Bikeability and the Twenty-Minute Neighborhood

How Infrastructure and Destinations Influence Bicycle Accessibility

By Nathan McNeil

Contact: nathan.mcneil@gmail.com; http://nathanmcneil.wordpress.com

Master of Urban and Regional Planning, Portland State University

June 4, 2010

Blank Page

Acknowledgements

Many thanks to Rex Burkholder and Lydia Rich for supporting bicycle and pedestrian research at Portland State University and for encouraging sustainable transportation in the Metro region. I owe much gratitude to Professor Jennifer Dill for her support, assistance and encouragement on this project and throughout my time in the Master of Urban Regional Planning program. To Lynn Weigand for her support and feedback on this project and for bringing opportunities to Portland State students to study and work in the bicycle and pedestrian planning field through the Initiative for Bicycle and Pedestrian Innovation.

Blank Page

Bikeability and the Twenty-Minute Neighborhood:
How Infrastructure and Destinations Influence Bicycle Accessibility

By Nathan McNeil

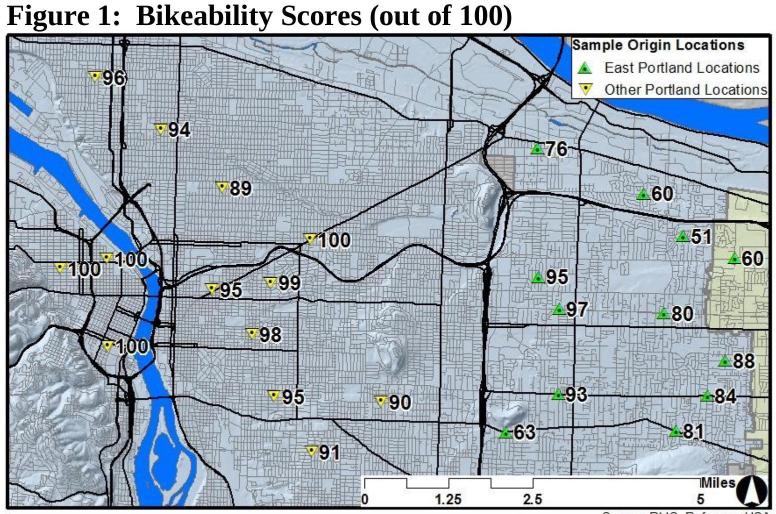
Table of Contents

Blank Page

Executive Summary

The "20-minute neighborhood" is often thought of as a place wherein daily needs can be met within a walkable area. With Portland's recently adopted goal of increasing bicycle ridership to a 25% mode share by the year 2030, efforts to incorporate bicycles into this concept will become increasingly important. However, limited research has examined the mix of physical infrastructure and land uses that constitute a "bikeable" neighborhood or community. This paper explores a methodology for assessing a neighborhood's bikeability based on its mix of infrastructure and destinations – essentially the 20-minute neighborhood for bicycles. The area of outer east Portland, an area east of 82nd Avenue with substantially lower bicycling rates than other Portland neighborhoods, is used as a case study and compared to an assessment of neighborhoods that are considered to be bike-friendly (downtown, inner-east and north Portland). The paper examines prior approaches to assessing bikeability, details a new method to measure bikeability, presents the findings, and explores what impact expected or potential transportation and land use changes might have on bikeability.

Figure 1: Bikeability Scores (out of 100)



Source: RLIS, ReferenceUSA

The findings confirmed that, taking into account route infrastructure and destination accessibility, east Portland is considerably less bikeable than inner Portland locations. Figure 1 shows current bikeability scores derived in this paper. East Portland locations had an average bikeability score of 76 (out of 100) compared to an average of 96 for inner Portland neighborhoods. The impact of planned bicycle facility improvements was found to increase bikeability scores in east Portland; however, those locations still lagged far behind other Portland neighborhoods primarily due to lower street connectivity and fewer destinations. Areas where cyclists' needs were underserved due to a lack of access to a specific type of destination are identified as opportunities for considering new shops, services, or developments that could exert a positive influence on a neighborhood's bikeability; for example, several strategically placed grocery stores would increase bikeability in east Portland.

Introduction and Background

Dense, well-connected neighborhoods where residents can access services, shopping, transit, restaurants and employment centers without the use of a car are often lauded as an important next step in urban and suburban development. These goals have come up in the aftermath of decades of federally-subsidized automobile and highway-centric planning that encouraged development of cheap land on the periphery of metropolitan areas, tore up existing urban streetcar systems, and disconnected urban neighborhoods with highway projects. Given that much of the current urban landscape was created for the automobile, it is no surprise that most people view the car as a necessity.

However, many places are now embracing the idea that auto-dependent cities are not sustainable from an environmental, economic and national-security standpoint. In recent years, planners have grappled with many of the problems left by years of this kind of auto-oriented planning. Auto-dependent cities are damaging quality of life - poor air quality is increasingly impacting public health; traffic jams are siphoning off hours that could be spent with families, exercising, working, or any number of other productive or relaxing activities; disconnected street systems are preventing us from interacting with our neighbors or shopping in local stores.

Many communities struggle to recreate the kinds of neighborhoods that sprang up prior to the age of the automobile. The existing street-grids and overall landform remain from the before the postwar highway era in some places; however, many areas were divided up by highway construction or built after that time, including most suburban neighborhoods. Even in areas that retain an existing land-use pattern from a pre-automobile age and have characteristics of a non-automobile dependent neighborhood, uses and infrastructure have adapted to automobile. For example, many urban and suburban residents drive out to complexes of mega-stores, causing local shops and services to dwindle. Efforts to recreate neighborhoods where residents can manage (and want to manage) without cars usually focus on providing transportation options, attracting a diversity of uses (including all essential uses) and attaining a certain threshold of population density within a limited space.

The area of outer east Portland provides an interesting case study of a community largely shaped by the automobile, but struggling to become increasingly urban and decreasingly auto-dependent. Figure 2 shows the area identified in the 2009 East Portland Action Plan as constituting East Portland, which was described in the plan as an area that is “transitioning from its once suburban and semi-rural form into an increasingly urban community - a fact that brings both benefits and challenges to the area.”[1] While most of the streets are rectilinear and the Portland street grid is noticeable in places, there are also many neighborhoods that were developed without connectivity in mind and the area is generally dependent on a hierarchical street system with limited through streets. Among the goals expressed in the 2009 plan are to improve the area’s land use mix by encourage mixed-use development and multi-use commercial areas, to increase the safety and accessibility of bicycling, and to improve connectivity.[2] Currently, bicycle mode splits are quite low. As seen in Figure 3, most areas of east Portland have bicycle mode splits (albeit for commuting trips) of less than 0.5% as of the 2000 census.

Figure 2: East Portland as defined in the East Portland Action Plan

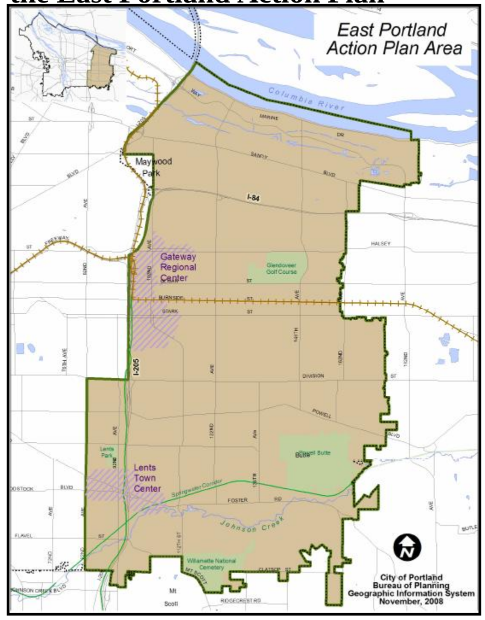
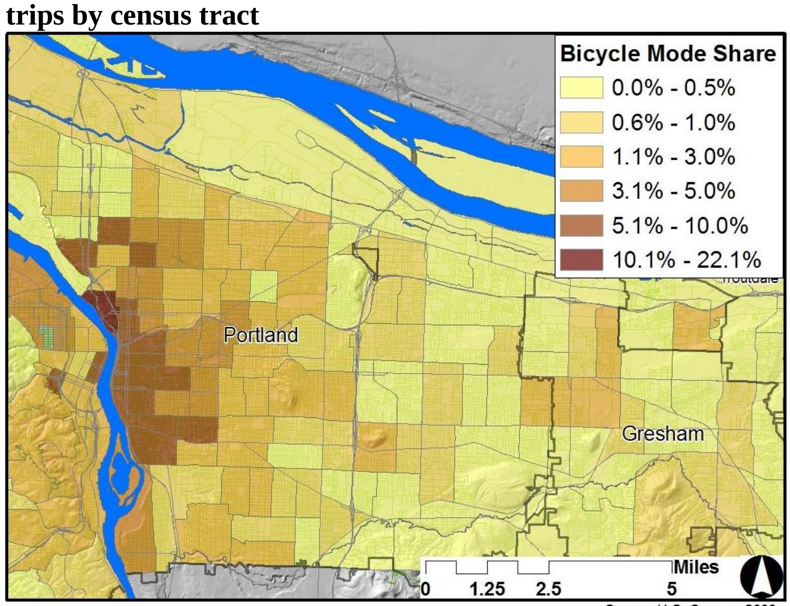


Figure 3. 2000 Portland bicycle mode share for commute trips by census tract



Source: U.S. Census, 2000

---

[1] City of Portland, Bureau of Planning and Sustainability. *East Portland Action Plan*. 2009. Accessed online 5/25/10 at http://www.portlandonline.com/shared/cfm/image.cfm?id=214221. Pg 1.

[2] *East Portland Action Plan, pg 15.*

History and Literature Review

Walkability in the early 20th Century

Prior to the rise of the automobile and subsequent auto-centric city layout, many cities were composed of walkable, dense neighborhoods connected by centrally located transit stations. Out of necessity and ease, neighborhoods contained a multitude of uses. Steadily, advances in technology, from roads to street carriages to subways, increased the distances that were manageable yet still allowed people to carry out these essential tasks. With cars, the development of a highway system and the explosive post-war growth of the suburbs, the calculus of the neighborhood changed dramatically. People could afford a private house with a back yard in a suburb and still commute into jobs in city centers. The car allowed cities to become spread out and forced planners to actively plan for walkability, rather than having it be a natural side-effect of urban development. In 1929, at the end of the decade in which cars asserted themselves as a force in the urban landscape, Clarence Perry, working with the Regional Plan of New York, articulated an ideal neighborhood unit based on a quarter mile walk around an elementary school, which would be the primary meeting point for many civic activities.[3] Perry envisioned that people would walk within the unit limits, but would take cars to travel beyond the unit. Since arterials would surround the unit, walking and bicycling between neighborhood units was challenging.[4]

The twenty-minute neighborhood concept in Portland

Toward the end of the 20th century, a number of attempts were made to incorporate walkability into neighborhood planning, from New Urbanism to Transit-Oriented Development to Complete Streets. Portland development firm Gerding Edlin has marketed the idea of a 20-minute neighborhood as a key consideration and quality of life decision. In marketing mixed-use projects, they emphasize a principal of easy access, though not exclusively walkability: "Imagine being able to do all of the necessary and enjoyable things that make life great within 20 minutes of your home .

---

[3] Perry, Clarence. *The Neighborhood Unit*, 1929.
[4] Peter Hall's *Cities of Tomorrow* (Third Edition, Blackwell Publishing, 2002) provides a solid overview of these and other 20th century planning topics.

. . Twenty minutes on foot is ideal, but 20 minutes by transit, bike or even auto is a reasonable goal."[5]

Portland's Bureau of Planning and Sustainability (BPS) is examining 20-minute neighborhoods as it updates the Portland Plan. In May 2009, BPS issued a status report aimed at considering how the concept of the 20-minute neighborhood should inform the Portland Plan update.[6] The report defines the 20-minute neighborhood as "another name for a walkable environment." In considering if a neighborhood should be considered a 20-minute neighborhood, the report reasons that under safe, conducive conditions, 20 minutes translates to about a quarter to half a mile – a consideration of the destinations and density of the neighborhood in that limited area would determine if it was such a walkable neighborhood. The status report briefly considers how bicycles impact this understanding of a 20-minute neighborhood, asking if "bicycle and transit access [can] enlarge the market area for neighborhood serving services without increasing density."

In 2009, a group of Portland State Masters of Urban and Regional Planning (MURP) students conducted a workshop project exploring the applicability of the Bureau of Planning and Sustainability's (then Bureau of Planning) concept of the 20-minute neighborhood to a specific place - West Portland Park.[7] The group also sought to use the concept "as a framework to initiate community discussions about the neighborhood's unique assets and challenges in order to build the connections and information necessary to actively engage in future planning efforts." The PSU group found that the concept of a 20-minute neighborhood was useful in:

- Identifying shortcomings and articulating goals for the neighborhood;
- Framing a conversation around the linkage of land use and transportation access in neighborhood planning; and,
- Transitioning to thinking about access and destinations and away from a focus on the importance of boundaries (such as neighborhood or city lines).

Although agencies and firms in Portland have adopted the phrase "20-minute neighborhood," the definition of the term remains unclear. Is it better understood as a distance (e.g. a quarter mile, half mile or something else) or strictly a time of travel (20 minutes of traveling be it by foot, bike, transit or other means)? Or does it refer to how far people are willing to travel by foot

---

[5] Gerding Edlen, *Principles of Place*, Marketing Brochure, 2007. Accessed online 5/24/2010 at http://www.gerdingedlen.com/files/pdf/principles_of_place.pdf

[6] City of Portland Bureau of Planning and Sustainability. *Portland Plan Status Report: 20 Minute Neighborhoods*. May 2009. Accessed online 6/1/2010 at http://www.portlandonline.com/portlandplan/index.cfm?a=246917&c=46822

[7] Intersect Planning, "20 Minutes in West Portland Park." Portland State University Master of Urban and Regional Planning Workshop, June 2009.

and on a bike, with or without connections to transit? To begin to address these questions, it is necessary to consider what constitutes a walkable or bikeable distance.

What is "walkable"?

How far will people walk?

A meta-study of attributes of walkable environments found that, of seven studies reviewed, five argued land use mix (e.g. the destinations in a neighborhood) was a key attribute, while another five argued that street network and connectivity were key attributes.[8] Residential density was the only attribute cited by a greater number of the studies (six). However, land-use mix and residential density are arguably highly correlated: as residential density leads to more destinations, the land-use mix becomes more conducive to walking as a mode of transportation.

A study by Moudon et al (2006) found that environmental attributes positively associated with walking included higher residential density and smaller street-blocks around home, as well as shorter distances to food and daily retail facilities from home.[9] The study identified average distances that people were willing to walk to reach eating/drinking establishments and grocery stores as being 860 and 1445 feet, respectively. A key question asked by the study was "What are the neighborhood destinations?**"** Based on percent of survey respondents that walk to locations on a daily basis, the results were grocery stores (45.9%), non-fast food restaurants (23.0%), drug stores (19.2%), convenience stores (16.3%), banks (15.8%), café/coffee shops (15.0%), and post offices (12.8%). In a separate analysis underway at Oregon Public Health Division's Environmental Public Health Tracking Program, results suggest that 1650 feet constitutes a reasonable assumption of the distance people would be willing to walk to a transit stop, based on an average walking speed of 2.75 feet/second (on the slow end for older adults) and a walk time of 10 minutes (the average time people who walk to rail stops spend on that walk).[10] These sample distances, ranging from 860 feet for grocery stores to 1650 feet for transit stops, fall on either side of the 1320 feet (quarter mile) metric often assumed as walkable.

---

[8] Mantri, Anupama. *A GIS Based Approach to measure Walkability of a Neighborhood*. March 2008, Master's Thesis at University of Cincinnati, pg 28.

[9] Moudon, Anne Vernez, Chanam Lee, Allen D. Cheadle, Cheza Garvin, Donna Johnson, Thomas L. Schmid, Robert D. Weathers, and Lin Lin. "Operational Definitions of Walkable Neighborhood: Theoretical and Empirical Insights". Journal of Physical Activity and Health 2006, 3, Suppl 1, S99-S117.

