Water Treatment Certificate Seminar

By
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EBMUD

Ancient civilizations established themselves around water sources. While the importance of ample water quantity for drinking and other purposes was apparent to our ancestors, an understanding of drinking water quality was not well known or documented. Although historical records have long mentioned aesthetic problems (an unpleasant appearance, taste or smell) with regard to drinking water, it took thousands of years for people to recognize that their senses alone were not accurate judges of water quality

Water treatment originally focused on improving the aesthetic qualities of drinking water. Methods to improve the taste and odor of drinking water were recorded as early as 4000 B.C. Ancient Sanskrit and Greek writings recommended water treatment methods such as filtering through charcoal, exposing to sunlight, boiling, and straining. Visible cloudiness (later termed turbidity) was the driving force behind the earliest water treatments, as many source waters contained particles that had an objectionable taste and appearance. To clarify water, the Egyptians reportedly used the chemical alum as early as 1500 B.C. to cause suspended particles to settle out of water. During the 1700s, filtration was established as an effective means of removing particles from water, although the degree of clarity achieved was not measurable at that time. By the early 1800s, slow sand filtration was beginning to be used regularly in Europe.

Nephelometric Turbidity Unit
"NTU"

- During the mid to late 1800s, scientists gained a greater understanding of the sources and effects of drinking water contaminants, especially those that were not visible to the naked eye. In 1855, epidemiologist Dr. John Snow proved that cholera was a waterborne disease by linking an outbreak of illness in London to a public well that was contaminated by sewage.
- In the late 1880s, Louis Pasteur demonstrated the “germ theory” of disease, which explained how microscopic organisms (microbes) could transmit disease through media like water.

During the late nineteenth and early twentieth centuries, concerns regarding drinking water quality continued to focus mostly on disease-causing microbes (pathogens) in public water supplies. Scientists discovered that turbidity was not only an aesthetic problem; particles in source water, such as fecal matter, could harbor pathogens. As a result, the design of most drinking water treatment systems built in the U.S. during the early 1900s was driven by the need to reduce turbidity, thereby removing microbial contaminants that were causing typhoid, dysentery, and cholera epidemics. To reduce turbidity, some water systems in U.S. cities (such as Philadelphia) began to use slow sand filtration.

- While filtration was a fairly effective treatment method for reducing turbidity, it was disinfectants like chlorine that played the largest role in reducing the number of waterborne disease outbreaks in the early 1900s. In 1908, chlorine was used for the first time as a primary disinfectant of drinking water in Jersey City, New Jersey. The use of other disinfectants such as ozone also began in Europe around this time, but were not employed in the U.S. until several decades later.

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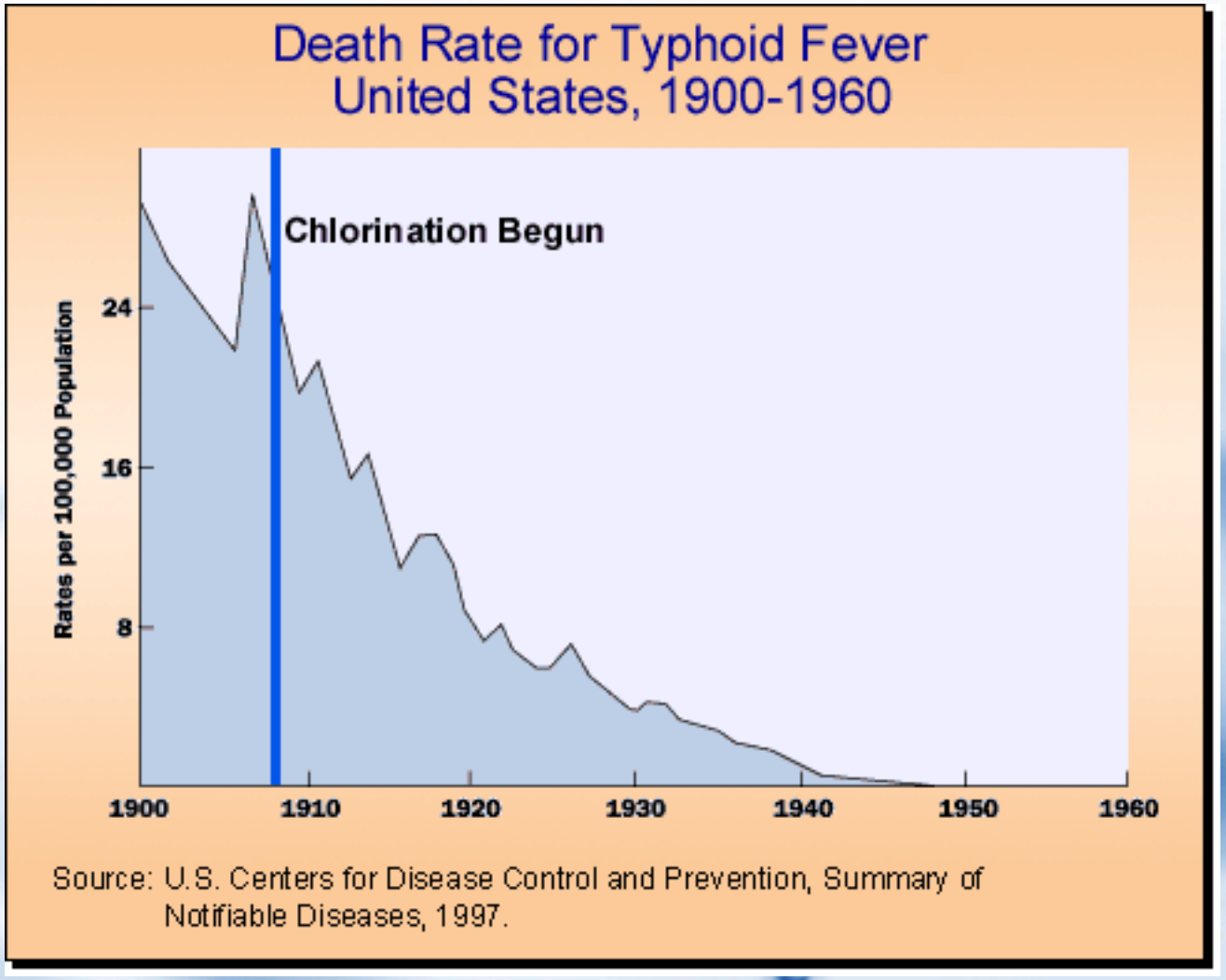

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Federal regulation of drinking water quality began in 1914, when the U.S. Public Health Service set standards for the bacteriological quality of drinking water. The standards applied only to water systems which provided drinking water to interstate carriers like ships and trains, and only applied to contaminants capable of causing contagious disease. The Public Health Service revised and expanded these standards in 1925,1946, and 1962.

- By the late 1960s it became apparent that the aesthetic problems, pathogens, and chemicals identified by the Public Health Service were not the only drinking water quality concerns. Industrial and agricultural advances and the creation of new man-made chemicals also had negative impacts on the environment and public health. Many of these new chemicals were finding their way into water supplies through factory discharges, street and farm field runoff, and leaking underground storage and disposal tanks. Although treatment techniques such as aeration, flocculation, and granular activated carbon adsorption (for removal of organic contaminants) existed at the time, they were either underutilized by water systems or ineffective at removing some new contaminants.

Health concerns spurred the federal government to conduct several studies on the nation's drinking water supply. One of the most telling was a water system survey conducted by the Public Health Service in 1969 which showed that only 60 percent of the systems surveyed delivered water that met all the Public Health Service standards. Over half of the treatment facilities surveyed had major deficiencies involving disinfection, clarification, or pressure in the distribution system (the pipes that carry water from the treatment plant to buildings), or combinations of these deficiencies. Small systems, especially those with fewer than 500 customers, had the most deficiencies. A study in 1972 found 36chemicals in treated water taken from treatment plants that drew water from the Mississippi River in Louisiana. As a result of these and other studies, new legislative proposals for a federal safe drinking water law were introduced and debated in Congress in 1973.

