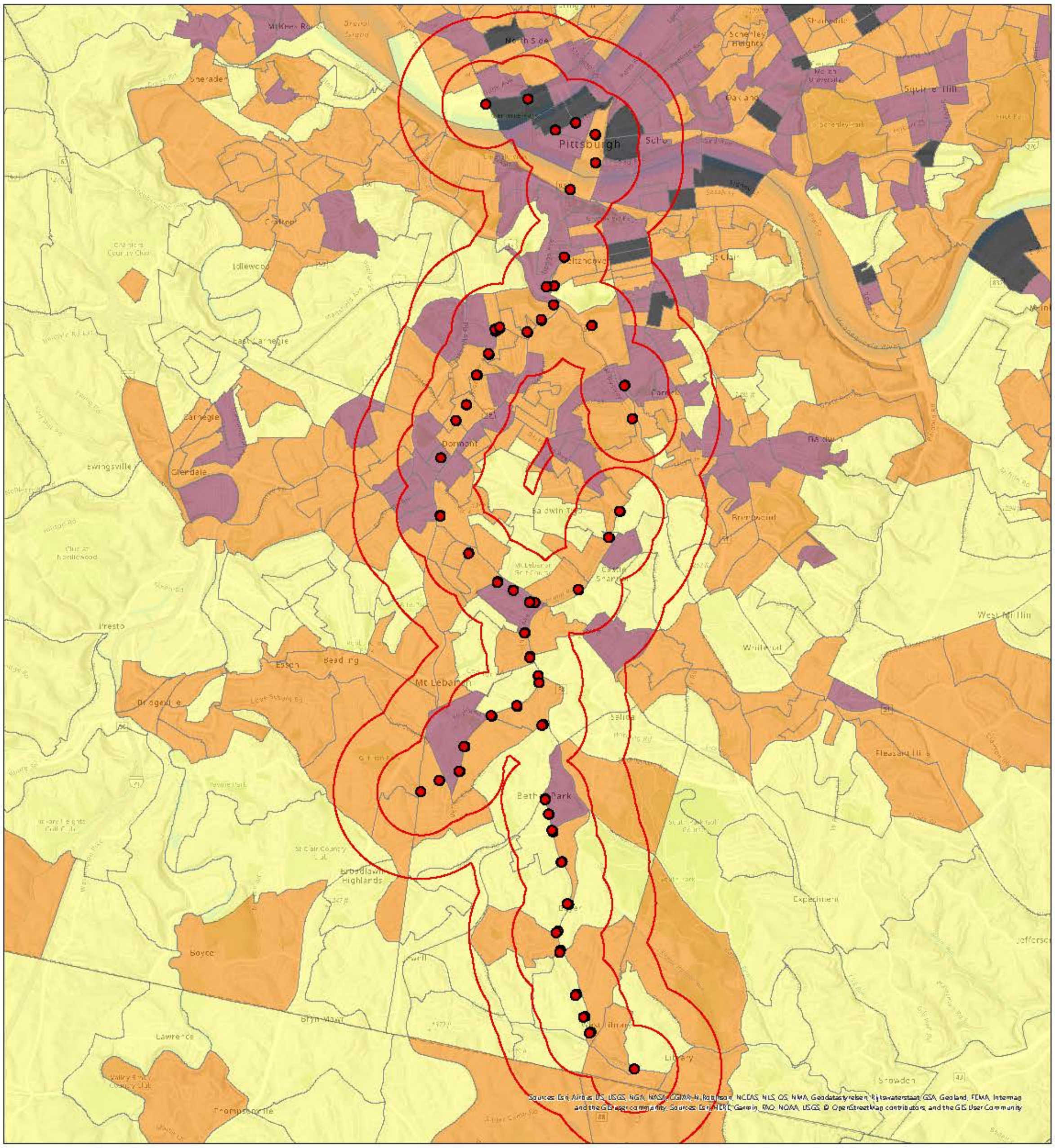
0 0.38 0.75 1.5 2.25 3 Miles



Station Typology for Light Rail Transit:
Phoenix-Mesa-Scottsdale, AZ

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

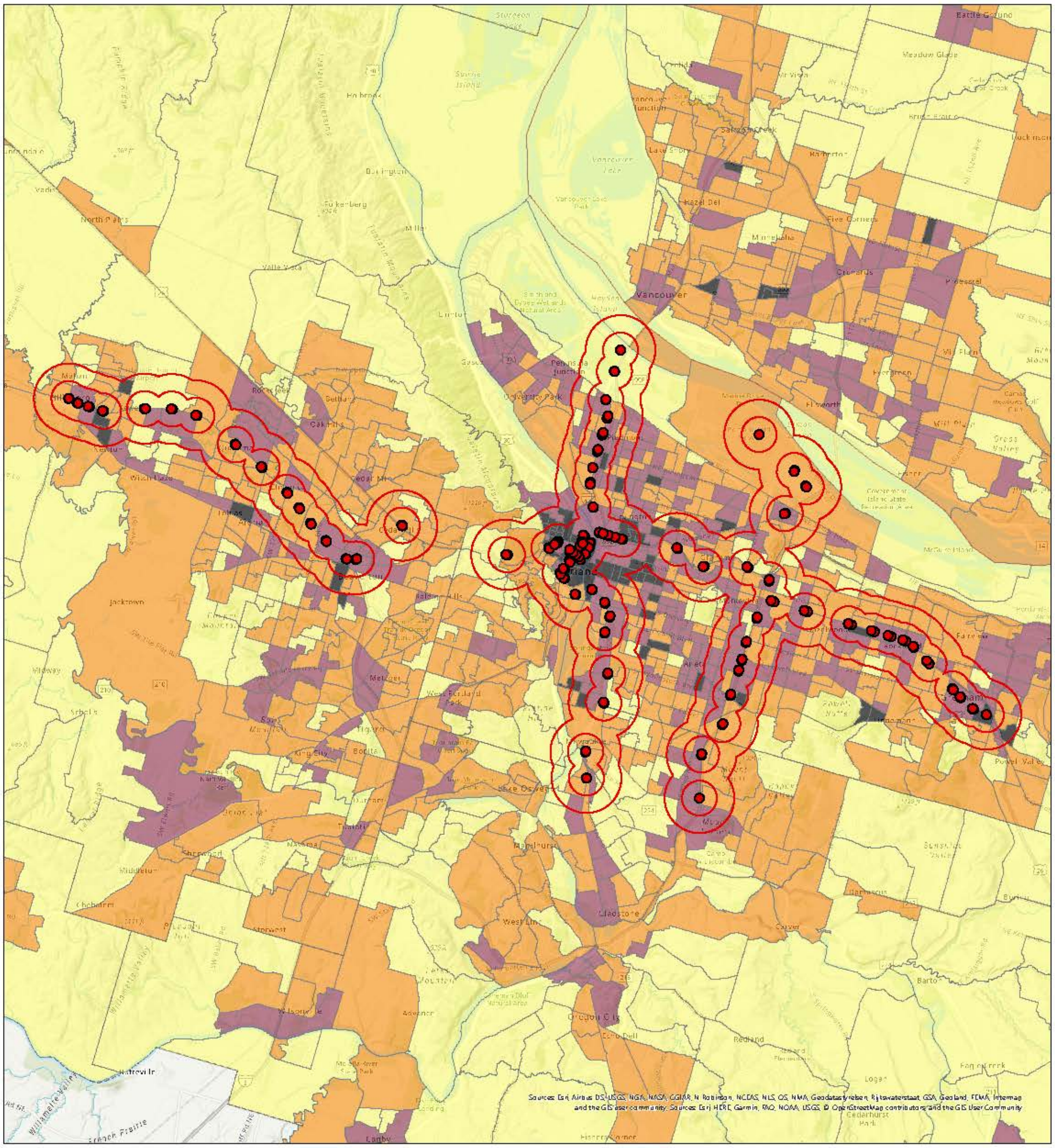
