A Focus Technology of the

American Association of State Highway and Transportation Officials (AASHTO)

Technology Implementation Group (TIG)

Virtual Weigh-In-Motion

A "WIM-win" for transportation agencies

Championed by the WIM Lead States Team

2006-2007 Presentation

AASHTO Technology Implementation Group

- TIG accelerates adoption of life- and money-saving, high-payoff innovations for higher performing roads

- TIG chose WIM/VWIM as focus technology for non-traditional uses (enforcement)

- Lead States Team
  - North Dakota (Chair)
  - California
  - Florida
  - Indiana
  - Nevada

WIM Backdrop

- 25+ year track record
- Standard: 2 sensors in road, scale between
  - Sensors: vehicle speed & length
  - Scale weight: all axles, left & right wheels
  - Date/time - truck location, direction
- Evolution
  - Wireless
  - Software for info management/analysis
  - Advanced camera systems
  - Solar power & satellite communications

What's new: Virtual WIM for weight compliance, screening & enforcement.

Virtual WIM

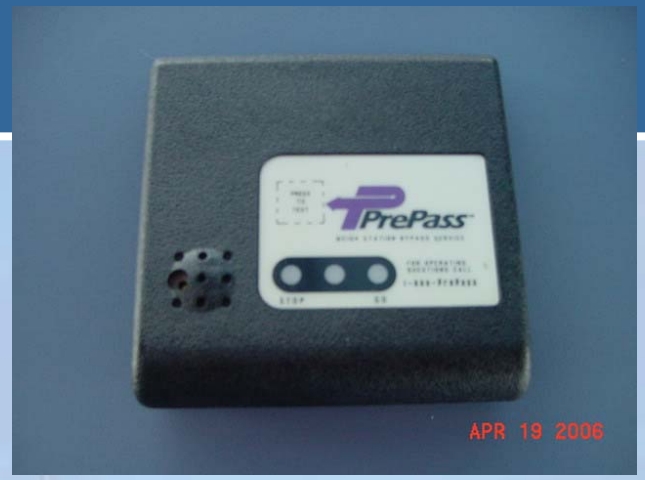
- Game changer for enforcement
- Non-intrusive, unmanned
- Automated data collection
- Eases traffic flow
- Selective, not random, inspections

VWIM: real-time data from a distance.

Electronic Pre-clearance

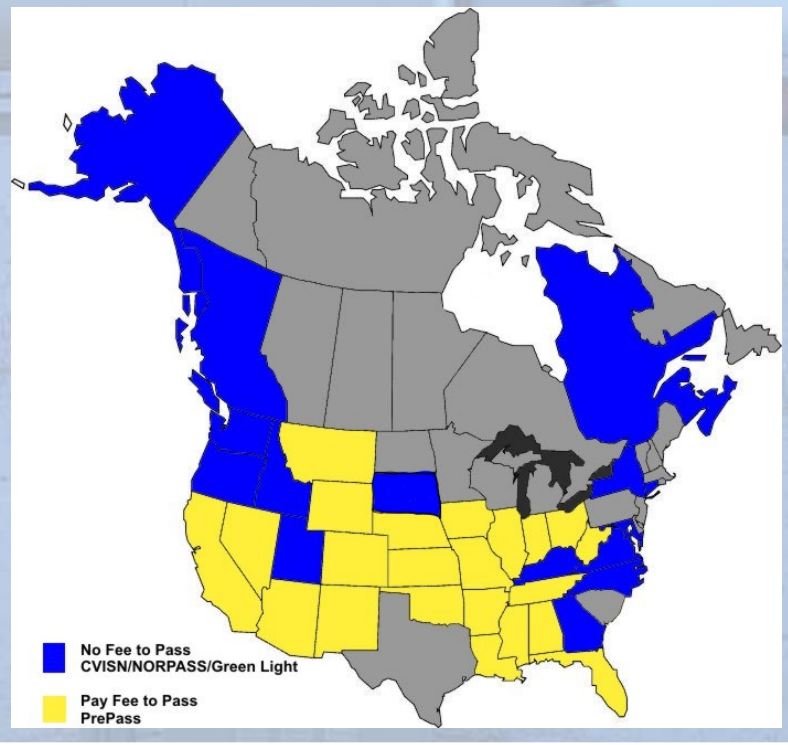
- In some States, linked to WIM
- Trucks often bypass weigh station
- Communicate via transponder for vehicle identity
  - Green for “bypass”
  - Red for “pull in”
- Credential check: State / National databases
- Nationwide
  - 40 jurisdictions use e-screening
  - 300 sites
  - 430,000 trucks with transponders

Pre-Clearance Vendors



PrePass™, NorPass, GreenLight

- **PrePass™**
  - Adopted by about 25 States
  - PrePass™ supplies equipment; State may handle WIM integration
  - NorPass & GreenLight transponders can register for PrePass™ use
  - Cost to carrier for “bypass” when scale’s open
- **NorPass**
  - Deployed in about 12 States and Canadian Provinces
  - States pay for equipment & maintenance
  - Carrier buys own transponder
- **GreenLight**
  - Oregon only
  - State owns, operates, administers database
  - Reads any transponder registered with Oregon
  - Free transponders to qualified carriers



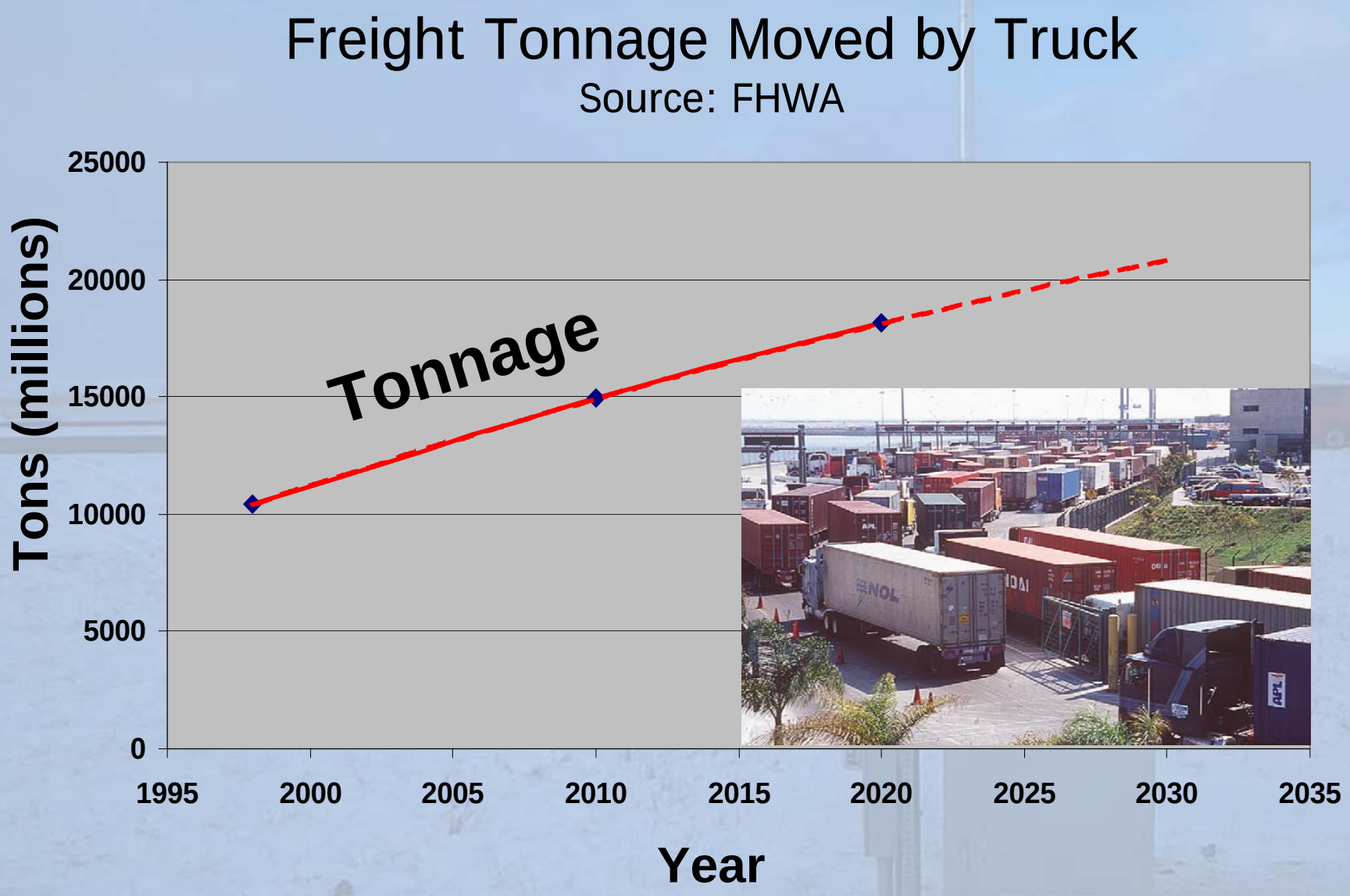
Why VWIM, Why Now?

