Brake Pad Partnership Technical Studies
Estimates of Copper in Runoff to the San Francisco Bay

Summary of Findings

The Brake Pad Partnership commissioned a watershed modeling study to obtain estimates of the amount of copper in runoff to the San Francisco Bay (bay). AQUA TERRA Consultants conducted the modeling, with some assistance from Jim Carleton of the U.S. EPA. AQUA TERRA Consultants used the U.S. EPA's Hydrological Simulation Program-FORTRAN (HSPF) model to estimate the copper in runoff to the bay. Limited calibration runs were performed for Castro Valley Creek to determine selected copper washoff parameters, which were then adjusted and applied to all 22 of the sub-watersheds within the bay watershed. Consistency and quality assurance checks on as many sites/stations as possible with readily available data were performed.

The copper source estimates used in the watershed modeling were developed for the Brake Pad Partnership by Process Profiles. Estimates of the air deposition of copper, which are primarily due to brake pad wear debris, were modeled for the Brake Pad Partnership by Atmospheric and Environmental Research, Inc. The watershed modeling also relied on water quality monitoring that was performed for the Brake Pad Partnership by the San Francisco Estuary Institute. All of these supporting studies are described elsewhere. Key modeling procedures include:

- HSPF model runs were performed for each sub-watershed for water years 1981 through water year 2005; this ensured that an appropriate range of weather conditions was modeled.
- Local data for land use, soils, topography, and meteorology was used to set up the model for each of 22 sub-watersheds in the greater San Francisco Bay watershed.
- Land use types to be modeled were categorized as developed pervious, impervious, agricultural, shrub and wooded, grassland and wetland, and forest.
- Copper emissions were treated as if they were applied evenly across the appropriate land use category for each sub-watershed and were uniform over time except for wet deposition of copper, architectural releases of copper, and copper in industrial runoff, which are rain-dependent.
- Brake wear debris released direct to roadways was modeled as applied to impervious surfaces, while non-brake releases were modeled as going straight to storm drains, to agricultural land, or to developed land, depending on the type of release.
- Three cases of copper release (flux) scenarios were modeled, one called brakes-high, one called brakes-low, and one called median estimate. These three scenarios were selected because results based on them adequately represent the range of relative contribution of copper released from brakes, and because they take the uncertainty in both brake and non-brake releases into account. Each scenario was modeled with and without the brake source terms in order to get an estimate of the relative contribution of copper from brakes.
- Model results were processed for flow, sediment and copper loads; annual and mean annual loads were tabulated; and daily flows and concentrations (both sediment and copper, total and dissolved) were reviewed as a quality assurance confirmation.

The modeling produced the following key findings:

- The total load of copper in runoff to the bay was estimated to be 56,000 kg/y.
- The contribution of copper from brake pads to the total copper load in runoff to the bay is from 10% (for the brakes-low case) to 35% (for the brakes-high case).
- The contribution of copper in runoff due to brake pads is higher in urbanized sub-watersheds than in rural sub-watersheds. For example, for the median estimate case in the individual sub-watersheds, the contribution of copper from brake pads to the copper load in runoff varies from more than half in highly urbanized watersheds to 15% for the rural sub-watersheds.
- Of the six sub-watersheds that contribute the greatest copper load to the bay, some have their largest contribution from sediment, some from brakes, and some from non-brake anthropogenic sources.