Hazardous Wastes
Announcements

- Review session Tuesday, February 10 at 7 pm in 1104 Gilman – come with questions!
- First exam Friday, February 13th in class
- Field trip on Wednesday at the Boone County Landfill (optional since using personal vehicles) – sign up if need or can offer a ride
**hydraulic conductivity**

\[ v = k \frac{dH}{dL} \quad Q = k \frac{dH}{dL} A \]

- 0.7 Mgal/yr

- 20 cm

- L \[ \text{clay liner} \]

How much leachate will migrate through a 2' clay liner each year if clay has a permeability of \(1.5 \times 10^{-7} \text{ cm/s}\) over 100 acre site. Leachate is 20 cm above liner.

\[ H = \frac{2 \times 30.48}{2(30.48)} \]

\[ v = 1.5 \times 10^{-2} \text{ cm/s} \left( \frac{2.70.48 + 20}{2 \times 30.48} \right) = 2 \times 10^{-7} \text{ cm/s} = 2 \times 10^{-9} \text{ m/s} \]

\[ Q = VA = 2 \times 10^9 \text{ m/s} \times 100 \text{ acre} \times \frac{4047 \text{ m}^2}{\text{acre}} \times \frac{60 \text{ sec}}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}} \times \frac{24 \text{ hr}}{\text{day}} \times \frac{365 \text{ day}}{\text{yr}} \]

\[ k = 264.2 \text{ scf/ft}^3 = 6.7 \text{ Mgal/yr} \]
Hazardous Wastes

- Scope of the Hazardous Waste Problem: 250,000 tons per year in U.S. (300-500 world-wide)
- Hazardous Wastes Generators: 20,000
- Treatment Storage and Disposal Facilities (TSDF): 3000
- 93% of hazardous wastes managed by: 60 TSDF’s
• Chemical Products Industry ($125b annually) contributes 50% of hazardous wastes
• Number of Chemicals – 70,000
• New Chemicals Manufactured every year: 1500
• Abandoned Hazardous Wastes Sites: 50,000
Superfund

- In 1980 Congress passed the **C**omprehensive **E**nvironmental **R**esponse **C**ompensation **L**iability and **A**ct

CERCLA - Superfund
Superfund

- $1.6b from taxes on crude oil & commercial chemicals
- every state had to compile a list of hazardous waste sites and submit it to EPA
  - National Priorities List (NPL)
Superfund

- EPA prioritized these sites based on the potential hazard from groundwater ($S_{GW}$), surface water ($S_{SW}$), and air exposure ($S_A$):

$$S_M = \frac{1}{1.73} \sqrt{S_{GW}^2 + S_{SW}^2 + S_A^2}$$

where $S_M$ is the composite score.
Superfund

- There are 1300 sites on the list
- Only ~200 sites have been cleaned up
- There are 3 unique things about Superfund
  - *ex post facto*
    - party can be liable for actions that were previously legal
  - potentially responsible party
  - innocent landowner liability
    - anyone who buys property contaminated with hazardous wastes can be liable
    - only way to avoid liability is to make “a___ a_____ inquiry” prior to purchase
Superfund

- **joint and several liability**
  - liability can be shared between parties or any one party may be liable for entire cleanup
  - “deep pockets”
    - EPA only needs to sue one party
    - that party must sue other parties to recoup cleanup costs
Figure 7: Superfund Remedial Actions: Source Control Treatment Projects (FY 1982 - 2002)*

Ex Situ Technologies (499) 58%
- Physical Separation (20) 2%
- Incineration (on-site) (43) 5%
- Bioremediation (54) 6%
- Thermal Desorption (69) 8%
- Chemical Treatment (10) 1%
- Incineration (off-site) (104) 12%
- Solidification/Stabilization (157) 18%
- Other (ex situ) (42) 5%

In Situ Technologies (364) 42%
- Soil Vapor Extraction (213) 25%
- Bioremediation (48) 6%
- Solidification/Stabilization (48) 6%
- Flushing (16) 2%
- Chemical Treatment (12) 1%
- Other (in situ) (27) 3%

Other (in situ) (27)
- In Situ Thermal Treatment (8)
- Multi-Phase Extraction (8)
- Neutralization (4)
- Phytoremediation (4)
- Vitrification (2)
- Electrical Separation (1)
**dioxin**

