

# Glossary

***abiotic*** The nonliving elements in the environment.

***absorption*** Assimilation of molecules or other substances into the physical structure of a liquid or solid without chemical reaction.

***accuracy*** A measure of how closely the model matches observed data.

***acetic acid*** Chemical produced by fermentation that is used as a carbon source for biological processes. Chemical formula is  $\text{CH}_3\text{COOH}$ .

***acetogenesis*** The metabolic process that converts volatile acids to acetate, the primary substrate of acetoclastic methanogenesis.

***acid*** (1) A substance that can react with a base to form a salt. (2) A substance that can donate a hydrogen ion or proton.

***acidity*** The capacity of an aqueous solution to neutralize a base.

***acidogenesis*** The formation of organic substrates to short-chain volatile fatty acids.

***ACR*** Air volume-to-filter cloth surface area ratio in a baghouse.

***actinomyces*** Microorganisms typically found in compost; they have characteristics of both bacteria and fungi.

***activated carbon*** A highly adsorbent form of carbon used to remove dissolved organic matter from water and wastewater, or to remove odors and toxic substances from gaseous emissions.

***activated charcoal*** See *activated carbon*.

***activated sludge*** The biologically active solids in an activated sludge process.

## Design of Municipal Wastewater Treatment Plants

**activated sludge process** A biological wastewater treatment process in which a mixture of wastewater and biologically enriched sludge is mixed and aerated to facilitate aerobic decomposition by microbes.

**activation energy** The energy required to initiate a process or reaction.

**admixture** (1) A material or substance added during mixing. (2) A substance other than cement, aggregate, or water that is mixed with concrete.

**adsorption** The process of transferring molecules of gas, liquid, or a dissolved substance to the surface of a solid, where it is bound by chemical or physical forces.

**adsorption capacity** The maximum amount of contaminant an adsorptive media (e.g., activated carbon) can collect.

**advanced oxidation processes** Processes using a combination of disinfectants, (e.g., ozone and hydrogen peroxide) to oxidize toxic organic compounds into a nontoxic form.

**advanced secondary treatment** Secondary wastewater treatment with enhanced solids separation.

**advanced wastewater treatment** Treatment processes designed to remove pollutants that are not adequately removed by conventional secondary treatment processes.

**aeration** The addition of air or oxygen to water or wastewater, typically by mechanical means, to increase dissolved oxygen levels and maintain aerobic conditions.

**aerator** A device used to introduce air or oxygen to water or wastewater.

**aerobe** An organism that requires free oxygen for respiration.

**aerobic** Condition characterized by the presence of free oxygen.

**aerobic digestion** Solids stabilization process involving direct oxidation of biodegradable matter and oxidation of microbial cellular material.

**agar** A gelatinous substance extracted from red algae, typically used to culture microorganisms.

**agar plate** A circular glass plate, containing agar or another nutrient medium, used to culture microorganisms.

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

**agronomic rate** The annual whole biosolids application rate (dry weight basis) is designed to do the following:

- (1) Provide the amount of nitrogen needed by the food crop, feed crop, fiber crop, silvicultural crop, horticultural crop, or vegetation grown on the land.
- (2) Minimize the amount of nitrogen that passes below the root zone of the crop or vegetation and enters the groundwater.

**air changes per hour (ACH)** A measure of the ventilation rate of an enclosed volume.

**air diffuser** A device designed to transfer atmospheric oxygen into a liquid.

**airlift pump** A device for pumping liquid by injecting air near the bottom of a riser pipe submerged in the liquid to be pumped, which lowers the specific gravity of the fluid mixture and allows it to rise up the riser pump.

**air pollutant concentration** The measure of a pollutant in the ambient air. The units may be expressed as mass per unit volume or as a molar ratio.

**air scour** The agitation of granular filter media with air during the filter backwash cycle.

**air stripping** The process of removing volatile and semivolatile contaminants from liquid by passing air and liquid countercurrently through a packed tower.

**aliquot** The amount of sample used for analysis.

**alkali** A substance with highly basic properties.

**alkaline** Water containing enough alkalinity to raise the pH above 7.0.

**alkaline stabilization** The process by which lime or other alkaline materials are added to solids to raise the pH above 12 for 2 hours to reduce pathogens.

**alkalinity** The ability of a water to neutralize an acid via the presence of carbonate, bicarbonate, and hydroxide ions.

**alpha factor** The ratio of oxygen-transfer coefficients for water and wastewater at the same temperature and pressure; used in sizing aeration equipment.

**alternative system (onsite wastewater treatment)** An onsite wastewater treatment system that is not a conventional system (as described by local regulatory code).

**alum** Common name for aluminum sulfate, frequently used as a coagulant in water and wastewater treatment. Chemical formula is  $\text{Al}_2(\text{SO}_4)_3 \cdot 14\text{H}_2\text{O}$ .

**aluminum sulfate** See *alum*.

**amendment** Organic material or bulking agent (e.g., wood chips or sawdust) added to municipal solids in a composting operation to promote uniform air flow.

**ammonia** A compound of hydrogen and nitrogen that occurs extensively in nature. Chemical formula is  $\text{NH}_3$ .

**ammonia-nitrogen** The quantity of elemental nitrogen present in the form of ammonia and the ammonium ion.

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

**ammonium ion** A form of ammonia found in solution; the ion  $\text{NH}_4^+$ .

**amoeba** A single-celled protozoan microbe. Also ameba.

## Design of Municipal Wastewater Treatment Plants

***amoebic dysentery*** A form of dysentery caused by a protozoan parasite, typically resulting from poor sanitary conditions and transmitted by contaminated food or water. Also amebic dysentery.

***anaerobe*** An organism that can thrive in the absence of free oxygen, nitrate, and nitrite.

***anaerobic*** Condition characterized by the absence of free oxygen and other electron receptors such as nitrate and sulfate. As a process, anaerobic implies the active presence of strictly anaerobic organisms. As an activated sludge process component, anaerobic implies the active presence of anaerobic and facultative organisms.

***anaerobic digestion*** Solids stabilization process operated specifically without oxygen in which much of the organic wastefeed is converted to methane and carbon dioxide.

***anion*** A negatively charged ion that migrates to the anode when an electrical potential is applied to a solution.

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

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

***annual whole solids application rate*** The maximum amount of biosolids (dry weight basis) that can be applied to a unit area of land during a 365-day period.

***anode*** The positive electrode via which current leaves an electrolyte solution.

***anodic protection*** Electrochemical corrosion protection achieved via the use of an anode with a higher electrode potential than the metal to be protected.

***anoxic*** Condition characterized by the absence of free oxygen.

***anthracite*** A hard, black coal containing a high percentage of fixed carbon and a low percentage of volatile matter; it burns with little or no smoke.

***anthropogenic compounds*** Compounds created by human beings; they often are relatively resistant to biodegradation.

***aqueous chlorine*** Chlorine or chlorine compounds dissolved in water; often mistakenly called "liquid chlorine."

***arc screen*** Type of coarse screening device.

***arc-flash*** The release of electrical energy at the point of a fault or short-circuit.

***Archea*** The phylogenic class of prokaryotes that contain methanogens.

***Archimedes' screw pump*** See *screw pump*.

***area sources*** An open surface or basin that emits air pollutants.

***aerated SRT*** Solids retention time within the aerated portion of an activated sludge tank. See *solids retention time*.

***anamnox*** Biological anaerobic ammonium oxidation process catalyzed by specialized planctomycete bacteria, whereby ammonia and nitrite are consumed to produce primarily nitrogen gas.

***as-built drawings*** A copy of the original plans and specifications prepared for construction that have been corrected to reflect how a facility was actually built or installed.

***ash*** The nonvolatile inorganic solids that remain after incineration.

***aspergilosis*** A repertory infection, growth, or allergic response caused by the *Aspergillus* fungus.

***aspirating aerator*** Aeration device using a motor-driven propeller to draw atmospheric air into the turbulence caused by the propeller and, thereby, form small bubbles.

***aseptic*** The state of being free of pathogens.

***at-grade alternative*** Above-grade soil treatment area designed and installed using suitable imported soil material for fill so some part of the infiltrative surface is located at the original ground.

***atmospheric pressure*** The force exerted by the weight of the atmosphere above the point of measurement.

***autooxidation*** A self-induced oxidation process.

***autothermal thermophilic aerobic digestion*** An aerobic digestion process in which the microbes generate enough heat to maintain temperatures in the thermophilic range. When maintained for enough time to meet 40 CFR 503 requirements, the process results in a biosolid that is relatively pathogen free.

***autotrophic membrane bio-reactor*** Biological reactor that uses low-pressure membranes to deliver hydrogen gas as an electron donor to autotrophic bacteria, which reduce nitrate or other oxidized contaminants.

***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 the measure of elemental chlorine).

***available short-circuit current*** The amount of electrical current that will flow in an electrical system during a fault (short-circuit).

***average day, maximum month*** The average daily flow or mass of a constituent during the month of maximum measurements for that constituent.

***average daily flow*** The total flow past a physical point over a period of time divided by the number of days in that period, typically taken to mean a yearly (annual) average.

***average flow*** The arithmetic average of flows measured at a given point, typically taken to mean a yearly (annual) average.

## Design of Municipal Wastewater Treatment Plants

***averaging periods*** The unit of time over which a measurement is taken.

***autogenous combustion*** Burning that occurs when the heat of combustion of a wet organic material or solids is sufficient to vaporize the water and maintain combustion without auxiliary fuel.

***autogenous temperature*** Equilibrium temperature in solids combustion wherein the heat input from the fuel equals the heat loss, and combustion is self-supporting.

***autothermal thermophilic aerobic digestion*** A biological digestion system that converts soluble organics to lower-energy forms via anaerobic, fermentative, and aerobic processes at thermophilic temperatures.

***autotroph*** Organism that derives its cell carbon from carbon dioxide.

***axial flow*** The flow of fluid in the same direction as the axis of symmetry of a tank or basin.

***axial flow pump*** A type of centrifugal pump in which fluid flow remains parallel to the flow path and develops most of its head by the lifting action of the vanes.

***bacilli*** Rod-shaped bacteria.

***backflow flow*** Liquid flowing opposite to the desired direction in a water distribution system; it may result in contamination from a cross-connection.

***backflow prevention device*** Device used to prevent cross-connection (backflow) of nonpotable water into a potable water system.

***backmixing*** Mixing thermally dried product with dewatered solids before the mix enters the dryer. Also, the dispersion of mixed liquor from the outlet end of an aeration tank towards the inlet, whereby nitrite and nitrate are subject to denitrification.

***backwash*** A high-rate reversal of flow for the purpose of cleaning or removing solids from a filter bed or screening medium.

***backwash rate*** The flowrate used during backwash operations.

***backwash reject water ratio*** The ratio of backwash water used relative to the amount of total water filtered.

***backwater*** Increased water surface elevation in a channel upstream of the reference point.

***bacteria*** A group of universally distributed, rigid, essentially unicellular microscopic organisms lacking chlorophyll. They perform a variety of biological treatment processes (e.g., biological oxidation, solids digestion, nitrification, and denitrification). Some are pathogenic.

***bacteriophage*** Viruses that infect bacteria.

***baffle*** An obstructing device or plate used to provide even flow distribution or to prevent short-circuiting. Also, a wall or partition used to create zones within a basin.

**baghouse** An air-cleaning device that removes particulate from an airstream via filters. The filters are cleaned internally within the device.

**ball valve** A valve using a rotating ball with a hole through it that allows flow straight through when the ball is in the open position.

**Band screen** A type of fine screening device.

**Bar** A type of screening media.

**base** (1) A substance that can accept a proton. (2) A substance that can react with an acid to form a salt. (3) An alkaline substance.

**baseline** A sample used as a comparative reference point when conducting further tests or calculations.

**basicity factor** Factor used to determine the neutralization capabilities of alkaline reagents used to treat acidic wastes.

**Bay Area Sewage Treatment Emissions model** A mass emissions model that predicts the fate of compounds in the liquid phase of a wastewater treatment plant and predicts mass emission rate into the air phase.

**batch reactor** A reactor that treats a specific volume (batch) of liquid or solids at a time; it is designed to completely mix its contents and ensure that every drop or particle receives the same degree of treatment.

**bed depth** The depth of media in a vessel.

**Beggiatoa** Filamentous microbe, typically associated with solids bulking, that thrives in low dissolved oxygen levels and/or high sulfide levels.

**belt conveyor** A device used to transport material; it consists of a continuous-loop belt that revolves around head and tail pulleys.

**belt filter press** See *belt press*.

**belt press** A device that uses a series of porous moving belts revolving over a series of pulleys to drain water from solids.

**belt thickener** A mechanical solids-processing device that uses a revolving horizontal filter belt to thicken solids before dewatering and use or disposal.

**bench test** A small-scale laboratory test or study used to determine whether a technology is suitable for a particular application.

**benthic** Relating to the environment at the bottom of a body of water.

**bentonite** Colloidal claylike mineral that can be used as a coagulant aid in water treatment systems. Sometimes used as the earth component or soil amendment when constructing a pond or landfill liner because of its low permeability.

**Design of Municipal Wastewater Treatment Plants**

**berm** A horizontal earthen ridge or bank.

**best available control technology** The best technology, treatment techniques, or other means available after considering field (not solely laboratory) conditions.

**bicarbonate** A chemical compound containing an  $\text{HCO}_3$  group.

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

**biflow filter** Granular media filter characterized by water inflow from both the top and the bottom to a collector in the center of the filter bed.

**bilharzia** A waterborne disease; also known as schistosomiasis.

**binary fission** Form of asexual reproduction in some microbes in which the parent organism splits into two independent organisms.

**bioaccumulative** A characteristic of a chemical whose rate of intake into a living organism is greater than the organism's rate of excretion or metabolism.

**bioaerosol** A mist that could transport biological material.

**bioassay** An analytical method in which an organism's response to biological treatment or an environment is measured by changes in biological activity.

**biochemical oxidation** Oxidative reactions initiated by biological activity and resulting in the chemical combination of oxygen with organic matter.

**biochemical oxygen demand** A standard measure of wastewater strength that quantifies the oxygen consumed by microorganisms in the fluid within a stated period of time (typically 5 days at  $20^\circ\text{C}$ ). See *BOD* and *cBOD*.

**biocide** A chemical used to inhibit or control the population of troublesome microbes.

**biodegradable** Capable of undergoing biological decomposition.

**biofilm** An accumulation of microbial growth on the surface of an object.

**biological filter** A bed of sand, stone, or other media on which a layer of microorganisms grow. (1) A wastewater system in which microbes metabolically break down the complex organic materials into simple, more stable substances. (2) A fixed-media air-treatment system in which microorganisms on the media surface oxidize contaminants.

**biofilter** See *biological filter*.

**biofuel** A combustible organic material (e.g., biosolids) that can be used as a substitute for fossil fuel.

**biogas** The gases produced via the anaerobic decomposition of organic matter.

**biological denitrification** An anoxic process in which microorganisms transform nitrate-nitrogen into inert nitrogen gas; an electron donor drives the reaction.

**biological oxidation** A process in which living organisms oxidize organic matter into a more stable or mineral form.

**biological process** Any process in which microorganisms metabolically break down complex organic materials into simple, more stable substances.

**biological synthesis yield** Mass of solids produced through biological growth divided by the mass of substrate removed (typically BOD or COD).

**biomass** The mass of microorganisms in a biological treatment process.

**biomass concentration ( $ML^2$ )** A measure of the amount of biomass available to treat wastewater or solids. It is the mass of biomass removed from a known quantity of carriers divided by the specific surface area provided by the carriers.

**biomass density ( $ML^3$ )** The biomass concentration divided by the measured or estimated biofilm thickness (L).

**bioreactor** An vessel in which microorganisms suspended in a liquid metabolically break down complex organic materials into simple, more stable substances. The vessel also may include a variety of attached devices used to control the reaction.

**bioscrubber** An air-treatment system in which contaminants are oxidized by microorganisms.

**biosolids** Solids that have been removed from wastewater and stabilized (e.g., digested or composted) to meet the criteria in the U.S. Environmental Protection Agency's (U.S. EPA's) 40 CFR 503 regulations and, therefore, can be beneficially used.

**biota** All living organisms in a system.

**bioturbation** The displacement and mixing of sediment particles by benthic organisms. Such activity in the mixing zone may help disperse any contaminants remaining in effluent and increase the exchange of oxygen and nutrients between the sediment and the water.

**biotower** A generic term for in-vessel biological air treatment. Can be either a bioscrubber or biotrickling filter. See *biological filter*.

**biotrickling filter** A biological air-treatment technology in which microorganisms attached to a fixed media oxidize contaminants in the gas phase. Nutrients are often added to the liquid that continuously trickles over the media to ensure that the microbes have enough substrate.

