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MEMORANDUM

November 30, 2022

To: Bryan Davis
Organization: Chittenden County Regional Planning Commission
From: Sean Dajour, Theja Putta, Michael Blau
Project: Chittenden County Regional Planning Commission Active Transportation Plan Update

Re: Task 3.3 Trip Potential Analysis – FINAL DRAFT

INTRODUCTION

Trip potential is an evaluation of factors that are likely to lead to higher levels of walking activity, bicycling activity and trail usage. The analysis is intended to highlight areas where the existing infrastructure already supports high numbers of people walking and biking or where such activity is currently low and improvements in infrastructure would be expected to increase it. Numerous studies[1] have identified positive correlations between walking and biking activity and factors including land use diversity, intersection density, population density, and destination density. Several studies have sought to identify ways to predict the probability and volume of walking and biking trips more accurately, but a consistent model has not emerged due to the granular and hard-to-predict nature of walking and biking.[2] Namely, individuals' decisions whether to walk, bike, or use another mode are influenced by preferences, unique characteristics of their surroundings, and other factors for which data is limited or unavailable.

We conducted four trip potential analyses: one for bicyclists countywide, one for pedestrians countywide, and two for pedestrians in local jurisdictions (South Burlington and Milton) identified by CCRPC staff. For each mode, CCRPC staff selected up to five unique trip types (origin-destination or O-D pairs). Because the origin-destination connections are modeled without regard for the underlying transportation network, we can identify locations where trip activity could occur regardless of whether walk/bike facilities currently exist or not. This is useful for highlighting areas where new or improved connections would be expected to increase walking and biking activity. The manner of calculating origin-destination pairs gets at land use

[1] Adams MA, Ding D, Sallis JF, Bowles HR, Ainsworth BE, Bergman P, et al. Patterns of neighborhood environment attributes related to physical activity across 11 countries: a latent class analysis. Int J Behav Nutr Phys Act. 2013;10:34. // Frank L, Giles-Corti B, Ewing R. The influence of the built environment on transport and health. J Transp Health. 2016;3:423–5. https ://doi.org/10.1016/j.jth.2016.11.004. // Sallis JF, Cerin E, Conway TL, Adams MA, Frank LD, Pratt M, et al. Physical activity in relation to urban environments in 14 cities worldwide: a cross-sectional study. Lancet. 2016;387:2207–17. // Saelens BE, Handy SL. Built environment correlates of walking: a review. Med Sci Sports Exerc. 2008;40(7 Suppl):S550–66. https ://doi.org/10.1249/MSS.0b013 e3181 7c67a 4.

[2] Singleton, Patrick Allen, "The Theory of Travel Decision-Making: A Conceptual Framework of Active Travel Behavior" (2015). TREC Friday Seminar Series. 84. https://pdxscholar.library.pdx.edu/trec_seminar/84

diversity and destination density. Because of the nuanced nature of trip types and the significant proportion of trips with vague or undefined types, this is an imperfect analysis and is but one way of looking at needs for infrastructure to accommodate walking and biking activity. Taken in combination with the Bicycle Network Analysis (BNA) and equity analysis, it should provide a robust picture of current and potential active transportation activity in the CCRPC region.

Methodology

The methodology uses an origin-destination model which looks for a combination of origin and destination locations within a specified reasonable walking or biking distance determined by the project team (see tables in Analysis Results). The following categories of data are included as inputs and discussed in greater detail below:

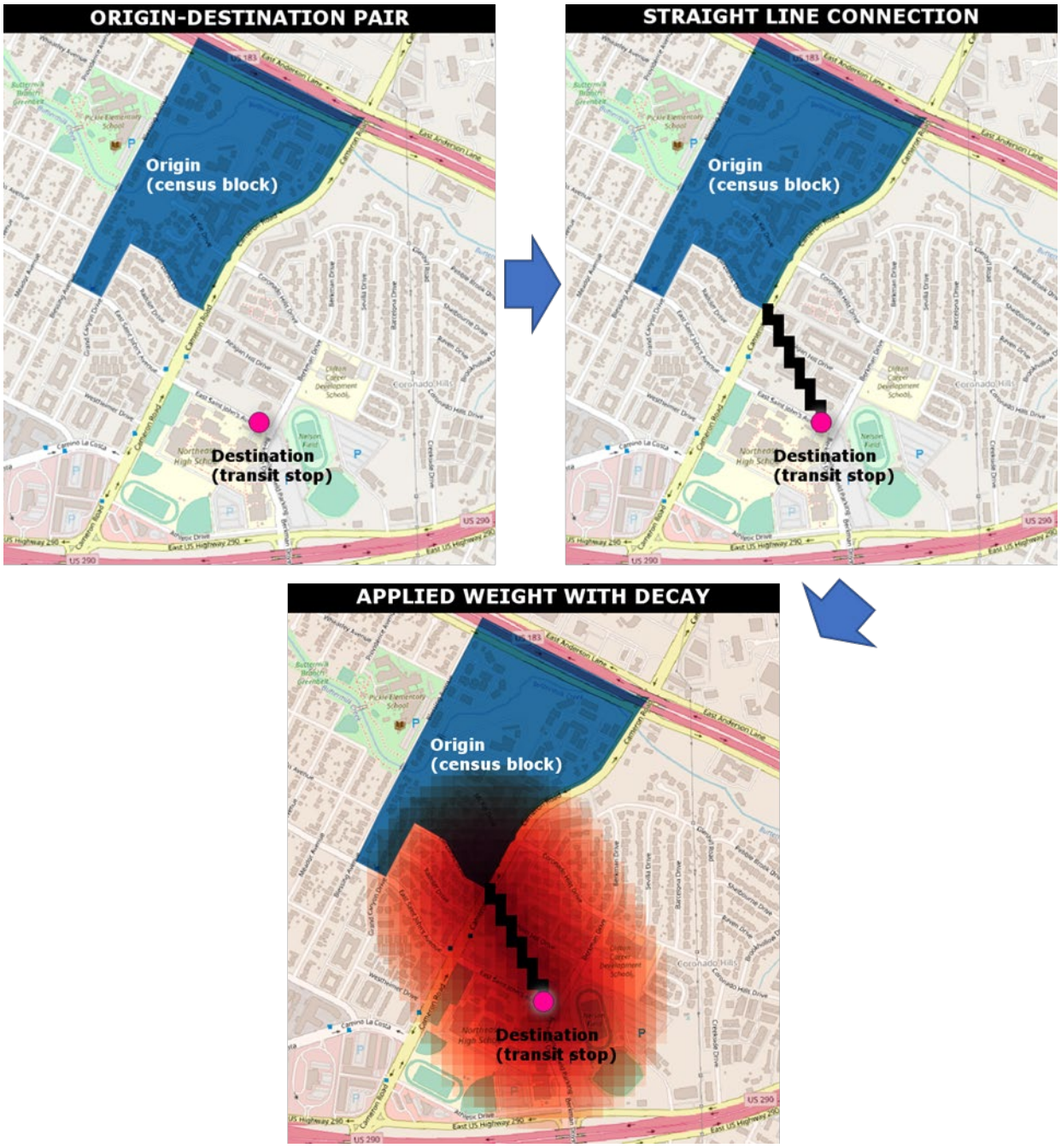
- Commercial activity
- Employment
- K-12 Schools[3]
- Parks
- Population
- Transit

Trip Potential Index

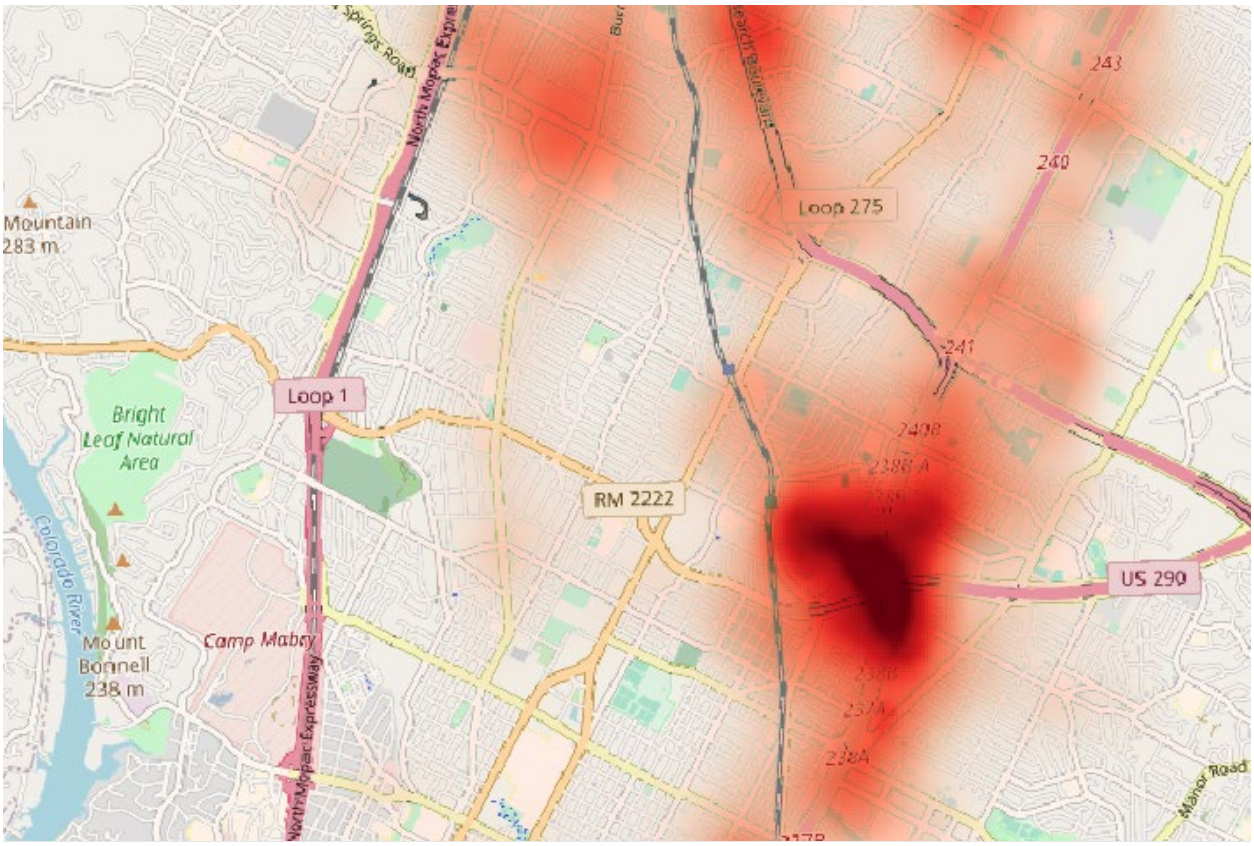
An index was calculated for each type of origin-destination pairing. The index was developed by identifying features in the origin and destination datasets that are within walking or biking distance. The index is calculated by iterating over origin and destination pairs, drawing a straight line connecting the two, and then applying a value to the connection, with a decay factor applied as distance from the straight line connection increases. **Notably, this emphasizes the potential connection between origins and destinations, rather than simply highlighting destinations.**

Consider an example connection between a Census block and a nearby transit stop:

[3] Most college and university students live within walking distance to campus, and were omitted from the bike trip potential analysis. The project team also determined that including University of Vermont in either analysis would overshadow other results due to its extremely high walk/bike potential.



The value assigned to the straight line is the product of the origin and destination weights combined. As the potential trip strays from the straight line, the combined weight of the trip pair decreases (referred to as "decay"). When this process is iterated for all possible origins and destinations, the results are summarized into an index, resulting in something that looks like this example:



For each trip type (i.e. type of OD pair), a trip potential index is calculated as described above. These values are then synthesized into an overall composite index using weights that indicate the relative importance of a trip type. The result of this is an overall composite trip potential index for the entire study area which considers the different types of trips of interest. The inputs used for the different trip types and their corresponding weightings are given in the subsequent sections of this memo.

Input Variables

Population

Population data was derived from 2019 Census data at the block group level. As some block groups are quite large in the County, lines connecting origins and destinations may not capture the trip potential for that O-D pair accurately. For this reason, block group polygons are converted to representative points that are generated randomly within the polygon. The number of points for each polygon depends on the area of the polygon (with one point for every square kilometer of land area). The population for each block group is then assigned to each point within the polygon equally.

Employment

Employment data is based on Longitudinal Employer-Household Dynamics (LEHD) data from the 2019 Census and includes employers of all sizes. The data is joined to block groups and the polygons are converted to points, similar to the process for population data.

Transit Stops

CCRPC provided transit stop location information from Green Mountain Transit for the transit variable.

Parks

The parks variable was developed through a combination of Open Street Map (OSM) data and CCRPC data. OSM data contains playgrounds, fields, and other small neighborhood parks while CCRPC data contains protected land and larger parks.

K-12 Schools

K-12 schools were derived from OSM data.

Commercial Activity

OSM data includes locations categorized as retail or shopping malls. These data were augmented with supermarket, convenience stores, pharmacies, and general store locations.

ANALYSIS RESULTS

Bicycle Trip Potential

Origin Destination Matching

The datasets described previously were combined into origin-destination pairs based on which origin or destination types would reasonably be expected to have potential for bicycling activity:

Origin features	Destination features	Bike - Max OD distance	Bike Weight
Population	Parks	2.5 miles	10
Population	Employment	3 miles	20
Population	K-12 Schools	2 miles	5
Population	Commercial activity	2 miles	15
Employment	Commercial activity	1 mile	5

Overall Results

More densely populated cities and towns within Chittenden County have the highest bicycling trip potential overall (Figure 1), but there are smaller cities and suburbs such as Williston, Richmond, and Hinesburg that have strong internal trip potential but few potential connections to neighboring communities. South Burlington, Winooski, and Essex Junction have some shared trip potential, whereas Williston, Richmond, and Hinesburg are more isolated. Burlington and Winooski have the highest concentration of bicycle trip potential. Both communities have urban centers with many destinations. Riverside Avenue and North Willard Street in Burlington appear to be the streets where the trip potential for bicyclists is highest. For Winooski, Main Street appears to have the strongest bicycle trip potential.

