POST-CONSTRUCTION ANALYSIS

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Policy, Planning and Sustainability Administration (PPSA)
District Department of Transportation (DDOT)

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INTRODUCTION & BACKGROUND

The District Department of Transportation (DDOT) is continually planning, designing, and constructing new and updated facilities across the District of Columbia. Most projects are rooted in enhancing the quality of life of residents by improving safety and mobility, ensuring a range of transportation options are available and convenient, and addressing ongoing transportation concerns in the community. DDOT is committed to working with communities to identify issues, develop solutions, and implement changes to the street network. However, a final step is necessary for ensuring changes on the ground address the original issues identified by community members and stakeholders: a post-construction evaluation. In other words, if a roadway improvement was intended to reduce automobile speeds, are measured speeds actually lower? Likewise, if a cycling project was constructed to make the street more attractive to a variety of cyclists, are more cyclists actually using the facility and are residents and commuters choosing to bike instead of using other modes of transportation?

Because DDOT is prioritizing safer, more livable streets and connected neighborhoods through street enhancement projects, it is imperative that impacts are measured after construction so that future projects can be informed by lessons from past efforts and that future designs can be modified to better address issues. This post-construction analysis study is a before-after evaluation of three recent construction projects in Washington, D.C.:

- **M STREET NW CYCLE TRACK**: a 1.3-mile cycle track with paint and flex-post buffers between parked vehicles, intersection “turning zones” and relevant signing and pavement markings, bike signals at some locations, and the elimination of one travel lane (completed in 2014). Limits of the study are 28th Street NW to the west and Thomas Circle to the east.

- **SHERMAN AVENUE NW STREETSCAPE**: a 0.85-mile traffic calming and streetscaping project that eliminated one travel lane in each direction, allowing for widened sidewalks and trees, lighting, landscaped median, and left-turn lanes at intersections (completed in 2013). Limits of the study are Barry Place NW to the south and New Hampshire Avenue/Park Road NW to the north.

- **NAYLOR ROAD SE TRAFFIC CALMING**: a 0.4-mile project with several median pedestrian refuge areas at unsignalized crossing locations, a painted median, upgraded sidewalks, and speed camera (completed in 2012).

Guided by earlier planning studies, the three study projects were each implemented to address specific issues within those communities. As a result, the data and analysis performed for each location is unique to the local and regional issues of that particular street and community and included a wide range of data and methods to understand the impact of these facilities on cyclists, motorists, and pedestrians. For example, Sherman Avenue was known to have speeding issues prior to construction so measuring post-construction speeds is a relatively straightforward method of understanding potential changes. However, speeding was not considered an issue on M Street and therefore no speed evaluation was conducted. Table 1 and Table 2 summarize the data collected and methodologies used for each facility, respectively.
<table>
<thead>
<tr>
<th>FEATURE</th>
<th>M STREET NW</th>
<th>SHERMAN AVENUE NW</th>
<th>NAYLOR ROAD SE</th>
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</table>
| **Safety**                                  | • DDOT Crash Reports  
• Video  
• On-site observations | • DDOT Crash Reports  
• On-site observations  
• Auto speeds | • DDOT Crash Reports  
• On-site observations  
• Auto speeds |
| **Bicycle/Pedestrian Quality of Service and Mobility** | • Lane configurations  
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• Signal timing plans  
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• Intersection turning movement counts  
• Field conditions  
• Vehicle volumes, speeds, vehicle classification  
• Field conditions |
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<td>• Intercept Surveys</td>
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<td>• Parking supply/demand analysis</td>
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M STREET NW

M Street NW, classified as a minor arterial, is an east-west roadway connecting Georgetown to the west and the Near Northeast and Gallaudet University to the east. In May 2014, DDOT finished construction of a 1.3-mile westbound cycle track on the north side of M Street NW, starting at Thomas Circle NW and continuing west to 28th Street NW. The M Street NW cycle track is the most recently constructed of the three study locations in this summary and likely attracted the most public attention due to its location and its “impacts” to the overall downtown street network. As the westbound couplet to the previously implemented L Street NW separated bike lane in the eastbound direction, DDOT was able to improve on some design elements of the L Street NW cycle track with the M Street NW cycle track. Design elements include:

- Elimination of a single auto travel lane on the north side
- A separated bike lane on the north side of the roadway between the existing curb and parked vehicles that were shifted from the curb
- A 3-foot buffer of paint and plastic flex posts separates parked vehicles from the bike lane
- A 5 to 6-foot wide bike lane, which is narrower than the L Street NW cycle track to reduce potential parking and loading conflicts
- Parking and loading zones are located adjacent to the bike lane
- “Turning zones” at intersections to accommodate right-turning vehicles and through cyclists. The design is less abrupt than those on L Street NW.

