

Solid Waste Management and Disposal

Chapter 18





Where do we put the waste?

Waste in Space?

1. Cost (\$10,000/kg)
2. Accidents happen
3. Space debris
4. Waste made of natural resources
5. If space is solution-encourages more waste



Waste in ocean?

- Before the 50's, no plastic
- 1988 Ocean Dumping Ban Act
(Kids found medical waste on beach – hypodermic needles etc.)
- 1988 Medical Waste Tracking Act
(Now “Cradle to Grave” Monitoring)



WASTING RESOURCES

- *Solid waste*: any unwanted or discarded material we produce that is not a liquid or gas.
 - *Municipal solid waste (MSW)*: produced directly from homes.
 - *Industrial solid waste*: produced indirectly by industries that supply people with goods and services.
- *Hazardous (toxic) waste*: threatens human health or the environment because it is toxic, chemically active, corrosive or flammable.

Mining Waste

- Rock and soil removed
- Milling operations (to separate target from ore) - tailings
- Water drained into ponds and sometimes leaks out
- Estimated 1-2 billion tons of mining waste/year



Agricultural Waste

- 1,240 metric tons manure/year
- Majority of farm waste used as fertilizer
- Other materials burned
- Run-off risk



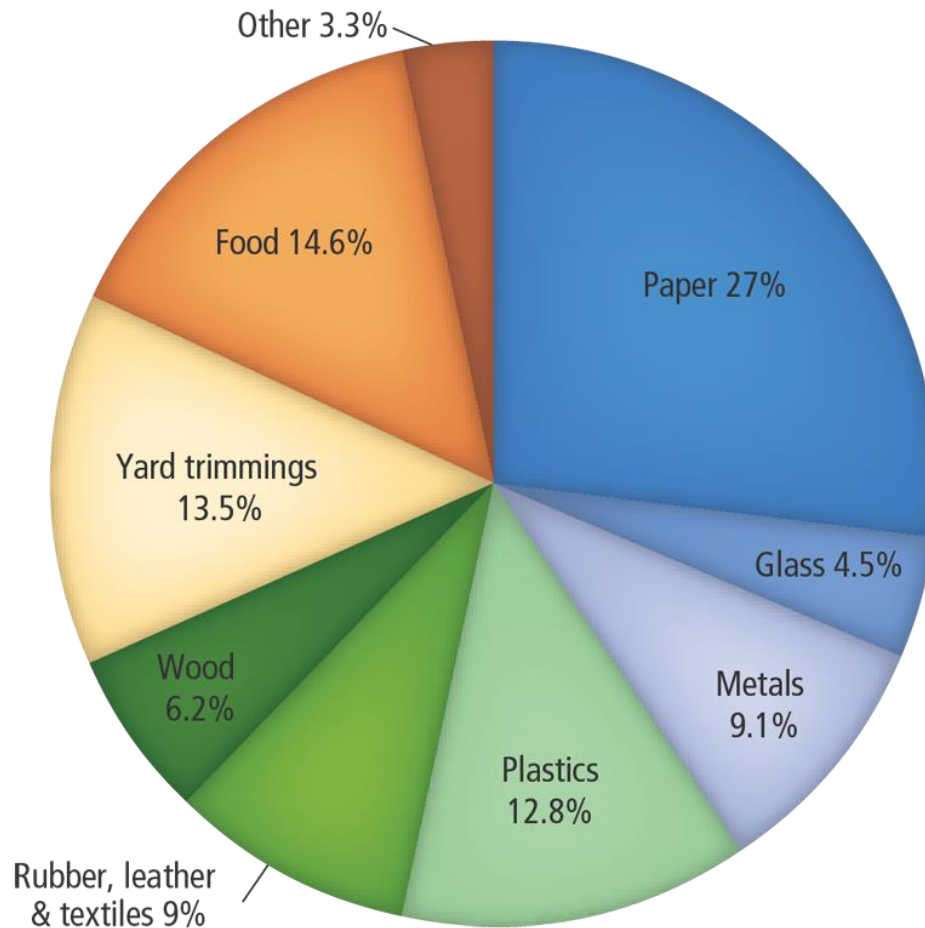
Industrial Solid Waste

- 220 mil. - 600 mil. metric tons/year
- Demolition waste, sand, sludge, ash etc.

