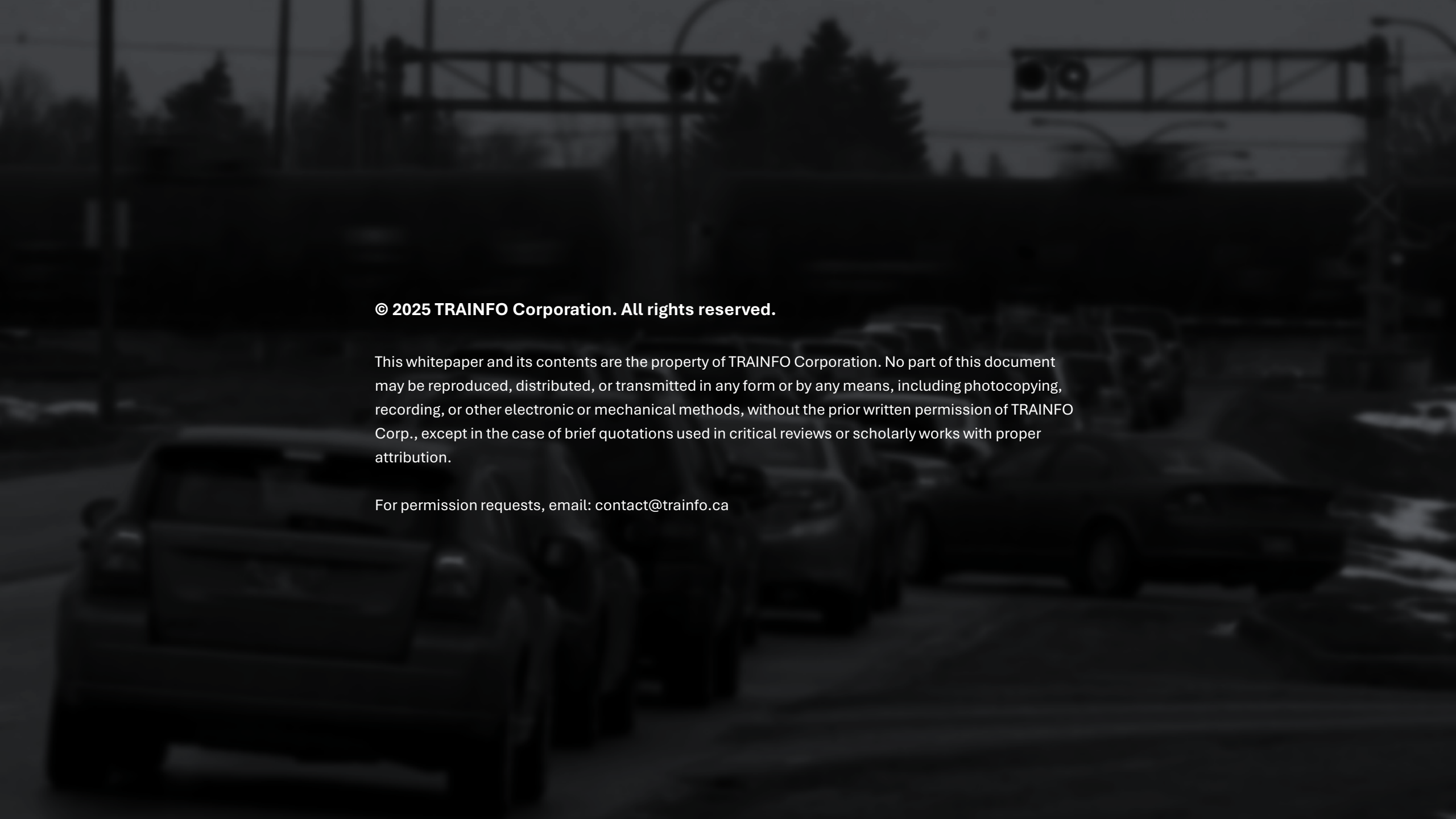
Whitepaper

Rethinking Rail Crossing Safety and Mobility:

An Introduction to Rail Crossing Information Systems

TRAINFO



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Executive Summary

Rail crossings present complex and costly safety and mobility challenges in communities across North America. Traditional infrastructure approaches like grade separations are expensive, disruptive, and slow to implement. This whitepaper introduces Rail Crossing Information Systems (RCIS) as a new and highly effective alternative that provides real-time, predictive, and integrated information to road users and emergency responders. RCIS enables cities to reduce congestion, collisions, and emergency delays at a fraction of the cost of grade separation. This paper outlines the RCIS concept, its benefits, implementation roadmap, and real-world results.

