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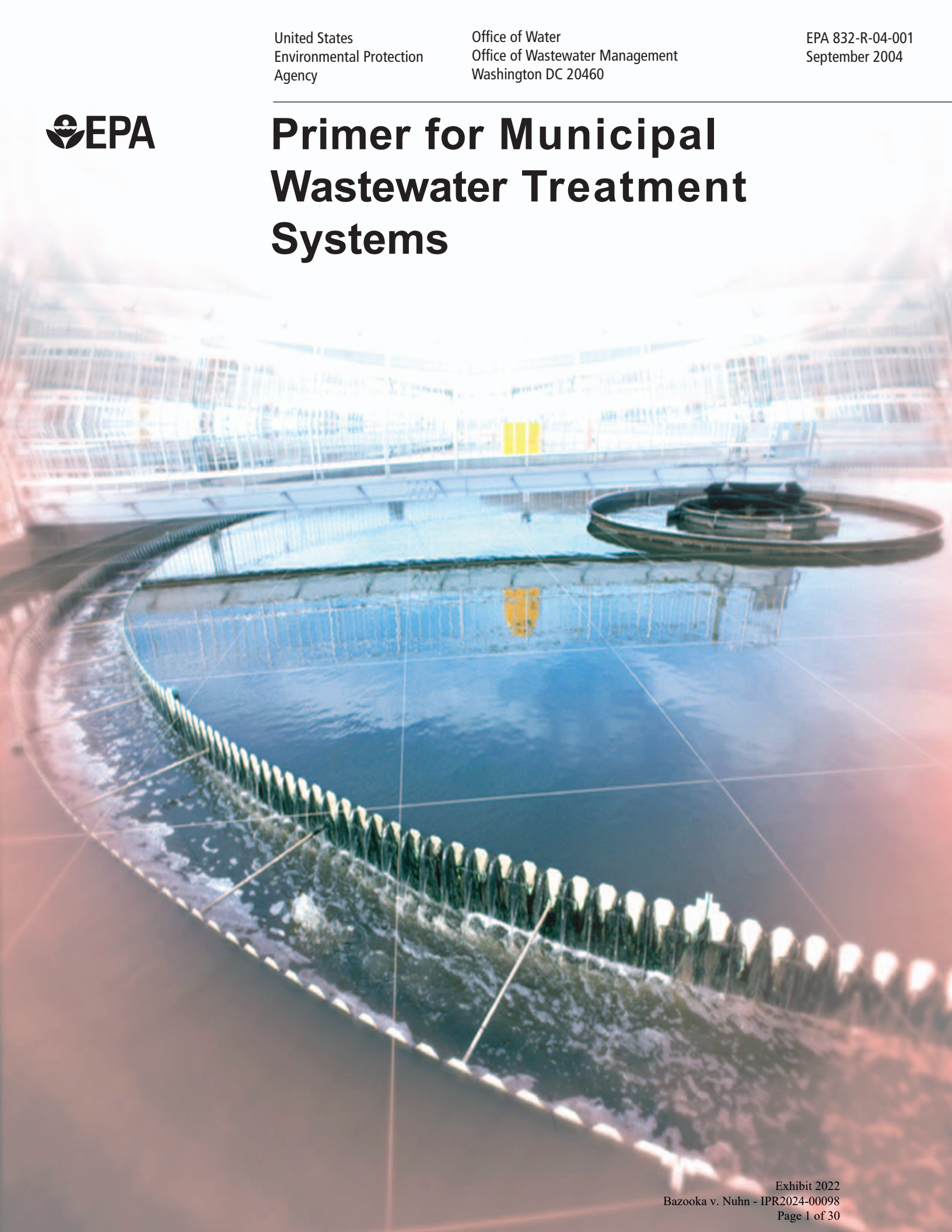
Primer for Municipal Wastewater Treatment Systems



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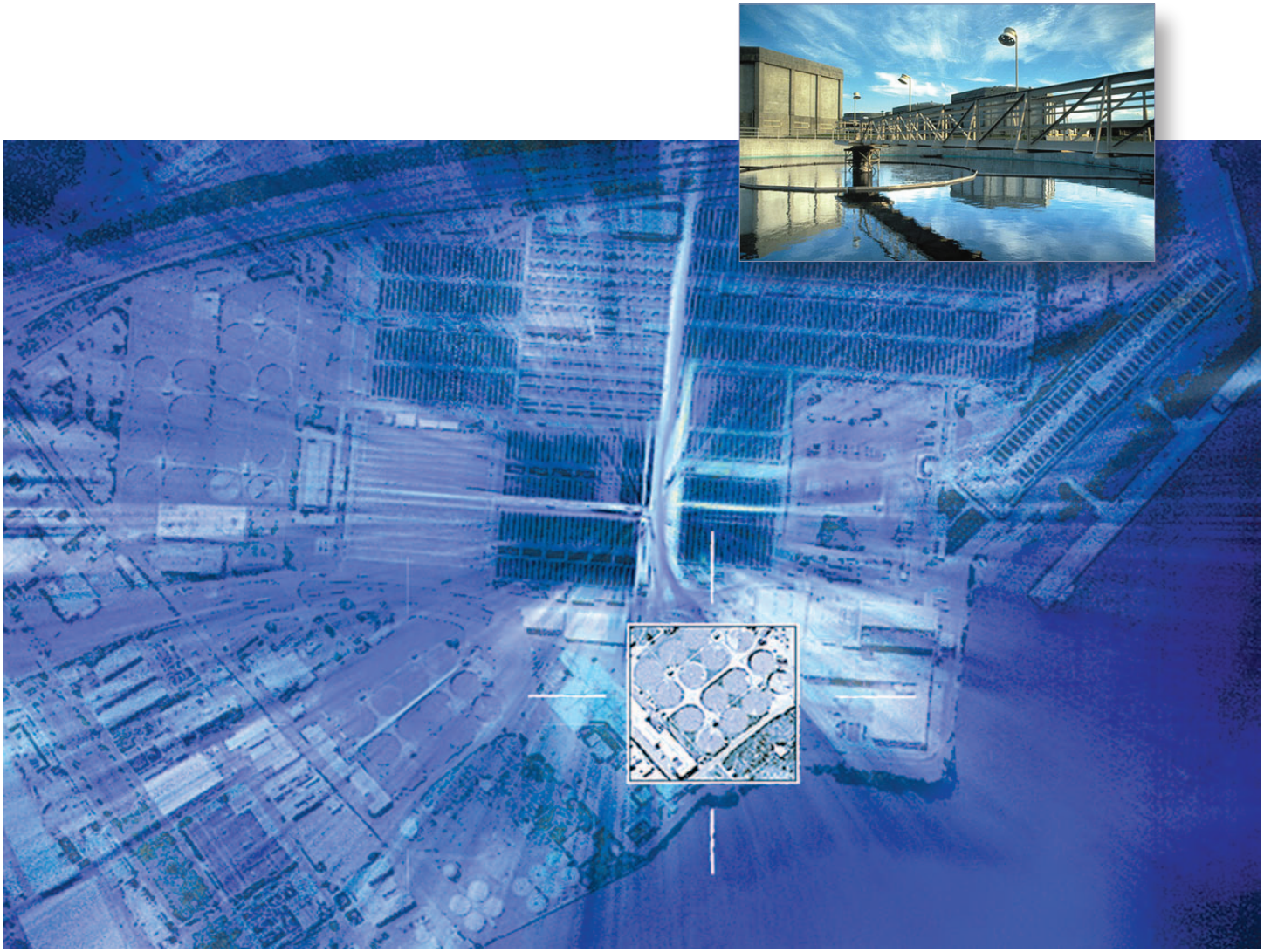
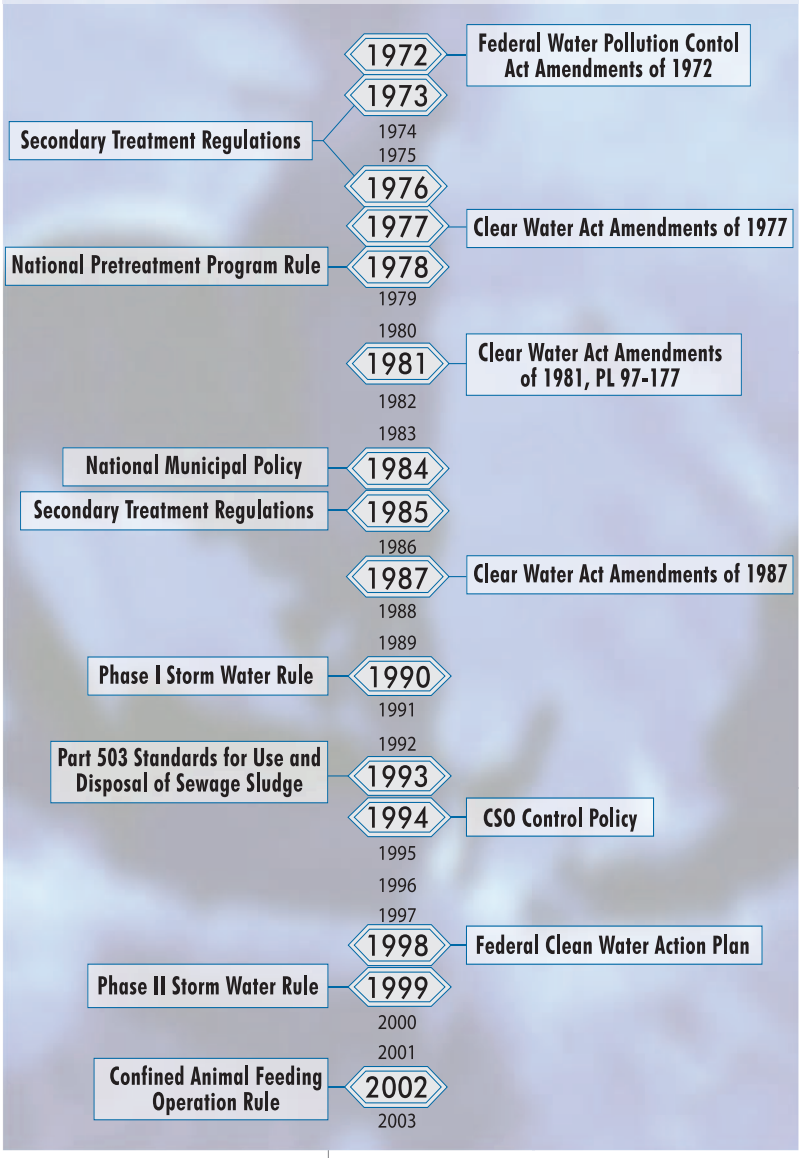


Timeline of Federal Water Pollution Control Acts and Programs



Clean Water Act Requirements for Wastewater Treatment

The 1972 Amendments to the Federal Water Pollution Control Act (Public Law 92-500–, known as the Clean Water Act (CWA), established the foundation for wastewater discharge control in this country. The CWA's primary objective is to 'restore and maintain the chemical, physical and biological integrity of the nation's waters.'