**black box model** See *statistical model*.

**blinding** The reduction or cessation of flow through a filter caused by solids obscuring or filling the openings in the filter media.

**blower** A device that conveys air at pressures up to 103 kPa (15 psi); it has many uses at a wastewater treatment plant (to provide dissolved oxygen in aerobic treatment processes, to provide fresh air in enclosed spaces, etc.).

**BOD<sub>5</sub>** Five-day uninhibited biochemical oxygen demand.

**booster pump** A pump used to raise the pressure of the fluid on its discharge side.

**bound water** (1) Water strongly adsorbed to or absorbed by colloidal particles. (2) Water associated with the hydration or crystalline compounds.

**breakpoint chlorination** A treatment approach in which chlorine is added to the disinfection process until all chlorine demand has been oxidized. Further addition will result in a chlorine residual.

**brine-recovery reverse osmosis** A reverse osmosis process used to concentrate the brine generated by another reverse osmosis process. Also called *secondary reverse osmosis*.

**Brinell hardness number** A measure of the indentation hardness of materials.

**broad-crested weir** A weir with a substantial crest width in the direction parallel to the direction of water flowing over it.

**bromine** A halogen used as a water disinfectant in combination with chlorine as a chlorine-bromide mixture.

**brownfield** Currently occupied or previously developed industrial site.

**brush aerator** Mechanical aeration device most frequently used in oxidation ditch wastewater treatment plants; consists of a horizontal shaft with protruding paddles that is rapidly rotated at the water surface. Also called a *rotor*.

**British thermal unit (Btu)** The quantity of heat required to raise the temperature of 1 lb of water from 60 to 61°F at a constant pressure of 1 atm.

**budget estimate** A capital cost estimate used to establish the owner's budget. It should be prepared based on flow sheets, layouts, and details about major equipment quantity, type, and sizing (at a minimum).

**buffer zone** The distance between a wastewater or solids management process and an environmentally or socially sensitive area (e.g., a waterbody, the habitat of an endangered species, or a residential area).

**bulk density** The density-to-volume ratio for a solid, including the voids in the bulk material.

**bulk-specific surface area ( $L^2/L^3$ )** The total surface area provided per bulk unit volume of carriers. This value is reported by the manufacturer and may or may not include a reduction to account for the portion of the carrier element not conducive to biofilm

attachment because of scouring resulting from collisions with other carriers in the reactor (i.e., unprotected area).

**bulk-specific volume ( $L^3/L^3$ )** The volume displaced by carriers per bulk unit volume of media; determined by the bulk density of the carriers divided by the specific gravity of the carrier material.

**bulking** A phenomenon at activated sludge plants in which solids do not readily settle or concentrate because of the predominance of filamentous organisms.

**bulking agent** In composting, a carbon-rich material added to a solids mixture to increase porosity, solids content, and carbon-to-nitrogen ratio.

**butterfly valve** A valve with a stem-operated disk that is rotated to be parallel to the liquid flow when opened and perpendicular to the flow when closed.

**bypass** A channel or pipe arranged to divert flow around a tank, treatment process, or control device.

**Bypass screens** Devices used for emergency screening.

**cake** Dewatered material from a filter press, centrifuge, or other dewatering device; it is now thick enough to be handled as a solid, not a liquid.

**cake filtration** A classification for filtration technology that removes solids on the entering face of the granular media.

**cake solids** The percentage of suspended solids in the dewatered cake.

**calcining** Exposing an inorganic compound to a high temperature to alter its form and drive off a substance that originally was part of the compound.

**calcium carbonate** A white, chalky substance that is the principal source of water hardness and scale. Chemical formula is  $CaCO_3$ .

**calcium carbonate equivalent** A convenient unit of exchange ( $mg/L CaCO_3$ ) for expressing all ions in water by comparing them to calcium carbonate. Calcium carbonate has a molecular weight of 100 and an equivalent weight of 50.

**calcium hydroxide** A compound used as a solids conditioner to improve the thickening and/or dewatering properties of solids; also used in alkaline stabilization processes. Commonly called *slaked lime*, *hydrated lime*, or *pickling lime*. Chemical formula is  $Ca(OH)_2$ .

**calcium hypochlorite** A chlorine compound frequently used as a water or wastewater disinfectant. Chemical formula is  $Ca(OCl)_2$ .

**calcium oxide** Compound used as a solids conditioner to improve the thickening and/or dewatering properties of solids; also used in alkaline stabilization processes. Commonly known as *burnt lime*, *lime*, or *quicklime*. Chemical formula is  $CaO$ .

**capillary force** The attraction of water to soil particle surfaces; it increases as soil pore size decreases.

**capture efficiency** The percentage of the solids fed to a dewatering device that is removed with the cake.

**carbon** An element present in many inorganic and all organic compounds.

**carbon dioxide** A nonflammable, colorless, odorless gas formed in animal respiration, as well as the combustion and decomposition of organic matter. Chemical formula is  $\text{CO}_2$ .

**carbon dioxide equivalent ( $\text{CO}_2^e$ )** A measure of how much global warming a given type and amount of greenhouse gas may cause, using carbon dioxide as a baseline.

**carbon footprint** A measure of the amount of carbon dioxide produced by a person, organization, or location at a given time.

**carbonaceous biochemical oxygen demand (CBOD)** The portion of biochemical oxygen demand that consumes oxygen via carbon oxidation; typically measured after a sample has been incubated for 5 days. Also called *first-stage biochemical oxygen demand*.

**carbon adsorption** The use of powdered or granular activated carbon to remove refractory and other organic matter from water.

**carbonation** The diffusion of carbon dioxide gas throughout a liquid.

**catenary screen** A type of coarse screening device.

**cathode** The negative electrode where the current leaves a electrolyte solution.

**cathodic protection** Electrochemical corrosion protection achieved by imposing an electrical potential to counteract the galvanic potential between dissimilar metals, which otherwise would lead to corrosion.

**cation** A positively charged ion that migrates to the cathode when an electrical potential is applied to a solution.

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

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

**cavitation** The formation of a partial vacuum in a flowing liquid as a result of the separation of liquid's parts. The collapse of these parts may cause pitting on metal surfaces inside the pump such as the impeller and casing.

**cell yield** The mass of cells produced per the mass of substrate consumed.

**Celsius** The international name for the centigrade temperature scale, in which the freezing and boiling points of water are 0 and 100°C, respectively, at a barometric pressure of 760 mm of mercury. Also called *centigrade*.

**centigrade** A thermometer temperature scale, in which the freezing and boiling points of water are 0 and 100°C, respectively, at a barometric pressure of 760 mm of mercury. Also called *Celsius*. To convert temperatures from centigrade to Fahrenheit, multiply by 1.8 and add 32.

**centrate** The liquid remaining after solids have been removed via a centrifuge.

**centrifuge** A dewatering device that relies on centrifugal force to separate particles of varying density (e.g., water and solids).

**centrifugal pump** A pump with a high-speed impeller that relies on centrifugal force to convert velocity into head pressure. Flow enters in front of the impeller and flows peripherally out of the pump and into the piping system. The amount of flow varies based on pressure.

**chain-and-flight collector** A mechanism for collecting solids in rectangular sedimentation basins or clarifiers.

**chain-driven screen** A type of coarse screening device.

**channel** (1) A perceptible natural or artificial waterway that contains moving water or forms a connecting link between two bodies of water or two water-bearing structures. (2) The deep portion of a river or waterway where the main current flows. (3) The part of a waterbody deep enough to be used for navigation in an area otherwise too shallow for shipping.

**channeling** A situation in processes with packed material that occurs when water finds furrows or channels through the media in which it can flow without contacting—and reacting with—the microorganisms.

**check valve** A valve that opens in the direction of normal flow and closes when flow reverses.

**chemical coagulation** A process in which an inorganic chemical is added to wastewater to destabilize and aggregate colloidal and finely divided suspended matter.

**chemical conditioning** Mixing chemicals with solids before dewatering and/or thickening to improve the solids separation characteristics. Typical conditioners include polyelectrolytes, aluminum and iron salts, and lime.

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

**chemical equilibrium** A condition in which there is no net transfer of mass or energy between system components. It occurs 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 one gram of hydrogen. It is found by dividing the formula weight by its valence.

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

**chemical oxidation** A process in which chemical compounds (e.g., ozone, chlorine, and potassium permanganate) are added to oxidize compounds in water or wastewater.

**chemical oxygen demand (COD)** A measure of the organic matter in water or wastewater that can be oxidized by a chemical agent (e.g., a solution of potassium dichromate).

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

**chemical sludge** Solids resulting from chemical treatment processes of organic wastes that are not biologically active. Formed by adding a chemical (e.g., an iron or aluminum salt) to wastewater to precipitate phosphorus.

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

**chisel plow** A static plow shank used to slice soil during the installation of subsurface drip tubing.

**chloramines** Disinfecting compounds of organic or inorganic nitrogen and chlorine.

**chlorinated** (1) Water or wastewater that has been treated with chlorine. (2) An organic compound to which chlorine atoms have been added.

**chlorination** The process of adding chlorine to a water or wastewater, typically to disinfect it.

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

**chlorine** An oxidant typically used as a disinfectant in water and wastewater treatment. Chemical formula is  $\text{Cl}_2$ .

**chlorine contact chamber** A vessel in which chlorine is diffused through water or wastewater; enough contact time is provided for disinfection.

**chlorine demand** The difference in the amount of chlorine added to water or wastewater and the amount of residual chlorine remaining after a specific contact time (typically 15 minutes).

**chlorine dioxide** Chemical frequently used in disinfection. Chemical formula is  $\text{ClO}_2$ .

**chlorine dose** The amount of chlorine added to a liquid, typically expressed in milligrams per liter or pounds per million gallons.

**chlorine residual** The amount of chlorine remaining in water after application and contact time. See *free chlorine residual*.

**chlorine tablets** A common term for pellets of solidified chlorine compounds (e.g., calcium hypochlorite) used to disinfect water.

**chlorine toxicity** A measure of chlorine's detrimental effects on biota.

**chlorophenols** A group of toxic, colourless, weakly acidic organic compounds in which one or more of the hydrogen atoms have been replaced by chlorine atoms. Most applications of chlorophenols are based on their toxicity: they and compounds made from them are used to control bacteria, fungi, insects, and weeds.

**cholera** A highly infectious disease of the gastrointestinal tract caused by waterborne bacteria.

**clarifier** A quiescent tank in which suspended solids are removed from wastewater via gravity. It typically is equipped with a motor-driven chain-and-flight or rake mechanism to collect settled sludge and move it to a final removal point. Also called *sedimentation* or *settling basins*.

**clarification** Any process or combination of processes whose primary purpose is to reduce the concentration of suspended matter in a liquid.

**Class A biosolids** Biosolids that contain less than 1 000 most probable number (MPN)/g of fecal coliforms and less than 3 MPN/4g of *Salmonella* bacteria and meet one of six stabilization alternatives given in 40 CFR 503. The material also must meet the pollutant limits and vector-attraction reduction requirements set forth in Part 503.

**Class B biosolids** Biosolids that contain less than 2 million colony-forming units (CFU) [most probable number (MPN)] of fecal coliforms per gram of dry biosolids. The material also must meet the pollutant limits and vector-attraction reduction requirements set forth in 40 CFR 503.

**Clean Air Act** Initially passed in 1963, the Clean Air Act is the law that defines U.S. EPA's responsibilities for protecting and improving the nation's air quality and the stratospheric ozone layer. It has been amended several times since it was first enacted; the most recent amendment was passed in 1990.

**clean filter headloss** Initial headloss value at the start of the filtration cycle (after the backwash cycle), when the medium is clean.

**Clean Water Act** Enacted in 1972, the Clean Water Act is the primary federal law regulating water pollution. It was last updated in 1987.

**clearwell** A tank or reservoir of filtered water that may be used to backwash a filter.

**climate change** Any long-term, significant change in the weather patterns of an area.

**coagulant** Chemical added to wastewater to destabilize, aggregate, and bind together colloids and emulsions to improve the settleability, filterability, or drainability of solids. A simple electrolyte, typically an inorganic salt containing a multivalent cation of aluminum, iron, or calcium [e.g.,  $\text{FeCl}_3$ ,  $\text{FeCl}_2$ ,  $\text{Al}_2(\text{SO}_4)_3$ , and  $\text{CaO}$ ]. Also, an inorganic acid or base that induces coagulation of suspended solids.

**coagulation** (1) The destabilization and initial aggregation of finely divided suspended solids by the addition of a polyelectrolyte or a biological process. (2) 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 particle, thereby destabilizing the particle.

**coalesce** The merging of two droplets to form one large droplet.

**coarse sand** Sand with particles typically larger than  $0.5$  mm in diameter.

**coarse screen** A screening device that typically has openings between  $6$  and  $36$  mm ( $0.25$  and  $1.4$  in.).

**cocci** Sphere-shaped bacteria.

**co-digestion** A process in which two or more types of substrates (feedstocks) are digested together in the same reactor. Frequently refers to anaerobic digestion of solids together with food wastes, food processing wastes, FOG, or other organic waste material.

**coefficient** A numerical measure of a physical or chemical property that is constant for a system under specified conditions (e.g., the coefficient of friction).

**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  $1$   $\text{dyne}/\text{cm}^2$ .

**cogeneration** See *combined heat and power*.

**coliform bacteria** Rod-shaped bacteria living in the intestines of humans and other warm-blooded animals.

**collector** A mechanism used in clarifiers to collect and remove settled solids from the tank bottom.

**colloid** A suspended solid with a diameter less than  $1$   $\mu$ , which cannot be removed by sedimentation alone.

**colony-forming units** The number of bacteria present in a sample, as determined in a laboratory plate-count test. In this test, the number of visible bacteria colony units present is counted.

**colorimetric** The use of color change as an indicator.

**combined heat and power** A process in which one fuel simultaneously or sequentially produces useful heat and power. The power is typically electrical power, but can be direct mechanical-drive power.

**combined sewer overflow** A mixture of stormwater and sanitary wastewater in a combined sewer whose volume exceeds the collection system's capacity during a storm event and is discharged (untreated) directly to a receiving water.

**comminutor** A circular screen with cutters that grind large wastewater solids into smaller particles.

**compensation** A trade-off action intended to make a project more acceptable to stakeholders.

**completely-mixed, stirred-tank reactor** An ideal reactor in which the concentrations are uniform throughout.

**compliance standards** The water-quality and biosolids-quality requirements specified in a treatment plant's NPDES permit that must be met before the effluent can be discharged and the biosolids beneficially used (or disposed).

**composite variable** A combination of state variables typically to form variables that can actually be measured in the plant (e.g. BOD<sub>5</sub>, total COD, TKN, total phosphorus, TSS, VSS).

**composting** Stabilization process relying on the aerobic decomposition of organic matter in solids by bacteria and fungi.

**compressible medium filter** A filter that uses a synthetic-fiber compressible porous material as the filter medium instead of conventional granular material.

**compression settling** A sedimentation phenomenon in which particles in a concentrated suspension will only settle if the existing structure of settled particles is compressed.

**computational fluid dynamics** A series of algorithms and calculations used to predict or validate the behavior of liquid or gases flowing over or through constructed surfaces.

**concentration** (1) The amount of a substance dissolved or suspended in a unit volume of solution. (2) The process of increasing the amount of a substance per unit volume of solution.

**conditioning** A chemical, physical or biological process designed to improve the thickening or dewatering characteristics of a solids.

**conduction** A transfer of heat energy via direct contact of the materials. In biosolids drying, heat is conducted to biosolids via contact with heated surfaces. Sometimes called *indirect drying*.

**connected load** The total load of all of the electrical equipment in a facility.

**constant-rate filtration** Filter operation in which flow through the filter is maintained at a constant rate by an adjustable effluent-control valve or influent-control weir.

**constant-velocity channel** A channel configuration that has a constant or nearly constant velocity, regardless of flow depth. Used in grit removal.

**constructed wetlands** A wastewater treatment system that uses the aquatic root system of cattails, reeds, and similar plants to treat wastewater applied either above or below the soil surface.

**contact stabilization process** A modification of the activated sludge process in which raw wastewater is aerated with activated sludge for a short time before solids removal and continued aeration in a stabilization tank. Also called the *biosorption process*.

**contaminant** Any foreign component present in another substance.

**contamination** The degradation of natural water, air, or soil quality resulting from human activity.

**contingency** A reserve in a cost estimate for events that experience has shown will likely occur. The greater the engineering detail provided, the lower the contingency.

**continuous element screen** A type of fine screening device.

**contractor** The company responsible for constructing the facilities in accordance with contract documents; typically selected through a public bidding process.

