CALIFORNIA WMA STUDY: ACCELERATED LOAD TESTING, USE IN RUBBERIZED ASPHALT, EMISSION REDUCTION, AND LONG-TERM FIELD PERFORMANCE

David Jones, PhD
University of California Pavement Research Center

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Summary

- Introduction
- Caltrans research objectives
- ALT and lab testing results
- Emissions
- Field tests
- Conclusions

Introduction

- Rapid growth in the use of WMA
- In 2006, limited research to back up claims
- Better understanding required before full implementation

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California Research Objectives

- Determine whether the addition of additives to reduce the production and construction temperatures of asphalt concrete influences performance
- Investigate additional benefits
  - Use in rubberized AC
  - Increased RAP content
  - Night paving
  - Late season paving
  - Long hauls
  - Overcome environmental constraints
- Guide the implementation of WMA

Workplan Summary

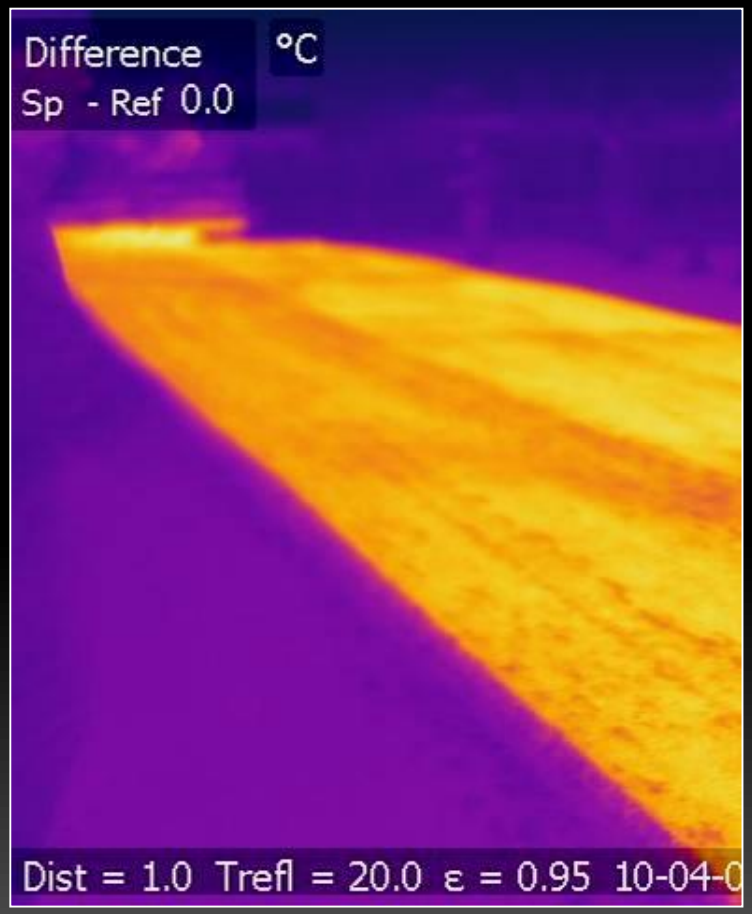
- Objectives met through:
  - Laboratory studies
  - Accelerated load testing
  - Field testing
- Phased approach followed
- Phase 1 & 2 DGAC
  - 3 most prominent technologies in 2007
    - Advera WMA®
    - Evotherm™
    - Sasobit®
  - Rutting and moisture sensitivity

Workplan Summary

- Phase 3, R-WMA-G
  - 7 technologies/each group
    - Advera® WMA.
    - Astec Double Barrel® Green.
    - Cecabase RT®.
    - Evotherm DAT™.
    - Gencor Ultrafoam GX™.
    - Rediset™ WMX.
    - Sasobit®
- Laboratory studies
  - PMFC, PMLC, LMLC
  - Rutting & cracking performance
  - Moisture sensitivity
  - Other
    - Durability (OGFCs)
    - Aging
    - Emissions

Workplan Summary

- Accelerated load testing
  - Test track construction monitoring
  - Rutting
  - Moisture sensitivity
  - Cracking
  - Binder aging
  - Forensic
- Field studies
  - Constructability
  - Long-term performance



Accelerated Load Testing

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Phase 1 & 2 Observations

- Early rutting potential linked to less binder oxidation (beware of reducing binder content)
- No indication that the three warm-mix additives tested influence long-term rutting & fatigue performance or increase moisture sensitivity
- Construction quality/engineering remains a key concept
- Key issues
  - Beware wet aggregates
  - Beware initial "tenderness" because of less binder oxidation

Phase 3 Observations

- WMA mixes had significantly less smoke & odor
- WMA mixes were notably more workable
- Compaction generally poor
  - Beware temperature limits
    - Set on compaction requirements, not production!
  - Rethink compaction
  - Oxidation rates on rubber different to conventional
  - Different warm-mix technologies have different influences on mix chemistry and emissions
- WMA generally had equal or better performance

Laboratory Testing

- Rutting performance (Shear, AMPT, and Hamburg)
  - Early rutting potential
  - Similar after about 9 – 12 months
    - Matched ALT and field performance
- Fatigue cracking performance (beam fatigue)
  - WMA had no effect, matched ALT and field performance
- Moisture sensitivity (Hamburg, TSR)
  - Some issues with water based technologies
  - Moisture in aggregate
    - Did not match Phase 2 ALT, but did match field in some instances
- Durability (Cantabro)
  - Some effect depending on technology, matched field performance

