TRANSPORTATION RESEARCH SUMMARY

This document summarizes transportation research addressing issues raised by the Transportation Chapter staff team and the Transportation Committee for use in drafting the Comprehensive Plan update. It is to be used in conjunction with the maps and the Roadway Safety Plan report provided separately. Please note that the research here is hardly exhaustive does not necessarily definitively answer the questions raised, but hopefully it at least informs those issues. Also, it does not include all research collected – it focuses on the most relevant and reliable research among the many documents we reviewed. Finally, it should be noted that other knowledge has been brought into the policy analysis via the staff team's professional expertise – the research here focuses more on emerging topics of concern.

CONTENTS

ROADWAY SAFETY

In January 2016, MnDOT released its "Roadway Safety Plan" for Saint Paul, a consultant-produced document with City of Saint Paul staff participation that was designed to address:

1. Identifying crash types that represent the greatest opportunity for the reduction of fatalities and severe injuries.
2. Identifying strategies that have demonstrated a high level of effectiveness at mitigating the priority crash types.
3. Identifying locations along the city's system that are most at-risk for the priority crash types and are therefore the highest priority candidates for safety investments.

Their approach proactively focused on "at-risk" situations rather than actual crash history because of the irregular nature of severe crashes. Indeed, severe crashes are largely predictable based on design and other roadway attributes.

Research findings:

- Saint Paul averaged almost 60 severe crashes per year from 2009-2013.
- 39% of severe crashes were on municipal streets, 36% on Ramsey County roads, and 25% on state highways.
- 91% of severe crashes were on arterials and collectors, though they represent only 21% of roadway mileage in the city.
- A majority of severe intersection-related crashes occurred at locations with traffic signal control and with 15,000+ ADT on the approaching streets.
- The most common types of severe crashes involved pedestrians/bicycles or right angle (T-bone) collisions.
- Of severe crashes on municipal streets, 50% were on 2-lane streets, 28% on 4- to 6-lane undivided streets, and 2% on 3-lane streets.
- Based on design and situation, the following corridors present the greatest opportunities to reduce the number of severe crashes (5% of city streets, could address 36% of severe crashes):
    - Arcade Street
    - Como Avenue
    - Cretin Avenue
    - Edgecumbe Road
    - Fairview Avenue
    - Johnson Parkway
    - Kasota Avenue
    - Kellogg Boulevard
    - Payne Avenue
    - Ruth Street
    - Selby Avenue
    - Third Street

- Ames/Hazelwood Avenue
- Arlington Avenue
- Case Avenue
- Clarence Street
- Earl Street
- Grand Avenue
- Hamline Avenue
- Prior Avenue
- Suburban Avenue
- Western Avenue

- The types of safety projects recommended include:
  - Improving pedestrian safety (primarily at intersections)
  - Reducing the frequency of red light violations at traffic signals
  - Improving the safety characteristics of undivided streets

The specific safety improvement strategies could include:

Table 3-1. Urban Infrastructure-based Safety Strategies

Strategy	Crash Reduction Factor	Typical Installation Cost
Road Diet (convert to three-Lanes)	30 percent to 50 percent	$160,000/Mile
Access Management	5 percent to 30 percent	$360,000/Mile
Traffic Signal Confirmation Lights	25 percent to 85 percent (violations)	$2,500/Intersection
Pedestrian/Bike – Countdown Timer	25 percent	$12,000/Intersection
Pedestrian/Bike – Leading Pedestrian Interval	30 percent to 45 percent	$600/Intersection
Pedestrian/Bike – Curb Extensions	40 percent to 45 percent	$36,000/Corner
Pedestrian/Bike – Median Refuge Island	40 percent to 45 percent	$25,000/Approach

Note: An expanded discussion of driver-behavior strategies is provided in the Section 5, Beyond Infrastructure.

Source: FHWA 2015

See the full Roadway Safety Plan document provided separately for more details.

TRUE CAPACITY OF A 3-LANE ROAD

Academic research, which MnDOT cites in their policy documents, suggests that 3-lane roads can handle up to about 17,500 ADT. Based on this, MnDOT allows converting 4-lane state (or state aid) roads to 3-lane designs when there are 15,000 or fewer vehicles per day, or more than that if the requestor can prove via a capacity analysis that Level of Service (LOS) D or better will be maintained. However, other places (notably Seattle)

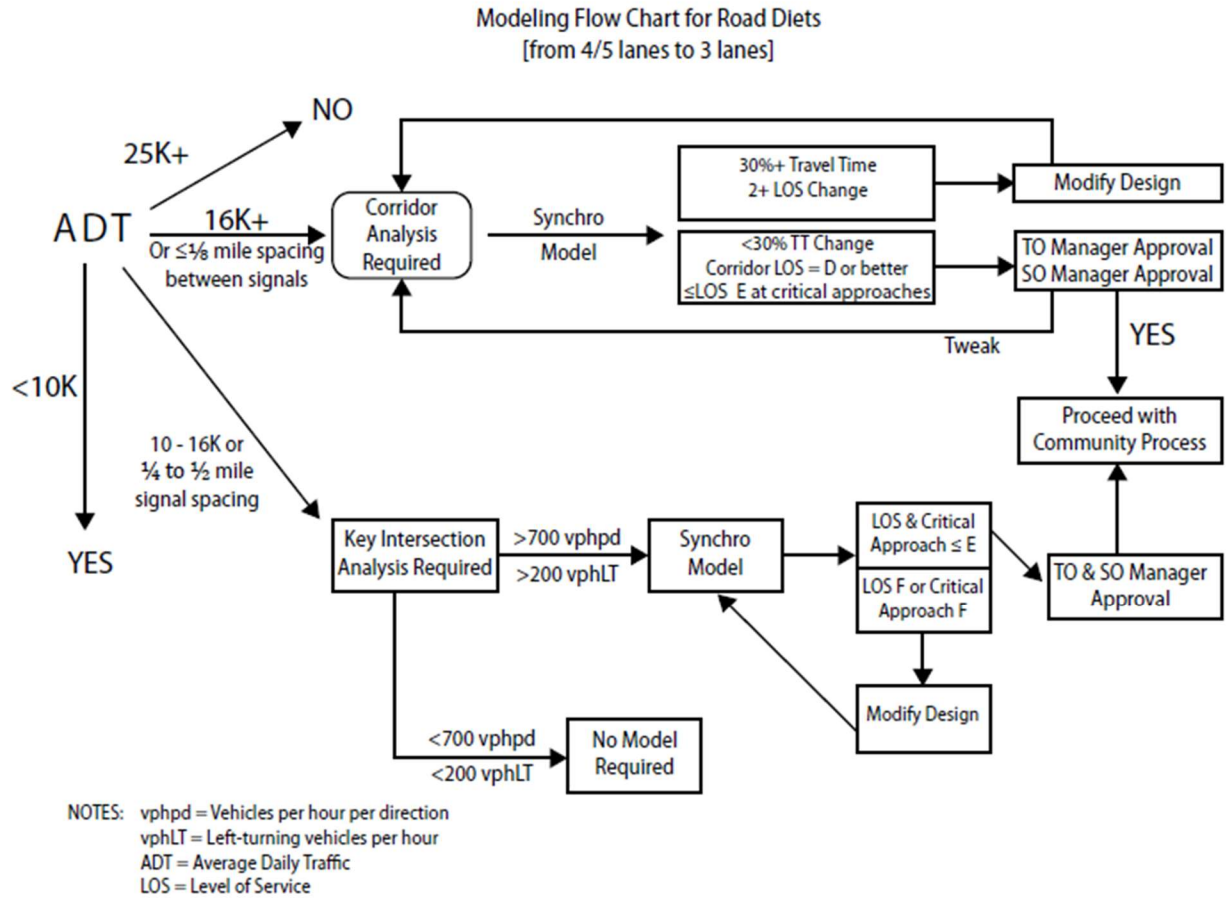
consider 4- to 3-lane conversions for roads with much higher ADT, such as Rainier Avenue (see its 1-year evaluation for details).

The experience of City of Saint Paul staff is that the number of access points and the types of vehicles (especially transit) play a very significant role in the viability of a 4- to 3-lane conversion. Thus, ADT alone is far from sufficient to make decisions on such conversions – a more contextually based analysis is required.

The Federal Highway Adminstration (FHWA) says this about ADT for "road diets" (4- to 3-lane conversions):

> The ADT provides a good first approximation on whether or not to consider a Road Diet conversion. If the ADT is near the upper limits of the study volumes, practitioners should conduct further analysis to determine its operational feasibility. This would include looking at peak hour volumes by direction and considering other factors such as signal spacing, turning volumes at intersections, and other access points. Each practitioner should use engineering judgment to decide how much analysis is necessary and take examples from this report as a guide.
>
> - A 2011 Kentucky study showed Road Diets could work up to an ADT of 23,000 vehicles per day (vpd).[35]
>
> - In 2006, Gates, et al. suggested a maximum ADT of between 15,000 and 17,500 vpd.[36]
>
> Knapp, Giese, and Lee have documented Road Diets with ADTs ranging from 8,500 to 24,000 vpd.[37] The FHWA advises that roadways with ADT of 20,000 vpd or less may be good candidates for a Road Diet and should be evaluated for feasibility. Figure 12 shows the maximum ADTs used by several agencies to determine whether to install a Road Diet. Road Diet projects have been completed on roadways with relatively high traffic volumes in urban areas or near larger cities with satisfactory results.
>
> http://safety.fhwa.dot.gov/road_diets/info_guide/ch3.cfm

Seattle, as quoted in the above FHWA guidance, uses a complicated system to evaluate road diet feasibility, which starts with the benchmark of 25,000 ADT. Though they require LOS D in general, they allow LOS E at critical approaches under certain circumstances.



HEALTH IMPACTS OF TRANSPORTATION

From a 2016 report by Arup on health and mobility:

Road injuries are the eighth-leading cause of death globally and they are the biggest cause of death for people aged 15 to 25. Poor traffic policies and infrastructure, such as unsafe pedestrian crossings can lead to accidents. Human behaviours, such as excessive speeding and alcohol consumption, are responsible for 90% of road fatalities. Pedestrians are the most likely road users to be killed in road accidents and chances for their survival decrease with increasing vehicle speed. Roads with speed limits of 20 mph are the safest, with only 5% of pedestrians likely to die from collision with a vehicle at this speed. In collisions at 30mph, about half of pedestrians die, with fatalities rising to 95% at 40mph.

Areas where residents tend to drive less and rely on alternative modes have lower traffic fatality rates than more automobile dependent communities. Research shows that presence of more pedestrians and cyclists on the street is associated with a reduced risk of motor vehicle collision, suggesting that motorists drive more cautiously due to increased awareness of high levels of pedestrian/cycling activities51. Increased walking, cycling and public transport appears to increase overall security of places and reduce crime rates by providing passive surveillance of city streets and transit waiting areas.

Transport systems are a great contributor to air pollution through vehicle emissions. Ambient air pollution was linked to 3.7 million premature deaths globally in 2012 and 40,000 deaths annually in the UK54. Vehicle emissions contribute substantially to air pollution through nitrogen oxides (NOx), particulate matter (from road dust, brake linings and tire wear) and volatile organic compounds. Air pollution, amongst tobacco smoking, allergens and occupational risks, is considered a primary risk factor for chronic respiratory conditions and is closely associated with increased incidences of cancer.

