

# Glossary

**absorption** (1) Taking up of matter in bulk by other matter, as in dissolving of a gas by a liquid. (2) Penetration of substances into the bulk of the solid or liquid. See also *adsorption*.

**absorption capacity** A measure of the quantity of a soluble substance that can be absorbed by a given quantity of a solid substance.

**acclimation** The dynamic response of a system to the addition or deletion of a substance until equilibrium is reached; adjustment to a change in the environment.

**accuracy** The absolute nearness to the truth. In physical measurements, it is the degree of agreement between the quantity measured and the actual quantity. It should not be confused with “precision,” which denotes the reproducibility of the measurement.

**acid** (1) A substance that tends to lose a proton. (2) A substance that dissolves in water with the formation of hydrogen ions. (3) A substance containing hydrogen which may be replaced by metals to form salts.

**acid-forming bacteria** Microorganisms that can metabolize complex organic compounds under anaerobic conditions. This metabolic activity is the first step in the two-step anaerobic fermentation process leading to the production of methane.

**acidity** The quantitative capacity of aqueous solutions to neutralize a base; measured by titration with a standard solution of a base to a specified end point; usually expressed as milligrams of equivalent calcium carbonate per liter (mg/L CaCO<sub>3</sub>); not to be confused with pH. Water does not have to have a low pH to have high acidity.

**acre-foot (ac-ft)** A volume of water 1-ft deep and 1 ac in area, or 43 560 cu ft (1 233.5 m<sup>3</sup>).

**Operation of Municipal Wastewater Treatment Plants**

**activated carbon** Adsorptive particles or granules usually obtained by heating carbonaceous material in the absence of air or in steam and possessing a high capacity to selectively remove trace and soluble components from solution.

**activated carbon adsorption** Removal of soluble components from aqueous solution by contact with highly adsorptive granular or powdered carbon.

**activated carbon treatment** Treatment process in which water is brought into contact with highly adsorptive granular or powdered carbon to remove soluble components; process may be applied to raw water, primary effluent, or chemically clarified wastewater for nonspecific removal of organics, or to secondary effluent as a polishing process to remove specific organics.

**activated sludge** Sludge particles produced by the growth of organisms in the aeration tank in the presence of dissolved oxygen.

**activated-sludge loading** The pounds (kilograms) of BOD in the applied liquid per unit volume of aeration capacity or per pound (kilogram) of activated sludge per day.

**activated-sludge process** A biological wastewater treatment process that converts nonsettleable (suspended, dissolved, and colloidal solids) organic materials to a settleable product using aerobic and facultative microorganisms.

**adsorption** The adherence of a gas, liquid, or dissolved material to the surface of a solid or liquid. It should not be confused with *absorption*.

**adsorption water** Water held on the surface of solid particles by molecular forces with the emission of heat (heat of wetting).

**advanced waste treatment** Any physical, chemical, or biological treatment process used to accomplish a degree of treatment greater than that achieved by secondary treatment.

**aerated contact bed** A biological treatment unit consisting of stone, cement-asbestos, or other surfaces supported in an aeration tank, in which air is diffused up and around the surfaces and settled wastewater flows through the tank; also called a *contact aerator*.

**aerated pond** A natural or artificial wastewater treatment pond in which mechanical or diffused air aeration is used to supplement the oxygen supply.

**aeration** (1) The bringing about of intimate contact between air and a liquid by one or more of the following methods: (a) spraying the liquid in the air; (b) bubbling air through the liquid; and (c) agitating the liquid to promote surface absorption of air. (2) The supplying of air to confined spaces under nappes, downstream from gates in conduits, and so on, to relieve low pressures and to replenish air entrained and removed from such confined spaces by flowing water. (3) Relief of the effects of cavitation by admitting air to the affected section.

***aeration period*** (1) The theoretical time, usually expressed in hours, during which mixed liquor is subjected to aeration in an aeration tank while undergoing activated-sludge treatment. It is equal to the volume of the tank divided by the volumetric rate of flow of the wastewater and return sludge. (2) The theoretical time during which water is subjected to aeration.

***aeration tank*** A tank in which wastewater or other liquid is aerated.

***aerator*** A device that brings air and a liquid into intimate contact. See *diffuser*.

***aerobic*** Requiring, or not destroyed by, the presence of free or dissolved oxygen in an aqueous environment.

***aerobic bacteria*** Bacteria that require free elemental oxygen to sustain life.

***aerobic digestion*** The breakdown of suspended and dissolved organic matter in the presence of dissolved oxygen. An extension of the activated-sludge process, waste sludge is stored in an aerated tank where aerobic microorganisms break down the material.

***aerobic lagoon*** An oxygen-containing lagoon, often equipped with mechanical aerators, in which wastewater is partially stabilized by the metabolic activities of bacteria and algae. Small lagoons (less than 0.5 ac [0.2 ha] and less than 3-ft [0.9-m] deep) may remain aerobic without mechanical aeration. See also *anaerobic lagoon*.

***aerosol*** Colloidal particles dispersed in a gas, smoke, or fog.

***agglomeration*** Coalescence of dispersed suspended matter into larger flocs or particles.

***agitator*** Mechanical apparatus for mixing or aerating. A device for creating turbulence.

***air-bound*** Obstructed, as to the free flow of water, because of air entrapped in a high point; used to describe a pipeline or pump in such condition.

***air chamber*** A closed pipe chamber installed on the discharge line of a reciprocating pump to take up irregularities in hydraulic conditions, induce a uniform flow in suction and discharge lines, and relieve the pump of shocks caused by pulsating flow.

***air-chamber pump*** A displacement pump equipped with an air chamber in which the air is alternately compressed and expanded by the water displaced by the pump, resulting in the water being discharged at a more even rate.

***air diffuser*** Devices of varied design that transfer oxygen from air into a liquid.

***air diffusion*** The transfer of air into a liquid through an oxygen-transfer device. See *diffusion*.

***air gap*** The unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or outlet supplying water to a tank, plumbing fixture, or other device, and the flood-level rim of the receptacle.

**Operation of Municipal Wastewater Treatment Plants**

**air lift** A device for raising liquid by injecting air in and near the bottom of a riser pipe submerged in the liquid to be raised.

**air-lift pump** A pump, used largely for lifting water from wells, from which fine pressured air bubbles are discharged into the water at the bottom of the well. The bubbles reduce the density of the water at the bottom, allowing the denser surrounding water to push it up in the discharge pipe to the outlet. Also called an *air lift*.

**air stripping** A technique for removal of volatile substances from a solution; employs the principles of Henry's Law to transfer volatile pollutants from a solution of high concentration into an air stream of lower concentration. The process ordinarily is designed so that the solution containing the volatile pollutant contacts large volumes of air. The method is used to remove ammonia in advanced waste treatment.

**algae** Photosynthetic microscopic plants that contain chlorophyll that float or are suspended in water. They may also be attached to structures, rocks, etc. In high concentrations, algae may deplete dissolved oxygen in receiving waters.

**algal assay** An analytical procedure that uses specified nutrients and algal inoculums to identify the limiting algal nutrient in water bodies.

**algal bloom** Large masses of microscopic and macroscopic plant life, such as green algae, occurring in bodies of water.

**alkali** Generally, any substance that has highly basic properties; used particularly with reference to the soluble salts of sodium, potassium, calcium, and magnesium.

**alkaline** The condition of water, wastewater, or soil that contains a sufficient amount of alkali substances to raise the pH above 7.0.

**alkalinity** The capacity of water to neutralize acids; a property imparted by carbonates, bicarbonates, hydroxides, and occasionally borates, silicates, and phosphates. It is expressed in milligrams of equivalent calcium carbonate per liter (mg/L CaCO<sub>3</sub>).

**alkyl benzene sulfonate (ABS)** A type of surfactant, or surface active agent, present in synthetic detergents in the United States prior to 1965. ABS was troublesome because of its foam-producing characteristics and resistance to breakdown by biological action. ABS has been replaced in detergents by linear alkyl sulfonate, which is biodegradable.

**alum, aluminum sulfate** [Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub> × 18H<sub>2</sub>O] Used as a coagulant in filtration. Dissolved in water, it hydrolyzes into Al(OH)<sub>3</sub> and sulfuric acid (H<sub>2</sub>SO<sub>4</sub>). To precipitate the hydroxide, as needed for coagulation, the water must be alkaline.

**ambient** Generally refers to the prevailing dynamic environmental conditions in a given area.

**ammonia, ammonium** (NH<sub>3</sub>, NH<sub>4</sub><sup>+</sup>) Urea and proteins are degraded into dissolved ammonia and ammonium in raw wastewaters. Typically, raw wastewater contains

30 to 50 mg/L of  $\text{NH}_3$ . Reactions between chlorine and ammonia are important in disinfection.

**ammonia nitrogen** The quantity of elemental nitrogen present in the form of ammonia ( $\text{NH}_3$ ).

**ammoniator** Apparatus used for applying ammonia or ammonium compounds to water.

**ammonification** Bacterial decomposition of organic nitrogen to ammonia.

**amoeba** A group of simple protozoans, some of which produce diseases such as dysentery in humans.

**ampere** The unit of measurement of electrical current. It is proportional to the quantity of electrons flowing through a conductor past a given point in one second and is analogous to cubic feet of water flowing per second. It is the current produced in a circuit by one volt acting through a resistance of one ohm.

**amperometric** Pertaining to measurement of electric current flowing or generated, rather than by voltage.

**anaerobic** (1) A condition in which free and dissolved oxygen are unavailable. (2) Requiring or not destroyed by the absence of air or free oxygen.

**anaerobic bacteria** Bacteria that grow only in the absence of free and dissolved oxygen.

**anaerobic digestion** The degradation of concentrated wastewater solids, during which anaerobic bacteria break down the organic material into inert solids, water, carbon dioxide, and methane.

**anaerobic lagoon** A wastewater or sludge treatment process that involves retention under anaerobic conditions.

**anion** A negatively charged ion attracted to the anode under the influence of electrical potential.

**anionic flocculant** A polyelectrolyte with a net negative electrical charge.

**anoxic** Condition in which oxygen is available in the combined form only; there is no free oxygen. Anoxic sections in an activated-sludge plant may be used for denitrification.

**antagonism** Detrimental interaction between two entities. See also *synergism*.

**antichlors** Reagents, such as sulfur dioxide, sodium bisulfite, and sodium thiosulfate, that can be used to remove excess chlorine residuals from water or watery wastes by conversion to an inert salt.

**anticorrosion treatment** Treatment to reduce or eliminate corrosion-producing qualities of a water.

**Operation of Municipal Wastewater Treatment Plants**

**appurtenances** Machinery, appliances, or auxiliary structures attached to a main structure enabling it to function, but not considered an integral part of it.

**aqueous vapor** The gaseous form of water. See *water vapor*.

**area drain** A drain installed to collect surface or stormwater from an open area of a building.

**automatic recording gauge** An automatic instrument for measuring and recording graphically and continuously. Also called *register*.

**automatic sampling** Collecting of samples of prescribed volume over a defined time period by an apparatus designed to operate remotely without direct manual control. See also *composite sample*.

**autothermal thermophilic aerobic digestion** As part of the aerobic digestion process, heat is evolved. In a contained vessel, the sufficient heat is generated to maintain temperatures in the thermophilic range. At higher temperatures, detention time requirements are reduced for a given solids reduction resulting in an end product that is relatively pathogen free.

**autotrophic organisms** Organisms including nitrifying bacteria and algae that use carbon dioxide as a source of carbon for cell synthesis. They can consume dissolved nitrates and ammonium salts.

**available chlorine** A measure of the total oxidizing power of chlorinated lime, hypochlorites, and other materials used as a source of chlorine as compared with that of elemental chlorine.

**average** An arithmetic mean obtained by adding quantities and dividing the sum by the number of quantities.

**average daily flow** (1) The total quantity of liquid tributary to a point divided by the number of days of flow measurement. (2) In water and wastewater applications, the total flow past a point over a period of time divided by the number of days in that period.

**average flow** Arithmetic average of flows measured at a given point.

**average velocity** The average velocity of a stream flowing in a channel or conduit at a given cross section or in a given reach. It is equal to the discharge divided by the cross-sectional area of the section or the average cross-sectional area of the reach. Also called *mean velocity*.

**axis** A line about which a figure or a body is symmetrically arranged, or about which such a figure or body rotates.

**backflow connection** In plumbing, any arrangement whereby backflow can occur. Also called *interconnection*, *cross connection*.

**backflow preventer** A device on a water supply pipe to prevent the backflow of water into the water supply system from the connections on its outlet end. See also *vacuum breaker* and *air gap*.

**backflushing** The action of reversing the flow through a conduit for the purpose of cleaning the conduit of deposits.

**back-pressure valve** A valve provided with a disk hinged on the edge so that it opens in the direction of normal flow and closes with reverse flow; a check valve.

**backwashing** The operation of cleaning a filter by reversing the flow of liquid through it and washing out matter previously captured in it. Filters include true filters such as sand and diatomaceous earth-types, but not other treatment units such as trickling filters.

**bacteria** A group of universally distributed, rigid, essentially unicellular microscopic organisms lacking chlorophyll. They perform a variety of biological treatment processes including biological oxidation, sludge digestion, nitrification, and denitrification.

**bacterial analysis** The examination of water and wastewater to determine the presence, number, and identity of bacteria; more commonly called *bacterial examination*.

**bacterial examination** The examination of water and wastewater to determine the presence, number, and identity of bacteria. Also called *bacterial analysis*. See also *bacteriological count*.

**bacteriological count** A means for quantifying numbers of organisms. See also *most probable number*.

**baffles** Deflector vanes, guides, grids, gratings, or similar devices constructed or placed in flowing water, wastewater, or slurry systems as a check or to produce a more uniform distribution of velocities; absorb energy; divert, guide, or agitate the liquids; and check eddies.

**barminutor** A bar screen of standard design fitted with an electrically operated shredding device that sweeps vertically up and down the screen cutting up material retained on the screen.

**bar screen** A screen composed of parallel bars, either vertical or inclined, placed in a waterway to catch debris. The screenings are raked from it either manually or automatically. Also called *bar rack*, *rack*.

**base** A compound that dissociates in aqueous solution to yield hydroxyl ions.

**basic data** Records of observations and measurements of physical facts, occurrences, and conditions, as they have occurred, excluding any material or information developed by means of computation or estimate. In the strictest sense, basic data include only the recorded notes of observations and measurements, although in general use it

is taken to include computations or estimates necessary to present a clear statement of facts, occurrences, and conditions.

***Beggiatoa*** A filamentous organism whose growth is stimulated by H<sub>2</sub>S.

***belt screen*** A continuous band or belt of wire mesh, bars, plates, or other screening medium that passes around upper and lower rollers and from which the material caught on the screen is usually removed by gravity, brushes, or other means.

***bicarbonate alkalinity*** Alkalinity caused by bicarbonate ions.

***bioassay*** (1) An assay method using a change in biological activity as a qualitative or quantitative means of analyzing a material's response to biological treatment. (2) A method of determining the toxic effects of industrial wastes and other wastewaters by using viable organisms; exposure of fish to various levels of a chemical under controlled conditions to determine safe and toxic levels of that chemical.

***biochemical*** (1) Pertaining to chemical change resulting from biological action. (2) A chemical compound resulting from fermentation. (3) Pertaining to the chemistry of plant and animal life.

***biochemical oxidation*** Oxidation brought about by biological activity resulting in the chemical combination of oxygen with organic matter. See *oxidized wastewater*.

***biochemical oxygen demand (BOD)*** A measure of the quantity of oxygen used in the biochemical oxidation of organic matter in a specified time, at a specific temperature, and under specified conditions.

***biochemical oxygen demand (BOD) load*** The BOD content (usually expressed in mass per unit of time) of wastewater passing into a waste treatment system or to a body of water.

***biodegradation*** The destruction of organic materials by microorganisms, soils, natural bodies of water, or wastewater treatment systems.

***biofilm*** Accumulation of microbial growth on the surface of a support material.

***biological contactors*** Inert surfaces engineered to provide a high specific surface area on which a biofilm can develop; usually designed so that the surface is cyclically moved through the medium to be biologically oxidized and through the open air so that oxygen transfer occurs.

***biological denitrification*** The transformation of nitrate nitrogen to inert nitrogen gas by microorganisms in an anoxic environment in the presence of an electron donor to drive the reaction.

***biological filter*** A bed of sand, gravel, broken stone, or other medium through which wastewater flows or trickles. It depends on biological action for its effectiveness.

**biological filtration** The process of passing a liquid through a biological filter containing fixed media on the surfaces of which develop zoogeal films that absorb and adsorb fine suspended, colloidal, and dissolved solids and release end products of biochemical action.

**biological oxidation** The process by which living organisms in the presence of oxygen convert organic matter into a more stable or mineral form.

**biological process** (1) The process by which metabolic activities of bacteria and other microorganisms break down complex organic materials into simple, more stable substances. Self-purification of polluted streams, sludge digestion, and all the so-called secondary wastewater treatments depend on this process. (2) Process involving living organisms and their life activities. Also called *biochemical process*.

**biomass** The mass of biological material contained in a system.

**biosolids** The organic product of municipal wastewater treatment that can be beneficially used.

**bleed** (1) To drain a liquid or gas, as to vent accumulated air from a water line or to drain a trap or a container of accumulated water. (2) The exuding, percolation, or seeping of a liquid through a surface.

**blinding** (1) Clogging of the filter cloth of a vacuum filter, belt press, belt thickener, or pressure filter. (2) Obstruction of the fine media of a sand filter.

**blowdown** (1) The removal of a portion of any process flow to maintain the constituents of the flow within desired levels. The process may be intermittent or continuous. (2) The water discharged from a boiler or cooling tower to dispose of accumulated dissolved solids.

**bottom contraction** The reduction in the area of overflowing water caused by the crest of a weir contracting the nappe.

**bottom ventilation** Movement of air through the medium of a wastewater filter facilitated by vent stacks or provisions for the entrance or exit of air at the base of the filter.

**bound water** (1) Water held strongly on the surface or in the interior of colloidal particles. (2) Water associated with the hydration of crystalline compounds.

**branch circuit** That portion of the wiring system between the final overcurrent device that protects the circuit and the outlet.

**breakpoint chlorination** Addition of chlorine to water or wastewater until the chlorine demand has been satisfied, with further additions resulting in a residual that is directly proportional to the amount added beyond the breakpoint.

**brush aerator** A surface aerator that rotates about a horizontal shaft with metal blades attached to it; commonly used in oxidation ditches.

**buffer** A substance that resists a change in pH.

**bulking** Inability of activated-sludge solids to separate from the liquid under quiescent conditions; may be associated with the growth of filamentous organisms, low DO, or high sludge loading rates. Bulking sludge typically has an SVI > 150 mL/g.

**bus** An electrical conductor that serves as a common connection for two or more electrical circuits. A bus may be in the form of rigid bars, either circular or rectangular in cross section, or in the form of stranded conductor cables held under tension.

**butterfly valve** A valve in which the disk, as it opens or closes, rotates about a spindle supported by the frame of the valve. The valve is opened at a stem. At full opening, the disk is in a position parallel to the axis of the conduit.

**bypass** An arrangement of pipes, conduits, gates, and valves by which the flow may be passed around a hydraulic structure appurtenance or treatment process; a controlled diversion.

**cake** Wastewater solids that have been sufficiently dewatered to form a semisolid mass.

**calcium hypochlorite**  $[\text{Ca}(\text{OCl})_2 \cdot 4\text{H}_2\text{O}]$  A solid that, when mixed with water, liberates the hypochlorite ion  $\text{OCl}^-$  and can be used for disinfection.

**calibration** (1) The determination, checking, or rectifying of the graduation of any instrument giving quantitative measurements. (2) The process of taking measurements or of making observations to establish the relationship between two quantities.

**calorie** The amount of heat necessary to raise the temperature of 1 g of water at 15 °C by 1 °C.

**capacitor (condenser)** A device to provide capacitance, which is the property of a system of conductors and dielectrics that permit the storage of electrically separated charges when potential differences exist between the conductors. A dielectric is an insulator.

**capacity** (1) The quantity that can be contained exactly, or the rate of flow that can be carried out exactly. (2) The load for which an electrical apparatus is rated either by the user or manufacturer.

**carbon (C)** (1) A chemical element essential for growth. (2) A solid material used for adsorption of pollutants.

**carbonaceous biochemical oxygen demand (CBOD)** A quantitative measure of the amount of dissolved oxygen required for the biological oxidation of carbon-containing compounds in a sample. See *BOD*.

**carbon adsorption** The use of either granular or powdered carbon to remove organic compounds from wastewater or effluents. Organic molecules in solution are drawn to the highly porous surface of the carbon by intermolecular attraction forces.

**carbonate hardness** Hardness caused by the presence of carbonates and bicarbonates of calcium and magnesium in water. Such hardness may be removed to the limit of solubility by boiling the water. When the hardness is numerically greater than the sum of the carbonate alkalinity and bicarbonate alkalinity, the amount of hardness is equivalent to the total alkalinity and is called *carbonate hardness*. It is expressed in milligrams of equivalent calcium carbonate per liter (mg/L CaCO<sub>3</sub>). See also *hardness*.

**carbonation** The diffusion of carbon dioxide gas through a liquid to render the liquid stable with respect to precipitation or dissolution of alkaline constituents. See also *recarbonation*.

**carcinogen** A material that induces excessive or abnormal cellular growth in an organism.

**carrying capacity** The maximum rate of flow that a conduit, channel, or other hydraulic structure is capable of passing.

**cascade aerator** An aerating device built in the form of steps or an inclined plane on which are placed staggered projections arranged to break up the water and bring it into contact with air.

**cathodic protection** An electrical system for prevention of rust, corrosion, and pitting of steel and iron surfaces in contact with water. A low-voltage current is made to flow through a liquid or a soil in contact with the metal in such a manner that the external electromotive force renders the metal structure cathodic and concentrates corrosion on auxiliary anodic parts used for that purpose.

**cation** A positively charged ion attracted to the cathode under the influence of electrical potential.

**cationic flocculant** A polyelectrolyte with a net positive electrical charge.

**caustic alkalinity** The alkalinity caused by hydroxyl ions. See also *alkalinity*.

**cavitation** (1) The action, resulting from forcing a flow stream to change direction, in which reduced internal pressure causes dissolved gases to expand, creating negative pressure. Cavitation frequently causes pitting of the hydraulic structure affected. (2) The formation of a cavity between the downstream surface of a moving body (e.g., the blade of a propeller) and a liquid normally in contact with it. (3) Describing the action of an operating centrifugal pump when it is attempting to discharge more water than suction can provide.

**Celsius** The international name for the centigrade scale of temperature, on which the freezing point and boiling point of water are 0 °C and 100 °C, respectively, at a barometric pressure of  $1.013 \times 10^5$  Pa (760-mm Hg).

