

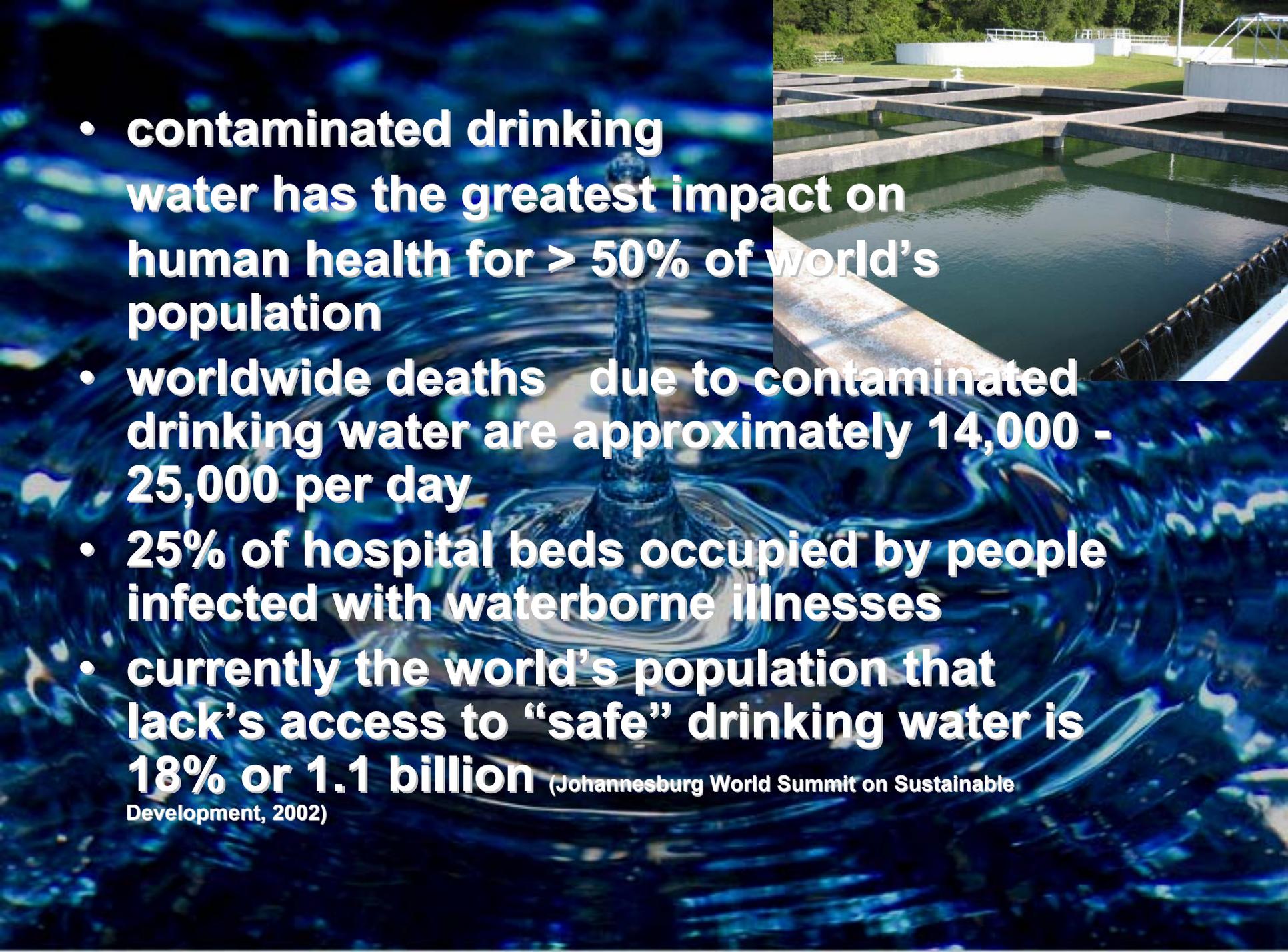
Water Treatment



CE 326 Principles of Environmental Engineering

February 16, 2007

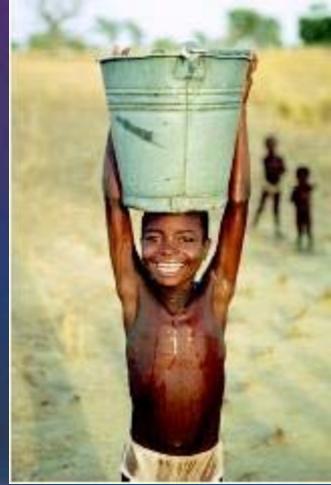
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- **contaminated drinking water has the greatest impact on human health for > 50% of world's population**
 - **worldwide deaths due to contaminated drinking water are approximately 14,000 - 25,000 per day**
 - **25% of hospital beds occupied by people infected with waterborne illnesses**
 - **currently the world's population that lack's access to "safe" drinking water is 18% or 1.1 billion** (Johannesburg World Summit on Sustainable