Trip potential from **population centers to parks** (Figure 2) is mostly represented in downtown Burlington and the center of Winooski, but there is a noticeable decrease in trip potential on the Winooski side of the Winooski River in comparison to the Burlington side, possibly because of fewer neighborhood parks and larger natural areas in Winooski. There is a high concentration of employment centers in Winooski, Burlington and South Burlington for commuters making the trip by bike (Figure 3). Employment trip potential is still present but begins to fade once one approaches Williston and Essex Junction. There is significant trip potential for bicyclists **commuting to K-12 school areas** in major city hubs such as Burlington, South Burlington, Winooski, and Essex Junction (Figure 4). Winooski and Burlington have the highest trip potential for commuters in **population centers looking to engage in commercial activities** (Figure 5). There is a stark contrast between Winooski and Burlington and the surrounding cities. Colchester, Essex Junction, South Burlington and Williston have some potential but this decreases further

from Burlington. The trip potential for **employment to commercial activity** is highest in Winooski, Burlington, and in Essex, South Burlington and Williston (Figure 6).

The countywide bicycle trip potential results confirm what we may intuitively surmise (i.e., Burlington area has higher bike potential than outlying areas). These results will be combined with Bicycle Network Analysis scenario planning in a subsequent task to identify routes for better bicycling along higher trip potential corridors in and out of Burlington and elsewhere in the county where trip potential is high.

