Lesson 19: Solid Waste

Solid Wastes

June 6, 2006

Chuck Treser
University of Washington
Dept. of Environmental and Occupational Health Sciences

Lesson Overview

- Solid Waste Disposal
  - Generation & Storage
  - Collection & Transport
  - Disposal Options
    - Landfills
    - Incineration
- Alternatives to Waste Disposal
  - Reduction
  - Reuse / Recycling
- Hazardous Wastes

RCRA Definition
(Resource Conservation and Recovery Act)

ALL MATERIALS

- DISCARDED
- SERVED ITS INTENDED PURPOSE
- BY-PRODUCT OF MINING OR MANUFACTURING
- SOLID, SEMI-SOLID, LIQUID OR CONTAINED GASEOUS MATERIAL
- EXCLUDED UNDER §261 AS:
  - SEWAGE
  - CWA POINT DISCHARGE
  - IRRIGATION RETURN
  - NUCLEAR WASTE
  - IN SITU MINING WASTE

MATERIAL IS A RCRA SOLID WASTE IRRESPECTIVE OF WHETHER IT IS:
- DISCARDED
- USED
- REUSED
- RECYCLED
- RECLAIMED
- STORED OR ACCUMULATED FOR ANY OF THE ABOVE PURPOSES

GARBAGE, REFUSE or SLUDGE OTHER MATERIAL IS NOT A SOLID WASTE UNDER RCRA
Garbage

Municipal Solid Waste (MSW)

MSW Generation 1960 - 2003

MSW Generation by Type

Source: U.S. E.P.A, 2005
Sources of MSW, U.S.
2003

- Containers and Packaging 31.7%
- Yard trimmings 12.1%
- Other Waste 5.0%
- Nonrecyclable Debris 28.2%
- Food waste 11.7%

Source: U.S. EPA, 2005

Storage

- Residential
- Commercial
- Compaction

Residential Storage
Transfer Stations (Continued)

Disposal

Disposal Options:
- Sanitary Landfill
- Incineration
- Other
  - Composting
  - Ocean Dumping

MSW Management, 2003

Source: U.S. E.P.A, 2005
Disposal Options (Continued)

National Average Tipping Fees in the U.S.


Disposal Options (Continued)

TRENDS IN WASTE GENERATION, RECOVERY & DISPOSAL


Sanitary Landfills

Cedar Hills Landfill
Issaquah, Washington
Sanitary Landfills (Continued)

When landfill is full, layers of soil and clay seal in trash.

- Methane storage and compressor building
- Leachate treatment system
- Electricity generator building
- Leachate storage tanks
- Leachate monitoring well
- Groundwater monitoring well
- Leachate pumped up to storage tanks for safe disposal
- Clay and plastic lining to prevent leaks; pipes collect leachate from bottom of landfill

Sanitary Landfills (Continued)
Sanitary Landfills (Continued)

[Image of a sanitary landfill site with machinery and a landscape in the background]

Sanitary Landfills (Continued)

[Image of a sanitary landfill site with machinery and a landscape in the background]

Sanitary Landfills (Continued)

[Image of a sanitary landfill site with machinery and a landscape in the background]
Sanitary Landfills (Continued)

Number of Landfills

Source: U.S. E.P.A. 2005
Sanitary Landfills (Continued)

YEARS OF REMAINING LANDFILL CAPACITY


Sanitary Landfills (Continued)

LAND DISPOSAL OF MUNICIPAL WASTE BY MAJOR COUNTRIES


Former Landfill Turned Park
Cambridge, MA

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Incineration

Incineration (Continued)

Combustion of Municipal Waste by Major Countries

Regulation of MSW

- Resource Conservation & Recovery Act (RCRA)
  - Increasingly stringent requirements for MSW
  - Essentially equivalent to Hazardous Waste TSD
  - Subtitle C: Hazardous Wastes

Questions

Lesson 19. Solid & Haz. Waste

Alternative Technologies

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University of Washington
Dept. of Environmental and Occupational Health Sciences
What can be done?

