

Water Treatment

Drinking Water Quality

- Much of the world's drinking water is contaminated and poses serious health threats
- U.S. Safe Drinking Water Act of 1974 requires EPA to establish national drinking water standards
- Alternates to Tap Water:
 - Bottled water- is it really from natural spring? Also, puts too many plastic bottles in landfill!
 - Home filters- Types
 - Point of entry- all water is filtered
 - Point of use- faucet filter, under counter filter

Water Quality Standards

- The EPA (Environmental Protection Agency) sets Maximum Contaminant Levels (MCLs) for drinking water
- There are standards for numerous contaminants, two of which cause an immediate health threat if exceeded
 - Coliform bacteria -because they may indicate presence of disease-causing organisms
 - Nitrate - can cause ‘blue baby syndrome’—nitrate reacts with blood and blood can’t carry as much oxygen

Water Quality Report

- Received by all homeowners in the U.S.
- Cobb county gets water from Chattahoochee River and Lake Allatoona
- Cobb county's report highlights
 - <http://water.cobbcountyga.gov/files/2007CCR.pdf>

In Cobb County (& most counties in Georgia)...

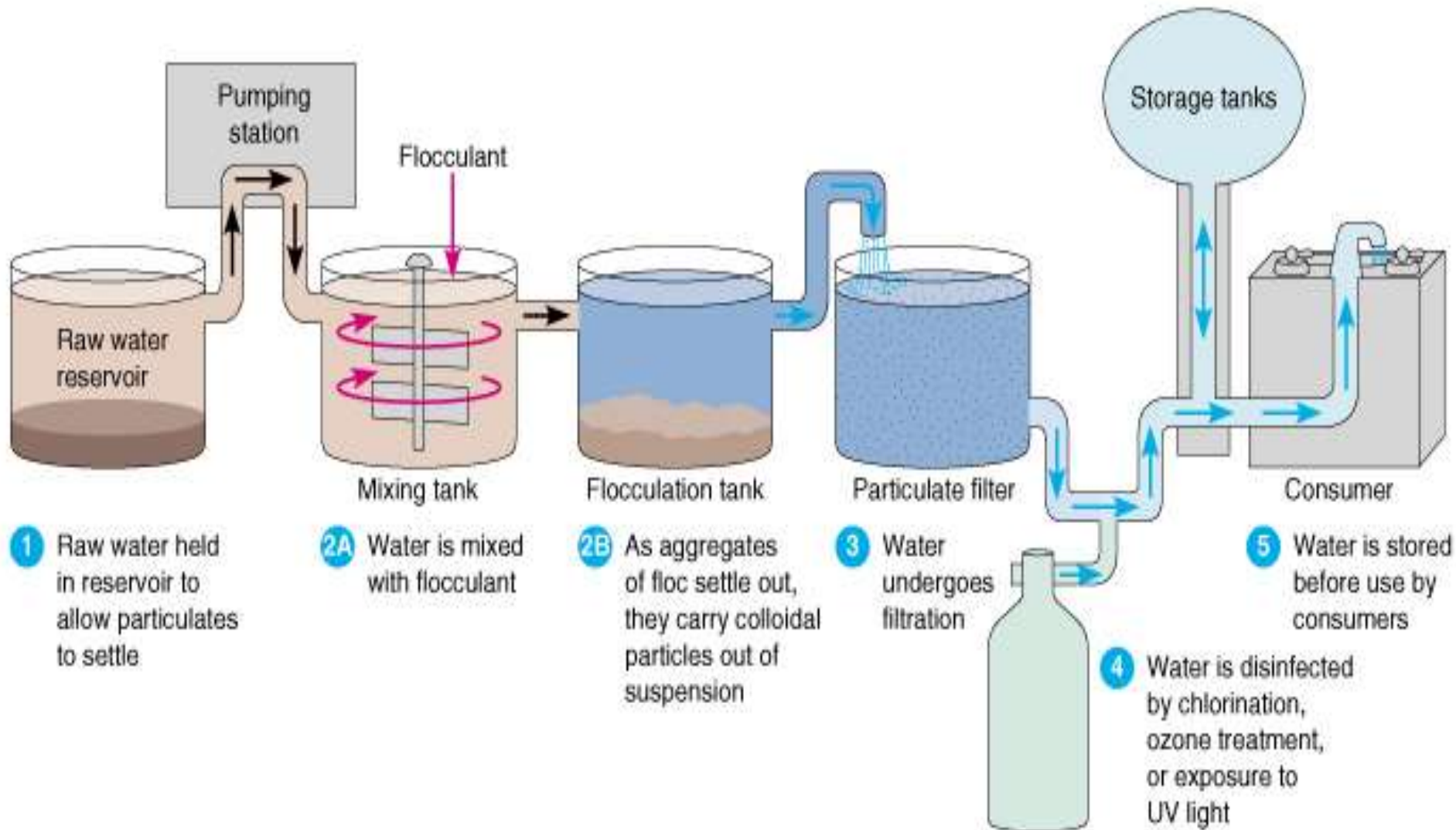
- What ever goes down the curb, goes down a drain, which flows into the nearest body of surface water.
- Often contains gasoline, oil, trash, chemicals that could harm aquatic life.
- Eventually reaches water treatment plant where it is treated and you consume it.



MUNICIPAL WATER PURIFICATION PLANTS

Treats water from rivers, lakes,
etc to send to homes for municipal
use.

Municipal Water Purification Plant



Water Treatment Plant Stages

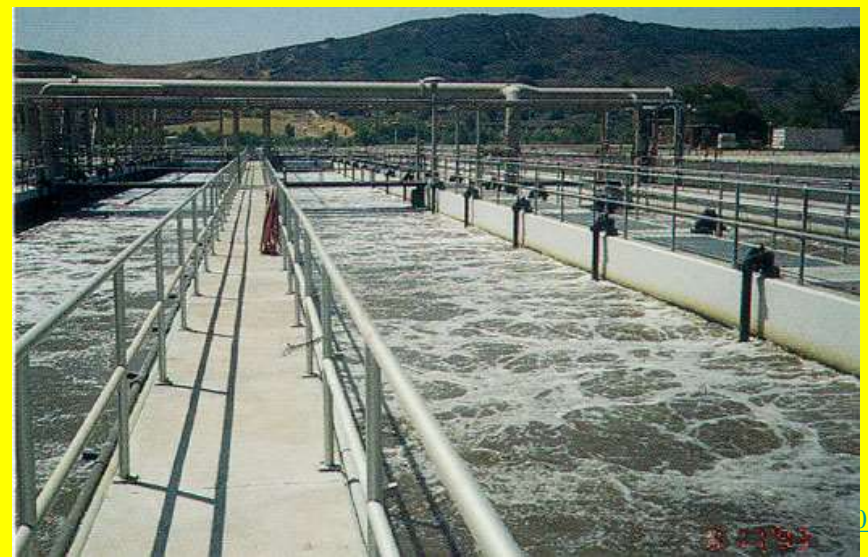
Depending on the type of treatment plant and the quality of raw water, treatment generally proceeds in the following sequence of stages:

1. Screening
2. Aeration
3. pH correction
4. Coagulation and flocculation
5. Sedimentation
6. Pre-chlorination and dechlorination
7. Filtration
8. Disinfection
9. pH adjustment

- As required, other steps will be added, depending on the chemistry of the treated water.

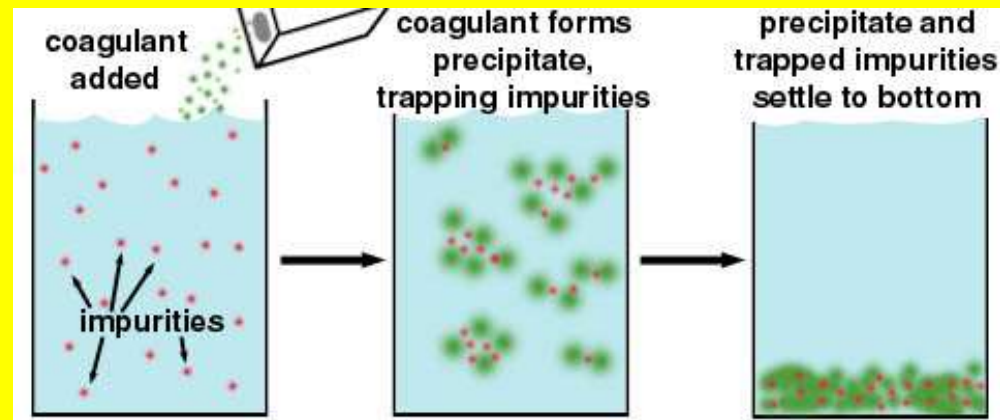
Initial Stages

1. **Screening** - removal of any coarse floating objects, weeds, etc.
2. **Aeration** - dissolving oxygen into the water
 - removes smell and taste
 - promotes helpful bacteria growth
 - precipitates nuisance metals like iron and manganese.
3. **pH correction** - preparing for coagulation and to help precipitate metals. (remember how acid rain leaches metals out of soil?- make water acidic to leach out metals)



