



U.S. Department of Transportation
Federal Highway Administration



University of Rhode Island



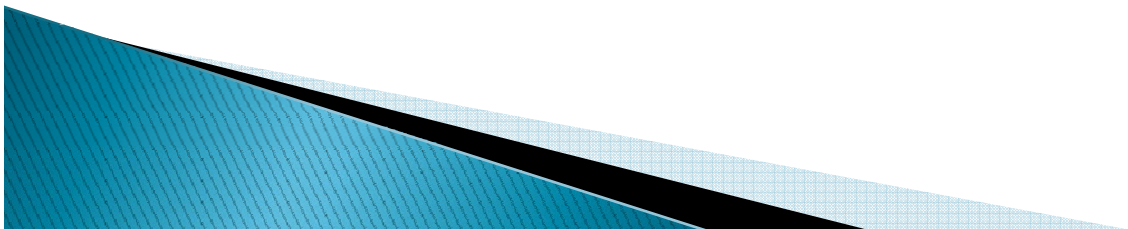
Analysis and Evaluation of WIM Data in Rhode Island, USA

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University of Rhode Island
Dwight David Eisenhower Fellowship Transportation Program



Outline

- ▶ Current Truck Load Level
- ▶ WIM sensors – Oversize/Overweight
- ▶ Study Areas
- ▶ Objectives
- ▶ Average Daily Truck Traffic
- ▶ Truck Classification
- ▶ Conclusions
- ▶ Acknowledgements



Current Truck Load Level

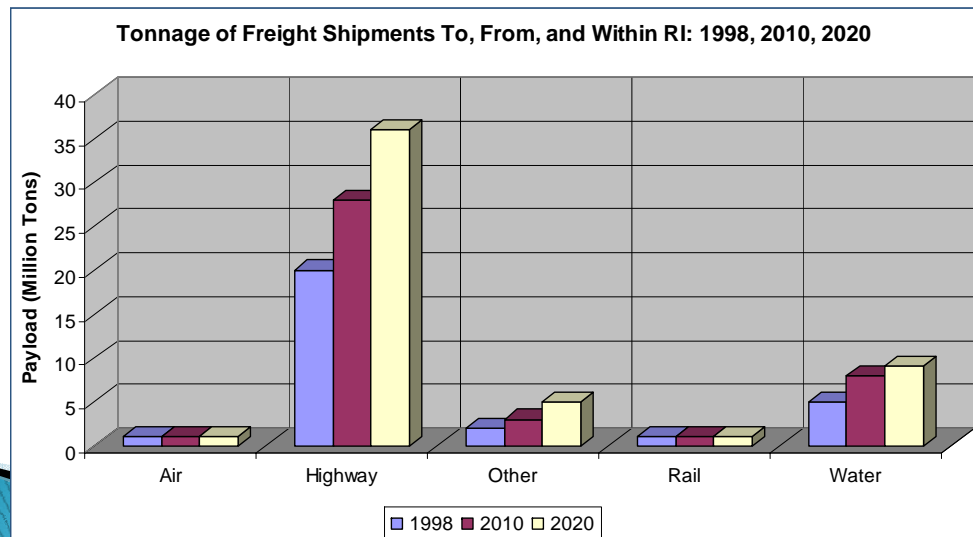
Rhode Island provides a transportation link to the Northeast corridor



Federal Highway Administration



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Use of highway to transport freight in RI is larger among other modes

Current Truck Load Level

- ▶ Growth in Truck Traffic is not unique to RI
- ▶ Nationwide ...
 - More Trucks
 - 11% increase in number of trucks from 1992 (5.1 million) to 1997 (5.7 million)
 - More Combination Trucks
 - 27% increase overall
 - 30% increase in trucks with single trailers (greatest increase among 5-or more axle trucks; 34% increase)
 - 74% increase in trucks with double trailers
 - 400% increase in trucks with triple trailers
 - Weighing more
 - 37% increase in the range of 50–100 kips
 - 46% increase in the range of 100–130 kips
 - 28% increase in the range of >130 kips

Source: U.S. Census Bureau, 1997 Economic Census: Vehicle Inventory and Use Survey, October 1999.

Current Truck Load Level

- ▶ Percent of Heavy truck loads is Increasing
- ▶ Even Heavier trucks are allowed to travel on network
 - Vehicle Permit System – “One Time Overloading”
 - Common practice for states to issue – “Routine Permits”
- ▶ More than 2.3 million overweight trucks on national network per year
 - Significant effect on pavements and bridges
 - Impose additional wear and tear on an already weakened infrastructure
- ▶ Aging Infrastructure
 - More than 50% of RI bridges are rated structurally deficient or functionally obsolete



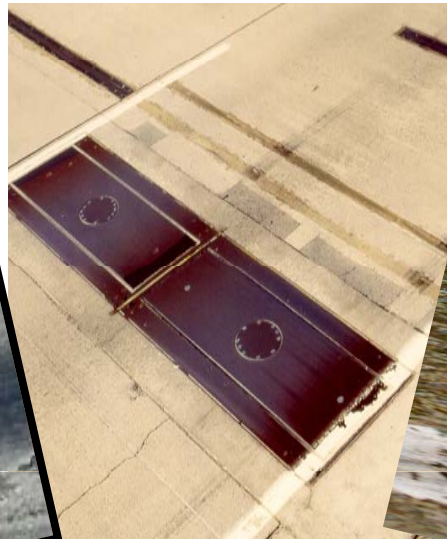
Weight in Motion Systems

- ▶ Devices designed to collect traffic data directly from roadway surface as they drive over a sensor
- ▶ More effective and less time consuming than static weight station systems

