Wet-Weather Pollution Prevention through Materials Substitution

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OBJECTIVES

• To investigate the potential pollutant release from common building materials both when the materials are new and after aging.
  – A complete investigation would include subjecting the selected materials to adverse conditions, including snowmelt runoff that contains road salt.
• To compare traditional laboratory testing techniques for leaching potential with the release seen in the laboratory and in the field when the materials are exposed to rainwater.

LITERATURE REVIEW:
First Flush Roof Concentrations (μg/L)

<table>
<thead>
<tr>
<th>Material</th>
<th>Copper</th>
<th>Zinc</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyester roof</td>
<td>6,817</td>
<td>2,076</td>
<td>510</td>
</tr>
<tr>
<td>Tile roof</td>
<td>1,905</td>
<td>360</td>
<td>172</td>
</tr>
<tr>
<td>Gravel roof</td>
<td>140</td>
<td>36</td>
<td>22</td>
</tr>
</tbody>
</table>

From Boller 1997

Photos taken approximately 60 years apart of this statue show evidence of severe deterioration due to the effects of acid rain.

Map courtesy of U.S. Geological Website on Acid Rain

Sponsors and Additional Researchers

Current Sponsors:
U.S. Environmental Protection Agency
Alabama Water Resources Research Institute

Undergraduate Research Assistants:
Blaine Collier and Amanda Lowry
**Good (1993): Washington State Coastal Sawmill Facility**

- Sampled the following roof types:
  - rusty galvanized metal
  - weathered metal
  - built-up (plywood with roofing paper and tar)
  - flat tar-covered with reflective aluminum paint
  - new anodized aluminum
- Dissolved metals and toxicity still high three hours after storm beginning, indicating potential continued leaching

### Roof Runoff Concentrations (μg/L)

<table>
<thead>
<tr>
<th></th>
<th>Copper</th>
<th>Zinc</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Built-up roof</td>
<td>Total: 166</td>
<td>&lt; 17</td>
<td>&lt; 17</td>
</tr>
<tr>
<td></td>
<td>Dissolved: 128</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rusty galvanized roof</td>
<td>Not given</td>
<td>Total: 302</td>
<td>Total: 12,200</td>
</tr>
<tr>
<td></td>
<td>Dissolved: 35</td>
<td>Dissolved: 11,900</td>
<td></td>
</tr>
</tbody>
</table>

From Good 1993

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**Asphalt and Tars**

- Coal tars and pitches contain PAHs, many of which are human carcinogens.
- Asphalt is an animal carcinogen and may be human carcinogen.
- Chemical modifiers often used to increase the operating range of asphalts and to prevent stripping of asphalt from binders.
- Fillers include carbon black from pyrolyzed tires.
- Stabilizing additives include cellulose fiber, rock wool fiber, and/or polymers.
- Road runoff has been shown to contain SVOCs, including PAHs. The contribution from atmospheric deposition versus the asphalt is unknown.

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**Concrete**

- Often suggested as a repository for solid and liquid waste – solidification with uses in construction and roadways.
- Wiebusch et al. (1998) tested brick sands and found that the greater the concentration of alkaline and alkaline earth metals in the sand, the greater the release of heavy metals (Cr, Co, Ni, Cu, Zn, As, Se, Cd, Pb).
- Non-ferrous foundry residuals (investigated as a concrete additive) were found to be toxic by Microtox™ assay; Ferrous foundry residuals acceptable (Bastian and Alleman 1998).

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**Treated Woods**

- Epibiota on treated panels of wood had more copper and arsenic than epibiota on untreated panels. Accumulation in the food chain undefinable (Weis and Weis 1999).