**centigrade** A thermometer temperature scale in which 0° marks the freezing point and 100° the boiling point of water at 760-mm Hg barometric pressure. Also called *Celsius*. To convert temperature on this scale to Fahrenheit, multiply by 1.8 and add 32.

**centrate** Liquid removed by a centrifuge; typically contains high concentrations of suspended, nonsettling solids.

**centrifugal pump** A pump consisting of an impeller fixed on a rotating shaft and enclosed in a casing having an inlet and a discharge connection. The rotating impeller creates pressure in the liquid by the velocity derived from centrifugal force.

**centrifugal screw pump** A centrifugal pump having a screw-type impeller; may be of axial flow or combined axial and radial flow.

**centrifugation** Imposition of a centrifugal force to separate solids from liquids based on density differences. In sludge dewatering, the separated solids commonly are called *cake* and the liquid is called *centrate*.

**centrifuge** A mechanical device in which centrifugal force is used to separate solids from liquids or to separate liquids of different densities.

**certification** A program to substantiate the capabilities of personnel by documentation of experience and learning in a defined area of endeavor.

**cfs (cu ft/sec)** The rate of flow of a material in cubic feet per second; used for measurement of water, wastewater, or gas; equals  $2.832 \times 10^{-2}$  m<sup>3</sup>/s.

**chain bucket** A continuous chain equipped with buckets and mounted on a scow. Also called a *ladder dredge*.

**chamber** Any space enclosed by walls or a compartment; often prefixed by a descriptive word indicating its function, such as *grit chamber*, *screen chamber*, *discharge chamber*, or *flushing chamber*.

**change of state** The process by which a substance passes from one to another of the solid, the liquid, and the gaseous states, and in which marked changes in its physical properties and molecular structure occur.

**channel** (1) A perceptible natural or artificial waterway that periodically or continuously contains moving water or forms a connecting link between two bodies of water. It has a definite bed and banks that confine the water. (2) The deep portion of a river or waterway where the main current flows. (3) The part of a body of water deep enough to be used for navigation through an area otherwise too shallow for naviga-

tion. (4) Informally, a more or less linear conduit of substantial size in cavernous limestones or lava rocks. See also *open channel*.

***channel roughness*** That roughness of a channel including the extra roughness owing to local expansion or contraction and obstacles, as well as the roughness of the stream bed proper; that is, friction offered to the flow by the surface of the bed of the channel in contact with the water. It is expressed as the roughness coefficient in velocity formulas.

***check valve*** A valve with a disk hinged on one edge so that it opens in the direction of normal flow and closes with reverse flow. An approved check valve is of substantial construction and suitable materials, is positive in closing, and permits no leakage in a direction opposite to normal flow.

***chemical*** Commonly, any substance used in or produced by a chemical process. Certain chemicals may be added to water or wastewater to improve treatment efficiency; others are pollutants that require removal.

***chemical analysis*** Analysis by chemical methods to show the composition and concentration of substances.

***chemical coagulation*** The destabilization and initial aggregation of colloidal and finely divided suspended matter by the addition of an inorganic coagulant. See also *flocculation*.

***chemical conditioning*** Mixing chemicals with a sludge prior to dewatering to improve the solids separation characteristics. Typical conditioners include polyelectrolytes, iron salts, and lime.

***chemical dose*** A specific quantity of chemical applied to a specific quantity of fluid for a specific purpose.

***chemical equilibrium*** The condition that exists when there is no net transfer of mass or energy between the components of a system. This is the condition in a reversible chemical reaction when the rate of the forward reaction equals the rate of the reverse reaction.

***chemical equivalent*** The weight (in grams) of a substance that combines with or displaces 1 g of hydrogen. It is found by dividing the formula weight by its valence.

***chemical feeder*** A device for dispensing a chemical at a predetermined rate for the treatment of water or wastewater. The change in rate of feed may be effected manually or automatically by flowrate changes. Feeders are designed for solids, liquids, or gases.

***chemical gas feeder*** A feeder for dispensing a chemical in the gaseous state. The rate is usually graduated in gravimetric terms. Such devices may have proprietary names.

***chemical oxidation*** The oxidation of compounds in wastewater or water by chemical means. Typical oxidants include ozone, chlorine, and potassium permanganate.

**Operation of Municipal Wastewater Treatment Plants**

**chemical oxygen demand (COD)** A quantitative measure of the amount of oxygen required for the chemical oxidation of carbonaceous (organic) material in wastewater using inorganic dichromate or permanganate salts as oxidants in a 2-hour test.

**chemical precipitation** (1) Formation of particulates by the addition of chemicals. (2) The process of softening water by the addition of lime or lime and soda to form insoluble compounds; usually followed by sedimentation or filtration to remove the newly created suspended solids.

**chemical reaction** A transformation of one or more chemical species into other species resulting in the evolution of heat or gas, color formation, or precipitation. It may be initiated by a physical process such as heating, by the addition of a chemical reagent, or it may occur spontaneously.

**chemical reagent** A chemical added to a system to induce a chemical reaction.

**chemical sludge** Sludge obtained by treatment of water or wastewater with inorganic coagulants.

**chemical solution tank** A tank in which chemicals are added in solution before they are used in a water or wastewater treatment process.

**chemical tank** A tank in which chemicals are stored before they are used in a water or wastewater treatment process.

**chemical treatment** Any treatment process involving the addition of chemicals to obtain a desired result such as precipitation, coagulation, flocculation, sludge conditioning, disinfection, or odor control.

**chloramines** Compounds of organic or inorganic nitrogen formed during the addition of chlorine to wastewater. See *breakpoint chlorination*.

**chlorination** The application of chlorine or chlorine compounds to water or wastewater, generally for the purpose of disinfection, but frequently for chemical oxidation and odor control.

**chlorinator** Any metering device used to add chlorine to water or wastewater.

**chlorine (Cl<sub>2</sub>)** An element ordinarily existing as a greenish-yellow gas about 2.5 times heavier than air. At atmospheric pressure and a temperature of  $-30.1^{\circ}\text{F}$  ( $-48^{\circ}\text{C}$ ), the gas becomes an amber liquid about 1.5 times heavier than water. Its atomic weight is 35.457, and its molecular weight is 70.914.

**chlorine contact chamber** A detention basin provided to diffuse chlorine through water or wastewater and to provide adequate contact time for disinfection. Also called a *chlorination chamber* or *chlorination basin*.

**chlorine demand** The difference between the amount of chlorine added to a wastewater and the amount of chlorine remaining after a given contact time. Chlorine

dosage is a function of the substances present in the water, temperature, and contact time.

**chlorine dose** The amount of chlorine applied to a wastewater, usually expressed in milligrams per liter (mg/L) or pounds per million gallons (lb/mil. gal).

**chlorine ice** A yellowish ice formed in a chlorinator when chlorine gas comes in contact with water at 49 °F (9 °C) or lower. Chlorine ice is frequently detrimental to the performance of a chlorinator if it is formed in quantities sufficient to interfere with the safe operation of float controls or to cause plugging of openings essential to flow indication, control, or rate of application.

**chlorine residual** The amount of chlorine in all forms remaining in water after treatment to ensure disinfection for a period of time.

**chlorine room** A separate room or building for housing chlorine and chlorination equipment, with arrangements for protecting personnel and plant equipment.

**chlorine toxicity** The detrimental effects on biota caused by the inherent properties of chlorine.

**chromatography** The generic name of a group of separation processes that depend on the redistribution of the molecules of a mixture between a gas or liquid phase in contact with one or more bulk phases. The types of chromatography are adsorption, column, gas, gel, liquid, thin-layer, and paper.

**ciliated protozoa** Protozoans with cilia (hair-like appendages) that assist in movement; common in trickling filters and healthy activated sludge. Free-swimming ciliates are present in the bulk liquid, stalked ciliates are commonly attached to solids matter in the liquid.

**circuit** A conductor or a system of conductors through which an electrical current flows or is intended to flow.

**circuit breaker** A device designed to open or close a circuit by nonautomatic means and open the circuit automatically on a predetermined overload of current without injury to itself.

**clarification** Any process or combination of processes whose primary purpose is to reduce the concentration of suspended matter in a liquid; formerly used as a synonym for *settling* or *sedimentation*. In recent years, the latter terms are preferable when describing settling processes.

**clarifier** Any large circular or rectangular sedimentation tank used to remove settleable solids in water or wastewater. A special type of clarifier, called an *upflow clarifier*, uses flotation rather than sedimentation to remove solids.

**clear-water basin** A reservoir for the storage of filtered water of sufficient capacity to prevent the necessity of frequent variations in the rate of filtration with variations in demands. Also called *filtered-water reservoir*, *clear-water reservoir*, *clear well*.

**closed centrifugal pump** A centrifugal pump having its impeller built with the vanes enclosed within circular disks.

**closed conduit** Any closed artificial or natural duct for conveying fluids.

**closed impeller** An impeller having the side walls extended from the outer circumference of the suction opening to the vane tips.

**coagulant** A simple electrolyte, usually an inorganic salt containing a multivalent cation of iron, aluminum, or calcium [for example,  $\text{FeCl}_3$ ,  $\text{FeCl}_2$ ,  $\text{Al}_2(\text{SO}_4)_3$ , and  $\text{CaO}$ ]. Also, an inorganic acid or base that induces coagulation of suspended solids. See also *flocculant*.

**coagulant or flocculant aid** An insoluble particulate used to enhance solid-liquid separation by providing nucleating sites or acting as a weighting agent or sorbent; also used colloquially to describe the action of flocculents in water treatment.

**coagulation** The conversion of colloidal (<0.001 mm) or dispersed (0.001 to 0.1 mm) particles into small visible coagulated particles (0.1 to 1 mm) by the addition of a coagulant, compressing the electrical double layer surrounding each suspended particle, decreasing the magnitude of repulsive electrostatic interactions between particles, and thereby destabilizing the particle. See also *flocculation*.

**coagulation basin** A basin used for the coagulation of suspended or colloidal matter, with or without the addition of a coagulant, in which the liquid is mixed gently to induce agglomeration with a consequent increase in the settling velocity of particulates.

**coating** A material applied to the inside or outside of a pipe, valve, or other fixture to protect it primarily against corrosion. Coatings may be of various materials.

**Cocci** Sphere-shaped bacteria.

**codisposal** Joint disposal of wastewater sludge and municipal refuse in one process or facility. Disposal can be intermediate, as with incineration or composting, or final, as with placement in a sanitary landfill.

**coefficient** A numerical quantity, determined by experimental or analytical methods, interposed in a formula that expresses the relationship between two or more variables to include the effect of special conditions or to correct a theoretical relationship to one found by experiment or actual practice.

**coefficient of viscosity** A numerical factor that is a measure of the internal resistance of a fluid to flow; the greater the resistance to flow, the larger the coefficient. It is equal to the shearing force in dynes per square centimeter ( $\text{dyne}/\text{cm}^2$ ) transmitted from one

fluid plane to another parallel plane 1 cm distant, and is generated by a difference in fluid velocities in the two planes of 1 cm/s in the direction of the force. The coefficient varies with temperature. Also called *absolute viscosity*. The unit of measure is the poise, a force of 1 dyne/cm<sup>2</sup>.

**cohesion** The force of molecular attraction between the particles of any substance that tends to hold them together.

**coil** A set of windings with or without an iron core, shaped to produce a magnetic force when current flows through the windings. This force is used in relays and other electrical equipment to pull contacts together or to separate them.

**coliform-group bacteria** A group of bacteria predominantly inhabiting the intestines of man or animal, but also occasionally found elsewhere. It includes all aerobic and facultative anaerobic, Gram-negative, non-spore-forming, rod-shaped bacteria that ferment lactose with the production of gas. Also included are all bacteria that produce a dark, purplish-green metallic sheen by the membrane filter technique used for coliform identification. The two groups are not always identified, but they are generally of equal sanitary significance.

**collection system** In wastewater, a system of conduits, generally underground pipes, that receives and conveys sanitary wastewater or stormwater; in water supply, a system of conduits or canals used to capture a water supply and convey it to a common point.

**colloids** Finely divided solids (less than 0.002 mm and greater than 0.000 001 mm) that will not settle but may be removed by coagulation, biochemical action, or membrane filtration; they are intermediate between true solutions and suspensions.

**colony** A discrete clump of microorganisms on a surface as opposed to dispersed growth throughout a liquid culture medium.

**color** Any dissolved solids that impart a visible hue to water.

**colorimeter** An instrument that quantitatively measures the amount of light of a specific wavelength absorbed by a solution.

**combined available chlorine** The concentration of chlorine that is combined with ammonia as chloramine or as other chloro derivatives, yet is still available to oxidize organic matter.

**combined available residual chlorine** That portion of the total residual chlorine remaining in water or wastewater at the end of a specified contact period that will react chemically and biologically as chloramines.

**combined residual chlorination** The application of chlorine to water or wastewater to produce, with natural or added ammonia or with certain organic nitrogen compounds, a combined chlorine residual.

**combined sewer** A sewer intended to receive both wastewater and storm or surface water.

**combustible-gas indicator** An explosimeter; a device for measuring the concentration of potentially explosive fumes. The measurement is based on the catalytic oxidation of a combustible gas on a heated platinum filament that is part of a Whetstone bridge.

**commercially dry sludge** Sludge containing not more than 10% moisture by weight; the limit is 5% in the fertilizer trade.

**comminution** An in-stream process of cutting and screening solids contained in wastewater flow.

**comminutor** A shredding or grinding device that reduces the size of gross suspended materials in wastewater without removing them from the liquid.

**complete mix** Activated sludge process whereby wastewater is rapidly and evenly distributed throughout the aeration tank.

**composite sample** A combination of individual samples of water or wastewater taken at preselected intervals to minimize the effect of the variability of the individual sample. Individual samples may be of equal volume or may be proportional to the flow at the time of sampling.

**compost** The product of the thermophilic biological oxidation of sludge or other materials.

**concentration** (1) The amount of a given substance dissolved in a discrete unit volume of solution or applied to a unit weight of solid. (2) The process of increasing the dissolved solids per unit volume of solution, usually by evaporation of the liquid. (3) The process of increasing the suspended solids per unit volume of sludge as by sedimentation or dewatering.

**concentrator** A solids contact unit used to decrease the water content of sludge or slurry.

**condensate** Condensed steam from any heat exchanger.

**condensation** The process by which a substance changes from the vapor state to the liquid or solid state. Water that falls as precipitation from the atmosphere has condensed from the vapor state to rain or snow. Dew and frost are also forms of condensation.

**condenser** Any device for reducing gases or vapors to liquid or solid form.

**conditioning** The chemical, physical, or biological treatment of sludges to improve their dewaterability.

**conductor** A material that offers very little resistance to the flow of current and is, therefore, used to carry current or conduct electricity.

**conduit (duct) bank** A length of one or more conduits or ducts (which may be enclosed in concrete) that is designed to contain cables.

**contacts** Any set of points that may be joined manually or automatically to complete a circuit. Contacts are found in breakers, switches, relays, and starters.

**contact stabilization** Modification of the activated-sludge process involving a short period of contact between wastewater and sludge for rapid removal of soluble BOD by adsorption, followed by a longer period of aeration in a separate tank where sludge is oxidized and new sludge synthesized.

**contact tank** A tank used in water or wastewater treatment to promote contact between treatment chemicals or other materials and the liquid treated.

**contact time** The time that the material processed is exposed to another substance (such as activated sludge or activated carbon) for completion of the desired reaction. See also *detention time*.

**contamination** The introduction into water of microorganisms, chemicals, wastes, or wastewater in a concentration that makes the water unfit for its intended use.

**continuous-flow pump** A displacement pump within which the direction of flow of the water is not changed or reversed.

**continuous-flow tank** A tank through which liquid flows continuously at its normal rate of flow, as distinguished from a fill-and-draw or batch system.

**continuous load** A load where the maximum current is expected to continue for 3 hours or more.

**contracted weir** A rectangular notched weir with a crest width narrower than the channel across which it is installed and with vertical sides extending above the upstream water level producing a contraction in the stream of water as it leaves the notch.

**controlled discharge** Regulation of effluent flowrates to correspond with flow variations in receiving waters to maintain established water quality.

**controller** A device or group of devices, that serve to govern, in some predetermined measure, the electrical power delivered to the apparatus to which it is connected.

**convection** (1) In physics, mass motions within a fluid resulting in the transport and mixing of the properties of that fluid, caused by the force of gravity and by differences in density resulting from nonuniform temperature. (2) In meteorology, atmospheric motions that are predominantly vertical, resulting in vertical transport and mixing of atmospheric properties; sometimes caused when large masses of air are heated by contact with a warm land surface.

**conventional aeration** Process design configuration whereby the aeration tank organic loading is higher at the influent end than at the effluent end. Flow passes through a serpentine tank system, typically side-by-side, before passing on to the secondary clarifier. Also called *plug flow*.

**conventional treatment** Well-known or well-established water or wastewater treatment processes, excluding advanced or tertiary treatment; it generally consists of primary and secondary treatment.

**conversion factor** A numerical constant by which a quantity with its value expressed in units of one kind is multiplied to express the value in units of another kind.

**cooling coil** A coil of pipe or tubing containing a stream of hot fluid that is cooled by heat transfer to a cold fluid outside. Conversely, the coil may contain a cold fluid to cool a hot fluid in which the coil is immersed.

**core sampler** A long, slender pole with a foot valve at the bottom end that allows the depth of the sludge blanket to be measured. Sometimes called a *sludge judge*.

**correlation** (1) A mutual relationship or connection. (2) The degree of relative correspondence, as between two sets of data.

**corrosion** The gradual deterioration or destruction of a substance or material by chemical action, frequently induced by electrochemical processes. The action proceeds inward from the surface.

**corrosion control** (1) In water treatment, any method that keeps the metallic ions of a conduit from going into solution, such as increasing the pH of the water, removing free oxygen from the water, or controlling the carbonate balance of the water. (2) The sequestration of metallic ions and the formation of protective films on metal surfaces by chemical treatment.

**critical depth** The depth of water flowing in an open channel or partially filled conduit corresponding to one of the recognized critical velocities.

**critical flow** (1) A condition of flow in which the mean velocity is at one of the critical values, ordinarily at Belanger's critical depth and velocity; also used in reference to Reynolds' critical velocities, which define the point at which the flow changes from streamline or nonturbulent flows. (2) The maximum discharge of a conduit that has a free outlet and has the water ponded at the inlet.

**cross connection** (1) A physical connection through which a supply of potable water could be contaminated or polluted. (2) A connection between a supervised potable water supply and an unsupervised supply of unknown potability.

**culture** Any organic growth that has been developed intentionally by providing suitable nutrients and environment.

***culture media*** Substances used to support the growth of microorganisms in analytical procedures.

***cyclone separator*** A conical unit used for separating particles by centrifugal force.

***data*** Records of observations and measurements of physical facts, occurrences, and conditions reduced to written, graphical, or tabular form.

***debris*** Generally, solid wastes from natural and man-made sources deposited indiscriminately on land and water.

***decantation*** Separation of a liquid from solids or from a liquid of higher density by drawing off the upper layer after the heavier material has settled.

***dechlorination*** The partial or complete reduction of residual chlorine by any chemical or physical process. Sulfur dioxide is frequently used for this purpose.

***declining growth phase*** Period of time between the log-growth phase and the endogenous phase, where the amount of food is in short supply, leading to ever-slowing bacterial growth rates.

***decomposition*** The breakdown of complex material into simpler substances by chemical or biological processes.

***decomposition of wastewater*** (1) The breakdown of organic matter in wastewater by bacterial action, either aerobic or anaerobic. (2) Chemical or biological transformation of the organic or inorganic materials contained in wastewater.

***defoamer*** A material having low compatibility with foam and a low surface tension. Defoamers are used to control, prevent, or destroy various types of foam, the most widely used being silicone defoamers. A droplet of silicone defoamer contacting a bubble of foam will cause the bubble to undergo a local and drastic reduction in film strength, thereby breaking the film. Unchanged, the defoamer continues to contact other bubbles, thus breaking up the foam. A valuable property of most defoamers is their effectiveness in extremely low concentration. In addition to silicones, defoamers for special purposes are based on polyamides, vegetable oils, and stearic acid.

***degasification*** (1) The removal of a gas from a liquid medium. (2) In water treatment, the removal of oxygen from water to inhibit corrosion. It may be accomplished by mechanical methods, chemical methods, or a combination of both.

***degreasing*** (1) The process of removing greases and oils from waste, wastewater, sludge, or solids. (2) The industrial process of removing grease and oils from machine parts or iron products.

***degree*** (1) On the centigrade or Celsius thermometer scale, 1/100 of the interval from the freezing point to the boiling point of water under standard conditions; on the

**Operation of Municipal Wastewater Treatment Plants**

Fahrenheit scale, 1/180 of this interval. (2) A unit of angular measure; the central angle subtended by 1/360 of the circumference of a circle.

**demand** The rate at which electrical energy is delivered to a piece of power-consuming equipment or system.

**demand average** The demand on an electrical system or any of its parts over an interval of time, as determined by dividing the total number of watt-hours by the number of hours (units of time) in the interval.

**demand coincident** The sum of two or more demands that occurs in the same demand interval.

**demand factor** The ratio of the maximum demand of the system or part of a system to the total connected load of the system or part of the system under consideration.

**demand instantaneous peak** The maximum demand at the instant of greatest load.

**demand interval** The period of time that electrical energy flows is averaged to determine demand, such as 60 minutes, 15 minutes, or instantaneous.

**demand maximum** The greatest of all demands of the load under consideration that occurs during a specified period of time.

**demand noncoincident** The sum of two or more individual demands that do not occur in the same demand interval, which is meaningful only when considering demands within a limited period of time, such as a day, week, month, and a heating or cooling season.

**denitrification** The anaerobic biological reduction of nitrate nitrogen to nitrogen gas; also, removal of total nitrogen from a system. See also *nitrification*.

**density current** A flow of water through a large body of water that retains its unmixed identity because of a difference in density.

**deoxygenation** The depletion of the dissolved oxygen in a liquid either under natural conditions associated with the biochemical oxidation of the organic matter present or by addition of chemical reducing agents.

**deoxygenation constant** A constant that expresses the rate of the biochemical oxidation of organic matter under aerobic conditions. Its value depends on the time unit involved (usually 1 day) and varies with temperature and other test conditions.

**departure** The difference between any single observation and the normal.

**deposition** The act or process of settling solid material from a fluid suspension.

**depth of blanket** Level of sludge in the bottom of a secondary clarifier, typically measured in feet.

**design criteria** (1) Engineering guidelines specifying construction details and materials. (2) Objectives, results, or limits that must be met by a facility, structure, or process in performance of its intended functions.

**design flow** Engineering guidelines that typically specify the amount of influent flow that can be expected on a daily basis over the course of a year. Other design flows can be set for monthly or peak flows.