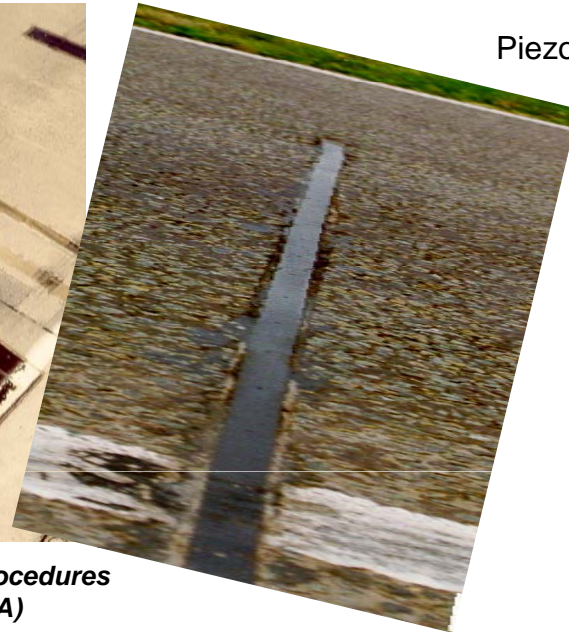
Bending Plate



Load Cell



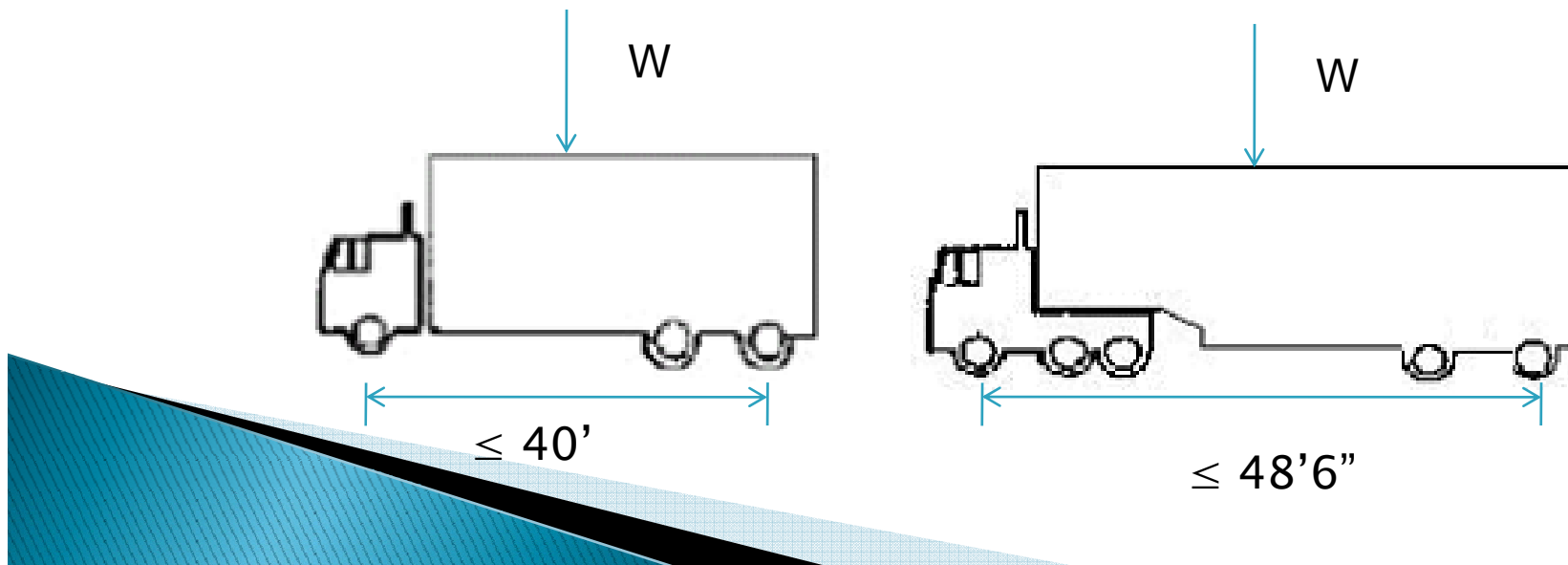
Piezoelectric



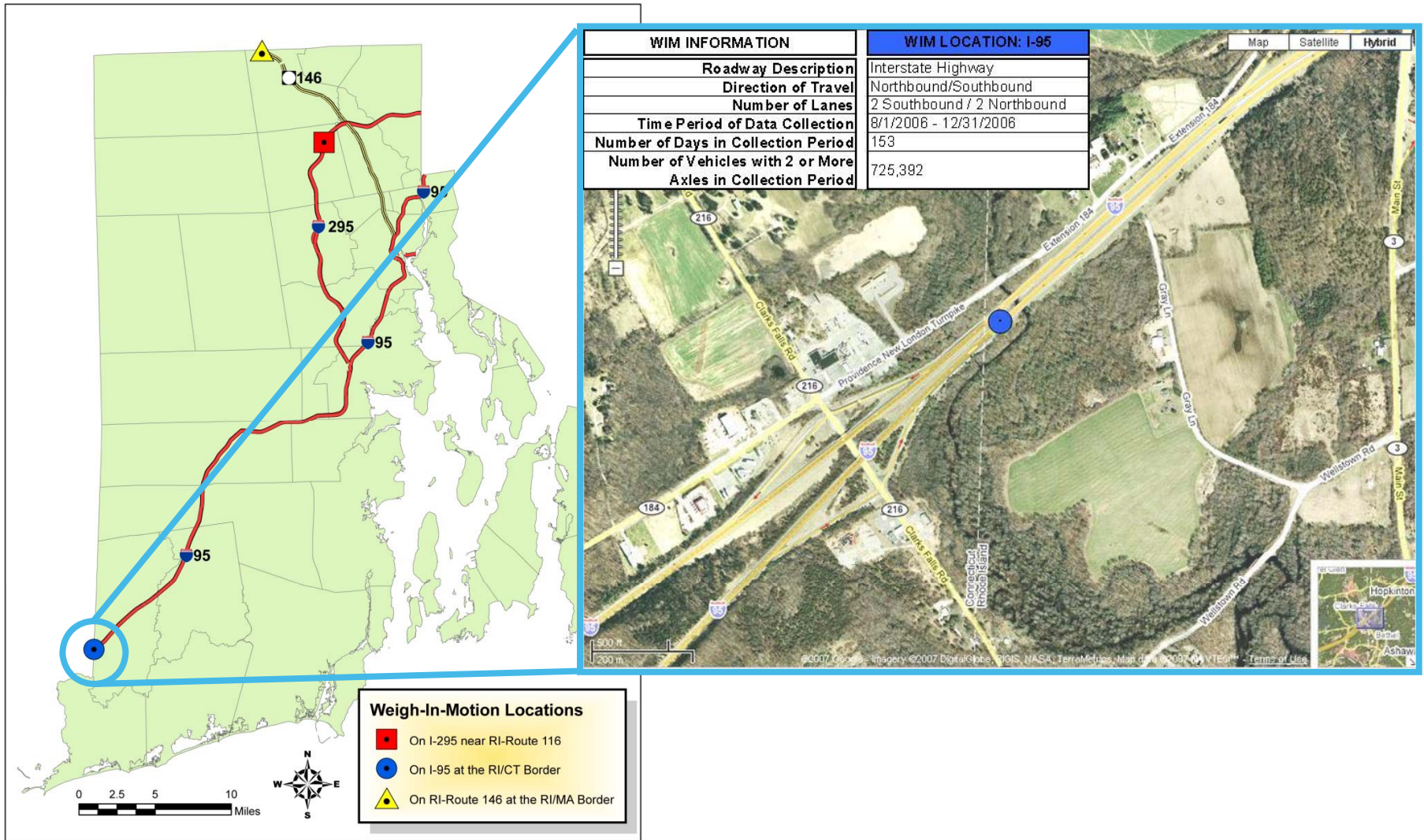
(Courtesy of *Quality Control Procedures for Weigh-in-Motion data FHWA*)

