Rural Intelligent Transportation Systems Resource Guide

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Cowlitz-Wahkiakum
Council of Governments
TRANSPORTATION

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Acronyms and Definitions

ITS: Intelligent Transportation Systems

CC: Crash Counter Measures

TM: Traffic Management

OM: Operations & Maintenance

ES: Emergency Services

STW: Surface Transportation & Weather

RTM: Rural Transit and Mobility

TTI: Tourism & Travel Information

DMS: Dynamic Messaging Sign

RRFB: Rectangular Rapid Flashing Beacon

FHWA: Federal Highway Administration

PHB: Pedestrian Hybrid Beacon

HAWK: High Intensity Activated Crosswalk

ARC-IT: Architecture Reference for Cooperative and Intelligent Transportation

TIB: Transportation Improvement Board

CERB: Community Economic Revitalization Board

TSMO: Transportation Systems Management and Operations

USDOT: United States Department of Transportation

DCWS: Dynamic Curve Warning Systems

SWRTPO: Southwest Washington Regional Transportation Planning Organization

CWCOG: Cowlitz-Wahkiakum Council of Governments

Acknowledgements

The Cowlitz-Wahkiakum Council of Governments (CWCOG) prepared this report to serve the transportation safety needs of southwest Washington communities. The CWCOG would like to thank those who helped in developing the Intelligent Transportation Systems Resource Guide, including local WSDOT staff. The CWCOG serves as the lead agency for the Southwest Washington Regional Transportation Planning Organization.

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Purpose of this document.

The purpose of this publication is to provide introductory information for elected officials in the Southwest Washington Regional Transportation Planning Organization (SWRTPO) region to improve their understanding of Intelligent Transportation Systems and their link to road safety. Improving safety is a significant goal in the Moving Forward 2050 Regional Transportation Plan and ITS can play a key role in improving safety outcomes.

What Is Rural ITS?

Intelligent Transportation Systems (ITS) uses technology to address various transportation related issues. The goal is to reduce the number and severity of collisions and enhance situational awareness for all users. When discussing Rural ITS specifically, it narrows the wide selection of tools into a proven subset of tools that are effective in rural areas.

It is particularly important in a rural context because of the increased risk of car related collisions in rural areas. According to the United States Department of Transportation (USDOT) in an article published in 2022 “While only 19% of the U.S population lives in rural areas, 43% of all roadway fatalities occur on rural roads, and the fatality rate on rural roads is almost two times higher than on urban roads”. Within the Southwest Washington Transportation Region, in 2021 and 2022 there were thirty-five fatalities each year. Leading to about eleven fatalities per 100,000 people. In comparison to 2020 the number of fatalities was sixteen total, averaging five fatalities per 100,000 people.

Rural ITS provides an opportunity to help reduce the number and severity of crashes through its increased focus on safety, awareness, and mobility. Over the years, ITS tools have become more cost-effective to deploy, giving more financially constrained agencies an opportunity to tackle local challenges. These tools reinforce proven methods or counter measures to enhance road user safety.

The information in this guide is repackaged from several sources. A major contributor to this guide is the *Rural ITS Toolkit Primer* from the Federal Highway Administration (FHWA) National Center for Rural Road Safety. This toolkit is a comprehensive summary of Intelligent Transportation Systems and useful tips for rural areas.

Benefits of ITS

There are a variety of benefits that an agency can gain from deploying an ITS tool. This is especially true in areas where crash histories may indicate a need for increased safety enhancements. ITS solutions tend to have crosscutting benefits that can improve transportation efficiency, mobility, safety, and reduce environmental impacts. Some ITS tools can enhance data collection allowing deeper analysis into potentially dangerous areas or conditions.

Important Considerations

There are several ITS tools, and each can help address different challenges. When considering a tool to employ it is important to think through the questions below. Applying these questions will help determine which tool(s) may be appropriate.

- *Problem/Site Evaluation*: Agencies may have to collect additional information about the problem or the site to determine the applicability of a technology tool.
- *Inadvertent impacts*: Does the proposed solution simply shift the problem to another location, or create more work for a different agency?
- *Timeline*: How long will it take to plan and implement the proposed solution?
- *Costs*: How much will the project cost? Costs will vary based on the size and scope of a project including factors such as terrain, necessary staff, training, maintenance, and inflation.
- *Lifecycle*: What is the lifecycle of the proposed solution, who will maintain it, and how will it be updated or replaced?
- *Performance Measures*: How will the tool be evaluated to determine if it is effective?