**convection** Transfer of heat energy via the motion of a mass of fluid (e.g., air). In biosolids drying, this refers to the transfer of heat from hot gas directly to biosolids. Sometimes called *direct drying*.

**core blow** A method of clearing the feed ports in a recessed plate-and-frame filter press.

**corner sweep** A scraper used to remove solids from the corner of a square clarifier.

**corrosion** The process of breaking down a metal via a chemical or electrochemical reaction with the surrounding medium.

**corrosive** The characteristic of a chemical agent that reacts with the surface of a metal, causing it to deteriorate or wear away.

**criteria pollutants** Compounds for which a National Ambient Air Quality Standard has been established.

**critical shear stress** The pressure required to move or scour particles from a surface.

**cross-collector** A mechanical solids-collection mechanism that extends the width of one or more longitudinal sedimentation basins; used to consolidate and convey accumulated solids to a final removal point.

**cross-connection** A physical connection in a plumbing system through which a potable water supply could be contaminated by wastewater.

**cross-flow filtration** A filtration method in which the influent flows parallel to the surface of the filter medium.

**crypto** See *Cryptosporidium*.

**cryptosporidiosis** Gastrointestinal disease caused by ingesting waterborne *Cryptosporidium parvum*, often the result of drinking contaminated runoff from pastures or farmland.

***Cryptosporidium parvum*** A species of *Cryptosporidium* known to be infectious to humans. A protozoan parasite that can live in the intestines of humans and animals.

**culture** A microbial growth developed by furnishing enough nutrients in a suitable environment.

**cut-throat flume** Essentially, a Parshall flume with the center throat section “cut out”. The typical converging inlet section of the Parshall flume is directly connected to the typical outlet diversion section. The flume works well when submerged. Useful for distributing flow to basins or reactors.

**cyclone degritter** A conical device that uses centrifugal force to separate grit from organics in grit slurries.

**cycle time** The time between pump starts; it includes the pump running time and the pump “off” time.

**cyclone** A conical vessel used to initially separate grit from water in the cyclone-classifier grit slurry-dewatering device.

**cyst** A resting stage formed by some bacteria and protozoa in which the whole cell is surrounded by a protective layer.

**decant** The act of separating liquid from settled solids by pouring or drawing off the upper layer of liquid after the solids have settled.

**dechlorination** A chemical or physical process in which residual chlorine is partially or completely reduced.

**declining-rate filtration** Filter operation in which the rate of flow through the filter declines throughout the length of the filter run. The level of the liquid above the filter

## Design of Municipal Wastewater Treatment Plants

bed rises throughout the length of the filter run due to the increase in headloss that occurs as solids accumulate on the media.

**deep-bed filter** A granular media filter with a sand or anthracite bed up to 1.8 m (6 ft) deep.

**definitive estimate** A capital cost estimate prepared from very well-defined engineering data. Typically prepared at the end of the design delivery process when the construction documents have been completed.

**deflagration** Combustion. Typically referring to a fire or explosion in a thermal drying system.

**degree day** A measure of heating used when determining the volatile solids reduction in an aerobic digester based on published curves. It is computed as the product of the aerobic digester liquid temperature ( $^{\circ}\text{C}$ ) multiplied by the digester's solids retention time (days).

**delta ( $\Delta$ ) P** Differential pressure.

**delta ( $\Delta$ ) T** Differential pressure.

**demand charge** A cost per kVa based on the peak power flow into a facility. This charge is a result of the electric utility's need to size its facilities to serve the maximum power that a facility will require at any given point in time.

**demand load** The total power load of all equipment that would be expected to operate at the same time.

**denitrification** A biological process in which nitrates are converted to nitrogen.

**denitritation** The bacterial reduction of nitrite in the absence of free oxygen.

**density** The ratio of the mass of an object to its volume.

**depth filtration** A classification for filters in which significant solids removal occurs within the filter medium.

**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 the performance of its intended functions.

**design standards** Standards established for the design of equipment and structures. These standards may or may not be mandatory.

**detection threshold** The odor concentration at which, statistically, half of the odor panel could correctly select the odorous sample from carbon-filtered (odor-free) air.

**detention time** The time theoretically required to displace the contents of a tank or unit at a given rate of discharge.

***detritus tank*** A square grit chamber with a revolving rake to scrape settled grit to a sump for removal.

***dewater*** (1) To extract a portion of the water in a sludge or slurry. (2) To drain or remove water from an enclosure.

***dewatering*** A process (e.g., filter press or centrifuge) that removes a portion of the water contained in solids. Dewatering is distinguished from thickening in that the resulting dewatered cake may be handled as a solid, not a liquid.

***dewatering lagoon*** A lagoon constructed with a sand and underdrain bottom to draw water away from solids.

***dew point*** The temperature to which air with a given concentration of water vapor must be cooled for the vapor to condense.

***diffused aeration*** A system that injects 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*** A system that forms small air bubbles below the surface of a liquid to transfer oxygen to the liquid. See *diffused aeration*.

***diffused-air aeration*** A system that introduces compressed air to water via submerged diffusers or nozzles.

***diffuser*** A porous plate, tube, or other device through which air is forced and divided into minute bubbles for diffusion in liquids. Also can be a perforated tube through which a solution of a chemical is introduced. In the activated sludge process, it is a device for dissolving air into mixed liquor. It also is used to mix chemicals (e.g., chlorine) through perforated holes.

***digested solids*** Solids in which the concentration of volatile solids has been significantly reduced via oxidation by microbes in an aerobic or anaerobic reactor. The digested material is now relatively non-putrescible and inoffensive.

***digester*** A tank or other vessel used to store and anaerobically or aerobically decompose the organic matter in solids. See also *aerobic digestion* and *anaerobic digestion*.

***digestion*** The process of biologically oxidizing the organic matter in solids, thereby reducing the concentrations of volatile solids and pathogens.

***dilution*** (1) Lowering the concentration of a solution by adding more solvent. (2) The engineered mixing of discharged water with receiving water to lessen its immediate aesthetic and/or biochemical effects.

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**dilution-to-threshold (D/T) ratio** A non-dimensional, volumetric ratio measure of odor concentration. It is expressed as the sample volume plus the volume of dilution air divided by the sample volume.

**direct costs** The component of capital cost estimates that includes land and site development costs, costs of services to the site, and relocation costs. These costs also include contractor's overhead, profit, mobilization, bond and insurance, and construction contingencies.

**direct osmosis** A natural phenomenon in which water flows from the lower osmotic pressure solution to the higher osmotic pressure solution.

**direct potable reuse** Supplying highly treated wastewater effluent directly to the intake source of a potable water treatment system (eliminating any intermediate natural storage system).

**Disc screen** A type of fine screening device.

**discharge** The release of effluent, by any means, to the environment.

**discrete particle settling** Phenomenon referring to sedimentation of particles from a suspension that has a low solids concentration.

**disk filter** A filtration system in which a cloth or steel disk is the filter medium.

**disinfectant** A substance used to disinfect water, wastewater, or solids.

**disinfection** The selective destruction of disease-causing microbes via the application of chemicals or energy.

**dispersal** A method of spreading effluent over and into the final receiving environment.

**dispersion model** A mathematical tool used to characterize the fate of pollutants released from the emission point and predict concentration at selected downwind receptors.

**dissolved air flotation** A clarification process in which minute bubbles attach themselves to flocculated material, float to the surface, and are removed via an overflow weir. Heavier solids settle to the bottom and also are periodically removed.

**dissolved organic carbon** The fraction of total organic carbon that is dissolved in a water sample.

**dissolved oxygen** The oxygen dissolved in a liquid.

**dissolved solids** Solids in solution that cannot be removed via filtration. See *total dissolved solids*.

**diurnal flow** A daily fluctuation in flowrate or composition that is similar from one 24-hour period to another.

**doctor blade** A scraping device used to remove or regulate the amount of material on a belt, roller, or other moving or rotating surface.

**dolomite** A natural mineral consisting of calcium carbonate and magnesium carbonate. Chemical formula is  $\text{CaMg}(\text{CO}_3)_2$ .

**dolomitic lime** Lime containing 35 to 40% magnesium oxide.

**domestic wastewater** Wastewater originating in sanitation devices (e.g., sinks and toilets) in residential dwellings, office buildings, and institutions. Also called *sanitary wastewater*.

**dose** A specific quantity of a substance applied to a unit quantity of liquid to obtain a desired effect.

**downwash** The downward movement of a plume caused by the aerodynamic effects of wind moving around structures and on the lee side of tall stacks.

**draft tube** A centrally located vertical tube used to promote mixing in a solids digester or aeration basin.

**drip irrigation** Distribution of effluent water over an infiltrative surface via pressurized low flow discrete emitters on or within plastic tubing (lines) supplied by associated devices and parts (pump, filters, controls, and piping). Drip irrigation can be at the surface or subsurface.

**Drum screen** A type of fine screening device.

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

**dry pit** The chamber in a conventional wastewater pumping station where the pump, motor, piping, and valves are located.

**dry weather flow** A measure of total flows in the sanitary collection system under dry weather conditions. It is the sum of the volume of wastewater discharges and the volume of groundwater infiltrating the collection system.

**drying** Using thermal or radiant energy to evaporate moisture from biosolids or solids.

**drying bed** A partitioned area consisting of sand or other porous material on which solids are dewatered via drainage and evaporation.

**dual-media filter** A granular media filter that uses two types of filter media (typically silica sand and anthracite).

**duckweed** See *Lemnaceae*.

**duplex pump** A reciprocating pump that has two side-by-side cylinders connected to the same suction and discharge lines.

*dynamic head* See *total dynamic head*.

*dynamic simulation* A simulation in which the inputs to the model vary with time.

*dysentery* A disease of the gastrointestinal tract typically resulting from poor sanitary conditions; transmitted by consuming contaminated food or water.

*E. coli* See *Escherichia coli*.

*energy conservation measure (ECM)* A physical improvement, plant operation, or equipment maintenance practice that reduces the consumption of energy or improves the management of energy demand..

*effective collector size* A major parameter for characterizing filter media. In the case of granular filter media, the effective size is equal to the sieve size, in millimeters, that will pass 10% (by weight) of the sand.

*effluent* Partially or completely treated water or wastewater flowing out of a basin or treatment plant.

*ejector* A device that passes steam, air, or water through a Venturi to develop suction to move another fluid. Sometimes called an *eductor* or *jet pump*.

*electrical distribution system* The network of electrical wires and equipment in the wastewater treatment plant.

*electrolyte* A chemical substance or mixture, typically liquid, containing ions that migrate in an electric field.

*emission isolation flux chamber* A sampling device that allows the collection of contaminants from liquid or solid surfaces by isolating a sampling area from the ambient air. It uses a carrier gas to deliver the contaminants to the sample collection or measurement device so that a contaminant concentration can be determined for a given surface area.

*Emission point* The location of the stack, vent, or area where a pollutant is released into ambient air.

*empty bed contact time* The time that a substance theoretically remains in a specified volume, vessel, or media.

*environmental management system (EMS)* A set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency.

*endogenous respiration* Bacterial growth phase during which microbes metabolize their own protoplasm without creating more protoplasm because not enough food is available.

**endothermic** A process or reaction during which heat is absorbed.

**energy audit** A study to identify opportunities for improving plant efficiency and reducing operating costs, as well as quantify the cost and savings of these options.

**energy star** An international standard for energy-efficient consumer products.

**enhanced biological phosphorus removal** The biological removal of phosphorus through the cultivation and wasting of bacteria that retain excess phosphorus.

**enteric bacteria** Bacteria that inhabit the gastrointestinal tract of warm-blooded animals.

**environmental justice** The practice of ensuring that minority groups do not bear an inequitable environmental burden as a result of a project.

**Electric Power Research Institute (EPRI)** An organization that conducts research and development on technology, operations, and the environment for the global electric power sector.

**EQ** (1) Effluent quality index; a measure of the entire effluent pollution load to a receiving waterbody. (2) "Exceptional Quality" biosolids, which meet 40 CFR 503 Table 3 pollutant limits, Class A pathogen requirements, and vector-attraction reduction requirements.

**equalization** The process of dampening hydraulic or organic variations in a flow so nearly constant conditions can be achieved.

**equalization basin** A basin or tank used to equalize flow.

**equitable distribution of regional resources** The practice of ensuring that public facilities are equally dispersed among the communities they serve.

**energy services contracting (ESC)** A project delivery process in which savings brought about by an energy-conservation project, renewable-energy project, or other facility improvement are used to pay for the cost of the capital improvement.

**energy services company (ESCO)** A business that provides energy services contracting.

**Escherichia coli** A fecal coliform bacteria species used as an indicator of wastewater pollution.

**estuary** A semi-enclosed coastal waterbody at the mouth of a river in which rivers' current meets the sea's tide.

**eutrophic lake** A lake with an abundant supply of nutrients, excessive growth of floating algae, and an anerobic hypolimnion.

**eutrophication** Nutrient enrichment of water causing excessive growth of aquatic plants and eventual deoxygenation of the waterbody.

**evaporation pond** A natural or artificial pond that converts solar energy into heat to evaporate water.

*evaporation rate* The mass or quantity of water evaporated from a specified water surface per unit of time

*evapotranspiration* The sum of evaporation and plant transpiration.

*exceptional quality (EQ) biosolids* Biosolids that meet the Class A pathogen-reduction requirements in 40 CFR 503, meet the vector-attraction reduction requirements [503.33(a)(1) through (8)], and have low concentrations of regulated pollutants (503.13, Table 3).

*exclusionary areas* Existing site features that should be avoided during plant siting and layout.

*exothermic* A process or reaction that **produces** heat.

*extended aeration* A modification of the activated sludge process that uses long aeration periods to promote aerobic digestion of the biological mass via endogenous respiration. The process also stabilizes organic matter under aerobic conditions and emits gaseous products. The effluent contains finely divided suspended matter and soluble matter.

*extended aeration process* A variant of the activated sludge process with a longer detention time to allow endogenous respiration to occur.

*facultative bacteria* Microbes that can survive with or without oxygen.

*facultative lagoon* A lagoon or pond in which wastewater is stabilized by aerobic, anaerobic, and facultative bacteria.

*facultative ponds* See *facultative lagoons*.

*fall* A sudden change in the water surface elevation.

*fatigue life* The number of hours or revolutions at which 10% of the bearings are likely to fail because of fatigue.

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

*feces* Excrement of humans and animals.

*fermentation* The conversion of organic matter into carbon dioxide, methane, and other low-molecular-weight compounds.

***ferric chloride*** A soluble iron salt often used as a solids conditioner to enhance precipitation, bind up of sulfur compounds, or improve the thickening and/or dewatering properties of solids. Chemical formula is  $\text{FeCl}_3$ .

***ferric sulfate*** A water-soluble iron salt formed by the reaction of ferric hydroxide and sulfuric acid or by the reaction of iron and hot concentrated sulfuric acid; also obtainable in solution by the reaction of chlorine and ferrous sulfate. A commonly used coagulant, it often is used as a solids conditioner to enhance solids precipitation to improve the thickening and/or dewatering properties of residuals. Chemical formula is  $\text{Fe}_2(\text{SO}_4)_3$ .

***ferrous chloride*** A soluble iron salt often used as a solids conditioner to enhance precipitation, bind up sulfur compounds, or improve the thickening and/or dewatering properties of solids. Chemical formula is  $\text{FeCl}_2$ .

***ferrous sulfate*** A water-soluble iron salt that is a commonly used coagulant. It is used with lime as a solids conditioner to enhance solids precipitation to improve the thickening and/or dewatering properties of residuals. Sometimes called *copperus* or *iron vitriol*. Chemical formula is  $\text{Fe}(\text{SO}_4) \cdot 7\text{H}_2\text{O}$ .

***fertilizer*** Materials (typically those containing nitrogen and phosphorus) that are added to soil to provide essential nutrients for plant growth.

***fiber-reinforced concrete*** Concrete reinforced with fiberglass materials.

***filamentous growth*** The hair-like biological growth of some species of bacteria, algae, and fungi that results in poor solids settling.

***fill fraction (%)*** The total bulk volume ( $\text{L}^3$ ) of carriers installed in a reactor, expressed as a percentage of the wet reactor volume.

***fill systems*** Above-grade soil treatment area designed and installed so the entire infiltrative surface is located above the original ground elevation; suitable imported soil material is used for fill.

***filter*** A device using a granular material, woven cloth, or other medium to remove suspended solids from water, wastewater, or air.

