Ohio Highway-Rail Grade Crossing State Action Plan

Ohio Rail Development Commission

Public Utilities Commission of Ohio

February 2022

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Executive Summary

During 2021-2022, the Ohio Rail Development Commission (ORDC) and the Public Utilities Commission of Ohio (PUCO) developed the Ohio Highway-Rail Grade Crossing State Action Plan (SAP) for the State of Ohio. This document is an update to Ohio's original plan that was published in 2011 and updated as of fiscal year (FY) 2016. The purpose of this plan is to:

- Describe Ohio's current practices and programs related to highway-rail grade crossing and pathway grade crossing safety;
- Conduct a conceptual safety analysis to identify potential emphasis areas and key areas of need; and,
- Identify an action plan for the implementation of short- and long-term strategies to aid in achieving the overarching goals of improving safety at public highway-rail grade crossings throughout the state.

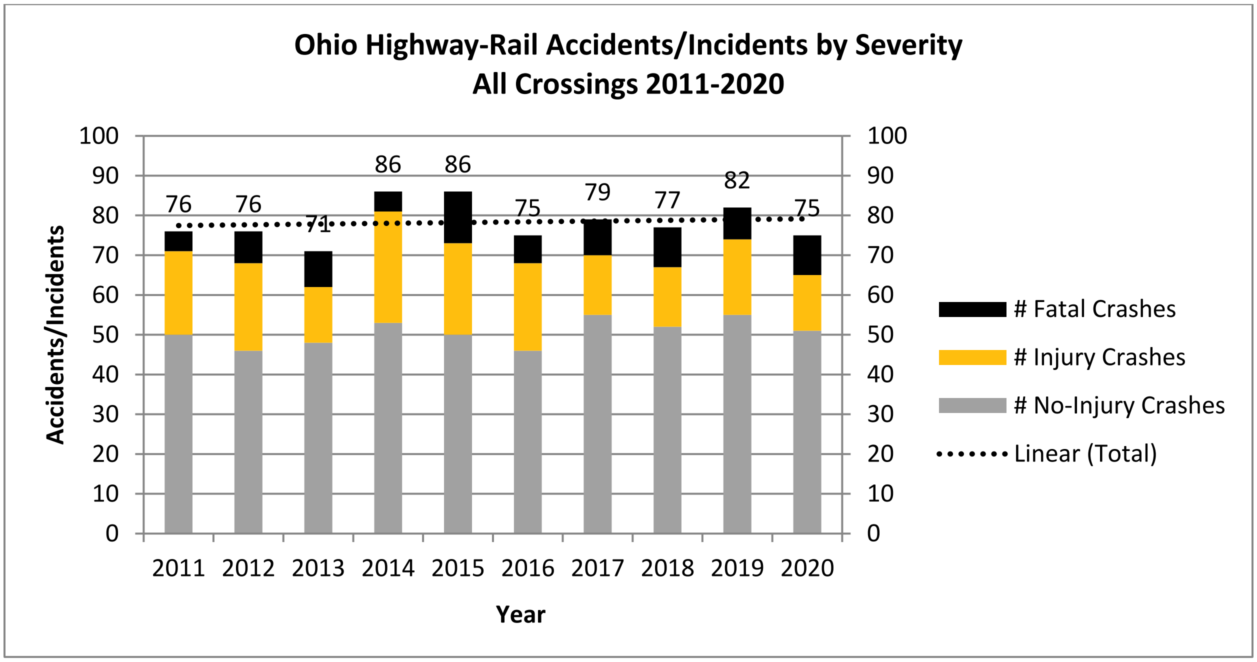
The development of this SAP complies with federal requirements as described under Section 11401 of the Fixing America's Surface Transportation (FAST) Act and as amended by the Final Rule issued by the Federal Railroad Administration (FRA) on December 14, 2020 and codified in Section 234.11 of Title 49 of the Code of Federal Regulations (49 CFR § 234.11). This SAP development process also provides the State of Ohio an opportunity to work with multiple stakeholders to identify strategies for improving highway-rail grade crossing and pathway grade crossing safety statewide. Per the federal requirements in the Final Rule, each State's SAP must accomplish the following:

- Identify highway-rail and pathway grade crossings that:
    - Have experienced at least one accident/incident within the previous three (3) years;
    - Have experienced more than one accident/incident within the previous five (5) years; and,
    - Are at high-risk for accidents/incidents as defined in the action plan.
- Identify data sources used to categorize and evaluate the highway-rail grade crossings, including pathway grade crossings.
- Discuss specific strategies, including highway-rail grade crossing closures or grade separations, to improve safety at those crossings over a period of at least four years.
- Provide an implementation timeline for the strategies identified.
- Designate an official responsible for managing implementation of the state's highway-rail grade crossing action plan.

A document developed jointly by the FRA and Federal Highway Administration (FHWA) identifying strategies for development of a Model SAP for states – *Noteworthy Practices Guide: Highway-Railway Grade Crossing Action Plan and Project Prioritization* (2016) – and valuable guidance from FRA staff during 2018-2021 was also used as a guide for the development of this 2022 Ohio SAP.[1]

Ohio is a crossroads state with an extensive transportation infrastructure that features a dense network of railroads. As of 2019, there are over 5,000 miles of active main line rail in the state, as well as over 120,000 miles of roadway.[2] Consequently, there are a large number of public crossings. And as of 2021, there were close to 5,700 public highway-rail grade crossings statewide.[3]

This SAP presents a data analysis for ten years of available accident/incident data between the years 2011 and 2020. This assessment is based on accident/incident records maintained by the FRA Office of Safety Analysis. While the total number of accidents/incidents fluctuates from year to year, the overall trend has been flat over the past decade.



[1] Federal Highway Administration & Federal Railroad Administration, *Highway-Railway Grade Crossing Action Plan and Project Prioritization Noteworthy Practices*, November 2016. Retrieved from: https://safety.fhwa.dot.gov/hsip/xings/fhwasa16075/

[2] Ohio Railroad Development Commission, *State of Ohio Rail Plan*, January 2019. Retrieved from: https://www.rail.ohio.gov/static/Documents/State+of+Ohio+Rail+Plan+Final.pdf

[3] Public Utilities Commission of Ohio, Ohio Railroad Information System. Retrieved from: https://gradecrossings.puco.ohio.gov/search

Per federal guidance, this SAP also identifies locations where two (2) or more accidents/incidents have occurred within the previous five (5) years. In total, 43 public highway-rail grade crossings and six private highway-rail grade crossings were identified that experienced two (2) or more accidents/incidents between 2016 and 2020.

This SAP includes a conceptual risk assessment of the statewide public highway-rail grade crossing network through an analysis of publicly available accident/incident and safety data compared to crossing features and characteristics such as highway and railroad traffic volumes and speeds, existing warning devices, and crossing geometry. The following crossing characteristics were reviewed as part of this analysis, based on accident/incident history over the previous ten years:

- Average Annual Daily Traffic (AADT)
- Number of Trains per Day
- Number of Motor Vehicle Collisions at Each Crossing During the Previous 5-Year Period
- Number of Tracks
- Number of Roadway Lanes
- Roadway Geometry
- Maximum Railroad Timetable Speed
- Grade Crossing Illumination
- Distance to Nearest Intersection
- Highway Speed Limit
- Warning Device

As identified during the conceptual data and risk analysis and the stakeholder outreach conducted during development of the SAP, the highest priority highway-rail grade crossing safety needs and challenges in Ohio and related key areas of need/emphasis areas include:

- **Crossings in Densely Populated Areas:** Highway-rail grade crossings located in denser and more developed areas of Ohio present unique challenges. These crossings often have higher traffic volumes than their counterparts in less densely populated areas and are also more likely to have commercial accesses, private driveways, and intersections with public roadways in close proximity to the crossing. These crossings are also more likely to host pedestrian and bicycle traffic.
- **Vehicles Stopped on Crossings:** This includes instances of vehicles stopped or stalled on the tracks at the crossing prior to being struck by a train. In general, causes could range from a tractor-trailer becoming high-centered and stuck due to a severely humped crossing or a vehicle with mechanical issues becoming disabled on a crossing. In other cases, a queue of vehicles stopping at an adjacent traffic signal may extend onto the crossing (called a Short Storage Crossing). This is caused by a short roadway segment of 200 feet or less between the railroad tracks and the adjacent intersection, which creates

the potential for traffic stopping at a traffic control device (i.e., stop/yield sign or traffic signal) to queue across the railroad tracks.

- **Automobile Incidents:** A review of the recent accident/incident history in Ohio shows that approximately two thirds of highway-rail accidents/incidents have involved automobiles in the previous five years. This is a significantly higher proportion compared to the national average.
- **Circumvention of Active Warning Devices:** A review of the recent accident/incident history shows that 26 percent of Ohio highway-rail accidents/incidents in the previous five years have involved motorists driving around the gates compared to 16 percent for all other states in the US.

For the State of Ohio, railroad safety strategies are implemented by ORDC and PUCO through their administration of the federal Railway-Highway Crossings Program (administered by ORDC) and the State Grade Crossing Protection Program (administered by PUCO). Historically, ORDC has managed approximately $15 million of federal highway safety funding (including Section 130 funds) allocated to the state each year. Ohio receives approximately $9.5 million in Section 130 funding annually from the FHWA for the implementation of safety improvements at public highway-rail grade crossings.[4] This funding is supplemented by other federal highway safety program funds. Funds are made available for this program with a 100% federal share as of the 2021 Infrastructure Investment and Jobs Act (IIJA). Prior to the IIJA, funds were made available at a ratio of 90 percent federal to 10 percent state or local match, with total funding or cash incentives available for crossing consolidation projects. Examples of eligible projects include the installation of new or upgraded highway-rail grade crossing signal systems; interconnection of highway-rail grade crossing signals with roadway traffic signals; and improvements to roadway approaches, crossing surfaces, and roadway geometry improvements. However, most Section 130 projects have involved the installation of new active warning devices. The PUCO administers approximately $1.2 million of state funding for crossings not selected for federal funding and for local communities to install supplemental enhancements such as rumble strips, illumination, improved signage, vegetation cut-back or other safety measures that these communities deem necessary.

Through the development of this SAP, ORDC and PUCO established a series of goals and objectives and related strategies designed to improve safety for the key areas of need/emphasis areas identified through the safety analysis.

[4] Federal Highway Administration, Distribution of Railway-Highway Crossings Program Funds Apportioned for Fiscal Year 2021. Retrieved from: https://www.fhwa.dot.gov/legsregs/directives/notices/n4510854/n4510854_t13.cfm

Ohio's SAP goals include:

- **Goal 1:** Reduce the number and rate of crashes, incidents, injuries, and fatalities involving trains;
- **Goal 2:** Improve the identification of high-risk highway-rail grade crossings;
- **Goal 3:** Prevent railroad trespasser accidents, incidents, injuries, and fatalities;
- **Goal 4:** Support education and outreach efforts to increase grade crossing safety;
- **Goal 5:** Improve the consistency and effectiveness of enforcement and compliance programs; and,
- **Goal 6:** Identify mitigation efforts to reduce incidents caused by queuing at crossings.

Specific actionable objectives intended to help achieve Ohio's SAP goals are also provided in further detail in the SAP. For each actionable objective, the SAP proposes a series of specific strategies for Ohio to continue to pursue. The actionable objectives described in the SAP include:

- **Objective 1:** Update the State's Railroad Crossing Inventory Database
- **Objective 2:** Extra Mile Program for Multiple-Crash At-Grade Crossings
- **Objective 3:** Changes in the State's Approach to the Corridor Program
- **Objective 4:** Preemption Program
- **Objective 5:** LED Upgrade Program
- **Objective 6:** Policy Guidance for Non-Motorized Transportation
- **Objective 7:** Best Practices for Community Growth Near Highway-Rail Grade Crossings

More information about these objectives can be found in **Section 7.3** of the SAP.

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CONTENTS

FIGURES

TABLES

1.0 Introduction

Section 11401 of the Fixing America's Surface Transportation (FAST) Act requires each state to develop a Highway-Rail Grade Crossing State Action Plan (SAP). This Ohio SAP has been developed for the State of Ohio by the Ohio Rail Development Commission (ORDC) and the Public Utilities Commission of Ohio (PUCO) through coordination with stakeholders statewide, the Federal Railroad Administration (FRA), the Federal Highway Administration (FHWA), and in consideration of applicable federal requirements. Through thoughtful and strategic implementation of this SAP, it is envisioned that statewide safety efforts can be better coordinated and equipped to address a diverse and complex assortment of highway-rail grade crossing safety issues across the State of Ohio.

The mission statement below defines the purpose of the Ohio SAP and has helped to guide its development:

Enable roadway users to make safe decisions at highway-rail grade crossings, so that everyone can get home safely.

Realizing the bold vision of the mission statement above requires leadership by ORDC and PUCO, coordinated action across all agencies and with the aid of all highway-rail grade crossing safety stakeholders, and broad public awareness.

1.1 Background

Per the Rail Safety Improvement Act of 2008 (RSIA), ten states were mandated to develop an Action Plan to improve highway-rail grade crossing safety in their respective jurisdictions. These ten states were those that each had the highest number of recorded accidents/incidents respectively over the previous decade. Ohio was one of the ten states identified, and, in 2011, Ohio published its first *Ohio Railroad Safety Improvement Plan*.[5] Ohio updated this initial plan in 2018 based on Fiscal Year (FY) 2016 data.

Later, the FAST Act of 2015 directed the FRA to require all 50 states to develop Action Plans.

On December 14, 2020, FRA published its Final Rule specifying the requirements for State Action Plans and establishing a deadline of February 14, 2022, for states to submit their plans to FRA for review.[6] This rule was codified in Section 234.11 of Title 49 of the Code of Federal

[5] Federal Railroad Administration, *Ohio Railroad Safety Improvement Plan*, 2011. Retrieved from: https://railroads.dot.gov/sites/fra.dot.gov/files/2020-12/SAP-Ohio.pdf

[6] Federal Register, Federal Railroad Administration Final Rule: State Highway-Rail Grade Crossing Action Plans, December 14, 2020. Retrieved from: https://www.govinfo.gov/content/pkg/FR-2020-12-14/pdf/2020-26064.pdf

Regulations (49 CFR § 234.11). In summary, the Final Rule requires that SAPs include the following information:

- Identification of crossings that:
    - Have experienced crashes within the previous three years;
    - Have experienced multiple crashes within the previous five years; and,
    - Are at high-risk for accidents/incidents as defined in the action plan.
- Identification of data sources used to categorize and evaluate highway-rail grade crossings, including any pathway grade crossings.
- Discussion of specific strategies, including highway-rail grade crossing closures or grade separations, to improve safety at those crossings over a period of at least four years.
- Designation of an official responsible for managing implementation of the state's highway-rail grade crossing action plan.

While the requirements above apply to all 50 states, the FRA outlined the additional requirement that each of the ten states originally required to develop an Action Plan per RSIA shall submit a revised SAP that addresses two additional required elements:

- How the state implemented the state highway-rail grade crossing action plan that it previously submitted to FRA for review and approval.
- How the state will continue to reduce highway-rail and pathway grade crossing safety risks.

In addition to these requirements outlined in the Final Rule, the FHWA and FRA had previously developed a guidance document for SAPs known as the *Highway-Railway Grade Crossing Action Plan and Project Prioritization Noteworthy Practices Guide*, which included a model Action Plan outline for states that wish to develop their own SAP.[7] This published guidance – along with valuable insight from FRA staff – was used as a reference for the development of this 2022 Ohio SAP.

This document reflects the cumulative efforts of prior legislation, rulemaking, and guidance created for the purpose of establishing a standardized approach to SAP development with the overall intent of improving safety at highway-rail grade crossings nationwide.

[7] Federal Highway Administration & Federal Railroad Administration, Highway-Railway Grade Crossing Action Plan and Project Prioritization Noteworthy Practices Guide, November 2016. Retrieved from: https://safety.fhwa.dot.gov/hsip/xings/fhwasa16075/fhwasa16075.pdf

1.2 Scope

The general planning process employed by ORDC and PUCO to develop the Ohio SAP included the following elements:

- Assess current planning and programs statewide that target highway-rail grade crossing safety and investment (see Section 2.0 of this SAP for more details)
- Assess the current process used by the State of Ohio to identify and prioritize highway-rail grade crossing safety investments (see Section 2.0 of this SAP for more details)
- Conduct data analysis that presents the results of a robust analysis of ten years of available FRA accident/incident data, for the years 2011 to 2020 inclusive, and state highway-rail grade crossing inventory data that evaluates the general highway-rail grade crossing environment statewide in terms of strengths, vulnerabilities, and challenges in highway-rail grade crossing safety (see Section 3.0 of this SAP for more details)
- Assess the current highway-rail grade crossing environment generally and provide an overview of the state rail network (see Section 3.0 of this SAP for more details)
- Conduct a risk assessment of the statewide highway-rail grade crossing network through an analysis of accident/incident and safety data compared to crossing features and characteristics including items such as highway and railroad traffic volumes and speeds, existing warning devices, crossing geometry, and other considerations (see Section 4.0 of this SAP for more details)
- Conduct stakeholder and public outreach and coordination with rail safety stakeholders. The purpose of the outreach was to acquire inputs for the development of the SAP and to seek partners to help ORDC and PUCO implement the actions of the SAP. Presentations on the activity were provided to both the State Highway Safety Program Steering Committee and a meeting of the commissioners of the ORDC. A stakeholder meeting was held virtually on January 11, 2022, and included participation by representatives from ORDC and PUCO, FRA, and multiple railroads operating in the state (see Section 5.0 of this SAP for more details)
- Identify the highest-priority highway-rail grade crossing safety challenges in the state in terms of key areas of need / emphasis areas (see Section 6.0 of this SAP for more details)
- Review prior action items from previous state planning efforts (see Section 7.0 of this SAP for more details)
- Develop an action plan to identify goals and objectives for addressing highway-rail grade crossing safety challenges, create an implementation plan ORDC and PUCO and its

partners will undertake for accomplishing goals and objectives and to identify process and metrics for measuring progress during the four-year horizon of the SAP (2022-2025), and identify challenges to meeting goals and objectives. The implemented actions will address key safety challenges and solutions related to the "4 E's" of highway-rail grade crossing safety – *Engineering, Education, Enforcement, and Emergency services* (see Section 7.0 of this SAP for more details)

- Consider next steps by providing an overview of the short-term actions (for the four-year horizon for this SAP, or years 2022-2025) and long-term actions (for years 2026-2029) that will be undertaken to assist ORDC and PUCO in achieving the goals and objectives of this SAP (see Section 8.0 of this SAP for more details)

1.3 Goals and Objectives

As identified during the data and risk analysis and the stakeholder outreach conducted for development of the SAP, the highest priority highway-rail grade crossing safety needs and challenges in Ohio and related key areas of need/emphasis areas include:

- **Crossings in Densely Populated Areas:** Highway-rail grade crossings located in denser and more developed areas of Ohio present unique challenges. These crossings often have higher traffic volumes than their counterparts in less densely populated areas and are also more likely to have commercial accesses, private driveways, and intersections with public roadways in close proximity to the crossing. These crossings are also more likely to host pedestrian and bicycle traffic.
- **Vehicles Stopped on Crossings:** This includes instances of vehicles stopped or stalled on the tracks at the crossing prior to being struck by a train. In general, causes could range from a tractor-trailer becoming high-centered and stuck due to a severely humped crossing or a vehicle with mechanical issues becoming disabled on a crossing. In other cases, a queue of vehicles stopping at an adjacent traffic signal may extend onto the crossing (called a Short Storage Crossing). This is caused by a short roadway segment of 200 feet or less between the railroad tracks and the adjacent intersection, which creates the potential for traffic stopping at a traffic control device (i.e., stop/yield sign or traffic signal) to queue across the railroad tracks.
- **Automobile Incidents:** A review of the recent accident/incident history in Ohio shows that approximately two thirds of highway-rail accidents/incidents have involved automobiles in the previous five years. This is a significantly higher proportion compared to the national average.

- **Circumvention of Active Warning Devices:** A review of the recent accident/incident history shows that 26 percent of Ohio highway-rail accidents/incidents in the previous five years have involved motorists driving around the gates compared to 16 percent for all other states in the US.

Through the development of this SAP, ORDC and PUCO established a series of goals and objectives and related strategies designed to improve safety for the key areas of need / emphasis areas identified through the safety analysis. Each is based on federal guidance to establish goals that are **S**mart, **M**easurable, **A**greed-upon, **R**ealistic, and **T**ime-bound (SMART framework).

ORDC and PUCO's SAP goals include the following:

- **Goal 1:** Reduce the number and rate of crashes, incidents, injuries, and fatalities involving trains;
- **Goal 2:** Improve the identification of high-risk highway-rail grade crossings;
- **Goal 3:** Prevent railroad trespasser accidents, incidents, injuries, and fatalities;
- **Goal 4:** Support education and outreach efforts to increase grade crossing safety;
- **Goal 5:** Improve the consistency and effectiveness of enforcement and compliance programs; and,
- **Goal 6:** Identify mitigation efforts to reduce incidents caused by queuing at crossings.

1.4 National Grade Crossing Safety Trends

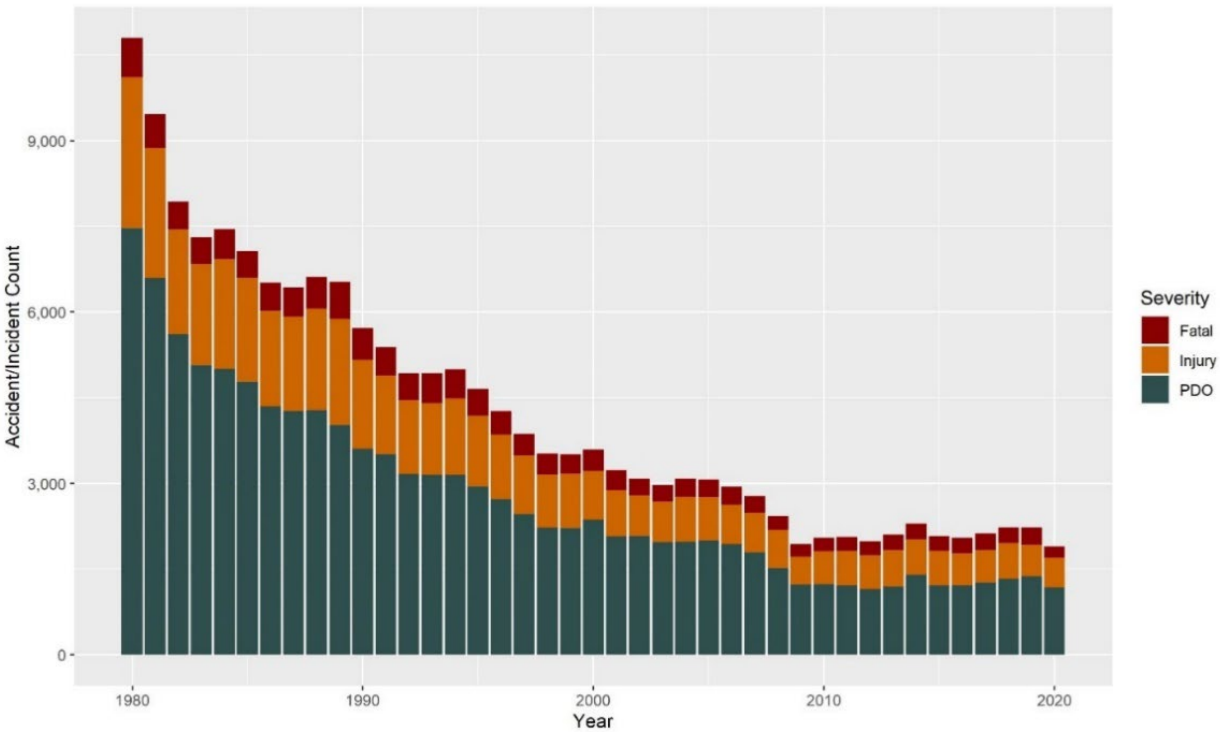
At a national level, the U.S. has made remarkable progress in the last 40 years in reducing the total number of accidents/incidents at highway-rail grade crossings. As shown in Figure 1, the annual number of accidents/incidents was reduced by approximately 80 percent from 1980 to 2020. Over this same time period, the national vehicle-miles traveled doubled, and the ton-miles of freight transported by train increased by 75 percent. However, over the last ten years, the total number of accidents/incidents in the U.S. has begun to plateau at nearly 2,000 accidents/incidents per year.

A large factor in this success story has been the overall reduction in the total number of highway-rail grade crossings through closure, consolidation, or grade separation. In 1980, more than 200,000 public highway-rail grade crossings existed in the U.S. As of 2020, this number has been reduced to approximately 135,000. These reductions were the result of many factors including the active pursuit of closures by railroads, state agencies, and local roadway authorities as well as route rationalization associated with mergers, consolidations, and bankruptcies of many Class I railroads during the time period and the subsequent abandonment of some lines.

Notably, this reduction in highway-rail grade crossings at a national level slowed around 2010, coinciding precisely with the plateauing of annual accidents/incidents in the U.S. This finding highlights the importance of crossing closures and grade separations in the pursuit of safer highway-rail grade crossings and echoes the common rail safety refrain that "the safest crossing is no crossing at all."

Within Ohio, this trend has been largely mirrored, with a plateau in the number of accidents/incidents beginning in 2009. The state has experienced approximately 70 to 90 accidents/incidents per year since 2010.

Figure 1 | National Grade Crossing Accidents/Incidents, including Property Damage Only (PDO), from 1980 to 2020

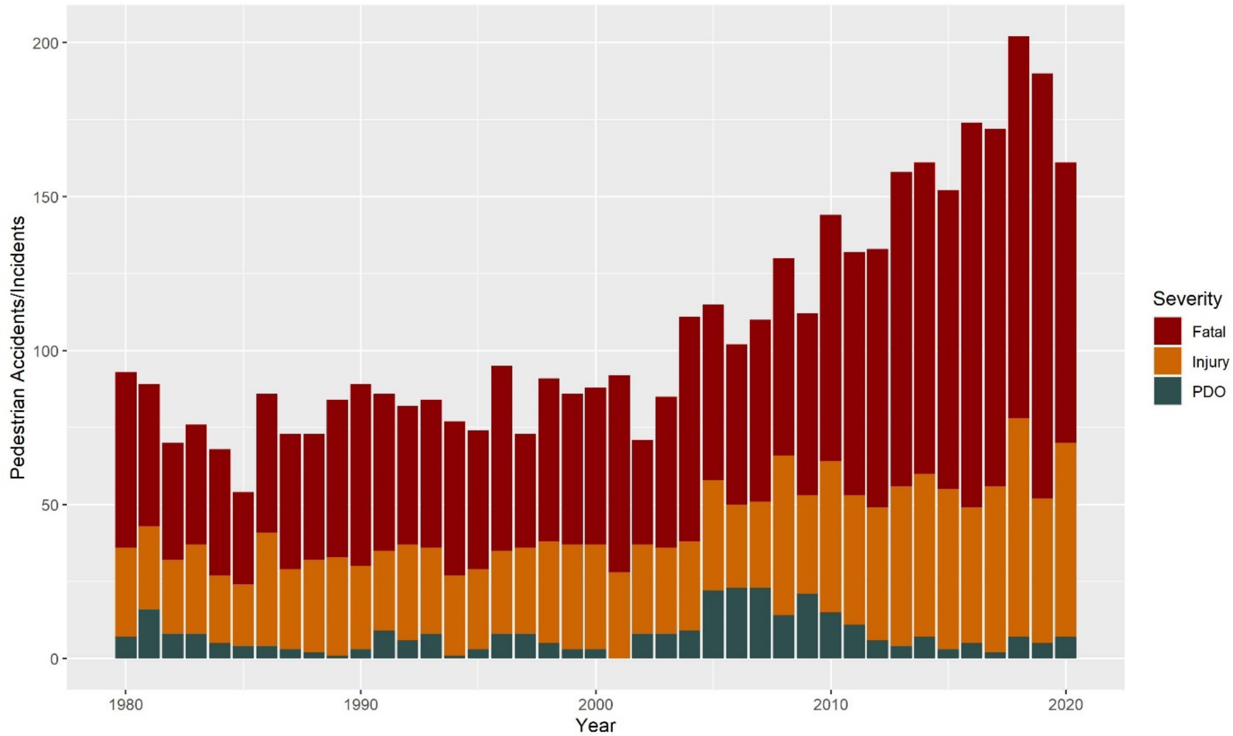


Source: FRA Accident/Incident Data as Reported by Railroads

One area that has not seen the same improvement as those shown in the previous section is pedestrian-related accidents/incidents. While the total count of all accidents/incidents has been in decline, the number of pedestrian-related accidents/incidents at highway-rail grade crossings has been on the rise for the past 15 years; see Figure 2. Pedestrian accidents/incidents are also much more likely to result in fatal or severe injury. Additionally, this data may or may not include pedestrian accidents/incidents occurring more than one-quarter mile from a defined highway-rail grade crossing. Correspondence with FRA staff indicates that reporting on these incidents varies from state to state and from railroad to railroad. However, engagement with railroad stakeholders indicates that these trespassing-related incidents are also on the rise nationally.

Within Ohio, the number of pedestrian accidents/incidents in the last ten years has ranged from zero to eight per year with an average of five per year as reported by railroads to the FRA. Note that this figure most likely does not include fatal trespassing accidents/incidents occurring more than a quarter mile from a crossing or incidents determined to be suicide.

Figure 2 | National Pedestrian Accidents/Incidents, from 1980 to 2020



1.4.2 Comparison of Ohio to Other States

One method of evaluating Ohio's current grade crossing safety issues and safety program effectiveness is to compare the total number of accidents/incidents that have been recorded in Ohio to similar data for other states (Figure 3). The data show that Ohio ranks 9th for total accidents/incidents. However, the count of accidents/incidents alone does not account for the fact that some states have much higher levels of rail activity—and thus more opportunities for highway-rail collisions—than other states.

Another comparison method that normalizes for this effect is the comparison of the total number of accidents/incidents per crossing in each state. This result is shown in Figure 4 and represents a more accurate comparison. Under this measure, Ohio improves to 25th place.

Figure 3 | Accidents/Incidents by State (2016-2020)

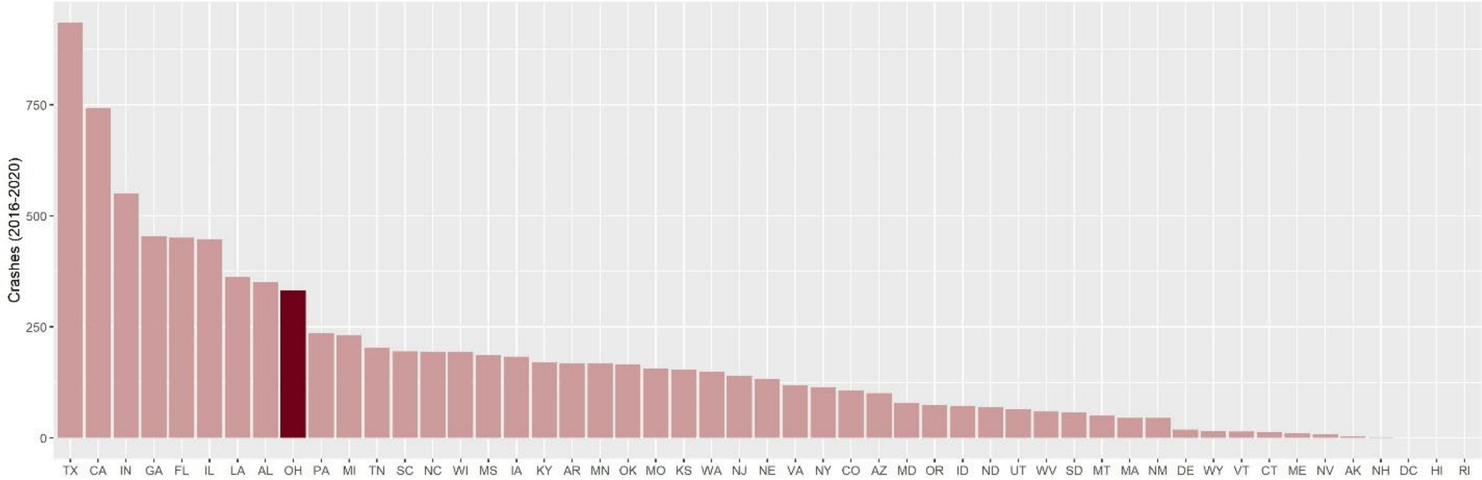
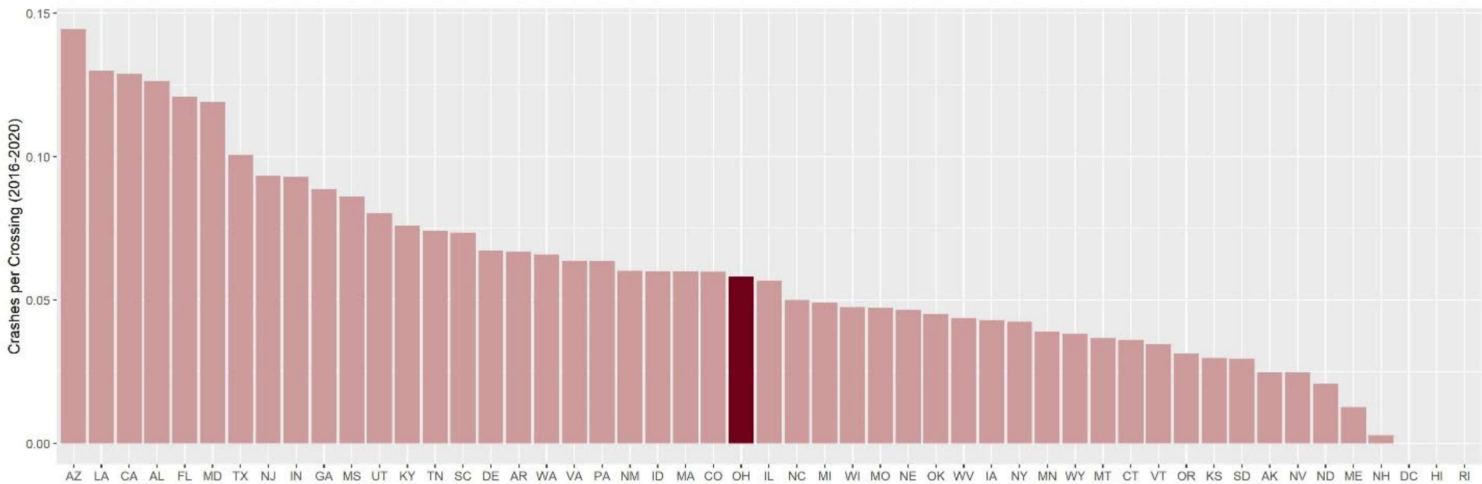


Figure 4 | Accidents/Incidents per Crossing by State (2016-2020)



2.0 Statewide Highway-Rail Grade Crossing Safety Efforts

The purpose of this section is to provide an overview of current statewide highway-rail grade crossing safety planning and programs in Ohio. The goal of these efforts is to mitigate risk factors, minimize deaths and injuries, and identify and prioritize infrastructure investment at highway-rail grade crossings statewide.