Tool Categories

The following category listings are from the FHWA Rural Intelligent Transportation Systems Toolkit, each tool falls into one or more categories. Every category includes several tools for use on a local project. According to FHWA[1]:

- *Crash Countermeasures (CC): Focus on reducing frequency and severity of crashes.*
- *Traffic Management (TM): Tools facilitate the identification of congestion and the management of traffic.*
- *Operations and Maintenance (OM): Facilitate operations, enhance maintenance, or extend the longevity of the transportation assets.*
- *Emergency Services (ES): Support, facilitate and expedite emergency response efforts.*
- *Surface Transportation and Weather (STW): Monitor weather conditions on the transportation network and mitigate weather related impacts.*
- *Rural Transit and Mobility (RTM): Tools expand, enhance, and coordinate public transportation.*
- *Tourism and Travel Information (TTI): Expand or enhance dissemination about travel conditions and tourism opportunities in the surrounding region.*

Each category is meant to be a guide of what type of recommended tool achieves what goal. As a tool can fit one or more categories, tools may offer a wider applicability that can help address multiple solutions at once. An ITS tool might even create an opportunity to communicate and work with other tools. Examples can range from including multiple sensors or sequencing tools

[1] Federal Highway Association National Center for Rural Road Safety, *Rural Intelligent Transportation Systems (ITS) Toolkit*; https://ruralsafetycenter.org/wp-content/uploads/2022/08/ITS_Toolkit_Primer_final_508.pdf

to help disseminate information to the public. Understanding the safety needs and identifying what category it might fall under narrows the number of tools one needs to consider.

Common Tools

ITS tools that have a history of applicability in rural areas are identified by FHWA National Center for Rural Road Safety. Table 1 summarizes the name of the tool, its category, a brief description, the estimated capital costs, and the issues addressed.[2]

Table 1: Common ITS Tools

Name of Tool	Category of Tool(s)	Short Description	Estimated Capital Costs (2016 Dollars)	Issues Addressed
Automated Visibility Warning Systems	CC OM STW	Deploys weather sensors to detect inclement weather conditions to warn drivers ahead of reduced visibility areas or other cautions through signs.	Medium to High ($50,000 - $250,000)	• Weather Warning
Highway-Rail Crossing Safety Systems	CC TM	The goal of applying Intelligent Transportation Systems at a highway-rail crossing is to improve safety, enhance communications, and reduce congestion at highway-rail intersections.	Low to High depending on the type of tech installed. (<$50,000 - $250,000)	• Highway-Rail Crossing Warning
Animal Warning Systems	CC	Intended to warn motorists about the potential or actual presence of animals on the road. Best used to mitigate large mammal/vehicle collisions.	Low to High (<$50,000- $250,000)	• Animal Warning
Pedestrian Safety Systems	CC OM TTI TM	Provide feedback to pedestrians and increase awareness to motorists that pedestrians are present.	Low (<$50,000)	• Pedestrian Safety • Collision Avoidance • Collision Notification
Site Management During Avalanches/ Slide Risk Periods	OM	Several types of sensors are employed to inform agencies and public of an ongoing or high-risk avalanche/slide area.	High ($100,000 - $250,000)	• Resource Mapping and Monitoring • Avalanches/Slides

[2] Rural Intelligent Transportation System (ITS) Toolkit - National Center for Rural Road Safety (ruralsafetycenter.org)

Name of Tool	Category of Tool(s)	Short Description	Estimated Capital Costs (2016 Dollars)	Issues Addressed
Fixed Automated Spray Technology	OM	An anti-icing treatment method to prevent the formation and bonding of frost, ice, and snow to the roadway. *Typically deployed over bridges	High ($100,000 - $250,000)	• Icing of Roads
Coordinated Rural Transit Service	RTM	Link separate services to overcome service gaps. Along with, Coordinate arrival and departure times to lessen wait time.	High ($100,000 - $250,000)	• Rural Transit Service Response Time • Rural Transit Wait Time • Rural Transit Availability
Speed Warning Systems	CC OM	Inform motorists that based on their vehicle speed, road geometry, weather conditions, or other factors, that they are driving too fast	Low (<$50,000)	• Road Geometry Warning • Speed Approaching Population Centers
Dynamic Message Signs (DMS)	CC ES OM RTM STW TTI TM	Dynamic message signs (DMS) provide short pieces of information to the traveling public. Can be portable, semi-permanent, or permanent installations. Effective for alerting motorists to operational, regulatory, warning or guidance announcements at a specific location.	Low to Higher (<$50,000->$250,000)	• Pre-Trip Information • En-Route Information

