Texas Department of Transportation

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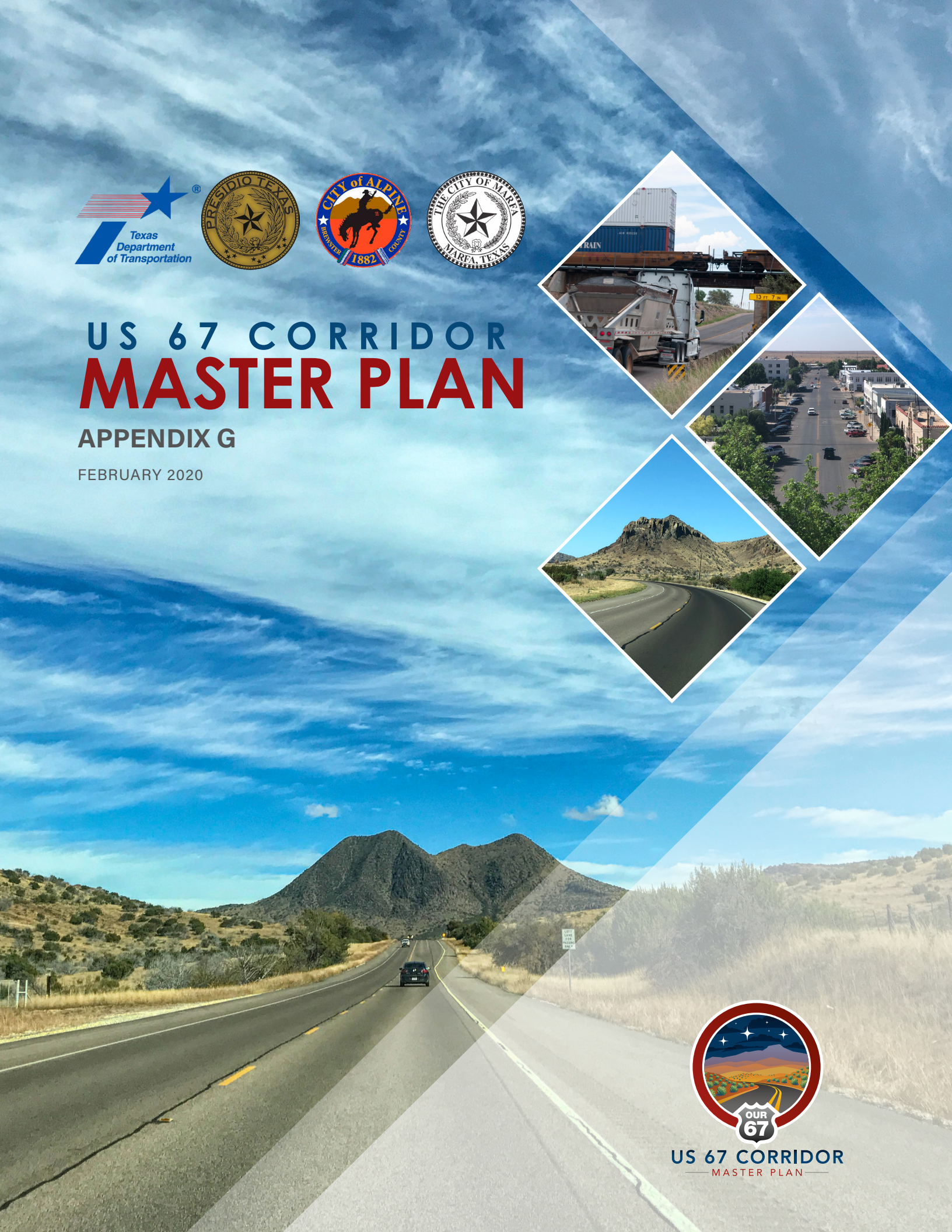
US 67 CORRIDOR MASTER PLAN

APPENDIX G

FEBRUARY 2020



OUR 67

US 67 CORRIDOR
MASTER PLAN

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Memorandum

To: *Rebecca Reyes, TxDOT Project Manager*
Christopher Weber, TxDOT Alpine Area Engineer

From: *CDM Smith*

Date: *February 2020*

Subject: *US 67 Corridor Intelligent Transportation Systems (ITS) Plan Technical Memorandum*

1.0 Introduction

The purpose of this technical memorandum is to develop an Intelligent Transportation Systems (ITS) plan as part of the master plan for the US 67 study corridor. This document is complementary to **Appendix F – Intelligent Transportation Systems (ITS) Needs Assessment**. The Needs Assessment technical memorandum identified the existing and planned needs, goals, and objectives related to ITS and Transportation Systems Management and Operations (TSMO) for the US 67 study corridor and recommended initial mitigation strategies and solutions to address operational issues along the corridor.

From the Needs Assessment, this technical memorandum presents the ITS plan for the study corridor that documents and describes recommended ITS implementation throughout the corridor. This memorandum identifies ITS concepts, strategies, and techniques to improve operations along the study corridor. The memorandum also identifies specific applications for the study corridor and determines the level of integration needed to make strategies interoperable in the Texas Department of Transportation (TxDOT) El Paso and Odessa Districts and US 67 study corridor. The ITS plan also provides a suggested timeline for implementing the ITS strategies.

The US 67 study corridor stretches 142 miles from Interstate 10 (I-10) west of Fort Stockton to the Presidio/Ojinaga Port of Entry (POE) on the United States (U.S.)/Mexico border. US 67 provides access to the towns of Alpine, Marfa, Presidio, and surrounding communities, as well as Big Bend National Park, Sul Ross State University, the Marfa Lights, Big Bend Ranch State Park, Fort Leaton State Park, and Fort Davis attractions. This rural area has experienced growth in recent years driven by many factors, including tourism growth, international commerce, and Permian Basin oil field development. In response to these trends, TxDOT, in partnership with communities, is developing a corridor master plan to help determine current and future transportation needs along US 67. **Figure 1** shows the study corridor.

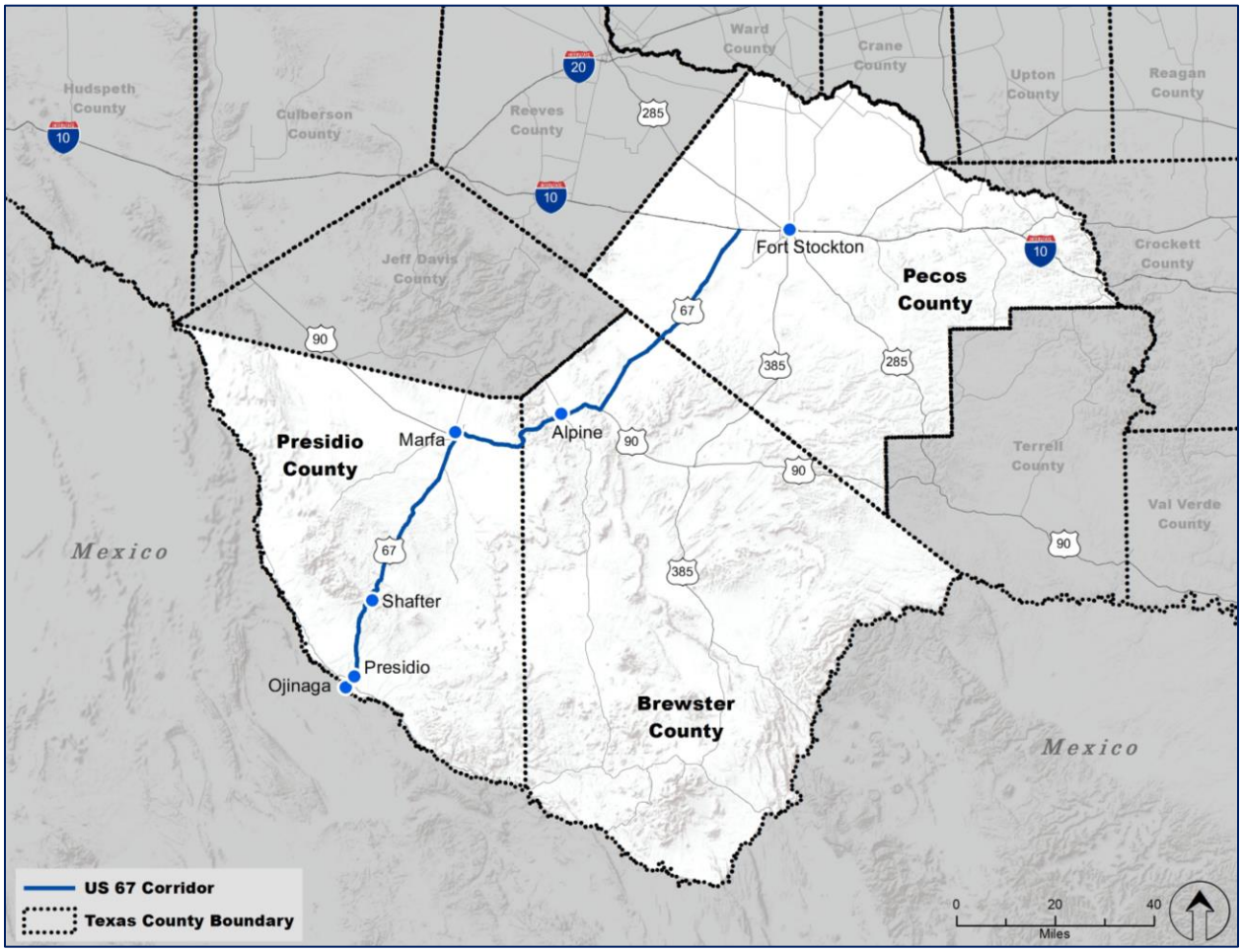


Figure 1: US 67 Corridor Master Plan Study Corridor

The remainder of this technical memorandum is divided into three sections:

- **Section 2** addresses the ITS categories that were identified in the scope of work. This includes identifying where other non-ITS strategies are also proposed. The categories are limited to those projects that are included in this plan.
- **Section 3** presents high-level strategies and how ITS projects are developed from them.
- **Section 4** provides a timeline for the implementation of ITS projects.

2.0 ITS Categories

Based on the issues identified in Appendix F – Intelligent Transportation Systems (ITS) Needs Assessment for the US 67 study corridor, the study team developed a list of potential ITS solutions using the Rural ITS Toolkit[1] recently updated by the National Center for Rural Road Safety, which is a center founded by the Federal Highway Administration (FHWA). The toolkit identifies 42 rural transportation critical need applications focused on common needs in rural areas. These tools are categorized into seven areas within the toolkit: (1) Crash Countermeasures (CC); (2) Traffic Management (TM); (3) Operations & Maintenance (OM); (4) Emergency Services (ES); (5) Surface Transportation & Weather (STW); (6) Rural Transit & Mobility (RTM); and (7) Tourism & Travel Information (TTI). As part of the initial stages of the study work, eight categories were identified. **Table 1** matches the toolkit topic areas to the initially defined categories for the US 67 study area. Each of these ITS categories is described below.

Table 1: Rural ITS Toolkit Topic Areas vs US 67 Initial ITS Categories

Rural ITS Toolkit Topic Areas	US 67 Initial ITS Categories
Crash Countermeasures	Safety
Traffic Management	Traffic Performance Measurement
Operations and Maintenance	Corridor Operations
Emergency Services	Incident Management and Response Including “Mayday”
Surface Transportation and Weather	Weather
Rural Transit and Mobility	Safety (applied to mobility)
Tourism and Traveler Information	Traveler Information
Other (not in Rural ITS Toolkit)	Communications and Power

Table 2 matches the seven overall plan goals with the initial ITS categories.

[1] National Center for Rural Road Safety https://ruralsafetycenter.org/resources/rural-its-toolkit/

Table 2: US 67 Master Plans Goals versus Initial ITS Categories

		US 67 Initial ITS Categories						
		Safety	Traffic Performance Measurement	Corridor Operations	Incident Management and Response Including "Mayday"	Weather	Traveler Information	Communication and Power
US 67 Corridor Master Plan Goals	Improve Safety	✓	✓	✓	✓	✓	✓	✓
	Improve Emergency Response	✓		✓	✓		✓	✓
	Promote Sustainability		✓	✓			✓	
	Maintain a State of Good Repair		✓	✓		✓		
	Support Economic Development		✓	✓			✓	
	Enhance Multimodal Connectivity		✓	✓			✓	✓
	Improve Mobility	✓			✓	✓	✓	✓

When the Rural Toolkit is matched against the needs and goals provided in the ITS Needs Assessment, 17 of the 42 Rural ITS tools were identified as applicable to the US 67 study corridor. These tools were selected based on the corridor needs, and applicability (medium to high). In addition, five more tools were developed by the team that are outside of those identified in the federal toolkit. When completed, additional objectives were identified for each of the goals.

2.1 Safety

When applied to safety, ITS is primarily targeted at reducing crashes. A significant safety evaluation has been completed for the corridor and documented in **Appendix D – Safety Analysis**. Numerous strategies were identified. Many of them are traditional traffic engineering strategies, such as adding capacity, improving geometrics, implementing signing and striping improvements.

One principle of traffic engineering is to provide safe, functional, efficient, and economic solutions. Typically, the simplest application is applied first, with more complex treatments added as warranted. For example, horizontal and vertical curves are designed to provide sufficient sight distance and to provide the most natural driving experience, and superelevation is used to provide positive physical guidance to vehicles. Curve warning signs are only added to alert road users to conditions that might call for a reduction of speed or an action in the interest of safety and efficient traffic operations. Additionally, through the long-term efforts under the Manual on Uniform Traffic Control Devices, signing and striping have been standardized so that elements become natural

triggers. For example, a yellow stripe should always indicate to a driver that their travel way is to the right of the yellow stripe.

When ITS is introduced to address safety issues, the conditions are typically such that the non-ITS solutions are not sufficient by themselves. So, while improving safety may be at the core of most ITS projects, the ITS systems are in addition to the traditional tools and applications.

2.2 Traffic Performance Measurement

Traffic management relates to the operations of traffic control devices within the field. For the US 67 study corridor, this includes Dynamic Message Signs (DMS) and cameras, as well as monitoring of systems such as weather warnings and animal warning systems. Successful operations and agency management require the ability to measure performance and can also demonstrate success to decision makers. ITS devices and systems are frequently the means by which performance data is measured and collected. As an example, travel times collected by traffic monitoring sensors provide data on how frequently travel times are affected by the weather. This data can be used to demonstrate the value of weather warning systems. Performance measures help an agency make better decisions about future projects by justifying those decisions that have achieved success in the past.

Performance measures require data. That data frequently must be combined from a variety of sources. Some data is available in a historic manner, such as crash data. Crash data can be collected from paper forms to fully electronic systems. Other data is only available from ITS devices such as traffic detectors and weather stations.

2.3 Corridor Operations

At the heart of ITS is using technology to improve the safety and efficiency of corridor operations. A key characteristic of ITS is that systems work best when they are integrated (e.g., traveler information integrated with sensor data). This need for integration also applies to agencies (state and local). The corridor operation concept is open enough to include almost all other categories but is typically used to address those ITS issues not covered by other categories. The identified needs for US 67 study corridor operations could include areas such as work zones, traveler services, and some additional areas related to incident clearance.

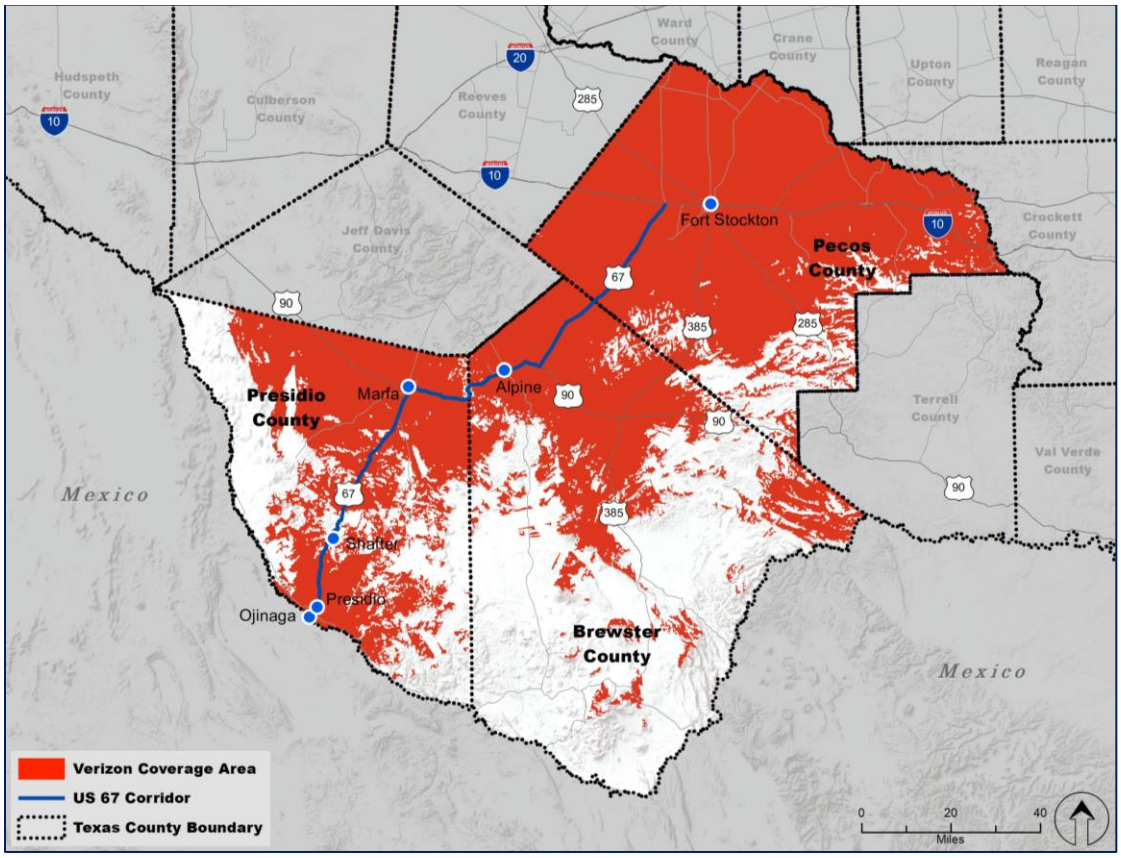
2.4 Incident Management and Response Including “Mayday”

A key aspect of rural operations is incident management. With distances between destinations greater and resources often more limited, incident management becomes more critical. While much of incident management is accomplished by direct response from emergency providers, ITS can play an important role. This section addresses incident management in general with a focus on ITS systems that could be helpful.

Incident management can be broken into several components. Typically, these components are identified as notification, verification, response, management, and post-incident management. Each is discussed in turn, including a description of how ITS can play a critical role.

Notification is often a call to 911. The 911 centers in rural areas are frequently the county sheriff's office. Notification can be achieved as simply as through phone and radio or part of a complex computer-aided dispatch system. Early notification is more important in rural areas relative to the "golden hour". The golden hour refers to the statistic that if an injured person receives medical attention within the first hour of injury, the likelihood of recovery increases dramatically. In urban areas of the corridor with the proliferation of cell phones and increased traffic, phone calls to 911 are made very quickly after an incident.

Mayday systems include systems such as OnStar. These systems trigger an automatic notification to a generally private staffed response center when certain conditions occur, then they call 911. These systems rely on cellular communication networks. As shown in **Figure 2**, most of the US 67 study corridor is covered by cell phone service. Verizon is shown as an example in **Figure 2**; other phone carriers may also be present. Approximately 19 miles (13 percent) of the corridor lacks cell phone service. These sections are concentrated at the mountainous area near Shafter and the mountainous area west of Alpine near the Presidio County line known as Paisano Pass. Without mayday systems, the crash victims must make a phone call themselves or rely on the next traveler on the road to notice the crash and report it.



Source: Utah Department of Transportation, 2019

Figure 2: Cell Phone Coverage Map

ITS can play a role in supporting increased communications. Mayday systems are important ITS systems for rural corridors, but they are typically the responsibility of car manufacturers or third-party private sector support centers. Automated incident detection is a common ITS application although this application is best for a short, dedicated facility such as a tunnel or a bridge due to the very high implementation cost. Deploying such an application in a rural corridor like US 67 is challenging due to the cost.

Verification can be through ITS camera/ Closed Circuit Television (CCTV) images or repeated phone calls. While any emergency response center will begin their response immediately, camera images can provide additional information such as the potential for hazardous material conditions before emergency responders arrive at the scene. This information saves precious time in making sure the right resources respond. Additionally, especially in rural areas, drivers may not know their precise location. Repeated phone calls help dispatch centers piece together improved location information. While full camera coverage of the study corridor is likely not cost-effective, some camera coverage will prove beneficial to at least some incidents. Recommendations for CCTV implementation along the US 67 study corridor are detailed in **Section 3.3.2** and **Section 3.3.3**.

Response is limited by the distance and available emergency responders. The only true assistance comes from additional resources. Response is not typically considered ITS related.

Proper **incident management** at the scene is critical for the safety of responders and travelers alike. A large advantage can be gained with simple training of police and firefighters for traffic control at an incident. If resources are available from transportation agencies or private recovery or traffic control firms, additional ITS assets can be brought to an incident scene (e.g., arrow boards or portable changeable message signs) that relieve police and firefighters from traffic control responsibilities.

An example to increase the emergency response assets at a low cost that has been used elsewhere is to retrofit old fire trucks, that would otherwise be decommissioned, into blocker trucks by adding arrow boards on each side and the rear of each vehicle. The amber LED light arrow sticks can be set to flash in the desired direction of travel. Other specialty equipment and systems may be available as commercial products and new systems can be developed and tested to help protect the scene and manage traffic.

As part of typical traffic incident management, post-incident management is often included as "after-action reports". The responding parties will get together and discuss the management of the recent incident and try to identify areas for improvement. Areas for improvement could include additional training or support. Any recommendations need to be addressed within the agencies.

2.5 Weather

ITS is typically dynamic while responding to current weather conditions. Very few systems that impact driving are as dynamic as the weather. Designing around the prevention of damage for something unprecedented (e.g., a 500-year flood) is difficult, and ITS is instrumental in making the transportation system more resilient to these events. ITS can contribute to managing traffic before events (e.g., advanced signal timing, traveler information to support evacuation), or during events by

providing robust communications, camera images, and additional traveler information services. A good example for the US 67 study corridor would be warnings of ice on the road at Paisano Pass.

2.6 Traveler Information

Traveler information is often more critical in rural areas than in urban areas. Rural areas typically lack the redundant close proximity to parallel routes that are common in urban areas. When travelers start a trip, they have little choice in routes. Information is key to helping travelers make safe decisions.

Rural corridors generally do not experience recurring congestion where travel time information to multiple destinations is most typically applied. However, major events like weather and crashes can have a significant impact on travel times between communities. An example for the US 67 study corridor is that fog or ice can increase travel times greatly. If travelers have this information before they leave their community, they may determine the trip is no longer feasible or change their trip plans before they leave. If an event is severe enough (e.g., a bridge is out), longer alternate routes can be selected.

Traveler information requires several components. The first is data. Travel time data from sensors, third party data (e.g., Waze), or other systems is required before travel times can be provided. The same is true with weather and incidents – data must be collected first. The second component is a traveler information system that assembles and processes the data. In the simplest systems, this can be a controller in a signal cabinet. For a corridor such as US 67, traveler information is more typically addressed at a traffic management center. A US 67 center could be a computer at a local agency or part of the larger El Paso or Statewide regional traffic management centers or both. Considering the wide variety of information desired, access by responding personnel is required.

From the TMC, the information needs to be distributed. Information can be distributed via Dynamic Message Signs (DMS) on the road, through social media, or third-party systems.

2.7 Communications and Power

For all ITS systems, and all operations systems (whether electronic or manual), good communications are essential for timely and effective management of the transportation network. In a rural corridor, communications are almost always electronic, whether shared data on devices or voice radio traffic.

For the US 67 study corridor, communications are integral to ITS and generally addressed with each project. ITS treatments near communities will have easier access to power and communications. Those ITS treatments in more rural areas may depend more on solar power and radio or cellular communications. Other options for communications include leasing systems from the private sector. The key design and planning consideration is ensuring all systems address power and communications in some manner. No system should be completely isolated.

3.0 ITS Strategies and Projects

The following section reviews the ITS specific issues and needs that have been identified in the previous stage of this study and ties them to specific ITS projects.

