



SOLID & HAZARDOUS WASTE

CHAPTER 21

WHAT HAPPENED AT LOVE CANAL?

Video

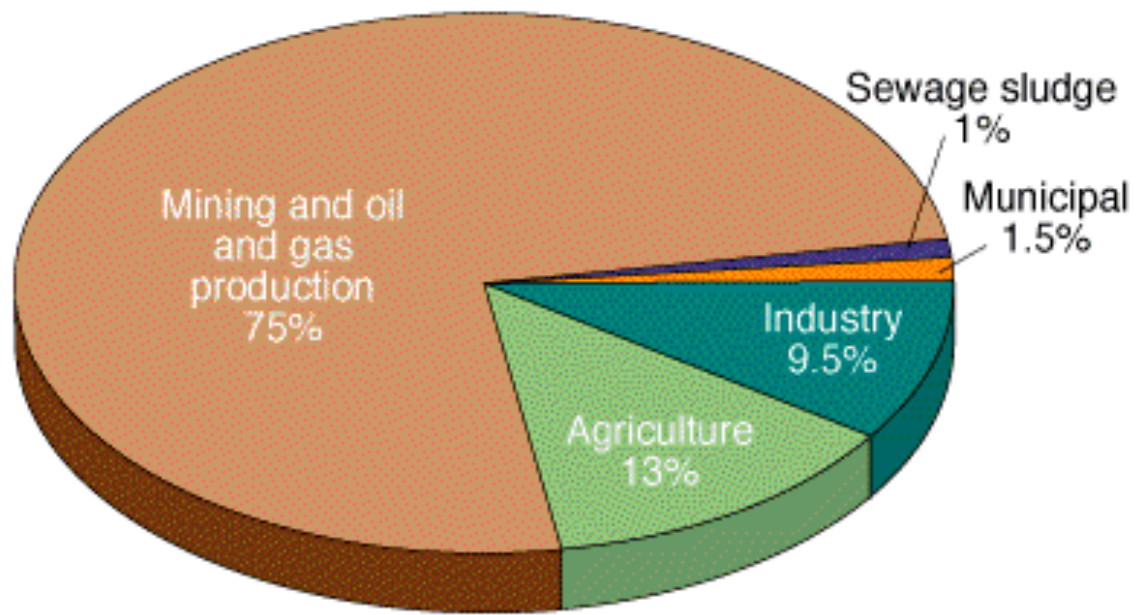
TYPES OF WASTE

- Before the Industrial Revolution, almost all waste was Biodegradable
 - Now most is Nondegradable or hazardous or both.
 - **TOXIC WASTE** - can injure or kill - must be disposed of without harming or polluting
 - **SOLID WASTE** - cannot go down sewage system - must be disposed of.
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HOW MUCH DO WE GENERATE?

- We have 4.5% of the world's population and we produce about **33% of the world's solid waste.**
- About 44 tons/person
- **98.5% of solid waste in U.S. comes from mining, oil & natural gas production, agriculture and industrial activities to produce goods and services. (GRAPH)**

Sources of solid waste in the United States



What is a high-waste society?


- We throw away:
 - Enough AI to rebuild the country's commercial airline fleet every 3 months
 - Enough tires to encircle the planet almost three times
 - About 18 billion disposable diapers/year
 - About 2 disposable razors, 30 million cell phones, 18 million computers, & 8 million TV sets
 - About 2.5 million nonreturnable plastic bottles/hour
 - About 1.5 billion pounds of edible food /year
 - Enough office paper to build a 3.5 meter wall from NY City to San Francisco / year.
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What is Industrial Waste?


- Scrap metal, plastic, paper, fly-ash and sludge
- Most is buried or incinerated at site where it is produced.




MUNICIPAL SOLID WASTE (MSW)

- 1.5% comes from homes and businesses
 - Cause water pollution in fresh and salt water, air pollution, etc.
 - **GARBAGE**
 - Must be disposed of in landfills and burned.
 - Some is recycled or composted or incinerated but most (58%) ends up in a landfill.
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What is hazardous waste?

- Any discarded solid or liquid material that contains:
 - **Carcinogenic, mutagenic, or teratogenic compounds** at levels exceeding certain limits
 - **Catches fire easily** (gasoline)
 - Is **reactive** or **unstable** enough to explode or **release toxic fumes**
 - Is **capable of corroding metal containers** such as barrels or drums.
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*What is
NOT
included?*