2.1 Statewide Highway-Rail Grade Crossing Programs

A review of relevant recent and publicly available state, regional, and local safety resources to synthesize the state of practice by Ohio agencies is presented in this section. Statewide funding programs, safety programs, and public education programs – as discovered through an analysis of available recent planning documents, desktop analysis of internet sources, and coordination with ORDC and PUCO – are identified and described, as applicable.

The State of Ohio has a vibrant railroad safety program with two principal agencies responsible for administering both regulatory enforcement of railroads and capital improvement programs. PUCO serves as the regulatory body in charge of overseeing Ohio's railroads. It accomplishes this through a combination of regulatory enforcement, inspections, and grant programs. ORDC administers federal highway safety funds from the Ohio Department of Transportation (ODOT) that are utilized for railroad safety infrastructure improvement projects.

2.1.1 Statewide Safety Initiatives

The known federal, state, and local programs that specifically target highway-rail grade crossing safety in Ohio are identified and described in this section.

Railroad Inspections

The state employs 13 railroad inspectors that monitor grade crossings, inspect railroad tracks and equipment, investigate all grade crossing incidents, and administer Ohio's grade crossing database. Ohio inspectors are certified by the FRA and represent five of the six FRA inspection disciplines. These inspectors annually conduct over 5,600 grade crossing inspections with a total of 6,076 conducted in 2021. In addition to their standard inspection work, these individuals also respond to the concerns of the public such as complaints of rough crossings, excessive noise, bridge debris, and overgrown weeds and vegetation that can obstruct sight at railroad crossings, as well as investigate crashes/derailments and assist in the review and approval of grade crossing upgrades and improvements.

Grade Crossing Project Managers

In addition to the 13 railroad inspectors identified above, the state also employs four grade crossing project managers and one preemption project manager who administer the construction of all federally funded grade crossing projects. Project management includes warning devices, surface, and signal preemption projects.

Master Agreements

Ohio was an early industry leader, entering into Master Agreements with individual railroads dating back to the 1970s. Early on, the state realized it needed a legal framework to expedite the safety program process. As a result, the state has Master Agreements with railroads operating in Ohio for warning device and surface reconstruction projects. More recently, Ohio has entered into Master Agreements with local highway authorities for preemption-related projects and roadway safety modifications at grade crossings.

Blocked Crossing Data Collection

Blocked crossings have been an ongoing issue for the state over the last few years. The Ohio Revised Code §5589.21 states that no railroad may block a public street, road, or highway for longer than five minutes. At the end of the five minutes the train must clear the tracks for not less than three minutes. This rule only applies to a stationary train, not one that is moving through the crossing. Enforcement of the rule has historically been handled by local law enforcement. A 2017 federal court decision has created uncertainty regarding the enforcement of this state law. Currently, there is a case regarding Ohio’s blocked crossing laws pending at the Ohio Supreme Court (State of Ohio v. CSX Transportation, Inc.). Due to the lack of enforcement authority and the high number of complaints being received, the state began collecting blocked crossing reports. In 2019, the FRA launched a web portal for the public to submit blocked crossing reports which has superseded state-level collection of blocked crossing data. All complainants are now encouraged to utilize the FRA portal to submit blocked crossing reports.

Diagnostic Reviews

In addition to diagnostic reviews for prospective state or federally funded warning device upgrades, in some circumstances the state provides diagnostic reviews as service to all communities and local roadway authorities, regardless of state funding participation. If a community or local highway authority contacts the state with a safety concern about a crossing, the state will establish a diagnostic review as a requirement to establish federal funding for upgrades. However, if a community or local highway authority wishes to do an improvement project or consider crossings for upgrades or closures as a part of the process to establish a quiet zone, the state will hold a diagnostic review to formalize improvements and recommendations, even when state funding cannot be used for such projects. The state is a resource for all communities and local highway authorities with a rail nexus.

Safety Upgrades

The conversion of passive warning devices to active warning devices (i.e., flashing light signals, bells, and/or roadway gates) or other crossing safety upgrades has been a priority of the state's highway-rail grade crossing improvement efforts. Over the 2017-2021 federal fiscal year period, the state has initiated 388 federally funded safety projects throughout the state, with 100 initiated in 2021. Over the same state fiscal year period, PUCO undertook 56 additional state funded projects ranging from installation of active warning devices to supplemental safety measures.

Grade Separation Program

In response to blocked crossings and significant changes in rail traffic resulting from the purchase and subsequent division of Conrail, Ohio initiated a special program for grade separations. Originally budgeted at $200 million, the program was concluded in 2017 and resulted in 24 new grade separations.

Consolidation Program

In 1991, the FRA set a goal to close 25 percent of highway-grade crossings in the U.S., and the state continues to work toward that goal. The current consolidation program works to eliminate redundant crossings in exchange for implementing safety improvements at other crossings within the community. These improvements, such as flashing light signals, bells, and gates, upgraded crossings surfaces, signage and illumination, or financial contributions to grade separations at crossings in the community are paid for through a combination of federal, state, and railroad funds. When a local community agrees to permanently close a highway-rail grade crossing to vehicle traffic, the state works to provide funding for the agreed upon upgrades. Potential closure candidates are identified by a variety of sources. A team will then survey the site, evaluate the project, and determine the level of participation for the local highway authority and railroad. In addition to the various programs, the state also has the statutory authority to close crossings through proceedings initiated by the local highway authority or railroad.

Corridor Program

In an effort to take advantage of economies of scale and the closure of redundant crossings, the State of Ohio promotes the concept of upgrading multiple highway-rail grade crossings along the same rail line segment as a coordinated effort. The objective of this program is to upgrade all at-grade crossing locations in the corridor with state-of-the-art active warning devices. The program initiated with large scale, high-density Class I railroad corridors. Corridor projects have included Norfolk Southern corridors between Columbus and Cincinnati and between the Ohio River and Columbus, as well as multiple corridors on the CSX Transportation network.

However, based on Ohio's experience with implementing such large corridor projects, the state and the railroads came to a mutual understanding that it is more efficient to concentrate on smaller corridors spanning multiple crossings within a single municipality. Smaller corridors provide more opportunities for smaller Class II and Class III railroads to participate in corridor projects and focus more on community-based improvements. The state gives special consideration to communities or rail lines with increased traffic or train speeds.

Projects have been progressed on the CSX Transportation network in Marion County, Eaton, Glendale, and Tiffin and on the Chicago, Ft. Wayne and Eastern line in Van Wert, along with several smaller communities statewide on current and potential future corridor improvements.

Preemption Program

The state launched a Statewide Railroad Preemption Evaluation Program in 2009. The purpose of the program was to interconnect railroad signals with nearby highway traffic signals to discourage traffic queueing across highway-rail grade crossings. Specifically, the program evaluates and prioritizes improvements for highway-rail grade crossings and nearby highway traffic signals that are or should be interconnected for the purpose of interrupting the normal sequence of the traffic signal in order to clear traffic from the crossing and intersection before a train arrives at the crossing. The goal is to reduce this type of accident by developing and implementing standards for establishing appropriate railroad preemption timing parameters and making other improvements to the operations and control equipment for both the highway-rail grade crossing and highway traffic signal systems.

The program, while originally focused on preemption installations, has evolved into more broadly addressing traffic queuing across grade crossings. Additional strategies in situations where full preemption is not appropriate continue to be developed. Often these strategies involve working with communities to identify other improvements that will reduce vehicular traffic queueing across highway-rail grade crossings.

School Initiative Program

The state reaches out to the over 1,300 Ohio school districts encouraging their transportation personnel to report any concerns with public highway-rail grade crossings through which they travel. The state can assist in the removal of weeds and vegetation that obstructs sight distance at crossings and can try to effectuate repairs at rough crossings used by school transportation. Ohio’s professional school bus drivers and transportation officials are in a unique position relative to grade crossings and the state appreciates the assistance received from these individuals. The state is also taking action by proactively seeking information from school districts to help update school bus counts and other highway-rail grade crossing data.

Crossing Exemptions

Under Ohio Revised Code §4511.63, as authorized by 49 CFR 392.10(b)5, any local authority may file a request for exemption from stopping at highway-rail grade crossings for those vehicles statutorily required to stop. In cases where the railroad is not actively using a crossing, local authorities such as school districts routinely ask for a crossing to be made exempt so that buses and placarded vehicles do not have to stop at the crossing. Once an application is received by the state, comments are requested from all parties and a public hearing is conducted. After considering any comments or information gathered, the state either rejects or approves the application with certain conditions. Exemptions granted typically involve inactive or lightly used rail lines or locations where the crossing is on a highway with a relatively high speed. In these cases, the risk of rear end collisions is significantly greater than the risk of a car/train collision. Furthermore, exemptions may be terminated if the operating conditions at the crossing change. Currently, there are 125 crossing exemptions in Ohio with three petitions currently awaiting a decision from the commissioners of the PUCO.

2.1.2 Statewide Public Education Programs

The known federal, state, and local programs that educate the public about highway-rail grade crossing safety and trespassing prevention programs in Ohio are identified and described in this section.

Operation Lifesaver

Operation Lifesaver, Inc. (OLI) is a non-profit public information and education program that, since 1972, has helped to prevent and reduce accidents/incidents (including trespassing) resulting in injuries and fatalities and improve driver performance over the approximately 300,000 public and private highway-rail grade crossings in the U.S.

The railroads in Ohio, state agencies, law enforcement, and other organizations partner through OLI to raise awareness of highway-rail grade crossing safety and to reduce highway-rail grade crossing and trespassing fatalities and incidents. OLI engages and educates the public and various stakeholders through its website, social media, safety “blitzes” at identified crossings, and free public presentations made by trained OLI presenters and volunteers. Both ORDC and PUCO provide grant funding on an annual basis for OLI initiatives and have participated in large-scale events including the Ohio State Fair and the Ohio School Boards Association Capital Conference.

Both the PUCO and ORDC serve on the Ohio OLI board and have numerous employees trained as Operation Lifesaver volunteers. Participation in OLI is encouraged, and OLI safety messaging is incorporated into both agencies’ public messaging.

2.1.3 Statewide Highway-Rail Grade Crossing Funding Programs and Administration

The known federal, state, and local programs that fund highway-rail grade crossing improvements and investments in Ohio and how they are administered are identified and described in this section.

Rail-Highway Crossing Improvement Program (Section 130)

The Railway-Highway Crossings (Section 130) program under the Highway Safety Improvement Program (HSIP) administered by the FHWA provides funding for the elimination of hazards at U.S. highway-railroad grade crossings. Since the program's debut in 1987, there has been a significant decrease in fatalities at public highway-railroad grade crossings nationwide despite: 1) an increase in vehicle miles traveled (VMT) on roadways, and 2) an increase in passengers and freight moved over railroad corridors. Funding from this program helped to eliminate many safety hazards in Ohio and other states, largely through the installation and upgrade of protective devices at public highway-railroad grade crossings.

Ohio receives approximately $9.5 million annually from the FHWA for the implementation of safety improvements at locations where a public roadway intersects active railroad tracks.[8] This funding is supplemented with other FHWA safety funding as well as state funding for program administration. The result is in an approximately $15 million annual grade crossing safety program at the ORDC. Currently, nearly 5,700 public highway-rail grade crossings statewide are eligible for this financial assistance. Funds are made available for this program with a 100-percent federal share as of the 2021 IIJA with other incentives available for crossing consolidation projects. Prior to the IIJA, funding was made available at a match ratio of 90 percent federal to 10 percent state or local match (or potentially a railroad match). In addition to the dedicated program, ORDC often includes grade crossing improvements in its state rehabilitation program and federal grant applications to the FRA. These grade crossing project elements are funded at the ratio of the overall rehabilitation project.

State Grade Crossing Protection Program

Ohio Revised Code Section §4907.472 established the Grade Crossing Protection Fund for the State of Ohio. This fund allocates $1.2 million annually to be used for the reduction of hazards at railroad grade crossings. For crossings not selected for federal funding, the state-funded Grade Crossing Protection Program allows local communities to share the cost of installing safety devices with the state and the railroad. Communities who utilize this program may be required to pay between 25 and 65 percent of the cost of the project, with the railroad responsible for ten percent plus ongoing maintenance. The state allocates funds for this program based on an objective formula measuring the seriousness of the hazard and other special conditions at the crossing. Communities or local roadway authorities wishing to access state funding must apply to the state for consideration.

[8] Federal Highway Administration, Distribution of Railway-Highway Crossings Program Funds Apportioned for Fiscal Year 2021. Retrieved from: https://www.fhwa.dot.gov/legsregs/directives/notices/n4510854/n4510854_t13.cfm

Supplemental Assistance Program

The state also administers a supplemental assistance program to provide safety enhancements at crossings at which state or federal installation of active warning devices (i.e., gates, bells, and/or flashing light signals) is pending, as well as at crossings that have only passive warning signage. Up to $5,000 per application is available for physical improvements around the crossing such as rumble strips, illumination, improved signage, vegetation clearing, or other safety enhancements. Local governments may undertake these physical improvements as an interim measure while waiting for active warning devices to be installed, but the supplemental assistance is not used to install active warning devices. To apply for supplemental assistance, the local highway authority can apply to the state for approval. Once construction has been completed and approved, the local highway authority may submit eligible costs for reimbursement.

2.2 Assessment of Current Process to Identify and Prioritize Highway-Rail Grade Crossing Investment Statewide

2.2.1 Current Crossing Improvement Prioritization Process

The Section 130 program provides state DOTs with flexibility in determining an appropriate means of selecting and prioritizing projects. As noted in the FHWA's Highway-Railway Grade Crossing Action Plan and Project Prioritization Noteworthy Practices Guide[9], most state DOTs fall into one of three categories of project prioritization:

- **Process driven:** Under a process driven approach, projects are selected predominantly through coordination with stakeholders such as local governments and railroads.
- **Data driven:** A data driven approach relies on established formulas to identify grade crossings with the highest risk levels in order to prioritize their selection.
- **Hybrid:** This approach uses a combination of the previous two approaches, typically beginning with a data driven risk formula to create a preliminary list of high-risk crossings relying on the judgment of department staff and coordination with stakeholders to select projects within this list.

[9] Federal Highway Administration & Federal Railroad Administration, *Highway-Railway Grade Crossing Action Plan and Project Prioritization Noteworthy Practices Guide*, November 2016. Retrieved from: https://safety.fhwa.dot.gov/hsip/xings/fhwasa16075/fhwasa16075.pdf

ORDC and PUCO currently employ a hybrid approach, using both data-driven tools as well as extensive coordination with railroads, local highway authorities, and complaints from the general public as sources of identification of potential safety issues.

ORDC and PUCO do not use a custom hazard index formula to prioritize crossings for improvements. Rather, ORDC and PUCO consult the FRA Web-Based Accident Prediction System (WBAPS) ranking.[10] Using the WBAPS ranking as a baseline, crossings are selected using a combination of engineering judgment and identification of projects that can be efficiently combined with compatible planned and programmed transportation infrastructure projects such as roadway reconstruction projects, and through routine coordination with railroads and local roadway authorities.

ORDC and PUCO staff conduct routine field diagnostic reviews of crossings to collect updated crossing characteristic information, identify potential safety issues, and recommend improvements to mitigate identified safety issues. ORDC and PUCO maintain a statewide highway-rail grade crossing inventory database to retain this data.

2.2.2 Evaluation of Grade Crossing Hazard Ranking Models

In 2016, ORDC conducted a study to analyze the hazard ranking model used by rail safety agencies in Ohio to compare highway-railroad grade crossings for safety improvements. The current model has been in use for over two decades. The research team from Ohio University reviewed available literature, interviewed state DOT personnel at eight different states about their experiences using their model, and performed detailed statistical analysis of the different models. After this process, it was determined that there is no evidence to indicate that a different model than the currently used hazard ranking model would provide a superior statistical analysis tool. The Ohio University research team recommended Ohio and other state agencies continue to use the current model.

As part of this plan development process a new proposed hazard index model was developed using more modern statistical techniques. Additionally, an alternative model proposed in a recent Transportation Research Board publication was assessed to determine its potential usefulness. A comparison of the effectiveness of the various models found very close performance between the custom proposed hazard index model and the existing FRA accident prediction model. Given the ease of use and existing trust already established by many years of use of the FRA model, this plan concurs with the recommendation in the Ohio University study that the state should continue to use the FRA model for grade crossing prioritization purposes.

[10] Federal Railroad Administration, Web-Based Accident Prediction System (WBAPS). Retrieved from: https://safetydata.fra.dot.gov/webaps/

It should be noted that under the language in the recently enacted IIJA, the FRA is required to update the current accident prediction model within two years. At that time, Ohio may wish to reevaluate the benefits of various predictive models.

3.0 Data Analysis

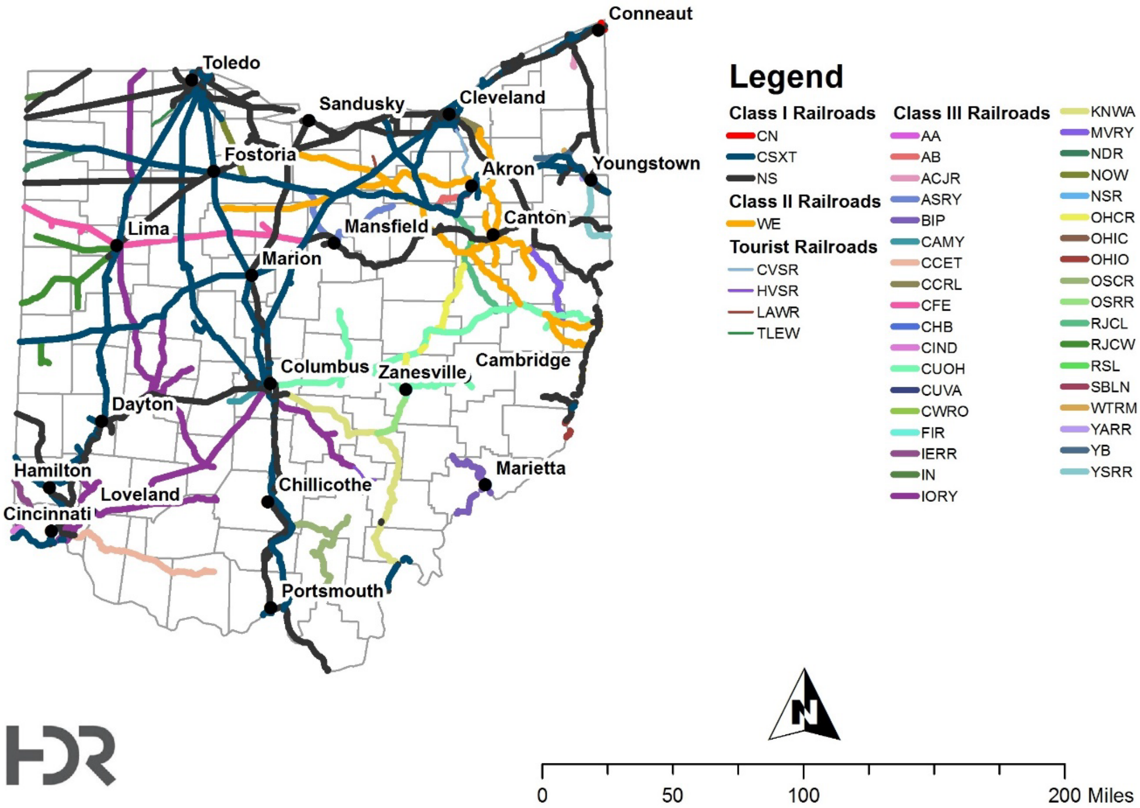
The purpose of this section is to:

- Provide an overview of the ownership and general characteristics of the state rail network, general freight rail traffic flows in terms of average number of trains and tonnage, and highway-rail grade crossings within the State of Ohio;
- Identify and describe data sources available for general evaluation of the state's highway-rail grade crossing environment, related risk factors, and accidents/incidents that have resulted in fatalities, injuries, and accidents; and,
- Present an analysis of available accident/incident data and state highway-rail grade crossing inventory data that evaluates the general highway-rail grade crossing environment statewide in terms of strengths, vulnerabilities, and challenges in highway-rail grade crossing safety.

3.1 State Rail Network Overview

The Ohio state rail network is comprised of 5,803 total rail miles.[11] A map of the state rail network is presented in Figure 5. The most up-to-date information on railroad ownership and route mileage in Ohio is provided in Table 1.

Figure 5 | Ohio Rail Network Map (2021)



Source: Prepared by HDR using FRA geospatial and ORDC/PUCO data) (https://fragis.fra.dot.gov/gisfrasafety/)

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[11] State of Ohio Rail Plan, January 2019

Table 1 | Ohio Railroad Ownership and Route Mileage

Railroad	Reporting Mark	Miles Operated
Class I Railroads		**3,000**
Canadian National Railway	CN	4
CSX Transportation, Inc.	CSX	1364
Norfolk Southern Corporation	NS	1632
Class II Railroads		**392**
Wheeling and Lake Erie	WE	392
Class III Railroads		**1,691**
Ann Arbor Railroad	AA	5
Akron Barberton Cluster Railway	AB	43
Ashtabula, Carson & Jefferson Railroad	ACJR	6
Ashland Railway	ASRY	65
Belpre Industrial Parkersburg Railroad	BIP	40
Cleveland and Cuyahoga Railway	CCRL	33
Camp Chase Railway	CAMY	19
Cincinnati Eastern Railroad	CCET	69
Chicago, Fort Wayne & Eastern	CFE	123
Cleveland Harbor Belt	CHB	2
Central Railroad of Indiana	CIND	21
Columbus & Ohio River Railroad	CUOH	218
Cleveland Works Railway	CWRO	10
Flats Industrial Railroad	FIR	3
Grand River Railway	GRRW	3
Indiana Eastern Railroad	IERR	14
Indiana Northeastern Railway Company	IN	11
Indiana & Ohio Railway	IORY	324
Kanawha River Railroad	KNWA	116

Railroad	Reporting Mark	Miles Operated
Mahoning Valley Railway	MVRY	50
Napoleon, Defiance & Western Railway	NDW	49
Northern Ohio & Western Railway	NOW	25
Newburgh & South Shore Railway Company	NSR	5
Ohio Central Railroad	OHCR	74
Ohio South Central Railroad	OSCR	64
Ohio Southern Railroad	OSRR	48
Ohio Terminal Railway	OHIO	13
R.J. Corman Railroad	RJCL/RJCW	165
Republic Short Line	RSL	1
Warren & Trumbull Railroad	WTRM	4
Youngstown & Austintown Railroad	YARR	5
Youngstown Belt Railroad	YB	31
Youngstown and Southeastern Railroad	YSRR	32
TOTALS		**5,083**

Source: State of Ohio Rail Plan, January 2019 and ORDC/PUCO staff

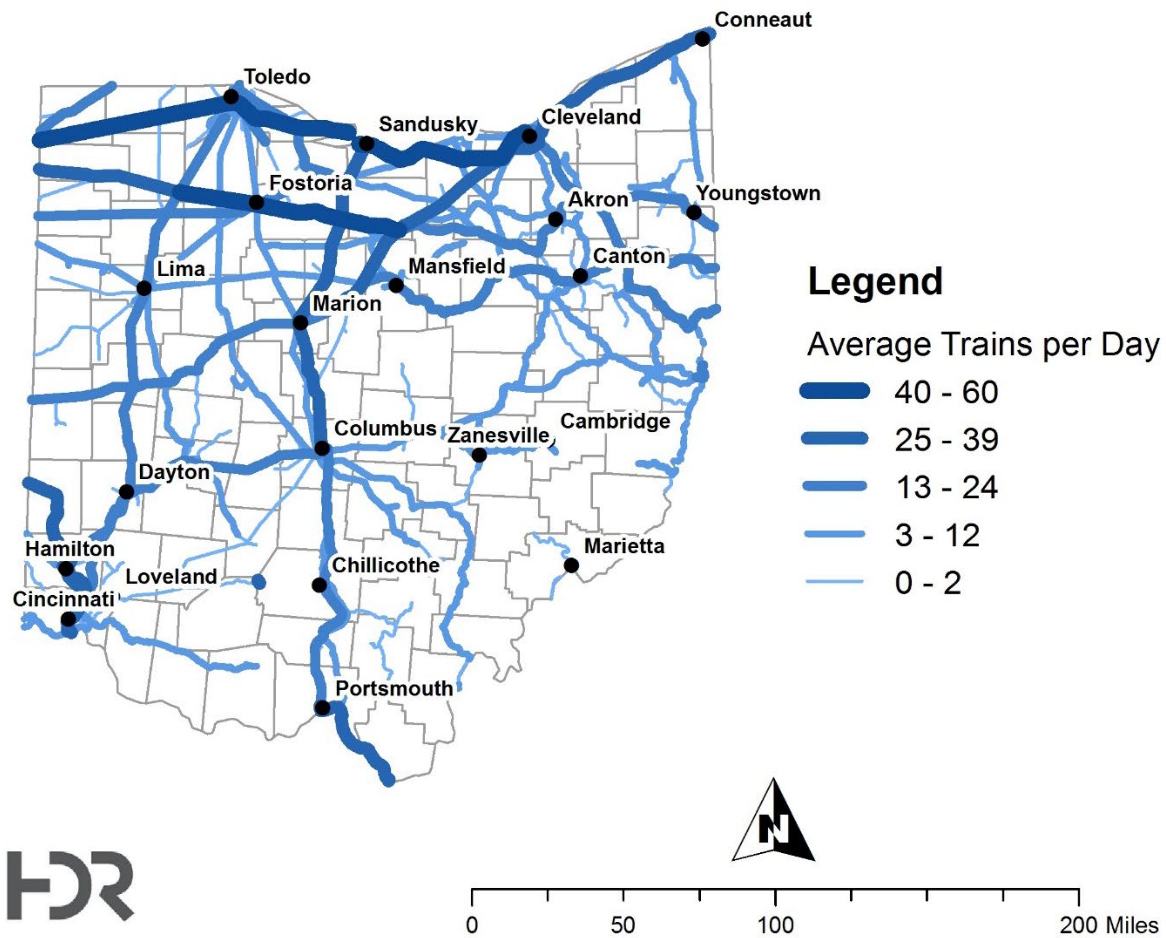
3.2 Overview of Current and Potential Future Rail Traffic Volumes on the State Rail Network

This section provides a general overview of freight volumes and movement by rail in Ohio to provide additional context of the state rail network and to present additional details on potential conditions and safety risk factors at highway-rail grade crossings statewide.

As shown in Figure 6:

- The highest number of trains per day (up to 60 trains per day) is observed on:
  - The NS Chicago Line between the Indiana/Ohio border and Cleveland via Toledo and the Cleveland Line continuing east from Cleveland to the Ohio/Pennsylvania border.
  - The CSX Garrett, Willard, and Greenwich subdivisions between the Indiana/Ohio border and Cleveland via Fostoria.
- High rail traffic volumes are also observed on the NS Sandusky District between Sandusky and Columbus.
- Ohio's Class II and Class III railroads generally have a lower number of average daily train movements, as compared to the Class I railroads.

Figure 6 | Average Trains per Day by Rail Line (2021)



Source: Prepared by HDR using FRA geospatial data (https://fragis.fra.dot.gov/gisfrasafety/)

3.3 State Highway-Rail Grade Crossing Environment Overview

The state rail network intersects with a comprehensive network of public and private roadways in rural and urban areas statewide. The types of highway- or pathway-rail intersections include:

- **Public At-Grade Crossing** – An at-grade crossing of a public roadway with a rail line. Public grade crossings are roadways that are under the jurisdiction of, and maintained by, a public highway authority (e.g., city or village, county, township, or state).
- **Grade Separated Crossing** – An overpass or underpass structure that crosses over or under a rail line, usually eliminating a previous at-grade crossing. Grade separated crossings are typically for public roadways but can also be for private roadways in select instances.
- **Private At-Grade Crossing** – An at-grade crossing of a private roadway with a rail line. Private grade crossings are on privately owned roadways, such as on a farm, ranch, or in an industrial area, and are intended for use by the owner or by the owner's invitees. A private crossing is not intended for public use and is not maintained by a public highway authority. Additionally, private grade crossings are governed by agreements between the railroad and the private crossing owner. The state does not have regulatory oversight of private crossings and cannot expend Section 130 or other federal highway safety funds at private crossings.
- **Pathway Grade Crossing** – An at-grade crossing of a public footpath or recreational trail with a rail line that is not shared with a public or private roadway. These crossings are primarily intended for use by non-motorized transportation only.

Table 2 identifies the current number of active highway-rail grade crossings by type in Ohio, including pathway grade crossings. Ohio has approximately 5,658 public highway-rail grade crossings. Nearly 70 percent of Ohio's public highway-rail grade crossings are equipped with active warning devices consisting of train-activated flashing light signals – with or without automatic gates.

Table 2 | Highway-Rail Grade Crossings by Type in Ohio (2021)

Highway-Rail Grade Crossing Type	Number
Total At-Grade Crossings	8,672
Public At-Grade Crossings	5,658
Public At-Grade Crossings with Passive Warning Devices	1,708
Public At-Grade Crossings with Active Warning Devices	3,950
Private At-Grade Crossings	2,989
Pathway Grade Crossings	25

3.4 Data Sources

The following sources were used to support the analysis of the highway-rail grade crossing environment, related risk factors, and accident/incident and statewide inventory data for the development of this SAP:

- FRA Accident/incident Data for the ten-year period, 2011 through 2020 inclusive[12]
- FRA Highway-Rail Grade Crossing Inventory[13]
- Ohio Railroad Information System[14]

ORDC and PUCO maintain highway-rail grade crossing inventory data for the State of Ohio, known as the Ohio Railroad Information System. ORDC and PUCO actively update and maintain the crossing inventory through routine field inspections and diagnostic reviews, as well as through ongoing coordination with relevant stakeholders.

[12] Federal Railroad Administration, Accident/Incident Data as Reported by Railroads. Retrieved from: https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/on_the_fly_download.aspx
[13] Federal Railroad Administration, Highway-Rail Grade Crossing Inventory. Retrieved from: https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/DownloadCrossingInventoryData.aspx
[14] Public Utilities Commission of Ohio, Ohio Railroad Information System. Retrieved from: https://gradecrossings.puco.ohio.gov/search

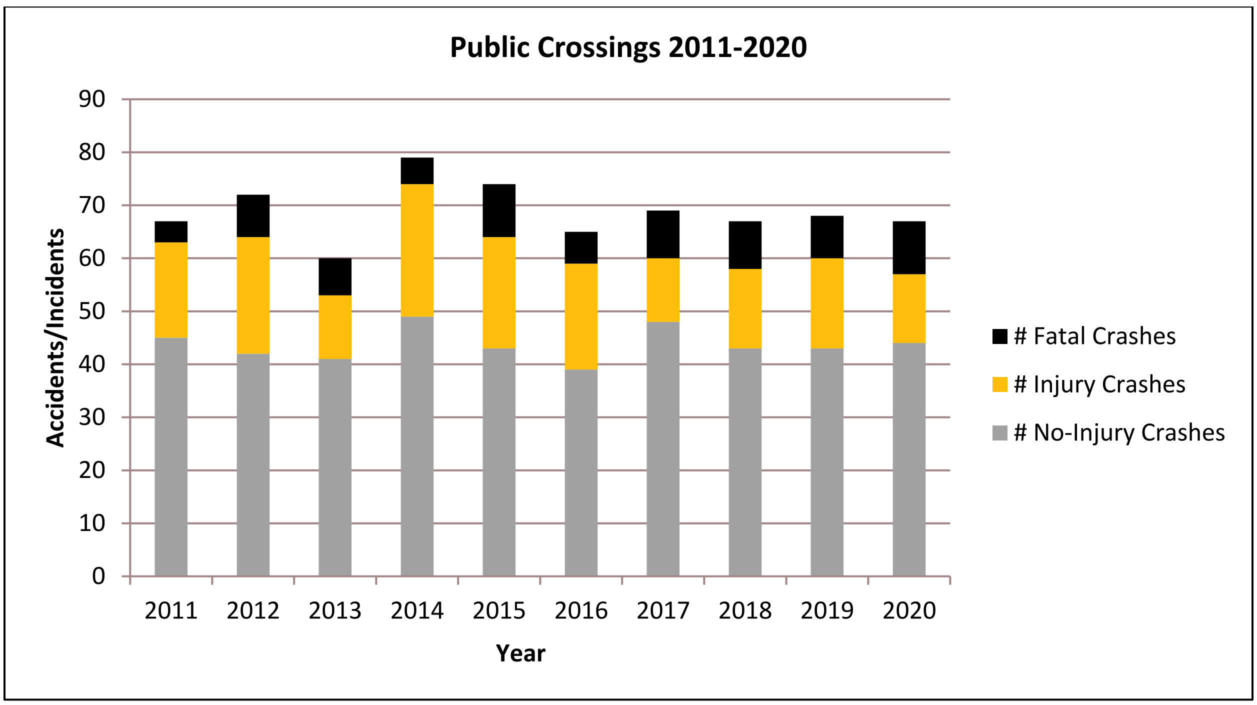
3.5 Ten Year Trends (2011 through 2020)

This section presents the results of a robust analysis of ten years of available accident/incident data for the years 2011 and 2020 inclusive for state highway-rail grade crossing inventory data. It evaluates the general highway-rail grade crossing environment statewide in terms of strengths, vulnerabilities, and challenges in highway-rail grade crossing safety. A total of 783 highway-rail accidents/incidents occurred in Ohio over the years 2011 through 2020. Of those, 688 accidents/incidents occurred at public highway-rail grade crossings, while the remaining 95 accidents/incidents occurred at private highway-rail grade crossings. Only public highway-rail and pathway grade crossings are included in this analysis.

3.5.1 Accident/Incident Severity

Figure 7 below shows the ten-year accident/incident trend at public highway-rail grade crossings, grouped by severity (those resulting in a fatality, those resulting in injuries [non-fatal], and those with property damage only [PDO – no injuries or fatalities]).

Figure 7 | Ohio Highway-Rail Accidents/Incidents by Severity



3.5.2 Accident/Incident Frequency Trends

Figure 8 below shows the ten-year trend line of total accidents/incidents at public highway-rail grade crossings in Ohio, while Figure 9 below shows the national trend. Both the national and Ohio trend lines show very little change in the number of annual accidents/incidents over this time period.

Figure 8 | Ohio Highway-Rail Accidents/Incidents per Year Ten-Year Trend Line

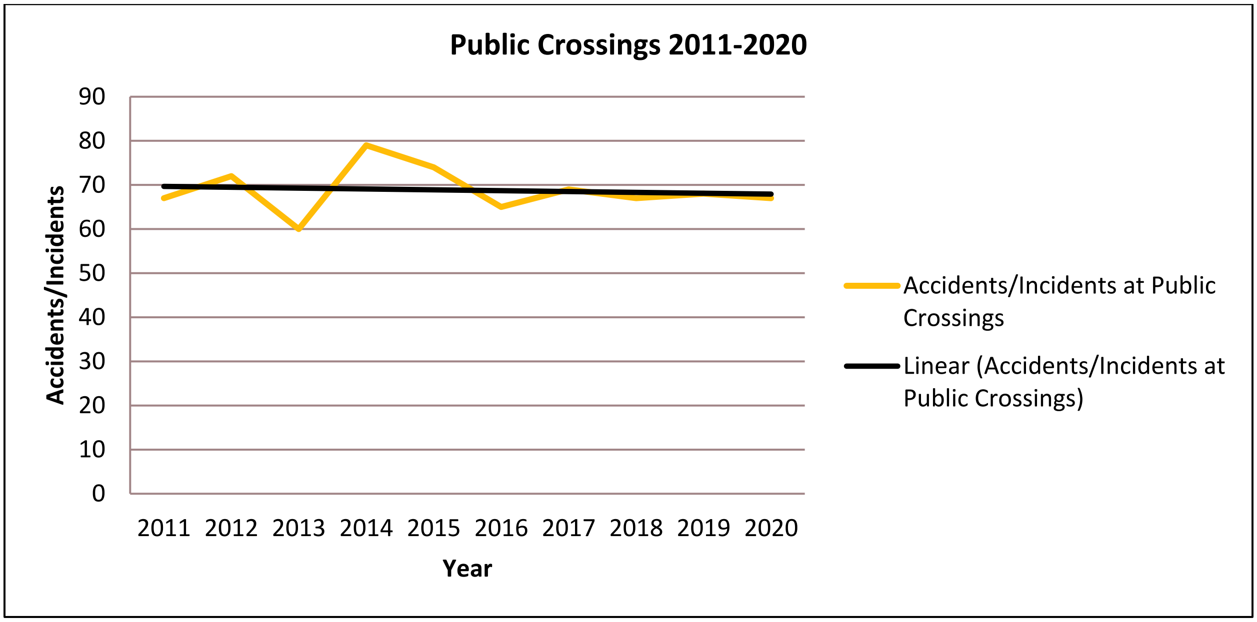
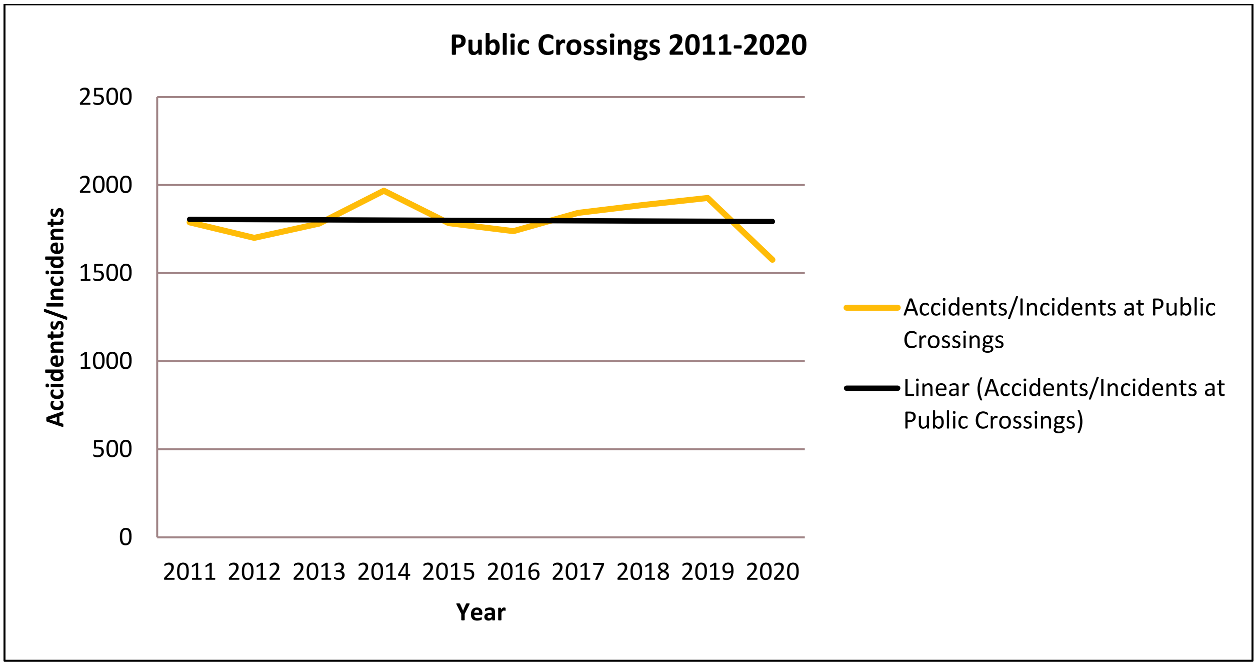


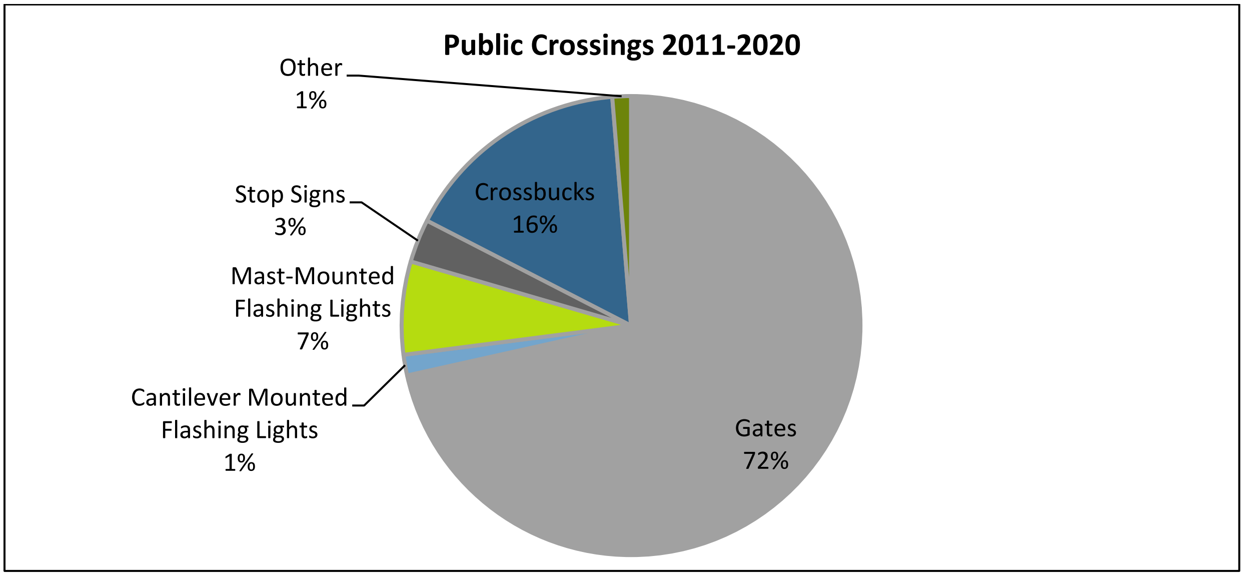
Figure 9 | U.S. Highway-Rail Accidents/Incidents per Year Ten-Year Trend Line



3.5.3 Accidents/Incidents by Crossing Protection Type

Figure 10 below illustrates the type of crossing protection or warning device installed at crossings at the time when accidents/incidents occurred. Some highway-rail grade crossings that have experienced accidents/incidents have since been upgraded with more advanced warning devices or have been permanently closed.

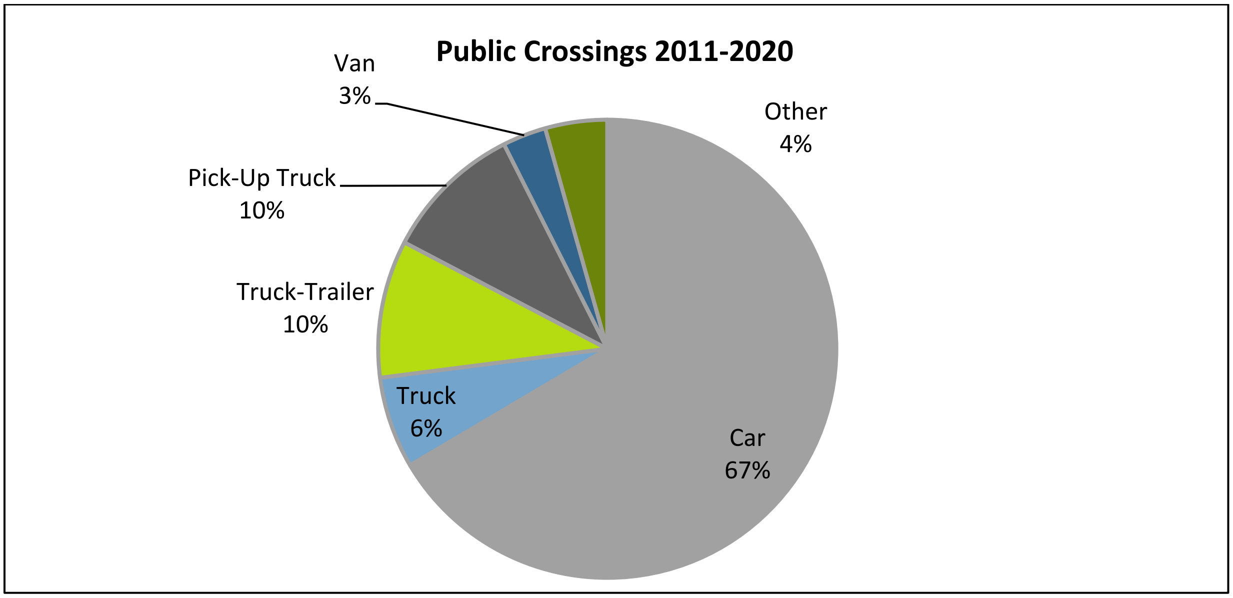
Figure 10 | Ohio Highway-Rail Accidents/Incidents by Crossing Protection Type (At the Time of the Incident)



3.5.4 Accidents/Incidents by Vehicle Type

Figure 11 below shows the distribution of vehicle types in recorded accidents/incidents.

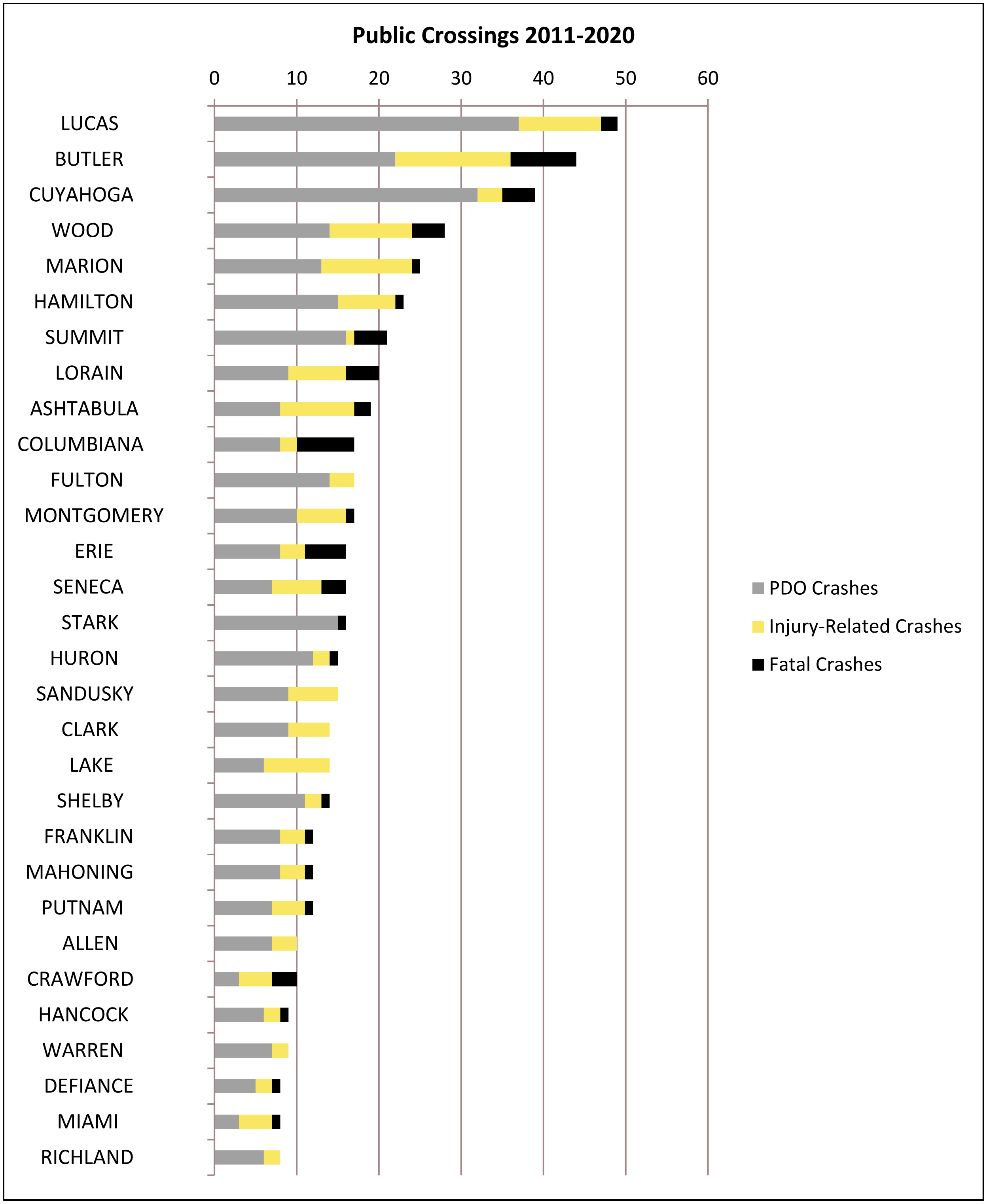
Figure 11 | Ohio Highway-Rail Accidents/Incidents by Vehicle Type



3.5.5 Accidents/Incidents by County

Figure 12 below shows the distribution of highway-rail accidents/incidents by county.

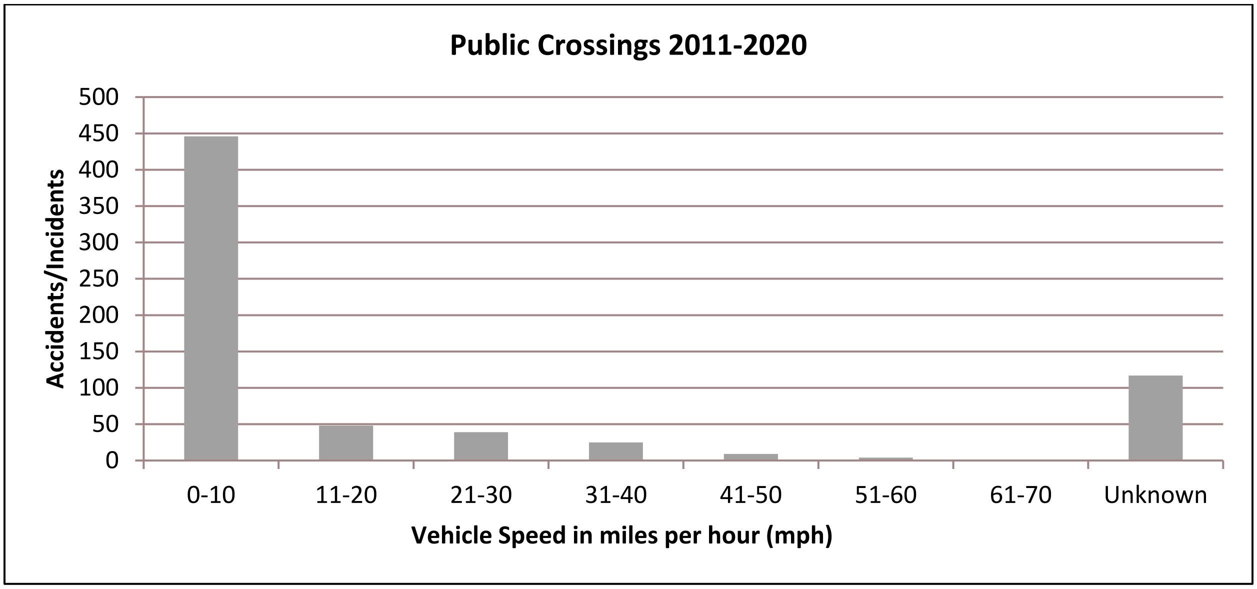
Figure 12 | Ohio Highway-Rail Accidents/Incidents by County (Top-30)



3.5.6 Accidents/Incidents by Vehicle Speed

As shown in Figure 13 below, most accidents/incidents involve a low vehicle speed, including stopped vehicles and vehicles that braked but failed to yield to an oncoming train.

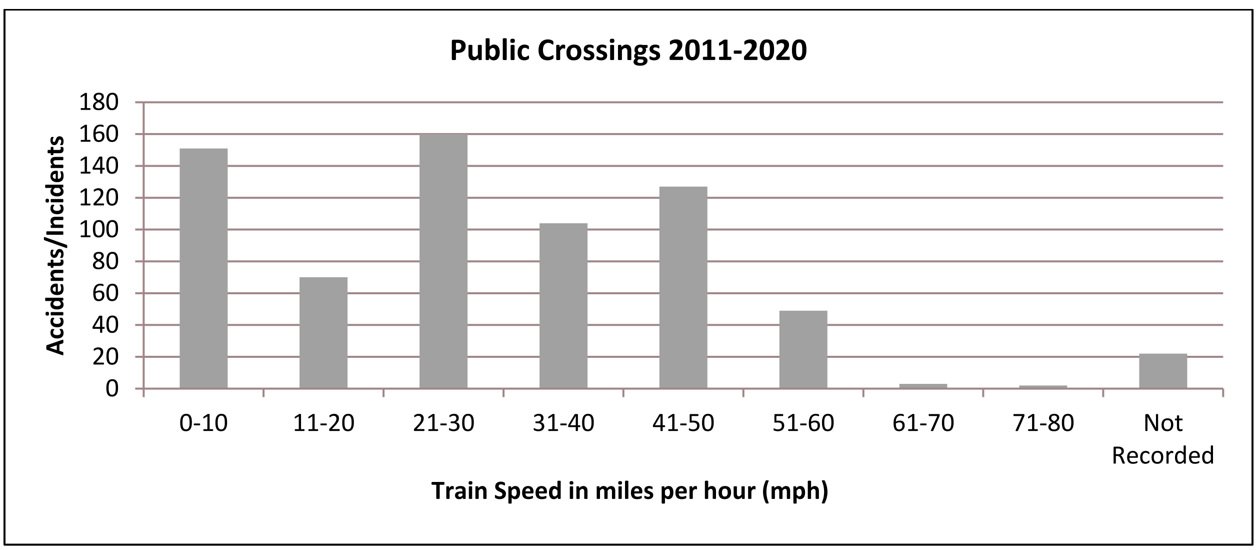
Figure 13 | Ohio Highway-Rail Accidents/Incidents by Vehicle Speed



3.5.7 Accidents/Incidents by Train Speed

Figure 14 below shows the recorded train speed for accidents/incidents. The prevalence of low-speed incidents may indicate situations where highway users are attempting to beat a slow-moving train or are failing to stop when a crossing is occupied by a standing train. High-speed incidents often involve vehicles stopped or stalled on crossings, or vehicles driving around gates.

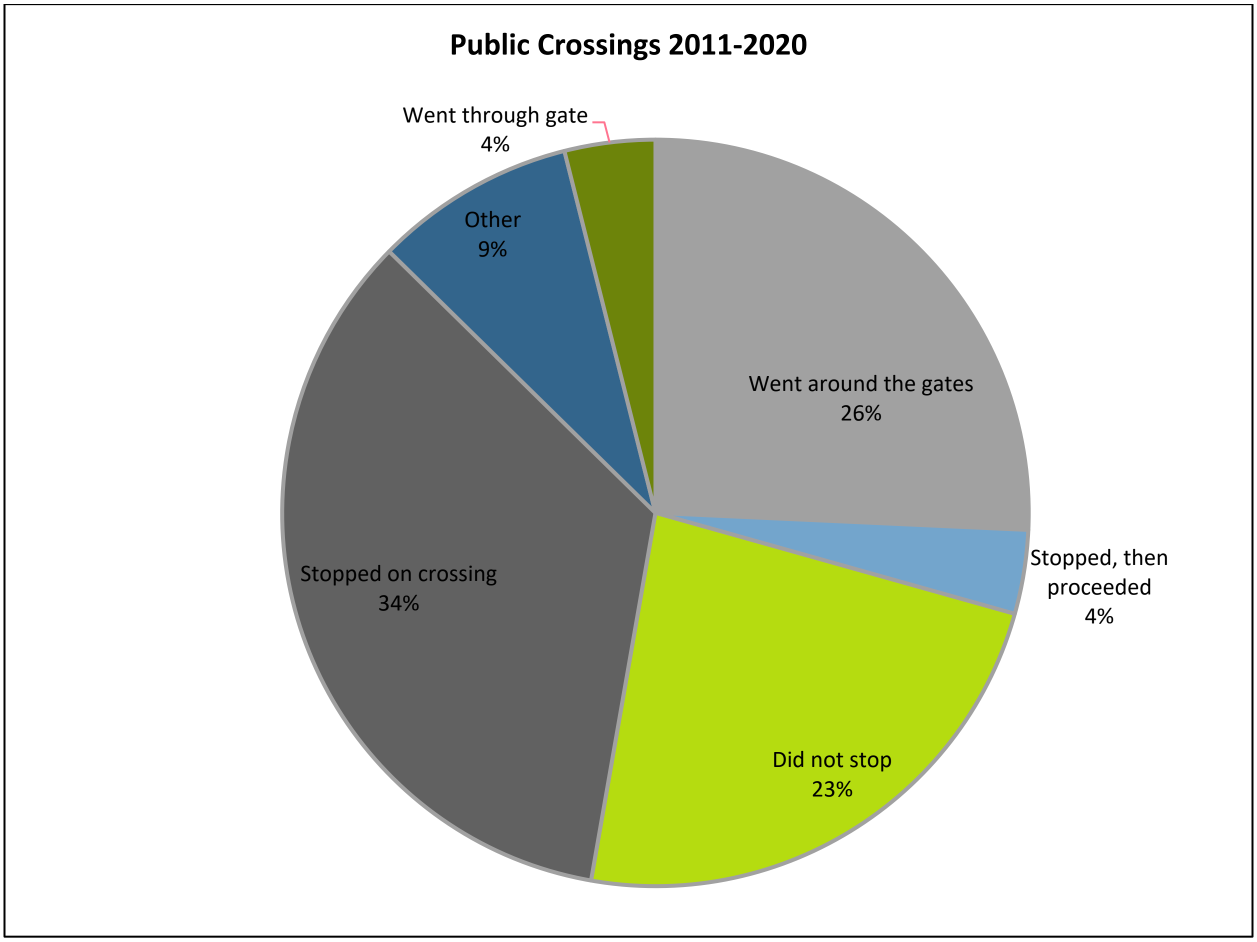
Figure 14 | Ohio Highway-Rail Accidents/Incidents by Train Speed



3.5.8 Accidents/Incidents by Driver Behavior Type

Figure 15 below shows the distribution of recorded driver behaviors that contributed to accidents/incidents. While vehicles stopped or stalled on a crossing make up over a third of accidents/incidents, most accidents/incidents are due to drivers going through or around gates or otherwise not stopping for the train.

Figure 15 | Ohio Highway-Rail Accidents/Incidents by Driver Behavior Type



3.5.9 Accidents/Incidents by Time of Day and Month

Table 3 below shows the prevalence of accidents/incidents at different times of day during different months of the year. Higher numbers of accidents/incidents are occurring in Ohio during winter months and at night.

Table 3 | Ohio Highway-Rail Accidents/Incidents by Time of Day and Month (Public Crossings, 2011 to 2020)

Time	January	February	March	April	May	June	July	August	September	October	November	December	Total	
Midnight - 3:00 AM	8	8	6	11	6	7	7	9	8	10	4	13	97	14.1%
3:00 AM - 6:00 AM	5	6	5	3	3	7	7	10	6	9	6	6	73	10.6%
6:00 AM - 9:00 AM	7	5	9	4	6	4	3	3	6	8	4	11	70	10.2%
9:00 AM - 12:00 PM	7	3	11	2	6	7	14	6	2	11	3	3	75	10.9%
12:00 PM - 3:00 PM	9	9	5	6	4	8	11	5	4	4	9	9	83	12.1%
3:00 PM - 6:00 PM	17	6	4	7	8	5	5	8	6	7	7	6	86	12.5%
6:00 PM - 9:00 PM	8	6	9	7	4	6	5	7	9	8	8	9	86	12.5%
9:00 PM - Midnight	6	14	9	8	11	9	8	10	11	6	10	16	118	17.2%
Total	67	57	58	48	48	53	60	58	52	63	51	73	688	100.0%
	9.7%	8.3%	8.4%	7.0%	7.0%	7.7%	8.7%	8.4%	7.6%	9.2%	7.4%	10.6%		

Figure 16, Figure 17, and Figure 18 below show the accident/incident distribution by weather, roadway conditions, and visibility, respectively. The majority of accidents/incidents are occurring during clear weather, and dry roadway conditions. Of note is that slightly more highway-rail grade crossing accidents/incidents in Ohio occur at night than during daylight hours.

Figure 16 | Ohio Highway-Rail Accidents/Incidents by Weather

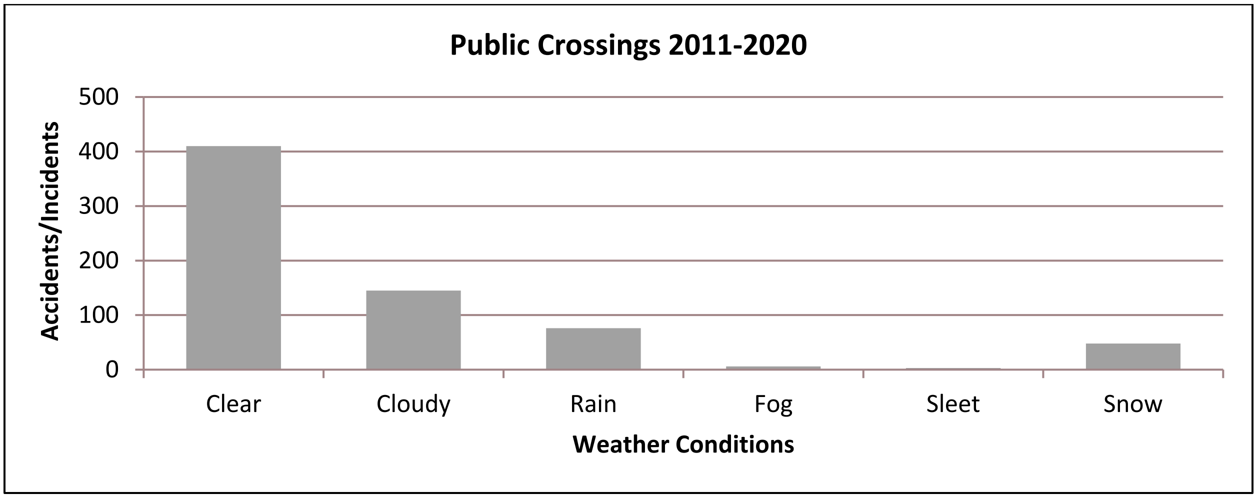


Figure 17 | Ohio Highway-Rail Accidents/Incidents by Roadway Conditions

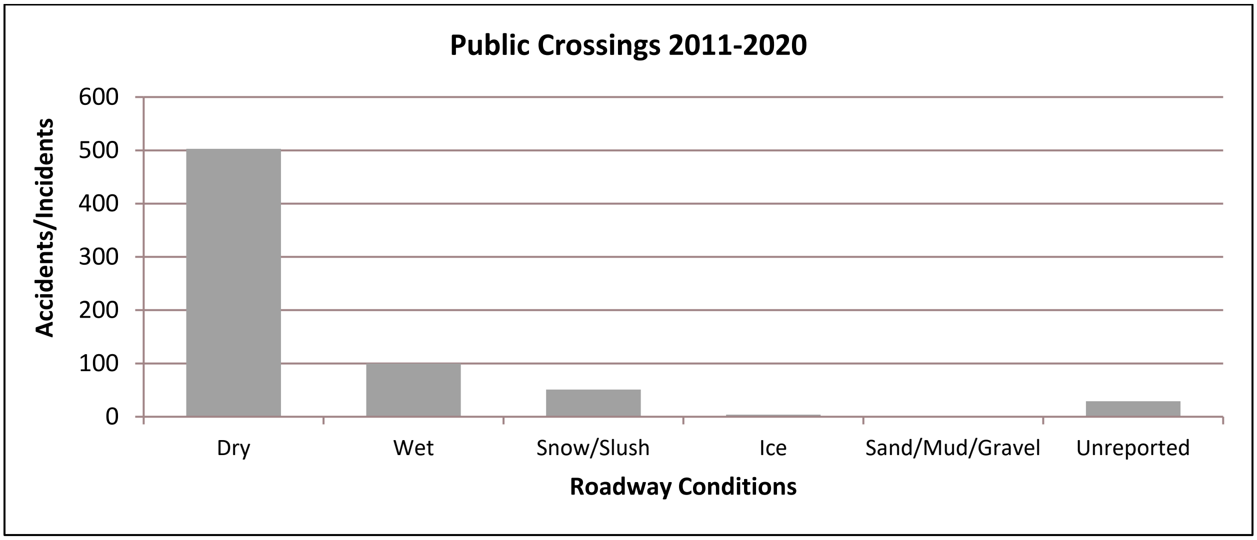
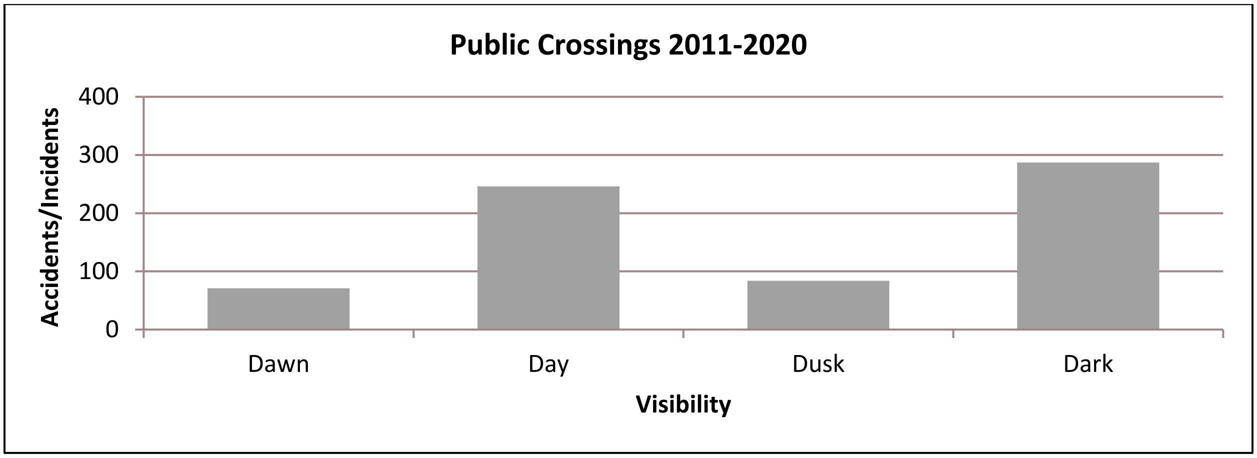


Figure 18 | Ohio Highway-Rail Accidents/Incidents by Visibility



3.6 National Comparisons

A series of charts were developed comparing the distribution of various accident/incident types for Ohio compared to all other states in the U.S. The purpose of this exercise was to identify those characteristics that pose unique challenges or issues for Ohio grade crossing safety. This exercise can also help to guide the development of targeted solutions. The comparison charts were developed using the most recent five years of accident/incident data (2016 through 2020). The figures are also divided into separate distributions for crossings with active warning devices installed and those with only passive warning devices installed.

The first example shows a comparison of the distribution of accidents/incidents by highway vehicle type (Figure 19). For both warning device categories, the auto category comprises the largest category of vehicle type. This category includes most passenger vehicles but does not include pickup trucks. Compared to other states, Ohio has much higher proportions of auto-related accidents/incidents with approximately 60 percent being of this type. The proportions for nearly all other vehicle types are lower in Ohio compared to other states.

Notably, for other states, pedestrian-related accidents/incidents are the second most common highway user type. While the distribution of pedestrian-related accidents/incidents is lower in Ohio, it is important that pedestrian issues and solutions be recognized specifically in this document in light of feedback received during the stakeholder engagement process and ongoing efforts by the FRA to emphasize the importance of pedestrian safety.

