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Safety of Highway-Rail Grade Crossings

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December 2006
Final Report

always expect a train

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13. ABSTRACT (Maximum 200 words)

The Public Education and Enforcement Research Study (PEERS) was a collaborative effort between the Federal Railroad Administration, the Illinois Commerce Commission, and local communities in the State of Illinois. The purpose of the project was to promote safety at highway-rail intersections by reducing incidents, injuries, and fatalities through new technologies and methodologies. The role of the John A. Volpe National Transportation Systems Center was to monitor and evaluate highway-rail intersections in Illinois communities using video data collection while the communities conducted education and enforcement campaigns. The data collection and analysis efforts focused on three highway-rail intersections in Arlington Heights, IL. The effectiveness of the programs was determined by counting the number of motorists and pedestrians that violated the crossing warning devices during three project phases. These violations were divided into three types based on highway-user assumed risk. The crossings in Arlington Heights saw an overall reduction in violations from the pre-test to the post-test of 30.7 percent. The largest reduction, 71.4 percent, occurred in the most risky type of violation, type III. Pedestrians most often committed these types of violations. At the crossing with an adjacent commuter rail station, a reduction of 76.3 percent occurred in the most risky pedestrian violations. Overall, highway-user behavior changed for the safer during the study, and pedestrians, especially commuters, were the most affected by the PEERS programs.

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Appreciation is also due to Union Pacific, Metra, and Burlington Northern Santa Fe railroads and their employees, as well as town employees from Arlington Heights, Bartlett, and Macomb, IL, for their much-needed cooperation to keep the field systems running. Operation Lifesaver, Inc. volunteers deserve thanks for the energy and time spent promoting crossing safety. The local law enforcement officers who participated and public utilities commission employees who created educational materials are acknowledged for their dedication to educating the public in rail safety issues.

The authors would also like to acknowledge USDOT Volpe National Transportation Systems Center (Volpe Center) team members. Anya A. Carroll, Principal Investigator, Highway-Rail Grade Crossing Safety Research, Volpe Center, provided overall direction and invaluable guidance and leadership. William Baron, Volpe Center, and Alan Kauffman, CSC, installed all field systems and maintained them for the project's life. Barry Mickela and Andy Lam, both of the Volpe Center, provided technical leadership. Steven Peck, Volpe Center, supplied technical support. Frank Foderaro, Volpe Center, analyzed the data and organized the results. Cassandra Oxley of CASE, LLC, provided the report editing and formatting.

Finally, Tashi Ngamdung, John Mayers, Perla Garcia, Avinash Rao, and Malachi Hul, all of the Volpe Center, contributed countless hours to viewing the video data and populating the database.

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Executive Summary

Under sponsorship from the United States Department of Transportation (USDOT), Federal Railroad Administration (FRA), the John A. Volpe National Transportation Systems Center (Volpe Center) participated in the Public Education and Enforcement Research Study (PEERS). The Volpe Center monitored eight highway-rail grade crossings in three communities in the State of Illinois to determine the effectiveness of safety education and enforcement programs. Cameras collected video images of the crossings when warning devices were activated. The communities participating in the study sporadically conducted education and enforcement programs for 12 months. The Volpe Center team collected video images for 16 months: 2 months of pre-test data, 12 months of data while the safety programs were conducted, and 2 months of post-test data.

This report focuses on the results from the community of Arlington Heights, IL, where the Volpe Center team monitored three highway-rail grade crossings at Arlington Heights Road, Evergreen Avenue, and Dunton Avenue. The crossings are in close proximity, about 700 feet apart; and all have two-quadrant gates, flashing lights, and bells. A Northeastern Illinois Regional Commuter Rail (Metra) station is adjacent to the Dunton Avenue crossing. The station produces considerable pedestrian activity at the crossing.

The Volpe Center team analyzed the video images collected for pedestrian and motorist violations of the crossing warning devices. The violations were divided in three types based on the amount of risk in the highway-user's behavior: (1) a type I violation occurs when a motorist or pedestrian enters the crossing when the warning lights are flashing but before the gate arms have begun to move; (2) a type II violation happens when a highway-user enters the crossing when the gate arms are in motion, either in their descent (before train arrival) or ascent (after train departure); (3) a type III violation occurs as a highway-user enters the crossing after the gate arms are in their horizontal position.

The PEERS project can be deemed a success if one of two goals are met. The first goal is for the research to produce meaningful, transferable results. The amount of data collected must be sufficient to determine the effectiveness of the treatments. A sufficient sample size indicates that the analyses and results gathered from the data would be able to be replicated in other environments under similar circumstances. This goal was met; the Volpe Center team recorded over 60,000 train events and 120,000 violations.

The second goal is for the PEERS program to be effective in changing behavior around highway-rail grade crossings. The programs are considered successful if the violation rate is reduced by 50 percent over the course of the study. The violation rate was calculated as the violation count for a given time period divided by the associated number of train events. For the three grade crossings in Arlington Heights, the violation rate for the three types combined was reduced by 30.92 percent from the pre-test to the post-test period.

Although the 50 percent reduction goal was not achieved when examining all three grade crossings as a whole, the study included plans to examine the violation rates individually. The following are areas in which the PEERS programs were considered a success. Analysis of the violation rate by type revealed a 71.4 percent decrease from pre-test to post-test period for the most risky, or type III, violations. Further segregation by type of violation and mode of transportation revealed successful reductions from the pre-test to post-test periods, in both pedestrian type I (61 percent) and pedestrian type III (71 percent) violation rates. Finally, when considering the individual crossings, the Dunton Avenue crossing experienced a successful reduction from pre-test to post-test periods in pedestrian type III violations (76.3 percent).

One of the most effective education and enforcement programs were the crossing safety blitzes. These occur when police officers at highway-rail grade crossings encourage and enforce good safety practices. Violation rates on days when blitz activity occurred were lower than other days in the test period. The data suggests that pedestrians responded more positively than motorists to the crossing safety blitzes. The results of this study suggest the PEERS programs were most effective in reducing the most dangerous pedestrian behaviors and were especially effective on commuters who were regularly exposed to enhanced education and enforcement programs.

1.0 Introduction

1.1 Background

The USDOT Volpe Center provides technical support to FRA on all aspects of highway-rail grade crossing safety research, as well as rail safety research in general. One major effort has been to develop a more precise understanding of what risks are present at grade crossings and how best to decrease or eliminate these various risk elements. The Volpe Center has supported FRA since 1971 in the conduct of grade crossing safety research. Significant progress has been made in improving the safety of public highway-rail grade crossings. Although both motor vehicle and train traffic have increased for the years between 1993 and 2003, data have shown that the number of collisions at grade crossings has decreased by 41 percent, from 4,892 to 2,909, respectively. More importantly, the number of fatalities has declined from 626 to 325 (48 percent). A more recent data snapshot shows that since 2000, collisions at grade crossings have declined by 16.4 percent, fatalities by 22.6 percent, and injuries by 17.8 percent. Though these trends are all positive, the challenge is to continue to improve the safety of highway-rail grade crossings since they represent a significant portion of the overall risk from highway and railroad operations.

In the State of Illinois, over 63 percent of all highway-rail grade crossing collisions occur at crossings where active warning devices exist. In 1994, the USDOT's *Grade Crossing Action Plan Support Proposals* [1] set a goal to reduce grade crossing collisions and fatalities nationwide by 50 percent over 10 years. Education and enforcement were two of the six broad categories undertaken by USDOT to meet this goal. In 2004, the *Secretary's Action Plan on Highway-Rail Crossing Safety and Trespass Prevention* [2] identified expanding educational outreach and energizing enforcement as key elements. PEERS analyzed the implementation of education and enforcement programs as an alternative safety measure (ASM) at active grade crossings in Illinois.

1.2 Research Origin

The Federal Railroad Safety Authorization Act of 1994 (Public Law 103-440, November 2, 1994) required that every train approaching a highway-rail grade crossing sound the locomotive horn. A community may be exempt from this requirement if horn silence is determined not to present significant risk with respect to loss of life or injury, or a supplemental safety measure (SSM) exists that fully compensates for the absence of the locomotive horn. In 2000, FRA announced the Notice of Proposed Rule Making on the Use of Locomotive Horns at Highway-Rail Grade Crossings. The rule proposed guidelines and firm criteria to silence a train horn at a grade crossing. Under the Final Rule on the Use of Locomotive Horns at Highway-Rail Grade Crossings published in 2004, a community must present a quiet zone risk index that does not exceed the crossing risk when the horn is sounded or that does not exceed the average national risk for gated, public crossings where train horns are sounded. This inspired a desire to evaluate low-cost safety measures to reduce the risk of grade crossing collisions and fatalities. Non-engineering ASMs, including programmed enforcement and public education and awareness, can be used in establishing a quiet zone to lower the quiet zone risk index. Each community must validate the effectiveness of the ASM with a documented violation rate reduction.

FRA and the Illinois Commerce Commission (ICC) provided matching funds to support a study of education and enforcement alternative safety measures. FRA and ICC bestowed grants on communities to establish a 12-month grade crossing safety education and enforcement program. The PEERS project also included a field operational test (FOT) of education and enforcement applications by an objective third party, the Volpe Center. The Volpe Center installed video cameras at selected grade crossings to monitor pedestrian and motor vehicle driver behavior. The focus of this report is the analysis of three crossings in Arlington Heights, IL, from July 1, 2003, through October 31, 2004.

2.0 Objective and Scope

2.1 Objective

The Volpe Center's role in the PEERS project was to observe driver and pedestrian behavior at highway-rail grade crossings. Specifically, the Volpe Center monitored the crossings for violations of the grade crossing warning devices. The first objective was determining whether enough data could be collected to provide significant and meaningful results about the effectiveness of education and enforcement activities. The final objective was for the Volpe Center to determine whether community education and/or enforcement activities were successful in significantly reducing the violation rate at the subject highway-rail grade crossings. Violation rate is the count of violations for a time period divided by the number of opportunities a violation can occur, established in this report as a train event. A train event is defined as any time the crossing warning devices are activated, either when a train is on approach or in the event of a false activation.

2.2 Project Success Definition

The PEERS project can be deemed a success if one of two goals are met. The first is for the research to produce meaningful, transferable results. The amount of data collected must be sufficient to determine the effectiveness of the treatments. A sufficient sample size indicates that the analyses and results gathered from the data could be replicated in other environments under similar circumstances.

The second goal is for the PEERS program to be effective in changing behavior at highway-rail grade crossings. The programs are considered successful if the violation rate is reduced by 50 percent over the course of the study. A reduction in violations corresponds to a reduction in incidents, therefore creating a safer environment. The report entitled *Photo Enforcement At Highway-Rail Grade Crossings in the United States: July 2000-July 2001* [3] provides case studies of violation reductions and corresponding reductions in incidents.

2.3 Assumptions

The evaluation team made no assumptions as to the quality, quantity, or usability of the data collected. Provided good data was collected, the following assumptions were made:

- Commercial, off-the-shelf equipment purchased would be reliable to collect FOT data.
- Video data would be transferred from the remote sites to the Volpe Center in Cambridge, MA, via the Internet.
- The Volpe Center would receive community activity plans to conduct case study analyses.
- Coordination among all parties involved would facilitate a productive work environment.
- Staff required to view and populate the database would be available to deliver timely results.

2.4 Overview

The PEERS evaluation project conducted by the Volpe Center was designed to analyze the effects of education and enforcement programs on motorist and pedestrian behavior at highway-rail grade crossings. In this report, the term pedestrian refers to all nonmotorized traffic (for example, walkers or bicyclists). ICC initially selected four cities to receive grants under the program. The program later expanded to include 22 participant communities.

Three of the four original communities, Arlington Heights, Bartlett, and Macomb, implemented similar, well-defined education and enforcement activities targeted at reducing or eliminating pedestrian and motorist violations at grade crossings. The fourth community, Downer's Grove, chose to evaluate photo enforcement as the selected SSM. Each community prepared a comprehensive plan that combined education and enforcement activities.

The communities enacted education and enforcement activities that focused on highway-rail grade crossing safety. Some activities were passive, including safety inserts with utility bills, radio and television public service announcements, poster campaigns, and train station public address announcements. Some initiatives were proactive and involved members of local law enforcement and the community. These included participation in the Officer on a Train program, sponsored by Operation Lifesaver, Inc., an increase in Operation Lifesaver presentations throughout the community, and police education and enforcement blitzes.

Three kinds of blitzes were scheduled sporadically throughout the life of the program. Information blitzes notified highway-users of the dangers associated with disobeying crossing warning devices. During both motorist and pedestrian enforcement blitzes, police officers issued citations to violators of the crossing warning devices. Figure 1 shows an example of a poster used in the safety campaign.

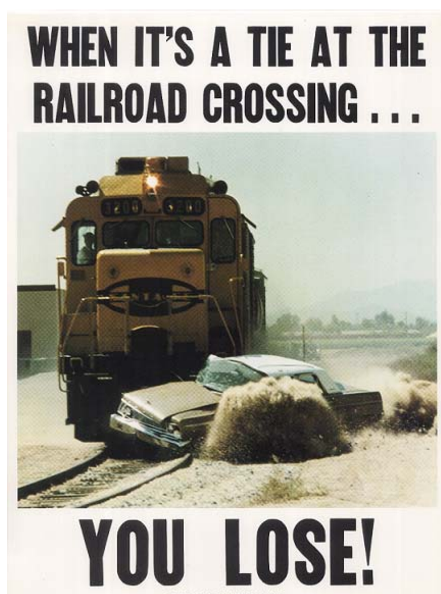


Figure 1. Sample Operation Lifesaver Safety Poster

To evaluate safety, the evaluation team used video cameras to observe motorist and pedestrian behavior at eight grade crossings. Safety was measured by observing the frequency with which motorists and pedestrians violated the traffic control devices that warned them of approaching trains. The team selected violations rather than accidents because violations occur at a much higher frequency. Accidents at the eight grade crossings occur at too low a frequency to detect performance differences. Motorist and pedestrian violations represent a reasonable surrogate since this behavior is a precursor to grade crossing incidents [4].

To evaluate the effectiveness of the education and enforcement programs, it was necessary to measure the number of the motor vehicle and pedestrian violations that occur before, during, and after the program was implemented. Therefore, the lifespan of the project was divided into three phases. The pre-test phase occurred before the communities began their education and enforcement programs. This period lasted 2 months, from July 1, 2003, through August 31, 2003. The test phase was 12 months long, from September 1, 2003, through August 31, 2004. During this time, the communities conducted their education and enforcement plans. The final 2 months of the study, September 1, 2004, through October 31, 2004, were a post-test measurement of violations. This data was useful in determining any lasting effects from the programs.

2.5 PEERS Project Participants

The PEERS project was a cooperative effort between FRA and the ICC. FRA served as the project sponsor by providing half of the funds for the community grants and funding the Volpe Center to conduct the evaluation program and prepare the effectiveness results. The ICC provided the other half of the funds for the community grants. The participating communities and crossings were chosen under the guidance of the ICC. The Volpe Center served as an independent third party to collect and analyze data from the selected crossings; its responsibilities included acquiring necessary equipment for the PEERS project, obtaining permission from the necessary agencies to install equipment, collecting data, and providing an analytical final report.

Cooperation was needed from various parties to make this project a success. The participating communities of the Village of Arlington Heights, the City of Macomb, and the Village of Bartlett were responsible for drafting a proposal and budget addressing identified railroad safety concerns. They were also accountable for outlining and conducting the education and enforcement activities. The communities made certain that electric power was available for the video cameras. In addition, three railroads were involved in the PEERS project. The Burlington Northern Santa Fe Railway (BNSF), Metra, and Union Pacific Corporation (UP) all granted permission to connect the Volpe Center video surveillance systems to the warning devices. BNSF also generously allowed Volpe Center electronic equipment to be installed inside of their crossing bungalows.

2.6 Change in Scope

Over the course of the project, unanticipated events resulted in adjusting the scope to meet the project needs. The Volpe Center team collected video data images from all three participating communities. The estimated total number of train events for the 8 crossings was 183,120. A viewer could watch and record information for approximately 70 train events per workday. In the interest of providing timely results, the analysis portion of the project focused solely on the Village of Arlington Heights. This reduced the project duration. As a result, the Volpe Center team recorded 60,942 train events and observed 120,234 violations. Raw video data from the remaining two communities is available for future review and analysis.

The time frames for the pre-test and post-test case phases were shortened from the original statement of work. Equipment and software troubleshooting resulted in shortening the phases from 3 months to 2 months. The Volpe Center team observed an additional type of violation in the preliminary data viewing. This violation was labeled type IV and occurred when train passengers debarked onto a center platform and exited the crossing while the warning devices were still active. These violators were clearly taking a risk, especially in second train coming situations. The local law enforcement officials decided not to enforce type IV violations for fear that the passengers would cross at a more dangerous place along the tracks. Because these violators were not targeted in the enforcement efforts, they were not included in the study. Raw video data of this type of violation is available for future review and analysis.

3.0 Site Selection

3.1 Chosen Communities

The PEERS program was conceived in part by Senator Richard J. Durbin (D-IL). Senator Durbin's staff chose the original four communities based on perceived rail safety needs. The four communities were Arlington Heights, Macomb, Bartlett, and Downer's Grove. Each community responded to the request for grant proposals and agreed to actively participate in the education and enforcement initiatives. The Village of Downer's Grove opted to participate in a photo-enforcement campaign, instead of law enforcement blitzes, and was not included in the Volpe Center's evaluation study. Figure 2 shows diagram of the communities' locations in the State of Illinois. Because of the decision to focus only on Arlington Heights in this report, Appendix A contains the detailed information about Macomb and Bartlett.

Figure 2. Map of Illinois and Selected Communities

3.2 Arlington Heights

The Village of Arlington Heights is a suburb of Chicago in Cook County, located approximately 22 miles from the downtown area. The population is 76,031. The village has 10 public at-grade crossings, 2 pedestrian crossings, and 2 Metra stations. The line through Arlington Heights is a triple track owned and operated by UP. Metra commuter trains utilize this line. The line carries, on average, 63 Metra trains plus another dozen UP freight trains each weekday.

The three crossings included in the PEERS study are Arlington Heights Road, Dunton Avenue, and Evergreen Avenue. Prior to the passage of the Final Rule on the Use of Locomotive Horns at Highway-Rail Grade Crossings, the community of Arlington Heights established a quiet zone and the locomotive horn was not sounded through the crossings. Each crossing is equipped with flashing lights and motorist and pedestrian gates. The track circuitry utilizes constant warning time and simultaneous preemption for the three adjacent crossings. The crossings are four traffic lanes wide. In February 2002, FRA published the *Report on High Risk Crossings and Mitigation*

Efforts by State [3]. The highway-rail grade crossing at Arlington Heights Road was designated as one of Illinois' State-suggested high-risk crossings.

4.0 Research Approach

4.1 Site Location Surveys

The Volpe Center PEERS evaluation team conducted grade crossing site surveys on June 25-26, 2002, and September 23-25, 2002. The purpose of these site surveys was to gather pertinent information about the crossings and determine suitable locations for camera and field computer equipment. At each crossing, the team was accompanied by railroad personnel. In Arlington Heights, the three crossings are located approximately 700 feet apart. Figure 3 shows a schematic of the three crossings in Arlington Heights.

Dunton Avenue is the farthest west, followed by Evergreen Avenue and then Arlington Heights Road. A Metra station is located adjacent to the Dunton Avenue crossing. Dunton Avenue has the heaviest pedestrian traffic flow and the lightest motor vehicle flow, with an estimated average annual daily traffic (AADT) of 1,600 vehicles. Evergreen Avenue has moderate pedestrian traffic volume and heavier motor vehicle flow, with an estimated AADT of 3,400 vehicles. Arlington Heights Road has light pedestrian traffic volume and the heaviest AADT at 28,400 vehicles. While on location, the team surveyed each grade crossing, examined the surrounding area, photographed the sites, interviewed railroad personnel, and documented their findings. Appendix A provides the complete site survey document.

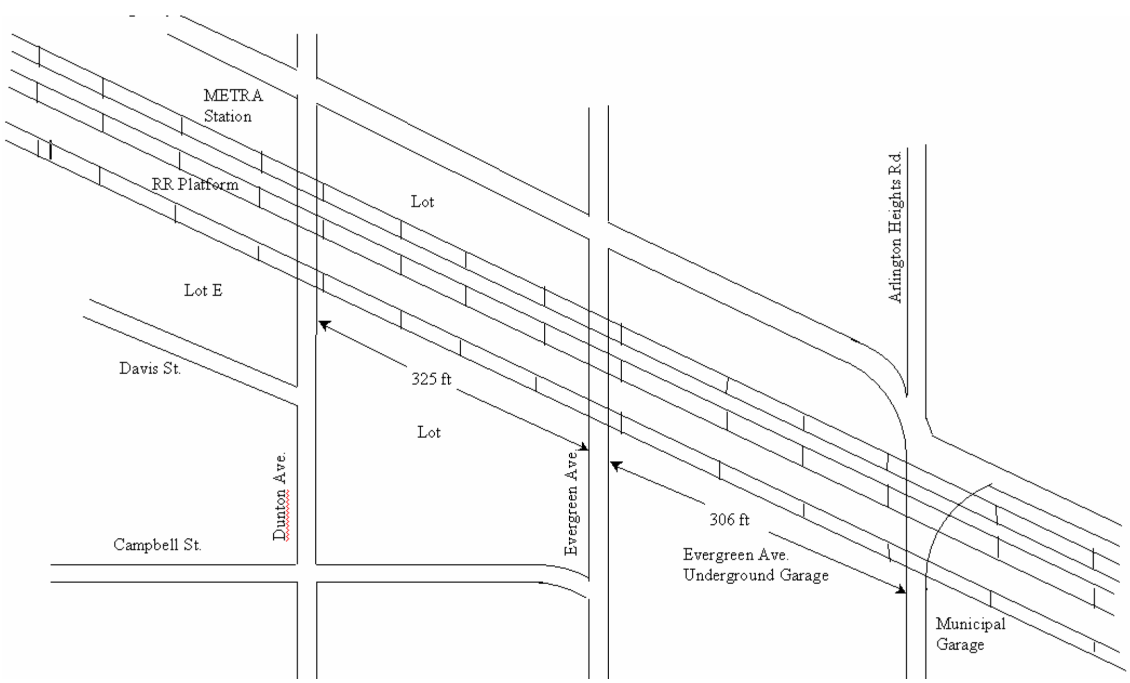


Figure 3. Arlington Heights Crossings Schematic

4.1.1 Dunton Avenue

The Dunton Avenue crossing (DOT Crossing Number 176925Y) consists of three main tracks owned by UP. The milepost number is 0022.46. Train speeds through the crossing range from 20 to 40 miles per hour. The smallest crossing angles are between 60 and 90 degrees. Four highway traffic lanes cross the tracks. A Metra station is adjacent to the crossing, has a center track platform, and is located west of the street. Continuous pedestrian traffic occurs in the vicinity of the crossing. The surrounding area is designated for commercial use.

The crossing has active warning devices. The signage at the crossing consists of two reflective crossbuck signs and two “3-TRACKS” signs. Six red and white reflective gates (four of which are pedestrian gates), four sets of mast-mounted flashers, one cantilever-mounted flasher, and one bell are in place. All gates at the crossing are train activated. In the history of this crossing, three accidents have occurred. These resulted in one pedestrian injury. The last reported accident occurred on June 19, 2002. The vehicle was unoccupied during the collision, and no one was injured. The two best locations for the cameras were the northeast and southeast corners. Appendix A includes photographs and diagrams of the Dunton Avenue grade crossing.

4.1.2 Evergreen Avenue

The Evergreen Avenue crossing (DOT Crossing Number 176924S) is located at milepost number 0022.39. The train speeds through the crossing range from 20 to 40 miles per hour. The smallest crossing angles are between 60 and 90 degrees. Two motor vehicle traffic lanes are over the crossing. The Dunton Avenue crossing is 325 feet to the west, and the Arlington Heights Road crossing is 306 feet to the east. The surrounding area is designated for commercial use; however, pedestrian activity is limited.

The crossing has active warning devices. The crossing signage consists of two reflective crossbuck signs and two “3-TRACKS” signs. Six red and white reflective gates (four of which are pedestrian gates), four sets of mast-mounted flashers, and one warning bell are in place. All gates are train activated. There has been no report of incidents at the crossing. The team chose to locate the cameras on the northeast and southwest corners. Appendix A includes photographs and diagrams of the Evergreen Avenue grade crossing.

4.1.3 Arlington Heights Road

The Arlington Heights Road crossing (DOT Crossing Number 176923K) is located at milepost number 0022.31. The train speeds through the crossing range from 20 to 40 miles per hour. The smallest crossing angles are between 60 and 90 degrees. Four highway traffic lanes traverse the crossing. A complicated intersection is north of the crossing at Arlington Heights Road and Northwest Highway. The roads carry heavy automobile traffic, but pedestrian activity is limited. The surrounding area is designated for commercial use.

The crossing has active warning devices. The signage at the crossing includes two reflective crossbuck signs, two “3-TRACKS” signs, and one dynamic “NO TURN” lighted sign. Three red and white reflective gates (one of which is a pedestrian gate), two sets of cantilever-mounted flashers, two sets of mast-mounted flashers, and one warning bell are in place. In the history of this crossing, nine accidents have occurred. These resulted in three fatalities and four injuries. The last reported accident occurred October 29, 2002. A vehicle stopped on the crossing was unoccupied when struck by a freight train. The last fatal accident at the Arlington Heights Road crossing occurred March 3, 1998. A passenger train struck a pick-up truck that had driven around or through the active gate system. The driver was killed and the passenger injured. The two cameras were placed on the northwest and southeast corners. Appendix A includes photographs and diagrams of the Arlington Heights Road grade crossing.

4.2 Remote Data Collection System

Even though data analysis was only performed on data collected from three crossings located in the community of Arlington Heights, data was collected from a total of nine crossings. These crossings were located in Arlington Heights, Bartlett, and Macomb, IL. A total of 4 computers, 17 video cameras, 17 camera pole mounts, 17 transmitter and power supply box pole mounts, the PEERS light pole power system, and the PEERS Volpe Box system were used at the 9 crossings.

The Volpe Center evaluation team developed the PEERS light pole power system, which contained an AC power outlet, high current battery charger, RB30 relay, video transceiver, and a 12 volt 12 AH battery. This system was necessary in order to provide sufficient power for some of the study cameras. At specific locations, the only available power was from the street lighting system. This system only received power during the nighttime hours of operation. During the night by use of the Volpe light pole power system, the batteries would be charged. Then, at dawn and throughout the day, the cameras and transmitters would operate only on battery power. Figure 4 shows a camera and pole schematic.

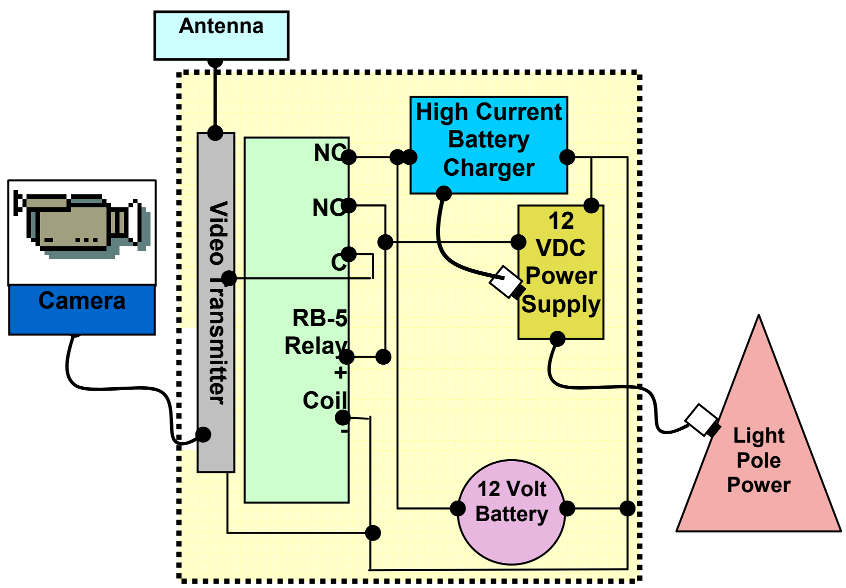


Figure 4. PEERS Light Pole Power System Schematic

The PEERS Volpe remote data collection box system stored the receiver, the radio frequency video receiver, the computer processor unit, and the digital subscriber line modem (DSL). Figure 5 shows a diagram of the field system.