- Radioactive wastes
 - Household hazardous or toxic materials
 - Mining wastes
 - Oil-and-gas drilling wastes
 - Liquid waste containing organic hydrocarbons (i.e. acetone)
 - Cement kiln dust
 - Small business and factory waste
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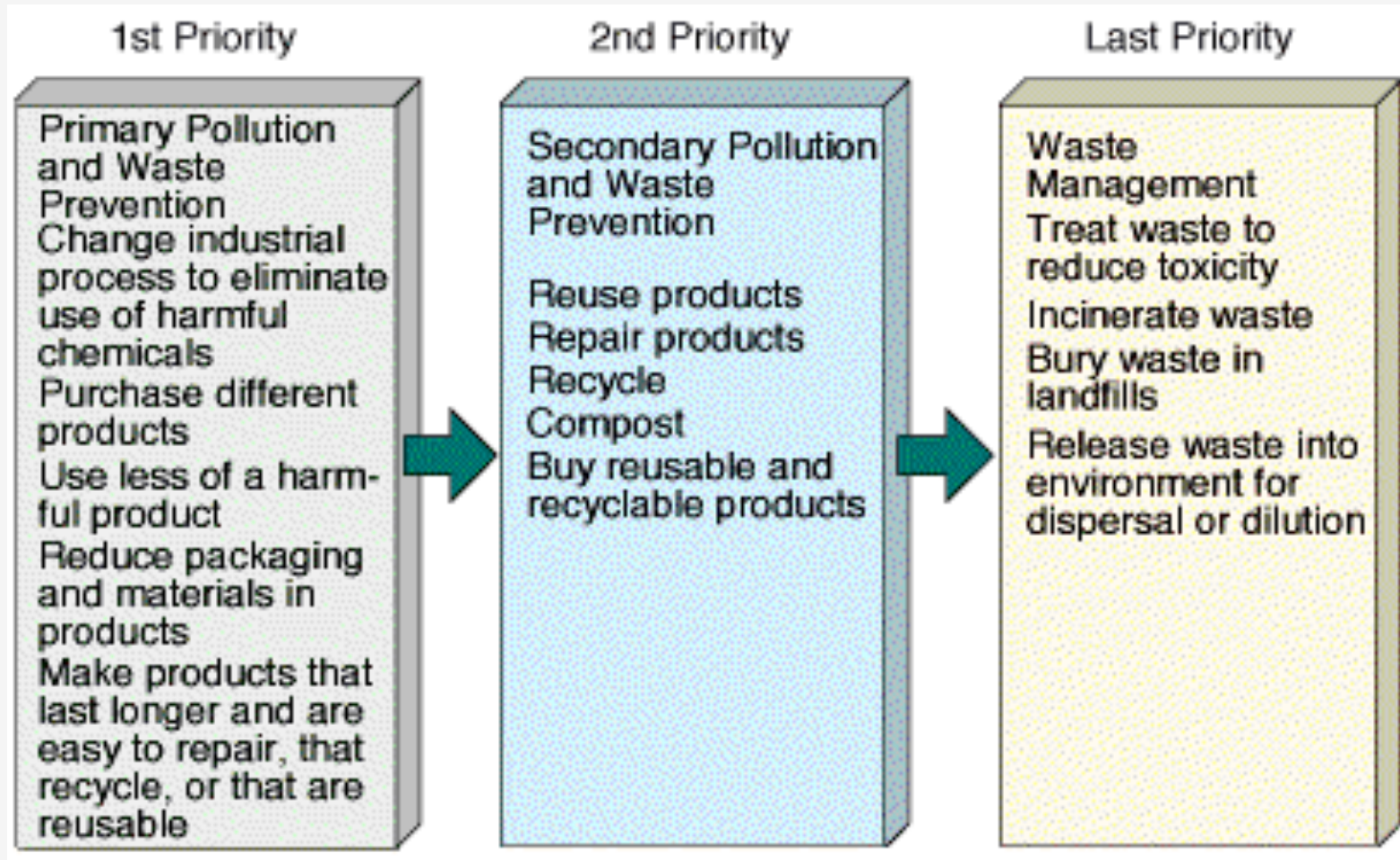
*95 % OF THE COUNTRY'S
HAZARDOUS WASTE IS NOT
REGULATED BY LAW!!!*

