# Evaluation of a Rectangular Rapid Flashing Beacon system at Belmont Ridge Road and W&OD Trail mid-block crosswalk

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Land development planning trends for more than the past decade have embraced the concept of walkable and bicycle-friendly communities. When planning a shared use path for pedestrians and biking use, most planners and engineers would agree, the safest design scenario involves a path isolated from the highway travel lanes to provide significant separation from the higher-speed traffic.

Despite the efforts to plan for off-route paths, when developing shared use paths in both urban and rural areas, the path must cross the highway, and thus safety is jeopardized unless adequate means are in place to mitigate the risks.

**Figure 1 – Belmont Ridge Road at the W&OD crossing looking north**

Since the 1950s, much of the public park amenities in northern Virginia have been under the management of the Northern Virginia Regional Park Authority (NVRPA). Today, NVRPA parks represents three counties—Arlington, Fairfax and Loudoun—and three cities—the City of Alexandria, the City of Falls Church and the City of Fairfax. NVRPA Parks encompass almost 11,000 acres of woodlands, streams and rolling Virginia countryside. NVRPA's assets include 31 regional parks featuring golf courses, swimming pools, hiking trails and much more.

One of the most popular parks in the NVRPA program is the Washington & Old Dominion (W&OD) Shared Use Trail. In 1987, the W&OD Trail was designated a National Recreation Trail by the U.S. Department of the Interior and is a very popular recreation destination for bicyclists, walkers and runners. It is also used regularly by bicyclists and pedestrians as a route from home, direct or via the Washington Metro, to work and to shopping. Between two and three million people use the W&OD trail each year, thus making it one of the most successful rail-trails in the nation.

The entire 45-mile trail is nine-feet-wide asphalt and a painted yellow centerline. The trail terminus is located in Purcellville, Va., in Loudoun County and connects with the Mount Vernon Trail in Arlington, Va.

As this trail meanders through some of the most urbanized areas in northern Virginia, the trail crosses numerous high-speed, high-volume highways, thus creating a conflict point for the modes of transportation using the highway and trail routes.

In 2009, the Virginia Department of Transportation (VDOT) installed experimental zigzag pavement markings on Belmont Ridge Road in advance of the W&OD trail crossing. Belmont Ridge Road was chosen because of its high posted speed limit (45 mph), high traffic volumes (17,800 vehicles per day), roadway geometry (sharp vertical and horizontal curvature), high trail volumes and motorists' limited sight distance approaching the trail.[1] The purpose of the zigzag pavement markings was to increase motorist awareness in advance of the mid-block crossing location. Although the results of Dougald's research indicated the zigzag markings had a positive response for the intended objective, VDOT continued to receive complaints and concerns from trail users about the safety issues at this location. In 2011, the NVRPA commissioned an evaluation of their crossing locations along the Trail. The *Existing Conditions Report*[2] included an evaluation of six crossing locations, including the Belmont Ridge Road crossing. From the report, the NVRPA further developed a series of recommendations to improve trail safety.

Among the recommendations was the installation of a Rectangular Rapid Flashing Beacon (RRFB) system to supplement the existing zigzag markings.

## RRFB

RRFBs are user-actuated amber light-emitting diodes that supplement warning signs at unsignalized intersections or mid-block crosswalks and are a lower cost alternative to traffic signals.

The Federal Highway Administration created the opportunity for use of the RRFB in limited circumstances in 2008.[3] In 2011, VDOT obtained authorization from the FHWA for statewide interim use of the RRFBs.

Following authorization from the FHWA, the VDOT Traffic Engineering Division established guidance to its district offices for the FFRB system installations. The guidance included the following basic criteria for FFRB installations:

- >20 pedestrians in the peak hour
- Crosswalk is justified from an engineering analysis and MUTCD compliant with marking and signs
- Other options have been reviewed and determined by engineering judgement not to be applicable.

In April 2013, VDOT installed the RRFB system that included two units on each side of the W&OD Trail crossing.

The Virginia Center for Transportation Innovation and Research under contract with the FHWA completed a study to evaluate the utility, effectiveness and safety of the RRFB system. The report was released in May 2015.[4] The study scope included an evaluation one year following the initial installation. In a separate study, crash data will be evaluated for the three-year period before and after installation.

## Site Conditions/Installation

The trail, which runs east/west in relation to Belmont Ridge Road, has yellow skip lines that run down the centerline. As the trail approaches Belmont Ridge Road, in both directions, the skip lines become solid. Additionally other pavement markings and trail rumble strips and stencils indicating "ROAD XING" and "STOP" are located on each trail approach to the crossing. Signage on the trail includes an advance STOP warning sign with a placard stating "CAUTION HIGH SPEED HIGH VOLUME TRAFFIC CROSSING AHEAD" and double-mounted STOP signs at the crossing.

