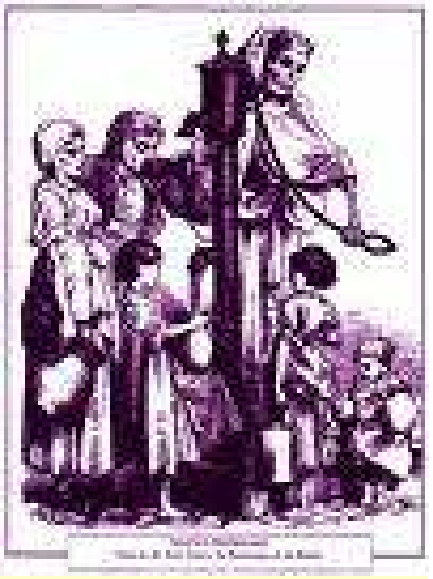
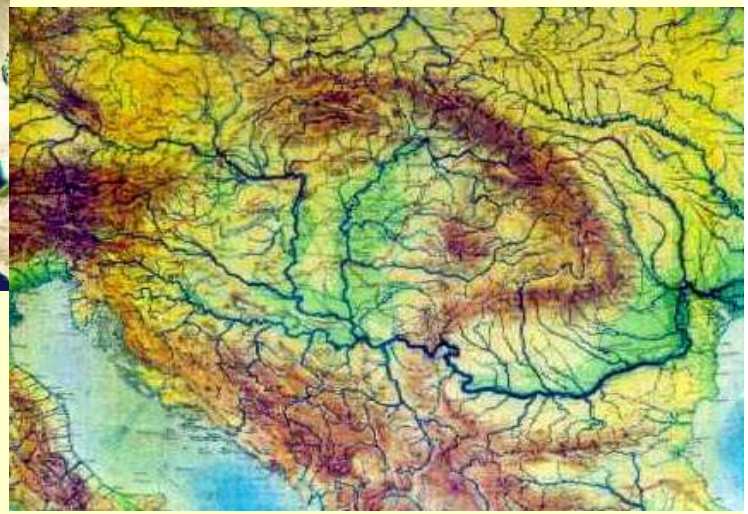
Environmental hygiene II.



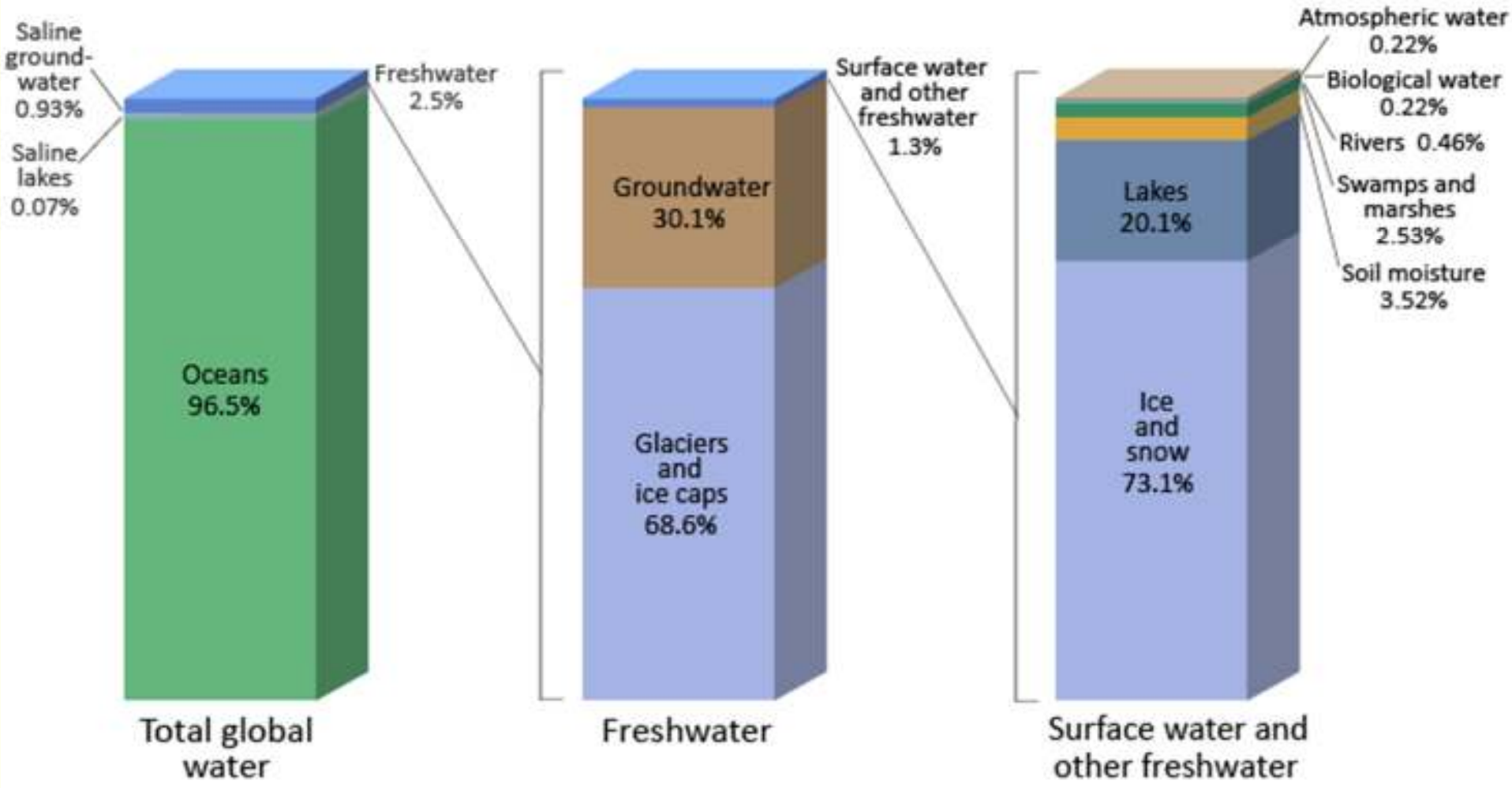
SU Department of Public Health



Only 3 % of the world's water supply is freshwater,

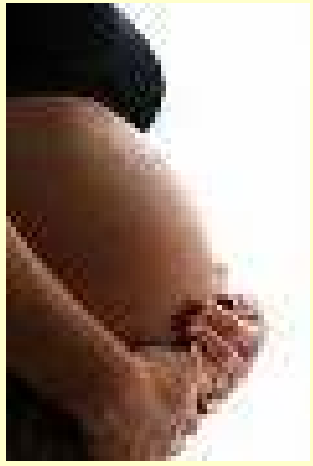
two-thirds of that **frozen, forming the polar ice caps, glaciers, and icebergs.**

Distribution of Earth's Water



Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources.

Personal biological requirement:
2-3 l
/person/day

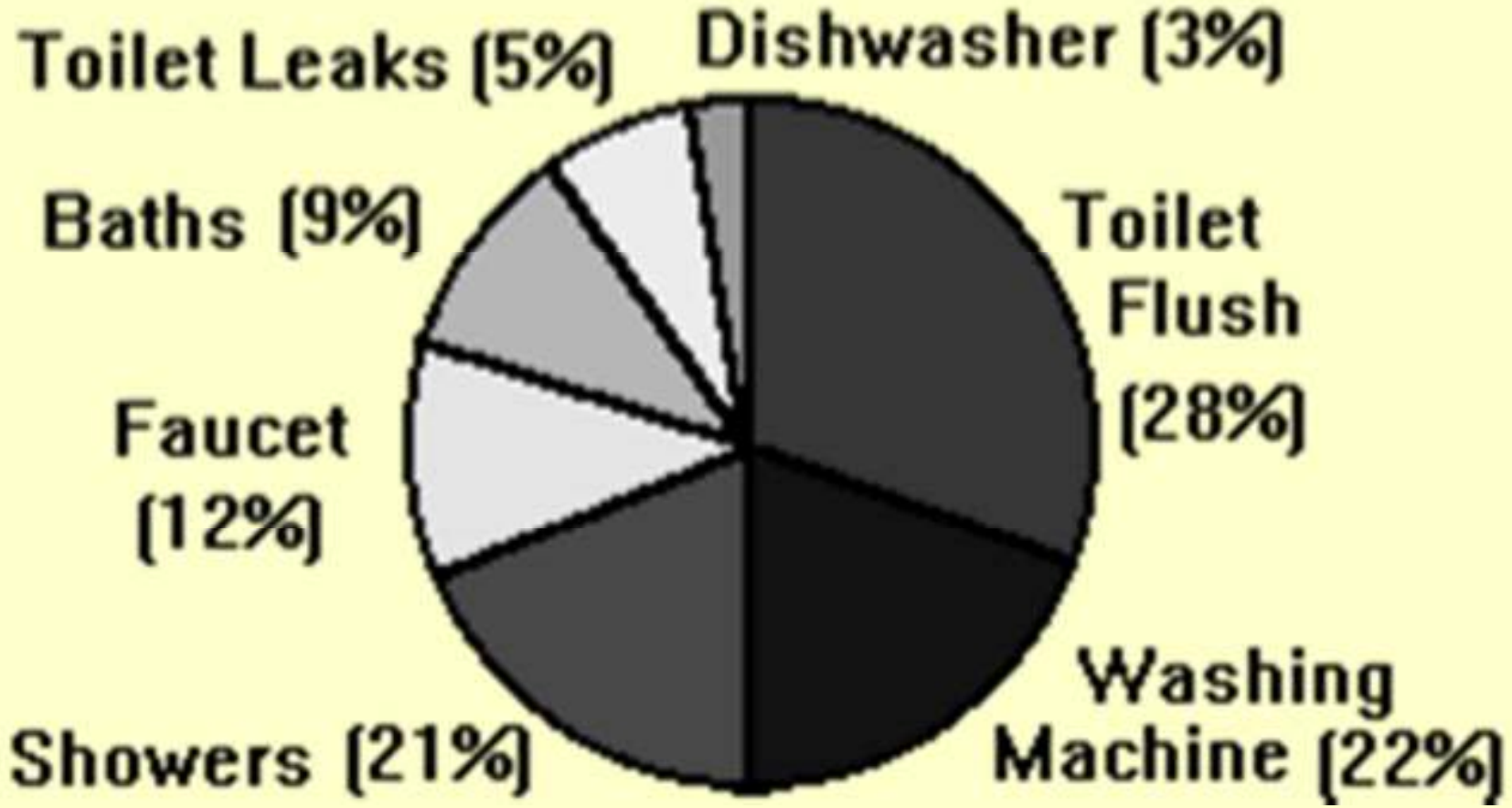


Water used in developed countries:
100-150 l/person/day



Water consumption in the household

Physiological need of drinking water: 2-3 l/person/day
(~temperature, wind, humidity, type of work)



Source: EPA http://water.epa.gov/drink

Children in a refugee camp (Iraq, 2006)

Survivors receive packets of drinking water at a relief camp (in the southern Indian city of Madras Dec. 28, 2004.)

Pakistani villagers pull drinking water from a 122-meter (400-foot) well.

Collecting water is usually the job of women.

Water your yard and outdoor plants early or late in the day to reduce evaporation.

Use a shut-off nozzle on your hose.

Use plants that require less water.

Mulch around plants to hold water in the soil.

Get an Energy Star labeled washing machine.

Wash only full loads.

Use a low flow showerhead.

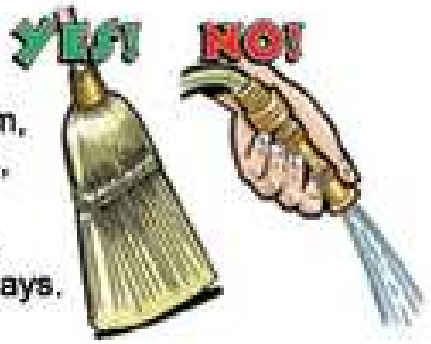
Take shorter showers — five minutes or less is best.

Turn off the water while soaping hands and brushing teeth.

Turn off sink faucet while scrubbing dishes and pots.

Install new toilets that use less than 1.6 gallons per flush.

Put faucet aerators on sink faucets.



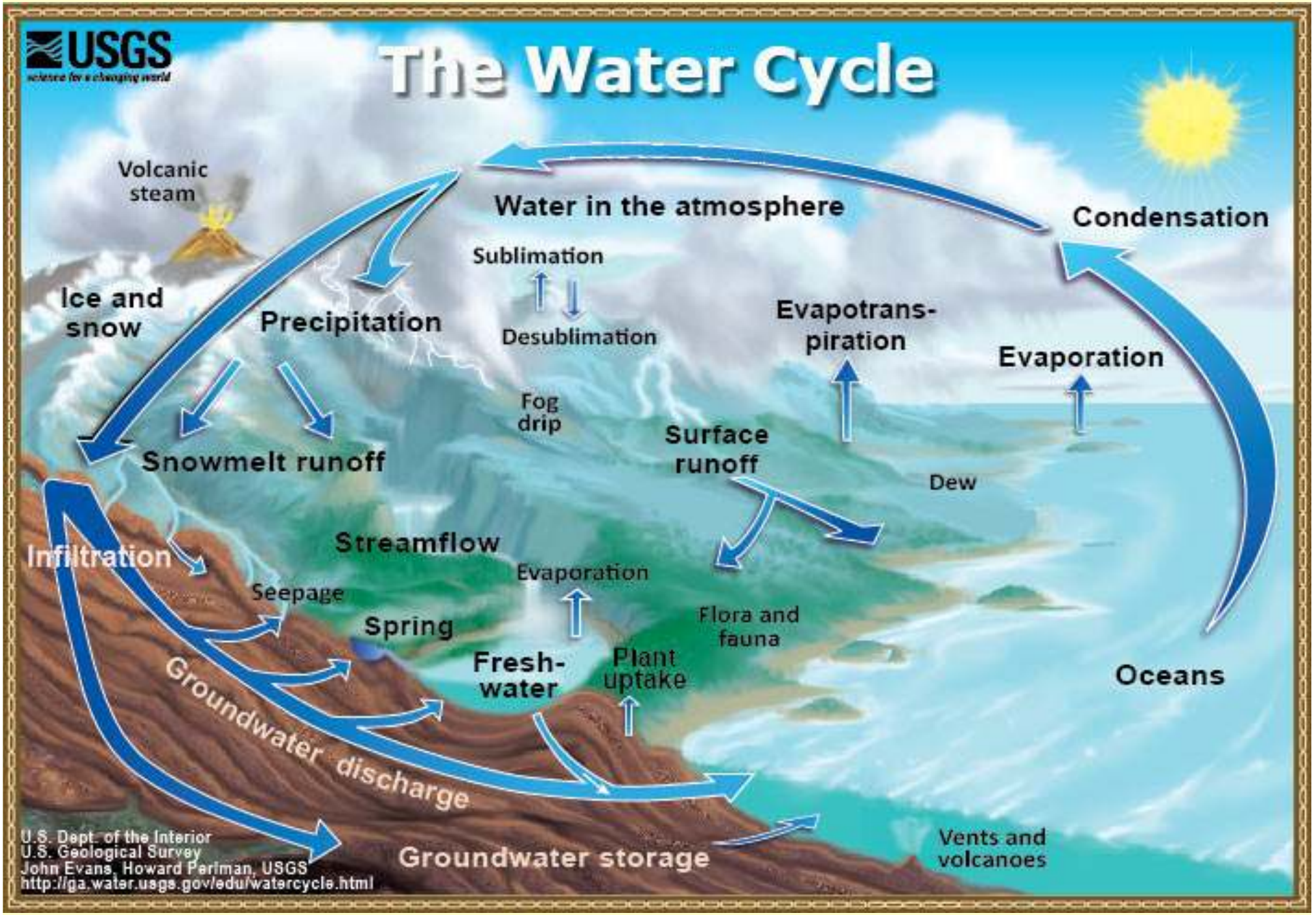
Us a broom, not a hose, to clean driveways and walkways.