The CWA established a control program for ensuring that communities have clean water by regulating the release of contaminants into our country's waterways. Permits that limit the amount of pollutants discharged are required of all municipal and industrial wastewater dischargers under the National Pollutant Discharge Elimination System (NPDES) permit program. In addition, a construction grants program was set up to assist publicly-owned wastewater treatment works build the improvements required to meet these new limits. The 1987 Amendments to the CWA established State Revolving Funds (SRF) to replace grants as the current principal federal funding source for the construction of wastewater treatment and collection systems.

Over 75 percent of the nation's population is served by centralized wastewater collection and treatment systems. The remaining population uses septic or other onsite systems. Approximately 16,000 municipal wastewater treatment facilities are in operation nationwide. The CWA requires that municipal wastewater treatment plant discharges meet a minimum of 'secondary treatment'. Over 30 percent of the wastewater treatment facilities today produce cleaner discharges by providing even greater levels of treatment than secondary.

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The Need for Wastewater Treatment

Wastewater treatment is needed so that we can use our rivers and streams for fishing, swimming and drinking water. For the first half of the 20th century, pollution in the Nation's urban waterways resulted in frequent occurrences of low dissolved oxygen, fish kills, algal blooms and bacterial contamination. Early efforts in water pollution control prevented human waste from reaching water supplies or reduced floating debris that obstructed shipping. Pollution problems and their control were primarily local, not national, concerns. Since then, population and industrial growth have increased demands on our natural resources, altering the situation dramatically. Progress in abating pollution has barely kept ahead of population growth, changes in industrial processes, technological developments, changes in land use, business innovations, and many other factors. Increases in both the quantity and variety of goods produced can greatly alter the amount and complexity of industrial wastes and challenge traditional treatment technology. The application of commercial fertilizers and pesticides, combined with sediment from growing development activities, continues to be a source of significant pollution as runoff washes off the land.

Water pollution issues now dominate public concerns about national water quality and maintaining healthy ecosystems. Although a large investment in water pollution control has helped reduce the problem, many miles of streams are still impacted by a variety of different pollutants. This, in turn, affects the ability of people to use the water for beneficial purposes. Past approaches used to control water pollution control must be modified to accommodate current and emerging issues

Effects of Wastewater on Water Quality

The basic function of the wastewater treatment plant is to speed up the natural processes by which water purifies itself. In earlier years, the natural treatment process in streams and lakes was adequate to perform basic wastewater treatment. As our population and industry grew to their present size, increased levels of treatment prior to discharging domestic wastewater became necessary.

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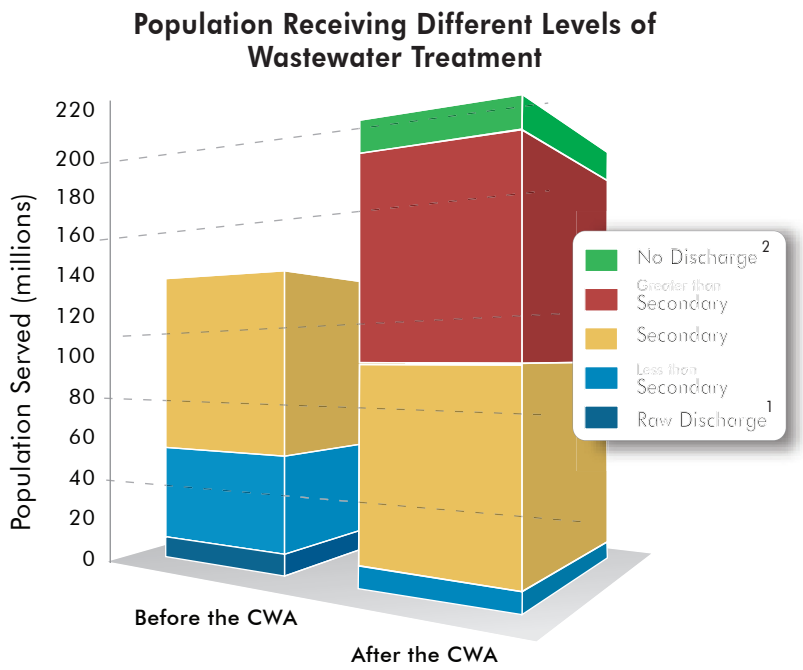
(Data form U.S. Public Health Service multi wastewater inventories: 2000 USEPA Clean Watershed Needs Survey)



[1] Raw discharges were eliminated by 1996
[2] Data for the "no-discharge" category were unavailable for 1968

Some of the key challenges faced by wastewater treatment professionals today:

- Many of the wastewater treatment and collection facilities are now old and worn, and require further improvement, repair or replacement to maintain their useful life;
- The character and quantity of contaminants presenting problems today are far more complex than those that presented challenges in the past;
- Population growth is taxing many existing wastewater treatment systems and creating a need for new plants;
- Farm runoff and increasing urbanization provide additional sources of pollution not controlled by wastewater treatment; and
- One third of new development is served by decentralized systems (e.g., septic systems) as population migrates further from metropolitan areas.

Collecting and Treating Wastewater

The most common form of pollution control in the United States consists of a system of sewers and wastewater treatment plants. The sewers collect municipal wastewater from homes, businesses, and industries and deliver it to facilities for treatment before it is discharged to water bodies or land, or reused.

Centralized Collection

During the early days of our nation's history, people living in both the cities and the countryside used cesspools and privies to dispose of domestic wastewater. Cities began to install wastewater collection systems in the late nineteenth century because of an increasing awareness of waterborne disease and the popularity of indoor plumbing and flush toilets. The use of sewage collection systems brought dramatic improvements to public health, further encouraging the growth of metropolitan areas. In the year 2000 approximately 208 million people in the U.S. were served by centralized collection systems.

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Combined Sewer Systems

Many of the earliest sewer systems were combined sewers, designed to collect both sanitary wastewater and storm water runoff in a single system. These combined sewer systems were designed to provide storm drainage from streets and roofs to prevent flooding in cities. Later, lines were added to carry domestic wastewater away from homes and businesses. Early sanitarians thought that these combined systems provided adequate health protection. We now know that the overflows designed to release excess flow during rains also release pathogens and other pollutants.

Simplified Urban Water Cycle

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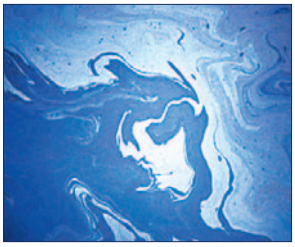

Pollutants

Oxygen-Demanding Substances

Dissolved oxygen is a key element in water quality that is necessary to support aquatic life. A demand is placed on the natural supply of dissolved oxygen by many pollutants in wastewater. This is called biochemical oxygen demand, or BOD, and is used to measure how well a sewage treatment plant is working. If the effluent, the treated wastewater produced by a treatment plant, has a high content of organic pollutants or ammonia, it will demand more oxygen from the water and leave the water with less oxygen to support fish and other aquatic life.

Organic matter and ammonia are "oxygen-demanding" substances. Oxygen-demanding substances are contributed by domestic sewage and agricultural and industrial wastes of both plant and animal origin, such as those from food processing, paper mills, tanning, and other manufacturing processes. These substances are usually destroyed or converted to other compounds by bacteria if there is sufficient oxygen present in the water, but the dissolved oxygen needed to sustain fish life is used up in this break down process.

Pathogens

Disinfection of wastewater and chlorination of drinking water supplies has reduced the occurrence of waterborne diseases such as typhoid fever, cholera, and dysentery, which remain problems in underdeveloped countries while they have been virtually eliminated in the U.S.

Infectious micro-organisms, or pathogens, may be carried into surface and groundwater by sewage from cities and institutions, by certain kinds of industrial wastes, such as tanning and meat packing plants, and by the contamination of storm runoff with animal wastes from pets, livestock and wild animals, such as geese or deer. Humans may come in contact with these pathogens either by drinking contaminated water or through swimming, fishing, or other contact activities. Modern disinfection techniques have greatly reduced the danger of waterborne disease.

Nutrients

Carbon, nitrogen, and phosphorus are essential to living organisms and are the chief nutrients present in natural water. Large amounts of these nutrients are also present in sewage, certain industrial wastes, and drainage from fertilized land. Conventional secondary biological treatment processes do not remove the phosphorus and nitrogen to any substantial extent -- in fact, they may convert the organic forms of these substances into mineral form, making them more usable by plant life. When an excess of these nutrients overstimulates the growth of water plants, the result causes unsightly conditions, interferes with drinking water treatment processes, and causes unpleasant and disagreeable tastes and odors in drinking water. The release of large amounts of nutrients, primarily phosphorus but occasionally nitrogen, causes nutrient enrichment which results in excessive growth of algae. Uncontrolled algae growth blocks out sunlight and chokes aquatic plants and animals by depleting dissolved oxygen in the water at night. The release of nutrients in quantities that exceed the affected waterbody's ability to assimilate them results in a condition called eutrophication or cultural enrichment.

