



# Overview

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- ❑ Analysis
  - Age Distribution
  - Fleet Mixture
  - Average Speed compared to user defined Operating Mode Distributions
- ❑ Results
- ❑ Findings
- ❑ Questions

# Background

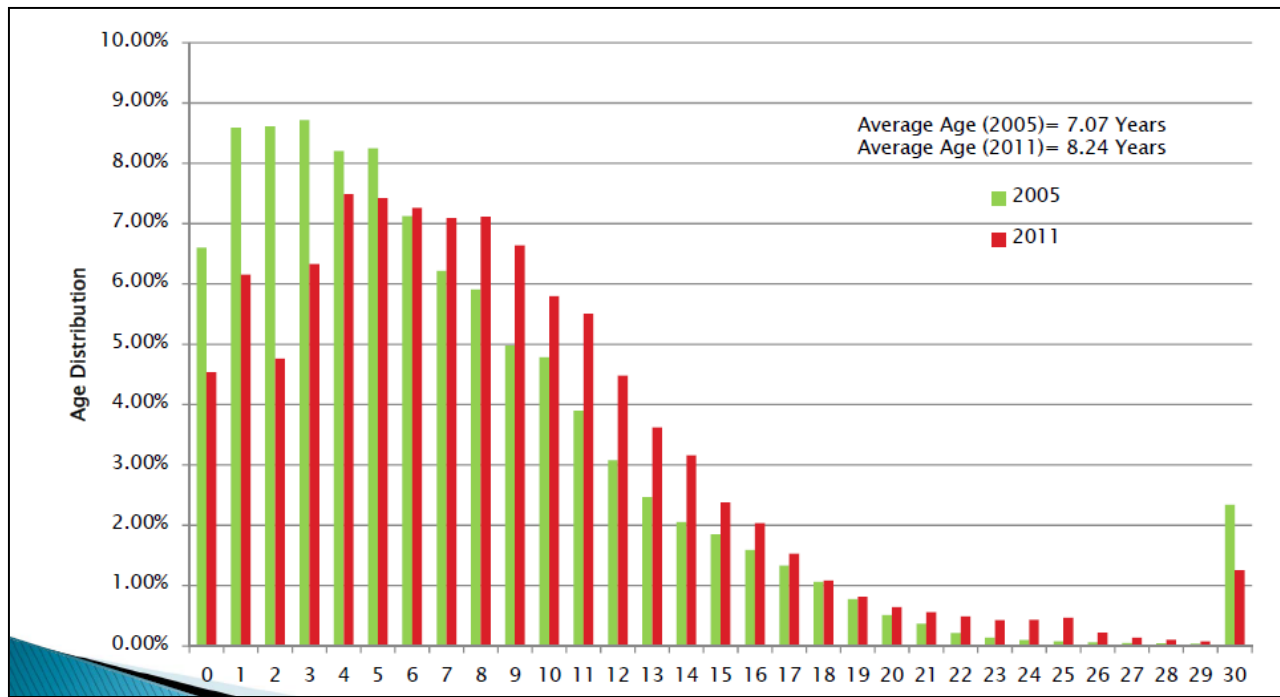
- ❑ Project sponsored by Federal Highway Administration (FHWA)
- ❑ MOVES Regional Level Sensitivity Analysis
  - Report released in December of 2012
- ❑ MOVES Project Level Sensitivity Analysis
  - Was a follow up analysis to the Regional Level Sensitivity Analysis
  - Parameters chosen to be analyzed for the Project Level analysis were based on some of the findings from the Regional Level Analysis
  - Final Report completed in March

# Age Distribution

- ❑ Age Distribution was analyzed for the Regional Level Sensitivity Analysis
- ❑ The Project Level Analysis applied more meaningful variations
  - Reached out to the Metropolitan Washington Council of Governments (MWCOCG) to obtain data.
- ❑ Analyzed multiple vehicle types
  - Passenger Cars
  - Transit Buses
  - Single Unit Trucks