- Green paint on the pavement to indicate areas of potential conflict between bicyclists and motorists, primarily used at turning zones and driveways.
- Signal timing and phasing changes throughout the corridor to accommodate the two new bike signals and the loss of a travel lane.

The construction of the cycle track affected the lane configuration and cross section of M Street NW in the following ways:

- **WEST OF CONNECTICUT AVENUE NW:** four westbound 10-foot travel lanes with one eight-foot parking lane on either side were converted to two 10-foot travel lanes, one westbound 11-foot travel lane, one eight-foot parking lane, one nine-foot parking lane, and one five-foot bicycle lane with a three-foot buffer, for a total of 56 feet.

- **EAST OF CONNECTICUT AVENUE NW:** four westbound 10-foot travel lanes with parking permitted in the curb lanes on either side were converted to two 11-foot travel lanes, one westbound 11-foot travel lane, one eight-foot parking lane, one nine-foot parking lane, and one six-foot bicycle lane with a three-foot buffer, for a total of 40 feet.
Sherman Avenue NW, classified as a minor arterial, is a north-south roadway connecting New Hampshire and Georgia Avenues in Petworth with Florida Avenue near the U Street corridor. Prior to 2010, Sherman Avenue was positioned primarily as a commuter corridor, featuring a four-lane cross-section with narrow sidewalks and no pedestrian refuge areas or bicycle facilities.

In 2010 DDOT began a comprehensive reconstruction of Sherman Avenue between Monroe Street/Park Road and Barry Place, a distance of approximately 0.85 miles, with the goals of improving safety, providing better facilities for non-auto travelers, and repositioning the roadway as a neighborhood-serving street. Completed in 2013, the project included the following changes:

- Curb-to-curb cross-section reduced from 60 feet to 52 feet by removing a travel lane in each direction and replacing it with a landscaped median and left-turn lanes at intersections
- Sidewalks widened and tree boxes and landscaped buffers incorporated
- Permanent, striped parking lanes added on both sides of the street with curb extensions at intersections to reduce pedestrian crossing distances
- Shared lane markings (i.e., “sharrows”) added in both directions to indicate that motorists should share the road with cyclists, that cyclists have the right to use the full travel lane, and to provide guidance on roadway positioning for cyclists to keep them away from the door zone of parked vehicles.
NAYLOR ROAD SE
Naylor Road SE, classified as a minor arterial, serves the Hillcrest neighborhood and serves as a local and commuter route to suburban Maryland. Prior to reconstruction in 2012, Naylor Road SE consisted of two 16-foot travel lanes (one lane per direction) with on-street parking on both sides of the street along the corridor. Six-foot sidewalks with a five-foot buffer were also provided in both directions, with the exception of the area between T Street SE and 28th Street SE, where the buffer is approximately three feet. The reconstruction of Naylor Road SE resulted in high high-visibility crosswalks, six median pedestrian refuges with landscaping, a striped median, striped on-street parking where possible, and a speed camera.
FINDINGS

Overall, the post-construction evaluation found that conditions did improve for each of the three modified corridors, although some elements were more conclusive than others and in some cases additional data will likely be required to more fully understand corridor impacts. The following represents key findings from the three corridors, organized by various themes determined to be significant during earlier planning studies.

M STREET NW

BICYCLE QUALITY OF SERVICE AND MOBILITY

AM peak hour bicycle volumes increased 47 percent between 2013 and 2014 and 71 percent between 2013 and 2015 after construction of the cycle track. Summer bicycle counts have been taken between 18th Street NW and 19th Street NW during the AM and PM peak hours since 2010. Bicycle volumes were relatively constant prior to construction but increased significantly once the cycle track was installed. This trend is consistent with those measured once cycle tracks were installed elsewhere in the District (i.e., 15th Street NW, Pennsylvania Avenue, and L Street NW) and in other locations across the country.