1. Understanding the Problem

Blocked and occupied rail crossings cause wide-ranging societal, operational, and economic problems. The impacts are often underestimated, yet they affect thousands of road users every day.

Key challenges include:

- **Traffic Congestion:** Trains that block crossings create traffic backups that can extend across multiple intersections and disrupt network-wide traffic flows.
- **Collision Risks:** Drivers may engage in risky behavior, such as trying to beat the train or violating warning signals.
- **First Responder Delays:** Blocked crossings delay ambulances, fire trucks, and police, which can lead to increased property damage and higher fatality rates.
- **Public Complaints:** Citizens often express frustration about perceived inaction, which can erode trust in public agencies.

Despite installing standard safety devices like flashing lights, bells, and gates (FLBG), these problems persist. Grade separation has been the go-to recommendation, but it often proves infeasible due to high costs (often $30–$100M per site), lengthy timelines (5–10 years), and potential community disruption.

Many cities and counties feel stuck between ineffective solutions and unaffordable ones.

The Hidden Crisis at Rail Crossings

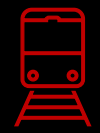
Rail crossings are an overlooked but urgent public safety and mobility issue across North America. While major crashes and derailments draw headlines, the more frequent and persistent challenge occurs at the thousands of locations where railroads and roadways intersect—often with tragic consequences.

Every 3 hours there's a rail crossing collision

On average, there is a collision at a rail crossing every 3 hours. Each day, at least one person loses their life as a result. These incidents are not confined to rural or poorly equipped areas—approximately 2/3 of all rail crossing accidents occur at locations already outfitted with active warning devices like flashing lights, bells, and gates. Even with these systems in place, 25% of all accidents happen because drivers are trying to outrun the train. This data points to a sobering conclusion: traditional infrastructure alone is not enough.

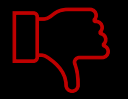
2/3 of collisions occur at active crossings

What's more troubling is that progress has stalled. Between 1981 and 2000, annual rail crossing collisions fell from 9,461 to 3,502—a remarkable 63% decrease, averaging about 5% improvement per year. But in the last 15 years, that momentum has completely disappeared. Instead of continued reductions, the number of incidents has held steady or even risen, with an average 1% annual increase in collisions since 2015.



Trains are 25% longer today than 2008

Meanwhile, the operational landscape is becoming more complex. Train lengths have increased by 25% between 2008 and 2018, meaning longer blockages, more traffic disruption, and greater risk at crossings. Public frustration is rising as well: complaints about blocked crossings have more than doubled in just five years, from 10,405 in 2020 to 26,729 in 2024.



Public complaints have doubled in last 5 years

This convergence of persistent collisions, longer trains, and growing public dissatisfaction highlights a critical gap: existing tools—while necessary—are no longer sufficient. To reduce risk and improve traffic flow, cities and agencies need a smarter, scalable solution that adds a layer of intelligence and communication to crossings. That's where Rail Crossing Information Systems (RCIS) come in.

