CALIFORNIA. DEPT. OF WATER RESOURCES.
BULLETIN.

BULLETIN No. 80-5
NOVEMBER 1975

Reclamation of Water from Wastes In Southern California

save water
DWR

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

--Las Virgenes Municipal Water District photo

IRRIGATION OF GOLF courses, parks, greenbelts, and agricultural land are among the beneficial uses that are being made of reclaimed waste water. Currently in Southern California, the amount being reclaimed is small in comparison with the potential.

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Reclamation of Water from Wastes In Southern California

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State of California
DEPARTMENT OF WATER RESOURCES
P.O. Box 388
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CONVERSION FACTORS

English to Metric System of Measurement

Quantity	English unit	Multiply by	To get metric equivalent
Length	inches	2.54	centimeters
	feet	30.48	centimeters
		0.3048	meters
		0.0003048	kilometers
	yards	0.9144	meters
	miles	1,609.3	meters
		1.6093	kilometers
Area	square inches	6.4516	square centimeters
	square feet	929.03	square centimeters
	square yards	0.83613	square meters
	acres	0.40469	hectares
		4,046.9	square meters
		0.0040469	square kilometers
	square miles	2.5898	square kilometers
Volume	gallons	3,785.4	cubic centimeters
		0.0037854	cubic meters
		3.7854	liters
	acre-feet	1,233.5	cubic meters
		1,233,500.0	liters
	cubic inches	16.387	cubic centimeters
	cubic feet	0.028317	cubic meters
	cubic yards	0.76455	cubic meters
		764.55	liters
Velocity	feet per second	0.3048	meters per second
	miles per hour	1.6093	kilometers per hour
Discharge	cubic feet per second or second-feet	0.028317	cubic meters per second
Weight	pounds	0.45359	kilograms
	tons (2,000 pounds)	0.90718	tons (metric)
Power	horsepower	0.7460	kilowatts

FOREWORD

As we broaden the scope of water management, we recognize the need for the reclamation of waste water, both to stretch our available supplies, thus reducing the need for new and expanded surface water supplies, and to dispose of used water in an economical, effective, and environmentally acceptable way. This does not mean that reclamation is a panacea for all our water problems--indeed, reclamation itself presents much that demands solution. But, in this time of environmental concerns and economic crises, we must expand our efforts in this field and develop meaningful reclamation projects.

For a number of years, the Department of Water Resources has been conducting a statewide inventory of waste water production and reclamation practices (reported in the bulletins of the Nos. 68 and 130 series). A review of these publications will show comparatively little progress in water reclamation has been made in the last decade. In March 1973, the Department published, as Bulletin No. 189, a report on "Waste Water Reclamation: The State of the Art." In addition, it has undertaken a series of overview studies of waste water supplies and reclamation projects throughout the State, which are reported in the Bulletin No. 80 series.

This bulletin, which reports on the overview study in Southern California, points up the many opportunities for reclamation that exist and identifies those specific waste water treatment facilities with a potential for reclamation.

From the information developed in this and related studies, the Department recommends that the agencies involved consider the implementation of specific reclamation projects. Wherever possible, the Department will assist in this program. The Department will include such projects in its current revision of the water management element of The California Water Plan. Amounts of water that can be reclaimed will be included in the analyses of water supply and demand. A concerted effort must be made to move from the planning stage to the actual reuse of reclaimed water. In some cases, water supply agencies will be required to cooperate with agencies providing waste treatment in a manner which has not previously occurred. Failure of such cooperation cannot be permitted to delay reclamation efforts.

In the preparation of this bulletin, the Department had the advice of a committee of representatives of a number of public agencies and other concerned citizens. Their contribution has been invaluable.

Ronald B. Robie
Ronald B. Robie, Director
Department of Water Resources
The Resources Agency
State of California

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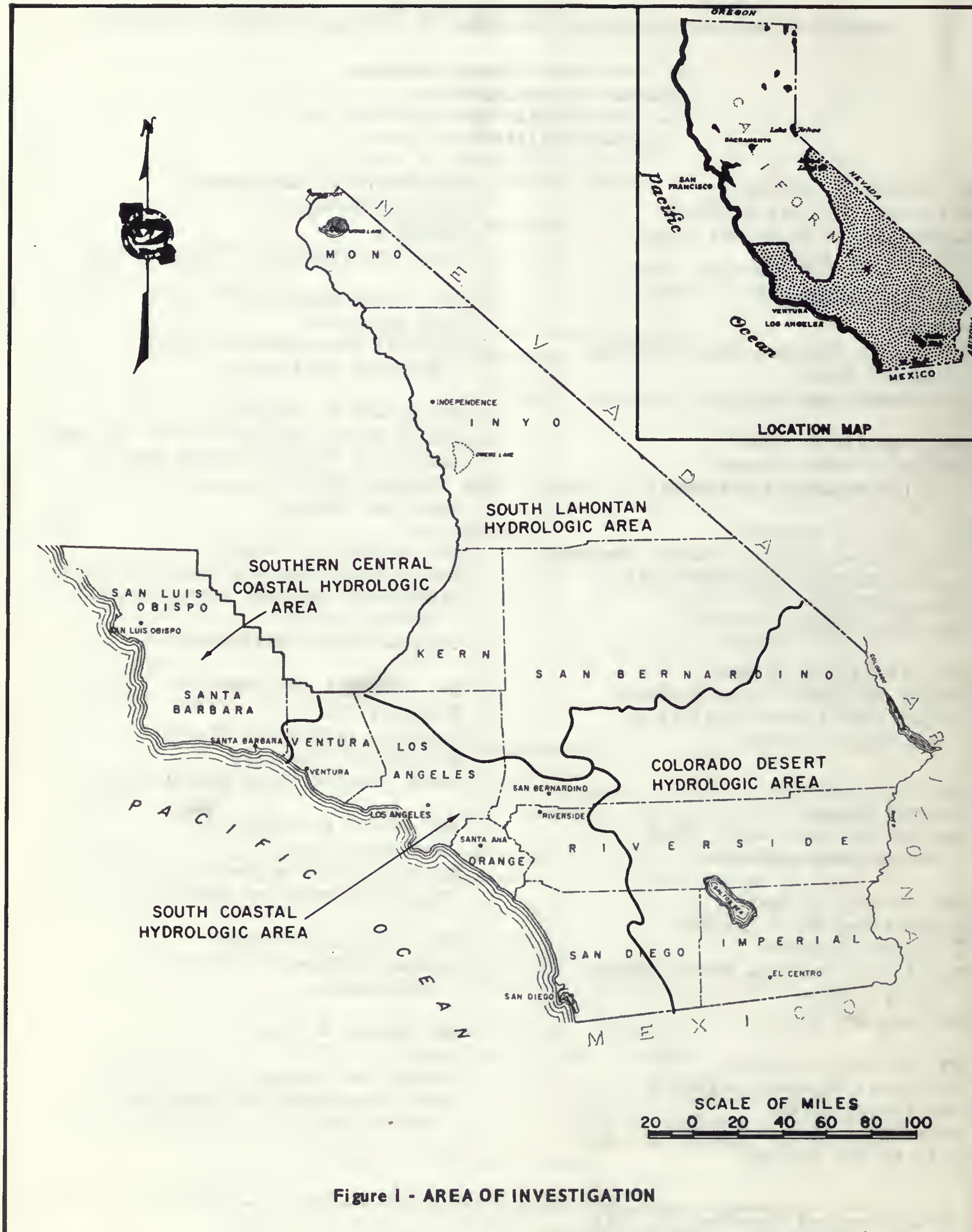


Figure I - AREA OF INVESTIGATION

CHAPTER I. INTRODUCTION

Southern California is an area where more water is used each year than is supplied by nature. For some time to come, water imported through existing facilities, together with local supplies, will meet the major demand. However, in specific locations and for specific uses, additional supplies are needed now. In time, they may be needed throughout the area. Because the sources of supplemental supplies are remote from the heavily populated coastal counties, importation requires the construction and operation of expensive facilities with considerable energy requirements. Therefore, consideration must be given to the more effective use of available supplies. The reclaiming of used water is one way to achieve this objective. Moreover, reclamation offers the operators of treatment plants a means of disposing of their treated waste water that is environmentally acceptable.

Hence, the need for this overview study of the potentialities of reclamation of waste water in Southern California. It is one of several overview studies being carried out by the Department of Water Resources as part of its statewide program to investigate various aspects of waste water reclamation under authorization of the State Legislature (California Water Code, Section 230 and Division 7, Chapters 6 and 7).

Objectives of Investigation

The primary objective of the study is to provide the information needed to determine the role of waste water reclamation in the management of Southern California's water resources. Specific objectives are to:

1. Report on historical waste water production and reclamation practices;
2. Establish an approximation of the amounts of waste water available for reclamation between 1973 and 2000;
3. Identify specifc reclamation opportunites that warrant further consideration for development; and
4. Identify major factors that should be weighed in considering the implementation of specific reclamation projects.

Scope and Conduct of Investigation

For historical waste water production and past and present reclamation practices, the study was limited to data covering 1967 to 1973. To confirm the accuracy and completeness of this information, earlier data were reviewed.

To determine the reclamation possibilities in Southern California to the year 2000, the quantities of waste water produced were estimated, and a range of amounts of that production that might be reclaimed was determined.

Those reclamation opportunities that appear worthy of further consideration and possible development were selected on the basis of potential markets, quantity and quality of treated waste water, estimates of conveyance costs, and consideration of the Basin Water Quality Control Plans of the State Water Resources Control Board.

To aid in the planning needed before implementing a project, an analysis was made of all factors that should be weighed. The major ones are presented in this report.

Area of Investigation

Southern California, as used in this report, is the area forming the Southern District of the Department of Water Resources. It encompasses six coastal counties (San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, and San Diego) and six inland counties (Inyo, San Bernardino, Riverside, and Imperial and portions of Mono and Kern). This area covers approximately 63,500 square miles, or 41 million acres (Figure 1). Southern California is divided into four major hydrologic areas: the Central Coastal Hydrologic Area (southern portion), the South Coastal Hydrologic Area, the South Lahontan Hydrologic Area,

WASTE WATER RECLAMATION--A PERSPECTIVE

The starting point for any discussion of waste water reclamation is the water cycle (Figure 2), which is one of the unending systems through which nature restores—for reuse—the basic elements of life: food, air, and water. In truth, there is no "waste" water in nature's cycle; waste water is a term invented to describe water after it has been put to a beneficial use. Even that used water which is "wasted" by being disposed of to the ocean is eventually returned--desalted--through evaporation and precipitation.