3.1 Summary of Issues and Needs

Three primary sources of information are used to identify the issues and needs. The first source is the US 67 Safety Analysis Technical Memorandum (Appendix D – Safety Analysis), with a detailed analysis of the crash history of the corridor. The second source is the summary from the Bus Tour #1 (December 12, 2017). The third source consists of anecdotal information provided during discussions with TxDOT study team and in-person conversations. The majority of the conversations were focused on expressing needs related to safety and operations. ITS concepts were developed from these conversations and presented back to TxDOT. Additionally, more ITS focused discussions with the TxDOT team provided feedback and thoughts on the ITS systems under consideration.

Based on the needs identified for the US 67 study corridor, projects were first developed from the Rural ITS Toolkit. Of the 42 tools identified in the Rural ITS Toolkit, 17 are applicable to the US 67 study corridor – 8 tools in crash countermeasures, 2 tools in emergency services, 1 tool in operations and maintenance, 1 tool in surface transportation and weather, 2 tools in tourism and travel information, and 3 tools in traffic management. In addition, other ITS tools have been identified that do not match directly to the Rural ITS Toolkit. All the tools match against the categories and strategies identified in the ITS Needs Assessment, and all match against the Goals and Objectives identified **Attachment A**. Each tool may translate to one or more potential projects.

High capital cost was not used to eliminate potential solutions at this stage (although high capital cost may be a limiting characteristic later, as conceptual alternatives for the corridor are developed and evaluated). However, only solutions with at least medium applicability to the US 67 study corridor are presented in the memorandum, with the exception of Vehicle Detection because it is regarded as an enabling technology for several ITS applications that are relevant to the corridor. **Table 3** provides applicable categories of tools along with rough capital costs and corridor applicability.

Table 3: Potential ITS Solutions for the US 67 Corridor by Category

Categories	Tool #	Tool Name/Description	Capital Costs	US 67 Applicability
Crash Countermeasures	CC1	Animal Warning Systems	High	High
	CC2	Automated Visibility Warning Systems*	Medium to High	High
	CC3	Bicycle Safety Systems	Low	Medium
	CC8	Pedestrian Safety Systems	Low	High
	CC6	Highway-Rail Crossing Safety Systems	Low to Higher	Medium
	CC9	Road Geometry Warning System	Low to Higher	High
	CC11	Speed Warning Systems	Low	Medium
	CC12	Work Zone Safety Systems	Low to Higher	Medium
Traffic Management	TM2	Variable Speed Limit (VSL)	Low to Higher	Medium
	TM5	Vehicle Detection*	Low	Low**
	TM8	Planned Special Event Management Systems	Low to Higher	High
Operations and Maintenance	OM2	Site Management During Rockslides	High to Higher	Medium
Emergency Services	ES1	Next Generation 911	Higher	Medium
	ES2	Smartphone Applications for First Responders	Higher	Medium
Surface Transportation and Weather	STW1	Integrated Weather Monitoring/Prediction Systems*	Low to Medium	High
Tourism and Traveler Information	TTI3	Dynamic Message Sign (DMS)	Low to Higher	Medium
	TTI4	Integrated Traveler Information Systems	Higher	High
Other ITS	Other	Power and Communication	High	High
	Other	Traffic Surveillance Cameras*	High	High
	Other	POE Smart Parking System	Higher	High
	Other	Incident Management Support Truck	Low	High
	Other	Traffic Incident Management Training	Low	High
	Other	Establish Corridor Coordination Groups	None	High

* The equipment and location of these systems are rolled into the Total Station concept.

** Retained because vehicle detection is an important enabler for other ITS applications.

Legend:

Capital Costs: Low ($0 to $50,000), Medium ($50,000 to $100,000), High ($100,000 to $250,000), Higher (Above $250,000) (Source: Rural ITS Toolkit)

US 67 Applicability: Low, Medium, High

3.2 ITS Tools

This ITS Plan document is part of a larger overall Corridor Master Plan. As such, the ITS projects described below should be considered potential projects as an input into the overall plan. Many of these projects may be superseded due to redundancy and/or irrelevancy by other recommended projects. Therefore, this section is intended to be more inclusive of all ITS potential projects, even if many of them are not included in the final corridor plan.

In this section, all the potentially applicable ITS tools are mentioned under each Rural ITS Toolkit topic area. Each strategy will match a number of ITS categories (i.e., Safety, Weather, Traffic Management, Operations and Maintenance, Emergency Services, Tourism and Traveler Information, Traffic Performance Measurement, and Communications) as identified in **Table 3**.

3.2.1 Crash Countermeasures

This strategy includes tools that are focused on reducing crash frequency and severity. The tools identified are relevant to US 67 study corridor operations for short- and mid-term implementations. Details, including the location and cost of the proposed projects identified under each tool, are presented in **Attachment A**.

CC1 Animal Warning Systems

Animal warning systems help to mitigate vehicle collisions with large animals. They use electronic sensors to detect animals. The animal warning system typically includes a signboard that activates flashing lights when an animal is detected.

Applications of animal warning systems are limited to a few miles at a time. Sensors are typically effective for hundreds of feet, not thousands. Therefore, applications are typically targeted to locations that are consistent with numerous animal crashes. Warnings need to be proximate to animal detections both geographically and within a set time period. Additionally, drivers tend to only pay attention to active warnings for a short period of time (and therefore a short distance traveled).

Animal crashes account for a large number of the total crashes along the US 67 study corridor. In Appendix D – Safety Analysis, using the criterion of recommending an animal warning system at all severe crashes with animals, ten locations were recommended across the US 67 study corridor. Of these, 2 locations are between Fort Stockton and Alpine, 2 between Alpine and Marfa, and 6 between Marfa and Presidio. As shown in **Figure 3** the crashes tend to be located throughout the study corridor, but concentrations are present between Presidio and Marfa and between Alpine and I-10. Potential Animal Warning Projects are described in **Table 4** and mapped in **Figure 4**.

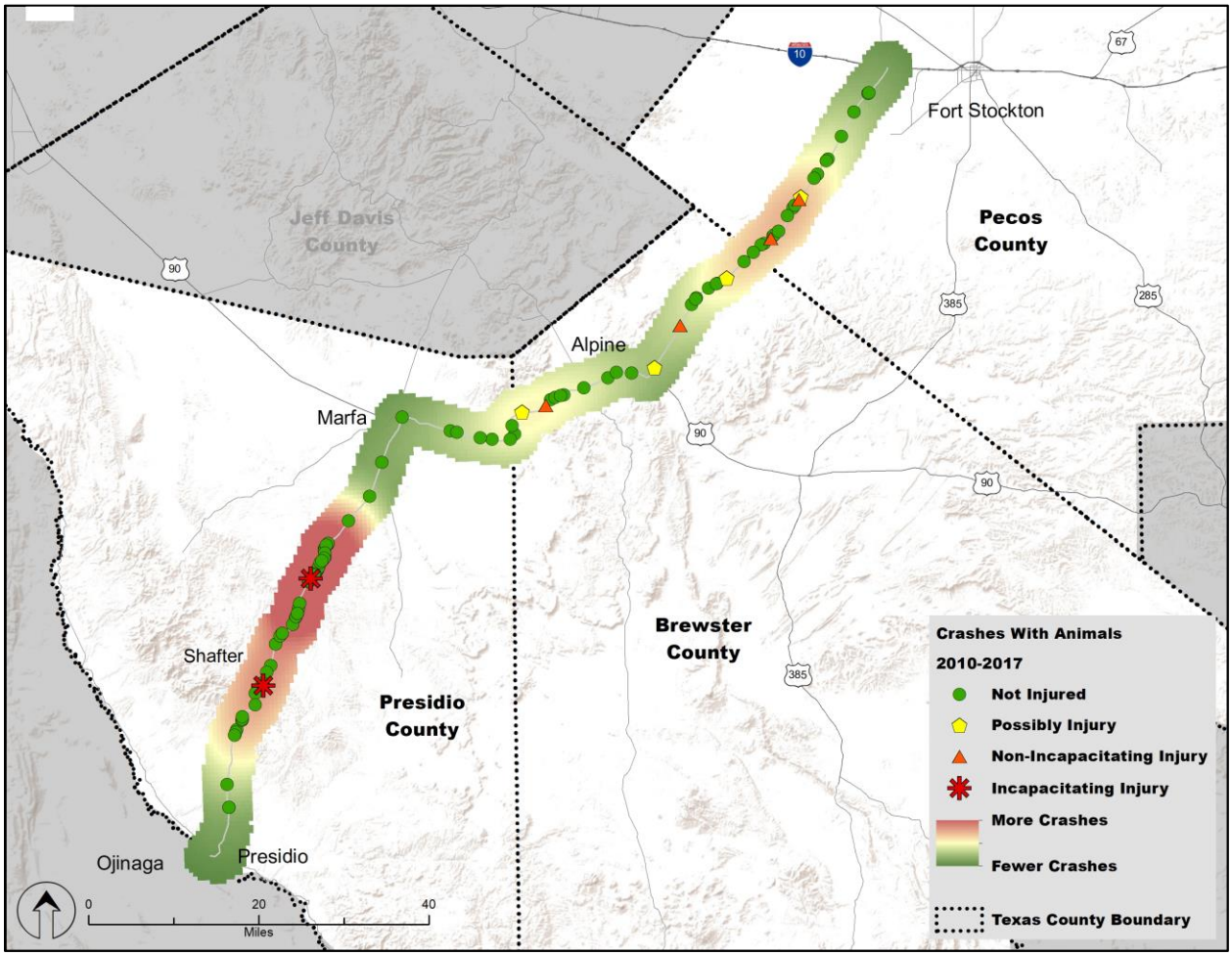


Figure 3: Animal Crashes Hotspot

Table 4: Potential Animal Warning Projects

ITS Device	Location	Comments	Estimated Cost (2019 Dollars)
Animal Warning System South	25 miles South of Marfa	animal sensors in each direction every 500 feet for 20 miles	$3,700,000
Animal Warning System North	Between Alpine and Fort Stockton	animal sensors in each direction every 500 feet for 12 miles	$2,300,000

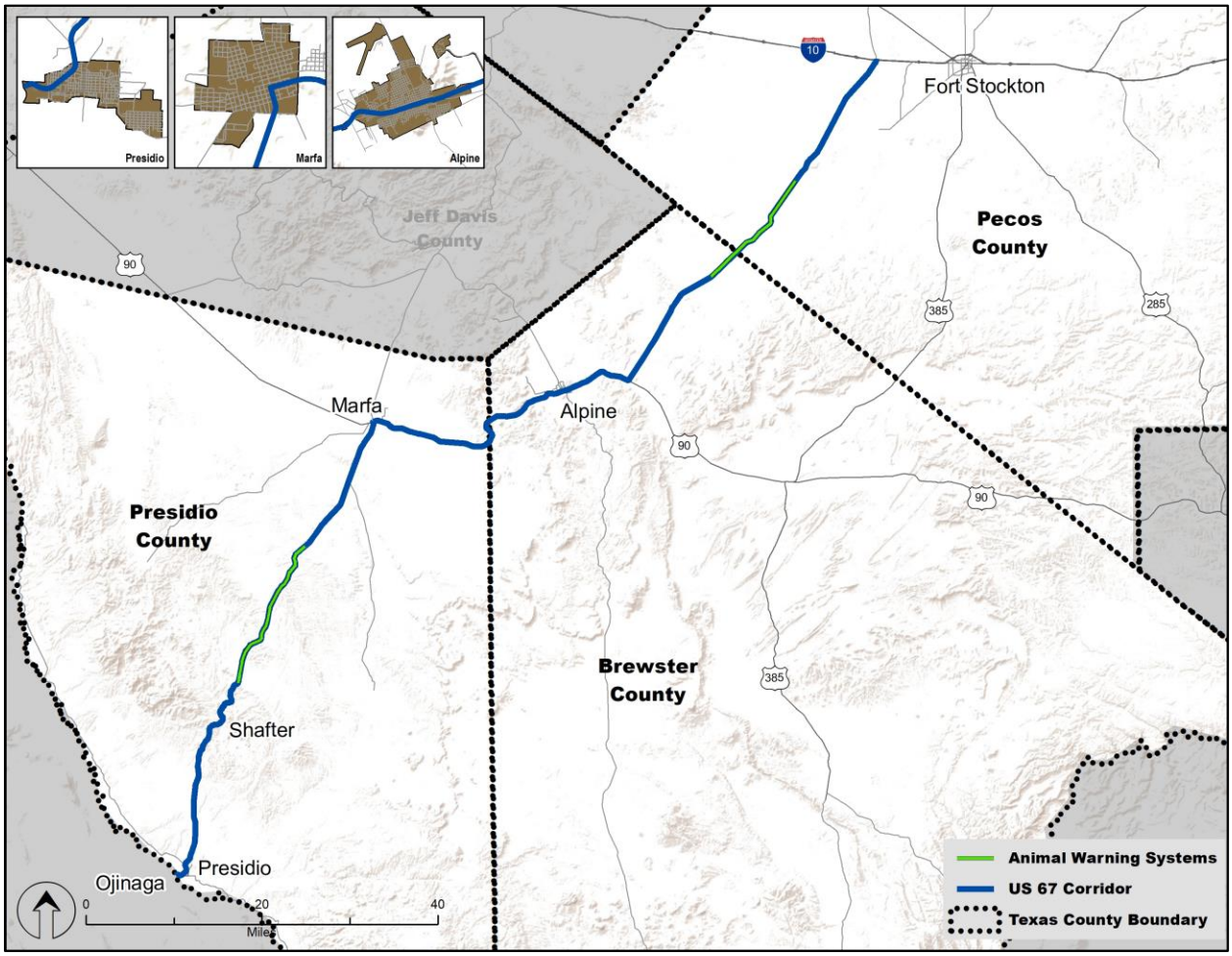


Figure 4: Animal Warning Project Locations

CC2 Automated Visibility Warning Systems

Automated Visibility Warning Systems (AVWS) warn drivers by providing severe weather condition information like fog, snow, dust, smoke, etc. The system requires a weather station and DMS or flashing lights on a static sign. The system can be independent or managed by a TMC. Flashing lights will activate or a message will be displayed on the DMS when severe weather conditions are detected. AVWS are also coordinated with the traveler information system to spread the appropriate warning message.

Fog is generally an issue in the mountainous curves between Presidio and Marfa. A proposed automated visibility warning system would rely on a weather station placed in this area and DMS placed in advance of these curves to inform drivers about poor visibility. This AVWS system is isolated at the Paisano Pass.

This project directly relates to two other projects. First, the concept of the "total station," which is discussed at the end of this section. The proposed AVWS for Paisano Pass will include several other

components, similar to the total station. This AVWS system also includes a DMS, which separates it from the other total station projects. Secondly, fog or other weather conditions exist at times along larger portions of the corridor. In these cases, the proposed projects for traveler information systems will be used to provide weather warnings to larger sections of the corridor. Therefore, the complexity and costs related to this project exceed those of typical isolated AVWS. For US 67 the system is called Weather Warning System/Total Station.

Potential Weather Warning System/Total Station project is laid out in **Figure 5** and tabulated in **Table 5**.

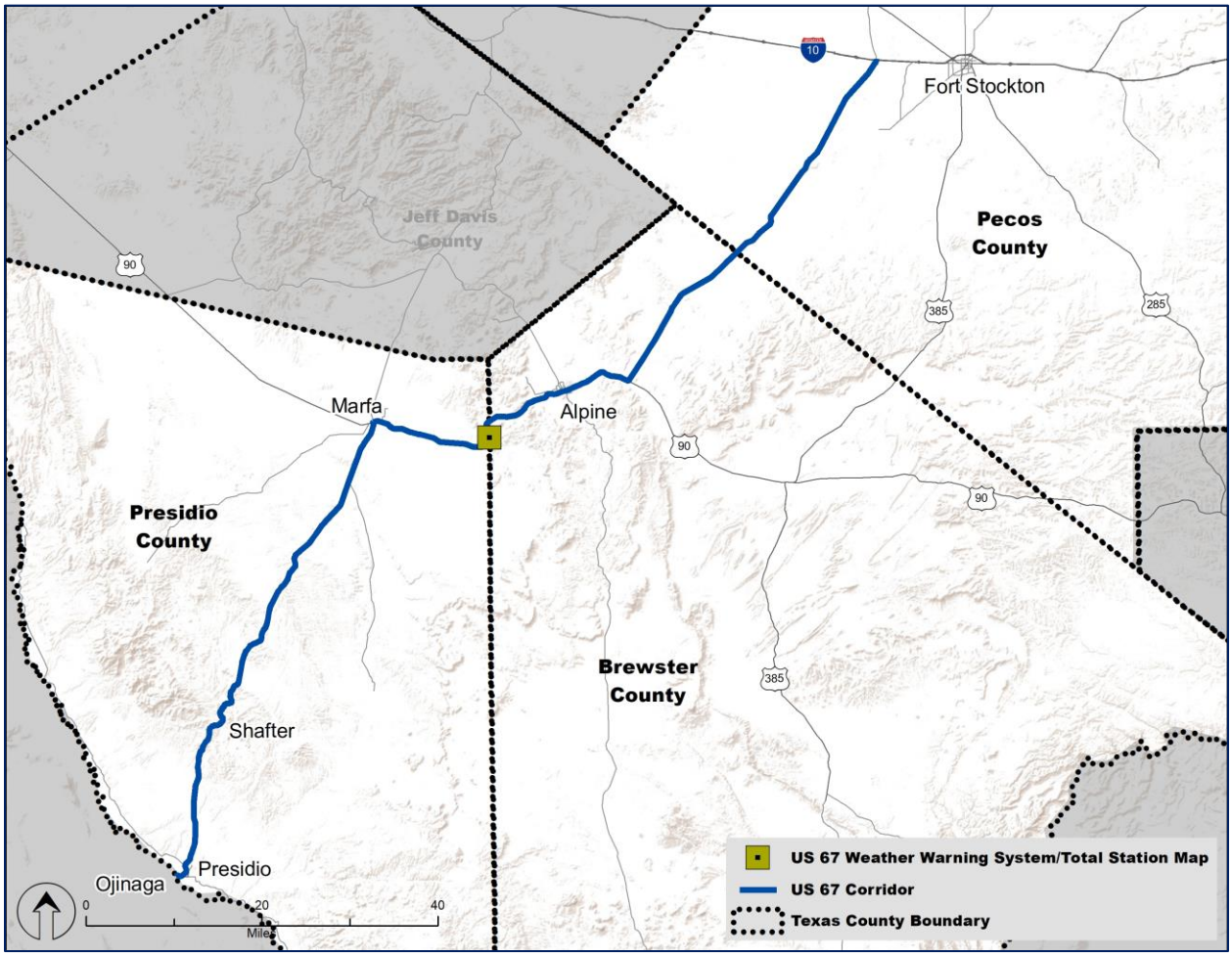


Figure 5: Potential Weather Warning System

Table 5: Potential Weather Warning System Project

ITS Device	Location	Comments	Estimated Cost (2019 Dollars)
Paisano Pass Weather Warning System	Paisano Pass including 2 DMS at locations entering and exiting curved roads	Provides warnings for fog and ice conditions at and near the pass	$750,000

CC3 Bicycle Safety Systems

Bicycle safety systems help to identify or detect the presence of a bicycle and increase the safety and visibility of a bicyclist. These systems can be installed at crossings as an automated device or a pushbutton. Some of the bicycle safety systems are as follows:

- Protected yet concurrent signal phasing
- Red-light cameras
- Automated speed enforcement systems
- Green wave programs (corridor signal coordination)
- Bicycle warning systems (tunnels, bridges, roadway crossings)

Many of the treatments identified above are applicable to a range of urban safety treatments and are better addressed through signal timing and general safety efforts such as speed enforcement. The use of pedestrian buttons serves both bicyclists and pedestrians. Systems that use detectors to automatically detect bicycles are more applicable to paths that cross roads than to urban areas in general. Warning systems at cross streets without a signal can be implemented. These systems use a pedestrian push button to trigger flashers on a static sign that warn drivers a pedestrian or bicyclist is crossing at an established crosswalk that is not at a signal. Often the crosswalk lights up when activated. These systems may require local ordinance changes.

Through public outreach activities, the public consistently identified the need for bicycle and pedestrian improvements both along the US 67 study corridor and within the communities the corridor serves. In response, complete streets improvements were developed for Presidio, Marfa, Alpine, and rural segments of US 67. Complete streets are streets that are designed to serve all users of the streets – vehicles, freight, bicycles, pedestrians, etc., based on the context and function of the roadway and land use. Through a collaborative effort among TxDOT, stakeholders, local elected officials, and the public, context-sensitive complete streets options were developed based on national and state best practices and guidelines.

Nine crashes out of the 878 corridor crashes between 2010 and 2018 were bicycle/pedestrian crashes. All of them occurred in Alpine and Marfa at unsignalized intersections. Crash locations involving severe crashes with bicycles and pedestrians were identified as potential candidates for bicycle and pedestrian warning systems.

Additionally, many pedestrian and bicyclist needs are addressed in the complete streets alternatives. Potential Bicycle/ Pedestrian Warning System Projects are shown in **Figure 6**. Cost estimates are presented in **Section CC8 Pedestrian Safety Systems**.

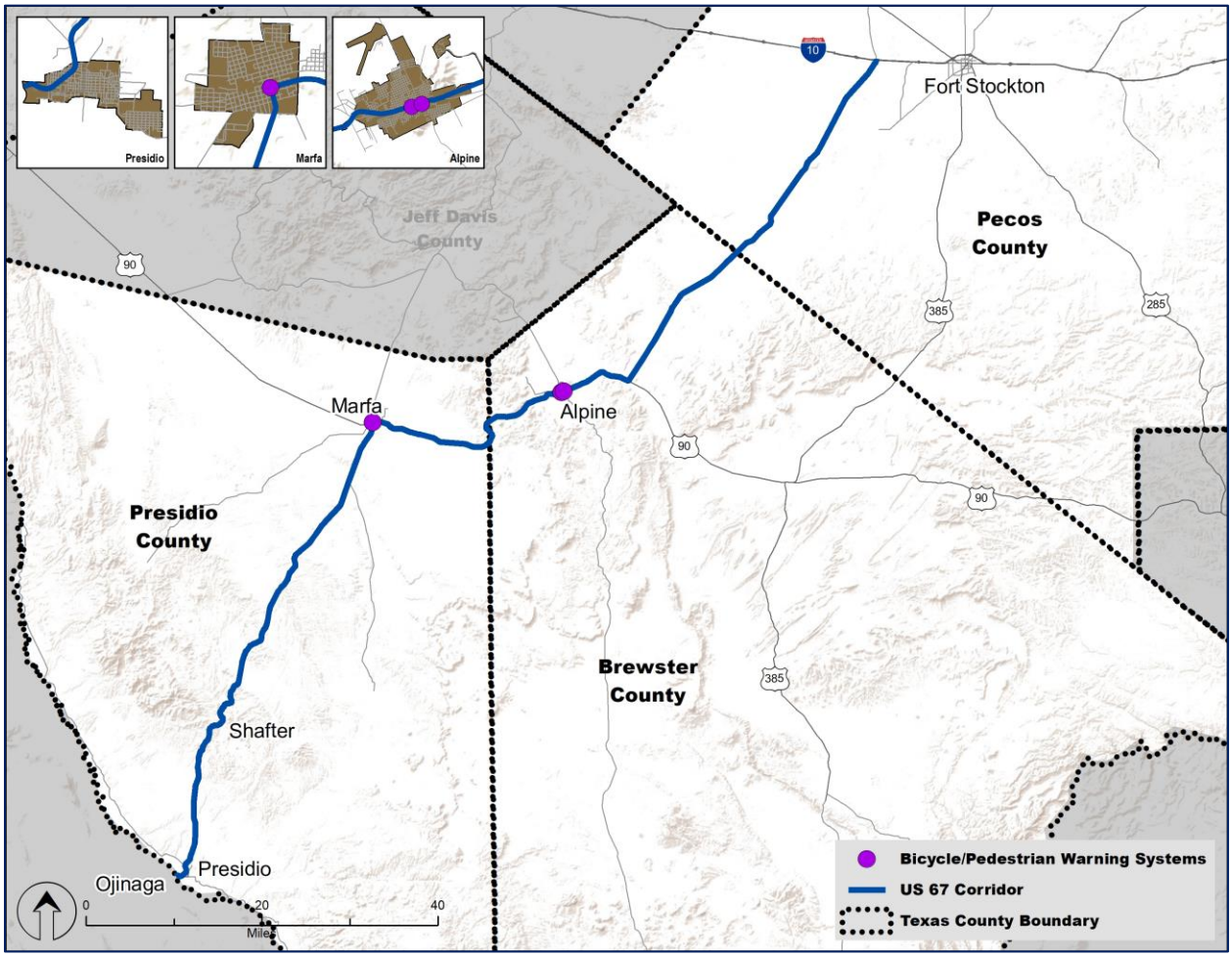


Figure 6: Potential Bicycle/ Pedestrian Warning System Locations

CC8 Pedestrian Safety Systems

Pedestrian safety systems alert motorists of the presence of pedestrians to improve pedestrian safety while crossing roads. From the Rural ITS Toolkit, this system has multiple options to choose from:

- Red-light enforcement cameras or no-turn-on-red signals
- Variable speed limits
- Countdown signals/illuminated walk signal pushbuttons
- Flashing crosswalk lights/pedestrian hybrid beacon/road lighting technology
- Automated pedestrian detection systems for traffic signals

Pedestrian hybrid beacons warn and control traffic at unsignalized locations and assist pedestrians in crossing a street or highway at a marked crosswalk. Systems that use detectors to automatically

detect pedestrians are more applicable to walking paths that cross roads than to urban areas where pedestrians may do a variety of activities near the road.