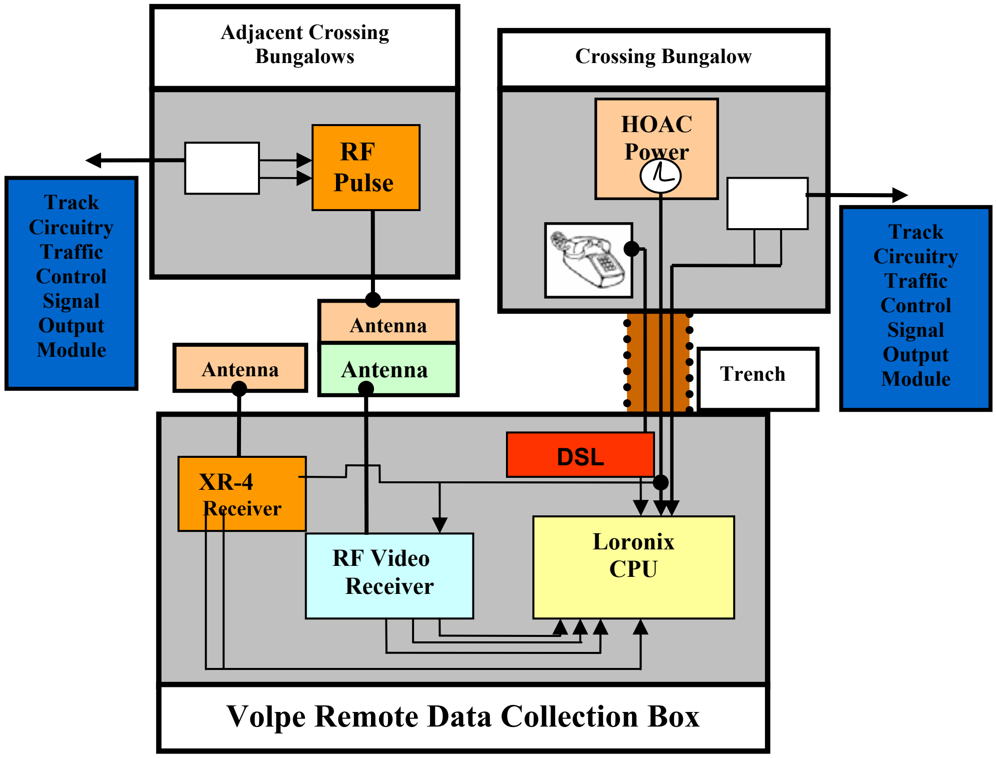


Figure 5. Field System Schematic

The Arlington Heights crossings consisted of three parallel east-west traveling mainline railroad tracks and three north-south traveling roadways. The Volpe Center remote data collection system consisted of one computer, six video cameras (two at each crossing—one on the north side and the other on the south side both facing the crossing), six camera pole mounts, six PEERS light pole power system box pole mounts, six PEERS light pole power system boxes (two at each crossing, mounted on the pole a few inches below each camera), and one PEERS Volpe remote data collection box system (stored adjacent to the railroad crossing signal bungalow at Evergreen Avenue).

The Volpe Center remote data collection box also housed a telephone line to permit direct connection with the onsite computer and high-speed DSL Internet service, the track circuitry traffic signal output module, and the RF pulse transmitter. All electrical power was supplied by the Village of Arlington Heights and UP. Appendix B provides diagrams of the project equipment and design.

The Loronix software package was selected for the video data collection. The Volpe Center evaluation team had previous experience with the Loronix software. The video data files were divided into two types, alarm and non-alarm. The cameras collected video data around the clock. An alarm file was created when the track circuitry indicated that the crossing warning devices had been activated. All other images were labeled as non-alarm files. The software allowed the alarm files to be separately designated and had the capability to remotely access the video database. The Loronix software also offered electronic code stamping, which branded each video image with a time and date stamp. The Volpe Center video analysis technical staff attended training sessions to familiarize themselves with the software and its applications. Selected PEERS evaluation team members took Loronix Basic User Operator Training; one individual also attended Loronix Administrator Training.

The information gathered from each video clip was stored in a database created in Microsoft Access. Access provides a large data storage capacity, which allows for the data to easily be queried.

4.3 Data Collection

Video data was collected and stored onsite in each community and then transmitted to the Volpe Center via the Internet. Each camera captured, digitized, and catalogued alarm video on the remote stations. Three computers with an in-house Internet connection were used to download the site data to the Volpe Center. One workstation per community was designated for study participation. Based on the large volume of data collected, a backup hard drive was necessary as additional storage for data that would be accessed later for analysis. All video images collected were transferred to DVD media for viewing and archiving. The Volpe Center workstations used a local client to access the remote database. By using structured query language (SQL) calls, the Volpe Center could call up the appropriate alarm data and pull the video and associated information off the remote systems and upload them to the Volpe Center workstations. Figure 6 shows a schematic of this remote data collection system.

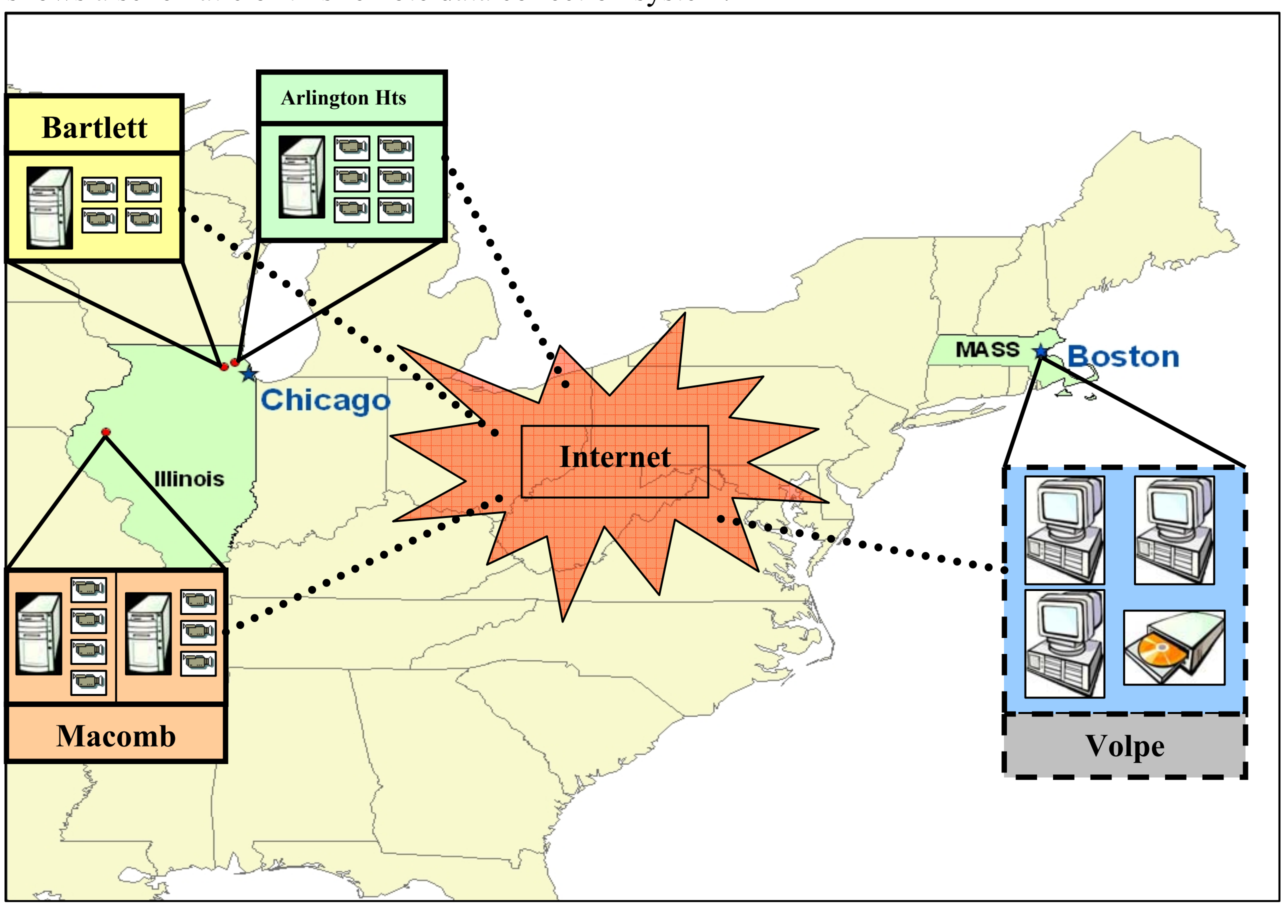


Figure 6. Remote Data Collection Schematic

The crossings were monitored by six cameras (two at each crossing, facing the railroad tracks from opposing directions). Both cameras were continuously recording data, and alarm events triggered by warning device activations were tagged and saved for a minimum of 60 days. These events recorded activity starting 10 seconds before warning device activation and continued 30 seconds after the warning devices were deactivated. Only one camera per crossing was analyzed for violation activity, and the other cameras were used as a backup or if a closer unobstructed view was needed from the opposite direction. The video data files were divided into alarm files and non-alarm files. The files of interest to this project were the alarm files, which contained footage of the activated crossing warning devices. Non-alarm video files were deleted first from the computer memory to preserve alarm video files. Data was downloaded to the Volpe Center workstation via the Internet and backed up on DVD media for processing and archiving purposes.

The data was transmitted using commercially available Internet connections. In Arlington Heights and Bartlett, the systems were connected to the Internet through public DSL; in Macomb, the connection was via high-speed cable access. The video data was uploaded from the field computers to the Internet and then downloaded from the Internet to the Volpe Center workstations.

The PEERS team was not allowed to connect to the remote field computers using the Volpe Center's local area network (LAN). Newly instituted Federal security guidelines would not accommodate the needs of the PEERS project. The main issue was that the data was collected and stored on publicly accessible PCs. The remote computer systems were not trusted networks and were not certified, according to U.S. Federal standards. Instead, the PEERS team used a separate high-speed T3 line for faster download outside the Volpe Center's network. The PEERS project took advantage of the existing Internet service provider connection to the Volpe National Transportation Systems Center network (VNTSC network) by installing a dedicated router outside the VNTSC network firewall and then creating a new subnet for the PEERS project. To alleviate any security concerns, the router was configured only to allow selected internal public addresses.

The PEERS team also determined the Internet Protocol addresses for internal and external access. Once completed, the staff created access restrictions to assure that no other traffic was allowed in or out of the PEERS segment. The VNTSC network was chosen over the Volpe Center's LAN because it was not possible to pass the type of video and database information transmitted by the Loronix equipment through the LAN firewall. This connection provided the PEERS team greater control over the VNTSC network server firewall, permitting secure connectivity with the remote PEERS recorders.

File transfer protocol and direct connection were used to download alarm video data to the workstations at the Volpe Center. The Volpe Center workstations were connected remotely through the Internet to access the site databases using SQL calls. The appropriate alarm data was queried, and the video and associated information was uploaded from the remote systems to the Volpe Center workstations. Data was stored on local hard disk drives and backed up on DVD media for processing and archiving.

4.4 Analysis Method

The data were collected and analyzed as a before-during-after study. Although the before-during-after study has recently come under some criticism due to the regression to mean phenomenon, the

Volpe Center has had success in using this method in the past [4]. The test data was collected over a period greater than 1 year in an attempt to eliminate any seasonal affects on the data.

A grade crossing violation occurs when a motor vehicle or a pedestrian disregards active crossing warning devices either audible, visual, or both and enters the grade crossing zone. In Arlington Heights, the crossings were equipped with flashing lights, gates, and bells; however, no train horn was sounded during the study period. Activation time is when the track circuitry activates the warning devices at the crossing.

Three commonly categorized types of violations exist: type I, II, and III. The definition of each type is listed below.

- A type I violation occurs when a violator traverses the crossing while the lights are flashing, the bells are ringing, but before gate descent.
- A type II violation occurs when a violator traverses the crossing during gate descent or ascent with audible devices sounding.
- A type III violation occurs when a violator traverses the grade crossing after the gates finish their descent and are fully deployed in a horizontal position.

Type III violations are the most risky and type I the least. The type I violation occurs at the first warning that a train is on approach to the crossing. Type II violations occur both before and after the train arrival at the crossing. This type of violation is of particular concern during second train coming events, as the first train departs and the second train is arriving. During a type III violation, the gate is in the horizontal position, and a motorist or pedestrian would have to go around, or through, the downed gate. Figure 7 shows examples of each violation.

Figure 7. (Clockwise) Type I Violation, Type II Violation, Pedestrian Type III Violation, Motorist Type III Violation

A before-during-after design was used to evaluate the benefit of public awareness programs in each neighborhood. The collected data was divided into three parts. The 2 months of data collected before implementation of the program served as a pre-test. This data reflected population behavior without any (safety) influence from the PEERS programs. This is not to say, however, that no safety awareness programs existed during this time. Operation Lifesaver, for example, continued its normal activities in the community during this test period.

The data collected during the 12-month period following the pre-test period reflects motorist and pedestrian behavior while exposed to the PEERS enhanced safety initiatives and is referred to as the test period. The initiatives implemented during the test period included safety inserts with utility bills, radio and television public service announcements, poster campaigns, and train station public address announcements. Some initiatives were proactive and involved members of local law enforcement and the community. These included an increase in Operation Lifesaver presentations throughout the community and police education and enforcement blitzes. The test data was compared with the pre-test period data to evaluate the effect the PEERS project had on motorist and pedestrian behavior.

The final set of data was collected immediately following the test period and is referred to as the post-test data. This data was collected for 2 months following the conclusion of the PEERS project, during which time all enhanced safety initiatives were stopped. This data was examined to evaluate the lasting effects of the safety initiatives.

5.0 Data Analysis

5.1 Data Analysis Plan

Before the start of the project, a data analysis plan was developed, outlining the types and quantity of data to be collected and the methods of interpreting the data to obtain an understanding of the changes in highway-user behavior. All data fields were gathered from the train event video images. In Arlington Heights, the predicted number of train events was 76,300, giving a sufficient sample size and satisfying a requisite power determination. The results obtained from this data can be replicated in other environments under similar circumstances and satisfy the first established goal of producing meaningful, transferable results.

As the second goal of the project was to reduce highway-rail grade crossing violations by 50 percent, accurate methods for calculating violation frequency, time-to-collision, warning time, and violation time were necessary. These are factors that may affect a change in highway-user behavior and require more complete inspection. Appendix C contains the complete data analysis plan.

5.2 Selection of Data Attributes

The 16 months of video collection provided a valuable data source about driver behavior at these highway-rail grade crossings in Illinois. The data points extracted from these video clips were chosen to aid in determining the amount of risk a motorist or pedestrian was taking. The team used *Field Evaluation of a Wayside Horn at Highway-rail Grade Crossings* [5] and *Evaluation of the School Street Four-Quadrant Gate/In-Cab Signaling Grade Crossing System* [6] as references in selecting the data attributes. Table 1 provides a list of the data gathered from the video alarm events recorded.

Table 1. Data Dictionary for Video Events

Data	Description
Date	Date event occurred
Crossing Name	Name of street crossing
Crossing Activation Time	Specific time when the track circuitry trigger activates the safety devices at the crossing
Gate Activation Time	Time when the gates begin to descend
Train Presence	Yes or No (false alarm)
Train Arrival Time	Time when train arrived at the grade crossings
Type of Train	Freight, passenger, track maintenance
Motor Vehicle Arrival Time	Time when the motor vehicle arrived at the grade crossing
Pedestrian Arrival Time	Time when the pedestrian arrived at the grade crossing
Violation: Type I	Number of violators that went through the crossing while lights were flashing but before gate descent
Violation: Type II	Number of violators that went through the crossing during gate descent
Violation: Type III	Number of violators that went through the grade crossing after gate descent
Violation After Train but Before Gates Ascend	Yes or No
Violator Direction	The direction (N, S, E, W) from which the violator approached the crossing
Train Direction	The direction (N, S, E,W) from which the train approached the crossing
Track	The track that the train is on when it traverses the crossing (north side or south side, east side or west side)
Second Train Event	Yes or No
End of Event Time	Time when the train has completely cleared the crossing and gates have retracted or the recording timed out

5.3 Database Development

The database for the PEERS project was constructed in Microsoft Access. Every train event viewed is a unique entry into the database regardless of whether a violation occurs or not. A unique number identifies each train event and violation. Three linked tables store all pertinent information from each train event. The train event table captures basic details about the warning device activation, train presence, and violation occurrence. One entry is in the train event table for every train event viewed. The violation table captures a summary of the violation counts during the train event and details about the train movement. One entry is in the violation table for every train event viewed. The third table is the violation details table. The data gathered in this table is detailed information on the violator movements. There is one entry for each violation observed; for one train event numerous entries can exist.

Volpe Center PEERS evaluation team members viewed the recorded video images. The data was tabulated manually for each train event. An observer viewed and recorded data for approximately 70 train events per workday. In total, 60,942 train events and 120,234 violations were observed at the three highway-rail grade crossings in Arlington Heights during the 16-month study period.

5.4 Performance Measures

From the observed data the evaluation team can gather performance measures to evaluate the success of the PEERS FOT program. The first performance measure is the frequency of violations. For each phase of the project, the number of train events observed varied. Thus, it is necessary to use a rate of violations per train event. The violation frequency data can be demarcated into the three violation types, the three crossings, and the two modes of transportation used by the violator. This specific level of detail enabled the Volpe Center evaluation staff to establish trends in data and determine how the PEERS program was most effective.

Time-to-collision, warning time, and violation time were also examined to evaluate the degree of risk associated with driver and pedestrian behavior. Time-to-collision is a performance measure of time, in seconds, of the estimated train arrival at the location of the violator when the violator enters the crossing zone. Warning time is the measure, in seconds, of the amount of time the motorist or pedestrian has to respond to the warning signals at the crossing. Violation time, in seconds, is a performance measure of the length of time between the activation of the crossing warning signals and the time of the violation.

The PEERS enhanced education and enforcement activities were conducted over the course of 12 months; for the majority of those activities, it is not possible to isolate their effect on crossing safety. With the exception of the information and enforcement blitzes, it is impossible to determine who was exposed to the PEERS initiatives. The blitzes were scheduled to target specific audiences. The effects of a blitz can be seen in the violation rate on the days the police are present.

5.5 Results

The project suffered minor data loss in most months. The most extreme occurred during March 2004. For this reason, the violation count from March 1, 2004, to April 31, 2004 (denoted by an * in Table 2 below), is much lower than other months. Table 2 and Figure 8 show violation counts by 2-month periods.

Table 2. Total Violation Counts by 2-Month Period

Total Violation Counts by 2-Month Period	
Period	*Violation Count*
Pre-Test-July-August 2003	18,066
September-October 2003	16,353
November-December 2003	14,372
January-February 2004	14,005
March-April 2004	*10,777
May-June 2004	15,670
July-August 2004	15,444
Post-Test-September-October 2004	15,547

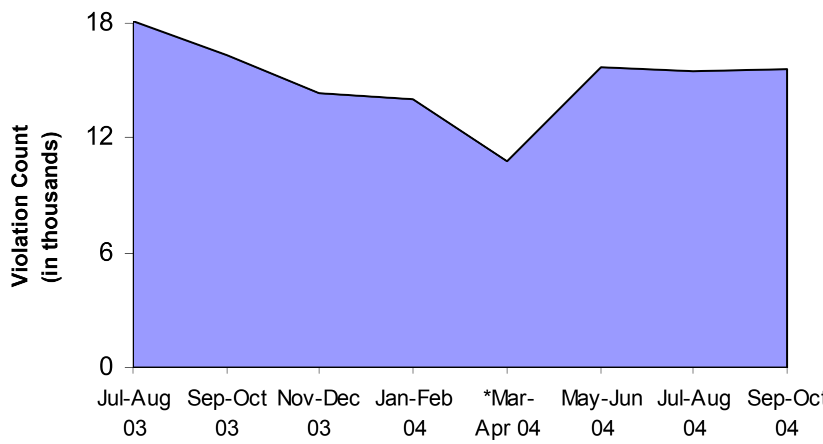


Figure 8. Total Violation Counts by 2-Month Period

Before beginning data analysis, an alpha level of 0.05 was chosen to test for significance at a 95 percent level of confidence. The raw data was organized into a number of tables, with summary totals of violations calculated by train event. In this manner, analyses are normalized by train event. In addition, the data was segregated into three periods: the pre-test period from July through August 2003, the test period from September 2003 through August 2004, and the post-test period from September through October 2004. The data was subsequently analyzed using SAS Institute software.

Initially, summary statistics were calculated to determine the spread and nature of the data. Univariate analysis was run on the data, examining the total number of all violations over the three distinct test periods. In addition, a histogram was produced from this data (see Appendix D). From the histogram, it is evident that the data fits a typical Poisson distribution.

As the data was unbalanced, a mixed model approach was chosen. The specific model was constructed with weighted violations as the dependent variable and period as the sole independent variable. Period, as opposed to days, was used to reflect the change over time attributable to the efforts of education and enforcement. The difference of least squares means (LS-means) is an arithmetic difference between two value estimates that are calculated using a method of LS-means estimation. It is used when the study is not strictly tied to the parameterization of the design. The data displayed a typical Poisson distribution, but the data collection process was interrupted producing unbalanced data; therefore, the mixed method of analysis using LS-means estimation compensated for these non-normal circumstances. These differences can be viewed as differences in violation rates between test periods.

5.5.1 Total Violation Counts and Rates

Violation counts were normalized over each project phase. The violation rate was calculated as the violation count for a given time period divided by the associated number of train events. Using these adjusted figures, the reduction in violation rate was measured from the pre-test period to the post-test period, producing a 30.92 percent reduction. Table 3 and Figure 9 show these results. Breaking the data down by type of violation, mode of transportation, and crossing will reveal the specific areas that achieved a 50 percent reduction.

Table 3. Overall Violation Rates by Period

Overall Violation Rate			
	Period		
	Pre-Test	*Test*	*Post-Test*
Violation Count	18,066	86,621	15,547
Train Events	6,963	45,305	8,674
Rate	2.59	1.91	1.79

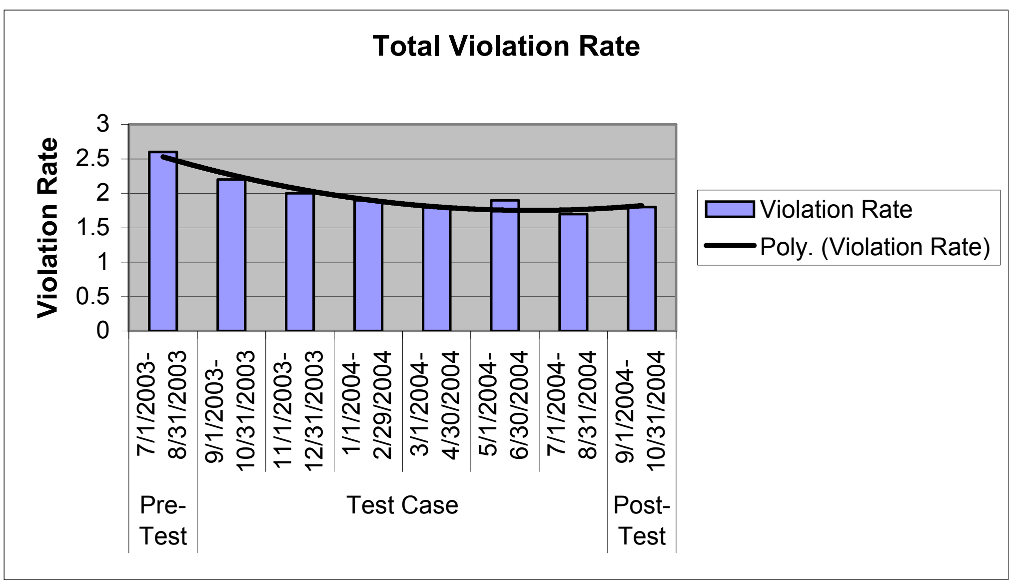


Figure 9. Violation Rate for All Crossings

The model was tested using data from all crossings and for all types of violations, producing significant results ($p<0.0001$). When the data is examined for differences by test period, significant findings are observed in all three possible scenarios. Table 4 shows the associated probabilities. These findings suggest that overall highway-user behavior changed at the three

Arlington Heights grade crossings examined. (Please note that a positive difference denotes a decrease in the rate of violations between the two associated test periods.)

Table 4. Probabilities for Differences of LS-Means, All Violations and Crossings

Probabilities Differences of LS-Means All Violations, All Crossings		
Period – Period	*Difference*	*Probability*
Pre-Test – Test	0.6826	<0.0001
Pre-Test – Post-Test	0.8022	<0.0001
Test – Post-Test	0.1196	0.0009

However, these summary counts and significance tests on the data, taken as a whole, do not provide much insight into the nature and frequency of the types of violations witnessed and program effectiveness. Violation counts are affected by mode of travel, as well as specific grade crossing site locations. By stratifying the data into distinct classes by mode of travel, grade crossing site location, and type of violation, more information on the PEERS program effectiveness becomes evident.

5.5.2 Violation Counts and Rates by Type of Violation

Because the violations are divided into three types, varying degrees of risky behavior can be analyzed. As mentioned earlier, a type III violation is associated with riskier highway-user behavior than a type II (or type I violation) because a type III violation occurs closer in time to the train's arrival at the highway-rail grade crossing.

From the pre-test period to the test period, no significant ($p=0.2651$) detectable change was observed in the type I violation rate. From the pre-test period to the post-test period, however, a minimal increase in the type I violation rate was observed. The increase was found to be statistically significant ($p=0.0003$). A type I violation occurs when warning lights and audible signals have begun but before gates have begun to move. This is the first indication that a train is approaching the crossing. A motorist nearing the crossing at this time may not be able to stop safely, and nonmotorized users feel they have enough time to complete their crossing activities. The type I violation could be denoted as a less conscious decision to violate the warning devices, similar to a yellow light signal at a highway-highway intersection or the countdown to a pedestrian crossing signal, and is thus expected to be less affected by the education and enforcement programs than the other types of violations. An increase in type I violations occurred; therefore the 50 percent reduction goal was not met in this specific circumstance.

A significant decrease in the type II violation rate was observed between the pre-test period and the test period (-20.8 percent, $p<0.0001$), as well as between the pre-test period and the post-test period (-23.0 percent, $p<0.0001$). Although a marked decrease in type II violations occurred, it did not meet the designated 50 percent reduction goal.

A significant decrease in the type III violation rate was observed between the pre-test period and the test period (-53.4 percent, $p<0.0001$), as well as between the pre-test period and the post-test period (-71.4 percent, $p<0.0001$). These results suggest that taken as a whole, pedestrians and motorists were taking fewer risks in situations where the level of risk is high. The reduction in type III violations is a success because it exceeds the designated 50 percent goal. Table 5 and Figure 10 show violation rates by type for the pre-test, test, and post-test periods.

Table 5. Violation Rates by Violation Type, All Crossings

Violation Rates by Violation Type for All Crossings			
Violation	*Pre-Test*	*Test*	*Post-Test*
Type I	0.46	0.48	0.53
Type II	1.35	1.07	1.04
Type III	0.78	0.36	0.22

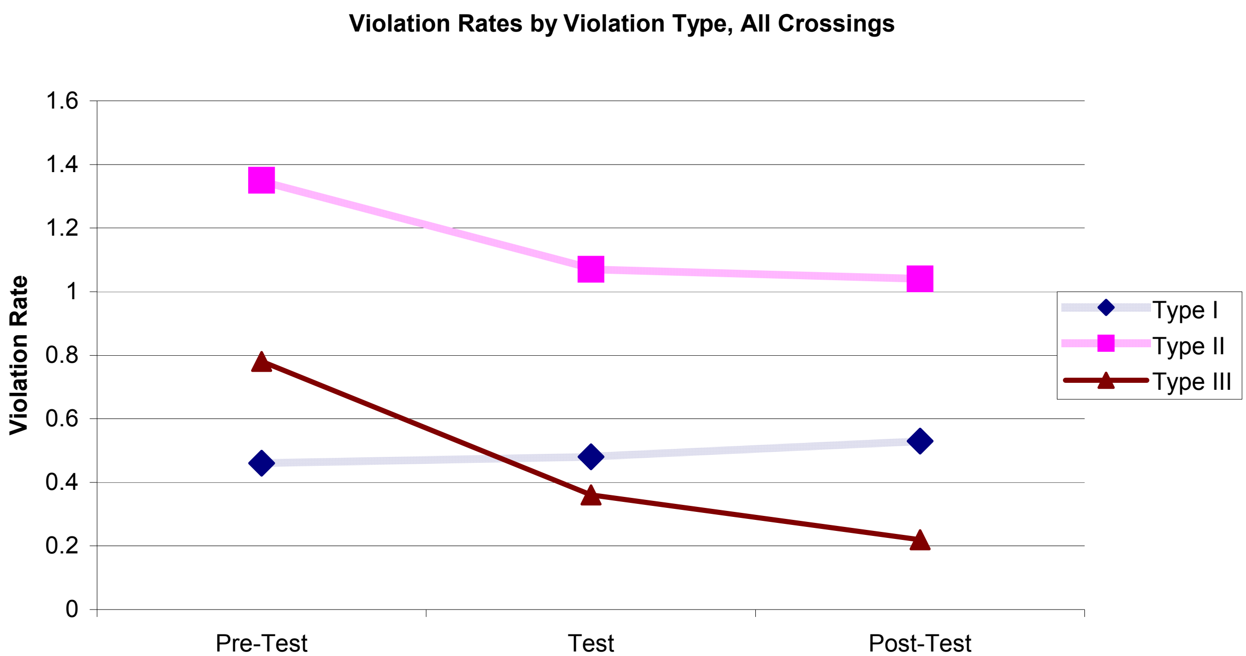


Figure 10. Violation Rates by Violation Type, All Crossings

5.5.3 Violation Counts and Rates by Transportation Mode

The nature of violations committed by pedestrians and motorists differ. During the course of this evaluation study, pedestrians were more likely to disobey a fully deployed gate than motorists. Motorists also tend to be impatient and violate the warning devices as they are deactivated. The data show that pedestrians and bicyclists commit 99 percent of all type III violations, while motorists commit 82 percent of all type II violations and 96 percent of all type I violations. As a result of these differences, the data are analyzed by the mode of transportation involved. Initially, raw violation counts are presented as a basis for further examination (see Table 6). Figure 11, Figure 12, and Figure 13 are pie charts that show the mix of motorist and pedestrian violations by violation type.

