PBOT
PORTLAND BUREAU OF TRANSPORTATION

1120 SW Fifth Ave, Suite 1331, Portland OR 97204
Phone: 503-823-4000 Portland.gov/Transportation

Memorandum

To: Northwest Parking District Stakeholder Advisory Committee
From: Chris Corral, Program Specialist, Vision Zero
Clay Veka, Vision Zero Program Coordinator
Date: 07/17/2024
Subject: Proposal for a "No Turn on Red" Program in Northwest Portland

Proposal Summary

To improve pedestrian safety and support walkability in Northwest Portland, PBOT's Vision Zero team proposes installing "no turn on red" and Pedestrian Head Starts at 15 intersections in the Northwest neighborhood. PBOT is seeking funding for this project from the Northwest Parking District Stakeholder Advisory Committee. This project will cost up to $143,000.

Introduction

In October 2020, Portland City Council adopted the Northwest in Motion Plan, meant to guide PBOT transportation investments in and around the Northwest District neighborhood. In addition to discrete projects, the plan recommended implementation of Pedestrian Head Starts and "no turn on red" as two treatments that could be used to improve safety and comfort for pedestrians in the Northwest District. Both types of pedestrian improvements at traffic signals were also called for in PedPDX, Portland's pedestrian master plan, and the Vision Zero Action Plan Update 2023-25.

Pedestrian Head Starts are changes in signal timing that improve the visibility of pedestrians crossing signalized intersections by giving a walk signal before the traffic light for parallel traffic turns green. This reduces the tendency for drivers to turn in front of pedestrians as soon as a light turns green by giving pedestrians several seconds to cross before people driving may advance. Pedestrian Head Starts have been shown to reduce pedestrian-vehicle collisions as much as 60%.[i] PBOT will also install Accessible Pedestrian Signal push-button devices with audible signals at all intersections equipped with Pedestrian Head Starts to meet accessibility guidelines for blind or low vision people.

Figure 1: PBOT's standard signage for red light turn restrictions.

"No turn on red" is a treatment at signalized intersections that prohibits people driving from turning when the signal is red. Instead, drivers must wait to turn when the signal is green. The turning restriction is indicated by a "no turn on red" sign posted at the intersection. This treatment reduces conflicts by reducing the chance that people in motor vehicles turn into people in crosswalks or bike lanes. Research shows this treatment improves safety with minimal impacts to people driving and traffic circulation.[ii] A 2022 study of traffic impacts resulting from "no turn on red" found an average queue increase of less than one vehicle per signal cycle[ii].

The "no turn on red" and Pedestrian Head Start treatments are relatively low-cost and can be combined to maximize the safety benefit for people walking and biking. Many cities across the United States have adopted these as standard practice for improved safety at signalized intersections, including Seattle, San Francisco, and Boston.

Pedestrian Head Starts already exist at dozens of intersections citywide, particularly at intersections with exclusive bike or pedestrian phases and at high conflict intersections. "No turn on red" is installed throughout the city at signals with exclusive bike or pedestrian phases and Neighborhood Greenways. In the Northwest District, there are Pedestrian Head Starts on NW Glisan Street at 15th and 13th avenues, and NW Everett Street at 13th Avenue. "No turn on red" is posted at 11 intersection approaches in the Northwest Parking District.

Project Proposal

PBOT staff has identified the Northwest neighborhood as a top candidate for systemic implementation of "no turn on red" and Pedestrian Head Start treatments due to high pedestrian activity. PBOT staff propose using $143,000 of NW Parking District funds to implement a comprehensive "no turn on red" program. The proposal includes:

- "no turn on red" at 15 intersections
- Pedestrian Head Starts at 11 intersections
- Accessible Pedestrian Signal push-buttons at 5 intersections in the Northwest Parking District

The intersections proposed for these treatments are:

- NW Everett Street at 18th, 19th, 21st, and 23rd avenues
- NW Glisan Street at 18th, 19th, 21st, and 23rd avenues
- NW Lovejoy Street at 18th, 19th, 21st, and 23rd avenues
- NW Northrup Street at 23rd Avenue
- NW Raleigh Street at 23rd Avenue
- NW Thurman Street at 23rd Avenue

The cost of implementation includes purchase and installation of "no turn on red" signs including traffic control and equipment required for installation; purchase and installation of new signal controllers capable of pedestrian head starts where necessary; and staff time to test and program revised signal timing. This request is based on a preliminary estimate of work required. PBOT staff have identified which signals will require push-button installation and controller upgrades. Cost savings may be realized from completing multiple intersections at once.

PBOT will post “no turn on red” at all approaches for each of the intersections identified above. Six of the identified intersections already have Accessible Pedestrian Signal push-buttons, and PBOT will install Accessible Pedestrian Signal push-buttons for some crossings of the other five. The remaining four intersections present technical challenges that make it too difficult to add Pedestrian Head Starts and Accessible Pedestrian push buttons as part of this project. These intersections will be upgraded when another capital project upgrades the crossings.

Conclusion

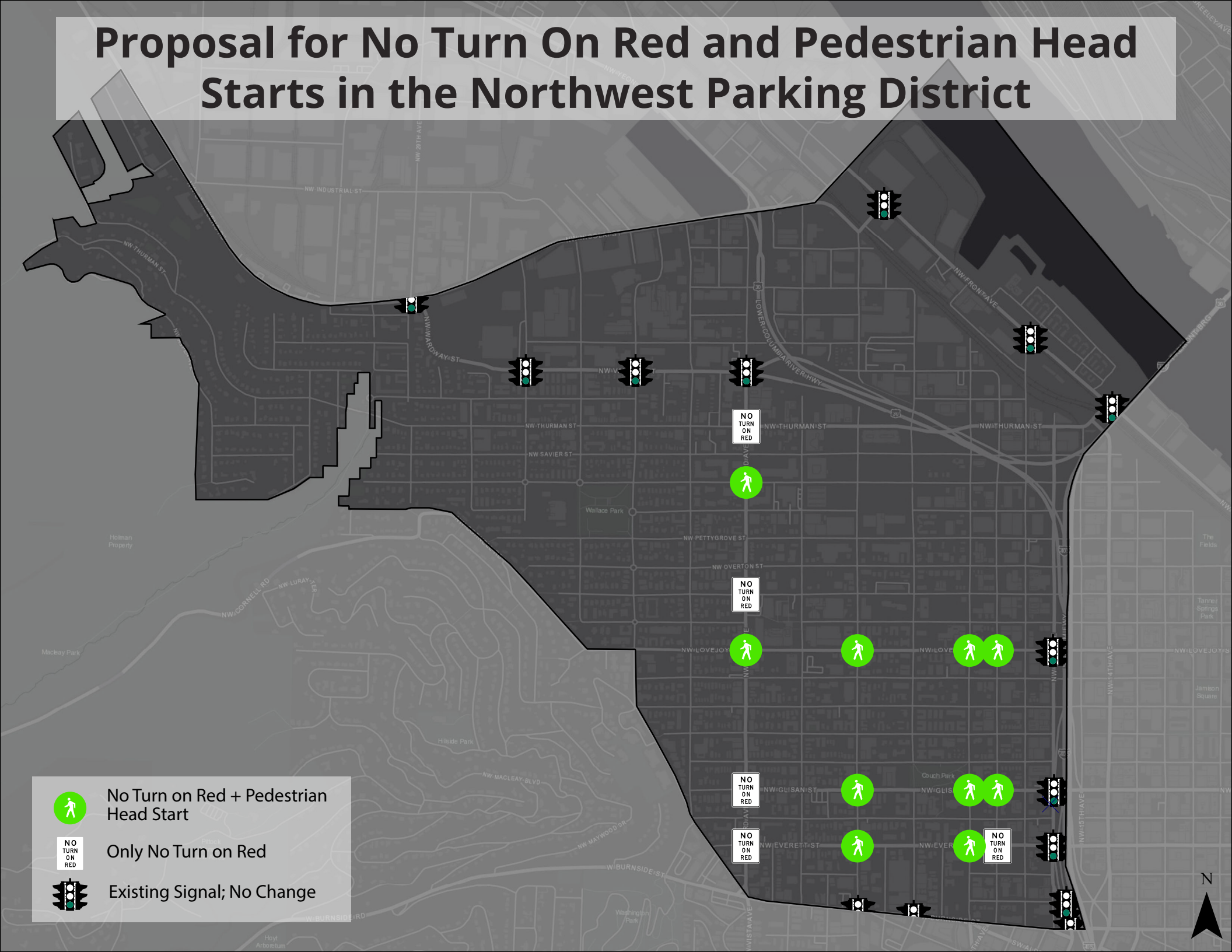
PBOT believes the Northwest neighborhood offers a promising opportunity to pursue a systemic, district-wide approach to improving pedestrian safety and comfort at signalized intersections with Pedestrian Head Starts paired with “no turn on red.” This effort is aligned with the systemic and preventative principles of Vision Zero. We urge consideration of this proposal for the use of Northwest Parking District revenue to implement this project.

