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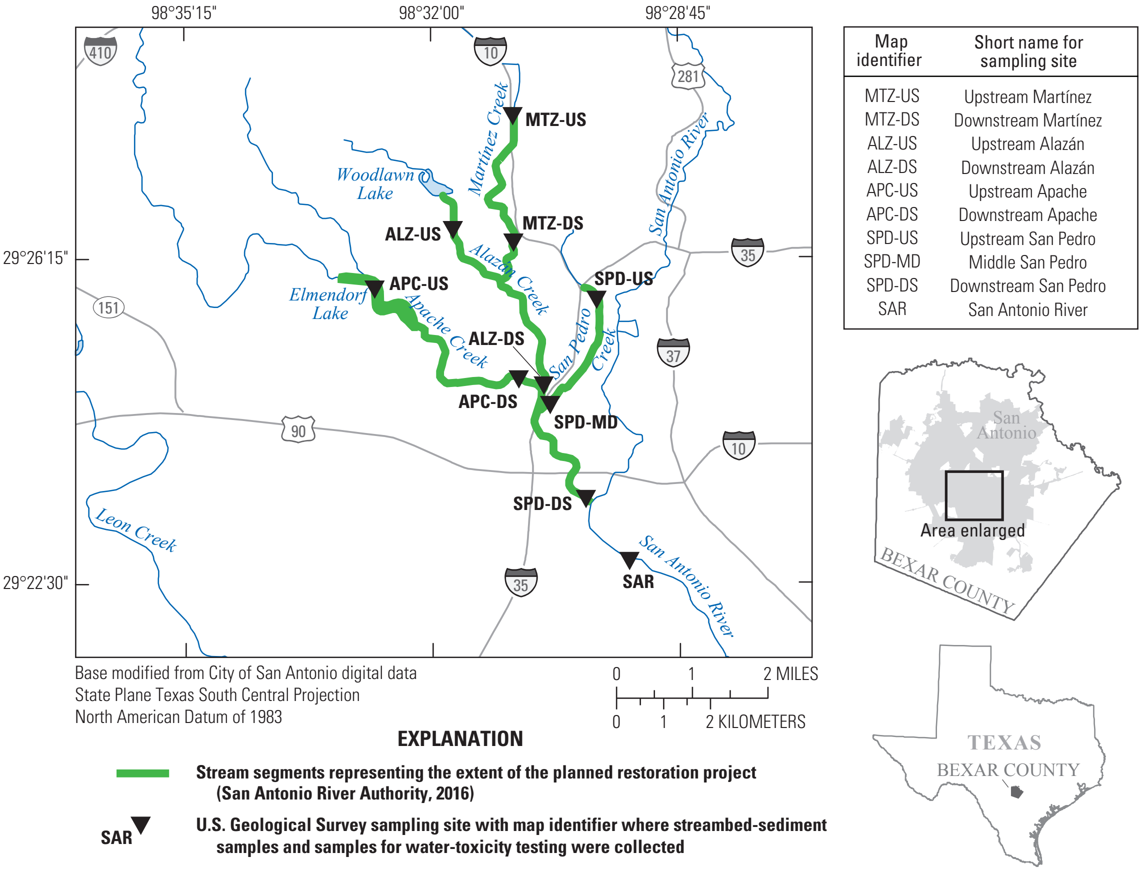
Selected Streambed Sediment Compounds and Water Toxicity Results for Westside Creeks, San Antonio, Texas, 2014

Introduction

The Alazán, Apache, Martínez, and San Pedro Creeks in San Antonio, Texas, are part of a network of urban tributaries to the San Antonio River, known locally as the Westside Creeks (fig. 1). The Westside Creeks flow through some of the oldest neighborhoods in San Antonio. The disruption of streambed sediment is anticipated during a planned restoration to improve and restore the environmental condition of 14 miles of channelized sections of the Westside Creeks in San Antonio. These construction activities can create the potential to reintroduce chemicals found in the sediments into the ecosystem where, depending on hydrologic and environmental conditions, they could become bioavailable and toxic to aquatic life. Elevated concentrations of sediment-associated contaminants often are measured in urban areas such as San Antonio, Tex. (Ging and others, 1999; Chalmers and others, 2007). Contaminants found in sediment can affect the health of aquatic organisms that ingest sediment. The gradual accumulation of trace elements and organic compounds in aquatic organisms can cause various physiological issues and can ultimately result in death of the aquatic organisms; in addition, subsequent ingestion of aquatic organisms can transfer the accumulated contaminants upward through the food chain (a process called biomagnification).