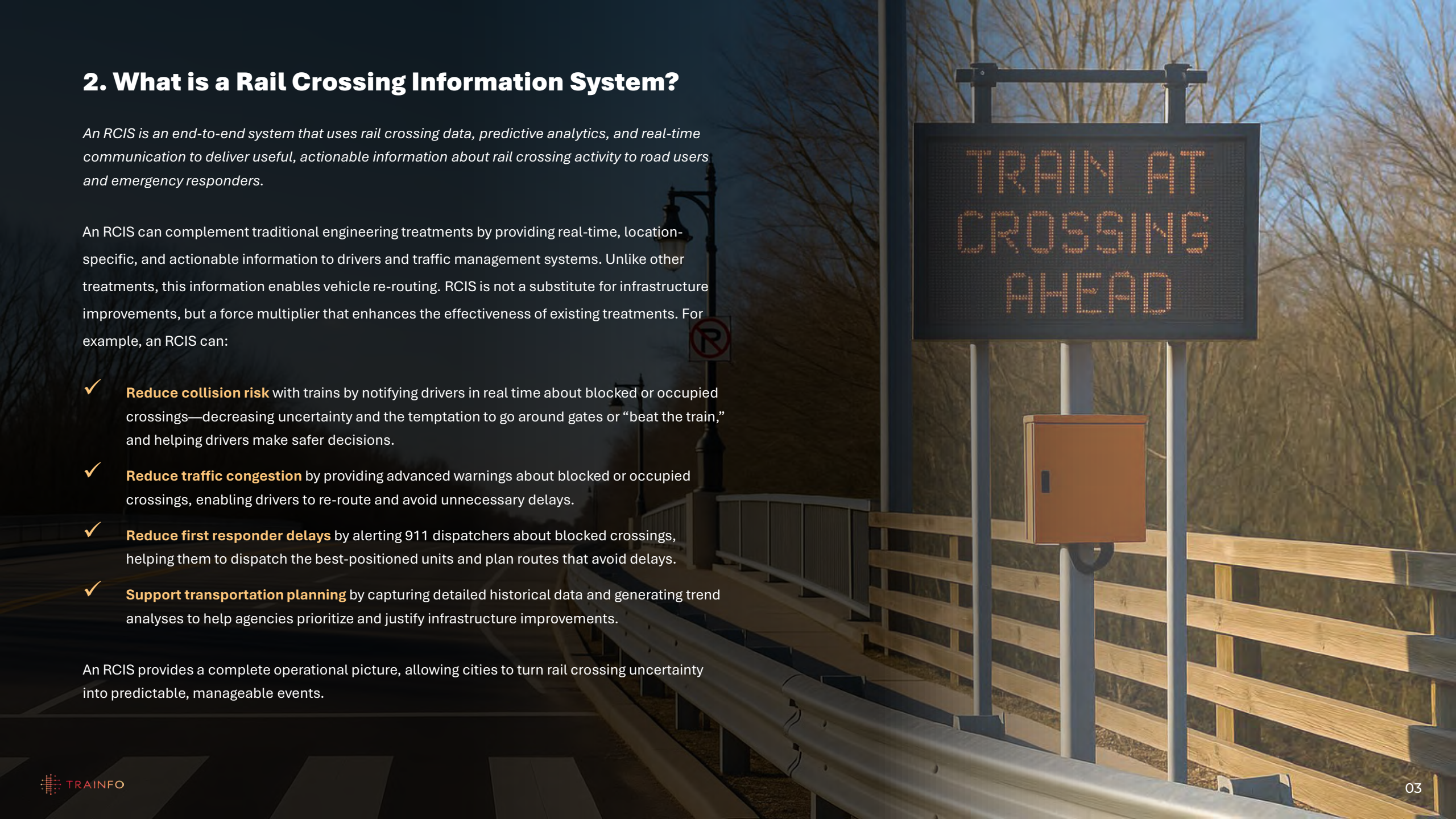
2. What is a Rail Crossing Information System?

An RCIS is an end-to-end system that uses rail crossing data, predictive analytics, and real-time communication to deliver useful, actionable information about rail crossing activity to road users and emergency responders.

An RCIS can complement traditional engineering treatments by providing real-time, location-specific, and actionable information to drivers and traffic management systems. Unlike other treatments, this information enables vehicle re-routing. RCIS is not a substitute for infrastructure improvements, but a force multiplier that enhances the effectiveness of existing treatments. For example, an RCIS can:

- ✓ **Reduce collision risk** with trains by notifying drivers in real time about blocked or occupied crossings—decreasing uncertainty and the temptation to go around gates or "beat the train," and helping drivers make safer decisions.
- ✓ **Reduce traffic congestion** by providing advanced warnings about blocked or occupied crossings, enabling drivers to re-route and avoid unnecessary delays.
- ✓ **Reduce first responder delays** by alerting 911 dispatchers about blocked crossings, helping them to dispatch the best-positioned units and plan routes that avoid delays.
- ✓ **Support transportation planning** by capturing detailed historical data and generating trend analyses to help agencies prioritize and justify infrastructure improvements.

An RCIS provides a complete operational picture, allowing cities to turn rail crossing uncertainty into predictable, manageable events.



Key Components of an RCIS

1st Component
Data Collection

The first core component of an RCIS is accurate and reliable train detection.

Our sensors are installed off rail property, eliminating the need for railroad approvals and streamlining deployment. These sensors capture critical data such as the activation status of warning systems, train presence, speed, direction, and whether the train is freight or passenger. Built-in edge computing ensures real-time quality control, while onboard modems wirelessly transmit validated data to our cloud servers. With greater than **99.99% accuracy**, this component delivers the trusted foundation needed for effective rail crossing insights and public safety interventions.

