Exhibit A

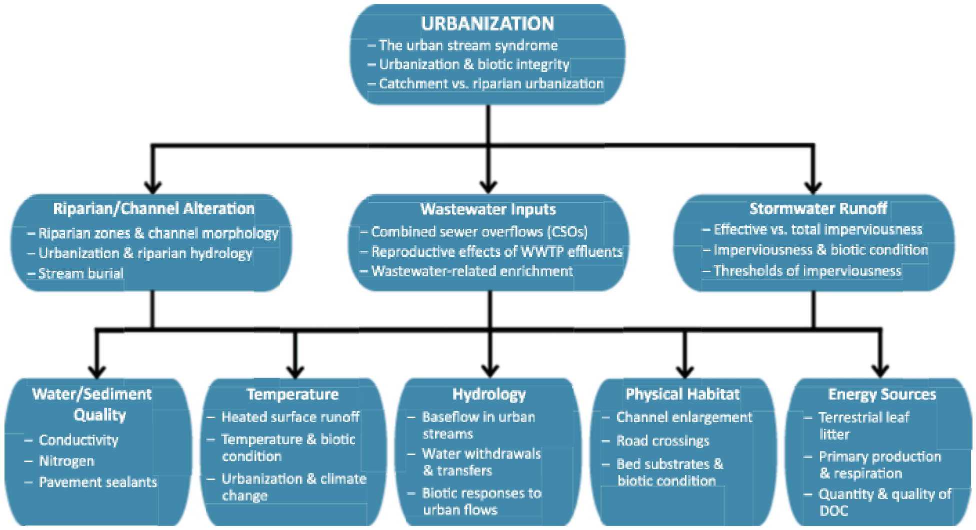
CADDIS: The Causal Analysis/Diagnosis Decision Information System

Volume 2: Sources, Stressors & Responses

http://www.epa.gov/caddis/ssr_urb_intro.html

EPA United States Environmental Protection Agency

CADDIS Volume 2: Sources, Stressors & Responses



Click on any heading to see more detailed information about that pathway.
Click on subheadings to read more about highlighted topics under each heading.

Urbanization is an increasingly pervasive land cover transformation that significantly alters the physical, chemical and biological environment within surface waters.

The diagram above provides a simple schematic illustrating pathways through which urbanization may affect stream ecosystems. **Riparian/channel alteration**, **wastewater inputs** and **stormwater runoff** associated with urbanization can lead to changes in five general stressor categories: **water/sediment quality**, water **temperature**, **hydrology**, **physical habitat** within the channel, and basic **energy sources** for the stream food web.

This module is organized along these pathways. You can learn more about urban stream sources and stressors by clicking on these headings in the diagram above. You can click on subheadings within each shape to learn about specific topics in greater detail. To return to this organizational diagram from any point in the module, simply click on the Urbanization link in navigation bar (at left) or in the breadcrumbs (at top).

You also can download a **PDF version of the Urbanization module** (44pp, 3MB, About PDF), and view a **complete list of references** cited in the module.

Last updated on Tuesday, July 31, 2012

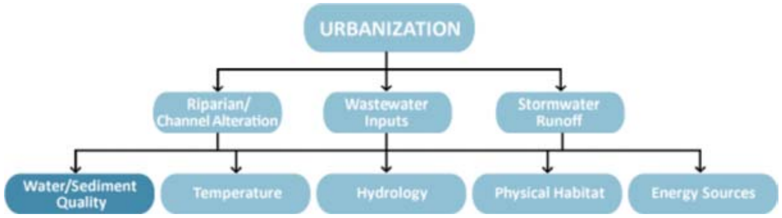
Exhibit B
EPA Publication #1

CADDIS Volume 2: Sources, Stressors & Responses

Pavement sealants & PAHs
&
References for the Urbanization Module

http://www.epa.gov/caddis/ssr_urb_wsq4.html
&
http://www.epa.gov/caddis/ssr_urb_ref.html

CADDIS Volume 2: Sources, Stressors & Responses



Pavement sealants & PAHs

Polycyclic aromatic hydrocarbons (PAHs) are common pollutants in urban streams, resulting from numerous transportation-related sources including **oil leakage, vehicle exhaust, tire and brake wear, and pavement erosion**. Many studies have shown that these compounds can **adversely affect stream biota** (e.g., Maltby et al. 1995, Pinkney et al. 2004).

Courtesy of U.S. EPA

Pavement sealants are routinely applied to parking lots and driveways to protect the underlying surfaces, and these sealants can be significant sources of PAHs. For example:

- PAH concentrations were **65 times higher** in runoff from coal-tar seal-coated parking lots versus unsealed parking lots (Mahler et al. 2005).
- PAH concentrations in stream sediments were **3.9 to 32 mg kg^{-1} higher** downstream of coal-tar seal-coated parking lots versus upstream reference sites (Scoggins et al. 2007).