GROUND WATER CONTAMINATION IN THE UNITED STATES

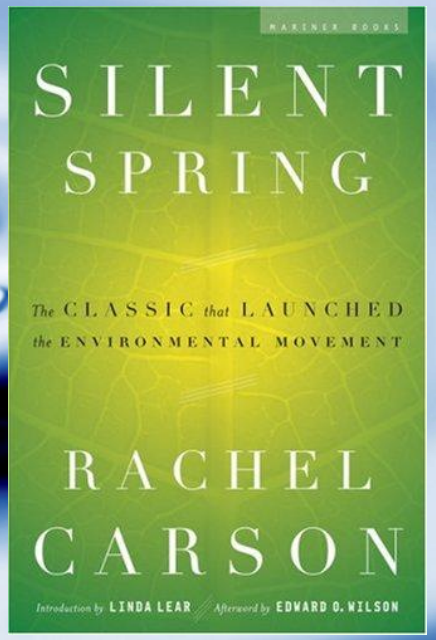
Pollutants	Found in No. of States
Nitrates	49
Volatile organic substances	48
Petroleum products	46
Metals	45
Pesticides	43
Brine/salinity	37
Synthetic organic substances	36
Arsenic	28
Other substances	26
Other agricultural chemicals	23
Radioactive material	23
Fluoride	20
Other inorganic substances	15

UN FAO, Control of Water Pollution from Agriculture", www.fao.org/docrep/W2598E/w2598e00.htm (US EPA, 1994)

Environmental Progress

- Industrial pollution had come to all time highs; waters undrinkable and almost toxic. Fish kills were prevalent downstream to wastewater outlets and industrial waste lines. This was a systemic problem that would ultimately lead to scarce drinkable water sources

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY



Rachel Carson's book "Silent Spring" influenced grassroots movements that led to environmental activism. In response, the US government created the Environmental Protection Agency

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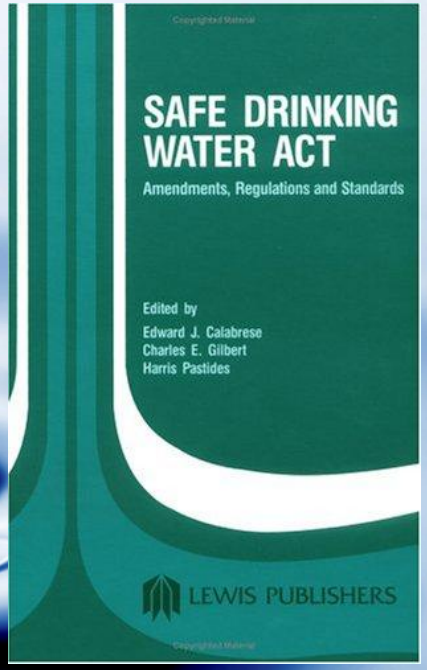
- Chemical contamination of water supplies was only one of many environmental and health issues that gained the attention of Congress and the public in the early 1970s. This increased awareness eventually led to the passage of several federal environmental and health laws, one of which was the Safe Drinking Water Act of 1974. That law, with significant amendments in 1986 and 1996, is administered today by the U.S. Environmental Protection Agency's Office of Ground Water and Drinking Water (EPA) and its partners.

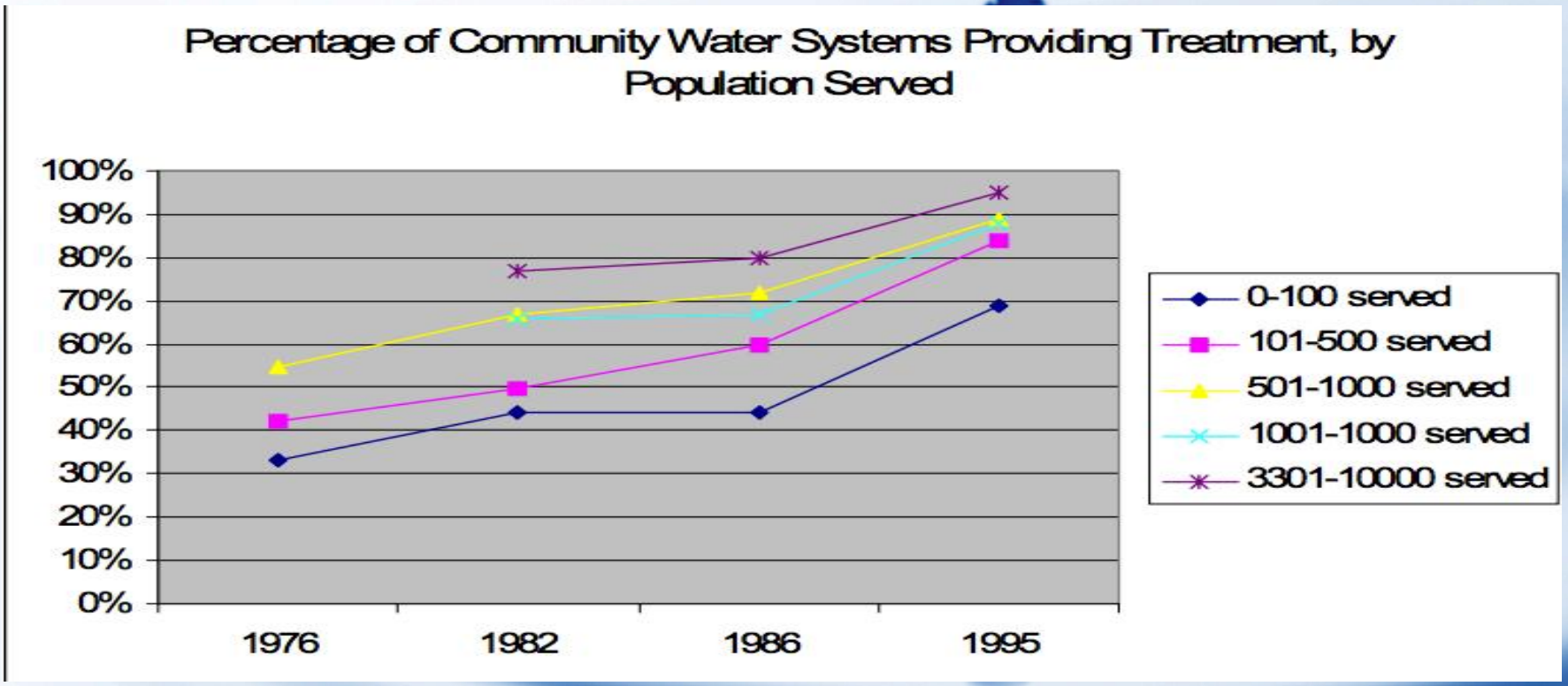
US Environmental Protection Agency

- The finding of suspected carcinogens in drinking water established a widespread urgency that led to the passage and signing into law of the Safe Drinking Water Act in December, 1974



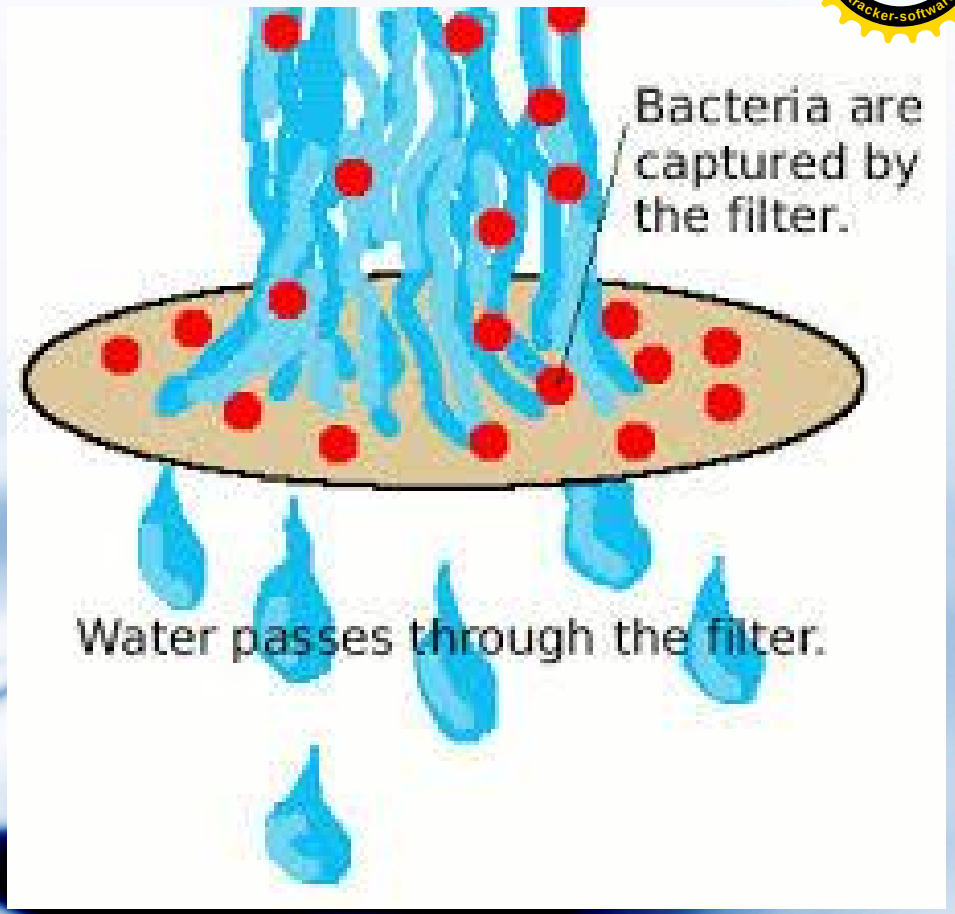
The SDWA was signed into law by President Ford giving the federal government, through the US EPA the authority to set national standards.

