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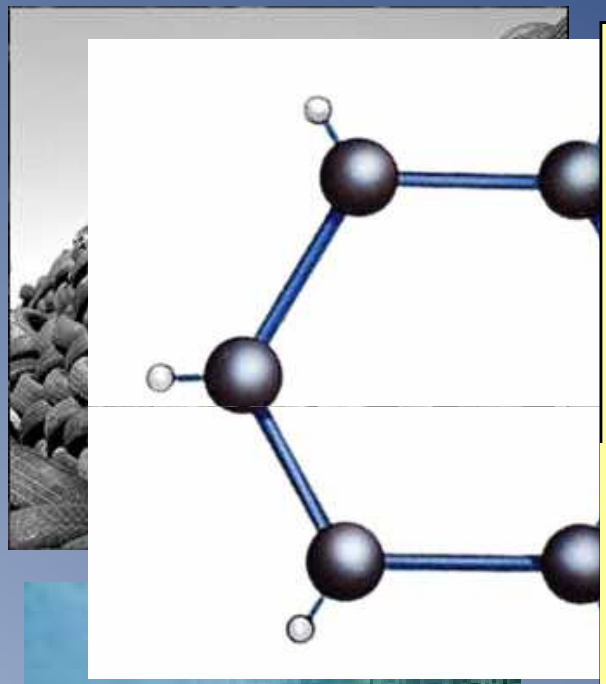
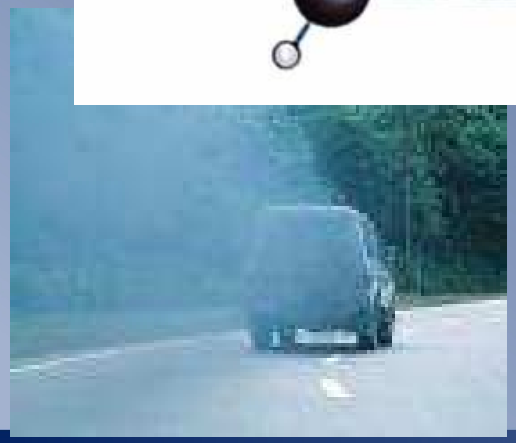
science for a changing world

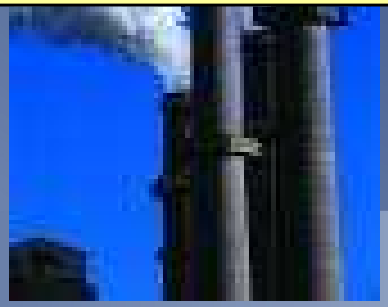
Coal-Tar-Based Pavement Sealcoat, PAHs, and Environmental Health

U.S. Department of the Interior
U.S. Geological Survey

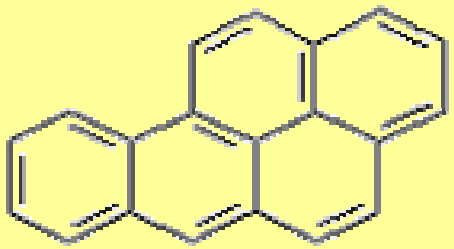
What are polycyclic aromatic hydrocarbons (PAHs)?

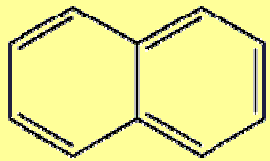




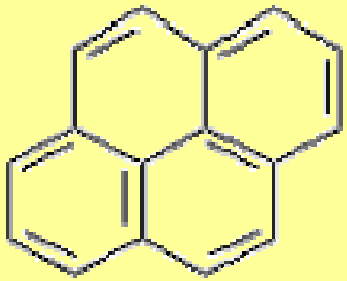


Benzo(a)pyrene





Naphthalene



Pyrene

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Why do we care about PAHs?

- 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

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NAWQA: Contaminant Trends in Lake Sediment

http://tx.usgs.gov/coring/index.html

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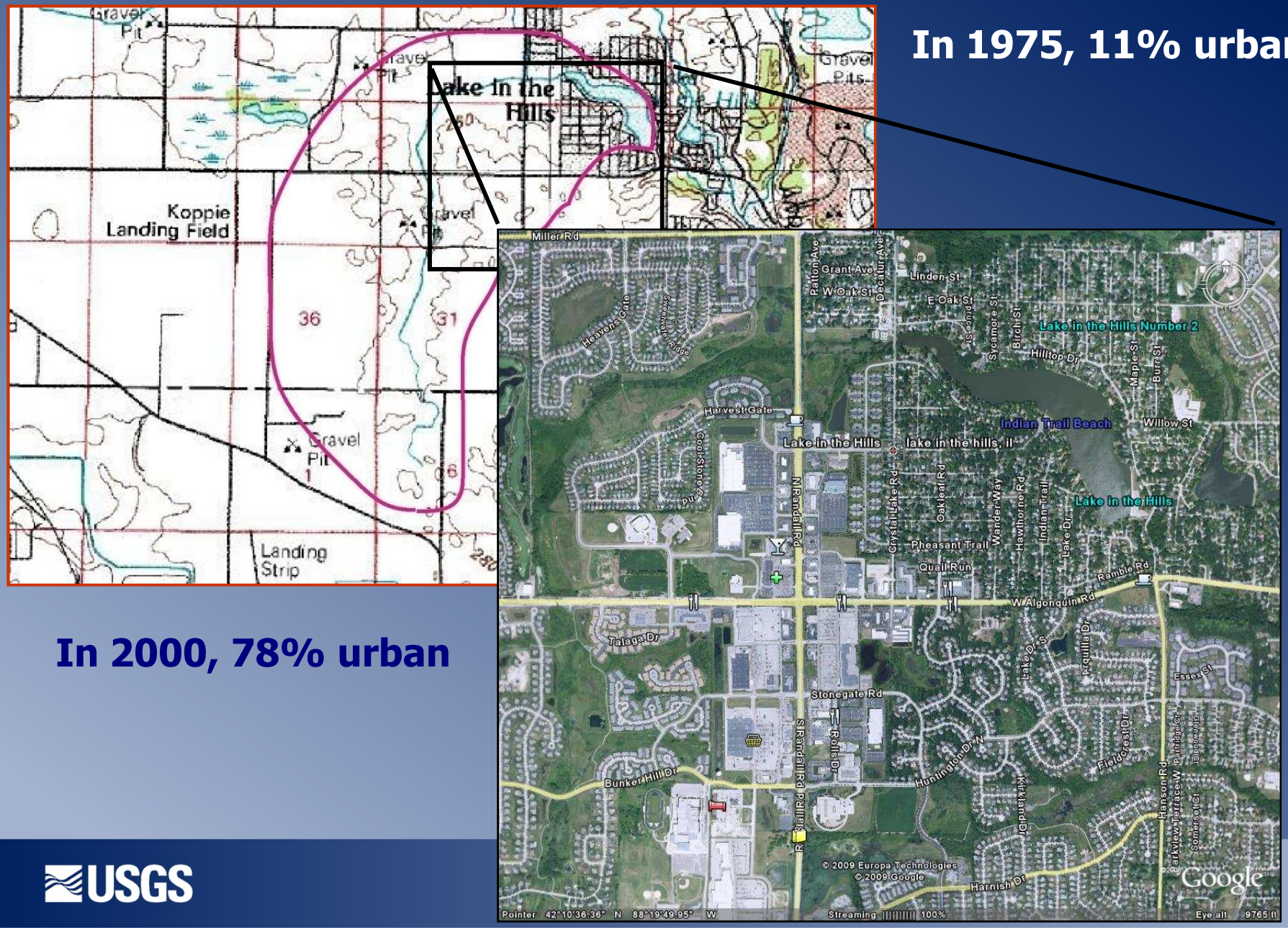
Lake in the Hills, near Chicago