People living near major roads with heavy traffic experience constant traffic noise and can suffer from sleep deprivation and annoyance as well as stress and depression. Traffic noise can be reduced through quieter road surfaces such as porous asphalt which is considered to reduce noise by 4–8 dB, roughly the same effect as reducing traffic volume by half.

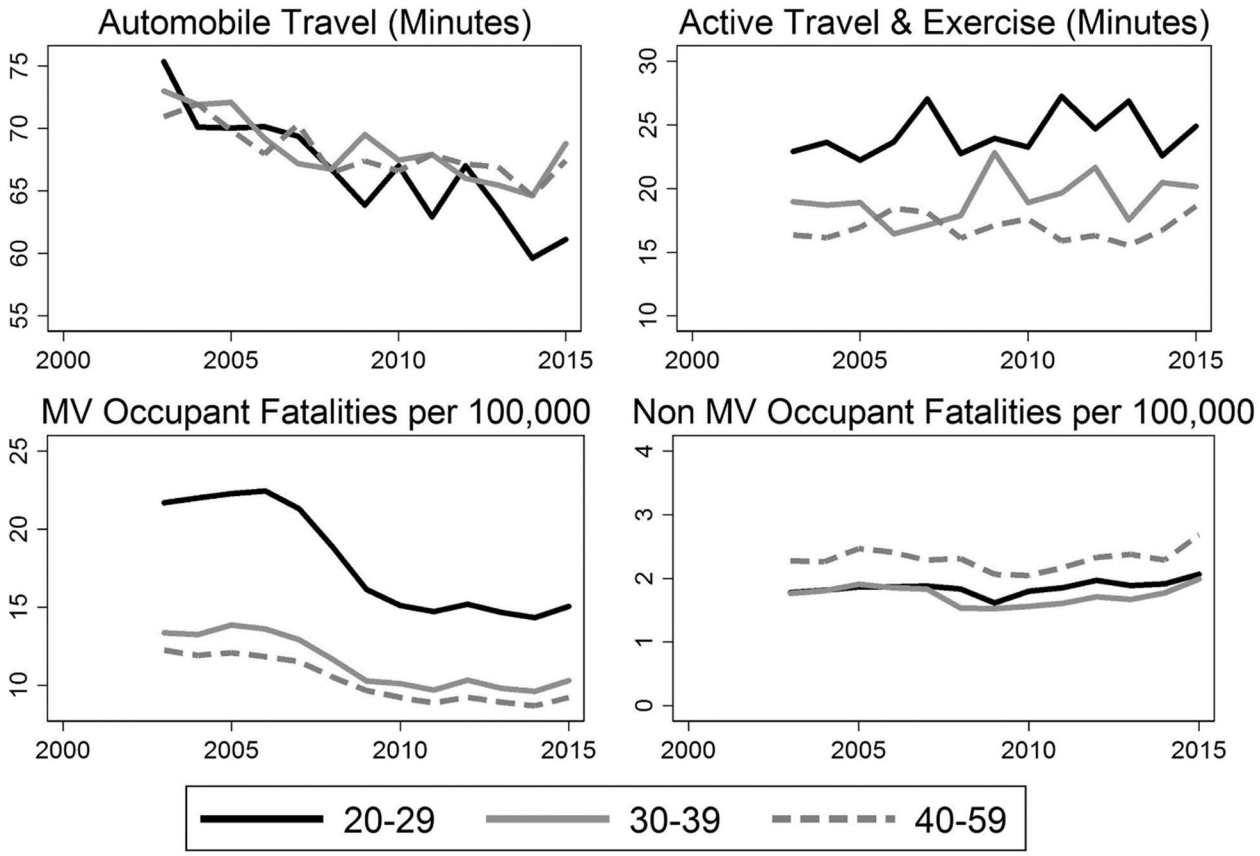
Heavy traffic is also linked to community severance, reduced social interaction and inability to access social services and support. Young and older residents of streets with light traffic reported twice as many acquaintances and friends on their street than residents of streets with heavy traffic. In addition, heavy traffic results in a feeling of 'reduced ownership' of streets, which can be prevented by better street design, promoting socialising among residents38. A meta-analysis on the links between social relationship and mortality found that the quality and quantity of social relationships influences mortality to the extent comparable with well-established risk factors such as smoking and alcohol consumption. Different transport modes can also aid the social interactions and cohesion through direct contact alongside the possibilities of people meeting and socializing.

Research has suggested correlations between travel mode and stress levels with several studies indicating that commuting by automobile generally appears to be more stressful than travelling by other modes. This stress appears to be attributable to factors outside the driver's control including traffic delays, unpredictable behaviours of other drivers, anxiety and time pressures.

http://publications.arup.com/~/media/Publications/Files/Publications/H/Health_and_Mobility_051016.ashx

EFFECT OF VMT ON ROAD SAFETY

Decreased VMT per person has mirrored a corresponding drop in time spent on automobile travel. In certain age groups, these decreases roughly correlate to the positive effect on vehicle occupants' safety, but appears to have no effect on non-occupants' safety in the roadway. That is, no effect on pedestrian and bicycle crashes. (Noreen McDonald. "Trends in Automobile Travel, Motor Vehicle Fatalities, and Physical Activity: 2003-2015." *American Journal of Preventative Medicine*, published online February 9, 2017.)



BIKE AND PEDESTRIAN COUNTS

2013 and 2014 reports available here: https://www.stpaul.gov/departments/public-works/bicycles/bicycle-traffic-count . Highlights from the most recent report in 2014:

Top 2014 Bicycling Locations

(Location totals reflect tabulated 2-hour peak counts)

1. Marshall Ave Bridge (347)
2. Ford Parkway Bridge (249)
3. Summit Ave east of Fairview Ave (232)
4. Mississippi River Blvd south of Jefferson (217)
5. U of M Transitway west of Energy Park Dr (192)
6. Marshall Ave west of Cleveland Ave (150)
7. Summit Ave east of Dale St (120)
8. Summit Ave east of Western (119)
9. Raymond Ave south of Como Ave (86)
10. Energy Park Dr southwest of U of M Transitway (79)

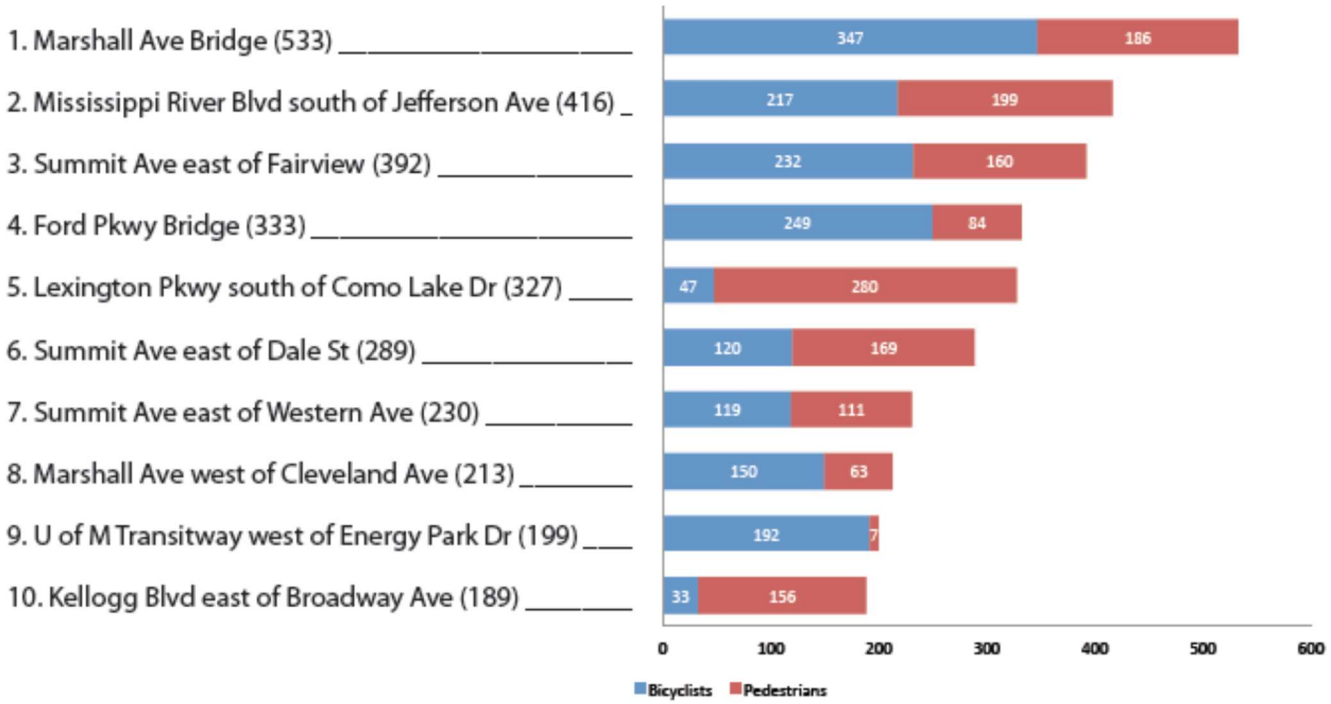
Top 2014 Walking Locations

(Location totals reflect tabulated 2-hour peak counts)

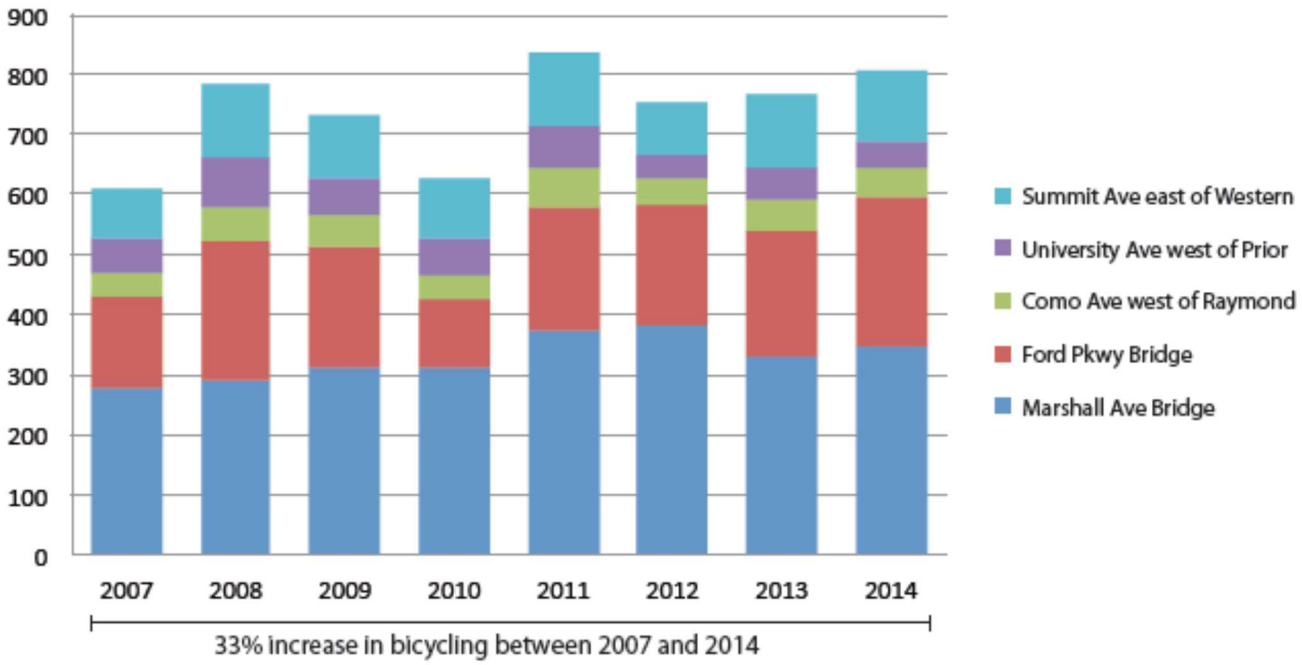
1. Lexington Pkwy south of Como Lake Dr (280)

