RISKS TO PUBLIC HEALTH FROM CHEMICALS FOUND IN BROCK INFILL AND IN SOIL AT PLAYING FIELDS

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RISKS TO PUBLIC HEALTH FROM PLAYING FIELDS

- All sports-fields contain various chemicals, including traces of various metals, and, potentially, perfluorinated alkyl substances (PFAS).

- This is true of both synthetic turf-fields and of ordinary grass & soil fields.

- Are the chemicals in synthetic turf fields, and/or in grass & soil fields, present at unhealthful concentrations?

- Let’s look first at PFAS … in soil and Brock infill
**How much PFAS is in uncontaminated soil?**

- Wenyu Zhu *et al.* (2019) evaluated uncontaminated soils in Vermont

- Shallow soil samples obtained from 66 sites
  - State forests, parks, school-yards, and other green areas

- Wide range of various PFAS detected

- Let’s look at their results ...
<table>
<thead>
<tr>
<th>PFAS</th>
<th>10th percentile</th>
<th>95th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFPeA</td>
<td>less than 70 ng/kg</td>
<td>360 ng/kg</td>
</tr>
<tr>
<td>PFHxA</td>
<td>less than 7.6 ng/kg</td>
<td>920 ng/kg</td>
</tr>
<tr>
<td>PFHpA</td>
<td>less than 4.4 ng/kg</td>
<td>650 ng/kg</td>
</tr>
<tr>
<td>PFOA</td>
<td>59 ng/kg</td>
<td>1,000 ng/kg</td>
</tr>
<tr>
<td>PFNA</td>
<td>62 ng/kg</td>
<td>390 ng/kg</td>
</tr>
<tr>
<td>PFDA</td>
<td>40 ng/kg</td>
<td>390 ng/kg</td>
</tr>
<tr>
<td>PFUdA</td>
<td>35 ng/kg</td>
<td>180 ng/kg</td>
</tr>
<tr>
<td>PFBS</td>
<td>less than 6 ng/kg</td>
<td>500 ng/kg</td>
</tr>
<tr>
<td>PFBS</td>
<td>less than 14 ng/kg</td>
<td>380 ng/kg</td>
</tr>
<tr>
<td>PFOS</td>
<td>310 ng/kg</td>
<td>3,000 ng/kg</td>
</tr>
<tr>
<td>PFDS</td>
<td>less than 5.3 ng/kg</td>
<td>170 ng/kg</td>
</tr>
</tbody>
</table>
How much PFAS is in Brockfill?

- One “non-regulated” PFAS (perfluoropentanoic acid, PFPeA) detected in the infill (J-qualified, estimated value)

- Two other PFAS (but not PFPeA) detected in “synthetic leachate” generated from infill (tests of leachate were more sensitive than tests of infill)

- These results suggest that infill contains about:
  - 455 ng/kg of perfluoropentanoic acid (PFPeA)
  - 58 ng/kg of perfluorohexanoic acid (PFHxA)
  - 100 ng/kg of perfluoroheptanoic acid (PFHpA)

- Recall that uncontaminated soil (per Zhu et al., 2019) contains up to (at the 95th percentile):
  - 360 ng/kg of PFPeA
  - 920 ng/kg of PFHxA
  - 650 ng/kg of PFHpA
  - Many other PFAS, at concentrations up to 3,000 ng/kg
Are PFAS in soil, or in infill, harmful to health?

- Per MA DEP, acceptable daily intake of regulated PFAS (from all sources, including food, drinking water, and incidental ingestion of dust and soil) = 5 nanograms PFAS per kilogram body weight per day (5 ng/kg-day)

- How much incidental ingestion of soil and/or infill would an athlete receive playing on a sports field?

  - And would such ingestion be unhealthful?

- Here’s how we addressed this question ...
EXPOSURE-SCENARIOS CONSIDERED

❖ Consider an athletic girl, aged 5 - 18

❖ Make conservative assumptions:
  ❖ Plays daily on sports fields, 9 months per year
  ❖ Incidentally ingests 100 mg/day of either infill or soil
  ❖ Absorbs 100% of ingested PFAS, and 50% of ingested metals
  ❖ Acceptable daily intake-values derived by applying ample margins of safety (MA DEP "reference dose")

❖ Assume parallel exposures for
  ❖ Synthetic field with Brockfill infill
  ❖ Natural grass field with ordinary soil
Daily doses of PFAS from incidental ingestion of infill and of soil (based on Zhu et al., 2019), compared with acceptable daily intake of PFAS

