You're standing on it! Coal-tar-based pavement sealcoat and environmental and human health

Barbara J. Mahler, Ph.D., P.G., Research Hydrologist, and **Peter C. Van Metre**, Ph.D., Research Hydrologist,
U.S. Geological Survey Texas Water Science Center, Austin, Texas

Studies by the U.S. Geological Survey (USGS) have demonstrated that coal-tar-based sealcoat—a product marketed to protect and beautify the asphalt pavement of driveways and parking lots—contributes polycyclic aromatic hydrocarbons (PAHs) to air, soils, streams and lakes, and homes.

What are sealcoat, coal tar, and PAHs?

Pavement sealcoat (also called sealant or driveway sealer) is a black liquid sprayed onto the asphalt pavement of residential driveways, parking lots, and even some playgrounds (Fig.1). Most sealcoat products have a coal-tar-pitch or asphalt (oil) base. Sealcoat used in the central, southern, and eastern U.S. commonly contains coal-tar pitch, and sealcoat used in the western U.S. commonly contains asphalt. Coal-tar pitch, a known human carcinogen, is the residue remaining after distillation of coal tar, a byproduct of the coking of coal. Coal-tar-based sealcoat typically is 20 to 35 percent coal-tar pitch and contains from 50,000 to 100,000 milligrams per kilogram (or parts per million) PAHs, about 1,000 times more PAHs than in asphalt-based sealcoat products. There are hundreds of times more PAHs in coal-tar-based sealcoat than in tire particles, used motor oil, or other urban sources. Several PAHs are toxic, carcinogenic, mutagenic, and/or teratogenic (causing birth defects). At least seven PAHs, including benzo[a]pyrene, are probable human carcinogens.

PAHs from coal-tar-based sealcoat contaminate air, soil, streams and lakes, and homes

PAHs from coal-tar-based pavement sealant find their way into many parts of the environment (Fig. 2). When coal-tar-based sealcoat is first applied, as much as one-half of the PAHs volatilize (evaporate) into the air, which is why recently sealed pavement gives off such a strong smell, particularly on a hot day. A study in Austin, Tex., measured PAHs in air over a parking lot following application of coal-tar-based sealcoat; PAH concentrations initially were hundreds to thousands of times higher than in air over unsealed parking lots. Concentrations decreased during the following weeks, but even years after application, coal-tar-sealcoated lots continue to release about 60 times more PAHs into the air than do unsealed asphalt lots. The amount of PAHs released into the air from coal-tar-sealcoated lots in the U.S. each year is estimated to exceed that from vehicle emissions.

Friction from vehicle tires abrades pavement sealcoat into small particles—sealcoat wear is visible in high traffic areas within a few months after application. Dust on the coal-tar-sealcoated pavement surface contains PAHs at concentrations that

Figure 1: Sealcoat is the black liquid sprayed onto the asphalt pavement of some parking lots, driveways, and playgrounds. The sealcoat product predominantly used in the central, southern, and eastern U.S. contains coal tar, a known human carcinogen.

are hundreds of times higher than those in dust on concrete or unsealed asphalt pavement (Fig. 3). Wind, rain, and snowplows transport some of that dust to nearby soil.

Stormwater transports abraded sealcoat particles off pavement, and the first stop for stormwater runoff in many communities is a retention pond. By design, retention ponds trap particles, which creates an unintended problem for many municipalities because PAHs accumulate in the pond sediment. Sediment in 5 of 10 ponds sampled in the Minneapolis-St. Paul, Minn., metropolitan area had PAH concentrations that exceeded a threshold above which disposal costs greatly increase—if PAHs in just 10% of the estimated 20,000 stormwater ponds in the area exceed that threshold, costs for disposing of the sediment could reach $1 billion.

Some sealcoat particles are transported by streams and rivers to lakes, where they are deposited in lake sediment. The PAH chemical fingerprints—the combination of different PAHs measured in a sample—for lake sediments studied by the USGS in central, southern, and eastern U.S. cities are a close match for those in dust from coal-tar-sealcoated pavement. The chemical fingerprints for lake sediment in the western U.S., where the coal-tar product is not commonly used, are different. Coal-tar-based sealcoat was estimated to contribute about one-half of the PAHs in sediment from 40 urban lakes studied by the USGS; vehicles and coal combustion contributed most of the rest.