0 0.5 1 2 3 4 Miles



Station Typology for Light Rail Transit:
Pittsburgh, PA

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

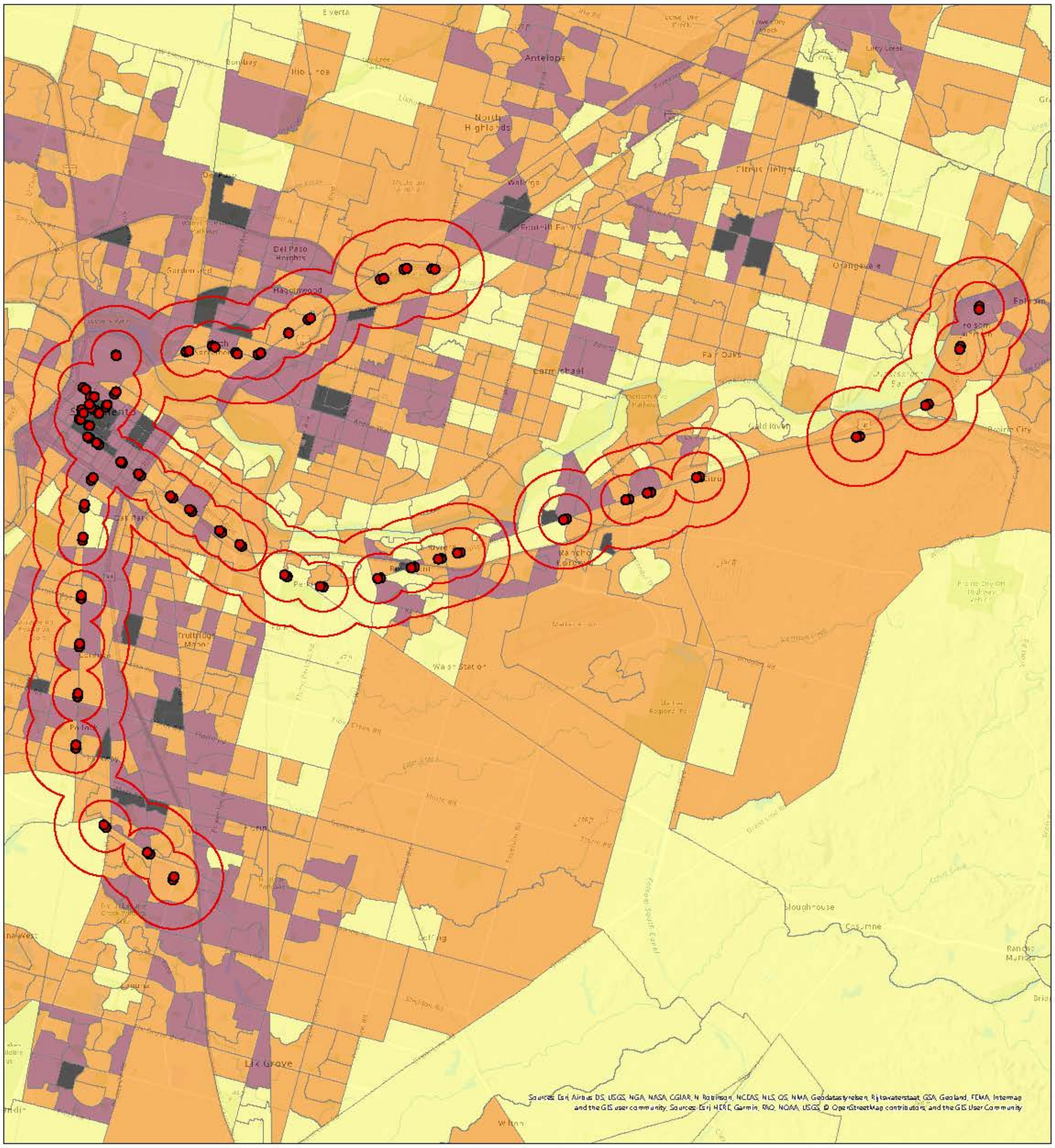
0 0.4 0.8 1.6 2.4 3.2 Miles



Station Typology for Light Rail Transit:
Portland-Vancouver-Hillsboro, OR-WA

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

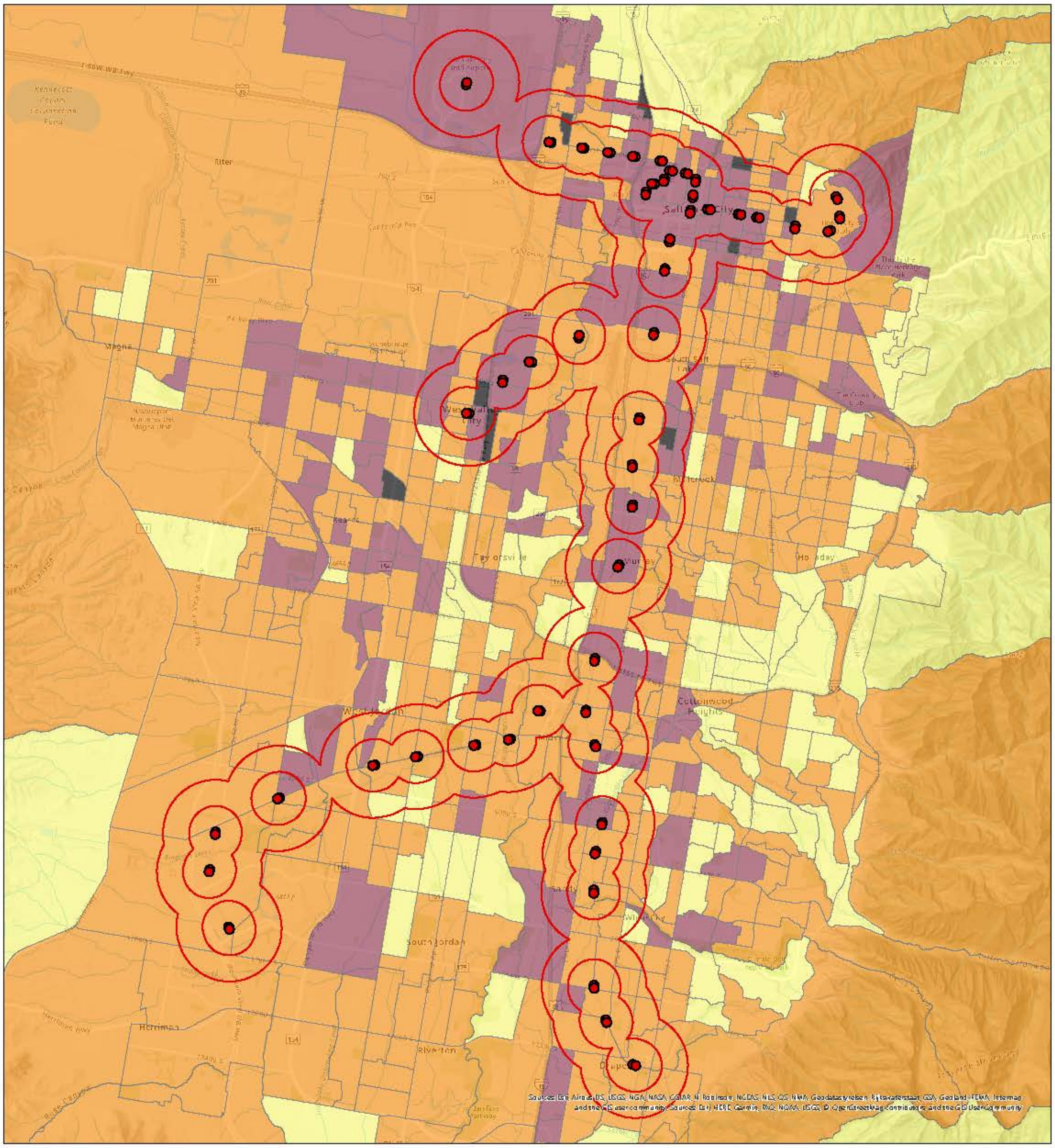
0 1 2 4 6 8 Miles



Station Typology for Light Rail Transit:
Sacramento--Roseville--Arden-Arcade, CA