- Enforcement
- Resource Management
- Budget realities
  - Cost of Right-of-Way
  - Cost to build
- Damage from overweight trucks
- Lessen volume at choke points
- Curb congestion - $63B/year in U.S.
- Expedite commerce
- Stem air pollution
- Sharpen predictions for design/maintenance

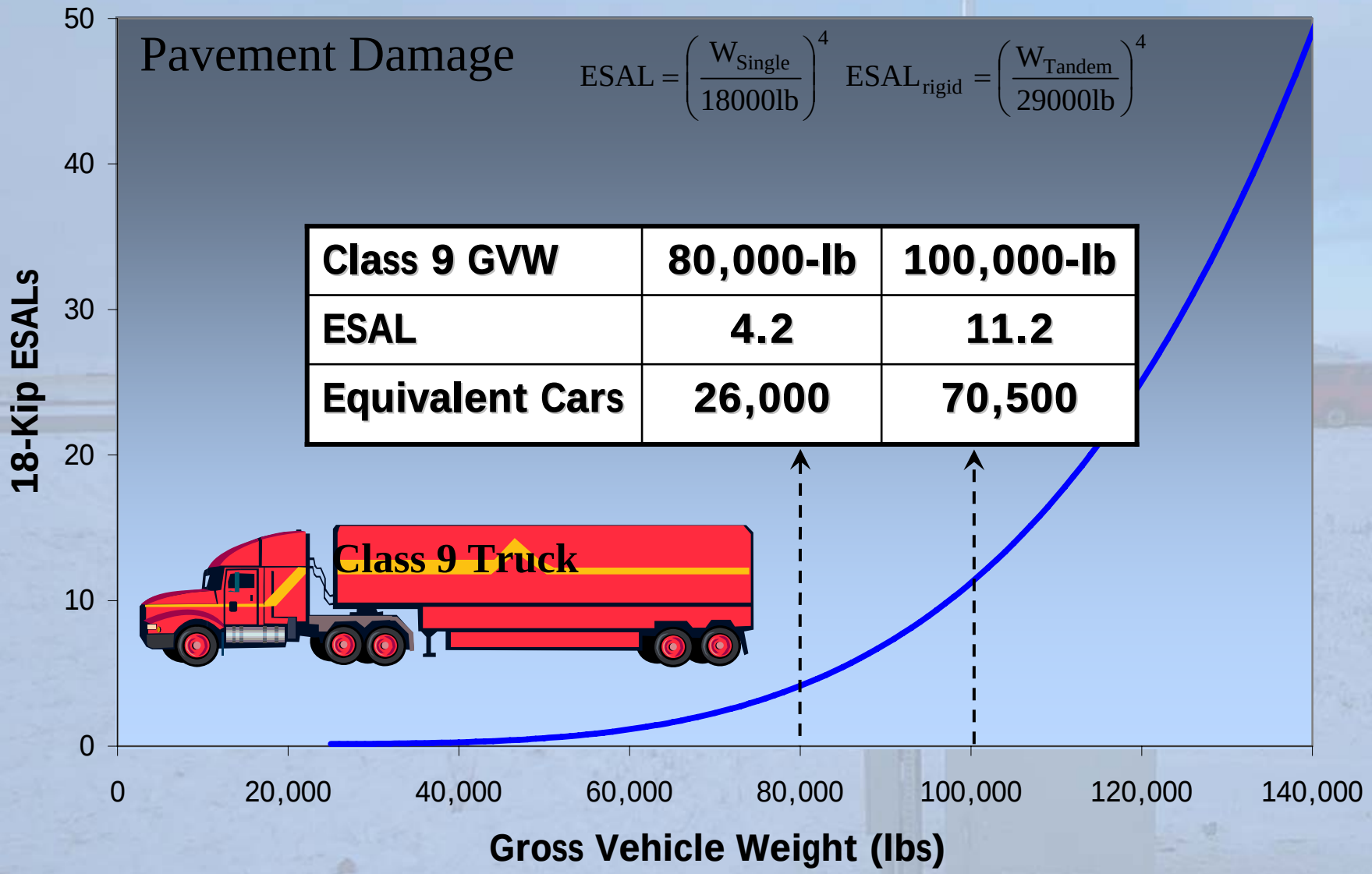
Over the next 20 years, truck tonnage is expected to increase at a rate more than five times that of population growth.

Texas Transportation Institute

Why VWIM, Why Now (continued)



Why VWIM, Why Now? (cont'd)
ESAL 101 (Equivalent Single Axle Loads)

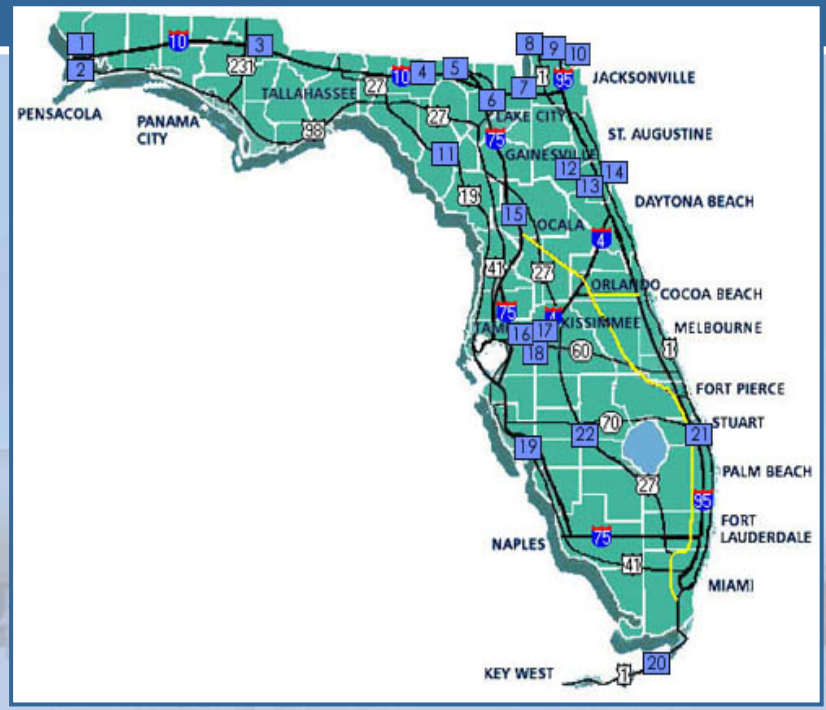


Dr. Andrew P. Nichols data/graphic

WIM Stakeholders

- Driving public
- American Trucking Associations
- State Departments of Transportation
- Departments of revenue
- U.S. Department of Transportation
- Federal Highway Administration
- American Association of State Highway and Transportation Officials
- Federal Motor Carrier Safety Administration
- State highway patrols
- Motor carriers
- Commercial Vehicle Information Systems and Networks (CVISN)

Florida's WIM Experiences



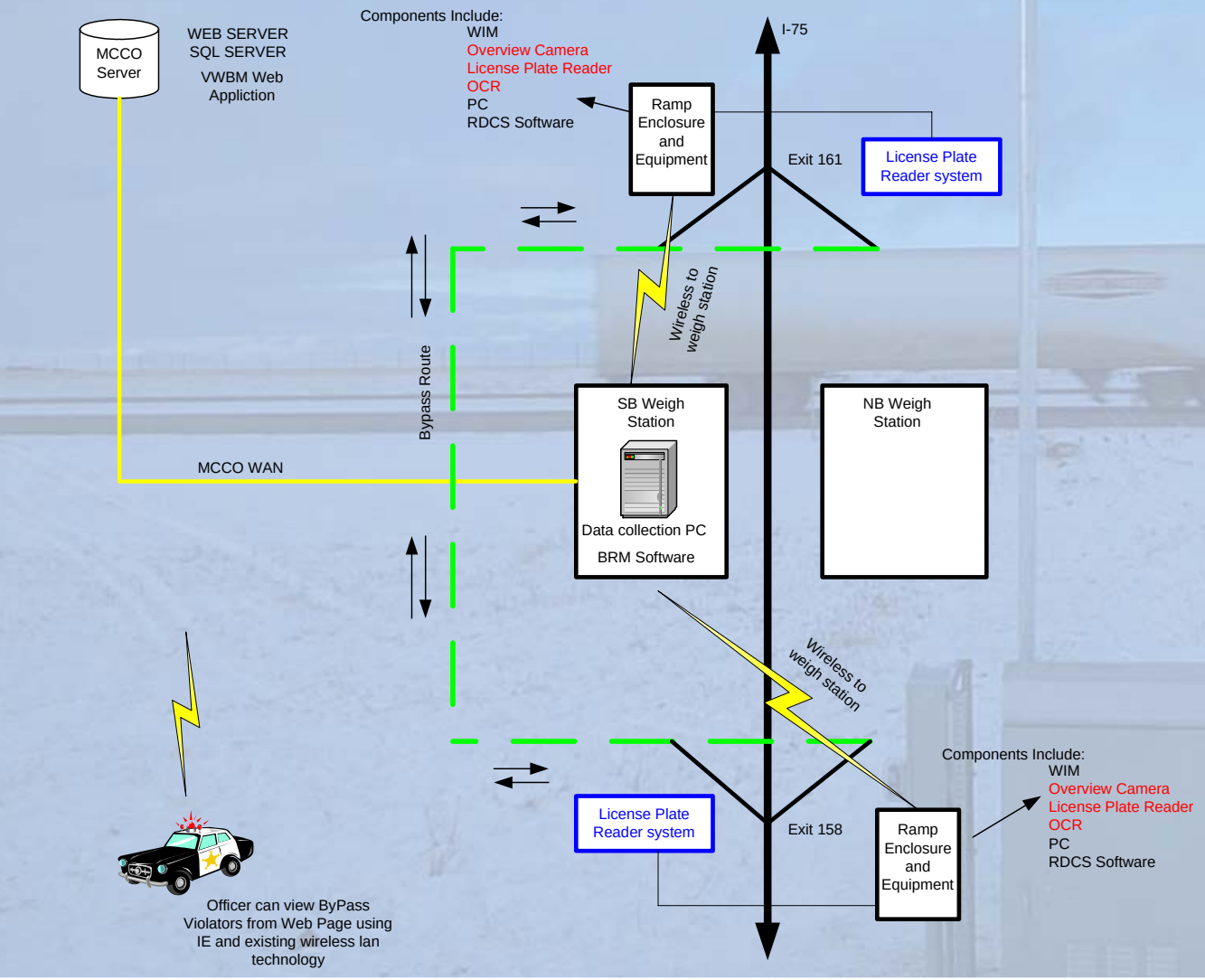
- 41 WIMs deployed
- Ramp WIMs all Interstate sites
- 16 MCCO WIMS
- Sensor Technology: load cell, Kistler & Piezo
- 2 mainline WIM deployments
  - Escambia Bay Bridge (Hurricane Ivan)
  - Plantation Key (one way in & out)
- Virtual WIM, 3-D Scanning