Oversize / Overweight

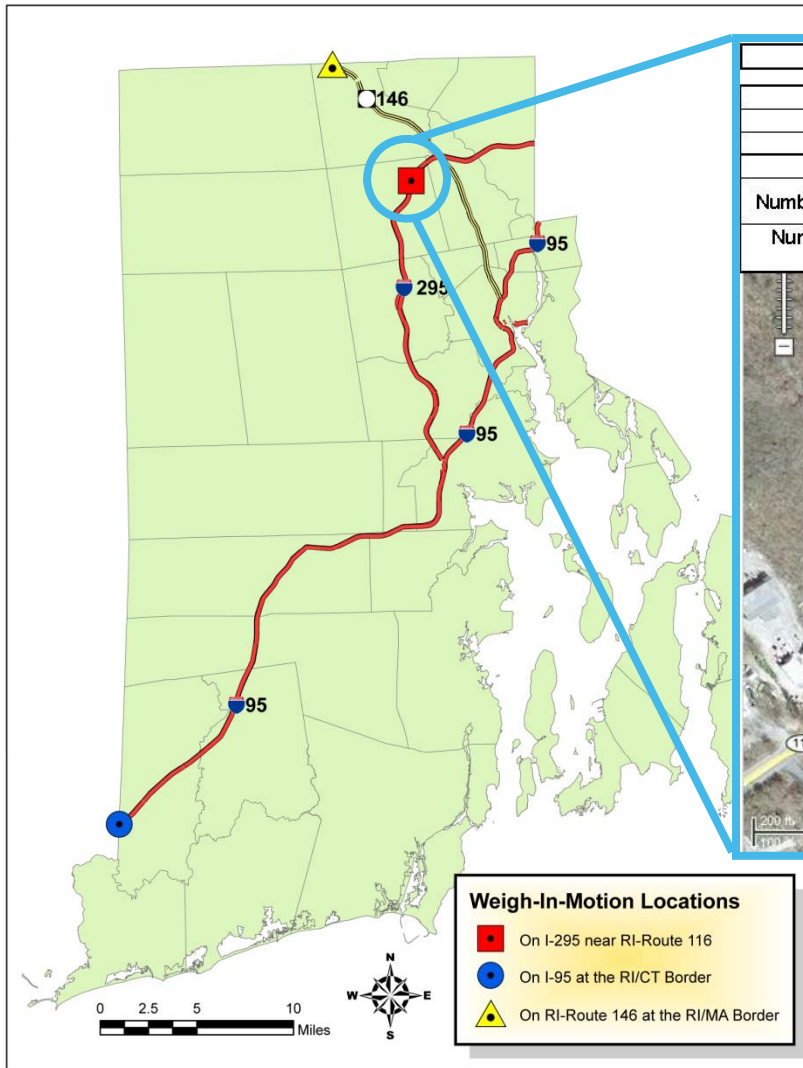
- ▶ For the State of Rhode Island
 - Oversize Limitations:
 - Maximum continuous length = 48 ft 6 in
 - Overweight Limitations:
 - Maximum Legal Gross Vehicle Weight = 80 kips