FIGURE 2
M STREET PEAK HOUR BIKE VOLUMES
(BETWEEN 18TH & 19TH STREET NW)

<table>
<thead>
<tr>
<th>Year</th>
<th>AM Peak Hour</th>
<th>PM Peak Hour</th>
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<tbody>
<tr>
<td>2010</td>
<td>40</td>
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<tr>
<td>2015</td>
<td>90</td>
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BICYCLE QUALITY OF SERVICE AND MOBILITY

Based on results from a cyclist intercept survey on M Street NW, 24 percent of cyclists using the corridor changed their travel habits after construction of the cycle track, either switching from other modes of transportation to cycling or changing their cycling route in order to bike on M Street NW. Before construction of the cycle track 11 percent of cyclists used public transportation, 4 percent used an automobile, 4 percent walked, 4 percent would not have taken the trip, and 1 percent would have taken a taxi.

Approximately 73 percent of surveyed cyclists now bike on M Street NW more frequently than before construction. Approximately 20 percent of respondents used it about the same amount, 5 percent were using it for the first time, and 2 percent use it less frequently.

Danish bicycle level of service (LOS) analyses show significantly improved operations for cyclists with the cycle track. After construction, the LOS improved for each segment analyzed. The pre-construction LOS varied from D to F, indicating a fair to very poor quality of service for cyclists. Post-construction, the Danish bicycle LOS varies from A to D along the corridor, indicating a very good to fair quality of service for cyclists.

Cycling on M Street is faster than driving during the PM peak hour, assuming a 15 mph cycling speed. Post-construction, the total bicycle travel time from Thomas Circle to 28th Street NW is approximately 11 minutes for cyclists traveling at 10 mph and approximately 7.5 minutes for cyclists traveling at 15 mph during AM and PM peak hours. Cyclists can expect to stop at three to five signals along the corridor for a total of 2.5 to 3.5 minutes of stopped delay.
**EXECUTIVE SUMMARY**

**USER BEHAVIOR**

**M STREET NW/CONNECTICUT AVENUE NW RHODE ISLAND AVENUE NW: SEPARATED BIKE LANE AND BIKE SIGNAL**

The path of least resistance is often used by cyclists at the M Street NW/Connecticut Avenue NW/Rhode Island Avenue NW intersections, often choosing the location that allows them to travel through the intersection on the most immediate green signal. Approximately 73 percent of cyclists used the separated bike lane on Rhode Island Avenue (i.e., the intended design approach), while 16 percent stayed in the M Street travel lane and 11 percent turned left onto Rhode Island Avenue.

Approximately 23 percent of bicyclists who used the separated bike lane on Rhode Island Avenue NW disregarded the bike signal. Data collection included 5.5 hours of observations during AM, midday, and PM peak periods. The sample size included 218 cyclists on a single day.

**FIGURE 5**

Cycling Paths at M Street/Rhode Island Avenue/Connecticut Avenue

**M STREET NW 22ND STREET NW: TURNING ZONE AND BIKE SIGNAL**

A 50 percent bike signal compliance rate was observed at the bike signal at M Street NW 22nd Street NW. Data collection included 3.5 hours of observations during AM and PM peak periods. The sample size included 158 cyclists on a single day.

Approximately ten percent of motorists made an illegal right turn on red across the separated bike lane at M Street NW / 22nd Street NW. Data collection included 3.5 hours of observations during the AM and PM peak periods. The sample size included 517 right-turning vehicles on a single day.
TURNING ZONES

At three turning zone locations (16th Street NW, 20th Street NW, 24th Street NW) few vehicle-bicycle conflicts were observed during video review and motorists yielded to cyclists every time. Video revealed a total of 29 conflicts (e.g., when cyclists and motorists entered the turning zone area at approximately the same time) across 11 hours of video data.

The intended path through the turning zone was not always clear to motorists, particularly at 16th Street NW, where 32 motorists made a right turn from the through-movement lane (across the turning zone) during the 3.5 hours of data collection.

On average, approximately five to ten percent of bicyclists at the three noted turning zone locations ran a red signal from the cycle track, although this was more pronounced at the 16th Street NW turning zone and less of an issue at 24th Street NW. This compliance rate is significantly higher than at 22nd Street where the bike signal adds additional delay to westbound traffic and results in 50 percent signal compliance.