Warning systems at cross streets without a signal are possible and should be included in the bicycle warning systems described in the **Section CC3 Bicycle Safety Systems**.

As discussed in the bicycle safety systems section, nine crashes out of the 878 corridor crashes were bicycle/pedestrian crashes. All of them occurred in Alpine and Marfa at unsignalized intersections. Crash locations involving severe crashes with bicycles and pedestrians were identified as potential candidates for pedestrian and bicycle safety systems, and are presented in **Table 6.**

Table 6: Potential Bicycle/ Pedestrian Safety Projects

ITS Device	Location	Comments	Estimated Cost (2019 Dollars)
Bicycle/ pedestrian Warning System 1	S Garnett St and W Holland Ave., Alpine	Stand-alone pedestrian button and flashers	$100,000
Bicycle/ pedestrian Warning System 2	N 5th St and W Holland Ave., Alpine	Stand-alone pedestrian button and flashers	$100,000
Bicycle/ pedestrian Warning System 3	San Antonio St and Highland Ave., Marfa	Stand-alone pedestrian button and flashers	$100,000

CC6 Highway-Rail Crossing Safety Systems

Highway-rail crossing safety (HRCS) Systems identified in the Rural ITS Toolkit notify the train operator of a delayed vehicle on the tracks and inform motorists of an oncoming train using a DMS. An HRCS system can use any of the following to support its operation: access control gates, flashing lights, DMS, vehicle detection, in-vehicle sensing, traffic signal preemption, and integrated traveler information systems. An HRCS system improves safety and communications and reduces congestion.

Only one at-grade railroad crossing exists along the study corridor, at the crossing of US 67 and Old Alpine Highway. Buses are legally required to make a complete stop at the Texas-Pacifico crossing northeast of Alpine whether or not a train is present, which creates a safety hazard since there are curves on both sides of the crossing and cars (which are not required to stop) are typically driving at 75 miles per hour or more. In the relatively open rural landscape, especially at night, trains and the active crossing gates are visible, but trucks and buses stopped at the crossing are much less visible. Providing advanced information on the approaching curved sections is important for everyone's safety. This project is not recommended for short-term implementation due to low rail and traffic volumes but rather should be considered in the long-term as volumes increase in the future. Potential highway-rail crossing safety systems on the US 67 study corridor are shown in **Table 7**.

Table 7: Potential Highway-Rail Crossing Safety Projects

ITS Device	Location	Comments	Estimated Cost (2019 Dollars)
Highway-Rail Crossing Safety System	Crossing of US 67 and Old Alpine Highway (21 miles south of I-10)	Provides detection and warnings for stopped or slow-moving vehicles at and near the crossing.	$250,000

Therefore, the railroad at the crossing of US 67 and Old Alpine Highway should consider a rail crossing safety system that will focus on stopped vehicle detection for the northbound and southbound approaches as shown in **Figure 7** as a long-term consideration.

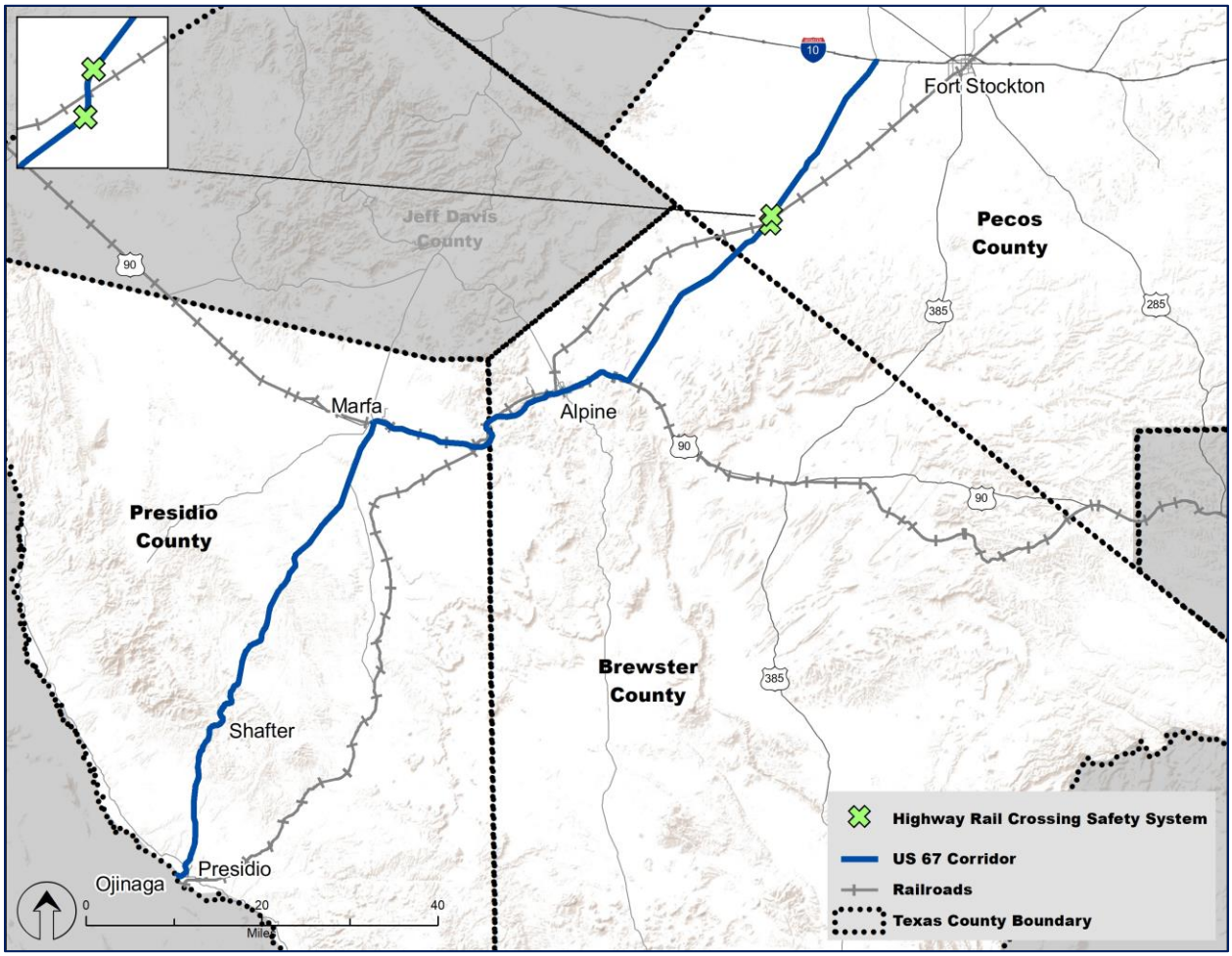


Figure 7: Highway-Rail Crossing Safety Systems Locations

CC7 Intersection Collision Warning Systems (ICWS)

Intersection collision warning systems (ICWS) use DMS to display the details of approaching vehicles to drivers approaching or waiting at the intersection. An ICWS tool is useful at intersections where one direction is stop-controlled and the other direction is uncontrolled. The ICWS informs drivers about an approaching vehicle at crossings.

Three locations across the US 67 study corridor were initially recommended for an ICWS in Appendix D – Safety Analysis: one at US 67/I-10, one at the US 67/US 90 Y-Intersection, and another at the Marfa Lights location.

All three locations have been studied and documented in the Appendix D – Safety Analysis. For all three, separate recommendations were made on safety improvements, none of which included an ICWS. No projects are currently recommended using ICWS.

CC9 Road Geometry Warning System

Road geometry warning system warns road users of ramp rollover risks, sharp curves, steep downhills, and heights of structures/over-height of vehicles. This system primarily benefits heavy vehicles by providing advanced warning. This system uses signboards/flashing beacons.

This system becomes an ITS system when it is combined with vehicle detection. A static sign with continuous flashers is not an ITS. A static sign with flashers that only illuminate when a vehicle is detected to warn of roadway geometry could be considered an ITS.

Two low bridge locations in Alpine are candidates for an over-height vehicle detection system. Both systems would provide active flashers and a warning when over-height vehicles are approaching the bridges. Due to their proximity and similar design, they have been combined into a single project. Potential over-height vehicle warning system projects are shown in **Figure 8** and tabulated in **Table 8**.

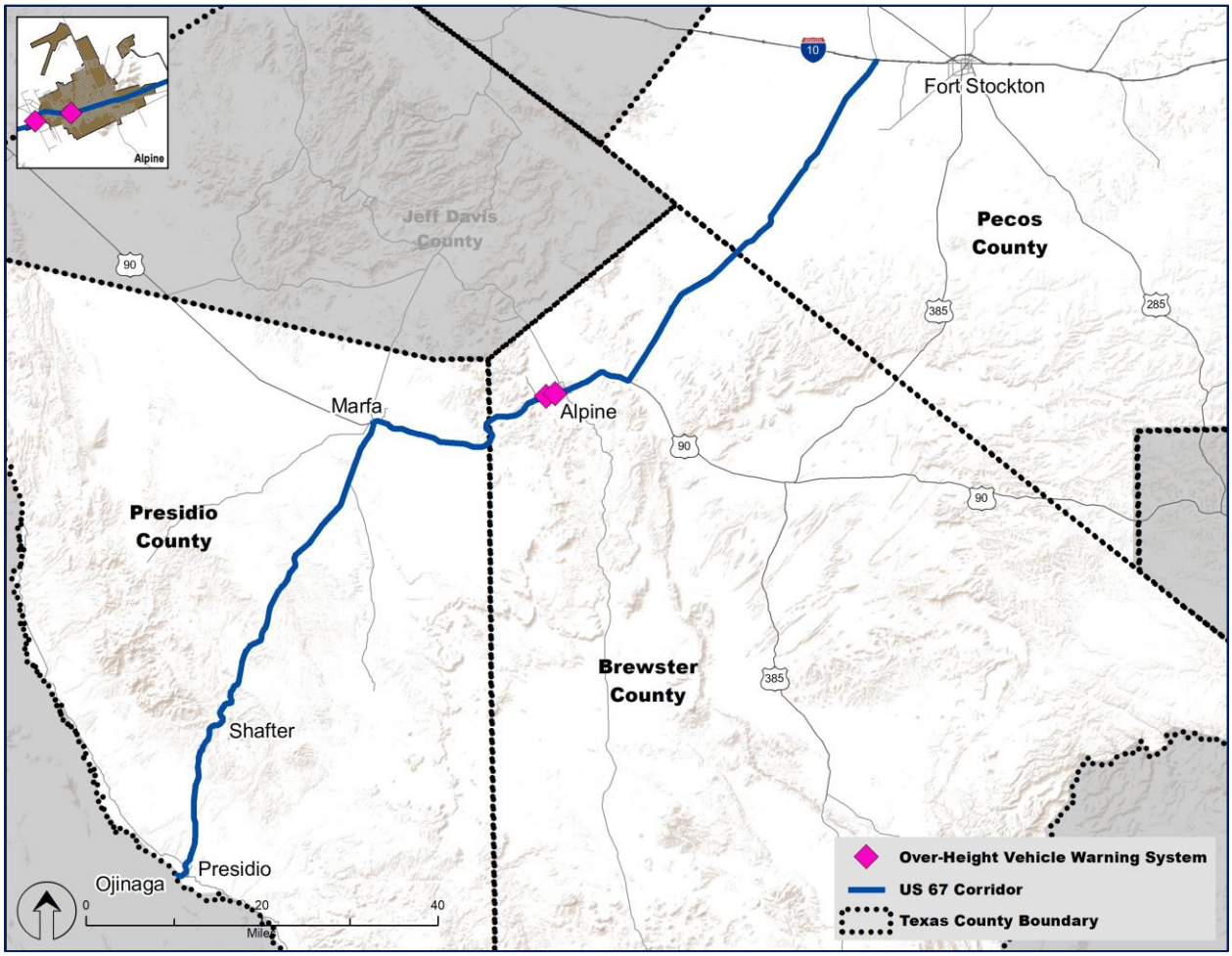


Figure 8: Over-Height Vehicle Warning System

Table 8: Potential Over-Height Vehicle Warning System Projects

ITS Device	Location	Comments	Estimated Cost (2019 Dollars)
Over-Height Vehicle Warning System NB and SB US 67 (two locations)	Crossing south end of Alpine	Provides detection and warnings for over-height vehicles approaching the crossing from both directions. These are two locations combined as a single project due to their proximity.	$250,000

CC11 Speed Warning Systems

Speed warning systems inform motorists about the speed of their vehicles, weather conditions, road geometry, and other factors.

There are several curves recommended for physical improvements such as high friction surface treatment or improving the superelevation of the curve. Many will also have improvements such as additional static signs including chevrons on the curves. These locations and treatments are detailed in Appendix D – Safety Analysis.

This ITS plan only discusses the two treatments at various curves that could be considered ITS projects. The first is the use of sequential lighting chevrons and is known as a sequential dynamic curve warning system. This system uses a speed monitoring detector and triggers the illumination of LEDs outlining chevron signs in a linear sequence throughout the curve. This system helps to illuminate and define the curve. The second system is the flashing beacon which also uses a speed monitoring detector, but in this case, it triggers flashers on a curve warning sign. This system becomes an ITS system when it is combined with vehicle detection. A static sign with flashers that only illuminate when a speeding vehicle is detected could be considered an ITS system. Criteria for speed warning systems are shown in **Table 9**.

Table 9: Criteria for Speed Warning Systems Countermeasures

Criteria	Countermeasure	ITS	Count
Radius of curve less than 1810 ft and no presence of severe crashes within 150 ft of curve. Nearby curves were combined for this treatment.	Flashing Beacon	Yes	10
Radius of curve less than 1810 ft and presence of severe crash within 150 ft of curve	Sequential Dynamic Curve Warning System	Yes	7

Sequential dynamic curve warning systems are proposed at seven locations (five between Presidio and Marfa and two between Marfa and Alpine) and the flashing beacons are proposed at ten locations along the US 67 study corridor. The flashing beacons are located south and north of Shafter. The locations are depicted in **Figure 9** and the cost estimate is shown in **Table 10**. The area around the US 67 study corridor is known for its dark sky considerations. In fact, the Big Bend Ranch State Park, located east of the study corridor, has an International Dark Sky Park designation. The use of any lighting treatments in the study corridor will need to be examined against any dark sky area restrictions.

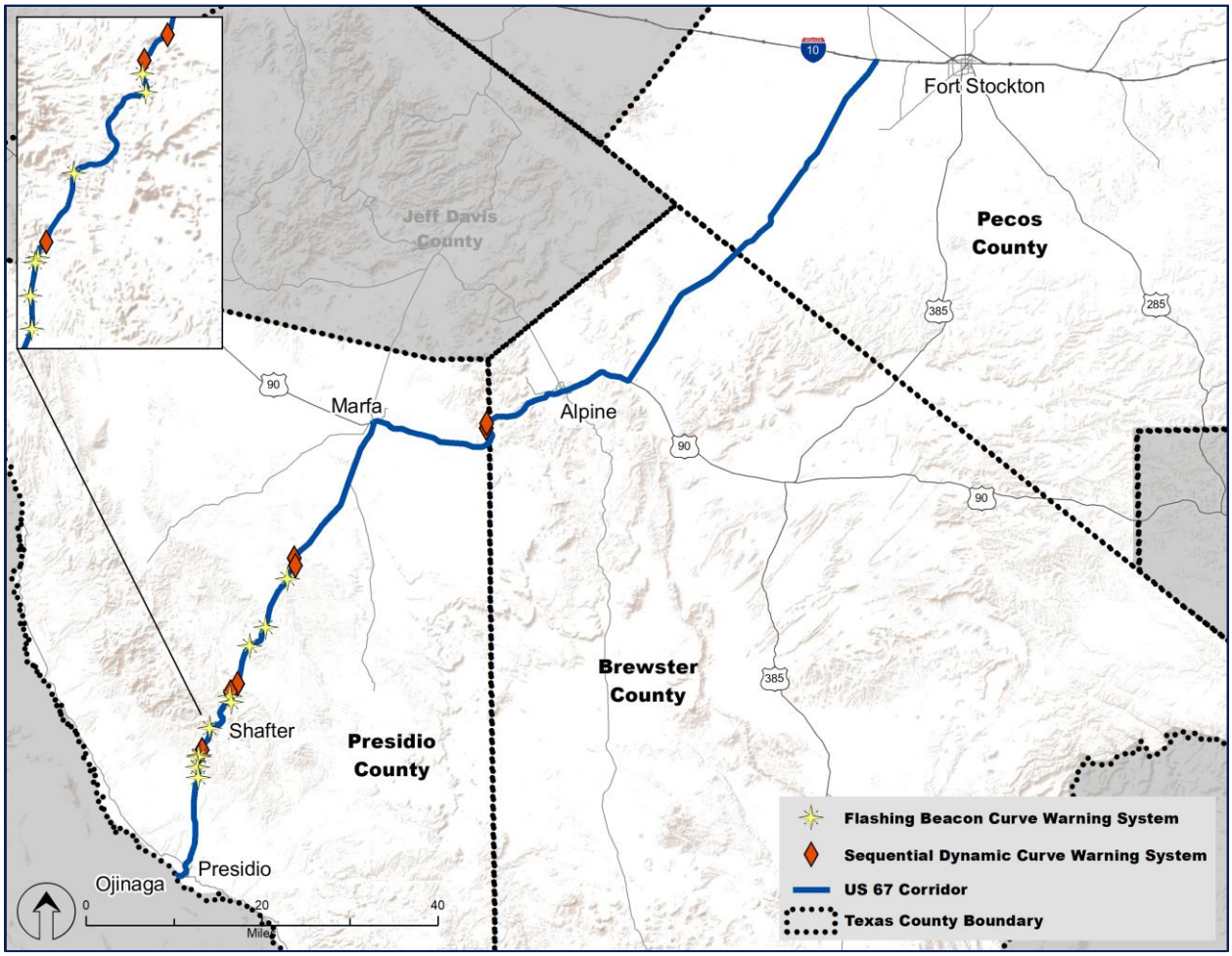


Figure 9: Potential Speed Warning Systems

Table 10: Potential Speed Warning Systems Countermeasures Projects

ITS Device	Location	Comments	Estimated Cost (2019 Dollars)
Flashing Beacon Curve Warning System	10 Locations	Provides detection of fast-approaching vehicles and activates sequential curve warning signs.	$150,000 per location
Sequential Dynamic Curve Warning System	7 Locations	Provides detection of fast-approaching vehicles and activates sequential curve warning signs.	$450,000 per location

CC12 Work Zone Safety Systems

Work zone safety systems enhance safety in and around work zones by alerting construction workers of any vehicle coming nearby and alerting motorists about the ongoing changes on a roadway, such as a lane configuration change, congestion, alternative routes, and change in speed limit. This system uses various ITS applications like speed compliance systems, dynamic late lane merge systems, queue

detection systems, cameras, and Bluetooth detectors to monitor traffic. DMS and integrated traveler information systems can also be used.

Work zones are by nature temporary. No permanent safety systems are recommended. The recommendation is for TxDOT to require work zone safety systems on all work zones lasting longer than one continuous month. The system should have, at a minimum, Portable Changeable Message Signs (PCMS) on both approaches that provide real-time delay information as well as the requirement that incident information within the work zone be messaged within 30 minutes of verification.

3.2.2 Traffic Management (TM)

This category from the Rural ITS Toolkit provides the tools that facilitate the identification of congestion and the management of traffic. Some of the tools identified as relevant to US 67 operations for short- and mid-term implementation are listed below. In addition, other ITS tools have been described for consideration in future efforts as the needs and demands of the corridor change. Details, including the location and cost of the proposed projects identified under each tool, are presented in **Attachment A**.

TM2 Variable Speed Limit (VSL)

VSL is a tool used to lower the speed of vehicles traveling at high speed. VSL can be used in special circumstances (e.g., school zones, inclement weather conditions, poor pavement conditions, traffic volume and operation speeds during incidents) and allows the operating agency to balance between the needs of safety and efficiency. VSL uses DMS to display the roadway conditions and can coordinate with Road Weather Information Systems (RWIS) and work zone safety systems.

The primary use of VSL in the US 67 study corridor would be for weather conditions. The equipment necessary to determine weather conditions is included in project CC2.1, in the deployment of additional RWIS included in the total station concept discussed in **Section 3.3.3**, and in the deployment of traveler information DMS below. No urban special use zones exist within the study corridor. Therefore, no isolated VSL-only systems are recommended, although VSL functionality may be included as part of other systems such as weather warning and traveler information systems.

TM5 Vehicle Detection

Vehicle detection is a tool that allows agencies to identify vehicle presence, speed, weight, direction, and occupancy. Vehicle detection enhances safety, provides travel-time information, reduces congestion, monitors travel flow, counts vehicles, detects queues, and identifies pedestrians/bicyclists. Vehicle detection can be installed in-road or over the road and it consists of various sensors. Potential vehicle detection through third-party vendors is described in **Table 11**.

Table 11: Potential Vehicle Detection Projects

ITS Device	Location	Comments	Estimated Cost (2019 Dollars)
Third-party data real-time travel time information feed to the traffic center for public dissemination	Corridor wide, looking for travel times between communities only	Measures travel times and provides to TxDOT for use with traveler information systems. Costs assumed for 4-year contract.	$500,000 (4 years)

The primary uses of vehicle detection in the US 67 study corridor would be for travel times and vehicle counts. For determining travel times, sample data is gathered from a fraction of the traffic and used to estimate an average travel time across a set distance (e.g., between Alpine and Marfa). If travel time information is procured through a third party, no equipment is necessary. Data during overnight conditions may be infrequent and it incurs an annual subscription fee.

Traffic counting equipment is a separate system. The counters must be able to detect all passing vehicles to be accurate. However, counters may not need to report information in real-time. Daily or monthly downloads may be sufficient for user needs. The equipment and locations necessary for traffic counting are included in the total station concept described in **Section 3.3.3**. Traffic counters will be addressed separately below as part of the total station project.

TM8 Planned Special Event Management Systems

Planned special event management systems allow road users to obtain information about upcoming events through social media, traveler information systems, DMS, and 511. It uses vehicle detection and cameras during the events to monitor traffic conditions and informs both road users and the authorities.

An application like this is potentially useful for the many special events in the region, such as the Marfa Lights Festival, various county fairs, the TransPecos festival, and various bicycle and running races. The ITS devices can be permanent or portable, depending on the number of events per year. Existing social media and travel information sites should also be used to disseminate the information.

3.2.3 Operations and Maintenance (O&M)

This category includes tools that facilitate operations, enhance maintenance, or extend the longevity of transportation assets. Only one tool was identified as relevant for US 67 study corridor operations.

Note that this application has been adapted from the Rural ITS Toolkit's Site Management During Avalanches tool since avalanches are not an issue in the US 67 study corridor, but rockslides have been noted in some sections. The technologies used to detect the two events are similar.

Details, including the location and cost of the proposed projects identified for this tool, are presented in **Attachment A**.

OM2 Site Management During Rockslides

Site management tools inform the authorities and public of rockslide conditions and the usability of roads in rockslide prone areas. Various sensors, access control gates, and DMS are used in this tool. Sensors like ultrasonic, geophones, tilt sensors and environmental sensor stations are used to identify the risk of rockslides; vehicle detection sensors identify the number of vehicles in the rockslide prone areas. These sensors send a warning message to the authorities or maintenance staff about the road closure. Access control gates will get activated and stop the public from entering the prone area; while DMS conveys the road conditions to the public.

Rockslides are an issue at a few points along the US 67 study corridor. They generally occur at specific locations before and after Shafter and near the Paisano Pass. An ITS solution could be adding a monitor on cliffs and slopes to determine when rockslides occur. The system would then trigger warning signs to alert motorists until cleanup is complete. Potential rockslide warning systems for the US 67 study corridor are depicted in **Figure 10** and described in **Table 12**.