Scoggins et al. (2007) examined the effect of these sealcoats on benthic macroinvertebrate assemblages. They found that:

- Average **macroinvertebrate densities were two times higher** at sites upstream of seal-coated parking lots.
- **Chironomid density decreased** at sites downstream of seal-coated parking lots, whereas **oligochaete density usually increased**.
- **Increases in pool habitat PAH sediment toxicity units** between sites upstream and downstream of seal-coated parking lots explained **decreases in macroinvertebrate richness and density** (Fig 25).

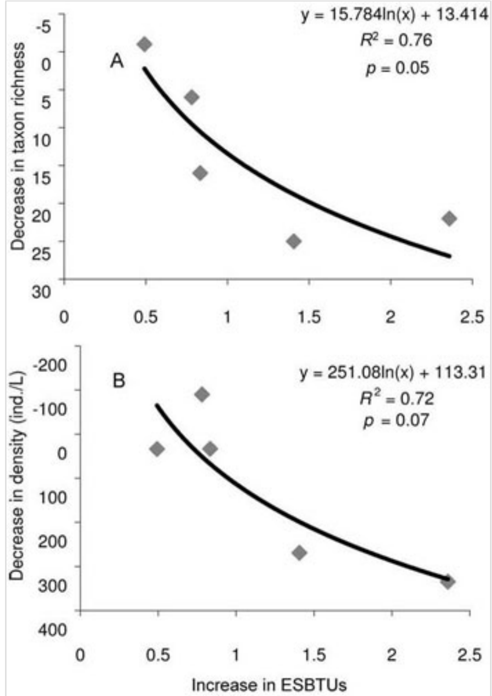


Figure 25. Regression plot of the decrease in (A) macroinvertebrate richness and (B) density between sites upstream and downstream of seal-coated parking lots, as a function of the increase in PAH equilibrium partitioning sediment benchmark toxicity units (ESBTUs) in pool sediments between those sites. ESBTUs were based on 16 EPA priority PAH pollutants; values > 1 suggest toxicity.

From *Scoggins M et al. 2007. Occurrence of polycyclic aromatic hydrocarbons below coal-tar-sealed parking lots and effects on stream benthic macroinvertebrate communities. Journal of the North American Benthological Society 26(4):694-707*. Reprinted with permission.

Click below for more information on specific topics

Urbanization & conductivity | Nitrogen in urban streams | Pavement sealants

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CADDIS Volume 2: Sources, Stressors & Responses

References for the Urbanization Module

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Last updated on Tuesday, July 31, 2012

Exhibit C
EPA Publication #2

STORMWATER BEST MANAGEMENT PRACTICE:
Coal-Tar Sealcoat, Polycyclic Aromatic
Hydrocarbons, and Stormwater Pollution
EPA 833-F-12-004
November 2012

http://www.epa.gov/npdes/pubs/coaltar.pdf

United States Environmental Protection Agency

Stormwater Best Management Practice

Coal-Tar Sealcoat, Polycyclic Aromatic Hydrocarbons, and Stormwater Pollution

Permits for Clean Water NPDES

Minimum Measure

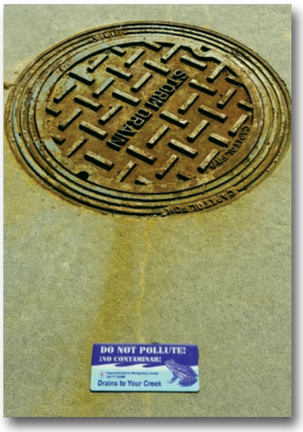
Pollution Prevention/Good Housekeeping

What Is Coal-Tar Sealcoat?

Coal-tar sealcoat is a type of sealant used to maintain and protect driveway and parking lot asphalt pavement. Coal-tar sealcoat typically contains 20 to 35% coal tar pitch, a byproduct of the steel manufacturing industry, which is 50% or more polycyclic aromatic hydrocarbons (PAHs) by weight.

Could Coal-Tar Sealcoat Be a Concern for Stormwater?

Studies found that PAHs are significantly elevated in stormwater flowing from parking lots and other areas where coal-tar sealcoats were used as compared to stormwater flowing from areas not treated with the sealant. For example, one study found the amount of PAHs in stormwater runoff was 65 times higher from parking lots sealed with coal-tar sealant vs. stormwater from unsealed parking lots. Another study found that coal-tar sealcoat is the largest source of PAHs to 40 urban lakes (Van Metre and Mahler, 2010). PAHs from coal-tar sealcoat may accumulate in the sediment of stormwater ponds, requiring expensive disposal of the dredged PAH-contaminated sediment.



PAHs are of concern because of their harmful impacts on humans and the environment. They are persistent organic compounds, and several PAHs are known or probable human carcinogens and toxic to aquatic life.

What Are States and Municipalities Doing to Address PAHs from Coal-Tar Sealcoat?