2. Mississippi River Blvd south of Jefferson (199)
3. Marshall Ave Bridge (186)
4. Summit Ave east of Dale St (169)
5. Summit Ave east of Fairview (160)
6. Kellogg Blvd east of Broadway Ave (156)
7. Dale St north of Charles Ave (129)
8. Wabasha St Bridge (124)
9. Broadway Ave north of Kellogg Blvd (121)
10. Summit Ave east of Western Ave (111)

Top 2014 Total Non-Motorized Locations (Bicycle + Pedestrian Counts)
(Location totals reflect tabulated 2-hour peak counts)

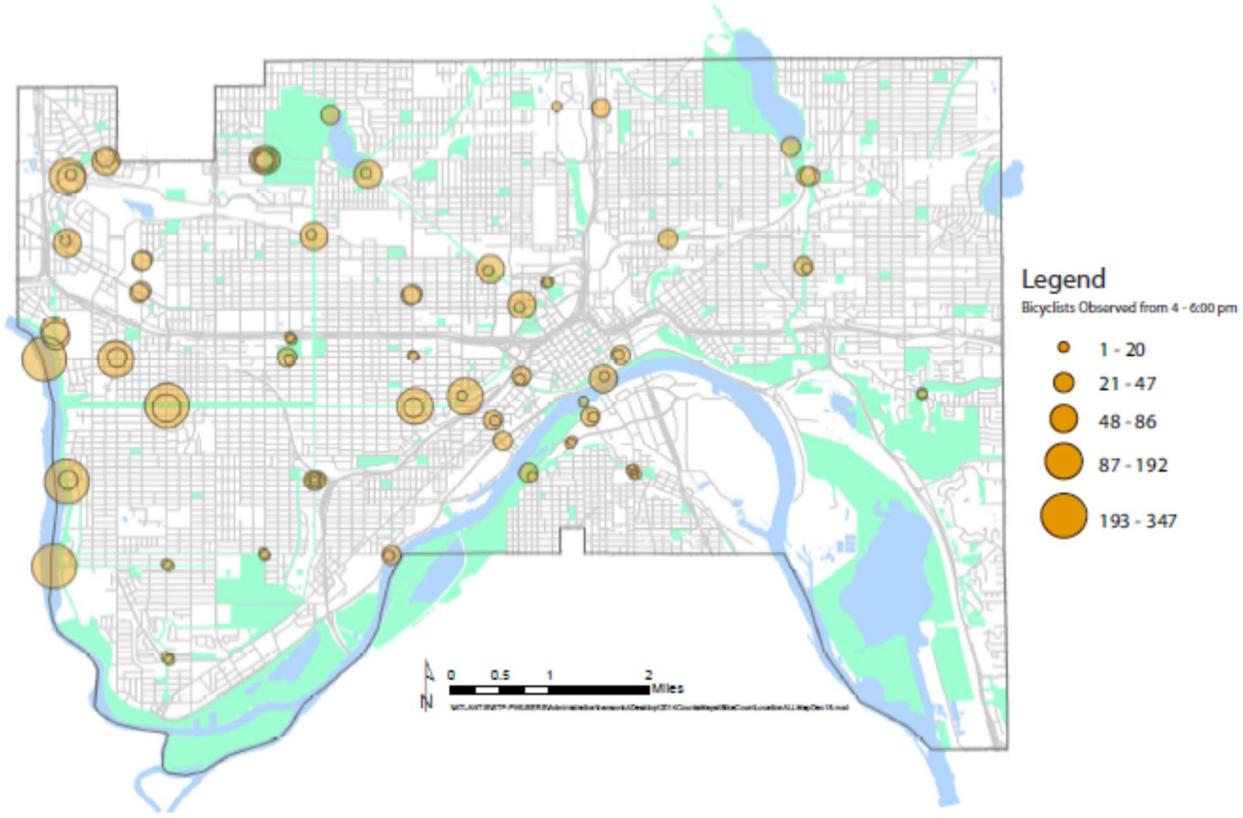


Bicycle Traffic at 5 Select Locations, 2007 - 2014*
(Location totals reflect tabulated 2-hour peak counts)

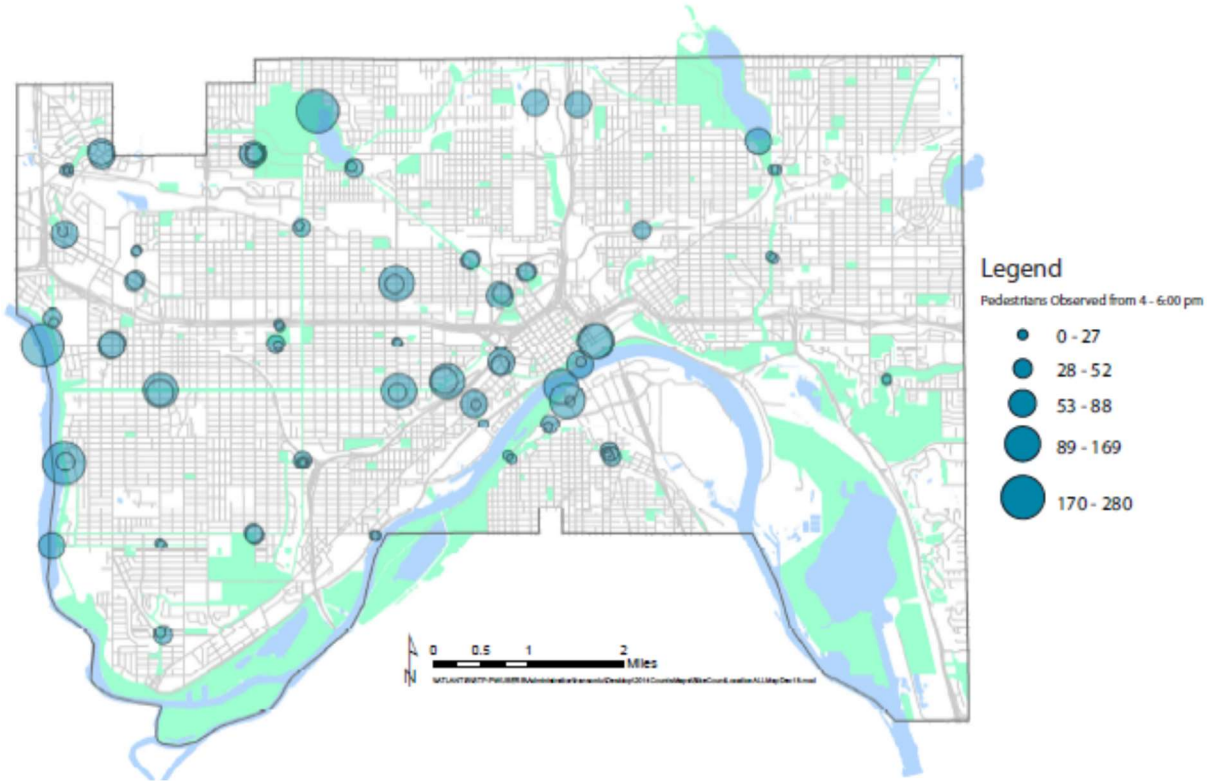


*(Locations recording the longest range of standardized annual count data in Saint Paul)

2014 Observed Peak Hour (4 - 6 p.m.) Bicycle Traffic



2014 Observed Peak Hour (4 - 6 p.m.) Pedestrian Traffic



Here's how St. Paul compares nationally according to the 2015 American Community Survey data, via the League of American Bicyclists (note that this measures bicycle commuting by our residents, not bicycling that occurs in the city for all purposes by all people):

THE LEAGUE OF AMERICAN BICYCLISTS since 1880

			Bike Commute Rate	*Percent Change in Bicycle Commuting*				
			2015	1990 to 2015	2000 to 2015	2005 to 2015	2010 to 2015	2014 to 2015
United States			0.60%	46.5%	56.7%	48.5%	13%	-3.8%
City	State	2015 Rank by Bike	2015	1990 to 2015	2000 to 2015	2005 to 2015	2010 to 2014	2014 to 2015
Portland	OR	1	7.0%	504.5%	297.3%	101.6%	18%	-2.3%
Minneapolis	MN	2	5.0%	207.8%	164.5%	106.2%	44%	7.6%
San Francisco	CA	3	4.3%	348.1%	116.8%	132.8%	24%	-1.8%
Washington	DC	4	4.1%	440.5%	252.4%	136.3%	31%	5.5%
Seattle	WA	5	4.0%	163.8%	113.0%	73.3%	10%	8.3%
New Orleans	LA	6	3.3%	261.9%	184.7%	241.9%	86%	-1.6%
Oakland	CA	7	2.9%	161.3%	137.2%	88.3%	62%	-20.8%
Tucson	AZ	8	2.4%	-14.3%	8.4%	7.2%	-19%	-31.6%
Philadelphia	PA	9	2.2%	285.3%	155.4%	147.4%	22%	14.4%
Denver	CO	10	2.1%	143.4%	120.7%	48.7%	-4%	-15.7%
St. Paul	MN	11	2.1%	313.5%	222.7%	201.5%	126%	41.4%
Sacramento	CA	12	1.9%	-0.1%	40.4%	8.4%	-24%	-0.7%
Chicago	IL	13	1.8%	541.4%	260.3%	167.9%	39%	5.8%
Honolulu	HI	14	1.8%	44.7%	44.6%	24.8%	11%	-8.0%
Pittsburgh	PA	15	1.7%	308.2%	284.6%	67.6%	4%	-16.6%
Boston	MA	16	1.6%	82.5%	64.7%	70.4%	13%	-33.6%

DRIVER'S LICENSE TRENDS

According to a 2016 University of Michigan study, the % of 20- to 24-year-olds in 1983, 2008, 2011, and 2014 with driver's licenses were 91.8%, 82.0%, 79.7%, and 76.7%, respectively.

