U. S. Department
of Transportation
Federal Railroad Administration

North Carolina "Sealed Corridor" Phase I
U.S. DOT Assessment Report

Report to Congress

Executive Summary And Treatment Techniques

Office of Railroad Development May 2002

Executive Summary

In response to a request in the Senate Report 107-38 accompanying the Department of Transportation and Related Agencies Appropriations Act, 2001, this report documents the benefits of the State of North Carolina's "Sealed Corridor" initiative and the improvements completed at highway-rail grade crossings from March 1995 through September 2000 in terms of "Lives Saved." The analysis concludes that five lives were saved during the study period and that this positive benefit of the Sealed Corridor improvements will grow as vehicle volume, trains frequency and train speeds increase.

The North Carolina Department of Transportation (NC DOT) plays a prominent role among States pursuing High-Speed Ground Transportation (HSGT) development. The State contains much of the designated "Southeast High-Speed Rail (SEHSR) Corridor" which connects Washington, DC, through Richmond, VA to Raleigh and Charlotte, NC with extensions south to Columbia, SC, Savannah, GA and southwest to Greenville, SC, Atlanta and Macon, GA, and Jacksonville, FL. Recognizing that improved safety must accompany improved service, the State has instituted an innovative "Sealed Corridor" program initiative, which aims at improving or closing every grade crossing, public and private, along the chosen route between Charlotte and Raleigh, NC via Greensboro on the North Carolina Railroad. The "Sealed Corridor" initiative is also a model research approach to examine grade crossing issues in other corridors.

The "Sealed Corridor" consists of 216 grade crossings, 44 of which are private crossings. Phase I of the implementation plan for the corridor addresses 100 crossings between Charlotte and Greensboro. Fifty-two of the 100 crossings have been improved and/or closed. The research documented in this report assesses the safety benefits of the improvements made to the highway-rail intersections from March 1995 to September 2000.

The intent of this research is to assess the progress being made at the highway-rail grade crossings that have been treated with improved warning devices as part of Phase I. Some of the improvements include non-standard devices such as traffic channelization and four-quadrant gates. The progress is described in terms of safety benefits. Crash data were examined through December 2000 to ensure any incidents that may have occurred at crossings improved through September 2000 would be included. This report also contains an analysis and evaluation of whether the resulting reduction in accidents is sustainable through the year 2010 when the State expects that train speeds along the corridor should achieve 110 mph.

Safety benefits are developed through the use of two techniques: (1) a *Fatal Crash Analysis* approach to estimate "Lives Saved" through December 2000; and (2) a prediction of "Lives Saved" based on the reduction of risk at those treated crossings using a modified United States Department of Transportation (U.S. DOT) Accident Prediction Formula. Further predictions are then completed by reviewing the reduction in risk of the entire Phase I project with all 100 crossings improved and/or closed. The resulting risk reduction that can be anticipated through the year 2010 is then calculated at operating train speeds of 110 mph along the corridor.

Conclusions

At least five lives have been saved.

The "fatal crash analysis method" was used to calculate the differences between the annual (or monthly) fatality rates, based on actual experience at the improved crossings, before and after the improvements were made at each crossing. To calculate "Lives Saved", those differences were multiplied by the number of years (or months) through December 2000 that each specific crossing had been improved. The sum of these results was then calculated over all of the crossings that were improved. This resulted in an estimate of 5.8, or, conservatively, 5 lives saved as a result of the 52 improvements implemented through December 2000.

The "modified U.S. DOT accident prediction formula" recognizes the probabilistic nature of grade crossing fatalities and relies on a combination of actual experience at the improved crossings and an extensive database of experience at similar crossings nationwide. The formula was used to estimate the annual fatality rates at each crossing before and after each improvement and these estimates were accumulated for corridor-wide results. This method estimated that the improvements implemented through 2000 are reducing fatalities by approximately 1.3 each year, or over one life saved each year. This correlates well with the results derived from the "fatal crash analysis method", thus providing FRA confidence in the benefits of the improvements to date.