Figure 19 | Ohio vs. National Accidents/Incidents by Vehicle Type (2016 to 2020)

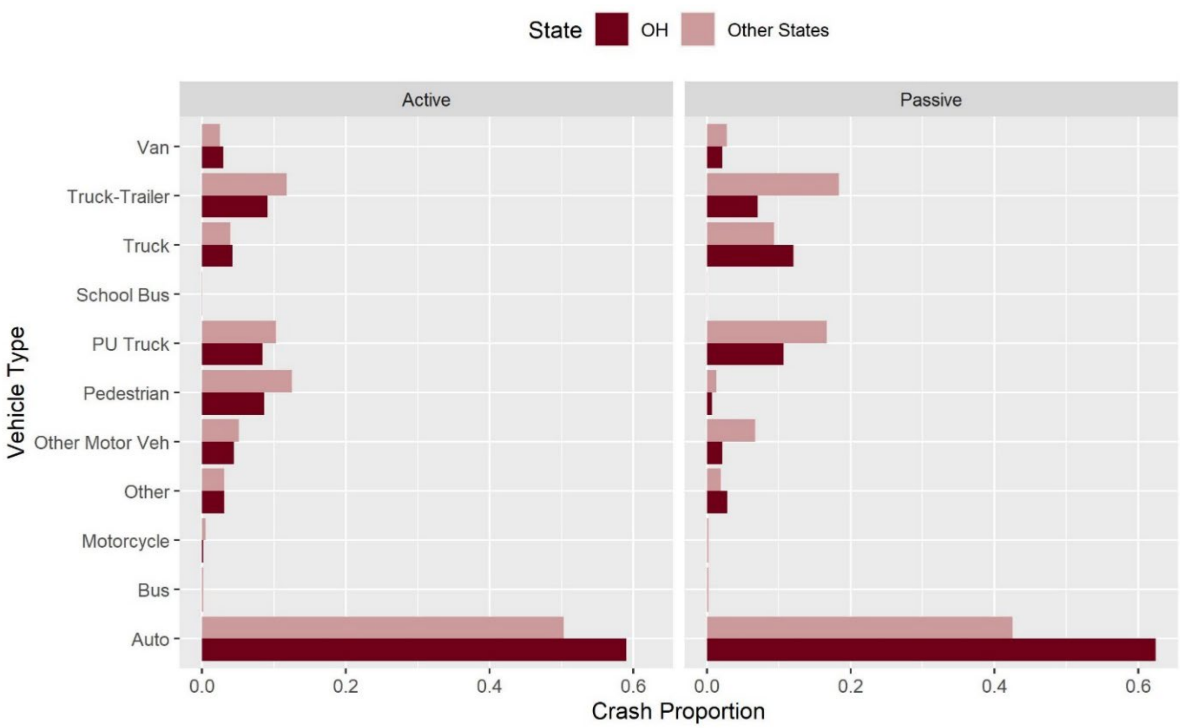


Figure 20 shows the distribution of accidents/incidents by the contributing motorist action. Under crossings with active warning devices installed, the proportion of motorist actions in the "stopped on crossing" and "drove around gate" categories are both higher than other states. Combined, these two motorist actions account for more than two thirds of all accidents/incidents at crossings with active warning devices. The "drove around gate" motorist action is particularly concerning given the high proportion of public crossings in Ohio that are equipped with gates and lights. Special focus will need to be given to identify potential safety measures that can address these issues including medians, four-quadrant gates, and additional education and enforcement measures.

The figure also shows a very high proportion of accidents/incidents at passively protected crossings within the "did not stop" category. Nearly three-quarters of all accidents/incidents at passively protected crossings are of this type. The risk assessment conducted in the next section will place additional focus on these motorist action categories to identify potential contributing factors. There can be many assumptions made about driver behavior factoring into accidents/incidents at grade crossings. However, these factors will be difficult to measure in an objective manner given that they are not recorded in the current FRA accident/incident records.

Figure 20 | Ohio vs. National Accidents/Incidents by Motorist Action (2016 to 2020)

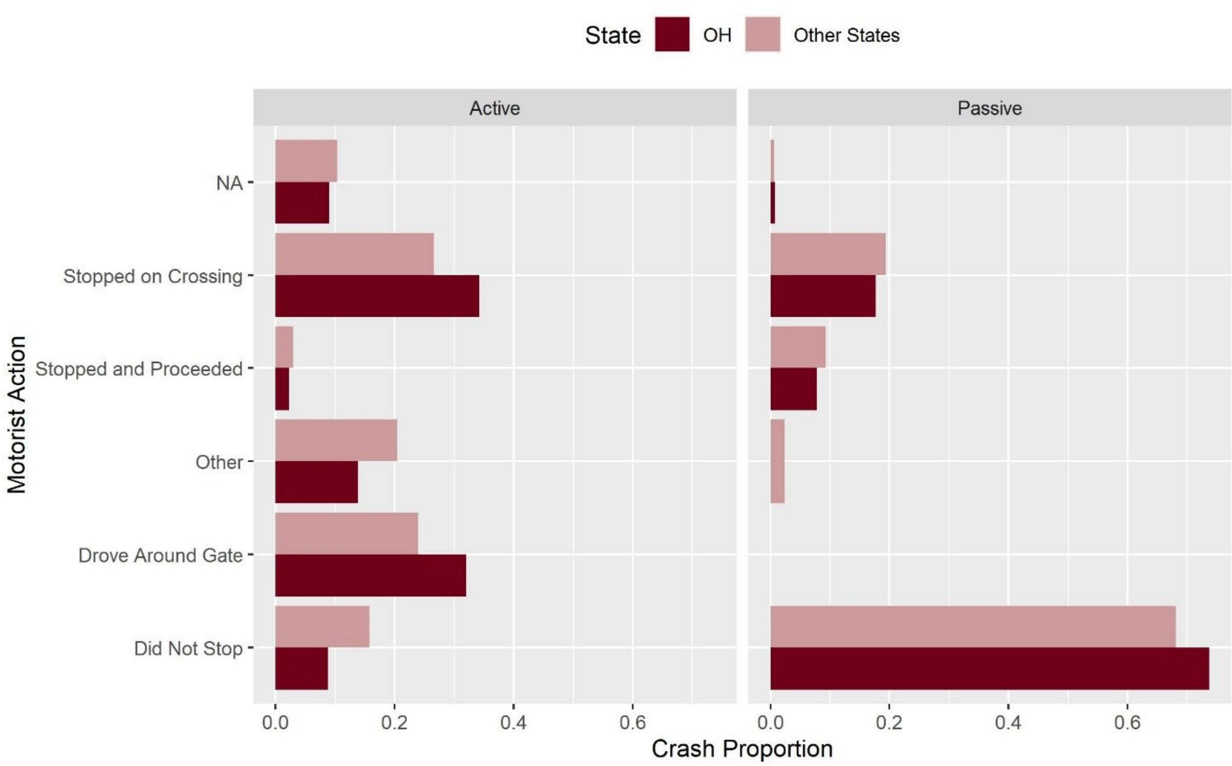
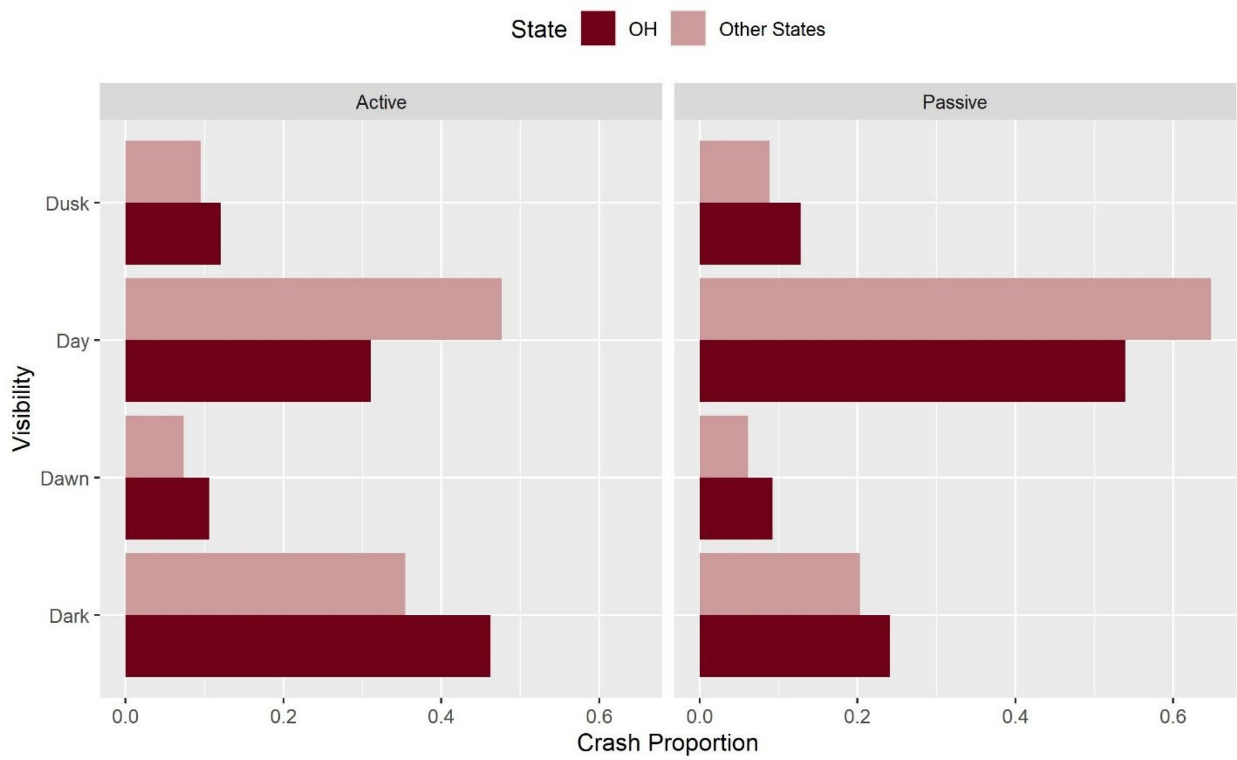


Figure 21 shows the distribution of accidents/incidents by visibility conditions. In Ohio, the distribution of accidents/incidents is higher for dusk, dawn, and dark conditions compared to other states. In fact, crashes at dark make up more than 45 percent of all accidents/incidents at actively protected crossings compared to approximately 35 percent for other states. Accidents/incidents in this category can sometimes be related to insufficient crossing illumination, leading to more difficult visibility in non-daytime hours. This type of accident/incident will be explored further in the risk assessment section to identify potential correlations with crossing illumination and other crossing characteristics.

Figure 21 | Ohio vs. National Accidents/Incidents by Visibility Conditions (2016 to 2020)



3.7 Identification of Crossings That Have Experienced Recent Accidents/Incidents

3.7.1 Crossings That Have Experienced At Least One Accident/Incident Within the Previous Three Years

Based on a review of available FRA accident/incident data, within the previous three (3) years there were 202 accidents/incidents at public highway-rail grade crossings and 32 accidents/incidents at private highway-rail grade crossings in Ohio.

Table 4 below provides a summary of the public highway-rail grade crossings in Ohio that experienced accidents/incidents during the previous three (3) years, based on information contained within the publicly available FRA accident/incident data.

Table 5 below provides a summary of the private highway-rail grade crossings in Ohio that experienced accidents/incidents within the previous three (3) years, based on information contained within the publicly available FRA accident/incident data.

Table 4 | Public Highway-Rail Grade Crossing Accident/Incident Locations Within Previous Three Years (2018 to 2020)

DOT#	Highway Name	RR	Subdivision	County	Type of Protection[15]
001901B	TWP 100	WE	CAREY	WYANDOT	Crossbucks
001945B	SR 103	WE	CAREY	CRAWFORD	Gates
002017K	GORE ORPHANAGE RD	WE	CAREY	LORAIN	Stop Signs
002090H	GUILFORD BLVD	WE	AKRON	MEDINA	Gates
002096Y	BONETA RD	WE	AKRON	SUMMIT	Gates
141707T	SALT SPRINGS RD	CSX	NEW CASTLE	TRUMBULL	Gates
141992U	POWDER MILL RD	CSX	NEW CASTLE	PORTAGE	Gates
142005B	BAILEY RD	CSX	NEW CASTLE	SUMMIT	Gates
142007P	BROAD BLVD	CSX	NEW CASTLE	SUMMIT	Gates
142037G	MAIN ST	CSX	NEW CASTLE	WAYNE	Gates
142183M	PERRY ST	CSX	WILLARD	SENECA	Gates
142191E	WALL ST	CSX	WILLARD	SENECA	Gates
142234V	POPLAR ST	CSX	FOSTORIA	SENECA	Gates
142246P	TR261	CSX	WILLARD	SENECA	Gates
142270R	SOUTH TARR ST	CSX	WILLARD	WOOD	Gates
142348H	HIRE RD	CSX	GARRETT	DEFIANCE	Gates
142352X	SQUIER ST	CSX	GARRETT	DEFIANCE	Gates
142377T	TITTLE RD	CSX	GARRETT	DEFIANCE	Mast-Mounted Flashing Lights

[15] Type of protection as recorded in accident/incident report at time of incident.

DOT#	Highway Name	RR	Subdivision	County	Type of Protection[15]
151011D	FARSON ST	CSX	OHIO RIVER	WASHINGTON	Mast-Mounted Flashing Lights
151321X	PLEASANT-RENNER RD	IORY	MIDLAND	WARREN	Stop Signs
151916D	DAYTON AVE	IORY	MIDLAND	FAYETTE	Mast-Mounted Flashing Lights
151965A	EAST DALTON RD	IORY	MIDLAND	CLINTON	Stop Signs
151976M	SR 28	IORY	MIDLAND	CLINTON	Mast-Mounted Flashing Lights
152351T	KINGS RUN RD	CSX	CINCINNATI TERMINAL	HAMILTON	Gates
152368W	WYOMING AVE	CSX	CINCINNATI TERMINAL	HAMILTON	Gates
152395T	HANOVER ST	CSX	CINCINNATI TERMINAL	BUTLER	Gates
152401U	MAPLE AVE	NS	LAKE	BUTLER	Gates
152406D	HEATON ST	CSX	TOLEDO	BUTLER	Gates
152418X	WAYNE MADISON RD	CSX	TOLEDO	BUTLER	Gates
152420Y	PIERSON RD	CSX	TOLEDO	BUTLER	Gates
152445U	ANDERSON FERRY RD	CSX	INDIANA	HAMILTON	Mast-Mounted Flashing Lights
153930F	S BROADWAY ST	CSX	TOLEDO	MONTGOMERY	Crossbucks
155053D	LINDEN AVE	CSX	TOLEDO	MONTGOMERY	Gates
155184G	CANAL ST	CSX	TOLEDO	MIAMI	Gates
155186V	E MAIN ST	CSX	TOLEDO	MIAMI	Gates
155201V	RUSK RD	CSX	TOLEDO	MIAMI	Gates
155253M	SR274	CSX	TOLEDO	SHELBY	Gates
155281R	AUGLAIZE ST	CSX	TOLEDO	AUGLAIZE	Gates
155665A	WEST FOURTH ST	CSX	TOLEDO	ALLEN	Gates
155676M	E KIBBY ST	CSX	TOLEDO	ALLEN	Gates
155691P	E FLANDERS AVE	CSX	TOLEDO	ALLEN	Gates
155716H	N 8 RD	CSX	TOLEDO	PUTNAM	Gates
155720X	WILLIAMSTOWN RD	CSX	TOLEDO	PUTNAM	Gates
155721E	SECOND ST	CSX	TOLEDO	PUTNAM	Gates
156051T	DEPOT ST	CSX	MARIETTA	WASHINGTON	Stop Signs
156066H	GRAVEL BANK RD	CSX	MARIETTA	WASHINGTON	Crossbucks
228676S	PENNSYLVANIA AVE	CSX	COLUMBUS	DELAWARE	Gates
228732W	SOUTH EAST ST	CSX	COLUMBUS	MARION	Gates
228765J	N PATTERSON ST	CSX	COLUMBUS	WYANDOT	Gates
228825R	SOUTH ST	CSX	PEMBERVILLE	WOOD	Gates
228843N	GENOA RD	CSX	PEMBERVILLE	WOOD	Gates
228850Y	WEST UNION ST	CSX	TOLEDO TERMINAL	WOOD	Crossbucks
232121N	DETROIT AVE	AA	ANN ARBOR SYSTEM	LUCAS	Gates

DOT#	Highway Name	RR	Subdivision	County	Type of Protection[15]
258365X	COUNTY RD M	IORY	DT&I NORTH	FULTON	Crossbucks
258784V	CHAMPION AVE	IORY	DT&I MIDDLE	CLARK	Stop Signs
258786J	NORTH BURNETT RD	IORY	DT&I MIDDLE	CLARK	Stop Signs
261540P	KENTON AVE	CSX	MOUNT VICTORY	MARION	Gates
262064J	POLE-LANE RD	CSX	MOUNT VICTORY	MARION	Gates
262073H	JEFFERSON ST	CSX	MOUNT VICTORY	MARION	Gates
262074P	GREENWOOD ST	CSX	MOUNT VICTORY	MARION	Gates
262420C	EAST 116TH ST	CCRL	MAHONING	CUYAHOGA	Gates
264970K	PIPER RD	ASRY	SYSTEM	RICHLAND	Crossbucks
472004E	CR9/MYERS RD	NS	PITTSBURGH	ASHTABULA	Gates
472188G	LS/WEST 111TH ST	NS	PITTSBURGH	CUYAHOGA	Gates
472191P	LS/WEST 116TH ST	NS	PITTSBURGH	CUYAHOGA	Gates
472268A	CR 301/MOORE RD	NS	LAKE	LORAIN	Gates
472291U	LS/WASHINGTON AVE	NS	LAKE	LORAIN	Gates
472352H	SR - 4/STATE ROUTE 4	NS	LAKE	ERIE	Unknown[16]
472402J	SR 53/SR 53	NS	LAKE	SENECA	Gates
472574S	CR 1/STATE LINE RD	NS	LAKE	PAULDING	Gates
473424M	LS/LANE ST	NS	POCAHONTAS	LAWRENCE	Gates
473425U	LS/RIVERSIDE DR	NS	POCAHONTAS	LAWRENCE	Gates
473497X	CR 30/COOK RD	NS	LAKE	SCIOTO	Gates
473546S	WESTFELD RD CR15	WE	BREWSTER	MEDINA	Mast-Mounted Flashing Lights
473662F	MONROE ST	WE	LAKE	HURON	Crossbucks
473672L	CR 177/PORTLAND RD	NS	LAKE	SANDUSKY	Gates
473686U	SR 101/MAPLE ST	NS	LAKE	SANDUSKY	Gates
473709Y	LS/HAYES AVE	NS	LAKE	SANDUSKY	Gates
473711A	US 20 BUS/STATE ST	NS	LAKE	SANDUSKY	Gates
473875R	STARR AVE	NS	DEARBORN	LUCAS	Gates
473883H	LS/PAINE AVE	NS	DEARBORN	LUCAS	Crossbucks
473893N	2844 N SUMMIT ST	AA	ANN ARBOR SYSTEM	LUCAS	Gates
475196J	LS/WOOD ST	NS	FREMONT SW LEAD NW	SANDUSKY	Unknown[17]
476822C	LS/HARDIN ST	NS	WESTERN SPUR	HANCOCK	Stop Signs
476826E	LS/W. LIMA ST	NS	LAKE	HANCOCK	Stop Signs
477034N	ST. ANTHONY RD	RJCW	ST MARYS	MERCER	Crossbucks
481395A	TR 236N/DELANO RD	NS	LAKE	ROSS	Gates

[16] Crossing is identified as grade-separated (railroad under) in the FRA database.
[17] Crossing is identified as grade-separated (railroad over) in the FRA database.

DOT#	Highway Name	RR	Subdivision	County	Type of Protection[15]
481426W	LS/HIGH ST	NS	LAKE	PICKAWAY	Gates
481481W	TWP 114/ORANGE RD	NS	LAKE	DELAWARE	Gates
481482D	TR 1041/FRANKLIN ST	NS	LAKE	DELAWARE	Stop Signs
481487M	CR 98/PEACHBLOW RD	NS	LAKE	DELAWARE	Gates
481536G	SR 95/CENTER ST	NS	LAKE	MARION	Gates
481546M	CR 26/MARSEILLES-GAL	NS	LAKE	MARION	Gates
481551J	SR 294/ROUTE 294	NS	LAKE	CRAWFORD	Gates
481665W	CR 20/BOGART RD	NS	LAKE	ERIE	Gates
502499T	CR 44/APPLE CREEK RD	NS	PITTSBURGH	WAYNE	Gates
502574C	19TH ST	WE	CLEVELAND	STARK	Gates
502730L	CS/8TH ST NE	NS	PITTSBURGH	STARK	Gates
502858G	LS/FIFTEENTH ST	NS	PITTSBURGH	MAHONING	Gates
502873J	LS/NEW GARDEN AVE	NS	PITTSBURGH	COLUMBIANA	Gates
502876E	CR 444A/LINCOLN AVE	NS	PITTSBURGH	COLUMBIANA	Gates
502896R	LS/CHESTNUT ST	NS	PITTSBURGH	COLUMBIANA	Gates
502963H	LS/JOHNSON RD	NS	PITTSBURGH	MAHONING	Gates
502964P	TR 327/HEACOCK RD	NS	PITTSBURGH	MAHONING	Gates
503012K	LS/KEYSTONE ST	NS	PITTSBURGH	STARK	Gates
503022R	SR 183/BURTON LIMA	NS	PITTSBURGH	PORTAGE	Gates
503025L	CR 87/WATERLOO RD	NS	PITTSBURGH	PORTAGE	Gates
503033D	LS/TWINSBURG RD	NS	RAVENNA-DRAWBRIDGE	SUMMIT	Gates
503248C	TWP 469/PICOMA RD	NS	PITTSBURGH	BELMONT	Gates
503566N	NEW MILFORD RD	NS	CLEVELAND LINE	PORTAGE	Gates
503593K	FAIRVIEW AVE	CSX	NEW CASTLE	SUMMIT	Gates
508935A	TOWN/SYLVANIA AVE	NS	DEARBORN	LUCAS	Gates
508943S	US 24/DETROIT AVE	NS	DEARBORN	LUCAS	Crossbucks
509271S	SR 163/HARBOR RD	NS	DEARBORN	OTTAWA	Gates
509454K	LS/WENZ RD	NS	DEARBORN	LUCAS	Gates
509457F	LS/HOLLAND SYLVANIA	NS	DEARBORN	LUCAS	Gates
509470U	CR 84/GARDEN RD	NS	DEARBORN	LUCAS	Gates
509512D	CR E/RD E	NS	DEARBORN	FULTON	Gates
509519B	CR D/RD D	NS	DEARBORN	FULTON	Gates
509522J	LS/BARRE RD	NS	DEARBORN	FULTON	Crossbucks
509535K	SR 2/DEFIANCE ST	NS	DEARBORN	WILLIAMS	Gates
509546X	CR 15/UNION ST	NS	DEARBORN	WILLIAMS	Gates
510668Y	FILLMANS BOTTOM RD	CUOH	PAN	TUSCARAWAS	Crossbucks
513328X	MCKINLEY AVE	CSX	SCOTTSLAWN	FRANKLIN	Gates
513364T	FAIRWOOD AVE	KNWA	SYSTEM	FRANKLIN	Gates
513418W	HWY 37	KNWA	KNWA	FAIRFIELD	Gates
513607T	LIME CITY RD	CSX	TOLEDO BRANCH	WOOD	Gates
513615K	MCCUTCHENVILLE PL	CSX	TOLEDO BRANCH	WOOD	Mast-Mounted Flashing Lights

DOT#	Highway Name	RR	Subdivision	County	Type of Protection[15]
513627E	DUNBRIDGE RD	CSX	TOLEDO BRANCH	WOOD	Mast-Mounted Flashing Lights
513748C	US-68	CSX	TOLEDO BRANCH	HARDIN	Gates
513805N	MORSE RD	CSX	SCOTTSLAWN	UNION	Stop Signs
513832K	INDUSTRIAL PKWY	CSX	SCOTTSLAWN	UNION	Gates
518472G	E MAIN ST	CSX	MOUNT VICTORY	RICHLAND	Gates
518535J	TWINSBURG-ELYRIA	CSX	GREENWICH	LORAIN	Gates
523488N	LS/WITTENBERG ST	NS	LAKE	CLARK	Gates
523504V	LS/BECHTLE AVE	NS	LAKE	CLARK	Gates
523793Y	ERIE ST	CSX	ERIE WEST	LAKE	Gates
523832M	WALTER MAIN RD	CSX	ERIE WEST	ASHTABULA	Gates
523850K	LS/ABBE RD	NS	DEARBORN	LORAIN	Gates
523866G	TR 39/OBERLIN RD	NS	DEARBORN	LORAIN	Gates
523884E	EAGLE ST	CSX	ERIE WEST	ASHTABULA	Gates
523890H	NEW LONDON RD	CSX	ERIE WEST	ASHTABULA	Gates
523910S	SALISBURY RD	CSX	ERIE WEST	ASHTABULA	Gates
523914U	MILL ST	CSX	ERIE WEST	ASHTABULA	Gates
524053X	SR 61/CEYLON RD	NS	DEARBORN	ERIE	Gates
524062W	CR 5/PERKINS AVE	NS	DEARBORN	ERIE	Gates
524070N	LS/MILLS ST	NS	DEARBORN	ERIE	Gates
524223P	HWY/BESSEMER AVE	NS	DEARBORN	CUYAHOGA	Gates
524226K	LS/AETNA RD	NS	RAVENNA-DRAWBRIDGE	CUYAHOGA	Gates
524298N	BROOKPARK RD	CSX	CLEVELAND SHORT LINE	CUYAHOGA	Gates
524339R	LS/GLENDALE AVE	NS	RAVENNA-DRAWBRIDGE	CUYAHOGA	Gates
524340K	LS/GRACE ST	NS	RAVENNA-DRAWBRIDGE	CUYAHOGA	Gates
524644B	CR/ALEX BELL RD	NS	LAKE	MONTGOMERY	Gates
524676G	SR122DA/MANCHESTER	NS	LAKE	BUTLER	Gates
524727P	LS/STATION AVE	NS	LAKE	HAMILTON	Gates
524736N	CITY/MAPLE ST	NS	LAKE	HAMILTON	Gates
524746U	LS/BEECH ST	NS	LAKE	HAMILTON	Gates
524882U	LS/SHARON RD	NS	LAKE	HAMILTON	Gates
524960Y	78TH ST	CSX	CINCINNATI TERMINAL	BUTLER	Gates
524962M	LS/CRESCENTVILLE RD	NS	LAKE	HAMILTON	Gates
525120T	SR142-1	NS	LAKE	MADISON	Gates
525193D	US 127/HAMILTON	NS	LAKE	BUTLER	Gates
525239P	TYLERSVILLE RD	IORY	MASON	WARREN	Mast-Mounted Flashing Lights

DOT#	Highway Name	RR	Subdivision	County	Type of Protection[15]
525267T	ALPINE AVE	IORY	BLUE ASH	HAMILTON	Crossbucks
525295W	HARRIS AVE	IORY	BLUE ASH	HAMILTON	Cantilever Mounted Flashing Lights
527809G	LS/CENTRAL AVE	NS	LAKE	GREENE	Gates
527976F	SR - 41/S. CHARLESTON	NS	LAKE	CLARK	Gates
532686H	TR-237/PEVEE RD	NS	PITTSBURGH	ALLEN	Stop Signs
532710G	L/MAIN ST	NS	LIMA	ALLEN	Crossbucks
538785B	HB HOLE RD	CSX	INDIANAPOLIS LINE	DARKE	Gates
538794A	NORTH CENTER	CSX	INDIANAPOLIS LINE	DARKE	Gates
544661W	MAIN ST	CSX	FORT WAYNE	COLUMBIANA	Gates
544662D	ELM ST	NS	PITTSBURGH	COLUMBIANA	Gates
544717N	LOGANGATE RD	CSX	NON SUBDIVISION	HUBBARD	Gates
544871L	LS/BROADWAY ST	NS	CLEVELAND LINE	ALLIANCE	Gates
840691D	INDEPENDENCE RD	CWRO	SYSTEM	CLEVELAND	Gates
852880J	49TH ST	NSR	MARCY	CUYAHOGA HTS	Gates
867102P	MATZINGER RD	CSX	TOLEDO TERMINAL	TOLEDO	Gates
905282V	NEW YORK AVE	AA	ANN ARBOR RR	TOLEDO	Stop Signs

Table 5 | Private Highway-Rail Grade Crossing Accident/Incident Locations Within Previous Three Years (2018 to 2020)

DOT#	Highway Name	RR	Subdivision	County	Type of Protection[18]
000000A[19]	ZERO TRACK	CWRO	SYSTEM	CUYAHOGA	Unknown
141701C	MCDONALD RD	CSX	NEW CASTLE	TRUMBULL	Mast-Mounted Flashing Lights
151960R	PRIVATE	IORY	MIDLAND	CLINTON	Stop Signs
152009F	PRIVATE	CUOH	MT VERNON	LICKING	Stop Signs
152020F	PRIVATE	CUOH	MT VERNON	LICKING	Stop Signs
473418J	PRIVATE	NS	POCAHONTAS	LAWRENCE	Stop Signs
473820D	PRIVATE	NS	LAKE	OTTAWA	Unknown
477497L	PRIVATE	NS	LAKE	WILLIAMS	Unknown
481357R	PRIVATE	NS	LAKE	ROSS	Stop Signs

[18] Type of protection as recorded in accident/incident report at time of incident.
[19] Note: This crossing ID appears to be incorrect, but the correct ID is unknown.

DOT#	Highway Name	RR	Subdivision	County	Type of Protection[18]
503642E	LARRICK RD	CUOH	CAMBRIDGE	GUERNSEY	Crossbucks
510268F	PRIVATE	NS	DEARBORN	ERIE	Stop Signs
524834E	PRIVATE RD	CIND	SYSTEM	HAMILTON	Unknown
525189N	PRIVATE	NS	LAKE	BUTLER	Stop Signs
525192W	PRIVATE	NS	LAKE	BUTLER	Stop Signs
840695F	719	CWRO	SYSTEM	CUYAHOGA	Crossbucks
840697U	719 CROSSING	CWRO	SYSTEM	CUYAHOGA	Stop Signs
873091T	PRIVATE	NS	LAKE	BUTLER	Mast-Mounted Flashing Lights
904514E	PRIVATE	NS	LAKE	HURON	Stop Signs
923039D	782 TRACK ROAD	CWRO	SYSTEM	CUYAHOGA	Unknown
923042L	ZERO TRACK	CWRO	SYSTEM	CUYAHOGA	Stop Signs
923043T	W DOCK ACCESS RD	CWRO	SYSTEM	CUYAHOGA	Stop Signs
923425N	PRIVATE	NS	DEARBORN	ERIE	Stop Signs
923579Y	PRIVATE	NS	PITTSBURGH	JEFFERSON	Stop Signs
925473K	PRIVATE	NS	PITTSBURGH	COLUMBIANA	Gates
937063V	WALBRIDGE YARD	CSX	TOLEDO TERMINAL	WOOD	Stop Signs
946469D	PRIVATE	NS	LAKE	HAMILTON	Unknown
954113R	PRIVATE	NS	LAKE	FRANKLIN	Unknown
976869D	NATIONAL LIME	CSX	COLUMBUS	WYANDOT	Stop Signs
978642S	CHARTER STEEL	NSR	SYSTEM	CUYAHOGA	Stop Signs

3.7.2 Crossings That Have Experienced Multiple Accidents/Incidents Within the Previous Five Years

Based on a review of available FRA accident/incident data, 43 public highway-rail grade crossings and six private highway-rail grade crossings experienced multiple reported accidents/incidents in Ohio over the previous five-year period.

Table 6 below provides a summary of the public highway-rail grade crossings in Ohio that experienced multiple accidents/incidents during the previous five (5) years, based on information contained within the publicly available FRA accident/incident data.

Table 7 below provides a summary of the private highway-rail grade crossings in Ohio that experienced accidents/incidents within the previous five (5) years, based on information contained within the publicly available FRA accident/incident data.

Table 6 | Public Highway-Rail Grade Crossing Multiple Accident/Incident Locations Within Previous Five Years (2016 to 2020)

DOT#	Highway Name	RR	Subdivision	County	No. of Incidents	Type of Protection[20]
524223P	BESSEMER AVE	NS	DEARBORN	CUYAHOGA	6	Gates
508943S	US 24 DETROIT AVE	NS	DEARBORN	LUCAS	5	Crossbucks
509519B	CR D ARCHBOLD RD	NS	DEARBORN	FULTON	4	Gates
905282V	NEW YORK AVE	CN	SHORELINE	LUCAS	4	Crossbucks
153762C	WEST TEMPLE ST	IORY	MIDLAND	FAYETTE	3	Mast-Mounted Flashing Lights
153930F	S BROADWAY ST	CSX	TOLEDO	MONTGOMERY	3	Crossbucks
509454K	WENZ RD	NS	DEARBORN	LUCAS	3	Gates
509522J	CR C W BARRE RD	NS	DEARBORN	FULTON	3	Crossbucks
141707T	SALT SPRINGS RD	CSX	NEW CASTLE	TRUMBULL	2	Gates
142234V	POPLAR ST	CSX	FOSTORIA	SENECA	2	Gates
152395T	HANOVER ST	CSX	CINCINNATI TERMINAL	BUTLER	2	Gates
152406D	HEATON ST	CSX	TOLEDO	BUTLER	2	Gates
155053D	LINDEN AVE	CSX	TOLEDO	MONTGOMERY	2	Gates
155281R	AUGLAIZE ST	CSX	TOLEDO	AUGLAIZE	2	Gates
155665A	W FOURTH ST	CSX	TOLEDO	ALLEN	2	Gates
155676M	E KIBBY ST	CSX	TOLEDO	ALLEN	2	Gates
155716H	N 8 RD	CSX	TOLEDO	PUTNAM	2	Gates
228850Y	WEST UNION ST	CSX	TOLEDO TERMINAL	WOOD	2	Hwy Traffic Signal
472574S	CR 1 STATE LINE RD	NS	LAKE	PAULDING	2	Gates
472691M	CANNON RD	WE	CLEVELAND	CUYAHOGA	2	Gates
473711A	SR-20/STATE ST	NS	LAKE	SANDUSKY	2	Gates
473875R	STARR AVE	NS	DEARBORN	LUCAS	2	Gates
481482D	TR – 1041	NS	LAKE	DELAWARE	2	Gates
502876E	CR 444A LINCOLN AVE	NS	PITTSBURGH	COLUMBIANA	2	Gates
503013S	SR 225 UNION AVE	NS	PITTSBURGH	STARK	2	Gates
503025L	CR 87 WATERLOO RD	NS	PITTSBURGH	PORTAGE	2	Gates

[20] Type of protection as recorded in accident/incident report at time of incident.