In 1975, 11% urban

In 2000, 78% urban

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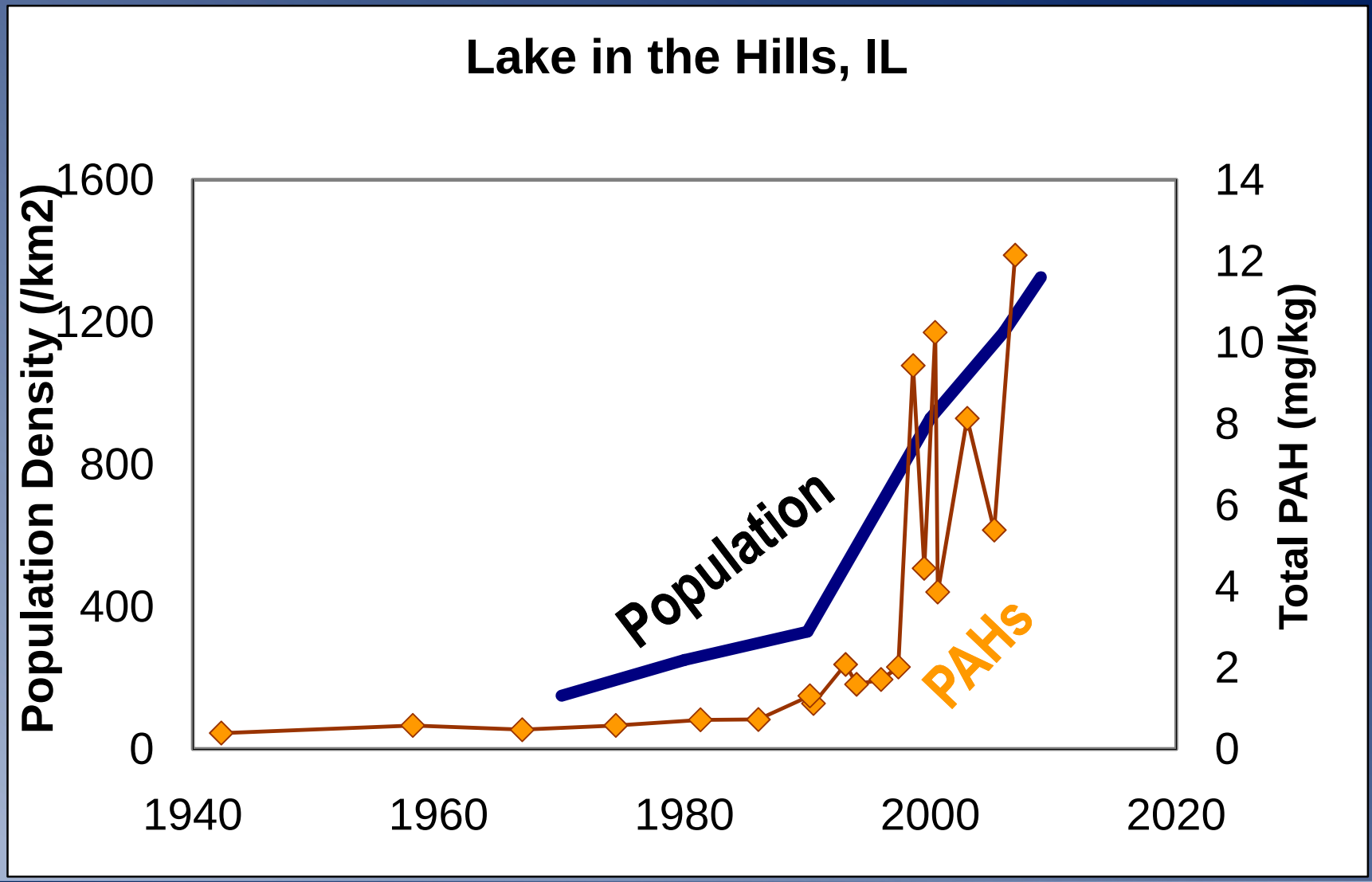
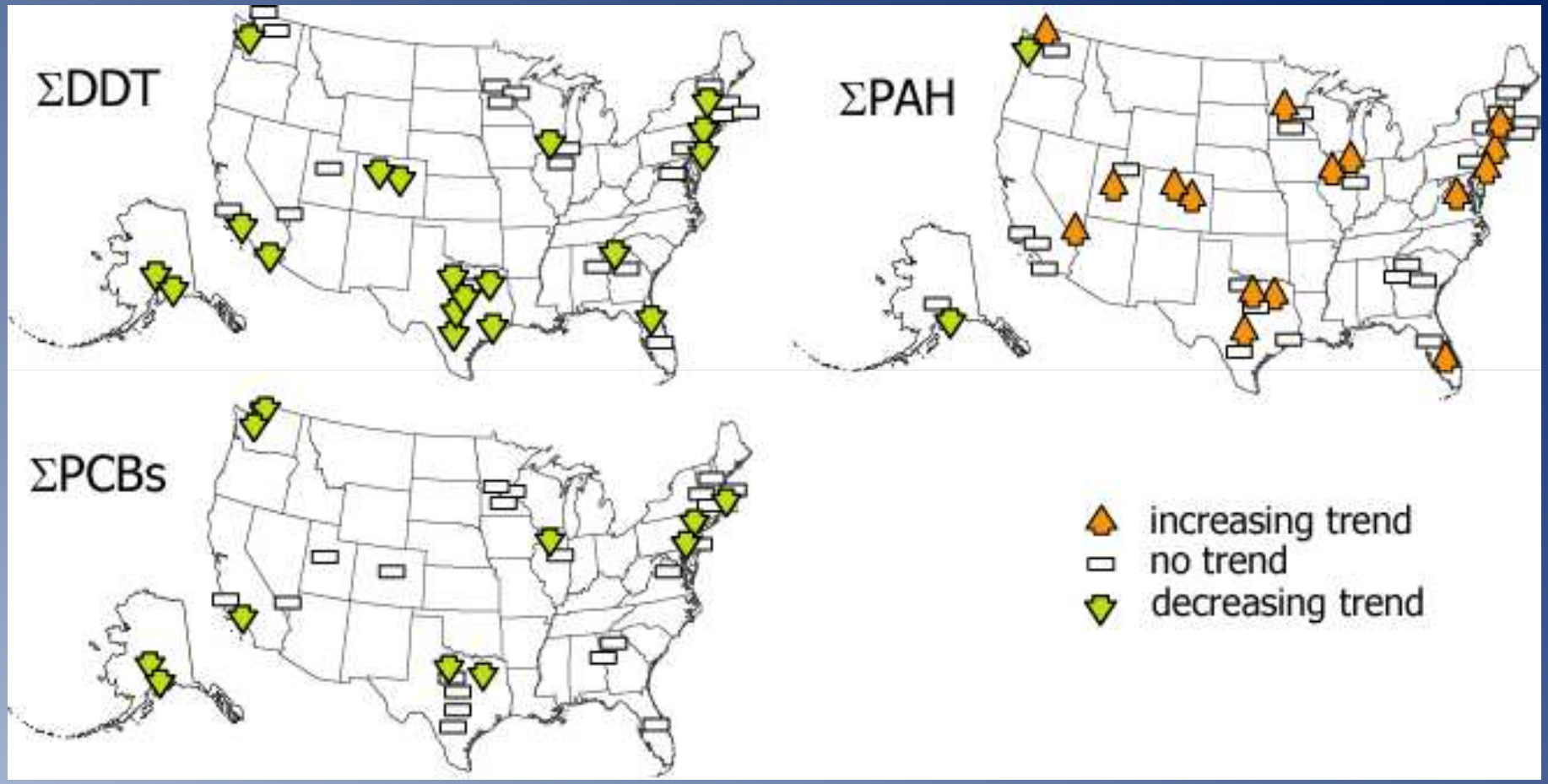
Population and PAH in lake sediment



Trends since 1970



Van Metre et al., 2000, Environ. Sci. &Tech.
Van Metre and Mahler, 2005, Environ. Sci. & Tech.

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The first clue: high PAH in Austin stream sediment

- **Extremely high (>1,500 mg/kg) PAHs in some small drainages**
- **Compare to Probable Effect Concentration (PEC) of 23 mg/kg**
- **So … what's upstream?**

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PAHs in urban sources

All concentrations in mg/kg (averages of up to 6 studies)

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**

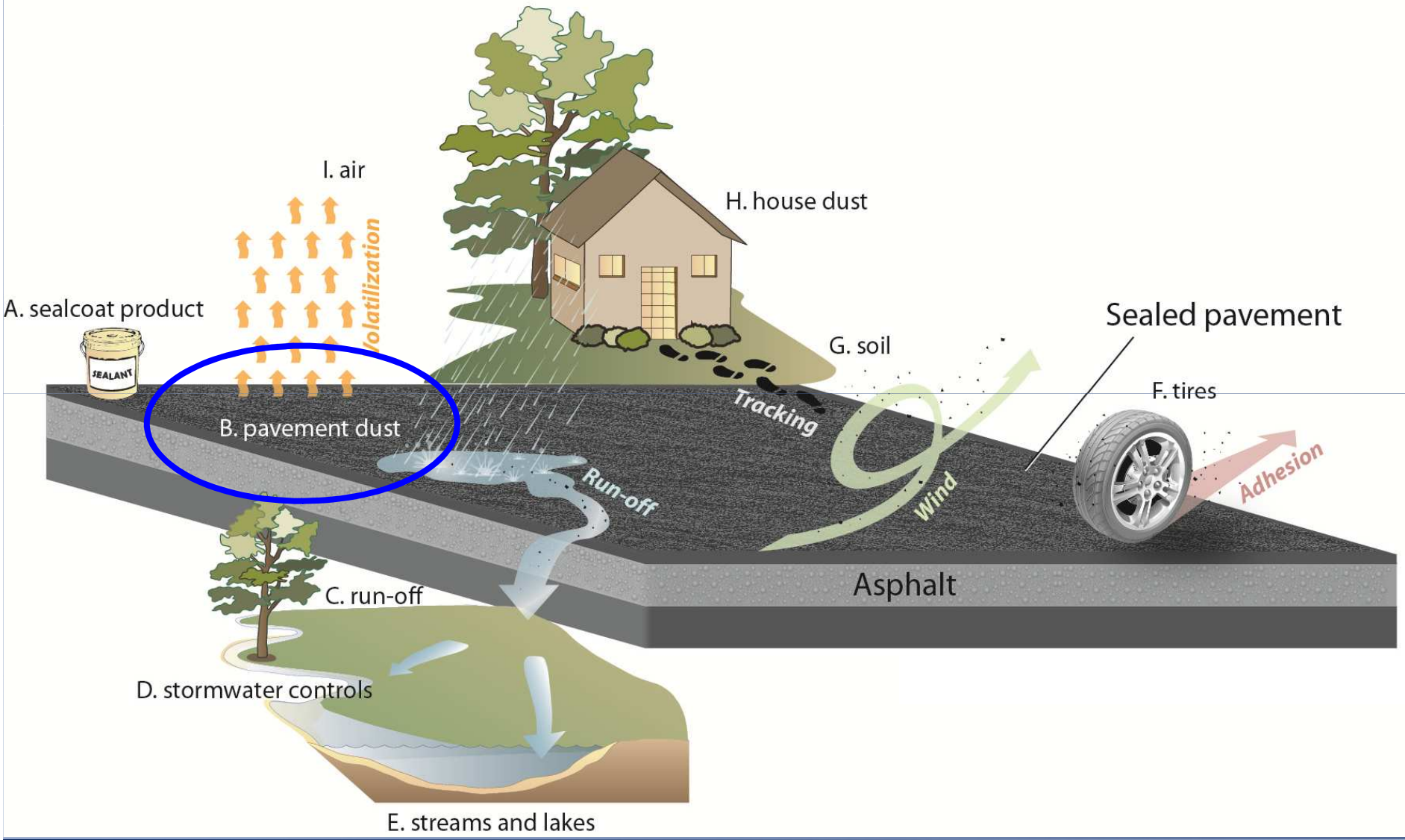
~70,000

Is use of sealcoat extensive?

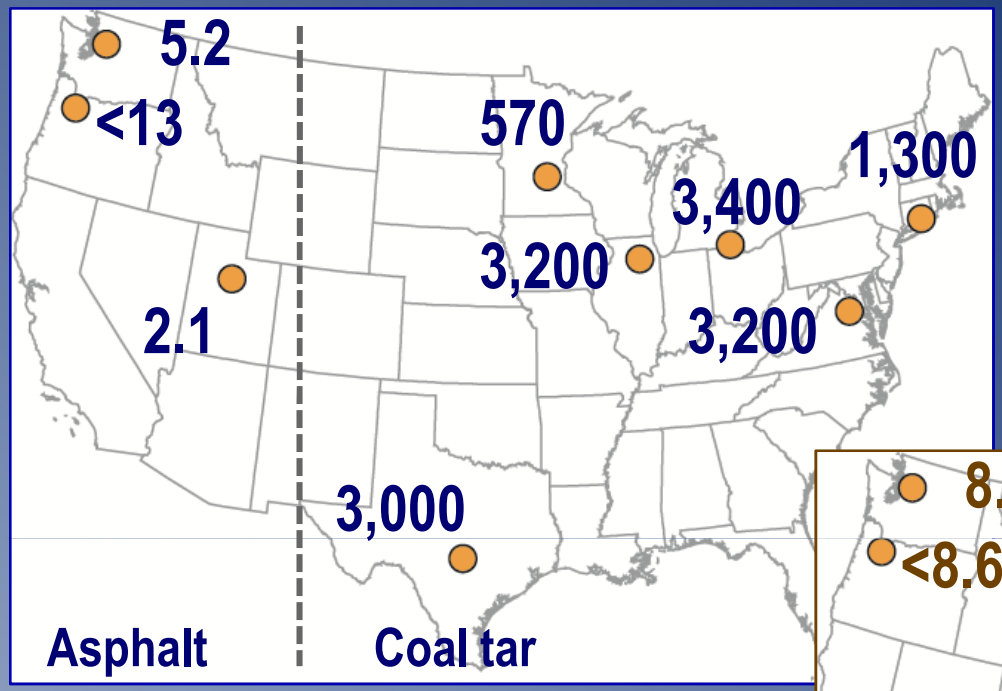
- 85 million gallons per year (per industry)
- 170 mi^2, or 110,000 ac covered

