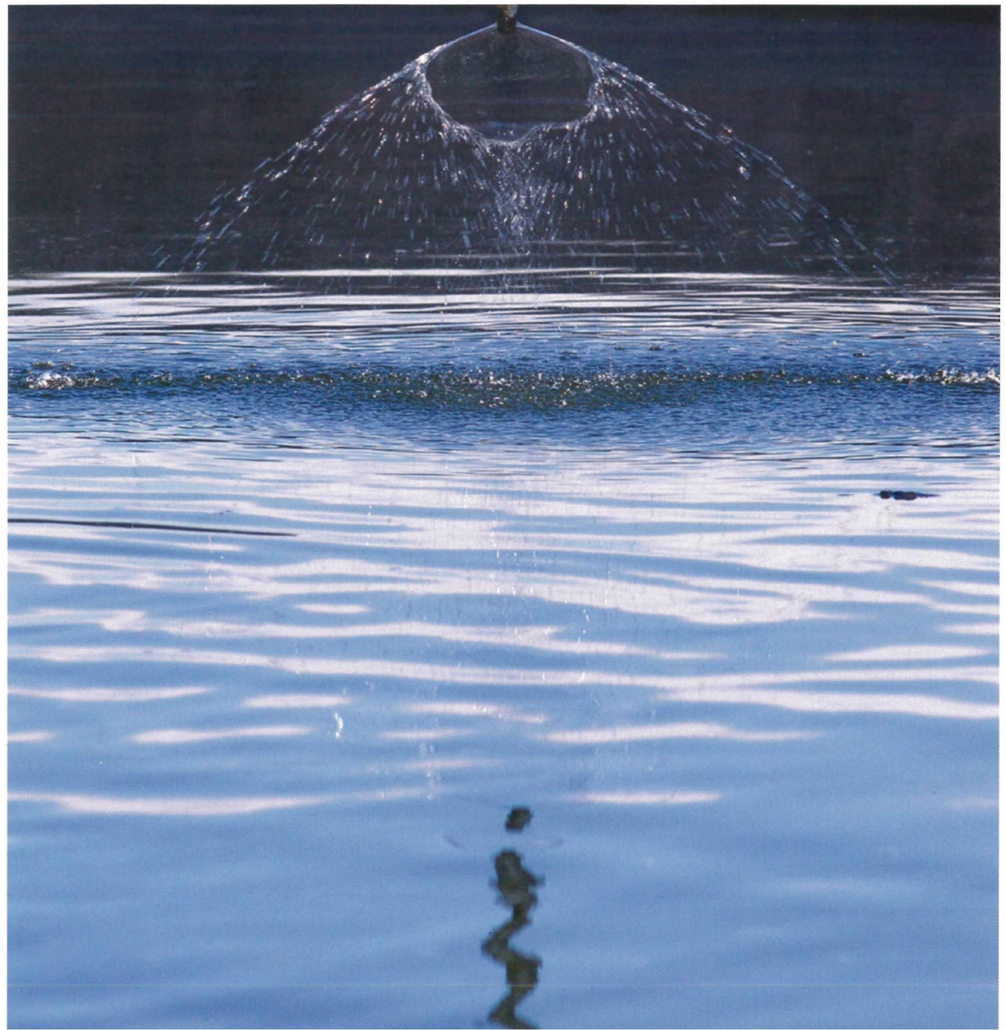
WATER EDUCATION
FOUNDATION
717 K Street, Suite 317
Sacramento, CA 95814
916.444.6240
www.watereducation.org
www.aquafornia.com

LAYPERSON'S GUIDE TO

California Wastewater

Prepared by the Water Education Foundation



Contents

The *Layperson's Guide to California Wastewater* is prepared and distributed by the Water Education Foundation as a public information tool. It is part of a series of Layperson's Guides that explore pertinent water issues in an objective, easy-to-understand manner.

The mission of the Water Education Foundation, an impartial, nonprofit organization, is to create a better understanding of water resources and foster public understanding and resolution of water resource issues through facilitation, education and outreach.

For more information contact:

WATER EDUCATION
FOUNDATION

717 K Street, Suite 317
Sacramento, CA 95814
Phone: (916) 444-6240
Fax: (916) 448-7699
www.watereducation.org
www.aquafornia.com

Editor: Sue McClurg
Author: Cindy Nickles
Editorial Assistance: Robin Douglas
Design: Curtis Leipold

Photo Credits:
Leslie Scopes Anderson
California Association of Sanitation Agencies
Coachella Valley Water District
City of Los Angeles, Department of Public Works
Lara Meeker with Los Angeles Waterkeeper
Orange County Sanitation District
Sacramento Regional County Sanitation District
Sacramento Suburban Water District
San Francisco Public Library

Graphics:
Sacramento Regional County Sanitation District

Printed 2013

ISBN: 978-1-61948-002-5

On the Cover:
The secondary clarifier at the Western Water Recycling Facility.
Photo by Western Municipal Water District, Michael J. Elderman Photography

Today's Wastewater Systems

Does anyone really ever give a second thought about what happens to the water used after toilet flushing, teeth brushing, showering, doing laundry and washing dishes?

Usually out of sight, out of mind are the thoughts of private citizens of the day-to-day inspection, preventive maintenance and operation of sewer systems; repair and replacement of aging sewer pipes and other infrastructure; collection of sewage and treatment of wastewater; and sewage disposal and pollution prevention.

California has many different types of entities that collect, convey, treat and dispose of their community's wastewater. Under the special district classification, there are sanitary districts, sanitation districts, water districts and community services districts. Cities, counties and joint powers authorities can also be wastewater service providers.

To sum up their tasks, these entities are responsible for almost all wastewater infrastructure planning, funding, design and construction activities along with maintenance and operation of the facilities for their ratepayers. In general, they operate their own budgets with money collected from property taxes and ratepayer fees and spent within local service areas.

There are basic organizational differences among the entities, however. For example, sanitary districts like the Rancho Murieta Community Services District and Goleta Sanitary District have elected boards, while the boards of directors for sanitation districts like the Sacramento Regional County Sanitation District and Sonoma County Water Agency are comprised of members from county boards of supervisors and city councils.

Agencies also differ in that some encompass both wastewater collection and treatment services, while others divide the duties. In the Bay Area, the Central Contra Costa Sanitary District is responsible for both collecting and treating wastewater. Coachella Valley Water District provides wastewater collection and treatment services in Riverside County and small portions of Imperial and San Diego counties. In Lake County, the city of Clear Lake maintains the sewer lines within city limits, and the Clear Lake Sanitary District is responsible for the treatment of the sewage at the district treatment plant.

Public agency personnel and equipment are available around the clock 24 hours a day, seven days a week, 365 days a year to respond to residential, commercial and industrial customer emergencies, including sewage backups, overflows and loss of service.

In general, agencies that provide wastewater services are public – not private. Their public origins can be traced back to the leadership of Governor Hiram Johnson and his push for public programs and social reforms against a backdrop of private political corruption. "With public servants whose sole thought is the good of the state the prosperity of the state is assured, exaction and extortion from the people will be at an end, in every material aspect advancement will be ours, development and progress will follow as a matter of course, and popular government will be perpetuated," he said in his first inaugural address on Jan. 3, 1911.

The importance of these public agency services in the daily lives of residents and business owners is the take-home message in a city of Los Angeles Department of Public Works video, "A Day Without Public Works." The video available at www.youtube.com also delivers the message that support for infrastructure spending is critical to accommodate upgrading and maintenance of aging public works, including wastewater systems.

Today's wastewater agencies are also focused on water reuse, byproducts recycling and renewable energy production. Many are engaged in full scale water recycling efforts designed to provide new sources of water supply for Californians, while others are involved in producing renewable energy such as digester gas that can be used on-site or fed back into the electrical system to provide green energy for others.

Digesters at a wastewater treatment plant destroy pathogens, resulting in biosolids that may be recycled.

Glossary

Biosolids – The solid organic material that is separated during the wastewater treatment process, treated according to regulations to the point that it is a usable product, and then recycled.

Clarify – To make clear or pure by separating and eliminating suspended solid material.

Coagulation – The clumping together of solids so they can more easily be settled out or filtered out of water.

Collection System – The sewer system of pipes that carries wastewater from homes and businesses to a treatment plant or reclamation plant.

Combined Sewer – A wastewater collection system that carries both raw sewage and stormwater to a treatment plant.

Disinfection – Final step in the treatment process. Commonly, chlorine is added to the treated wastewater to kill disease-causing organisms. There are other alternatives for achieving disinfection, including ultraviolet light.

Effluent – Treated wastewater flowing out of a treatment plant.

Filtration – The process of water passing through porous material such as sand or synthetic membranes to trap and remove particles.

Influent – Untreated wastewater that enters a wastewater treatment plant.

Primary Treatment – First major treatment in a wastewater treatment facility that removes solids and floating matter using screening, skimming and sedimentation.

Publicly Owned Treatment Works (POTWs) – Public wastewater systems built, operated and maintained by government agencies. They include sewer pipes, maintenance holes (formerly called manholes), pumps, treatment plants and other related infrastructure.

Reverse Osmosis – A method of removing very small particles, including salts or other ions, from water by forcing water through a semi-permeable membrane.

Secondary Treatment – The biological portion of wastewater treatment that relies on the growth of microorganisms to clean the wastewater after primary treatment. Several different types of secondary processes can be used, including activated sludge, trickling filters, pond systems and wetland systems.

Sedimentation – The settling of solids in a body of water using gravity.

Sludge – The organic solid waste material that settles out in the wastewater treatment process. If sludge is converted into a usable end product, it is no longer called sludge.