# Age Distribution

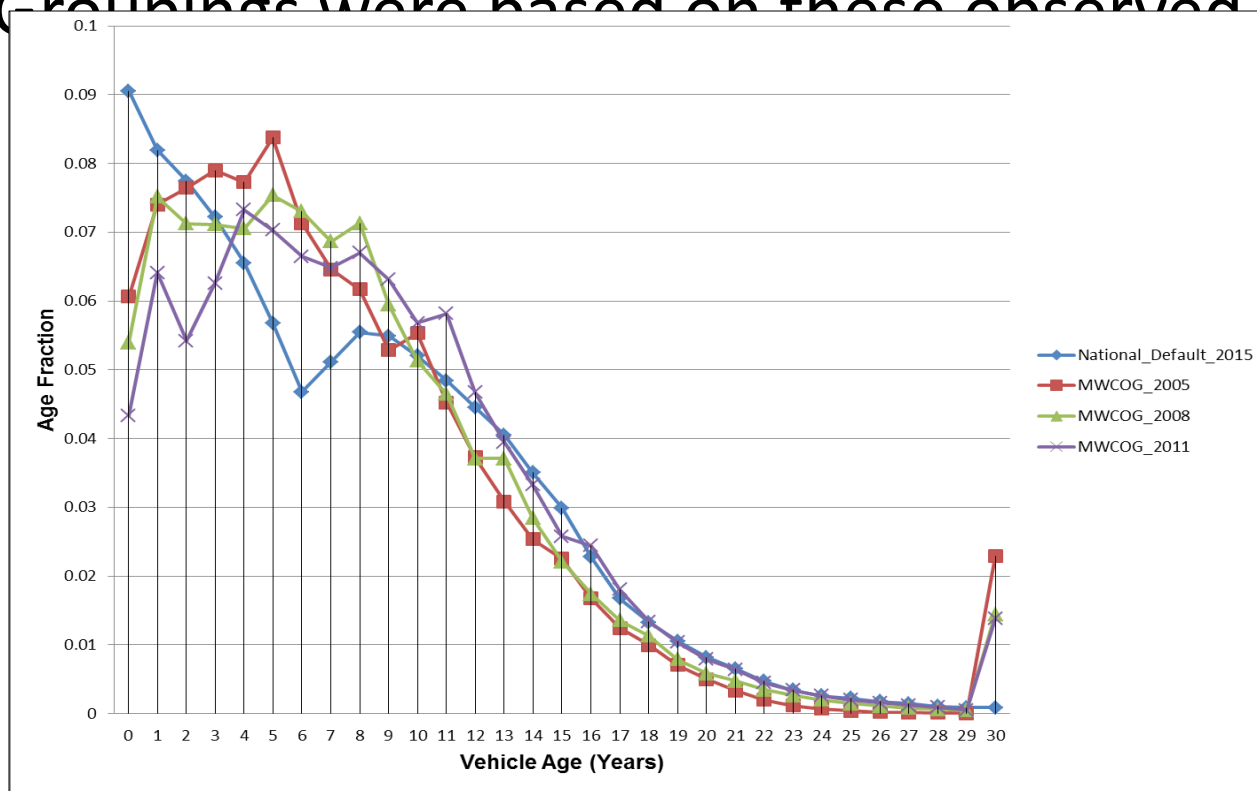
- ❑ MWCOG provided data for 2005, 2008, and 2011
- ❑ The data showed the fleet aging throughout the years



# Passenger Car Age Distribution

## Trends

- ❑ More variable for newer model years
- ❑ Less variable for latter years
- ❑ Age Groupings were based on these observed trends



# Passenger Car Age Distribution

## Groupings

- Passenger Cars were put into five age groups
- Five Scenarios were analyzed
- Scenario 1 has the least amount of variation based

upon the observed data

- Scenario 5 has the highest amount of variation base

upon the observed data

Vehicle Age Range	Baseline Age Fractions	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
0-3 years	0.32	-5%	-10%	-20%	-30%	-45%
4-7 years	0.22	-2%	-5%	-7.50%	-10%	-20%
8-12 years	0.26	+5%	+10%	+20%	+30%	+50%
13-17 years	0.14	+4%	+8%	+15%	+20%	+30%
18-30 years	0.06	+2.5%	+5%	+7.5%	+10%	+25%
Average Vehicle Age	<b>7.48</b>	<b>7.68</b>	<b>7.86</b>	<b>8.21</b>	<b>8.53</b>	<b>9.24</b>