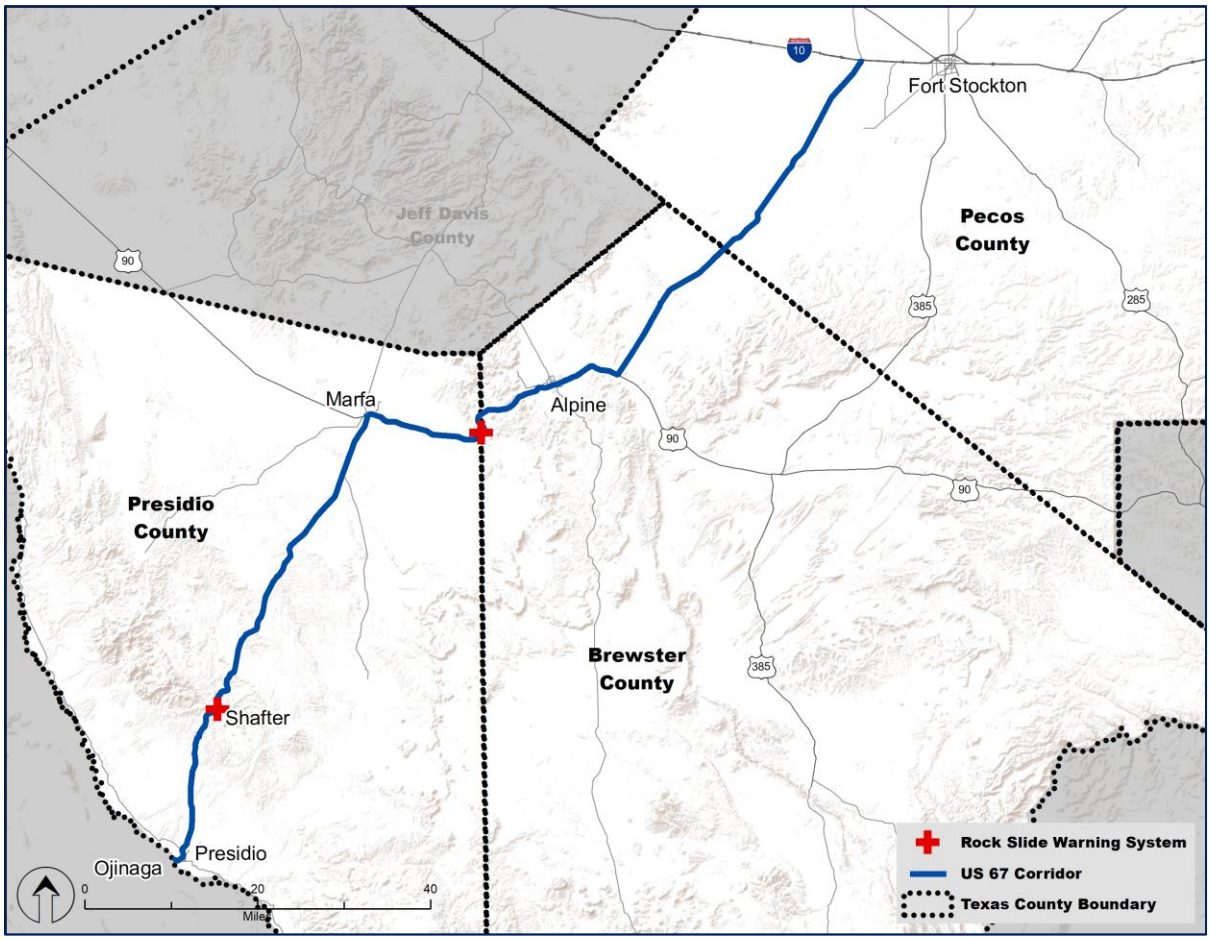


Figure 10: Rockslide Warning System

Table 12: Potential Rockslide Warning Projects

ITS Device	Location	Comments	Estimated Cost (2019 Dollars)
Rockslide Warning System Shafter	Near Shafter	Coverage will depend on the number of sensors.	$750,000
Rockslide Warning System Paisano Pass	Paisano Pass	Coverage will depend on the number of sensors.	$750,000

3.2.4 Emergency Services (ES)

Emergency services support, facilitate, and expedite emergency response efforts. In rural corridors, the two key issues are the proximity of services and communications. In a dense urban environment, emergency responders may be within a mile of any incident. In a rural corridor, police and fire response are necessarily sparser; therefore, quick response is dependent on the location of the incident. No ITS project can address this concern. The second concern regards communications, including the reporting of incidents and in coordinating resources between emergency responders and hospitals. Communications is discussed in **Section 3.3.1**.

ES1 Next Generation 911 (NG911)

NG911 is an updated version of 911 services. In addition to 911 services, it allows the public to send photos, videos, and text messages. This tool allows the dispatcher to identify the caller's location and sends the response teams, thereby providing faster response times. NG911 allows information sharing and call rerouting with other 911 call centers. This tool requires computer hardware and software improvements and coordination with emergency response agencies (911 call centers, first responders, local hospitals, and others) combined with GIS mapping technology.

NG911 is very dependent on the robustness and capabilities of the existing cellular service along the corridor. It is not cost-effective for a county 911 center to upgrade all its systems if rural users do not have the coverage and bandwidth to use those capabilities. If the communications network is capable, NG911 is even more valuable in a rural setting where response times are typically higher than urban areas. Potential NG911 projects on the US 67 study corridor are described in **Table 13**. The costs presented in this table include the construction and maintenance of a standalone NG911 call for US 67. Another option that would reduce the cost is to use companies such as Motorola to provide NG911 services at a specific cost to users. The potential drawback of this option is that vendor call centers may not be as effective in responding to emergency calls as a local center.

Table 13: Potential Next Generation 911 Projects

ITS Device	Location	Comments	Estimated Cost (2019 Dollars)
NG911 System 1	Presidio County	Covers 1 County	$4,000,000
NG911 System 2	Brewster and Pecos Counties	Covers 2 Counties	$4,000,000

ES2 Smartphone Applications for First Responders

Smartphone applications for first responders improve the communication between the hospital and the Emergency Medical Technicians (EMTs) in the field when an incident occurs. EMTs can send photos, videos, and audio files to the nearest hospitals from the incident and can also receive the patient's records from the hospital. Response times can improve by up to 50 percent and expedite the treatment process in rural areas.

As with the NG911 projects, this project is highly dependent on the robustness and capabilities of existing cellular service along the corridor. Smartphone applications are not recommended for US 67 in the short term, but if the communications network can be improved, possibilities exist. Responders could use existing applications such as Apple iMessaging. Capabilities may be present within existing radio systems. Even if a radio is lower bandwidth, in a rural area with small amounts of traffic, lower-quality images could possibly be transmitted through new applications. These existing applications are not common commercially available systems at this time, but a study could be done to determine the feasibility of developing an application. Potential smartphone application projects on the US 67 study corridor are shown in **Table 14**.

Table 14: Potential Smart Applications for First Responders

ITS Device	Location	Comments	Estimated Cost (2019 Dollars)
Smartphone Applications	Presidio, Brewster, and Pecos Counties	Covers full corridor	$300,000

3.2.5 Surface Transportation and Weather (STW)

This category includes tools that monitor weather conditions on the transportation network and mitigate weather-related impacts. There is a single tool that is relevant to the US 67 study corridor.

STW1 Integrated Weather Monitoring/Prediction Systems

Integrated weather monitoring/prediction systems represent a combination of technologies that collect, transmit and disseminate weather and road condition information. This tool is also coordinated with the National Weather Service to predict inclement weather conditions. The component of an Integrated Weather Monitoring/Prediction System that collects weather data is an Environmental Sensor Station (ESS). The ESS measures real-time weather-related conditions, including pavement temperature, wind speed and direction, precipitation, water level conditions, humidity, and visibility. This data is transmitted to automated warning systems, the traffic operations center, and other maintenance/operations facilities for decision support.

Weather monitoring is important for rural corridors, and three additional weather station locations have been identified. However, the functionality of the weather stations has been rolled into the total station concept identified in **Section 3.3.3**.

3.2.6 Tourism and Travel Information (TTI)

This category includes tools that expand or enhance the dissemination of travel conditions and tourism opportunities in the surrounding region. Some of the tools are identified as relevant to the US 67 study corridor operations for short- and mid-term implementation.

TTI3 Dynamic Message Sign (DMS)

DMS usually displays short information on roadway conditions to motorists using a large electronic screen either installed as a portable, semi-permanent, or permanent sign along the road. DMS can be mounted on overhead gantries or located alongside the roadway. This tool coordinates with other ITS applications to display distance and/or travel times, traffic conditions, road incidents, and safety/public service information.

Traveler information is critical in a rural area. When major incidents occur, travelers that are not informed may drive an hour or more only to be forced to return due to a road closure. Energy and time are lost, and travelers are exposed to increased risk. Providing information before a traveler departs the urban area allows travelers to decide to delay their trip rather than become stranded in a rural area exposed to the elements with no services.

The recommendation is to add small DMS approaching and leaving Presidio, Marfa, and Alpine, as shown in **Figure 11**. These DMS would be controlled by TxDOT but local authorities may be granted control. The DMS entering the communities can be used to inform travelers of incidents ahead in the urban area such as crashes and special events. The DMS leaving the towns should default to travel time information but can be used for incident information, work zone information, or weather-related cautions potentially including recommendations on variable speed limits. Potential DMS projects are described in **Table 15**.

Additionally, DMS could be placed before the access ramps to the rest stop areas. These DMS could support by providing real-time parking, safety, and travel time information. These locations could also include cameras for incident and operations monitoring. This improvement will enhance safety by providing drivers with access to critical information on road conditions ahead prior to rest areas, in particular to commercial vehicles that may need appropriate rest areas. The details and costs associated with this recommendation are assumed to be part of the rest areas design alternatives.

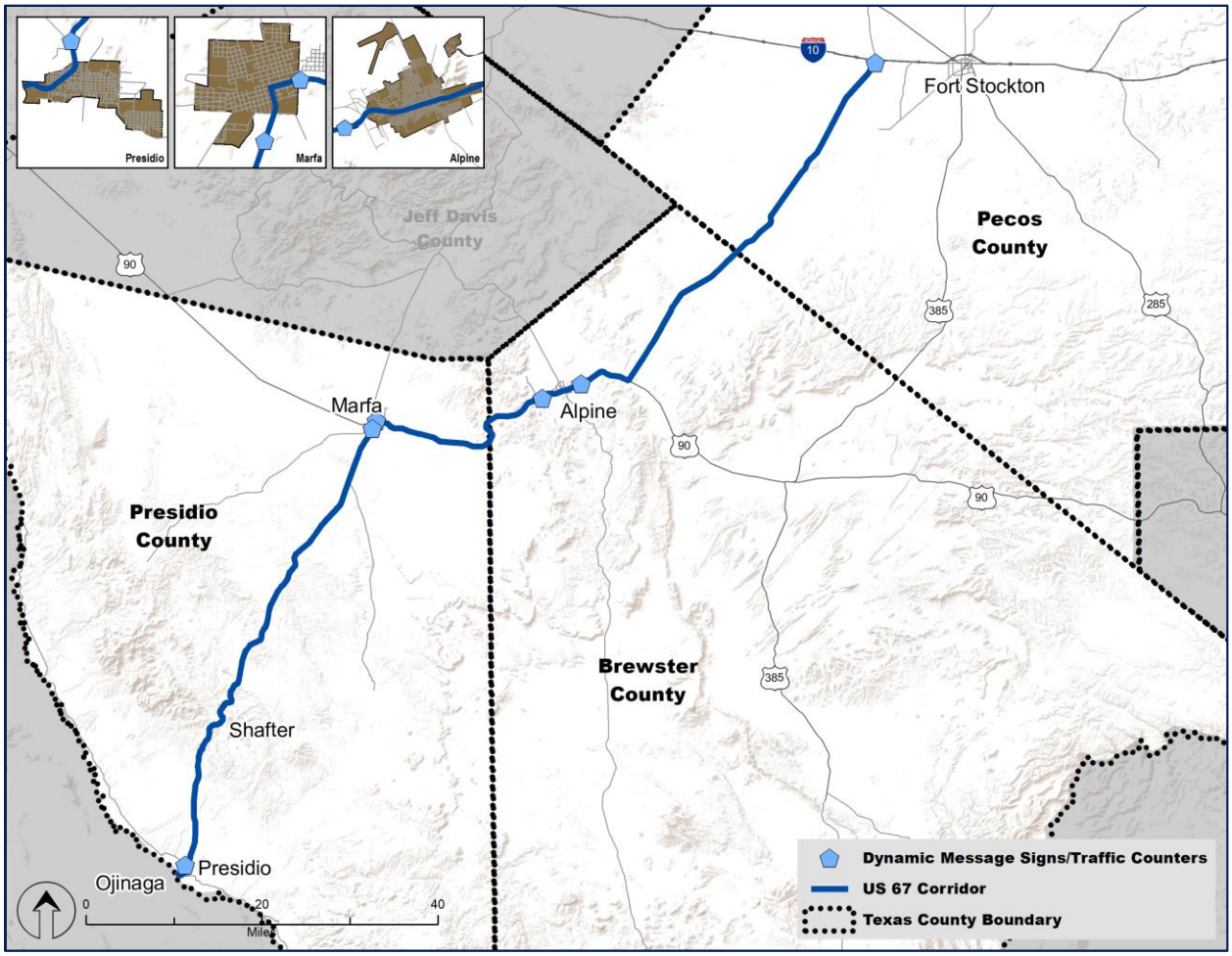


Figure 11: Dynamic Message Sign Locations

Table 15: Potential Dynamic Messaging Sign Projects

ITS Device	Location	Comments	Estimated Cost (2019 Dollars)
DMS approaching and leaving Marfa	Marfa	Covers vehicle information within the city	$550,000
DMS approaching and leaving Alpine	Alpine	Covers vehicle information within the city	$550,000
DMS approaching and leaving Presidio	Presidio	Covers vehicle information within the city	$300,000

TTI4 Integrated Traveler Information Systems

Integrated traveler information systems help travelers plan their trip before it begins or en-route from origin to destination with more efficiency and safety. It collects all types of roadway information (e.g., road and weather conditions, congestion, tourism, real-time transit information) through various devices and transmits the information to the public using various means such as websites, 511, social media, and radio.

An integrated traveler information system is more about automated feeds of data from a number of other systems – for example, real-time weather from a weather station. This information is collected and presented in a user-friendly format using a variety of methods including web sites and social media. Currently, no real-time information systems exist in the corridor. Information from other ITS projects such as the traffic sensors and weather monitoring systems can be included in the future.

The recommendation is for TxDOT to continue to examine the available sources and to implement a corridor-specific traveler information system at such time in the future when multiple real-time sources are available. The potential project recommended for this application is to procure third-party real-time travel time information for public dissemination. This project is described in more detail above under the TM5 Vehicle Detection section.

3.3 Other ITS Improvements

This section briefly describes two technologies that may not be ITS solutions in and of themselves, but are important for providing the communications, power, and visual detection required for other potential solutions.

3.3.1 Power and Communications

All ITS depends on power and communications. Fiber optic cable is a technology that allows for the transmission of communications over large distances. Fiber optic infrastructure is generally used as the backbone for CCTV, DMS, traffic sensors, and other ITS devices.

Private fiber is available along most of the study corridor. At certain spots, providing Wireless Networking/Worldwide Interoperability for Microwave Access (Wi-Fi/WiMAX) may be easier along the corridor. This would allow for both emergency communications from vehicles and pushing data/notices to vehicles.

Wireless communications can be accomplished through several standards or systems. Dedicated short-range communications are advanced technologies that allow automobiles to communicate with other automobiles or the infrastructure using a wireless communications channel. Communications can be through cellular systems (e.g., 5G) or microwave.

Both communication methodologies require additional studies including a review of potential wireless conflicts in the corridor and formal discussions with the owners of fiber in the corridor. These options should be evaluated against the cost and benefit of a TxDOT-installed communications infrastructure. A third study is recommended specifically related to enhancing the existing emergency services radio system.

Solar power is a viable and invaluable option in this area, as the equipment does not need a utility power drop, which can be highly expensive. Solar power also provides a cleaner and sustainable option. Texas ranks 16 out of 50 states in annual sunlight hours in the U.S., so solar power is quite viable from an operations perspective. Solar projects are part of the larger proposed ITS projects. So, no stand-alone solar power project is defined in this section.

Three options below, described in **Table 16**, are included in this ITS plan. These three are different enough that they are recommended as separate studies, although TxDOT may choose to combine them into a single larger communication study.

Table 16: Potential Communication Studies:

Study	Location	Comments	Estimated Cost (2019 Dollars)
Study to provide fiber-optic access along corridor	Corridor wide	Study the ability to work with fiber optic providers to develop improved access.	$500,000 (Preliminary)
Study to provide enhanced cellular communications along corridor	Corridor wide	Study the ability to work with cellular providers to develop improved service.	$500,000 (Preliminary)
Study on data over current radio system	Corridor wide	Study the ability to send still pictures over current radio system.	$300,000 (Preliminary)

3.3.2 Traffic Surveillance Cameras

Traffic surveillance cameras are a major part of most intelligent transportation systems. On surface roads, they are typically mounted on high poles or masts, sometimes along with streetlights. Cameras permit the operating agency to view traffic conditions, such as congestion, crashes and other events. Cameras can be panned, tilted, or zoomed to provide operators with the best possible view of the roadway. Cameras assist operators and, ultimately, emergency responders with confirming, locating, and managing incidents, construction zones, and congested areas. Higher-end cameras may be able to see over a mile. Infrared cameras can also be used to see better in the dark and over longer distances. Cameras can be used in other applications, such as license plate recognition or stopped vehicle detection systems, but these cameras are serving more like a sensor than a surveillance tool. Cameras are expected to be included as part of the total station concept outlined below.

3.3.3 Total Station Concept

As discussed throughout this section, power and communications are critical to ITS systems in rural corridors. Many of the systems proposed are in or adjacent to urban areas with easy access to power and communications or are relatively stand-alone systems that can work from solar power and cellular dial-up connections. However, with long stretches of the study corridor in rural areas, it is not practical to have frequent access to power and communications. Each connection is expensive. Therefore, to best take advantage of these connections when they are established, the consolidation of many of the recommended systems into one total station is recommended.

Previously mentioned systems recommended along the corridor and rolled into the Total Station concept include the following: Automated Visibility Warning Systems, Variable Speed Limits, Roadway Weather Information Systems, and Traffic Surveillance Cameras. As the counts should not vary significantly, their exact location along a stretch of road is not critical. As mentioned with cameras, full coverage of the corridor is not cost-effective, so the placement of any camera is random with respect to need. However, the location of weather stations is more dependent on spacing. Therefore, the location recommendations of the weather stations will drive the location of the total

stations. All of these systems being co-located should minimize costs and improve the ability to maintain them. Each system will add greatly to the capabilities of the corridor. The count stations will provide annual and seasonal data for planning and programming purposes. The cameras may provide valuable information for events that occur within viewing range and may be critical for incident response. The Automated Visibility Warning Systems (AVWS) in the Paisano Pass is also rolled into the total station concept. This system is described separately in **Section 3.2.1** Crash Countermeasures, under the CC2 Automated Visibility Warning Systems. Potential total station projects along the corridor are shown in **Figure 12** and described in **Table 17**.

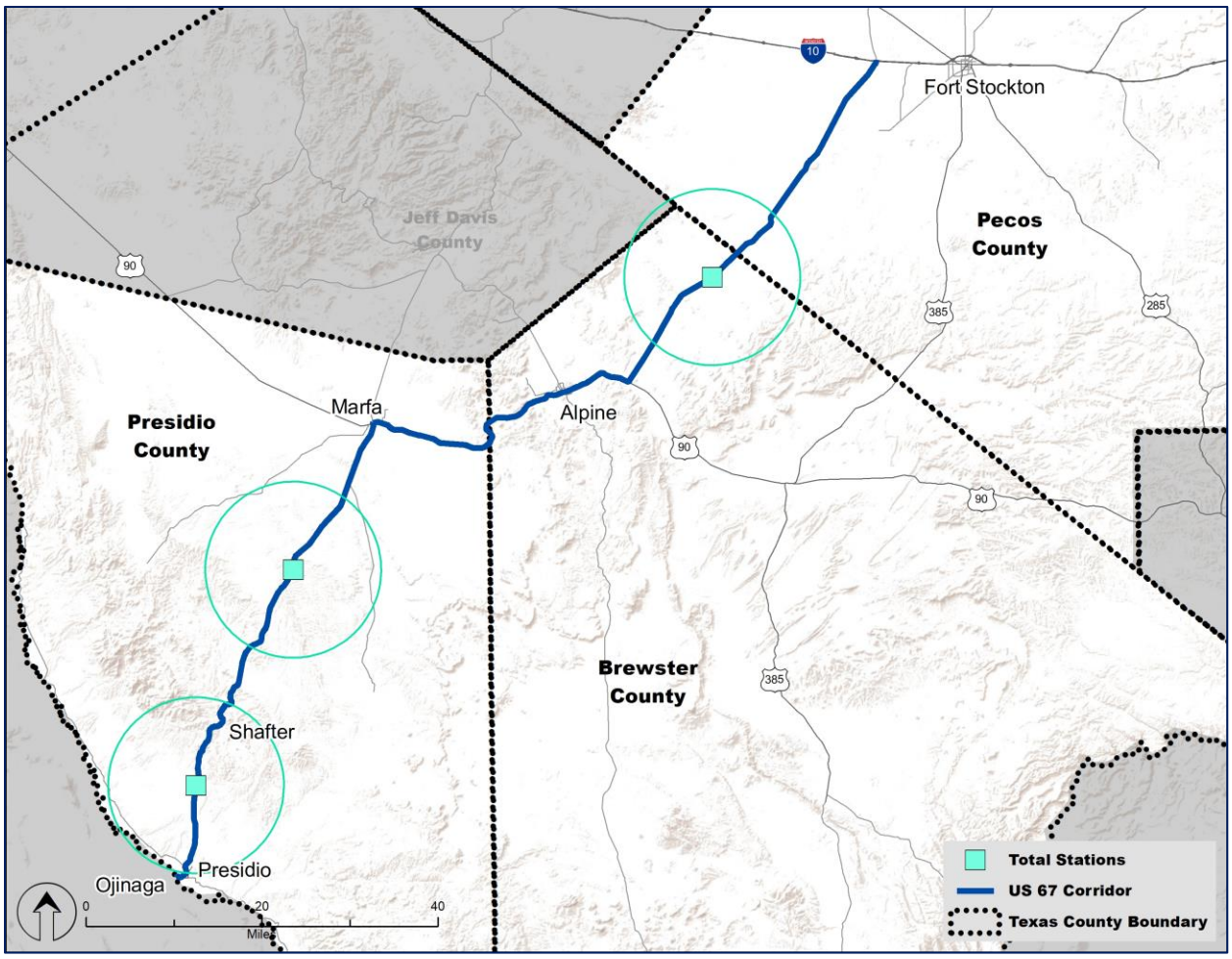


Figure 12: Potential Total Station Projects

Table 17: Potential Total Station Projects

ITS Device	Location	Comments	Estimated Cost (2019 Dollars)
Total Station 1	Between Alpine and Fort Stockton	RWIS covers 10-mile radius	$550,000
Total Station 2	Between Shafter and Marfa	RWIS covers 10-mile radius	$550,000
Total Station 3	Between Presidio and Shafter	RWIS covers 10-mile radius	$550,000

3.3.4 Port of Entry (POE) Smart Parking System

During discussions with stakeholders, it was noted that there are a few instances during the year where traffic at the POE is significantly higher than normal and results in traffic backups of several miles. These days are typically limited to a few known holidays. When looking at ways to address the queues on the US 67 study corridor, the concept of a smart parking system was developed. Instead of traffic queueing on US 67 for miles, traffic could be parked in vacant land near the POE.

The smart parking system would require a large paved area near the POE. Several potential candidate sites were identified, but ultimately a location north of the POE facility was chosen with access to it though Puerto Rico Street as shown in **Figure 13**. This location and potential design are discussed in the **Appendix N – Alternative Analysis**. Traffic would approach the POE as normal, but slightly before the POE would be diverted to the parking facility. This would remove the traffic from US 67, allow drivers to turn off their vehicles saving fuel and improving air quality, and eliminate the issues with employee access. Additional operations could be added including transit access.

There are several options available regarding technology. License plate readers, smartphone applications, and simple paper ticket systems are all options. A likely simple solution is grouping vehicles by parking rows and calling individual rows at a time. All options will likely require additional personnel resources during operations. Potential smart parking system improvements are shown in **Figure 13** and described in **Table 18**.