Almost immediately, the introduction of impurities begins. Nature itself adds some, these are dust, dissolved gases and salts, weathered and decomposed rock particles, organic matter, and such suspended materials as silt, bacteria, and algae. People enter the cycle to develop a water supply for their own uses and, by doing so, add still more impurities (Figure 3).

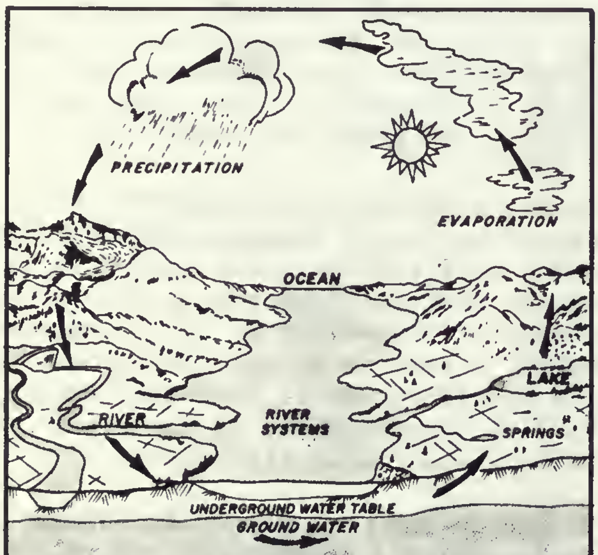


Figure 2 - WATER CYCLE

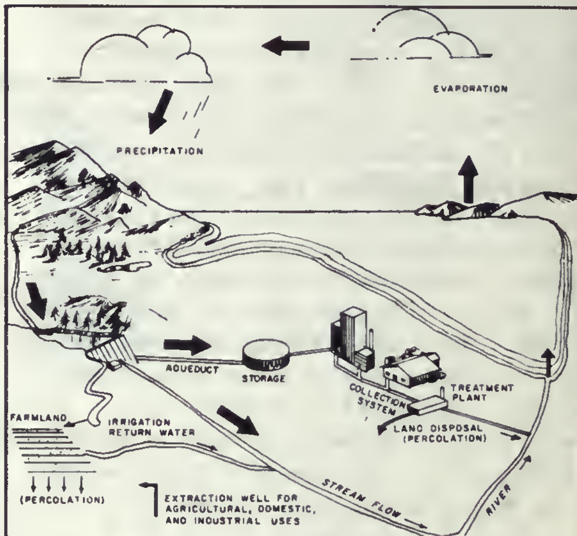


Figure 3 - PEOPLE'S ENTRANCE IN THE WATER CYCLE

These impurities may exceed nature's renewal capabilities--within the alloted time and place; therefore, to help maintain the balance needed for operation of the water cycle, we have built treatment facilities for removing some of the impurities from the water we have used. In general, these treatment processes simulate the processes used within the natural cycle.

Figure 4 is a simplified diagram of the complex network such use and artificial treatment introduce into the water cycle. The diagram is an attempt to depict the variety of roles played by water (i.e., a supply to meet a variety of beneficial uses, an element to enhance the environment, a waste to be collected and disposed of, etc.) and the intricate interrelationships that have evolved.

For the most part, the uses can be grouped under industrial, domestic (municipal), agricultural, and recreational. The waste and the Colorado Desert Hydrologic Area. (Details on water supply and demand in each hydrologic area are given in Appendix A, which is bound separately.)

The topography is marked by striking extremes, beaches and plains along the coast, deserts in the interior, and fertile valleys, rolling foothills, and jagged mountain peaks interspersed between. The area also shows sharp contrasts in climate, resulting partly from its topographic extremes and partly from the confluence of cool, damp ocean air and hot, dry desert air.

Major streams draining the coastal areas are the Santa Maria, Santa Ynez, Santa

water from agricultural and recreational uses is usually returned (discharged) directly to nature. Most of that from industrial and municipal uses is collected and treated before it is discharged. Thus, in this report, the quantity of waste water "produced" is that quantity of industrial and municipal waste water that enters a treatment plant where it will be treated before it is returned to the natural cycle.

Likewise, "reclaimed" waste water--as used in this report--is that portion of the industrial and municipal waste water which has been collected and treated and then planned for reuse for a beneficial purpose (see "direct use" and "artificial recharge" in Figure 4).

It should also be noted that, although not considered as reclamation in this report, reuse may also be incidental to disposal (see "land disposal" and "stream discharge" in Figure 4).

(A glossary of terms used in this report is bound at the back.)

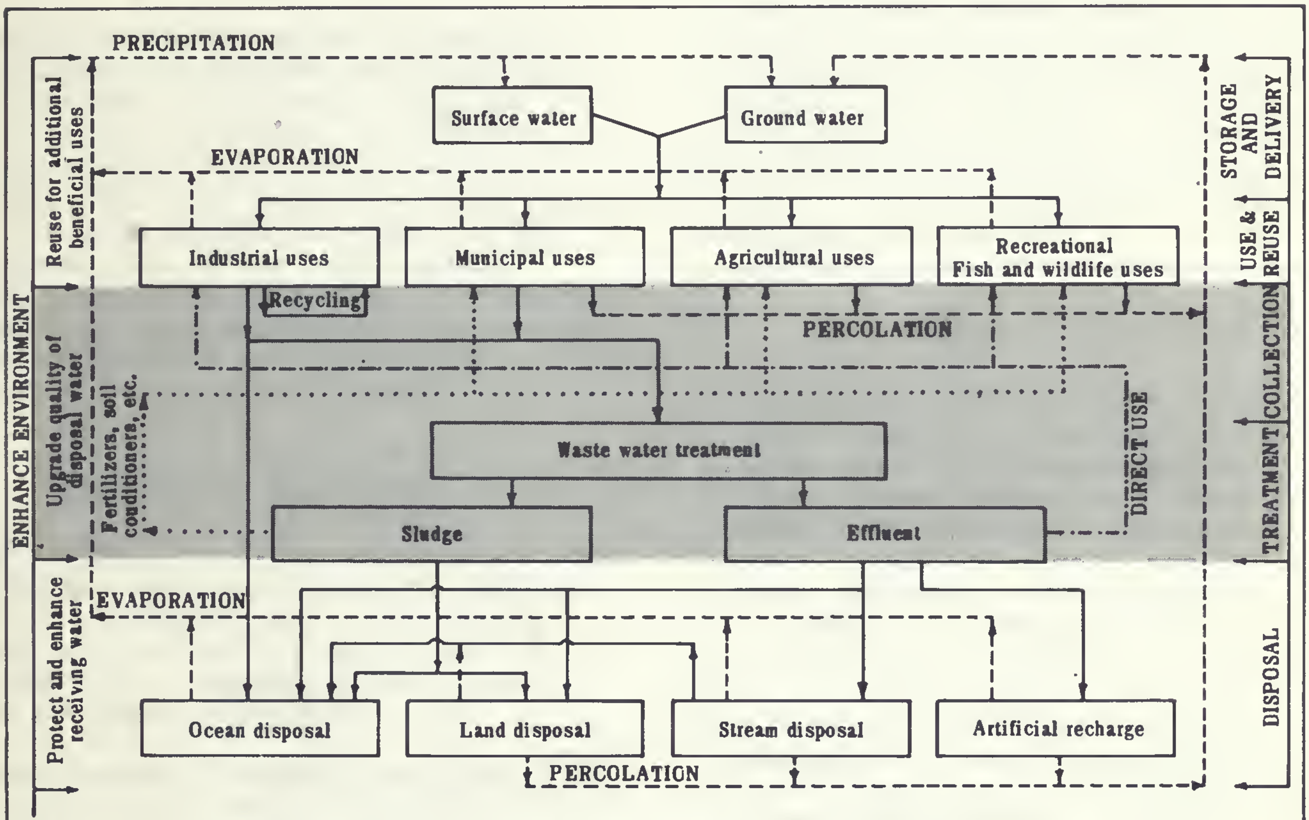


Figure 4 - COMPLEX INTERRELATIONSHIPS OF PEOPLE'S ENTRANCE IN THE WATER CYCLE

Clara, Los Angeles, San Gabriel, Santa Ana, Santa Margarita, San Luis Rey, and San Diego Rivers. Major streams draining the inland areas are the Colorado, Whitewater, New, Alamo, Owens, and Mojave Rivers.

The coastal flat lands are highly urbanized. The major developments are the Cities of San Luis Obispo and Santa Barbara, the developments on the Oxnard Plain of Ventura County, the cities on the Coastal Plain of Los Angeles and Orange Counties, and metropolitan San Diego.

Coastal flat lands outside the urbanized portions are devoted to irrigated agriculture. Agriculture in the inland areas is limited largely by the lack of water supplies. Where low cost water is available--as in the Imperial and Coachella Valleys, which use Colorado River water for irrigation--a significant agricultural economy has developed.

A summary of the 1970 population, land use, and average annual precipitation in Southern California is given below:

- Population: 11,840,000
- Urban land: 1,240,000 acres
- Agricultural land: 1,390,000 acres
- Average precipitation: 7.8 inches
- Range of average annual precipitation: 3 to 22 inches

CHAPTER II. HISTORICAL PRODUCTION, TREATMENT, AND RECLAMATION

The first objective of this report is to provide information on historical waste water production and reclamation practices. Discussions of treatment processes that have been used and of research conducted for reclamation are also included in this chapter.

Historical Production

Waste water production data were compiled for the period between 1967-68 and 1972-73 (water years) for the 110 major waste water treatment plants in Southern California having a design capacity of 1 million gallons per day (mgd) or greater (Table 1).

Approximately 97 percent of the local population in Southern California who are served by treatment plants are covered by these data. In 1972-73 approximately 1,386,000 acre-feet of waste water came into these major plants; of this, 1,311,000 acre-feet, or 95 percent, was in the South Coastal Hydrologic Area (Figure 5). (Appendix B, which is bound separately, compares the inflow to these plants with that to all plants in Southern California.)

Treatment of Waste Water

In general, the treatment processes used separate waste water into two parts--liquid (effluent) and solids (sludge). Both contain varying amounts of organic and inorganic matter, some of which may be harmful.