***filter aid*** A polymer, coagulant, or other material added to improve the effectiveness of filtration.

***filter bottom*** See *underdrain*.

***filter cycle*** The filter's operating time between backwashes. Also called *filter run time*.

***filter fly*** See *Psychoda fly*.

***filter gallery*** A passageway to provide access for installing and maintaining underground filter pipes and valves.

**filter loading, hydraulic** The volume of liquid applied per unit area of the filter bed per day.

**filter loading, organic** The quantity of biochemical oxygen demand applied per unit area of the filter bed per day.

**filter press** A dewatering device in which water is forced from solids under high pressure.

**filter run** See *filter cycle*.

**filter-to-waste** An operating procedure in which the filtrate produced immediately after backwash is wasted.

**filtrate** Liquid remaining after solids were removed via filtration.

**filtration rate** A measurement of the volume of water applied to a filter per unit of surface area in a stated period of time.

**final clarifier** See *secondary clarifier*.

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

**fine-bubble aeration** A method of diffused aeration that uses fine bubbles to take advantage of their high surface areas to increase oxygen transfer rates.

**fines** Particles at the lower end of a range of particle sizes.

**fine sand** Sand particles with diameters that typically range from 0.3 to 0.6 mm.

**fine screen** A screening device with openings greater than 0.5 mm to 6 mm.

**first flush** Surface runoff at the beginning of a storm, which often contains much of the solid matter washed from streets and other surfaces.

**first-order reaction** A reaction in which the rate of change is directly proportional to the concentration of the reactant raised to the first power.

**fixed-film process** A biological treatment process in which the microbes are attached to an inert medium (e.g., rock or plastic). Also called *attached-growth process*.

**fixed suspended solids** The inorganic content of suspended solids in a water or wastewater sample, determined after heating the sample to 600°C.

**flange** A projecting rim or edge used for attachment to another object.

**flap valve** A valve that is hinged on one edge and opens in the direction of normal flow and closes with flow reversal.

**flash mixing** Process using a motor-driven stirring device designed to disperse coagulants or other chemicals instantly, before flocculation.

**flight** (1) The horizontal scraper on a rectangular solids collector. (2) The helical blade on a screw pump.

**floatables** Materials (e.g., oil, scum, paper, and plastic) that do not settle; instead, they float at the surface of a discharge.

**float switch** An electrical or pneumatic switch operated by a float in response to changing liquid levels.

**floc** (1) Small, gelatinous masses formed in water by adding a coagulant or in wastewater via biological activity. (2) Collections of smaller particles agglomerated into larger, more easily settleable particles via chemical, physical, or biological treatment.

**flocculant** Water-soluble organic polyelectrolytes that are used alone or with an inorganic coagulant (e.g., aluminum or iron salts) to agglomerate solids into large, dense floc particles that settle rapidly and improve the thickening and dewatering properties of solids.

**flocculating tank** A tank used to form floc via gentle agitation of liquid suspensions, with or without the aid of chemicals.

**flocculation** (1) In wastewater treatment, the agglomeration of colloidal and final suspended matter after coagulation via gentle agitation by mechanical or hydraulic means. (2) Gentle stirring or agitation to accelerate the agglomeration of particles to enhance sedimentation or flotation.

**flocculation agent** A coagulation substance that, when added to water, forms a flocculant precipitate that will entrain suspended matter and expedite sedimentation, as well as solids thickening and dewatering.

**flocculant aid** An insoluble particulate used to enhance solids–liquid separation by providing nucleating sites or acting as a weighting agent or sorbent; also used colloquially to describe the action of flocculants in wastewater and biosolids treatment.

**flocculant settling** A phenomenon referring to the sedimentation of particles in a dilute suspension as they coalesce (flocculate).

**flocculants** Organic polyelectrolytes used alone or with metal salts to coagulate solids particles.

**flocculator** A device used to enhance the formation of floc via gentle stirring or mixing.

**flotation** A treatment process in which gas bubbles are introduced to water and attach to solid particles, creating bubble–solid agglomerates that float to the surface, where they are removed.

**flotation thickening** Solids thickening via dissolved air flotation.

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

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

**flowrate** The volume or mass of a gas, liquid, or solid material that passes some point in a stated period of time.

**flow splitter** A chamber that divides incoming flow into two or more streams.

**fluid** Any material or substance that flows or moves, whether in a semisolid, liquid, solids, or gaseous form or state.

**fluidization** The upward flow of a gas or fluid through a granular bed at enough velocity to suspend the grains.

**flume** A channel used to carry water.

**flux** The volumetric filtration rate for a given area of membrane, expressed as flowrate per unit area per time. A typical unit of flux is liters per square meter per day (gallons per square foot per day) of membrane area per day.

**flux chamber** See *emission isolation flux chamber*.

**fly ash** One of the residues generated when coal is combusted; it typically is captured from the chimneys of coal-fired power plants. Depending on the source and makeup of the coal being burned, the components of the resulting fly ash vary considerably; however, all fly ash includes substantial amounts of silicon dioxide ( $\text{SiO}_2$ ) and calcium oxide ( $\text{CaO}$ ).

**force main** A pipeline through which flow is transported from a point of higher pressure to a point of lower pressure.

**forward osmosis** A natural phenomenon in which water flows from a lower osmotic pressure solution to a higher osmotic pressure solution (the same as direct osmosis).

**fouling factor** A design criterion used to allow for some variation in equipment performance resulting from fouling.

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

**freeboard** The vertical distance between the normal maximum liquid level in a basin and the top of the basin; it is provided so waves and other liquid movements will not overflow the basin.

**free chlorine** The amount of chlorine available as dissolved gas, hypochlorous acid, or hypochlorite ion.

**free chlorine residual** The portion of total residual chlorine remaining after a specific contact time that will react as hypochlorous acid or hypochlorite ion.

- free oil** Non-emulsified oil that separates from water, typically in 5 minutes or less.
- free settling** The settling of discrete, nonfloculant particles in a dilute suspension.
- free water** Suspended water covering the surface of solid particles or the walls of fractures as a film. The amount of water present in the film is in excess of pellicular water. The water is free to move in any direction under the pull of the force of gravity and unbalanced film pressure.
- friction factor** A measure of the resistance to liquid flow caused by the texture of a pipe or channel wall.
- full-cost pricing** Prices for products and services that fully support the cost of providing them.
- fully submerged disk filter** The disk filter and the backwash mechanism are submerged in the tank.
- fuzzy filter** See *compressible medium filter*.
- fuzzy logic** A process-control system intended to replace a skilled human operator by using multilevel logic to adjust process operations based on a set of approximate, rather than exact, rules.
- garnet** A dense mineral often used as a filtration media.
- gas** Of the three states of matter, the state with no fixed shape or volume and capable of expanding indefinitely.
- galvanize** An electrolytic or hot dipping process to coat steel products with zinc to increase corrosion resistance.
- gastroenteritis** An inflammation of the stomach and intestinal tract.
- gastrointestinal** Related to the stomach or intestines.
- gate valve** A valve with a disk that slides over the opening through which water flows.
- gear pump** A positive-displacement pump in which cavities created between the teeth of two meshing gears move fluid from the suction to the discharge side of the pump.
- Giardia lamblia** A protozoan parasite; responsible for giardiasis.
- giardiasis** A gastrointestinal disease caused by ingesting waterborne *Giardia lamblia*, often resulting from the activity of beavers, muskrats, or other warm-blooded animals in surface water used as a potable water source.
- globe valve** A valve that can be closed by lowering a horizontal plug onto a matching seat in the center of the valve.
- grab sample** A single water or wastewater sample taken at a time and place representative of total discharge.

**Design of Municipal Wastewater Treatment Plants**

**grade** (1) The finished surface of a civil structure. (2) The inclination or slope of a surface or structure. (3) To rate according to a standard or size.

**gradient** The rate of change of an elevation, velocity, pressure, temperature, or other parameter.

**granular media filtration** A tank or vessel filled with sand or other granular media to remove suspended solids and colloids from water or wastewater as it flows through the media.

**granule** Small particle of dried product; typically within 0.5 to 5.0 mm in diameter. See *pellet*.

**gravel** Rock fragments measuring 2 to 70 mm in diameter often used as support material in granular media filters.

**gravitational acceleration** The acceleration of a free-falling body caused by the force of the Earth's gravity; equal to 9.81 m (32.2 ft) per second per second.

**gravity belt thickener** A solids dewatering device that uses a porous filter belt to promote water drainage via gravity.

**gravity filter** A granular media filter that operates at atmospheric pressure.

**gravity system** A hydraulic system that relies on gravity flow and does not require pumping.

**gravity thickening** A process in which a sedimentation basin is designed to operate at high solids loading rates to thicken residuals. It typically includes vertical pickets mounted onto the revolving solids scrapers to help release entrained water.

**gray water** All non-toilet household water (e.g., water from sinks, baths, and showers). Also called *sullage*.

**grease** Common term for the fats, oils, waxes, and related constituents found in wastewater.

**grease trap** A receptacle used to collect grease and separate it from wastewater.

**greenfield construction** A piece of previously undeveloped land in a city or a rural area.

**greenhouse gas (GHG)** Any of the gases (e.g., carbon dioxide, methane, ozone, and fluorocarbons) whose absorption of solar radiation is responsible for the greenhouse effect.

**Green Globes™** An online tool that offers an assessment protocol, rating system, and guidance for green building design, operation, and management.

**grit** Sand, gravel, cinders, and other heavy solid matter with settling velocities substantially higher than those of organic (putrescible) solids in wastewater.

**grit chamber** A settling chamber used to remove grit from organic solids via sedimentation or air-induced agitation.

**grit classifier** A mechanical device that uses an inclined screw or reciprocating rake to wash putrescible organics from grit.

**grit removal** A preliminary wastewater treatment process to remove grit from organic solids.

**grit washer** A device used to wash organic matter from grit.

**groundwater** Subsurface water found in porous rock strata and soil.

**guide vane** A device used to direct or guide the flow of a liquid or vapor.

**Gujer matrix** A table of state variables and their interactions in the model. Also called a *Peterson matrix*.

**gypsum** A mineral consisting primarily of fully hydrated calcium sulfate. Chemical formula is  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ .

**half-life** The time required for half of the atoms of a particular radioactive substance to transform, or decay, to another nuclear form.

**half-saturation concentration** The concentration at which the processing rate is half of its maximum rate. Used in the Monod equation and switching functions.

**halide** A compound containing a halogen.

**halogen** One of the chemical elements of the group consisting of fluorine, chlorine, bromine, iodine, and astatine.

**hammermill** A device with hammerlike arms used to shred or grind solids to facilitate further treatment or disposal.

**hazardous air pollutants (HAPs)** The 188 compounds or chemical groups that are listed in Section 112 of the Clean Air Act.

**head** A measure of the pressure exerted by a fluid, expressed as the height of an enclosed column of the fluid that could be balanced by the pressure in the system.

**header** A pipe manifold fitted with several smaller lateral outlet pipes used to collect or distribute flow.

**headloss** (1) The difference in water level between the upstream and downstream sides of a treatment process that is attributed to friction losses. (2) Energy loss for a fluid moving through a conduit caused by friction, turbulence, and other energy uses.

**headworks** The initial structure and devices located at the receiving end of a water or wastewater treatment plant.

**heat drying** The process by which sludge is thermally heated to remove moisture and produce a dry product that can meet the Class A biosolids criteria.

**heat value** The quantity of heat that can be released from residuals per unit mass of the solids.

**heavy metals** Metals that can be precipitated by hydrogen sulfide in an acid solution and that may be toxic to humans in excess of certain concentrations .

**hedonic tone** A relative measure of pleasantness or unpleasantness; typically pertains to odors.

***Helicobacter pylori*** A bacterium that causes stomach ulcers and has been identified as an emerging waterborne health threat.

**helminth** A parasitic worm.

**Hemicellulose** Heteropolymers present in plant cell walls (along with cellulose).

**Henry's law** The principle that at a constant temperature, the concentration of a gas dissolved in a fluid (with which it does not combine chemically) is almost directly proportional to the partial pressure of the gas at the surface of the fluid.

**hepatitis** An acute viral disease that results in liver inflammation; it may be transmitted via water directly contaminated by wastewater.

**heterotrophic bacteria** A type of bacteria that derives its cell carbon from organic carbon; most pathogenic bacteria are heterotrophic bacteria.

**high-calcium lime** Lime containing 95 to 98% calcium oxide.

**high-density polyethylene** A synthetic organic material often used as a landfill liner because of its low permeability.

**high-pressure membranes** Nanofiltration and reverse osmosis membranes.

**hindered settling** Phenomenon referring to sedimentation of particles in a suspension of intermediate concentration. The interparticle forces of the particles hinder the settling of neighboring particles.

**horizontal benchmark** Fixed point for horizontal control of construction works.

**hyacinth** Floating aquatic plants whose roots provide a habitat for a diverse culture of aquatic organisms that metabolize organics in wastewater.

**hydrated lime** Limestone that has been "burned" and treated with water under controlled conditions to convert calcium oxide into calcium hydroxide.

**hydraulic grade line** The piezometric surface in a pressure conduit; the water surface in open-channel flow conditions.

**hydraulic gradient** The slope of the hydraulic grade line, which indicates the change in pressure head per unit of distance.

**hydraulic jump** A sudden rise in water surface level that occurs when water with high velocity (supercritical velocity) transitions to low velocity (subcritical flow).

**hydraulic loading** Total volume of liquid applied per unit of time to a tank or treatment process.

**hydraulic radius** The ratio of the area of flow (wetted area) to its wetted perimeter.

**hydraulic residence time** Vessel volume divided by the liquid throughput rate, expressed in minutes, hours, or days (depending on the situation).

**hydraulic retention time** The length of time that a given hydraulic loading of wastewater or solids will be retained in a pipe, reactor, unit process, or facility.

**hydrocyclone** A conical-shaped device that uses centrifugal force to separate grit and other solids from a liquid.

**hydrogen peroxide** An oxidizing agent used for odor control and disinfection. Chemical formula is  $H_2O_2$ .

**hydrogen sulfide** A toxic and corrosive gas formed by the decomposition of organic matter containing sulfur. Chemical formula is  $H_2S$ .

**hydrolysis** Enzyme-mediated reactions that convert complex organic compounds (i.e., particulate) into simple compounds or reduced-mass materials. Often refers to solids particle breakdown in the first step of anaerobic digestion.

**hydrophilic** Having a strong affinity for water.

**hydrophobic** Having an aversion to water.

**hydrostatic pressure** The pressure exerted by water as a result of depth alone.

**hydrotest** A method for testing the integrity of piping, tubing, or vessels by filling them with water and pressurizing them.

**hypochlorite** Chlorine anion typically used as an alternative to chlorine gas for disinfection. Chemical formula is  $OCl_2^-$ .

**Imhoff tank** A two-story wastewater treatment tank; sedimentation occurs in the upper compartment, and anaerobic digestion occurs in the lower compartment.

**incineration** The process of reducing the volume of a solid by burning of organic matter.

**incinerator** A furnace or device for incinerating solids.

**inclined cylindrical screens** A type of fine screening device.

***indicator organism*** A microbe whose presence indicates the absence or presence of a specific pollutant.

***indirect costs*** The component of capital cost estimates that includes engineering, permitting, and legal services during construction, as well as contingencies and any other associated costs.

***indirect potable reuse*** The use of highly treated reclaimed water to augment a surface water or groundwater intended to serve as a potable water supply.

***industrial waste*** Waste generated by manufacturing or industrial practices that is not a hazardous waste regulated under Subtitle C of the Resource Conservation and Recovery Act.

***inert*** Having no inherent power of action, motion, or resistance.

***inerts*** Constituents that are assumed not to react with anything in the model. Inerts may be soluble or insoluble, organic or inorganic.

***infectious agent*** Any organism that can be communicated in body tissues and can cause disease or other adverse health effects in humans.

***infiltrate*** To filter into or through; permeate (e.g., effluent into soil).

***infiltration chamber*** A pre-formed, manufactured distribution medium with an open bottom that typically is used in soil-treatment areas.

***influent*** Water or wastewater flowing into a basin or treatment plant.

***influent characterization*** See *influent stoichiometry*.

***influent fractionation*** See *influent stoichiometry*.

***influent stoichiometry*** The breakdown of influent constituents into state variables. Also called *influent fractionation* and *influent characterization*.

***injector*** A mechanical device for feeding gaseous chemical into a stream whereby pressurized water creates a vacuum that draws the chemical.

***inorganic matter*** Substances of mineral origin (not containing carbon) that are not subject to decay.

***innovative technology*** A process or technique that represents an advancement over the existing state of the art but has not been fully proven under the circumstances of its contemplated use.

***insoluble*** Incapable of being dissolved.

***instrumentation*** Technology used to control, monitor, or analyze physical, chemical, or biological parameters.

**interceptor** A pipe that receives flow from a number of other pipes or outlets for disposal or conveyance to a treatment plant.

