

Polycyclic Aromatic Hydrocarbons And Coal-Tar Pavement Sealants

UPDATE

January 19, 2017

Christopher Magruder
SWWT Science Advisory Committee Coordinator



sweet water
SOUTHEASTERN WISCONSIN WATERSHEDS TRUST, INC.

Who Have We Met With?

- * Sweet Water Clean Rivers, Clean Lake Conference
- * Midwest Water Analysis Conference
- * American Water Resources Association Conference - Wisconsin Chapter
- * **Intergovernmental Cooperation Executive Council**
- * MMSD Technical Advisory Team
- * MMSD Executive Director
 - *WDNR AOC-RAP Coordinator and Committee
- *WDNR S.E. District Stormwater Manager
 - *City of Milwaukee Sustainability Director
 - *UWM Environmental Committee
 - *Sweet Water Science Advisory Committee
- *Sweet Water Policy Advisory Committee

ICC's Executive Council

Polycyclic Aromatic Hydrocarbons And Coal- Tar Pavement Sealants

Meeting - November 14, 2016

Christopher Magruder

Science Advisory Committee Coordinator

Matthew T. Magruder

MMSD Research Manager



ICC's Executive Council Adopted Resolution

December 12, 2016

“It is resolved that the ICC acknowledges that coal-tar is a significant source of polycyclic aromatic hydrocarbon (PAH) loading to Milwaukee-area streambed sediments - posing great risk to both human and aquatic life - and appointed officials will work within their statutory authority to support restrictions of application, or outright banning, of coal-tar products within their respective municipalities.”

The Milwaukee Study and Findings Published

SETAC PRESS

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Environmental Toxicology

PRIMARY SOURCES AND TOXICITY OF PAHS IN MILWAUKEE-AREA STREAMBED SEDIMENT

AUSTIN K. BALDWIN,*† STEVEN R. CORSI,† MICHELLE A. LUTZ,† CHRISTOPHER G. INGERSOLL,‡ REBECCA DORMAN,‡
CHRISTOPHER MAGRUDER,§ and MATTHEW T. MAGRUDER,§
†US Geological Survey, Middleton, Wisconsin, USA
‡Milwaukee Metropolitan Sewerage District, Milwaukee, Wisconsin, USA

(Submitted 10 May 2016; Returned for Revision 23 June 2016; Accepted 21 November 2016)

Abstract: High concentrations of polycyclic aromatic hydrocarbons (PAHs) in streams can be a significant stressor to aquatic organisms. To understand the likely sources and toxicity of PAHs in Milwaukee-area streams, streambed sediment samples from 40 sites and parking lot dust samples from 6 sites were analyzed for 38 parent PAHs and 25 alkylated PAHs. Diagnostic ratios, profile correlations, principal components analysis, source-receptor modeling, and mass fractions analysis were used to identify potential PAH sources to streambed sediment samples, and land-use analysis was used to relate streambed sediment PAH concentrations to different urban-related land uses. On the basis of this multiple lines-of-evidence approach, coal-tar pavement sealant was indicated as the primary source of PAHs in a majority of streambed sediment samples, contributing an estimated 77% of total PAHs to samples, on average. Comparison with the probable effect concentrations and (or) the equilibrium partitioning sediment benchmark indicates that 78% of stream sediment samples are likely to cause adverse effects to benthic organisms. Laboratory toxicity tests on a 16-sample subset of the streambed sites using the amphipod *Hyalella azteca* (28-d) and the midge *Chironomus dilutus* (10-d) measured significant reductions in 1 or more biological endpoints, including survival, in 75% of samples, with *H. azteca* more responsive than *C. dilutus*. *Environ Toxicol Chem* 2016;9999:1–14. © 2016 The Authors. Environmental Toxicology and Chemistry Published by Wiley Periodicals, Inc. on behalf of SETAC.