- Since the passage of the original Safe Drinking Water Act, the number of water systems applying some type of treatment to their water has increased. According to several EPA surveys, from 1976 to 1995,the percentage of small and medium community water systems (systems serving people year-round) that treat their water has steadily increased. For example, in 1976 only 33 percent of systems serving fewer than 100 people provided treatment. By 1995, that number had risen to 69 percent.



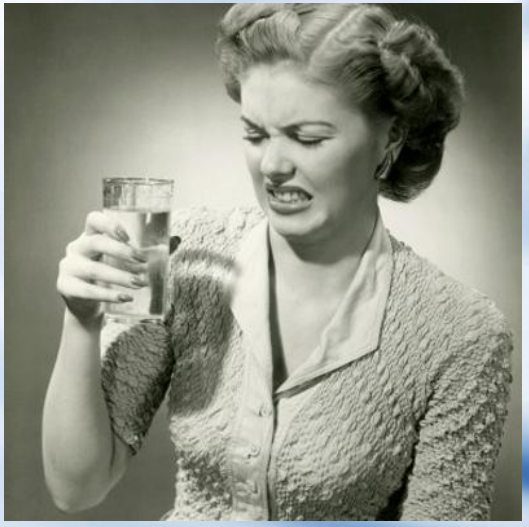
Since their establishment in the early 1900s, most large urban systems have always provided some treatment, as they draw their water from surface sources (rivers, lakes, and reservoirs) which are more susceptible to pollution. Larger systems also have the customer base to provide the funds needed to install and improve treatment equipment. Because distribution systems have extended to serve a growing population (as people have moved from concentrated urban areas to more suburban areas), additional disinfection has been required to keep water safe until it is delivered to all customers.

Today, filtration and chlorination remain effective treatment techniques for protecting U.S. water supplies from harmful microbes, although additional advances in disinfection have been made over the years. In the 1970s and 1980s, improvements were made in membrane development for reverse osmosis filtration and other treatment techniques such as ozonation. Some treatment advancements have been driven by the discovery of chlorine-resistant pathogens in drinking water that can cause illnesses like hepatitis, gastroenteritis, Legionnaire's Disease, and cryptosporidiosis. Other advancements resulted from the need to remove more and more chemicals found in sources of drinking water.



Do Not Drink!

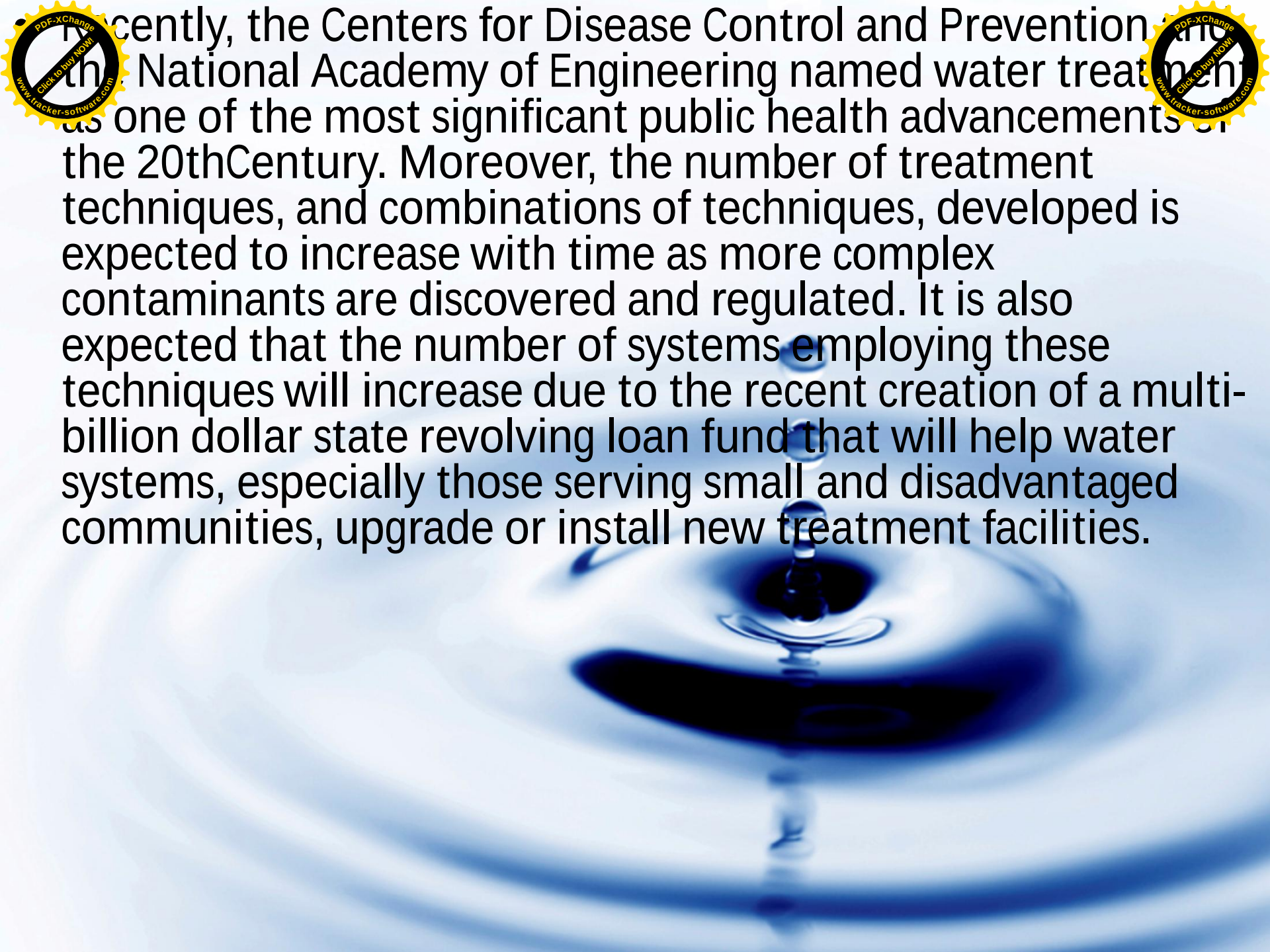
- Milwaukee, Wisconsin 1994
- The parasitic outbreak of cryptosporidium in the Drinking Water that made 400,000 people sick and killed more than 100.



According to a 1995 EPA survey, approximately 64 percent of community ground water and surface water systems disinfect their water with chlorine. Almost all of the remaining surface water systems, and some of the remaining ground water systems, use another type of disinfectant, such as ozone or chloramine.