Figure 1: Countywide Bicycle Trip Potential, Composite

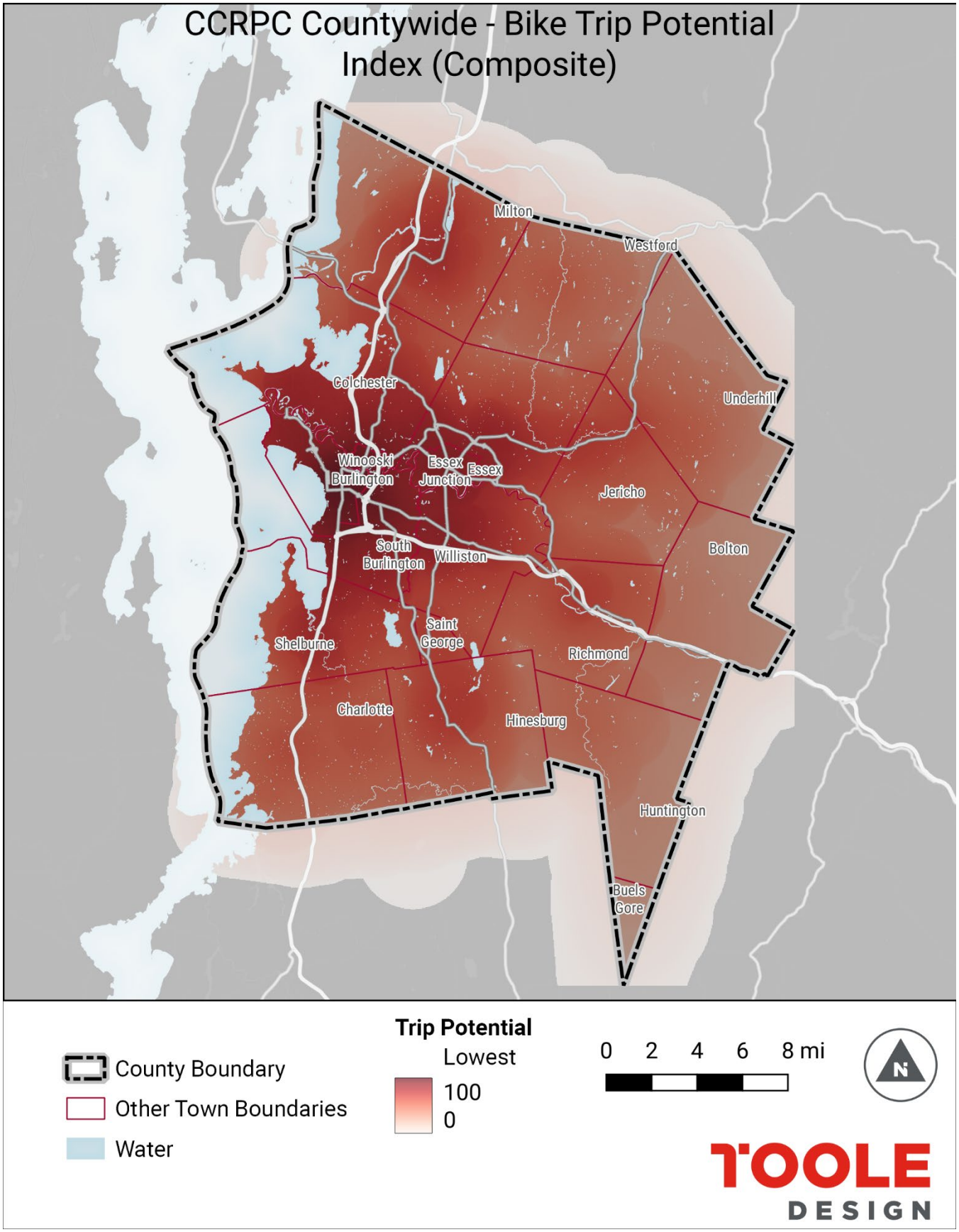


Figure 2: Countywide Bicycle Trip Potential, Population to Parks

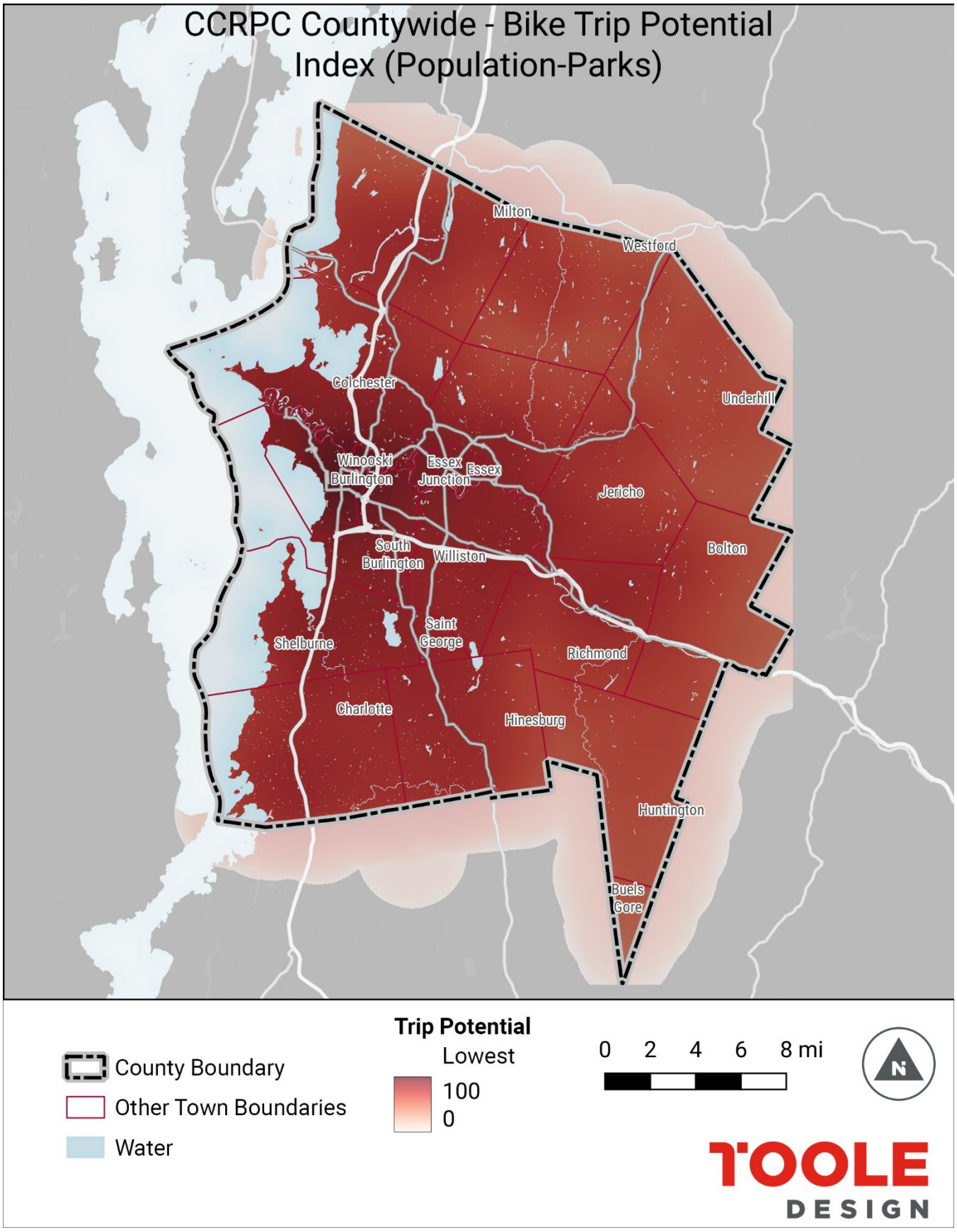


Figure 3: Countywide Bicycle Trip Potential, Population to Employment

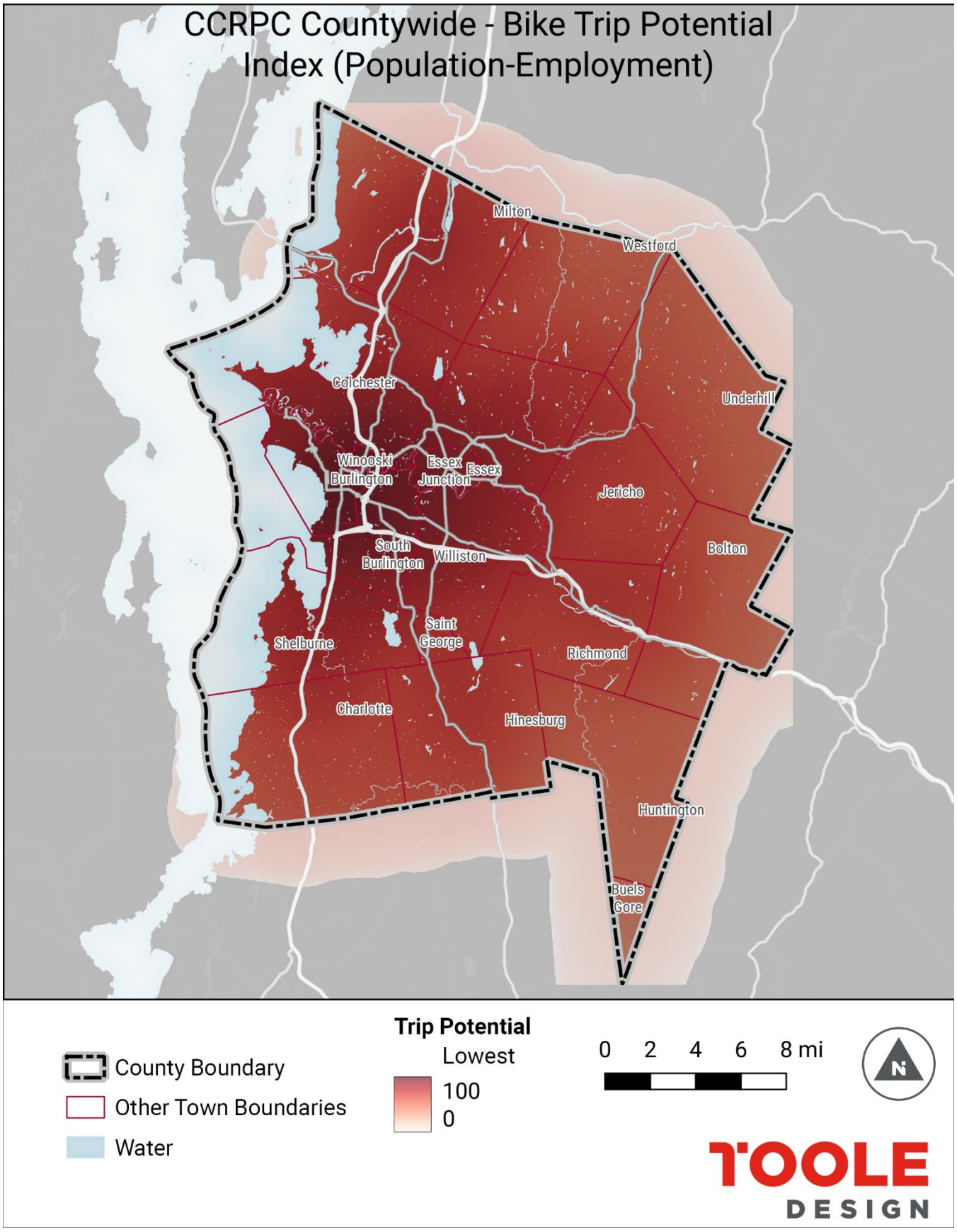


Figure 4: Countywide Bicycle Trip Potential, Population to Schools

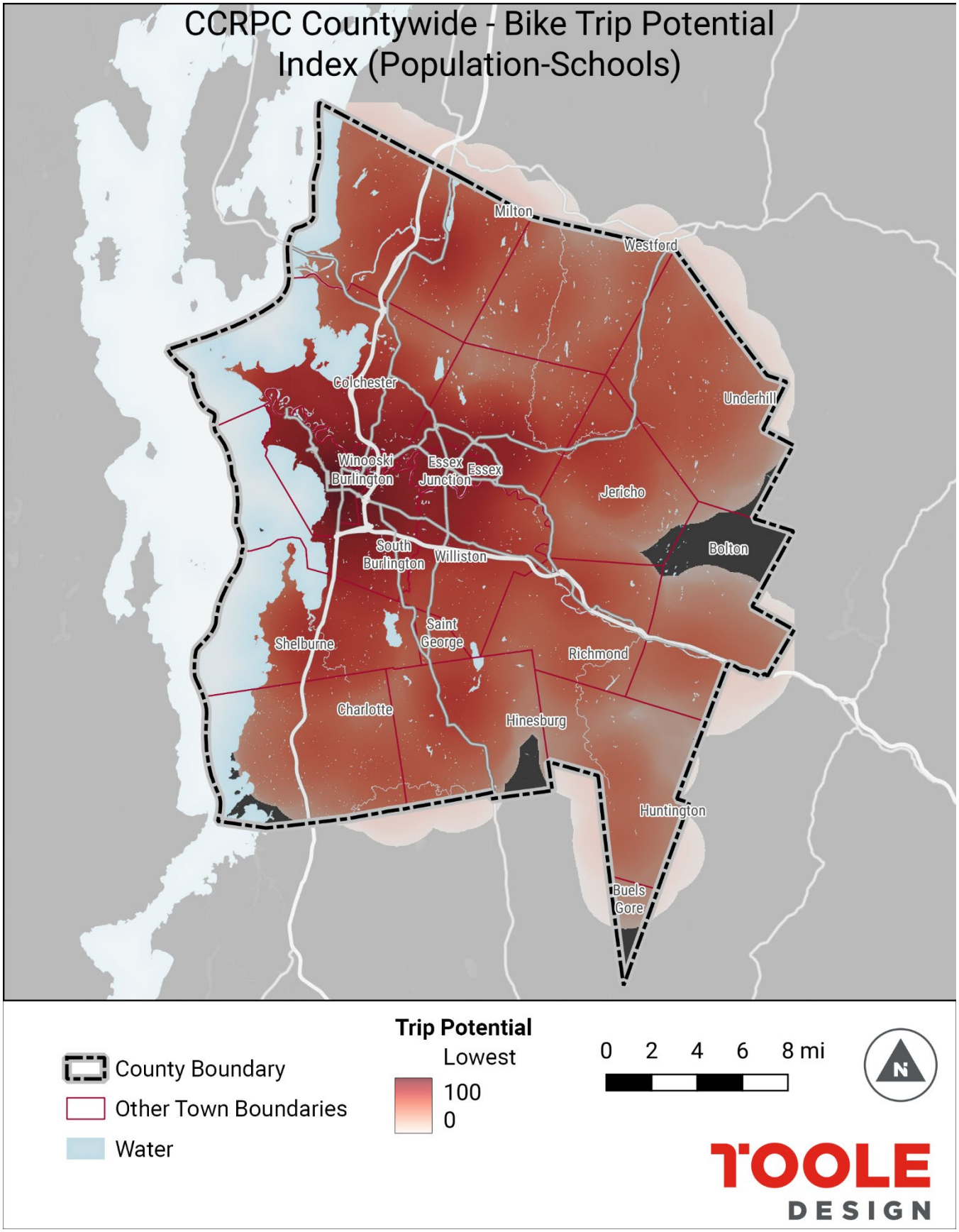


Figure 5: Countywide Bicycle Trip Potential, Population to Commercial

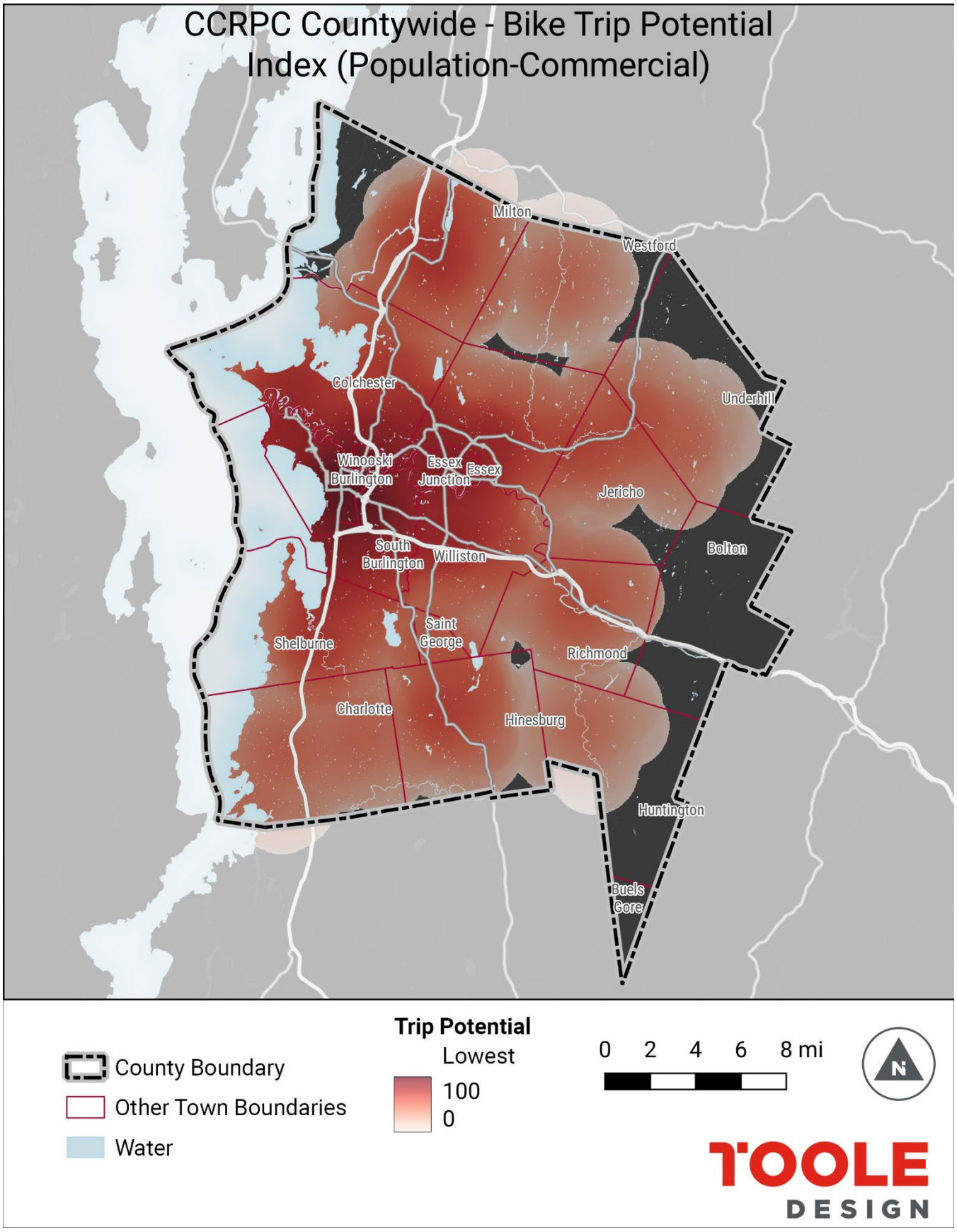
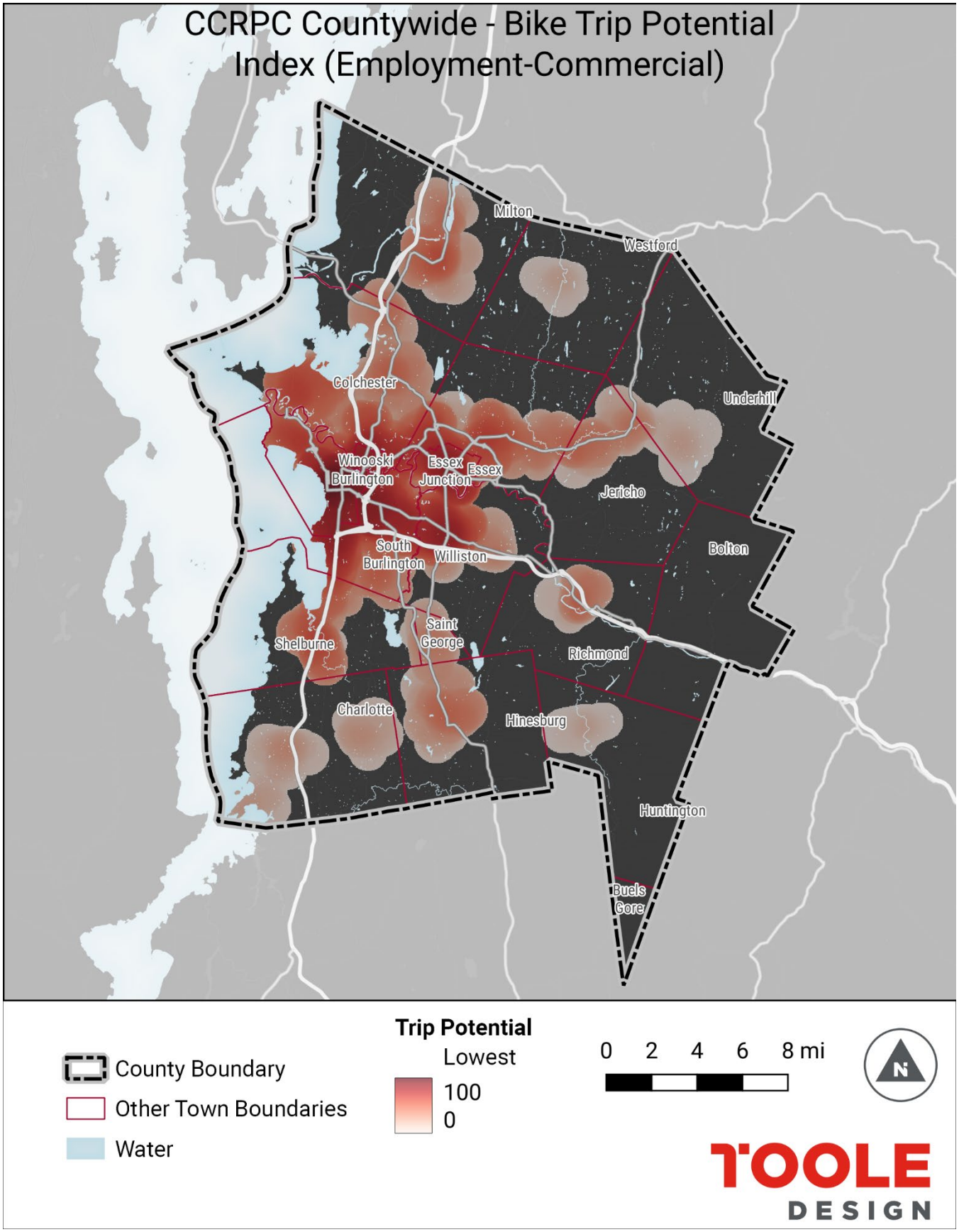


Figure 6: Countywide Bicycle Trip Potential, Employment to Commercial



Countywide Pedestrian Trip Potential

Origin-Destination Matching

The datasets described previously were combined into origin-destination pairs based on which origin or destination types would reasonably be expected to have potential for walking activity:

Origin features	Destination features	Walk - Max OD distance	Walk Weight
Population	Transit	0.5 mile	20
Employment	Transit	0.5 mile	20
Population	Employment	1 mile	10
Population	Commercial activity	0.75 mile	15
Transit	Commercial activity	0.5 mile	10

The initial countywide pedestrian trip potential results showed very high values for Burlington due to the large number of destinations there. The Burlington values are so high that it overshadows the rest of the region, which appears to have no trip potential (left image). We applied a logarithmic rescaling factor which suppresses the effect of some of the very high values, and the results from outside the Burlington area are more observable (Figure 7).

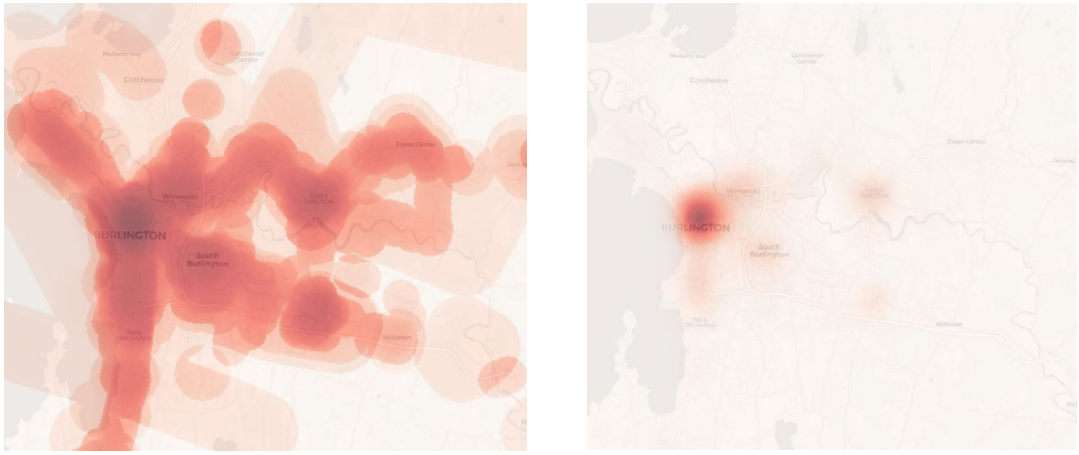