FL truck volume has increased over 10% annually in the last 5 years.

Video: Florida MCCO
1st Full Service WIM Station

Florida Virtual Weigh Station

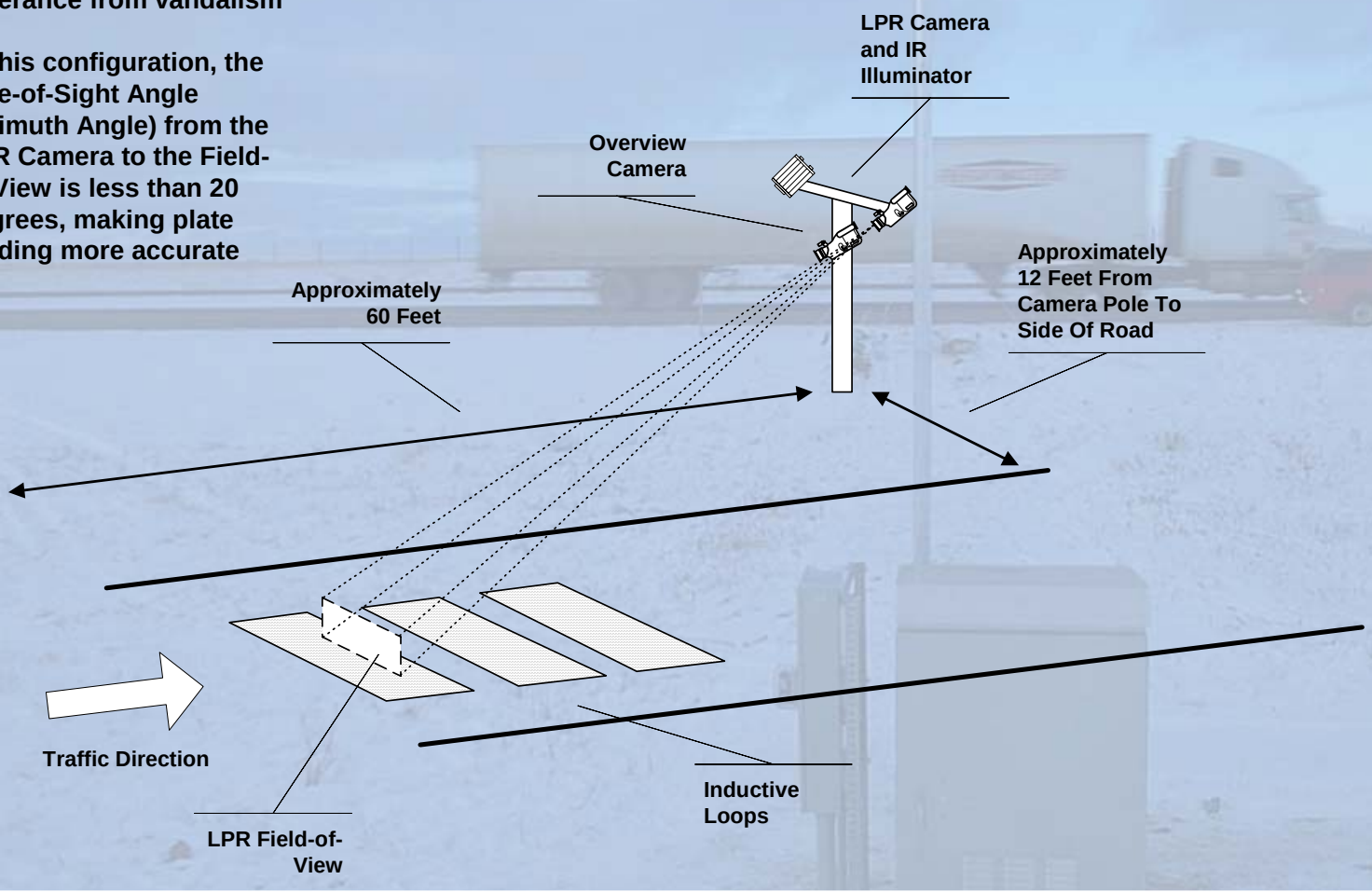
Punta Gorda Virtual WIM ByPass System



Bypass Monitor Virtual Weigh Station: Distances and VWS Configuration

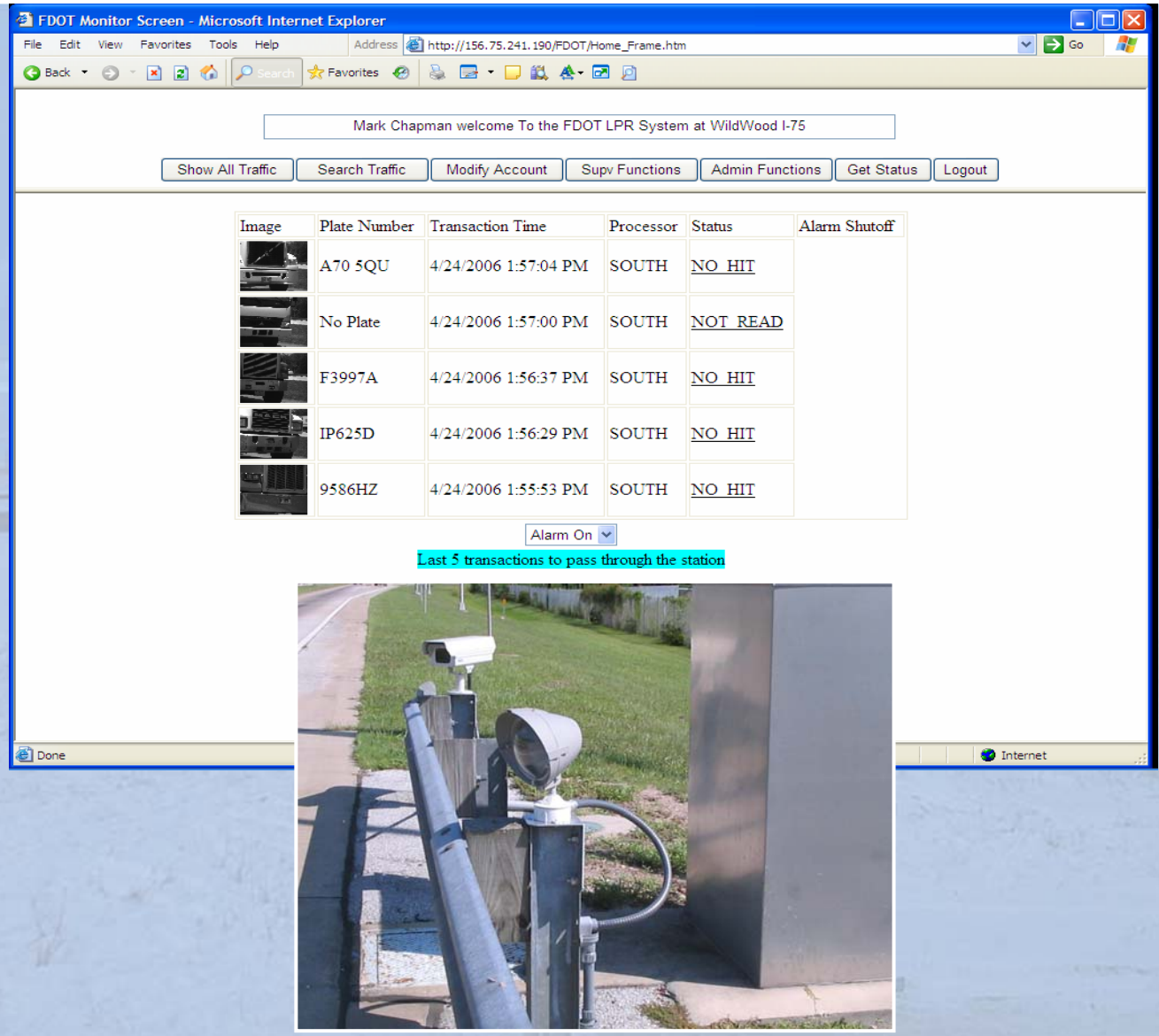
The height of the lowest mounted camera (Overview Camera) is approximately 12 feet measured from the pavement to provide better deterance from vandalism

In this configuration, the Line-of-Sight Angle (Azimuth Angle) from the LPR Camera to the Field-of-View is less than 20 degrees, making plate reading more accurate



Florida's WIM Results

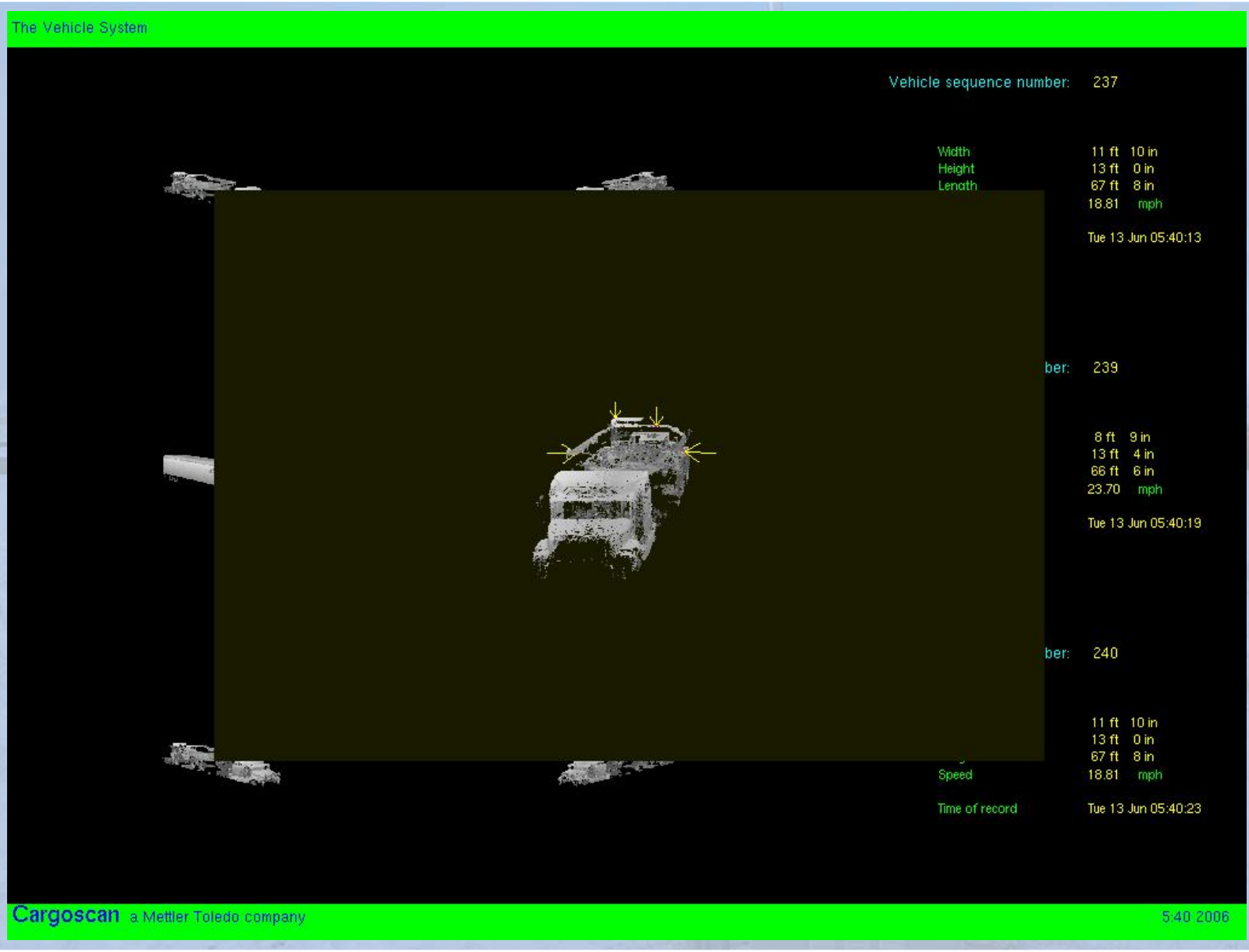
- 15 million trucks weighed in motion last year
- 24/7 on Interstates, near-95% open rate
- Pull in rates 15%-18% Statewide
- Data for ESAL classifications 4-14
- License Plate Reader deployment
- Ahead: 3D Dimensioning, Thermal Eye



New Cargoscan Laser Software for 3-Dimensioning Scanner at Flagler

- **Vehicle dimensioning system provides 3D image of vehicle with arrows identifying highest and widest points**

- **Provides actual L x W x H of vehicles**



3-D WIM Record

WIM DATA

000965 01/15/04 14:35 **Class:** 9 **Speed:** 41 mph **Gross:** 74322 lbs

Over Height Combin OverWt

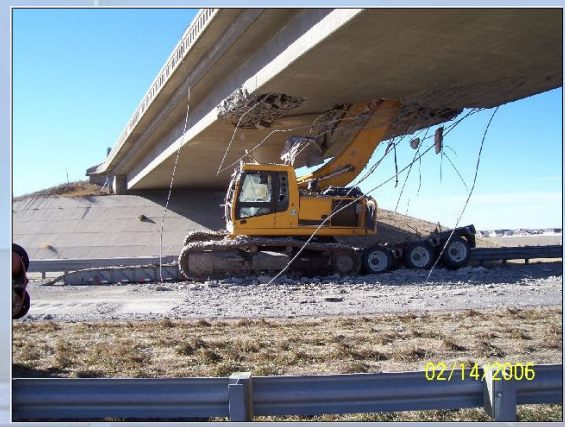
```
Length: 54'4"  Width: 10'    Height: 14'5"

1.............2...3.................................4...5
|----14.3-----|4.4|-----------31.5-------------|4.1|
|------18.7-------|                              |
|                 |---------------40.0----------------|
|-----------------------54.3-----------------------|

Axle     1       2       3       4       5
RGHT    4673    8941    9573    7338    6578
LEFT    4936    8607    8716    7446    7514

TOTL    9609   17548   18289   14784   14092
TNDM                  35837           28876

InBr 1-3  45446  2-5  64713
```

3D Dimensioning for Infrastructure Protection

- **Cargoscan 3D measuring lasers + integration with ITS & fixed WIM facilities = heightened ability to intercept violators and protect infrastructure**

Photos:

- **8-ton backhoe on top of a flatbed trailer**
- **Extended shovel arm of hardened refined steel**
- **Overpass: commercial-grade concrete, reinforced with 1 1/2 inch steel rebar spaced at 6 inch intervals in a criss-cross pattern layered at 1 foot vertical spacing**



Florida's Best Practices

- **Sites for ramp weighing facilities**
  - **Straight, far from major tangent for over 1 mile**
  - **At least 1 mile from ramps to avoid traffic weave/merge**
  - **Level elevation**
  - **Avoid**
    - Blocking private property access & egress
    - Wetlands
    - Endangered species habitats
    - Rezoning
    - Housing/commercial
- **WIM Life Expectancy**
  - **Load cell, 14+ years**
  - **Bending plate, 15 years**
  - **Quartz, 3+ years**
  - **Piezo varies**

Florida's Challenges

- **License Plate Readers**

  Vendor: The Revenue Market Inc. (TRMI)

  - **Night washout / weather**
  - **Affordable precise triggering systems**
  - **Wide lane coverage with single cameras**
  - **Damaged / low contrast plates**
  - **Infrared illumination = reduced optical character recognition (OCR) performance**
  - **Illumination to minimize motorist concerns**

California's WIM Experiences

- **110 WIM sites**
- **34 PrePass™ sites**
  (1 of 25 States, 259 sites)
- **Virtual weigh station prototype**
- **Data collection for trends and patterns**
  - **Example: Schuyler Heim Bridge outside ports of Long Beach & Los Angeles**
  - **18% of trucks overweight**
  - **1000 trucks/month exceed 100,000 pounds**
  - **Link to early failure of bridge deck: 3rd in 12 years**

Cordelia VWS in-ground equipment

Prototype VWIM Station - Cordelia, CA

California's WIM Results

- Caltrans considering widespread VWS
- Expecting reduction in infrastructure damage
- Still planning to use fixed stations at choke points
- PrePass™ and expedited commerce
  - Less time in inspections
  - Fuel economy
  - Reduced emissions
  - Reduced congestion at fixed stations