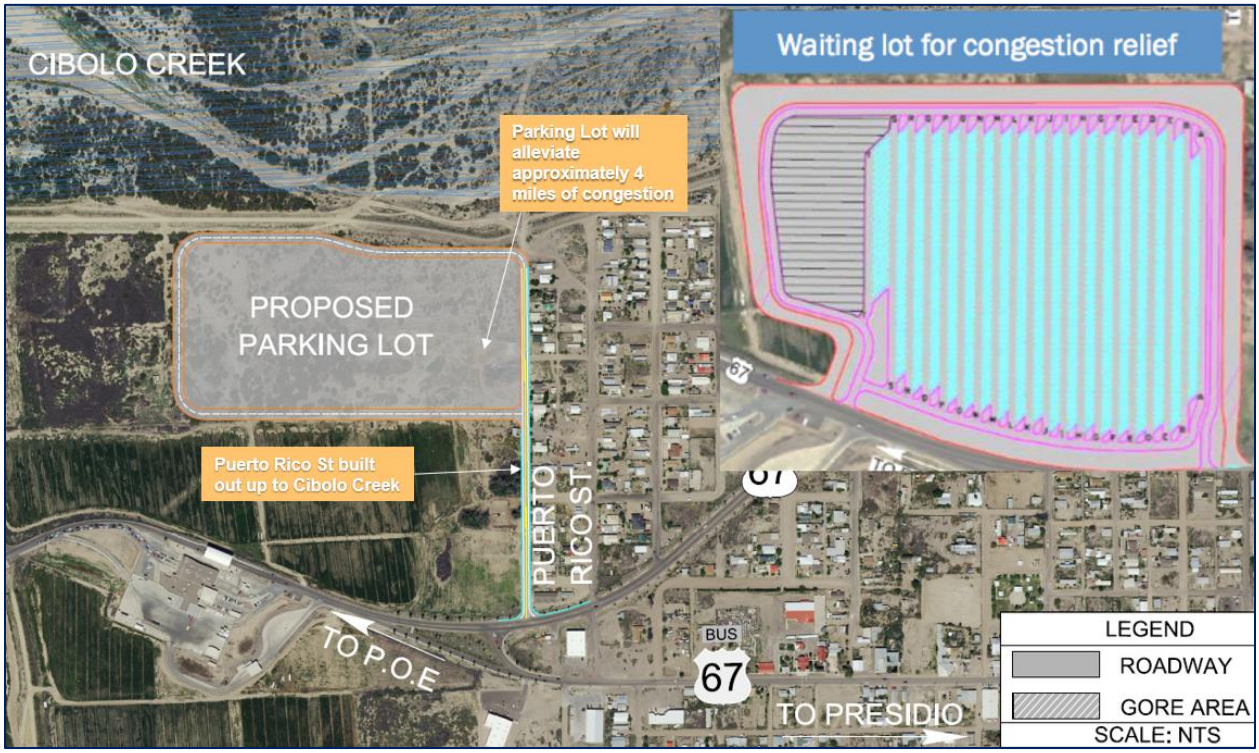


Figure 13: Potential Smart Parking Systems

Table 18: Potential Smart Parking Systems

ITS Device	Location	Comments	Estimated Cost (2019 Dollars)
POE Smart Parking System	North of POE	Location-specific coverage	$1,900,000

3.3.5 Incident Management Support Truck

Providing positive protection for emergency responders at the scene of an incident can be instrumental in alerting motorists of an incident or major event along the US 67 study corridor. This practice is often accomplished with DOT maintenance vehicle support at an incident including the use of arrow boards and Portable Changeable Message Signs (PCMS). Alternatively, the fire department can provide their own protection with the proper training and meeting the proper standards of the state. One recommendation, successfully done in other cities in Texas, is the refurbishment of old fire trucks turned into blocker trucks by adding arrow boards on each side and the rear of each vehicle. The control panel for the amber LED light arrow sticks can be programmed to flash in the desired direction of travel. **Table 19** presents an estimated cost for this recommendation.

Table 19: Incident Management Support Truck

ITS Device	Location	Comments	Estimated Cost (2019 Dollars)
Refurbishment of Old Fire Trucks	Corridor wide	None	$100,000

3.3.5 Traffic Incident Management Training

This project will seek appropriate incident management training from the Federal Highway Administration (FHWA) or other sources and offer to all incident responders in the study corridor including police, fire, and towing/recovery firms. Costs are entirely coordination and procurement.

3.3.6 Establish Corridor Coordination Groups

This project consists solely of staff time for organizing and managing corridor working groups and recurring meetings with agencies to coordinate planning and operations. No specific cost is associated with this effort.

4.0 Implementation of ITS Projects

There are several factors that affect the time of implementation for most of the potential ITS projects. While budget is always an issue, two other primary factors exist. The first is matching projects to goals and objectives. The second is the relation of the project to other projects throughout the study corridor.

4.1 Goals and Objectives

The ITS needs defined in Appendix F – Intelligent Transportation Systems (ITS) Needs Assessment were developed from the Safety Analysis Technical Memorandum (Appendix D – Safety Analysis), the bus tour notes, and other observations. These were then matched against the seven overall goals for the corridor:

- Improve Safety
- Improve Emergency Response
- Promote Sustainability
- Maintain a State of Good Repair
- Support Economic Development
- Enhance Multimodal Connectivity
- Improve Mobility

From these seven goals, several objectives were developed.

Each of the potential projects was matched against the goals and objectives. The matrix is presented in **Attachment A**. As shown in the matrix, all goals have a potential project assigned to them, and all projects meet some objective. The matrix also provides an indication of how well each project matches the various objectives.

4.2 Estimated ITS Capital Costs

The projects and estimated costs are intended to be considered as isolated alternative packages. There have been a wide variety of potential solutions identified in separate reports. For example, in the Safety Analysis Technical Memorandum, there are some treatments that have been investigated in terms of striping, geometric concerns, and rumble strips on the centerline, among others. Most of these are lower-cost physical treatments. However, they are part of TSMO but are not ITS applications. Therefore, these solutions are not part of this memorandum. Solutions included in the 'Other' category are best thought of as enabling infrastructure for potential future ITS applications. **Table 20** below shows the estimated costs (assumes 2019 average costs) by ITS category. More details about individual project costs within each category are shown in **Attachment A**.

Table 20: Estimated Project costs by ITS Category

Capital Projects	Number of Projects	Total Estimated Costs (2019 Dollars, rounded)
Crash Countermeasures (CC) And Surface Transportation and Weather	25	$12,200,000
Traffic Management (TM)	1	$500,000
Operations and Maintenance (OM)	2	$1,500,000
Emergency Services (ES)	3	$8,300,000
Tourism and Traveler Information (TT)	3	$1,400,000
Communications and Power (COM)	3	$1,300,000
Total Station (TOT)	3	$1,700,000
POE Smart Parking and Other ITS projects	4	$2,100,000
Total Capital Budget		$29,000,000

4.3 Timeline for Implementation of ITS Projects

Table 21 shows the recommendations for when the potential ITS projects should be implemented. Through the various Corridor Working Group meetings, public meetings and bus tours, many of the proposed ITS projects along US 67 have been identified as priorities. These projects are recommended for short-term implementation (up to 5 years). They are generally focused on specific locations, costs are low to medium, and they provide the most benefit in terms of safety and operations. Projects that could be addressed in other ways or where the benefit is not substantial, are recommended for mid-term implementation (5 to 10 years). Other projects that require higher capital costs, require studies before implementation, or that would benefit the US 67 study corridor in future applications, can be implemented in the long-term (10 plus years).

Table 21: Timeline for implementation by Project

Categories	Tool #	Tool Name/Description	Implementation Term
Crash Countermeasure	CC1	Animal Warning Systems	Mid
	CC2	Automated Visibility Warning Systems*	Short
	CC3	Bicycle Safety Systems	Short
	CC8	Pedestrian Safety Systems	Short
	CC6	Highway-Rail Crossing Safety Systems	Long
	CC9	Road Geometry Warning System	Short
	CC11	Speed Warning Systems	Short
	CC12	Work Zone Safety Systems	Short
Traffic Management	TM2	Variable Speed Limit (VSL)*	Mid
	TM5	Vehicle Detection**	Mid
	TM8	Planned Special Event Management Systems	Mid
Operations and Maintenance	OM2	Site Management during Rockslides	Short
Emergency Services	ES1	Next Generation 911	Long
	ES2	Smartphone Applications for First Responders	Mid
Surface Transportation and Weather	STW1	Integrated Weather Monitoring/Prediction Systems*	Mid
Tourism and Traveler Information	TTI3	Dynamic Message Sign (DMS)	Short
	TTI4	Integrated Traveler Information Systems**	Mid
Other ITS	Other	Power and Communication	Long
	Other	Traffic Surveillance Cameras*	Mid
	Other	Port of Entry Smart Parking System	Mid
	Other	Incident Management Support Truck	Short
	Other	Traffic Incident Management Training	Short
	Other	Establish Corridor Coordination Groups	Short

*The equipment and location of these systems are rolled into the Total Station concept.

** TM5/TTI4 are rolled into one project. The recommendation is to procure third-party real-time travel time for public dissemination

Attachment A: ITS Projects

Projects matched to goals:

Each of the potential projects was matched against the goals and objectives. As shown in the matrix, all goals have a project assigned, and all projects meet some objective. The matrix also provides an indication of how well each project matches the various objectives.

Project costs by category:

This table summarizes the individual projects and their costs by category.

Project sheets:

Each sheet provides individual project details, including location and cost of the potential projects.

PROJECTS MATCHED TO GOALS

1 Improve Safety	Metric	Animal Warning System South	Animal Warning System North	Weather Warning System Paisano Pass/Total Station	Bicycle/Pedestrian Warning System 1 at Alpine	Bicycle/Pedestrian Warning System 2 at Alpine	Bicycle/Pedestrian Warning System 3 at Marfa	Highway-Rail Crossing Warning System	Over-Height Vehicle Warning System	Flashing Beacon Curve Warning System (Ten locations)	Sequential Dynamic Curve Warning System (Seven Locations)	Real Time Travel Time Information/Vehicle Detection	Rockslide Warning System at Shafter	Rockslide Warning System at Paisano Pass	Next Gen 911 for Presidio County	Next Gen 911 for Brewster and Pecos Counties	Smartphone Applications for First Responders	Dynamic Message Sign outside of Marfa	Dynamic Message Sign outside of Alpine	Dynamic Message Sign outside of Presidio	Study To Provide Fiber Access Along Corridor	Study To Provide Enhanced Cellular Communications Along Corridor	Study on Data Over Current Radio System	Total Station between Alpine and Fort Stockton (RWIS, CCTV, Vehicle Detection)	Total Station between Shafter and Marfa (RWIS, CCTV, Vehicle Detection)	Total Station at Location Presidio and Shafter (RWIS, CCTV, Vehicle Detection)	Smart Parking at POE	Incident Management Support Truck	Traffic Incident Management Training	Establish Corridor Coordination Groups
1.1 Enhance travel safety through identified crash reduction measures.																														
1.1.1 Provide Curve Warnings based on safety criteria	Reduce number of crashes on curves	○	○	○	○	○	○	◑	○	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1.1.2 Provide Weather Warnings when appropriate to the corridor	Reduce number of crashes in fog and ice conditions	○	○	●	○	○	○	○	○	○	○	◑	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1.1.3 Intersection Improvements from master plan	Reduce number of crashes at intersections	○	○	○	◑	◑	◑	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1.1.4 Provide Animal Warning systems per master plan	Reduce number of animal crashes	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1.2 Enhance travel safety through public outreach campaigns.																														
1.2.1 Provide information to travelers on congestion/incidents prior to reaching decision points.	Number of messages on DMS outside communities	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	●	●	●	●	○	○	○	◑	◑	◑	◑	○	○	○
1.2.2 Add lights and flashers where identified in safety plan	Number of flashers added	○	○	○	◑	◑	◑	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1.3 Reduce secondary incidents through advance warning of events																														
1.3.1 Provide information to travelers on incidents prior to reaching queues	Number of messages on DMS outside communities	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	●	●	●	○	○	○	◑	◑	◑	◑	○	○	○
1.3.2 Provide Weather Warnings when appropriate to the corridor	Reduce number of crashes in fog and ice conditions	○	○	●	○	○	○	○	○	○	○	◑	○	○	○	○	●	●	●	●	○	○	○	●	●	●	○	○	○	○
1.3.3 Provide improved incident scene management	Provide TIM training to all local police and fire	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	◑
1.4 Provide safe travel in work zones.																														
1.4.1 Provide advance warning of road work	Number of messages on DMS outside communities	○	○	◑	○	○	○	○	○	○	○	◑	○	○	○	○	●	◑	◑	◑	○	○	○	○	○	○	○	○	○	○
1.4.2 Provide smart work zones when appropriate	Contractually require SWZ for projects greater than 10 miles	○	○	◑	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1.5 Provide enhanced bicycle and pedestrian safety																														
1.5.1 Provide bicycle and pedestrian lanes	Number of miles of bicycle and pedestrian lanes	○	○	○	●	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1.5.2 Provide bicycle/pedestrian warning systems	Reduce number of bicycle/pedestrian crashes near warning systems	○	○	○	●	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1.5.3 Implement complete streets per master plan	Reduce number of crashes at intersections	○	○	○	◑	◑	◑	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1.6 Reduce road departure crash occurrence.																														
1.6.1 Reduce crashes where super has changed	Reduce number of crashes on curves with super changes	○	○	○	○	○	○	○	○	◑	◑	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1.6.2 Reduce crashes where HFST was applied	Reduce number of crashes on curves with HFST applications	○	○	○	○	○	○	○	○	◑	◑	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1.6.3 Reduce crashes where curve speed warning systems were implemented	Reduce number of crashes on curves where warning systems were implemented	○	○	○	○	○	○	○	○	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1.7 Minimize the number of non-recurring incidents.																														
1.7.1 Implement safety projects from master plan	Reduce number of crashes	●	●	●	●	●	●	●	●	●	●	◑	○	○	○	○	○	◑	◑	◑	○	○	○	◑	◑	◑	○	○	○	○
1.8 Minimize the duration of incidents.																														
1.8.1 Provide improved incident management	Provide TIM training to all local police and fire	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	○
1.9 Reduce secondary incidents through advance warning of lane-blocking events																														
1.9.1 Provide information to travelers on congestion/incidents prior to reaching decision points.	Number of messages on DMS outside communities	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	●	●	●	○	○	○	●	●	●	○	○	○	○
1.9.2 Provide improved incident management	Provide TIM training to all local police and fire	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	○

PROJECTS MATCHED TO GOALS

		Animal Warning System South	Animal Warning System North	Weather Warning System Paisano Pass/Total Station	Bicycle/Pedestrian Warning System 1 at Alpine	Bicycle/Pedestrian Warning System 2 at Alpine	Bicycle/Pedestrian Warning System 3 at Marfa	Highway-Rail Crossing Warning System	Over-Height Vehicle Warning System	Flashing Beacon Curve Warning System (Ten locations)	Sequential Dynamic Curve Warning System (Seven Locations)	Real Time Travel Time Information/Vehicle Detection	Rockslide Warning System at Shafter	Rockslide Warning System at Paisano Pass	Next Gen 911 for Presidio County	Next Gen 911 for Brewster and Pecos Counties	Smartphone Applications for First Responders	Dynamic Message Sign outside of Marfa	Dynamic Message Sign outside of Alpine	Dynamic Message Sign outside of Presidio	Study To Provide Fiber Access Along Corridor	Study To Provide Enhanced Cellular Communications Along Corridor	Study on Data Over Current Radio System	Total Station between Alpine and Fort Stockton (RWIS, CCTV, Vehicle Detection)	Total Station between Shafter and Marfa (RWIS, CCTV, Vehicle Detection)	Total Station at Location Presidio and Shafter (RWIS, CCTV, Vehicle Detection)	Smart Parking at POE	Incident Management Support Truck	Traffic Incident Management Training	Establish Corridor Coordination Groups
2 Improve Emergency Response	**Metric**																													
2.1 Provide means to notify authorities of new incidents.																														
2.1.1 Increase cell phone coverage	Measure coverage by 2 largest carriers	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◑	◑	●	○	○	○	○	○	○	○
2.1.2 Pilot automated incident notification systems	Implement pilot project	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	◑	○	○	○	◑	◑	◑	○	○	○	○	○	○	○
2.2 Provide means to verify the incident to authorities.																														
2.2.1 Provide camera coverage in the corridor	Number of miles visible by camera	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	●	○	○	○	○
2.2.2 Provide a way to share video or pictures between responders	Implement pilot project	○	○	○	○	○	○	○	○	○	○	○	○	○	◑	◑	◑	○	○	○	○	○	●	◑	◑	◑	○	○	○	○
2.3 Expedite the clearance of hazards.																														
2.3.1 Provide improved incident management	Provide TIM training to all local police and fire	○	○	○	○	○	○	○	○	○	○	○	○	○	◑	◑	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2.4 Improve capabilities of local emergency responders.																														
2.4.1 Provide improved incident management	Provide TIM training to all local police and fire	○	○	○	○	○	○	○	○	○	○	○	○	○	◑	◑	○	○	○	○	○	○	○	○	○	○	○	●	●	○
2.5 Coordinate with other agencies on incidents.																														
2.5.1 Provide improved incident management	Provide TIM training to all local police and fire	○	○	○	○	○	○	○	○	○	○	○	○	○	◑	◑	○	○	○	○	○	○	○	○	○	○	○	●	●	○
2.5.2 Pilot improved communications project	Implement pilot project	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	○	○	○	○	◑	◑	●	○	○	○	○	○	○	○
3 Enhance Multimodal Connectivity	**Metric**																													
3.1 Collect and share current travel conditions data with other agencies.																														
3.1.1 Collect system performance information	Provide vehicle and classification counts	◑	◑	○	○	○	○	○	○	◑	◑	◑	○	○	○	○	○	◑	◑	◑	○	○	○	●	●	●	◑	◑	◑	◑
3.1.2 Exchange data with local and transit agencies	Establish agreements to share data	○	○	○	○	○	○	○	○	○	○	○	○	○	◑	◑	○	◑	◑	◑	○	○	○	○	○	○	◑	◑	◑	◑
3.2 Increase availability and access to data for planning, operations, and other purposes.																														
3.2.1 Establish working groups to coordinate planning and operations	Establish working groups	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●
3.2.2 Exchange data with local and transit agencies	Establish agreements to share data	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●
3.3 Integrate operational improvements into capital project planning and design.																														
3.3.1 Implement complete streets per master plan	Implement projects	○	○	○	◑	◑	◑	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
3.3.2 Provide bicycle and pedestrian lanes	Number of miles of bicycle and pedestrian lanes	○	○	○	●	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
3.3.3 Provide bicycle/pedestrian warning systems	Implement projects per master plan	○	○	○	●	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
3.4 Provide improved commercial vehicle service.																														
3.4.1 Better manage delays at POE on high traffic volume days	Implement smart parking system at POE	○	○	○	○	○	○	○	○	○	○	◑	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	◑	◑	◑

PROJECTS MATCHED TO GOALS

4 Improve Mobility	Metric	Animal Warning System South	Animal Warning System North	Weather Warning System Paisano Pass/Total Station	Bicycle/Pedestrian Warning System 1 at Alpine	Bicycle/Pedestrian Warning System 2 at Alpine	Bicycle/Pedestrian Warning System 3 at Marfa	Highway-Rail Crossing Warning System	Over-Height Vehicle Warning System	Flashing Beacon Curve Warning System (Ten locations)	Sequential Dynamic Curve Warning System (Seven Locations)	Real Time Travel Time Information/Vehicle Detection	Rockslide Warning System at Shafter	Rockslide Warning System at Paisano Pass	Next Gen 911 for Presidio County	Next Gen 911 for Brewster and Pecos Counties	Smartphone Applications for First Responders	Dynamic Message Sign outside of Marfa	Dynamic Message Sign outside of Alpine	Dynamic Message Sign outside of Presidio	Study To Provide Fiber Access Along Corridor	Study To Provide Enhanced Cellular Communications Along Corridor	Study on Data Over Current Radio System	Total Station between Alpine and Fort Stockton (RWIS, CCTV, Vehicle Detection)	Total Station between Shafter and Marfa (RWIS, CCTV, Vehicle Detection)	Total Station at Location Presidio and Shafter (RWIS, CCTV, Vehicle Detection)	Smart Parking at POE	Incident Management Support Truck	Traffic Incident Management Training	Establish Corridor Coordination Groups
4.1 Provide non-recurrent and recurrent event-related information to motorists.																														
4.1.1 Provide information to travelers on incidents prior to reaching queues	Number of messages on DMS outside communities	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	●	●	●	●	○	○	○	◑	◑	◑	◑	○	○	○
4.1.2 Provide Weather Warnings when appropriate to the corridor	Number of messages on DMS outside communities	○	○	●	○	○	○	○	○	○	○	◑	○	○	○	○	●	●	●	●	○	○	○	●	●	●	○	○	○	○
4.1.3 Provide travel times between communitees	Number of messages on DMS outside communities	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	●	●	●	●	○	○	○	●	●	●	○	○	○	○
4.2 Eliminate or mitigate bottlenecks and hazards																														
4.2.1 Provide information to travelers on hazards to avoid incidents	Implement projects per master plan	○	○	○	○	○	○	●	●	◑	◑	○	○	○	○	○	○	●	●	●	○	○	○	◑	◑	◑	○	○	○	○
4.3 Provide real-time travel time and congestion limits for travel in work zones.																														
4.3.1 Provide advance warning of road work	Number of messages on DMS outside communities	○	○	○	○	○	○	○	○	○	○	◑	○	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○
4.3.2 Provide smart work zones when appropriate	Contractually require SWZ for projects greater than 10 miles	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	◑	◑	◑
4.4 Provide advance notice prior to environmental impact: snow/ice, rock slides, and dust storms.																														
4.4.1 Provide Weather Warnings when appropriate to the corridor	Number of messages on DMS outside communities	○	○	●	○	○	○	○	○	○	○	◑	○	○	○	○	●	●	●	●	○	○	○	●	●	●	○	○	○	○
4.4.2 Provide Rock Slide Warnings when appropriate at spot locations	Number of messages on DMS at spot locations	○	○	○	○	○	○	○	○	○	○	◑	●	●	○	○	○	○	○	○	○	○	○	◑	◑	◑	○	○	○	○
4.4.3 Provide Ice and other weather Warnings when appropriate at spot locations	Number of messages on DMS at spot locations	○	○	●	○	○	○	○	○	○	○	◑	○	○	○	○	○	○	○	○	○	○	○	◑	◑	◑	○	○	○	○
5 Promote Sustainability	**Metric**	0.33	0.33	0	0	0	0	0.33	0.33	0.5	0.5	0.8	0	0	0	0	0	1	1	1	0	0	0	0.67	0.67	0.67	0.5	0.17	0.17	0.1
5.1 Enhance quality of life																														
5.1.1 Provide information to travelers to avoid incidents	Implement projects per master plan	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	●	●	●	○	○	○	◑	◑	◑	◑	○	○	○
5.1.2 Provide travel times to travelers to avoid congestion	Number of messages on DMS outside communities	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	●	●	●	○	○	○	●	●	●	○	○	○	○
5.2 Maintain good air quality																														
5.2.1 Improve operations where bottlenecks are identified	Implement projects per master plan	○	○	○	○	○	○	●	●	◑	◑	○	○	○	○	○	○	●	●	●	○	○	○	◑	◑	◑	○	○	○	○
5.2.2 Better manage delays at POE on high traffic volume days	Implement smart parking system at POE	○	○	○	○	○	○	○	○	○	○	◑	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	◑	◑	◑
5.3 Minimize impact to natural resources																														
5.3.1 Provide Animal Warning systems per master plan	Reduce number of animal crashes	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
5.3.2 Reduce road departure occurrence throughout	Reduce number of single vehicle run off the road crashes	○	○	○	○	○	○	○	○	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