Study Areas



Study Areas



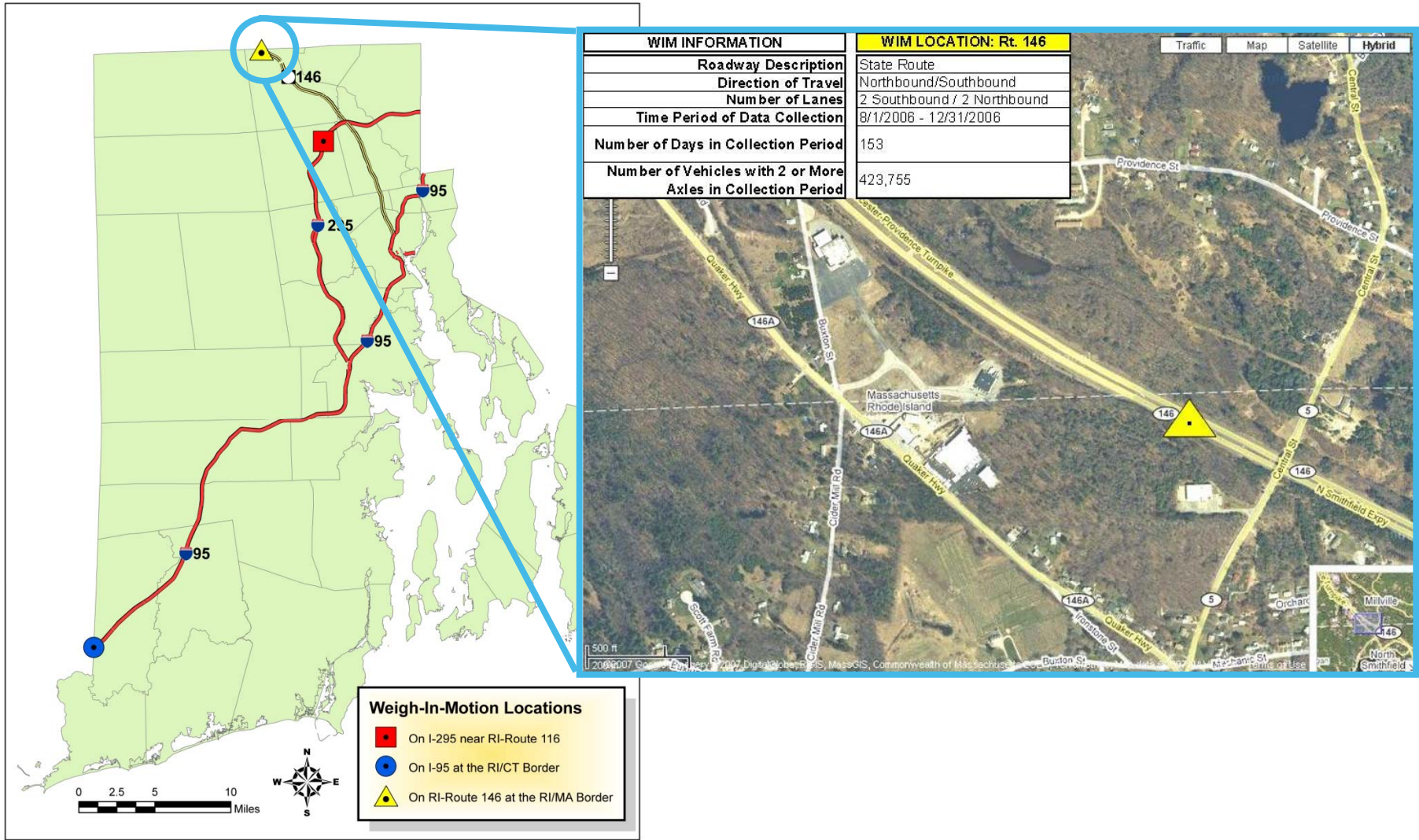
WIM INFORMATION	WIM LOCATION: I-295
Roadway Description	Interstate Highway
Direction of Travel	Northbound/Southbound
Number of Lanes	3 Southbound / 3 Northbound
Time Period of Data Collection	8/1/2006 - 12/31/2006
Number of Days in Collection Period	153
Number of Vehicles with 2 or More Axles in Collection Period	557,388

Map controls: Traffic, Map, Satellite, Hybrid

Map labels: W Reservoir Rd, George Washington Hwy, I-116, I-295, I-95, Harris Rd

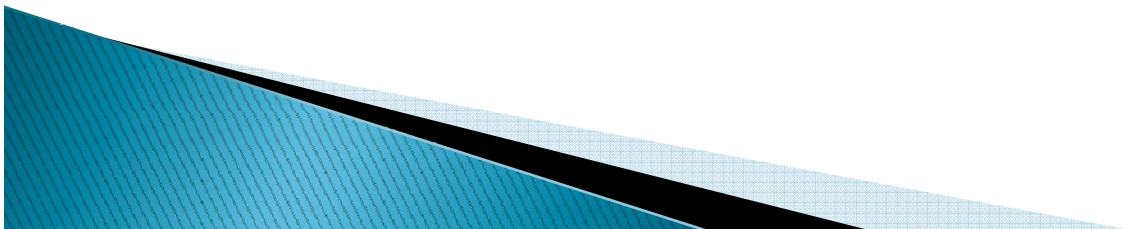
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Study Areas



Objectives

- ▶ Reformat and Isolate the data into month
- ▶ Evaluate the ADTT
- ▶ Classify truck data into:
 - Number of axles
 - Vehicle class
 - Vehicle type
- ▶ Calculate the total gross vehicle weight and by vehicle type



Weight-in-Motion Data

- ▶ Information is compiled
- ▶ Data is Isolated into months and reformatted
- ▶ For RT-146

August

File	Edit	Format	View	Help										
44.000	3.5000e+05	1.0000	3.0000	6.0000	10.000	12.000	7.0000	3.0000	5.0000	6.3900	2.0000	3.3100	14.1	
44.000	3.5000e+05	5.0000	4.0000	6.0000	10.000	12.000	7.0000	3.0000	5.0000	5.0700	2.0000	2.8700	13.4	
44.000	3.5000e+05	5.0000	5.0000	6.0000	10.000	12.000	7.0000	5.0000	5.0000	13.230	2.0000	6.1700	18.7	
44.000	3.5000e+05	5.0000	5.0000	6.0000	10.000	12.000	7.0000	5.0000	5.0000	9.4800	2.0000	3.5300	14.7	
44.000	3.5000e+05	1.0000	2.0000	6.0000	10.000	12.000	7.0000	3.0000	5.0000	3.5300	2.0000	1.9800	12.8	
44.000	3.5000e+05	1.0000	3.0000	6.0000	10.000	12.000	7.0000	3.0000	5.0000	7.0600	2.0000	3.3100	14.1	
44.000	3.5000e+05	1.0000	3.0000	6.0000	10.000	12.000	7.0000	3.0000	5.0000	7.2800	2.0000	3.9700	12.8	
44.000	3.5000e+05	1.0000	3.0000	6.0000	10.000	12.000	7.0000	3.0000	5.0000	7.0600	2.0000	3.7500	13.1	
44.000	3.5000e+05	5.0000	5.0000	6.0000	10.000	12.000	7.0000	5.0000	5.0000	21.610	2.0000	8.6000	21.0	
44.000	3.5000e+05	1.0000	2.0000	6.0000	10.000	12.000	7.0000	3.0000	5.0000	7.9400	2.0000	3.5300	13.1	
44.000	3.5000e+05	5.0000	4.0000	6.0000	10.000	12.000	7.0000	5.0000	5.0000	9.2600	2.0000	3.9700	13.1	
44.000	3.5000e+05	5.0000	5.0000	6.0000	10.000	12.000	7.0000	5.0000	5.0000	11.240	2.0000	5.0700	14.7	
44.000	3.5000e+05	5.0000	4.0000	6.0000	10.000	12.000	7.0000	3.0000	5.0000	6.8300	2.0000	3.5300	13.4	
44.000	3.5000e+05	1.0000	2.0000	6.0000	10.000	12.000	7.0000	5.0000	5.0000	16.540	2.0000	7.5000	20.6	
44.000	3.5000e+05	5.0000	4.0000	6.0000	10.000	12.000	7.0000	5.0000	5.0000	17.860	2.0000	9.2600	21.3	
44.000	3.5000e+05	5.0000	4.0000	6.0000	10.000	12.000	7.0000	3.0000	5.0000	7.2800	2.0000	3.5300	13.4	
44.000	3.5000e+05	1.0000	2.0000	6.0000	10.000	12.000	7.0000	5.0000	5.0000	18.520	2.0000	5.2900	13.4	
44.000	3.5000e+05	5.0000	5.0000	6.0000	10.000	12.000	7.0000	5.0000	5.0000	18.080	2.0000	6.3900	21.0	
44.000	3.5000e+05	1.0000	2.0000	6.0000	10.000	12.000	7.0000	5.0000	5.0000	12.570	2.0000	4.8500	18.0	
44.000	3.5000e+05	5.0000	4.0000	6.0000	10.000	12.000	7.0000	3.0000	5.0000	7.7200	2.0000	4.4100	14.4	
44.000	3.5000e+05	5.0000	4.0000	6.0000	10.000	12.000	7.0000	3.0000	5.0000	7.7200	2.0000	3.5300	14.4	
44.000	3.5000e+05	1.0000	3.0000	6.0000	10.000	12.000	7.0000	5.0000	5.0000	8.6000	2.0000	3.3100	14.1	
44.000	3.5000e+05	5.0000	5.0000	6.0000	10.000	12.000	7.0000	5.0000	5.0000	22.490	2.0000	5.0700	20.6	
44.000	3.5000e+05	5.0000	5.0000	6.0000	10.000	12.000	7.0000	5.0000	5.0000	8.3800	2.0000	3.3100	13.7	
44.000	3.5000e+05	1.0000	2.0000	6.0000	10.000	12.000	6.0000	3.0000	5.0000	6.6100	2.0000	2.6500	13.1	
44.000	3.5000e+05	1.0000	2.0000	6.0000	10.000	12.000	6.0000	5.0000	5.0000	8.8200	2.0000	4.1900	14.1	