Keywords: Polycyclic aromatic hydrocarbons (PAHs) Sediment toxicity Storm water runoff Coal-tar pavement sealant

INTRODUCTION

Polycyclic aromatic hydrocarbons (PAHs) are widespread contaminants in urban aquatic sediments and typically occur as complex mixtures [1,2] with numerous natural and anthropogenic sources. Polycyclic aromatic hydrocarbons are categorized as either petrogenic or pyrogenic: petrogenic PAHs form at low temperatures over geologic time scales, whereas pyrogenic PAHs form rapidly at high temperatures during incomplete combustion of carbon-based material. Sources of petrogenic PAHs include fossil fuels such as unprocessed coal and crude and refined petroleum products (gasoline, diesel, motor oil, home heating oil, lubricants, and asphalt) [3]. Pyrogenic PAHs come from natural sources, such as forest and grass fires and volcanic eruptions, and from anthropogenic sources, such as gasoline- and diesel-engine exhausts, coal-fired power plant emissions, coke-oven emissions, residential wood burning, creosote, and coal tar from legacy manufactured gas plants and pavement sealants [2–4].

Polycyclic aromatic hydrocarbons are transported to streams and lakes via atmospheric deposition; industrial and wastewater discharges; and runoff from surfaces such as streets, parking lots, and rooftops [4,5]. Most PAHs are hydrophobic and thus sorb to suspended particulates in the water column and subsequently

precipitate and accumulate in streambed and lakebed sediments. Some PAHs are toxic, carcinogenic, mutagenic, and (or) teratogenic and can therefore be detrimental to aquatic organisms [6]. Sediment contaminated with PAHs can also pose an economic burden to communities charged with contamination clean-up. Communities in the area of Minneapolis–St. Paul (MN, USA) estimate that the disposal cost of dredged sediment from storm water ponds will reach \$1 billion, because elevated PAH concentrations in the sediment—chiefly from coal-tar-based pavement sealant—require disposal in specially lined landfills [7]. In the Great Lakes region (USA), more than \$500 million has been spent since 2002 at 19 different sites to clean up contaminated sediment, with a primary focus on polychlorinated biphenyls and PAHs [8].

A recent study of streams in the area of Milwaukee (WI, USA) found that, among 15 classes of organic contaminants, PAHs posed the greatest risk to aquatic organisms [9]. The present study provides a more comprehensive assessment of the potential toxicity of sediment-associated PAHs to benthic aquatic organisms in Milwaukee-area streams by comparing PAH concentrations in streambed sediment samples with sediment quality guidelines and through laboratory toxicity tests. In addition, a multiple-lines-of-evidence approach is used to determine the most important sources of PAHs to Milwaukee-area streambed sediment. Individually, each diagnostic method used in the present study has limitations and uncertainties. By using a multiple-lines-of-evidence approach, the uncertainties of each method are mitigated, and common conclusions are strengthened [10,11]. The diagnostic methods used for identification of PAH sources were land-use analysis [12], ratios of parent to alkylated PAHs [2], ratios of high molecular weight to low molecular weight PAHs [7], diagnostic ratios of

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* Address correspondence to akbaldwi@usgs.gov
Published online in Wiley Online Library
(wileyonlinelibrary.com).
DOI: 10.1002/etc.3694

❖ Journal of Environmental Toxicology and Chemistry

❖ Toxicity and primary sources of PAHs in Milwaukee-area streambed sediment:

(Austin K. Baldwin, Steven R. Corsi, Michelle A. Lutz, Christopher G. Ingersoll, Rebecca Dorman, Christopher Magruder, Matthew T. Magruder)

Milwaukee Findings

Toxicity to aquatic organisms

- PAH concentrations exceed Sediment Quality Guidelines at many sites
 - Sites exceeding Threshold Effect Concentration: 37/40
 - Sites exceeding Probable Effect Concentration: 13/40
- Bioassays demonstrate increasing PAH concentrations were associated with decreasing *Hyalella* survival



Source apportionment

- 8 methods indicate that coal tar-based sealcoat is the primary source of PAHs to Milwaukee streams
 - EPA CMB Model: On average 77% of PAHs are from coal tar sealcoat dust

USGS and MMSD Joint Press release

Coal tar main source of toxicity in waterways

Chemicals in sealants run off, study says

DON BEHM
MILWAUKEE JOURNAL SENTINEL

Coal-tar sealants applied to blacktop parking lots and driveways are the primary source of toxic chemicals found in the muck at the bottom of Milwaukee-area waterways, according to a study by the U.S. Geological Survey and the Milwaukee Metropolitan Sewerage District.

Tests of muck samples collected at 40 locations along 19 creeks and rivers in the metropolitan area, and dust from six parking lots, found that coal-tar sealants contributed up to 94% of all polycyclic aromatic hydrocarbons, or PAHs, in streambed sediment, says the study published last week in the journal *Environmental Toxicology and Chemistry*.