California's Best Practices

- Installations part of construction projects
- Concrete 150 foot approach, 50 foot following
  - Rapid set concrete
  - Developed flatness specification
  - Configuration & specification adopted by SHRP & LTPP
- Bending plate standard
  - Consistently accurate to ~5%
  - Functional in all but severe weather conditions

California's Challenges

- **Traffic volumes vs installation & maintenance**
- **Multiple ports of entry**
  - Mexico
  - Arizona
  - Nevada
  - Oregon
- **Multiple seaports of entry**
  - Long Beach
  - Los Angeles
  - Oakland
  - Stockton and Sacramento
- **Significant infrastructure damage from Pacific Rim traffic trucked through California**
- **Right-of-Way not available where most needed**
- **No earmarks for WIM funding**

Nevada's WIM Experiences

- **Early adopter: 1979 semi-portable**
- **Today**
  - **68 portable sites, 34 locations**
    - Short term counts
  - **6 permanent WIM locations: I-15 and I-80**
    - Continuous data 97% of time
- **2 uses: planning, screening for enforcement**
- **Data downloaded to NDOT Carson City**
- **General Packet Radio Service (GPRS) – alternative to landline and cell**

Nevada DOT Bending Plate Installation

Nevada's WIM Results

- Portable WIM, Elko County, SR-766
  - 78 LCVs screened for overweight
  - 74 found to be >5% over legal limit
  - 95% accuracy in identifying violators
- Continuous Permanent WIM, Elko
  - Pinpointed hours of most I-80 overweights
  - Detailed hourly report
  - NHP deployed resources during targeted time
- Laptop saves labor, avoids roadblocks, promotes safety
- Data use: roadway design, tax allocation, air quality, hourly reports, Federal submittal
- Installation costs
  - 4-lane, turnkey WIM: $200K
  - Traditional site: $1M not including ROW

Nevada's Best Practices (Part I)

- Permanent WIM at high volume locations
  - Locations/funding coincide with construction projects
- Portable for short term monitoring
  - Data collection/enforcement screening on lower order roads
- Upstream site selection for permanent WIM
  - Joint screening at check site in conjunction with enforcement activity

Nevada's Best Practices (Part II)

- **GPRS**
  - Reliable connectivity where landline's not practical
- **Annual maintenance/calibration**
  - Verification: type "9" vehicle drives across sensors 78 times
  - Portable WIM capacitive mats: self-calibration software coefficient
- **Agency collaboration**
  - Traffic Information: acquires, installs, maintains
  - Highway Patrol: enforces size and weight laws

Nevada's Challenges

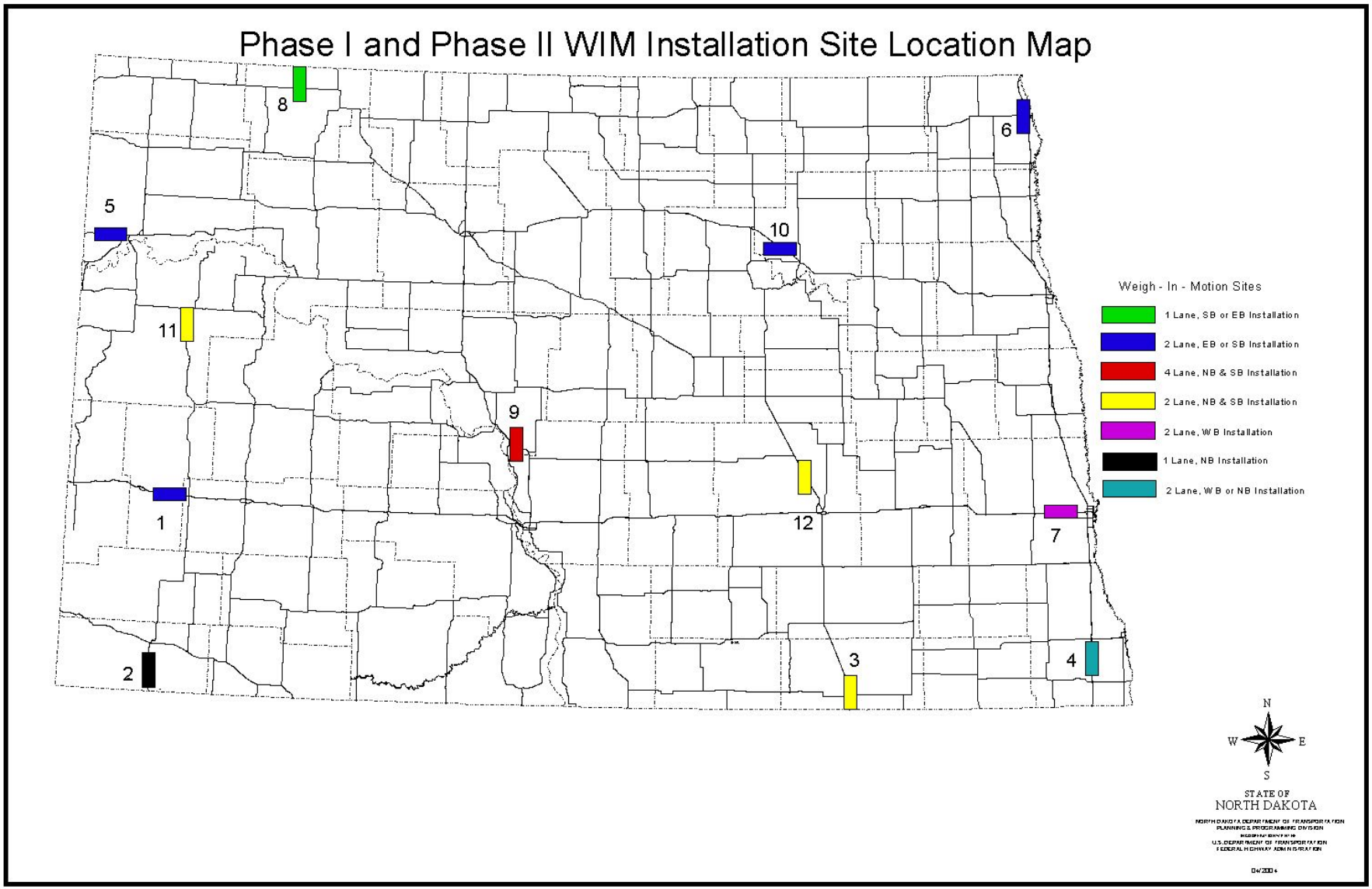
- Cost vs functionality
- Bending plate, Kistler, Class I Piezo
  - $10K for 2 sensors/each lane, PCC only
  - $10K for 2 sensors/each lane, ACC or PCC
  - $2K for 2 sensors/each lane, ACC or PCC
- Portable
  - $8K per sensor
  - Short life expectancy, 2-4 years
- Hidden costs
  - Peripherals
  - Maintenance/calibration
  - Training
- Virtual WIM long-range deployment
  - Interagency division of responsibility

North Dakota's WIM Experiences

- Increased mobile enforcement
- 12 Sites deployed
  - All Virtual WIM
  - Wireless Data transferred to 36 patrol units
  - $105K for single lane
  - $125K for two
  - No video capture or portable WIM
- Goals
  - Non-intrusive to improve mobility
  - Promote commerce
  - Alternative to static weigh stations
- Maintenance responsibilities
  - NDDOT: cabinets & roadway
  - NDHP: in-cruiser