2nd Component
Predictive Analytics

The second core component of an RCIS is our cloud-based analytics engine.

Leveraging machine learning algorithms built on data from more than 1 million trains and patented processes, it predicts when rail crossings will activate and clear—with an **accuracy of ±1 minute, 90% of the time**. The system can also integrate traffic data to assess and forecast the impact of blocked crossings on vehicle delays. This predictive insight transforms raw train detection data into actionable intelligence, empowering agencies to manage traffic flow, emergency response, and public communication more effectively.

3rd Component
System Integrations

The third core component of an RCIS is seamless integration with public and operational systems.

Real-time data—delivered in under 2 seconds from detection—is shared via APIs to roadside dynamic message signs (DMS), static signs with flashing beacons, mobile navigation apps like Waze, and advanced traffic management systems (ATMS). It also connects to computer-aided dispatch (CAD) for 911 services, 511 traveler information systems, and fleet management platforms for transit and commercial vehicles. These integrations ensure timely, location-specific information reaches the right people, improving safety, response times, and traffic coordination.

RCIS and the 3E's Framework

Efforts to improve safety and mobility at rail crossings are traditionally organized under the "3E's" framework: Engineering, Education, and Enforcement. Each pillar addresses a different aspect of risk mitigation and operational efficiency. While Education focuses on raising public awareness and Enforcement ensures compliance with laws and regulations, Engineering applies physical and technological solutions to reduce conflicts between rail and road users.

By integrating seamlessly with other engineering interventions, RCIS offers a cost-effective and scalable approach to managing the operational challenges posed by at-grade crossings. It helps cities and agencies make smarter use of their infrastructure investments while advancing the shared goals of the 3E's—enhanced safety, improved mobility, and better compliance at rail crossings.

Education — **Engineering** — Enforcement

Flashing Lights, Bells, and Gates

Standard active warning devices that alert drivers about trains at the crossing

Rail Crossing Information Systems

Real-time and predictive notifications that alert drivers about trains in advance of the crossing to enable re-routing

Channelization & Pavement Markings

Measures such as medians, bollards, and dynamic envelopes that discourage unsafe movements around gates and clarify safe zones for drivers

Traffic Signals

Tools like pre-emption, pre-signals, and queue cutters that help synchronize highway signals with rail activity to prevent vehicle queuing on tracks

Grade Separations

The most robust solution—physically separating road and rail traffic through overpasses or underpasses

3. Video Cameras and Pre-emption are not an RCIS

A common misconception is that a Rail Crossing Information System (RCIS) is simply a video camera that detects trains. While train detection plays a role in RCIS, it represents only a fraction of what a true RCIS encompasses.

	Video Cameras & Pre-Emption	RCIS (TRAINFO)
Accuracy	× Video detection systems typically offer up to 90% accuracy under ideal conditions, but accuracy can degrade due to weather, lighting, and occlusion. × Pre-emption systems rely on track circuit activations, which can be triggered without a train actually occupying the crossing or activating the warning system. × Up to 20% of pre-emption signals are false positives without a train at the crossing.	✓ Independently verified 99.99% accuracy in field tests, with reliable performance across all train movements—including stopped, switching, and shunting. ✓ Accurately detects warning system malfunctions, and ignores irrelevant events like false pre-emption signals, providing a true picture of crossing status and traffic impact. ✓ Unaffected by environmental conditions like sun glare, rain, snow, or obstructed sight lines—ensuring consistent, around-the-clock reliability.
Predictive logic	× Cannot predict when a crossing will be blocked or cleared, or how long delays will last. × Provide no insight into traffic impacts without costly customization and calibration.	✓ Forecasts train presence and how long a crossing will be blocked and when it will clear. ✓ Informs drivers about how long they will be *delayed*, not simply how long the train will be occupying the crossing.
Integrations	× Typically do not support real-time integration with third-party systems. × Building these integrations requires extensive testing and joint development with other vendors—a process that can take years and may still result in limited functionality.	✓ Distributes information to multiple platforms — including roadside signage, navigation apps, traffic management centers, and emergency response systems — so users receive it where and when they need it.
Operational intelligence	× Do not offer a centralized dashboard or analytics platform.	✓ Includes a dashboard with historical trends, real-time metrics, and actionable intelligence for both operations and long-term planning.
Support and maintenance	× Maintenance of these systems often falls on in-house staff, usually leading to neglect and eventual system failure or obsolescence. × Typically no reinvestment or software improvement after installation.	✓ Vendors like TRAINFO provide continuous updates, performance monitoring, diagnostics, and customer support to ensure long-term effectiveness.