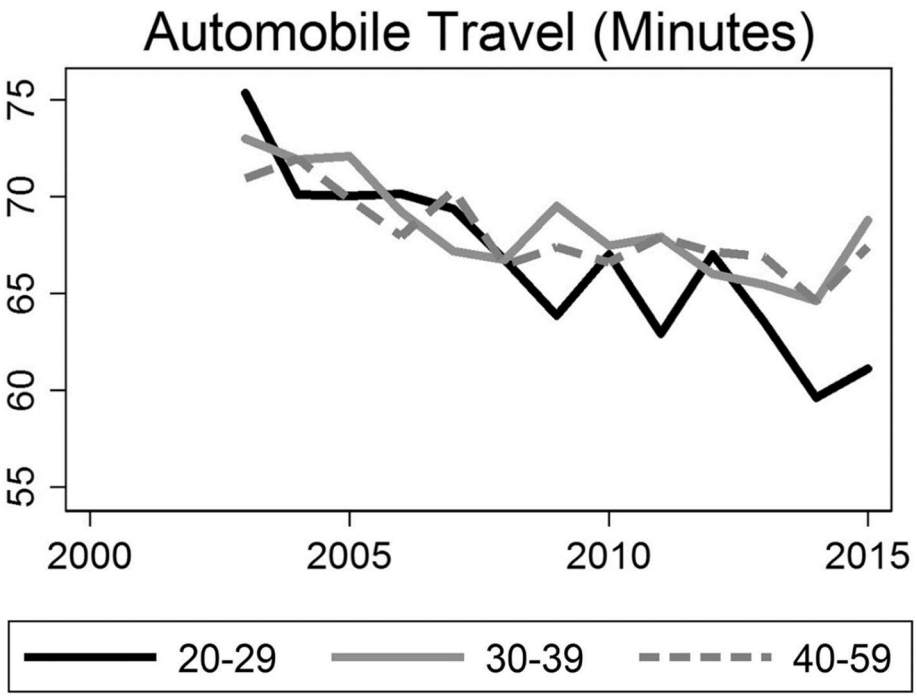
Met Council 2013 TBI report: Car Ownership and Number of Licenses In 2006 the total number of vehicles in the US was greater than the number of licensed drivers, with a peak of 1.24 vehicles per licensed driver. Since then, vehicle ownership per licensed driver has declined by 4 percent.

Also decreasing is the percentage of the population holding a driver's license. From 1992 to 2011 there was a 4 percent decline in the number of people holding a driver's license, from 90 percent to 86 percent of those within the driving age (16 and older). Many young people are postponing getting their licenses for a variety of reasons, including, decreased disposable income largely due to the recession, and a desire to live in denser communities with access to transit and the options of walking and biking. (Provide entire report.)

VMT TRENDS

VMT Trends data for the nation, the metro area, and Saint Paul are provided in this section.

Nationally, per capita VMT decreased in multiple age groups from 2003 to 2015. (Noreen McDonald. "Trends in Automobile Travel, Motor Vehicle Fatalities, and Physical Activity: 2003-2015." *American Journal of Preventative Medicine*, published online February 9, 2017.)



I. Minnesota Go Report

Figure 4: Per capita vehicle miles traveled in the Twin Cities Metro

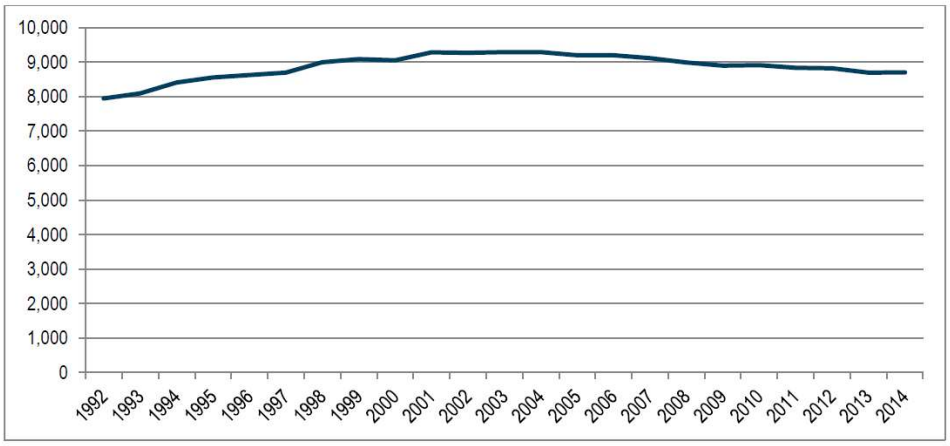


Figure 5: Transit ridership in the Twin Cities Metro (in millions), 2003 – 2014[13]

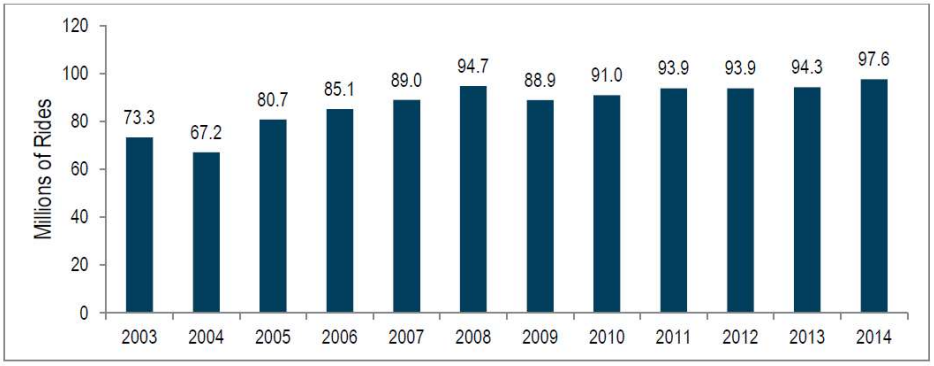
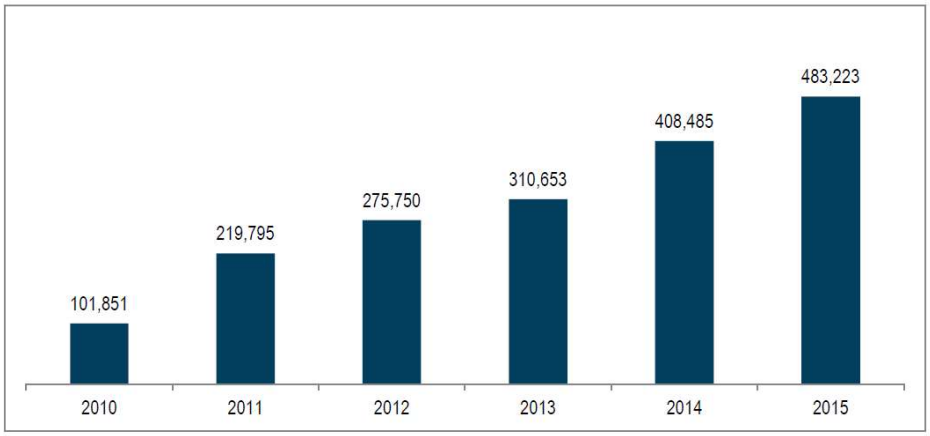


Figure 6: Nice Ride Minnesota total trips taken, 2010 – 2015[24]



Driving

The **general decline in per-capita auto usage** in the Twin Cities metro has continued since 2004, though a slight uptick in 2014 per-capita VMT may suggest that we have reached the end of year-over-year

declines, as is shown in Figure 4. Carpooling rates to work have remained consistent at about 8.4 percent.

Transit

Transit ridership has increased by roughly 24 million rides per year in the Twin Cities since 2003. The increase in demand for public transportation systems has been driven by multiple demographic groups. **Transit is needed to support aging baby boomers**, many of whom will reduce their driving as they continue to age.

Some literature suggests that younger generations may be pursuing car free lifestyles in urban settings, and are reducing their overall dependence on the automobile. It is uncertain whether this trend may be due in part to a recent weak job market for college graduates and larger student loan debt burdens, affecting young adults' ability to afford cars and homes. Nonetheless, this trend may result in **an increase in transit ridership among young, college-educated adults**. The influx of people moving into urban areas also creates a larger demand for transit accessibility with population density in urban areas. An increase in investment and expansion of transit systems will likely be needed in the future to keep up with demand.

Transit ridership in the Minneapolis-St. Paul region rose dramatically in 2014, up 3.5 percent over 2013, which may be partially explained by the opening of Metro Transit's Green Line between Downtown Minneapolis and Downtown Saint Paul. Light rail transit provides a high quality alternative to automobile travel and decreases personal transportation costs in areas close to stations for those who use transit service when compared to automobile usage. The Green Line carried 6.5 million riders during the 7 months that it was operating in 2014. Metro Transit's other light rail line, the Metro Blue Line, carried 9.5 million riders in 2014 – 11.2 percent of Metro Transit's total 2014 ridership. Recent estimates show that light rail accounts for about 20 percent of all transit trips taken in the Twin Cities.

Walking and Biking

Rates of walking and bicycling both increased in the Twin Cities from 2001 to 2010. Overall, two percent of trips in the Twin Cities are completed by bike, while 6 percent are completed on foot. In Minneapolis**, the number of regular bicycle commuters more than doubled in less than two decades**, from around 3,000 in 1993 to 7,000 in 2010. Widespread facility improvements mean that access to bike lanes is no longer a significant factor associated with likelihood of bicycling in Minneapolis and many other cities and towns.

Bike sharing has continued to grow since it was introduced in the Twin Cities. Nice Ride Minnesota has seen increased ridership every year since its launch in 2010, as is shown in Figure 6.

Increases in walking can be seen in certain demographic groups, including aging residents who may choose to move to areas that are walkable to reduce the amount that they need to drive. There is a debate as to whether people are actively seeking to live in communities that facilitate car free living. Existing information shows that **property values are higher in areas with stronger Walk Scores** (a proprietary system that analyzes routes from one address to local amenities and provides a score based

on how many are within a walkable distance), perhaps indicating that there is, in fact, **higher demand for homes within short distance of walkable amenities**

In St. Paul, on our 786 stretches of arterials and collectors with traffic counts data, AADT increased by 2,010,596 vehicles from 2008 to 2015, an average increase of 2,558 per road segment. The increase from 2012 to 2015 was greater: 2,883,796 vehicles, an average increase of 3,669 per road segment. The drop from 2008 to 2012 was probably related to the economic recession.

AGE AND TRANSPORTATION MODE

While the personal vehicle (car) is still the primary mode of transportation for all age groups, the literature agrees that millennials use public transportation and active transportation more frequently than other generations. Likewise, older adults (70+) use public transportation more frequently than middle-aged adults, who rely heavily on cars. The literature does not agree on whether the trend of increased demand for public transportation amongst millennials will persist as millennials age into older adults.

