DRISI
Caltrans Division of Research, Innovation and System Information

ASWSC Phase 3

Migration of the Automated Safety Warning System Controller to the Caltrans Advanced Transportation Controller Platform

Need and Background Part 1 of 6

Jeremiah Pearce P.E., Caltrans District 2

Jeff Worthington, Caltrans District 2

Doug Galarus, Montana Tech

UTAH STATE

MONTANA STATE UNIVERSITY
Western Transportation Institute

Abstract

The Automated Safety Warning System Controller (ASWSC) was developed through a multi-phased research and development effort by Caltrans and the Western States Rural Transportation Consortium (WSRTC). The ASWSC interfaces with roadside sensors and signs to actuate safety warning messages such as icy curve and high wind warnings. For instance, wind warning messages may be actuated on a changeable message sign (CMS) when wind speed, as read from an RWIS sensor, exceeds a given threshold. The ASWSC allows for automated data collection and application of best practice algorithms to analyze sensor data and to actuate related warning messages and signals in real time. The hardware and software system was pilot tested by multiple users and over multiple years in the field in preparation for wider deployment. While the system was developed on an industrial hardware platform and standard Linux, and performed very well in the field, it became desirable to deploy the system using Caltrans' Linux-based Advanced Transportation Controller (ATC), which is now available for purchase from multiple vendors and standardized for Caltrans. This presentation will cover project history, detailed architecture and current status.

Original Problem Statement

In order to provide better safety warning information to motorists, how can roadside condition sensor data be automatically analyzed, and real-time road condition information be displayed to the traveling public?

[Caltrans Research Problem Statement - 2005]

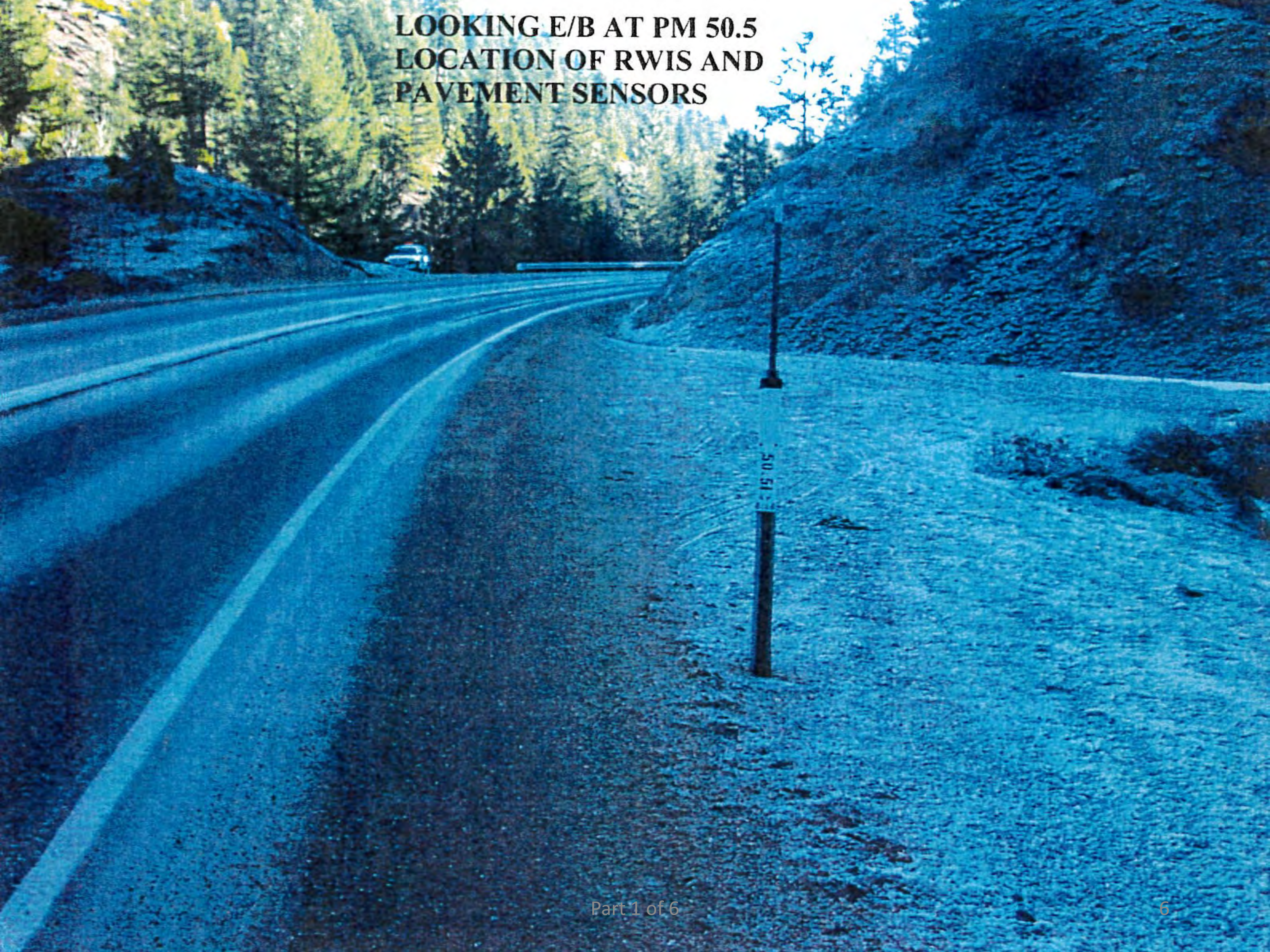
Original Problem Statement

Automated warning systems are not a new concept within the transportation community… To date, all of these systems are unique implementations that use one-of-a-kind software for control… A standardized automated warning system controller, which controls standardized field elements in a system environment, has not been developed to date.

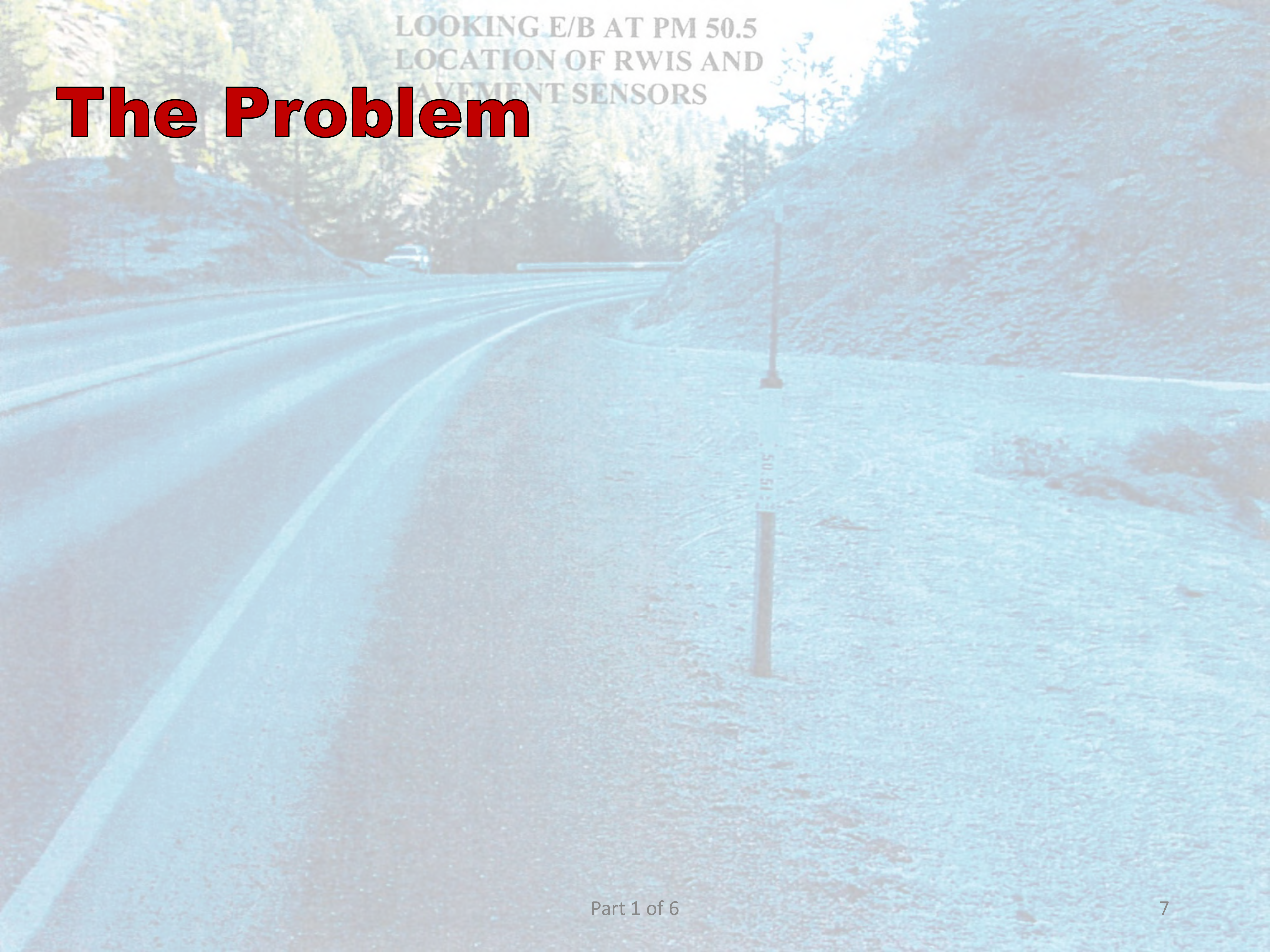
[Caltrans Research Problem Statement - 2005]

Outline

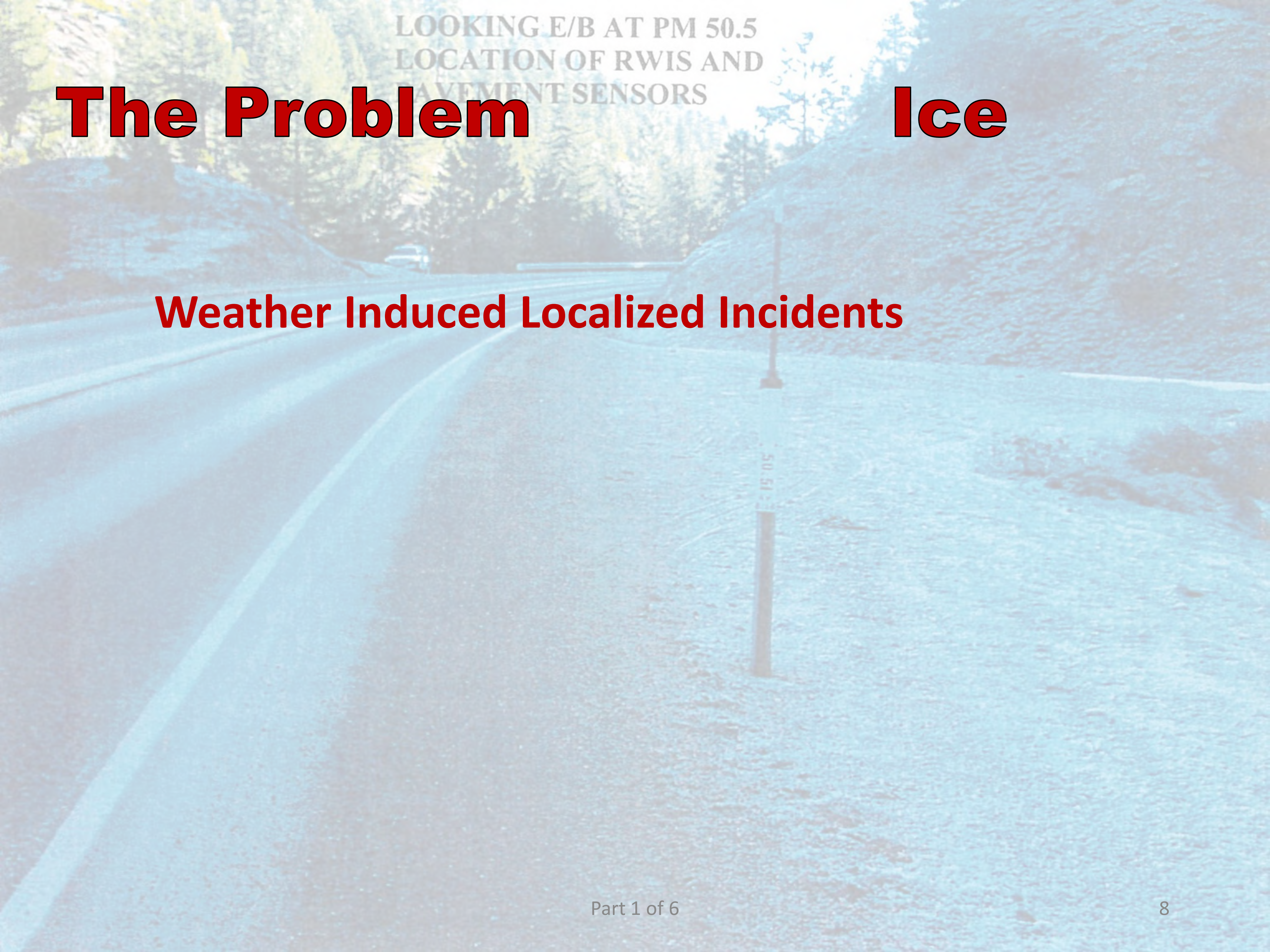
1. ***Background Need and Purpose – Jeremiah Pearce***
2. ***Development Phases 1 and 2 – Doug Galarus***
3. ***Deployment and Testing Phases 1 and 2 – Jeremiah Pearce***
4. ***Development Phase 3 – Doug Galarus***
5. ***Deployment and Testing Phase 3 – Jeff Worthington***
6. ***Concluding Remarks and What's Next – Jeff, Doug, and Jeremiah***


