

# Smart Investing: The Roadway Safety Portfolio

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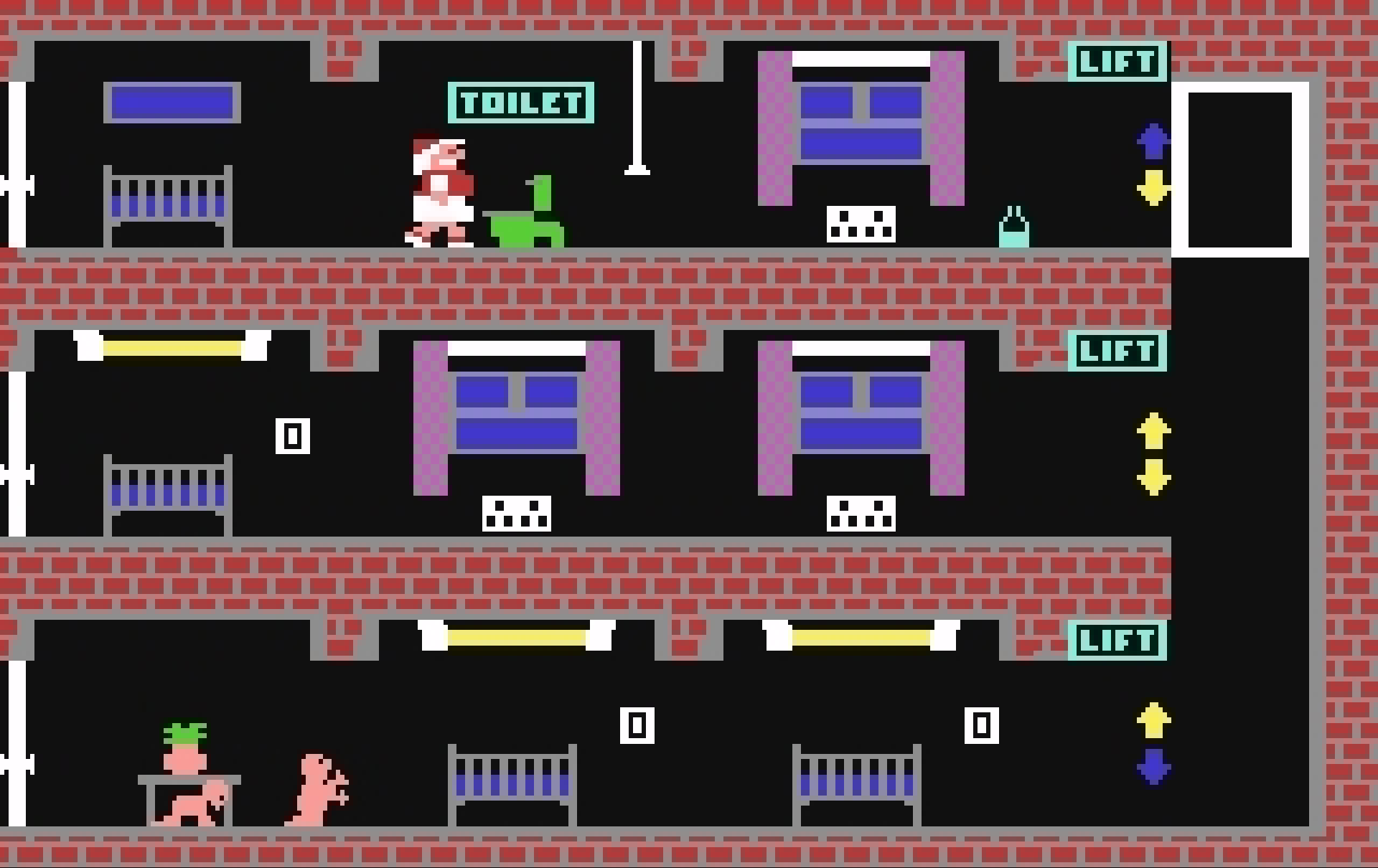
1234

