

Title: Purification of Water

Source: The Water Sourcebook Series, U.S. Environmental Protection Agency

Subject(s): Science, Social Studies

Grade(s): 6-8

Objectives: Students will identify reasons for purifying water; describe the water treatment processes that occur at a water filtration and treatment plant; describe the wastewater treatment processes that occur at a municipal wastewater treatment facility; compare municipal water purification systems to the way water is purified in nature; and discuss the advantages and disadvantages of chlorinated water.

Summary: Students will draw and label the activities involved in each step of the water purification and wastewater treatment processes, and discuss what might happen if a step was not included. The students will then research the amount of chlorine added at each type of treatment facility and discuss the possible effects of over-chlorination, as well as alternative methods of disinfection.

Extensions: Take a trip to the local water and wastewater treatment plants, or invite a speaker from either facility to come speak to the students about the water purification and wastewater treatment processes. Alternatively, have students view “The Full Treatment” – an interactive tour of a wastewater treatment facility online at Fairfax Water (http://www.fcwa.org/education/the_plant/index.html)

Standards: S6E3. Students will recognize the significant role of water in earth processes.

SS8G1 Student will describe Georgia with regard to physical features and location.

SS8CG5 Student will analyze the role of local governments in the state of Georgia.

PURIFICATION OF WATER

6-8

OBJECTIVES

The student will do the following:

1. Identify the reasons for purifying water for communities.
2. Describe the water treatment processes that occur at a water filtration and treatment plant.
3. Describe the wastewater treatment processes that occur at a municipal wastewater treatment facility.
4. Compare the municipal system's water purification system to the ways water is purified in nature.
5. Discuss the advantages and disadvantages of chlorinated water.

SUBJECTS:

Ecology, Chemistry, Health

TIME:

50 - 90 minutes

MATERIALS:

photographs or posters of water and wastewater treatment plants
list of steps involved in water and wastewater treatment plants
local map
student sheets

BACKGROUND INFORMATION

Rivers and lakes are sources of water for municipal areas. Water samples collected from these water sources often look cloudy. Samples can look clear and still contain invisible sources of pollution. Rivers and lakes must be monitored for contamination and other sources of pollution.

Water that enters the municipal water supply has to be cleaned before it can be used and must also be cleaned after it is used. Thus, the water is both pre-cleaned and post-cleaned. Pre-cleaning takes place at a water treatment plant, and post-cleaning takes place at a wastewater treatment plant.

In some areas of the country, raw or insufficiently treated wastewater threatens the purity of the water resources. Poorly treated wastewater may contain harmful levels of bacteria and chemicals that can jeopardize human life.

Municipal water systems are responsible for cleaning the water before it is used. The water treatment system includes standardized steps for the treatment of the water before it is allowed to enter the homes of individual citizens.

The following steps are included in a water treatment filtration system:

1. Screening removes large objects from the water.
2. Pre-chlorination adds chlorine to kill disease causing organisms.
3. Flocculation adds alum and lime to remove suspended particles by trapping them in a jelly-like suspension formed from the added particles.
4. Settling allows trapped particles and solids to settle to the bottom.
5. Sand filtration allows sand to act as a natural filter, removing nearly all suspended material.
6. Post-chlorination adjusts the chlorine to maintain long-term action to kill disease-causing organisms.
7. Other treatments, such as fluoridation, pH adjustment, and further aeration, can be optional steps.

The following steps are included in a wastewater treatment system:

1. Preliminary Treatment: Screening is when large objects are removed; smaller objects are ground into even smaller pieces, and sand and dirt are allowed to settle out.
2. Primary Treatment: Primary settling happens when floating grease and scum are skimmed and heavier organic solids settle out.
3. Secondary Treatment: Aeration tanks add air and allow bacteria to digest organic substances. Sometimes rock or plastic media filters are used to grow bacteria that consume organisms in the wastewater.
4. Final settling is when bacteria settle out of the wastewater and are removed to a solids treatment process for stabilization. The stabilized solids, called biosolids, are then suitable for disposal on cropland, in landfills, or for other beneficial uses, such as compost.
5. Disinfection or chlorination means that additional chlorine is added to kill disease-causing organisms. Chlorine can be harmful to humans in large amounts. Chlorine can react with water and produce harmful substances such as chloroform which is carcinogenic. Other popular means of disinfection include ultraviolet irradiation that uses ultraviolet rays to kill harmful bacteria.
6. Optional treatments include controlling water pH by using carbon dioxide to form carbonic acid. Carbonic acid can neutralize alkaline compounds. Heavy metal ions and phosphate ions can also be removed by precipitation.
7. Advanced treatment processes also remove toxins such as ammonia.