The U.S. Geological Survey, in cooperation with the San Antonio River Authority, collected sediment samples and water samples for toxicity testing from sites on the Westside Creeks as part of an initial characterization of selected contaminants in the study area. Samples were collected in January 2014 during base-flow conditions and again in May 2104 after a period of



Map identifier	Short name for sampling site
MTZ-US	Upstream Martínez
MTZ-DS	Downstream Martínez
ALZ-US	Upstream Alazán
ALZ-DS	Downstream Alazán
APC-US	Upstream Apache
APC-DS	Downstream Apache
SPD-US	Upstream San Pedro
SPD-MD	Middle San Pedro
SPD-DS	Downstream San Pedro
SAR	San Antonio River

Base modified from City of San Antonio digital data
State Plane Texas South Central Projection
North American Datum of 1983

EXPLANATION

Stream segments representing the extent of the planned restoration project (San Antonio River Authority, 2016)

SAR ▼ U.S. Geological Survey sampling site with map identifier where streambed-sediment samples and samples for water-toxicity testing were collected

Figure 1. Locations of sites where streambed-sediment samples and samples for water-toxicity testing were collected from the Westside Creeks and San Antonio River, San Antonio, Texas, 2014.

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stormwater runoff (poststorm conditions). Sediment samples were analyzed for selected constituents, including trace elements and organic contaminants such as pesticides, brominated flame retardants, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs). In addition, as an indicator of ecological health (and possibly bioavailability of contaminants in disturbed streambed sediments), the toxicity of water samples to the indicator species *Pimephales promelas* (fathead minnow) was evaluated by using standard 7-day water-toxicity testing.

Sediment Quality Results

Potential risks of contaminants in sediment were evaluated by comparing concentrations of contaminants in sediment to effects-based sediment quality guidelines (SQGs). The SQGs evaluate the potential toxicity of bed sediments to benthic biota. Two SQG concentration levels were used: (1) a lower level, called the threshold effect concentration (TEC), below which harmful effects to benthic biota are not expected; and (2) a higher level, the probable effect concentration (PEC), above which harmful effects are expected to occur frequently (MacDonald and others, 2000).

Trace Elements

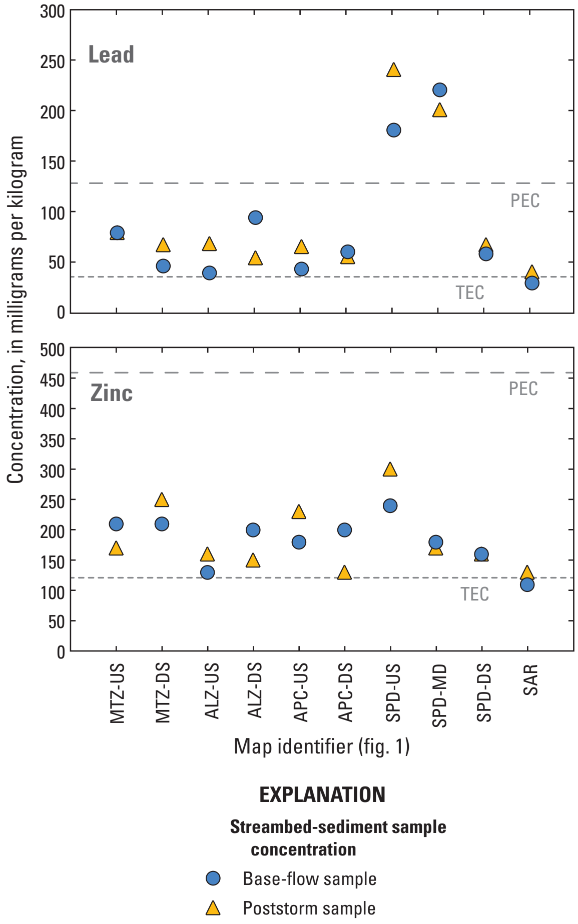
The concentrations of the trace elements arsenic, cadmium, mercury, and nickel were less than the TEC in all of the samples. Lead and zinc were most frequently detected at concentrations greater than the TEC (fig. 2). Concentrations of lead in all four samples collected from the upper and middle San Pedro Creek sites were greater than the PEC. Sources of the lead concentrations in the samples collected at these two sites might include older petroleum storage tanks that held leaded fuel or possibly from a variety of automobile components used in the numerous automobile-related businesses in the area (Texas Commission on Environmental Quality, 2009).