Alternatives

- Waste reduction
- Reuse
- Recycling

Disposal Priorities
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Waste Reduction
- Use less
- Just in Time Inventory
- Reduced Packaging
- Household Hazardous Waste Collection

Waste Reuse
- Reuse of an item for the same purpose
  - Bottle Recycling
  - Shopping Bags
  - Repair consumer goods

Waste Recycling
- Reuse or conversion of an item for a different purpose
  - Recycled products
  - Composting
  - Energy recovery
**Recycled Wastes**

MATERIALS RECYCLED IN 1995

- Paper & Paperboard: 32.0 million tons (16.0%)
- Compost: 4.3 million tons (2.2%)
- Metal: 4.2 million tons (2.2%)
- Glass: 3.5 million tons (1.5%)
- Plastics: 3.3 million tons (1.5%)
- All other: 2.7 million tons (1.4%)

Total Recycling: 56.2 million tons

Source: Characterization of MSW Report, Franklin Assn, 1998

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**Recycling Rates**

WASTE RECYCLING RATES - 1960 TO 2000

- 1960: 6.3% recycling rate
- 1980: 14.4 million tons recycled
- 1995: 32.9 million tons recycled
- 2000: 56.2 million tons recycled


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**An Unfinished Agenda**

PRODUCTS DISCARDED IN MSW, 1995 (after recycling)

- Containers & Packaging: 29.7% (45.1 million tons)
- Non-durables: 28.7% (45.5 million tons)
- Durables: 17.1% (25.9 million tons)
- Yard Waste: 13.7% (20.7 million tons)
- Food Waste: 8.0% (13.4 million tons)
- Other: 2.1% (3.1 million tons)

Total Discarded: 151.7 million tons

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Recycling Rates

MSW Recycling

Recycling Plastics
Composting

Composting (Continued)

THE COMPOSTING PROCESS

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e) Composting facility, Edmonton, Alberta
What makes it hazardous?

EPA classifies hazardous and toxic waste in one or more of the following categories:
- Ignitability
- Corrosiveness
- Reactivity
- Toxicity

A group of its own

- Radioactive: very hazardous material (nuclear power plants, nuclear weapons production)
Dealing with Hazardous Wastes

Various Methods

Out of sight – out of mind

- Where it goes, nobody knows!
- Deep well injection
- Surface impoundments
- Hazardous waste landfills
- Incineration

Advantages
- Safe method if sites are chosen carefully
- Wastes can be retrieved if problems develop
- Low cost

Disadvantages
- Leaks or spills at surface
- Leaks from corrosion of well casing
- Existing fractures or earthquakes can allow wastes to escape into groundwater
- Encourages waste production
Advantages

- Inexpensive
- Can store wastes indefinitely with secure double liners

Disadvantages

- Groundwater contamination from leaking liners (or no lining) or leak in transport pipe
- Air pollution from volatile organic compounds
- Overflow from flooding
- Disruption and leakage from earthquakes
- Promotes waste production
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Surface Impoundment

Mass burn Incinerators

- Commercial incinerators or cement kilns
- Burn around 750 - 3000 degrees F
Incinerator

Clean-up Methods
For soil & water

Bioremediation

- Injection of oxygen, microorganisms (bacteria) into contaminated soil or water.
- Effective for organic wastes (pesticides, gasoline, diesel fuel, etc).
- Does not work well with toxic metals, highly concentrated chemical wastes.
Phytoremediation

- Natural or genetically engineered plants that filter and remove contaminants from the soil

**Trade-Offs**

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tr>
<td>Easy to establish</td>
<td>Slow (can take several growing seasons)</td>
</tr>
<tr>
<td>Inexpensive</td>
<td>Effective only at depth plant roots can reach</td>
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<tr>
<td>Can reduce material dumped into landfills</td>
<td>Some toxic organic compounds may evaporate from plant leaves</td>
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<td>Produces little air pollution compared to incineration</td>
<td>Some plants can become toxic to animals</td>
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<td>Low energy use</td>
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Phytoremediation can be used to treat both inorganic metals and organic contaminants. Examples include:

- **Sunflower**: Absorbs and stores radioactive strontium-90 and cesium-137. Use is currently limited to contaminated land that is cleared beyond buffer zones.
- **Willow tree**: Absorbs and stores aromatics, chlorinated hydrocarbons, and volatile organic compounds. If removed early, the willow can be burned.
- **Indian mustard**: Absorbs and stores heavy metals, chlorinated hydrocarbons, and aromatics. The plant can be harvested, dried, and incinerated.
Brownfield's

What are Brownfield's?

- Industrial & commercial sites that have been abandoned and in most cases contaminated.

Hazardous Waste Regulations

- RCRA
- Superfund (CERCLA)
RCRA

- Resource Conservation & Recovery Act
- Passed by US Congress in 1976
- Amended in 1984

RCRA

This law requires:
- EPA to identify hazardous wastes & set standards. (States manage)
- Firms that store, treat, or dispose of more than 110 kg (220 lbs) per month must have permit.
- Permit holders to use a cradle-to-grave system for wastes.

Superfund aka CERCLA

- Comprehensive Environmental Response Compensation & Liability Act
- Passed in 1980 by US Congress
CERCLA

Identify and clean up abandoned hazardous waste sites & underground tanks leaking toxic chemicals

National Priorities List

To keep taxpayers from footing most of the bill clean ups are based on the polluter-pays principle

The EPA is in charge of:
- Finding the parties responsible for each site.
- Ordering them to pay for the entire clean up.
- Suing them if they do not.

