Gulf Coast Research Center for Evacuation and Transportation Resiliency

LSU / UNO University Transportation Center

Active Transportation Measurement: Minneapolis Case Study

Final Report

Billy Fields, Angie Cradock, Jessica Barrett, and Steve Melley

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GULF COAST RESEARCH CENTER FOR EVACUATION AND TRANSPORTATION RESILIENCY

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16. Abstract:

This research examines longitudinal bicycle count data to better understand the impact of new bicycle facilities on use. The study site is Minneapolis which has invested close to $25 million over 8 years to improve active transportation facilities as part of the federal Nonmotorized Transportation Program. GIS buffering analysis, Ordinary Least Squares regression analysis, and individual growth models were used to analyze the bicycle count data. Longitudinal analysis through the individual growth models found that three key factors appear to be leading to the growth in cycling at study locations: the presence of bicycle facilities at the count location, the existing length of bicycle facilities in the adjacent areas, and the facilities added over time. Each of these factors contributes to the growth in the number of cyclists observed at count locations over the study period.

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Executive Summary

Over the last 8 years, Minneapolis has invested close to $25 million in new bicycle/pedestrian facilities and programs as part of the federal Nonmotorized Transportation Pilot Program. As part of this project, pre- and post-intervention data have been collected on usage rates in and around new facility sites. This unique data set presents an important opportunity to longitudinally evaluate change in built environment on bicycling usage. This type of research has been identified as an important area for further research to understand the impact of environmental change within an established population (Sallens, Sallis and Frank 2003).

This research analyzes pre- and post-intervention counts at locations around Minneapolis to assess the impact of new bicycle facilities of use. Data from 40 locations that had 3 or more years of count data were acquired and analyzed in context of socio-demographic and land use characteristics. GIS protocols were followed in conducting buffer analysis at the 400 and 800 meter levels (Appendix A). This was followed by a preliminary evaluation through Ordinary Least Squares regression analysis to determine key relationships. Finally, longitudinal analysis using linear individual growth models was used to investigate trends in bicycle counts over time.

This research found that three key factors appear to be leading to the growth in cycling at study locations: the presence of bicycle facilities at the count location, the existing length of bicycle facilities in the adjacent areas, and the facilities added over time. Each of these factors contributes to the growth in the number of cyclists observed at count locations over the study period.

While multiple years of data were analyzed for this study, the time lag between infrastructure introduction and counts was often short. When available, future research should examine longer time intervals to establish patterns of change in use over time.

Abstract

This research examines longitudinal bicycle count data to better understand the impact of new bicycle facilities on use. The study site is Minneapolis which has invested close to $25 million over 8 years to improve active transportation facilities as part of the federal Nonmotorized Transportation Program. GIS buffering analysis, Ordinary Least Squares regression analysis, and individual growth models were used to analyze the bicycle count data. Longitudinal analysis through the individual growth models found that three key factors appear to be leading to the growth in cycling at study locations: the presence of bicycle facilities at the count location, the existing length of bicycle facilities in the adjacent areas, and the facilities added over time. Each of these factors contributes to the growth in the number of cyclists observed at count locations over the study period.

1.0 Introduction

Over the last 10 years, the fields of public health, transportation, and urban planning have developed a solid base of scholarship that examines the impact of active transportation facilities on usage rates (Beuhler and Pucher 2012, Pucher et al 2010, Handy 2005, Dill and Carr 2003). Most of these studies utilize cross-sectional data to analyze the impact of active transportation facilities. A major impediment to understanding the precise relationship between environmental interventions and active transportation use is the lack of longitudinal data that tracks bicycling use over time.

To more effectively examine the impact of new facilities on an existing population, pre- and post- data need to be collected prior to and after an infrastructure intervention. Sallens, Sallis and Frank (2003) argue that this type of research is necessary to understand the impact of environmental change within an established population. Only a handful of studies have utilized longitudinal designs to examine the impact of infrastructure investments on active transportation use over time (Parker et al 2011, Krizek et al 2009). These studies have generally found that the addition of active transportation facilities to an area has a statistically significant effect of usage levels.

This study adds to this growing base of scholarship through a longitudinal evaluation of the implementation of the Nonmotorized Transportation Pilot Program (NMTPP) in Minneapolis. The approximately $25 million in federal investments in Minneapolis in active transportation programming and infrastructure improvements was begun in 2006 and is currently completing final installation of infrastructure improvements. Detailed, multi-year data on bicycling use was collected at a set of 55 locations throughout Minneapolis and represents the most extensive set of longitudinal bicycle count data in the country. Analysis of these data provides an important platform for program evaluation (Boarnet 2011).

This report is broken into three additional sections. First, background on the NMTPP and an overview of the Minneapolis specific program, BikeWalk Twin Cities, is discussed. This is followed by an overview of the methodology GIS protocols for the study. The final section details the analysis of count data in Minneapolis.

2.0 Nonmotorized Transportation Pilot Program (NMTPP) Overview

This section provides context on the goals and mechanisms of the federal Nonmotorized Transportation Pilot Program (NMTPP). This is followed by an overview of the specific issues related to the Minneapolis portion of the program.

2.1 NMTPP Background

The Nonmotorized Transportation Pilot Program (NMTPP) was included in the 2005 transportation bill, Safe Accountable Flexible Transportation Equity Act: A Legacy for Users (SAFETEA-LU). Section 1807 of the legislation authorized $100 million to create “a network of nonmotorized transportation infrastructure facilities” to connect activity centers in 4 communities (Minneapolis, MN, Sheboygan, WI, Columbia, MO, and Marin, CA). Each community was appropriated approximately $25 million over 5 years.

The Pilots represented a diverse set of community typologies designed to test how nonmotorized transportation could work in multiple settings. These included large city environments (Minneapolis), more rural locations (Sheboygan), small college towns (Columbia), and suburban/rural environments (Marin). Each community sought to address transportation needs in different ways with programming and infrastructure treatments selected individually in each community. In essence, there were 4 separate programs created to implement nonmotorized transportation in these differing settings.

To capture the inner workings of this diverse program, the Pilot communities created a unique collaborative research working group that was designed to track the impact that the new active transportation improvements had on usage rates. Members of this group included each of the Pilot communities along with the Federal Highway Administration, the Marin County Bicycle Coalition, the Rails-to-Trails Conservancy, and the Centers for Disease Control and Prevention (CDC). The USDOT’s Volpe Center was tasked with coordinating research efforts.

The initial research program established by the Pilots was a survey of Pilot communities designed to establish before and after usage trends. This survey was conducted by the University of Minnesota Center for Transportation Studies and NuStats (Krizek et al 2007). Community surveys were conducted in each of the Pilots and in a control community (Spokane, WA) in 2006 and again in 2010.

The resulting study was not able to find any significant change in usage rates at the community level during the course of the program. The difficulty in conducting a probability-based sample without more detailed and regular nonmotorized transportation data was cited as a significant barrier to this type of research (Gotschi et al 2011).

In addition to the larger survey effort, the Pilots crafted an extensive count program to track trends in usage at a more micro-scale. Instead of trying to track the impact of the program across a whole community as the survey had, the count program was designed to provide detailed data on usage trends in neighborhoods surrounding the new active transportation treatments. The most extensive of these count programs was in Minneapolis.

The results of the count and wider research program were compiled in a final report to Congress issued in the summer of 2012 (FHWA 2012). The broad results of the program are impressive. Over the course of the last seven years, the Pilot communities have constructed over 221 miles of new bicycle facilities with an overall increase in bicycling at count locations of 49% from 2007 to 2010. The program remains ongoing with 130 miles of additional bicycle facilities funded for construction over the next several years.

While this overall analysis provides a useful gauge of the impact of the program, the analysis to this point has been too coarse to model the intricate set of relationships that could impact active transportation usage trends. This research takes the existing Pilot research further through a detailed analysis of the Minneapolis bicycle count data.

2.2 Bike Walk/Twin Cities Program Characteristics

The Minneapolis Pilot program was administered by the non-profit Transit for Livable Communities (TLC). TLC created a comprehensive program called Bike/Walk Twin Cities that was designed around 3 key goals:

- Maximizing existing road space for all users by creating an interconnected network of active transportation facilities
- Creating a legacy system with lasting value through use of innovative planning, performance measures, and infrastructure
- Building professional, political, and public capacity for project planning and implementation (Fields and Hull 2013).

The heart of the innovative intermodal system envisioned by TLC was the provision of multiple types of on-road facilities designed to link the pre-existing fairly robust off-road network of active transportation facilities. Prior to the Pilot program, Minneapolis had 46 miles of on-street facilities and 75 miles of trails. By 2011, the Pilot program had significantly increased lane miles of on-road facilities (130 miles) and increased off-road trails slightly (86 miles). The mileage increases were significant with a 181% increase in on-road facilities and a 15% increase in off-road trails (Fields and Hull 2013).

The variety of types of on-road facilities also increased dramatically. Prior to the Pilot, Minneapolis' on-road facilities were almost exclusively bike lanes with bike lanes accounting for 87% of all on-road facilities. The only two other on-road facility types recorded in the database for this period were wide shoulders and a small bike boulevard project. By 2011, both the diversity and the percentage of more diverse on-road facility miles had grown. Bike lanes in

2011 accounted for 75% of the active transportation facility profile with multiple new innovative treatments now included as on-road facilities (Figure 1).

In addition to the focus on the provision of new, innovative facilities, Bike/Walk Twin Cities created an extensive count program to monitor program impacts. The Minneapolis active transportation count program undertaken during the Pilot program is the most extensive active transportation count program in the country. Over the last 5 years, counts have been conducted at 317 individual locations. Fifty-five of these locations were selected for inclusion in a multi-year count program. The counts were conducted in partnership between the City of Minneapolis' Department of Public Works and TLC.

The time and resource commitment from these groups for the counts has been significant. The count program has consisted of both manual and automated counts taken throughout the year. Manual counts have been centered in September with additional counts at some locations being taken throughout the rest of the year. In addition, multiple automated trail counts that provide continuous data throughout the course of a year have also been utilized.

Of these count data streams, the multi-year count data provides the strongest platform for longitudinal analysis with reliable, multi-year count numbers at a diversity of locations around the Minneapolis area. These counts were conducted utilizing a format adapted from the National Bicycle & Pedestrian Documentation Project which specifies screen line counts for 2 hour intervals from 7 to 9 AM and 4 to 6PM on weekdays with some additional counts on weekends as well. Data on weather conditions and other special conditions is also collected. Yearly counts were conducted during the month of September in Minneapolis with some additional counts taking place at selected locations during other times of the year.

Count reports have been published yearly with detailed information about individual count sites and specific project-level information (Bike/Walk Twin Cities 2011). In addition, detailed work on understanding how these 2 hour counts relate to overall patterns of daily active transportation travel has also been undertaken. Hankey et al (2012) found that these counts provide a representative sample of street types across Minneapolis and provide a solid foundation for understanding traffic patterns during the month that the data was collected (September).

Manual count data provide a good measure of corridor-level active transportation behavior at specific locations (Parker et al 2011), but do not shed light on the reasons that an individual might choose (or not choose) to bicycle or on secondary effects that the bicycle trip may or may not produce (Krizek et al 2009). Given these limitations, the present study cannot provide guidance on the extent of potential benefits that may accrue from the bicycling behavior in relation to auto trip replacement.

3.0 Methodology and GIS Protocols

This research seeks to identify the factors that are associated with increased bicycle use. This study uses the social ecological model to provide a conceptual framework for answering this question. The social ecological framework proposes that physical activity rates can be explained through the analysis of "combination of psychosocial and environmental–policy variables" (Sallens, Sallis and Frank 2003, p. 80).

To operationalize this, the environmental-policy and psychosocial variables need to be defined. Handy (2005) identifies a comprehensive set of environmental correlates from exiting studies focusing on the built environment. She defines "the built environment as consisting of three general components: land use patterns, the transportation system, and design." (p. 5). For this study, these broad categories of environmental correlates have been defined to include population density, business uses, street connectivity, transit use, presence of bike facilities, and road use intensity.

There are a number of ways to measure these variables based on data available, level of accuracy, and goals of the research. Forsyth's work in Minneapolis on GIS measurement and walking (2012) provide an excellent platform for conceptualizing and operationalizing variable measurement. Specific protocols for measuring these variables in a GIS platform were established for this project based on those best practices laid out by Forsyth (2012).

The specifics of our approach, while based on Forsyth, occasionally differed based on our focus on bicycling and changes in some data sources. This research project tested numerous approaches to optimize GIS measurement protocols for bicycling. The specific measurement protocols for each variable are laid out in Appendix A.

3.1 Study Sample

We obtained data describing bicycle counts and on-site bicycle facilities at 55 count sites provided by Transit for Livable Communities (TLC) and the City of Minneapolis. Fifteen of these sites had only two years of count data and were excluded from analyses, as trends are best estimated when three or more points are available. Therefore, all analyses were conducted among the 40 count sites that had at least 3 annual September counts conducted between 2007 and 2011. More detailed information on the count locations is provided in Appendix B which provides detailed information about the count years, specific count numbers for each of the selected locations, and comparison of actual and predicted model slopes.

3.2 Count and On-Site Facility Data

The primary outcome of interest was annual bicycle counts. Count data also included several characteristics of the weather on each count day, including temperature, wind speed, and precipitation. These data also described bicycle facility improvements made annually at each count site. Improvements made on-site were either the installation of new bicycle facilities or the enhancement of existing facilities (e.g., from a shoulder to a bicycle lane). We summarized annual counts conducted in September of each year from 2007-2011 for each site.

3.3 Buffer Data

We also obtained descriptive characteristics of quarter and half mile buffers surrounding each count site, based on characteristics previously described in the literature as factors related to cycling (Forsyth 2006, Krizek and Johnson 2006). Road and area characteristics investigated included bicycle facility length, population and employment density, retail square footage, park and recreational square footage, street connectivity (i.e. intersection count), length of transit routes, and proportion of road length comprised of major roads. Socio-demographic characteristics investigated included proportion of residents who are white, proportion with no vehicle available, proportion with two or more vehicles available, proportion actively commuting, proportion below poverty, and proportion foreign born. We summarized each variable descriptively and examined correlations between all variables of interest to determine bivariate associations.

4.0 Minneapolis Bike Count Evaluation

4.1 Analysis

Ordinary least squares (OLS) regression analysis was conducted within each of the 40 count sites individually and overall, to investigate broad trends in bicycle counts to provide guidance for building growth models. We investigated through OLS regression the relationships between annual bicycle counts and each of the buffer variables of interest, as well as weather variables, to understand the general relationship between these and bicycle counts. Each variable was included in the model one at a time, and those found to be associated with bicycle counts overall were included one by one as covariates in OLS models predicting trends in bicycle counts over time. OLS regression analysis assumed that all counts collected within a particular site were independent of one another.

In order to account for the longitudinal nature of the count data, we fit linear individual growth models to investigate the trends in bicycle counts over time. Unlike the OLS regression analysis, the individual growth model analysis accounted for the correlation between annual counts within a given site. In these models, we allowed for baseline variation in bike counts across sites (i.e. different intercepts) and also for site-specific rate of change in bike counts over time (i.e. different slopes). The primary predictors tested in these models were an indicator for an on-site facility during each of the 5 count years, baseline (2007) bicycle facility length in the buffer surrounding the count site, and bicycle facilities length added in the buffer each year. Both the quarter and half mile buffer sizes were analyzed. Additionally, the same covariates analyzed in OLS models were tested one by one in the individual growth models. We used $p<0.05$ to represent a statistical significance level. We built models up, beginning with unconditional means and growth models, and assessed model fit statistics to determine the additional variation in the outcome explained by variables added to each model.

4.2 Results

Descriptive characteristics of the 40 Twin Cities count sites with at least 3 years of count data are shown in Table 1. Broad analyses of individual buffer variables indicated that higher proportion of white residents, higher employment density, and lower proportion of major road length were associated with higher bicycle counts. Other buffer variables tested showed no significant associations with annual bicycle counts in preliminary descriptive analysis.

A number of new, innovative facility types were installed during the Pilot program. Table 2 highlights the annual bicycle facility length in the buffer surrounding the count sites. Table 3 summarizes annual bicycle counts and weather characteristics on the day of the counts. In the 40 sites with 3 or more years of count data, the mean number of bicyclists increased 33.8% from 2007 to 2011 during the evening commute period.

The sites themselves had different types of facilities and facility changes over time. Among the 40 sites with at least 3 years of count data, there were 9 sites that received on-site facility improvements over time. Five of these 9 sites had new facilities installed, and four of these 9 sites received enhanced facilities. Of the remaining 31 sites, 20 had on-site facilities already in 2007, and 11 did not. On-site improvements were made primarily in 2010 (n=7 sites), with additionally 1 made in 2008 and 1 made in 2011.

In the model evaluation, the difference in bicycle facility types made a difference in terms of the associated counts. As shown in Model 1, adjusting for percent major road length in the 800 meter buffer and precipitation the count day, presence of a bicycle facility on the count site was associated with higher bicycle counts in 2007 (difference=41.8 additional cyclists; $p=0.04$). Bicycle counts among sites without an on-site facility increased at a rate of 5.6 cyclists per year between 2007 and 2011, and the presence of an on-site facility was associated with an additional rate of increase of 2.0 cyclists per year, although neither of these annual rates of increase were statistically significant. Model 2 includes the addition of the total bicycle facilities in the buffer (at baseline in 2007) and the rate of change over time. Model 3 includes estimates of the annual increase in bicycle facilities installed as part of the initiative, and an indicator for the rate of change over time.

Tables 4 and 5 depict results from the individual growth model analysis estimating differences in annual bicycle counts based on several predictor variables. Among all buffer variables tested, only proportion of major road length and length of total bicycle facilities were included in the final models, as they were theoretically important variables that remained significant or influential in the growth models. Table 4 presents results using characteristics of the 800 meter buffer around count sites, and Table 5 presents results using characteristics of the 400 meter buffer.

Results from the unconditional means model indicated that 89% of the variation in bicycle counts was due to between-site variation, and the remaining 11% was due to within-site variation (data not shown). Results from the unconditional growth model indicated that bicycle counts were increasing on average over time, and 20% of the within-site variation in bicycle counts was explained by time, leaving 80% of the within-site variation attributable to other factors.

Model 1 demonstrates that presence of a bicycle facility on the count site was associated with higher bicycle counts, adjusting for percent major road length in the 800 meter buffer and precipitation the count day. The addition of on-site facility, precipitation, and percent major road length to the model explained an additional 3% of the within-site variation in bicycle counts. Model 2 includes the addition of the total bicycle facilities in the buffer (at baseline in 2007) and the difference in rate of change over time due to bicycle facilities. These explained an additional 1% of the within-site variation in counts, and were not statistically significant predictors of counts.

Model 3, the final adjusted model, includes estimates of the annual increase in bicycle facilities installed as part of the initiative and the difference in rate of change over time due to added bicycle facilities. In 2007 the average bicycle count per site was 128 (SE 22), for a site with no on-site facility, average percent major road length in the buffer (mean=14.1%), average total bicycle facilities in the buffer (mean=12,600 ft), and with no precipitation on the count date. On average, counts increased at a rate of 8.31 (SE 3.79) cyclists per year between 2007 and 2011, for a site with average total bicycle facilities in the buffer, during years when no bike facilities were added in the buffer. Having an on-site facility increased bike counts by 44 (SE 19) cyclists on average. In 2007, every 1000 ft higher than average total bike facilities in the buffer were associated with 3.66 (SE 2.43) additional cyclists, although this difference was not statistically significant. Then, counts increased at a rate of 0.79 (SE 0.40) additional cyclists per year between 2007 and 2011 for every 1000 ft above the average total bike facilities in the buffer as of 2007. In the first year bicycle facilities were added to a site’s buffer, every 1000 ft added was associated with 44 (SE 9.5) fewer cyclists that year. In later years, counts increased at a rate of 11 (SE 2.3) additional cyclists per year for every 1000 ft of bike facilities added in the buffer. Precipitation and percent major road length in the buffer were both substantially negative but not statistically significant predictors of counts.

The initial drop and the subsequent significant gains in cyclists may tell us about how behavior is altered both during construction and over time. One possible explanation is that the initial drop in cyclists could be due to disruption caused by facility construction. The addition of the time variable suggests that it may take time for cyclists to change behavior to start riding new facilities. Given these findings, future research that examines behavior in relation to facility change over a longer time horizon may be useful.

Similar model effect estimates were found when analyzing 400 meter buffer characteristics with some exceptions. Total bicycle facility length in 2007 in the 400 meter buffer was associated with increased bicycle counts (estimate 18.9, SE 6.9), but not a statistically significant increase in rate of increase in bicyclist over time. The annual added bicycle facilities were associated with fewer counts in the first year of addition (estimate -120.8, SE 30.1), and a greater rate of increase in counts over time (estimate 32.8, SE 7.5).

4.3 Discussion

Community investments in active transportation infrastructure, such as occurred during the Nonmotorized Transportation Pilot Program in Minneapolis, may effectively increase the number of bicyclists utilizing the system. From a policy perspective, focused active transportation investments can help to establish a multi-year trend of increased usage that builds over time.

Results from this study suggest that the presence of bicycle facilities at the count location, the existing length of bicycle facilities in the adjacent areas and the facilities added over time each contribute to the growth in the number of cyclists observed at count locations during the years observed. Locations that started with more bicycle facilities in their adjacent buffer area added more cyclists over time, and when more facilities were added to the adjacent areas, the rate of cyclists added increased even more. Bicycle facilities emerged as the primary correlate of counts and growth in counts over time. Several characteristics of the count locations' adjacent areas were investigated for their impact on counts. The final models presented here explained approximately 40% of the within-site variation in bicycle counts, suggesting that additional analyses may be able to reveal other characteristics of count locations that explain the growth in cyclists over time.

This study capitalized on unique, longitudinal bicycle count data collected in concert with broad initiatives to improve bicycle facilities in the Twin Cities area, and used a robust analysis approach to estimate growth in cyclists associated with these initiatives. These results are similar to the findings from longitudinal analysis of the Twin Cities conducted by Krizek et al (2009). In a longitudinal analysis of the impact of large bicycle facilities on commuting patterns from 1990 to 2000 using Census data, Krizek et al (2009) found that statistically significant increases in bicycle commuting were found in areas in close proximity to new facilities. Our analysis adds to this body of knowledge with implications both for the Twin Cities and other cities interested in expanding bicycle systems.

While this research adds to the growing body of evidence on the impact of bicycle facilities on use, several caveats need to be considered. First, the study doesn't distinguish purpose of travel or potential changes in mode share. Therefore, secondary environmental or potential congestion impacts cannot be extrapolated (Krizek et al 2009). Also, bicyclists were not uniquely identified, nor were the effects of local construction on cycling behavior identified. In addition, while the study measures existing land use and density, it does not, as Levine (2006) is careful to point out, address why there is such a small overall quantity of mixed land use. In other words, the present study does not address the underlying structural questions of land use and regulation that limit environments conducive to walking and bicycling. This is important to consider when looking at the impact of fairly modest active transportation intervention within the larger stream of status quo auto-oriented investments (Fields and Hull 2013).

In addition, examining an intervention over a short term presents a snapshot in time. Additional years of bicycle counts and a broader set of months of data would strengthen the ability to estimate the impact of the interventions. While impacts of usage trends are a key policy impact variable, the study does not track other broader policy indicators of the Pilot program like changing administrative practices within agencies or changing cultural perceptions about bicycle use by the general public. These policy impacts of the Pilot may be even more important in the long-term for overall bicycle usage and system building (Fields and Hull 2013). Additional research that analyzes these components over time can help to understand more clearly the intricate processes of community change.

Figures and Tables

Figure 1 Diversity of On-road Bicycle Facilities 2011

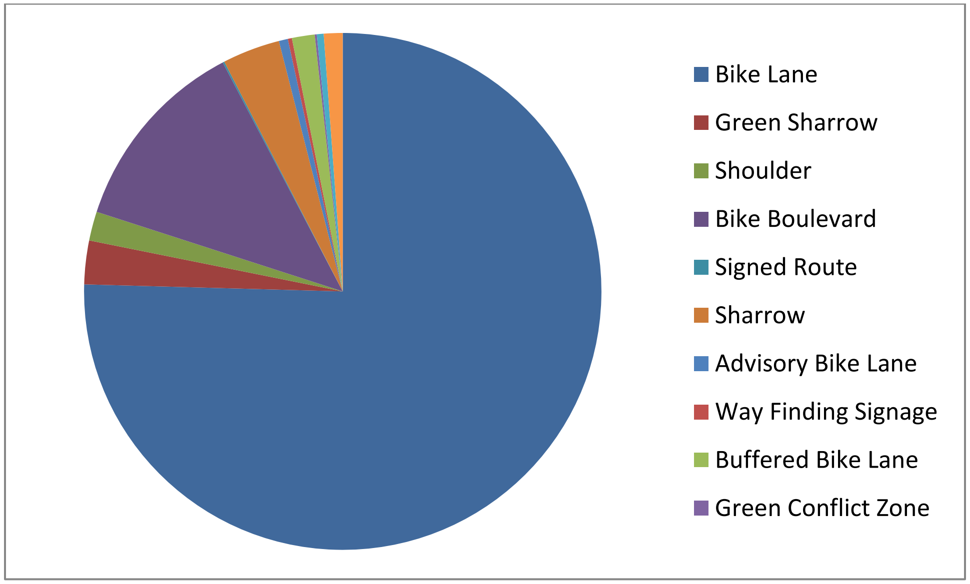


Table 1. Characteristics of the buffer network surrounding Twin Cities count sites with 3 or more annual counts, 2007-2011 (N=40)

	400 m Buffer						800 m Buffer				
	N	**Mean**	**SD**	**Min**	**Median**	**Max**	**Mean**	**SD**	**Min**	**Median**	**Max**
CHARACTERISTICS OF BUFFER											
BICYCLE FACILITIES											
Total Bicycle Facility Length (1000 ft) in 2007	40	3.8	2.6	0.0	3.7	9.2	12.6	8.0	0.0	12.7	27.6
POPULATION DENSITY											
Residential Density (Residents per Acre)	40	14	9	2	14	32	13	6	5	14	30
Employment Density (Workers per Acre)	40	19	27	0	9	110	21	31	0	9	131
Combined Residential and Employment Density	40	33	31	4	20	126	34	32	6	25	145
LAND USE											
% Retail and Other Commercial Square Footage	40	11.8	11.4	0.0	11.7	48.6	10.7	8.9	1.8	7.8	31.3
% Park, Recreational, or Preserve Square Footage	40	12.6	14.7	0.0	6.3	51.5	11.3	8.5	0.5	10.0	32.7
STREET CONNECTIVITY											
Number of Roadway Intersections in Buffer with at least 3 segments	40	23	9	4	23	39	90	21	42	91	125
TRANSIT USE											
Length in Feet (Thousands) of All Transit Routes (including Hi Frequency)	40	57.2	60.1	0.4	37.2	268.1	206.7	196.1	10.6	172.8	757.8
ROAD USE INTENSITY											
% Primary, Secondary, & Ramp Road Length	40	15.9	12.8	0.0	15.8	52.5	14.1	11.6	0.0	10.8	44.8