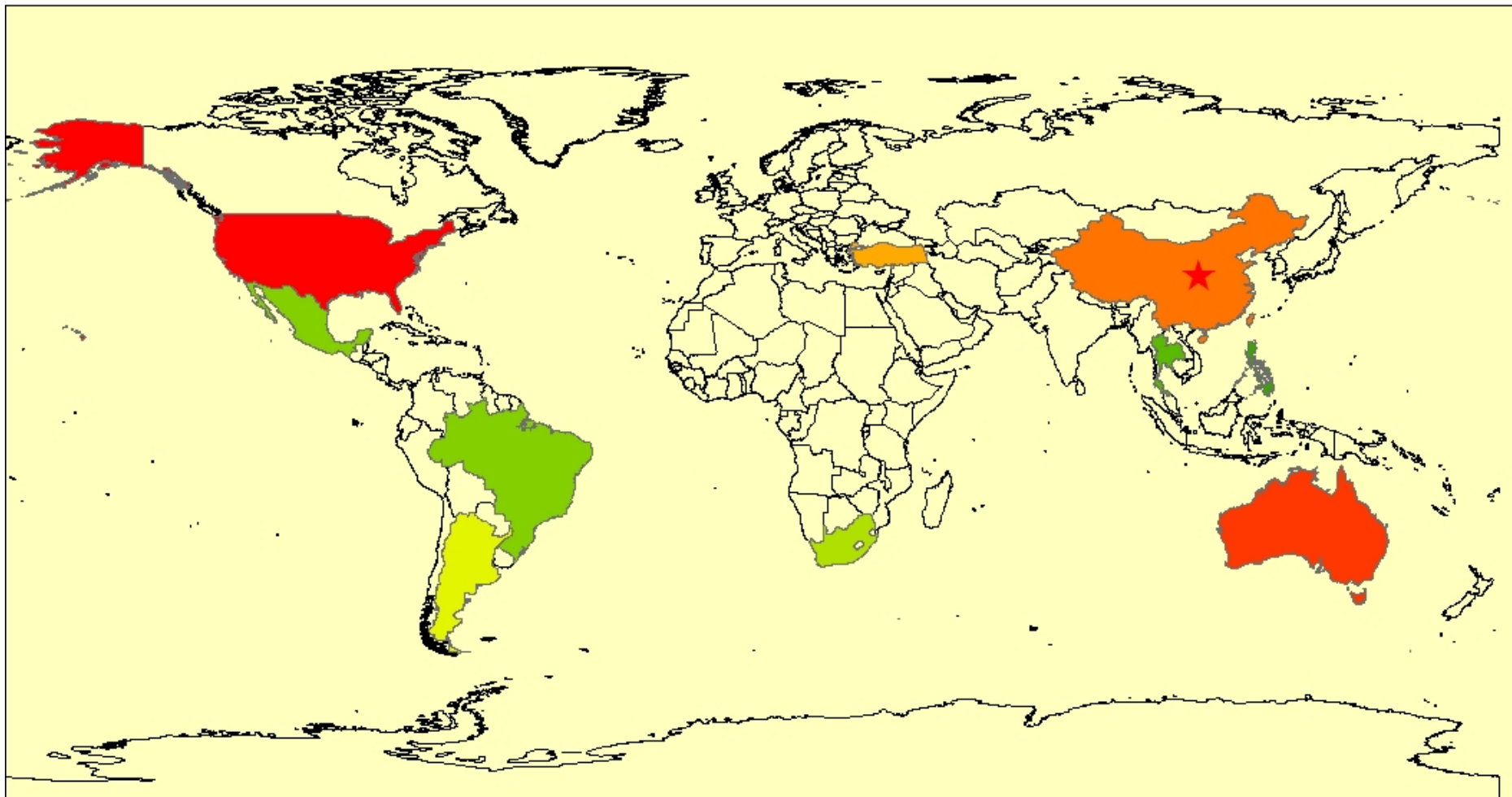


Municipal Solid Waste

- Household waste, commercial waste,
- 230 million metric tons/year



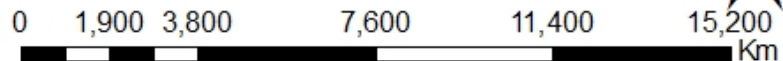
Municipal Solid Waste Per Capita of Major Polluters



MSW Per Capita

★ Xi'an City

Kg/Person/Year



Electronic Waste: A Growing Problem



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- E-waste consists of toxic and hazardous waste such as PVC, lead, mercury, and cadmium.
- The U.S. produces almost half of the world's e-waste but only recycles about 10% of it.