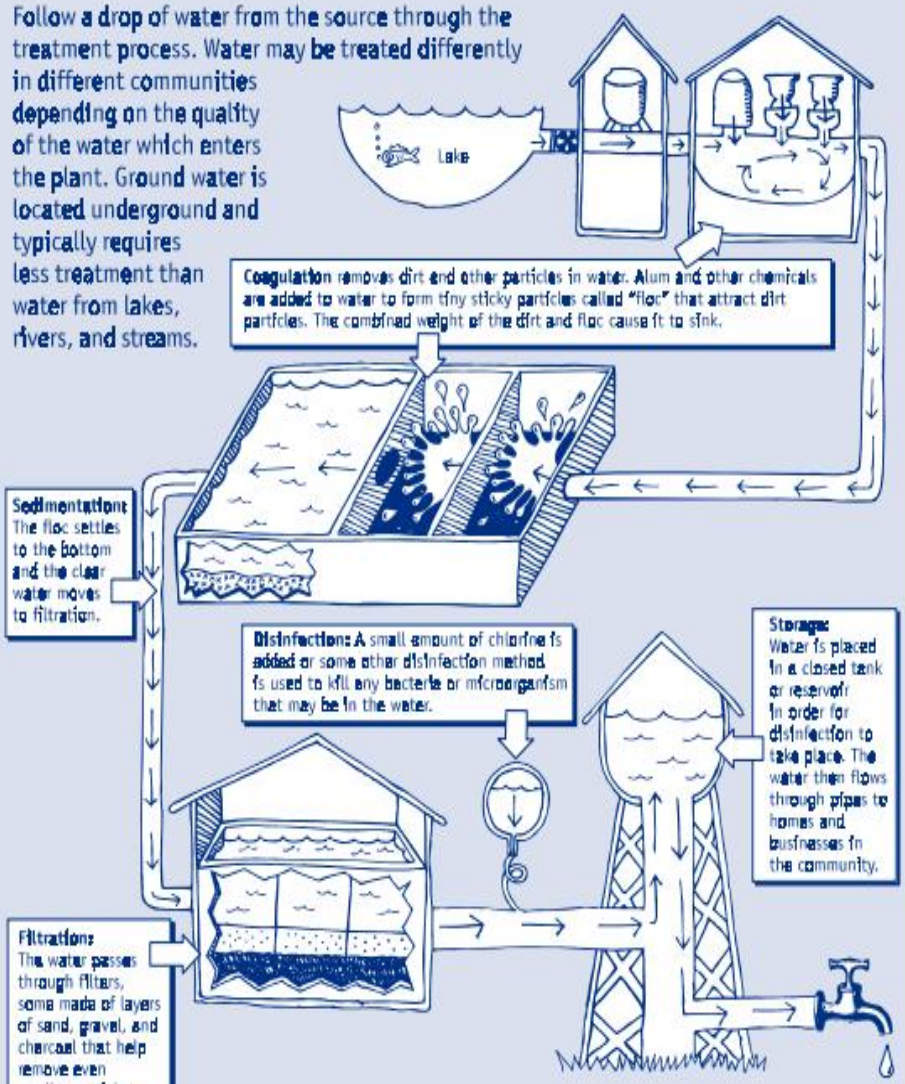
Many of the treatment techniques used today by drinking water plants include methods that have been used for hundreds and even thousands of years. However, newer treatment techniques (e.g., reverse osmosis and granular activated carbon) are also being employed by some modern drinking water plants.

Recently, the Centers for Disease Control and Prevention and the National Academy of Engineering named water treatment as one of the most significant public health advancements of the 20thCentury. Moreover, the number of treatment techniques, and combinations of techniques, developed is expected to increase with time as more complex contaminants are discovered and regulated. It is also expected that the number of systems employing these techniques will increase due to the recent creation of a multi-billion dollar state revolving loan fund that will help water systems, especially those serving small and disadvantaged communities, upgrade or install new treatment facilities.

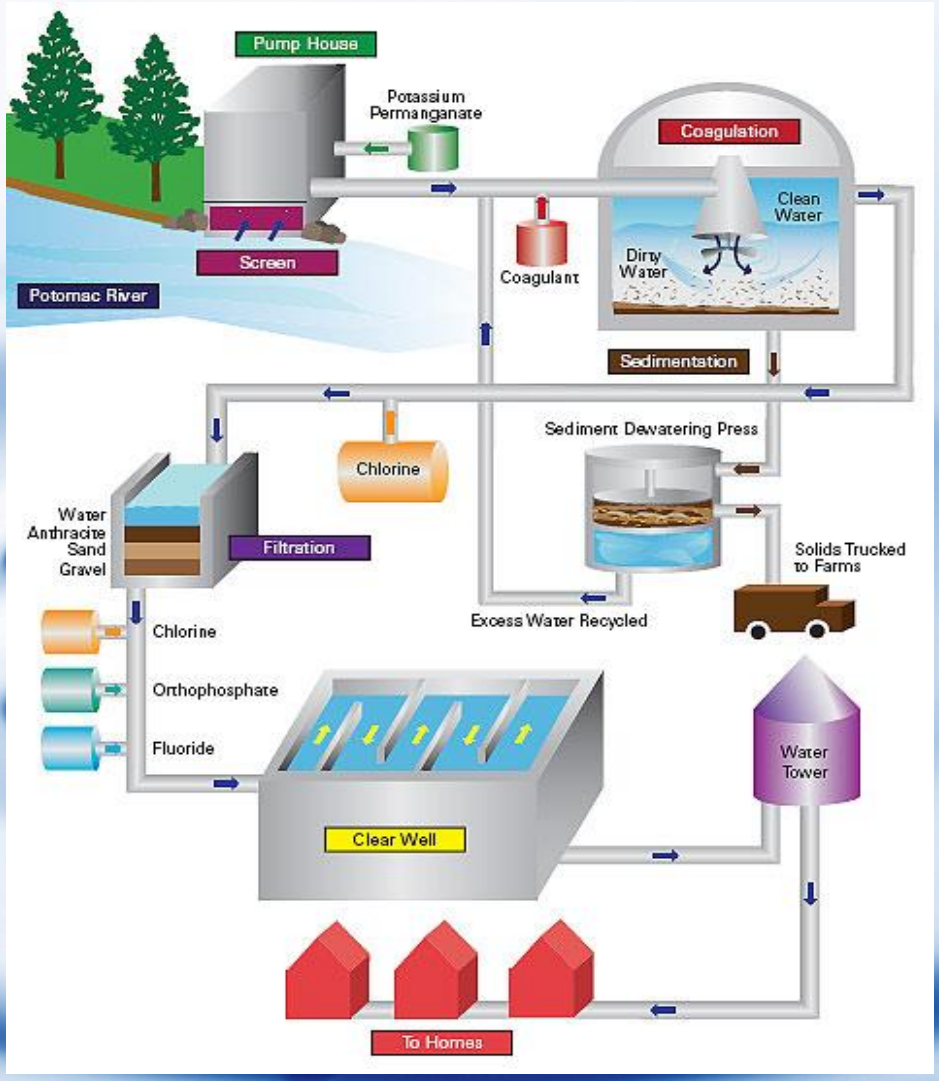


A Typical Water Treatment Plant

Follow a drop of water from the source through the treatment process. Water may be treated differently in different communities depending on the quality of the water which enters the plant. Ground water is located underground and typically requires less treatment than water from lakes, rivers, and streams.



Water Treatment



Why Treat Water?

Do Not Drink!