The accident reduction result is sustainable.

In order to estimate future accident reduction rates, the second of the above methods was used to ensure increases in train and vehicle exposure over time are considered in the analysis. By the year 2010, NC DOT projects that the vehicle traffic volume and the frequency and speed of trains will increase. The second method is capable of taking these factors into account.

Figure 1 shows the estimated annual fatalities under three conditions: (1) all 100 Phase I crossings have been treated (build), (2) no additional crossings are treated (i.e. only 52 of the 100 crossings have been treated, partial build) and (3) the baseline that would have existed if none of the Phase I crossings had been treated (no build). The graph shows the influence of the improvements, which were initiated in March 1995, on reducing the annual fatalities through the year 2000. In the build case, the improvements at the remaining 48 crossings in Phase I were assumed to be implemented in 2002, resulting in a further reduction in annual fatalities. The gradual increase in traffic volume and train frequency from 2002 through 2010 is expected to increase annual fatalities under all three conditions. Finally, the increase in train speed to 110 mph assumed to occur in 2010 would further increase all fatality rates.

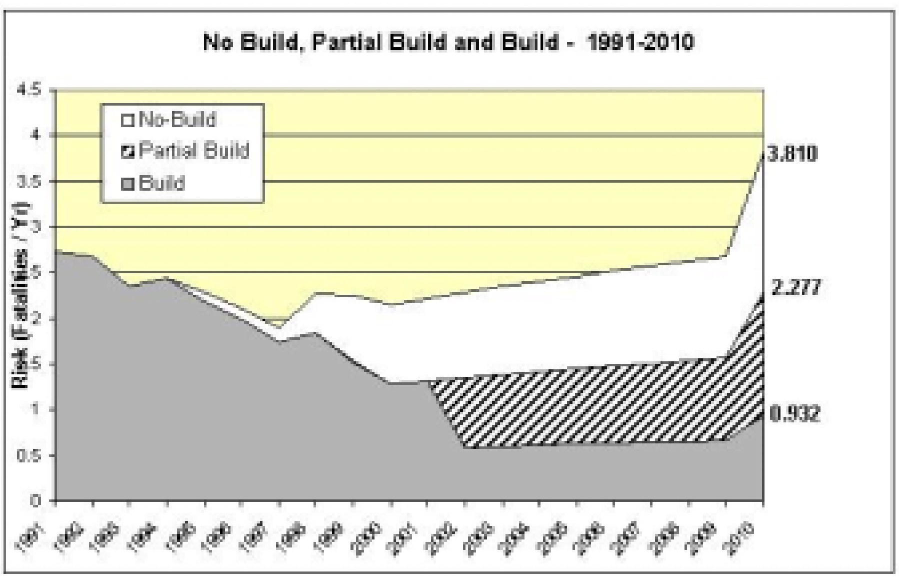

Figure 1. Build, Partial Build, No Build Risk Calculations from 1991 through 2010 Using the Modified U.S. DOT Formula

As can be seen in Figure 1, the difference in annual fatalities (the number of lives saved per year) under all three conditions (build, partial build, and no build) would continue to increase throughout the period to 2010. By 2010 the fatality rate resulting from the full treatment of the 100 crossings along the Phase I corridor would be 75 percent lower than the no build condition. Furthermore, if there were no more improvements implemented beyond the calendar year 2000, the annual fatalities in 2010 would still be 40 percent lower than the no build condition.