Approximately 90 percent of all bicyclists observed on M Street during data collection at these three sites positioned themselves in the separated bike lane in the turning zone.

No issues with traffic queuing through the turning zones were observed via video, which is consistent with the traffic operations analysis.

CYCLING DEMOGRAPHICS

A majority of surveyed cyclists are “choice riders” (i.e., people who have other transportation options).

- Over 95% of survey respondents have a driver’s license.
- Over 95% of survey respondents have a transit pass.
- Approximately 55% of survey respondents have one or more cars in their household.
- Nearly 30% of survey respondents have car share memberships.

43 percent of commuting cyclists using M Street after construction of the cycle track are female. According to the American Community Survey, the national average is 26 percent and the average for the District of Columbia is 33 percent. This suggests the cycle track increases the overall level of user comfort and convenience on the corridor.

The average age of surveyed cyclists was 33 with a relatively high median income (48% with incomes over $100K). This breaks from the common stereotype that bicycling for transportation is predominantly undertaken by very young people and those who cannot afford to drive.

APPROXIMATELY 43% OF SURVEYED CYCLISTS ON M STREET NW WERE FEMALE
**AUTO MOBILITY**

Removal of a travel lane resulted in minimal traffic diversion to other streets. On average, automobile volumes decreased by five to eight percent along the corridor after construction of the cycle track, but changes in volumes were more dramatic in some areas than others.

- During the AM peak hour, automobile volumes decreased the most (10 percent) east of 16th Street NW while decreasing the least (2 percent) west of New Hampshire Avenue NW.

- During the PM peak hour, automobile volumes actually increased by 0.3 percent east of 21st Street NW but volumes decreased dramatically (17 percent) west of 21st Street NW.

**Auto travel times increased minimally during the AM peak hour but did increase considerably during the midday and PM peak periods after construction of the cycle track.** Average travel times along the length of the corridor increased by approximately 30 seconds during the AM peak period, and by approximately four minutes during the midday and PM peak periods. The increase is primarily attributed to post-construction signal timing and progression changes (including the bike signal at 22nd Street which reduces available green time for the right-turn phase) and not related to roadway capacity issues.

**FIGURE 6**

M STREET NW AUTO TRAVEL TIME COMPARISON

Bike signal at 22nd Street NW.
AUTO MOBILITY

Automobile operations (i.e., level of service, delay, queuing) were minimally affected by the changes on M Street NW. Most intersections experienced minimal operational degradation after construction of the cycle track, the exception being the intersection of Connecticut Avenue NW/Rhode Island Avenue NW/18th Street NW, where the delay increased by 30 seconds per vehicle during the AM peak hour resulting in an overall intersection level of service E. Other locations did experience increased levels of delay (e.g., 24th Street, 15th Street), but are still well within acceptable operational delay thresholds.
SAFETY
More bicycle and pedestrian crashes were observed after construction of the cycle track. Bicycle crashes at intersections along the M Street NW corridor increased by 7.7 crashes per year after construction and pedestrian crashes increased by 6.7 crashes per year. It should be noted though that bicycle volumes increased dramatically after construction (i.e., over 70 percent), therefore overall exposure would likely result in some increases in crashes. The low number of crashes and limited length of time observed after construction (less than 1 year) is also too short to draw definitive conclusions.

The survey data suggest the M Street NW cycle track has increased the perception of safety and comfort for bicyclists, likely contributing to the high share of female bicyclists and riders who have other transportation options.

One notable aspect of this perception of safety is that it exists despite a lack of consensus that motorists are much more aware of them than they were before the facility was installed. This is consistent with previous research on bicyclists’ level of comfort with various facilities, and the perceived effectiveness of separated lanes at protecting bicyclists from motor vehicles.

PROJECT EFFECTIVENESS
The M Street NW separated bike lane project was largely successful in its goal of improving access for bicyclists, improving perceived safety by bicyclists, and increasing the number and variety of bicyclists on the corridor. The findings show a greater number of bicyclists and a broader range of bicyclists now use the corridor, with minimal impacts to automobile mobility. Likewise, the evaluation found that bicyclists perceive the corridor to be safer with the separated bike lane which in turn led to changes in behavior of those using the corridor (e.g., switching modes, choosing M Street over other routes).