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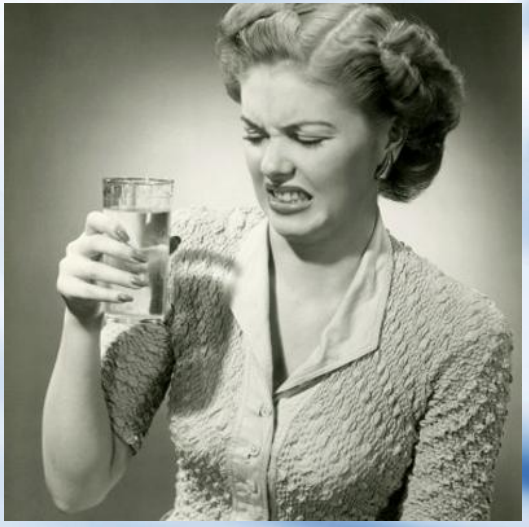
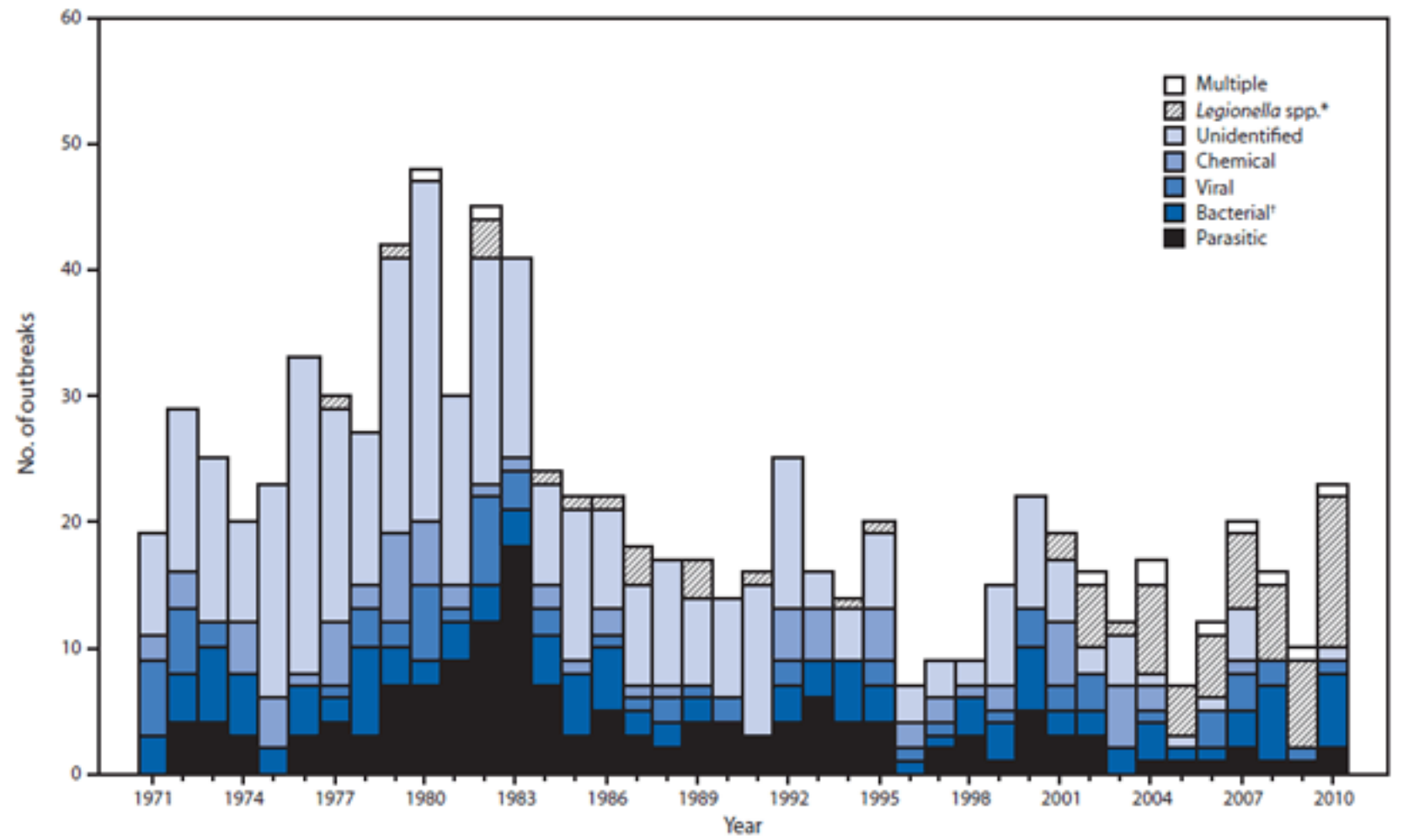
- The parasitic outbreak of cryptosporidium in the Drinking Water that made 400,000 people sick and killed more than 100.



Storage Issues

-American Family of 4 uses 400 gallons a day

Water Can be Deadly.



The Need For Professionals

- "A Competent Water Treatment Operator is the Foundation of Safe Drinking Water"

What we look for…

- Competent
- Detail Oriented
- Math and Science Foundation
- Problem Solver
- Critical Thinking
- Analytical

Job Growth and Opportunities

- Job Growth is expected to expand
- Expanding communities
- Retirements

City of Fairfield

Water Plant Operator II

2551

$71,310.72 - $86,679.84 Annually

Water Plant Operator III

2550

$78,713.44 - $95,675.84 Annually

Water Plant Operator IV

2540

$86,885.76 - $105,612.00 Annually

Contra Costa Water District

WTR TRTMT PLNT OPER GRADE III	$44.80	$47.04	$49.39	$51.86	$54.45
WTR TRTMT PLNT OPER GRADE IV	$47.08	$49.43	$51.90	$54.50	$57.22

Water!!! H20

Reservoir Management and Intakes

Definitions

- Aquifer- A natural underground layer of porous, water bearing materials (sand, gravel) usually capable of yielding a large amount or supply of water
- Artesian- Pertaining to groundwater, a well, or underground basin where the water is under a pressure greater than atmospheric and will rise above the level of its upper confining surface if given an opportunity to do so.
- Contamination- The introduction into water of microorganisms, chemicals, toxic substances, wastes, or wastewater in a concentration that makes the water unfit for its next intended use.
- Detention Time- The theoretical time required for a small amount of water to pass through a tank at a given rate of flow

- Drawdown- The drop in the water table or level of water in the ground when water is being pumped from a well, the amount of water used from a tank or reservoir, the drop in the water level of a tank or reservoir.
- Raw Water- Water in its natural state, prior to any treatment.
- Short Circuiting- A condition that occurs in tanks or basins when some of the flowing water entering a tank or basin flows along a nearly direct pathway from the inlet to the outlet. This is usually undesirable since it may result in shorter contact, reaction, or settling times in comparison with the theoretical detention time.
- Trihalomethanes (THMs)- A disinfection byproduct formed when Free Chlorine reacts with organic material in water. The resulting compounds are suspected of causing cancer.
- Stratification- The formation of separate layers (of temperature, plant, or animal life) in a lake or reservoir. Each layer has similar characteristics such as all water in the layer has the same temperature.

Sources of Water

Sources of Water

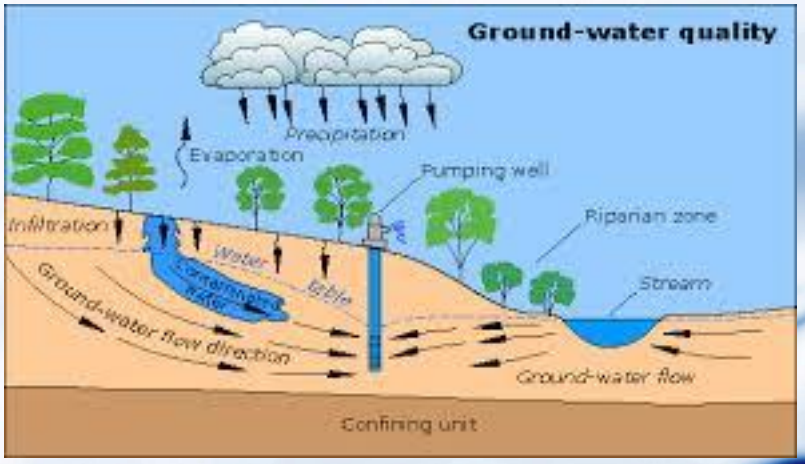
- Desalination- Water treated from the ocean

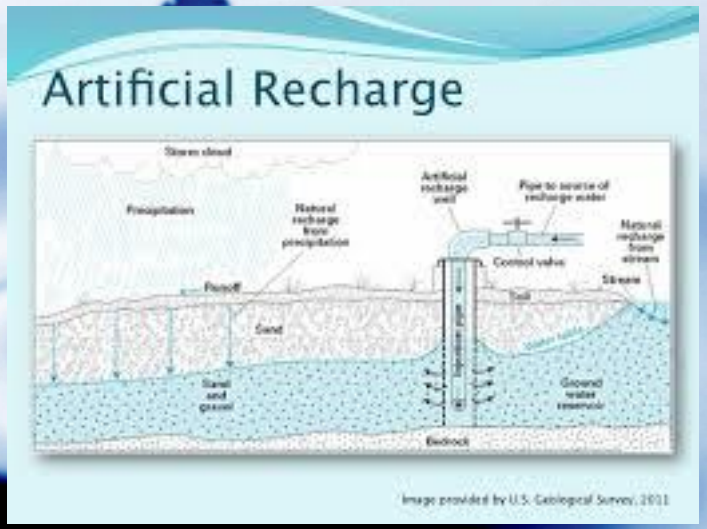
Sources of Water

- Surface Water

Sources of Water

- Groundwater





Surface Water… A scarce source

- 75% of the public water supply systems in the United States are from under ground sources, these systems supply only about 25% of the people who are served by public systems.
- Most large systems are dependent on surface supplies.

