Wet-Weather Pollution from Commonly-Used Building Materials

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QUESTIONS TO BE ANSWERED

- What is the potential pollutant release from common building materials both when new and after aging?
  - How does exposure to road salt and other adverse conditions affect pollutant release?
- Can we use short-term laboratory testing to predict long-term pollutant release in the field?
- Can we modify existing roofing materials or develop a more environmentally-friendly roofing material (focusing on those materials that are used in large quantities as roofing surfaces and substrates)?

<table>
<thead>
<tr>
<th>National Stormwater Quality Database</th>
</tr>
</thead>
<tbody>
<tr>
<td>(based on MS4 NPDES Phase I Permits)</td>
</tr>
<tr>
<td>Parameter:</td>
</tr>
<tr>
<td>All data combined:</td>
</tr>
<tr>
<td>Median (COV):</td>
</tr>
<tr>
<td>Residential (1,061 events):</td>
</tr>
<tr>
<td>Commercial (497 events):</td>
</tr>
<tr>
<td>Industrial (518 events):</td>
</tr>
<tr>
<td>Freeways (185 events):</td>
</tr>
</tbody>
</table>

Plating Company Study

- Semi-bright nickel, bright nickel, chrome
- Steel and aluminum substrates
- Galvanized roofing, partly painted – 10,000 sf

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Historical Concentrations (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc</td>
<td>0.8 – 3.0</td>
</tr>
<tr>
<td>Copper</td>
<td>0.02 – 0.7</td>
</tr>
<tr>
<td>Lead</td>
<td>ND – 0.1</td>
</tr>
<tr>
<td>TSS</td>
<td>5 – 76</td>
</tr>
</tbody>
</table>

Galvanized (Galvalume) Roofing – Airport Facility

- 7 storms sampled of direct roof runoff
  - Zinc
    - 0.42 to 14.7 mg/L (average 88% dissolved; COV = 7%).
  - Copper
    - 0.01 to 1.4 mg/L (average 75% dissolved; COV = 24%).
  - Lead
    - Not detected

**SCRAPYARD RUNOFF (SOLUBLE FRACTION)**

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Concentration (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphate</td>
<td>0.05 – 0.35</td>
</tr>
<tr>
<td>Copper</td>
<td>0.1 – 0.3</td>
</tr>
<tr>
<td>Lead</td>
<td>0.1 – 0.3</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.1 – 6.7</td>
</tr>
<tr>
<td>Calcium</td>
<td>8 – 200</td>
</tr>
<tr>
<td>Magnesium</td>
<td>1.8 – 12</td>
</tr>
</tbody>
</table>

Galvanized metal roofing panels used on a building in Denali, Alaska.

**Categories of Materials to be Investigated in both Laboratory and Field Testing**

- Galvanized metal (both painted and unpainted)
- Aluminum gutters/siding
- Vinyl roofing panels
- Asphalt roofing shingles
- Roofing felt
- Roofing sealants
- Membrane/rubberized roofing
- Cedar shingles
- Faux slate shingles (made from recycled materials)
- Untreated wood (with and without paint)
- Treated wood

**Laboratory Testing**

**Laboratory Testing: Roof Coatings and Sealers**

Potential Pollutants (from labels and MSDS):
- Leak Stopper – Rubberized Roof Patch
  Petroleum Distillate
  Penetrex™ (penetrating oil)
- Silver Dollar Fibered Aluminum Roof Coating
  Aluminum Flakes
  Asphalt
- Gardner Wet-R-Dri™ All Weather Plastic Roof Cement
  Petroleum Distillate
  Asphalt
  Silicate Mineral
  Chrysotile Mineral Fiber

**Analytes**

- pH
- Conductivity
- Chemical oxygen demand
- Semi-volatile organics (EPA Method 8270 and 608) – laboratory testing only
- Heavy metals and major cations (copper, chromium, cadmium, lead, zinc, arsenic, calcium, magnesium, sodium, potassium)
- Nutrients (nitrate, ammonia, total nitrogen, phosphate, total phosphorus)
- Toxicity (Microtox™) on periodic PSH field samples
### Methodology

- Summer 2002: Laboratory TCLP (acid rain simulation)
- Fall/Winter 2002 and Spring 2003: Laboratory investigation of selected materials using rainfall
- Winter 2004 – Laboratory-testing of 60-year-old outdoor (painted) metal roofing panels.
- Spring 2005: Reconstruction of test frames at PSH and UAB. Slight design modifications resulting in larger surface area and decreased angle of roofing section to match typical construction guidelines used.
- Summer 2005 – indefinite: Long-term, outdoor investigation from intact installations on test frames. Runoff samples analyzed regularly (every storm first two months; at least one storm per month after first two months).