Even less is regulated in developing countries

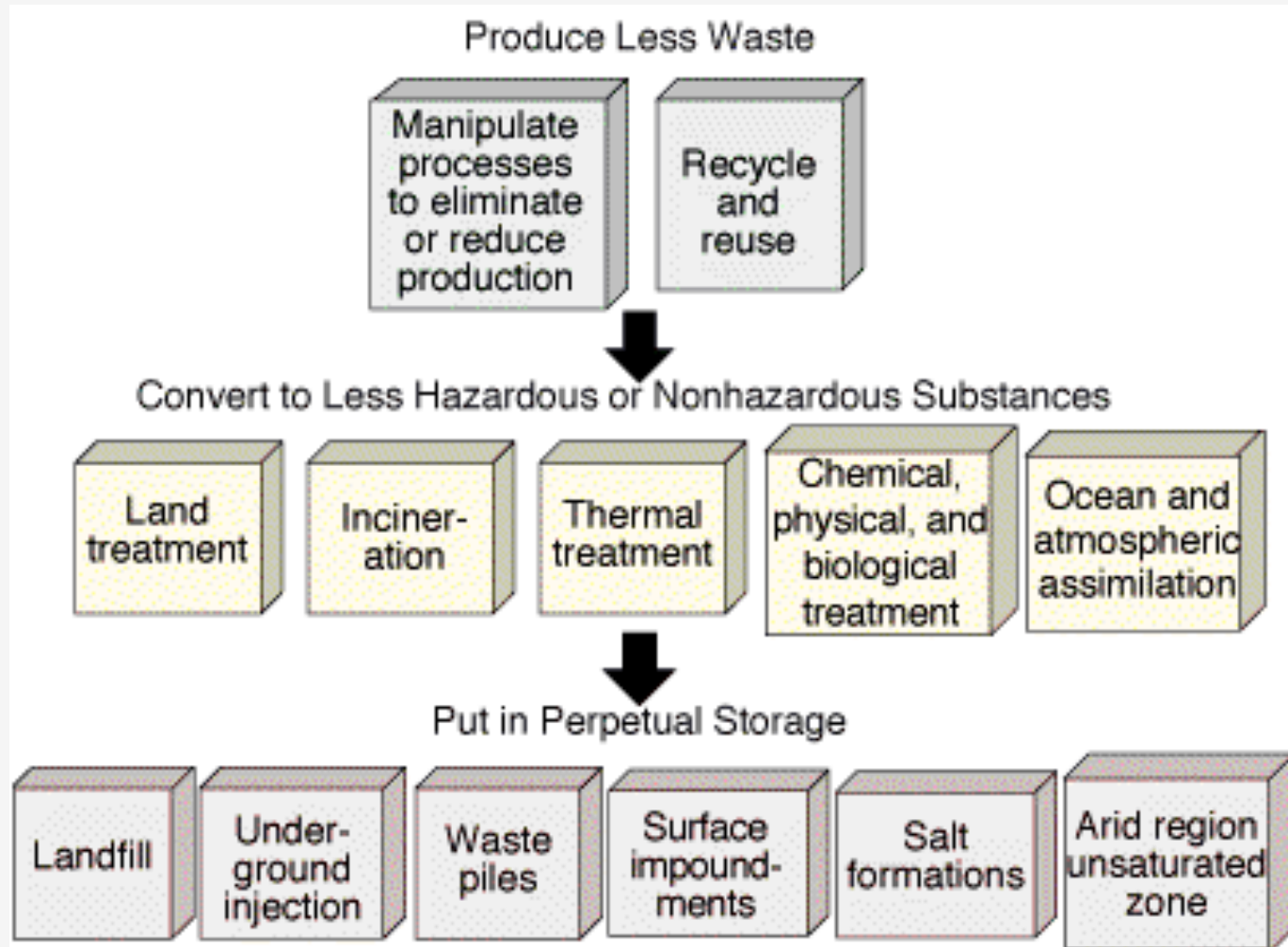
*There are
two
approaches:*

- 1. Waste management
 - High waste approach
 - Manage wastes in the best way not to harm the environment
 - Mainly by burying, burning, or shipping to another country or state
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- 2. Waste prevention
 - Low waste approach
 - Potential resources
 - Recycle or reuse or don't produce in the first place
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Dealing with solid waste



Dealing with hazardous waste



How can we reduce waste and pollution?

- Decrease consumption
 - Redesign products to use less material - eliminate unnecessary packaging.
 - Design products that produce less pollution and waste fewer resources Use less hazardous cleaning products
 - Design products to last longer
 - Trash taxes - pay by the bag
- 

Reuse

- Reduces waste, extends resource supplies, reduces energy use and pollution
 - Refillable glass beverage bottles
 - Refillable plastic soda bottles
 - Metal or plastic lunch boxes
 - Reusable plastic refrigerator containers rather than plastic bags
 - KEEPS HIGH QUALITY MATTER FROM BEING REDUCED TO LOW QUALITY MATTER.
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Recycle

- **Composting** - humus made when microorganisms break down organic matter
- Many people don't want to live near a large composting site
- NIMBY COMPLEX



PRIMARY RECYCLING

- Closed-loop - wastes are recycled to produce new products of the same type (aluminum cans into aluminum cans)

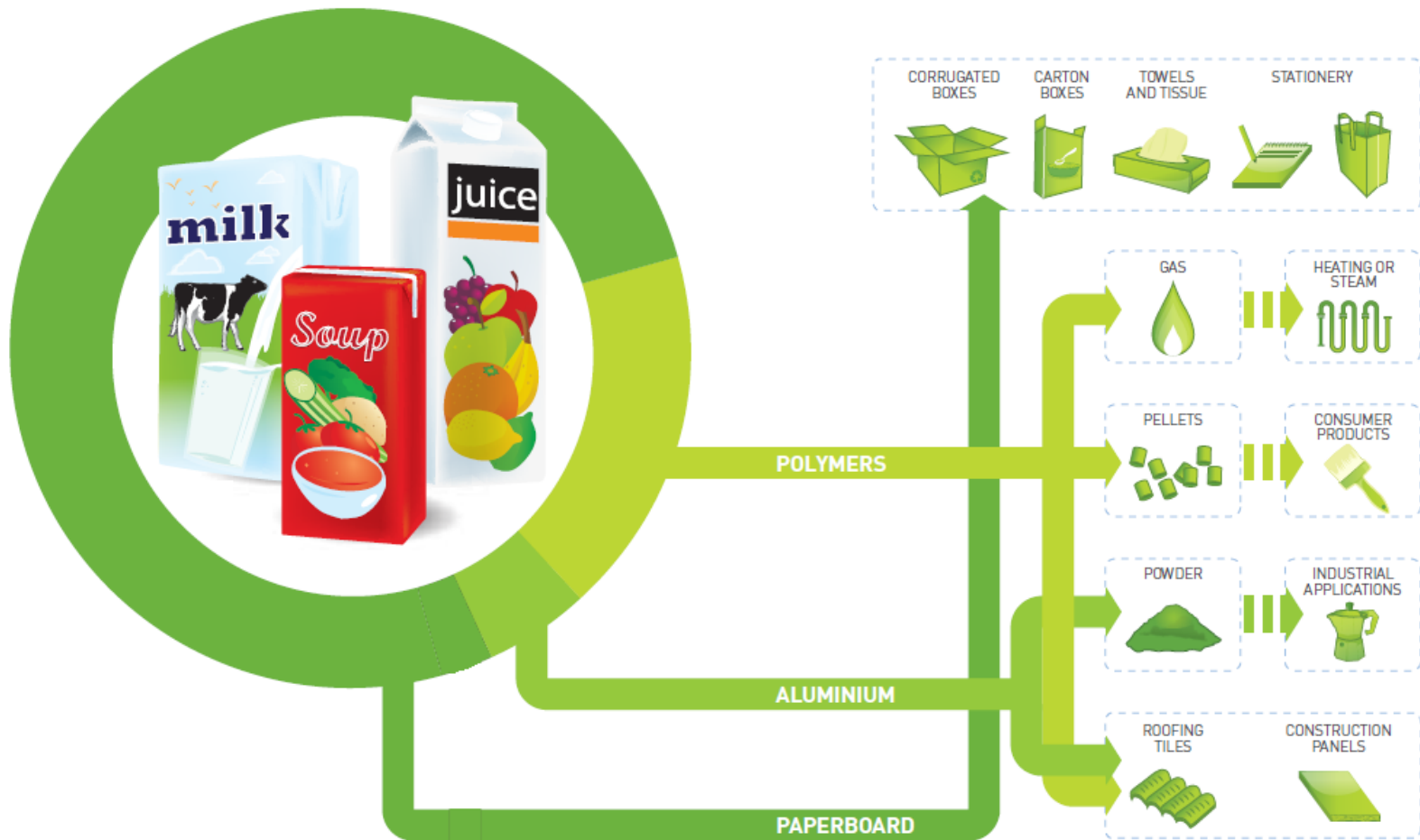


- Which of these would be used in primary recycling?