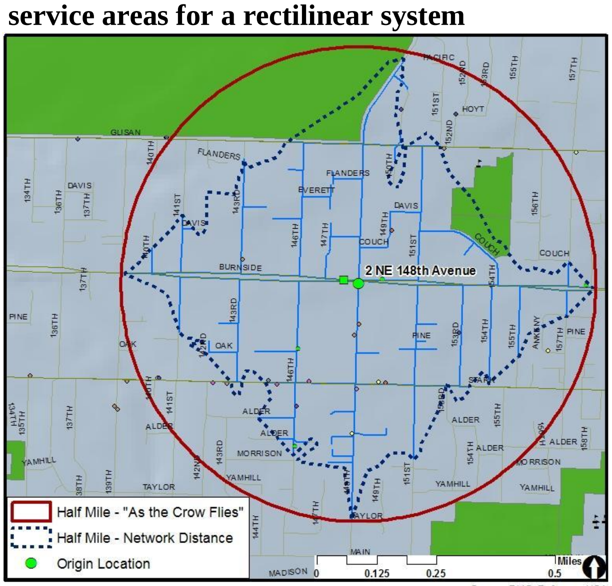
[10] Costantino, Daniel. Oregon Department of Human Services, Office of Environmental Public Health, Environmental Public Health Tracking, Personal communication, 6/1/ 2010.

Scoring walkability: Walkscore

One commonly used resource that places a "score" on a place's walkability is the website Walkscore. The site uses a proprietary program that analyzes destinations within a mile of a given starting address. Walkscore's scoring program apportions points based on a destination's proximity to the origin, with full points given (in a subcategory) for locations within 0.25 miles of the starting point, and partial points given until one mile is reached, after which no points are given. One problem with the Walkscore program is that it uses "as-the-crow-flies" calculations, rather than examining the actual street network. This approach is problematic because street network distances are often much longer and would therefore earn fewer points than as-the-crow flies distances, particularly with cul-de-sac or horseshoe style residential developments.

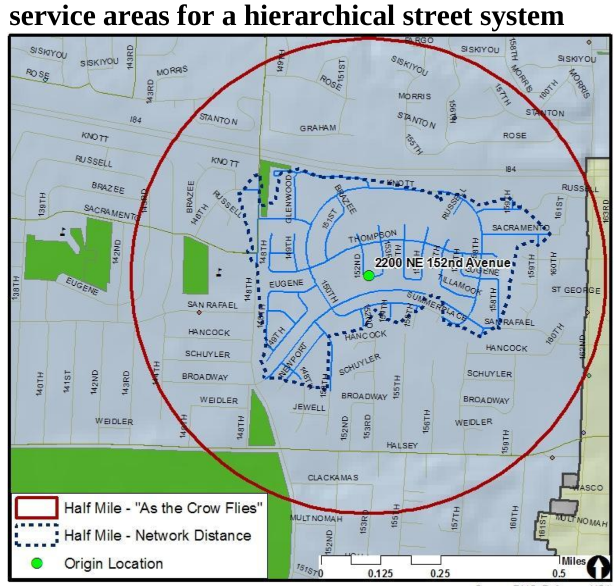
Figures 4 and 5 show two sample locations used in this study with half-mile barriers marked, both from an as-the-crow-flies standpoint (as Walkscore uses) and from a network standpoint (assuming that pedestrians and cyclists must take the existing route network). Areas with greater street connectivity (Figure 4 - left) have a larger service area than areas with fewer connected streets (Figure 5 - right). However, in neither case does the network service area cover nearly as much ground as the "as-the-crow-flies" calculation. Using the WalkScore method, which ignores network distances, street connectivity and route choice decisions, accessibility is likely exaggerated.

Figure 4: Network versus as-the-crow-flies service areas for a rectilinear system



Source: RLIS; ReferenceUSA

Figure 5: Network versus as-the-crow-flies service areas for a hierarchical street system



Source: RLIS; ReferenceUSA

What is "bikeable"?

How far will a cyclist go?

Cyclists are likely to want to access many of the same destinations as pedestrians; however because they can travel more quickly they may be willing to go further to reach those destinations. Using a simplified calculation that a cyclist travels at 10 mph, a 20 minute ride would enable the cyclist to travel 3.3 miles. However, like pedestrians, cyclists are likely willing to travel varying distances according to the individual cyclist, conditions and destination.

A 2008 study by Dill and Gliebe used GPS devices to track cyclists' activity.[11] GPS participants cycled an average of 6.2 miles per day and median of 4.9 miles per day. The median single trip distance was 2.8 miles, while median distances for trips other than to work or home varied from 1 to 2.1 miles. Applied to a 20-minute neighborhood, these distances may suggest that work locations can be a bit more spread out (2-4 miles from home) but that non-work destinations might need to be between zero and two miles from home to meet a functional definition of a 20-minute neighborhood.

The PSU study mostly consisted of currently regular cyclists and thus may be skewed toward more avid cyclists. Future new cyclists may have differing thresholds for distance and are more likely to be on the lower end of the spectrum. A 2002 study from the UK (Sully) asks "how far 'ordinary' cyclists are happy to use their bicycles before considering transferring to another form of transport."[12] The study argues that the distance most "ordinary" people are happy to cycle as part of an "ordinary" journey may be taken as around one third farther than the average distance cycled within a city (or within the trip purpose); applied to the Dill/Gliebe GPS bike study (with average non-work trip distances between one to just over two miles), these findings suggest that an ordinary cyclist would be willing to cycle roughly 1.33 to just over 2.66 miles to reach a destination.

Portland Bikeway Quality Index and Cycle Zone Analysis

Going beyond the question of how far a cyclist could or would cycle, the City of Portland has also conducted analyses of how suitable various neighborhoods are or could be for cycling.

---

[11] Dill, Jennifer and John Gliebe. "Understanding and Measuring Bicycling Behavior: A Focus on Travel Time and Route choice". Report No. OTREC-RR-08-03, Oregon Transportation Research and Education Consortium, December 2008.
[12] Sully, Alex. *How Far Are "Ordinary" Cyclists Happy to Cycle As Part Of An "Ordinary" Journey?* Paper presented at Velo Mondial, 2000. Accessed online 4/4/10 at http://www.velomondial.net/velomondiall2000/PDF/SULLY12.PDF.

Among those efforts is a "bikeway quality index" or BQI, which focuses on physical infrastructure and route characteristics.[13] Among the factors considered in the BQI are:

- Motor vehicle speeds and volumes
- Number of travel lanes
- Width of bicycle lanes
- Dropped bicycle lanes and difficult transitions
- Jogs in route
- Quality of pavement
- Quality of intersection crossings
- Number of stops

The BQI was one of the factors that informed Portland's Cycle Zone Analysis (CZA), which was designed to achieve **"**a better understanding of how existing conditions for bicycling vary across Portland" and allow "a more tailored approach to improving conditions for bicycling by directly addressing the deficiencies unique to each cycle zone."[14] The analysis breaks the city into 32 zones and analyzes each zone on a number of factors, including bikeway quality, physical barriers, density of roadway network, street connectivity, land topography (slope), and land use – it then rates each zone on existing conditions and its potential for increase bicycling.[15] The land use component of the analysis sought to address average trip distance by assessing the average distance from a residential tax lot to the nearest tax lot zoned for commercial use.[16] Because the CZA analysis does not factor in actual destinations, the land use portion of the analysis is theoretical based on zoning.

Other bikeability related research

A survey of recent work around bikeability reveals that the concept is gaining more attention; however, most current evaluations of bikeability or related concepts are similar to the CZA in that, to the extent that they incorporate land use, they generalize destinations significantly. For example, the *Pedestrian and Bicycle Information Center* put out a seven-question form designed to assess a neighborhood's bikeability. The questions are based primarily on facility infrastructure and driver behavior. However, the form does not consider accessibility to destinations.[17] A recent project by University of Washington graduate student Adam Parast compared bikeability in Portland and Seattle using a variety of inputs including bicycle facilities, connectivity, barriers, slope and zoning to create a rasterized map output of current and potential

---

[13] [13] City of Portland Bureau of Transportation. *Portland Bicycle Plan for 2030*, Appendix C, Page 2. Accessed online 6/1/2010 at http://www.portlandonline.com/transportation/index.cfm?c=44597&a=289122
[14] [14] City of Portland Bureau of Transportation. *Portland Bicycle Plan for 2030*, Appendix C, Page 2.
[15] City of Portland Bureau of Transportation. *Cycle Zone Analysis (CZA):A New Bicycle Transportation Planning Tool*. Presentation accessed online May 14 2010 at http://www.portlandonline.com/transportation/index.cfm?a=215045&c=34816.
[16] Birk, Mia, Kim Voros, Mike Rose, Roger Geller and Denver Igarta. *Cycle Zone Analysis: An Innovative Approach to Bicycle Planning*. TRB 2010 Annual Meeting. November 14, 2009.
[17] Pedestrian and Bicycle Information Center. *Bikeability Checklist*. Accessed online 6/1/2010 at http://www.bicyclinginfo.org/pdf/bikeability_checklist.pdf

bikeability.[18] Findings indicated that many parts of Portland, including parts of east Portland, have the potential to be very bikeable, and suggest some broad approaches (focused on facility improvement) that could be implemented to increase bikeability. Although zoning was used as a proxy for trip origin and destination demand, actual destinations were not incorporated into the study.

[18] Parast, Adam Bejan. *Portland and Seattle Cycle Analysis*. Unpublished paper. Accessed online 6/1/2010 at http://dl.dropbox.com/u/4080660/Adanced%20GIS%20Final%20Project%202%20-%20Adam%20Parast.pdf

Research Questions and Methodology

This study is based on several key questions pertaining to whether an average person can meet their daily needs while getting around on a bicycle, how a neighborhood could be evaluated for its bikeability, and what can be learned from the evaluation. The following questions guided the methodology, the sources used for the research, and the questions asked of the data:

- What are the places to which people make trips? How often do they visit various types of destinations?
- Where are the destinations actually located and how many of them are there?
- How large an area can a cyclist cover? Given a starting point, how large an area will a cyclist be able and willing to cover?
- How many essential destinations fall within this bicycle service area and how can we use this information to evaluate bikeability?

The focus of the study is on bicycle access and bikeability; however, walkability was also considered to provide a comparison. East Portland serves as the focus of the study, and neighborhoods in inner Portland (downtown, inner east and north Portland) are assessed to provide a comparison.

What are the places to which people make trips?

The first step was to identify where people actually go and how often they go there. This study examines how neighborhoods help or hinder people meeting their daily needs on a bicycle; therefore, I focused my research on home-based utilitarian trips and excluded any trips to and from work. As a starting point, the 2009 National Household Transportation Survey (NHTS) was used to assess the kinds of trips that cyclists make. However, the cyclist portion of the nationwide survey was skewed toward recreational cyclists, rather than the utilitarian cyclists that are the focus of this study. Twenty-one percent of bicycle trips recorded in the NHTS survey were taken for the purpose of recreation; in comparison just 3.5% of all trips were taken for the purpose of recreation (though utilitarian bicycle trips are more common in Portland than in other cities[19]). I determined that trips

[19] Annual survey results from the Portland City Auditor indicate that in 2009, 8% of residents commuted by bicycle, indicating high levels of utilitarian cycling (City of Portland Office of the City Auditor, 2009 Resident Survey Results, pg 34). Comparatively, 2009 NHTS indicate that just 1% of all trips in the United States are made by bicycle.

currently being taken by any mode should be examined based on the focus of whether a trip could be taken by bicycle, regardless of whether it currently is or not.

The sample of trips includes home-based trips to non-work destinations. Non-home based trips were removed from the sample, as were trips to and from work. Table 1 displays results combined into the categories of shopping and errands, social and recreational, and other.

Table 1. Percentage of home-based, non-work trips by destination/purpose.

Shopping / errands (total)	**25.1%**
Buy goods: groceries / clothing / hardware store	17.3%*
Buy services: video rentals / dry cleaner / post office / car service / bank	4.7%*
Other Shopping / errands	3.1%
Social / recreational (total)	**34.4%**
Go to gym / exercise / play sports	9.3%
Visit friends / relatives	8.5%
Go out / hang out: entertainment / theater / sports event / go to bar	3.6%*
Get Meal	7.0%
Coffee / ice cream / snacks	1.2%
Other Social / Recreational	4.9%
Other Trips (total)	**40.4%**
Go to school, school related	10.2%
Go to religious activity	5.4%
Medical / dental services	3.8%
Pet care: walk the dog/vet visits	2.2%
Day care, etc	0.4%
Transport someone	13.1%
Others	5.4%

Source: 2009 National Household Transportation Survey
Note: Shaded categories used in this analysis
*Starred categories broken down into further categories for analysis

Some of these categories were further broken down to get a fuller (less generalized) picture of places people visit. This was done because certain trip types that were combined in the NHTS survey could not actually be served interchangeably by various destination types – for example, while "services" including video rentals, dry cleaning, post offices, car service and banks were combined into one category on the NHTS survey, a post office would not satisfy your need if you wanted to withdraw funds and a bank would not satisfy your needs if you wanted to mail a package.

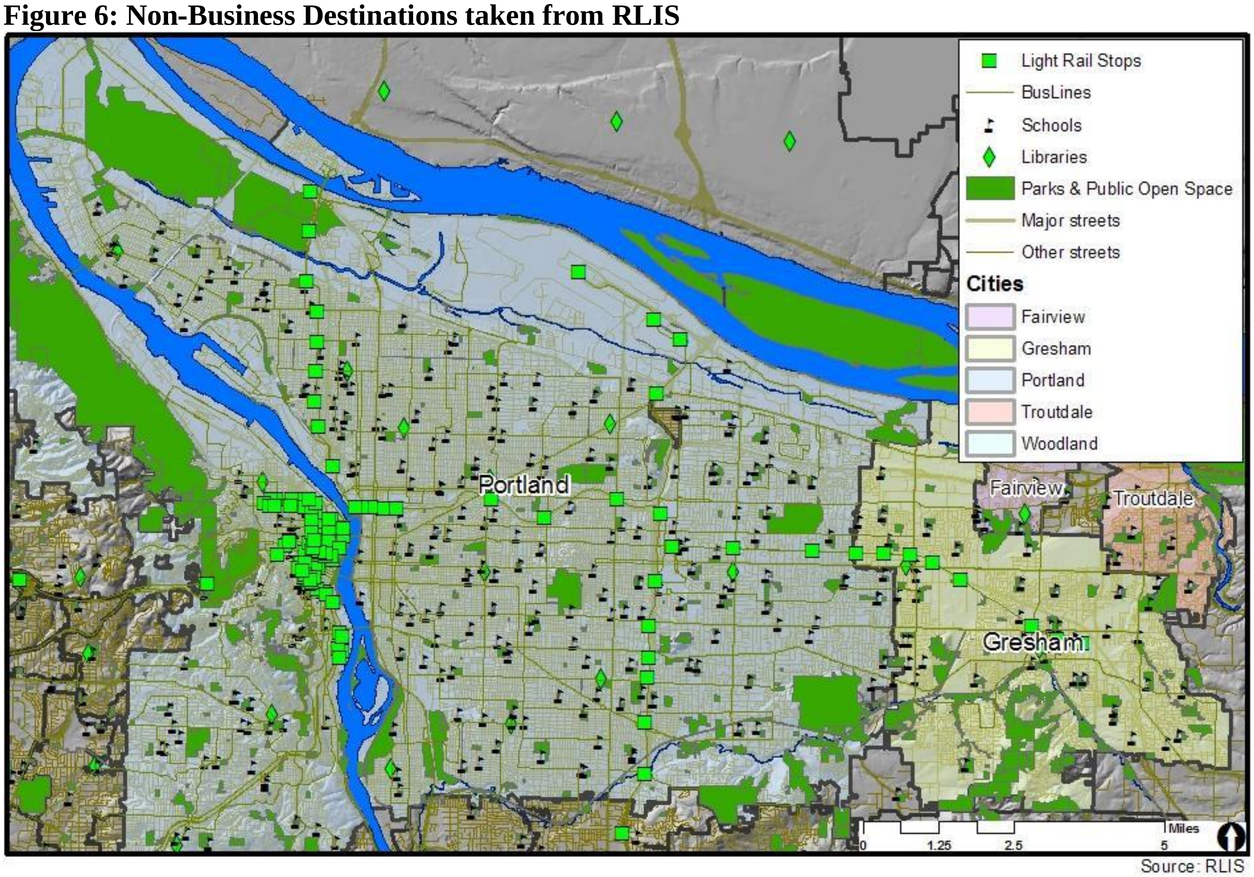
In addition to the destination by trip types identified in the NHTS data, several other categories which are not captured by the trip type data but are still important neighborhood elements were considered in the analysis. Parks were included, which might be the destination for the sporting, pet care trips, or general visits to public places. Libraries were also included and might additionally serve some school or public place trip types. Finally, transit connections (in this case light rail stops and bus lines) were included as important connections to areas beyond the immediate neighborhood. In the end, these destination types were identified through NHTS or other literature and assessed in this study:

- Parks, schools, libraries, child care, transit connections (light rail stops and bus lines), grocery stores (full service and specialty), clothing stores, general goods, beauty services (salons, barbers, etc), banks, mail services, laundry and cleaners, gyms, general entertainment, drinking establishments, movie theaters, restaurants, coffee and snack shops, and religious organizations.

