**Major Concepts**

- Sources and types of pollution that threaten water supplies
  - Point sources & nonpoint sources
- Clean Water Act
- Safe Drinking Water Act
- Wastewater treatment
  - Septic systems & wastewater treatment plants
  - Biological oxygen demand & sag curve

**Water Quality**

- Characteristics of water
  - Taste, color, temperature, purity, toxicity
- Water quality requirements vary with intended use
  - High quality needed for drinking water and certain industrial uses
  - Lower quality may be acceptable for irrigation
    - Wastewater reuse

**Types of Pollution**

- Inorganic chemicals
  - Of particular concern are metals
    - Lead, cadmium, mercury, arsenic, copper
  - Can cause serious acute and chronic health problems
- Sources include
  - Mining and manufacturing
  - Agriculture
  - Households
  - Arial deposition from fossil fuel burning

- Organic chemicals
  - Volatile organic compounds (VOCs)
    - Solvents, petroleum fuels, fuel additives
  - Synthetic organic compounds (SOCs)
    - Pesticides, dioxins, PCBs
- Sources include
  - Industry
  - Agriculture
  - Households
Types of Pollution

- Biological – waterborne disease
  - 1 million illnesses each year in U.S.
  - Bacteria
    - Typhoid fever, cholera, bacillary dysentery
  - Viruses
    - Viral hepatitis, acute gastroenteritis
  - Parasites
    - Amebic dysentery, giardiasis

- Radioactive
  - Most common in water are
    - Radium, uranium, radon and man-made radionuclides
  - Naturally occurring radionuclides appear mainly in groundwater
  - Surface waters more likely to contain artificial radionuclides
    - Atmospheric fallout from nuclear testing

Sources of Pollution in U.S. Rivers

- Point sources
  - Industrial discharges and municipal wastewater treatment plants
    - Regulated under federal Clean Water Act
    - National Pollutant Discharge Elimination System (NPDES) permits
  - Underground injection wells

- Nonpoint sources
  - Agricultural runoff
    - Pesticides
    - Nutrients (fertilizers) – cause eutrophication
    - Sediment
  - Urban storm water
    - Pesticides
    - Nutrients (fertilizers)
    - Sediment
    - Petroleum
  - Hydro / habitat modification
    - Combined storm sewers & runoff
  - Resource extraction
    - 9%
  - Land disposal
    - 3%
  - Silviculture
    - 6%
  - Construction
    - 4%
  - Agriculture
    - 39%
  - Municipal
    - 11%
  - Unknown
    - 4%
  - Industrial
    - 6%
  - Combined storm sewers & runoff
    - 6%
## Drinking Water Treatment

- Municipal drinking water treatment in the United States
  - 170,000 public water supply systems
    - 115,000 small scale suppliers
    - 55,000 community supply systems
  - Supply water to 250 million Americans

## Drinking Water Treatment

- Main treatment steps
  - Coagulation - flocculation
  - Sedimentation
  - Filtration
  - Disinfection

## Disinfection

- Most critical step in water treatment
- Goal: destroy all organisms in water supply
- Chlorine
  - Major disinfectant used in U.S. today
  - Form disinfection byproducts
- Alternatives
  - UV radiation
  - Ozone
  - Chloramines

## Drinking Water Regulation

- Safe Water Drinking Act
  - U.S. Environmental Protection Agency sets Maximum Contaminant Levels (MCLs)
    - Protect the public health and welfare from specific water pollutants
    - Delegated enforcement to individual states
    - Oversight provided by the USEPA

## Wastewater Treatment and Disposal

- Sewage
  - In many developing countries
    - Human waste pollutes land and water
  - Organic material can serve as food for disease-producing organisms living in the water

## Biological Oxygen Demand (BOD)

- As microorganisms decompose organic material in water, they use dissolved oxygen
- If water overloaded with biodegradable organic pollutants, decomposition can deplete dissolved oxygen supply
- Kills fish and other aquatic organisms that depend on dissolved oxygen for respiration
- Reaeration of water caused by
  - Turbulent flow
  - Aquatic plant photosynthesis
Biological Oxygen Demand (BOD)
- Sag curve
  - Deoxygenation and reaeration of water presented graphically
  - Shows level of dissolved oxygen over time
  - Shows “critical point”
    - Minimum dissolved oxygen
    - Maximum aquatic life impact

BOD and Sag Curve

Types of Sewage Disposal
- Pit privies
- Individual septic systems
- Municipal sewage treatment plant

Pit Privy
- Separation from water
- Drainage
- Ventilation

Individual Septic System
- Septic tank
- Leach field

Jon B. Marshack, D.Env.
State Water Resources Control Board
Prevent Septic System Failure

- Proper installation
  - Separation from water sources
  - Soil properties - drainage
- Keep microorganisms healthy
  - Minimize toxins
- Don’t overload with solids
  - Grease, fats, food wastes
  - Remove solids periodically

Municipal Sewage Treatment

- Speeds up natural purification processes
  - Settling
  - Biooxidation
  - Filtration
- Stages of treatment
  - Primary
  - Secondary
  - Tertiary
  - Sludge disposal

Primary and Secondary Wastewater Treatment

- Primary treatment
  - Mechanical processes for removal of solids
  - Bar screen
  - Grinder or comminuter
  - Clarifier

Bar Screen
Municipal Sewage Treatment

- Secondary treatment
  - Trickling filters and activated sludge treatment
    - Bacteria break down and digest organic material in the sewage
  - Sludge from primary and secondary treatment
    - Dried
    - Disposed of in landfill or composted

Activated Sludge Tank (drained)
Municipal Sewage Treatment

- **Tertiary treatment**
  - Advanced wastewater treatment methods, including
    - Air stripping of ammonia
    - Coagulation
    - Rapid granular filtration
    - Reverse osmosis – membrane filtration
  - Further reduce BOD, salts, pathogens and other pollutants

Municipal Sewage Treatment

- **Sludge treatment and disposal**
  - Sludge or “biosolids”
    - Solids and associated liquids separated from wastewater during sewage treatment
  - Sludge disinfection
    - Destroys pathogens in the sludge to prevent the spread of disease
  - Digested sludge may be air dried
  - Disposal in landfill or reused as agricultural fertilizer

Future Outlook

On a planet covered with water, yet plagued by waterborne disease, drought, and water mismanagement, we must promote conservation, efficiency, and frugality.

- Every drop counts!