- 4 watersheds in Texas: 1-2% area
- 1 watershed in Illinois: 4% of area
  - 42% of parking lot area
  - 89% of driveway area

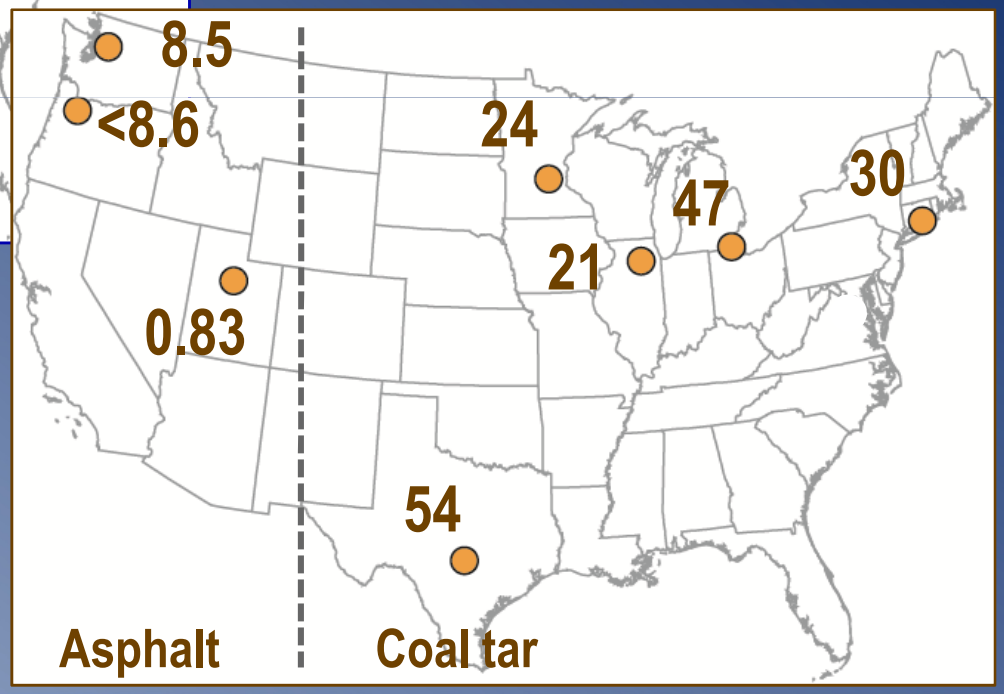
Sealcoat PAH transport pathways



Sealed pavement dust
Total PAH (mg/kg)



Unsealed pavement dust



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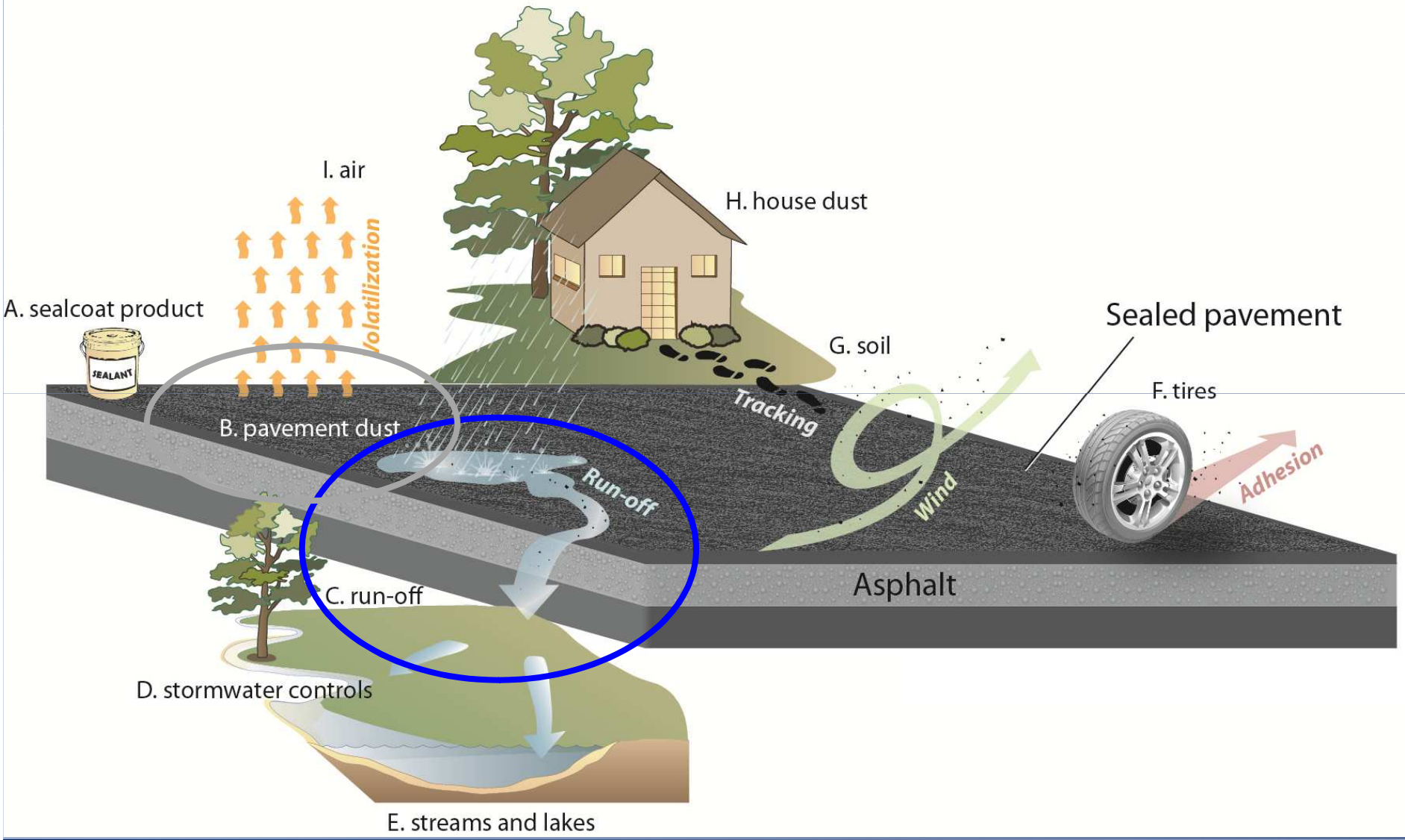
Van Metre et al., 2009, Environ. Sci. & Tech.