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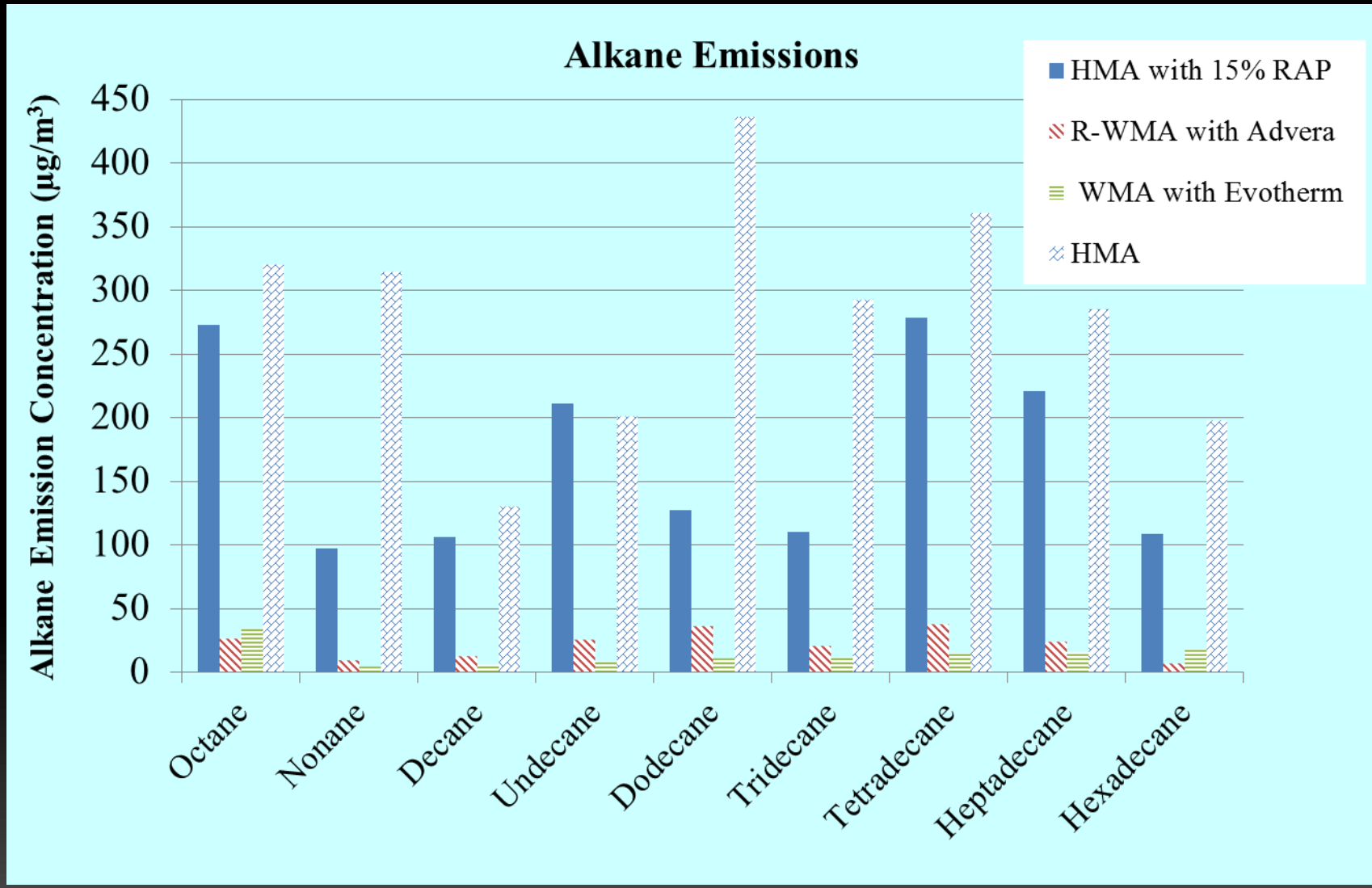
