

## MEMORANDUM

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To: Professor Joe Grengs  
From: H. Kelley, K. Moss, L. Reigstad, C.Tso  
Date: 12/4/2013  
Re: Pedestrian Walking Time Impacts from Bridge Closures in the I-94 Rehabilitation Project

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### **SUMMARY**

This study investigates the impacts on pedestrian travel associated with 12 bridge removals planned for the Michigan Department of Transportation's (MDOT) I-94 Rehabilitation Project. Figure 1 shows where the project corridor and study area is located. The project spans 6.7 miles of I-94 in the City of Detroit, from Conner Street in the east to I-96 in the west. Residents living in neighborhoods close to I-94 rely on bridges to access destinations on the other side of the freeway.

For this study, time increases were recorded in minutes by walking time to destinations, from the centroid of occupied Detroit parcels. Low levels of car-ownership in our study area suggest that pedestrians within one and a half miles of bridge closures are likely to experience reduced levels of connectivity compared to other Detroiters. Our analysis finds that the most affected parcels in terms of total increased travel time are located on the north and south sides of the I-94 freeway, east of I-75. Based on our analysis, we found that the bridge closures induce a significant travel time cost equivalent to more than 2,000 hours when summing all extra travel minutes for all parcels in this area. While K-8 schools, higher education institutions, and food pantries are locations where pedestrians would experience noticeable higher travel times, major institutions, grocery stores, and job training facilities are destinations that show little change. The impact on pedestrian accessibility will depend on the type of destination and if alternative bridges are accessible after the bridge closures.

### **INTRODUCTION**

Transportation investment and advancement often do not create equal benefits for all communities. The issue of transportation equity arises when low-income inner-city travelers disproportionately bear the cost of new transportation projects, while auto-dependent and suburban travelers see improvement in their commutes (Bullard, 2003; Grengs, 2002). The I-94 Rehabilitation Project will spend \$2.7 billion on a 6.7 mile long segment of I-94 in Detroit, adding one travel- and two service-lanes in each direction. The project will reconfigure the M10 / I-94 interchange as well as on and off ramps, and replace several overpasses (Michigan Department of Transportation, 2010). The Michigan Department of Transportation argues that the project is vital to alleviating congestion along a highway corridor that carries 160,000 daily vehicles, and to providing trucks with improved passage to international border crossings. Yet, these regional implications do little to absorb the harm the I-94 project may cause to pedestrian circulation in Detroit – particularly in areas of Detroit experiencing redevelopment, but still containing substantial areas of low auto-ownership, poverty and disinvestment (U.S. Census Bureau, 2011).

The affected portion of I-94, running west from Conner Street to I-96, passes through the up-and-coming Midtown district, which is home to many neighborhoods, large employers and public institutions. It is also recently the site of much redevelopment and new employment. Major institutions in this area include Wayne State University, Henry Ford Hospital, the Detroit Public Library - Main Branch, Detroit Institute

of Arts, College for Creative Studies and the Detroit Medical Center. Additional anchors along the corridor include Eastern Market and Wayne County Community College - Eastern Campus. Numerous K-8 schools and social services are also located along the corridor.

The I-94 Rehabilitation Project proposes to permanently eliminate 12 overpasses. Without these walkable overpasses that connect people and destinations on both sides of the freeway, pedestrians will face higher time costs when traveling across I-94. Figure 2 identifies the 12 bridge removals and shows that community facilities in the study area cluster around Woodward Avenue between the M-10 and I-75 freeways. Additionally, eight pedestrian bridges (not shown in Figure 2) will be rebuilt with a steeper incline, posing greater difficulty for elderly pedestrians, wheelchair users, or travelers with disabilities. Despite plans to replace these latter connections, given the difficult fiscal climate in the state, communities may experience years or decades before restoration of access.

This paper investigates the extent to which these 12 bridge closures impact neighborhood pedestrian access. We primarily examine change in walking time between neighborhood parcels and important neighborhood destinations or major institutions after connections are removed. The next three sections of this study will present the selection of data and methodologies, the results of the analysis, and the study limitations.

## **METHOD**

The impact study published by MDOT claims that the rehabilitation project will result in improved automobile and pedestrian mobility. The principal goal of the study is to identify the level of impact on the mobility of local pedestrians after the removal of 12 walkable bridges as a result of the I-94 Rehabilitation Project. For this study, the effect on pedestrian mobility is measured by the change in travel time in minutes per trip from before and after bridge removals. We expected that the change in travel time will increase for most residents because they will be forced to take longer routes to common destinations as a result of the bridge removals. Our task is to calculate these travel time increases, and then to evaluate which locations within the study area are most burdened by the bridge removals. The main GIS tool used in this study was *Network Analyst* - which is a tool to analyze travel times and distance to destinations in a simulated network. This study utilized both the *Closest Facility* and the *OD Cost Matrix* functions of *Network Analyst*. The project heavily took advantage of the shapefile editor, buffers, select by location, field calculation, geocoding and table joins.

To begin the analysis, we created a network dataset with a road shapefile for Detroit, separating out only using only pedestrian accessible, walkable roads. For each category of destination, we used the *New Closest Facility* function to determine the walking distance from each parcel centroid to the nearest destination, before and after bridge removals. Destination categories include temp agencies, food pantries, recreation centers, job training sites, libraries, health clinics and schools. Using the nearest destination is not ideal for all situations. For example, most people are readily willing to substitute one library for another, but far less willing to substitute one elementary school for another. For elementary and high schools, we used the *OD Cost Matrix* function, which finds the travel distance between each parcel centroid and all schools considered in the analysis. Using the *OD Cost Matrix* function to find distances to all destinations – rather than the single closest destination -- allowed us to hold destinations constant, and prevented Network Analyst from selecting a new closest facility after we introduced

simulated bridge closures. We then calculated the change in distance before and after bridge removals for each facility grouping. In addition to elementary and high schools, we also used the *OD Cost Matrix* approach for analyzing major cultural, medical, and higher educational facilities.