% Local Neighborhood Road, Rural Road, City Street Length	40	80.0	13.7	47.5	80.9	100.0	83.8	11.6	55.0	86.3	100.0
% Walkway/Pedestrian Trail Length	40	2.6	5.1	0.0	0.0	22.1	1.3	2.5	0.0	0.0	11.1
GENERAL											
Distance from Count Site to Minneapolis Mean Center of Population (Thousands of Feet)	40	11.1	5.9	2.8	9.1	25.5	11.1	5.9	2.8	9.1	25.5
Distance from Count Site to Minneapolis Mean Center of Employment (Thousands of Feet)	40	10.4	7.0	2.1	8.1	30.0	10.4	7.0	2.1	8.1	30.0
	N	**Mean**	**SD**	**Min**	**Median**	**Max**	**Mean**	**SD**	**Min**	**Median**	**Max**
SOCIO-DEMOGRAPHICS OF RESIDENTS											
RACE/ETHNICITY											
% White	40	65.5	23.1	14.1	76.6	92.7	63.8	22.4	20.7	69.6	92.1
% Black	40	17.6	17.4	0.6	9.3	66.6	19.8	17.6	1.3	14.4	54.0
% Hispanic	40	7.2	6.9	1.9	3.9	31.7	7.4	7.3	2.3	4.0	33.8
% American Indian Alaska Native	40	2.0	5.0	0.0	0.8	31.8	2.1	3.9	0.1	0.9	20.0
% Asian	40	8.1	5.7	1.8	6.1	23.4	7.1	4.6	2.1	5.4	18.5
% Native Hawaiian Pacific Islander	40	0.1	0.1	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.2
% Other	40	3.1	3.8	0.2	1.4	16.5	3.5	4.4	0.5	1.7	19.6
% One or More Races	40	3.7	1.7	1.6	3.3	8.8	3.7	1.4	2.2	3.1	7.2
AGE & SEX											
% Male	40	51.4	4.7	43.7	51.2	65.5	51.8	3.1	46.4	51.2	60.4
% Male under 5 years	40	2.4	1.8	0.1	1.9	7.3	2.8	1.5	0.5	2.8	6.2
% Male 5 to 9 years	40	2.0	1.9	0.0	1.3	7.2	2.1	1.4	0.2	2.0	5.1
% Male 10 to 14 years	40	1.5	1.6	0.0	0.9	5.8	1.6	1.3	0.1	1.6	5.3
% Male 15 to 17 years	40	0.9	0.9	0.0	0.6	3.3	1.0	0.7	0.1	0.9	3.3
% Male 18 to 24 years	40	11.3	10.9	2.3	6.5	45.8	10.6	9.8	2.6	6.6	40.5
% Male 25 to 34 years	40	12.5	6.9	4.3	9.3	28.4	12.6	5.4	4.9	11.2	22.3
% Male 35 to 64 years	40	17.1	8.4	1.1	16.2	42.1	17.6	6.4	3.0	18.0	29.8

% Male 65 years and older	40	3.7	3.6	0.1	3.1	23.3	3.5	2.3	0.5	3.2	15.3
% Female	40	48.6	4.7	34.5	48.8	56.3	48.2	3.1	39.6	48.8	53.6
% Female under 5 years	40	2.4	1.8	0.0	2.0	6.9	2.7	1.5	0.5	2.5	5.9
% Female 5 to 9 years	40	2.0	1.8	0.0	1.3	6.7	2.0	1.4	0.2	2.1	5.2
% Female 10 to 14 years	40	1.5	1.5	0.0	1.0	5.8	1.7	1.2	0.1	1.6	5.3
% Female 15 to 17 years	40	0.9	0.9	0.0	0.6	3.4	1.0	0.8	0.1	0.9	3.4
% Female 18 to 24 years	40	12.7	11.8	2.1	8.3	42.7	11.1	10.1	2.3	7.6	40.7
% Female 25 to 34 years	40	11.2	5.3	3.4	10.1	21.3	11.1	4.4	3.4	10.6	19.3
% Female 35 to 64 years	40	13.6	5.8	0.7	12.7	24.1	14.3	5.5	2.0	13.3	24.8
% Female 65 years and older	40	4.4	4.1	0.1	3.4	23.9	4.2	2.3	0.6	3.9	12.6
% No Vehicle Available	40	13.3	8.5	0.0	11.6	32.3	13.0	7.8	0.4	12.2	29.1
% 2 or more Vehicles Available	40	46.3	16.8	13.3	43.3	84.5	46.0	16.2	16.9	45.7	83.9
% Below Poverty	40	28.4	18.9	3.8	20.8	70.5	28.9	18.1	4.1	25.8	65.8
% Foreign Born	40	18.0	11.1	5.1	15.7	42.3	18.0	10.5	5.2	15.3	40.5
% Active Commuting (walk, bike, public transit)	40	34.5	13.8	7.8	35.7	57.6	34.8	13.6	9.0	37.2	56.8

Table 2. Bicycle facility length in buffer network surrounding count sites, 2007-2011 (N=40)

			400 m Buffer					800 m Buffer				
Bicycle facility length (1000 ft)	Year	N	Mean	SD	Min	Median	Max	Mean	SD	Min	Median	Max
Total bike facilities	2007	40	0.30	0.78	0.00	0.00	2.60	0.45	1.10	0.00	0.00	3.94
	2008	40	0.01	0.07	0.00	0.00	0.45	0.05	0.15	0.00	0.00	0.53
	2009	40	0.06	0.23	0.00	0.00	1.11	0.40	1.11	0.00	0.00	4.29
	2010	40	0.35	0.75	0.00	0.00	2.64	1.01	1.80	0.00	0.00	5.97
	2011	40	0.92	1.08	0.00	0.62	3.72	3.82	3.25	0.00	3.08	11.08
Advisory bike lane	2007	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2008	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2009	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2010	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2011	40	0.00	0.00	0.00	0.00	0.00	0.03	0.17	0.00	0.00	1.07
Bike Boulevard	2007	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2008	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2009	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2010	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2011	40	0.09	0.34	0.00	0.00	1.53	0.45	1.12	0.00	0.00	4.43
Bike Lane	2007	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2008	40	0.00	0.00	0.00	0.00	0.00	0.01	0.08	0.00	0.00	0.53
	2009	40	0.06	0.23	0.00	0.00	1.11	0.35	1.01	0.00	0.00	4.29
	2010	40	0.30	0.67	0.00	0.00	2.64	0.79	1.63	0.00	0.00	5.97
	2011	40	0.60	0.86	0.00	0.00	3.08	2.64	2.75	0.00	1.91	9.15
Bike Path	2007	40	0.30	0.78	0.00	0.00	2.60	0.45	1.10	0.00	0.00	3.94
	2008	40	0.01	0.07	0.00	0.00	0.45	0.04	0.13	0.00	0.00	0.50
	2009	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	2010	40	0.04	0.19	0.00	0.00	0.87	0.04	0.19	0.00	0.00	0.87
	2011	40	0.11	0.34	0.00	0.00	1.37	0.37	0.82	0.00	0.00	3.13
Buffered Bike Lane	2007	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2008	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2009	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2010	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2011	40	0.00	0.00	0.00	0.00	0.00	0.01	0.08	0.00	0.00	0.53
Bus Mall	2007	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2008	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2009	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2010	40	0.00	0.02	0.00	0.00	0.15	0.18	0.47	0.00	0.00	1.60
	2011	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Enhanced Sharrow	2007	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2008	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2009	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2010	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2011	40	0.03	0.21	0.00	0.00	1.31	0.17	0.53	0.00	0.00	1.83
Green Conflict Zone	2007	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2008	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2009	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2010	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2011	40	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.00	0.00	0.38
Green Sharrow	2007	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2008	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2009	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2010	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2011	40	0.00	0.00	0.00	0.00	0.00	0.02	0.09	0.00	0.00	0.56
Sharrow	2007	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	2008	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2009	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2010	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2011	40	0.08	0.32	0.00	0.00	1.47	0.12	0.49	0.00	0.00	2.79
Shoulder	2007	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2008	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2009	40	0.00	0.00	0.00	0.00	0.00	0.05	0.19	0.00	0.00	0.88
	2010	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2011	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 3. Annual bicycle counts and count day characteristics, 2007-2011 (N=40 count sites)

Bicycle Counts	***Year***	***N***	***Mean***	***SD***	***Min***	***Median***	***Max***
Number of Cyclists	2007	29	142	115	14	113	514
	2008	39	177	155	10	116	598
	2009	40	167	151	12	118	633
	2010	39	156	143	8	117	585
	2011	38	190	185	9	143	787
Weather	*Year*	*N*	*Mean*	*SD*	*Min*	*Median*	*Max*
Average Temperature (F)	2007	29	54.9	2.4	54	54	63
	2008	39	59.0	2.9	57	57	63
	2009	39	70.2	0.9	68	70	71
	2010	38	59.7	3.4	53	61	65
	2011	37	58.7	6.1	51	62	69
Wind Speed (mph)	2007	29	11.5	4.1	5.8	15.1	15.1
	2008	39	7.6	3.3	5.3	5.3	12.3
	2009	39	6.9	2.3	3.1	6	9.2
	2010	38	6.5	1.9	5.1	5.1	10.2
	2011	37	10.2	2.5	2.4	10.1	12.1
	Year	*N*	*N*	*%*			
Precipitation (# Days when Precipitation)	2007	29	3	10.3			
	2008	39	0	0.0			
	2009	40	13	32.5			
	2010	39	2	5.1			
	2011	38	0	0.0			

Table 4. Individual linear growth models predicting trends in bicycle counts among sites over time, using 800 meter buffer (N=40)

	Unconditional Means Model			Unconditional Growth Model			Model 1			Model 2			Model 3		
800 Meter Buffer	*Estimate*	*SE*	*P-value*	*Estimate*	*SE*	*P-value*	*Estimate*	*SE*	*P-value*	*Estimate*	*SE*	*P-value*	*Estimate*	*SE*	*P-value*
Intercept	166.66	23.14	***<.0001***	148.29	20.04	***<.0001***	125.40	21.52	***<.0001***	128.57	21.54	***<.0001***	127.72	21.59	***<.0001***
Time (years)				8.89	3.05	***0.004***	6.98	3.26	***0.03***	7.03	3.21	***0.03***	8.31	3.79	***0.03***
On Site Facility							44.03	18.71	***0.02***	39.25	19.31	***0.04***	44.05	19.12	***0.02***
Precipitation							-22.34	11.98	0.06	-21.85	12.00	0.07	-10.85	11.36	0.34
Percent Major Road Length in Buffer*							-0.71	1.49	0.64	-1.19	1.58	0.46	-1.36	1.58	0.39
Total Bicycle Facilities (1000 feet) in Buffer, 2007*										3.55	2.43	0.15	3.66	2.43	0.14
Total Bicycle Facilities (1000 feet) in Buffer, 2007* x Time										0.68	0.40	0.09	0.79	0.40	***0.05***
Added Bicycle Facilities (1000 feet) in Buffer (initial year)													-43.96	9.52	***<.0001***
Added Bicycle Facilities (1000 feet) in Buffer x Time													10.98	2.29	***<.0001***
Model Fit															
-2 Res Log Likelihood	2107.80			2071.80			2045.70			2038.30			2010.40		
AIC	2111.80			2079.80			2053.70			2046.30			2018.40		
Residual Variance	2458.15			1959.08			1909.41			1897.74			1578.09		
Pseudo R-square				0.20			0.03			0.01			0.17		

* Site-level variable that was grand mean-centered for model interpretation; estimate represents bicycle counts associated with average level of characteristic.

Model Fit statistics: Smaller is better for -2 Res Log Likelihood and AIC. Residual Variance indicates the amount of variance not explained by model variables. Pseudo R-square indicates the proportion of the within-site variance explained by the variables added to the current model over the previous model.

Table 5. Individual linear growth models predicting trends in bicycle counts among sites over time, using 400 meter buffer (N=40)

	Unconditional Means Model			**Unconditional Growth Model**			**Model 1**			**Model 2**			**Model 3**		
400 Meter Buffer	*Estimate*	*SE*	*P-value*	*Estimate*	*SE*	*P-value*	*Estimate*	*SE*	*P-value*	*Estimate*	*SE*	*P-value*	*Estimate*	*SE*	*P-value*
Intercept	166.66	23.14	***<.0001***	148.29	20.04	***<.0001***	123.97	21.35	***<.0001***	128.27	20.70	***<.0001***	132.84	20.72	***<.0001***
Time (years)				8.89	3.05	***0.004***	6.89	3.28	***0.04***	7.15	3.24	***0.03***	5.20	3.56	0.15
On Site Facility							46.49	18.64	***0.01***	39.22	19.43	***0.05***	38.11	19.33	***0.05***
Precipitation							-22.07	12.01	0.07	-22.73	12.01	0.06	-15.58	11.25	0.17
Percent Major Road Length in Buffer*							-0.85	1.35	0.53	-1.34	1.31	0.32	-1.42	1.29	0.28
Total Bicycle Facilities (1000 feet) in Buffer, 2007*										18.02	6.93	***0.01***	18.86	6.85	***0.01***
Total Bicycle Facilities (1000 feet) in Buffer, 2007* x Time										1.80	1.25	0.15	1.75	1.26	0.17
Added Bicycle Facilities (1000 feet) in Buffer													-120.82	30.11	***<.0001***
Added Bicycle Facilities (1000 feet) in Buffer x Time													32.83	7.46	***<.0001***
Model Fit															
-2 Res Log Likelihood	2107.80			2071.80			2045.70			2030.60			1998.60		
AIC	2111.80			2079.80			2053.70			2038.60			2006.60		
Residual Variance	2458.15			1959.08			1909.72			1892.58			1601.34		
Pseudo R-square				0.20			0.03			0.01			0.15		

* Site-level variable that was grand mean-centered for model interpretation; estimate represents bicycle counts associated with average level of characteristic.

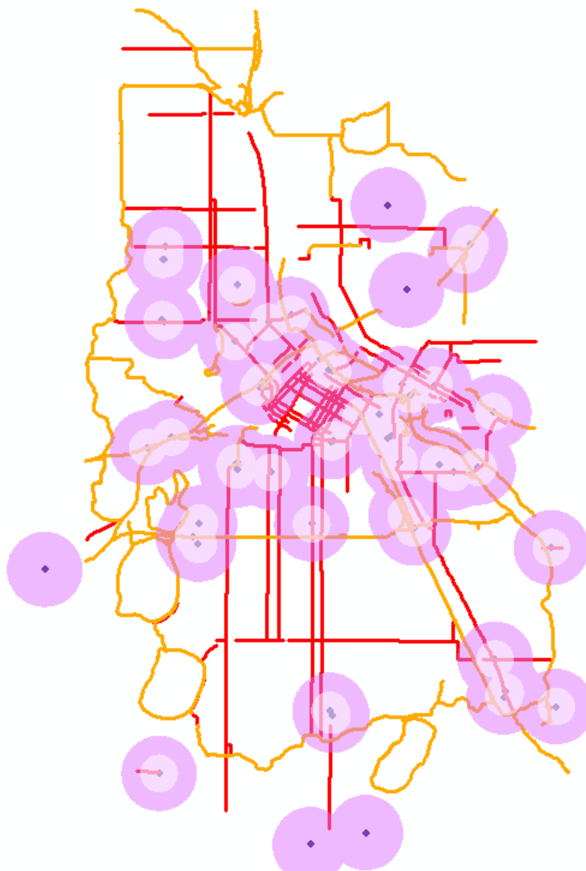
Model Fit statistics: Smaller is better for -2 Res Log Likelihood and AIC. Residual Variance indicates the amount of variance not explained by model variables. Pseudo R-square indicates the proportion of the within-site variance explained by the variables added to the current model over the previous model.

Appendix A: Minneapolis Demographic Buffer Analysis: GIS Protocols

One of the key foundational steps necessary for conducting an analysis of the impact of Bike Walk Twin Cities was the establishment of a GIS database of landscape and sociodemographic characteristics of the impacted areas of the city. To produce a solid GIS frame for analysis, multiple, technical steps must be followed based on a rigorous protocol. This section outlines the rationale and protocols established for this project.

A.1 Buffer Selection

Half-mile and quarter-mile buffers were created for 55 bicycle count sites in the Twin Cities. These count sites from the full set of TLC/DPW count locations because they met two criteria.



Buffers and Count Locations

First, counts at these locations were conducted in 2011 and second there was at least one other count done in previous years. These criteria enabled comparison of the change in bicycle volumes over time.

Half-mile and quarter-mile buffers are generally considered reasonable distances for analysis of active transportation. For this project, the buffers are used as a unit of analysis for the demographic and environmental conditions of a given count site.
Most of these count sites are within a quarter-mile or half-mile of bicycle facilities (paths or lanes). These buffers and their intersection with bicycle facilities are illustrated on the map to the right.

All but three of resulting 55 buffers (half-mile or quarter-mile) are located within the City of Minneapolis. Of these three, two are bridge counts on the Mississippi River which fall in the jurisdictions of both Minneapolis and St. Paul. The other is the site in St. Louis Park (#901), to the west of Minneapolis.

A.2 Metadata

This section outlines all of the data being summarized for the selected buffers.

<u>2010 Census</u>
Total Population
Sex by Age
Race
Hispanic
Number of Households
Housing Occupancy Status
Housing Tenure

<u>2010 LED Data</u>
Number of Workers (Residing in area)
Number of Workers (Employed in area)
Number of Workers by Industry (Residing in area)
Number of Workers by Industry (Employed in area)

<u>2006-10 American Community Survey</u>
Means of Transportation
Travel Time to Work
Vehicles Available by Sex
Income per Capita
Poverty Status
Foreign-Born

<u>Land Use, Urban Form, and Location Variables</u>
Land Use (Metro GIS)
Population Density (2010 Census)
Employment Density (2010 LED)

Population + Employment Density (2010 Census and LED)
Household Units/Acre (2010 Census)
Average Block Size (Census Tiger files)
Distance from Minneapolis Mean Center of Population (2010 Census)
Distance from Minneapolis Mean Center of Employment (2010 LED)

<u>Transportation Variables</u>
Bicycle Counts, 2007-2011 (TLC)
Bicycle Count Site Characteristics (TLC)
Length of Bicycle Facilities in Buffer by Classification (TLC) and year
Annual Average Daily Traffic for Vehicles along Bicycle Facility at Count Site (Metro GIS/TLC)
Length of Roadways by Classification (Census TIGER files)
Total Number of Intersections (Census TIGER files)
Transit Stops per Buffer (Metro GIS)
High Frequency Transit Stops per Buffer (Metro GIS)
Transit Route Length in Buffer (Metro GIS)
High Frequency Transit Route Length in Buffer (Metro GIS)

A.3 Demographic Data Sources and Geographic Assignment

A combination of 2010 Census, 2010 Longitudinal Employment-Household Dynamics, and 2006-2010 ACS data were utilized for demographic analysis. While the 100% block-level data from the 2010 Census is preferable, the 2010 Census block level data does not provide information on economic data like Journey to Work or Income. After the 2000 Census the annual ACS replaced the decennial Census Supplemental Survey which covered these economic data with an approximately 17% sample size (1-in-6 households). The ACS was not fully implemented until 2005.

ACS data for the variables we are interested in is only available down to the census tract, not the block or block group. Furthermore, this tract-level data is only available from 5-year estimates because of small single-year sampling sizes that would make small area estimates prone to extremely high margin of error. So while 2010 Census data is based on 100% sample data at the census block level, the 2006-10 ACS data is based on 12.5% (1-in-8) sample data at the census tract level (Wombold, 2008).

We, therefore, interpolate tract-level trends to the block level in order to most accurately assign demographic data from a portion of a census tract to a given buffer. We do this by utilizing an areal interpolation technique similar to “areal weighting”.

A.4 Areal Weighting for ACS variables

Areal weighting is used to interpolate buffer specific trends for variables which are only available at the tract level from the ACS. These are mostly economic trends like Means of Transportation to Work, Vehicles Available, Aggregate Household Income, and Poverty Status. This method is more complex than simply applying a geometric ratio based on the percentage of land area of a given tract contained in the buffer. It is being utilized because there is significant variation within census tracts which may cause the geometric ratio to give inaccurate numbers. A geometric ratio assumes uniform distribution. We will still use a geometric ratio at the block level where necessary because this is the smallest geographic unit available and we cannot interpolate trends below this level in a simple way.

In contrast to a geometric ratio, the areal weighting technique uses a proportional population ratio which represents the percent of a given universe, or population, of a census tract contained in the buffer. This ratio relies on a subset of data. The subsets of data will be discussed in more detail later but all are block-level data from the 2010 Census or 2010 Longitudinal Employment-Household Dynamics. Because data only go down to the block level, it is necessary to use a geometric ratio to clip blocks that intersect the buffer boundary.

A sample exercise was done to compare results from a geometric ratio versus a proportional population ratio. This exercise can be found in the appendix and confirms the notion that a geometric ratio is more likely to be inaccurate because of its assumption that distributions of populations are even throughout a tract. In this sample, the geometric ratio would assign 1,780 out of 4,602 persons residing in a census tract to the buffer. By comparison, the proportional population would assign 1,216 out of 4,602 persons from the same census tract. The overcounting of the geometric ratio is explained by large presence of non-residential uses (commercial and open space) in the buffer portion of the census tract. Assuming a uniform distribution is clearly not the best way to deduce buffer-specific trends from the census tract.

A.5 2010 Census Data and 2010 LED Data

Data from the 2010 Census and 2010 LED database are provided at the block-level and are used in the same manner.

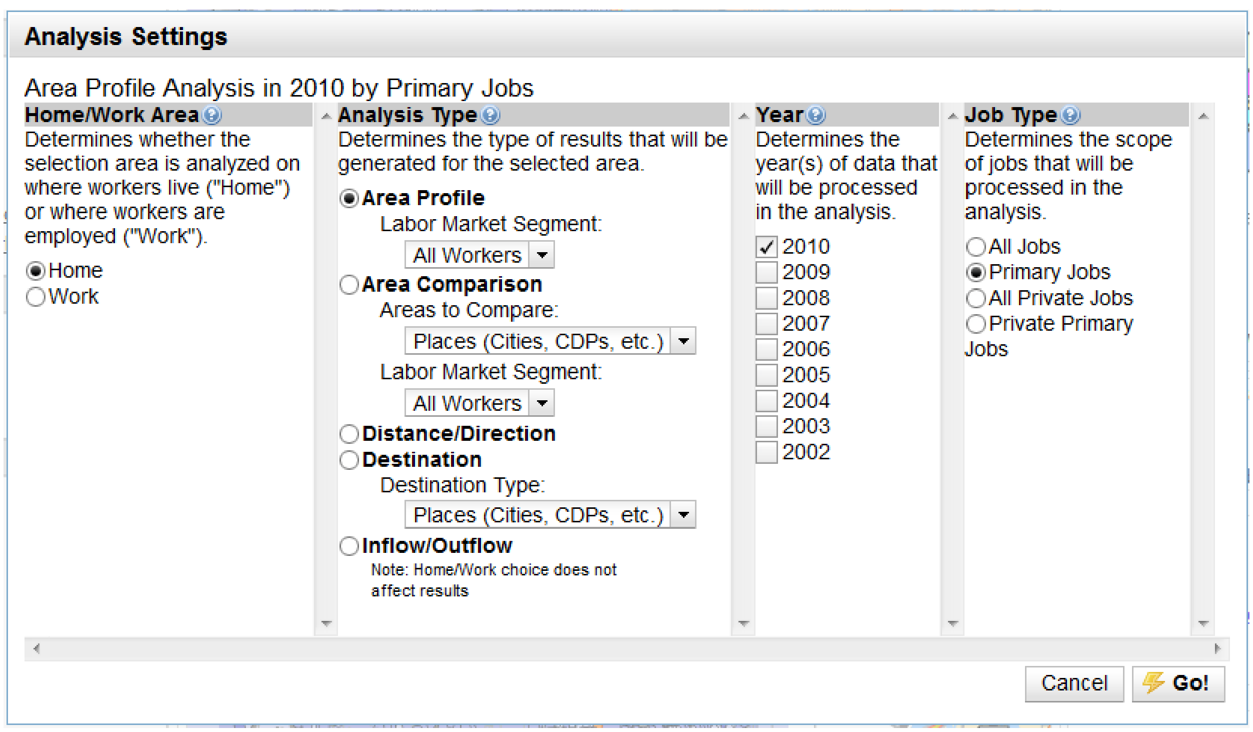
As previously mentioned, 2010 Census data is 100% data and is available at the block level. Calculating these data within a buffer is rather simple compared to the tract-level data from the ACS. All data in blocks completely contained within a buffer are assigned to the buffer. This excludes blocks which are physically isolated by water and have no access roads. The remaining blocks are those that intersect the buffer boundary and are thus effectively “clipped”. For these, a “geometric ratio” is applied based on the percentage of land area of the block contained within the buffer as compared to the overall land area of the block. This ratio is multiplied by the data of a given census block to get the raw number contained in the buffer.

The following data was extracted from the 2010 Census at the block level: Total Population; Sex by Age; Race; Ethnicity (Hispanic); Number of Households; Housing Occupancy Status; and Housing Tenure.

The 2010 Census does not provide block level data for the workforce population. For this reason we use block-level data from the 2010 Local Employment-Household Dynamics (LED) database provided by the Census Bureau.

The Census Bureau has partnered with local states to create the Longitudinal Employer-Household Dynamics (LED) database. This block-level data provides origin and destination data for work trips and is available from 2002 to 2010. The employment data is derived from Unemployment Insurance Wage Records reported by employers and maintained by each state for the purpose of administering its unemployment insurance system. The states assign employer locations, while workers' residence locations are assigned by the U.S. Census Bureau using data from multiple federal agencies. The data is manipulated for confidentiality reasons but general commuting patterns and spatial patterns are maintained at the block level.

For purposes of this project we use the block-level origin (home) and destination (work) data for 2010 for primary jobs. Primary jobs are used as opposed to all jobs because it is the primary job upon which the ACS questionnaire is based. This ensures compatibility between the datasets. This gives us the number of workers residing in the area as well as working in the area.



Worker data from the LED source is also stratified by NAICS industry, as illustrated in the table below. These industries may later be aggregated into more basic industries.

This LED data source is only beginning to become widely used in academic and policy circles. The Greater New Orleans Community Data Center (GNOCDC) has recently published several reports using LED data: *Economic Ties Across South Louisiana*; *Post-Katrina Commuting Patterns*; and Job *Sprawl in Metro New Orleans* (GNOCDC, 2012).

Jobs by NAICS Industry Sector
Agriculture, Forestry, Fishing and Hunting
Mining, Quarrying, and Oil and Gas Extraction
Utilities
Construction
Manufacturing
Wholesale Trade
Retail Trade
Transportation and Warehousing
Information
Finance and Insurance
Real Estate and Rental and Leasing
Professional, Scientific, and Technical Services
Management of Companies and Enterprises
Administration & Support, Waste Management and Remediation
Educational Services
Health Care and Social Assistance
Arts, Entertainment, and Recreation
Accommodation and Food Services
Other Services (excluding Public Administration)
Public Administration

A.6 2006-10 ACS Data

The remaining demographic data was extracted from the 2006-10 ACS at the tract level. This includes: Means of Transportation; Travel Time to Work; Vehicles Available by Sex; Aggregate Household Income; Poverty Status; and Foreign-Born.

Because census tracts are much larger than census blocks, a different methodology is needed for reliable, buffer-specific analysis. This methodology can take two approaches: a focus on single year ACS projections or a multi-year estimate (2006-10 values). The latter approach is used in this project in order to maintain the values from the 5-year data. A proportional population ratio is utilized to determine the ACS values from any given tract contained in a buffer. This methodology can be seen in the appendix.

We use block-level data derived from the 2010 Census or Longitudinal Employer-Household Dynamics database (LED) to establish a base population number for each specific tract contained in the buffer. It is important to note that census tracts are comprised of block groups which are in turn comprised of blocks.

In order to get the total population (and later percentage) of a tract contained in a buffer we must add together all of the blocks it contains. For blocks which are dissected by the buffer boundary a "geometric ratio" is used to calculate the percentage of land area (excluding water based on TIGER water shapefiles) of the block in the buffer relative to the overall land area of the block. This ratio is then multiplied by the total population of the block to get an approximate population of the block residing in the buffer. These dissected block populations are added to those blocks completely contained in the buffer to get a tract-specific buffer population.

This tract-specific population contained within the buffer is then divided by the total population of the entire tract to establish a "proportional population" ratio.
It is important to note that when we say population, this is a broad term and does not speak to a specific population being accounted for. Each table taken from the ACS is representative of a specific population, or "universe". These universes include the total population; worker population; and total households.