DOT#	Highway Name	RR	Subdivision	County	No. of Incidents	Type of Protection[20]
503593K	FAIRVIEW AVE	CSX	NEW CASTLE	SUMMIT	2	Gates
513251M	CR – 26 PHILLIPI RD	NS	LAKE	FRANKLIN	2	Gates
513832K	INDUSTRIAL PKWY	CSX	SCOTTSLAWN	UNION	2	Gates
523504V	LS/BECHTLE AVE	NS	LAKE	CLARK	2	Gates
523836P	SR 252 COLUMBIA RD	NS	DEARBORN	CUYAHOGA	2	Gates
523850K	ABBE RD	NS	DEARBORN	LORAIN	2	Gates
524062W	CR 5 PERKINS AVE	NS	DEARBORN	ERIE	2	Gates
524190E	EAST 26TH ST	NS	DEARBORN	CUYAHOGA	2	Gates
524232N	CR55 MCCRACKEN RD	NS	DEARBORN	CUYAHOGA	2	Gates
524339R	GLENDALE AVE	NS	RAVENNA-DRAWBRIDGE	CUYAHOGA	2	Gates
524678V	SR 122/FIRST ST	NS	LAKE	BUTLER	2	Gates
524884H	E KEMPER RD	NS	LAKE	HAMILTON	2	Gates
525239P	TYLERSVILLE RD	IORY	MASON	WARREN	2	Hwy Traffic Signal
527809G	LS/CENTRAL AVE	NS	LAKE	GREENE	2	Gates
527976F	SR 41 S CHARLESTON	NS	LAKE	CLARK	2	Gates
544661W	S MAIN ST	NS	PITTSBURGH	COLUMBIANA	2	Gates
544662D	S ELM ST	NS	PITTSBURGH	COLUMBIANA	2	Gates

Table 7 | Private Highway-Rail Grade Crossing Multiple Accident/Incident Locations Within Previous Five Years (2016 to 2020)

DOT#	Highway Name	RR	Subdivision	County	No. of Incidents	Type of Protection[21]
904514E	PRIVATE	NS	LAKE	HURON	4	Hwy Traffic Signal
477497L	PRIVATE	NS	LAKE	WILLIAMS	2	Unknown
923039D	MILL RD	CWRO	SYSTEM	CUYAHOGA	2	Stop Signs
923042L	C1	CWRO	SYSYEM	CUYAHOGA	2	Stop Signs
923043T	480 RD	CWRO	SYSTEM	CUYAHOGA	2	Stop Signs
923425N	PRIVATE	NS	DEARBORN	ERIE	2	Stop Signs

4.0 Risk Assessment

The purpose of this section is to:

- Perform a conceptual risk assessment of the statewide highway-rail grade crossing network in Ohio through an analysis of the statewide accident/incident and safety data, consideration of trends, and evaluation of public and financial impacts. The assessment will also consider where focused attention and prioritized investment could potentially make a positive impact by reducing accidents/incidents and related public consequences statewide.
- Identify areas with highway-rail grade crossing safety needs and challenges statewide for further consideration by stakeholders during development of this SAP.
- Identify and describe strategies that have the greatest potential to focus resources that improve safety, minimize deaths and life-changing injuries, and mitigate challenges at highway-rail grade crossings. These strategies will follow the "4 E's" of highway-rail grade crossing safety: **E**ngineering, **E**ducation, **E**nforcement, and **E**mergency services – and will consider effective and affordable countermeasures that can be deployed for site-specific locations or widely at numerous highway-rail grade crossings statewide.

[21] Type of protection as recorded in accident/incident report at time of incident.

4.1 Foundations and Methodology

4.1.1 Exposure Index

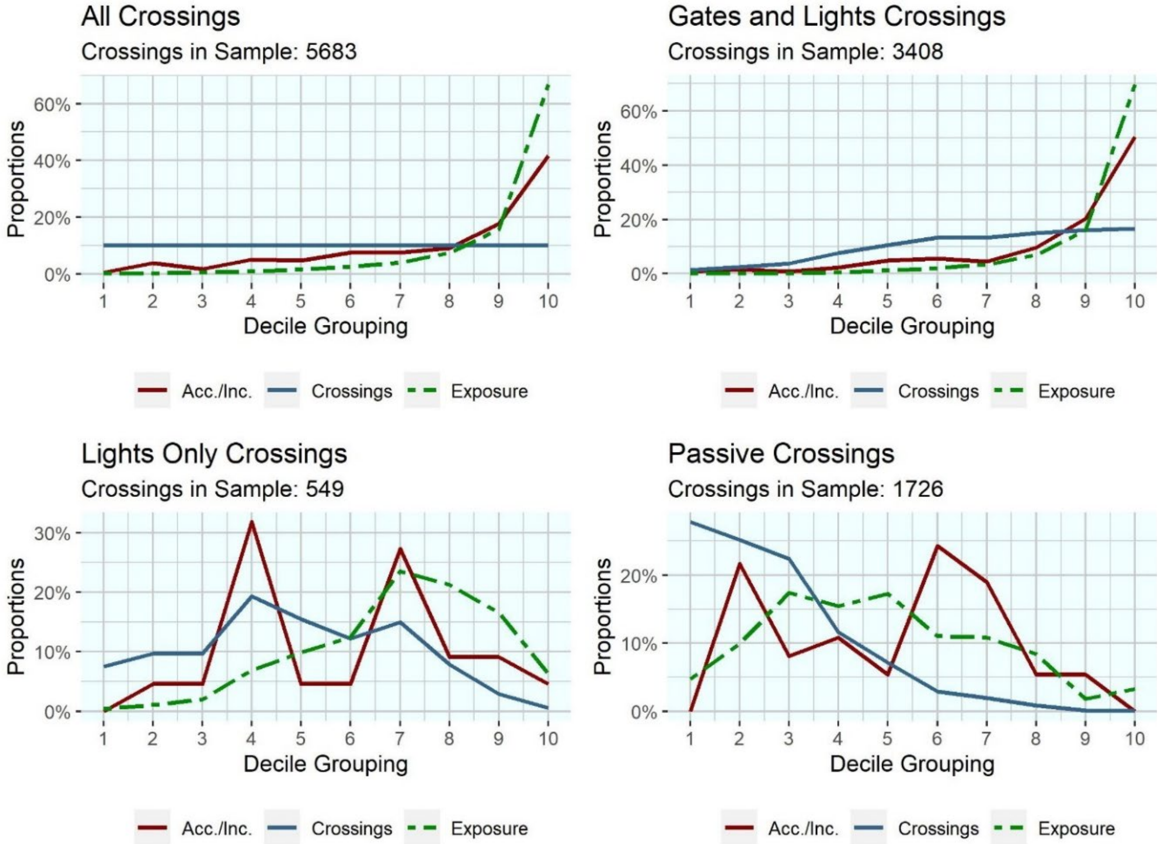
One of the key foundations of this analysis is an understanding of the relationship between exposure index (i.e., highway AADT multiplied by number of trains per day) and highway-rail grade crossing accidents/incidents (crashes). Within nearly every facet of transportation safety analysis, crashes are assessed not only by their raw count, but by a crash rate normalized by the amount of traffic using a roadway segment or entering at intersection. Highway-rail grade crossing crashes are unique in that they are dependent on the presence of both highway vehicles and trains for a collision to occur. To account for this, standard industry practice calls for using the exposure index of a crossing as the baseline for understanding the potential for a crash. Exposure index is used as the baseline input for nearly all common grade crossing hazard models including the FRA’s current accident prediction model.

A useful way of looking at the relationship between exposure index and accidents/incidents is by plotting the proportions among all crossings. Figure 22 below shows this relationship for all crossings in Ohio from 2016 to 2020 as well as for the following subsets:

1. Crossings with gates and flashing light signals;
2. Crossings with flashing light signals only; and
3. Crossings with passive protection (e.g., crossbuck, stop or yield sign, or both).

In each chart, the crossings are grouped into ten deciles based on the exposure index values. (A decile is a quantitative method of splitting up a set of ranked data into ten equally large subsections, or buckets.) This figure shows that in general, as exposure index increases, the proportion of accidents/incidents increases as well. One notable feature of this figure is the slightly different shape of the proportion curve for passive and flashing lights only crossings. Rather than a continual increase in crash proportion, the peak proportions are seen in the seventh decile for both of these groupings. After this decile, the proportions begin to decline again. This suggests that the relationship between accidents/incidents and exposure index may not be as strong for passive and flashing lights only crossings as it is for crossings with gates and lights. This also suggests that accidents/incidents at passive and flashing lights only crossings may be impacted more by other risk factors that will be explored later in this section.

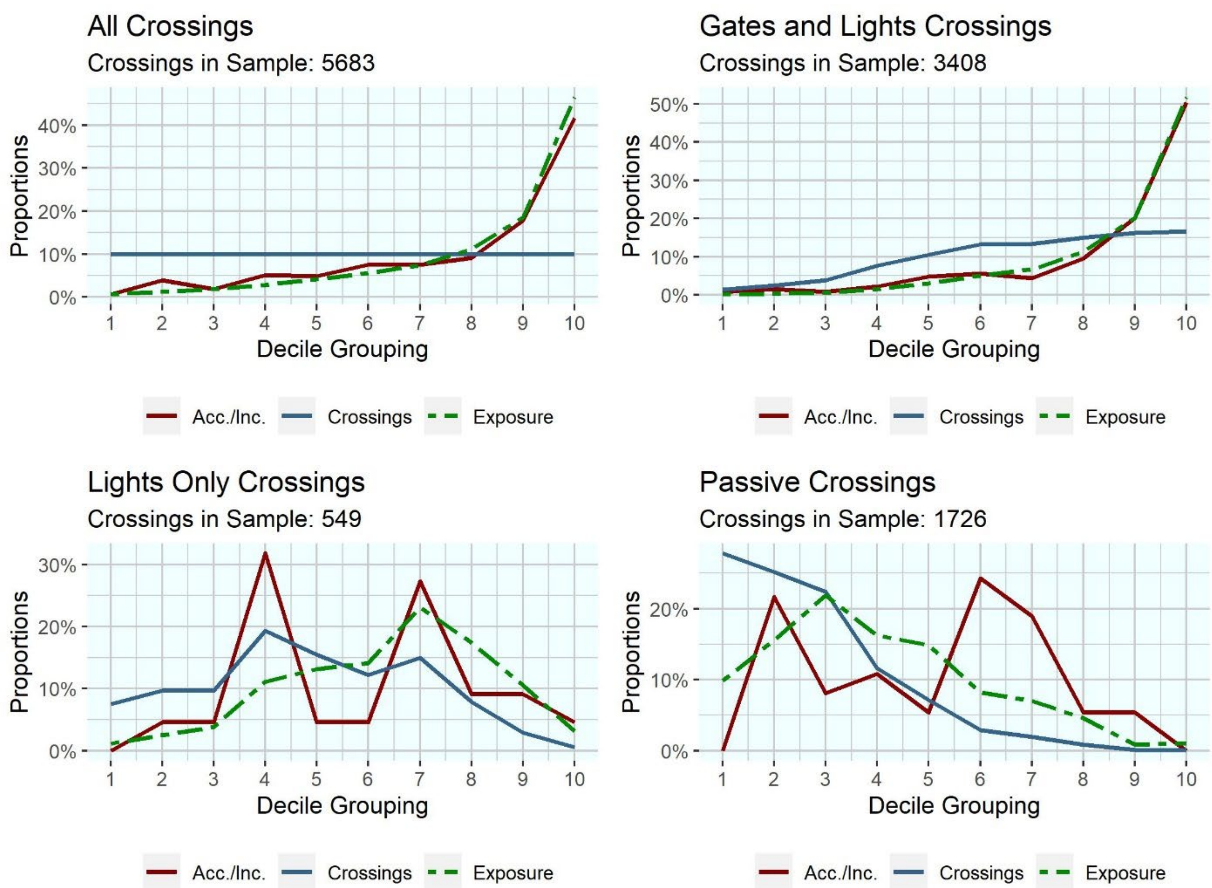
Figure 22 | Proportions of Crossings, Accidents/Incidents, and Exposure (2016 to 2020)



4.1.2 Adjusting for Exposure Index Skew

Another notable feature of the charts shown in Figure 22 above is the extreme jump in proportion of exposure index that occurs in the last decile. The top 10 percent of crossings in Ohio contain over 60 percent of the exposure (and thus opportunities for collisions). This is due to the highly skewed nature of the exposure index values: the majority of crossings in Ohio have low exposure index values, but a small proportion of the crossings have extremely high values. One common method of adjusting and normalizing for this effect is to take the square root (or similar fractional root) of the exposure index value. Specific to Ohio, raising the exposure index to the power of 3/5 (or 0.6) resulted in the best fit for the data. This approach has the effect of reducing the skew by substantially reducing the extremely high exposure index values. The results of this approach are shown in Figure 23 below. The results show a much closer fit between the proportions of exposure index and accidents/incidents, particularly for crossings with gates and flashing light signals.

Figure 23 | Proportions of Crossings, Accidents/Incidents, and Adjusted Exposure (2016 to 2020)



4.1.3 Adjusting for Warning Device Factors

The next two sections assess the impact of various crossing characteristics on overall highway-rail grade crossing safety. In order to accomplish this, the variation in crash rates between crossing types must be normalized to reduce their influence on the final results. Table 8 below summarizes the crash rates for each warning device category and also shows the adjustment factor to be applied to each category's exposure index. After applying these factors, the average five-year crash rate per 1,000 adjusted exposure index will be 0.160 for all warning device categories.

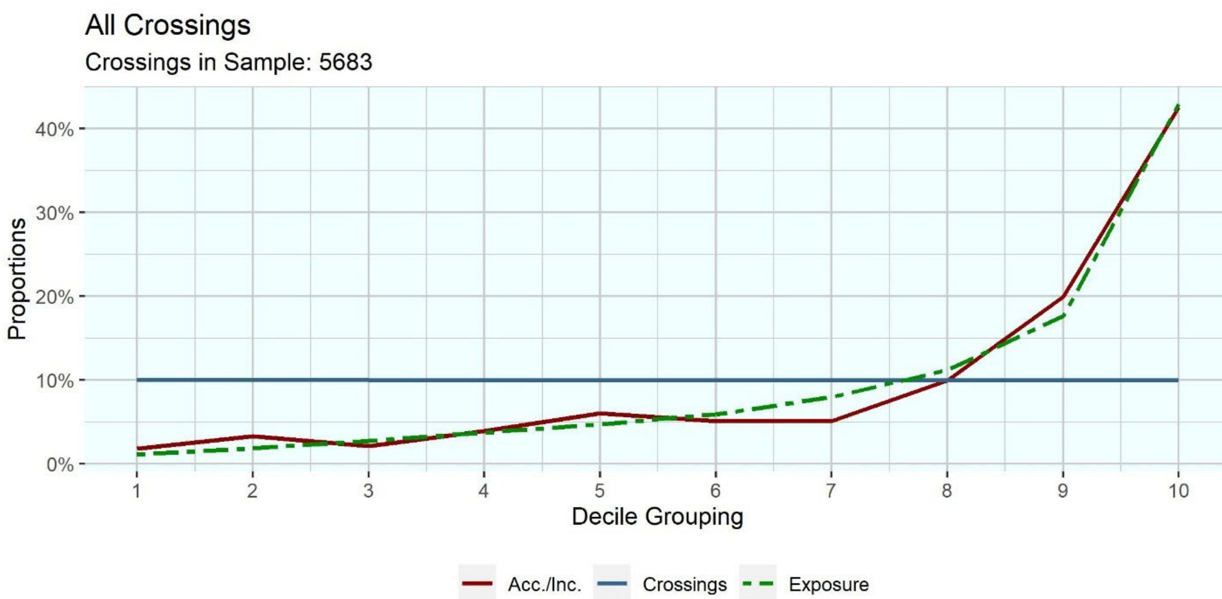
Table 8 | Warning Device Adjustment Factors, 2016 to 2020

Warning Device	Crash Rate (per 1,000 Adjusted Exposure Index)	Adjustment Factor
Gates and Flashing Light Signals	0.078	0.489
Flashing Light Signals Only	0.121	0.758
Passive	0.160	1.0

Note: Common warning device adjustment factors used in hazard index models such as the New Hampshire Index are typically set at 0.1 for gates and lights and 0.6 for lights only, but are often modified to reflect local or regional conditions

Figure 24 below shows the proportions of crossings, accidents/incidents, and exposure index after applying adjustments for both the exposure index skew and the warning device factors. The relationship between exposure and accidents/incidents is now much stronger and the impacts of exposure index and warning device category will be reduced throughout the remainder of the analysis.

Figure 24 | Proportions of Crossings, Accidents/Incidents, and Adjusted Exposure (With Warning Factor Adjustments), 2016 to 2020



4.2 Risk Factor Assessment: FRA-Defined Characteristics

This section provides a detailed assessment of the impacts of various crossing characteristics and risk factors on the overall safety of Ohio highway-rail grade crossings. These characteristics identified by FRA include:

- AADT;
- Total number of trains per day that travel through each crossing;
- Total number of motor vehicle collisions during the previous five (5) year period;
- Number of main tracks at each crossing;
- Number of roadway lanes at each crossing;
- Sight distance (stopping, corner, and clearing) at each crossing;
- Roadway geometry (vertical and horizontal); and,
- Maximum railroad timetable speed.

The following pages include a summary of the results for each factor using data from 2016 to 2020.

4.2.1 Average Annual Daily Traffic (AADT)

Figure 25 provides a summary of the statistical relationships between average annual daily traffic (AADT) and recent accidents/incidents in Ohio. For this first risk factor, a more detailed description and interpretation of the results is provided below. The results are shown as a series of four figures.

Accident/Incident Rate – All Crossings (Figure 25, Top Left):
This chart is the primary tool by which each crossing characteristic is assessed for risk factor potential. For continuous variables, such as AADT and train volumes, crossings are grouped into deciles (sequential groups of 10 percent of all crossings) based on each characteristic. The average value for each decile grouping is displayed on the "x-axis." The characteristic will be defined as a potential risk factor if there is a clear trend of increasing or decreasing accident/incident rates over these deciles. For discrete variables, the rates of each distinct category will be reviewed to identify specific values that result in higher or lower rates.

The example shows a relatively consistent accident/incident rate across all deciles. While there is some variation between deciles, there is no clear trend that would indicate a positive or negative correlation. This is the expected result given the work in the previous section to normalize and account for highway and train volume data.

Proportion of Crossings, Accidents/Incidents, and Exposure (Figure 25, Bottom Left):
This chart provides additional contextual information about the distribution of the crossing characteristics and the distribution of exposure and accidents/incidents across the characteristics. In the example, the crossing accidents/incidents are highly concentrated in the higher deciles. The distribution line is in nearly perfect alignment with the distribution of exposure index across the crossings. This is the expected result after normalizing for exposure index in the previous sections. For other crossing characteristics, the distribution of these three lines provides additional information that may help to explain the results from the top two figures.

Map of Accident/Incident Locations (Figure 25, Top Right):
This figure provides a statewide map of Ohio and displays the locations of crossings with accidents/incidents. The point locations are color-coded to reflect variations in the target characteristic. In the example, the dark red points indicate the locations of crossings with high highway AADT. These are primarily concentrated in the urban areas such as Toledo, Cleveland, and northern Cincinnati. The light blue points indicate lower highway AADT, typically concentrated in less dense areas of the state.

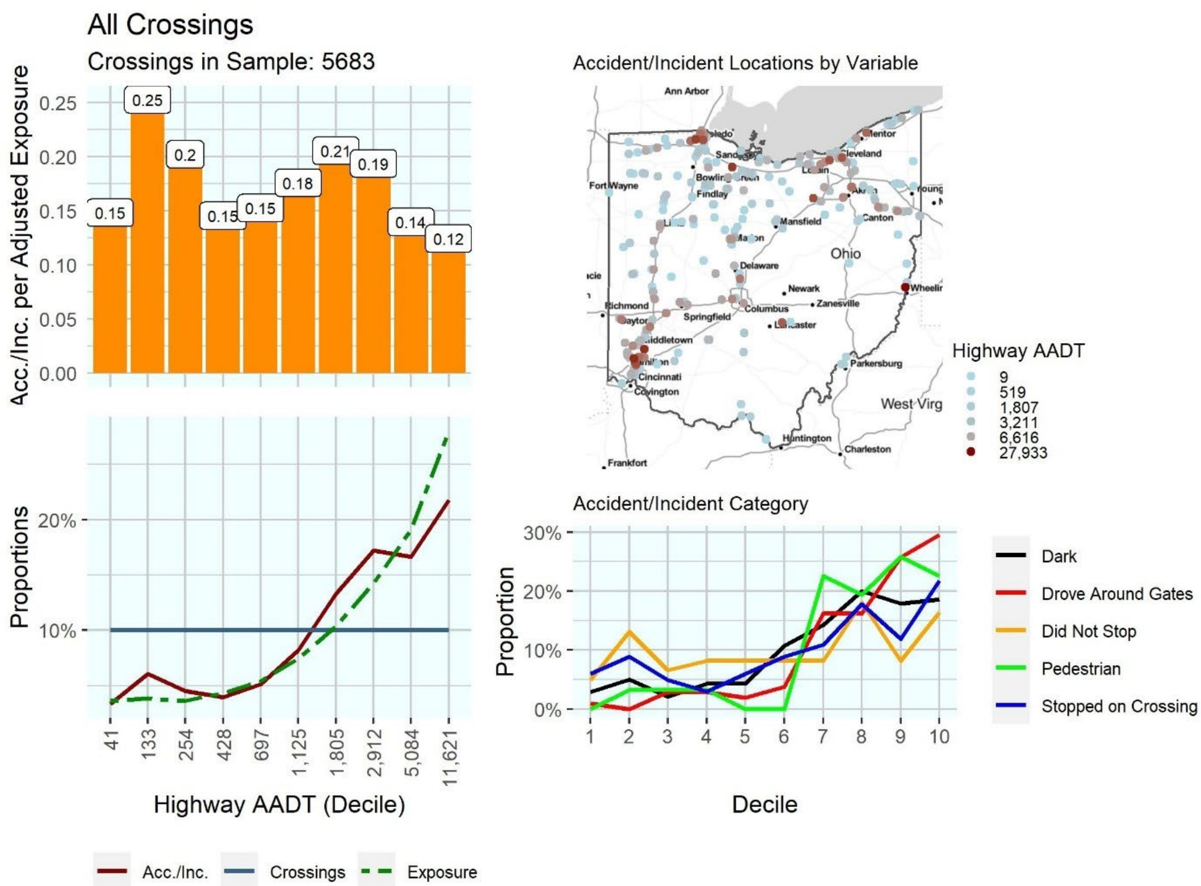
Accident/Incident Category (Figure 25, Bottom Right):
The purpose of this figure is to provide additional context on different types of accidents/incidents and specifically how each may be correlated with various crossing risk factors. The identification of these factors is discussed further in the previous National Comparisons section. Based on this analysis, five different accident/incident types were visualized on this figure in terms of the proportion of the type occurring within each of the ten decile groupings. These include the following accident/incident categories:

- Dark
- Drove Around Gates
- Did Not Stop
- Pedestrian
- Stopped on Crossing

In the example figure, all five accident/incident types generally follow similar distributions, but the "drove around gates" category shows a slightly higher correlation between this accident/incident type and highway AADT. This can be explained in part because crossings with higher AADT are generally more likely to be equipped with gates and lights. In contrast, the "did not stop" category shows only a slight increase in proportion at higher deciles, indicating that this type is less impacted by highway AADT levels.

As noted earlier, the frequency of accidents/incidents is highly correlated with both highway AADT and daily train volumes. As such, this risk factor will be included in the proposed hazard index model discussed further in the next section.

Figure 25 | Example Results Figure – Highway AADT



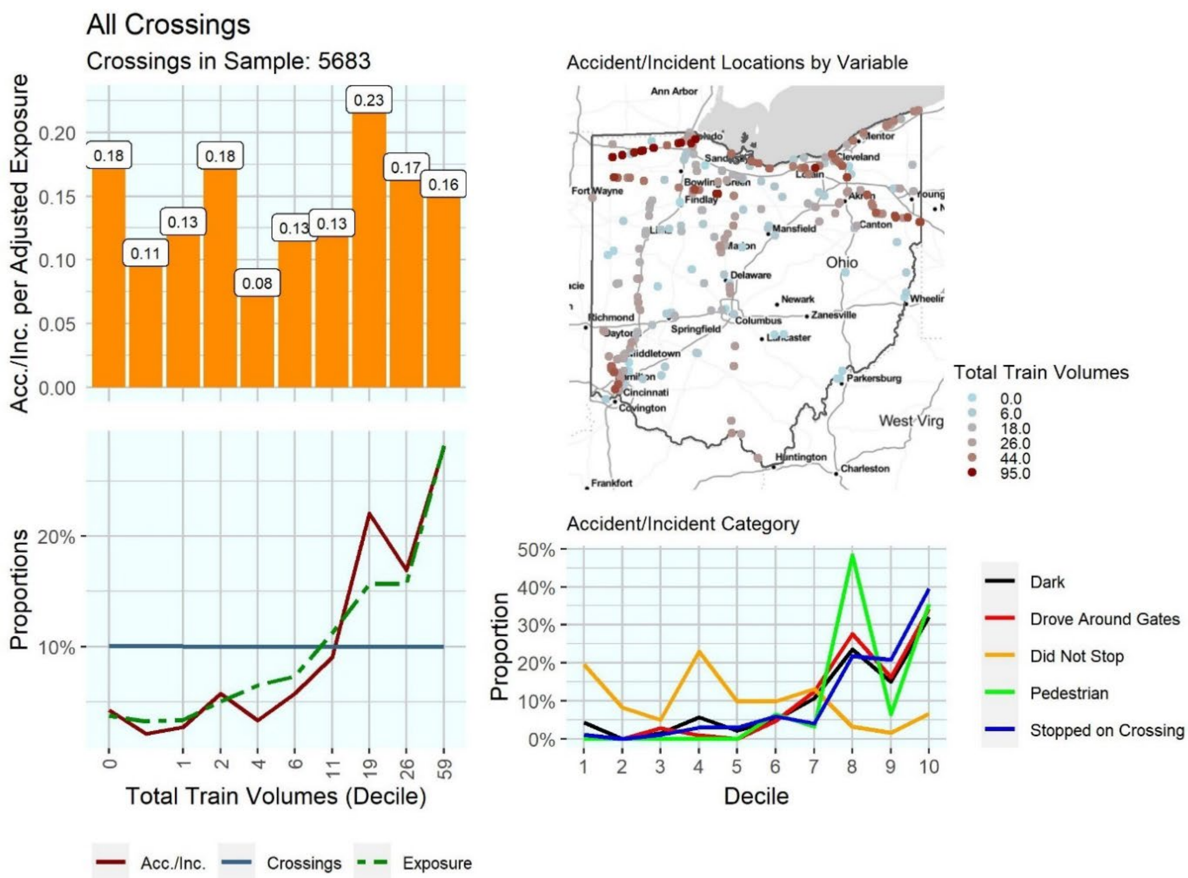
4.2.2 Trains per Day

Figure 26 provides a summary of the statistical relationships between the average count of trains per day and recent accidents/incidents in Ohio. Overall, the results are very similar to the findings for highway AADT. The figures show that while there is some variation in accident/incident rate between deciles, there is no strong positive or negative correlation. Again, this is an expected result as both the highway AADT and daily train volume factors have been accounted for in the adjusted exposure index calculations discussed in the previous section.

Interestingly, while most of the accident/incident categories show a positive correlation with increased trains per day, the “did not stop” category shows a mostly flat correlation, with slightly higher proportions of these crashes in the lower decile groupings. A possible explanation of this finding is that collisions of this type are driven in part by driver complacency. That is, drivers who frequently travel over low-volume grade crossings may become accustomed to not looking for an approaching train and be less vigilant in their crossing awareness. This would be consistent with feedback received during the stakeholder engagement meeting.

Given the known strong correlation between train volumes and accidents/incidents, it is recommended that this factor be included in the proposed hazard index model.

Figure 26 | Risk Assessment Summary – Trains Per Day

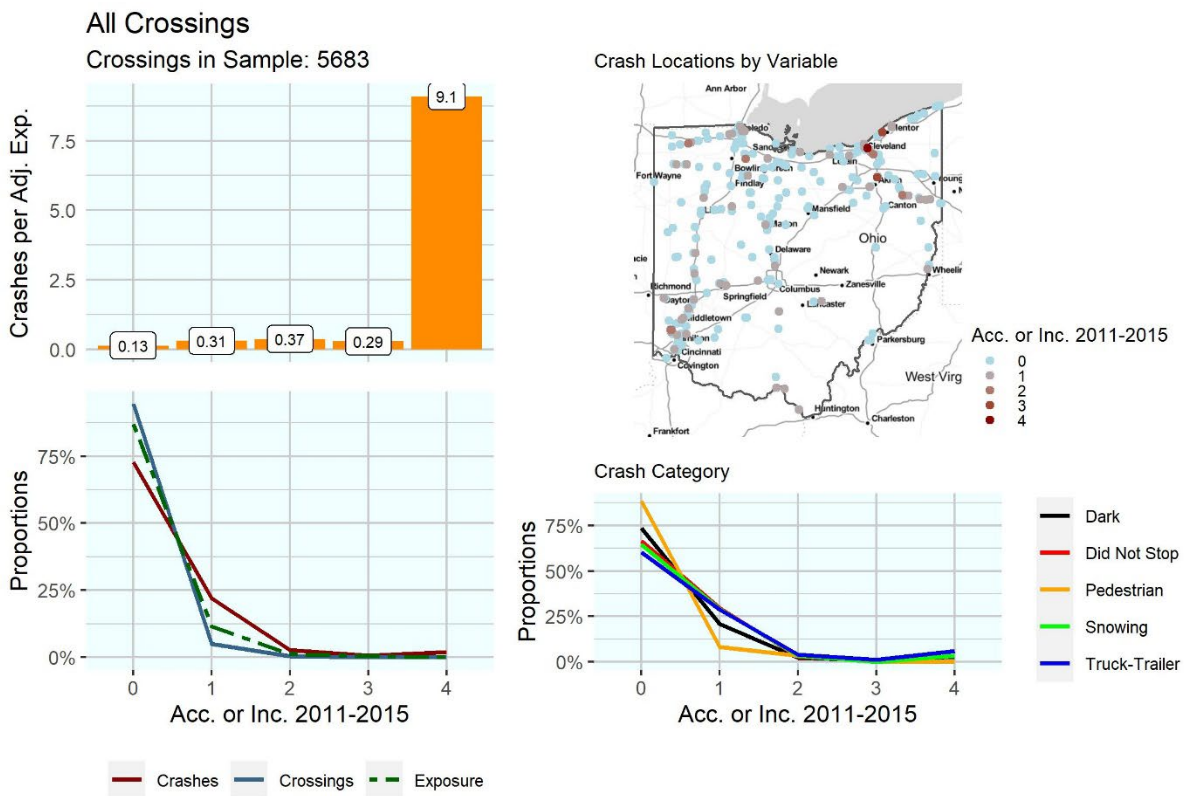


4.2.3 Motor Vehicle Collisions During the Previous Five-Year Period

Figure 27 provides a summary of the statistical relationships between the accidents/incidents in the previous five years (2011 through 2015) and recent accidents/incidents (2016 through 2020) in Ohio. The figures show that crossings that recorded between one and three accidents/incidents in the previous five years experienced slightly more than double the accident/incident rates of those that recorded zero accidents/incidents. Crossings that experienced four accidents/incidents in the previous five years resulted in a significantly higher accident/incident rate. However, care should be taken in interpreting this result as only one crossing falls into this final category. Categories with extremely small sample sizes are much more likely to be disproportionately impacted by even a single recorded accident/incident.

Once again, the data show that "did not stop" motorist actions are more likely to occur at crossings that recorded zero accidents/incidents, further indicating that these types are more likely to be sporadic driver inattention issues rather than a specific safety issue at the crossings. Given these results, it is recommended that previous accidents/incidents be included in the proposed hazard index model.

Figure 27 | Risk Assessment Summary – Previous Accidents/Incidents

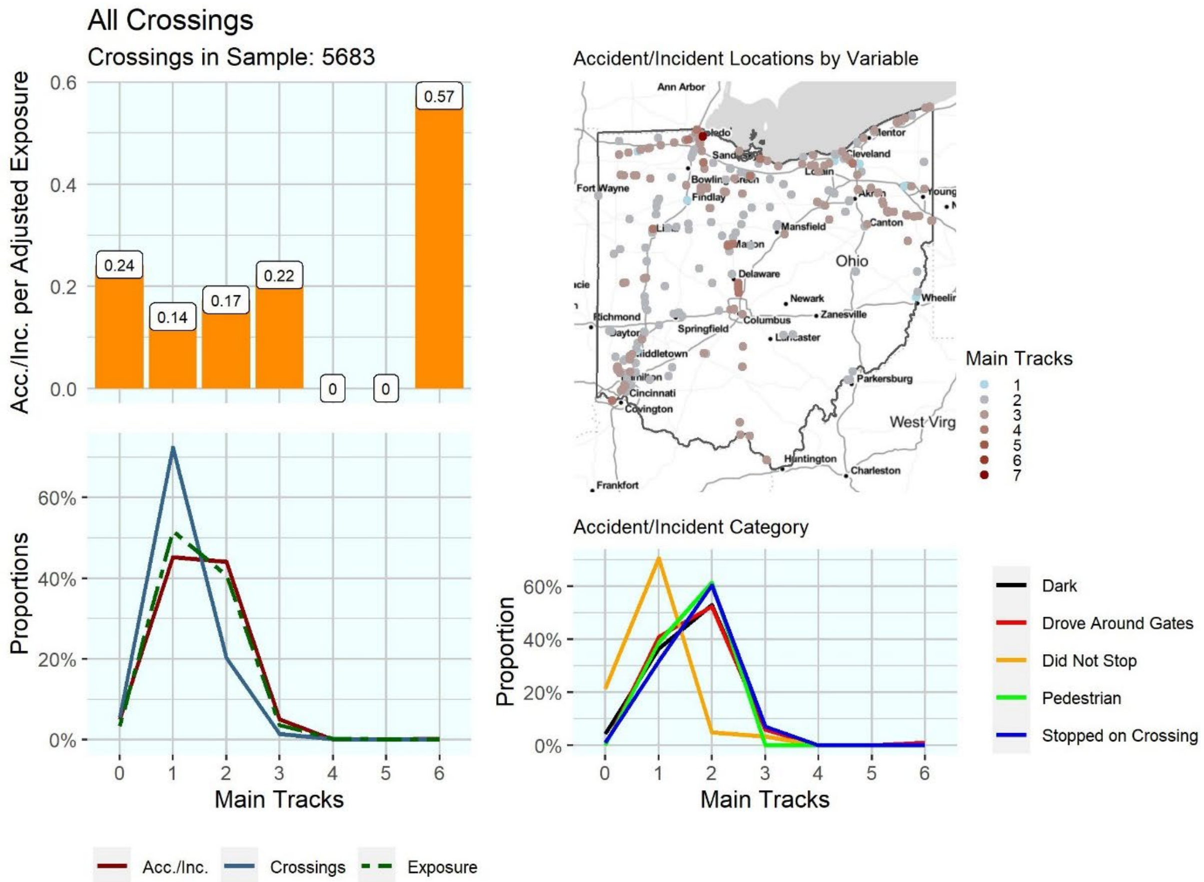


4.2.4 Number of Main Tracks

Figure 28 provides a summary of the statistical relationships between the number of main tracks at crossings and recent accidents/incidents in Ohio. The figures show that more than 70 percent of Ohio crossings have only one main track, another 20 percent have two main tracks, and the remaining crossings have between three and six main tracks, or zero main tracks. The figures show very little correlation between this crossing characteristic and an increase or decrease in accident/incident rate. The highest rate is found at crossings with six main tracks. However, only one crossing falls within this category, and as discussed for the previous characteristic, categories with small sample sizes are much more likely to be impacted by even a single accident/incident.