Terms

carcinogen: cancer-causing agent.

chlorination: water disinfection by chlorine gas or hypochlorite.

flocculation: the process of forming aggregated or compound masses of particles, such as a cloud or a precipitate.

purification: the process of making pure, free from anything that debases, pollutes, or contaminates.

settling: the process of a substance, such as heavy organic solids or sediment, sinking.

sewage contamination: the introduction of untreated sewage into a water body.

wastewater: water that has been used for domestic or industrial purposes.

ADVANCE PREPARATION

- A. Research the water treatment and wastewater treatment plants in your area.
- B. Display diagrams of water and wastewater treatment plants on bulletin boards.
- C. Make duplicate copies of the steps in water and wastewater treatment.

PROCEDURE

1. Setting the stage

- A. Locate the water treatment and wastewater treatment plants in your area on a local map.
- B. Discuss the water supply that provides the water for the water treatment plants.

- C. Compare the number of students in the class who use water from a water treatment plant with the number who have private wells.

II. Activities

- A. List the steps involved in purification of a municipal water supply and explain what happens at each step.
- B. Ask the students to draw and label the activities involved in each of the steps.
- C. Have the students speculate regarding what might happen if a step was not included.
- D. List the steps involved in the treatment of wastewater at a wastewater treatment plant.
- E. Ask the students to draw and label the activities involved in each of the steps.
- F. Have the students speculate regarding what might happen if a step was not included.
- G. Have the students research the amount of chlorine added to the water at each treatment facility. Discuss as a class the possible effects of over-chlorinating.
- H. Discuss alternative methods of disinfection.
- I. Have the students compare their drawings and descriptions to the wall diagrams.

III. Follow-Up

- A. Ask students to research the optional steps used by water treatment facilities in local and surrounding communities. Discuss which optional steps can be detrimental to people or to the environment.
- B. Discuss the possible hazards of using well water rather than water from a water treatment facility.

IV. Extensions

- A. Take a field trip to the local water treatment and wastewater treatment plants.
- B. Secure a speaker from a local, state or federal environmental agency, the local utility company, or an environmental consulting firm to discuss each person's responsibility in protecting our surface waters.
- C. Develop a clean water monitoring group to collect data from local rivers and streams.

RESOURCE

American Chemical Society, ChemCom: Chemistry in the Community, Kendall Hunt Publishing Company, Dubuque, Iowa, 1993.

The following steps are included in a water treatment filtration system:

1. Screening— removal of large objects from the water.
2. Pre-chlorination — addition of chlorine to kill disease-causing organisms
3. Flocculation — addition of alum and lime to remove suspended particles by trapping them in a jelly-like suspension formed from the added particles
4. Settling — trapped particles and solids are allowed to settle to the bottom
5. Sand filtration — sand acts as a natural filter, removes nearly all suspended material
6. Post-chlorination — adjustment of the chlorine to maintain long-term action to kill disease-causing organisms
7. Other treatments — fluoridation, pH adjustment, and further aeration can be optional steps

The following steps are included in a wastewater treatment system:

Step 1 – Preliminary Treatment:

1. Screening — large objects are removed; smaller objects are ground into even smaller pieces, and sand and dirt are allowed to settle out.

Step 2 – Primary Treatment:

2. Primary settling — floating grease and scum are skimmed and solids settle out.

Step 3 – Secondary Treatment:

3. Aeration — aeration tanks add air and allow bacteria to digest organic substances.
4. Final settling — sludge continues to settle out, and it is aerated, chlorinated, and dried for incineration or for dumping in landfills.
5. Disinfection/chlorination — additional chlorine is added to kill disease-causing organisms. Other disinfection processes include ultraviolet irradiation.
6. Optional treatments — water pH can be controlled by using carbon dioxide to form carbonic acid. Carbonic acid can neutralize alkaline compounds. Heavy metal ions and phosphate ions can also be removed by precipitation.