# MAD



# NURSE





BABIES 03

SCORE 0

GAS 03

KEYS

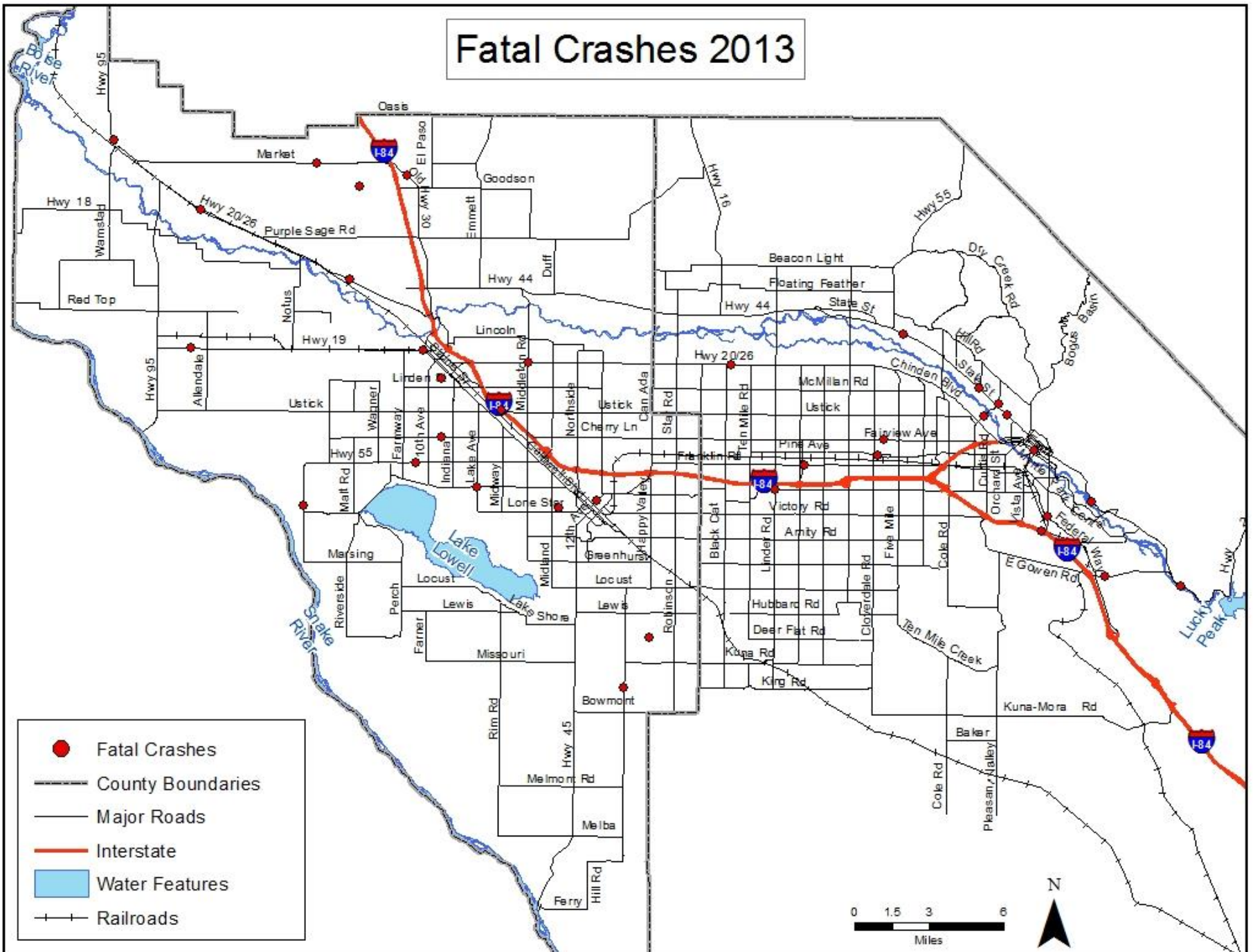
QUIET

SOUND

EXIT

PAUSE

# Fatal Crashes 2013



# Most Common Elements in Fatalities

## *Ada & Canyon Counties*

<u>2009</u>	<u>2010</u>	<u>2011</u>	<u>2012</u>	<u>2013</u>
Intersections	Run Off Road	Intersections	Intersections	Intersections
Aggressive	Aggressive	Aggressive	Aggressive	Aggressive
Impaired	Impaired	Run Off Road	Impaired	Impaired