Figure 2. Southeast High Speed Rail Corridor

<u>Further conclusions</u>

- The benefit/cost ratio of improvements at crossings with previously experienced fatalities is high. For example, the fatal crash analysis showed that this ratio would be 40:1 for the ten crossings in Phase I with a history of fatal crashes, and 22:1 for the Sugar Creek Road crossing, where five years of post-improvement "after" data is available.
- A detailed analysis was not performed on the additional 116 crossings on the "Sealed Corridor" that are planned to be improved in Phases II, III, and IV. A simple extrapolation of the results of Phase I suggests that approximately 5.5 lives per year would be saved by implementing all phases of the Sealed Corridor program.
- The crossings along the Phase I portion of the Sealed Corridor are also typical of conditions on the ten other high-speed rail corridors designated under Section 104 (d) (2) of Title 23, US Code. This suggests that similar plans for corridor grade crossing improvements be given serious consideration in connection with high-speed rail upgrades in these corridors.
- The implementation of the North Carolina "Sealed Corridor" initiative is a demonstration of non-standard corridor highway-railroad grade crossing improvements. As the rest of this demonstration is implemented it should be monitored to serve as a basis for assessing the potential impact of similar programs in other corridors.

Treatment Techniques

Closing and Consolidation of Crossings

Crossing closures are the most effective treatment. Consolidation projects involve closing crossings identified as redundant in "Traffic Separation Studies" (TSS) and routing traffic over the remaining crossings. TSSs are comprehensive engineering studies used on a corridor-wide basis to evaluate crossings and the surrounding highway network within a community. The goal of the traffic separation studies performed by NC DOT was to consolidate redundant and/or unsafe grade crossings while identifying ways to improve highway traffic flow across the rail corridor.

NC DOT introduced a new process for conducting the TSS, documenting the approach in 1995 to establish a thorough and consistent process to be used throughout the State. The new process is proactive and prioritizes safety and risk-reduction. It specifies the sequence of decisions and activities from bringing consultants and relevant stakeholders into the planning phase through the final implementation. The TSS is a comprehensive evaluation of traffic patterns and road usage for an entire municipality or region. Part of the study determines if any of the public crossings should be closed or grade separated (bridged) to improve safety.