LOOKING E/B AT PM 50.5
LOCATION OF RWIS AND
PAVEMENT SENSORS

The Problem

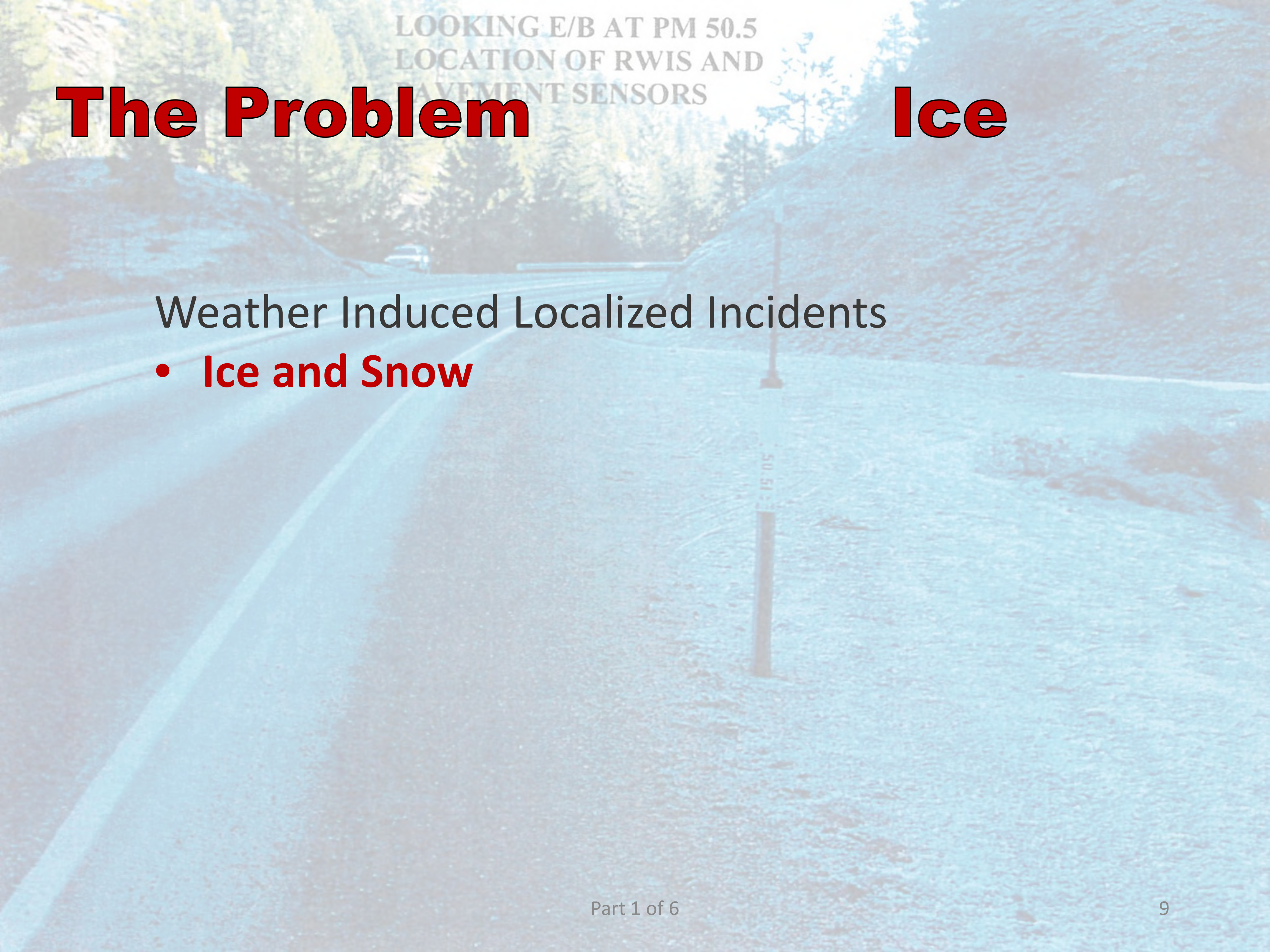


The Problem Ice



Weather Induced Localized Incidents

The Problem Ice



Weather Induced Localized Incidents

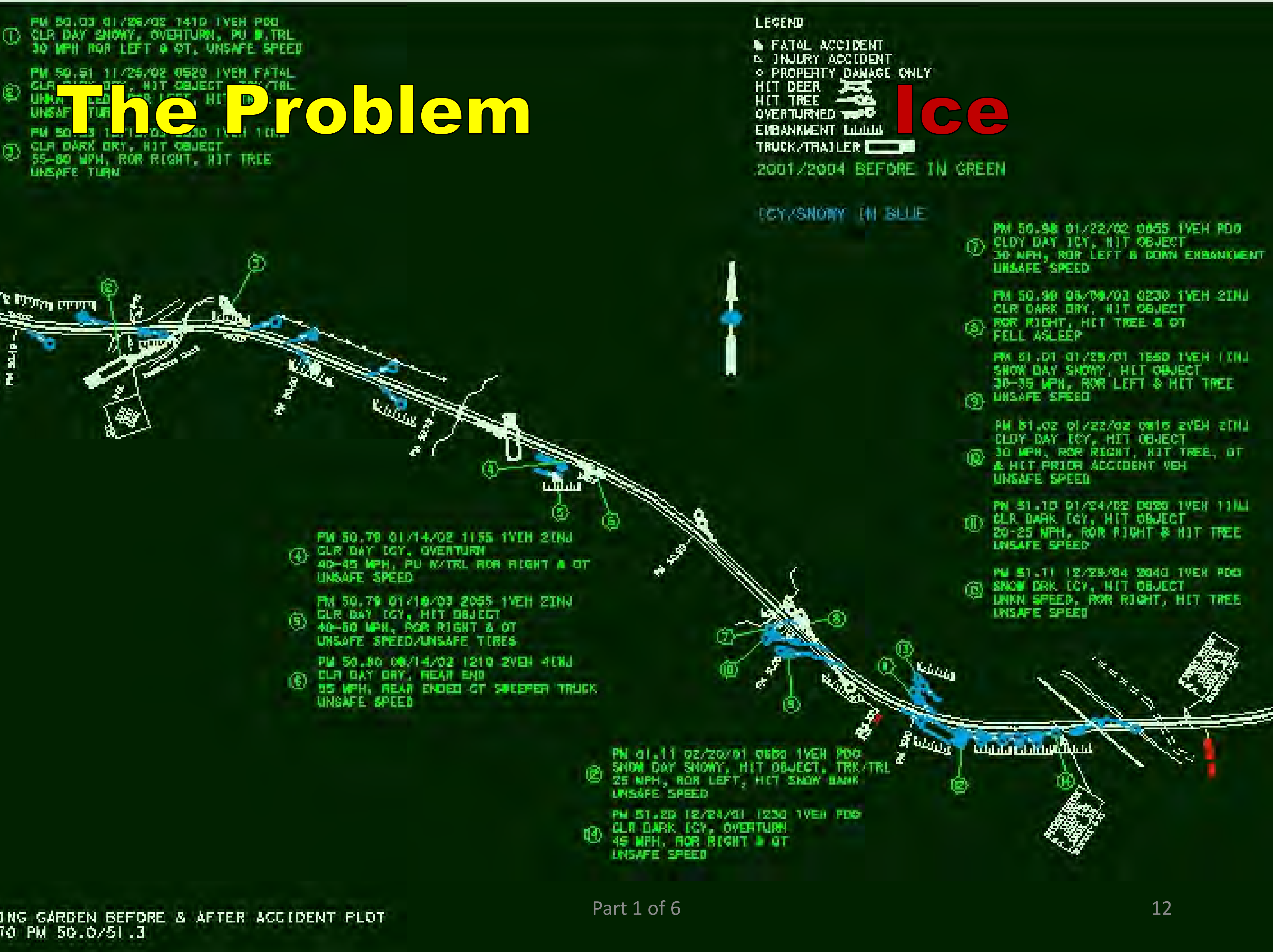
- **Ice and Snow**


The Problem
Ice
Redding
5
139
89
36
395
Spring Garden RWIS and CCTV
99
Chico
149
70
162
49
80
Reno
580
40 mi

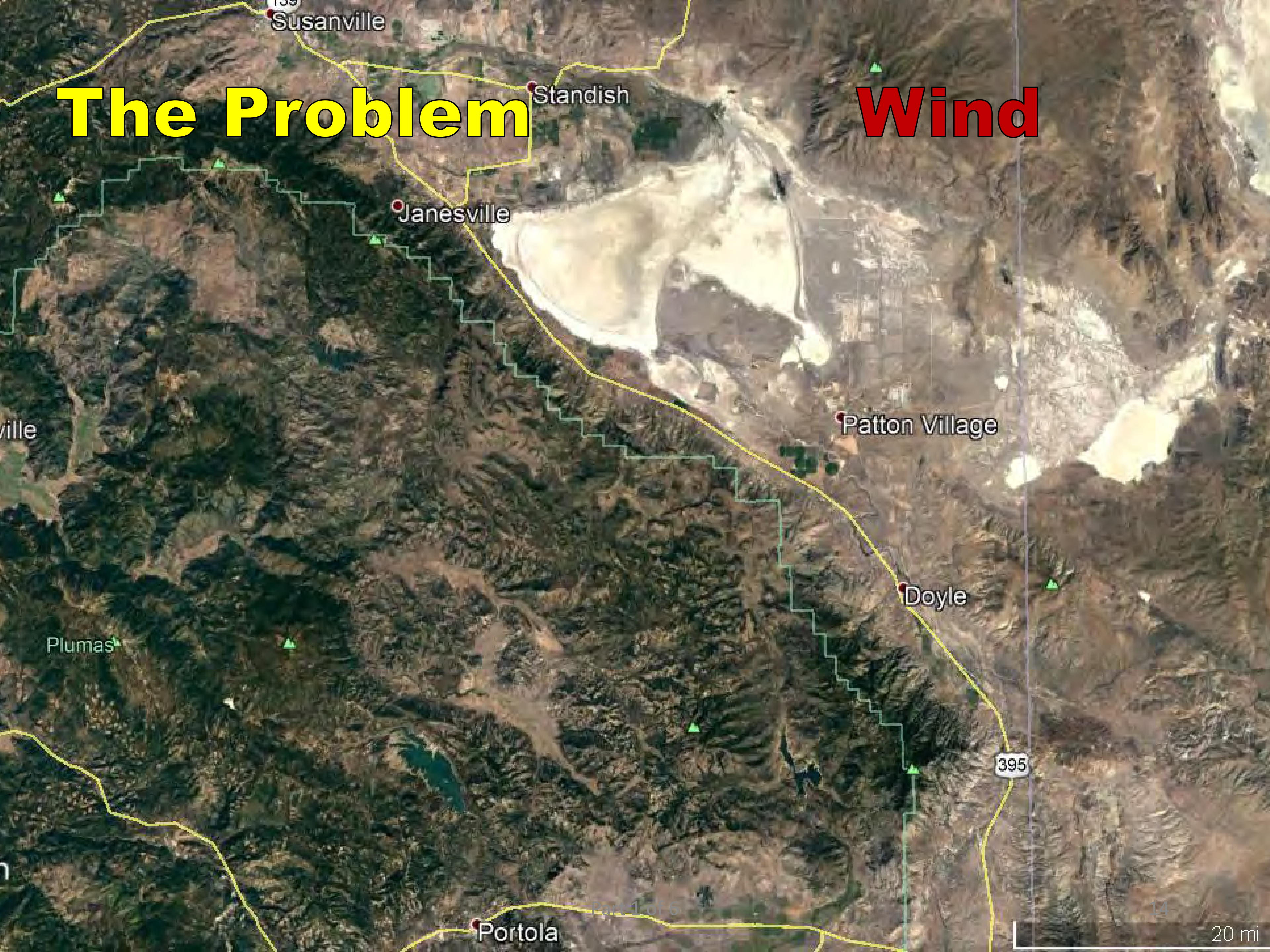
The Problem Ice

The Problem

Ice




The Problem
Wind
Boyd


The Problem
Wind
Susanville
Standish
Janesville
Patton Village
Doyle
Plumas
395
Portola
20 mi

The Problem Fog

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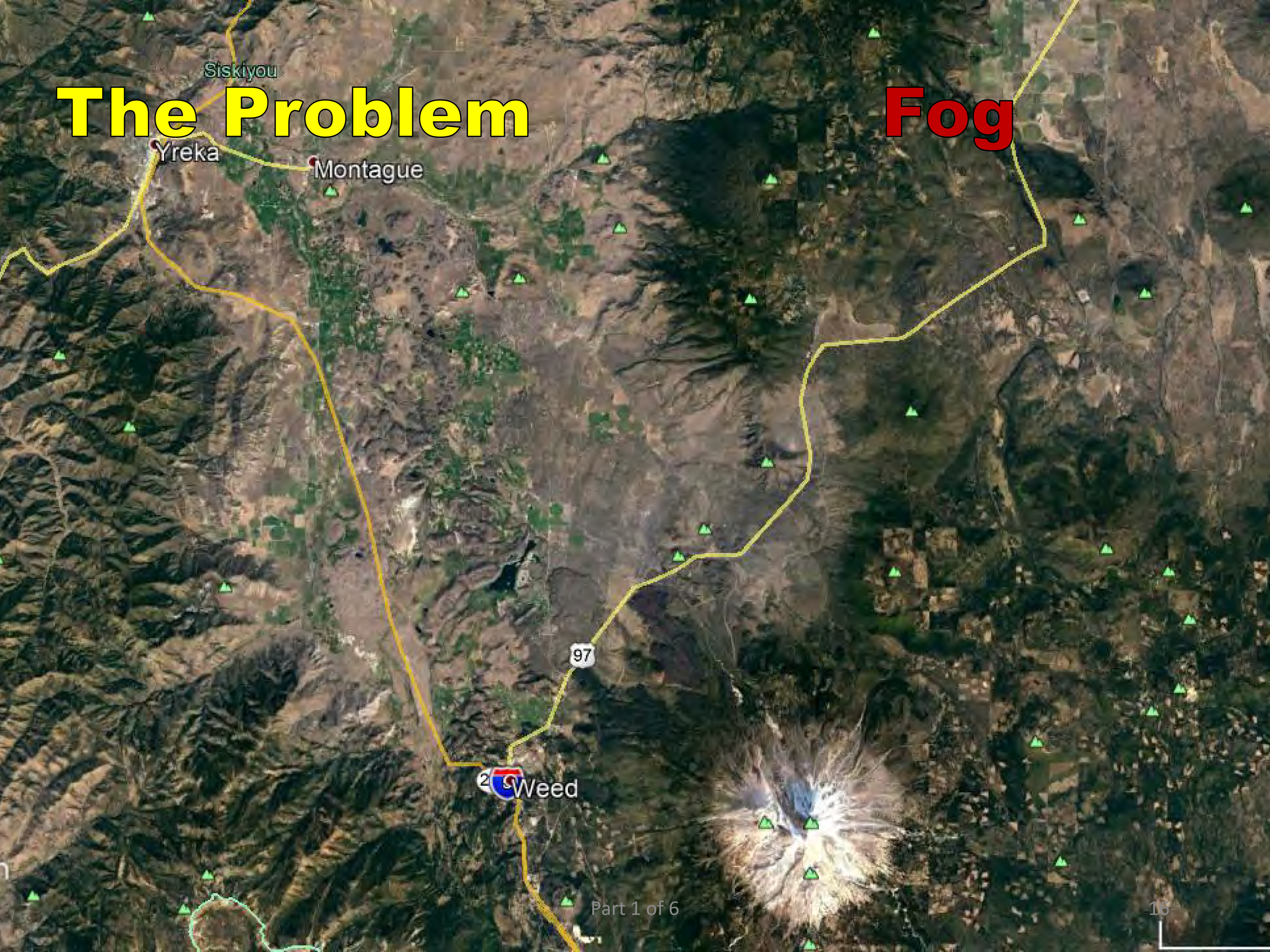
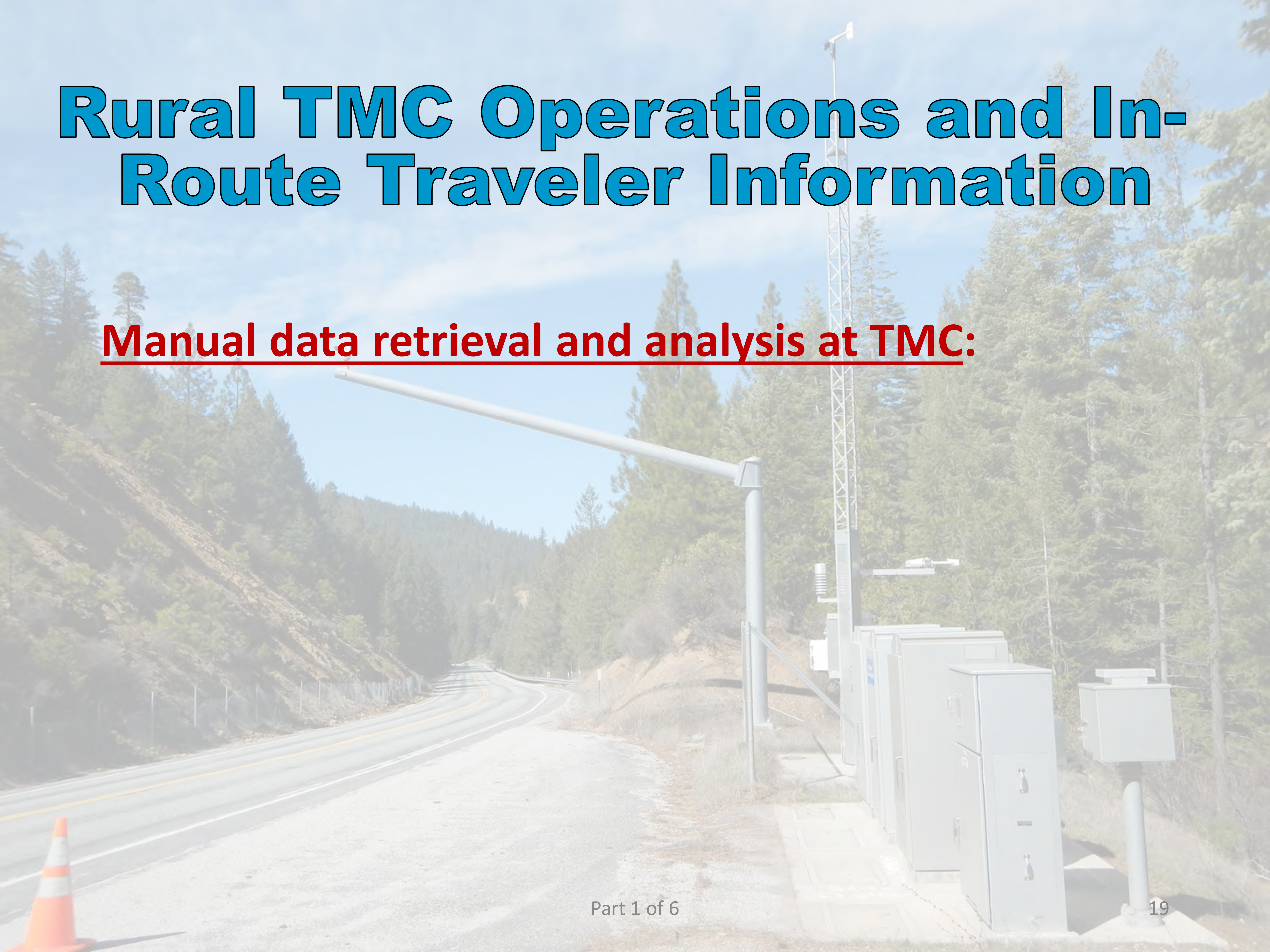