The reason it is important to distinguish the universe of a variable for geographic analysis is because each has a unique geographic distribution. It should not be assumed that the geographic distribution of any universe is similar to another. For instance, the overall population distribution is not always correlated to the household distribution because of varying household sizes.

These unique distributions are the key reason for using block-level data as opposed to using a tract-level "geometric ratio" method for deriving the portion of a universe population located within a buffer. The block is much smaller and thus less prone to misrepresentation by aggregation.

The table below shows the tract-level variables from the ACS and their universes.

Census Tract Data

Variable	Source	Table	Universe
Vehicles Available by Sex	2006-10 ACS	B08014	Workers 16 years and over in households
Travel Time to Work	2006-10 ACS	B08303	Workers 16 years and over who did not work at home
Means of Transportation to Work	2006-10 ACS	B08301	Workers 16 years and over

Aggregate Household Income in the Past 12 Months (2010$)	2006-10 ACS	B19025	Households
Poverty Status in the Past 12 Months by Sex by Age	2006-10 ACS	B17001	Population for whom poverty status is determined
Place of Birth by Citizenship Status	2006-10 ACS	B05002	Total Population

Based on this table:

- The **total population universe** is used to figure Poverty Status and Foreign Born. For Poverty Status, this will actually be amended in a later section to exclude the Group Quarters population.
- The **worker population universe** is used to figure Means of Transportation to Work, Travel Time to Work, and Vehicles Available by Sex
- The **total households universe** is used to figure Income per Capita

A.7 Demographic Calculation Methods by Variable

This section details the quantitative methods used to derive buffer-specific demographic data. While each variable is somewhat unique, the largest differences in methodology are between the 2010 Census variables and 2006-10 ACS variables.

A.8 2010 Census Variables

As mentioned in the section above, the data from the 2010 Census is available at the block level. Therefore the calculation methods are simple and do not require accounting for tracts. The first step is to calculate the geometric ratio, or percentage of each block contained within the tract. The following formula will be used:

$$Geometric\ Ratio = \frac{Square\ Footage\ of\ block\ contained\ in\ buffer}{Total\ Square\ Footage\ of\ block}$$

After this ratio is calculated it is multiplied by the entire population of a given variable for each block. Finally, the resulting numbers for all blocks intersecting with the buffer is added together to get the buffer-specific total.

A.9 2006-10 ACS Variables

The 2006-10 ACS variables are a bit more complex than the 2010 Census Data. They are only provided at the tract level and thus block-level trends must be deduced based on variables at the tract level and geographic trends at the block level.

The following subsections will discuss the methodology for calculating ACS demographics for the buffer by universe.

For all universes, we begin by creating a “proportional population” ratio for that universe:

1. Calculate the total population of a universe in each census tract. This is done by summing up all blocks within the census tract.
2. Calculate the total population in the census tract contained by the buffer. This is done in a manner similar to the Census 2010 methodology, using a geometric ratio, applying it to all blocks intersecting the buffer, and finally summing up the numbers of all blocks.
3. Create a "proportional population" ratio by taking the universe number within the buffer (Step 2) and dividing it by the universe number of the entire tract (Step 1).

A.10 Total Population Universe

This universe is being used to calculate the Poverty Status by Sex by Age variable and Foreign Born variable. It should be noted that while the Foreign Born variable uses the Total Population universe, the actual universe of the Poverty Status variable is "the population for whom poverty status is determined." The only difference between these universes is that poverty status is not determined for those living in group quarters.

Foreign Born

Once the "proportional population" ratio for the total population is figured for the portion of a tract contained in the buffer the following steps should be taken to figure the foreign born population of the buffer:

1. Apply the "proportional population" ratio by the number of foreign born residents in each 2006-10 census tract intersecting the buffer.
2. Add up the numbers for each census tract in the buffer to get a buffer total for 2006-10.

Poverty Status

As mentioned, the actual universe for Poverty Status is the total population minus the population living in group quarters. Group quarters are defined as:

Any place where people live together on a more than temporary basis; some GQs include military barracks, prisons (NOT jails), nursing homes (NOT hospitals); college residence halls; workers' dormitories; and facilities for people needing emergency shelter (domestic violence shelters, homeless shelters, natural disaster shelters, etc.).

(http://www.lib.ncsu.edu/data/censusterms.html#GQ)

Table P-29 from the 2010 Census provides a breakdown of the population that lives in households and those that live in group quarters. This block-level data is used to create the universe for this Poverty Status variable by excluding the population in group quarters. The population living in group quarters is slightly less than 5% but this population could be concentrated in certain areas and thus skew the data at the buffer level.

Once the "proportional population" ratio for non-group quarters population is figured for the portion of a tract contained in the buffer the following steps should be taken to figure the population of the buffer living below poverty:

3. Apply the “proportional population” ratio by the population living below poverty in each 2006-10 census tract intersecting the buffer.
4. Add up the numbers for each census tract to get a buffer total for 2006-10.

A.11 Worker Population Universe

This universe applies to the following variables: Means of Transportation to Work, Travel Time to Work, and Vehicles Available by Sex. The “base” data being used to assign data to the block level is the LED source.

Once the “proportional population” ratio for the worker population is figured for the portion of a tract contained in the buffer the following steps should be taken to figure the number of each attribute for a variable (e.g. Bicycle Commuters in Means of Transportation variable dataset):

1. Multiply the “proportional population” ratio by the attribute value of a given dataset (e.g. # of Bicycle Commuters) for each 2006-10 census tract intersecting the buffer.
2. Add up the numbers for each census tract to get a buffer total for 2006-10.

A.12 Households Universe

While the Median Household Income and Mean Household Income were downloaded, they are not relevant for this project. Median Household Income cannot be disaggregated because we do not have access to the full range of values from the ACS. Mean Household Income could be used but instead Income per capita is used because it is believed to be more accurate of the overall welfare of an area since it accounts for persons, and thus household size not just households. For example, a household with five persons and an income of $100,000 should be considered less wealthy than a household with two persons and an income of $100,000.

For Income per capita:

1. Calculate the tract-specific Aggregate Household Income by multiplying the Household “Proportional Population” Ratio by the Total Aggregate Household Income.
2. Sum up the resulting Aggregate Household Income values for each “clipped” tract contained in the buffer.
3. Next we need to calculate the denominator for “Income per capita,” the total population. First we need to know the total population in each census tract from 2006-10. For this we will use Table DP-05.
4. The next step is to get the total population within the buffer to serve as a denominator for Aggregate Income. To do this, multiply the total population of the tract from Table DP-05 by the “proportional population” ratio for the total population based on 2010 Census data.

5. Sum up the resulting Total Populations for each "clipped" tract contained in the buffer.
6. Divide the total Aggregate Household Income of the buffer (Step 2) by the Total Population of the buffer (Step 5) to get the 2006-10 Income per capita (2010$) for the buffer.

A.13 Demographic Analysis GIS Work Flow

This section will illustrate GIS work flows for computing the demographics from the 2010 Census, 2010 LED, and 2006-10 ACS. As mentioned previously, these datasets require different methodologies to derive buffer-specific data.

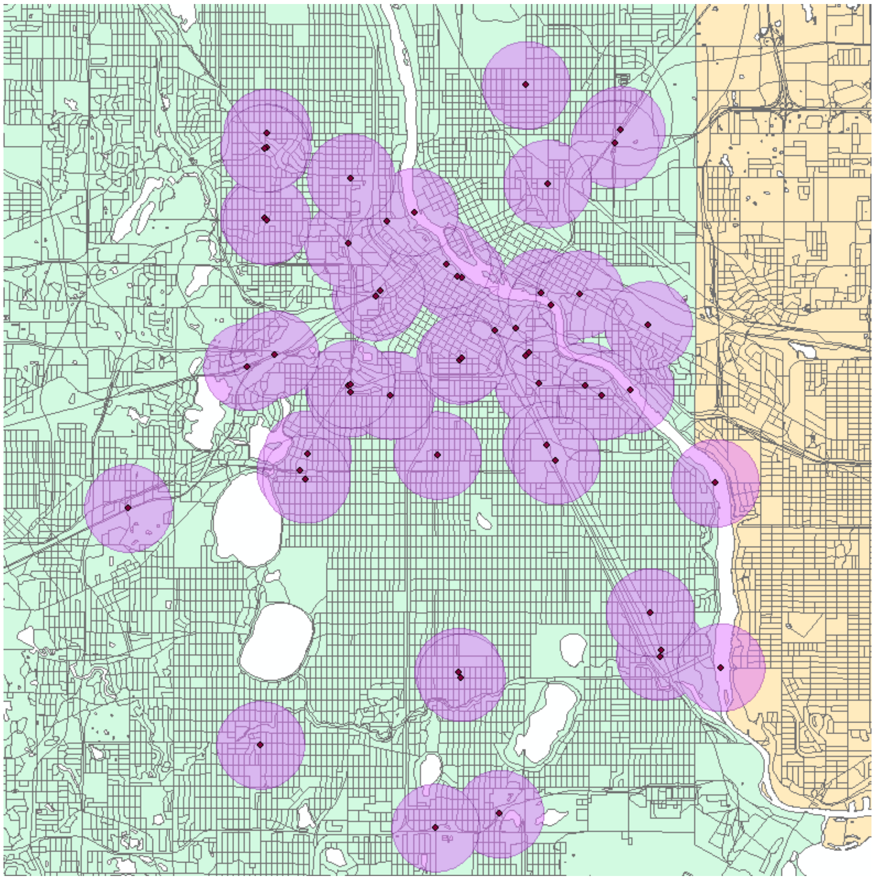
A.14 2010 Census Work Flow

This section illustrates the process of creating "geometric ratios" for all census blocks intersecting count site buffers. This GIS work flow is only being used for the 2010 Census and 2010 LED variables.

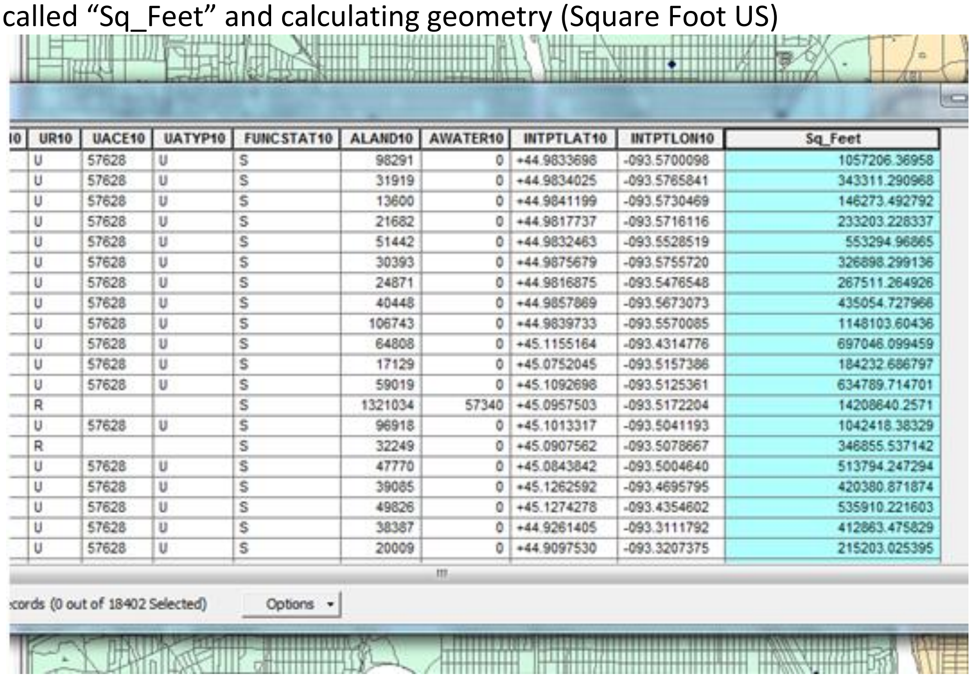
The data sources used in this process include:

2010 TIGER census block shapefiles for Hennepin and Ramsey counties
2010 TIGER census tract shapefiles for Hennepin and Ramsey counties
2010 TIGER area water shapefiles for Hennepin and Ramsey counties
2010 TIGER linear road shapefiles for Hennepin and Ramsey counties
55 TLC Bicycle Count site x and y coordinates

Step 1: Erase all water from census blocks/tracts using the Erase Tool



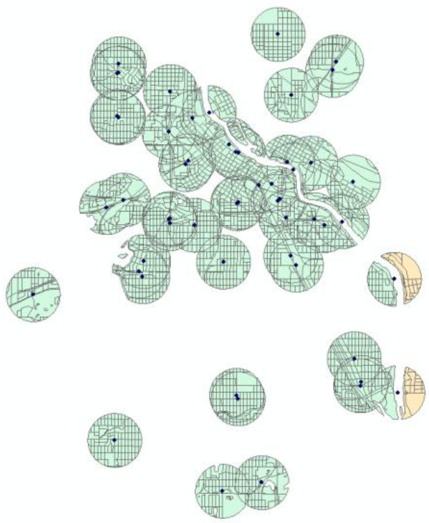
Step 2: Calculate Square Footage of all census blocks/tracts by adding a new “double” field called “Sq_Feet” and calculating geometry (Square Foot US)



10	UR10	UACE10	UATYP10	FUNCSTAT10	ALAND10	AWATER10	INTPTLAT10	INTPTLON10	Sq_Feet
	U	57628	U	S	98291	0	+44.9833698	-093.5700098	1057206.36958
	U	57628	U	S	31919	0	+44.9834025	-093.5765841	343311.290968
	U	57628	U	S	13600	0	+44.9841199	-093.5730469	146273.492792
	U	57628	U	S	21682	0	+44.9817737	-093.5716116	233203.228337
	U	57628	U	S	51442	0	+44.9832463	-093.5528519	553294.96865
	U	57628	U	S	30393	0	+44.9875679	-093.5755720	326898.299136
	U	57628	U	S	24871	0	+44.9816875	-093.5476548	267511.264926
	U	57628	U	S	40448	0	+44.9857869	-093.5673073	435054.727966
	U	57628	U	S	106743	0	+44.9839733	-093.5570085	1148103.60436
	U	57628	U	S	64808	0	+45.1155164	-093.4314776	697046.099459
	U	57628	U	S	17129	0	+45.0752045	-093.5157386	184232.686797
	U	57628	U	S	59019	0	+45.1092698	-093.5125361	634789.714701
	R			S	1321034	57340	+45.0957503	-093.5172204	14208640.2571
	U	57628	U	S	96918	0	+45.1013317	-093.5041193	1042418.38329
	R			S	32249	0	+45.0907562	-093.5078667	346855.537142
	U	57628	U	S	47770	0	+45.0843842	-093.5004640	513794.247294
	U	57628	U	S	39085	0	+45.1262592	-093.4695795	420380.871874
	U	57628	U	S	49826	0	+45.1274278	-093.4354602	535910.221603
	U	57628	U	S	38387	0	+44.9261405	-093.3111792	412863.475829
	U	57628	U	S	20009	0	+44.9097530	-093.3207375	215203.025395

cords (0 out of 18402 Selected) Options

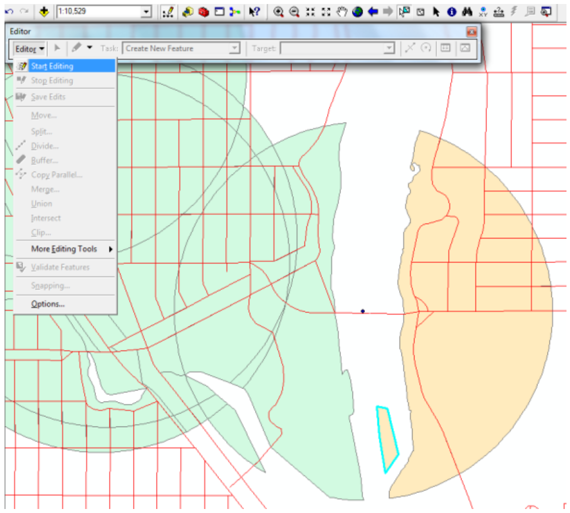
Step 3: Intersect blocks/tracts with half mile buffers, first for Hennepin Co. and then for Ramsey Co.



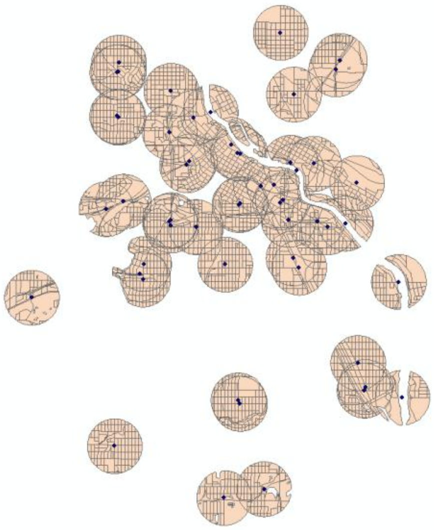
Step 4: Erase any land isolated from other land that is not connected to the main land area by a road.

- Each buffer area is analyzed individually by using the select by attributes tool with the TLC ID number as the common attribute.
- If a polygon of land is isolated from the main area of land and is not connected by a road select that polygon with the select tool. Since all we have are vehicular road TIGER files, use Google Maps to see if there is any other land connection not indicated by the TIGER road shapefile (e.g. bike/ped path or park road). If there are no other connections according to Google Maps maintain the selection.
- Right-click the layer, scroll down to Selection, and create a new layer from the selection.
- Enter an editing session by clicking on the editor toolbar and clicking Start Editing. Reselect the isolated portion of land and open up the attribute table and click the selected bar at the bottom of the table to show only the selected portion of land. Right-click the left side of the row on the arrow. Click Delete Selected. Save and exit the editing session.
- If a portion of land is a part of a larger geography (block) and needs to be disaggregated open up the Advanced Editing tool, select the portion, and click

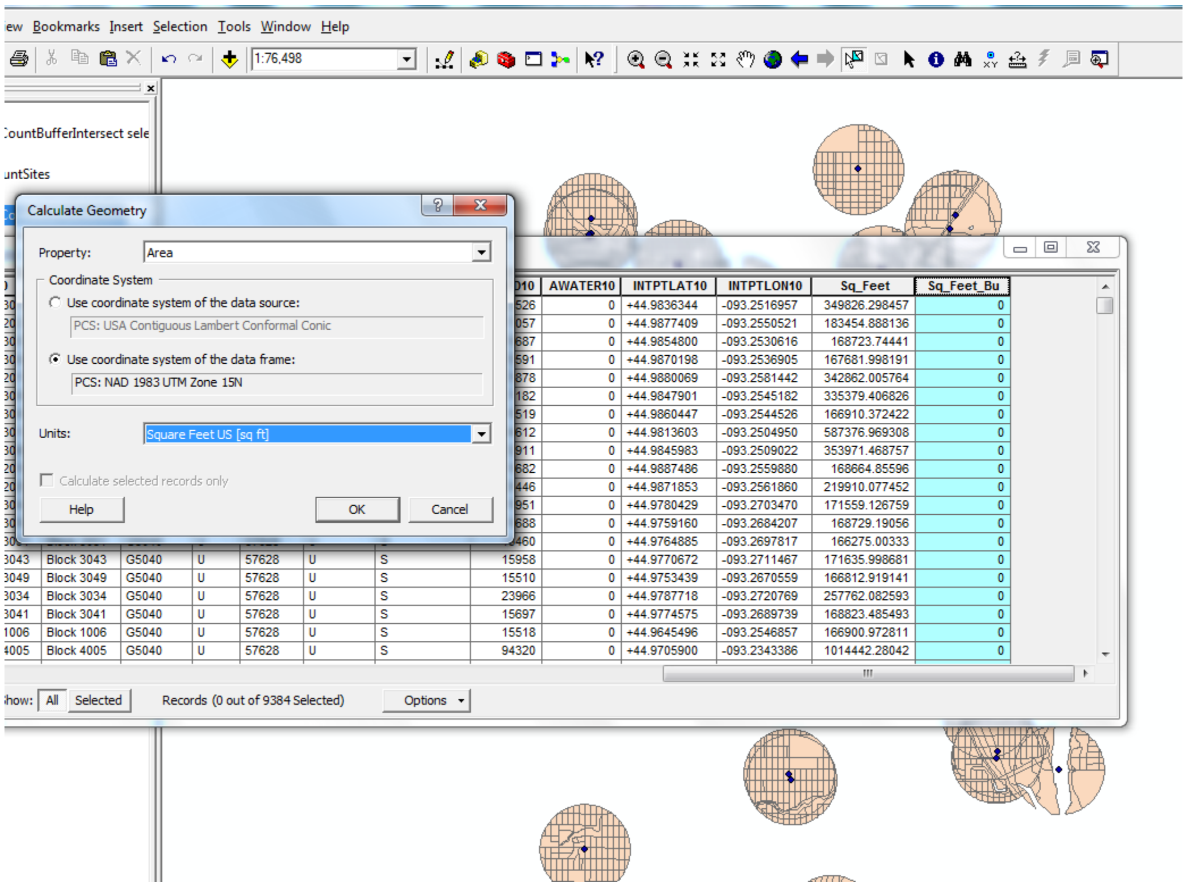
explode then proceed as noted above.



Step 5: Merge the edited Hennepin and Ramsey County Intersect Buffers with the Merge Tool. Save it in an appropriate place.

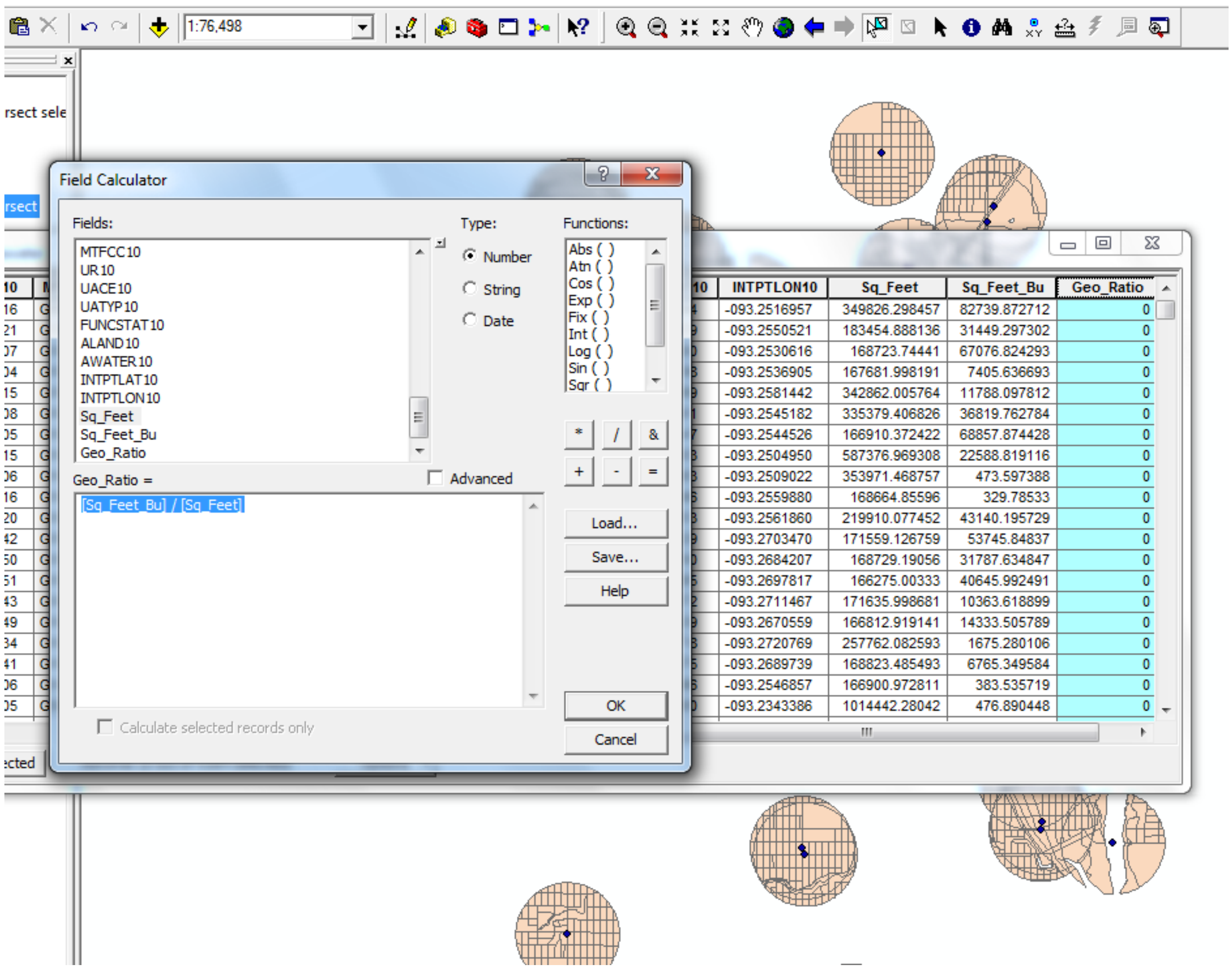


Step 6: Calculate Square Footage of blocks/tracts contained in buffers by adding a new "double" field called "Sq_Feet_bu" and calculating geometry (Square Foot US) based on the coordinate of the data frame.



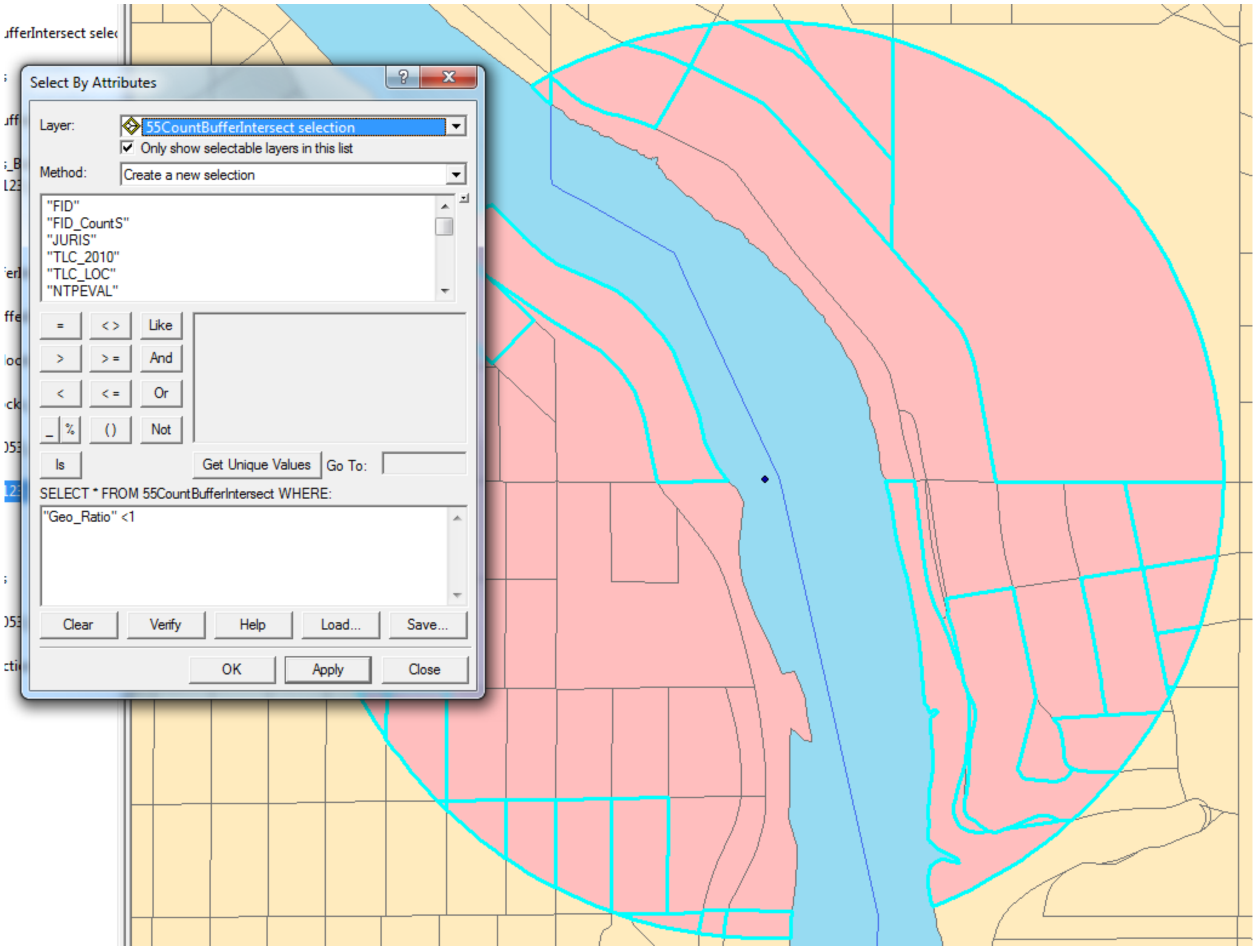
Step 7: Calculate the "Geometric Ratio" of the area contained in the buffer to the area overall.