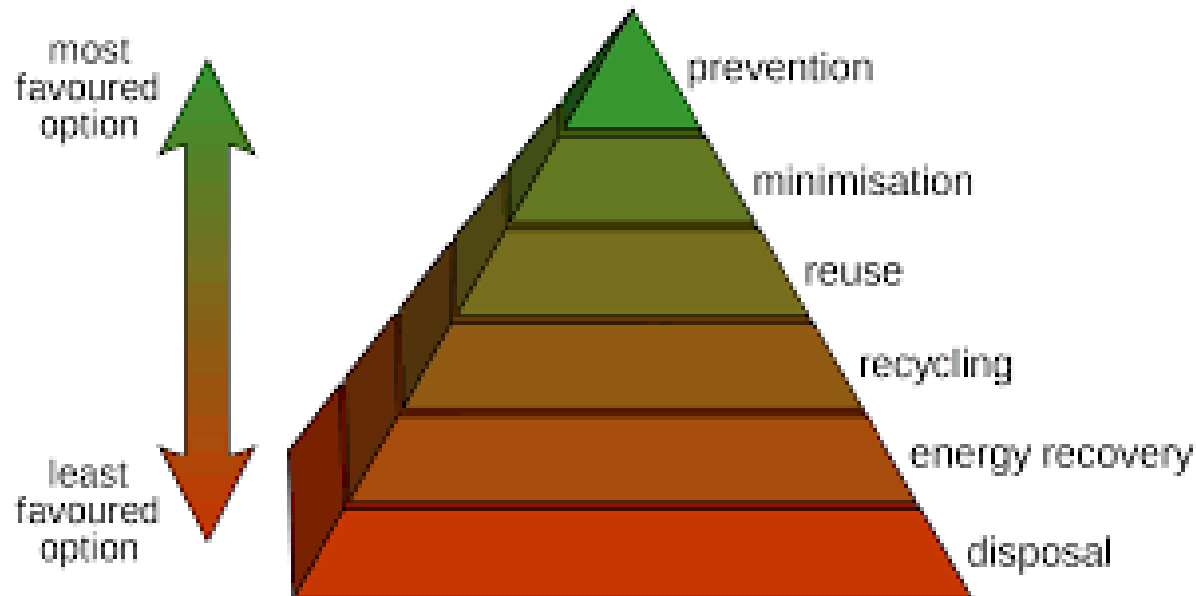
Figure 22-4

50 Million metric tons of e-waste a year



Five Techniques for Waste Disposal

1. Landfills
2. Incineration
3. Composting
4. Source reduction
5. Recycling



Landfills (Open Dumps) “A pile of garbage”



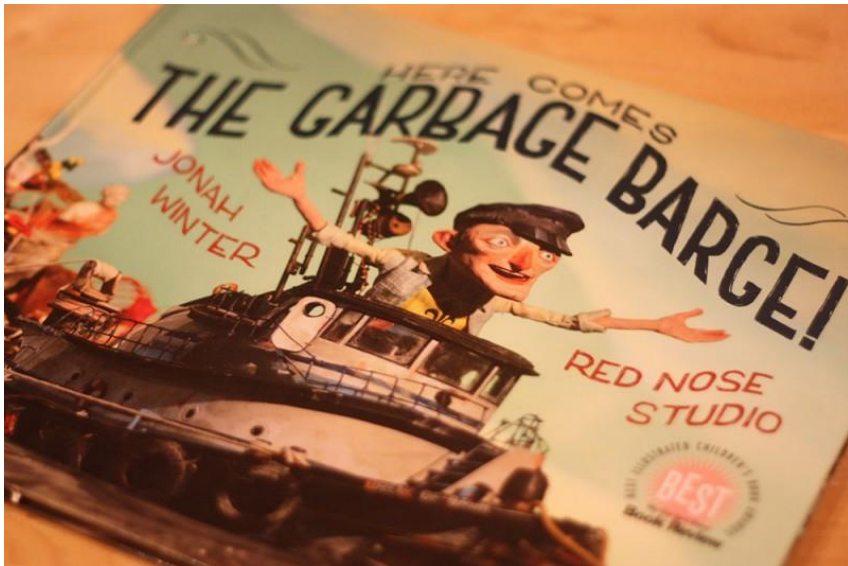
- “Smokey Mountain”,
Manila
- Attracts birds, rodents,
insects
- Makes “chemical
soup” (leachate) which
enters groundwater



