DOE's Studies of Weekday/Weekend Ozone Pollution in Southern California

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Participants/Technical/Logistical Assistance

- Bay Area Air Quality Management District
- California Air Resources Board
- Caltrans
- Desert Research Institute
- Envair
- ENVIRON
- Freeman, Sullivan, Inc.
- Sonoma Technology, Inc.
- South Coast Air Quality Management District
- Wiltech

Los Angeles Ozone Maxima

- The ozone peak in 2001 was 0.190 ppm on Sunday, August 26 in the east San Gabriel Valley, compared to a peak of 0.184 ppm in the year 2000, on Sunday, May 28, in the northwest San Bernardino Valley. – from the AQMD Advisor, December 2001 issue
- The highest ambient ozone concentrations in urban California locations occur on weekends. Changes in emissions are responsible for elevated weekend ozone. The objective of this study is to understand why.

Policy Questions

- Which is the most effective and least costly means of reducing ambient ozone in urban locations – NOx controls, VOC controls, or both?
- When a majority of the ozone exceedances fall on weekends, how do you design an effective strategy to reduce ambient ozone levels?

OVERVIEW

- Study Design
- Hypotheses tested in study
- Findings
- Conclusions

Overall Study Approach/Design

- Meet with government/industry groups throughout study period to share information (http://www.arb.ca.gov/aqd/weekendeffect/weekendeffect.htm)
- Retrospective Analysis of Ambient Data
- Formulation of Study Hypotheses
- Emission Inventory Development
- Field Study
- Data Analysis
- Study Reports
- 5 papers submitted to the Journal of the Air & Waste Management Association for review and publication; one more paper to be submitted in 6 weeks

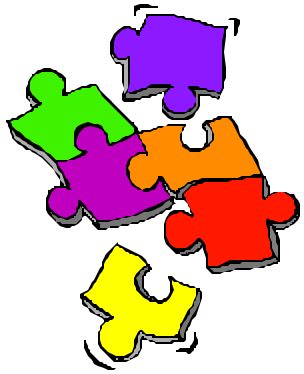
Hypotheses Addressed by Study

Hypotheses	Importance for Ozone Production	Confidence Level
1. NOx emissions reduction		
2. NOx emissions timing (NOx “boost”)		
3. Pollutant carryover near the ground		
4. Pollutant carryover from aloft		
5. Increased weekend VOC emissions		
6. Increased photolysis due to decreased PM		

SUMMARY OF FINDINGS

Emission Inventory Activities, Various Analyses, Hypotheses Tested, and Study Results

Emission Inventory Activities – Purpose & Objectives

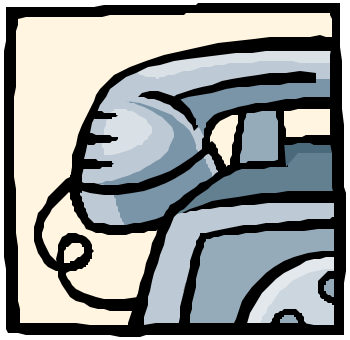


Purpose: Address a lack of weekend-specific emissions data, which are needed to support air quality modeling exercises for weekend conditions in Los Angeles.

Objectives:

- Characterize WD-WE activity patterns for certain types of area sources in Los Angeles.
- Coordinate with concurrent data collection efforts:
  - Enhanced air quality monitoring at fixed locations
  - Air quality monitoring from a vehicle-mounted mobile platform
  - Monitoring of traffic volumes on surface streets
  - Acquisition of freeway-based traffic volumes
  - Acquisition of continuous emissions monitoring systems (CEM) data for major stationary point sources

Approach



- What? Telephone and mail surveys
- Who? Residences and small businesses
- When? September 29-October 8, 2000, plus separate study of lawn/garden maintenance businesses from September 6-25, 2001
- Where? Four neighborhoods of Los Angeles (L.A.) were selected to coordinate with concurrent WD-WE air quality measurements. The commercial lawn/garden study was distributed across L.A. County.