The treatment processes are generally referred to as primary, secondary, and advanced (if advanced treatment follows secondary it is called tertiary). Although chlorination is usually included in all degrees of treatment, it is generally considered a separate process. Its main objective is to disinfect, or destroy pathogenic organisms.

The effluent coming from the treatment processes is generally defined by the degreee of treatment given it--primary, secondary, and tertiary.

Primary treatment physically removes much of the settleable and floatable material in sewage, thus reducing biochemical oxygen demand (BOD) and suspended solids.

Following primary treatment, secondary treatment may also be given; it produces a more oxidized, stable waste water by biologically reducing oxygen-demanding wastes thereby further reducing BOD and suspended solids (Table 2). The two major forms of secondary treatment used are trickling filters and activated sludge. In both, organic matter is stabilized biologically.

WHAT IS THE SIGNIFICANCE OF BOD?

For a watercourse to be regarded as a "living" stream, it must contain enough oxygen to support aquatic life, including the bacteria that are necessary to decompose the organic wastes which come into the stream. If the amount of oxygen required by the bacteria exceeds the supply in the water, the stream is no longer a viable watercourse: wastes will not be assimilated and fish will die.

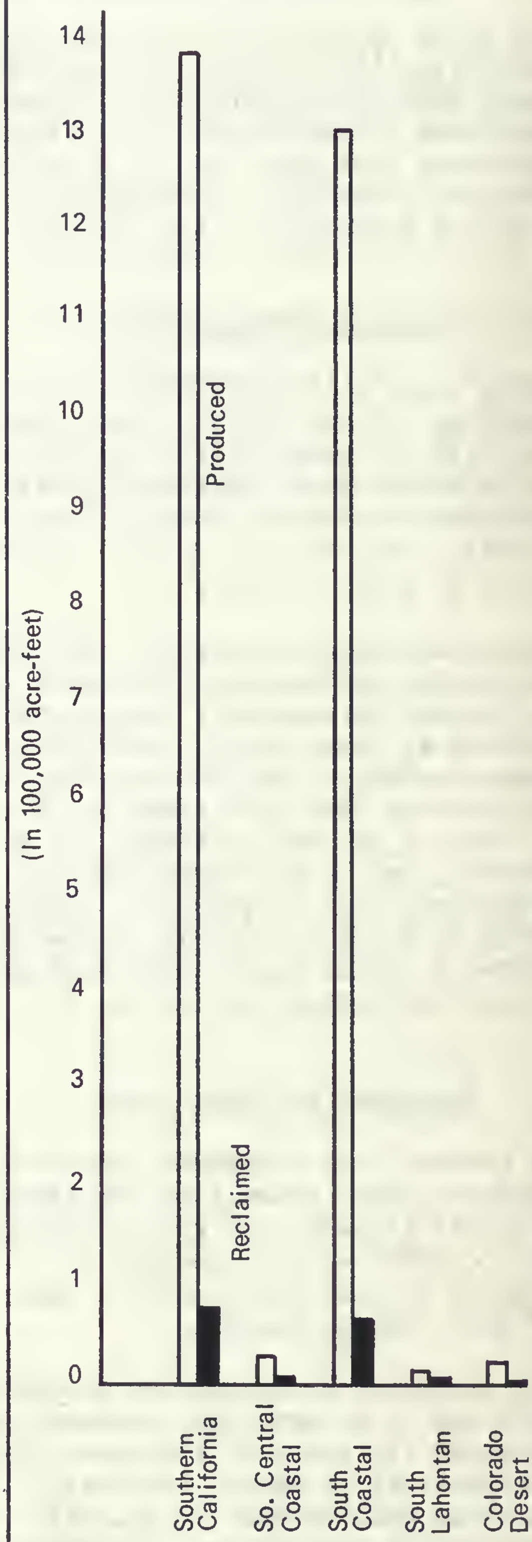
It is, therefore, important that the treatment processes given to waste water reduce this oxygen demand. Thus, BOD (for biochemical oxygen demand) has become a recognized measure of the effectiveness of a treatment process.

TABLE I
WASTE WATER PRODUCTION AND RECLAMATION* IN SOUTHERN CALIFORNIA

Hydrologic area Water year	Waste water production		Waste water reclaimed 1000 AF
	Daily flow mgd	Annual flow 1000 AF	
Southern Central Coastal			
1967-68	28	31	3
1968-69	32	35	3
1969-70	31	35	3
1970-71	31	35	4
1971-72	31	34	4
1972-73	32	36	3
South Coastal			
1967-68	1,012	1,135	49
1968-69	1,073	1,203	40
1969-70	1,087	1,218	40
1970-71	1,106	1,238	54
1971-72	1,132	1,271	54
1972-73	1,170	1,311	70
South Lahontan			
1967-68	13	15	3
1968-69	14	16	4
1969-70	15	16	5
1970-71	16	17	4
1971-72	17	19	4
1972-73	16	18	4
Colorado Desert			
1967-68	14	16	4
1968-69	16	18	3
1969-70	17	19	4
1970-71	17	19	5
1971-72	17	19	5
1972-73	18	21	3
Total Southern California			
1967-68	1,067	1,197	58
1968-69	1,136	1,272	50
1969-70	1,150	1,288	52
1970-71	1,169	1,309	66
1971-72	1,197	1,344	68
1972-73	1,236	1,386	80

* At waste water treatment plants with a design capacity of 1 mgd or greater

FIGURE 5
WASTE WATER RECLAMATION IN 1972-73



Although secondary treatment reduces most of the oxygen-demanding substances, it does not remove any of the dissolved inorganic matter or certain of the dissolved organic matter. Therefore, waste water that contains high concentrations of dissolved minerals and toxic materials, even though it undergoes secondary treatment, can have undesirable environmental effects and not be suitable for reuse.

Sludge from these processes is usually digested; then it is dried and disposed of on land, discharged into the ocean without drying*, or incinerated.

Advanced treatment processes can significantly reduce such detrimental substances in waste water as nutrients, dissolved solids, suspended or colloidal solids, toxic materials, and other constituents. Physical, chemical, or biological processes, or a combination of them, are used to the degree that the quality of the effluent will be acceptable for intended beneficial uses.

Processes used for advanced treatment include carbon adsorption, chemical coagulation, chemical precipitation, mixed media filtration, ammonia stripping, and the desalting processes of reverse osmosis, electrodialysis, ion exchange, and distillation.

Most of the waste water at the major plants in Southern California receives either primary or secondary treatment. It is then discharged to land, to surface streams, or to the ocean. The specific type of treatment and place of discharge for the major treatment plants are included in Appendix B, which is bound separately. An analysis of these data shows that of the 30 plants discharging effluent to saline waters, 15 discharge 980,000 acre-feet of primary effluent and 17 plants discharge 168,000 acre-feet of secondary effluent (two plants give secondary treatment to only a portion of their waste water). In addition, 30 plants that provide secondary treatment discharge 160,000 acre-feet of treated effluent to surface waters, while 47 discharge 73,000 acre-feet of secondary effluent to land.

TABLE 2
WASTE WATER TREATMENT EFFICIENCIES
in %

Treatment process	Removal	
	Suspended solids	BOD
Primary treatment		
Conventional	50-65	25-50
Conventional with floccula-tion and aeration added	Up to 70	Up to 60
Stabilization ponds*	Up to 70	45-60
Secondary treatment		
Activated sludge		
Conventional	75-95	75-95
High rate (complex mix)	75-90	75-90
Contact stabilization	**	85-90
Extended aeration	**	75-95
Step aeration	**	90-95
Trickling filters	70-90	75-90
Oxidation ponds*	Up to 90	50-95

*Values do not include possible secondary effects of algae.
**Not readily available.

To date, only limited use has been made of advanced treatment processes because of their high cost. Between 1967 and 1973, two advanced treatment facilities were operational in Southern California (operated by Chino Basin Municipal Water District and Sanitation Districts of Los Angeles County), although several research projects utilized advanced treatment. All are discussed later in this chapter.

The quality of waste water coming from the plants in Southern California is characterized by its many constituents. As indicated in the following tabulation, the mineral quality of the waste waters produced in Southern California varies

* The discharge of municipal and industrial sludge directly to the ocean without further treatment is now prohibited under the "Water Quality Control Plan for Ocean Waters of California", adopted July 6, 1972, by the State Water Resources Control Board.

greatly in terms of total dissolved solids (TDS). This variation results from a great many causes, most common of which are differences in the quality of the water supplies, the varying contribution of industrial wastes, and the intrusion of sea water into sewerlines at some places.

RANGES OF TDS CONCENTRATION IN WASTE WATER*

Hydrologic Area	Average TDS range in mg/l
Southern Central Coast	850–1,700
South Coastal	260–2,690
South Lahontan	200–1,120
Colorado Desert	340–3,520

*See Appendix B (bound separately) for details on TDS and other constituents.

Historical Reclamation Practices

In Southern California, treated waste water has been used for many years for irrigation, industrial, and recreational purposes and for replenishing the ground water supply.

One of the earliest cases was at the Tri-Cities sewage treatment plant, operated by the City of Pasadena, which utilized the effluent from an activated sludge treatment plant for irrigation in 1924. Even prior to that time, both the Cities of Pomona and Pasadena were using treated sewage for irrigation of tree-grown crops.

In 1931, San Diego Teachers' College began irrigating lawns and shrubs with treated waste water, but it has since abandoned the practice.

In 1942, Kaiser Steel Corporation began operating a waste water treatment facility at its Fontana plant where about 750,000 gallons of both sanitary and process waste water are reused daily. This project was the first in California to be designed and constructed for the industrial use of treated waste water. Moreover, it was the first plant in this area to reclaim effluent because of regulations restricting the discharge of wastes, while also providing a source of inexpensive water.