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ADTT

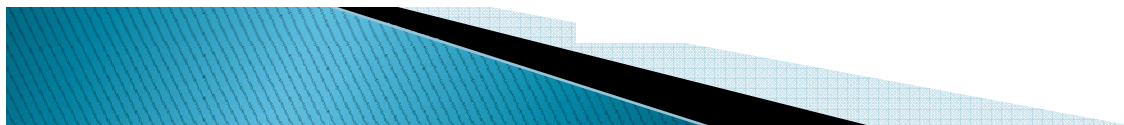
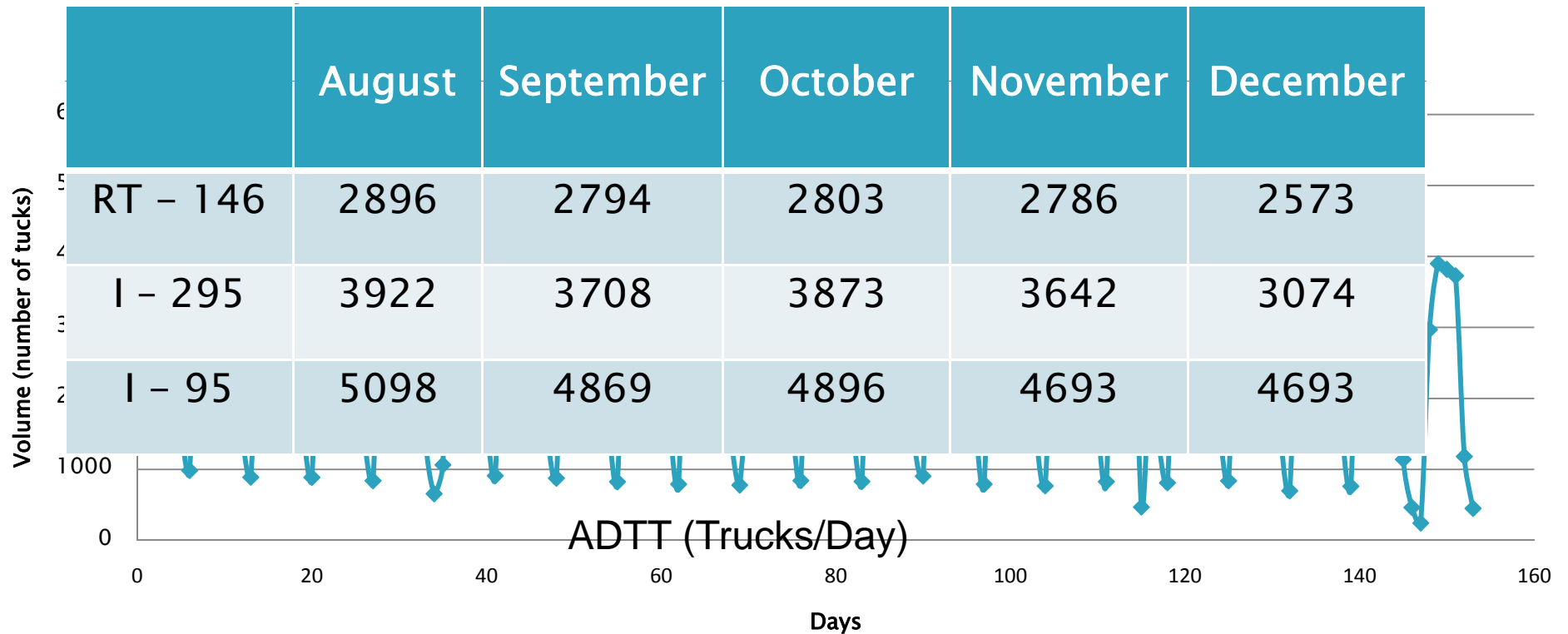
- ▶ Average Daily Truck Traffic
- ▶ Data divided into hours of each day
- ▶ For RT.146 – August

Days	Hours									
	1	2	22	23	24	
1	63	47					59	55	64	
2	49	51					59	51	65	
3	56	51					68	57	67	
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29	55	54					69	48	68	
30	54	41					81	61	80	
31	58	52					82	76	67	