Given this result, it is recommended that this factor not be included in the proposed hazard index model. However, further consideration of the number of other tracks is considered later in this section.

Figure 28 | Risk Assessment Summary – Number of Main Tracks

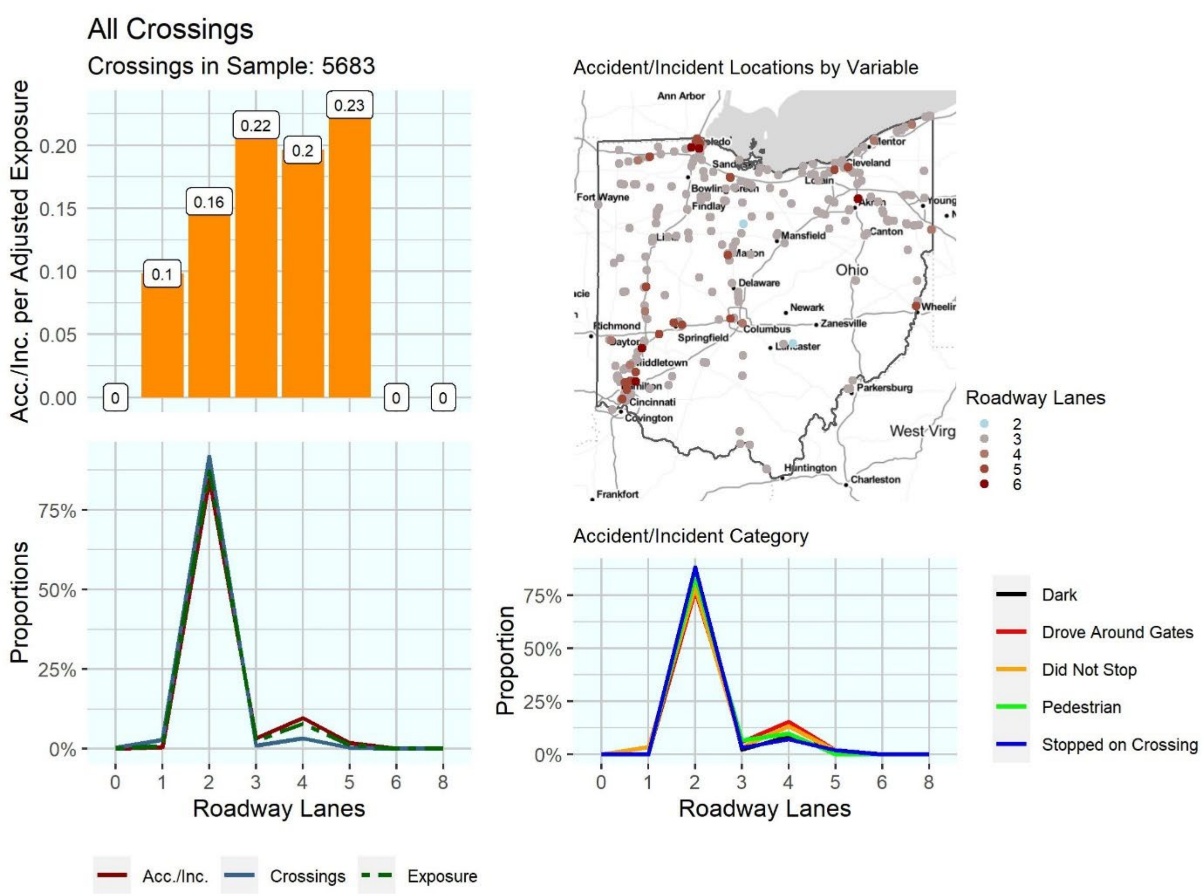


4.2.5 Number of Roadway Lanes

Figure 29 provides a summary of the statistical relationships between the number of roadway lanes at crossings and recent accidents/incidents in Ohio. The figures show that more than 90 percent of crossings in Ohio consist of two-lane roadways. Four-lane roadways are the next most common configuration at approximately three percent of crossings. The figure shows a positive correlation between number of roadway lanes and accident/incident rates. Additionally, the figures show that the "drove around gates" motorist action is slightly more prevalent at crossings with four-lane roadways. The most common motorist action for crossings with two-lane roadways is "stopped on crossing."

Given this result, it is recommended that this factor be included in the proposed hazard index model.

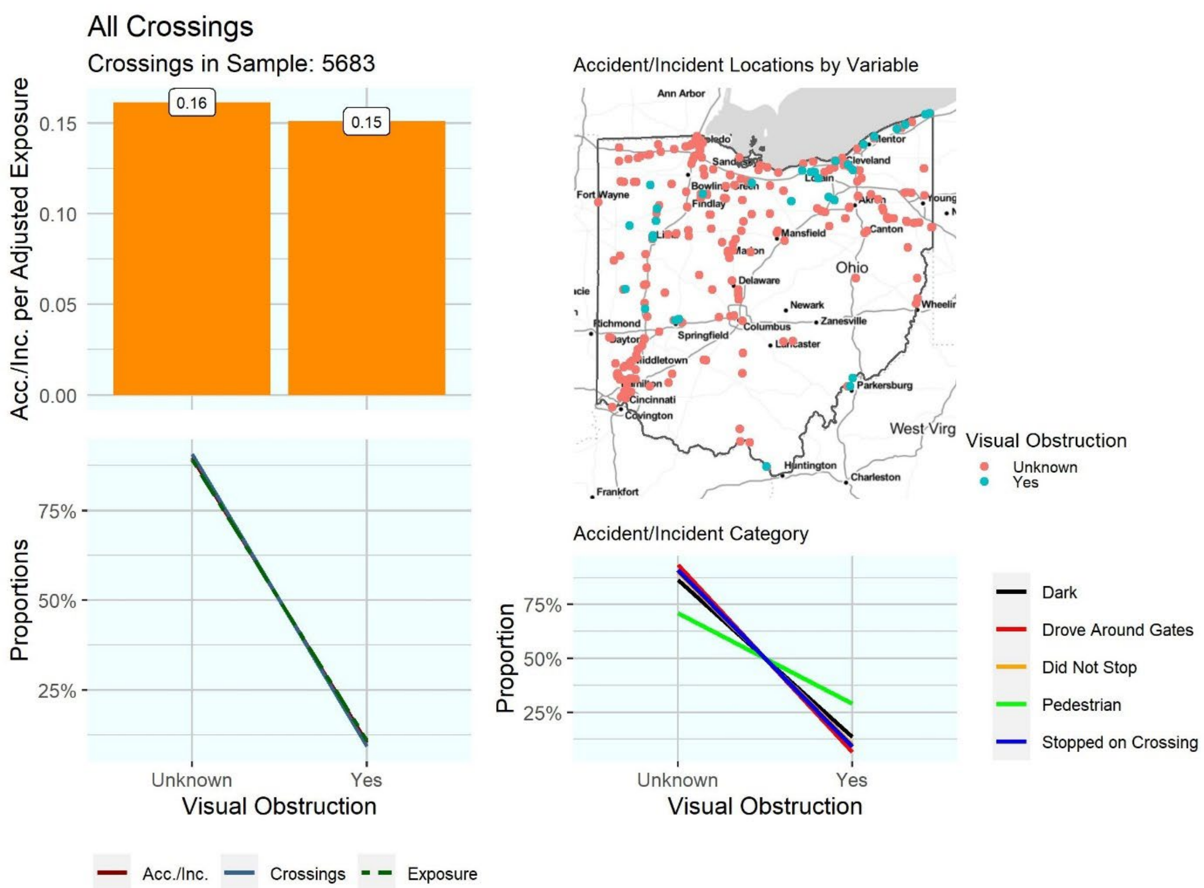
Figure 29 | Risk Assessment Summary – Number of Roadway Lanes



4.2.6 Sight Distance

PUCO maintains records of permanent visual obstructions along each quadrant of each crossing, recently adding this field to the new grade crossing database (see Section 7.3.1). These obstructions include buildings, topographic features, vegetation on private property, and other similar obstructing features. Figure 30 provides a summary of the statistical relationships between the presence of any permanent visual obstruction and recent accidents/incidents in Ohio. Upon initial review, the figures show very little difference in accident/incident rates between crossings with and without visual obstructions. Interestingly, pedestrian-related accidents/incidents are much more likely to occur at crossings with visual obstructions. Further analysis revealed that this is the case only for crossings with gates and lights. At these crossings, approximately one out of every three pedestrian accidents/incidents occur at a crossing with a visual obstruction based on the current data. However, given the recent implementation of this record, data collection is not complete for the entire state. While this information will not play a major role in the proposed hazard index model, it is important information to record for consideration during future crossing diagnostic reviews, annual crossing inspections, and discussions of potential improvement options.

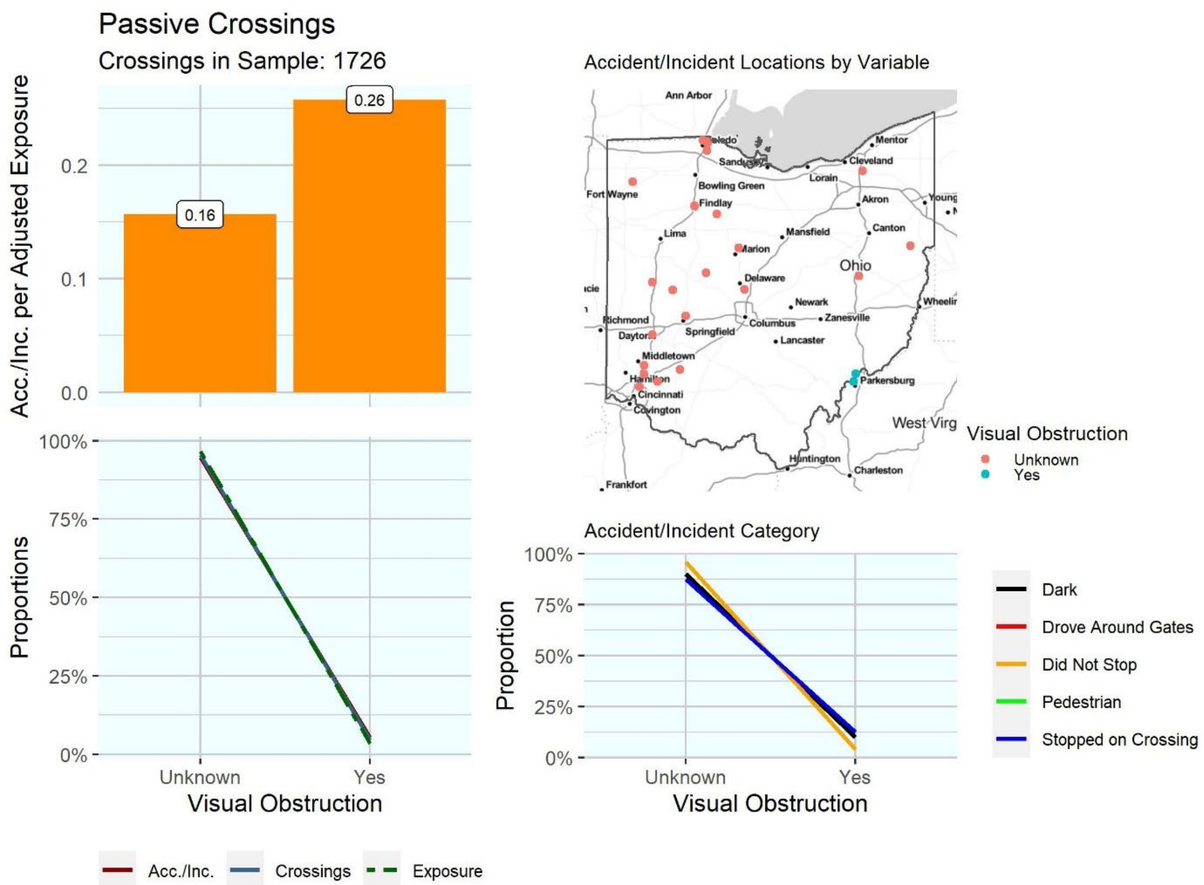
Figure 30 | Risk Assessment Summary – Sight Distance



Additional analysis also shows that while for all crossings combined, the presence of a visual obstruction does not impact the accident/incident rate, this is not the case for all crossing types. For crossings protected by passive signage or flashing lights only, the results do show a positive correlation between the presence of a visual obstruction and an increase in the accident/incident rate. These results for passive crossings are shown below in Figure 31. While not shown, the results for flashing lights only crossings show nearly identical patterns.

Given this result, it is recommended that the presence of visual obstructions be included in the proposed hazard index model, but only for crossings that are not equipped with gates and lights.

Figure 31 | Risk Assessment Summary – Sight Distance (Passive Crossings)

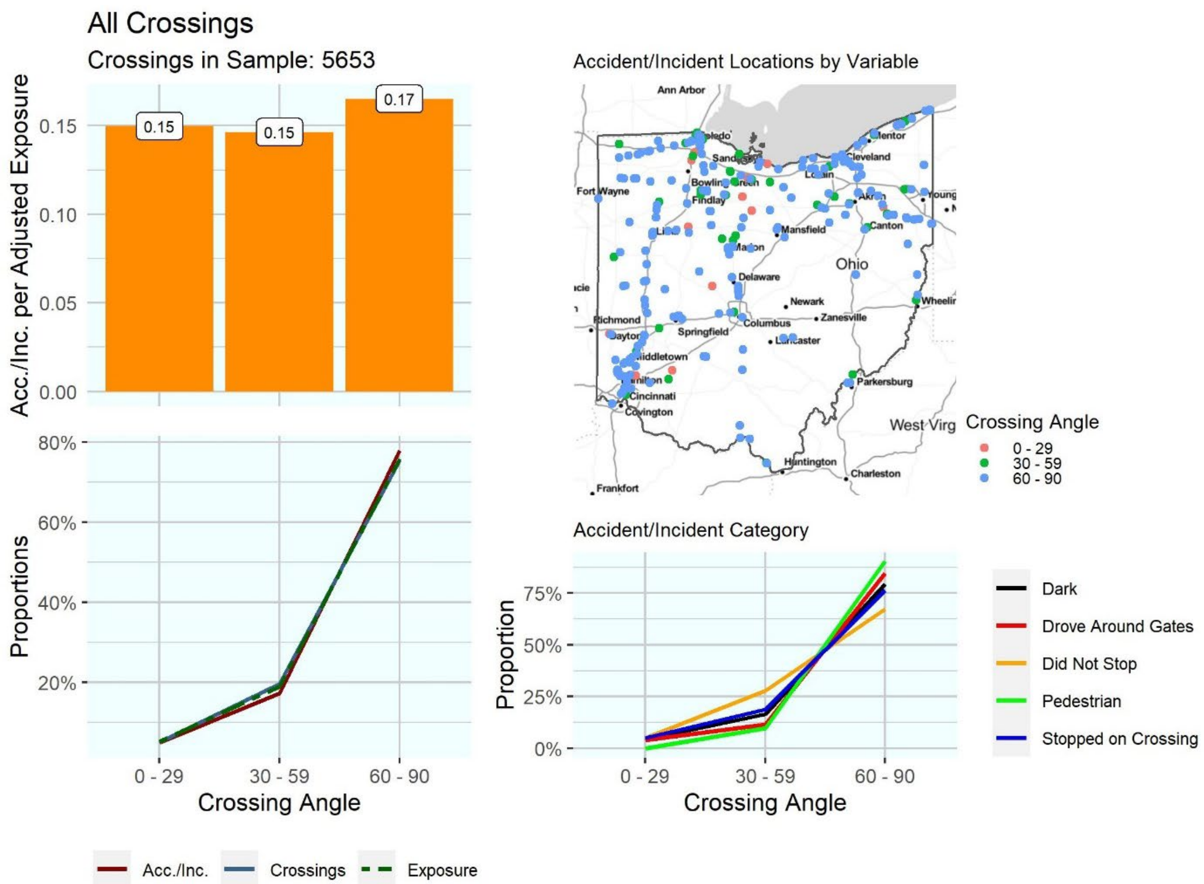


4.2.7 Roadway Geometry (Horizontal)

Figure 32 provides a summary of the statistical relationships between the horizontal crossing angle and recent accidents/incidents in Ohio. The smallest crossing angle is recorded in 30-degree increment between 0 (parallel) and 90 (perpendicular) alignments. The figures show that approximately 75 percent of all crossings have a horizontal alignment between 60 and 90 degrees. The figures also show that there is no evident correlation between crossing angle and the accident/incident rate. Furthermore, the distribution of accident/incident category is relatively uniform with only the "did not stop" category being slightly more likely to occur at 30-to-59-degree crossings and slightly less likely to occur at 60-to-90-degree crossings.

Given this result, it is recommended that this factor not be included in the proposed hazard index model.

Figure 32 | Risk Assessment Summary – Roadway Geometry (Horizontal)

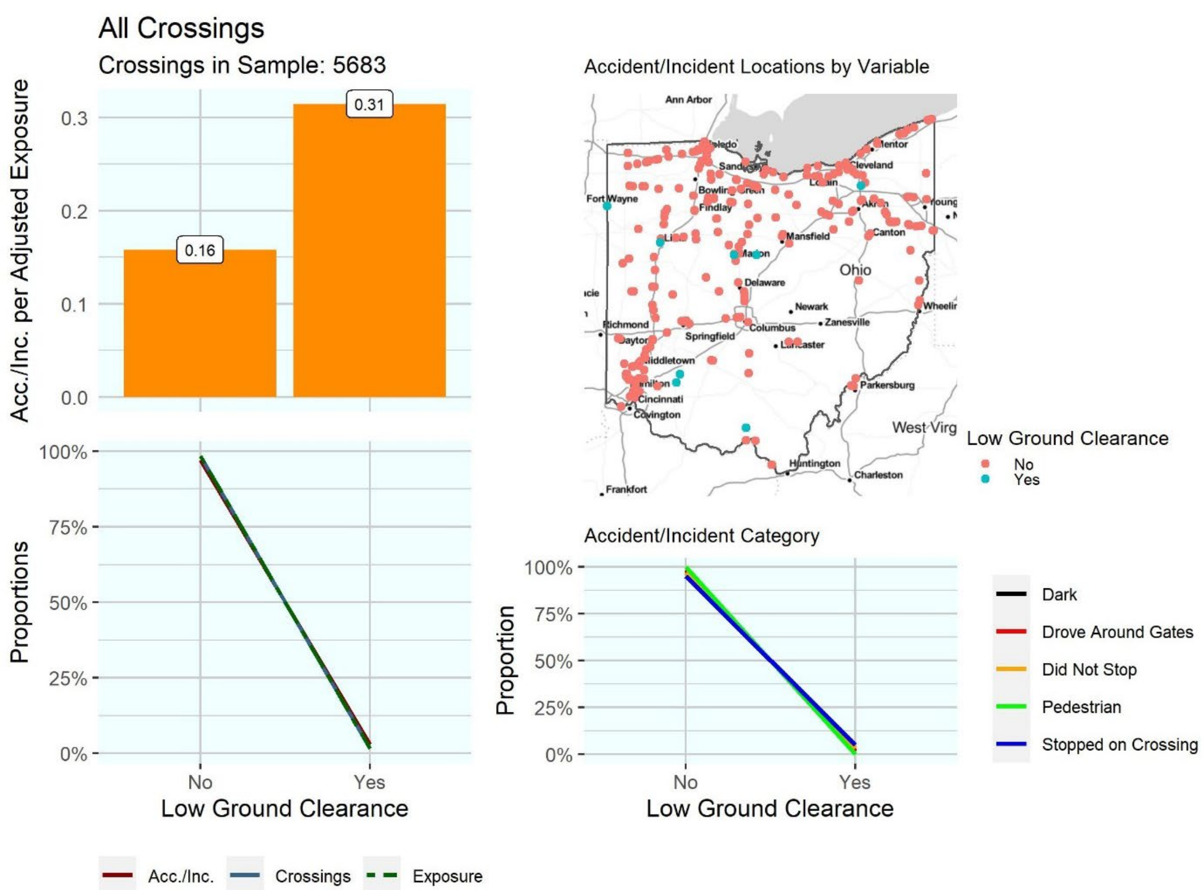


4.2.8 Roadway Geometry (Vertical)

Detailed information on vertical roadway geometry such as roadway approach grades is not currently collected by PUCO. As a proxy measure for grade crossing vertical geometry, this analysis uses the presence of railroad low ground clearance signs (Manual on Uniform Traffic Control Devices [MUTCD] sign “X-W10-5”) to indicate potential vertical geometry issues. Figure 33 provides a summary of the statistical relationships between the presence of railroad low ground clearance signs and recent accidents/incidents in Ohio. The figures show a positive correlation between the presence of railroad low ground clearance signs and an increase in the accident/incident rate. The figures also show very few differences in the distribution of the various accident/incident categories. However, additional review of this data for passive crossings shows that approximately 12 percent of “stopped on crossing” motorist actions at passive crossings occur at crossings with a railroad low ground clearance sign, despite these crossings accounting for less than two percent of passive crossings.

Given these findings, it is recommended that this factor be included in the proposed hazard index model.

Figure 33 | Risk Assessment Summary – Railroad Low Ground Clearance Signage



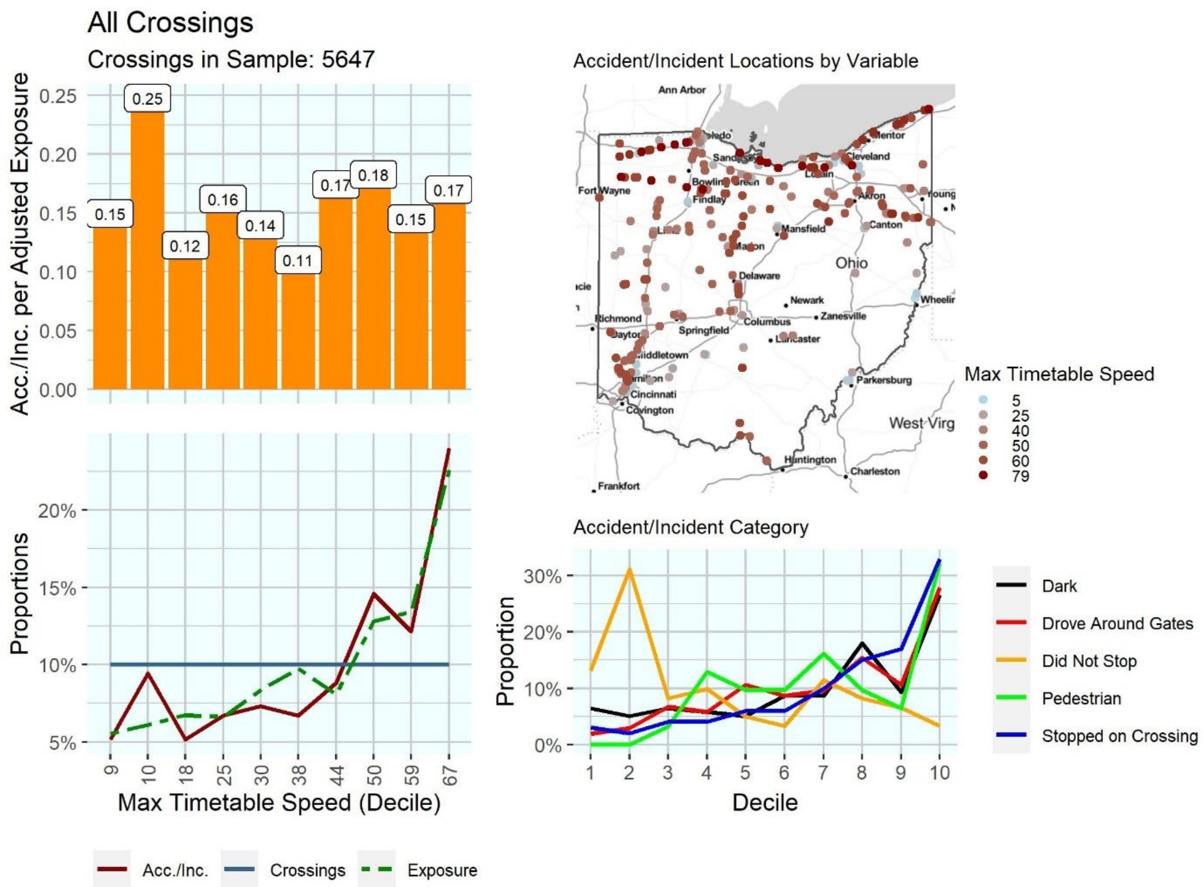
4.2.9 Maximum Timetable Speed

Figure 34 provides a summary of the statistical relationships between the maximum timetable speed (e.g., freight and passenger train speed limits) and recent accidents/incidents in Ohio. Because of the fairly evenly distributed range of typical operating speeds for trains across the rail network, no specific correlation was noted for the maximum timetable speed factor in terms of overall accidents/incidents.

However, the “did not stop” motorist behavior is overrepresented at crossings where train speeds are low (approximately 10 mph). This may be the result of highway users feeling more confident that they have enough time to beat a slow-moving train through a crossing. While trains moving at speeds of 20 mph or less are more likely to be able to stop short of a stationary obstruction such as a vehicle stopped on a crossing, trains are not able to stop suddenly for an unexpected motorist.

Given this result, it is recommended that this factor not be included in the proposed hazard index model.

Figure 34 | Risk Assessment Summary – Maximum Timetable Speed



4.3 Risk Factors Assessment: Additional Crossing Characteristics

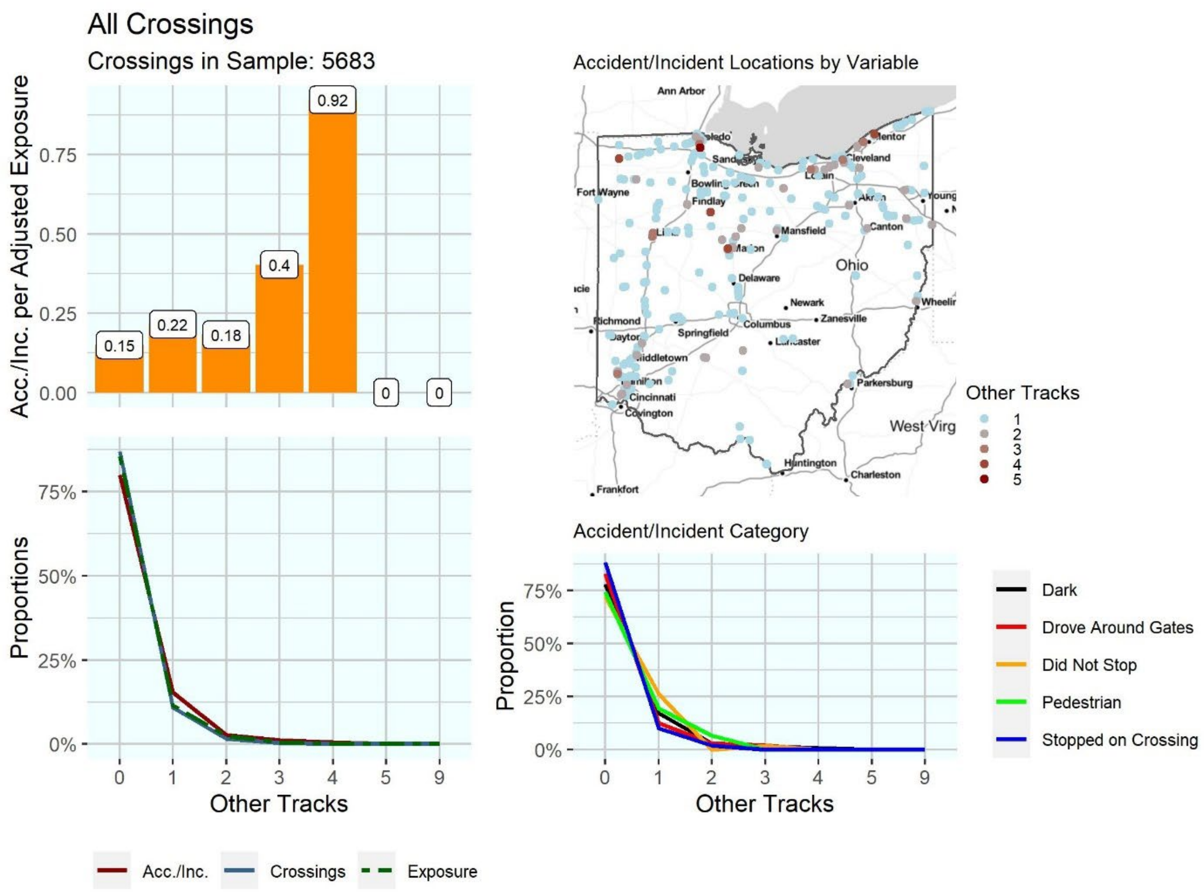
While not specifically required by the FRA, it can be beneficial to review additional potential risk factors to identify crossing characteristics that may play a role in grade crossing safety, and which may be used to enhance the proposed hazard index model.

4.3.1 Number of Other Tracks

While the previous review of number of main tracks provided an inconclusive result, a review of the number of other tracks (i.e., siding, yard, industry spur, etc.) provides potentially more useful data. Figure 35 provides a summary of the statistical relationship between the number of other tracks and recent accidents/incidents in Ohio. While just over 75 percent of Ohio crossings do not have any other-than-main tracks, those that do tend to experience higher accident/incident rates.

Given these results, it is recommended that this factor be included in the potential hazard index model.

Figure 35 | Risk Assessment Summary – Number of Other Tracks

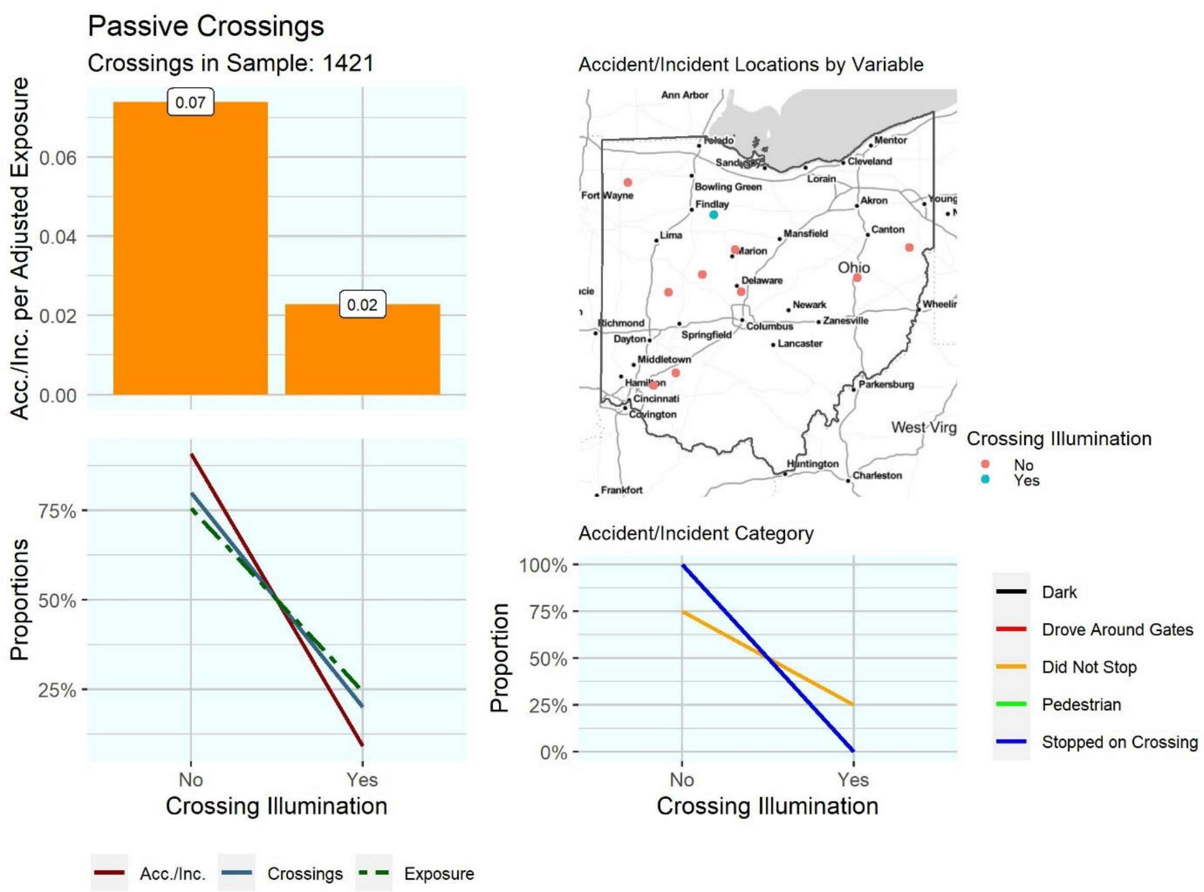


4.3.2 Illumination

Many states have found that crossing illumination is a useful grade crossing safety improvement. The improvement is typically more cost-effective than the installation of gates and lights, particularly if a power source is located nearby. Since crossing illumination is primarily of the most benefit at passive, rural crossings, this analysis focuses on those crossing types. Figure 36 provides a summary of the statistical relationship between the presence of crossing illumination at passive, rural crossings, and recent accidents/incidents in Ohio. The figure shows that the accident/incident rate is higher for crossings without illumination for this particular crossing type. Additionally, all of the "stopped on crossing" and 75 percent of the "did not stop" accident/incident types occurred at crossings without illumination.