For all facilities, change in travel distance was converted to change in travel time by assuming the average pedestrian walks about 3.5 feet per second and 2.4 miles per hour (LaPlante and Keaser, 2007). Lastly, we aggregated the walking time changes into a ranking system by assigning values to the occupied parcels, from least to most impacted by walking time changes across all facilities. This allowed us to easily identify the areas most impacted by the bridge removals and cross-reference them with demographic data.

We retrieved data in multiple categories to structure the analysis, including: a streets shapefile from the Michigan Geographic Framework; block group boundaries from the 2010 Census; households in poverty, no vehicle households, African American population, school-age population, and bicyclists, walkers, and transit commuters from the American Community Survey 5-year estimates for 2007-2011; parcel data from the University of Michigan SAND Lab; active K-12 schools from Excellent Schools Detroit; temp agencies, human services and food pantry data came from the National Center for Charitable Statistics; grocery store data came from Alex B. Hill and recreation centers and job training site information came from the City of Detroit. All other minor sources are included in the appendix.

**Measures Used:** We used occupied parcels as the primary spatial unit of analysis in order to capture detailed impacts absent from the block group level of analysis. We also incorporated demographic and population data at the block group level in order to identify and compare our study area to greater Detroit. We particularly considered demographic characteristics such as poverty levels, age, auto ownership, and commutes by mode. We defined our study area through the use of two buffers. To identify parcels, we first selected the occupied parcels of each block group within a 1.5 mile buffer around bridge closures. The second buffer includes the maximum distance of each facility from a bridge closure, to accommodate the fact that nearest facilities may be outside of the 1.5 mile buffer of parcels. We analyzed all facilities within a two mile buffer of a bridge closure point, ensuring that we accounted for outlying facilities.

**Assumptions and Limitations:** (1): Our analysis is slightly weakened by the fact that the facilities buffer (2 miles) is not precisely double the size of the parcel buffer (1.5 miles). This is problematic for our findings because parcels on the fringe of the 1.5 mile border may have nearest facilities that are outside of the 2 mile buffer, and not factored in the parcel rankings. This limitation primarily affects ranking values for parcels at the fringe of the parcel buffer. This limitation was necessary because of time constraints in the data collection phase. (2): We assumed that residents would use many of the major destinations, not just the closest one. Many of the major destinations are significantly larger than others, and we calculated multiple centroids for larger destinations. Therefore, some locations are represented by more than one point, locations, such as the Detroit Medical Center, and may artificially appear more popular than locations represented by a single point. To compensate for this complication, we used median walking times and not averages. (3): This study did not account for pre-existing accessibility issues. Even though the travel increases are at times minimal, total travel times for daily activities may still be very high. While studying these factors falls outside the scope of this study, the existing difficulties of Detroiters are compounded by the I-94 Project in a way not captured in this study. (4): Although total time increase is negligible for some parcels, qualitative opportunity loss is not captured by this study.

Although beyond the scope of this study, assessing the full range of opportunity by accounting for accessibility to multiple destinations through a “cumulative opportunities” approach would count the number of destinations within a threshold travel time and offer a fuller evaluation of the effects of the bridge removals (Grengs, 2009).

## **FINDINGS & DISCUSSION**

As shown in Figure 3, the study area contains a disproportionately high share of the city’s zero-vehicle households, which are more likely to rely on public and non-motorized transportation. Figure 4 also demonstrates that our study area is disproportionately dependent on transit, bike, and walking as their primary commute mode. While Figure 5 demonstrates that the poverty level in our study area is not substantially different from the poverty level in the city of Detroit, poverty is nevertheless a significant characteristic of our study area.

Figure 6 shows the aggregate time increase for all destinations, and the callouts on the map illustrate time increases for several example parcels. The areas of highest impact are parcels nearest to the bridge removals along I-94. The most severely impacted parcels are east of the I-94 and I-75 intersection, and west of the major eastside arterial, Gratiot Avenue. However, as Figure 7 shows, these parcels are in block groups that have very low population. Furthermore, Figure 6 highlights that the negative impacts on walking time diminish as distance from the closure points increases, showing a positive correlation between distance to closure points and travel time impact. Table 1 shows that 21% of the non-vacant parcels will feel no impact in walking time and 11% of the non-vacant parcels will see increase in travel time between 10 to 50 minutes. Most notably, the total increase in walking time felt by the community as a result of these closures is over 2,050 hours, or more than 85 days.

Figure 6 shows that walking time increase is widespread throughout the study area, however; maps for each type of destination reveal that not every bridge removed bridge has the same level of impact on pedestrian travel. Rather, the impact of each the bridge closures removal depends on the type and location of the destination. Figure 8 and Figure 9 demonstrate this point. In Figure 8, we see no time change for parcels south of I-94 and nearest to the closure points at the intersection of M10 and I-94 (labeled “A” on the map), while the parcels directly north of these bridge removals (labeled “B” on the map) do demonstrate exhibit an increase. Figure 9, however, shows the opposite trend. Here, the same bridge closures removals impact those living south of the freeway, but not the north. This comparison shows that the type of the location and its proximity to the corridor determines the extent of the negative change in accessibility.

Moreover, those living further from other alternative, accessible bridges feel a heavier impact from a bridge removal than those living near other bridges that will remain open. . Figure 10 shows that the parcels near a cluster of three bridge closures (labeled “A” on the map) exhibit no time change. Despite losing three bridges, these parcels near these three bridge removals have access to alternative overpasses that neutralize the impact of the closures. However, travel time to recreation centers increases substantially for the southeastern parcels by the eastern-most closure (labeled “B” on the map); this may suggest that these parcels heavily depend on the closed bridge to travel across the freeways. This observation reveals that a neighborhood that loses one bridge might experience larger reductions in pedestrian accessibility than a neighborhood that loses multiple pedestrian bridges.

