BRAKE PAD PARTNERSHIP

2007 Stakeholder Conference Summary

July 31, 2007

Overview of the Brake Pad Partnership

The 2007 Brake Pad Partnership Stakeholder Conference opened with a welcome and introductions. Sarah Connick, the Brake Pad Partnership's facilitator, gave an overview of the Partnership's history and laid out ground rules for the conference. Sarah explained that

- High levels of copper in the South San Francisco Bay have been a regulatory concern since the 1980s.
- South Bay sewage treatment plants reduced their copper discharges by 10-fold.
- After that (in the early ’90s), copper levels in the Bay plateaued and stormwater was found to have unexpectedly high levels of copper.
- A study estimated that up to 80% of the copper in stormwater was from brake pads.

Stormwater managers investigated regulatory approaches for addressing copper from brake pads and decided that a voluntary approach was best, and the Brake Pad Partnership was formed. The Partnership's stakeholders include stormwater managers, brake pad manufacturers, water quality regulators, and environmental groups. The stakeholders have committed to participating actively and working collaboratively, with no lawsuits or legislation. In addition, the brake pad manufacturers involved in the Partnership have committed to reporting on copper use in original equipment brake pads annually to track trends, and introducing new reduced-copper products within five years if the Partnership found that brake pads are a significant source of copper in surface waters.

The Partnership has three main purposes, which are to:

1. Determine whether the contribution of copper from brake pads to copper levels in surface waters is substantial, using SF Bay as an example,
2. Develop a tool that manufacturers can use to evaluate the potential water quality impacts of other brake pad ingredients, and
3. Demonstrate an approach to solving tricky, non-point pollution problems through cooperation and collaboration.

What the Partnership Has Learned About Brake Pads

After Sarah spoke, three members of the Brake Pad Partnership's steering committee who represent brake pad manufacturing firms gave presentations. Bob Peters of Akebono-USA talked about original equipment brake lining materials. His presentation included:

- A tutorial on friction and the desired characteristics of brake pad materials,
- An explanation of the Federal Motor Vehicle Safety Standard for brakes on new automobiles and its impact on the use of copper in brake pads, and

- A discussion of trends in brake pad formulations, the various categories of formulations, and the role of copper in friction material.

Bob explained that the escalating price of copper is resulting in reduced use in brake pad formulations, and that the market pressure and the environmental pressure to reduce the use of copper are aligned. Bob discussed the global nature of the brake pad manufacturing industry, and talked about the timeline for implementing new materials. Original equipment materials go through many rounds of time-consuming and expensive tests after their development phase. In designing brake lining materials, safety is the most important criteria. Finally, Bob let the audience know that the Brake Manufacturers Council's involvement in the Partnership has been as a consistent, dedicated, reliable partner since its inception. As a result of involvement in the Partnership, the Product Environmental Committee was formed, and the Council is interested in how requirements might be crafted to be effective and equitable among brake pad suppliers and among all the copper load sources.

Chris Shepley of Brake Parts Inc. talked about manufacture of aftermarket brake lining materials. He explained that there are virtually no regulations or safety standards for aftermarket brakes, and that some unscrupulous manufacturers introduce inferior products. However, legitimate aftermarket brake lining suppliers put effort into designing materials with safety foremost in mind. Chris explained that the timeline for introduction of new aftermarket brake lining materials is not as lengthy as the timeline for original equipment materials.

Mark Phipps of Morse Automotive then presented an overview of the latest results from the Copper Use Monitoring Program. The Brake Manufacturers Council-Product Environmental Committee conducts an annual survey of copper use in original equipment brake lining materials in popular American-made vehicles as part of their participation in the Partnership. The data provided are used to track trends in copper use. Mark explained that although the total mass of brake lining copper per vehicle increased slightly between 2004 and 2005, the copper content is lower than it was in 2002 and 2003.

Mark Schlautman of Clemson University, who serves as Technical Advisor to the Partnership's steering committee and who as a contractor to the Partnership performed physical and chemical characterization studies of brake pad wear debris, discussed how representative samples of brake pad wear debris are obtained and how the size distribution of the particles was determined. Airborne brake pad wear debris particles are small; the central value for their diameter is 3.5 μm. The concentration of copper throughout the range of particle sizes is fairly constant. Mark also presented the results of leaching tests on brake pad wear debris. Leaching of copper from the nonairborne representative brake pad wear debris ranged from 60% to 100% in the more aggressive leaching solutions, and from less than 1% up to 3.5% in the less aggressive leaching solutions. The rate of leaching is fast, on the order of a few hours.

