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Ch. 14 Water Pollution

Water Pollution-Ch. 14 F/R, 14.3 in Frog book (iPad)

Big ideas:

1. Rivers are continuous, so easier to find sources along the route (continuity analysis: all sources add to total)

2. Groundwater is harder to determine point sources, as flow is over larger area (not confined by river banks) and there is no continuity analysis possible (we don't know sources and sinks)

3. Oceans are the hardest to trace, and impact everyone eventually

Table 10.4 Major Categories of Water Pollutants

Category	Examples	Sources
Cause Ecosystem Disruption		
1. Oxygen-demanding wastes	Animal manure, plant residues	Sewage, agricultural runoff, paper mills, food processing
2. Plant nutrients	Nitrates, phosphates, ammonium	Agricultural and urban fertilizers, sewage, manure
3. Sediment	Soil, silt	Land erosion
4. Thermal changes	Heat	Power plants, industrial cooling
Cause Health Problems		
1. Pathogens	Bacteria, viruses, parasites	Human and animal excreta
2. Inorganic chemicals	Salts, acids, caustics, metals	Industrial effluents, household cleansers, surface runoff
3. Organic chemicals	Pesticides, plastics, detergents, oil, gasoline	Industrial, household, and farm use
4. Radioactive materials	Uranium, thorium, cesium, iodine, radon	Mining and processing of ores, power plants, weapons production, natural sources

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Surface water impairment:

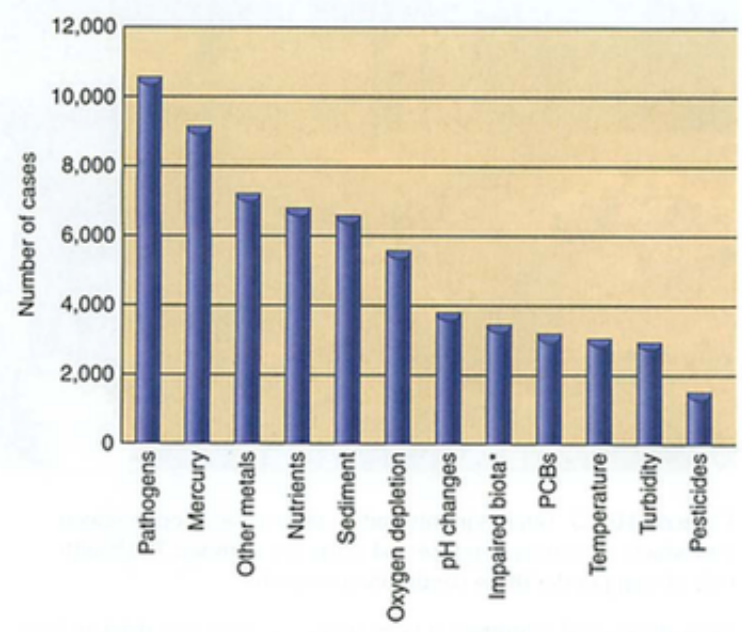

Figure 10.21 Twelve leading causes of surface-water impairment in the United States. *Undetermined causes. *Source:* Data EPA, 2009.

Module 41-Humans and livestock

Point source vs. non-point source Legal liability? Tracking? How is this different in oil spills?

BOD: impacted by anything that will decompose aerobically

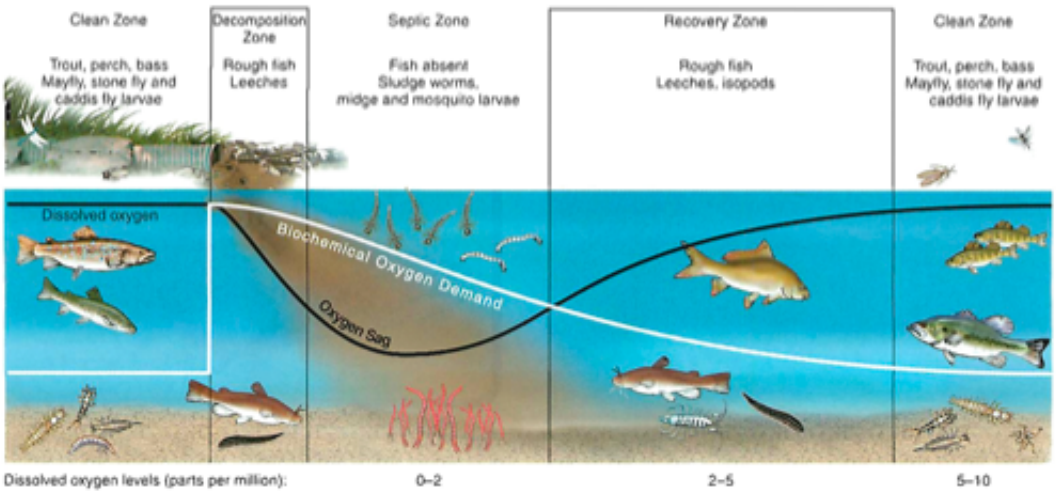

Figure 10.15 Oxygen sag downstream of an organic source. A great deal of time and distance may be required for the stream and its inhabitants to recover.