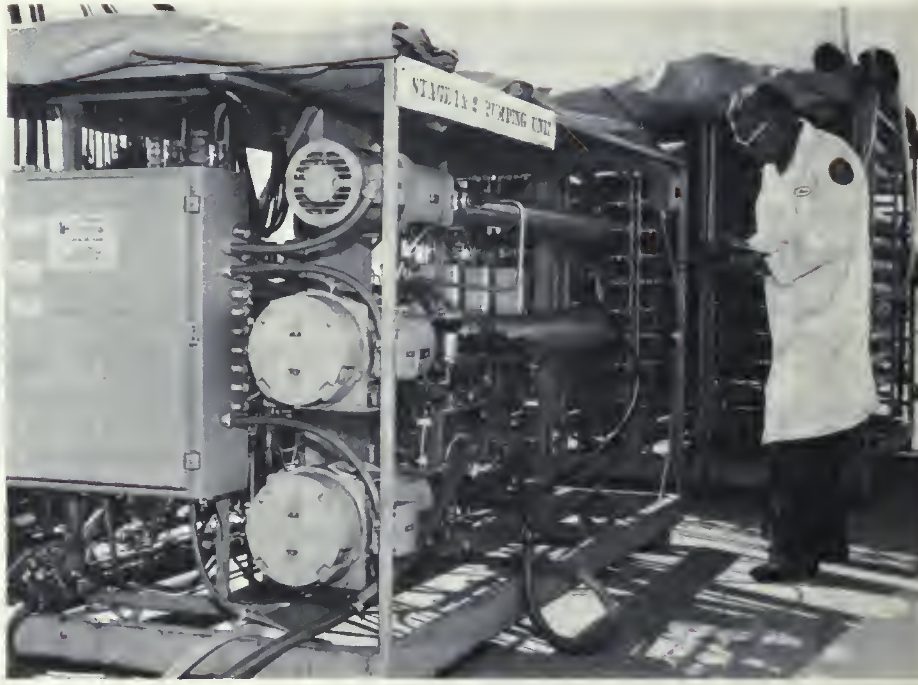
More recently, the Whittier Narrows Water Reclamation and San Jose Creek Water Renovation Plants, both in the vicinity of Whittier Narrows, were constructed by the County Sanitation Districts of Los Angeles County to supply treated waste water for ground water recharge and to reduce the costs of waste disposal. These plants now have the capacity to treat about 45,000 acre-feet annually for replenishment of downstream ground water basins.

Treated waste water has been used since 1961 to help maintain recreation lakes operated by the Santee County Water District in San Diego County. Some of the water was, at one time, used to fill a swimming pool; however, this practice has been discontinued because of the high cost of correcting turbidity, which resulted from oxidation of manganese and possibly some iron by chlorine used for disinfection.

Near Lancaster, the County Sanitation Districts of Los Angeles County and the Sanitation Division of the County Engineer's office have, since February 1970, also been using treated waste water for filling recreation lakes.

In San Bernardino County, treated waste water is being used to partially fulfill the court-ordered obligation of Chino Basin Municipal Water District and Western Municipal Water District to supply 42,000 acre-feet of water annually to Orange County Water District, which is downstream in the lower Santa Ana River drainage area. The City of Burbank in Los Angeles County has been using treated waste water since 1966 for boiler feed and cooling water in the city-owned power plant.

The Talbert Water District operated a reclamation project in the Costa Mesa area of Orange County from 1956 to 1961 (when urbanization forced agriculture out) for irrigation of canning tomatoes and lima beans. The project used primary effluent



--City of San Diego photo

PILOT PLANT for desalting raw sewage by the reverse osmosis process is being operated by City of San Diego. Reverse osmosis is one of the processes that is used for desalting brackish water and ocean water.

a variety of reverse osmosis configurations. The suspended solids in this effluent averaged 100 mg/1 and the TDS was 2,000 to 4,000 mg/1. At the conclusion of these tests, the city decided that further studies were necessary and that only tubular configurations would be considered.

In 1968, two small bench-size tubular units, treating 1,500 gallons per day (gpd) of raw sewage, were installed. They were operated until 1970. Pretreatment was limited to putting the sewage through a simple rough intake screen (1/4 inch by 1/4 inch). The objective was to see how raw sewage would affect the units.

In 1970, a continuous, automated tubular unit was built. The pilot plant, with a capacity to produce 20,000 gpd, consists of a series of tube membranes set in rows of five and six modules, used in two stages. The flow pattern is in series, with the brine from the first stage going through a second pump to stage two. The plant is turning out 16,000 gpd of high quality water containing less than 400 mg/1 TDS from incoming waste water (influent) containing about 2,000 mg/1 of TDS.

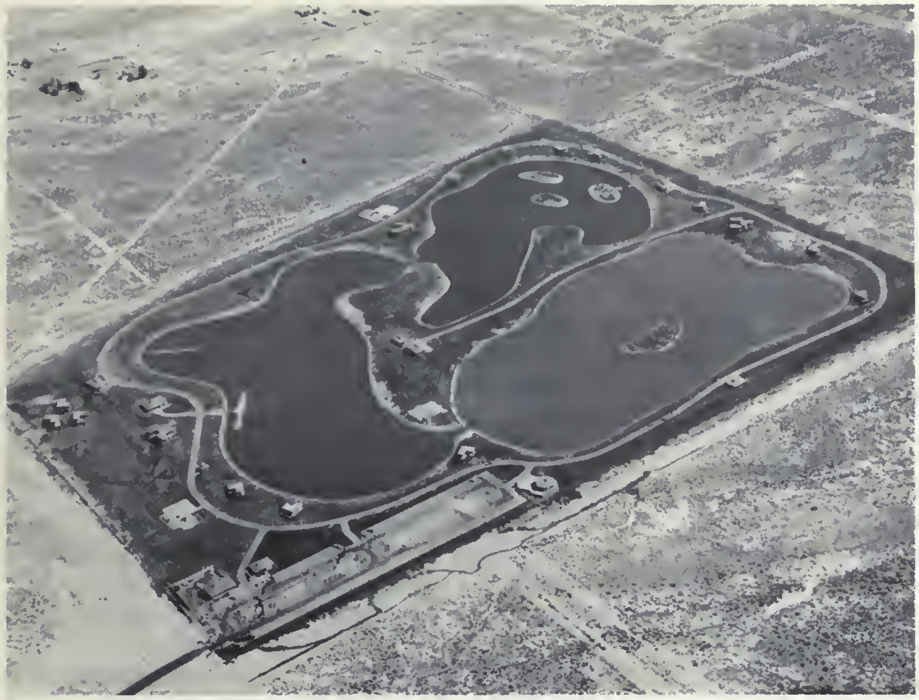
This water has been used for boiler feed and for a cooling tower system, but is now being used for irrigation of a sod farm.

The desalted water is also being tested by the University of California at Berkeley for presence of viruses.

<u>County Sanitation Districts of Los Angeles County</u>

The County Sanitation Districts of Los Angeles County have been involved in pilot plant evaluations of advanced treatment processes since 1965. This work has been conducted jointly with the U. S. Environmental Protection Agency at the districts' Pomona Water Renovation Plant. Purposes of the research are to demonstrate feasibility, improve performance, determine operating cost, obtain operating experience, and develop design information. The research is concentrated on demineralization, nutrient removal, and disinfection. At present, the research being carried out is concerned with development of virus removal techniques.

In addition, the County Sanitation Districts worked with the Sanitation



--Sanitation Districts of Los Angeles County photo

RECREATION LAKES in Apollo Park Aquatic Recreation Area near Lancaster in Antelope Valley are supplied with tertiary treated waste water from the District 14 Water Renovation Plant operated by the Sanitation Districts of Los Angeles County. The recreation lakes are operated by the Los Angeles County Department of County Engineer.

Division of the County Engineer's office in a four-year research and development program, which ended in 1968. The results of this program proved that it was economically feasible to meet minimum health and water quality standards for water-related recreational activities by tertiary treatment of conventional oxidation pond effluent at the water renovation plant near Lancaster. This treatment consists of coagulation with aluminum sulfate, sedimentation, filtration through a dual-media gravity anthracite sand filter, and chlorination. This reduced turbidity, algae, phosphate, bacteria, and virus.

As a result of the study program, an advanced treatment facility with 0.5 mgd capacity has been added at the plant, with treated water used to fill three recreation lakes. The lakes and their surrounding park provide facilities for boating, fishing, camping, hiking, picnicking, and sports.

City of Los Angeles

The City of Los Angeles has proposed a cooperative project between its Department of Water and Power and Bureau of Sanitation using the carbon adsorption process. It would treat secondary effluent from Hyperion Treatment Plant, the city's major waste water treatment plant. The carbon adsorption process removes oxygen-demanding materials not removed in normal sewage treatment processes, thus reducing taste and color and improving bacteriological quality. Heavy metals may also be reduced.

The project, as proposed, would be a two-phase operation to supply treated water to the nearby West Coast Basin Barrier, which consists of injection wells along the coast to repel sea water intrusion into the basin. The initial phase is a demonstration project to supply a portion of the water needed for the barrier and to investigate the effects of residual organics. The planned second phase is a 35 mgd facility to supply the entire barrier project.

In addition, secondary effluent is to be used for industrial purposes by Standard Oil Company of California.

Orange County Water District

Orange County Water District has constructed a prototype waste water reclamation and sea water desalination plant called the Orange County Coastal Project, also referred to as Water Factory 21. The supply of water for the reclamation part of the plant will ultimately be 15 mgd of secondary effluent from the trickling filters of County Sanitation Districts of Orange County Treatment Plant No. 1. The treatment process will include lime coagulation, ammonia stripping, recarbonation, and chlorination. The treated water is to be blended in equal volume with desalinated sea water, which has passed through the desalination part of the plant, to a quality suitable for ground water recharge. If the water from the plant is not sufficient to meet the need, fresh water from other sources could be added to the blend. Recharge through injection wells will replenish the ground water basin and provide a hydraulic barrier to prevent landward movement of sea water.