- Add a new field called "Geo_Ratio". Make sure it is a float field and not double.
- Enter the following equation in the Field Calculator: [Sq_Feet_Bu] / [Sq_Feet]



Step 7: Do a Quality Check by looking at each buffer individually.

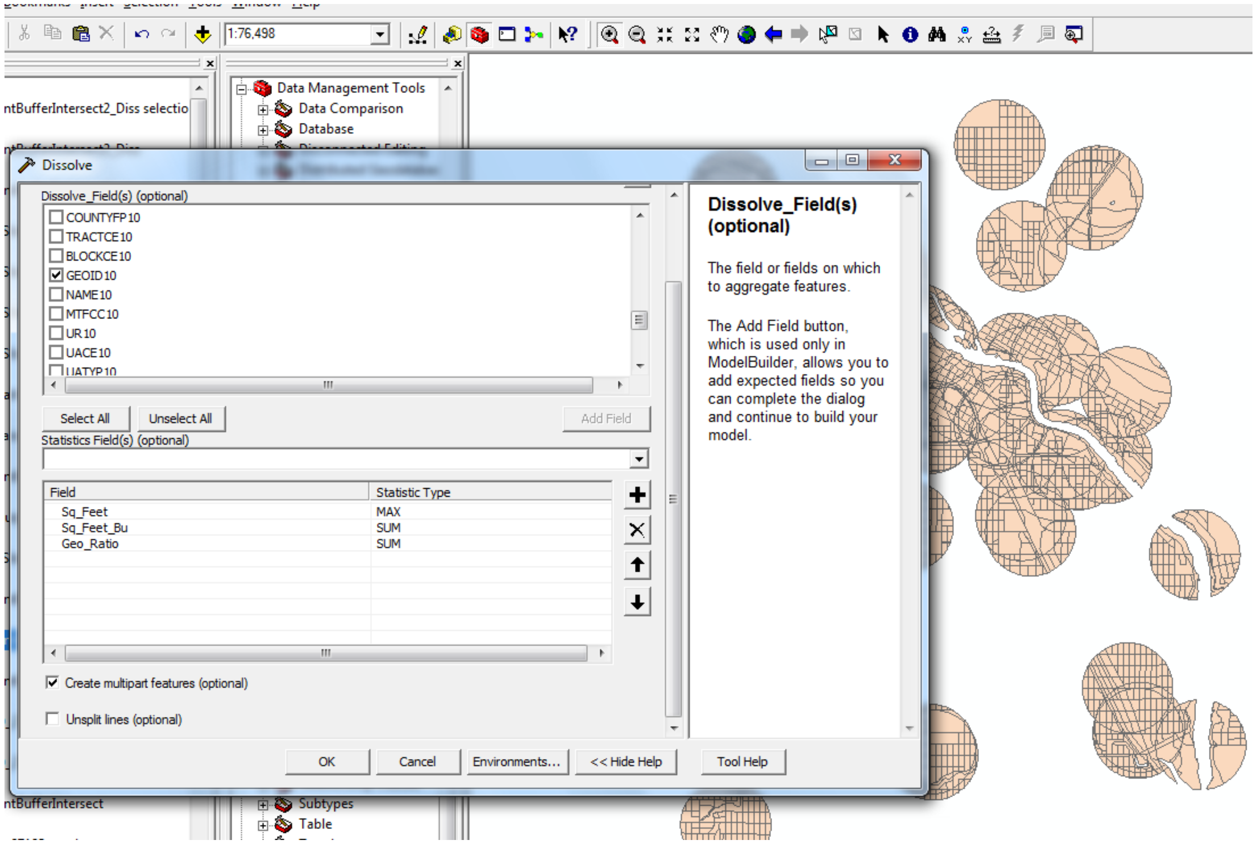
- Use the Select by Attributes tool to create a new layer for an individual buffer
- Add in the water layers and block/tract layers for reference.
- Use the Select by Attributes tool to select the blocks/tracts with geometric ratios under 1. Only the areas that intersect buffer border and areas with water should have a ratio lower than 1. Some areas that should be 1 will be extremely close (e.g. .999998) but calculations may result in a slight rounding error. Ignore these areas as they are so close to 1 it will not make a difference.



Step 8: Use Dissolve tool to re-aggregate blocks/tracts which were split by overlapping buffer boundaries.

- Open Dissolve Toolbox
- Select the intersected buffer layer as the input. Select the TLC ID and Census block/tract ID as the Dissolve Fields. In the Statistics Field add all columns to be included in the final output, including census/ACS data, square footage, and the ratio.
  - Use MAX as the statistic type for the original "Sq_Feet" in order to avoid overcounting. This will ensure that the square footage of divided portions of blocks does not multiply this number.
  - Use SUM as the statistic type for the buffer area stat "Sq_Feet_bu" in order to ensure that the square footage of divided portions are combined.
  - Use SUM as the statistic type for the buffer area stat "Geo_Ratio" in order to ensure that the square footage of divided portions are combined.
  - Make sure "Multipart Feature" is checked

- Click OK and run the Dissolve. Now you should have all data for each buffer broken up by block.



Step 9: View the resulting dataset.

- Open the attribute table and add a new field called "Check". Calculate it as the buffer area/block area and ensure its similarity to the original "Geo_Ratio".
- Note that summing up the split-up portions of census blocks will result in some "Geo_Ratio" values being slightly under or over 1, ranging from 0.999999 to 1.000001. These are for all functional purposes equal to 1.
- Export this attribute table. It will likely be too large to view in ArcMap.

A.15 2006-10 ACS Work Flow

The procedures for this work flow focuses on half mile buffers but the process is exactly the same for quarter mile buffers.

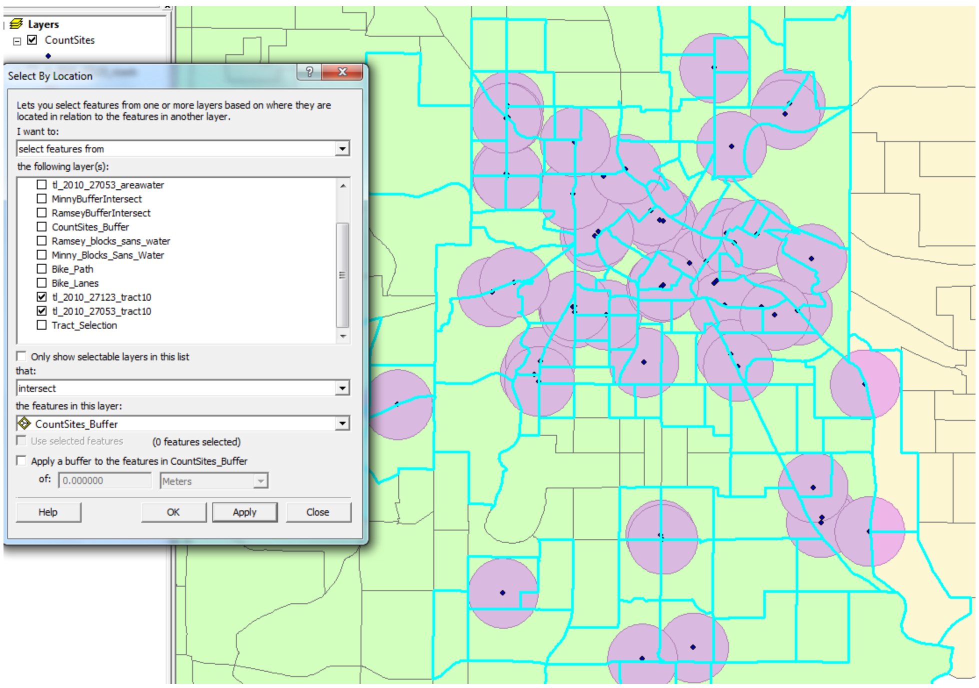
The data sources used in this process include:

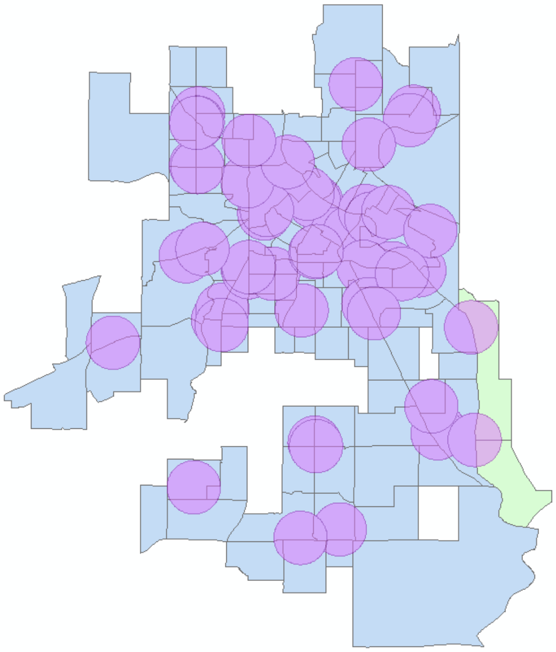
- 2010 TIGER census block shapefiles for Hennepin and Ramsey counties
- 2010 TIGER census tract shapefiles for Hennepin and Ramsey counties
- 2010 TIGER area water shapefiles for Hennepin and Ramsey counties
- 2010 TIGER linear road shapefiles for Hennepin and Ramsey counties

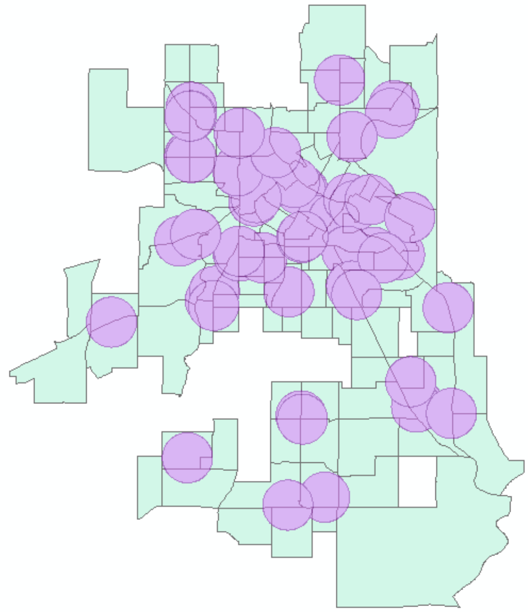
- 55 TLC Bicycle Count site x and y coordinates

Step 1: Select all census tracts that intersect the half mile buffers and create new layer

- Perform selection for both counties
- Right-click on county layers and create a new layer based on the selection for each county
- Merge these layers together using the Merge Tool

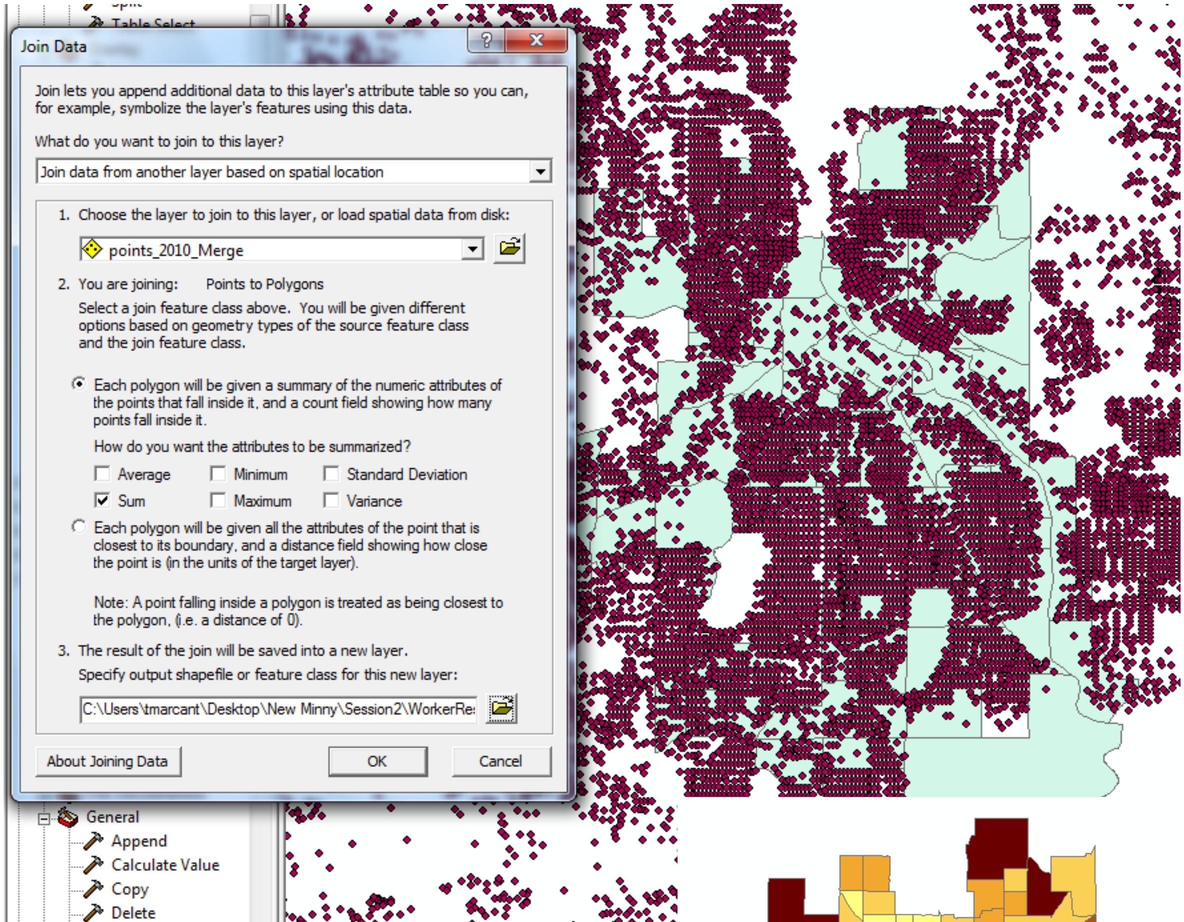


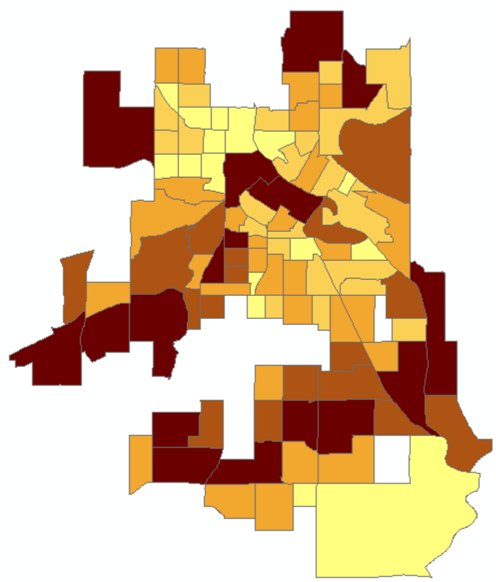




Step 2: Add the relevant universe data to the census tracts for Hennepin and Ramsey County. (We will be using LED workers' home data)

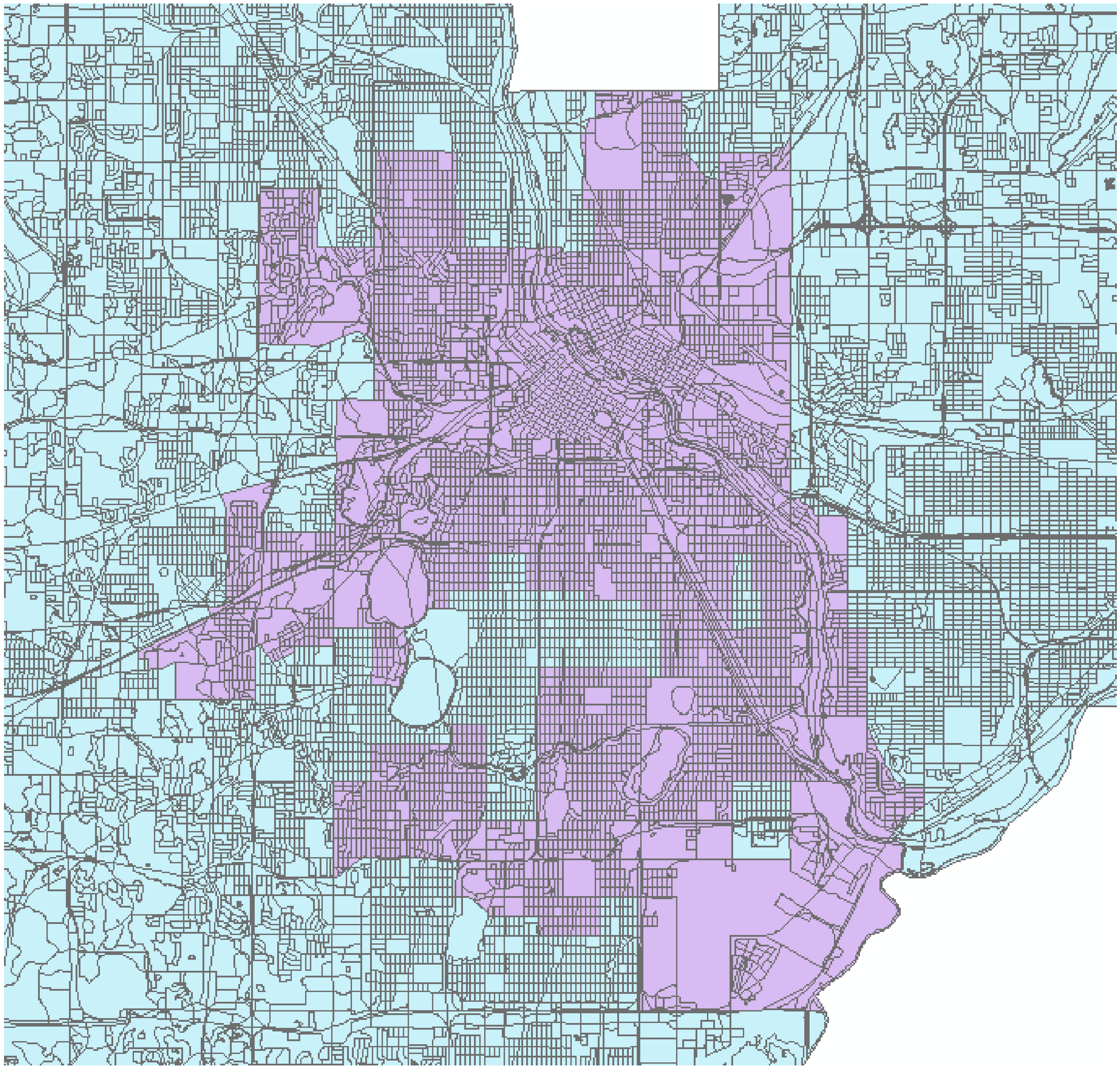
- Add the LED point data the map with census tract selection as the underlying layer. All we need is the number of workers, or field name "c000"
- Merge the LED point data (worker's home) for both counties
- Perform a spatial join where each polygon is given the SUM of all numeric attributes of the points that fall inside it. This SUM value will serve as the denominator for the proportional population ratio for each tract.





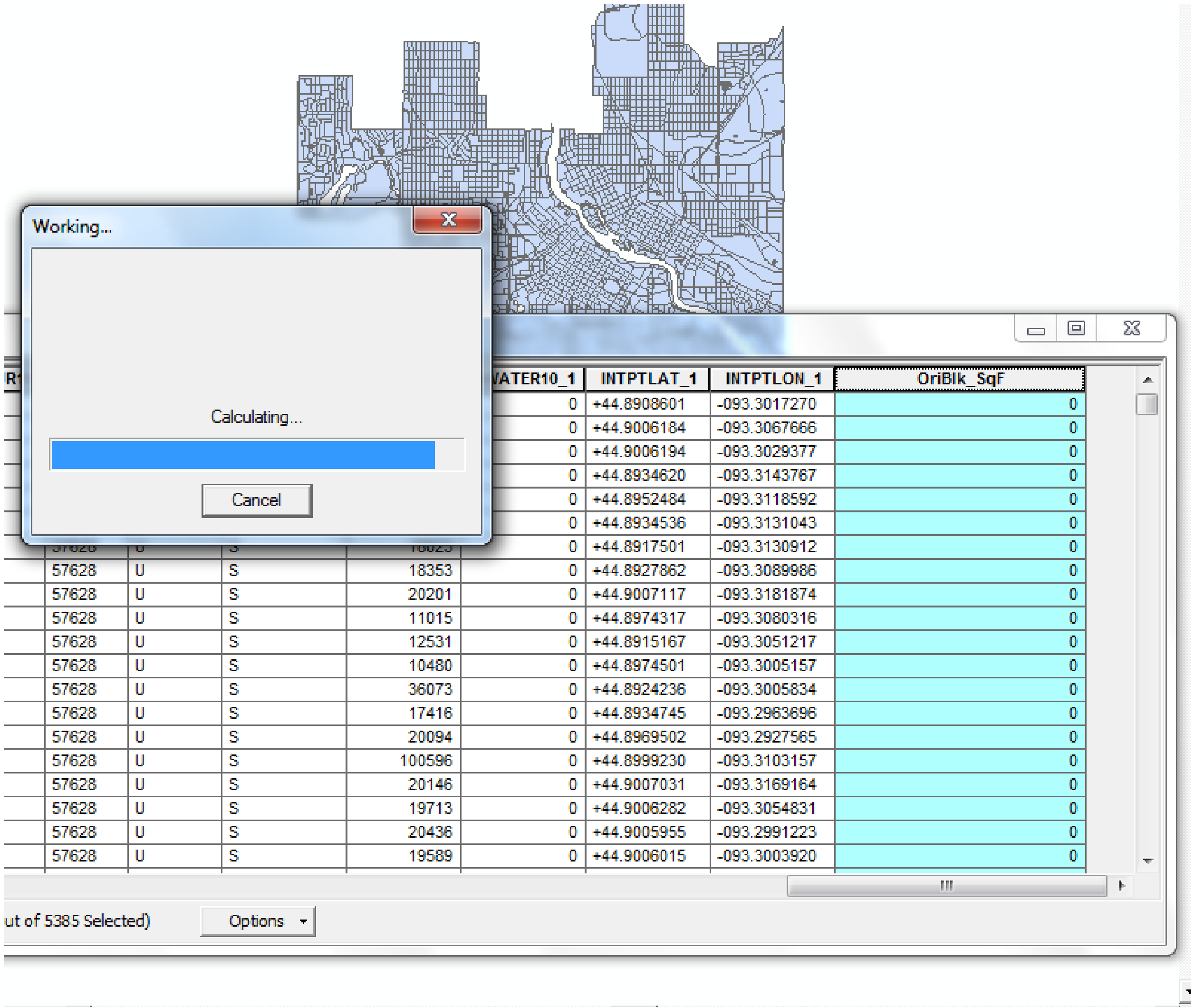
Step 3: Create a new layer with all of the census tra e count buffers.

- Merge the TIGER census block layers fron
- Clip the merged census block layer by the
- Intersect this layer with the tract layer frc the tract data to the blocks layer.



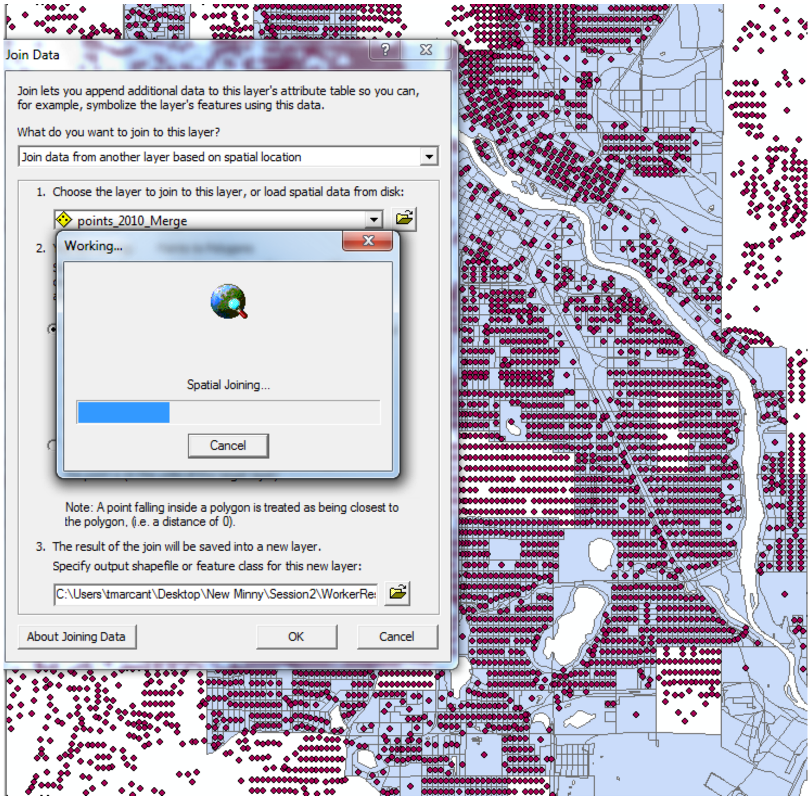
Step 4: Erase all Water and Calculate Land Area

- Merge water layers from both counties and use Erase tool to erase from the intersected block layer
- Add new field in attribute layer called “Oriblk_SqF”.
- Calculate this field using Calculate Geometry - Area. Use the coordinate system of the data frame and use Square Feet (US) as the unit.
- This area field will be used to calculate the geometry ratio necessary to determine the population of a “clipped” block at the buffer boundary.



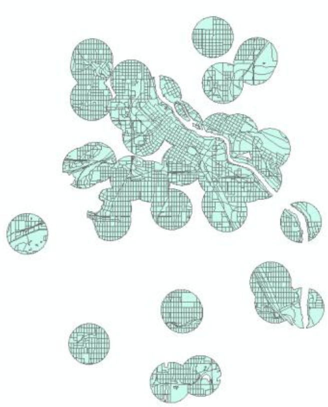
Step 5: Add in LED data for all blocks using Spatial Join

- Perform a Spatial Join to join all LED data to each block in tracts intersecting the buffer.



Step 6: Add in edited buffer block layer from previous GIS Work Flow and Clip the census block layer by this layer

- Add the edited buffer block layer from the previous GIS Work Flow which has all of the land isolated by water erased.
- Use the Clip tool to clip the census block layer from the previous step by this edited buffer block layer.

