Augmented Speed Enforcement NRITS 2013

Randy Woolley
Caltrans Division of Research, Innovation & System Information

Overview

- Sponsored by Rural Safety Innovation Program (RSIP) under the Research & Innovative Technology Program (RITA) at USDOT
- The project aimed to find technologies that would be able to slow traffic in **rural** work zones
- This project had one USDOT Grant with two Caltrans contracts to two universities
- USDOT Customer is Linda Dodge

Overview

- Each university designed and/or integrated off-the-shelf components to develop a system
- Data was collected on SR152 near Los Banos, CA between mid May and Mid July 2012. There were two weeks of baseline, two weeks for each system individually, and two weeks with both systems working in the work zone
- No data was collected during the July 4 holiday week.

Augmented Speed Enforcement (aSE)
Montana State University (WTI) Team

Nic Ward
Western Transportation Institute
Montana State University

Doug Galarus
Western Transportation Institute
Montana State University

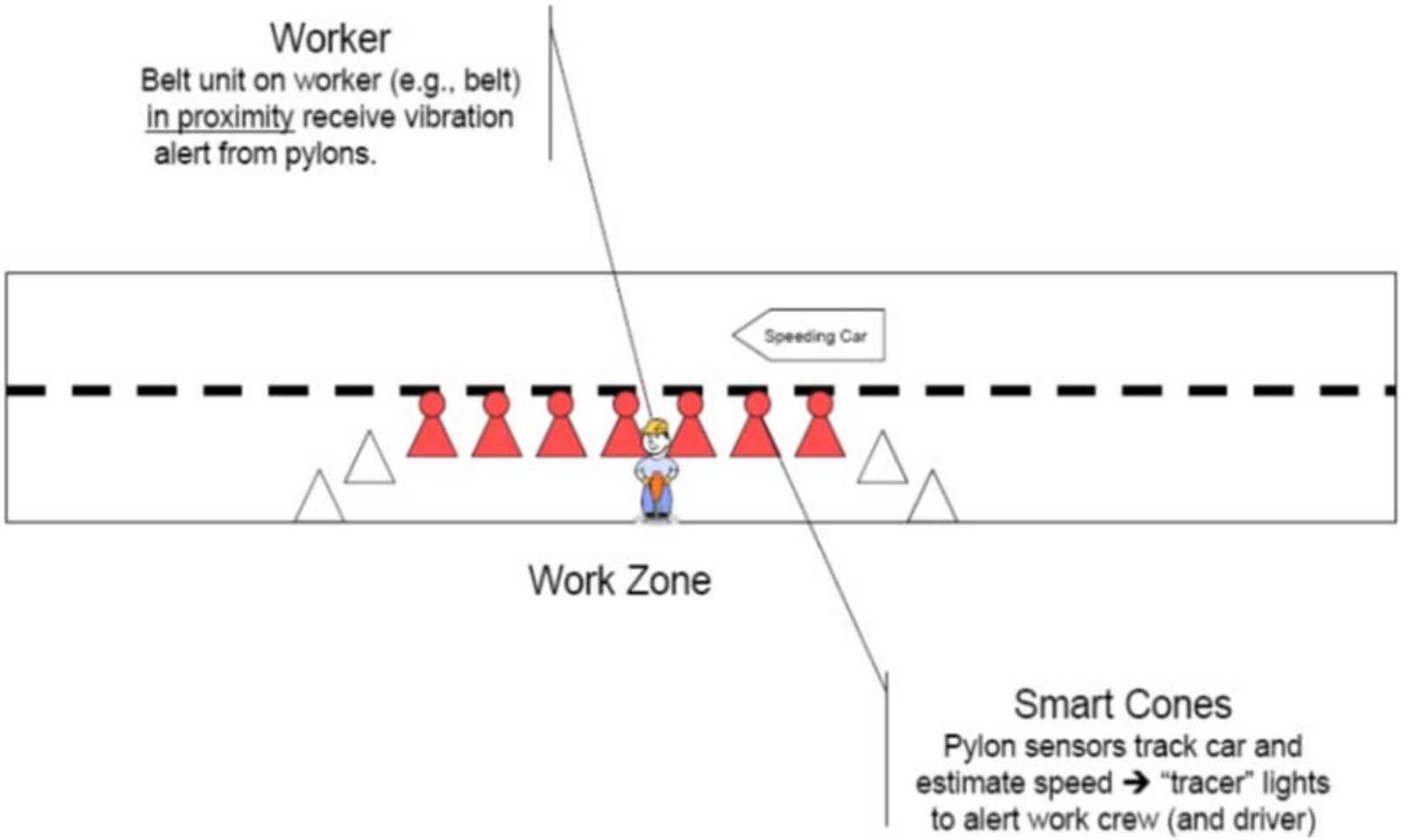
Larry Hayden
Western Transportation Institute
Montana State University

Montana State

- In May and June 2012, WTI deployed 28+ "Smart Drums" (sDrums) along a moving workzone on SR-152 in Central California to determine if they could improve safety by reducing speed in the work zone.
- Using ZigBee communication, the sDrums form a standalone, mesh network to provide warning to drivers via a synchronized light pattern triggered by radar detection of speed.
- Pagers are also incorporated into the system to notify workers of speeding vehicles.

WTI Subsystem

Function: Portable work zone hazard detection system for driver and worker warning that can be integrated with existing work zone infrastructure.



Four sDrum Types:

Master / Data Logger:

- Radar
- Light
- Controller
- Power
- Communication (Zigbee)

Slave:

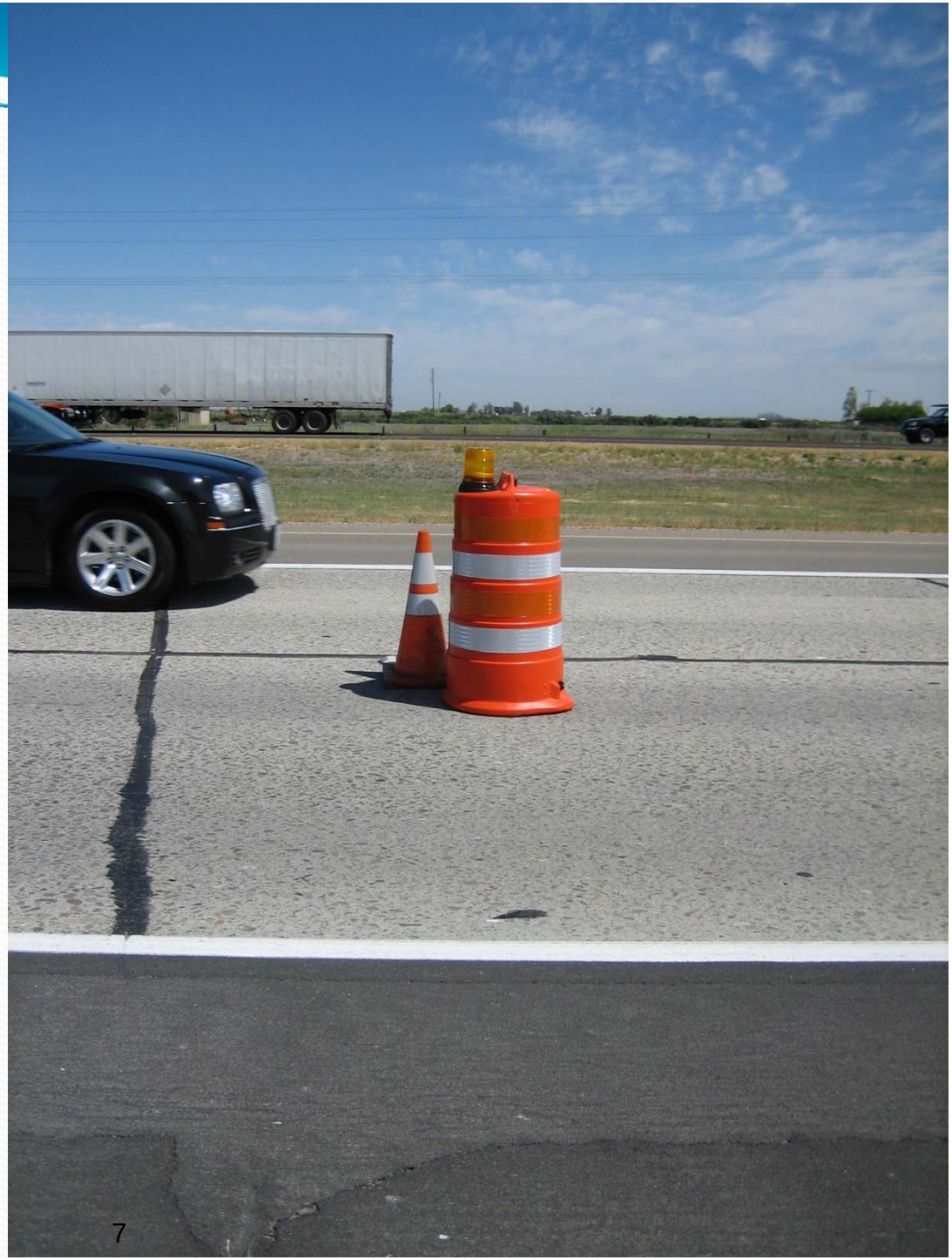
- Light
- Power
- Communication (Zigbee)