Figure 7: Initial results (right), logarithmic rescaling factor to suppress high values in Burlington (left)

Overall results are shown in Figure 8. There is significant pedestrian trip potential between **population centers and transit** in Burlington, South Burlington, Winooski, and Essex Junction as noted by the dark red highlights on the map (Figure 9). Burlington features the most concentrated trip potential. **Employment to transit** trip potential is strongest in Burlington and Winooski, with smaller hubs of potential activity in South Burlington, Essex, Essex Junction, Milton, and Williston (Figure 10). A corridor of potential activity reaches from Burlington to Shelburne, likely due to the Green Mountain Transit #6 line. The strongest **population to employment** trip potential is in the Burlington and Winooski area, with moderate trip potential in South Burlington, Essex Junction and Williston (Figure 11). **Population to commercial** trip potential in the region is heavily concentrated in Burlington, Winooski, and Essex

Junction (Figure 12). There are many commercial attractions in Essex Junction that may create a stronger population to commercial trip potential in that community. Essex Junction is a densely populated village area that also features the busiest Amtrak station in the state.[4] While the population is only 10,000, there may be a large number of people outside of the community that are drawn in due the amenities and accessibility via Amtrak. **Commercial to transit** trip potential is concentrated in Burlington, Winooski, South Burlington, and Williston with smaller pockets throughout the county (Figure 13).