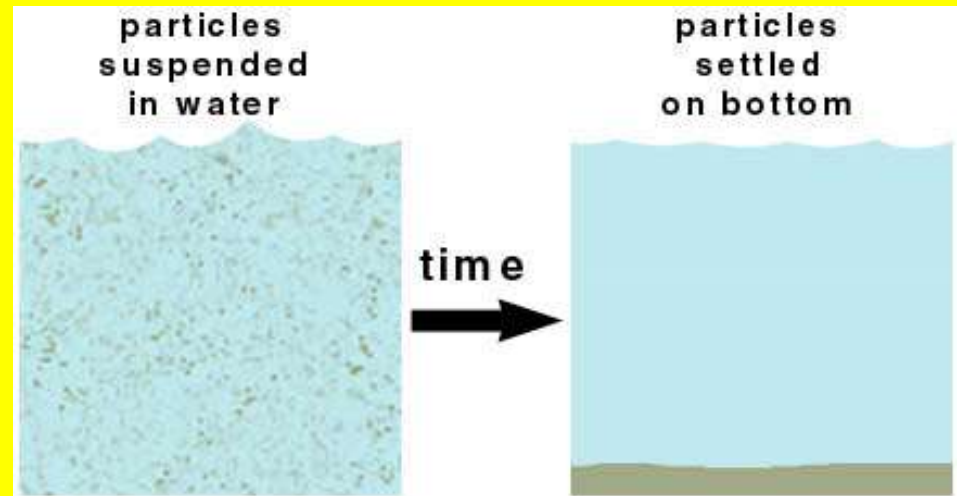
4. Coagulation and flocculation –

- add coagulating agent (aluminum sulfate or iron sulfate)
- causes agglomeration (clumping) and sedimentation of solid particles
- these solid particles are called floc or sludge



5. Sedimentation –

- Floc settles out and is scraped and vacuumed off the bottom of large sedimentation tanks.
- Clarified water drains out of the top of these tanks in a giant decanting process.



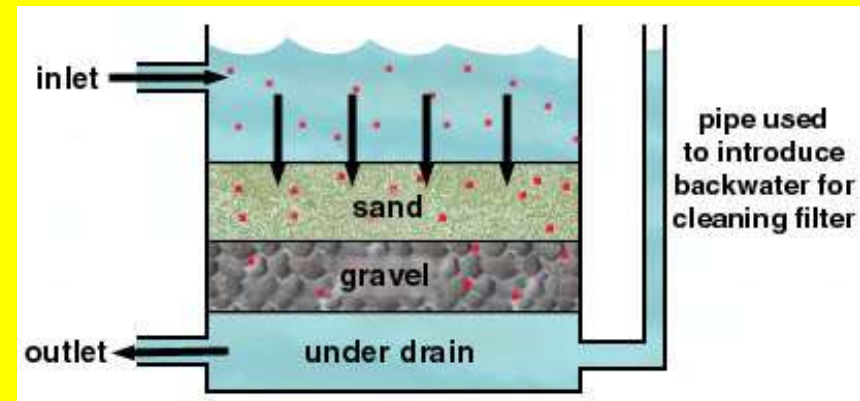
6. Pre-chlorination and dechlorination -

mostly to kill algae that would otherwise grow and clog the water filters. Also kills much of the remaining bacteria

Filtering Out What's Left

7. Filtration (depends on size of plant/volume of water considerations)

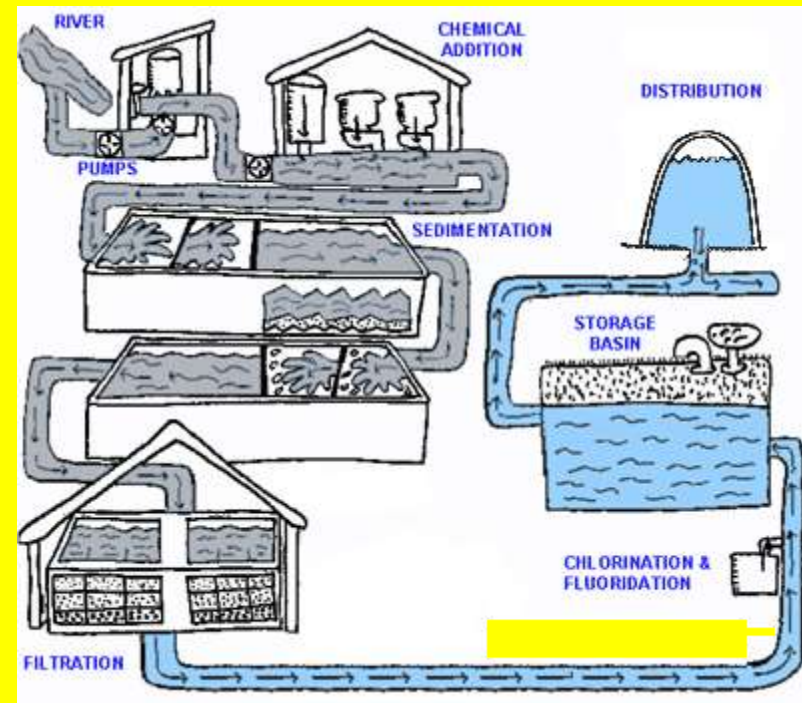
- Rapid-sand filters force water through a 0.45-1m layer of sand and work faster, needing a smaller area. But they need frequent back-washing
- Slow-sand filters require a much larger area but reduce bacteriological and viral levels to better due to the Schmutzdecke (biofilm) layer. The top 1 inch of biofilm must be periodically scraped off and the filter occasionally back-washed



