Coal-Tar-Based Pavement Sealcoat, PAHs, and Environmental Health
What are PAHs and why do we care?

- Toxic to aquatic life and to mammals
- Cause tumors and mutations
- Cause birth defects
- Seven are probable human carcinogens (EPA B2 carcinogens)
- 16 are EPA Priority Pollutants
Contaminant Trends since 1970

Van Metre and Mahler, 2005, Environmental Sci. & Tech.
City of Austin measures PAH concentrations greater than 1,500 mg/kg
How much PAH in each source?

1,500 mg/kg in creek sediment

- Fresh asphalt 1.5
- Weathered asphalt 3
- Fresh motor oil 4
- Brake particles 16
- Road dust 24
- Tire particles 86
- Diesel engine 102
- Gasoline engine 370
- Used motor oil 440

Pavement Sealcoat

- Asphalt Based ~ 50
- Coal-tar-based ~ 100,000

All concentrations in mg/kg (averages of 1-6 studies)
PAH in runoff

- Sampled runoff from 13 parking lots
- Analyzed particles and water for PAHs

Mahler et al., 2005, Environ. Sci. & Tech.
PAH in particles from parking lots

- Black R. Ohio, EPA Superfund Site: 1,100 mg/kg
- Mean concentration is 65 times greater
- Charles River: 130 mg/kg
- Mean Urban Lakes: 12 mg/kg

Total PAH (mg/kg)

- Unsealed
- Coal-tar sealed
- PEC

Legend:
- 3,500
- 54
Sealed pavement dust
Total PAH (mg/kg)

Unsealed pavement dust

Van Metre et al., 2009, Environ. Sci. & Tech.
Environmental Forensics: PAH fingerprints

- Coal vs. Lake Anne: $r=0.60$
- CT dust vs. Lake Anne: $r=0.94$
- Gas vehicle vs. Lake Anne: $r=0.68$
CMB source modeling

- **Vehicle/traffic related**
  Gasoline and diesel soot and exhaust, tunnel air, used oil, tires, asphalt wear
- **Coal combustion**
  Residential, power plant, and coking
- **Fuel oil combustion**
- **Wood burning**
- **Coal-tar based sealcoat**
PAH sources to U.S. urban lakes

Probable Effect Concentration

Coal-tar based sealcoat

Urban Lakes

- sealcoat
- vehicles
- coal
- oil
- wood
Sources of PAHs to Lake Anne

**Date sediment deposited**

- 1970
- 1980
- 1990
- 2000

**PAH concentration (mg/kg)**

- 0
- 5
- 10
- 15
- 20
- 25

**Sources**

- Total PAH
- Wood burning
- Vehicles
- Coal burning
- Coal-tar sealcoat
A large coal-tar-sealcoat contribution translates to high PAH concentrations.
23 ground-floor apartments, dust indoors and out
Median total PAH [mg/kg]

- No coal-tar sealcoat: 5.1 mg/kg (n=12)
- Coal-tar sealcoat: 129 mg/kg (n=11)

Mahler et al., 2010, Environ. Sci. & Tech.
Air Quality?
Volatilization of PAH

We used paired high volume air samples to measure PAH volatilization from sealcoated pavement.
**PAH in-use lots**

- $\Sigma PAH_8$ in unsealed lots (geometric means)
- $HAT = 63 \quad AMB = 26 \, ng/m^3 \quad flux = 1.4 \, \mu g/m^2 \, h$
- $\Sigma PAH_8$ in sealcoated lots
- $HAT=1,320 \quad AMB = 138 \, ng/m^3 \quad flux = 88 \, \mu g/m^2 \, h$
Over freshly applied sealcoat
Concentrations in air

- $\Sigma PAH_8$ 2 hours after application
  - $HAT = 300,000$  $AMB = 5,400$ ng/m$^3$

- $\Sigma PAH_8$ 149 days after (during winter)
  - $HAT=291$  $AMB = 28$ ng/m$^3$
Trend after application

**Concentration**

- **PAH (ng/m³)**
  - HAT
  - AMB

**Flux**

- **PAH₈ flux (ug/m² h)**

**Days since sealing**

- Summer
- Winter
- Summer
PAH loss from the sealant

![Graph showing PAH loss over days since application.](image)
Volatilization shifts the PAH profile

Fraction of total PAH

- NIST-CT
- Dust TX
- Product
- 1 day
- 45 days
- 376 days

3 ring
4 ring
5-6 ring

Phe  Anth  Flu  Pyr  BaA  Chry  BbF  BkF  BeP  BaP  IP  BgP

USGS
And a shift in emissions, too.
∑PAH volatilized during drying

∑PAH$_8$ (ug/m$^2$ h)

day-night
regression  $R^2=0.95$
measured flux

∑PAH $\approx 2.8$ g/m$^2$
ΣPAH mass lost from the sealant

ΣPAH ~5.8 g/m²

16 d
Total PAH emissions during drying

Annual coal-tar sealcoat use: 85 million gal

Area covered: ~440 km²

PAH emission rate: 3 g/m²

ΣPAH₈ emissions/yr: ~1,000 Mg

ΣPAH₁₆ vehicle emissions, 2010: 840 Mg*

ΣPAH₈ vehicle emissions, 2010: ~50 Mg*

* Shen et al., 2011
Original graphic courtesy Aaron Hicks, City of Austin, Tex.