PROCEEDINGS

OF THE

SECOND ANNUAL CONFERENCE

OF

Watercare

ON

Water Reclamation & Domestic Water Conservation

JUNE 1975

Proceedings of the

SECOND ANNUAL CONFERENCE

of the

CALIFORNIA ASSOCIATION OF RECLAMATION ENTITIES OF WATER (Watercare)

held

24 & 25 June 1975

at

Dominican College, San Rafael, California

Local Hosts and Program Development
by
North Marin County Water District
Marin Municipal Water District

CONTENTS

Program - Research

Hugo H. Sephton, University of California Sea Water Conversion Laboratory

INCREASED EFFICIENCIES IN THE DISTILLATION PROCESS BY THE USE OF FOAMING AGENT ADDITIVES

Gordon Culp, Clean Water Consultants, El Dorado Hills

AMMONIA STRIPPING AND HIGH RATE FILTRATION

Robert C. Scott, Hydrologist, U. S. Environmental Protection Agency

TRACE ORGANICS IN THE ENVIRONMENT--
CURRENT STATUS OF EPA INVESTIGATIONS

Henry J. Ongerth, State Sanitary Engineer, California Department of Health

A PUBLIC HEALTH OVERVIEW OF REUSE

Program - Domestic Water Conservation

Marvin Winer, Brown and Caldwell, Walnut Creek

THE EFFECT OF PEAK-LOAD PRICING ON WATER CONSUMPTION AND REVENUES

James E. Lattie, Director of Public Information, East Bay Municipal Utility District

PUBLIC EDUCATION CAMPAIGNS TO CUT WATER USE

John Olaf Nelson, General Manager, North Marin County Water District

WATER CONSERVATION IN NEW RESIDENTIAL DEVELOPMENT

Tom Thorner, Attorney, Marin Municipal Water District

LEGAL ASPECTS OF WATER CONSERVATION

J. D. Stroeh, General Manager, Marin Municipal Water District

TOTAL APPROACH TO DOMESTIC WATER CONSERVATION

Program - Tour

Tour of PACHECO VALLE, a new residential community in which water conservation devices have been installed.

Program - WATERCARE Business Meeting

Minutes of Meeting

Ronald B. Robie

Director
California Department of Water Resources

THE TREAD OF MIGHTY ARMIES

THE TREAD OF MIGHTY ARMIES*

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

John Nelson asked me to emphasize water conservation in my remarks today, and he was quite taken aback when he learned the title of my presentation would be "The Tread of Mighty Armies." I think he was expecting something a little more traditional.

Actually, the title is quite logical. It is taken from the Victor Hugo quote:

> "Greater than the tread of mighty armies
> is an idea whose time has come."

In my opinion, water conservation is not only an idea whose time has come -- it has almost gone!

Not that I am supporting the sentiment that we are in a "water crisis." Indeed, just the opposite. California has sufficient developed supplies which, if transported to places of need and managed in a prudent manner, can meet our needs for many years.

By "prudent management," I mean management which includes conservation. The Department of Water Resources is strongly committed to this concept. We define water conservation in its broadest sense, to include consideration of

*Presented at the Annual Conference of California Association of Reclamation Entities of Water (WATERCARE), on June 24, 1975, in San Rafael, California.

techniques and practices which, in many cases, have been largely overlooked by the water community.

Of course, I have no need to lecture the members of WATERCARE about the importance of conservation. The whole thrust of your organization has been toward water reclamation and reuse and the extension and improvement of public water supplies through employment of new water sciences.

As many of you probably know, our Department recently adopted a new "Water Management Policy" stressing maximum use of existing supplies, consideration of alternatives, water reuse, and water conservation.

It is important that all members of the water community give wholehearted support to water conservation in all of its aspects, particularly by conducting active public information programs and by using management tools which have been too long neglected.

A member of your organization, who has asked to remain anonymous, once predicted:

"Water people, your lives
Will be filled with abuse
If you don't soon perfect
Waste water reuse."

I would like to add to that my own quatrain:

"The State will react
With much consternation
If you don't implement
True conservation."

Certainly, to get the public involved with water conservation is one of the first steps. Recently, some local water districts have recognized the need for public information programs stressing water conservation, although these are sometimes mere public relations efforts and lacking in substance. However, some mandatory conservation programs are already underway, particularly here in Marin County.

A northern California newspaper carried a story a few days ago about a local irrigation district which was calling for water conservation for the next few days. When I read the article, I couldn't help wondering why the district was asking for short-term conservation. Water conservation is something that should start becoming a part of our lives and not serve merely as a stop-gap measure.

It is most important that individual water users understand the necessity of saving water, both for the resource itself and because saving water saves energy.

For example, water conservation reduces the amount of flow through sewers, thus reducing waste treatment construction and operation costs . . . and energy use. Reduced water use results in reduced pumping costs . . . and energy use.

Sacramentans are getting that particular message -- at least the ones who ride buses are. The Sacramento Area Water Works Association has posted advertising placards admonishing:

Turn Off Water Waste

Turn On Energy Savings

Don't be a Gutter Flooder.

In spite of this high-visibility public relations effort, I am sure that many people are probably wasting water through leaky faucets or gutter flooding because most Sacramento utilities have very low unmetered rates.