PROJECTS MATCHED TO GOALS

		Animal Warning System South	Animal Warning System North	Weather Warning System Paisano Pass/Total Station	Bicycle/Pedestrian Warning System 1 at Alpine	Bicycle/Pedestrian Warning System 2 at Alpine	Bicycle/Pedestrian Warning System 3 at Marfa	Highway-Rail Crossing Warning System	Over-Height Vehicle Warning System	Flashing Beacon Curve Warning System (Ten locations)	Sequential Dynamic Curve Warning System (Seven Locations)	Real Time Travel Time Information/Vehicle Detection	Rockslide Warning System at Shafter	Rockslide Warning System at Paisano Pass	Next Gen 911 for Presidio County	Next Gen 911 for Brewster and Pecos Counties	Smartphone Applications for First Responders	Dynamic Message Sign outside of Marfa	Dynamic Message Sign outside of Alpine	Dynamic Message Sign outside of Presidio	Study To Provide Fiber Access Along Corridor	Study To Provide Enhanced Cellular Communications Along Corridor	Study on Data Over Current Radio System	Total Station between Alpine and Fort Stockton (RWIS, CCTV, Vehicle Detection)	Total Station between Shafter and Marfa (RWIS, CCTV, Vehicle Detection)	Total Station at Location Presidio and Shafter (RWIS, CCTV, Vehicle Detection)	Smart Parking at POE	Incident Management Support Truck	Traffic Incident Management Training	Establish Corridor Coordination Groups
6 Maintain a State of Good Repair	**Metric**																													
6.1 Maintain roads and equipment																														
6.1.1 Use traffic data to monitor road conditions	Provide vehicle and classification counts	◑	◑	○	○	○	○	○	○	◑	◑	◑	○	○	○	○	○	◑	◑	◑	○	○	○	●	●	●	◑	◑	◑	◑
6.1.2 Use asset management systems to monitor ITS equipment maintenance	Maintain adequate ITS records and review on recurring basis	○	○	○	○	○	○	○	○	○	○	◑	○	○	○	○	○	○	○	○	○	○	○	◑	◑	◑	○	○	○	●
6.2 Use additional funding sources to improve corridor operations																														
6.2.1 Pay for ITS projects with new funding to preserve current funding sources	Monitor and record funding sources for ITS projects	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●
6.2.2 Match roadway performance to ITS devices for benefits	Monitor and record operations performance measures in the corridor	◑	◑	○	○	○	○	○	○	◑	◑	◑	○	○	○	○	○	◑	◑	◑	○	○	○	●	●	●	◑	◑	◑	●
7 Support Economic Development	**Metric**																													
7.1 Assess impact of traffic on Corridor																														
7.1.1 Use traffic data to monitor road conditions	Provide vehicle and classification counts	◑	◑	○	○	○	○	○	○	◑	◑	◑	○	○	○	○	○	◑	◑	◑	○	○	○	●	●	●	○	○	○	○
7.1.2 Match roadway performance to ITS devices for benefits	Monitor and record operations performance measures in the corridor	◑	◑	○	○	○	○	○	○	◑	◑	◑	○	○	○	○	○	◑	◑	◑	○	○	○	●	●	●	○	○	○	○
7.2 Minimize construction impacts																														
7.2.1 Provide advance warning of road work	Number of messages on DMS outside communities	○	○	◑	○	○	○	○	○	○	○	◑	○	○	○	○	●	◑	◑	◑	○	○	○	○	○	○	○	○	○	○
7.2.2 Provide smart work zones when appropriate	Contractually require SWZ for projects greater than 10 miles	○	○	◑	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
7.3 Implement projects to help with freight operations																														
7.3.1 Better manage delays at POE on high traffic volume days	Implement smart parking system at POE	○	○	○	○	○	○	○	○	○	○	◑	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	○	○	○

Legend:

Project directly applies to Goals and Objectives ●

Project indirectly applies to Goals and Objectives ◑

Project do not apply to Goals and Objectives ○

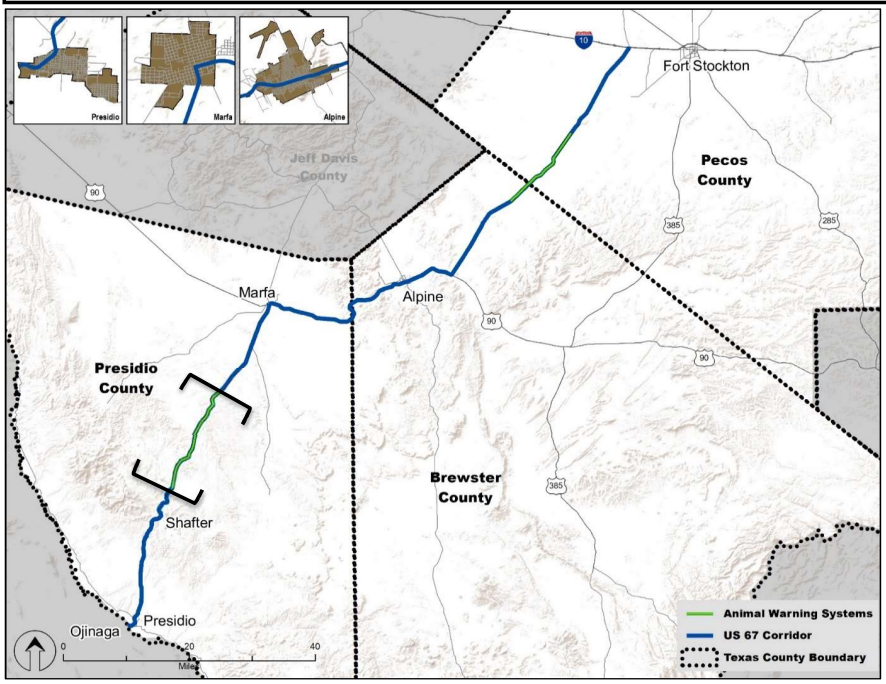
Detailed Cost Breakdown by ITS Category

Categories	Project Number	Capital Projects		2019 Total Costs
Crash Countermeasures / Surface Transportation and Weather	CC1.1	Animal Warning System South	$	3,700,000
	CC1.2	Animal Warning System North	$	2,300,000
	CC2.1/STW.1	Weather Warning System Paisano Pass/Total Station	$	750,000
	CC3/CC8	Bicycle/Pedestrian Warning System #1 at Alpine	$	100,000
	CC3/CC8	Bicycle/Pedestrian Warning System #2 at Alpine	$	100,000
	CC3/CC8	Bicycle/Pedestrian Warning System #3 at Marfa	$	100,000
	CC6	Highway-Rail Crossing Warning System	$	250,000
	CC9	Over-Height Vehicle Warning System	$	250,000
	CC11.1	Flashing Beacon Curve Warning System (Ten locations)	$	1,500,000
	CC11.2	Sequential Dynamic Curve Warning System (Seven Locations)	$	3,150,000
		Crash Countermeasures / Surface Transportation and Weather Subtotal	*$*	*12,200,000*
Traffic Management	TM5 / TTI4	Real Time Travel Time Information/Vehicle Detection	$	500,000
		Traffic Management Subtotal	*$*	*500,000*
Operations and Maintenance	OM2.1	Rockslide Warning System at Shafter	$	750,000
	OM2.2	Rockslide Warning System at Paisano Pass	$	750,000
		Operations and Maintenance Subtotal	*$*	*1,500,000*
Emergency Services	ES1.1	Next Gen 911 for Presidio County	$	4,000,000
	ES1.2	Next Gen 911 for Brewster and Pecos Counties	$	4,000,000
	ES2.1	Smartphone Applications for First Responders	$	300,000
		Emergency Services Subtotal	*$*	*8,300,000*
Tourism and Traveler Information	TTI3.1	Dynamic Message Sign outside of Marfa	$	550,000
	TTI3.2	Dynamic Message Sign outside of Alpine	$	550,000
	TT13.3	Dynamic Message Sign outside of Presidio	$	300,000
		Tourism and Traveler Information Subtotal	*$*	*1,400,000*
Communications and Power	COM1.1	Study To Provide Fiber Access Along Corridor	$	500,000
	COM1.2	Study To Provide Enhanced Cellular Communications Along Corridor	$	500,000
	COM1.3	Study on Data Over Current Radio System	$	300,000
		Communications and Power Subtotal	*$*	*1,300,000*
Total Station	TOT1.1	Total Station between Alpine and Fort Stockton (RWIS, CCTV, Vehicle Detection)	$	550,000
	TOT1.2	Total Station between Shafter and Marfa (RWIS, CCTV, Vehicle Detection)	$	550,000
	TOT1.3	Total Station at Location Presidio and Shafter (RWIS, CCTV, Vehicle Detection)	$	550,000
		Total Station Subtotal	*$*	*1,650,000*
Other	OTH1.1	Smart Parking at POE	$	1,900,000
	OTH1.2	Incident Management Support Truck	$	100,000
	OTH1.3	Traffic Incident Management Training	$	100,000
	OTH1.4	Establish Corridor Coordination Groups	$	-
		Other Subtotal	*$*	*2,100,000*
		Total Capital Budget	$	28,950,000
		Total Capital Budget (rounded)	**$**	**29,000,000**

Owner	Cost		
TxDOT	Engineering (Study and Design)	$	297,430
Project Name	Construction	$	2,974,300
Animal Warning System South			
Project Number	2016 Total Cost	$	3,271,730
CC1.1	2019 Total Cost*	$	3,700,000
Implementation Term	*accounts for 4% increase rounded to the next higher hundred-thousand		
Mid Term			

Description

This project will consist of installing large animal sensors in each direction of travel every 500 feet for 20 miles. The sensors will communicate to a cabinet at either end which will trigger flashers on appropriate static signs placed every five miles if an animal is detected. Engineering is estimated at 10% of construction costs. The proposed project limits are identified for the south section is shown in brackets.



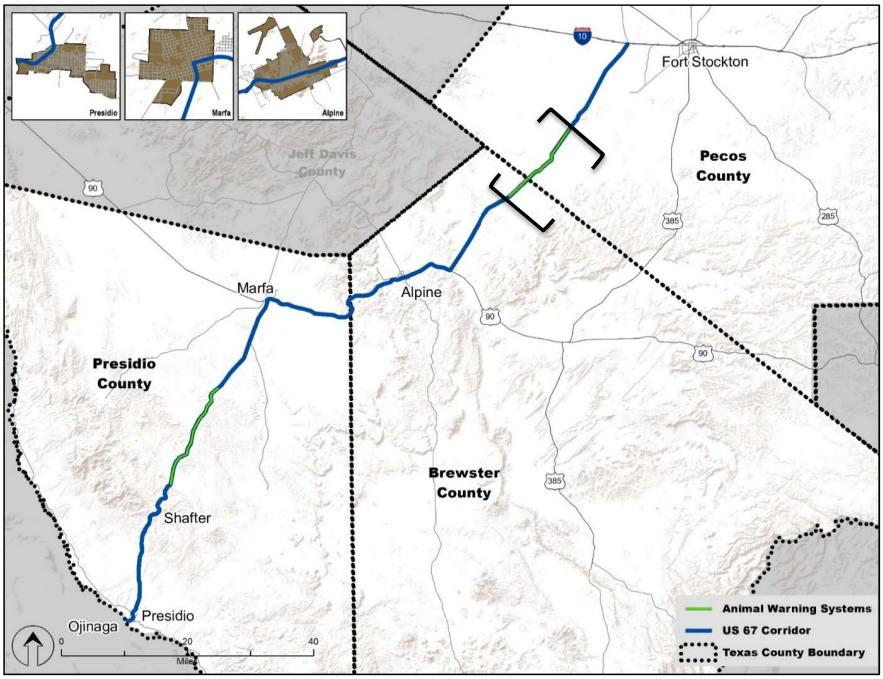
Cost Estimate

Item	Unit/mile		Total Cost	
Purchasing	$	87,500	$	1,750,000
Planning	$	58,300	$	58,300
Installation	$	58,300	$	1,166,000
2016 Total Cost			$	2,974,300

Owner	Cost		
TxDOT	Engineering (Study and Design)	$	180,790
Project Name	Construction	$	1,807,900
Animal Warning System North			
Project Number	2016 Total Cost	$	1,988,690
CC1.2	2019 Total Cost*	$	2,300,000
Implementation Term	*accounts for 4% increase rounded to the next higher hundred-thousand		
Mid Term			

Description

This project will consist of installing large animal sensors in each direction of travel every 500 feet for 12 miles. The sensors will communicate to a cabinet at either end which will trigger flashers on static signs placed every four miles if an animal is detected. Engineering is estimated at 10% of construction costs. The proposed project limits are identified for the north section is shown in brackets.



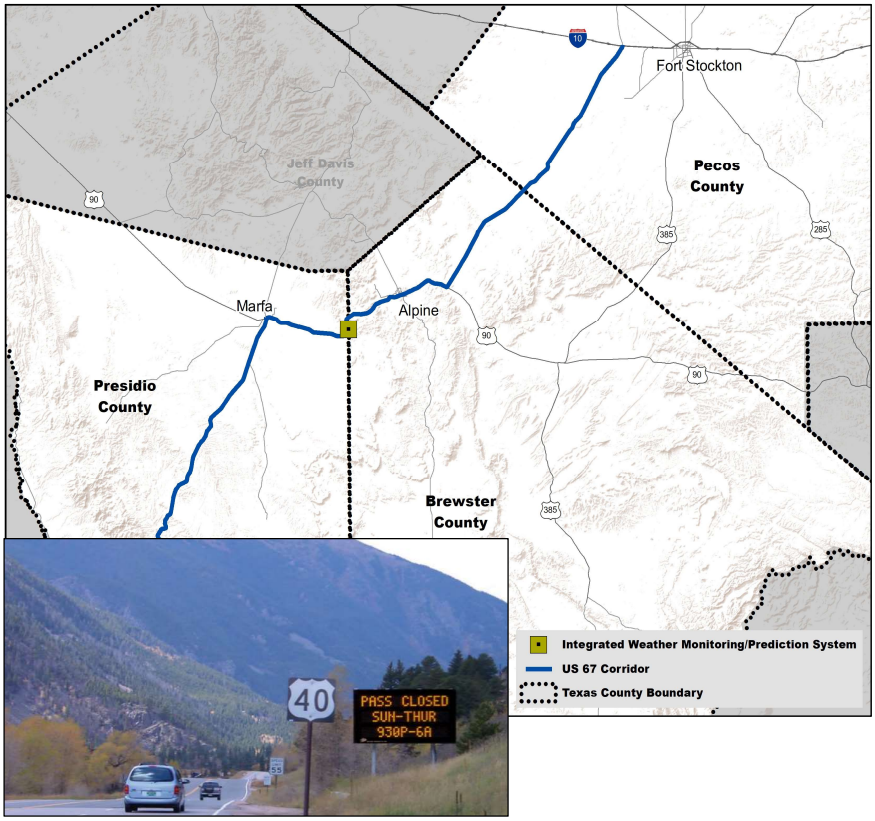
Cost Estimate

Item	Unit/mile		Total Cost	
Purchasing	$	87,500	$	1,050,000
Planning	$	58,300	$	58,300
Installation	$	58,300	$	699,600
2016 Total Cost			$	1,807,900

Owner	Cost		
TxDOT	Engineering (Study and Design)	$	58,500
Project Name	Construction	$	585,000
Weather Warning System Paisano Pass/Total Station			
Project Number	2016 Total Cost	$	643,500
CC2.1	2019 Total Cost*	$	750,000
Implementation Term	*accounts for 4% increase rounded to the next higher fifty-thousand		
Short/Mid Term			

Description

This project will consist of adding a new Roadway Weather Information System (RWIS) station at the Paisano Pass. The weather station will have full power and communications. The local controller will connect to two Dynamic Message Signs (DMS) deployed for each direction of travel approaching the pass. The DMS shall display adverse weather condition warnings. In addition, and matching the total station concept, counters and a camera will also be included at the site. Engineering is estimated at 10% of construction costs.



Source: skylineproducts.com

Source: Arizona DOT Dust Warning System

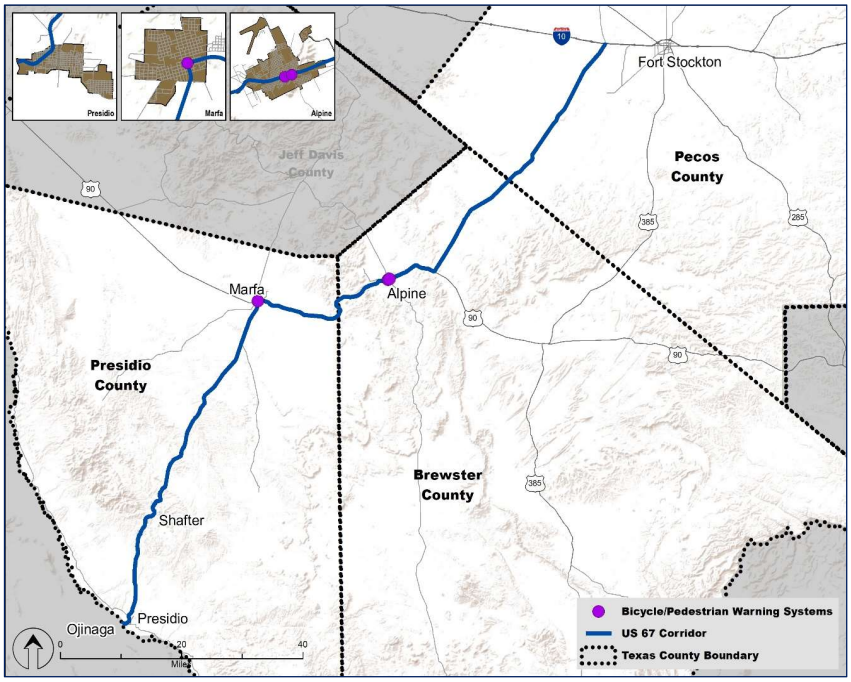
Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost
New DMS	Each	2	$ 87,500	$ 175,000
Power and Coms	Mile	4	$ 50,000	$ 200,000
RWIS	Each	1	$ 75,000	$ 75,000
Pan–Tilt–Zoom (PTZ) camera	Each	1	$ 75,000	$ 75,000
Counters	Each	2	$ 30,000	$ 60,000
2016 Total Cost				$ 585,000

Owner	Cost per location		
TxDOT	Engineering (Study and Design)	$	7,000
Project Name	Construction	$	70,000
Bicycle/Pedestrian Warning System (Two intersections in Alpine and one intersection in Marfa)	2016 Total Cost	$	77,000
Project Number	2019 Total Cost*	$	100,000
CC3/CC8	*accounts for 4% increase rounded to the next higher fifty-thousand		
Implementation Term			
Short Term			

Description

This project will consist of installing a pedestrian button on each side of US 67 that activates flashers on two static signs as well as in pavement lighting. Engineering is estimated at 10% of construction costs.



Source: Courtesy of Jaime Sullivan

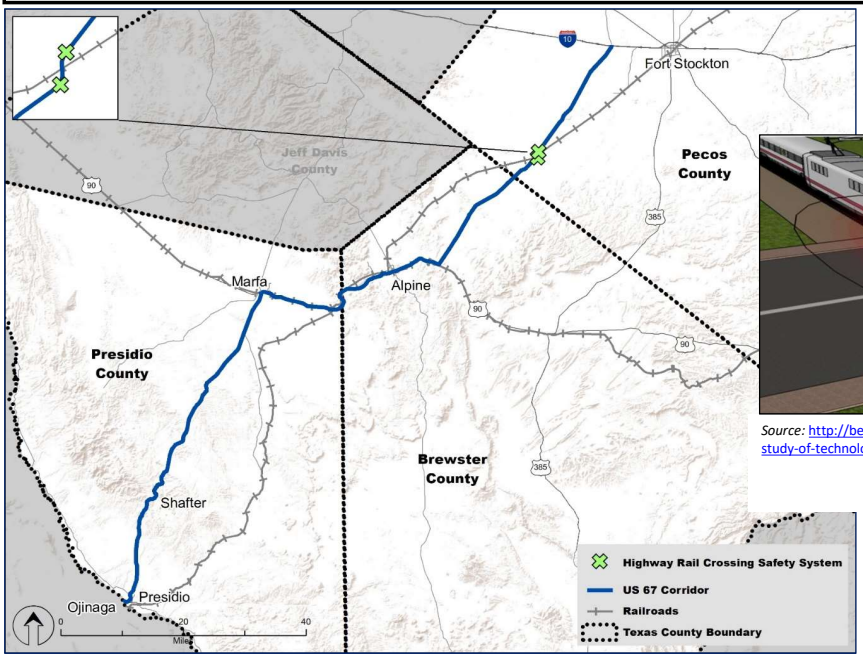
Cost Estimate

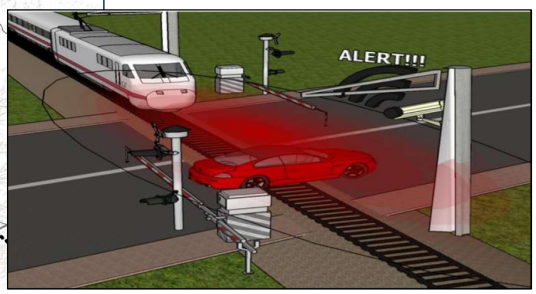
Item	Unit	Quant	Unit Cost	Total Cost
Ped Button	Each	2	$ 10,000	$ 20,000
Static Sign/ Flashers	Each	2	$ 10,000	$ 20,000
Power and Coms	Mile	0.1	$ 50,000	$ 5,000
In pavement lights	Each	1	$ 25,000	$ 25,000
2016 Total Cost				$ 70,000

Owner	Cost		
TxDOT	Engineering (Study and Design)	$	18,000
Project Name	Construction	$	180,000
Highway-Rail Crossing Warning System			
Project Number	2016 Total Cost	$	198,000
CC6.1	2019 Total Cost*	$	250,000
Implementation Term	*accounts for 4% increase rounded to the next higher fifty-thousand		
Long Term			

Description

This project will consist of adding a stopped vehicle detection system at the grade crossing. A controller will be installed that can activate flashers on static warning signs on the relative approach. Engineering is estimated at 10% of construction costs.





Source: http://begiralerailway.com/wp-content/uploads/2019/06/Comparative-study-of-technologies-for-the-detection-of-obstacles-in-level-crossings-v2.pdf

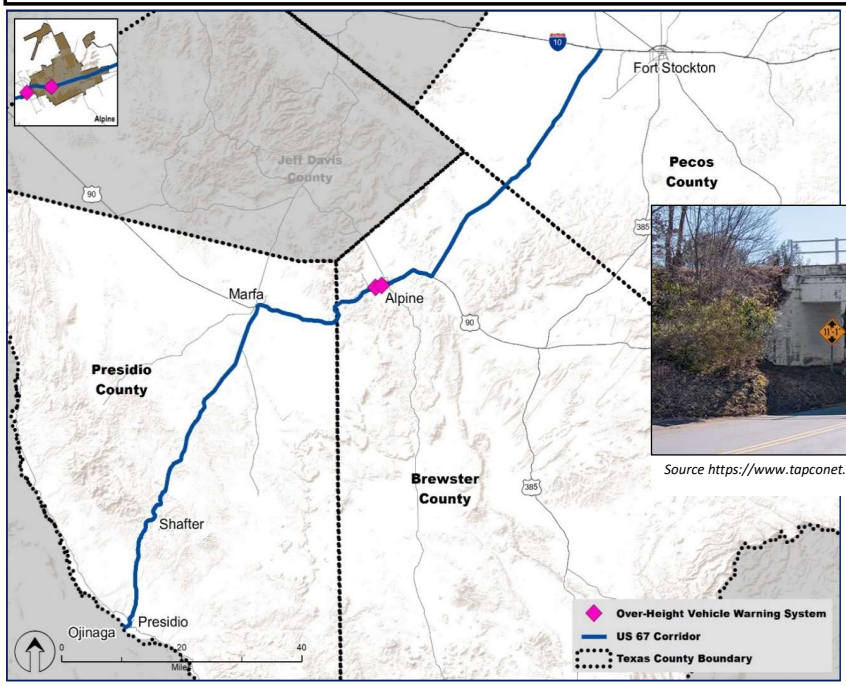
Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost
Vehicle Detector	Each	2	$ 30,000	$ 60,000
Static Sign/ Flashers	Each	2	$ 10,000	$ 20,000
Integration with RR	Each	1	$ 50,000	$ 50,000
Power and Coms	Mile	1	$ 50,000	$ 50,000
2016 Total Cost				$ 180,000

Owner	Cost		
TxDOT	Engineering (Study and Design)	$	17,500
Project Name	Construction	$	175,000
Over-Height Vehicle Warning System			
Project Number	2016 Total Cost	$	192,500
CC9	2019 Total Cost*	$	250,000
Implementation Term	*accounts for 4% increase rounded to the next higher fifty-thousand		
Short Term			

Description

This project will consist of installing over-height vehicle detectors in both directions of US 67 approaching the low bridge crossing on the southwest side of Alpine. Warnings will be provided to trucks using flashing beacons with a static sign. Engineering is estimated at 10% of construction costs.