- dibenzo-\(\rho\)-dioxin
- over twenty different isomers
- byproduct of herbicide/pesticide manufacture
- created during incineration of hazardous wastes and/or plastics
- contaminant in 2,4-D, agent of range and others
- carcinogenic, teratogenic, mutagenic, embryo-toxic in animal studies
- bioaccumulates in fatty tissue
- no known link to human exposure
polychlorinated biphenyl (PCB)

- over 200 isomers
- different chlorine composition (Araclor 1248)
- virtually indestructible - useful as transformer fluid (in every transformer: 1930 - 1970)
- toxic effects to exposed workers noted in 1937
- environmental contamination realized in 1969
- 1.46 pounds produced prior to 1977
- led to Toxic Substance Control Act of 1976
What makes a waste hazardous?

- Potentially dangerous to human health or the environment
- Causes adverse physiological effects
- Official EPA definition
  - On EPA list (it must be discarded to be classified as a waste) or
  - Exhibits certain characteristics

Hazardous Waste Accumulation Area

Hazardous Waste in this area will be picked up on a regular basis.

Don't forget Special wastes: Batteries, aerosols, e-waste, sharps, lamps, ballasts, mercury thermometers. Visit our web site for more details: www.safety.uwm.edu

Label container completely with the full name of the chemical (no abbreviations, symbols, or structures).

Contents

If your container is full before your scheduled pick up, call x4999 or 2883. Please give your name, building, room#, how many containers you need and a brief description of the waste.

Causes adverse physiological effects

Official EPA definition

On EPA list (it must be discarded to be classified as a waste) or

Exhibits certain characteristics

listed waste

characteristic
Listed Wastes (Appendix C)

- **F Wastes**
  - from non-specific sources
    - e.g. chlorinated solvents
      - Trichloroethylene
      - Methylene chloride

- **K Wastes**
  - from specific sources
    - e.g. wood preserving wastes (contain creosote and possibly arsenic)
Listed Wastes (Appendix C)

- **P Wastes**
  - off spec products and intermediates
  - acutely toxic
    - e.g. toxaphene

- **U Wastes**
  - off spec products and intermediates
    - generally toxic
    - DDT
DDT

- Organochlorine
The Panama Canal (1905-1910)

- The construction of the Panama Canal was possible only after yellow fever and malaria were controlled.
  - These diseases were a major cause of death and disease among workers.
- In 1906, there were over 26,000 employees working on the Canal.
  - 21,000 were hospitalized for malaria during their work.
  - By 1912, there were over 50,000 employees, and the number hospitalized decreased to 5,600.
  - They used an integrated program of insect and malaria control.
Biomagnification
Characteristic Wastes

- Ignitibility
  - Liquid with < 24% alcohol
  - Has a flash point < 60°C
  - Capable of spontaneous combustion
  - Ignitable compressed gas
  - Oxidizer
Characteristic Wastes

- Corrosivity
  - Aqueous pH $\leq 2$ or $\geq 12.5$
  - Corrodes steel at a rate of 6.35 mm/y at 55°C
Characteristic Wastes

- Reactivity
  - Normally unstable
  - Reacts violently with water
  - Forms explosive mixtures with water
  - Generates toxic vapors
  - Cyanide or sulfur containing waste
Characteristic Wastes

- Toxicity (EP Toxicity test)
  - Liquid extract from acid extraction has to meet the required standard
  - e.g.:
    - $\leq 5.0$ mg/L arsenic
    - $\leq 0.5$ mg/L benzene
    - $\leq 0.20$ mg/L vinyl chloride
## EP Toxicity