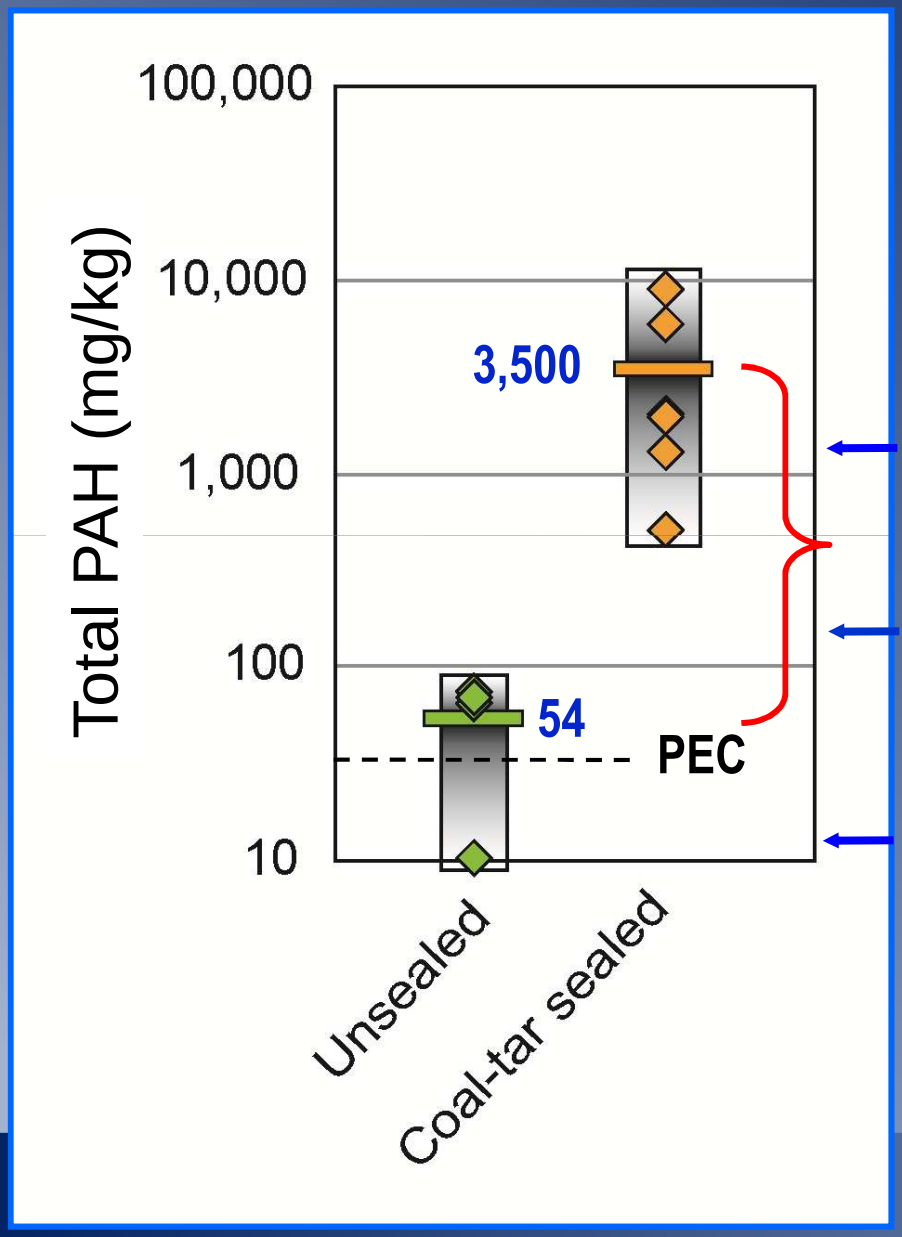
Sealcoat PAH transport pathways



PAH in runoff

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

PAH in particles from parking lots



Black R. Ohio, EPA Superfund Site 1,100 mg/kg

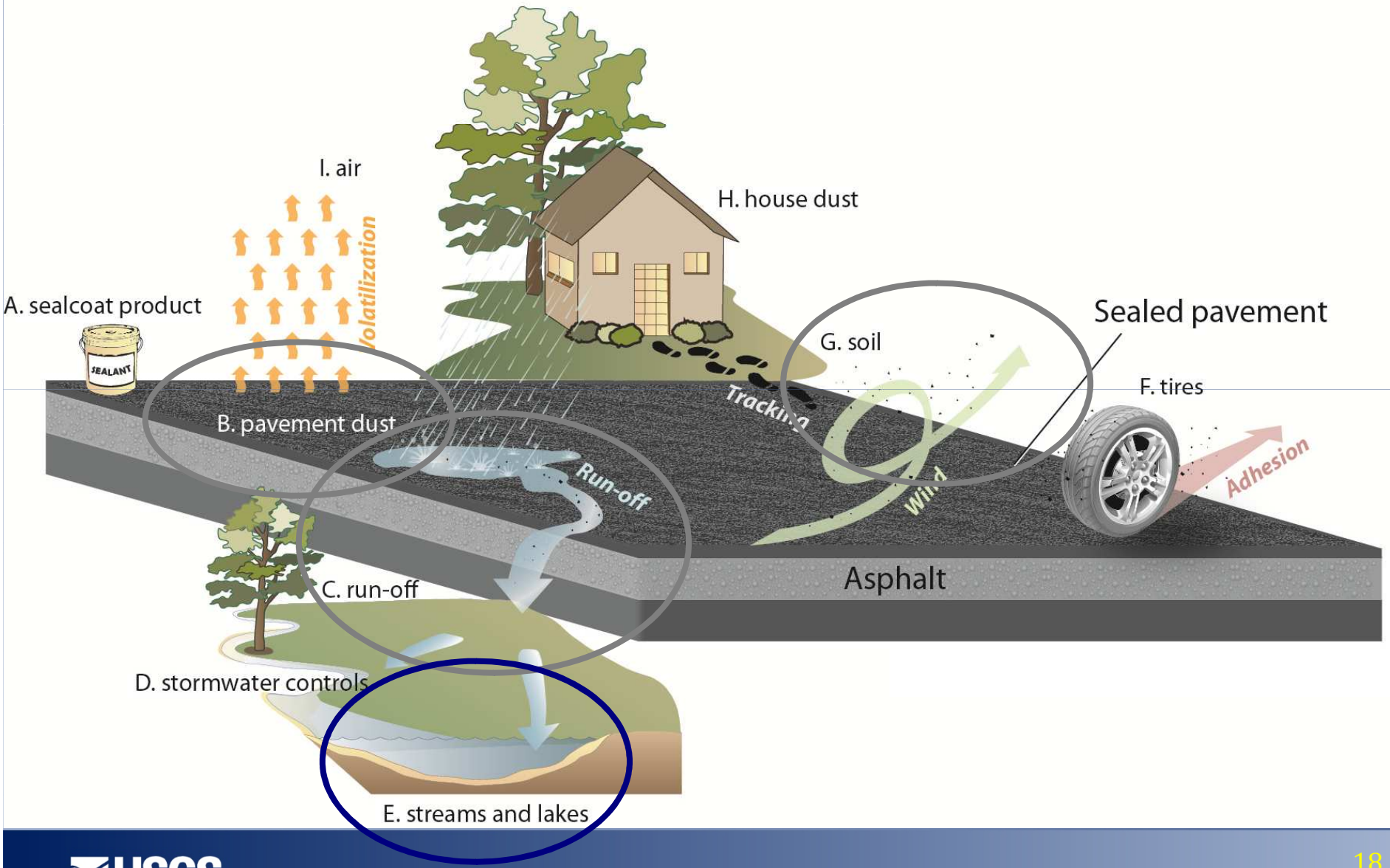
Mean concentration is 65 times greater

Charles River 130 mg/kg

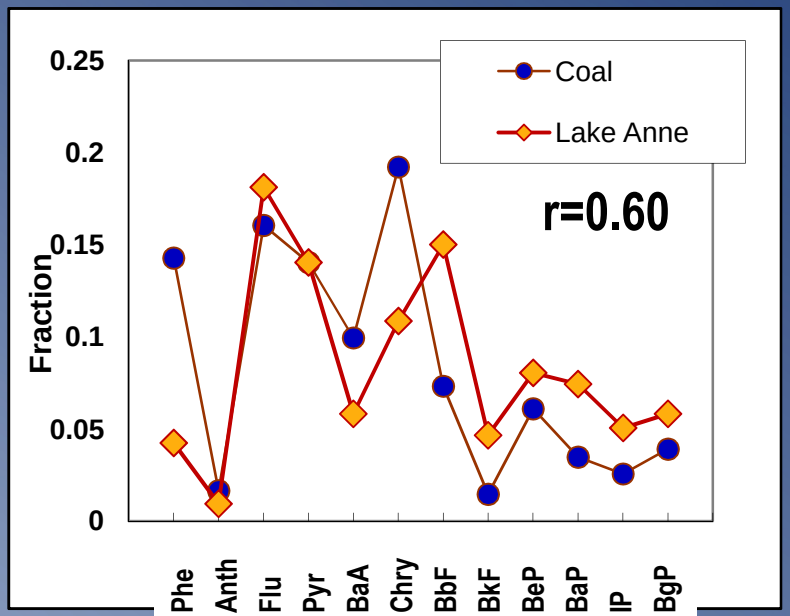
Mean Urban Lakes 12 mg/kg

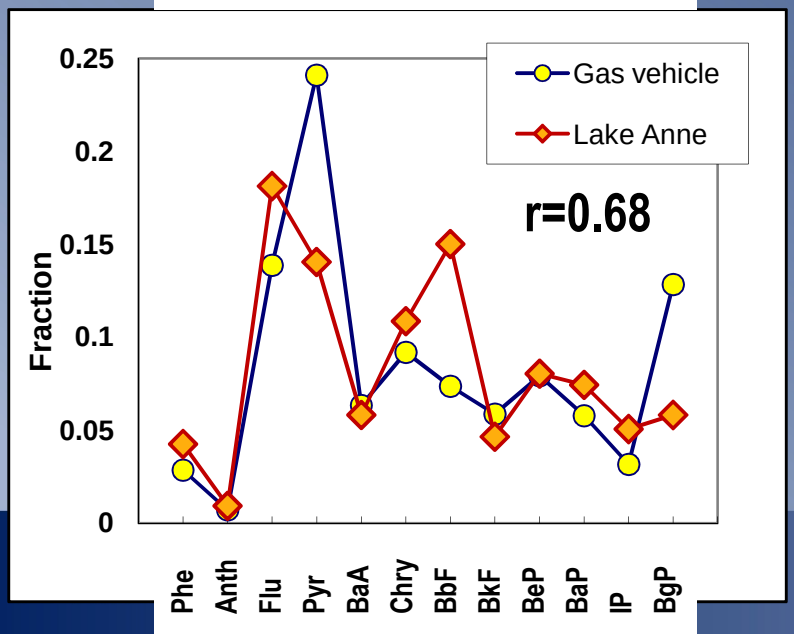
Mahler et al., 2005, Env. Sci. & Tech.

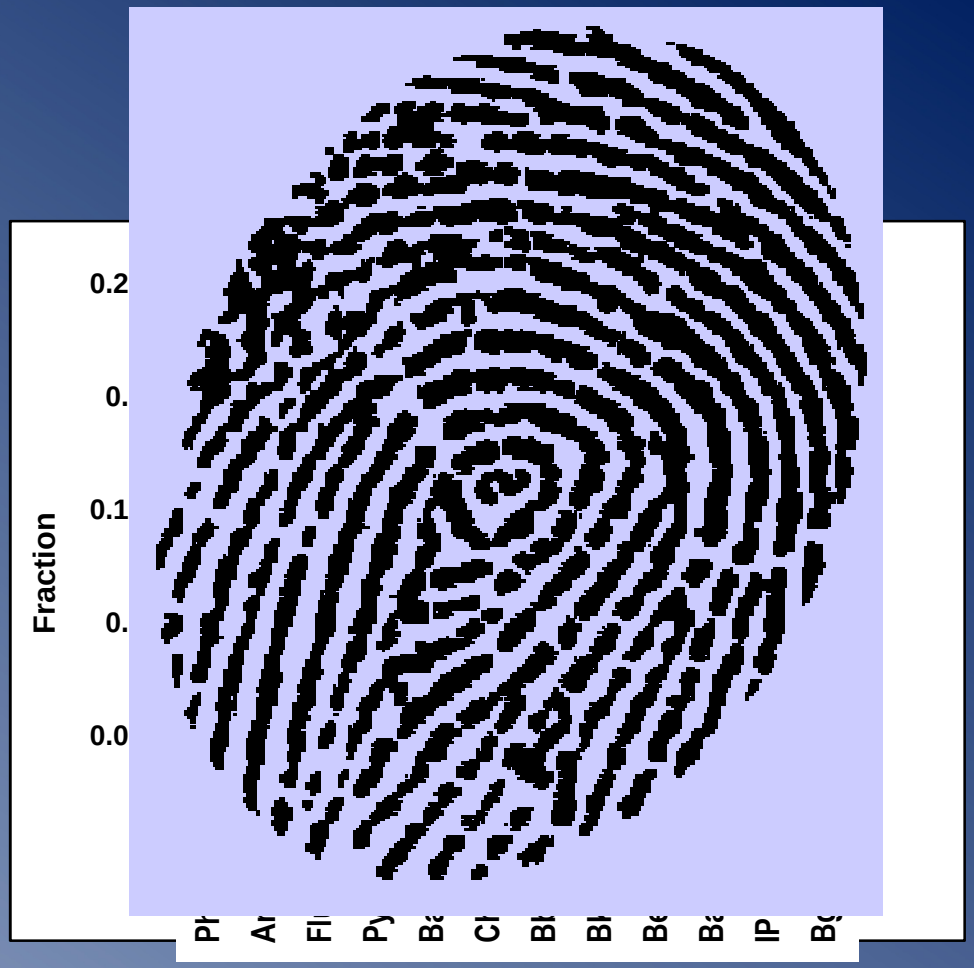
Sealcoat PAH transport pathways



Environmental Forensics: PAH fingerprints







CMB* source modeling

- **Vehicle/traffic related**

  Gasoline and diesel soot and exhaust, tunnel air, used oil, tires, asphalt wear
- **Coal combustion**

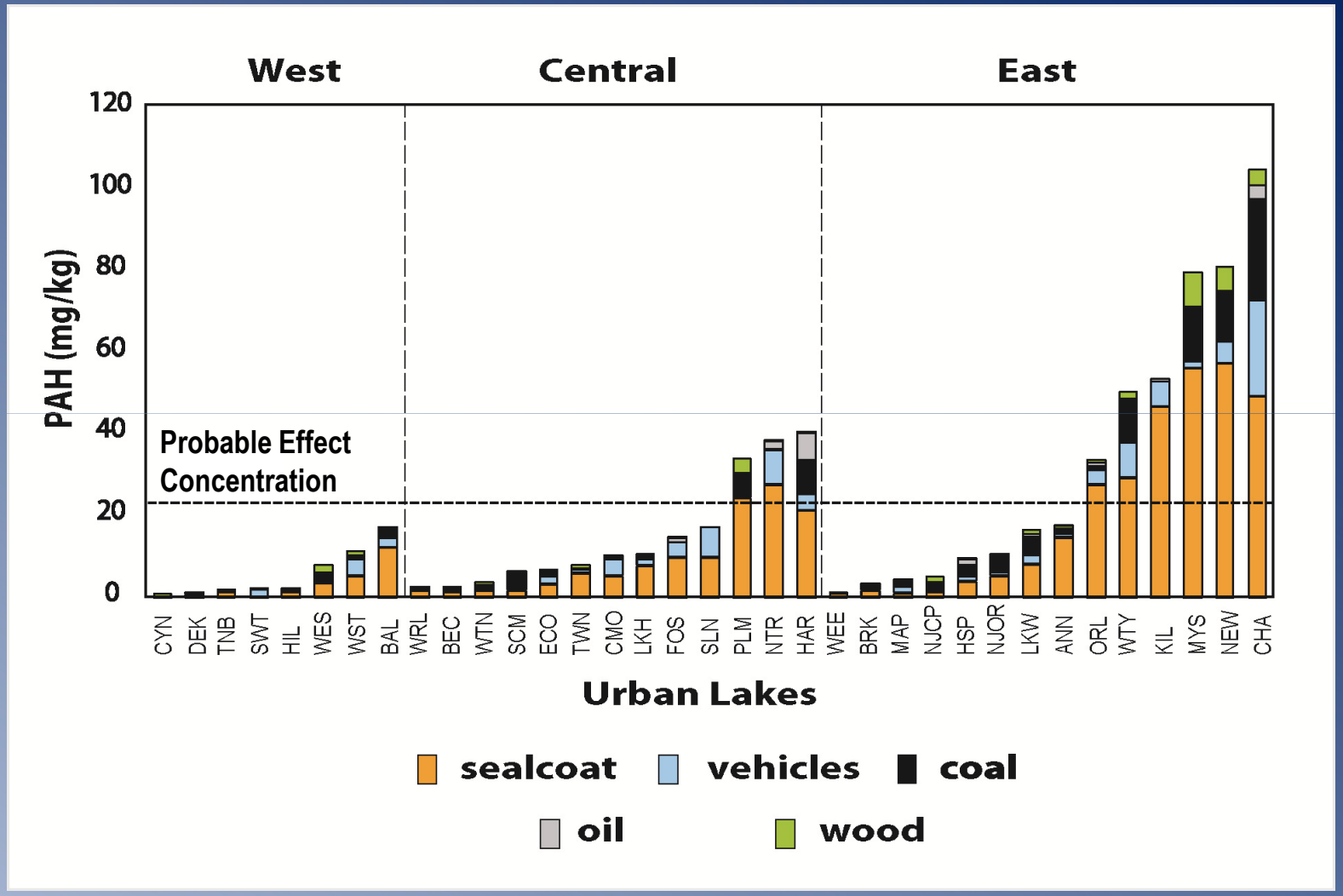
  Residential, power plant, and coking plant emissions
- **Fuel oil combustion**
- **Wood burning**

  Pine-wood soot particles
- **Coal-tar-based sealcoat**

  NIST standard, products, scraping s, and pavement dust

*EPA contaminant mass balance model

PAH sources to U.S. urban lakes



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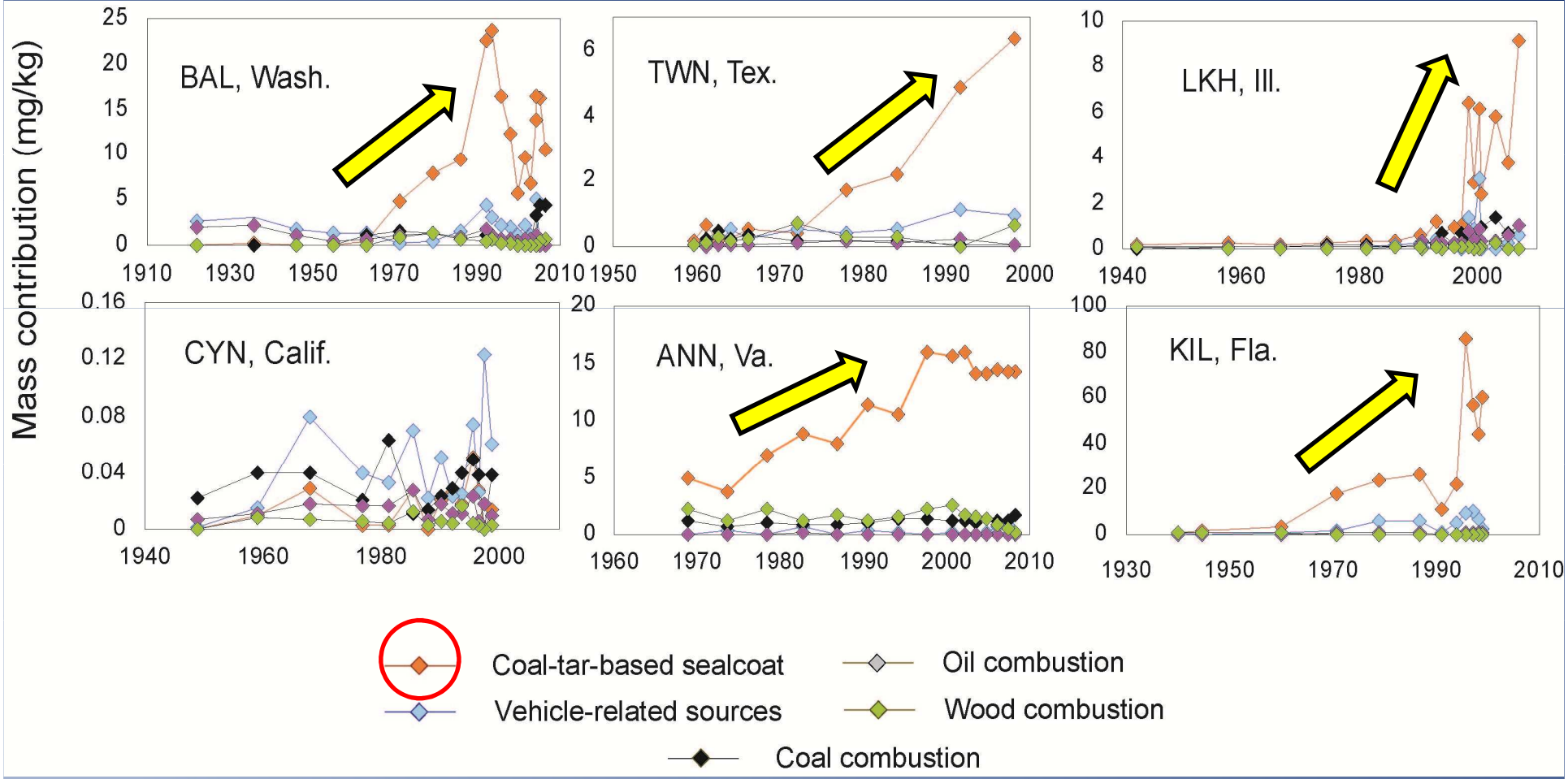
Van Metre and Mahler, 2010, STOTEN