Development, 2002)

World Water

- **2.5 billion are without proper sanitation**
- **More than 5 million people die each year from diseases caused by unsafe drinking water, lack of sanitation, and insufficient water for hygiene.**
- **In fact, over 2 million deaths occur each year from water-related diarrhea alone.**
- **At any given time, almost half of the people in developing countries suffer from water-related diseases.**



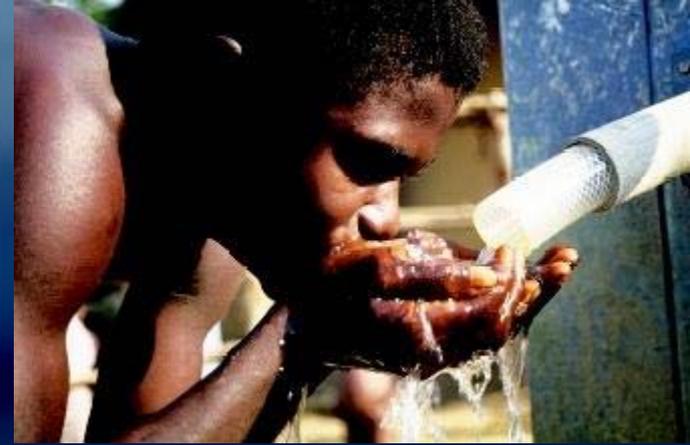
World Water

- Insufficient sanitation of water and sanitation disproportionately affect women, children, and the poor.
- The majority of deaths from water-related diarrhea are among children under 15, and women.
- Agriculture accounts for more than 90 percent of global water consumption.
- The inefficient use of water for irrigation has led to depletion of groundwater resources in many of the world's most important agricultural regions, and is the primary source of groundwater pollution in parts of Europe, the US, and Asia.

LEADING IRRIGATION COUNTRIES

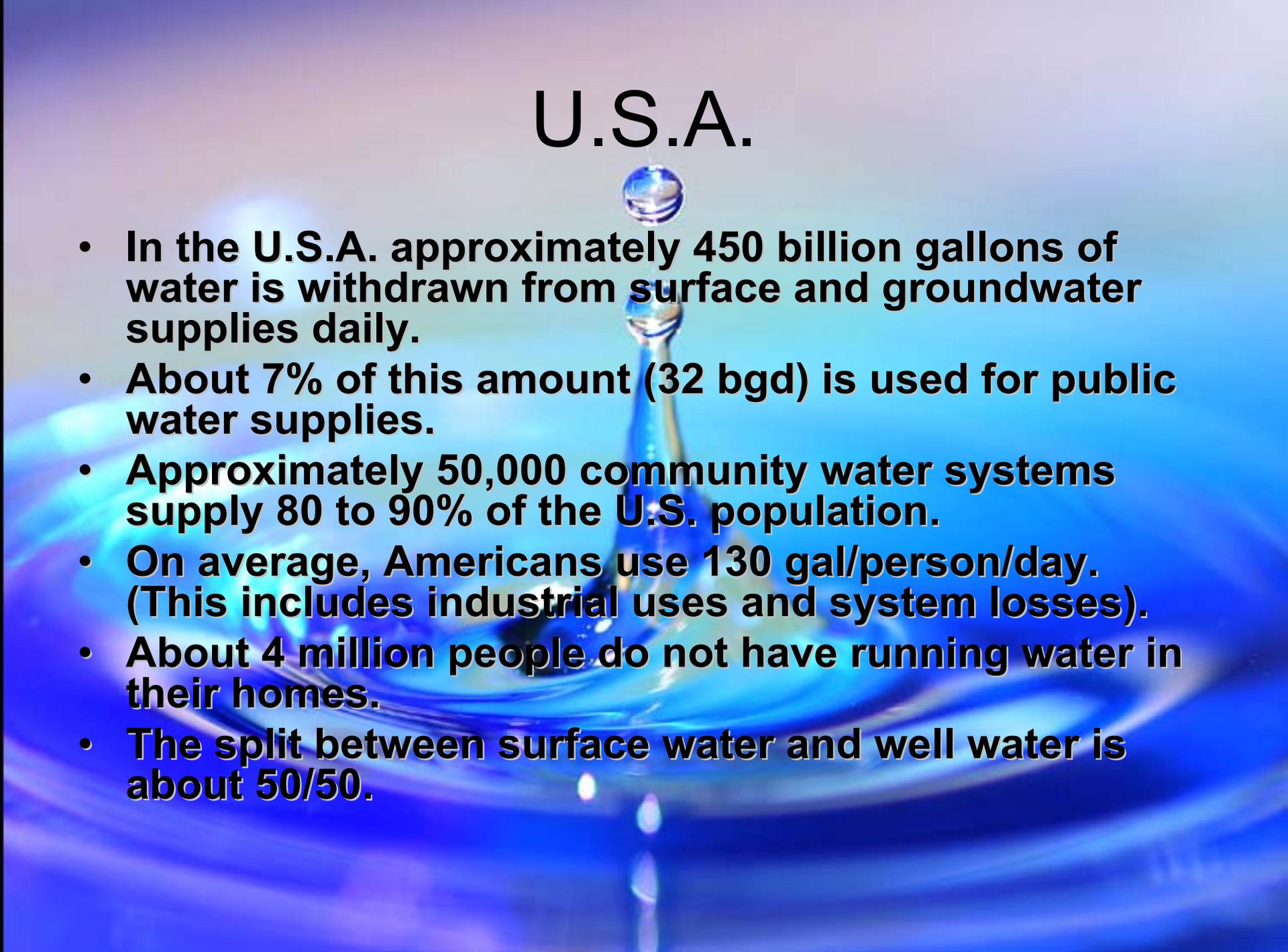
Country	Irrigated Area (1,000 Square Kilometers)	Irrigated Land as a Percentage of Cropland	Water Used in Irrigation (Cubic Kilometers)	Percentage of all Water Withdrawals used for Irrigation
World	2,298	19	2,286	69
China	513	52	400	87
India	460	29	353	93
United States	209	11	196	42
Pakistan	163	80	151	97
Mexico	62	25	67	86
Egypt	33	100	47	86