Tertiary Treatment – Additional treatment processes used to clean wastewater even further following primary and secondary treatment. Normally implies the removal of nutrients, such as phosphorous and nitrogen, and a high percentage of suspended solids. Also known as advanced treatment.

Wastewater – The mixture of used water and human waste carried away by drains and sewers.

Water Recycling – The treatment of wastewater to make it suitable for a beneficial reuse, such as landscape irrigation or groundwater recharge. A separate *Layperson's Guide to Water Recycling* has been published by the Water Education Foundation and is available at www.watereducation.org

Legal and Regulatory Primer

"No one shall with malice pollute the waters where they issue publicly. Should anyone pollute them, his fine shall be ten thousand sestertii." – Sextus Juliano Frontinus, Water Commissioner of the city of Rome, 97 AD (Source: www.sewerhistory.org)

Laws and regulations against water pollution have been in existence for ages in one form or another with varying degrees of effectiveness.

On the legislative front in the 1940s, both state and federal governments began to seriously address the increasing water quality problems resulting from unprecedented population growth and industrial development.

In California, problems with the assortment of water pollution laws on the books ranged from overlapping regulations and dueling government agencies to differing legal interpretations. Among those advocating for action were urban, industrial, agricultural and recreational water users.

As a result, the Legislature enacted the Dickey Water Pollution Act (Dickey Act), which took effect Oct. 1, 1949. Under the Dickey Act, a State Water Pollution Control Board was created to set statewide policy and coordinate state agency activities in controlling water pollution. It also created nine Regional Water Pollution Control Boards for each of the state's major watersheds to deal with region-specific issues, depending on geography and precipitation, along with the needs of region-specific recreation, agriculture and industry.

In 1948 Congress passed the Federal Water Pollution Control Act, which over the years was often amended, sometimes extensively.

Into the 1950s and 1960s, revisions were made to both federal and state water pollution laws. In California, for example, the Water Pollution Control Board was renamed the State Water Quality Control Board to emphasize a broader field of water quality issues than sewage and industrial waste control responsibilities. A follow-up change toward a more coordinated water regulatory program resulted in the merger of the State Water Quality Control Board and State Water Rights Board into the State Water Resources Control Board (State Water Board) in 1967.

In 1969 the Legislature enacted the centerpiece of California's water quality legislation – the Porter-Cologne Water Quality Control Act (Porter-Cologne Act).

In part, Section 13000 of the law says that "activities and factors which may affect the quality of the waters of the state shall be regulated to attain the highest water quality which is reasonable, considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible."

Biological processes are incorporated during secondary treatment to remove contaminants dissolved in the wastewater.

The Porter-Cologne Act authorized the State Water Board to develop statewide policy for water quality control. In an excerpt, the law said, "The health, safety and welfare of the people of the state requires that there be a statewide program for the control of the quality of all the waters of the state."

Also, it expanded the authority of the nine Regional Water Quality Control Boards (Regional Water Boards), which were the former Regional Water Pollution Control Boards. As the Porter-Cologne Act said, "Factors of precipitation, topography, population, recreation, agriculture, industry and economic development vary from region to region within the state; and that the statewide program for water quality control can be most effectively administered regionally, within a framework of statewide coordination and policy."

Based on watersheds, the Regional Water Boards are referred to by specific names: North Coast, San Francisco Bay, Central Coast, Los Angeles, Central Valley, Lahontan, Colorado River Basin, Santa Ana and San Diego. Under their new authority, they were to establish region-specific water quality standards and adopt water quality control plans, issue permits for the discharge of treated wastewater that specified maximum-allowed levels of pollutants, monitor discharges and manage polluted runoff.

Together the State Water Board and Regional Water Boards are referred to as the California Water Boards and are included under the umbrella of the California Environmental Protection Agency (Cal/EPA) headquartered in Sacramento.

Meantime back on Capitol Hill, environmental-related activities had become a national priority following the establishment of the U.S. Environmental Protection Agency (EPA) in 1970. The public, Congress and the president rallied behind a consistent, comprehensive, long-term approach to water pollution control.

President Richard Nixon's State of the Union address Jan. 22, 1970, included the following excerpt: "Clean air, clean water, open spaces – these should once again be the birthright of every American. … I shall propose to this Congress a $10 billion nationwide clean waters program to put modern municipal waste treatment plants in every place in America where they are needed to make our waters clean again, and do it now."

Congress passed the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500), referred to as the Clean Water Act, and now the main federal law on water pollution in the United States. So influential was California's Porter-Cologne Act that sections of it were used as the basis to write the CWA. A federal-state partnership, its goal was to "restore and maintain the chemical, physical and biological integrity of the nation's waters."

Under the authority of EPA, the new law required standards for surface water quality, mandated sewage treatment and regulated wastewater discharges into the nation's surface waters. It would set water quality goals, guidelines and technology based limits, but individual states, territories and tribes would primarily administer and enforce the federal programs on their own, including the development of water quality standards. The CWA also set the stage for state and federal government entities to provide significant technical and financial assistance to the regulated community.

During the early stages of the CWA implementation, the focus was on designing, building and operating wastewater treatment systems for pollution control. Federal and state funding programs, including California bond measures passed by voters, helped communities finance municipal wastewater collection and treatment facilities.

For California to operate under the CWA, the state's Porter-Cologne Act was amended to authorize the State Water Board and Regional Water Boards to implement the federal programs (see page 10).

All aspects of the wastewater treatment process are featured on a school education "job shadowing" tour for high school students and a teacher.

Discharge Permit Program

The CWA made it against the law to discharge pollutants from what are called "point sources" (including discharges from wastewater treatment plant pipes, ditches or other conveyances) "into the waters of the United States" unless authorized by a permit under a program called the National Pollutant Discharge Elimination System (NPDES). California law requires wastewater treatment plants to have permits if they discharge treated wastewater to land.

Each and every publicly owned wastewater treatment plant in California must have an individualized permit issued by its Regional Water Board to comply with a very detailed and complex set of operating conditions to discharge treated wastewater. In the 1970s permits were 10- to 20-page documents. Today some permits can exceed 200 pages, but they average between 150 and 175 pages.

Permits have many requirements. They set maximum limits on concentrations and mass emissions of pollutants in treated wastewater before it can be discharged, along with monitoring and reporting requirements. A permit will also specify if additional actions are required such as industrial pretreatment or sewer overflow programs. By law, the specific methods undertaken in order to meet specifications in the permit are at the discretion of the wastewater agency.

In 1972 Congress passed the Clean Water Act.

Permitting is not a one-size-fits-all process. No two discharge permits are identical because each permit is customized for the type of water body the treated wastewater is released into (whether a lake or stream, for example) and the uses of that water body (whether for swimming or drinking, for example). Similar to driver's license renewals, permits must also be renewed at regular intervals and under certain conditions can also be denied. Permits can be re-opened prior to expiration depending on the circumstances.

Treated wastewater discharged by treatment plants must meet limits that are set for wastewater contaminants, called constituents, by the Regional Water Boards. Constituents vary widely, but the major classes are nutrients, microorganisms, salts, metals, natural organic matter and synthetic organic compounds. Limitations involving concentration (in parts per million or milligrams per liter) and/or mass (pounds per day or grams per day) are used for measuring and controlling pollutants.

Twenty first century scientific and technological advancements are making it possible to detect minute levels of compounds in the environment. Wastewater professionals, scientists, regulators and others are monitoring these contaminants, referred to as "emerging constituents." (See Challenges chapter.)

As part of the law, Congress established the National Pretreatment Program to remove industrial pollutants such as copper, lead, nickel, other heavy metals and organic compounds before they reach the public wastewater system. The practice is called "pretreatment."

Pretreatment programs, which are included in discharge permits issued to all but the smallest wastewater treatment agencies, require industries to remove their own contaminants before their wastewater enters into the sewer system where it can cause damage to sewer collection systems, interference with wastewater treatment plant operations and contamination of sewage sludge.

For example, since 1973 Goleta Sanitary District in Santa Barbara County has been operating a pretreatment program. Under its Industrial Waste Control Program, industrial and commercial customers are required to keep hazardous substances out of the sewer collection system. The goals of this program are to protect ocean water quality and the district's treatment plant.

Regional Water Boards monitor wastewater treatment plants for compliance with their permits, including inspections and reviews of water quality reports. Noncompliance can result in heavy fines ranging upward of $1 million. A Cease and Desist Order may also be issued to a wastewater treatment plant for a violation or threatened violation of a waste discharge requirement and permit. Depending on the circumstance, the order could require the plant to comply immediately, include a schedule for compliance or take a preventive action.

Regional Board Requirements

Under the law, each Regional Water Board must develop and adopt a long-range Basin Plan, also called a Water Quality Control Plan. Basin Plans are required to include water quality objectives, policies, regulations and implementation programs along with the designated "beneficial uses" of the water bodies within the regions such as drinking, swimming, fishing, protection of aquatic life and agricultural irrigation. The law calls for them to be reviewed on a three-year cycle for updating with new science, water quality issues and laws and regulations.

The Regional Water Boards must also make lists of water bodies and constituents in each water body that are not meeting water quality standards as set in their Basin Plans. These lists are called 303(d) lists after the section in the CWA.

