Appendix C. Corridor Spacing Research

Task 3 of the Twin Cities Bicycle Study called for the development of bicycle corridor spacing guidelines. This section summarizes research of the spacing of planned regional bicycle corridors in three peer regions, and documents a comparison of spacing in those regions with the draft network proposed in October 2013.

National research into regional bikeway spacing guidelines did not uncover any substantive research or state-of-practice documentation with an explicit focus on bikeway spacing at the regional level. Traditionally, the development of spacing guidelines is most commonly associated with motor vehicle roadway networks where spacing guidelines help transportation agencies make plans based on a functional classification system and the capacity needed to handle volumes of traffic across a network. The spacing of higher level roadways (collectors and arterials) are closely tied to population and trip generation factors that increase significantly within developed areas.

Regional bicycle system spacing needs are currently less defined in practice. The focus of bicycle network planning is typically on access to the system with an emphasis on increasing network density in more developed urban areas. There are not defined standards for level of access to the network at the local or regional level. However, it is useful to examine the bicycle networks of peer regions as a consideration for addressing the needs of the Twin Cities.

Under direction of Council staff, the project team identified three peer regions to analyze and compare regional bicycle system network density and system spacing, Atlanta, Denver and Nashville. These peer regions were selected based on review of these regional efforts and identification of some similarities to the Twin Cities..

Comparing corridor spacing between regions comes with some notable caveats. First, each region's topography and geography is unique, and uniquely frames decisions about infrastructure. The particular spacing of corridors may also be shaped by a Metropolitan Planning Organization's goals for corridor identification, and the commitment of regional leaders to invest in a bicycle transportation network. Finally, each region has unique population patterns and densities, to which the corridors will respond – these factors are highlighted in Table 1. With those notable caveats, we provide a snapshot comparison of corridor spacing between these regions.

Table 1. Comparison of Population Characteristics

Metropolitan Statistical Area	*Overall Population (2010)*	*2010 population density (people per square mile)*
Atlanta-Sandy Springs-Roswell, GA	5.9 million	2173
Denver-Aurora-Lakewood, CO	3.1 million	4803
Nashville-Davidson–Murfreesboro–Franklin, TN	1.8 million	1695
Minneapolis-St. Paul-Bloomington, MN-WI Metropolitan Statistical Area	3.7 million	3383

Source: Census Bureau

METHODOLOGY.

For each region, the project team geo-referenced maps from regional planning documents in ArcGIS for easy scaling, and then drew concentric circles at 5, 10, 15 and 20 miles out from the heart of the region's downtown. Points at which identified bicycle corridors crossed each of those concentric circles were identified. Along each of those four concentric circles, we recorded the linear distance between the points at which a corridor crosses the circle. Then, we averaged the distances between those points. This number represented the average spacing of corridors at that specific distance (5, 10, 15, or 20 miles) from downtown.

Though this procedure was somewhat inexact in the measurement step, subsequent use of the methodology should achieve substantively similar results. Also, each region had unique features that required slight modification to the methodology. The purpose of this analysis was to gain a general sense of how the proposed Regional Bicycle Transportation Network Corridors compare to other regional networks and help inform recommendations for spacing assumptions based on local context and Metropolitan Council designated planning area definitions.

ATLANTA CORRIDOR SPACING.

The team reviewed the "Atlanta Region Bicycle and Pedestrian Walkways Plan" (2007). Figures 1A and 1B show the concentric circles used for measurement in the Atlanta region and Table 2 summarizes the average corridor spacing.

Table 2. Atlanta Region Corridor Spacing

Distance from city center >	*5 miles*	*10 miles*	*15 miles*	*20 miles*
Average corridor spacing	3.38 miles	3.05 miles	6.6 miles	7.05 miles

DENVER CORRIDOR SPACING.

The team reviewed the "Pedestrian and Bicycle Element of the 2035 Metro Vision Regional Transportation Plan" (2006). Figure 2 shows the concentric circles used for measurement in the Denver region and Table 3 summarizes the average corridor spacing.