Several states and cities have taken action to address PAHs from coal-tar sealcoat. The following are some notable examples:

- The city of Austin, Texas banned the sale and use of coal-tar containing pavement sealants in 2005: http://austintexas.gov/department/coal-tar
- The District of Columbia banned the sale and use of coal-tar sealcoat in 2009: http://green.dc.gov/coaltarban
- In 2009, Minnesota restricted state agencies from purchasing undiluted coal tar-based sealant and directed its Pollution Control Agency to study the environmental effects of coal tar-based sealants and to develop management guidelines: www.pca.state.mn.us/index.php/water/water-types-and-programs/stormwater/municipal-stormwater/restriction-on-coal-tar-based-sealants.html
- Washington State banned the sale of coal-tar pavement sealants on January 1, 2012 and banned the use of such sealants after July 1, 2013: https://fortress.wa.gov/ecy/publications/summarypages/1104021.html

Alternatives to Coal-Tar Sealcoat

Pavement options such as pervious concrete, permeable asphalt and paver systems do not require sealants. These types of pavements allow for stormwater to naturally infiltrate, resulting in decreased runoff.

Office of Water, 4203M
www.epa.gov/npdes/pubs/coal-tar.pdf
www.epa.gov/npdes/stormwater/menuofbmps

EPA 833-F-12-004
November 2012

For More Information

For more information you can watch EPA's webinar *Stormwater, Coal-Tar Sealcoat and Polycyclic Aromatic Hydrocarbons* available at: http://cfpub2.epa.gov/npdes/courseinfo.cfm?program_id=0&outreach_id=645&schedule_id=1169.

For information on assessing the toxicity of PAHs in sediment see: www.epa.gov/nheerl/download_files/publications/PAHESB.pdf from EPA's Office of Research and Development.

Additionally, you can visit the USGS webpage on PAHs and coal-tar-based sealcoat: http://tx.usgs.gov/coring/allthingssealcoat.html.

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EPA's Integrated Risk Information System (IRIS): www.epa.gov/IRIS/

Exhibit D

Publications of Scientific Studies of Refined Tar-Based Pavement Sealers (RTS) in the Environment

Sponsored by the Pavement Coatings Technology Council

(rev. April 2014)

PAVEMENT COATINGS
TECHNOLOGY COUNCIL

WWW.PAVEMENTCOUNCIL.ORG

PUBLICATIONS OF SCIENTIFIC STUDIES OF TAR-BASED SEALANTS IN THE ENVIRONMENT SPONSORED BY THE PAVEMENT COATINGS TECHNOLOGY COUNCIL

(REV. APRIL 2014)

Peer Reviewed Papers in Science Journals:

O'Reilly, K., Ahn, S., Pietari, J. and Boehm, P. (2014). Use of Receptor Models to Evaluate Sources of PAHs in Sediments. *Polycyclic Aromatic Compounds*. Awaiting DOI.

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Post-Publication Peer Review Reports:

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Information Quality Act Requests for Correction of Information Under the U.S. Geological Survey Information Quality Guidelines, available at http://www.usgs.gov/info_qual/

- May 15, 2013: Topic – There is No Scientific Basis for the USGS to Claim that RTS is a Major Source of PAHs in U.S. Sediments
- May 31, 2013: Topic – The USGS is Using Inaccurate and Misleading Photographs of Fish with Skin Tumors as a Scare Tactic to Promote Advocacy Goals
- September 17, 2013: Topic – USGS claims of health risks are based on a "risk assessment" that exaggerates exposure, selects data for inclusion or omission without explanation, fails to consider the many other sources of PAHs, does not use best-available toxicity estimates, and many other flaws of both omission and commission.

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Pietari, J., O'Reilly, K. and Boehm, P. (2010). Polycyclic Aromatic Hydrocarbons in Stormwater and Urban Sediments: A Review. *Stormwater* Magazine. September 2010.

Presentations at Recent Scientific Meetings:

LeHuray, A. and Beatty, K. (2014). Key Science Issues to be Considered in the IRIS Hazard Assessment of the Index Compound for the PAHs, Benzo(a)Pyrene. Presentation at the NIOSH 2014 Toxicology and Risk Assessment Conference (TRAC), Cincinnati, OH April 7-10, 2014.

Magee, B. and Keating-Connolly, Janet (2013). Research-Based Input Parameters for Risk Assessment of Coal-Tar-Based Pavement Sealants. Abstract accepted for presentation at the 34th annual meeting of the Society of Environmental Toxicology and Chemistry (SETAC) Nashville, TN November 17-21, 2013.

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DeMott, R.P. and Gauthier, T.D. (2011). Use of Mass Balance Bounding Estimates and Sensitivity Analysis to Prioritize PAH Inputs in Urban Systems. Abstract and Poster Presented at the *32nd Annual Meeting of the Society of Environment Toxicology and Chemistry (SETAC)*, Boston, Nov. 2011.

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Exhibit E

TECHNICAL EVALUATION OF VAN METRE AND MAHLER (2010)

Prepared by
Kirk T. O'Reilly, Ph.D. J.D.
Exponent, Inc.