*Note: Top 3 common elements each year. Not listed in 1-2-3 order*

# fatal crash locations

are

random



fatal crash types are **predictable**





**focus on the predictable**



# The Roadway Safety Portfolio

## 1. Current Safety Solutions: Systemic Approach

- Run Off Road Crash Treatments
- Intersection Treatments

## 2. Traffic Safety Culture

- Within Transportation Agencies
- Road User Behavior

## 3. Technological Advances

- Connected Vehicles
- Autonomous Vehicles

# Run Off Road

»» Systemic Solutions

# How to reduce run-off-road crashes

1

- Keep Vehicle on Road

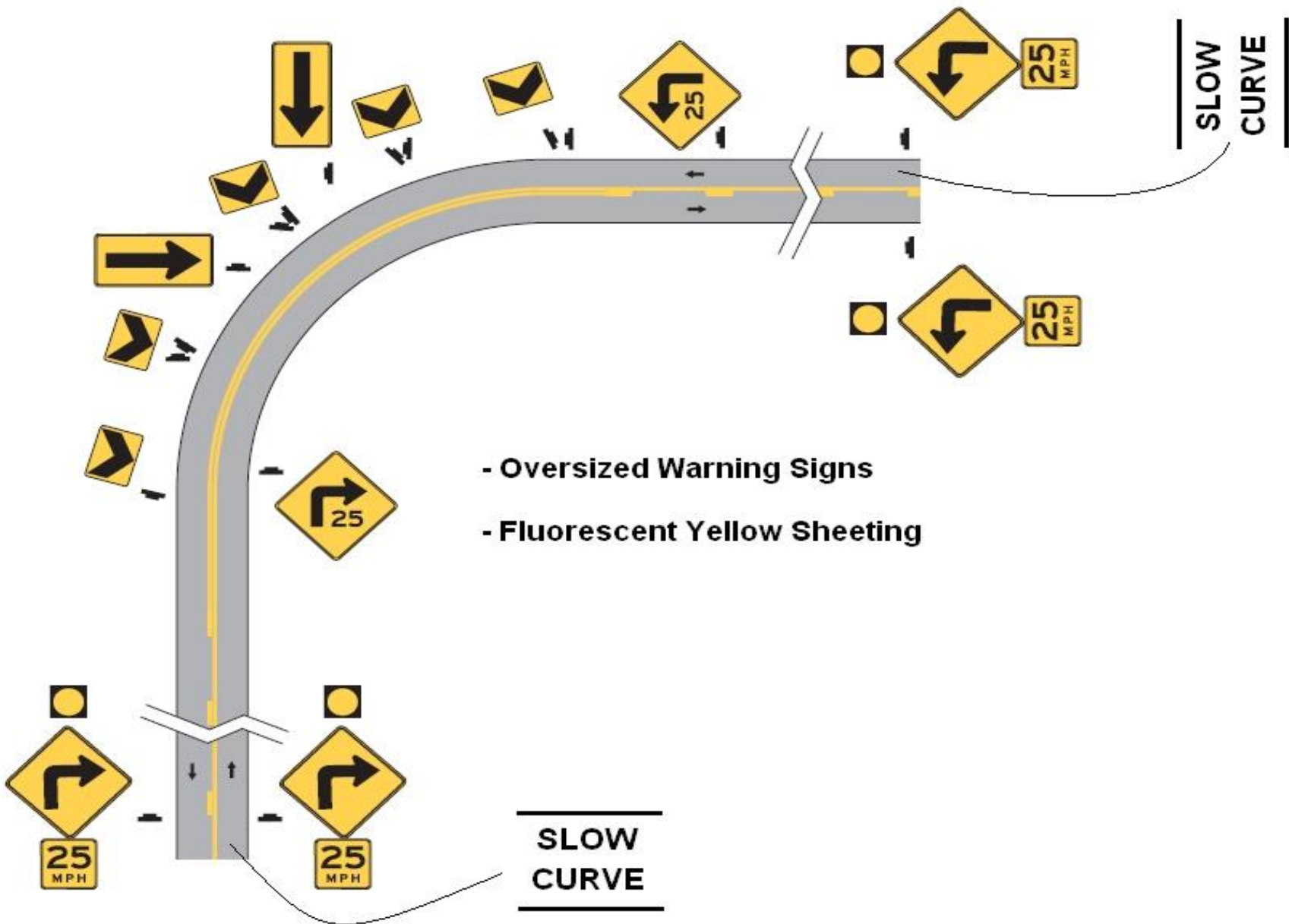
2

- Safe Recovery

3

- Reduce Severity

# Curve sign and marking enhancements



# Basic Curve Warning Sign



# Chevrons



# Advanced Curve Pavement Marking



# Advanced Signing with Beacons





# Centerline Rumble Strips

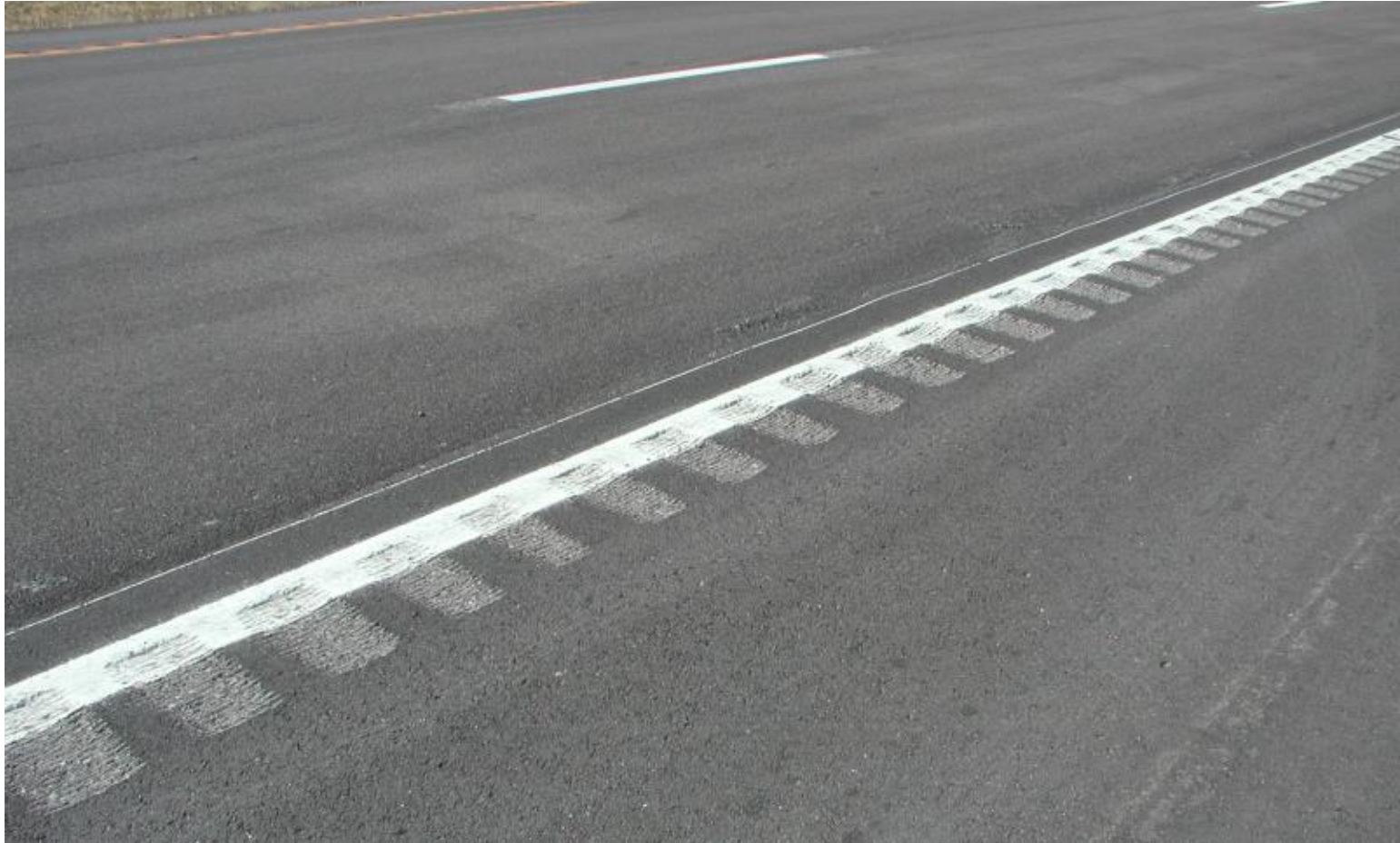
1. **Centerline rumble strips extend into the travel lane-most common**
2. **Centerline rumble strips within pavement markings**
3. **Centerline rumble strips beyond pavement markings**