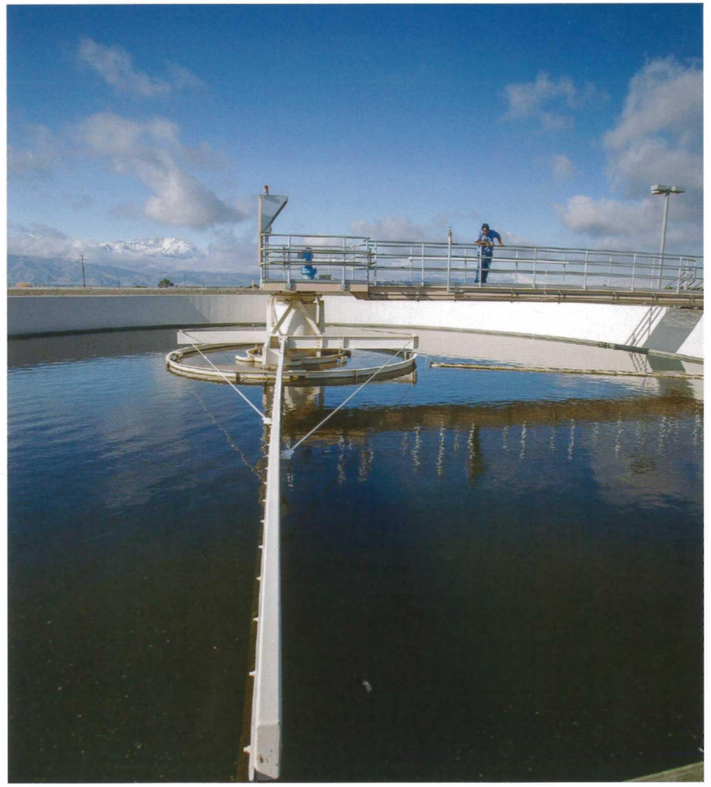
California's 2008-10 303(d) list, the most recent available, numbered 1,133 water body segments for all nine Regional Water Boards and included rankings of high, medium or low priorities. It is revised in even-numbered years.

For each lake, river, bay, ocean area or other body of water on the 303(d) list, the Regional Water Board prepares a written restoration plan, similar to a pollution budget for the water body. The plan, called a Total Maximum Daily Load (TMDL), includes all sources of pollutants, explains how the particular water body doesn't measure up to the water quality standards set for it, offers an action plan for how it will improve water quality and develops a schedule for actions. The TMDLs, or written reports, must account for all sources of the pollutants that caused the water to be listed. Complex TMDLs can cost more than $1 million to prepare and significantly more to implement.

The Lake Tahoe TMDL, a Nevada and California bi-state plan, was approved by EPA in 2011 after 10 years of scientific studies. To reach the goal of returning the lake to almost 100 feet of clarity within 65 years, the report requires reductions in sediments and nutrients to be achieved in each of the four primary sources of these pollutants: urban stormwater runoff, forest runoff, stream channel erosion and atmospheric deposition. The TMDL outlines measures to reduce each source. To reduce the amount of fine sediment and nutrients entering the lake, the California Lahontan Regional Water Board and the Nevada Division of Environmental Protection will coordinate with local jurisdictions, including the counties, departments of transportation, the city of South Lake Tahoe and other stakeholders.

To address and regulate water quality pollution problems that cross regional boundaries or are statewide, the State Water Board may also develop what are called Water Quality Control Plans, and has adopted plans to address enclosed bays and estuaries, ocean waters, temperature (thermal), and the San Francisco Bay/Sacramento-San Joaquin Delta Estuary.

Secondary clarifiers separate the solids from the liquids during the wastewater treatment process.



Because of mercury pollution issues in the San Francisco Bay, the San Francisco Bay Regional Water Board set a Mercury TMDL and issued a watershed permit that must be followed by public wastewater treatment plants, generally referred to as publicly owned treatment works or POTWs, and others in the Bay Area. To help comply with the TMDL, the Bay Area Pollution Prevention Group has initiated outreach programs to dental assistants and hygienist schools to remind them to practice mercury best management practices.

The federal and state water quality laws are dynamic laws that continue to be amended to reflect new issues, including recent changes addressing biosolids management.

The public has many opportunities to participate in State Water Board and Regional Water Board activities – from formal hearings to informal collaborative stakeholder sessions. People may also sign up for mailing and e-mail lists, watch webcasts and webinars, and access online databases. (See References sidebar.)

Wastewater agencies are also regulated by other government agencies (see sidebar) and may fall under the jurisdiction of other laws, including the California Environmental Quality Act and federal Clean Air Act. An example would be the air pollution laws in Southern California's South Coast Air Basin that trigger local wastewater agencies to follow regulations for combustion devices and emergency engines.

Primary Agencies Involved in Wastewater

California State Water Resources Control Board – Created by the Legislature in 1967, the five full-time member State Water Board protects water quality by setting statewide policy, coordinating and supporting the Regional Water Board efforts and reviewing petitions that contest Regional Water Board actions. The State Water Board is also solely responsible for allocating surface water rights. The members are appointed to four-year terms by the governor and confirmed by the Senate. http://www.swrcb.ca.gov

Regional Water Quality Control Boards – There are nine Regional Water Boards, each with seven part-time members appointed by the governor and confirmed by the Senate. They develop basin plans for their hydrologic areas, govern requirements/issue waste discharge permits, take enforcement action against violators and monitor water quality. http://www.waterboards.ca.gov/waterboards_map.shtml

Region 1 – North Coastal Regional Water Quality Control Board
Region 2 – San Francisco Bay Regional Water Quality Control Board
Region 3 – Central Coastal Regional Water Quality Control Board
Region 4 – Los Angeles Regional Water Quality Control Board
Region 5 – Central Valley Regional Water Quality Control Board
Region 6 – Lahontan Regional Water Quality Control Board
Region 7 – Colorado River Regional Water Quality Control Board
Region 8 – Santa Ana Regional Water Quality Control Board
Region 9 – San Diego Regional Water Quality Control Board

U.S. Environmental Protection Agency (EPA) – Established in 1970, EPA is a federal regulatory agency responsible for protecting environmental quality throughout the nation. It acts in an oversight role over the State and Regional Water Boards and their implementation of the Clean Water Act (CWA). EPA's Office of Wastewater Management, under the CWA, works with EPA regions, states, local governments, tribes, the private sector and non-governmental organizations to regulate discharges into surface waters such as wetlands, lakes, rivers, estuaries, bays and oceans. California is under the jurisdiction of EPA Region 9 (Pacific Southwest).

California Air Resources Board – http://www.arb.ca.gov

California Department of Fish and Wildlife – http://www.dfg.ca.gov

California Department of Pesticide Regulation – http://www.cdpr.ca.gov

California Department of Public Health – http://www.cdph.ca.gov

Collection and Conveyance

Although wastewater collection systems are mostly invisible, the public can rest assured that vast labyrinths of pipelines are beneath their feet collecting and moving raw sewage away from homes, schools, restaurants, shops and other businesses and into the principal sewer mains also buried deep under streets, alleys or other rights-of-way.

Local wastewater agencies own and are typically responsible for the entire wastewater collection and conveyance infrastructure. One possible exception is sewer laterals that extend from the residence or building to the sewer main line that is shared with others. Sewer laterals can be owned by the wastewater agency or by the private property owners.

Sewer mains connect to collectors and trunk lines, all increasingly larger pipes that may eventually become interceptor pipes – some interceptor pipes are 10 feet or larger in diameter. These pipes convey wastewater to treatment plants. Like tunnels, the larger pipes can be walked through for maintenance, repairs and inspections. Most everyone has seen the metal plates that cover maintenance holes (formerly called manholes) that provide access to the sewers.

Because of California's diverse geography, a number of system configurations are used. Gravity, pumping plants or a combination of both conveys wastewater to treatment plants. In a low-lying area such as a beach community or a mountainous location, pumping plants or lift stations are necessary to move wastewater under pressure to higher elevations. Pressurized pipes coming out of pumping plants are called force main sewers, or force mains. Drop structures move wastewater from higher to lower elevations, and siphons move it underneath freeways and rivers.

In Contra Costa County, for example, about 45 million gallons of wastewater from more than 461,000 residential and more than 5,000 business customers flow each day primarily by gravity through more than 1,500 miles of underground pipe in Central Contra Costa Sanitary District's collection system to its Martinez Treatment Plant.

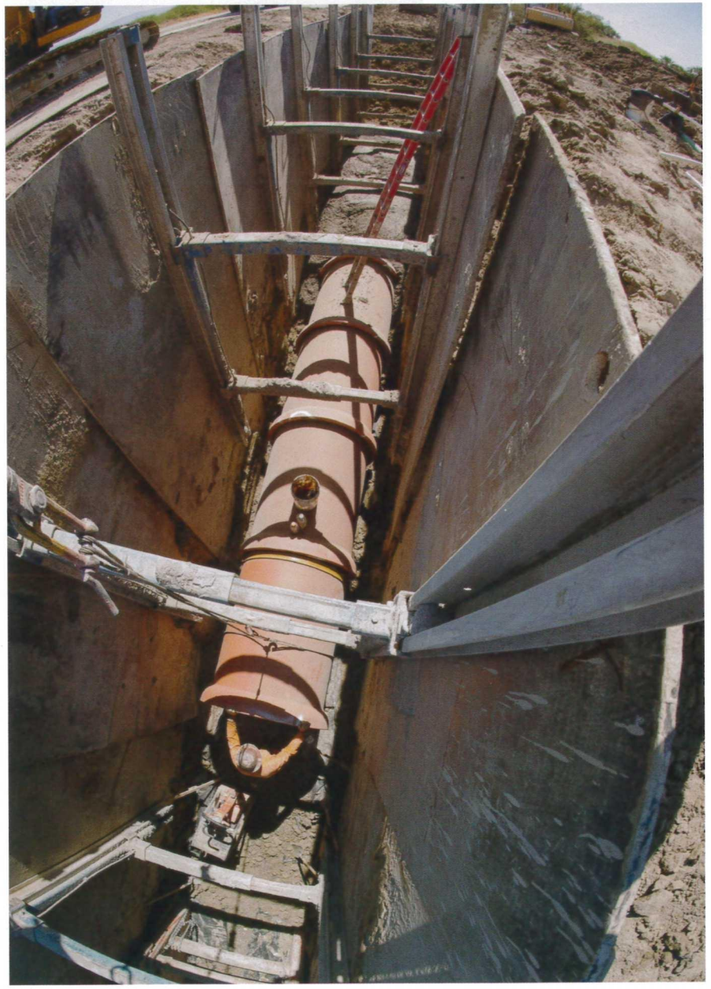
Los Angeles has one of the largest collection systems in the world, including more than 6,700 miles of public sewers serving a population of more than 4 million. Its wastewater collection system, which contains 140,000 maintenance holes, conveys about 400 million gallons per day of flow from residences and businesses.