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

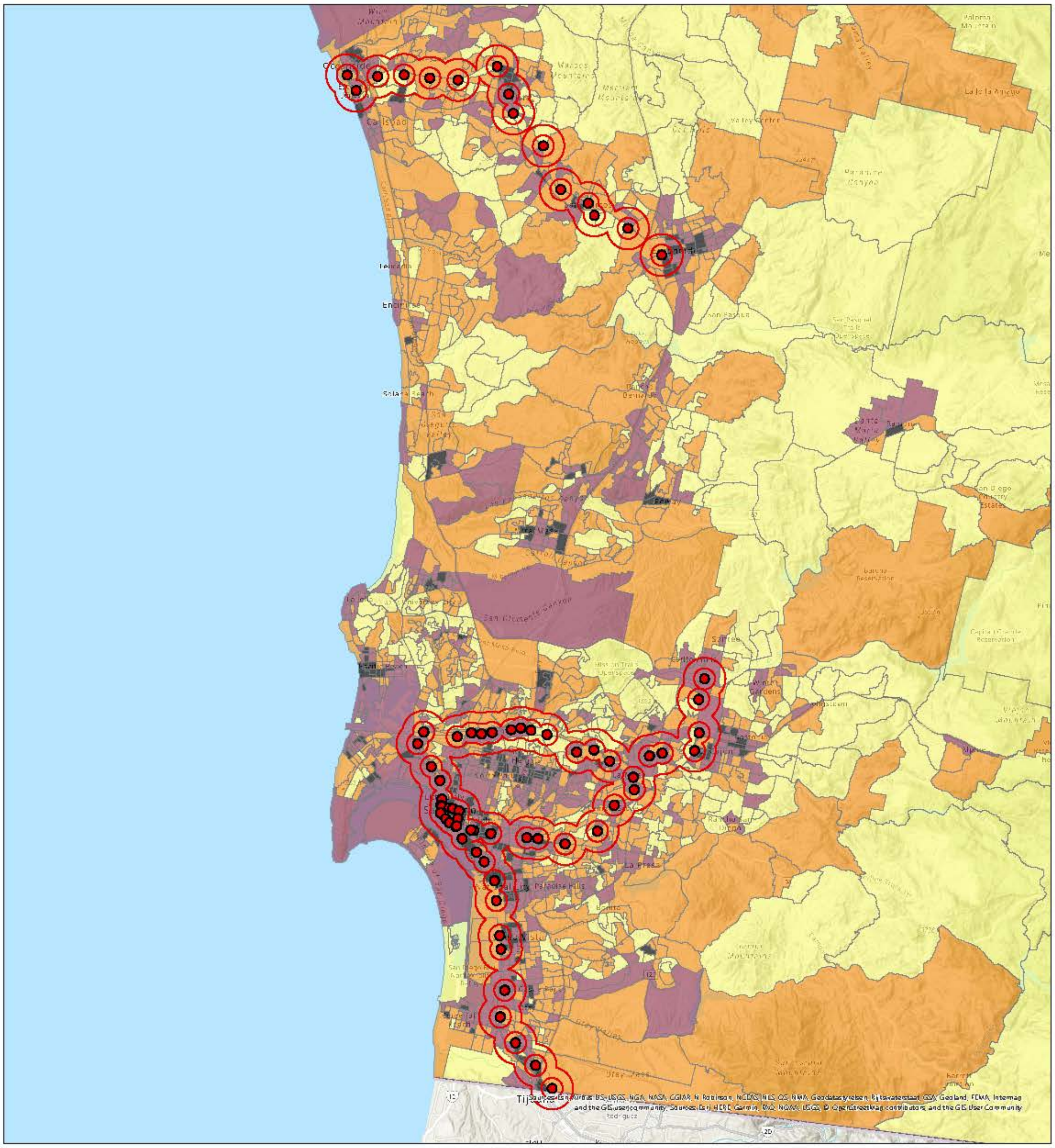
Miles
0 0.5 1 2 3 4



Station Typology for Light Rail Transit:
Salt Lake City, UT

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