Three features unique to Denver required a modified methodology. First, the Rocky Mountains to the region's west limit development and trail connections there. Thus, only the portion of concentric circles outside of the mountainous area was included in the measurements. Second, especially in the southern part of the region, no trails are planned because of a large swath of protected lands and a resultant lack of planned development. Thus, the portion of the 20-mile concentric circle that traveled through this area was not included in measurements. Finally, two kinds of corridors were designated in the Denver region. First were regional corridors. Second, the plan also designated local (or community) corridors, that according to the plan, "will primarily supplement and provide connections with the Regional Bicycle Corridor System" (page 44). The team first evaluated the regional corridors alone, and then evaluated them together with local/community corridors.

Table 3. Denver Region Corridor Spacing

	Distance from city center			
Average corridor spacing	*5 miles*	*10 miles*	*15 miles*	*20 miles*
regional corridors only	4.2 miles	4.69 miles	4.99 miles	5.85 miles
regional and community corridors	1.28 miles	1.76 miles	2.01 miles	2.09 miles

In the end the team elected to evaluate the regional corridors alone, as the intent and definitions for the community corridors were not well aligned with definitions for the proposed Regional Bicycle Transportation Network in the Twin Cities.

NASHVILLE CORRIDOR SPACING.

The team reviewed the "Nashville Area Bicycle and Pedestrian Study" (2009). Figure 3 shows the concentric circles used for measurement in the Nashville region and Table 4 summarizes the average corridor spacing.

Nashville has one unique feature – areas to the west were not part of the bicycle corridor study, and as such, those portions of each of the concentric circles were not included in this analysis.

Table 4. Nashville Region Corridor Spacing

Distance from city center >	*5 miles*	*10 miles*	*15 miles*	*20 miles*
Average corridor spacing	2.6 miles	4.13 miles	3.87 miles	5.3 miles

TWIN CITIES CORRIDOR SPACING.

The team used the October 2013 draft of the regional bicycle network to evaluate the corridor spacing for the Regional Bicycle Transportation Network. Figure 4 shows the concentric circles used for measurement in the Twin Cities region and Table 5 summarizes the average corridor spacing.

Three features unique to the Twin Cities refined our methodology in the region. First, there are two principal downtowns, and not just one. For this reason, we drew two circles at the 5 mile scale – one around downtown Minneapolis and one around downtown St. Paul, and the combination of the two circles provided the average spacing. Subsequent concentric circles were drawn focused between the downtowns, roughly centered in the Midway area in St. Paul. Second, two types of corridors are proposed in the Twin Cities. Thus, separation between the priority regional bicycle corridors was measured alone, and then separation between all bicycle corridors was measured. The third unique aspect was that the distance between corridors at the 20 mile distance was so great that linear measurements of distance were made in two segments, making certain such linear segments measured distances that stayed between the 15 and 20 mile circles. It should be noted that much of this area captures parts of the region outside of the developed and developing area, and the land use context for the peer examples was not able to be clearly defined.

Table 5. Twin Cities Region Corridor Spacing (based on October 2013 Draft network)

Distance from city center >	*5 miles*	*10 miles*	*15 miles*	*20 miles*
Average corridor spacing – entire regional network	1.09 miles	1.66 miles	2.73 miles	5.3 miles

SUMMARY & ANALYSIS.

Table 6 summarizes the corridor spacing for the three peer regions and the proposed Regional Bicycle Transportation Network (based on the October 2013 draft network)

Table 6. Summary of Corridor Spacing

Distance from city center >	*5 miles*	*10 miles*	*15 miles*	*20 miles*
Atlanta	3.38	3.05	6.6	7.05
Denver *	4.2	4.69	4.99	5.85
Nashville	2.6	4.13	3.87	5.3
Peer Average	**3.39**	**3.96**	**5.15**	**6.07**
Proposed Regional Bicycle Transportation Network	*1.09*	*1.66*	*2.73*	*5.3*

*Denver includes Regional Corridors only

The results of the analysis show the proposed Regional Bicycle Transportation Network corridors have a spacing density that exceeds those found in the peer regions, especially in relation to the core urban areas at 5 and 10 miles. This is due, in large part, to the mature network of existing bicycle facilities found in the Twin Cities region, which provides a more robust framework for a bicycle transportation system.