Fully 78% of the samples contained enough PAHs to be considered toxic and capable of causing adverse effects in aquatic ani-

mal life. The study is the latest consequence of regulations in Wisconsin and many other states requiring developers to excavate stormwater storage basins next to massive parking lots. PAHs cling to dirt, sand and other particles in the stormwater that settle to the bottom of the basins.

Communities in the Minneapolis-St. Paul metropolitan area estimate it will cost up to \$1 billion to dispose of PAH-contaminated sediment in the stormwater ponds when the basins are dredged for maintenance.

Coal tar, a byproduct of converting coal to coke — a solid-carbon fuel and carbon source for the steel-making industry — is a known human carcinogen. As coal is heated to produce coke, coal tar vapors are released.

Pavement sealants made with coal tar contain much higher concentrations of PAHs — up to 1,000 times more — than available substitute products made with asphalt emulsions, according to other studies.

Asphalt sealant products are known as seal coats. They are

Press release
December 22, 2016

- * Milwaukee Journal- Sentinel article (Dec. 26, 2016).
- * USA Today article (Dec. 27, 2016).
- * Wisconsin Public Radio story (Dec. 23, 2016)

USA Today Network

Don Behm, Milwaukee Journal Sentinel Published 7:10 a.m. ET Dec. 26, 2016

Updated 6:58 p.m. ET Dec. 26, 2016



Mike Daffison, left, and Micah Jacobson of Struck and Irwin Paving, apply slurry seal Aug. 12, 2011, to East Bennett Avenue in Milwaukee's south side. (Photo: John Klein, Milwaukee Journal Sentinel)

Some driveway sealants create toxic muck in streams

MILWAUKEE — Coal-tar sealants applied to blacktop parking lots and driveways are the primary [source of toxic chemicals found in the muck](#) at the bottom of area waterways, according to a study from the U.S. Geological Survey and the Milwaukee Metropolitan Sewerage District.

Tests of muck samples collected at 40 locations along 19 creeks and rivers in the metropolitan area and dust from six parking lots found that coal-tar sealants contributed up to 94% of all polycyclic aromatic hydrocarbons, or PAHs, in streambed sediment, [according to the study](#), published Thursday in the journal [Environmental Toxicology and Chemistry](#).

WPR News

Study: Coal Tar Sealant Harming Milwaukee-Area Streams

Sealant Is Major Source Of Toxic Pollutant In Streambed Sediments

Friday, December 23, 2016, 11:05am

By Chuck Quirnbach



A study published this week has found a type of blacktop sealant is the main source of a harmful pollutant in Milwaukee-area streams. Coal tar-based sealant is a liquid sprayed on parking lots, driveways and playgrounds. It often [runs off into waterways](#) through wastewater or industrial discharges, and runoff. The [study](#) by the U.S. Geological Survey and the Milwaukee Metropolitan Sewerage District found the sealant is the primary source of a group of hydrocarbons known as polycyclic aromatic hydrocarbons - or PAHs - in Milwaukee streambed sediments.

Geological Survey Hydrologist Austin Baldwin said tiny aquatic insects are often harmed by the sealant.

"We found 75 percent of the sampled sites were toxic," Baldwin said. "They either reduced survival or reduced other things like growth or reproduction."

Why Should We Care About PAHs?

- * Many PAHs are toxic, carcinogenic, or mutagenic to aquatic life and humans.
- * These environmental effects can be additive.
- * Prenatal exposure to PAHs linked to later developmental problems.
- * 17 PAHs have been identified as being of greatest concern with regard to potential exposure and adverse health effects on humans ([Agency for Toxic Substances and Disease Registry](#)).
- * 16 PAHs are on USEPA's priority pollutant list.
- * Costly to remediate.

Public health concerns prompt physician policy

Nov 16, 2016

The American Medical Association (AMA) adopts policy advocating for legislation banning coal-tar sealants due to the human health effects.

- The AMA new policy is aimed at reducing or ending the use of common coal-tar-based sealcoats that are used and applied on pavement and playgrounds across the country. The new policy advocates for legislation either to ban the use of pavement sealcoats containing PAHs or to require the use of sealcoat products with minimal PAH. According to the International Agency for Research on Cancer, PAH compounds have been proven to be carcinogenic, mutagenic and teratogenic to humans.