Arguments that trend will persist:

- The latest generation of young adults is marrying later, pursuing higher education, prefers lively cities over suburbs, and gets around on foot, by bike, in public transit, and by Lyft and Uber, in addition to driving their own cars
- Millennials have lower rates of driver licenses
- Millennials tend to be less enamored of the suburban, auto-oriented lifestyles favored by their parents
- Millennials prefer slower public transport modes when given the choice, which allow them to use travel time for digital pursuits instead of driving

Arguments that trend will not persist:

- Life cycle factors common among young people increase public transit usage but these factors are unlikely to persist as they age
- Young people live in urban areas and have increased access and utility for public transportation

Key Facts:

- Primary mode of transportation for all age groups is the car
- Biking and walking have increased for all age groups
- Millennials are more likely to use multiple transportation modes. According to a survey of Millennials in six urban areas, 69 percent of respondents said they use multiple transportation modes to reach a destination at least a few times per week. Millennials in these cities average three modes per trip.
- The proportion of young adults with a driver's licenses has decreased considerably in the past 25 years. Millennials also have lower rates of vehicle registration and car ownership, and increased rates of public transport usage.
    - Census data show that the share of 16 to 24 year-olds traveling to work by car declined by 1.5 percentage points between 2006 and 2013, while the share of young people getting to work by public transportation, on foot or by bicycle, or else working from home, had increased.
- The number of daily auto trips has decreased for all ages, and is lower for millennials and older adults (70+) than for middle-aged adults. This hasn't been accompanied by a significant increase in other mode of travel, meaning young people are going fewer places.
    - Between 2001 and 2009, the average number of miles driven by 16 to 34 year-olds dropped by 23 percent, as a result of young people taking fewer trips, shorter trips, and a larger share of trips by modes other than driving. Older adults (70+) also take fewer trips, travel shorter distances, and

have shorter travel times. They are also least likely to use public transit (e.g. bus, rail), walking, and bicycling modes to travel.

- U.S. drivers under age 30 accounted for 13.7 percent of total U.S. miles driven in 2009, compared with 20.8 percent in 1995

Noreen C. McDonald found (in a 2015 JAPA article) that Millennials have reduced driving by about 7 to 8% from 1995 to 2009, with these additional findings:

- Declining travel is due to changing attitudes and perspectives about driving as well as lifestyle changes such as increased schooling, decreased employment, and delay in marriage and childbearing.
- The decrease in driving has not been accompanied by an increase in other modes of travel or a decline in average trip length, meaning that younger Americans are increasingly going fewer places. Among young adults, lifestyle shifts such as decreased employment and delayed household formation explain 10% to 25% of declining automobility; changes specific to young adults such as increased online interaction and differing attitudes to mobility account for 35% to 50% of the change; and the remaining decrease, 40%, is due to a general decline in travel experienced by all Americans in the late 2000s.

ECONOMIC AND HEALTH IMPACTS OF BIKING

MnDOT study shows economic, health benefits of bicycling in Minnesota

A recent University of Minnesota study funded by MnDOT shows the economic significance of the bicycling industry and events in Minnesota, bicycling infrastructure use across the state, and the health benefits associated with bicycle commuting.

“MnDOT has long identified bicycling as an important part of the state’s multimodal transportation system,” said Tim Henkel, modal planning and program management assistant commissioner. “This first-ever study generated new information that will inform policy and program strategies on bicycling as we determine levels of future investment.”

The study shows that in 2014, the bicycling industry generated $778 million of economic activity, which includes $209 million of labor income and 5,519 jobs. Nearly 80 percent of that economic activity came from manufacturing and wholesale business.

Minnesota communities host more than 100 bicycle events annually and bring an estimated 50,212 visitors to the state. Trail rides, races, mountain bicycling events and bicycle tours generated $14.3 million of economic activity, which included $4.6 million in

labor income and 150 jobs, the study found.

To estimate the use of bicycling infrastructure, researchers looked at the use of trails and other facilities to quantify demand for bicycling in the state. They found that between 87 million and 96 million bicycle trips are made annually for commuting, recreation and other purposes.

“These estimates will help state and local policy makers and transportation planners and engineers build a safe, sustainable transportation system that meets the needs of Minnesota residents in the 21st century,” said Henkel. “We also know that safer bicycling infrastructure and networks will lead to more people bicycling and bicycling trips.”

The study found that bicycle commuting in the Twin Cities Metropolitan Area prevents 12 to 61 deaths per year, saving between $100 million and $500 million. Bicycle commuting lowers the risk of many diseases, but most significantly obesity, hypertension, heart disease and diabetes.

“These study findings tell a compelling story for the positive effects of bicycling and provide direct evidence that supports the efforts to promote bicycling related industry, infrastructure, events and activities,” said Henkel.

The “Assessing the Economic Impact and Health Effects of Bicycling in Minnesota” study was funded by MnDOT with research conducted by the University of Minnesota’s Tourism Center, School of Public Health, Extension and the Humphrey School of Public Affairs.

Read the study here.

Assessing the Economic Impact and Health Effects of Bicycling in Minnesota

December 2016

By Xinyi Qian, Neil Linscheid, Brigid Tuck, Greg Lindsey, Jessica Schoner, Mark Pereira, Aaron Berger

This project estimated the economic impact of the bicycling industry and events in Minnesota, estimated bicycling infrastructure use across the state, and assessed the health effects of bicycling in the Twin Cities metropolitan area (TCMA). A survey of bicycling-related manufacturers, wholesalers, retailers, non-profit and advocacy groups found the industry produced a total of $779.9 million of economic activity in 2014. Using data from multiple sources, the number of bicycle trips in Minnesota was estimated to be between 75.2 and 96 million annually. The TCMA accounts for 69%-72% of the total number of trips and miles traveled in Minnesota. Bicycling events, including races, non-race rides, fundraising events, mountain bicycling events, high school races, and bicycle tours,

produced a total of $14.3 million of economic activity in 2014. All six types of bicycling events mainly attract white, non-Hispanic male participants. “Riding my bicycle” was the most frequently identified reason to attend an event (except for fundraising event participants), and there is a variety of enjoyable attributes that differed across event types. Overall, respondents were satisfied with the events. Bicycle commuting prevents 12 to 61 deaths per year, saving $100 million to $500 million. Bicycle commuting three times per week is also linked to 46% lower odds of metabolic syndrome, 32% lower odds of obesity, and 28% lower odds of hypertension, all of which lower medical costs. Project findings tell a compelling story for the positive effects of bicycling and provide direct evidence that supports the efforts of promoting bicycling-related industry, infrastructure, events, and activities.

http://mndot.gov/research/reports/2016/201636.pdf

WHAT ARE THE IMPACTS OF MOTOR VEHICLE CRASHES?

According to a NHTSA study: In 2010, there were 32, 999 people killed, 3.9 million were injured, and 24 million vehicles were damaged in motor vehicle crashes in the United States. The economic costs of these crashes totaled $242 billion. Included in these losses are lost productivity, medical costs, legal and court costs, emergency service costs (EMS), insurance administration costs, congestion costs, property damage, and workplace losses. The $242 billion cost of motor vehicle crashes represents the equivalent of nearly $784 for each of the 308.7 million people living in the United States, and 1.6 percent of the $14.96 trillion real U.S. Gross Domestic Product for 2010. These figures include both police-reported and unreported crashes. When quality of life valuations are considered, the total value of societal harm from motor vehicle crashes in 2010 was $836 billion. Lost market and household productivity accounted for $77 billion of the total $242 billion economic costs, while property damage accounted for $76 billion. Medical expenses totaled $23 billion. Congestion caused by crashes, including travel delay, excess fuel consumption, greenhouse gases and criteria pollutants accounted for $28 billion. Each fatality resulted in an average discounted lifetime cost of $1.4 million. Public revenues paid for roughly 7 percent of all motor vehicle crash costs, costing tax payers $18 billion in 2010, the equivalent of over $156 in added taxes for every household in the United States. Alcohol involved crashes accounted for $52 billion or 22 percent of all economic costs, and 84 percent of these costs occurred in crashes where a driver or non-occupant had a blood alcohol concentration (BAC) of .08 grams per deciliter or greater. Alcohol was the cause of the crash in roughly 82 percent of these cases, causing $43 billion in costs. Crashes in which alcohol levels are BAC of .08 or higher are responsible for over 90 percent of the economic costs and societal harm that occurs in crashes attributable to alcohol use. Crashes in which police indicate that at least one driver was exceeding the legal speed limit or driving too fast for conditions cost $52 billion in 2010. Seat belt use prevented 12,500 fatalities, 308,000 serious injuries, and $50 billion in injury related costs in 2010, but the failure of a substantial portion of the driving population to buckle up caused 3,350 unnecessary fatalities, 54,300 serious crashes, and cost society $10 billion in easily preventable injury related costs. Crashes in which at least one driver was identified as being distracted cost $40 billion in 2010. The report also includes data on the costs associated with motorcycle crashes, failure to wear motorcycle helmets, pedestrian crash, bicyclist crashes, and numerous different roadway designation crashes.

BIKE AND PED MAINTENANCE FUNDING

HOW COMMUNITIES ARE PAYING TO MAINTAIN TRAILS, BIKE LANES, AND SIDEWALKS

Advocacy Advance 2014

Findings:

- TRAILS
    - Trails increase the values of nearby properties, attract business activity as multi-use facilities, and increase local tax revenues
    - In Columbus, Ohio, the Columbus and Franklin County Metro Parks (Metro Parks) is a regional public agency responsible for more than 150 miles of recreational trails which are a part of the largest connected, off-street paved trail network in the United States. Metro Parks owns and operates small plow machines specifically for its trails. The plows are deployed whenever snow is greater than 2 inches. Metro Parks is a politically independent public agency created by Ohio law in 1945. Its primary funding source is a 10-year, property tax (0.75-mill) approved by Franklin County voters in 2009.
    - In Dayton, Ohio, the Metropolitan Planning Organization (MPO) conducted a study that shows an annual nearly $15 million economic impact of the trail system, which cost a total of approximately $50 million over 30 years.
    - Through field observation and public agency input, the Lake Tahoe Regional Planning Agency was made aware that multi-use paths and sidewalks were not being maintained to a high enough standard. To determine their options, they hired Alta Planning + Design to find successful examples of maintenance, and maintenance funding in comparable communities where outdoor activities are significant drivers of tourism. That report found that while grants generally do not pay for maintenance activities, several grant programs – from sources such as the North Lake Tahoe Resort Association, California Tahoe Conservancy, and Southern Nevada Public Land Management Act –that pay for new construction require maintenance schedules and funding sources in their applications. While enforcement of these requirements is often lacking, it shows the necessity for thinking about maintenance at the start of construction.
    - Federal transportation funding is generally focused on providing capital funding for road projects. In the last federal transportation bill, Moving Ahead for Progress in the 21st Century (MAP-21), three programs that were focused on bicycling and walking – Safe Routes to School, Recreational Trails, and Transportation Enhancements – were consolidated into one program: the Transportation Alternatives Program (TAP). This consolidation was accompanied by a roughly 30% reduction in funding. However, bicycling and walking projects continue to be eligible under other federal transportation funding programs and states and MPOs can make project selection criteria that are compatible with Complete Streets policies that have proliferated in recent years.
    - Although bicycling and walking projects can be built with many federal funding sources, the capital funding bias of federal transportation funding means that there are only a handful of programs that can fund bicycling and walking facility maintenance, and particularly trail maintenance. The federal Recreational Trails Program (RTP) is the primary program for funding trail maintenance. It is also important for trail maintenance funding because two other federal programs that can fund trail maintenance do so because they can fund any project that is eligible for RTP funding. There are many eligible uses for RTP funds, but most notable from a maintenance perspective are:
        - Maintenance and restoration of existing trails.
        - Development and rehabilitation of trailside and trailhead facilities and trail linkages.
        - Purchase and lease of trail construction and maintenance equipment.
        - Assessment of trail conditions for accessibility and maintenance.
- PROTECTED BIKEWAYS
    - City council allocated $1,500,000 local capital funds annually for pedestrian and bicycle safety enhancements in Washington, DC.
- BICYCLE LANES
    - In Cincinnati, bicycle lanes are treated like other road facilities and contracted out to private firms for regular sweeping. The bidding process occurs every two years and additional requirements, and costs, for specific bicycle lane sweeping are relatively new. Sweeping costs were reported at between $55-62 per curb mile of bicycle lanes for sweeping once a month plus an additional sweep in March, April, May, September, and October – peak months for bicycle traffic in a city with slightly lower bicycle commuter rates than average. Funding for street sweeping comes from the stormwater management fund, which is paid for by utility bills to citizens. As with maintenance funding, reconstruction funding is also handled in the same way as other road

facilities with a wide mix of federal, state, and municipal funding used when a road or bicycle lane is repaved. The City often uses road repaving or rehabilitation as an opportunity to implement its bicycle plan and create or improve bicycle lanes. For the most part, bicycle lanes are still new facilities and have not reached the 15-30 lifespan prior to reconstruction or shorter term preventative maintenance.