<table>
<thead>
<tr>
<th>PFAS</th>
<th>Dose from Brockfill (picograms/kg-day)</th>
<th>Dose from Soil (picograms/kg-day)</th>
<th>Acceptable Daily Intake (picograms/kg-day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFPeA</td>
<td>0.83</td>
<td>&lt;0.13 – 0.7</td>
<td>Assume &gt; 5,000</td>
</tr>
<tr>
<td>PFHxA</td>
<td>0.11</td>
<td>&lt;0.01 - 1.7</td>
<td>5,000</td>
</tr>
<tr>
<td>PFHpA</td>
<td>0.18</td>
<td>&lt;0.01 - 1.2</td>
<td>5,000</td>
</tr>
<tr>
<td>Five additional, MA DEP-regulated, PFAS</td>
<td>&lt;0.01</td>
<td>&lt;0.03 – 5.5</td>
<td>5,000</td>
</tr>
</tbody>
</table>
OTHER POTENTIALLY TOXIC CHEMICALS
IN SOIL AND IN BROCKFILL

❖ Various metals, present naturally and/or because of contamination

❖ Three potentially important metals, toxicologically:
  ❖ Arsenic & Cadmium
    ❖ Poses risk of cancer
  ❖ Lead
    ❖ Poses risk of harm to developing brains
## Concentrations of two metals in infill and in soil, from Oak Bluffs Elementary School and MVRHS

<table>
<thead>
<tr>
<th>Metal</th>
<th>Brockfill (mg/kg)</th>
<th>Elementary school soil (mg/kg)</th>
<th>MVRHS soil (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>None detected (&lt;0.079)</td>
<td>1.6</td>
<td>1.9</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.042</td>
<td>None detected (&lt; 0.1)</td>
<td>None detected (&lt; 0.1)</td>
</tr>
<tr>
<td>Lead</td>
<td>None detected (&lt;0.102)</td>
<td>24.2</td>
<td>16.2</td>
</tr>
</tbody>
</table>
Daily doses of three metals from incidental ingestion of infill and of soil, compared with acceptable daily intakes

<table>
<thead>
<tr>
<th>Metal</th>
<th>Dose from Brockfill (ng/kg-day)</th>
<th>Dose from Soil (ng/kg-day)</th>
<th>Acceptable Daily Intake (ng/kg-day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>&lt;0.07</td>
<td>2.0</td>
<td>300</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.04</td>
<td>&lt;0.4</td>
<td>500</td>
</tr>
<tr>
<td>Lead</td>
<td>&lt;0.09</td>
<td>97</td>
<td>750</td>
</tr>
</tbody>
</table>
**OTHER FIELD COMPONENTS:**

GREENFIELD SYNTHETIC TURF, SHOCK PAD, GLUES

- Trace, estimated amounts of a few PFAS detected in these other components, all at concentrations smaller than the trace concentrations of PFAS detected in the Brock infill and/or Brockfill “leachate”

- Potentially toxic metals detected either at trace, estimated concentrations or not at all

- No adverse impact expected on either the environment or the public health
WOULD TESTS FOR TOTAL ORGANIC FLUORINE (TOF) BE INFORMATIVE?

- No.

- Soil would be expected to contain much more organic fluorine than Brockfill or other synthetic field-components.

- Soil can contain bacteria, *Streptomyces cattleya*, that naturally biosynthesize various organofluorine chemicals.

- Several plant-species biosynthesize organofluorine chemicals.

- Countless, non-PFAS, organofluorine compounds will have deposited onto soils from ambient air.

- The best way to find PFAS is to analyze for PFAS.
Would tests for total oxidizable precursors to PFAS (top) be informative?

- No.

- This test is appropriate only for materials that are
  - known to contain organofluorine chemicals that
  - might, *under strongly oxidizing conditions*, degrade into one or more PFAS of toxicologic significance.

- Neither Brockfill nor other synthetic field-components are such materials;

- and nothing about a sports field, whether synthetic or natural, represents strong oxidizing conditions.
ARE MICROPLASTICS AT ISSUE HERE?

- No.

- Brockfill consists only of wood granules.

- Small amounts of microplastic may form, however, from wear-and-tear of synthetic grass surface.

- This “secondary” microplastic would be negligible compared with microplastics ubiquitous in fresh water, seawater, drinking water, food, ambient air, and soil.

- No reliable evidence that exposures to microplastics harm health (see, for example, WHO, 2019, *Microplastics in Drinking Water*).