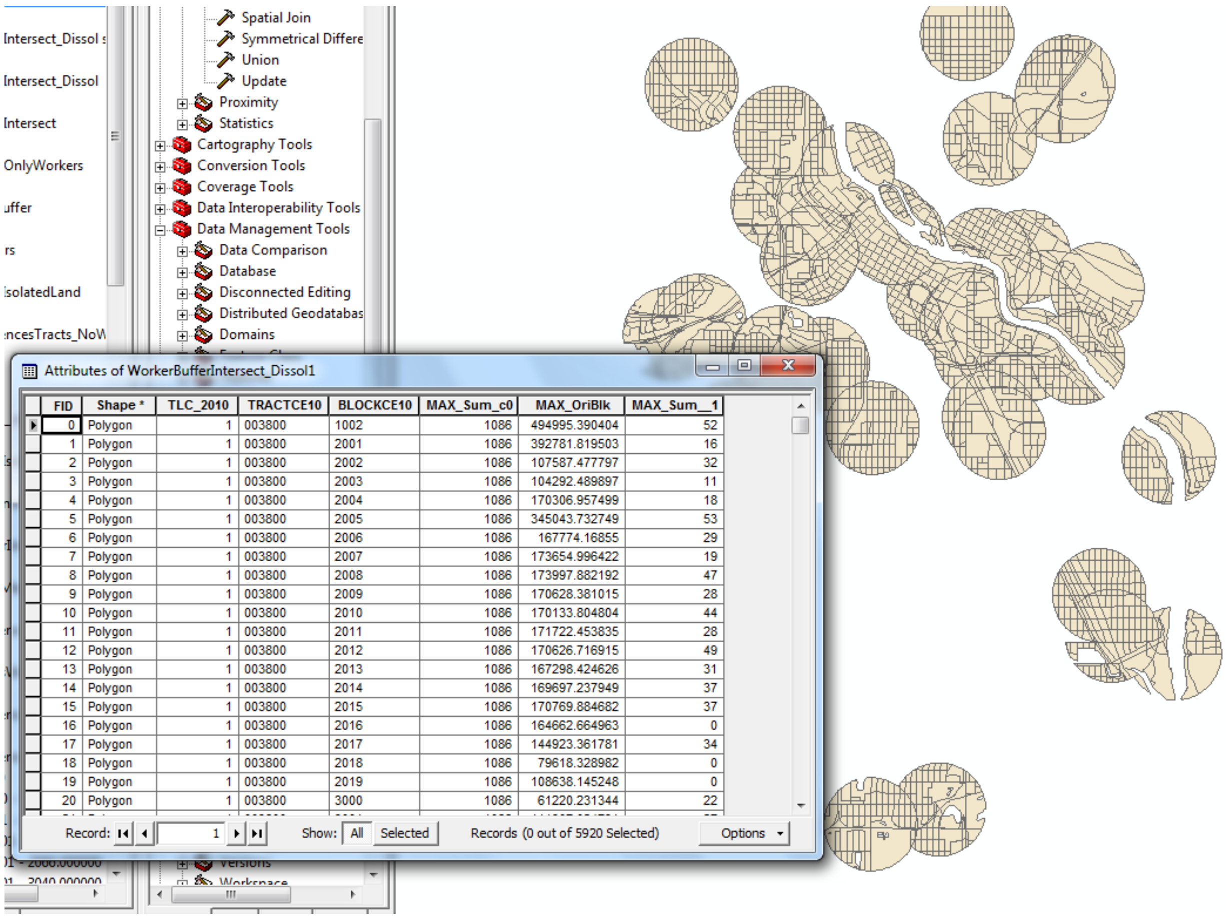


Step 7: Intersect clipped buffer blocks layer with TLC count buffers to assign TLC data

Step 8: Dissolve the layer from the previous step

- Open the Dissolve Tool

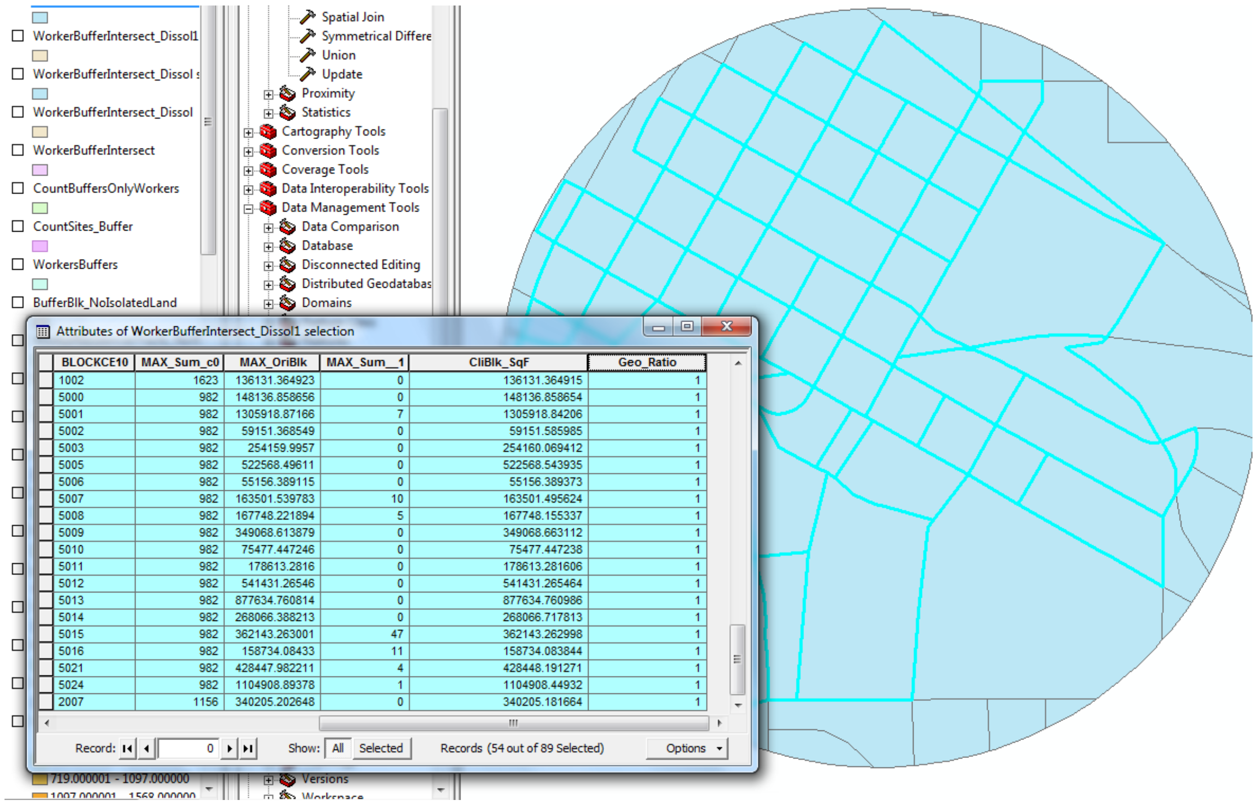
- For Dissolve Fields, select TLC ID, Census Tract ID, and Census Block ID
- For the Statistics Fields, select Sum_c000 (For the Tract), Sum_c000 (For the Block), and OriBlk_SqF. Put all of these Statistic Types as MAX
- Make sure multipart features is check and Run Dissolve.



FID	Shape *	TLC_2010	TRACTCE10	BLOCKCE10	MAX_Sum_c0	MAX_OriBlk	MAX_Sum__1
0	Polygon	1	003800	1002	1086	494995.390404	52
1	Polygon	1	003800	2001	1086	392781.819503	16
2	Polygon	1	003800	2002	1086	107587.477797	32
3	Polygon	1	003800	2003	1086	104292.489897	11
4	Polygon	1	003800	2004	1086	170306.957499	18
5	Polygon	1	003800	2005	1086	345043.732749	53
6	Polygon	1	003800	2006	1086	167774.16855	29
7	Polygon	1	003800	2007	1086	173654.996422	19
8	Polygon	1	003800	2008	1086	173997.882192	47
9	Polygon	1	003800	2009	1086	170628.381015	28
10	Polygon	1	003800	2010	1086	170133.804804	44
11	Polygon	1	003800	2011	1086	171722.453835	28
12	Polygon	1	003800	2012	1086	170626.716915	49
13	Polygon	1	003800	2013	1086	167298.424626	31
14	Polygon	1	003800	2014	1086	169697.237949	37
15	Polygon	1	003800	2015	1086	170769.884682	37
16	Polygon	1	003800	2016	1086	164662.664963	0
17	Polygon	1	003800	2017	1086	144923.361781	34
18	Polygon	1	003800	2018	1086	79618.328982	0
19	Polygon	1	003800	2019	1086	108638.145248	0
20	Polygon	1	003800	3000	1086	61220.231344	22

Step 9: Calculate land area for census blocks in each buffer and Calculate Geometry Ratio

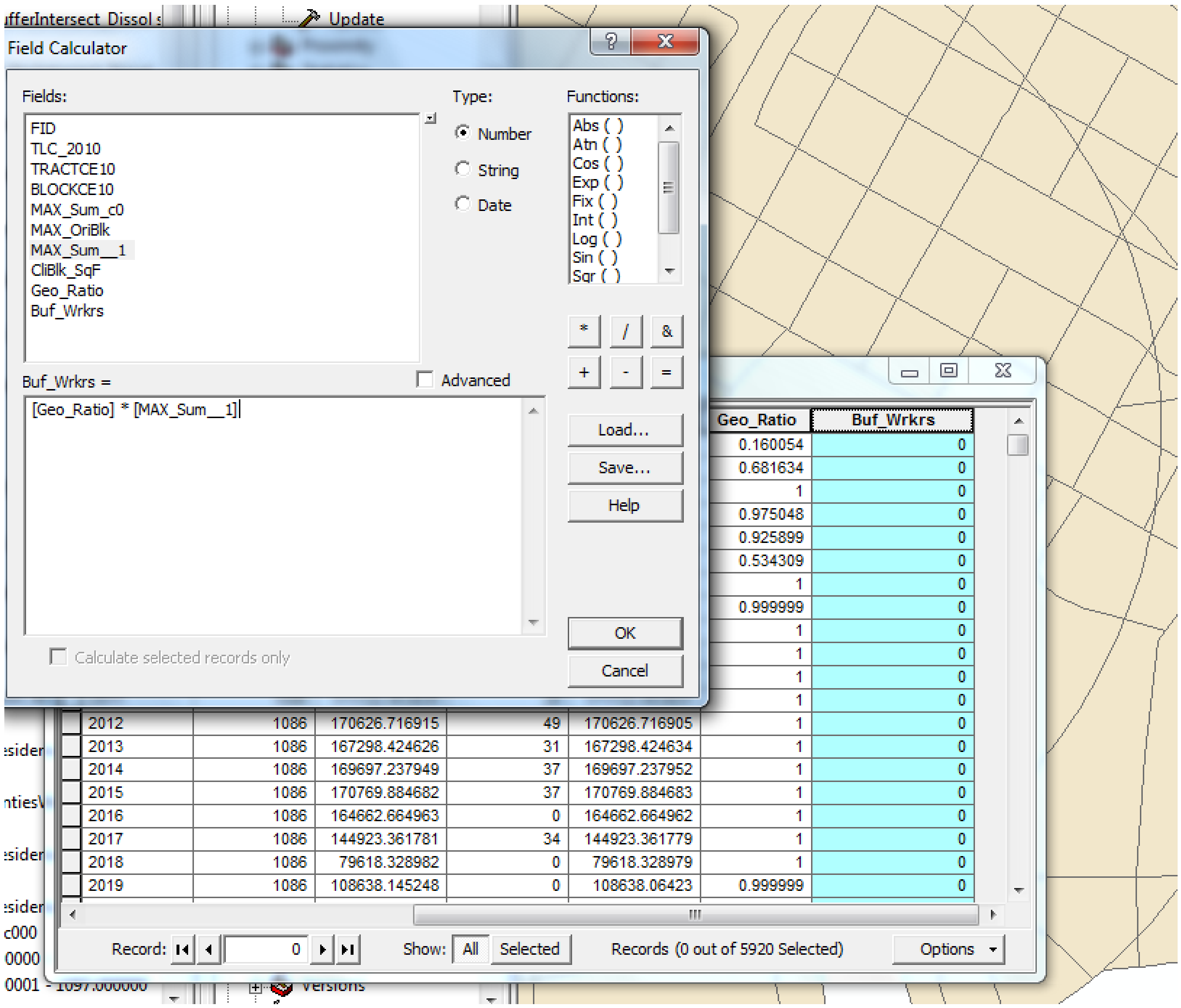
- Create new double attribute called "CliBlk_SqF"
- Calculate geometry using the coordinate system of the data frame and square feet (US) as the unit.
- Create new float attribute called "Geo_Ratio"
- Calculate this attribute by using the Field Calculator and dividing the "CliBlk_SqF" by "OriBlk_SqF".
- Check that the geometry ratio is accurate by creating a new layer for one TLC buffer and selecting all blocks that are close to 1. Due to a rounding error, some may be 0.99999 or similar but for all intents and purposes are equal to 1. All of the interior blocks should be selected.



BLOCKCE10	MAX_Sum_c0	MAX_OriBlk	MAX_Sum__1	CliBlk_SqF	Geo_Ratio
1002	1623	136131.364923	0	136131.364915	1
5000	982	148136.858656	0	148136.858654	1
5001	982	1305918.87166	7	1305918.84206	1
5002	982	59151.368549	0	59151.585985	1
5003	982	254159.9957	0	254160.069412	1
5005	982	522568.49611	0	522568.543935	1
5006	982	55156.389115	0	55156.389373	1
5007	982	163501.539783	10	163501.495624	1
5008	982	167748.221894	5	167748.155337	1
5009	982	349068.613879	0	349068.663112	1
5010	982	75477.447246	0	75477.447238	1
5011	982	178613.2816	0	178613.281606	1
5012	982	541431.26546	0	541431.265464	1
5013	982	877634.760814	0	877634.760986	1
5014	982	268066.388213	0	268066.717813	1
5015	982	362143.263001	47	362143.262998	1
5016	982	158734.08433	11	158734.083844	1
5021	982	428447.982211	4	428448.191271	1
5024	982	1104908.89378	1	1104908.44932	1
2007	1156	340205.202648	0	340205.181664	1

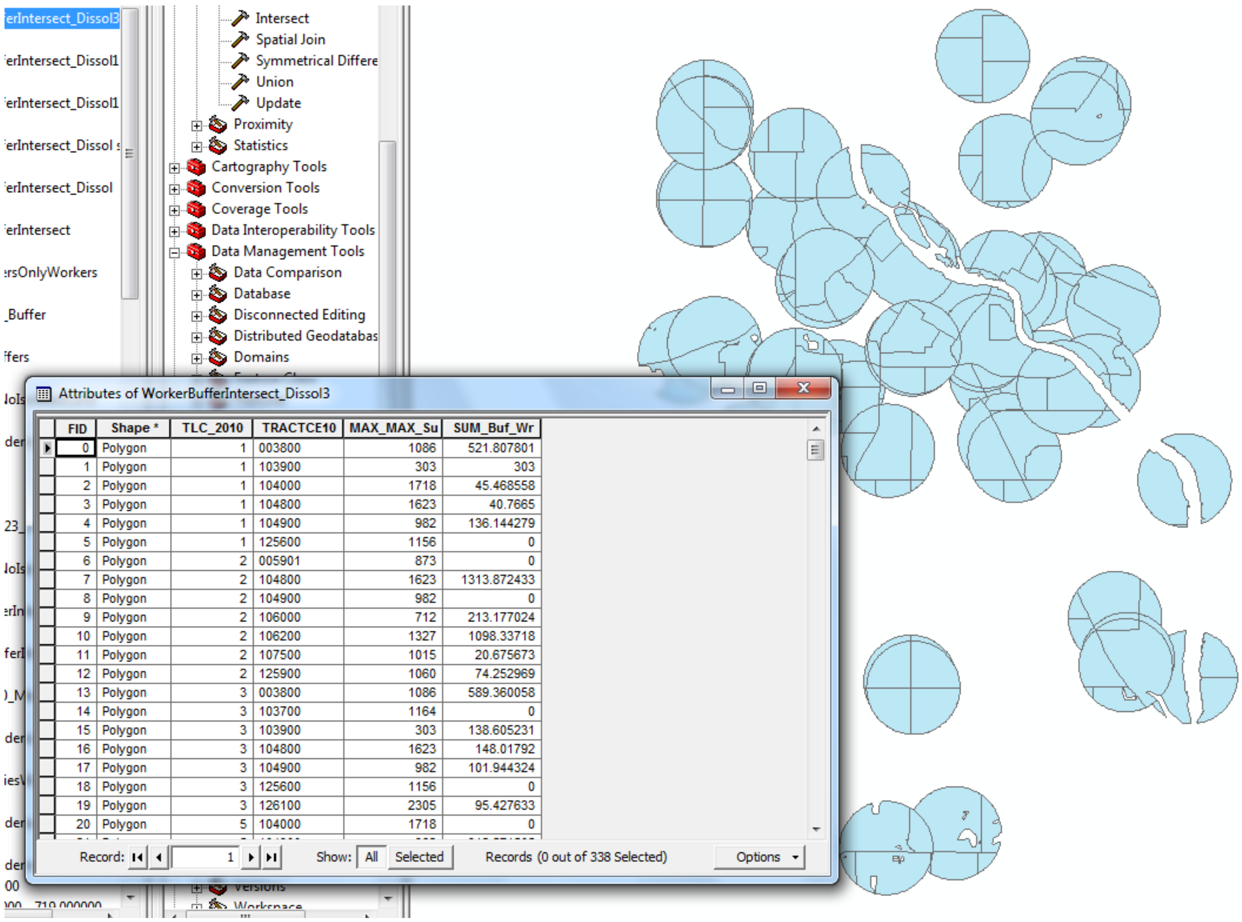
Step 10: Calculate the number of workers (or other population) in each tract of a buffer

- Create new float field called “Buf_Wrkrs”
- Using the Field Calculator, multiply the geometry ratio by the total workers in the block to get the workers residing in the buffer.



Step 11: Dissolve the layer from the previous step to calculate the proportional population ratio

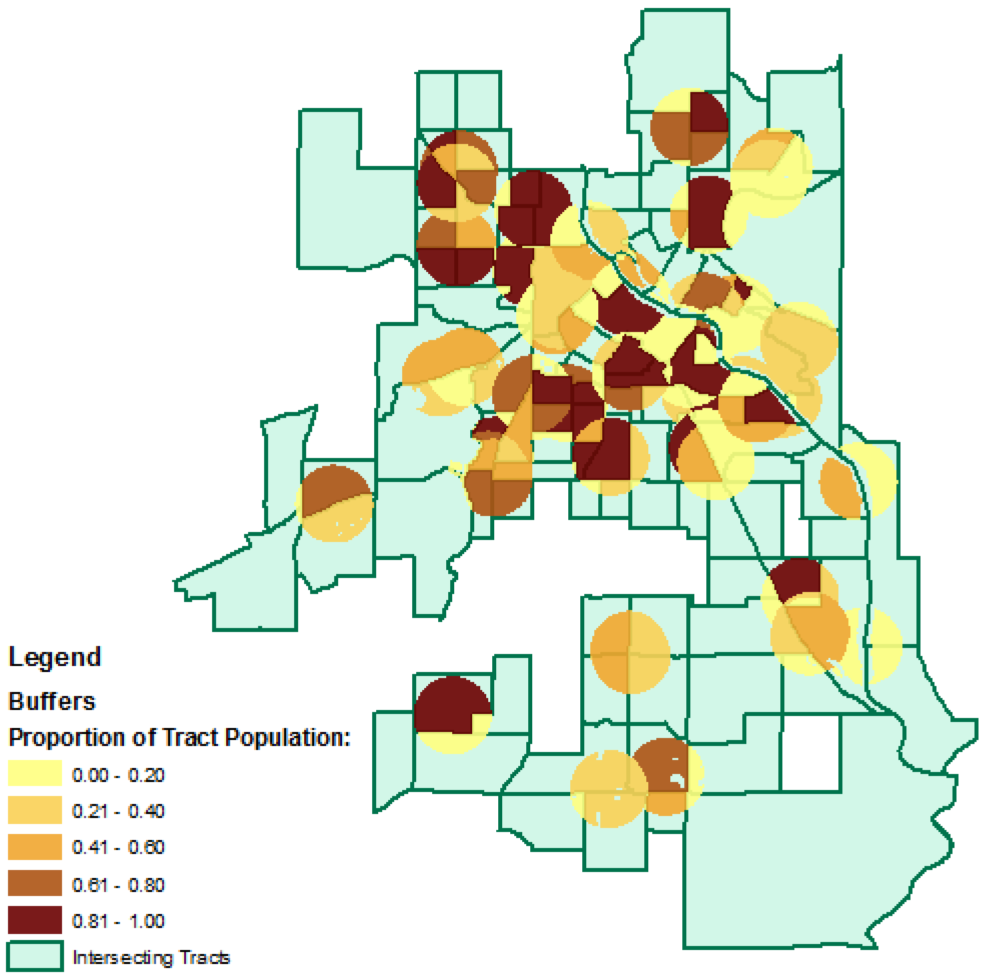
- Open the Dissolve Tool
- For Dissolve Fields, select TLC ID and Census Tract ID
- For the Statistics Fields, select Sum_c000 (For the Tract) and Buf_Wrkrs. For the Statistic Types use MAX for the former and SUM for the latter.
- Make sure multipart features is check and Run Dissolve.



FID	Shape *	TLC_2010	TRACTCE10	MAX_MAX_Su	SUM_Buf_Wr
0	Polygon	1	003800	1086	521.807801
1	Polygon	1	103900	303	303
2	Polygon	1	104000	1718	45.468558
3	Polygon	1	104800	1623	40.7665
4	Polygon	1	104900	982	136.144279
5	Polygon	1	125600	1156	0
6	Polygon	2	005901	873	0
7	Polygon	2	104800	1623	1313.872433
8	Polygon	2	104900	982	0
9	Polygon	2	106000	712	213.177024
10	Polygon	2	106200	1327	1098.33718
11	Polygon	2	107500	1015	20.675673
12	Polygon	2	125900	1060	74.252969
13	Polygon	3	003800	1086	589.360058
14	Polygon	3	103700	1164	0
15	Polygon	3	103900	303	138.605231
16	Polygon	3	104800	1623	148.01792
17	Polygon	3	104900	982	101.944324
18	Polygon	3	125600	1156	0
19	Polygon	3	126100	2305	95.427633
20	Polygon	5	104000	1718	0

Step 12: Calculate the Proportional Population Ratio for each tract in a buffer

- Add new float field called “PrPop_Rat”
- Use the Field Calculator to calculate it as the “Sum_Buf_Wr” (Total Workers in Buffer) divided by the “MAX_MAX_Su” (Total Workers in Tract)
- Do a Quality Check



Step 13: Join relevant ACS data to resulting layer and perform Buffer Calculations

- Join the excel spreadsheet containing all of the relevant ACS variables to be calculated.
  - Make sure the Tract ID in the spreadsheet matches the Tract ID in the layer. It will probably be necessary to create a new column in excel to make the match work.
    - Take the unique identifier and use the Text to Columns tool in Excel to separate the numbers unique to the Tract ID (six digits after the county identifier).
    - Excel will get rid of leading zeros but we need these. To keep these create a new column to the write and type in TEXT(A2,"000000").
  - Perform the join in ArcMap and make sure that you check "Keep only matching records". Since we choose only the relevant tracts to extract from

American FactFinder this should not be necessary but it is done as a precaution.
- View the resulting join to make sure it worked.
- Export the table as a dbf
- Open the dbf in excel and make all the calculations necessary using the proportional population ratio and then combining all census tracts for each buffer. This is done in Excel because it is simpler than in ArcMap. The Join in ArcMap was just to match all of the relevant data.

A.16 Land Use Patterns

This variable provides the land area (square footage) of each land use (excluding open water) as provided by a 2010 land use shapefile provided by the Metro GIS DataFinder from datafinder.org. The table below shows the DataFinder classification system for land uses intersecting count site buffers.

2010 Land Use Classifications in Buffers

Code	Description
113	Single Family Detached
114	Single Family Attached
115	Multifamily
116	Manufactured Housing Parks
120	Retail and Other Commercial
130	Office
141	Mixed Use Residential
142	Mixed Use Industrial
143	Mixed Use Commercial
151	Industrial and Utility
160	Institutional
170	Park, Recreational, or Preserve
173	Golf Course
201	Major Highway
202	Railway
203	Airport
210	Undeveloped
220	Open Water

http://datafinder.org/catalog/index.asp#Planning%20and%20Development

In order to calculate the square footage of each area the following steps will be taken:
1. Add the Land Use Layer and intersect with buffers from previous GIS steps which excludes water and land that is not accessible.
2. Calculate the land area of each parcel in square footage.
3. Add up all of the square footage by land use using the Dissolve tool in ArcMap.

a. We exclude Open Water from the analysis since it is not “accessible” and was already clipped using TIGER files.

A.17 Density

Density is calculated in several ways, including: Population Density; Employment Density; Population + Employment Density; and Household Units per Acre.

Population Density

This refers to the residential population density. It is calculated by dividing the 2010 residential population by the land area (excluding water). The data source for this is the 2010 decennial census which provides block level data.

Employment Density

This refers to the employment or job (workers employed in the area) density. It is calculated by dividing the 2010 worker population by the land area. Again, the source for workers at the block level is from the LED tool, OnTheMap.

Population + Employment Density

This combines the residential population density with employment density. It is calculated by simply add the former two variables together as they would have the same denominator (land area).

Household Units/Acre

This measure of density refers to the residential built environment density. It is calculated by dividing the 2010 total number of household units (occupied and vacant) by the land area (excluding water) in acres. The data source utilized is the 2010 decennial census block level data.

A.18 Average Block Size

Census blocks are the smallest unit of analysis from the Census Bureau and are any areas that are completely bounded by roadways. The average size of census blocks in area is thought to be related to walkability or connectivity (Forsyth et al., 2012).

This variable calculates the average size of census blocks. It is computed by calculating the square footage of each census block that intersects the buffer. For “clipped” blocks that intersect the buffer boundary, only the clipped portion will be calculated. Then, an average of square footage of all census blocks intersecting the buffer is calculated.

A.19 Centrality within the City

This variable is meant to describe the location of a count site relative to the Mean Center of Population and Mean Center of Employment in the City of Minneapolis. It provides the distance (in feet), as the crow flies, from any given count site to the Mean Centers of Population or Employment. Central locations within the city may be more convenient and attractive to cyclists because of their proximity to many destinations, such as businesses, friends and family, or other amenities.

It is important to note that the Mean Center is not necessarily synonymous with the Central Business District (CBD). It is merely a representation of the geographic center of a distribution of points, weighted by either population or employment. If an area is highly mono-centric then the Mean Center may be located within the CBD. However, given that most modern American cities are at least somewhat poly-centric, this is probably more the exception than the rule.