Table 6. Violation Counts by Transportation Mode and Violation Type

Violation Counts By Mode of Transportation and Violation Type	
Pedestrian	
Type I	1,062
Type II	12,243
Type III	23,678
Motorist	
Type I	28,409
Type II	54,630
Type III	212

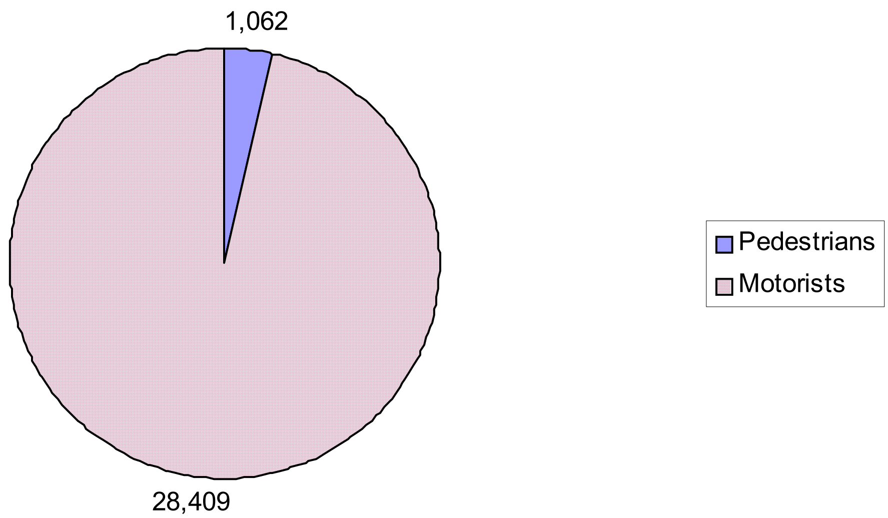


Figure 11. Type I Violation Counts by Mode of Transportation

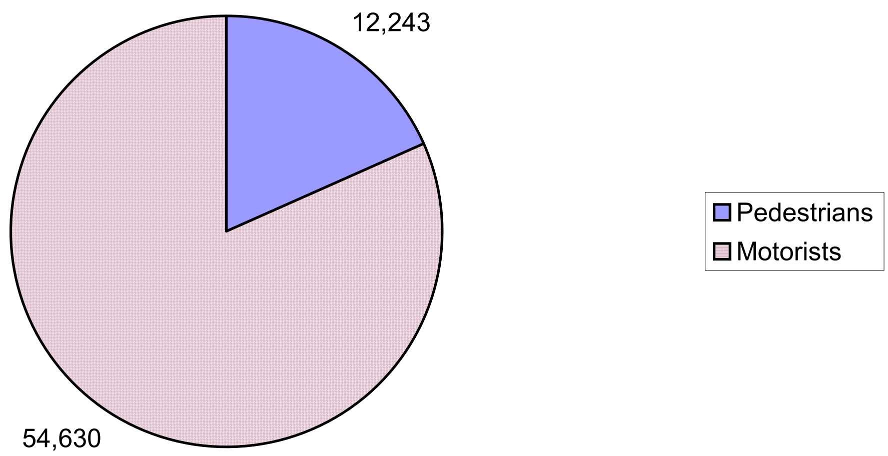


Figure 12. Type II Violation Counts by Mode of Transportation

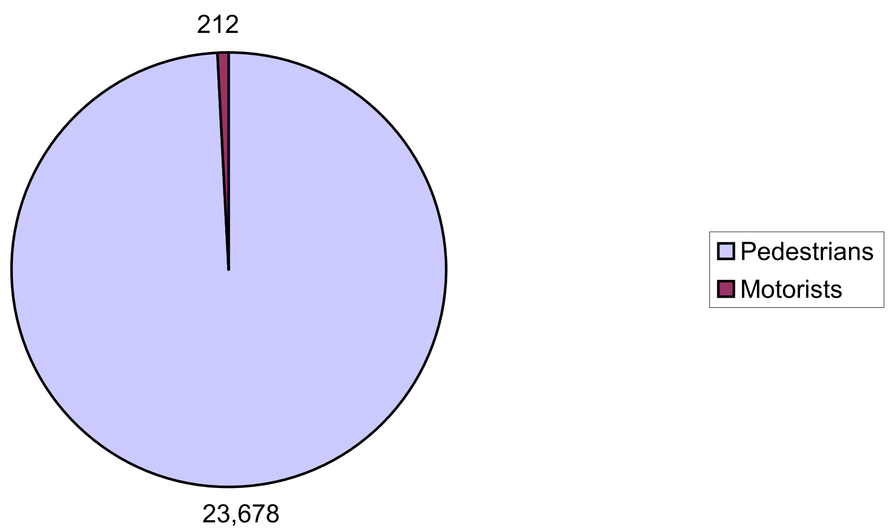


Figure 13. Type III Violation Counts by Mode of Transportation

Initially, an examination of all pedestrian violations was undertaken to determine whether a relationship exists between test (or time) period and violation counts. Using a mixed model, the analysis produced significant results of a decrease between the pre-test period and test period, as well as between the pre-test period and post-test period, as detailed in Table 7. Given these results, a more stratified analysis was performed.

Table 7. Probabilities for Differences of LS-Means, Pedestrian Violations, All Crossings

Probabilities Differences of LS-Means Pedestrian Violations, All Crossings		
Period – Period	*Difference*	*Probability*
Pre-Test – Test	0.5085	<0.0001
Pre-Test – Post-Test	0.6247	<0.0001
Test – Post-Test	0.1161	<0.0001

A significant decrease in pedestrian type I, II, and III violation rates was observed between the pre-test period and the test period (p<0.0001), as well as between the pre-test period and the post-test period (p<0.0001). Table 8 and Figure 14 contain pedestrian violation rates by type of violation, while Table 9 contains associated probabilities based upon differences of LS-means analysis. (A positive decrease is again indicative of a decrease in the violation rate.)

Table 8. Pedestrian Violation Rates by Violation Type, All Crossings

Pedestrian Violation Rates by Violation Type for All Crossings			
Violation	*Pre-Test*	*Test*	*Post-Test*
Type I	.04	.01	.01
Type II	.26	.19	.21
Type III	.78	.36	.22

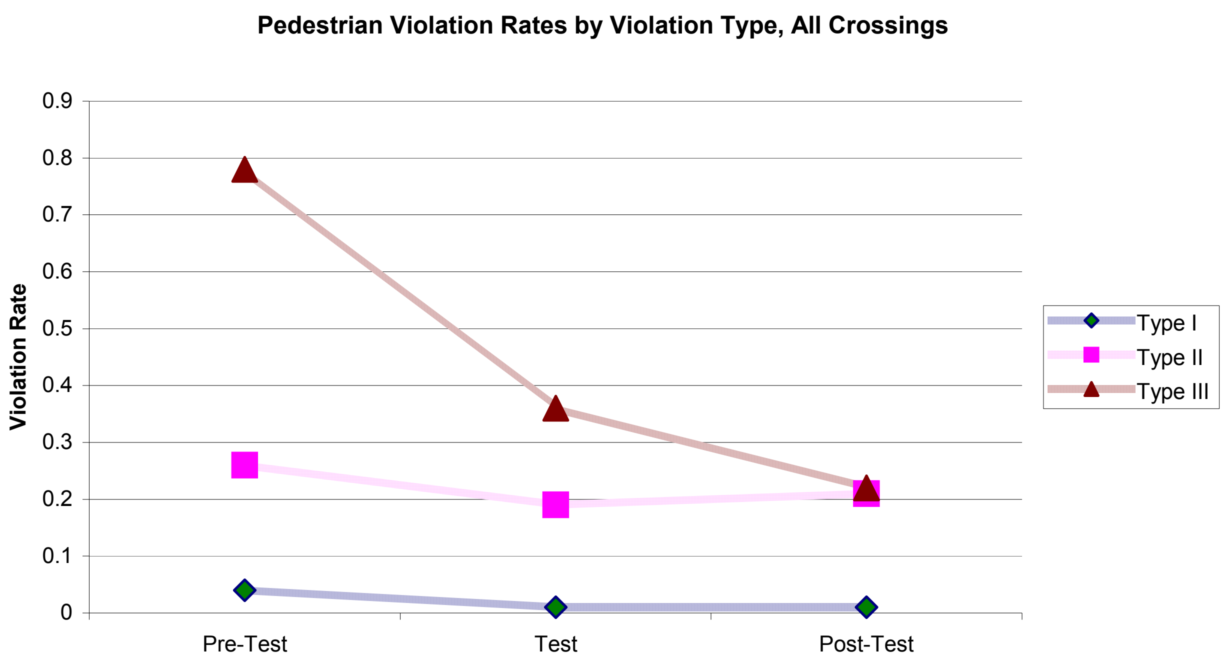


Figure 14. Pedestrian Violation Rates by Violation Type, All Crossings

Table 9. Probabilities for Differences of LS-Means, Pedestrian Violations, All Crossings

Probabilities Differences of LS-Means Pedestrian Violations, All Crossings		
Type I Violations		
Period – Period	*Difference*	*Probability*
Pre-Test – Test	0.0223	<.0001
Pre-Test – Post-Test	0.0227	<.0001
Test – Post-Test	0.0004	0.8351
Type II Violations		
Pre-Test – Test	0.0697	<.0001
Pre-Test – Post-Test	0.0477	<.0001
Test – Post-Test	-0.0220	0.0078
Type III Violations		
Pre-Test – Test	0.4166	<.0001
Pre-Test – Post-Test	0.5543	<.0001
Test – Post-Test	0.1377	<.0001

Relatively few type I violations were committed by pedestrians; however, the violation rate was reduced by nearly 61 percent when measuring differences between the pre-test and the post-test periods. The type II violation rate for pedestrians for the same period was reduced by 18 percent. The type III violation rate experienced the greatest reduction, showing a reduction in violations of 71 percent. All three types of pedestrian violations experienced a statistically significant reduction during the PEERS programs. Based upon these analyses, strong evidence exists that pedestrian behavior was affected at the Arlington Heights highway-rail grade crossings. The reduction in type I pedestrian violations was successful based on the designated 50 percent reduction project goal; the reduction in type II pedestrian violations was not deemed successful against the designated target goal; and the reduction in type III violations was deemed successful.

An examination of all motorist violations at all crossings was undertaken to determine whether a relationship exists between test (or time) period and violation counts. The motorist violations were significantly reduced from the pre-test to the test period ($p<0.0001$) and from the pre-test to the post-test period ($p<0.0001$) (see Table 10).

Table 10. Probabilities for Differences of LS-Means, Motorist Violations, All Crossings

Probabilities Differences of LS-Means Motorist Violations, All Crossings		
Period – Period	*Difference*	*Probability*
Pre-Test – Test	0.1741	<0.0001
Pre-Test – Post-Test	0.1775	<0.0001
Test – Post-Test	0.0035	0.8692

The spread of the motorist violation data suggested the need for further testing of violations by type. Most motorist violations were type II violations. (See Table 6 above for violation counts.) Table 11 and Figure 15 contain motorist violation rates by type of violation, while

Table 12 contains associated probabilities based upon differences of LS-means analysis. Over time, the type II violation rate decreased by 24 percent ($p<0.0001$), when measuring differences between the pre-test and the post-test periods. Although a reduction occurred in the type III violation rate for the motorist population for the same period, the change was not found to be statistically significant ($p=0.1407$). In addition, the data were too sparse for further analyses and showed a large variance. In contrast to the riskier type II and III violations, the motorist type I violation rate experienced an increase of 21 percent ($p<0.0001$) over the project duration. Motorist violations only saw a significant reduction in type II violations; however, this did not achieve the designated 50 percent reduction goal. With these findings, sufficient evidence does not exist to support the hypothesis that motorist behavior was affected on the whole.

Table 11. Motorist Violation Rates by Violation Type, All Crossings

Motorist Violation Rates by Violation Type for All Crossings			
Violation	*Pre-Test*	*Test*	*Post-Test*
Type I	.42	.46	.51
Type II	1.09	.88	.83
Type III	.01	.00	.00

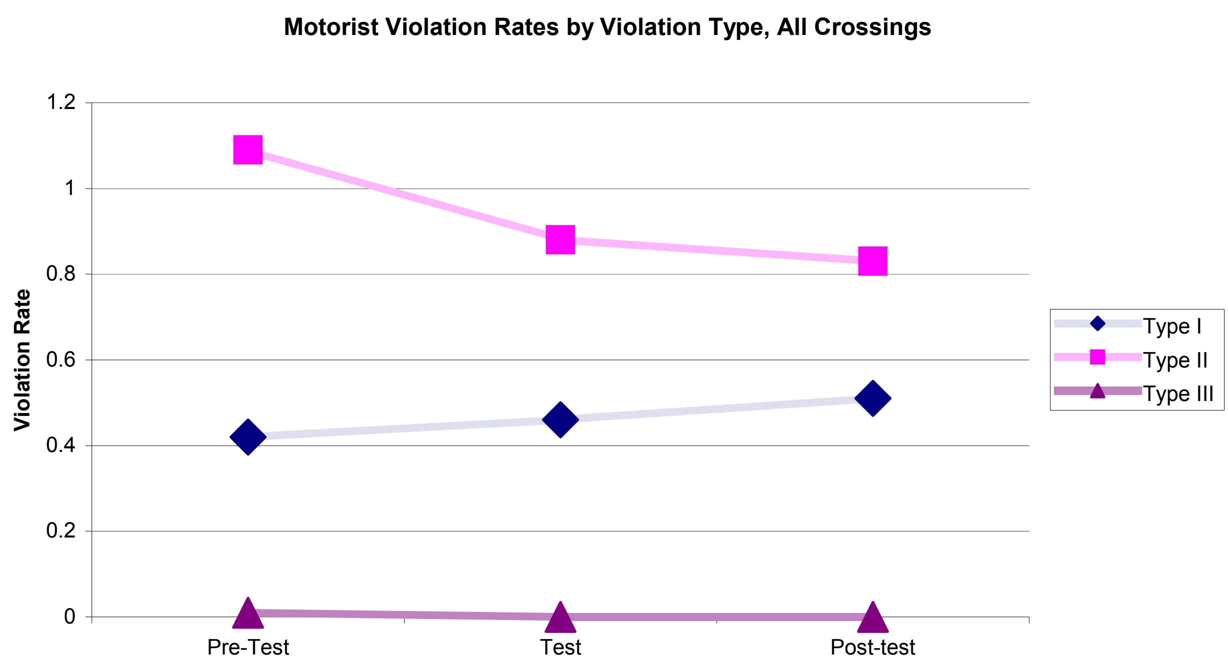


Figure 15. Motorist Violation Rates by Violation Type, All Crossings

Table 12. Differences of LS-Means, Motorist Violations, All Crossings

Differences of LS-Means Motorist Violations, All Crossings		
Type I Violations		
Period – Period	*Difference*	*Probability*
Pre-Test – Test	-0.0385	0.0078
Pre-Test – Post-Test	-0.0893	<0.0001
Test – Post-Test	-0.0507	0.0001
Type II Violations		
Pre-Test – Test	0.2113	<0.0001
Pre-Test – Post-Test	0.2627	<0.0001
Test – Post-Test	0.0514	<0.0001
Type III Violations		
Pre-Test – Test	0.0013	0.5608
Pre-Test – Post-Test	0.0041	0.1407
Test – Post-Test	0.0028	0.1665

5.5.4 Violation Counts and Rates by Crossing

Each crossing in this study has different demographic and traffic characteristics. Arlington Heights Road carries primarily motor vehicle traffic and has a busy highway-highway intersection immediately to the north. Evergreen Avenue also carries primarily motor vehicle traffic, although not as heavy as Arlington Heights Road. Dunton Avenue has an adjacent commuter rail station and is therefore bustling with pedestrian activity, especially during the morning and evening rush hours. For these reasons, it is beneficial to separate the data by crossing. Figure 16 shows the distributions of violations by mode of transportation for each crossing.

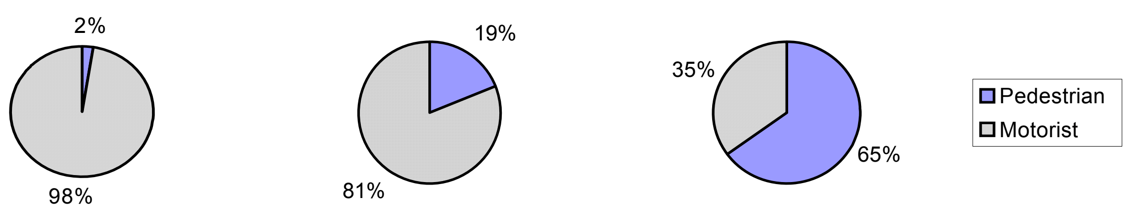


Figure 16. (Left to Right) Arlington Heights Road, Evergreen Avenue, and Dunton Avenue Distribution of Violations by Mode of Transportation

A total of 20,717 train events were recorded at the Arlington Heights Road crossing over the course of the project. Traffic across the Arlington Heights Road crossing is primarily motorist traffic, with limited pedestrian activity. Table 13 and Figure 17 show motorist and pedestrian violation rates at Arlington Heights Road.

The type I motorist violation rate experienced an increase throughout the course of the project. Motorist type II violations at Arlington Heights Road experienced a statistically significant reduction ($p=0.0072$) from the pre-test to the post-test period. The type II motorist violation rate at Arlington Heights Road was reduced by 16.3 percent from the pre-test to test period. An increase

(10.0 percent) in the type II motorist violation rate was observed, however, when measuring the difference between the test and post-test periods, indicating a rebound of the motorist behavior to past unsafe (violation of warning device) behaviors following the conclusion of the PEERS programs. Differences in the type III motorist violation rates between the three testing periods were minimal due to the very small sample size. The reduction from the pre-test to the post-test period in motorist type III violations at Arlington Heights Road were not found to be statistically significant (p=0.4665). Motorist violations at Arlington Heights Road were not reduced enough, or at all, to be considered a designated 50 percent reduction success.

The magnitudes of the estimated differences for pedestrian violations at Arlington Heights Road were so small relative to other violation differences that the results were insignificant. Appendix D provides difference of LS-means tables for Arlington Heights Road.

Table 13. Motorist and Pedestrian Violation Rates, Arlington Heights Road

Arlington Heights Road Motorist and Pedestrian Violation Rates by Violation Type/Period				
Violation Type	*Mode*	*Pre-Test*	*Test*	*Post-Test*
Type I	M	1.09	1.17	1.21
	P	0.005	0.003	0.003
Type II	M	1.11	0.93	1.02
	P	0.08	0.03	0.02
Type III	M	0.004	0.004	0.001
	P	0.06	0.01	0.01

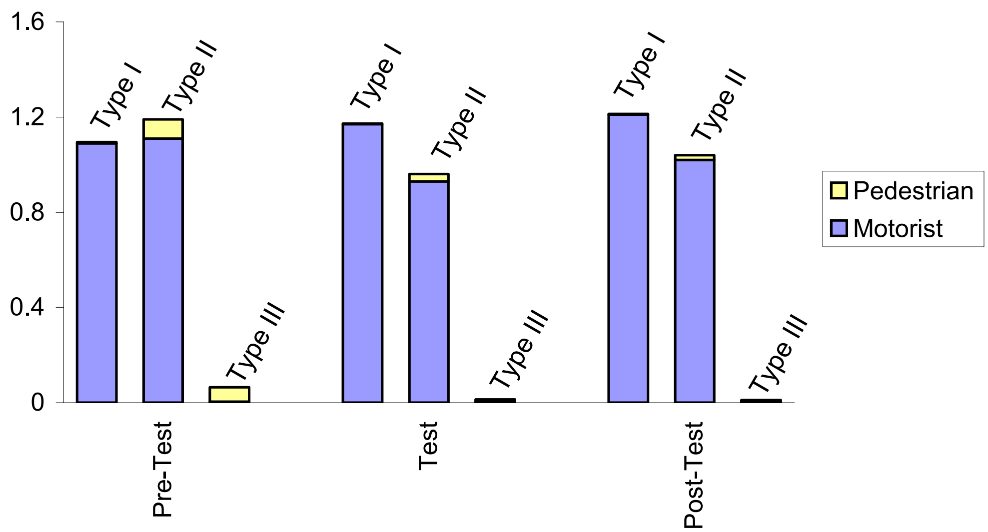


Figure 17. Motorist and Pedestrian Violation Rates, Arlington Heights Road

Like the Arlington Heights Road crossing, the Evergreen Avenue crossing had similar motorist and pedestrian traffic patterns. Table 14 and Figure 18 show motorist and pedestrian violation rates for Evergreen Avenue.

The motorist violation rates for type I violations showed a slight reduction between the pre-test and test periods and a slight increase between the test and post-test periods. The net effect was one of no difference between the pre-test and post-test period type I motorist violation rates. The reduction in motorist type I violations from the pre-test to the post-test period was not statistically significant ($p=0.9890$). Motorist type II violations at Evergreen Avenue were reduced significantly from the pre-test to the post-test period ($p<.0001$). However, motorist type II violations only showed a reduction of 21.2 percent from the pre-test to the post-test period. Finally, the sample size for motorist type III violations at Evergreen Avenue was too small to draw any conclusions. The reduction in motorist type III violations from the pre-test to the post-test was not found to be statistically significant ($p=0.1708$). Overall, the reduction in motorist violation rates at Evergreen Avenue does not meet the designated 50 percent reduction goal.

The magnitudes of the estimated differences in type I pedestrian violations at Evergreen Avenue were too small to draw any conclusions. The type II pedestrian violation rates between the pre-test and post-test periods was reduced 12.9 percent, but the reduction in type II violations during those periods was not found to be statistically significant ($p=0.0742$). The reduction in type III pedestrian violations was statistically significant ($p<0.0001$), and the violation rate was reduced 37.6 percent. Although a reduction in type II and type III pedestrian violations occurred, at Evergreen Avenue, the designated 50 percent reduction goal was not met. Appendix D provides difference of LS-means tables for Evergreen Avenue.

Table 14. Motorist and Pedestrian Violation Rates, Evergreen Avenue

Evergreen Avenue Motorist and Pedestrian Violation Rates by Violation Type/Period				
Violation Type	*Mode*	*Pre-Test*	*Test*	*Post-Test*
Type I	M	0.10	0.06	0.10
	P	0.04	0.01	0.01
Type II	M	1.27	1.13	1.00
	P	0.26	0.21	0.23
Type III	M	0.01	0.005	0.001
	P	0.11	0.04	0.07

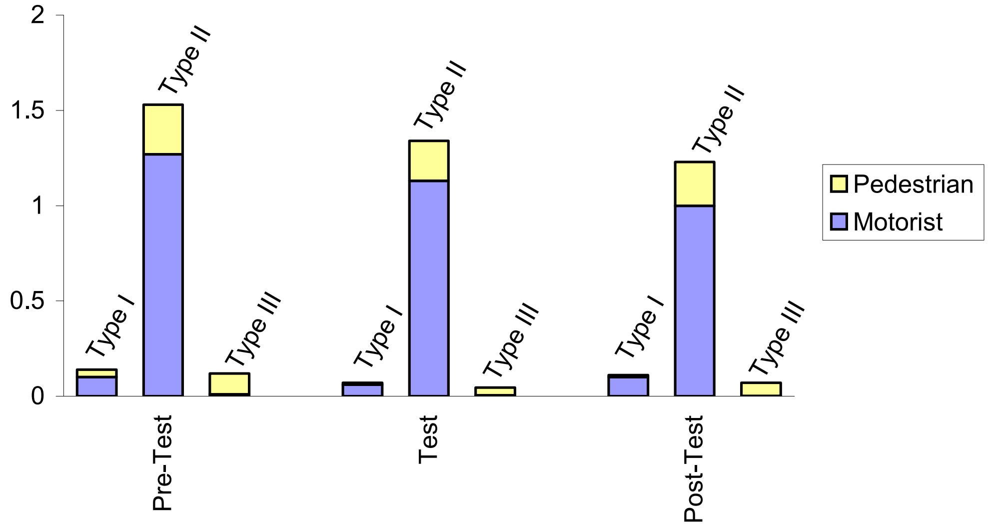


Figure 18. Motorist and Pedestrian Violation Rates, Evergreen Avenue

Unlike both the Arlington Heights Road crossing and the Evergreen Avenue crossing, the Dunton Avenue crossing has an adjacent Metra commuter rail station stop and, as such, has extremely different motorist and pedestrian traffic patterns. For this reason, heavy pedestrian activity occurs at the crossing, and this crossing exhibits the highest number of type III violations. Eighty-three percent of all pedestrian violations occurred at the Dunton Avenue crossing. Table 15 and Figure 19 show motorist and pedestrian violation rates at Dunton Avenue.

The type I motorist violation rate at Dunton Avenue did not change from the pre-test period to the test period and was reduced only slightly (12.4 percent) from the pre-test period to the post-test period. The reduction in pre-test and post-test period type I motorist violations was not significant ($p=0.1207$). The reduction in motorist type II violations was statistically significant ($p<0.0001$), and the motorist type II violation rate was reduced 38.7 percent from the pre-test period to the post-test period. The estimated differences in motorist type III violations at Dunton Avenue were too small to draw any meaningful conclusions. The reduction in all types of motorist violations at Dunton Avenue failed to meet the designated 50 percent reduction goal.

The magnitudes of the estimated differences for type I pedestrian violations at Dunton Avenue were too small to yield any positive results. The type II pedestrian violation rates decreased 11.4 percent from the pre-test period to the post-test period, but a statistically significant reduction did not occur ($p=0.0597$). Neither the reduction in pedestrian type I nor type II violations at Dunton Avenue met the designated 50 percent reduction goal. The type III pedestrian violation rates experienced a large reduction (76.3 percent) between the pre-test and post-test periods. The reduction in pre-test and post-test pedestrian type III violations at Dunton Avenue was statistically significant ($p<0.0001$). This reduction may be indicative of a behavioral change for pedestrians, most of whom are commuters, at the Dunton Avenue crossing. The reduction in pedestrian type III violations at Dunton Avenue is considered a success because it exceeds the designated 50 percent goal. Appendix D provides difference of LS-means tables for Dunton Avenue.

Table 15. Motorist and Pedestrian Violation Rates, Dunton Avenue

Dunton Avenue Motorist and Pedestrian Violation Rates by Violation Type/Period				
Violation Type	*Mode*	*Pre-Test*	*Test*	*Post-Test*
Type I	M	0.13	0.13	0.11
	P	0.07	0.03	0.03
Type II	M	0.88	0.61	0.54
	P	0.43	0.33	0.39
Type III	M	0.0004	0.003	0.001
	P	2.20	0.96	0.52

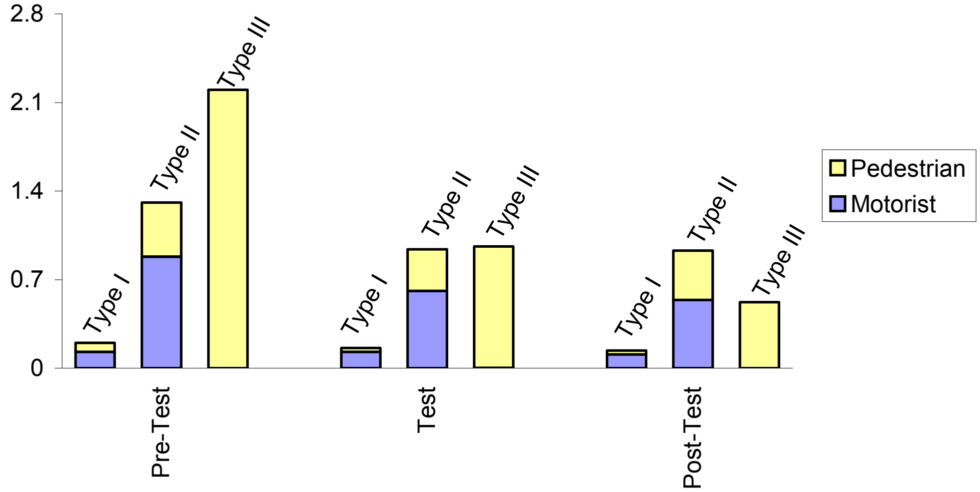


Figure 19. Motorist and Pedestrian Violation Rates, Dunton Avenue

5.5.5 Violation Counts and Rates During Blitz Activity

Blitz activity occurred at all three crossings at various times during the 12-month test period, between September 1, 2003, and August 31, 2004. Three types of blitzes were conducted: information blitzes, motor vehicle enforcement blitzes, and pedestrian enforcement blitzes. Citations were only issued during the enforcement blitzes. Over the 12-month test period, the Arlington Heights police force conducted 8 information blitzes, 12 pedestrian enforcement blitzes, and 16 motor vehicle enforcement blitzes. The penalty for disobeying the grade crossing warning devices in Illinois is a mandatory $250 fine or 25 hours of community service. Eighty-three citations were issued during the blitzes: 9 to pedestrians, 5 to trespassers, and 69 to motor vehicle drivers.