REPAIR REDUCE RE-USE REPAIR
SAVE WATER ... IN THE HOME
SAVE WATER ... IN THE GARDEN
DEPARTMENT OF WATER AND FORESTRY

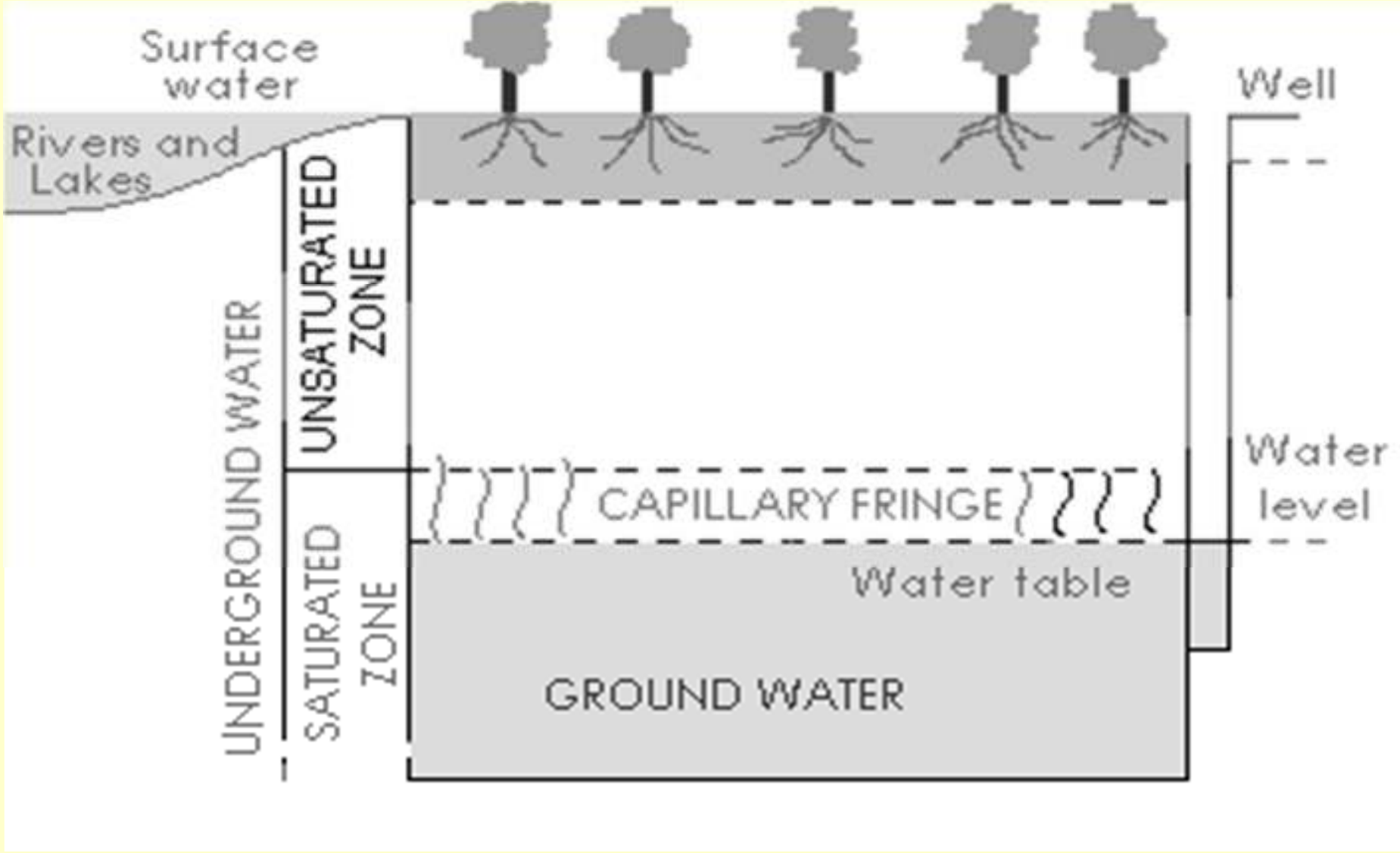
WATER
USE IT
WISELY

Quality requirements of drinking water

- Free of harmful chemical and biological agents
- Should contain minerals
- Cool, refreshening, at the temperature of 12 ^{o}C
- Clean, odourless, normal taste
- Cheap, accessible in large amount

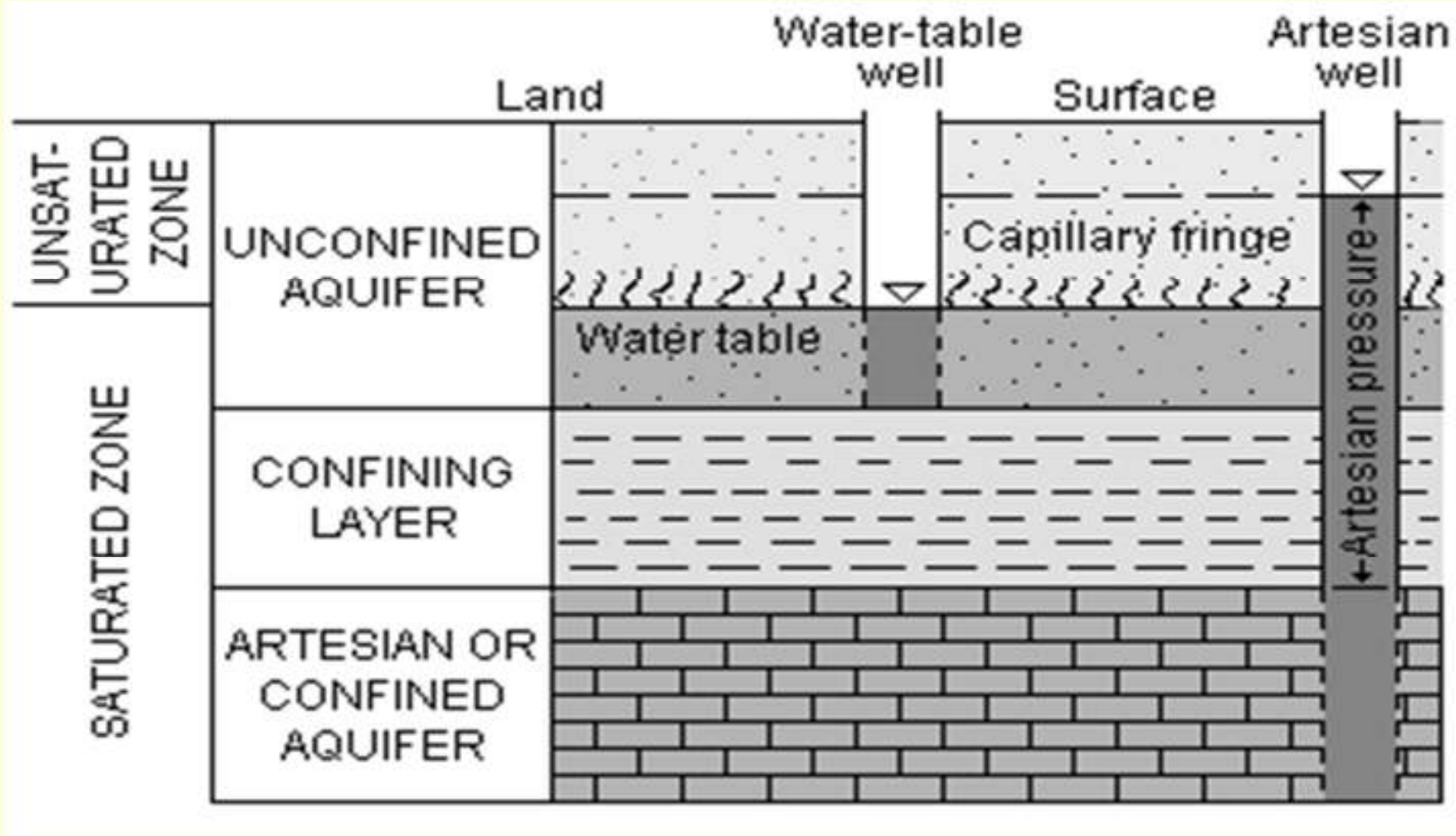

USGS
science for a changing world
The Water Cycle
Volcanic steam
Water in the atmosphere
Condensation
Sublimation
Desublimation
Ice and snow
Precipitation
Evapotrans-piration
Evaporation
Fog drip
Surface runoff
Snowmelt runoff
Dew
Infiltration
Streamflow
Evaporation
Seepage
Spring
Flora and fauna
Fresh-water
Plant uptake
Oceans
Groundwater discharge
Groundwater storage
Vents and volcanoes
U.S. Dept. of the Interior
U.S. Geological Survey
John Evans, Howard Perlman, USGS
http://ga.water.usgs.gov/edu/watercycle.html

Water in nature



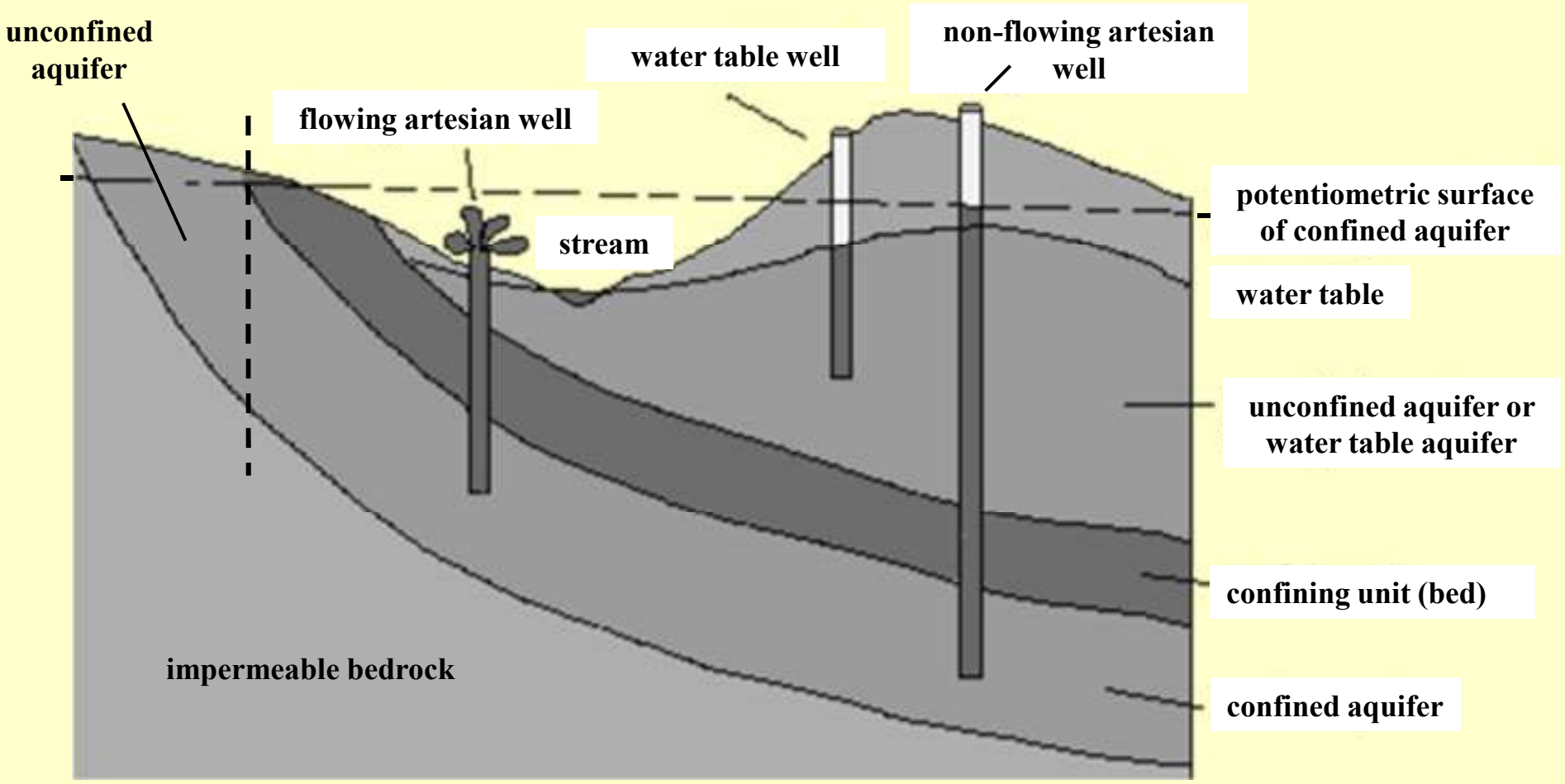
Source: EPA http://water.epa.gov/drink

Water sources I.



Source: EPA http://water.epa.gov/drink

Water sources II.



Source: EPA http://water.epa.gov/drink

Bank filtration

Water quality is the **physical**, **chemical** and **biological** characteristics of water.

