SILT LOADING PILOT STUDY

Sondra Rosenberg
UC Davis-Caltrans Air Quality Project
University of California, Davis

October 10, 2002

Overview

- **Background**

  Measuring paved road PM_{10} , silt loading
- **Objective**

  Local silt loading measurements and land use
- **Method**

  Site selection, sampling, laboratory analysis
- **Findings**
- **Limitations**
- **Future**

How Is Paved Road PM_{10} Measured?

- **Direct:** upwind-downwind concentration measurements
- **Predicted:** $E = k(sL/2)^{0.65}(w/3)^{1.5}$,where

  E = emission factor (g/VKT)

  K = base emission factor

  sL = silt loading (g/m^3)

  W = average vehicle weight

EPA studies showed that other factors, such as ADT and traffic speed are accounted for in sL

Silt Loading

- **Difficult to collect** – required collection of material from roadway surface
- **Time consuming** – ½ hr to 2 hours per site
- **EPA silt loading database**
  - Use if local data not available
  - Out of date and inconsistent
  - Limited

Objectives of This Study

- **Compare locally collected silt loading values to adjacent land use**
- Compare these values to those in the EPA silt loading database
- Compare these values to other roadway factors such as ADT and roadway type

Method – Site Selection

- Land use
  - Using a city of Davis land use map, we chose areas of approximately constant land use
  - Possible sites were designated as one of the following land use categories:
    - Low density residential
    - High density residential
    - Business/industrial
    - Industrial
    - Urban/agricultural transition
    - Agricultural

Site Selection (Cont.)

- Traffic counts
  - Using city of Davis traffic counts, we chose roads with a variety of ADT
  - Possible sites (roadway sections) were designated as one of the following traffic categories:
    - Low ADT – up to 5,000 vehicles/day
    - Medium ADT – 5,000 to 10,000 vehicles/day
    - High ADT – over 10,000 vehicles/day

Site Selection (Cont.)

- Roadway type
  - We referenced a city of Davis roadway type map to insure a variety of roadway types were used
  - At least one site was chosen for each of the following roadway types:
    - Collectors
    - Minor arterials
    - Major arterials

Method - Collection

- Mark off area of road
- Measure area, note lanes and speed limit
- Vacuum with tared and numbered vacuum bag
- 1-3 site increments, 3-15 feet long

Method – Laboratory Analysis

- Weigh bag with sample
- Remove as much of sample as possible and weigh
- Weigh vacuum bag – determine loss in bag
- Oven dry and weigh again - % water
- Sieve - smallest being 75μm
- Weigh each sieve

% Silt = (mass in pan/mass in all sieves and pan)/100

sL = % silt applied to total sample

Findings

- Land use appears to be strongly associated with silt loading and, therefore, emission factors.
- As ADT increases, silt loading decreases.
- Road type has little effect on silt loading in this study. This may be because other variables changed largely.

Average by Land Use

Land Use	Silt Loading	Emission Factor	Emission Factor
	(g/m^2)	(g/VKT)	(g/VKT)
		W=1.5	W=3
Low Density Residential (3)	0.1884	0.3507	0.9917
High Density Residential (1)	0.1722	0.3303	0.934
Business/Industrial (2)	0.2128	0.379	1.0715
Industrial (1)	0.4445	0.612	1.731
Urb/Ag Trans. Average (3)	0.2672	0.4125	1.1667
Agricultural (1)	0.8539	0.935	2.645

Average by ADT

Average Daily Traffic	Silt Loading (g/m^2)	Emission Factor (g/VKT)	Emission Factor (g/VKT)
		W=1.5	W=3
Low ADT (4)	0.4391	0.584	1.6513
Medium ADT (3)	0.2392	0.408	1.1543
High ADT (4)	0.1973	0.3412	0.965

Average by Road Type

Road Type	Silt Loading	Emission Factor	Emission Factor
	(g/m^2)	(g/VKT)	(g/VKT)
		W=1.5	W=3
Collector (1)	0.2031	0.368	1.04
Minor Arterial (5)	0.238	0.3995	1.1294
Major Arterial (5)	0.374	0.5119	1.4482

Findings (Cont.)

- Measured silt loadings varied from the closest EPA silt loading database values by as little as 0.6% to as much as 2123%, with 2/3 of our data varying by more than 50%.
- This lead to the calculated emission factors being quite different as well.

Table 4	Measured Values Compared to Closest Database Values														
Mesured					sL Database				Difference						
S	PSL	ADT	sL	EF	PSL	ADT	sL	EF	ADT	PSL	sL	% diff	EF	% diff
	(mph)		(g/m^2)		(mph)		(g/m^2)					sL		EF
1	45	15376	0.05	0.2288	45	14441	0.02	0.13	935	0	0.03	152	0.1033	82.35
2	25	10557	0.172	0.5086	45	10521	0.09	0.33	36	-20	0.082	91.33	0.175	52.46
			0.172	0.5086	25	5135	0.4	0.88	5422	0	-0.228	-56.95	-0.371	-42.18
			0.172	0.5086	25	17425	0.04	0.2	-6868	0	0.132	330.5	0.3117	158.3
3	25	11286	0.139	0.4427	35	10170	0.14	0.44	1116	-10	-9E-04	-0.643	-0.002	-0.418
4	35	6507	0.197	0.5542	35	10170	0.14	0.44	-3663	0	0.057	40.36	0.1096	24.65
			0.197	0.5542	25	5135	0.38	0.85	1372	10	-0.184	-48.29	-0.297	-34.86
5	35	14408	0.445	0.942	35	10170	0.14	0.44	4238	0	0.305	217.5	0.4975	111.9
			0.445	0.942	45	14441	0.02	0.13	-33	-10	0.425	2123	0.8165	650.7
6	25	2410	0.203	0.5662	25	2155	0.81	1.39	255	0	-0.607	-74.93	-0.825	-59.31
7	35	5009	0.24	0.6314	25	5135	0.4	0.88	-126	10	-0.16	-39.95	-0.248	-28.22
8	45	1943	0.854	1.44	25	1975	0.19	0.54	-32	20	0.664	349.4	0.8978	165.6
			0.854	1.44	45	10521	0.09	0.33	-8578	0	0.764	848.8	1.1064	331.7
9	30	1830	0.47	0.9771	25	1975	0.19	0.54	-145	5	0.28	147.5	0.4349	80.22
10	50	5720	0.281	0.6992	25	5135	0.38	0.85	585	25	-0.099	-26.05	-0.152	-17.81
			0.281	0.6992	50	15566	0.08	0.31	-9846	0	0.201	251.3	0.3902	126.3
11	45	4430	0.229	0.6123	25	5135	0.38	0.85	-705	20	-0.151	-39.71	-0.238	-28.03
			0.229	0.6123	45	10521	0.09	0.33	-6091	0	0.139	154.6	0.2787	83.55

* W assumed to be 2 tons

Some values are compared to more than one value in the database.

This is because one has similar ADT and another a similar posted speed limit, etc.

PSL stand for "Posted Speed Limit"

Limitations

- Number of samples
- No measure of vehicle weight
- Not exactly “free flowing” traffic

Future

- Expand study to San Joaquin valley
  - 150 to 200 samples
  - Approx 30 samples from each land use classification, with consideration to varying ADT
  - Explore possibility of land use “correction factor” in PM_{10} calculations and/or default silt loading values
  - Forecast future PM_{10} by using land use forecasts (and expected population increases)