World Water



- During the 1990s, about 438 million people in developing countries gained access to improved drinking water, demonstrating the possibility for major improvements in safe water access worldwide.
- At the Millennium Summit in September 2000, world leaders agreed to the goal of halving, by 2015, the proportion of people without access to safe drinking water and sanitation.
- To meet this goal, an additional 1.6 billion people will need access to adequate water, and 2 billion will need improved sanitation.
- The annual investment required to meet the goal is estimated to be \$20 billion, nearly twice the current level of investment.

U.S.A.



- In the U.S.A. approximately 450 billion gallons of water is withdrawn from surface and groundwater supplies daily.
- About 7% of this amount (32 bgd) is used for public water supplies.
- Approximately 50,000 community water systems supply 80 to 90% of the U.S. population.
- On average, Americans use 130 gal/person/day. (This includes industrial uses and system losses).
- About 4 million people do not have running water in their homes.
- The split between surface water and well water is about 50/50.

- **In rural areas 95% of the population uses groundwater.**
- **20% of all public water supply wells and 29% of wells in urban areas have detectable levels of at least one volatile organic compound.¹**
- **At least 13 organic chemicals that are confirmed animal or human carcinogens have been detected in drinking water wells.**
- **Toxic organics were found in some wells in almost every state east of the Mississippi, trichloroethylene (TCE) was the most prevalent.**
- **1000 public drinking water systems that serve 12 million people in the U.S. exceed nitrate levels at least some of the time. 8.7 million of these people are in California.**

Iowa Water

- In Iowa, 70% of our drinking water comes from ground supplies.
- Iowans use an average of 66 gal/person each day.
- Farms lose 145 million tons of soil each year.
- Soil runoff is the leading pollutant in Iowa's waterways.
- Iowa has lost over 99.9% of its wetlands.
- Iowans apply more fertilizer than all states except Illinois.
- In 1996 there were 731,000 fish killed from manure and chemical spills..
- About 4% of public water systems had excessive bacterial counts during sampling period.