#82820359

SECONDARY RECYCLING

- Open loop - waste materials are converted into different products
 - Soda bottles into carpet



Why recycle?

- Pay-as-you throw - pay by the bag for garbage that must be disposed of
 - Recycling creates jobs
 - Makes us feel like we are helping
 - Does not make sense if it costs more than to send to landfill or burn
 - May not make sense for plentiful resources
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Why don't we recycle more?

- We **don't include the environmental and health costs** of raw materials in the market prices of consumer items
- **Need more tax breaks** for companies that recycle
- We **don't have large, steady markets for recycled items.**



Recycling:

- **Aluminum** - produces less air/water pollutants and uses less energy than mining and processing aluminum ore
 - 62% is recycled
 - Cheaper to use refillable glass or plastic bottles
 - **Paper** - easy to recycle
 - About 50% is recycled
 - Saves energy
 - Reduces pollution
 - Prevents groundwater pollution by ink
 - Saves water
 - Saves landfill space
 - Creates jobs
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Recycling:

- **Plastics**
 - Made from petrochemicals
 - One of the ***leading producers of hazardous waste***
 - Made from many types of resins - only ***5-6% recycled***
 - Have to be separated by type
 - Oil is cheaper than recycling plastics
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Detoxifying hazardous waste

- Convert to less hazardous or non-hazardous materials
- **Bioremediation** - biological treatment
 - Done by microorganisms
 - Could clean up contaminated sites, groundwater, etc.
 - Seems to work well for organic wastes but not heavy metals
- **Phytoremediation** - uses plants



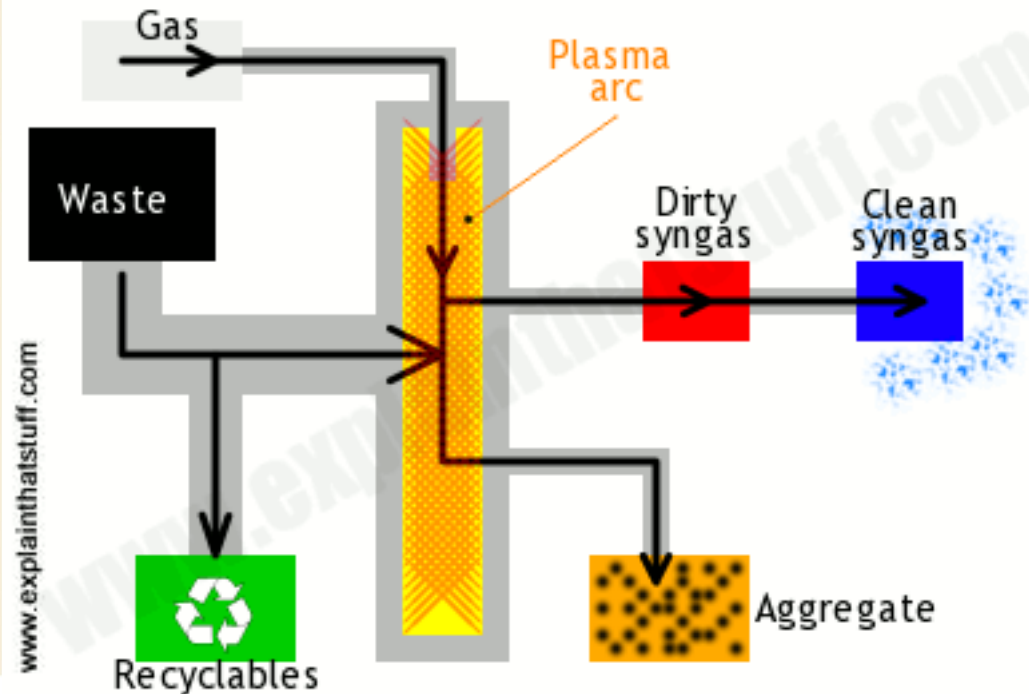
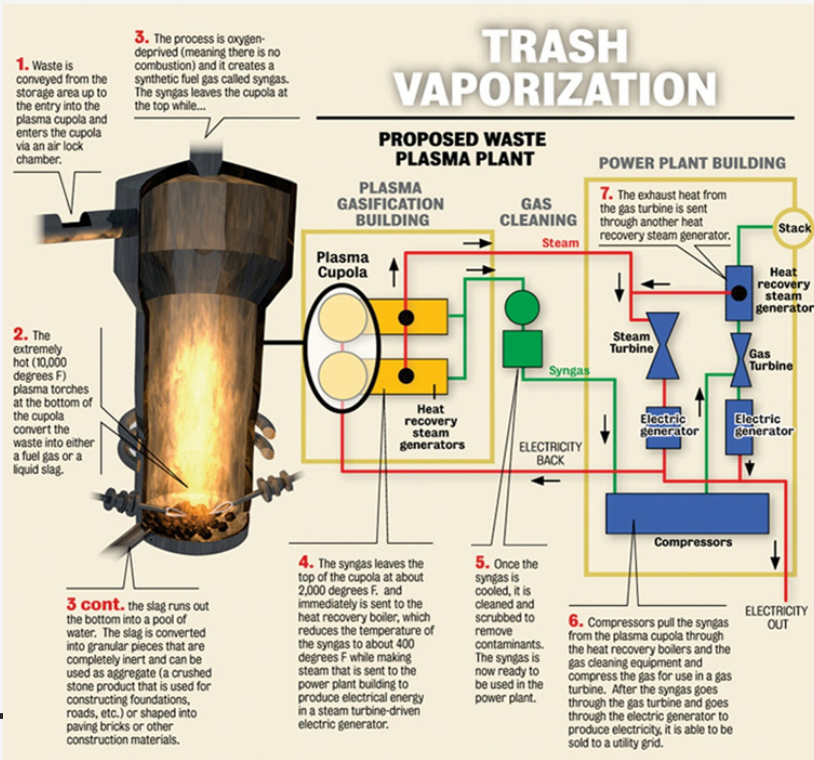
Using chemicals to detoxify