South Tahoe Public Utility District's collection system includes 330 miles of sewer lines, 42 lift stations and 17,000 connections.

As raw sewage travels from Point A to Point B, there is the risk of wastewater overflows (sewer spills) caused by clogged pipes, tree roots that block pipes, deteriorating and aging pipes, and heavy rain storms that overwhelm the system with too much water.

To keep sewers working, agencies focus on a wide variety of operations and maintenance activities. Crews of maintenance workers inspect sewer systems manually and by closed-circuit television, clean the insides of pipes, remove roots, construct new sewer pipes or repair aging ones and provide emergency response for overflows and backups.

This sewer project consists of approximately 34,300 lineal feet of 33-inch and 42-inch diameter gravity sewer pipeline.



Resources

Bay Area Clean Water Agencies – A local government agency created by a joint powers agreement in 1984. Its membership includes wastewater agencies that provide sanitary sewer services to more than 7 million people living in the nine-county San Francisco Bay Area. Principal members include the Central Costa County Sanitation District, the city of San Jose, East Bay Dischargers Association, East Bay Municipal Utility District and San Francisco Public Utilities District. http://bacwa.org

California Association of Sanitation Agencies – A statewide trade association of municipalities, special districts and joint powers agencies that provide wastewater collection, treatment and water recycling services. CASA was founded in 1955 and CASA members represent more than 90 percent of the sewered population of California. www.casaweb.org

Central Rural Water Association – Provides on-site technical assistance and specialized training for rural water and wastewater systems. http://www.calruralwater.org

Central Valley Clean Water Association – A regional association representing wastewater treatment and collection system agencies in the Central Valley. http://www.cvcwa.org

California Water Environment Association – A statewide nonprofit public benefit association whose mission is to protect the water environment by educating, training and certifying the competency of individuals who work in the water quality field. Approximately 80 percent of CWEA's more than 9,000 members work for municipal wastewater agencies and collection systems, both large and small, throughout California. www.cwea.org

Southern California Alliance of Publicly Owned Treatment Works – A nonprofit corporation of more than 90 wastewater treatment and collection system agencies and one large regional water treatment agency. Together, its membership collects and/or treats the wastewater for more than 16 million Southern Californians in seven counties. www.scap1.org

My Water Quality Website – Sponsored by the California Water Quality Monitoring Council, a joint partnership between the California Environmental Protection Agency, the California Natural Resources Agency, and several stakeholder organizations from both inside and outside state government. State legislation in 2006 mandated water quality monitoring and assessment activities be coordinated and information be made available to decision makers and the public via the Internet. http://www.CaWaterQuality.net

Treatment and Disposal

Water Quality

Historical accounts point to wastewater treatment as a relatively modern practice. By the 1920s, wastewater treatment was a mechanical process involving settling, skimming off floating materials and removing solids. By the end of World War II, technological advances made biological processes possible. In the 1970s when strict environmental regulations were implemented, these original systems needed to be upgraded and supplemented.

Today's wastewater treatment plants are often complex facilities that use modern technology and reflect advancements in engineering principles and practices, chemistry and microbiology. The wastewater field has a language of its own. A few examples of terms that might be unfamiliar to the layperson include food-to-microorganism ratio, sludge age, detention time, hydraulic loading, organic loading and mean cell retention time. These terms are often related with complex mathematical equations that help determine the size and types of equipment that are needed to clean the wastewater.

The initial step in the wastewater treatment process is called **preliminary treatment** and begins as all raw sewage from domestic and commercial sources enters the treatment plant at the plant's "headworks."

Wastewater flows through bar screens (influent screens) typically made of steel or iron bars. Most bar screen spacing is less than one inch, but bars can be up to several inches apart. Large objects ranging from trash and toys to rocks and branches that could clog or damage plant machinery are mechanically raked and screened out from the sewage.

After screening, the wastewater enters a grit removal device. There are several types of devices to remove grit, but the most common one is a large tank, where the objects small enough to get through the influent screens such as sand, coffee grounds, egg shells, jewelry and coins can sink to the bottom by gravity. The collected debris is usually hauled off to a landfill for disposal.

After leaving the grit chamber, wastewater is ready for **primary treatment**. During this mostly physical process, wastewater is piped into primary settling or sedimentation tanks where heavy particles sink and light particles float. Mechanical arms slowly move across the top of the tank collecting the lighter materials like soap, oils and grease. Sometimes referred to as "scum," it is skimmed off the top, and then removed from the tank. Heavier material that settles to the bottom of the tanks is removed with mechanical arms that move it to a location where it can be pumped out to the tanks. This material is called "primary sludge" or "primary solids."

The first major wastewater treatment phase is called "primary" and uses screening, skimming and sedimentation processes.

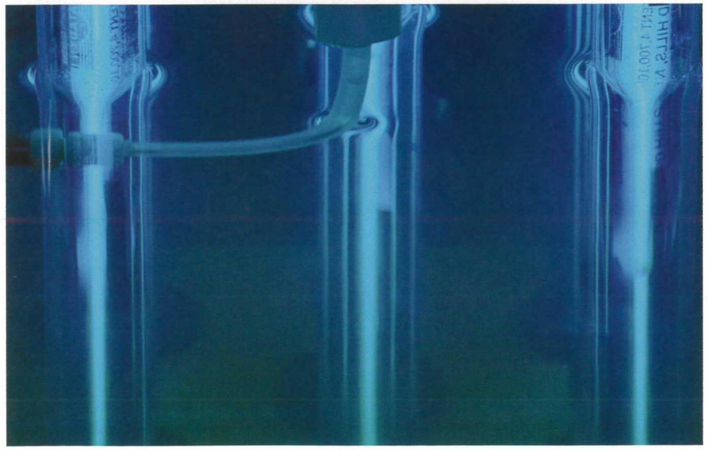
With very few exceptions, wastewater is further treated beyond the primary treatment stage.

During **secondary treatment**, biological processes are incorporated to remove contaminants dissolved in the wastewater. One of the methods used is called activated sludge. Wastewater goes into large rectangular tanks, with air pumped in to promote the growth of naturally occurring microorganisms that feed on organic materials.

After the microorganisms have absorbed and digested the organic materials, the wastewater is sent into secondary sedimentation tanks (secondary clarifiers), where the microorganisms eventually settle to the bottom and are removed. The heavier materials that have settled to the bottom are called "secondary sludge" or "secondary solids." Secondary solids are usually sent to solids handling facilities for further processing.

By the time secondary treatment is done, 85 percent or more of the solids and organic materials are removed from the wastewater. Activated sludge is just one example of a treatment process that meets secondary treatment objectives.

In most situations, secondary treatment must be followed by a **disinfection process** to kill harmful pathogens (protozoa, bacteria and viruses). Chlorine is one of the most common disinfectants. When chlorine is used, it is often necessary to remove the chlorine with other chemicals before the wastewater is put back into the waterways. There are several other options for disinfecting wastewater such as ultraviolet light disinfection.



Ultraviolet light (UV) lamps are among the options for disinfecting wastewater.

Under certain circumstances, secondary treatment and disinfection may not make wastewater clean enough to release back into the environment. To meet more stringent public health and environmental regulations, many wastewater agencies have added more advanced wastewater treatment processes between secondary treatment and disinfection.

This additional step is called is called **tertiary treatment**, derived from the Latin word, meaning "of a third," or **advanced treatment**. During these processes, various methods can be used to remove a variety of constituents.

One form of advanced treatment is filtration, which is used to remove very small particles. A common filtration process involves passing wastewater through a bed of sand or other fine-grained material. Filtration can also be achieved by passing wastewater through synthetic microfiltration membranes with very small openings that leave the particles behind. After sufficient filtration, wastewater can be used for almost any purpose except direct human consumption.

Wastewater treatment plants can be designed to remove nutrients such as nitrogen and phosphorus. This can be achieved through stand-alone advanced treatment processes, or the capability can be built-in to certain types of secondary treatment processes.

Biosolids Management

At most wastewater treatment plants, the scum, primary solids and secondary solids undergo additional treatment – often through a process called **anaerobic digestion**. In this process, the material is heated to 100-plus degrees Fahrenheit in tanks called digesters. The heat, breakdown of organic material and lack of oxygen in the digesters destroy pathogens. When the process is complete, the solids are suitable for recycling as a fertilizer in certain conditions and are now appropriately called "biosolids."

Other processes that can be used to turn wastewater solids into biosolids include composting and heat drying into pellets.

Many wastewater agencies have managed the solids remaining after the treatment processes by drying them in the open air or through belt presses to remove water and then hauling them to landfills for disposal.

