Initial Field Deployment Results of Green PCB Removal from Sediment Systems (GPRSS)

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Purpose of Study

- Develop/optimize technology capable of removing PCBs from contaminated sediments
- Develop design for functional GPRSS unit
- Produce and prove functionality of prototype units in a laboratory setting
- Produce fully-functional GPRSS units for testing at a demonstration site in Altavista, VA
- Evaluate efficacy of GPRSS technology for the remediation of PCB-contaminated sediments

Overview of Previous Results

- Various polymers tested for ability to remove PCBs from contaminated sediments (Table 1)
  
<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Diffusion Rate (ug/in²/week)</th>
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<tbody>
<tr>
<td>LDPE</td>
<td>12.48</td>
</tr>
<tr>
<td>LDPE</td>
<td>13.42</td>
</tr>
<tr>
<td>PP</td>
<td>4.20</td>
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</tbody>
</table>

- Butyl Rubber, Norprene, Gum Rubber/Foam showed highest removal capacities
- Interior solvent studies showed marked increase in PCB removal capacity when combined with polymers (Table 2)
- Polymer blanket designed for feasibility studies
- Small-scale demonstration unit produced for testing and physical optimization studies (Figure 1)

Current Research Results (FY13/FY14)

- Current work focused on optimizing GPRSS technology for use in real-world applications.
  - Creation of functional design; production of prototype test units using results from previous studies
  - Commercial vendor produced “spikes” of different polymers (LDPE, HDPE, PP) to allow for testing and evaluation. Figure 2 shows an HDPE spike
  - Testing was performed to determine the “sphere of influence” each individual spike would have. The original prototypes had a 2” spacing between spikes
  - The results of this study (Table 4) showed that a 3” spacing would suffice
  - Concurrent testing of the mass-produced spikes was conducted to determine the transport rate of the PCBs through the various polymers
    - Results (Table 5) showed that LDPE had the highest transport capability for PCBs, however physical characteristics of the polymer proved to be unsuitable for real-world use
    - HDPE spikes had nearly as high a diffusion rate as LDPE, and were rigid enough for insertion into sediments

- Field deployment was undertaken in a contaminated pond in Altavista, VA in September 2013
  - Two 9ft² treatment zones were cordoned off; pre-treatment concentrations were obtained
  - Each treatment zone was divided into 9 zones which were treated with an individual GPRSS unit. Pre- and post-concentration samples were taken from the locations marked in Figure 3
  - All samples were split for analysis both at KSC and by an independent certified 3rd party laboratory.
  - First samples were taken in early February (~19 weeks), and the ethanol was replaced and the blankets were re-installed for a second treatment. The results of the 3rd party testing are given in Table 6/7. KSC analysis showed even higher removal rates.

Summary

- Developed and optimized design for GPRSS technology
- Laboratory-scale tests proved functionality of GPRSS design
- Final down-select of polymers were chosen based upon laboratory results
- Produced multiple units for field demonstration at Altavista, VA
- Preliminary results (certified 3rd party lab) show that 70% of sites sampled have been reduced to below EPA action limits for PCBs

Future Directions

- Analyze 2nd sample set (~32 weeks) from Altavista, VA field demonstration
- Analyze GPRSS blankets from Altavista, VA field demonstration to attempt mass-balance of PCBs
- Evaluate re-usability of both blanket and interior solvent
  - Test effectiveness of removal capability of PCBs over multiple removal cycles
  - Test extraction efficiency from polymer blanket
- Evaluate capability of combining polymer blanket with AMTS technology for degradation of PCBs removed/extracted from contaminated sediments