---

[i] A.C. Fayish and Frank Gross, “Safety effectiveness of leading pedestrian intervals evaluated by a before–after study with comparison groups,” Transportation Research Record No. 2198 (2010): 15–22.

[ii] J. Wolfgram, R. Fish, W. Raja, and R. Jain, “Analysis of expanded no turn on red applications in Washington, DC, USA,” Institute of Transportation Engineers (ITE), ITE Journal No. 92 (2022): 40 – 44.

Proposal for No Turn On Red and Pedestrian Head Starts in the Northwest Parking District



Shutterstock/Lamont Smalls

Analysis of Expanded No Turn on Red Applications in Washington, DC, USA

By Joshua Wolfgram, P.E., PTOE, RSP1 (M), Robin Fish, P.E., PTOE, RSP1, Wasim Raja, P.E. (M), and Rahul Jain, P.E., PTOE (M)

The Vision Zero program in the District of Columbia, USA (the District), aims to eliminate traffic fatalities and serious injuries by 2024 through solutions focused on engineering, education, and enforcement programs. No Turn on Red (NTOR) is one of several engineering solutions identified in the program for rapid design and implementation. Currently, limited federal or local guidance is available to aid in the selection, implementation, and evaluation of right-turn-on-red restrictions on a large scale. Rather, NTOR prohibitions are traditionally evaluated on a case-by-case basis.

In late 2018, the District Department of Transportation (DDOT) selected 100 pilot locations for NTOR implementation to protect non-motorized roadway users such as pedestrians, schoolchildren, and cyclists. The selection process was based on the level of pedestrian activity, proximity to pedestrian generators (such as schools or metro stations), crash history, and geometric or operational characteristics. The project team completed a before-and-after study to quantify and assess the impact of these new restrictions to determine if future expansion of the restrictions was feasible.

NTOR restrictions have previously been implemented in the District based on prior studies and analysis. Therefore, some of the pilot locations had a partial (time of day) or full-time NTOR restriction on one or more approaches in the before condition. However, the partial restrictions were changed into full-time restrictions and the new signs were installed at consistent, highly visible locations at each intersection.

Observations and Analysis

1. Data Collection.

The AM and PM peak hours for the study intersections occurred between 7:00 a.m. and 9:00 a.m. and 4:15 p.m. to 6:15 p.m., respectively. Off-peak hours were defined as 11:00 a.m. to 1:00 p.m. and 7:00 p.m. to 8:00 p.m. for the afternoon and evening periods, respectively. The "before" or pre-evaluation was conducted from February 2019 to March 2019. The "after" or post-evaluation was conducted from April 2019 to May 2019 after an adjustment period of at least 4 weeks following installation of the new NTOR signs. Data was available for both the before and after periods at 74 locations, which were the focus of this study.