**design loadings** Flowrates and constituent concentrations that determine the design of a process unit or facility necessary for proper operation.

**design voltage** The nominal voltage for which a line or piece of equipment is designed. This is a reference level of voltage for identification and not necessarily the precise level at which it operates.

**detention time** The period of time that a water or wastewater flow is retained in a basin, tank, or reservoir for storage or completion of physical, chemical, or biological reaction. See also *contact time*, *retention time*.

**detergent** (1) Any of a group of synthetic, organic, liquid, or water-soluble cleaning agents that are inactivated by hard water and have wetting and emulsifying properties but, unlike soap, are not prepared from fats and oils. (2) A substance that reduces the surface tension of water.

**detoxification** Treatment to modify or remove a toxic material.

**dewater** (1) To extract a portion of the water present in a sludge or slurry. (2) To drain or remove water from an enclosure. A river bed may be dewatered so that a dam can be built; a structure may be dewatered so that it can be inspected or repaired.

**dewatered sludge** The solid residue remaining after removal of water from a wet sludge by draining or filtering. Dewatering is distinguished from thickening in that dewatered sludge may be transported by solids handling procedures.

**dewatering** The process of partially removing water; may refer to removal of water from a basin, tank, reservoir, or other storage unit, or the separation of water from solid material.

**dewpoint** The temperature to which air with a given concentration of water vapor must be cooled to cause condensation of the vapor.

**dialysis** The selective separation of dissolved or colloidal solids on the basis of molecular size by diffusion through a semipermeable membrane. See also *reverse osmosis*.

**differential plunger pump** A reciprocating pump with a plunger so designed that it draws the liquid into the cylinder on the upward stroke but is double-acting on the discharge stroke.

**Operation of Municipal Wastewater Treatment Plants**

***diffused aeration*** Injection of air under pressure through submerged porous plates, perforated pipes, or other devices to form small air bubbles from which oxygen is transferred to the liquid as the bubbles rise to the water surface.

***diffused air*** Small air bubbles formed below the surface of a liquid to transfer oxygen to the liquid.

***diffuser*** A porous plate, tube, or other device through which air is forced and divided into minute bubbles for diffusion in liquids. In the activated sludge process, it is a device for dissolving air into mixed liquor. It is also used to mix chemicals such as chlorine through perforated holes.

***diffusion*** (1) The transfer of mass from one fluid phase to another across an interface, for example liquid to solid or gas to liquid. (2) The spatial equalization of one material throughout another.

***diffusion aerator*** An aerator that blows air under low pressure through submerged porous plates, perforated pipes, or other devices so that small air bubbles rise continuously through the water or wastewater.

***digested solids*** Solids digested under either aerobic or anaerobic conditions until the volatile content has been reduced to the point at which the solids are relatively nonputrescible and inoffensive.

***digester*** A tank or other vessel for the storage and anaerobic or aerobic decomposition of organic matter present in the sludge. See also *anaerobic digestion*.

***digester coils*** A system of hot water or steam pipes installed in a digestion tank to heat the digester contents.

***digestion*** (1) The biological decomposition of the organic matter in sludge, resulting in partial liquefaction, mineralization, and volume reduction. (2) The process carried out in a digester.

***discharge*** The flow or rate of flow from a canal, conduit, pump, stack, tank, or treatment process. See also *effluent*.

***discharge area*** The cross-sectional area of a waterway. Used to compute the discharge of a stream, pipe, conduit, or other carrying system.

***discharge capacity*** The maximum rate of flow that a conduit, channel, or other hydraulic structure is capable of passing.

***discharge head*** A measure of the pressure exerted by a fluid at the point of discharge, usually from a pump.

***discharge rate*** (1) The determination of the quantity of water flowing per unit of time in a stream channel, conduit, or orifice at a given point by means of a current meter,

rod float, weir, pitot tube, or other measuring device or method. The operation includes not only the measurement of velocity of water and the cross-sectional area of the stream of water, but also the necessary subsequent computations. (2) The numerical results of a measurement of discharge, expressed in appropriate units.

***disconnecting means*** A device, group of devices, or other means whereby the conductors of a circuit can be disconnected from the source of power.

***discrete sedimentation*** Sedimentation in which removal of suspended solids is a function of terminal settling velocity.

***disinfectant*** A substance used for disinfection and in which disinfection has been accomplished.

***disinfected wastewater*** Wastewater to which a disinfecting agent has been added.

***disinfection*** (1) The killing of waterborne fecal and pathogenic bacteria and viruses in potable water supplies or wastewater effluents with a disinfectant; an operational term that must be defined within limits, such as achieving an effluent with no more than 200 colonies fecal coliform/100 mL. (2) The killing of the larger portion of microorganisms, excluding bacterial spores, in or on a substance with the probability that all pathogenic forms are killed, inactivated, or otherwise rendered nonvirulent.

***dispersion*** (1) Scattering and mixing. (2) The mixing of polluted fluids with a large volume of water in a stream or other body of water. (3) The repelling action of an electric potential on fine particles in suspension in water, as in a stream carrying clay. This dispersion usually is ended by contact with ocean water causing flocculation and precipitation of the clay, a common cause of shoaling in harbors. (4) In a continuous-flow treatment unit, the phenomenon of short-circuiting.

***displacement pump*** A type of pump in which the water is induced to flow from the source of supply through an inlet pipe and valve and into the pump chamber by a vacuum created therein by the withdrawal of a piston or piston-like device which, on its return, displaces a certain volume of the water contained in the chamber and forces it to flow through the discharge valves and discharge pipes.

***disposal*** Release to the environment. See also *ultimate disposal*.

***dissolved air flotation (DAF)*** A separation process in which air bubbles emerging from a supersaturated solution become attached to suspended solids in the liquid undergoing treatment and float them up to the surface. See also *diffused air*.

***dissolved oxygen (DO)*** The oxygen dissolved in liquid, usually expressed in milligrams per liter (mg/L) or percent saturation.

***dissolved solids*** Solids in solution that cannot be removed by filtration; for example, NaCl and other salts that must be removed by evaporation. See also *total dissolved solids*.

**distributor** A device used to apply liquid to the surface of a filter or contact bed. Distributors are of two general types: fixed and movable. The fixed type consists of perforated pipes, notched troughs, sloping boards, or sprinkler nozzles. The movable type consists of rotating, reciprocating, or traveling perforated pipes or troughs applying a spray or a thin sheet of liquid.

**diurnal** (1) Occurring during a 24-hour period; diurnal variation. (2) Occurring during the day (as opposed to night). (3) In tidal hydraulics, having a period or cycle of approximately 1 tidal day.

**diversity** The characteristic or variety of electrical loads whereby individual maximum demands usually occur at different times. Diversity among equipment loads results in diversity among the loads of transformers, feeders, and substations.

**diversity factor** The ratio of the sum of the coincident demands of two or more loads to their maximum demands for the same period.

**domestic wastewater** Wastewater derived principally from dwellings, business buildings, institutions, and the like. It may or may not contain groundwater, surface water, or stormwater.

**dosing tank** Any tank used in applying a dose; specifically used for intermittent application of wastewater to subsequent processes.

**double-suction impeller** An impeller with two suction inlets, one on each side of the impeller.

**double-suction pump** A centrifugal pump with suction pipes connected to the casing from both sides.

**DPD method** An analytical method for determining chlorine residual using the reagent DPD (n-diethyl-p-phenylenediamine). This is the most commonly and officially recognized test for free chlorine residual.

**drag** The resistance offered by a liquid to the settlement or deposition of a suspended particle.

**drag coefficient** A measure of the resistance to sedimentation or flotation of a suspended particle as influenced by its size, shape, density, and terminal velocity. It is the ratio of the force per unit area to the stagnation pressure and is dimensionless. See also *friction factor*.

**drain** (1) A conduit or channel constructed to carry off, by gravity, liquids other than wastewater, including surplus underground, storm, or surface water. It may be an open ditch, lined or unlined, or a buried pipe. (2) In plumbing, any pipe that carries water or wastewater in a building drainage system.

**drawdown** (1) The magnitude of the change in surface elevation of a body of water as a result of the withdrawal of water. (2) The magnitude of the lowering of the water surface in a well, and of the water table or piezometric surface adjacent to the well, resulting from the withdrawal of water from the well by pumping. (3) In a continuous water surface with accelerating flow, the difference in elevation between downstream and upstream points.

**drum screen** A screen in the form of a cylinder or truncated cone that rotates on its axis.

**dry-bulb temperature** The temperature of air measured by a conventional thermometer.

**dry feeder** A feeder for dispensing a chemical or other fine material to water or wastewater at a rate controlled manually or automatically by the rate of flow. The constant rate may be either volumetric or gravimetric.

**drying beds** Confined, shallow layers of sand or gravel on which wet sludge is distributed for draining and air drying; also applied to underdrained, shallow, dyked, earthen structures used for drying sludge.

**dry suspended solids** The weight of the suspended matter in a sample after drying for a specified time at a specific temperature.

**dry weather flow** (1) The flow of wastewater in a combined sewer during dry weather. Such flow consists mainly of wastewater, with no stormwater included. (2) The flow of water in a stream during dry weather, usually contributed entirely by groundwater.

**dual-media filters** Deep-bed filters using discrete layers of dissimilar media, such as anthracite and sand, placed one on top of the other.

**duplex pump** A reciprocating pump consisting of two cylinders placed side by side and connected to the same suction and discharge pipe; the pistons move so that one exerts suction while the other exerts pressure resulting in continuous discharge from the pump.

**dynamic equilibrium** See *population dynamics*.

**dynamic head** (1) When there is flow, (a) the head at the top of a waterwheel; (b) the height of the hydraulic grade line above the top of a waterwheel; and (c) the head against which a pump works. (2) That head of fluid that would produce statically the pressure of a moving fluid.

**dynamic suction head** The reading of a gauge on the suction line of a pump corrected for the distance of the pump below the free surface of the body of liquid being pumped; exists only when the pump is below the free surface. When pumping proceeds at the required capacity, the vertical distance from the source of supply to the center of the pump minus velocity head and entrance and friction losses. Internal pump losses are not subtracted.

**dynamic suction lift** When pumping proceeds at the required capacity, the vertical distance from the source of supply to the center of the suction end of a pump, plus velocity head and entrance and friction losses. Internal pump losses are not added.

***E. coli*** See *Escherichia coli*.

**eductor** A device for mixing air with water; a liquid pump operating under a jet principle, using liquid under pressure as the operating medium to entrain air in the liquid. See also *ejector*.

**effective size** The diameter of the particles, spherical in shape, equal in size, and arranged in a given manner, of a hypothetical sample of granular material that would have the same transmission constant as the actual material under consideration. There are a number of methods for determining effective size, the most common being that developed by Allen Hazen, which consists of passing the granular material through sieves with varying dimensions of mesh. In this method, the effective size is determined from the dimensions of that mesh, which permits 10% of the sample to pass and will retain the remaining 90%; in other words, the effective size is that for which 10% of the grains are smaller and 90% larger.

**effervescence** The vigorous escape of small gas bubbles from a liquid, especially as a result of chemical action.

**efficiency** The relative results obtained in any operation in relation to the energy or effort required to achieve such results. It is the ratio of the total output to the total input, expressed as a percentage.

**effluent** Wastewater or other liquid, partially or completely treated or in its natural state, flowing out of a reservoir, basin, treatment plant, or industrial treatment plant, or part thereof.

**effluent quality** The physical, biological, and chemical characteristics of a wastewater or other liquid flowing out of a basin, reservoir, pipe, or treatment plant.

**ejector** A device for moving a fluid or solid by entraining it in a high-velocity stream or air or water jet.

**elbow** A pipe fitting that connects two pipes at an angle. The angle is always 90 deg unless another angle is stated. Also called an *ell*.

**electromotive force** The property of a physical device that tends to produce an electrical current in a circuit. It is the moving force that causes current to flow (see *volt*).

**elevation head** The energy possessed per unit weight of a fluid because of its elevation above some point. Also called *position head* or *potential head*.

**elutriation** A process of sludge conditioning whereby the sludge is washed with either fresh water or plant effluent to reduce the demand for conditioning chemicals

and to improve the settling or filtering characteristics of the solids. Excessive alkalinity is removed in this process.

**emission** Discharge of a liquid, solid, or gaseous material.

**emulsifying agent** An agent capable of modifying the surface tension of emulsion droplets to prevent coalescence. Examples are soap and other surface-active agents, certain proteins and gums, water-soluble cellulose derivatives, and polyhydric alcohol esters and ethers.

**emulsion** A heterogeneous liquid mixture of two or more liquids not normally dissolved in one another, but held in suspension one in the other by forceful agitation or by emulsifiers that modify the surface tension of the droplets to prevent coalescence.

**endogenous respiration** Autooxidation by organisms in biological processes.

**energy (electrical)** As commonly used in the utility industry, electrical energy means kilowatt-hours.

**Enterococci** A group of Cocci that normally inhabit the intestines of man and animals. Incorrectly used interchangeably with *fecal Streptococci*.

**entrainment** The carryover of drops of liquid during processes such as distillation. The trapping of bubbles in a liquid produced either mechanically through turbulence or chemically through a reaction.

**enzyme** A catalyst produced by living cells. All enzymes are proteins, but not all proteins are enzymes.

**epidemic** A disease that occurs simultaneously in a large fraction of the community.

**equalization** In wastewater systems, the storage and controlled release of wastewaters to treatment processes at a controlled rate determined by the capacity of the processes, or at a rate proportional to the flow in the receiving stream; used to smooth out variations in temperature and composition as well as flow.

**equalizing basin** A holding basin in which variations in flow and composition of a liquid are averaged. Such basins are used to provide a flow of reasonably uniform volume and composition to a treatment unit. Also called *balancing reservoir*.

**equilibrium** A condition of balance in which the rate of formation and the rate of consumption or degradation of various constituents are equal. See also *chemical equilibrium*.

**equilibrium constant** A value that describes the quantitative relationship between chemical species in a system at equilibrium.

**equivalent calcium carbonate** A common form of expressing hardness, the acidity, or the carbon dioxide, carbonate, bicarbonate, noncarbonate, hydroxide, or total alkalinity

of water; expressed in milligrams per liter (mg/L). It is calculated by multiplying the number of chemical equivalents of any of these constituents present in 1 L by 50, the equivalent weight of calcium carbonate. See also *chemical equivalent*.

***Escherichia coli (E. coli)*** One of the species of bacteria in the fecal coliform group. It is found in large numbers in the gastrointestinal tract and feces of warm-blooded animals and man. Its presence is considered indicative of fresh fecal contamination, and it is used as an indicator organism for the presence of less easily detected pathogenic bacteria.

***eutrophication*** Nutrient enrichment of a lake or other water body, typically characterized by increased growth of planktonic algae and rooted plants. It can be accelerated by wastewater discharges and polluted runoff.

***evaporation*** (1) The process by which water becomes a vapor. (2) The quantity of water that is evaporated; the rate is expressed in depth of water, measured as liquid water removed from a specified surface per unit of time, generally in inches or centimeters per day, month, or year. (3) The concentration of dissolved solids by driving off water through the application of heat.

***evaporation opportunity*** The ratio of the rate of evaporation from a land or water surface in contact with the atmosphere to evaporation under existing atmospheric conditions; that is, the ratio of the actual to the potential rate of evaporation. Also called *relative evaporation*.

***evaporation rate*** The quantity of water, expressed in terms of depth of liquid water, evaporated from a given water surface per unit of time. It is usually expressed in inches or millimeters per day, month, or year.

***evapotranspiration*** Water withdrawn from soil by evaporation or plant transpiration; considered synonymous with consumptive use.

***evapotranspiration potential*** Water loss that would occur if there was never a deficiency of water in the soil for use by vegetation.

***explosimeter*** A device for measuring the concentration of potentially explosive fumes. Also called a *combustible-gas indicator*.

***extended aeration*** A modification of the activated-sludge process using long aeration periods to promote aerobic digestion of the biological mass by endogenous respiration. The process includes stabilization of organic matter under aerobic conditions and disposal of the gaseous end products into the air. Effluent contains finely divided suspended matter and soluble matter.

***extended aeration process*** A modification of the activated-sludge process. See *extended aeration*.

**extraction** The process of dissolving and separating out particular constituents of a liquid by treatment with solvents specific for those constituents. Extraction may be liquid–solid or liquid–liquid.

**facultative** Having the ability to live under different conditions; for example, with or without free oxygen.

**facultative bacteria** Bacteria that can grow and metabolize in the presence, as well as in the absence, of dissolved oxygen.

**facultative lagoon** A lagoon or treatment pond with an aerobic upper section and an anaerobic bottom section so that both aerobic and anaerobic biological processes occur simultaneously.

**Fahrenheit** A temperature scale in which 32° marks the freezing point and 212° the boiling point of water at 760-mm Hg. To convert to centigrade (Celsius), subtract 32 and multiply by 0.5556.

**false filter bottom** A type of underdrainage system consisting of a porous or perforated floor suspended above the true bottom of the filter. See also *underdrain*.

**fats (wastes)** Triglyceride esters of fatty acids; erroneously used as a synonym for *grease*.

**fecal coliform** Aerobic and facultative, Gram-negative, non-spore-forming, rod-shaped bacteria capable of growth at 44.5 °C (112 °F), and associated with fecal matter of warm-blooded animals.

**fecal indicators** Fecal coliform, fecal Streptococci, and other bacterial groups originating in human or other warm-blooded animals, indicating contamination by fecal matter.

**fecal Streptococci** The subgroup of enterococci that is of particular concern in water and wastewater. See also *Enterococci*.

**feeder** A circuit conductor between the service equipment or switchboard and the branch circuit overcurrent device.

**fermentation** Changes in organic matter or organic wastes brought about by anaerobic microorganisms and leading to the formation of carbon dioxide, organic acids, or other simple products. See also *biological oxidation*.

**ferric chloride (FeCl<sub>3</sub>)** A soluble iron salt often used as a sludge conditioner to enhance precipitation or bind up sulfur compounds in wastewater treatment. See also *coagulant*.

**ferric sulfate [Fe<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>]** A water-soluble iron salt formed by reaction of ferric hydroxide and sulfuric acid or by reaction of iron and hot concentrated sulfuric acid; also obtainable in solution by reaction of chlorine and ferrous sulfate; used in conjunction with lime as a sludge conditioner to enhance precipitation.

**ferrous chloride ( $FeCl_2$ )** A soluble iron salt used as a sludge conditioner to enhance precipitation or bind up sulfur. See also *coagulant*.

**ferrous sulfate ( $FeSO_4 \cdot 7H_2O$ )** A water-soluble iron salt, sometimes called *copperas*; used in conjunction with lime as a sludge conditioner to enhance precipitation.

**field groundwater velocity** The actual or field velocity of groundwater percolating through water-bearing material. It is measured by the volume of groundwater passing through a unit cross-sectional area in unit time divided by the effective porosity. Also called *effective groundwater velocity*, *true groundwater velocity*, *actual groundwater velocity*.

**field moisture capacity** The approximate quantity of water that can be permanently retained in the soil in opposition to the downward pull of gravity. It may be expressed as a percentage of dry weight or in inches for a given depth of soil. The length of time required for a soil to reach field moisture capacity varies considerably with various soils, being approximately 24 to 48 hours for sandy soils, 5 to 10 days for silt clay soils, and longer for clays. Also called *capillary capacity*, *field carrying capacity*, *maximum water-holding capacity*, *moisture-holding capacity*, *normal moisture capacity*.

**field permeability coefficient** The rate of flow of water, in gallons per day (gpd) or liters per second (L/s), under prevailing conditions, through each 1 ft (0.3 m) of thickness of a given aquifer in a width of 1 mile (1.6 km), for each 1 ft/mile (0.19 m/km) of hydraulic gradient. Also called *hydraulic conductivity*.

**filamentous growth** Intertwined, thread-like biological growths characteristic of some species of bacteria, fungi, and algae. Such growths reduce sludge settleability and dewaterability.

**filamentous organisms** Bacterial, fungal, and algal species that grow in thread-like colonies resulting in a biological mass that will not settle and may interfere with drainage through a filter.

**filter** A device or structure for removing solid or colloidal material, usually of a type that cannot be removed by sedimentation, from water, wastewater, or other liquid. The liquid is passed through a filtering medium, usually a granular material but sometimes finely woven cloth, unglazed porcelain, or specially prepared paper. There are many types of filters used in water and wastewater treatment. See also *pressure filter*.

**filter aid** Solid particulate media (for example, diatomaceous earth) added to a filter to improve the rate of filtration; also used colloquially to describe flocculents in water treatment; same as filtration aid. See also *coagulant* or *flocculent aid*.

**filter bed** (1) A type of bank revetment consisting of layers of filtering medium of which the particles gradually increase in size from the bottom upward. Such a filter

allows the groundwater to flow freely, but it prevents even the smallest soil particles from being washed out. (2) A tank for water filtration that has a false bottom covered with sand, such as a rapid sand filter. (3) A pond with sand bedding, as a sand filter or slow sand filter. (4) The media that comprise a trickling filter.

**filter bottom** (1) The underdrainage system for collecting the water that has passed through a rapid sand filter and for distributing the wash water that cleans the filtering medium. (2) The underdrainage system supporting the graded gravel of a biological bed. It may consist of specially fabricated tile or concrete blocks containing waterways and slots in the top for conveying the underdrainage, or it may consist of inverted half tile.

**filter cake** The solids collected on the surface of a mechanical filter. It also applies to spent cake removed from a diatomaceous earth filter.

**filter clogging** The effect occurring when fine particles fill the voids of a sand filter or biological bed, or when growths form surface mats that retard the normal passage of liquid through the filter.

**filter cloth** A fabric stretched around the drum of a vacuum filter.

**filtered wastewater** Wastewater that has passed through a mechanical filtering process but not through a trickling filter bed.

**filter efficiency** The operating results of a filter as measured by various criteria such as percentage reduction in suspended matter, total solids, BOD, bacteria, or color.

**filter flooding** The filling of a trickling filter to an elevation above the top of the medium by closing all outlets in order to reduce or control filter flies.

**filter gallery** A gallery provided in a treatment plant for the installation of conduits and valves and used as a passageway to provide access to them. See also *pipe gallery*.

**filter loading** Organically, the pounds (kilograms) of BOD in the applied liquid per unit of filter bed area or volume per day. Hydraulically, the quantity of liquid applied per unit of filter bed area or volume per day.

**filter media** (1) Material through which water, wastewater, or other liquid is passed for the purpose of purification, treatment, or conditioning. (2) A cloth or metal material of some appropriate design used to intercept sludge solids in sludge filtration. (3) Particulate (sand, gravel, or diatomaceous earth) or fibrous (cloth) material placed within a filter to collect suspended particles.

