Chemical Fate and Exposure Pathways from the 2023 Chemical Spill and Chemical Fires in East Palestine, Ohio

November 6, 2023

Andrew Whelton, Ph.D.
Professor of Civil, Environmental, and Ecological Engineering
Director for the Center for Plumbing Safety
awhelton@purdue.edu

Funded by:
Rapid public health scientific support in response to disasters

2014 Chemical Spill (WV)
2017 Tubbs Fire (CA)
2018 Camp Fire (CA)
2020 Oregon Fires (OR)
2021 Chemical Spill (HI)
2021 Marshall Fire (CO)
2023 Chemical Spill/Fires (OH)
2023 Maui Fires (HI) and others...

Key Questions:
1. What chemicals should been looked for?
2. Where did/do the chemicals go?
3. How do you return infrastructure/homes to safe use?
4. What were/are the chemical exposures?

National Academies of Science, Engineering, and Medicine Workshop  November 2023
A LOT of people are providing scientific support for this effort

Andrew Whelton, Ph.D., Civil Env. Eng
Caitlin Proctor, Ag. Env. Eng.
Linda Lee, Ph.D., Agronomy
Jeff Youngblood, Ph.D., Materials Eng.
Marty Frisbee, Ph.D., Earth Sci.
Brock Harpur, Ph.D., Entomology
Youn Jeong Choi, Ph.D., Agronomy
Gouri Prabhakar, Ph.D., Atmospheric Sci.
Bobbie Vance, Civil Eng.
Brad Caffery, Civil Eng.
Stefanie Surdyka, ChE
Madeline Frasure-Lauth, Env. & Eco. Engr.
Paula Coelho, Env. & Eco. Engr.
Rasul Diop, Env. & Eco. Engr.
Stephanie Heffner, Env. & Eco. Engr.
Kristofer Isaacson, Env. & Eco. Engr.
Gracie Fitzgerald, Env. & Eco. Engr.
Aliya Ehde, Env. & Eco. Engr.
Akshat Verma, Materials Eng.
Katherine Del Real, Env. & Eco. Engr.
Laura Gustafson, Civil Eng.
Ana Maria Torres, Civil Eng.
Sam Spears, Env. & Eco. Engr.
Kyle Doudrick, Ph.D
Civil & Env. Engineering
Heather Whitehead, Ph.D.
Chemistry and Biochemistry

National Academies of Science, Engineering, and Medicine Workshop
November 2023
East Palestine, Ohio Chemical Spill and Chemical Fires

149 rail cars, 38 derailed
11 derailed were combustible liquids, flammable liquids, and flammable gas.

Feb 3: wreck
Feb 6: open burn

OH Air Model (Theory)
- Border of OH/PA
- Plume model, 1 mile evacuation
- 2 mile shelter-in-place

1 mile evacuation
Creek
Creek
Creek
Creek
Our 6 field investigations, February-June 2023

**Goal:** To better understand the chemicals present and human exposure pathways.

**Environment**
1. Atmospheric modeling to understand the initial chemical fate and the open burn.
2. Creek water sampling to identify chemicals released (i.e., TPH, PFAS, VOCs, SVOCs, metals).
3. Estimated chemical biodegradability in creeks.
4. Evaluated sorbent pad cleanup effectiveness.
5. Evaluated the impact of aeration on chemical emission from creeks.

**Buildings**
1. Documented household and business owner experiences and reviewed test results.
2. Sampled private drinking water wells and reviewed other results.
3. Wipe sampled building exteriors and new vinyl siding.
4. Analyzed honey from nearby apiaries.
Contaminated “Municipal Building” decontaminated in March, 85 N. Market Street

“Strohecker Building”
213 N Pleasant Dr.

“CERAMFAB Building”
900 E. Taggart St.

Contaminated creek water flowed near and under 100+ buildings.

Storm drains emptied into creeks.
• 3 weeks after the derailment visible contamination and odor was in the creeks.
• Chemicals were removed from creeks by aeration, air knifing, soil washing, pressure washing rocks, flushing downstream. Sorbent pads/booms were also present.
• Some roads and buildings were pressure washed.
• Buildings along the creeks had the characteristic indoor odors. Contamination was found inside.
<table>
<thead>
<tr>
<th>Media</th>
<th>Location</th>
<th>Parameter(s)</th>
<th>Instrumentation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Creeks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>9 locations inside and 6 locations outside East Palestine</td>
<td>TPH, VOC, SVOC, PFAS, pH, ions, heavy metals</td>
<td>DR3900, GC/MS, HRMS, ICP-OES, IC</td>
</tr>
<tr>
<td>Sediment</td>
<td>In and outside East Palestine</td>
<td>VOC, SVOC, PFAS</td>
<td>GC/MS, HRMS</td>
</tr>
<tr>
<td><strong>Properties</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private well water</td>
<td>15 wells, 1 cistern</td>
<td>VOC, SVOC, PFAS, pH, ions, heavy metals</td>
<td>GC/MS, ICP-OES, IC</td>
</tr>
<tr>
<td>Surface wipes</td>
<td>Exterior of 4 buildings in East Palestine within 1.5 miles of the derailment site</td>
<td>VOC, SVOC</td>
<td>GC/MS</td>
</tr>
<tr>
<td>Air</td>
<td>Sulphur Run, Leslie Run</td>
<td>PID signal</td>
<td>PID</td>
</tr>
<tr>
<td><strong>Commercial products</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honey</td>
<td>4 apiaries in Columbiana Co., OH and Beaver County, PA</td>
<td>VOC</td>
<td>GC/MS</td>
</tr>
<tr>
<td>Silicone items</td>
<td>Products from a business located directly above Sulphur Run in East Palestine</td>
<td>VOC, SVOC</td>
<td>GC/MS</td>
</tr>
</tbody>
</table>
Creek samples were collected Feb. 26 and 27, 2023