Acronyms for category of tools:

CC- Crash Countermeasures
TM- Traffic Management
OM- Operations and Maintenance
ES- Emergency Services
STW- Surface Transportation & Weather
RTM- Rural Transit and Mobility
TTI- Tourism & Travel Information

ITS Highlights and Traditional Countermeasures

In combination with traditional countermeasures, ITS tools enhance methods that work but do not reach the desired safety outcomes. In many cases, retrofitting existing infrastructure or portable systems may be deployed to enhance awareness and improve safety in a location. For example, highlighted under the Pedestrian Safety Systems tool in the Rural ITS Toolkit, many of the tools tend to expand upon existing infrastructure with increased signage and incorporation of lights. Speed warning systems and dynamic message signs are also common in rural locations and may not require extensive electrical infrastructure as they may run on solar power.

Speed Warning Systems

Figure 1: Speed Warning System

A Speed Warning System informs motorists that based on the posted speed limit, their vehicle speed, road geometry, weather conditions, or other factors, they should slow down or monitor their speed. Frequently these systems are combined with another piece of signage like advisory speeds for curves or a reduced speed limit change. As a tool it helps inform and remind drivers to travel at appropriate speeds for the conditions. The total capital cost for this tool is low, typically less than $50,000. Installation, support, and maintenance in Washington and other states tended to cost less than $10,000 a year.

Dynamic Message Signs

Dynamic Message Signs (DMS), also known as Variable Message Signs, or Changeable Message Signs, provide short pieces of information to the traveling public. DMS are effective for alerting motorists to operational, regulatory, warning or guidance announcements at a specific location. Allowing motorists to respond through adjusting driving behavior, choosing an alternate route, or change when they travel. These signs can be portable, semi-permanent, or permanent installations. The use of portable DMS is relatively inexpensive (both for purchase and rental) and can be especially useful in rural areas because they can be moved to multiple locations as needed. Portable DMS does not require dedicated power and communications on site. They typically draw power from solar panels, and either use cellular or satellite communications.

Credit 1: WSDOT TSMO Program Plan; Portable DMS

The capital costs for this tool can range from less than $50,000 to above $250,000 depending on the type of DMS chosen and its size. In operations and maintenance, it tends to be lower than $50,000 a year. Maintenance costs vary depending on if the installation is permanent or a portable unit. Its total cost comes down to the size of the system. Permanent installations tend to be more expensive due to the infrastructure required.

Credit 2: WSDOT TSMO Program Plan; Permanent DMS

Rectangular Rapid-Flashing Beacon (RRFB)

An increasingly common safety improvement for pedestrian crosswalks includes flashing lights that activate to warn drivers that pedestrians are crossing the roadway. According to the FHWA these types of crosswalk improvements are "particularly effective at multilane crossings with speed limits less than 40 miles per hour. Research suggests RRFBs can result in motorist yielding rates as high as 98 percent at marked crosswalks…"[3]. The results vary depending on the road type however they remain effective at grabbing a driver's attention. They are successful in stopping traffic when a pedestrian activates the signal. RRFB's tend to cost between $4,500 and $52,000, with the average cost estimated at around $22,250. These costs include the complete system and installation.

Figure 2: Picture of a flashing beacon; Note that this is not an RRFB.

Pedestrian Hybrid Beacons

Figure 3: Photo of a Pedestrian Hybrid Beacon/ High Intensity Activated Crosswalk (HAWK)

"The Pedestrian Hybrid Beacon (PHB), and sometime referred to as a High Intensity Activated Crosswalk (HAWK) is a traffic control device designed to help pedestrians safely cross higher-speed roadways at midblock crossings and uncontrolled intersections"[4]. Once a pedestrian presses the button they light from yellow to red and direct motorists to slow down and stop. A pedestrian is signaled to walk when activated, and after they have safely crossed the street, the lights go back to yellow and turn off. These tend to work well in areas that are three lanes and difficult to cross.