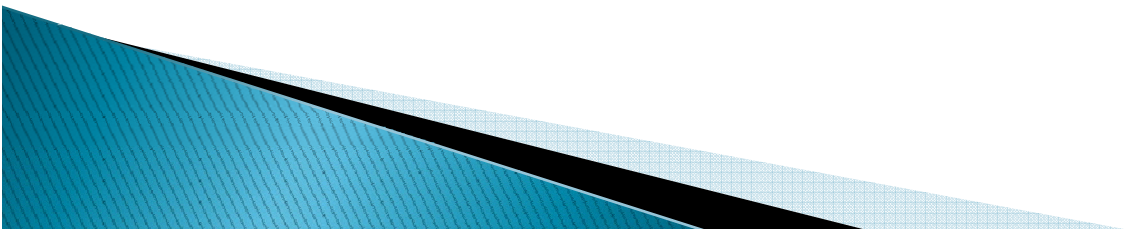
47.8 41.7 63.9 52.0 54.8 2896

ADTT

- ▶ For I – 295
- ▶ Around 5000 trucks/day for weekdays



ADTT

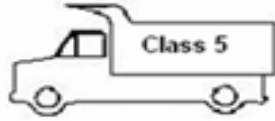
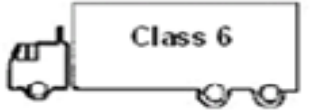
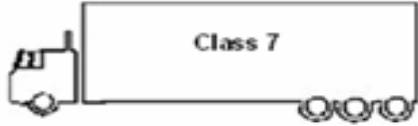
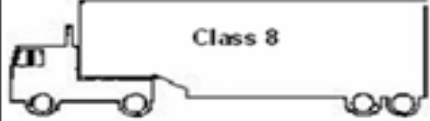
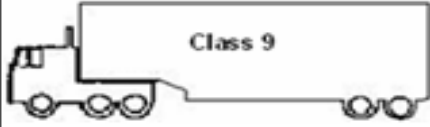
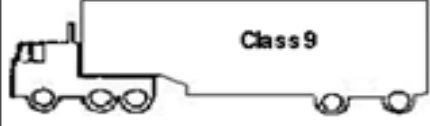
- ▶ Dramatic drops for August–December 2006
 - September 4, Monday: Labor Day
 - October 9, Monday: Columbus Day
 - November 23, Thursday
 - November 24, Friday
 - December 25, Monday: Christmas Day
- Thanksgiving Day
- 

Number of Axles

- ▶ Calculated from spacing magnitude
- ▶ For example:
 - If spacing 4 is equal to 0 then the number of axles is equal to 4
- ▶ For I-95:
 - The 99 % of trucks' number of axles varies from 2 to 5

	2	3	4	5	sum
August	21.15	4.48	7.37	66.10	99.1
September	20.60	4.90	7.51	66.17	99.2
October	19.78	4.92	6.91	67.62	99.2
November	19.82	4.81	6.51	68.02	99.2
December	19.43	5.01	6.20	68.60	99.2

Vehicle Class and Vehicle Type

	Vehicle Type	Axle Spacing (min/max) , (ft)
VT 03	 <p>Class 5</p> <p>Single unit truck, 2 axles</p>	AXS 1 (6/21)
VT 11	 <p>Class 6</p> <p>Single unit truck, 3 axles</p>	AXS 1 (0/20) AXS 2 (0/5.8)
VT 17	 <p>Class 7</p> <p>Single trailer, 4 axles</p>	AXS 1 (0/40) AXS 2 (0/9.8) AXS 3 (0/5.8)
VT 19	 <p>Class 8</p> <p>Single trailer, 4 axles</p>	AXS 1 (0/40) AXS 2 (0/40) AXS 3 (0/5.8)
VT 22	 <p>Class 9</p> <p>Single trailer, 5 axles</p>	AXS 1 (0/40) AXS 2 (0/5.8) AXS 3 (0/40) AXS 4 (0/5.8)
VT 23	 <p>Class 9</p> <p>Single trailer, 5 axles</p>	AXS 1 (0/40) AXS 2 (0/5.8) AXS 3 (0/40) AXS 4 (0/11.7)

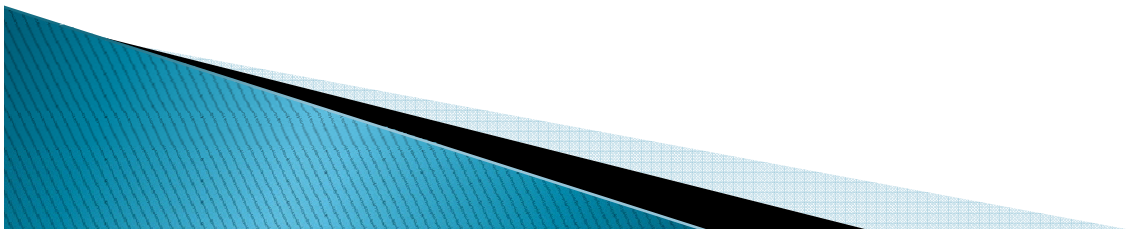
Vehicle Class

- ▶ Data given by the WIM Stations
- ▶ Classified in numbers from 1–12
- ▶ For I–95:
 - Around the 97 % of the trucks are class 5 to 9
 - Equivalent to trucks which number of axles are form 2 to 5 axles

	5	6	7	8	9	sum
August	21.15	3.97	0.50	7.38	63.68	96.7
September	20.60	4.42	0.68	7.31	63.75	96.8
October	19.78	4.39	0.53	6.91	65.25	96.9
November	19.82	4.30	0.45	6.57	65.63	96.8
December	19.43	4.38	0.47	6.36	66.34	97.0

Vehicle Type

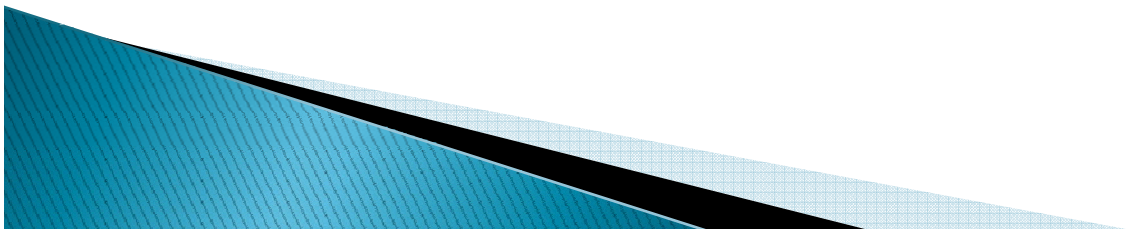
- ▶ Vehicle type is in function of:
 - Number of axles
 - Spacing
 - Axles' Weight
- ▶ Following New Jersey DOT vehicle type description