Sanitary Landfills

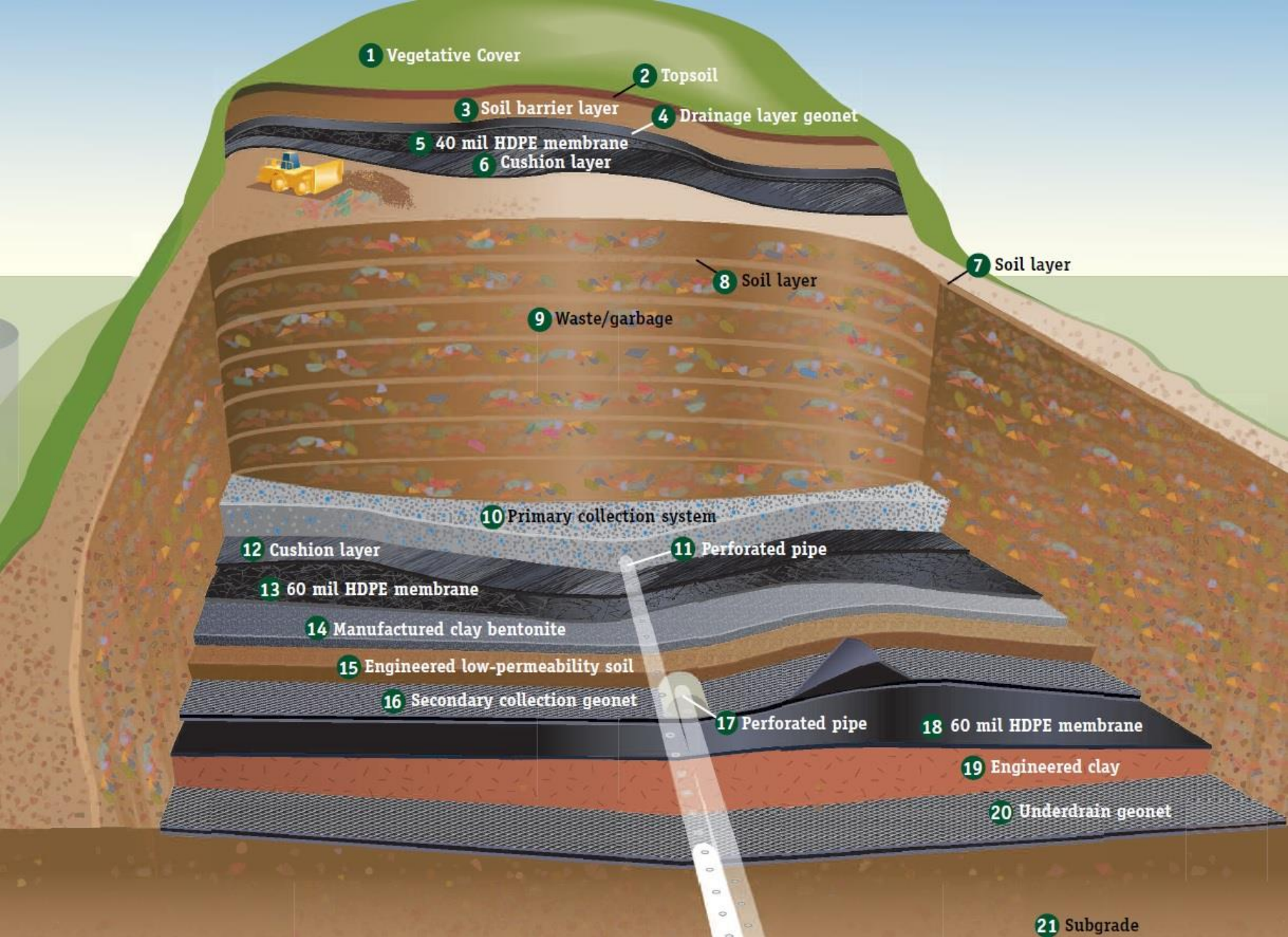
- Usually constructed above clay
- New landfills have impermeable liner and complex bottom layers to trap leachate
- Methane levels monitored
- Compacted and covered with soil reduces rate and lessens fire danger and decreases odor

New York Garbage Barge Embarrassment



Burying Solid Waste

- Most of the world's MSW is buried in landfills that eventually are expected to leak toxic liquids into the soil and underlying aquifers.
 - *Open dumps*: are fields or holes in the ground where garbage is deposited and sometimes covered with soil. Mostly used in developing countries.
 - *Sanitary landfills*: solid wastes are spread out in thin layers, compacted and covered daily with a fresh layer of clay or plastic foam.



1 Vegetative Cover

2 Topsoil

3 Soil barrier layer

4 Drainage layer geonet

5 40 mil HDPE membrane

6 Cushion layer

7 Soil layer

8 Soil layer

9 Waste/garbage

10 Primary collection system

12 Cushion layer

11 Perforated pipe

13 60 mil HDPE membrane

14 Manufactured clay bentonite

15 Engineered low-permeability soil

16 Secondary collection geonet

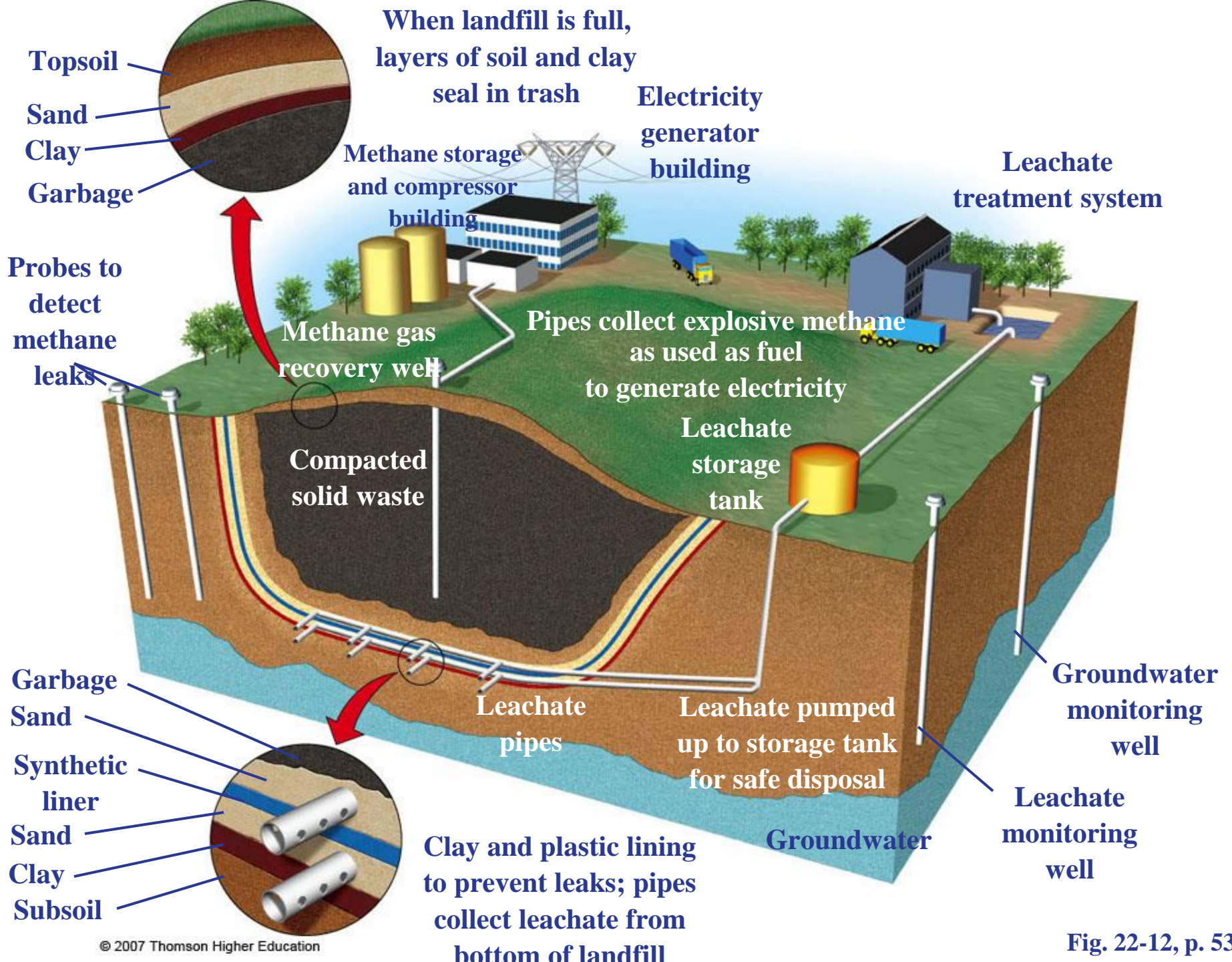
17 Perforated pipe

18 60 mil HDPE membrane

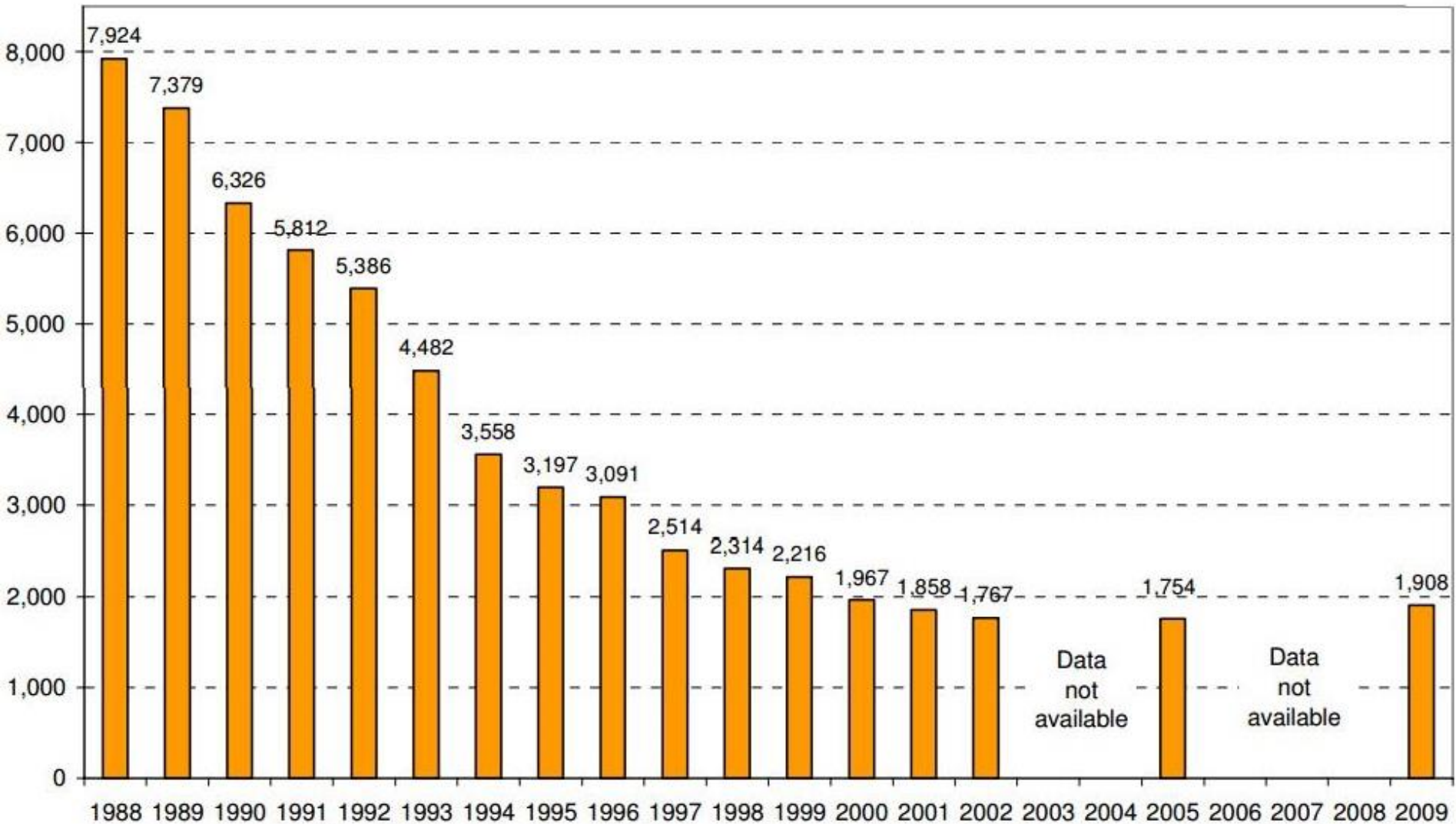
19 Engineered clay

20 Underdrain geonet

21 Subgrade



US Landfills



Landfill rules

- No oil
- No antifreeze
- No air conditioner coolant
- No car batteries
- Tires have to be quartered or shredded

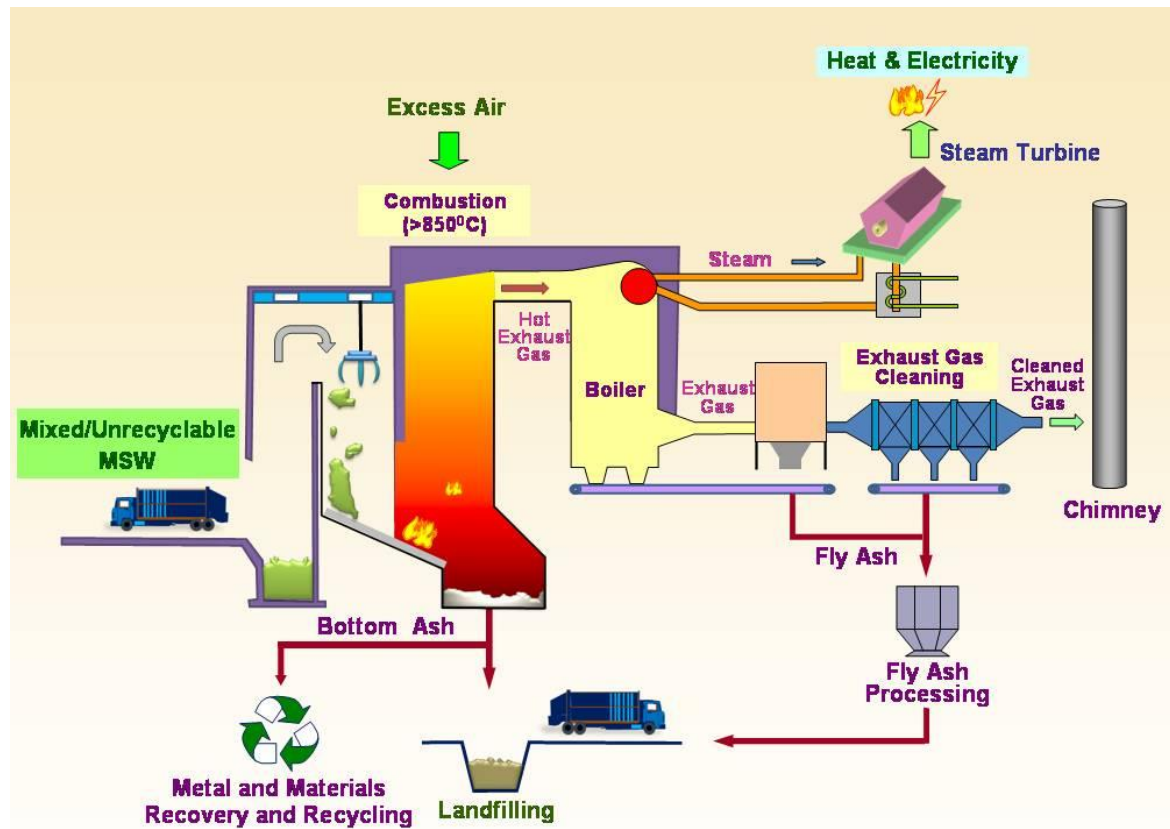
Landfill Mining



- Metals etc.
- Reduces demand for mining in nature
- Use magnets and conveyer belts

Incineration

- Burning refuse in a controlled manner
- 12% of waste in US
- Used to produce electricity



Incineration



- Backyard burning banned (L.A. saw too much pollution etc.)
- Volume of garbage reduced by 80-90% but ash is very toxic (dioxins, mercury, cadmium, etc. enter air). Bury remainder in landfill.
- UK burns 90% of waste (in theory, if properly run, CO₂ and H₂O should be only emissions).