## **CONCLUSIONS**

The I-94 Rehabilitation Project is intended to improve efficiency for vehicles along the corridor, but comes at a cost to pedestrians living and working in the area. Residents in close proximity to the project are highly dependent on accessing important destinations as pedestrians, because poverty is prevalent and households are disproportionately without private vehicles. By quantifying the time increase for pedestrians traveling to daily activities, we found that some residents of the study area are likely to experience substantial burdens in pedestrian travel time as a results of the bridge removals. Our findings clarify that there is not an easy alternative to improving this situation as the removal of each bridge impacts different destinations to varying degrees. But the method outlined in this study offers a means by which alternative scenarios might be tested in their effects on local residents, and for prioritizing closures with the goal of preserving as much pedestrian accessibility as possible.

## References

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[http://www.michigan.gov/mdot/0,4616,7-151-9621\\_11058\\_53088\\_53115-86490--,00.html](http://www.michigan.gov/mdot/0,4616,7-151-9621_11058_53088_53115-86490--,00.html)  
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<http://factfinder2.census.gov>

## Interstate 94 Expansion in Context, City of Detroit 2013



Map by L. Reigstad, December 2013. Data Sources: 2013 Michigan Geographic Framework; University of Michigan SAND Lab.

Figure 1



## Neighborhood Facilities Overview with Numbered Bridge Removals

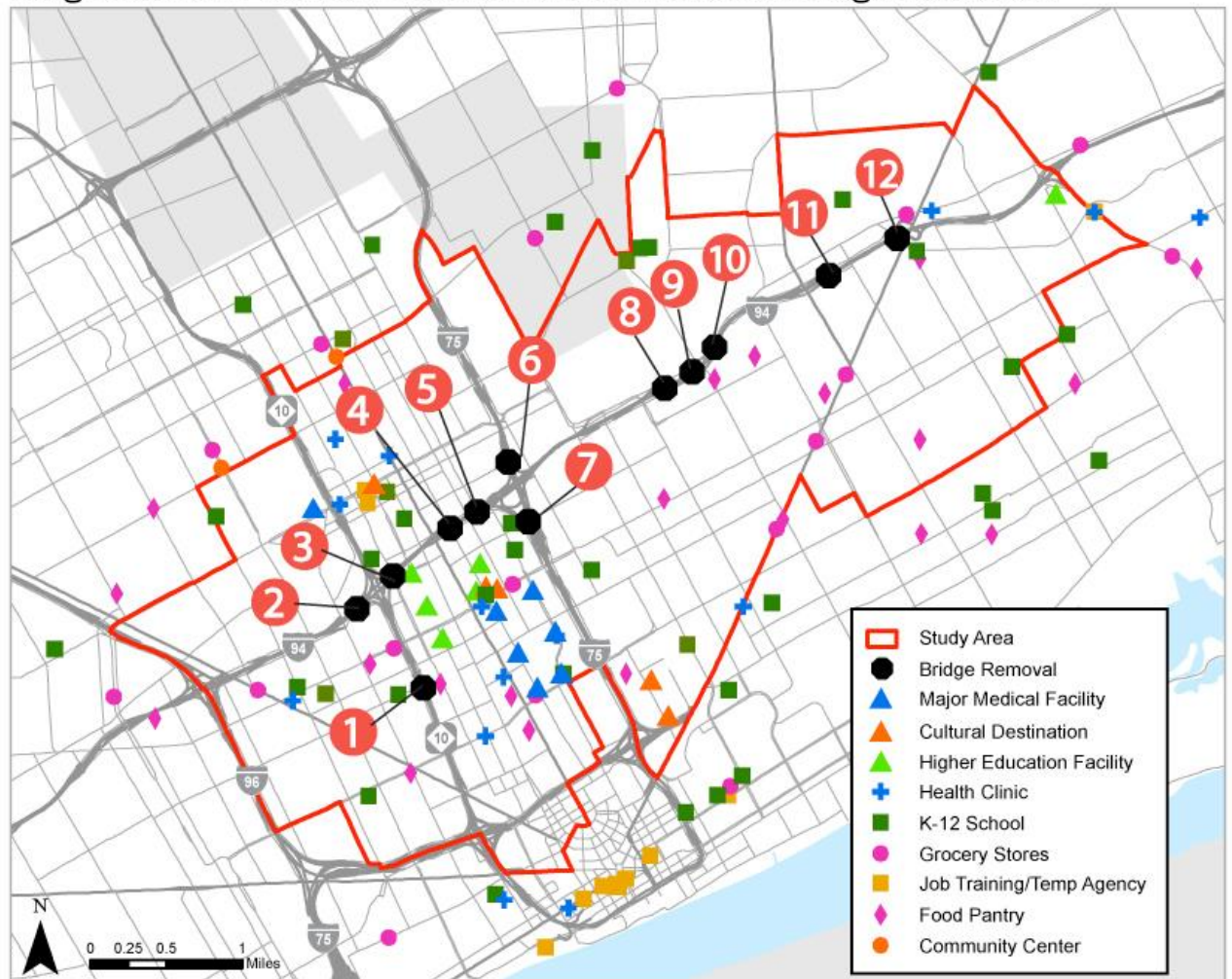
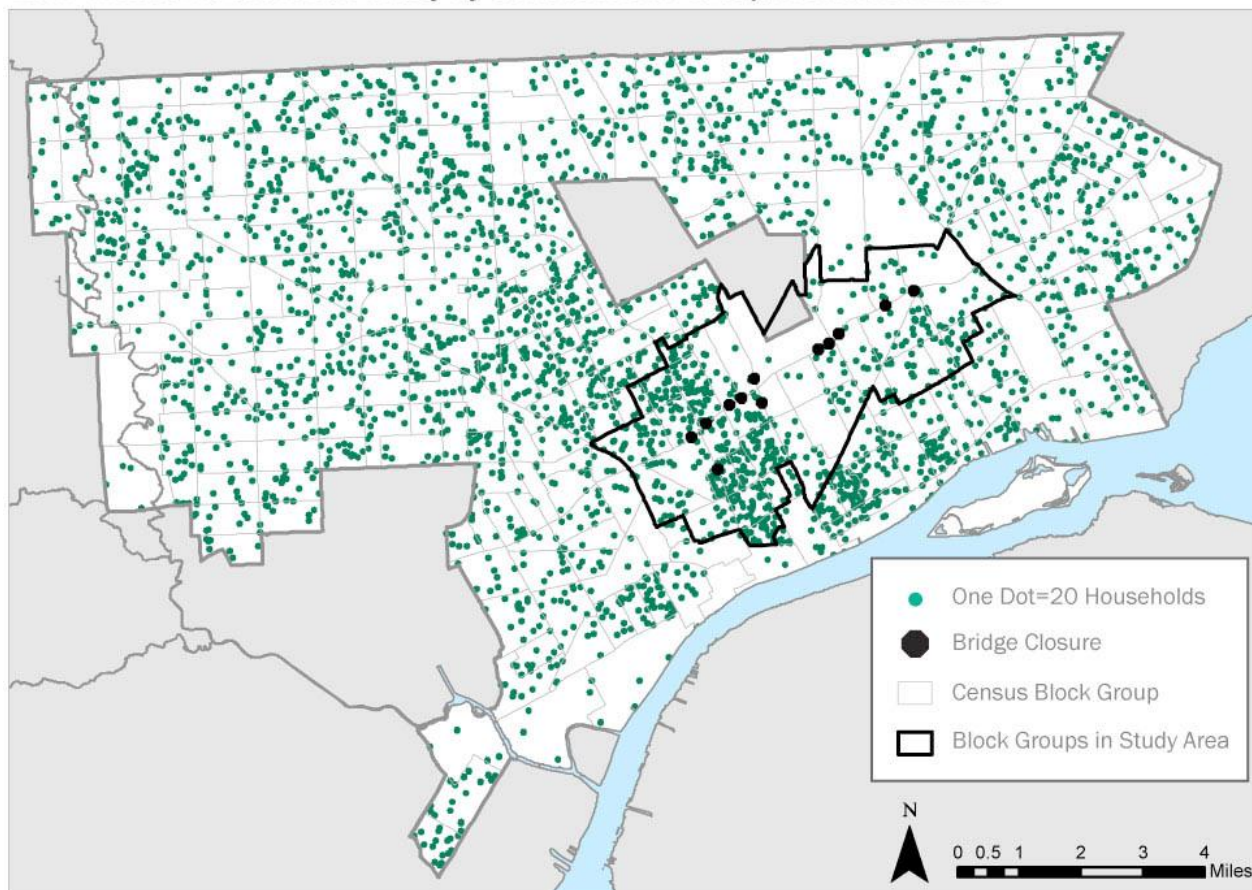