- Arlington is one of several cities in Texas that collect a quarter-cent sales and use tax exclusively for the maintenance and rehabilitation of existing public streets, as allowed by Texas statute. This spring, voters in Arlington approved the renewal of the street maintenance tax until 2019 by a vote of 81% to 19%. This means that bicycle facilities built prior to that vote can now be maintained with those sales tax revenues, which pay for between 90-95% of all street maintenance in the City.

- SIDEWALK
  - Making abutting property owners responsible for sidewalk maintenance is common, for both routine maintenance and reconstruction. A 2010 survey of 82 cities in 45 states found that 40% of cities require property owners to pay the full cost of repairing sidewalks, 46% share the cost with property owners, and 13% pay the full cost of repairing sidewalks.
  - It is easy to understand why property owners in the 86% of cities where they must pay all or part of the cost for sidewalk repairs are hesitant to accept this responsibility. Here are some of the basic problems that occur when abutting property owners are responsible for sidewalk maintenance
  - To address the serious problems created by the most common way cities deal with sidewalk maintenance, many cities share costs with property owners or adopt other policies to make their sidewalk repair enforcement more palatable.
    - Cost sharing programs are the most common way that cities ease the burden on property owners. Cost sharing often means that the City will pay 50-75% of the cost of a sidewalk repair.
    - Use the borrowing ability of the City to provide low cost financing to property owners. In Princeton, New Jersey, the Borough allows homeowners to pay for their sidewalk repair assessments over the life of the Borough's ten year municipal bond at the same interest rate as the Borough.
    - Assess repairs at the time of property transactions. In New Jersey, a Certificate of Occupancy must be issued whenever a property is sold, and sometimes when a rental property is occupied by a new tenant. Before a Certificate of Occupancy is issued, the building is inspected for safety hazards, including unsafe sidewalks and curbs. Most sidewalk repairs in New Jersey that are initiated by individual property owners occur as a result of this policy. This process helps property owners because the repairs can be paid for with cash generated by the real estate transaction. In California, cities such as Piedmont and Pasadena have adopted point-of-sale programs similar to the Certificate of Occupancy program in New Jersey.
    - Equity-based assistance payments. The Portland DOT has an application for those making less than $35,000 per year to have repair costs covered by the state.

HOW CAN A STREETSCAPE BE PERCEIVED AS MORE PLEASANT?

Generally, focusing on improving basic infrastructure, including sidewalks, curb cuts, street lights, benches, and a having buffer between street and sidewalk can improve perceived and actual walkability. A good infrastructure network is important for both pedestrians and cyclists. Changing perceptions of cyclists may need more than just infrastructure improvements. Prioritizing buffered/protected bike lanes and trails may have the greatest effect on perceptions of safety.

Academic Research Findings Summary

Is Your Neighborhood Designed to Support Physical Activity? A Brief Streetscape Audit Tool, Preventing Chronic Disease: Public Health Research, Practice, and Policy, 2015

- Presence of the following are important for supporting walking for all ages:
  - Sidewalks

    - Curb cuts
    - Street lights
    - Benches
    - Buffer between street and sidewalk
- Presence of the following are also important for children:
    - Trees and overhead coverage
    - Absence of trip hazards

How Can Psychological Theory Help Cities Increase Walking and Bicycling?, Journal of the American Planning Association, 2014

- Well connected low traffic streets with sidewalks increase walking
- Increasing biking needs to include promotion and off-street/protected bike infrastructure
- Built environment is an important in influencing behavior
- Striped bike lanes may not increase cycling in a poor biking environment
- Social norms do not play a significant role in walking or biking behavior
- Factors influencing walking and biking are different
- Attitudes toward biking are more important than toward walking
- Demographics are very important influences on psychological factors/behavior
- Older adults have more negative attitudes for both modes
- Women had negative attitudes toward biking
- Demographic factors may be equal to or greater than the environmental influence, particularly for biking
- Separated bike facilities may be more attractive to women
- Cities focusing on increasing walking do not need to focus on changing attitude
- Improvements to physical environment could increase walking

Operational Definitions of a Walkable Neighborhood, Journal of Physical Activity and Health, 2006

- Factors that influence walking rates:
    - Positive relationships:
        - Residential density
        - Smaller block size
        - Proximity to grocery (within ¼ mi.)
        - Proximity to restaurants (within ¼ mi.)
        - Retail stores
    - Negative relationships:
        - Large office complexes
        - Too many educational facilities
    - Neutral relationship:
        - Parks

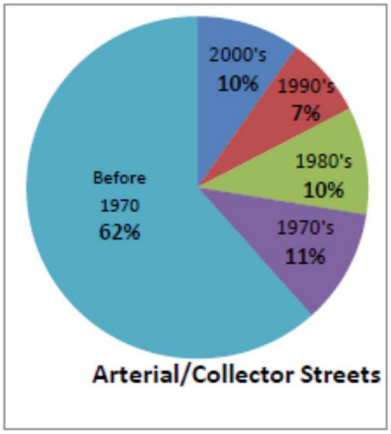
Perceived urban design qualities and affective experiences of walking, Journal of Urban Design, 2016

- Attend to weak spots in pedestrian infrastructure

PAVEMENT CONDITION INDEX (PCI)

A citywide survey of PCI, produced in 2013 for Public Works, provided the following information:

Figures 3 & 4: Last Date Streets were Reconstructed/Constructed



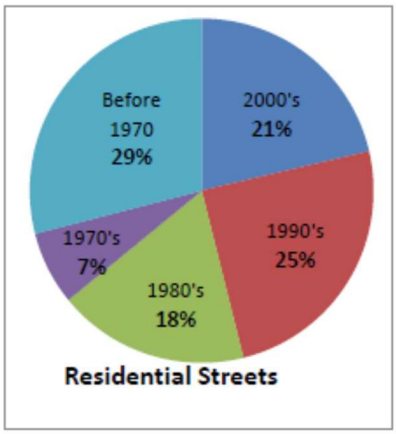


Figure 5: Current Condition of Residential Streets and Type of Maintenance Needed