Iowa Water

- **Trihalomethanes were detected in over 70% of samples over a seven year period. Only 10% of samples exceed drinking water standards.**
- **High nitrate levels were found in 18% of private wells and 2% of public water systems.**
- **The herbicide atrazine was found in 22% of drinking water samples. Only 1% of samples exceed drinking water standards.**

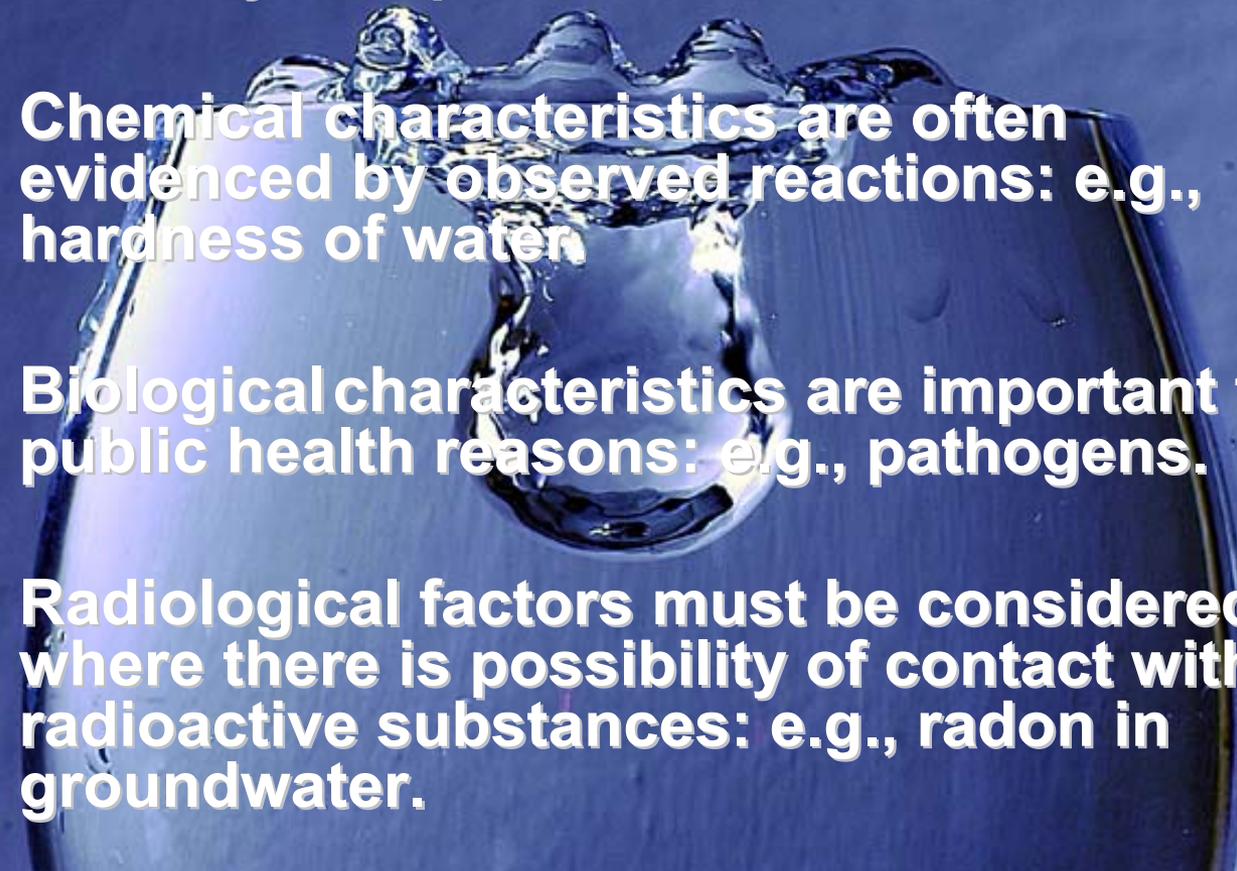
Hardness and Trace Metals

- **life expectancy for white males over 45 years of age hasn't changed much since 1900 (mainly due to little progress in the control of cardiovascular disease)**
- **in 1959 researchers noticed a large discrepancy between rates of cardiovascular heart disease depending on geographic location**
- **significant negative correlations were found between mortality from cardiovascular heart disease and magnesium, calcium, bicarbonate, sulfate, fluoride, dissolved solids, specific conductance, and pH**
- **most significant negative correlation was for hardness**