Figure 2

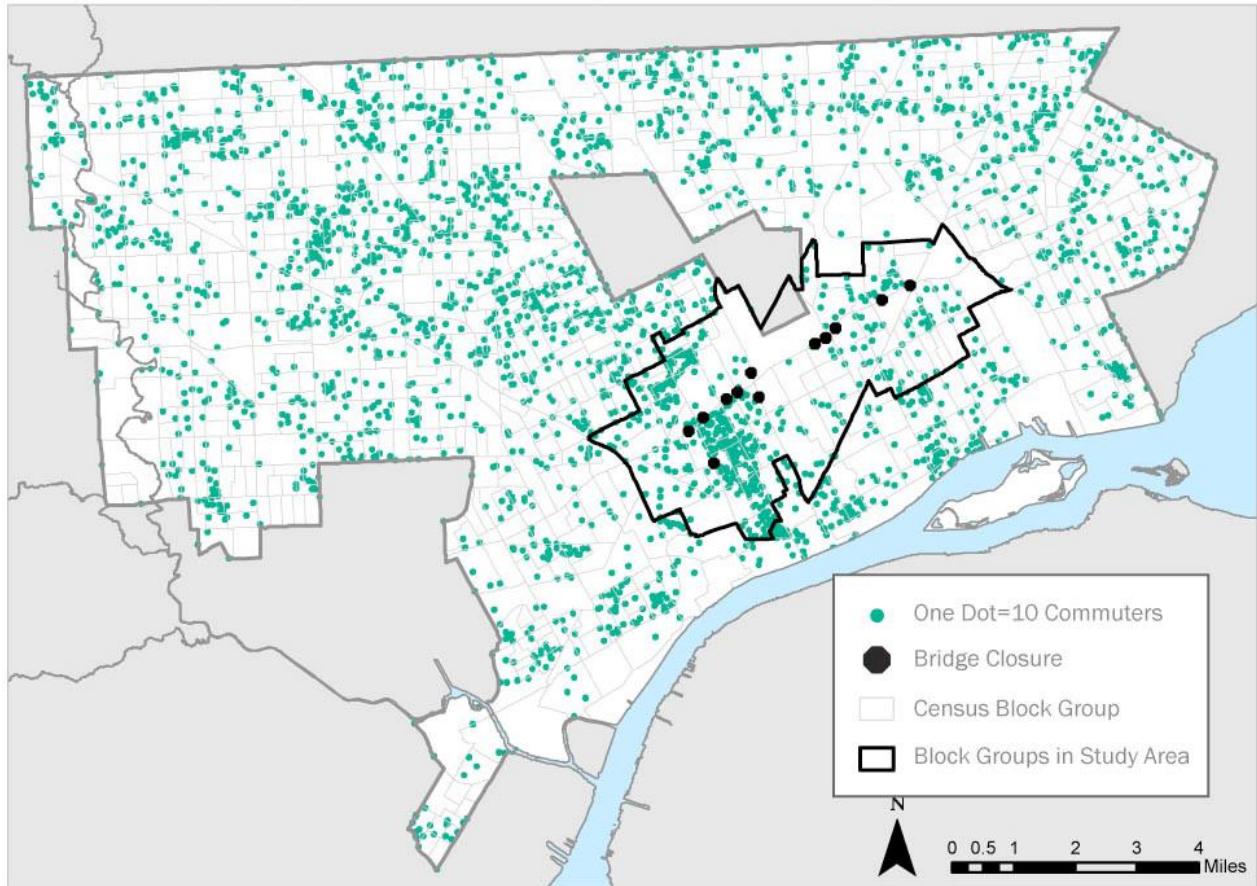
### Zero-Vehicle Household Density by Census Block Group, Detroit MI 2010