The Problem Etc.

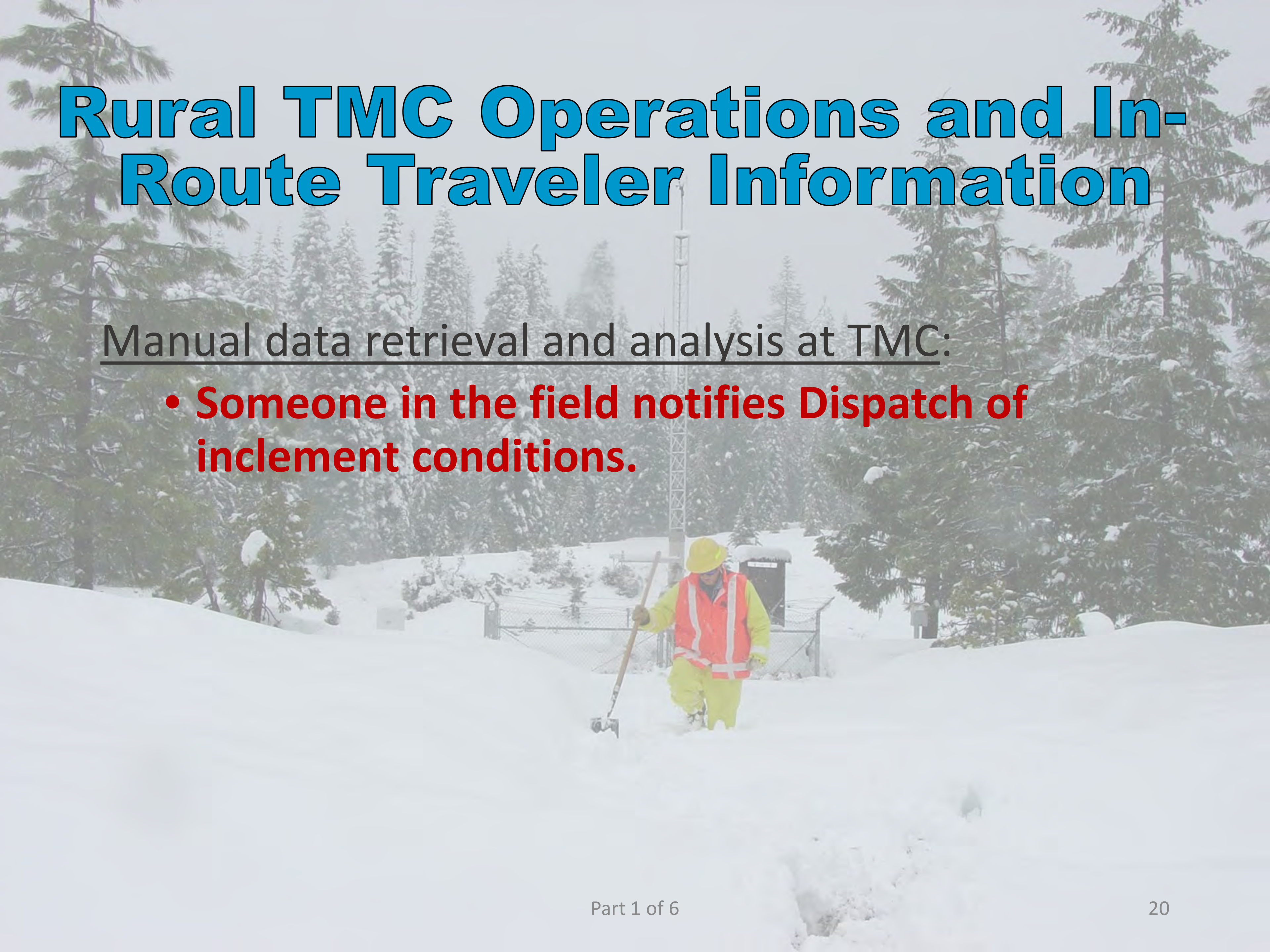
Rural TMC Operations and In-Route Traveler Information

Rural TMC Operations and In-Route Traveler Information



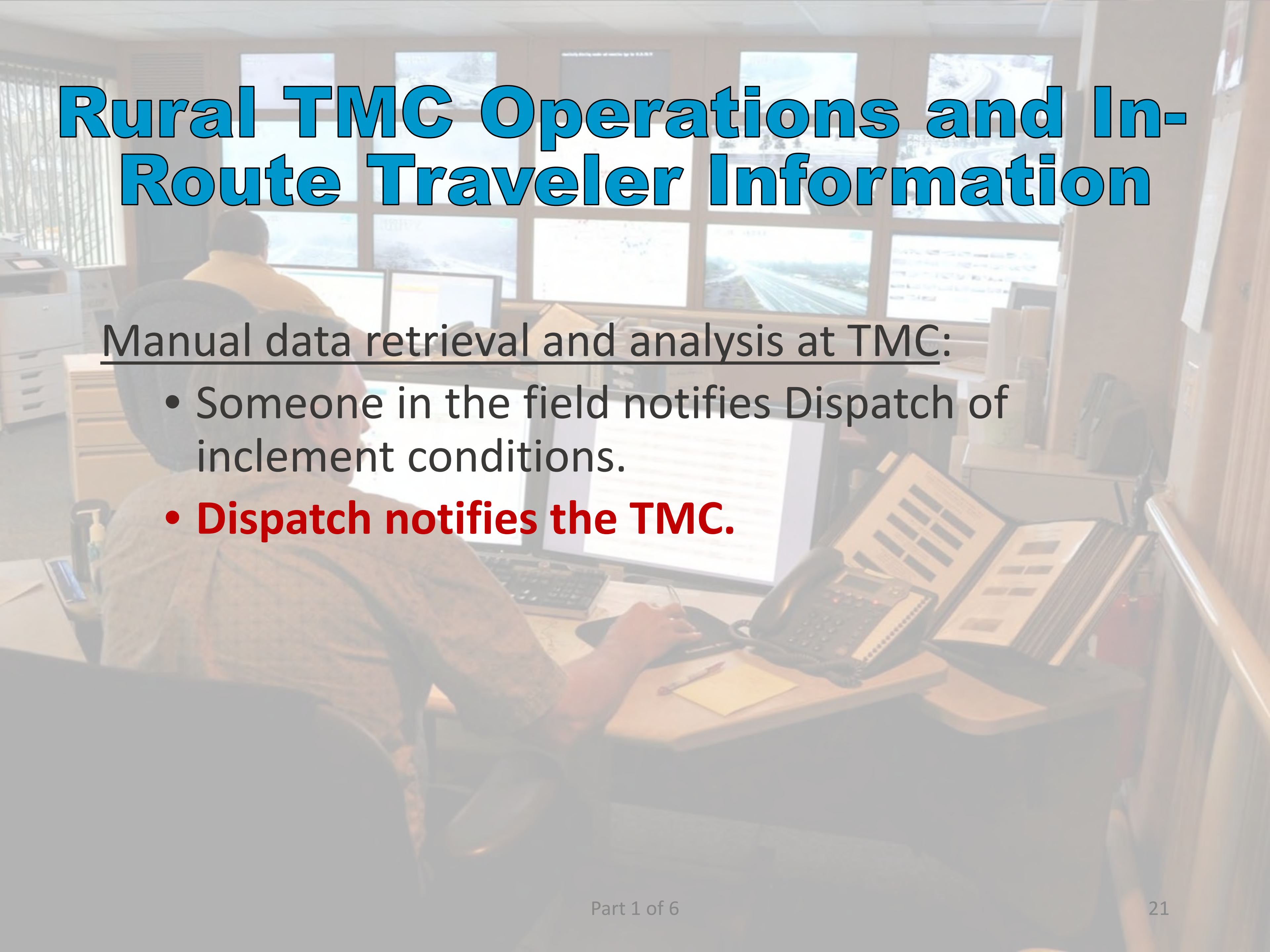
<u>Manual data retrieval and analysis at TMC</u>:

Rural TMC Operations and In-Route Traveler Information



Manual data retrieval and analysis at TMC:

- **Someone in the field notifies Dispatch of inclement conditions.**



Rural TMC Operations and In-Route Traveler Information

Manual data retrieval and analysis at TMC:

- Someone in the field notifies Dispatch of inclement conditions.
- **Dispatch notifies the TMC.**

Rural TMC Operations and In-Route Traveler Information

<u>Manual data retrieval and analysis at TMC:</u>

- Someone in the field notifies Dispatch of inclement conditions.
- Dispatch notifies the TMC.
- **The TMC operator verifies conditions on RWIS.**

Rural TMC Operations and In-Route Traveler Information

Manual data retrieval and analysis at TMC:

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- The TMC operator verifies conditions on RWIS.
- **The TMC operator manually sets the warning (CMS, EMS, Flashing beacon).**

Photo from Ian Turnbull

Rural TMC Operations and In-Route Traveler Information

Manual data retrieval and analysis at TMC:

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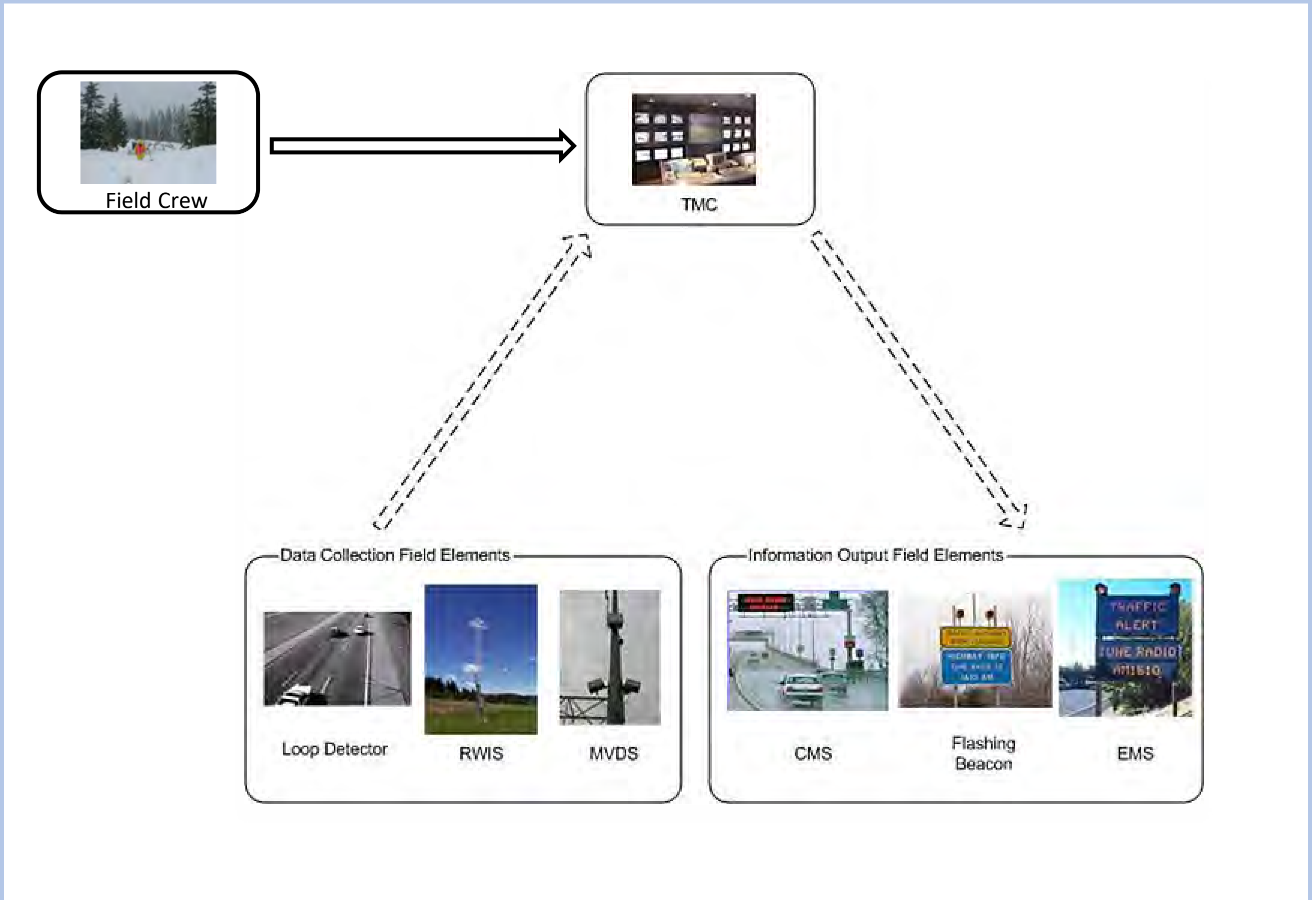
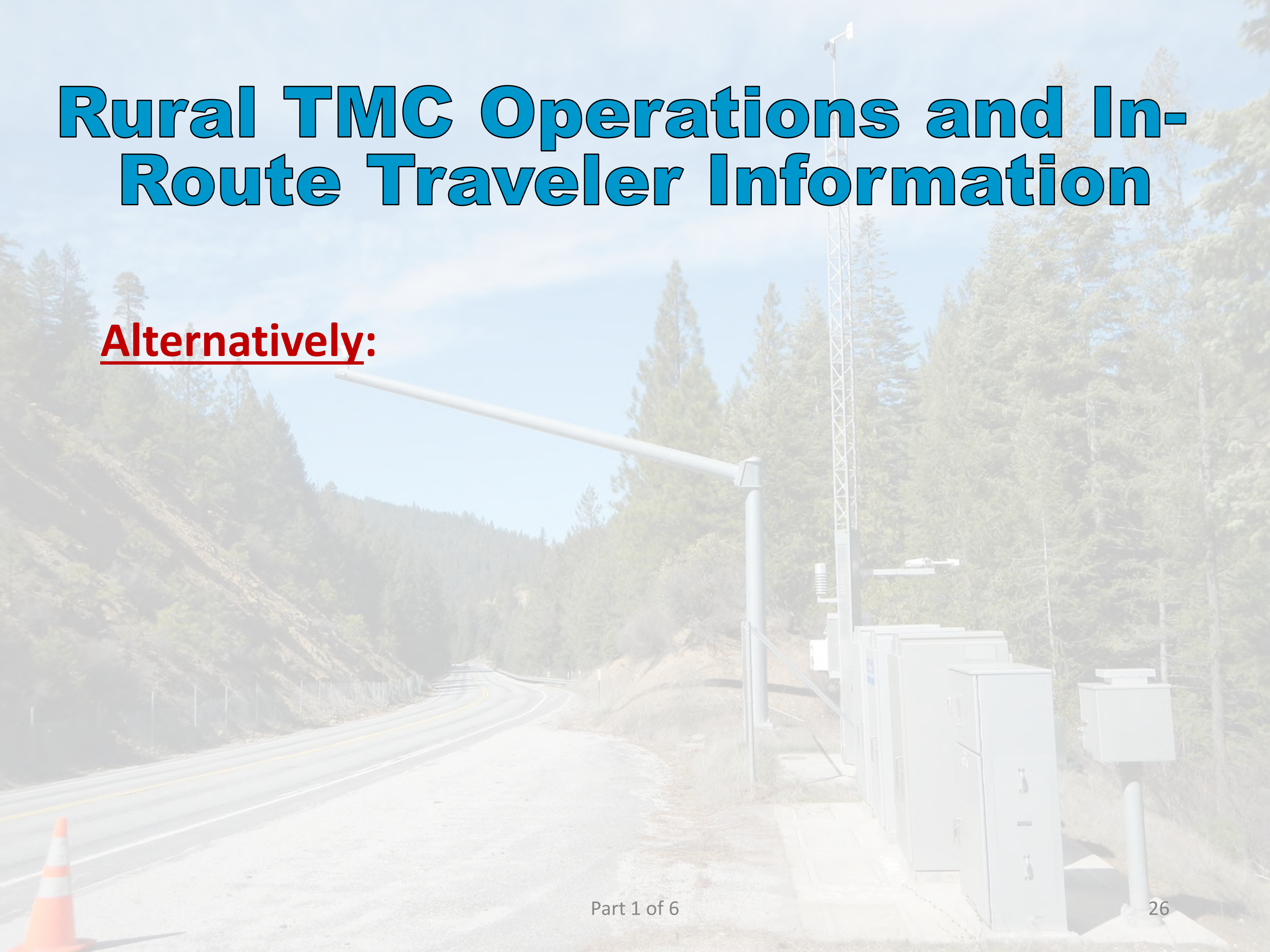
- **The warning stays in place until the TMC operator is informed of a change or notices it.**

Rural TMC Operations and In-Route Traveler Information



TMC Monitoring and Warning Message Activation

Rural TMC Operations and In-Route Traveler Information



Alternatively:

Rural TMC Operations and In-Route Traveler Information

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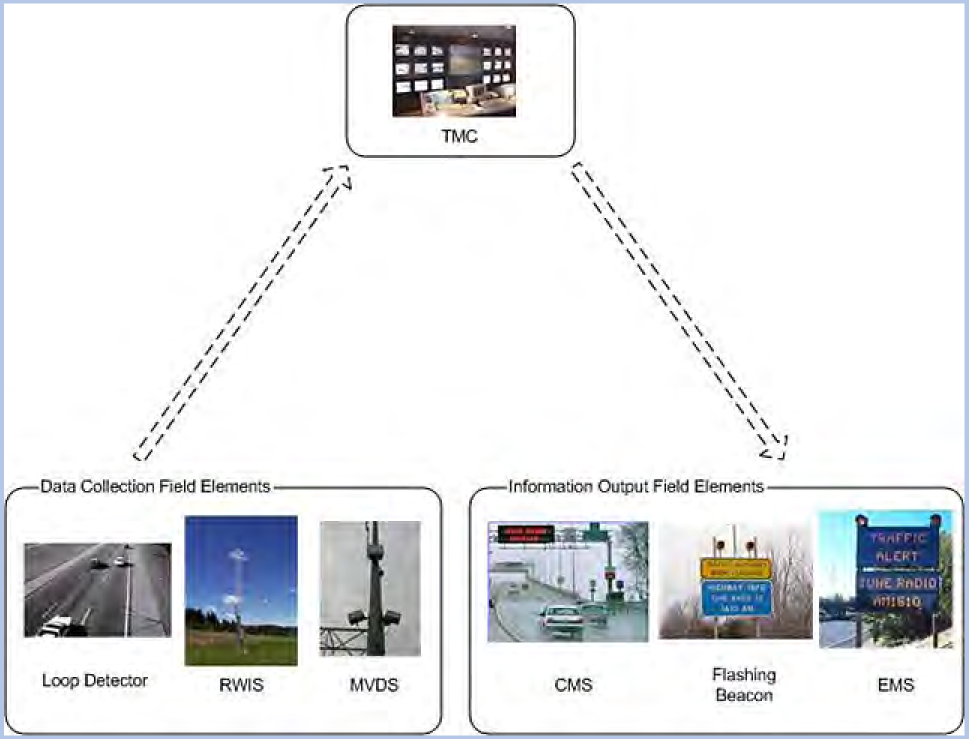

TMC Monitoring and Warning Message Activation

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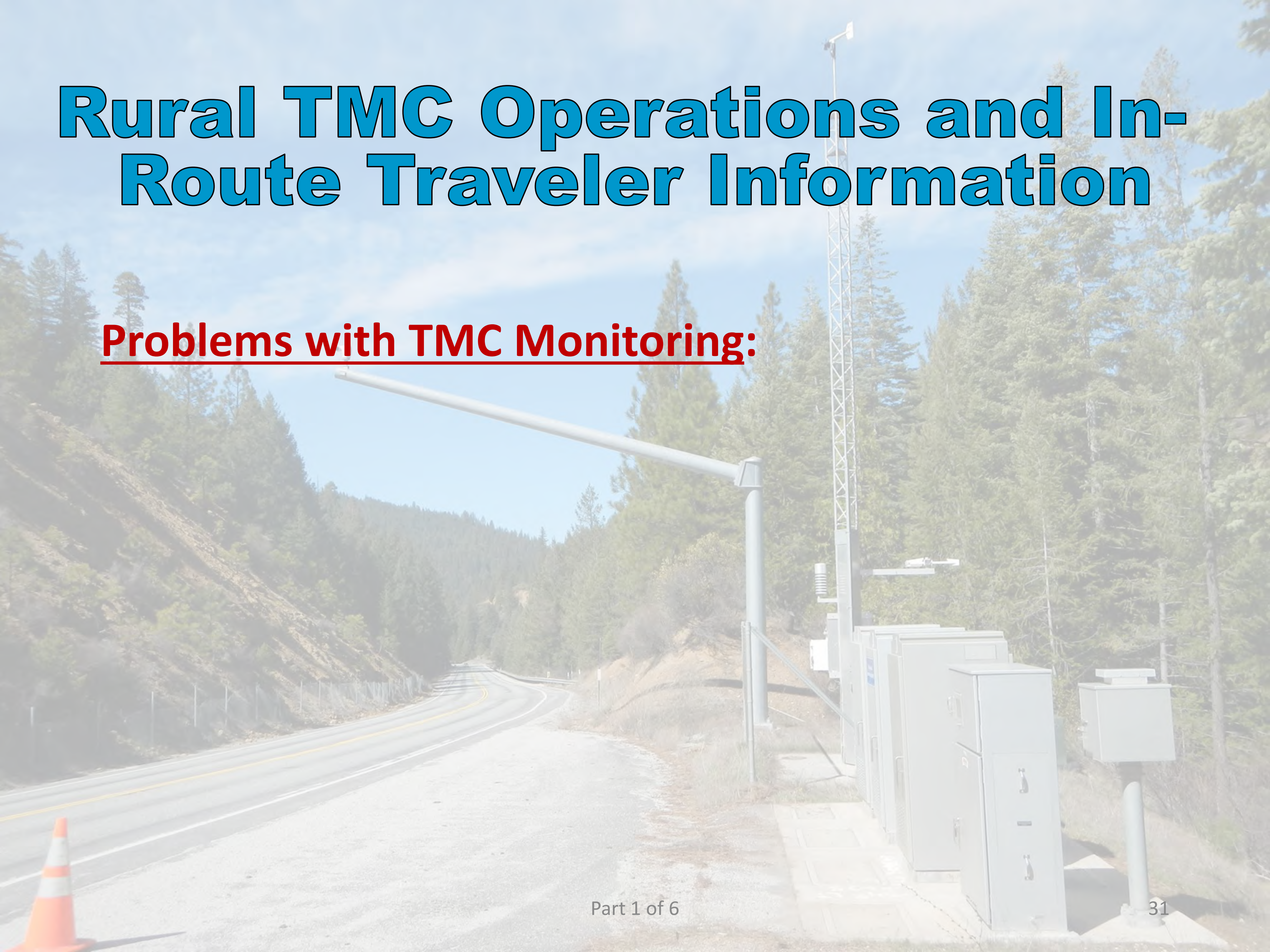
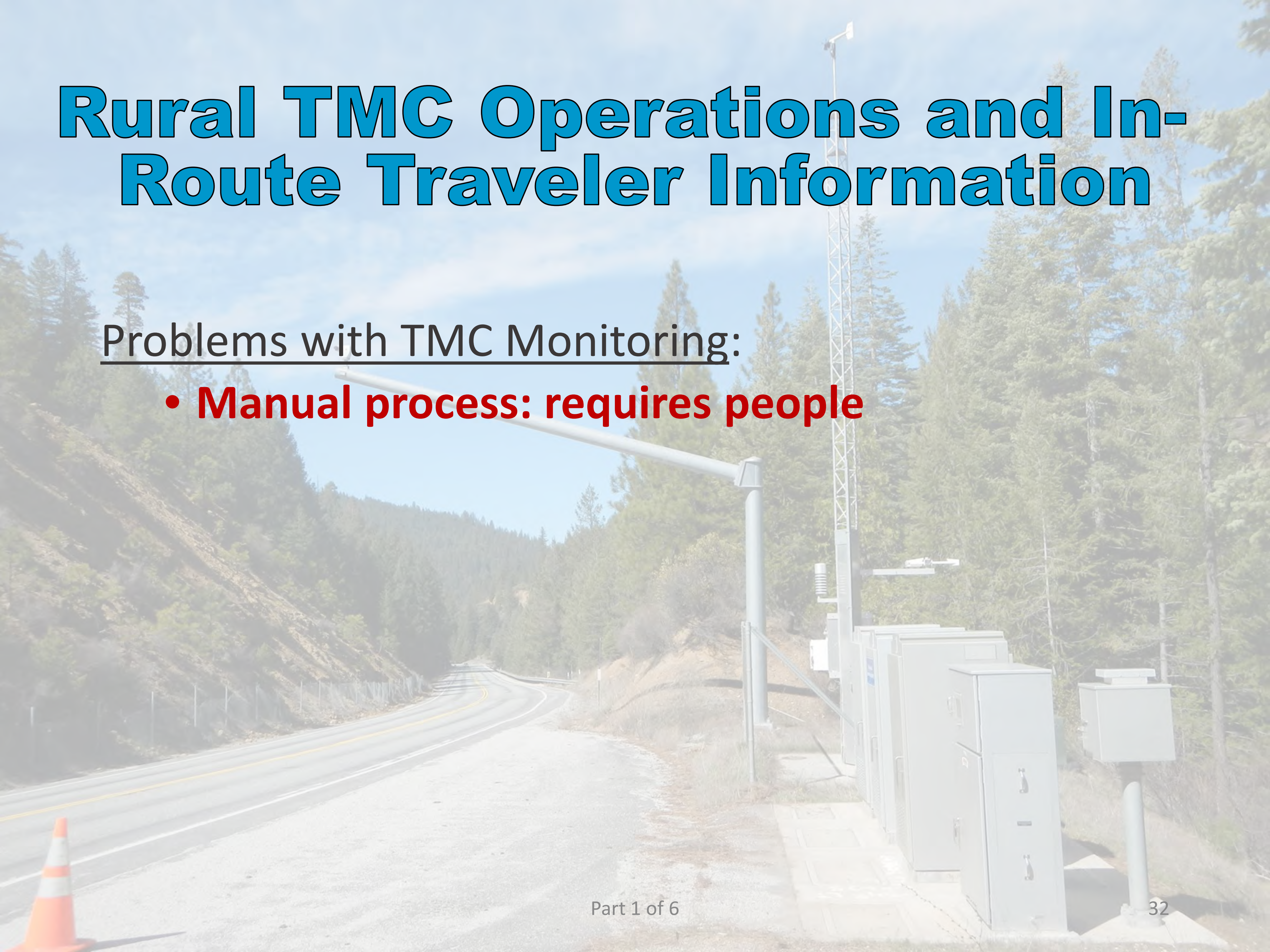