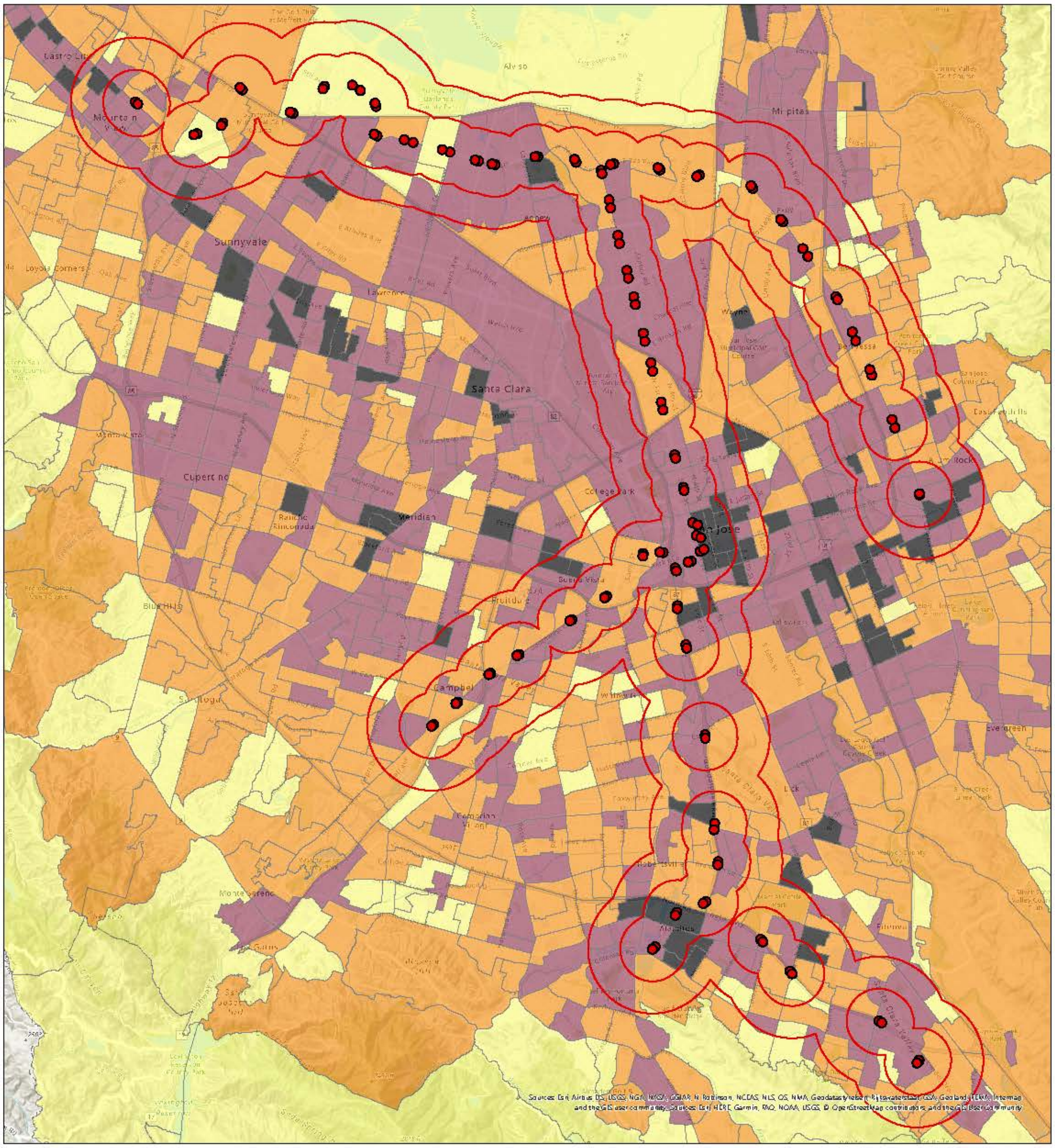
0 0.5 1 2 3 4 Miles



Station Typology for Light Rail Transit:
San Diego-Carlsbad, CA

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

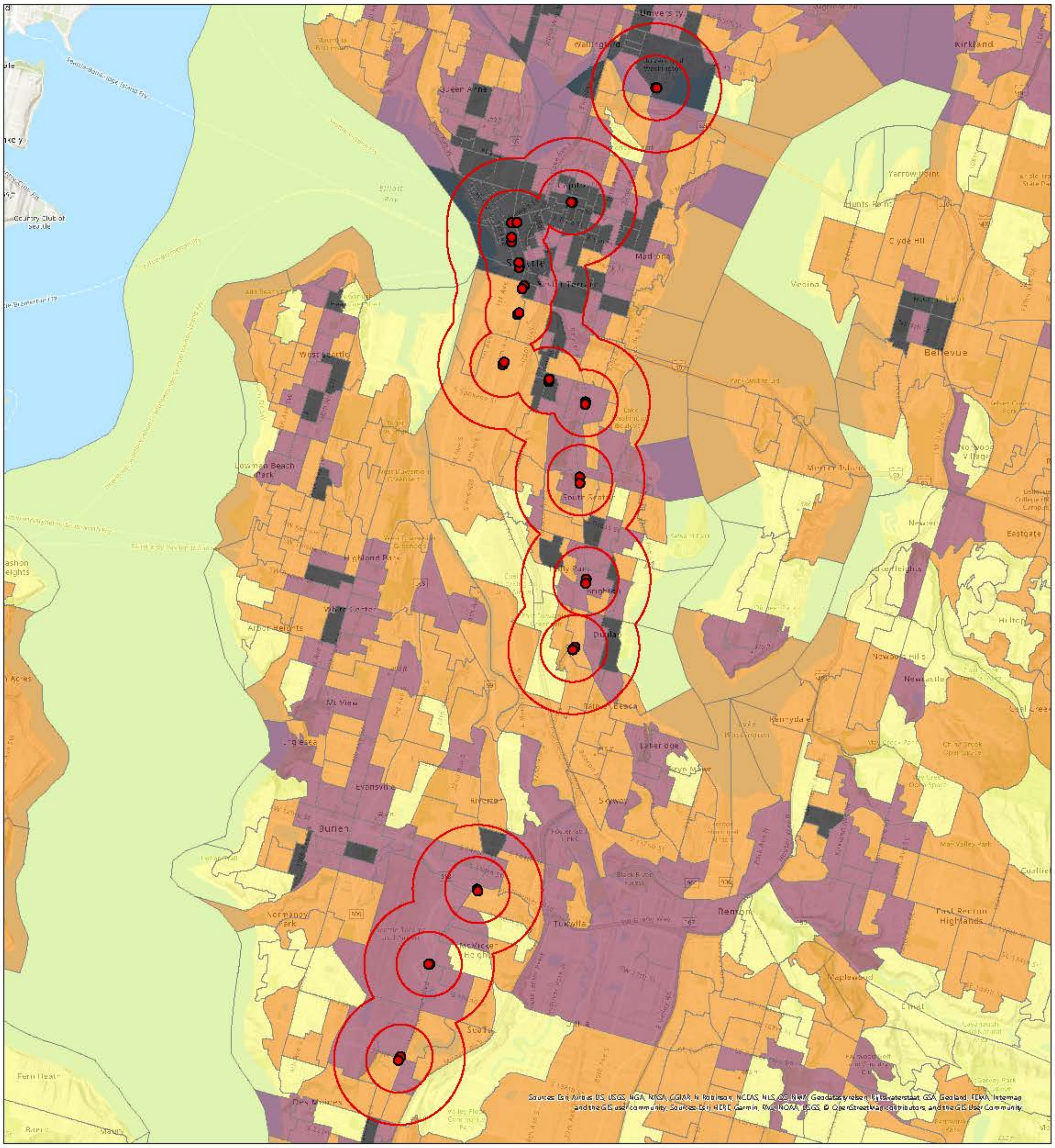
0 1.5 3 6 9 12 Miles