Source https://www.tapconet.com/solar-led-division/overheight-warning-system

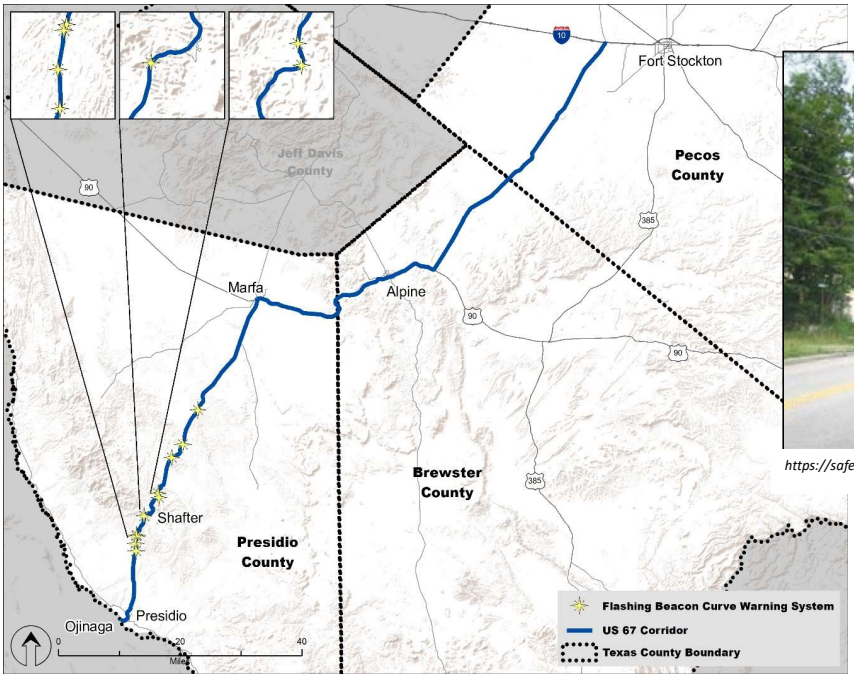
Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost
Vehicle Detector	Each	2	$ 15,000	$ 30,000
Static Sign/ Flashers	Each	2	$ 10,000	$ 20,000
Power and Coms	Mile	1	$ 50,000	$ 50,000
Controller & Misc.	Each	1	$ 75,000	$ 75,000
2016 Total Cost				$ 175,000

Owner	Cost per location		
TxDOT	Engineering (Study and Design)	$	10,000
Project Name	Construction	$	100,000
Flashing Beacon Curve Warning System (Ten locations)			
Project Number	2016 Total Cost	$	110,000
CC11.1	2019 Total Cost*	$	150,000
Implementation Term	*accounts for 4% increase rounded to the next higher fifty-thousand		
Short Term			

Description

This project will consist of adding a speed detection system for both directions approaching the designated curve. A controller will monitor the detectors and activate flashers on a static sign automatically when warranted. Engineering is estimated at 10% of construction costs.



https://safety.fhwa.dot.gov/roadway_dept/horicurves/fhwasa15084/ch4.cfm

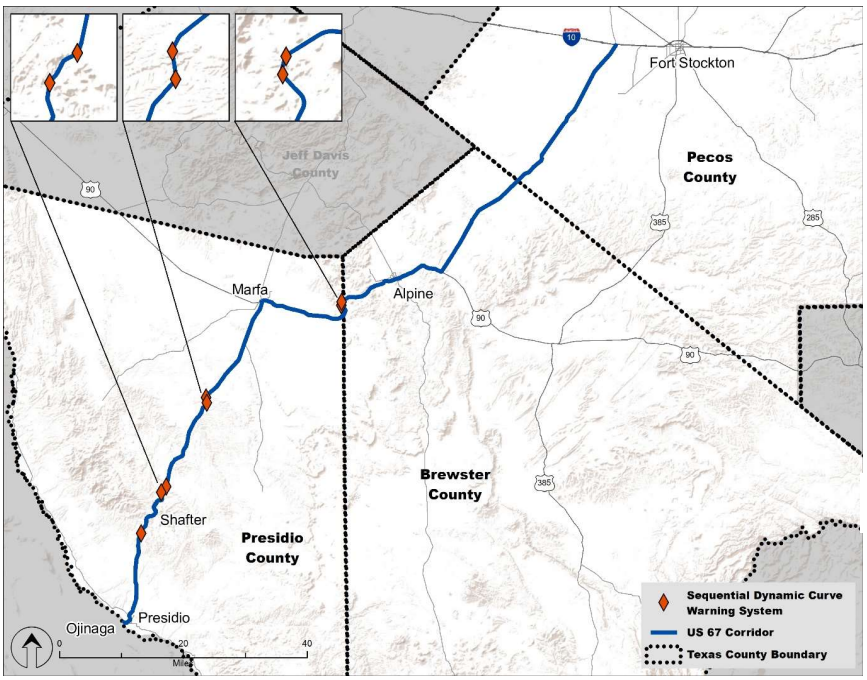
Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost
Vehicle Detector	Each	2	$ 15,000	$ 30,000
Static Sign/ Flashers	Each	2	$ 10,000	$ 20,000
Power and Coms	Mile	1	$ 50,000	$ 50,000
2016 Total Cost				$ 100,000

Owner	Cost per location		
TxDOT	Engineering (Study and Design)	$	35,500
Project Name	Construction	$	355,000
Sequential Dynamic Curve Warning System (Seven Locations)			
Project Number	2016 Total Cost	$	390,500
CC11.2	2019 Total Cost*	$	450,000
Implementation Term	*accounts for 4% increase rounded to the next higher fifty-thousand		
Short Term			

Description

This project will consist of adding a speed detection system for both directions approaching the designated curve. A controller will monitor the detectors and automatically light chevron signs in a sequential manner through the curve when warranted. Engineering is estimated at 10% of construction costs.



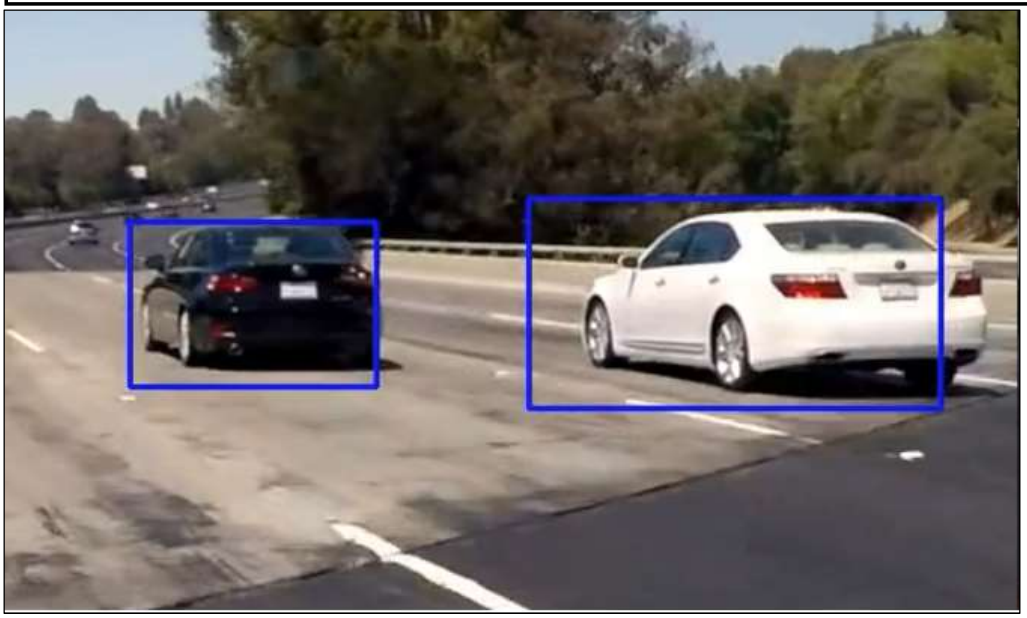
https://www.roadtraffic-technology.com/contractors/driver_info/trafficalm

Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost
Vehicle Detector	Each	2	$ 15,000	$ 30,000
Static Sign/ Flashers	Each	20	$ 10,000	$ 200,000
Power and Coms	Mile	1	$ 50,000	$ 50,000
Controller & Misc.	Each	1	$ 75,000	$ 75,000
2016 Total Cost				$ 355,000

Owner	Cost for third party data		
TxDOT	Engineering (Study and Design)	$	40,000
Project Name	Annual Third Party for 4 years	$	400,000
Real Time Travel Time Information/Vehicle Detection			
Project Number	2016 Total Cost	$	440,000
TM5 / TTI4	2019 Total Cost*	$	500,000
Implementation Term	*accounts for 4% increase rounded to the next higher fifty-thousand		
Mid Term			

Description
This project will procure real time data from a third party vendor. The purpose is to disseminate travel times between communities. An average cost estimate for the first 4 years is provided at this point.



Source: https://towardsdatascience.com/vehicle-detection-and-tracking-6665d6e1089b

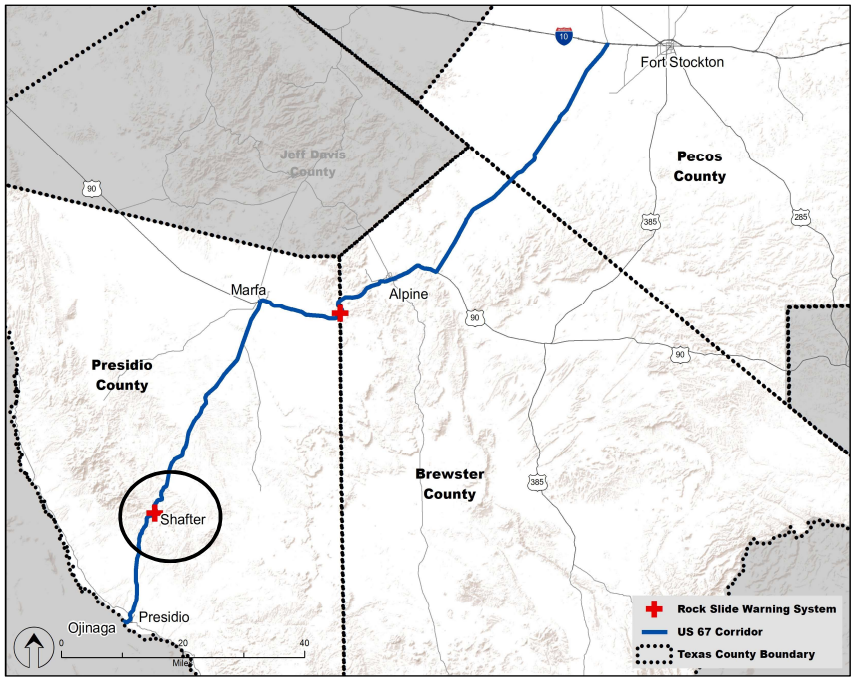
Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost	
Third Party Vendor (4 year contract)				$	400,000
2016 Total Cost				$	400,000

Owner	Cost		
TxDOT	Engineering (Study and Design)	$	150,000
Project Name	Construction	$	500,000
Rockslide Warning System at Shafter			
Project Number	2016 Total Cost	$	650,000
OM2.1	2019 Total Cost*	$	750,000
Implementation Term	*accounts for 4% increase rounded to the next higher fifty-thousand		
Short Term			

Description

There are no off the shelf rockslide warning systems from vendors. This will need to be engineered using new sensors. This project will consist of adding a dynamic message sign (DMS) in both directions approaching the area of concern. Rock slide detection sensors will identify when conditions indicate a potential rockslide. These sensors will send a warning message to the authorities or maintenance staff regarding the conditions to allow for consideration of a road closure. Engineering is estimated at 30% of construction costs. The proposed project location is identify in a circle.



https://upload.wikimedia.org/wikipedia/commons/c/c3/Falling_rocks_sign.jpg

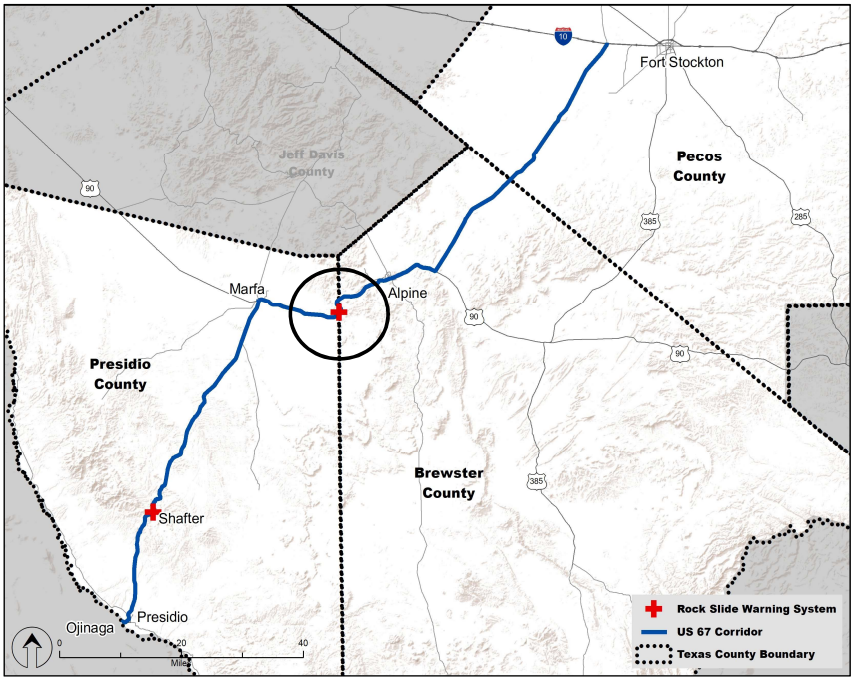
Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost
Detector/ Sensor	Each	2	$ 100,000	$ 200,000
Dynamic Message Signs	Each	2	$ 87,500	$ 175,000
Power and Coms	Mile	1	$ 50,000	$ 50,000
Controller & Misc.	Each	1	$ 75,000	$ 75,000
2016 Total Cost				$ 500,000

Owner	Cost per location		
TxDOT	Engineering (Study and Design)	$	150,000
Project Name	Construction	$	500,000
Rockslide Warning System at Paisano Pass			
Project Number	2016 Total Cost	$	650,000
OM2.2	2019 Total Cost*	$	750,000
Implementation Term	*accounts for 4% increase rounded to the next higher fifty-thousand		
Short Term			

Description

There are no off the shelf rockslide warning systems from vendors. This will need to be engineered using new sensors. This project is separate from the weather warning system, but will be integrated into the weather warning system if deployed. The system will take advantage of the Dynamic Message Sign in both directions approaching the area of concern. Rockslide detection sensors will identify when conditions indicate a potential rock slide. These sensors will send a warning message to the authorities or maintenance staff about the road closure. Engineering is estimated at 30% of construction costs. The proposed project location is identify in a circle.



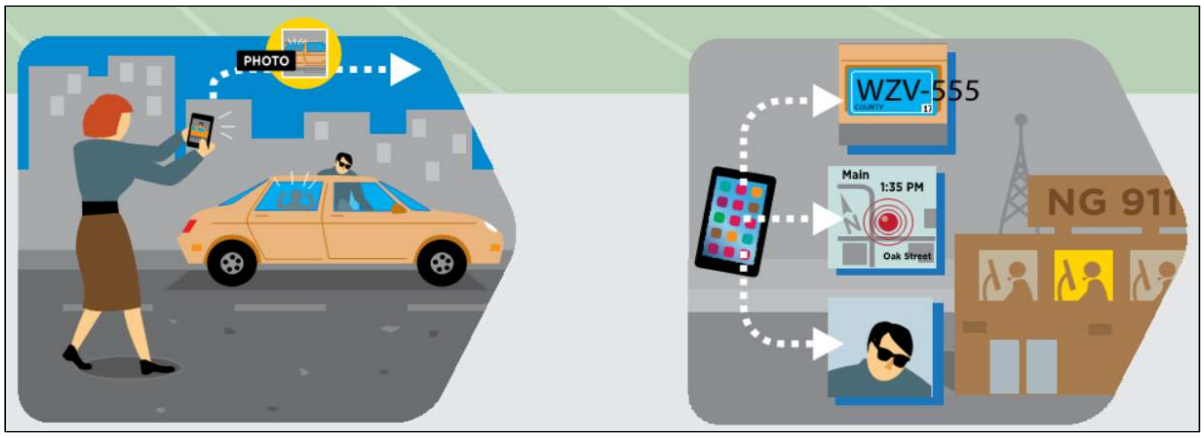
https://upload.wikimedia.org/wikipedia/commons/c/c3/Falling_rocks_sign.jpg

Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost	
Detector/ Sensor	Each	2	$ 100,000	$	200,000
Dynamic Message Signs	Each	2	$ 87,500	$	175,000
Power and Coms	Mile	1	$ 50,000	$	50,000
Controller & Misc.	Each	1	$ 75,000	$	75,000
2016 Total Cost				$	500,000

Owner	Cost		
TxDOT	Study	$	900,000
Project Name	Application development	$	3,000,000
Next Gen 911 for Presidio County			
Project Number	2019 Total Cost*	$	4,000,000
ES1.1	*rounded to the nearest million		
Implementation Term			
Long Term			

Description
This tool requires computer hardware and software improvements and coordination with emergency response agencies (911 call centers, first responders, local hospitals, and others) combined with GIS mapping technology. Engineering is estimated at 30% of study costs.

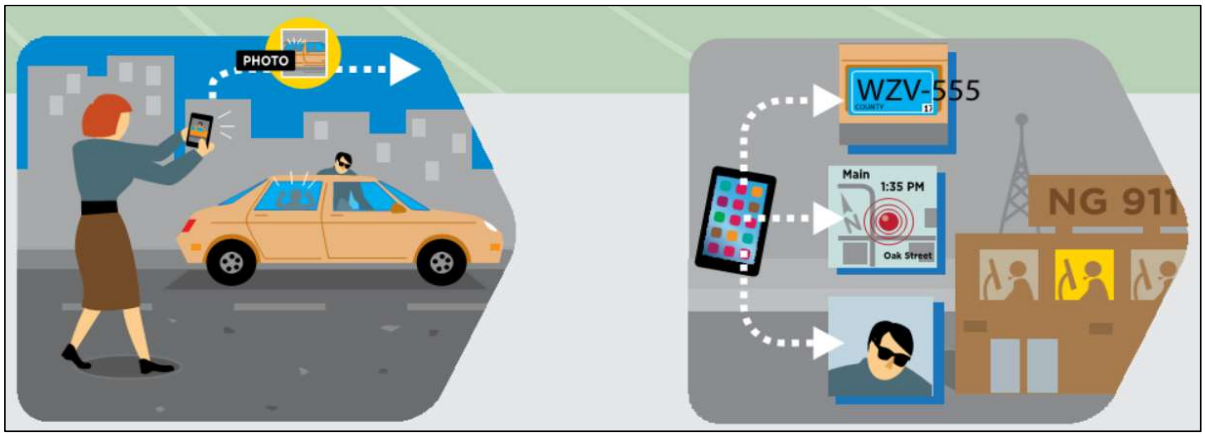


Source: National 911 Project

Decisions can not be made on if it is possible to proceed and what the costs are until a thorough study is completed. The study will need to look at the existing 911 system hardware and software and determine what is required to upgrade or replace the current system. Costs can vary widely. Estimates are from $1-5M per public safety answering point (PSAP). $3M is assumed as a planning level cost.

Owner	Cost		
TxDOT	Study	$	900,000
Project Name	Application development	$	3,000,000
Next Gen 911 for Brewster and Pecos Counties			
Project Number	2019 Total Cost*	$	4,000,000
ES1.2	*rounded to the nearest million		
Implementation Term			
Long Term			

Description
This tool requires computer hardware and software improvements and coordination with emergency response agencies (911 call centers, first responders, local hospitals, and others) combined with GIS mapping technology. Engineering is estimated at 30% of construction costs.

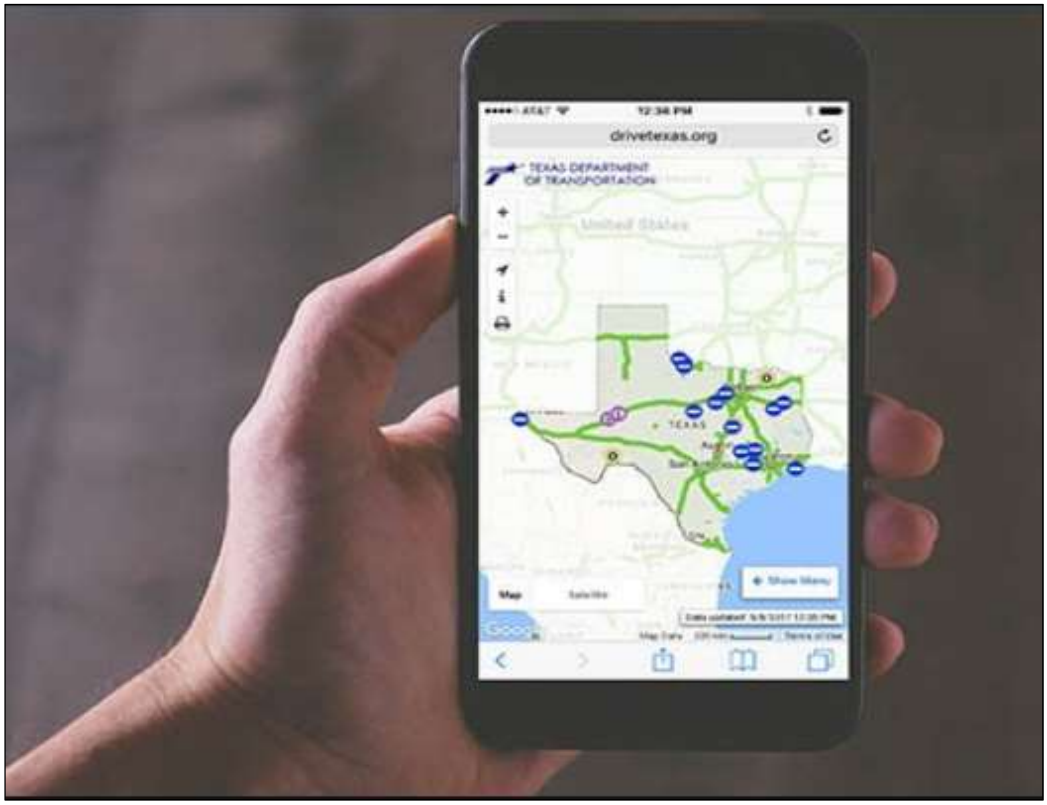


Source: National 911 Project

Decisions can not be made on if it is possible to proceed and what the costs are until a thorough study is completed. The study will need to look at the existing 911 system hardware and software and determine what is required to upgrade or replace the current system. Costs can vary widely. Estimates are from $1-5M per public safety answering point (PSAP). $3M is assumed as a planning level cost.

Owner	Cost		
TxDOT			
Project Name	Application development	$	300,000
Smartphone Applications for First Responders			
Project Number	2019 Total Cost*	$	300,000
ES2.1	*rounded to the nearest hundred-thousand		
Implementation Term			
Mid Term			

Description
This tool requires computer hardware and software improvements and coordination with emergency response agencies (911 call centers, first responders, local hospitals, and others) combined with GIS mapping technology.



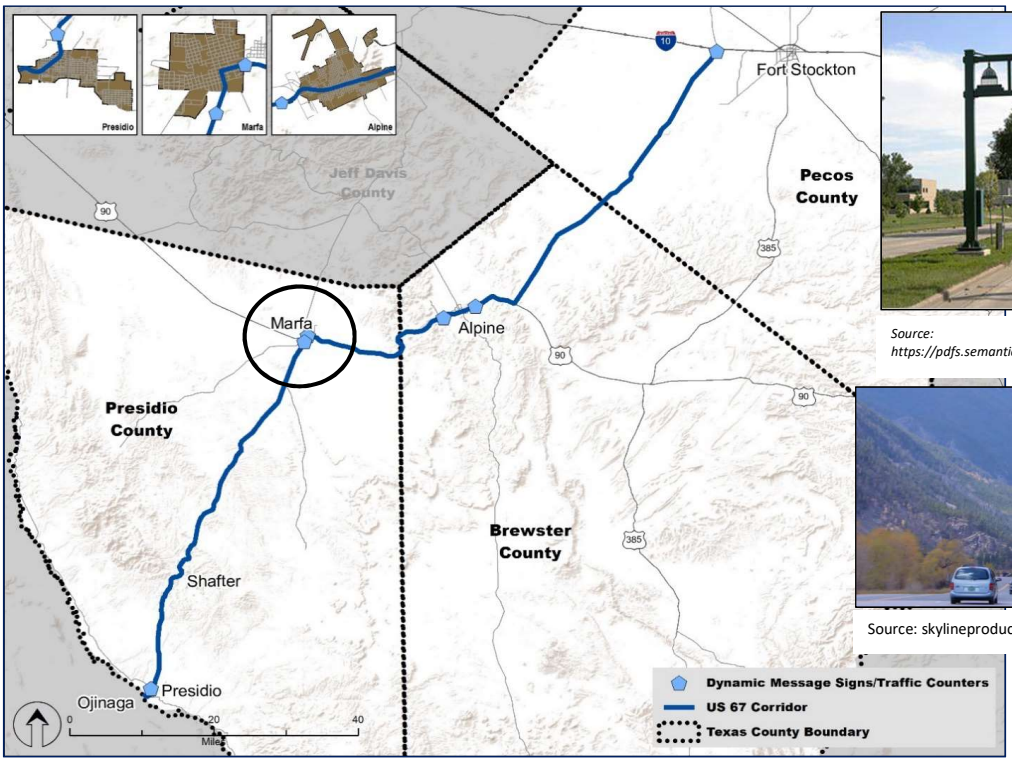
Source: Driving Texas DOT

The development of an application requires a study to determine what services are proposed to be included. The application is expected to be based off of existing systems (i.e., an existing TMC that has all the data). Application development can be completed in house depending on staff knowledge, or contracted out. It is likely that the software developer for the TMC will have the capabilities and knowledge to develop an application to support the TMC functions in a cost effective manner.