Only 29 of the 337 days of data collected in the test period experienced some blitz activity. Figure 20 is a pie chart of the number of train events observed during the test period and whether they occurred on a blitz day or not.

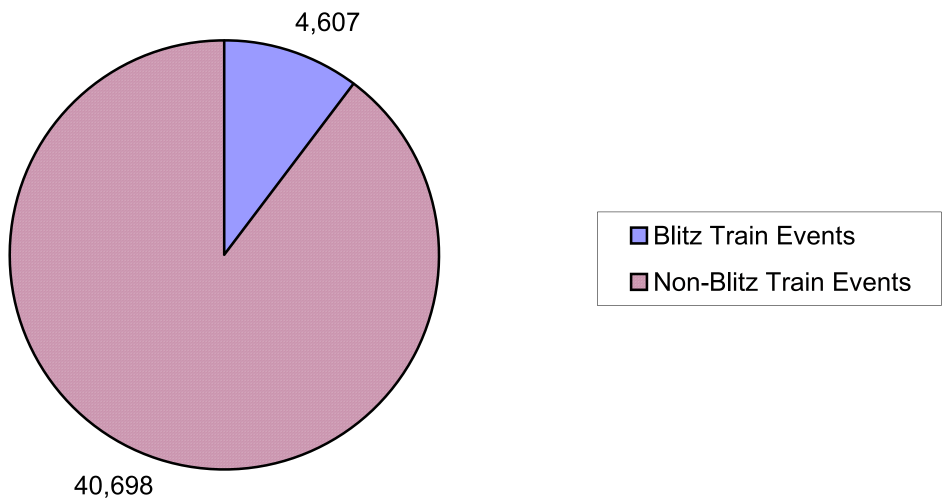


Figure 20. Count of Train Events on Blitz and Non-Blitz Days

For analysis, the three types of blitzes were first combined into one because the effects are similar. The blitzes were not scheduled regularly nor were they evenly distributed throughout the 12-month period. For example, during the period of September 1, 2003, through October 31, 2003, 11 days had blitz activity as compared to the period of November 1, 2003, through December 31, 2003, where only 1 day had blitz activity. This made a balanced approach difficult. For this reason, Table 16 shows three time periods: the overall test period and the two 2-month periods with the most blitz activity. Comparing the entire test period with rates calculated only on associated blitz days, the violation rate for the days associated with the blitz efforts was only slightly lower than the violation rate calculated for all days within the test period. In periods with the most blitz activity, however, the violation rates were lower than the overall violation rate for that period.

Table 16. Test Period Violation Rates versus Blitz Days Violation Rate

Test Period Violation Rates versus Blitz Days Violation Rates			
	9/1/03-8/31/04	9/1/03-10/31/03	7/1/04-8/31/04
Test Period	1.82	2.20	1.70
Blitz Days	1.78	2.00	1.61

Motorists and pedestrians were targeted differently during the blitz activities. The pedestrian enforcement blitzes had more officers present at the crossings than the motor vehicle enforcement blitzes. Pedestrians also had an opportunity to interact with the officers about crossing safety. For this reason, the evaluation team examined the effects of the blitzes on motorist and pedestrians separately. Table 17 and Figure 21 show the motorist and pedestrian violation rates for the test period, all blitz days, and the days on which the blitz targeted the mode of travel. Motorist violation rates exhibited no change on all blitz and motor vehicle enforcement blitz days. Pedestrian violation rates, however, were 18.1 percent lower on all blitz days than the overall test period and 30.8 percent lower on days when there was a pedestrian enforcement blitz. These numbers suggest that pedestrians responded more positively to the information and enforcement blitzes.

Table 17. Test Period Violation Rates versus All and Mode-Specific Blitz Days Violation Rates by Mode of Transportation

Test Period Violation Rates versus All and Mode-Specific Blitz Days Violation Rates			
	Test Period	All Blitz Days	Mode-Specific Blitz Days
Motorist	1.347	1.356	1.328
Pedestrian	0.565	0.463	0.391

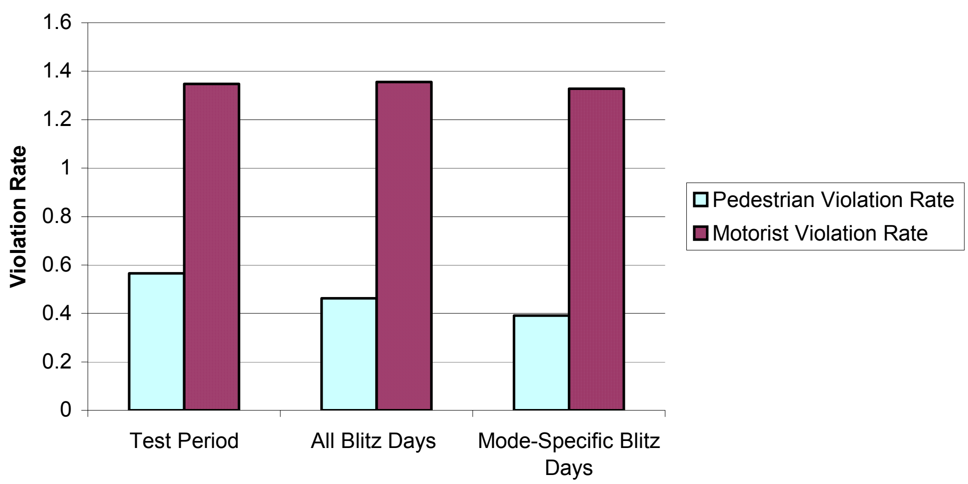


Figure 21. Test Period Violation Rates versus All and Mode-Specific Blitz Days Violation Rates by Mode of Transportation

5.5.6 Violation Counts and Rates During Second Train Events

During the course of the study, unforeseen environmental factors existed that could have affected the PEERS evaluation results. These factors were highway-rail grade crossing user incidents that occurred in the Chicago area during the PEERS study period. These incidents were high profile pedestrian fatalities; several of them included children. In particular, two of the fatalities were the result of a second train situation. A second train event occurs on a rail line with multiple tracks when two trains occupy the crossing warning block at the same time. The fatalities may have occurred because the victims did not expect another train to pass through the crossing.

Consideration was given to the potential effects of these incidents on highway-user behavior. Of particular interest was whether or not highway-users behaved more cautiously when a possibility of a second train event existed. This was done by comparing the violation rates for the pre-test and post-test periods. More specifically, this included comparing the violation rates for before the first train enters a crossing to the violation rates for after the first train departs a crossing. Table 18 shows the comparison between pre-test and post-test type II violation rates for both before and after the first train. Only type II violation rates were used because type I and type III violation rates were considered too small to provide meaningful results.

Table 18. Violation Rates for Type II Violations, Before and After the First Train

Type II Violation Rates Before and After the First Train				
		Pre-Test	Post-Test	Percent Reduction
Type II	Overall	1.35	1.04	23.0%
	Before First Train Arrival	0.33	0.31	6.1%
	After First Train Departure	1.02	0.73	28.4%

For type II violation rates during the pre-test period, three times as many violations occurred after the first train departs as violations before the first train arrives. This is believed to be because when the train leaves the crossing, people are instilled with a false sense of security and ignore the crossing warning devices. The rate for before first train arrival was minimally reduced from pre-test to post-test (6 percent). The type II violation rate for after the first train departure, however, was reduced almost 30 percent. This would indicate that highway-users were more sensitive to the possibility of a second train event. This behavior change may have been prompted by media attention to the fatal accidents. Because highway-users appeared sensitive to the possibility of second train coming situations, it can be hypothesized that their behavior would also be affected by additional safety improvements, such as passive or active second train warning devices.

5.5.7 Other Performance Measures

Time-to-collision, warning time, and violation time were also examined to evaluate the degree of risk associated with driver and pedestrian behavior. Time-to-collision is a performance measure of time, in seconds, of the estimated train arrival at the location of the violator when the violator enters the crossing zone. Warning time is the measure, in seconds, of the amount of time the motorist or pedestrian has to respond to the warning signals at the crossing. Violation time, in seconds, is a performance measure of the length of time between the activation of the crossing warning signals and the time of the violation.

Time-to-collision and violation time were unchanged during the course of the study. These performance measures do not take into account the fact that fewer violations were committed in the test and post-test periods. The times are based on motorists and pedestrians that continue to commit violations. This result indicates that those highway-users who continue to commit violations continue to do so in the same manner. The warning times at the Arlington Heights crossings were consistent over the course of the study. This performance measure did not provide any new information.

6.0 Conclusions

6.1 Conclusions and Recommendations

The PEERS project can be deemed a success if one of two goals were met. The first goal was for the research to produce meaningful, transferable results. The second goal was for the PEERS program to be effective in changing behavior around highway-rail grade crossings. The programs are considered successful if the violation rate is reduced by the designated 50 percent goal over the course of the study. The first goal was met. The second goal was met for type III violations, which is representative of the most risky behavior. The PEERS project can therefore be considered successful.

The results of the data analysis of the PEERS project revealed an overall decrease of 30.7 percent in the violation rate at the three crossings in Arlington Heights. However, more detailed information was available from the data collected during the PEERS evaluation study. The type of violation recorded conveyed additional information about specific highway-user behavior. The results showed decreases for the more risky type II and the most risky type III violations. A considerable reduction of 71.4 percent occurred in type III violations. This indicates that the PEERS programs were most effective in changing exceptionally risky behavior.

The analysis of the data by mode of travel revealed that the reduction in motorist violations was not statistically significant. The reduction in all pedestrian violations was statistically significant. This indicates a safety conscious change in pedestrian behavior at the three grade crossings in Arlington Heights. By examining the data more closely, the majority of reductions in violations occurred at the Dunton Avenue crossing. The results showed the most significant reductions in pedestrian violations, especially the most risky, type III violations. The pedestrians at the Dunton Avenue crossing were mostly commuters accessing the adjacent commuter rail station. This group of highway-users entered the crossing zone on a regular basis and was likely exposed to most, if not all, of the blitz activities. The results determined a significant decrease in violations on blitz days, indicating the blitzes were an effective grade crossing safety tool for pedestrians. While waiting for trains to clear the highway-rail grade crossing, the commuters were a captive audience with time to listen, and experience enhanced education and enforcement efforts underway at the station and the crossing. The PEERS programs were effective in reducing the most dangerous pedestrian behaviors and were especially effective on commuters that were exposed to the crossing and the programs on a daily basis.

Outside events may have impacted the results. For example, high profile fatal pedestrian incidents occurred at other crossings in the Chicago area. These may have affected highway-user behavior during second train events.

The Volpe Center viewed and recorded over 60,000 train events and over 120,000 violations at the three Arlington Heights crossings. The sample size collected was large enough to provide statistical confidence in the results. The results are transferable and could be replicated under similar circumstances.

The analysis of the PEERS enhanced education and enforcement programs provides support to the following recommendations:

- Crossing demographics and characteristics were determined to play a large role in the results of the PEERS programs; therefore, data from other communities could be analyzed with a stronger focus on the crossing environment.
- A more global picture can be developed by conducting a comparison study of PEERS efforts in rural versus urban/suburban communities. The raw video data collected from Macomb, IL, could be analyzed for a rural perspective.
- The Microsoft Access database for Arlington Heights contains additional information not used in the analysis in this report. These data fields may be used for future studies exploring driver behavior or other areas.
- The enhanced education and enforcement initiatives could be evaluated using a cost benefit study. This study could use potential lives saved versus the cost of law enforcement to conduct blitzes.
- Another area worthy of pursuit is investigating how often blitzes should be performed to maximize effectiveness.
- Second train warning devices (either active or passive) may be useful in discouraging risky highway-user behavior at multiple track crossings.

6.2 Lessons Learned

During the course of the project, the PEERS team encountered unexpected obstacles and complexities. These situations were handled accordingly and provide a basis of knowledge that will serve to improve future remote data collection projects. A major point of interest during the PEERS was cyber and network security. Government networks and connections must be certified, as directed under new guidance and regulation, to adhere to security standards and procedures. In addition to in-house equipment, the field computers must also meet stringent security guidelines. The use of firewall and anti-virus software can protect against computer hacking and virus infiltration. In addition to security, the PEERS team also encountered slow data transfer speeds to the Volpe Center. The reason was an inadequate upload speed from the field computers. The project incurred additional cost to increase the upload speed so that files could be transferred at a reasonable rate.

The installation of the field camera equipment also provided some learning experiences. The Arlington Heights street lights were on a photocell, operating only during the dark hours. A solar powered battery pack was designed to resolve this issue. However, the pole mounted battery compartments must be tightly secured to reduce vibration and movement that could result in camera malfunction.

The involvement of many stakeholders proved another challenge for the PEERS team. Creating a working relationship with a variety of stakeholders takes time, effort, patience, and compromise. The project schedule must account for additional time to get all parties involved.

Anytime people are forced to change their behavior, there will be those who will resist. On enforcement blitz days, police officers required highway-users to comply with the crossing warning devices. At times, this compliance meant passengers missing their trains. Articles were published in the local newspaper detailing the public’s difficulty accepting the enforced grade crossing safety rules. Figure 22 shows a photograph of a law enforcement officer requiring commuters to comply with the crossing warning devices.

Figure 22. Law Enforcement Requires Compliance with the Crossing Warning Devices, Dunton Avenue

Appendix A.
Site Survey Documents

U.S. Department
of Transportation

Technical Report

Research and Special Programs Administration

John A. Volpe
National Transportation Systems Center

Subject: ***Public Education and Enforcement Research Study: Technical Site Survey Report***

Date: November 14, 2002

From: William Baron, Patrick Bien-Aime, Anya Carroll, Alan Kauffman, Andy Lam, Steven M. Peck, and Suzanne Sposato

Reply to Attn of: Volpe Center, DTS-75

To: Ron Reis, Manager of Grade Crossing Safety Programs
Federal Railroad Administration
Steve Laffey, Transportation Policy Analyst
Illinois Commerce Commission

The Highway-Rail Grade Crossing Safety Research Team of the Volpe Center was tasked by the FRA Office of Safety to work with the Illinois Commerce Commission (ICC) on a project entitled the "Public Education and Enforcement Research Study (PEERS)". The PEERS team includes William Baron, Patrick Bien-Aime, Anya Carroll, Alan Kauffman, Andy Lam, Steven M. Peck, and Suzanne Sposato. The objective of this project is to demonstrate that through enhanced education and awareness activities, in combination with targeted enforcement, violations of traffic laws at highway-railroad grade crossings can be significantly reduced. The Volpe Center has been tasked to purchase and install video surveillance systems, to collect, monitor and analyze data, and to develop a report summarizing the motorist and pedestrian behavior at eight grade crossings in three Illinois communities.

The project entails the collection and analysis of motorist and pedestrian behavior data for 18 months at eight highway-rail grade crossings in three communities in Illinois. The three communities are Macomb, Bartlett, and Arlington Heights. There are three grade crossings in Macomb, two grade crossings in Bartlett, and three grade crossings in Arlington Heights. Site surveys were initially conducted on June 25 – 26, 2002 and then again on September 24 – 26, 2002.

This memorandum discusses (1) the observations and findings at each grade crossing from the site visit and (2) additional issues that need to be addressed the Volpe Center.

The PEERS team conducted grade crossing site surveys in Macomb on June 25, 2002 and on September 25, 2002, and in Bartlett and Arlington Heights on June 26, 2002 and on September 24 and 26, 2002. At each grade crossing railroad personnel accompanied the team. The team surveyed each grade crossing, examined the area surrounding the grade crossing, interviewed railroad personnel, and documented their findings. Listed below are the findings for each grade crossing broken down by community.

Macomb, IL

Macomb is located 200 miles west of Chicago and home to Western Illinois University. The town's approximate population is 18,558, which includes the university's enrollment of 10,573 undergraduate students.

Macomb is situated along the Burlington Northern and Sante Fe Railroad Company (BNSF) railroad that carries approximately 20 trains per day, two Amtrak trains and eighteen freight trains. The grade crossings to be evaluated are Jackson Street crossing, Ward Street crossing, and Lafayette Street crossing.

The findings of the site visit including the technical survey list, digital photographs, and proposed pole locations are included in Attachment 1 (Site Survey List – Macomb, IL).

Bartlett, IL

Bartlett is a suburb of Chicago approximately thirty-five miles to the northwest. The village of Bartlett has an approximate population of 37,000 residents.

Bartlett is situated along a Northeast Illinois Regional Commuter Railroad Corporation (Metra) line that is owned and operated under contract by the Union Pacific Railroad. The two grade crossings to be evaluated in Bartlett are the Oak Ave crossing and the Western Ave crossing.

The two grade crossings are approximately 900 feet apart with a Metra station located between the two grade crossings, adjacent to the Oak Ave crossing.

The findings of the site visit including the technical survey list, digital photographs, and proposed pole locations are included in Attachment 2 (Site Survey List – Bartlett, IL).

Arlington Heights, IL

Arlington Heights is a suburb of Chicago approximately twenty-two miles to the north. The village of Arlington Heights has an approximate population of 76,031 residents.

> Arlington Heights is also situated along a Metra line that is owned and operated under contract by the Union Pacific Railroad. The three grade crossings to be evaluated are the Dunton Street crossing, the Evergreen Street crossing, and the Arlington Heights Road crossing.

The three grade crossings are located approximately 700 feet apart with a Metra station located adjacent to the Dunton Avenue crossings.

The findings of the site visit including the technical survey list, digital photographs, and proposed pole locations are included in Attachment 3 (Site Survey List – Arlington Heights, IL).

The Highway-Rail Grade Crossing Safety Research Team of the Volpe Center attended the PEERS project kick-off meeting on June 27, 2002 in Downers Grove, IL. The meeting consisted of the introductions of each group involved in the project, a presentation by the Volpe PEERS Project Manager detailing the Volpe Center's capabilities, and a discussion of what needs to be done to continue the project in a timely manner. The presentation and the meeting minutes are contained in Attachment 4.

The site surveys conducted in June and September of 2002 provided valuable information required to proceed farther with this project. Many additional issues have surfaced as a result of the surveys. Currently the Volpe PEERS team is working on solutions for these problems. The main issues that require attention include high-speed Internet connection, active continuous power sources, system issues, and camera issues.

The following issues were address at the PEERS team meeting held on October 28, 2002 Room 6-625 at the Volpe National Transportation Systems Center in Cambridge, MA:

General information

Digital Subscriber Line (DSL) has to be a mile within company's central office in order for it to properly connect. There is no problem in Arlington Heights, but Bartlett and Macomb still remain questionable. A PEERS team member will look up an online map and assign a street addresses for the Bartlett and Macomb bungalows and determine their distances from the nearest DSL central office. The lead time for DSL is about two weeks.

The cameras will not have landline cables connecting them to the system. Video will be send back wirelessly to the bungalows. Therefore, power is needed for the cameras to operate. There will be six cameras connected to each system.

1. <u>DSL issues</u>

Arlington Heights

- Arlington Heights has a phone line with high speed provider Ameritech.

- Union Pacific (UP) doesn't want the PEERS system in their railroad bungalow, therefore, a separate box will be mounted outside next to the railroad bungalow (see Arlington Heights block diagram).

Bartlett

- Western Avenue and Oak Avenue have no addresses and no phone lines.

Macomb

- Jackson Street has a phone line, but not with Ameritech and an Ameritech line is needed to get DSL.

- Lafayette Street and Ward Street have no addresses, and therefore, no phone line.

Power issues

Arlington Heights

- Dunton Avenue North – IDOT Traffic Signal pole will be used, an electrician will be hired to install an outlet.

- Dunton Avenue South – Outlet exists, but it is on photo cell timer, therefore, power supply to the poles is needed.

- Evergreen Avenue North-IDOT Traffic Signal pole will be used, an electrician will be hired to install an outlet.

- Evergreen Avenue South – Outlet exist, but it is on photo cell timer, therefore, power supply to the poles is needed.

- Arlington Heights Road North-IDOT Traffic Signal pole will be used, an electrician will be hired to install an outlet.

- Arlington Heights Road North-IDOT Traffic Signal pole will be used, an electrician will be hired to install an outlet.

Bartlett

- Western Avenue North-Outlet already exist, but power is on photo cell timer. Rechargeable power supply is needed for the poles.

- Western Avenue South-Outlet already exist, but it is on photo cell timer. Rechargeable power supply is needed for the poles.

- Oak Avenue North-Outlet already exist, but it is on a photo cell timer. Rechargeable power supply is needed for the poles.

- Oak Avenue South-Outlet already exist, but it is on photo cell timer. Rechargeable power supply is needed for the poles.

Macomb

- Lafayette Street East-No power problem, an outlet was added by an electrician and will be sending a bill for $140.00.

- Lafayette Street West-No power problem, outlet already in place.
- Jackson Street East-No problem, power will be running from an adjacent bungalow.
- Jackson Street West – Ameran, a private company, will provide power after the Volpe Center provides receptacle mast and weather head.
- Ward Street North – Ameran, a private company, will provide power after the Volpe Center provides receptacle mast and weather head.
- Ward Street East. Ameran, a private company, will provide power after the Volpe Center provide receptacle mast and weather head.

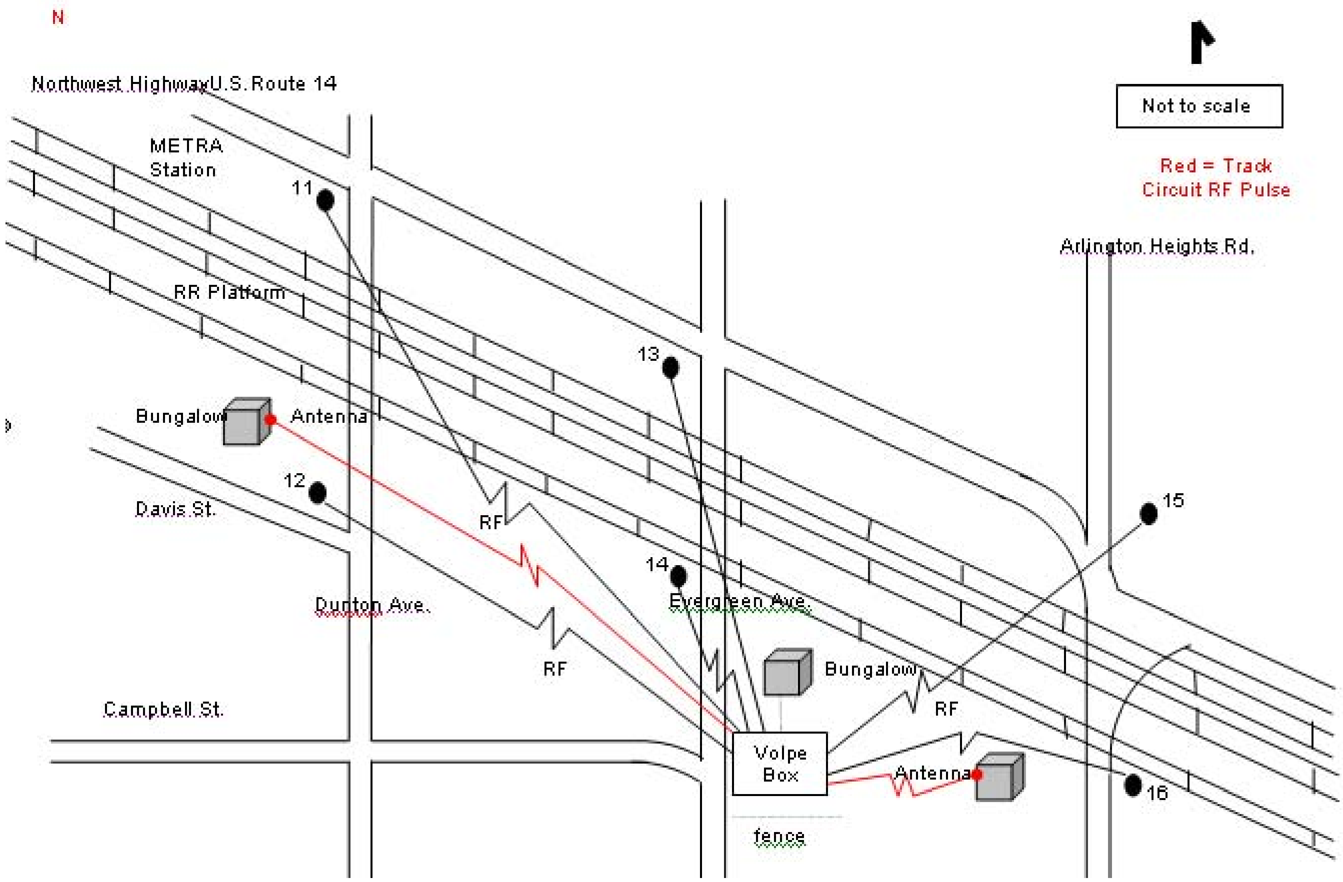
System issues

- The new Loronix system has no audio input and no modem, but it has a network interface card and different video compression.
- The PEERS project will use two new Loronix systems and if possible two older Loronix systems will be upgraded.

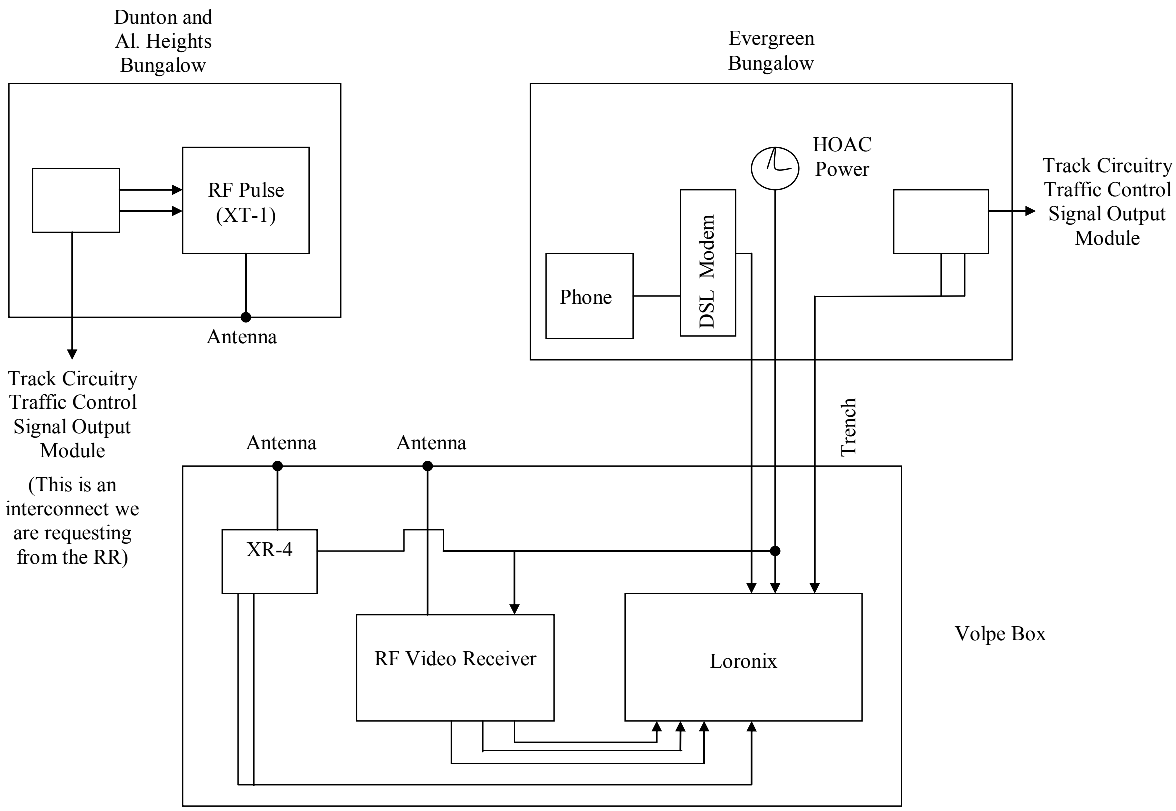
Cameras issues

- An uninterruptible power supply (UPS) will be used for the poles without photo cell timers.