**interface model** A model that describes how output variables are passed from one type of model to a different type of model, which uses different variables for its inputs.

**intermediate pumping station** A pumping station created at a location in the treatment process other than influent or effluent pumping.

**invert** The lowest point of the internal surface of a drain, sewer, or channel at any cross-section.

**International Organization for Standardization (Organisation internationale de normalisation) (widely known as ISO)** An international standards-setting body composed of representatives from various national standards organizations.

**jar test** A test procedure using laboratory glassware to evaluate coagulation, flocculation, and sedimentation in a series of parallel comparisons.

**jet** A stream of pressurized liquid or vapor from a nozzle or orifice.

**jet aeration** Wastewater aeration system using floor-mounted nozzle aerators that combine liquid pumping with air diffusion.

**kinematic viscosity** A fluid's absolute viscosity divided by its mass density.

**L10 Life (fatigue life, rating life)** The number of hours or revolutions at which 10% of the bearings are likely to fail because of fatigue.

**lagoon** An excavated basin or natural depression that contains water, wastewater, or solids.

**land application** The process of spreading of biosolids on land to improve and maintain productive soils and stimulate plant growth.

**land disposal** The process of spreading large volumes of solids on land in a dedicated disposal site.

**landfill** A land-based disposal site designed to collect and store solid wastes while minimizing environmental hazards and protecting the quality of surface water and groundwater.

**lateral** A secondary pipe that branches off from a main water pipe, or header.

**launder** A trough used to transport water.

**Leadership in Energy and Environmental Design (LEED®)** A Green Building Rating System™ developed and administered by the U.S. Green Building Council to encourage and accelerate the global adoption of sustainable green buildings, and to develop sustainable design, construction, management, and operation practices through the creation

and implementation of universally understood and accepted tools and performance criteria.

**leachate** Fluid that percolates through solid materials or wastes; it typically contains suspended solids, dissolved materials, or products of the solids.

**leach line (lateral)** A pipe, tubing, or other conveyance method used to carry and distribute effluent.

**lift station** A chamber that contains the pumps, valves, and electrical equipment necessary to pump water or wastewater.

**lime** Any of a family of chemicals [e.g., calcium hydroxide, limestone (calcite), or a mixture of calcium and magnesium carbonate] used to increase the pH of wastewater or solids to promote precipitation, improve solids thickening and/or dewatering characteristics, or kill pathogens.

**lime recalcining** The process of recovering lime from water or wastewater solids; it typically involves a multiple-hearth furnace.

**lime slaker** A device used to hydrate quicklime.

**lime stabilization** A process in which lime is added to solids to raise the pH to 12 for at least 2 hours to chemically inactivate pathogens.

**limestone** A sedimentary rock composed primarily of calcium carbonate.

**liner** (1) A barrier of plastic, clay, or other impermeable material that prevents leachate from contacting surface water or groundwater. (2) A protective, corrosion-resistant layer attached or bonded to the inside of a tank, pipe, or other equipment.

**liquid chlorine** A chlorine compound that contains no water; it occurs when gaseous chlorine is put under high pressure. Stored in steel drums and cylinders.

**loss of head** A decrease in total energy that results from friction, bends, obstructions, etc. in a pipeline or channel. Also called *headloss*.

**low-pressure membranes** Microfiltration and ultrafiltration membranes.

**luminaries** Light fixtures.

**lysis** A cell rupture that results in loss of its contents.

**malodor** An odor that is offensive or creates a nuisance.

**marine** Of or pertaining to the sea; existing in or produced by the sea (ocean).

**mass balance** A method for analyzing physical systems based on the law of conservation of mass. By accounting for all material entering and leaving a system, mass flows can be identified that otherwise might have been unknown or difficult to measure.

**mass transfer** The movement of atoms or molecules via diffusion or convection from an area of high concentration to one of low concentration.

**materials balance** See *mass balance*.

**maturation** Sufficient decomposition of organic matter to achieve a stable material.

**maximum achievable control technology** The level of air pollution control technology required by the Clean Air Act.

**maximum contaminant level** The maximum permissible level of a contaminant in water delivered to the free-flowing outlet of the ultimate user of a public water system.

**maximum contaminant level goal** The maximum level of a contaminant (including an adequate safety margin) at which no known or anticipated adverse effect on human health would occur.

**maximum daily peaking factor** Ratio of the maximum daily flow or constituent mass to the annual average value.

**maximum monthly peaking factor** Ratio of the maximum monthly flow or constituent mass to the annual average value.

**minimum daily peaking factor** Ratio of the minimum daily flow or constituent mass to the annual average value.

**mean cell residence time** The average time that a microbial cell remains in an activated sludge system. It is equal to the mass of cells divided by the rate at which cells are wasted from the system.

**mean velocity** The average velocity of a fluid flowing in a channel, pipe, or duct, determined by dividing the discharge by the cross-sectional area of the flow.

**mechanical aeration** A system that mechanically agitates water to promote mixing with atmospheric air.

**mechanically activated solar drying beds** Drying beds that use a robot to break up the surface of drying solids to increase the evaporation rate.

**mechanistic model** A model that describes a process' behavior in a mechanistic manner (i.e., equations are used to directly describe outputs based on input variables in an attempt to match the observed behavior of the process). Also called *physics-based models* because they attempt to describe the physical behavior of the process. Most process models typically used for design are mechanistic models.

**media displacement volume ( $L^3/L^3$ )** The volume of a reactor displaced by the installed carrier media, calculated as the bulk *specific volume* multiplied by the *fill fraction*.

**medium compression** The medium properties (e.g., porosity, collector size, and depth) are all adjusted by the applied medium compression ratio. This action occurs in a compressed medium filter.

**membrane bioreactor** A wastewater treatment process that basically combines the activated sludge process with membrane filtration. The membranes are suspended in an activated sludge reactor to separate liquid from solids.

**membrane brine** A concentrated slurry containing the solids rejected by high-pressure membranes during filtration. Also called *membrane concentrate*.

**membrane concentrate** A concentrated slurry containing the solids rejected by membranes during filtration.

**membrane diffuser** A fine-bubble aeration diffuser with perforated flexible plastic membranes.

**membrane filter** (1) A filtration process in which membranes separate solids from liquid. (2) A paperlike filter, with small pore sizes, that can retain bacteria for use in laboratory examinations of water.

**membrane reject** A slurry containing the solids rejected by low-pressure membranes during filtration.

**mesh** (1) The number of openings per lineal inch, measured from the center of one wire or a bar to a point 25.1 mm (1 in.) distant. (2) A type of screening media.

**mesophilic** An operating temperature range (typically 30 to 40°C) for anaerobic digestion; it affects the microbial population in the digester and the reaction rates.

**mesophilic digestion** A process in which solids are digested by microorganisms that thrive in the mesophilic temperature range (about 30 to 40°C).

**metabolic models** Models developed to describe the metabolic processes of biological treatment by evaluating the rates of transformations occurring, including intermediate compounds.

**metabolism** The biological conversion of organic matter to cellular matter and gaseous byproducts.

**metal** In general, the chemical elements that easily lose electrons to form positive ions.

**metal salt coagulants** Alum and iron (III) salts, which typically are used to coagulate solids particles.

**metering pump** A pump that provides a specific volume of fluid; used to add treatment chemicals to water or wastewater.

***methanogenesis*** The metabolic conversion of organic acids or hydrogen and carbon dioxide to methane. The primary methanogenic populations associated with anaerobic digestion are acetoclastic methanogens and hydrogenotrophic methanogens.

***methanogens*** A group of anaerobic bacteria responsible for converting organic acids into methane gas and carbon dioxide.

***methanol*** A solvent often used as a supplemental carbon source during denitrification. Chemical formula is  $\text{CH}_3\text{OH}$ .

***method detection limit*** The lowest quantity of a substance that, when analyzed using a given method, can be unequivocally distinguished from a blank that has undergone the same process.

***methylothrophic methanogenesis*** Methanogenic populations that can convert methylated compounds (e.g., methanethiol and triemethyl amine) into methane. These organisms are thought to be significant in controlling odors from biosolids.

***microconstituents*** Natural and anthropogenic substances (e.g., elements and inorganic and organic chemicals) detected in water and the environment, for which a prudent course of action is suggested for the continued assessment of the potential effect on human health and the environment.

***microfiltration*** A low-pressure membrane filtration process that removes suspended solids and colloids larger than  $0.1 \mu$  from wastewater.

***microfloc*** Destabilized floc particle that permits in-depth penetration of a granular media filter bed to optimize the filter's solids retention capacity.

***microorganism*** Organisms observable only through a microscope. Also called *microbes*.

***microscreens*** A filtration device consisting of a rotating drum with a fine-mesh screen fixed to its periphery. As water flows through the interior of the drum, solids are retained by the mesh for later removal via a high-pressure wash.

***mist eliminator*** A physical obstruction in an air stream designed to collect suspended liquid droplets.

***misting scrubber*** An air treatment technology in which a scrubbing liquid is sprayed into the contaminated air stream. The contaminant is removed either by physical impingement or via chemical reaction with the scrubbing liquid.

***mitigation*** Changes or additions to a treatment plant design to reduce or eliminate identified impacts.

***mixed liquor*** The mixture of wastewater and activated sludge being treated in an aeration basin.

***mixed-liquor suspended solids*** The suspended solids concentration in the mixture of wastewater and activated sludge being treated in the aeration basin.

***mixed-liquor volatile suspended solids*** The volatile fraction of mixed-liquor suspended solids.

***mixed-media filter*** A granular media filter using two or more types of filter media with different sizes and specific gravities (typically silica sand, anthracite and ilmenite or garnet).

***mixing tank*** A tank equipped with a device for agitating or mixing wastewater or solids to increase the dispersion rate of applied chemicals.

***mixing zone*** A limited area of a natural waterbody where highly treated wastewater is received and diluted. The intent of mixing zones is to prevent discharged effluent from harming the aquatic environment and its designated uses (e.g., drinking, fishing or swimming). In theory, this zone allows for efficient, natural pollutant assimilation. In practice, mixing zones can be used as long as the waterbody's integrity is not impaired.

***model*** An equation or set of equations used to describe a process or several connected processes.

***mole*** The molecular weight of a substance, typically expressed in grams.

***molecular weight*** The sum of the atomic weights of all the atoms in a molecule.

***Monod equation*** An equation typically used in wastewater treatment models to describe the kinetics of biological growth. Identical in form to the Michaelis–Menten equation often referred to in industrial applications.

***monomedia filter*** A granular media filter using only one size and type of filter media.

***most probable number*** A statistical analysis technique based on the number of positive and negative results acquired when testing multiple portions of equal volume; typically used to count pathogens in solids samples.

***motor control center*** A structure housing the controls for electrical equipment (multiple motor starters, variable-frequency drives, circuit breakers, etc.).

***mound*** An above-grade soil treatment area designed and installed with at least 305 mm (12 in.) of clean sand (ASTM C-33) between the bottom of the infiltrative surface and the original ground elevation. It uses pressure distribution to distribute effluent across the mound. A final cover of suitable soil material stabilizes the surface and supports vegetative growth.

***moving-bed filter*** A granular media filter that continuously cleans and recycles filter media while the filter continues to operate.

**mudballs** Agglomerations of floc, solids, and filter media in a filter bed that may grow into a larger mass and reduce filtration efficiency.

**mud valve** A valve used to drain sediment from the bottom of a sedimentation basin or to drain the contents of an aeration tank.

**mudwell** Common name used for a backwash reject water storage basin.

**multi-criteria decision analysis** A tool that helps decision makers take multiple criteria into account when comparing design alternatives.

**multimedia filter** A granular media filter that uses two or more types of filter media with different sizes and specific gravities (e.g., silica sand, anthracite, and ilmenite or garnet).

**multiple-hearth furnace** An incinerator consisting of numerous hearths that is used to combust organic solids or recalcinate lime.

**multiple rake screen** A type of fine screening device.

**municipal waste** The combined solid and liquid waste from residential, commercial, and industrial sources.

**municipal wastewater treatment plant** Collectively, the buildings, processes, and equipment needed to treat municipal wastewater.

**Nasal Ranger<sup>®</sup>** A field olfactometer developed by St. Croix Sensory.

**National Ambient Air Quality Standards (NAAQS)** Outdoor standards for air pollutants (e.g., ozone, sulfur dioxide, particulates, nitrogen dioxide, carbon monoxide, and lead) shown to cause adverse health effects. An ambient standard has been established for each of these pollutants; they can be found in 40 CFR 50.

**National Pollutant Discharge Elimination System** As authorized by the Clean Water Act, this is a permit program that controls water pollution by regulating point sources that discharge pollutants into waters of the United States.

**needle valve** A valve that controls flow by means of a tapered needle that extends through a circular outlet.

**negative head** Filter operating condition that occurs when the pressure in the filter bed is less than atmospheric pressure during a filter cycle.

**neighborhood advisory committee (NAC)** A committee comprised of community stakeholders that have some level of contribution to the design of the facility.

**neoprene** A synthetic rubber with a high level of resistance to oils, ozone, oxidation, and flame; made by polymerizing chloroprene.

**nephelometric turbidity unit** A measure of turbidity via instrumentation.

**net environmental benefit** The sum of the positive benefits minus the sum of the negative impacts of a particular project or treatment system on the environment.

**net positive suction head** The difference between the total absolute pressure head and the vapor pressure of the liquid being pumped.

**net specific surface area ( $L^2/L^3$ )** The resulting *specific surface area* within a reactor based on the *bulk specific surface area* and the installed *fill fraction*.

**net yield** The net mass of solids produced in a biological process divided by the mass of substrate removed, typically BOD or COD. It is equal to the synthesis yield minus decay.

**neutralization** A chemical process that produces a solution that is neither acidic or alkaline.

**New York State Energy Research and Development Authority (NYSERDA)** A public-benefit corporation created in 1975 and focused solely on research and development with the goal of reducing the state's petroleum consumption.

**nitrate** A stable, oxidized form of nitrogen. Chemical formula is  $\text{NO}_3^-$ .

**nitrate formers** See *nitrobacter*.

**nitrate-nitrogen** The nitrate concentration reported in terms of the nitrogen in the nitrate. See *nitrate*.

**nitric acid** Chemical is used in cleaning and preservation. Chemical formula is  $\text{HNO}_3$ .

**nitrification** A biological process in which ammonia is converted first to nitrite and then to nitrate.

**nitrifying bacteria** Bacteria that can oxidize nitrogenous material.

**nitratation** The biological conversion of nitrite to nitrate.

**nitritation** The biological oxidation of ammonia to nitrite.

**nitrite** An unstable, easily oxidized nitrogen compound. Chemical formula is  $\text{NO}_2^-$ .

**nitrite formers** See *Nitrosomonas*.

**nitrite-nitrogen** See *nitrite*.

**nitrobacter** Nitrifying bacteria that convert nitrites to nitrates. Also called *nitrate formers*.

**nitrogen fixation** The biological conversion of atmospheric nitrogen to nitrogen compounds.

**nitrogen oxides ( $\text{NO}_x$ )** Compounds formed during combustion.

**nitrogen oxide compounds ( $\text{NO}_x$ )** Pollutants formed during combustion.

**nitrogen removal** Physical, chemical, and biological processes that remove nitrogen from wastewater.

**nitrogenous biochemical oxygen demand** The portion of biochemical oxygen demand whereby oxygen is consumed as a result of the oxidation of nitrogenous material; measured after the carbonaceous oxygen demand has been satisfied. Also called *second-stage biochemical oxygen demand*.

**nitrogenous oxygen demand** The portion of oxygen demand associated with the oxidation of nitrogenous material, and the oxidation of free ammonia and ammonia released from nitrogenous material.

**Nitrosomonas** Ammonia-oxidizing bacteria that convert ammonia to nitrite under aerobic conditions and derive energy from the oxidation reaction.

**Nocardia** Bacteria that can accumulate to create a nuisance foam in aeration basins and secondary clarifiers.

**non-ionic polymer** A polyelectrolyte with no net electrical charge.

**nonpoint source** A source of air or water pollutants whose discharges are more diffuse (e.g., fertilizer runoff from farms).

**nonsettleable solids** Suspended solids that typically remain in suspension for more than 1 hour.

**nuisance** The condition created when an odor concentration injures human health, is offensive to the senses, or interferes with the reasonable or comfortable enjoyment of life and property.

**numerical solver** Software used to solve the multiple differential equations in a model using numerical methods.

**nutrient** (1) Any substance that is assimilated by organisms to promote or facilitate their growth. (2) Nitrogen and phosphorus, when considering their potential to result in excess biological growth in the environment.