Station Typology for Light Rail Transit:
San Jose-Sunnyvale-Santa Clara, CA

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

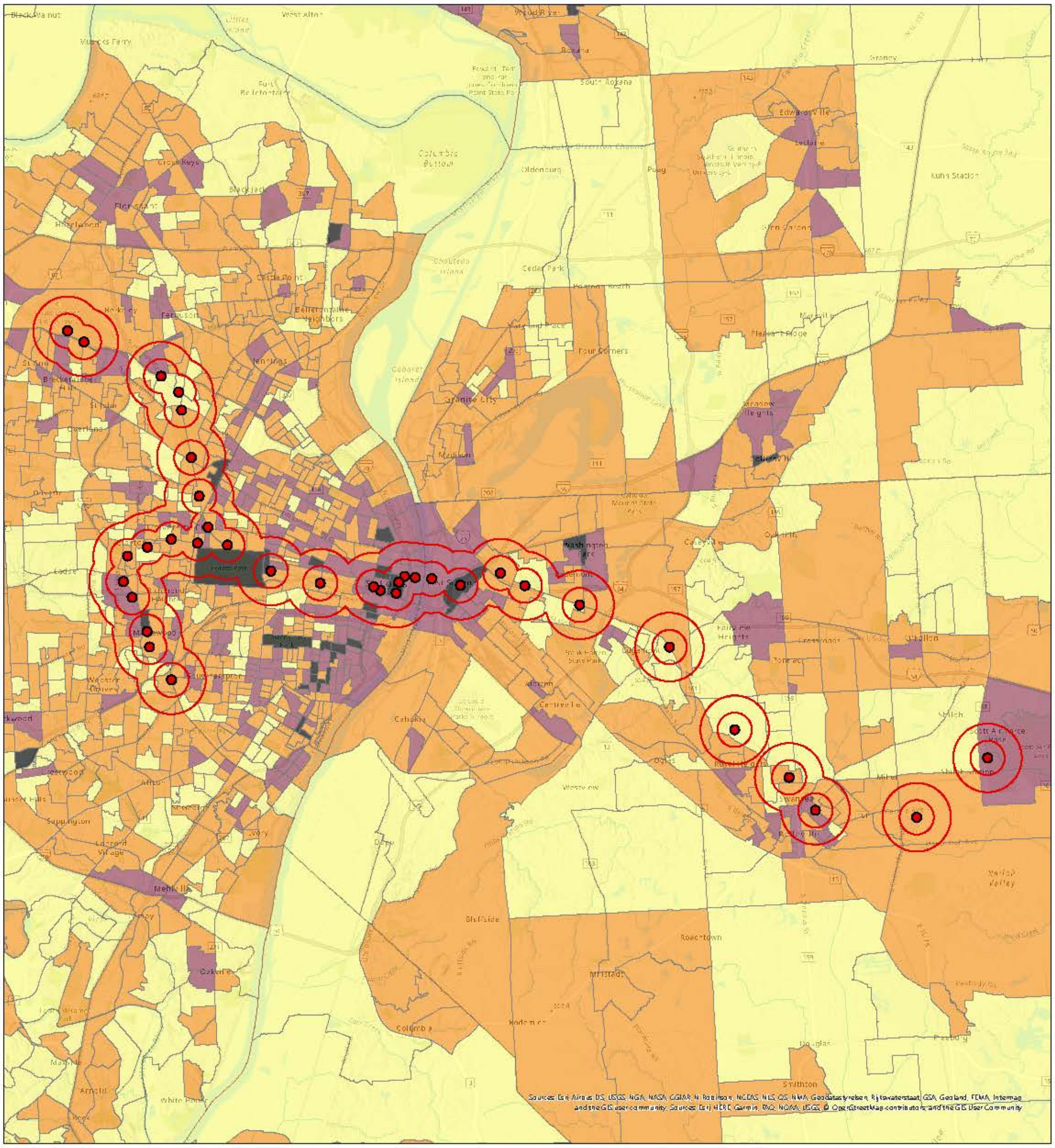
0 0.5 1 2 3 4 Miles



Station Typology for Light Rail Transit:
Seattle-Tacoma-Bellevue, WA

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

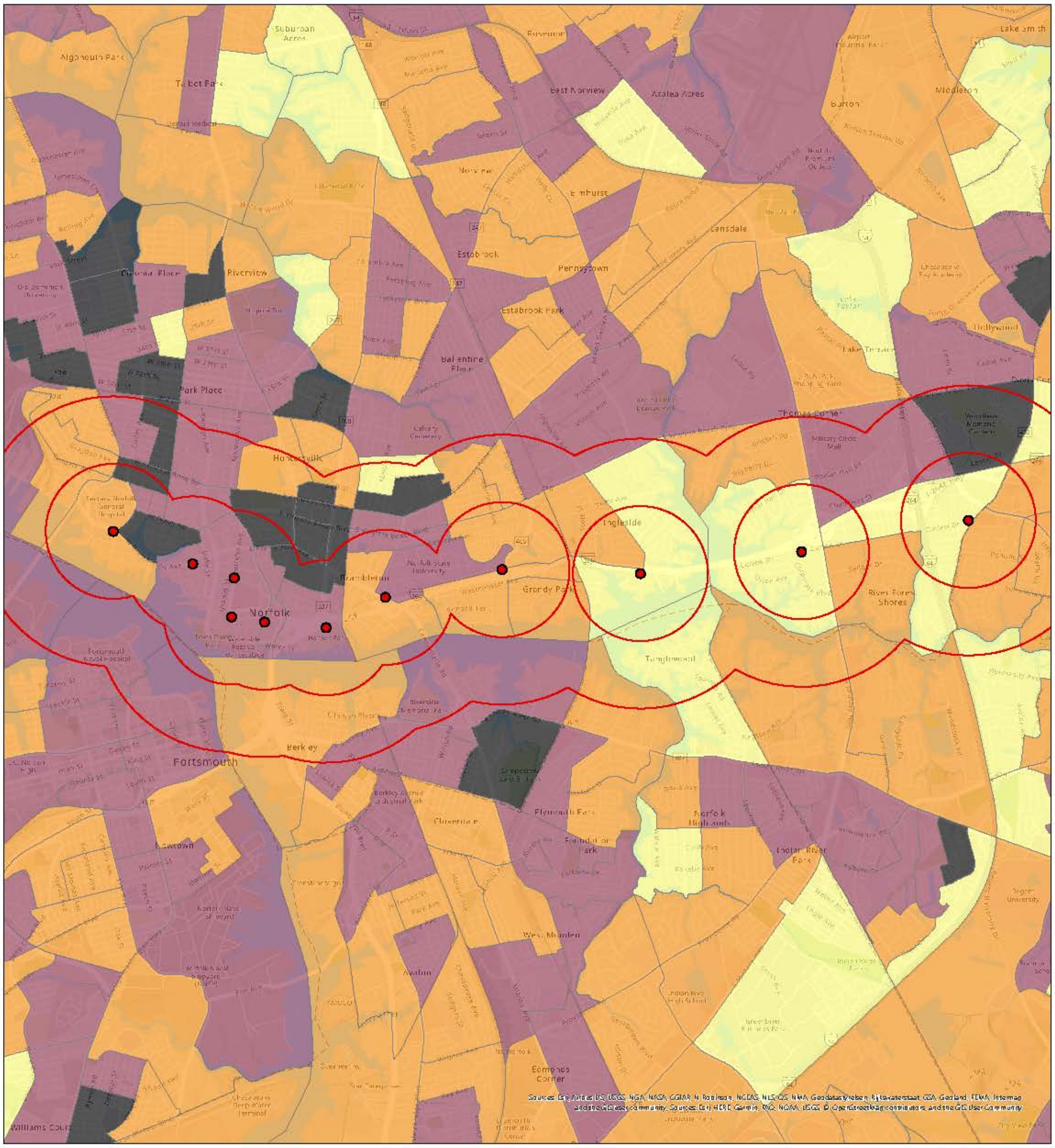
0 0.5 1 2 3 4 Miles



Station Typology for Light Rail Transit:
St. Louis, MO-IL

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

Miles
0 1 2 4 6 8



Station Typology for Light Rail Transit:
Virginia Beach-Norfolk-Newport News, VA-NC

Buffers: Half & 1 Mile
LRT Buffers
Station Types
High MA
Mod MA
Low MA
Poor MA

N

0 0.25 0.5 1 1.5 2 Miles