Water's physical (physical chemistry) examination is include
acidity, electrical conductivity, temperature.

Water's chemical examination >>>

Water’s microbiological examination>>>

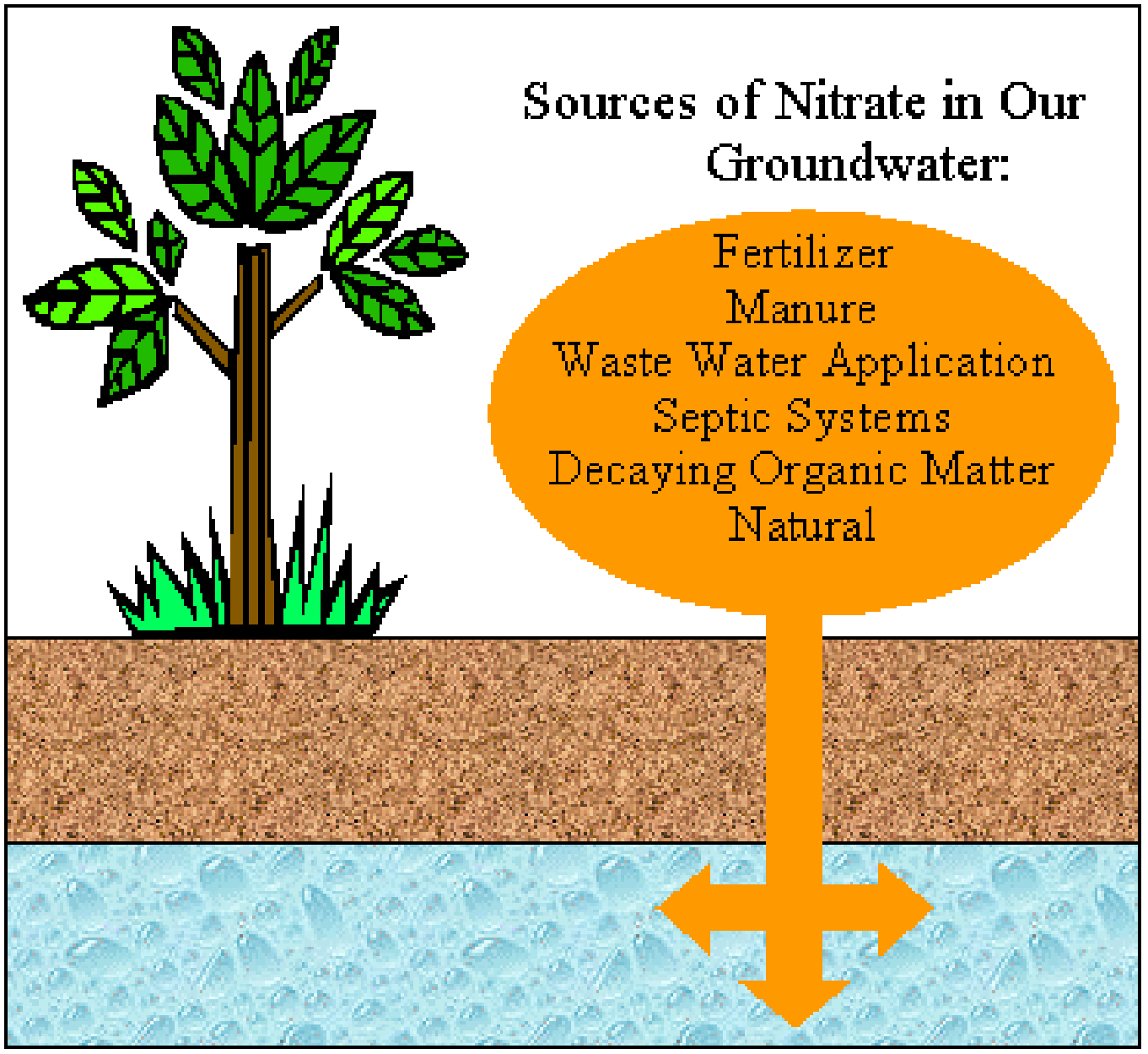
Biological water examination>>>

Common water constituents and their limit values in drinking water

Constituent	*Limit*	*Unit*
Arsenic	10	µg/l
Cadmium	5,0	µg/l
Fluoride	1,5	mg/l
Lead	10	µg/l
Mercury	1,0	µg/l
Nitrates	50	mg/l
Nitrites	0,50	mg/l
Total trihalomethanes	50	µg/l

Selected water constituents and their effects on human health

- **Nitrates:** high levels may causes methemoglobinemia in infants
- **Fluoride**: low levels increase risk of caries, high levels cause fluorosis with disorders of enamel formation and renal damage, narrow beneficial concentration range (~1-1,5 mg/l)
- **Arsenic: may occur as a natural, geological contaminant of drinking water (as in some regions of the Hungarian Great Plains), toxic to several organ systems (arsenosis) and carcinogenic on chronic exposure**
- **Chlorination by-products** (**trihalomethanes - THMs**): **cause unpleasant taste and odor, chronic exposure can cause kidney and liver damage and cancers**
- **Iodine**: **usually low in drinking water at high altitudes, low concentrations can increase incidence of goitre (hypothyroidism)**
- **Calcium-oxide** (CaO): **concentration determines water *hardness*, „soft" water is associated with increased rates of cardiovascular disease, while hard water with increased rates of gall-, and kidney-stones.**


Sources of Nitrate in Our Groundwater:
Fertilizer
Manure
Waste Water Application
Septic Systems
Decaying Organic Matter
Natural

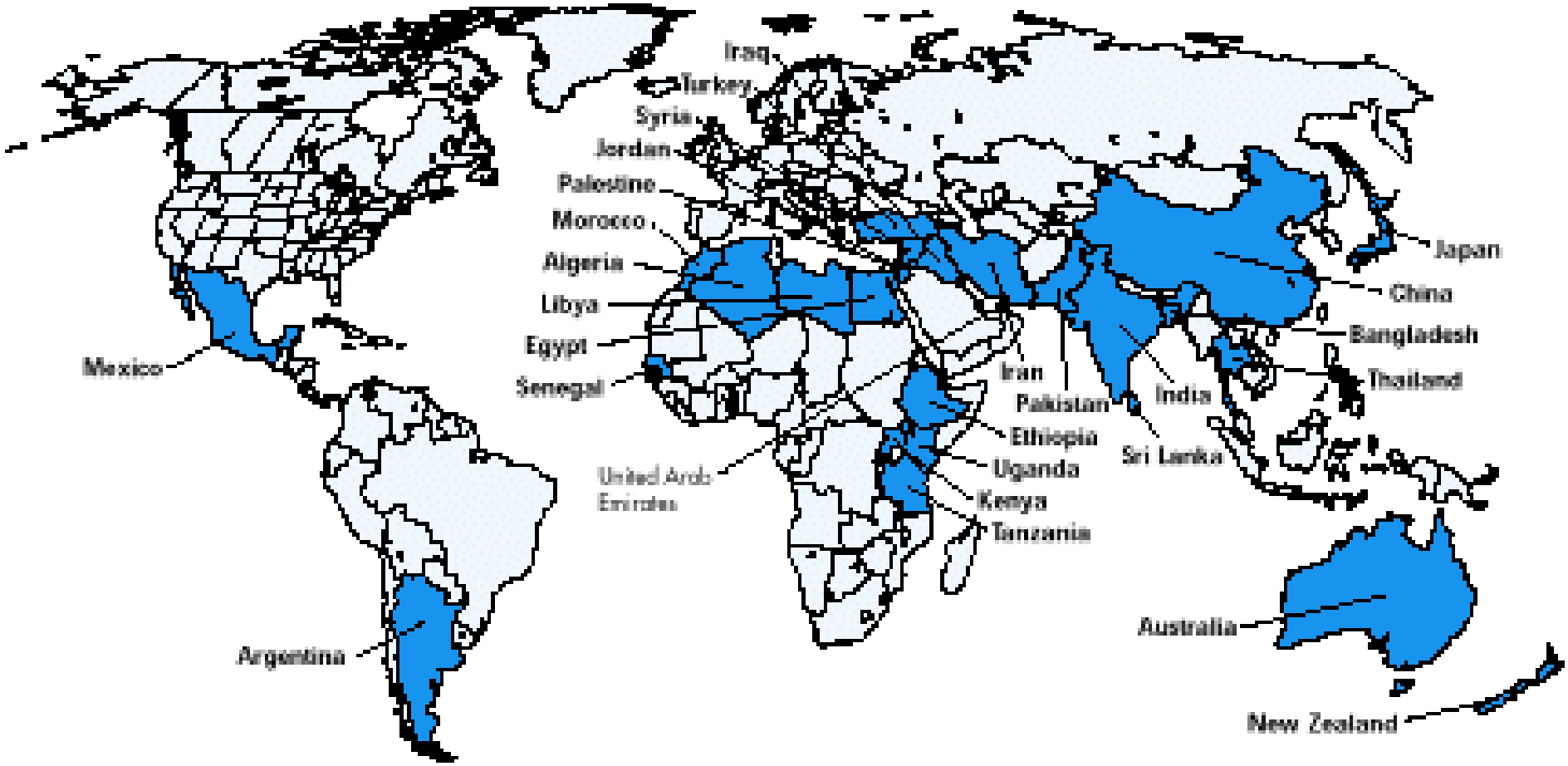
„Blue baby”

Nitrite and nitrate

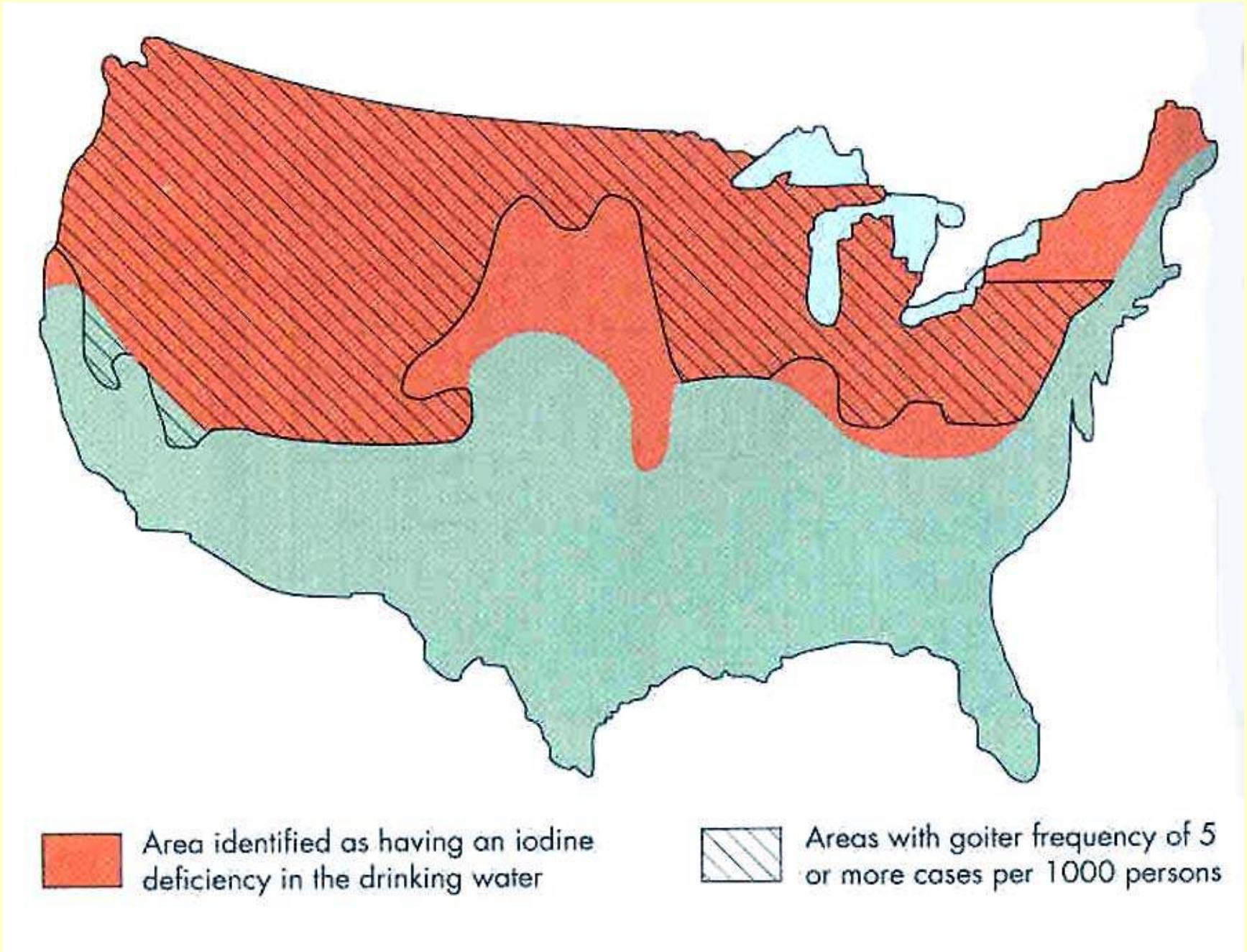
- Lack of pipelines, technological problems or excessive fertilizer usage may lead to this problem
- Nitrite causes **methaemoglobiaemia** especially in small babies („blue baby").
- Reasons: **undeveloped gastrointestinal bacterial colonisation, unmature kidney, F-hemoglobine.**
- **Boiling the water does not eliminate the chemicals.**
- Limit: **nitrate**: 50 mg/l, **nitrite**: 0,5 mg/l (0,1 mg / l if the water comes from pipelines).