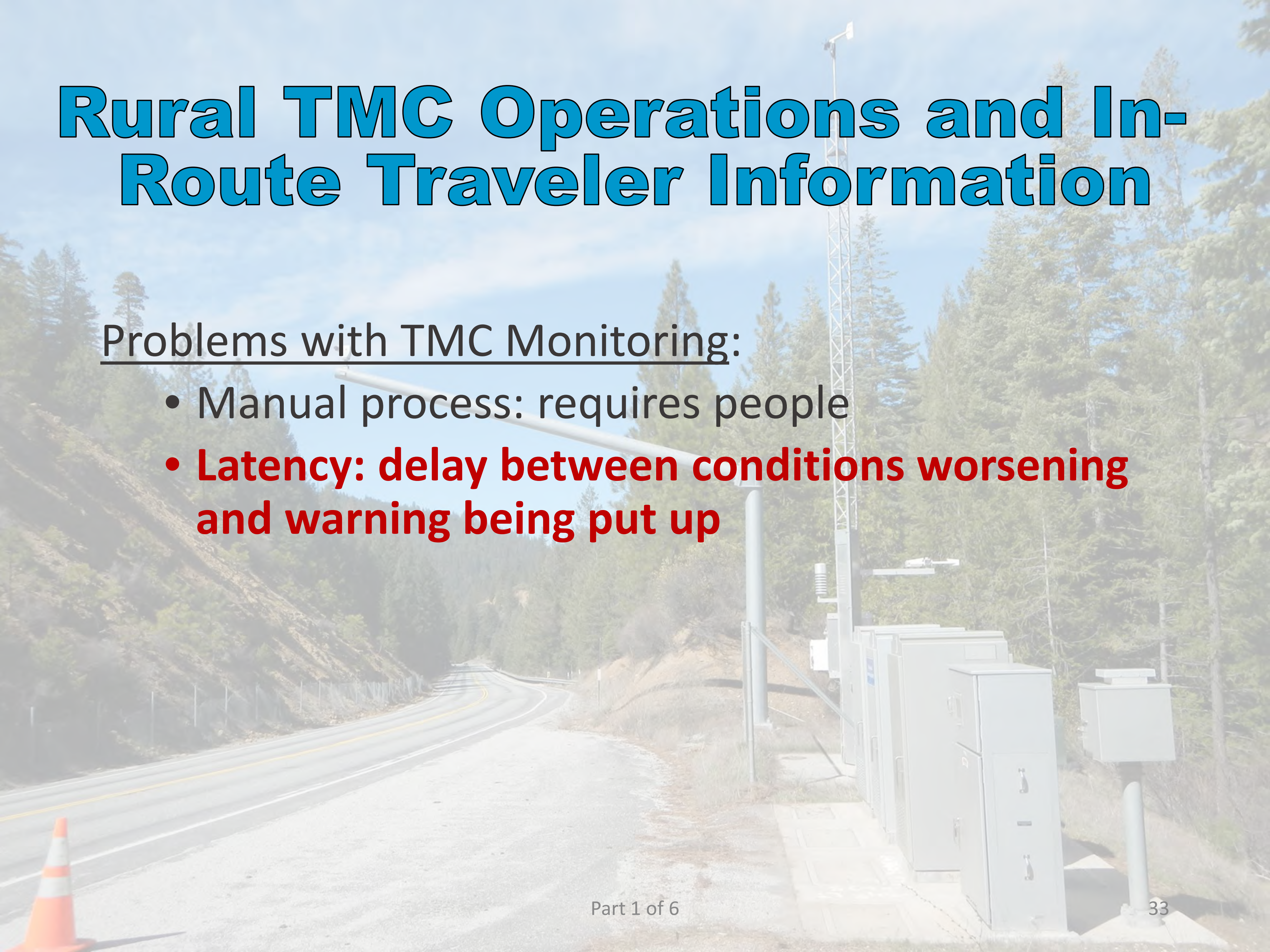
Problems with TMC Monitoring:

Rural TMC Operations and In-Route Traveler Information

<u>Problems with TMC Monitoring</u>:

- **Manual process: requires people**





Rural TMC Operations and In-Route Traveler Information

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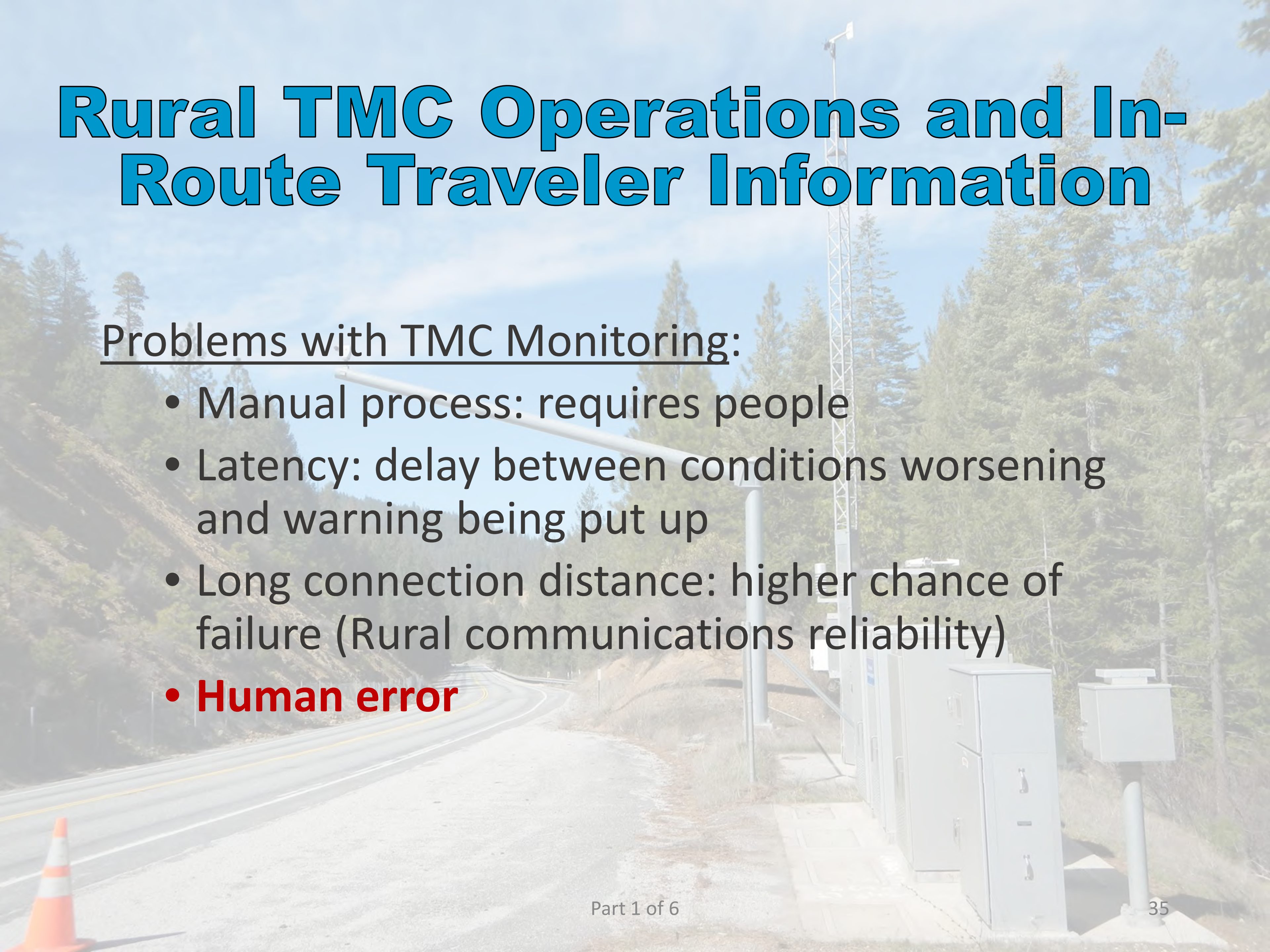
- **Long connection distance: higher chance of failure (Rural communications reliability)**



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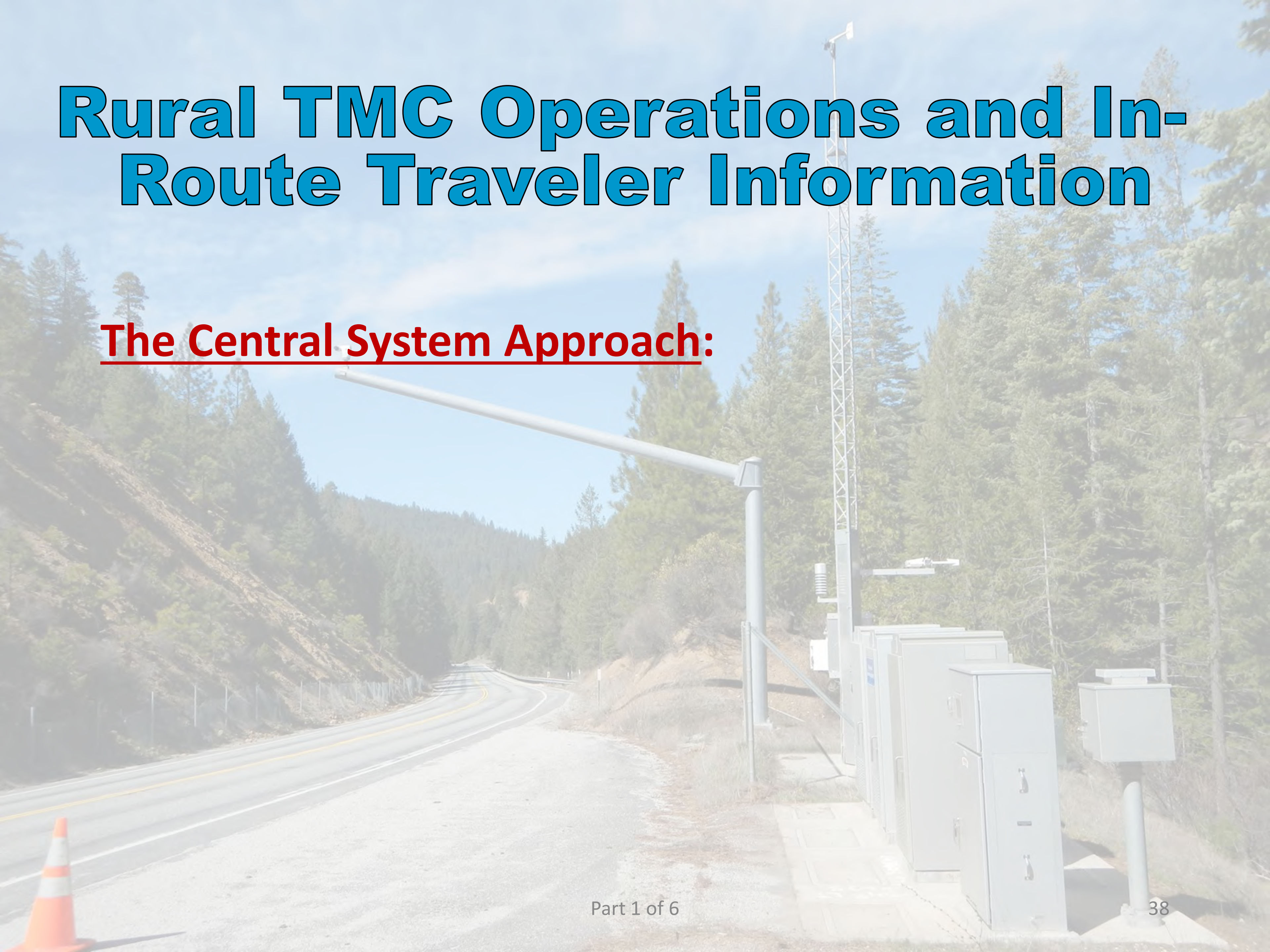
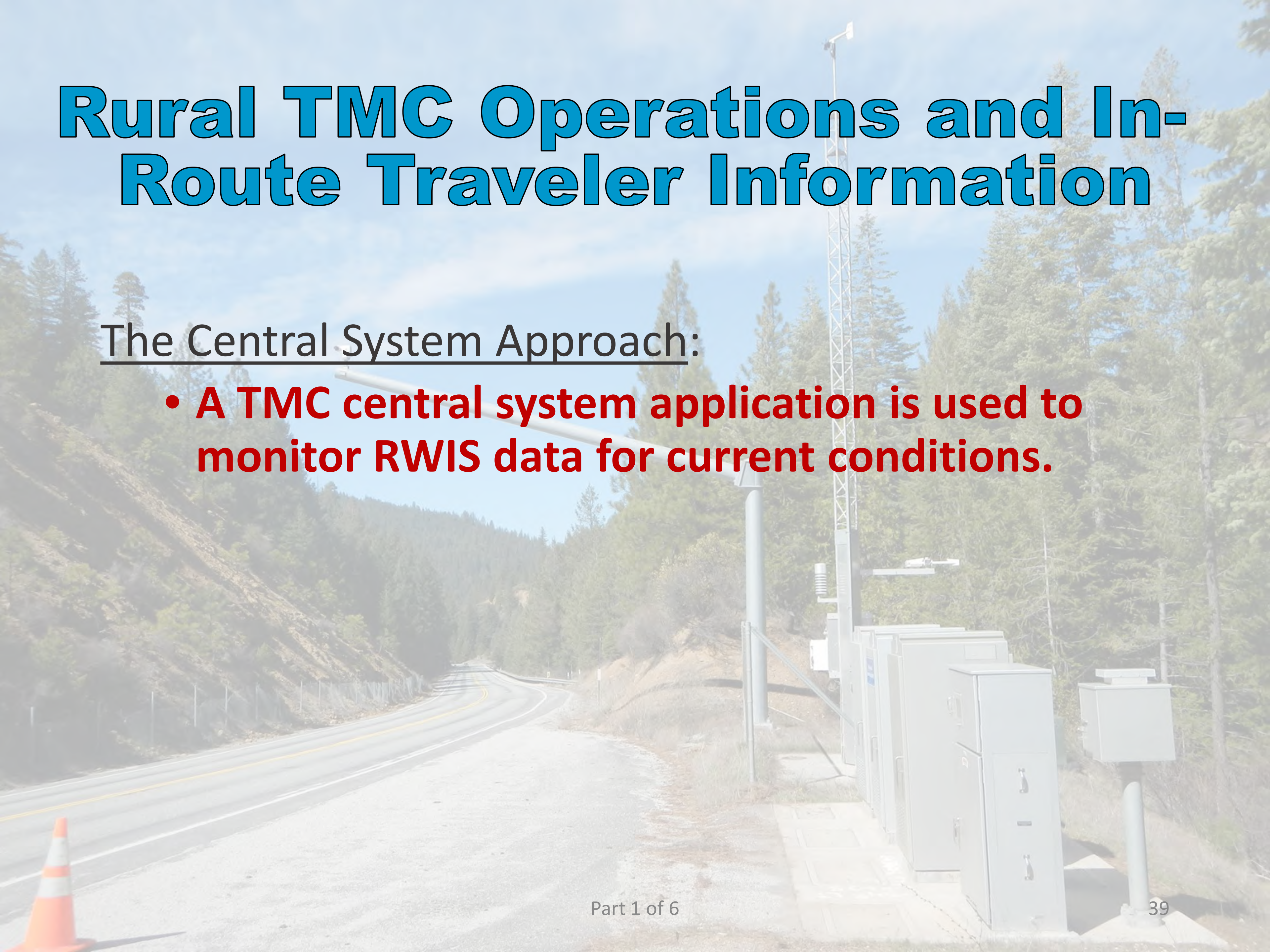
- Human error
- Off hours issues – TMC not manned 24/7
- **Process often breaks down at the warning removal step**

Rural TMC Operations and In-Route Traveler Information



The Central System Approach:



Rural TMC Operations and In-Route Traveler Information

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- **A TMC central system application is used to monitor RWIS data for current conditions.**