Where are those places actually located?

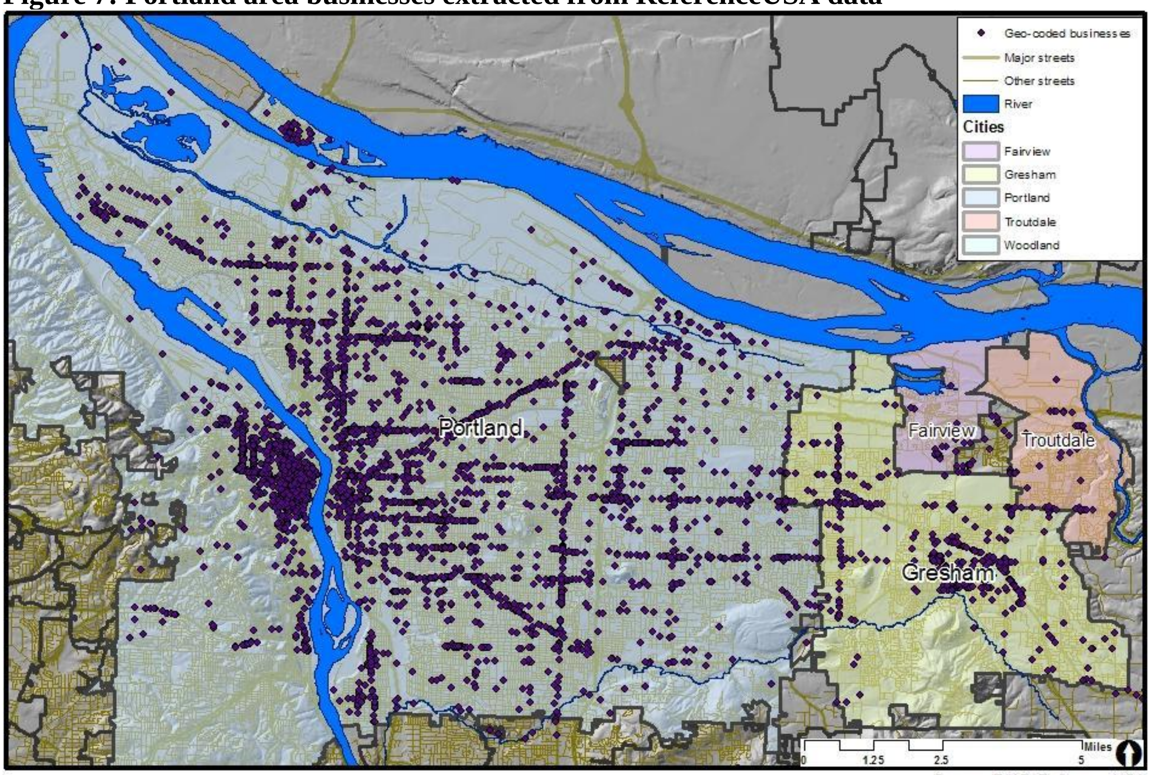
In order to analyze whether someone could walk or cycle to a particular location, it was first necessary to identify where these possible destinations were located. Metro's Regional Land Information System (RLIS) contains geo-coded data of some of the destinations used in the study, including parks, schools, libraries, and transit connections (light rail stops and bus lines). Figure 6 shows destinations taken from this source that were considered in the study.

Figure 6: Non-Business Destinations taken from RLIS



Business address data for other destination types were acquired through a data clearinghouse, ReferenceUSA. Standard Industrial Classification (SIC) codes were used to select all businesses within specified zip codes in a chosen category type – business addresses were gathered for all child care providers, grocery stores (separated out into full service and specialty stores), clothing stores, general goods stores, beauty services (including salons, barbers, etc), banks, mail services (including post offices and private mail providers), laundries and cleaners, gyms, general entertainment (including bowling, performance venues, etc), drinking establishments, movie theaters, restaurants, coffee and snack shops, and religious organizations. The geographic extent of the businesses selected included areas in outer east Portland (including areas of Gresham and Fairview) and the comparison neighborhoods of inner east, north and downtown Portland, along with a buffer to absorb the full bikeable areas from selected starting points.[20] 6,098 businesses were selected, and 5,951 were successfully geo-coded - over a 97% match rate after manual matching. Of those not matched, most either lacked a street address or were P.O. Boxes. All matched destinations extracted from ReferenceUSA are shown in Figure 7.

Figure 7: Portland area businesses extracted from ReferenceUSA data



Source: RLIS, ReferenceUSA

[20] Zip codes used were: 97024, 97030, 97060, 97080, 97201, 97202, 97203, 97204, 97205, 97206, 97208, 97209, 97210, 97211, 97212, 97213, 97214, 97215, 97216, 97217, 97218, 97220, 97221, 97227, 97230, 97232, 97233, 97236, 97239, 97240, 97266, 97282, 97283, 97286, 97293, and 97296.

How large an area can a cyclist cover?

Information from the literature review suggested that the average cyclist would be willing to travel a distance of about 1.33 to just over 2.66 miles for most non-work trips. As will be discussed later, destinations closer than 2.5 miles were determined to be more bikeable (i.e. would be acceptable biking trips to a greater portion of the population), while destinations greater than 2.5 miles away were not determined to contribute to a bikeable neighborhood. Although Dill and Gliebe's finding indicated that cyclists appear to be willing to travel further for work related trips (i.e. commuting), since this study is focused on non-work trips, a lesser distance is appropriate. Further, because this study is interested in trips that **might** be made by bicycle (often by people that are not currently bicycling) a distance threshold lower than the average threshold of current (and therefore likely more experienced) cyclists seemed appropriate.

One important consideration was the type of route and how different bicycle facilities encourage or discourage cycling. Distances were varied based on bicycle route choice research that suggests that cyclists will be willing to go further if the environment is pleasant. Environments more conducive to cycling were assumed to lengthen the distance a cyclist would be willing to travel, while environments that were not conducive to cycling were assumed to decrease the distance a cyclist would be willing to travel.

Based on bicycle route choice modeling findings being developed at Portland State, each road segment was given a new "effective length" which assumed that, for each mile a cyclist would be willing to travel under standard conditions (in this case, assumed to be a street with a bike lane), they would be willing to travel X miles on Y type of road.[21] Table 2 demonstrates the effective length of each segment was calculated. The actual length was multiplied by the inverse of the distance threshold multiplier: Effective Length = (Actual Length) / (Distance Threshold Multiplier). Local streets not identified as arterials or other bike routes (most of the generally lower traffic side streets in Portland) were assigned a threshold multiplier of 1 (the same as roads with bike lanes). Streets designated as "low traffic through streets" in RLIS were treated as bicycle boulevards (with a 1.22 threshold multiplier) because they provide some similar benefits –good connectivity and limited automobile interactions.

[21] Broach, Joe. PhD Student, Portland State University, Personal Communication, April 19, 2010.

Table 2: Network Route Choice Assumptions

Street Facility Type	Distance Threshold Multiplier*	Example: Actual Length	Example: Effective Length
Bike lane	1.0	1000 feet	1000 feet
Bike boulevard	1.22	1000 feet	819 feet
Bike path	1.35	1000 feet	740 feet
Minor arterial (10-20k cars/day)	0.82	1000 feet	1,219 feet
Major arterial (20-30k cars/day)	0.42	1000 feet	2,381 feet
Highway (30k cars/day)	0.14	1000 feet	7,142 feet
Freeways	Not Accessible (represented in the model as 0.01)	1000 feet	18.9 miles

*Distance an average cyclist would travel on this facility type for each unit of their presumed distance threshold

Next, a multimodal network was built that combined street data with off-street multi-use trails using the new "effective length" column as the network impedance. Figures 8 and 9 demonstrate how the effective length influenced the size and shape of the area encompassing all the possible locations a cyclist could reach in X miles (going forward, the distance cutoff will be referred to as the "network radius", while the area bounded by the outer extent of all network radii is the "service area"). In Figure 8, a low traffic bikeway runs north and south of the origin location, enabling the cyclist to move further in those directions. In comparison, no such facility exists moving east and west, resulting in a shorter willingness to cycle in those directions. Figure 9, which shows an origin location abutting a multi-use trail – the Springwater Corridor – shows a more dramatic example of a service area, wherein east-west movement is facilitated by the trail, movement to the north and northwest resembles the diamond shaped pattern one would expect from a more traditional gridded street network, while movement to the south and southeast is hampered by fewer streets and geographic barriers (Note: the extent of the barriers are exaggerated because

Figure 8: Example service area - Low Traffic Bikeway (SE 117th Avenue)

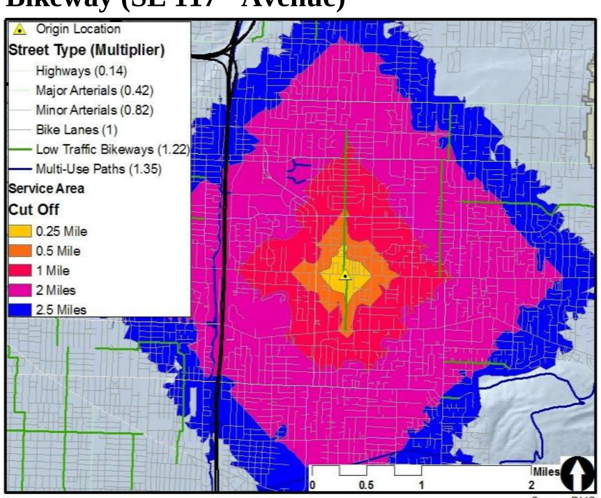
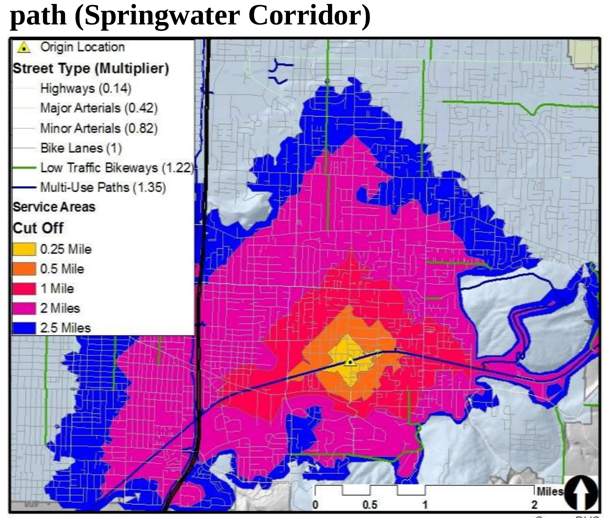


Figure 9: Example service area - Multi-use path (Springwater Corridor)



the network runs up against the Clackamas County line, which was the extent of the network – this mostly effects the 2 and 2.5 mile network radii).

Selecting origin locations

A set of origin locations was needed to run the analysis. Thirteen locations were selected from outer east Portland neighborhoods, while thirteen locations were selected from inner Portland neighborhoods (including downtown, inner east and north Portland) to provide a comparison sample. The locations represented a variety of geographic locations and neighborhood types. Some of the locations were near major bike routes while others were distant from bicycle facilities; some were near large clusters of businesses while others were more isolated. The sampling was not intended to be random, but rather sought to encompass a variety of origin location types. Figure 10 shows each of the sample home or origin locations (along with an assigned identifying number). From those sample home locations, service areas were calculated using network radius distances based on the effective length field. Pedestrian service areas were calculated using network radii of 0.25, 0.5 and 1 mile. The bicycle service areas were calculated using network radii of 1, 2 and 2.5 miles. Figures 11 and 12 show the service areas for each of the home locations.

Figure 10: Sample origin locations (with location ID) selected for the study

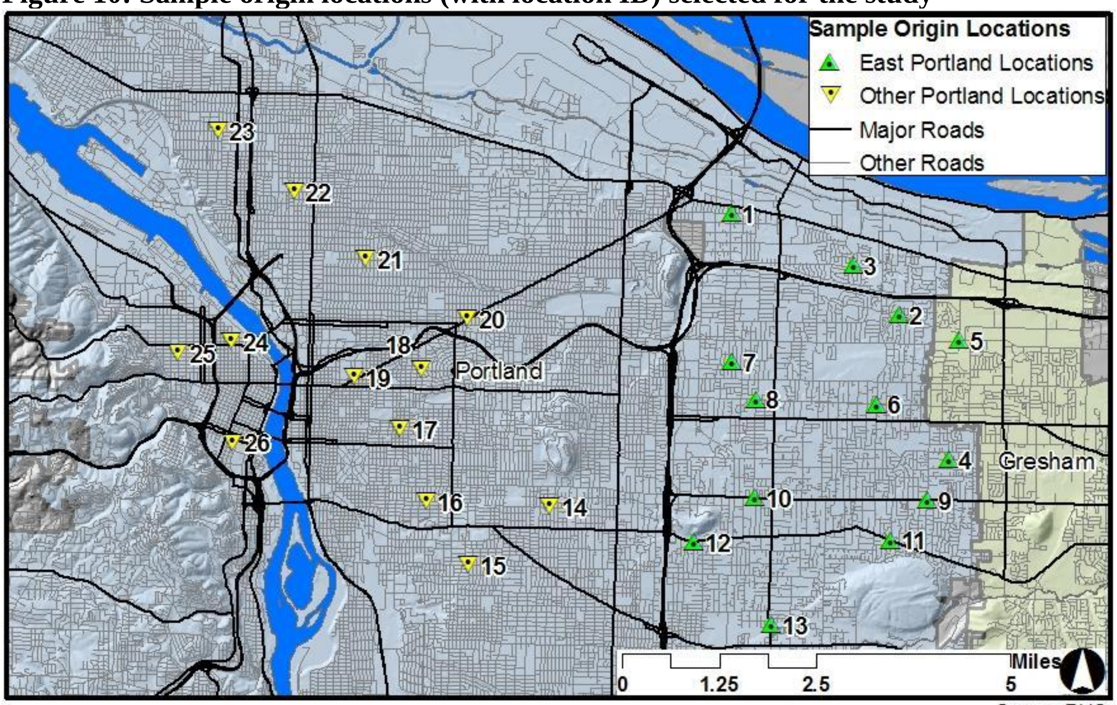
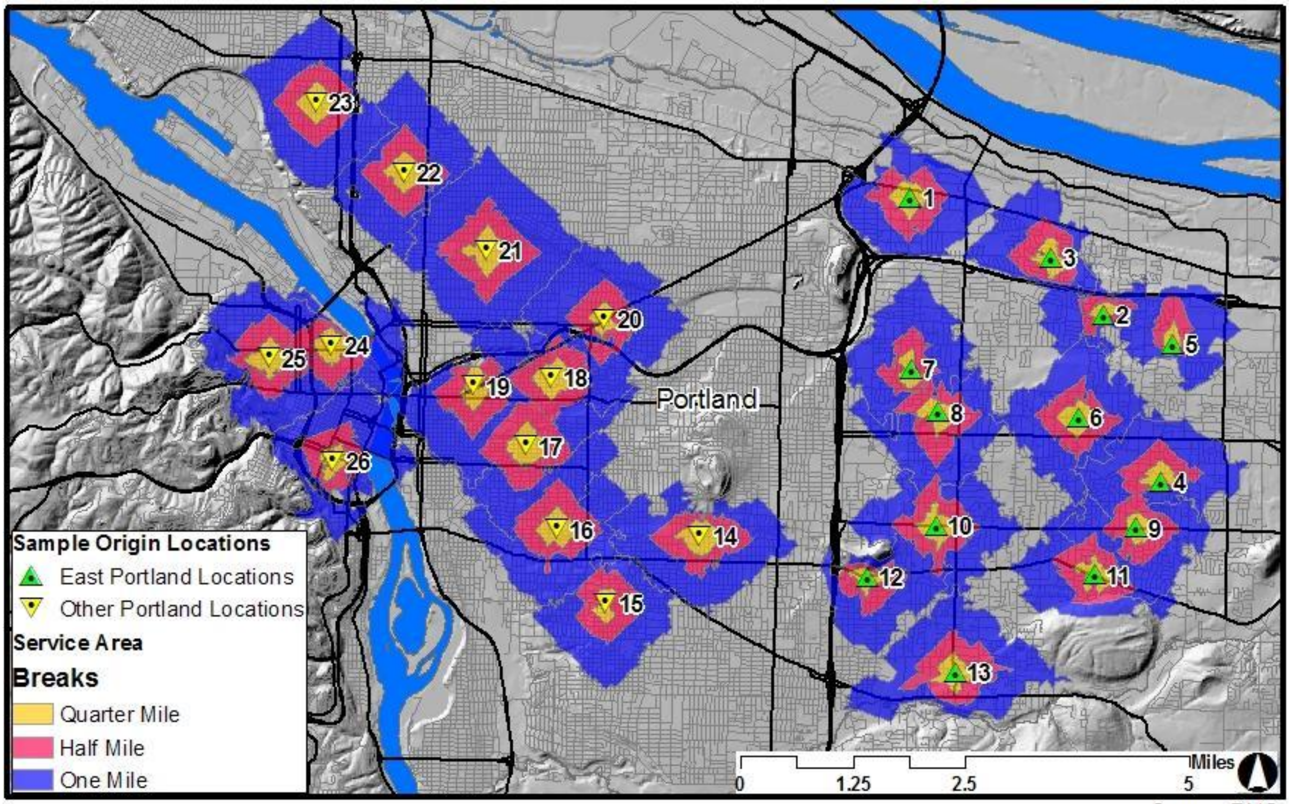
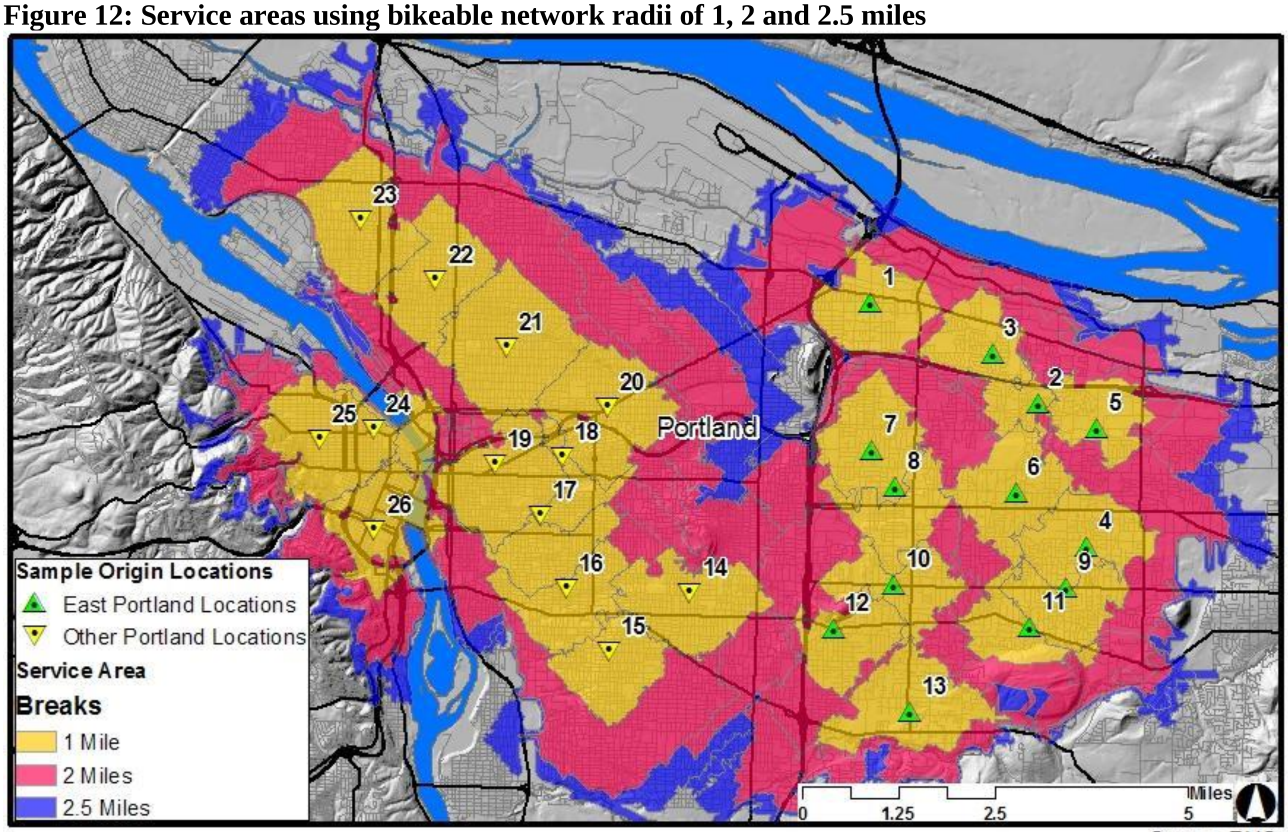