# Passenger Car Age Distribution Results

Source Type	Pollutant	Case	Average Age	Emission Rate (gram/vehicle-mile)	Percent Change
Passenger Car	CO	Baseline	7.48	1.484	-
		Scenario 1	7.68	1.516	2.15%
		Scenario 2	7.86	1.548	4.14%
		Scenario 3	8.21	1.604	7.49%
		Scenario 4	8.53	1.653	10.24%
		Scenario 5	9.24	1.776	16.47%
	NOX	Baseline	7.48	0.2929	-
		Scenario 1	7.68	0.3017	2.91%
		Scenario 2	7.86	0.3104	5.63%
		Scenario 3	8.21	0.3246	9.76%
		Scenario 4	8.53	0.3367	12.99%
		Scenario 5	9.24	0.3700	20.84%
	VOC	Baseline	7.48	0.0398	-
		Scenario 1	7.68	0.0409	2.88%
		Scenario 2	7.86	0.0421	5.56%
		Scenario 3	8.21	0.0439	9.51%
		Scenario 4	8.53	0.0455	12.62%
		Scenario 5	9.24	0.0502	20.78%
	PM2.5	Baseline	7.48	0.0067	-
		Scenario 1	7.68	0.0068	1.16%
		Scenario 2	7.86	0.0069	2.27%
Scenario 3		8.21	0.0070	4.01%	
Scenario 4		8.53	0.0071	5.56%	
Scenario 5		9.24	0.0075	9.94%	

