

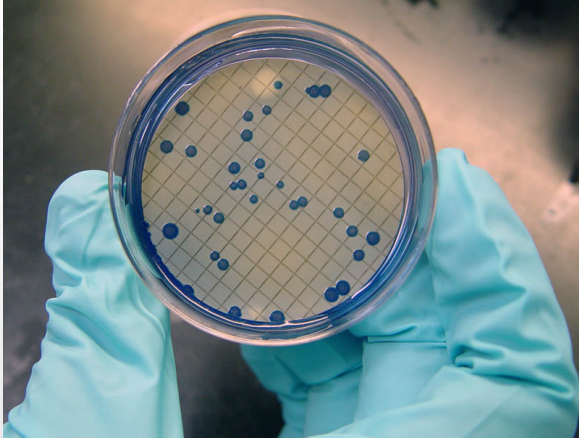
The background of the slide is a light gray gradient. It is decorated with numerous water droplets of various sizes. Some droplets are large and prominent, while others are small and subtle. They are scattered across the slide, with a higher concentration in the top-left and bottom-right corners. The droplets have a realistic, glossy appearance with highlights and shadows.

# WATER TREATMENT & POLLUTION

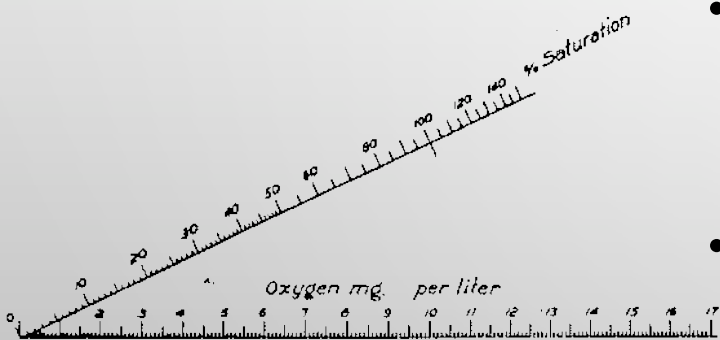
# WATER POLLUTANTS

- Any chemical, biological, physical change in water quality that has a harmful effect on living organisms or make water unsuitable for desired uses
- Types of pollutants:
  - **Infectious Agents:** Bacteria, viruses, protozoa, worms
  - **Oxygen-Demanding Wastes:** Animal manure
  - **Inorganic Chemicals:** Toxic metals such as lead
  - **Plant Nutrients:** Nitrate, phosphorus
  - **Sediment:** Soil, Silt
  - **Radioactive Materials:** Uranium
  - **Heat (Thermal) Pollution:** Excessive heat