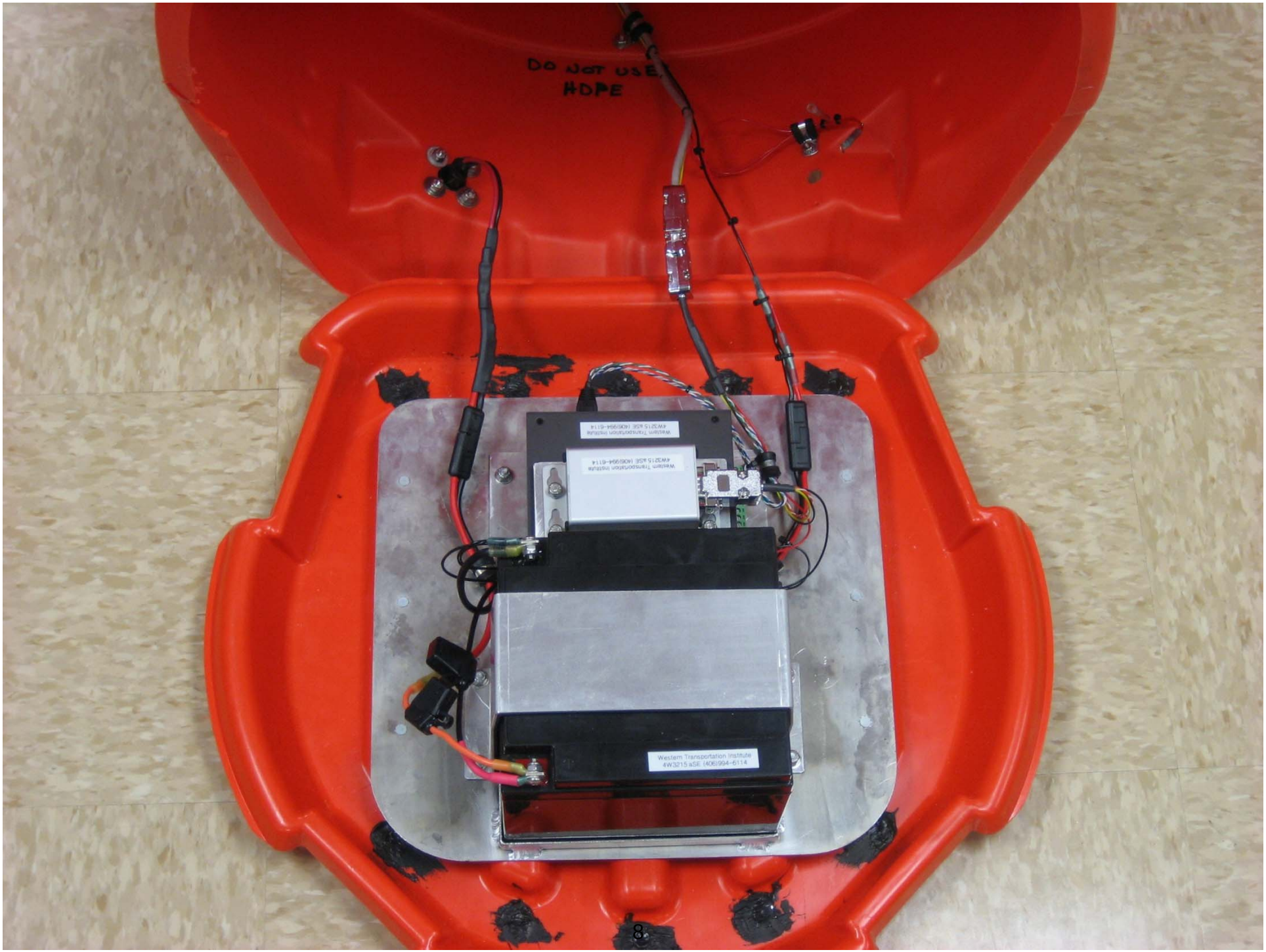
Pager:

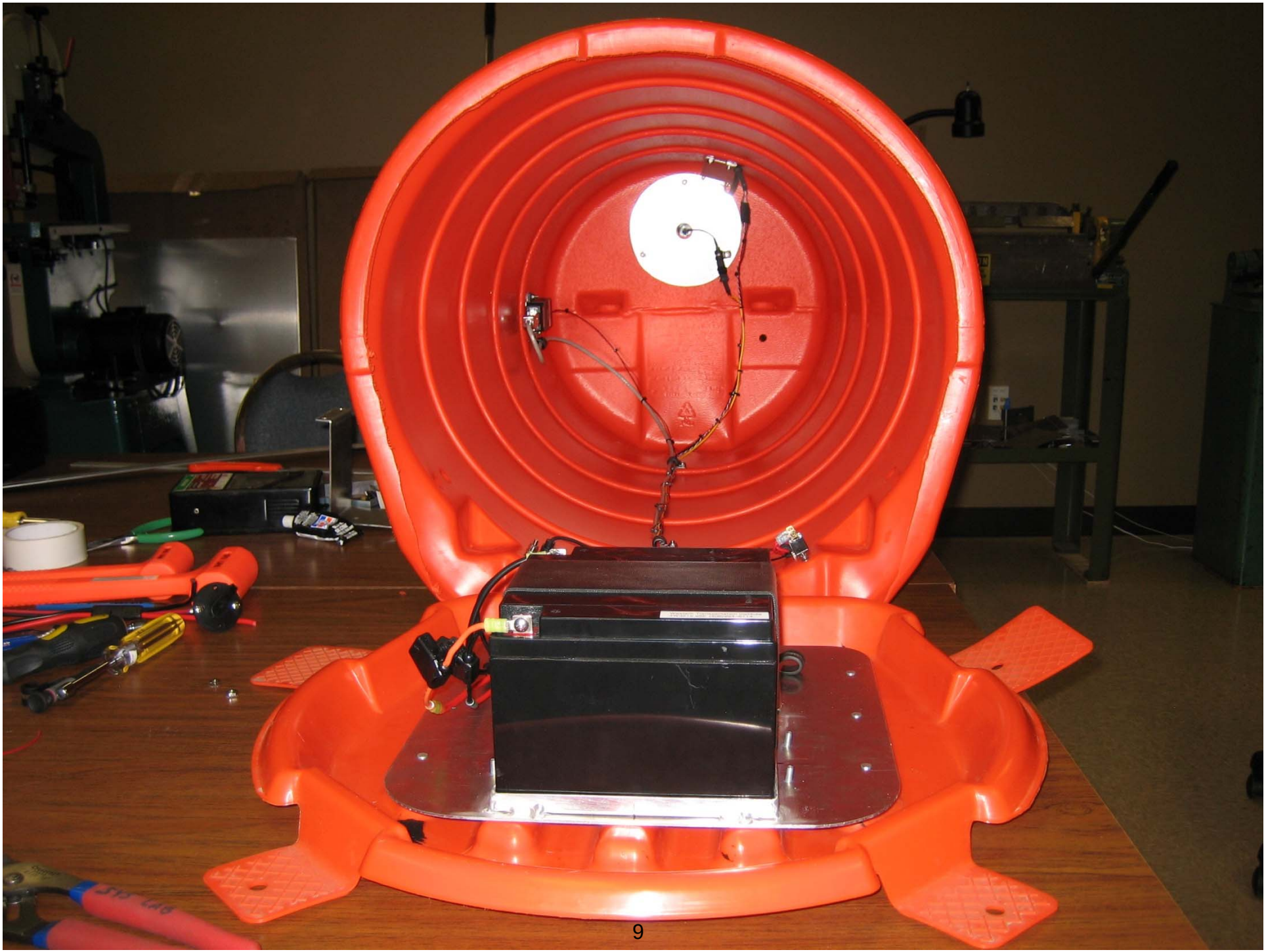
- Pager Base Station
- Power
- Communication (Zigbee)