The results at the 10 to 15 mile distance could suggest that the density of the proposed Regional Bicycle Transportation Network might be disproportionately out of line with the peer regions, with our proposed network being roughly twice the density of the 3 metro area averages. However, the fact that the two core cities of Minneapolis and Saint Paul are spaced 10 miles apart, makes it reasonable to expect the densities to be higher at greater distances from the combined core, or at the 10 and even 15 mile range, based on the natural overlap of dense urban form extending outward from both downtowns.

The comparison of results at the 20 mile level should be viewed cautiously based on the inconsistent methods that had to be applied for both Denver and Nashville. The network proposed in October was still found to be in line with the results as presented, but the project team recommends that more emphasis should be placed on providing connections to the developed and developing areas out beyond 20 miles where the predominance of rural land use outweighs the need for rigid corridor spacing. The reference to this analysis in section seven is therefore limited to presenting the comparisons at the 5, 10 and 15 mile extents.

FIGURE 1A. Atlanta 10, 15 and 20 mile measurement

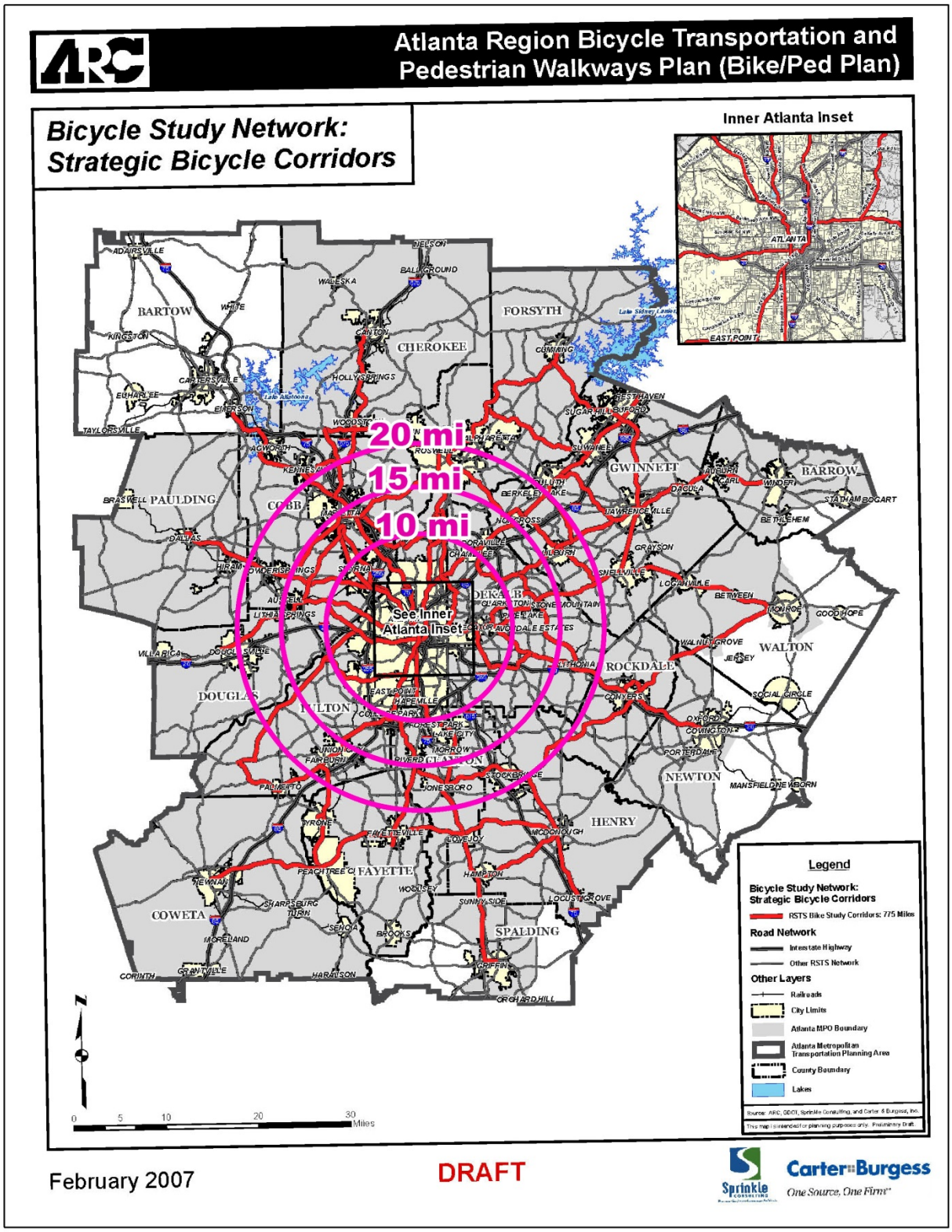

FIGURE 1B. Atlanta 5 mile measurement

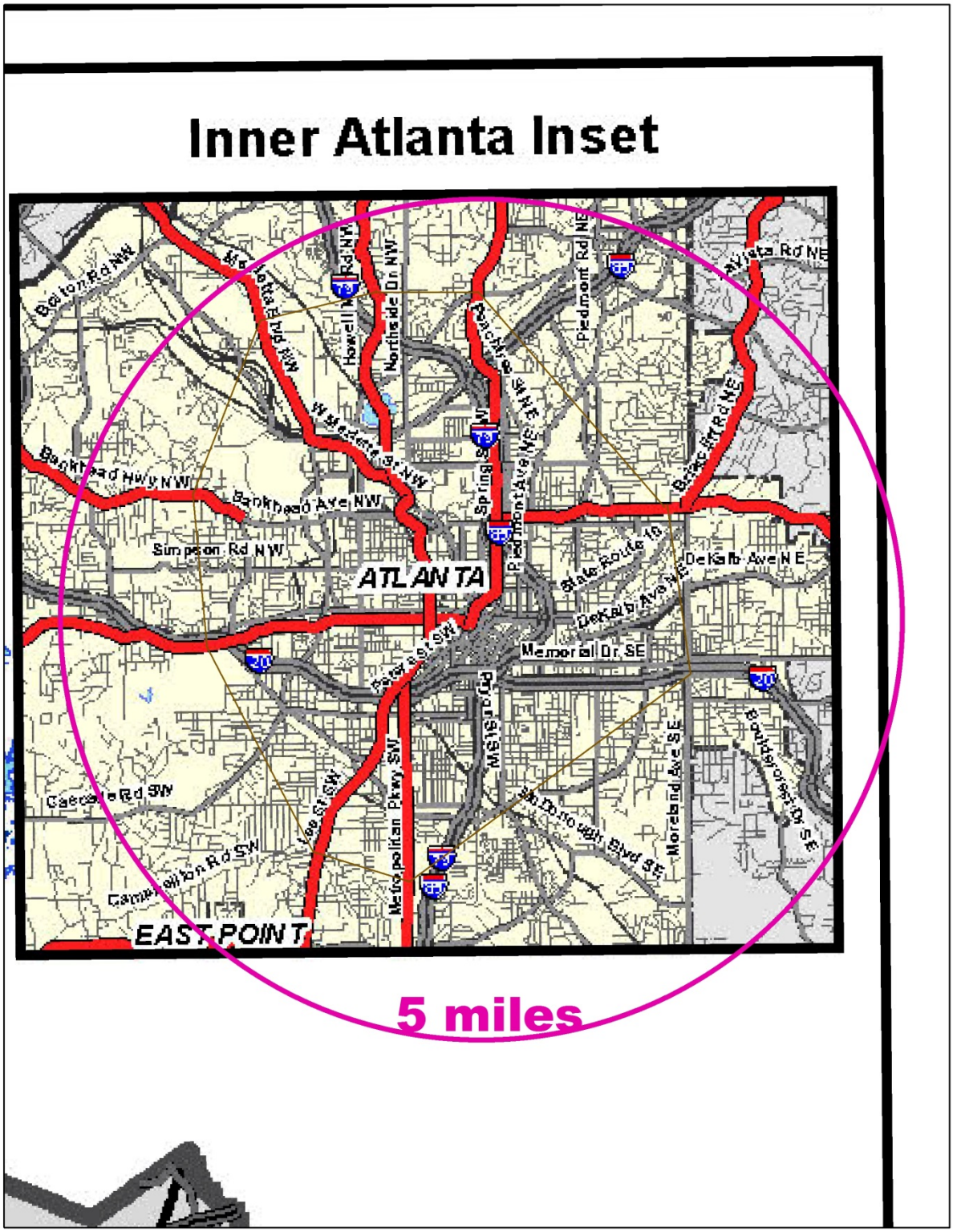

FIGURE 2. Denver corridors and measurements

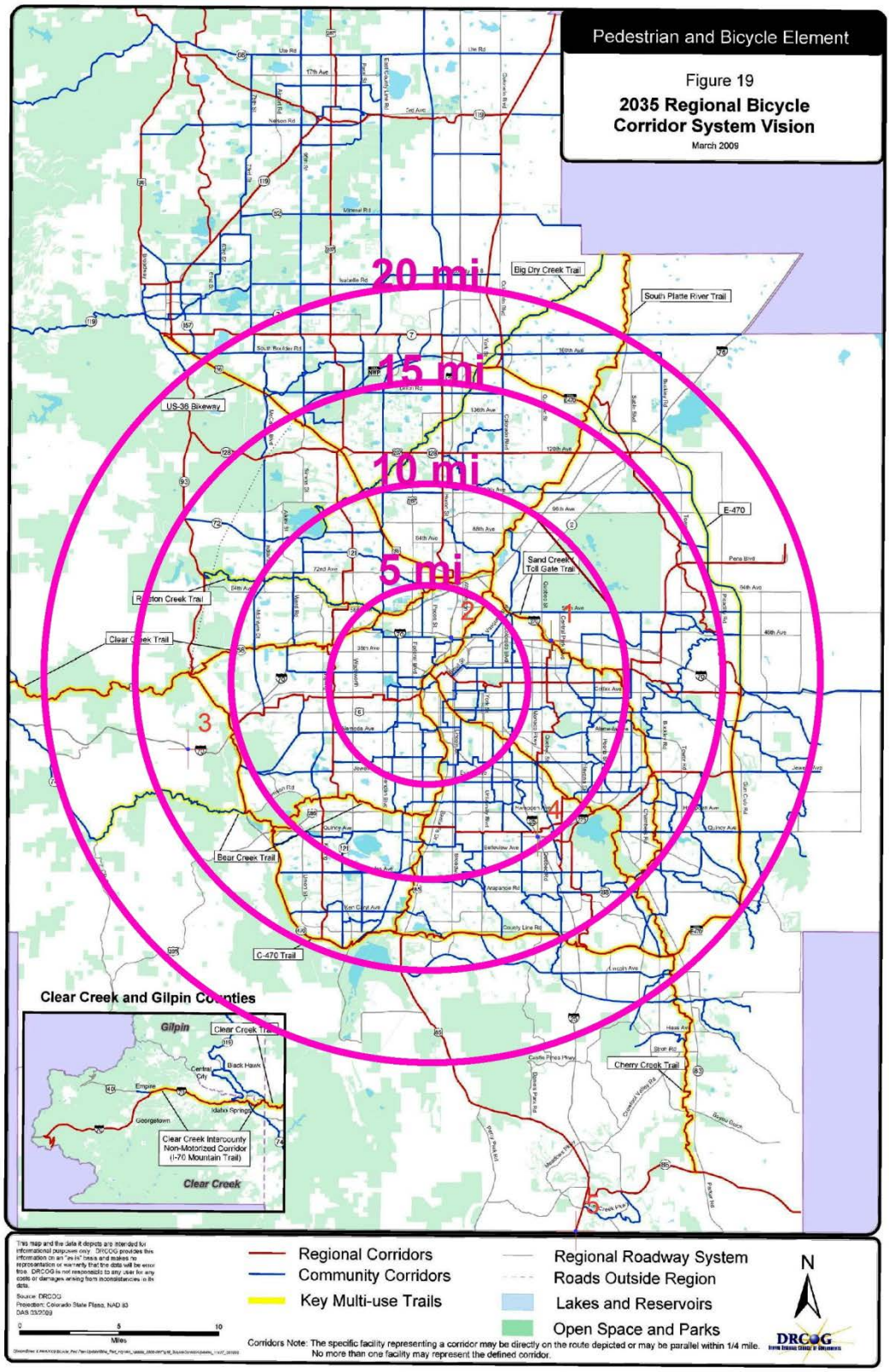

FIGURE 3. Nashville corridors and measurements

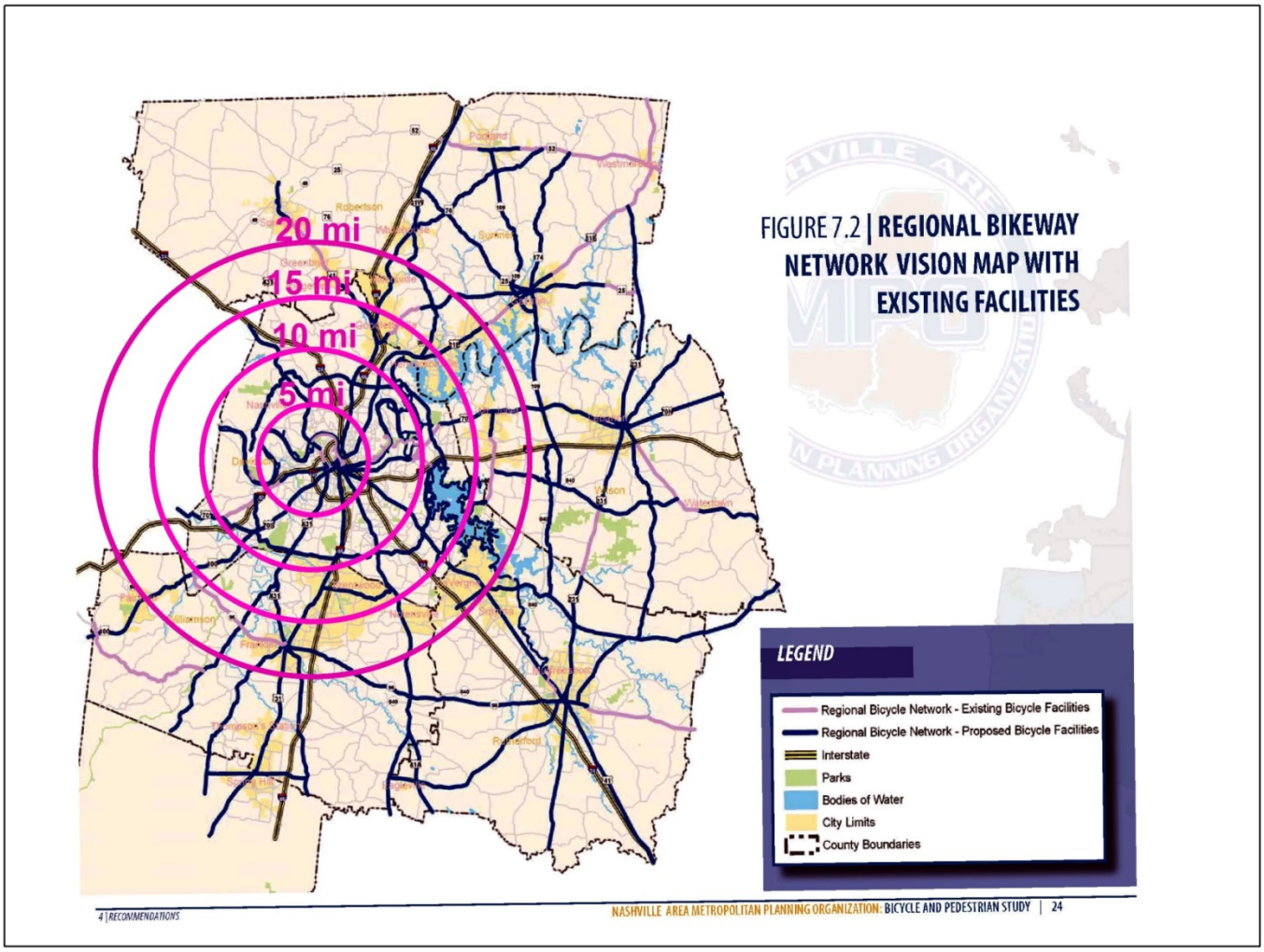

FIGURE 4. Proposed Regional Bicycle Transportation Network (October Draft) and measurements