Arsenic poisoning can lead to skin cancer and excessive growth of keratin on the feet

Arsenic contaminates millions of people's drinking water in West Bengal and Bangladesh



Countries with endemic fluorosis due to excess fluoride in drinking water


Area identified as having an iodine deficiency in the drinking water
Areas with goiter frequency of 5 or more cases per 1000 persons

Water's microbiological examination

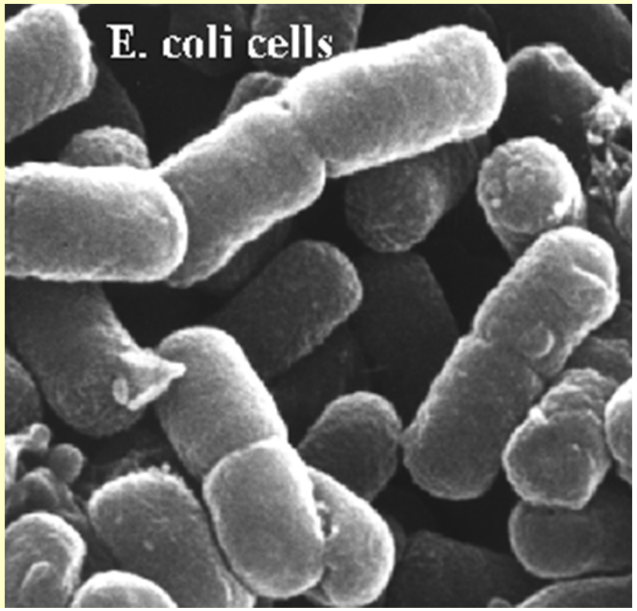
Total bacterial count in 1 ml water (incubated at 22ºC and 37ºC for 24 hours).

Typically three **indicator bacteria** are chosen: coliforms, Escherichia coli and Pseudomonas aeruginosa.

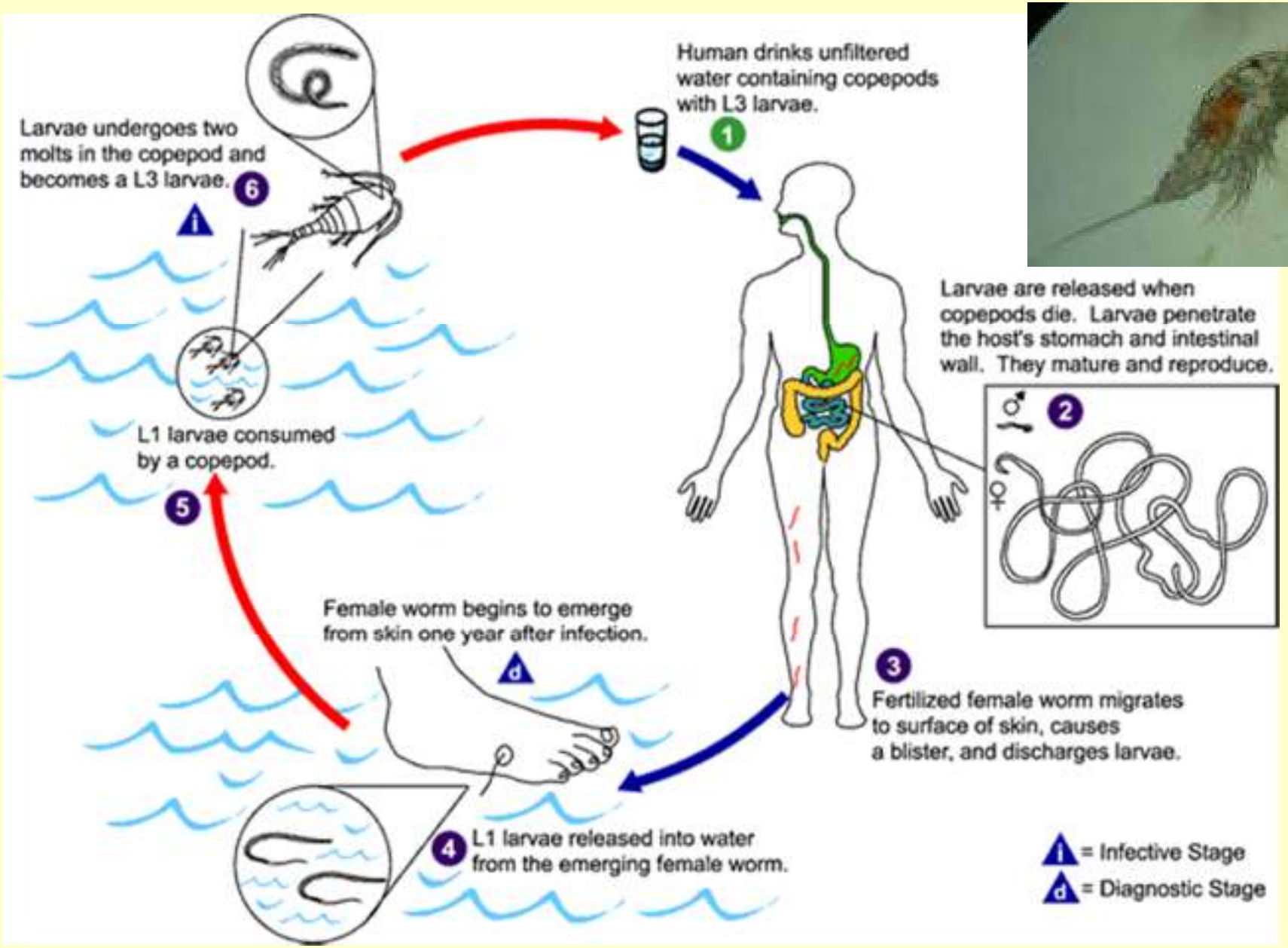
If is needed infectious agents' present also investigated.

Coliform bacteria
are common in the environment and are generally not harmful. However, **the presence of these bacteria in drinking water is usually** a result of a problem with the treatment system or the pipes which distribute water, and **indicates that the water may be contaminated with germs that can cause disease**.

Fecal Coliform and E. coli are bacteria whose presence **indicates that the water may be contaminated with human or animal wastes**. Microbes in these wastes can cause short-term effects, such as diarrhea, cramps, nausea, headaches, or other symptoms.



- **Water-borne diseases**: oral-fecal diseases **transmitted through ingestion of contaminated water** (**cholera**, typhoid fever, amebiasis)
- **Water-washed diseases**: usually oral-fecal or contact diseases resulting from **inadequate personal hygiene due to lack of water** (**salmonellosis**, amebiasis, hepatitis A and E
- **Water-based diseases**: the **pathogen spends a part of its life-cycle in water** and infection occurs through ingestion or contact (**schistosomiasis**, dracunculiasis)
- **Water-related vector-borne diseases**: the **life-cycle of a primary arthropod vector of the pathogen is connected to water** (**malaria**, dengue, filariasis, yellow fever)
- **Water-dispersed diseases**: **pathogen lives and reproduces in water and transmission occurs by dispersion of contaminated water droplets into the air and subsequent inhalation** (**legionellosis**)



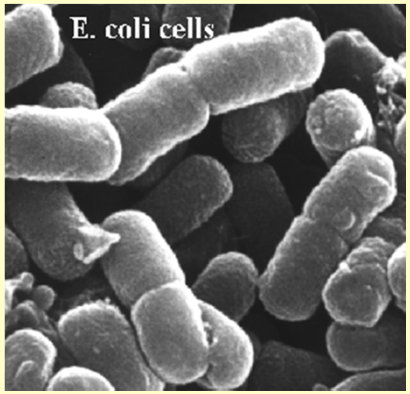
Dracunculiasis (Guinea-worm infection)

(Example for water-based diseases)

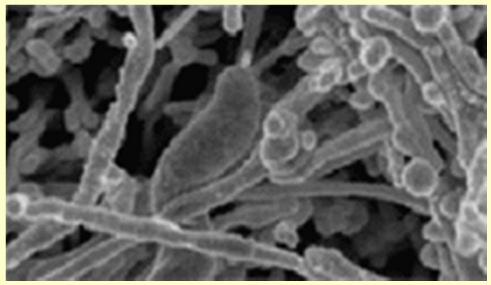
Dracunculiasis (Guinea worm infection)

People swallow the infected copepods and…

This Nigerian woman is gathering water from a local pond, which is used as a source of drinking water. But because of a Guinea worm larvae infestation, this water must be filtered to remove the water fleas that carry the parasitic larvae of the Guinea worm.

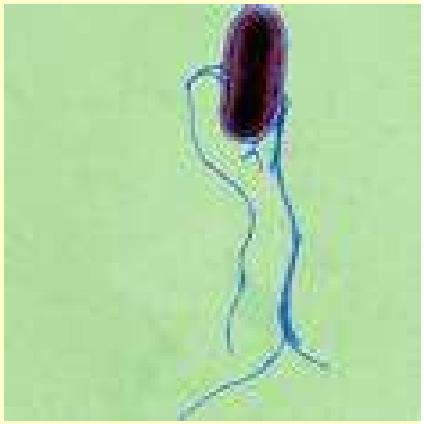


E. Coli O : 124

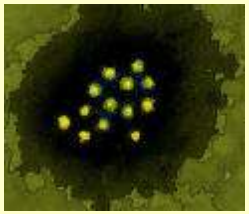


Campylobacter jejuni

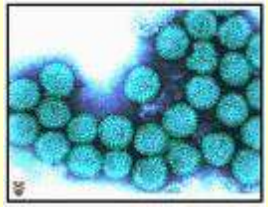
Shigella flexneri



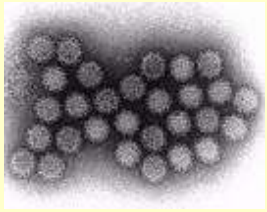
Salmonella typhi



Hepatitis A

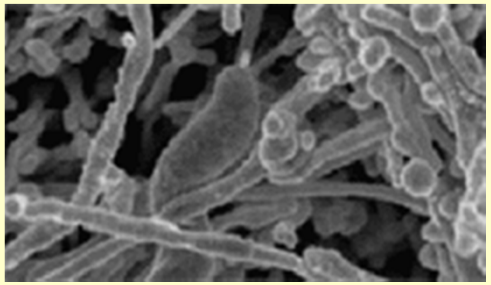


Rotavirus

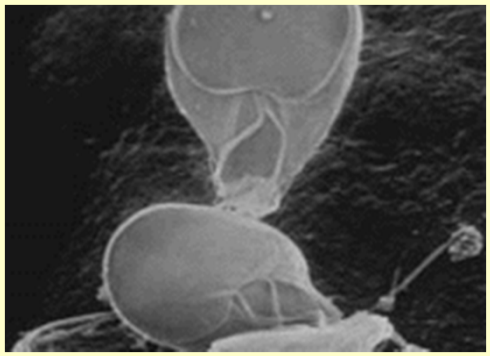


Calicivirus

Adenovirus



Cryptosporidium

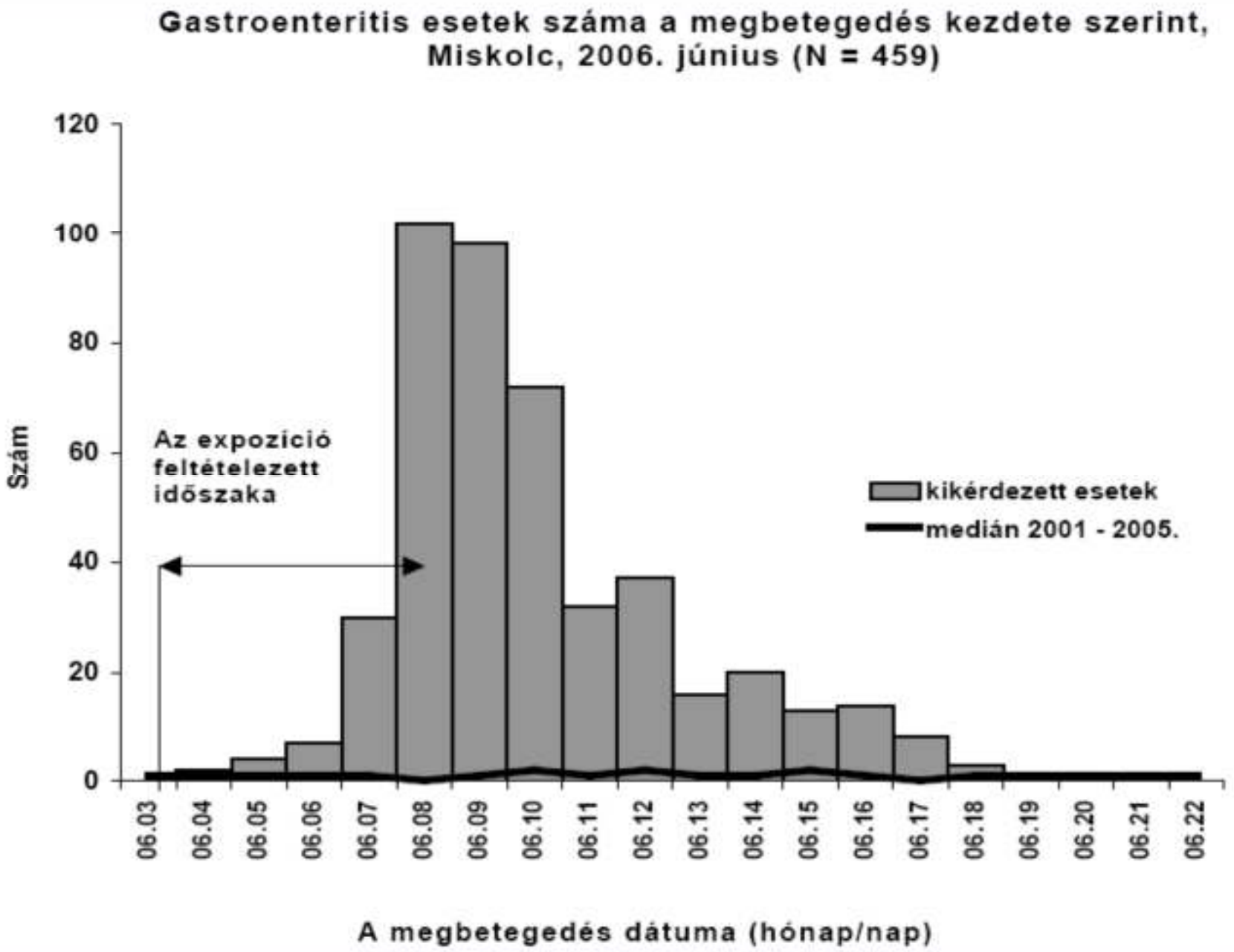


Giardia lamblia

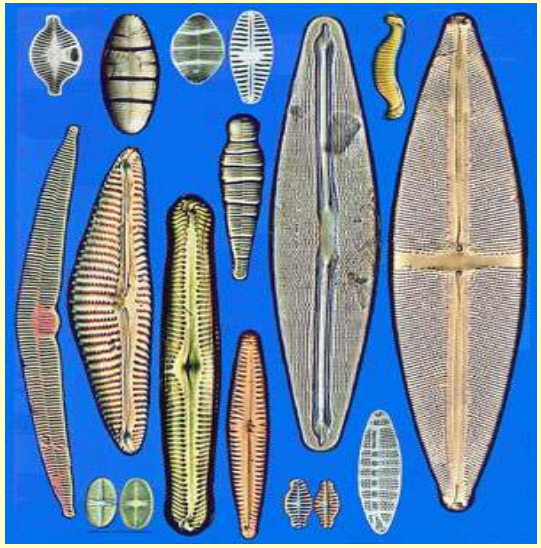
Some infectious agents transmitted by water also

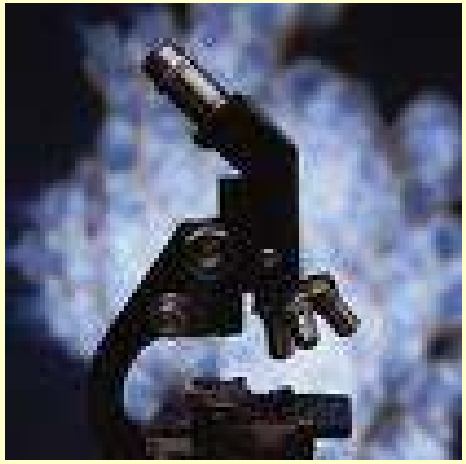
An example of water-borne disease
Miskolc, 2006. June 4-22.