LESSONS LEARNED
Using post-construction crash data to evaluate safety impacts of a project can be time consuming, particularly because at least three years of crash data is typically required for a robust before-after evaluation. For bicycle and pedestrian projects, another challenge with using crash data to draw conclusions is that the number of crashes is relatively small and do not inform of real safety issues. While we do know that bicyclists feel safer on these facilities, it is important to collect more detailed crash data over time across the City to better understand objective safety impacts.

Relying on a single set of before and after traffic counts to assess a growth or decline in bicycling can be problematic because changes in bicycle volumes is highly influence by seasonal variations such as temperature and precipitation. On key bicycling corridors such as M Street NW, installation of continuous counters should be considered to ensure a more robust set of bicycle volume data can be relied upon to make informed decisions.

FIGURE 8
SURVEY OF BICYCLING COMFORT ON M STREET NW

Physical protection increases comfort of cyclists.
SHERMAN AVENUE NW

AUTO MOBILITY
Traffic volumes decreased on Sherman Avenue after roadway reconstruction.

- Daily traffic volumes decreased by approximately 1,040 vehicles, with a corresponding increase on some parallel corridors (e.g., 5th Street NW increased by nearly 2,000 vehicles).
- During the weekday PM peak hour, peak direction northbound volumes (i.e., outbound) decreased along Sherman Avenue by more than 17 percent.

The number of large trucks decreased on Sherman Avenue after construction. The number of heavy vehicles decreased on Sherman Avenue and other parallel corridors (Georgia Avenue and 5th Street NW), with a reduction on Sherman Avenue from 5 percent of total traffic to 2.8 percent.

Automobile operations (i.e., level of service, delay, queuing) were minimally affected by the changes on Sherman Avenue NW. All intersections are shown to have an overall intersection level of service of D or better under post-construction conditions during midday and PM peak hours. Most intersections experienced very little overall change in delay.
Automobile speeds decreased on Sherman Avenue after roadway reconstruction. 85th percentile speeds on Sherman Avenue decreased from 32 mph to 29 mph in the northbound direction and 35 mph to 28 mph in the southbound direction (11 percent and 21 percent reduction, respectively). The posted speed limit is 25 mph.

On-street parking is near capacity in some locations, but overall, parking is readily available since completion of Sherman Avenue.

- Demand for parking in residential areas is nearing capacity (90 percent occupied), particularly during overnight periods, but readily available during the day (63 to 74 percent occupied).
- Demand for parking in commercial areas, the south in particular, is busiest during lunchtime hours (74 percent occupied) but readily available throughout most of the day (32 to 64 percent).
SAFETY

The number of crashes decreased significantly at the evaluated Sherman Avenue intersections after roadway reconstruction. The 23 percent decline in total crashes and the 43 percent decline in injury crashes along Sherman Avenue well outpaces the approximately 8 percent decline in traffic volumes that occurred over the same time period.

The number of crashes increased at the evaluated Georgia Avenue intersections after roadway reconstruction on Sherman Avenue. Total and injury crash totals increased from pre- to post-construction conditions on Georgia Avenue by 51 percent and 33 percent, respectively.

PEDESTRIAN AND BICYCLE QUALITY OF SERVICE

Streetscape work and upgraded pedestrian infrastructure significantly improved conditions for those traveling on foot within the study area. Post-construction pedestrian LOS results were generally favorable, ranging from A to C along Sherman Avenue NW. From an empirical standpoint, the project improved sidewalks by removing obstructions like telephone poles and adding grass buffers and new street trees between the sidewalk and street. Conditions at intersections were also improved through the installation of ADA-compliant curb ramps, countdown pedestrian signals, and high-visibility crosswalk markings. Traffic calming measures implemented as part of the streetscape work, such as the travel lane reduction, median refuges, and curb extensions, also benefitted pedestrians by reducing crossing distances at intersections while at the same time improving pedestrian comfort by reducing vehicle speeds along Sherman Avenue.