Pesticides

Of the 19 pesticides investigated in this study, historical-use pesticides that have been banned or are being phased out because of their toxicity and persistence in the environment were more frequently detected in streambed-sediment samples compared to current-use pesticides. Three chlordane compounds (*cis*-chlordane, *trans*-chlordane, and *trans*-nonachlor) were detected in all of the samples collected during both base-flow and poststorm conditions. Pesticides were most frequently detected in concentrations greater than their PECs in samples from the upstream and middle San Pedro sites. During base-flow conditions, concentrations of DDD, DDE, and DDT exceeded their PECs in the sample collected from the middle San Pedro site. During poststorm conditions, chlordane, DDD, and DDE concentrations in samples collected at the upstream San Pedro site, and DDD and DDE concentrations at the middle San Pedro site exceeded their PECs.

Flame Retardants

Brominated flame retardants are generally added to plastics, foams, and fabrics to increase the fire resistance of products such as electronics, automobiles, clothing, and furniture (Shaw and others, 2010). Brominated flame retardants (such as the polybrominated biphenyl ether congeners 85, 153, and 154) were found at every site where streambed sediments were collected; the concentrations measured were typically greater than the available guidelines for aquatic life, and not all compounds have guidelines (Environment Canada, 2013). Brominated flame retardants were more frequently detected in samples collected during poststorm conditions than in those collected during base-flow conditions, with the greatest increase in the number of brominated flame retardants detected when comparing samples collected from the San Pedro Creek sites during base-flow and poststorm conditions.



[TEC, threshold effect concentration; PEC, probable effect concentration]

Figure 2. Comparison of consensus-based sediment quality guidelines (MacDonald and others, 2000) with concentrations of lead and zinc in streambed-sediment samples collected from sites on the Westside Creeks and San Antonio River, San Antonio, Texas, 2014.

Polychlorinated Biphenyls

The most common sources of PCBs are plasticizers, hydraulic lubricants, and dielectric fluids used in electrical capacitors (Smith and others, 1988). Streambed-sediment samples collected from 10 sites were analyzed for 18 common PCB congeners. The PCBs 174, 187, and 194 were found in every streambed-sediment sample collected during both base-flow and poststorm conditions. The concentrations of total PCBs, computed as the sum of the 18 reported congeners, did not exceed the TEC in any of the samples. The concentrations of total PCBs in the samples collected during base-flow and poststorm conditions from the upstream and middle sites on San Pedro Creek were greater than the concentrations in the samples collected from the other study sites.

Polycyclic Aromatic Hydrocarbons

Concentrations for the majority of the individual PAHs analyzed and the total PAH concentration exceeded their TECs. The PECs were exceeded in 30 of 220 analyses. At the upstream Apache site, 6 of the individual PAHs concentrations measured in the sample collected during base-flow conditions exceeded the 9 established PECs and 8 PECs were exceeded in the sample collected during poststorm conditions. The total PAH concentration in the sample collected during poststorm conditions was 3.3 times greater than the PEC developed for total PAHs, making it the most contaminated site in regards to total PAHs in the study area (fig. 3).

Average PAH profiles for samples collected during base-flow and stormflow conditions at sites in the study area were computed by averaging each of the 12 normalized compound concentrations measured in the 10 samples collected during the different hydrologic conditions; the ratio of concentration of each of the 12 PAH compounds to the total sum of the PAH compound concentrations was used to normalize concentrations. Average PAH profiles computed for base-flow samples and poststorm samples were compared to seven published PAH source profiles (Van Metre and Mahler, 2010) including, but not limited to, coal-tar sealants, automobile emissions, and coal-fired powerplant emissions. The graphical representations of the average base flow and average poststorm streambed-sediment PAH profiles most closely resemble that of the parking lot coal-tar sealcoat dust PAH source profile (fig. 3).

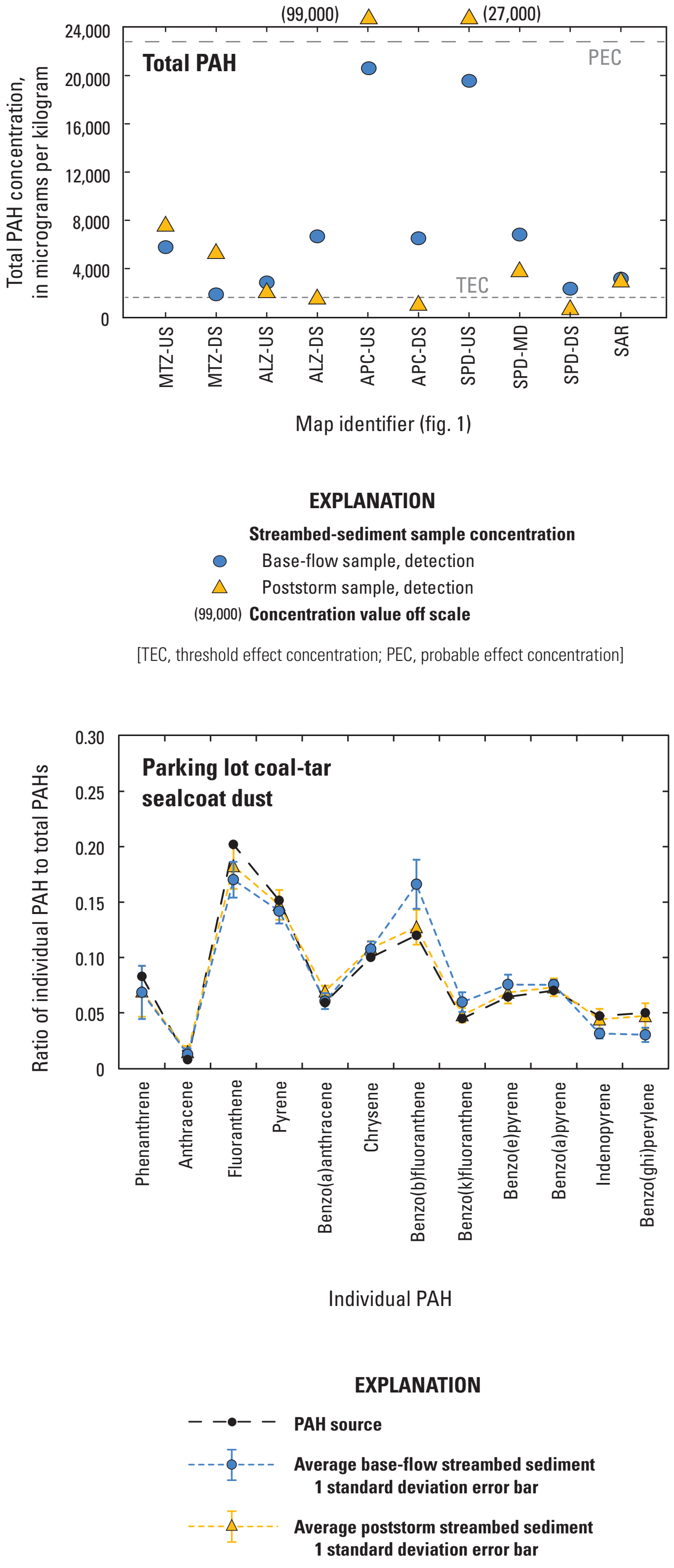


Figure 3. Comparison of consensus-based sediment quality guidelines (MacDonald and others, 2000) with concentrations of total polycyclic aromatic hydrocarbons (PAHs) and comparison of PAH source profile for parking lot coal-tar sealcoat dust (Van Metre and Mahler, 2010) to PAH profiles for average streambed sediment computed from samples collected during base-flow and poststorm conditions from sites on the Westside Creeks and San Antonio River, San Antonio, Texas, 2014.