Inorganic and Synthetic Organic Chemicals

A vast array of chemicals are included in this category. Examples include detergents, household cleaning aids, heavy metals, pharmaceuticals, synthetic organic pesticides and herbicides, industrial chemicals, and the wastes from their manufacture. Many of these substances are toxic to fish and aquatic life and many are harmful to humans. Some are known to be highly poisonous at very low concentrations. Others can cause taste and odor problems, and many are not effectively removed by conventional wastewater treatment.

Thermal

Heat reduces the capacity of water to retain oxygen. In some areas, water used for cooling is discharged to streams at elevated temperatures from power plants and industries. Even discharges from wastewater treatment plants and storm water retention ponds affected by summer heat can be released at temperatures above that of the receiving water, and elevate the stream temperature. Unchecked discharges of waste heat can seriously alter the ecology of a lake, a stream, or estuary.

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Workers install sewer line

Sanitary Sewer Systems

Sanitary sewer collection systems serve over half the people in the United States today. EPA estimates that there are approximately 500,000 miles of publicly-owned sanitary sewers with a similar expanse of privately-owned sewer systems. Sanitary sewers were designed and built to carry wastewater from domestic, industrial and commercial sources, but not to carry storm water. Nonetheless, some storm water enters sanitary sewers through cracks, particularly in older lines, and through roof and basement drains. Due to the much smaller volumes of wastewater that pass through sanitary sewer lines compared to combined sewers, sanitary sewer systems use smaller pipes and lower the cost of collecting wastewater.

Wastewater Treatment

In 1892, only 27 American cities provided wastewater treatment. Today, more than 16,000 publicly-owned wastewater treatment plants operate in the United States and its territories. The construction of wastewater treatment facilities blossomed in the 1920s and again after the passage of the CWA in 1972 with the availability of grant funding and new requirements calling for minimum levels of treatment. Adequate treatment of wastewater, along with the ability to provide a sufficient supply of clean water, has become a major concern for many communities.

Primary Treatment

The initial stage in the treatment of domestic wastewater is known as primary treatment. Coarse solids are removed from the wastewater in the primary stage of treatment. In some treatment plants, primary and secondary stages may be combined into one basic operation. At many wastewater treatment facilities, influent passes through preliminary treatment units before primary and secondary treatment begins.

Preliminary Treatment

As wastewater enters a treatment facility, it typically flows through a step called preliminary treatment. A screen removes large floating objects, such as rags, cans, bottles and sticks that may clog pumps, small pipes, and down stream processes. The screens vary from coarse to fine and are constructed with parallel steel or iron bars with openings of about half an inch, while others may be made from mesh screens with much smaller openings.

Screens are generally placed in a chamber or channel and inclined towards the flow of the wastewater. The inclined screen allows debris to be caught on the upstream surface of the screen, and allows access for manual or mechanical cleaning. Some plants use devices known as comminutors or barminutors which combine the functions of a screen and a grinder. These devices catch and then cut or shred the heavy solid and floating material. In the process, the pulverized matter remains in the wastewater flow to be removed later in a primary settling tank.

"the ability to provide a sufficient supply of clean water continues to be a major national concern"

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Basic Wastewater Treatment Processes

Physical

Physical processes were some of the earliest methods to remove solids from wastewater, usually by passing wastewater through screens to remove debris and solids. In addition, solids that are heavier than water will settle out from wastewater by gravity. Particles with entrapped air float to the top of water and can also be removed. These physical processes are employed in many modern wastewater treatment facilities today.

Biological

In nature, bacteria and other small organisms in water consume organic matter in sewage, turning it into new bacterial cells, carbon dioxide, and other by-products. The bacteria normally present in water must have oxygen to do their part in breaking down the sewage. In the 1920s, scientists observed that these natural processes could be contained and accelerated in systems to remove organic material from wastewater. With the addition of oxygen to wastewater, masses of microorganisms grew and rapidly metabolized organic pollutants. Any excess microbiological growth could be removed from the wastewater by physical processes.

Chemical

Chemicals can be used to create changes in pollutants that increase the removal of these new forms by physical processes. Simple chemicals such as alum, lime or iron salts can be added to wastewater to cause certain pollutants, such as phosphorus, to floc or bunch together into large, heavier masses which can be removed faster through physical processes. Over the past 30 years, the chemical industry has developed synthetic inert chemicals know as polymers to further improve the physical separation step in wastewater treatment. Polymers are often used at the later stages of treatment to improve the settling of excess microbiological growth or biosolids.

After the wastewater has been screened, it may flow into a grit chamber where sand, grit, cinders, and small stones settle to the bottom. Removing the grit and gravel that washes off streets or land during storms is very important, especially in cities with combined sewer systems. Large amounts of grit and sand entering a treatment plant can cause serious operating problems, such as excessive wear of pumps and other equipment, clogging of aeration devices, or taking up capacity in tanks that is needed for treatment. In some plants, another finer screen is placed after the grit chamber to remove any additional material that might damage equipment or interfere with later processes. The grit and screenings removed by these processes must be periodically collected and trucked to a landfill for disposal or are incinerated.

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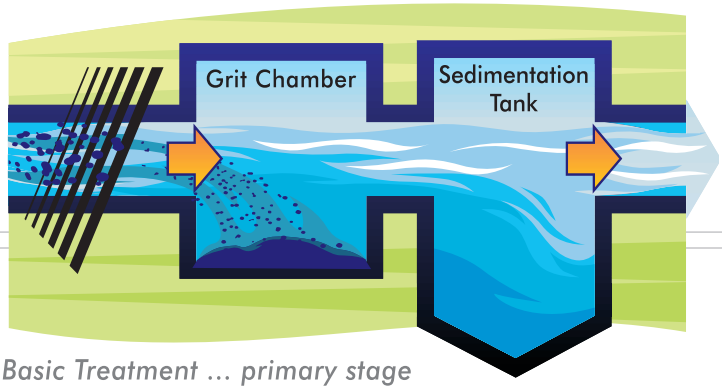


Basic Treatment ... primary stage

Primary Sedimentation

With the screening completed and the grit removed, wastewater still contains dissolved organic and inorganic constituents along with suspended solids. The suspended solids consist of minute particles of matter that can be removed from the wastewater with further treatment such as sedimentation or gravity settling, chemical coagulation, or filtration. Pollutants that are dissolved or are very fine and remain suspended in the wastewater are not removed effectively by gravity settling.

When the wastewater enters a sedimentation tank, it slows down and the suspended solids gradually sink to the bottom. This mass of solids is called primary sludge. Various methods have been devised to remove primary sludge from the tanks. Newer plants have some type of mechanical equipment to remove the settled solids from sedimentation tanks. Some plants remove solids continuously while others do so at intervals.

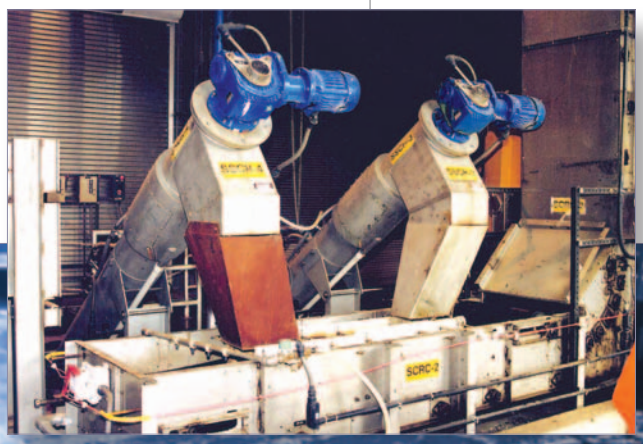
Secondary Treatment

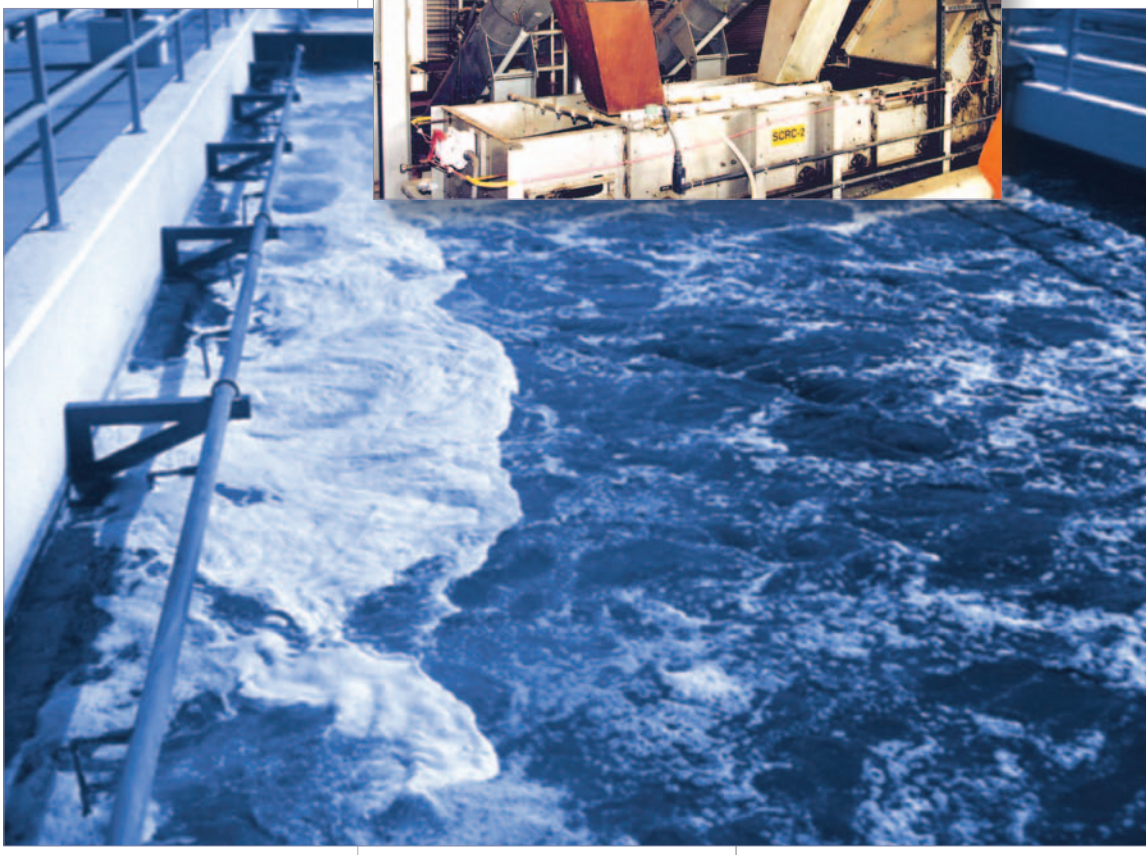
After the wastewater has been through Primary Treatment processes, it flows into the next stage of treatment called secondary. Secondary treatment processes can remove up to 90 percent of the organic matter in wastewater by using biological treatment processes. The two most common conventional methods used to achieve secondary treatment are attached growth processes and suspended growth processes..