Bicycle quality of service saw moderate improvements as a result of the project’s traffic calming impacts. Post-construction bicycle LOS results were generally favorable, ranging from A to C. Although these quantitative results cannot be directly compared to pre-construction conditions due to a lack of available data, empirical findings indicate that conditions have improved. Although Sherman Avenue was reduced to one lane per direction, leaving fewer opportunities for drivers to maneuver around cyclists, the larger roadway and streetscape modifications included in the Sherman Avenue project, namely the traffic calming measures and travel lane reduction that resulted in a decrease in vehicle volumes and speeds, are more positively impactful to bicycling comfort and safety. Furthermore, the installation of sharrows in the center of the travel lanes helps to inform motorists that bicycles are likely to be present in the street and to remind them that both modes have equal roadway rights. At the same time, sharrows provide bicyclists with guidance on roadway placement to keep them away from dangerous door zones at the edges of the traveled way.

PROJECT EFFECTIVENESS

The Sherman Avenue streetscape project was largely successful in its overarching goal of reestablishing the residential nature of the corridor. The post-construction data shows a reduction in vehicle volumes, vehicle speeds, and truck traffic relative to pre-construction conditions, while at the same time improving pedestrian conditions through a number of infrastructure changes (e.g., reduction in travel lanes, expanded sidewalk, pedestrian refuges), the addition of landscaped features, and shared-lane bicycle markings (i.e., sharrows).

LESSONS LEARNED

A robust set of consistent data must be gathered for pre- and post-construction conditions. In the case of Sherman Avenue NW, during the pre-construction assessment, AM peak period traffic conditions were not evaluated and crash data was only gathered at three intersections. The lack of information makes it more difficult to fully understand project impacts and whether a project met the original project goals.

FIGURE 13
SHERMAN AVENUE CRASH HISTORY

<table>
<thead>
<tr>
<th>CRASHES IN 3 YEARS</th>
<th>TOTAL CRASHES</th>
<th>INJURY CRASHES</th>
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<tr>
<td>SPRING ROAD</td>
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<td>MONROE STREET</td>
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</tr>
</tbody>
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SHERMAN AVENUE CROSS STREETS, NORTH-TO-SOUTH
SAFETY

Measured safety impacts on Naylor Road SE appear to be negligible. Three years of crash data were collected before (2006-2008) and after construction (2012-2014), and results indicate crashes have slightly increased at several study intersections but were reduced at Altamont Place SE where a previous issue with parked vehicle crashes appears to have been significantly improved. It should be noted that the number of crashes pre- and post-construction are relatively low, which makes it difficult to assess the effectiveness of the roadway modifications in improving safety.

No pedestrian or bicycle crashes were reported for post-construction conditions. One pedestrian crash and two bicycle crashes were reported pre-construction.

AUTO MOBILITY

Traffic delay is minimally affected by the roadway modifications. Capacity was not altered in the study area and therefore no noticeable changes in automobile delay were measured.

Corridor speeds reduced dramatically as a result of roadway modifications. 85th percentile speeds in 2006 prior to construction were approximately 40 miles per hour (posted speed limit of 25 mph). Speeds were measured in three separate locations on Naylor Road SE, and although speeds still exceed the 25 mph speed limit in all locations and directions, 85th percentile speeds now range between 26 and 34 mph.

Impacts of the speed camera on speeds is inconclusive. Although speeds on Naylor Road SE were shown to have decreased significantly it is unclear whether this effect is due to the speed camera, the traffic calming treatments, or some combination of the two. The lowest 85th percentile speeds were actually found to occur to the south near Skyland (South of Altamont Place), measuring 26 to 29 miles per hour, while the highest measured speeds were to the north between T Street SE and 27th Street NE, measuring 33 to 34 miles per hour.

PROJECT EFFECTIVENESS

The Naylor Road SE roadway enhancements were mostly successful in its goal of reducing automobile speeds and improving safety along the corridor. Due to limited pre-construction data, it is difficult to provide a direct comparison of pre- and post-construction impacts, but speeds have appeared to decrease considerably and are now much more in line with the posted speed limit of 25 mph. Overall, the number of crashes has changed minimally, but some targeted locations did experience reduced numbers of crashes.

LESSONS LEARNED

Naylor Road SE was completed as part of a larger neighborhood livability study, and as a result, the pre-construction data collected along Naylor Road SE was more limited than the other two projects. Studies that cover larger study areas and many streets are less likely to have a large amount of data on specific streets, and therefore fewer informed conclusions can be drawn about post-construction impacts.