Again… Communities are built around water…

- Communities are built around high quality water sources.
- Communities are built around sustainable water sources.
- Water sources have to replenish themselves through the water cycle.

Water Source Selection

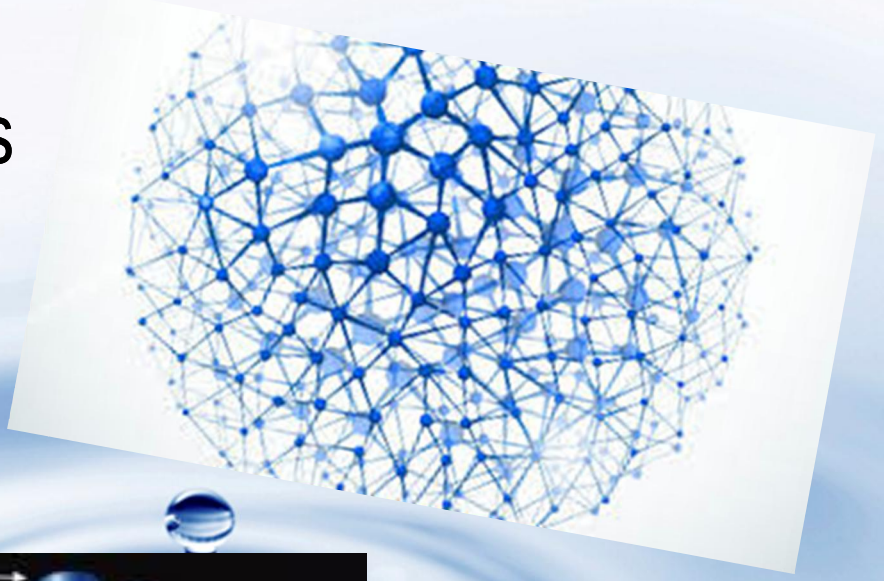
- When picking a water source ensure it is a high quality water source.
- High water quality is from precipitation, whether snow or rain

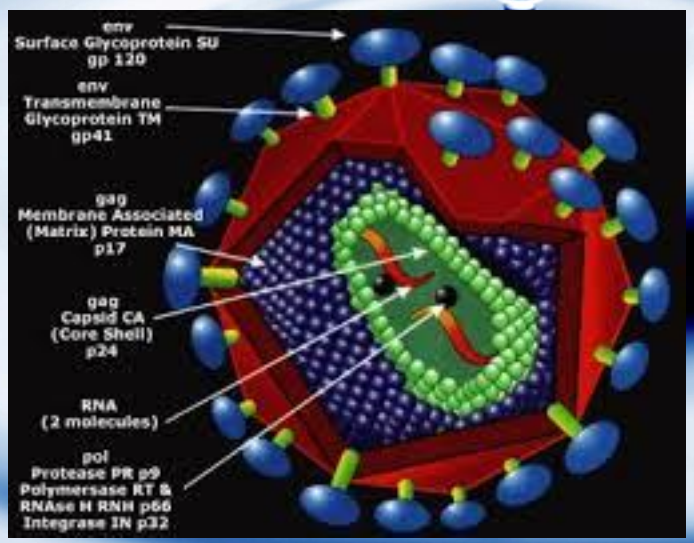
Physical Characteristics of Water

- Turbidity
- Color
- Temperature
- Tastes
- Odors

Other Characteristics

- Chemical Characteristics
- Biological Factors
- Radiological Factors





Safe Drinking Water Act

- 1974
- Set National Drinking Water Standards
- Defined a Public Water System
  - 15 service connections
  - 25 individuals at least 60 days of the year

Reservoir Management and Intakes

Definitions

- Aeration- The process of adding air to water. Air can be added to water by either passing air through water or passing water through air.
- Aerobic- A condition in which atmospheric or dissolved molecular oxygen is present in the aquatic (water) environment
- Anaerobic- A condition in which atmospheric or dissolved molecular oxygen is NOT present in the aquatic (water) environment.

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- Complete Treatment- a method of treating water, which consists of the addition of coagulant chemicals, flash mixing, coagulation-flocculation, sedimentation and filtration. Also called convention filtration.
- Density- A means of how heavy a substance (solid, liquid or gas) is for its size. Density is expressed in terms of weight per unit volume, that is, grams per cubic centimeter or pounds per cubic foot.
- Direct Filtration- a method of treating water, which consists of the addition of coagulant chemicals, flash mixing, coagulation, minimal flocculation, and filtration. The flocculation facilities may be omitted, but the physical-chemical reactions will occur to some extent. The sedimentation process is omitted.

- Epilimnion- The upper layer of water in a thermally stratified lake or reservoir. This layer consists of the warmest water and has a fairly uniform temperature. The layer is readily mixed by wind action.
- Flushing- a method used to clean water distribution lines.
- Head- The vertical distance (in feet) equal to the pressure (in psi) at a specific point. The pressure head is equal to the pressure in psi times 2.31 ft/psi.
- Hypolimnion- The lowest layer in a thermally stratified lake or reservoir. This layer consists of colder, more dense water, has a constant temperature and no mixing occurs.
- pH- an expression of the intensity of the basic or acidic condition of a liquid . It is measured 0- 15
- Thermal Stratification- The formation of layers of different temperatures in a lake or reservoir.
- Thermocline-The middle layer in a thermally stratified lake or reservoir. In this layer there is a rapid decrease in temperature with depth.

Our dependency on surface water

- “During the past few decades, more and more people in both cities and rural areas have become either partially or wholly dependent on surface reservoirs and lakes as a source for their water supplies” (Ken Kerri, pg. 46)

Raw Water Storage

Factors Affecting Water Quality

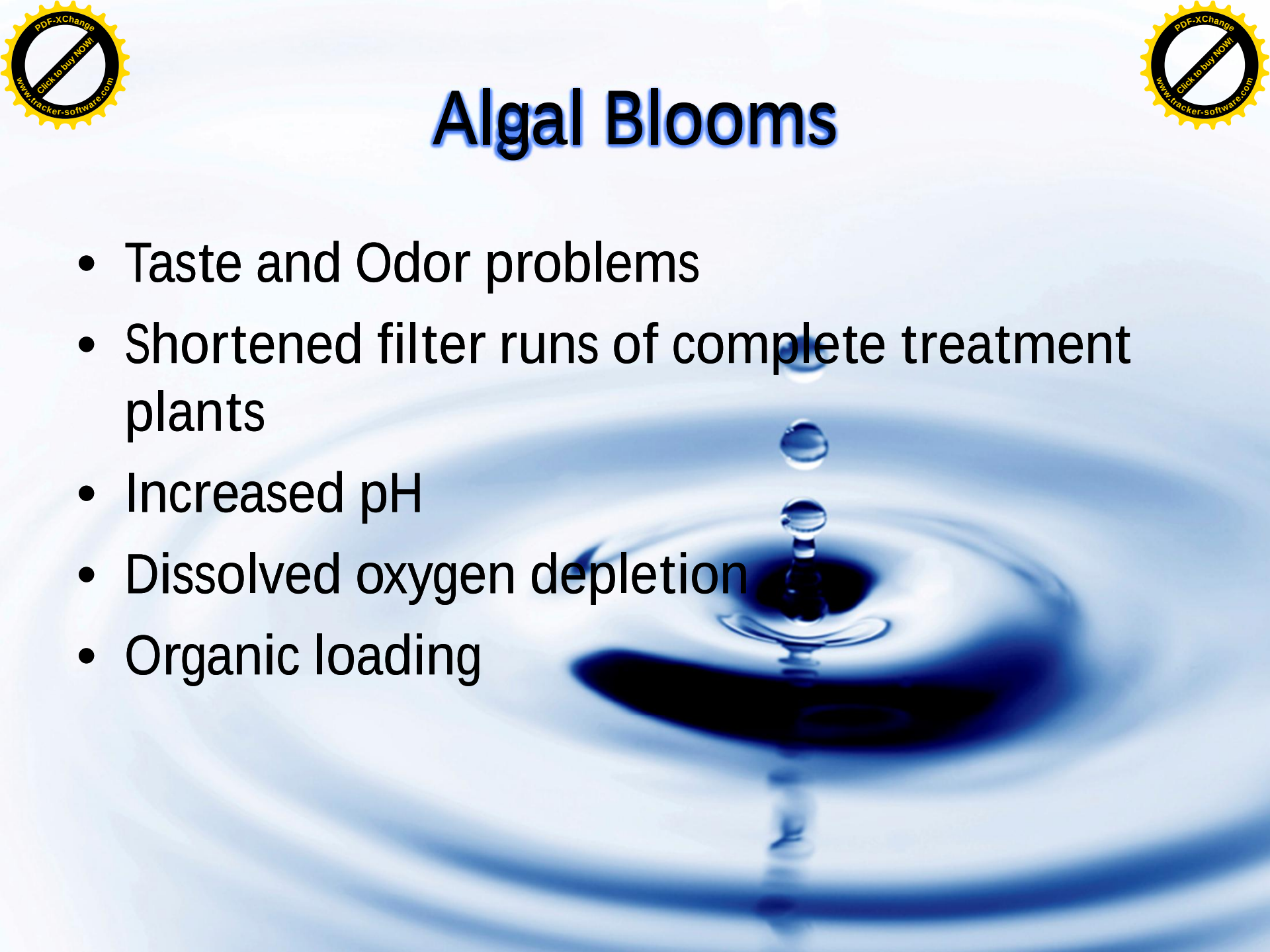
- Wastewater
- Agricultural runoff
- Grazing livestock
- Drainage from mining areas
- Runoff from urban areas
- Industrial discharges