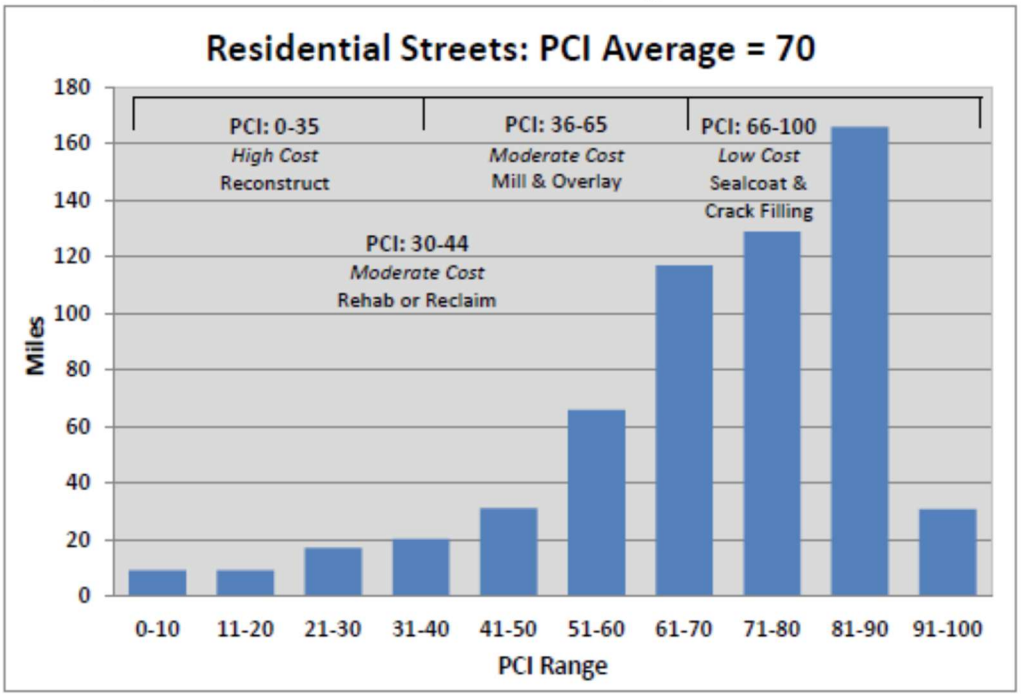
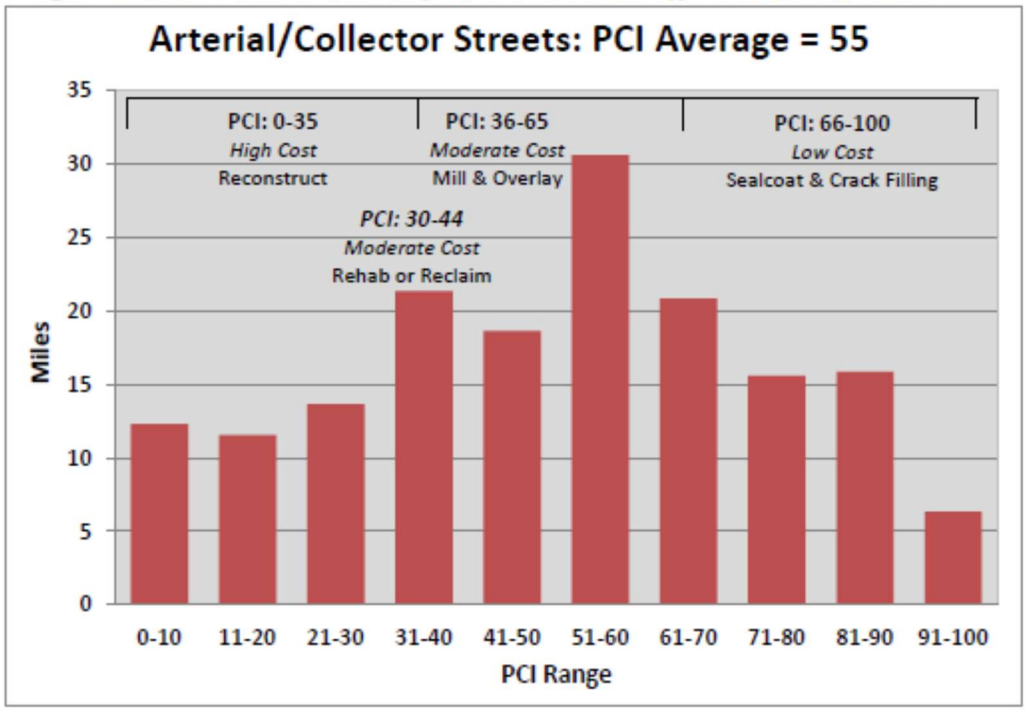
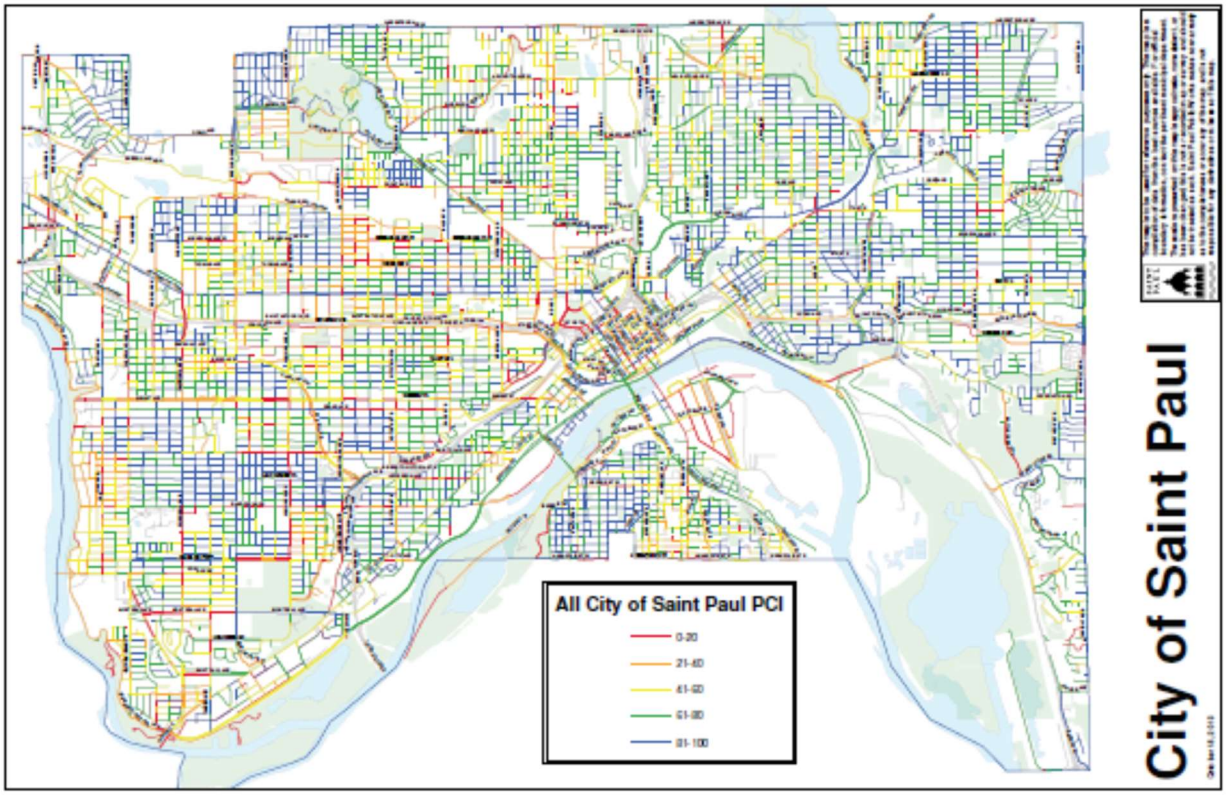
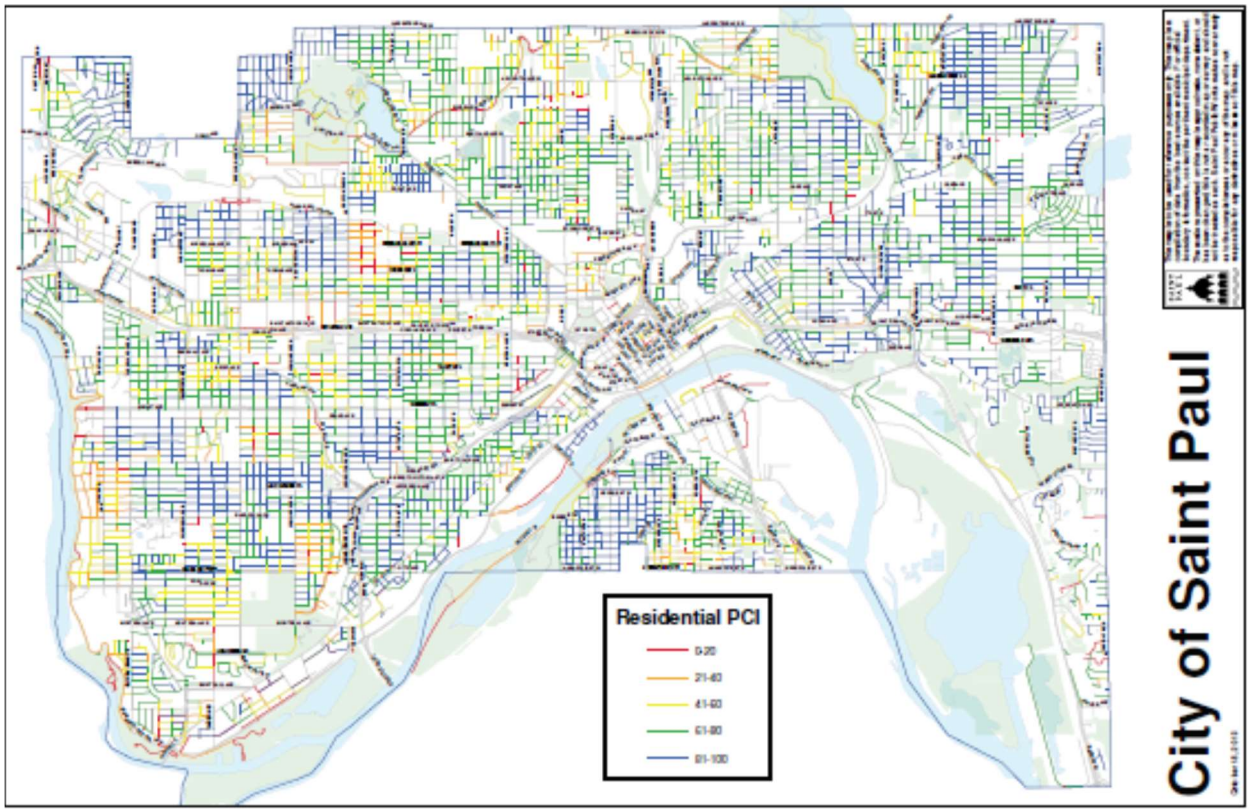
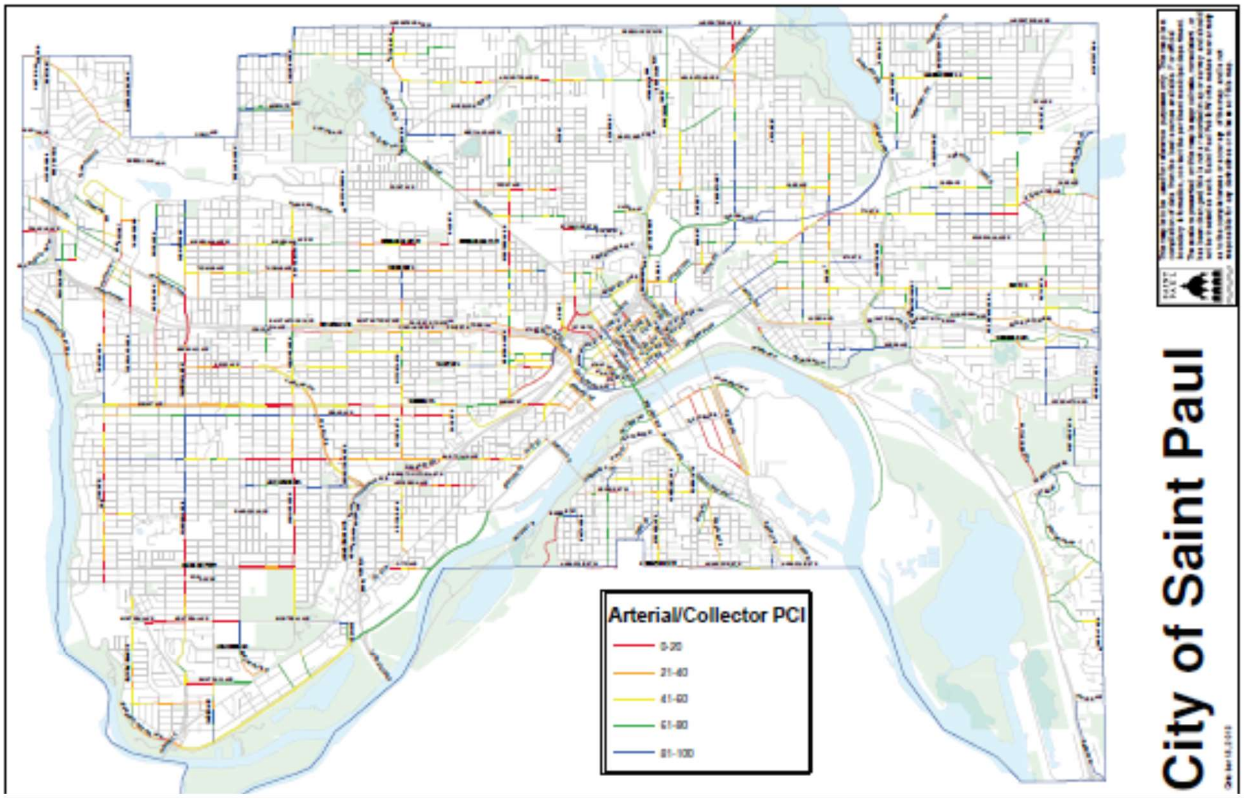