Figure 11: Service areas using walkable network radii of 0.25, 0.5 and 1 mile



Source: RLIS

Figure 12: Service areas using bikeable network radii of 1, 2 and 2.5 miles



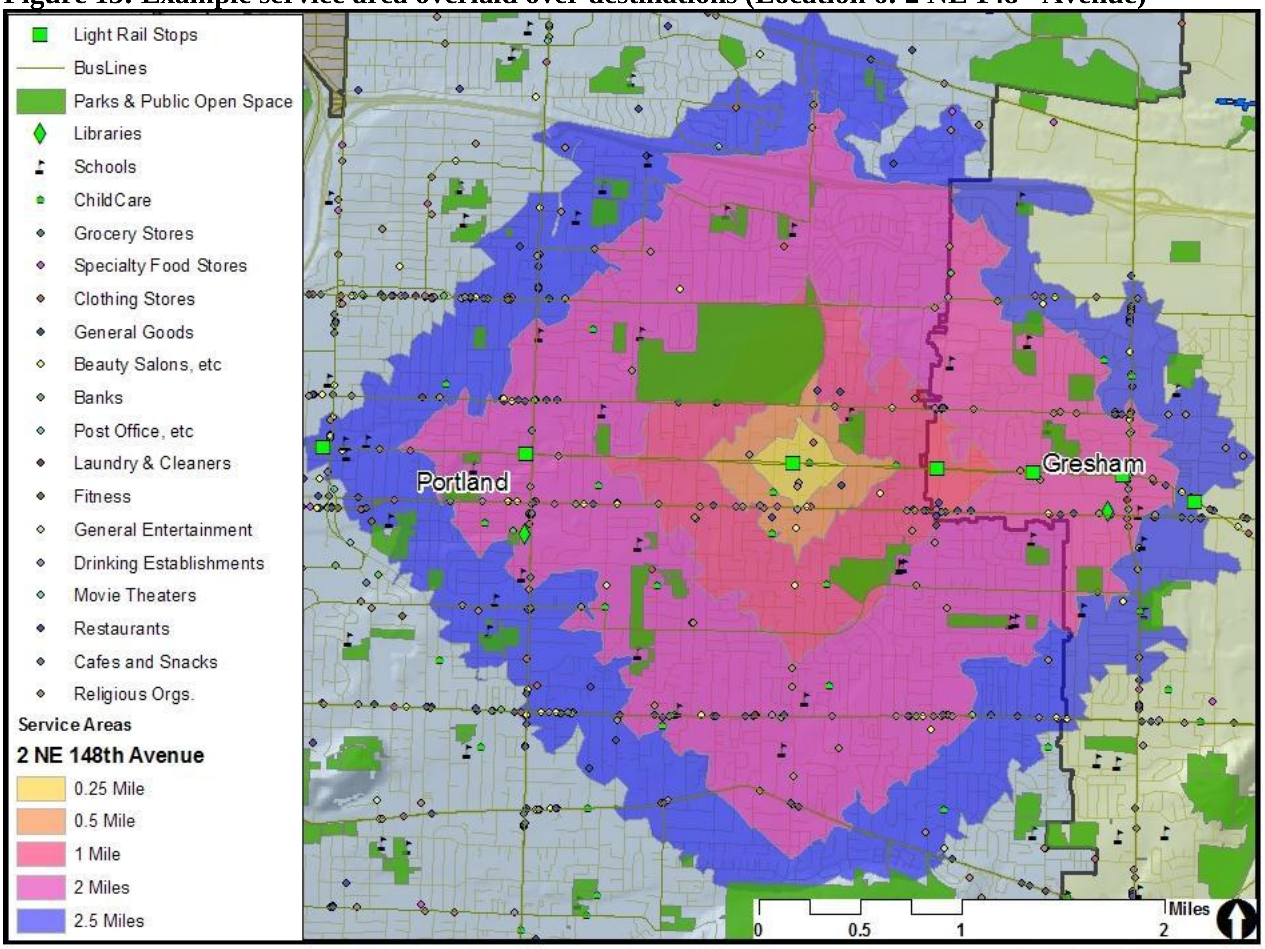
Source: RLIS

Evaluation: Scoring bikeability and walkability

Using the geo-coded information on all the business and other destination locations, a sampling of starting home locations, and a set of corresponding service areas for each of those starting locations, the next step is to gather the information in order to analyze the walkability and bikeability of those locations.

The number of destinations by destination type in each ring (13 X 5 = 65 rings in east Portland and 65 rings in inner Portland) was determined using a spatial join (creating a binary 1= present 0=not) for each item and then counting the number in each service area. In tabulating the destination counts, each of the variously sized service areas for each of the origin locations had a corresponding count of the number of destinations by that type in the service area. Figure 13 provides an example of the pedestrian and bicycle service areas around one origin location (Location #6) with destination locations mapped over service areas. Table 3 provides counts for each of the service areas.

Figure 13: Example service area overlaid over destinations (Location 6: 2 NE 148th Avenue)



Source: RLIS; ReferenceUSA

Table 3: Count of destinations reachable in service areas from Location #6

Number of locations within (effective distances):	Quarter Mile	Half Mile	One Mile	2 Miles	2.5 Miles
Area (Square Miles)	0.11	0.41	1.80	7.55	11.92
Light Rail Stops	1	1	2	5	7
Bus Lines	2	3	5	11	14
Parks and Open Public Spaces	0	3	6	28	50
Libraries	0	0	0	2	2
Child Care	1	4	5	13	18
Preschools	0	0	0	1	4
Elementary Schools	0	0	1	15	21
Middle Schools	0	0	0	3	7
High Schools	0	0	0	4	7
Full Grocery Stores	0	0	0	4	6
Specialty Grocery Stores	0	2	5	16	31
Clothing Stores	1	2	5	12	28
General Goods Stores	0	2	4	29	41
Beauty Salons, Barbers, etc	0	2	5	27	46
Banks	0	0	0	10	13
Mail Services, including post offices	0	0	0	1	3
Laundry and Cleaners	0	0	1	6	12
Fitness Locations	0	0	2	4	9
General Entertainment (bowling, theaters, etc)	0	0	1	2	3
Drinking Establishments	1	1	4	18	27
Movie Theaters	0	0	0	1	1
Restaurants	0	1	11	36	61
Cafés and Snacks	0	1	2	9	15
Religious Organizations	2	3	10	42	66

In order to create an objective assessment of the bikeability of the sampled origin locations, a scoring method was developed using the destination counts. NHTS data and a review of related literature regarding common destinations were used to create a system wherein a maximum number of points were assigned to each destination category: a location received the full or partial points depending on its proximity to the origin location.

For this study, network distances were used, rather than as-the-crow-flies distances as used in the Walkscore program, to evaluate the accessibility of the sample origin locations to the various destinations. For the purpose of comparing how neighborhoods fair as bicycling versus walking places, two scores were calculated for each origin location – a bikeability score and a walkability score. For the bikeability score, all locations within one mile of the origin location were assumed to be fully accessible and eligible for the full points available for that destination type, while areas within 2 miles of the origin location were eligible for up to 50% of the points available for that destination type; areas between 2 and 2.5 miles were eligible for up 25% of the available points. For the purpose of walkability, the cut-off distances were similar to the Walkscore distances -

locations within 0.25 miles could receive 100% of the full points for the destination type, dropping to 50% for 0.5 miles and 25% for destinations within 1 mile of the origin.

Assumptions varied about how many locations of a specific destination type were needed to receive full credit (i.e. be fully bikeable or walkable). For example, for some destination types, such as post offices or public libraries, a single location was assumed to satisfy the need for that destination type. However, for other destination types, such as restaurants, it was assumed that a single location would not satisfy a person's needs – a larger number of restaurants was needed to provide choice and variety for most people. Specifically, it was assumed that if twelve restaurants were reachable the neighborhood would be sufficiently walkable or bikeable; the scoring algorithm provided partial credit for each restaurant up to twelve. Table 4 shows the point system used with the destination types, maximum available points by destination type, and criteria used to determine points.

Table 4: Destination types evaluated, with related maximum score and scoring criteria

Destination Type	**Max Points**	**Scoring Criteria**
Light Rail Stops	5	Full points for one occurrence
Bus Lines	5	1.25 for each occurrence up to full points (4 occurrences)
Parks and Open Public Spaces	10	Full points for one occurrence
Libraries	2.5	Full points for one occurrence
Child Care	2.5	Full points for one occurrence
Preschools	2.5	Full points for one occurrence
Elementary Schools	2.5	Full points for one occurrence (public only)
Middle Schools	2.5	Full points for one occurrence (public only)
High Schools	2.5	Full points for one occurrence (public only)
Full Grocery Stores	7.5	3.75 for each occurrence up to full points (2 occurrences). No points beyond first break (0.25 miles for pedestrian or 1 mile for cyclists)
Specialty Grocery Stores	2.5	0.625 for each occurrence up to full points (4 occurrences).
Clothing Stores	5.0	1.25 for each occurrence up to full points (4 occurrences).
General Goods Stores	5.0	1.25 for each occurrence up to full points (4 occurrences). No points beyond first break (0.25 miles for pedestrian or 1 mile for cyclists)
Beauty Salons, Barbers, etc	2.5	0.625 for each occurrence up to full points (4 occurrences).
Banks	2.5	1.25 for each occurrence up to full points (2 occurrences).
Mail Services, including post offices	2.5	Full points for one occurrence
Laundry and Cleaners	2.5	1.25 for each occurrence up to full points (2 occurrences). No points beyond first break (0.25 miles for pedestrian or 1 mile for cyclists)
Fitness Locations	5.0	2.5 for each occurrence up to full points (2 occurrences).
General Entertainment (bowling, theaters, etc)	2.5	1.25 for each occurrence up to full points (2 occurrences).
Drinking Establishments	5.0	1.25 for each occurrence up to full points (4 occurrences).
Movie Theaters	2.5	1.25 for each occurrence up to full points (2 occurrences).
Restaurants	7.5	0.625 for each occurrence up to full points (12 occurrences).
Cafés and Snacks	5.0	1.25 for each occurrence up to full points (4 occurrences).
Religious Organizations	7.5	1.5 for each occurrence up to full points (5 occurrences).
Maximum Total	**100.0**	

Based on my research into the number and types of trips people make, I made decisions on how many points to assign per destination category (i.e. the relative importance of one destination type compared to another), how to discount points based on distance from the starting location, and the number of locations needed. However, those decisions were ultimately arbitrary and as research in these areas improves, assumptions could be refined to improve the utility of the tool. Table 5 provides a score sheet demonstrating how the point system would work out for the example above.