# Shoulder Rumble Strips



# Edge Line Rumble Stripes



# Safety Edge<sub>SM</sub>



*Georgia DOT Safety Wedge Hardware.*

# Raised Pavement Markers



# Guardrail Delineation



# Barrier Delineation



# High Friction Surface Treatment

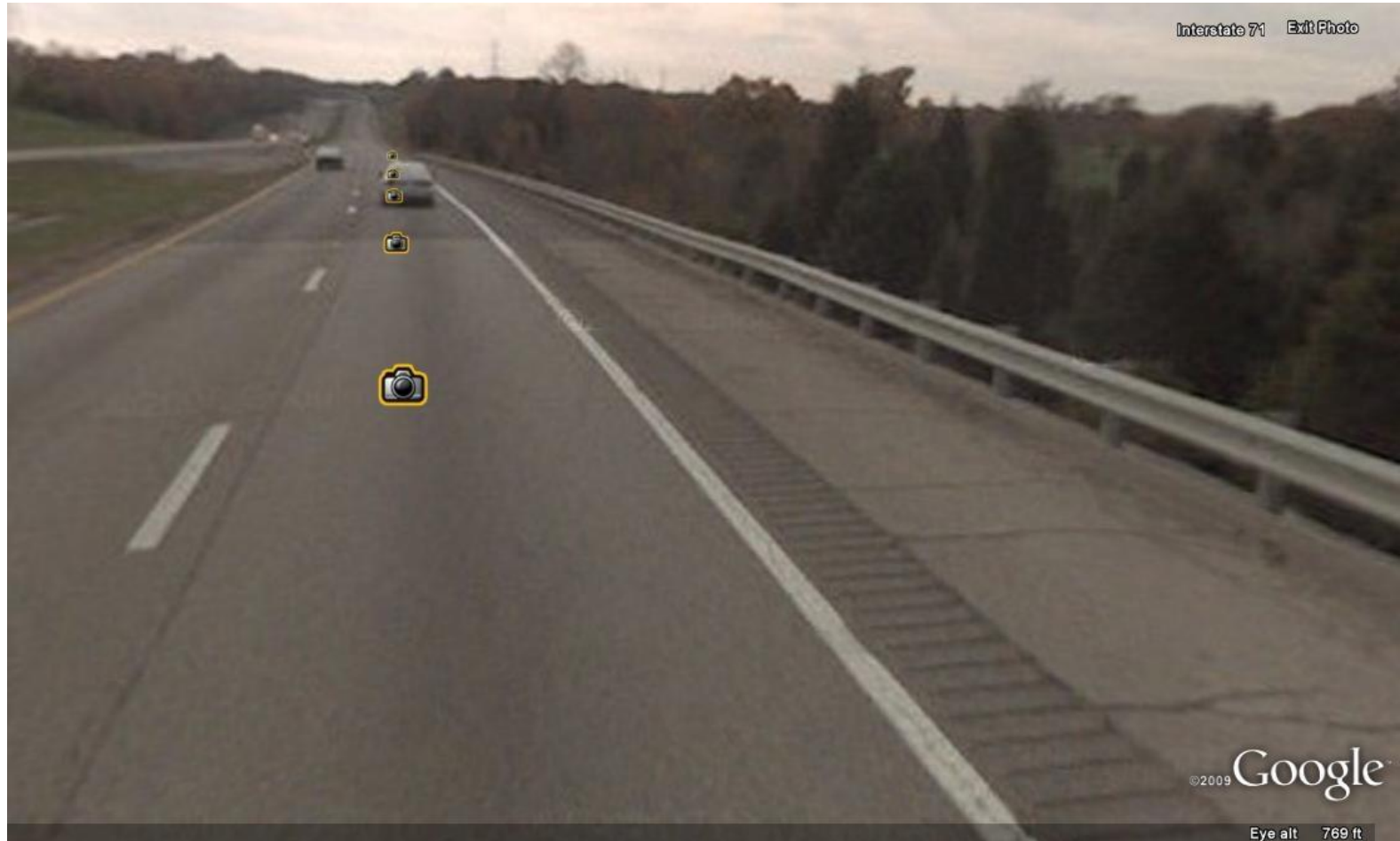




# Cable Median Barrier



# Guardrail Crashes



# Tree Removal



# Utility Poles Relocated or Removed



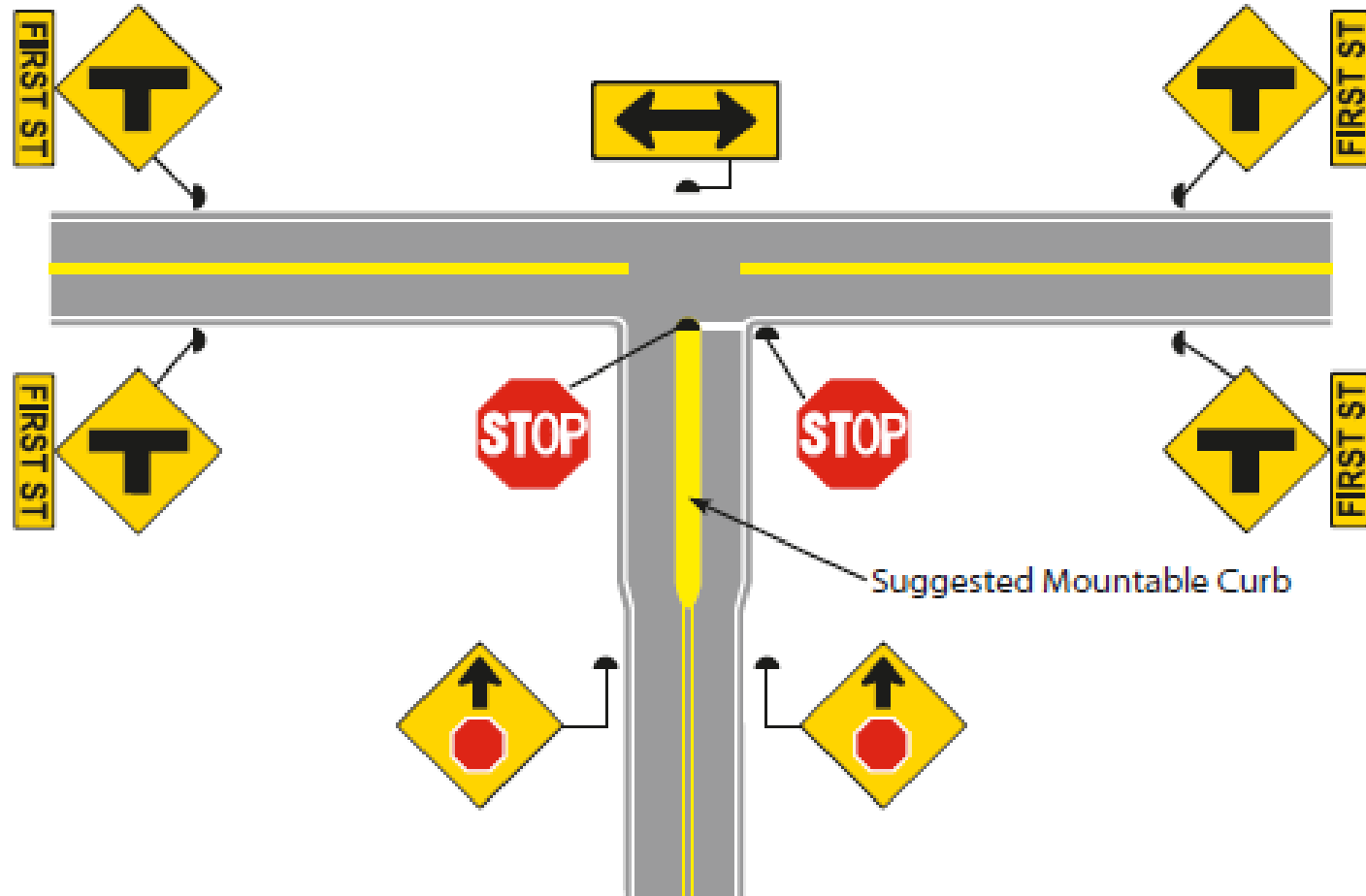
# Unsignalized Intersections

» Systemic Solutions

# How to get hurt at a stop-controlled intersections

1. Run a stop sign
2. Pull out in front of someone after stopping