Final Touches

8. Disinfection - water completely free of suspended sediment is treated with a powerful oxidizing agent usually one of three types:

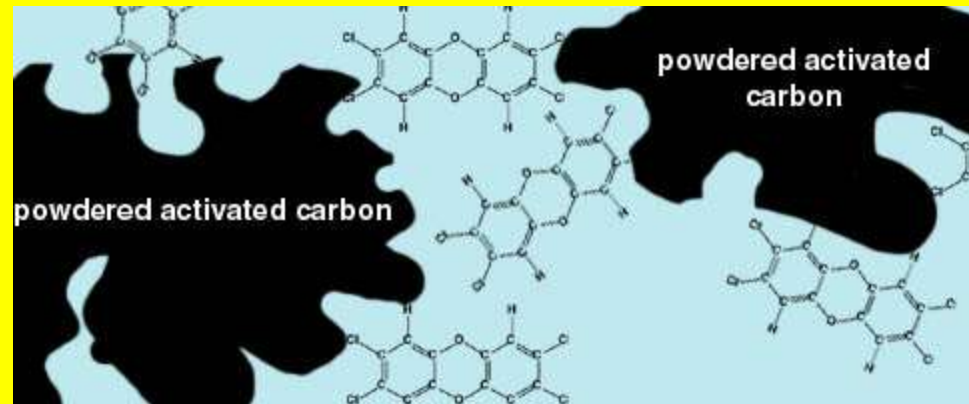
- Chlorine
 - Chlorine can form harmful byproducts and has suspected links to stomach cancer and miscarriages.
- Chloramine (chlorine then ammonia)
 - Many agencies now residually disinfect with Chloramine- does not dissipate from water before reaching consumers like chlorine does
- Ozone- more expensive
- UV-light



9. pH adjustment - so that treated water leaves the plant in the desired range of 6.5 to 8.5 pH units.

Possible Additional Steps

- **Heavy metal removal:** most treatment plants do not have special stages for metals but rely on oxygenation, coagulation and ion exchange in filters to remove them. If metals persist, additional treatment would be needed
- **Troublesome organics:** Activated carbon filters are required where soluble organic constituents are present because many will pass straight through standard plants, e.g. pesticides, phenols and MTBE



After treatment, where does it go?

- After water is treated, it is stored in a water tower, then sent thru pipes to your home.



WATER POLLUTION CONTROLS

Source Reduction

- Stop producing the pollution
- Eliminate lead from gas- decreased lead in water
- Better handling of oil (double hulled ships)
- Banning of DDT & PCB's in 1970's
- Modifying agricultural practices- fewer pesticides, fertilizers
- Recycling
- Industries must separate their wastes to remove metals which can be sold to other companies that use it for their products
 - EX: Printing companies sell silver waste to company. Printing co. does not pay hazardous waste fee & silver is reused. Purchasing company gets what they need at a cheaper price.

Non-Point Reduction

- Agriculture- soil conservation methods, use precise amounts of pesticides, fertilizers, etc.
- Preserving wetlands to filter pollutants
- Urban runoff- recycle waste oil instead of sending down drains, pick up trash, minimize fertilization & pesticide application in your yard, banning phosphate detergent use
 - Chesapeake Bay (America's largest estuary) declined by early 1970's
 - Citizens groups, state legislature & federal govt, all worked together to fix the Bay
 - Banned phosphate detergents, upgraded overburdened WWTP
 - Since 1980's phosphate levels have dropped 40%
 - Chesapeake Bay is slowly recovering

WASTEWATER TREATMENT PROCESS

- **Takes effluent water from homes, industry & agriculture and treats water to send back to river.**
- **Use the same processes of purification that would occur in a natural aquatic system only they do it faster and in a controlled situation.**

Wastewater comes from...

- Domestic used water and toilet wastes
- Rainwater
- Industrial effluent
(Toxic industrial water is pretreated)
- Livestock wastes

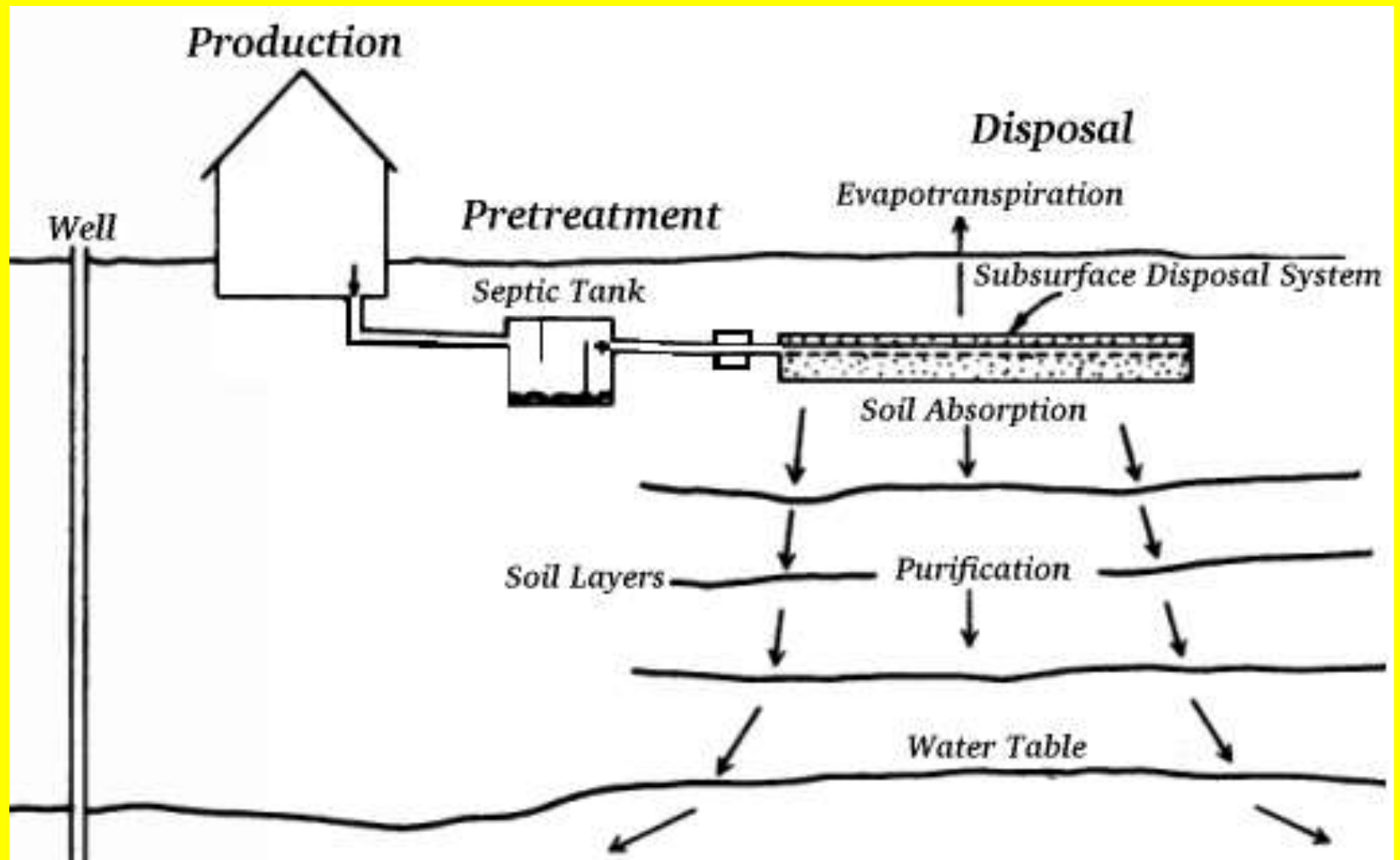


Wastewater Treatment

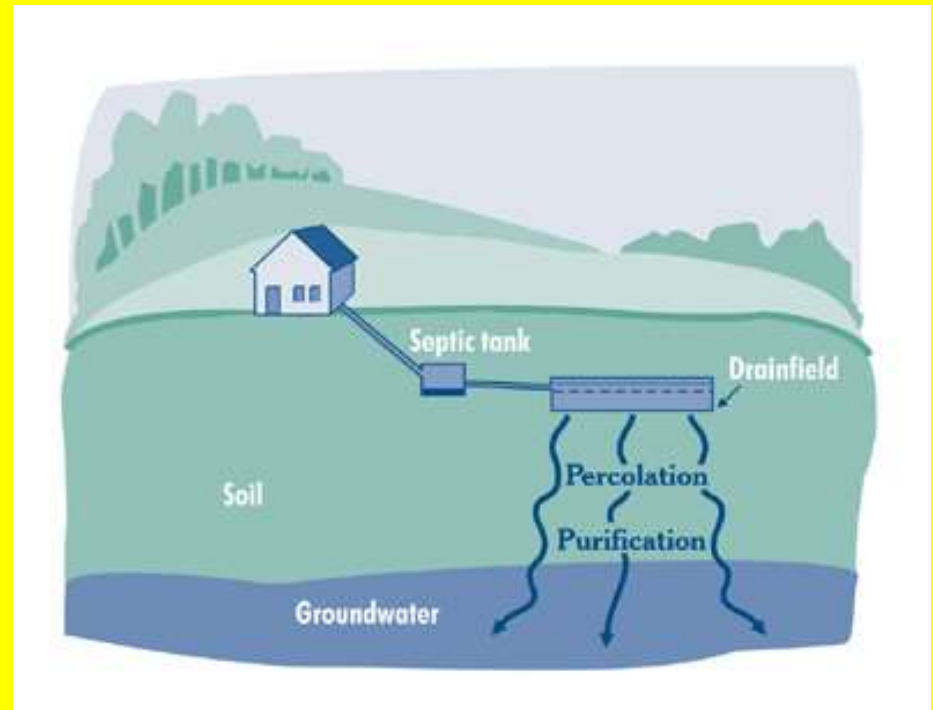
Types of treatment systems include:

- Septic Tanks typically treat small volumes of waste (e.g., from a single household, small commercial/industrial)
- Waste Water Treatment Plants (WWTPs) typically treat larger volumes of municipal or industrial waste.