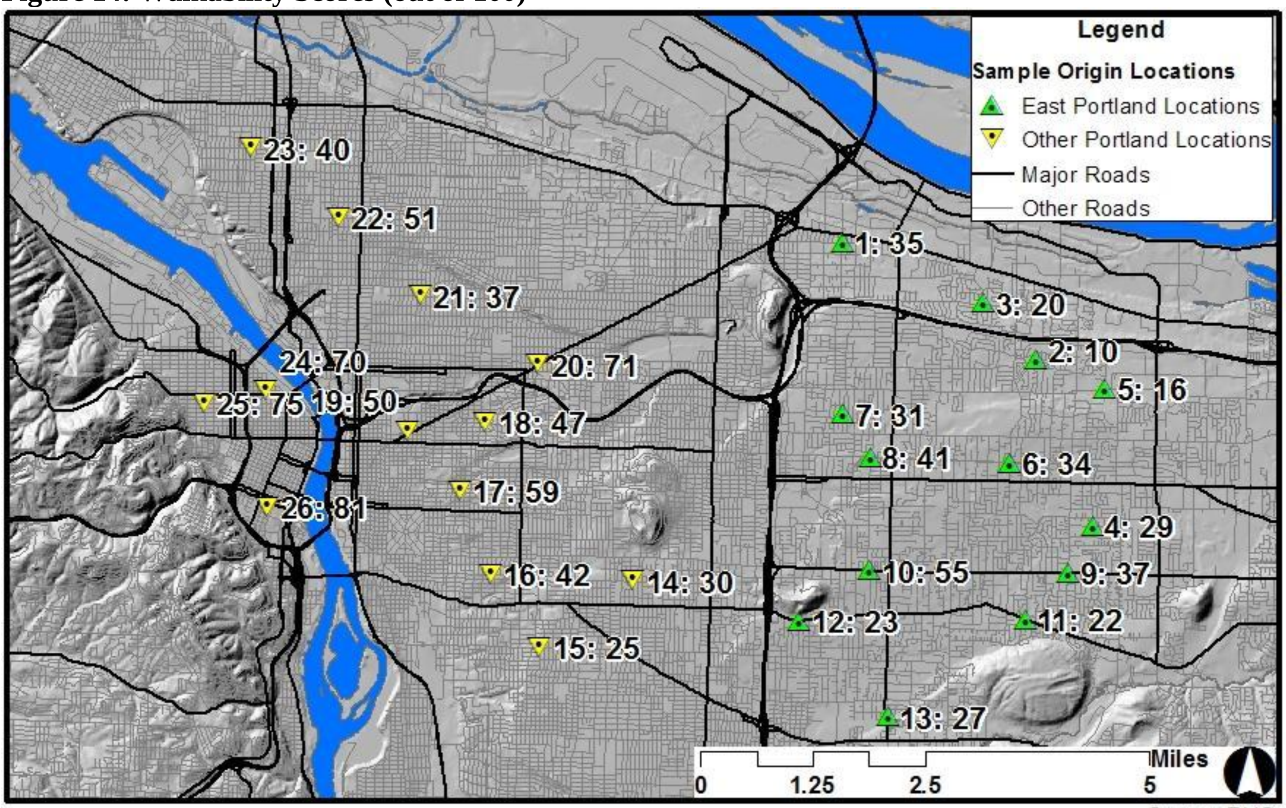
Table 5: Scoring worksheet for example origin at 2 NE 148th Avenue

Destination Type	**Maximum Possible**	**One Mile (full points)**	**2 Miles (50%)**	**2.5 Miles (25%)**	**Points Received**
Light Rail Stops	5	2	5	7	5
Bus Lines	5	10	22	28	5
Parks and Open Public Spaces	10	6	28	50	10
Libraries	2.5	0	2	2	**1.25**
Child Care	2.5	5	13	18	2.50
Preschools	2.5	0	1	4	**1.25**
Elementary Schools	2.5	1	15	21	2.50
Middle Schools	2.5	0	3	7	**1.25**
High Schools	2.5	0	4	7	**1.25**
Full Grocery Stores	7.5	0	4	6	**0**
Specialty Grocery Stores	2.5	5	16	31	2.5
Clothing Stores	5	5	12	28	5
General Goods Stores	5	4	29	41	5
Beauty Salons, Barbers, etc	2.5	5	27	46	2.5
Banks	2.5	0	10	13	**1.25**
Mail Services, including post offices	2.5	0	1	3	**1.25**
Laundry and Cleaners	2.5	1	6	12	**1.25**
Fitness Locations	5	2	4	9	5
General Entertainment (bowling, theaters, etc)	2.5	1	2	3	**1.88**
Drinking Establishments	5	4	18	27	5
Movie Theaters	2.5	0	1	1	**0.63**
Restaurants	7.5	11	36	61	**7.19**
Cafés and Snacks	5	2	9	15	**3.75**
Religious Organizations	7.5	10	42	66	7.5
Maximum Possible	**100**			**Actual Bikeability Score:**	**79.69**

Findings

Walkability and bikeability scores were tabulated for each of the input origin locations. Figure 14 shows walkability scores for each location while Figure 15 shows bikeability scores for each location. Walkability scores were necessarily lower than bikeability scores because the smaller network radii were used for the walkability scores – 0.25, 0.5 and 1 mile as opposed to the 1, 2 and 2.5 mile radii used for the bikeability scores.[22] Since bicycles can cover a larger area, cyclists can reach more destinations and meet more of their daily needs.

Figure 14: Walkability Scores (out of 100)



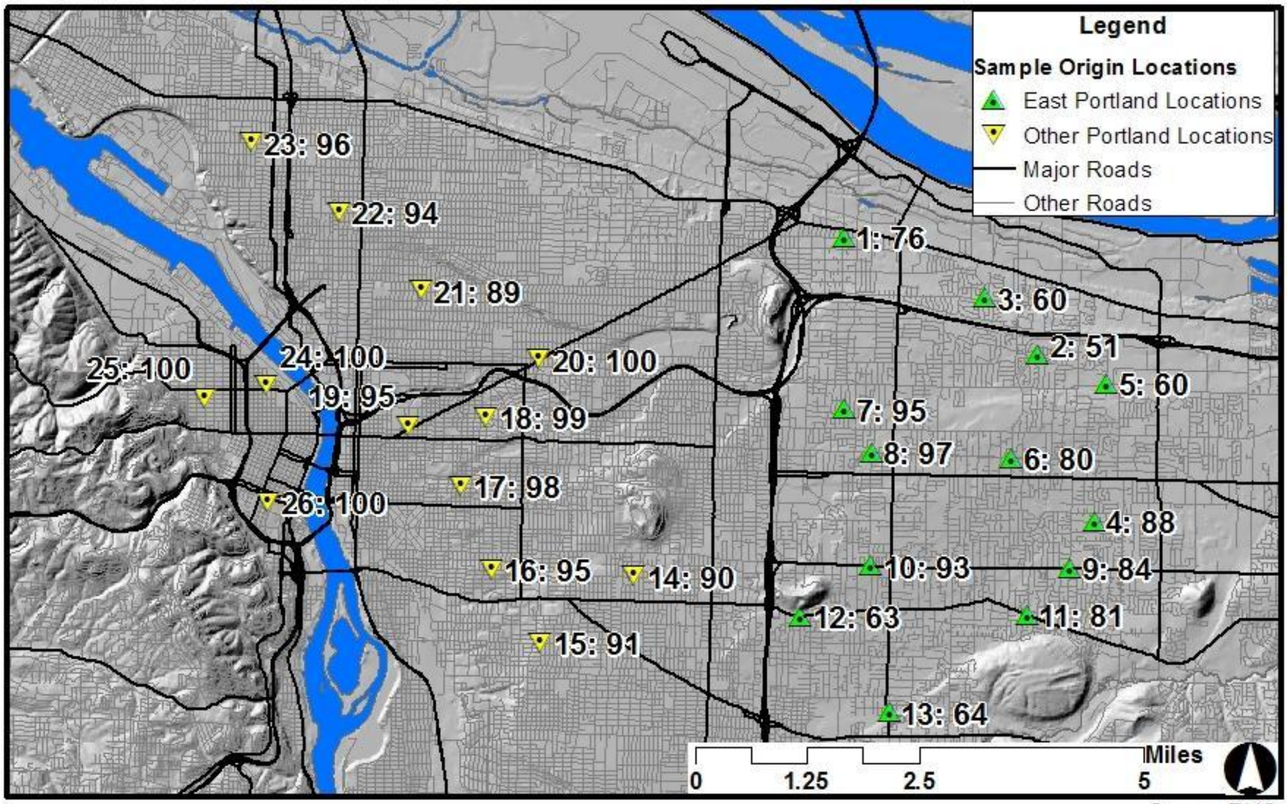
Source: RLIS

The east Portland locations had an average bikeability score of just over 76 out of 100, compared to an average score of just under 96 for the locations in inner Portland. The east Portland locations also had significant variability in their scores, ranging from a low of 51 for a location on a horseshoe style block near I-84 to a score of 97 in a more gridded and commercial neighborhood. In comparison, the locations in inner Portland had less variability – ranging from 89 to 100

[22] Walkability scores derived here are considerably lower than Walkscore ratings for similar locations. This may be partly due to differences in the categories and points given per category; however, more likely is that the as-the-crow-flies service area calculations used by Walkscore overestimate the actual walkable distance (see figures 4 and 5).

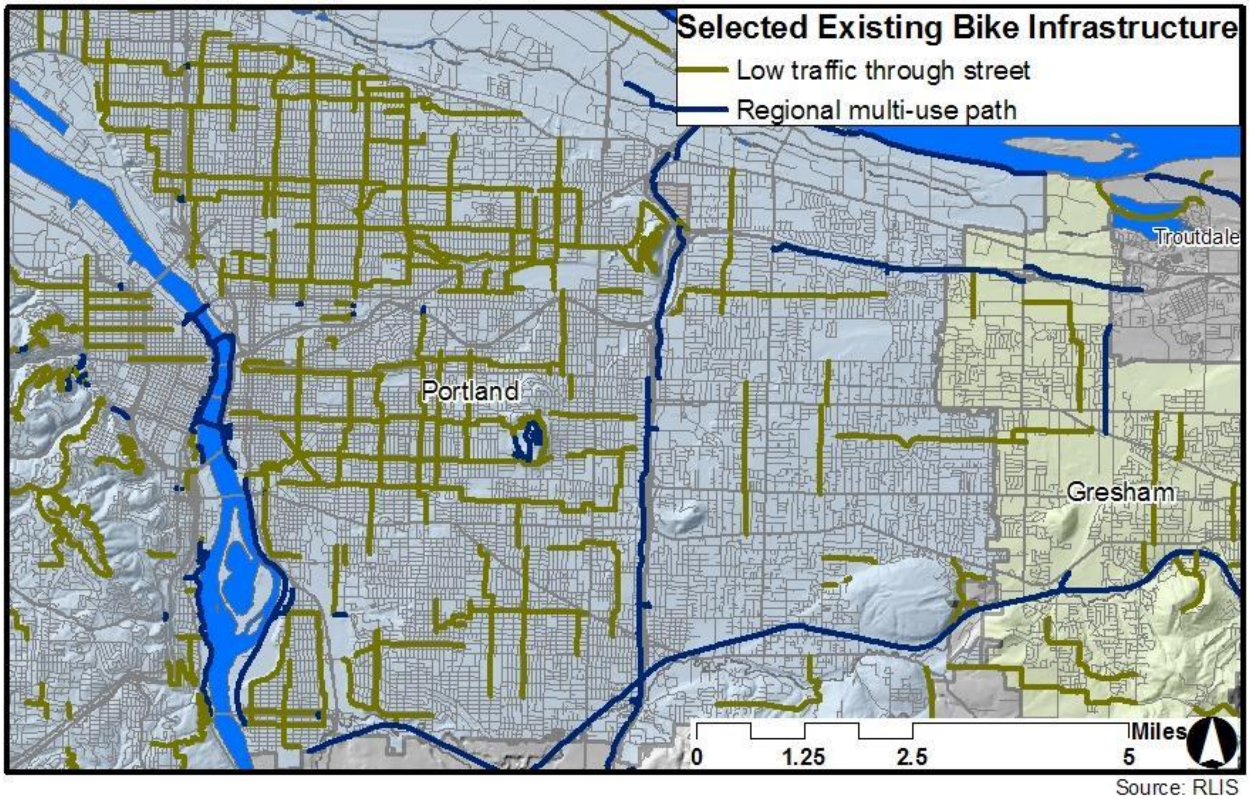
(including all three downtown locations). While the scores provide a simple basis for comparing neighborhoods, it is worth exploring some possible reasons for the differences to glean lessons about infrastructure (street and bikeway system) and land-use (destinations) improvements that might help improve both scores. Three locations in east Portland that stand out, with bikeability scores of 97, 95 and 93, will be discussed below.

Figure 15. Bikeability Scores (out of 100)



One initial postulation would be that east Portland locations received lower scores because the existing street system posed a limitation on the size of the area to which a cyclist would be able to access (service area), either through a lack of connectivity or through a lack of bicycle-friendly infrastructure on existing streets. Figure 16 shows existing bicycle route types identified as being preferred routes, including off-street multi-use paths and low-traffic through-streets (a designation used to encompass official bicycle boulevard and unofficial low-traffic through-streets offering good connectivity but limited automobile traffic).

Figure 16: Map of existing low traffic through-streets and multi-use paths



There are far fewer low-traffic through-streets and multi-use paths in east Portland than in other areas. Table 6 shows the miles of several bicycle facility types located within the one mile service areas of each origin location. Bike lanes and multi-use trails have an approximate parity between east Portland locations and inner Portland locations. However, there is a stark difference between the average miles of bike boulevards, with an average of 1.2 miles per location in east Portland compared to over 7 miles per location in inner Portland. A look at the correlation of bikeability with bike facility mileage shows a strong correlation in east Portland (.80) compared to no correlation in inner Portland. Bike lanes have a moderate correlation to bikeability in both groups. Interestingly, the multi-use trails have a moderate negative correlation with bikeability in east Portland, suggesting that multi-use trails may generally exist in places which offer little access to destinations.

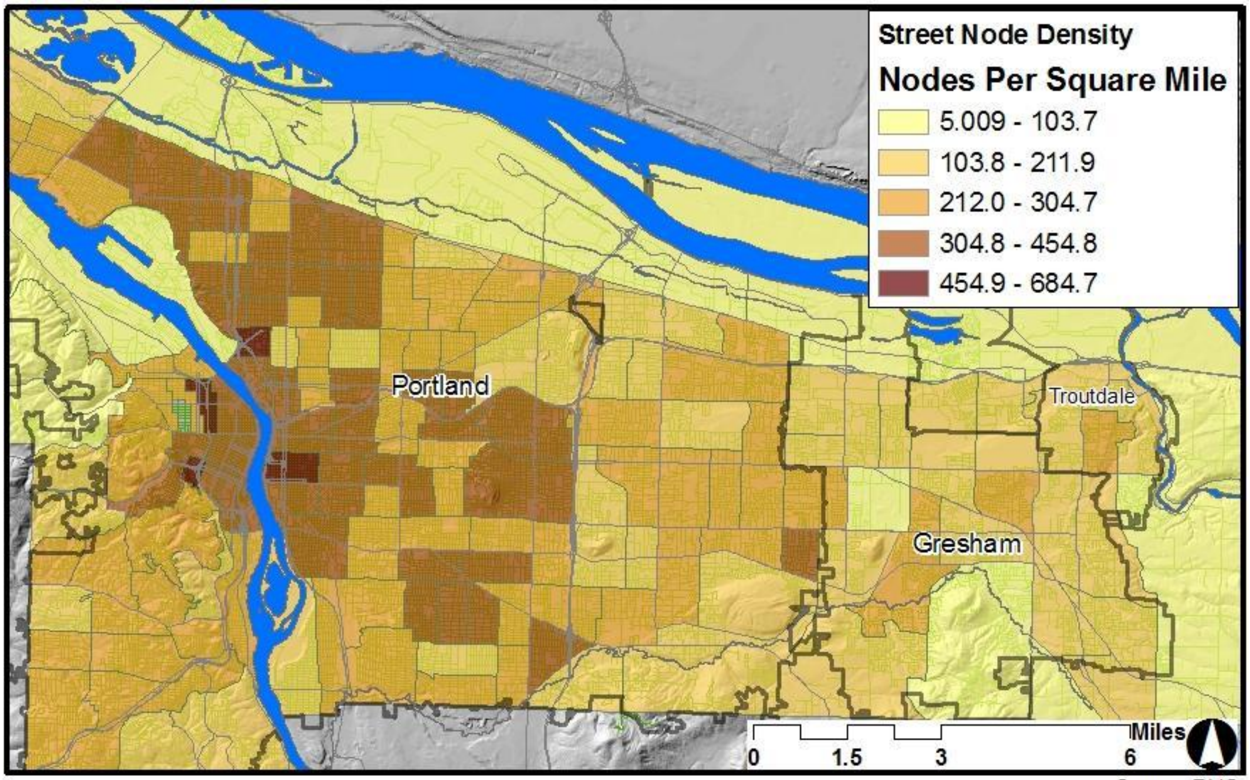
Table 6. Miles of Bicycle Facility Located within the One Mile Service Areas

ID	East Portland Locations	Bikeability Score	Bike Blvd. Miles	Bike Lane Miles	Multi-Use Trail Miles
8	10 NE 117th Ave.	97.2	1.59	4.42	0.53
7	950 NE 110th Ave.	95.3	2.31	4.19	0.50
10	11700 SE Division St.	92.8	1.90	5.20	0.00
4	1450 SE 167th Ave.	87.5	2.43	3.11	0.00
9	2500 NE 162nd Ave.	84.1	1.08	2.14	0.00
11	15300 SE Powell Blvd.	80.6	1.28	3.37	0.88
6	2 NE 148th Ave.	79.7	1.76	5.33	0.00
1	4700 NE 109th Ave.	75.9	0.80	3.83	2.60
13	5700 SE 122nd Ave.	64.4	0.27	4.00	3.19
12	10200 SE Powell Blvd.	63.4	0.50	1.62	1.15
3	3500 NE 141st Ave.	60.4	0.00	1.62	1.59
5	1600 NE 169th Ave.	59.7	1.06	1.30	1.66
2	2200 NE 152nd Ave.	50.7	0.65	2.00	2.13
	East Average	**76.28**	**1.20**	**3.24**	**1.09**
	Correlation with Bikeability	**-**	**0.80**	**0.69**	**-0.70**

ID	Inner Portland Locations	Bikeability Score	Bike Blvd. Miles	Bike Lane Miles	Miles Multi-Use Trail
20	4214 NE Sandy Blvd.	100	8.46	2.24	0.40
24	1084 NW Marshall St.	100	5.12	8.04	2.21
25	502 SW Mill St.	100	6.58	6.49	1.51
26	806 NW 22nd Ave.	100	1.35	8.02	5.02
18	524 NE 32nd Ave.	98.8	7.58	2.50	1.84
17	1050 SE 28th Ave.	97.5	12.20	2.34	1.67
23	6516 N Denver Ave.	95.6	6.95	3.67	0.38
16	303 NE 16th Ave.	95	9.71	1.89	0.73
19	2866 SE 34th Ave.	95	6.38	5.24	0.65
22	18 NE Alberta St.	94.4	9.53	4.11	0.00
15	4450 SE 43rd Ave.	91.3	2.71	2.29	0.93
14	2868 SE 65th Ave.	90	4.75	0.30	0.00
21	3310 NE 18th Ave.	88.8	11.40	1.91	0.73
	Inner Average	**95.88**	**7.13**	**3.77**	**1.24**
	Correlation with Bikeability	**-**	**-0.14**	**0.63**	**0.55**

In addition to the less bicycle-friendly infrastructure, east Portland is less well connected than other parts of Portland. This can be observed by simply travelling the streets of east Portland – blocks are longer, there are more dead-ends and fewer through-streets. Another somewhat simplistic way to explore street connectivity is to examine the density of street nodes (a node exists at the end of each street segment). Figure 17 shows the number of street nodes per square mile in Portland, displaying the relatively poor connectivity in east Portland.