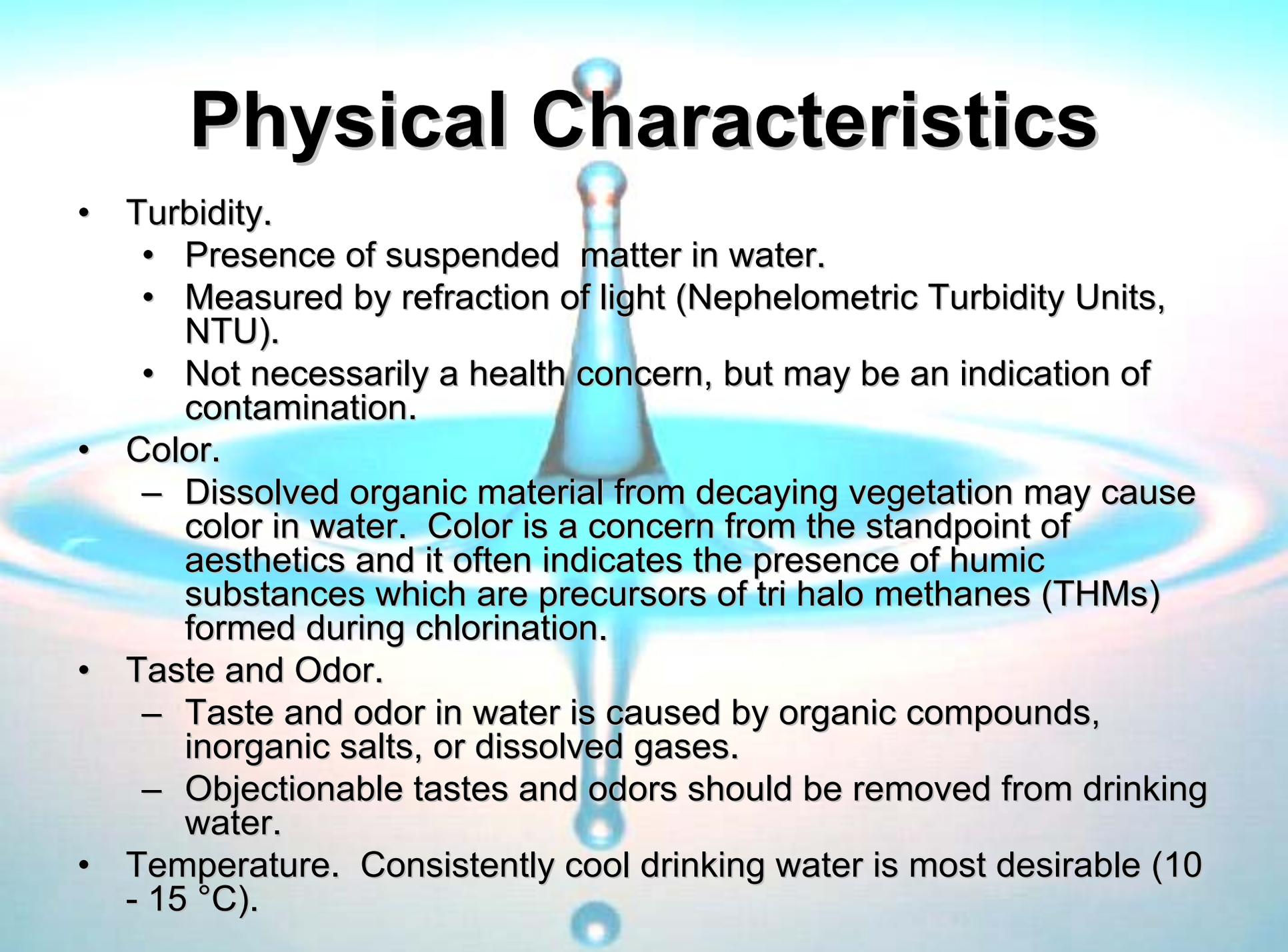
Hardness and Trace Metals

- mortality from cardiovascular heart disease in hard water areas has been shown to be half that in soft water areas
- trace metals may be an important factor
- corrosiveness of water may be an important factor
- studies in Texas have shown a relationship between the levels of lithium in groundwater and incidence of schizophrenia, psychosis, neurosis, personality problems, and homicidal tendencies.
- Very hard water is considered > 200 mg/L as CaCO_3

Four Water Quality Characteristics

1. **Physical characteristics** relate to quality of water for domestic use: e.g., color, turbidity, temperature, and taste and odor.
 2. **Chemical characteristics** are often evidenced by observed reactions: e.g., hardness of water.
 3. **Biological characteristics** are important for public health reasons: e.g., pathogens.
 4. **Radiological factors** must be considered where there is possibility of contact with radioactive substances: e.g., radon in groundwater.
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Physical Characteristics



- Turbidity.
 - Presence of suspended matter in water.
 - Measured by refraction of light (Nephelometric Turbidity Units, NTU).
 - Not necessarily a health concern, but may be an indication of contamination.
- Color.
 - Dissolved organic material from decaying vegetation may cause color in water. Color is a concern from the standpoint of aesthetics and it often indicates the presence of humic substances which are precursors of tri halo methanes (THMs) formed during chlorination.
- Taste and Odor.
 - Taste and odor in water is caused by organic compounds, inorganic salts, or dissolved gases.
 - Objectionable tastes and odors should be removed from drinking water.
- Temperature. Consistently cool drinking water is most desirable (10 - 15 °C).