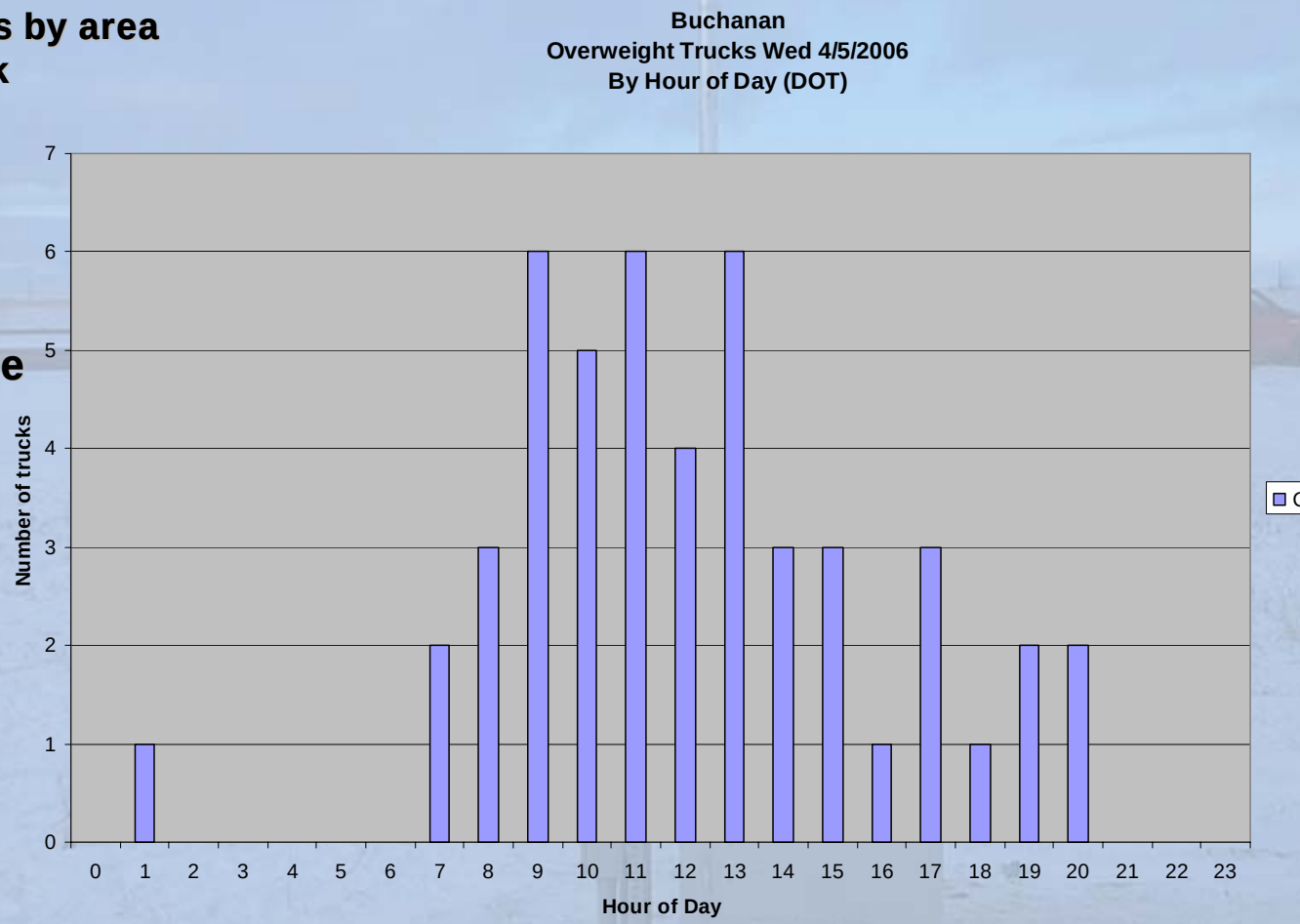
Video: North Dakota WIM

North Dakota WIM Map



North Dakota's WIM Results

- **Enforcement, screening, safety compliance**
  - **Target areas of known violations**
  - **Target worst violators by area and time of day/week**
    - Historical Data
    - Real-time Data
- **No ticketing directly from WIM readings**
- **Design of infrastructure to withstand loadings**
- **Legal weight trucks avoid delays**

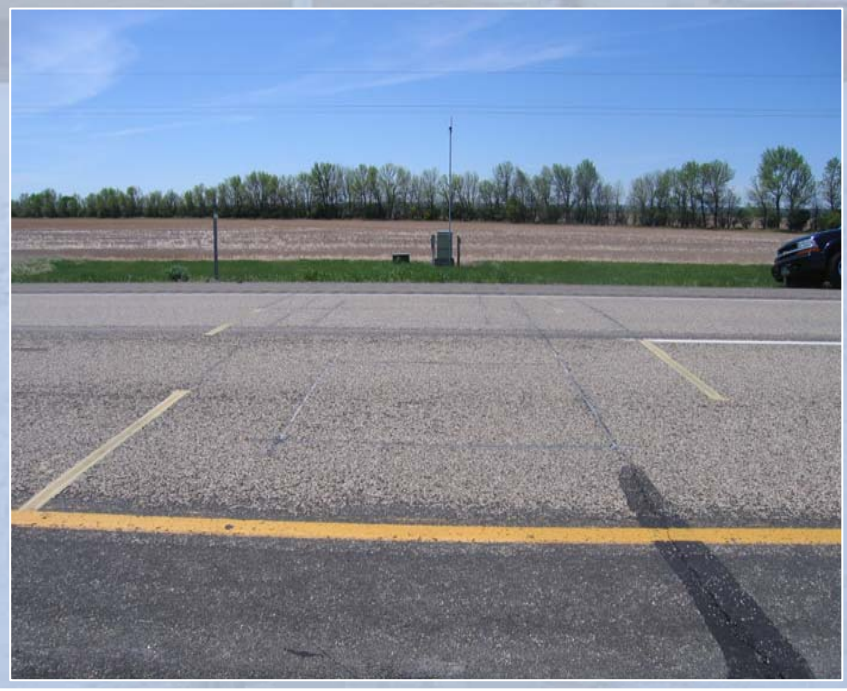


North Dakota's Best Practices

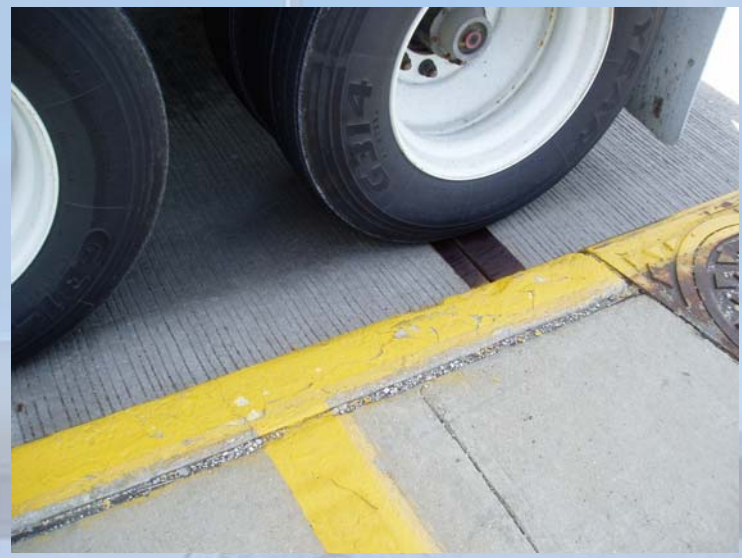
- Reasonable installation schedule
  - 1 lane instrumented/day
  - 1 lane/week calibration, wire hook ups, installation
- Funding: $2M for 12 sites, construction funds only
- Highway Patrol and DOT partnered in location selection
- PAT/IRD electronics, Kistler quartz piezo sensors
- Sites: no grade greater than + or -2%, tangent sections only
- Training: 8 hours for equipment 8 calibration: both HP and NDDOT personnel
- Annual calibration
- Long range VWIM deployment plan

North Dakota's Challenges

- After the warranty
- Manpower
- Communication options
- Calibration and maintenance: to contract or not to contract

