Water Pollution

I. Water as a Natural Resource

A. Near-Surface Components of Hydrologic Cycle
1. Oceans
2. Rivers
3. Groundwater

B. Water as a Resource (Important Uses)
1. Required for Life: Plants, Animals
2. Human Consumption
3. Irrigation / Agricultural Production
4. Industrial Processing
5. Domestic Wastewater Management (sewage)

C. Water Use in the United States
1. Basic Budget (approximate)
   a. U.S. Rainfall = 4200 billion gal/day (input)
   b. Evapotranspiration = 2750 billion gal/day (output)
   c. Streamflow+Groundwater = 1400 billion gal/day

2. Human Consumption of Water
   a. average human needs 1 gal/day for internal consumption
   b. U.S. daily consumption = 400 billion gallons per day
   c. Actual Use = 1800 gal/person/day
      (1) consumption, cooking, washing, industrial, agricultural

3. Water Resource Problems
   a. Water use does not match population / needs
   b. water pollution reduces effective amount available for use

4. Water Supplies in U.S.
   a. Surface Water vs. Groundwater
      (1) surface water important in humid regions
      (2) groundwater important in arid regions
         (a) largest reservoir of unfrozen fresh water
   b. Seasonal Variation in Water supply
      (1) droughts
      (2) seasonal rainfall changes
   c. Dams and Water Reservoirs
   d. Highest Water Use
      (1) Urban Areas
      (2) SW U.S.
         (a) irrigation
         (b) high population growth
         (c) arid conditions

II. Water Pollution Issues

A. Introduction

1. water is a good solvent, commonly associated with dissolved chemical constituents
2. "pollution" - contamination of water with unwanted or hazardous chemical constituents
3. common pollution sources
   a. industry
   b. agriculture
   c. domestic sewage

B. Natural Geochemical Cycles

1. water dissolving elemental constituents from rock and sediment material
2. Commonly dissolved weathering products from rock material
   a. calcium, iron, sulfer, sodium, chloride, magnesium

C. Residence Time - duration with which water resides in Earth reservoir systems

1. > residence time > opportunity for dissolution and addition of dissolved chemical constituents
2. residence time of dissolved ions - the lenght of time that individual ionic species are present in a dissolved state before they are removed by natural "attenuation" processes

D. Pollution Sources

1. Point vs. Nonpoint Sources
   a. point pollution - pollutants are released at a discrete point of discharge
      (1) e.g. a sewer outlet
   b. nonpoint pollution - pollutants are released as diffuse contaminants from across the landscape
      (1) e.g. fertilizer runoff from farmland
      (2) petroleum-based runoff from parking lots

2. Industrial Pollution - 10's of thousands of chemicals are created each year by industrial and pharmaceutical chemists, industry forms a primary source of water pollution

   a. Inorganic Pollutants - Metals
      (1) e.g. mercury
         (a) naturally occurring in rocks, thermometers, equipment
         (b) very toxic, affects nervous system
         (c) propagates easily through the food chain (e.g. seafood)
      (2) Other metals - all toxic to system
         (a) chromium - common in metals manufacturing
         (b) lead - common in mining, batteries
         (c) cadium
         (d) iodine
   b. Other Inorganic Pollutants
      (1) industrial acids
      (2) acid mine drainage

(a) common in coal and sulfide mining districts
(3) asbestos - carcinogenic

c. Organic Pollutants
(1) organic chemicals - carbon-based compounds
(2) 1000's of naturally occurring and synthetic organic compounds exist
(3) some organic chemicals are extremely carcinogenic or toxic to humans and animals
(4) examples
(a) oil spills
(b) leaking gas storage tanks
(c) PCB's - polychlorinated biphenyls - common as coolant in electrical equipment

d. Thermal Pollution of Water
(1) hot water pollution
(2) destructive of cold water fisheries and other organisms
(3) sources of thermal pollution
(a) power plants (cooling water)
(b) industrial cooling processes

e. Microorganisms
(1) sewage discharge - source of viruses and bacteria
(2) excess nutrient discharge - nitrogen
(a) nitrogen is important fertilizaer source for plants
(b) algal blooms, excessive algal growth
(3) eutrophication - excessive algal and plant growth with deposition of organic matter to bottom of surface water bodies
(a) result: organic infilling of water bodies and oxygen deficient environments

f. Agricultural Pollution
(1) Fertilizers - nitrogen and phosphorous
(a) fertilizer runoff in streams and lakes
(b) excessive plant growth / eutrophication
(c) nitrate contamination -"blue baby syndrome"
(2) Sediment Pollution - erosion and surface runoff
(3) Herbicides and Pesticides