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Dead zones: low DO levels (via BOD or thermal pollution)
Eutrophication: too much food (nutrients), algal bloom (know the mechanism)
Cultural Eutrophication: anthropogenic
Pathogens: cholera and hepatitis (esp. after disasters)
Explain cholera mechanism: intestinal, shock dehydration, cure for infants: salt and sugar water
Fecal Coliform: e. coli from humans, used as an indicator species (see recent rains here)

Septic systems:

Septic tank: septage into leach field (elab into the trees)
Cesspool: deeper, raw sewage leaks into groundwater/ocean (e.g. puako)

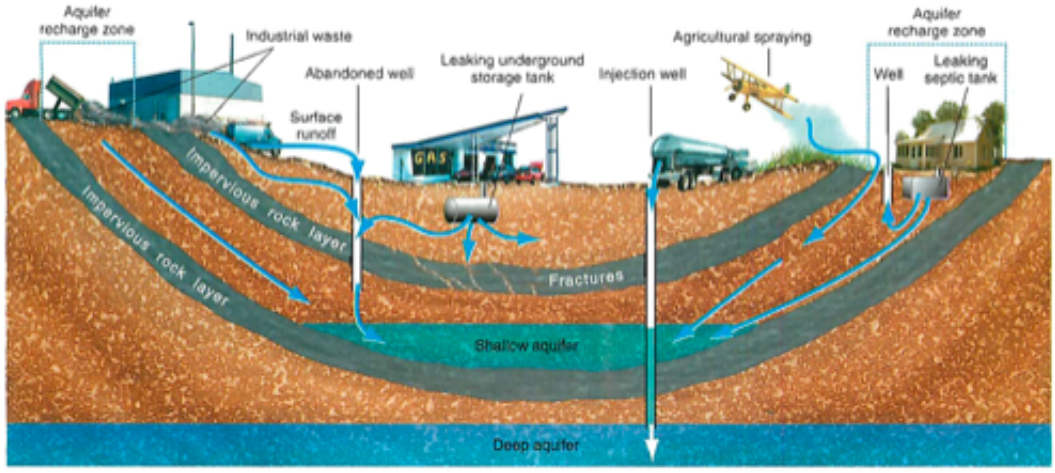

Figure 10.23 Sources of groundwater pollution. Septic systems, landfills, and industrial activities on aquifer recharge zones leach contaminants into aquifers. Wells provide a direct route for injection of pollutants into aquifers.

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Wastewater treatment:

Primary: sedimentation tanks
Secondary: bacterial breakdown
Tertiary: chemical breakdown (chlorine, ozone-only ozone kills viruses)