# MEASURING WATER QUALITY



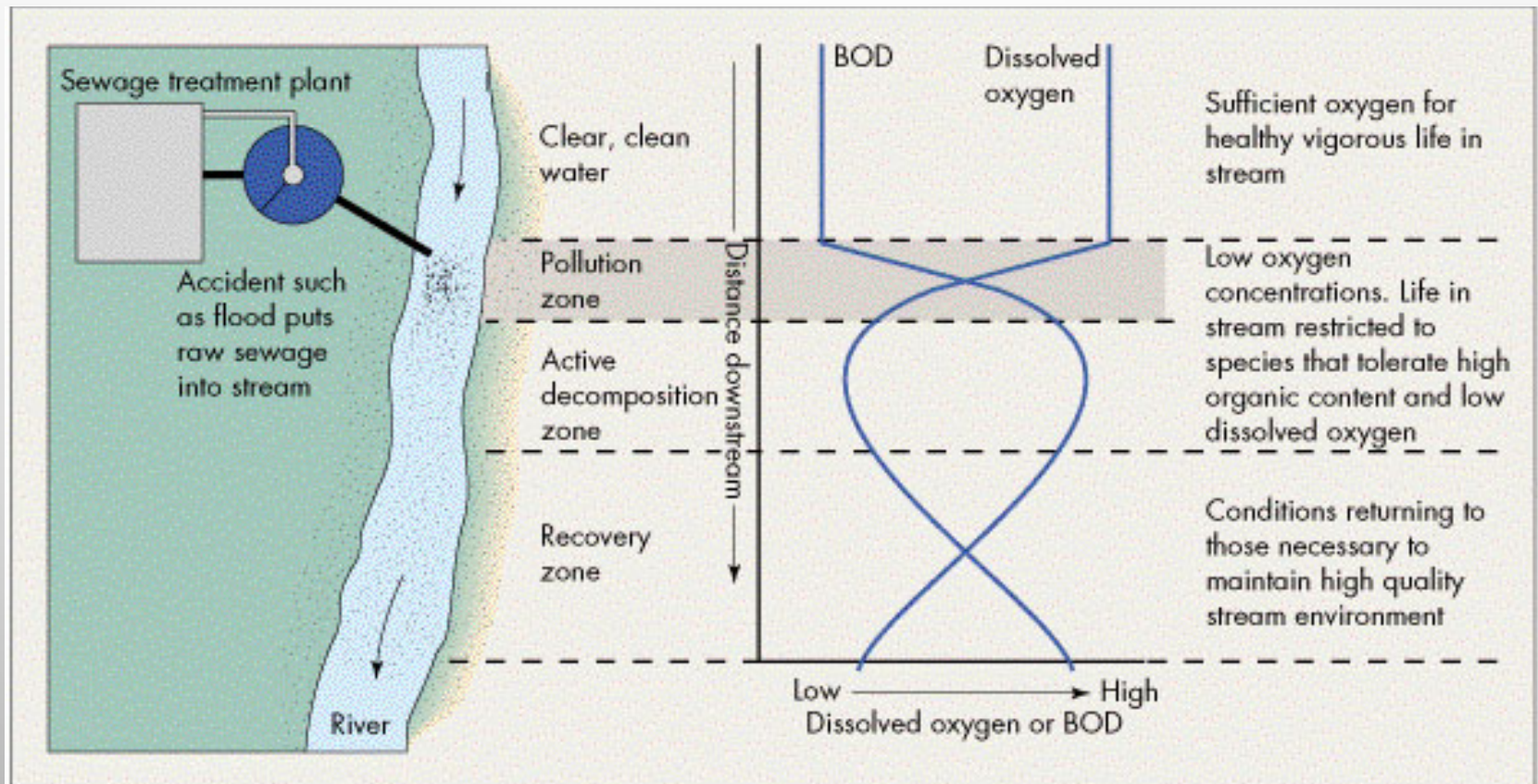
Water temperatures °Cent.



- **Measuring colonies of *fecal coliform***
  - 0 colonies per 100 mL in drinking water/200 colonies per 100 mL in swimming pools
- **Biological Oxygen Demand (BOD)**
  - Amount of dissolved oxygen needed by aerobic decomposers to break down the organic materials in a certain volume of water over 5-day incubation period.
- **Chemical Analysis:** determines presence and concentrations of most inorganic/organic chemicals
- **Using indicator species (macroinvertebrates) and plants**

# BIOLOGICAL OXYGEN DEMAND

- Low oxygen conditions may kill fish and other organisms.
- All streams have some capability to degrade organic waste. Problems occur when stream is overloaded with biochemical oxygen-demanding waste.