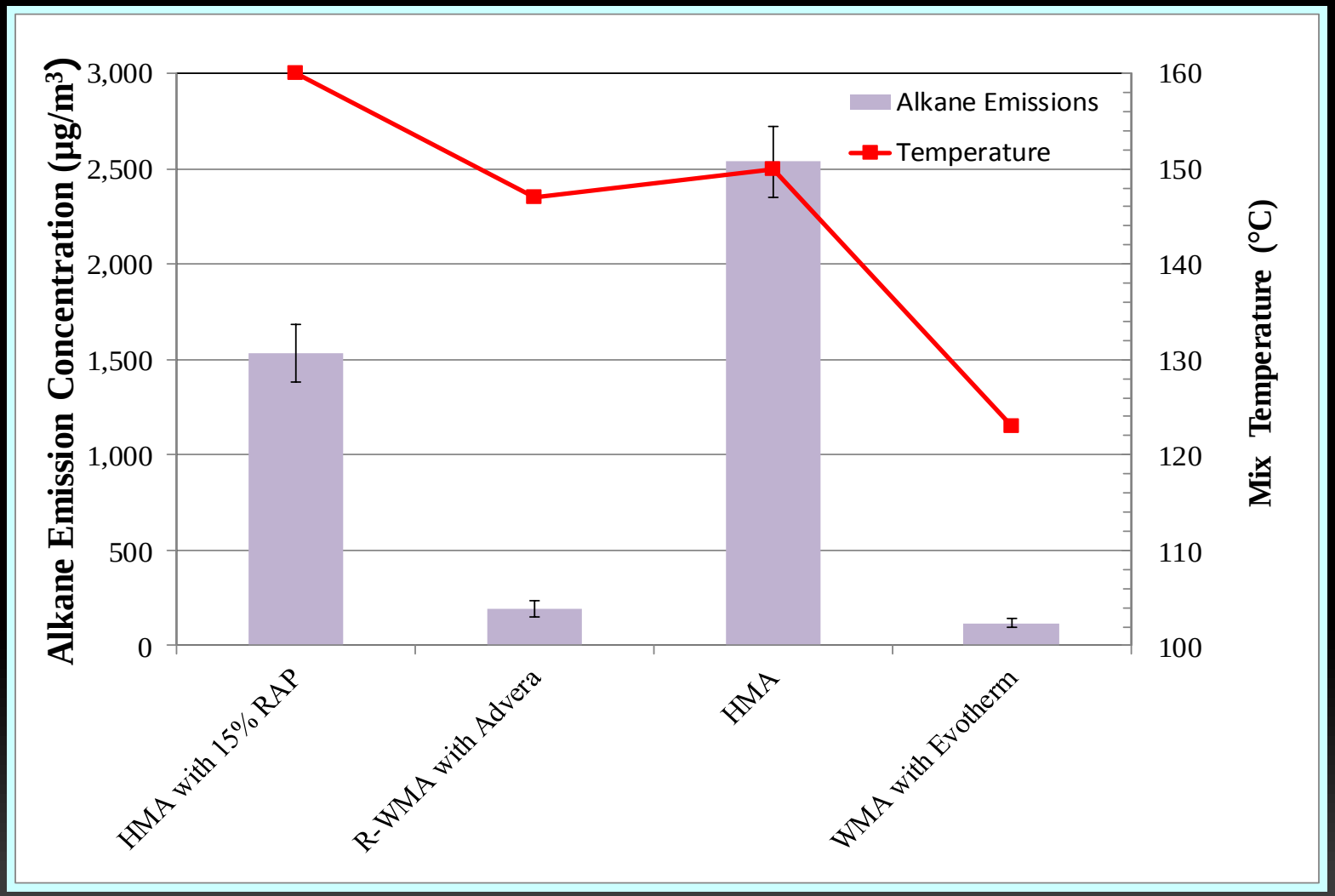
Sampling Process