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**Paints**

- Davis and Burns (1999)
  - Investigated lead concentrations from 169 different painted structures.
  - Order of release of lead from painted structures: wood (range 2.6 – 380 μg/L) > brick (range 3.3 – 240 μg/L) > block (range 2 – 110 μg/L)
  - Age and paint condition greatly influenced the leachability of lead from the paint.
  - In stormwater, lead from painted structures was 70% in the particulate form, suggesting release of pigments from paint binder.
Eikelboom, Ruwiel, and Goumans (2001)

- Late 1970s – early 1980s, Dutch began looking for ways to recycle waste products.
- Due to soil and water pollution concerns, needed to develop “proper and safe solutions” for materials disposal/reuse.
- Developed Dutch Building Materials Decree
  - Decree is applicable to materials used in construction that is in contact with rain, surface water and groundwater (e.g., embankments, roads, outside walls of buildings, foundations, roofs).
  - Anecdotal evidence suggests that this decree has been successful in judging the environmental quality of construction materials in both a direct and indirect way, including the potential reuse of waste products in construction materials.

Categories of Materials to be Investigated

- road/parking lot asphalt
- asphalt cement sealer
- concrete pavement
- galvanized metal
- aluminum gutters/siding
- vinyl siding
- asphalt roofing shingles
- roofing tar and felt
- membrane roofing
- faux slate shingles (made from recycled materials)
- untreated wood (with and without paint)
- treated wood (with and without paint)
- bricks
- concrete masonry units (CMU)

Roofing Shingles (Asphalt)

Roofing Panels

- Ondura™ Vinyl Roofing Panels
- White Plastic Roofing Panels
- Fiberglass Roofing Panels

Roof Coatings

Roofing Compound Components

- Kool Seal ® White Acrylic Patching Cement
  - Acrylic Resin
- Kool Seal ® Ultra High Reflectivity White Elastomeric Roof Coating
  - 100% Acrylic Elastomeric Resin
- Kool Seal ® Ultra High Performance Aluminum Roof Coating (Fibered)
  - Synthetic Reinforcing Fibers
  - Petroleum Hydrocarbons
Roofing Compound Components

- Leak Stopper – Rubberized Roof Patch
  - Petroleum Distillate
  - Liquid Rubber
  - Penetrex™ (a penetrating oil)
- Silver Dollar Fibered Aluminum Roof Coating
  - Aluminum Flakes
  - Calcium Carbonate
  - Cellulose Fiber
  - Stoddard Solvent
  - Asphalt
- Gardner Wet-R-Dri™ All Weather Plastic Roof Cement
  - Petroleum Distillate
  - Asphalt
  - Cellulose Fiber
  - Silicate Mineral
  - Chrysotile Mineral Fiber

Woods (Pressure-Treated CCA and Water Proofed)

Materials Purchased to Date

Analytes

- pH
- conductivity
- chemical oxygen demand
- semi-volatile organics and pesticides (EPA Method 8270 and 608)
- heavy metals and major cations (copper, chromium, cadmium, lead, zinc, arsenic, calcium, magnesium, sodium, potassium) [by ICP]
- nutrients (nitrate, ammonia, phosphate)

Methodology

- Summer 2002: Laboratory investigation of materials using TCLP
- Fall/Winter 2002: Laboratory investigation of materials using rainfall
- Fall 2002 – indefinite: Long-term investigation of pollutant leaching from building materials by installing them outdoors and analyzing samples from intact panels regularly.

Results

- Phase I laboratory investigation (the investigation of the potential leaching from the materials using traditional procedures) nearing completion.
- Preliminary data available for nutrients, semi-volatile organics.
- Data not shown for pH, as minimal change occurred from the materials as compared to the leachant solution.
Summary of Results to Date

- Galvanized aluminum roofing added highest concentrations of conductivity (dissolved ions), ammonia, and nitrate. The Gardner Wet-R-Dri sealer had the highest concentration of phosphate.
- Compared to background, elevated concentrations of conductivity, phosphate, nitrate and ammonia were found in tar shingles, vinyl roofing, aluminum flashing and roofing felt.
- Highest organic concentrations seen in roofing felt: bis(2-ethylhexyl) phthalate at 315 μg/L.

Conclusions

- From preliminary results, nutrient contributions could be considerable from these materials. Nutrient testing would be recommended.
- Additional work is needed to confirm the applicability of TCLP testing to predicting stormwater loadings. This work will be beginning in the Fall of 2002.
- Monitoring of field installations required to determine the effects of weathering on intact pieces required to predict stormwater loadings. Installation practices such as exposing cut edges and use of sealers may impact the temporal pattern of pollutant release from these materials.