Map by H. Kelley, K. Moss, L. Reigstad, C. Tso, December 2013. Data Sources: 2007-2011 ACS 5-year Estimates, Table 08201, U.S. Census Bureau; 2010 TIGER shapefiles, U.S. Census Bureau; 2013 Michigan Geographic Framework.

Figure 3

### Density of Bike/Walk/Transit Commuters by Census Block Group, Detroit MI 2010

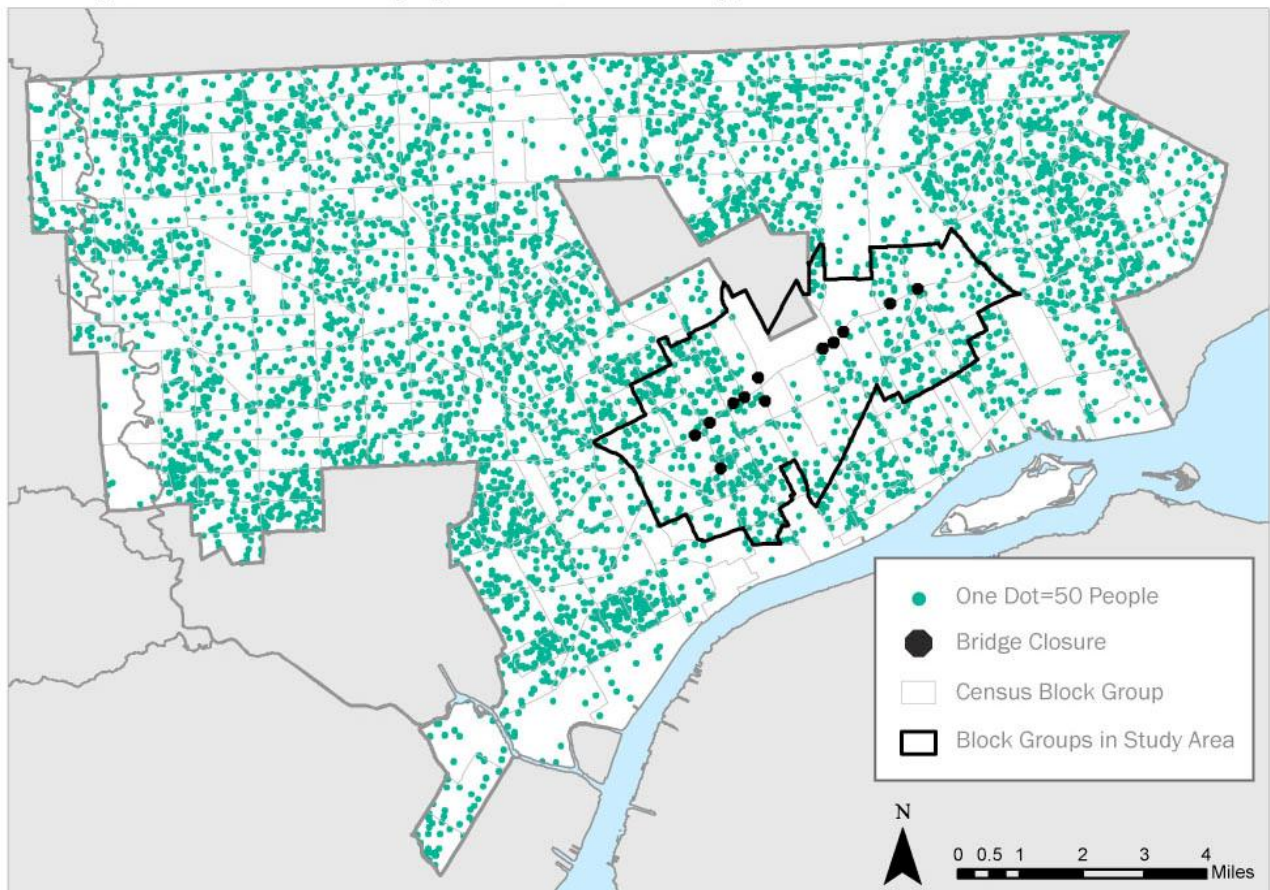


Map by H. Kelley, K. Moss, L. Reigstad, C. Tso, December 2013. Data Sources: 2007-2011 ACS 5-year Estimates, Table B08101, U.S. Census Bureau; 2010 TIGER shapefiles, U.S. Census Bureau; 2013 Michigan Geographic Framework.

Figure 4



### Density of Persons in Poverty by Census Block Group, Detroit MI 2010

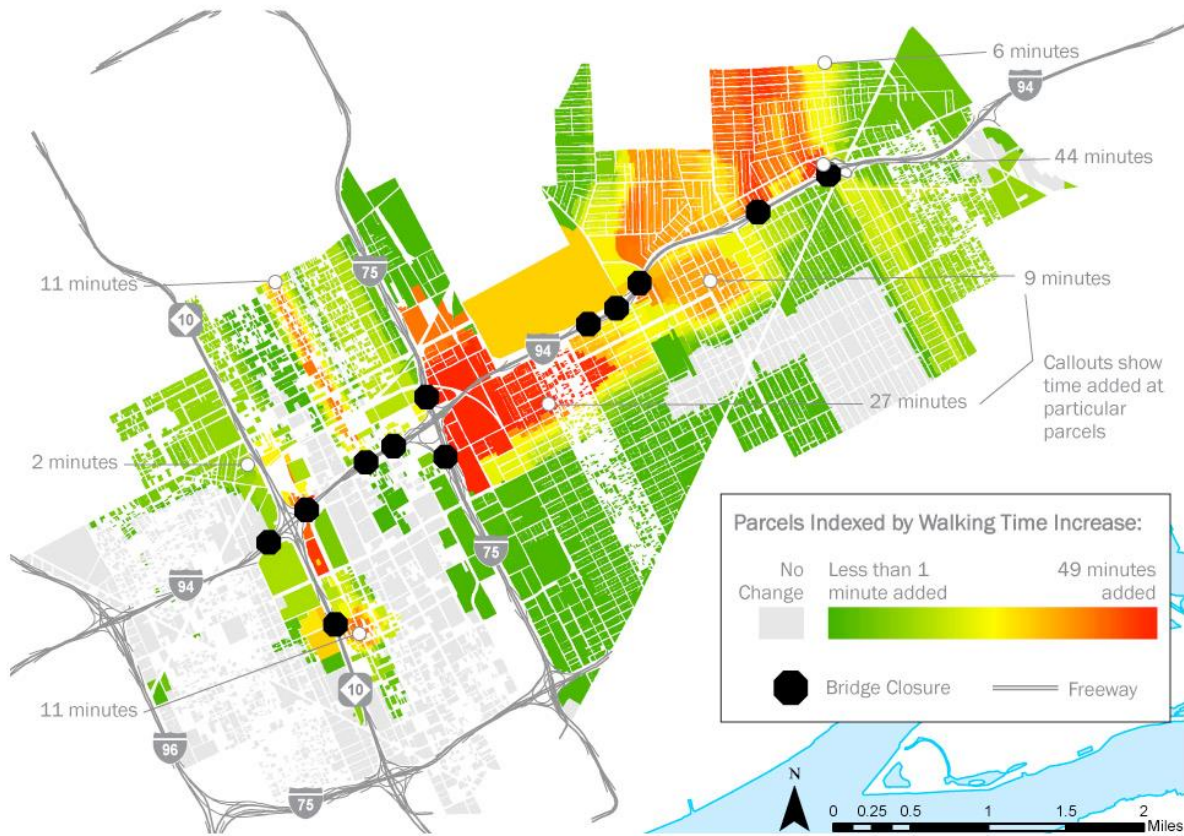


Map by H. Kelley, K. Moss, L. Reigstad, C. Tso, December 2013. Data Sources: 2007-2011 ACS 5-year Estimates, Table B17001, U.S. Census Bureau; 2010 TIGER shapefiles, U.S. Census Bureau; 2013 Michigan Geographic Framework.

Figure 5

## Interstate 94 Expansion Project in Detroit

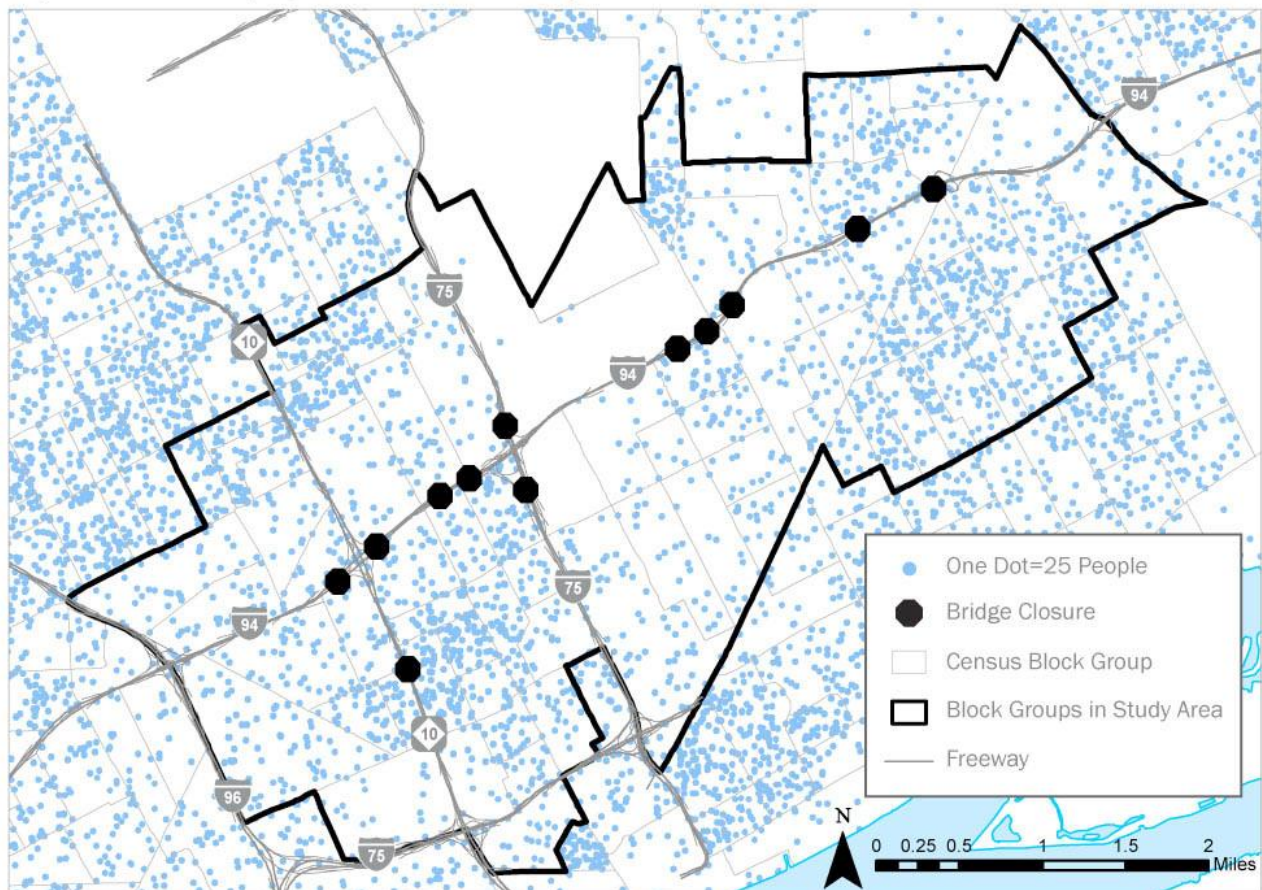
Total Walking Time Increase to all Neighborhood Facilities after Bridge Closures