Exposure to Coal-Tar Sealants pose risk of developing cancer

The excess cancer risk for people living adjacent to coal-tar-sealcoated pavement (1.1 cancer incidences for every 10,000 individuals exposed) **was 38 times higher, on average (central tendency)**, than for people living adjacent to unsealed pavement.

What's Next?


- * Merge key elements of the draft White Paper with the finding of published Professional Paper.
- * *Sweetwater Science Advisory Committee* technical review of a merged fact sheet or document.
- * After technical review of merged fact sheet or document it will be provide to *Sweetwater Policy Advisory Committee* for advice on how to proceed with alternative(s).


UNIVERSITY OF WISCONSIN
UWMILWAUKEE

Evaluation of Impact and Management of Polycyclic Aromatic Hydrocarbons from Coal-Tar Sealants in Wisconsin

A White Paper for Southeastern Wisconsin Watersheds Trust

Katlyn Pluer • Luke Webber • Michael Brennan • Karsen Gosh
12/14/2015



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This article includes online-only Supplemental Data. This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited. * Address correspondence to abaldwin@usgs.gov. † Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/etc.3694

What Else?

cleanwisconsin



TAR-BASED PAVEMENT SEALANTS AND TOXIC PAH POLLUTION



OVERVIEW: Toxic PAH pollution poses risks to human health and the health of fish and other aquatic life living in our lakes and rivers. Tar-based pavement sealants are typically the most potent source of toxic PAHs in our urban landscapes.

Pavement sealants are coatings intended to give driveways and parking lots a more even black color. Manufacturers claim these products help protect underlying pavement, but there is little evidence to support that claim. Tar-based and asphalt-based pavement sealants are the two main types on the market today.

The problem with tar-based pavement sealants

Both types of pavement sealants contain a type of pollutant called polycyclic aromatic hydrocarbons (PAHs). These toxic compounds include chemicals known to cause cancer and developmental problems in children. The level of PAHs in tar-based pavement sealants is up to 1,000 times higher than in asphalt-based sealants.

How are people exposed to PAHs from tar-based pavement sealants?

Pavement sealants are worn down over time by weather, tire abrasion, and foot traffic. LOOSE SEALANT PARTICLES ARE BLOWN OR TRACKED INTO HOMES, SCHOOLS, AND OTHER NEARBY BUILDINGS. Those toxic particles are also scraped up by snowplows and washed away by rain and spring meltwater, ending up in our water bodies.

How significant is the health risk?

The coal tar pitch used in tar-based pavement sealants is a hazardous waste. Children living in homes where parking lots are coated with tar-based pavement sealants face a 14-fold increase in cancer risk compared to those living next to unsealed lots, according to researchers at Baylor University and the U.S. Geographical Survey. A lifetime of exposure can lead to cancer rates 38 times higher than normal.

Children living from birth to age 6 near parking lots coated with tar-based sealants have a 14x higher cancer risk compared to those living near unsealed lots

EXAMPLE PAH LEVELS (MG/G):

Fresh asphalt	0.0015
Wood fire smoke	0.002-0.0114
Weathered asphalt	0.003
Fresh motor oil	0.004
Open burning	0.005-0.7
Brake particles	0.016
Road dust	0.024
Tire particles	0.096
Diesel engine exhaust	0.102
Gasoline engine exhaust	0.37
Used motor oil	0.44
Asphalt-based sealant	0.05
Tar-based sealant	70 - 250



- ❖ Tar-Based Pavement Sealants and Toxic PAH Pollution - Fact Sheet.
- ❖ Continuing PAH and Coal-tar Sealants Research.
- ❖ Continuing Educational Public Outreach.

Why should we take action on coal-tar sealants now?

- Excessive PAHs in coal-tar sealants are known to be detrimental to the environment and human health.
- Most studies find coal-tar sealants are a primary source of PAHs in areas where used, including the **MILWAUKEE REGION!**
- Arguments for policy action can be made on multiple grounds:
 - Human health
 - Environmental health
 - Economics
- Coal-tar sealants are a **CONTROLLABLE** source with **REASONABLE** alternatives available.

A Regional or Statewide Coal-Tar Sealant Policy would do the following:

1. Protect human health.
 - By reducing exposure to potential carcinogens
2. Protect aquatic ecosystems from harm.
 - By reducing lethal and sublethal effects
3. Reduce municipal costs for hazardous/contaminated sediment disposal.
4. Determine if a regional phase-out or ban on coal-tar sealants is necessary.

Acknowledgements