What the Partnership Has Learned About Copper and Brake Pad Wear Debris Transport in the Environment

Jim Pendergast, a member of the Partnership's steering committee who works for EPA's Office of Water, provided an overview of the factors that inform the Brake Pad Partnership's technical studies. He explained that

- Total copper is important in tracking where copper ends up. Particulate matter is formed during braking, but copper is in both dissolved and particulate form when running off in storm water.
- There is a lag time between deposition and runoff, so an understanding of the accumulation of copper on land is important. Not all material washes off with each runoff event.
- Deposition occurs continuously but runoff occurs intermittently.
- The amount of brake pad wear debris is miniscule compared to the amount of sediment loading in creeks.

Jim also gave the audience an outline of the information expected to be gleaned from the technical studies. Questions the copper inventory work was designed to answer include:

- How much copper is generated from brake pad wear debris?
- How much copper comes from other anthropogenic sources?
- What is the uncertainty in source contributions?

Questions the air deposition modeling answered are:

- Are brake pad wear debris particles small enough to be air transported?
- Where does airborne brake pad wear debris (and the associated copper) fall?

The watershed modeling was conducted so the Partnership would learn:

- How significant is brake pad wear debris as a source of copper in the watersheds?
- How does land use affect the relationship between sources of copper and the amount in runoff?
- How much copper goes into the Bay from runoff?

Finally, the bay modeling addresses:

- How much copper in Bay is from brake pad wear debris?
- How long does the copper from brake pad wear debris stay in the Bay?

Kirsten Rosselot, the Brake Pad Partnership's Project Manager and the contractor who produced the copper release estimates, talked about sources of copper in the San Francisco Bay watershed. Copper releases from brake pads were estimated by develop air emission factors using several approaches and then selecting the most appropriate air emission factor. Partitioning information was used to estimate releases to roadway based on the air emission estimates. Methodologies for estimating copper releases from more than a dozen categories of nonbrake sources varied depending on the type of release. Estimated releases were apportioned to each of the 23 sub-watersheds within the San Francisco Bay watershed, and were assigned to one of three categories of land use, air, surface waters, or bay waters. Key findings are

- A little more than half of the estimated 80,000 kg/y of copper released from brake pads in the San Francisco Bay watershed are to air.

- A substantial amount of the anthropogenic copper releases in the watershed are from non-brake sources.
- Copper is released directly to bay waters and to surface streams and storm drains as well as to air, soil, and impervious surfaces. The models tell us how much of the releases to the different environmental compartments wind up in runoff.

Betty Pun of AER, Inc., who performed the air deposition modeling for the Brake Pad Partnership, talked about her findings. AER modeled wet and dry deposition fluxes of copper in the watershed for a five-year period from March 2000 to February 2005. Dispersion and deposition of copper in the Castro Valley sub-watershed was modeled using a detailed source-based dispersion model to simulate local impacts, while a regional-scale box model was used to account for regional-scale effects. The deposition estimates in the Castro Valley sub-watershed were scaled using modeled information along with estimates of copper releases to produce estimates of the rate of wet and dry deposition in the remaining 22 sub-watersheds in the greater San Francisco Bay Area watershed. In the Castro Valley sub-watershed modeling

- Copper emissions were treated as uniform over time.
- Estimated copper releases from vehicles on surface streets were treated as a uniform source over the watershed.
- Estimated releases from Interstate 580 (I-580), which bisects the southern portion of the sub-watershed, were treated as a line source.
- Source loading estimates for surface streets in Castro Valley were adjusted upwards by a factor of five and emissions from I-580 were adjusted downwards by a corresponding amount.