Map by H. Kelley, K. Moss, L. Reigstad, C. Tso, December 2013. Data Sources: 2013 Michigan Geographic Framework; University of Michigan SAND Lab.



### Population Density by Census Block Group, Detroit MI 2010



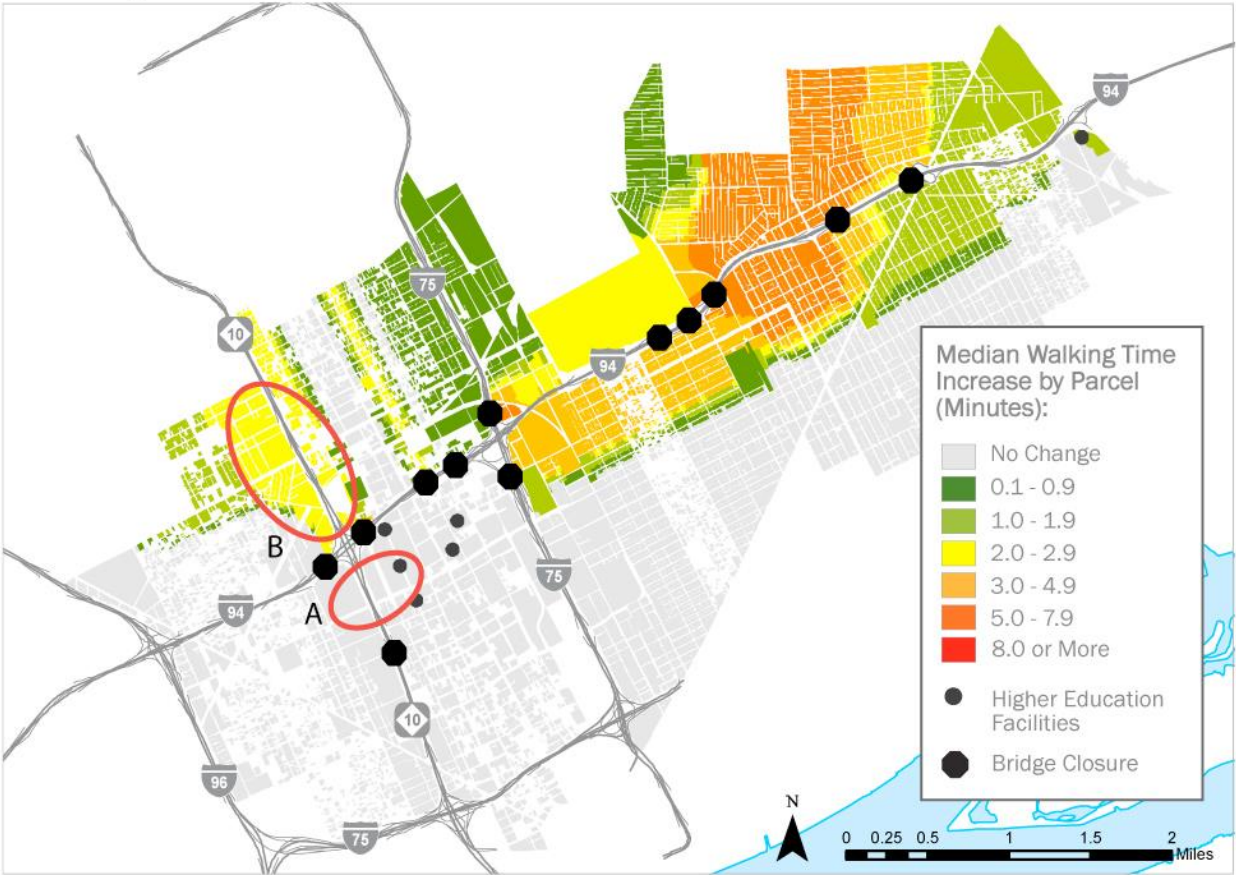
Map by H. Kelley, K. Moss, L. Reigstad, C. Tso, December 2013. Data Sources: 2010 Decennial Census, Table P1, U.S. Census Bureau; 2010 TIGER shapefiles, U.S. Census Bureau; 2013 Michigan Geographic Framework.