Repeater:

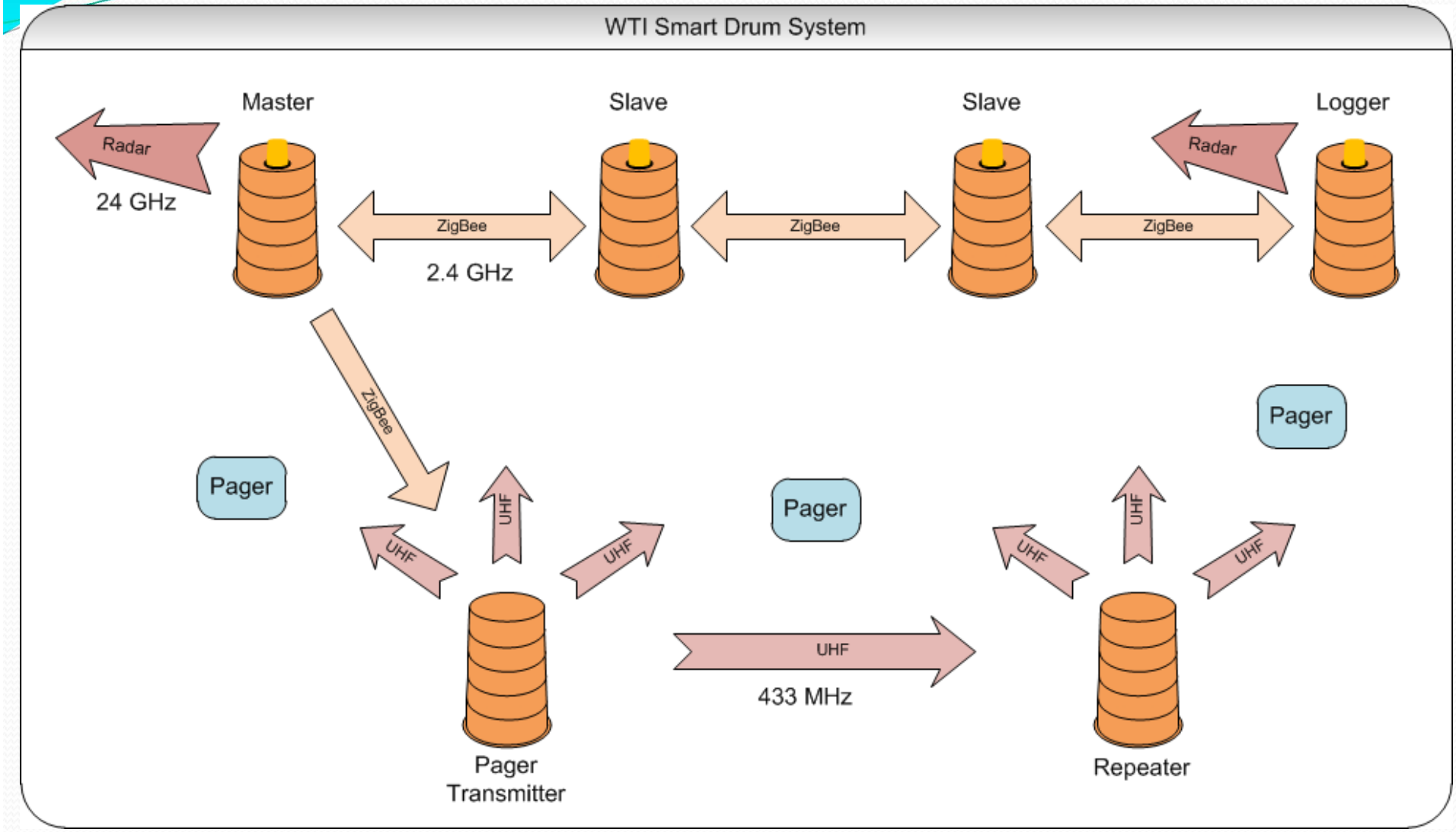
- Pager Repeater
- Power




DO NOT USE
HDPE
Western Transportation Institute
4W3215 aSE (406)994-6114



System Communication Architecture



Design

- Use Broadcast to flash all lights rather than use more advanced lighting patterns that would require point-to-point communication.
- Control lights via a single master cone with a radar sensor. Then communication will only consist of light messages.
- Log data via other (backup) master cones, also equipped with radar. Do not transmit this data.
- Other than the master cone, the order of placement of cones does not matter.
- The system could consist of a master cone alone, or a master cone and variable number of slave (light) cones.
- No vehicle tracking – the flash pattern in the relatively short length of layout for 28+ cones will not follow vehicles.
- Multiple master-slave subsystems could be used to provide finer granularity.
- No interaction with the other (PATH) subsystem.