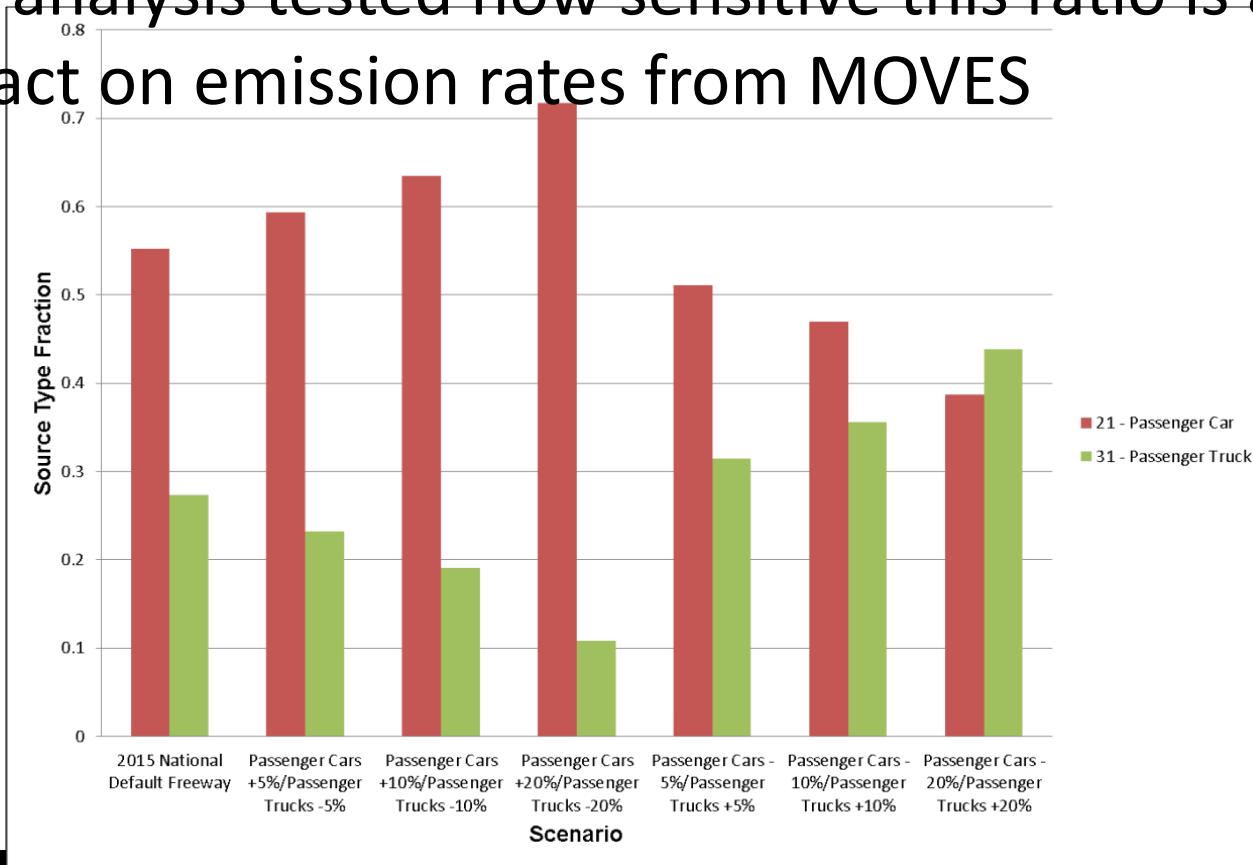


# Fleet Mix

- ❑ Analyzed five cases to determine how sensitive fleet can be a specific MOVES link
- ❑ The five cases include
  - Geographic area comparisons of fleet mix(Georgia Tech provided data)
  - Passenger Car to Passenger Truck ratio
  - Percent Truck Mix
  - Truck Type Mix
  - Transit Bus Mix

# Passenger Car to Passenger Truck Ratio

- ❑ Passenger Car and Passenger Truck CO emission rates are significantly different
- ❑ This analysis tested how sensitive this ratio is and the impact on emission rates from MOVES



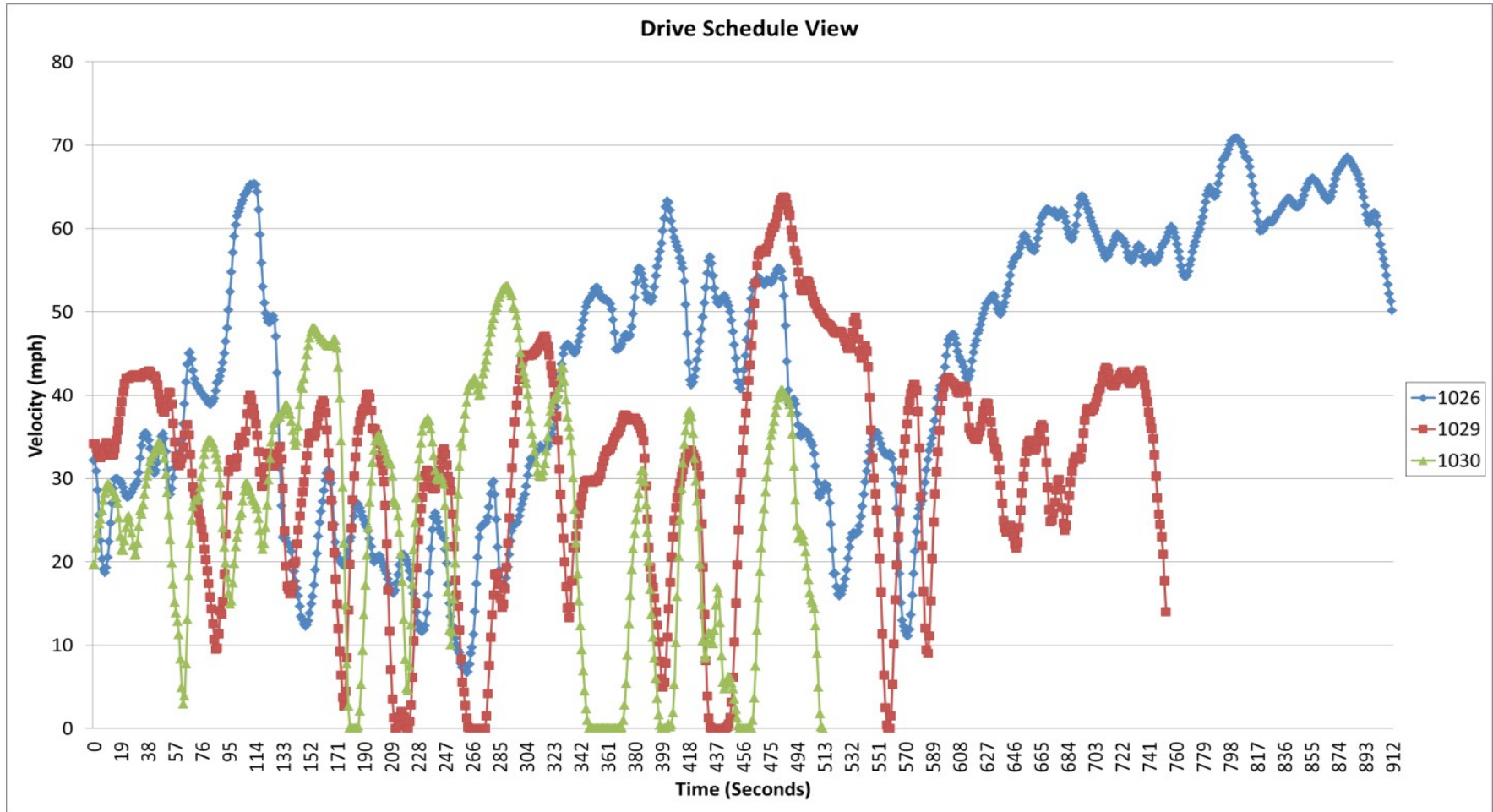
# Passenger Car to Passenger Truck Ratio Results