[3] Federal Highway Administration, *Rectangular Rapid Flashing Beacons (RRFB);* Rectangular Rapid Flashing Beacons (RRFB) | FHWA (dot.gov)

[4] Federal Highway Administration, *Pedestrian Hybrid Beacons;* Pedestrian Hybrid Beacons | FHWA (dot.gov)

These cost anywhere between $21,000 to $128,000, with an average per unit cost of $57,680.

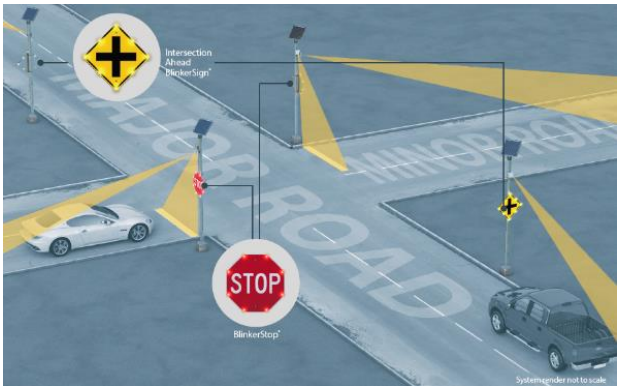
Dynamic Curve Warning System (DCWS)

Credit 3: Federal Highway Administration

Dynamic Curve Warning systems can take a variety of forms. The system operates through measuring the speeds of approaching vehicles and providing either static or dynamic messaging to drivers traveling too fast. Typically, a system combines chevron signs with solar powered flashing lights. These signs are programmed to light up all at once or sequentially when a sensor detects a vehicle. Dynamic Curve Warning Systems are significantly more expensive than static signs. USDOT recommends limiting the application to locations where other less expensive devices have failed to solve the issue. In terms of safety, it's applicable to all crash types and severities, while studies have shown to reduce speeds as much as 8.8 mph. [5]

Intersection Conflict & Trail Warning Systems

"Intersection conflict and trail conflict warning systems provide real-time, dynamic alerts to the traveling public about vehicles or pedestrians that are approaching or waiting at intersections or trail crossings. These traffic control devices improve awareness of others and help reduce collisions and increase intersection safety."[6] As a recommended strategy by the Washington State Department of Transportation (WSDOT), this ITS tool uses sensors, roadway signs, and flashing lights to alert motorists of potential intersection conflicts. This tool works best for unsignalized intersections and trail crossings with risk factors like a history of intersection collisions or high volumes on one or all intersection legs.



Credit 4: Stinson Traffic Solutions

[5] U.S Department of Transportation Federal Highway Administration, *Curve Safety Solutions*; https://highways.dot.gov/sites/fhwa.dot.gov/files/2023-04/FHWA-Curve-Safety-Solutions.pdf

[6] Washington State Department of Transportation. Transportation Systems Management and Operations, *Intersection conflict & trail warning systems*; https://tsmowa.org/category/intelligent-transportation-systems/intersection-conflict-trail-warning-systems

Emerging Technology

Credit 5: US Department of Transportation

There are two specific tools recommended in the FHWA toolkit, an Automatic Crash Notification System and Connected Vehicles. Each tool requires a broadband connection, communicative technology, and in some cases a subscription to remain active.

These technologies offer the opportunity to increase safety measures dramatically. However, there are key components that make them difficult to deploy. The major barriers include reliable broadband connectivity, and the automobile market share that have adopted emerging communication technology into their vehicles. Improving other infrastructure needs to happen first before these tools will be deployable in rural areas soon.

From an agency's point of view, the reliance on consumer adoption makes these tools difficult to control. If these technologies continue to expand market penetration it may be worthwhile to research ways that an agency can prepare to utilize the technology as it is more widely applicable.

Funding Opportunities

ITS projects receive funding the same way as most transportation projects. As these tools seek to advance transportation related goals, they often fall under the same categories of funding as traditional measures.

Surface Transportation Block Grant/Carbon Reduction Program

WSDOT allocates Surface Transportation Block Grant and Carbon Reduction Program funds to Metropolitan Planning Organizations (MPO's) and County Lead Agencies. Distribution of funds is through the SWRTPO Board for all five counties. Projects must align with regional priorities. The solutions that ITS tools provide are eligible under the CWCOG's goals for the Metropolitan and Regional Transportation Plan. Almost all the ITS tools highlighted in this document would be eligible for these grants.