### Results: Laboratory Testing

- Data not shown for pH, as minimal change occurred from the materials as compared to the leachant solution.
- 60+-year old roofing panel testing complete. Primary analytes were metals since these were metal panels with original paint.
- Conductivity not shown – most samples near background, but metal roofing panels generated elevated conductivity.

#### Chemical Oxygen Demand

**Laboratory-Scale Tests**

#### Nitrate

**Laboratory-Scale Tests**

#### Ammonia-Nitrogen (NH₃-N)

**Laboratory-Scale Tests**
Phosphate (PO₄-P)

Laboratory-Scale Tests

Copper

Laboratory-Scale Tests

Lead

Laboratory-Scale Tests

Zinc

Laboratory-Scale Tests

Aged Roofing Panels

60+-Year Roofing Panels: Heavy Metals

Cu

Cr

Pb

Zn
Results: Field Testing

- 2.5 months of sampling and exposure complete.
- pH, conductivity, and COD values showed little variability between storms.
- Conductivity stabilized after ~20 days
- Physical degradation of roofing panels, particularly the metal panels, is visible after two weeks of exposure.
Summary of Results to Date: Laboratory TCLP

- **Organics:**
  - Most non-detects. Highest: roofing felt [bis(2-ethylhexyl) phthalate = 315 μg/L].
  - COD: Pressure-treated wood > Silver Dollar Aluminum Roofing Coating > Roofing felt.

- **Nutrients:**
  - Nitrate highest: roofing felt, the two woods, and Leak Stopper.
  - Ammonia high: galvanized metal and roofing felt.
  - Phosphate elevated: galvanized metal and Gardner Wet-R-Dri.

- **Metals:**
  - Copper highest in the two woods, followed by shingles and Silver Dollar Aluminum Coating (order of magnitude lower).
  - Lead highest: Leak Stopper.
  - Others high: Silver Dollar Coating and galvanized metal.
  - Zinc highest: galvanized metal (Zn is sacrificial cation).
  - Others elevated but four orders of magnitude less: waterproof wood, Leak Stopper, faux slate, and Kool-Seal White Acrylic.

Summary of Results to Date: Laboratory Aged roofing panels for both dissolution and TCLP:

- 1 – 5 mg/kg of Cu
- 1 – 10 mg/kg Cr
- 30 – 70 mg/kg Pb.
- Zinc 3 orders of magnitude higher than Pb (10 – 40 g/kg).

- Little difference noted between the rusted and non-rusted panels (testing on no-paint areas).
- Paint likely contributed Cr and Pb to leachate.
- Overall Cr concentrations were higher when the painted panel was dissolved.

- Aged panels [simulated rainwater] had measurable releases of chromium, lead and zinc, although concentrations 2 – 4 orders of magnitude less than that released in TCLP test.
- No Cu detected when panels exposed to simulated rainfall.
- Pollutant release in same TCLP tests (new and old material) showed similar results.

Summary of Results to Date: Outdoor Testing

- **pH:** All samples have runoff pH between 5 – 6.5, except for roofing felt, rubberized roofing, and cedar shakes (all of which have runoff pH < 5).
- **Wood panels,** both treated and untreated, have high conductivity and COD levels.
- **Roofing felt,** cedar shakes, and water-proof wood highest nitrate concentrations. Water-proof wood also had high ammonia releases.
- **Asphalt shingles** yield total phosphorous levels four times greater than any other roofing panels, whereas untreated plywood generated elevated average phosphate levels.

Conclusions and Future Research

- **Materials with metallic preservatives or metal skin coatings** (metal flakes a listed ingredient) tend to leach more of the measured metals. Treated woods contributed Cu significantly more than any other material.
- **Laboratory shows** that nutrient contributions could be considerable. Follow-up testing to measure nutrients. Early sampling indicates nutrient contributions could be considerable.
- **Field installations** required to determine the effects of weathering on intact pieces so as 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.
- **Long term testing** began this summer at UAB and PSH (to look at climatic differences in degradation).
  - Elevated COD in runoff from wood products.
  - Elevated NO₃ concentrations in runoff from roofing felt and wood roofing materials.

Questions?