- June 2-3. **Heavy rainfall** in the geographical area
- Public health authorities: **compulsory report of gastroenteritinal patients, recommendation of boiling the water before consumption; supply of safe drinking water**
- 3614 patients detected with diarrhea, 179 hospitalized
- Lab tests confirmed Calici virus in 20 cases, Campylobacter in 75 cases
- Data evaluation of 459 patients on next slide

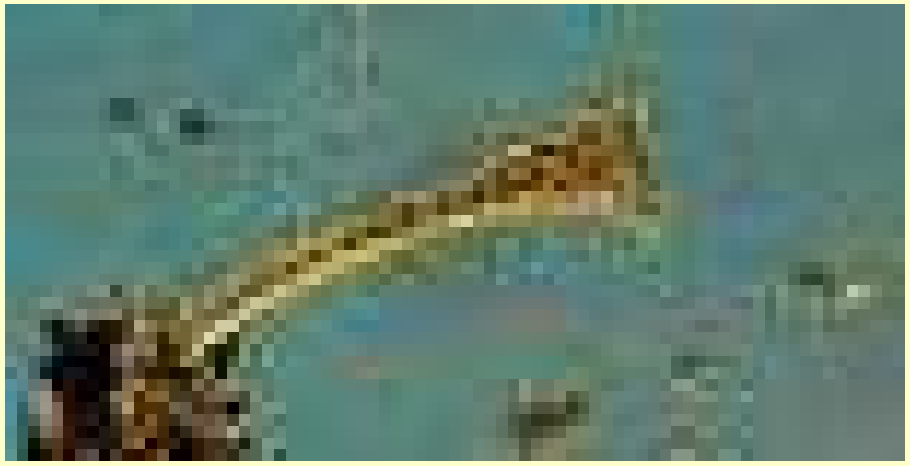

Gastroenteritis esetek száma a megbetegedés kezdete szerint,
Miskolc, 2006. június (N = 459)
Szám
120
100
80
60
40
20
0
Az expozíció
feltételezett
időszaka
kikérdezett esetek
medián 2001 - 2005.
06.03
06.04
06.05
06.06
06.07
06.08
06.09
06.10
06.11
06.12
06.13
06.14
06.15
06.16
06.17
06.18
06.19
06.20
06.21
06.22
A megbetegedés dátuma (hónap/nap)

Biological water examination





Diatoms (microscopic algae)



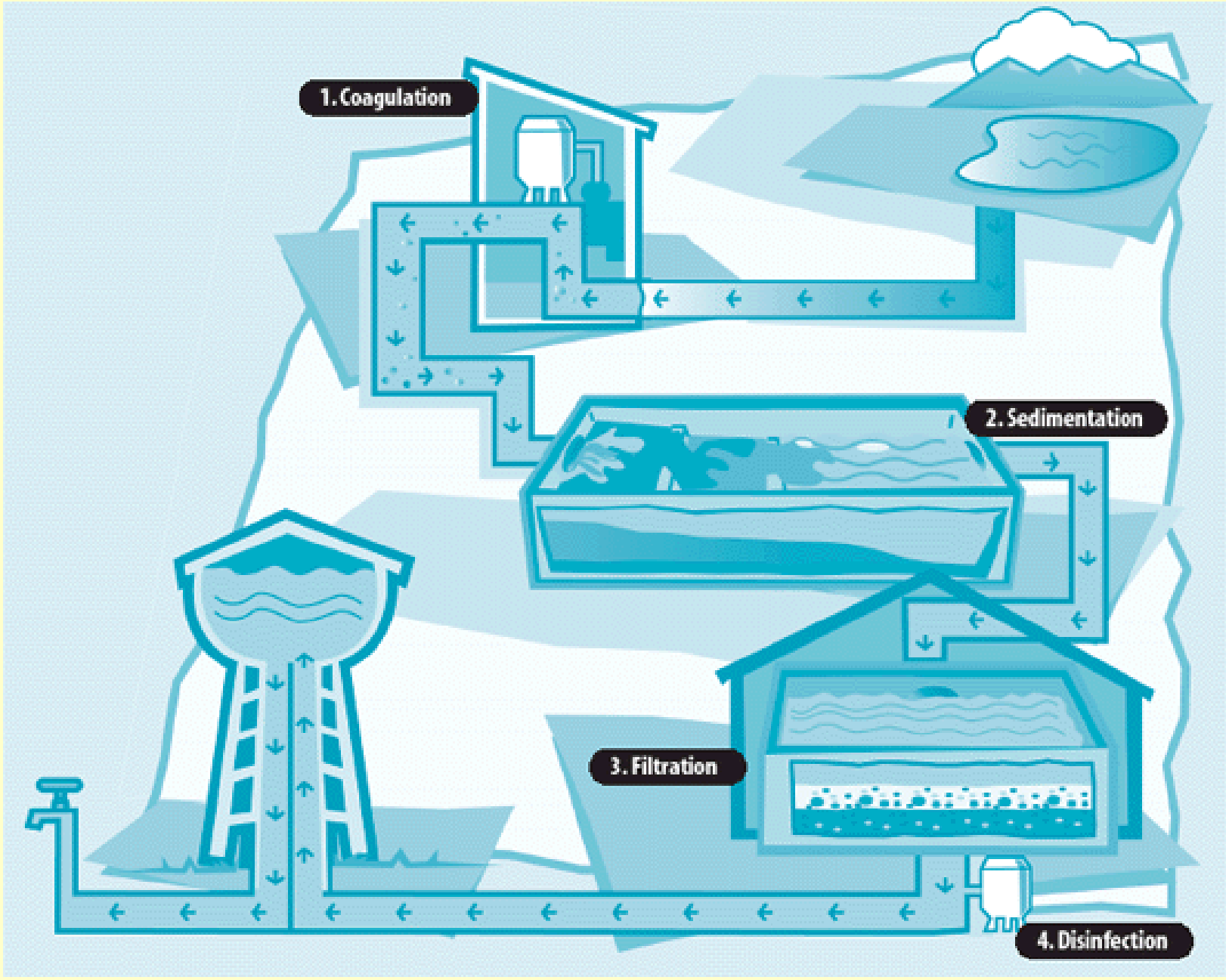
When to have your local water-supply tested

- ✓ **Test annually for coliform bacteria and nitrates.** Dug (shallow) wells are particularly vulnerable to bacterial contamination, while other types of wells with no history of problems may not need testing as often. Test for sodium, sulfates, iron, manganese, and lead every three years unless you have had recent problems with any of these contaminants.
- ✓ **If you suspect contamination or** if you know that potential pollution sources (farms, landfills, toxic disposal sites, etc.) are located in the vicinity of your well, you should have your water tested more frequently (i.e., twice a year).
- ✓ **If the taste, odor, or color of your water changes, or** if your family experiences recurrent, unexplained gastrointestinal illnesses, have your water tested.
- ✓ Have the water supply tested **before purchasing a new home, or** after you have done any construction or remodeling on your home.
- ✓ **A total coliform bacteria test is recommended after you have replaced old pipes or installed a new well or pump**. Total coliform is an indicator of septic system problems and poor well construction.
- ✓ **Testing for nitrates is recommended in the early months of pregnancy and again after the baby is born.**
- ✓ **If your well is located near industrial sites, your water should be tested for toxic metals** such as lead, mercury, arsenic, and nickel. Unless you suspect that your water is contaminated, routine annual testing for these metals may not be practical since the tests are expensive.

Source: EPA http://water.epa.gov/drink

Solar Bottle: works with the sun to allow UV-A radiation and increased tempertaure
to destroy pethogenic organism in drinking water (Swiss product)


DRINKING
WATER
PROTECTION
AREA



Water treatment: **1. Coagulation**, **2. Sedimentation**, **3. Filtration**, **4. Disinfection**

Chemical, biological and physical pollution

- **Inorganic chemical compounds:** heavy metals, **mercury, lead, nickel, cianide** (pl. a Tisza 2000. évi, Romániából érkező szennyezése)

- **Organic chemical compounds: oil, detergents, fertilizers, pesticides**

- **Physical pollution:** radiating materials, heat pollution

- **Biological pollution**

Pollution of river Tisza in 2000.

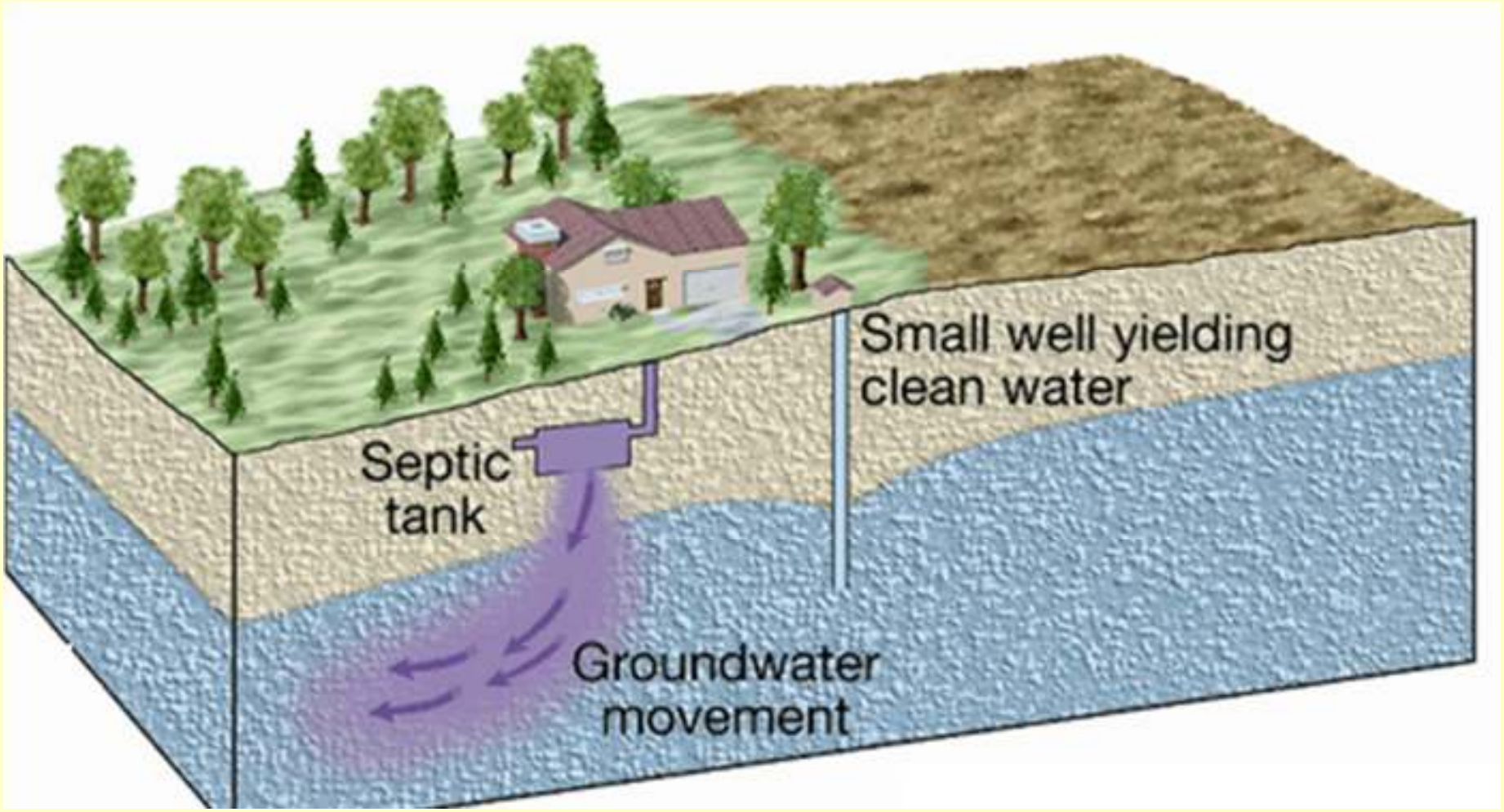
	Helyszín:	Időpont:	Maximális koncentráció:
1.	Szamos - Csengernél	II. 1.	32,6 mg/l cianid
2.	Tisza - Lónyánál	II. 3.	13,5 mg/l cianid
3.	Tisza - Tiszalöknél	II. 5.	3,7 mg/l cianid
4.	Tisza - Kisköre felett	II. 8.	3,8 mg/l cianid
5.	Tisza - Szolnoknál	II. 9.	3,2 mg/l cianid
6.	Tisza - Tápénál	II. 11.	2,2 mg/l cianid
7.	Tisza - Tiszaszigetnél	II. 11.	1,49 mg/l cianid

- 2000. January 30th. Baia Mare – 1000 m^3 **cianide**
- 2000. March 10. Heavy metals (**Cu, Zn, Pb**)
- 2000. March 27. Lead pollution

Rew sewage and industrial wate flows into the U.S. from Mexico as New River passes to California