Chemical Characteristics

- Inorganic Substances.

- Chloride.

- All waters contain some chloride due to leaching of mineral sedimentary deposits, infiltration of sea water, or industrial and agricultural influence. Concentrations in excess of 250 mg/L may cause noticeable taste.

- Copper.

- Found in some natural waters, particularly around ore deposits and mines. Small quantities are not considered a problem, but may cause a undesirable taste in water.

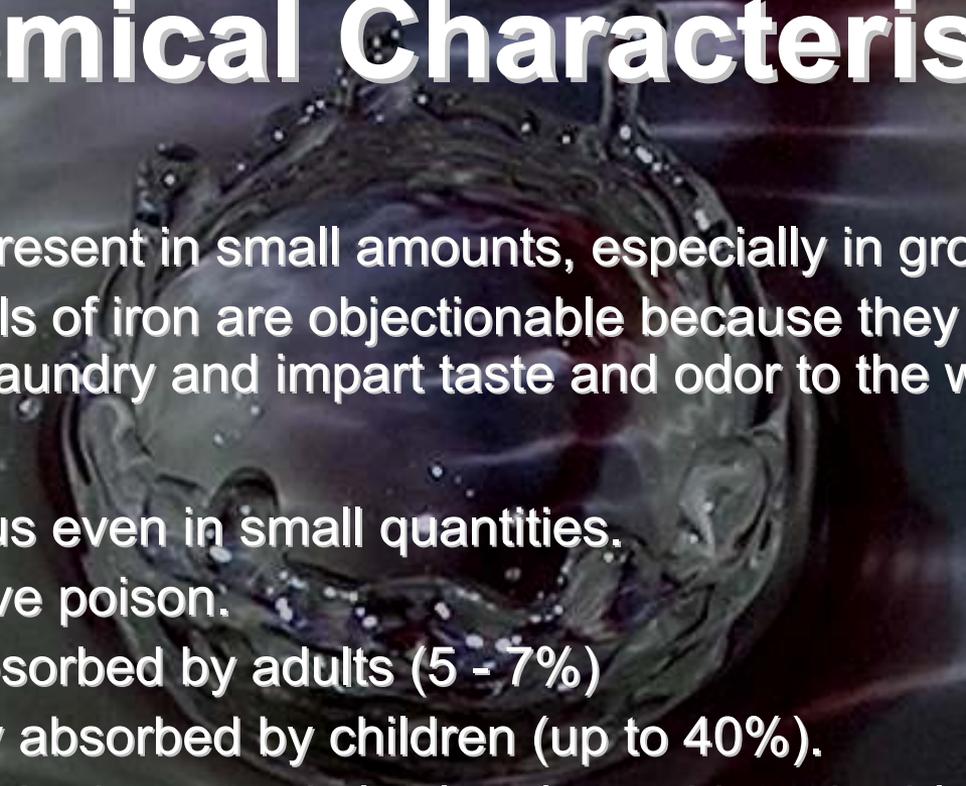
- Fluorides.

- Some waters contain natural fluorides. Good in preventing tooth decay when concentration is between 0.7 and 1.2 mg/L.
 - Higher concentrations can lead to fluorosis a discoloration and pitting of teeth in children.