**C3-sheen**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Purdue (ppb)</th>
<th>Ohio EPA (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butyl acrylate</td>
<td>10.16</td>
<td>136</td>
</tr>
<tr>
<td>2-Butoxyethanol</td>
<td>4,455</td>
<td>5,540</td>
</tr>
<tr>
<td>2-Ethylhexanol</td>
<td>41.09</td>
<td>38.6</td>
</tr>
<tr>
<td>2-Ethylhexylacrylate</td>
<td>7.86</td>
<td>89.7</td>
</tr>
</tbody>
</table>

**C2-sheen**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Purdue (ppb)</th>
<th>Ohio EPA (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butyl acrylate</td>
<td>0</td>
<td>20.2</td>
</tr>
<tr>
<td>2-Butoxyethanol</td>
<td>5,215</td>
<td>2,270</td>
</tr>
<tr>
<td>2-Ethylhexanol</td>
<td>13.7</td>
<td>36.1</td>
</tr>
<tr>
<td>2-Ethylhexylacrylate</td>
<td>60.0</td>
<td>19.6</td>
</tr>
</tbody>
</table>

**C1-sheen**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Purdue (ppb)</th>
<th>Ohio EPA (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butyl acrylate</td>
<td>3.72</td>
<td>1.3</td>
</tr>
<tr>
<td>2-Butoxyethanol</td>
<td>10,460</td>
<td>150</td>
</tr>
<tr>
<td>2-Ethylhexanol</td>
<td>177.0</td>
<td>310</td>
</tr>
<tr>
<td>2-Ethylhexylacrylate</td>
<td>70.2</td>
<td>23.3</td>
</tr>
</tbody>
</table>

All TPH < 1 ppm
Sheen composition unclear

**Legend**
- **Spill site**
- **Sulphur Run**
- Sample locations
- **Leslie Run**

<table>
<thead>
<tr>
<th>Compound</th>
<th>C4-sheen</th>
<th>C5-sheen</th>
<th>C6-sheen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butyl acrylate</td>
<td>23.9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2-Butoxyethanol</td>
<td>520.8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2-Ethylhexanol</td>
<td>198.3</td>
<td>27.5</td>
<td>&lt;LOQ</td>
</tr>
<tr>
<td>2-Ethylhexylacrylate</td>
<td>467.6</td>
<td>27.5</td>
<td>41.0</td>
</tr>
</tbody>
</table>
A variety of different workers (i.e., CDC employees, US Sen. Vance Office, PA Sen. Mastriano, USEPA contractor, RR workers, East Palestine municipal employees) as well as residents reported health impacts.
Some preliminary results: 4 months after the incident

1. **Atmospheric modeling**: Chemical air contamination from the crash and burn extended outside the evacuation and shelter-in-place zones which supports odor reports from Negley and elsewhere.

2. **Creek water**: Early on, waterway contamination was likely heterogeneous. Levels changed with time partly due to weather events and cleanup actions.

3. **Chemical biodegradability in creeks**: Predictions indicate negligible biodegradation.

4. **Aeration of creeks**: One human exposure pathway outside and inside buildings.

5. **Building indoor air**: Contaminated for 4.5 months. Butyl acrylate, 2-EHA, and more.

6. **Private drinking water wells**: Not found to be contaminated by the disaster despite reports by some nonresidents that they had been.

7. **Honey from nearby apiaries (< 1.5 miles)**: Not contaminated with butyl acrylate, 2-EHA, and 2-EHL during our investigation.
A better understanding of chemical fate and exposures can be achieved by organizations finalizing and sharing their results

Texas A&M University  Lawyers and their consultants
Carnegie Mellon University  Homeowners
West Virginia University  Business owners
Wayne State University  Consultants who volunteered
Youngstown State University  Others
Purdue University
University of Notre Dame
Ohio State University
University of Kentucky
Duquesne University

Q:
- What was the study goal?
- What and where were samples collected?
- How were they analyzed?
- What were the detection limits?
- How frequent were samples collected?
- What are the findings and recommendations?
The Next Chemical Disaster:
Research and Policy Needs To Better Protect Public Health and Inform Post-Disaster Health Studies

1. Formal check-down approach to identify the chemical exposure pathways
2. Chemical modeling to predict exposures when creeks are aerated
3. Checklist of pros/cons of equipment and analytical methods
4. Guidance on analytical screening for “unknowns” in water/air/soil and on surfaces
5. Train decision makers about monitoring equipment limitations and PPE
6. Setup mechanisms to rapidly engage academic institutions for advanced analytical capabilities and decision-making which commercial laboratories and government labs often do not have
Chemical Fate and Exposure Pathways from the 2023 Chemical Spill and Chemical Fires in East Palestine, Ohio

November 6, 2023

Andrew Whelton, Ph.D.
Professor of Civil, Environmental, and Ecological Engineering
Director for the Center for Plumbing Safety
awhelton@purdue.edu

Funded by: