APES Ch. 18 Notes: Municipal Solid Waste Disposal and Recovery

18.1 Notes

I. The Solid-Waste Problem

A. Disposal of **municipal solid waste (MSW)**, also known as trash or garbage

1) Examples of MSW—packaging, food scraps, grass clippings, discarded furniture, computers, tires, discarded appliances...

2) Non-examples of MSW— industrial, nuclear, hazardous, construction waste (C-waste depending on location)

EPA 2014 stats: https://www.epa.gov/smm/advancing-sustainable-materials-management-facts-and-figures#Materials

a) trash generation: ~258 million tons
largest components: paper, paperboard, yard trimmings, food
i. paper and paperboard: 26%
ii. yard trimmings and food: 28.2%
iii. plastics: 13%
iv. metals: 9%
v. rubber, leather, textiles: 9%
vi. wood: 6%
vii. glass: 4%

b) How much went to landfills? 52.7%

c) How much was recycled? 34.6%

d) How much was combusted (WTE)? 12.8%

3) Control of local governments: options—

a) Local government owns the collection trucks etc.
b) Using private contractors for services
c) Recycling tax
d) **PAYT – pay-as-you-throw**
e) Household recycling bins
f) Private companies in charge of recycling

B. **landfills – municipal solid waste landfill (MSWLF)**

1) general info

a) definition: *depositing waste on the ground and burying it with at least six inches of dirt*

b) *municipal solid waste landfill (MSWLF)* "receives household wastes but can also receive non-hazardous sludge, industrial solid waste, construction and demolition debris"

https://www.epa.gov/environmental-topics/land-waste-and-cleanup-topics

"Modern landfills are well-engineered and managed facilities for the disposal of solid waste. Landfills are located, designed, operated and monitored to ensure compliance with federal regulations. They are also designed to protect the environment from contaminants, which may be present in the waste stream. Landfills cannot be built in environmentally-sensitive areas, and they are placed using on-site environmental monitoring systems. These monitoring systems check for any sign of groundwater contamination and for landfill gas, as well as provide additional safeguards. Today's landfills must meet stringent design, operation and closure requirements established under the Resource Conservation and Recovery Act (RCRA)."

2) general procedures / options
   a) landfill siting (approval)
   b) landfill expansion
   c) landfill closure
   d) landfill reclamation (golf course, etc.)

3) nonhazardous landfill types
   a) traditional **municipal solid waste landfill (MSWLF) -** see previous page
      i. **bioreactor landfills (bioreactors)**
      - a special type of MSWLF
      - quickly transform and degrade organic waste
      - "addition of liquid and sometimes air to enhance microbial processes"
   b) **industrial waste landfill -** designed for management of non-hazardous industrial process wastes
      i. **construction and demolition debris (C & D) landfill**
      - "only accepts concrete, asphalt, brick, wood, drywall, asphalt roofing shingles, metals, and some types of plastics
      - C&D landfills are subject to less stringent standards than municipal solid waste landfills due to the relatively inert nature of C&D debris materials"

      ii. **Coal Combustion Residual (CCR) landfill** – "used to manage and dispose of coal combustion residuals (CCRs or coal ash)."

4) Pinellas County's Bridgeway Acres Landfill
   a) address: 3095 114th Ave. North, St. Petersburg (727) 464-7500
   b) hours: Waste is accepted Monday-Friday, 6 a.m. – 6 p.m., and Saturday 7 a.m. – 5 p.m. Closed Sundays and designated holidays.

from http://www.pinellascounty.org/solidwaste/landfill-garbage.htm

"Pinellas County Solid Waste manages the only landfill in the county that takes household garbage. Under the ground in Pinellas County there is a natural layer of clay. Our landfill was made by building a clay wall around that natural clay layer underground. The man made clay wall and the natural clay floor join to make a sort of 'bathtub.' The clay 'bathtub' keeps waste in our property and out of the land around it. Because there is limited landfill space, we try burying only waste that can't be burned or recycled such as:
Big items - boats, mattresses, or couches; Construction debris – walls from a house;
Large amounts of waste that we cannot burn, from companies – such as a truckload of lipstick, paintballs....

Trash taken to the landfill is spread, crushed, and covered with ash from the waste-to-energy plant. Though there are some things that are not burned, and sometimes we can't burn our garbage if the waste-to-energy plant is down for repairs or maintenance, most of our waste (85%) is recycled or made into energy in the waste-to-energy plant."

5) advantages of landfills
   a) *no burning* needed
   b) *air pollution minimal*
   c) *constant burying of the layers*—vermin (rats, etc.) are kept to a minimum

6) problems with landfills
   a) *leachate generation*
      - **leachate**—*water tainted with pollutants*
      - forms from percolation and dissolving chemicals

- *can have heavy metals, battery acid, cleaning fluid, pesticides, POPs…*

b) *methane production*

- buried wastes promotes *anaerobic* bacterial action
- **biogas** is produced (usually 2/3 CH_4 with H_2 and CO_2)
  - biogas seeping underground can poison root systems of plants
  - biogas can seep upward into homes and may cause explosions
- **LFG** = **landfill gases –** typically 50% CH_4, 42% CO_2, 7% N_2, 1% O_2

from http://www.floridacenter.org/

"*Old landfills that have been closed or are in need of closing, but have no gas management plan, can be a significant source of odors and greenhouse gases*. Gas extraction tends to be expensive and out of the reach of most small communities managing their solid waste facilities. An attractive alternative is to *incorporate a bio-reactive layer into the design of a landfill cover or in areas with significant release of gas into the atmosphere (typically referred to as hot spots)*… These barriers will reduce emissions of NMOCs (non-methane organic compounds) and should also reduce odors."

- *gas wells* – purifying LFGs:
  - GTE = gas-to-energy
    http://www.energysystemsgroup.com/landfills.asp
  - clean, safe energy source to generate electricity
  - EPA's **Landfill Methane Outreach Program (LMOP)**
    http://www.epa.gov/lmop/
    "a voluntary assistance and partnership program that promotes the use of landfill gas as a renewable, green energy source."

c) *incomplete decomposition* – production of biogas

- lack of moisture and exposure to the elements slow down decomposition of biodegradable materials buried in a landfill
- increased water increases decomposition BUT would increase the toxicity of the leachate

d) *settling*

- settling and compacting of waste as it decomposes
- monitoring the area to maintain a level surface

e) *land values and land use*

http://realtormag.realtor.org/daily-news/2015/07/10/landfills-dont-always-drop-home-values

NIMBY – "not in my backyard" **LULU** – "locally unwanted land use"
NIMTOO – "not in my term of office!"

7) improving landfills

a) landfill **siting** – an example process

characteristics of landfill siting: high ground, significant distance above the water table

(from http://dnr.wi.gov/topic/landfills/sitingfaq.html)

- initial site inspection
- initial site report (ISR)
- pre-feasibility report
- feasibility report
- environmental analysis
- public hearings
- plan of operation report
- landfill construction documentation report
- negotiation
- arbitration, if needed

b) main parts of a landfill

- leachate collection system
- contoured floor

- layers of soil, sand/gravel, clay in a pyramidal shape
- layers of refuse buried

(quote from http://www.floridacenter.org/)

"Typically, *landfill leachate collection systems are positioned above the liner and are designed to function in a free-flowing gravitational mode for the entire active and post-closure periods. Leachate collection systems consist of: underdrains, collection trenches and pipes, line clean-out ports, pumps and lift stations, and storage tanks or wet wells*. Clogging of any portion of the system can lead to higher hydraulic heads within the waste zone and increase the potential for leakage through the liner."

C. *combustion* (burning) of waste

1) advantages
   a) reduction of the weight and volume of trash
   b) reduction of toxic substances into two types of ash
      - *fly ash* (collected from fumes)
      - *bottom ash* (collects at the bottom of the boiler)
   c) trash picked up as usual, just to a different destination
   d) electricity can be produced in **waste-to-energy (WTE)** facilities
      - **resource recovery**—separating materials before and after combustion

2) *Pinellas County WTE facility* http://www.pinellascounty.org/utilities/wte.htm
   a) address: 3001 110th Avenue North, St. Petersburg (727) 464-7500
   b) hours: waste is accepted Monday – Friday 7 a.m. to 3 p.m.
   c) the facility receives ~85% of the county's solid waste

The Waste-to-Energy (WTE) facility has the capacity to burn 3,000 tons of garbage every day. The WTE facility processes about one million tons of garbage every year. The process can produce up to 75 megawatts (MW) per hour of electricity. It sells about 60 MW to Progress Energy for distribution within the community, and the remainder powers the plant itself. *This electricity powers approximately 43,000 homes and businesses every day.* The WTE facility uses state-of-the-art air pollution control technology, which continuously monitors WTE emissions, ensuring the plant's emissions fall within the United States Environmental Protection Agency's (EPA) standards.

There is a 70,000 square foot building next to the WTE facility that contains the Materials Recovery System (MRS) used to recover metals in the garbage. The MRS contractor separates combusted metals from the WTE facility ash, shreds the metals, and sorts them using mechanical equipment such as magnets and eddy currents. The recovered metals are sold to steel mills and smelters for recycling.

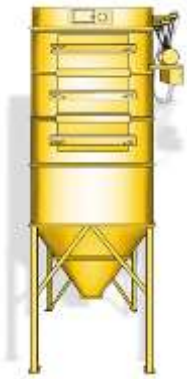
3) Disadvantages of WTE
   a) health effects from particulates, heavy metals, dioxins, etc.
   b) expensive to build
   c) ash is sometimes tainted with hazardous substances (cannot be reused)
   d) may conflict with recycling programs for combustible materials

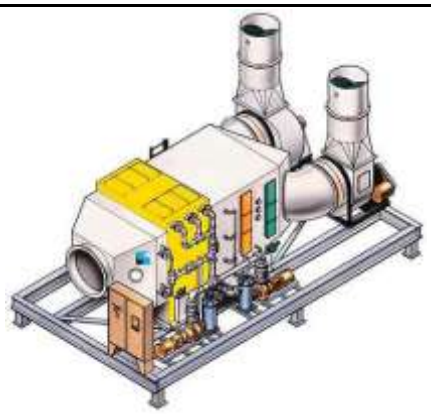
4) operating facility procedures
   a) *inspection* of incoming waste; removal of recyclables and noncombustibles
   b) *magnetic treatment to remove iron* for recycling
   c) waste is put through a *shredder*
   d) waste is blown into *boilers*
   e) water flowing in the boiler walls is converted to *steam* to turn *turbines* to generate power

f) bottom ash is sent to a processing facility
g) ash is sent to landfills

5) special pollution control equipment (see Ch. 21)
   a) **bag house (baghouse) collectors**—a giant "vacuum cleaner" with hundreds of fabric filter bags that clean the air of soot, smoke and metals
   b) **scrubber** sprays a slurry of lime (CaO) into the hot exhaust, which neutralizes acid SOx gases and can improve the capture of mercury (Hg) in the exhaust

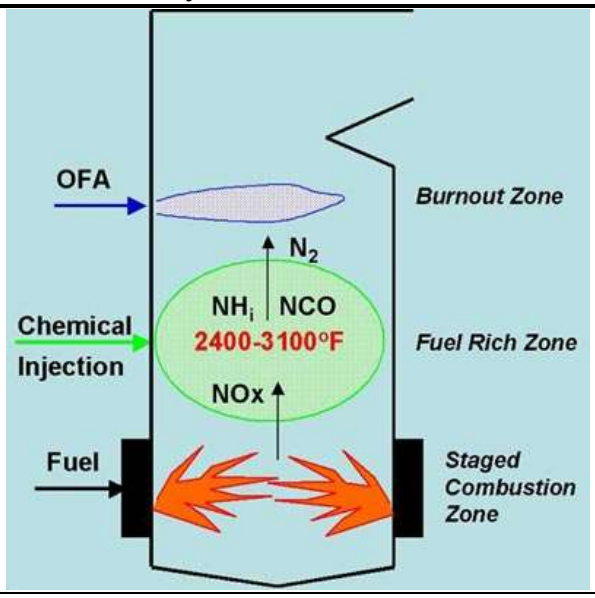
BAGHOUSE COLLECTORS www.whirlair.com | **SCRUBBER** www.mist-dust-collection.com





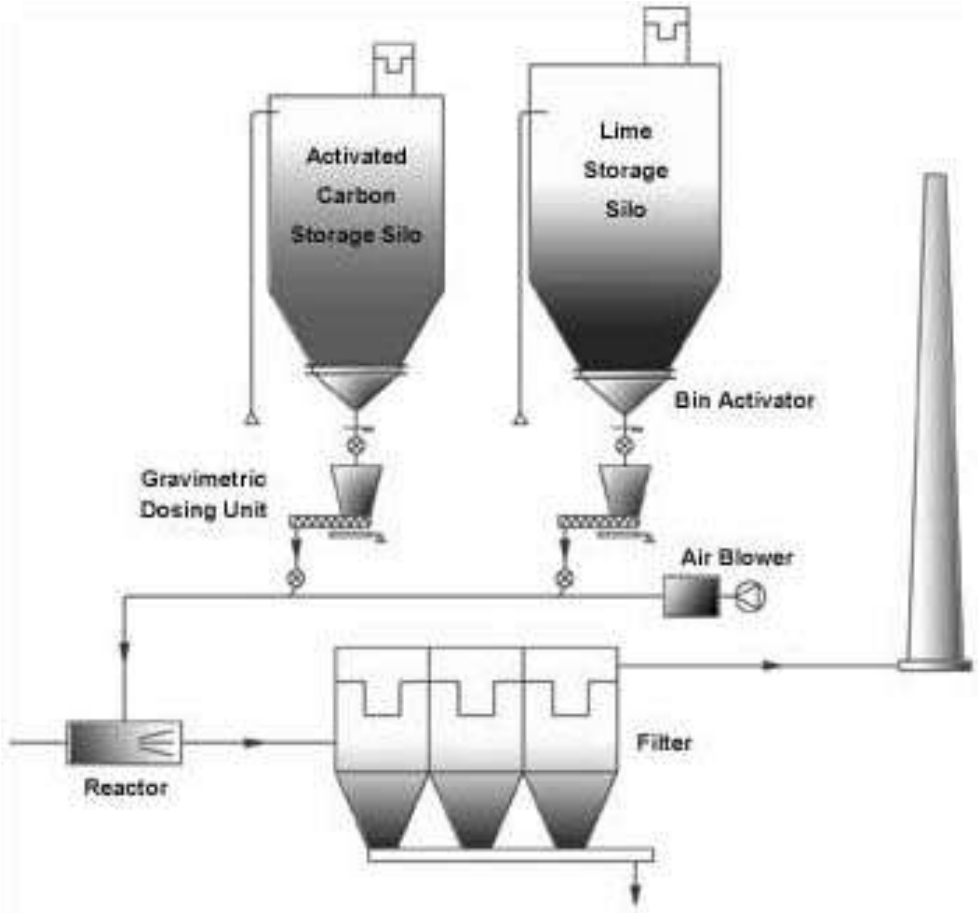
c) ***Selective Non-Catalytic Reduction* or *SNCR*** converts NOx to harmless nitrogen (N_2) by spraying ammonia (NH_3) or urea [$CO(NH_2)_2$] into the hot furnace

SCNR from www.netl.doe.gov
(OFA = overfire air NCO = isocyanate radical NH_i = amine radical)



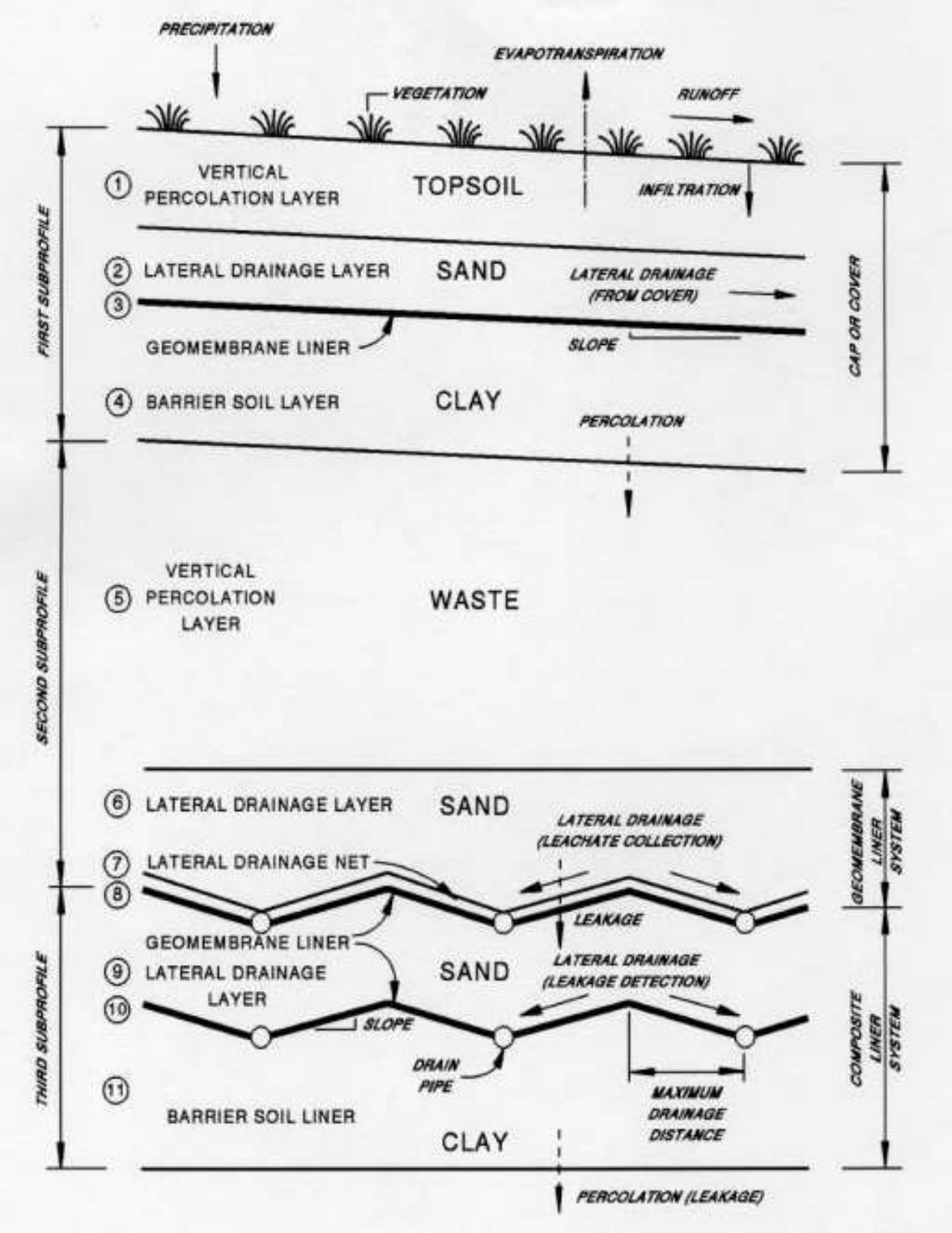
d) **Carbon Injection systems** blow charcoal into the exhaust gas to absorb Hg. Carbon injection also controls organic emissions such as dioxins." Hg emissions are reduced ~90%.

Carbon Injection system from blake.montclair.edu



D. Costs of Municipal Solid Waste Disposal: related issues
   1) site acquisition
   2) trash collection costs
   3) trash hauling costs
   4) trash transfer stations
   5) public vs. private ownership/management of landfills
   6) violators of policy (catching "midnight dumpers")

LANDFILL DESIGN (from http://msw.cecs.ucf.edu/collegestudents.html)



18.2 Notes

II. Solutions to the Problem

A. **source reduction** *(waste prevention, pollution prevention P2)— "pre-cycling"*

1) definition— *the reduction of the amount and/or toxicity of waste at or before the point of generation*

a) reduction of waste

b) conservation of resources

from https://www.epa.gov/p2

> *"Pollution prevention (P2) is any practice that reduces, eliminates, or prevents pollution at its source, also known as 'source reduction.' Source reduction is fundamentally different and more desirable than recycling, treatment and disposal. There are significant opportunities for industry to reduce or prevent pollution at the source through cost-effective changes in production, operation, and raw materials use. The opportunities for source reduction are often not realized because existing regulations focus upon treatment and disposal."*

2) examples

a) making packaging lighter, using less materials

b) use email rather than paper mail

c) keep records and store them electronically

d) donation of unwanted items to charities and thrift stores

e) selling unwanted items online

f) photocopying two-sided documents

g) product maintenance and repair rather than disposal

h) buy items with less bulky packaging

i) mulching and backyard composting of yard waste

3) *benefits* (from the EPA)

a) *saves natural resources*

b) *reduces toxicity of waste*

c) *reduces costs to communities, businesses, schools and consumers*

d) *prevents emissions of many GHG (Greenhouse gases)*

e) *saves energy*

f) *reduces the need for new landfills and combustors*

B. the recycling solution

Pinellas County recycling: http://www.pinellascounty.org/utilities/recycle.htm

1) basic terminology

a) *reduce*—decreased production of waste

b) *reuse*—finding another use for the object or substance without any transformation

c) *recycle*—use of the material as a source raw material, involves physical transformation

> "Recycling is defined as the recovery of materials, such as paper, glass, plastic, metals, construction and demolition (C&D) material and organics from the waste stream (e.g., municipal solid waste), along with the transformation of materials, to make new products and reduce the amount of virgin raw materials needed to meet consumer demands."

d) *recovery*—process to recover useful material from mixed waste

e) *raw materials*: crude or processed materials that can be converted by manufacture, processing, or combination into a new and useful product

2) levels of recycling
   a) **primary recycling**—*when the original waste material is made back into the same material* (newspaper → newsprint paper)
   b) **secondary recycling**—*when the original waste material is made into some other product* (newspaper → cardboard)
   c) **tertiary recycling**—*breaking material down to components that composed the original product*; often through depolymerization

3) municipal recycling
   a) different cities have different guidelines for pickup etc.
   b) *characteristics of a successful recycling program*
      - *PAYT charges*
      - *mandatory, with fines for violators*
      - *curbside pickup with free bins*
      - *a community effort—business and residential*
      - *organized and clear-cut guidelines and goals*

4) recycling of paper and paper products
   a) plain paper, envelopes, newspaper, magazines, phone books, cardboard…
   b) **post-consumer waste**—*paper recycled by consumers*
      - this is really recycled paper
      - look for a high % of post-consumer waste on the label
   c) **pre-consumer waste**—*scrap paper at the processing plant*, not ever sent out as a product
   d) demand for recycled paper fluctuates; some forest-poor countries pay for used paper
   e) recycled paper is made into new newsprint, boxes and office paper, paper towels, tissue products, insulation, cereal boxes, molded packaging, hydro-mulch, gypsum wallboard, even compost and cat litter
   f) info and stats

PAPER stats from American Forest & Paper Association, www.afandpa.org :

- Every day, U.S. papermakers recycle enough paper to fill a 15 mile long train of boxcars.
- Every ton of paper that is recovered saves 3.3 cubic yards of landfill space.
- U.S paper recovery has grown by 76 percent since 1990, when the paper industry established its first recovery goal to advance recycling.
- A single tree can absorb more than 10 pounds of CO_2 each year.

5) recycling of glass
   a) food and beverage containers; clear/green/brown
   b) some characteristics of glass
      - nonporous and impermeable
      - does not deteriorate, corrode, stain or fade
      - glass is *100% recyclable*
      - glass recycling is a *closed-loop system*, creating no additional waste or by-products

- *Glass containers can go from recycling bin to store shelf in as little as 30 days.*

c) basic glass vocabulary
- *cullet*— pieces of glass, ordinarily discarded, that are added to new material to assist in the melting and making of new glass
- *sand*—fine-grain, loose, *granular quartz* (SiO_2) used in making glass
- *soda ash*— commercial *sodium carbonate* (Na_2CO_3) used as a raw material for making glass

d) *bottle laws*—requiring a deposit on beverage containers
http://www.bottlebill.org/legislation/usa.htm
- existing bottle deposit law states: California, Connecticut, Hawaii, Iowa, Maine, Massachusetts, Michigan, New York, Oregon, and Vermont

e) characteristics and stats

GLASS info from EPA :
https://www.epa.gov/recycle/how-do-i-recycle-common-recyclables#gla

"Glass, especially glass food and beverage containers, can be recycled over and over again. Americans generated 11.5 million tons of glass in 2014, about 26 percent of which was recovered for recycling. Making new glass from recycled glass is typically cheaper than using raw materials. Most curbside community recycling programs accept different glass colors and types mixed together, and then glass is sorted at the recovery facility. Check with your local program to see if you need to separate your glass or if it can be mixed together.Glass in durable goods, such as furniture, appliances, and especially consumer electronics, round out the sources of post-consumer glass."

6) recycling of plastics

a) recycling codes

Code 1 PETE or PET: Polyethylene terephthalate
Code 2 HDPE: High density polyethylene
Code 3 V: Polyvinylchloride (or PVC)
Code 4 LDPE: Low density polyethylene
Code 5 PP: Polypropylene
Code 6 PS: Polystyrene
Code 7 OTHER, PC: polycarbonate
Code 7 OTHER, PMMA: polymethyl-methacrylate
Code 7 OTHER, N-66 nylon-66

b) how plastics are made, from the EPA

"*Plastics are* **polymers**. The simplest definition of a polymer is something made up of many units. *Polymers are chains of molecules*. Each link of the chain is usually made of carbon, hydrogen, oxygen, and/or silicon. To make the chain, many links, are hooked, or polymerized, together.

To create polymers, petroleum and other products are heated under controlled conditions and broken down into smaller molecules called monomers. These **monomers** *are*

the building blocks for polymers. Different combinations of monomers produce plastic resins with different characteristics, such as strength or molding capability.

Plastics can be divided in to two major categories: **thermosets** *and* **thermoplastics**. A thermoset is a polymer that solidifies or "sets" irreversibly when heated. They are useful for their durability and strength, and are therefore used primarily in automobiles and construction applications. Other uses are adhesives, inks, and coatings.

A thermoplastic is a polymer in which the molecules are held together by weak bonds, creating plastics that soften when exposed to heat and return to original condition at room temperature. Thermoplastics can easily be shaped and molded into products such as milk jugs, floor coverings, credit cards, and carpet fibers.

Plastic resins are processed in several ways, including extrusion, injection molding, blow molding, and rotational molding. All of these processes involve using heat and/or pressure to form plastic resin into useful products, such as containers or plastic film."

c) info and stats

general **PLASTIC** stats:

- *PETE (#1) and HDPE (#2) are the most commonly recycled plastics.*
- Much of the polyester carpet made in the US is from recycled soda bottles.
- Recycled plastic is also made into plastic lumber, clothing, flower pots, insulation for sleeping bags & ski jackets, car bumpers and more.

PLASTIC info from EPA
https://www.epa.gov/recycle/how-do-i-recycle-common-recyclables#pla :

- "Americans generated 33 million tons of plastics in 2014, about 13 percent of the waste stream.
- Only 9.5 percent of plastics were recycled in 2013.
- …Plastics are a rapidly growing segment of the MSW stream. The largest category of plastics are found in containers and packaging (e.g., soft drink bottles, lids, shampoo bottles), but they also are found in durable (e.g., appliances, furniture) and nondurable goods (e.g., diapers, trash bags, cups and utensils, medical devices)."

7) recycling of metals

ALUMINUM stats:

- Aluminum cans made their first appearance in America in 1953.
- *We use about 392 cans per person per year.*
- Aluminum cans typically have a recycled aluminum content of about 55%.
- ***Recycling aluminum saves about 95% of the energy it would take to produce aluminum from its original source, bauxite.***
- *Recycling one aluminum can saves enough electricity to run a TV for three hours.*
- *Aluminum recycling is so efficient that it can take as few as 60 days for a can to be collected, melted down and made into a new can sitting on a grocery store shelf.*
- Recycled aluminum is made into cans, pie pans, house siding, small appliances, lawn furniture; in fact, almost everything aluminum.

Source: The Aluminum Association, Inc.; American Beverage Association

From the EPA

- "The largest source of aluminum in the MSW stream is aluminum *used beverage containers (UBCs)* and other packaging containers.
- Other sources of aluminum are found in durable and nondurable goods, such as appliances and automobile parts.
- *Manufacturers make 99% of all beer cans and 97% of all soft drink cans from aluminum.*
- Automobiles also contain aluminum, but this aluminum is generally not calculated in measures of MSW generation, recycling, or disposal."

STEEL – alloy of iron (Fe; "ferrous"= Fe^{2+}, with other metals such as C, Mn, Si, Cu, Al, B, Cr, Co, Mo, Ni, Ti, W, V, Zr

STEEL stats from the EPA:

- "More than 1,000 facilities in the US make and process steel, and most are located in the Great Lakes region and the South.
- Other sources of steel in the MSW stream are containers and packaging, such as food packaging and aerosol cans.
- Large quantities of steel and other ferrous metals are found in construction materials and transportation products, such as automobiles, locomotives, and ships, but these are not included in calculations of MSW. These non-MSW products are, however, highly recycled."

8) recycling of paper

PAPER stats from the EPA:
https://www.epa.gov/recycle/how-do-i-recycle-common-recyclables#pap

- Paper makes up nearly 30 percent of municipal solid waste (trash) generated each year, more than any other material.
- Americans recycled about 65 percent of the paper they used in 2014. This recovered paper is used to make new paper products, saving trees and other natural resources.

9) other items of interest in recycling

- cereal boxes
- yard wastes
- textiles (fabrics)
- tires
- holiday trees
- aerosol cans

10) items that require special pickup

- fluorescent bulbs
- motor oil
- paint cans
- old computers
- white metal (appliances)

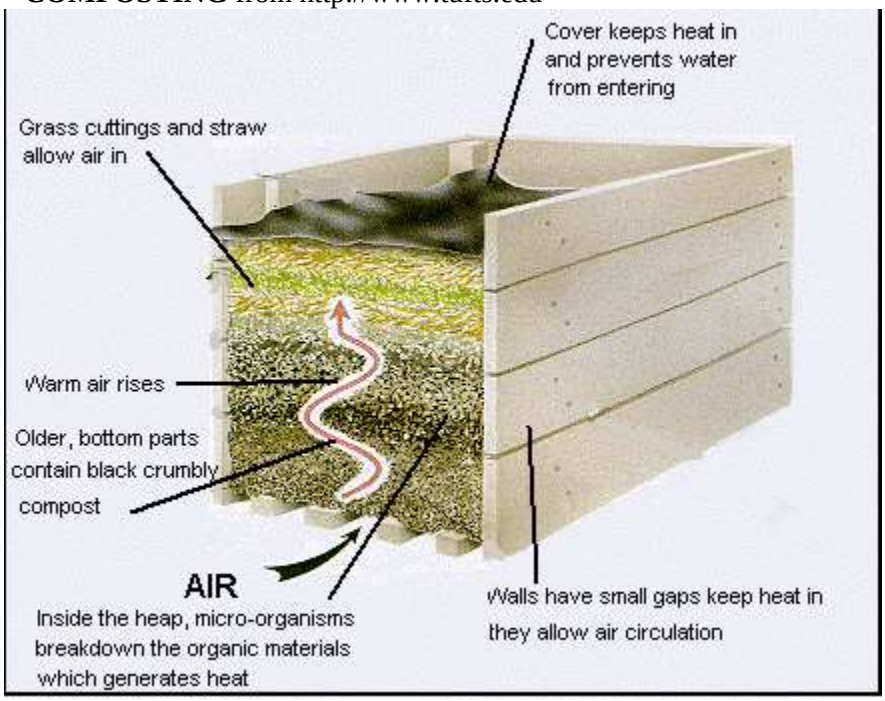
11) *completing the loop*: buying recycled
   a) The "cycle" part of the word is important, and to complete a cycle, four phases must be gone through: collection, sorting, reclamation and marketing.
   b) Recycling may be mechanical, chemical or thermal.

C. **Composting** natural composting = aerobic biological decomposition

1) *benefits of composting* from the EPA
   a) *"Suppress plant diseases and pests.*
   b) *Reduce or eliminate the need for chemical fertilizers.*
   c) *Promote higher yields of agricultural crops.*

d) *Facilitate reforestation, wetlands restoration, and habitat revitalization efforts by amending contaminated, compacted, and marginal soils.*
e) *Cost-effectively remediate soils contaminated by hazardous waste.*
f) *Remove solids, oil, grease, and heavy metals from stormwater runoff.*
g) *Capture and destroy 99.6 percent of industrial volatile organic chemicals (VOCs) in contaminated air.*
h) *Provide cost savings of at least 50% over conventional soil, water, and air pollution remediation technologies, where applicable."*

COMPOSTING from http://www.tufts.edu



2) EPA: What to compost

Animal manure	Fireplace ashes	Nut shells
Cardboard rolls	Fruits and vegetables	Sawdust
Clean paper	Grass clippings	Shredded newspaper
Coffee grounds and filters	Hair and fur	Tea bags
Cotton rags	Hay and straw	Wood chips
Dryer/vacuum cleaner lint	Houseplants	Wool rags
Eggshells	Leaves	Yard trimmings

3) EPA: What not to compost, and why

Leave Out...	**Reason Why...**
Black walnut tree leaves or twigs	Releases substances that might be harmful to plants
Citrus rinds (e.g., grapefruit, lemons, limes, oranges)	Might contain fruit flies and eggs
Coal or charcoal ash	Might contain substances harmful to plants
Dairy products (e.g., butter, egg yolks, milk, sour cream, yogurt)	Create odor problems and attract pests such as rodents and flies

Diseased or insect-ridden plants	Diseases or insects might survive and be transferred back to other plants
Fats, grease, lard, or oils	Create odor problems and attract pests such as rodents and flies
Meat or fish bones and scraps	Create odor problems and attract pests such as rodents and flies
Pet wastes (e.g., dog or cat feces, soiled cat litter)	Might contain parasites, bacteria, germs, pathogens, and viruses harmful to humans
Yard trimmings treated with chemical pesticides	Might kill beneficial composting organisms
Source: https://www.epa.gov/recycle/composting-home	

18.3 Notes

III. Public Policy and Waste Management

A. the regulatory perspective

1) **Solid Waste Disposal Act of 1965**
   a) gave financial and technical power to the Bureau of Solid Waste Management
   b) established grant programs to support the use of improved methods for disposal
   c) established grant programs to support the development of solid waste disposal plans by states and interstate agencies

2) *Resource Recovery Act of 1970:*
   a) gave power to the newly formed EPA
   b) encourages individual states to formulate waste management programs

3) **Resource Conservation and Recovery Act (RCRA) of 1976** ("rick-rah")
   a) primary law governing the disposal of solid and hazardous waste
   b) amended the Solid Waste Disposal Act of 1965
   c) goals
      - To protect human health and the environment form the potential hazards of waste disposal
      - To conserve energy and natural resources
      - To reduce the amount of waste generated
      - To ensure that wastes are managed in an environmentally sound manner
   d) summary
      - "command and control" approach
      - closures of local dump sites
      - regulations for landfills
      - regulations of combustion facilities
      - required states to formulate solid waste management plans

4) *Solid Waste Disposal Act Amendments of 1980*
   a) provided EPA tougher enforcement powers to deal with illegal dumpers of hazardous waste
   b) the Agency's authority to regulate certain high-volume, low-hazard wastes (known as "special wastes") was restricted
   c) funds were authorized to conduct an inventory of hazardous waste sites

5) **Superfund** Act (**CERCLA***: Comprehensive Environmental Response, Compensation, and Liability Act of 1980):* hazardous waste
(will be discussed at length in the next chapter)

6) **Hazardous and Solid Waste Amendments (HSWA) of 1984** ("hiss-wah")
   a) *the most significant set of amendments to RCRA*
   b) created the new regulatory program for underground storage tanks (UST)
   c) hazardous waste facilities owned or operated by federal, state, or local government agencies must be inspected annually, and privately owned facilities must be inspected at least every two years

B. **integrated solid waste management** (ISWM, IWM)

1) EPA definition: *complete waste reduction, collection, composting, recycling, and disposal system*

https://www.thebalance.com/integrated-solid-waste-management-iswm-an-overview-2878106
"An efficient ISWM system considers how to reduce, reuse, recycle, and manage waste to protect human health and the natural environment. It involves evaluating local conditions and need, then choosing, mixing and applying the most suitable solid waste management activities according to the conditions."

2) progression
   a) landfill (worst option for trash)
   b) incineration (burning trash for fuel)
   c) recycling and composting (materials redone as resources)
   d) reuse (keeping it out of the waste stream)
   e) reduction (don't generate as much trash)

3) waste reduction (see 18.2)
   a) *extended product responsibility (EPR)*

from the EPA:
"Product stewardship is a product-centered approach to environmental protection. Also known as extended product responsibility (EPR), product stewardship *calls on those in the product life cycle—manufacturers, retailers, users, and disposers—to share responsibility for reducing the environmental impacts of products*."

   b) parts: businesses, retailers, consumers, state/local/federal government
   c) types of products:

*batteries, packaging, carpet, vehicles, mercury-containing products (*thermometers, thermostats, fluorescent lights, some batteries, some vehicle parts, medical waste), *building materials, paint, pesticides, propane tanks and gas canisters, radioactive materials*

from the EPA:
"*Currently, it is estimated that 75% of a vehicle's weight is being recycled, mostly its metal components—the chassis, engine block, and radiator*, for example. The other 25%, is known as auto shredder residue (ASR) or "fluff" contains plastics, rubber, wood, paper, fabrics, and glass. Each year, about 5 million tons of ASR are disposed of in landfills."

   f) *PAYT – Pay-As-You-Throw*
   from the EPA:

"Traditionally, residents pay for waste collection through property taxes or a fixed fee, regardless of how much or how little trash they generate. Pay-as-you-throw (PAYT) breaks with tradition by treating trash services just like electricity, gas, and other utilities. Households pay a variable rate depending on the amount of service they use."

g) EPA's *WasteWise*—program with voluntary membership, to form and implement solid waste reduction programs

2) *waste disposal*—encouragement of WTE and better related technology development

3) recycling and reuse
   a) *materials recovery facilities (MRF)*
   b) reuse first
   c) more durable quality of goods
   d) buy recycled ("close the loop")
   e) some states have banned the disposal of recyclable items in landfills
   f) *national* bottle-deposit law ("Bottle Bills") in the future?
   g) Pollution prevention (P2) is any practice that reduces, eliminates, or prevents pollution at its source, also known as "source reduction."
   h) Source reduction is fundamentally different and more desirable than recycling, treatment and disposal.
   i) There are significant opportunities for industry to reduce or prevent pollution at the source through cost-effective changes in production, operation, and raw materials use.
   j) The opportunities for source reduction are often not realized because existing regulations focus upon treatment and disposal.