[4] Amtrak service to Burlington started in July 2022, which may change this dynamic if CCRPC reruns the trip potential analysis in the future.

Figure 8: Countywide Pedestrian Trip Potential, Composite

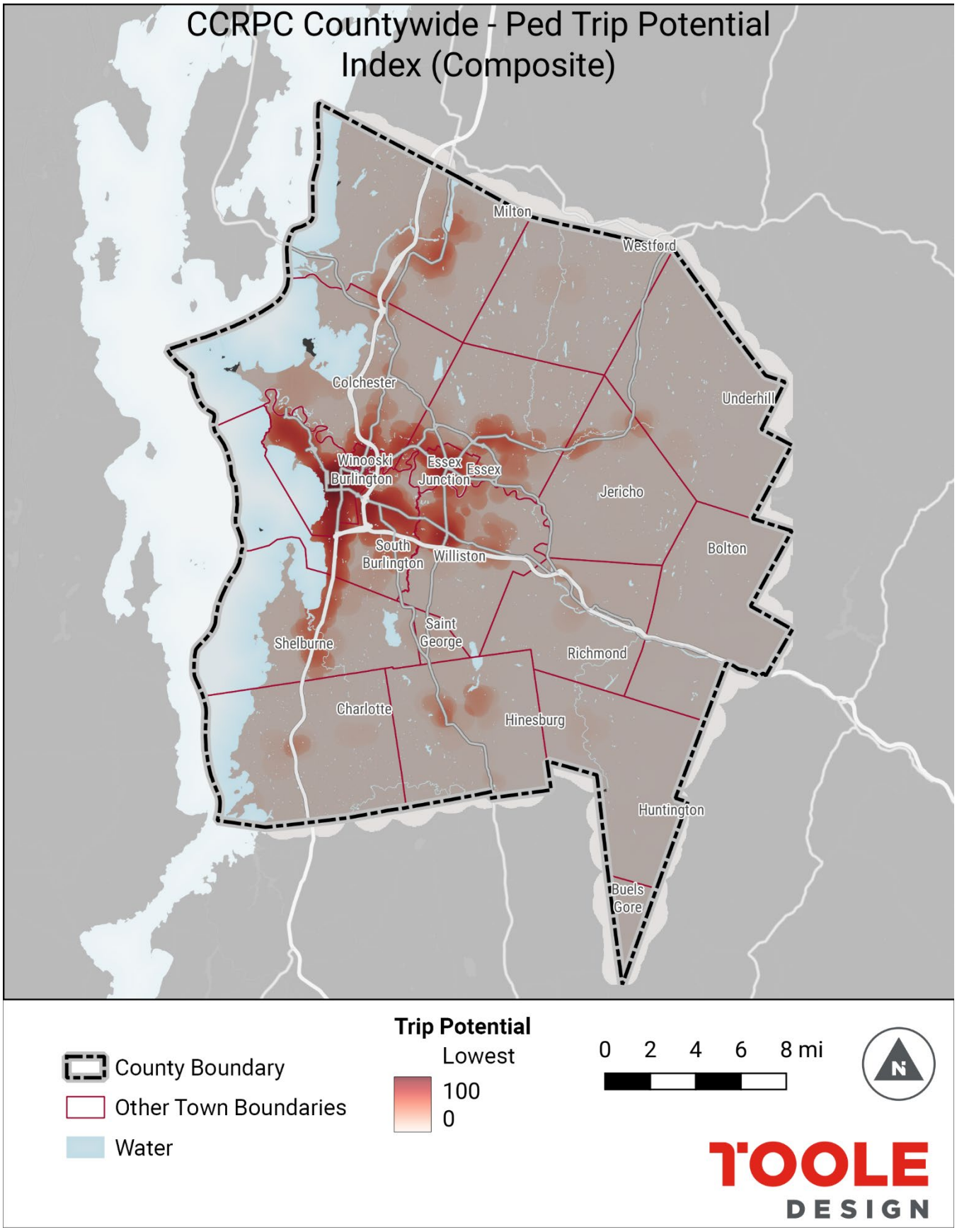


Figure 9: Countywide Pedestrian Trip Potential, Population to Transit

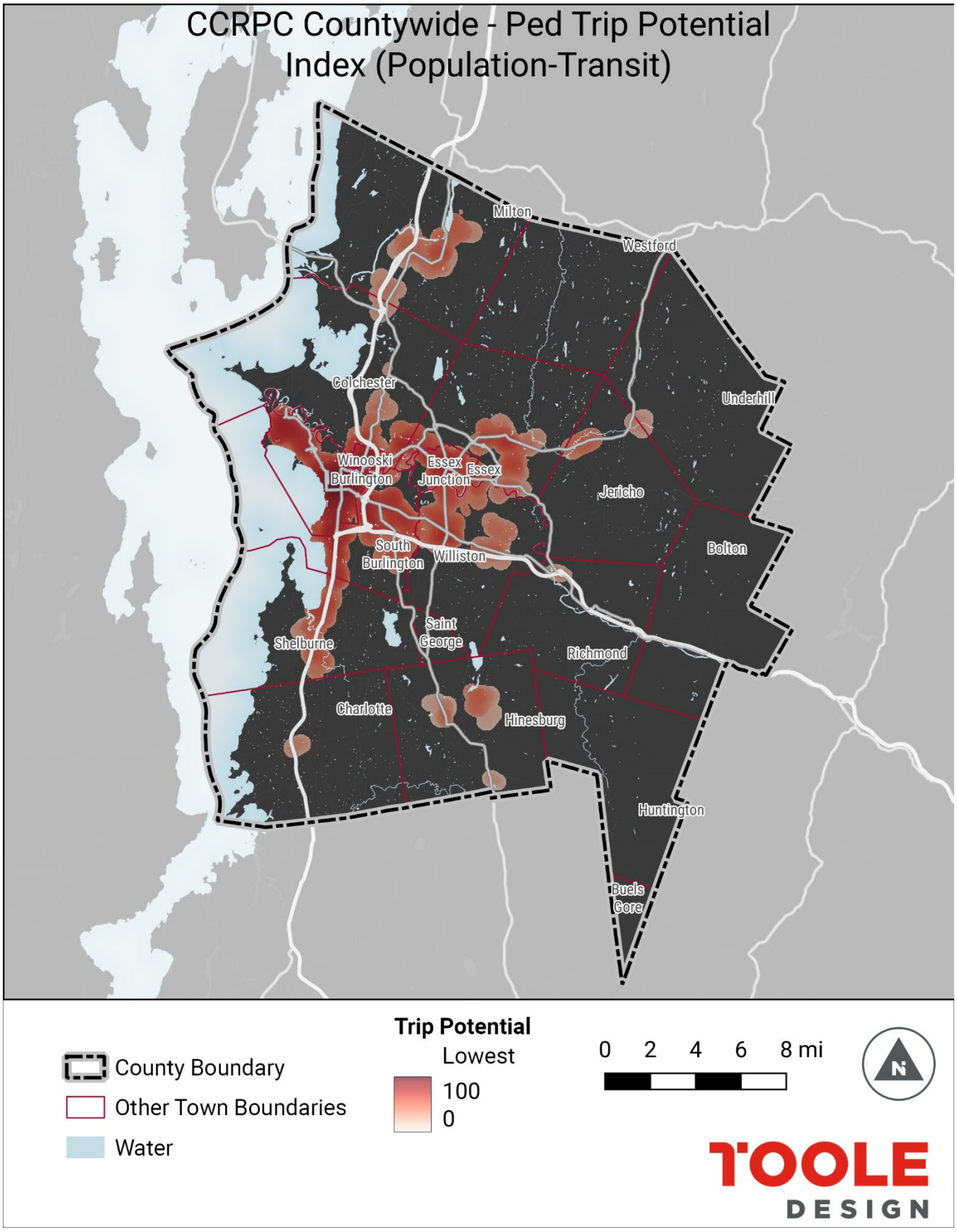


Figure 10: Countywide Pedestrian Trip Potential, Employment to Transit

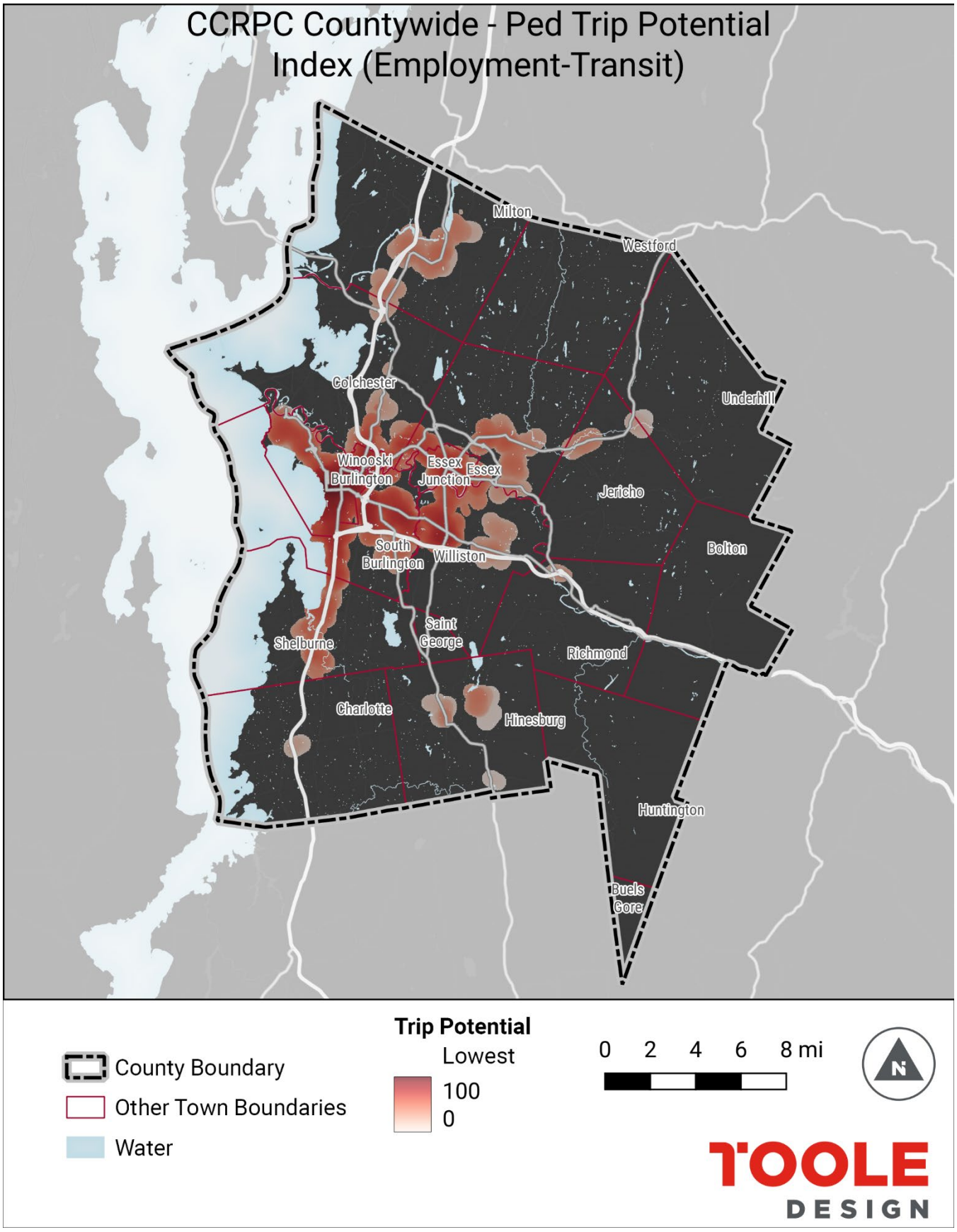


Figure 11: Countywide Pedestrian Trip Potential, Population to Employment

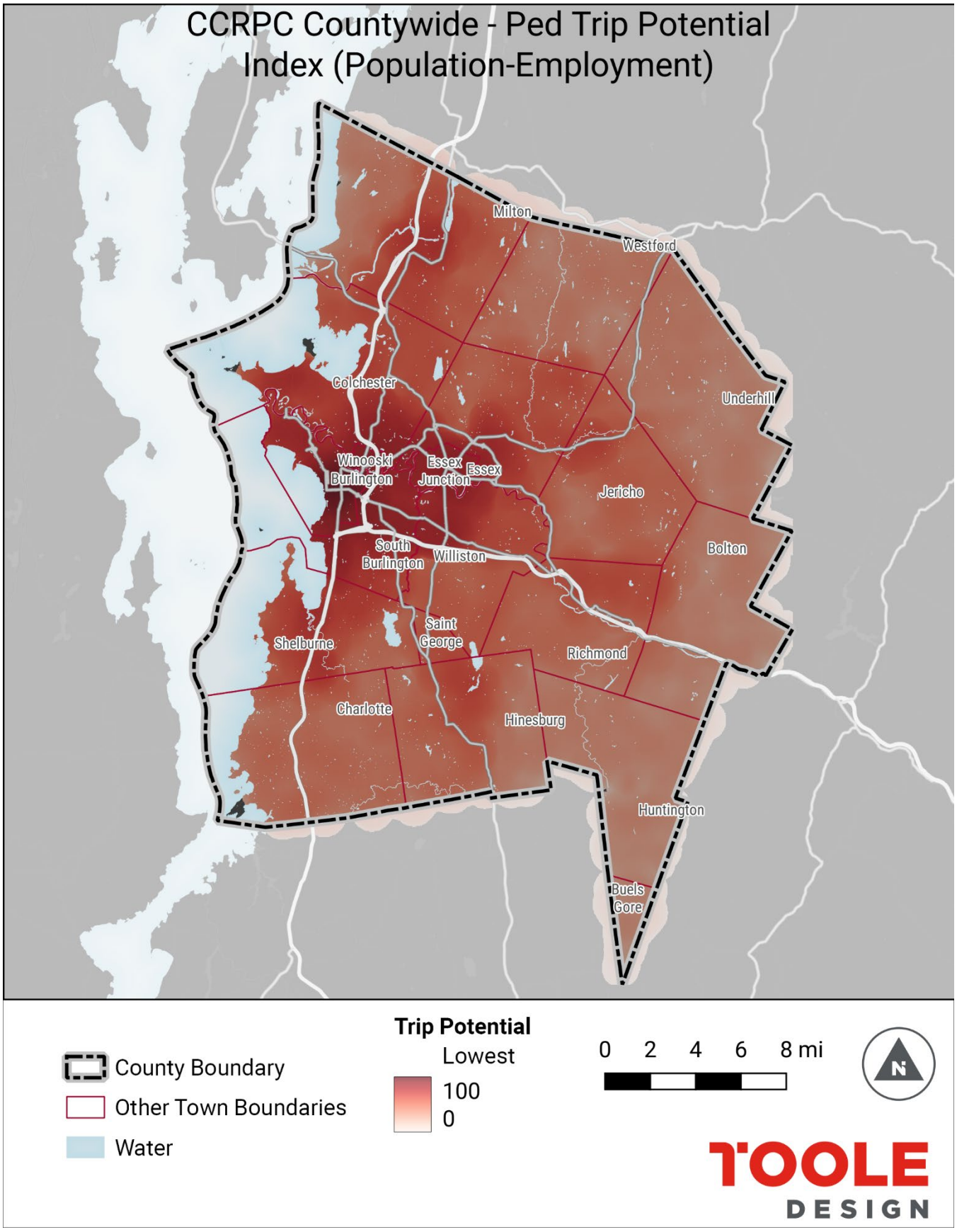


Figure 12: Countywide Pedestrian Trip Potential, Population to Commercial

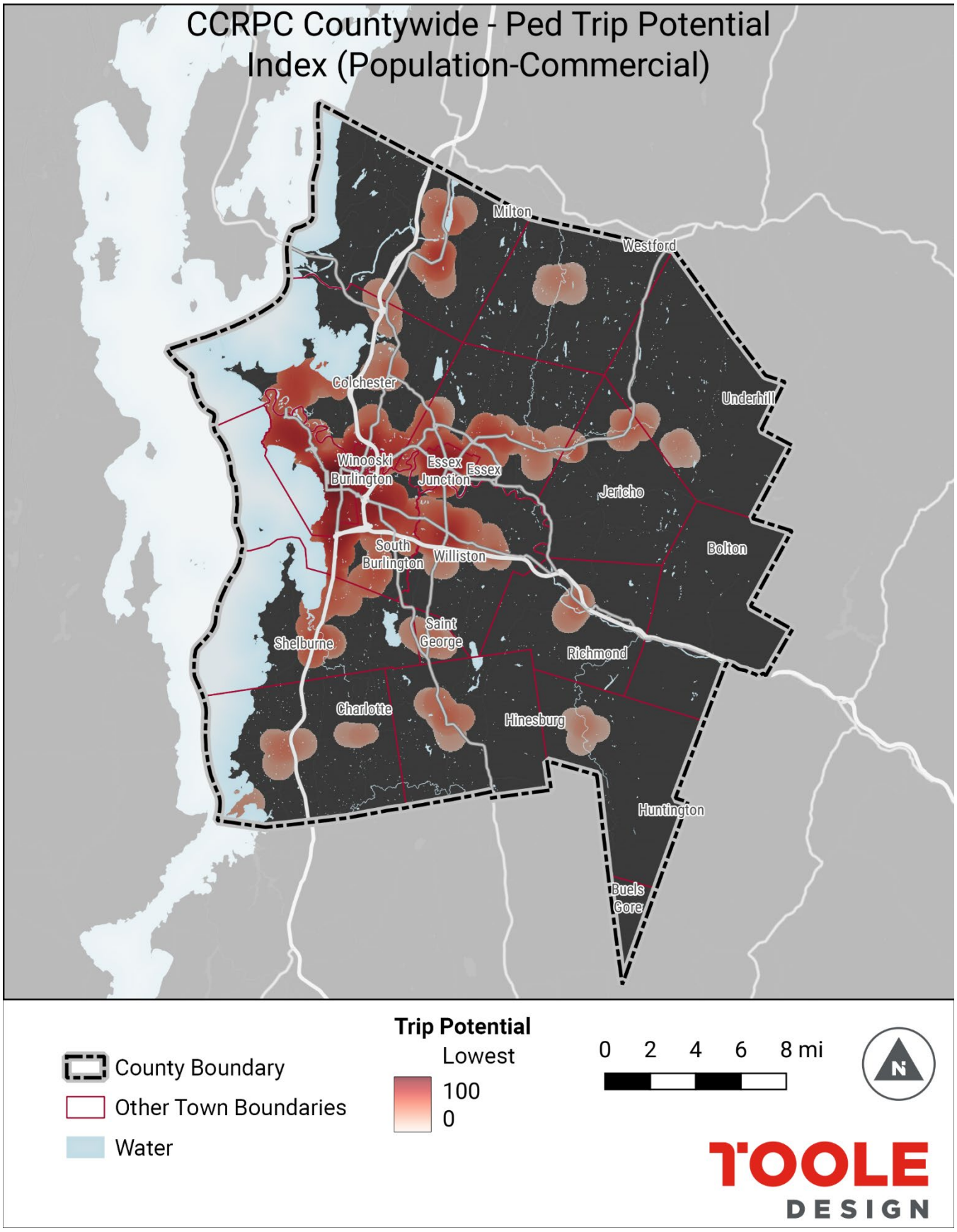
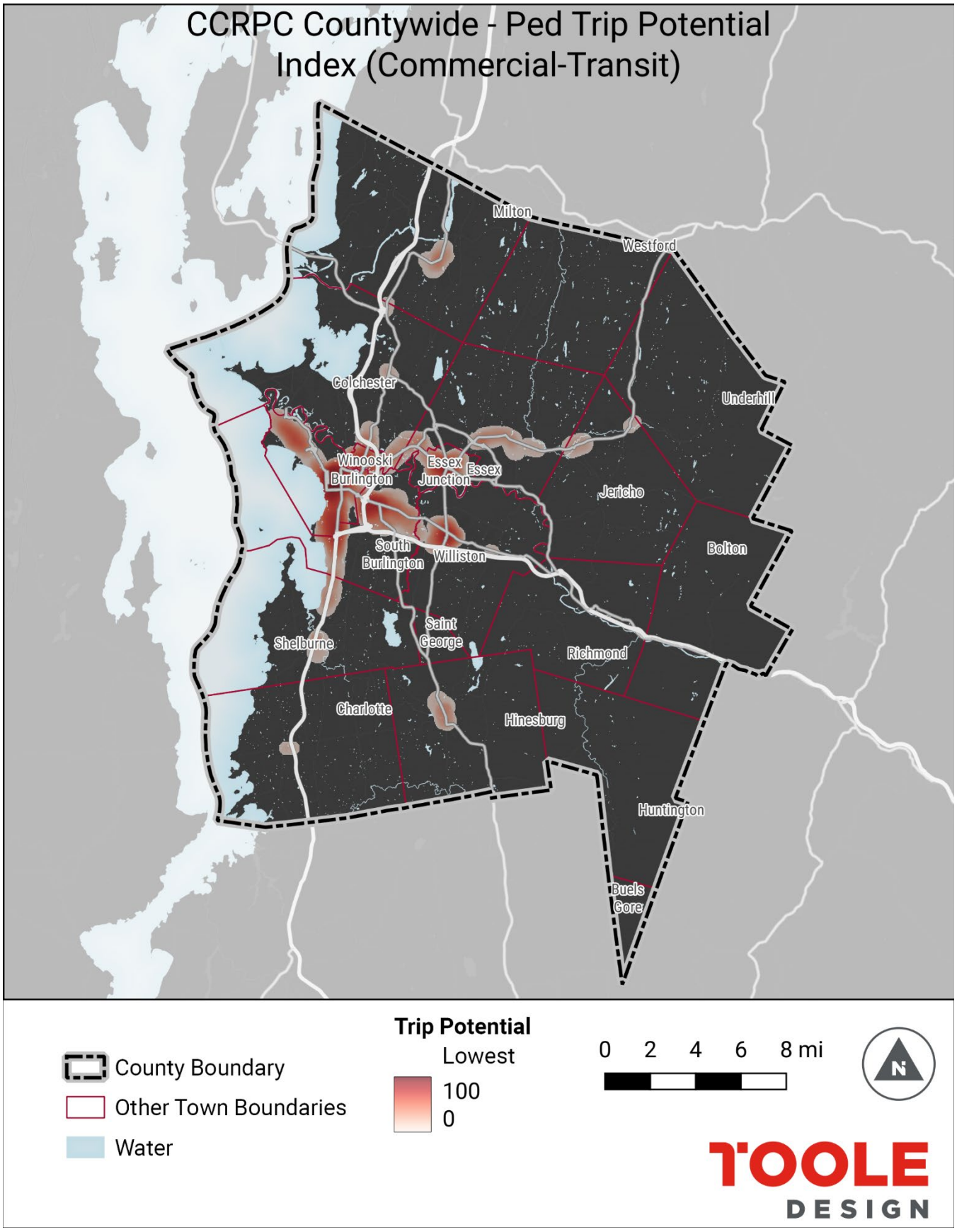


Figure 13: Countywide Pedestrian Trip Potential, Commercial to Transit



Local Pedestrian Trip Potential

By nature, walking trips tend to be short distances within local communities, so a countywide pedestrian trip potential analysis is not necessarily the most accurate or helpful proxy for actual pedestrian activity and demand. CCRPC staff selected Milton and South Burlington for additional analysis to understand pedestrian trip potential in those communities. These two communities were selected because they are two of the fastest growing communities in the state (according to US Census data 2010 and 2020), both are home to populations historically excluded from the planning process, and neither has an adopted comprehensive walk/bike plan. Note, however, that South Burlington has an active Bicycle & Pedestrian Committee which successfully advances active transportation projects in the City, and Milton has an adopted Recreation Master Plan that includes active transportation facilities and calls for the development of an active transportation plan that comprehensively considers walking, biking and trail connectivity in Milton.

Origin-Destination Matching

The datasets described previously were combined into origin-destination pairs based on which origin or destination types would reasonably be expected to have potential for walking activity:

Origin features	Destination features	Walk - Max OD distance	Walk Weight
Population	Transit	0.5 mile	20
Transit	Employment	0.5 mile	20
Population	Employment	1 mile	10
Population	Commercial activity	0.75 mile	15
Transit	Commercial activity	0.5 mile	10

Overall trip potential for the Town of Milton is relatively low compared to other communities within the county. The composite map shows that pedestrian trip potential is confined almost exclusively to the Village of Milton (Figure 13). However, **population to employment** trip potential is higher, although it still centers primarily on the Village. There is a high amount of trip potential for **employment centers and commercial activity** alone, but **transit** trip potential is low (Figures 14-18).

Pedestrian trip potential for South Burlington is highest near the borders of Burlington and Winooski. It appears that the trip potential from surrounding cities is merging with South Burlington and contributing to higher trip potential and walkability. The center of South Burlington is completely blank in the composite map (Figure 19), while the patterns for individual O-D pairs are more distributed throughout South Burlington (Figures 20-24).