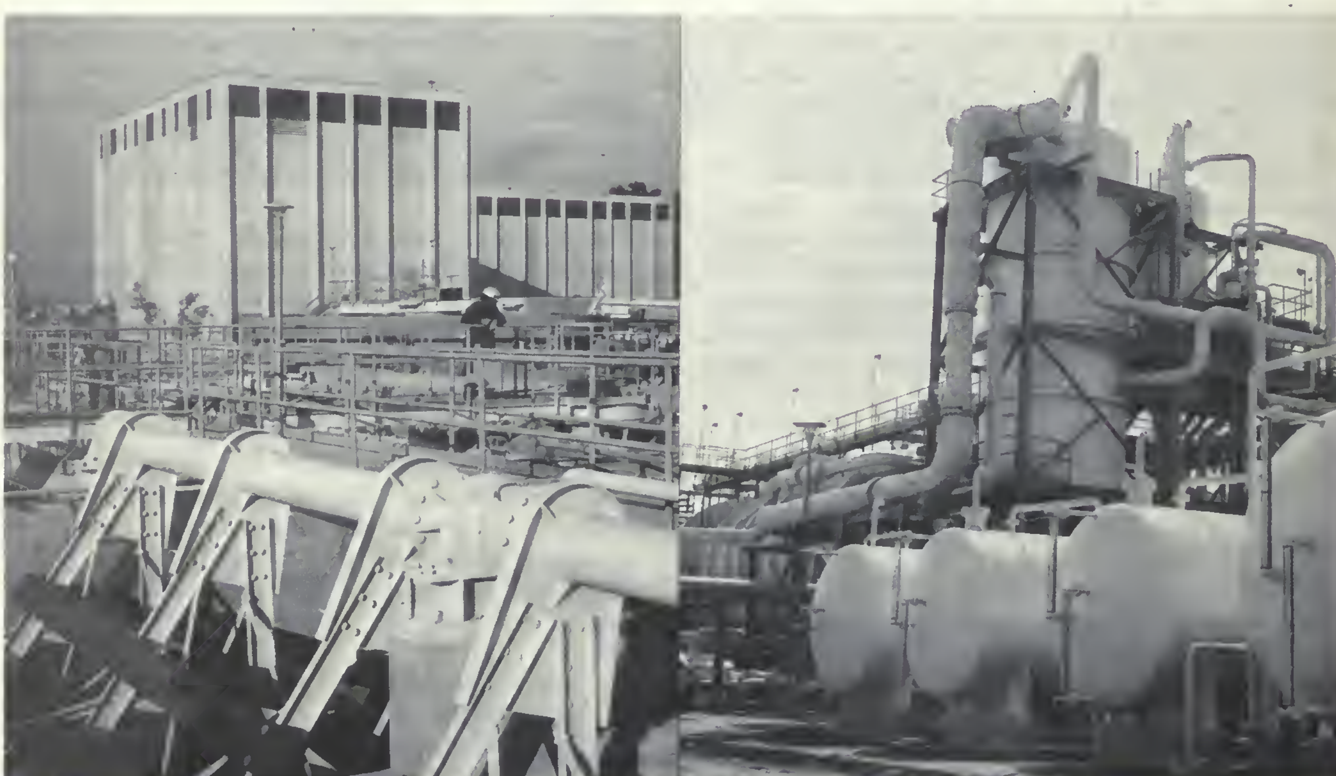
Eastern Municipal Water District

In Riverside County, Eastern Municipal Water District, in cooperation with the U. S. Environmental Protection Agency, conducted a six-year study, ending in 1971, on the use of treated waste water to recharge the ground water.

The district's study indicates that under the planned reclamation there is a decided reduction in evapotranspiration losses, thus improving ground water quality by lessening the concentration of dissolved salts. No evidence of degradation of ground water quality has been detected in water wells surrounding the replenishment area.

Chino Basin Municipal Water District

Chino Basin Municipal Water District, which serves a portion of Riverside



--Orange County Water District photo

WATER FACTORY 21 is designed both to treat waste water (left) and to desalt ocean water (right). Waters are to be blended for injection through wells into the ground water basin. Purpose of the injection is to create a "barrier" against the intrusion of sea water into the usable aquifers underlying Orange County. Operator of the facility will be the Orange County Water District.

and San Bernardino Counties, constructed an 8-mgd tertiary treatment plant, which went into operation January 1973. The plant further treats the secondary effluent from the Ontario-Upland trickling filter plant, using chemical coagulation and flocculation, settling basins, and gravity filters. Some of the effluent is used for irrigation of the Ontario National Golf Course.

However, the major part is discharged to the Santa Ana River, to recharge ground water basins in Orange County, supporting at the same time recreational activities, such as fishing, contact sports, and picnicking.

Irvine Ranch Water District

The Irvine Ranch Water District in Orange County has conducted tests using Pressure Pipe Treatment (PPT). The treatment uses traditional pipelines for the dual purpose of providing transportation and in-line treatment of the waste water.

In one configuration of the PPT system, raw or primary sewage is mixed with activated sludge at one end of the pipeline. Biological treatment takes place in the pipeline while dissolved oxygen is maintained by addition of air or pure oxygen. The activated sludge is separated at the other end of the pipeline and part of the sludge is returned to the beginning point. The remainder is used as a soil conditioner. The effluent is stored in a reservoir for future use in agricultural irrigation.

Santee County Water District

The Santee Water Reclamation Project in Sycamore Canyon in San Diego County provides reclaimed waste water for recreational uses. Raw sewage is treated in an activated sludge treatment plant and then is discharged into an oxidation pond. Part of the treated effluent is pumped up the canyon where it is filtered through natural underground aquifers into a chlorination chamber before entering the recreation lakes. The lakes have been used since 1961 for several recreational activities, limited initially to picnicking and boating and progressing through a "Fish for Fun" program to a normal fishing program suspended only during the spawning season.

Even though virus isolations were made upon all samples of raw sewage and upon 95 percent of the samples of secondary effluent, the wastes of the recreation lakes have been found to be free of measurable virus concentrations. Further, the public has accepted use of the lakes.

All the recreation programs have been accomplished with full knowledge of the water's origin by the participants.

The remaining, larger part of the treated effluent goes directly from the plant to Sycamore Canyon Creek, which is tributary to the San Diego River. Because the river bed is normally dry, the treated effluent is not diluted. The California Regional Water Quality Control Board, San Diego Region, has issued a cease-and-desist order against this discharge practice. By the beginning of 1976, the treated effluent will be discharged into the San Diego Metropolitan Sewer System.

In addition, the district is also negotiating with the San Diego Gas and Electric Company for use of waste water for the cooling system of a proposed power plant.

Las Virgenes Municipal Water District

The Las Virgenes Municipal Water District, which faces an expansion of facilities, has experimented with an activated sludge treatment system at its Tapia Plant in Malibu Canyon of Los Angeles County to produce a better quality waste water for reclamation. Its staff believes that this plant, when properly designed and operated, can produce an effluent equal to that from many tertiary concepts now in operation.

The district, in its search for ways to increase use of waste water and (or) reduce capital costs, has studied a simplified single stage oxygen contact system. This consists of injection of high-purity oxygen in the activated sludge while covering the existing aeration tanks and recirculating a gas of up to 50 percent oxygen. By conversion of existing equipment, substantial savings in capital may be possible and, at the same time, the throughput may be increased without deterioration of the quality of the effluent. The water is being used for irrigation.

CHAPTER III. POTENTIAL RECLAMATION

The second and third objectives of this study are to give approximations of future reclamation and to identify areas that deserve further consideration. This is information that can be used in projecting supplies of reclaimed waste water for developing water management plans.

For a more definitive examination of potential reclamation projects, some of the major factors that should be considered are identified and discussed in the next chapter.

Range of Projected Reclamation

To give an indication of the overall reclamation opportunities in Southern California, a range of potential waste water reclamation quantities for 1973-2000 has been developed. The range, which is given in Figure 6, shows that by 2000, Southern California could be reclaiming 770,000 acre-feet more waste water than it is today. Approximately 90 percent of this potential is in the South Coastal Hydrologic Area. It should be pointed out that 770,000 acre-feet is equivalent to the projected rate of increase in demand for water in the South Coastal Hydrologic Area over a period of 15 to 25 years, depending upon future conditions. It is also the amount of water estimated to be used each year by 3-1/2 million persons.

For the lower value of the range, the actual quantities of waste water reclaimed in 1973 were used. For the year 2000, present quantities were increased with the following additions:

- o In the coastal areas, those new water reclamation projects that seemed to be ensured, either by a start of construction or by a specific allocation of funds for construction.

- o In inland areas, the same percentage of future municipal and industrial applied water as is being reclaimed today.

In establishing the upper value, these two assumptions were made: (1) the water quality objectives established in the Basin Water Quality Control Plans of the State Water Resources Control Board will be met and (2) any health problems, including control of stable organics and other hazardous constituents in waste water, will be resolved.