Nutrients

- Phosphate, nitrate, organic nitrogen compounds can stimulate algae growth

Algal Blooms

- Taste and Odor problems
- Shortened filter runs of complete treatment plants
- Increased pH
- Dissolved oxygen depletion
- Organic loading



Reservoir Overturn

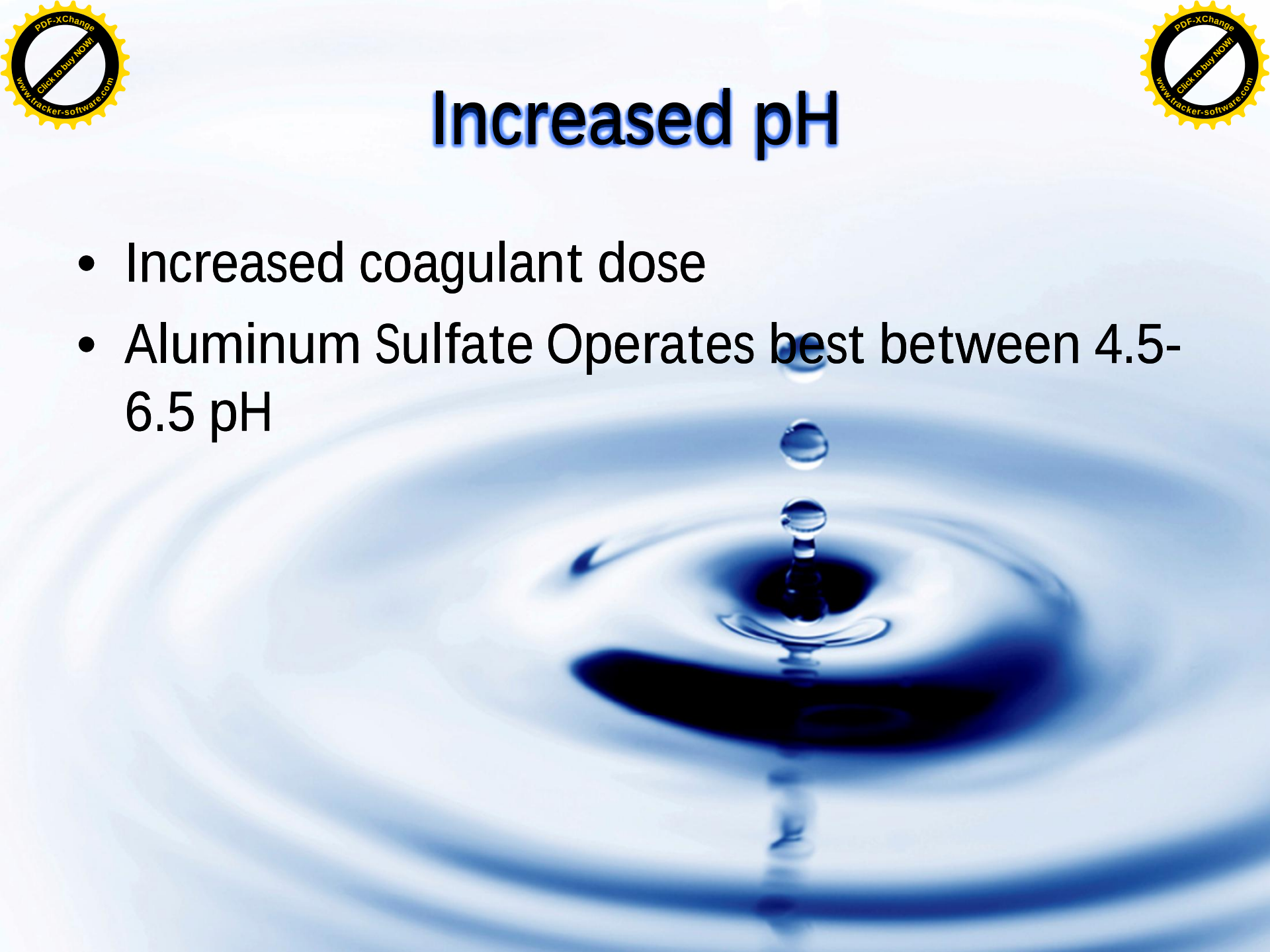
- In the fall when the days are shorter and temperatures drop, the upper layer cools and sinks. The result is a mixed reservoir with no optimum layer.