Each intersection was surveyed during a peak hour and off-peak hour. Intersections were assigned to either an AM Peak or PM Peak based on the whichever peak had the higher total right turning volumes. Afternoon off-peaks were assigned to AM locations and evening off-peaks were assigned to PM locations.

2. Field Observations and Measurements

The following data were collected for each intersection:

- **Vehicle and Pedestrian Conflicts.** Events where a vehicle failed to yield to the pedestrians crossing were recorded during green intervals and red intervals at parallel and perpendicular crosswalks, respectively. Unsafe turning maneuvers were recorded in both crosswalks to determine if more conflicts will occur during the green interval since vehicles are not permitted to turn right on red.
- **Vehicle to Vehicle Conflicts.** This type of conflict results from a right-turn-on-red maneuver where a vehicle accepts an inadequate gap when turning right. The event was recorded only if this maneuver caused the conflicting through vehicle to brake or take other evasive actions.
- **Crosswalk Encroachment.** Encroachment occurs when right-turning vehicles pull past the stop bar to wait in the crosswalk for an acceptable turning gap during the red interval. This is undesirable as vehicles can interfere with crossing pedestrians and/or cyclists. This event was recorded each time the front tires of a vehicle obstructed the crosswalk pavement markings of a perpendicular crosswalk, regardless of whether there was a pedestrian in the crosswalk. To be counted as an encroachment, the observer had to note the vehicle pausing in the crosswalk for any length of time. Continuous right-turn-on-red movements were not counted as they did not create an obstruction for pedestrians.
- **Compliance with NTOR Signs.** Drivers turning right on red despite NTOR signage were recorded as NTOR violations. This action may or may not have resulted in a conflict with pedestrians or vehicles as described in the sections above.
- **Queue Measurements.** Observers recorded the maximum queue (total stopped vehicles) in the rightmost lane at the end of the red interval of each cycle. At the end of the green interval, the observer recorded the number of vehicles in queue that successfully cleared the intersection.
- **Cycle Failures.** Observers recorded any residual queue that had arrived during the previous red interval and did not clear during the following green interval. Residual queues were labeled cycle failures.

3. Design Approach

The new regulatory R10-11 signs implemented at the 100 pilot intersections followed the *Manual on Uniform Traffic Control Devices* (MUTCD) standards. All existing signs were replaced by standard R10-11 signs with retroreflective white color backgrounds and a diagrammatic "Red Ball" graphic. The new signs were attached to mast arms (if present) or to the pole directly below/above the rightmost signal head to provide maximum visibility. In addition, supplemental near-side NTOR signs were placed on all approaches where the stop bar was greater than 120 feet (ft.) (36.6 meters) from the far-side sign.

Figure 1 illustrates some examples of the existing signs (on the left) that were replaced with new R10-11 "Red Ball" NTOR signs (on the right).

Current DC law prohibits right turn against a red arrow signal display. One of the objectives of this study was to determine if the installation of R10-11(1) "NO TURN ON RED ARROW" signs improved compliance with this law.

