9-12

WASTEWATER TREATMENT

OBJECTIVES

The student will do the following:

1. Define wastewater and list components of wastewater.
2. Describe the function of a wastewater treatment plant.
3. Create a wastewater treatment model and use it to clean wastewater.
4. Describe some primary and secondary wastewater treatment methods.

SUBJECT:
Science (Physical Science, Physics)

TIME:
2-3 class periods

MATERIALS:
student sheets
writing materials

BACKGROUND INFORMATION

Wastewater is not just sewage. All the water used in the home that goes down the drains or into the sewage collection system is wastewater. This includes water from baths, showers, sinks, dishwashers, washing machines, and toilets. Small businesses and industries often contribute large amounts of wastewater to sewage collection systems; others operate their own wastewater treatment systems. In combined municipal sewage systems, water from storm drains is also added to the municipal wastewater stream. The average American contributes 265-568 liters (66 to 192 gallons) of wastewater each day. Wastewater is about 99 percent water by weight and is generally referred to as influent as it enters the wastewater treatment facility. "Domestic wastewater" is wastewater that comes primarily from individuals, and does not generally include industrial or agricultural wastewater.

At wastewater treatment plants, this flow is treated before it is allowed to be returned to the environment, lakes, or streams. There are no holidays for wastewater treatment, and most plants operate 24 hours per day every day of the week. Wastewater treatment plants operate at a critical point of the water cycle, helping nature defend water from excessive pollution. Most treatment plants have primary treatment (physical removal of floatable and settleable solids) and secondary treatment (the biological removal of dissolved solids).

Primary treatment involves:

1. screening- to remove large objects, such as stones or sticks, that could plug lines or block tank inlets.

2. grit chamber- slows down the flow to allow grit to fall out

3. sedimentation tank (settling tank or clarifier)- settleable solids settle out and are pumped away, while oils float to the top and are skimmed off

Secondary treatment typically utilizes biological treatment processes, in which microorganisms convert nonsettleable solids to settleable solids. Sedimentation typically follows, allowing the settleable solids to settle out. Three options include:

1. Activated Sludge- The most common option uses microorganisms in the treatment process to break down organic material with aeration and agitation, then allows solids to settle out. Bacteria-containing "activated sludge" is continually recirculated back to the aeration basin to increase the rate of organic decomposition.

2. Trickling Filters- These are beds of coarse media (often stones or plastic) 3-10 ft. deep. Wastewater is sprayed into the air (aeration), then allowed to trickle through the media. Microorganisms, attached to and growing on the media, break down organic material in the wastewater. Trickling filters drain at the bottom; the wastewater is collected and then undergoes sedimentation.

3. Lagoons- These are slow, cheap, and relatively inefficient, but can be used for various types of wastewater. They rely on the interaction of sunlight, algae, microorganisms, and oxygen (sometimes aerated).

After primary and secondary treatment, municipal wastewater is usually disinfected using chlorine (or other disinfecting compounds, or occasionally ozone or ultraviolet light). An increasing number of wastewater facilities also employ tertiary treatment, often using advanced treatment methods. Tertiary treatment may include processes to remove nutrients such as nitrogen and phosphorus, and carbon adsorption to remove chemicals. These processes can be physical, biological, or chemical.

Settled solids (sludge) from primary treatment and secondary treatment settling tanks are given further treatment and undergo several options for disposal. (See Sludge Treatment and Disposal Methods on page 2-87 & 2-114 thru 2-115.)

Terms

activated sludge: sludge particles produced by the growth of microorganisms in aerated tanks as a part of the activated sludge process to treat wastewater

aeration: exposing to circulating air; adds oxygen to the wastewater and allows other gases trapped in the wastewater to escape (the first step in secondary treatment via activated sludge

process)

biochemical oxygen demand (BOD): a laboratory measurement of wastewater that is one of the main indicators of the quantity of pollutants present; a parameter used to measure the amount of oxygen that will be consumed by microorganisms during the biological reaction of oxygen with organic material

biosolids: sludge that is intended for beneficial use. Biosolids must meet certain government-specified criteria depending on its use (e.g., fertilizer or soil amendment)**.**