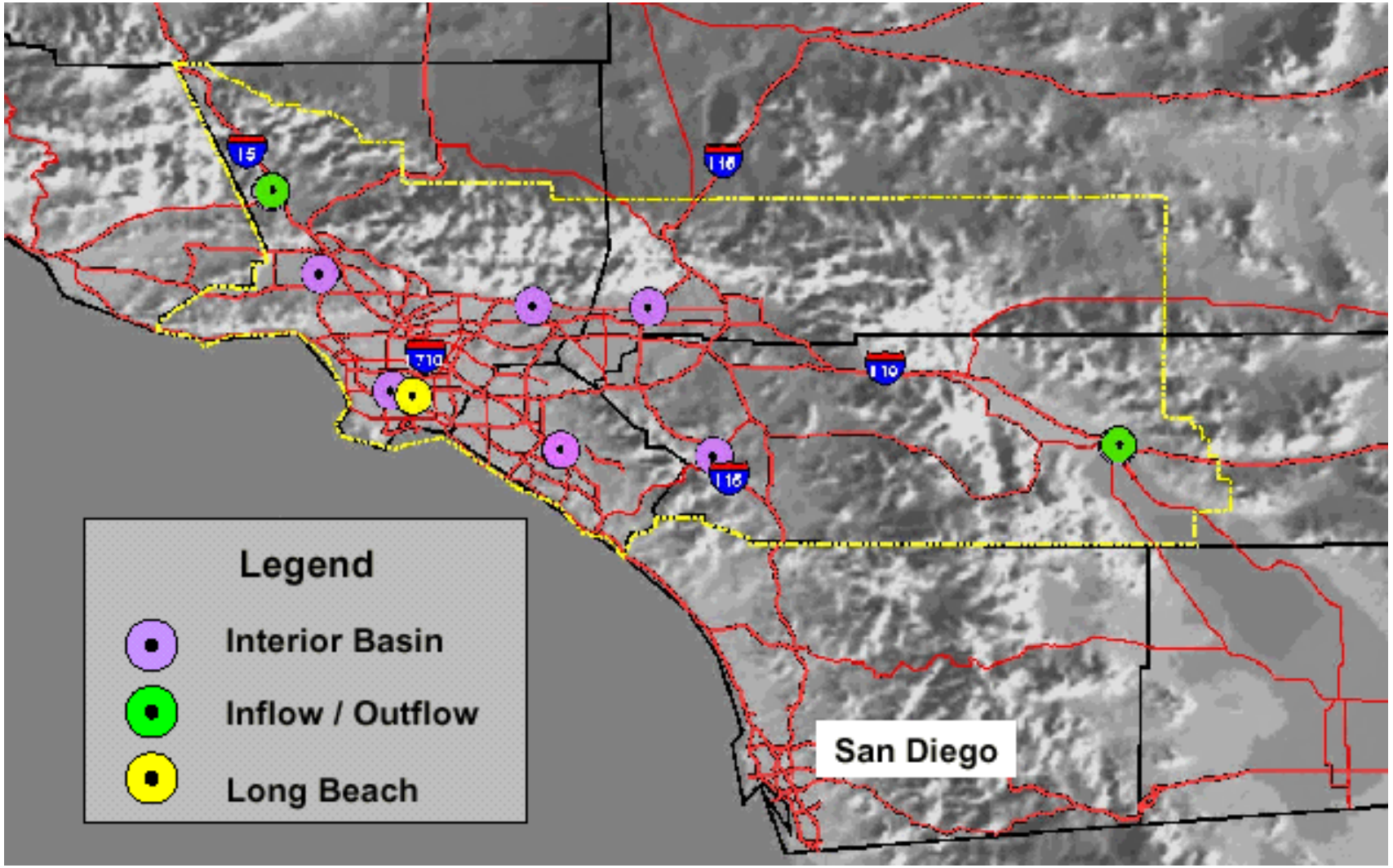
Weekend Activity Reductions for Surveyed Businesses