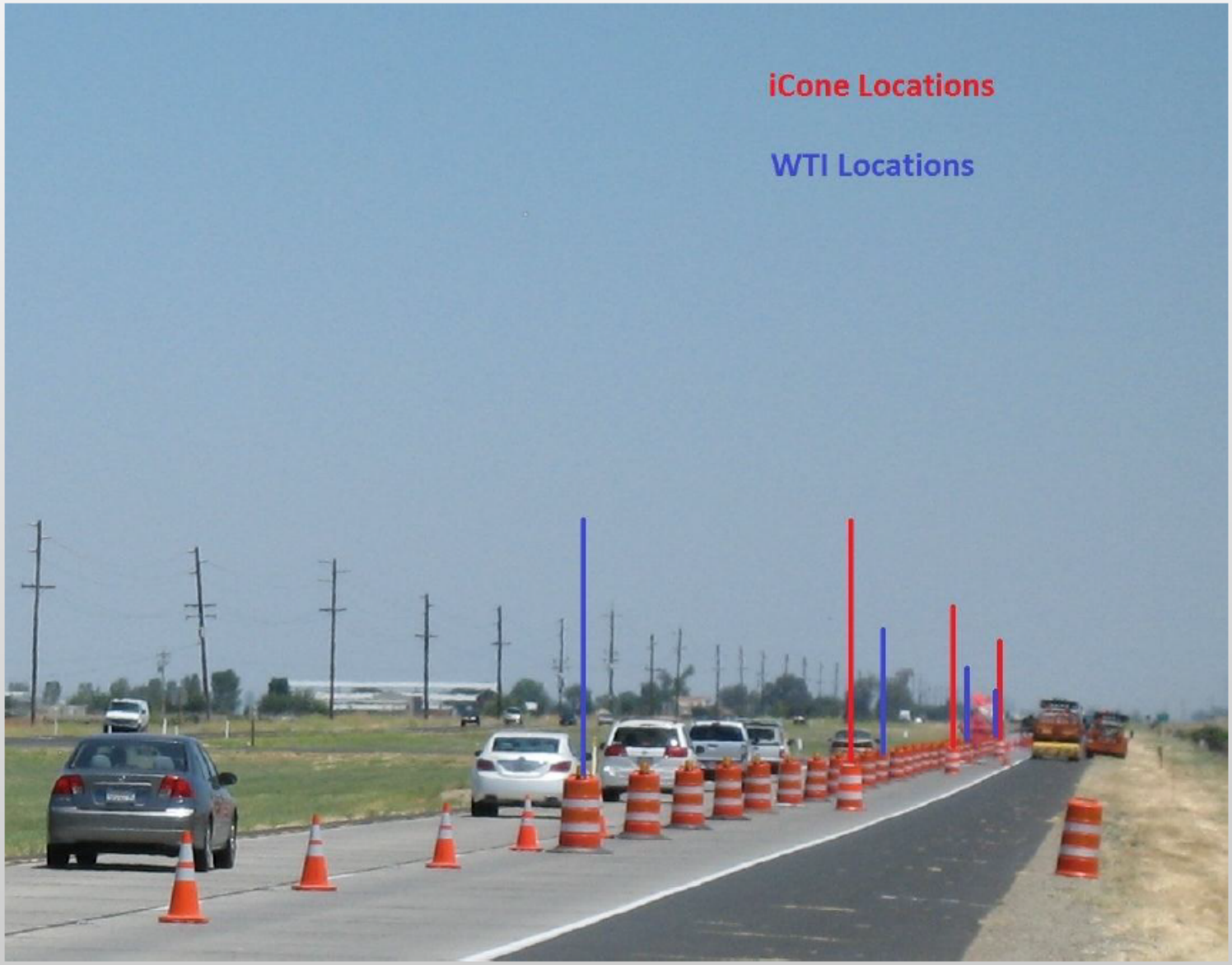

JH 3168 B
CONNECTICUT
DID YOU KNOW...
LEARN MORE ABOUT THE CONNECTICUT RIVER VALLEY AT...
uhaul.com
AD-63664

Pilot Testing – Caltrans District 10

SR 152 Between Los Banos and Chowchilla

May-July, 2012

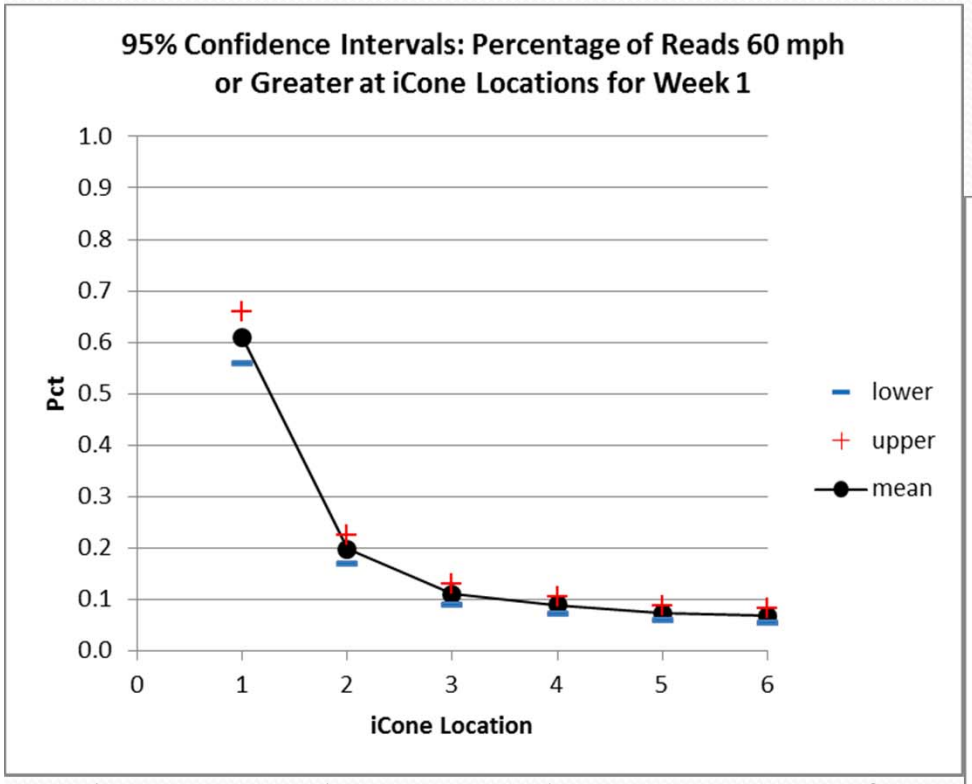
This is a representation of the standard layout of the WTI drums and the iCones



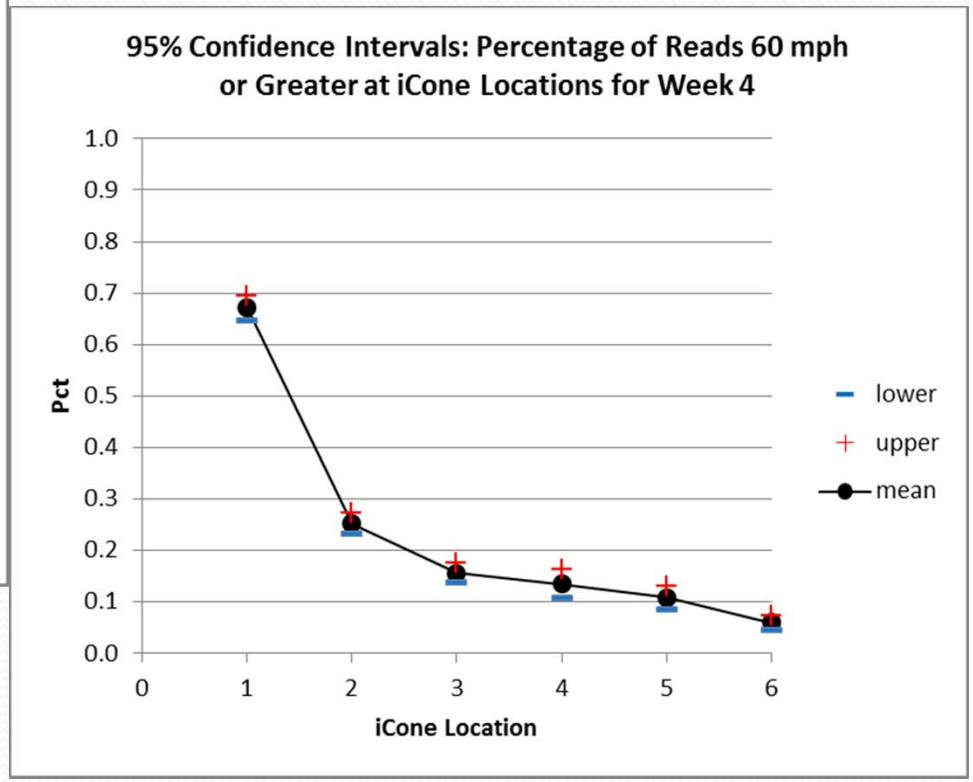
Note that the third iCone is halfway between the third and fourth WTI drum

Evaluation of Speed Data

WTI Only System



Baseline



There is a reduction in the percentage of reads 60 mph or greater as one progresses through the work zone, even during the baseline weeks.

Topics for Further Research

- Light patterns and effectiveness
- Radio options for extended drum spacing or drum sets used 50 foot spacing x 28 drums, covers 1400 feet of work zone, 100 foot spacing would double that
- Radios and protocols for implementing complex light patterns
- Improving radar range (could see and warn cars soner)
- Minimum number of drums and spacing to be effective
- Spacing of drum sets (e.g. 4 drum sets at ¼ mi spacing)
- Component alternatives to reduce cost and improve performance
- Custom designed paging system for transportation use

Augmented Speed Enforcement (aSE)