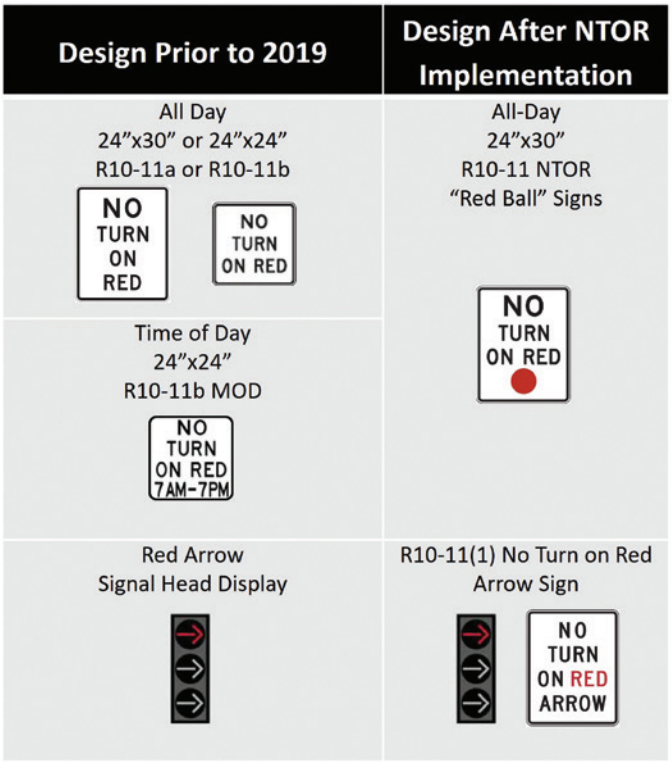


Figure 1. Changes in No Turn on Red Regulatory Signage.

4. Summarized Results

Following the before and after observation periods, the safety, compliance and operational data was evaluated to determine the impacts of NTOR implementation. Safety data for the three undesirable driving behaviors (i.e., failure to yield to pedestrians, crosswalk encroachment, and vehicle-vehicle conflicts) was compared in the before and after conditions. Driver compliance after implementing NTOR was compared to compliance in the before condition at locations with previous time of day or All-Day restrictions, as well as at locations where only a red arrow signal display was present. In addition, maximum queue lengths and residual queues were compared to identify any operational impacts as a result of NTOR implementation. In total, the 74 observed intersections yielded evaluations of 252 unique approaches.

5. Pedestrian and Vehicle Safety

This study evaluated the safety impacts of implementing NTOR restrictions at all times and all applicable approaches of the 74 study intersections based on the performance measures shown in Table 1. These results are aggregated across all approaches and observation periods.

Reductions in failure to yield behaviors were observed during both the green and red intervals. These reductions indicate that NTOR implementation did not increase aggressive turning behavior during the green interval. Instead, the data suggests that since drivers are at a complete stop when the green interval begins, they may yield completely to pedestrians before completing legal right turn maneuvers on green. In addition, Vehicle to Vehicle conflicts were nearly eliminated, showing a 97 percent reduction following NTOR implementation.

Table 1. Safety Compliance Measures.

Performance Measure	Observations Before	Observations After	Percent Change
Vehicle-Vehicle Conflict (Red Interval)	124	4	-97%
Failure to Yield to Pedestrians (Green Interval)	322	132	-59%
Failure to Yield to Pedestrians (Red Interval)	166	13	-92%
Crosswalk Encroachment	604	787	+30%

While the failure to yield behavior metrics showed improvements when aggregated across all 252 approaches, four approaches experienced increases in failure to yield during green behaviors. This suggests that while overall there is a safety benefit to NTOR implementation, there are locations where NTOR implementation may in fact increase conflicts between turning vehicles and pedestrians. Further analysis should be conducted to determine the site-specific characteristics that would lead to these outcomes. A cursory evaluation shows that the locations with increased conflicts are capacity-constrained intersections, suggesting that as drivers become impatient, they will be less likely to yield to pedestrians, even with NTOR.

As shown in Table 1, crosswalk encroachment behavior increased by 30 percent after implementing NTOR restrictions. The combination of this increase with the reduction in failure to yield behavior suggests that many vehicles were accustomed to turning right on red in the "before" condition and began to encroach into the crosswalk. However, upon detecting the new NTOR signs, drivers did not complete the illegal right-turn-on-red movement and therefore remained in the crosswalk. This was confirmed by the field observations. It is possible that subsequent study of these locations could reveal a reduction in the crosswalk encroachment behavior as drivers become more familiar with the new NTOR restrictions.