PAH Trends in New Urban Lakes



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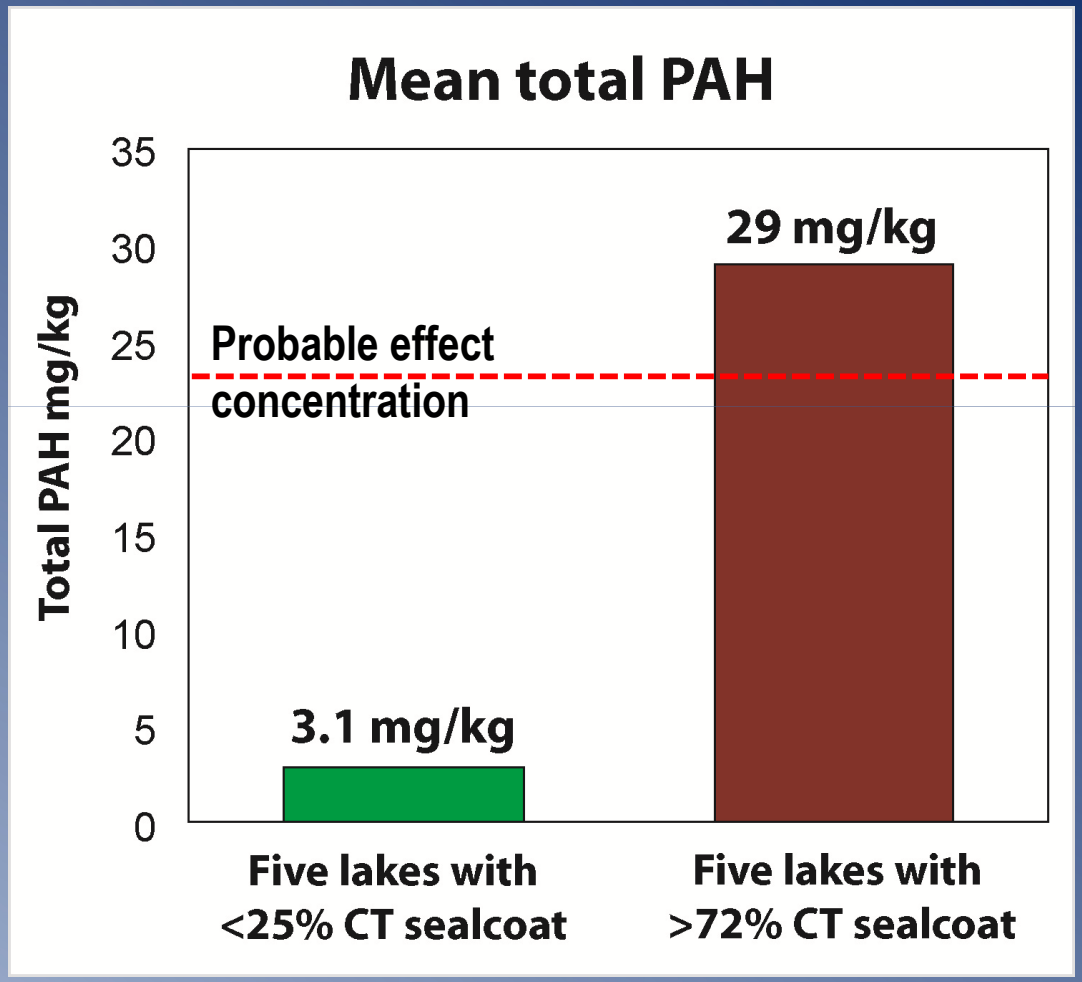
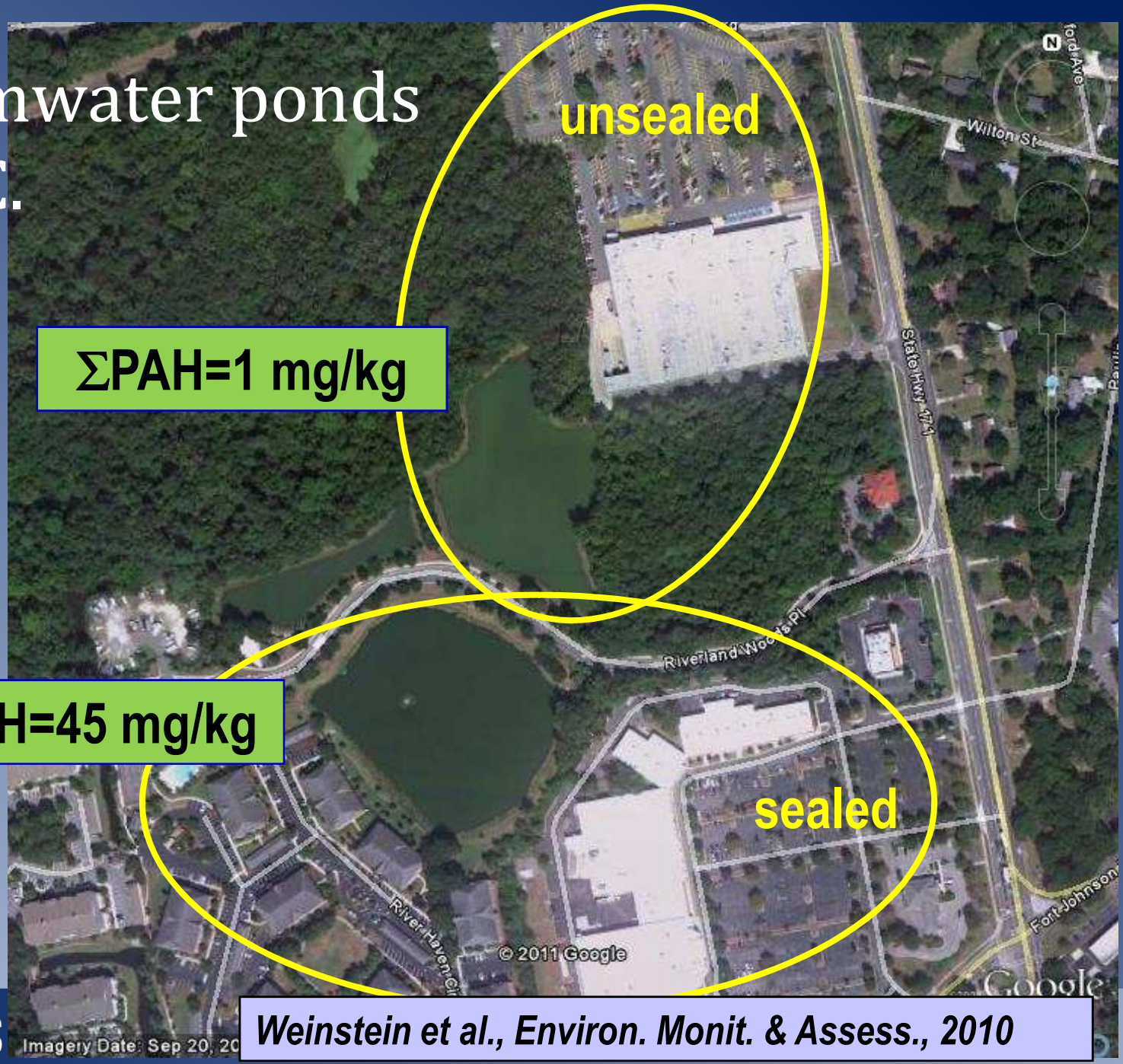
A large coal-tar-sealcoat contribution translates to high PAH concentrations



Stormwater ponds in S.C.



Weinstein et al., Environ. Monit. & Assess., 2010

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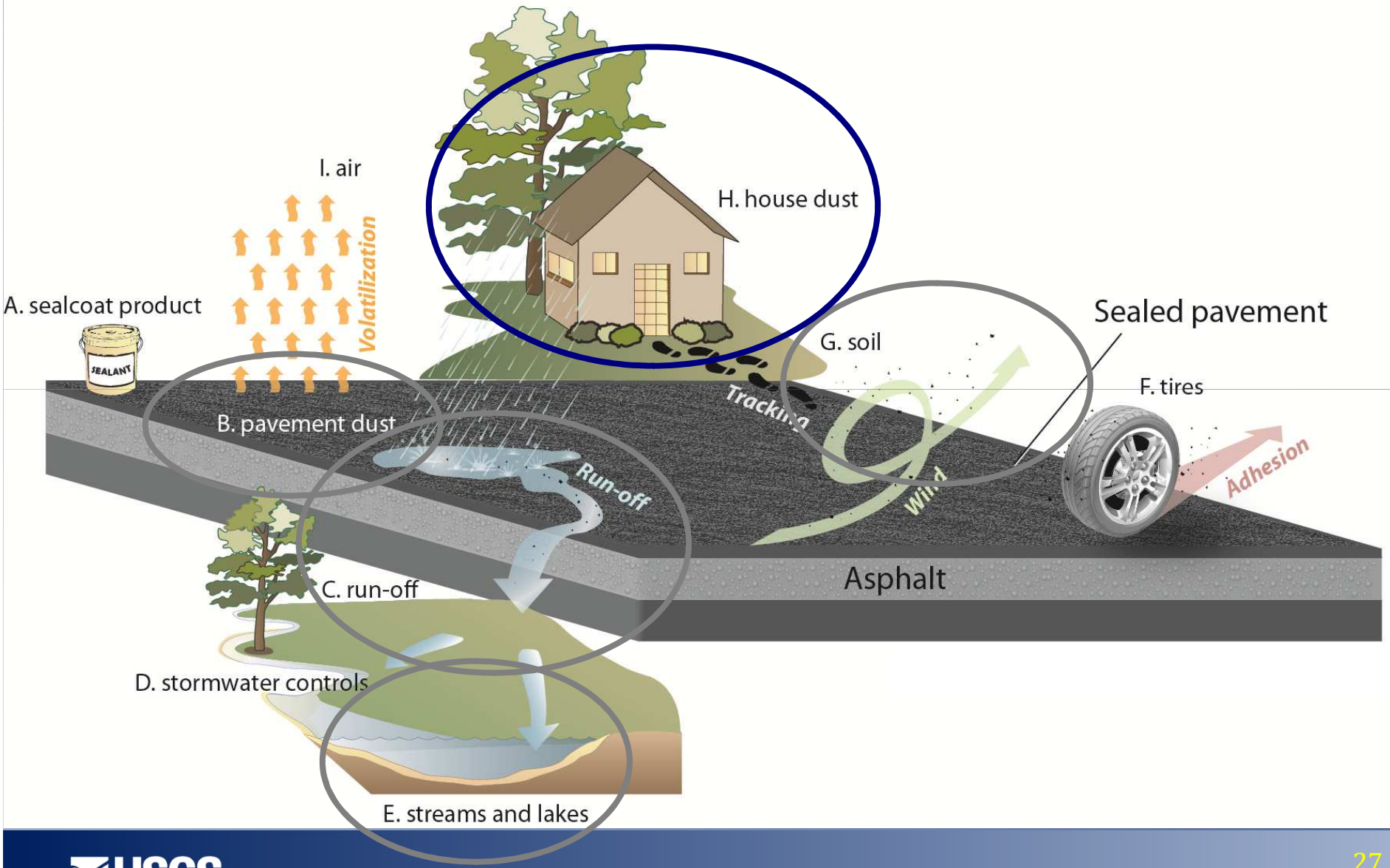
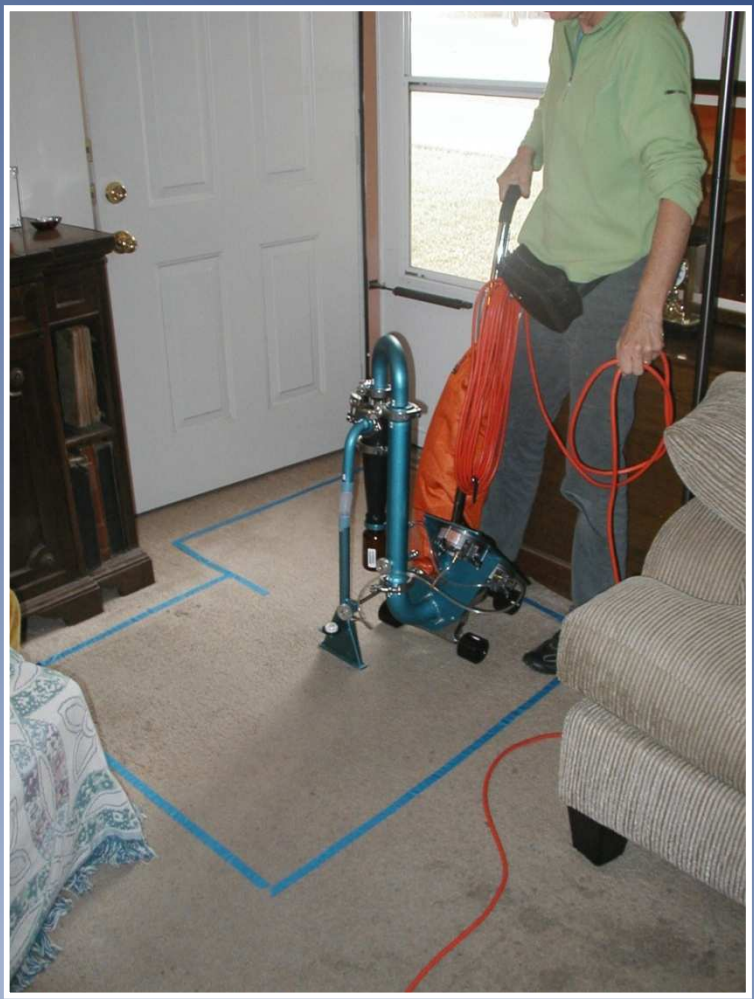
Effects on aquatic biota