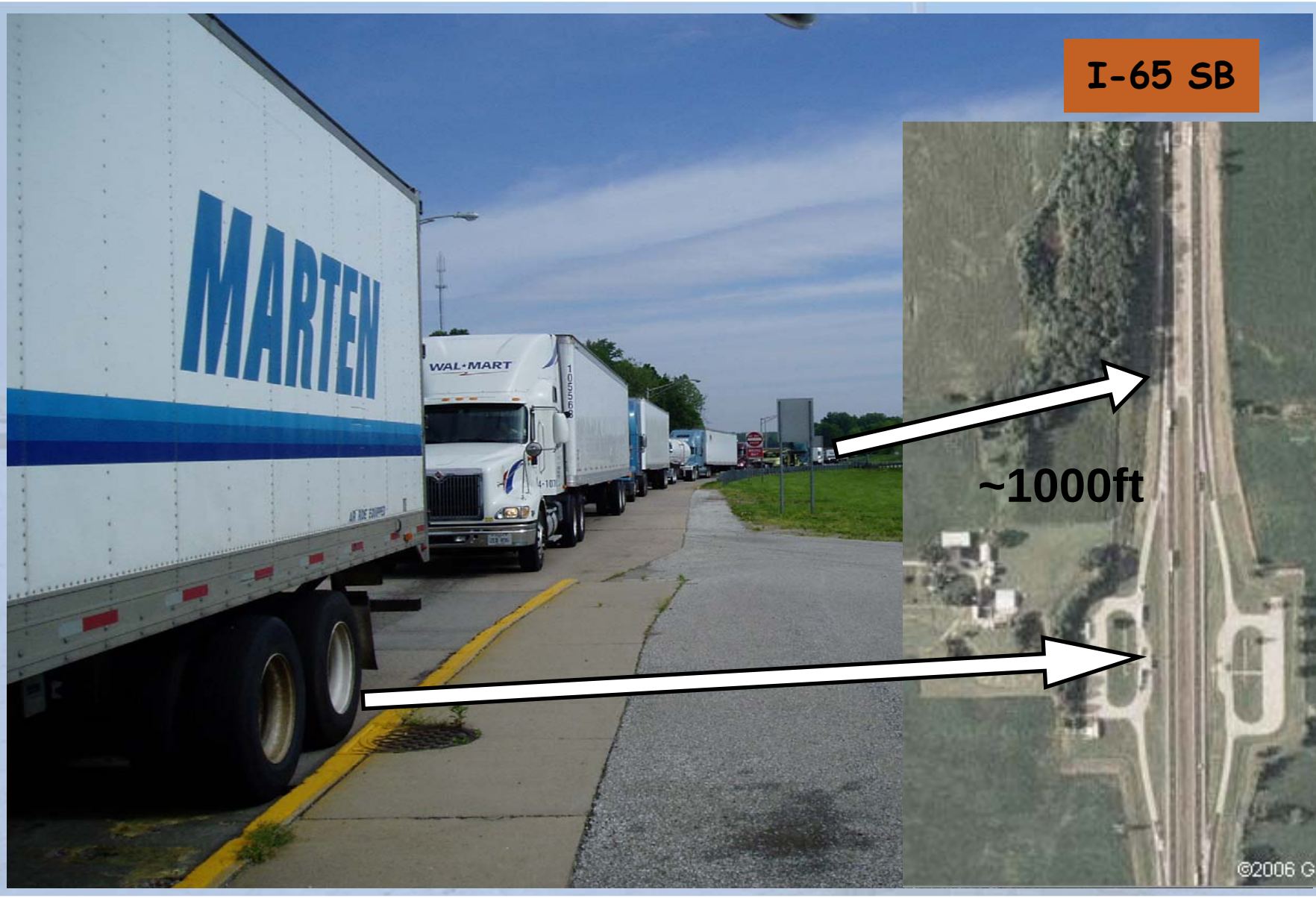


Indiana's WIM Experiences

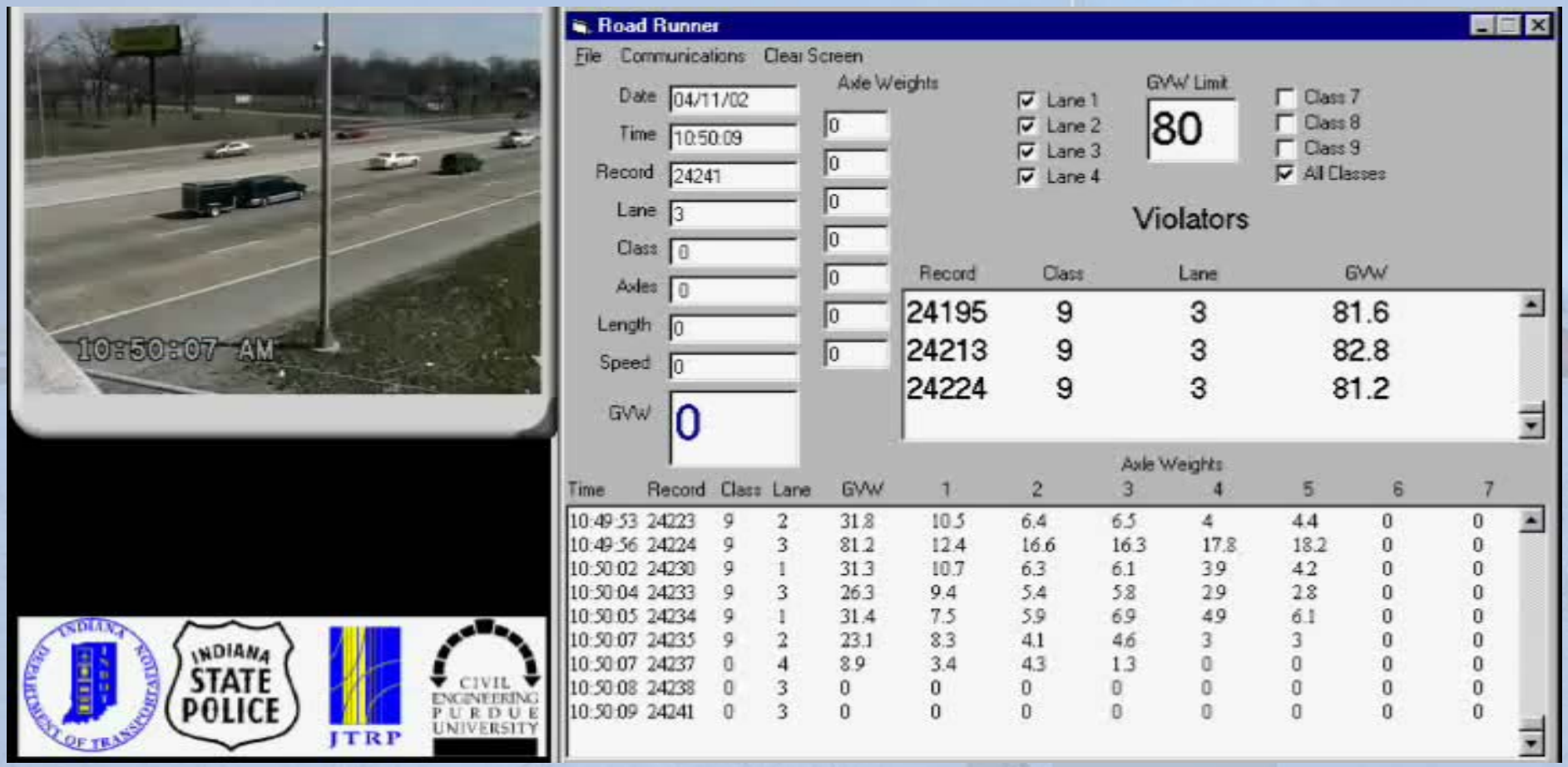


- Virtual WIM: 3 sites
- 50 WIM sites for data/research studies
- 12,000 miles of federal/State highways
- Pre-clearance: 2 of 10 permanent scales with mainline WIM
- Other 8: pre-clearance based on safety records
  (no weight check)

Seymour Weigh Station 5/9/06



Video: Overweight on Indiana's Borman Expressway Laptop Screen Seen by an Officer (continued)



Overweight on Indiana's Borman Expressway: Laptop Screen Seen by an Officer (continued)

Road Runner

File Communications Clear Screen

Date 04/11/02
Time 10:50:36
Record 24280
Lane 2
Class 9
Axles 5
Length 44
Speed 54.6
GVW 124.

Axle Weights: 11.5, 20.3, 21.1, 35.7, 35.9, 0, 0

Lane 1 ☑ Lane 2 ☑ Lane 3 ☑ Lane 4 ☑

GVW Limit 80

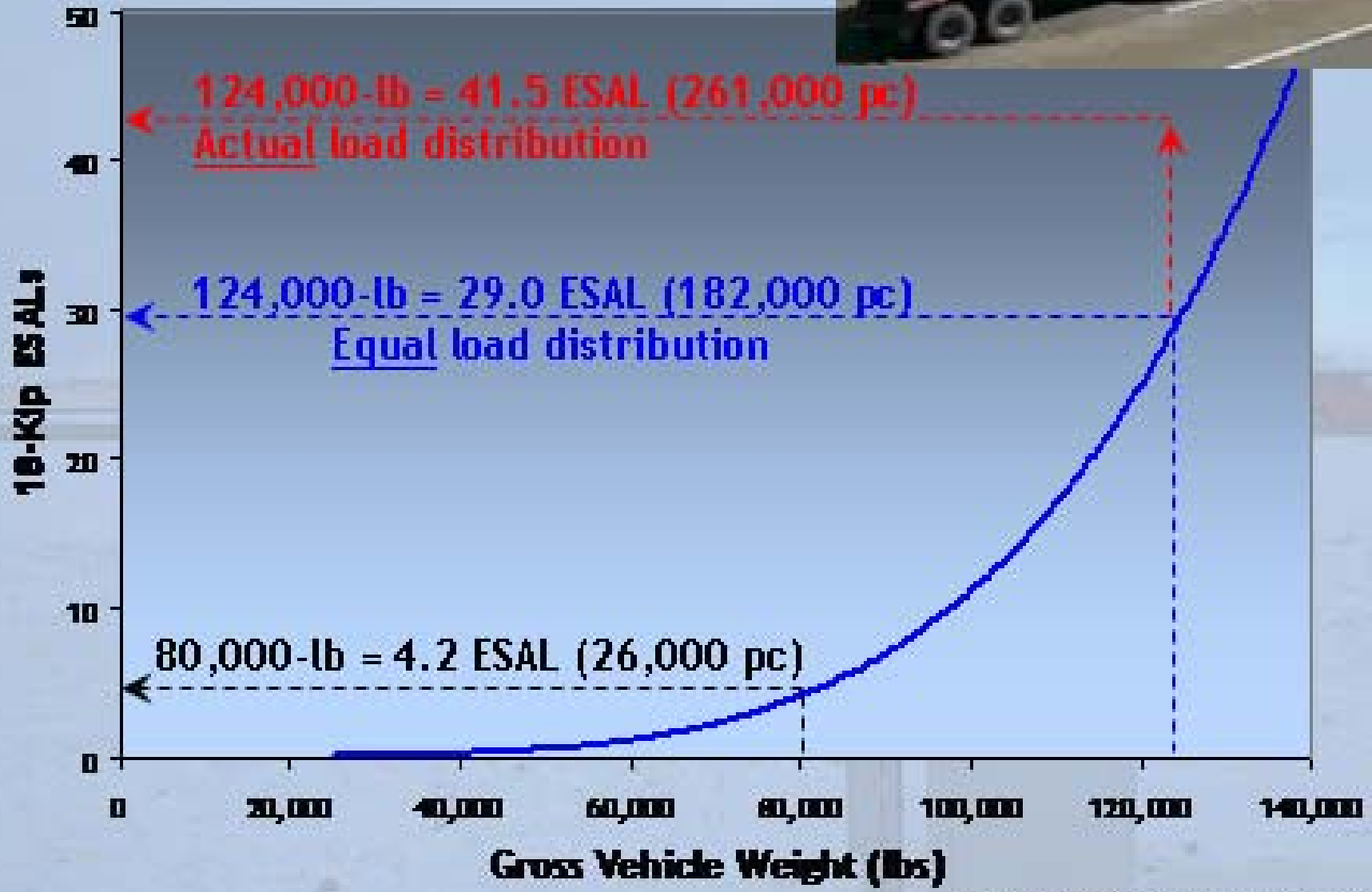
Class 7 ☐ Class 8 ☐ Class 9 ☐ All Classes ☑