decomposition: the process of breaking down into constituent parts or elements

domestic wastewater: wastewater that comes primarily from individuals, and does not generally include industrial or agricultural wastewater

effluent: treated wastewater, flowing from a lagoon, tank, treatment process, or treatment plant

grit chamber: a chamber or tank used in primary treatment where wastewater slows down and heavy, large solids (grit) settle out and are removed

influent: wastewater flowing into a treatment plant

lagoons (oxidation ponds or stabilization ponds): a wastewater treatment method that uses ponds to treat wastewater. Algae grow within the lagoons and utilize sunlight to produce oxygen, which is in turn used by microorganisms in the lagoon to break down organic material in the wastewater. Wastewater solids settle in the lagoon, resulting in effluent that is relatively well treated, although it does contain algae.

municipal: of or relating to a municipality (city, town, etc.). Municipal wastewater is primarily domestic wastewater**.**

primary treatment: the first stage of wastewater treatment that removes settleable or floating solids only; generally removes 40% of the suspended solids and 30-40% of the BOD in the wastewater

secondary treatment: a type of wastewater treatment used to convert dissolved and suspended pollutants into a form that can be removed, producing a relatively highly treated effluent. Secondary treatment normally utilizes biological treatment processes (activated sludge, trickling filters, etc.) followed by settling tanks and will remove approximately 85% of the BOD and TSS in wastewater. Secondary treatment for municipal wastewater is the minimum level of treatment required by the Clean Water Act.

sedimentation: the process used in both primary and secondary wastewater treatment, that takes

place when gravity pulls particles to the bottom of a tank (also called settling).

settling tank (sedimentation tank or clarifier): a vessel in which solids settle out of water by gravity during wastewater or drinking water treatment processes.

sludge: any solid, semisolid, or liquid waste that settles to the bottom of sedimentation tanks (in wastewater treatment plants or drinking water treatment plants) or septic tanks

tertiary treatment: any level of treatment beyond secondary treatment, which could include filtration, nutrient removal (removal of nitrogen and phosphorus) and removal of toxic chemicals or metals; also called "advanced treatment" when nutrient removal is included

total suspended solids (TSS): a laboratory measurement of the quantity of suspended solids present in wastewater that is one of the main indicators of the quantity of pollutants present

trickling filter process: a biological treatment process that uses coarse media (usually rock or plastic) contained in a tank that serves as a surface on which microbiological growth occurs. Wastewater trickles over the media and microorganisms remove the pollutants (BOD and TSS). Trickling filters are followed by settling tanks to remove microorganisms that wash off or pass through the trickling filter media.

turbidity: the cloudy or muddy appearance of a naturally clear liquid caused by the suspension of particulate matter

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

PROCEDURE

I. Setting the Stage

A. Make transparencies of Teacher Sheets. Copy Student Sheets.

B. Discuss the processes involved at a typical municipal wastewater treatment facility.

C. Discuss typical municipal wastewater collection systems.

D. Relate discussion to any relevant local or national wastewater issues.

II. Activity

A. Have students complete Student Sheet.

B. (Optional): Have students research pertinent local or national wastewater issues and write a paper on their issue of choice.

III. Follow-up

A. Have students determine which types of treatment (primary, secondary, tertiary) and specific processes are used at the local municipal wastewater treatment facility.

B. Have students discuss the plant's efficiency (with respect to various contaminants) with a plant operator. Learn about any "pretreatment" operations conducted for industrial wastewater.

IV. Extensions

A. Visit the local municipal wastewater treatment plant, or invite a speaker from the plant to talk to the class.

B. View a video or slides of various types of wastewater treatment processes.

C. Determine which types of municipal treatment processes are used in industrial wastewater treatment processes. Discuss which processes are used for particular industries and why.