Project Overview & Field Test Results

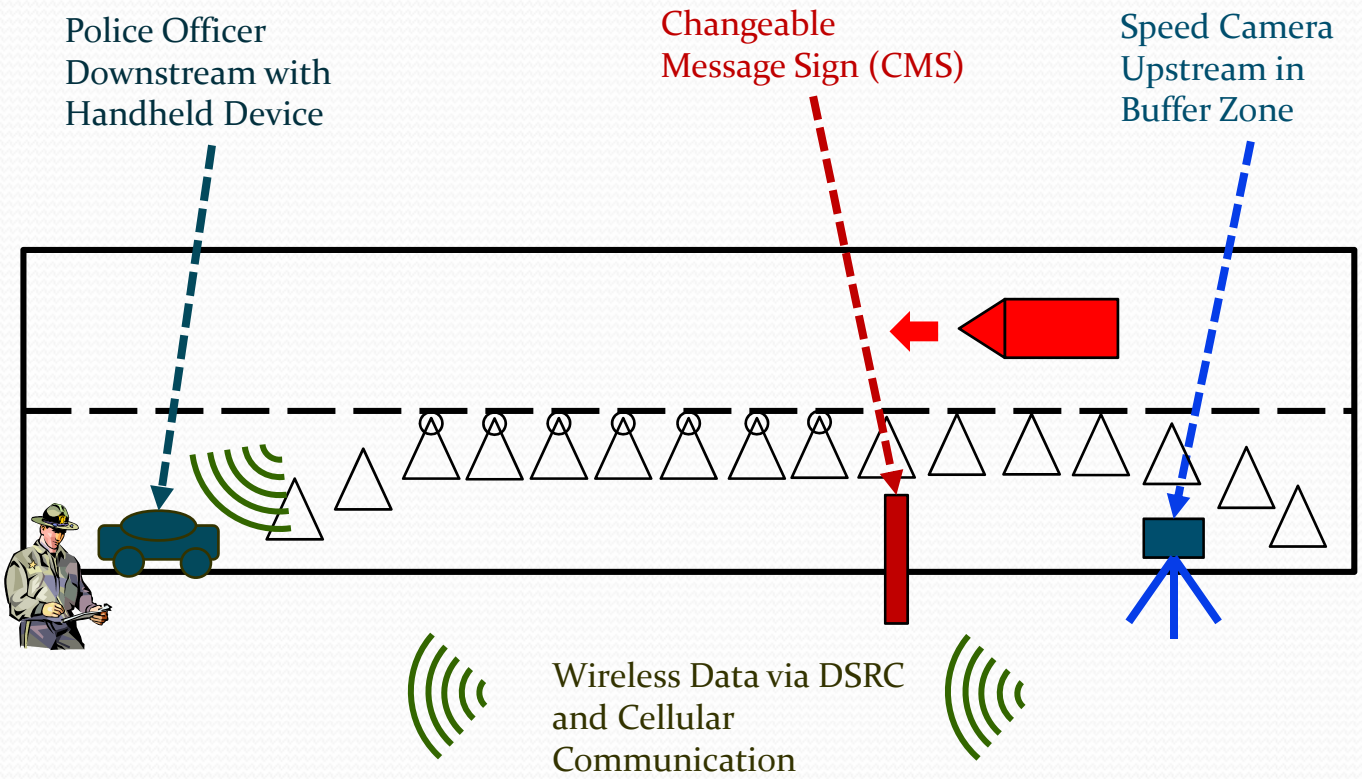
Ching-Yao Chan, Somak Datta Gupta

California PATH Team

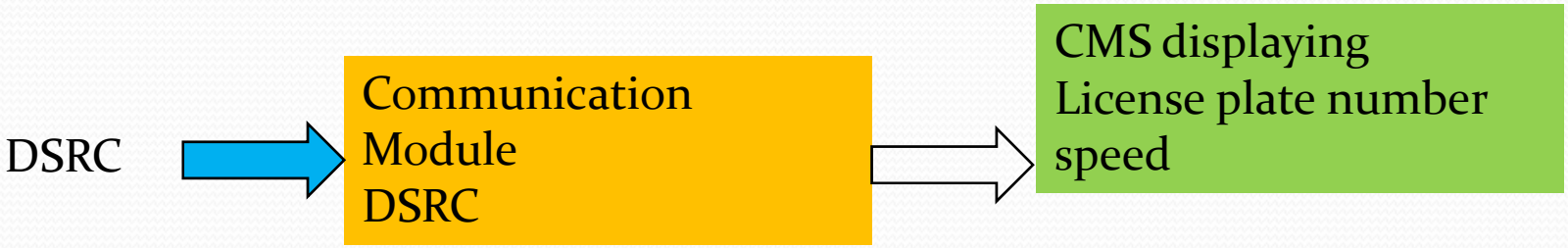
PATH Augmented Speed Enforcement (aSE) Functional Objectives

- For Drivers
  - Provide feedback if a vehicle is traveling over the speed limit before the active work area of the work zone
  - Offer enhanced alerts with identified license plate number and measured speed (your speed and license number on a portable message sign)
- For California Highway Patrol (CHP) officers
  - Provide alerts when there are vehicles traveling at excessive speeds
  - Speed enforcement the responsibility of the California Highway Patrol

PATH Augmented Speed Enforcement (aSE) System



PATH aSE Components: Changeable Message Sign



Actions at CMS:

Data transmission arriving via DSRC, received at CMS

CMS displaying speeding vehicle's license plate number and measured speed prior to vehicle arrival

PATH aSE Components:
Data Access and Display for CHP

Actions at Server and CHP:

Data transmission via Cellular Communication, received at Project Server maintained by PATH

Prepare and store data, ready for access in a web page format

Web page display updated periodically whenever there is new data

A higher speed threshold (70 mph) is used to filter data to avoid excessive display to CHP

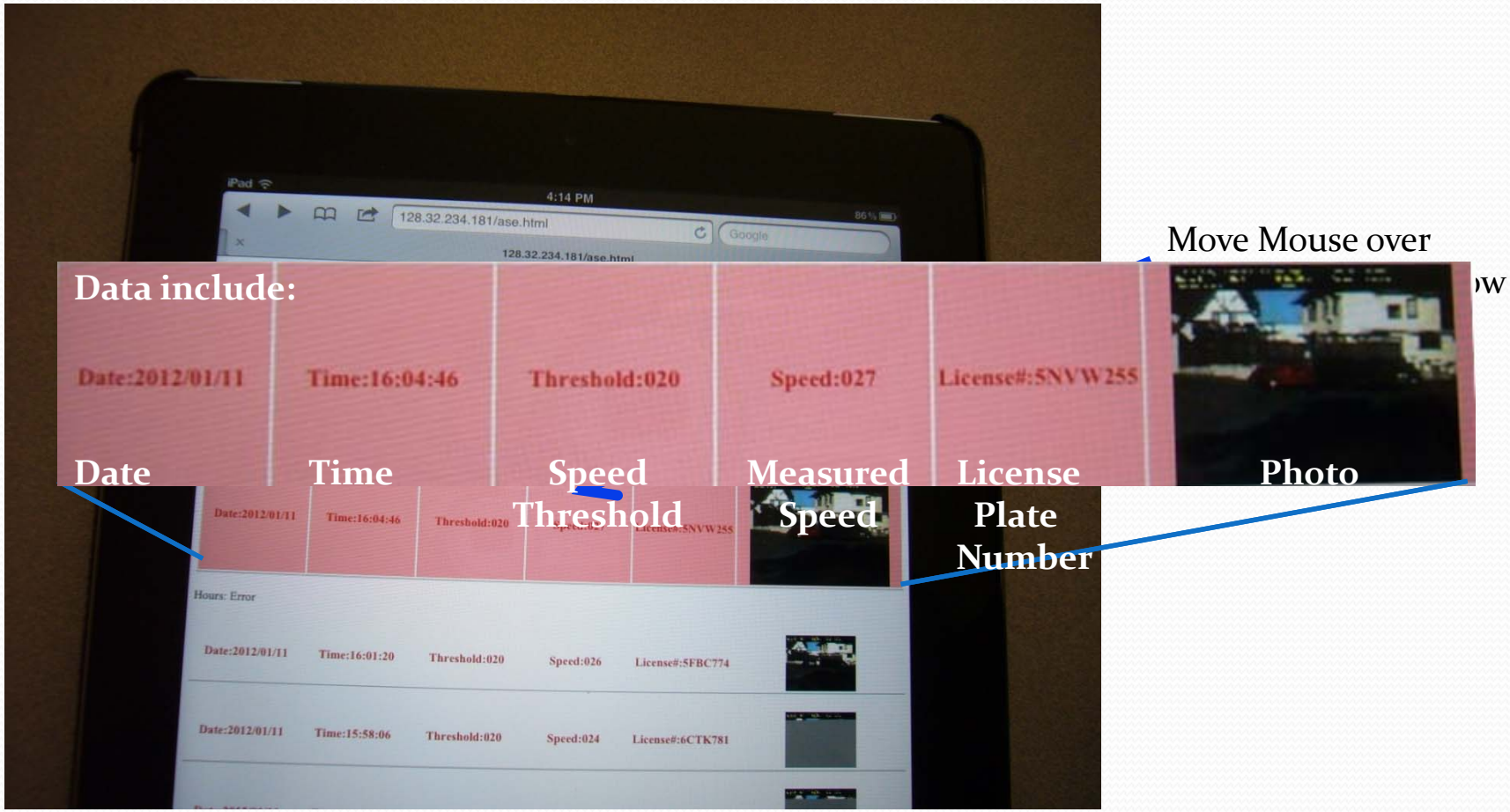
CHP sees display with a standard internet browser

CHP or other authorized users can be at any location and moving dynamically but still be able to monitor the operation.