However in recent decades biosolids have gained recognition as an important resource that can be recycled. In 1993 EPA published landmark regulations that set standards for safely recycling biosolids. Biosolids are also regulated under other laws, including the Resource Conservation and Recovery Act and Clean Air Act.

Since these laws passed, wastewater agencies have been placing an increasing emphasis on ensuring that benefits of organic matter and nutrients in biosolids are put to good use. To reduce energy costs and comply with stricter environmental regulations, and as a result of science and technology, there are green solutions associated with solids and biosolids management.

Wastewater agencies are contributing to California's renewable energy mandate via the production and use of methane from microbial activity in anaerobic digestion. In an effort to enhance biogas production, many are now accepting hauled in organic waste such as fats, oils and grease and food waste for anaerobic digestion. These practices not only help fulfill renewable energy mandates but also help divert organic waste out of landfills, fulfilling legislative mandates.

As one example, the East Bay Municipal Utility District's (EBMUD) waste-to-power program uses biogas emitted by the microorganisms to generate renewable energy to power its wastewater treatment plant and sell the excess back to the electrical grid.

A graphic illustrating the city of San Diego's Metro Biosolids Center and a video can be accessed from this link: http://www.sandiego.gov/mwwd/facilities/metrobiosolids.shtml

Before biosolids are recycled as a soil amendment, fertilizer or compost ingredient, they must comply with local, state and federal regulations and are tested for pollutants, including nutrients, pathogens, heavy metals and synthetic organic compounds. Comprehensive risk assessments by EPA continue as does research by universities across the country, including California. Wastewater agencies also fund research to answer new or outstanding questions relative to the safety of biosolids recycling.

Nevertheless some people still have uncertainty regarding the safety of biosolids recycling. Several local governments, including counties, have enacted limitations or even bans on beneficial use and are the subject of litigation.

Water Recycling

Water and wastewater agencies, from large to small and from all corners of California, are producing and using recycled water – the highly treated effluent that flows out of the treatment plant. Recycled water is treated to meet local, state and federal regulatory guidelines for its intended end use, which can range from construction activities and cooling water for powerplants to golf course irrigation and toilet flushing.

Recycled water increasingly is being used as a viable water source in California because water management is shifting away from the construction of new dams and reservoirs. New water treatment technologies are now considered a realistic way of maintaining a supply of water to meet demand.

The California State Legislature has set specific goals for the amount of water recycling in the future. That includes increasing the use of recycled water by at least 1 million acre-feet (an acre-foot is about 326,000 gallons or enough water to fill a football field to a depth of one foot) per year by 2020, and by at least 2 million acre-feet per year by 2030.

Purple pipes and related equipment and posted signage differentiate a recycled water system from a drinking water system.

Recycled water is delivered through separate purple pipe infrastructure to differentiate it from the system used to deliver drinking water.

More information is available in the *Layperson's Guide to Water Recycling*, published by the Water Education Foundation. Purchase it online at www.watereducation.org or call 916.444.6240.

Current Challenges

Aging Wastewater Infrastructure

The cornerstone of municipal wastewater systems is infrastructure, but it is aging and sometimes stressed by population growth. There is also the uncertainty of climate change-related impacts.

To manage the increased wastewater from a population of 38 million that is projected by the Public Policy Institute of California to reach 42 million to 48 million people by 2020, wastewater systems and services must expand. The question, of course, is how to pay for such large but necessary investments.

Today's Californians are benefiting from local wastewater systems built during the last century and paid for primarily by federal government funds and grant programs. The biggest infusion of federal and state funds occurred in the decade after passing the Clean Water Act in 1972. Current customer rates and fees reflect those former investments.

According to EPA, treatment plants typically have a useful life of 20 to 50 years before they require expansion or rehabilitation. Sewer pipes have life cycles that can range from several decades up to more than 100 years, depending on the type of material used, where they are located and how they were installed. EPA has estimated that the nation must invest $390 billion over the next 20 years to replace existing wastewater systems and build new ones to meet increasing demand.

In a similar vein, the American Society of Civil Engineers (ASCE) Report Card 2012 reported that the state's infrastructure investment has not kept up with its growing population demands and is continuing to delay much-needed renewal and maintenance.

According to the ASCE Report Card, California's infrastructure earned an overall grade of "C" and needs an additional annual investment of $65 billion. The state's wastewater system infrastructure earned a C+. The annual investment needed to raise its wastewater infrastructure grade from a C+ to a B is $4.5 billion annually for the next 10 years, according to the report card.

To finance the long-overdue capital improvement projects to upgrade or replace existing wastewater systems, a number of ideas are being discussed in financial circles. They include creating a long-term federal financing source such as a federal clean water trust fund that would leverage public and private funding for infrastructure projects, including wastewater systems. Financing from state and local governments could also come via general obligation bonds, sales taxes, general tax revenues, or special assessments. Public-private partnerships are another option.

Without state and federal funding available, the primary source of revenues for fixing aging wastewater collection systems and treatment facilities are the fees charged to individual ratepayers. Under voter-approved Proposition 218, ratepayer approval is necessary before rates can be increased to pay for operations or capital improvement projects. Public rate-setting processes include written notices, known as Proposition 218 notices, and public hearings. Because municipal wastewater agencies are governed by city councils, county boards of supervisors or elected boards, their meetings are always open to the public, with opportunities available for providing comments. Many agency documents, reports and contracts are available to the public also.

Constituents of Emerging Concern

A topic in and out of the news and on the minds of the public is the presence of constituents of emerging concern (CECs) in water bodies, including wastewater effluent, which can now be detected by advanced scientific testing. CECs, a broad and generic term, are also referred to as emerging constituents, endocrine-disrupting chemicals (EDCs) or pharmaceuticals and personal care products. They are also called non-traditional pollutants.

CECs can be categorized into the following groups: synthetically and naturally occurring hormones; personal care products; pharmaceutically active compounds; pesticides, herbicides and insecticides; industrial and household chemicals; disinfection by-products; and metals.

Although they are not directly regulated by the state or federal government, CECs have the attention of the State Water Board, which has adopted an amendment to its Recycled Water Policy related to CECs. Some individual discharge permits also require monitoring of CECs.

Research and studies continue on CEC issues, including occurrence; effects on people, animals, aquatic life and the environment; and treatment methods, by the wastewater community and state and federal government, along with other entities such as statewide and national wastewater organizations. As more scientific research is completed, state and federal agencies continually add requirements to address contaminants when they are proven to be harmful.

According to the Bureau of Reclamation's "Secondary/Emerging Constituents Report" (2009), "approximately 87,000 emerging compounds have been identified as possible EDCs (EPA, 2008)." In its conclusion, the report explained that, "CECs are diverse compounds whose characteristics vary even within the same subcategory."

Among the report's recommendations were that consideration should be given to the following: "The willingness of the public to pay for potentially costly mitigation efforts; the importance of CECs in surface water and drinking water relative to other public health and environmental concerns; and the potential loss or gain related to waiting for more information or taking action despite uncertainties regarding CECs."

Research results from a project report published by the National Water Research Institute on "Source, Fate, and Transport of Endocrine Disruptors, Pharmaceuticals, and Personal Care Products in Drinking Water Sources in California" will be used to better assess any potential health and environmental impacts of CECs.

Wastewater agencies operate laboratories that constantly monitor wastewater as it undergoes treatment processes.

Climate Change

According to EPA's Climate Change Basics website, (www.epa.gov/climatechange/basics), climate change "refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation or wind patterns, among other effects, that occur over several decades or longer."

Breaking down the definition, EPA identifies global warming as the "recent and ongoing rise in global average temperature near earth's surface. … However, global warming itself represents only one aspect of climate change."

Impacts that climate change could have on wastewater and drinking water utilities were detailed in a 104-page report, "Confronting Climate Change: an Early Analysis of Water and Wastewater Adaptation Costs," released in October 2009 by the National Association of Clean Water Agencies and the Association of the Metropolitan Water Agencies, prepared by CH2M Hill. The report estimated the adaptation costs for those facilities could range from $448 billion to $944 billion through 2050.

"Climate change will impact wastewater utilities on a number of fronts," the report said. Among the climate-related challenges addressed in the report were extreme storm events and overall precipitation increases; the need for additional flood protection measures such as levees, seawalls and pumping; and wastewater cooling systems to protect fisheries due to increased temperatures.

According to the report, "The total estimated Net Present Value (NPV) cost of wastewater system climate change adaptation in the U.S. is between $123 billion and $252 billion above and beyond existing wastewater system infrastructure upgrade, renewal and replacement programs that EPA estimates to be between $300 billion and $500 billion for combined drinking water and wastewater for the 2007-2027 period. The NPV early estimate includes both capital and O&M cost estimates."

Wastewater agencies across the state are improving the energy efficiency of their operations to reduce demands on fossil fuel energy sources, producing renewable energy using biogas, solar and wind, and reducing their greenhouse gas emissions. They are also developing strategies to adapt to expected changes in climate.

Among the green efforts agencies are encompassing include converting from gasoline-fueled vehicle fleets to cleaner burning, lower emission alternative fuel vehicles and changing to solar panel installations to generate electricity.

The California Wastewater Climate Change Group has for the past several years led an effort for science-based, cost-effective climate change solutions and served as a resource for wastewater agencies on climate change issues. It is a collaboration of the California Association of Sanitation Agencies, Bay Area Clean Water Agencies, Central Valley Clean Water Association and Southern California Alliance of Publicly Owned Treatment Works.

Nonpoint Source Pollution

In most areas of California, collection systems that transport domestic and commercial wastewater to treatment plants are independent of storm drain systems designed for flood control that carry runoff from rainfall, irrigation or other activities.