Reduced Filter run times

- Plant management becomes hard when filter runs are short

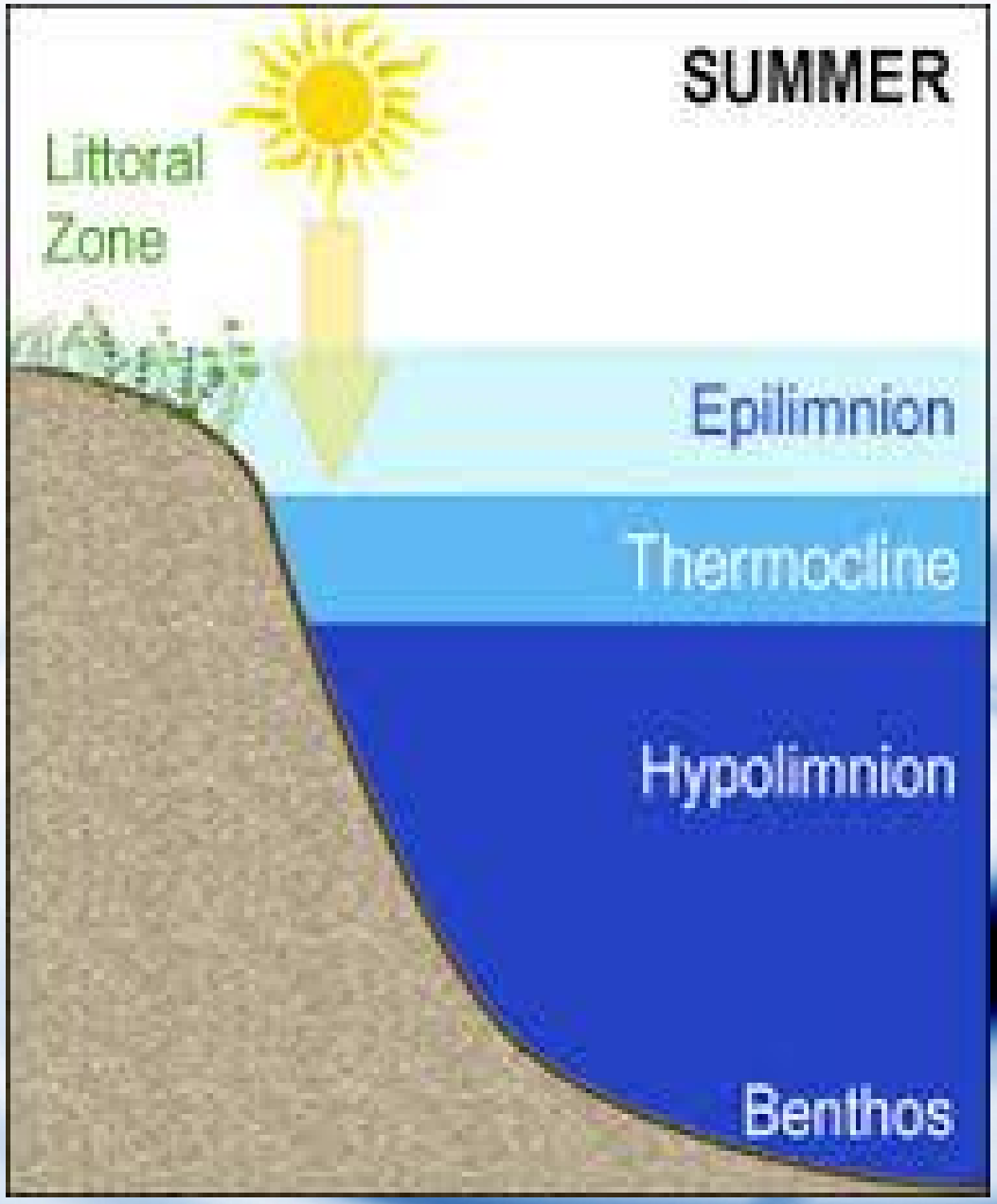
Increased pH

- Increased coagulant dose
- Aluminum Sulfate Operates best between 4.5-6.5 pH



Dissolved Oxygen Depletion

- Fish kills
- Odor problems with the water
- Iron and manganese issues



Importance of Reservoir Management

- Easier to treat
- Less taste and Odor issues
- Cheaper to treat

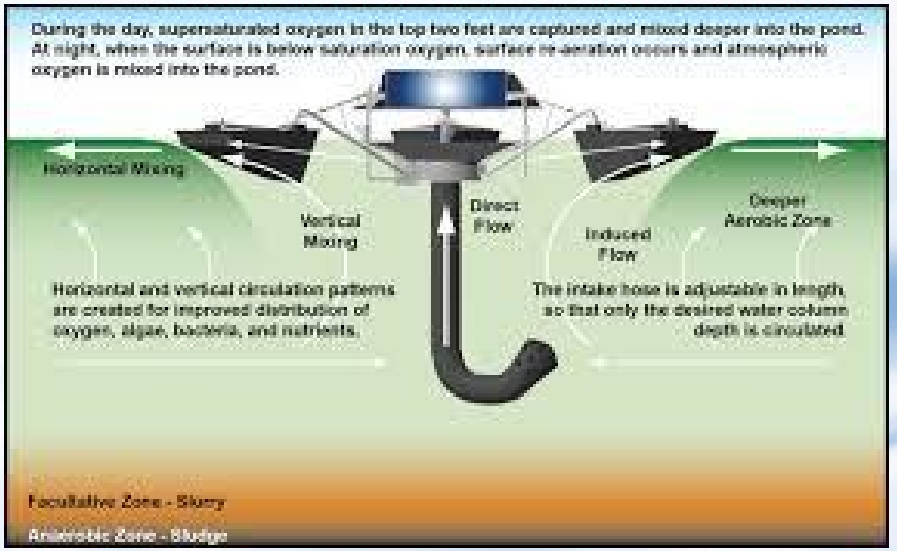
Reservoir Management

- Removal of Trees and Brush
- Copper Sulfate
- Livestock Grazing
- Use of Pesticides
- Wildfires
- Farming
- Use of fertilizers

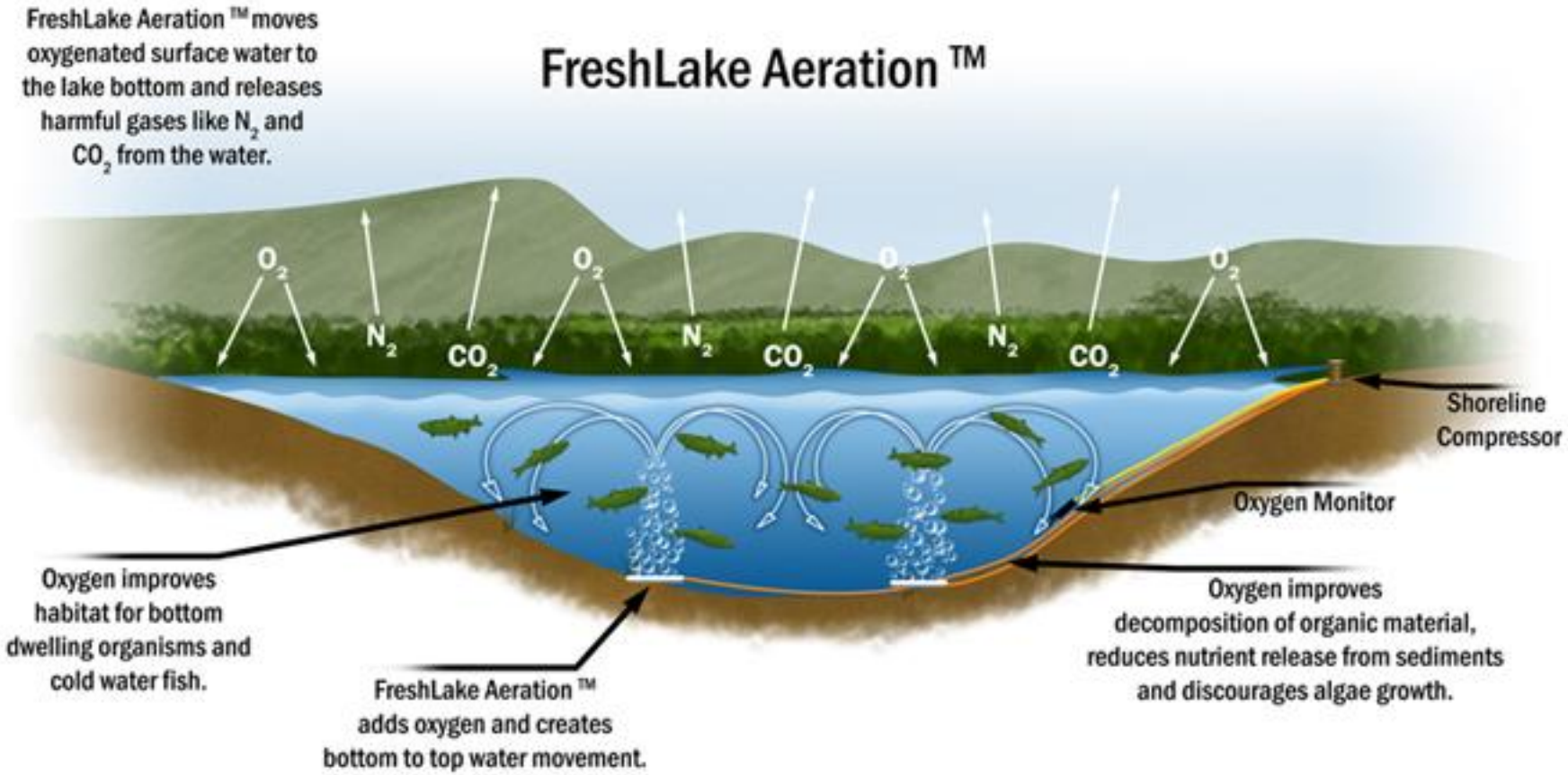
Re-Aeration

- Solarbee
- Hypolimnetic oxygenation system

Solarbee



Hypolimnetic Oxygenation System



- Questions?
- Concerns?
- Comments?

Resources

- www.epa.gov
- www.cdc.gov
- Ken Kerri, Water Treatment Plant Operation Vol 1.