Figure 17: Measuring Connectivity – Street nodes per square mile, by census tract



Source: RLIS

In order to test the notion that the existing bikeway infrastructure and street connectivity resulted in smaller service areas in east Portland, a line was drawn around all the possible places to which someone could cycle from each given location and the area inside of that boundary was calculated. Because the area within 1 mile of the origin location holds the strongest influence over the bikeability score, the 1 mile network radius service areas are compared here. As seen in Table 7, the size of the service area within the one mile network radius for each of the origin locations is considerably smaller for east Portland locations. On average, someone leaving from one of the east Portland locations and biking for one mile could reach destinations within an area of 1.48 square miles. Comparatively, someone leaving from inner Portland could reach destinations within an area of 1.97 miles.

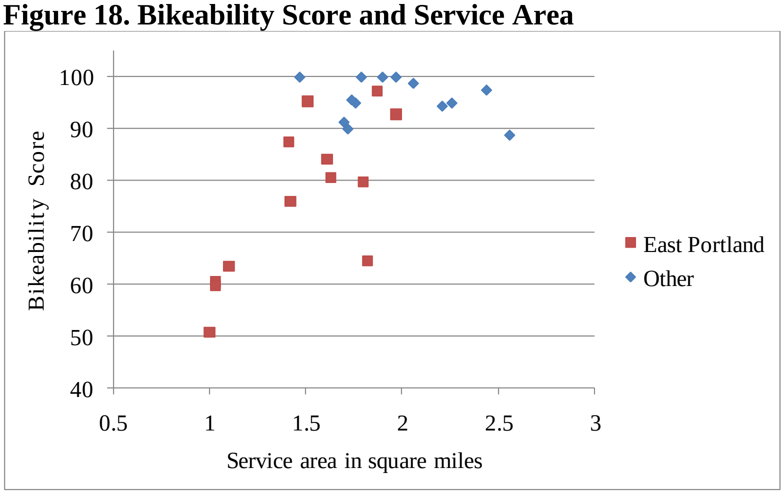
Table 7: **Bikeability Score and One Mile biking area by Origin Location**

ID	East Portland Locations	Bikeability Score	1 Mile Network Radius Service Area (mi.^{2})
8	10 NE 117th Ave.	97.2	1.87
7	950 NE 110th Ave.	95.3	1.51
10	11700 SE Division St.	92.8	1.97
4	1450 SE 167th Ave.	87.5	1.41
9	2500 NE 162nd Ave.	84.1	1.61
11	15300 SE Powell Blvd.	80.6	1.63
6	2 NE 148th Ave.	79.7	1.8
1	4700 NE 109th Ave.	75.9	1.42
13	5700 SE 122nd Ave.	64.4	1.82
12	10200 SE Powell Blvd.	63.4	1.1
3	3500 NE 141st Ave.	60.4	1.03
5	1600 NE 169th Ave.	59.7	1.03
2	2200 NE 152nd Ave.	50.7	1
	East Average:	**76.3**	**1.48**
	Correlation with Bikeability:		**0.74**

ID	Inner Portland Locations	Bikeability Score	1 Mile Network Radius Service Area (mi.^{2})
20	4214 NE Sandy Blvd.	100	1.97
24	1084 NW Marshall St.	100	1.79
26	502 SW Mill St.	100	1.47
25	806 NW 22nd Ave.	100	1.9
18	524 NE 32nd Ave.	98.8	2.06
17	1050 SE 28th Ave.	97.5	2.44
23	6516 N Denver Ave.	95.6	1.74
19	303 NE 16th Ave.	95	1.76
16	2866 SE 34th Ave.	95	2.26
22	18 NE Alberta St.	94.4	2.21
15	4450 SE 43rd Ave.	91.3	1.7
14	2868 SE 65th Ave.	90	1.72
21	3310 NE 18th Ave.	88.8	2.56
	Inner Average:	**95.9**	**1.97**
	Correlation with Bikeability:		**-0.26**

Figure 18 shows the relationship between service area and bikeability score. For the east Portland locations, a larger service area is closely related to a higher bikeability score. The three locations mentioned previously, with scores of 97, 95 and 93 (locations 8, 7 and 10, respectively) had among the largest service areas of their group - the routes available and street connectivity

Figure 18. Bikeability Score and Service Area

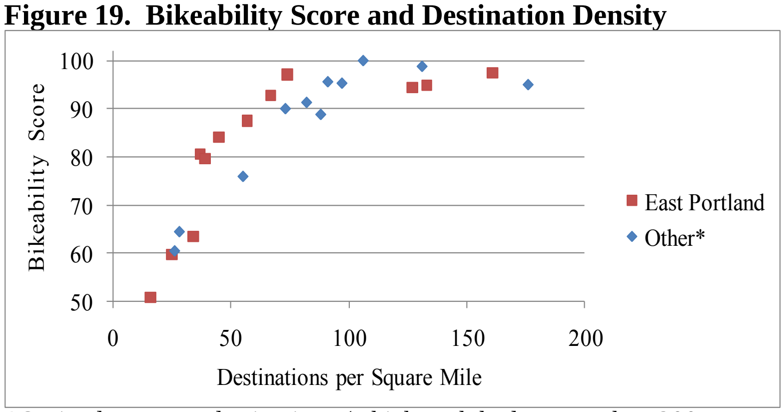


allow cyclists starting at those locations to cover 28% more ground than cyclists starting at the other east Portland locations.[23] However, for the locations in other areas of Portland, the relationship between the size of the reachable area and the corresponding bikeability score is much less evident. In fact, one of the downtown locations (#26) with a 100 score has the smallest area of all non-east Portland locations, while one of the northeast locations (#21) has the largest area and the lowest score of the non-east Portland locations. Further, one of the east Portland locations with a relatively large service area at 1.82 square miles (#13) has a relatively low bikeability score. These findings indicate that some factor other than area is very important.

A review of the number of destinations (of all types) that fall within the one mile network radius service area for each origin location is shown in Table 8. The table gives a sense of the dramatically different land-use characteristics of east Portland and the other neighborhoods examined in this study. Column 4 shows the total number of destinations reachable within the one mile boundary, while column 5 shows the density of destinations (the number of destinations divided by the size of the area in square miles) within the boundary.

East Portland locations provided access to, on average, a quarter the density of destinations as the other locations: 46.3 compared to 194.5 destinations per square mile. Even excluding the three downtown locations, the remaining comparison locations average 116.8 destinations per square mile – considerably higher than east Portland. Notably, the three high scoring east Portland locations have by far the greatest number of destinations and density of destinations, while the low scoring location with the relatively large service area (#13) has among the lowest of densities. These findings indicate a stronger connection between the number of destinations and the bikeability of a neighborhood. Figure 19 illustrates the relationship between bikeability and destination density.

Figure 19. Bikeability Score and Destination Density



*Omits downtown destinations (which each had greater than 200 destinations per square mile and bikeability ratings of 100)

[23] The average 1 mile network radius area of these three locations is 1.78 square miles, versus 1.29 miles for the other east Portland locations.

Table 8: Destinations and Destination Density within one mile of origin locations

ID	East Portland Locations	Bikeability Score	1 Mile Service Area (mi.^{2})	Total Destinations in 1 Mile Area	Dest. / Square Mile
8	10 NE 117th Ave.	97.2	1.87	138	74
7	950 NE 110th Ave.	95.3	1.51	146	97
10	11700 SE Division St.	92.8	1.97	133	67
4	1450 SE 167th Ave.	87.5	1.41	80	57
9	2500 NE 162nd Ave.	84.1	1.61	73	45
11	15300 SE Powell Blvd.	80.6	1.63	61	37
6	2 NE 148th Ave.	79.7	1.8	71	39
1	4700 NE 109th Ave.	75.9	1.42	78	55
13	5700 SE 122nd Ave.	64.4	1.82	51	28
12	10200 SE Powell Blvd.	63.4	1.1	38	34
3	3500 NE 141st Ave.	60.4	1.03	27	26
5	1600 NE 169th Ave.	59.7	1.03	26	25
2	2200 NE 152nd Ave.	50.7	1	16	16
	East Average:	**76.3**	**1.48**	**72.08**	**46.3**
	Correlation with Bikeability:			**0.93**	**0.89**
ID	**Inner Portland Locations**	**Bikeability Score**	**1 Mile Service Area (mi.^{2})**	**Total Destinations in 1 Mile Area**	**Dest. / Square Mile**
20	4214 NE Sandy Blvd.	100	1.97	208	106
24	1084 NW Marshall St.	100	1.79	847	474
25	806 NW 22nd Ave.	100	1.9	602	317
26	502 SW Mill St.	100	1.47	836	568
18	524 NE 32nd Ave.	98.8	2.06	270	131
17	1050 SE 28th Ave.	97.5	2.44	393	161
23	6516 N Denver Ave.	95.6	1.74	159	91
16	2866 SE 34th Ave.	95	2.26	301	133
19	303 NE 16th Ave.	95	1.76	310	176
22	18 NE Alberta St.	94.4	2.21	281	127
15	4450 SE 43rd Ave.	91.3	1.7	139	82
14	2868 SE 65th Ave.	90	1.72	126	73
21	3310 NE 18th Ave.	88.8	2.56	224	88
	Inner Average:	**95.9**	**1.97**	**361.15**	**194.5**
	Correlation with Bikeability			**0.66**	**0.63**

One problem with simply comparing the absolute number of destination or the destination density is that a person might be able to reach several restaurants while not having your grocery, park, school or other needs met. In order to provide a sense of which specific types of destinations were responsible for lower bikeability scores, Table 9 shows the scoring data assessed to demonstrate how many points were lost per category.

Table 9: Bikeability Points by Destination Category

Category	Available Points	East Portland Average Score	East Portland Average Points Lost	Inner Portland Average Score	Inner Portland Average Points Lost
Full Grocery Stores	7.5	3.17	4.33	6.92	0.58
Movie Theaters	2.5	0.55	1.95	1.88	0.63
Light Rail Stops	5.0	3.37	1.63	3.46	1.54
Fitness Locations	5.0	3.37	1.63	4.9	0.1
Libraries	2.5	0.96	1.54	1.92	0.58
Restaurants	7.5	6.08	1.42	7.5	0
Cafés and Snacks	5.0	3.63	1.37	5	0
Preschools	2.5	1.3	1.2	2.31	0.19
Clothing Stores	5.0	3.8	1.2	4.95	0.05
Laundry and Cleaners	2.5	1.35	1.15	2.5	0
General Goods Stores	5.0	3.94	1.06	5	0
General Entertainment (bowling, theaters, etc)	2.5	1.61	0.89	2.21	0.29
Mail Services, including post offices	2.5	1.73	0.77	2.4	0.1
Drinking Establishments	5.0	4.28	0.72	5	0
High Schools	2.5	1.83	0.67	2.5	0
Banks	2.5	1.97	0.53	2.5	0
Middle Schools	2.5	2.12	0.38	2.5	0
Beauty Salons, Barbers, etc	2.5	2.14	0.36	2.5	0
Child Care	2.5	2.16	0.34	2.5	0
Specialty Grocery Stores	2.5	2.16	0.34	2.5	0
Religious Organizations	7.5	7.27	0.23	7.5	0
Bus Lines	5.0	5	0	5	0
Parks and Open Public Spaces	10	10	0	10	0
Elementary Schools	2.5	2.5	0	2.4	0.1
Total	**100**	**76.28**	**23.72**	**95.87**	**4.13**

Access to grocery stores was the number one destination detractor for the east Portland locations, accounting for, on average, a loss of 4.33 points. Following grocery stores, a number of other categories represented areas where accessibility is lacking, including access to movie theaters (1.95 points lost on average), light rail stops (1.63 points lost on average), fitness locations (1.63 points lost on average), libraries (1.55 points lost on average), restaurants (1.42 points lost on average) and cafes/snacks (1.37 points lost on average). In comparison, locations in inner Portland received full points in 14 of the 24 destination categories. Access to light rail was one of the major detractors; almost all of the points lost in the light rail category were in the four southeast Portland locations. No other categories accounted for more than a percentage point loss in score.

Future Scenarios

Although the analysis to this point examines only the bicycle infrastructure and land use/destination mix as it currently stands today, it is worth considering how these factors might change in the future and how those changes would impact bikeability. Further, how might planning efforts respond to the gaps identified by this analysis to take actions that improve bikeability in east Portland and other areas?

Improving bikeability by improving the bicycle network

Portland's City Council recently passed the Portland Bicycle Plan for 2030. Among the bicycle improvements called for in the plan is a major expansion of the city's bicycle boulevard network. Additionally, the plan calls for the adoption of new street treatments such as enhanced share roadways (ESRs) and advisory bike lanes (ABLs), which tend to be on lower traffic streets. Figure 18 shows the planned build-out broken into the two categories identified as having the most positive influence on cyclists' willingness to travel further distances – multi-use trails and bike boulevards (here incorporating enhanced share roadways and advisory bike lanes).

Figure 18: Portland Bicycle Plan for 2030 – Build-out of selected route types

Source: RLIS, Portland Bureau of Transportation

In order to assess what impact these planned improvements would have on bikeability in Portland, the bikeability scoring process was re-run using the 2030 system. For the purposes of this study, ESRs and ABLs were assigned the same threshold multiplier as bicycle boulevards - 1.22. Once route choice models built that factor in these route types, the model could be refined. Destination locations from the original analysis were retained to isolate the difference that the updated bicycle infrastructure would have on bikeability. Table 9 shows the effect that the 2030 bicycle infrastructure has on both the 1 mile network radius area and the bikeability score of each origin location.