6. Compliance

The compliance with new NTOR restrictions was evaluated based on the type of restriction in place in the before condition. Table 2 shows this comparison by observation period. Where no restriction previously existed, the percent change is not reported.

The field data shows a reduction in NTOR violations in the three remaining scenarios (i.e., at locations with an existing NTOR restriction in the before condition) when evaluated by observation period. Increased compliance is likely due to better

Table 2. NTOR Compliance.

Pre-Implementation Restriction	Number of Approaches	Violations Before	Violations After	Percent Change	Violations per Hour
AM Peak (7:00 a.m. – 9:00 a.m.)					
None	75	N/A	60	N/A	1.6
Time of Day (7 a.m. to 7 p.m.)	14	10	6	-40%	0.86
All-Day	13	15	8	-47%	1.2
Red Arrow Signal Display	0	N/A	N/A	N/A	N/A
Afternoon Off-Peak (11:00 a.m. – 1:00 p.m.)					
None	75	N/A	43	N/A	1.1
Time of Day (7 a.m. to 7 p.m.)	14	11	5	-55%	0.71
All-Day	13	18	5	-72%	0.76
Red Arrow Signal Display	0	N/A	N/A	N/A	N/A
PM Peak (4:15 p.m. – 6:00 p.m.)					
None	99	N/A	93	N/A	1.9
Time of Day (7 a.m. to 7 p.m.)	32	37	26	-30%	1.6
All-Day	17	16	11	-31%	1.3
Red Arrow Signal Display	2	80	29	-64%	29
Evening Off-Peak (7:00 p.m. – 8:00 p.m.)					
None	99	N/A	70	N/A	1.4
Time of Day (7 a.m. to 7 p.m.)	32	N/A	14	N/A	0.88
All-Day	17	23	8	-65%	0.94
Red Arrow Signal Display	2	41	10	-76%	10

signage visibility when converting to signs with better reflectivity, uniform placement, and consistent messaging. The study recognizes that the minimum adjustment period lasted only 4 weeks and may have contributed to a higher compliance with new regulatory signs, especially where new restrictions were implemented. Also, the sample size for the red arrow signal display category is only two locations. Additional locations should be observed with Red Arrow Signal Displays and supplementary R10-11(1) signs to test the transferability of these results.

7. Queues

Maximum right turn queue lengths were recorded as a measurement for operational performance. Queue lengths in the after condition were compared against the queues recorded in the before condition to identify locations that were adversely impacted due to new NTOR restrictions. The average and maximum number of right turn vehicles queued can be found in **Table 3**.

Table 3. Before-After Comparison of Right Turn Queues (# of vehicles).

Observation Period	Avg. Queue Before	Avg. Queue After	Max Queue Before	Max Queue After
AM Peak	2.78	3.22	20	22
Mid-Day Off-Peak	1.87	2.08	16	20
PM Peak	3.68	3.89	29	36
Evening Off-Peak	1.84	2.37	15	19

No observation period saw an average queue increase greater than one; however, maximum queues increased for all peaks. This suggests that while the magnitude of queueing did not increase considerably, there is potential for greater variation from cycle to cycle and higher maximum queues. The PM peak observation period contained the locations with the highest magnitude of queue increases, with locations ranging from two additional vehicles up to 23 additional vehicles. However, most locations did not see substantial increases in queueing, with 121 approaches (81 percent) having less than two additional vehicles queued in the PM peak.

These minimal impacts to traffic operations were expected, given that the pilot locations were prescreened to identify potential impacts to traffic operations. Similar results showing minimal impacts to traffic operations should not be assumed at future NTOR implementations without conducting similar traffic operations analysis.