Figure 14: Milton Pedestrian Trip Potential, Composite

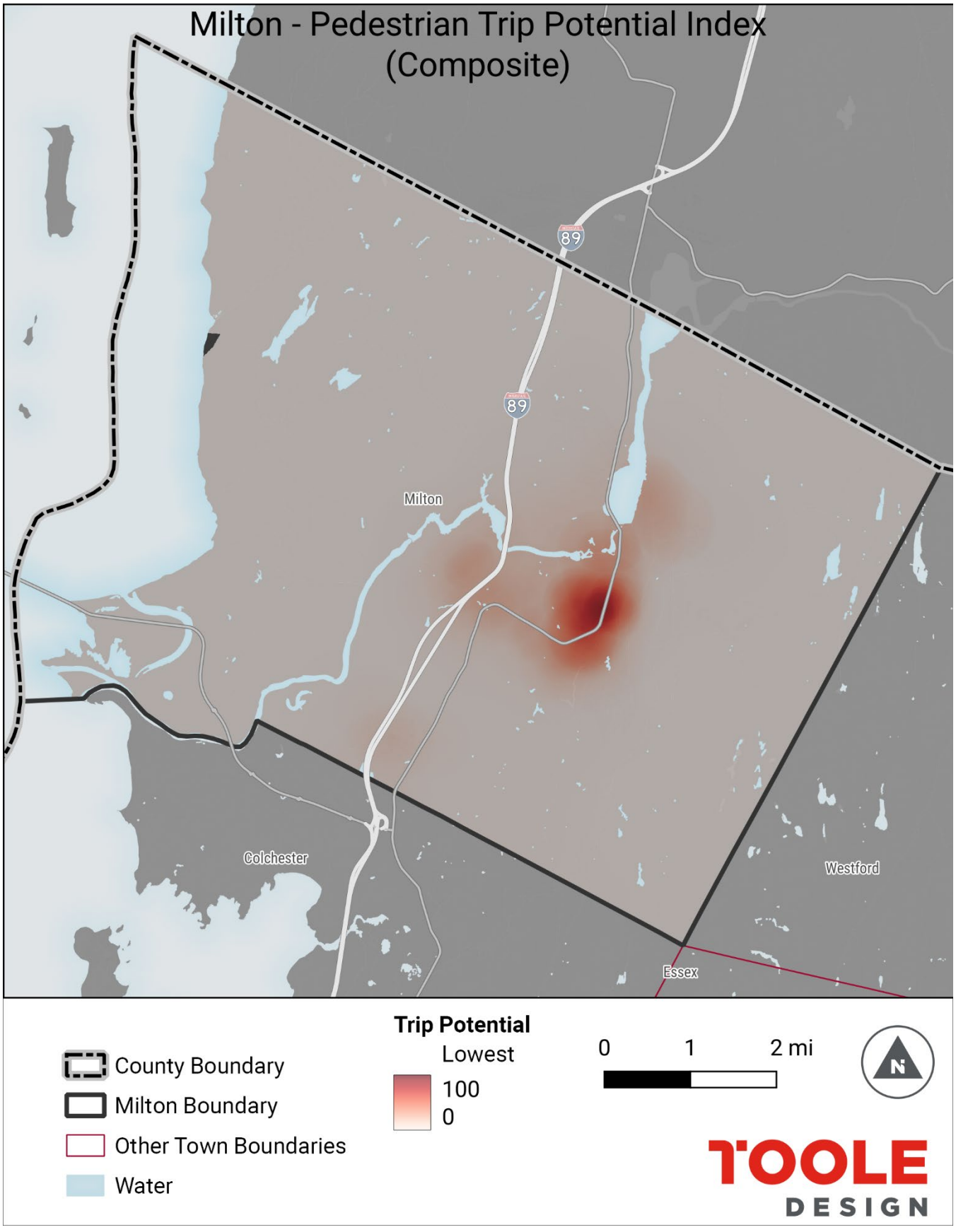


Figure 15: Milton Pedestrian Trip Potential, Population to Transit

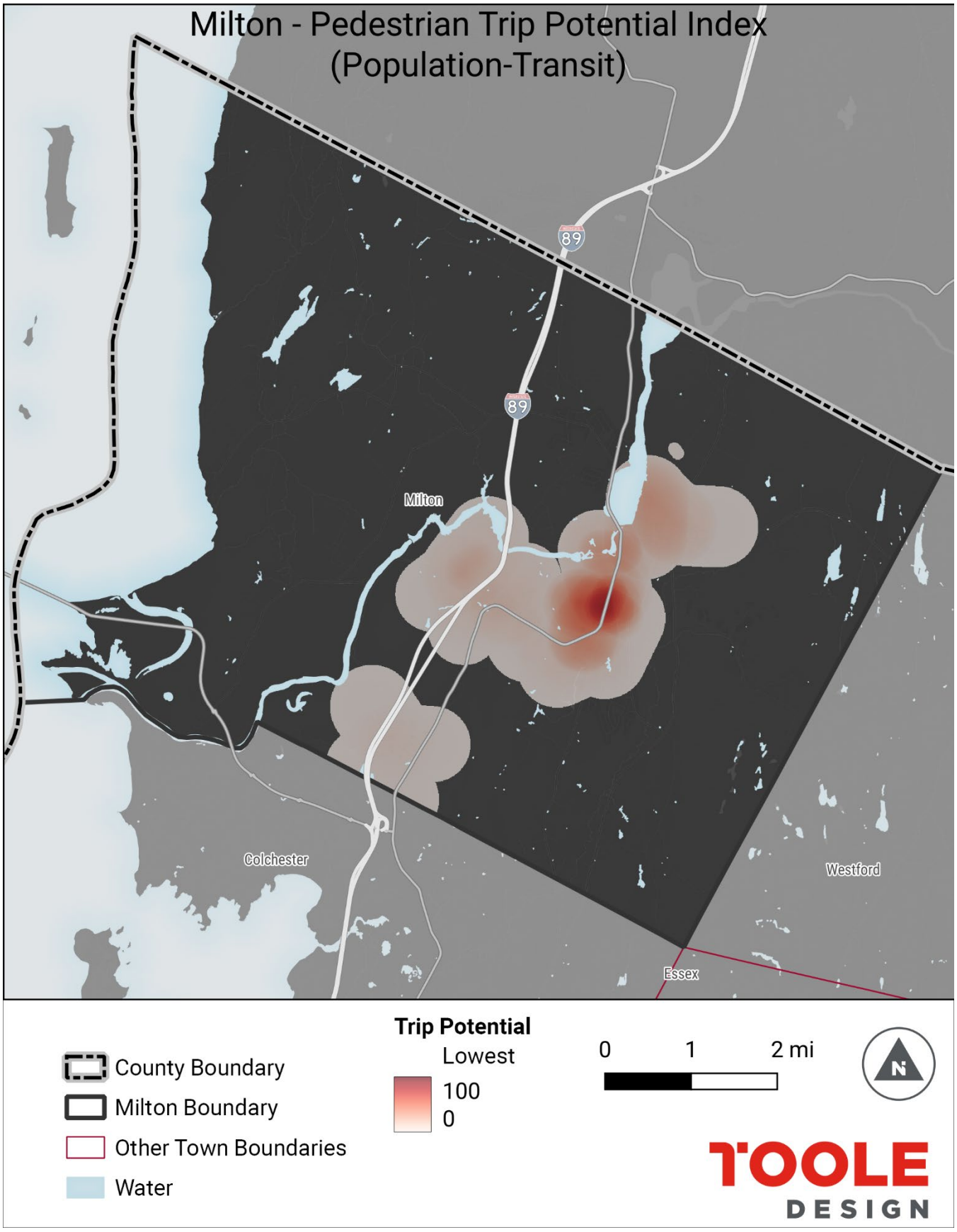


Figure 16: Milton Pedestrian Trip Potential, Transit to Employment

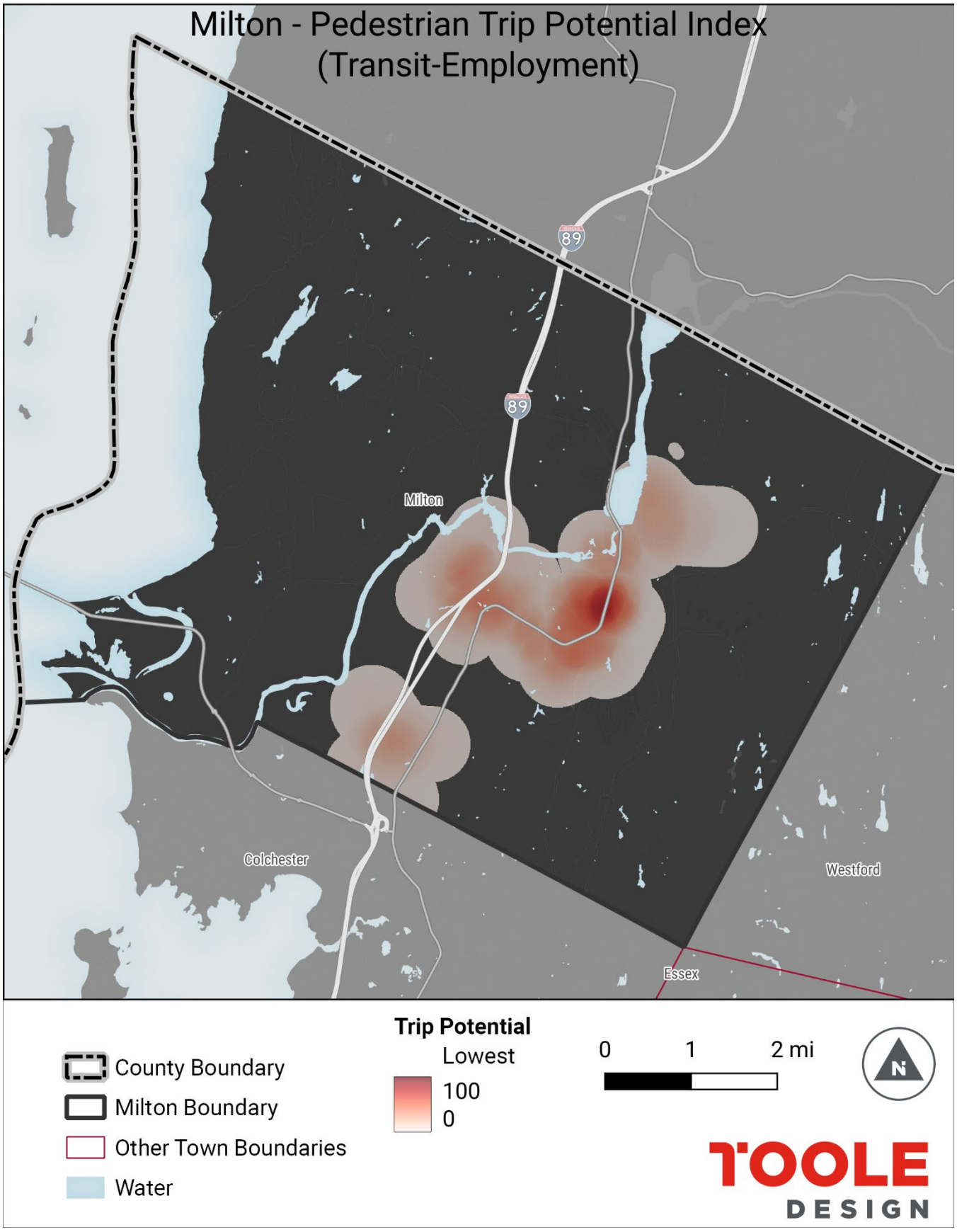


Figure 17: Milton Pedestrian Trip Potential, Population to Employment

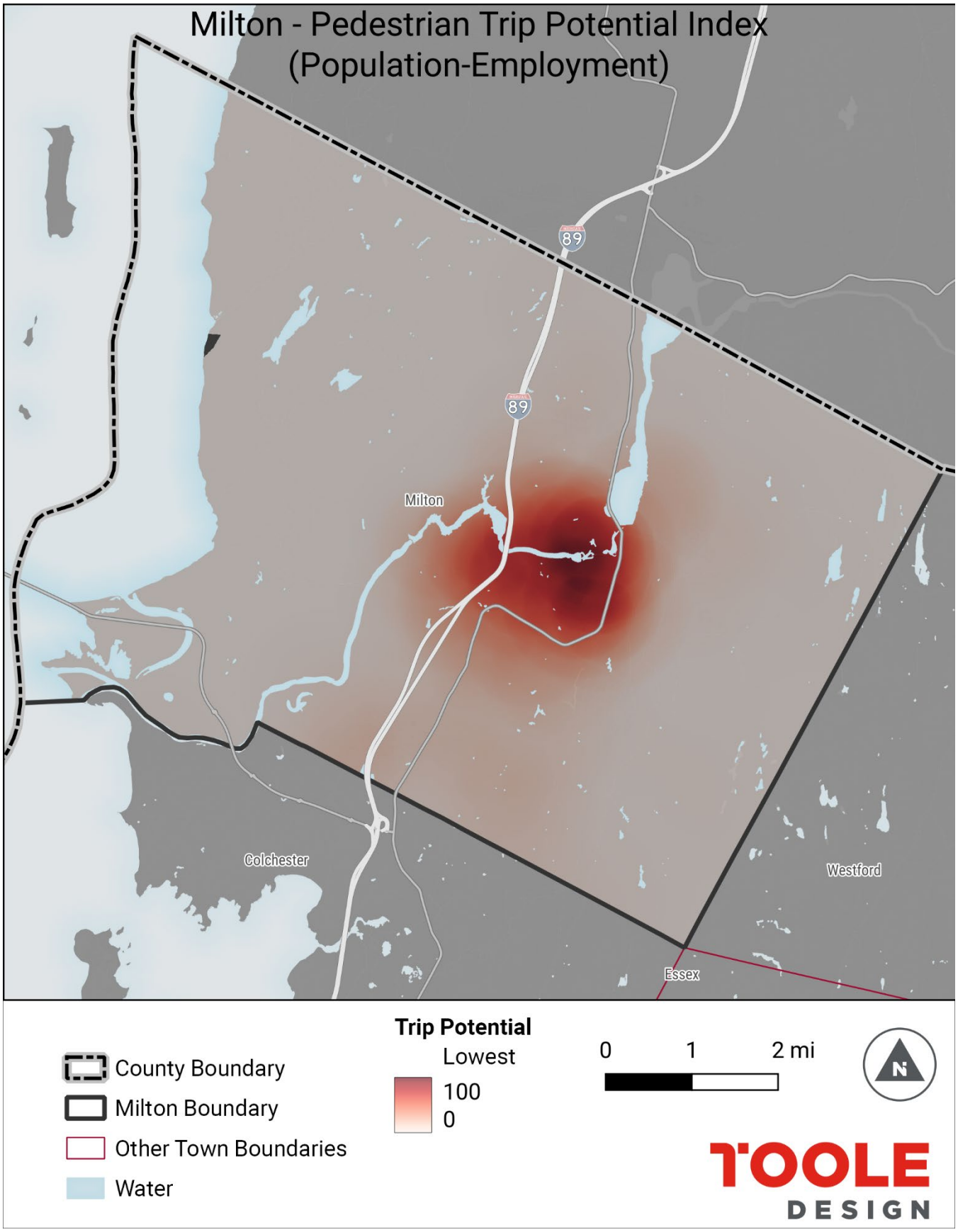