E. Pollution Prevention and Remediation

1. pollution prevention devices
2. ground and surface water remediation
a. chemical treatment strategies


Explanation
Area problem
Area in which significant surface-water pollution from point sources is occurring
Specific types of point-source pollutants
Coliform bacteria from municipal waste or feedlot drainage
PCB (polychlorinated biphenyl), PBB (polybromated biphenyl), PVC (polyvinyl chloride), and related industrial chemicals
Heavy metals (e.g., mercury, zinc, copper, cadmium, lead)
Nutrients from municipal and industrial discharges
Heat from manufacturing and power generation

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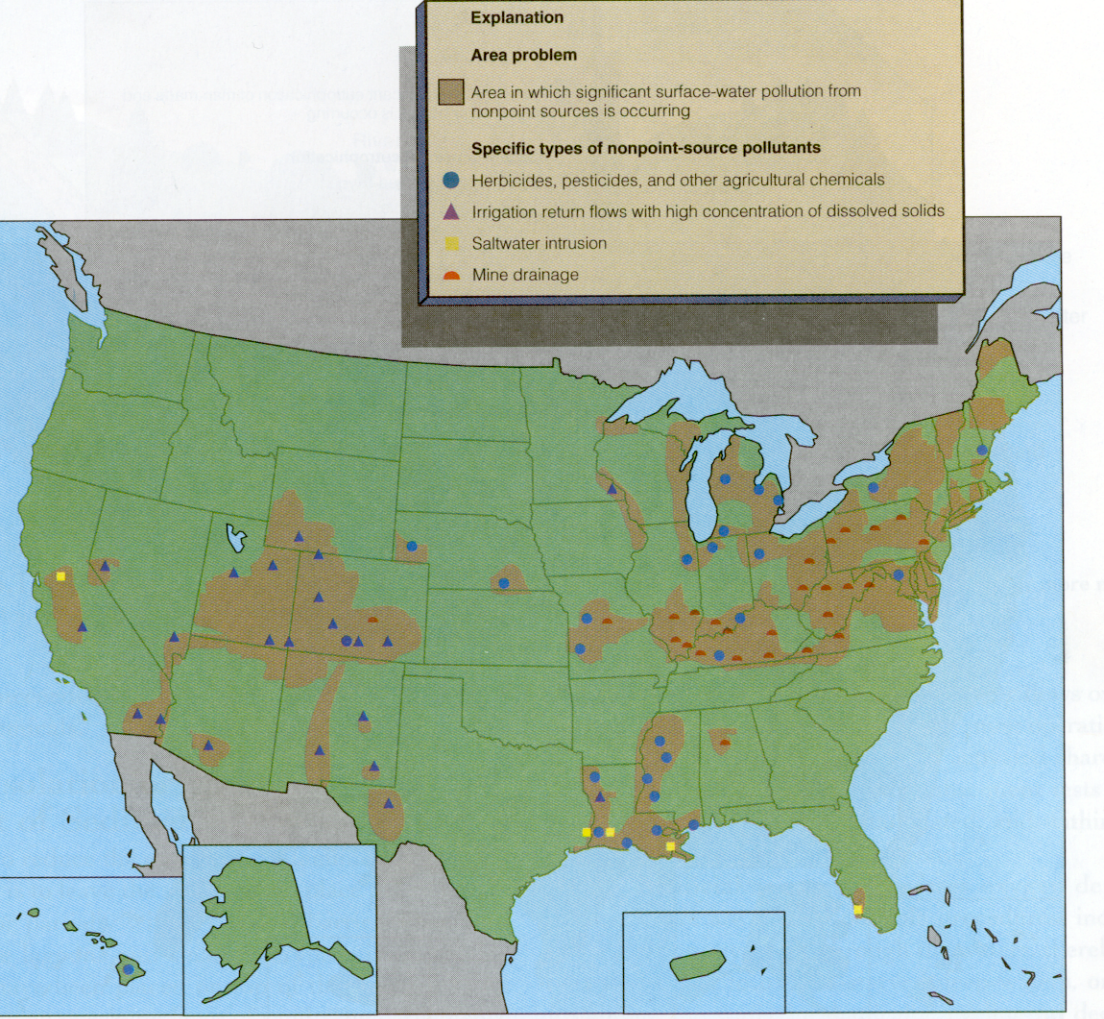
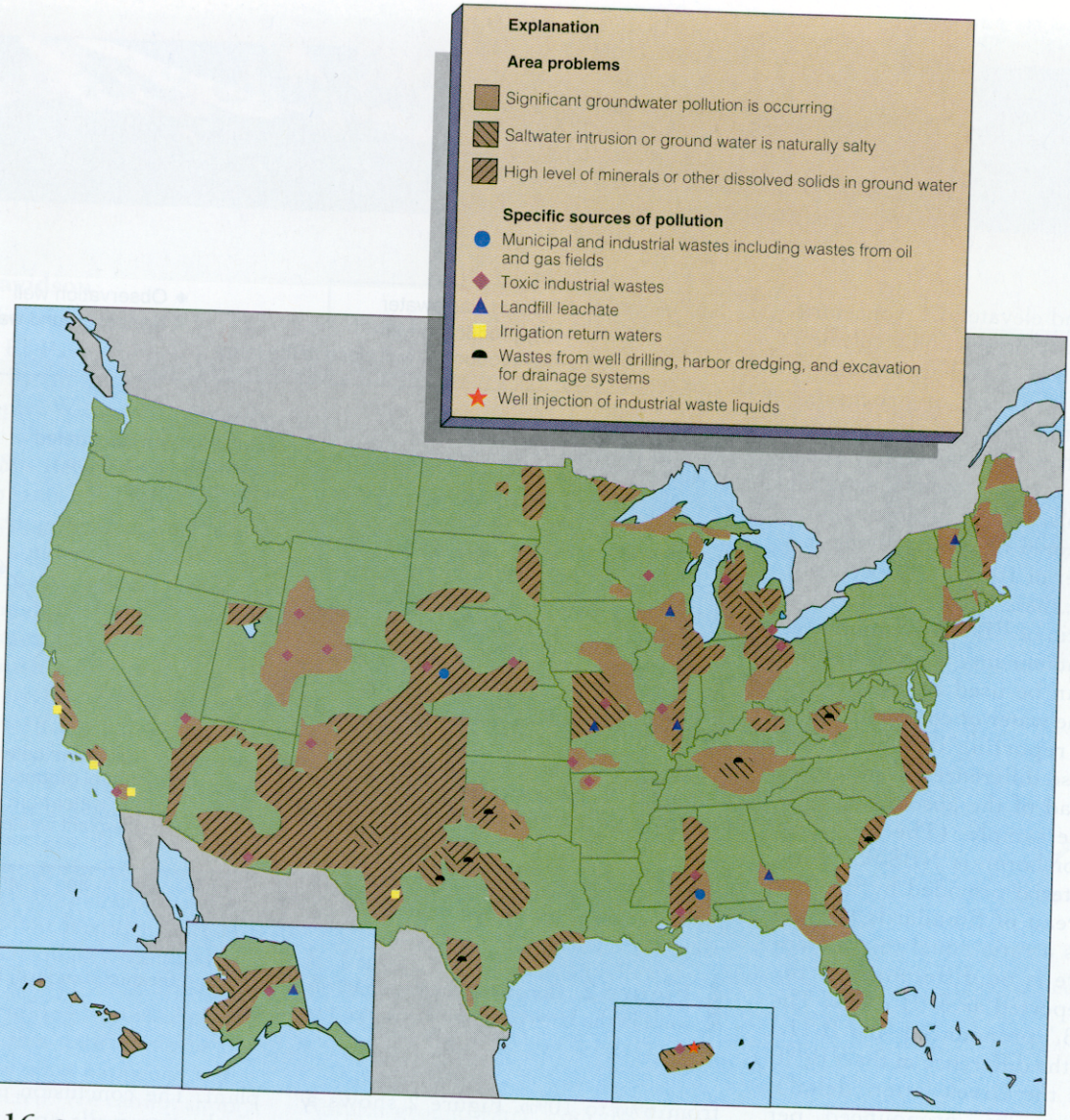

Explanation
Area problem
Area in which significant surface-water pollution from nonpoint sources is occurring
Specific types of nonpoint-source pollutants
Herbicides, pesticides, and other agricultural chemicals
Irrigation return flows with high concentration of dissolved solids
Saltwater intrusion
Mine drainage



16 Groundwater pollution problems. Source: Modified from U.S. Water Resources Council, *The Nation's Water Resources*