March 25, 2014

Exponent®

External Memorandum

TO: Anne LeHuray

FROM: Kirk O'Reilly

DATE: March 25, 2014

SUBJECT: Technical Evaluation of Van Metre and Mahler 2010

Exponent has been evaluating the U.S. Geological Survey's (USGS) research concerning the potential role of refined tar sealer (RTS) since 2009. Mahler, Van Metre and their colleagues have published a series of papers promoting "the Mahler hypothesis" that proposes that RTS is a major source of polycyclic aromatic hydrocarbons (PAHs) in urban sediments. As described in O'Reilly et al 2012, there are number of technical issues that raise questions about the conclusions presented in Mahler et al 2005, Van Metre et al 2009, and Van Metre and Mahler 2010. The 2010 paper introduces the application of EPA's chemical mass balance (CMB) model to assess the hypothesis that RTS is the dominant source of PAHs in the sediments of 40 urban lakes. Because the authors described the results of only 4 of about 200 model runs, our initial evaluation of Van Metre and Mahler 2010 was incomplete. In response to a Freedom of Information Act (FOIA) request, the USGS provided sufficient data to recreate these four model runs, but not the complete CMB output files for any of the runs.

The purpose of this memorandum is to discuss a range of technical issues concerning Van Metre and Mahler's application of CMB.

Key findings include:

- CMB can match mixtures of the proposed sources to sediment PAH profiles whether or not a RTS source term is included.
- When the RTS source profile is changed from one based on parking lot dust to another based on the chemical analysis of RTS, CMB eliminates it as a source from most of the sediments samples considered.

The evaluation indicates that the results of CMB do not provide support for the Mahler hypothesis. Because other researchers (Crane 2013; Witter et al 2014) have begun to apply the methods described in Van Metre and Mahler 2010, the USGS should consider retracting the article.

Comments:

1. **The validity of CMB depends on how closely the inputs meet the strict assumptions underlying the model.**

The following summarizes the assumptions underlying CMB (Coulter 2004) and why Van Metre and Mahler (2010) fails to address them. Some points are discussed in more detail in subsequent sections.

I. <u>The composition of each source emission profile is consistent over the period model.</u>
   a. No site-specific emission data was used.
   b. The source profiles used were averages of published data. There was no evaluation of how representative they were to actual sources.
   c. The variability among the literature source profiles was taken into consideration.
   d. The composition of the emission sources used are known not be consistent and change to due to fuel, temperature, oxygen availability and other combustion process conditions (Lima et al 2005).

II. <u>Chemical species do not react with each other or the environment.</u>
   a. PAH react quickly in the atmosphere so emission chemistry does not represent depositional chemistry (Galarneau 2008; Lima et al 2005). This factor was ignored.
   b. Sealers weather resulting in changes in their PAH profile (O'Reilly et al 2012). This was considered.
   c. Together, this results in a greater chance of identifying the sealers as sources.

III. <u>All sources that contribute significantly to the receptors have been identified and their profile is known.</u>
   a. A limited set of sources was considered. Evaluation of site-specific sources was not conducted.
   b. As noted there is great uncertainty in whether the source profiles used as input represent actual sources.

IV. <u>The composition of each source is linearly independent or other sources.</u>
   a. The results present indicate a positive relationship between the mass sourced by sealers and the mass sourced by other sources (R^2=0.63). Samples with more sealer also had more other sources.
   b. This is the opposite of the result expected if sealers were actually a source.

V. Measurement uncertainties are random, uncorrelated, and normally distributed.
  a. This assumption could not be met with most of the source data so a generic uncertainty factor of 40% was applied (Li et al 2003).
  b. This value was based typical analytical precision and ignores the variability in the chemical profiles of potential sources.
  c. Profiles based on a limited set of published data are not expected to be random, uncorrelated, or normally distributed.

2. CMB allows calculations of potential relative source contributions only if the actual sources are known.

This statement is based on the simple mathematical concept that one can only calculate an unknown when there are a sufficient numbers of knowns. Without independent verification that the source inputs used are appropriate and sufficient, CMB output cannot be used to verify the contribution of a given source.

3. Discussion of only 4 of 200 model runs provides an incomplete picture the results of the CMB evaluation.

VanMetre and Mahler (2010) states that 200 CMB model runs were conducted, but only four were discussed in detail. While requested, neither the input parameters nor model output of the others 196 runs have been provided. As highlighted in the following comments, model output based on conditions that should have been run by the authors leads to results that are significantly different than those claimed in the article.

Many of the source profiles used by VanMetre and Mahler are from Li et al (2003). As demonstrated by Li and a subsequent paper (Bzdusek et al. 2004), model outputs are highly dependent on model inputs (Figure 3-1). A discussion of receptor modeling requires presentation of the full range of results.