PAHs from pavement with coal-tar-based sealcoat make their way indoors, too. In a study in Austin, Tex., concentrations of PAHs in house dust in apartments adjacent to parking lots with coal-tar-based sealcoat were 25 times higher than

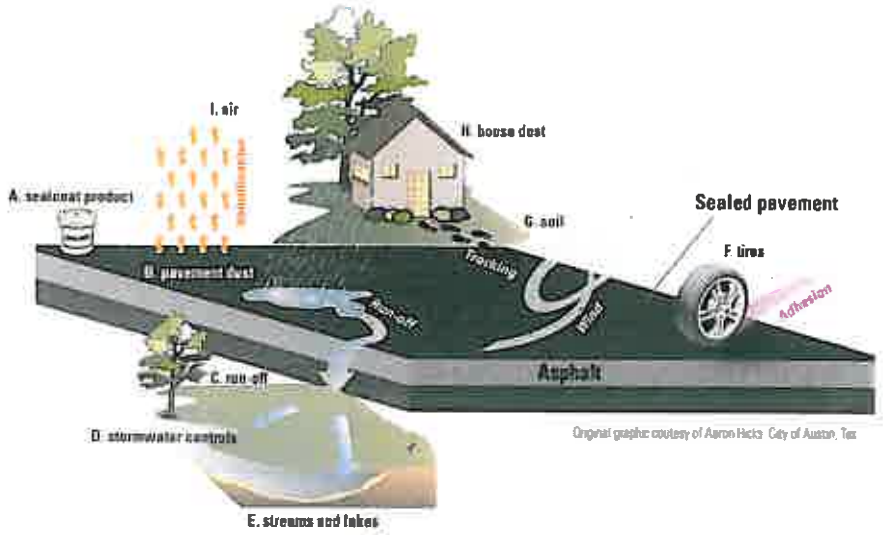

Figure 2: PAHs from coal-tar-based pavement sealcoat are transported by different pathways to various environmental compartments. Once dry, the sealcoat product (A), which contains high concentrations of PAHs, is abraded into a powder and becomes part of the dust on the pavement (B). That dust is transported by storm runoff (C) to stormwater management devices (D) or to receiving streams and lakes (E). Parking lot dust also adheres to tires (F), which track it onto unsealed pavement, and wind and runoff transport the dust to nearby soils (G). Dust particles also are tracked on shoes into residences, where they become incorporated into house dust (H). Coal-tar-based pavement sealcoat also contains volatile PAHs that are released into the air (I). (Modified from Mahler, B.J., 2012, Environ. Sci. Technol. 56(6):3039-3045)

Figure 3: Dust swept from pavement with coal-tar-based sealcoat contains very high concentrations of polycyclic aromatic hydrocarbons (PAHs).