**filter ponding** The formation of ponds on the surface of trickling filters, caused by excessive biofilm growth, media degradation, or inadequate ventilation. Sometimes called *filter pooling*.

**filter press** A plate and frame press operated mechanically to produce a semisolid cake from a slurry. See also *plate press*.

**filter rate** The rate of application of material to some process involving filtration, for example, application of wastewater sludge to a vacuum filter, wastewater flow to a trickling filter, or water flow to a rapid sand filter.

**filter run** (1) The interval between the cleaning and washing operation of a rapid sand filter. (2) The interval between the changes of the filter medium on a sludge dewatering filter.

**filter strainer** A perforated device inserted in the underdrain of a rapid sand filter through which the filtered water is collected and through which the wash water is distributed when the filter is washed. Also called a strainer head.

**filter underdrain** A system of subsurface drains to collect water that passes through a sand filter or biological bed. See also *filter bottom*.

**filter wash** The reversal of flow through a rapid sand filter to wash clogged material out of the filtering medium and relieve conditions causing loss of head. Also called *backwash*.

**filtrate** The liquid that has passed through a filter.

**filtration** The process of contacting a dilute liquid suspension with filter media for the removal of suspended or colloidal matter, or for the dewatering of concentrated sludge.

**final effluent** The effluent from the final treatment unit of a wastewater treatment plant.

**final sedimentation** The separation of solids from wastewater in the last settling tank of a treatment plant.

**fire flow** The rate of flow, usually expressed in gallons per minute (gpm) or cubic meters per second ( $m^3/s$ ), that can be delivered from a water distribution system at a specified residual pressure for fire fighting. When delivery is to fire department pumpers, the specified residual pressure is generally 20 psi (138 kPa).

**fire pressure** The pressure necessary in water mains when water is used for fire fighting; applied to cases in which the pressure for fire fighting is increased above that normally maintained for general use.

**fire-service connection** A pipe extending from a main to supply a sprinkler, stand-pipe, yard main, or other fire protection system.

**fire system** A separate system of water pipes or mains and their appurtenances installed solely to furnish water for extinguishing fires.

**first-stage BOD** That part of oxygen demand associated with biochemical oxidation of carbonaceous material. Usually, the greater part of the carbonaceous material is oxidized before the second stage (active oxidation of the nitrogenous material) takes place.

**five-day biochemical oxygen demand ( $BOD_5$ )** A standard test to assess wastewater pollution due to organic substances, measuring the oxygen used under controlled conditions of temperature (20 °C) and time (5 days).

**fixed distributor** A distributor consisting of perforated pipes or notched troughs, sloping boards, or sprinkler nozzles that remain stationary when the distributor is operating. See also *distributor*.

**fixed solids** The residue remaining after ignition of suspended or dissolved matter.

**flame arrester** (1) A device incorporating a fine-mesh wire screen or tube bundle inserted in a vent or pipe and designed to resist the flashback of flame. (2) Device consisting of a multiple number of corrugated stamped sheets in a gas-tight housing. As a flame passes through the sheets, it is cooled below the ignition point.

**flange** A projecting rim, edge, lip, or rib.

**flap gate** A gate that opens and closes by rotation around a hinge or hinges at the top side of the gate.

**flap valve** A valve that is hinged at one edge and opens and shuts by rotating about the hinges. See also *check valve*.

**flash dryer** A device for vaporizing water from partly dewatered and finely divided sludge through contact with a current of hot gas or superheated vapor. It includes a squirrel-cage mill for separating the sludge cake into fine particles.

**flash mixer** A device for uniform, quick dispersal of chemicals throughout a liquid.

**flash point** The temperature at which a gas, volatile liquid, or other substance ignites.

**flat-crested weir** A weir with a horizontal crest in the direction of flow and of appreciable length when compared with the depth of water passing over it.

**flight** A scraper in a rectangular sedimentation tank with blades that move sludge along the bottom of the tank to a collection point. As the flights return, scum is collected on the surface of the tank and pushed to an outlet point.

**float control** A float device that is triggered by changing liquid levels that activates, deactivates, or alternates process equipment operation.

**float gauge** A device for measuring the elevation of the liquid, the actuating element of which is a buoyant float that rests on the surface of the liquid and rises or falls with it. The elevation of the surface is measured by a chain or tape attached to the float.

**floating cover** A gas-tight metal cover floating on the sludge in a digestion tank, with guides to assist in smooth vertical travel as the sludge level changes.

**float switch** An electrical switch operated by a float in a tank or reservoir and usually controlling the motor of a pump.

**float valve** A valve, such as a plug or gate, that is actuated by a float to control the flow into a tank.

**floc** Collections of smaller particles agglomerated into larger, more easily settleable particles through chemical, physical, or biological treatment. See also *flocculation*.

**flocculant** Water-soluble organic polyelectrolytes that are used alone or in conjunction with inorganic coagulants, such as aluminum or iron salts, to agglomerate the solids present to form large, dense floc particles that settle rapidly.

**flocculating tank** A tank used for the formation of floc by the gentle agitation of liquid suspensions, with or without the aid of chemicals.

**flocculation** In water and wastewater treatment, the agglomeration of colloidal and finely divided suspended matter after coagulation by gentle stirring by either mechanical or hydraulic means. For biological wastewater treatment in which coagulation is not used, agglomeration may be accomplished biologically.

**flocculation agent** A coagulating substance that, when added to water, forms a flocculent precipitate that will entrain suspended matter and expedite sedimentation; examples are alum, ferrous sulfate, and lime.

**flocculator** (1) A mechanical device to enhance the formation of floc in a liquid. (2) An apparatus for the formation of floc in water and wastewater.

**flood flow** The discharge of a stream during periods of flood.

**flood frequency** The frequency with which the maximum flood may be expected to occur at a site in any average interval of years. Frequency analysis defines the "n-year flood" as being the flood that will, over a long period of time, be equaled or exceeded on the average once every n years. Thus, the 10-year flood would be expected to occur approximately 100 times in a period of 1 000 years, and of these, 10 would be expected to reach the 100-year magnitude. Sometimes expressed in terms of percentage of probability; for example, a probability of 1% would be 100-year flood; a probability of 10% would be a 10-year flood.

**flood-protection works** Structures built to protect lands and property from damage by floods.

**flotation** (1) Separation of suspended particles, or oil and grease, from solution by naturally or artificially raising them to the surface, usually with air. (2) Thickening of

waste activated sludge by injecting air into it and introducing the mixture into a tank where the air buoys the sludge to the surface.

**flow** (1) The movement of a stream of water or other fluid from place to place; the movement of silt, water, sand, or other material. (2) The fluid that is in motion. (3) The quantity or rate of movement of a fluid discharge; the total quantity carried by a stream. (4) To issue forth or discharge. (5) The liquid or amount of liquid per unit time passing a given point.

**flow-control valve** A device that controls the rate of flow of a fluid.

**flow equalization** Transient storage of wastewater for release to a sewer system or wastewater treatment plant at a controlled rate to provide a reasonably uniform flow for treatment.

**flowrate** The volume or mass of a gas, liquid, or solid material that passes through a cross section of conduit in a given time; measured in such units as kilograms per hour (kg/h), cubic meters per second ( $m^3/s$ ), liters per day (L/d), or gallons per day (gpd).

**flow recording** Documentation of the rate of flow of a fluid past a given point. The recording is normally accomplished automatically.

**flow regulator** A structure installed in a canal, conduit, or channel to control the flow of water or wastewater at the intake or to control the water level in a canal, channel, or treatment unit. See also *rate-of-flow controller*.

**flow sheet** A diagrammatic representation of the progression of steps in a process showing their sequence and interdependence.

**fluidized bed reactor** A pressure vessel or tank that is designed for liquid–solid or gas–solid reaction. The liquid or gas moves upward through the solids particles at a velocity sufficient to suspend the individual particles in the fluid. Applications include ion exchange, granular activated carbon adsorbers, and some types of furnaces, kilns, and biological contactors.

**flushing** The flow of water under pressure in a conduit or well to remove clogged material.

**foam** (1) A collection of minute bubbles formed on the surface of a liquid by agitation, fermentation, and so on. (2) The frothy substance composed of an aggregation of bubbles on the surface of liquids and created by violent agitation or by the admission of air bubbles to liquid containing surface-active materials, solid particles, or both. Also called *froth*.

**food-to-microorganism (F:M) ratio** In the activated-sludge process, the loading rate expressed as pounds of BOD<sub>5</sub> per pound of mixed liquor or mixed liquor volatile suspended solids per day (lb BOD<sub>5</sub>/d/lb MLSS or MLVSS).

**foot valve** (1) A valve placed at the bottom of the suction pipe of a pump that opens to allow water to enter the suction pipe, but closes to prevent water from passing out of it at the bottom end. (2) A valve with the reverse action attached to the drainage pipe of a vacuum chamber. It allows water to drain out, but closes to hold the vacuum.

**forced aeration** The bringing about of intimate contact between air and liquid where the air, under pressure, is applied below the surface of the liquid through diffusers or other devices that promote the formation of small bubbles.

**force main** A pressure pipe joining the pump discharge at a water or wastewater pumping station with a point of gravity flow.

**formazine turbidity unit (FTU)** A standard unit of turbidity based on a known chemical reaction that produces insoluble particulates of uniform size. The FTU has largely replaced the JTU. Also known as *nephelometric turbidity unit*.

**fouling** A gelatinous, slimy accumulation resulting from the activity of organisms in the water. Fouling may be found on concrete, masonry, or metal surfaces, but tuberculation is found only on metal surfaces.

**Francis turbine** A reaction turbine of the radial inward-flow type.

**free available chlorine** The amount of chlorine available as dissolved gas, hypochlorous acid, or hypochlorite ion that is not combined with an amine or other organic compound.

**free available residual chlorine** That portion of the total residual chlorine remaining in water or wastewater at the end of a specified contact period that will react chemically and biologically as hypochlorous acid or hypochlorite ion.

**freeboard** The vertical distance between the normal maximum level of the surface of the liquid in a conduit, reservoir, tank, or canal and the top of the sides of an open conduit or the top of a dam or levee, which is provided so that waves and other movements of the liquid will not overflow the confining structure.

**free flow** A condition of flow through or over a structure where such flow is not affected by submergence or the existence of tailwater.

**free oxygen** Elemental oxygen (O<sub>2</sub>).

**free-swimming ciliate** Mobile, one-celled organisms using cilia (hair-like projections) for movement.

**free water** Suspended water constituting films covering the surface of solid particles or the walls of fractures, but in excess of pellicular water; mobile water is free to move in any direction under the pull of the force of gravity and unbalanced film pressure.

**frequency** (1) The time rate of vibration or the number of complex cycles per unit time. (2) The number of occurrences of a certain phenomenon in a given time. (3) The

number of occasions on which the same numerical measure of a particular quantity has occurred between definite limits. (4) The number of cycles through which an alternating current passes per second. Frequency has been generally standardized in the electrical utility industry in the United States at 60 cycles per second (60 Hz).

***fresh-air inlet*** A specially constructed opening usually provided with a perforated cover to facilitate ventilation of a wastewater line.

***fresh sludge*** Sludge in which decomposition is little advanced.

***fresh wastewater*** Wastewater of recent origin containing dissolved oxygen.

***friction factor*** A measure of the resistance to flow of fluid in a conduit as influenced by wall roughness.

***friction head*** The head loss resulting from water flowing in a stream or conduit as the result of the disturbances set up by the contact between the moving water and its containing conduit and by intermolecular friction. In laminar flow, the head loss is approximately proportional to the first power of the velocity; in turbulent flow to a higher power, approximately the square of the velocity. While, strictly speaking, head losses such as those caused by bends, expansions, obstructions, and impact are not included in this term, the usual practice is to include all such head losses under this term.

***friction loss*** The head loss resulting from water flowing in a stream or conduit as the result of the disturbances set up by the contact between the moving water and its containing conduit and by intermolecular friction. See also *friction head*.

***fungi*** Small, nonchlorophyll-bearing plants that lack roots, stems, or leaves; occur (among other places) in water, wastewater, or wastewater effluents; and grow best in the absence of light. Their decomposition may cause disagreeable tastes and odors in water; in some wastewater treatment processes they are helpful and in others they are detrimental.

***fuse*** A protective device that carries the full current of a circuit. If the current is higher than the fuse rating, it contains a substance that will melt and break the current. Fuses cannot be reset but must be replaced.

***gas chromatography*** A method of separating a mixture of compounds into its constituents so they can be identified. The sample is vaporized into a gas-filled column, fractionated by being swept over a solid adsorbent, selectively eluted, and identified.

***gas chromatography-mass spectrometry (GC-MS)*** An analytical technique involving the use of both gas chromatography and mass spectrometry, the former to separate a complex mixture into its components and the latter to deduce the atomic and molecular weights of those components. It is particularly useful in identifying organic compounds.

**gas dome** In sludge digestion tanks, usually a steel cover floating entirely or in part on the liquid sludge.

**gasification** The transformation of soluble and suspended organic materials into gas during waste decomposition.

**gas production** The creation of a gas by chemical or biological means.

**gate valve** A valve in which the closing element consists of a disk that slides over the opening or cross-sectional area through which water passes.

**gauge** (1) A device for indicating the magnitude or position of an element in specific units when such magnitude or position is subject to change; examples of such elements are the elevation of a water surface, the velocity of flowing water, the pressure of water, the amount or intensity of precipitation, and the depth of snowfall. (2) The act or operation of registering or measuring the magnitude or position of a thing when these characteristics are subject to change. (3) The operation of determining the discharge in a waterway by using both discharge measurements and a record of stage.

**globe valve** A valve having a round, ball-like shell and horizontal disk.

**gpcd** The rate of water, wastewater, or other flow measured in U.S. gallons (liters) per capita of served population per day.

**gpd** The rate of water, wastewater, or other flow measured in U.S. gallons (liters) per day.

**gpm** The rate of water, wastewater, or other flow measured in U.S. gallons (liters) per minute.

**grab sample** A sample taken at a given place and time. It may be representative of the flow. See also *composite sample*.

**gradient** The rate of change of any characteristic per unit of length or slope. The term is usually applied to such things as elevation, velocity, or pressure. See *slope*.

**grease and oil** In wastewater, a group of substances including fats, waxes, free fatty acids, calcium and magnesium soaps, mineral oils, and certain other nonfatty materials; water-insoluble organic compounds of plant and animal origins or industrial wastes that can be removed by natural flotation skimming.

**grease skimmer** A device for removing floating grease or scum from the surface of wastewater in a tank.

**grit** The heavy suspended mineral matter present in water or wastewater, such as sand, gravel, or cinders. It is removed in a pretreatment unit called a *grit chamber* to avoid abrasion and wearing of subsequent treatment devices.

**grit chamber** A detention chamber or an enlargement of a sewer designed to reduce the velocity of flow of the liquid to permit the separation of mineral (grit) from organic solids by differential sedimentation.

**grit collector** A device placed in a grit chamber to convey deposited grit to a point of collection.

**grit separator** Any process or device designed to separate grit from a water or wastewater stream.

**grit washer** A device for washing organic matter out of grit.

**ground** A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and earth, or to some conducting body that serves in place of earth.

**grounded** Connected to earth or to some conducting body that serves in place of the earth.

**hardness** A characteristic of water imparted primarily by salts of calcium and magnesium, such as bicarbonates, carbonates, sulfates, chlorides, and nitrates, that causes curdling and increased consumption of soap, deposition of scale in boilers, damage in some industrial processes, and sometimes objectionable taste. It may be determined by a standard laboratory titration procedure or computed from the amounts of calcium and magnesium expressed as equivalent calcium carbonate. See also *carbonate hardness*.

**hazardous waste** Any waste that is potentially damaging to environmental health because of toxicity, ignitability, corrosivity, chemical reactivity, or other reasons.

**head** (1) The height of the free surface of fluid above any point in a hydraulic system; a measure of the pressure or force exerted by the fluid. (2) The energy, either kinetic or potential, possessed by each unit weight of a liquid, expressed as the vertical height through which a unit weight would have to fall to release the average energy possessed. It is used in various compound terms such as *pressure head*, *velocity head*, and *loss of head*. (3) The upper end of anything, such as a headworks. (4) The source of anything, such as a head-water. (5) A comparatively high promontory with either a cliff or steep face extending into a large body of water, such as a sea or lake. An unnamed head is usually called a *headland*.

**header** (1) A structure installed at the head or upper end of a gully to prevent overfall cutting. (2) A supply ditch for the irrigation of a field. (3) A large pipe installed to intercept the ends of a series of pipes; a manifold. (4) The closing plate on the end of a sewer lateral that will not be used immediately.

**head gate** A gate at the entrance to a conduit such as a pipeline, penstock, or canal.

**head loss** Energy losses resulting from the resistance of flow of fluids; may be classified into conduit surface and conduit form losses.

**headworks** (1) All the structures and devices located at the head or diversion point of a conduit or canal. The term as used is practically synonymous with *diversion works*; an intake heading. (2) The initial structures and devices of a water or wastewater treatment plant.

**heat exchanger** A device providing for the transfer of heat between two fluids.

**heat treatment** A sludge conditioning process combining high temperature, time, and pressure to improve the dewaterability of organic sludge.

**heavy metals** Metals that can be precipitated by hydrogen sulfide in acid solution, for example, lead, silver, gold, mercury, bismuth, and copper.

**high-purity oxygen** A modification of the activated-sludge process using relatively pure oxygen and covered aeration tanks in a conventional flow arrangement.

**high-rate aeration** A modification of the activated-sludge process whereby the mixed liquor suspended solids loadings are kept high, allowing high food-to-microorganism (F:M) ratios and shorter detention times.

**humus sludge** Sloughed particles of biomass from trickling media that are removed in the secondary clarifier.

**hydrated lime** Limestone that has been “burned” and treated with water under controlled conditions until the calcium oxide portion has been converted to calcium hydroxide.

**hydraulic loading** The amount of water applied to a given treatment process, usually expressed as volume per unit time, or volume per unit time per unit surface area.

**hydraulic radius** The cross-sectional area of a stream of water divided by the length of that part of its periphery in contact with its containing conduit; the ratio of area to wetted perimeter. Also called *hydraulic mean depth*.

**hydrocarbon** Any of the class of compounds consisting solely of carbon and hydrogen. Usually derived from petroleum.

**hydrogen-ion concentration** The concentration of hydrogen ions in moles per liter of solution (moles/L). Commonly expressed as the pH value, which is the logarithm of the reciprocal of the hydrogen-ion concentration. See also *pH*.

**hydrogen sulfide (H<sub>2</sub>S)** A toxic and lethal gas produced in sewers and digesters by anaerobic decomposition. Detectable in low concentrations (%) by its characteristic “rotten egg” odor. It deadens the sense of smell in higher concentrations or after pro-

longed exposure. Respiratory paralysis and death may occur quickly at concentrations as low as 0.07% by volume in air.

**hydrostatic level** The level or elevation to which the top of a column of water would rise from an artesian aquifer or basin, or from a conduit under pressure.

**hypochlorination** The use of sodium hypochlorite ( $\text{NaOCl}_2$ ) for disinfection.

**hypochlorite** Calcium, sodium, or lithium hypochlorite.

**Imhoff cone** A cone-shaped graduated vessel used to measure the volume of settleable solids in various liquids of wastewater origin during various settling times.

**impedance, resistance, and reactance** The relationship between impedance, resistance, and reactance is given by the following equation:

$$Z = R + jX$$

Where

$Z$  = impedance ( $\Omega$ ),

$R$  = resistance ( $\Omega$ ),

$X$  = reactance ( $\Omega$ ), and

$j$  is the imaginary unit  $\sqrt{-1}$ .

**impeller** A rotating set of vanes designed to impel rotation of a mass of fluid.

**incineration** Combustion or controlled burning of volatile organic matter in sludge and solid waste reducing the volume of the material while producing heat, dry inorganic ash, and gaseous emissions.

**incinerator** A furnace or apparatus for incineration.

**index** (1) An indicator, usually numerically expressed, of the relation of one phenomenon to another. (2) An indicating part of an instrument.

**indicator** (1) A device that shows by an index, pointer, or dial the instantaneous value of such quantities as depth, pressure, velocity, stage, or the movements or positions of water-controlling devices; a gauge. See also *recorder*. (2) A substance giving a visible change, usually of color, at a desired point in a chemical reaction, generally at a prescribed end point.

**indicator gauge** A gauge that shows, by means of an index, pointer, or dial the instantaneous value of such characteristics as depth, pressure, velocity, stage, discharge, or the movements or positions of waste-controlling devices. See also *indicator*, *recorder*.

**industrial wastewater** Wastewater derived from industrial sources or processes.

**infectious hepatitis** An acute viral inflammation of the liver characterized by jaundice, fever, nausea, vomiting, and abdominal discomfort; may be waterborne.

**infiltration** (1) The flow or movement of water through the interstices or pores of a soil or other porous medium. (2) The quantity of groundwater that leaks into a pipe through joints, porous walls, or breaks. (3) The entrance of water from the ground into a gallery. (4) The absorption of liquid by the soil, either as it falls as precipitation or from a stream flowing over the surface.

**inflow** In relation to sanitary sewers, the extraneous flow that enters a sanitary sewer from sources other than infiltration, such as roof leaders, basement drains, land drains, and manhole covers. See also *infiltration*.

**influent** Water, wastewater, or other liquid flowing into a reservoir, basin, treatment plant, or treatment process. See also *effluent*.

**inlet** (1) A surface connection to a drain pipe. (2) A structure at the diversion end of a conduit. (3) The upstream end of any structure through which water may flow. (4) A form of connection between the surface of the ground and a drain or sewer for the admission of surface or stormwater. (5) An intake.

**inlet control** Control of the relationship between headwater elevation and discharge by the inlet or upstream end of any structure through which water may flow.

**inorganic** All those combinations of elements that do not include organic carbon.

**inorganic matter** Mineral-type compounds that are generally nonvolatile, not combustible, and not biodegradable. Most inorganic-type compounds or reactions are ionic in nature; therefore, rapid reactions are characteristic.

**instrumentation** Use of technology to control, monitor, or analyze physical, chemical, or biological parameters.

**interlock** A means of tying one or more circuits to another. It may be mechanical in nature but more likely involves the use of relays or solid state components.

**intermittent chlorination** A technique of noncontinuous chlorination used to control biological fouling of surfaces in freshwater circuits, particularly those used for heat transfer.

**intermittent filter** A natural or artificial bed of sand or other fine-grained material to the surface of which wastewater is applied intermittently in flooding doses and through which it passes; filtration is accomplished under aerobic conditions.

**inventory** A detailed list showing quantities, descriptions, and values of property. It may also include units of measure and unit prices. The term is often confined to consumable materials but may also cover fixed assets. When an inventory covers all property of the enterprise and is priced as of a certain date, it is known as an appraisal.