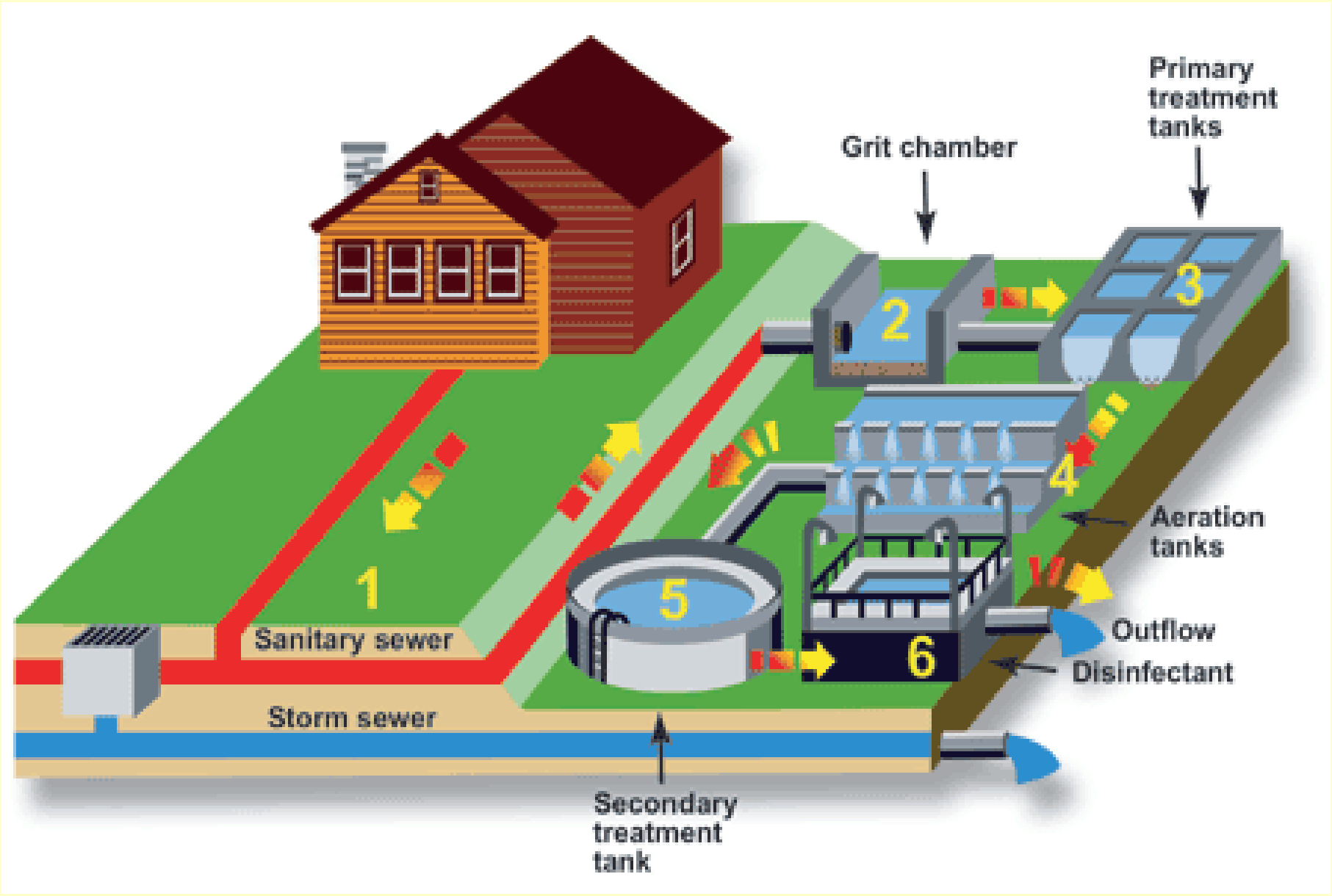
This particular beach is located just south of the Tijuana river outlet and north of the Mexican Border.

China: in 278 towns there is no any kind of sewage treatment
(it mean more than half of the Chinese population)


Small well yielding
clean water
Septic
tank
Groundwater
movement

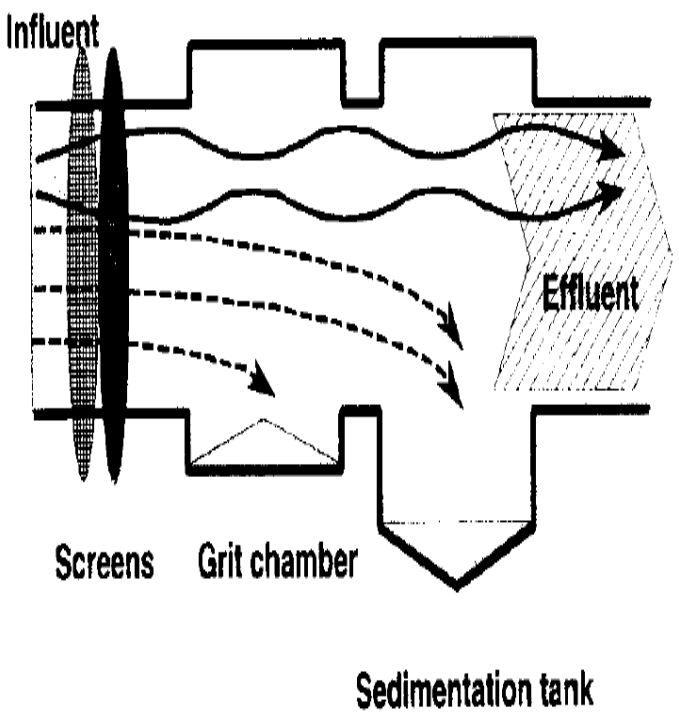
Wastewater treatment plant

- **Mechanical cleaning** (filtration of solid components, settling)
- **Biological cleansing**
- **Chemical cleansing**

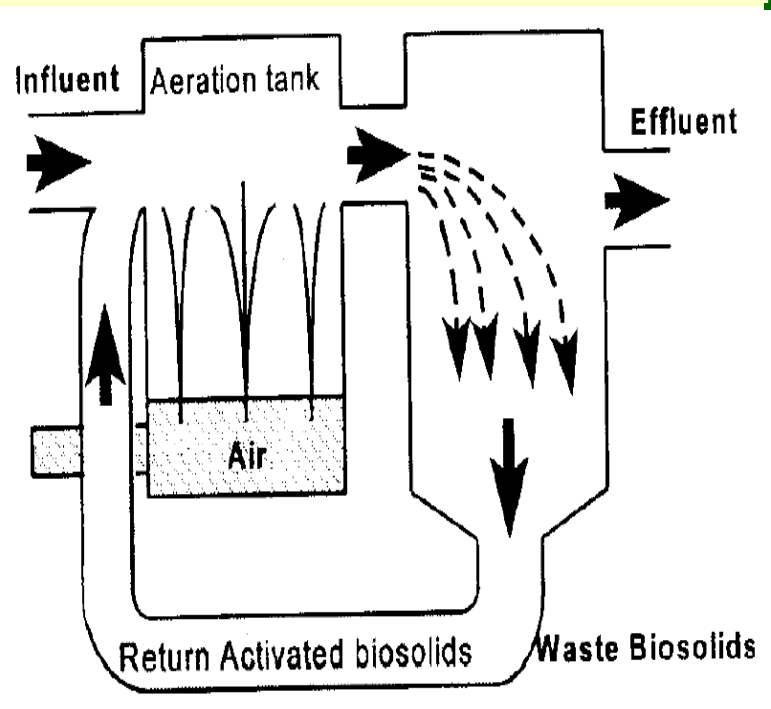

Primary treatment tanks
Grit chamber
2
3
4
1
5
6
Aeration tanks
Outflow
Disinfectant
Sanitary sewer
Storm sewer
Secondary treatment tank

The basic processes involved in sewage treatment

Primary treatment



Secondary treatment



Post-treatment processes

Disinfection (chlorine, ozone, UV etc..)

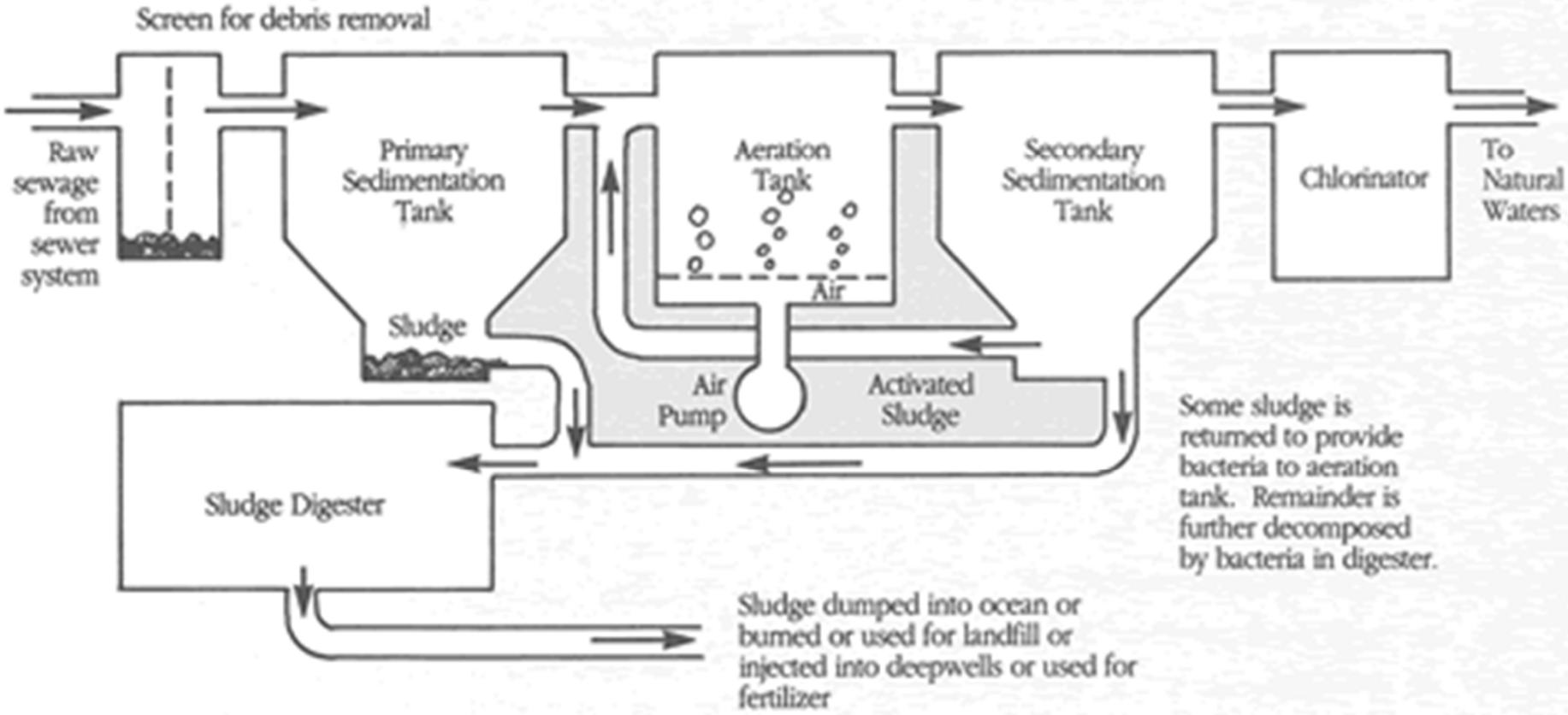
Dechlorination...