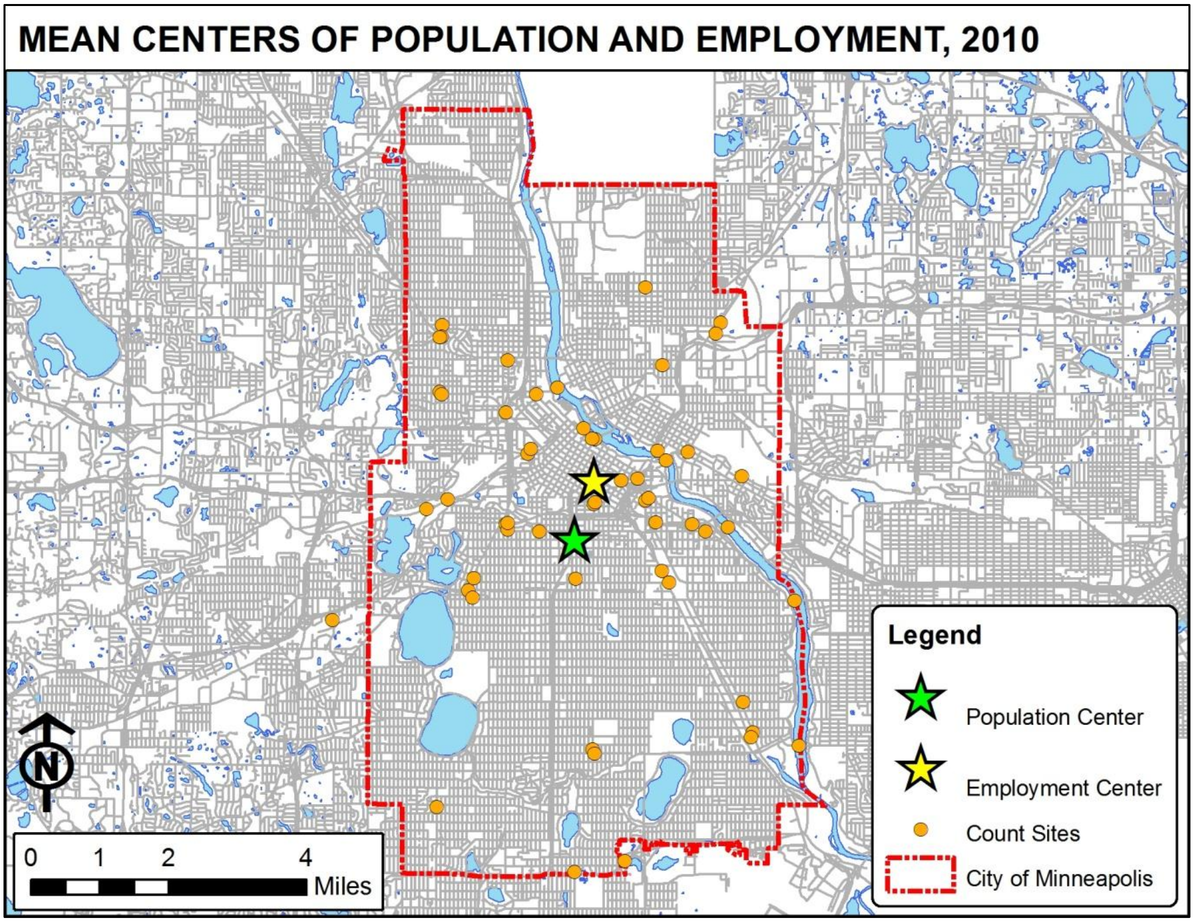
Distance from Mean Center of Population

This is calculated by computing the distance (in feet) of the count site point to the point that represents the Mean Center of Population. Follow these steps:

- Convert block level population data from the 2010 Census to point data.
- Open the Mean Center tool and select this point data layer as the input and select the population as the Weight Field. Click OK.
- Run the Near tool under Analysis. Select the count sites layer as the input and the Mean Center as the Near Feature. Check Feet as the unit of measurement.
- Open the resulting layer to view the distance in feet. All count sites should have the same Near_FID. Save and Export the table.

Distance from Mean Center of Employment

This is calculated in the same manner as the Mean Center of Population except that it utilized LED data which is already point data.



A.20 Transportation System Variables

Bicycle Counts

All 55 quarter and half-mile buffers include count data for 2011 and at least one other year. Count data for every year are included (2007-2011). Some notes are made at count sites. These notes are included with the original symbology below:

* = Intersection Count Estimate – Bike Only
^ = Imputed 3-years Average
# = NOT INCLUDED IN TLC BENCHMARK

Bicycle Count Site Facility Characteristics

For all count sites it was determined whether or not the count site was adjacent to bicycle facilities. If a site was adjacent to a facility, the type of facility, name of facility, year installed, and length of the facility segment was provided.

It should be noted that the data provided has some important limitations. The facility shapefiles did not go far beyond the City of Minneapolis so it was impossible to calculate the length of facilities in the St. Louis Park count site (#901) and some areas along the periphery.

That being said, it should also be noted that the length provided is only a length of the segment. Some facilities are split up into segments based on the year installed or other factors.

Length of Bicycle Facilities in Buffer
For bicycle facility length, we simply summed up the total length in feet of each type of bicycle facility in quarter and half mile buffers.

To create these buffers:

- Import whole buffer boundary, clipped buffer boundary, and water shapefile for both counties
- Intersect the water layer with the whole buffer boundary. This splits the water segments according to TLC ID buffer.
- Merge the intersected water layer with the clipped buffer boundary.
- Dissolve by TLC ID.

After creating the adjusted buffer boundaries follow the steps below to extract the footage of bike facilities by type (Note: This is done for Bike Lanes. For Bike Paths there are no sub-types)

- Intersect the adjusted buffer with Bike Lanes
- Dissolve this intersected layer with TLC ID and Type as the Dissolve Fields and Segment Length as the Statistics field with SUM as the Statistics Type. Export the attribute table.

Annual Average Daily Traffic
Annual Average Daily Traffic (AADT) is only available for major roads in Hennepin and Ramsey counties. This data is used where it is contiguous with a bike facility adjacent to a bicycle count site. For these count sites, the AADT value for the facility adjacent to a count site is provided. The years in which data was available vary by site, with the most recent data coming from 2008-2010. Only the most recent data was provided with the exception of the three sites with 2010 values where the 2008 value was also included. This was done to leave the possibility of only including 2008-2009 values so as to be more consistent. It should be noted that AADT counts appear to only occur every other year, with some sites being counted in even numbered years and others in odd numbered years.

Length of Roadways by Classification
For this variable we wanted to calculate the length of roadways in each buffer by classification.

For roadway classification we used the MAF/TIGER (MFTCC) classification scheme used by the Census Bureau and provided in the 2010 TIGER shapefile for roads. This classification scheme can be found at http://www.census.gov/geo/www/tiger/tgrshp2010/TGRSHP10SF1AF.pdf.

Note that since the roadway shapefiles represent centerlines and they do not provide two lines for divided facilities like interstates and major highways. However, some lower volume divided roads are represented by two centerlines. Forsyth et al. accounted for this by manually deleting one side of divided facilities so that their length is not duplicated.

Forsyth et al. also deleted interstates and ramps because their focus was the pedestrian and they did not disaggregate roadways by classification. Since we are disaggregating roadways by MFTCC classification we do not need to exclude these facilities.

Unfortunately the TIGER file used for this variable duplicates some facilities which are classified as one or more RTTYP codes (e.g. Interstates, US, County, etc.). Simply Dissolving by MFTCC will not remove this duplication because some duplicated roadways were in turn classified as more than one MFTCC. In order to account for this we removed all duplications by following the steps below.

- Add the merged roadway file for both Hennepin and Ramsey counties
- Clip by the half mile buffer that includes water but excludes inaccessible land area
- Use the Erase Tool to successively remove duplications of facilities with multiple RTTYP codes.
    - Select by Attributes all roadways with RTTYP = 'I'. Create new layer from this selection and call it Interstates.
    - Use the Erase Tool to remove all roadways that are along the Interstate segments.
    - Do this for each RTTYP until all duplications are removed. Then, merge all selections together.

RTTYP Classification of Roadway Facilities

RTTYP	Description
I	Interstate
U	U.S.
S	State Recognized
C	County
M	Common Name
O	Other
Source:	http://gis.stackexchange.com/questions/20545/what-does-the-code-rttyp-represent-in-the-usa-tiger-road-files

Using the process described above we removed 84 roadway segment duplications. This decreased the total from 2,060 to 1,976 segments in the buffer areas. In terms of duplicative roadway length removed, this process removed 339,247 feet of duplicative roadways, decreasing the total of all buffers from 3,086,326 feet to 2,747,079 feet. This could be interpreted as an 11% reduction in over representation by duplication of segments.

After this process was completed the end result is a cleaned roadways shapefile that is clipped by a half mile buffer, including water but excluding inaccessible land area. Using this shapefile we derived the length of facilities by MFTCC classification.

- Intersect the roadway layer with the buffer layer (half or quarter mile)
- Dissolve this layer with TLC ID and MFTCC as the Dissolve Fields
- Add Field for Length and Calculate the length in Feet using the coordinate system of the data frame
- Export the Dissolved layer's attribute table and put into master spreadsheet.

MTFCC	Description
S1100	Primary Road
S1200	Secondary Road
S1400	Local Neighborhood Road, Rural Road, City Street
S1500	Vehicular Trail (4WD)
S1630	Ramp
S1640	Service Drive usually along a limited access highway
S1710	Walkway/Pedestrian Trail
S1720	Stairway
S1730	Alley
S1740	Private Road for service vehicles
S1750	Internal US Census Bureau use
S1780	Parking Lot Road

Number of Roadway Intersections
Street Connectivity is measured by counting the total number of intersections in a buffer.

The road dataset being used is the 2010 TIGER file for all roads. In this dataset, all roads are classified based on their scale, ownership, and access. This classification scheme can be found at http://www.census.gov/geo/www/tiger/tgrshp2010/TGRSHP10SF1AF.pdf. The table above shows all classifications present in the study area.

This section is based on the methodology used by Forsyth et al. in NEAT GIS Protocols Version 5. In this methodology Forsyth counted each intersection with a valence of 3 or higher, meaning three or more roadway segments converge at the intersection. In this methodology, two way intersections like 90 degree turns are not included.

Forsyth et al. (2012) also removed Interstates and only counted intersections with Ramps when they connected a "local road" with a limited access facility. She also used a tolerance of 10-15 meters to properly represent intersections whose centerlines may be offset. She found no significant difference between the two lengths so we used 10 meters.

Step 1: Clip all roadways by half mile buffer

- Import the half mile buffer and roadways shapefile for Hennepin and Ramsey counties
- Buffer the half mile buffer by an additional 50 meters to account for intersections that may potentially be excluded because of their centerline being out of the half mile buffer.
- Clip all roadways by this adjusted half mile buffer.

Step 2: Dissolve all roads

- Use the Dissolve tool to remove duplication of roads because of the buffer clipping. Select linearID or other unique ID as the Dissolve Field.

Step 3: Using the Editor Toolbar remove Ramps that only connect limited-access highways to other portions of limited access highways. (Note: This was done manually by comparing the roadway shapefile (TIGER lines) with Google Maps.)

Step 4: Remove Interstates

- Select by Attributes -> RTTYP = 'I' and create new layer from selection
- Select by Location -> Select features from Roads layer that are identical to the Interstate selection layer. This is done to account for duplication of facilities that are classified as Interstates as well as other classes like State Highways.
- Open up the attribute table with the selected features and right click on the left part of any row, click Deleted Selected.
- The only roadway left with a classification of S1100 should be Highway 52. Remove this as well.
- Exit Edit Session

Step 5: Remove Ramps that do not connect to local roads

- Select by Attributes -> MTFCC = '1630' and create new layer from this selection. Export this layer and save in an appropriate location.
- Start an edit session and remove all ramps that connect limited-access highways to other limited-access highways or ramps. Obvious examples include cloverleafs and flyovers.
- Save Edits and exit the editing session.
- From the original roadway file (the one that includes all roadways except Interstates) Select by Attributes -> MTFCC = '1630' and then right click the layer and Switch Selection so that all other types are selected. Create a new layer from this selection.
- Merge this new layer with the edited Ramps shapefile to get a new shapefile that excludes Interstates and Ramps that do not connect to local roads.

Step 6: Create Intersection Points

- Open the Intersect Tool and select the edited roadway shapefile from the previous step. Put the XY Tolerance to 10 meters to account for duplication errors resulting from slightly offset center lines. Select Point as the output type. Click OK

Step 7: Remove Duplicate Points

- The Intersect tool will create duplicate points at virtually all intersections because it treats each segment intersection as unique. In this manner a four-way intersection may have four points.
- Use the Add XY Coordinates Tool under the Features tab under Data Management Tools to assign XY coordinates to each intersection point.
- Use the Dissolve Tool to remove duplicates based on the XY coordinates. Use the X Coordinate and Y Coordinate as Dissolve Fields. It is not important to have any Statistics Fields selected.

Step 8: Manually remove inappropriate intersection points

- Use the editor toolbar to remove intersection points that do not have at least 3 segments converging at the intersection or that are otherwise inappropriate (e.g. remaining ramp errors).
- Export this layer as a new shapefile

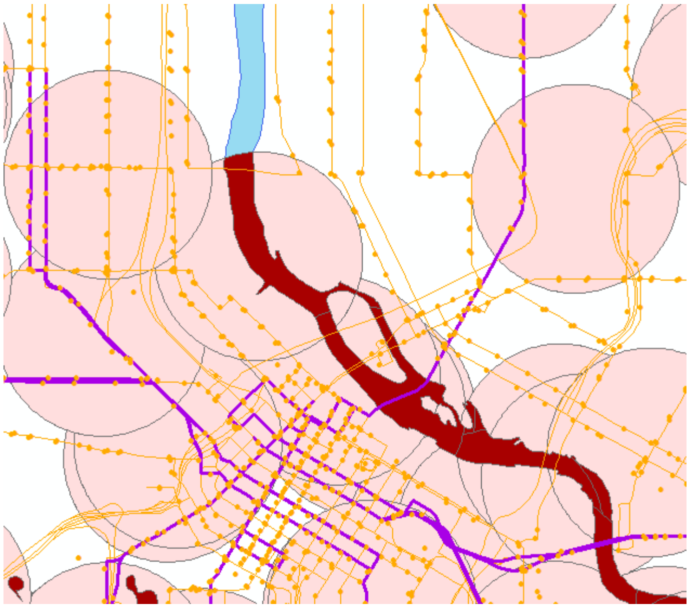
Step 9: Assign the intersection points to buffers

- Import the clipped half mile and quarter mile buffers (excluding water and inaccessible land area)
- Use the Intersect Tool to assign intersection points to the clipped buffers.
- Use the Dissolve Tool to get the count of intersection points in each count site buffer. Use the TLC ID as the Dissolve Field and the FID from the Intersection Point layer as the Statistics Field with COUNT as the Statistics Type.

Transit Service

The variables for transit service include the number of transit stops in a buffer as well as the total length of transit routes in a buffer. This is done for both the overall transit system and the high frequency transit system. Note that the high frequency transit system is included in the overall transit system and is composed of 12 routes throughout the Twin Cities area.

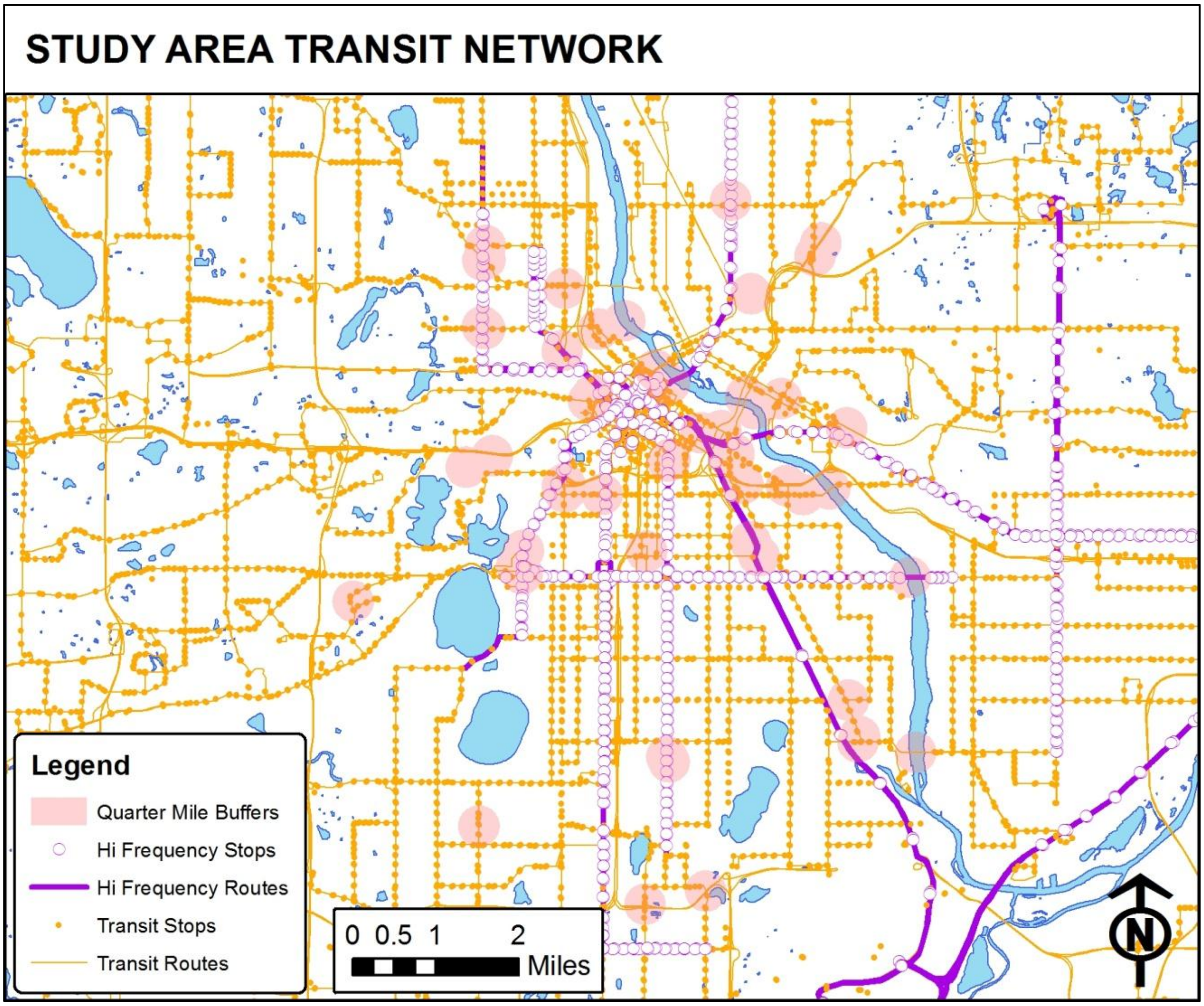
It was explored whether or not we should use the complete half and quarter mile buffers or the "clipped" versions which exclude water and inaccessible land area. Ultimately the complete buffers were chosen as there are many transit routes that cross the Mississippi River and other bodies of water. Their exclusion could skew the length for many of the buffers along the



river. The only real concern with using the complete buffer was that it may include stops or segments of routes in areas that were determined to be inaccessible or isolated. However, upon inspecting the map it was found that there were no transit stops or routes in the inaccessible land areas of the clipped portions of the buffers.

When calculating the length of transit facilities we calculated the length in feet of a transit route, regardless of directional service. This means that if a route was bi-directional on one roadway, its length would only be counted once as opposed to twice. This is how the transit data was provided from the Metro GIS website. While directional information was available for Hi Frequency routes these directional routes were aggregated to form a non-directional route so as to be consistent with the overall transit network routes. Direction is disregarded because this metric is more focused on coverage, or access to transit, than on the level of service of transit routes.

Stop spacing of transit stops may make the length variable an unreliable measure since areas along the High Frequency network have longer spacing between stops than the local service routes. This is especially true of the Hiawatha Light Rail line. Longer stop spacing may cause misrepresentation since some buffers may have a sizable length of transit routes but fewer number of stops because of longer stop spacing on certain routes, especially some High Frequency routes. Stop spacing can be seen in the map on the next page.

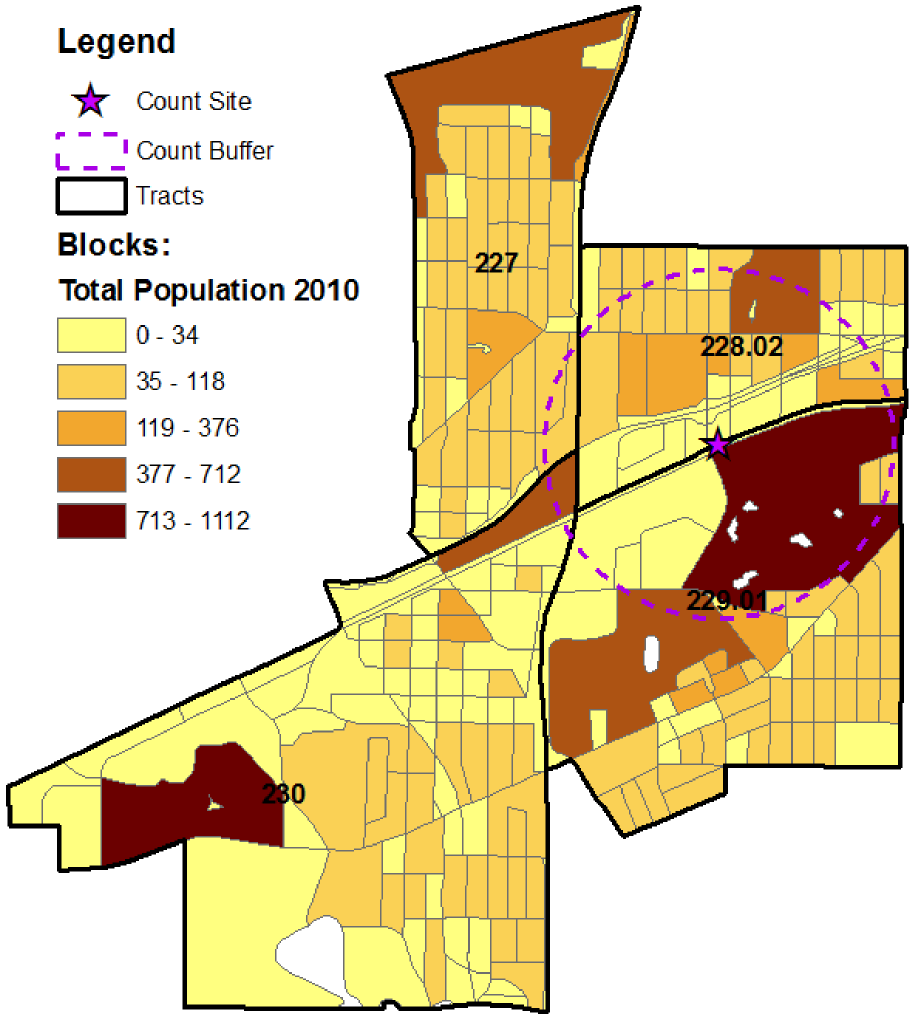


A.21 Areal Weighting Technique Sample

Areal weighting is an areal interpolation technique which uses subsets of data to interpolate the distribution of data at a larger geography. In this case, we will be using 2010 Census block-level data as a subset for 2006-10 ACS tract-level data. 2010 Census data is available at the block level, the finest level of geography available from the Census Bureau. Therefore there are no possible subsets and block level data will simply use a geometric ratio technique to calc…

To better explain the “areal weighting” methodology for ACS, tract-level demographics we will do a sample that compares a “geometric ratio” clip to the “proportional population” clip. The count site we are using is #901 in St. Louis Park, just outside Minneapolis. We will use aerial imagery of the buffer area to gauge which method is a closer approximation.

The map below shows the four census tracts which intersect the half-mile buffer and the total population of the blocks contained within each of these tracts. Note that water is erased from these layers for the sake of calculating land area for ratios. This map shows that the population within a census tract is almost never uniform. Therefore, using geometric ratios based on the percentage of land of a tract contained in the buffer is inappropriate. To reinforce this concept, the tables and map on the next pages will compare results from the simple, geometric ratio to the more complex proportional population ratio.



Proportional Population Method

Census Tract	Tract Land Area (Sq Ft)	Census Block	Block Land Area (Sq Ft)	Block Population (2010)	Block Land Area in Buffer (Sq Ft)	Ratio	Adjusted Population
229.01	26730739.39	3003	4107710.05	585	406203.75	0.10	58
229.01	26730739.39	1008	115138.35	41	88220.13	0.77	31
229.01	26730739.39	1005	6448937.07	1,112	5960579.03	0.92	1,028
229.01	26730739.39	1009	342696.56	70	54230.29	0.16	11
229.01	26730739.39	1004	866268.05	0	866268.05	1.00	0
229.01	26730739.39	1002	2252143.46	0	1897524.37	0.84	0
229.01	26730739.39	3001	578375.28	311	75193.63	0.13	40
229.01	26730739.39	1003	247849.02	0	243630.49	0.98	0
229.01	26730739.39	1001	179787.03	0	179787.03	1.00	0
229.01	26730739.39	3002	33784.92	0	33784.92	1.00	0
229.01	26730739.39	1007	197711.50	46	197711.50	1.00	46
229.01	26730739.39	1006	223530.45	53	101499.01	0.45	24
229.01	26730739.39	1000	257030.30	0	237179.24	0.92	0

Total Population of Tract in Buffer:	1,239
Total Population of Tract (2010):	4,689
Proportional Population Ratio:	0.26
Total Tract Population (2006-10):	4,602
Buffer Population from Tract 229.01:	1,216

Source: 2010 Census, Table P-1

Geometric Ratio Method

Census Tract	Tract Land Area (Sq Ft)	Census Block	Block Land Area in Buffer (Sq Ft)
229.01	26730739.39	3003	406203.75
229.01	26730739.39	1008	88220.13
229.01	26730739.39	1005	5960579.03
229.01	26730739.39	1009	54230.29
229.01	26730739.39	1004	866268.05
229.01	26730739.39	1002	1897524.37
229.01	26730739.39	3001	75193.63
229.01	26730739.39	1003	243630.49
229.01	26730739.39	1001	179787.03
229.01	26730739.39	3002	33784.92
229.01	26730739.39	1007	197711.50
229.01	26730739.39	1006	101499.01
229.01	26730739.39	1000	237179.24

Total Land Area of Tract in Buffer:	10341811.44
Total Land Area of Tract:	26730739.39
Geometric Ratio:	0.39
Total Tract Population (2006-10):	4,602
Buffer Population from Tract 229.01:	1,780

Source: 2006-10 ACS, Table DP-05

As the tables on this page show, the geometric and proportional population ratios result in very different numbers. In the case of Census Tract 229.01 in the St. Louis Park count buffer, the geometric ratio overcounts the population relative to the proportional population ratio.

As the map on the next page illustrates, this is because of the presence of large, undeveloped tracts of land in the buffer portion of the tract (mostly parks and parking lots). Also, most of the land use in the buffer portion is commercial, contributing to a low residential population. While there are a few apartment buildings

present, the distribution of residences is still low
relative to the rest of the tract.

The overcounting at this St. Louis Park count site indicates the problem inherent in using a geometric ratio approach at the tract level: assuming even population distribution across the census tract. The proportional population ratio appears to be a much more reliable method. Still, it is not a perfection representation.

Works Cited

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Maantay, J., Maroko, A., & Herrmann, C. (2007). Mapping Population Distribution in the Urban Environment: The Cadastral-based Expert Dasymetric System (CEDS). *Cartography and Geographic Information Science , 34* (2), 77-102.