Arlington Heights – Dunton Ave, Evergreen Ave, and Arlington Heights Rd
Block Diagram



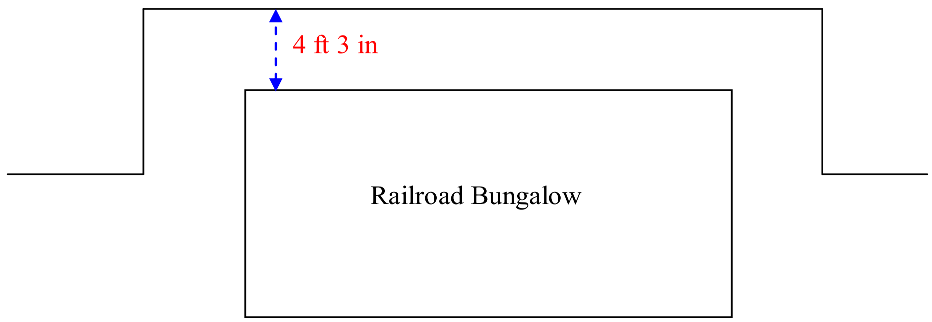
Volpe Box Diagram for Evergreen Avenue in Arlington Heights



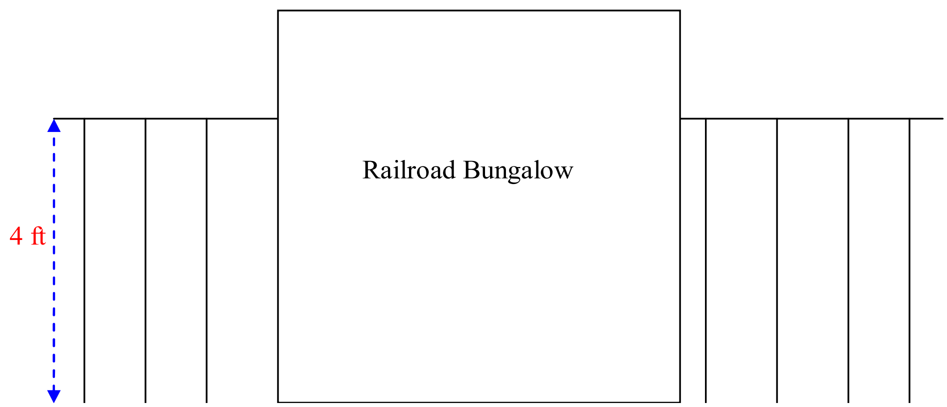
Evergreen Avenue - Arlington Heights

Fence Behind Bungalow

Top View



Front View



U.S. Department
of Transportation

Research and Special Programs Administration

Attachment 1-Site Survey List

John A. Volpe
National Transportation Systems Center

Location: Macomb, IL

Date: June 25, 2002
September 25, 2002

Surveyor: VOLPE PEERS TEAM

Contact: Corzett, Dan – Signal Supervisor; BNSF
Golder, Dwight – Manager Signals; BNSF
BNSF Flag man

Notes:

On June 25, 2002 three Burlington Northern and Santa Fe Railway Company (BNSF) representatives provided the PEERS team with a safety briefing and then accompanied the PEERS team to all three crossings in the village of Macomb.

On September 25, 2002 two BNSF representatives accompanied the PEERS team at all three crossings in the village of Macomb. The railroad bungalows were opened and the PEERS team was permitted to view the inside. The positions of possible poles to mount cameras were recorded. The Ward Street crossing has streetlights on the north and south sides that would make reasonable choices. The railroad tracks cross Jackson Street, a five-lane highway, at an angle. In order to capture all crossing activity poles nearly 300 feet away will have to be used. The Lafayette Street crossing does not offer any options for pole mounts on the north side. It will be unconventionally monitored with both cameras on the south side. The PEERS team was met later that afternoon with an official of the Village of Macomb Department of Public Works to discuss electrical power in the selected poles.

General Information

* All three crossings are on the same section of BNSF track.

1	City:	Macomb
2	County:	McDonough
3	Track Owner:	BNSF
4	Number of Tracks:	One
5	Train Frequency:	20 / Day

6	Train Type:	2 Amtrak 18 Freight
7	Rail Road Personnel Assistance:	Yes
8	Rail Road Property Access:	Yes

Lafayette Street Crossing

1	DOT Crossing Number:	072896B
2	Bungalow Mile Post Number:	202.36
3	Type of Tracks:	Main
4	Type of Crossing:	Public At Grade
5	Speed Range:	1 to 79
6	Maximum Speed:	79
7	Warning Device: Signs:	3 Reflective Cross Bucks
8	Warning Device: Train Activated:	3 R/W Reflective Gates 3 Sets of Mast Mounted FL 3 Sets of Cantilever Mounted FL 1 Bell
9	Commercial Power Available:	Yes
10	Type of Development:	Commercial
11	Smallest Crossing Angle:	30 to 59 Degrees
12	Number of Traffic Lanes Crossing Tracks:	5
13	Pavement Crosshatch Markings:	Yes
14	Estimated AADT:	9100
15	Blue Print Availability:	Yes
16	Pole Locations:	See Lafayette Street Drawing

17 Recent Accident History:

No major accidents recently. On average one gate a month is broken off. There has been a maximum of four gates broken in one month.

18 Environment Description:

The area is commercial. There are businesses on either side of Lafayette street to the north of the grade crossing. There are businesses and the town common to the south side. The crossing is complex (See attached drawing and digital photographs.).

19 Gate Description:

There are gates from all approaches. Three gates total. No pedestrian gates. The gates are all train activated.

20 Pedestrian Description:

There did not appear to be much pedestrian activity, however the town common and businesses are on one side of the crossing with commercial and residential areas on the other.

Jackson Street Crossing

1	DOT Crossing Number:	072890K
2	Bungalow Mile Post Number:	202.91
3	Type of Tracks:	Main
4	Type of Crossing:	Public At Grade
5	Speed Range:	1 to 79
6	Maximum Speed:	79
7	Warning Device: Signs:	2 Reflective Cross Bucks
8	Warning Device: Train Activated:	2 R/W Reflective Gates 2 Sets of Cantilever Mounted FL 4 Sets of Mast Mounted FL 1 Bell
9	Commercial Power Available:	Yes
10	Type of Development:	Commercial
11	Smallest Crossing Angle:	30 to 59 Degrees
12	Number of Traffic Lanes Crossing Tracks:	5

13	Pavement Crosshatch Markings:	Yes
14	Estimated AADT:	12100
15	Blue Print Availability:	Yes
16	Pole Locations:	See Jackson Street Drawing
17	Recent Accident History:	

There has been one recent accident. A car was pushed into the crossing by a tractor-trailer. The train did see the car and slowed to less than 10 mph. No one was hurt, everyone had evacuated from the vehicles.

18 Environment Description:

The area is commercial. The track crosses the road at an angle of approximately 22 degrees. There is over 300 feet between the gates. Within this span, there are entrance/exits to four businesses. Two of the businesses appear closed. Another is a car wash and the last is a business with an entrance/exit outside of the gates and crossing. The road is 5-lane highway with 2 lanes in both directions and a center turning lane. The gates do not block the turning lane. (See attached drawing and digital photographs.)

19 Gate Description:

There are gates on both approaches that are train activated. The gates cover 2 lanes of traffic each, leaving the center lane un-gated.

20 Pedestrian Description:

There did not appear to be much pedestrian foot traffic.

Ward Street Crossing

1	DOT Crossing Number:	072906E
2	Bungalow Mile Post Number:	203.11
3	Type of Tracks:	Main
4	Type of Crossing:	Public At Grade
5	Speed Range:	1 to 79
6	Maximum Speed:	79
7	Warning Device: Signs:	2 Reflective Cross Bucks
8	Warning Device: Train Activated:	2 R/W Reflective Gates 2 Sets of Mast Mounted FL 1 Bell
9	Commercial Power Available:	Yes
10	Type of Development:	Commercial
11	Smallest Crossing Angle:	30 to 59 Degrees
12	Number of Traffic Lanes Crossing Tracks:	2
13	Pavement Crosshatch Markings:	No
14	Estimated AADT:	8200
15	Blue Print Availability:	Yes
16	Pole Locations:	See Ward Street Drawing
17	Recent Accident History:	

There have not been any accidents at the crossing within the past ten years.

18 Environment Description:

The area is commercial. There is steady motor vehicle traffic. There is a dirt road parallel to the tracks to the north; it accesses a Wendy's parking lot. There is a road parallel to the tracks to the south; it accesses a storage facility on the southwest corner and an auto body shop on the southeast corner. (See attached drawing and digital photographs.)

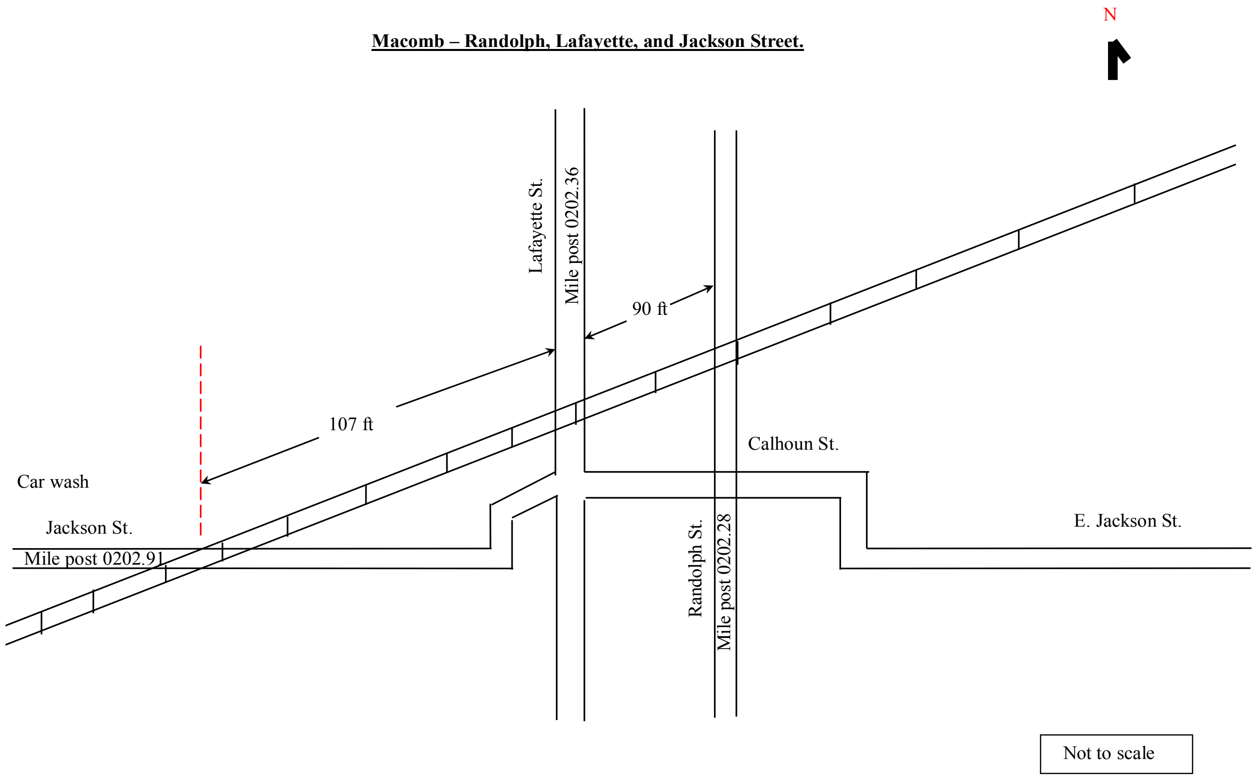
19 Gate Description:

There are gates on both approaches that are train activated. The gates are typical two-quadrant gates.

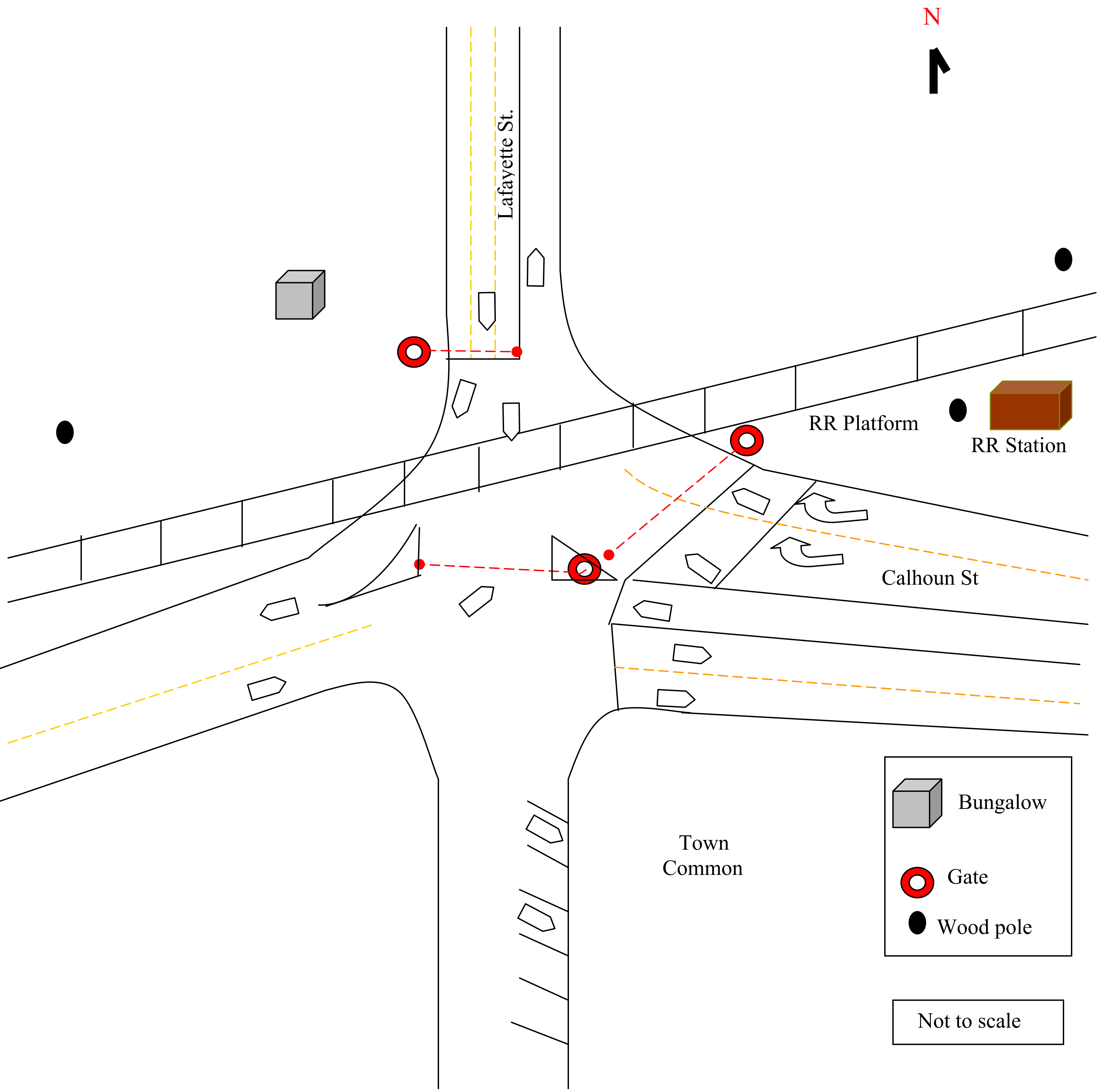
20 Pedestrian Description:

There did not appear to be much pedestrian foot traffic.

Macomb–Lafayette St., Jackson St., Block Diagram



Macomb–Lafayette Street Crossing # 079896B
Railroad Milepost: 0202.36



Lafayette Street Crossing
Macomb, IL

Figure 1. Southeast corner facing northwest.

Figure 2. Southwest corner facing north.

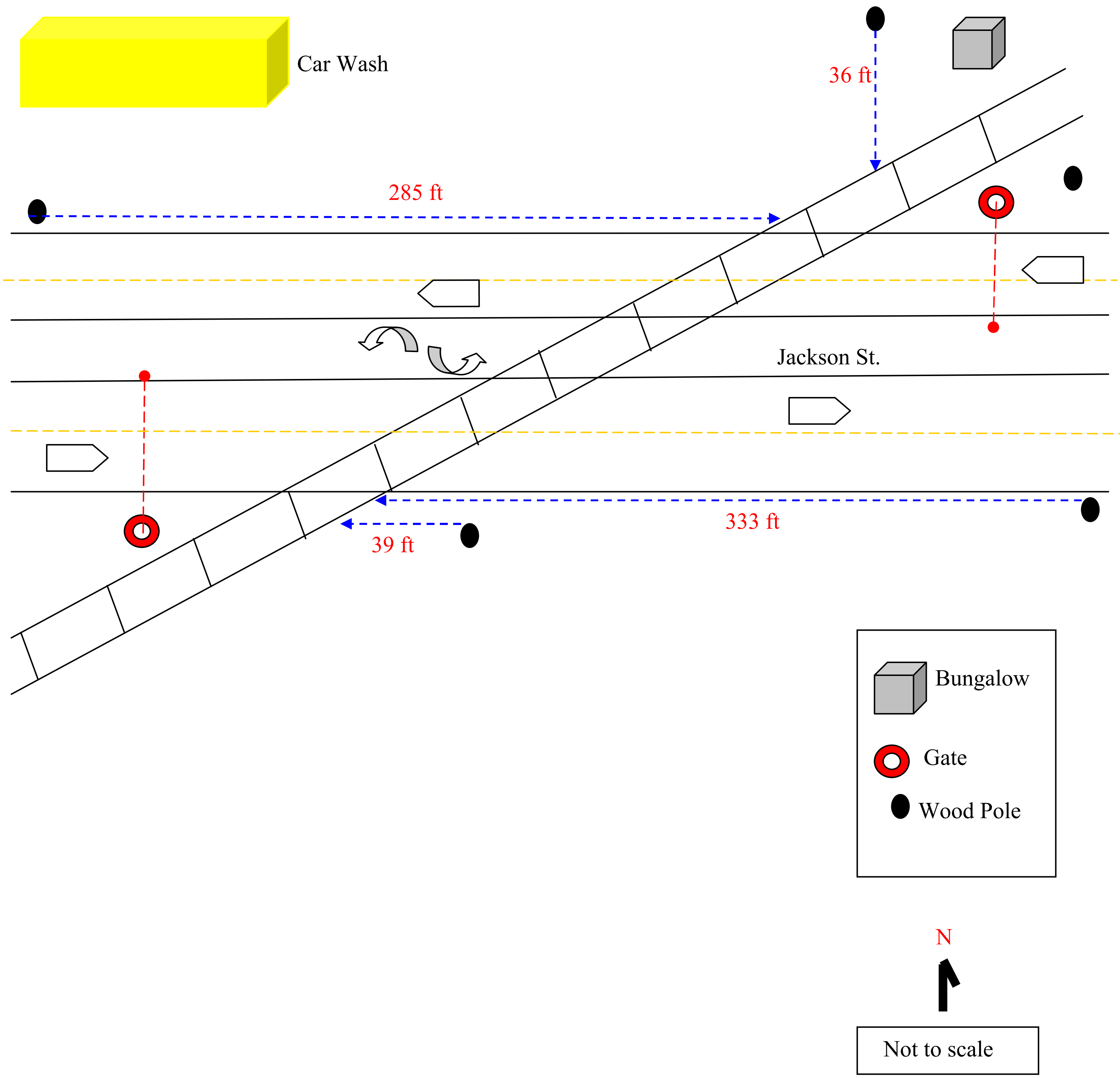
Figure 3. Northeast corner facing south.

Figure 4. Northwest corner facing southeast.

Figure 6. Northwest corner facing southeast.

Figure 7. Northeast corner facing southwest.

Macomb–Jackson Street Crossing # 072890K
Railroad Milepost: 0202.91



Jackson Street Crossing
Macomb, IL

Figure 1. Northeast corner facing west.

Figure 2. Southwest corner facing west.

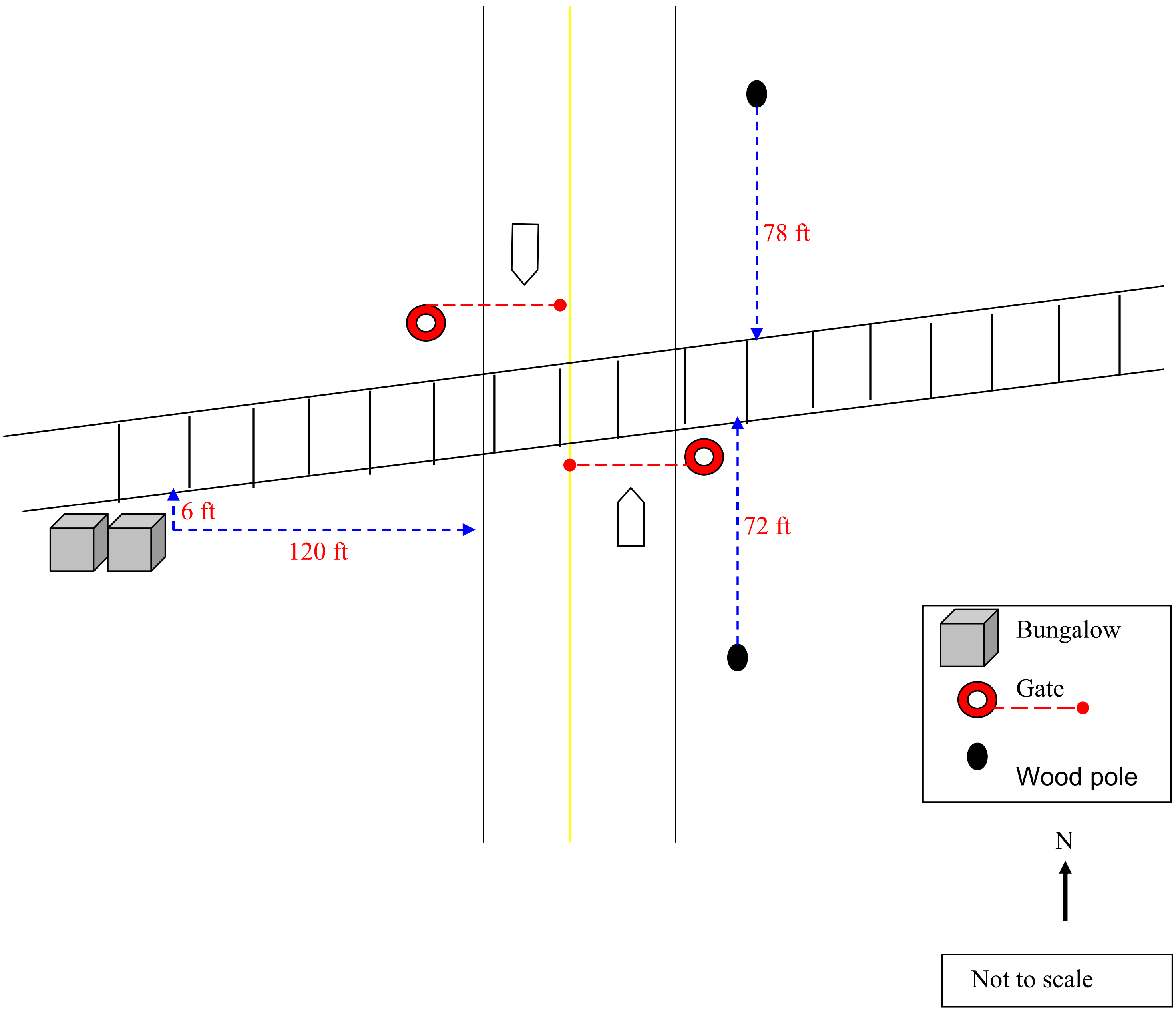
Figure 3. Southeast corner facing northeast.

Figure 4. Northwest corner facing east.

Figure 5. Southeast corner facing northwest.

Figure 6. Southeast corner facing northeast.

Macomb–Ward Street Crossing # 072906E
Railroad Milepost: 0203.14



Ward Street Crossing
Macomb, IL

Figure 1. Northwest corner facing south.

Figure 2. Northeast corner facing west.

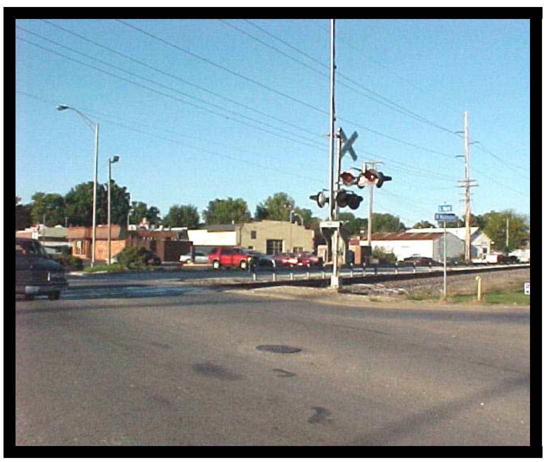


Figure 3. Southwest corner facing northeast.

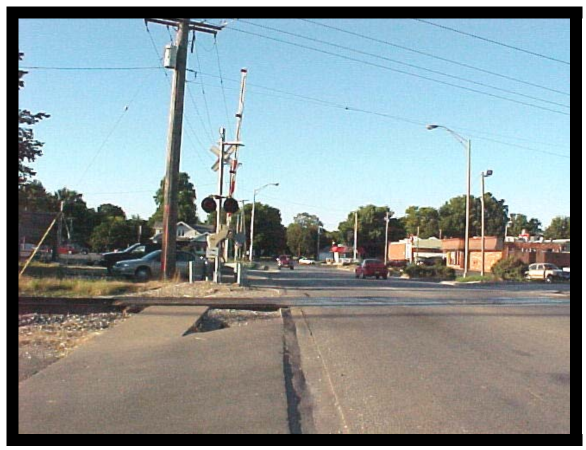


Figure 4. Southwest corner facing north.

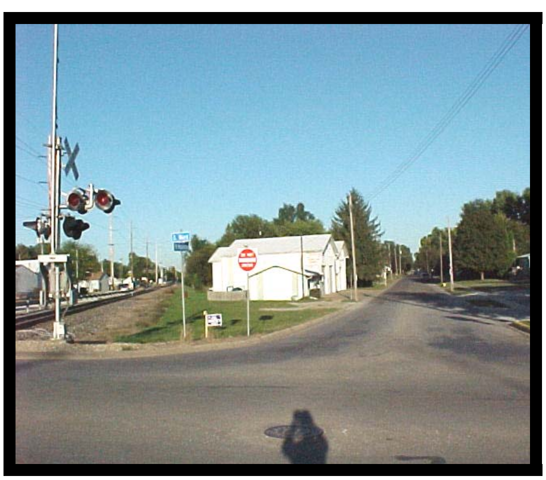


Figure 5. Southwest corner facing east.

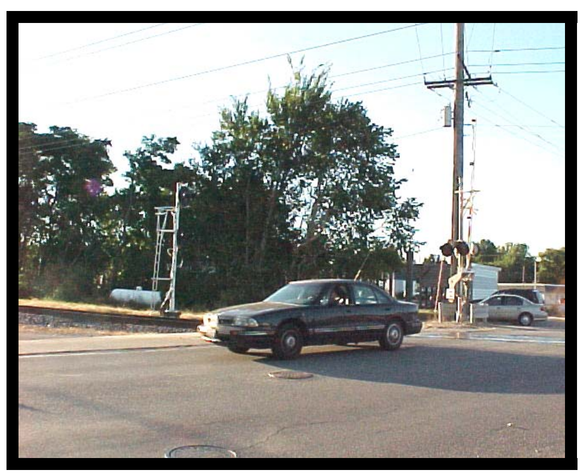


Figure 6. Southeast corner facing northwest.

U.S. Department
of Transportation

**Research and
Special Programs
Administration**

Attachment 2-Site Survey List

John A. Volpe
National Transportation Systems Center

Location: Bartlett, IL

Date: June 26, 2002
September 24, 2002

Surveyor: VOLPE PEERS TEAM

Contact: Gasinski, Jack-Metra Safety Official
McCormack, Elizabeth – Village of Bartlett Administrative Assistant
Kuester, Paul – Village of Bartlett Department of Public Works

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Notes:

Jack Gasinski of Metra accompanied the PEERS team at the grade crossings in the village of Bartlett and the village of Arlington Heights. The official provided a safety briefing before the grade crossing evaluations in the village of Arlington Heights.

The two grade crossings are on the same section of Metra rail line. The two grade crossings are located approximately 842 feet apart with a Metra station located adjacent to the Oak Avenue grade crossing and between the grade crossings.

On September 24, 2002 a Mr. Gasinski accompanied the PEERS team at both grade crossings in the village of Bartlett. The bungalows could not be opened. Contacts within the Metra signaling department were suggested to obtain a dedicated line within the relay house. Representatives from the Village of Bartlett and the Department of Public Works were contacted to obtain permission to use town-owned decorative light poles to mount cameras.

General Information (All Crossings)

* Both crossings are on the same section of Metra track.