Pollutant	Description	Emission Rate (gram/vehicle-mile)	Percent Change
CO	Baseline_Highway	2.5700	-
	Passenger Cars +5%/Passenger Trucks -5%	2.4692	-3.92%
	Passenger Cars +10%/Passenger Trucks -10%	2.3684	-7.84%
	Passenger Cars +20%/Passenger Trucks -20%	2.1668	-15.69%
	Passenger Cars -5%/Passenger Trucks +5%	2.6708	3.92%
	Passenger Cars -10%/Passenger Trucks +10%	2.7716	7.84%
	Passenger Cars -20%/Passenger Trucks +20%	2.9733	15.69%
NOX	Baseline_Highway	1.2006	-
	Passenger Cars +5%/Passenger Trucks -5%	1.1727	-2.33%
	Passenger Cars +10%/Passenger Trucks -10%	1.1447	-4.65%
	Passenger Cars +20%/Passenger Trucks -20%	1.0889	-9.31%
	Passenger Cars -5%/Passenger Trucks +5%	1.2285	2.33%
	Passenger Cars -10%/Passenger Trucks +10%	1.2565	4.65%
	Passenger Cars -20%/Passenger Trucks +20%	1.3123	9.31%

# Average Speed and Operating Mode Distribution Comparison

- ❑ Compared utilizing average speed for a link to a user defined operating mode distribution
  - When using average speed with MOVES, default drive schedules are applied
- ❑ Highway Capacity Manual (HCM) based drive schedules
- ❑ Georgia Tech provided operating mode distributions

# Example of MOVES Default Drive Schedules



# Intersection Analysis

## □ Intersection

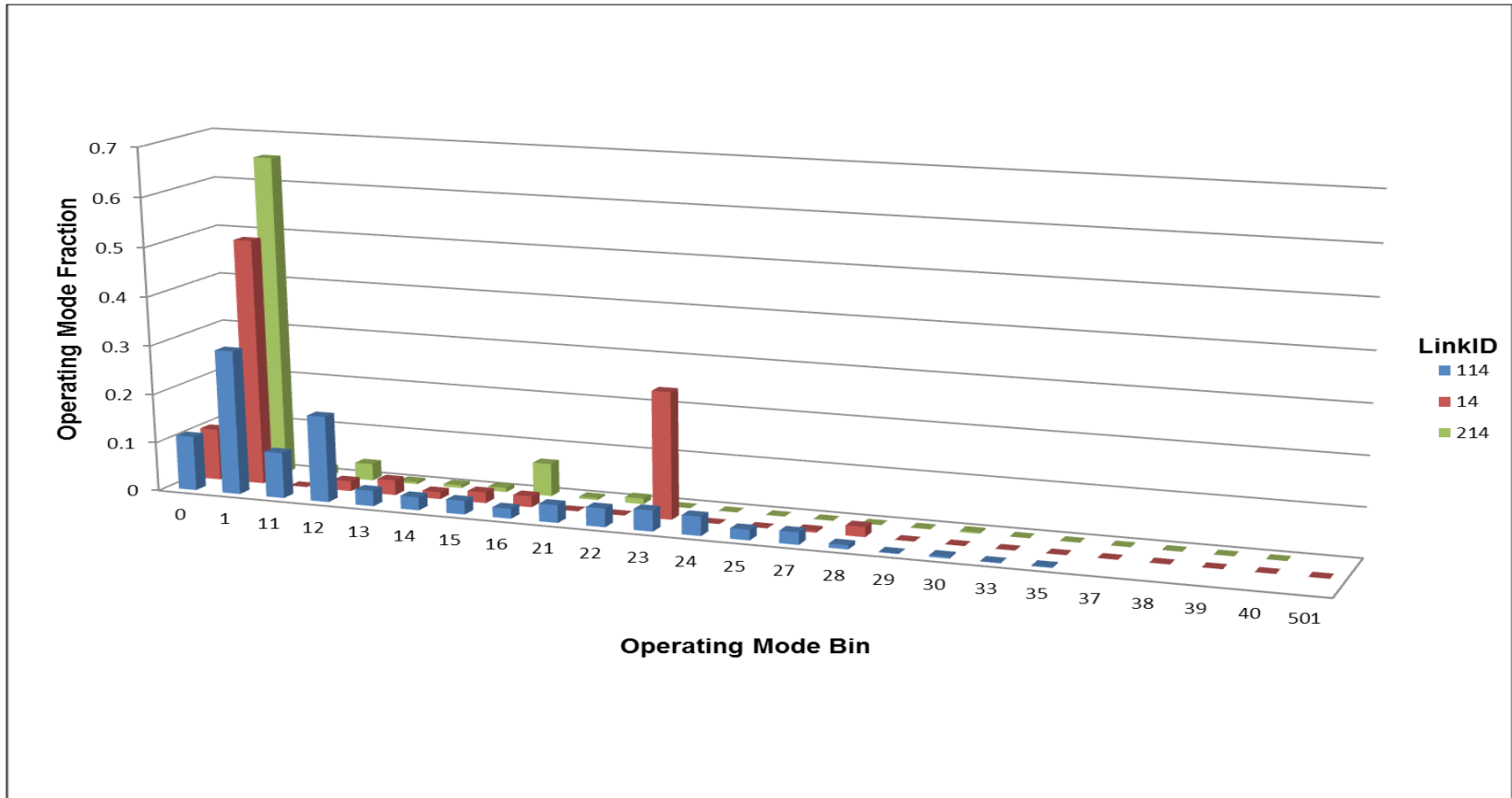
- 25 mph, 35 mph, 45 mph approach speeds
- LOS B,D, and E
- Consisted of approach, queue, and departure (acceleration) links