Attached Growth Processes

In attached growth (or fixed film) processes, the microbial growth occurs on the surface of stone or plastic media. Wastewater passes over the media along with air to

Solids removed from automated bar screens





Aerated Grit Chamber

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Sequencing Batch Reactor

provide oxygen. Attached growth process units include trickling filters, biotowers, and rotating biological contactors. Attached growth processes are effective at removing biodegradable organic material from the wastewater.

A trickling filter is simply a bed of media (typically rocks or plastic) through which the wastewater passes. The media ranges from three to six feet deep and allows large numbers of microorganisms to attach and grow. Older treatment facilities typically used stones, rocks, or slag as the media bed material. New facilities may use beds made of plastic balls, interlocking sheets of corrugated plastic, or other types of synthetic media. This type of bed material often provides more surface area and a better environment for promoting and controlling biological treatment than rock. Bacteria, algae, fungi and other microorganisms grow and multiply, forming a microbial growth or slime layer (biomass) on the media. In the treatment process, the bacteria use oxygen from the air and consume most of the organic matter in the wastewater as food. As the wastewater passes down through the media, oxygen-demanding substances are consumed by the biomass and the water leaving the media is much cleaner. However, portions of the biomass also slough off the media and must settle out in a secondary treatment tank.

Trickling Filters

Suspended Growth Processes

Similar to the microbial processes in attached growth systems, suspended growth processes are designed to remove biodegradable organic material and organic nitrogen-containing material by converting ammonia nitrogen to nitrate unless additional treatment is provided. In suspended growth processes, the microbial growth is suspended in an aerated water mixture where the air is pumped in, or the water is agitated sufficiently to allow oxygen transfer. Suspended growth process units include variations of activated sludge, oxidation ditches and sequencing batch reactors.

The suspended growth process speeds up the work of aerobic bacteria and other microorganisms that break down the organic matter in the sewage by providing a rich aerobic environment where the microorganisms suspended in the wastewater can work more efficiently. In the aeration tank, wastewater is vigorously mixed with air and microorganisms acclimated to the wastewater in a suspension for several hours. This allows the bacteria

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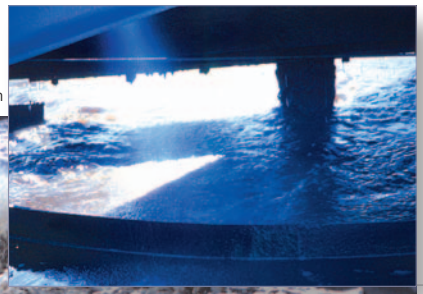
Brush Aerators in an Oxidation Ditch



Centerfeed well of a clarifier for removing excess biomass

and other microorganisms to break down the organic matter in the wastewater. The microorganisms grow in number and the excess biomass is removed by settling before the effluent is discharged or treated further. Now activated with millions of additional aerobic bacteria, some of the biomass can be used again by returning it to an aeration tank for mixing with incoming wastewater.

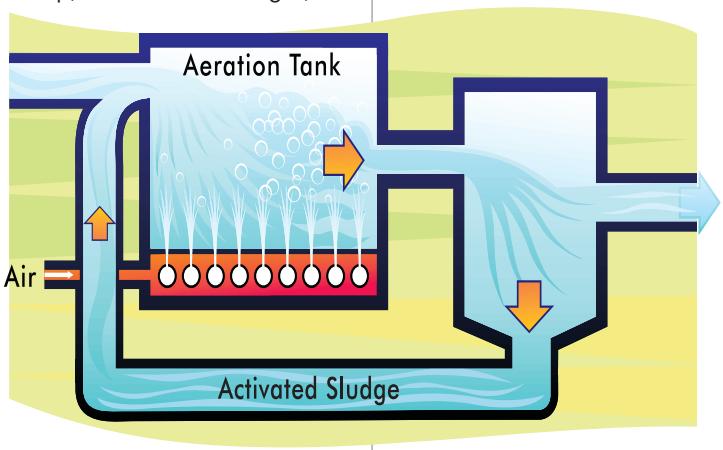
The activated sludge process, like most other techniques, has advantages and limitations. The units necessary for this treatment are relatively small, requiring less space than attached growth processes. In addition, when properly operated and maintained, the process is generally free of flies and odors. However, most activated sludge processes are more costly to operate than attached growth processes due to higher energy use to run the aeration system. The effectiveness of the activated sludge process can be impacted by elevated levels of toxic compounds in wastewater unless complex industrial chemicals are effectively controlled through an industrial pretreatment program.

An adequate supply of oxygen is necessary for the activated sludge process to be effective. The oxygen is generally supplied by mixing air with the sewage and biologically active solids in the aeration tanks by one or more of several different methods. Mechanical aeration can be accomplished by drawing the sewage up from the bottom of the tank and spraying it over the surface, thus allowing the sewage to absorb large amounts of oxygen from the atmosphere. Pressurized air can be forced out through small openings in pipes suspended in the wastewater. Combination of mechanical aeration and forced aeration can also be used. Also, relatively pure oxygen, produced by several different manufacturing processes, can be added to provide oxygen to the aeration tanks.

From the aeration tank, the treated wastewater flows to a sedimentation tank (secondary clarifier), where the excess biomass is removed. Some of the biomass is recycled to the head end of the aeration tank, while the remainder is "wasted" from the system. The waste biomass and settled solids are treated before disposal or reuse as biosolids.

Lagoons

A wastewater lagoon or treatment pond is a scientifically constructed pond, three to five feet deep, that allows sunlight,



Secondary Treatment Suspended Growth Process

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Wastewater Lagoon

algae, bacteria, and oxygen to interact. Biological and physical treatment processes occur in the lagoon to improve water quality. The quality of water leaving the lagoon, when constructed and operated properly, is considered equivalent to the effluent from a conventional secondary treatment system. However, winters in cold climates have a significant impact on the effectiveness of lagoons, and winter storage is usually required.

Lagoons have several advantages when used correctly. They can be used for secondary treatment or as a supplement to other processes. While treatment ponds require substantial land area and are predominantly used by smaller communities, they account for more than one-fourth of the municipal wastewater treatment facilities in this country. Lagoons remove biodegradable organic material and some of the nitrogen from wastewater.

Land Treatment

Land treatment is the controlled application of wastewater to the soil where physical, chemical, and biological processes treat the wastewater as it passes across or through the soil. The principal types of land treatment are slow rate, overland flow, and rapid infiltration. In the arid western states, pretreated municipal wastewater has been used for many years to irrigate crops. In more recent years, land treatment has spread to all sections of the country. Land treatment of many types of industrial wastewater is also common.

Whatever method is used, land treatment can be a feasible economic alternative, where the land area needed is readily available, particularly when compared to costly advanced treatment plants. Extensive research has been conducted at land treatment sites to determine treatment performance and study the numerous treatment processes involved, as well as potential impacts on the environment, e.g. groundwater, surface water, and any crop that may be grown.

Slow Rate Infiltration

In the case of slow rate infiltration, the wastewater is applied to the land and moves through the soil where the natural filtering action of the soil along with microbial activity and plant uptake removes most contaminants. Part of the water evaporates or is used by plants. The remainder is either collected via drains or wells for surface discharge or allowed to percolate into the groundwater.

Slow rate infiltration is the most commonly used land treatment technique. The wastewater, which is sometimes disinfected before application, depending on the end use of the crop and the irrigation method, can be applied to the land by spraying, flooding, or ridge and furrow irrigation. The method selected depends on cost considerations, terrain, and the type of crops. Much of the water and most of the nutrients are used by the plants, while other pollutants are transferred to the soil by adsorption, where many are mineralized or broken down over time by microbial action.

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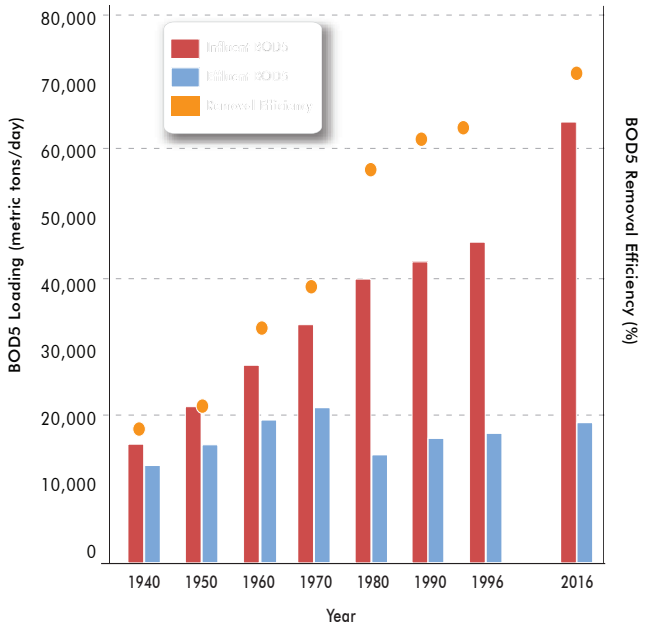
Biologically Degradable Wastewater Treated in the U.S. has increased since 1940, however, treatment efficiency has improved so that pollution has decreased.



[1] 165 gal/capita-day is based on data in the Clean Water Needs Surveys for 1978 through 1986 and accounts for residential, commercial, industrial, stormwater, and infiltration and inflow components.

Rapid Infiltration

The rapid infiltration process is most frequently used to polish and recover wastewater effluents for reuse after pretreatment by secondary and advanced treatment processes. It is also effective in cold or wet weather and has been successfully used in Florida, northeastern and arid southwestern states. Large amounts of wastewater are applied to permeable soils in a limited land area and allowed to infiltrate and percolate downward through the soil into the water table below. If the water is to be reused, it can be recovered by wells. The cost-effectiveness of this process depends on the soil's ability to percolate a large volume of water quickly and efficiently, so suitable soil drainage is important.

Overland Flow

This method has been used successfully by the food processing industries for many years to remove solids, bacteria and nutrients from wastewater. The wastewater is allowed to flow down a gently-sloped surface that is planted with vegetation to control runoff and erosion. Heavy clay soils are well suited to the overland flow process. As the water flows down the slope, the soil and its microorganisms form a gelatinous slime layer similar in many ways to a trickling filter that effectively removes solids, pathogens, and nutrients. Water that is not absorbed or evaporated is recovered at the bottom of the slope for discharge or reuse.

Constructed Wetlands

Wetlands are areas where the water saturates the ground long enough to support and maintain wetland vegetation such as reeds, bulrush, and cattails. A "constructed wetlands" treatment system is designed to treat wastewater by passing it through the wetland. Natural physical, chemical, and biological wetland processes have been recreated and enhanced in constructed wetlands designed specifically to treat wastewater from industries, small communities, storm runoff from urban and agricultural areas, and acid mine drainage. Significant water quality improvements, including nutrient reduction, can be achieved

Constructed Wetlands

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Disinfection

Untreated domestic wastewater contains micro-organisms or pathogens that produce human diseases. Processes used to kill or deactivate these harmful organisms are called disinfection. Chlorine is the most widely used disinfectant but ozone and ultraviolet radiation are also frequently used for wastewater effluent disinfection.

Chlorine

Chlorine kills micro-organisms by destroying cellular material. This chemical can be applied to wastewater as a gas, a liquid or in a solid form similar to swimming pool disinfection chemicals. However, any free (uncombined) chlorine remaining in the water, even at low concentrations, is highly toxic to beneficial aquatic life. Therefore, removal of even trace amounts of free chlorine by dechlorination is often needed to protect fish and aquatic life. Due to emergency response and potential safety concerns, chlorine gas is used less frequently now than in the past.

Ozone

Ozone is produced from oxygen exposed to a high voltage current. Ozone is very effective at destroying viruses and bacteria and decomposes back to oxygen rapidly without leaving harmful by products. Ozone is not very economical due to high energy costs.

Ultraviolet Radiation

Ultra violet (UV) disinfection occurs when electromagnetic energy in the form of light in the UV spectrum produced by mercury arc lamps penetrates the cell wall of exposed microorganisms. The UV radiation retards the ability of the microorganisms to survive by damaging their genetic material. UV disinfection is a physical treatment process that leaves no chemical traces. Organisms can sometimes repair and reverse the destructive effects of UV when applied at low doses.

Pretreatment

The National Pretreatment Program, a cooperative effort of Federal, state, POTWs and their industrial dischargers, requires industry to control the amount of pollutants discharged into municipal sewer systems. Pretreatment protects the wastewater treatment facilities and its workers from pollutants that may create hazards or interfere with the operation and performance of the POTW, including contamination of sewage sludge, and reduces the likelihood that untreated pollutants are introduced into the receiving waters.

Under the Federal Pretreatment Program, municipal wastewater plants receiving significant industrial discharges must develop local pretreatment programs to control industrial discharges into their sewer system. These programs must be approved by either EPA or a state acting as the Pretreatment Approval Authority. More than 1,500 municipal treatment plants have developed and received approval for a Pretreatment Program.

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Advanced Methods of Wastewater Treatment

As our country and the demand for clean water have grown, it has become more important to produce cleaner wastewater effluents, yet some contaminants are more difficult to remove than others. The demand for cleaner discharges has been met through better and more complete methods of removing pollutants at wastewater treatment plants, in addition to pretreatment and pollution prevention which helps limit types of wastes discharged to the sanitary sewer system. Currently, nearly all WWTPs provide a minimum of secondary treatment. In some receiving waters, the discharge of secondary treatment effluent would still degrade water quality and inhibit aquatic life. Further treatment is needed. Treatment levels beyond secondary are called advanced treatment.

Advanced treatment technologies can be extensions of conventional secondary biological treatment to further stabilize oxygen-demanding substances in the wastewater, or to remove nitrogen and phosphorus. Advanced treatment may also involve physical-chemical separation techniques such as adsorption, flocculation/precipitation, membranes for advanced filtration, ion exchange, and reverse osmosis. In various combinations, these processes can achieve any degree of pollution control desired. As wastewater is purified to higher and higher degrees by such advanced treatment processes, the treated effluents can be reused for urban, landscape, and agricultural irrigation, industrial cooling and processing, recreational uses and water recharge, and even indirect augmentation of drinking water supplies.

Monitoring a discharger as part of a Pretreatment Program

Nitrogen Control

Nitrogen in one form or another is present in municipal wastewater and is usually not removed by secondary treatment. If discharged into lakes and streams or estuary waters, nitrogen in the form of ammonia can exert a direct demand on oxygen or stimulate the excessive growth of algae. Ammonia in wastewater effluent can be toxic to aquatic life in certain instances.

By providing additional biological treatment beyond the secondary stage, nitrifying bacteria present in wastewater treatment can biologically convert ammonia to the non-toxic nitrate through a process known as nitrification. The nitrification process is normally sufficient to remove the toxicity associated with ammonia in the effluent. Since nitrate is also a nutrient, excess amounts can contribute to the uncontrolled growth of algae. In situations where nitrogen must be completely removed from effluent, an

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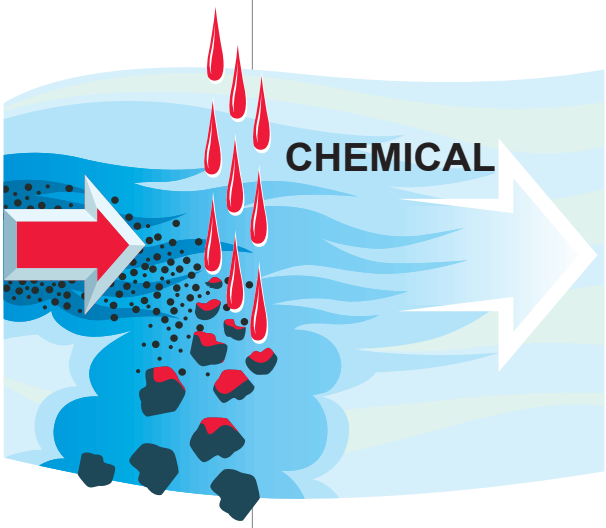
Nitrification Process Tank

additional biological process can be added to the system to convert the nitrate to nitrogen gas. The conversion of nitrate to nitrogen gas is accomplished by bacteria in a process known as denitrification. Effluent with nitrogen in the form of nitrate is placed into a tank devoid of oxygen, where carbon-containing chemicals, such as methanol, are added or a small stream of raw wastewater is mixed in with the nitrified effluent. In this oxygen free environment, bacteria use the oxygen attached to the nitrogen in the nitrate form releasing nitrogen gas. Because



nitrogen comprises almost 80 percent of the air in the earth's atmosphere, the release of nitrogen into the atmosphere does not cause any environmental harm.

Biological Phosphorus Control

Like nitrogen, phosphorus is also a necessary nutrient for the growth of algae. Phosphorus reduction is often needed to prevent excessive algal growth before discharging effluent into lakes, reservoirs and estuaries. Phosphorus removal can be achieved through chemical addition and a coagulation-sedimentation process discussed in the following section. Some biological treatment processes called biological nutrient removal (BNR) can also achieve nutrient reduction, removing both nitrogen and phosphorus. Most of the BNR processes involve modifications of suspended growth treatment systems so that the bacteria in these systems also convert nitrate nitrogen to inert nitrogen gas and trap phosphorus in the solids that are removed from the effluent.

Coagulation-sedimentation

A process known as chemical coagulation-sedimentation is used to increase the removal of solids from effluent after primary and secondary treatment. Solids heavier than water settle out of wastewater by gravity. With the addition of specific chemicals, solids can become heavier than water and will settle.

Alum, lime, or iron salts are chemicals added to the wastewater to remove phosphorus. With these chemicals, the smaller particles 'floc' or clump together into large masses. The larger masses of particles will settle faster when the effluent reaches the next step--the sedimentation tank. This process can reduce the concentration of phosphate by more than 95 percent.

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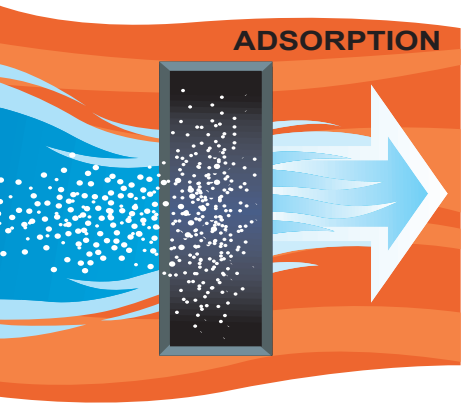
Although used for years in the treatment of industrial wastes and in water treatment, coagulation-sedimentation is considered an advanced process because it is not routinely applied to the treatment of municipal wastewater. In some cases, the process is used as a necessary pretreatment step for other advanced techniques. This process produces a chemical sludge, and the cost of disposing this material can be significant.



Carbon adsorption

Carbon adsorption technology can remove organic materials from wastewater that resist removal by biological treatment. These resistant, trace organic substances can contribute to taste and odor problems in water, taint fish flesh, and cause foaming and fish kills.

Carbon adsorption consists of passing the wastewater effluent through a bed or canister of activated carbon granules or powder which remove more than 98 percent of the trace organic substances. The substances adhere to the carbon surface and are removed from the water. To help reduce the cost of the procedure, the carbon granules can be cleaned by heating and used again.

The Use or Disposal of Wastewater Residuals and Biosolids

When pollutants are removed from water, there is always something left over. It may be rags and sticks caught on the screens at the beginning of primary treatment. It may be the solids that settle to the bottom of sedimentation tanks. Whatever it is, there are always residuals that must be reused, burned, buried, or disposed of in some manner that does not harm the environment.

The utilization and disposal of the residual process solids is addressed by the CWA, Resource Conservation and Recovery Act (RCRA), and other federal laws. These Federal laws re-enforce the need to employ environmentally sound residuals management techniques and to beneficially use biosolids whenever possible. Biosolids are processed wastewater solids ("sewage sludge") that meet rigorous standards allowing safe reuse for beneficial purposes. Currently, more than half of the biosolids produced by municipal wastewater treatment systems is applied to land as a soil conditioner or fertilizer and the remaining solids are incinerated or landfilled. Ocean dumping of these solids is no longer allowed.

Prior to utilization or disposal, biosolids are stabilized to control odors and reduce the number of disease-causing organisms. Sewage solids, or sludge, when separated from the

Biosolids Digestor

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wastewater, still contain around 98 percent water. They are usually thickened and may be dewatered to reduce the volume to be transported for final processing, disposal, or beneficial use. Dewatering processes include drying beds, belt filter presses, plate and frame presses, and centrifuges. To improve dewatering effectiveness, the solids can be pretreated with chemicals such as lime, ferric chloride, or polymers to produce larger particles which are easier to remove. Digestion is a form of stabilization where the volatile material in the wastewater solids can decompose naturally and the potential for odor production is reduced. Digestion without air in an enclosed tank (anaerobic solids digestion) has the added benefit of producing methane gas which can be recovered and used as a source of energy.

Land Application of Biosoilds

Stabilization of solids may also be accomplished by composting, heat treatments, drying or the addition of lime or other alkaline materials. After stabilization, the biosolids can be safely spread on land.

Land Application

In many areas, biosolids are marketed to farmers as fertilizer. Federal regulation (40 CFR Pert 503) defines minimum requirements for such land application practices, including contaminant limits, field management practices, treatment requirements, monitoring, recordkeeping, and reporting requirements. Properly treated and applied biosolids are a good source of organic matter for improving soil structure and help supply nitrogen, phosphorus, and micronutrients that are required by plants. Biosolids have also been used successfully for many years as a soil conditioner and fertilizer, and for restoring and revegetating areas with poor soils due to construction activities, strip mining or other practices. Under this biosolids management approach, treated solids in semi-liquid or dewatered form are transported to the soil treatment areas. The slurry or dewatered biosolids, containing nutrients and stabilized organic matter, is spread over the land to give nature a hand in returning grass, trees, and flowers to barren land. Restoration of the countryside also helps control the flow of acid drainage from mines that endangers fish and other aquatic life and contaminates the water with acid, salts, and excessive quantities of metals.

Incineration

Incineration consists of burning the dried solids to reduce the organic residuals to an ash that can be disposed or reused. Incinerators often include heat recovery features. Undigested sludge solids have significant fuel value as a result of their high organic content. However, the water content must be greatly reduced by dewatering or drying to take advantage of the fuel potential of the biosolids. For this reason, pressure filtration dewatering equipment is used to obtain biosolids which are sufficiently dry to burn without continual reliance on auxiliary fuels. In some cities, biosolids are

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Composted Biosolids

mixed with refuse or refuse-derived fuel prior to burning. Generally, waste heat is recovered to provide the greatest amount of energy efficiency.

Beneficial Use Products from Biosolids

Heat dried biosolids pellets have been produced and used extensively as a fertilizer product for lawn care, turf production, citrus groves, and vegetable production for many years. Composting of biosolids is also a well established approach to solids management that has been adopted by a number of communities. The composted peat-like product has shown particular promise for use in the production of soil additives for revegetation of topsoil depleted areas, and as a potting soil amendment.

Effective pretreatment of industrial wastes prevents excessive levels of unwanted constituents, such as heavy metals (i.e. cadmium, mercury, and lead) and persistent organic compounds from contaminating the residuals of wastewater treatment and limiting the potential for beneficial use.

Effective stabilization of wastewater residuals and their conversion to biosolid products can be costly. Some cities have produced fertilizers from biosolids which are sold to help pay part of the cost of treating wastewater. Some municipalities use composted, heat dried, or lime stabilized biosolid products on parks and other public areas.

Decentralized (Onsite and Cluster) Systems

A decentralized wastewater system treats sewage from homes and businesses that are not connected to a centralized wastewater treatment plant. Decentralized treatment systems include onsite systems and cluster systems. An onsite system is a wastewater system relying on natural processes, although sometimes containing mechanical components, to collect, treat, disperse or reclaim wastewater from a single dwelling or building. A septic tank and soil adsorption field is an example of an onsite system. A wastewater collection and treatment system under some form of common ownership that collects wastewater from two or more dwellings or buildings and conveys it to a treatment and dispersal system located on a suitable site near the dwellings or buildings is a cluster system. Decentralized systems include those using alternative treatment technologies like media filters, constructed wetland systems, aerobic treatment units, and a variety of soil dispersal systems. Soil dispersal systems include

Egg-shaped Digestors

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pressure systems such as low pressure pipe and drip dispersal systems. These systems treat and disperse relatively small volumes of wastewater, and are generally are found in rural and suburban areas. While septic tanks and soil absorption systems have significant limitations, decentralized systems can effectively protect water quality and public health from groundwater and surface water contamination if managed properly (i.e. properly sited, sized, designed, installed, operated, and maintained). Nitrate concentrations in groundwater that exceed the drinking water standards can cause health problems.

Treatment

Onsite wastewater systems contain three components: a treatment unit which treats water prior to dispersal into the environment; a soil dispersal component which assures that treated water is released into the environment at a rate which can be assimilated; and a management system which assures proper long term operation of the complete system. Disinfection of the treated effluent may be provided prior to dispersal. A typical onsite system consists of a septic tank followed by an effluent distribution system. Alternative treatment systems include aerobic treatment and sand filtration systems.

Septic tank and distribution box

Conventional Septic Tanks

A septic tank is a tank buried in the ground used to treat sewage without the presence of oxygen (anaerobic). The sewage flows from the plumbing in a home or small business establishment into the first of two chambers, where solids settle out. The liquid then flows into the second chamber. Anaerobic bacteria in the sewage break down the organic matter, allowing cleaner water to flow out of the second chamber. The liquid typically discharges through a sub-surface distribution system. Periodically, the solid matter in the bottom of the tank, referred to as septage, must be removed and disposed of properly.

Aerobic Treatment Units

Aerobic treatment units are also used to provide onsite wastewater treatment. They are similar to septic tanks, except that air is introduced and mixed with the wastewater inside the tank. Aerobic (requiring oxygen) bacteria consume the organic matter in the sewage. As with the typical septic system, the effluent discharge from an aerobic system is typically released through a sub-surface distribution system or may be disinfected and discharged directly to surface water. Aerobic treatment units also require the removal and proper disposal of solids that accumulate in the tank.

Media Filters

Media filters are used to provide further treatment of septic tank effluent, and provide high levels of nitrification. They can be designed to pass the effluent once or multiple times through the media bed. Media, such as sand, acts as a filter. The media is placed two to three feet deep above a liner of impermeable

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Onsite aerobic treatment unit

material such as plastic or concrete. Septic tank effluent is applied to the filter surface in intermittent doses and is further treated as it slowly trickles through the media. In most media filters, wastewater is collected in an underdrain then either pumped back to the filter bed or to other types of treatment.

Dispersal Approaches

Traditional onsite systems include treatment units followed by a drainfield or absorption field. Wastewater from the treatment unit is dispersed through a suitable soil layer where it receives additional treatment by the soil microorganisms and filtering properties of the soil. If the soil is unsuitable for the installation of a soil absorption field, alternative methods can be used to further treat or distribute the treated effluent. The most common alternative dispersal systems include low pressure pipe, mounds, drip disposal, and evapotranspiration beds.

Absorbtion Field

When soil conditions permit, the most common method to disperse septic tank or aerobic system effluent is an absorption field consisting of a series of perforated parallel pipes laid in trenches on gravel or crushed stone or as a direct discharge to the soil through trenches. Typically, effluent flows into the absorption field from a distribution box which maintains an even flow of effluent to the absorption field. From there, the effluent drains through the stone and into the soil which provides further treatment.