Type of Business	N	NE	Percent Reduction in Activity Level Relative to Weekdays	
			Saturday Reduction	Sunday Reduction
All businesses	131	1914	70%	79%
Offices	88	1138	65%	72%
Other workplaces	44	776	76%	89%
Businesses with equipment in use	26	651		
Gas Ovens	8	245	45%	74%
IC Engines	12	192	73%	77%
Motor Oils	12	204	74%	80%
Paints or Solvents	18	569	77%	90%
Lawn and Garden Equipment**	151	5436	92%	95%

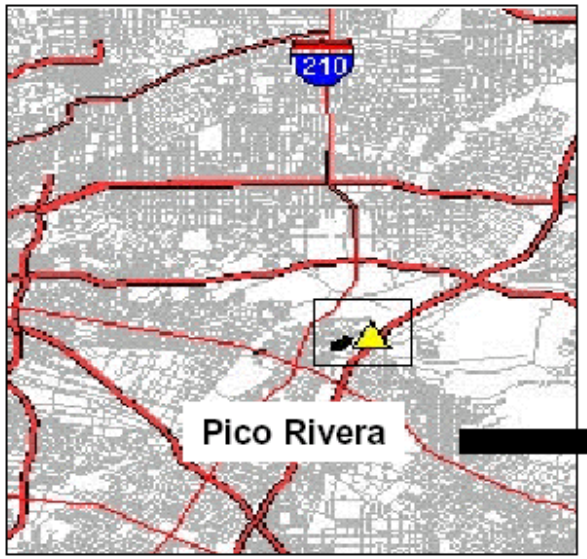
N = Number of businesses sampled; NE = Number of workers employed by sampled businesses.

**Commercial-use lawn and garden data were collected during a separate, follow-up survey.

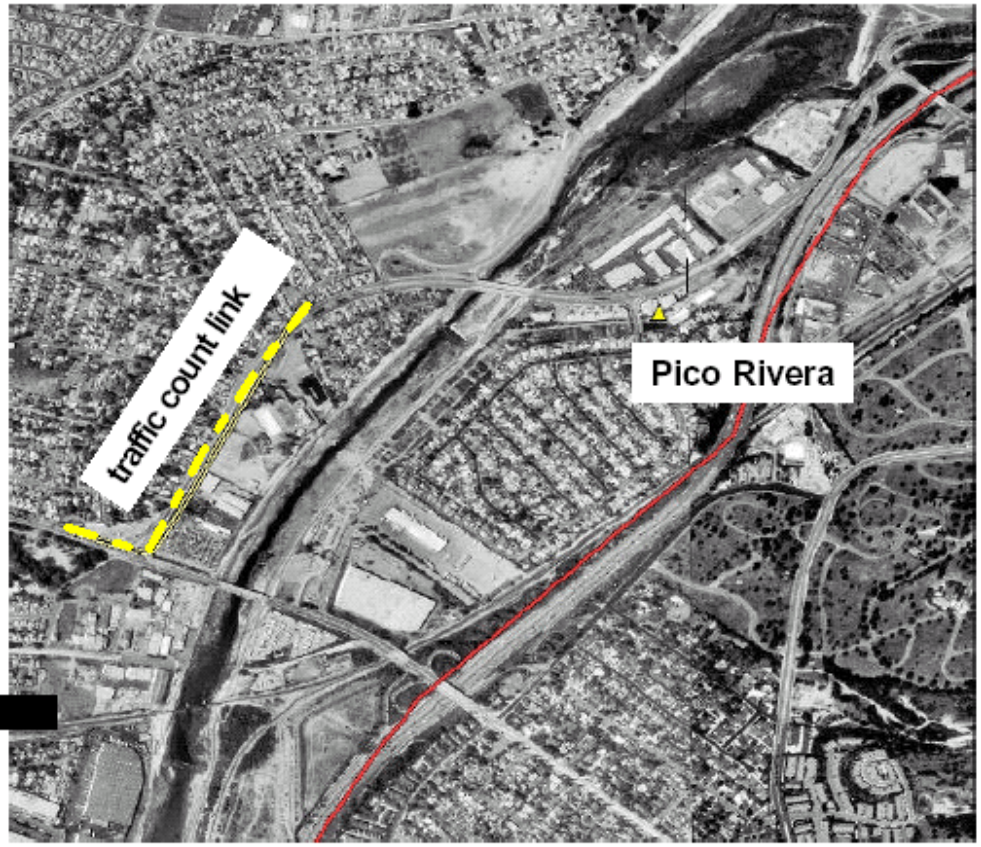
Traffic Data: Caltrans Weigh-in-Motion (WIM) Sensor Data Analyzed for this Study