**ion** A charged atom, molecule, or radical that affects the transport of electricity through an electrolyte or, to a certain extent, through a gas. An atom or molecule that has lost or gained one or more electrons.

**ion exchange** (1) A chemical process involving reversible interchange of ions between a liquid and a solid, but no radical change in structure of the solid. (2) A chemical process in which ions from two different molecules are exchanged. (3) The reversible transfer or sorption of ions from a liquid to a solid phase by replacement with other ions from the solid to the liquid. See also *regeneration*.

**irrigation** The artificial application of water to lands to meet the water needs of growing plants not met by rainfall.

**irrigation requirement** The quantity of water, exclusive of precipitation, that is required for crop production. It includes surface evaporation and other economically unavoidable water waste.

**irrigation return water** Drainage water from irrigated farmlands, generally containing high concentrations of dissolved salts and other materials that have been leached out of the upper layers of the soil.

**jacketed pump** A pump equipped with jackets around the cylinders, heads, and stuffing boxes through which steam or other heat may be forced to permit the handling of such materials as pitch, resin, and asphalt that are solid when cold but melt on heating; when the pump handles materials at high temperatures, cold water may be substituted for steam or heat.

**Jackson turbidity unit (JTU)** A standard unit of turbidity based on the visual extinction of a candle flame when viewed through a column of turbid water containing suspended solids. It varies with the solids composition (barium sulfate, diatomaceous earth, and so on). The JTU has largely been replaced by the more reproducible nephelometric turbidity unit.

**jar test** A laboratory procedure for evaluating coagulation, flocculation, and sedimentation processes in a series of parallel comparisons.

**jet** The stream of water under pressure issuing from an orifice, nozzle, or tube.

**joint** (1) A surface of contact between two bodies or masses of material of like or different character or composition. (2) A connection between two lengths of pipe, made either with or without the use of a third part. (3) A length or piece of pipe.

**kinematic viscosity** Ratio of absolute viscosity, expressed in poises (grams per centimeter per second [g/cm·s]), and the density, in grams per cubic centimeter (g/cm<sup>3</sup>), at room temperature.

**Operation of Municipal Wastewater Treatment Plants**

**kinetics** The study of the rates at which changes occur in chemical, physical, and biological treatment processes.

**Kjeldahl nitrogen (TKN)** The combined amount of organic and ammonia nitrogen.

**Kraus process** A modification of the activated-sludge process in which aerobically conditioned supernatant liquor from anaerobic digesters is added to activated sludge aeration tanks to improve the settling characteristics of the sludge and to add an oxygen resource in the form of nitrates.

**kilovar** One thousand reactive volt amps (see *power*).

**kilovolt** One thousand volts.

**kilowatt** One thousand watts.

**kilowatt-hour** The units of electrical energy equal to one kilowatt of electrical power in an electrical circuit for 1 hour.

**laboratory procedures** Modes of conducting laboratory processes and analytical tests consistent with validated standard testing techniques.

**lag growth phase** The initial period following bacterial introduction during which the population grows slowly as the bacteria acclimates to the new environment.

**lagoon** Any large holding or detention pond, usually with earthen dikes, used to contain wastewater while sedimentation and biological oxidation occur. See also *anaerobic lagoon*.

**laminar flow** The flow of a viscous fluid in which particles of the fluid move in parallel layers, each of which has a constant velocity but is in motion relative to its neighboring layers. Also called *streamline flow*, *viscous flow*.

**land application** The recycling, treatment, or disposal of wastewater or wastewater solids to the land under controlled conditions.

**landfill** The disposal of solid wastes or sludges by placing on land, compacting, and covering with a thin layer of soil.

**leachate** Liquid that has percolated through solid waste or other permeable material and extracted soluble dissolved or suspended materials from it.

**leakage** Uncontrolled loss of water from artificial structures as a result of hydrostatic pressure.

**leakage detector** A device or appliance, the principle of which is the audibility of water flowing through a leak. Most of these devices are marketed under descriptive trade names.

**lethal concentration** The concentration of a test material that causes death of a specified percentage of a population, usually expressed as the median or 50% level ( $L_{50}$ ).

**lift station** A structure that contains pumps and appurtenant piping, valves, and other mechanical and electrical equipment for pumping water, wastewater, or other liquid. Also called a *pumping station*.

**lighting panel** An enclosure carrying numerous low-voltage breakers, switches, and fuses serving lights or receptacles in an area.

**lime** Any of a family of chemicals consisting essentially of calcium hydroxide made from limestone (calcite) composed almost wholly of calcium carbonate or a mixture of calcium and magnesium carbonate; used to increase pH to promote precipitation reactions or for lime stabilization to kill parthenogenic organisms.

**lining** A protective covering over all or a portion of the perimeter of a conduit or reservoir intended to prevent seepage losses, withstand pressure, or resist erosion. In the case of conduits, lining is also sometimes installed to reduce friction losses.

**lipids** A group of organic compounds that make up the fats and other esters with analogous properties.

**liquefaction** (1) Act or process of liquefying or of rendering or becoming liquid; reduction to a liquid state. (2) Act or process of converting a solid or a gas to a liquid by changes in temperature or pressure, or the changing of the organic matter in wastewater from a solid to a soluble state.

**liquid** A substance that flows freely; characterized by free movement of the constituent molecules among themselves, but without the tendency to separate from one another, which is characteristic of gases. Liquid and fluid are often used synonymously, but fluid has the broader significance of including both liquids and gases.

**liquid chlorine** Elemental chlorine converted to a liquid state by compression and refrigeration of the dry, purified gas. Liquid chlorine is shipped under pressure in steel containers.

**load** The amount of electrical power required at any specified point or points on an electrical system. Load originates at the power-consuming equipment (see *demand*).

**load center** A point at which the load of a given area is assumed to be concentrated.

**load diversity** The difference between the sum of the individual maximum demands of two or more individual loads and the coincident maximum demand of those loads.

**load factor** The ratio of the average load in kilowatts supplied during a designated period to the peak or maximum load in kilowatts occurring in that period. Load factor, in percent, may be derived by multiplying the kilowatt-hours used in the period by

100 and then dividing by the product of the maximum demand in kilowatts and the number of hours in the period.

**log growth phase** Initial stage of bacterial growth, during which there is an ample food supply, causing bacteria to grow at their maximum rate.

**loss of head** (1) The decrease in energy between two points resulting from friction, bend, obstruction, expansion, or any other cause. It does not include changes in the elevation of the hydraulic grade unless the hydraulic and energy grades parallel each other. (2) The difference between the total heads at two points in a hydraulic system.

**low-rate filter** A trickling filter designed to receive a small load of BOD per unit volume of filtering material and to have a low dosage rate per unit of surface area, usually 2 to 5 mgd/ac ( $2.2 \times 10^{-5}$  to  $5.4 \times 10^{-5}$  m<sup>3</sup>/m<sup>2</sup>·s) generally without recirculation. The organic loading (BOD) rate is usually in the range of 5 to 25 lb/1 000 cu ft (80 to 400 g/m<sup>3</sup>). Also called a *standard rate filter*.

**Manning formula** A formula for open-channel flow published by Manning in 1890. It gives the value of *c* in the Chezy formula. See also *Manning roughness coefficient*.

**Manning roughness coefficient** The roughness coefficient in the Manning formula for determination of the discharge coefficient in the Chezy formula.

**manometer** An instrument for measuring pressure. It usually consists of a U-shaped tube containing a liquid, the surface of which moves proportionally in one end of the tube with changes in pressure in the liquid in the other end; also, a tube-type of differential pressure gauge.

**mass spectrometer** A device that permits observation of the masses of molecular fragments produced by destructible bombardment of the molecule with electrons in a vacuum; coupled with gas chromatography (GC-MS), mass spectrometry can yield very specific compound identification.

**mass spectrometry** A means of sorting ions by separating them according to their masses.

**mean** (1) The arithmetic average of a group of data. (2) The statistical average (50% point) determined by probability analysis.

**mean cell residence time (MCRT)** The average time that a given unit of cell mass stays in the activated-sludge aeration tank. It is usually calculated as the total mixed liquor suspended solids in the aeration tank divided by the combination of solids in the effluent and solids wasted.

**mechanical aeration** (1) The mixing, by mechanical means, of wastewater and activated sludge in the aeration tank of the activated-sludge process to bring fresh surfaces of liquid into contact with the atmosphere. (2) The introduction of atmospheric

oxygen into a liquid by the mechanical action of paddle, paddle wheel, spray, or turbine mechanisms.

***mechanical aerator*** A mechanical device for the introduction of atmospheric oxygen into a liquid. See also *mechanical aeration*.

***mechanically cleaned screen*** A screen equipped with a mechanical cleaning apparatus for removal of retained solids.

***mechanical rake*** A machine-operated mechanism used for cleaning debris from racks located at the intakes of conduits supplying water to hydroelectric power plants, water supply systems, or for other uses, and conveying wastewater to pumps or treatment processes.

***median*** In a statistical array, the value having as many cases larger in value as cases smaller in value.

***membrane filter test*** A sample of water is passed through a sterile filter membrane. The filter is removed and placed on a culture medium and then incubated for a preset period of time. Coliform colonies, which have a pink to dark-red color with a metallic sheen, are then counted using the aid of a low-power binocular wide-field dissecting microscope. The membrane filter test is used to test for the presence and relative number of coliform organisms.

***mercaptans*** Aliphatic organic compounds that contain sulfur. They are noted for their disagreeable odor and are found in certain industrial wastes.

***mercury gauge*** A gauge in which the pressure of a fluid is measured by the height the fluid pressure will sustain a column of mercury.

***mesh*** One of the openings or spaces in a screen. The value of the mesh is usually given as the number of openings per linear inch. This gives no recognition to the diameter of the wire; thus, the mesh number does not always have a definite relationship to the size of the hole.

***mesophilic*** That group of bacteria that grow best within the temperature range of 20 to 40 °C (68 to 104 °F).

***mesophilic digestion*** Digestion by biological action at 27 to 38 °C (80 to 100 °F).

***mesophilic range*** Operationally, that temperature range most conducive to the maintenance of optimum digestion by mesophilic bacteria, generally accepted as between 27 and 38 °C (80 and 100 °F).

***metabolism*** (1) The biochemical processes in which food is utilized and wastes formed by living organisms. (2) All biochemical reactions involved in cell synthesis and growth.

**metazoan** A group of animals having bodies composed of cells differentiated into tissues and organs and usually having a digestive cavity lined with specialized cells.

**meter** An instrument for measuring some quantity such as the rate of flow of liquids, gases, or electric currents.

**methane (CH<sub>4</sub>)** A colorless, odorless, flammable, gaseous hydrocarbon present in natural gas and formed by the anaerobic decomposition of organic matter, or produced artificially by heating carbon monoxide and hydrogen over a nickel catalyst. See also *anaerobic digestion*.

**methane bacteria** A specialized group of obligate anaerobic bacteria that decompose organic matter to form methane.

**methane fermentation** A reaction sequence that produces methane during the anaerobic decomposition of organic waste. In the first phase, acid-forming bacteria produce acetic acid; in the second, the methane bacteria use this acid and carbon dioxide to produce methane. Fermentation results in the conversion of organic matter into methane gas.

**mgd** Million gallons per day; a measure of flow equal to 1.547 cu ft/sec, 681 gpm, or 3 785 m<sup>3</sup>/d.

**mg/L** Milligrams per liter; a measure of concentration equal to and replacing ppm in the case of dilute concentrations.

**microbial activity** The activities of microorganisms resulting in chemical or physical changes.

**microbial film** A gelatinous film of microbial growth attached to or spanning the interstices of a support medium. Also called *biological slime*.

**microorganisms** Very small organisms, either plant or animal, invisible or barely visible to the naked eye. Examples are algae, bacteria, fungi, protozoa, and viruses.

**microscopic** Very small, generally between 0.5 and 100 μm, and visible only by magnification with an optical microscope.

**microscopic examination** (1) The examination of water to determine the presence and amounts of plant and animal life, such as bacteria, algae, diatoms, protozoa, and crustacea. (2) The examination of water to determine the presence of microscopic solids. (3) The examination of microbiota in process water, such as the mixed liquor in an activated-sludge plant.

**mist** Fine liquid droplets of such small size that gravity separation is hindered. Fog is a water mist.

***mixed-flow pump*** A centrifugal pump in which the head is developed partly by centrifugal force and partly by the lift of the vanes on the liquid. This type of pump has a single inlet impeller; the flow enters axially and leaves axially and radially.

***mixed liquor*** A mixture of raw or settled wastewater and activated sludge contained in an aeration tank in the activated-sludge process. See also *mixed liquor suspended solids*.

***mixed liquor suspended solids (MLSS)*** The concentration of suspended solids in activated-sludge mixed liquor, expressed in milligrams per liter (mg/L). Commonly used in connection with activated-sludge aeration units.

***mixed liquor volatile suspended solids (MLVSS)*** That fraction of the suspended solids in activated-sludge mixed liquor that can be driven off by combustion at 550 °C (1022 °F); it indicates the concentration of microorganisms available for biological oxidation.

***mixed-media filter*** A filter containing filtering media of different particle size or density.

***mixing basin*** A basin or tank in which agitation is applied to water, wastewater, or sludge to increase the dispersion rate of applied chemicals; also, tanks used for general mixing purposes.

***mixing chamber*** A chamber used to facilitate the mixing of chemicals with liquid or the mixing of two or more liquids of different characteristics. It may be equipped with a mechanical device that accomplishes the mixing.

***mixing channel*** A channel provided in a water or wastewater treatment plant; the hydraulic characteristics of the waterway or its construction features are such that chemicals or liquids are thoroughly mixed.

***modified aeration*** A modification of the activated-sludge process in which a shortened period of aeration (1.5 to 3 hours) is used with a reduced quantity of suspended solids (200 to 500 mg/L MLSS) in the mixed liquor. Sludge settling is usually poor; high suspended solids concentration may be expected in effluent.

***moisture*** Condensed or diffused water collected on or excluded to a surface.

***moisture content*** The quantity of water present in soil, wastewater sludge, industrial waste sludge, and screenings, usually expressed in percentage of wet weight.

***mole*** (1) Molecular weight of a substance, normally expressed in grams. (2) A device to clear sewers and pipelines. (3) A massive harbor work, with a core of earth or stone, extending from shore into deep water. It serves as a breakwater, a berthing facility, or a combination of the two.

**monitoring** (1) Routine observation, sampling, and testing of designated locations or parameters to determine the efficiency of treatment or compliance with standards or requirements. (2) The procedure or operation of locating and measuring radioactive contamination by means of survey instruments that can detect and measure, as dose rate, ionizing radiations.

**Monod equation** A mathematical expression first used by Monod in describing the relationship between the microbial growth rate and concentration of growth-limiting substrate.

**most probable number (MPN)** That number of organisms per unit volume which, in accordance with statistical theory, would be more likely than any other number to yield the observed test result or would yield the observed test result with the greatest frequency. Expressed as density of organisms/100 mL. Results are computed from the number of positive findings of coliform group organisms resulting from multiple portion decimal dilution plantings. Used commonly for coliform bacteria.

**motor controller** A specialized type of controller whose typical functions performed by a motor controller include starting, accelerating, stopping, reversing, and protecting motors.

**moving average** Trend analysis tool for determining patterns or changes in treatment process. For example, a 7-day moving average would be the sum of the datum points for 7 days divided by 7.

**mudballs** (1) Accretions of siliceous incrustations on the exterior surface of sand grains. From these incrustations grow numerous filamentous organisms over which there is a gelatinous coating. Mudballs are approximately spherical in shape and vary in size from that of a pea up to 1 or 2 in. (2.5 to 5.1 cm) or more in diameter. They are formed principally by the retention and gradual building up of growths that are not completely removed by the washing process. (2) Balls of sediment sometimes found in debris-laden flow and channel deposits.

**mud blanket** A layer of flocculant material that forms on the surface of a sand filter.

**multimedia filter beds** A filtration apparatus consisting of two or more media, such as anthracite and sand, through which wastewater flows and by which it is cleansed. Media may be intermixed or segregated.

**multiple-hearth incinerator** A countercurrent-type of incinerator frequently used to dry and burn partially dried sludges. Heated air and products of combustion pass by finely pulverized sludge that is continuously raked to expose fresh surfaces.

**multiple-stage sludge digestion** The progressive digestion of waste sludge in two or more tanks arranged in series.

***multistage pump*** A centrifugal pump with two or more sets of vanes or impellers connected in series in the same casing. Such a pump may be designated as two-stage, three-stage, or more, according to the number of sets of vanes used. The purpose is to increase the head of the discharging fluid.

***municipal wastewater treatment*** Generally includes the treatment of domestic, commercial, and industrial wastes.

***nappe*** The sheet or curtain of water overflowing a weir or dam. When freely overflowing any given structure, it has a well-defined upper and lower surface.

***National Pollutant Discharge Elimination System (NPDES)*** A permit that is the basis for the monthly monitoring reports required by most states in the United States.

***negative head*** (1) The loss of head in excess of the static head (a partial vacuum). (2) A condition of negative pressure produced by clogging of rapid sand filters near the end of a filter run.

***negative pressure*** A pressure less than the local atmospheric pressure at a given point.

***nematode*** Member of the phylum (Nematoda) of elongated cylindrical worms parasitic in animals or plants or free-living in soil or water.

***nephelometer*** An instrument for comparing turbidities of solutions by passing a beam of light through a transparent tube and measuring the ratio of the intensity of the shattered light to that of the incident light.

***nephelometric turbidity unit (NTU)*** Units of a turbidity measurement using a nephelometer.

***net available head*** The difference in pressure between the water in a power conduit before it enters the water wheel and the first free water surface in the conduit below the water wheel.

***n factor*** Values of the roughness coefficient used in Manning formula or Kutter formula. See also *roughness coefficient*, *Manning formula*.

***nitrate (NO<sub>3</sub>)*** An oxygenated form of nitrogen.

***nitrification*** The oxidation of ammonia nitrogen to nitrate nitrogen in wastewater by biological or chemical reactions. See also *denitrification*.

***nitrifying bacteria*** Bacteria capable of oxidizing nitrogenous material.

***nitrite (NO<sub>2</sub>)*** An intermediate oxygenated form of nitrogen.

***nitrogen (N)*** An essential nutrient that is often present in wastewater as ammonia, nitrate, nitrite, and organic nitrogen. The concentrations of each form and the sum (total nitrogen) are expressed as milligrams per liter (mg/L) elemental nitrogen. Also

present in some groundwater as nitrate and in some polluted groundwater in other forms. See also *nutrient*.

**nitrogen cycle** A graphical presentation of the conservation of matter in nature showing the chemical transformation of nitrogen through various stages of decomposition and assimilation. The various chemical forms of nitrogen as it moves among living and nonliving matter are used to illustrate general biological principles that are applicable to wastewater and sludge treatment.

**nitrogenous oxygen demand (NOD)** A quantitative measure of the amount of oxygen required for the biological oxidation of nitrogenous material, such as ammonia nitrogen and organic nitrogen, in wastewater; usually measured after the carbonaceous oxygen demand has been satisfied. See also *biochemical oxygen demand*, *nitrification*, *second-stage BOD*.

**nitrogen removal** The removal of nitrogen from wastewater through physical, chemical, or biological processes, or by some combination of these.

**Nitrosomonas** A genus of bacteria that oxidize ammonia to nitrate.

**Nocardia** Irregularly bent, short filamentous organisms that are characterized in an activated-sludge system when a dark chocolate mousse foam is present.

**nonclogging impeller** An impeller of the open, closed, or semiclosed type designed with large passages for passing large solids.

**nonsettleable solids** Suspended matter that will stay in suspension for an extended period of time. Such a period may be arbitrarily taken for testing purposes as 1 hour. See also *suspended solids*.

**nonuniform flow** A flow in which the slope, cross-sectional area, and velocity change from section to section in the channel.

**nozzle** (1) A short, cone-shaped tube used as an outlet for a hose or pipe. The velocity of the emerging stream of water is increased by the reduction in cross-sectional area of the nozzle. (2) A short piece of pipe with a flange on one end and a saddle flange on the other end. (3) A side outlet attached to a pipe by riveting, brazing, or welding.

**nozzle aerator** An aerator consisting of a pressure nozzle through which water is propelled into the air in a fine spray. Also called *spray aerator*.

**nutrient** Any substance that is assimilated by organisms and promotes growth; generally applied to nitrogen and phosphorus in wastewater, but also to other essential and trace elements.

**odor control** Prevention or reduction of objectionable odors by chlorination, aeration, or other processes, or by masking with chemical aerosols.

**odor threshold** The point at which, after successive dilutions with odorless water or air, the odor of a sample can barely be detected. The threshold odor is expressed quantitatively by the number of times the sample is diluted with odorless water or air.

**off-peak power** That part of the available load or energy that can be produced at off-peak hours outside the load curve when the combined primary and secondary load has fallen below plant capacity.

**ohm** The unit of measurement of electrical resistance. It is that resistance through which an electromotive force of one volt will produce a current of one ampere.

**oil separation** (1) Removal of insoluble oils and floating grease from municipal wastewater. (2) Removal of soluble or emulsified oils from industrial wastewater.

**open centrifugal pump** A centrifugal pump in which the impeller is built with a set of independent vanes.

**open channel** Any natural or artificial water conduit in which water flows with a free surface.

**open-channel flow** Flow of a fluid with its surface exposed to the atmosphere. The conduit may be an open channel or a closed conduit flowing partly full.

**open impeller** An impeller without attached side walls.

**operators** (1) Persons employed to operate a treatment facility. (2) Mechanism used to manipulate valve positions.

**organic** Refers to volatile, combustible, and sometimes biodegradable chemical compounds containing carbon atoms (carbonaceous) bonded together with other elements. The principal groups of organic substances found in wastewater are proteins, carbohydrates, and fats and oils. See also *inorganic*.

**organic loading** The amount of organic material, usually measured as BOD<sub>5</sub>, applied to a given treatment process; expressed as weight per unit time per unit surface area or per unit weight.

**organic nitrogen** Nitrogen chemically bound in organic molecules such as proteins, amines, and amino acids.

**orifice** (1) An opening with a closed perimeter, usually of regular form, in a plate, wall, or partition through which water may flow; generally used for the purpose of measurement or control of such water. The edge may be sharp or of another configuration. (2) The end of a small tube such as a pitot tube or piezometer.

**orifice plate** A plate containing an orifice. In pipes, the plate is usually inserted between a pair of flanges and the orifice is smaller in area than the cross section of the pipe.

**orthophosphate** (1) A salt that contains phosphorus as  $(\text{PO}_4)^{-3}$ . (2) A product of hydrolysis of condensed (polymeric) phosphates. (3) A nutrient required for plant and animal growth. See also *nutrient, phosphorus removal*.

**osmosis** The process of diffusion of a solvent through a semipermeable membrane from a solution of lower concentration to one of higher concentration.