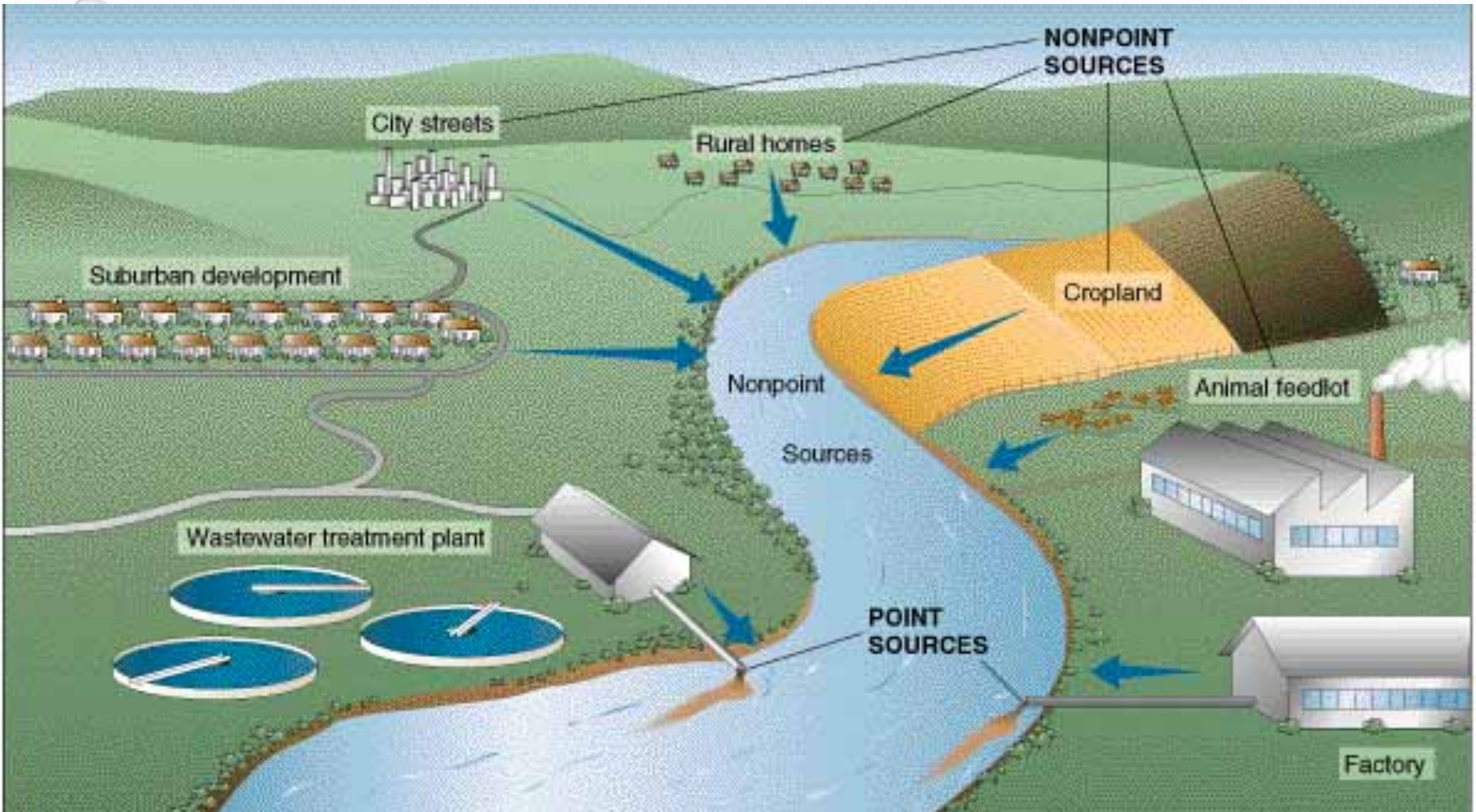




## POINT VS. NONPOINT SOURCES

- **Point:** discharge pollution at specific locations through pipes, ditches, sewers into bodies of surface water
  - Factories, Sewage Treatment plants, Abandoned underground mines, oil tankers
- **Nonpoint sources:** Cannot be traced to any single site of discharge
  - Acid deposition, runoff from croplands, livestock feedlots, logged forests, urban streets, lawns, golf courses & parking lots

# POINT AND NONPOINT SOURCE



# GROUNDWATER POLLUTION

- Source of drinking water and irrigation
  - Pollution comes from :
    - Dumping wastes into storage lagoons, septic tanks, landfills, hazardous waste dumps and deep injection wells
    - Oil spills/dumping gasoline & paint thinners into groundwater
    - Hazardous wastes, gasoline, oil in metal pipes long-term
- Has a hard time cleansing itself because it flows slowly (no dispersal), has smaller populations of decomposing bacteria, has cold temps that slow down chemical reactions that decompose wastes