SEPTIC TANKS



- In rural areas or in particular urban communities in the U.S., human wastewater will be treated through individual septic tank systems
 - Microorganisms breakdown waste
 - Wastewater is filtered thru soil & rocks of leachfield
 - If no leachfield, septic truck sucks out waste & sends to WWTP.

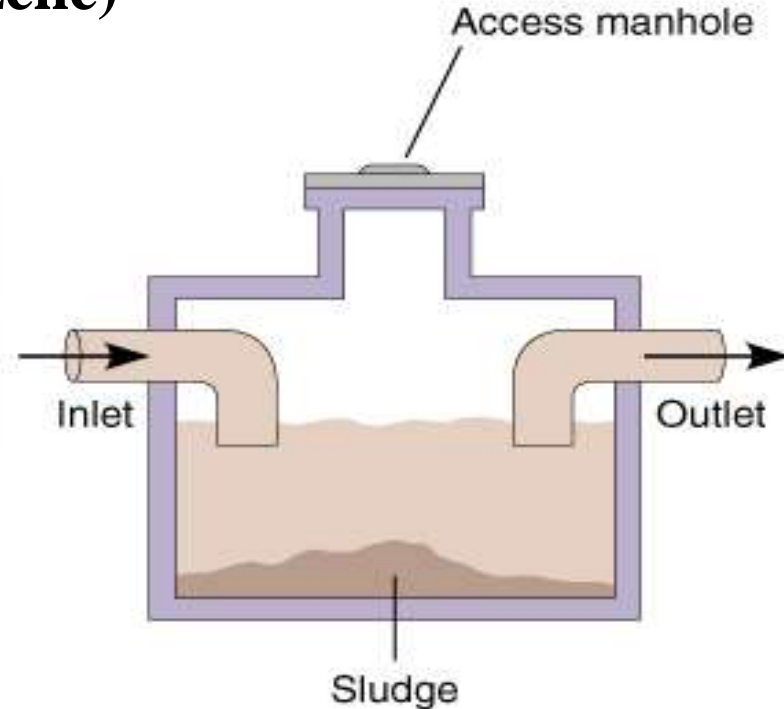
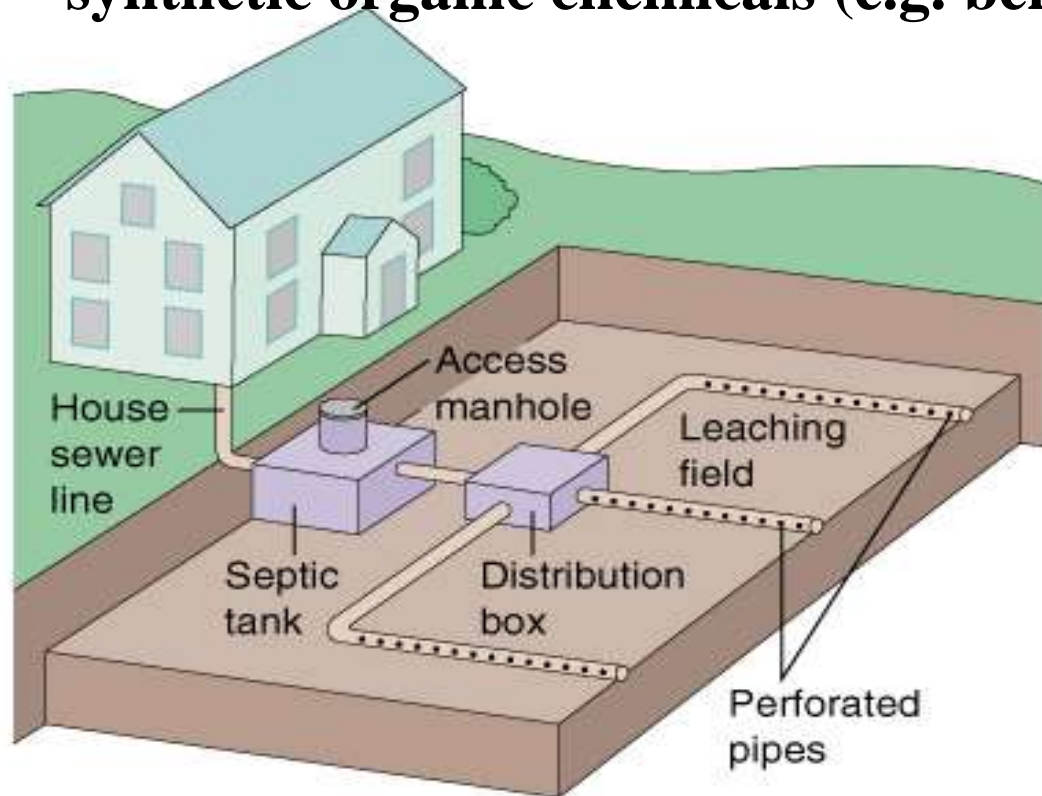