WSDOT Pedestrian/Bicyclist and Safe Routes to School Programs

These programs focus on improving the transportation system to enhance safety and mobility for people who choose to walk or bike. ITS tools that seek to eliminate pedestrian and bicyclist fatalities and serious injuries, as well as increase connected pedestrian and bike facilities are eligible.

Washington State Transportation Improvement Board

Under the Washington Transportation Improvement Board (TIB) there are various grants that are applicable to ITS projects. Some grants include the Small City Active Transportation Program, Urban Active Transportation Program, and the Complete Streets Award. These tackle various aspects of the transportation system and most of the highlighted ITS tools are applicable.

Community Economic Revitalization Board

The Community Economic Revitalization Board (CERB) offers funding through a variety of programs. Specifically, ITS projects that provide improvements to public infrastructure and facilities can take advantage of the Prospective Development Program. To qualify for this program, an improvement to the public facility or infrastructure must link to making private business development more likely to occur. An agency must conduct an economic feasibility study with CERB staff before applying.

ITS Architecture

Regional Intelligent Transportation System (ITS) Architecture: An Architecture is defined as "A specific, tailored framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects in a particular region. It functionally defines what pieces of the system are linked to others and what information is exchanged between them."[7]

ITS projects fall under what is called an ITS Architecture. The architecture is the broader framework for the ITS network. It is the detailed plan for moving forward to provide a variety of interrelated solutions to improve safety using technology of one form or another. The detail level of an architecture system is dependent upon the needs of the agency. If the agency chooses to introduce a single counter measure to address a specific problem, it can remain simple. As additional interrelated counter measures are implemented, it may become helpful or necessary to integrate the effort into a more formal ITS architecture. If using federal funds on a project, it is a requirement to build an ITS Architecture.

Most of the regional ITS architecture is devoted to showing all the existing and planned operational transportation systems in a region and how they will fit together. From a planning perspective, the regional ITS architecture should support the region's objectives and support the specific needs of transportation planning agencies. Including how to collect, archive, and process data as well as monitor performance.

Benefits to Creating an ITS Architecture

There are numerous benefits an agency can gain by building a simple ITS Architecture. An ITS Architecture enables a broader view that allows agencies to:

- Provide cost-effective solutions.
- Experience a more seamless service across jurisdictional boundaries.
- Examine how a new ITS tool fits in the overall system.
- Access new data and share it across agencies.
- Provide a structure and document the relationships between ITS applications within the region.

The CWCOG ITS Architecture only addresses a few categories for the metropolitan planning area (Longview Urban Area) but illustrates and documents the integration of ITS projects at a regional level. With the goal that all stakeholders and users can effectively use the architecture to support project scoping and implementation.

[7] Federal Highway Administration, *Regional ITS Architecture;* Regional ITS Architecture and ITS Strategic Plans | Organizing and Planning for Operations - FHWA Office of Operations (dot.gov)

Building an ITS Architecture

There are several things to consider when building out an ITS architecture for your agency, even at a simple level. The area that the architecture should cover is important. When building at a regional level, there is increased effectiveness in communication and service levels compared to a local level. However, a regional level architecture requires more time, in the form of agency coordination, and in-depth details throughout the process. Building an architecture at a local level can still gain the net benefits of effectiveness at a smaller scope. The scope of an architecture all depends on what resources the agency has available.

When developing a system, it is important to consider these questions:

- What are the Intelligent Transportation Systems (ITS) involved?
- Who oversees these ITS systems and what are their responsibilities?
- How does this ITS tool contribute to the overall system?
- Are connections in place for communication between agencies?
- Is there a plan to maintain this architecture?

Once an agency determines the scope of their ITS architecture and considers the questions above, they may begin in creating the ITS architecture which includes the following steps:

- *Getting Started*: Identify important stakeholders, those currently and possibly involved, local champions, and develop a team to assist.
- *Gather Data*: Inventory existing and planned ITS systems and develop the roles and responsibility for stakeholders.
- *Define Interfaces*: Identify connections between systems, then define the information exchanged on each connection.
- *Implementation*: Develop an implementation guide for projects that will flow from the local or Regional ITS Architecture. Including a sequence of projects, a list of needed agency agreements, and a list of standards for implementation.
- *Use of Regional ITS Architecture*: Success hinges on effective use of the architecture. This is when benefits are realized.
- *Maintain the Regional ITS Architecture*: Use a maintenance plan to guide controlled updates to the architecture to accurately reflect ITS capabilities and plans. The Regional ITS Architecture can be updated as needed or on a predetermined time cycle. The USDOT recommends when choosing a pre-determined cycle to use the STIP time frame. If updating the ITS Architecture as needed it usually only updates when major changes or additions occur.