3. Other driver does 1 or 2

# Basic Sign and Marking Improvements



# Raised Splitter Island on the Approach





# Flashing Solar Powered LED Beacon



# Flashing Overhead Intersection Beacon



# Thru Approach Activated Warning System



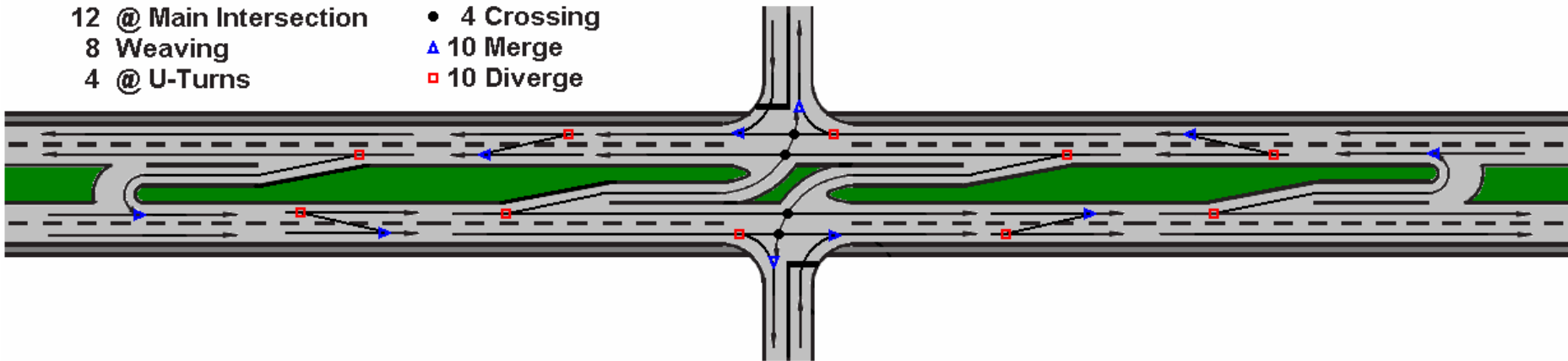
# Retroreflective Sign Posts



# J-Turn Modifications on High-Speed Divided Arterials

## 24 Total J-Turn Conflict Points

- |                        |              |
|------------------------|--------------|
| 12 @ Main Intersection | • 4 Crossing |
| 8 Weaving              | ▲ 10 Merge   |
| 4 @ U-Turns            | ◻ 10 Diverge |