<table>
<thead>
<tr>
<th>EPA HW No.</th>
<th>Constituent</th>
<th>Regulatory level (mg/L)</th>
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<tbody>
<tr>
<td>D004</td>
<td>Arsenic</td>
<td>5.0</td>
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<tr>
<td>D005</td>
<td>Barium</td>
<td>100.0</td>
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<tr>
<td>D018</td>
<td>Benzene</td>
<td>0.5</td>
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<tr>
<td>D006</td>
<td>Cadmium</td>
<td>1.0</td>
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<tr>
<td>D019</td>
<td>Carbon tetrachloride</td>
<td>0.5</td>
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<tr>
<td>D020</td>
<td>Chlordane</td>
<td>0.03</td>
</tr>
<tr>
<td>D021</td>
<td>Chlorobenzene</td>
<td>100.0</td>
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<tr>
<td>D022</td>
<td>Chloroform</td>
<td>6.0</td>
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<tr>
<td>D007</td>
<td>Chromium</td>
<td>5.0</td>
</tr>
<tr>
<td>D023</td>
<td>o-Cresol</td>
<td>2000.0&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>D024</td>
<td>m-Cresol</td>
<td>200.0&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>D025</td>
<td>p-Cresol</td>
<td>200.0&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>D026</td>
<td>Cresol</td>
<td>200.0&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>D016</td>
<td>2,4-D</td>
<td>10.0</td>
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<td>D027</td>
<td>1,4-Dichlorobenzene</td>
<td>7.5</td>
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<tr>
<td>D028</td>
<td>1,2-Dichloroethane</td>
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<tr>
<td>D029</td>
<td>1,1-Dichloroethylene</td>
<td>0.7</td>
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<tr>
<td>D030</td>
<td>2,4-Dinitrotoluene</td>
<td>0.13&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>D012</td>
<td>Endrin</td>
<td>0.02</td>
</tr>
<tr>
<td>D031</td>
<td>Heptachlor (and its epoxide)</td>
<td>0.008</td>
</tr>
<tr>
<td>D032</td>
<td>Decachlorobenzene</td>
<td>0.13&lt;sup&gt;c&lt;/sup&gt;</td>
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<td>D033</td>
<td>Hexachloro-1,3-butadiene</td>
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<tr>
<td>D034</td>
<td>Hexachloroethane</td>
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<td>Lead</td>
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<td>D013</td>
<td>Lindane</td>
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<td>D009</td>
<td>Mercury</td>
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<tr>
<td>D014</td>
<td>Methoxychlor</td>
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<td>D035</td>
<td>Methyl ethyl ketone</td>
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<tr>
<td>D036</td>
<td>Nitrobenzene</td>
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<td>D037</td>
<td>Pentachlorophenol</td>
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<td>D038</td>
<td>Pyridine</td>
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<td>D010</td>
<td>Selenium</td>
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</tr>
<tr>
<td>D011</td>
<td>Silver</td>
<td>5.0</td>
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<tr>
<td>D039</td>
<td>Tetrachloroethylene</td>
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<tr>
<td>D015</td>
<td>Toxaphene</td>
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<td>D040</td>
<td>Trichloroethylene</td>
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<td>D041</td>
<td>2,4,5-Trichlorophenol</td>
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<td>D042</td>
<td>2,4,6-Trichlorophenol</td>
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<td>D017</td>
<td>2,4,5-TP (Silvex)</td>
<td>1.0</td>
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<tr>
<td>D043</td>
<td>Vinyl chloride</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Cradle to Grave

- RCRA requires a manifest system to track hazardous wastes from its source of generation to ultimate disposal
- Generator required to maintain records and assume responsibility for the waste along the way
### EPA Uniform Hazardous Waste Manifest

#### Form Details
- **Form Name:** EPA Uniform Hazardous Waste Manifest
- **Page:** 1
- **Image Resolution:** 36x36 to 576x756

#### Table Structure
<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
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<tbody>
<tr>
<td>Generator's Name and Mailing Address</td>
<td>Manifest Document No.</td>
</tr>
<tr>
<td>2. Page of Information in the shaded area is not required by Federal law.</td>
<td>A. State Manifest Document Number</td>
</tr>
<tr>
<td>3. Generator's Name and Mailing Address</td>
<td>4. Generator's Phone ( )</td>
</tr>
<tr>
<td>5. Transporter 1 Company Name</td>
<td>6. US EPA ID Number</td>
</tr>
<tr>
<td>7. Transporter 2 Company Name</td>
<td>8. Transporter's Phone</td>
</tr>
<tr>
<td>9. Designated Facility Name and Site Address</td>
<td>10. Transporter's Phone</td>
</tr>
</tbody>
</table>

#### Instructions
- Please print or type.
- (Form designed for use on elite (12-pitch) typewriter.)

#### Notes
- EPA Form 5300-22 (Rev. 4/85) Previous editions are obsolete.
Hazardous Waste Landfill

Filter layer

Solid waste

Compacted clay liner

Drain pipes

Native soil foundation

(b) Liner
(not to scale)