The results of the air deposition modeling showed that

- Dry deposition is the dominant source of depositional copper, even during the rainy season.
- Local emissions (emissions occurring within the sub-watershed) account for most of the dry deposition.
- Regional emissions are the dominant source of copper in wet deposition, and therefore do not vary significantly among the sub-watersheds.
- There is no local component of copper emissions to San Francisco Bay waters, and the estimated average dry deposition rate direct to Bay waters is 0.8 μg Cu/m^2/day, while the estimated average wet deposition rate direct to Bay waters is 0.9 μg Cu/m^2/day. Note that the modeled estimate for wet deposition represents wet deposition for an average calendar day and not wet deposition for days with rain.
- The estimated average rate of dry deposition in the Castro Valley sub-watershed is 20 μg Cu/m^2/day, and the estimated average rate of wet deposition in the Castro Valley sub-watershed is 1.2 μg Cu/m^2/day.

Tony Donigian of AQUA TERRA, who in conjunction with the EPA performed the Brake Pad Partnership's watershed modeling, explained that the objectives of the watershed modeling were to

- Provide daily loadings of flow, total suspended solids, and copper to the bay model.

- Estimate the relative contribution of brake pad wear debris in runoff to the bay.

The HSPF model was used, and Tony explained the data sources for all of the modeling parameters, the way in which land use categories were handled, and what calibration and consistency checks were performed in order to verify that the results of the watershed modeling are reliable. Model runs were simulated for 25 years, from October of 1980 to September 2005, in order to capture potential variations in weather. Model runs were performed for scenarios that were based on uncertainties in the copper release estimates, with and without the contribution from brake pads. The modeling scenarios provide an estimate of the upper and lower bounds of the relative contribution of copper from brake pads. Model results were shown to be consistent with other similar studies, and provide reasonable loads to the bay model.

Key findings of the watershed modeling effort are

- Copper occurs naturally in soils, and sediment loads in runoff contribute substantially to the copper found in runoff to the bay.
- Brake pad contributions of copper in runoff were estimated to range from 10% to 35% of total copper runoff loads to the Bay.
- In some highly urbanized sub-watersheds within the San Francisco Bay watershed, the median estimate for the relative contribution of copper from brake pads approaches 50%, while in others, brake pads are estimated to contribute less than 5% of the copper load in runoff to the bay.
- The median estimate for the relative contribution of copper in runoff from non-brake pad anthropogenic sources of copper ranges from less than 15% in some watersheds to nearly 50% in others.

Terry Cooke of URS Corp., the contractor for the Partnership's bay modeling, discussed how the bay modeling will be conducted and how the results will be presented. He explained that short-term bay modeling will be conducted using MIKE 21, a tidal time scale depth-averaged model. The results from MIKE 21 will be used to provide input for a longer time scale box model that can provide long-term estimates. Modeling for representative water year types (wet, dry, and normal) will be conducted, and the effect of uncertainties in the copper release estimates on the relative contribution of copper from brake pads will be assessed. Terry explained that previous modeling efforts show that the expectation is that

- Changes in tributary loads can result in changes in copper concentrations in the Bay. When tributary loads were tripled in a previous study and the changes in average dissolved copper at one location were evaluated over six months, the dissolved copper increased by up to 1.2 ug/L.
- The expected timescales for changes depend on the Bay segment. The expected time scale in the Lower South Bay is one to two years, and the expected time scale in the South Bay is six to eight years.

Translating Information Into Action

Jim Pendergast presented a brief wrap-up of the results of and plans for the technical studies, and timelines for next steps were described by Sarah Connick and Kelly Moran, who represents the Bay Area Storm Water Management Agencies Association on the Brake Pad Partnership's steering committee. Independent of the timeline for efforts on the part of brake pad

manufacturers to reduce their use of copper are compliance timelines for copper Total Maximum Daily Load (TMDL) regulations for creeks in Southern California. The timeline for replacement of brake pad materials for each original equipment platform is expected to be ten years, and the dry weather TMDL for Ballona Creek is scheduled for full compliance less than ten years from now. In addition to these timelines is the timeline for implementation of potential legislation developed by the Partnership regarding the copper content of brake pads.

Next Steps

Conference participants participated in a brainstorming session regarding next steps for the Partnership. Ideas put forth include:

Timing for next steps:

- Determine that there is an issue (finish the studies, including loading from the San Joaquin/Sacramento River delta).
- Do not allow project "drift"—i.e., finish the Partnership's studies for the Bay and then discuss the creeks.
- The bay modeling is not in the critical path to decision-making; instead, use a few scenarios to make a case and take the next step.
- The scope is bigger now than it was when the Partnership started and if there is a problem with copper in surface water, it needs to be resolved.