# Signalized Intersections

» Systemic Solutions

## How to get hurt at a traffic signal...

1. Run a red light
2. Make a left turn in front of oncoming traffic
3. Other driver does 1 or 2

# Countermeasures for Systemic Deployment

1. Stop red light running
2. Stop left turn crashes



# How to stop red light running

1. **Conspicuity**
2. Signal Timing
3. Enforcement

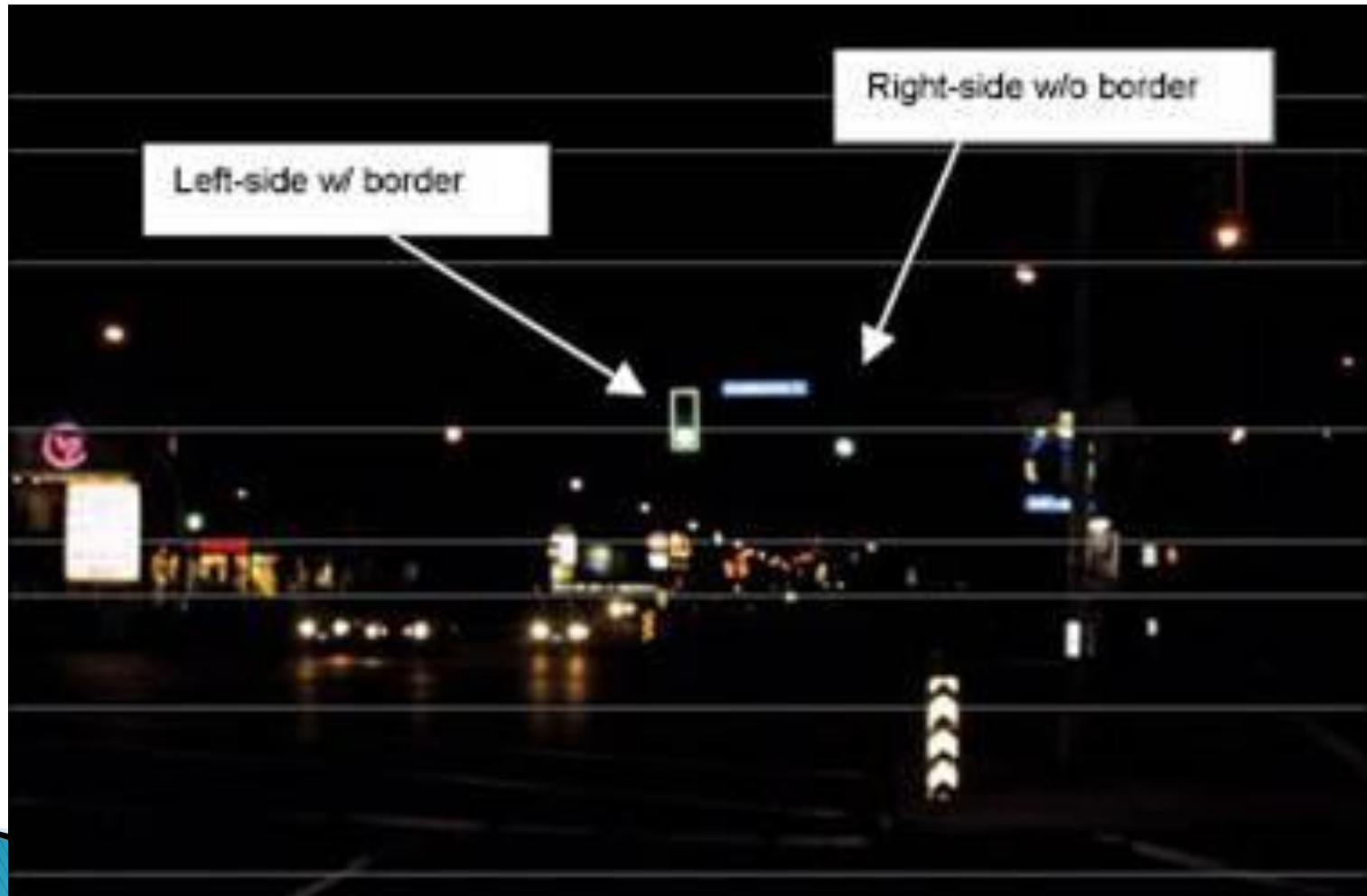
# 12-inch Heads, One Signal Head per Lane, and Back Plates



# Retroreflective Back Plates (Daylight)



# Retroreflective Back Plates (Night)



# Advance “Signal Ahead” Warning Sign



**Actuated versions – connected to signal timing**



# Advance Cross Street Name Signs



# Supplemental Signal Face per Approach



# Late Night Flash

- ▶ Eliminate late night flashing operations
  - Especially Red-on-mainline, Yellow-on-side-street



# How to stop red light running

1. Conspicuity
- 2. Signal Timing**
3. Enforcement

# Clearance Interval Equations: NCHRP 731

$$Y = t + \frac{1.47V}{2a + 64.4g}$$

$$R = \frac{W + L}{1.47V} - 1$$

Where:

t = PRT (s),

a = deceleration rate (ft/s<sup>2</sup>),

V = 85th percentile approach speed (mph),

g = approach grade (percent divided by 100, negative for downgrade),

W = intersection width measured from the back edge of the approaching movement stop line to the far side of the intersection as defined by the extension of the curb line or outside edge of the farthest travel lane (ft), and

L = length of vehicle (ft).

## Signal Timing – Coordination

- ▶ Fewer stops = fewer opportunities to run red lights

# How to stop red light running

1. Conspicuity
2. Signal Timing
3. **Enforcement**

# Automated Red-Light Enforcement



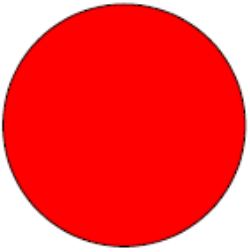
# Enforcement-Assisted Lights



# Change of Permitted and Protected Left-Turn Phase to Protected-Only



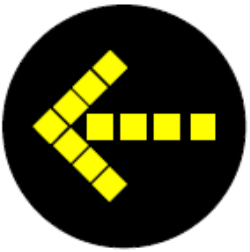
# Flashing Yellow Arrow



A solid red light means STOP. Drivers turning left must stop and wait.



A solid yellow arrow warns drivers that the left-turn signal is about to go to red and they should prepare to stop, or prepare to complete their left turn if they are within the intersection.



A flashing yellow arrow means turns are permitted, but you must first yield to oncoming traffic and pedestrians and then proceed with caution. Oncoming traffic has a green light.



A solid green arrow means it is safe to turn left. Oncoming traffic must stop.