- In LDC, urban wastewater is seldom treated and instead flows raw through collectors to bodies of water (like in the US 100 years ago)

Septic tanks are easier & faster to install than sewage system. Many communities do not want them because they prevent fast recycling of water back to ecosystem.

Septic Tanks

- **Approx. 22 million systems in operation (30% of US population)**
- **Suitability determined by soil type, depth to water table, depth to bedrock and topography**
- **Commonly fail due to poor soil drainage**
- **Potential contaminants: bacteria, heavy metals, nutrients, synthetic organic chemicals (e.g. benzene)**

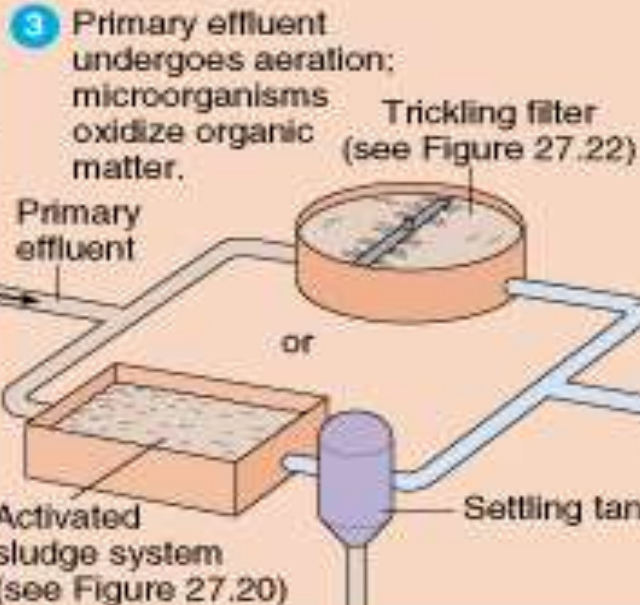


WASTEWATER TREATMENT PLANTS (WWTP'S)