- Cyclodextrin – a type of sugar made from corn starch to remove toxic materials such as solvents, pesticides, and hydrocarbons from contaminated soil and groundwater



Using a plasma torch to detoxify

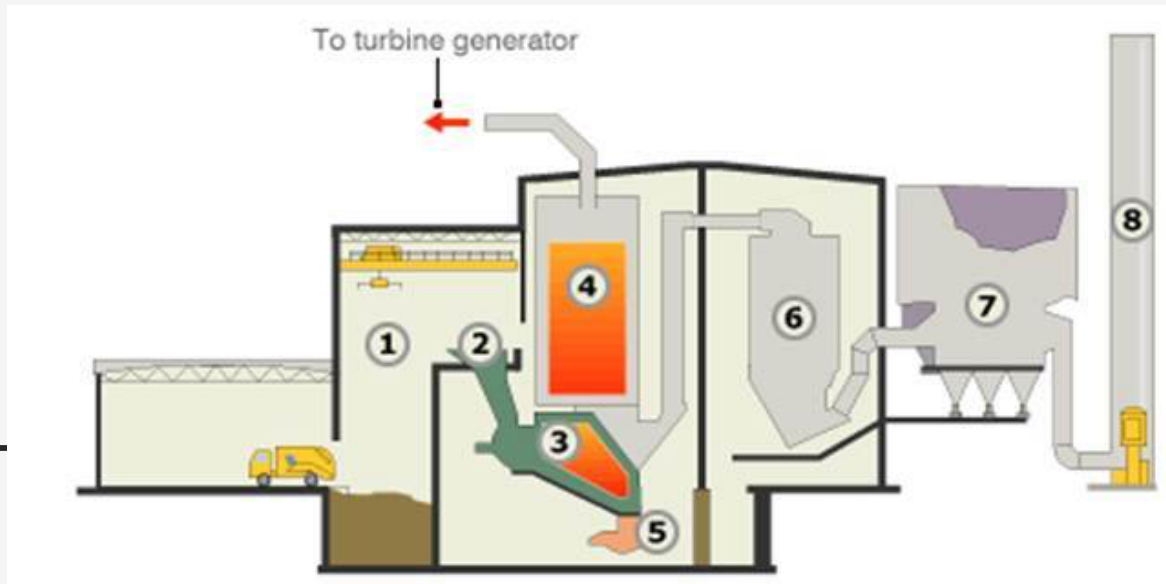
- Plasma arc torch exposes wastes to extremely high temperatures
- Break waste down into ions and atoms that can be converted to simple molecules, cleaned up and released as a gas
- Convert hazardous inorganic matter into a molten glassy material that captures toxic metals and keeps them from leaching in to groundwater.



Incineration



- Mass-burn incinerators - don't separate materials
 - Expensive
 - Creates few long term jobs
 - Creates bad air pollution
 - Can cause cancer clusters
 - *Many have been shut down for these reasons*



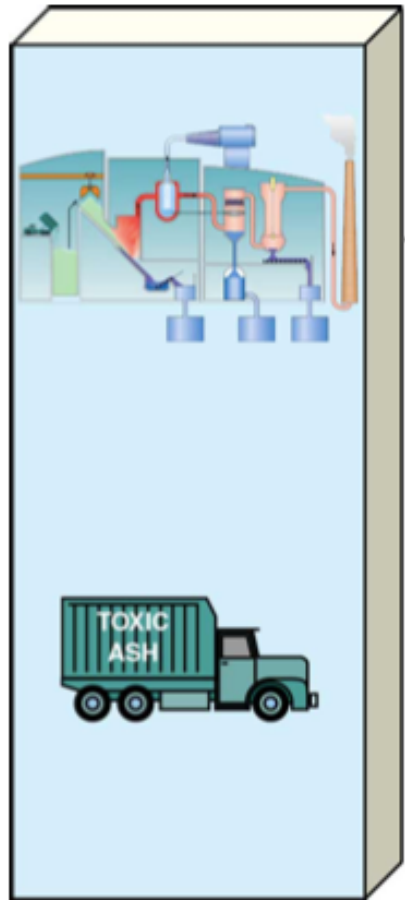
Advantages & disadvantages of Incineration