When it rains, stormwater picks up "nonpoint source" pollutants on its way to gutters and drains, including cigarettes, trash, automotive fluids, used oil, paint, fertilizers and pesticides, lawn and garden clippings and pet waste, from streets, parking lots, driveways, yards and human encampments. Because most storm drains do not connect into sewer pipes, stormwater pollution travels in the storm drains directly to lakes, streams and oceans without being cleaned or treated.

Because most storm drains do not connect into sewer pipes, stormwater has historically often traveled through storm drains directly into lakes, streams and oceans without undergoing treatment, though more recently stormwater is now often held in detention basins, allowing pollutants to settle out before the water is released or it percolates through to groundwater. Many stormwater agencies now use stormwater detention basins and other diversion technologies as well.

The 1987 amendments to the CWA established the Section 319 Nonpoint Source Management Program. Updates to the program were released in 1997 and 2012. The program requires that water bodies impaired by nonpoint sources be identified and for stakeholders to implement best management practices to reduce runoff along with monitoring and evaluating progress on improvements. Unlike with source point regulations, there are few numeric criteria requirements.

Wastewater agencies are involved in local, regional and statewide partnerships and associations to protect watersheds, prevent stormwater pollution and promote water quality. Examples include the Sacramento Stormwater Quality Partnership, which includes the county of Sacramento and cities of Sacramento, Citrus Heights, Elk Grove, Folsom, Galt and Rancho Cordova; the Fresno Metropolitan Flood Control District's Clean Stormwater Grant Program; and the Santa Clara Valley Urban Runoff Pollution Prevention Program, an association of 15 government agencies in the Santa Clara Valley.

Under EPA's Adopt Your Watershed program (http://water.epa.gov/action/adopt), members of the public can get involved in activities to protect and restore their local watersheds.

Because most storm drains do not connect into sewer pipes, stormwater typically travels through storm drains directly into lakes, streams and oceans without undergoing treatment, although efforts are underway to clean up and monitor these nonpoint sources of pollutants. Right, Ballona Creek is monitored for water quality by a Los Angeles Waterkeeper DrainWatch volunteer.

Public Education

Despite the embarrassing "yuck" factor that inevitably comes up, public education and outreach are critical to keeping wastewater systems operating 24/7/365. For example, local and regional campaigns are educating Californians on how they can change their personal habits to reduce impacts to both their own household sewer system and also to their community's wastewater system.

Saying it straight out is the Orange County Sanitation District in its "What to Flush" school education program. "It's simple, the toilet is only meant to flush the three P's – pee, poop and paper," the campaign says. "Human waste and toilet paper should be the only thing going down the toilet. Unfortunately, over the years, people have turned the toilet into a trash can."

When items like disposable diapers, dental floss, wipes, facial tissues, paper towels, coffee grounds, sanitary products, medications, cat box litter, deceased pet fish, and cigarette butts are flushed down the toilet, they clog household plumbing, waste water, harm public sewer systems and the oceans, and add to the cost of treating and disposing of wastewater – often resulting in higher utility bills. A dangerous caveat to kitty litter is Toxoplasmosis, a parasite found in cat waste that is harmful to marine biology.

To educate customers, the wastewater community has stepped up its public and school education programs. For example, the "No Drugs Down the Drain" program, sponsored by the cities of Los Angeles, Riverside and San Diego, county of Los Angeles, Inland Empire Utilities Agency, Orange County Sanitation District and Sanitation Districts of Los Angeles County with the partnership of the California Pharmacists Association, includes information about the problems with flushing unused, unwanted and expired medications down the toilet or drain and offers alternative, safe and proper disposal choices. The website at www.nodrugsdownthedrain.org/NoDrugs also offers information by zip code to those living outside of the sponsors' areas. Similar programs around the state include the Sonoma County Water Agency Safe Medicine Disposal program and Sacramento Regional County Sanitation District (SRCSD) "Don't Flush Your Meds" program.

The Tahoe City Public Utility District (TCPUD) implores customers not to throw wipes down the toilet. "They can clog the connection to the sewer line causing backups resulting in expensive repairs for the homeowners and/or cause backups that spill sewage into our fragile mountain environment," the district wrote in a "Wipes Clog Pipes" flyer. "Flushable is a catchy phrase and companies use it to market their products. The challenge is that wipes can't break down and more and more of our sewer lines and pumps are being clogged with these wipes. Please help us keep sewage in pipes and out of our environment by not throwing any type of wipe down the toilet."

The proper disposal of fats, oils and grease (called FOG by the wastewater community) is the focus of many agency public information programs, especially right before Thanksgiving and the holiday season. Frying and cooking oils, salad dressings, soups, meat trimmings and bacon fat, and greasy leftovers should never be poured down the drain because they can solidify in household and local agency sewer pipes, clog them and lead to sewer backups, overflows into the environment, and increased customer sewer rates to pay for sewer maintenance and plumbing repairs. At the Sacramento Area Sewer District, FOG-related sewer work costs approximately $3 million each year.

TCPUD has free cooking oil/grease disposal containers for its customers. The Bay Area Pollution Prevention Group (BAPPG), a committee of the Bay Area Clean Water Agencies, uses English, Spanish and Asian radio ad campaigns during the holidays to focus on the proper disposal of FOG. A related BAPPG program with the San Francisco Bay Keeper involved outreach with stores that sell turkey fryers to include proper FOG disposal information.

Public education efforts also include wastewater treatment plant tours tailored for adults and as part of school education programs.

Wastewater agencies have also worked with the public to be good neighbors. In the 1970s SRCSD planned a large undeveloped buffer area between its regional wastewater treatment plant and surrounding neighborhoods in south Sacramento County. The 2,650-acre Bufferlands has led to conservation of increasingly scarce wetlands, grasslands and riparian forest habitats. In another example, as the city of Los Angeles embarks on a 10-Year L.A. Sewers Construction Program, the Department of Public Works will use microtunneling technology whenever possible to be less disruptive to neighborhoods.

Wastewater agencies host treatment plant tours as part of their educational and public outreach programs.

Case Studies

California – the third largest state in land area – is approximately 156,000 square miles, with an average width of 150 to 200 miles. Mt. Whitney at 14,495 feet is the highest point in the contiguous United States; Badwater in Death Valley National Park at 282 feet below sea level is the lowest elevation point in the United States; and the San Francisco Bay is the largest natural harbor and estuary, including the Delta, on the West Coast.

The state's geographical diversities combined with varying populations and water resources create many challenges that were recognized by California's legal and regulatory forefathers when they created nine separate Regional Water Boards to work within local and regional parameters in creating wastewater regulatory programs.

Excerpts from Regional Water Board fact sheets illustrate why different types of wastewater collection, treatment and disposal systems must be designed, planned, built and operated to meet the needs of California residents, industries and visitors, which included 13.6 million international tourists in 2010. (http://www.visitcalifornia.com)

The type of wastewater treatment system a community will have is dependent on location, population and where the treated water will be released.

- The North Coast Region, from the Oregon border to Marin County, has a 340-mile-long coastline, wet coastal mountain areas and drier inland valleys, and timber harvesting, agriculture, recreation and tourism industries.
- The San Francisco Bay Region, home to more than 7 million people, includes high-tech industries in the Silicon Valley, oil refineries in Contra Costa County and agriculture – such as vineyards and dairies.
- The Central Coast Region, from Santa Clara County south to northern Ventura County, has 378 miles of coastline, agriculture, tourism, power and oil production, and food processing industries.
- The Los Angeles Region, with more than 10 million residents, includes the coastal watersheds of Los Angeles and Ventura counties, along with portions of Kern and Santa Barbara counties.
- The Central Valley Region is 60,000 square miles with the Sierra Nevada on the east, coast ranges and Klamath Mountains on the west, Oregon border on the north and Tehachapi Mountains on the south. The Sacramento and San Joaquin rivers and their tributaries drain the major part of this area through the Delta into San Francisco Bay. The Bay-Delta is the focal point of the State Water Project and federal Central Valley Project.
- The Lahontan Region, named for a prehistoric lake, runs from the Oregon border south along the eastern crest of the Sierra Nevada through the northern Mojave Desert. Within this area are hundreds of lakes, including Lake Tahoe and Mono Lake, streams and wetlands. Tourism ranks as the most important industry.
- The Colorado River Basin Region, which covers the state's most arid area, has two water bodies of state and national significance: the Colorado River and Salton Sea. Colorado River water irrigates more than 700,000 acres of farmland and provides drinking water to people in the southern coastal cities.
- The Santa Ana Region, from the San Bernardino and San Gabriel mountains in the north and east to Newport Bay along the coast, is geographically the smallest at 2,800 square miles but has one of the largest populations with almost 5 million people.
- The San Diego Region is 85 miles of coastline from Laguna Beach to the Mexican Border. It extends 50 miles inland to the crest of the coastal mountain range.

What type of wastewater treatment system a community will have depends on location, population and where the treated water will be released – whether it will be discharged in the interior of the state, including lakes, rivers or streams or the Delta, or along the coastlines into the ocean. Other disposal methods, including land application and percolation ponds, which further clean effluent by filtering it through soil, are also used.

The following case studies describe examples of discharge programs, an advanced water treatment project and a wastewater overflow (sewage spill) scenario.

Bay/Ocean Discharge Program

The story behind the city of Los Angeles' Hyperion Treatment Plant – the largest wastewater treatment facility in Southern California – includes a chronicle of successes and failures, grassroots efforts and, ultimately, recognition by the American Public Works Association (APWA) as one of the 10 Most Outstanding Public Works Projects of the 20th Century.