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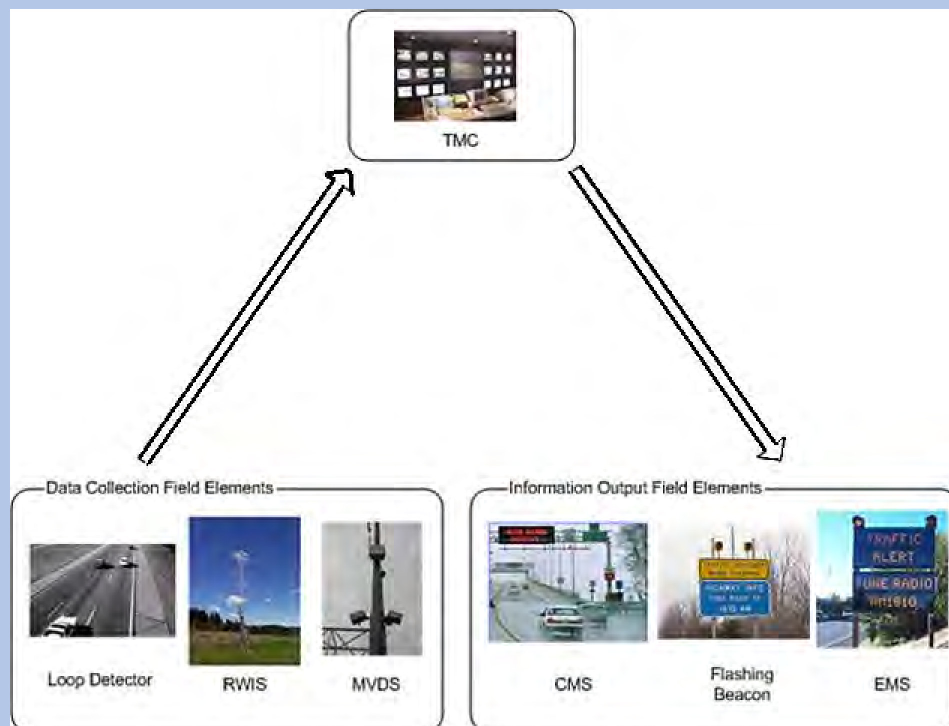
- A TMC central system application is used to monitor RWIS data for current conditions.
- The application sets warning messages and activates field elements.
- **The application monitors conditions and removes the warning when conditions improve.**

Rural TMC Operations and In-Route Traveler Information

The Central System Approach:

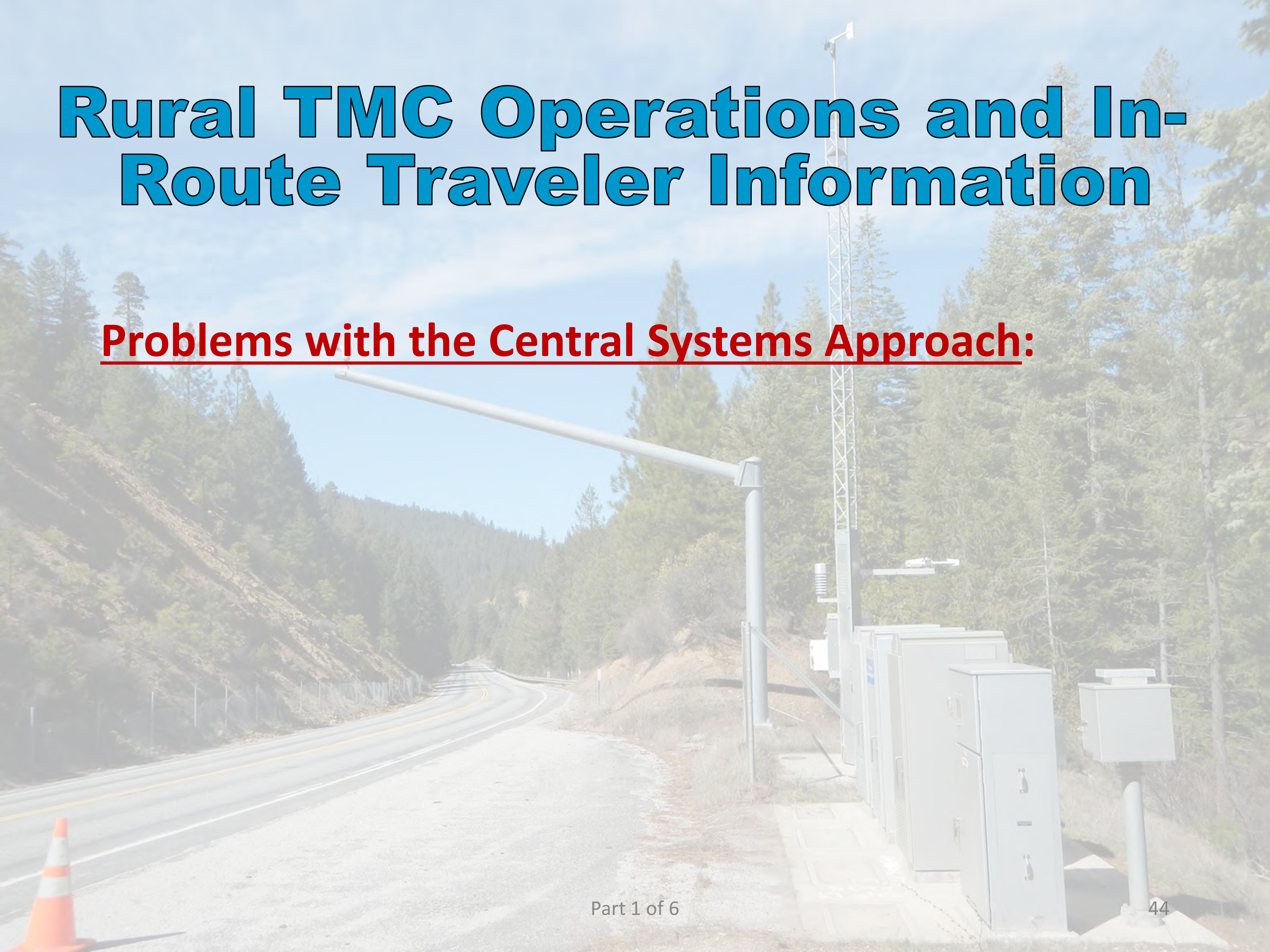
- A TMC central system application is used to monitor RWIS data for current conditions.
- The application sets warning messages and activates field elements.
- The application monitors conditions and removes the warning when conditions improve.
- **Requires a dedicated and reliable, high-bandwidth connection between the field elements and the TMC.**

Rural TMC Operations and In-Route Traveler Information



Central System Automated Warning System

Rural TMC Operations and In-Route Traveler Information



Problems with the Central Systems Approach:

Rural TMC Operations and In-Route Traveler Information

Problems with the Central Systems Approach:

- **A dedicated and reliable high-bandwidth connection between the field elements and the TMC is often unavailable in remote rural locations.**

Rural TMC Operations and In-Route Traveler Information

Can we automate this process in the field?

Rural TMC Operations and In-Route Traveler Information

Can we automate this process in the field?

We can and we have!

Fredonyer Icy-Curve Warning System

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- **History at Fredonyer – It's Complicated!**

Fredonyer Icy-Curve Warning System

- History at Fredonyer – It's Complicated!
- **See Ken Beals' detailed analysis, "A Tale of Two RWIS".** http://www.westernstatesforum.org/PastForums/2008/Default.html

Fredonyer Icy-Curve Warning System

- Current version of the architecture commissioned in 2006.

Fredonyer Icy-Curve Warning System

- Current version of the architecture commissioned in 2006.
- **Similar site conditions to Spring Garden.**

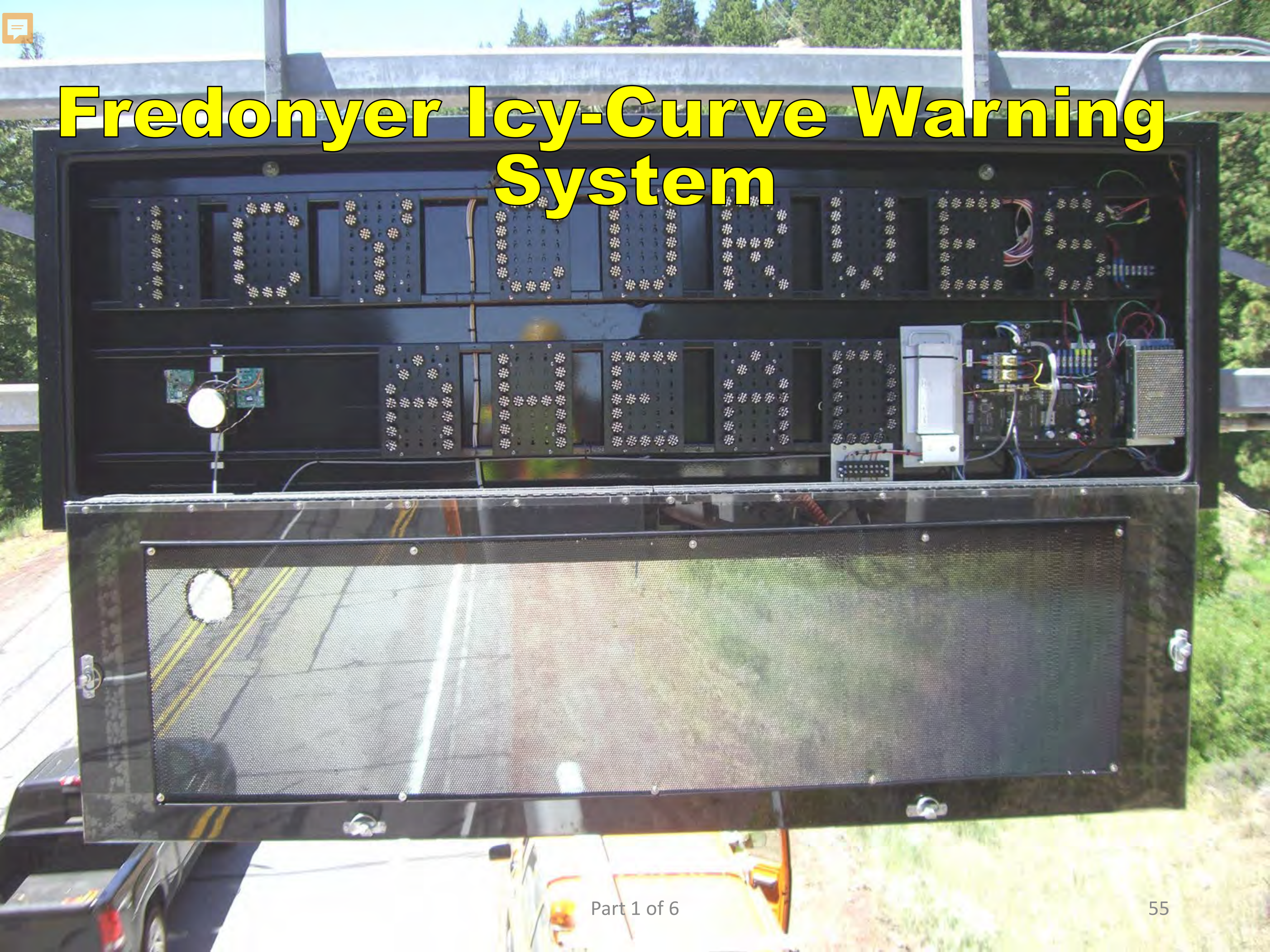
Fredonyer Icy-Curve Warning System

- **2011 study indicates an 18% reduction in crashes.**
- Veneziano (2011) - "Evaluation of the Fredonyer Pass Icy Curve Warning System"

Fredonyer Icy-Curve Warning System

- So why not duplicate the architectural model of Fredonyer at Spring Garden?

Fredonyer Icy-Curve Warning System



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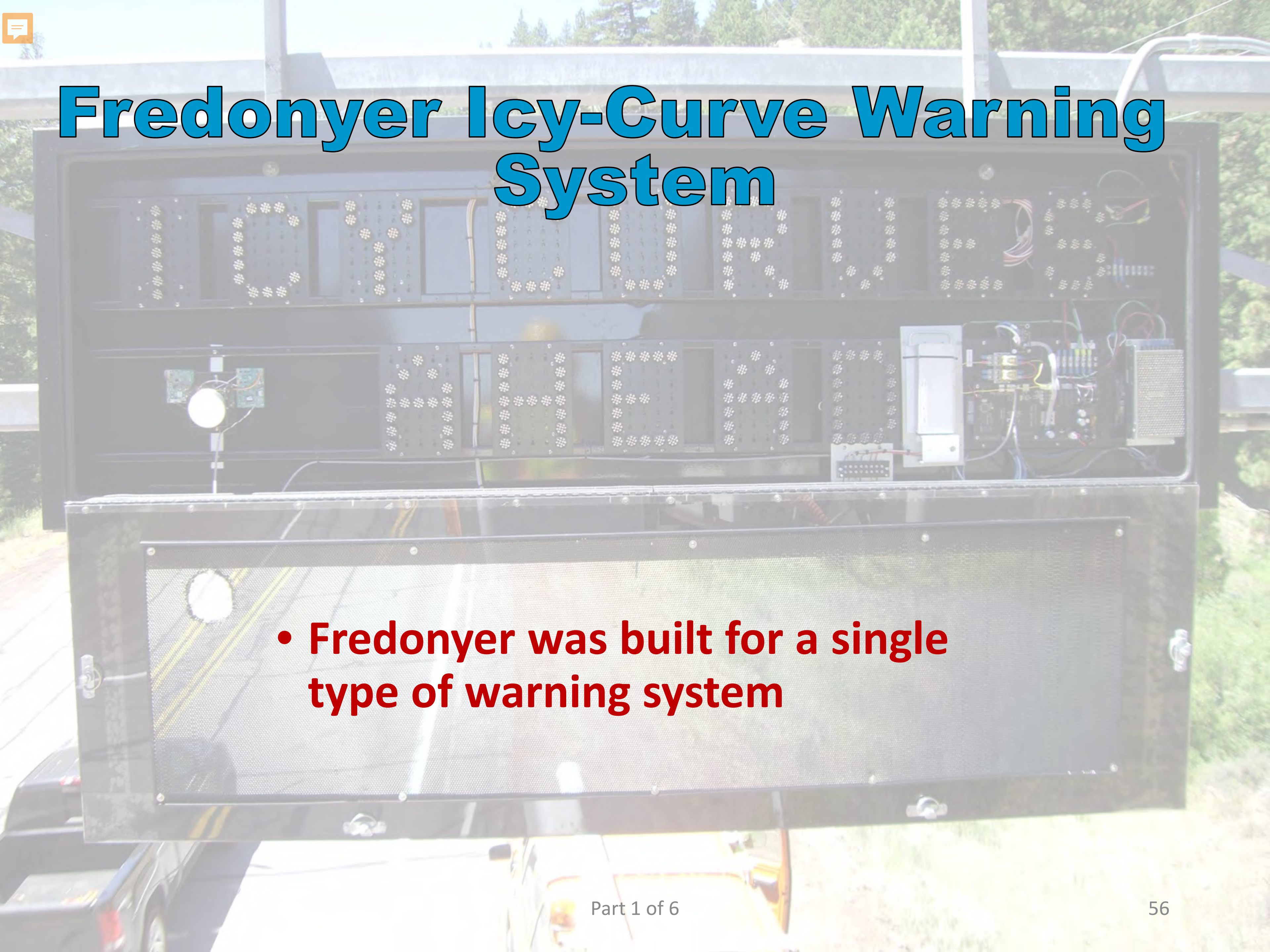
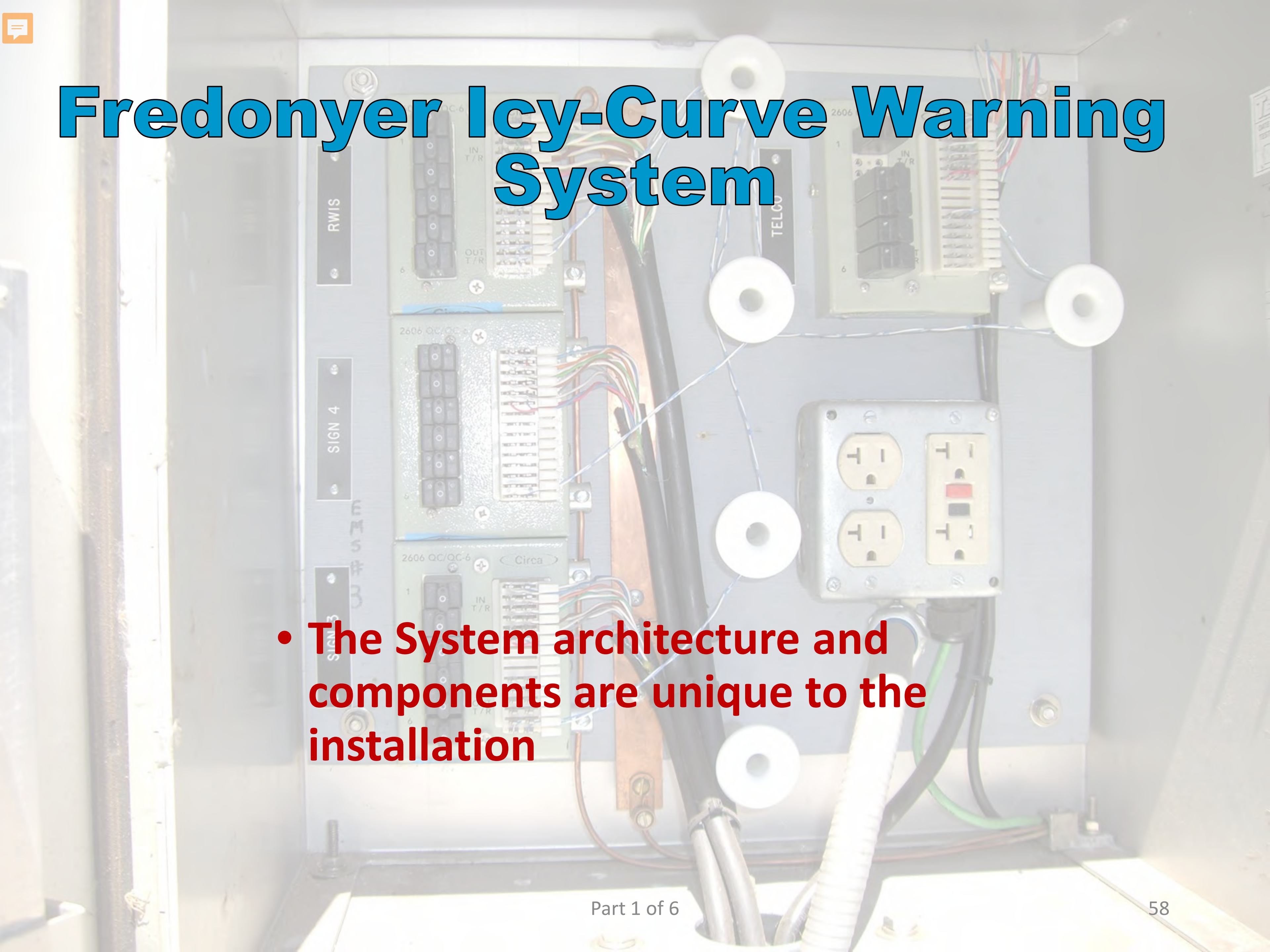


- Fredonyer was built for a single type of warning system

Fredonyer Icy-Curve Warning System

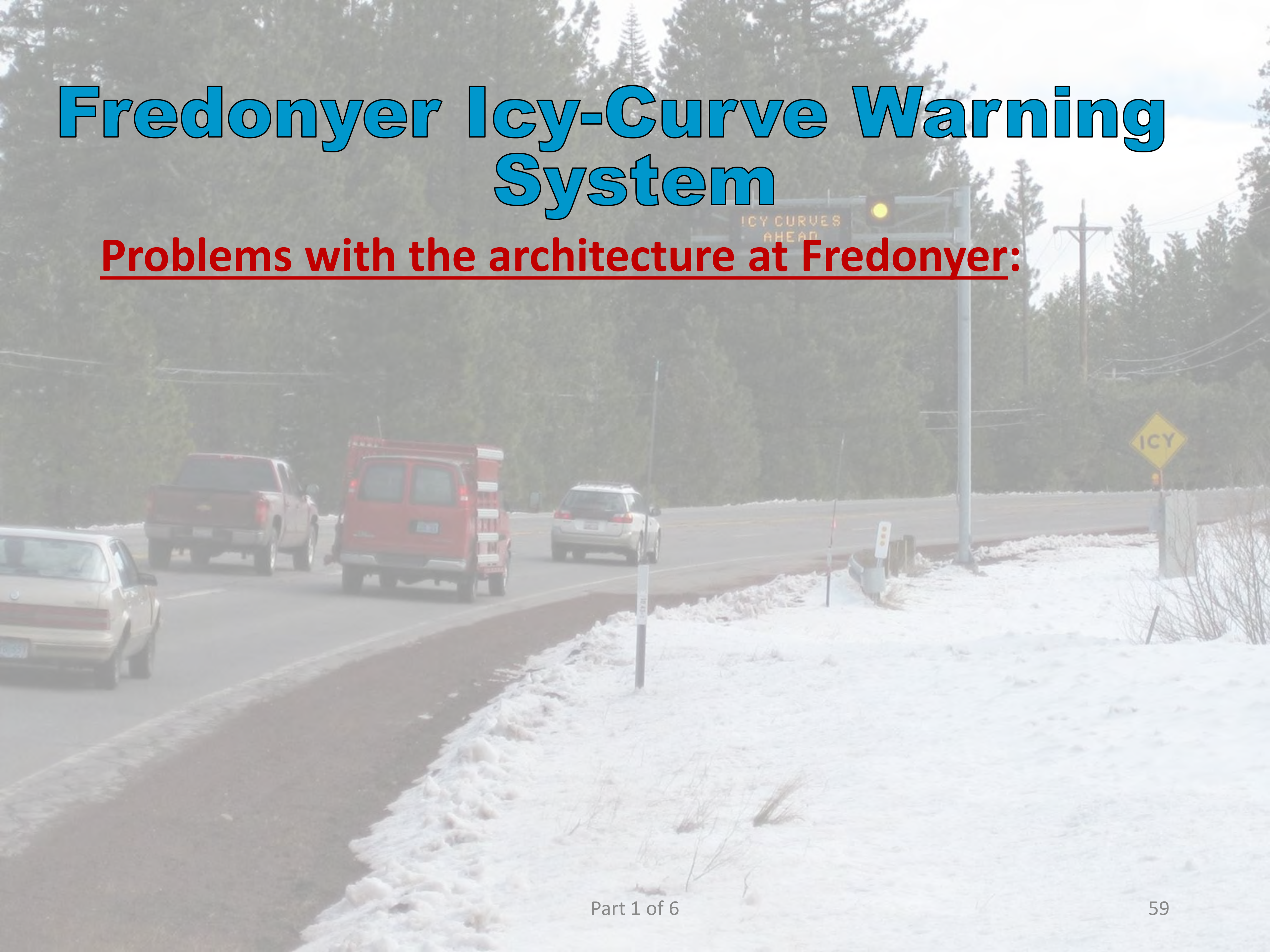
Fredonyer Icy-Curve Warning System



- The System architecture and components are unique to the installation

Fredonyer Icy-Curve Warning System

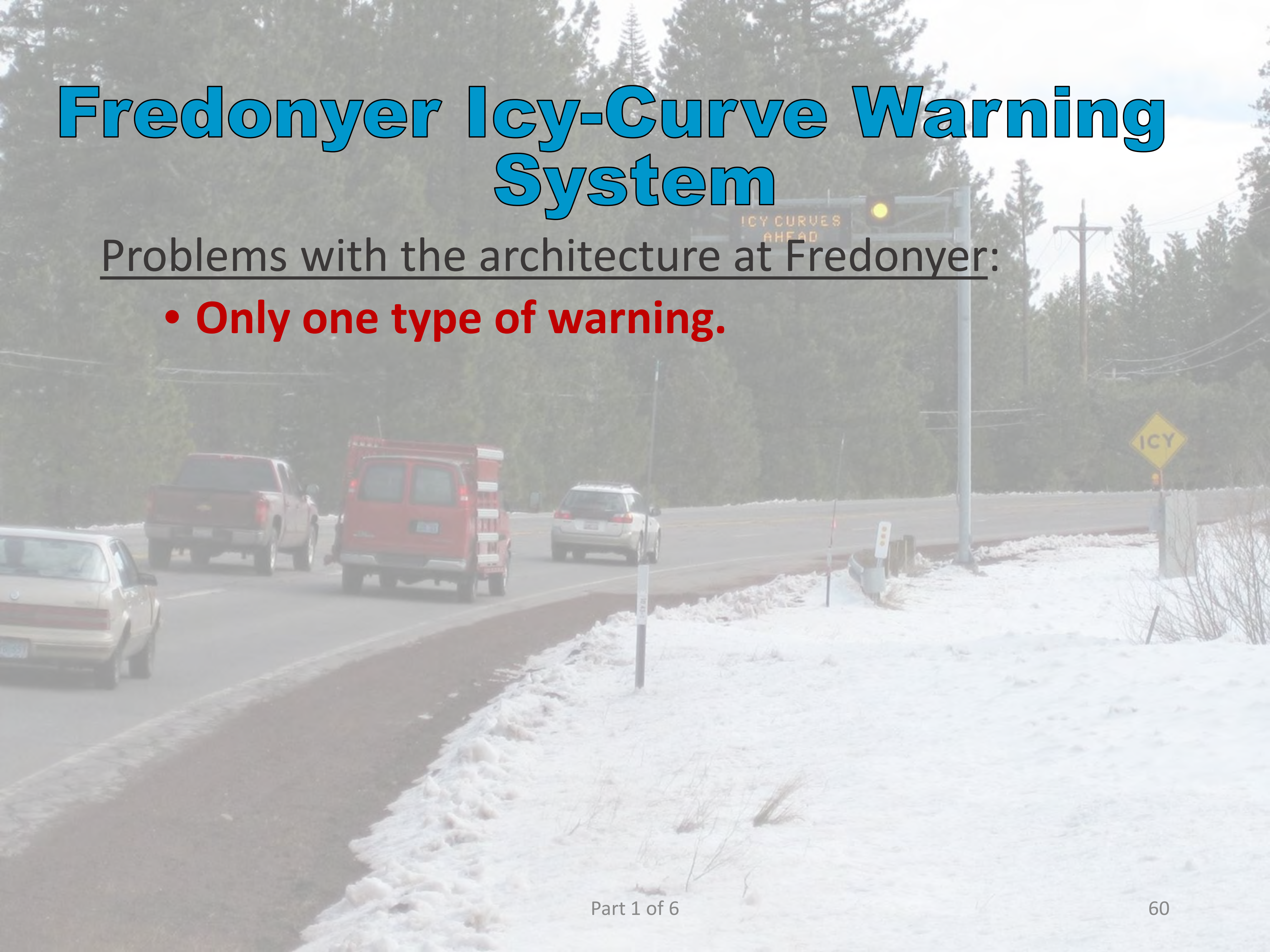
Problems with the architecture at Fredonyer:



Fredonyer Icy-Curve Warning System

Problems with the architecture at Fredonyer:

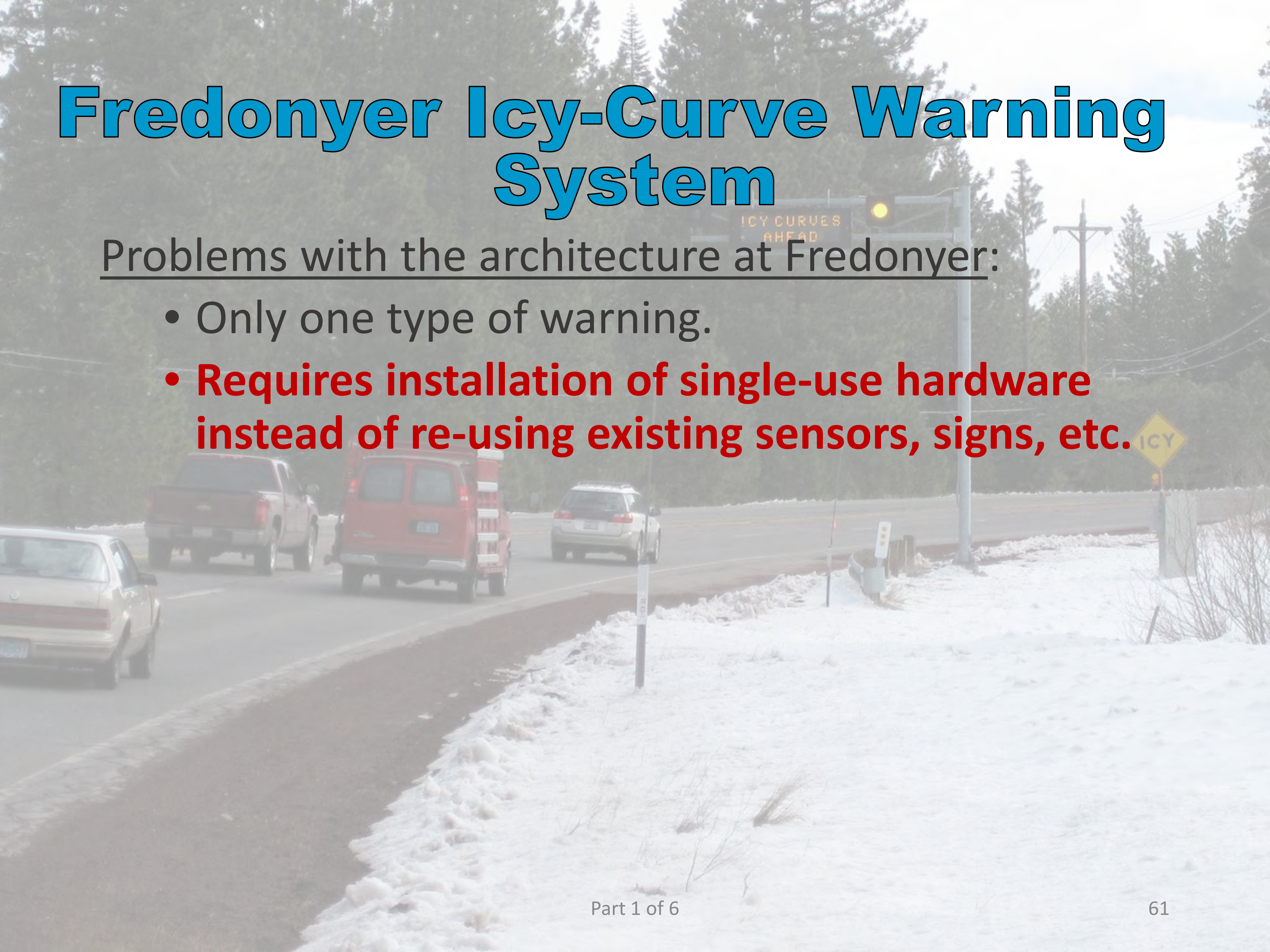
- **Only one type of warning.**



Fredonyer Icy-Curve Warning System

Problems with the architecture at Fredonyer:

- Only one type of warning.
- **Requires installation of single-use hardware instead of re-using existing sensors, signs, etc.**