CMS Field Setup

- CMS
  - Located ~300 meters from speed camera
    - Default "Work Zone Speed Limit 55 MPH"
    - Violator over speed threshold "License ABC123 65MPH"

PATH aSE Components
- Portable Device Display



Summary: Speed Data Observation

- iCone data reveals an effective reduction of higher speed vehicles
- Both WTI and PATH sub-systems showed reduction of high speed vehicles, when compared to the baseline scenario
- Radar data at CMS showed speed reduction
- In all, the PATH system achieved its primary objective of lowering the speed of vehicles in the work zone improving safety for the workers and the traveling public

DSRC TEST

- **Objectives of DSRC Testing for aSE project**
  - **DSRC module performance in extended transmission range**
  - **Data transmission in an alternative configuration with a relay**

Pictures of Testing

CA-37 E, Petaluma, CA

Richmond Field Station - Elbow Configuration

DSRC Testing Summary: Point to Point

- Range of 1.1 miles was tested at CA-37E, Petaluma, CA, in a rural setting.
- A transmit power range of 17-20 dbm is adequate for successful transmission.
- This allow operation of radios with transmit powers comfortably below their stated maximum of 23 dbm.
- Testing in a suburban area proves the capability of the setup to work in harsher radio environment and still achieve a 1.2 mile long range.

DSRC Testing Summary: Relay

- Testing at Richmond Field Station proved effectiveness of relay in transmitting messages without any perceptible delay or loss of data.
- Directional antennas were used in the rural test. Omnidirectional antennas was used in the relay test.
- The downside of the relay configuration is the added complexity of deployment in the field.
- Nonetheless, tests demonstrated the feasibility of relay, when necessary, in locations with unfavorable road geometry.

Summary: PATH aSE System

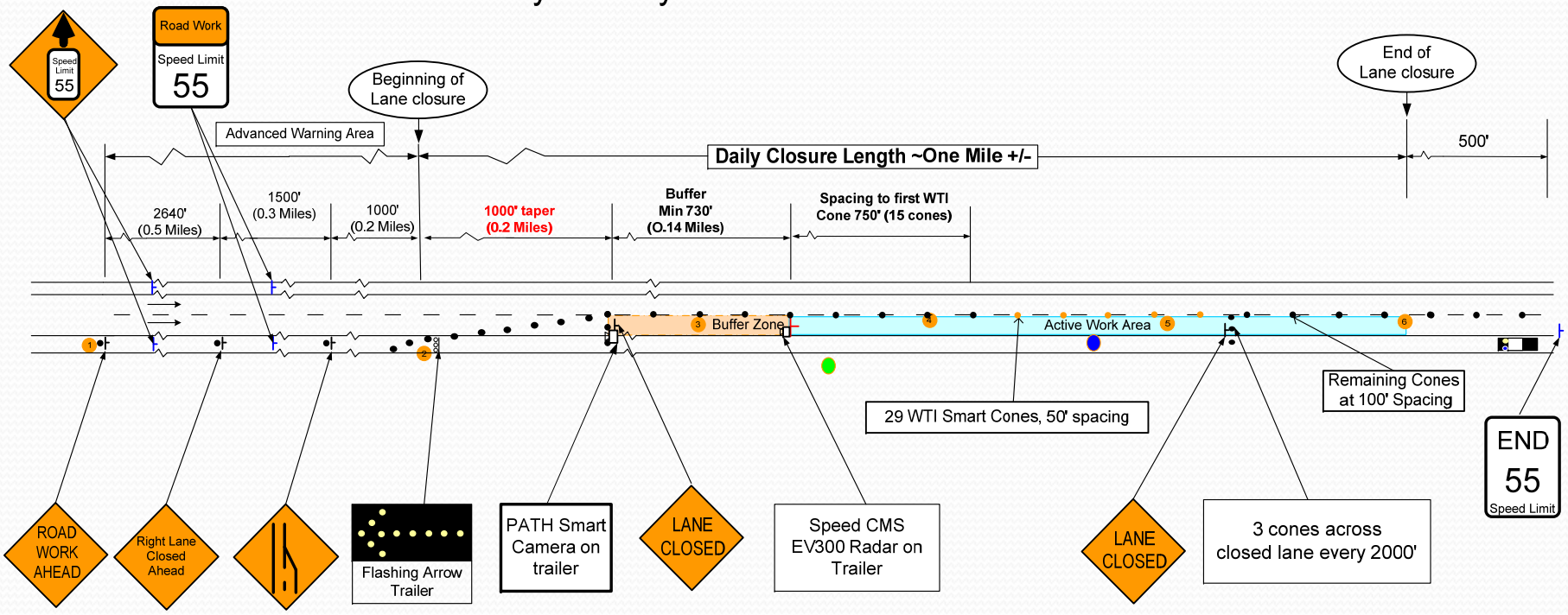
- An aSE system that integrated technologies
- Observable reduction of speeding vehicles
- Demonstrated effectiveness in field tests
- Involvement and positive feedback from Caltrans and CHP to ensure usability
- Future studies can benefit from
  - Systematic and in-depth data collection
  - Evaluation of driver behaviors
  - Operation in diverse environment, such as incident zones and high-risk locations with speeding hazards

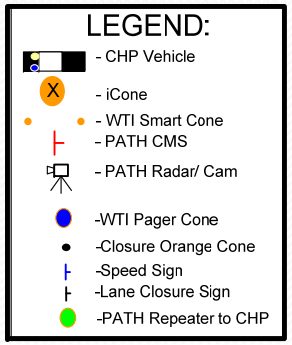
Field Data Collection

Field Data Collection Lane Closure

CA MUTCD Plate 10

Randy Woolley- aSE Lane Closure Plan



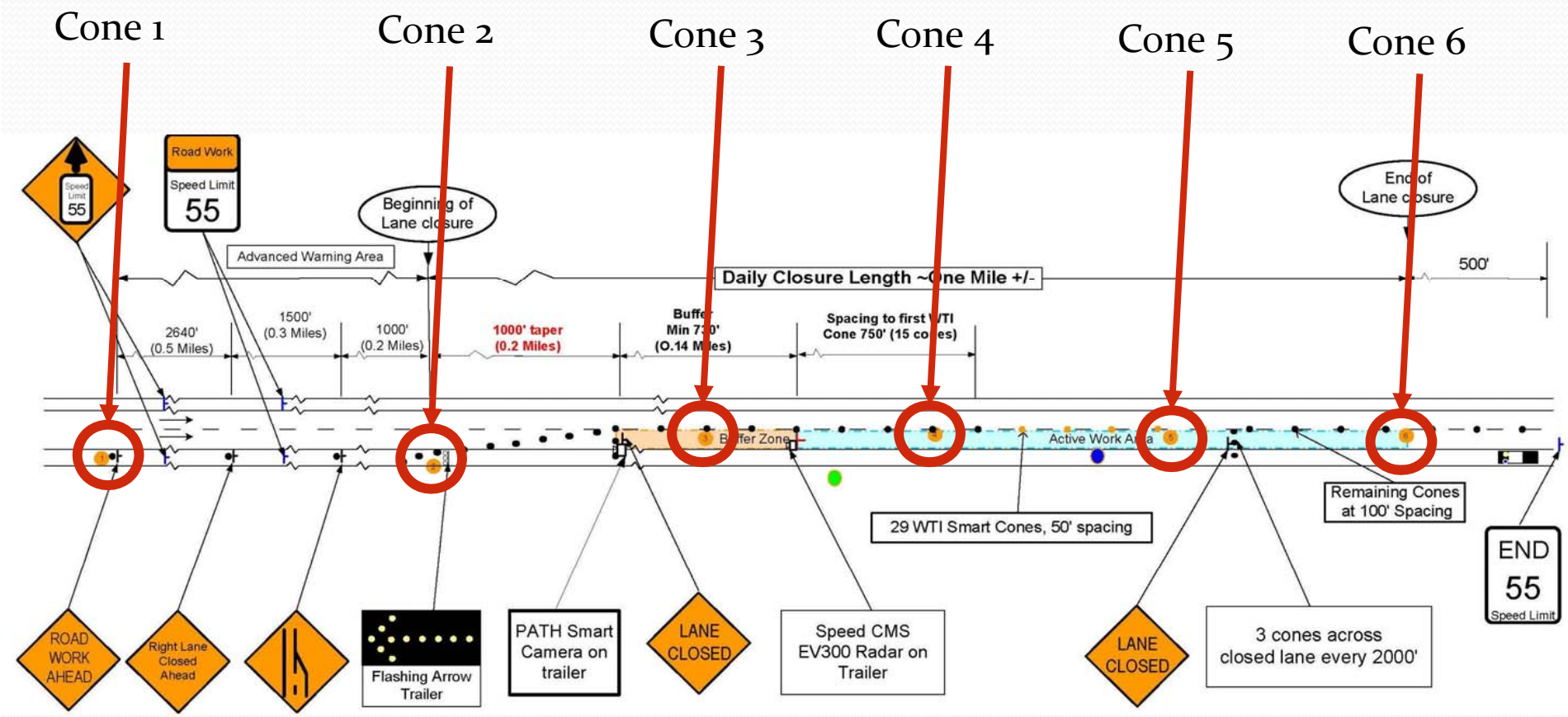


Work Zone Closure Notes:

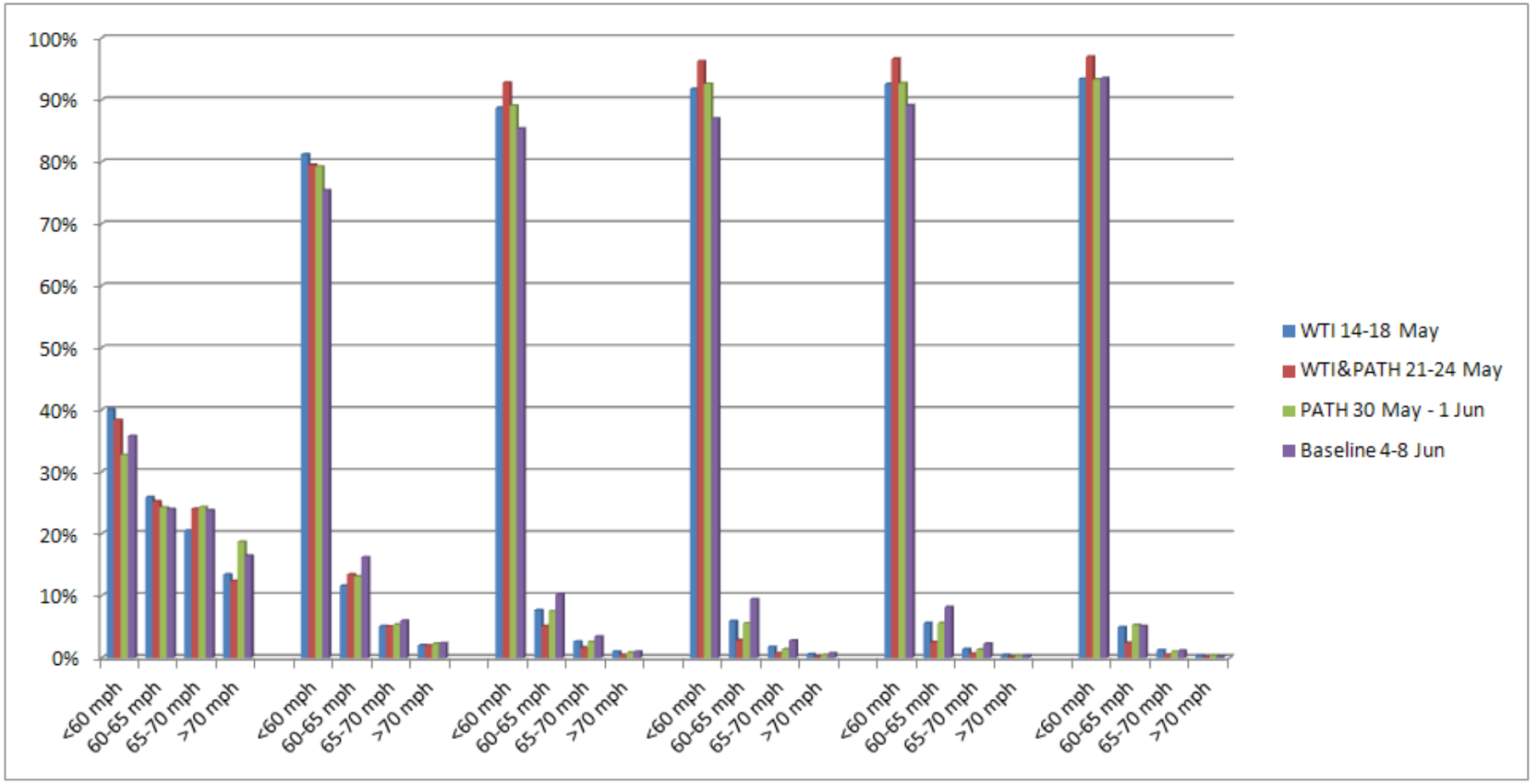
1. Closure Set with standard cones at 50 foot spacing through taper, buffer zone, and first 45 cones in active work area
2. After first 45 cones of active work area, cone spacing increases to 100 feet
3. Cones 16 to 45 of active work area have a WTI Smart Cone placed beside, or just behind the standard cone
4. Speed Signs located halfway between closure signs as shown
5. iCones 1 & 2 as shown, iCones 3-6 evenly spaced from middle of Buffer Zone to end of Active Work Area
6. Layout based on Caltrans T11 layout, distances based on Caltrans T10 layout due to traffic posted speed