In the late 1800s, raw sewage from El Pueblo de Nuestra Señora la Reina de los Ángeles (the Town of Our Lady Queen of the Angels) was conveyed through natural waterways to the ocean.

Los Angeles in 1892 bought 200 acres in Playa del Rey – south of what is now the Los Angeles International Airport – for the location of what eventually would be the Hyperion Treatment Plant. Raw sewage was discharged into the ocean until 1925 when a simple screen plant started operation.

The screened wastewater discharged into the ocean did not prevent beach closures, which only increased with the growing Los Angeles population. In 1900, the city's population totaled more than 100,000; in 1940, it numbered 2.8 million people, according to U.S. Census statistics.

Following World War II, a new plant – the Hyperion Treatment Plant – was planned, funded and built. When it began operating in 1950, it was the first large secondary treatment plant on the West Coast and included biosolids processing. But a population growth spurt and lack of funds to enlarge the plant impacted levels of treatment, and water quality standards were rarely met. Discoveries by scientists included fish with fin rot and dolphins with tumors. Surfers and swimmers had skin rashes and became sick with flu-like symptoms.

According to a news release from APWA, "By 1957, the new plant was discharging a blend of secondary and primary effluent through a five-mile ocean outfall. Hyperion then stopped its biosolids-to-fertilizer program and began discharging digested sludge into the Santa Monica Bay through a separate seven-mile ocean outfall. Discharging 25 million pounds of wastewater solids per month began to take its toll on the marine life in Santa Monica Bay."

Concerned about the pollution in Santa Monica Bay, a group of Los Angeles area residents founded Heal the Bay in 1985. Massive grassroots efforts led to major facility upgrades in the late 1980s and a full secondary treatment system was rebuilt and opened in 1998. The result: a 95 percent reduction in the amount of wastewater solids going into Santa Monica Bay.

Heal the Bay's 2012 End of Summer Beach Report Card reported that beach water quality statewide was improved and on the rise, citing continued improvement at Los Angeles County and Santa Monica beaches, among others.

Research into alternative sustainable biosolids solutions led to the Terminal Island Renewable Energy (TIRE) program. TIRE, which is being demonstrated under an EPA Underground Injection Control permit, puts brine, treated effluent, biosolids and re-slurried biosolids in depleted deep subsurface oil and gas formations where the earth's high temperature biodegrades the organic compounds to generate methane gas to produce an environmentally safe renewable energy, while the carbon dioxide is sequestered, or isolated.

Operating since 1894, the Hyperion Treatment Plant is the city of Los Angeles's oldest and largest wastewater treatment facility.

Inland Surface Water Discharge

The Sacramento Regional County Sanitation District (SRCSD) has embarked on wastewater treatment plant upgrades to meet new and stricter water quality regulations required by the Central Valley Regional Water Board for treated water discharged into the Sacramento River to significantly improve water quality in the Sacramento River and Delta.

The Guardian laboratory boat crew monitors water quality and collects water samples at upstream and downstream sites of the wastewater plant discharge into the Sacramento River.

As background, in late 2010 new permit regulations were issued. Among other requirements, the permit contains mandates that require SRCSD to plan, design and construct new treatment facility upgrades for ammonia and nitrate removal, filtration and disinfection by 2021.

On a fast-track, in 2012 the Advanced Treatment Technology Pilot project was constructed to help SRCSD decide what technology to use in its treatment plant upgrade. The pilot facilities include new air activated sludge facilities with biological nutrient removal. Downstream of the activated sludge facilities, different types of filtration technologies and disinfection technologies are being tested.

SRCSD provides wastewater conveyance and treatment services to residential, industrial and commercial customers throughout unincorporated Sacramento County, the cities of Citrus Heights, Elk Grove, Folsom, Rancho Cordova, Sacramento and West Sacramento and the communities of Courtland and Walnut Grove. Under this regional system, wastewater travels through 177 miles of pipelines to a treatment plant south of Sacramento in Elk Grove, where approximately 150 million gallons of wastewater are treated each day and discharged into the Sacramento River.

Discharge to Land

The Fresno/Clovis Regional Water Reclamation Facility, operated by the city of Fresno, provides wastewater treatment services for the greater Fresno metropolitan area in the central San Joaquin Valley.

The plant, located in Fresno, receives 68 million gallons of wastewater on an average day with the capacity to treat 80 million gallons a day. After primary and secondary treatment processes, the treated wastewater is directed to 1,660 acres of ponds to percolate into the ground. A portion is also supplied directly to nearby farmers to irrigate fodder and fiber crops, such as alfalfa and cotton.

In 1891 the city began its first sewer system with the construction of a 24-inch outfall sewer to a 40-acre "sewer farm" located southwest of Fresno. As the population grew, additional septic tanks were added to the sewer farm to provide partial treatment of waste before being spread on land and used for irrigation.

An 812-acre parcel of property was acquired by the city in 1909 and would become the site of the current facilities. In the meantime, to cope with the demands of the city and agriculture, more acreage was purchased and more septic tanks were installed. Even the groundwater elevation was lowered to increase percolation capacity.

A major new treatment plant was constructed in 1947 to provide primary treatment to sewage before continued land disposal and local irrigation use. Population growth required a second plant in 1958.

In 1966 the city was designated as the sewering agency for the local metropolitan area and assumed the role of developing a long-range, area-wide wastewater treatment and disposal plan. After the Clean Water Act was passed, major construction projects improved facilities to meet water quality requirements. Due to more population growth, the latest plant expansions were in the late 1990s. A cogeneration facility uses the methane gas to partially meet the plant's energy requirements.

Alternative Treatment

The city of Arcata's Marsh and Wildlife Sanctuary on the North Coast is also home to a unique wastewater treatment facility that uses alternative technology to remove wastewater contaminants. The 307-acre ecosystem on the north end of Humboldt Bay integrates conventional treatment processes with the natural processes of freshwater marshes. Salt marsh, tidal sloughs, grassy uplands, mudflats and a brackish marsh provide habitat for wildlife.

Located along the Pacific Flyway, the sanctuary provides wetland habitat for more than 300 species of birds and numerous species of mammals, amphibians, insects and plants. There are also approximately five miles of walking and biking trails and the Arcata Marsh Interpretive Center.

But at one time, the marsh was the site of the county landfill, and became known as "Mount Trashmore." Klopp Lake was originally a leachate basin for the landfill.

The first water treatment plant in 1949 offered only primary treatment, releasing un-chlorinated effluent into the Arcata Bay. In 1957, 55 acres of oxidation ponds were added for a secondary treatment process. Chlorination was added in 1966 and an additional process was added in 1975 to remove the remaining chlorine.

With the arrival of the Clean Water Act, the county landfill located next to the primary and secondary wastewater treatment plant was closed in 1973 and restored to a grassy upland. To comply with the new federal law, plans for a new regional treatment facility were proposed in 1975, but the citizens of Arcata eyed the plan with skepticism. Among the reasons were the large energy requirements for pumping sewage to the plant and the potential for breaks in the pipes crossing the bay posed environmental concerns.

Instead the community, including city officials and a group of professors from the local university, proposed an alternative wastewater treatment facility. Pilot projects were successful, and on July 4, 1981, the original Arcata Marsh and Wildlife Sanctuary covering 75 acres was dedicated. In 1983 the State Water Resources Control Board permits allowed Arcata to upgrade its wastewater treatment plant, including wetland treatment enhancement units.

As a result of the marsh system, the effluent finally discharged into Humboldt Bay has gone through enhanced secondary treatment.

The city of Arcata's Marsh and Wildlife Sanctuary on the North Coast is also home to a unique wastewater treatment facility that uses alternative technology to remove wastewater contaminants.

Advanced Water Treatment

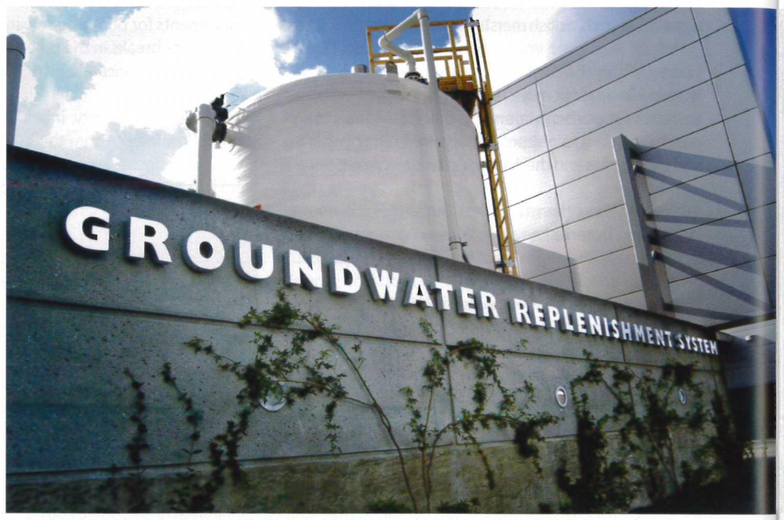
After wastewater is treated to a secondary level at the Orange County Sanitation District (OCSD), some of it goes to the ocean and some of it flows to the Groundwater Replenishment System (GWRS) in Fountain Valley where it undergoes a state-of-the-art purification process consisting of microfiltration, reverse osmosis and ultraviolet light with hydrogen peroxide. As a result, the treated water is described as near-distilled quality.

It is the world's largest advanced water purification facility of its kind, with a daily output of 70 million gallons. Approximately 35 million gallons per day of the treated water are pumped into injection wells to create a seawater intrusion barrier. Another 35 million gallons are pumped daily to Orange County Water District's (OCWD) percolation basins in Anaheim where the water from the system naturally filters through sand and gravel to the aquifers of the groundwater basin.