Based on this result, it is recommended that crossing illumination at rural crossings with passive protection be included in the proposed hazard index model.

Figure 36 | Risk Assessment Summary – Illumination (Passive, Rural Crossings)

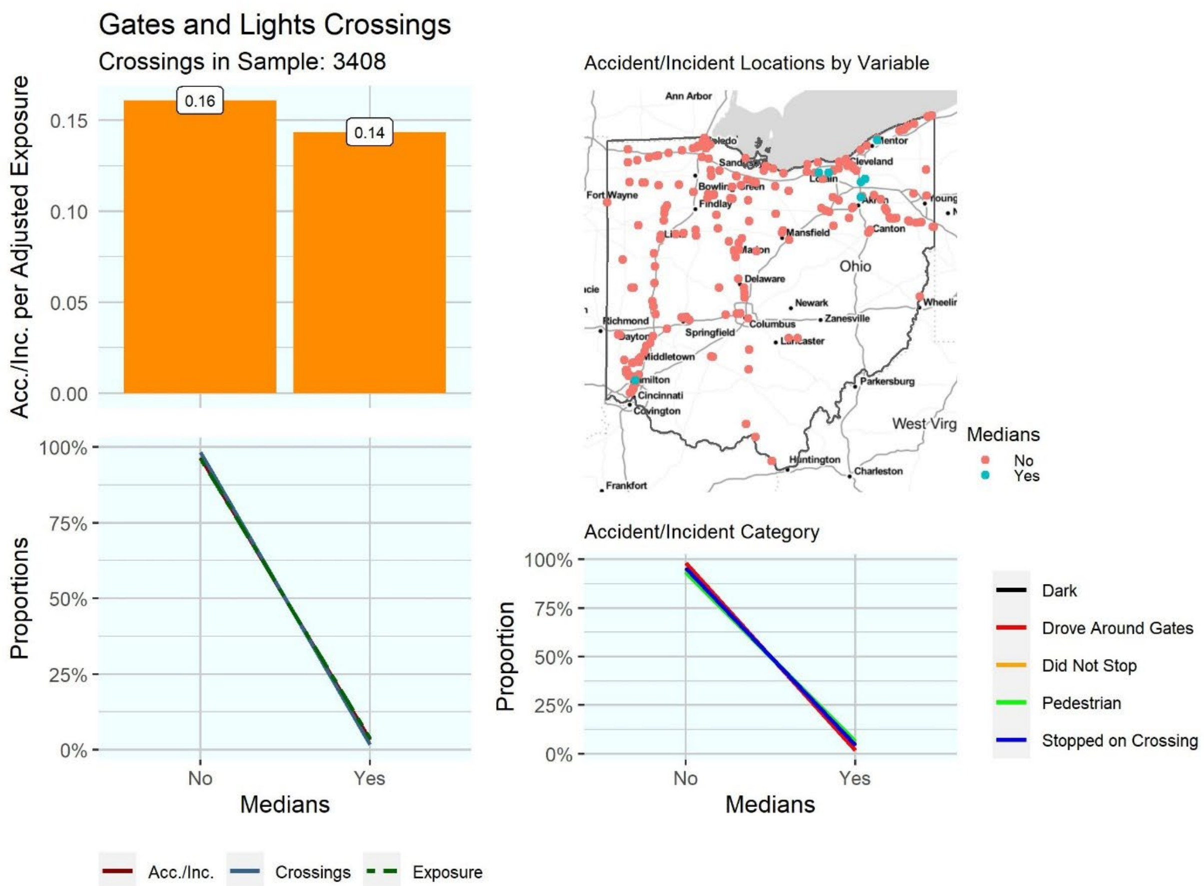


4.3.3 Medians at Gated Crossings

With the understanding that highway users circumventing gates is a key driver of accidents/incidents in Ohio, it is useful to review the effectiveness of countermeasures such as medians which prevent this motorist behavior. Figure 37 provides a summary of the statistical relationship between the presence of medians at crossings equipped with gates and lights and recent accidents/incidents in Ohio. It should be noted that only 56 crossings in Ohio currently meet these criteria. The results show a slightly higher accident/incident rate for crossings without medians, but the difference is relatively minor. However, the figures also show that nearly 100 percent of "stopped on crossing" and "drove around gates" accident/incident types occurred at crossings without medians.

Based on this current result, it is recommended that this factor not be included in the potential hazard index model, primarily due to the small number of crossings currently equipped with medians. However, if the number of crossings with medians increases, it is recommended that this factor be reconsidered for future risk assessments and hazard index modeling efforts.

Figure 37 | Risk Assessment Summary – Medians at Gated Crossings



4.4 Crossing Characteristics Summary

The previous section identified correlations between accident/incident rates and various crossing characteristics. The results of this effort are summarized in Table 9 below. Characteristics listed as "Include" will be considered during the next steps to develop a custom hazard index model for Ohio. The goal of the hazard index model is to identify crossings at high-risk for accidents/incidents for the purpose of prioritizing future investments in highway-rail grade crossing safety. The proposed model will be compared against other commonly used prioritization techniques, including the FRA's accident prediction model and a new proposed model based on recent research.

Table 9 | Characteristics to Include in Proposed Hazard Index Model

Characteristic	Include in Model
FRA-Defined Risk Factors	---
Average Annual Daily Traffic	Include
Trains per Day	Include
Motor Vehicle Collisions During the Previous 5-year Period	Include
Number of Main Tracks	Do Not Include
Number of Roadway Lanes	Include
Sight Distance (Visual Obstructions)	Include for Passive, Flashing Lights Only Crossings
Roadway Geometry (Horizontal)	Do Not Include
Roadway Geometry (Vertical)	Include
Maximum Timetable Speed	Do Not Include
Additional Risk Factors	---
Number of Other Tracks	Include
Illumination	Include for Rural, Passive Crossings
Medians at Gated Crossings	Do Not Include

4.5 Hazard Index Models

Hazard index models are predictive formulas used to assess the potential risks for accidents/incidents at highway-rail grade crossings. Most typical models use a variety of factors such as highway volumes and speed, rail volumes and speed, and crossing characteristics such as geometry and type of warning device installed. The hazard index model results can then be used to prioritize safety improvements to the highest risk crossings. Ohio currently uses the FRA's Accident Prediction Model for this purpose. This section provides an overview of the FRA model and proposes an alternative model using more modern statistical analysis techniques.

4.5.1 FRA Accident Prediction Model

The FRA's current accident prediction model was developed in the 1980s and has only seen minor updates to model coefficients since its inception. The Web Accident Prediction System (WBAPS) is the online implementation of this model, allowing users to download accident prediction results for any crossing in the country.[22] The prediction values are based on multiple crossing characteristics including highway and train speeds and volumes, previous crash history, and crossing geometry.

Per the recently enacted IIJA, the FRA is required to update the current accident prediction model within two years.

4.5.2 ZINDOT Model

In the last few years, there has been much academic research related to improving highway-rail grade crossing predictive formulas. One recent research paper published in the Journal of Traffic and Transportation Engineering proposed a series of formulas referred to as the ZINDOT model.[23] The intention of this proposed model was to develop a hazard index model using what is known as a zero-inflated negative binomial (ZINB) model. The ZINB model type is particularly effective at modeling count data with a significantly high probability of a zero value. Highway-rail accident/incident counts are an excellent candidate for this type of model due to the fact that most crossings do not experience any accidents/incidents. For example, in Ohio, accidents/incidents only occur at approximately one percent of all crossings in any given year.

The ZINB model addresses this excess number of zeros by building in a two-step modeling process. The first step of the model uses a binomial logistic regression model to first estimate the probability that a given crossing will have a zero count. The second step of the model is a traditional negative binomial model used to estimate the count of accidents/incidents at each crossing.

The ZINDOT model in particular uses the ZINB approach while using only the crossing attributes available within the FRA's grade crossing accident prediction model. The model is referenced here and used as a point of comparison in the following section. Specifically, the inclusion of this model seeks to answer the question of whether models based on national datasets are more or less accurate than models based solely on state data for individual states.

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[22] Federal Railroad Administration, Web-Based Accident Prediction System (WBAPS). Retrieved from: https://safetydata.fra.dot.gov/webaps/

[23] Mathew, Jacob and Benekohal, Rahim F., *A New Accident Prediction Model for Highway-Rail Grade Crossings Using the USDOT Formula Variables*, 2020. Retrieved from: https://davidpublisher.com/Public/uploads/Contribute/5f43533833a24.pdf

4.5.3 Custom Alternative Hazard Index Model

This section discusses the development of an alternative hazard index model based on the characteristics listed above. Like the ZINDOT model, the ZINB model type was used as the base for this analysis. RStudio software was used to develop the custom ZINB model for estimating accidents/incidents at Ohio highway-rail crossings. Specifically, the "pscl" package[24] was utilized for its zero inflated, negative binomial, and two-step modeling functionality. Multiple combinations of the previously identified crossing characteristics were attempted to identify the model that most accurately predicts accidents/incidents for Ohio.

Ultimately, the most successful model configuration used daily train volumes as the sole variable for the zero-inflated component of the model. Logically this is a reasonable result given that highway-rail accidents/incidents can only occur in the presence of railroad traffic. Interestingly, the relationship between highway AADT and exposure index were found to be weaker than daily train volumes alone.

The most successful model configuration used a combination of the square root of exposure index, five-year accident/incident history, the number of other-than-mainline tracks, and the presence of illumination at rural, passive crossings as the key variables for the count model component.

The proposed hazard index model is provided below:

$$\boldsymbol{N_{CountFinal} = N_{CountPredicted} \times (1 - P_{InflatedZero})}$$

$$N_{CountPredicted} = e^{[-2.938 + 0.806*Acc5yr\ 0.00254*\sqrt{ExpInd}+0.722*RurPassIllum+0.289*trackNumOther\ ]}$$

$$P_{InflatedZero} = \frac{z}{1+z}$$

$$z = e^{[0.932 - 0.176*TrainADT]}$$

Where:

- ExpInd = Exposure Index ('Average Annual Daily Traffic' x 'Daily Train Volumes')
- Acc5yr = Five-Year Accident/Incident Count (2016-2020)
- TrainADT = Daily Train Volumes
- RurPassIllum = Rural Passive Crossing with Illumination (1); Otherwise (0)
- trackNumOther = Number of Other-Than-Mainline Tracks

[24] Pscl package reference manual: https://cran.r-project.org/web/packages/pscl/pscl.pdf

4.5.4 Measuring Hazard Index Model Effectiveness

One method of evaluating the effectiveness of the various models is to compare these models against actual accident/incident data over set time periods. Figure 38 summarizes the cumulative sum of accidents/incidents based on hazard model rank for accidents/incidents occurring in the first ten months of 2021 (January through October). This represents the most current accident/incident data available at the time of this writing. The red line represents the cumulative sum of actual crashes over this time period. A perfect hazard index model would accurately rank all of the crossings that experience a crash at the top of the rankings and would therefore match this red line.

Each of the hazard index model lines represents the cumulative count of accidents/incidents in order of the model ranking. The closer the hazard index model line is to the red, actual line, the more accurate and effective it is considered to be. The hazard index rankings were based on the following information:

- **FRA WBAPS:** Based on year 2021 WBAPS results collected in January 2022
- **ZINDOT and Custom Models:** Calculated using current grade crossing characteristics and accident/incident history for 2016 through 2020.

Additional details for the top 50 ranked crossings are shown in Figure 39. The results show that the custom hazard index model performs roughly equivalently to the WBAPS model. Of the 41 crossings that experience accidents/incidents over this time period, the custom model identified five (12.2 percent) while the WBAPS model identified four (9.8 percent). Both models performed substantially better than the ZINDOT model, which surprisingly failed to identify multiple accidents/incidents until farther down in its rankings.

Figure 38 | Prioritization Model Comparison (2021 Accident/Incident Data)

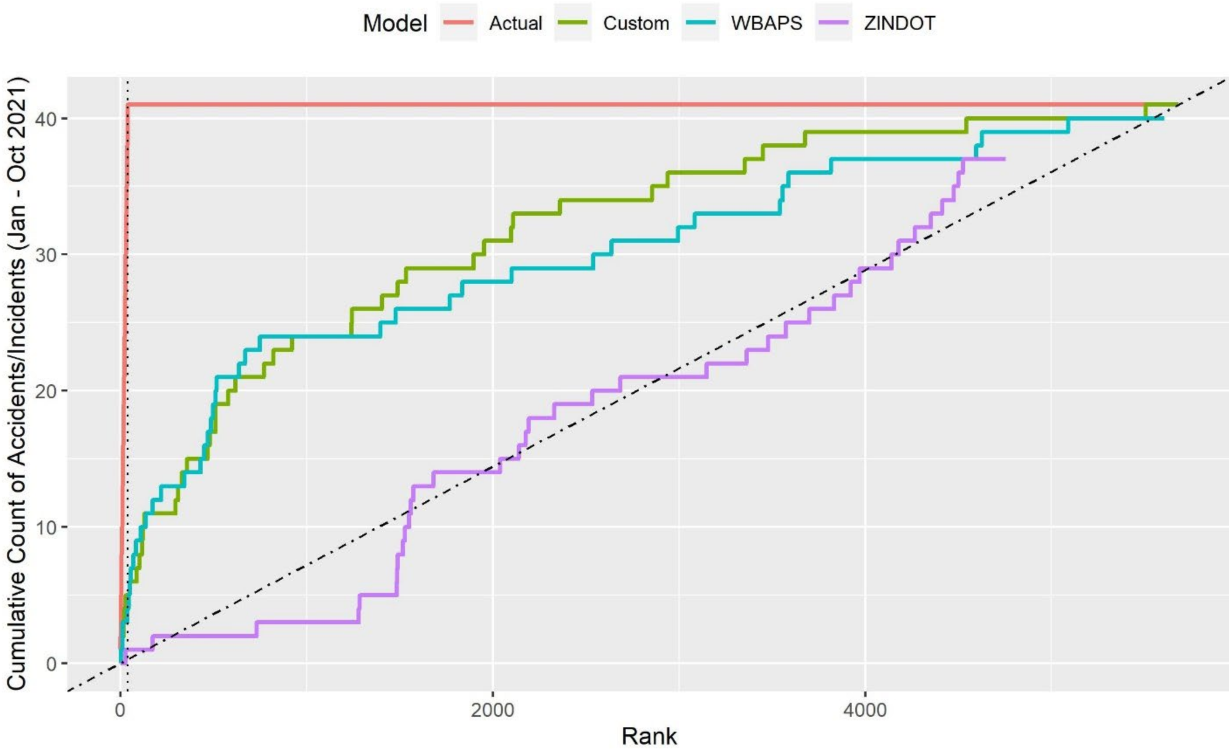
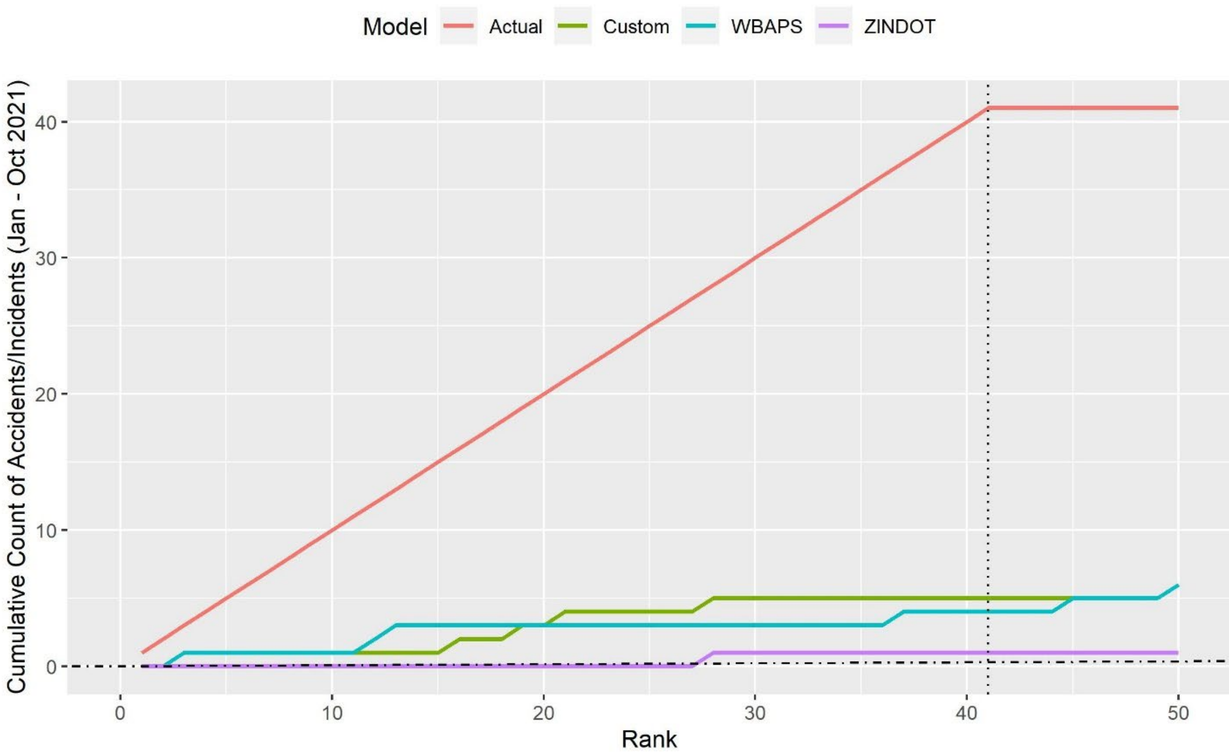


Figure 39 | Prioritization Model Comparison – Top 50 by Rank (2021 Accident/Incident Data)



4.6 Identification of Public Highway-Rail Grade Crossings at High-Risk for Accidents/Incidents

This section summarizes and compares the results of the FRA's Web Based Accident Prediction System (WBAPS) currently used by the state to prioritize highway-rail grade crossing improvements and the results found by applying the proposed alternative hazard index model to Ohio's current highway-rail grade crossing inventory.

4.6.1 Web Based Accident Prediction System

The current top-10 highest-ranking crossings identified in the WBAPS report for Ohio (retrieved September 8, 2021) are summarized in Table 10 below.

Table 10 | Top 10 High-Risk Public Crossings per FRA Web Accident Prediction System

DOT#	Highway Name	RR	Subdivision	County	Type of Protection
524223P	BESSEMER AVE	NS	CLEVELAND LINE	CUYAHOGA	GATES
228850Y	WEST UNION ST	CSX	TOLEDO TERMINAL	WOOD	STOP SIGNS
509519B	RD D	NS	CHICAGO LINE	FULTON	GATES
509454K	WENZ RD	NS	CHICAGO LINE	LUCAS	GATES
503013S	UNION AVE	NS	CLEVELAND LINE	STARK	GATES
523836P	COLUMBIA RD	NS	CHICAGO LINE	CUYAHOGA	GATES
502876E	LINCOLN AVE	NS	FORT WAYNE LINE	COLUMBIANA	GATES
513251M	PHILLIPI RD	NS	DAYTON	FRANKLIN	GATES
473711A	STATE ST	NS	TOLEDO DISTRICT	SANDUSKY	GATES
523850K	ABBE RD	NS	CHICAGO LINE	LORAIN	GATES

4.6.2 Proposed Hazard Index Model

The proposed hazard index model described in the previous section results in an identification of the top 10 highest-ranking crossings as shown in Table 11 below. Seven of the crossings included on this list are shared with the top-ten list from the FRA WBAPS rankings.

Table 11 | Top 10 High-Risk Public Crossings per Proposed Hazard Index Model

DOT#	Highway Name	RR	Subdivision	County	Type of Protection
524223P	BESSEMER AVE	NS	CLEVELAND LINE	CUYAHOGA	GATES
523836P	COLUMBIA RD	NS	CHICAGO LINE	CUYAHOGA	GATES
509519B	RD D	NS	CHICAGO LINE	FULTON	GATES
509454K	WENZ RD	NS	CHICAGO LINE	LUCAS	GATES
502876E	LINCOLN AVE	NS	FORT WAYNE LINE	COLUMBIANA	GATES
509457F	HOLLAND-SYLVANIA RD	NS	CHICAGO LINE	LUCAS	GATES
503013S	UNION AVE	NS	CLEVELAND LINE	STARK	GATES
155665A	WEST FOURTH ST	CSX	TOLEDO	ALLEN	GATES
523850K	ABBE RD	NS	CHICAGO LINE	LORAIN	GATES
524884H	E KEMPER RD	NS	CINCINATTI LINE	HAMILTON	GATES

4.7 Conclusion

The results of this analysis highlight the challenge in estimating the future locations of grade crossing accidents/incidents based on existing crossing characteristics and past accident/incident history. Using either the proposed hazard index model or the existing FRA WBAPS model captured only 10 to 12 percent of the crossings with accidents/incidents in 2021.

One of the primary challenges facing Ohio moving forward is the question of how to best distribute funding for highway-rail grade crossing safety improvements when there are very few crossing candidates that clearly stand out among all others in terms of safety needs and potential for accidents/incidents. Based on this analysis, it is recommended that Ohio continue to consider measures such as local support, railroad support, community and stakeholder feedback, and project expediency in addition to risk factors when determining crossing improvement prioritization.

5.0 Stakeholder Involvement in State Action Plan Development

This section describes the process by which ORDC and PUCO engaged relevant stakeholders and the general public to gather input on current needs and issues in the state relating to highway-rail grade crossing safety, as well as current efforts and partnerships underway to address these needs and issues.

Stakeholder and public outreach are critical to the SAP's development. Direct input from stakeholders is especially helpful in pinpointing and identifying problematic areas and crossings that pose unique risks. For example, there might be a crossing that has experienced frequent near misses, but no recorded accidents or incidents show up in the FRA database. Stakeholder and public involvement also can spark conversation that leads to further collaboration regarding potential highway-rail grade crossing engineering, education, or enforcement improvements. Further, the stakeholder and public outreach process is in itself an opportunity to reinforce highway-rail safety messages.

The SAP engagement strategy consisted of two primary tools and approaches described in more detail below.

5.1 Process for Stakeholder Involvement in State Action Plan Development

5.1.1 Virtual Rail Summit Meeting

Meeting Facilitation Strategy

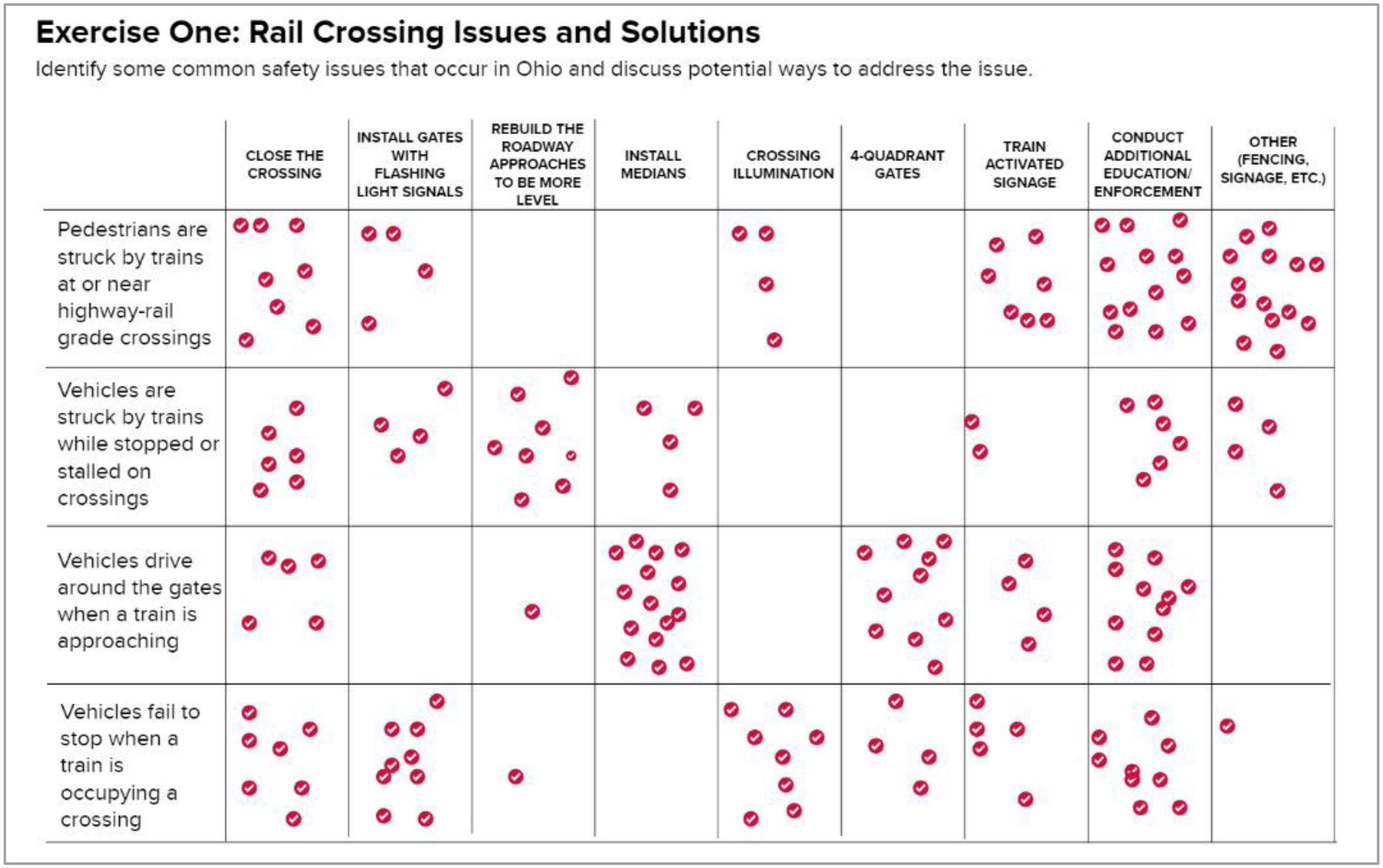
ORDC and PUCO hosted a virtual rail safety stakeholder summit meeting (Virtual Rail Summit) on January 11, 2022, using the Webex virtual meeting platform. Since the start of the 2019 novel coronavirus disease (COVID-19) pandemic, virtual meetings have become the new standard for stakeholder and public engagement and have allowed for increased attendance and engagement compared to traditional in-person approaches.

Multiple rail safety stakeholders attended the virtual meeting, including representatives from Class I, Class II, and Class III railroads, and the FRA. Meeting facilitators used interactive tools including live polling via Mentimeter and an interactive whiteboard via Mural.

The use of online live polling allowed for direct audience participation by incorporating a series of questions related to various components of what would later become the SAP. These questions were used as conversation starters to help catalyze open conversation between attendees and the facilitation team.

The Mural boards functioned as a means for displaying information that would typically be presented in a flip chart or roll plot and allowed the meeting participants to collaboratively share their feedback on potential solutions and key areas of need by moving dot icons and placing sticky notes. Exercise One, shown in Figure 40 below, allowed participants to “vote” on potential solutions to common highway-rail grade crossing safety issues. These tally votes were then used to help facilitate an open discussion about the issues and solutions.

Figure 40 | Virtual Rail Summit Whiteboard Activity Using Mural



Exercise Two allowed the meeting participants to share their feedback on specific locations where issues are present, or action is needed by moving icons and placing sticky notes onto a map depicting Ohio's rail network and major highways. Facilitators then asked the participants to elaborate on the specific issues and locations noted.

5.1.2 Online Public Survey

Survey Methodology

In order to engage members of the public in the safety planning process, ORDC and PUCO conducted an online survey using JotForm to gain input on areas that need safety or rail improvements, potential engineering solutions, and educational programs and awareness. Respondents were asked to rank potential solutions to rail crossing scenarios that pose a threat to drivers. They were also asked to provide input on the effectiveness of educational programs that promote staying safe around railroad crossings. Due to COVID-19, all outreach for the survey was done online or by email.

The results of this survey were used to measure public support for various improvement strategies and to aid in the identification of highway-rail grade crossing locations that are perceived as potentially problematic in any way.

5.1.3 Other Stakeholder Engagement Opportunities

A presentation on the SAP development process and preliminary data analysis was given to ODOT's State Highway Safety Program Steering Committee on December 15, 2021. The Steering Committee consists of stakeholders from ODOT, metropolitan planning organizations, the Ohio State Highway Patrol, FHWA, and other organizations involved in highway safety initiatives.

In January of 2022, a presentation on the SAP was given to the commissioners of the ORDC.

Each of these events provided an opportunity for open discussion about highway-rail safety.

5.2 Concepts from Stakeholder Outreach

5.2.1 Virtual Rail Summit Meeting

Meeting Summary

The Virtual Rail Summit meeting was held virtually via Webex on January 11, 2022. Stakeholders in attendance included representatives from the railroads operating within the state, as well as representatives from the FRA. The goals of the stakeholder meeting included:

- Outlining the state highway-rail grade crossing safety planning process;
- Reviewing safety data and analysis;
- Discussing current efforts or initiatives; and,
- Obtaining stakeholder input on goals and opportunities for the SAP.

The stakeholder meeting included discussions about current safety and education initiatives. The overall sentiment was that Ohio is doing a good job with implementing rail safety improvement projects at specific crossing locations, but there may be some areas where additional education or enforcement is needed within the community to change pedestrian and driver behaviors.

Communication and collaboration are needed to continue to find opportunities to close crossings or implement other mitigations, such as permanent medians at crossings where motorists are frequently driving around down gates.

As a part of the stakeholder meeting, attendees utilized Mural, an online feedback tool that allows users to provide feedback on a virtual whiteboard. In Exercise Two on Mural, stakeholders were asked to identify specific locations, corridors, common scenarios, risk factors, and demographics groups by moving icons on a map to where current improvements are needed.

Attendees primarily used the map in Exercise Two to highlight issues with trespassing at or near highway-rail grade crossings. These trespassing issues were noted along rail corridors in urban areas, including Toledo, Columbus, and Hamilton, and are believed to be driven by persons loitering or camping along railroad right-of-way.

Issues with blocked crossings were also noted by stakeholders during the Exercise Two map activity. Complex rail yard switching operations were discussed as one cause of recurring blocked crossing complaints from citizens in Marion.

5.2.2 Online Public Survey

The online survey was available from December 20, 2021, through February 4, 2022. It was promoted at stakeholder meetings as well as in the invitation for the Virtual Rail Summit Meeting. The online survey facilitated feedback from an additional 14 people during the time it was available.

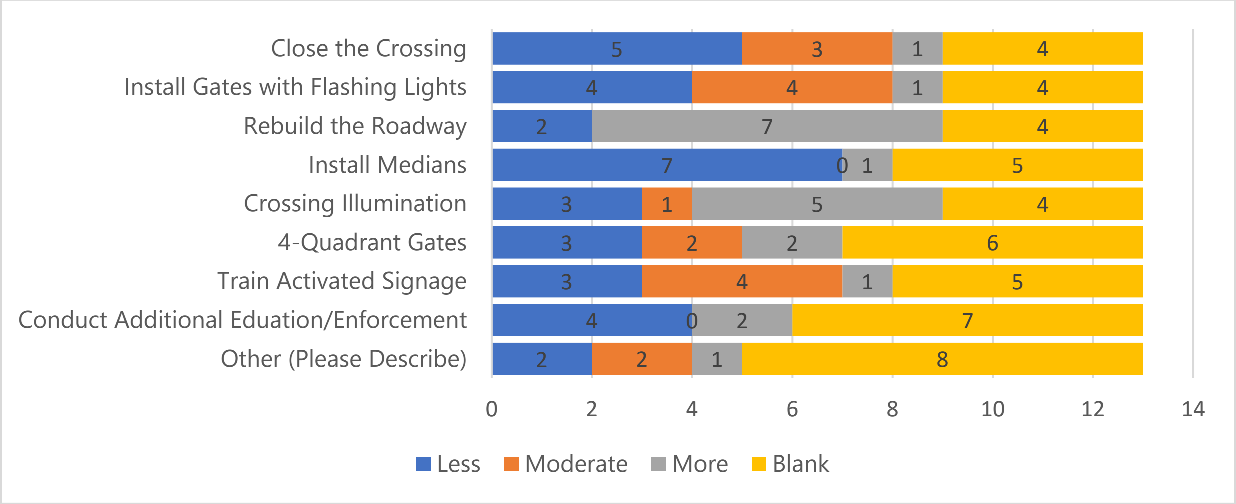
Comment Map

A Comment Map was provided at the beginning of the online survey. Respondents were asked to indicate specific locations that they felt were problematic or warranted further review. Two locations were identified on the map and described as follows:

- "Crossing in Lawshe, OH needs repair. Paving is uneven and very difficult to cross. Poses a risk to motorcycle traffic and is very rough to cross in general."
- "I'm concerned about the crossing in Columbus where the CSX railroad crosses Highland Drive on the Northwest side of the city. This crossing is in a neighborhood, but is difficult for pedestrians and bicycles to safely cross. Sidewalks and a pedestrian crossing would be greatly beneficial to the area."