**outfall** (1) The point, location, or structure where wastewater or drainage discharges from a sewer, drain, or other conduit. (2) The conduit leading to the ultimate disposal area.

**outlet** A point on the wiring system at which the current is taken to supply utilization equipment.

**overflow rate** One of the criteria in the design of settling tanks for treatment plants; expressed as the settling velocity of particles that are removed in an ideal basin if they enter at the surface. It is expressed as a volume of flow per unit water surface area.

**overflow weir** Any device or structure over which any excess water or wastewater beyond the capacity of the conduit or container is allowed to flow or waste.

**overland flow** (1) The flow of water over the ground before it enters some defined channel. (2) A type of wastewater irrigation.

**overturn** The phenomenon of vertical circulation that occurs in large bodies of water because of the increase in density of water above and below 39.2 °F (4 °C). In the spring, as the surface of the water warms above the freezing point, the water increases in density and tends to sink, producing vertical currents; in the fall, as the surface water becomes colder, it also tends to sink. Wind may also create such vertical currents.

**oxidant** A chemical substance capable of promoting oxidation, for example,  $\text{O}_2$ ,  $\text{O}_3$ , and  $\text{Cl}_2$ . See also *oxidation, reduction*.

**oxidation** (1) A chemical reaction in which the oxidation number (valence) of an element increases because of the loss of one or more electrons by that element. Oxidation of an element is accompanied by simultaneous reduction of the other reactant. See also *reduction*. (2) The conversion of organic materials to simpler, more stable forms with the release of energy. This may be accomplished by chemical or biological means. (3) The addition of oxygen to a compound.

**oxidation ditch** A secondary wastewater treatment facility that uses an oval channel with a rotor placed across it to provide aeration and circulation. The screened wastewater in the ditch is aerated by the rotor and circulated at approximately 1 to 2 ft/sec (0.3 m/s). See also *secondary treatment*.

**oxidation pond** A relatively shallow body of wastewater contained in an earthen basin of controlled shape in which biological oxidation of organic matter is effected by natural or artificially accelerated transfer of oxygen.

**oxidation process** Any method of wastewater treatment for the oxidation of the putrescible organic matter.

**oxidation–reduction potential (ORP)** The potential required to transfer electrons from the oxidant to the reductant and used as a qualitative measure of the state of oxidation in wastewater treatment systems.

**oxidized sludge** Sludge in which the organic matter has been stabilized by chemical or biological oxidation.

**oxidized wastewater** Wastewater in which the organic matter has been stabilized.

**oxygen (O)** A necessary chemical element. Typically found as O<sub>2</sub> and used in biological oxidation. It constitutes approximately 20% of the atmosphere.

**oxygenation capacity** In treatment processes, a measure of the ability of an aerator to supply oxygen to a liquid.

**oxygen consumed** A measure of the oxygen-consuming capability of inorganic and organic matter present in water or wastewater. See also *chemical oxygen demand*.

**oxygen deficiency** (1) The additional quantity of oxygen required to satisfy the oxygen requirement in a given liquid; usually expressed in milligrams per liter (mg/L). (2) Lack of oxygen.

**oxygen transfer** (1) Exchange of oxygen between a gaseous and a liquid phase. (2) The amount of oxygen absorbed by a liquid compared to the amount fed into the liquid through an aeration or oxygenation device; usually expressed as percent.

**oxygen uptake rate** The oxygen used during biochemical oxidation, typically expressed as mg O<sub>2</sub>/L/h in the activated sludge process.

**oxygen utilization** (1) The portion of oxygen effectively used to support aerobic treatment processes. (2) The oxygen used to support combustion in the degradation of sludge by incineration or wet-air oxidation.

**ozonation** The process of contacting water, wastewater, or air with ozone for purposes of disinfection, oxidation, or odor control.

**ozone (O<sub>3</sub>)** Oxygen in a molecular form with three atoms of oxygen forming each molecule.

**paddle aerator** A device, similar in form to a paddle wheel, that is used in the aeration of water.

**panel board** One or more panel units designed for assembly into a single panel, including buses, and with or without switched and/or automatic overcurrent devices. Panel boards are used to control light, heat, or power circuits of small individual or grouped loads. They are designed to be set in a cabinet box or in or against a wall or partition and are accessible from the front only (see *switchboard*).

**Parshall flume** A calibrated device developed by Parshall for measuring the flow of liquid in an open conduit consisting essentially of a contracting length, a throat, and an expanding length. At the throat is a sill over which the flow passes at Belanger's critical depth. The upper and lower heads are each measured at a definite distance from the sill. The lower head need not be measured unless the sill is submerged more than about 67%.

**partial pressure** The pressure exerted by each gas independently of the others in a mixture of gases. The partial pressure of each gas is proportional to the amount (percent by volume) of that gas in the mixture.

**particles** Generally, discrete solids suspended in water or wastewater that can vary widely in size, shape, density, and charge.

**parts per million (ppm)** The number of weight or volume units of a minor constituent present with each 1 million units of a solution or mixture. The more specific term, milligrams per liter (mg/L), is preferred.

**pathogenic bacteria** Bacteria that cause disease in the host organism by their parasitic growth.

**pathogens** Pathogenic or disease-producing organisms.

**peak** (1) The maximum quantity that occurs over a relatively short period of time. Also called *peak demand*, *peak load*. (2) The highest load carried by an electric generating system during any specific period. It is usually expressed in kilowatts (kW).

**peak load** (1) The maximum average load carried by an electric generating plant or system for a short time period such as 1 hour or less. (2) The maximum demand for water placed on a pumping station, treatment plant, or distribution system; expressed as a rate. (3) The maximum rate of flow of wastewater to a pumping station or treatment plant. Also called *peak demand*.

**period** (1) The interval required for the completion of a recurring event. (2) Any specified duration of time.

**peripheral weir** The outlet weir extending around the inside of the circumference of a circular settling tank over which the effluent discharges.

**permeability** (1) The property of a material that permits appreciable movement of water through it when it is saturated; the movement is actuated by hydrostatic pres-

sure of the magnitude normally encountered in natural subsurface water. Perviousness is sometimes used in the same sense as permeability. (2) The capacity of a rock or rock material to transmit a fluid. See also *permeability coefficient*.

***permeability coefficient*** A coefficient expressing the rate of flow of a fluid through a cross section of permeable material under a hydraulic or pressure gradient. The standard coefficient of permeability used in the hydrologic work of the U.S. Geological Survey (USGS), known also as the *Meinzer unit*, is defined as the rate of flow of water in gallons per day (gpd) at 60 °F through a cross section of 1 ft (0.3 m) under a hydraulic gradient of 100%. See also *field permeability coefficient*.

***pervious*** Possessing a texture that permits water to move through perceptibly under the head differences ordinarily found in subsurface water. See also *permeability*.

***pH*** A measure of the hydrogen-ion concentration in a solution, expressed as the logarithm (base 10) of the reciprocal of the hydrogen-ion concentration in gram moles per liter (g/mole/L). On the pH scale (0 to 14), a value of 7 at 25 °C (77 °F) represents a neutral condition. Decreasing values indicate increasing hydrogen-ion concentration (acidity); increasing values indicate decreasing hydrogen-ion concentration (alkalinity).

***phase*** Any portion of a physical system separated by a definite physical boundary from the rest of the system. The three physical phases are solid, liquid, and gas; colloids are the dispersed phase and liquids are the continuous phase.

***phenolic compounds*** Hydroxyl derivatives of benzene. The simplest phenolic compound is hydroxyl benzene (C<sub>6</sub>H<sub>5</sub>OH).

***phosphate*** A salt or ester of phosphoric acid. See also *orthophosphate*, *phosphorus*.

***phosphorus*** An essential chemical element and nutrient for all life forms. Occurs in orthophosphate, pyrophosphate, tripolyphosphate, and organic phosphate forms. Each of these forms and their sum (total phosphorus) is expressed as milligrams per liter (mg/L) elemental phosphorus. See also *nutrient*.

***phosphorus removal*** The precipitation of soluble phosphorus by coagulation and subsequent flocculation and sedimentation.

***photosynthesis*** The synthesis of complex organic materials, especially carbohydrates, from carbon dioxide, water, and inorganic salts with sunlight as the source of energy and with the aid of a catalyst, such as chlorophyll.

***photosynthetic bacteria*** Bacteria that obtain their energy for growth from light by photosynthesis.

***physical analysis*** The examination of water and wastewater to determine physical characteristics such as temperature, turbidity, color, odors, and taste.

**Operation of Municipal Wastewater Treatment Plants**

***physical-chemical treatment*** Treatment of wastewater by unit processes other than those based on microbiological activity. Unit processes commonly included are precipitation with coagulants, flocculation with or without chemical flocculents, filtration, adsorption, chemical oxidation, air stripping, ion exchange, reverse osmosis, and several others.

***physical treatment*** Any treatment process involving only physical means of solid-liquid separation, for example, screens, racks, clarification, and comminutors. Chemical and biological reactions do not play an important role in treatment.

***phytoplankton*** Plankton consisting of plants, such as algae.

***pin floc*** Small floc particles that settle poorly.

***pipe*** A closed conduit that diverts or conducts water or wastewater from one location to another.

***pipe diameter*** The nominal or commercially designated inside diameter of a pipe, unless otherwise stated.

***pipe fittings*** Connections, appliances, and adjuncts designed to be used in connection with pipes; examples are elbows and bends to alter the direction of a pipe; tees and crosses to connect a branch with a main; plugs and caps to close an end; and bushings, diminishers, or reducing sockets to couple two pipes of different dimensions.

***pipe gallery*** (1) Any conduit for pipe, usually of a size to allow a person to walk through. (2) A gallery provided in a treatment plant for the installation of conduits and valves and used as a passageway to provide access to them.

***pipng system*** A system of pipes, fittings, and appurtenances within which a fluid flows.

***piston pump*** A reciprocating pump in which the cylinder is tightly fitted with a reciprocating piston.

***plant hydraulic capacity*** The level of flow into a plant above which the system is hydraulically overloaded.

***plastic media*** Honeycomb-like products, manufactured from plastics of various compositions, with high surface area: volume ratios that are used in trickling filters in place of crushed stone. The product is available in large modules fabricated from sheets that may be cut to size on-site, and small discrete pieces to be loosely packed in the filter bed. See also *trickling filter*.

***plate press*** A filter press consisting of a number of parallel plate units lined with filter cloth that rests on drainage channels in the plates. Pressure is exerted by the pumping of solids into chambers created between the cloths. The operation is carried out in batches.

**plug flow** Flow in which fluid particles are discharged from a tank or pipe in the same order in which they entered it. The particles retain their discrete identities and remain in the tank for a time equal to the theoretical detention time.

**plumbing** (1) The pipes, fixtures, and other apparatus inside a building for bringing in the water supply and removing the liquid and waterborne wastes. (2) The installation of the foregoing pipes, fixtures, and other apparatus.

**plumbing fixtures** Receptacles that receive liquid, water, or wastewater and discharge them into a drainage system.

**plunger pump** A reciprocating pump with a plunger that does not come in contact with the cylinder walls, but enters and withdraws from it through packing glands. Such packing may be inside or outside the center, according to the design of the pump.

**pneumatic ejector** A device for raising wastewater, sludge, or other liquid by alternately admitting it through an inward swinging check valve into the bottom of an airtight pot and then discharging it through an outward swinging check valve by admitting compressed air to the pot above the liquid.

**point gauge** A sharp-pointed rod attached to a graduated staff or vernier scale used for measuring the elevation of the surface of water. The point is lowered until the tip barely touches the water and forms a streak in flowing water and a meniscus jump in still water. It can also be used in a still well and can operate on an electric current with a buzzer or light that will operate when contact with the water is made.

**polishing** A general term for those treatment processes that are applied after conventional ones. See also *advanced waste treatment*, *tertiary treatment*.

**pollution** (1) Specific impairment of water quality by agricultural, domestic, or industrial wastes (including thermal and atomic wastes) to a degree that has an adverse effect on any beneficial use of the water. (2) The addition to a natural body of water any material that diminishes the optimal economic use of a water body by the population it serves and has an adverse effect on the surrounding environment.

**polychlorinated biphenyls (PCBs)** A class of aromatic organic compounds with two six-carbon unsaturated rings, with chlorine atoms substituted on each ring and more than two such chlorine atoms per molecule of PCB. They are typically stable, resist both chemical and biological degradation, and are toxic to many biological species.

**polyelectrolyte flocculants** Polymeric organic compounds used to induce or enhance the flocculation of suspended and colloidal solids and thereby facilitate sedimentation or the dewatering of sludges.

**polyelectrolytes** Complex polymeric compounds, usually composed of synthetic macromolecules that form charged species (ions) in solution; water-soluble polyelec-

trolytes are used as flocculants; insoluble polyelectrolytes are used as ion exchange resins. See also *polymers*.

***polymers*** Synthetic organic compounds with high molecular weights and composed of repeating chemical units (monomers); they may be polyelectrolytes, such as water-soluble flocculents or water-insoluble ion exchange resins, or insoluble uncharged materials, such as those used for plastic or plastic-lined pipe and plastic trickling filter media.

***polyvinyl chloride (PVC)*** An artificial polymer made from vinyl chloride monomer ( $\text{CH}_2\text{:CHCl}$ ); frequently used in pipes, sheets, and vessels for transport, containment, and treatment in water and wastewater facilities. See also *polymers*.

***population dynamics*** The ever-changing numbers of microscopic organisms within the activated sludge process.

***population equivalent*** The estimated population that would contribute a given amount of a specific waste parameter ( $\text{BOD}_5$ , suspended solids, or flow); usually applied to industrial waste. Domestic wastewater contains material that consumes, on the average, 0.17 lb of oxygen/cap/d (0.08 kg/cap·d), as measured by the standard BOD test. For example, if an industry discharges 1 000 lb of BOD/d (454 kg/d), its waste is equivalent to the domestic wastewater from 6 000 persons ( $1\ 000/0.17 =$  approximately 6 000).

***pore*** As applied to stone, soil, or other material, any small interstice or open space, generally one that allows the passage or adsorption of liquid or gas.

***pore space*** Open space in rock or granular material.

***porosity*** (1) The quality of being porous or containing interstices. (2) The ratio of the aggregate volume of interstices in a rock or soil to its total volume; usually stated as a percentage.

***positive-displacement pump*** Pump type in which liquid is induced to flow from the supply source through an inlet pipe and inlet valve. Water is brought into the pump chamber by a vacuum created by the withdrawal of a piston or pistonlike device, which, on its return, displaces a certain volume of water contained in the chamber and forces it to flow through the discharge valve and pipe.

***postaeration*** The addition of air to plant effluent to increase the oxygen concentration of treated wastewater.

***postchlorination*** The application of chlorine to wastewater following treatment.

***power (apparent)*** The mathematical product of the volts and amps of a circuit. The product generally is divided by 1000 and designated as kilovolt amperes (kVA).

**power (electric)** The time rate of transferring or using electrical energy, usually expressed in kilowatts (kW).

**power (reactive)** That portion of *apparent power* that does no work. It is usually measured in kilovars. Reactive power must be supplied to most types of magnetic equipment, such as motors, ballasts, transformers, and relays. Typically, it is supplied by generators or by electrostatic equipment such as capacitors.

**power requirements** The rate of energy input needed to operate a piece of equipment, a treatment plant, or other facility or system. The form of energy may be electrical, fossil fuel, other types, or a combination.

**preaeration** A preparatory treatment of wastewater consisting of aeration to remove gases, add oxygen, promote flotation of grease, and aid coagulation.

**prechlorination** The application of chlorine to wastewater at or near the treatment plant entrance. Often used after bar screens and grit chambers to control odors in primary settling tanks.

**precipitate** (1) To condense and cause to fall as precipitation, as water vapor condenses and falls as rain. (2) The separation from solution as a precipitate. (3) The substance that is precipitated.

**preliminary treatment** Unit operations, such as screening, comminution, and grit removal, that prepare the wastewater for subsequent major treatment.

**press filter** A press operated mechanically for partially dewatering sludge. See also *filter press, plate press*.

**pressure** (1) The total load or force acting on a surface. (2) In hydraulics, unless otherwise stated, the pressure per unit area or intensity of pressure above local atmospheric pressure expressed in pounds per square inch (psi) or kilograms per square centimeter ( $\text{kg}/\text{cm}^2$ ).

**pressure filter** (1) An enclosed vessel having a vertical or horizontal cylinder of iron, steel, wood, or other material containing granular media through which liquid is forced under pressure. (2) A mechanical filter for partially dewatering sludge. See also *filter press, plate press*.

**pressure gauge** A device for registering the pressure of solids, liquids, or gases. It may be graduated to register pressure in any units desired.

**pressure-relief valve** Valve that opens automatically when the pressure reaches a preset limit to relieve stress on a pipeline.

**pressure tank** A tank used in connection with a water distribution system for a single household, for several houses, or for a portion of a larger water system that is airtight

and holds both air and water and in which air is compressed and the pressure so created is transmitted to the water.

**pretreatment** Treatment of industrial wastewater at its source before discharge to municipal collection systems.

**primary effluent** The liquid portion of wastewater leaving the primary treatment process.

**primary sedimentation tank** The first settling tank for the removal of settleable solids through which wastewater is passed in a treatment works. Sometimes called a *primary clarifier*.

**primary sludge** Sludge obtained from a primary sedimentation tank.

**primary treatment** (1) The first major treatment in a wastewater treatment facility, used for the purpose of sedimentation. (2) The removal of a substantial amount of suspended matter, but little or no colloidal and dissolved matter. (3) Wastewater treatment processes usually consisting of clarification with or without chemical treatment to accomplish solid-liquid separation.

**primary voltage** The voltage of the circuit supplying power to a transformer, as opposed to the output voltage or load-supplied voltage, which is called *secondary voltage*. In power supply practice, the primary is almost always the high-voltage side and the secondary the low-voltage side of the transformer.

**propeller pump** A centrifugal pump that develops most of its head by the propelling or lifting action of the vanes on the liquid. Also called an *axial-flow pump*.

**propeller-type impeller** An impeller of the straight axial-flow type.

**proportional weir** A special type of weir in which the discharge through the weir is directly proportional to the head.

**protozoa** Small one-celled animals including amoebae, ciliates, and flagellates.

**publicly owned treatment works** Wastewater treatment plant.

**pump** A mechanical device for causing flow, for raising or lifting water or other fluid, or for applying pressure to fluids.

**pump curve** A curve or curves showing the interrelation of speed, dynamic head, capacity, brake horsepower, and efficiency of a pump.

**pump efficiency** The ratio of energy converted into useful work to the energy applied to the pump shaft, or the energy difference in the water at the discharge and suction nozzles divided by the power input at the pump shaft.

**pumping head** The sum of the static head and friction head on a pump discharging a given quantity of water.

**pumping station** (1) A facility housing relatively large pumps and their appurtenances. *Pump house* is the usual term for shelters for small water pumps. (2) A facility containing lift pumps to facilitate wastewater collection or reclaimed water distribution.

**pump pit** A dry well or chamber, below ground level, in which a pump is located.

**pump stage** The number of impellers in a centrifugal pump; for example, a single-stage pump has one impeller; a two-stage pump has two impellers.

**putrefaction** Biological decomposition, usually of organic matter, with the production of foul-smelling products associated with anaerobic conditions.

**putrescibility** (1) The relative tendency of organic matter to undergo decomposition in the absence of oxygen. (2) The susceptibility of wastewaters, effluent, or sludge to putrefaction. (3) The stability of a polluted, raw, or partially treated wastewater.

**quicklime** A calcined material, the major part of which is calcium oxide, or calcium oxide in natural association with a lesser amount of magnesium oxide. It is capable of combining with water, that is, being slaked.

**raceway** Any channel for holding wires, cables, or bus bars that is designed expressly and solely for that purpose. Raceways may be of metal or insulating materials and the term includes rigid metal conduit, nonmetallic conduit, flexible metal conduit, and electrical metallic tubing. Raceways may be located beneath the floor or on or above the surface (refer to the National Electric Code for approved raceways).

**rack** A device fixed in place and used to remove suspended or floating solids from wastewater. It is composed of parallel bars that are evenly spaced. See also *screen*.

**radial flow** The direction of flow across a tank from center to periphery or vice versa.

**radiation** (1) The emission and propagation of energy through space or through a material medium; also the energy so propagated. (2) The dispersion of energy by electromagnetic waves rather than by conduction and convection.

**range** A measure of the variability of a quantity; the difference between the largest and smallest values in the sequence of values of the quantity.

**rate** (1) The speed at which a chemical reaction occurs. (2) Flow volume per unit time. See also *kinetics*.

**rate-of-flow controller** An automatic device that controls the rate of flow of a fluid.

**rate-of-flow recorder** A recorder for registering the rate of flow of water; generally, used with a rapid sand filter.

**raw sludge** Settled sludge promptly removed from sedimentation tanks before decomposition has much advanced.

**Operation of Municipal Wastewater Treatment Plants**

**raw wastewater** Wastewater before it receives any treatment.

**reaction rate** The rate at which a chemical reaction progresses. See also *kinetics, rate*.

**reactor** The container, vessel, or tank in which a chemical or biological reaction is carried out.

**recalcining** Recovery of lime from water and wastewater treatment sludge.

**recarbonation** (1) The process of introducing carbon dioxide as a final stage in the lime-soda ash softening process to convert carbonates to bicarbonates and thereby stabilize the solution against precipitation of carbonates. (2) The addition of carbon dioxide to the effluent of an advanced wastewater treatment ammonia air stripping process to lower the pH. (3) The diffusion of carbon dioxide gas through a liquid to replace the carbon dioxide removed by the addition of lime. (4) The diffusion of carbon dioxide gas through a liquid to render the liquid stable with respect to precipitation or dissolution of alkaline constituents.

**receiving water** A river, lake, ocean, or other watercourse into which wastewater or treated effluent is discharged.

**receptacle** A contact device installed at the outlet for connection of a single attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is a single device containing two or more receptacles.

**reciprocating pump** A type of displacement pump consisting essentially of a closed cylinder containing a piston or plunger as the displacing mechanism. Liquid is drawn into the cylinder through an inlet valve and forced out through an outlet valve. When the piston acts on the liquid in one end of the cylinder, the pump is termed *single-action*; when it acts in both ends, it is termed *double-action*.

**recirculation** (1) In the wastewater field, the return of all or a portion of the effluent in a trickling filter to maintain a uniform high rate through the filter. Return of a portion of the effluent to maintain minimum flow is sometimes called *recycling*. (2) The return of effluent to the incoming flow. (3) The return of the effluent from a process, factory, or operation to the incoming flow to reduce the water intake. The incoming flow is called *makeup water*.