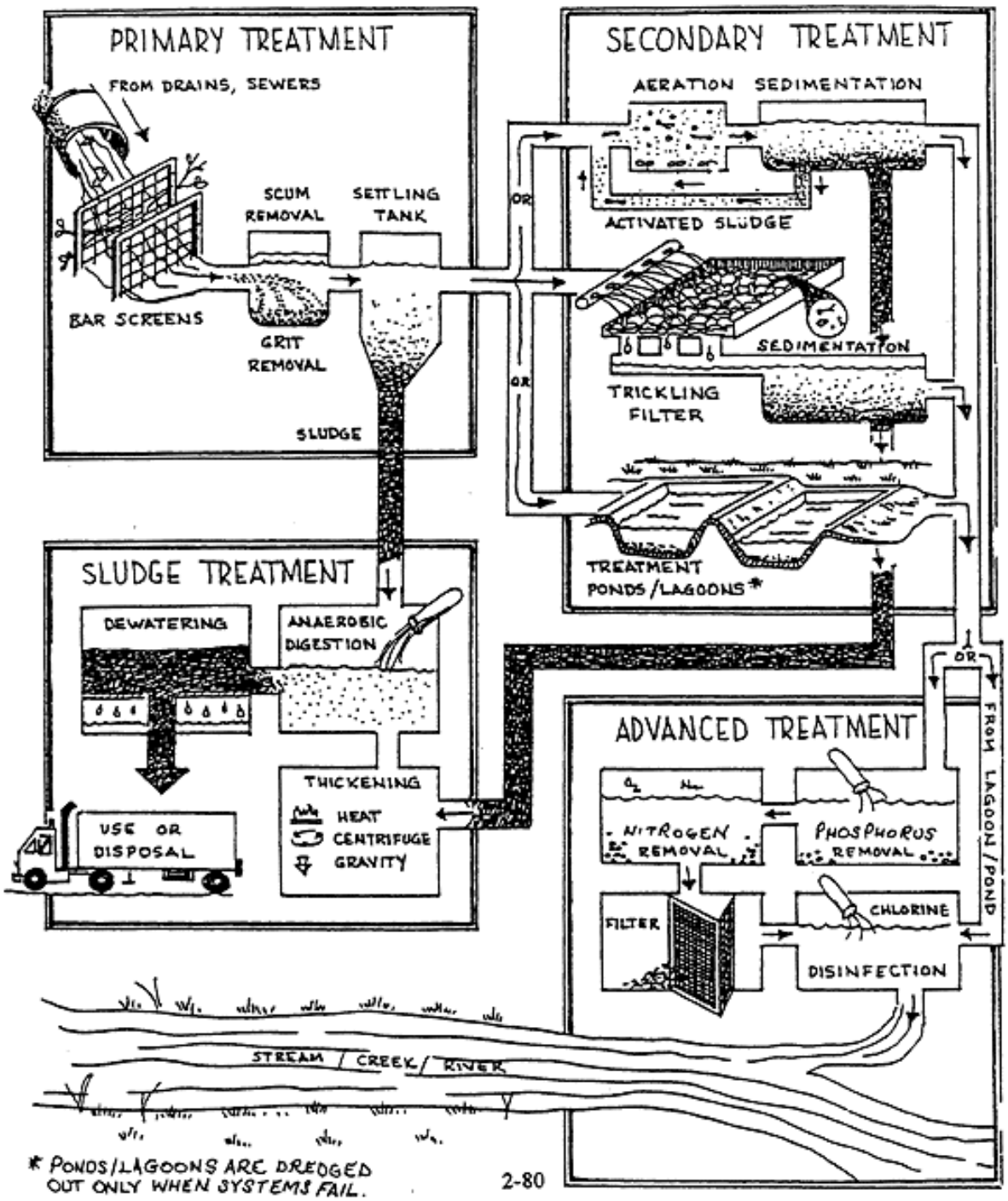
RESOURCES

National Geographic Society Teachers Handbook, Geography: Reflections on Water", Nov. '92.