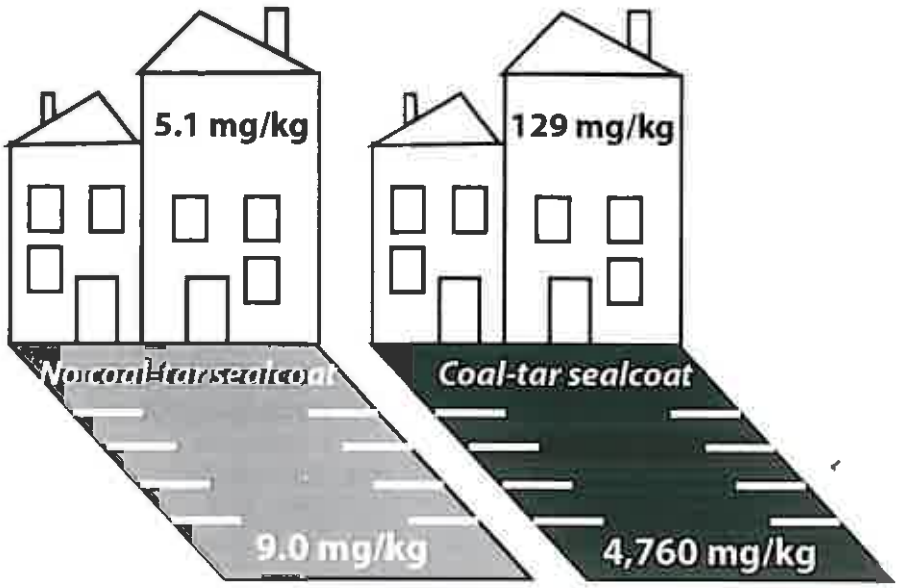

Figure 4: Concentrations of PAHs in house dust in apartments adjacent to parking lots with coal-tar-based sealcoat were 25 times higher, on average, than concentrations in those adjacent to asphalt or concrete parking lots or parking lots with asphalt-based sealcoat. Concentrations in dust on the pavement surface were 530 times higher. Concentrations shown, in milligrams per kilogram (mg/kg, or parts per million), are medians for 12 parking lots without coal-tar-based sealcoat and 11 parking lots with coal-tar-based sealcoat. (Modified from Mahler, B J., 2010, Environ. Sci. Technol., 44, 894-900.)

in those with concrete, unsealed asphalt, or asphalt-based-sealcoated parking lots (Fig. 4). House dust is a source for human exposure to many contaminants, including PAHs. This is particularly true for small children, who spend time on the floor and put their hands and objects into their mouths. Although tobacco smoking, candle and incense burning, and barbecue and fireplace use have been suggested to affect PAH concentrations in house dust, the study found no relation between any of these and PAH concentrations in the house dust.

Our environment and us—what are the PAH concerns?

Some PAHs are toxic to mammals, birds, fish, amphibians, and plants. Insects and other small creatures that live in streams and lakes are particularly sensitive to PAH contamination; they are an important part of the food chain and often are monitored as indicators of stream quality. Recent studies have shown that aquatic life downstream from sealcoated parking lots is impaired. Salamanders and newts exposed to sediment contaminated with coal-tar-based sealcoat have stunted growth, difficulty swimming or righting themselves, and liver problems; and frogs exposed to sediment contaminated with coal-tar-based sealcoat have stunted growth, develop more slowly than usual, or die.

People can be exposed to PAHs in sealcoat through incidental ingestion of coal-tar sealcoat particles abraded from driveways, parking lots, or playgrounds. There is a significant increase in estimated excess lifetime cancer risk for residents living near coal-tar-sealcoated pavement associated with incidental ingestion of PAH-contaminated soil and house dust. Much of the exposures associated with the excess risk occur during childhood. Other exposure pathways include skin contact with the sealed pavement or abraded particles and inhalation of PAH-contaminated air near sealcoated parking lots.

Regulatory and retail actions

Actions have been taken in some parts of the U.S. to ban or restrict the use of coal-tar-based sealcoat in the U.S. The first ban was implemented by the City of Austin, Tex., in 2006. Since then, sales and use of coal-tar-based sealcoat have been banned in numerous cities (including Minneapolis, Minn., and Washington, D.C.), in three counties, and in the State of Washington. Other local and state jurisdictions have used voluntary or limited-use restrictions for certain groups (e.g., city governments) to discourage use of coal-tar-based sealcoat.

Several national and regional hardware and home-improvement retailers have voluntarily ceased selling coal-tar-based sealcoat, and some applicators have chosen to use only asphalt-based sealcoat. Many sealcoat applicators in areas unaffected by bans or restrictions, however, continue to use coal-tar-based sealcoat.

This article summarizes background information and scientific findings in articles written by USGS researchers and their colleagues from other federal, state, and local agencies and universities and published in scientific journals: Mahler et al., 2012, Environ. Sci. Technol. 56(6):3039-3045; Mahler et al., 2010, Environ. Sci. Technol. 2010, 44, 894-900; Van Metre et al., 2012, Atmospheric Environment 51:108-115; and Williams et al., E.S., Environ. Sci. Technol., in press, DOI: 10.1021/es303371t. The journal articles and additional information on coal-tar-based sealcoat are available at: http://tx.usgs.gov/coring/allthingssealcoat.html.

Barbara Mahler, a Research Hydrologist at the U.S. Geological Survey Texas Water Science Center, can be reached at (512) 927-3566 or bjmahler@usgs.gov.