In effect, the upper value is an expression of the total amount of

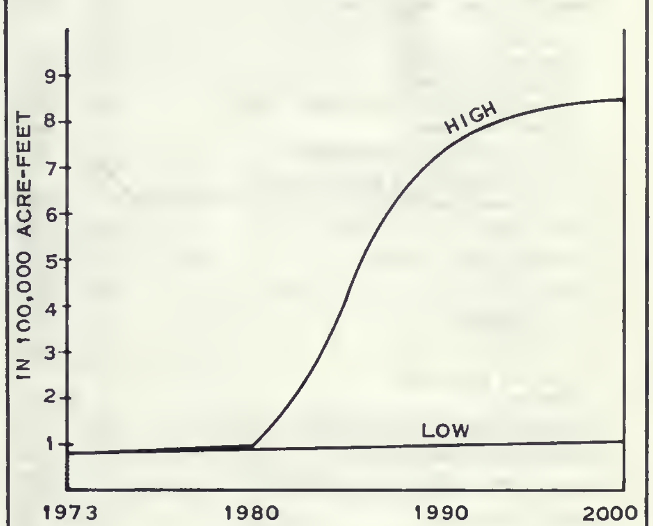


Figure 6 - RANGE OF POTENTIAL WASTE WATER RECLAMATION QUANTITIES, 1973-2000

TABLE 3
POTENTIAL RECLAMATION IN SOUTHERN CALIFORNIA

Hydrologic area / Discharger	Potential waste water for reclamation[1] Amount acre-feet	Quality TDS in mg/l	Potential beneficial uses
South Central Coastal — Subtotal	26,000		
City of San Luis Obispo	3,100	850	Crop irrigation
South San Luis Obispo Sanitation District	2,000	1,000	Crop irrigation
Carpinteria Sanitary District	1,200	1,570	Crop irrigation
Goleta Sanitary District	8,700	1,110	Park irrigation
City of Santa Barbara	6,700	1,700	Park irrigation
City of Santa Maria	4,300	1,220	Crop irrigation
South Coastal — Subtotal	370,500		
Las Virgenes Municipal Water District Tapia Plant	6,300	1,260	Crop and park irrigation
Sanitation Districts of Los Angeles County			
Pomona Plant	5,600	630	Crop and park irrigation, ground water recharge[2]
Long Beach Plant	15,700	900	Park irrigation, oil field repressurization, sea water barrier project[2]
San Jose Creek Plant	18,000	680	Ground water recharge[2] park and golf course irrigation
City of Los Angeles			
Hyperion Plant	22,400	930	Sea water barrier project[2] industrial uses
Glendale Plant	25,800	--	Golf course and park irrigation, industrial cooling
Sepulveda Plant[3]	35,900	--	Ground water recharge[2] park irrigation
Orange County Sanitation Districts			
Plant No. 1	37,600	850	Park irrigation, industrial cooling, sea water barrier project[2]
Plant No. 2	103,800	990	Park irrigation and industrial cooling, sea water barrier project[2]
City of San Clemente	2,300	1,060	Park and golf course irrigation
San Juan Capistrano	5,000	1,260	Park irrigation
South Laguna Sanitary District	3,700	1,160	Park irrigation
City of Oceanside			
La Salina Plant	4,100	1,200	Crop irrigation, ground water recharge[2]
San Luis Rey Plant	1,300	1,260	Crop irrigation, ground water recharge[2]
Pomerado County Water District[4]	900	--	Crop irrigation
City of San Diego			
Rose Canyon Plant[3]	1,300	--	Golf course and park irrigation
Mission Bay Plant[3]	1,300	--	Golf course and park irrigation
Lower San Diego River Plant[3]	1,300	--	Golf course and park irrigation
Balboa Park Plant[3]	800	--	Golf course and park irrigation
Chula Vista Golf Course Plant[3]	1,700	--	Golf course and park irrigation
Chino Basin Municipal Water District			
Carl B. Masingale Plant	5,000	460	Ground water recharge[2], crop irrigation
Chino Plant	2,500	570	Ground water recharge[2], crop irrigation
Fontana Plant	1,300	360	Crop irrigation
City of Colton	4,500	510	Crop irrigation
City of Redlands	4,300	510	Crop and park irrigation
City of Rialto	3,400	420	Crop and park irrigation
City of San Bernardino			
Plant No. 2	28,600	530	Golf course and park irrigation
Eastern Municipal Water District			
Hemet-San Jacinto Plant	3,200	730	Crop irrigation, ground water recharge[2]
Jurupa Community Services District	900	800	Crop irrigation
City of Riverside	21,100	720	Crop irrigation
Rubidoux Community Services District	900	690	Crop irrigation
South Lahontan — Subtotal	3,200		
Sanitation Districts of Los Angeles County			
Lancaster Plant	3,200	610	Park and crop irrigation, recreation lakes
Total	399,700		

1 Based on present design capacity of plants and current quality of waste water. See text for other considerations used.

2 Assumes that State Department of Health requirements will be met

3 Proposed plant

4 Now closed; could be reactivated

waste water projected to be produced in Southern California minus:

- o All effluent that contains more than 1,000 mg/l TDS. This was an arbitrary decision based on the widely accepted concept of usable quality water. However, it is recognized that other constituents are also crucial in the determination of reclamation possibilities and that effluent of a higher TDS content is being reclaimed at some places and will continue to be reclaimed.

- o The amount of effluent estimated to be required to carry off the sludge. (This was assumed to be 25 percent of the additional amount of waste water reclaimable.)

[illegible] Reclamation Opportunities

[illegible] of specific reclamation [illegible]ities that were deemed worthy [illegible] early consideration for [illegible]nt or additional reclamation [illegible] in Table 3. They represent [illegible] 400,000 acre-feet of waste [illegible]. The list was arrived at by [illegible]lowing process:

1. [illegible]tified all treatment plants [illegible] sufficient present capacity [illegible] treat additional amounts of [illegible] water.

2. [illegible]mined how much of these [illegible] carrying off sludge. Also, the waste water with a TDS concentration greater than 1,000 mg/l was subtracted, unless poorer quality water from that plant is now being reclaimed and reused; in that case, it was regarded as reclaimable. Also, in certain water-deficient areas, water of poorer quality was considered reclaimable.

3. Identified possible beneficial uses for the effluent by considering present and projected land use and recommendations of the Basin Water Quality Control Plans of the State Water Resources Control Board. (The assumption was made that existing and proposed thermal plants using or proposing to use ocean water for cooling will continue to do so.)

4. Determined if the treated waste water could be made available at a cost reasonably competitive with that of alternative water supplies. Plants were not included if the estimated cost of transporting the effluent to the points of use (i.e., the additional cost above that of treating and disposing of the waste water to meet discharge requirements) was excessive.

The result is a list of those areas with an apparent potential for reclamation. It should be noted that virtually none of the beneficial uses proposed would involve domestic supply, which is at present a prime public health concern.

Some of the major factors that should be considered before implementation of [illegible]

RECREATION LAKES AND FACILITIES supplied with reclaimed waste water by the Santee County Water District in San Diego County. This project has been one of the most successful demonstrations of the use of reclaimed waste water.

CHAPTER IV. FACTORS TO BE CONSIDERED FOR RECLAMATION PROJECTS

Before a reclamation project is implemented, a number of factors must be examined. The final objective of this study was to identify the more significant of these factors. They can be summarized in the following questions:

- How much waste water is available?
- Does it meet the quality requirements that have been set for the intended beneficial use?
- What will be the impact upon the environment of the use of this water?
- Is this water reasonably competitive in cost with other supplies?
- What are the legal constraints governing appropriation of reclaimed water?
- Will the public accept use of reclaimed water for the intended beneficial purposes?
- Can reclamation be handled by existing agencies?

Conditions will vary within the different areas, and each potential project must be considered on an individual basis.

Waste Water Quantities

As was pointed out in the preceding chapter, only a portion of the waste water produced could be reclaimed; some of it would be lost, some would be too far from the points of use, and some would be needed for transporting sludge.

The amount that would be available is important in determining the beneficial uses that could be served. Some uses need large supplies; others do not.

Also of significance is the reliability of the supply. If an area is contemplating the exportation of its waste water, only short-term uses could be made of the treated water in the immediate area.

Location is also a key consideration. It is limiting factor even in the South Coastal Hydrologic Area, where the largest percentage of the population and the waste water are found. Most of the waste water is treated at plants along the coast, which means that the treated water would have to be pumped inland to the points of possible use, thus increasing the cost and energy demands.

Quality Requirements

Because a significant amount of fresh water used in Southern California has come from the Colorado River, which has a TDS content of approximately 750 mg/l, the salinity of the resultant waste water is such that it is not always desirable to reuse the water. With the introduction of low salinity water (estimated average of 130 to 150 mg/l) from the State Water Project into Southern California water supplies, the TDS content of the resultant waste water is expected to decline.

The range of TDS in waste water that has been produced in Southern California is indicated in Table 4.

However, TDS is not the only quality constituent to be considered in making a determination of whether or not treated waste water can be put to a beneficial use.

TABLE 4
TOTAL DISSOLVED SOLIDS CONTENT OF WASTE WATER:
ADEQUACY FOR BENEFICIAL USES AND PERCENT OF PRODUCTION

Beneficial use	Total dissolved solids content, in mg/l					
	Less than 500	500-750	750-1,000	1,000-1,500	1,500-2,000	More than 2,000
Irrigation (agriculture and landscaping)	Usable	Limited use	Limited use	Limited use	Limited use	Severe problem
Industry (boiler feed)	Usable	Usable	Usable	Usable	Usable	Problem above 3,000 mg/l
Recreation	Usable	Usable	Usable	Usable	Usable	Usable
Aquatic habitat	Usable	Usable	Usable	Usable	Usable	Usable
Percent of waste water in Southern California in 1972	15	14	24	34	10	3

To protect public health and the various recognized beneficial uses of water, criteria and guidelines have been established for the quality of reclaimed waste water, just as they have for the quality of other waters.

Details on water quality criteria and guidelines are given in Appendix C, which is bound separately; they are summarized below.

The use of reclaimed waste water for domestic purposes is under the jurisdiction of the public health agencies. Within California, these responsibilities reside in the State Department of Health.

Although the Department of Health has not established any quality criteria for reclaimed waste water to be used for domestic purposes, it has issued a policy statement on the subject. This statement declares as unacceptable the direct mingling of reclaimed waste water in a domestic water system and the direct injection of reclaimed waste water into aquifers supplying domestic water.

The Department of Health has not established any quality criteria for replenishing ground water basins either. It has indicated "injection may be considered as a future option contingent upon the availability of new supportive information and future needs." Ground water recharge by surface spreading may require additional research regarding possible health effects. Currently, it is proceeding on a case by case basis. Generally, if the amount of reclaimed waste water to be spread is a small fraction of the water in the ground water basin, the projects proceed. The Department of Health, although not legally prohibiting larger amounts, has recommended against or suggested delay of extensive recharge projects in some cases.

The Department of Health has also prepared a position paper* calling for research on the long-term effects on health associated with the stable organic materials that remain in waste water after treatment. The unknowns to be investigated include "the composition of the organic

* "Position on Basin Plan Proposals for Reclaimed Water Uses Involving Ingestion," Water Sanitation Section, California State Department of Health, September 1973.

materials; the types of long-term effects, synergistic effects, metabolic formations, treatment effects, methods of detection and identification, and ultimately, the levels at which long-term health effects are exerted".

The Department of Water Resources, the Department of Health, and the State Water Resources Control Board have convened a panel of nationally known experts to define the state of knowledge, to identify the questions needing answers, and to advise as to the type of research needed regarding recharge of ground water basins with reclaimed waste water and its subsequent use for a domestic supply. The Department of Health has adopted criteria for the use of reclaimed waste water for irrigation of crops, pasture land, and landscaping. In addition, the University of California has developed guidelines regarding the mineral quality of water to be used for irrigation of certain crops, which can be applied to the use of reclaimed waste water.

The U. S. Environmental Protection Agency has established quality criteria for water that is to be used for a number of industrial operations, which also can be applied to reclaimed waste water. Reclaimed waste water to be used for recreational purposes must meet quality criteria that have been established for these purposes by the State Department of Health.

When waste water is adequately treated, it may be used to augment streamflows to enhance habitat for fish and other wildlife. The State Department of Fish and Game has suggested criteria for the water quality to ensure this.

Table 4 indicates the adequacy of water with various concentrations of TDS for specific beneficial uses.

In addition to the criteria and guidelines described above, the California Regional Water Quality Control Boards have set and will continue to set specific waste discharge requirements to meet water quality objectives, based on the Water Quality Control Plans for each basin. They also set reclamation requirements for specific reclamation uses. The State Water Resources Control Board and the U. S. Environmental Protection Agency have also established policies and guidelines, such as the Nondegradation Policy and the California Ocean Plan.

The regulatory agencies are, in general, directing their efforts toward more stringent waste discharge requirements. One of the requirements is that by July 1, 1977, municipal waste water must be given the equivalent of secondary treatment before disposal to the surface waters of the State.