If no responsible found - money is drawn out of the "Superfund" for clean up.
Hazardous Waste Nightmare
The story of Love Canal

Love Canal
- Late 1800's - early 1900's
- New dream community on the eastern edge of Niagara Falls, NY proposed by William T. Love.
- Love felt that digging a short canal between the upper and lower Niagara Rivers, power could be generated cheaply for this “model city.”

Niagara Falls
Love Canal

- Love’s project was not really feasible due to economic times and newer technology (alternating current). He also ran out of money.
- 1910 - Love’s dream shattered.
- Just a partial ditch (60 feet by 3000 feet long) remained where construction began for the canal.

1910 – Love’s dream shattered.

- 1910 – 1927 canal used by residents to fish and swim
- 1927 - land annexed by the city
- 1942 - 1952 Canal becomes municipal and industrial chemical dumpsite for Hooker Chemical Co. 21,000 tons total were dumped in this area.
1953 - the Hooker Chemical Company, owners and operators of this property, covered the canal with soil and sold it to the Niagara Falls School Board for $1.00.

1955 - elementary school and playground constructed onsite.
1957 construction of homes were built on this property.
By 1978 - 800 homes had been built.
Love Canal

- Trees and gardens were turning black and dying.
- Noxious puddles in yards and basements.
- Children returned from play with burns on their hands and faces.
- Birth defect rates were rapidly increasing in this area.

Love Canal

- August 1978 - News story broke about Love Canal containing hazardous chemicals, several of them carcinogens.
Love Canal

Lois Marie Gibbs - “Mother of Superfund” created Love Canal Homeowners Association (LCHA).
Protested the situation to the government.
President Carter approved emergency financial aid for the residents.
By end of August, 98 families had been evacuated.
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Love Canal

- Eventually all but 67 families were relocated by 1979.
- Superfund/CERCLA goes into effect 1980.
- 239 homes closest to the canal were demolished and the southern section of the neighborhood declared uninhabitable.
- Summer 1990 - 200 northern homes considered “habitable.” Black Creek Village subdivision is established.
**Love Canal**

- Company has paid over $98 million and then some for clean-up of site and lawsuits.

**Assurances**

“The entire area is probably one of the most tested pieces of property on this planet. It’s probably one of the safest places to live.”

Mike Basile  
(spokesman for the EPA)
Doubts

“I haven’t found a scientist yet who would say the landfill won’t leak again. The logical flow of water in that community is from the landfill to the homes.”

Lois Gibbs

Love Canal

- September 2004 - area officially removed off of National Priorities List

Superfund Closer to Home

Gas Works Park
Welcome to Gasworks!

Gas Works Park

- 1900-1956 - Seattle Gas & Light company purchased this land for a gas processing plant.

Gas Works Park

- 1900-1930 - plant used coal, leaving behind coal tar and underground plumes of a substance called naphthalene.
- Today that product remains underground, but is believed to be so deep it’s actually below the bottom of Lake Union.
- City Officials plan to leave it untouched.
Gas Works Park

- 1930-1956 - plant used oil to convert to manufactured gas, which created a benzene plume.
- Benzene is a byproduct of gasoline.
- Plant closed in 1956 when natural gas became the new way to heat homes.

Gas Works Park

- 1961 - City of Seattle purchased land for $1.3 million dollars for future park. The City was fully aware of the contaminants and agreed to clean them up.
- 1976 - After 3 years of hauling away contaminated soil, the park opens to the public.

Gas Works Park

- 1984 - Park temporarily closed again due to heighten concern of health hazards.
- Park considered to be a Superfund site, but the state chose to clean it up instead.
- Politics and money delayed a thorough clean up until the 1990’s.
- $4 million dollars later, Gas Works Park was reopened.
Another Sign

**NOTICE**

THIS PARK AND ADJACENT LAKE CONTAIN HAZARDOUS SUBSTANCES

- Keep out of the lake and creek
- Exercise caution when walking near the lake
- Do not eat the soil or plants
- Do not drink the water
- Do not feed the fish

Gas Works Park

- Site still remains contaminated.
- Clean up still in progress.
- Bottom line: don’t eat the soil or drink the lake.

Questions
Web Resources

- U.S. Environmental Protection Agency
  > http://www.epa.gov/epaoswer/osw/hazwaste.htm
- Household Hazardous Wastes
  > http://outreach.missouri.edu/owm/hhw.htm
- King County Local Hazardous Waste Program
  > http://www.metrokc.gov/hazwaste/house/

Next Lesson

Housing & Urban Development