Figure 7

| <i>Minute Increase</i> | <i>Non-vacant Parcels</i> | <i>Percentage</i>    |
|------------------------|---------------------------|----------------------|
| No change              | 6809                      | 21.13%               |
| 0- 4.9                 | 16405                     | 50.91%               |
| 5-9.9                  | 5475                      | 16.99%               |
| 10-19.9                | 2614                      | 8.11%                |
| 20-29.9                | 864                       | 2.68%                |
| 30-39.9                | 49                        | 0.15%                |
| 40-49.9                | 7                         | 0.02%                |
| <b>Total:</b>          | <b><u>32222</u></b>       | <b><u>100.0%</u></b> |

Table 1 – Number of parcels falling within each range of walking time change, listed by percent of total parcels.

Median Walking Time Increase to all Higher Education Facilities  
after Bridge Closures, Detroit 2013

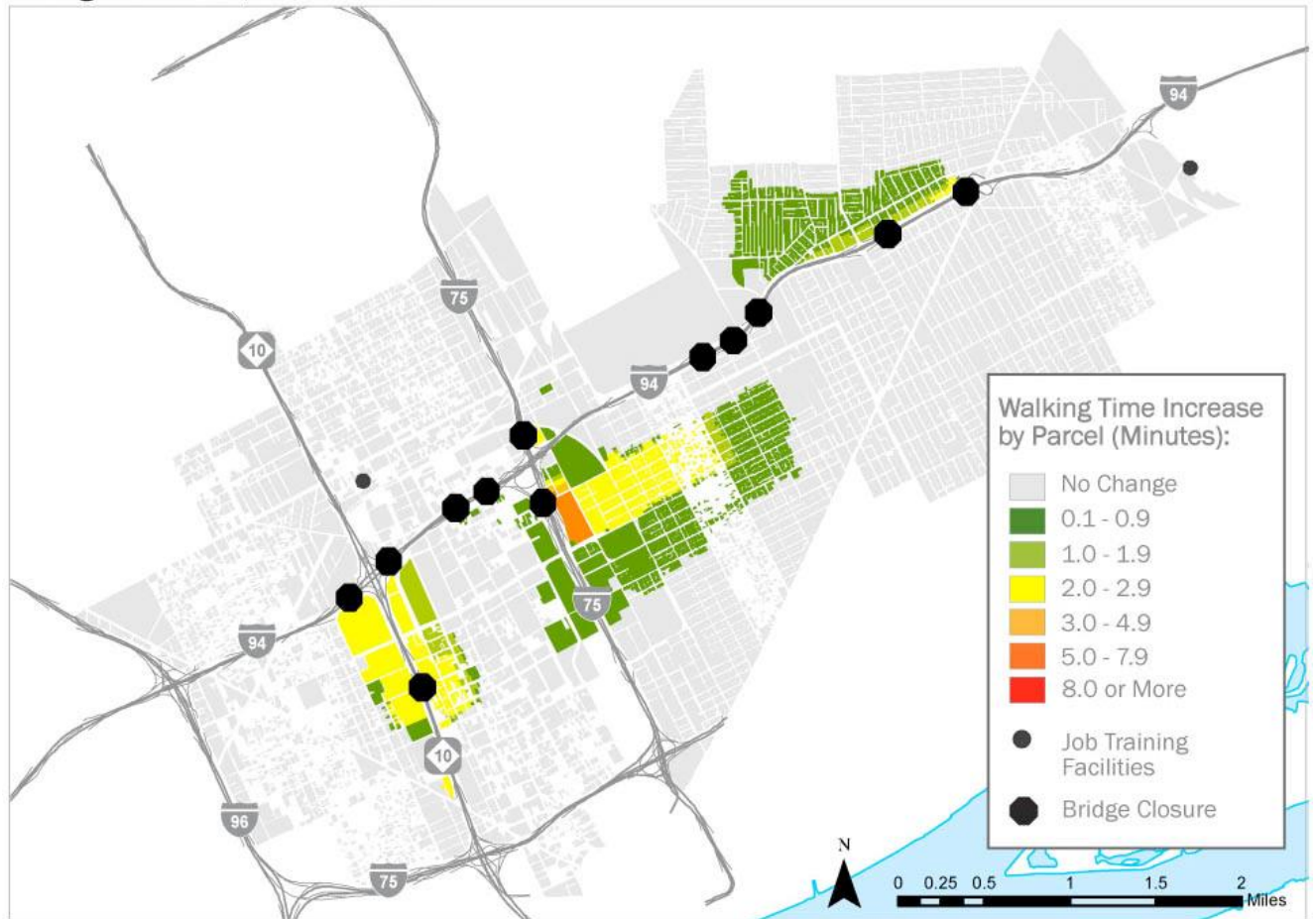


Map by H. Kelley, K. Moss, L. Reigstad, C. Tso, December 2013. Data Sources: 2010 TIGER shapefiles, U.S. Census Bureau; 2013 Michigan Geographic Framework; University of Michigan SAND Lab.

Figure 8



# Walking Time Increase to Closest Job Training Facility after Bridge Closures, Detroit 2013



Map by H. Kelley, K. Moss, L. Reigstad, C. Tso, December 2013. Data Sources: 2010 TIGER shapefiles, U.S. Census Bureau; 2013 Michigan Geographic Framework; University of Michigan SAND Lab.

Figure 9

# Walking Time Increase to Closest Recreation Center after Bridge Closures, Detroit 2013



Map by H. Kelley, K. Moss, L. Reigstad, C. Tso, December 2013. Data Sources: 2010 TIGER shapefiles, U.S. Census Bureau; 2013 Michigan Geographic Framework; University of Michigan SAND Lab.

Figure 10