Environmental Considerations

The reuse of waste water must be compatible with the total environment, which involves the economic-social environment as well as the physical environment. The physical environment is discussed here; the economic and social environments are dealt with in the sections that follow.

The physical environment to be considered encompasses surface water, ground water, soils, air, and ground cover. Protection of this environment can, to a large extent, be accomplished by giving the waste water a proper degree of treatment. However, as has been pointed out, the extent of treatment for domestic use required to protect health is not known and would require more research.

Both the federal and state governments require that, before construction can begin, studies must be made and reports prepared on the impact of a proposed project on the environment. Therefore, any proposed waste water reclamation project would be subjected to such scrutiny before it could be undertaken.

Costs of Other Supplies

A key requirement for a reclamtion project is a market for the reclaimed water. For sometime to come, water imported through existing facilities, together with local supplies, will meet the major demand. However, additional supplies are needed now in specific locations for specific uses and, in time, may be needed throughout the area. Reclaimed waste water is one of the possible supplies.

At the same time, it should be recognized that the reclaiming of waste water when other water supplies are already available in adequate amounts under long-term contracts might result in duplication of expenditures that must be paid for by the public. In the final analysis, therefore, economics is an important determining factor when comparing alternative water sources but should not necessarily be controlling. The costs of the actual treatment process vary greatly according to the size of plant, degree of treatment, location, costs of construction, operation and maintenance of facilities, climate, and quantity and quality of the waste water. Table 5 gives some comparative costs.

Also to be considered is the fact that energy consumption increases

TABLE 5
ESTIMATED COST FOR A 10 MGD WASTE WATER TREATMENT FACILITY [1]
in $

Process	Cost per 1,000 gallons		Cost per acre-feet	
	Each process	Cumulative	Each process	Cumulative
Process Without Chemical Coagulation				
Secondary treatment	0.20	0.20	65	65
Carbon adsorption	0.14	0.34	46	111
Disinfection	0.01	0.35	3	114
Demineralization	0.40	0.75	130	244
Process With Chemical Coagulation				
Secondary treatment	0.20	0.20	65	65
Chemical coagulation (lime)	0.09	0.29	29	94
Filtration	0.07	0.36	23	117
Nitrogen removal	0.11	0.47	35	152
Carbon adsorption	0.10	0.57	33	185
Disinfection	0.01	0.58	3	188
Demineralization	0.40	0.98	130	318

1 Includes capital, operation, and maintenance costs (EPA STP Construction Cost Index = 200).
Source: "Task 3, Treatment Processes for Waste Water Reclamation for Ground Water Recharge", California Water Resources Control Board, Department of Water Resources, and Department of Health, January 1975.

with the higher degrees of treatment (Table 6).

However, as is pointed out in a study* by the State Water Resources Control Board, it is possible to reduce the electric energy demand for sewage treatment processes. For one thing, the gas produced in the digestion of organic sludge can be converted into electric energy and used to meet part of the energy demand of the plant.

The study concluded that all the energy demand of a primary treatment plant could be met with this digester gas and about 70 percent of that for a secondary plant. At the same time, the study cautioned "that relying on digester gas as the only source of energy is not advisable even for primary plants. This precaution is necessitated because of upset periods when digester malfunctions may occur."

Also, the study showed that "generally the equipment required to utilize digester gas represents a high capital investment and an additional financial burden in terms of general operation and maintenance. For these reasons, such facilities are most attractive and desirable for larger treatment facilities."

It should be recognized that higher degrees of treatment will be required as waste discharge requirements become more stringent. Therefore, the cost added to bring the water to levels required for specific beneficial uses will decline or, in some cases, no additional treatment will be required.

Legal Considerations

In Northern California and some areas of Southern California, water that is used for irrigation, municipal, or industrial purposes is discharged or drains back into the natural source from which it was taken or into another natural stream, lake, or underground basin where it mingles with the water naturally present. If, in this use of water and its return to a natural source the prior user has no plan to reuse the water and intends only to be rid of it, the water is abandoned and becomes part of the public waters of the State, subject to being taken and used in accordance with the general law of water rights. This has been codified in Water Code Section 1202.

There are, however, two exceptions, relating to water that has been imported from another watershed or ground water basin.

The first exception is that imported water may not be taken under riparian right. The reasoning by the courts is that such water is present because of artificial augmentation of the stream, while a riparian land owner is entitled only to the natural advantages inherent in his land ownership. Appropriation, therefore, is the sole method by which

TABLE 6
ELECTRIC ENERGY CONSUMPTION FOR MUNICIPAL WASTE WATER TREATMENT*
In kilowatt hours per million gallons

Level of treatment	Energy** consumption in kwh/MG treated
Primary treatment	235
Secondary treatment	
Primary plus trickling filters	480
Primary plus activated sludge	880
Tertiary treatment	
Secondary treatment plus lime clarification, filtration, carbon adsorption	1,630
Secondary treatment plus filtration and reverse osmosis	3,000

* From Electric Power Consumption for Municipal Wastewater Treatment in the United States, EPA Research Center, July 1973

** Based on a 10 mgd plant

* "Effects of Energy Shortage on the Treatment of Wastewater in California" prepared by the Energy Task Force, State Water Resources Control Board, April 1974.

rights to abandoned imported waters flowing in natural streams may be acquired.

The second exception is this: Ordinarily, a downstream appropriator of water can object to the interruption by someone upstream of the flow to which he has a vested right. An importer of water may discontinue importing the water, he may discharge it elsewhere, or he may reuse it under such conditions that it no longer augments the natural supply of the downstream appropriator without incurring any obligation to the downstream appropriators.

It is now well established that, as part of his original right, an appropriator of water may, after using it once, recover the water before it leaves his property or his control and reuse it. It has also been the rule that if it was the appropriator's plan from the outset to use a natural stream channel to convey the water to the place of use, there is no abandonment of the water and the appropriator has the right to withdraw that quantity of water previously put in the stream at the point outside of his property. This rule has now been codified in Water Code Section 7075.

Thus a city or district which has appropriated water for use by its residents has the right to recover the water within its boundaries after use, to treat it as necessary, and to distribute it for reuse. The city or district may repeat that cycle as

-Sanitation Districts of Los Angeles County photo

REPLENISHING GROUND WATER basins with use of reclaimed waste water from the Whittier Narrows Treatment Plant in Los Angeles County. The water is discharged into the spreading basins, which are located along the Rio Hondo, and allowed to percolate into the ground water basin through the sandy soil. As the water trickles through the soil toward the ground water, more impurities are removed.

often as is practicable. It may do this even though its prior practice was to discharge the once-used water into a natural watercourse or basin from which it has been taken and used by others under appropriative right.

The California Supreme Court in City of Los Angeles v. City of San Fernando, et al., 14 Cal.3d 199 (1975) expanded this rule, holding that public agencies and public utilities also cannot lose their ground water rights through prescription (the claimed right to another's water because of prolonged use). The Supreme Court also ruled that where ground water storage space is in excess of that needed for natural recharge, an agency importing water into a basin may recapture its water after it percolates into the ground water basin. Thus, these two holdings permit an importer of water not only to use ground water storage, but also to prevent the taking of its stored water by appropriators or overlying landowners.

The more customary situation involving waste water reclamation is that a water district or other governmental entity delivers water to its domestic or industrial customers, the water is used and discharged into a system of underground sewer lines from which it is collected and treated by a separate district or governmental entity. As to the owner and operator of the sewage collection and disposal system which finds itself in control of large quantities of waste water, there does not appear to be any clear-cut authority. However, two theories have been developed to explain the status of such an entity.

The first theory is that the sewage system owner is in possession of abandoned personal property, that is, waste water in the underground sewer lines, over which it has complete dominion until it in turn abandons the water. This theory is not completely satisfactory because the waste water is never intentionally abandoned.

The second theory reasons that by virtue of the accepted function of a sewer system of receiving and conveying waste water, the owner of the system has by implication been granted the right by the appropriator of the water to reuse it or convey it to someone else. In the absence of any agreement between the district supplying the water and the district treating the waste water, this second theory would satisfactorily determine the relationship between the two entities.

Social and Institutional Aspects

Social aspects deal with public attitudes and concerns for social and economic well being. Institutional aspects involve the agencies that have been created to serve the public.

Social Aspects

Although the use of reclaimed waste water is socially unacceptable to many persons, there is a definite trend toward its acceptance, particularly for irrigation of landscaping, golf courses, and agriculture. Further, the Santee Water Reclamation Project has demonstrated the public's acceptance of properly treated waste water for such recreational uses as fishing, boating, and swimming, when it is accompanied by a well planned, effective public relations program. Also, the passage of bond issues for treatment facilities, such as the State Clean Water Bonds, including their implications for waste water reclamation, indicates a favorable public opinion in this direction.

Institutional Aspects

From an institutional standpoint, it must be recognized that many existing organizations which serve the public--such as water supply agencies, waste water treatment-and-disposal agencies, health agencies, recreational agencies, and fish and wildlife agencies--could affect and could be affected by waste water reclamation.

The functions of the different agencies are segmented and in some cases appear to overlap. Further, a number of considerations influence the way each organization carries out its waste water reclamation endeavor. Among these are the needs to provide specific service in an effective and economical manner, to protect the financial investments of its constituent taxpayers and service customers, to maintain its present and future services in harmony with its environment, and to enhance its image.

Segmentation of responsibility may be seen in water supply organizations. Because they are required to have a dependable supply of good quality water and large related economic investments amd commitments, they regard reclaimed water as simply an alternative source of supply with limitations on its use. Unless they can see a physical and economic advantage in its use, they will tend to use their existing sources. Yet, the state constitutional mandate to maximize beneficial use of water in the State requires a change in such attitudes.

Similarly, a number of waste water treatment-and-disposal agencies look upon reclamation as merely a means of treating and disposing of waste water and not as a potential means of providing a water supply. Therefore, agencies that are authorized both to supply water and to treat and dispose of waste water can more readily reclaim. Examples of these agencies are the Mojave Water Agency, the Eastern Municipal Water District, and certain municipalities (as the Cities of San Diego and Los Angeles).