Mound System

When the soil is not conducive to percolation or when the groundwater level is high, a mound system is commonly used. A mound system is a distribution system constructed above the original ground level by using granular material such as sand and gravel to receive the septic tank effluent before it flows to the native soil below. The effluent flows to a dosing tank that is equipped with a pump. Here the effluent is stored until there is sufficient liquid. Once the liquid is pumped out, it moves evenly throughout the mound before reaching less permeable soil or ground water. The granular material acts as a treatment medium and improves the removal of

Mound system under construction (photo courtesy of Ayres Associates)

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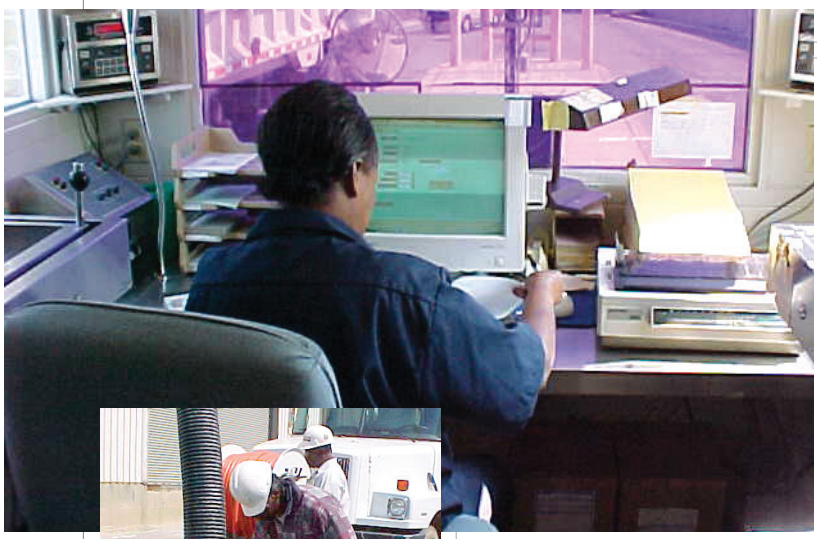
Licensed wastewater treatment plant operator



Sewer line maintenance

pollutants in ways that may not be provided by substandard native soils.

Drip Dispersal System

Where soils are very thin or have reduced permeability, drip dispersal systems can be utilized. The typical drip system operates like drip irrigation at a moderately high pressure. The components of a drip system include filters to remove solids, a network of drip tubes to disperse liquid into soil, tanks to hold liquid, and controllers to regulate the flow to the drip system.

Evapotranspiration Beds

Evapotranspiration (ET) bed is an onsite dispersal system where pretreated wastewater evaporates from the soil surface or is transpired by plants into the atmosphere. Usually, ET beds are used in arid climates and there is no discharge either to surface or ground water. Vegetation is planted on the surface of the sand bed to improve the transpiration process and landscaping enhances the aesthetics of the bed.

Management of Decentralized Systems

Ensuring performance of decentralized wastewater treatment systems is an issue of national concern because these systems are a permanent component of our nation's wastewater infrastructure. Twenty-five percent of households nationwide and one-third of the new homes being constructed are served by onsite systems. Many of the existing systems do not perform adequately due to a lack of management. Therefore, EPA promotes the sustained management of decentralized wastewater systems to enhance their performance and reliability. EPA strongly encourages communities to establish management programs for the maintenance of onsite systems in addition to improving local requirements for onsite system siting and system design. Communities benefit from effective onsite system management programs by enjoying improved protection of public health and local surface water and groundwater resources, preserving rural areas, protecting property owners' investments through increased system service life, and avoiding the need to finance costly central wastewater collection and treatment systems.

Asset Management

America's public water-based infrastructure – its water supply, wastewater, and storm water facilities, and collection/distribution systems – is integral to our economic, environmental and cultural vitality. Much of this country's public wastewater system

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infrastructure has crossed the quarter-century mark, dating back to the CWA construction grant funding of the 1970s. Many of our collection systems date from the end of World War II and the population boom of the post war era. The oldest portions of the collection system pipe network exceed 100 years of service. Significant parts of this infrastructure are severely stressed from overuse and the persistent under-funding of repair, rehabilitation, and replacement. In an increasing number of communities, existing systems are deteriorating, yet the demand for new infrastructure to accommodate growth presses unabated. A revitalized approach to managing capital wastewater assets for cost effective performance is emerging in this country. This asset management approach focuses on the cost effective sustained performance of the wastewater collection and treatment system assets over their useful life.

Operation

Wastewater collection and treatment systems must be operated as designed to adequately protect water quality and human health. Most systems are in operation every day of the year, rain or shine. Licensed and trained operators are responsible for the day-to-day performance of the wastewater system. Their responsibilities include budget and business administration, public relations, analytical testing, and mechanical engineering as well as overseeing the collection system and wastewater treatment processes.

Maintenance

Wastewater collection and treatment systems must provide reliable service and avoid equipment breakdowns. Most equipment breakdowns can be avoided if system operators inspect the equipment, including sewer lines and manholes, regularly. Preventive maintenance uses data obtained through the inspections in a systematic way to direct maintenance activities before equipment failures occur. A good program will reduce breakdowns, extend equipment life, be cost-effective, and help the system operators better perform their jobs.

Common Wastewater Treatment Terminology

Activated Sludge is a suspended growth process for removing organic matter from sewage by saturating it with air and microorganisms that can break down the organic matter.

Advanced Treatment involves treatment levels beyond secondary treatment.

Aeration Tank is a chamber for injecting air and oxygen into water.

Aerobic refers to a life or a process that occurs in the presence of oxygen.

Aerobic Treatment Units provide wastewater treatment by injecting air into a tank, allowing aerobic bacteria to treat the wastewater.

Algae are aquatic plants which grow in sunlit waters and release oxygen into the water. Most are a food for fish and small aquatic animals, but some cause water quality problems.

Alternative System A wastewater treatment or collection system utilized in lieu of a conventional system.

Anaerobic refers to a life or a process that occurs in the absence of free oxygen.

Bacteria are small living organisms which help consume the organic constituents of sewage.

Barminutor is a device mounted on bar screens in a wastewater treatment plant to shred material, such as rags and debris, that accumulates on the bars.

Bar Screen is composed of parallel bars that remove larger objects from wastewater.

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Black Water is the term given to domestic wastewater that carries animal, human, or food wastes.

Biological Nutrient Removal (BNR) is the use of bacteria to remove nutrients from wastewater.

Biomass is microbial growth.

Biosolids are treated sewage sludge solids that have been stabilized to destroy pathogens and meet rigorous standards allowing for safe reuse of this material as a soil amendment.

Biotower is a unit in which the waste is allowed to fall through a tower packed with synthetic media on which there is biological growth similar to the trickling filter.

BOD (Biochemical Oxygen Demand) is a measure of oxygen consumed in biological processes that break down organic matter in water.

Carbon Adsorption is a method to treat wastewater in which activated carbon removes trace organic matter that resists degradation.

Chlorination is the process of adding chlorine gas or chlorine compounds to wastewater for disinfection.

Chlorinator is a device that adds chlorine, in gas or liquid form, to wastewater to kill infectious bacteria.

Clarifier also known as a settling tank, removes solids from wastewater by gravity settling or by coagulation.

Clean Water Act (Federal Water Pollution Control Act) originally enacted in 1948 and amended in 1972, 1981 and 1987, the Clean Water Act has as its objective the restoration and maintenance of the "chemical, physical, and biological integrity of the Nation's waters."

Coagulation is the clumping together of solids to make them settle out of the sewage faster. Coagulation of solids is improved by the use of chemicals such as lime, alum, iron salts, or polymers

Combined Sewers carry both sewage and stormwater runoff.

Comminutor is a device to catch and shred heavy solid matter at the headworks of the wastewater treatment plant.

Composting is the natural biological decomposition of organic material in the presence of air to form a stabilized, humus-like material.

Conventional Systems are wastewater treatment systems that have been traditionally used to collect municipal wastewater in sewers and convey it to a central facility for treatment prior to discharge to surface waters. Either primary or secondary treatment may be provided in a conventional system.

Denitrification is the reduction of nitrite to nitrogen gas. Denitrification is carried out in wastewater treatment tanks by bacteria under anoxic conditions. The bacteria use the nitrate for energy, and in the process, release nitrogen gas. The nitrogen gas, a major constituent of air, is released to the atmosphere.

Diffused Air is a technique by which air under pressure is forced into sewage in an aeration tank. The air is pumped into the tank through a perforated pipe and moves as bubbles through the sewage.

Digestion of solids takes place in tanks where volatile organic materials are decomposed by bacteria, resulting in partial gasification, liquefaction, and mineralization of pollutants.

Disinfection is the killing of pathogenic microbes including pathogenic bacteria, viruses, helminths, and protozoans.

Dispersal/Percolation involves a volume of wastewater applied to the land, penetrating the surface, and passing through the underlying soil.

Dissolved Oxygen (DO) is the amount of free oxygen in solution in water, or wastewater effluent. Adequate concentrations of dissolved oxygen are necessary for fish and other aquatic organisms to live and to prevent offensive odors.

Eligible Costs are those wastewater reduction activities that can be funded with State Revolving Fund (SRF) loans.

Effluent is the treated liquid that comes out of a treatment plant after completion of the treatment process.

Eutrophication is the normally slow aging process by which a lake evolves into a bog or marsh and ultimately disappears. During eutrophication, the lake becomes enriched with nutrients, especially nitrogen and phosphorus, which support the excess production of algae and other aquatic plant life. Eutrophication may be accelerated by many human activities.

Evapotranspiration is the uptake of water from the soil by evaporation and by

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transpiration from the plants growing thereon.

Floc is a clump of solids formed in sewage by biological or chemical action.

Flocculation is the process by which clumps of solids in sewage are made to increase in size by chemical action.

Gray Water refers to domestic wastewater composed of wash water from sinks, shower, washing machines (does not include toilet wastewater).

Grinder Pump is a mechanical device which shreds wastewater solids and raises the fluid pressure level high enough to pass wastewater through small diameter pressure sewers.

Grit Chamber is a small detention basin designed to permit the settling of coarse, heavy inorganic solids, such as sand, while allowing the lighter organic solids to pass through the chamber.

Groundwater is the zone beneath the ground surface saturated with water that has seeped down through soil and rock.

Impervious means resistant to penetration by fluids or by roots.

Incineration involves combustion of the organic matter in sewage sludge, producing a residual inert ash.

Infiltration is the penetration of water through the ground into sub-surface soil or the passing of water from the soil into a pipe, such as a sewer.