WSDOT Resources

WSDOT offers various resources on ITS tools and implementation. Like the FHWA National Center for Rural Road Safety's Toolkit, WSDOT offers a similar guide for implementing ITS tools and other countermeasures. The Transportation Systems Management and Operations (TSMO)

department has a guide that encompasses a much broader category of countermeasures beyond those that fall under ITS. Click here to access the website or search WSDOT TSMO.

Other Resources

As this document is only meant to provide a brief introduction to ITS, the information below provides deeper understanding and access to additional information.

ITS Benefits, Costs, and Lessons Learned Map

A website created by the Intelligent Transportation Systems Joint Program Office of USDOT features an interactive map containing examples of ITS projects. Users can explore specific examples within Washington or throughout the United States. Click here to access the resources available through the Intelligent Transportation Systems Join Program office at the USDOT website.

ARC-IT

The Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) provides a common framework for planning, defining, and integrating intelligent transportation systems. It is a reference architecture providing a common basis for planners and engineers with differing concerns to conceive, design and implement systems using a common language as a basis for delivering ITS. Link to the website or search for the ARC-IT site for more information.

CWCOG MPO ITS Architecture Website

As an MPO, the CWCOG created an ITS Architecture. This website provides a good framework of what a fully fleshed out system looks like applicable to a small metropolitan area. As a small metropolitan area, the CWCOG's ITS Architecture is simple and does not include a substantial number of projects. A major metropolitan area's ITS plan would be much more robust. To explore the resource, click here or locate through the CWCOG Transportation Program website.

Rules and Regulations

There are federal regulations regarding what an ITS architecture must comply with, under 23 CFR Part 940, these regulations are mandatory when using federal funds. Link to Website or search for Code of Federal Regulations.

If using federal funds, a requirement under these regulations is that a Regional ITS Architecture must be built within 4 years of the project completion.

Best Practices and Conclusion

The USDOT has outlined certain best practices when it comes to deploying ITS. Below are the core ideas that are most relevant to the agencies within the Southwest Washington Regional Transportation Planning Organization[8]:

[8]USDOT, *Rural Transit ITS Best Practices* (2003). (pg.8-4, 8-5)

- Implement technology in a focused scope; If implementing multiple technologies do so incrementally as to build upon existing systems and allow time for training on what each technological item does.
    - Make sure all the stakeholders are engaged in the project, especially in the initial planning and design stage.
    - Identify how the project will benefit participants and the public.
- Dedicate one entity to being responsible for implementation and on-going support.
    - This reduces the risk of misunderstandings between vendors.
- To ensure future technologies are compatible, technology should be upgradable and adaptable.
- For projects that involve multiple agencies, developing a memorandum of understanding (MOU) with clear roles can help clarify each participant's responsibilities to avoid future challenges.
- Be open to working with new agencies and staff.
    - Some more complex tools require outside data from another agency. Knowing what a tool may require outside of one's own agency will create a smooth deployment of the tool.
- Providing appropriate ongoing training is crucial to maintaining ITS tools.
    - Some of the recommended tools in this guide are only useful to the extent that an agency can utilize them. Providing training in how to use a tool ensures that it remains an important device in the agency's toolbelt.

Deploying Intelligent Transportation Systems is best suited when tied to an objective. For example, tools that help pedestrians cross the street work towards increasing visibility and reducing the chances of a potential collision. In utilizing an ITS tool, it is best to think of ways that they can help an agency achieve their goals.

Another consideration when deploying new ITS tools is the potential need for community education on the tools' intent and value to improve safety. As some tools rely on sensors and cameras, a community may begin to feel an increased presence of perceived surveillance. Make sure that the community knows these tools are meant to serve the needs of community members.

ITS systems are not one size fits all, so when venturing into the world of ITS, it is important for an agency to make incremental steps. An increasingly important and relevant topic when it comes to transportation is safety. Although not the sole solution to improve safety, Intelligent Transportation Systems are one tool that can further progress on goals and improve safety outcomes.

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