**nutrient trading** A structured credit trading system for pollutant contributors to a specific receiving waterbody. The system allows entities to earn nutrient removal credits for treating beyond permit requirements and trade those credits to other entities to allow them to cost-effectively meet their nutrient removal requirements.

**odor character** A reference vocabulary used to describe the perceived characteristics of an odor.

**odor concentration** An odor measurement expressed as a dilution-to-threshold ratio (D/T), a nondimensional volumetric ratio.

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***odor dispersion*** The dilution of an odor via turbulent mixing of the odorant with ambient air from the point of release to downwind locations.

***odor intensity*** A measurement of the relative strength of an odor, expressed in parts per million by volume (ppm) of 1-butanol in air.

***odor intensity referencing scale*** A tool commonly used to evaluate odors that is standardized upon a given reference chemical.

***odor persistency*** The rate at which an odor's intensity decreases with dilution (i.e., the slope factor in Steven's law).

***odor panel*** A group of five or more individuals selected and trained to assess odors in accordance with established procedures and guidelines. An odor laboratory will draw an odor panel from a pool of trained assessors.

***odor thresholds*** The odor concentration that, statistically, half of the odor panel would detect or recognize the odor.

***odor unit (OU)*** Originally defined as a unit mass of odor per unit volume, it now typically is used to describe an odor concentration, expressed as a dilution ratio.

***offgas*** The gaseous emissions from a process or equipment.

***olfactometer*** A device used by a panel of testers to compare the odor from an ambient air sample to reference samples of varying dilutions to determine odor strength.

***olfactometry*** The measurement of odors using the sense of smell.

***onsite (wastewater treatment) system*** A system designed to collect and treat wastewater from one or more dwellings, buildings, or structures; the resulting effluent is dispersed on property owned by the individual or entity.

***open channel*** A natural or artificial channel in which fluid flows with a free surface open to the atmosphere.

***open drip proof*** A designation for electrical motor enclosures in which the ventilating openings are constructed so successful operations are not affected by drops of liquid or solid particles that strike or enter the enclosure at any angle from 0 to 15° downward from vertical.

***open-path optical transect method*** A method for measuring odorants across an open surface or basin.

***operation cost index (OCI)*** A parameter that integrates effluent criteria, energy costs, and solids treatment costs.

***order-of-magnitude estimate*** A capital cost estimate made without detailed engineering data; typically prepared at the end of the schematic design phase of the design delivery process.

**organic loading** The amount of organic matter applied to a treatment process per day.

**organic nitrogen** Nitrogen that is bound to carbon-containing compounds. Measured as the difference between TKN and ammonia-nitrogen.

**organic phosphorus** Phosphorus that is bound to carbon-containing compounds.

**orifice plate** (1) A flow meter that measures flow as a function of differential pressure across a flow-restricting orifice. (2) A flow-limiting device.

**outfall** The location where stormwater, wastewater, or reclaimed water is discharged to a receiving waterbody. Also refers to the pipeline or conduit that conveys flow to a receiving water.

**overflow rate** A measure of the upward water velocity in a sedimentation tank, expressed as flow per day per unit of basin surface area ( $L^3/L^2/T$  which is equal to  $L/T$ , a velocity). Also called *surface loading rate*.

**ovum** A mature egg ready to be fertilized.

**owner** The entity that possess property, or in a construction project, pays for the design, modifications, and/or construction. The owner may be public (e.g., a government agency) or private (e.g., a commercial land-development firm).

**oxic** A biological environment that contains molecular oxygen.

**oxidation** (1) A chemical reaction in which an element or ion loses electrons. (2) The biological or chemical conversion of organic matter to simpler, more stable forms.

**oxidation ditch** An extended aeration waste treatment process that occurs in an oval-shaped channel or ditch (also called a *racetrack*); aeration is provided by a mechanical brush aerator or by diffusers with mechanical mixers.

**oxidation pond** An earthen wastewater basin in which organic matter is biologically oxidized naturally or with the assistance of mechanical oxygen-transfer equipment.

**Oxidation-reduction potential** The potential required to transfer electrons from an oxidant to a reductant; it indicates the likelihood that an oxidation–reduction reaction will occur.

**oxygen transfer** (1) The 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; typically expressed as percent.

**oxygen uptake** The amount of oxygen used during biochemical oxidation.

**oxygen uptake rate** The oxygen used during biochemical oxidation, typically expressed as  $mg\ O_2/(L \cdot h)$  in the activated sludge process.

**ozonation** A treatment process that uses ozone for oxidation, disinfection, or odor control.

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**ozonator** An ozone generator.

**ozone** A strong oxidizing agent with disinfection properties similar to chlorine. Also used in odor control and solids processing. Chemical formula is O<sub>3</sub>.

**ozone generator** A device used to produce ozone by passing air or oxygen through an electric field.

**packed bed scrubber** A type of mist scrubber that uses internal packing to provide a contact surface for contaminants and the scrubbing liquid.

**Palmer Bowlus flume** A flow meter particularly suited for insertion into pipes and manholes.

**partially submerged disk filter** The disk filter is partially submerged in the tank with backwash mechanism remains above the water surface.

**particle size distribution** A method for characterizing the size spectrum of suspended solids particles in wastewater.

**particulate** Typically considered to be a solid particle larger than 1 μ; large enough to be removed from water or wastewater via filtration.

**pasteurization** A process in which heat is applied for a specific period of time to kill pathogens.

**pathogen** Highly infectious, disease-producing microbes typically found in sanitary wastewater.

**peak flow** Flow experienced during hours of high demand; typically determined to be the highest 2-hour flow expected under any operating conditions.

**peaking factor** The ratio of peak to mean value of a measured quantity; the mean value typically is the annual or yearly average.

**pellet** See *granule*. The term *pellet* often is used to refer to granules that are more uniform in shape and size.

**perforated plate** A type of screening media.

**peristaltic pump** A type of positive-displacement pump whereby the fluid is squeezed through a flow tube by external rollers.

**permeate** Filtered or treated effluent from a filtration or reverse osmosis membrane. Filtration membrane effluent also is called *filtrate*.

**Peterson matrix** See *Gujer matrix*.

**pH** The reciprocal of the logarithm of the hydrogen ion concentration in gram moles per liter. On the 0 to 14 pH scale, a value of 7 at 25°C (77°F) represents a neutral condi-

tion. Decreasing values indicate increasing hydrogen ion concentration (acidity), and increasing values indicate decreasing hydrogen ion concentration (alkalinity).

**phosphate** A salt or ester of phosphoric acid.

**phosphorus** A nutrient that is an essential element of all life forms.

**physical treatment** A water or wastewater treatment process that uses only physical methods (e.g., filtration or sedimentation).

**physical-chemical treatment** A water or wastewater treatment process that uses both physical and chemical methods.

**Physics-based model** See *mechanistic model*.

**phytotoxic** Poisonous to plants.

**piezometer** An instrument fitted to the wall of a pipe or container to measure pressure head; it consists of a small pipe and manometer.

**piezometric head** The elevation plus pressure head.

**pig** A water-propelled internal pipe cleaner.

**pigment** Finely ground, natural or synthetic, inorganic or organic, insoluble dispersed particles that, when dispersed in a liquid vehicle to make paint, may provide several beneficial characteristics (e.g., color, opacity, hardness, durability, and corrosion-resistance).

**pilot plant** A water or wastewater treatment plant that is smaller than full-scale; it is used to test and evaluate a treatment process.

**pinch valve** A valve with one or more flexible elements that can be pinched to stop flow.

**piston pump** A reciprocating pump whose piston typically incorporates a sliding seal with the cylinder wall.

**plate-and-frame press** A batch-process dewatering system in which solids are pumped through a series of parallel plates fitted with filter cloth.

**plenum** An air-filled space in a structure in which air is distributed evenly.

**plug flow** A flow condition characterized by the fact that fluid and fluid particles discharge a system in the same sequence they enter.

**plume** A plume is a concentration distribution caused by the release of pollutants as they are transported down gradient.

**plunger pump** A reciprocating pump whose plunger does not contact the cylinder wall; instead, it enters and withdraws from the cylinder through packing glands, that hold a deformable material used to control leakage around the plunger.

***point source*** A source of pollutants characterized by the existence of a specific discharge point (e.g., stack, vent, or outfall pipe).

***pollutant*** A substance, organism, or energy form present in amounts that impair or threaten an ecosystem to the extent that its current or future uses are precluded.

***polyelectrolytes*** Complex polymeric compounds typically composed of synthetic macromolecules that form charged ions in solution. Water-soluble polyelectrolytes are used as flocculants; insoluble polyelectrolytes are used as ion exchange resins.

***polyelectrolyte flocculant*** A polymeric organic compound used to induce or enhance the flocculation of suspended and colloidal solids, and thereby facilitate solids thickening or dewatering.

***polymers*** Synthetic organic compounds with high molecular weights and repeating chemical units (monomers); these polyelectrolytes may be water-soluble flocculants or water-insoluble ion exchange resins.

***polymer injection ring*** A device with four or more equally spaced ports designed to inject polymer into a solids pipeline. Installed as part of the piping, this device should promote thorough, even distribution for thorough mixing with solids.

***polyphosphates*** Phosphate compounds used as sequestration agents to prevent the formation of iron, manganese, and calcium carbonate deposits.

***pond depth*** The radial dimension of the water that has been separated from thickened solids in a centrifuge. Also called *pool depth*.

***pool depth*** The radial dimension of the water that has been separated from thickened solids in a centrifuge. Also called *pond depth*.

***porosity*** The ratio of the void space to the total volume of the porous medium.

***porous disk diffuser*** A circular, fine-bubble aeration device made of porous plastic or ceramic.

***positive-displacement pump*** A pump in which liquid is drawn into a cavity and the pressure is increased, which forces the liquid through an outlet port into the discharge line.

***post-aeration*** A process in which oxygen is added to effluent before it is discharged to a receiving water.

***post-treatment*** Treatment of water or wastewater treatment plant effluent to further enhance its quality.

***potassium permanganate*** Chemical frequently used in odor control. Chemical formula is  $\text{KMnO}_4$ .

***powdered activated carbon*** A powdered form of activated carbon that is slurried and fed to water to absorb organics (e.g., taste- and odor-causing constituents).

***power grid*** The network of electrical wires and equipment owned and operated by an electrical utility.

***preaeration*** A preliminary treatment process in which wastewater is aerated to remove gases, add oxygen, promote the flotation of grease, and/or aid coagulation.

***precoat*** Applying an inert material to a filter cloth to prevent solids from blinding the cloth and facilitate cake release.

***precipitation*** (1) Any chemical reaction in which a dissolved substance becomes a solid. (2) Any form of water (e.g., rain, snow, sleet, or hail) that falls to the earth's surface.

***preliminary treatment*** Treatment steps (e.g., comminution, screening, grit removal, preaeration, and/or flow equalization) that prepare wastewater influent for further treatment.

***pressate*** The liquid wastestream from a filter press.

***pressure filter*** A filter enclosed in a vessel that may be operated under pressure.

***pretreatment*** (1) The initial water or wastewater treatment process that precedes primary treatment processes. (2) The treatment of industrial wastes to reduce or alter the characteristics of pollutants before the wastes are discharged to a wastewater treatment plant.

***primary clarifier*** A sedimentation basin that precedes secondary wastewater treatment.

***primary distribution*** The high-voltage section (at least 2 400 V) of the electrical distribution system.

***primary sedimentation*** A gravity-based process for removing settleable suspended solids from water or wastewater; typically occurs in a quiescent basin or clarifier. The principal form of primary wastewater treatment, which is used to reduce the solids loading on subsequent treatment processes.

***primary sludge*** Solids produced during primary wastewater treatment (e.g., sedimentation).

***primary residuals*** Solids produced via sedimentation.

***primary treatment*** Treatment processes (e.g., sedimentation and/or fine screening) designed to produce an effluent suitable for biological treatment.

***privatization*** The involvement of nonpublic and entrepreneurial interests in project development, ownership, and/or operation of municipal facilities (e.g., water and wastewater treatment systems).

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***process/equipment vendors*** Companies that sell equipment or supplies for a project to the contractor or owner.

***procurement*** The process of legally obtaining equipment or services; often requires a contract.

***program manager*** The person hired by the owner to oversee and manage the design consultant's day-to-day project activities.

***progressing cavity pump*** A pump used for viscous fluids (e.g., solids) that consists of a single-threaded shaft rotor rotating in a double-threaded rubber stator.

***progressive cavity pump*** See *progressing cavity pump*.

***proportional weir*** A weir whose discharge is directly proportional to the head. Sometimes called a *Sutro weir*.

***psychrometric chart*** A graph of the thermodynamic properties of moist air.

***publicly owned treatment works (POTW)*** Wastewater treatment works [both treatment plant(s) and collection system] owned by a state or municipality.

***pug mill*** A device with rotating blades that simultaneously mixes and grinds two materials to reduce the size of the mixture to facilitate further treatment or disposal.

***pump curves*** Graphs of pump characteristics (e.g., total discharge head, net positive suction head, power required, and efficiency relative to capacity) that indicate pump performance.

***pumping station*** A facility that contains the pumps, valves, and electrical equipment necessary to move water or wastewater through a distribution or collection system, respectively.

***pure-oxygen process*** A variant of the activated sludge process in which pure molecular oxygen is used rather than atmospheric oxygen.

***putrescible*** Organic matter that is likely to become a rotten, foul-smelling product when it decays or decomposes.

***pyrophoric*** Capable of spontaneous combustion.

***quality assurance*** Planned, systematic production processes that provide confidence in a product's suitability for its intended purpose

***quality control*** A system for verifying and maintaining a desired level of quality in a product or process by careful planning, use of proper equipment, continued inspection, and corrective action as required.

***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. This material can be slaked (i.e., chemically react with water or moist air).

**radial flow** A flow pattern in which the flowing materials are directed either from the center to the periphery or from the periphery to center.

**radiant** Transfer of heat via electromagnetic radiation (e.g., solar energy used to dry biosolids).

**rapid mix** Any method of quickly, thoroughly blending water, wastewater, or solids with coagulants or conditioning chemicals to ensure a complete reaction.

**rapid sand filter** A granular media filter in which water flows downward through the sand bed at a rate typically ranging from 80 to 320 L/min·m<sup>2</sup> (2 to 8 gal/min/ft<sup>2</sup>) of surface area.

**rat holing** Compaction on the side of a silo that occurs when the material being handled has sufficient cohesive strength to resist gravity flow through a silo. Typically, a channel will form where the material will fall through the silo; however, once the channel has emptied, all flow from the silo stops.

**rate schedules** The electric utility's list of charges for providing power to a wastewater treatment facility.

**rating life** The number of hours or revolutions at which 10% of the bearings are likely to fail because of fatigue.

**raw sludge** Untreated wastewater solids.

**reaeration** The absorption of oxygen into water under oxygen-deficient conditions.

**reasonable potential analysis (RPA)** An analysis of effluent constituents that have a reasonable potential to cause or contribute to a violation of a water quality standard.

**recarbonation** the reintroduction of carbon dioxide to water, typically during or after lime soda softening.

**recalcining** The process of recovering lime from solids; typically performed in a multiple-hearth furnace system.

**receiving water** A surface waterbody that receives effluent from a wastewater treatment plant.

**receptor** In odor modeling, a grid coordinate where pollutant concentrations are predicted.

**recessed plate-and-frame press** A separation device that uses pressure to force water through a series of filter cloths mounted between plates. Meanwhile, solids collect on the cloths.

**reciprocating rake screen** A type of coarse screening device.

**reclaimed wastewater** Wastewater treated to a level that allows its reuse for a beneficial purpose. Also called *recycled water*.

**recognition threshold** An odor concentration that, statistically, half of the odor panel would be able to characterize and distinguish from carbon-filtered (odor-free) air.

**recreational waters** Any waterbody used for recreational activities (e.g., swimming, boating, or fishing).

**rectifier** An electrical device that converts alternating current voltage to direct current voltage.

**recycle ratio** The recycled flowrate divided by the influent flowrate; applicable to an activated sludge system or other treatment system.

**recycling** The process of converting recovered materials into new products.

**reed bed** A treatment system in which wastewater or solids are used to grow reeds, which use the water, nitrogen, and other nutrients provided by the material. Reed beds have been used for both tertiary wastewater treatment and solids disposal.

**refractory** Temperature-resistant material used in high-temperature areas of furnaces, incinerators, and boilers to protect the metal housing or ducting. Refractory may be produced with insulating and abrasion-resistant qualities

**refractory organics** Organic substances that are difficult or impossible to metabolize in a biological system.

**regenerative thermal oxidation (RTO)** High-temperature oxidation of contaminants in an air stream; the system uses its waste heat to preheat the incoming airstream.