Influent refers to water, wastewater, or other liquid flowing into a reservoir, basin or treatment plant, or any unit thereof.

Inorganic refers to compounds that do not contain carbon.

Interceptors are large sewer lines that collect the flows from smaller main and trunk sewers and carry them to the treatment plant.

Intermittent sand filter involves a bed of sand or other fine-grained material to which wastewater is applied intermittently in flooding doses.

Lagoon is a shallow pond in which algae, aerobic and anaerobic bacterial purify wastewater.

Land Application is the controlled application of wastewater or biosolids onto the ground for treatment and/or reuse.

Lateral Sewers are small pipes that are placed in the ground to receive sewage from homes and businesses and convey it to main, trunk and interceptor sewer lines leading to the wastewater treatment plant.

Mechanical Aeration uses mechanical energy to inject air from the atmosphere into water to provide oxygen to create aerobic conditions.

Media Filters involves a bed of sand or other fine-grained material to which wastewater is applied, generally to physically remove suspended solids from sewage. Bacteria on the media decompose additional wastes. Treated water drains from the bed. Solids that accumulate at the surface must be removed from the bed periodically.

Microbes is shorthand for microorganisms.

Million Gallons Per Day (MGD) is a measurement of the volume of water.

Mound System is an effluent disposal system involving a mound of soil built up on the original ground surface to which effluent is distributed.

National Pollutant Discharge Elimination System (NPDES) is a program established by the Clean Water Act (CWA) that requires all wastewater discharges into "waters of the United States" to obtain a permit issued by the US Environmental Protection Agency (EPA) or a state agency authorized by the EPA.

Nitrification is the biochemical oxidation of ammonium to nitrate.

Nitrogenous Wastes are wastes that contain a significant concentration of nitrogen.

Nutrients are elements or compounds essential as raw materials for plant and animal growth and development.

Organic Matter is the carbonaceous material contained in plants or animals and wastes.

Overland Flow is land treatment which involves the controlled application of wastewater onto grass-covered gentle slopes, with impermeable surface soils. As water flows over the grass-covered soil surface, contaminants are removed and the water is collected at the bottom of the slope for reuse.

Oxidation involves aerobic bacteria breaking down organic matter and oxygen combining with chemicals in sewage.

Oxidation Pond is an aerated man-made pond used for wastewater treatment.

Ozonation is a disinfection process where ozone is

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generated and added to wastewater effluent to kill pathogenic organisms.

Pathogens are disease-causing microorganisms, including pathogenic bacteria, viruses, helminths, and protozoans.

Percolation is the movement of water through sub-surface soil layers, usually continuing downward to the groundwater.

Permeability is a measure of the ease with which water penetrates or passes through soil.

Phosphorus is a nutrient that is essential to life, but in excess, contributes to the eutrophication of lakes and other water bodies.

Pollution results when contaminants in human, animal, vegetable, mineral, chemical or thermal waste or discharges reach water, making it less desirable for domestic, recreation, industry, or wildlife uses.

Polymer is a long chain organic compound produced by the joining of primary units called monomers. Polymers are used to improve settling of suspended solids, remove solids from wastewater, and improve dewatering of biosolids.

Pressure Sewers are a system of pipes in which the water, wastewater or other liquid is transported under pressure supplied by pumps.

Pretreatment involves treatment of wastes or wastewater by industries performed prior to the discharge to the sewer system.

Primary Treatment is the initial stage of wastewater treatment that removes floating material and material that easily settles out.

Pump is a mechanical device for raising or lifting water or other fluid, or for applying pressure to fluids in pipes.

Receiving Waters are waterbodies (i.e. rivers, lakes, oceans, or other water courses) that receive discharges of treated or untreated wastewater.

Rotating Biological Contactor (RBC) is a wastewater treatment process involving large, closely-spaced plastic discs rotated about a horizontal shaft. The discs alternately move through the wastewater and the air, developing a biological growth on the surface of the discs that removes organic material in the wastewater.

Sanitary Sewer is the collection system for transporting domestic and industrial wastewater to municipal wastewater treatment facilities. Stormwater is not directed into this system but is handled by a separate system.

Secondary Treatment is the second stage in most wastewater treatment systems in which bacteria consume the organic matter in wastewater. Federal regulations define secondary treatment as meeting minimum removal standards for BOD, TSS, and pH in the discharged effluents from municipal wastewater treatment facilities.

Sedimentation Tanks are wastewater treatment tanks in which floating wastes are skimmed off and settled solids are removed for disposal.

Seepage is the slow movement of water through small cracks or pores of the soil, or out of a pond, tank or pipe.

Septage refers to the residual solids in septic tanks or other on-site wastewater treatment systems that must be removed periodically for disposal.

Septic Tanks are a type of onsite wastewater treatment system in which the organic waste is decomposed and solids settle out. The effluent flows out of the tank to a soil adsorption field or other dispersal system.

Sequencing Batch Reactors (SBR) are a variation of the activated sludge process where all treatment processes occur in one tank that is filled with wastewater and drawn down to discharge after treatment is complete.

Settleable Solids are solids that are heavier than water and settle out of water by gravity.

Sewers are a system of pipes that collect and deliver wastewater and/or stormwater to treatment plants or receiving waters.

Soil Absorption Field is a subsurface area containing a trench or bed with a minimum depth of 12 inches of clean stones and a system of piping through which treated wastewater effluent is distributed into the surrounding soil for further treatment and disposal.

Slow Rate Land Treatment involves the controlled application of wastewater to vegetated land at a few inches of liquid per week.

Storm Sewers are a separate system of pipes that carry rain and snow melt from buildings, streets and yards to surface waters.

Suspended Solids are the small particles suspended in water or wastewater.

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Transpiration is the process by which water vapor is released to the atmosphere by living plants.

Trickling Filter is a fixed film process that involves a tank, usually filled with a bed of rocks, stones or synthetic media, to support bacterial growth used to treat wastewater.

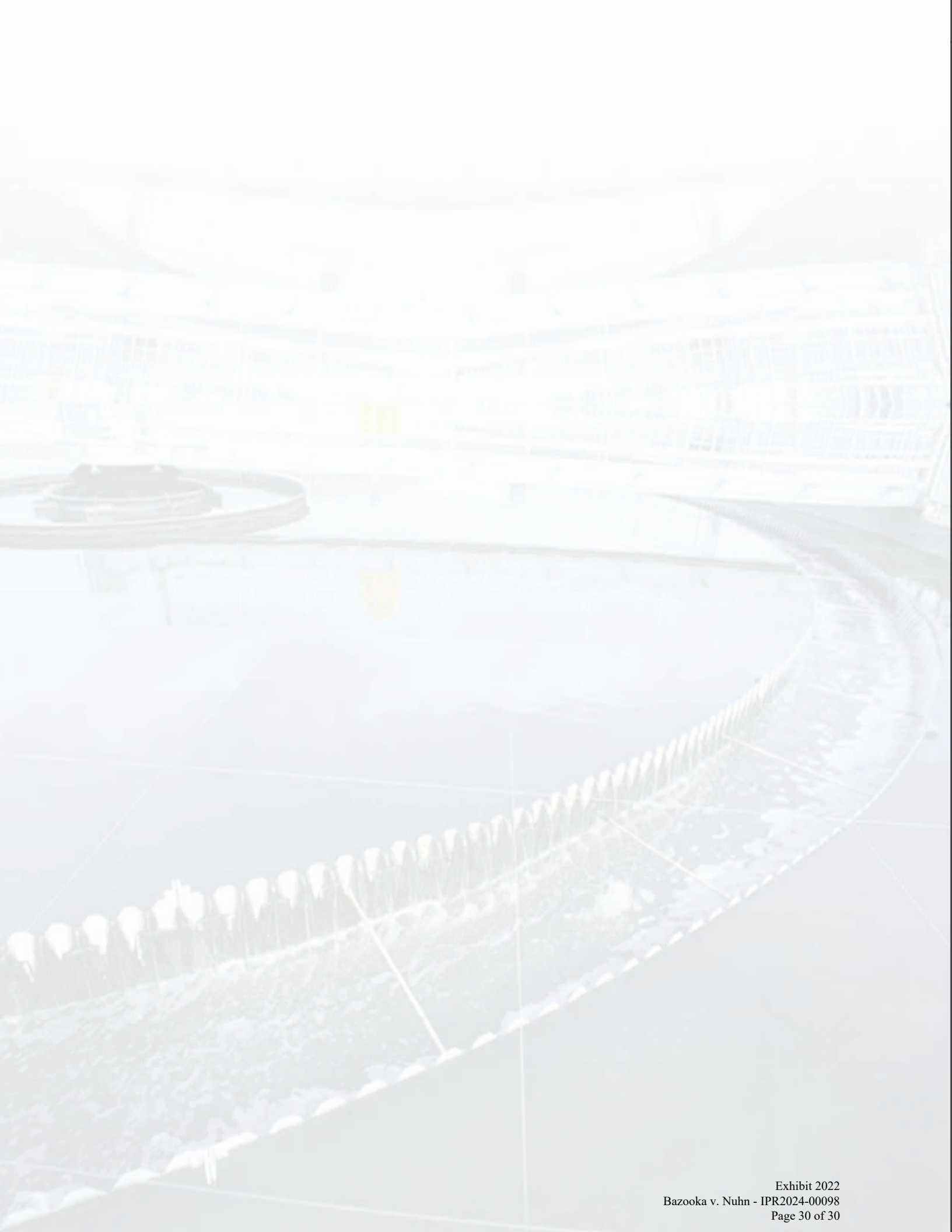
Ultraviolet Radiation (UV) is a disinfection process where wastewater is exposed to UV light for disinfection.

Virus is the smallest form of a pathogen which can reproduce within host cells.

Wastewater Treatment Plant is a facility involving a series of tanks, screens, filters, and other treatment processes by which pollutants are removed from water.

Water Table is the elevation of groundwater or saturated soil level in the ground.

For more information see:

www.epa.gov.owm

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