Potable water

Source: EPA – How wastewater treatment works: The basics

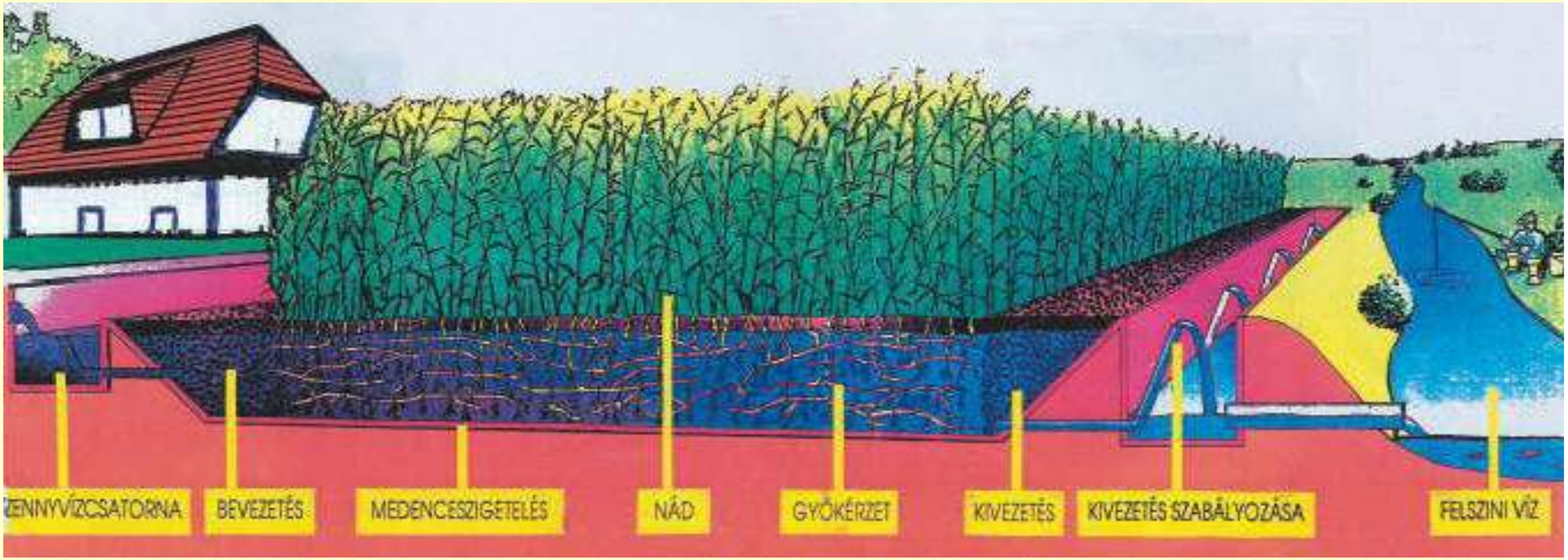
http://water.epa.gov/drink

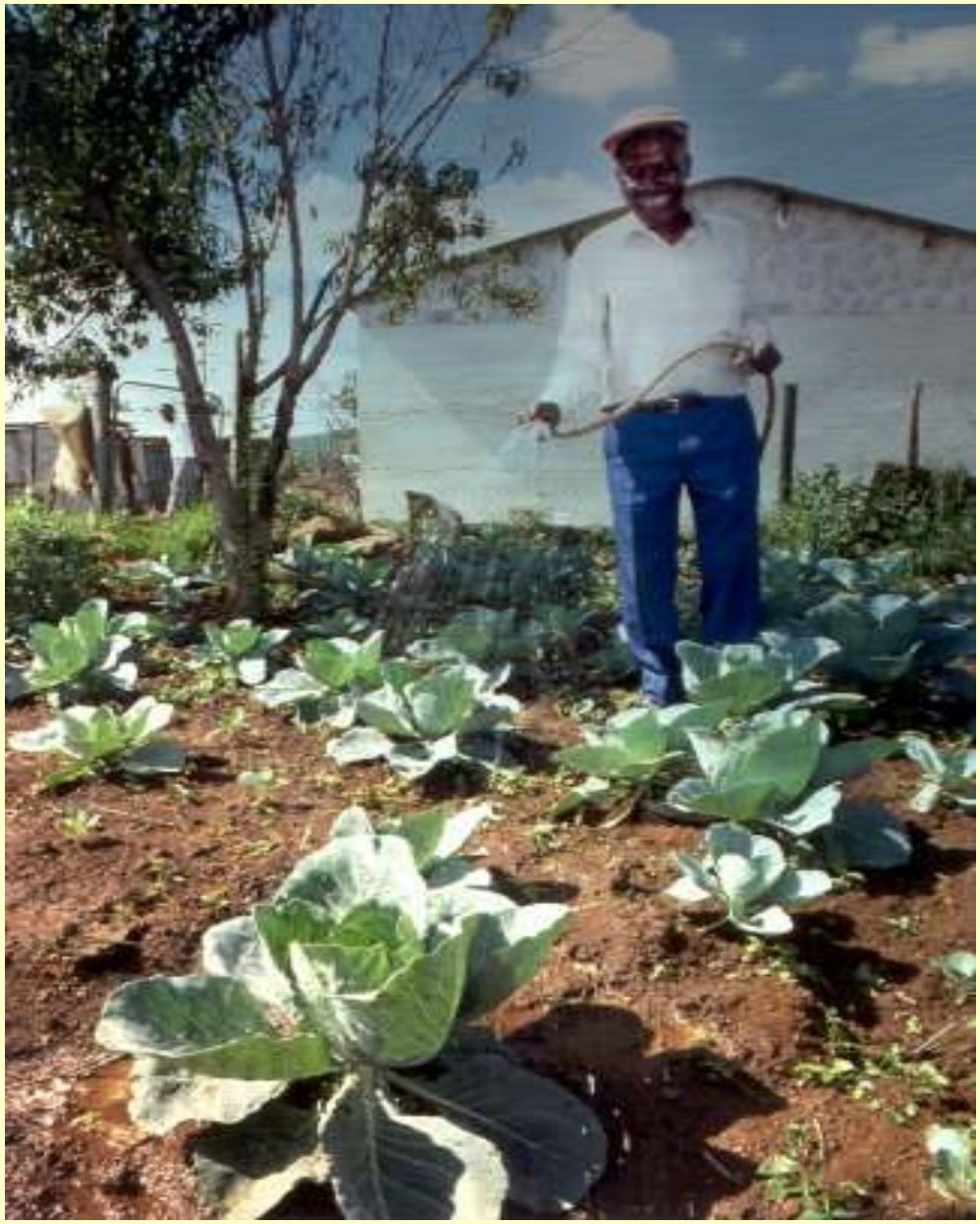
Secondary Sewage Treatment



Natural wastewater management techniques

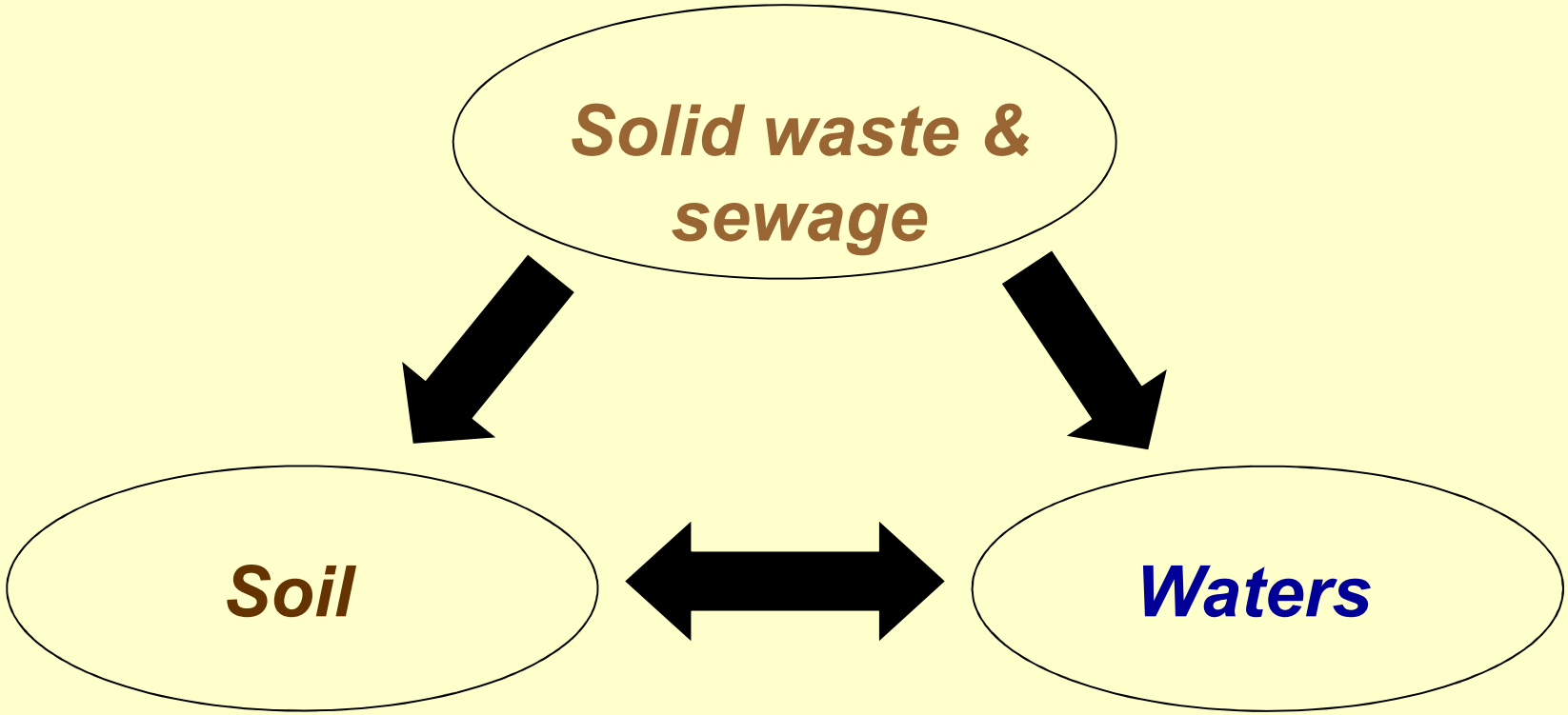
- Wetland
- Constructed pond
- Reed bed
- Combination of the above



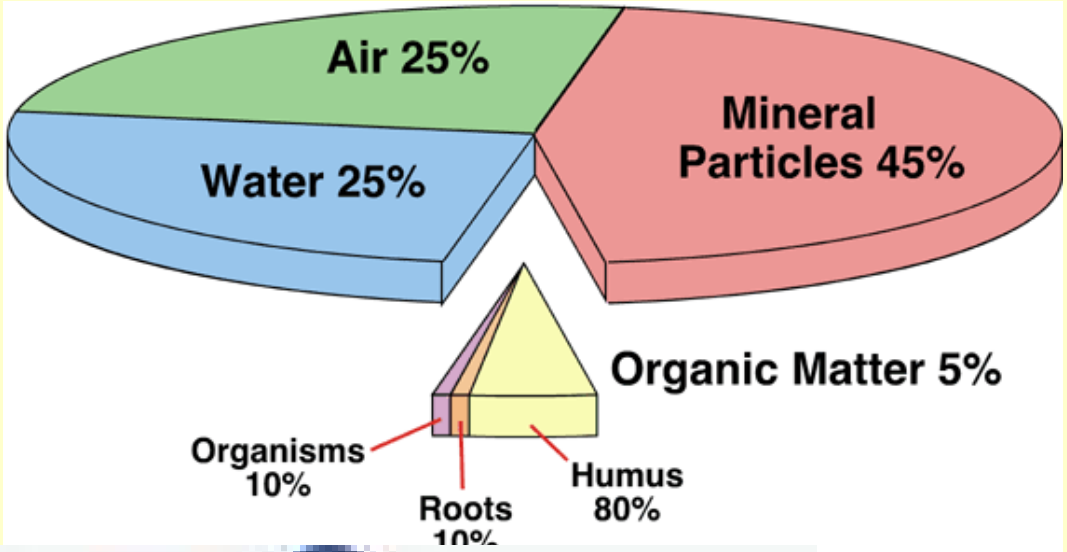


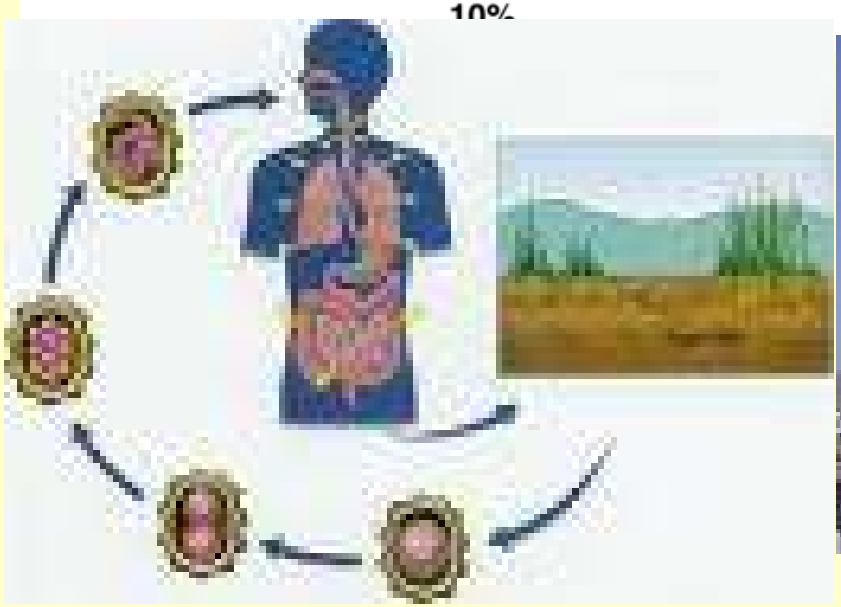
Watering vegetables with domestic water in South Africa.

Water, Soil, Waste & Sewage



Soil hygiene, waste problems





Taking soil samples

Dr Muffadal Ezzi, senior research scientist tests soil for pollution using the innovative Safe Soil Tester™ (United Kingdom)

Sources of pollution

Human waste

- ***Municipal solid waste*** : trash/garbage from streets and households **(Hungary: 3×10^6 t / year)**

- ***Agricultural and industrial non-hazardous waste***

(Hungary: 90×10^6 t / year)

- ***Hazardous waste*****:** chemical, mechanical & food industries, health care services **(Hungary: 2×10^6 t / year)**

- **Inorganic pollutants**
- **Organic pollutants:** (detergents, pesticides, fossil fuels, phenol… etc.)
- **Radioactive pollutants** (radon)
- **Microbial agents:** fungi, helminthic ova (playgrounds!), bacteria (S. typhi), spores (Cl. tetani), protozoans

Spores and helminthic ova in the soil may remain infective for years!

Inorganic pollution

Contaminants	Agricultural	Residential	Industrial	Natural
Antimony		✓		✓
Arsenic	✓			✓
Asbestos		✓		✓
Barium	✓	✓	✓	✓
Beryllium			✓	✓
Cadmium	✓	✓	✓	✓
Chromium	✓		✓	✓
Copper		✓	✓	✓
Cyanide	✓		✓	
Fluoride			✓	✓
Lead	✓	✓		✓
Mercury	✓	✓	✓	✓
Nickel		✓	✓	✓
Nitrate	✓	✓		✓
Nitrite	✓	✓		✓
Selenium	✓	✓	✓	✓
Thallium		✓		✓

Contaminants	Agricultural	Residential	Industrial	Natural
Aluminum	✓	✓	✓	✓
Chlorine	✓	✓	✓	✓
Iron		✓		✓
Manganese		✓		✓
Silver			✓	✓
Sodium	✓	✓		✓
Sulfate	✓	✓	✓	✓
Zinc		✓		✓

Source: EPA http://epa.gov

Organic pollution I.

Contaminants	Agricultural	Residential	Industrial	Natural
Benzene	✔		✔	
Carbon Tetrachloride		✓	✔	
Cis-1,2-Dichloroethylene			✔	
1,2-Dichloroethane		✓	✔	
1,1-Dichloroethylene		✓		
Dichloromethane			✔	
1,2-Dichloropane	✔		✔	
Ethylbenzene	✔		✔	
Monochlorobenzene	✔		✔	
O-Dichlorobenzene			✔	
O-, M-, P-Xylenes		✓	✔	
Para-Dichlorobenzene		✓		
Styrene			✔	
Trans-1,2-Dichloroethylene			✔	
Tetrachloroethylene			✔	
Toluene			✔	
1,2,4-Trichlorobenzene	✔		✔	
1,1,1-Trichloroethane			✔	
1,1,2-Trichloroethane			✔	
Trichloroethylene			✔	
Vinyl Chloride		✓		

Contaminants		Agricultural	Residential	Industrial	Natural
Alachlor		✔			
Atrazine		✔			
Benzo(a)pyrene				✔	
Carbofuran	POP	✔			
Chlordane	POP	✔			
Dalapon		✔			
Dibromochloropropane (DBCP)		✔			
2,4-Dichlorophenoxyacetic Acid		✔			
Di(2-ethylhexyl)-Adipate			✓	✔	
Di(2-ethylhexyl)-Phthalate			✓	✔	
2,3,7,8-TCDD (Dioxin)	POP	✔		✔	
Ethylene Dibromide (EDB)		✔		✔	
Dinoseb		✔			
Diquat		✔			
Endothall		✔			
Endrin	POP	✔			
Glyphosate		✔	✓	✔	
Heptachlor	POP	✔			
Heptachlor Epoxide		✔			

Organic and other pollution

Contaminants	Agricultural	Residential	Industrial	Natural
Hexachlorobenzene POP	✔			
Hexachlorocyclo-Pentadiene	✔			
Lindane	✔			
Methoxychlor	✔	✓		
Oxymyl(vydate)	✔			
Pentachlorophenol	✔		✔	
Picloram	✔			
Polychlorinated Biphenyls (PCBs) POP	✔		✔	
Simazine	✔		✔	
Silvex 2.4.5-TP	✔			
Toxaphene POP	✔			

Contaminants	Agricultural	Residential	Industrial	Natural
Alkalinity		✓	✔	
Detergents	✔	✓		
Coliform Bacteria	✔	✓		✔
Erosion and Sedimentation	✔		✔	
Hardness				✔
Radium			✔	✔
Total Dissolved Solids (TDS)	✔	✓	✔	✔

Source: EPA http://epa.gov

POP = Members of the „Dirty dozen" of Persistant Organic Pollutants banned internationally at the Stockholm Convention of 2001 (Not listed are: Aldrin, Dieldrin, DDT, Mirex)

Persistent Organic Pollutants (POPs)
are **chemical substances**
that **persist in the environment**,
bioaccumulate through the food web,
and **pose a risk of causing adverse effects to human health and the environment**.