8. Cycle Failures (Residual Queues)

Queue increases alone do not necessarily indicate a traffic operations concern if the intersection can still serve the additional queued vehicles during the following green interval. Therefore, in addition to queueing data, discharge rates were recorded to calculate increases in cycle failures (or residual queueing). Of the 504 approaches observed (252 unique approaches observed for two observation periods), 17 unique approaches (3 percent) were found to have additional cycle failures following NTOR implementation. The overall low number of approaches with cycle failures indicates that even where queues increased as a result of NTOR implementation, the majority of intersections had enough capacity to accommodate these queued vehicles. In response to the locations that did experience additional residual queues, the project team used the citywide traffic signal optimization program to evaluate signal timing changes to mitigate residual queue increases.

Conclusions and Findings

Currently, limited federal or local guidance is available to practitioners seeking to expand applications of NTOR. This pilot program and study sought to document the safety, compliance,

and operational impacts of new NTOR installations in an urban environment.

The outcomes of this study indicate potentially positive effects of NTOR restrictions that can serve as a basis for developing a standardized methodology that considers both peak and off-peak vehicle and pedestrian demands. The placement of new NTOR signs decreased overall right turn conflicts between pedestrians and vehicles across the study intersections. In addition, NTOR restriction compliance improved under the new R10-11 signs and uniform standards for installation across all intersections. These improvements came at overall minor impacts to traffic operations. These findings have helped the District identify a low-cost safety tool that will help in its pursuit of Vision Zero.

Figure 2. No Turn on Red Installation at 15th Street and Independence Avenue, SW.

The following recommendations were made:

- Maintain new NTOR restrictions at the 100 pilot locations, with further analysis to be conducted at the 17 approaches that experienced additional cycles failures and the five approaches that experienced increases in vehicle-pedestrian conflicts.
- Evaluate future locations for NTOR implementation using site-specific geometric and operations analysis. The operational prescreening ensured low impacts to traffic operations were observed; similar prescreening will benefit future implementations.
- Future signal designs should incorporate the R10-11 and R10-11(1) signs as a standard where applicable to improve compliance. Future signal designs should also incorporate the sign placement standards used in the designs for the pilot NTOR locations (i.e., installation of NTOR signs on mast arms where feasible, and installation of supplemental near-side signs when the far-side sign is greater than 120 ft. from the stop bar). **itej**

Joshua Wolfgram, P.E., PTOE, RSP1 (M) *is a project engineer in the Mid-Atlantic Traffic Engineering & ITS Department at Mead & Hunt. His experience spans traffic signal operations, traffic safety, multimodal analysis and design, and traffic signal design. Joshua strives to deliver innovative, effective traffic solutions that benefit clients and promote equity and mobility for communities.*

Robin Fish, P.E., PTOE, RSP1 *is the Washington, DC office manager and a senior project manager in the Mid-Atlantic Traffic Engineering & ITS Department at Mead & Hunt. Robin oversees all aspects of traffic engineering for the DC office, including traffic signal operations, traffic signal and ITS design, traffic safety, and multi-modal corridor design. He leads a team of talented traffic engineers and analysts to bring safe and efficient transportation solutions to the District of Columbia and the surrounding region.*

Wasim Raja, P.E. (M) *leads DDOT's Traffic Engineering and Safety Division (TESD) which focuses on improving District's multimodal transportation system by designing and constructing traffic safety projects. Over the last 12 years, Wasim and his team have implemented more than 500 intersection modification projects to improve safety and mobility of multimodal traffic in DC. Prior to joining DDOT, he oversaw public and private sector projects involving design, construction, maintenance, and operation of multimodal traffic systems; traffic engineering and safety studies; traffic signal optimization; transportation management planning; and transit signal prioritization.*

Rahul Jain, P.E., PTOE (M) *is a senior transportation engineer with the District Department of Transportation. He is responsible for overseeing major transportation projects and engineering contracts to ensure engineering standards and contractual requirements are met at all levels of planning and design. Rahul serves as a technical liaison with internal staff and external stakeholders on planning, analysis, and design aspects of various operational and safety improvement projects.*