Advantages

Reduced trash volume

Less need for landfills

Low water pollution



Disadvantages

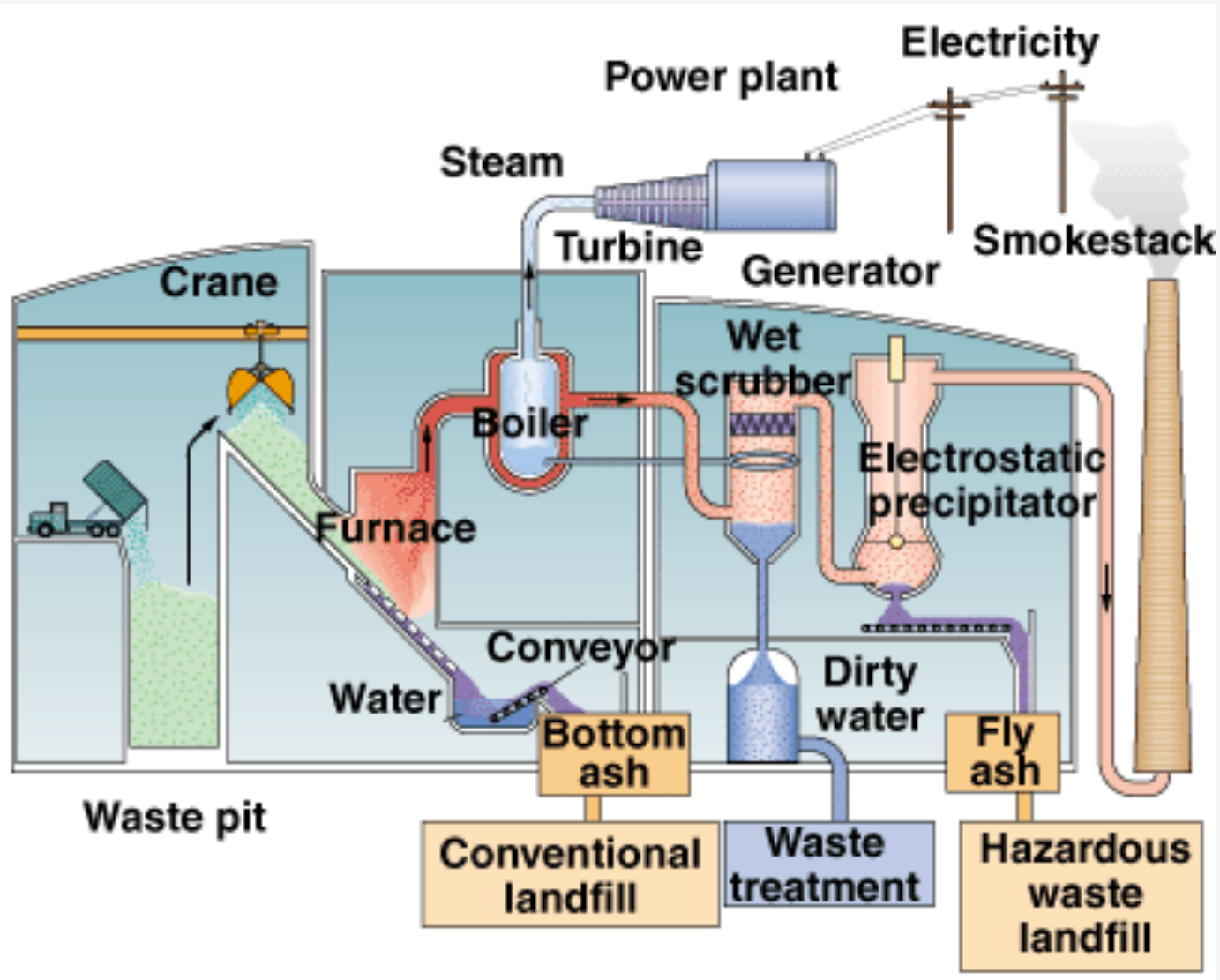
High cost

Air pollution
(especially toxic dioxins)