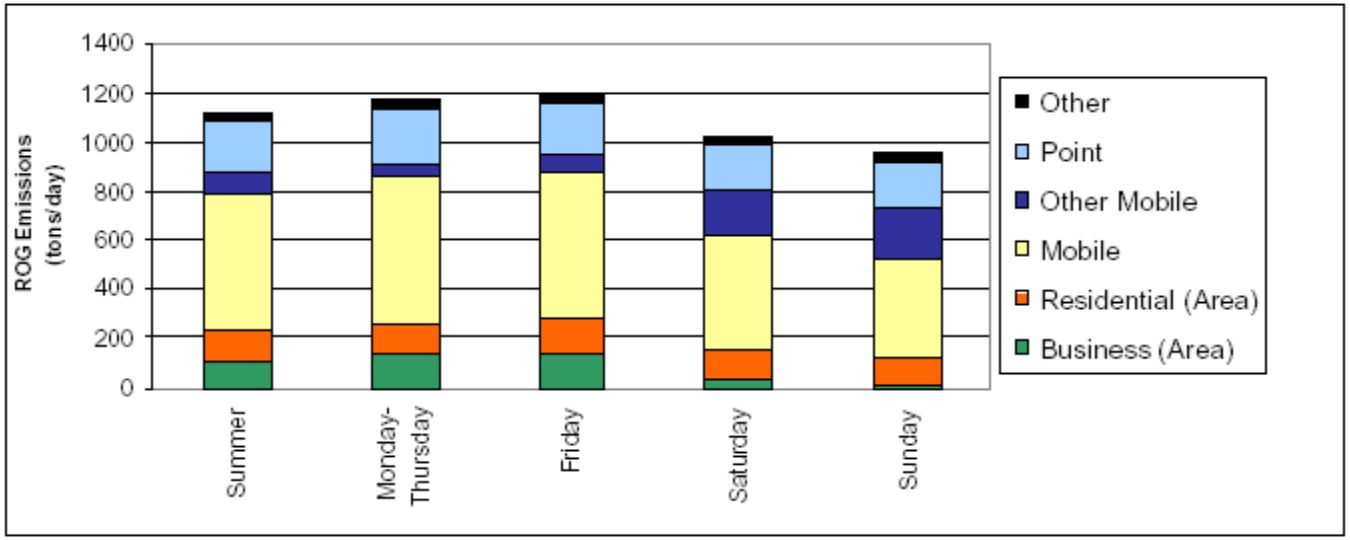
Traffic Count Data Collected on Surface Streets