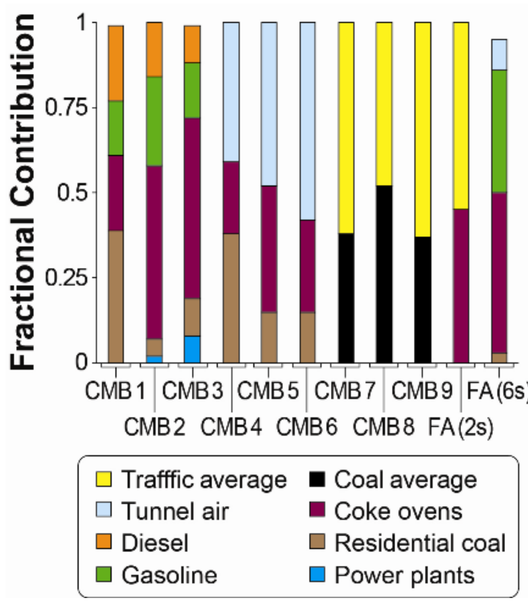

Figure 3-1: Fractional contribution of various PAH source types to sediment of Lake Calumet (Chicago, Illinois) based on nine CMB and two Factor Analysis model runs. Data from Li et al. 2003 and Bzdusek et al. 2004. The range of results highlights the sensitivity of receptor models to the specific inputs.

To resolve this gap, source input profiles used by Van Metre and Mahler were obtained through a FOIA request. Using CMB, we were able to recreate the published Van Metre and Mahler results for the four model runs, A through D, published in 2010. CMB was then rerun either excluding the RTS source or replacing it with an RTS source profile based on another USGS study (Selbig 2009). While Selbig's results were for unfiltered runoff, the low-solubility PAHs should be associated with the particles and thus comparable to the parking dust samples used by Van Metre and Mahler (O'Reilly et al. 2012).

Table 4-1 compares the three model runs. The coefficient of determination, R^2, is the average of the 120 samples. The measured and calculated total PAH concentrations for all 120 samples are shown in Figure 4-1. To compare the goodness of fit between the measured and modeled concentrations, Pearson correlation coefficients, r, were calculated using the results of the 120 sediment samples. The r for each of the three models exceeded 0.998. Note the difference in R^2 between those listed in Table 4-1, which are based on the fitting of individual PAHs within each sample, and r in Figure 4-1 which is fitting the total PAH concentrations.

Table 4-1: Comparison of the average results for three CMB model runs. All input conditions are consistent with Van Metre and Mahler 2010, except for the RTS source profile.

Model Conditions					Average Calculated Source Contribution				
RTS Source Profile	#PAHs	R2	X2	%Mass	RTS	Vehicle	Coal	Oil	Wood
Van Metre 2010	12	0.93	0.94	98.92	61%	26%	6%	1%	6%
Selbig 2009	11	0.92	1.15	103.50	21%	41%	8%	1%	29%
None	12	0.91	1.08	97.10	-	60%	8%	0%	31%

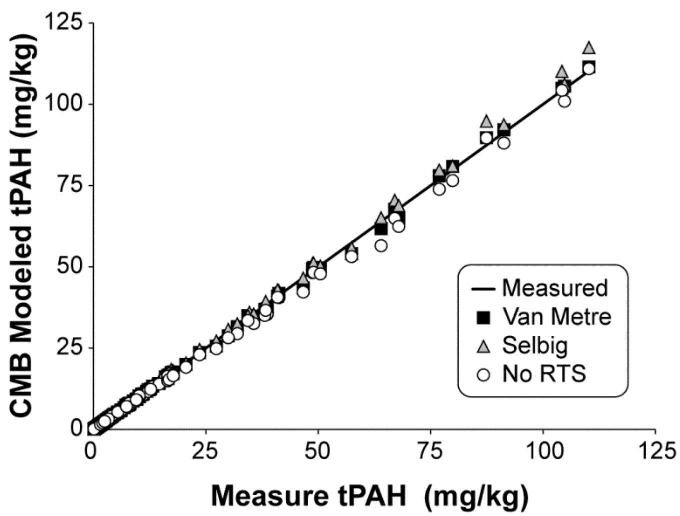

Figure 4-1: Correlations between measured and modeled total PAH concentration, $R^2 > 0.99$, are similar with or with RTS as a CMB source profile.

A collaborator of Van Metre and Mahler used CMB to evaluate sediments collected from storm water detention ponds in Minnesota (Crane 2013) and included model runs with and without RTS as a source input. Crane also found excellent agreement (r>0.99) between CMB model results whether or not RTS was considered a source. While Crane presented statistics that there may be a slightly better fit with the addition of two RTS source profiles than with just two traffic sources and one wood smoke source, the important finding is that CMB does an excellent job fitting the input source profiles to the sediment source profiles whether or not an RTS related source is included. As the model results are consistent with the null hypothesis, they provide no support for the Mahler hypothesis.

4. **The samples identified as RTS sources are actually dust collected parking lots, which suggest that they are likely a mixture of local sources. CMB indicates minor or no contribution when known RTS sample source profiles are used.**

The RTS profiles used in the 4 CMB model runs were based on the averages of samples collected either from parking lots in Austin, TX (Mahler et al 2005) or lots from 6 cities across the United States (Van Metre et al 2009). The relative contribution of RTS to the PAHs in these samples is unknown, as is the contribution of atmospheric deposition and other urban sources. Unlike the underlying data used to generate the other source profiles, parking lot dust is subject to weathering processes that are similar to those expected for sediment sources (O'Reilly et al 2012). It is interesting to note that while Van Metre and Mahler had source data for fresh RTS and from RTS test plots their use as a source profile was not discussed.