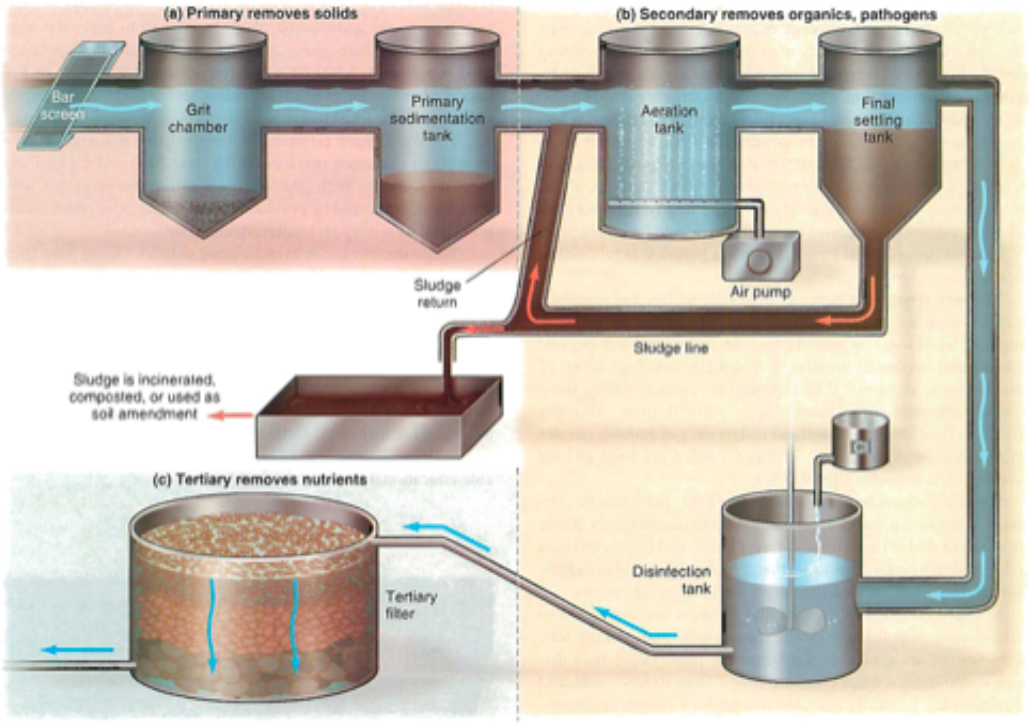

Figure 10.25 Activated sludge wastewater treatment. (a) Primary treatment removes only solids and suspended sediment. (b) Secondary treatment, through aeration of activated sludge, followed by sludge removal and chlorination of effluent, kills pathogens and removes most organic material. (c) During tertiary treatment, passage through a trickling bed evaporator and/or a tertiary filter further removes inorganic nutrients, oxidizes any remaining organics, and reduces effluent volume.

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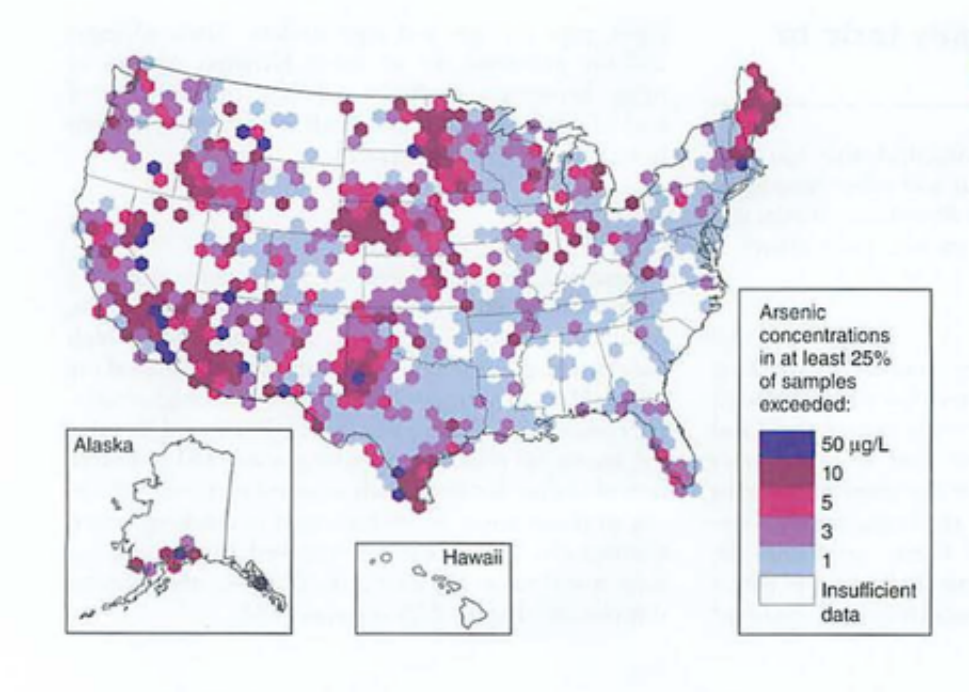
Module 42-Heavy metals and chemicals

Lead-heavy metal, damages brain, nervous system and kidneys, can be chelated from body using EDTA:
https://en.wikipedia.org/wiki/Chelation_therapy

Arsenic (e.g. ant poison, mystery novel poison), found in well water in E. India/Bangladesh:
https://en.wikipedia.org/wiki/Arsenic_poisoning

Often found where mining occurs:



n.b. no arsenic in Hawaii (why not?)

