United States Department of the Interior

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Dear Nancy:

Per your request, the USGS has reviewed the City of Austin (COA) sediment chemistry data and your conclusions regarding the probable source of high concentrations of PAH in soil and sediment near Barton Springs. The data include soil borings from under the Barton Hills Park Place apartments (BHPP) and adjacent property, parking lot sediment, and seal coating scraped from parking lots. At issue is the source of high PAH concentrations in parking lot and tributary sediment that could contribute to PAH loading to Barton Creek and other urban creeks in Austin.

THE ISSUE

As you know, the concentrations of PAHs in some of your samples of parking lot and tributary sediment are very high in comparison to aquatic sediments in urban areas nationally (Van Metre, Mahler, and Furlong, 2000), sediment quality guidelines (MacDonald and others, 2000), and street dust and urban source materials reported in the literature (Takada and others, 1991). A table of selected PAH concentrations is attached. Concentrations of benzo(a)pyrene (B(a)P) in two of your samples of sediment from the parking lot of the BHPP apartments (samples S-1 and S-3) were 238 and 223 mg/kg. In comparison, two of the most contaminated aquatic sediments sampled in the U.S. in our studies (USGS National Water-Quality Assessment Program) are the Charles River, near downtown Boston, and West Street Basin, a large stormwater pond in Los Angeles, where B(a)P concentrations were 7.2 and 4.1 mg/kg, respectively. These concentrations are about 1/30th to 1/60th the concentrations of the BHPP parking lot sediments.

The consensus-based sediment quality guideline for the protection of aquatic life, or probable effect concentration (PEC), for B(a)P is 1.45 mg/kg (MacDonald and others, 2000). Takada and others (1991) report B(a)P concentrations in 10 samples of Tokyo street dust ranging from 0.039 to 0.267 mg/kg, or about 1,000 times lower than concentrations in samples S-1 and S-3. Most of the Takada data are presented as the sum of combustion PAH (COMB; pyrene, fluoranthene, benz(a)anthracene, chrysene, benzofluoranthenes (b and k), B(a)P, benzo(e)pyrene, indeno(cd)pyrene, and benzo(ghi)perylene). Their most contaminated samples came from inside the Tokyo Expressway tunnel, where COMB ranged from 11.5 to 26.2 mg/kg. The Tokyo Expressway concentrations thus are about 100 times lower than the COMB concentrations of 2,790 and 2,630 mg/kg in samples S-1 and S-3. Comparisons such as these are what prompted Dr. Barbara Mahler's use of the term "astronomical" after

receiving verification of PAH concentrations in BHPP apartment tributary samples analyzed by the USGS National Water-Quality Laboratory.

SOIL BORING DATA

Given the very large concentrations in the parking lot and tributary sediments, the obvious next questions are, where are they coming from, where are they going, and what threat do they pose to people and aquatic organisms? We leave the final question to toxicologists and aquatic ecologists. Regarding source, one theory put forward by Dr. Allan Hatheway, retired geology professor from the University of Missouri, and reported in the *Austin-American Statesman*, is that PAHs could be coming from buried coal-gasification waste (the primary component of which is coal tar) under the apartments. In environmental studies two general pieces of information usually are necessary to link the occurrence of contaminants to a source: identification of a source containing elevated levels of the contaminants in question and definition of a plausible transport pathway.

Because no direct evidence of a waste dump exists, to test the theory of buried coal-gasification waste, COA made 10 borings down to bedrock in the parking lot and nearby areas and analyzed soil samples from several depths in those borings. B(a)P was detected in six of the 19 samples analyzed (that were provided to USGS for review) at a detection level of about 0.035 mg/kg, well below the PEC of 1.45 mg/kg. The highest concentration detected was 11.9 mg/kg (B1 (0-0.5 feet)) in a surface sample from a boring adjacent to the parking lot. This concentration is about 1/20th the concentration in sediment samples S-1 and S-3 from the parking lot; it contains surface soil and is therefore likely contaminated by the same surface source(s) as the other parking lot and tributary samples. In the three samples from boring B1, concentrations decrease with depth from 11.9 mg/kg at the surface to 0.25 mg/kg at 1.5 feet down to a nondetection at 5 feet.

If a buried waste site exists, PAH concentrations should increase with depth, not decrease. One other sample exceeded 1 mg/kg, a sample from 5-5.5 feet deep in boring B9A where B(a)P was 2.05 mg/kg, a concentration typical of moderately contaminated urban sediments (Van Metre, Mahler, and Furlong, 2000). Sample B9A (5-5.5 feet) is the only deeper boring sample with PAH concentrations that exceed the sediment quality guidelines; it could represent fill material containing either old urban soils or fire residues. In any case, the B(a)P concentration of sample B9A (5-5.5 feet) is less than 1/100th the concentrations in S-1 and S-3, therefore, it cannot represent a source for the high levels of PAH found in those samples. Our conclusion from the COA data is that there is no evidence for a waste dump at the site.