Vehicle Type

- ▶ For I-95:
 - The 92 % of the trucks are type:
 - 3, 11, 17, 19, 22, 23

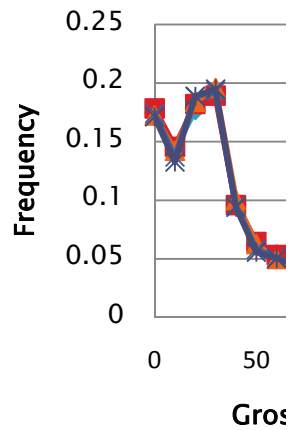
	3	11	17	19	22	23	sum
August	20.13	2.01	0.31	6.20	57.63	5.62	91.9
September	19.65	2.06	0.50	6.14	57.88	5.43	91.7
October	18.88	2.04	0.39	5.82	59.19	5.63	92.0
November	18.94	1.98	0.32	5.61	59.94	5.31	92.1
December	18.58	2.12	0.33	5.33	60.83	5.10	92.3



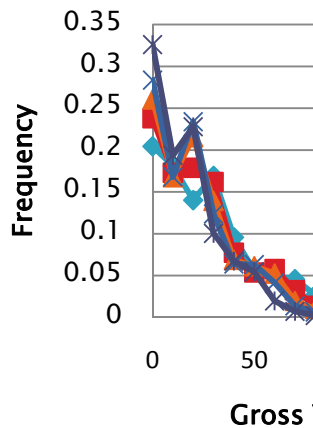
Gross Vehicle Weight

- ▶ Total Gross Vehicle Weight
 - Includes all vehicle types

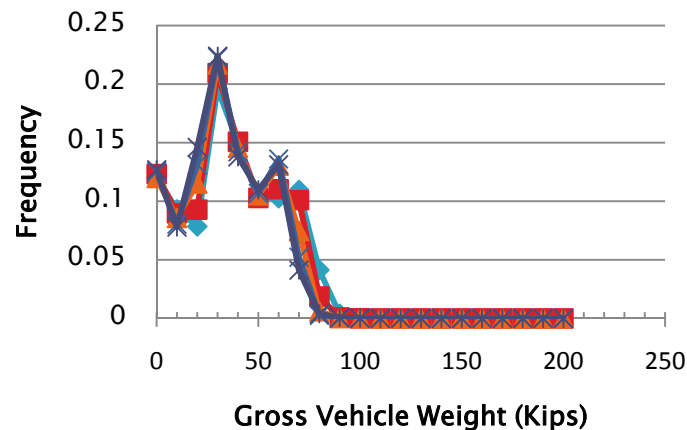
Total GW RT-146



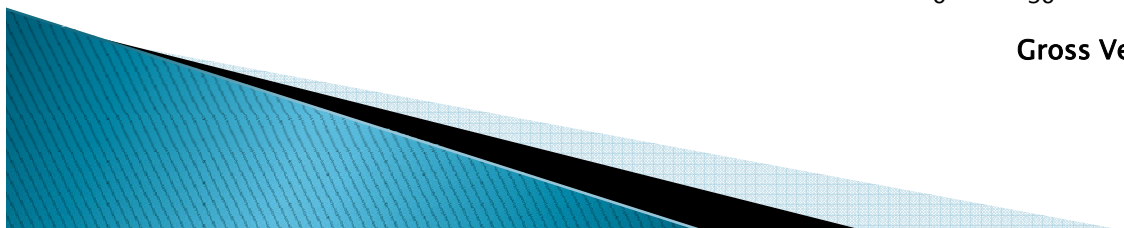
Total GW I-295



Total GW I - 95

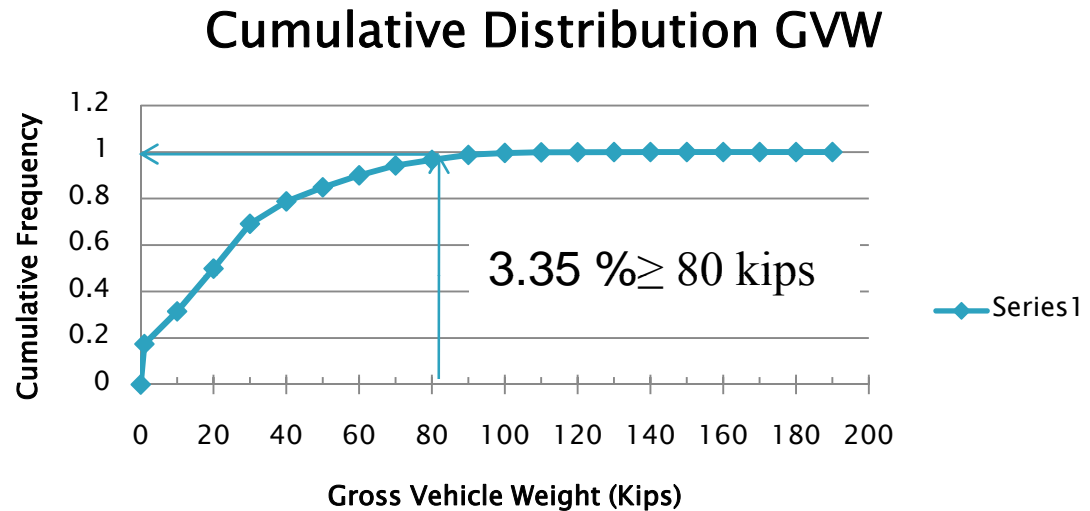


- ◆ August
- September
- ▲ October
- × November
- ✱ December



Gross Vehicle Weight

- ▶ Cumulative Distribution for RT-146

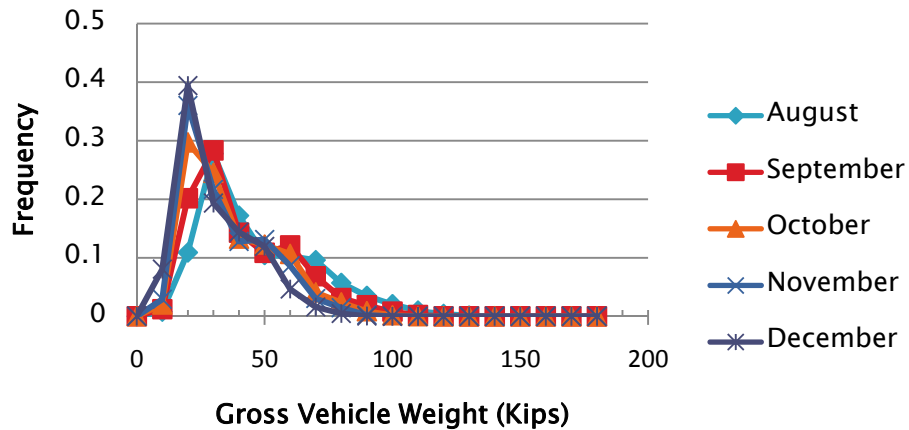


Site	Overload Number	Overload Frequency
RT - 146	14220	0.0335