**35 mph Scenario Intersection Data**

Approach Speed (mph)	LOS	Signal Cycle Length (seconds)	Yellow Time (seconds)	Green Time (seconds)	Red Time (seconds)	Vehicle Headway (seconds)	Decel Rate (mph/s)	Acc Rate (mph/s)	Volume per Cycle
35	B	55	4	10	41	14	-5	3	4
	D	95	4	23	68	10			10
	E	95	4	23	68	9			11

# Operating Mode Distributions

## 35 mph Intersection Scenario – Queue Links LOS D Operating Mode Distributions



# Intersection Results

Link Description	LinkID	Modeled Average Speed (mph)	Level of Service	CO Emission Rate (gram/veh-mile)	CO % Difference Compared to Average Speed	NOX Emission Rate (gram/veh-mile)	NOX % Difference Compared to Average Speed
Intersection Queue Link Average Speed	111	15.94	LOS B	3.066	-	0.366	-
Intersection Queue Link HCM	11			1.858	-39.38%	0.2254	-38.41%
Intersection Queue Link GATech	211			1.53	-50.09%	0.1875	-48.77%
Intersection Queue Link Average Speed	114	13.04	LOS D	3.273	-	0.3754	-
Intersection Queue Link HCM	14			2.477	-24.32%	0.3274	-12.77%
Intersection Queue Link GATech	214			1.871	-42.85%	0.2292	-38.95%
Intersection Queue Link Average Speed	117	13.81	LOS E	3.209	-	0.3725	-
Intersection Queue Link HCM	17			2.391	-25.49%	0.3144	-15.59%
Intersection Queue Link GATech	217			1.766	-44.97%	0.2164	-41.91%



# Some of the Findings

- ❑ Variations in Age Distribution from year to year can impact emission rates
- ❑ Passenger Car to Passenger Truck Ratio is important
- ❑ The proportion of combination trucks in your fleet mix has a large influence on composite emission rates
- ❑ Although a small sample size from this analysis:
  - There is large variation in emissions rates when comparing average speed to the HCM based operating mode distribution and/or Georgia Tech operating mode distribution.

# Acknowledgments

- ❑ Michael Claggett and Paul Heishman from FHWA
- ❑ Ann Xu, Randy Guensler, and Vetri Elango from Georgia Tech
- ❑ The late Ron Kirby from the Metropolitan Washington Council of Governments (MWCOCG)

# Questions?