Violators

Record	Class	Lane	GVW
24213	9	3	82.8
24224	9	3	81.2
24280	9	2	124.5

Time	Record	Class	Lane	GVW	Axle Weights 1	2	3	4	5	6	7
10:50:17	24254	8	3	19.2	5.9	6.3	3.5	3.4	0	0	0
10:50:17	24255	6	2	33.6	11.5	10.7	11.5	0	0	0	0
10:50:21	24265	11	3	60.9	10.4	13.2	14.1	10.3	12.9	0	0
10:50:27	24270	9	3	25.9	11.2	5	4.2	2.7	2.7	0	0
10:50:30	24271	9	3	76.1	9.2	17.5	18.7	15.3	15.3	0	0
10:50:32	24274	9	2	27.4	6.8	6.6	7.6	3.7	2.7	0	0
10:50:35	24276	9	2	27.4	8.2	5.6	5.9	2.3	5.2	0	0
10:50:36	24279	9	3	27.3	10.4	5.5	5.5	2.2	3.7	0	0
10:50:36	24280	9	2	124.5	11.5	20.3	21.1	35.7	35.9	0	0

VWIM in Indiana

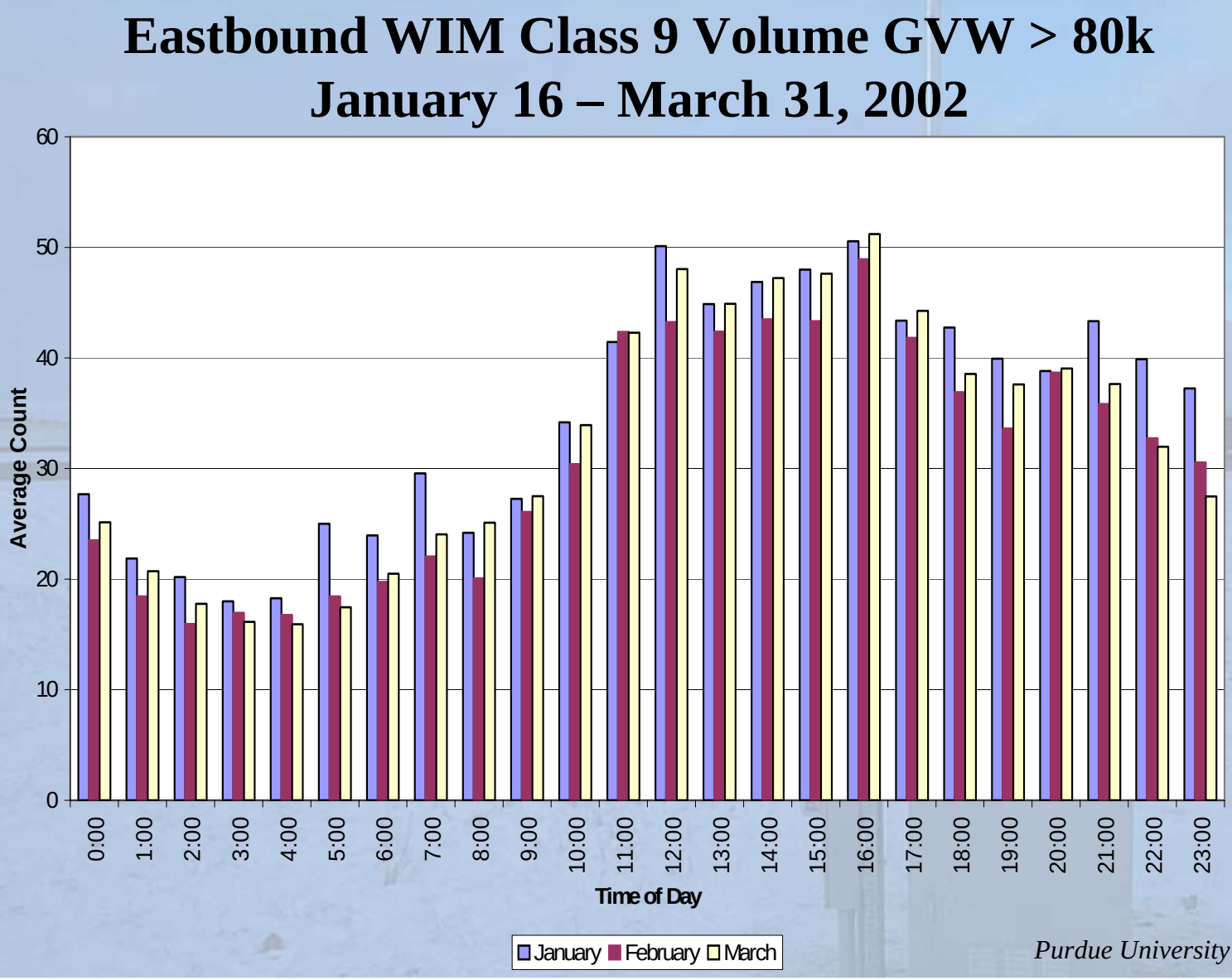


Dr. Andrew P. Nichols data/graphic

Indiana's WIM Results

- **Purdue Study on virtual scales**
  - **55x more efficient at citing overweights than traditional methods**
- **WIM, virtual scales, 24/7 collection**
  - **Plot hot spots**
  - **Intelligently decide where to work next**
- **Enforcement moves around**
  - **Advantages: covertness, unpredictability**
  - **Promotes weight law compliance**

I-80/94 – Hour of Day



Purdue University graphic

Indiana's Best Practices & Challenges

- **Strategic thinking/planning**
  - Convene stakeholders early on
  - Determine what each expects from sensor
- **Manpower**
  - More difficult to predict in rural than metro areas
  - Partner with enforcers to make sure VWIM operates where they work & can pull over safely
- **Pavement Prep**
  - Define standards for installation
  - 2 of Indiana's sites failed for lack thereof
- **Sensor life expectancy**
  - Sensors can outlast pavement
  - Assess how many years left in pavement & type of sensor that best matches up with volume of traffic
- **Quality control**
  - Viable, repeatable readings reinforce stakeholder confidence
- **Cameras**
  - Challenges: trucks blocked by traffic, multi-lane highways

Lead States at a Glance

- **Climate**
  - NV: arid, scorching desert, night freezes in high desert
  - FL: humid, coastal
  - IN: cold & hot, freezing & thawing
  - ND: extreme winters
  - CA: from mild coastal & salt air to desert, mountains & snow
- **Nevada**
  - Permanent WIM for high volume systems
  - Portable WIM for lower order roads
- **Florida**
  - Pioneer of License Plate Reader (LPR) systems
  - All Interstate facilities equipped with 45 mph ramp WIM lanes, 2 static scales, comfort/inspection barns, parking lots for 23-36 trucks
- **Indiana**
  - Unique working relationship among Indiana DOT, DOR/MCS, State Police & Purdue
  - Traffic Management Center, Indianapolis: INDOT & troopers
- **North Dakota**
  - Phase I and II WIM (03/04) is first large scale WIM program
  - Increased mobile enforcement
- **California**
  - Volume of sites: 1/6 of WIM sites in the country
  - Pacific Rim significant ports: freight bound for other States/countries

Lead State Common Issues

- Enforcing legal weights
- Priority of curbing congestion
  - FHWA: by 2020, more than 25,000 miles of highway will carry over 5000 commodity-carrying trucks each day
  - 1/5 of that mileage will be congested
- Budget, efficient use of resources
- Limited Right-of-Way
- Protecting infrastructure investment
- WIM-win with VWIM

Virtual WIM can eliminate backups at scales. Credentialing helps, but future growth demands VWIM to screen for violators so non-violators can move on down the road.

WIM-win

VWIM Boosts

- Enforcement
- Safety
- Data collection
- Asset management
- Accuracy of design
- Commerce
- Mobility

VWIM Saves

- Pavement life
- Maintenance costs
- Operating costs
- Construction costs
- ROW costs
- Manpower
- Troopers' time

WIM Lead States Team Contacts

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