Engagement:

- Engage the automobile manufacturers and make our case to them.
- Make sure the process is equitable; the brake manufacturers have been asked to do a lot and municipalities need to explain what they are doing about other sources.
- Have a plan that includes what municipalities can do in addition to the brake manufacturers.
- Industry and municipalities should work together on a plan.
- "Willing players" need a shared plan (a tangible written and integrated product) that they can all buy into and manage.
- Educate members of the regional water quality control boards.
- Determine if there is a role for consumers via labeling or education.
- Broaden the steering committee or create a subgroup of the steering committee whose charter is to create a plan.

Regulation/legislation:

- Any regulatory fix will be better if brake manufacturers help define what is possible and what will level the playing field; it's important to anticipate what will work.
- Pursue agreed upon and managed regulation/legislation that provides a level playing field for all brake pad manufacturers.

Other:

- Pursue NSF or other government funding for R&D on brake pad materials.
- Have the brake manufacturers self-regulate via an ASTM standard.

Challenges:

- The aftermarket brake pad manufacturers are not tied to the automobile manufacturers or engaged in the Brake Pad Partnership.
- Beware of substitutes for copper in brake pads.

Attendees

Ray Arnold (Copper Development Association)
Phil Bobel (Regional Water Quality Control Plant)
Ashley Boren (Sustainable Conservation)
Geoff Brosseau (BASMAA and CASQA)
Bill Busath (City of Sacramento)
Jim Carleton (US Environmental Protection Agency)
Robyn Carliss (Sustainable Conservation)
Lisa Carlson (City of Los Angeles)
Joe Cassmassi (South Coast Air Quality Management District)
Jack Charney (FDP Brakes)
Sarah Connick (Sustainable Conservation)
Terry Cooke (URS Corporation)
Susan Corlett (Sustainable Conservation)
Jamison Crosby (Contra Costa Clean Water Program)
Rodger Dabish (TMD Friction Inc.)
Tony Donigian (AQUA TERRA Consultants)
Karl Dreher (Caltrans)
Elizabeth Eastman (San Francisco Department of the Environment)
Michael Endicott (Sierra Club)
Jaime Favila (State Water Resouces Control Board)
Arleen Feng (Alameda County Public Works Agency)
Thom Fowler (Sustainable Conservation)
Meg Gale (San Francisco Public Utilities Commission)
Mary Green (Newark Fire Department)
Holly Guier (Newark Fire Department)
Tom Hall (EOA, Inc.)
Patrick T. Healey (FMSI and BMC)
Roger James (Water Resources Management)
John Johnston (California State University Sacramento)
Alex Karolyi (Sustainable Conservation)
Masoud Kayhanian (University of California, Davis)
Shin-Roei Lee (San Francisco Bay RWQCB)
Hong Lin (Contech Stormwater Solutions)
Sally Liu (environmental consultant/modeler)
Sandra Mathews (Lawrence Livermore National Laboratory)
Kelly Moran (TDC Environmental)
Rob Nelson (Arras Group)
Jim Pendergast (US Environmental Protection Agency)

Connie Perkins (City of Sacramento)
Bob Peters (Akebono)
Mark Phipps (Morse Automotive)
Betty Pun (AER, Inc.)
Terry Ragan (Robert Bosch North America)
David Renfrew (Weston Solutions, Inc.)
Jaime Rosenberg (City of Hayward)
Kirsten Rosselot (ProcessProfiles)
Emily Ruby (Lawrence Livermore National Laboratory)
Paul Salop (Applied Marine Sciences)
Mark Schlautman (Clemson University)
John Schupner (AMEC Earth and Environmental)
Chris Shepley (Affinia, Brake Parts Incorporated)
Xavier Swamikannu (Los Angeles RWQCB)
Dave Tamayo (Sacramento County Department of Water Resources)
Benjamin Tobler (San Diego RWQCB)
Mohammad Vakili (Continental Teves Automotive Systems)
William Van Peeters (Federal Highway Administration)
Richard Watson (Richard Watson & Associates, Inc.)
Philip Woods (US Environmental Protection Agency, Region 9)
Don Yee (San Francisco Estuary Institute)
Chris Zirkle (City of San Diego)