1	City:	Bartlett
2	County:	Cook
3	Track Owner:	Northeast Illinois Regional Commuter Railroad Corporation (Metra)
4	Number of Tracks:	2
5	Train Frequency:	46

6	Train Type:	
7	Rail Road Personnel Assistance:	Yes
8	Rail Road Property Access:	Yes

Oak Avenue Crossing

1	DOT Crossing Number:	372206B
2	Bungalow Mile Post Number:	0030.09
3	Type of Tracks:	Main
4	Type of Crossing:	Public At Grade
5	Speed Range:	1 – 70
6	Maximum Speed:	70
7	Warning Device: Signs:	2 Reflective Cross Bucks
8	Warning Device: Train Activated:	2 R/W Reflective Gates 1 Colored Gate 2 Sets of Mast Mounted FL 1 Bell
9	Commercial Power Available:	Yes
10	Type of Development:	Commercial
11	Smallest Crossing Angle:	60 to 90 Degrees
12	Number of Traffic Lanes Crossing Tracks:	2
13	Pavement Crosshatch Markings:	Yes
14	Estimated AADT:	8900
15	Blue Print Availability:	Yes
16	Pole Locations:	See Oak Avenue Drawing

17 Recent Accident History:

No recent accidents. The last documented accident occurred on September 24, 1980.

18 Environment Description:

The area is commercial on both sides of the tracks. There is a Metra station adjacent to the crossing. There are non-gated pedestrian crossings. See attached drawing and digital photographs.

19 Gate Description:

There are gates for both approaches. Both gates are train activated. There are no pedestrian gates. There are also 2 pedestrian crossings located further away from the crossing. Neither of these pedestrian crossings have any type of warning device.

20 Pedestrian Description:

There appears to be much pedestrian traffic at and around the crossing. There are Metra station platforms on either side of the tracks, with a station building only on one side.

Western Avenue Crossing

1	DOT Crossing Number:	372207H
2	Bungalow Mile Post Number:	0030.26
3	Type of Tracks:	Main
4	Type of Crossing:	Public At Grade
5	Speed Range:	10 to 70
6	Maximum Speed:	70
7	Warning Device: Signs:	2 Reflective Cross Bucks
8	Warning Device: Train Activated:	2 Colored Gates 2 Sets of Mast Mounted FL 1 Bells
9	Commercial Power Available:	Yes
10	Type of Development:	Open Space
11	Smallest Crossing Angle:	60 to 90 Degrees
12	Number of Traffic Lanes Crossing Tracks:	2
13	Pavement Crosshatch Markings:	Yes

14 Estimated AADT: 500

15 Blue Print Availability: Yes

16 Pole Locations: See Western Avenue Drawing

17 Recent Accident History:

No recent accidents. The last documented accident occurred on January 23, 1998.

18 Environment Description:

The area is open on one side of the crossing and commercial on the other. There does not appear to be much pedestrian or vehicle traffic at this crossing. See attached drawing and digital photographs.

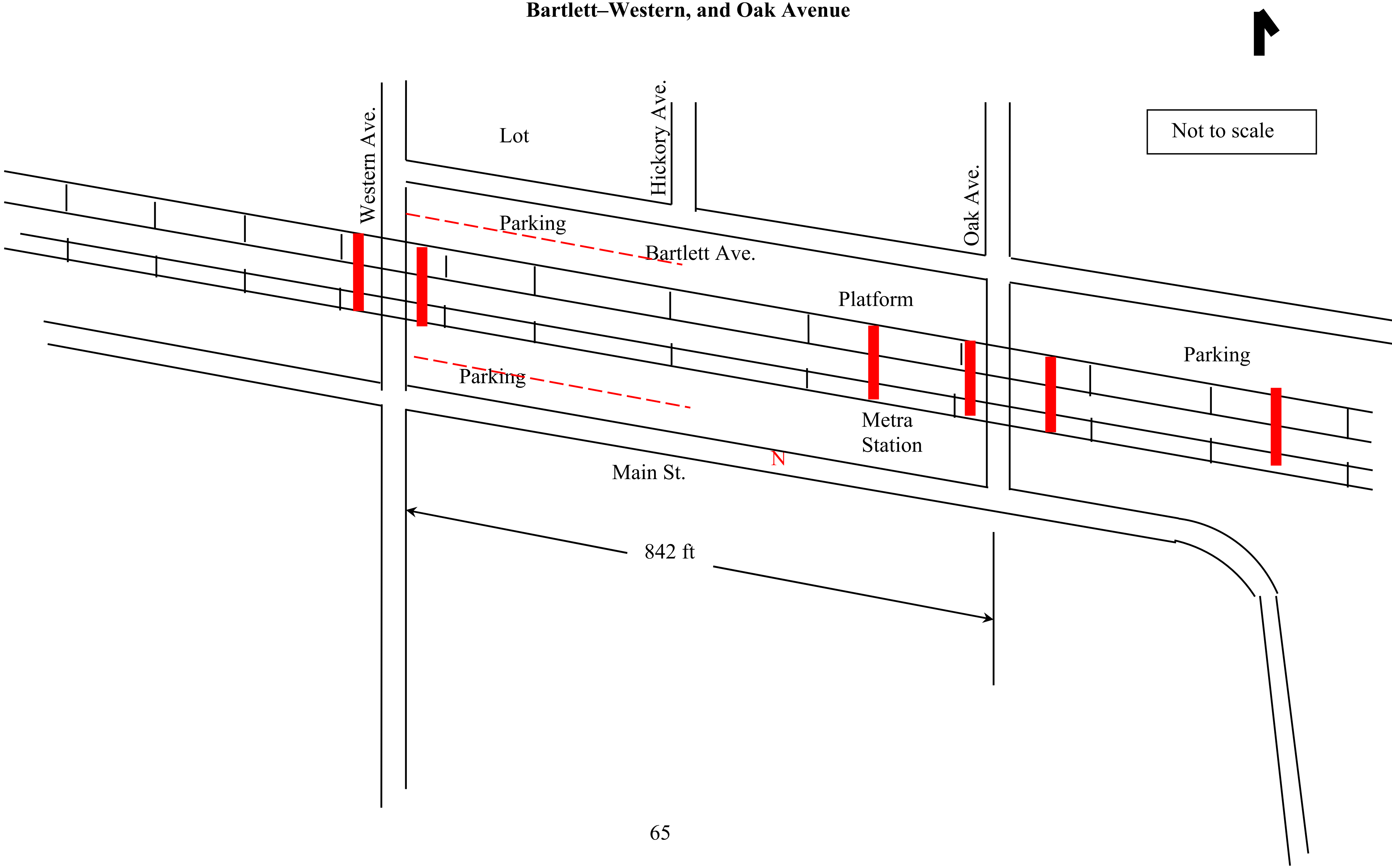
19 Gate Description:

There are gates on both approaches. Both gates are train activated. There are no pedestrian gates.

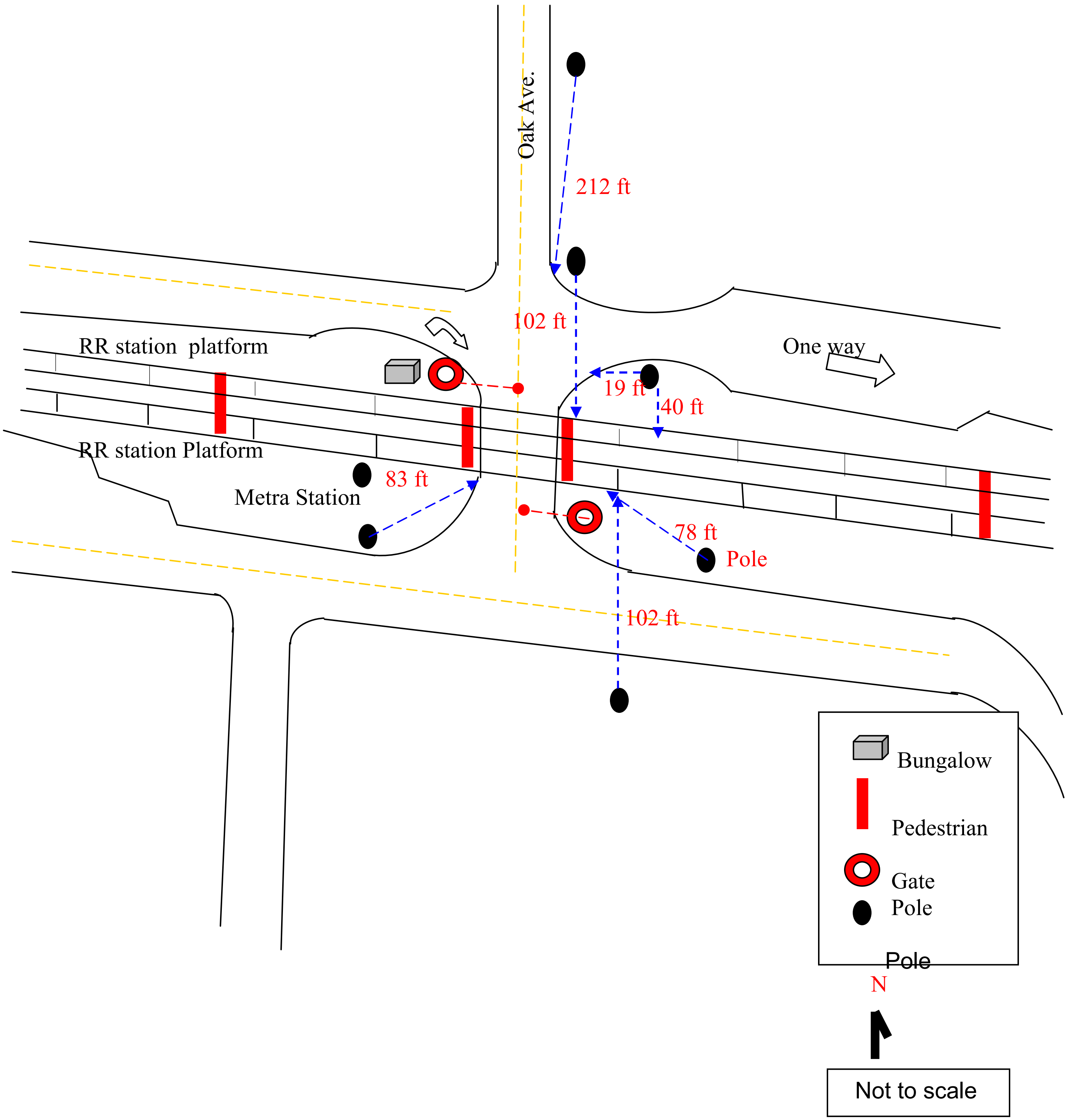
20 Pedestrian Description:

There does not appear to be much pedestrian traffic at the crossing.

Bartlett–Western, and Oak Avenue



Bartlett–Oak Avenue Crossing # 372206B
Railroad Milepost: 0030.09



Oak Avenue Crossing
Bartlett, IL

Figure 1. Southeast corner facing northwest.

Figure 2. Southwest corner facing north.

Figure 3. Northwest corner facing southeast.

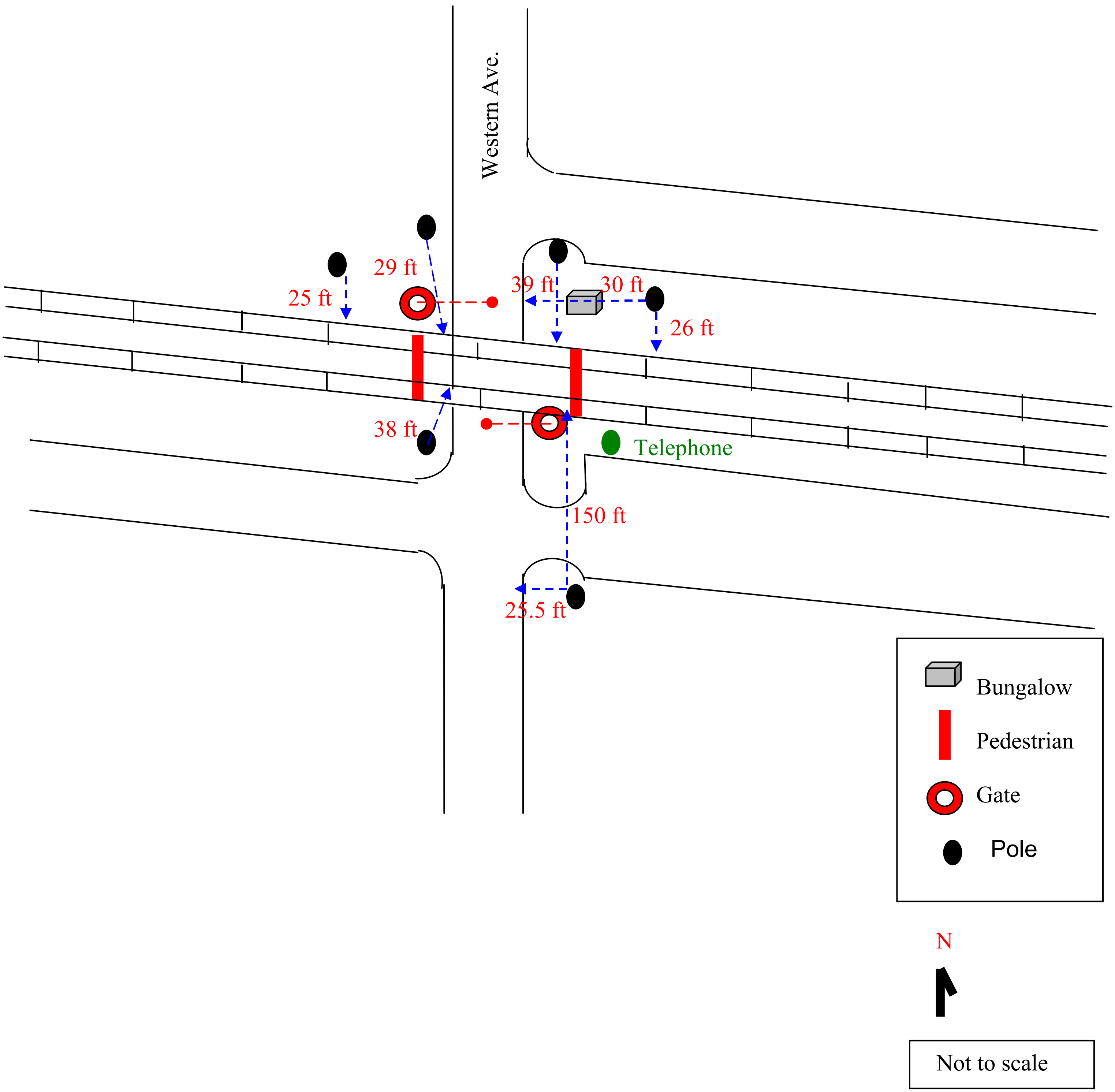
Figure 4. Northeast corner facing south.

Figure 5. Northeast corner facing west.

Figure 6. Southwest corner facing east.

Bartlett–Western Avenue Crossing # 372207H

Railroad Milepost: 0030.26



Western Avenue Crossing
Bartlett, IL

Figure 1. Southeast corner facing northwest.

Figure 2. Southwest corner facing north.

Figure 3. Northwest corner facing southeast.

Figure 4. Northeast corner facing south.

Figure 5. Southeast corner facing north.

Figure 6. Southwest corner facing northeast.

U.S. Department
of Transportation

Research and Special Programs Administration

Attachment 3-Site Survey List

John A. Volpe
National Transportation Systems Center

Location: Arlington Heights, IL

Date: June 26, 2002
September 26, 2002

Surveyor: VOLPE PEERS TEAM

Contact: Gasinkski, Jack – Metra Safety Official
Lienemann, Jerry – Union Pacific Manager Of Field Engineering
Free, Rich – Union Pacific Manager of Signaling Projects
Ferguson, Leon – Union Pacific District Signal Foreman
Mullany, Steve – Village of Arlington Heights Department of Public Works

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Notes:

Jack Gasinski of Metra Safety gave the PEERS team a safety briefing before the crossing evaluations and accompanied the PEERS team at all three crossings in the village of Arlington Heights.

The Metra line through Arlington Heights is owned and operated by the Union Pacific Railroad Company (UP) under contract with Metra. Mr. Gasinski did not know the specifics of the three crossings and suggested the team contact UP. Mr. Gasinski tried to contact UP with the PEERS team present but was unable to receive any information.

The three crossings are on the same rail line within an approximately 1000-foot span.

There are no town or utility poles available in the village of Arlington Heights. All lines are buried, including the railroad lines. There are however, traffic poles and street light poles that may be available for use to mount cameras.

On September 26, 2002 representatives from UP accompanied the PEERS team at all three crossings. UP expressed its desire to have the recording system housed in an external box behind the bungalow. A cable to connect the system to the track activation circuitry can be taken into the bungalow. The UP workers currently use digital radios that operate at 900 MHz and 930 MHz. It is essential that the system transmission signals do not interfere with the UP radio signals. The UP must be provided design specifications of the system and the interconnection to the railroad circuitry. They also must be notified in advance of the date and duration of the installation visit. There are sufficient poles for which to mount cameras. In the afternoon, a representative of the Village of Arlington Heights Department of Public Works met with the

PEERS team to discuss power supply issues in the desired, suitable poles chosen to mount cameras.

General Information (All Crossings)

* All three crossings are on the same section of Union Pacific Railroad Company track.

1	City:	Arlington Heights
2	County:	Cook
3	Track Owner:	Union Pacific Railway (UP)
4	Number of Tracks:	Three
5	Train Frequency:	75
6	Train Type:	63 Metra 12 Freight
7	Rail Road Personnel Assistance:	Yes
8	Rail Road Property Access:	Yes

Dunton Avenue Crossing

1	DOT Crossing Number:	176925Y
2	Bungalow Mile Post Number:	0022.46
3	Type of Tracks:	Main
4	Type of Crossing:	Public At Grade
5	Speed Range:	20 to 40
6	Maximum Speed:	40
7	Warning Device: Signs:	2 Signs that state "3-TRACKS" 2 Reflective Cross Bucks
8	Warning Device: Train Activated:	6 R/W Reflective Gates 4 Sets of Mast Mounted FL 1 Set of Cantilever Mounted FL 1 Bell
9	Commercial Power Available:	Yes
10	Type of Development:	Commercial
11	Smallest Crossing Angle:	60 to 90 Degrees
12	Number of Traffic Lanes Crossing Tracks:	4
13	Pavement Crosshatch Markings:	Yes
14	Estimated AADT:	1600
15	Blue Print Availability:	Yes
16	Pole Locations:	See Dunton Avenue Drawing

17 Recent Accident History:

The last reported accident at the crossing occurred on June 19, 2002. This accident involved an automobile in the North Direction stopped in the crossing. The vehicle was unoccupied during the collision and no one was injured. The next most recent accident occurred in February of 1977.

18 Environment Description:

The area is commercial on both sides of the track. There is a Metra station adjacent to the crossing. See attached drawing and digital photographs.

19 Gate Description:

There are traditional gates on both approaches and pedestrian gates at all 4 corners. All gates are train activated.

20 Pedestrian Description:

There is a Metra station adjacent to the crossing. There is a center track platform. There is continuous pedestrian traffic moving about the crossing.

Evergreen Avenue Crossing

1	DOT Crossing Number:	176924S
2	Bungalow Mile Post Number:	0022.39
3	Type of Tracks:	Main
4	Type of Crossing:	Public At Grade
5	Speed Range:	20 to 40
6	Maximum Speed:	40
7	Warning Device: Signs:	2 Signs that state "3-TRACKS" 2 Reflective Cross Bucks
8	Warning Device: Train Activated:	6 R/W Reflective Gates 4 Sets of Mast Mounted FL 1 Bell
9	Commercial Power Available:	Yes
10	Type of Development:	Commercial
11	Smallest Crossing Angle:	60 to 90 Degrees
12	Number of Traffic Lanes Crossing Tracks:	2
13	Pavement Crosshatch Markings:	Yes
14	Estimated AADT:	3400
15	Blue Print Availability:	Yes
16	Pole Locations:	See Evergreen Avenue Drawing

17 Recent Accident History:
No accidents reported at this crossing.

18 Environment Description:
The area is commercial on both sides of the track. Dunton Ave crossing is 325 feet to the west and Arlington Heights Road crossing is 306 feet to the east. See attached drawing and digital photographs.

19 Gate Description:
There are gates on both approaches and pedestrian gates at all 4 corners. All gates are train activated.

20 Pedestrian Description:
The area around the crossing is commercial; however there does not appear to be much pedestrian activity in the area.

Arlington Heights Road Crossing

1	DOT Crossing Number:	176923K
2	Bungalow Mile Post Number:	0022.31
3	Type of Tracks:	Main
4	Type of Crossing:	Public At Grade
5	Speed Range:	20 to 40
6	Maximum Speed:	40
7	Warning Device: Signs:	2 Signs that state "3-TRACKS" 2 Reflective Cross Bucks 1 Dynamic "No Turn" Lighted Sign
8	Warning Device: Train Activated:	3 R/W Reflective Gates 2 Sets of Cantilever Mounted FL 2 Sets of Mast Mounted FL 1 Bell
9	Commercial Power Available:	Yes
10	Type of Development:	Commercial
11	Smallest Crossing Angle:	60 to 90 Degrees
12	Number of Traffic Lanes Crossing Tracks:	4
13	Pavement Crosshatch Markings:	Yes
14	Estimated AADT:	28400

15 Blue Print Availability: Yes

16 Pole Locations: See Arlington Height Road Drawing

17 Recent Accident History:

The last reported accident occurred on January 4, 1999. The accident involved an automobile traveling in the north direction that drove into the crossing and was hit by a train. No injury was reported. Since 1980, there have been 8 accidents including the one in January of 1999. As a result of these accidents there has been 3 fatalities and 4 injuries reported. The last fatality occurred as a result of an accident on March 3, 1998.

18 Environment Description:

The area on either side of the tracks is commercial. The roads have heavy automobile traffic. There is not as much pedestrian traffic. This is a slightly more complicated crossing that is located at the crossing of Arlington Heights RD and Northwest Highway (See attached drawing and digital photographs.).

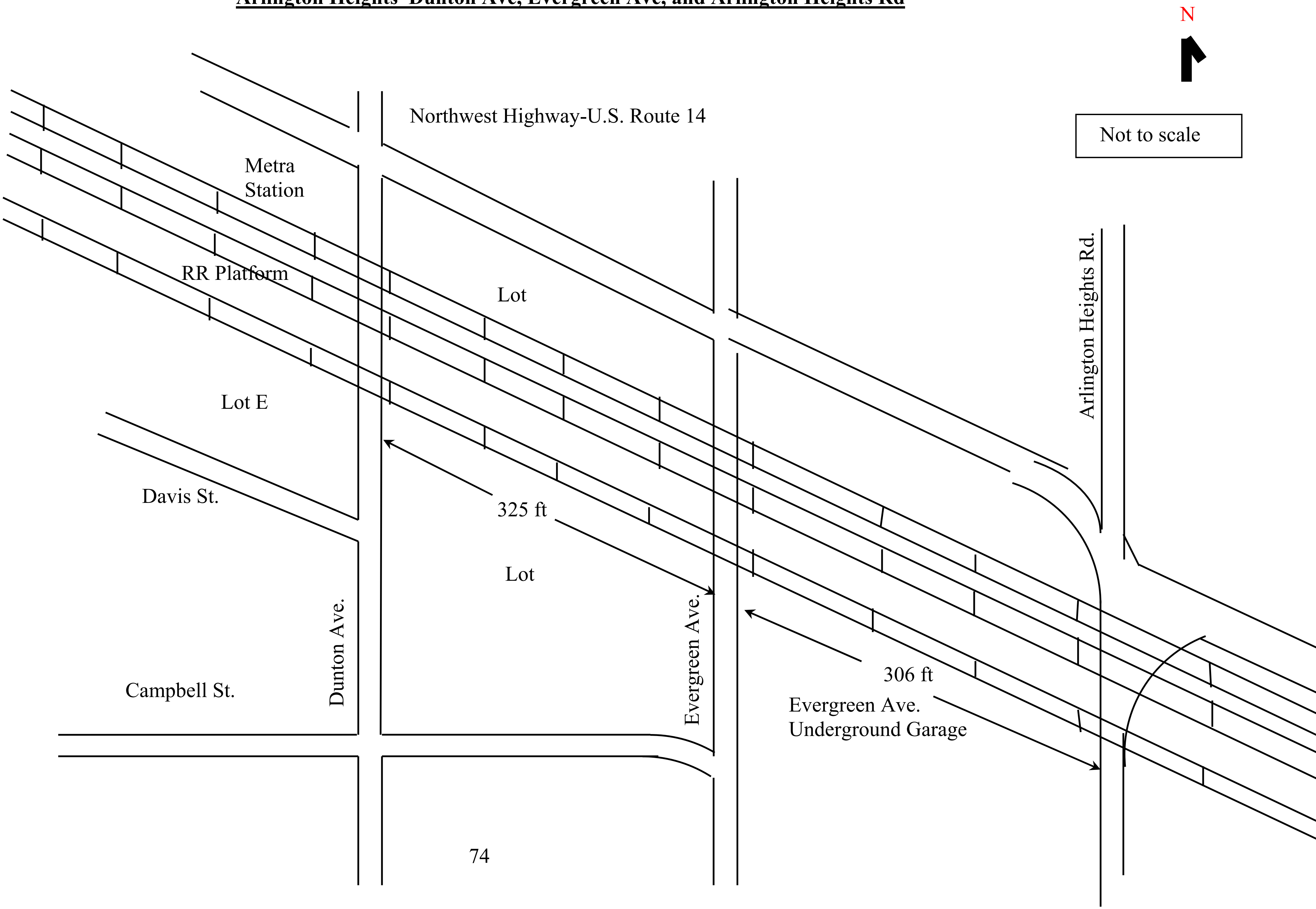
19 Gate Description:

Gates form both approaches. There is only one pedestrian gate at this crossing.

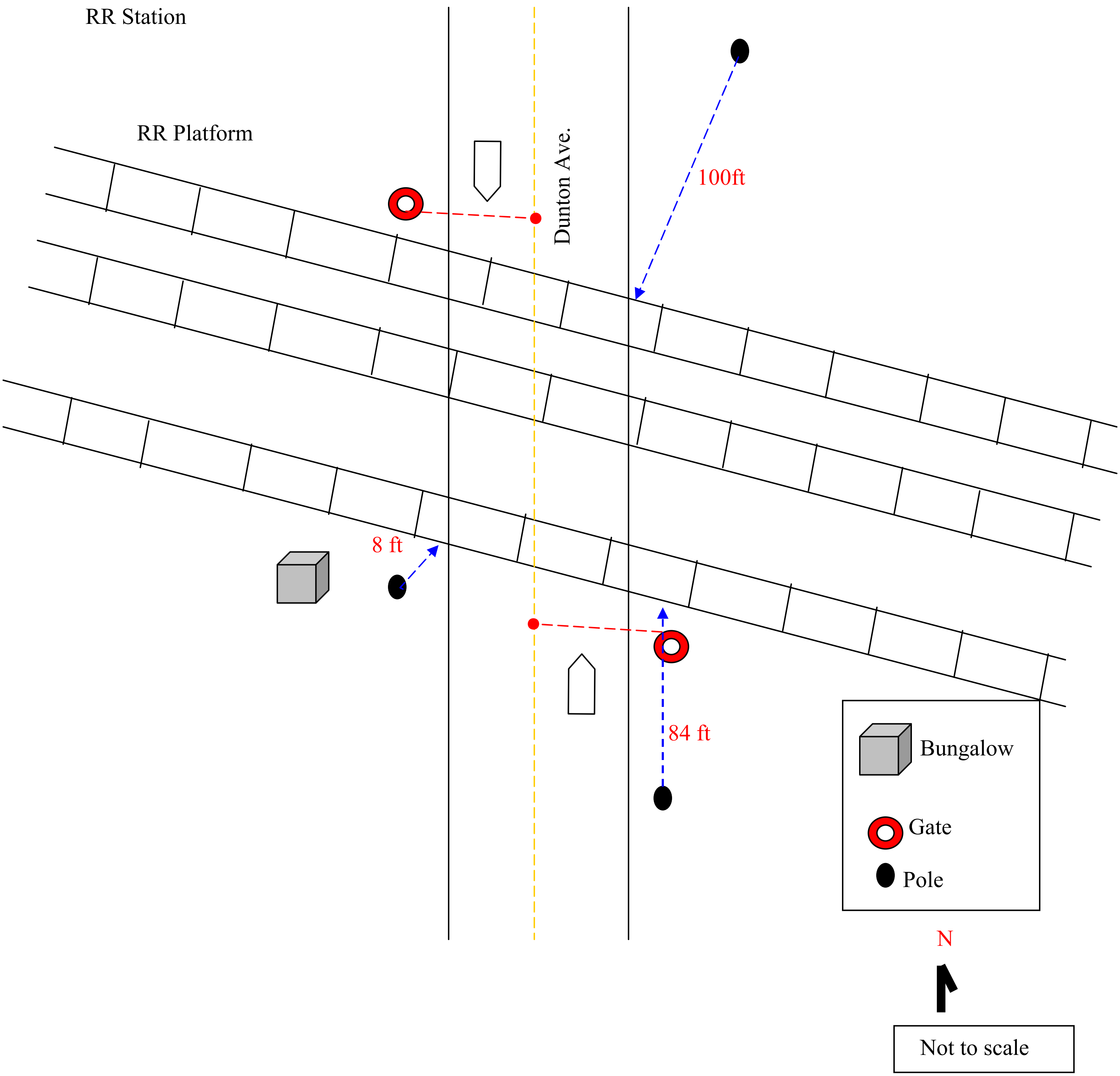
20 Pedestrian Description:

There did not appear to be much pedestrian activity.