We reran Van Metre and Mahler's Model A replacing the RTS dust samples with average of either the fresh RTS samples or average of the RTS test plot data from Mahler et al 2005. Benzo(e)pyrene was not included as data was not available for the earlier samples. CMB did not identify RTS as a potential source in most of the 120 sediment samples (Table 5-1).

Table 5-1: Summary of results for 3 CMB runs. Consistent with Van Metre's Model A, we first used parking lot dust as the RTS source profile. Based on data from Mahler et al 2005, the second run used the average of 6 samples of fresh RTS and the third, an average of samples collected over 4 weeks from RTS test plots.

	Lot Dust	**Fresh RTS**	**Test Plots**
# of samples with RTS contribution >0%	107	6	15
% RTS contribution			
Min	0.0	0.0	0.0
Max	95	23	33
Mean	46	0.6	1.5
Median	49	0.0	0.0
Average Model Parameters			
R^2	0.93	0.91	0.91
X^2	0.94	1.11	1.10
%Mass	98.9	96.7	96.7

5. The non-RTS source profiles used by VanMetre and Mahler are mathematical constructs based on the geometric mean of averaged values of PAH ratios taken from 37 articles. The similarity of these constructs to real work sources has not been demonstrated.

Except for the RTS, Van Metre and Mahler (2010) obtained all source profiles used in the four CMB model runs from the literature. The main source cited, Li et al 2003, also did not measure any actual sources but created profiles based on manipulation of published data from over 20 papers. Much of the data that Li used were not actual sample results, but averages of other data. As noted in the underlying papers cited by Li, the coefficients of variation (CV) or relative standard deviations (SD) of these initial data were high as indicated by a CV>100% or SD>mean. Li did not directly apply the source profiles, but generated geometric means of the ratio between each PAH and benzo(e)pyrene. These ratios were then combined as a PAH profile. In some cases, a partitioning factor was applied to estimate particle phase concentrations. The number of samples used to generate this average of an average differed between the individual PAHs potentially further skewing the generated profile. The resulting relative standard deviations were so high that Li's initial CMB runs resulted in "inestimable" source contributions for many sediment samples. To resolve this problem, first Li et al. and then Van Metre and Mahler arbitrarily reduced the uncertainty factor used in CMB.

Another problem with the Li data set is that some of the samples were not collected from the environment, but from within emissions pipes. Given the reactivity of PAH in the atmosphere, significant changes in PAH profile would be expected between pre-emission and when associated particles reach sediment.

No one has conducted an evaluation of the relevancy of these calculated profiles to actual sources within the air and watersheds of the lakes studied by VanMetre and Mahler (2010). Without such information, the CMB results have little value.

6. The issue of source collinearity was not adequately addressed.

One of the key assumptions of the CMB model is that source profiles are linearly independent of each other (Coulter 2004). Non-independence or collinearly can be an issue with pyrogenic PAHs due to the similarity of source profiles (O'Reilly et al. 2012). The degree of collinearity depends on the number of source categories, the abundance and variability of fitting species, and the relative contribution of each the source. As conditions vary from sample to sample, it is not possible to state that two or more profiles are overly collinear prior to applying them to a specific sample.

Determining whether collinearly among source profiles impacts model results is an important step in model validation (Watson 2004). CMB output files contain two performance factors that indicate the influence of collinearity. The first is the indicator of whether a source contribution is "estimable." While the model will estimate a source contribution even if a source is determined to be inestimable, it flags each source as either estimable or inestimable. A YES (estimable) indicates that the source contribution estimate combination meets the uncertainty criteria (Coulter 2004). Inestimable sources are caused by excessive similarity or collinearity among the source profiles. The standard errors associated with the estimated contribution of one or more inestimable sources are usually too large to allow an adequate separation of these source contributions to be made. As a means of dealing with inestimable sources is to combine them with other sources, the model suggests estimable liner combinations of inestimable sources. While the combined source results in a fit between sources and samples, it does not allow differentiation among the contribution estimates of the sources contained in the linear combination.

A second source estimate validation indicator is the Tstat, or ratio of the estimated source contribution to its standard error. A Tstat of greater than two is indicative of a contributing source. A Tstat of less than two suggests the source contribution is lower than the detection limit of the CMB method given the uncertainties associated with the source profile.

A summary of the collinearity indicators from VanMetre and Mahler's Model A is shown in Table 7-1. The RTS profile was not identified as an estimable source any of the 120 sediment samples. While four or five source profiles were provided, no more than two sources were estimable for any of the sediment samples and a majority had no estimable sources. Van Metre's RTS source profile met the Tstat criteria >2.0 for about a third of the samples, and the vehicle exhaust profile met the criteria with the greatest number of sediments samples. To broaden this evaluation, a summary of the collinearity indicators for three other CMB runs discussed in Van Metre and Mahler (2010) are in Table 7-1. The maximum number of samples with RTS as an estimable source was 12. The number of estimable sources identified is consistent with the results presented in Table 2. Van Metre and Mahler's RTS source profile met the Tstat criteria >2.0 for between 44 to 73% of the sediment samples.