**reclaimed wastewater** Wastewater used for some beneficial purpose usually after some degree of treatment.

**recorder** (1) A device that makes a graph or other record of the stage, pressure, depth, velocity, or the movement or position of water-controlling devices, usually as a function of time. See also *indicator*. (2) The person who records the observational data.

**recording gauge** An automatic instrument for measuring and recording graphically and continuously. Also called a *register*.

**rectangular weir** A weir having a notch that is rectangular in shape.

**recycle** (1) To return water after some type of treatment for further use; generally implies a closed system. (2) To recover useful values from segregated solid waste.

**recycling** (1) An operation in which a substance is passed through the same series of processes, pipes, or vessels more than once. (2) The conversion of solid waste into usable materials or energy.

**reduce** The opposite of oxidize. The action of a substance to decrease the positive valence of an ion.

**reduction** The addition of electrons to a chemical entity decreasing its valence. See also *oxidation*.

**refractory** Brick or similar material that lines a furnace or incinerator.

**regeneration** (1) In ion exchange, the process of restoring an ion exchange material to the state used for adsorption. (2) The periodic restoration of exchange capacity of ion exchange media used in water treatment.

**relative humidity** (1) The amount of water vapor in the air; expressed as a percentage of the maximum amount that the air could hold at the given temperature. (2) The ratio of the actual water vapor pressure to the saturation vapor pressure.

**relay** An electrical device that is designed to interpret input conditions in a prescribed manner and, after specified conditions are met, to respond to cause electrical operation or similar abrupt change in associated control circuits. The most common form of relay uses a coil and set of contacts. When current flows in the coil, contacts are opened or closed, depending on their arrangement. Relays are said to be normally open or normally closed.

**relief valve** A valve that releases air from a pipeline automatically without loss of water, or introduces air into a line automatically if the internal pressure becomes less than that of the atmosphere.

**removal efficiency** A measure of the effectiveness of a process in removing a constituent, such as BOD or TSS. Removal efficiency is calculated by subtracting the effluent value from the influent value and dividing it by the influent value. Multiply the answer by 100 to convert to a percentage.

**repair** An element of maintenance, as distinguished from replacement or retirement.

**replacement** Installation of new or alternate equipment in place of existing equipment for a variety of reasons, such as obsolescence, total disrepair, improvement, or modification.

**replacement cost** (1) The actual or estimated cost of duplication with a property of equal utility and desirability. (2) The cost of replacing property.

**residue** (1) The equilibrium quantity of a compound or element remaining in an organism after uptake and clearance. (2) The dry solid remaining after evaporation.

**resistance** The property of an electrical circuit or device that opposes current flow, thereby causing conversion of electrical energy to heat or radiant energy.

**respiration** Intake of oxygen and discharge of carbon dioxide as a result of biological oxidation.

**retention time** The theoretical time required to displace the contents of a tank or unit at a given rate of discharge (volume divided by the rate of discharge). Also called *detention time*.

**return sludge** Settled activated sludge returned to mix with incoming raw or primary settled wastewater. More commonly called *return activated sludge*.

**reverse osmosis** An advanced method used in water and wastewater treatment that relies on a semipermeable membrane to separate the water from its impurities. An external force is used to reverse the normal osmotic flow resulting in movement of the water from a solution of higher solute concentration to one of lower concentration. Also called *hyperfiltration*.

**revolving screen** A screen or rack in the form of a cylinder or a continuous belt that is revolved mechanically. The screenings are removed by water jets, automatic scrapers, or manually.

**Reynolds' number** A dimensionless quantity used to characterize the type of flow in a hydraulic structure where resistance to motion depends on the viscosity of the liquid in conjunction with inertia. It is equal to the ratio of inertial forces to viscous forces. The number is chiefly applicable to closed systems of flow, such as pipes or conduits where there is no free water surface, or to bodies fully immersed in the fluid so the free surface need not be considered.

**riprap** Broken stone or boulders placed compactly or irregularly on dams, levees, dikes, or similar embankments for protection of earth surfaces against the action of waves or currents.

**rising time** The time necessary for removal, by flotation, of suspended or aggregated colloidal substances.

**rotary distributor** A movable distributor made up of horizontal arms that extend to the edge of the circular trickling filter bed, revolve about a central post, and distribute liquid over the bed through orifices in the arms. The jet action of the discharging liquid normally supplies the motive power. See also *distributor*.

**rotary dryer** A long, slowly revolving, steel cylinder with its long axis slightly inclined, through which passes the material to be dried in hot air. The material passes through from inlet to outlet, tumbling about.

**rotary pump** A type of displacement pump consisting essentially of elements rotating in a pump case that is closely fit. The rotation of these elements alternately draws in and discharges the water being pumped. Such pumps act with neither suction nor discharge valves, operate at almost any speed, and do not depend on centrifugal forces to lift the water.

**rotary valve** A valve consisting of a casing more or less spherical in shape and a gate that turns on trunnions through 90 deg when opening or closing and having a cylindrical opening of the same diameter as that of the pipe it serves.

**rotating biological contactor (RBC)** A device for wastewater treatment composed of large, closely spaced plastic discs that are rotated about a horizontal shaft. The discs alternately move through the wastewater and the air and develop a biological growth on their surfaces.

**rotating distributor** A distributor consisting of rotating or reciprocating perforated pipes or troughs from which liquid is discharged in the form of a spray or in a thin sheet at uniform rates over the surface area to be wetted.

**rotifer** Minute, multicellular aquatic animals with rotating cilia on the head and forked tails. Rotifers help stimulate microfloral activity and decomposition, enhance oxygen penetration, and recycle mineral nutrients.

**roughing filter** A trickling filter used to remove an initial portion of the soluble BOD, usually about 50%, but not to provide complete removal.

**roughness coefficient** A factor in many engineering equations for computing the average velocity of flow of water in a conduit or channel. It represents the effect of the roughness of the confining material on the energy losses in the flowing water.

**safety valve** A valve that automatically opens when prescribed conditions, usually pressure, are exceeded in a pipeline or other closed receptacle containing liquids or gases. It prevents such conditions from being exceeded and causing damage.

**Salmonella** A genus of aerobic, rod-shaped, usually motile bacteria that are pathogenic for man and other warm-blooded animals.

**sampler** A device used with or without flow measurement to obtain a portion of liquid for analytical purposes. May be designed for taking single samples (grab), composite samples, continuous samples, or periodic samples.

**sand filter** A bed of sand through which water is passed to remove fine suspended particles. Commonly used in tertiary wastewater treatment plants and sludge drying beds.

**sanitary sewer** A sewer that carries liquid and waterborne wastes from residences, commercial buildings, industrial plants, and institutions together with minor quantities of ground, storm, and surface water that are not admitted intentionally. See also *wastewater*.

**Sarcadina** Species of amoeba found in wastewater. Does not play a significant role in the activated-sludge process other than as an indication of start up or the passing of a toxic influence.

**saturated air** Air containing all the water vapor that it is capable of holding at a given temperature and pressure.

**saturated liquid** Liquid that contains at a given temperature as much of a solute as it can retain in the presence of an excess of that solute.

**scraper** (1) Device used to remove solids from a clarifier to a sump. (2) Mechanism to remove dewatered solids from a belt filter press or conveyor.

**screen** A device with openings, generally of uniform size, used to retain or remove suspended or floating solids in flow stream preventing them from passing a given point in a conduit. The screening element may consist of parallel bars, rods, wires, grating, wire mesh, or perforated plate.

**screening** A preliminary treatment process that removes large suspended or floating solids from raw wastewater to prevent subsequent plugging of pipes or damage to pumps.

**screenings** (1) Material removed from liquids by screens. (2) Broken rock, including the dust, of a size that will pass through a given screen depending on the character of the stone.

**screenings grinder** A device for grinding, shredding, or macerating material removed from wastewater by screens.

**screw-feed pump** A pump with either a horizontal or vertical cylindrical casing in which operates a runner with radial blades like those of a ship's propeller. See also *vertical screw pump*.

**scrubbing** Removal of suspended solids and undesirable gases from gaseous emissions.

**scum** (1) The extraneous or foreign matter that rises to the surface of a liquid and forms a layer or film there. (2) A residue deposited on a container or channel at the water surface. (3) A mass of solid matter that floats on the surface.

**scum baffle** A vertical baffle dipping below the surface of wastewater in a tank to prevent the passage of floating matter.

**scum breaker** A device installed in a sludge digestion tank to break up scum.

**scum chamber** A space provided in a sludge digestion tank for accumulated scum rising from the digestion unit.

**scum collector** A mechanical device for skimming and removing scum from the surface of settling tanks.

**scum removal** Separation of floating grease and oil from wastewater usually during preliminary or primary treatment.

**scum trough** A trough placed in a primary sedimentation tank to intercept scum and convey it out of the tank.

**Secchi disk** Tool to measure the clarity of the water.

**secondary effluent** (1) The liquid portion of wastewater leaving secondary treatment. (2) An effluent that, with some exceptions, contains not more than 30 mg/L each (on a 30-day average basis) of BOD<sub>5</sub> and suspended solids.

**secondary sedimentation tank** A settling tank following secondary treatment designed to remove by gravity part of the suspended matter. Also called a *secondary clarifier*.

**secondary treatment** (1) Generally, a level of treatment that produces secondary effluent. (2) Sometimes used interchangeably with the concept of biological wastewater treatment, particularly the activated-sludge process. Commonly applied to treatment that consists chiefly of clarification followed by a biological process with separate sludge collection and handling.

**secondary voltage** The output or load-supplied voltage of a transformer or substation (see *primary voltage*).

**second-stage BOD** That part of the oxygen demand associated with the biochemical oxidation of nitrogenous material. As the term implies, the oxidation of the nitrogenous materials usually does not start until a portion of the carbonaceous material has been oxidized during the first stage.

**sedimentation** (1) The process of subsidence and decomposition of suspended matter or other liquids by gravity. It is usually accomplished by reducing the velocity of the liquid below the point at which it can transport the suspended material. Also called settling. It may be enhanced by coagulation and flocculation. (2) Solid-liquid separation resulting from the application of an external force, usually settling in a clarifier under the force of gravity. It can be variously classed as discrete, flocculent, hindered, and zone sedimentation.

**sedimentation tank** A basin or tank in which wastewater containing settleable solids is retained for removal of the suspended matter by gravity. Also called a *sedimentation basin*, *settling basin*, *settling tank*, or *clarifier*.

**Operation of Municipal Wastewater Treatment Plants**

**seed sludge** In biological treatment, the inoculation of the unit process with biologically active sludge resulting in acceleration of the initial stage of the process.

**self-cleansing velocity** The minimum velocity necessary to keep solids in suspension in sewers, thus preventing their deposition and subsequent nuisance from stoppages and odors of decomposition.

**separate sewer system** A sewer system carrying sanitary wastewater and other water-carried wastes from residences, commercial buildings, industrial plants, and institutions, as well as minor quantities of ground, storm, and surface water that are not intentionally admitted. See also *combined sewer, wastewater*.

**septage** The sludge produced in individual on-site wastewater disposal systems such as septic tanks and cesspools.

**septic** (1) Anaerobic. (2) Putrid, rotten, foul smelling; anaerobic.

**septicity** A condition produced by growth of anaerobic organisms.

**septic wastewater** Wastewater undergoing anaerobic decomposition.

**service** Conductors and equipment for delivering energy from the electrical supply system to the wiring system of the premises served.

**service charge** The rate charged by the utility for rendering service, usually used as a ready-to-serve charge.

**service conductors** Supply conductors that extend from the street main or from transformers to the service equipment of the premises served.

**service equipment** Necessary equipment usually consisting of a circuit breaker or switch and fuses and their accessories that is located near the point of entrance of the supply conductors to a building or other structure and intended to constitute the main control and means of cut-off of the electrical supply.

**settleability** The tendency of suspended solids to settle.

**settleability test** A determination of the settleability of solids in a suspension by measuring the volume of solids settled out of a measured volume of sample in a specified interval of time, usually reported in milliliters per liter (mL/L). Also called the *Imhoff cone test*.

**settleable solids** (1) That matter in wastewater that will not stay in suspension during a preselected settling period, such as 1 hour, but settles to the bottom. (2) In the Imhoff cone test, the volume of matter that settles to the bottom of the cone in 1 hour. (3) Suspended solids that can be removed by conventional sedimentation.

**settleometer** A 2-L or larger beaker used to conduct the settleability test.

**settling** The process of subsidence and deposition of suspended matter carried by a liquid. It is usually accomplished by reducing the velocity of the liquid below the point at which it can transport the suspended material. Also called *sedimentation*.

**settling tank** A tank or basin in which water, wastewater, or other liquid containing settleable solids is retained for a sufficient time, and in which the velocity of flow is sufficiently low to remove by gravity a part of the suspended matter. See also *sedimentation tank*.

**settling time** Time necessary for the removal of suspended or colloidal substances by gravitational settling, aggregation, or precipitation.

**settling velocity** Velocity at which subsidence and deposition of settleable suspended solids in wastewater will occur.

**sheet flow** Flow in a relatively thin sheet of generally uniform thickness.

**short-circuiting** A hydraulic condition occurring in parts of a tank where the time of travel is less than the flow-through time.

**side contraction** The contraction of the nappe or reduction in width of water overflowing a weir brought about by the detachment of the sides of the nappe or jet of water passing over the sides of the weir.

**side-water depth** The depth of water measured along a vertical exterior wall.

**single-action pump** A reciprocating pump in which the suction inlet admits water to only one side of the plunger or piston and the discharge is intermittent.

**single-stage digestion** Digestion limited to a single tank for the entire digestion period.

**single-suction impeller** An impeller with one suction inlet.

**skimming** (1) The process of diverting water from the surface of a stream or conduit by means of a shallow overflow. (2) The process of diverting water from any elevation in a reservoir by means of an outlet at a different elevation or by any other skimming device in order to obtain the most palatable drinking water. (3) The process of removing grease or scum from the surface of wastewater in a tank.

**skimmings** Grease, solids, liquids, and scum skimmed from wastewater settling tanks.

**slake** To become mixed with water so that a true chemical combination takes place, as in the slaking of lime.

**slimes** (1) Substances of a viscous organic nature, usually formed from microbiological growth, that attach themselves to other objects forming a coating. (2) The coating of biomass (humus, schmutzdecke, sluff) that accumulates in trickling filters or sand filters and periodically sloughs away to be collected in clarifiers. See also *biofilm*.

**slope** (1) The inclination of gradient from the horizontal of a line or surface. The degree of inclination is usually expressed as a ratio such as 1:25, indicating unit rise in 25 units of horizontal distance; or in a decimal fraction (0.04); degrees (2 deg 18 min); or percent (4%). (2) Inclination of the invert of a conduit expressed as a decimal or as feet (meters) per stated length measured horizontally in feet. (3) In plumbing, the inclination of a conduit, usually expressed in inches per foot (meter) length of pipe.

**sloughing** The disattachment of slime and solids accumulated on the media of trickling filters and RBCs in contact areas. Sloughed material usually is removed subsequently in clarifiers. See also *slimes*.

**slow sand filter** A filter for the purification of water in which water without previous treatment is passed downward through a filtering medium consisting of a layer of sand from 24- to 40-in. (0.6- to 1-m) thick. The filtrate is removed by an underdrainage system and the filter is cleaned by scraping off the clogged sand and eventually replacing it. It is characterized by a slow rate of filtration, commonly 3 to 6 mgd/ac (28 to 56 ML/ha·d) of filter area. Its effectiveness depends on the biological mat (or *schmutzdecke*) that forms in the top few millimeters.

**sludge** (1) The accumulated solids separated from liquids during the treatment process that have not undergone a stabilization process. (2) The removed material resulting from chemical treatment, coagulation, flocculation, sedimentation, flotation, or biological oxidation of water or wastewater. (3) Any solid material containing large amounts of entrained water collected during water or wastewater treatment. See also *activated sludge*, *settleable solids*.

**sludge age** Average residence time of suspended solids in a biological treatment system equal to the total weight of suspended solids in the system divided by the total weight of suspended solids leaving the systems.

**sludge blanket** Accumulation of sludge hydrodynamically suspended within an enclosed body of water or wastewater.

**sludge boil** An upwelling of water and sludge deposits caused by release of decomposition gases in the sludge deposits.

**sludge circulation** The overturning of sludge in sludge digestion tanks by mechanical or hydraulic means or by the use of gas recirculation to disperse scum layers and promote digestion.

**sludge collector** A mechanical device for scraping the sludge on the bottom of a settling tank to a sump from which it can be drawn.

**sludge concentration** Any process of reducing the water content of sludge leaving the sludge in a fluid condition.

**sludge density index (SDI)** A measure of the degree of compaction of a sludge after settling in a graduated container, expressed as mL/g. The sludge volume index (SVI) is the reciprocal of the sludge density index.

**sludge dryer** A device for removing a large percentage of moisture from sludge or screenings by heat.

**sludge drying** The process of removing a large percentage of moisture from sludge by drainage or evaporation by any method.

**sludge-gas holder** A tank used to store gas collected from sludge digestion tanks for the purpose of stabilizing the flow of gas to the burners, maintaining a nearly constant pressure, and supplying gas during periods when the digestion tanks are temporarily out-of-service or when gas production is low.

**sludge-gas utilization** Using the gas produced by the anaerobic digestion of sludge for beneficial purposes such as heating sludge, mixing sludge, drying sludge, heating buildings, incineration, or fueling engines.

**sludge pressing** The process of dewatering sludge by subjecting it to pressure, usually within a cloth fabric through which the water passes and in which the solids are retained.

**sludge reaeration** The continuous aeration of sludge after its initial aeration for the purpose of improving or maintaining its condition.

**sludge reduction** The reduction in quantity and change in character of sludge as the result of digestion.

**sludge solids** Dissolved and suspended solids in sludge.

**sludge thickener** A tank or other equipment designed to concentrate wastewater sludges.

**sludge thickening** The increase in solids concentration of sludge in a sedimentation tank, DAF, gravity thickener, centrifuge or gravity belt thickener.

**sludge utilization** The use of sludges resulting from industrial wastewater treatment as soil builders and fertilizer admixtures.

**sludge volume index (SVI)** The ratio of the volume (in milliliters) of sludge settled from a 1000-mL sample in 30 minutes to the concentration of mixed liquor (in milligrams per liter [mg/L]) multiplied by 1000.

**slurry** A thick, watery mud or any substance resembling it, such as lime slurry.

**soda ash** A common name for commercial sodium carbonate ( $\text{Na}_2\text{CO}_3$ ).

**sodium bisulfite ( $\text{NaHSO}_3$ )** A salt used for reducing chlorine residuals; a strong reducing agent; typically found in white powder or granular form in strengths up to 44%. At a strength of 38%, 1.46 parts will consume 1 part of chlorine residual.

**Operation of Municipal Wastewater Treatment Plants**

**sodium carbonate ( $Na_2CO_3$ )** A salt used in water treatment to increase the alkalinity or pH of water or to neutralize acidity. Also called *soda ash*.

**sodium hydroxide ( $NaOH$ )** A strong caustic chemical used in treatment processes to neutralize acidity, increase alkalinity, or raise the pH value. Also known as *caustic soda*, *sodium hydrate*, *lye*, and *white caustic*.

**sodium hypochlorite ( $NaOCl$ )** A water solution of sodium hydroxide and chlorine in which sodium hypochlorite is the essential ingredient.

**sodium metabisulfite ( $Na_2S_2O_5$ )** A cream-colored powder used to conserve chlorine residual; 1.34 parts of  $Na_2S_2O_5$  will consume 1 part of chlorine residual.

**soil absorption capacity** In subsurface effluent disposal, the ability of the soil to absorb water. See *soil absorption test*.

**soil absorption test** A test for determining the suitability of an area for subsoil effluent disposal by measuring the rate at which the undisturbed soil will absorb water per unit of surface.

**soil horizon** A layer or section of the soil profile, more or less well defined, occupying a position approximately parallel to the soil surface, and having characteristics that have been produced through the operation of soil-building processes.

**soil infiltration rate** The maximum rate at which a soil, in a given condition at a given time, can absorb water.

**soil porosity** The percentage of the soil (or rock) volume that is not occupied by solid particles, including all pore space filled with air and water. The total porosity may be calculated from the following formula: percent pore space =  $(1 - \text{volume weight} / \text{specific gravity}) \times 100$ .

**solids disposal** Any process for the ultimate disposal of solid wastes or sludges by incineration, landfilling, soil conditioning, or other means.

**solids inventory** Amount of sludge in the treatment system typically expressed as kilogram (tons). Inventory of plant solids should be tracked through the use of a mass balance set of calculations.

**solids loading** Amount of solids applied to a treatment process per unit time per unit volume.

**solids retention time (SRT)** The average time of retention of suspended solids in a biological waste treatment system, equal to the total weight of suspended solids leaving the system, per unit time.

**sparger** An air diffuser designed to give large bubbles, used singly or in combination with mechanical aeration devices.

**species** A subdivision of a genus having members differing from other members of the same genus in minor details.

**specific gravity** The ratio of the mass of a body to the mass of an equal volume of water at a specific temperature, typically 20 °C (68 °F).

**specific oxygen uptake rate** Measures the microbial activity in a biological system expressed in mg O<sub>2</sub>/g·h of VSS. Also called *respiration rate*.

**specific resistance** The relative resistance a sludge offers to the draining of its liquid component.

**specific speed** A speed or velocity of revolution, expressed in revolutions per minute (rpm), at which the runner of a given type or turbine would operate if it were so reduced in size and proportion that it would develop 1 hp under a 1-ft head. The quantity is used in determining the proper type and character of turbine to install at a hydroelectric power plant under given conditions.

**spiral-air flow diffusion** A method of diffusing air in the grit chamber or aeration tank of the activated-sludge process where, by means of properly designed baffles and the proper location of diffusers, a spiral helical movement is given to the air and the tank liquor.

**splitter box** (1) A division box that splits the incoming flow into two or more streams. (2) A device for splitting and directing discharge from the head box to two separate points of application.

**spray aerator** An aerator consisting of a pressure nozzle through which water is propelled into the air in a fine spray.

**spray irrigation** A method of land treatment for disposing of some organic wastewaters by spraying them, usually from pipes equipped with fixed or moving spray nozzles. See also *land application*.

**stabilization pond** A type of oxidation pond in which biological oxidation of organic matter is effected by natural or artificially accelerated transfer of oxygen to the water from air.

**staged digestion** The progressive digestion of waste in two or more tanks arranged in series, usually divided into primary digestion with mixed contents and secondary digestion where quiescent conditions prevail and supernatant liquor is collected.

**staged treatment** (1) Any treatment in which similar processes are used in series or stages. (2) In the activated-sludge process, two or more stages consisting of a clarifying stage and a biological stage, or two biological stages. (3) In anaerobic digestion, an operation in which sludge is completely mixed in the first tank and pumped to a second tank for separation of the supernatant liquor from the solids.