The system has also been used to provide peak wastewater disposal flow relief and indefinitely postponed the need for OCSD to construct a new ocean outfall by recycling wastewater flows that would otherwise be discharged to the Pacific Ocean.

Called the largest advanced wastewater treatment facility of its kind in the world, the system is a joint OCWD/OCSD project. It reached a major milestone on Dec. 10, 2012, when it marked 100 billion gallons of ultra-pure water produced since going on-line in January 2008.

In February 2012, OCWD broke ground on the GWRS Initial Expansion, which will result in the production of 100 million gallons per day beginning in early 2015.



The Orange County Sanitation District has the world's largest advanced water purification facility of its kind with a daily output of 70 million gallons. Currently the plant is undergoing expansion.

Wastewater Overflow Scenario

An "atmospheric river" hit the Sonoma Valley in late 2012. As a result of the extraordinary amount of heavy rainfall that inundated the area, two wastewater overflows occurred within the Sonoma Valley County Sanitation District.

As required by the State Water Board, the district has developed a Sewer System Management Plan, which describes how the sewer collection system is operated, maintained and evaluated. Its contents range from goals and an operations and maintenance program to emergency response and communications plans. For example, if a spill occurs, wastewater maintenance and work crews, including biologists, collect wastewater samples, evaluate environmental impacts and monitor the collection systems.

To help reduce overflows during large storms, the sanitation district has ongoing pipeline improvement and replacement projects, including the installation of five smart cover maintenance hole alarm systems. Smart covers on maintenance holes send alarms to sanitation staff when a wastewater collection pipe nears its capacity. Staff can then respond to the appropriate location and pump wastewater into a collection truck to prevent an overflow.

During a 1995 Sonoma County government restructuring, the Sonoma County Water Agency assumed responsibility for managing the county sanitation zones and districts that provide wastewater treatment, reclamation and disposal services. County sanitation districts are separate legal entities; sanitation zones are owned by the water agency. Each sanitation zone and district operates under a unique, individual permit from the San Francisco Bay Regional Water Board or North Coast Regional Water Board that set the requirements for their operations.

The Future

California's publicly owned wastewater systems are public assets confronting a challenging future. Could future wastewater and sanitation issues be even more complex than those of the past?

In its 2020 Vision for Clean Water, the National Association of Clean Water Agencies, Water Environment Federation and Association of Clean Water Administrators wrote, "We have inherited the water quality and infrastructure of the 20th century from our parents and grandparents – our children and grandchildren deserve the same from us in the 21st century."

Their goals, embraced by California wastewater agencies, include the following:

- Developing holistic watershed approaches that can effectively address the diffuse and complex sources of water pollution that hinder additional progress.
- Ensuring that maximum flexibility, creativity, authority, and innovation under the Clean Water Act are supported and barriers that may stand in the way of these objectives are addressed.
- Spreading awareness of the value of the nation's water, including the vital role of water and wastewater infrastructure in job creation, economic expansion and public health protection.
- Maximizing the effect of limited human and capital resources by focusing on the initiatives and projects that achieve the greatest water quality gains relative to the collective effort invested.
- Ensuring that municipalities and states have the funds and financial tools needed to implement programs that will ensure 40 more years of clean water improvements.

California's wastewater community is very focused on the replacement and improvement of aging infrastructure and the issue of how to pay for these future investments that are as crucial in this century as in the last century. It is important to realize that wastewater rates paid by most Californians today reflect past infusions of federal and state money. In other words, many people are not paying the full cost of wastewater infrastructure through their rates and fees.

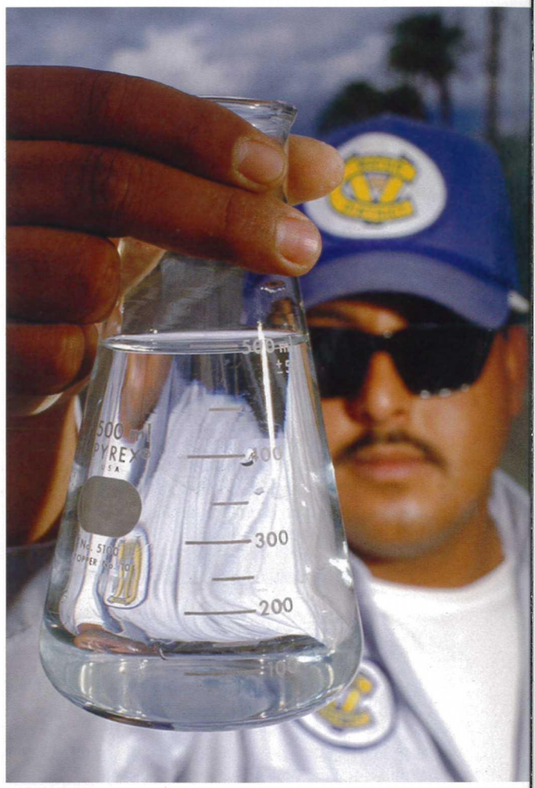
Wastewater entities also face potential obstacles that were not considered or planned for in the previous century. For example, the state's wastewater infrastructure is not immune from the impacts of future extreme wet weather events that could cause power outages at treatment plants. Planning for these natural disasters and climate change variables is front and center for wastewater agency managers in their efforts to prevent degraded water quality and protect the environment.

Look for wastewater agency managers to implement integrated planning processes and take advantage of more sustainable and comprehensive solutions to reach water quality objectives.

There will be increased interaction with the general public and policy leaders as people become increasingly aware of how their own activities and the associated impact of contaminants from those activities impact wastewater treatment, clean water and the environment.

As science and technology make possible advanced water quality testing from detecting compounds at parts-per-million (1 part compound to 1 million parts water) to parts-per-billion levels to parts-per-trillion levels, the detectable occurrence of CECs needs thoughtful public discussions. For example, when a new pollutant compound is detected, is there a health concern, or at what level does it become a health or environmental concern? If yes, who pays for costs to remove it from the wastewater?

Also on the radar are discussions on how treatment plants fit under the California Air Resources Board's "cap and trade" program as part of implementation of California's Assembly Bill 32 – The Global Warming Solutions Act of 2006. Opportunities could exist in the future for wastewater agencies to generate revenue through producing carbon offsets and to contribute to meeting air pollution reduction goals in a number of different ways.



Today's California public agency wastewater professionals are state-certified and at work around the clock 24/7 365 days of the year.

What might the next generation of sanitation look like? It could be the solar-powered portable toilet by environmental scientist and engineer Michael Hoffmann of the California Institute of Technology (Caltech). His toilet uses the sun to power an electrochemical reactor. The reactor breaks down water and human waste into fertilizer and hydrogen, which can be stored in hydrogen fuel cells as energy. The treated water could then be reused to flush the toilet or for irrigation.

A future model for the wastewater agency is detailed in a report titled *The Water Resources Utility of the Future: A Blueprint for Action*."It contemplates a new business approach where instead of simply collecting, treating and disposing of municipal and industrial wastewater, the utility of the future recognizes that its inputs are valuable resources," according to an excerpt."As such, its objectives are to separate, extract, reuse or convert valuable water, energy and commodities from wastewater while using utility assets in innovative ways to reduce costs, increase revenues and strengthen the local economy."The report was released in early 2013 by the National Association of Clean Water Agencies, Water Environment Research Foundation and Water Environment Federation.

Certified Wastewater Professionals

California's track record of safe and effective operations of wastewater treatment plants can be attributed to State Water Board certification standards for people working in the wastewater field. There are five levels of state-mandated wastewater treatment plant operator certification (Grades I-V) and requirements include a combination of education, training and experience.

Beyond the state-mandated certifications required for wastewater treatment plant operators, the California Water Environment Association offers voluntary education, training and certification in other vocations in the water quality field.

Voluntarily surpassing mandatory regulations, California public agencies are attaining certification for having environmental management system-based Biosolids Management Programs. This ongoing multi-level certification program is offered through the Water Environment Federation, in collaboration with the National Association of Clean Water Agencies and local and regional biosolids management organizations across the U.S. and Canada with support from the U.S. Environmental Protection Agency.

Looking to the future, the wastewater community is preparing for succession planning as retirements loom for veteran wastewater professionals. Wastewater agencies are involved in providing educational opportunities for people interested in pursuing a career in the wastewater field. For example, Laney College and EBMUD teamed up to offer a pre-apprenticeship level course of study to prepare students for plumbing careers in the water distribution industry.

References

Thank you for the historical background researched and collected by Jon Schladweiler, a historian with the Arizona Water Company. www.sewerhistory.org

National Water Research Institute "Source, Fate, and Transport of Endocrine Disruptors, Pharmaceuticals, and Personal Care Products in Drinking Water Sources in California" Project Report: www.nwri-usa.org/pdfs/NWRIFinalReportEDCsPPCPsMay2010.pdf

Bureau of Reclamation's "Secondary/Emerging Constituents Report" (2009): www.usbr.gov/lc/socal/reports/brineconcentrate/4SecondaryConstituents.pdf

"Confronting Climate Change: An Early Analysis of Water and Wastewater Adaptation Costs": www.amwa.net/galleries/climatechange/ConfrontingClimateChangeOct09.pdf

"A Citizen's Guide to the California Water Boards": www.waterboards.ca.gov/publications_forms/publications/general/docs/citizenguide2011.pdf State Water Board Office of Public Participation: 916.341.5254 or info@waterboards.ca.gov.

"The Water Resources Utility of the Future: A Blueprint for Action": www.nacwa.org/images/stories/public/2013-01-31waterresourcesutilityofthefuture-final.pdf