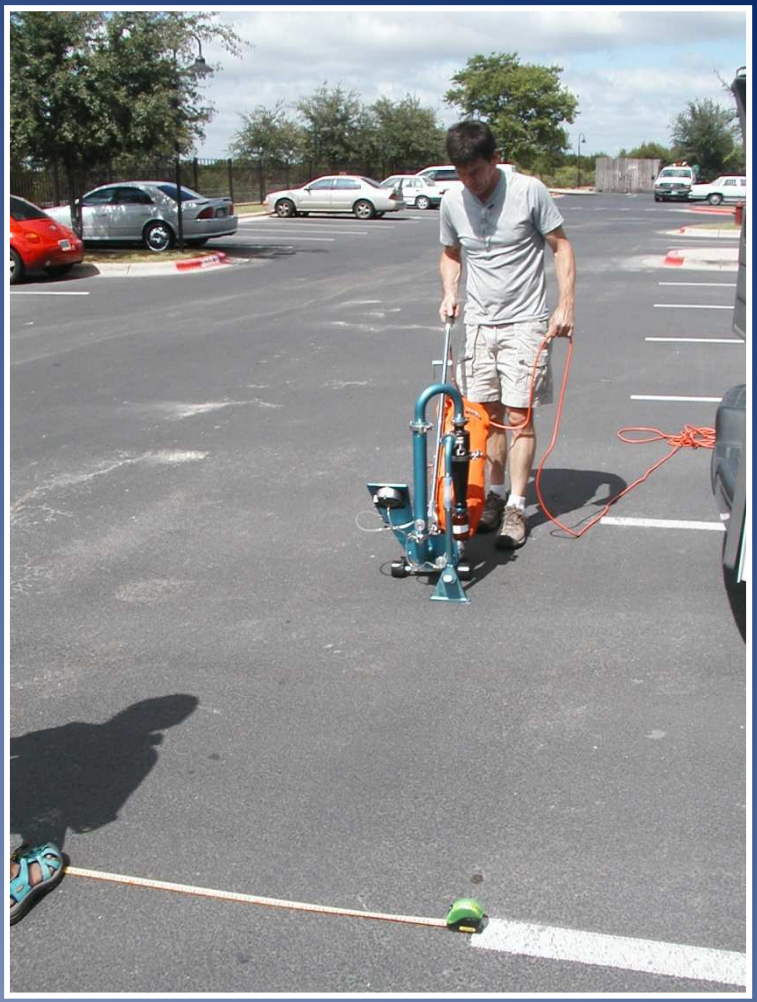
Bommarito et al., 2010, Ecotoxicology
Bommarito et al., 2010, Chemosphere
Bryer et al., 2009, Environ. Poll.
Bryer et al., 2006, Ecotoxicology
Scoggins et al., 2006, J. NABS

Sealcoat PAH transport pathways

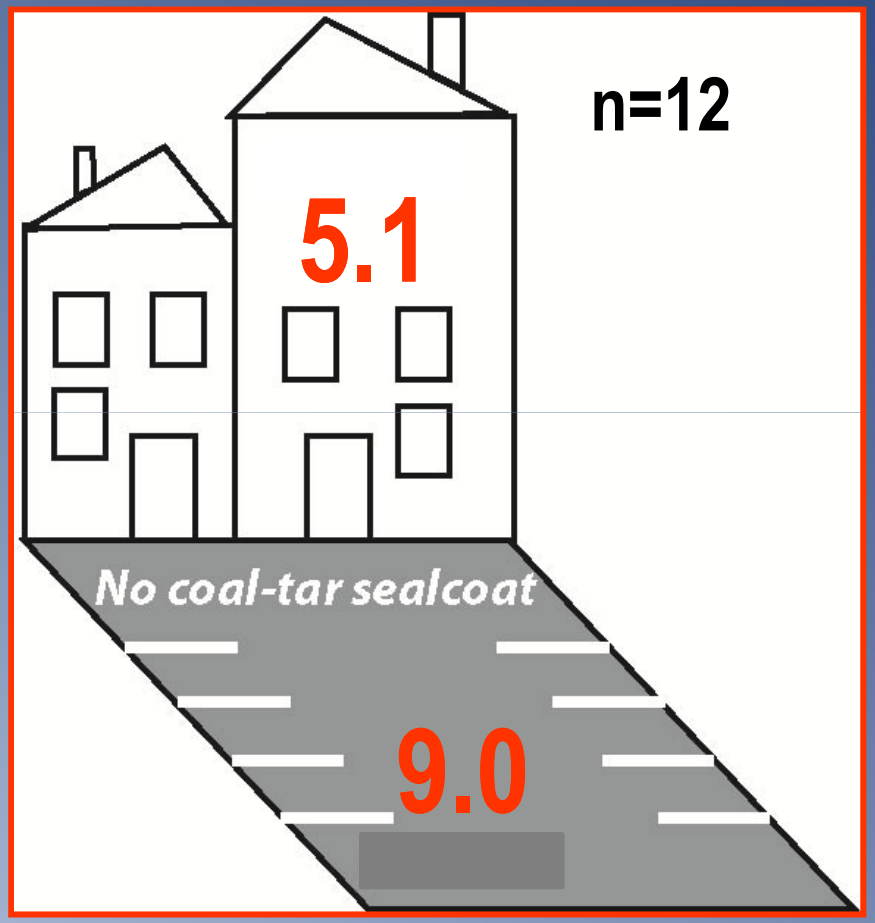


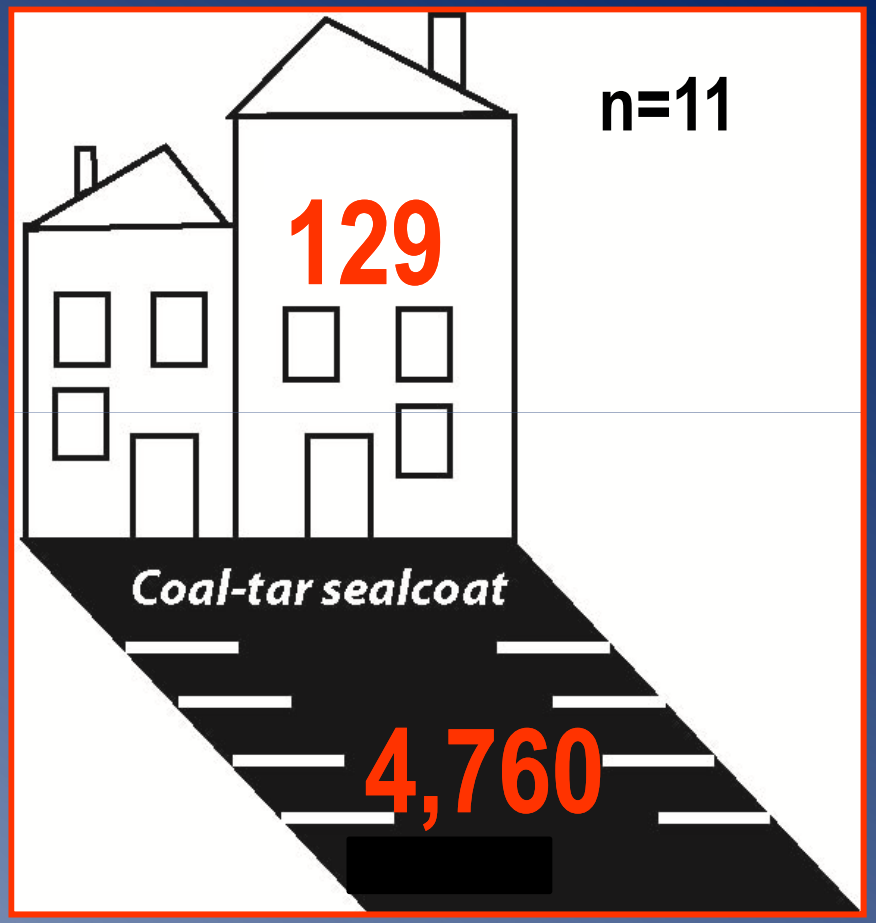
23 ground-floor apartments, dust indoors and out





Median total PAH [mg/kg]





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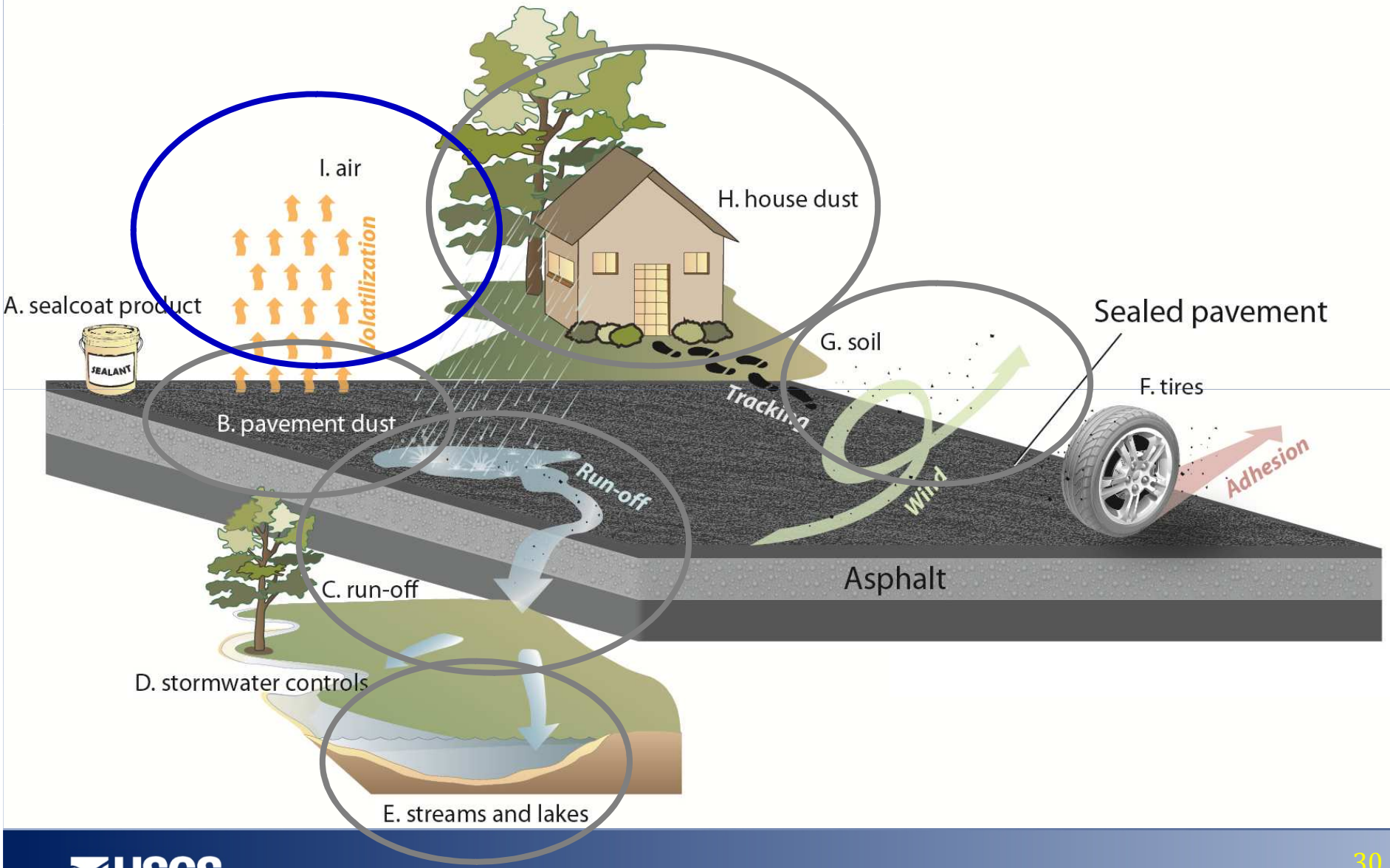
Mahler et al., 2010, Environ. Sci. & Tech.