Could ground water be transporting PAH from some undiscovered hot spot to the creek bed, as hypothesized by Dr. Hatheway in the *Austin-American Statesman* article of February 12? The answer to this question lies in the chemical properties of PAH. PAH are very hydrophobic and are almost insoluble in water. The reported octonol/water partition coefficient for B(a)P is about $10^{6.0}$ (range of $10^{5.81}$ to $10^{6.50}$; Lucius and others, 1992). That means that in a mixture of an organic solvent (octonol) and water, the concentration of B(a)P in the octonol will be about 10^6 (or 1,000,000) times higher than that in the water. In the environment, PAHs will occur almost entirely in the organic carbon phase of the sediment rather than with the water. This is why PAHs rarely are detected in water samples, even in urban stormwater (Baldys and others, 1996) but frequently are detected in sediment. Therefore, transport of PAHs in ground water

sufficient to result in the elevated concentrations found in the tributary is extremely unlikely. No PAH hot spot has been discovered, but even if there had been, there is no logical transport pathway from below the land surface, especially below the parking lot and buildings, onto the parking lot surface where the highest concentrations have been found. Good evidence exists for a far more plausible source.

PARKING LOT SEALANTS

If there isn't an old waste dump under the apartments, what is the source of the high PAH levels? Your (COA) staff's leading theory is that parking lot sealants containing coal tar are the source. In terms of the spatial distribution of PAH concentrations and a logical transport pathway, the COA theory makes sense. As shown in the attached table and graphs, concentrations of B(a)P and COMB PAH decrease progressively from the sealant scrapings from the parking lot (11,800 and 23,500 mg/kg), to sediment from the parking lot surface (2,630 and 2,790 mg/kg), to the tributary (286 and 735 mg/kg), to Barton Creek (69 mg/kg), to Barton Springs Pool after a flood overtopped the dam (18 mg/kg). This progressive decrease is what one would expect when moving away from a source.

Furthermore, this progression in concentrations defines a logical transport pathway if the transported media is sediment, including fine particles of sealant, eroded from the parking lot surface. The sealants show visible wear over time, are reapplied typically every 2 or 3 years, and the most contaminated sediment samples from on and near the parking lots had visible black particles in them. Additionally, PAH concentrations in the sealants are extremely high, about 20 to 40 times higher than used motor oil, the most contaminated urban source material reported by Takada and others (1991). Coal-tar based sealants appear to be a source of PAH not only from this parking lot, but from other parking lots in the city as well, on the basis of results of COA sampling.

CONCLUSIONS

COA data provide no evidence that a waste dump exists at the BHPP property, and they confirm that parking lot sealants contain high levels of PAH. The data further indicate that some PAHs are released from the parking lots, presumably by weathering of sealant, as indicated by very high levels of PAH in sediment from parking lot surfaces and adjacent soils. What is less clear is what the relative importance of sealants is as an urban nonpoint source of PAHs. What, for example, is the percentage of PAHs in Barton Creek or Barton Springs Pool from sealants versus all other urban nonpoint sources? At what rates do sealed parking lots release PAHs to the environment? These are important follow-up questions that COA continues to pursue. COA staff have made an important discovery that could eventually lead to the control of a significant PAH contaminant source in urban settings.

Sincerely,

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Research Hydrologist

Barbara Mahler, Ph.D
Research Hydrologist

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TABLE

Concentrations of benzo(a)pyrene (B(a)P) and the sum of combustion PAH (COMB) in selected sediment samples and source materials.

Source	B(a)P (mg/kg)	COMB (mg/kg)
Selected COA samples		
Seal coat from BHPP lot (S-4)	1,830	23,500
Seal coat from BHPP lot (S-5)	1,030	11,800
Parking lot sediment (S-1)	238	2,790
Parking lot sediment (S-3)	223	2,630
Boring B1 (0-0.5')	12	127
Boring B1 (1-1.5')	0.247	2.7
Boring B1 (5.5-6')	<.034	<0.193
Boring B9A (5-5.4')	2.05	30.8
Selected USGS samples		
Head of apartment trib (USGS)	63	735
Apartment trib (USGS)	25	286
Barton above sed (USGS)	6.4	69
Pool bottom after flood (USGS)	1.7	18
other USGS sites		
Charles River, Boston	7.2	80
West Street Basin, Los Angeles	4.1	52
Takada and others, 1991		
Asphalt, fresh		0.39 - 1.06
Asphalt, weathered		1.72 - 4.96
Tire particles		30.7 - 70.8
Fresh motor oil		5.05
Used motor oil		601

FIGURE. Combustion PAH in selected Barton Springs area samples.