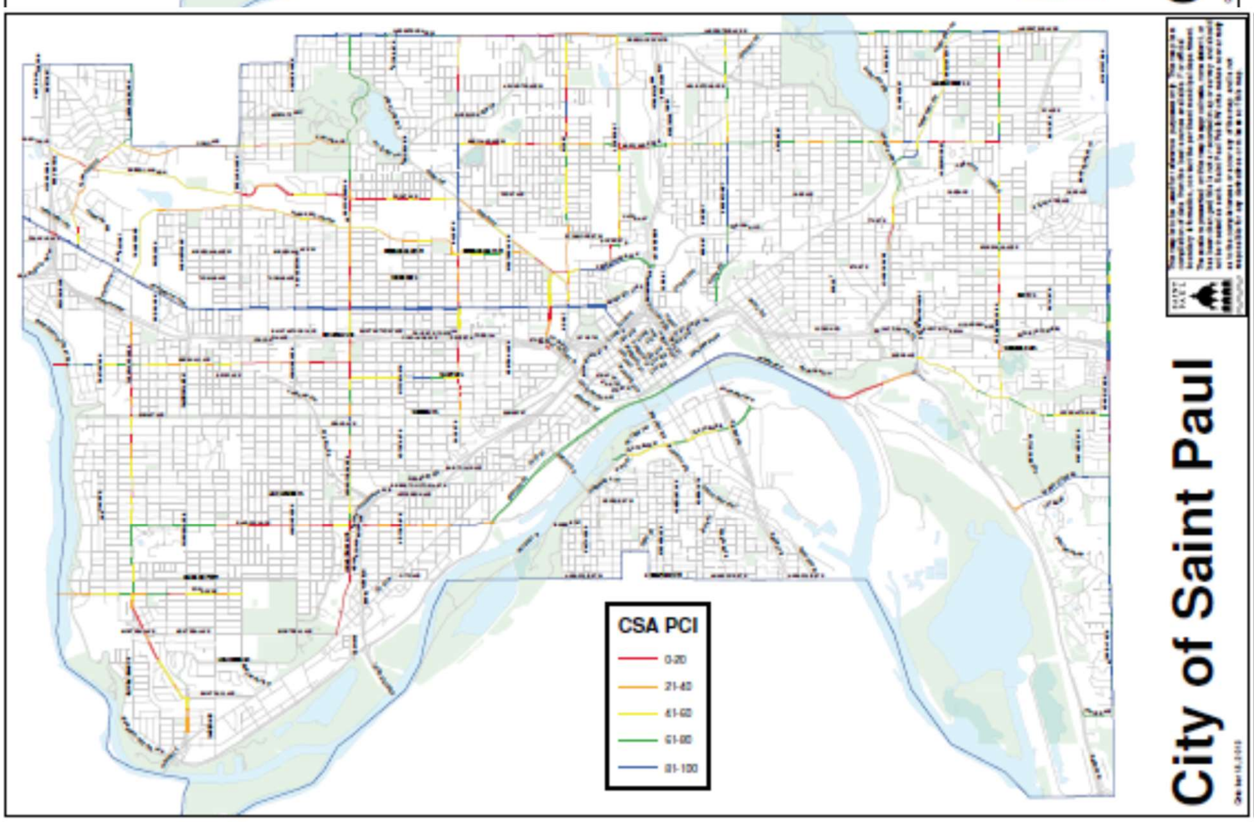
Figure 6: Current Condition of Arterial/Collector Streets and Type of Maintenance Needed

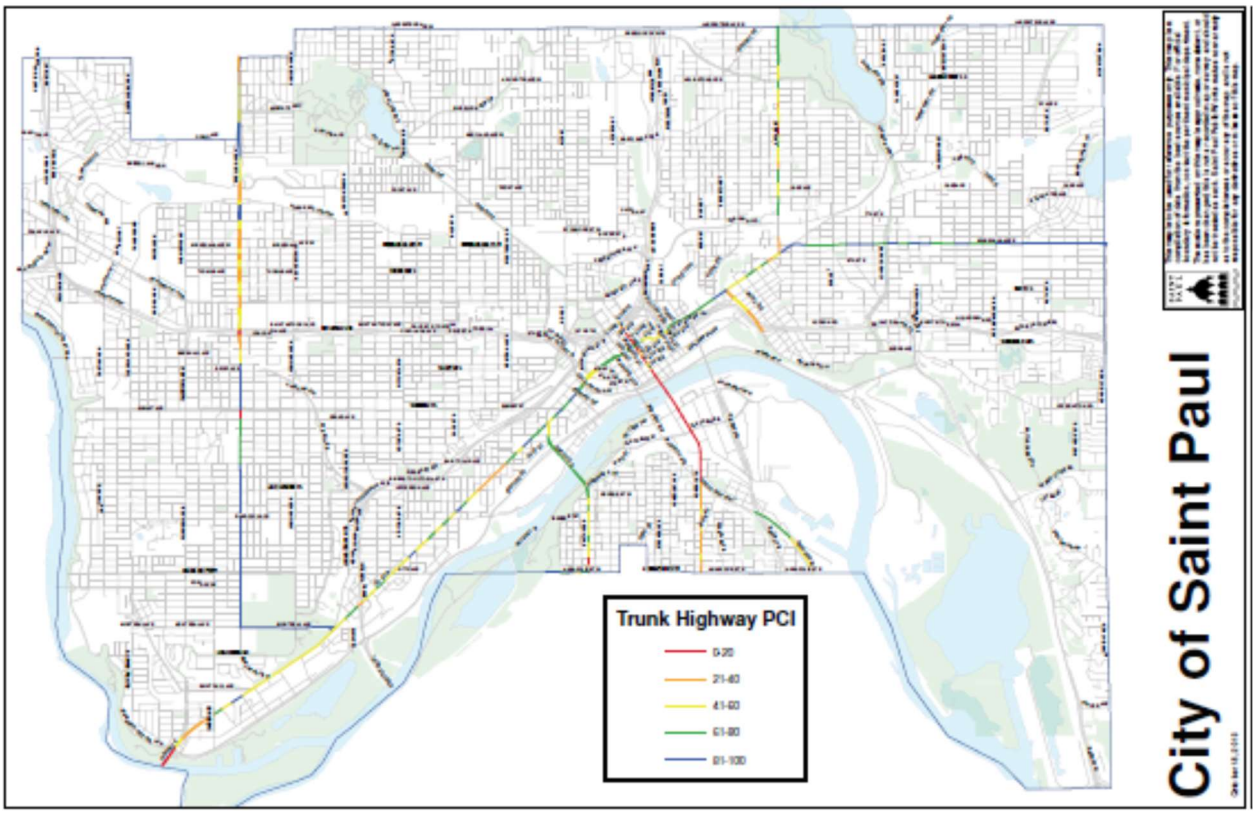





Residential PCI
0-20
21-40
41-60
61-80
81-100
City of Saint Paul


Arterial/Collector PCI
0-20
21-40
41-60
61-80
81-100
City of Saint Paul


CSA PCI
0-20
21-40
41-60
61-80
81-100
City of Saint Paul



AUTOMATED VEHICLES

Automated vehicles (AVs) are likely to be commercially available by 2021, with most involved companies anticipating such a vehicle by 2025. Technological, legal and social hurdles preclude certainty of availability, though many billions of dollars are being spent on AV research. AVs will probably, though not certainly, be electric rather than gasoline-fueled. A key, and very uncertain question for development and real estate patterns is whether AVs are predominantly owned or shared. Regardless of power and ownership models, AVs are anticipated to: reduce crash rates, create demand for additional pick-up/drop-off space, provide more flexibility in parking location (not necessarily near destinations), decrease transportation sector employment, and allow for narrower lanes with more vehicle volume capacity. There are many other potential effects that will require further study as the technology advances.

SCHOOL MODE USE

For Saint Paul Public Schools, 30,577 students were assigned to ride the bus out of a total student population of 39,300 in the 2016-17 school year. The 8,733 students not assigned to ride the bus are mainly those who live within the "walkable distance" of their school (1/2 mile for pre-K through 5th grade, 1 mile for grades 6-12) or live outside of Saint Paul and attend SPPS schools. Among the 30,577 assigned to ride the bus, percentage of ridership is: Elementary A.M. 81.25%, P.M. 83.41%., Middle A.M. 84.4%, P.M. 81.25%, High School A.M. 78.82%, P.M. 64.69%. More specifically by school, see the table below ("actual" meaning the # who actually ride the bus in general – others might walk, bike, or be dropped off by car):

School	A.M.	Assigned	Actual	P.M.	Assigned	Actual
Adam Spanish	78.06%	465	363	83.08%	467	388
AIM	88.64%	396	351	89.03%	392	349
Battle Creek El	84.26%	305	257	90.00%	260	234
Ben Mays/Cap Hill	82.92%	1101	913	87.99%	1007	836
Chelsea Hts	77.06%	218	168	84.85%	231	196
Cherokee	63.30%	218	138	81.14%	228	185
Como Park El	83.22%	292	243	86.91%	298	259
Daytons Bluff	73.37%	199	146	71.63%	208	149
Eastern Hts	62.74%	263	165	65.56%	270	177
Expo	72.22%	180	130	74.05%	185	137
Farns Lower	86.26%	393	339	78.03%	355	277
Farns Upper	87.31%	386	337	80.94%	341	276
Frost Lake	89.03%	237	211	89.39%	245	219
Four Seasons	89.92%	238	214	87.19%	242	211
Galtier	67.74%	124	84	74.11%	112	83
Groveland	94.02%	117	110	88.43%	121	107
Hamline	77.55%	294	228	75.92%	299	227
Heights El	85.32%	218	186	94.04%	218	205
JJ Hill	72.43%	243	176	73.66%	224	165
Highland Park El	76.51%	166	127	79.29%	169	134
Highwood Hills	84.07%	226	190	88.44%	225	199
Hazel Park	79.78%	366	292	83.38%	367	306
Jackson	81.50%	227	185	92.92%	226	210
John A Johnson	72.88%	295	215	83.00%	300	249
French Immersion	80.36%	336	270	87.89%	322	283
Linwood Lower	86.38%	213	184	78.95%	228	180
Linwood Upper	87.10%	372	324	81.31%	321	261
Horace Mann	na			na		
Mississippi	84.97%	366	311	85.32%	361	308
Maxfield	71.58%	95	68	73.68%	95	70
Nokomis North	88.65%	185	164	85.14%	148	126
Nokomis South	88.46%	156	138	89.05%	201	179
Obama	84.47%	322	272	84.27%	337	284
Phalen	na			na		
Randolph Hts	na			na		
Riverview	75.38%	264	199	83.21%	280	233
St. Paul Music	85.81%	458	393	84.54%	498	421
St. Anthony	na			na		
Vento	89.23%	325	290	95.68%	324	310
Wellstone	79.53%	337	268	85.00%	340	289
Crossroads	73.44%	512	376	81.56%	526	429
Elementary	81.25%	11108	9025	83.41%	10971	9151
Battle Creek Mdl	88.25%	502	443	87.99%	533	469
Creative Arts	80.99%	121	98	86.17%	94	81
Murray	87.82%	394	346	81.45%	399	325
Parkway	84.62%	299	253	78.50%	307	241
Ramsey	75.87%	344	261	71.17%	326	232
Middle	84.40%	1660	1401	81.25%	1659	1348
Central HS	56.64%	648	367	48.68%	984	479
Como Park HS	80.17%	696	558	58.20%	701	408
Harding HS	78.42%	913	716	66.34%	1108	735
Highland Park MS/HS	74.91%	805	603	62.75%	792	497
Humboldt/OWL	80.72%	892	720	65.91%	930	613
Leap	76.51%	166	127	0.725274725	182	132
Washington	89.84%	1418	1274	77.01%	1418	1092
High School	78.82%	5538	4365	64.69%	6115	3956
Total		18306	14791		18745	14455
	80.80%			77.11%		

However, often students who generally ride the bus might not on any given day. While the percentage of assigned riders who generally ride is around 80%, the ridership on any given day is estimated (informally by SPPS administration) to be closer to 50%.