Mercury-organic Methyl Mercury and inorganic (thermometers) "elemental mercury"
Burning coal, gold refining, mining, battery production (Minamata: https://en.wikipedia.org/wiki/Minamata_disease)
https://en.wikipedia.org/wiki/Mercury_poisoning
Limits to large fish consumption in pregnant women
"mad as a hatter" Milliners

Acid deposition:

Sulfur dioxide (SO_2) and nitrogen dioxide (N_2O)
"acid snow" and acid rain
also runoff into streams

Synthetics:

Pesticides with long decay rates (e.g. DDT)
https://en.wikipedia.org/wiki/DDT

Hormones and drugs:

Endocrine disrupters, not cleared by municipal water treatment systems

Perchlorates:

From rocket fuels (solid rockets, boosters) and explosives (Pohakuloa Training Area: PTA)

PCB: Poly chlorinated biphenyls (recall the orcas from "poisoned waters"), fat soluble, bioaccumulation in orcas, used as an insulating fluid in transformers (n.b. fire departments use hazmat suits when a transformer catches fire)

https://www.youtube.com/watch?v=fzbQjd_Oo4Q
PBDE: poly brominated diphenyl ethers-brain damage (TRIS in children's clothing as flame retardant)
https://en.wikipedia.org/wiki/Polybrominated_diphenyl_ethers
POP: persistent organic pollutants

Module 43: oil pollution

Slow to decompose, settles to bottom of ocean, e.g. Exxon Valdez (captain was drunk on duty) and BP oil spill in Gulf of Mexico ("Deepwater Horizon")
https://en.wikipedia.org/wiki/Oil_spill
Oil plumes to 3000' deep in ocean
Damage to fisheries, beaches and corals/seabed animals

Module 44: solid, thermal and noise pollution

Flotsam=floating stuff, jetsam=thrown (jettisoned) stuff
Garbage patch in pacific: pacific gyre
https://en.wikipedia.org/wiki/Great_Pacific_garbage_patch
Thermal pollution: usually associated with power plants (30% efficient, so 1000 mW power plant spews 2000mW of heat into water system)
Decreases DO levels, also thermal shock to smaller organisms
Noise pollution: serious threat to animals and humans
https://en.wikipedia.org/wiki/Noise_pollution
notice health impacts
dB (decibel scale): 210 dB = Saturn V rocket blastoff, 0 dB = anechoic chamber
>100 dB causes permanent hearing damage (ringing in the ears=dead cilia in cochlea)

Module 45: water pollution laws

Clean Water Act (CWA) 1972-protection and propagation of fish, shellfish and wildlife. Maintain and restore chemical, physical and biological props. of surface waters (n.b. not aquifers, n.b. economic impact of violations, externalized costs)

Table 10.5 Some Important Water Quality Legislation

1. *Federal Water Pollution Control Act (1972).* Establishes uniform nationwide controls for each category of major polluting industries.
2. *Marine Protection Research and Sanctuaries Act (1972).* Regulates ocean dumping and established sanctuaries for protection of endangered marine species.
3. *Ports and Waterways Safety Act (1972).* Regulates oil transport and the operation of oil-handling facilities.
4. *Safe Drinking Water Act (1974).* Requires minimum safety standards for every community water supply. Among the contaminants regulated are bacteria, nitrates, arsenic, barium, cadmium, chromium, fluoride, lead, mercury, silver, and pesticides; radioactivity and turbidity also are regulated. This act also contains provisions to protect groundwater aquifers.
5. *Resource Conservation and Recovery Act (RCRA) (1976).* Regulates the storage, shipping, processing, and disposal of hazardous wastes and sets limits on the sewering of toxic chemicals.
6. *Toxic Substances Control Act (TOSCA) (1976).* Categorizes toxic and hazardous substances, establishes a research program, and regulates the use and disposal of poisonous chemicals.
7. *Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (1980) and Superfund Amendments and Reauthorization Act (SARA) (1984).* Provide for sealing, excavation, or remediation of toxic and hazardous waste dumps.
8. *Clean Water Act (1985)* (amending the *1972 Water Pollution Control Act*). Sets as a national goal the attainment of "fishable and swimmable" quality for all surface waters in the United States.
9. *London Dumping Convention (1972).* Calls for an end to all ocean dumping of industrial wastes, tank-washing effluents, and plastic trash. The United States is a signatory to this international convention.

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CWA 1972
RCRA 1976
TOSCA 1976
CERCLA 1980

Safe Water drinking act (SWDA)

1974–EPA (formed under Nixon) est. max contaminant levels (MCL) (see list)

TABLE 45.1 The maximum contaminant levels (MCL) for a variety of contaminants in drinking water as determined by the U.S. Environmental Protection Agency, in parts per billion (ppb)

Contaminant category	Contaminant	Maximum contaminant level (ppb)
Microorganism	Giardia	0
Microorganism	Fecal coliform	0
Inorganic chemical	Arsenic	10
Inorganic chemical	Mercury	2
Organic chemical	Benzene	5
Organic chemical	Atrazine	3

Source: U.S. Environmental Protection Agency, http://www.epa.gov/safewater/contaminants/index.html.

REVIEW

http://physics.hpa.edu/physics/apenvsci/apes_exam_prep/apes%205%20steps%20to%20a%205/18-pollution.pdf