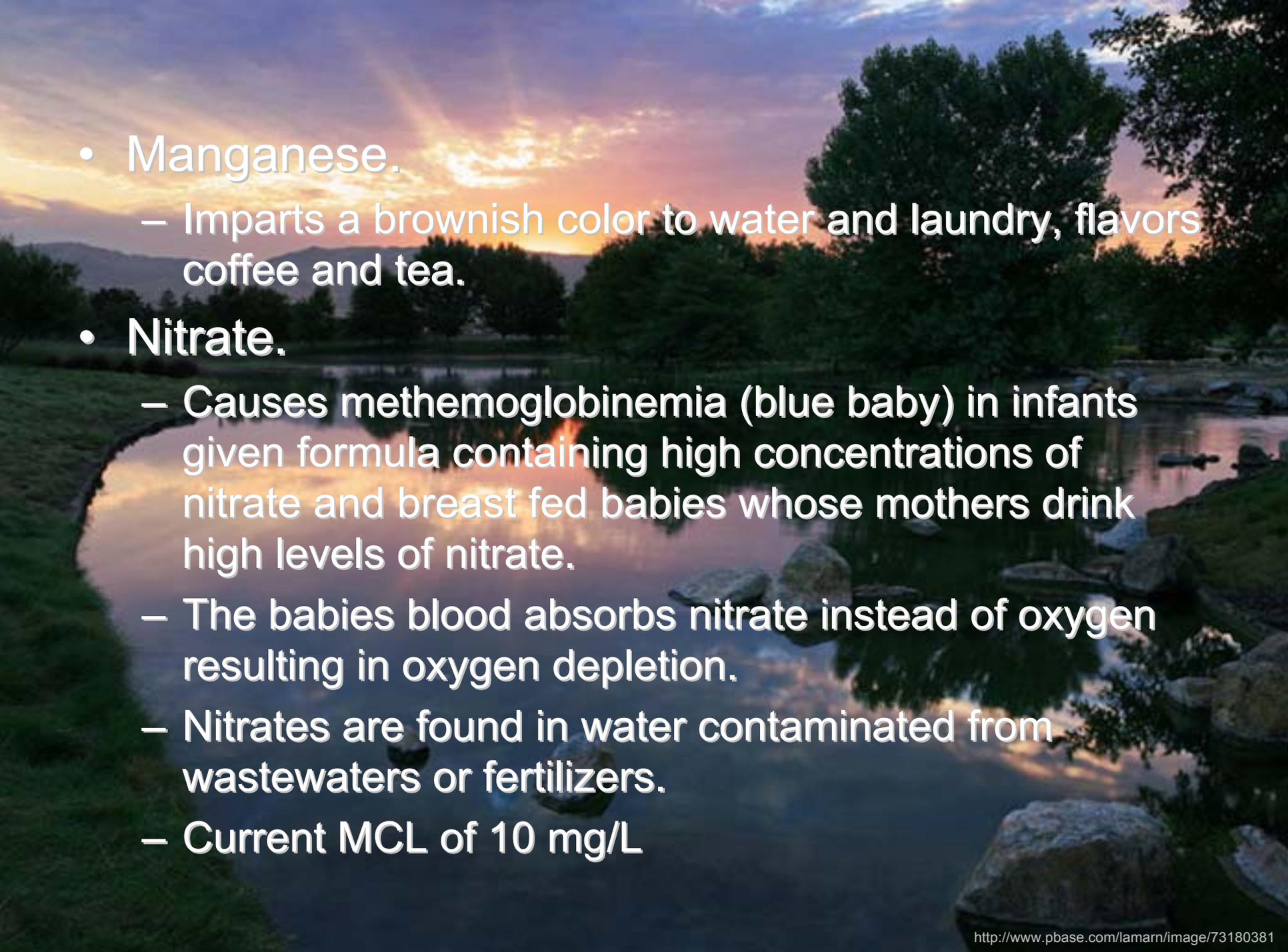
Dental Fluorosis

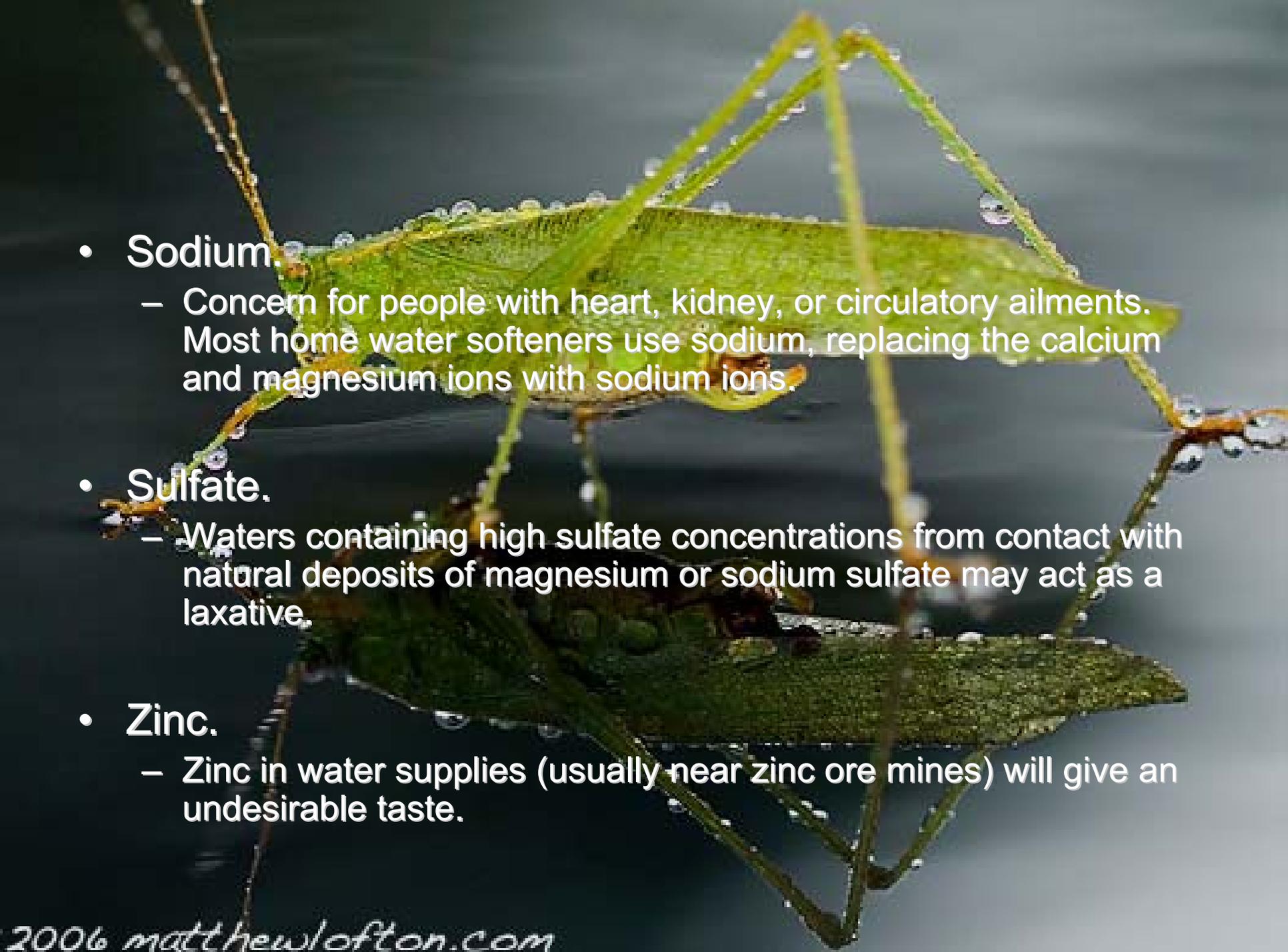


Chemical Characteristics



- Iron.
 - Usually present in small amounts, especially in groundwater.
 - High levels of iron are objectionable because they leave a brownish color on laundry and impart taste and odor to the water.
- Lead.
 - Dangerous even in small quantities.
 - Cumulative poison.
 - Poorly absorbed by adults (5 - 7%)
 - but highly absorbed by children (up to 40%).
 - Stored in the bone and slowly released into the bloodstream.
 - Lead poison can cause brain and nerve damage, kidney damage, anemia, and porphyrinuria (excretion of hemoglobin precursors in the urine).
 - Problem in drinking water due to lead solder, lead pipes, and lead cores in drinking water fountains.

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- Manganese.
 - Imparts a brownish color to water and laundry, flavors coffee and tea.
 - Nitrate.
 - Causes methemoglobinemia (blue baby) in infants given formula containing high concentrations of nitrate and breast fed babies whose mothers drink high levels of nitrate.
 - The babies blood absorbs nitrate instead of oxygen resulting in oxygen depletion.
 - Nitrates are found in water contaminated from wastewaters or fertilizers.
 - Current MCL of 10 mg/L

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- A close-up photograph of a vibrant green grasshopper perched on a leaf. The leaf and the grasshopper's body are covered with numerous small, clear water droplets, suggesting a recent rain or dew. The background is a soft, out-of-focus greyish-blue. The text of the presentation is overlaid on the left side of the image.
- **Sodium.**
 - Concern for people with heart, kidney, or circulatory ailments. Most home water softeners use sodium, replacing the calcium and magnesium ions with sodium ions.
 - **Sulfate.**
 - Waters containing high sulfate concentrations from contact with natural deposits of magnesium or sodium sulfate may act as a laxative.
 - **Zinc.**
 - Zinc in water supplies (usually near zinc ore mines) will give an undesirable taste.