**regenerative thermal oxidizer** An emissions-control device that uses heat to oxidize volatile organic compounds.

**residence time** The period of time that a volume of liquid or solids remains in a tank or system.

**residuals** The non-liquid components of wastewater that are removed from the liquid during various treatment processes.

**resin** General term applied to a wide variety of transparent and fusible products that may be natural or synthetic.

**resistivity** (1) A material's resistance to current per unit length for a uniform cross-section. (2) The reciprocal of conductivity.

**respiration** Intake of oxygen and discharge of carbon dioxide as a result of biological oxidation.

**retention time** The length of time that water or wastewater will be retained in a unit treatment process or facility.

***return activated sludge*** Settled activated sludge that is returned to the beginning of the activated sludge process to mix with raw or primary settled wastewater.

***return sludge*** See *return activated sludge*.

***reverse osmosis*** Technological process (and HPM membrane used to achieve this process) that uses forward osmosis phenomena to retain salts in the higher osmotic pressure solution when displacing water from this solution through the semipermeable HPM membranes (reverse osmosis membranes).

***rotameter*** A variable-area, constant-head, rate-of-flow volume meter in which the fluid flows upward through a tapered tub, lifting a shaped weight to a position where upward fluid force just balances the weight.

***rotary collector*** A rotating mechanism used in circular clarifiers to collect and remove settled solids.

***rotary drum thickener*** A rotating cylindrical screen used to thicken sludge.

***rotary kiln*** An incinerator consisting of a long, horizontal, slowly rotating cylinder in which material is fed at one end and tumbled by the kiln to promote drying as it is conveyed to the other end.

***rotary press*** A device that dewateres sludge by passing flow through a channel that is bound between two revolving screens. The filtrate passes through the screens while the dewatered sludge continues through the channel.

***rotating biological contactor*** A fixed-film biological treatment device in which microorganisms are grown on circular disks mounted on a horizontal shaft that slowly rotates in wastewater.

***sack screen*** A coarse screening device.

***Salmonella*** An aerobic bacteria that is pathogenic in humans; chiefly associated with food poisoning.

***salmonellosis*** A common type of food poisoning caused by eating food contaminated with *Salmonella* bacteria; it is characterized by a sudden onset of gastroenteritis.

***sand filtration*** See *granular media filtration*.

***sanitary wastewater*** Domestic wastewater that originated in sanitation devices (e.g., sinks, toilets, and washing machines).

***Scentometer*** A field olfactometer developed by Barnebey-Cheney Company in 1974.

***Schistosoma*** A parasitic flatworm or blood fluke that is drawn to freshwater snails during one phase of its life and to humans during another.

***schistosomiasis*** A waterborne disease common to tropical and subtropical regions; it is transmitted to humans who wade or bathe in water infested by *Schistosoma*. The life cycle of human schistosomes involves freshwater snails that act as an intermediate host to produce new parasites in the water phase.

***screen retention value*** Percentage of total influent solids retained by a screening device.

***screening*** (1) A physical separation process in which a screen is used to remove particles from a fluid. (2) The process of systematically examining multiple items to determine their suitability.

***screenings*** The material removed by a screening device.

***screenings conditioning*** A physical process in which collected screenings are dewatered, washed, and compressed.

***screenings organics test*** A method for determining the organic content of collected screenings.

***screenings washer/compactor*** Device used for screenings conditioning.

***screw conveyor*** A device that uses a helical screw rotating within a trough to convey material from one location to another.

***screw press*** A device in which a rotating helical screw presses solids against a cylindrical or conical screen to remove water from them.

***screw pump*** A low-lift, high-capacity pump that uses a helical screw rotating slowly in a trough or pipe to raise water from one elevation to another.

***scrubber*** A device used to remove particulate or pollutant gases from air or gas streams (e.g., exhaust gas).

***scrubbing*** A process in which impurities are removed from an air or gas stream by entraining the pollutants in a water spray.

***scum*** Buoyant materials (e.g., food wastes, grease, fats, paper, and foam) often found floating on the surface of primary and secondary settling tanks.

***scum collector*** A mechanical device that removes scum from the surface of a settling tank.

***scum trough*** A trough used to collect scum and convey it to another location for treatment or disposal; typically used in primary sedimentation processes.

***seal*** Anything that tightly or completely closes or secures a thing (e.g., packing or a mechanical device used to prevent leakage around a rotating motor shaft).

***seal water*** Water (typically treated effluent) pumped into a pump seal to reduce wear on the pump shaft; typically used in applications where grit or abrasive solids might be present.

**secondary clarifier** A vessel in which suspended matter is removed from wastewater via gravity; this vessel is located after a secondary treatment process.

**secondary effluent** Wastewater that has received preliminary, primary, and secondary treatment.

**secondary distribution** The low-voltage (480 V) section of the electrical-distribution system.

**secondary sludge** Solids generated during a secondary treatment process.

**secondary treatment** Any process designed to degrade the biological content of wastewater; typically follows primary treatment.

**sedimentation** A gravity-based process for removing settleable suspended solids from water or wastewater; typically occurs in a quiescent basin or clarifier.

**sedimentation basin** A quiescent tank in which suspended solids are removed from water or wastewater via gravity; they typically are equipped with a motor-driven rake to collect settled solids and move them to a central discharge point. Also called *clarifiers* or *settling tanks*.

**selective catalytic reduction (SCR)** A combustion process in which ammonia (or urea) and a catalyst react with  $\text{NO}_x$  to produce nitrogen, metal oxide, and water. The catalyst allows for lower-temperature operation than SNCR.

**selective non-catalytic reduction (SNCR)** A combustion process in which ammonia or urea is introduced at high temperatures and reacts with  $\text{NO}_x$  to form nitrogen, carbon dioxide, and water.

**self-priming pump** A pump designed to retain enough liquid in its casing to clear its passages of air, when necessary, so it can resume delivering liquid without outside attention. The design allows it to be placed above the level of the liquid being pumped.

**sensitivity analysis** A method for evaluating how changes in a model's input parameters affect its output.

**septage** The contents of a septic tank.

**sequencing batch reactor** A biological treatment process with five phases: fill, react, settle, draw, and idle. It typically includes a system of multiple tanks so one can be filled while another is treating wastewater or being drained.

**service factor** A measure of how much over the nameplate rating (i.e., maximum operating parameters) any given electric motor can be driven without overheating.

**settleability** The tendency of suspended solids to settle to the bottom of a tank or Imhoff cone.

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***settleable solids*** The portion of suspended solids that are the right size and weight to settle to the bottom of an Imhoff cone in 1 hour.

***settling tank*** A quiescent tank in which suspended solids are removed from water or wastewater via gravity; they typically are equipped with a motor-driven rake to collect settled solids and move them to a central discharge point. Also called *clarifiers* or *sedimentation tanks*.

***settling velocity*** The rate at which particles collect on the bottom of a tank or Imhoff cone.

***sewage*** See *wastewater*.

***sewer*** An underground pipe used to transport wastewater.

***sewerage*** A system of underground piping used to transport wastewater to one or more treatment plants.

***sewer gas*** A gaseous mixture produced when the organic matter in wastewater decomposes anaerobically in the collection system; typically contains high percentages of methane and hydrogen sulfide.

***sewershed*** The area that drains into a sewerage system.

***short-circuit current*** The amount of electrical current that will flow in an electrical system during a fault (short-circuit).

***short-circuiting*** Uneven flow through a vessel; it occurs when density currents or inadequate mixing allows some of the flow to leave the vessel more quickly than the rest.

***sidestream*** Liquid streams generated during solids processing or odor control that typically are returned to the head of a plant for re-processing in the wastewater treatment train.

***side water depth*** The depth of water in a basin or tank, as measured at the vessel's interior wall.

***sieve analysis*** A method for analyzing the particle size distribution of a granular material (e.g., filter sand); it typically involves pouring a sample through a standard series of sieves with increasingly smaller openings.

***sieve size*** A measure of the diameter of the openings in a sieve.

***silica*** A mineral composed of silicon and oxygen.

***silicate*** Any compound containing silicon, oxygen, and one or more metallic compounds.

***silo*** A tall, cylindrical vessel used to process or store solids.

**siloxanes** A family of anthropogenic organic compounds containing silicon, carbon, and oxygen that are becoming increasingly common in wastewater solids. When the solids are anaerobically digested, volatile siloxanes become part of the digester gas. When this gas is combusted, the siloxane compounds form tough, abrasive silicon dioxide deposits on the interior surfaces of boilers, engines, and other combustion-related equipment.

**simulator** Software used to run a model of a treatment process.

**simulation** A model run providing outputs based on model inputs.

**single line diagram** A drawing depicting the electrical distribution system in a facility.

**siphon** A closed conduit, a portion of which lies above the hydraulic grade line, resulting in a pressure less than atmospheric and requiring a vacuum within the conduit to start flow.

**skimming** The process of removing or diverting water and/or floating matter from the surface of a liquid.

**slake** To combine chemically with water or moist air.

**slaked lime** See *hydrated lime*.

**slime** (1) Viscous organic substances, typically formed via microbiological growth, that attach themselves to other objects, forming a coating. (2) The coating of biomass that accumulates in trickling filters or sand filters and periodically sloughs away to be collected in clarifiers.

**slow sand filter** A sand filter with low flowrates designed to promote the formation of a solids layer on top of the sand bed; this solids layer provides most of the filtration.

**sludge** Any residual produced during primary, secondary or advanced wastewater treatment that has not undergone any process to reduce pathogens or vector attraction. Also called *raw sludge*. The term *sludge* should be used with a specific process descriptor (e.g., primary sludge, waste activated sludge, or secondary sludge).

**sludge age** See *solids retention time*.

**sludge blanket** An accumulation of solids hydrodynamically suspended in a basin or tank.

**sludge volume index** The volume (in milliliters) occupied by 1 g of settled sludge after settling for 30 minutes in a 1-L graduated cylinder.

**slug load** A hydraulic or organic load suddenly added to a treatment process.

**sluice gate** A manually or power-operated gate used to isolate a channel from flow.

**slurry** A suspension of a relatively insoluble chemical in water; it typically has a suspended solids concentration of 5 000 mg/L or more.

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**sodium bisulfite** A liquid dechlorinating agent. Chemical formula is  $\text{NaHSO}_3$ .

**sodium chlorite** A frequently used chemical. Chemical formula is  $\text{NaClO}_2$ .

**sodium hydroxide** Caustic soda. Chemical formula is  $\text{NaOH}$ .

**sodium hypochlorite** A liquid chlorine solution frequently used as a water or wastewater disinfectant. Chemical formula is  $\text{NaOCl}$ .

**sodium metabisulfite** A crystalline form of sulfur dioxide used to remove chlorine. Chemical formula is  $\text{Na}_2\text{SO}_3$ .

**solid-bowl centrifuge** A centrifuge consisting of a conical bowl and an internal helical scroll that rotate at slightly different speeds to separate solids from water via centrifugal force; designed for continuous operations.

**solids** Any residual produced during wastewater treatment.

**solids balance** A mathematical representation of a treatment system that tracks the amount of solids entering and exiting each unit or process.

**solids content** The percentage of dry matter (by weight) in a mixture.

**solids disposal** The act of getting rid of solids via incineration, landfilling, surface disposal, etc.

**solids retention time** The average period of time that solids have remained in a process or system.

**solids stabilization** The act of reducing the number of pathogens in solids to meet the requirements of 40 CFR 503.

**solubility** The amount of a substance that can dissolve in a solution under a given set of conditions.

**soluble** Capable of being dissolved in a fluid.

**solution** A liquid that contains dissolved solute.

**solvent** A substance that dissolves another to form a solution.

**specific gravity** The ratio of the density of a substance to the density of water.

**specific oxygen uptake rate** A measure of the microbial activity in a biological system, expressed in  $\text{mg O}_2/\text{g}\cdot\text{h}$  of VSS. Also called *respiration rate* or *oxygen consumption rate*.

**specific resistance** A measure of how strongly solids oppose the draining of their liquid component.

**splitter box** A chamber that divides incoming flow into two or more streams.

**spore** A reproductive cell or seed of a microbe, often dormant or environmentally resistant.

**spray irrigation** A method of spreading reclaimed water on agricultural land.

**stability** The degree of oxidation or decomposition of organic matter.

**stabilization** A treatment process designed to reduce the number of pathogens in solids to meet the requirements of 40 CFR 503; the resulting biosolids also are less odorous and less likely to attract vectors.

**staged digestion** A treatment process in which solids are digested in phases. It consists of two or more tanks arranged in series, typically divided into primary digestion (where solids are mixed) and secondary digestion (where quiescent conditions prevail and supernatant liquor is collected).

**stair screen** A type of fine screening device.

**stakeholder** A person or group that has an investment, share, or interest in something (e.g., a business or industry).

**Standard Methods for the Examination of Water and Wastewater (Standard Methods)** A publication published jointly by the American Public Health Association, the American Water Works Association, and the Water Environment Federation; it contains descriptions of analytical techniques commonly accepted for use in water and wastewater treatment.

**stapling** The entanglement of stringy or fibrous debris on a mesh or bar rack.

**state variable** An element of the set of variables (e.g., organics and nutrients) that describe the state of a dynamic system. Some state variables can be measured directly (e.g., ammonia), but many have to be determined via special sampling and test methods.

**static head** The vertical distance between a fluid's supply surface level and free discharge level.

**static screen** A type of fine screening device.

**statistical model** An alternative to mechanistic models that uses statistical rules based on historical data to determine the likely behavior of a process rather than using fixed equations to do so. Also called a *black box model*.

**steady-state simulation** A simulation in which the inputs are fixed and do not change with time.

**step aeration** A variant of the activated sludge process in which settled wastewater is introduced at several points in the aeration tank to equalize the food-to-microorganism ratio.

**sterile** Free from bacteria or other microorganisms.

**Steven's law** A proposed relationship between the magnitude of a physical stimulus (e.g., odor concentration) and its perceived intensity or strength.

**stilling well** A tube or chamber used to dampen waves or surges in a large body of water or a flume; typically used for the purpose of water-level measurement.

**stoichiometric** Pertaining to the quantitative relationship between reactants and products in a chemical reaction (e.g., the ratio of chemical substances reacting in water that corresponds to their combined weights in the theoretical chemical reaction).

**stoichiometric coefficients** The coefficients given before substances in a balanced chemical equation that are used to convert mass units for the different substances in the reaction.

**storm sewer** An underground pipe used to transport stormwater, not wastewater.

**stormwater** Water produced during precipitation events (e.g., snowmelt and stormwater runoff).

**Streptococcus** A genus of bacteria that includes some of the most common human pathogens.

**struvite** A crystalline solid or tenacious scale (typically whitish in color). Chemical formula is  $MgNH_4PO_4 \cdot 6H_2O$ . Also called *magnesium ammonium phosphate*.

**submerged launder** A pipe and control valve constructed below the normal water level used to remove liquid from sedimentation basins. Frequently used in primary sedimentation basins to avoid the odors associated with free fall launders and weirs.

**submerged weir** A weir where the water level on the downstream side is as high or higher than the weir crest. Also called a *drowned weir*.

**submodel** A model within a model; typically used to describe a particular facet of a larger or complex process.

**subnatant** Liquid underneath the surface of floating solids.

**substrate** (1) Wastewater or solids constituents used to promote biological growth. (2) Any surface to which a coating is applied.

**sulfur dioxide** Chemical frequently used in dechlorination. Chemical formula is  $SO_2$ .

**sulfur-oxidizing bacteria** Bacteria that can oxidize hydrogen sulfide to sulfuric acid.

**sump** A pit or reservoir that collects water or wastewater for subsequent removal from the system.

**supermodel** A mechanism for passing variables between different types of models. A supermodel includes all of the process variables in every process, even if some are not thought to be significant. This makes it easier to pass variables between models without requiring an interface model.

**supernatant** (1) The liquid remaining above a sediment or precipitate after sedimentation. (2) The most liquid stratum in a solids digester.

**Support Center for Regulatory Air Models (SCRAM)** A U.S. Environmental Protection Agency Web site where guidance on dispersion models can be obtained.

**support gravel** Layers of graded gravel between the underdrain openings and filter media to prevent media from leaking into the underdrain.

**surcharge** (1) The height of wastewater in a sewer manhole above the crown of the sewer when the sewer is flowing completely full. (2) Loads on a system that are greater than typically anticipated. (3) An extra monetary charge imposed when set quantity or quality limits are exceeded, especially on flows discharged to a wastewater collection system.

**surface aerator** Mechanical aeration device consisting of a partially submerged impeller attached to a motor; it is mounted on floats or a fixed structure.

**surface area loading rate ( $M/L^2/T$ )** The substrate mass loading rate to a reactor divided by *net specific surface area*.