Figure 18: Milton Pedestrian Trip Potential, Population to Commercial

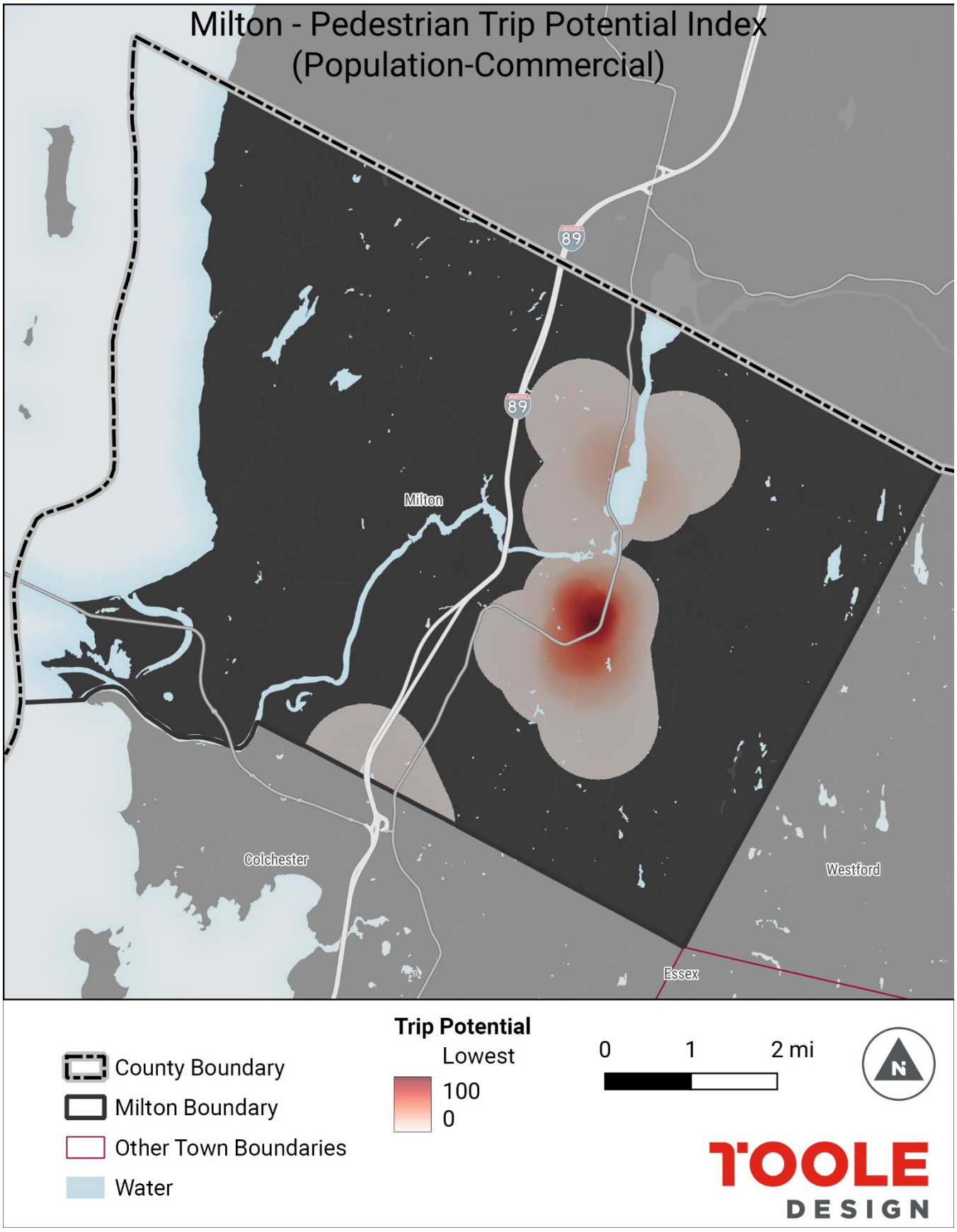


Figure 19: Milton Pedestrian Trip Potential, Transit to Commercial

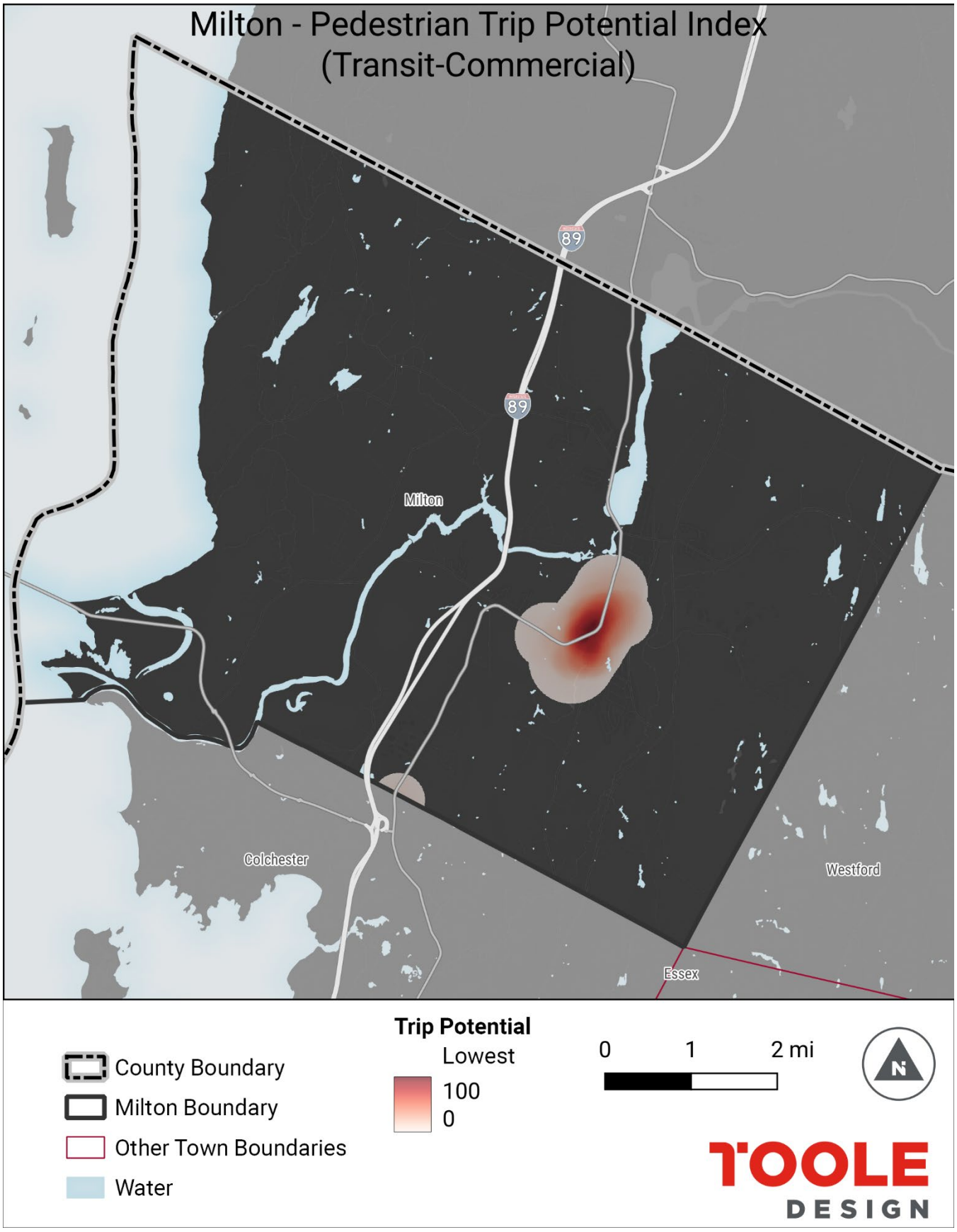


Figure 20: South Burlington Pedestrian Trip Potential, Composite

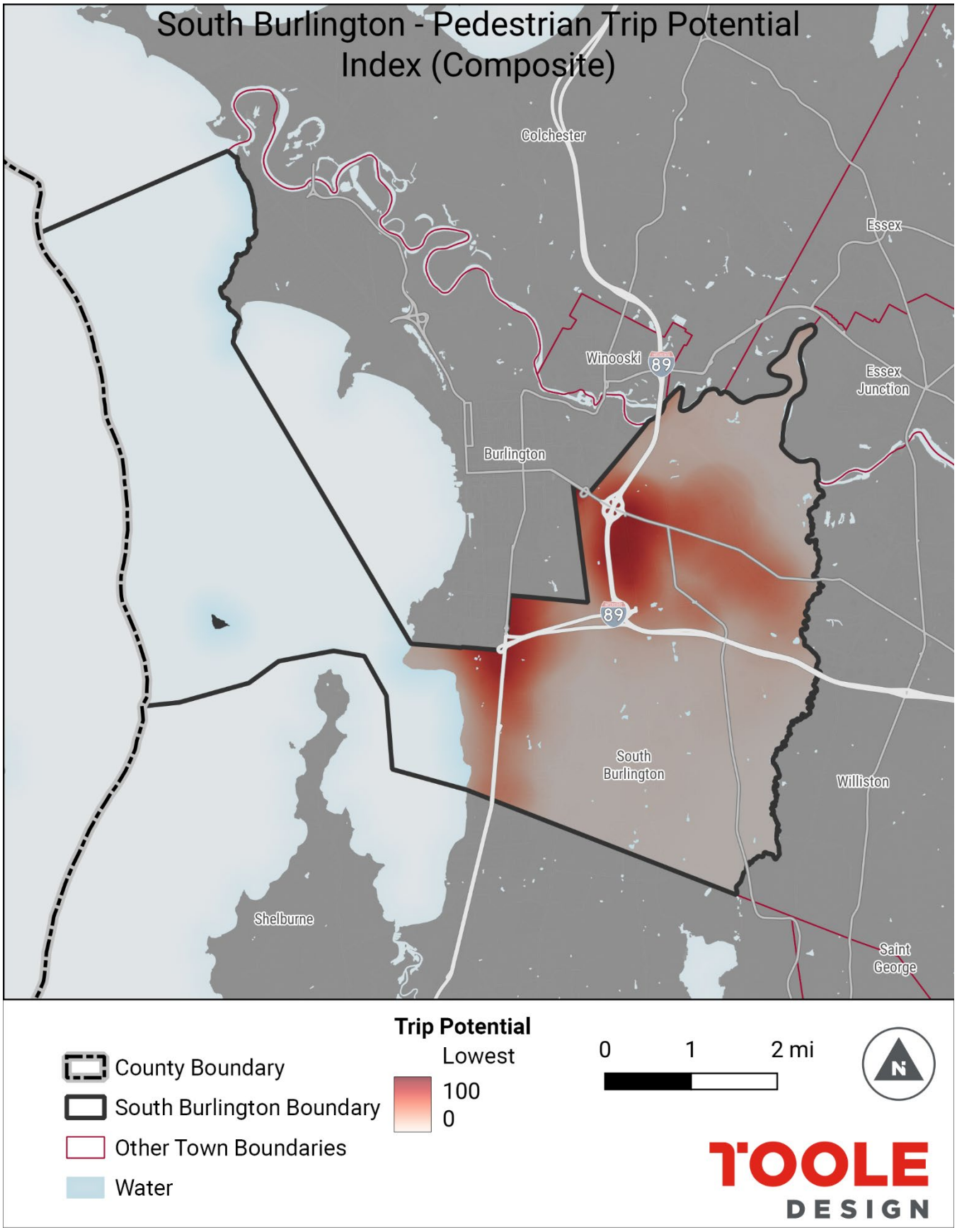


Figure 21: South Burlington Pedestrian Trip Potential, Population to Transit

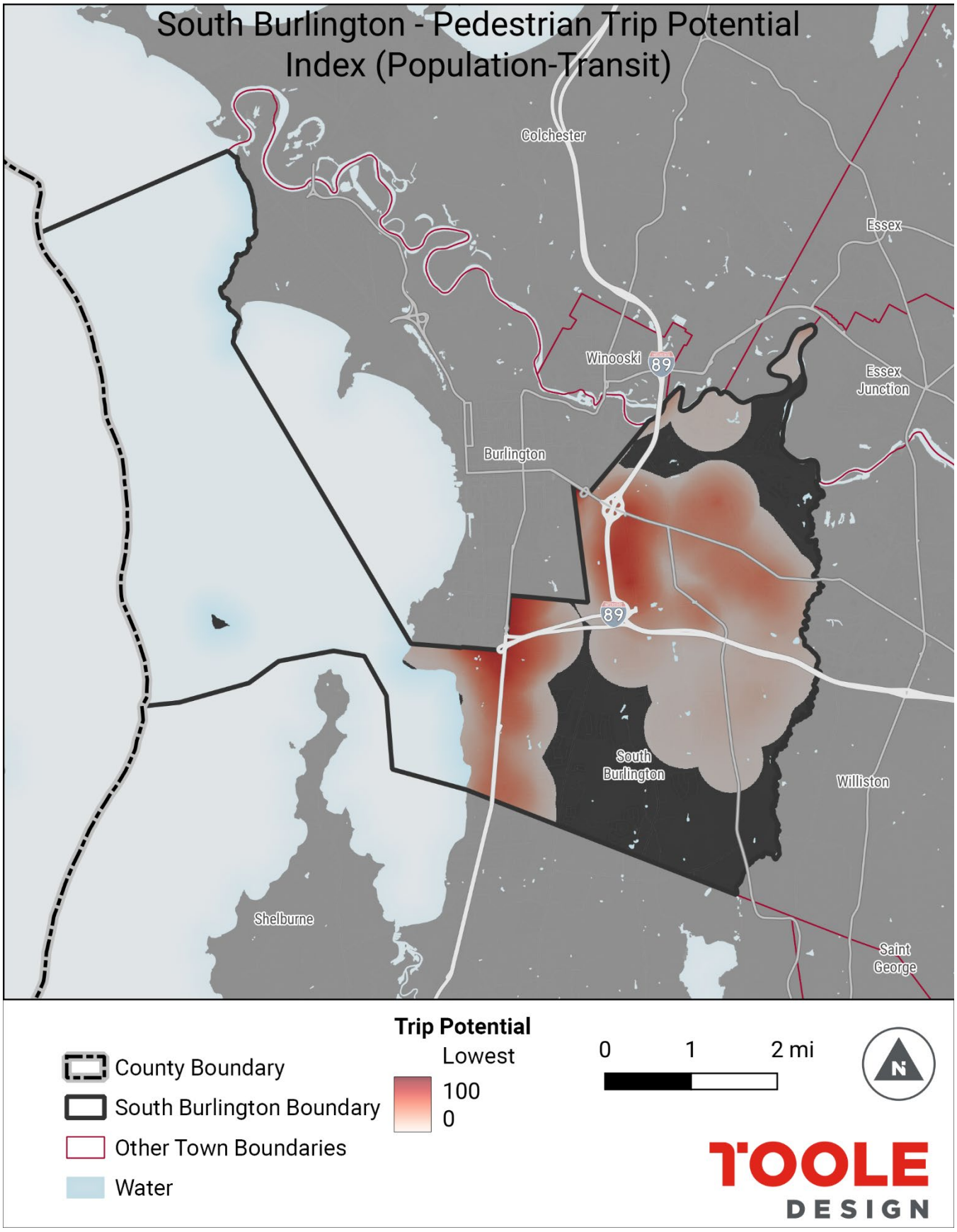