CMB's developer admits there are not hard rules concerning how collinearity indicators should be interpreted (Coulter 2004). But the limited number of estimable sources and the few sources meeting the Tstat criteria indicate that the inputs used in this assessment challenge CMB's key assumption that source profiles are linearly independent of each other. Such a finding is not surprising as the chemical similarity of different PAH sources has been identified as an issue which can limit the application of receptor models such as CMB (Galarneau 2008). The problem can be compounded in sediments as weathering that occurs between emission and deposition results in a residual profile of the more stable PAHs (O'Reilly et al. 2012). Without additional consideration of the influence of source collinearity, the results presented in Van Metre and Mahler (2010) are insufficient to support a hypothesis concerning the role of RTS as a PAH source in urban systems.

Table 7-1: Number of estimable sources and Tstat results for Van Metre and Mahler's Model A. The results suggest collinearity among source profiles was not adequately addressed.

Van Metre Model A

Number of samples where source is estimable

	Yes	No
RTS	0	107
Wood	1	64
Coal	13	43
Vehicles	1	107
Fuel oil	36	4

Estimable sources per sample (n=120)

Max	2
0	71
1	47
2	2

Percent of 120 samples Tstat >2.0

	Yes	No
RTS	38%	51%
Wood	2%	52%
Coal	4%	43%
Vehicles	28%	63%
Fuel oil	0%	33%

7. The potential contribution of coal tar from manufactured gas plants (MGPs) was not considered.

Although MGPs have long been known to be an important source of pyrogenic PAHs in the environment (Costa et al 2004) they have been ignored by VanMetre and Mahler. Such plants were typically placed along water bodies and are known sources of sediment contamination. Also, the tars from MGPs were sometimes incorporated into road base, thus spreading the material throughout a region (Hubbard and Draper 1911; Reinke and Glidden 2007) and potentially serving as source of sediment PAHs (Ahrens and Depree 2010).

Review of EPA's list of MGP sites indicates that many of the cities the USGS have been studying have had gas plant operations (EPA 1985). For example, Mahler et al 2005 focused on RTS evaluated suspended solids collected in Austin and Forth Worth, TX but failed to mention that both cities had MGPs. PAH source profiles associated with MGP waste were not included in Van Metre and Mahler's CMB source evaluations.

8. Principal component analysis (PCA) results indicate that the sources used in CMB do not properly represent the actual sources.

PCA is a multivariate approach for evaluating potential sources. When sources and their mixtures are evaluated together, the sources typically appear as end members on a PCA plot. Mixtures should plot within the area bounded by the sources (O'Reilly et al 2014). To evaluate the CMB input and outputs, the 40 lakes data was first run with the proposed source inputs used in Van Meter and Mahler's Model A. Unweathered RTS was also included. As shown in Figure 9-1, few of the sediment samples were within the area bounded by the proposed sources.

Source profiles were then created with combining the sources in the ratio indicated by CMB. These results were then analyzed by PCA. As shown in Figure 9-2, the sediment plots shifted to fit with in the area bounded the modeled identified sources.

These findings highlight two important points. First, they indicate that the source profiles used in CMB do not adequately represent the actual sources as few of the sediment samples plot with the expected area.

Secondly they demonstrate that, while correlation coefficients between the measured and modeled results are high, there are detectable difference in their PAH profiles. While the location of the modeled sediment profiles are consistent with a mixture of the coal, lot dust, and vehicles source profiles indicated by CMB, they do not represent the measured sediment profiles.

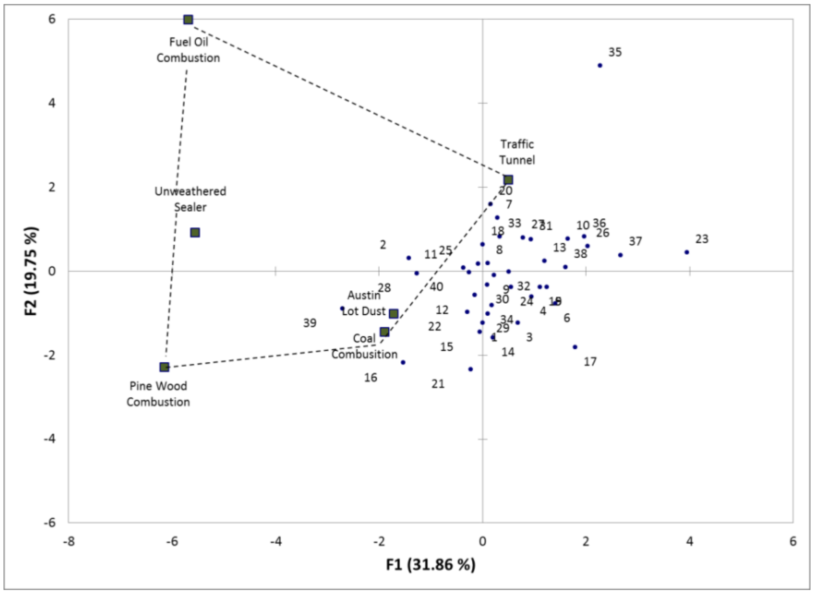

Figure 9-1: PCA of measured sediment profiles and proposed sources.