Sealcoat PAH transport pathways



Air Quality?

PAHs in air

Ambient Air (AMB)

Use gradient to estimate flux

Surface air layer (HAT)

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Results

- ΣPAH_8 in unsealed lots (geometric means)
- HAT = 66, AMB = 26 ng/m^3, flux = 1.4 µg/m^2 h
- ΣPAH_8 in sealcoated lots

Flux = 60x background

- HAT=1,320 , AMB = 138 ng/m^3, flux = 88 µg/m^2 h

ΣPAH_8 2 hours after application

HAT = 300,000 ng/m^3, AMB = 5,400 ng/m^3

flux = 45,000 µg/m^2 h

Flux = 30,000x background

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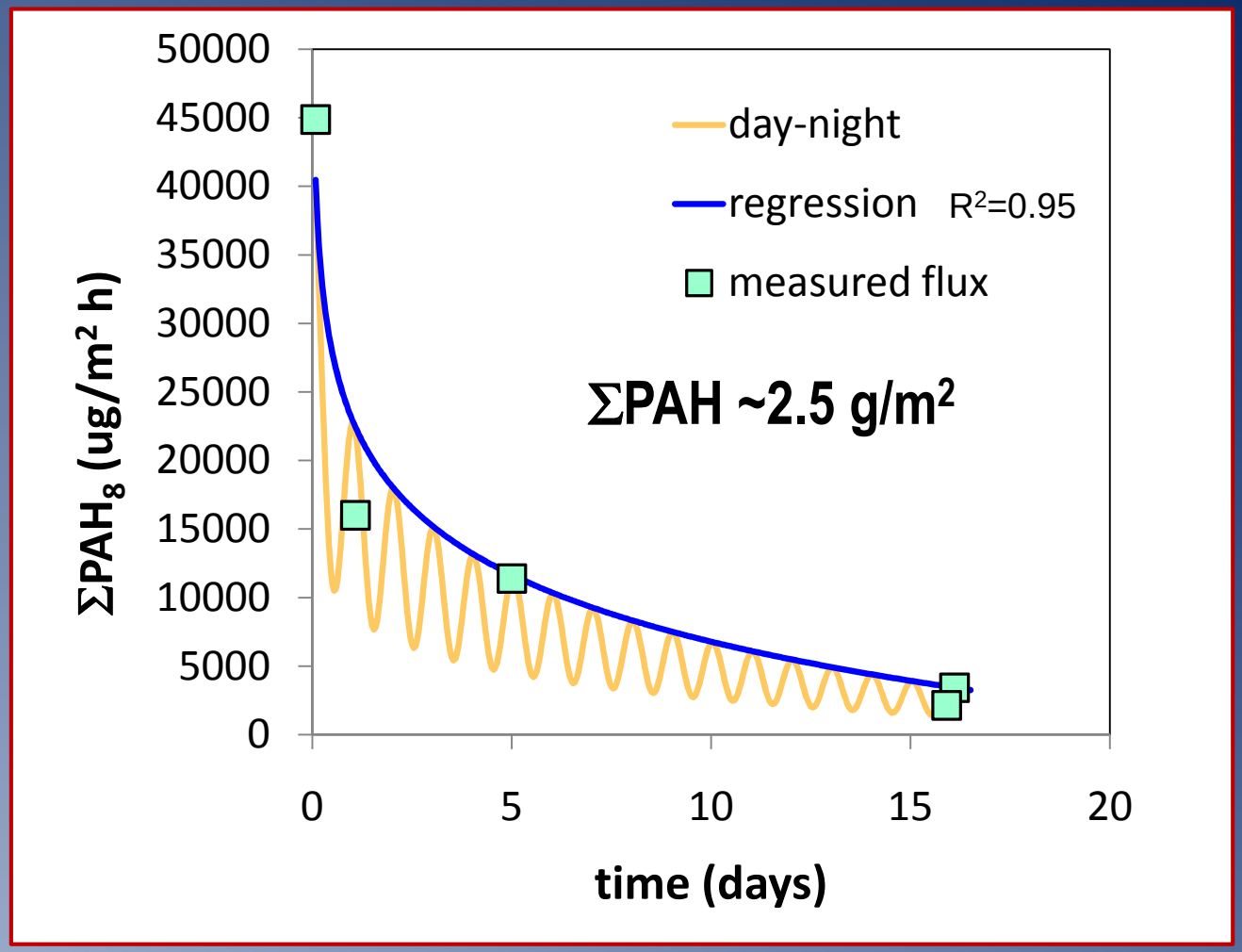
Total PAH emissions during drying



Total PAH emissions during drying

Annual coal-tar sealcoat use	85 million gal
Area covered	~440 km^2
PAH emission rate	2.5 g/m^2
ΣPAH_8 emissions/yr	**~1,000 metric tons (Mg)**
ΣPAH_{16} vehicle emissions, 2010	**840 Mg***
ΣPAH_8 vehicle emissions, 2010	**~50 Mg***

*** Shen et al., 2011**

Van Metre et al., in press, Chemosphere
Van Metre et al., in press, Atmos. Environment

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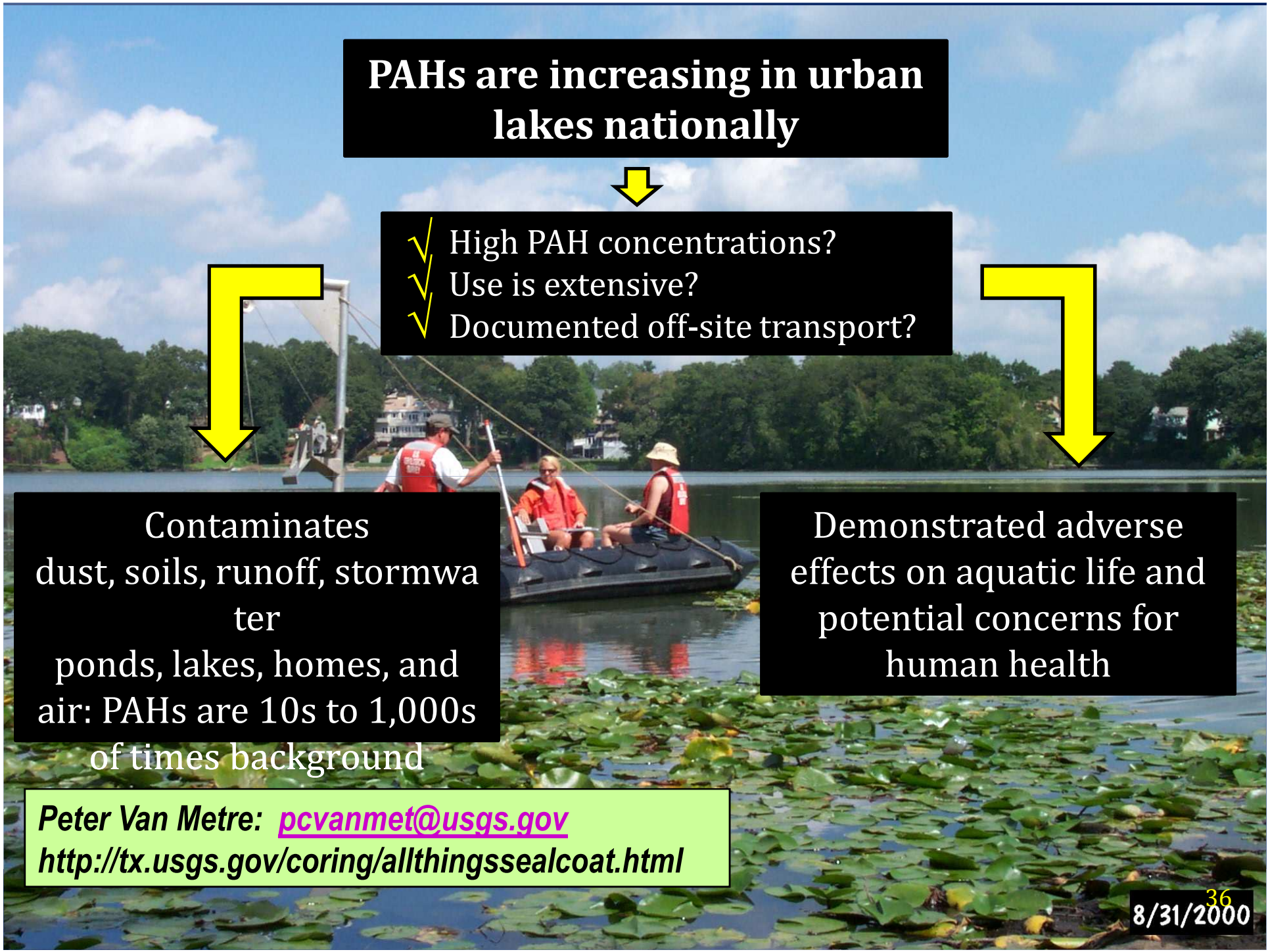
PAHs are increasing in urban lakes nationally
√ High PAH concentrations?
√ Use is extensive?
√ Documented off-site transport?
Contaminates
dust, soils, runoff, stormwa ter
ponds, lakes, homes, and air: PAHs are 10s to 1,000s of times background
Demonstrated adverse effects on aquatic life and potential concerns for human health
Peter Van Metre: pcvanmet@usgs.gov
http://tx.usgs.gov/coring/allthingssealcoat.html
8/31/2000