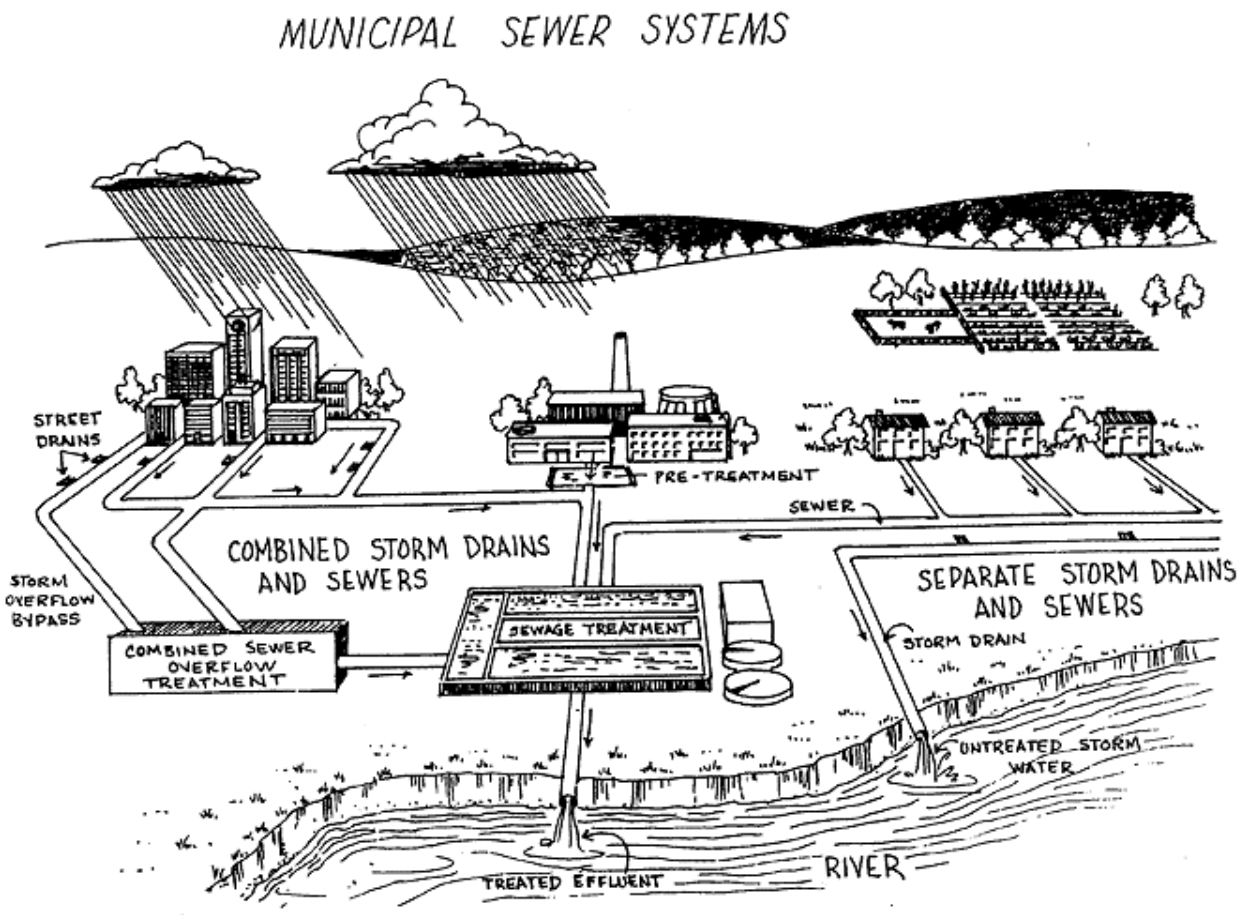
Nature Projects on File, "Cleaning Dirty Water," 6.008, The Diagram Group.

Water Environment Federation, "Clean Water for Today: What is Wastewater Treatment?" 1-800-444-2933 (Fax Reply Service)

TYPICAL WASTEWATER TREATMENT FACILITY



* PONDS/LAGOONS ARE DREDGED OUT ONLY WHEN SYSTEMS FAIL.


MUNICIPAL SEWER SYSTEMS
STREET DRAINS
PRE-TREATMENT
SEWER
COMBINED STORM DRAINS AND SEWERS
SEPARATE STORM DRAINS AND SEWERS
STORM OVERFLOW BYPASS
SEWAGE TREATMENT
COMBINED SEWER OVERFLOW TREATMENT
STORM DRAIN
UNTREATED STORM WATER
TREATED EFFLUENT
RIVER