**Operation of Municipal Wastewater Treatment Plants**

**staged trickling filter** A series of trickling filters through which wastewater passes successively with or without intermediate sedimentation.

**stale wastewater** Wastewater containing little or no oxygen, but as yet free from putrefaction. See also *septic wastewater*.

**stalked ciliates** Small, one-celled organisms possessing cilia (hair-like projections used for feeding) that are not motile. They develop at lower prey densities, long SRTs, and low F:M ratios.

**Standard Methods** (1) An assembly of analytical techniques and descriptions commonly accepted in water and wastewater treatment (*Standard Methods for the Examination of Water and Wastewater*) published jointly by the American Public Health Association, the American Water Works Association, and the Water Environment Federation. (2) Validated methods published by professional organizations and agencies covering specific fields or procedures. These include, among others, the American Public Health Association, American Public Works Association, American Society of Civil Engineers, American Society of Mechanical Engineers, American Society for Testing and Materials, American Water Works Association, U.S. Bureau of Standards, U.S. Standards Institute (formerly American Standards Association), U.S. Public Health Service, Water Environment Federation, and U.S. Environmental Protection Agency.

**standard pressure** Atmospheric pressure at sea level under standard conditions.

**static head** Vertical distance between the free level of the source of supply and the point of free discharge or the level of the free surface.

**static level** (1) The elevation of the water table or pressure surface when it is not influenced by pumping or other forms of extraction from the groundwater. (2) The level of elevation to which the top of a column of water would rise, if afforded the opportunity to do so, from an artesian aquifer, basin, or conduit under pressure. Also called *hydrostatic level*.

**static suction head** The vertical distance from the source of supply, when its level is above the pump, to the center line of the pump.

**static suction lift** The vertical distance between the center of the suction end of a pump and the free surface of the liquid being pumped. Static lift does not include friction losses in the suction pipes. Static suction head includes lift and friction losses.

**steady flow** (1) A flow in which the rate, or quantity of water passing a given point per unit of time, remains constant. (2) Flow in which the velocity vector does not change in either magnitude or direction with respect to time at any point or section.

**steady nonuniform flow** A flow in which the quantity of water flowing per unit of time remains constant at every point along the conduit, but the velocity varies along the conduit because of a change in the hydraulic characteristics.

**step aeration** A procedure for adding increments of settled wastewater along the line of flow in the aeration tanks of an activated-sludge plant. Also called *step feed*.

**stoichiometric** Pertaining to or involving substances that are in the exact proportions required for a given reaction.

**straggler floc** Large (6-mm or larger) floc particles that have poor settling characteristics.

**submerged weir** A weir that, when in use, has a water level on the downstream side at an elevation equal to, or higher than, the weir crest. The rate of discharge is affected by the tailwater. Also called a *drowned weir*.

**submergence** (1) The condition of a weir when the elevation of the water surface on the downstream side is equal to or higher than that of the weir crest. (2) The ratio, expressed as a percentage, of the height of the water surface downstream from a weir above the weir crest to the height of the water surface upstream above the weir crest. The distances upstream or downstream from the crest at which such elevations are measured are important, but have not been standardized. (3) In water power engineering, the ratio of tailwater elevation to the headwater elevation when both are higher than the crest. The overflow crest of the structure is the datum of reference. The distances upstream or downstream from the crest at which headwater and tailwater elevations are measured are important, but have not been standardized. (4) The depth of flooding over a pump suction inlet.

**substation** An assembly of equipment for switching and/or changing or regulating the voltage electrical supply.

**substrate** (1) Substances used by organisms in liquid suspension. (2) The liquor in which activated sludge or other matter is kept in suspension.

**suction head** (1) The head at the inlet to a pump. (2) The head below atmospheric pressure in a piping system.

**suction lift** The vertical distance from the liquid surface in an open tank or reservoir to the center line of a pump drawing from the tank or reservoir and set higher than the liquid surface.

**suctoreans** Ciliates that are stalked in the adult stage and have rigid tentacles to catch prey.

**sulfate-reducing bacteria** Bacteria capable of assimilating oxygen from sulfate compounds, reducing them to sulfides. See also *sulfur bacteria*.

**sulfur bacteria** Bacteria capable of using dissolved sulfur compounds in their growth; bacteria deriving energy from sulfur or sulfur compounds.

**sulfur cycle** A graphical presentation of the conservation of matter in nature showing the chemical transformation of sulfur through various stages of decomposition and assimilation. The various chemical forms of sulfur as it moves among living and non-living matter is used to illustrate general biological principles that are applicable to wastewater and sludge treatment.

**sump** A tank or pit that receives drainage and stores it temporarily, and from which the discharge is pumped or ejected.

**sump pump** A mechanism used for removing water or wastewater from a sump or wet well; it may be energized by air, water, steam, or electric motor. Ejectors and submerged centrifugal pumps, either float or manually controlled, are often used for the purpose.

**supernatant** (1) The liquid remaining above a sediment or precipitate after sedimentation. (2) The most liquid stratum in a sludge digester.

**supersaturation** (1) An unstable condition of a vapor in which its density is greater than that normally in equilibrium under the given conditions. (2) The condition existing in a given space when it contains more water vapor than is needed to cause saturation; that is, when its temperature is below that required for condensation to take place. This condition probably can occur only when water or ice is immediately present, and when the space contains no dust or condensation nuclei. (3) An unstable condition of a solution in which it contains a solute at a concentration exceeding saturation.

**suppressed weir** A weir with one or both sides flush with the channel of approach. This prevents contraction of the nappe adjacent to the flush side. The suppression may occur on one end or both ends.

**surface aeration** The absorption of air through the surface of a liquid.

**surface overflow rate** A design criterion used for sizing clarifiers; typically expressed as the flow volume per unit amount of clarifier space ( $\text{m}^3/\text{m}^2\cdot\text{s}$  [gpd/sq ft]).

**surfactant** A surface-active agent, such as ABS or LAS, that concentrates at interfaces, forms micelles, increases solution, lowers surface tension, increases adsorption, and may decrease flocculation.

**surge** (1) A momentary increase in flow (in an open conduit) or pressure (in a closed conduit) that passes longitudinally along the conduit, usually because of sudden changes in velocity or quantity. (2) Any periodic, usually abrupt, change in flow, temperature, pH, concentration, or similar factor.

**surge suppressor** A device used in connection with automatic control of pumps to minimize surges in a pipeline.

**surge tank** A tank or chamber located at or near a hydroelectric powerhouse and connected with the penstock above the turbine. When the flow of water delivered to the turbine is suddenly decreased, the tank absorbs the water that is held back and cushions the increased pressure on the penstock caused by the rapid deceleration of the water flowing in it; also, when the flow delivered to the turbine is suddenly increased, the tank supplies the increased quantity of water required until the flow in the penstock has been accelerated sufficiently. Also used in connection with pumping systems.

**suspended matter** (1) Solids in suspension in water, wastewater, or effluent. (2) Solids in suspension that can be readily removed by standard filtering procedures in a laboratory.

**suspended solids** (1) Insoluble solids that either float on the surface of, or are in suspension in, water, wastewater, or other liquids. (2) Solid organic or inorganic particles (colloidal, dispersed, coagulated, or flocculated) physically held in suspension by agitation or flow. (3) The quantity of material removed from wastewater in a laboratory test, as prescribed in *Standard Methods* and referred to as *nonfilterable residue*.

**switchboard** A large panel or assembly of panels on which switches, overcurrent, and/or other protective devices such as buses and instruments are mounted. Switchboards are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets.

**synergism** Interaction between two entities producing an effect greater than a simple additive one. See also *antagonism*.

**tapered aeration** The method of supplying varying quantities of air into the different parts of an aeration tank in the activated-sludge process, more at the inlet, less near the outlet, in approximate proportion to the oxygen demand of the mixed liquor under aeration.

**tee** A pipe fitting, either cast or wrought, that has one side outlet at right angles to the run. A single-outlet branch pipe.

**temperature** (1) The thermal state of a substance with respect to its ability to transmit heat to its environment. (2) The measure of the thermal state on some arbitrarily chosen numerical scale. See also *Celsius*, *centigrade*, *Fahrenheit*.

**temporary hardness** Hardness that can be removed by boiling; more properly called *carbonate hardness*. See also *carbonate hardness*, *hardness*.

**tertiary effluent** The liquid portion of wastewater leaving tertiary treatment.

**tertiary treatment** The treatment of wastewater beyond the secondary or biological stage; term normally implies the removal of nutrients, such as phosphorus and nitrogen, and a high percentage of suspended solids; term now being replaced by *advanced waste treatment*. See also *advanced waste treatment*.

**thermal stratification** The formation of layers of different temperatures in bodies of water.

**thermophilic digestion** Digestion occurring at a temperature approaching or within the thermophilic range, generally between 43 and 60 °C (110 and 140 °F).

**thermophilic range** That temperature range most conducive to maintenance of optimum digestion by thermophilic bacteria, generally accepted as between 49 and 57 °C (120 and 135 °F). See also *thermophilic digestion*.

**thickeners** Any equipment or process, after gravity sedimentation, that increases the concentration of solids in sludges with or without the use of chemical flocculents.

**threshold odor** The minimum odor of the water sample that can barely be detected after successive dilutions with odorless water. Also called *odor threshold*.

**threshold odor number** The greatest dilution of a sample with odor-free water that yields a definitely perceptible odor.

**titration** The determination of a constituent in a known volume of solution by the measured addition of a solution of known strength to completion of the reaction as signalled by observation of an end point.

**tolerance** The ability of an organism to withstand exposure to a specific compound; a tolerance level may be defined as a period of exposure or a level of exposure (concentration) that is withstood.

**total carbon (TC)** A quantitative measure of both total inorganic and total organic carbon as determined instrumentally by chemical oxidation to carbon dioxide and subsequent infrared detection in a carbon analyzer. See also *total organic carbon*.

**total dissolved solids (TDS)** The sum of all dissolved solids (volatile and nonvolatile).

**total dynamic discharge head** Total dynamic head plus the dynamic suction head or minus the dynamic suction lift.

**total dynamic head (TDH)** The difference between the elevation corresponding to the pressure at the discharge flange of a pump and the elevation corresponding to the vacuum or pressure at the suction flange of the pump, corrected to the same datum plane, plus the velocity head at the discharge flange of the pump minus the velocity head at the suction flange of the pump.

**total head** (1) The sum of the pressure, velocity, and position heads above a datum. The height of the energy line above a datum. (2) The difference in elevation between the surface of the water at the source of supply and the elevation of the water at the outlet, plus velocity head and lost head. (3) The high distance of the energy line above the datum; energy head. (4) In open channel flow, the depth plus the velocity head.

**total organic carbon (TOC)** The amount of carbon bound in organic compounds in a sample. Because all organic compounds have carbon as the common element, total organic carbon measurements provide a fundamental means of assessing the degree of organic pollution.

**total oxygen demand (TOD)** A quantitative measure of all oxidizable material in a sample water or wastewater as determined instrumentally by measuring the depletion of oxygen after high-temperature combustion. See also *chemical oxygen demand*, *total organic carbon*.

**total pumping head** The measure of the energy increase imparted to each pound of liquid as it is pumped, and therefore, the algebraic difference between the total discharge head and the total suction head.

**total solids (TS)** The sum of dissolved and suspended solid constituents in water or wastewater.

**total suspended solids (TSS)** The amount of insoluble solids floating and in suspension in the wastewater. Also referred to as *total nonfilterable residue*.

**toxicant** A substance that kills or injures an organism through chemical, physical, or biological action; examples include cyanides, pesticides, and heavy metals.

**toxicity** The adverse effect that a biologically active substance has, at some concentration, on a living entity.

**toxic wastes** Wastes that can cause an adverse response when they come in contact with a biological entity.

**trace nutrients** Substances vital to bacterial growth. Trace nutrients are defined in this text as nitrogen, phosphorus, and iron.

**transformer** An electromagnetic device for changing the voltage of alternating current electricity.

**trap** (1) A device used to prevent a material flowing or carried through a conduit from reversing its direction of flow or movement, or from passing a given point. (2) A device to prevent the escape of air from sewers through a plumbing fixture or catch basin.

**trash** Debris that may be removed from reservoirs, combined sewers, and storm sewers by coarse racks.

**trash rack** A grid or screen placed across a waterway to catch floating debris.

**trickling filter** Secondary treatment process where wastewater trickles over rock or honeycombed-shaped plastic media. Biomass and slimes containing microorganisms form on the media and utilize the organic matter for growth and energy.

**tri-halomethanes (THM)** Derivatives of methane ( $\text{CH}_4$ ) in which three halogen atoms (chlorine, bromine, or iodine) are substituted for three of the hydrogen atoms.

**trough** A structure, usually with a length several times its transverse dimensions, used to hold or transport water or other liquids.

**tube settler** A series of tubes, about 2 in. in diameter or 2-in. square, placed in a sedimentation tank to improve the solids removal efficiency.

**tubing** (1) Flexible pipe of small diameter, usually less than 2 in. (2) A special grade of high-test pipe fitted with couplings and fittings of special design.

**turbidimeter** An instrument for measurement of turbidity in which a standard suspension is used for reference.

**turbidity** (1) A condition in water or wastewater caused by the presence of suspended matter and resulting in the scattering and absorption of light. (2) Any suspended solids imparting a visible haze or cloudiness to water that can be removed by filtration. (3) An analytical quantity usually reported in turbidity units determined by measurements of light scattering. See also *formazine turbidity unit*, *nephelometric turbidity unit*.

**turbine pump** A centrifugal pump in which fixed guide vanes partially convert the velocity energy of the water to pressure head as the water leaves the impeller.

**turbulence** (1) The fluid property that is characterized by irregular variation in the speed and direction of movement of individual particles or elements of the flow. (2) A state of flow of water in which the water is agitated by cross currents and eddies, as opposed to laminar, streamline, or viscous flow. See also *turbulent flow*.

**turbulent flow** (1) The flow of a liquid past an object such that the velocity at any fixed point in the fluid varies irregularly. (2) A type of fluid flow in which there is an unsteady motion of the particles and the motion at a fixed point varies in no definite manner. Also called *eddy flow* or *sinuous flow*.

**turnover** The phenomenon of vertical circulation that occurs in large bodies of water. It results from the increase in density of water above and below 39.2 °F (4 °C), the temperature of minimum density. In the spring, as the surface of the water warms above

the freezing point, the water increases in density and tends to sink, producing vertical currents; in the fall, as the surface water becomes colder, it also tends to sink. Wind may also create such vertical currents. Also called *overturn*.

***two-staged digestion*** The biological decomposition of organic matter in sludge followed by solids–liquid separation of the digested sludge. Two-stage digestion uses two compartments or two tanks to separate the violent initial digestion period from the slower final period to enhance both the digestion and the solids–liquid separation after digestion.

***ultimate biochemical oxygen demand (BOD<sub>u</sub>)*** (1) Commonly, the total quantity of oxygen required to completely satisfy the first-stage BOD. (2) More strictly, the quantity of oxygen required to completely satisfy both the first-stage and second-stage BOD.

***ultimate disposal*** The final release of a biologically and chemically stable wastewater or sludge into the environment.

***ultraviolet radiation (UV)*** Light waves shorter than the visible blue-violet waves of the spectrum.

***ultraviolet ray*** Light rays beyond the violet of the spectrum; these are invisible to humans.

***underdrain*** A drain that carries away groundwater or the drainage from prepared beds to which water or wastewater has been applied.

***unsteady nonuniform flow*** Flow in which the velocity and the quantity of water flowing per unit time at every point along the conduit varies with respect to time and position.

***upflow*** Term used to describe treatment units in which flow enters at the bottom and exits at the top.

***upflow clarifier*** A treatment unit in which liquid containing suspended solids is passed upward through a blanket of settling sludge; mixing, flocculation, and solids removal are all accomplished in the same unit.

***upflow coagulation*** Coagulation achieved by passing liquid, to which coagulating chemicals may have been added, upward through a blanket of settling sludge.

***upflow filter*** A gravity or pressure filtration system in which the wastewater flows upward, generally first through a coarse medium and then through a fine medium, before discharging.

***upflow tank*** A sedimentation tank in which water or wastewater enters near the bottom and rises vertically, usually through a blanket of previously settled solids. The clarified liquid flows out at the top and settled sludge flows out the bottom; a vertical-flow tank.

*user* The party who is billed, usually for sewer service from a single connection; has no reference to the number of persons served. Also called a *customer*.

*user charge* Charge made to users of wastewater services supplied.

*utilization equipment* Equipment that uses electrical energy for mechanical, chemical, heating, lighting, or similar useful purposes.

*vacuum breaker* A device for relieving a vacuum or partial vacuum formed in a pipeline, thereby preventing backsiphoning.

*vacuum filter* (1) A filter used to accomplish sludge dewatering and consisting of a cylindrical drum mounted on a horizontal axis, covered with filter media, and revolving partially submerged in a dilute sludge mixture. A vacuum is maintained under the media for the larger part of a revolution to extract moisture. The dewatered cake that is formed is scraped off mechanically for disposal. See also *vacuum filtration*. (2) A diatomaceous earth filter open to the atmosphere and on the inlet side of a pump.

*vacuum filtration* A usually continuous filtration operation that is generally accomplished on a rotating cylindrical drum. As the drum rotates, part of its circumference is subject to an internal vacuum that draws sludge to the filter medium and removes water for subsequent treatment. The dewatered sludge cake is released by a scraper.

*vacuum pump* (1) A pump for creating a partial vacuum in a closed space. (2) A pump in which water is forced up a pipe by the difference in pressure between the atmosphere and a partial vacuum. (3) An air compressor used in connection with steam condensers and for improving the suction head on other pumps. The compressor takes its suction at low absolute pressure, performs a large number of compressions, and generally discharges at atmospheric pressure.

*valence* An integer representing the number of hydrogen atoms with which one atom of an element (or one radical) can combine (negative valence), or the number of hydrogen atoms the atom or radical can displace (positive valence).

*valve* (1) A device installed in a pipeline to control the magnitude and direction of the flow. It consists essentially of a shell and a disk or plug fitted to the shell. (2) In a pump, a waterway, passage through which is controlled by a mechanism.

*vapor* (1) The gaseous form of any substance. (2) A visible condensation such as fog, mist, or steam that is suspended in air.

*vaporization* The process by which a substance such as water changes from the liquid or solid state to the gaseous state.

**vapor pressure** (1) Pressure exerted by a vapor in a confined space. It is a function of the temperature. (2) The partial pressure of water vapor in the atmosphere. See also *relative humidity*. (3) The partial pressure of any liquid.

**velocity head** (1) The vertical distance or height through which a body would have to fall freely, under the force of gravity, to acquire the velocity it possesses. It is equal to the square of the velocity divided by twice the acceleration of gravity. (2) The theoretical vertical height through which a liquid body may be raised by its kinetic energy. It is equal to the square of the velocity divided by twice the acceleration caused by gravity.

**velocity meter** A vane water meter that operates on the principle that the vanes of the wheel move at approximately the same velocity as the flowing water.

**Venturi meter** A differential meter for measuring the flow of water or other fluid through closed conduits or pipes. It consists of a Venturi tube and one of several proprietary forms of flow-registering devices. The difference in velocity heads between the entrance and the contracted throat is an indication of the rate of flow.

**vertical pump** (1) A reciprocating pump in which the piston or plunger moves in a vertical direction. (2) A centrifugal pump in which the pump shaft is in a vertical position.

**vertical screw pump** A pump, similar in shape, characteristics, and use to a horizontal screw pump, but which has the axis of its runner in a vertical position.

**virus** The smallest (10 to 300 nm in diameter) life form capable of producing infection and diseases in man and animals.

**viscosity** The molecular attractions within a fluid that make it resist a tendency to deform under applied forces.

**V-notch weir** A triangular weir.

**void** A pore or open space in rock or granular material not occupied by solid matter. It may be occupied by air, water, or other gaseous or liquid material. Also called *interstice* or *void space*.

**volatile** Capable of being evaporated at relatively low temperatures.

**volatile acids** Fatty acids containing six or fewer carbon atoms. They are soluble in water and can be steam-distilled at atmospheric pressure. They have pungent odors and are often produced during anaerobic decomposition.

**volatile solids (VS)** Materials, generally organic, that can be driven off from a sample by heating, usually to 550 °C (1022 °F); nonvolatile inorganic solids (ash) remain.

**volatile suspended solids (VSS)** That fraction of suspended solids, including organic matter and volatile inorganic salts, that will ignite and burn when placed in an electric muffle furnace at 550 °C (1022 °F) for 60 minutes.

**volt** The unit of electromotive force or electrical pressure (analogous to water pressure). It is the electromotive force that, if steadily applied to a circuit having a resistance of one ohm, will produce a current of one ampere.

**voltage (of a circuit)** The root mean square (effective) difference in potential between any two points of the circuit concerned. On various systems such as a three-phase, 4-wire and a single-phase, 3-wire, there may be various circuits of varying voltages.

**volumetric** Pertaining to measurement by volume.

**volute pump** A centrifugal pump with a casing made in the form of a spiral or volute as an aid to the partial conversion of the velocity energy into pressure head as the water leaves the impellers.

**vortex** A revolving mass of water in which the stream lines are concentric circles and in which the total head for each stream line is the same.

**washout** Condition whereby excessive influent flows (typically at peak flow conditions) cause the solids in the aeration basins and/or clarifiers to be carried over into downstream processes or discharged to the receiving stream.

**waste activated sludge (WAS)** Solids removed from the activated-sludge process to prevent an excessive buildup in the system.

**wastewater** The spent or used water of a community or industry containing dissolved and suspended matter.

**water column** (1) The water above the valve in a set of pumps. (2) A measure of head or pressure in a closed pipe or conduit.

**water vapor** The gaseous form of water; molecules of water present as a gas in an atmosphere of other gases. Movement takes place from higher to lower vapor pressure regions to maintain vapor pressure equilibrium. Also called *aqueous vapor*.

**watt** The electrical unit of power. Power is the measure of the rate of doing work. A watt is the rate of energy transfer from one ampere flowing under a pressure of one volt at a unity power factor. It is analogous to horsepower or foot-pounds per minute of mechanical power. One horsepower is equivalent to approximately 746 W.

**weir** A device that has a crest and some side containment of known geometric shape, such as a V, trapezoid, or rectangle, and is used to measure flow of liquid. The liquid surface is exposed to the atmosphere. Flow is related to the upstream height of water

above the crest, position of crest with respect to downstream water surface, and geometry of the weir opening.

*weir overflow rate* The amount of flow applied to a treatment process (typically a clarifier) per linear measure of weir (gpd/lin ft).

*wet-air oxidation* A method of sludge disposal that involves the oxidation of sludge solids in water suspension under high pressure and temperature. Also called the *wet oxidation process*.

*wire-to-water efficiency* The ratio of mechanical output of a pump to the electrical input at the meter.