**surface area removal rate ( $M/L^2/T$ )** The mass of substrate removed in a reactor divided by *net specific surface area*.

**surface loading rate** A criterion used when designing sedimentation tanks, expressed as flow per day per unit of basin surface area. Also called the *overflow rate*.

**surface profile** Contour of a blast-cleaned or substrate surface, viewed from the edge (cross-section of the surface).

**surface tension** The force acting on a liquid surface that tends to minimize the area of the liquid surface. Produced by the unbalanced inward pull exerted on the layer of surface molecules by molecules below the liquid surface.

**surface wash** An auxiliary high-pressure water spray system used to agitate and wash the surface of granular media filters.

**suspended-growth process** A biological treatment process in which the microbes and substrate are suspended in the wastewater.

**suspended solids** Solids captured via filtration through a glass wool mat or 0.45- $\mu$  membrane.

**sustainability** Development that meets today's needs without compromising the ability of future generations to meet their own needs.

**switching function** An equation used to describe how reactions change based on environmental conditions (e.g., a switching function for dissolved oxygen can be used to describe different rates for anoxic versus aerobic conditions).

***syntrophic*** A condition in which two or more organisms combine metabolic activities to degrade a substrate that typically cannot be as well-degraded by one organism. Each organism's activities are critical to substrate degradation, but they are not performed for the organisms' mutual benefit.

***system curve*** A plot of total dynamic head versus flow for a piping system or network.

***system SRT*** Solids retention time within a processing system. In an activated sludge process, system SRT will include the length of time that solids are held in the anaerobic, anoxic, and aerobic portions of aeration tanks, as well as in the secondary clarifiers.

***tapered aeration*** A variant of the activated sludge process in which the amount of air supplied in an aeration basin is tapered to match the demand exerted by the microbes.

***Tedlar<sup>®</sup> bags*** These bags, which are made of a non-reactive material, are used to collect odor samples.

***Ten States Standards*** Common name for *Recommended Standards for Wastewater Facilities*, a report of the Wastewater Committee of the Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Engineers.

***terminal headloss*** The headloss that occurs at the end of a filter run cycle, signifying that the filter bed is filled with solids.

***terminal settling velocity*** The maximum sedimentation rate of an unhindered suspended solids particle.

***tertiary filtration*** A filtration process used to improve the quality of secondary effluent.

***tertiary treatment*** A physical, chemical, or biological process used to improve the quality of secondary effluent.

***theoretical oxygen demand*** A calculation of the amount of oxygen required to oxidize a compound to its final oxidation products; used to estimate the amount of organic matter in water or wastewater.

***thermal conditioning*** A process in which heat and pressure are applied to solids simultaneously to enhance their dewaterability without the addition of conditioning chemicals.

***thermal oxidation*** A process in which organic solids are converted to oxidized products by heating them in the presence of oxygen or air.

***thermal oxidizer*** An emissions-control device that uses heat to oxidize volatile organic compounds.

***thermal plastic*** A material that can be repeatedly softened by heat and hardened by cooling.

***thermal-set*** A material that becomes relatively infusible once it has undergone a chemical reaction via heat, catalysts, or ultraviolet light.

***thermophiles*** Bacteria that grow best at temperatures between 45 and 60°C.

***thermophilic*** An operating temperature range (typically 50 to 60°C) for an aerobic digester. It affects the microbial population in the digesters, as well as the reaction rates.

***thermophilic aerobic digestion*** An aerobic digester that operates in the range of 40 to 80°C.

***thermophilic digestion*** A process in which solids are digested by microorganisms that thrive in the thermophilic temperature range (about 50 to 60°C).

***thickener*** A tank vessel, or apparatus where residuals or a slurry is thickened by reducing its water content.

***solids thickening*** A process designed to increase the solids concentration in residuals by removing a portion of the liquid; such processes include a sedimentation tank, DAF, gravity thickener, centrifuge, gravity belt thickener, and membrane thickener.

***thixotropy*** The time-dependent ability of some emulsions and solids to change viscosity when left at rest.

***tide gate*** A swinging gate in a collection-system pipe that prevents seawater from entering the system during high tides.

***ton container*** A 1-ton storage container; typically used to store treatment chemicals (e.g., chlorine or sulfur dioxide).

***top dressing*** In landscaping, the application of a thin layer of soil or organic material to improve the turf surface by stimulating new growth, filling minor depressions, and improving drainage.

***total capital cost*** The sum of direct and indirect capital costs for a project.

***total dissolved solids*** The sum of all volatile and nonvolatile solids dissolved in a water or wastewater. Experimentally determined as solids remaining after a sample is filtered through a standard glass-fiber filter, placed in an evaporation dish, and heated to 180°C for 1 hour.

***total dynamic head*** The total energy that a pump must impart to water to move it from one point to another, measured as the difference in height between the free-water surface level on the discharge and suction sides of a pump.

***total inorganic nitrogen (TIN)*** Typically the sum of ammonia, nitrite, and nitrate-nitrogen concentrations in wastewater.

***total Kjeldahl nitrogen*** The sum of organic nitrogen plus ammonia-nitrogen.

**Total nitrogen** Typically the sum of TIN and organic nitrogen.

**total oxygen demand** A measure of the organic matter in a water or wastewater that can be converted to stable products in a platinum-catalyzed combustion chamber.

**total solids** (1) The sum of dissolved and suspended solids in a water or wastewater. (2) The matter remaining on a weighed dish after the fluid has been evaporated at 103 to 105°C.

**total maximum daily load (TMDL)** A calculated pollutant load typically developed based on water quality models and field testing; it identifies the maximum amount (in pounds per day) of one or more pollutants that can be discharged to a receiving water-body from sources within a defined area.

**total suspended solids** A measure of particulate suspended in a sample of water or wastewater. After filtering a sample of a known volume, the filter is dried and weighed to determine mass of the residue.

**totally enclosed fan cooled** A designation for a motor enclosure that is not airtight but does not allow free exchange of air between the inside and outside of the motor case. Exterior cooling is provided by an integral external fan.

**totally enclosed explosion proof** A designation for a motor enclosure that is not airtight but does not allow free exchange of air between the inside and outside of the motor case. Exterior cooling is provided by a nonsparking fan.

**TOXCHEM** A mass emissions model that predicts the fate of compounds in the liquid phase of a wastewater treatment plant and predicts mass emission rate into the air phase; it also includes some preliminary algorithms that estimate emissions from solids-handling processes.

**toxicity** The property of being poisonous or causing an adverse effect on a living organism.

**transmembrane pressure** The difference between feed pressure and permeate pressure (i.e., the driving force required to achieve a given flux through a membrane).

**trash rack** A coarse screening device that uses a set of parallel, stationary bars typically spaced 38 to 150 mm (1.5 to 6 in.) apart.

**traveling-bridge clarifier** A rectangular clarifier in which the solids-removal mechanism is supported by a mobile bridge.

**traveling-bridge filter** A granular media filter with multiple compartments that can be individually cleaned by a movable, bridge-mounted backwashing device without taking the entire filter out of service.

**trickling filter** An aerobic, fixed-film treatment process in which wastewater flows across a bed of highly permeable media. As the wastewater disperses, its organic matter is degraded by microorganisms in the slime on the media surface.

**trihalomethanes** Disinfectant byproducts formed when chlorine reacts with organic compounds in water. These halogenated organics are named as derivatives of methane and include suspected carcinogens.

**triple bottom line** A method of evaluating organizational performance by measuring economic success, environmental sustainability, and social responsibility.

**Trommel screen** A large rotating screen (i.e., a large metal mesh drum).

**turbidimeter** An instrument used to measure water turbidity by detecting the intensity of light scattered at angles from a beam of light projected through a water sample.

**turbidity** Suspended matter in water or wastewater that scatters or otherwise interferes with the passage of light through the water.

**turbidity breakthrough** The point when particles begin appearing in filtrate; an indication that filter effluent quality has deteriorated to an unacceptable level.

**turbidity unit** See *nephelometric turbidity unit*.

**turbulence** (1) A situation characterized by irregular variations in the speed and direction of movement of individual particles or elements of the flow. (2) A state of flow in which water is agitated by cross-currents and eddies, as opposed to laminar or streamlined flow.

**two-tray clarifier** Space-saving clarifier arrangement in which one longitudinal clarifier basin is located above another; they can be operated in parallel or in series.

**ultimate biochemical oxygen demand** The amount of oxygen required to completely satisfy carbonaceous and nitrogenous biochemical oxygen demand.

**ultrasonic** Sound waves at frequencies that are greater than or equal to 20 kHz. These frequencies are beyond the range of human hearing.

**ultraviolet light** The portion of the electromagnetic spectrum extending from the violet end of visible light to the X-ray region. Its wavelengths are between about 400 and 10 nm, corresponding to frequencies of  $7.5 \times 10^{14}$  to  $3 \cdot 10^{16}$  Hz.

**unburned lime** Another term for calcium carbonate.

**underdrain** A flow-collection and backwash water-distribution system used to support the filter bed in most granular media filters. Also called *filter bottom*.

**underflow** The concentrated solids removed from the bottom of a tank or basin.

**uniformity coefficient** A method of characterizing filter sand. It is equal to the sieve size, in millimeters, that will pass 60% of the sand divided by the size that will pass 10%.

**uninterruptable power supplies** Typically, a battery back-up system that will generate alternating current power during a power outage.

**upflow filter** A filtration system in which fluid flows upward through the filter bed.

**U.S. Environmental Protection Agency** The governmental agency in the United States with primary responsibility for enforcing federal environmental laws.

**utility energy service contract (UESC)** An agreement to partner with the electric utility to implement energy-conservation or renewable-energy projects.

**vacuum chamber sampler** A sample-collection device in which an empty sample bag is placed in a closed chamber, and then air is pumped out of the chamber to create a vacuum that expands the bag and draws gas into it.

**vacuum filter** A dewatering system in which a cloth-covered cylindrical drum slowly rotates in a tank of solids. An internal vacuum draws water through the filter cloth, while solids remain in the tank.

**valve** A device used to regulate the flow of fluids through a piping system.

**vapor flux** The rate at which mass is released through a unit surface area, commonly used to measure air emissions.

**variable declining-rate filtration** Filter operation whereby the rate of flow through the filter declines and the level of liquid above the filter rises throughout the filter run.

**variable-frequency drive** (1) A piece of electrical equipment that takes standard electrical power (typically 480 V, 50 to 60 Hz) and converts it into a variable-frequency power source to vary the speed of standard induction motors. (2) A method of controlling the rotational speed of an alternating current electric motor by controlling the frequency of the electrical power supplied to the motor.

**vector** An insect or other organism capable of transmitting pathogens to other species.

**velocity gradient** A measure of the degree of mixing imparted to water or wastewater during flocculation. Also called *G value*.

**velocity head** The kinetic energy in a hydraulic system.

**venture scrubber** See *Venturi scrubber*.

**Venturi meter** A meter used to measure flows in closed conduits by registering the difference in velocity heads at the entrance and outlet of a contracted throat.

**Venturi effect** An increase in a fluid's velocity as it passes through a constriction in a pipe or channel.

***Venturi scrubber*** A misting scrubber for gases. Its constriction is designed to emit miniscule droplets of a fluid at high velocity, thereby maximizing the scrubbing liquid's physical contact with contaminants.

***vertical benchmark*** The fixed point for vertical control of construction. The elevation datum should be indicated for the benchmark.

***vibratory plow*** An oscillating plow shank used to install subsurface drip tubing and utility lines.

***virus*** The smallest biological structure capable of reproduction; it can only grow and reproduce inside a host organism; infects its host, producing disease.

***viscosity*** The internal friction of a fluid that resists the force tending to cause the fluid to flow.

***vivianite*** Particulate crystals or scale that is blue, green, or gray-black in color. It is soluble in hydrochloric acid or nitric acid ( $\text{HNO}_3$ ) and turns opaque or dark when exposed to light. Chemical formula is  $\text{Fe}_3(\text{PO}_4)_2 \cdot 8(\text{H}_2\text{O})$ . Also called *hydrated iron phosphate*.

***V-notch weir*** A weir with a V-shaped notch; used to measure flow.

***volatile*** A substance that evaporates or vaporizes at a relatively low temperature.

***volatile organic compounds (VOC)*** The term, volatile organic compounds, is often used generically to mean total organic carbon. In the context of air quality, the term means total nonmethane hydrocarbons.

***volatile solids*** Organic matter subject to decomposition; it is ignitable at  $550^\circ\text{C}$ . Typically this is used to represent the organic fraction of the sludge or other solids material.

***volatile suspended solids*** Organic, biodegradable matter suspended in water or wastewater. The percentage of this matter in a total suspended solids sample is determined by heating the sample to  $600^\circ\text{C}$ .

***volume sources*** A three-dimensional source of pollutant emissions; typically refers to a situation (e.g., fugitive emissions) that is not easily characterized as a point or area source.

***volumetric feeder*** A device that delivers a constant preset or proportional volume of dry chemical; it is not affected by changes in material density.

***vortex*** A whirling mass of water or air with a cavity in the center toward which particles are drawn.

***vortex flow regulator*** A funnel-shaped flow-control device used to withdraw fluid from a storage basin, tank, or cistern at a uniform flowrate.

***vortex grit removal*** A treatment process that uses a mechanically or hydraulically induced vortex to capture grit in the center hopper of a circular tank.

## Design of Municipal Wastewater Treatment Plants

**waste activated sludge** Excess activated sludge that is discharged from an activated sludge treatment process.

**wasteload allocation (WLA)** The maximum load of pollutants that each point source and nonpoint source contributor is allowed to release into a particular waterway.

**wastewater** Water containing the wastes from households, commercial facilities, and industrial operations; it may be mixed with surface water, stormwater, or groundwater that infiltrated the collection system.

**WATER9** An emissions model available from U.S. EPA that predicts which compounds in wastewater will volatilize during collection, storage, treatment, and disposal, and estimates the rate at which they will be released to the atmosphere.

**water hammer** A rapid increase in pressure in a closed piping system that suddenly changes the velocity of its contents; this change may damage or rupture the piping system.

**Water Quality-Based Effluent Limits (WQBELs)** Regulatory limits for pollutant discharges that are established based on a waterbody's ability to assimilate pollutants while maintaining the water quality appropriate for its established beneficial uses; these limits are partially based on an antidegradation approach to pollution control.

**Water Quality Standards (WQS)** Regulatory limits for pollutant discharges that are established based on the receiving waterbody's designated uses, the criteria set to protect such uses, and other provisions established to avoid backsliding. These standards typically are addressed in a wastewater treatment plant's NPDES permit.

**water reclamation plant (WRP)** A wastewater treatment plant designed to produce water suitable for reuse.

**water reclamation** The process of removing solids and pollutants from wastewater and purifying the water so it is suitable for reuse.

**watershed** The area drained by a given waterbody.

**wedge wire** A type of screening media.

**weir** A baffle over which water flows.

**weir loading** The rate at which fluid flows out of a basin, expressed as the volume of liquid passing over a stated length of weir within a given timeframe.

**weir overflow rate** A measurement of the volume of water flowing over each unit length of weir per day.

**wet air oxidation** A process in which solids and compressed air are pumped into a pressurized reactor and heated to oxidize volatile solids without vaporizing the liquid.

**wetlands** Areas of land that are inundated or saturated by water (e.g., swamps, marshes, and bogs); they often support vegetation that thrives in saturated-soil conditions.

**wetlands treatment** A wastewater treatment system in which the aquatic root system of cattails, reeds, and similar plants are used to treat wastewater applied either above or below the soil surface. The vegetation, soil, and microbial environment filter and remove many contaminants from wastewater through natural processes.

**wet pit** See *wet well*.

**wet scrubber** An air pollution-control device that removes particulates and fumes from air by entraining them in a water spray.

**wet weather flow** The flow in a collection system that is the result of rainfall or snowmelt.

**wet well** A chamber in which water or wastewater is collected and to which the suction side of a pump is connected.

**wetted perimeter** The length of wetted contact area between a stream of flowing water and the channel that contains it.

**whole plant model** A model used to describe all unit processes in a treatment plant and all of their interconnections in the mass balance.

**wind-tunnel sampler** A sampling device that moves air across a surface to create the mass transfer of contaminants from liquid or solid surfaces and conveys the contaminants to a sample collection chamber or directly to a measurement device.

**windrow** A long, triangular-shaped pile of material.

**windrow composting** A composting method in which solids are mixed with a bulking agent and arranged in windrows that periodically are turned and remixed mechanically.

**wound-rotor motor** A motor whose rotor is designed to allow varying external resistances to be imposed. This allows the speed of the motor to be varied.

**zero liquid discharge** Description of a facility that discharges no liquid effluent to the environment.