Scenario-Based Questions

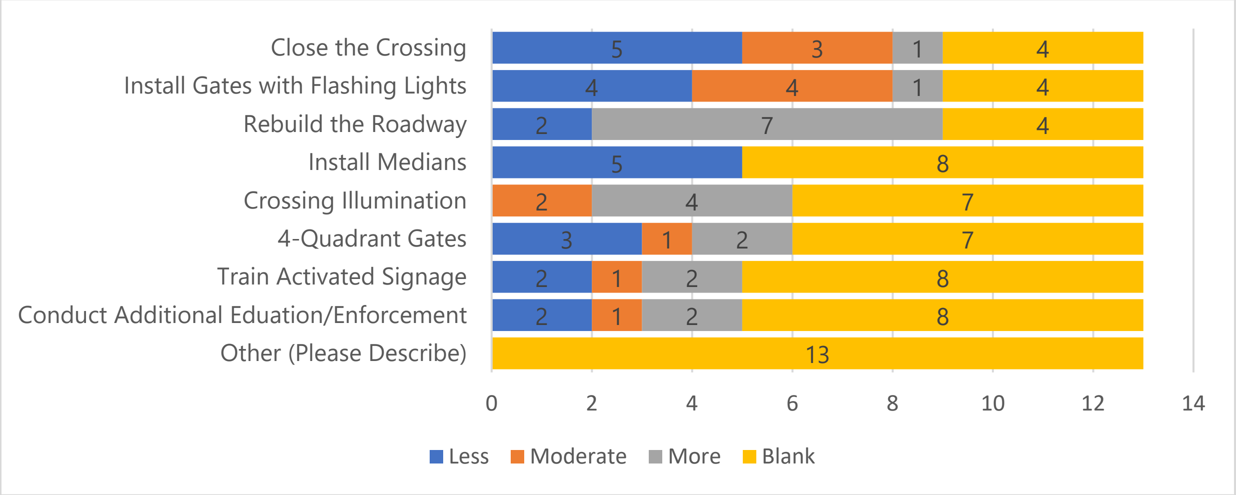
Scenario 1: At a crossing location where vehicles frequently become stuck or 'high-centered' on the tracks, how favorable are the following potential solutions?



Describe any other potential solutions for this scenario:

- "Warning signage for approaching vehicles"

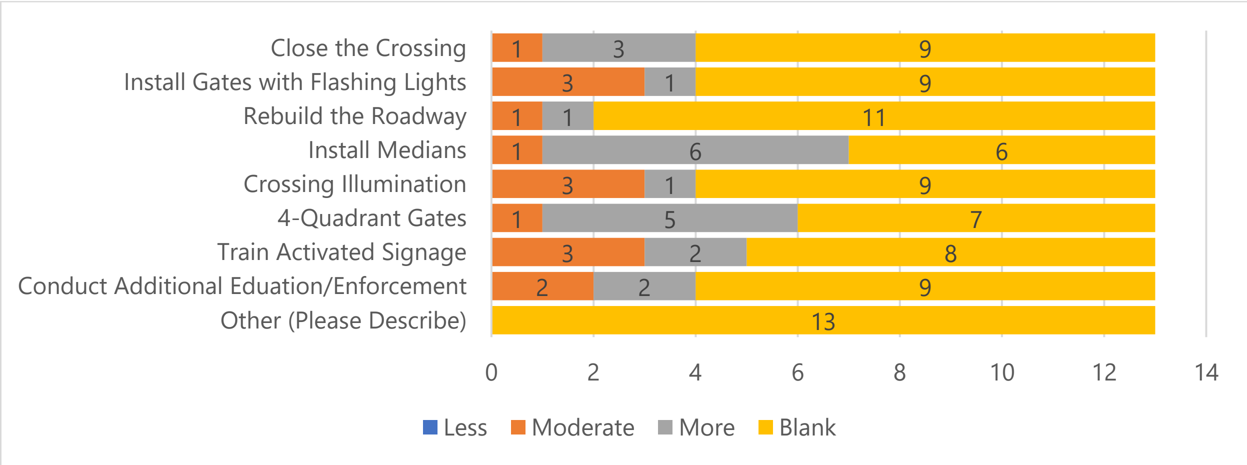
Scenario 2: At a crossing location where pedestrian accidents occur, how favorable are the following potential solutions?



Describe any other potential solutions for this scenario:

- "Pedestrian bridges/tunnels are easier/cheaper to build than a similar facility for cars"
- "Have strong law enforcement presence and or safety blitzes to raise public awareness"
- "Warning signage for pedestrians plus enforcement actions"

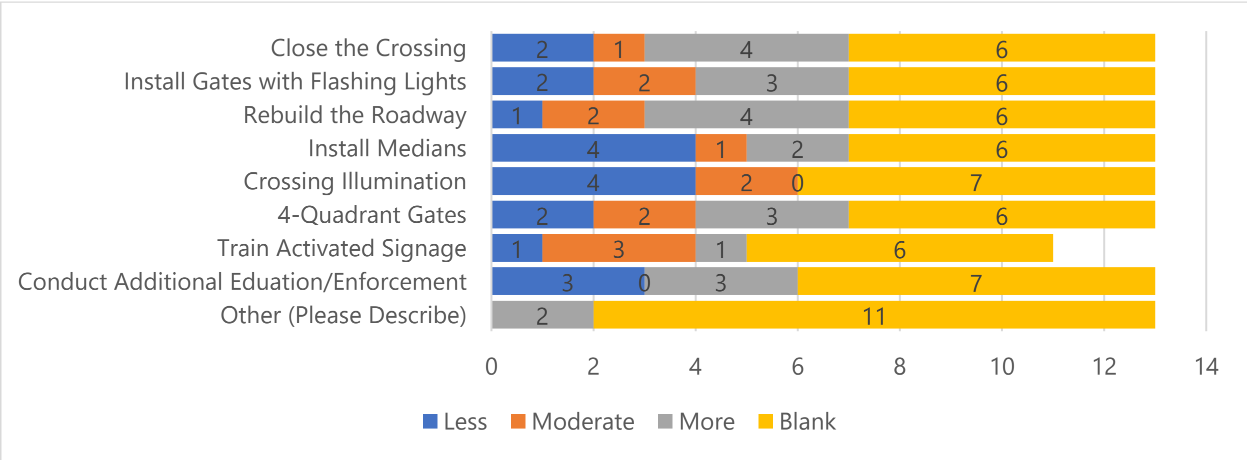
Scenario 3: At a crossing location where motorists frequently drive around the gates when they are activated, how favorable are the following potential solutions?



Describe any other potential solutions for this scenario:

- "Make it a silent crossing"
- "Active law enforcement presence and crossing blitzes to raise public awareness"
- "Enforcement of existing laws"

Scenario 4: At a crossing location where queuing at a nearby traffic signal may make it difficult for vehicles to stay clear of the tracks when a train is approaching, how favorable are the following potential solutions?



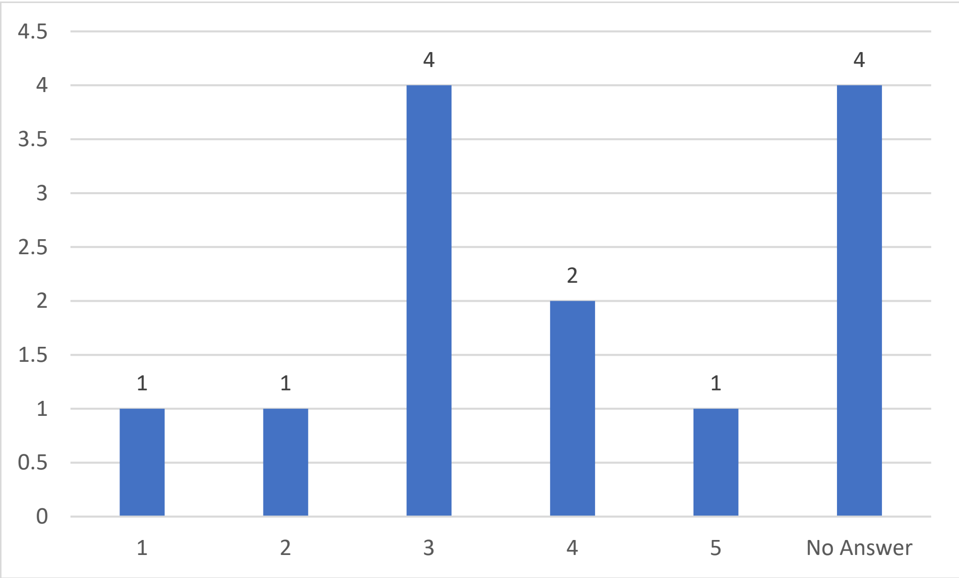
Describe any other potential solutions for this scenario:

- "Have train close gate earlier and have gates so people can't go around"
- "Re-time lights in the area / eliminate lights and reroute traffic to avoid backup"
- "Maybe speed bumps before the crossing to slow traffic"
- "Make it a silent crossing"
- "Install queue-cutter signal"

Educational Programs

Survey participants were asked to rate how effective current educational programs are at teaching people (including children and new drivers) about how to stay safe around railroad crossings. Examples provided include Operation Lifesaver presentations as well as driver education programs.

The rating scale was from 1, being the worst, to 5, being the best.



The average rating of existing educational opportunities was 3.27 out of 5.

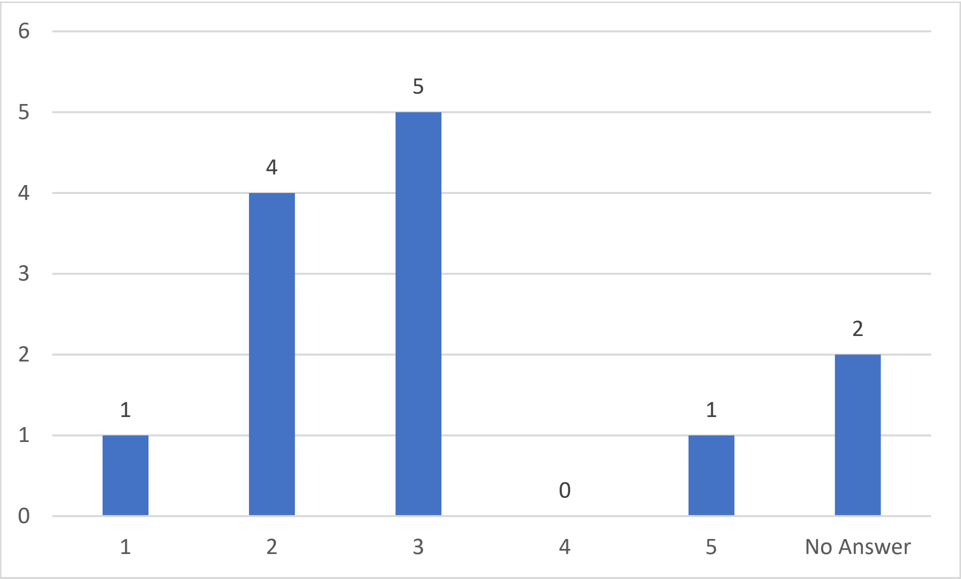
Survey respondents provided comments on the opportunities to improve highway-rail grade crossing safety education:

- “You would think that it would be common sense to be vigilant at railroad crossings... maybe a video presentation at all schools showing typical accidents...and at driver license stations, must watch before getting a license.”
- “Focused crossing safety blitz's”
- “Focused OL driver safety presentations.”
- “Better education and better enforcement”
- “Using collected data, use geofencing, social media, billboards and radio to target specific areas and the demographic involved in rail incidents. This will encourage the public to make smart decisions around tracks and trains.”

Safety Enforcement

Respondents were asked to rate current enforcement programs, and their ability to influence people (including pedestrians and drivers) to behave safely around railroad crossings. Examples provided were traffic and trespasser citations.

The rating scale was from 1, being the worst, to 5, being the best.



The average rating of existing safety enforcement was 2.67 out of 5.

Survey participants responded with opportunities for improving highway-rail grade crossing safety enforcement:

- "Crossing cameras"
- "Driving around gates probably needs stiffer penalties"

6.0 Highest-Priority Highway-Rail Grade Crossing Safety Challenges Statewide

This section identifies the highest priority highway-rail grade crossing safety needs and challenges in Ohio and related key areas of need/emphasis areas as preliminarily identified during development of the data and risk assessments undertaken by ORDC/PUCO, reviewed by stakeholders during outreach, and confirmed for development of the SAP's action plan.

6.1 Final Key Areas of Need/Emphasis Areas

After a review of the recent accident/incident history and existing grade crossing characteristics in Ohio through the risk assessment and in consideration of inputs from stakeholders and the public during outreach, ORDC and PUCO confirmed final key areas of need/emphasis areas that would be used to develop goals and objectives for improving highway-rail grade crossing safety statewide and for developing the SAP action plan. These include:

- **Crossings in Densely Populated Areas:** Highway-rail grade crossings located in denser and more developed areas of Ohio present unique challenges. These crossings often have higher traffic volumes than their counterparts in less densely populated areas and are also more likely to have commercial accesses, private driveways, and intersections with public roadways in close proximity to the crossing. These crossings are also more likely to host pedestrian and bicycle traffic.
- **Vehicles Stopped on Crossings:** This includes instances of vehicles stopped or stalled on the tracks at the crossing prior to being struck by a train. In some cases, this may be the result of a tractor-trailer becoming high-centered and stuck due to a severely humped crossing. In other cases, the queue of vehicles stopping at an adjacent traffic signal may extend onto the crossing (called a Short Storage Crossing). This is caused by a short roadway segment of 200 feet or less between the railroad tracks and the adjacent intersection, which creates the potential for traffic stopping at a traffic control device (i.e., stop/yield sign or traffic signal) to queue across the railroad tracks.
- **Automobile Incidents:** A review of the recent accident/incident history in Ohio shows that approximately two thirds of accidents/incidents have involved automobiles in the previous ten years. This is a significantly higher rate when compared to the national average.

- **Circumvention of Active Warning Devices:** A review of the recent accident/incident history shows that 26 percent of accidents/incidents in the previous ten years have involved motorists driving around the gates compared to 16 percent for all other states in the US.

6.2 Identification of Potential Improvement Strategies

This section identifies and describes potential strategies that have the greatest potential to focus resources that improve safety, minimize fatalities and injuries, and mitigate challenges on the state's highway-rail grade crossing network. Strategies address the "4 E's" of safety – Engineering, Education, Enforcement, and Emergency services – and consider effective and affordable countermeasures that can be deployed for site-specific locations or systematically throughout the state.

6.2.1 Examples of Potential Improvement Strategies

Many potential strategies are available to address highway-rail safety concerns and to make investments that mitigate risk. ORDC and PUCO are currently employing many of these countermeasures and has considered future implementation of others. These potential countermeasures can be considered for systematic deployment across the state highway-rail grade crossing network by ORDC and PUCO at those crossings identified as having a statistically higher-risk as well as at locations that do not have a history of accidents/incidents but possess risk factors for potential accidents/incidents.

Engineering

Warning Device Upgrades

The gates, flashing light signals, and signage at highway-rail grade crossings are the primary means of alerting highway users that a train will soon be arriving at the crossing. At a minimum, crossings should be equipped with passive signage including crossbucks and stop or yield signs. The installation of active warning devices such as flashing light signals increases the visibility of a crossing.

The additional installation of gates provides a physical barrier to prevent motorists from traversing the crossing. This may include the standard two-quadrant gate (one for each direction of vehicular travel), but also the potential for four-quadrant gates (one for each side of the lanes of travel on the roadway) which completely block the crossings. While typically more complicated and more expensive than standard two-quadrant gates, four-quadrant gate systems are more effective in reducing risk with minimal impact to adjacent roadway accesses and infrastructure.

Roadway Improvements

Improvements to the highway-rail grade crossing approaches also play a key role in improving crossing safety. Maintaining adequate quality for pavement on the approach and the crossing surface itself helps motorists maintain control of their vehicles while traversing the crossing. Designing crossings to minimize skew and avoiding severe grade transitions also allows motorists, pedestrians, and bicyclists to identify oncoming trains and stop more easily if necessary.

The installation of medians or channelization devices on roadway approaches may also be used in combination with gates and flashing light signals to make it more difficult for motorists to circumvent or drive around the gates when the gates are in the down positions. This combination of gates with medians or channelization devices has a similar effect on risk reduction as the four-quadrant gates discussed above but are typically more cost effective.

Additional roadway improvement options include passive and active advance warning signage, transverse rumble strips, and other advance warning systems to alert motorists prior to arriving at crossings.

Grade Separations

It is a common adage in the railroad industry that the safest crossing is no crossing at all. While the cost of a new grade separation project can be substantial, these projects result in a complete elimination of crossing risk. Grade separations should be considered at crossings where standard safety improvements are not sufficient, or where the frequency of the crossing being occupied by trains poses a risk to maintaining access for emergency services.

Crossing Closures

The closure or consolidation of crossings may also be used to improve safety throughout the state. Potential closures should be thoroughly reviewed to determine the potential impact on traffic and pedestrian circulation as well as the impact to emergency services response times.

Crossing Illumination

Maintaining sufficient illumination at crossings aids in crossing visibility for both motorists and approaching trains, particularly at passive crossings.

Education

Coordination with Ohio Operation Lifesaver

Operation Lifesaver, Inc. is a non-profit public safety education and awareness organization that strives to increase awareness of highway-rail grade crossing safety issues. Ohio Operation Lifesaver provides statistics and educational materials related to grade crossing safety in Ohio. Volunteers with the organization are also available to give educational presentations to groups such as students, professional truck drivers, and company safety programs.

Social Media Outreach

Many state DOTs are increasingly relying on social media platforms such as Facebook, Instagram, Twitter, and others to provide the public with information on roadway construction projects, stakeholder engagement opportunities, and general safety tips. These outlets may also be used to periodically post information regarding best practices for grade crossing safety to encourage safe habits and behavior for motorists and pedestrians.

Enforcement

Coordination with Law Enforcement

Local law enforcement agencies are often familiar with the locations of potentially problematic grade crossings. Routine coordination between ORDC and PUCO staff and law enforcement agencies will help to ensure that safety issues are identified early. Law enforcement personnel may also be able to assist with safe grade crossing practices through enhanced awareness and periodic enforcement and ticketing efforts.

Emergency Services

Identify Routinely Blocked Crossings

During day-to-day railroad operations, it is common for a train to block a crossing for extended periods of time while conducting switching at railroad yards or other routing operations. An extended blockage may negatively impact the response time for emergency responders such as fire, police, and emergency medical services (EMS). Coordination with local emergency services providers to identify locations of concern will help ORDC and PUCO staff to properly assess the situation and help to identify potential mitigation measures. In some cases, additional coordination with the railroad may reduce or eliminate blocked crossing concerns, while in other cases more extreme measures such as grade separations may be the only long-term solution.

Identifying Crossings Near Potentially Sensitive Land Uses

The proximity of highway-rail grade crossings to sensitive land uses such as schools and hospitals should be taken into consideration when evaluating potential crossing safety improvements. In addition to the potential for increased pedestrian activity, these crossings may also need to consider the impact of crossing delays as described above. Coordination with stakeholders in these sensitive groups will help to identify safety issues and also provide opportunities for education regarding general crossing safety issues.

7.0 Action Plan

7.1 Action Items that Addressed 2011 State Action Plan Challenges

In addition to completing many state objectives identified in the 2011 Ohio State Action Plan, the state undertook four distinct action items to address general program challenges:

1. First, the state established an LED Upgrade program in 2012. Due to ongoing complaints and maintenance issues with incandescent lights, the state identified that there were many crossings equipped with flashing light signal systems that had older 8" incandescent lights. To improve visibility and reduce maintenance requirements, the state established a program to upgrade 8" incandescent lights to 12" LED lights. The initial program in 2012 upgraded 341 crossings flashing light-only crossings. An additional 26 grade crossings that year also received the new 12" LED lights as part of the installation of new active warning devices. Ohio's program resulted in a reduction of complaints concerning flashing light failures at crossings with active warning devices. After that initial project, the state upgraded 120 more flashing light signal systems with 12" LED lights. In 2021, the state appropriated for FY 2022 and FY 2023 an additional 2 million dollars in state funds to be spent on upgrades to replace all incandescent lights at all grade crossings. Ohio is currently in the first FY of this additional funding. It is anticipated that over 128 crossing upgrades will be ordered in FY 2022 using these additional funds.
2. The state also funded a program to replace the pilot Buckeye Crossbuck assemblies after there were no significant findings, as well as all other crossbuck assemblies to support the change in retroreflectivity standards. The state partnered with the railroads to replace signs at over 2,000 passive crossings in the state. The result of this program brought every passive crossing in the state into compliance with the new MUTCD placement and reflectivity standards in a timely manner, as well as establishing or renewing partnerships with the railroads that continue today.
3. Additionally, the state has increased outreach efforts specifically geared towards educating the traveling public, law enforcement, and professional transportation drivers on the blue Emergency Notification Sign (ENS). An ENS slide is included in all state presentations, provided on handouts at informational sessions, and mentioned in conversations with members of the public who are new to or unfamiliar with the rail industry. In 2019, the PUCO developed ENS sign educational materials (magnets, stickers, and cards). These materials were distributed to school districts for school bus driver

education and have also been distributed to Ohio Operation Lifesaver for distribution in educational booths.

4. Lastly, the state wished to address hazard index forecasting limitations. The state conducted a study to analyze the hazard ranking model used by rail safety agencies in Ohio to prioritize highway-railroad grade crossings for safety improvements. It was determined at the time that there was no evidence to indicate that a different model than the currently used hazard ranking model would provide a superior hazard ranking of highway-railroad grade crossings in Ohio, and the Ohio University research team recommended ORDC and other state agencies continue to use the current model.

7.2 New Initiatives Since 2011

The state undertook new initiatives since 2011 in order to create a more comprehensive grade crossing safety program, partner with other state agencies and their safety organizations on a more coordinated and official level, increase educational outreach efforts, and benchmark the programs with state and industry efforts.

1. In 2015, the state undertook a pilot surface program to partner with railroads on crossing surface replacements on the state system. Railroads agreed to fund surface repairs at a 50 percent level, with the state funding the other 50 percent, and signed on to actively maintain or replace surfaces if the surface fails before the industry warranty expired. This program enabled the state to expedite the replacement of substandard grade crossing surfaces at 22 locations and guarantee to the traveling public that these crossings will remain in good condition for years to come. This approach is now utilized by ODOT for its roadway resurfacing program.
2. The state has also expanded its presence with multiple safety organizations throughout the state. Staff participates in the routine update of the State Highway Safety Plan (SHSP) and attends the SHSP steering committee meetings. As a member of the steering committee, the state has utilized the group for outreach with public sector partners for input on crossing safety issues, receiving feedback that allows the state to review and adapt practices. Additionally, the state holds two seats on the Ohio Operation Lifesaver board, provides grant funding for the organization, and actively participates in their outreach activities. These activities include tabling at the Ohio State Fair to disseminate information and providing presentations across the state on request. The state also attends a variety of community-centric conferences such as the Ohio Township Association's annual conference and the Ohio County Engineer's Conference, as well as regional state safety conferences.
3. The state hosts all Ohio railroads every few years for a grade crossing safety summit in order to discuss changes in the industry regarding grade crossing safety projects and

Ohio's rail safety programs. The state routinely asks railroads for feedback on the programs described in this document and how they compare to other state programs. The state uses this industry benchmarking in conjunction with inward and outward focused program reviews to adapt the programs to address changing community, railroad, and state needs. By constantly reviewing the safety programs, Ohio strives to run a more proactive, rather than reactive, state program.

4. The Adaptive Capacity Study (ACS) was jointly conducted by ORDC and ODOT in 2019-2020. The ACS developed, applied, and validated a methodology to evaluate the relative impact of occupied public railroad-highway grade crossings on road users and communities in Ohio. It does this on the basis of multiple criteria including public importance, delay to road users, redundancy, and safety. The resulting "Adaptive Capacity Score" provides an empirical basis to identify which crossings warrant prioritized consideration for potential investment. This prioritization in turn will provide an input to the process of directing limited public resources to roadway or railroad improvements at locations with the most significant impacts to public users and communities. Additional work is proposed to further the ACS by addressing concepts identified during development of the original work, as well as developing a schedule for updating the data and a methodology for improving the tool's availability to communities and stakeholders statewide.

7.3 Current Actionable Objectives

7.3.1 Objective 1: Update the State's Railroad Crossing Inventory Database

Beginning in 2016, the state began the process of replacing the previous railroad crossing inventory database with a technologically up to date, integrated geographic information system (GIS) enabled program equipped with improved data sharing and analysis tools. A field version of the application was built which allows for real-time field review and collection of crossing data attributes and other safety-related data by the State's rail inspectors.

This new database provides the following benefits:

- Additional functionality for ORDC and PUCO staff
- More grade crossing data consistency between state agencies
- Consistency with FRA grade crossing inventory forms
- New public-facing interface for improved access to grade crossing data

7.3.2 Objective 2: Extra Mile Program for Crossings that Have Experienced Accidents/Incidents

In response to the statistic that over 80 percent of accidents in Ohio occur at grade crossings already equipped with active warning devices, the state has implemented the Extra Mile Program. Initiated in 2015, staff review most recent hazard indexes and crashes and identify the crossings in the state most likely to experience accidents/incidents, according to the FRA WBAPS which have not had recent reviews or upgrades. Diagnostic reviews are held at each of these locations with the specific goal of reducing the likelihood of future accidents. The review team together with state, railroad, and local partners meet with additional community representatives, including engineers, EMS, and school administrators to look for possible safety solutions. Because the identified crossings already have active warning devices, the attendees are instructed to consider innovative solutions to improve the safety of train and vehicular movements through the crossing, looking beyond the crossing to roadway configurations, speed limit, traffic type, etc. Situation-specific treatments such as channelization, improved crossing illumination, and/or pavement markings may be considered as a part of this program. In federal FY 2021, four new projects were initiated to address various safety concerns at these crossings.

7.3.3 Objective 3: Changes in the State's Approach to the Corridor Program

The State of Ohio strives to find the best possible way to accomplish the upgrade of passive and potentially obsolete active warning devices to state-of-the-art flashing light signal systems and train-activated automatic gates at as many crossings as possible. The Corridor Program allows Ohio's partner railroads to coordinate upgrades along corridors with high rail traffic density and multiple passive or otherwise antiquated active warning devices in alignment with the state's goals. In addition, the railroads and state will partner to negotiate the elimination of redundant crossings within these corridors, where possible. This partnership allows for cost sharing of railroad and public funds towards a common objective of improving safety along critical rail corridors.

The State of Ohio continues to work with railroad partners towards the development of additional future Corridor projects. However, the state has made a conscious shift away from expansive corridors, encompassing multiple communities, towards smaller corridors, approaching each community individually. The state has found this approach more successful in negotiating roadway closures within a community, completing the corridor more quickly, and establishing solid working relationships between the state, community, and railroad that are beneficial to all parties. The state will continue the Corridor Program in this manner for the foreseeable future.

7.3.4 Objective 4: Preemption Program

Motorists queuing at highway traffic signals in close proximity of highway-rail grade crossings will often foul the tracks while waiting for the intersection to clear – increasing the potential for collisions and resulting injuries and fatalities at grade crossings. Signal preemption (the interconnection between highway-rail grade crossing warning devices and highway traffic signals), is a method to reduce the likelihood of vehicles fouling the tracks when a train is approaching. Preemption is now a requirement for all grade crossings with controlled highway intersections within 200 feet. Crossings with queuing from controlled intersections in excess of 200 feet are also considered for preemption. The state identified approximately 200 highway-rail grade crossings that have, or should have, interconnection with nearby highway traffic signals. These crossings are being prioritized and evaluated for potential improvements to reduce the likelihood of accidents/incidents. The Preemption Program will reduce the human factor of motorists being stopped on the tracks when a train is approaching, thereby increasing grade crossing safety. Improvements are programmed based on priority and funding availability. In addition to preemption projects meeting the state's standards, the state partners with railroads and communities on all crossings with queueing issues using a variety of alternative traffic control measures to reduce risk of vehicles occupying crossings for extended periods of time.

7.3.5 Objective 5: LED Upgrade Program

As part of the LED upgrade program, the state has made the decision to pursue the elimination of all incandescent lights at all crossings in the state. To begin this initiative, the state surveyed the railroads to determine the location and number of crossings with incandescent lights. The state appropriated for FY 2022 and FY 2023 an additional $2 million in state funds to be spent on LED upgrades. Ohio is currently in the first fiscal year of this additional funding. It is anticipated that over 128 crossing upgrades will be ordered in FY 2022 using these additional funds. Additional funding will be needed in future fiscal years to complete this objective.

7.3.6 Objective 6: Policy Guidance for Non-Motorized Transportation

Ohio is increasingly aware of the need to include pedestrian and bicycle traffic in grade crossing safety improvements. A number of efforts converge at highway-rail grade crossings, such as *Toward Zero Deaths* campaign goals, anticipated changes in MUTCD for pathway and pedestrian crossings, and Americans with Disabilities Act (ADA) compliance. The state has developed guidance incorporating non-motorized treatments into future highway-rail grade crossing safety projects and is currently working with ODOT to integrate this guidance into other related traffic engineering resources.

7.3.7 Objective 7: Best Practices for Community Growth Near Highway-Rail Grade Crossings

Suburban growth in exurban areas as well as residential infill, entertainment districts, and transit-oriented development near city centers have the potential to increase vehicular and pedestrian traffic at existing highway-rail grade crossings. In response to this, the state proposes to increase awareness among groups with a role in transportation planning, zoning, and development in Ohio.

7.4 Challenges to Program Success

Railroad infrastructure is generally privately owned and privately operated in the State of Ohio. Therefore, essentially all projects require some level of consensus among the parties involved, as well as Public Private Partnership (PPP) Agreements.

Additionally, data integrity is critical to good project selection. It is a continuous struggle to maintain timely and accurate data that provide for informed decisions. This challenge primarily comes from two sources: 1) the continually changing traffic counts for both roadways and railroads, and 2) the current FRA process that does not allow states to easily access updates made to the federal system by railroads. The state agencies are working cooperatively on the road traffic data collection issues. Unfortunately, the FRA train count issues rely on actions at the federal level, beyond the state’s control.

Continued crashes at gated crossings (multiple-crash locations) pose a significant challenge to the state when identifying further improvements at these locations. Often, if an engineering solution is available, it requires cooperation of multiple parties outside the state’s regulatory authority.

Limited funding also restricts the reach and impact of the program; however, the additional program eligibility authorized by the FAST Act and the IIJA has allowed non-traditional (i.e., non-light and gate) projects to receive funding. The state will continue to work with FHWA to establish project scopes that address safety concerns not previously eligible. One area that severely restricts the state’s program scope is the lack of statutory authority and funding outside of public crossings (including private crossings and trespassing issues away from at-grade crossings).

Another significant challenge to the state is the creation and implementation of quiet zones. There is no official state role for the establishment of quiet zones. However, communities often reach out to state staff as a result of prior coordination on other safety-related grade crossing projects. The state readily advises these communities to reach out to the FRA for further assistance but receives no further feedback or follow-up. Improved communication from the FRA to the state when quiet zones are established, what crossings are included, and what capital improvements were made in conjunction with the creation of a quiet zone would be extremely helpful to the state for monitoring and crossing inspection purposes. Additionally, more formal training from the FRA would benefit communities seeking to pursue quiet zones.

Lastly, there are limitations to hazard index forecasting. While the state takes input from multiple sources to identify the most hazardous crossings in the state, the primary source for project development is statistical modeling. As discussed, the state conducted research to validate the models used, but by definition, the statistical models have inherent limitations that need to be recognized and accounted for.

8.0 Next Steps Defined as Short-Term and Long-Term Actions

Implementation of the Action Plan described in Section 7.0 will be the joint responsibility of both ORDC and PUCO. The proposed actions will be implemented in coordination with stakeholders such as the state's railroads, local roadway authorities, and various other public agencies. Representatives from these stakeholder groups have been involved throughout the development of the SAP and will have the opportunity to review the final planning documentation. ORDC and PUCO will further coordinate with stakeholders throughout the implementation of these goals and action items now and in the future. Table 12 below provides an overview of the short-term actions (for the four-year horizon for this SAP, or years 2022 to 2025) and long-term actions (for years 2026 to 2029) that will be undertaken to assist ORDC and PUCO in achieving the goals and objectives of this SAP.

Table 12 | Short-Term and Long-Term Action Summary

Actionable Objective	Short-Term (1-4 Years) 2022-2025	Long-Term (5-8 Years) 2026-2029
Objective 1: Update the State's Railroad Crossing Inventory Database	Determine what additional data to include in enhanced crossing inventory and begin to collect data. Develop inspection plan to collect enhanced data for all crossings within four years.	Finalize collection of enhanced grade crossing data. Review enhanced data to identify potential risk factors. Continue to consider other potential data to include in the enhanced grade crossing inventory.
Objective 2: Extra Mile Program for Multiple-Crash At-Grade Crossings	Continue to adapt the project selection approach to reflect changing trends.	Continue to monitor the effectiveness of the modified safety improvement selection process. Periodically review the hazard rating formula to ensure that the resulting risk levels correlate to actual accident/incident data. Consider implementation of additional factors collected in the enhanced crossing inventory.
Objective 3: Changes in the State's Approach to the Corridor Program	Continue to promote community-based corridor studies and projects to maximize the impact of planning efforts and mobilization of construction teams.	Revisit previous corridor studies and projects to verify efficacy of improvements; identify lessons learned to apply to future corridor studies and projects.
Objective 4: Preemption Program	Continue to identify potential opportunities for signal preemption at crossings where queuing at a nearby intersection is likely; begin to explore alternative traffic mitigation strategies.	Follow-up with local roadway authorities and railroads to verify that existing preemption is functioning as intended and is still warranted as conditions change.

Actionable Objective	Short-Term (1-4 Years) 2022-2025	Long-Term (5-8 Years) 2026-2029
Objective 5: LED Upgrade Program	Continue to use LEDs to replace incandescent lights at crossings.	Ensure that appropriate lifecycle planning is documented for eventual timely replacement of LEDs.
Objective 6: Policy Guidance for Non-Motorized Transportation	Continue to engage with the traffic engineering community to ensure that highway-rail grade crossing safety needs for non-motorized transportation are incorporated into guidance documents and manuals.	Follow up with planning and engineering practitioners to see if policy guidance has made an impact on planning and engineering work in their communities.
Objective 7: Best Practices for Community Growth Near Highway-Rail Grade Crossings	Perform outreach with stakeholders to determine how the presence of highway-rail grade crossings factors into local and regional transportation planning decisions.	Identify and integrate highway-rail grade crossing safety considerations into the applicable design guidance documents.

8.1 State Officials Responsible for Action Plan Implementation

Each state developing an SAP is mandated under Section 11401 of the FAST Act to designate a state official responsible for managing implementation of the SAP. The state officials responsible for managing implementation of this Ohio SAP are identified in Table 13 below.

Table 13 | State Officials Responsible for Action Plan Implementation

Name	Title	Agency	Phone	Email
Jill Henry	Rail Division Chief	Public Utilities Commission of Ohio	614-466-1150	Jill.henry@puco.ohio.gov
Matthew Dietrich	Executive Director	Ohio Rail Development Commission	614-644-0295	Matt.dietrich@dot.ohio.gov