Belmont Ridge Road is a two-lane secondary road with a speed limit of 45 mph that runs generally in a north/south direction. In 2013, an operational analysis of Belmont Ridge Road revealed a regular level of service D and average daily traffic of nearly 18,000 vpd. Approximately six-percent of the traffic composition is heavy trucks. The geometry of Belmont Ridge Road consists of downhill grades on both the north and south approaches to the crossing. The northbound approach has a horizontal curve that decreases the viewing distance of the crossing, as opposed to the southbound approach, which has a relatively straight line of sight to the crossing.

To aid in addressing the sight distance deficiencies the NVRPA study recommended the elimination of parking near the trail, cleared vegetation and realigned access paths for pedestrians to reach the trail from Belmont Ridge Road.

The RRFB system includes two poles located on the east and west side of Belmont Ridge Road crosswalk. At the crosswalk, each pole is mounted with double-sided W11-15 fluorescent yellow-green bicycle/pedestrian signs; W16-7P arrow signs; and high-performance SB345 RRFBs.

In addition, each pole has an SC315 network controller, a solar panel to power the network controller for wireless transmission of the RRFBs on the upstream poles. The pressure-activated push button is compliant with the Americans with Disabilities Act (ADA) and MUTCD.

When activated, the RRFB emits rapid, alternating amber LED bursts of light to warn motorists that trail users are at the crossing. According to manufacturer's specifications, the pulses of light can be seen during daylight and nighttime at distances >1,000 feet and in certain situations >1 mile. Upon activation, the LED light stays on for 20 seconds, a time established by engineering analysis based on the crossing geometry and typical walking speed.

Figure 2 – RRFB and warning signs

## Data Collection

Data was collected in the earlier zigzag study and used as the before baseline. Trail and roadway activity on each approach was analyzed using inconspicuously mounted video cameras after the installation of the RRFB system.

Following the video data collection, the video was reviewed and data was tabulated for discrete trail user crossing events. The data tabulations included the following:

- Mode of crossing (walk, bike, etc.)
- Direction of crossing
- Dismount or stop (yes/no)
- Motorist yield (yes/no), and
- Direction of yield.

Vehicle speed data was collected using a LIDAR traffic counter one week after the RRFB installation. The purpose of the speed data collection was to analyze motorist reaction (in terms of speed) when a trail user activated the RRFBs and to compare the results with two sets of before data.

To gauge opinions of the RRFB system, surveys were administered to trail users onsite at the W&OD trail and online to bicycle clubs, one year after the installation. The survey was designed to ascertain the overall opinions of the RRFB system held by frequent and infrequent trail users.

After the number of potential RRFB activations were determined, the data was analyzed to find the RRFB activation rate:

Table 1 – RRFB Activation Rate

| Time Period | Crossings | Activations | Rate |
|---|---|---|---|
| 3 weeks after | 2,336 | 557 | 23.8% |
| 5 Mos. after | 1,849 | 542 | 29.3% |
| 1 Yr. after | 2,256 | 616 | 27.3% |
| Total | 6,441 | 1,715 | 26.6% |

An analysis of vehicles yielding to pedestrians or bicyclists was conducted. To account for the negative effect on the data from following cars in a platoon, only the leading car was observed.

Instances of immediate yields with no activation of the RRFB one year after the installation for all modes of crossing traffic revealed that in 32 percent of the crossings, the motorists yielded without activation of the RRFB—as contrasted with 50 percent of the motorists yielding to the crossing trail traffic when the RRFB was activated by the trail user.

Vehicle speed on approach to the crossing is one of the most difficult behaviors to modify. Speed data following the installation of the RRFBs was compared with prior data from before the installation of the zigzag markings and one year following the installation of the markings.

## Conclusions

The research of Dougald revealed positive responses to the installation of the RRFB at the Belmont Ridge Road and W&OD Trail crossing. The published findings include:

- RRFB systems have a positive effect on motorist yield rates.

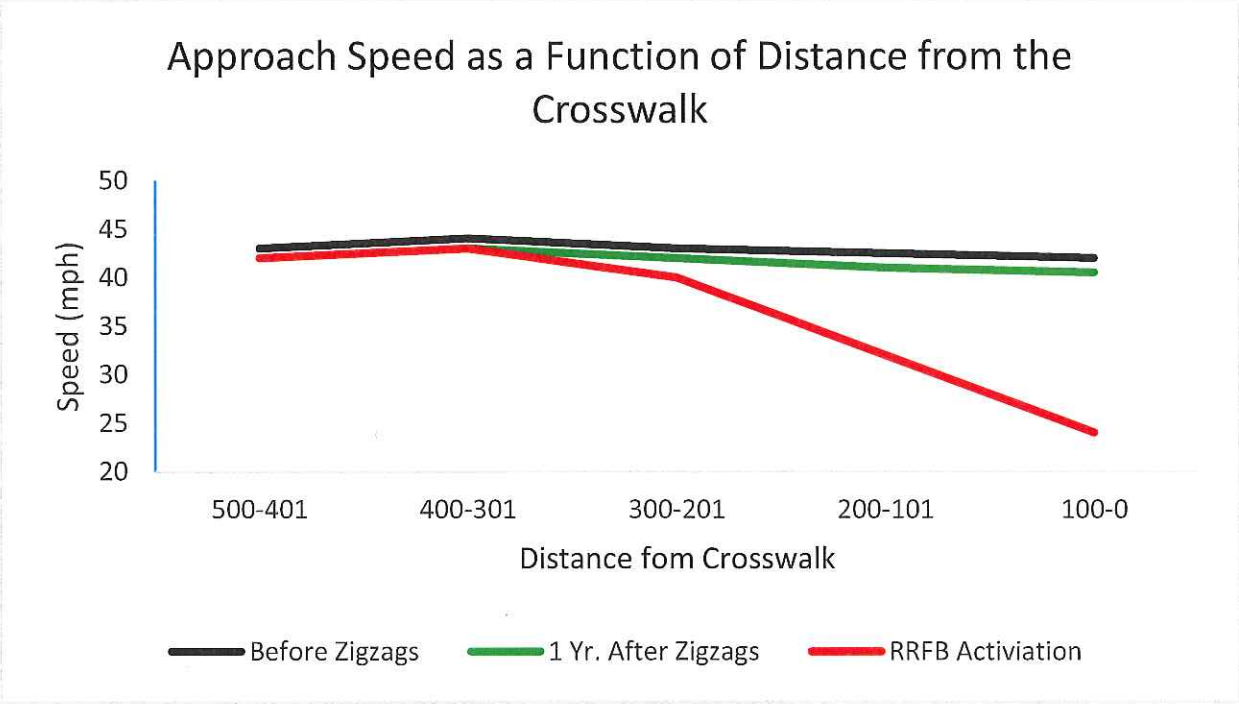


**Figure 3 – Approach Speed as a Function of Distance from the Crosswalk**

- RRFB system installed at the Belmont Ridge Road location has had a positive effect on motorist awareness.
- RRFB system is perceived by trail users as an enhancement to safety at the Belmont Ridge Road crossing.
- Trail user perception of the RRFB system benefits grew over time.
- There is a correlation between trail user activation of the RRFB system and the presence of traffic.
- W&OD Trail users are confused as to who has the right-of-way at the crossing location.

The study by Dougald found that the RRFB system enhanced safety at the crossing of Belmont Ridge Road and the W&OD Trail by increasing motorist awareness of pedestrians and bicyclists. This is evidenced by higher yield rates, motorist reductions, and trail user perception of increased safety. Motorist inattention and excessive approach speed are often contributing factors in a crash involving a pedestrian or bicyclist. It is logical to assume, therefore, that the RRFB system can lead to a reduction in crashes, both between a vehicle and a pedestrian or bicyclist and between vehicles.

The full Evaluation of a Rectangular Rapid Flashing Beacon System at Belmont Ridge Road and W&OD Trail Mid-Block Crosswalk study can be found online at: http://www.virginiadot.org/vtrc/main/online_reports/pdf/12-r22.pdf.

*Disclaimer:* The author of this article was not associated with the research activity described herein. Technical questions and credit for the research is attributed to Mr. Lance E. Dougald, Research Scientist with the Virginia Center for Transportation Innovation and Research, Charlottesville, Va. Mr. Dougald can be reached at (434) 293-1938 or Lance.Dougald@VDOT.Virginia.gov.

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[3] FHWA. MUTCD – Interim Approval for Optional Use of Rectangular Rapid Flashing Beacons, July 2008. http://mutcd.fhwa.dot.gov/resources/interim_approval/ia11/ia11_rrfb_iapmemo.pdf

[4] Dougald, L.E. Evaluation of Rectangular Rapid Flashing Beacon System at Belmont Ridge Road and W&OD Trail Mid-Block Crosswalk. http://www.virginiadot.org/vtrc/main/online_reports/pdf/15-r22.pdf