Produces a highly toxic ash

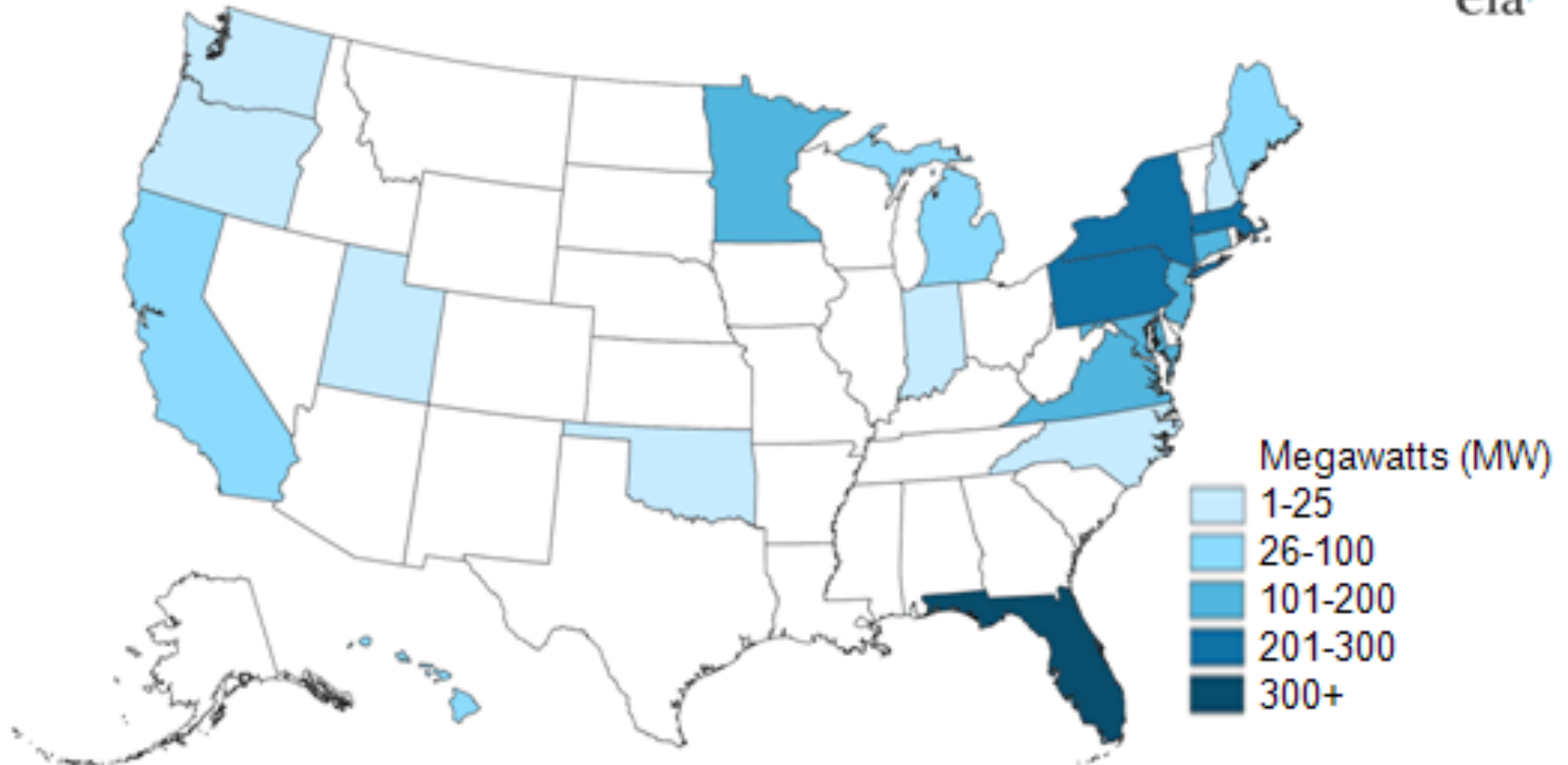
Encourages waste production

Waste-to-energy




MSW-to-Energy By State

Municipal solid waste electricity generating capacity by state, 2011



Land disposal

- Before 1970 most municipal waste was taken to open dumps, bulldozed & often burned, then covered with dirt
 - However dumps have become inadequate and everyone has the NIMBY complex
 - Ocean dumping washes back on the beach.
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Sanitary landfills

- Solid wastes are spread out in **thin layers** and **covered daily** with **clay or plastic foam**
 - Lined with clay and plastic
 - Has a second liner to collect ***leachate***
 - Has pipes to collect leachate, storage and disposal
 - **Usually built high on a hill above water table**
 - Vented to recover methane
 - Can be used for a park, golf course later
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State of the art sanitary landfill

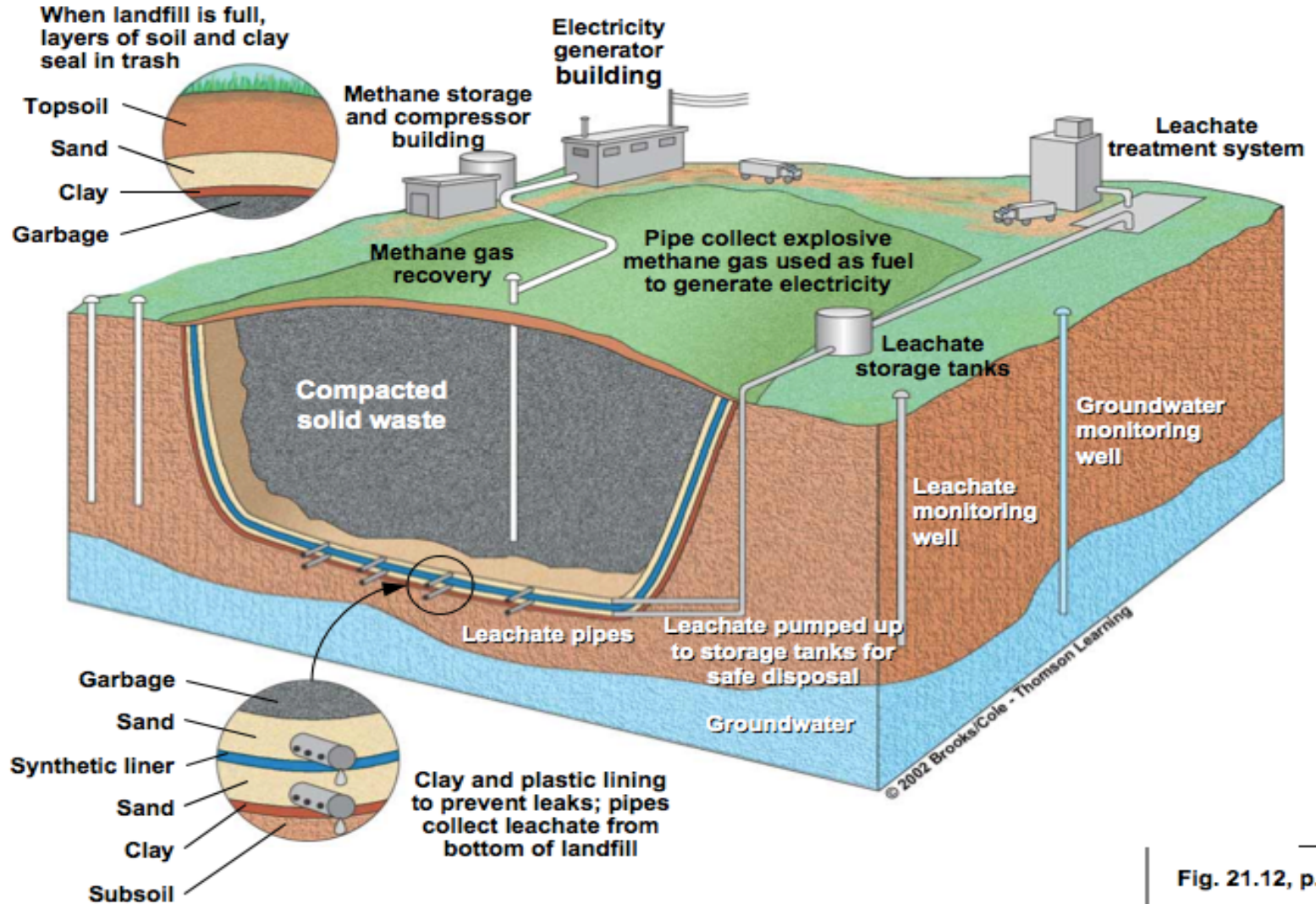


Fig. 21.12, p. 537

Drawbacks

- Traffic, noise and dust
 - Emit toxic gases - methane, H_2S , smog
 - Many things do not biodegrade when covered
 - Waste resources
 - Can cause land subsidence
 - Contaminate groundwater with leachate
-