Composting

- Uses natural processes of decomposition
- Compost: humus-like material of decomposed organic material
 - *Windrow*
 - *Aerated piles*
 - *Enclosed vessels*



Benefits

- Aerates the soil.
- Improves soil's ability to retain water and nutrients.
- Helps prevent erosion.
- Prevents nutrients from being dumped in landfills.

Windrow composting

- Compostable material in long rows or piles
- Turned by tractors



Aerated piles

- Large piles of material aerated by pumps
- Covered with insulating material



Enclosed vessels

- Rapid
- Complex
- Environmentally controlled drums or silos



Source Reduction

- Designing, manufacturing, purchasing, using, and reusing materials
 - *Design changes*
 - *Manufacturing changes*
 - *Purchasing decisions*
 - *Using alternative materials*
 - *Reusing items*



Good Examples:

- **UCLA**: Zero waste by 2020 (compostable or recyclable)
- **UCR**: Organic Waste Composted 1,663 tons
 - Landscape Waste 865 Tons
 - Co-mingled recycling 471 Tons
 - Paper/Cardboard 48 Tons
 - Construction Demolition (reused): 596 Tons
 - Solid/Municipal Waste (landfill) 898 Tons

= 83% Diversion Rate

Design changes

- Example: soft drink bottles and milk jugs
- Reduced packaging/plastic



Planned Obsolescence

- Some things are designed to fail so that you have to replace them.
- Sometimes they just make a newer model
- Proprietary batteries.



Planned Obsolescence

- Refrigerators
 - Cars
 - Air Conditioners
 - Bikes
 - Boats
 - Shoes
- Toys
 - Food processors
 - CD players
 - Speakers
 - Clothes
 - Computers



Manufacturing processes

- Industries reduce waste by limiting leaks, spills and accidents



Purchasing decisions

- Business and consumers can choose to purchase items with reduced packaging.
- Purchase in larger sizes
- Don't over purchase



Using less hazardous alternatives

- Cleaning products
- Pesticides
- Reduce amounts
- Follow labels



Reuse

- Industry waste exchanges
- “Pay-as-you-throw” programs per disposal instead of flat fee

WASTE IS NOT WASTE

Recycling

- Conservation of resources by converting them into new product.
- *Reduces pollutants*
- *Saves energy*
- *Creates jobs*
- *Reduced use of*
- *Landfills and incinerators*



Problems

- Recycling does have environmental costs.
- It uses energy and generates pollution.
- Ex. the de-inking process in paper recycling requires energy, and produces a toxic sludge that contains heavy metals.'
- Needs a market – subsidies keep prices of raw materials (like trees) low.

Benefits

- Conserves our natural resources
- Has a positive effect on the economy by generating jobs and revenues.
- For example, the Sunday edition of the New York Times consumes 62,000 trees.
- Currently, only about 20% of all paper in North America is recycled.

The New York Times

Glass



- U.S. recycles about 36% of its glass containers.
- It costs less to recycle glass than to make new glass.
- Mixed color glass “cullet” is used for glassphalt, a glass/asphalt mixture.

Aluminum



- This is the most recycled material in the U.S. because of \$.
- Making a new can from an old one requires a fraction of the energy than to make a new can from raw materials.
- Approximately $\frac{2}{3}$ of cans are recycled each year, saving 19 million barrels of oil annually.

Paper

- U.S. currently recycles 40% of its paper and paperboard.
- Denmark, recycles about 97% of its paper.
- Many U.S. mills are not able to process waste paper.
- Many countries like Mexico, import a large amount of wastepaper from the U.S.
- We export about 19% of our recycled paper.



PLASTICS



#1 - PET (Polyethylene terephthalate)

- PET is used to make soft drink bottles, peanut butter jars, etc.
- PET can be recycled into fiberfill for sleeping bags, carpet fibers, rope, and pillows.



#2 - HDPE (High-density polyethylene)

- HDPE is found in milk jugs, butter tubs, detergent bottles, and motor oil bottles.
- HDPE can be recycled into flowerpots, trash cans, traffic barrier cones, and detergent bottles.



#3 - PVC (Polyvinyl chloride)

- PVC is used in shampoo and cooking oil bottles & fast-food service items.



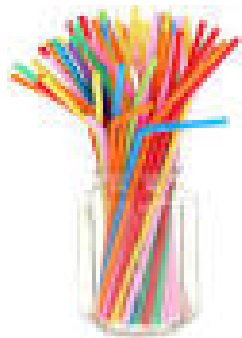
#4 - LDPE (Low-density polyethylene)

- LDPE is found in grocery bags, bread bags, shrink-wrap, and margarine tub tops.
- LDPE can be recycled into new grocery bags.