# Traffic Safety Culture

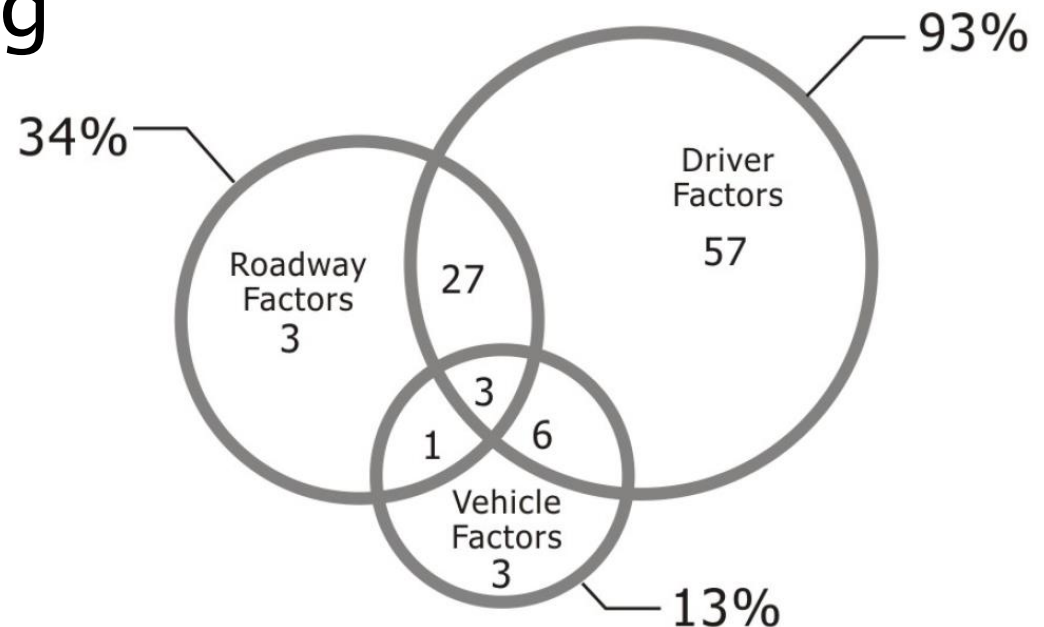
»» Transportation Agencies &  
Road Users

# Agency Safety Culture: Policies

- ▶ Outlasts individuals
  - ▶ Project → Program → Policy
  - ▶ Expand effective strategies to jurisdiction-wide policy and standard plans.
- 
- ▶ Example: Rumble Strips
    - **Project**            Try it once on a section of roadway
    - **Program**           Add to Rwd Implementation Plan
    - **Policy**             Rumble strips considered on every project (using regular funding)

# Safety Culture: Road User Behavior

- ▶ I am the weakest link
  - *Seriously. Me. Literally.*
- ▶ Safety Belts
- ▶ Impaired Driving



# Safety Culture: Mode Split

- ▶ Ped–Ped Fatalities: zero
- ▶ Bike–Ped Fatalities: near–zero
- ▶ Bike–Bike Fatalities: near–zero