Disposal of hazardous waste

- Deep well injection - pump underground under pressure into dry, porous geologic formations below aquifers
 - Surface impoundments - ponds, pits, or lagoons
 - About 5% of US waste is concentrated, put in drums, stored in landfills.
 - Eventually leak and get into groundwater
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Deep well injection

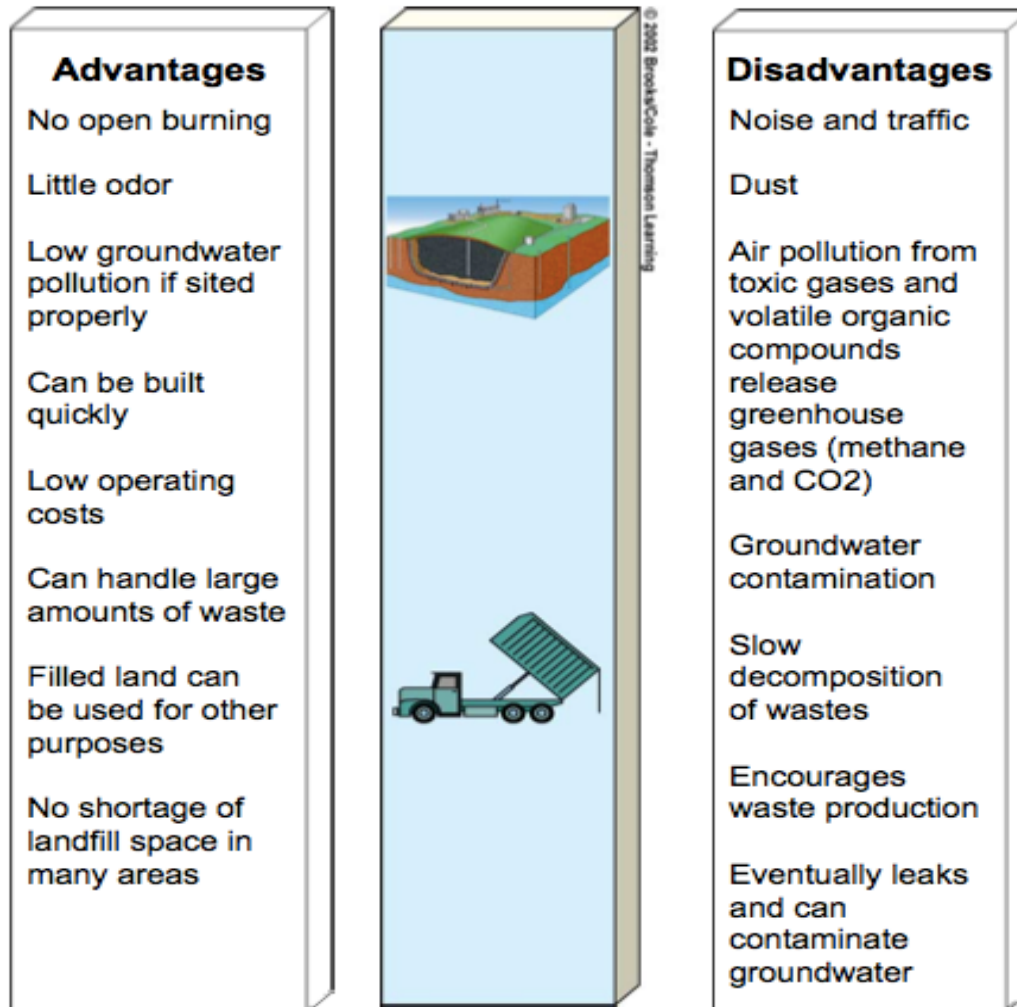


Fig. 21.13, p. 538

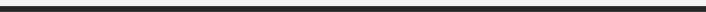
Exporting waste

- Ship to other states or other countries - mainly developing
 - Few states will now accept
 - Can legally ship to other countries
- Does not need EPA approval
 - Is done legally and illegally
 - Waste disposal firms charge high prices, dispose at low cost and pocket profit



Solution

- Might be to have a worldwide ban on all hazardous waste exports
- would still have illegal trade because of large profits
- Only real solution - not produce waste in the first place



- Resources Conservation & Recovery Act - 1976
- **Prohibited open burning in dumps**
- **EPA** must identify hazardous wastes & set standards for their management by states
- Firms that produce more than 220 lbs/mo must have permit stating how wastes will be managed
- **Cradle-to-grave tracking** - from production to disposal of hazardous waste



SUPERFUND *- 1980*



- Comprehensive Environmental Response, Compensation, and Liability Act
 - Plus ammendments
- Clean up abandoned hazardous waste sites such as Love Canal
- Try to find the culprit and have the “polluter pay”
- Hard to get on the list
- Much of the money is spent fighting the claims in court

*Once you
are on the
list...*

- Test groundwater for contamination
 - Isolate and stabilize wastes & protect the public
 - Put the worse sites on a National Priorities List
 - Do a total clean up:
 - Remove and treat drum stored waste
 - Excavate contaminated soil & burn it
 - Clean up contaminated soil by bio - or phytoremediation.
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What are Brownfields?

- Industrial & commercial sites that have been abandoned and in most cases **abandoned**
 - Empty factories, junkyards, old landfills, and boarded-up gas stations.
- Many sites could be cleaned up and developed by developers are concerned about their legal liability