Table 9: Impact of 2030 Build-out on service area and bikeability

		1 Mile Network Radius Area (square miles)			Bikeability Score		
ID	**East Portland Locations**	**Existing System**	**2030 Build-out**	**Percent Increase**	**Existing System**	**2030 Build-out** (existing land use)	**Percent Increase**
1	4700 NE 109th Ave.	1.42	1.52	7.2%	75.9	77.2	1.6%
2	2200 NE 152nd Ave.	1.00	1.30	29.8%	50.7	53.1	4.8%
3	3500 NE 141st Ave.	1.03	1.22	18.3%	60.4	62.4	3.3%
4	1450 SE 167th Ave.	1.41	1.59	13.0%	87.5	89.4	2.1%
5	1600 NE 169th Ave.	1.03	1.04	1.5%	59.7	59.7	0.0%
6	2 NE 148th Ave.	1.80	1.97	9.4%	79.7	79.7	0.0%
7	950 NE 110th Ave.	1.51	2.12	40.3%	95.3	95.3	0.0%
8	10 NE 117th Ave.	1.87	2.16	15.4%	97.2	97.2	0.0%
9	2500 NE 162nd Ave.	1.61	1.93	19.7%	84.1	85.0	1.1%
10	11700 SE Division St.	1.97	2.10	6.7%	92.8	94.4	1.7%
11	15300 SE Powell Blvd.	1.63	1.76	8.1%	80.6	82.8	2.7%
12	10200 SE Powell Blvd.	1.10	1.43	29.3%	63.4	67.5	6.4%
13	5700 SE 122nd Ave.	1.82	2.24	22.9%	64.4	64.4	0.0%
	East Average:	**1.48**	**1.72**	**17.0%**	**76.3**	**77.5**	**1.8%**
ID	**Inner Portland Locations**	**Existing System**	**2030 Build-out**	**Percent Increase**	**Existing System**	**2030 Build-out** (existing land use)	**Percent Increase**
14	2868 SE 65th Ave.	1.72	2.26	31.6%	90.0	93.1	3.5%
15	4450 SE 43rd Ave.	1.70	2.15	26.7%	91.3	92.5	1.4%
16	2866 SE 34th Ave.	2.26	2.46	9.1%	95.0	95.0	0.0%
17	1050 SE 28th Ave.	2.44	2.54	4.2%	97.5	97.5	0.0%
18	524 NE 32nd Ave.	2.06	2.25	9.2%	98.8	98.8	0.0%
19	303 NE 16th Ave.	1.76	2.15	22.3%	95.0	97.5	2.6%
20	4214 NE Sandy Blvd.	1.97	2.54	29.0%	100.0	100.0	0.0%
21	3310 NE 18th Ave.	2.56	2.82	10.2%	88.8	93.8	5.6%
22	18 NE Alberta St.	2.21	2.46	11.4%	94.4	94.7	0.3%
23	6516 N Denver Ave.	1.74	1.89	8.5%	95.6	95.6	0.0%
24	1084 NW Marshall St.	1.79	2.05	14.8%	100.0	100.0	0.0%
25	806 NW 22nd Ave.	1.90	2.05	8.1%	100.0	100.0	0.0%
26	502 SW Mill St.	1.47	1.66	12.9%	100.0	100.0	0.0%
	Inner Average:	**1.97**	**2.25**	**15.2%**	**95.9**	**96.8**	**1.0%**

The 2030 build out would have a significant impact on the area a cyclist could cover. Cyclists in east Portland would realize a 17% gain in the area they could cover compared with current access, slightly more in percentage terms than the 15.2% average gain cyclists in other neighborhoods would realize. However, east Portland cyclists' coverage area is still considerably smaller than that of inner Portland neighborhoods at 1.72 square miles of coverage for one mile of cycling compared to 2.25 square miles of coverage. Part of the reason for this is that, even with improvement in the bicycle infrastructure occurring across Portland, the bikeway system is still stronger in closer-in neighborhoods. Further, the broader issue of east Portland's relatively poor street connectivity is still a barrier to bicycle accessibility (despite some improved connections in the 2030 plan).

Improving bikeability by adding destinations

As previously mentioned, lack of access to grocery stores was the leading cause of lower bikeability scores in this analysis. An examination of the areas that have bicycle access to grocery stores reveals large gaps in east Portland. Using the analysis assumption that people would be willing to cycle one mile (but not further) to get to a full service grocery store (e.g. Safeway, Winco, etc), a service area was created by going one mile out from all full grocery stores in Portland. Anyone outside of this coverage area would have to cycle for more than one mile to get to a grocery store (and more importantly, to cycle more than a mile home with a load of groceries). Several strategically placed stores might significantly improve an area's bikeability. To test this idea, several suggested future grocery store sites were added based on gaps in the grocery store coverage and the analysis was rerun. Figure 19 shows existing grocery store coverage (based on a one mile network radius around existing grocery stores) and several potential locations for future grocery stores based on gaps in existing coverage (note that these locations do not take into account potential parcel size, availability, zoning, etc). Table 10 demonstrates how these selected future grocery store sites would improve bikeability scores for the east Portland locations. The three suggested grocery store locations increase the average bikeability score in east Portland from 76.3% to 77.4% - slightly less than improved bikeway infrastructure.

Figure 19: Grocery Store Coverage

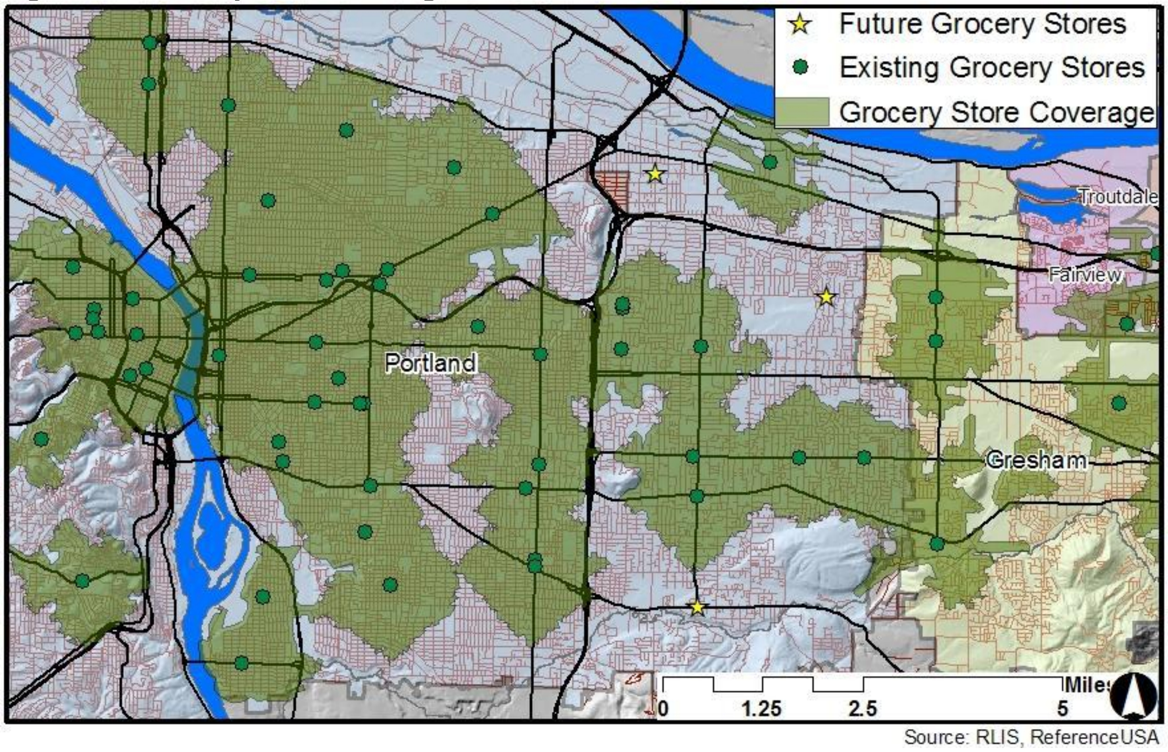


Table 10: Updated scores assuming new grocery stores added

ID	East Portland Locations	Current Bikeability Score	Score with new grocery stores
1	4700 NE 109th Ave.	75.9	**79.7**
2	2200 NE 152nd Ave.	50.7	**54.4**
3	3500 NE 141st Ave.	60.4	60.4
4	1450 SE 167th Ave.	87.5	87.5
5	1600 NE 169th Ave.	59.7	59.7
6	2 NE 148th Ave.	79.7	**83.4**
7	950 NE 110th Ave.	95.3	95.3
8	10 NE 117th Ave.	97.2	97.2
9	2500 NE 162nd Ave.	84.1	84.1
10	11700 SE Division St.	92.8	92.8
11	15300 SE Powell Blvd.	80.6	80.6
12	10200 SE Powell Blvd.	63.4	63.4
13	5700 SE 122nd Ave.	64.4	**68.1**
	Average:	**76.3**	**77.4**

Although the inaccessibility of grocery stores contributed the largest drag on bikeability scores in east Portland for any single destination category, a number of destination categories accounted for the generally lower scores. As mentioned in the findings, movie theaters, light rail stops, fitness locations, libraries, restaurants, and cafes were among the destinations responsible for the largest drops in scores. Policies that encouraged the clustering of these types of activities, in the lower scoring neighborhoods could go a long way toward further improving bikeability and addressing some of the bikeability gap between east Portland and other neighborhoods.

Limitations

This study presents a methodology for assessing the bikeability of a particular location using selected infrastructure and land use characteristics. The results present some generalized findings that do not take into consideration all the factors that make each neighborhood unique. The method and findings could be used to inform future attempts to understand bikeability, and hopefully, inform efforts to make underserved areas of Portland more bikeable. However, some areas have been identified that present limitations to this study and could be explored in future efforts to make findings more accurate and less generalized.

Choosing to cycle – There is limited research on what we know about the interaction between land use, destinations, infrastructure, and willingness to cycle. This study's scoring system assumes that many trip types currently taken by car and other modes could potentially be bicycle trips. However, it is unclear how many of these trips would be made by bicycle simply because the option is there.

Actual versus Potentially Bikeable Neighborhoods - Some of the locations identified as having high bikeability scores may be empirically unpleasant places to bike. These are essentially places where daily needs could be met on bicycle using existing route infrastructure. But, if people don't feel that the existing infrastructure creates a safe or enjoyable cycling environment, the bikeability rating merely represents a theoretical reality. However, such locations could be ideal places to focus transportation efforts and dollars on improving the cycling facilities and sense of safety because the landscape for a successful bikeable neighborhood already exists.

Limited route choice assumptions – While this study takes into account varying kinds of bicycle infrastructure (such as bike lanes, bike boulevard and multi-use paths), it does not take into account other factors such as slope, stops and signals per mile, turns and intersection maneuvers per mile, and bridge facilities. Future bikeability studies should look into incorporating these factors.

Standardized route choice assumptions – This study uses standard route choice ratios, for instance in assuming that everyone is willing to bicycle 35% further on an off-street multi-use trail than in a bike lane. In reality, each cyclist has their own set of preferences (e.g. most direct route, lowest traffic route, least elevation gain, etc). One interesting site that has started thinking about this issue is Cyclopath (www.cyclopath.org), which allows users to input individualized route type preferences and then outputs a suggested path based on those preferences (the site is currently geographically quite limited, operating just in the Minneapolis-St. Paul area).

Completeness of Business Data – This study relied on business reference data made available through the Portland State University Library by a subscription to ReferenceUSA. It is not clear how complete it is and within the time scope of this project only limited testing was possible. However, since the data pulled was the same for the entire city, the comparisons between neighborhoods are still informative.

Unique walkability factors not considered - For the comparison of bikeability scores to walkability scores the same network route choice assumptions were used. This was mainly done because the study was primarily focused on bikeability, but also in part to recognize that the routes that are attractive to cyclists are often attractive walking routes as well. Of course, this is a generalization and further studies, particularly those focusing on bicycling versus walking, could seek out route choice assumptions particular to pedestrians.

Market analysis needed for new business locations considerations - This study doesn't address the issue of factors such population density or other demographics and how these impact the ability of a neighborhood to sustain the number and variety of destinations needed to be walkable or bikeable. While suggesting new locations for businesses is easy, ensuring that they actually succeed is challenging, if not impossible. In areas where there may be an unfilled niche geographically (i.e. no other grocery stores for X miles) there may not be the population needed (according to market analyses, etc) to support a store. However, these types of situations may present opportunities to Portland or other municipalities to consider efforts to address population density issues or demographic barriers.

Summary of Key Findings and Conclusions

Summary of key findings

1. In both east Portland and inner Portland, people can get to more destinations and can meet more of their needs by bicycle than on foot.
2. Inner Portland locations are more bikeable; cyclists in inner Portland can cover over a third more territory (1.97 square miles) than cyclists in east Portland (1.48 square miles) by cycling the same effective distance (one mile, in this example). Further, the relationship between service area size and bikeability is particularly strong in east Portland, meaning that neighborhoods that are conducive to covering a lot of ground by bicycle are closely tied to higher bikeability ratings. This relationship is not so strong in inner Portland.
3. The Portland Bicycle Plan for 2030 build out would allow cyclists to cover 17% more ground in east Portland and 15% more ground in inner Portland. However, east Portland would still lag behind inner Portland both because it is starting so far behind in terms of bicycle facilities and because of its poor street connectivity.
4. East Portland has far fewer miles of bike boulevards or similar low traffic through streets - 1.2 miles on average in east Portland within a one mile service area compared to 7.1 miles on average in inner Portland; however, such routes show a strong correlation with increased bikeability in east Portland.
5. Multi-use trails have a negative correlation with bikeability in east Portland. This finding suggests that the trails may be concentrated in places that lack destinations.
6. East Portland has considerably fewer destinations per square mile. The correlation between destination density and bikeability is quite strong in both east and inner Portland.
7. Lack of access to grocery stores was the largest factor in decreasing bikeability scores in east Portland. Following grocery stores, lack of access to movie theaters, light rail stops, gyms, libraries, restaurants, and cafés all brought down bikeability scores considerably. However, policies that encourage carefully sited new stores or clusters could play an important role in increasing bikeability.

Conclusions

This study's methodology provides steps toward making an objective bikeability score – essentially asking if a place could be considered a 20-minute neighborhood. Whereas past studies considering bikeability rarely took land use and destinations into account in any in-depth way, and whereas other assessments that have taken destinations into account (such as Walkscore) didn't not take actual street or route networks into account, this project pushes the effort to integrate these transportation and land use factors. It expands upon bikeability studies such as Portland's Cycle Zone Analysis by examining land uses and destinations in-depth to provide a nuanced picture of the types of places that can be reached and, therefore, the needs that can be met from a particular starting location. It expands upon destination-based walkability studies such as Walkscore by using actual street networks and therefore provides a more realistic picture of how far a destination is from an origin location.

In its application, the process can be used to explore where planned (or hypothetical) infrastructure may be most helpful and which neighborhoods may not be receiving much added value from the planned improvements. The process can also be used to identify locations where certain kinds of destinations would be most helpful in promoting bikeability. This could be used to inform policies on developing or attracting certain types of destinations and businesses to specific locations or neighborhoods.

Finally, this study speaks to the ways that walkability and bikeability are related – and by extension, the usefulness of considering bikeable neighborhoods separately from walkable neighborhoods. Generally factors that make a neighborhood more walkable will also make it more bikeable, particularly in the area of land uses and destinations – for example identifying and working to fill gaps in essential shops, and services. In terms of infrastructure, needs for bikeability vary from those for walkability and should be considered separately.

This study does not intend to provide a conclusive answer to how bikeable or walkable a neighborhood is or could be. However, it does expand upon existing methods of evaluating neighborhoods on these factors. It also provides evidence for possible remedial actions and suggests areas where infrastructure improvements or new destinations could improve transportation options in east Portland.

Appendix: Tally of destination counts from origin locations

Neighborhood	ID	Address	Network Radius	Area (Sq. Miles)	Light Rail stop	Bus Lines	Parks	Libraries	Child Care	Pre	Elem	Middle	High	Full Grocery	Specialty Grocery	Clothing	General Goods	Beauty	Banks	Mail	Laundry	Fitness	General Entertain.	Drinking Est.	Movie Theaters	Restaurants	Cafes Snacks	Relig. Orgs.
East Portland	1	4700 NE 109th Avenue	2.5 Miles	9.05	5	30	37	1	5	1	6	3	4	1	29	16	31	16	10	6	4	5	3	18	1	41	15	29
			2 Miles	5.31	3	18	21	0	5	0	3	1	2	1	17	11	20	9	9	3	2	1	2	14	1	26	13	16
			1 Mile	1.42	0	10	8	0	1	0	1	1	1	0	8	1	9	3	4	1	0	0	0	6	1	12	5	8
			Half Mile	0.43	0	8	3	0	1	0	1	0	0	0	6	0	6	2	0	0	0	0	0	4	0	5	1	6
			Quarter Mile	0.11	0	4	0	0	0	0	0	0	0	0	1	0	4	1	0	0	0	0	0	1	0	1	0	1
East Portland	2	2200 NE 152nd Avenue	2.5 Miles	10.29	3	20	41	0	8	0	12	4	2	3	22	13	23	20	8	4	8	6	2	16	0	37	8	44
			2 Miles	6.04	2	18	27	0	5	0	5	3	1	1	11	7	11	8	3	1	3	1	2	4	0	15	3	22
			1 Mile	1.00	0	4	7	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	3
			Half Mile	0.18	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Quarter Mile	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
East Portland	3	3500 NE 141st Avenue	2.5 Miles	8.64	1	18	37	0	4	0	9	3	3	1	25	10	23	13	10	5	4	3	2	15	1	30	9	34
			2 Miles	5.49	0	12	26	0	0	0	4	2	2	1	14	5	13	6	7	4	2	0	1	5	1	16	6	19
			1 Mile	1.03	0	8	5	0	0	0	1	0	0	1	1	1	2	0	1	1	1	0	1	2	0	2	1	3
			Half Mile	0.36	0	4	2	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0
			Quarter Mile	0.10	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
East Portland	4	1450 SE 167th Avenue	2.5 Miles	10.13	6	18	51	1	20	7	17	8	5	7	25	18	32	42	7	3	14	6	3	19	2	62	10	68
			2 Miles	6.68	6	18	32	1	15	3	11	5	4	3	23	14	25	30	7	2	8	3	2	17	2	46	6	44
			1 Mile	1.41	2	10	7	0	2	1	4	2	1	1	3	3	5	8	0	0	2	2	0	4	0	11	2	12
			Half Mile	0.31	0	4	4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
			Quarter Mile	0.07	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
East Portland	5	1600 NE 169th Avenue	2.5 Miles	9.12	5	22	42	1	7	2	14	5	4	2	15	13	19	16	5	3	6	2	2	12	0	32	7	45
			2 Miles	5.49	3	19	23	1	3	0	5	1	1	2	11	7	14	7	5	3	6	2	1	6	0	21	5	24
			1 Mile	1.03	0	4	4	0	1	0	1	1	0	0	1	0	1	2	1	0	0	0	0	1	0	1	1	6
			Half Mile	0.21	0	2	2	0	0	0	1	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	1	1
			Quarter Mile	0.05	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
East Portland	6	2 NE 148th Avenue	2.5 Miles	11.92	7	28	50	2	18	4	21	7	7	6	31	28	41	46	13	3	12	9	3	27	1	61	15	66
			2 Miles	7.55	5	22	28	2	13	1	15	3	4	4	16	12	29	27	10	1	6	4	2	18	1	36	9	42
			1 Mile	1.80	2	10	6	0	5	0	1	0	0	0	5	5	4	5	0	0	1	2	1	4	0	11	2	10
			Half Mile	0.41	1	6	3	0	4	0	0	0	0	0	2	2	2	2	0	0	0	0	0	1	0	1	1	3
			Quarter Mile	0.11	1	4	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	2
East Portland	7	950 NE 110th Avenue	2.5 Miles	9.72	7	34	51	1	15	4	17	9	6	6	30	30	48	46	23	5	7	16	3	25	1	61	20	54
			2 Miles	5.90	4	30	29	1	6	3	11	5	5	4	13	21	34	31	21	4	5	9	2	16	0	38	17	36
			1 Mile	1.51	2	26	7	0	1	0	3	1	2	3	7	10	15	16	6	1	5	4	2	5	0	14	6	13
			Half Mile	0.29	0	6	1	0	1	0	0	0	0	0	2	1	1	1	2	1	3	2	0	4	0	3	0	2
			Quarter Mile	0.07	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
East Portland	8	10 NE 117th Avenue	2.5 Miles	12.42	8	34	60	1	22	4	20	11	6	7	44	35	58	60	25	5	10	20	6	34	1	87	28	70
			2 Miles	8.12	5	33	41	1	13	2	14	6	6	7	24	28	46	44	23	4	7	13	3	24	0	53	21	55
			1 Mile	1.87	2	14	12	1	3	1	3	1	1	2	5	9	11	13	5	1	2	5	1	9	0	15	7	10
			Half Mile	0.43	1	8	3	0	1	0	1	0	0	1	1	0	3	2	2	0	0	0	0	2	0	1	1	2
			Quarter Mile	0.10	1	4	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
East Portland	9	2500 NE 162nd Avenue	2.5 Miles	9.28	6	21	75	1	19	7	15	7	5	7	28	21	33	43	8	3	11	6	3	22	1	53	11	54
			2 Miles	6.19	3	16	39	1	15	6	11	7	3	3	20	13	19	30	4	1	11	4	2	15	1	40	6	44
			1 Mile	1.61	0	6	8	0	3	0	1	0	1	2	4	2	8	8	2	0	2	1	1	6	1	5	1	7
			Half Mile	0.37	0	2	0	0	0	0	0	0	0	1	0	1	5	6	1	0	1	1	0	4	1	4	1	0
			Quarter Mile	0.08	0	2	0	0	0	0	0	0	0	1	0	1	5	6	1	0	1	1	0	2	1	2	1	0
East Portland	10	11700 SE Division Street	2.5 Miles	12.92	7	34	67	1	22	3	19	11	7	10	45	29	61	63	31	5	10	17	6	36	1	105	27	59
			2 Miles	8.26	6	26	49	1	18	3	14	7	4	6	26	17	39	37	19	3	5	9	6	25	0	58	17	42
			1 Mile	1.97	0	11	13	1	5	1	3	1	0	2	8	7	12	11	4	1	2	4	0	7	0	12	8	14
			Half Mile	0.46	0	8	4	0	2	0	1	0	0	1	6	6	5	7	2	1	0	2	0	2	0	6	3	1
			Quarter Mile	0.12	0	4	2	0	1	0	0	0	0	1	1	2	4	1	1	1	0	1	0	0	0	2	2	0
East Portland	11	15300 SE Powell Blvd	2.5 Miles	10.34	2	20	85	0	21	5	16	7	3	5	21	18	29	35	5	2	10	7	5	19	1	46	11	51
			2 Miles	6.39	1	18	45	0	15	4	10	3	2	5	14	11	22	27	4	1	9	5	1	15	1	27	7	29
			1 Mile	1.63	0	5	2	0	2	2	2	2	1	1	4	3	6	4	2	0	2	0	1	4	0	9	0	8
			Half Mile	0.40	0	2	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	2	0	3
			Quarter Mile	0.09	0	2	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	2	0	0
East Portland	12	10200 SE Powell Blvd	2.5 Miles	10.64	6	26	69	2	14	2	16	10	4	6	38	23	45	49	25	3	3	13	5	28	1	93	25	54
			2 Miles	6.33	5	20	40	0	10	2	9	6	4	3	24	13	28	28	11	2	3	8	4	15	1	58	15	30
			1 Mile	1.10	2	8	8	0	0	0	1	1	0	0	1	0	2	2	0	0	0	0	4	0	0	4	0	8
			Half Mile	0.28	0	4	5	0	0	0	1	0	0	0	1	0	1	2	0	0	0	0	2	0	0	3	0	2
			Quarter Mile	0.06	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
East Portland	13	5700 SE 122nd Avenue	2.5 Miles	10.79	5	23	76	0	12	2	12	7	3	4	27	12	26	24	6	2	3	4	4	17	0	42	13	44
			2 Miles	6.71	3	18	48	0	7	0	6	3	1	2	14	9	19	15	4	2	2	3	2	9	0	24	9	23
			1 Mile	1.82	0	6	16	0	4	0	2	1	0	0	4	0	4	2	0	0	0	0	0	1	0	6	1	6
			Half Mile	0.49	0	4	7	0	1	0	1	1	0	0	1	0	2	1	0	0	0	0	0	0	0	2	0	3
			Quarter Mile	0.12	0	4	4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1

Neighborhood	ID	Address	Network Radius	Area (Sq. Miles)	Light Rail stop	Bus Lines	Parks	Libraries	Child Care	Pre	Elem	Middle	High	Full Grocery	Specialty Grocery	Clothing	General Goods	Beauty	Banks	Mail	Laundry	Fitness	General Entertain.	Drinking Est.	Movie Theaters	Restaurants	Cafes Snacks	Relig. Orgs.
Southeast Portland	14	2868 SE 65th Avenue	2.5 Miles	13.60	6	34	71	3	15	7	25	24	8	15	61	43	96	92	31	7	14	26	9	70	5	204	54	109
			2 Miles	8.51	0	26	44	2	8	5	15	15	2	8	43	26	61	63	16	6	7	15	5	49	5	141	32	69
			1 Mile	1.72	0	12	9	0	1	0	0	1	1	2	10	3	9	12	2	1	2	2	1	10	0	27	7	15
			Half Mile	0.46	0	4	3	0	1	0	0	1	0	0	2	0	0	1	0	0	0	1	0	2	0	3	0	3
			Quarter Mile	0.13	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2
Southeast Portland	15	4450 SE 43rd Avenue	2.5 Miles	11.49	0	34	63	3	9	10	20	18	4	12	43	37	82	75	21	8	12	19	7	56	6	169	46	89
			2 Miles	7.45	0	28	44	2	4	7	15	13	4	6	27	22	51	48	10	6	7	13	4	40	3	101	28	46
			1 Mile	1.70	0	16	8	0	1	1	3	3	1	3	4	6	14	12	4	2	3	4	0	9	0	22	11	13
			Half Mile	0.37	0	6	1	0	0	0	0	0	0	1	2	0	2	0	0	0	1	1	0	0	0	1	0	1
			Quarter Mile	0.06	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Southeast Portland	16	2866 SE 34th Avenue	2.5 Miles	12.51	1	60	78	3	15	13	20	21	9	17	54	61	122	113	41	10	31	28	14	90	8	275	67	101
			2 Miles	8.32	0	36	48	1	9	11	15	16	5	9	35	36	74	64	13	6	13	17	8	63	6	185	43	77
			1 Mile	2.26	0	18	18	0	4	3	5	6	2	6	13	14	25	24	6	3	4	3	6	22	2	68	21	27
			Half Mile	0.52	0	10	4	0	0	0	1	1	0	0	3	1	5	5	0	2	0	0	0	3	1	9	4	5
			Quarter Mile	0.12	0	2	0	0	0	0	1	1	0	0	1	0	2	1	0	0	0	0	0	0	0	3	0	3
Southeast Portland	17	1050 SE 28th Avenue	2.5 Miles	14.15	52	94	87	3	32	19	26	22	15	19	71	220	204	199	109	17	46	46	32	137	18	517	130	128
			2 Miles	8.91	7	85	63	2	18	13	16	16	9	13	49	158	141	134	59	9	35	29	18	91	12	320	75	85
			1 Mile	2.44	0	20	21	1	6	4	4	7	3	5	16	18	32	35	8	1	6	7	6	27	3	118	17	30
			Half Mile	0.58	0	4	8	0	3	1	1	2	1	2	4	5	5	7	1	0	3	3	2	9	0	26	5	12
			Quarter Mile	0.14	0	4	1	0	0	0	0	0	0	1	0	0	0	1	1	0	1	2	0	3	0	4	2	1
Northeast Portland	18	524 NE 32nd Avenue	2.5 Miles	14.51	15	78	81	3	30	16	26	22	11	17	70	143	163	163	68	11	36	32	18	111	12	390	95	129
			2 Miles	9.22	5	43	53	2	23	12	17	18	7	13	41	120	120	112	50	10	24	24	14	66	10	255	63	91
			1 Mile	2.06	1	24	13	0	6	4	4	7	2	5	8	15	20	31	9	1	7	4	3	17	2	56	12	21
			Half Mile	0.48	0	10	4	0	0	1	0	1	1	0	3	1	6	5	0	0	1	0	0	2	1	8	1	6
			Quarter Mile	0.12	0	4	1	0	0	0	0	0	0	0	2	0	4	0	0	0	0	0	0	1	0	0	0	2
Northeast Portland	19	303 NE 16th Avenue	2.5 Miles	13.72	67	99	102	4	35	21	26	24	17	22	83	251	224	244	127	16	50	55	35	150	20	602	153	137
			2 Miles	8.51	43	93	64	2	24	12	14	17	9	15	60	209	160	166	99	10	37	33	28	112	14	456	107	89
			1 Mile	1.76	0	30	20	0	2	0	1	2	4	2	16	18	26	25	8	1	7	7	4	24	3	85	15	21
			Half Mile	0.43	0	10	8	0	1	0	1	0	1	0	5	5	9	6	3	0	3	3	1	6	0	22	5	5
			Quarter Mile	0.09	0	6	1	0	0	0	0	0	0	0	0	0	3	1	1	0	0	1	0	0	0	3	1	0
Northeast Portland	20	4214 NE Sandy Boulevard	2.5 Miles	14.97	6	43	74	3	30	15	25	25	11	15	60	126	140	154	52	9	32	30	11	82	10	311	73	130
			2 Miles	9.16	2	36	38	2	22	13	17	16	6	12	28	57	86	90	37	6	20	16	8	52	5	179	32	67
			1 Mile	1.97	1	24	10	1	5	4	5	4	1	4	6	15	23	28	9	4	5	4	4	8	2	26	5	13
			Half Mile	0.39	0	14	1	1	1	1	0	0	0	2	4	9	14	14	6	2	3	3	3	3	1	14	3	4
			Quarter Mile	0.07	0	8	0	1	1	1	0	0	0	1	2	5	8	5	2	2	2	3	1	1	1	6	1	2
Northeast Portland	21	3310 NE 18th Avenue	2.5 Miles	14.73	19	64	98	3	46	15	24	25	13	13	77	132	136	153	60	9	29	24	11	82	7	309	71	146
			2 Miles	9.86	9	44	53	3	38	14	17	19	10	8	53	114	102	114	43	8	17	15	8	47	7	213	53	122
			1 Mile	2.56	0	14	7	1	7	3	4	4	1	1	12	20	19	30	6	0	4	1	0	8	0	45	11	26
			Half Mile	0.64	0	6	5	1	0	2	3	2	0	1	0	1	4	1	1	0	0	0	0	1	0	5	2	6
			Quarter Mile	0.15	0	6	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0
Northeast Portland	22	18 NE Alberta Street	2.5 Miles	11.88	16	47	69	2	36	11	17	18	8	7	64	89	83	101	39	6	13	14	4	48	2	195	46	122
			2 Miles	8.18	6	28	49	2	28	8	14	16	6	5	46	32	45	63	14	3	6	7	4	31	0	121	31	101
			1 Mile	2.21	2	16	17	1	14	2	4	8	4	1	20	15	21	27	5	2	3	3	2	13	0	42	11	50
			Half Mile	0.48	0	8	4	1	4	2	2	2	1	0	5	1	6	3	0	1	0	2	1	3	0	9	1	15
			Quarter Mile	0.12	0	2	1	0	3	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3
North Portland	23	6516 N Denver Avenue	2.5 Miles	9.27	8	22	64	1	26	6	15	19	5	3	43	20	39	54	13	3	8	9	3	38	0	95	19	98
			2 Miles	5.94	7	18	44	1	18	3	9	11	4	3	28	13	25	34	12	3	6	9	3	26	0	63	14	68
			1 Mile	1.74	3	14	17	0	2	1	4	3	1	2	14	5	4	17	5	1	3	5	1	14	0	26	6	13
			Half Mile	0.50	1	6	3	0	1	1	1	0	0	1	1	2	0	2	0	0	0	1	1	1	0	4	1	4
			Quarter Mile	0.12	0	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	3	0	1
Pearl District	24	1084 NW Marshall Street	2.5 Miles	11.64	72	96	106	3	37	12	16	13	15	12	77	244	179	213	115	11	39	45	26	123	13	519	129	107
			2 Miles	7.24	71	93	68	2	25	11	13	10	12	11	65	222	155	189	108	10	35	36	25	103	13	456	119	72
			1 Mile	1.79	40	68	20	1	8	2	4	2	4	5	28	96	70	95	37	3	10	16	9	55	5	225	45	17
			Half Mile	0.40	14	20	7	0	1	0	0	0	0	1	7	21	13	23	13	1	5	6	0	9	0	41	8	2
			Quarter Mile	0.10	6	4	4	0	0	0	0	0	0	1	3	7	2	10	7	0	3	3	0	2	0	11	2	0
Northwest Portland	25	806 NW 22nd Avenue	2.5 Miles	9.38	71	93	82	2	24	11	14	9	12	12	68	223	160	188	110	11	36	38	25	109	13	463	120	68
			2 Miles	5.70	65	92	58	2	16	7	10	6	9	9	44	149	120	151	88	8	24	33	21	87	9	365	92	48
			1 Mile	1.90	24	37	20	1	4	2	4	3	1	7	25	63	46	79	28	2	10	16	4	34	2	150	32	13
			Half Mile	0.51	6	11	4	0	2	0	1	0	1	3	6	25	24	35	10	0	4	3	1	7	1	60	16	6
			Quarter Mile	0.13	4	9	1	0	1	0	0	0	0	1	5	16	10	10	1	0	1	0	0	2	1	31	6	1
Downtown	26	502 SW Mill Street	2.5 Miles	10.32	75	101	105	2	22	11	14	9	14	15	68	218	173	194	113	13	40	51	28	119	15	511	132	93
			2 Miles	6.12	70	99	74	1	17	10	11	5	10	9	55	155	126	157	88	7	33	38	24	94	11	402	98	65
			1 Mile	1.47	39	83	33	1	10	6	5	2	7	2	17	82	57	75	51	5	16	17	16	41	7	198	51	28
			Half Mile	0.34	15	72	11	0	4	5	3	2	3	2	3	7	20	18	28	2	6	5	9	5	2	51	20	14
			Quarter Mile	0.09	7	53	3	0	1	2	1	1	1	0	0	0	7	2	7	1	2	1	2	1	0	15	5	4