Owner	Cost		
TxDOT	Engineering (Study and Design)	$	41,500
Project Name	Construction	$	415,000
Dynamic Message Sign outside of Marfa			
Project Number	2016 Total Cost	$	456,500
TTI3.1	2019 Total Cost*	$	550,000
Implementation Term	*accounts for 4% increase rounded to the next higher fifty-thousand		
Short Term			

Description

This project will consist of adding a Dynamic Message Sign approaching and leaving the Marfa. Engineering is estimated at 10% of construction costs. The proposed project location is identify in a circle.



Source: https://pdfs.semanticscholar.org/e900/95e0701875a4c1f906

Source: skylineproducts.com

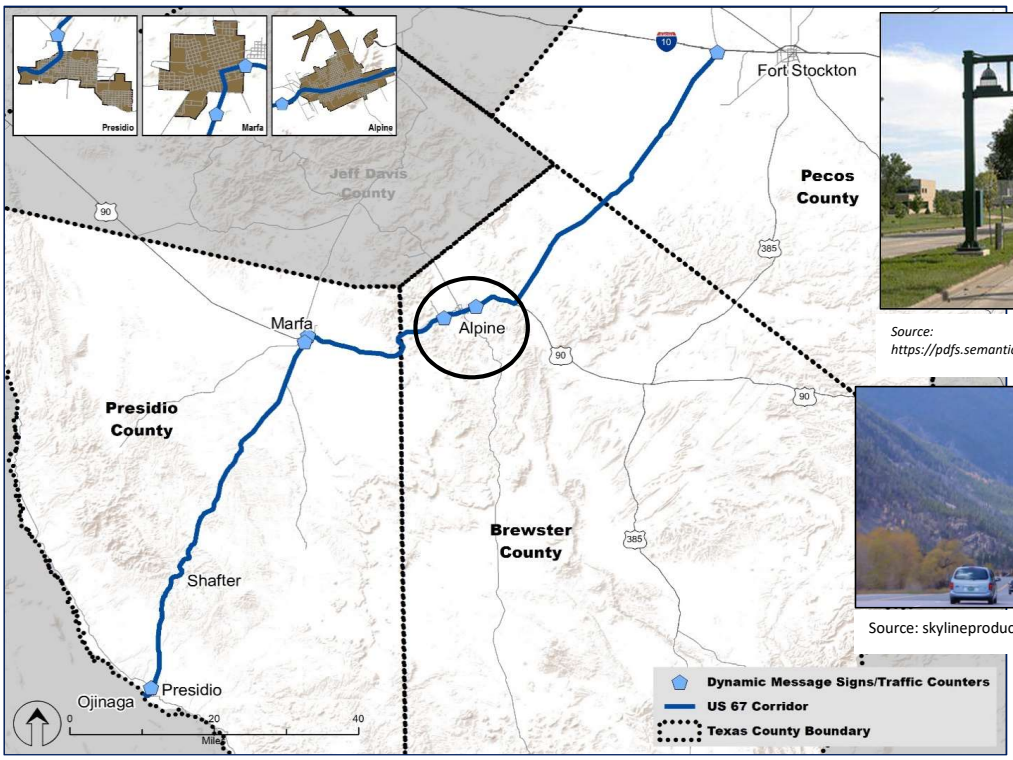
Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost
Dynamic Message Sign	Each	4	$ 87,500	$ 350,000
Integration	Each	1	$ 25,000	$ 25,000
Power and Coms	Each	4	$ 10,000	$ 40,000
2016 Total Cost				$ 415,000

Owner	Cost		
TxDOT	Engineering (Study and Design)	$	41,500
Project Name	Construction	$	415,000
Dynamic Message Sign outside of Alpine			
Project Number	2016 Total Cost	$	456,500
TTI3.2	2019 Total Cost*	$	550,000
Implementation Term	*accounts for 4% increase rounded to the next higher fifty-thousand		
Short Term			

Description

This project will consist of adding a portable Dynamic Message Sign approaching and leaving the Alpine. Engineering is estimated at 10% of construction costs.



Source: https://pdfs.semanticscholar.org/e900/95e0701875a4c1f906

Source: skylineproducts.com

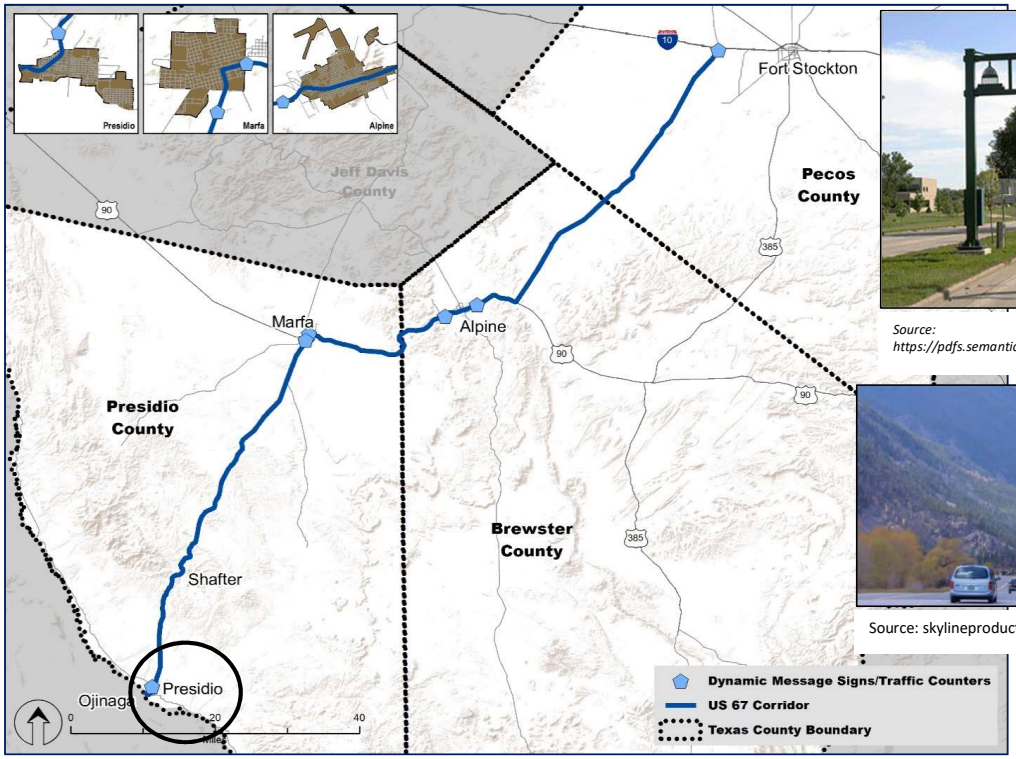
Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost
Dynamic Message Sign	Each	4	$ 87,500	$ 350,000
Integration	Each	1	$ 25,000	$ 25,000
Power and Coms	Each	4	$ 10,000	$ 40,000
2016 Total Cost				$ 415,000

Owner	Cost		
TxDOT	Engineering (Study and Design)	$	22,000
Project Name	Construction	$	220,000
Dynamic Message Sign outside of Presidio			
Project Number	2016 Total Cost	$	242,000
TT13.3	2019 Total Cost*	$	300,000
Implementation Term	*accounts for 4% increase rounded to the next higher fifty-thousand		
Short Term			

Description

This project will consist of adding a portable Dynamic Message Sign approaching and leaving the Presidio. Engineering is estimated at 10% of construction costs.



Source: https://pdfs.semanticscholar.org/e900/95e0701875a4c1f906

Source: skylineproducts.com

Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost
Dynamic Message Sign	Each	2	$ 87,500	$ 175,000
Integration	Each	1	$ 25,000	$ 25,000
Power and Coms	Each	2	$ 10,000	$ 20,000
2016 Total Cost				$ 220,000

Owner	Cost		
TxDOT			
Project Name	Study	$	500,000
Study To Provide Fiber Access Along Corridor			
Project Number	2019 Total Cost*	$	500,000
COM1.1	*rounded to the nearest hundred-thousand		
Implementation Term			
Long Term			

Description
This project will consist of identifying the locations and installing fiber optic cable along the corridor. Engineering is included in the cost.

Private fiber optic cable exists along large stretches of the US 67 corridor. A study is required to determine the cost of deploying state-owned and maintained fiber as opposed to leasing any fiber that is available. Fiber optic communications is not a requirement of any of the other proposed ITS systems, but would support all of them. The cost analysis should address one time and ongoing costs for all proposed systems along the corridor that are outside of communities.

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Owner	Cost		
TxDOT			
Project Name	Study	$	500,000
Study To Provide Enhanced Cellular Communications Along Corridor			
Project Number	2019 Total Cost*	$	500,000
COM1.2	*rounded to the nearest hundred-thousand		
Implementation Term			
Long Term			

Description
This project will analyze the existing cellular connections and provides information on enhancing the cellular service along the corridor. Engineering is included in the cost.

Private cellular communications exists throughout most of the US 67 corridor. A study is required to determine the cost of deploying state-owned and maintained cellular communications as opposed to utilizing existing private provider networks. The study should investigate opportunities for public private partnerships where cellular data service could be provided in exchange for private party access to TXDOT ROW.

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Owner	Cost		
TxDOT			
Project Name	Study	$	250,000
Study on Data Over Current Radio System			
Project Number	2019 Total Cost*	$	300,000
COM1.3	*rounded to the nearest hundred-thousand		
Implementation Term			
Long Term			

Description
This project will use the existing patrol's radio system and analyze the ability to send data over the current radio system. In particular, the ability to send an image over radio signals when there is no cellular services.

Conceptually, images can be sent over both digital and analog radio. Bandwidth is a big restriction for video; single images are also a concern but requires much less. For images, special equipment may be needed to upload the image in the field and download the image at another location. This study will determine if there is a way to accomplish this with the existing radio system with additional procured equipment.

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Owner	Cost		
TxDOT	Engineering (Study and Design)	$	42,300
Project Name	Construction	$	423,000
Total Station between Alpine and Fort Stockton (RWIS, CCTV, Vehicle Detection)			
Project Number	2016 Total Cost	$	465,300
TOT1.1	2019 Total Cost*	$	550,000
Implementation Term	*accounts for 4% increase rounded to the next higher fifty-thousand		
Mid Term			

Description

This project will consist of installing roadway weather information system (RWIS), pavement sensors, closed circuit television (CCTV), traffic detection, and radio tower at one location to minimize costs and improve maintainability. Engineering is estimated at 10% of construction costs.

Source: skylineproducts.com

Source: Arizona DOT Dust Warning System

Source: https://www.cctvcamerapros.com

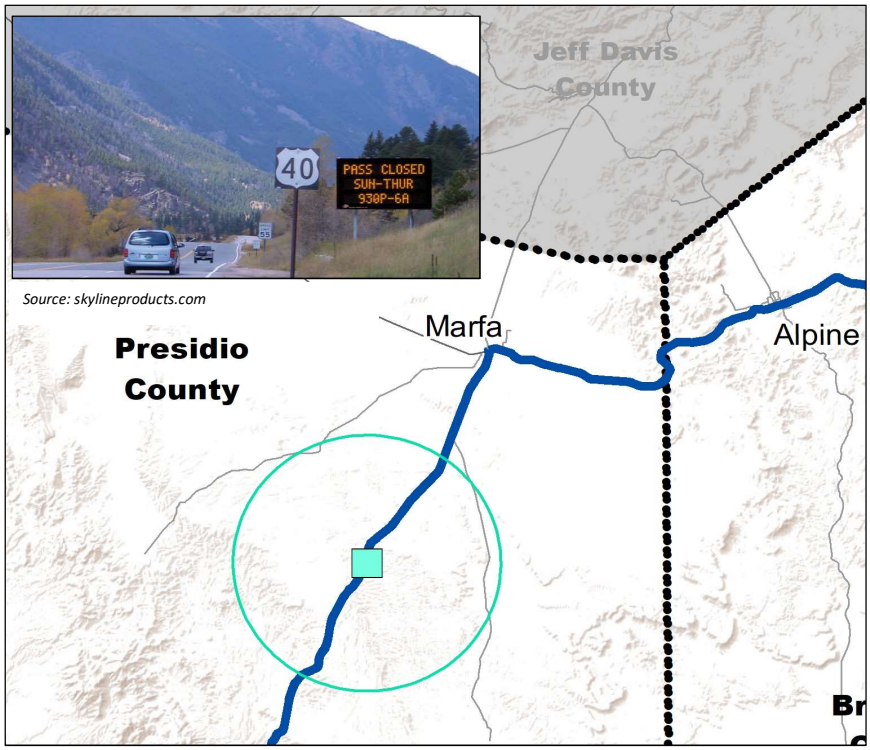
Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost
RWIS	Each	1	$ 75,000	$ 75,000
Pan–Tilt–Zoom (PTZ) camera	Each	1	$ 15,000	$ 15,000
Power and Coms	Mile	1	$ 200,000	$ 200,000
Cabinet and misc.	Each	1	$ 75,000	$ 75,000
Traffic Sensors	Each	4	$ 2,000	$ 8,000
Communications Tow	Unit	1	$ 50,000	$ 50,000
2016 Total Cost				$ 423,000

Owner	Cost		
TxDOT	Engineering (Study and Design)	$	42,300
Project Name	Construction	$	423,000
Total Station between Shafter and Marfa (RWIS, CCTV, Vehicle Detection)			
Project Number	2016 Total Cost	$	465,300
TOT1.2	2019 Total Cost*	$	550,000
Implementation Term	*accounts for 4% increase rounded to the next higher fifty-thousand		
Mid Term			

Description

This project will consist of installing roadway weather information system (RWIS), pavement sensors, closed circuit television (CCTV), traffic detection, and radio tower at one location to minimize costs and improve maintainability. Engineering is estimated at 10% of construction costs.



Source: skylineproducts.com

Source: Arizona DOT Dust Warning System

Source: https://www.cctvcamerapros.com

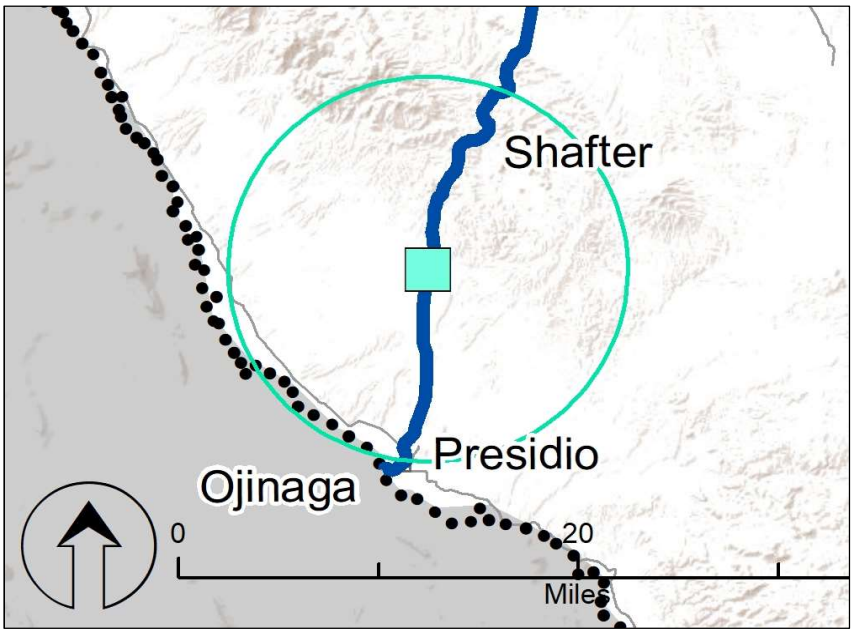
Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost
RWIS	Each	1	$ 75,000	$ 75,000
Pan–Tilt–Zoom (PTZ) camera	Each	1	$ 15,000	$ 15,000
Power and Coms	Mile	1	$ 200,000	$ 200,000
Cabinet and misc.	Each	1	$ 75,000	$ 75,000
Traffic Sensors	Each	4	$ 2,000	$ 8,000
Communications Tower	Unit	1	$ 50,000	$ 50,000
2016 Total Cost				$ 423,000

Owner	Cost		
TxDOT	Engineering (Study and Design)	$	42,300
Project Name	Construction	$	423,000
Total Station at Location Presidio and Shafter (RWIS, CCTV, Vehicle Detection)			
Project Number	2016 Total Cost	$	465,300
TOT1.3	2019 Total Cost*	$	550,000
Implementation Term	*accounts for 4% increase rounded to the next higher fifty-thousand		
Mid Term			

Description

This project will consist of installing roadway weather information system (RWIS), pavement sensors, closed circuit television (CCTV), traffic detection, and radio tower at one location to minimize costs and improve maintainability. Engineering is estimated at 10% of construction costs.



Source: Arizona DOT Dust Warning System

Source: skylineproducts.com

Source: https://www.cctvcamerapros.com

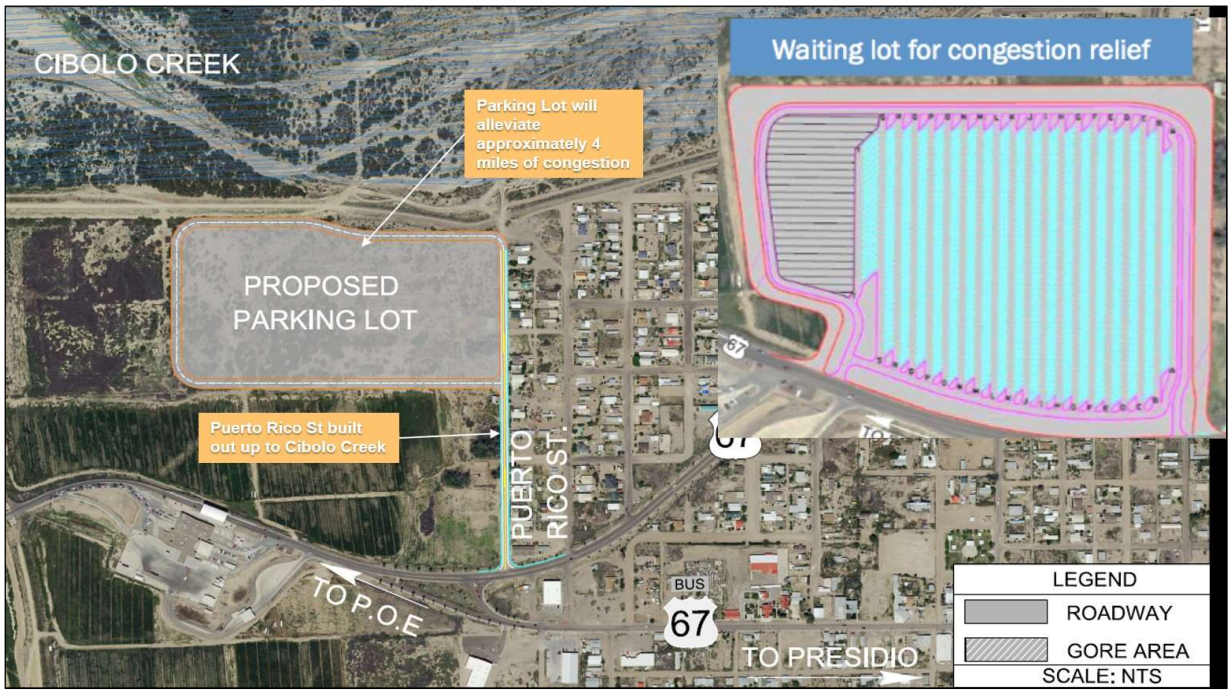
Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost
RWIS	Each	1	$ 75,000	$ 75,000
Pan–Tilt–Zoom (PTZ) camera	Each	1	$ 15,000	$ 15,000
Power and Coms	Mile	1	$ 200,000	$ 200,000
Cabinet and misc.	Each	1	$ 75,000	$ 75,000
Traffic Sensors	Each	4	$ 2,000	$ 8,000
Communications Tow	Unit	1	$ 50,000	$ 50,000
2016 Total Cost				$ 423,000

Owner	Cost		
TxDOT	Engineering (Study and Design)	$	382,500
Project Name	Construction	$	1,275,000
Smart Parking at POE			
Project Number	2016 Total Cost	$	1,657,500
OTH1.1	2019 Total Cost*	$	1,900,000
Implementation Term	*accounts for 4% increase rounded to the next higher hundred-thousand		
Mid Term			

Description

This project will design and deploy a smart parking system to be used on major holidays only. The system will require some form of manual check in and automated assignment. It will send the traveler to a designated area and then will provide notification to groups to proceed to the gate. Engineering including initial planning is 30% of construction costs.



Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost
Smart Parking	System	1	$ 300,000	$ 300,000
Pan–Tilt–Zoom (PTZ) camera	Each	10	$ 75,000	$ 750,000
Power and Coms	Mile	1	$ 50,000	$ 50,000
Cabinet and misc.	Each	1	$ 75,000	$ 75,000
Sensors	Each	50	$ 2,000	$ 100,000
2016 Total Cost				$ 1,275,000

Owner	Cost		
TxDOT	Procurement	$	61,000
Project Name	Total 2016	$	61,000
Incident Management Support Truck	Total 2019*	$	100,000
Project Number	*accounts for 4% increase rounded to the next higher fifty-thousand		
OTH1.2			
Implementation Term	Potential funding source		
Short Term	FHWA		

Description

This project consists of procuring a vehicle to provide incident management support for the corridor. This vehicle can be new or an older repurposed vehicle such as a fire truck. The vehicle will be outfitted with appropriate lights, arrow boards, dynamic message signs, and support equipment to support a lane closure such as cones and flares. The vehicle will be positioned within the corridor and deployed for major events.

Source: https://cdn.firehouse.com/files/base/cygnus/fhc/image/2018/01/960w/Irving_Blocker_Fire_Ap

Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost
Used Fire Truck	each	1	$ 50,000	$ 50,000
Modifications	package	1	$ 10,000	$ 10,000
Extra Equipment	package	1	$ 1,000	$ 1,000
2016 Total Cost				$ 61,000

Owner	Cost		
TxDOT	Coordination/procurement	$	60,000
Project Name	2016 Total Cost	$	60,000
Traffic Incident Management Training	2019 Total Cost*	$	100,000
Project Number	*accounts for 4% increase rounded to the next higher fifty-thousand		
OTH1.3			
Implementation Term	Potential funding source		
Short Term	FHWA		

Description

This project will seek appropriate incident management training from FHWA or other sources and offer to all incident responders in the corridor. This includes police, fire, and towing/recovery firms. Costs are entirely coordination and procurement.

Source: http://www.montana.edu/ltap/resources/tim/index.html

Source: https://ops.fhwa.dot.gov/eto_tim_pse/publications/timhandbook/chap3.htm

Cost Estimate

Item	Unit	Quant	Unit Cost	Total Cost
Training course	each	4	$ 15,000	$ 60,000
2016 Total Cost				$ 60,000

Owner	Cost		
TxDOT	Coordination/procurement	$	-
Project Name			
Establish Corridor Coordination Groups			
Project Number	Total	$	-
OTH1.4			
Implementation Term	Potential funding source		
Short Term	FHWA		

Description
This project consists solely of staff time organizing and managing corridor working groups and recurring meetings with agencies to coordinate planning and operations. No specific cost is associated with this effort.

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1882
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MARFA TEXAS
OUR 67
US 67 CORRIDOR
MASTER PLAN