I - 295	6244	0.0112
I - 95	1164	0.0016

Gross Vehicle Weight

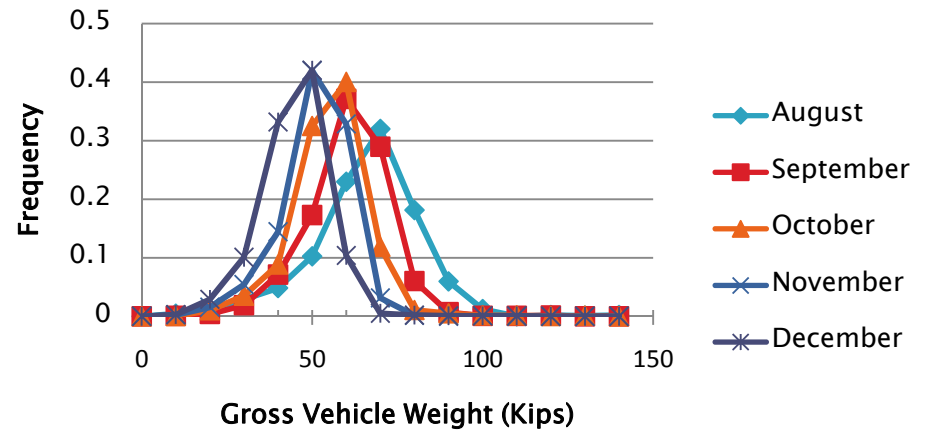
- ▶ GWV by Vehicle Type
 - ◉ Typical GWV profile

GWV_VTNJ22

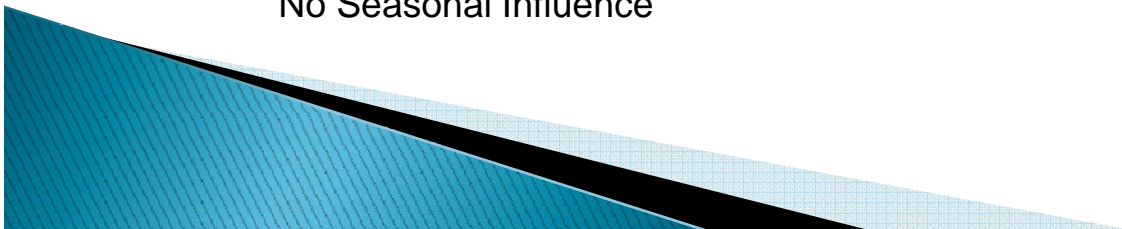


No Seasonal Influence

GWV_VTNJ17

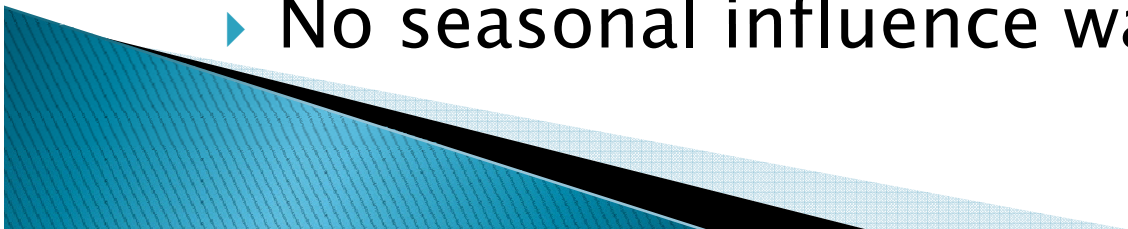


Seasonal Influence



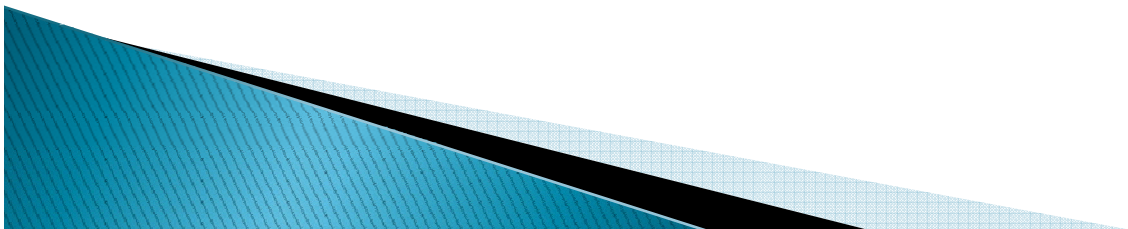
Conclusion

- ▶ Data was successfully divided into months
- ▶ ADTT
- ▶ Data was classified into:
 - Number of axles
 - Vehicle class
 - Vehicle type
 - Most common
 - 2 axles single unit truck, class 5, VT 03
 - 5 axles single trailer, class 9, VT 22
- ▶ Highest overload frequency:
 - 3.35% for RT-146
- ▶ No seasonal influence was found



Acknowledgements

- ▶ Dr. Mayrai Gindy
- ▶ Cornelius Albrecht
- ▶ URI Transportation Center
- ▶ UPRM Transportation Center
- ▶ Dr. Alberto Figueroa
- ▶ Dwight David Eisenhower Fellowship
Transportation Program
- ▶ FHWA



Questions
???