# WHY WE NEEDED TOILETS?



- Before late 1800s, we disposed of human waste was “outdoor privy” or behind nearest bush. Oftentimes, this would seep into drinking water leading to infectious disease.
- A need arose to clean the drinking water, so a one-way flow of flushing domestic and industrial wastewater into natural waterways (a la toilets & sewers)
  - Receiving waters became cesspools for foul odors, vermin, filth, too much organic matter, depleted dissolved oxygen and no life



# THE MAKING OF WASTEWATER TREATMENT PLANTS

- First plants were built around 1900 to treat flow was receiving waterways
  - Problem: Heavy amounts of water caused overflow
- Municipalities were then required to install separate systems—storm drains—to collect and drain runoff from precipitation & sanitary sewers for all wastewater—two SEPARATE systems
- Even into the 1970s, plants were releasing sewage into the waterways untreated→

Enter “The Clean Water Act of 1972”

- Even today, only 1/10 of treatment plants operate effectively in our country. However many developing places don't even have advanced sewage treatment



# THE PROCESS—THE OVERVIEW

- **Preliminary treatment:**

Debris and grit damage pumps so they must be removed by ***screening out debris*** (bar screen) and ***settling of grit*** (grit chamber—tank that slows velocity of grit so it can settle)



# THE PROCESS—THE OVERVIEW

- **Primary treatment—Removal of Particulate Organic Matter :**

Water flows through *primary clarifiers*, which is slow so it sits almost motionless and particulate organic matter settles to bottom where it is removed.

The oily, fatty material floats to top and skimmed

**Raw sludge:** particulate organic matter + oily, fatty material





# THE PROCESS—THE OVERVIEW

- Secondary treatment—Removal of Colloidal and Dissolved Organic Material:

Called *biological treatment* because it uses organisms (*natural decomposers and detritus feeders*) to feed on material and make CO<sub>2</sub>, mineral nutrients and water via cell respiration→but **must add O<sub>2</sub>**

- Trickling-filter system
- Activated-sludge systems



# THE PROCESS—THE OVERVIEW

- **Biological Nutrient Removal—Removal of Dissolved Inorganic Material:**

After treatment, the process left behind a nutrient rich discharge, which leads to possible eutrophication.

Secondary systems (**BNR**) have been added to remove nutrients and oxidize detritus

- Nitrogen: Activated-sludge is denitrified
- Phosphorus: Must be removed from environment as excess organisms are removed. Creates a raw sludge that is more nutrient-rich.





# THE PROCESS—THE OVERVIEW

- **Final Cleaning and Disinfection:**

With or without BNR, wastewater goes through a final clarification and disinfection process.

- Most widely used is a **chlorine gas** (effective & inexpensive).
  - Can be damaging to aquatic life so Clorox (sodium hypochlorite— $\text{NaClO}$ ) is often used.
- **Ozone** is also used—breaks down oxygen gas and kills microorganisms.
  - Very explosive
- **Ultraviolet Lights:** Kills microorganisms



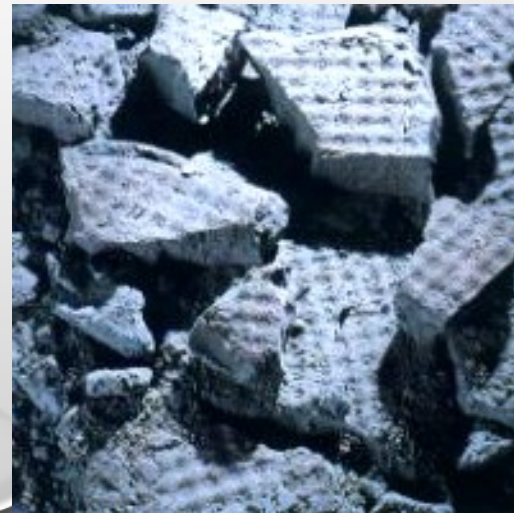
# THE PROCESS—THE OVERVIEW

- Studies show that after treatment the wastewater that is discharge has a lower organic/nutrient content than bodies it is being discharged into (10-20 ppm BOD vs. 200 ppm)
  - What does mean? Discharging wastewater might actually contribute to water quality!
- Process described represents state-of-the-art techniques. Some places use lower-quality treatment or discharge directly into ocean if a coastal city.