# Technology Solutions

»» Connection & Automation

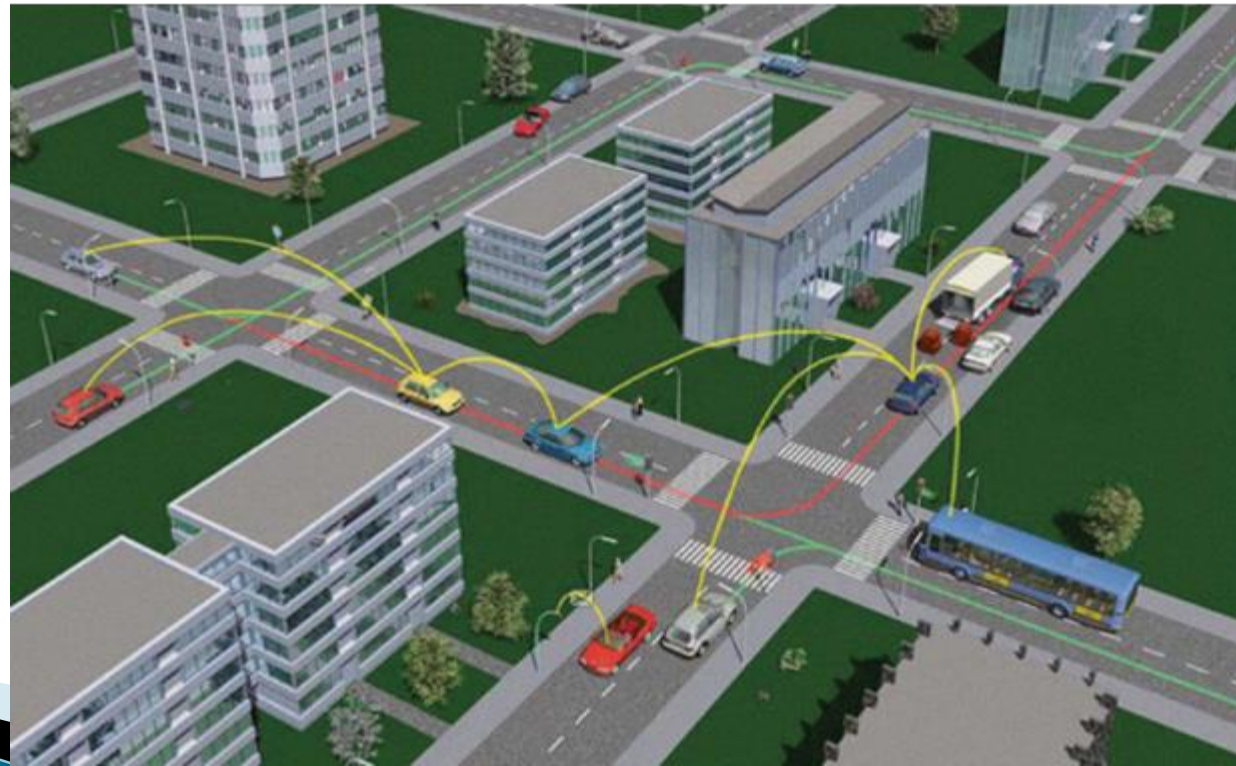
# Eliminate the Weakest Link

- ▶ Connected Vehicles
- ▶ Autonomous Vehicles

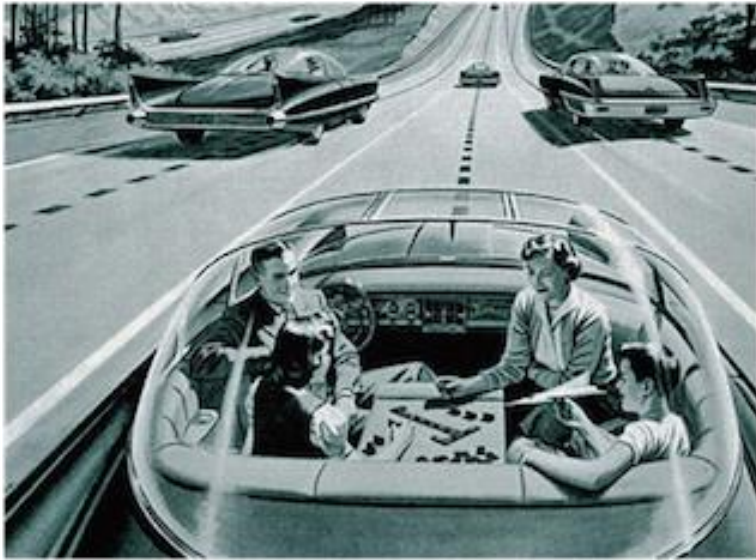


# Connected Vehicles

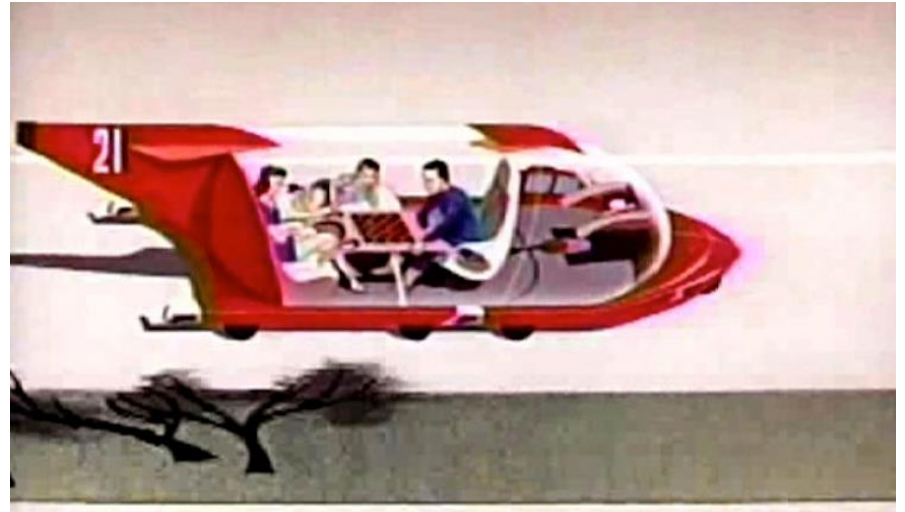
- ▶ Vehicle-to-Vehicle (V2V)
- ▶ Vehicle-to-Infrastructure (V2I)
- ▶ Vehicle-to-Pedestrian (V2P)



# Autonomous Vehicles



**1939**



**1958**



# Autonomous Vehicles

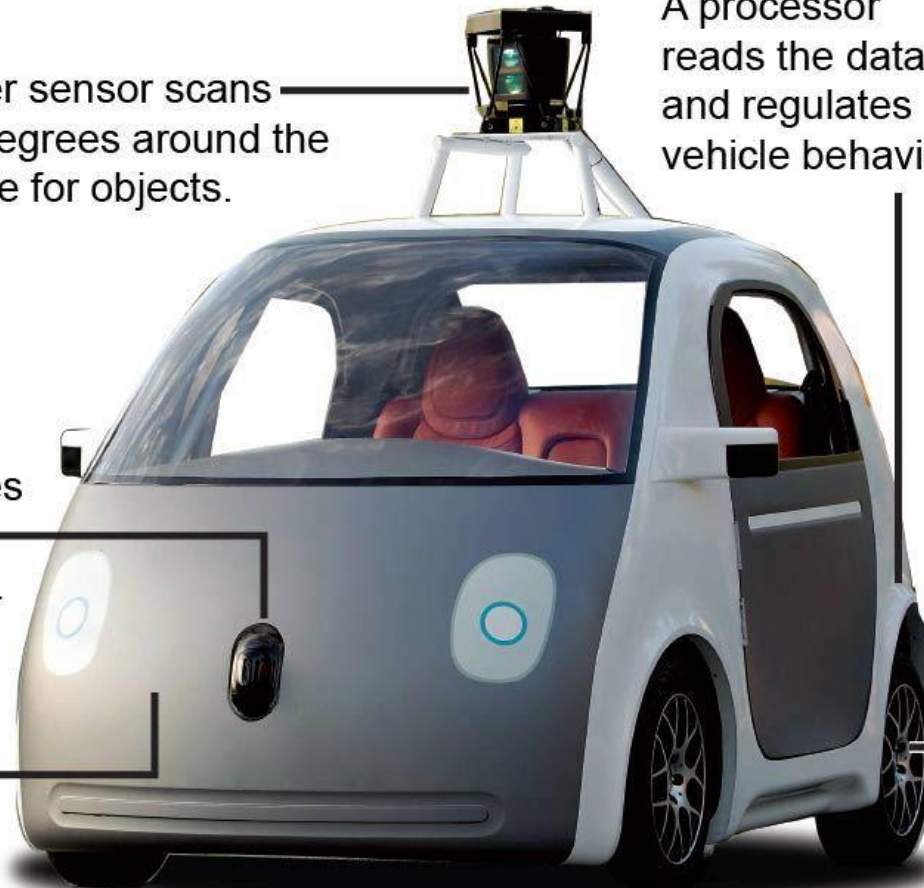
A laser sensor scans 360 degrees around the vehicle for objects.

A processor reads the data and regulates vehicle behavior.

Radar measures the speed of vehicles ahead.

An orientation sensor tracks the car's motion and balance.

A wheel-hub sensor detects the number of rotations to help determine the car's location.



# Smart Investing: The Roadway Safety Portfolio

1. Current Safety Solutions: Systemic Approach
2. Traffic Safety Culture
3. Technological Advances

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