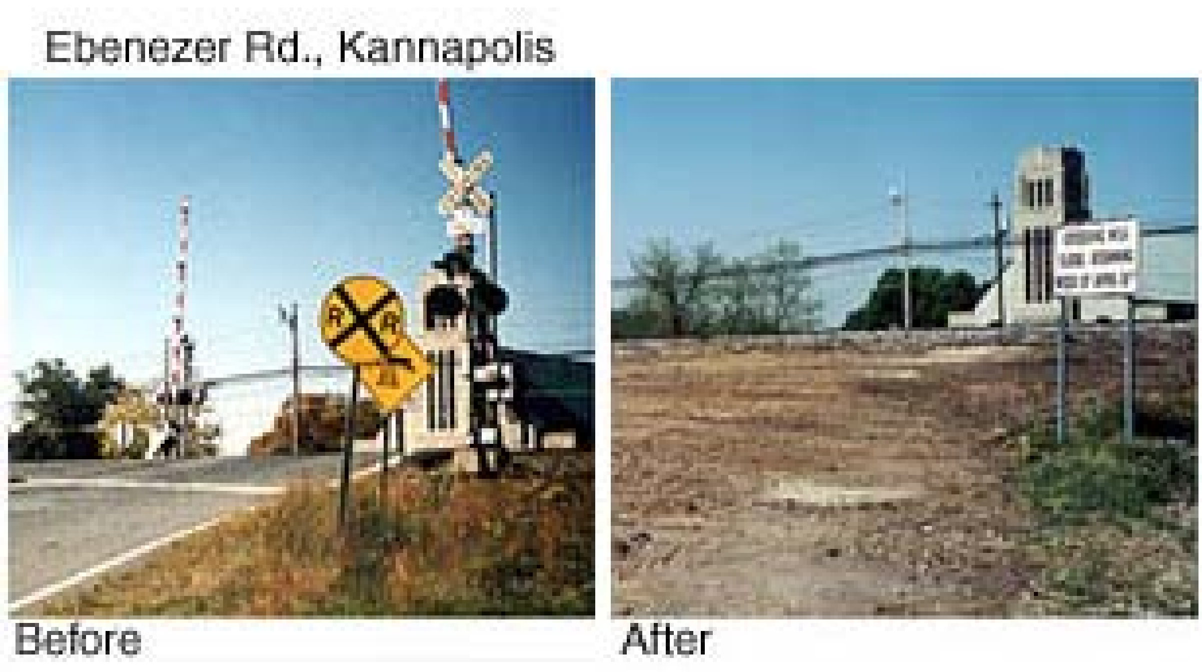

Figure 3 "Before and After" Views of Ebenezer Road

Grade Separation

Grade separation of the highway and the railroad tracks is both the most effective and the most expensive treatment to eliminate risk at a grade crossing. A grade separation project can cost on average $3-5 million dollars per location. Since grade separation is expensive it is not used as often as closing grade crossings.

Video Enforcement

A digital video ticketing system was demonstrated at the Henderson Street crossing in Salisbury, NC in August, 1998. This is a six-track crossing, with both freight and passenger service, a frequency of trains approximately one every 15 minutes, and a history of violations and incidents. With the cooperation of local law enforcement, violators were ticketed and fined. This demonstration resulted in a reduction in violations by 72 percent, showing that photo-based video enforcement methods combined with a fine/penalty structure are an effective alternative to traditional enforcement.

Four-Quadrant Gate Systems

The NC DOT has authorized engineering and construction of four-quadrant gate systems at several locations along the corridor. In 1994, during initial tests at Sugar Creek Road in Charlotte (selected because it has the highest Average Annual Daily Traffic (AADT) in the Corridor at more than 21,000 vehicles per day) violations were reduced by 86 percent.

When combined with 50 to 100-foot traffic channelization devices to further deter violations, the combination has been shown to be 98 percent effective in reducing violations.

Figure 4 4-Quad Gates at West Craighead Road, Charlotte, NC

Longer Gate Arm Systems

Longer gate arm systems cover at least 3/4 of the roadway. Tests conducted at the Orr Road crossing in Charlotte showed a 67 percent reduction of crossing violations.

A follow up test to gather "after" data on long gate arms was conducted at Orr Road a year after the first test to determine if the long gate arms retain their effectiveness. The results from this test show an improvement to an 84 percent reduction in crossing violations compared with pre-treatment "before" numbers.

Longer gate arms are being used in conjunction with traffic channelization devices, but not where they would block a street or driveway intersection close to the crossing.

Figure 5 Long Arm Gate at Orr Road.

Traffic Channelization Devices

Traffic channelization devices, also known as median barriers, have proven to be a low-cost investment with a high rate of return in safety at crossings. These devices cost on average $10,000 per location, have low maintenance costs and are highly effective. These were first demonstrated at Sugar Creek Road, and reduced violations by 77 percent.

Traffic channelization devices consist of a prefabricated mountable island made of a composite material painted yellow. Reflectorized paddle delineators or tubes, 24-inces high with yellow and black stripes, are mounted on the curb barrier. To accommodate wide loads, such as mobile homes, all delineators are required to bend and return to their upright position. The paddle delineators are mounted on a flexible rubber boot, which allows them to return to their original vertical position when impacted by vehicles. Concrete island median barriers also are used with the yellow striped delineators mounted to them.

Figure 6 Traffic Channelization Device at Hickory Ridge Road, Harrisburg, NC

Signs, Pavement Markings and Health Monitoring

Signs advising the motorist where to stop for activated crossing signals are being placed on all crossings receiving treatment. Pavement markings are also being upgraded in the corridor.

Another sign will provide a 1-800 emergency phone number that motorists can use to call the railroad to report any malfunctions of the crossing signals.

An Intelligent Signal Monitoring System is proposed for each public crossing to notify railroad personnel about malfunctions, and to improve the reliability of warning devices.

Figure 7 Grade Crossing 1-800 Sign