Why Train GPS Data Is Not a Feasible Solution

While it may seem logical to use train GPS data from railroads to predict or monitor rail crossing activity, this approach is highly problematic in practice.

Public agencies considering this path face serious limitations—both legal and technical—that significantly reduce its reliability, coverage, and usability. Six main limitations are provided here.

Bottom line: Train GPS data is not a viable foundation for a rail crossing information system. A purpose-built RCIS—using trackside detection, predictive analytics, and direct integration with traffic systems—offers a far more accurate, scalable, and agency-controlled solution for improving safety and mobility at rail crossings.

1. NO INSIGHT INTO CROSSING MALFUNCTIONS

Train GPS data does not detect or explain malfunctions of crossing infrastructure—such as gates stuck in the down position—which still cause major traffic delays and safety issues. Without direct monitoring of the crossing itself, key failure modes remain invisible.

2. TECHNICAL COMPLEXITY AND LACK OF STANDARDIZATION

Even if access is granted, the technical barriers are likely substantial. Railroads may use different data formats, update intervals, and GPS accuracy standards. Public agencies would be responsible for converting disparate data sources into a uniform, reliable format—an effort that requires significant investment in IT infrastructure and ongoing maintenance.

3. INCOMPLETE COVERAGE DUE TO TRACKAGE RIGHTS

Many rail corridors are shared by multiple railroads through arrangements known as *trackage rights*. Unless data is obtained from **every** railroad operating on a shared track, public agencies will lack a complete picture of train movements. This results in missing critical blockage events and leaves gaps in situational awareness, undermining the reliability of any system built on partial data.

4. RESTRICTIONS ON USE, STORAGE, AND REPORTING

Even with access to the data, agencies may be limited in what they're allowed to do with it. Railroads often prohibit long-term storage, detailed historical analysis, or integration into broader traffic management systems. These restrictions significantly reduce the data's strategic and operational value.

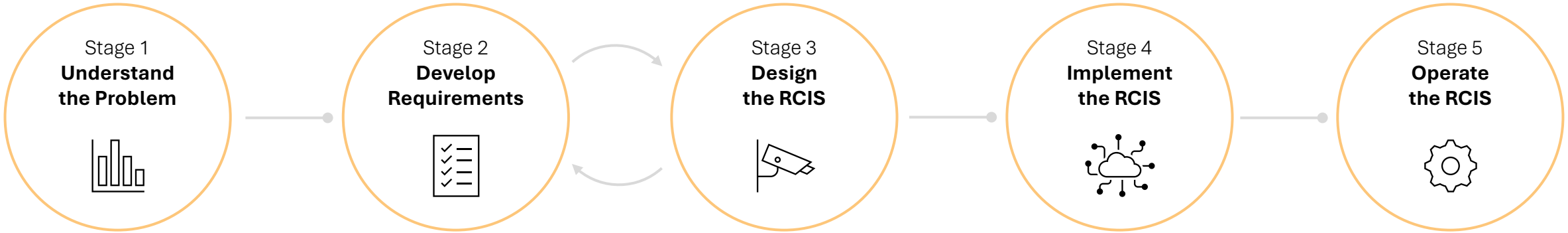
5. POOR VISIBILITY OF SWITCHING AND SHUNTING MOVEMENTS

Train GPS data typically lacks precision in low-speed switching or yard operations—exactly the kinds of movements that can block crossings for extended periods without being reflected accurately in GPS signals. These activities are common in urban areas and can cause some of the most unpredictable and frustrating delays.

6. LEGAL AND CONTRACTUAL BARRIERS

Accessing GPS data from freight railroads often requires extensive legal negotiations. Railroads are private entities with proprietary concerns and may impose strict conditions on data sharing—if they allow access at all. Negotiating these agreements can take years and may result in restrictions that severely limit the usefulness of the data.