Updated 06052012

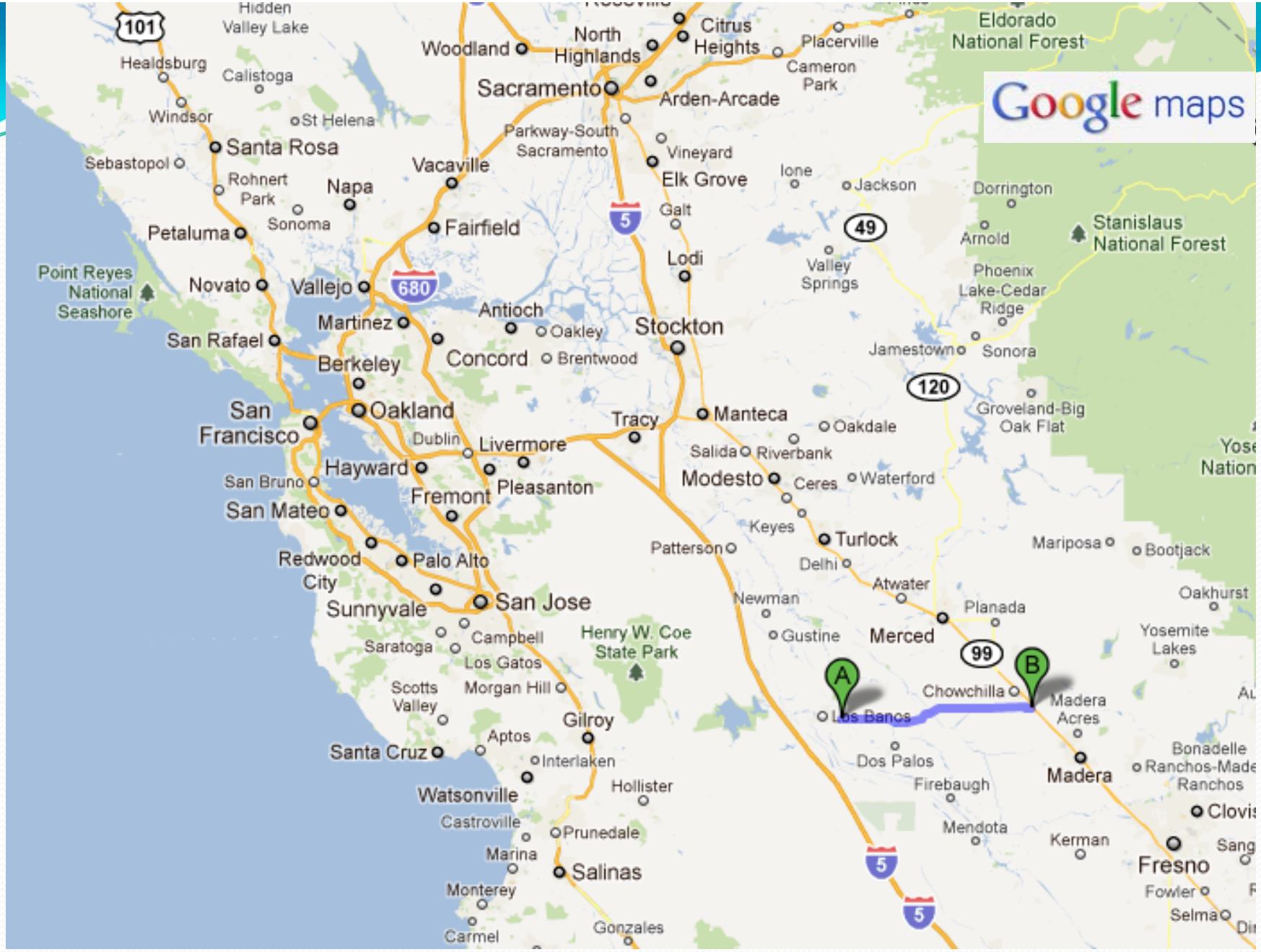
iCone Locations

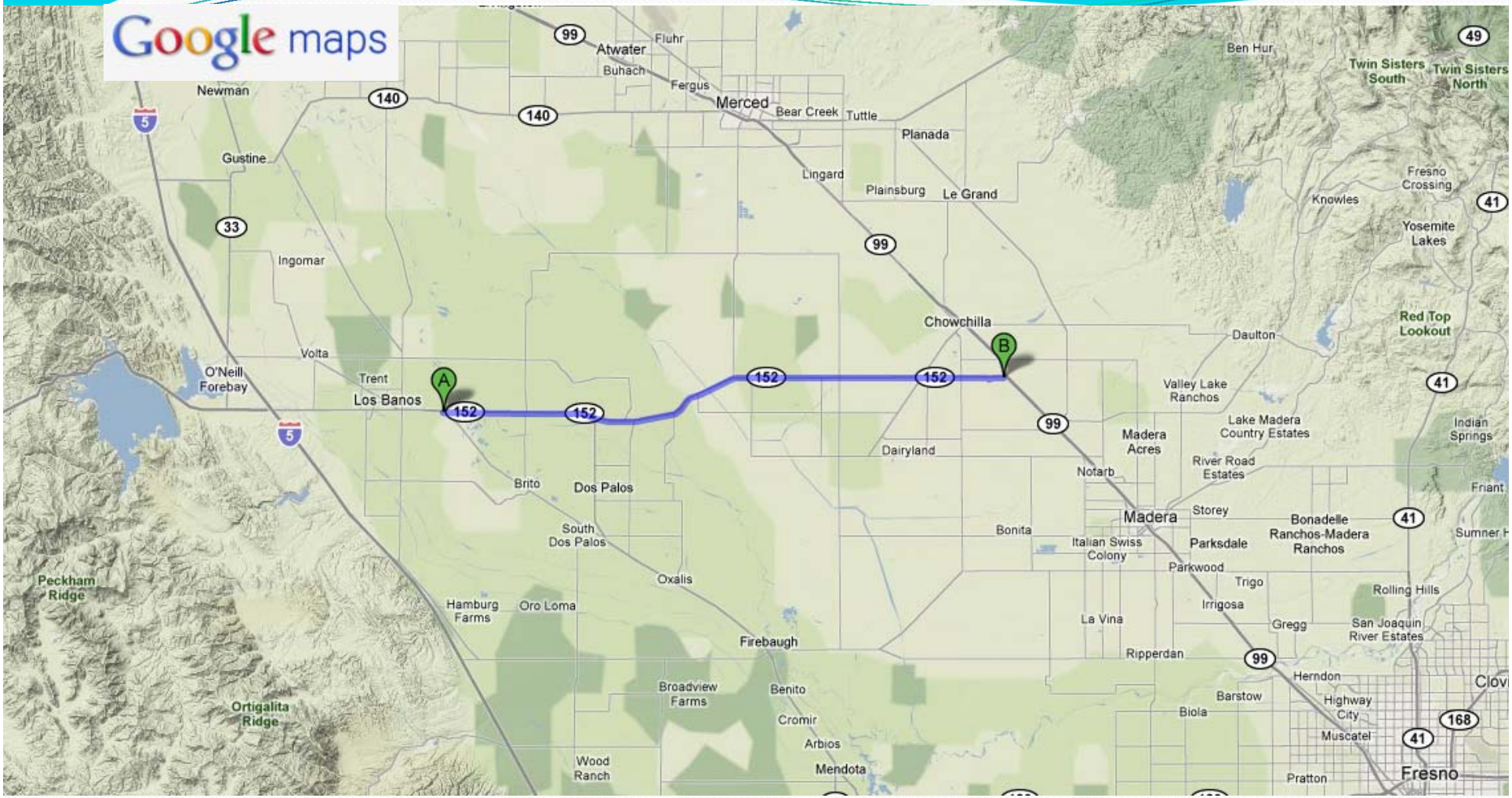


Overall Effects of Speed Distribution, Measured by iCones (1st 4 weeks for different scenarios)



Cone1 Cone2 Cone3 Cone4 Cone 5 Cone 6


Google maps
Hidden Valley Lake
Healdsburg
Calistoga
Windsor
St Helena
Santa Rosa
Sebastopol
Rohnert Park
Sonoma
Napa
Petaluma
Point Reyes National Seashore
Novato
Vallejo
Vacaville
Fairfield
Woodland
North Highlands
Citrus Heights
Placerville
Cameron Park
Eldorado National Forest
Sacramento
Arden-Arcade
Parkway-South Sacramento
Vineyard
Elk Grove
Galt
Lodi
Ione
Jackson
Dorrington
Arnold
Stanislaus National Forest
Valley Springs
Phoenix Lake-Cedar Ridge
Jamestown
Sonora
Groveland-Big Oak Flat
Antioch
Oakley
Brentwood
Martinez
Concord
San Rafael
Berkeley
Oakland
San Francisco
Dublin
Livermore
Pleasanton
Hayward
San Bruno
Fremont
San Mateo
Redwood City
Palo Alto
Sunnyvale
San Jose
Campbell
Saratoga
Los Gatos
Henry W. Coe State Park
Scotts Valley
Morgan Hill
Gilroy
Aptos
Santa Cruz
Interlaken
Watsonville
Hollister
Castroville
Prunedale
Marina
Salinas
Monterey
Carmel
Gonzales
Stockton
Tracy
Manteca
Oakdale
Salida
Riverbank
Modesto
Ceres
Waterford
Keyes
Turlock
Patterson
Delhi
Atwater
Newman
Gustine
Merced
Planada
Mariposa
Bootjack
Oakhurst
Yosemite Lakes
Chowchilla
Madera Acres
Los Banos
Dos Palos
Firebaugh
Madera
Bonadelle Ranchos-Madera Ranchos
Mendota
Kerman
Fresno
Fowler
Selma
Clovis
A
B
101
5
680
49
120
99


Google maps
A
B
152
152
152
152
99
140
140
33
5
5
49
41
41
41
168
Newman
Gustine
Ingomar
Volta
O'Neill Forebay
Trent
Los Banos
Atwater
Buhach
Fluhr
Fergus
Merced
Bear Creek
Tuttle
Planada
Lingard
Plainsburg
Le Grand
Chowchilla
Brito
Dos Palos
South Dos Palos
Oxalis
Hamburg Farms
Oro Loma
Firebaugh
Broadview Farms
Benito
Cromir
Arbios
Mendota
Wood Ranch
Peckham Ridge
Ortigalita Ridge
Dairyland
Bonita
Notarb
Madera Acres
Madera
Italian Swiss Colony
La Vina
Ripperdan
Valley Lake Ranchos
Daulton
Lake Madera Country Estates
River Road Estates
Storey
Parksdale
Parkwood
Trigo
Irrigosa
Gregg
Bonadelle Ranchos-Madera Ranchos
Herndon
Barstow
Biola
Highway City
Muscatel
Pratton
Fresno
Ben Hur
Twin Sisters South
Twin Sisters North
Fresno Crossing
Knowles
Yosemite Lakes
Red Top Lookout
Indian Springs
Friant
Rolling Hills
San Joaquin River Estates

Evaluation of Speed Data - Issues

- Multiple speed readings per vehicle – iCones and both systems
- Radar offset
- Traffic entering and leaving the closure via side roads
- MAZEEP location
- Maintenance workers and researchers location within the work zone- people and vehicles
- iCone pointing variation
- iCone and sDrum location variation
- Different Thresholds for the Two Systems
- Impact of Congestion Versus Free Flow – Traffic Volume
- Each system gathered independent data
- iCone data provided to both teams

Questions?

Thank You