Figure 22: South Burlington Pedestrian Trip Potential, Transit to Employment

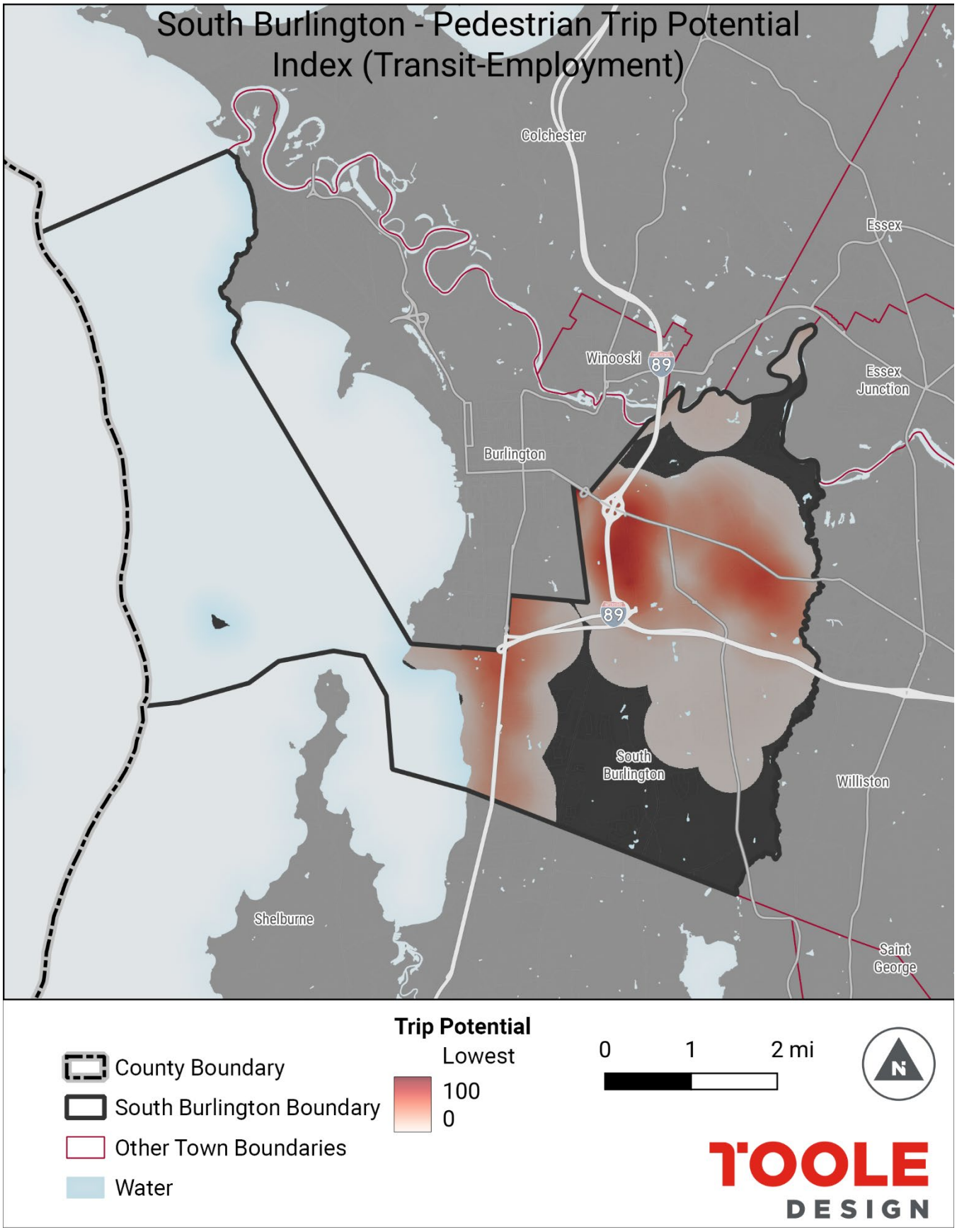


Figure 23: South Burlington Pedestrian Trip Potential, Population to Employment

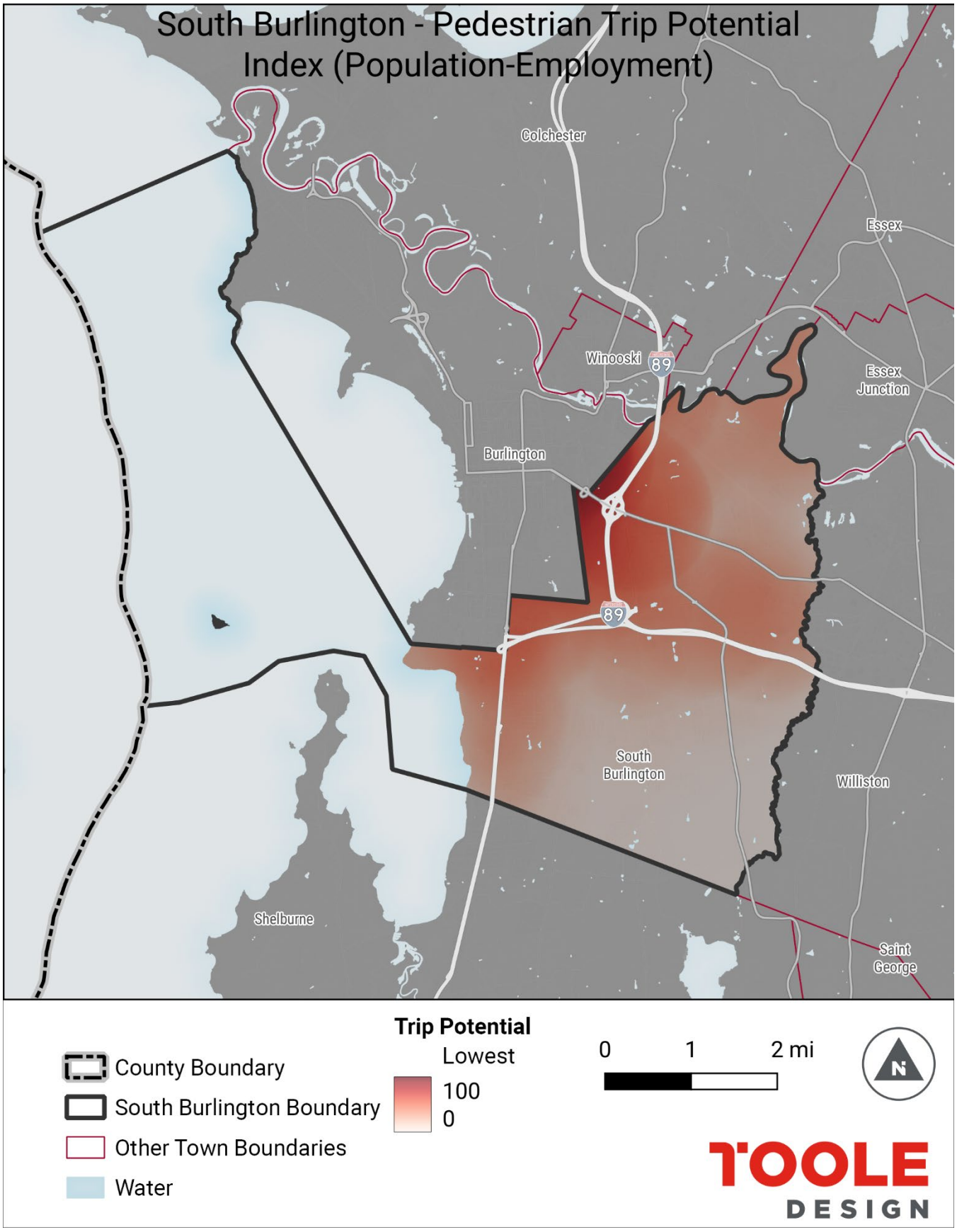


Figure 24: South Burlington Pedestrian Trip Potential, Population to Commercial

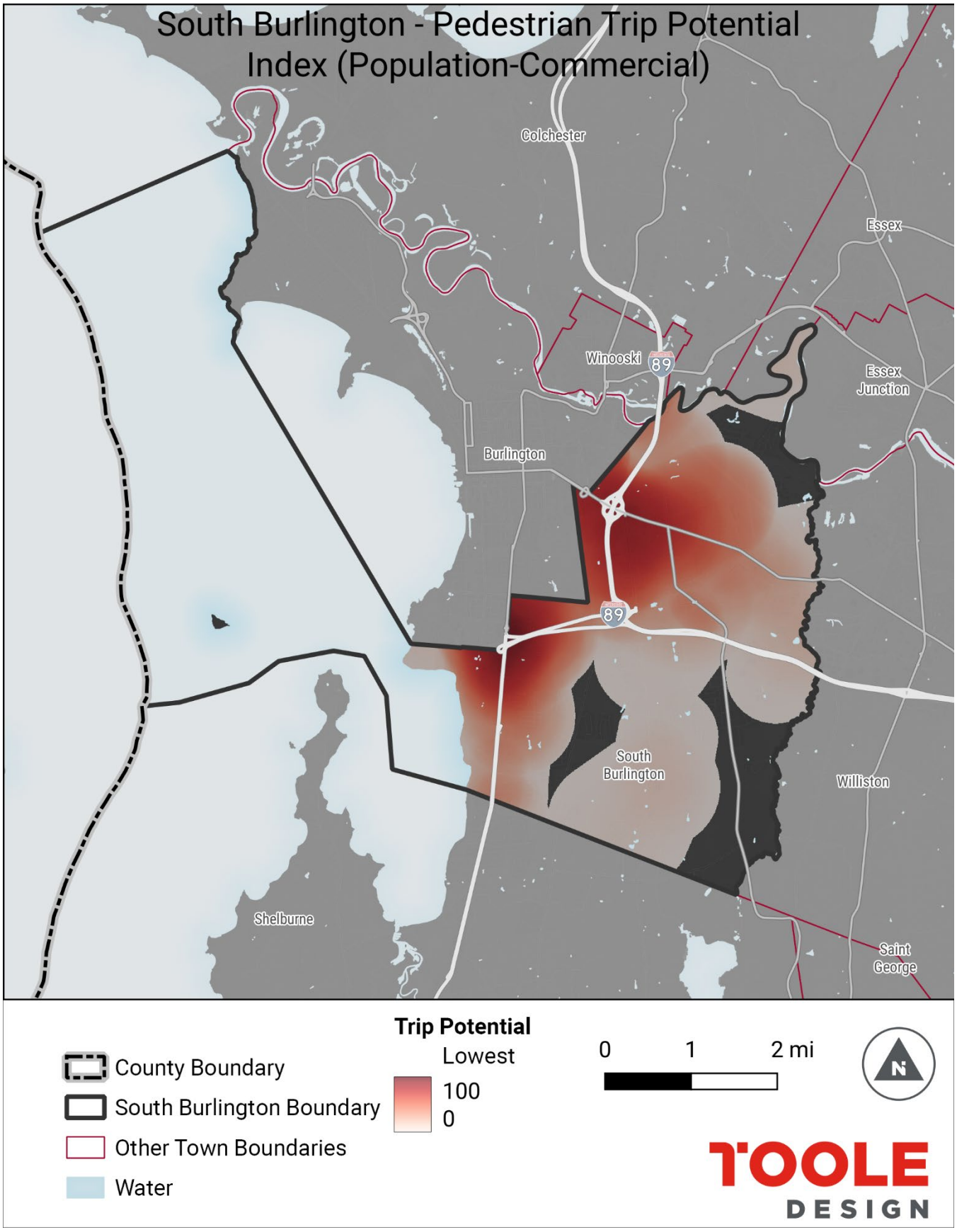


Figure 24: South Burlington Pedestrian Trip Potential, Transit to Commercial