#5 - PP (Polypropylene)

- PP is used in yogurt containers, straws, pancake syrup bottles, and bottle caps.
- PP can be recycled into plastic lumber, car battery cases, and manhole steps.



#6 - PS (Polystyrene)

- PS is found in disposable hot cups, packaging materials (peanuts), & meat trays
- PS can be recycled into plastic lumber, cassette tape boxes, and flowerpots.



#7 - Other

- A mixture of various plastics, like squeeze ketchup bottles & “microwaveable” dishes.



Post Consumer Waste

- Some recycled papers are pre-consumer, meaning leftover bits of paper cut off of larger rolls.
- Post-consumer would be actual used office paper

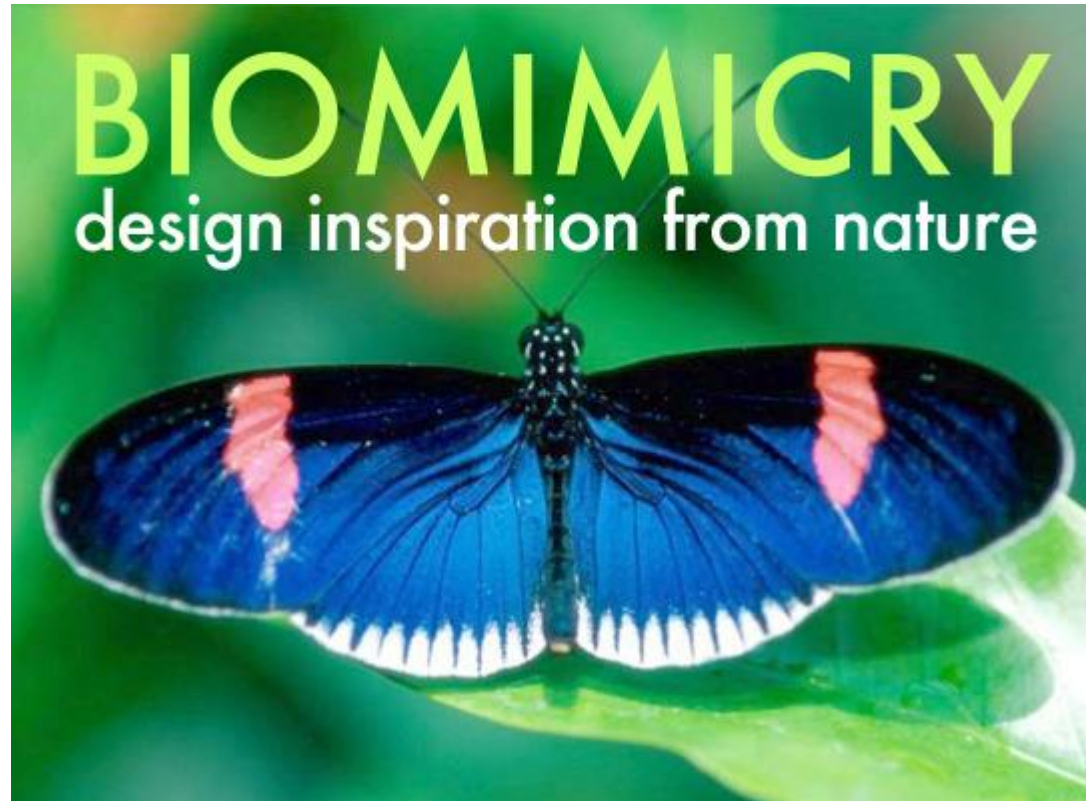


Solutions: Reducing Solid Waste

- *Refuse*: to buy items that we really don't need.
- *Reduce*: consume less and live a simpler and less stressful life by practicing simplicity.
- *Reuse*: rely more on items that can be used over and over.
- *Repurpose*: use something for another purpose instead of throwing it away.
- *Recycle*: paper, glass, cans, plastics...and buy items made from recycled materials.

Biomimicry

- Mimic natural chemical cycles
- Interact in complex resource exchange webs (non-linear)



Ocean Spray

- Captures methane from nearby landfill to power their plant
- Reduces costs of controlling pollution



Successful Examples

- Patagonia (post consumer recycled fleece, recycled threads program)
- Aveda (recycles caps and bottles)
- 3M
- Xerox
- Subaru
(zero waste factory).



What Can You Do?

Solid Waste

- **Follow the five Rs of resource use: Refuse, Reduce, Reuse, Repurpose, and Recycle.**
- **Ask yourself whether you really need a particular item.**
- **Rent, borrow, or barter goods and services when you can.**
- **Buy things that are reusable, recyclable, or compostable, and be sure to reuse, recycle, and compost them.**
 - **Do not use throwaway paper and plastic plates, cups and eating utensils, and other disposable items when reusable or refillable versions are available.**
- **Refill and reuse a bottled water container with tap water.**
- **Use e-mail in place of conventional paper mail.**
- **Read newspapers and magazines online.**
- **Buy products in concentrated form whenever possible.**