POP = Members of the „Dirty dozen" of Persistant Organic Pollutants banned internationally at the Stockholm Convention of 2001. **Co-signatories agree to outlaw nine of the dirty dozen chemicals, limit the use of DDT to malaria control, and curtail inadvertent production of dioxins and furans.**

The „Dirty Dozen”:

1. **Aldrin** (insecticide)
2. **Chlordane** (insecticide)
3. **DDT** (dichloro-diphenyl-trichloroethane) (disease vector control)
4. **Dieldrin** (agricultural operation)
5. **Endrin**
6. **Heptachlor** (termiticide)
7. **HBC** (hexachlorobenzene) (solvent for pesticides)
8. **Mirex** (termicitide)
9. **Toxaphene**
10. **PCBs** (polychlorinated biphenyls)
11. **Dioxins** (polychlorinated-dibento-p-dioxins)
12. **Furans** (polychlorinated-dibenzofurans)

UNEP (UN Environmental Programme)
Adds to „Dirty Dozen" List in 2009):

1. Pentabromodiphenyl ether
2. Octabromodiphenyl ether
3. Chlordecone
4. Lindane
5. Alpha-hexachlorocyclohexane
6. Beta-hexachlorocyclohexane
7. PFOS (perfluorooctanesulfonic acid, tetrabromodiphenyl ether and pentabromodiphenyl ether)
8. Hexabromobiphenyl
9. Pentachlorobenzene

Categories of health-care waste I.

- Infectious waste
- Pathological waste
- Sharps
- Pharmaceutical waste
- Genotoxic waste

- **Waste suspected to contain pathogens, e.g. laboratory cultures; waste from isolation wards; tissues (swabs), materials, or equipment that have been in contact with infected patients; excreta**
- **Human tissues or fluids, e.g. body parts; blood and other body fluids; fetuses**
- **Sharp waste, e.g. needles; infusion sets; scalpels; knives; blades; broken glass**
- **Waste containing pharmaceuticals, e.g. pharmaceuticals that are expired or no longer needed; items contaminated by or containing pharmaceuticals (bottles, boxes)**
- **Waste containing substances with genotoxic properties, e.g. waste containing cytostatic drugs (often used in cancer therapy); genotoxic chemicals**

Categories of health-care waste II.

- Chemical waste
- Wastes with high content of heavy metals
- Pressurized containers
- Radioactive waste

- **Waste containing chemical substances, e.g. laboratory reagents; film developer; disinfectants that are expired or no longer needed; solvents**
- **Batteries, broken thermometers; blood-pressure gauges; etc. heavy metals**
- **Gas cylinders; gas cartridges; aerosol cans**
- **Waste containing radioactive substances, e.g. unused liquids from radiotherapy or laboratory research; contaminated glassware, packages, or absorbent paper; urine and excreta from patients treated or tested with unsealed radionuclides; sealed sources**

Health-care waste generation according to national income level

- Annual waste generation (kg/head of population)
- High-income countries:
- — all health-care waste 1.1–12.0
- — hazardous health-care waste 0.4–5.5
- Middle-income countries:
- — all health-care waste 0.8–6.0
- — hazardous health-care waste 0.3–0.4
- Low-income countries:
- — all health-care waste 0.5–3.0

Health-care waste generation according to source size

- **Daily waste generation (kg/bed)**

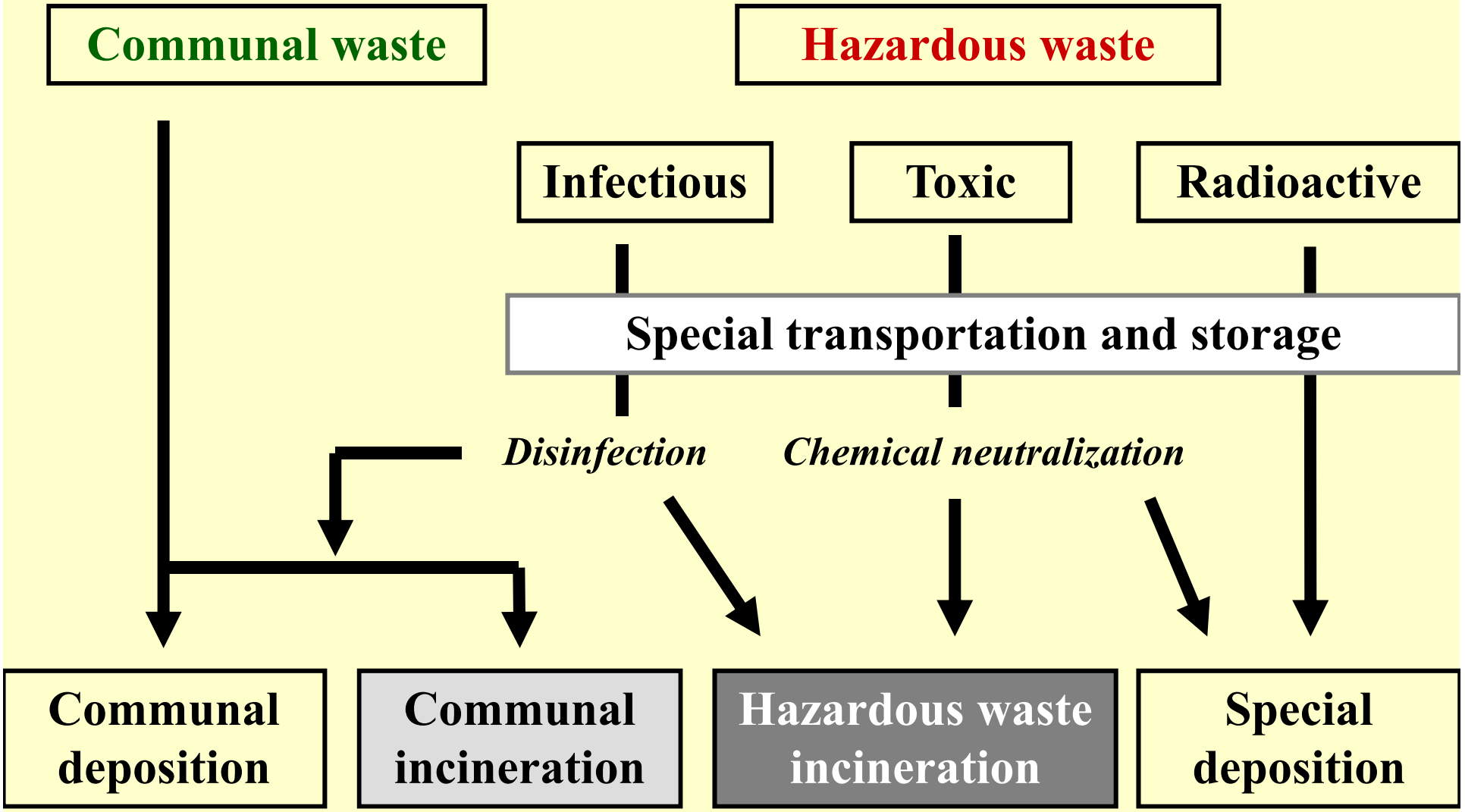
- **University hospital 4.1–8.7**
- General hospital 2.1–4.2
- District hospital 0.5–1.8
- Primary health-care centre 0.05–0.2

Total health-care waste generation by region

- **Daily waste generation (kg/bed)**

- **North America 7–10**
- Western Europe 3–6
- Latin America 3
- Eastern Asia:
- — high-income countries 2.5–4
- — middle-income countries 1.8–2.2
- Eastern Europe 1.4–2
- Eastern Mediterranean 1.3–3

Hazardous and non-hazardous solid waste disposal



Prevention of soil pollution

- ***Pesticide environmental limits*****:** difficult to set, basic rule is to accept concentrations in the soil that will not, with all likelihood, cause excessive accumulation in groundwater or various plants

- ***Microbe levels***: contaminated soil contains **helminthic ova, coliform bacteria and clostridia** in higher concentrations. These can be used as measures of the level of fecal soil contamination.

- ***Nitrogen index*****:** defined as **the ratio between inorganic and organic nitrogen**. Provides information on the self-purification of the soil. **Normal value:0.98**

- ***Technical prevention*****:** source reduction, waste recycling, landfill deposition, incineration, hygienic burial practices and disposal of animal cadavers

Waste neutralization

Solid waste

- Selective collection if possible (always for hazardous waste)
- Dehydration
- Transient storage
- Heat-treatment or incineration
- Biological neutralization
- Conditioning
- Chemical and physical neutralization
- Permanent storage, landfills etc…

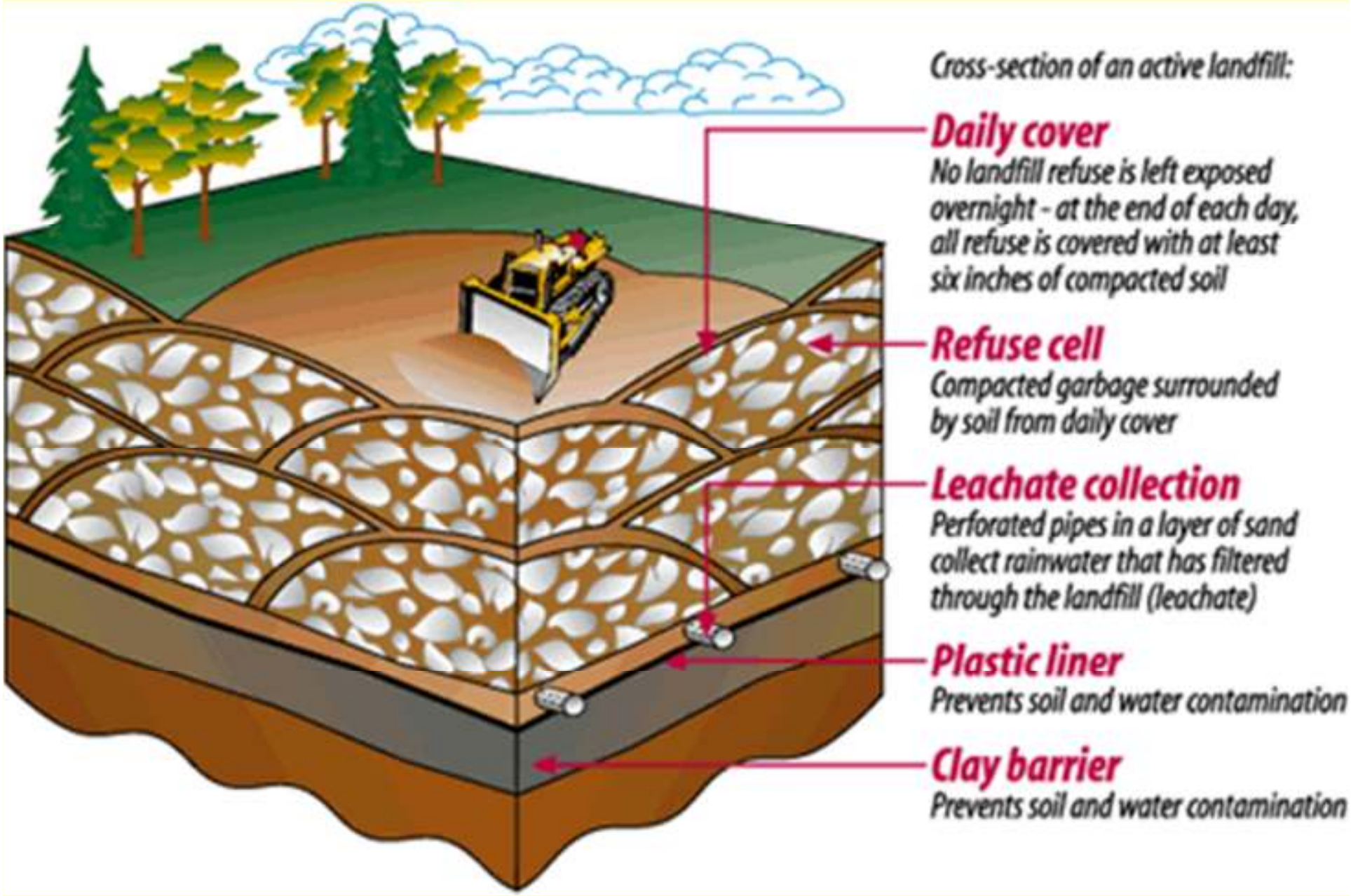
- ***Technical prevention*:**

- **source reduction**,
- **waste recycling**,
- **landfill deposition**,
- **incineration**,
- **hygienic burial practices** and
- **disposal of animal cadavers**

***Role of public health authorities*:**

  - **setting of environmental limits**
  - **monitoring soil pollution**
  - **supervision of industrial plants that produces** large amounts of waste or hazardous waste, and of waste-management facilities

Landfill


Cross-section of an active landfill:
Daily cover
No landfill refuse is left exposed overnight - at the end of each day, all refuse is covered with at least six inches of compacted soil
Refuse cell
Compacted garbage surrounded by soil from daily cover
Leachate collection
Perforated pipes in a layer of sand collect rainwater that has filtered through the landfill (leachate)
Plastic liner
Prevents soil and water contamination
Clay barrier
Prevents soil and water contamination