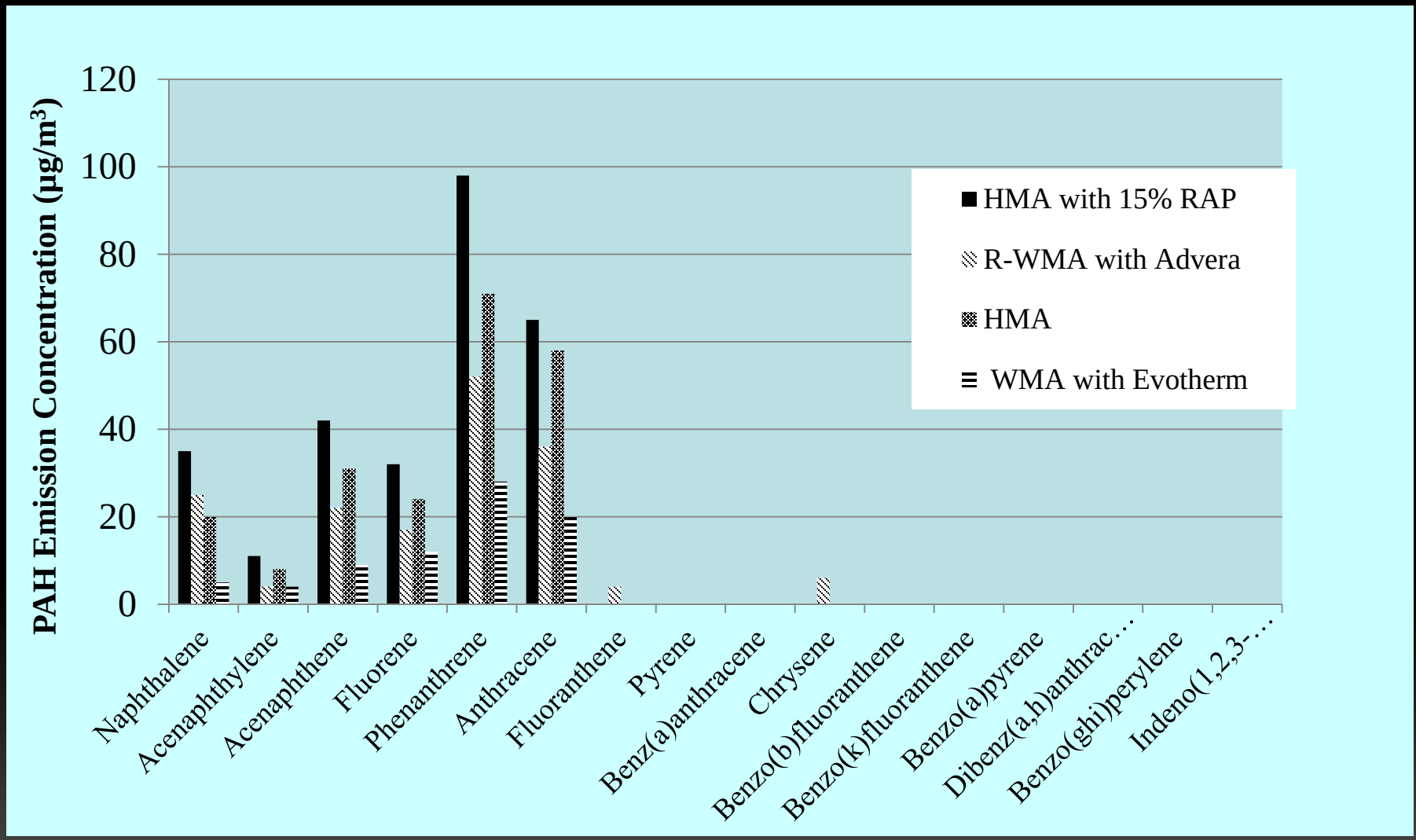
Alkane Emissions



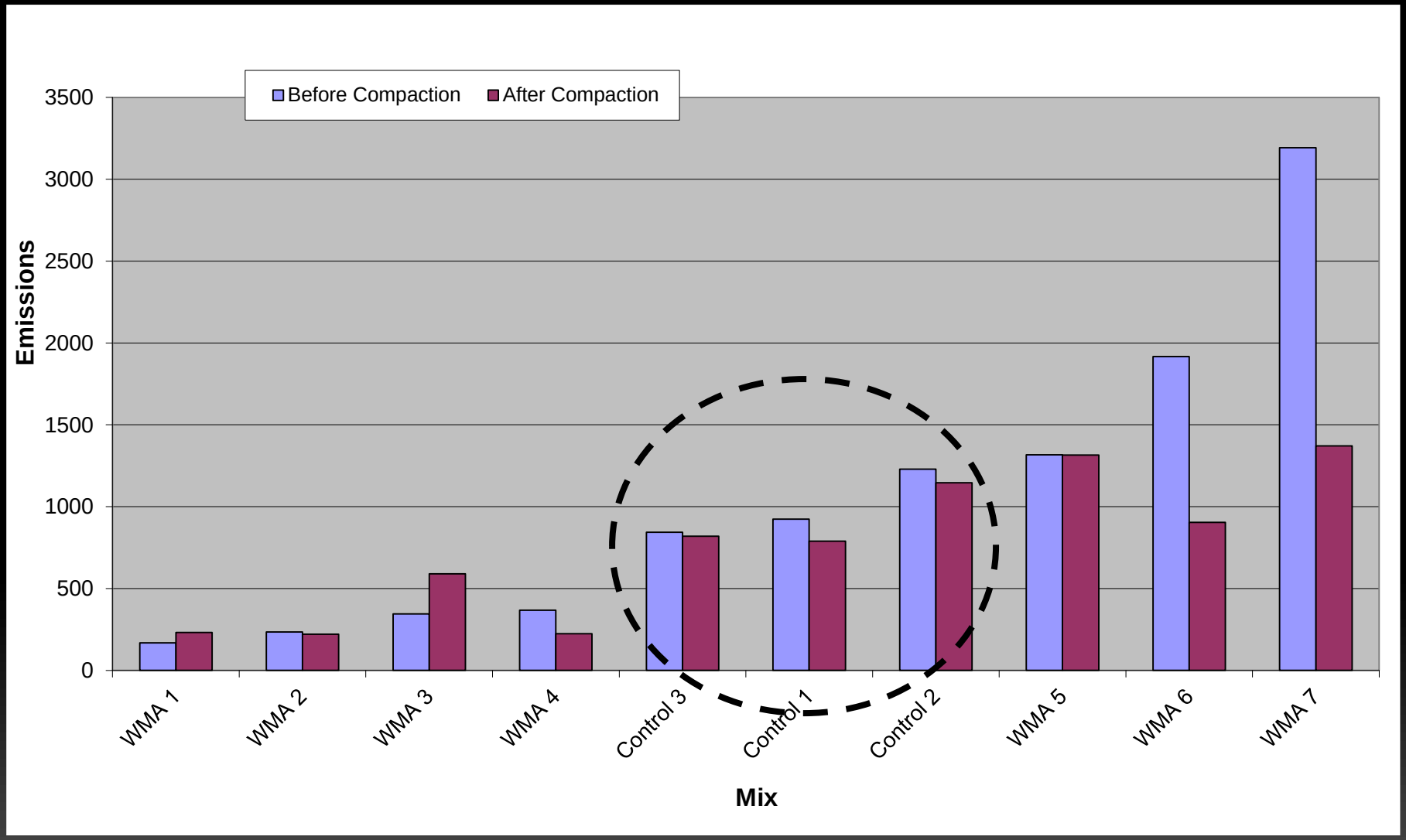
Total Alkane Emissions



PAH Emissions

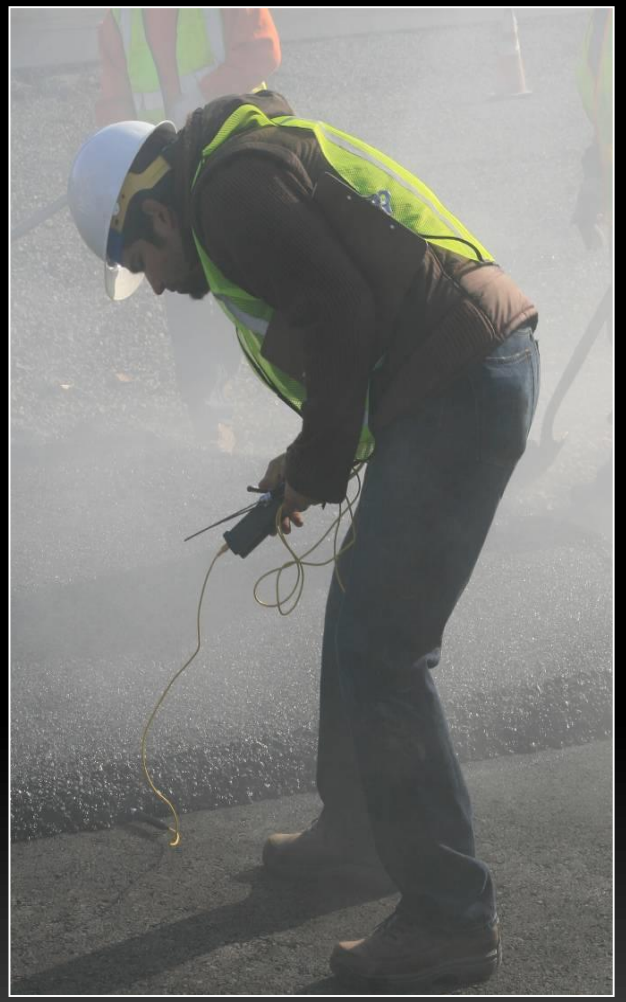


Phase 3 Emissions



Key Findings

- Alkane emissions ranged from 117 µg/m^3 (WMA) to 2,516 µg/m^3 for conventional HMA
- Majority of alkane emissions are volatilized in the first hour after the sampling initiation



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Field Tests

- Numerous pilot studies
- 10 monitored closely, selected based on key variable such as binder, haul time, mix, climate, etc
- Morro Bay (SLO-1)
  - PM, cold coastal
- McKinleyville (Hum-20)
  - PM-OGFC, long haul, cold coastal

Ravelling

Morro Bay: 2007 - 2013

McKinleyville: 2008 - 2012

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Conclusions

- Comprehensive, systematic study to guide implementation of WMA in California
  - Laboratory, ALT and field performance
- Confirmed equal performance can be obtained
  - Understand compaction temperatures and method
  - Beware initial tenderness/initial higher rutting
  - Beware moist aggregates
  - WMA does not replace good engineering practice
- Better performance than hot-mix on long hauls and on rubberized AC
- Significant reduction in alkane emissions

THANK YOU !

David Jones

djjones@ucdavis.edu

www.ucprc.ucdavis.edu

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