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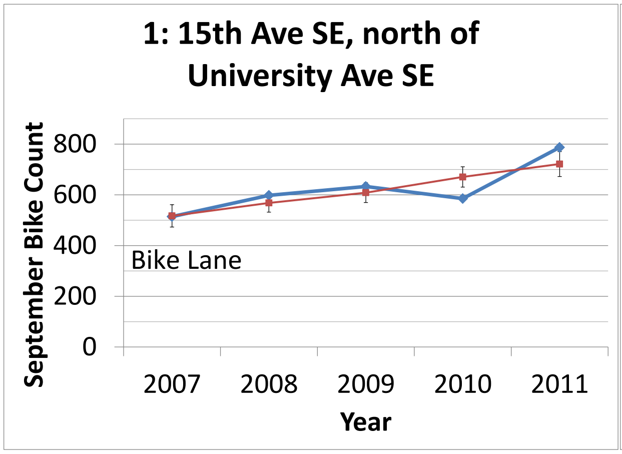
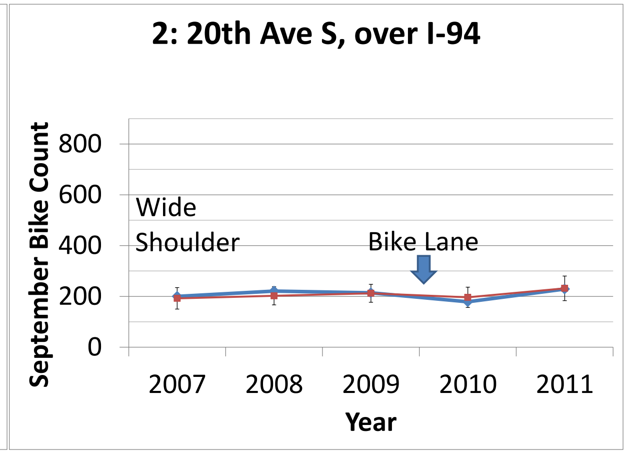
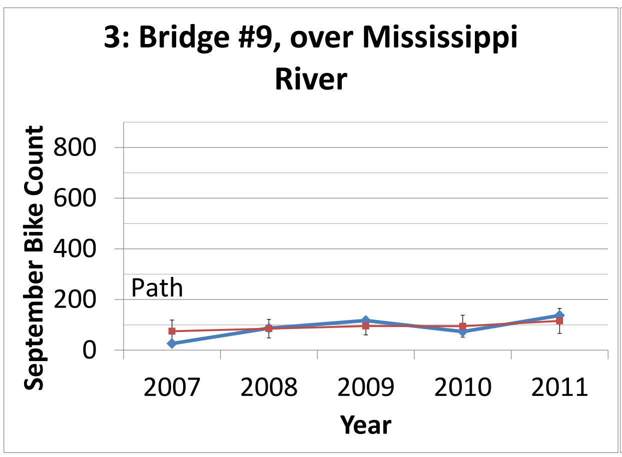
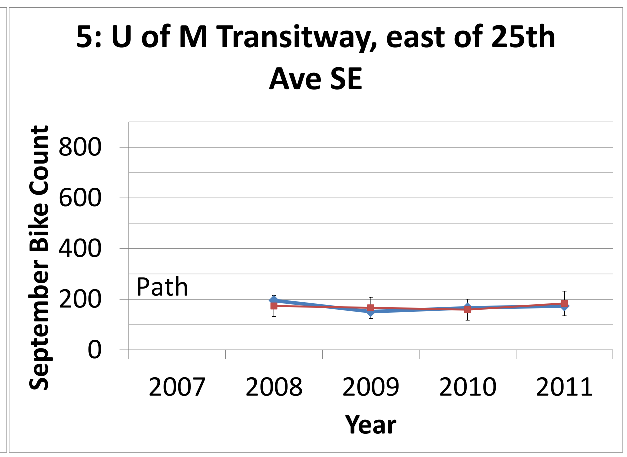
Appendix B: Detailed Count Location Trends By Year

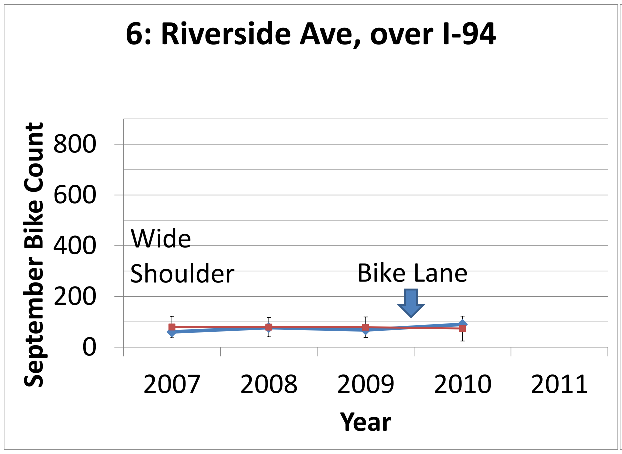
Blue lines & diamonds represent observed counts; red lines and triangles represent predicted counts based on individual growth model analysis (model 3; minimum 3 counts)

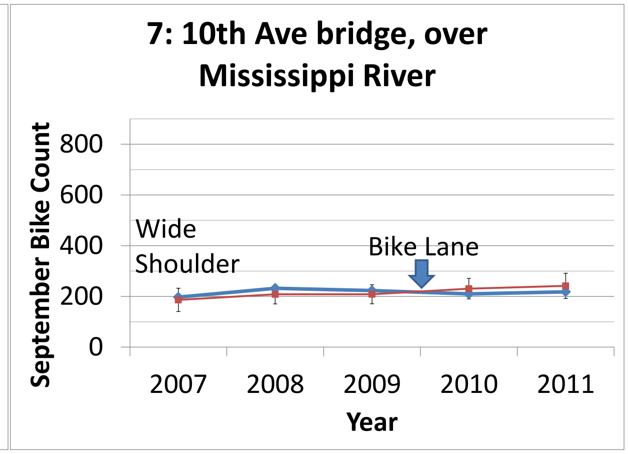


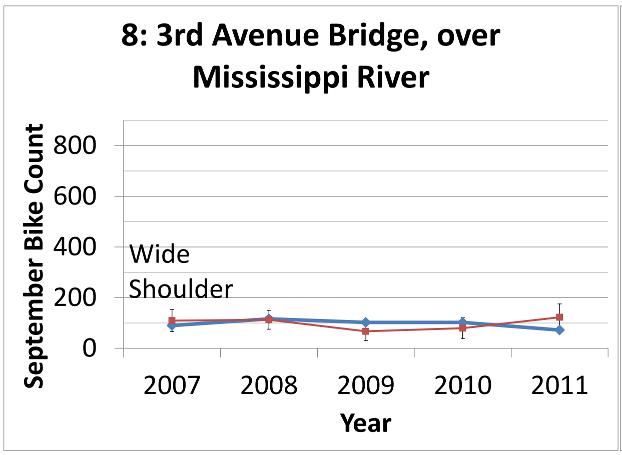


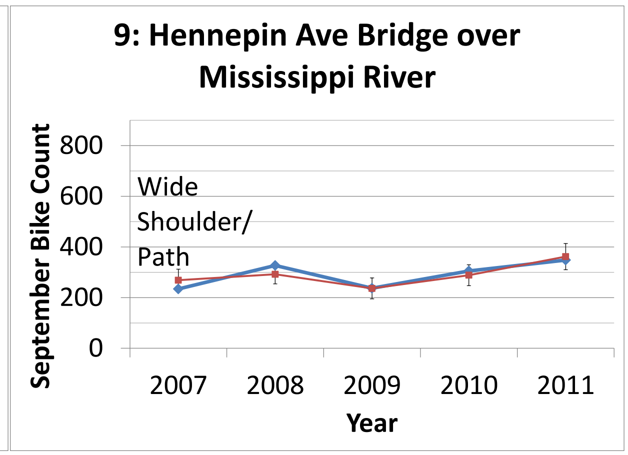


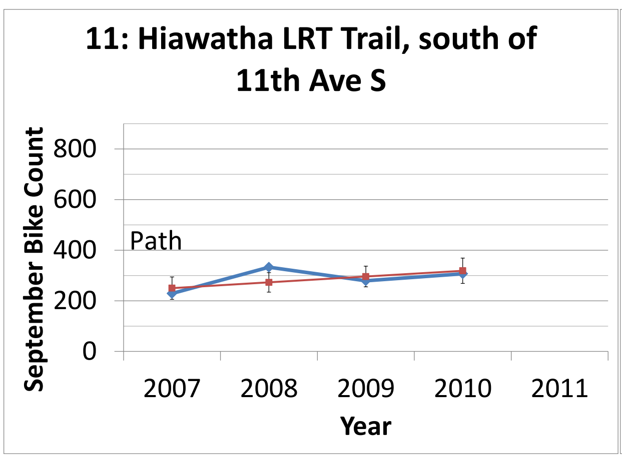


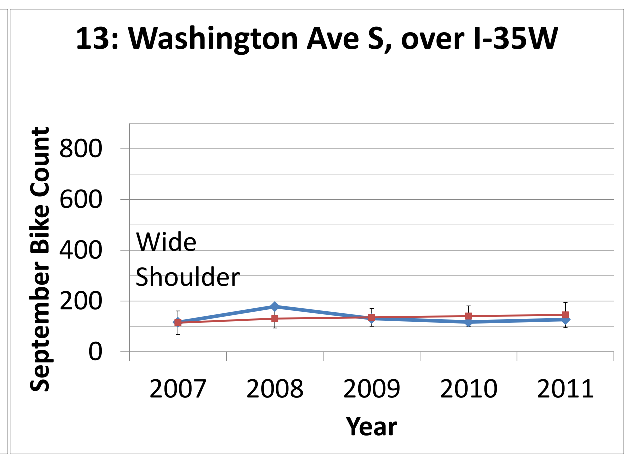

6: Riverside Ave, over I-94
September Bike Count
800
600
400
200
0
Wide
Shoulder
Bike Lane
2007
2008
2009
2010
2011
Year

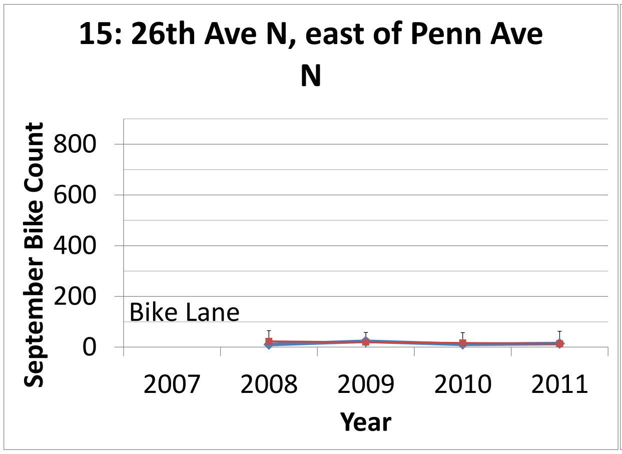

7: 10th Ave bridge, over Mississippi River
September Bike Count
800
600
400
200
0
Wide
Shoulder
Bike Lane
2007
2008
2009
2010
2011
Year

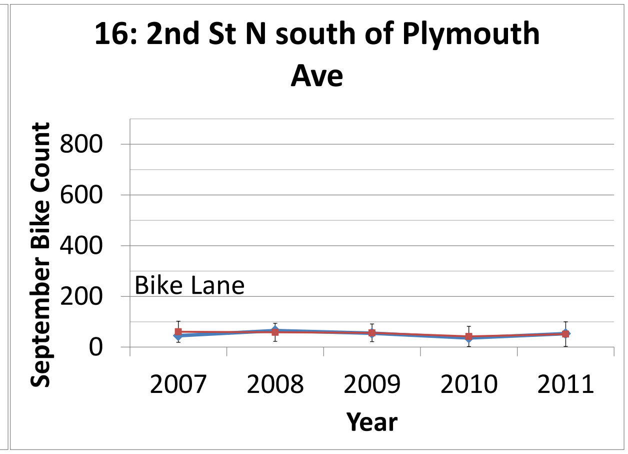

8: 3rd Avenue Bridge, over Mississippi River
September Bike Count
800
600
400
200
0
Wide
Shoulder
2007
2008
2009
2010
2011
Year

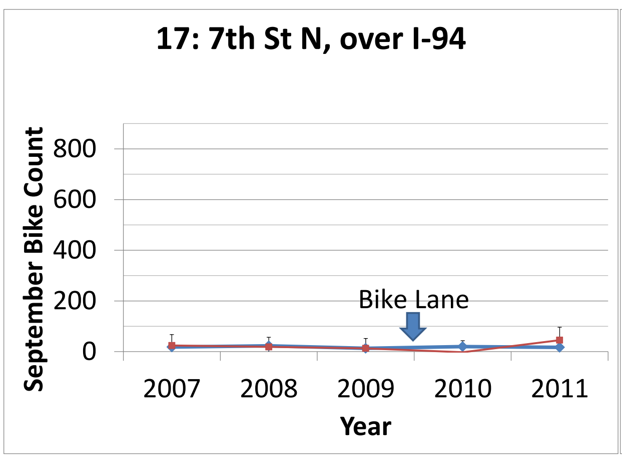

9: Hennepin Ave Bridge over Mississippi River
September Bike Count
800
600
400
200
0
Wide
Shoulder/
Path
2007
2008
2009
2010
2011
Year

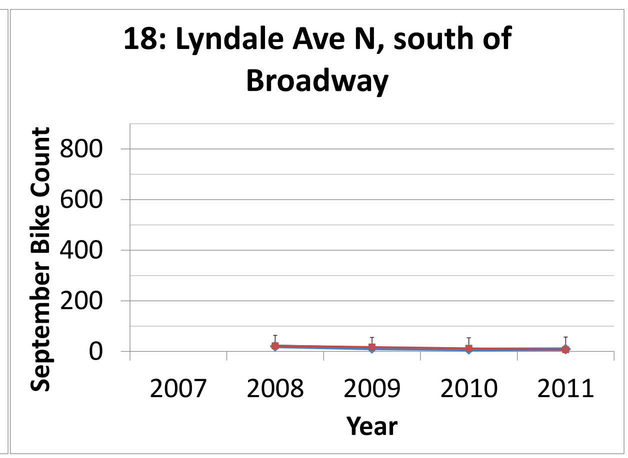

11: Hiawatha LRT Trail, south of 11th Ave S
September Bike Count
800
600
400
200
0
Path
2007
2008
2009
2010
2011
Year

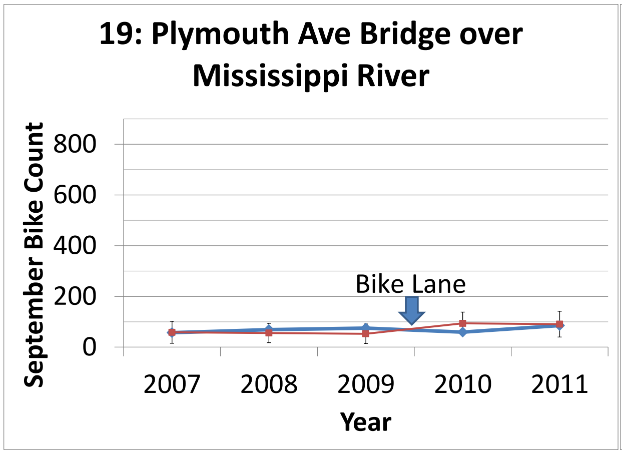

13: Washington Ave S, over I-35W
September Bike Count
800
600
400
200
0
Wide
Shoulder
2007
2008
2009
2010
2011
Year

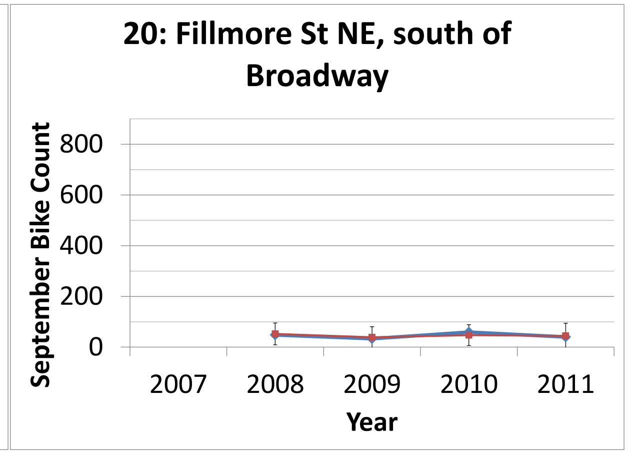

15: 26th Ave N, east of Penn Ave N
September Bike Count
800
600
400
200
0
Bike Lane
2007
2008
2009
2010
2011
Year

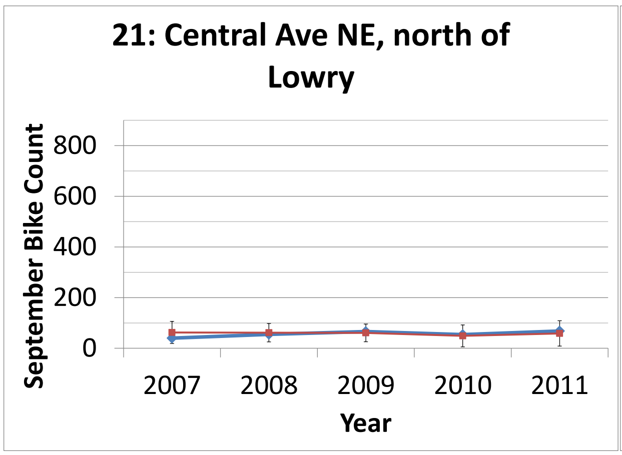

16: 2nd St N south of Plymouth Ave
September Bike Count
800
600
400
200
0
Bike Lane
2007
2008
2009
2010
2011
Year

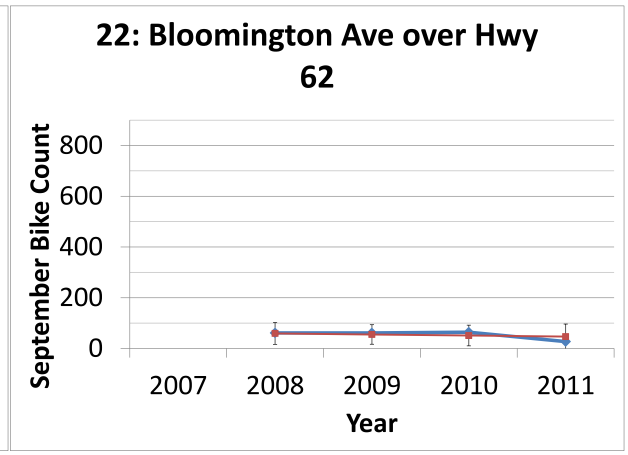

17: 7th St N, over I-94
September Bike Count
800
600
400
200
0
Bike Lane
2007
2008
2009
2010
2011
Year

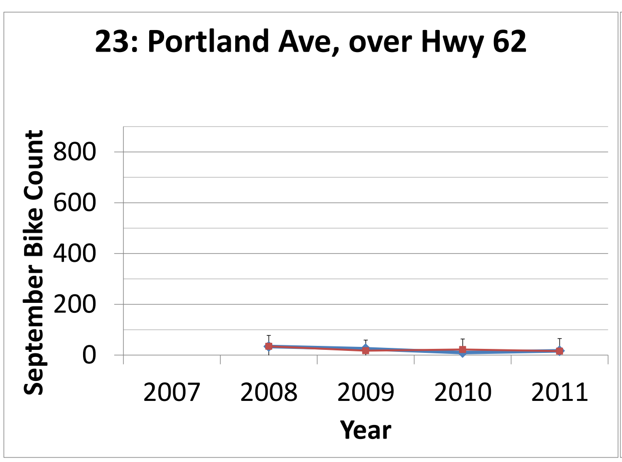

18: Lyndale Ave N, south of Broadway
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year

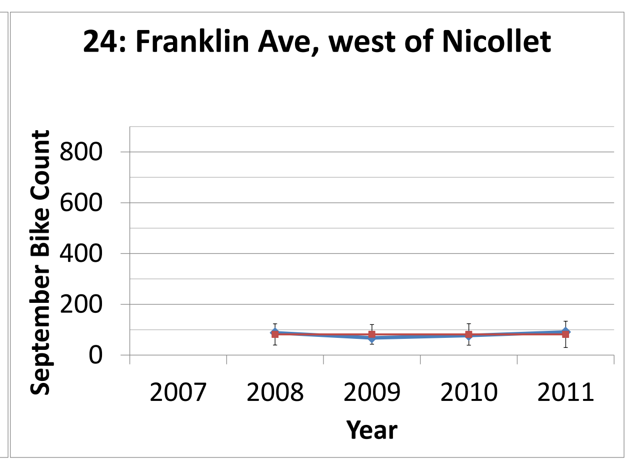

19: Plymouth Ave Bridge over Mississippi River
September Bike Count
800
600
400
200
0
Bike Lane
2007
2008
2009
2010
2011
Year

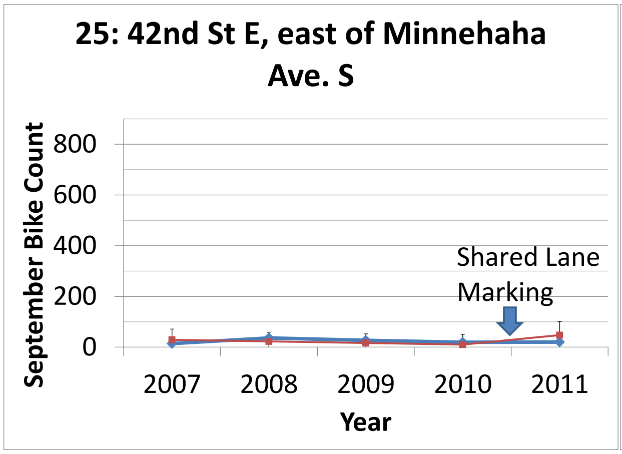

20: Fillmore St NE, south of Broadway
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year

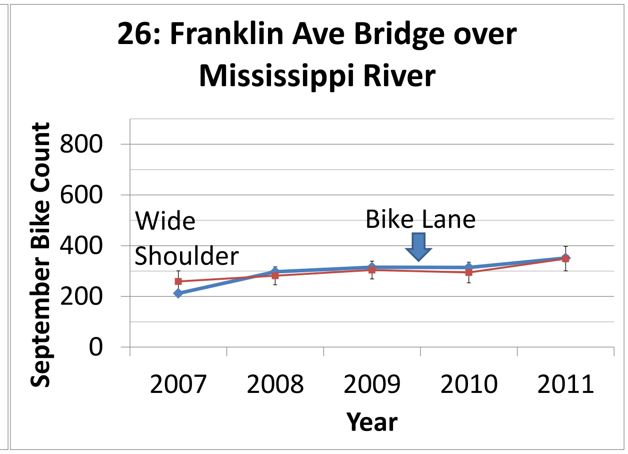

21: Central Ave NE, north of Lowry
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year

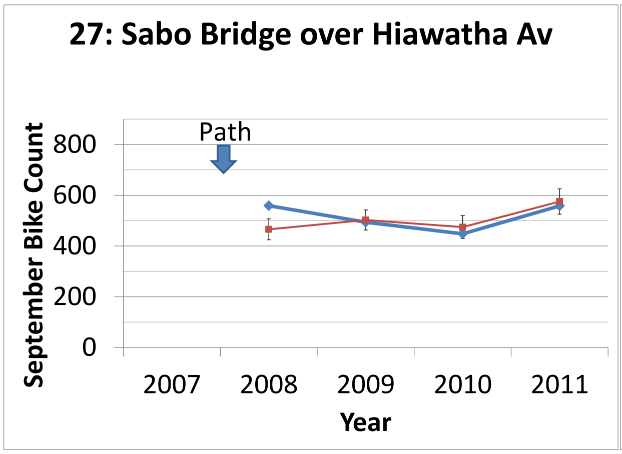

22: Bloomington Ave over Hwy 62
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year

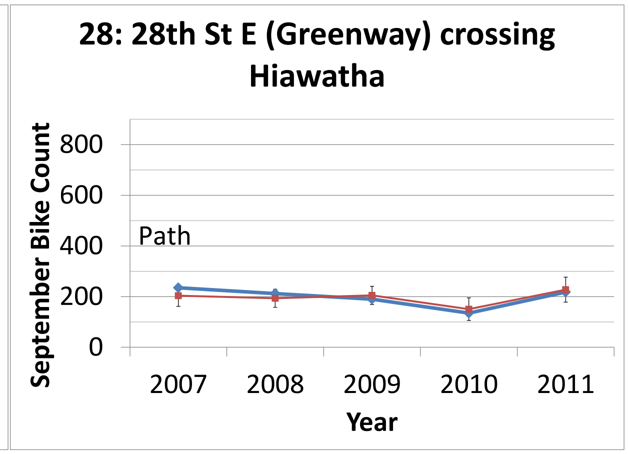

23: Portland Ave, over Hwy 62
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year

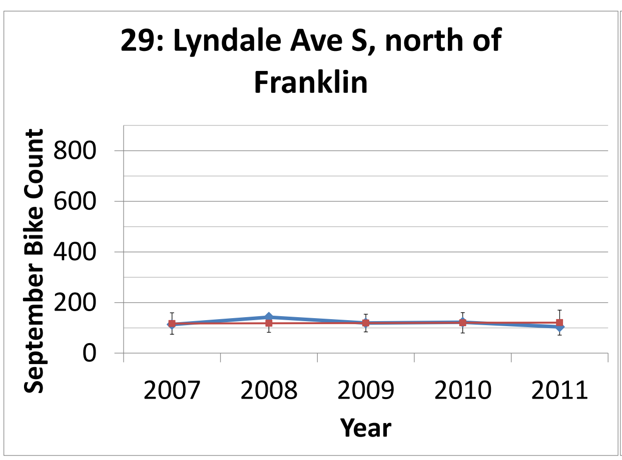

24: Franklin Ave, west of Nicollet
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year

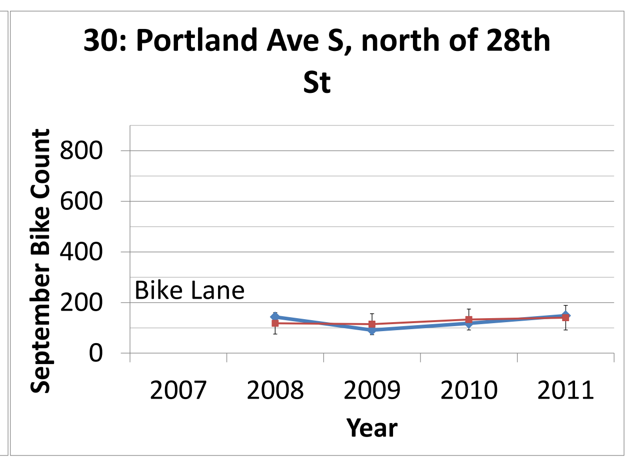

25: 42nd St E, east of Minnehaha Ave. S
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year
Shared Lane Marking

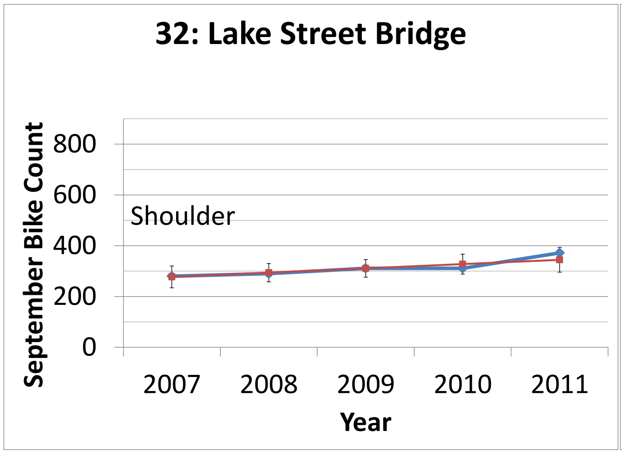

26: Franklin Ave Bridge over Mississippi River
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year
Wide Shoulder
Bike Lane

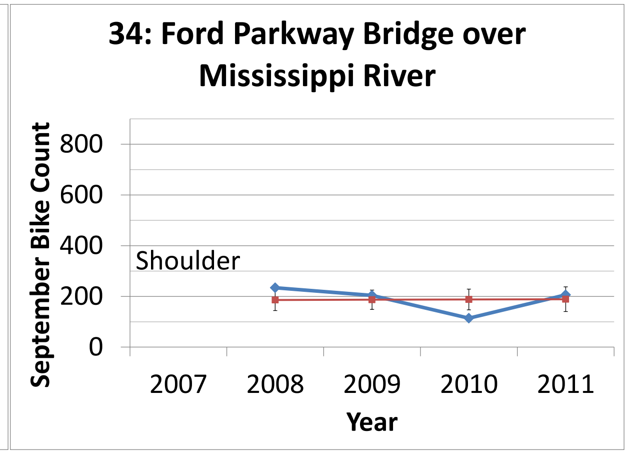

27: Sabo Bridge over Hiawatha Av
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year
Path

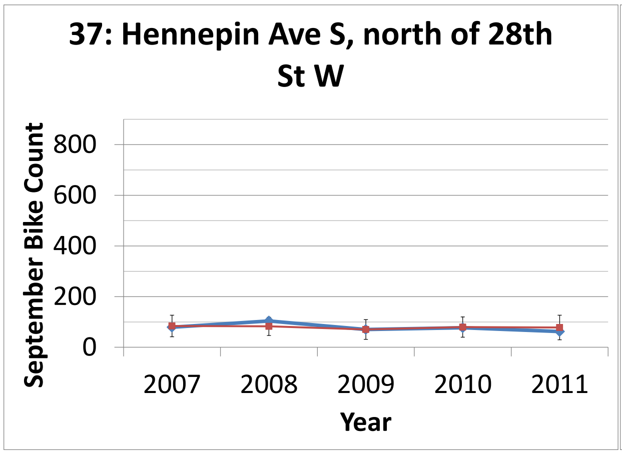

28: 28th St E (Greenway) crossing Hiawatha
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year
Path