As was pointed out earlier, the requirements, policies, and guidelines established by regulatory agencies (such as the State Water Resources Control Board, the State Regional Water Qualtiy Control Boards, the State Department of Health, and the State Department of Fish and Game) could impose limitations on the amount of waste water that might be recycled and reused. For example, strict adherence to the Nondegradation Policy of the State Water Resources Control Board could mean that reclaimed water with a TDS content higher than that of the underlying ground water would be prohibited from use for irrigation unless it underwent expensive desalination.

CHAPTER V. SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATION

Summary of Findings

In conducting this overview study of waste water reclamation potentialities in Southern California, the following findings were made:

1. The amount of waste water coming into treatment plants of 1.0 mgd or larger increased from 1,067 mgd (1,197,000 acre-feet annually) in water year (October 1 - September 30) 1967-68 to 1,236 mgd (1,386,000 acre-feet annually) in water year 1972-73. These data represent most of the waste water produced in Southern California.

2. Concentrations of total dissolved solids (TDS) in waste water produced in Southern California range from approximately 200 to 3,520 mg/l. About 53 percent of waste water produced in 1972-73 is of less than 1,000 mg/l TDS content and 29 percent is less than 750 mg/l TDS, which is the concentration in Colorado River water. The concentration is expected to decline as the amount of water from the State Water Project used in Southern California increases.

3. Of the 1,386,000 acre-feet of waste water treated in 1972-73 by major waste water treatment plants, 1,148,000 acre-feet was discharged to the ocean after receiving either primary or secondary treatment.

4. In water year 1972-73, 80,000 acre-feet of the waste water produced in Southern California was being reclaimed and used, largely for irrigation and industrial purposes, recreation lakes, and ground water recharge.

5. From 1967-68 to 1972-73 (water years), the increase in the amount of waste water reclaimed in Southern California has been very little--22,000 acre-feet.

6. Efforts to treat waste water by advanced treatment methods are being made mainly on an experimental basis, largely with federal support, because of the high cost of such methods.

7. On the basis of projected amounts of waste water to be produced and the TDS content of that water, a range was developed for the amount that might be reclaimed by the year 2000. According to this projection, Southern California could be reclaiming by that year as much as 770,000 acre-feet more waste water than it is today, or a total of 850,000 acre-feet.

8. Thirty-eight specific reclamation opportunities in Southern California have been identified; these would provide 400,000 acre-feet of water. The list is given in Table 3 on page 16. These were chosen primarily on the basis of assumed availability of market for the treated water, the quality of the water for the designated beneficial use, and the cost of transporting the water to the point of use. Although much remains to be determined regarding stable organics and other toxic substances in waste water used for recharging ground water basins, most of the projects identified would be developed for other beneficial uses.

9. A number of factors that should be considered in deciding whether to develop or enlarge a specific reclamation project were identified.

The major factors are:

- o The amount of waste water that is available and where it is.
- o The quality requirements for the designated beneficial use.
- o The impact of use of the water upon the environment.
- o The comparative cost of other supplies of water.
- o The legal constraints governing the appropriation of reclaimed water.
- o Public acceptance of the use of reclaimed waste water.
- o Capability of agencies for undertaking reclamation.

Conclusions

The following conclusions are drawn from the findings of this study:

1. The amount of current waste water reclamation is small and indications are that it will continue to be small unless major efforts are made to develop specific reclamation projects. The potential amount of reclamation is large.

2. Reclamation of waste water should provide a greater supplemental supply of water for Southern California.

3. A number of potential waste water reclamation projects in Southern California are worthy of consideration, particularly in the South Coastal Hydrologic Area.

4. Although much is known about treatment processes for reclaiming waste water to meet current requirements for most beneficial uses, more information needs to be developed on advanced treatment processes to reduce their cost so they can be more widely used.

5. Markets need to be identified where reclaimed waste water could and would be used.

6. The effect of the use of reclaimed waste water on the quality of the local water resources needs to be more fully defined.

7. Research regarding stable organics in waste water and their effect on public health is needed so that an assessment can be made of the suitability of reclaimed waste water for ground water recharge.

8. In many cases, the responsibility for handling and regulating the use, treatment, disposal, and reclamation of water is distributed among a number of different agencies; reclamation will require coordination of effort. Therefore, it is advisable to create or designate a single public agency (and expand its powers) or establish a joint powers agreement among existing agencies for both water supply and waste water collection, treatment, and disposal so that more efficient and economical operation can be achieved.

Recommendations

It is recommended that:

- o The agencies involved consider implementation of the specific reclamation projects identified in this and similar studies. Wherever possible, the Department will work with the agencies in this effort.
- o Information be developed on advanced treatment processes to reduce their cost so that they can be more widely used.
- o The implementation of such projects be considered in meeting the realistic water needs as part of the current revision of the water management element of the California Water Plan.

GLOSSARY OF TERMS

Activated sludge process is a treatment process that removes (by biological assimilation and decomposition) organic matter from waste water using a biologic floc in an aerobic environment.

Adsorption is a process for removing objectionable organic matter associated most often with taste and odors. Columns of activated carbon appear most promising.

Advanced treatment processes remove or reduce nutrients, dissolved solids, suspended or colloidal solids, toxic matter, and other constituents, using any physical, chemical, or biological process. Advanced treatment has come to mean any process added to the traditional primary-secondary treatment plant or to recently developed innovative processes not characteristic of recent practice.

Aeration tank is a chamber in which air is injected into waste water.

Algae are microscopic plants that grow in sunlit water that contains phosphates, nitrates, and other nutrients. Algae are food for small aquatic animals and, like all plants, add oxygen to the water. They are important in the fish-food chain in some instances.

Ammonia stripping is an advanced treatment process for the removal of gaseous ammonia-nitrogen employing stripping towers.

Bacteria are microscopic unicellular organisms which consume organic constituents in waste water.

BOD (biochemical oxygen demand) is the dissolved oxygen required by organisms for the aerobic decomposition of organic matter in a standard laboratory test.

Coagulation is the clumping together of solids to force them to settle out of waste water more quickly. Coagulation of solids is brought about through the use of certain chemicals, e.g., lime, alum, and iron salts. Coagulation is also brought about in biological treatment.

Degrees of treatment refer to the reduction and removal of undesirable constituents in waste water. In general, the degrees are termed primary, secondary, and advanced.

Digestion of sludge is a process which takes place in closed tanks where the organic materials decompose to form gases and a humus-like material that is periodically drained from the tank and dried for subsequent disposal.

Disinfection is the destruction of most disease causing (i.e., infectious) organisms, as contrasted with sterilization, which is the destruction of all living organisms.

Dissolved solids in waste water are the minerals, salts, and other chemicals which are dissolved in water as it passes through the air, over and underground, and through municipal, industrial, agricultural and other uses.

Distillation consists of heating the waste water to vapor or steam. When the steam is condensed to a liquid, it is almost pure water.

Effluent is the liquid product of a treatment unit, plant, or facility.

Electrodialysis is a process which separates soluble minerals from brackish water using an arrangement of anion- and cation-permeable membranes in a cell, across which an electric potential is applied.

Flocculation is a process by which clumps of suspended solids in waste water are formed and enlarged by chemical, physical, or biological action to facilitate their settling.

Incineration is the burning of digested sludge to remove water and reduce the remaining residue to a safe, noncombustible ash. The ash can then be safely disposed of, generally on land or underground.

Industrial wastes are liquid or solid waste substances, not sewage, from any producing, manufacturing, or processing operation.

Ions are electrically charged atoms or groups of atoms.

Organic wastes are wastes derived from plant or animal matter originating from domestic or industrial sources.

Oxidation is the breakdown of organic wastes or chemicals in waste water by bacterial or chemical processes in the presence of oxygen.

Oxidation ponds are manmade bodies of water in which wastes are consumed by bacteria as well as by oxygen from the atmosphere, generally with the aid of algae.

Planned reclaimed water use is the deliberate direct or indirect use of treated waste water.

Primary degree of treatment is the removal of settleable solids and floating matter from waste water by physical means.

Primary treatment involves physical processes for removal of settleable solids and floating matter by screening, skimming, and sedimentation.

Reclaimed water is water that, as a result of treatment of wastes, is suitable for a direct beneficial use or a controlled use that would not otherwise occur. (California Water Code, Section 13050 (n).)

Recycling is the direct reuse of water, without treatment, at the same general location or for the same purpose.

Reuse means the additional use of once-used water.

Reverse osmosis is the process of demineralization using a semipermeable osmotic membrane under pressure.

Salts are the minerals which water picks up as it passes through the air, over and underground, and through municipal, industrial, agricultural, and other uses.

Sand filters remove suspended solids from waste water as it filters through the sand to produce clarified water which drains from the sand bed. Bacteria may develop in some types of sand filters and aid in the clarification process.

Secondary degree of treatment is the reduction of suspended, colloidal, and dissolved organic matter in primary effluent by biological action.

Secondary treatment is the biological process of reducing suspended, colloidal, and dissolved organic matter from the effluent from primary treatment systems. Secondary treatment is usually carried out through the use of trickling filters or by the activated sludge process.

Sedimentation tanks are used to remove a portion of the solids from waste water where the solids settle to the bottom or float on top. The floatables are skimmed off the top, while the solids on the bottom are collected and pumped to digestion tanks, following which they may be processed by filtration and sometimes incineration, before final disposal.

Sewage includes all substances, liquid, or solid, associated with human activities, domestic, commercial, and industrial. For this report, the term sewage applies to waterborne wastes collected and treated by communities.

Sewerage is the apparatus for the collection, transportation, and pumping of waste water.

Sludge is the semisolid matter that settles to the bottom of sedimentation tanks or clarifiers. It is sufficiently liquid in character to be pumped.

Stable organics are organic compounds which remain, generally in minute quantity, in waste water after currently used treatment processes. They may pose a threat to health.

Suspended solids are small particles of solid pollutants that are present in waste waters and may be separated by sedimentation aided by chemical and biological treatment and sometimes filtration.

Tertiary degree of treatment is additional treatment to improve the quality of the effluent from secondary treatment systems.

Trickling filter, usually a bed of stones, is a support medium for bacterial growth. Waste water is trickled over the bed so that the bacteria can break down and assimilate the organic wastes.

Virus is the smallest known form of microorganism capable of causing disease.

Waste water is the used water, liquid waste, and drainage of a community, industry, or institution.

Waste water reclamation is the process of treating waste water to produce water for beneficial uses, its transportation to the place of use, and its actual use.

Water year is, in California, a year beginning October 1 and ending September 30 of the next year. For example, water year 1966-67 begins October 1, 1966, and ends September 30, 1967.