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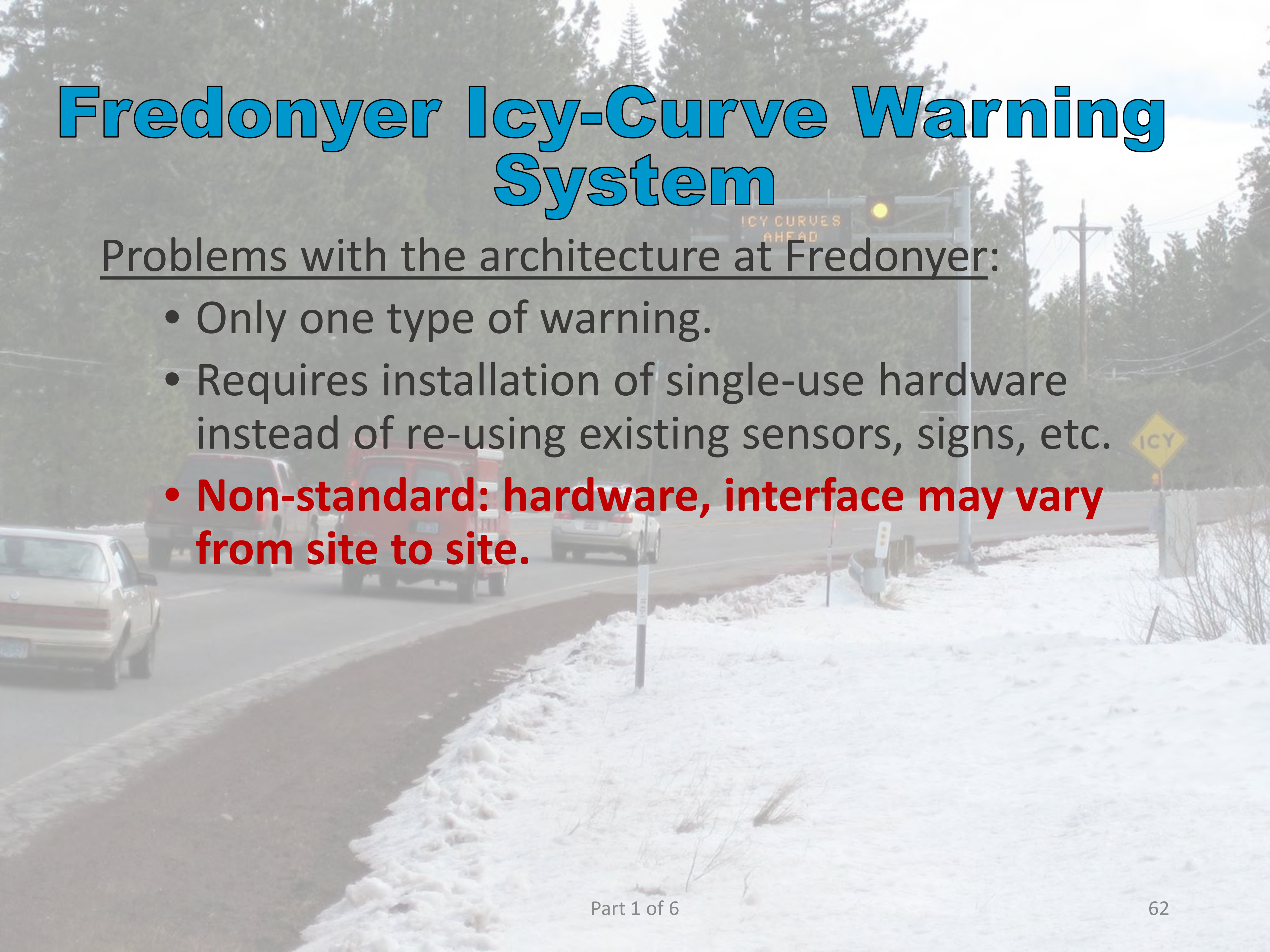

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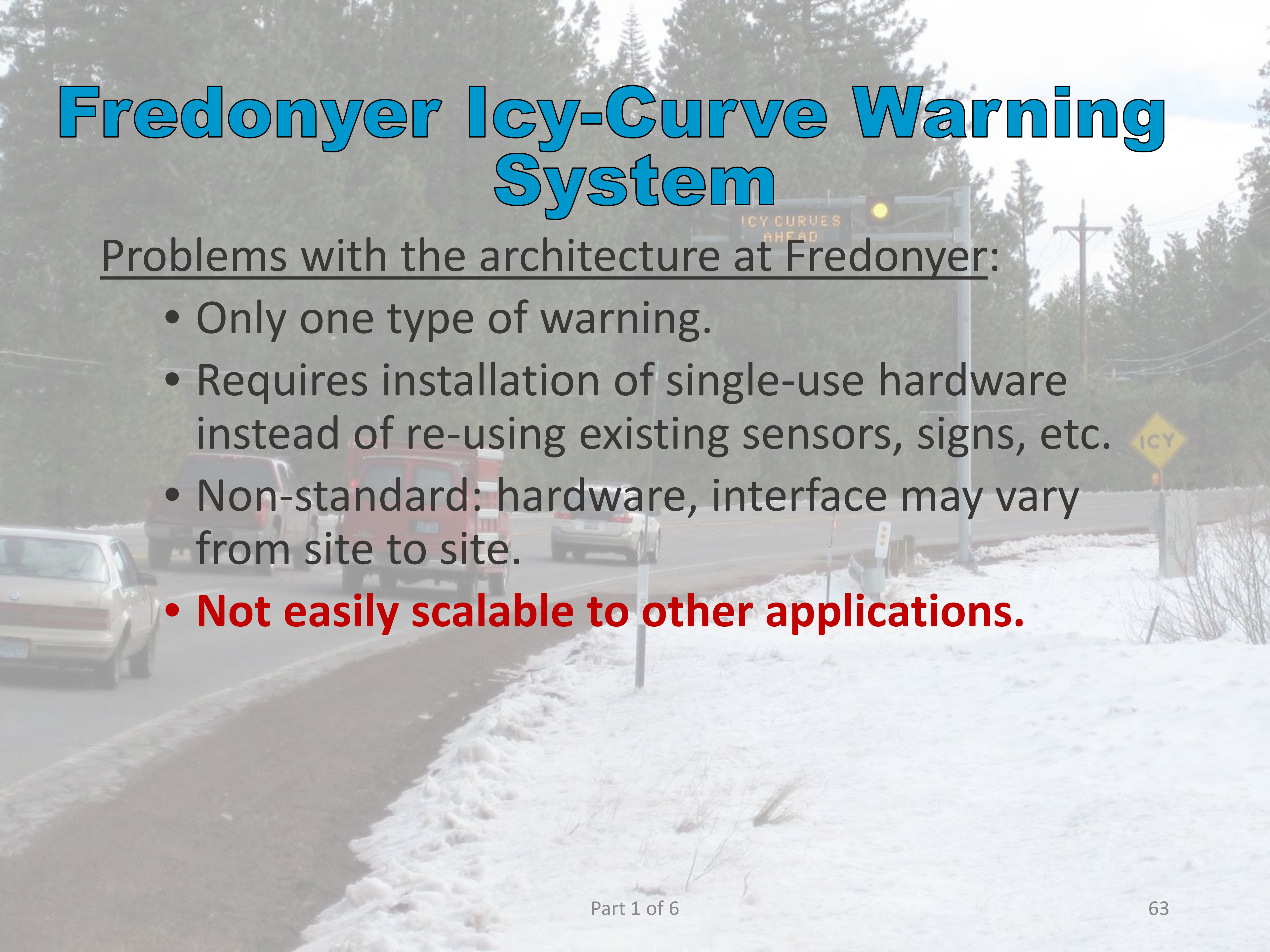

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- Not easily scalable to other applications.
- **Interoperability and integrating obsolete equipment replacements.**

Now What?

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What we need is a field controller that:

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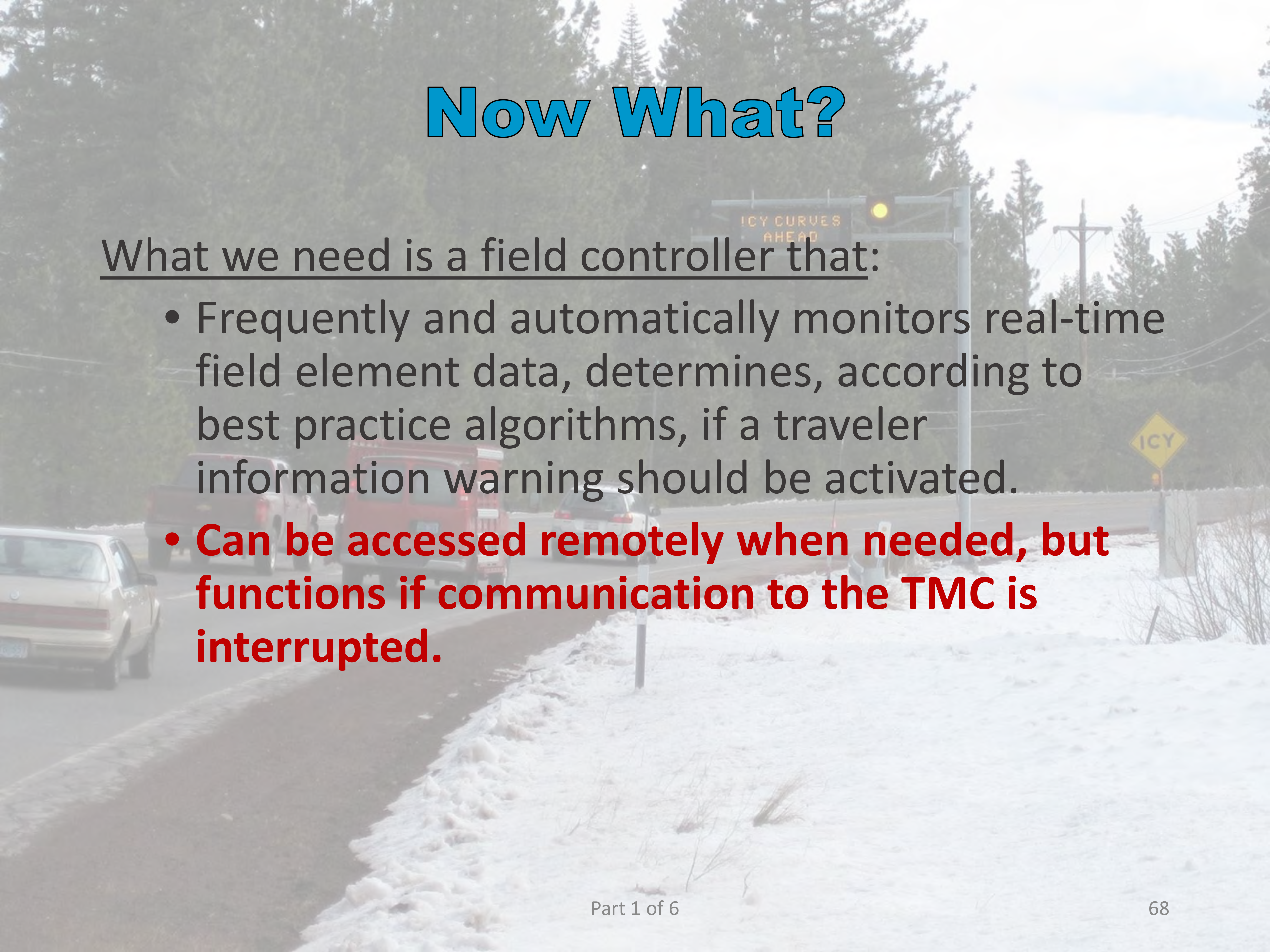
- **Frequently and automatically monitors real-time field element data, determines, according to best practice algorithms, if a traveler information warning should be activated.**



Now What?

What we need is a field controller that:

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- **ITS Elements can be used by the TMC when the Controller is not in a warning condition.**

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- Can be accessed remotely when needed, but functions if communication to the TMC is interrupted.
- ITS Elements can be used by the TMC when the Controller is not in a warning condition.
- **Is a standard form factor familiar to Caltrans Electrical Maintenance crews.**

The Automated Safety Warning System Controller (ASWSC)

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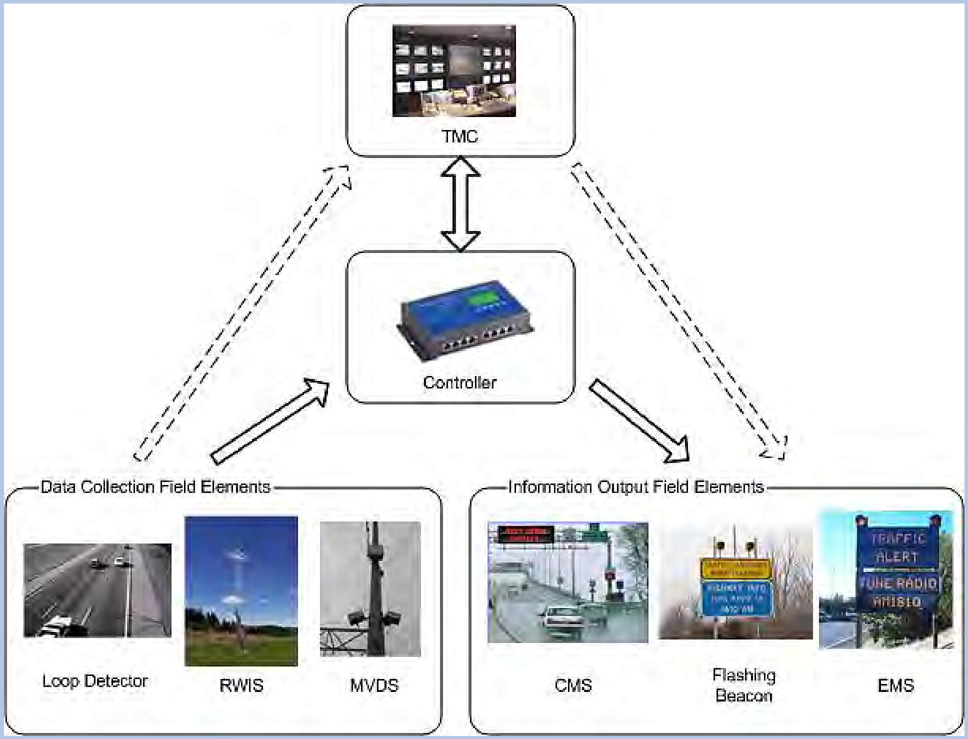

ASWSC System Architecture

The Automated Safety Warning System Controller (ASWSC)

- **A research project was initiated with the Western Transportation Institute (WTI) at Montana State University.**

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The Automated Safety Warning System Controller (ASWSC) Test Bed

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- **Doug...**

The Automated Safety Warning System Controller (ASWSC)

- References
  - "A Tale of Two RWIS", Ken Beals (2008). http://www.westernstatesforum.org/PastForums/2008/Default.html
  - "Evaluation of the Fredonyer Pass Icy Curve Warning System", David Veneziano (2011).
  - "Automated Safety Warning System Controller", Ed Lamkin and Ian Turnbull (2010).
- Photos Courtesy Of,
  - Ian Turnbull
  - Doug Galarus
  - Dan Richter
  - Ken Beals
  - Jeff Worthington
  - District 2 ITS Engineering and Support
  - District 2 Traffic Safety
  - Google Maps
  - Google Street View
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