

EPP 262, Principles of Environmental Health Sciences
Water and Wastewater – Part 1

SPH 262
Principles of Environmental Health Sciences

Water and Wastewater
Part 1: General Concepts

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CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

Major Concepts

- Hydrologic cycle – how water moves
 - ◆ Relative amounts of freshwater on earth
- Main consumers and major uses of water
- Water scarcity
 - ◆ Water shortages and potential conflict
 - ◆ Methods of water management

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Major Concepts

- Sources of freshwater
 - ◆ Surface waters and aqueducts
 - ◆ Types of wells used to pump groundwater
- Groundwater formation
 - ◆ Contamination
 - ◆ Recharge
 - ◆ Water mining
 - ◆ Fossil water
 - ◆ Problems associated with overuse

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Major Concepts

- Sources and types of pollution that threaten water supplies
 - ◆ Point sources
 - ◆ Nonpoint sources
- Federal Clean Water Act

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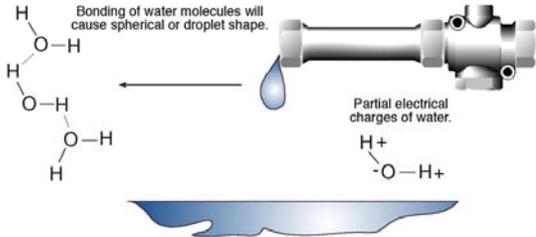
Introduction

“Water is cheap, accessible, plentiful, and relatively safe to drink.”

- Differences in beliefs about the importance of water quality, water scarcity, and water use can cause conflict and hinder a joint effort to protect the world’s water supplies

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Water Is a Unique Compound



Bonding of water molecules will cause spherical or droplet shape.

Partial electrical charges of water.

H⁺
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The Properties of Water

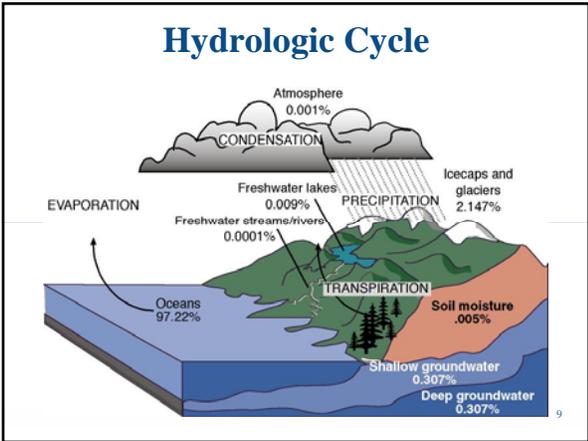
- Water exerts a major influence on the earth's environment
- Partial negative and positive charges
 - ◆ Easily dissolves most polar molecules
 - ◆ Solvent of the chemistry of life
- Water exists as solid, liquid, and vapor
 - ◆ Phase change essential in maintaining earth's temperature

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Hydrologic Cycle

- Processes involve sun, atmosphere, earth and water
 - ◆ Evaporation (from water)
 - ◆ Transpiration (from plants)
 - ◆ Condensation (cloud formation)
 - ◆ Transportation (wind)
 - ◆ Precipitation (rain, snow)
 - ◆ Runoff & subsurface flow (water movement)

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Water Resources

- Water covers 71% of earth's surface
- Amount of water on earth
 - ◆ 1.3 billion cubic kilometers
 - ◆ 0.025% of the mass of Earth
 - = ½ liter bottle in a minivan
- Only 2.5% is freshwater
- Only 0.3% available for use
 - ◆ Required by humans, animals, and plants

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Water Shortage and Scarcity

- Access to clean water
 - ◆ Critical to human well-being and survival
- 40% of the world's population facing water shortages or access problems
- Globally, demand for water is increasing about 2.3% annually
 - ◆ Doubling of demand every 21 years

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Water Shortage and Scarcity

- 1 in 5 people on earth lacks clean water supply
- 1.8 million children die each year from lack of water or from tainted water
- At some point in the future, worldwide water use will be limited by
 - ◆ Physical factors
 - ◆ Economic factors
 - ◆ Environmental factors

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Water Rights and Conflicts

- Many major water sources cross national and state boundaries
 - ◆ Ensures disputes over this valuable resource
- Bangladesh, India and Pakistan
- Middle Eastern Countries
- Southwestern U.S. and Mexico

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Water Consumption and Management

- Many factors impact amount and ways that countries use water
 - ◆ Economy
 - ◆ Available technology
 - ◆ Level of industry and agriculture
 - ◆ Culture
 - ◆ Climate

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Water Consumption and Management

- Effective water management
 - ◆ Improve water use efficiency
 - ◆ Decrease consumption
 - ◆ Help preserve remaining resources
- Sustainable water use
 - ◆ Current needs are met without diminishing the resource for use by future generations and at no expense to the environment

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Water Use

- 3 major water consumers
 - ◆ Agriculture
 - ◆ Industry
 - ◆ Domestic – households and individuals
- United States average daily water use from public supplies for all uses
 - ◆ Approx. 180 gallons per day per person

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Water Use – Agriculture

- Consumes largest portion of earth's freshwater supply
- 70% of world's water demand used for irrigation
 - ◆ 60 % of that is lost to evaporation and runoff

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Water Use – Industry

- Large quantities of water used for
 - ◆ Manufacturing
 - ◆ Power plant cooling and condensation
 - 250 gallons per person per day in U.S.
 - ◆ Waste disposal
- Industrial water use in U.S.
 - ◆ Over 200 billion gallons per day

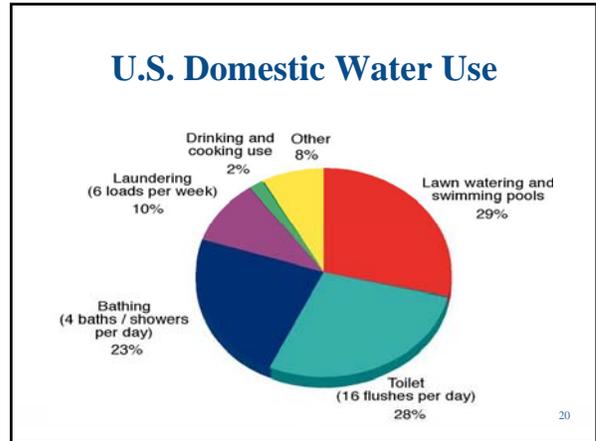
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Water Use – Domestic

- **75-135 gallons per person per day in United States**
- **Major household uses**
 - ◆ **Flushing toilets**
 - 5.7 billion gallons per day
 - ◆ **Bathing**
 - ◆ **Lawn watering**
 - ◆ **Laundering**

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Sources of Drinking Water – Surface Water

- **Vast amounts in United States**
 - ◆ 3.5 million miles of rivers and streams
 - ◆ 41 million acres of lakes
- **But not evenly distributed**
 - ◆ California & Southwest
- **Prone to contamination – exposed**
 - ◆ Industrial & municipal waste discharges
 - ◆ Diffuse pollution
 - Agricultural & urban runoff

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Surface Water

- **Water sources and watersheds require protection and management to limit or prevent contamination**
 - ◆ Regulation of waste discharges
 - ◆ Watershed protection
 - ◆ Limit recreational access
 - ◆ Public education
 - ◆ Pollution source control

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Ground Water

- **Worldwide volume**
 - ◆ 8.5 million cubic kilometers
 - ◆ 0.62% of the total water
- **Drinking water supply for**
 - ◆ 50% of the people living in United States
 - ◆ 95% of people living in U.S. rural areas

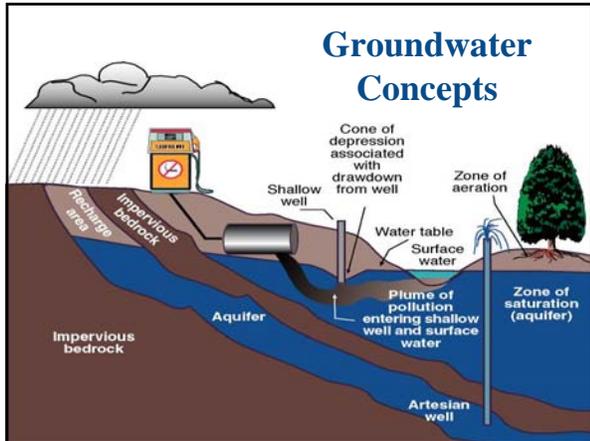
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Ground Water Formation

- **Precipitation and surface water percolate downward through spaces in the soil**
 - ◆ Pulled by gravity
- **Low permeability layers limit movement**
- **Aquifer**
 - ◆ Zone of saturation below water table
 - ◆ Water fills all pore spaces