4. The Five Stages of Implementing an RCIS



Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Quantify congestion, accidents, 911 delays	**Determine solution & performance specs**	**Select technologies and locations**	**Install the system and complete integrations**	**Operate and maintain the system**
This stage ensures you are targeting the right issues in the right places. Plus, it can help you build the business case and get funding.	This stage informs technology selection, scope, and budget. It's often iterative with Stage 3.	This stage selects technologies and develops the installation plan to meet system requirements. It's often iterative with Stage 2.	This stage involves installing equipment in the field, calibrating sensors, and integrating the system into third-party applications.	This stage involves preventing system failures, updating software, maintaining security credentials, and sustaining integrations.
Questions to answer: • Which crossings and streets are impacted? • What is the magnitude of these impacts? • Who's impacted and when?	**Questions to answer:** • What level of improvement is desired? • How much budget is available?	**Questions to answer:** • How am I getting rail crossing information data? • Where can I install sensors and signs? • Where do I need to deliver this information?	**Questions to answer:** • Who's responsible for field installation? • Which third-party systems need integrations?	**Questions to answer:** • Who's responsible for ensuring system uptime? • Who's responsible for system updates? • Who's responsible for monitoring integrations?

5. Cost-Effectiveness

	<$100k per crossing		$100k - $1M per crossing		>$1M per crossing
	 RCIS	 Channelization	 FLBG	 Traffic Signals	 Grade Separation
Traffic congestion	Up to 30% reduction	⊗	⊗	⊗	100% reduction
Drivers violating warning system	Up to 22% reduction in collisions at rail crossings	Up to 77% reduction in violations	⊗	Up to 24% reduction in violations	100% reduction
First responder delay	Up to 91% reduction	⊗	⊗	⊗	100% reduction

Rail Crossing Information System Benefits

RCIS costs typically range from $5K–$10K per crossing per year — less than 1% of the cost of grade separation. It is also scalable, enabling jurisdictions to address dozens of crossings instead of just one.

Performance results from deployments include:

- Up to **30% reduction** in traffic delays
- Up to **22% reduction** in collision risk
- Up to **91% reduction** in 911 response delays
- Significant **decline in driver violations**
- High **public satisfaction** and reduced complaints

RCIS vs Grade Separation: A Scalable Path to Safety

Improving safety at rail crossings is a critical national priority, and funding decisions must balance impact, cost, and scale. Grade separation is often seen as the gold standard—but it comes with significant financial and logistical barriers. Rail Crossing Information Systems (RCIS), by contrast, offer a highly scalable alternative that delivers meaningful safety outcomes at a fraction of the cost.

With the same $1 billion investment, **RCIS can prevent nearly 1,500 more collisions than grade separation** by addressing safety at a much larger number of crossings. While grade separation eliminates risk at a small number of high-priority sites, RCIS provides a broader, more cost-effective safety net—especially critical in areas where grade separation is not practical.

This is not an either-or choice. Grade separation will always be essential in some locations. But to scale safety nationwide, **RCIS offers an immediate, proven, and cost-efficient path forward**.

Same Budget, Very Different Results

How a hypothetical **$1 billion investment** could be used for RCIS vs grade separation.

	RCIS (TRAINFO)	Grade Separation	
Total Budget	$1,000,000,000	$1,000,000,000	*Same investment*
Cost per Crossing (10-year lifecycle)	$312,500	$50,000,000	*RCIS cost based on TRAINFO projects (including signs); Grade separation costs reflect urban projects*
Number of Crossings Improved	3,200	20	*RCIS improves **160x** more crossings*
Collisions Predicted at Treated Crossings (over 10 years)	7,837	253	*Based on Federal Railroad Administration GXAPS data*
Collision Reduction Rate	22%	100%	*Grade separation eliminates risk; RCIS reduces it*
Collisions Prevented	1,724	253	*RCIS prevents nearly **7x** more collisions*

6. Case Studies and Results

Chattanooga, TN

Reducing Congestion and Improving Safety

The City of Chattanooga implemented TRAINFO's RCIS at two crossings near the Norfolk Southern DeButts Yard, where frequent train activity caused significant delays.

With no budget for grade separation, the city deployed predictive train sensors and Dynamic Message Signs to inform and reroute drivers in real time. The result: a **25% reduction in delayed vehicles, over 90% prediction accuracy for train arrivals and clearances, and fewer risky driver behaviors.** Chattanooga's success demonstrates how RCIS can reduce congestion and improve safety at high-impact crossings—quickly and affordably—without requiring coordination with the railroad.

Charleston County, SC

Enhancing Emergency Response

Charleston County partnered with TRAINFO, RapidDeploy, and Skyline to overcome emergency response delays caused by blocked rail crossings.