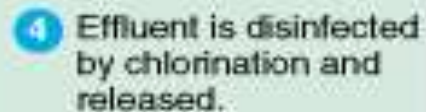
(a) PRIMARY TREATMENT



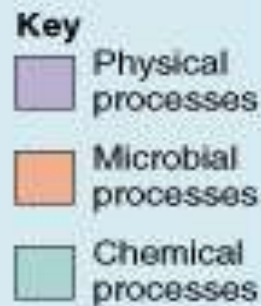
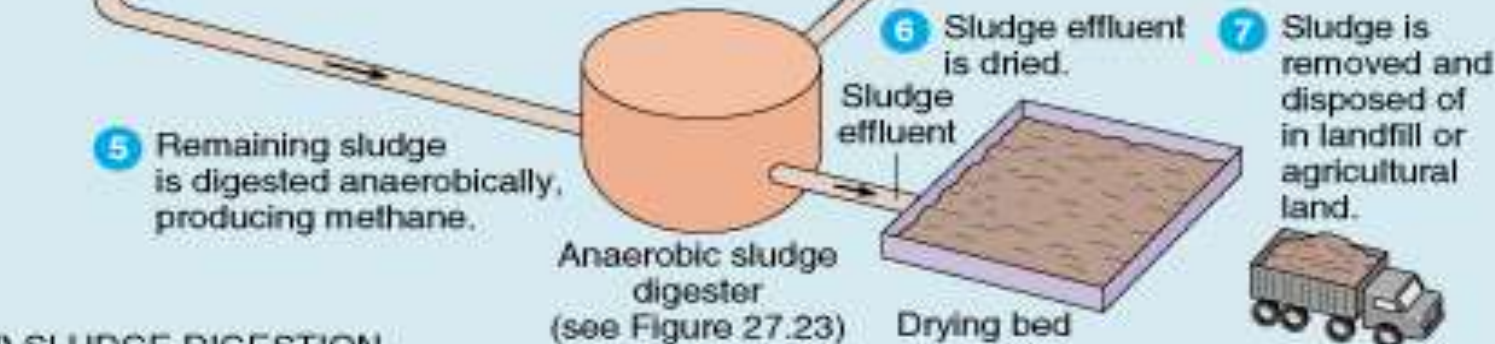
(b) SECONDARY TREATMENT (Biological oxidation)



(c) DISINFECTION AND RELEASE



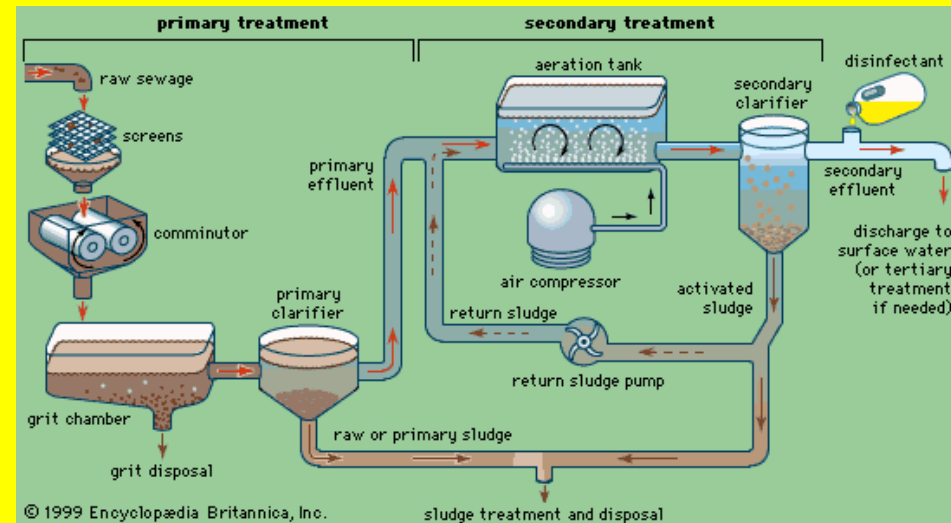
(d) SLUDGE DIGESTION



Waste Water Treatment Plants (WWTP's)

1. Primary Treatment (Physical Process)

- Removal of large objects using grates and screens
- Settling to remove suspended solids (primary sludge)
 - flocculating chemicals are added to enhance sedimentation



WWTP/Sewage Treatment

2. Secondary Treatment (Microbial Process)

- Receives primary effluent
- Biological degradation of the dissolved organic load
- Aeration to stimulate aerobic bacterial degradation
 - activated sludge reactor
 - trickling filter reactor
 - Sewage lagoon



Anaerobic Digestion of Sludge

- Sludges from the primary and secondary treatment settling tanks are pumped into an anaerobic digester
- Sludges contain cellulose, proteins, lipid and other insoluble polymers
- Anaerobic bacteria digest the sludge to methane and carbon dioxide
- Sludge is sent to landfill or incinerated. If no toxic metals present, could be used for fertilizer

WWTP/Sewage Treatment

3. Tertiary Treatment (Physiochemical Process)

- Receives secondary effluent
- Removes inorganic plant nutrients (nitrates & phosphates) from secondary effluent
- If nitrates & phosphates released, may cause eutrophication.
- Treated water is
 - discharged to waterways
 - Used for irrigation

Reusing Wastewater

- Currently, treated wastewater, no matter how “clean” cannot be directly mixed with treated raw water and supplied as potable (drinking) water.
- However, if a dual plumbing system is available, wastewater can be piped into facilities for specific, approved uses for which non-potable water is adequate
 - processing water in manufacturing process
 - Irrigation
 - Car washing



Alternatives to WWTP

- *Effluent sewerage*- several septic tanks connected to one mini-treatment plant- no drainfield
- Use *artificial wetlands*
 - Arcata, CA: sewage is piped to holding ponds, sediment settles, water passed to wetland where plant roots filter & cleanse, microorganisms decompose, water then passed to bay then ocean.