Water Toxicity Results

Six of the ten environmental water samples collected during base-flow conditions at the 10 sites were toxic to fathead minnow, causing appreciable reductions in survival rates and biomass (fig. 4). The relations between fathead minnow survival and concentrations of major ions measured in the water samples were examined and no appreciable correlations were observed. The relations between fathead minnow survival and concentrations of selected constituents in the streambed-sediment samples collected during base-flow conditions also showed no significant correlations. Fathead minnow populations in all 10 environmental water samples collected during poststorm conditions did not indicate any reductions in survival compared to the control water.

The compounds detected in the Westside Creeks are common in urban streams, but the San Pedro Creek sites were of specific concern because the sediments contained elevated concentrations of lead and historical-use pesticides that consistently exceeded applicable PECs. Additionally, the total PCB concentrations in samples at two San Pedro Creek sites, although less than the TEC, were the largest total PCB concentrations measured among all of the sites in the study area. During both base-flow and poststorm conditions, six individual PAHs were greater than their PECs, and total PAHs were greater than the PEC in samples collected during poststorm conditions at the upstream San Pedro Creek site.

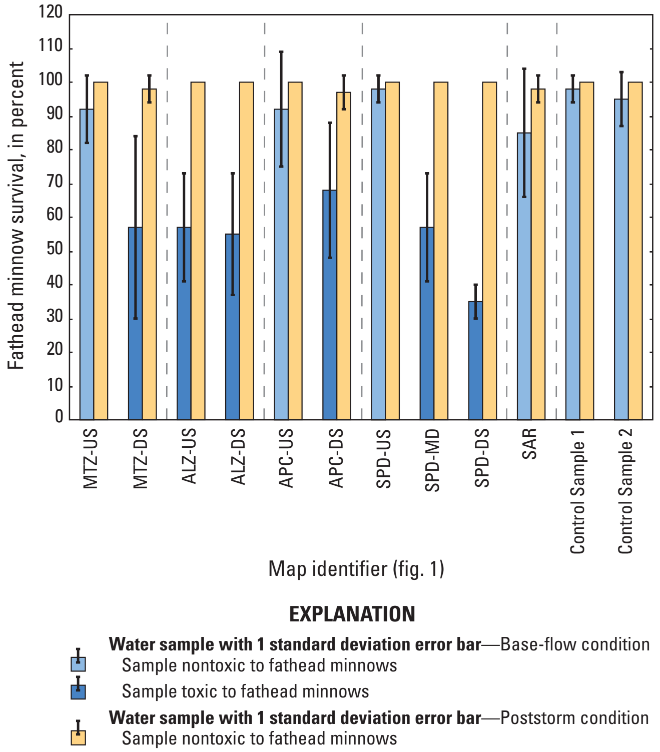


Figure 4. Responses of *Pimephales promelas* (fathead minnow) in 7-day exposure to water samples collected during base-flow and poststorm conditions from sites on the Westside Creeks and San Antonio River, San Antonio, Texas, 2014.

This fact sheet is based on the following U.S. Geological Survey report:

Crow, C.L., Wilson, J.T., and Kunz, J.L., 2016, Occurrence and concentrations of selected trace elements, halogenated organic compounds, and polycyclic aromatic hydrocarbons in streambed sediment and results of water-toxicity testing in Westside Creeks and the San Antonio River, San Antonio, Texas, 2014: U.S. Geological Survey Scientific Investigations Report 2016–5136, 56 p.

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