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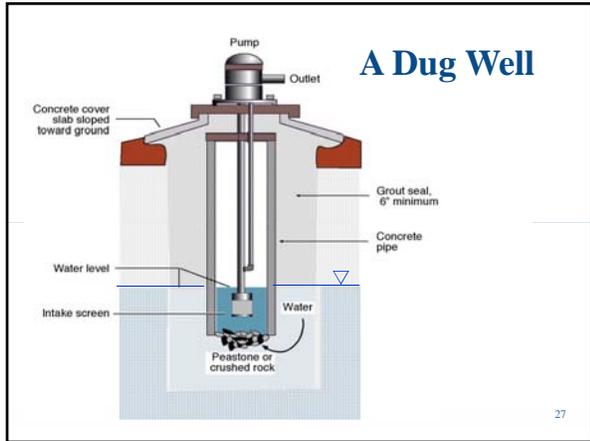
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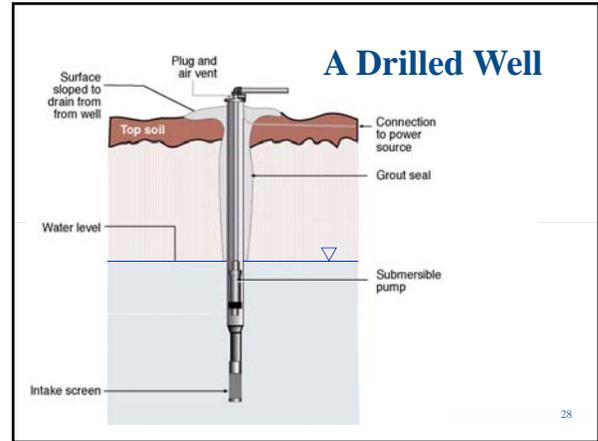
Wells

- **Types of groundwater wells**
 - ◆ Dug – least sophisticated, shallow
 - ◆ Driven
 - ◆ Bored or drilled
- **Surface seal**
 - ◆ Prevent contamination

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Groundwater Contamination

- **Potential pollution sources in the United States include:**
 - ◆ Over 23 million septic systems
 - ◆ 5 to 6 million underground storage tanks
 - ◆ Millions of tons of pesticides and fertilizers
 - ◆ Municipal landfills
 - ◆ Abandoned hazardous waste sites
 - ◆ Military facilities
 - ◆ Feedlots and dairies

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Recharge and Water Mining

- Recharge**
 - Replacement of groundwater by natural processes
- Water Stress**
 - Ratio of $\frac{\text{Water Withdrawal}}{\text{Water Availability}}$

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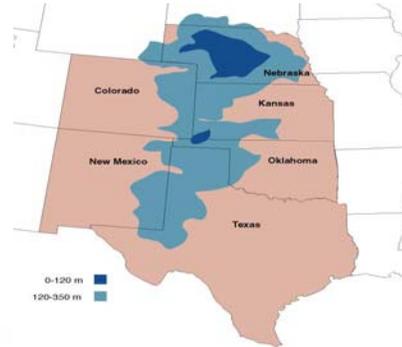
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Recharge and Water Mining

- Many groundwater basins are stressed
- Large amounts of water extracted faster than recharge can occur
 - ◆ Ogallala aquifer
 - Western Plains States
 - ◆ Great Central Valley groundwater basin
 - California

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Ogallala Aquifer



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Great Central Valley Groundwater Basin



- Largest contiguous basin in California
- 2nd largest basin in US
- 74% of State GW demand

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Subsidence and Salination

- Subsidence
 - ◆ Settling of soil as the water pumped out
 - ◆ Can cause permanent changes to
 - Land surface
 - Aquifer capacity
- Salination or salt water intrusion
 - ◆ Zone of saturation decreases as water pumped out of aquifer
 - ◆ Saltwater seeps into aquifer at the lower level or from ocean
 - polluting the freshwater

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Laws That Protect the Waters of the United States

- Resource Conservation and Recovery Act
- Comprehensive Environmental Response, Compensation and Liability Act (Superfund)
- Safe Drinking Water Act
- Federal Insecticide, Fungicide and Rodenticide Act
- Toxic Substances Control Act
- Clean Water Act

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Water Pollution

- Strategies to protect water supplies
 - ◆ Protect areas near drinking water sources
 - Source water protection programs
 - Wellhead protection programs
 - Limit nearby pollution sources
 - ◆ Water treatment
 - Disinfection and filtration
 - ◆ Limit pollutant discharges into waterways
 - NPDES permitting under Clean Water Act

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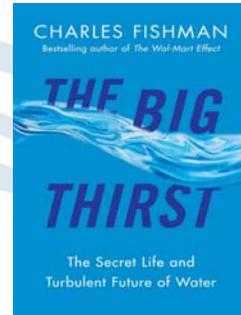
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Water Pollution

- **Federal Water Pollution Control Act of 1972**
 - ◆ Required secondary treatment of municipal wastes
- **Clean Water Act of 1977**
 - ◆ Control point sources
- **Water Quality Act of 1987**
 - ◆ Control nonpoint sources
- **EPA estimates public and private costs for water pollution treatment**
 - ◆ \$64 million/year

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Want to Know More?



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www.waterboards.ca.gov