TRAINFO's sensors predicted train blockages up to 10 minutes in advance and integrated with RapidDeploy's 911 mapping platform. This allowed dispatchers to reroute emergency vehicles in real time, avoiding delays and improving response times. The system **reduced train-related emergency delays by 91%, with at least one unit rerouted daily.** Charleston's approach illustrates how RCIS can enhance situational awareness, coordination, and routing for emergency services—especially in areas with constrained access and complex transportation networks.

New Haven, IN

A Scalable Solution for Small Cities

New Haven, Indiana, faced daily traffic backups and emergency delays at key crossings, including one on a primary 911 route.

Without the resources for grade separation, the city implemented TRAINFO's RCIS to provide real-time train detection, predictive alerts, and driver messaging through roadside signs. The system gave emergency responders the advance warning they needed to reroute and improved traffic conditions citywide. New Haven's success shows that RCIS works in communities of all sizes, with fast deployment, low cost, and no need for railroad approval—making it an ideal solution for small and mid-sized cities.

7. Common Misconceptions About RCIS

Despite its proven impact on rail crossing safety and mobility, Rail Crossing Information Systems (RCIS) are often misunderstood. Below are some of the most common misconceptions—and why they don't hold up.

MISCONCEPTION #1
"RCIS is just train detection"

False. Train detection is only one part of the equation. What makes an RCIS effective is its ability to predict train arrival and departure times, integrate anywhere (e.g., traffic signals, roadside signs, and any other third-party system), and support traffic management centers and public safety responders. It's the system's intelligence and connectivity—not just the sensors—that deliver real value.

MISCONCEPTION #2
"Grade separation is the only real solution"

False. Grade separation is a gold standard—but it's also expensive, time-consuming, and often not feasible. RCIS addresses many of the same challenges, such as reducing delays, driver frustration, and emergency response conflicts, at a fraction of the cost and with much greater flexibility and speed of deployment.

MISCONCEPTION #3
"There are no re-route options, so RCIS won't help"

False. Even when detours aren't available, RCIS still improves outcomes. It reduces risky behavior like gate running and U-turns, gives drivers more accurate expectations for wait times, enhances emergency response routing, and builds public trust by showing that the city is actively managing crossings with real-time tools.

MISCONCEPTION #4
"We can build an RCIS in-house for less"

False. Most in-house attempts underestimate the complexity of an effective RCIS. It's not just about hardware—it requires accurate train prediction models, robust system reliability, seamless integration with signal infrastructure, and ongoing maintenance and updates. DIY solutions often result in poor accuracy, long-term maintenance challenges, and ultimately higher costs due to system failures or lack of adoption.

MISCONCEPTION #5
"We can just use rail schedules or pre-emption data"

False. Rail schedules are rarely accurate enough for real-time applications. Freight trains especially are unpredictable and can arrive early, late, or not at all. Pre-emption signals, while useful, only activate once a train is already near the crossing. They provide no predictive insight and no information about blockage duration. Further, up to 20% of pre-emption activations don't result in a train at the crossing. Neither option comes close to replacing a full RCIS.

8. About TRAINFO

More than simply train detection, TRAINFO provides an effective end-to-end solution specifically designed for the unique features of rail crossings.

Specialized train detection sensors with 99.99% accuracy that are installed **off rail property**

Patented processes that provide train movement **predictions**

Out-of-the-box **analytics** dashboards for transportation and 911

Seamless **integrations** into roadside signs, traffic management centers, mobile apps, 911 software & more

24/7 remote **monitoring** and regular software updates to ensure system uptime and performance

Support from a dedicated RCIS solution engineer to guarantee your satisfaction

Up to **30%** reduction in congestion and collision risk & **91%** reduction in 911 delays

Less than **1%** of the cost of grade separation & eligible for FHWA Section 130 funding

Conclusion

RCIS represents a paradigm shift in how cities address traffic and safety challenges at rail crossings. Instead of relying solely on costly, disruptive infrastructure projects, agencies can now deploy intelligent systems that provide measurable benefits quickly and affordably.

With proven success in cities of all sizes, RCIS empowers transportation and emergency managers to make data-driven decisions, respond to public needs, and ensure the safety and mobility of their communities.

It's time to rethink how we manage rail crossings — and RCIS is the smarter path forward.

To learn more or get started with an RCIS in your community, contact TRAINFO or visit www.trainfo.ca.