PUSHING THE SCIENCE & INDUSTRY OF REMEDIATION FORWARD
Why are Granular Activated Carbon Products Different?

**Raw material dictates all of the product possibilities**

- Ash impurities inherited
- Density and hardness are linked
- Transport pore structure and adsorption kinetics
- Single unique family of products from a raw material source

Coconut ≠ Bituminous Coal ≠ Lignite ≠ Wood
Virgin vs. Reactivated Carbon

Virgin Carbons
- Newly manufactured from raw materials such as coal

Reactivated Carbons
- Two market segments: Drinking water (DW) and Wastewater (WW)
- DW carbons are closely managed
  - Resold to original customer
  - Supplemented with virgin
- Housekeeping on WW carbons very poor
  - Potential for heavy metals to persist after reactivation
- Should never be used for in situ remediation
Activated Carbon Rollover

- Without a treatment mechanism, you risk desorbing one contaminant for another ("rollover")
- Total organic carbon may also play a role

<table>
<thead>
<tr>
<th></th>
<th>Initial Spike</th>
<th>Equilibrium Conc.</th>
<th>2\textsuperscript{nd} Spike</th>
<th>1 hr</th>
<th>24 hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vial 1</td>
<td>2,000 ppm Xylene (X)</td>
<td>1.42 ppm X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vial 2</td>
<td>100 ppm Vinyl Chloride (VC)</td>
<td>2.42 ppm VC</td>
<td>2,000 ppm X</td>
<td>16.29 ppm VC</td>
<td>10.40 ppm X</td>
</tr>
</tbody>
</table>
Activated Carbon

- Relative adsorption strength increases with molecule complexity
  - Multi-cyclic > Mono-cyclic > Aliphatic
  - Double bond > Single Bond
  - Chlorinated > Non-Chlorinated

<table>
<thead>
<tr>
<th>Benzene (ppm)</th>
<th>Capacity (mg/gm)</th>
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<tbody>
<tr>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0.1</td>
<td>0.03</td>
</tr>
<tr>
<td>0.01</td>
<td>0.0007</td>
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</table>

<table>
<thead>
<tr>
<th>Ethylbenzene (ppm)</th>
<th>Capacity (mg/gm)</th>
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<tbody>
<tr>
<td>10</td>
<td>325</td>
</tr>
<tr>
<td>1</td>
<td>53</td>
</tr>
<tr>
<td>0.1</td>
<td>8.5</td>
</tr>
<tr>
<td>0.01</td>
<td>1.4</td>
</tr>
</tbody>
</table>
Analysis Showed

- **RPI Activated Carbon** - 58 wt% Diesel
  - Each gram contained – 0.61 gms carbon and 0.35 gms Diesel

- **Wood Based Carbon** – 29 wt% Diesel
  - Each gram contained 0.7 gms carbon and 0.2 gms Diesel
The **CARBON** cleans the GW
the **BUGS**
**CLEAN** the Carbon
Industry Said: the **BUGS** Are Too Big
y = -0.8471x + 179.67
R² = 0.9931

Fig 5

Mass Diesel Fuel Remaining (mg)
(Activated Carbon + RPI Culture)
So... How Does it Stack Up

• Remember NSZD Mass Removal Rate – 2 gms-PSH/m²-day
  • This becomes 730 gms-PSH/m²-yr

• Mass Removal Rate Estimated from Large Condensate Site
  • 5,065 gms-PSH/m²-yr  Roughly 7 times higher than NSZD
BOS 200 LNAPL Applications

• Previous Site As of June 2018: Out of 20 wells, 3 have measurable NAPL, 5 have benzene below MCL, 8 suggest submerged NAPL

• RPI Group has treated roughly 40 LNAPL sites including Crude Oil, Gasoline, Diesel, Mineral Spirits, Condensate, and paint thinners. About 60% are closed.

• Major Site in Denmark: Baseline - 1 to 5 feet of Petrol in monitor wells, Roughly 5 Years from Pilot, this site just received an NFA.
CAT100 – It’s a conductor – So what?
Injections are Surgical
Thank You for Attending

Questions?

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Observed Carbon Types

- Suspect Carbon
- Specks
- Spots
- Smears
- Even Distribution
- Heavy Distribution
- Vertical Seams
- Horizontal Seams
All Carbon Observation Wells