Arlington Heights–Dunton Ave, Evergreen Ave, and Arlington Heights Rd



Arlington Heights–Dunton Avenue Crossing # 176925Y
Railroad Milepost: 0022.46

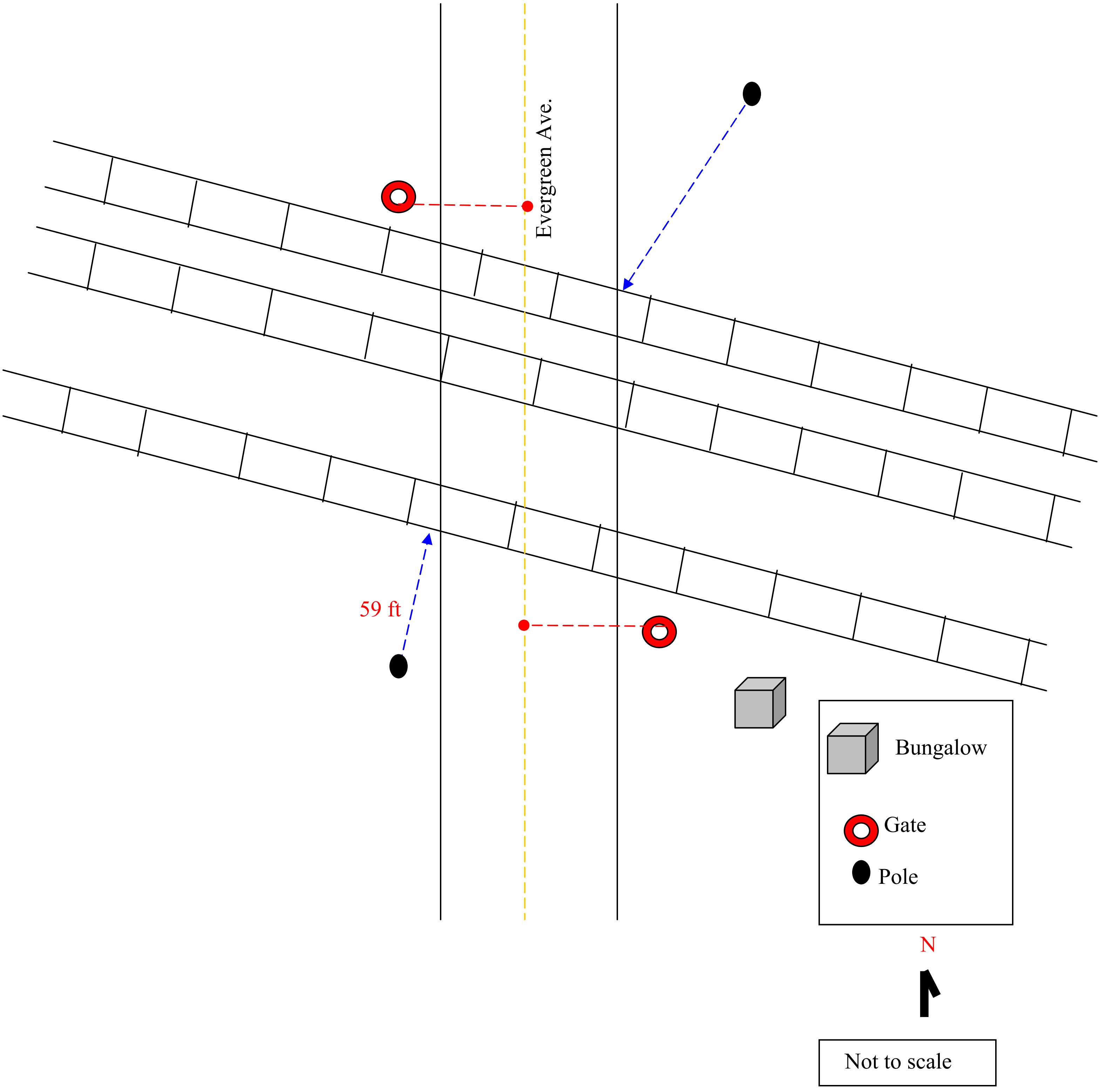


Dunton Avenue Crossing
Arlington Heights, IL






Arlington Heights–Evergreen Avenue Crossing # 176924S
Railroad Milepost: 0022.39



Evergreen Avenue Crossing
Arlington Heights, IL

Figure 1. Northwest corner facing southeast.

Figure 2. Northwest corner facing south.

Figure 3. Southeast corner facing northwest.

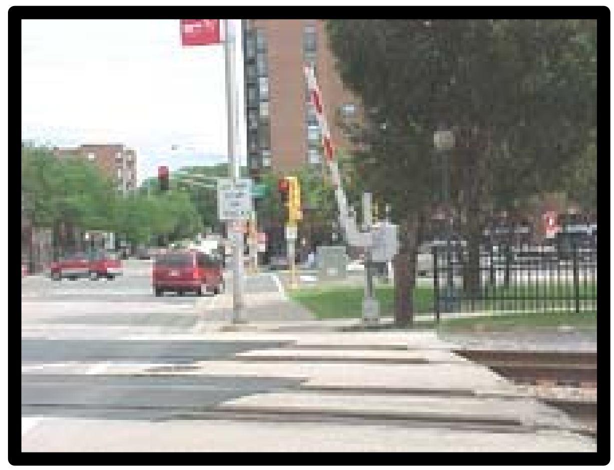
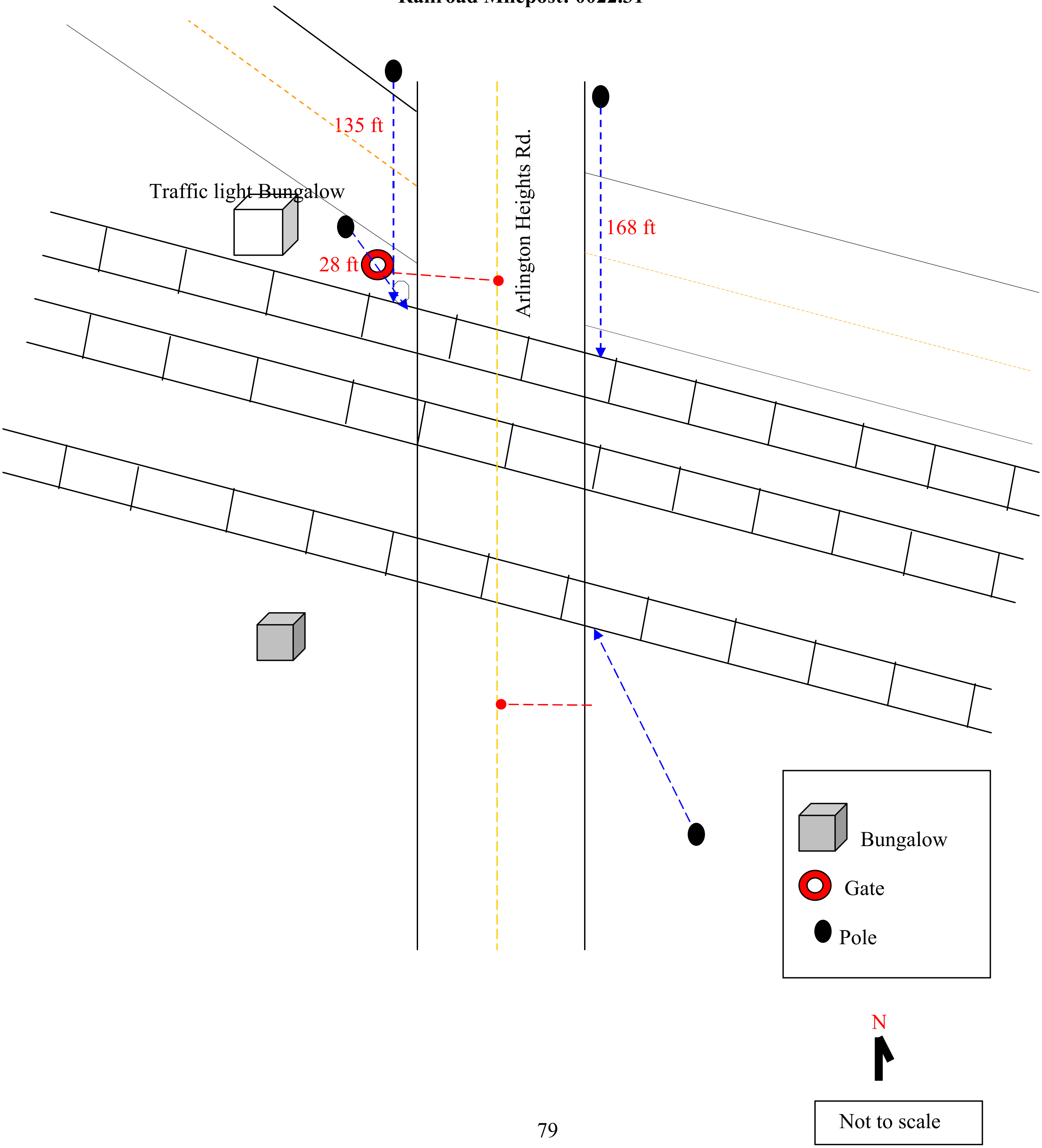


Figure 4. Southeast corner facing north.

Figure 5. Southeast corner facing north.

Figure 6. Northeast corner facing south.

Arlington Heights–Arlington Heights Road Crossing # 176923K
Railroad Milepost: 0022.31



Arlington Heights Road Crossing
Arlington Heights, IL

Figure 1. Northwest corner facing southeast.

Figure 2. Northeast corner facing south

Figure 3. Southeast corner facing northwest.

Figure 4. Southwest corner facing north.

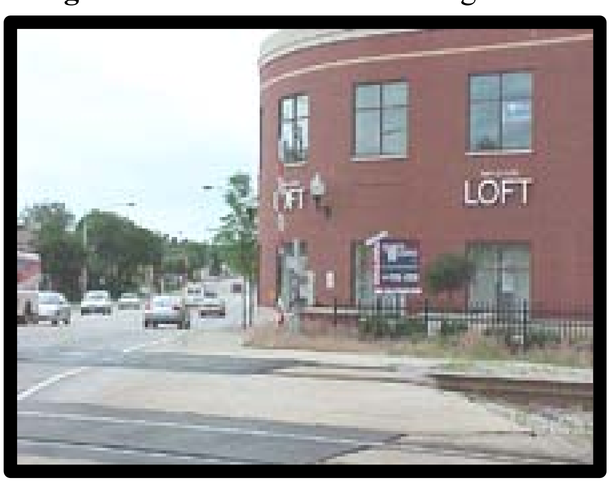


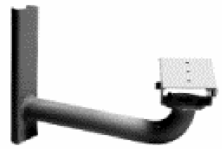
Figure 5. Northwest corner facing south.

Figure 6. Northwest corner facing east.

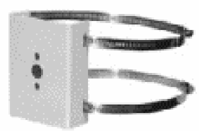
Appendix B.
Remote Data Collection System Equipment and Design Documents

PEERS Project Equipment and Mounts

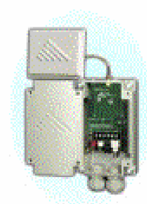
EX-27 Camera



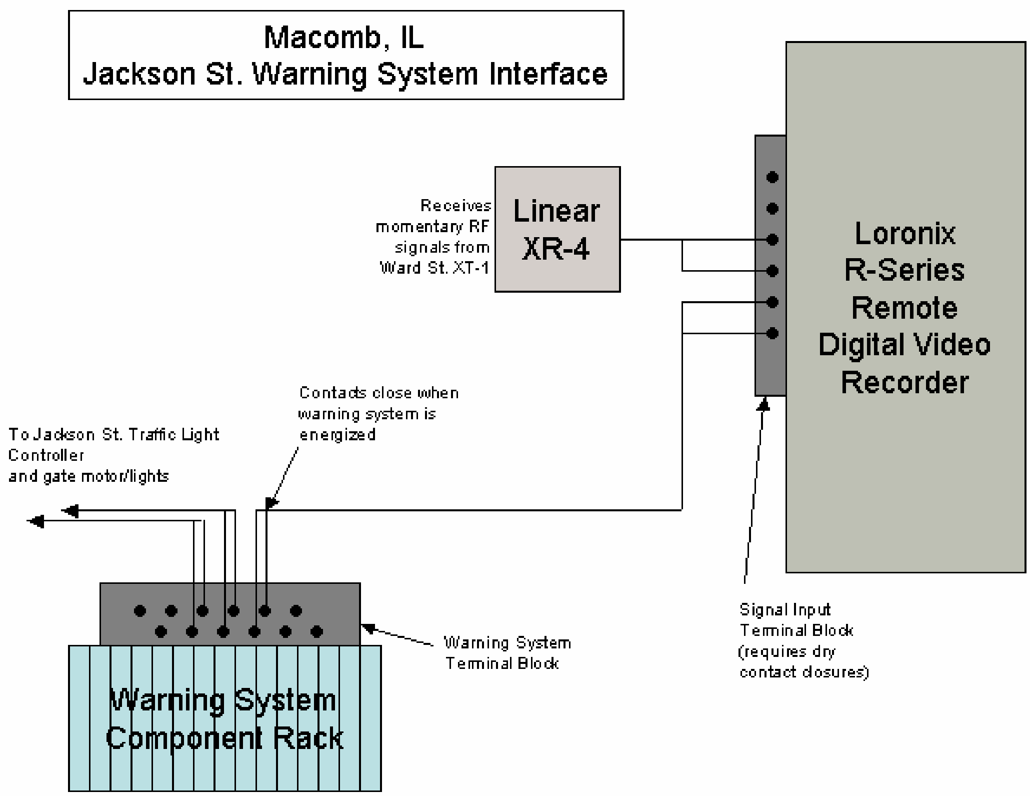
Pelco Pole Mount
For Camera

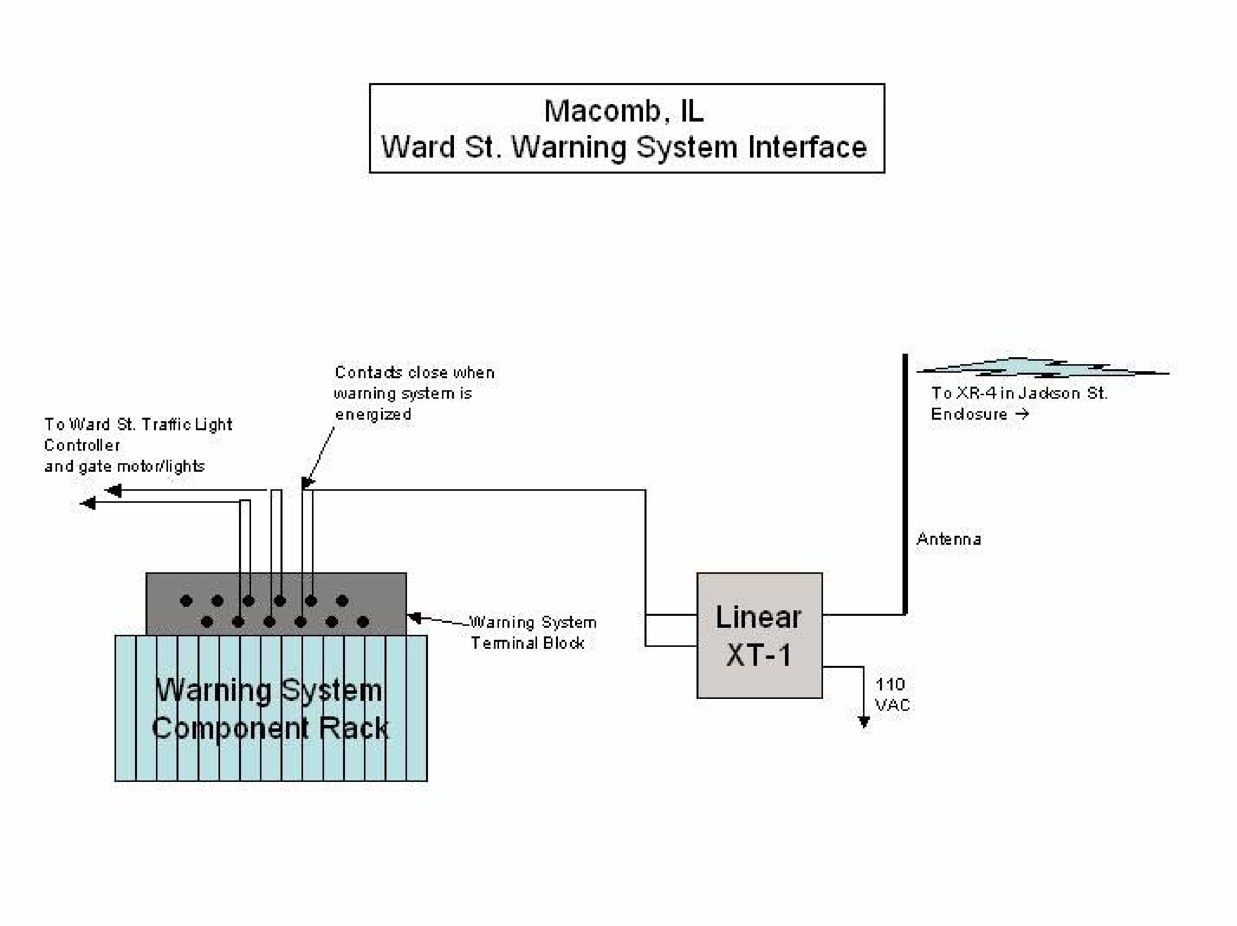


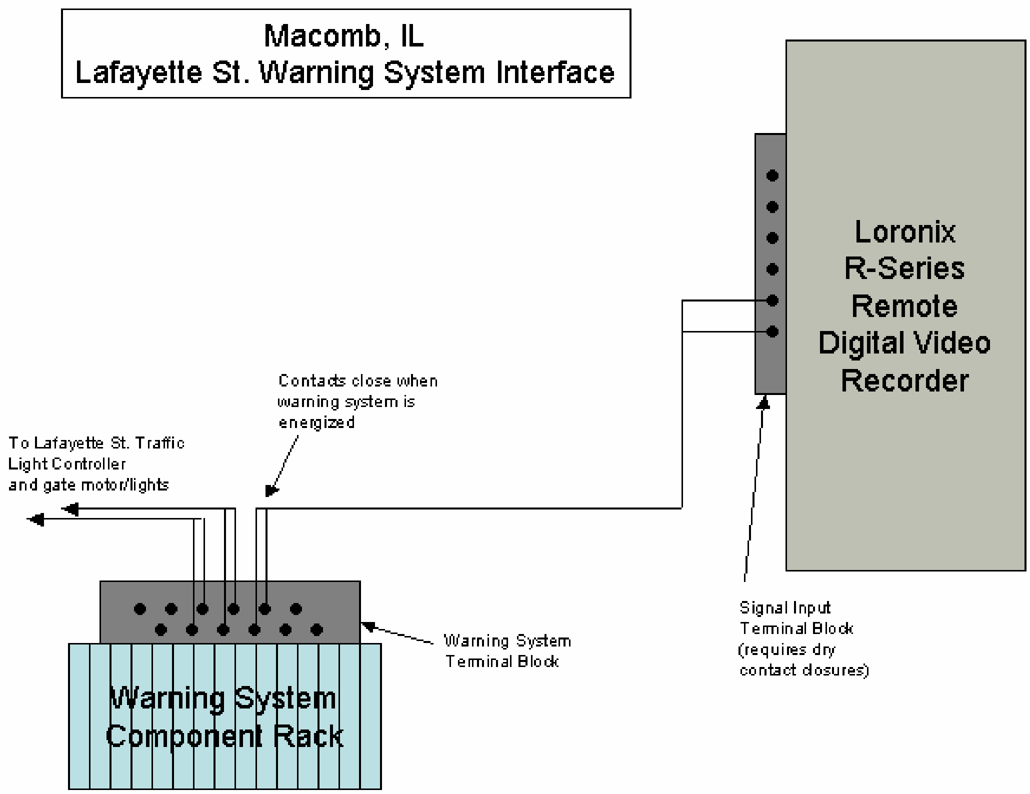
Pelco Pole Mount
For Transmitter
And Power Supply

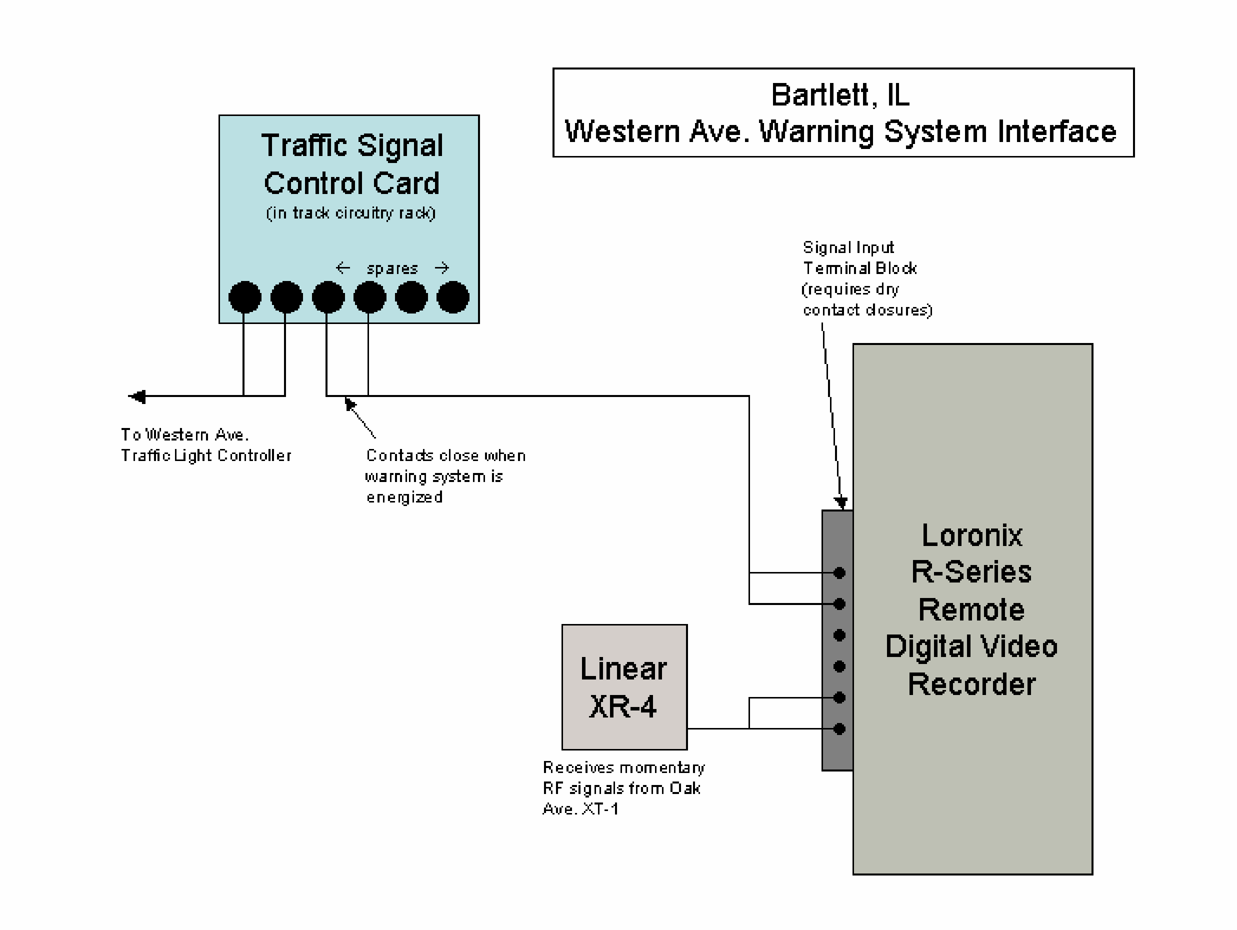


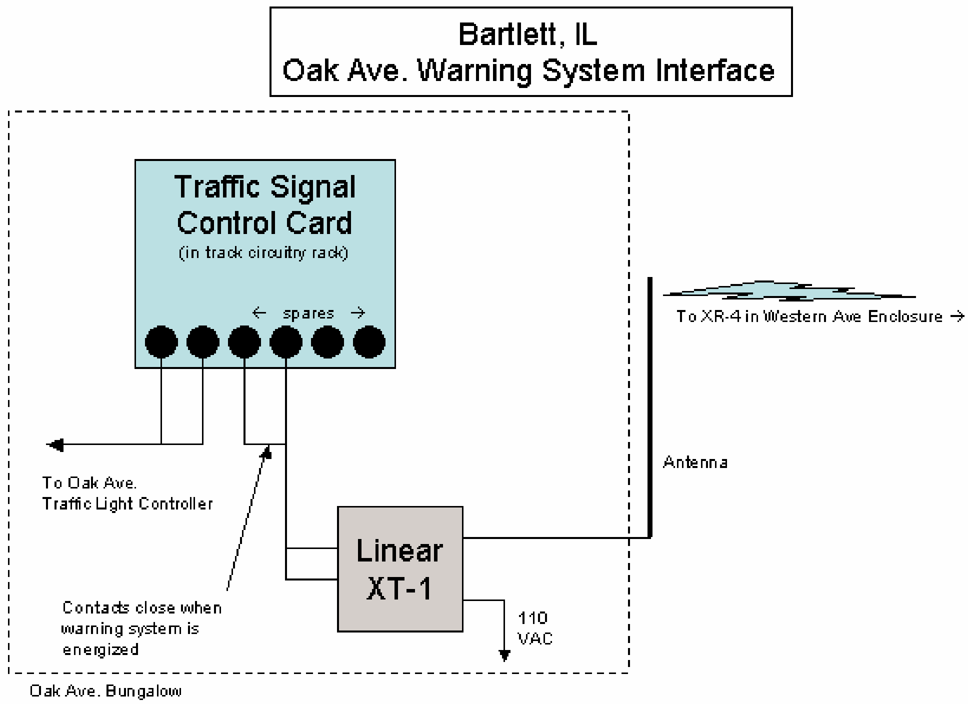
Video Transmitter

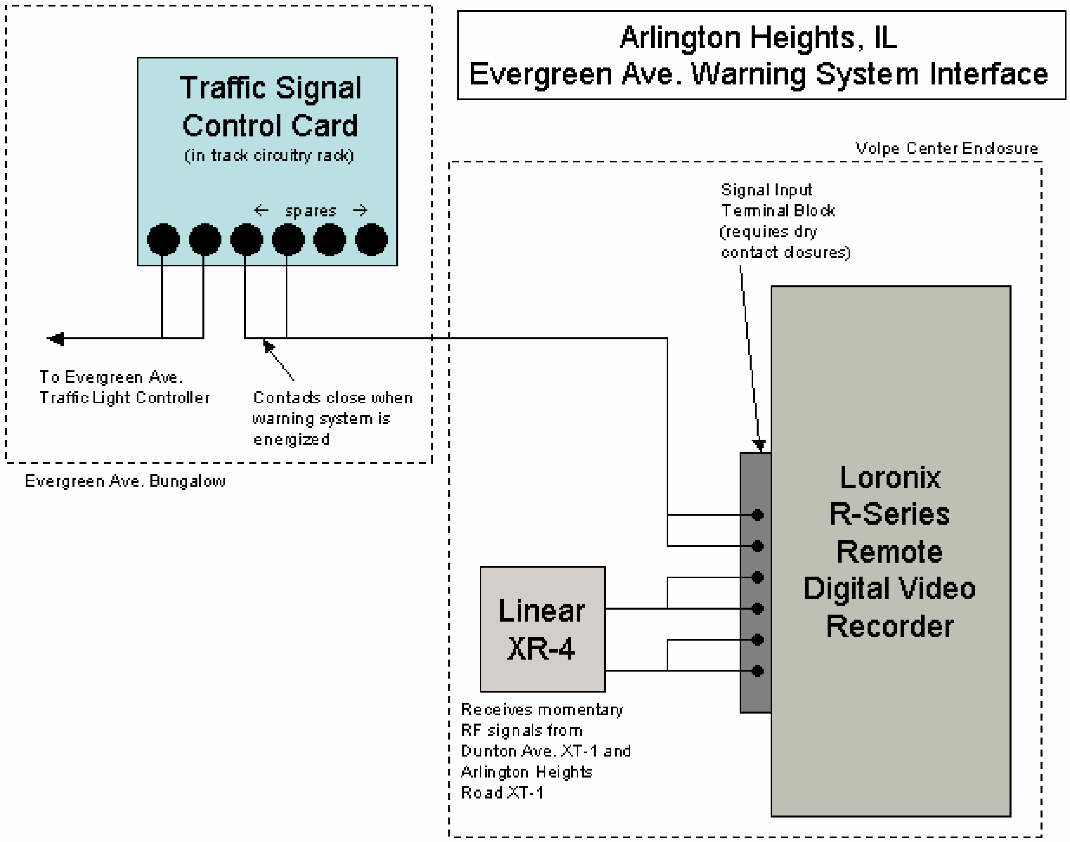

Macomb, IL
Jackson St. Warning System Interface
Receives momentary RF signals from Ward St. XT-1
Linear XR-4
Loronix R-Series Remote Digital Video Recorder
Contacts close when warning system is energized
To Jackson St. Traffic Light Controller and gate motor/lights
Warning System Terminal Block
Signal Input Terminal Block (requires dry contact closures)
Warning System Component Rack

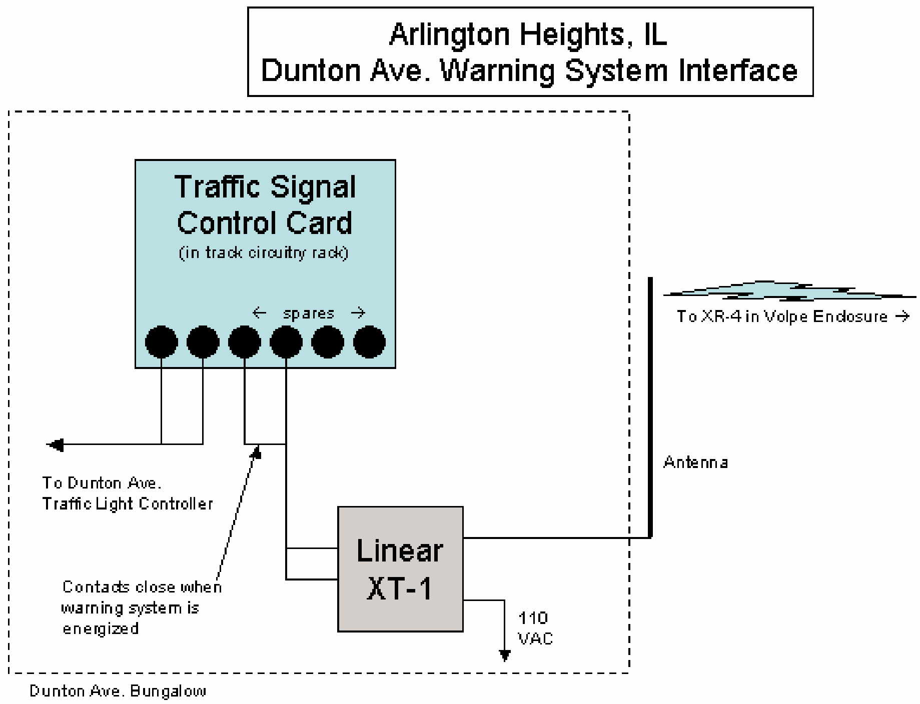

Macomb, IL
Ward St. Warning System Interface
Contacts close when warning system is energized
To Ward St. Traffic Light Controller and gate motor/lights
To XR-4 in Jackson St. Enclosure →
Antenna
Warning System Terminal Block
Linear XT-1
110 VAC
Warning System Component Rack

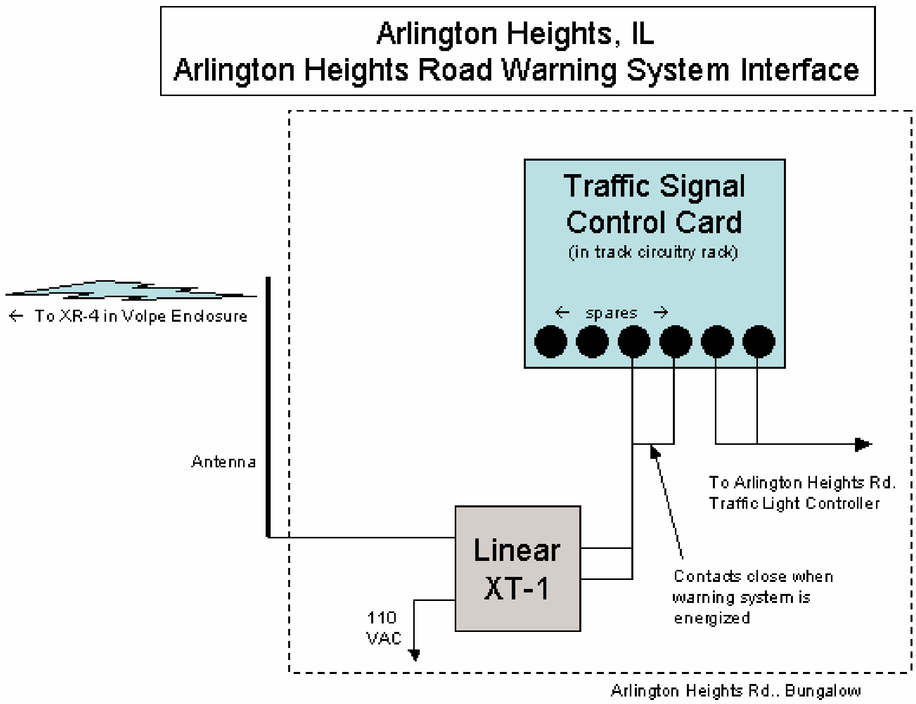

Macomb, IL
Lafayette St. Warning System Interface
Loronix
R-Series
Remote
Digital Video
Recorder
Contacts close when
warning system is
energized
To Lafayette St. Traffic
Light Controller
and gate motor/lights
Warning System
Terminal Block
Signal Input
Terminal Block
(requires dry
contact closures)
Warning System
Component Rack


Bartlett, IL
Western Ave. Warning System Interface
Traffic Signal Control Card
(in track circuitry rack)
← spares →
Signal Input Terminal Block (requires dry contact closures)
To Western Ave. Traffic Light Controller
Contacts close when warning system is energized
Loronix R-Series Remote Digital Video Recorder
Linear XR-4
Receives momentary RF signals from Oak Ave. XT-1


Bartlett, IL
Oak Ave. Warning System Interface
Traffic Signal
Control Card
(in track circuitry rack)
← spares →
To XR-4 in Western Ave Enclosure →
Antenna
To Oak Ave.
Traffic Light Controller
Linear
XT-1
Contacts close when
warning system is
energized
110
VAC
Oak Ave. Bungalow

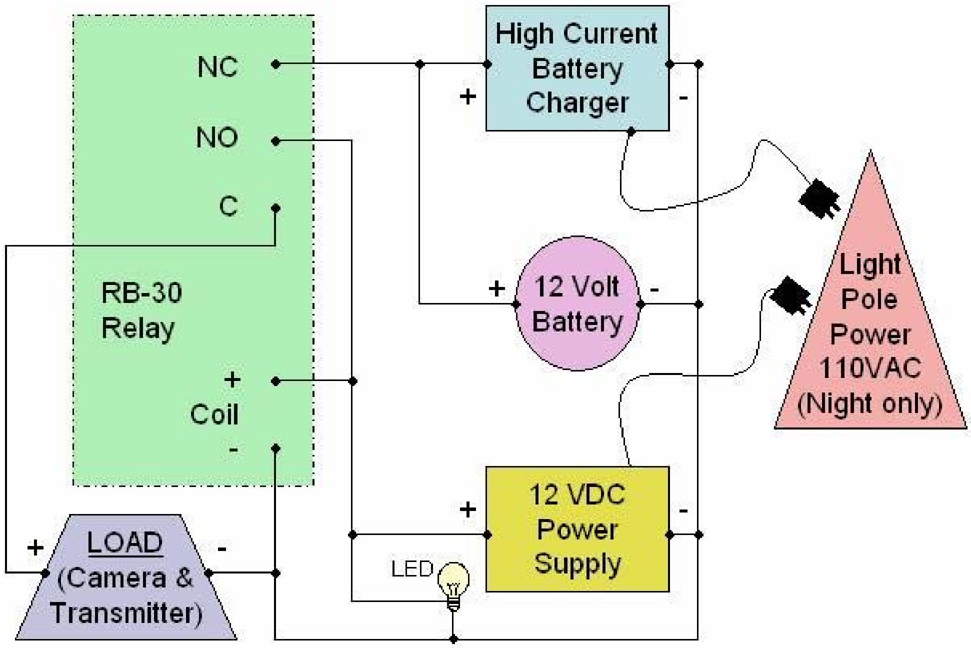

Arlington Heights, IL
Evergreen Ave. Warning System Interface
Traffic Signal
Control Card
(in track circuitry rack)
← spares →
To Evergreen Ave.
Traffic Light Controller
Contacts close when
warning system is
energized
Evergreen Ave. Bungalow
Volpe Center Enclosure
Signal Input
Terminal Block
(requires dry
contact closures)
Loronix
R-Series
Remote
Digital Video
Recorder
Linear
XR-4
Receives momentary
RF signals from
Dunton Ave. XT-1 and
Arlington Heights
Road XT-1

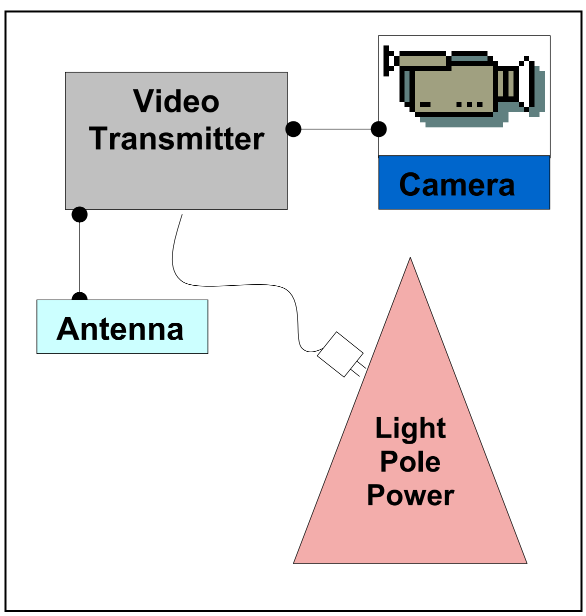

Arlington Heights, IL
Dunton Ave. Warning System Interface
Traffic Signal
Control Card
(in track circuitry rack)
← spares →
To XR-4 in Volpe Enclosure →
Antenna
To Dunton Ave.
Traffic Light Controller
Linear
XT-1
Contacts close when
warning system is
energized
110
VAC
Dunton Ave. Bungalow

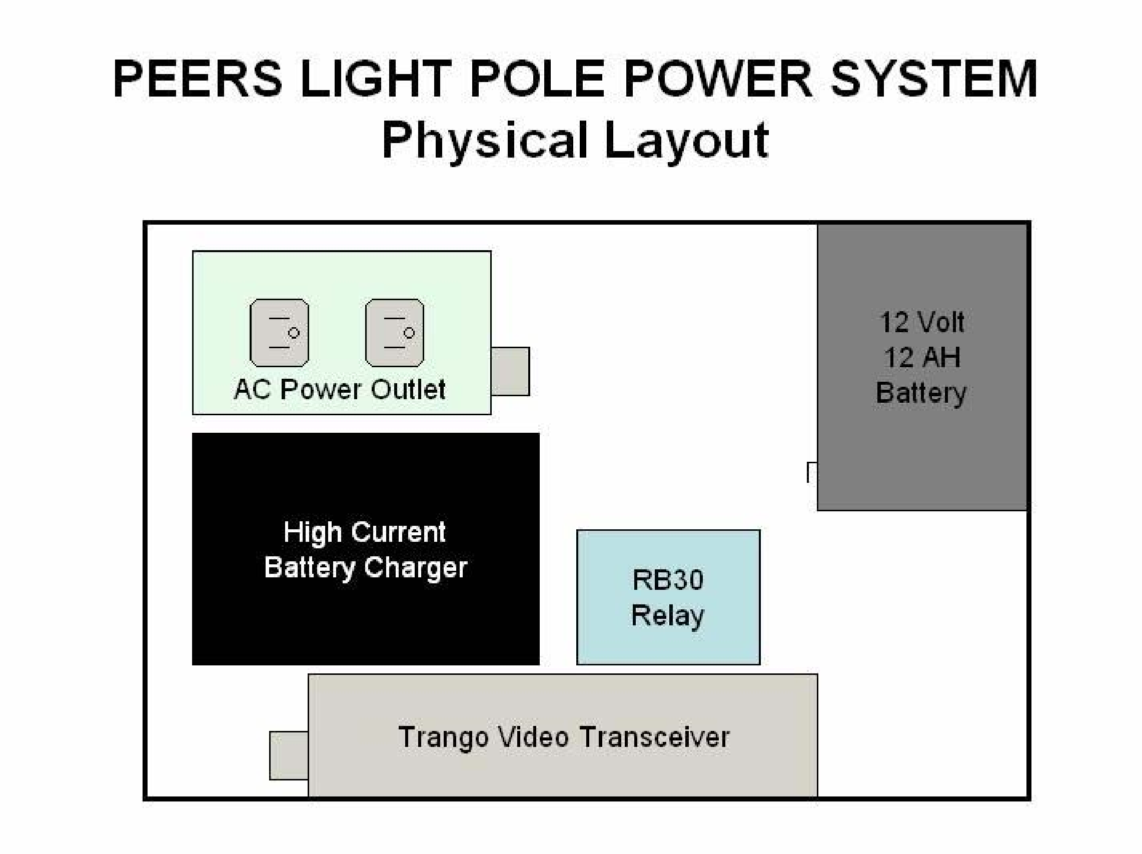


Arlington Heights, IL
Arlington Heights Road Warning System Interface
Traffic Signal Control Card
(in track circuitry rack)
← spares →
← To XR-4 in Volpe Enclosure
Antenna
To Arlington Heights Rd. Traffic Light Controller
Linear XT-1
Contacts close when warning system is energized
110 VAC
Arlington Heights Rd.. Bungalow

PEERS LIGHT POLE POWER SYSTEM
Wiring Diagram






PEERS LIGHT POLE POWER SYSTEM
Physical Layout
AC Power Outlet
12 Volt
12 AH
Battery
High Current
Battery Charger
RB30
Relay
Trango Video Transceiver

PEERS LIGHT POLE POWER SYSTEM
Interior Components

Bartlett Camera

Macomb Camera

Arlington Heights Camera

Appendix C.
Data Analysis Plan

Data Analysis Plan for PEERS Project

Video data of motorist and pedestrian behavior will be collected to determine the effect, if any, of the Public Education and Enforcement Research Study in each community on risky driver/pedestrian behavior. A before-during-after design will be used to evaluate the benefit of public awareness program initiatives in each neighborhood. Data will be collected for the 3 months before the implementation of the programs, 12 months during the project, and 3 months following the conclusion of the programs. The Volpe Center will gather the data on two workstations that back up each other. The video footage will be transmitted from the remote location to the Volpe Center via the Internet.

The data collection has been divided into three parts. The 2 months of data collected before the implementation of the program serves as a base case. This data is representative of the population behavior without any added safety influence from the education and enforcement program. The data collected during the 12-month project is a sample of driver/pedestrian behavior while being exposed to enhanced safety initiatives. Comparing the results of this data with the pre-test period the evaluation team will be able to evaluate the effect the PEERS project had on risky driver/pedestrian behavior. The final stage is the collection of post-test data. This is data for 2 months following the conclusion of the PEERS project. This data is important to assess the lasting effects of the safety initiatives.

The estimated total number of train events for the 8 crossings for the duration of the project is 134,000. Macomb, IL, has 3 crossings and 20 trains per day. There will be 2,600 events in both the pre- and post-test periods and 21,000 during the education and enforcement program. Bartlett, IL, has 2 crossings and 68 trains per day. There will be 3,600 events in both the pre- and post-test periods and 40,000 during the education and enforcement program. Arlington Heights, IL, has 3 crossings and 70 trains per day. There will be 7,600 events in both the pre and post-test periods and 51,100 during the education and enforcement program.

The table lists the data that will be gathered from the video recorded events. An event will be defined as an activation of the warning signals at the crossing. Each community has developed their own education and enforcement program. The data will be grouped by town to evaluate the effectiveness of each program. The data from each town will be further broken down by month in the second and third phases. This classification will be useful to see if the longer the program is running, when (if at all) it begins to make a difference in violation rates. And it will also be helpful in the post-test period to see if a drop-off in effectiveness of the program occurs as more time elapses.

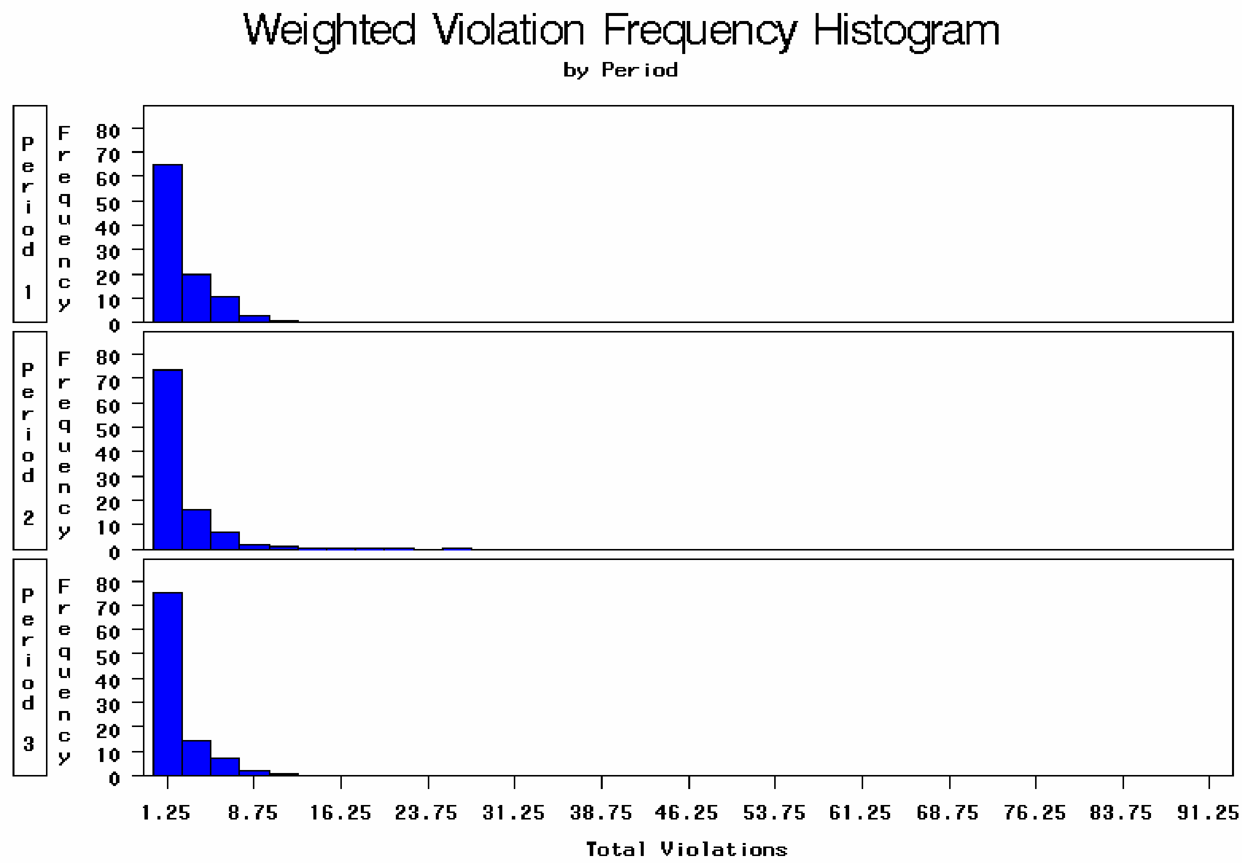
Data	Description
Date	Date event occurred
Crossing Name	Name of street crossing
Crossing Activation Time	Time when the train triggers the track circuitry to activate the safety devices at the crossing
Gate Activation Time	Time when the gates begin to descend
Train Presence	Yes or No (false alarm)
Train Arrival Time	Time when train arrived at the grade crossings
Type of Train	Freight, passenger, track maintenance
Motor Vehicle Arrival Time	Time when the motor vehicle arrived at the grade crossing
Pedestrian Arrival Time	Time when the pedestrian arrived at the grade crossing
Violation: Type I	Number of violators that went through the crossing while lights were flashing but before gate descent
Violation: Type II	Number of violators that went through the crossing during gate descent
Violation: Type III	Number of violators that went through the grade crossing after gate descent
Violation After Train but Before Gates Ascend	Yes or No
Violator Direction	The direction (N, S, E, W) from which the violator approached the crossing
Train Direction	The direction (N, S, E, W) from which the train approached the crossing
Track	The track that the train is on when it traverses the crossing (north side or south side, east side or west side)
Second Train Event	Yes or No
End of Event Time	Time when the train has completely cleared the crossing and gates have retracted or the recording timed out

From the observed data, the team can gather performance measures by which to judge the success of the PEERS project. The first performance measure is the frequency of violations. The frequency of violations can be separated by the three types of violations listed above. Type III violations are the most risky, type I the least.

In addition to measuring the success of the project by violation frequency, the riskiness of driver/pedestrian behavior can be measured by the time events. The three performance measures generated are warning time, time-to-collision, and violation time. Warning time is the measure of the amount of time the motorist or pedestrian has to respond to the warning signals at the crossing. It is the difference between the time the train arrives and the time the crossing signals are activated. The time-to-collision is a measure of driver/pedestrian behavior. It measures how far away, in seconds, the train is from the violator when he/she crosses the crossing. It is the difference between the train arrival time and the motor vehicle/pedestrian arrival time. The shorter the time-to-collision is the more risky the violation. Violation time is also a measure of human behavior. Violation time measures how much time passed between the activation of the crossing warning signals and the time of the violation. It is the difference between the motor vehicle/pedestrian arrival time and crossing activation time. The larger the violation time, the greater the risk of a collision.

The purpose of the data evaluation is to determine whether or not a statistically significant difference exists in driver/pedestrian behavior in the pre-test, testing, and post-test periods. Significant changes in the following are important: an increase in collision time, decrease in violation time, decrease in the number of violations, and a decrease in the number of risky (type II and III) violations.

Appendix D.
Violation Frequency Histogram and Difference of LS-Means


Weighted Violation Frequency Histogram
by Period
Period 1
Period 2
Period 3
Frequency
0
10
20
30
40
50
60
70
80
1.25
8.75
16.25
23.75
31.25
38.75
46.25
53.75
61.25
68.75
76.25
83.75
91.25
Total Violations

Differences of LS-Means Arlington Heights Road Motorist Violations		
Period – Period	*Difference*	*Probability*
Type I Violations		
Pre-Test – Test	-0.0873	0.0201
Pre-Test – Post-Test	-0.1263	0.0058
Test – Post-Test	-0.0390	0.2262
Type II Violations		
Pre-Test – Test	0.1805	<.0001
Pre-Test – Post-Test	0.0871	0.0072
Test – Post-Test	-0.0934	<.0001
Type III Violations		
Pre-Test – Test	0.0001	0.9861
Pre-Test – Post-Test	0.0028	0.4665
Test – Post-Test	0.0027	0.3113

Differences of LS-Means Arlington Heights Road Pedestrian Violations		
Period – Period	*Difference*	*Probability*
Type I Violations		
Pre-Test – Test	0.0019	0.1505
Pre-Test – Post-Test	0.0024	0.1377
Test – Post-Test	0.0005	0.6669
Type II Violations		
Pre-Test – Test	0.0495	<.0001
Pre-Test – Post-Test	0.0620	<.0001
Test – Post-Test	0.0125	0.0064
Type III Violations		
Pre-Test – Test	0.0445	<.0001
Pre-Test – Post-Test	0.0505	<.0001
Test – Post-Test	0.0060	0.0972

Differences of LS-Means Evergreen Avenue Motorist Violations		
Period – Period	*Difference*	*Probability*
Type I Violations		
Pre-Test – Test	0.0352	<.0001
Pre-Test – Post-Test	0.0001	0.9890
Test – Post-Test	-0.0351	<.0001
Type II Violations		
Pre-Test – Test	0.1398	<.0001
Pre-Test – Post-Test	0.2697	<.0001
Test – Post-Test	0.1298	<.0001
Type III Violations		
Pre-Test – Test	0.0056	0.2594
Pre-Test – Post-Test	0.0092	0.1708
Test – Post-Test	0.0036	0.4932

Differences of LS-Means Evergreen Avenue Pedestrian Violations		
Period – Period	*Difference*	*Probability*
Type I Violations		
Pre-Test – Test	0.0274	<.0001
Pre-Test – Post-Test	0.0254	<.0001
Test – Post-Test	-0.0019	0.5742
Type II Violations		
Pre-Test – Test	0.0545	<.0001
Pre-Test – Post-Test	0.0333	0.0742
Test – Post-Test	-0.0212	0.1485
Type III Violations		
Pre-Test – Test	0.0647	<.0001
Pre-Test – Post-Test	0.0409	<.0001
Test – Post-Test	-0.0238	0.0013

Differences of LS-Means Dunton Avenue Motorist Violations		
Period – Period	*Difference*	*Probability*
Type I Violations		
Pre-Test – Test	-0.0036	0.6736
Pre-Test – Post-Test	0.0162	0.1207
Test – Post-Test	0.0198	0.0065
Type II Violations		
Pre-Test – Test	0.2643	<.0001
Pre-Test – Post-Test	0.3397	<.0001
Test – Post-Test	0.0754	<.0001
Type III Violations		
Pre-Test – Test	-0.0023	0.4905
Pre-Test – Post-Test	-0.0002	0.9702
Test – Post-Test	0.0022	0.4454

Differences of LS-Means Dunton Avenue Pedestrian Violations		
Period – Period	*Difference*	*Probability*
Type I Violations		
Pre-Test – Test	0.0383	<.0001
Pre-Test – Post-Test	0.0420	<.0001
Test – Post-Test	0.0037	0.4289
Type II Violations		
Pre-Test – Test	0.1065	<.0001
Pre-Test – Post-Test	0.0499	0.0597
Test – Post-Test	-0.0566	0.0022
Type III Violations		
Pre-Test – Test	1.2322	<.0001
Pre-Test – Post-Test	1.6764	<.0001
Test – Post-Test	0.4441	<.0001

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Acronyms

AADT	annual average daily traffic
ASM	alternative safety measure
BNSF	Burlington Northern Santa Fe Railway
DSL	digital subscriber line
FOT	field operational test
FRA	Federal Railroad Administration
ICC	Illinois Commerce Commission
LAN	local area network
LS-Means	least squares means
Metra	Northeastern Illinois Regional Commuter Rail
PEERS	Public Education and Enforcement Research Study
SQL	structured query language
SSM	supplemental safety measure
UP	Union Pacific Corporation
USDOT	U.S. Department of Transportation
VNTSC network	Volpe National Transportation Systems Center network
Volpe Center	John A. Volpe National Transportation Systems Center

Glossary

Blitz–Presence of police officers at the highway-rail grade crossings encouraging and enforcing good safety practices

Difference of Least Squares Means–An arithmetic difference between two value estimates that are calculated using a method of least squares means estimation

Highway-user–Any motorist or pedestrian who uses the highway-rail grade crossing

Least Squares Means Estimation–A method of estimation used to minimize the expectation of the squared residual

Motorist–Persons using motorized modes of transportation through the grade crossing

Operation Lifesaver, Inc.–An international, nonprofit education and awareness program dedicated to ending tragic collisions, fatalities, and injuries at highway-rail grade crossings and on railroad rights of way

Pedestrian–Persons using nonmotorized modes of transportation (on foot, on bicycle) through the grade crossing

Post-test period–Two months after the conclusion of the enhanced grade crossing safety initiatives

Pre-test period–Two months before implementation of the enhanced grade crossing safety initiatives

Quiet zone–Areas where train horns can be silenced, provided that certain safety measures are put in place

Second train event–Occurrence on a rail line with multiple tracks when two trains occupy the crossing warning block at the same time

Test period–A 12-month period when communities enacted enhanced grade crossing safety initiatives

Time-to-collision–A performance measure of time, in seconds, of the estimated train arrival at the location of the violator when the violator enters the crossing zone

Train event–An opportunity for a highway-user to commit a violation because the crossing warning devices have been activated

Type I violation–A highway-user enters the grade crossing when the warning flashers are active but gates have not been activated (vertical position)

Type II violation–A highway-user enters the grade crossing when warning flashers are active and the gates are in motion

Type III violation–A highway-user enters the grade crossing when warning flashers are active and the gates are fully deployed (horizontal position)

Type IV violation–Debarking passengers violate the crossing by exiting the center platform while the warning devices are active

Violation rate–The count of violations normalized by the number of train events

Violation time–A performance measure, in seconds, of the length of time between the activation of the crossing warning signals and when the violation occurs

Warning time–A measure of the amount of time, in seconds, the motorist or pedestrian has to respond to the warning signals at the crossing