# WHERE DOES THE SLUDGE GO?

- Sludge is grayish, foul-smelling, syrupy with 97-98% water. Pathogens are present so considered biologically hazardous material.
- While hazardous, it is nutrient rich and could be used as a fertilizer if detoxified or pathogens killed.
  - Anaerobic Digestion
  - Composting
  - Pasteurization

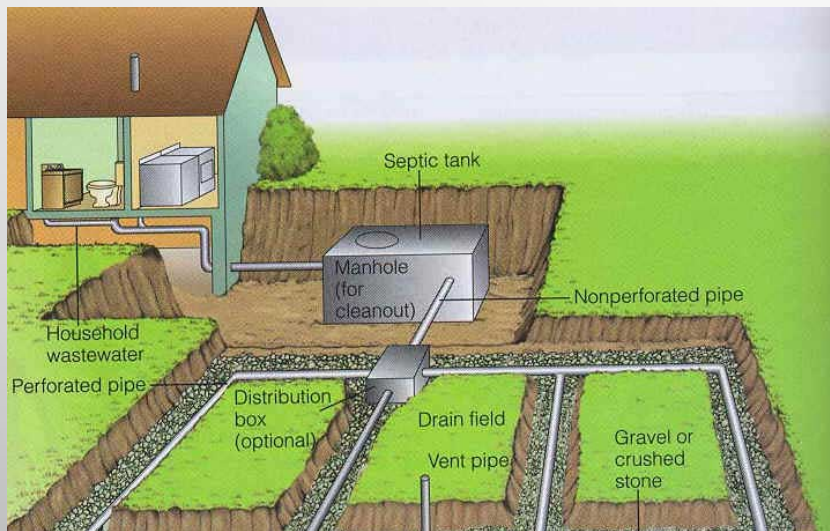


# DEWATERING OF SLUDGE



# ALTERNATIVE TREATMENT SYSTEMS

- Effluents/Wastewater for Irrigation
- Reconstructed Wetland Systems
- On-site wastewater treatment systems: for homes that lie outside municipal systems



- Most common system: Septic tank and leaching field
  - Frequently fail and result in unpleasant sewage backup into homes and pollution of groundwater/surface waters



# DRINKING WATER

- Good news: From 1970 to 2000, 38% more people have access to clean drinking water in developing countries.
  - Bad news: Still 1/5 people don't have access
- Drinking water treated much like wastewater but:
  - Held in reservoirs to help clarity and dissolved oxygen content decrease
  - Then pumped through purification plant so it meets government standards (sand filters/activated charcoal)



# LEGALLY SPEAKING: DRINKING WATER

- U.S. Safe Drinking Water Act (1974) required EPA to establish national drinking water standards (max contaminant levels) for any pollutants that may have adverse health affects.
- **Strengthened by:**
  - Combining small treatment systems to larger ones
  - Better public notification of drinking water violations
  - Banning lead in plumbing
- **Pressure to weaken:**
  - Eliminate national tests
  - Suspending requirement for media alerts
  - Allow violation if provider cannot afford
  - Eliminate requirement that water system use technology to eliminate cancer-causing contaminants.

# IS BOTTLED WATER THE SOLUTION?

- Some say that the bottled water is actually more contaminated than tap water.
  - Bacteria contaminate 1/3 of bottle water purchased in the U.S.
- Best next step: Reduce and prevent water pollution



## A TALE OF THREE WASTES

- Using the following three situations, write the story of what happens to each type of water pollution/wastes. Describe where they go and how they are removed from the water supply.
  - A pile of manure from a cow
  - Human waste in the toilet
  - Acid rain