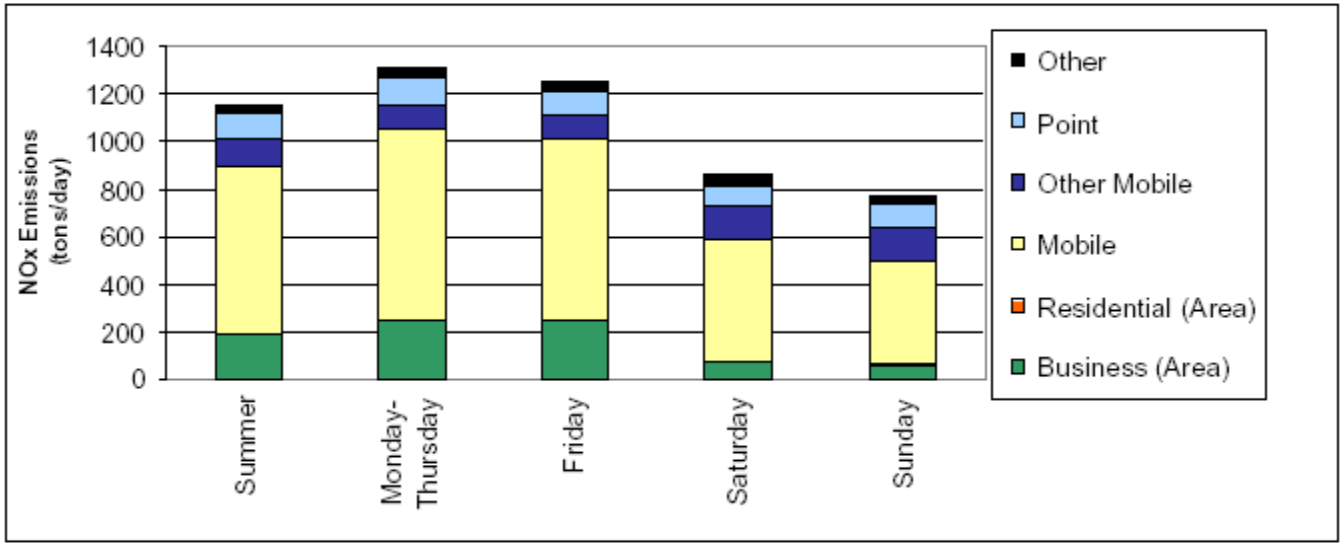


Surface street data collection near Pico Rivera monitoring site



Estimated Day-of-Week Emission Inventory After Applying Emission Activity Scaling Factors





SUMMARY:

Weekday/Weekend Emission Inventory Differences

- 12-18% reduction in ROG emissions on Saturday and Sunday relative to weekdays
- 35-41% reduction on NOx emissions on Saturday and Sunday relative to weekdays
- 30% increase in ROG/NOx ratio on weekends relative to weekdays
- Truck and bus freeway activity decreased by up to 80% on weekends. The decrease in ambient NOx concentrations is due mostly to lower heavy-duty truck activity and emissions on weekends.

STUDY CONCLUSIONS

CONCLUSIONS

Hypotheses	Importance for Ozone Formation	Confidence Level
1. NOx emissions reduction	Significant	High
2. NOx timing (NOx “boost”)	Insignificant	High
3. Pollutant carryover near the ground	Small	High
4. Pollutant carryover from aloft	Insignificant	Medium
5. Increased weekend VOC emissions	Small to Insignificant	Medium
6. Increased photolysis due to decreased PM	Small to Insignificant	Medium

Conclusions

- Atmospheric scientists/policy makers can seldom conduct controlled experiments of the kind that are needed to address policy-relevant issues.
- Emission changes that occur every Saturday and Sunday, relative to weekdays, allow us to observe how those changes influence ambient pollutant concentrations.
- These changes allow us to ask "what if" questions regarding reductions in ozone precursors emissions and how those changes influence ambient ozone levels.
- This study's data are of such high quality that we are able to observe and quantify differences in emissions and ambient levels of ozone and its precursors, even between Saturdays and Sundays, relative to weekdays.
- NO concentrations are 40% and 65% lower on Saturdays and Sunday, respectively, at several Los Angeles locations; ozone is ~30% and 50% higher on Saturdays and Sundays at those locations.

Conclusions

- NO_x controls in Southern California (and other urban U.S. locations) are counterproductive for reducing ambient ozone, and they actually increase ambient ozone levels. Were it not for large concurrent HC emission reductions on weekends, weekend ozone would be even higher than it is, and the weekend/ weekday ozone difference would be even larger.

- Because many urban US locations are HC-limited with regard to ozone formation, if effective HC controls can be put in place (eliminating high-emitting HC vehicles), the amount of ozone in the source region would be reduced and the issue of ozone downwind of the source region might be moot if the NAAQS is met.