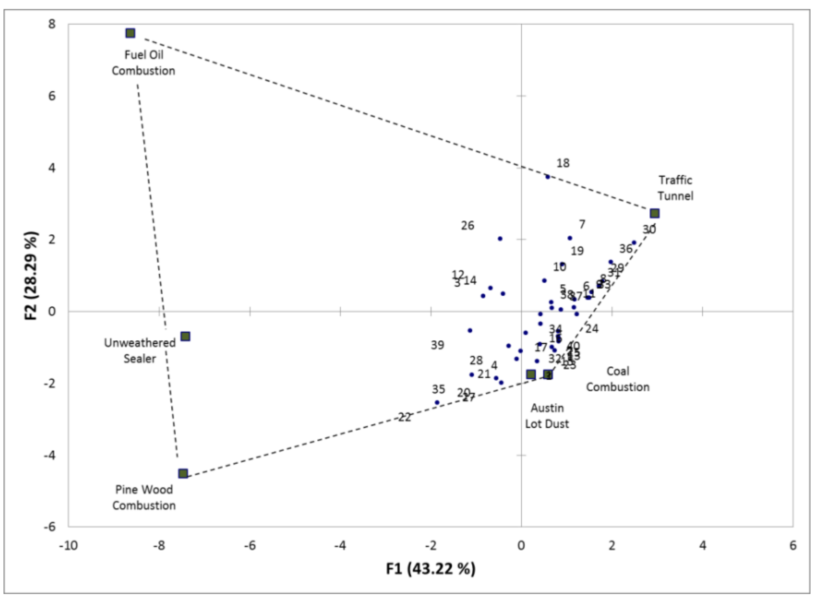

Figure 9-2: PCA of model sediment profiles and proposed sources.

9. **Reliance of other researchers on the CMB approach of Van Metre and Mahler (2010) highlights the need for the USGS to acknowledge its limitations**

    In Crane (2013) and Witter et al (2014), researchers applied Van Metre and Mahler CMB approach with little change to local sediment data sets. Because it has been shown that this approach assigns a RTS contribution to many urban sediments, it is not surprising they obtained similar results. The underlying problems described in this memorandum get lost when researcher defend their results by reliance on what appears to be an USGS approved methodology.

10. **The presentation of CMB model results as proven fact in legislative advocacy highlights the need for the USGS to acknowledge the model's limitations**

    While advocating for a RTS product ban in testimony to Washington State legislators, Van Metre cited the CMB results from a local lake as proof that a problem existed. Similarly, Crane used CMB results to successfully advocate for a product ban in Minnesota. Given the uncertainty in receptor modeling generally, and the weakness in this application, it is critical for agency scientist to accurately describe the meaning of model outputs when they are presented to non-technical policy makers (O'Reilly et al 2013).

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Exhibit F

Letter from Myron O. Knudson, Director, Superfund Division, EPA Region 6

to

Ms. Toby Hammett Futrell, City Manager, City of Austin, TX

dated

April 17, 2003

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

April 17, 2003

Ms. Toby Hammett Futrell
City Manager
City of Austin
124 S. Eighth Street, Suite101
Austin, TX 78701

Dear Ms. Futrell:

We have reviewed the Health Consultation prepared by the Texas Department of Health (TDH) and the Agency for Toxic Substances and Disease Registry (ATSDR) for the Barton Springs Pool in Austin, Texas. The U.S. Environmental Protection Agency (EPA) concurs with the overall conclusion of the TDH and the ATSDR that swimming and playing in the Barton Springs Pool do not pose an apparent public health hazard.

We also agree with the specific conclusions and public health action recommendations outlined in the consultation, including:

Conclusions

1. The information reviewed does not indicate that people who swim in the Barton Springs Pool would be exposed to levels of contaminants that would be expected to cause adverse effects.

2. Adverse health outcomes from exposure to soil near the creosote-treated posts used for erosion control near the shallow end of the pool are not likely.

3. The levels of total petroleum hydrocarbons detected in both the water and sediment in the pool are not expected to result in adverse health outcomes.

Public Health Action Recommendations

1. Provide public health education to address any concerns that the public may have concerning the risk associated with swimming in the pool.

2. Investigate the potential for the creosote-treated posts near the shallow end of the pool to serve as a source of polynuclear aromatic hydrocarbons in soil.

3. Continue to monitor the pool for total petroleum hydrocarbons.

If you have any questions, please contact Jon Rauscher or Don Williams of my staff at (214) 665-8513 or (214) 665-2197, respectively.

Sincerely yours,

Wren Stenger
for Myron O. Knudson
Director
Superfund Division