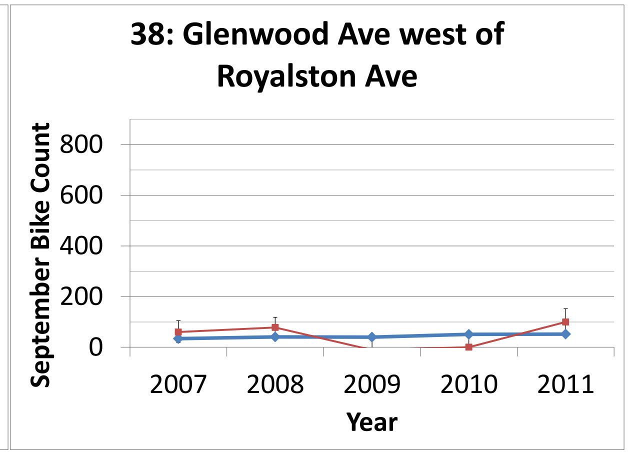

29: Lyndale Ave S, north of Franklin
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year

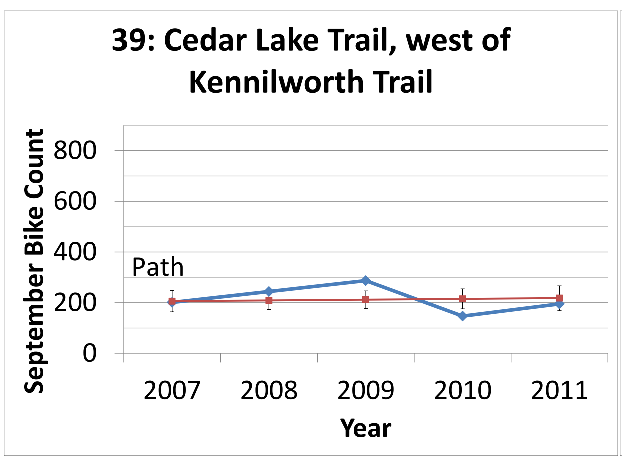

30: Portland Ave S, north of 28th St
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year
Bike Lane

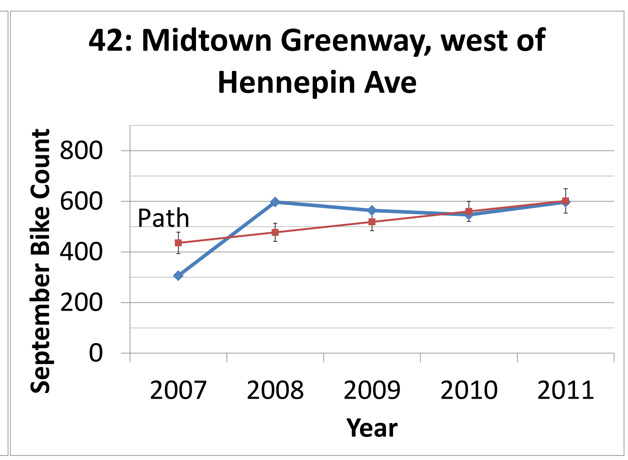

32: Lake Street Bridge
September Bike Count
800
600
400
200
0
Shoulder
2007
2008
2009
2010
2011
Year

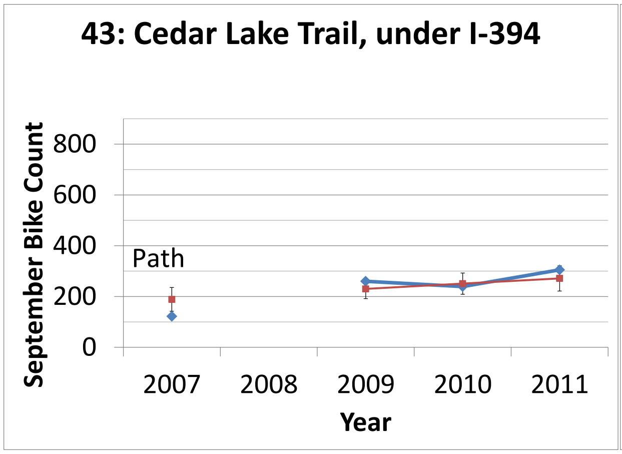

34: Ford Parkway Bridge over Mississippi River
September Bike Count
800
600
400
200
0
Shoulder
2007
2008
2009
2010
2011
Year

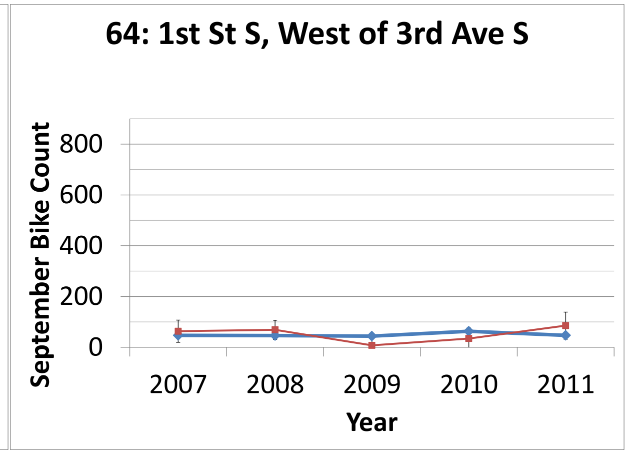

37: Hennepin Ave S, north of 28th St W
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year

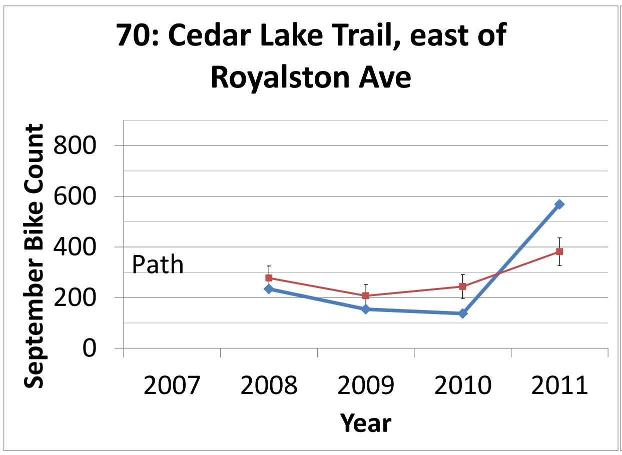

38: Glenwood Ave west of Royalston Ave
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year

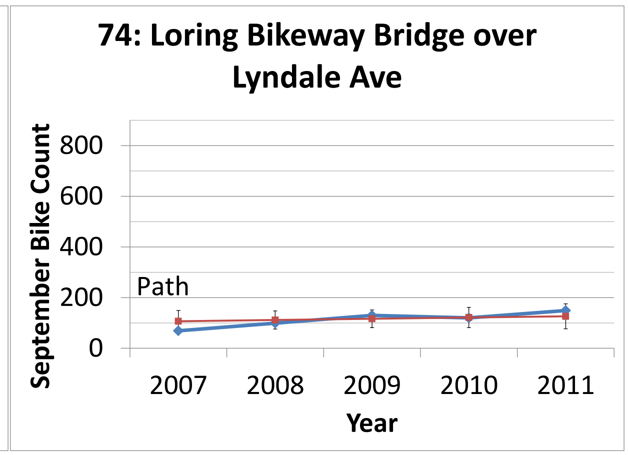

39: Cedar Lake Trail, west of Kennilworth Trail
September Bike Count
800
600
400
200
0
Path
2007
2008
2009
2010
2011
Year

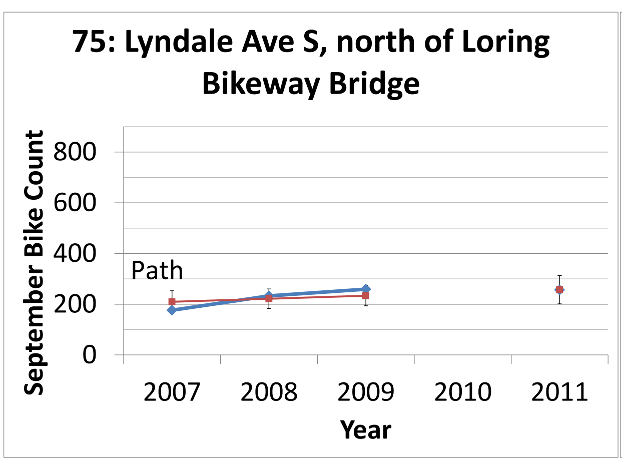

42: Midtown Greenway, west of Hennepin Ave
September Bike Count
800
600
400
200
0
Path
2007
2008
2009
2010
2011
Year

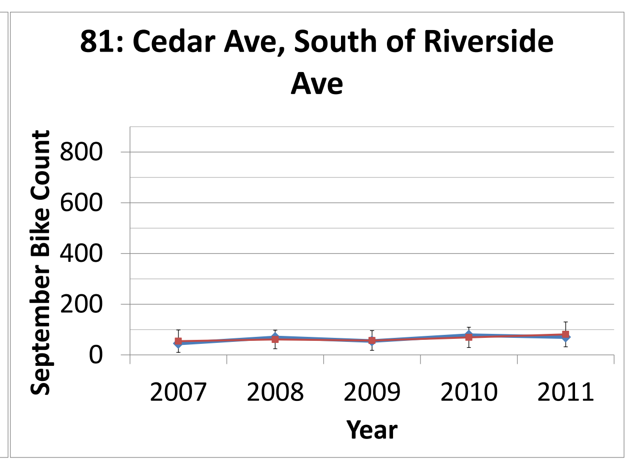

43: Cedar Lake Trail, under I-394
September Bike Count
800
600
400
200
0
Path
2007
2008
2009
2010
2011
Year

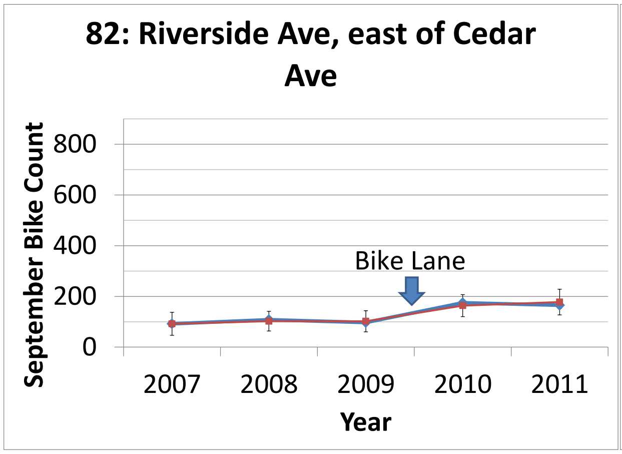

64: 1st St S, West of 3rd Ave S
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year

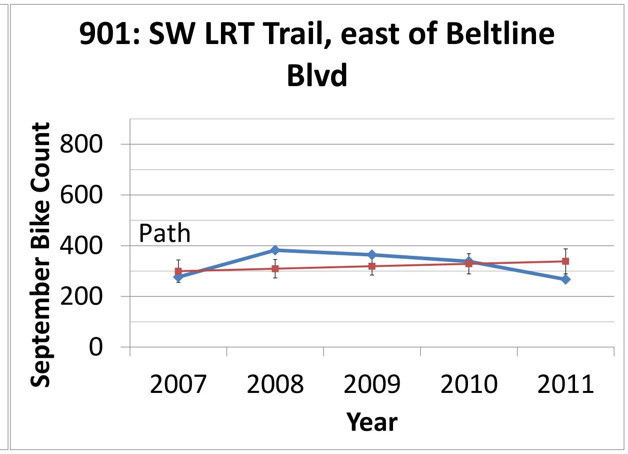

70: Cedar Lake Trail, east of Royalston Ave
September Bike Count
800
600
400
200
0
Path
2007
2008
2009
2010
2011
Year


74: Loring Bikeway Bridge over Lyndale Ave
September Bike Count
800
600
400
200
0
Path
2007
2008
2009
2010
2011
Year

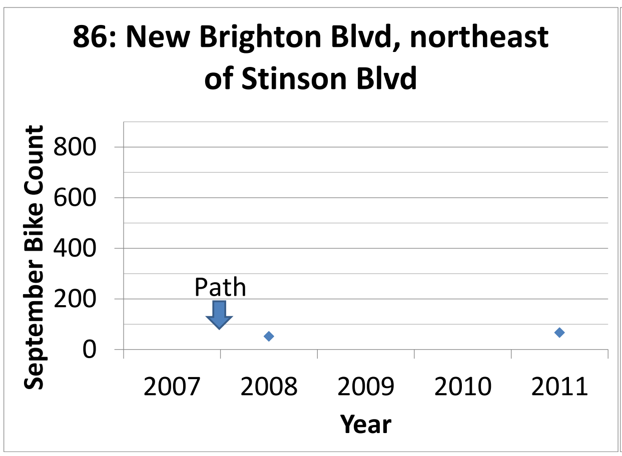

75: Lyndale Ave S, north of Loring Bikeway Bridge
September Bike Count
800
600
400
200
0
Path
2007
2008
2009
2010
2011
Year

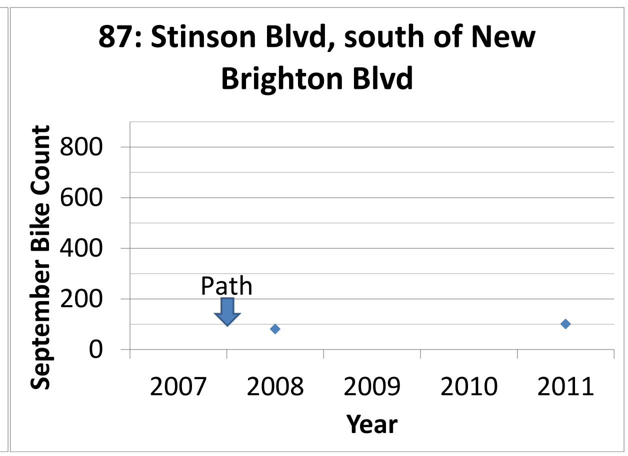

81: Cedar Ave, South of Riverside Ave
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year

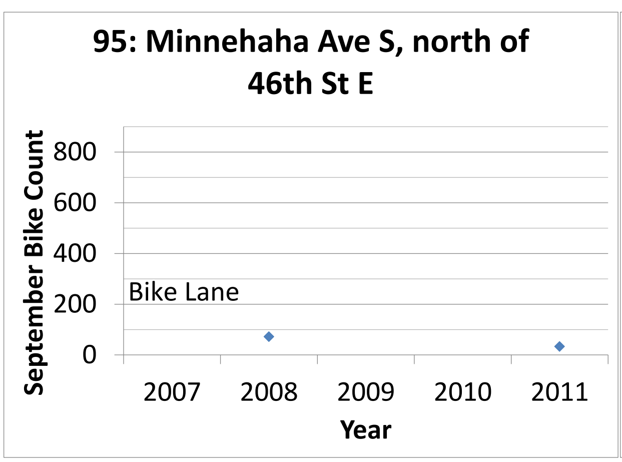


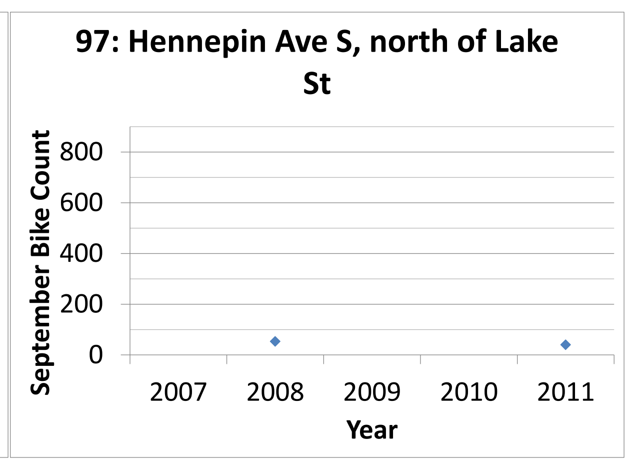


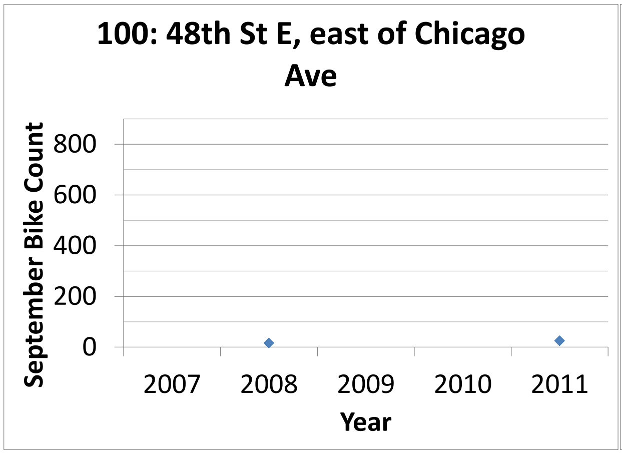
Count Locations with a Maximum of 2 Counts (Not included in models)

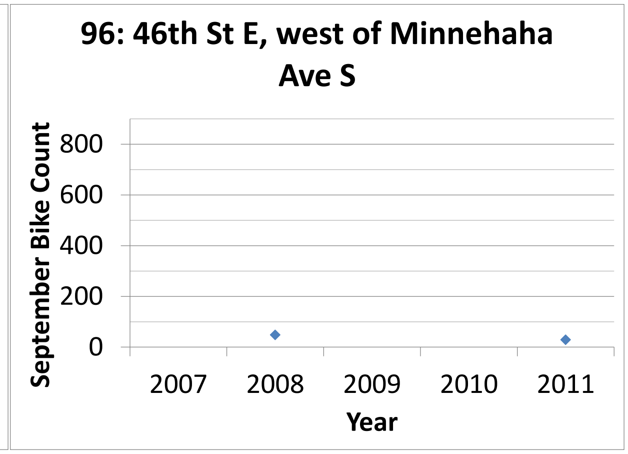


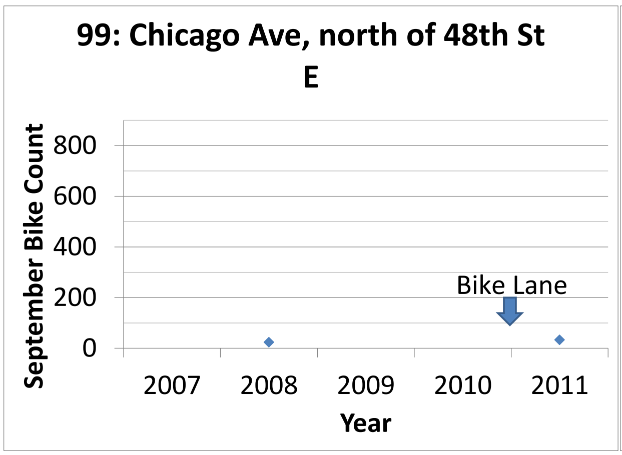


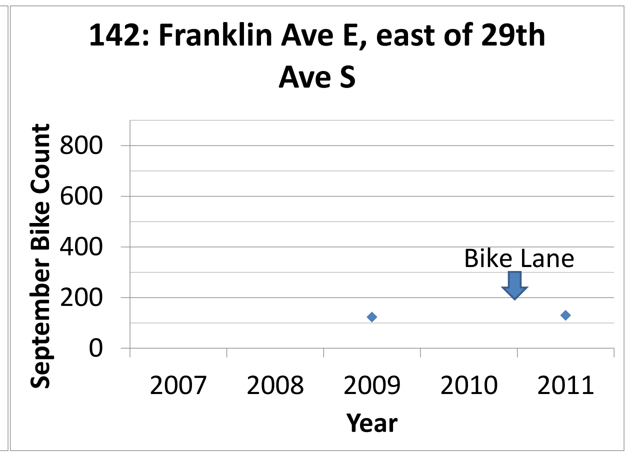


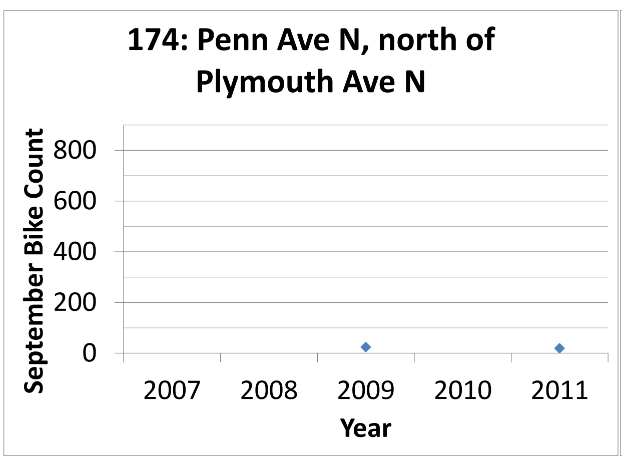


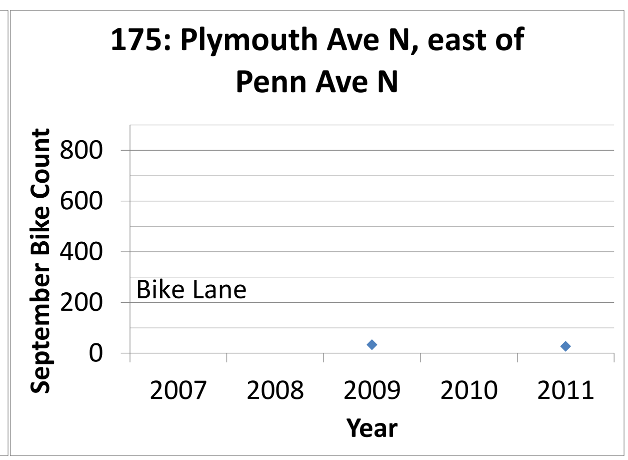

100: 48th St E, east of Chicago Ave
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year

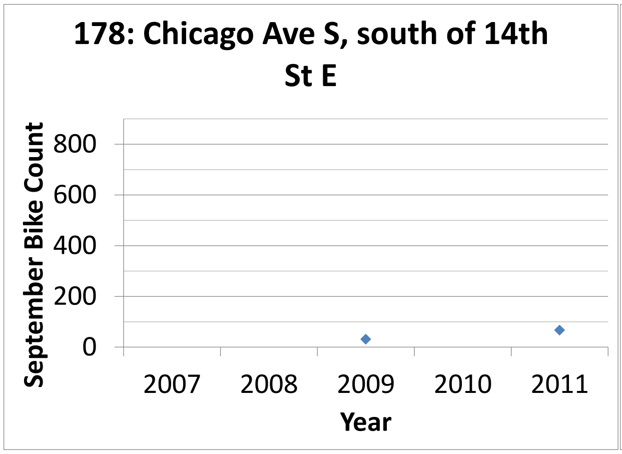

96: 46th St E, west of Minnehaha Ave S
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year

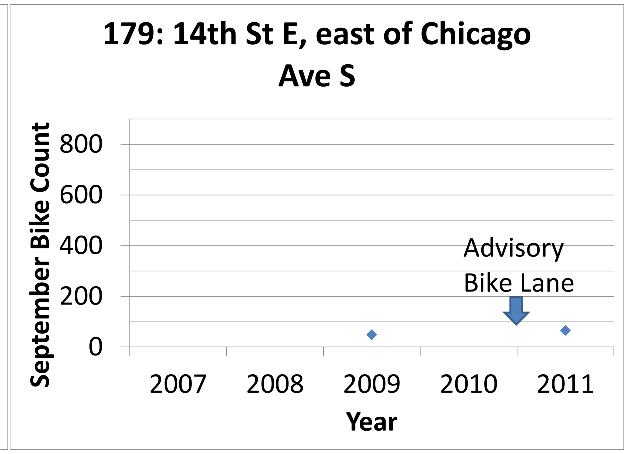

99: Chicago Ave, north of 48th St E
September Bike Count
800
600
400
200
0
Bike Lane
2007
2008
2009
2010
2011
Year

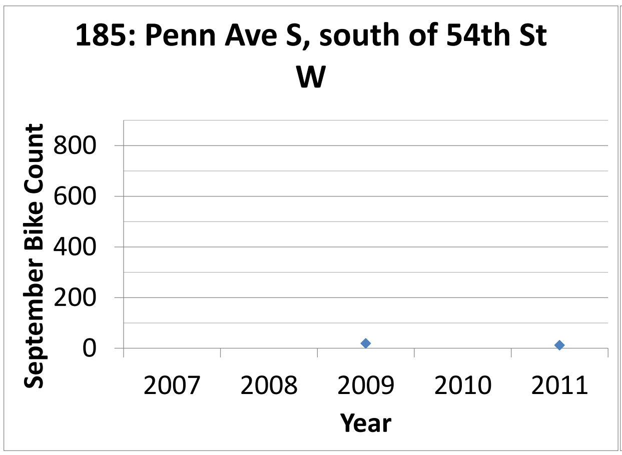

142: Franklin Ave E, east of 29th Ave S
September Bike Count
800
600
400
200
0
Bike Lane
2007
2008
2009
2010
2011
Year

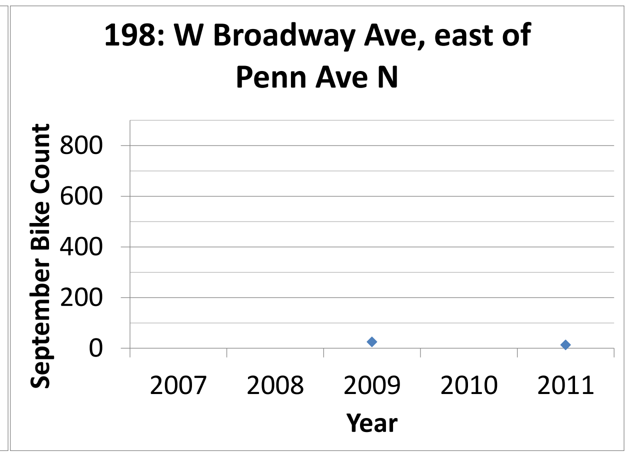

174: Penn Ave N, north of Plymouth Ave N
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year

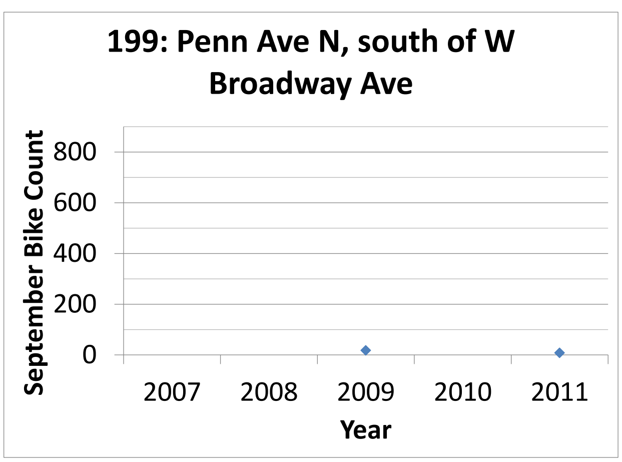

175: Plymouth Ave N, east of Penn Ave N
September Bike Count
800
600
400
200
0
Bike Lane
2007
2008
2009
2010
2011
Year


178: Chicago Ave S, south of 14th St E
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year


179: 14th St E, east of Chicago Ave S
September Bike Count
800
600
400
200
0
Advisory Bike Lane
2007
2008
2009
2010
2011
Year


185: Penn Ave S, south of 54th St W
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year


198: W Broadway Ave, east of Penn Ave N
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year


199: Penn Ave N, south of W Broadway Ave
September Bike Count
800
600
400
200
0
2007
2008
2009
2010
2011
Year

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