I recently received a knuckle-rapping in a newspaper editorial for suggesting that the time will come when metering can be justified in Sacramento simply for its environmental benefits.

The contention seems to be that, unless meters are justified on a strict cost-benefit basis, they are not needed. I disagree.

Last year the State Water Resources Control Board commissioned a study of water metering which showed that metered cities average 185 gallons per capita per day (700 liters) and unmetered cities average nearly double that amount -- 330 gallons per capita per day (1249 liters).[1/]

My water rates in Sacramento are excessively low. I pay only $3.90 a month for all the water I can waste!

Low water rates encourage the waste of water, and this cannot be tolerated anywhere -- regardless of whether an area is traditionally water-rich or water-short.

One sure way to promote water conservation is to make certain that water pricing adequately reflects the real cost of water. Currently, a great debate is raging through the water industry as to whether the traditional "cost of service" concept should be modified in favor of rate structures which have social and environmental goals in mind.

Actually, water rates have always been sensitive to social needs, as shown by the tremendous subsidies that the U. S. Bureau of Reclamation and many local California water agencies provide to their agricultural water users.

Furthermore, the method which most water utilities use to determine water rates subsidizes growth in demand at the fringes of urban areas by charging all district residents for the cost of necessary additions to the water supply and delivery system.

One issue that should be considered settled is the question of whether water demand is "price elastic," that is, whether demand goes down as price goes up. Although some people contend that elasticity within the range of water prices usually found in California does not exist, numerous studies have shown that elasticity does exist.

One survey by the Bureau of Reclamation showed that water use in a service area could be reduced by up to 50 percent by raising the water price from three to nine dollars an acre-foot (24 to 73 dollars per hectare meter).[2/]

At a meeting to consider our program to revise the Water Management Element of the California Water Plan, a work group headed by Dr. Tim Wallace, the Director of the Department of Food and Agriculture, concluded that we should no longer consider whether price elasticity exists for water, but rather how to implement the knowledge we already have.

In its final report, the National Water Commission noted:

> "Systems of pricing and user charges that recover the full costs of water services directly from users will conserve water supplies, discourage premature investment in water development projects, reduce financial burdens now borne by nonusers, and, most importantly, make the use of scarce resources more efficient."3/

Our challenge is to convert these findings into action. A number of forward-looking water agencies are already doing just that.

There is an increasing trend toward flat water rates, which charge all users the same amount per unit of water delivered. The North Marin and Marin Municipal Water Districts adopted this method more than a year ago.

At the other end of the state, the Los Angeles City Council is considering a proposed water rate change which incorporates flat unit rates. The proposal has already been approved by the Board of Water and Power Commissioners and is now awaiting action by the Council.

I strongly support the use of the flat rate structure because the knowledge we have of price elasticity of water indicates that when large industries face rising water costs, they will do what is necessary to conserve and reuse water.

Pressure for changes in water rates is coming from both consumers faced with rising costs and conservationists worried about the environmental costs of developing and delivering new water sources. Reexamination of water rate structures can help produce new thinking about the way we use water, which, hopefully, will lead to new methods of conserving both water and energy.

Let me go beyond the flat rate concept, and mention two new concepts in water pricing. One is peak demand pricing. Fairfax, Virginia, has adopted a rate which penalizes those who use more than 130 percent of their winter water demand.[4/] This will encourage conservation in summertime lawn irrigation and swimming pool use and will ameliorate the problems faced by Fairfax both in meeting summer peak demand and in treating the large flow of sewage during the summer. (Some have even suggested that a peak demand surcharge be placed on the times when commercials are being shown during the Superbowl due to high "peak flows" during those few moments, but hopefully we will not need to go that far!)

Another concept gaining increased acceptance is the idea of charging those who wish new water connections at least the entire cost of installing the connections, including the construction of new laterals and water treatment facilities. A recent report by the Council on Environmental Quality entitled "The Costs of Sprawl," pointed out that sprawling subdivisions consume much more water than more compact urban developments, and it is only proper to charge such new developments the full cost of new service.[5/]

The Department's role in rate design has been small in the past, except in setting prices to water wholesalers in the State Water Project. But in the future we will be paying more attention to water rates both in the Project and in the rest of the state, since rate design and water price may prove to be some of the most useful tools we have in implementing water and energy conservation.

In addition to water conservation at the municipal and industrial level, it must be undertaken by agriculture as well. An issue paper prepared for the National Conference on Water on the subject of water and food and fiber estimated that "More efficient use of irrigation water can reduce gross water demands, return flows, and salinity problems."[6/]

In a significant example, the paper stated that water use for projected irrigated areas nationwide in 1985 could be reduced by about 51 million acre-feet annually. This is about a third more than all of the water now applied in California for agricultural and urban uses!

We all know that about 85 percent of California's water uses are for agriculture, so it would appear that there is in this area the greatest potential for increasing the efficiency of water use. This is difficult in California because, in so many areas, agricultural water is priced artifically low.

One result of this low-price water is that farmers are less willing to practice efficiency. I have talked to representatives of the United States Department of Agriculture Soil Conservation Service (SCS), and they tell me that they notice a definite relationship between the price of water and efficiency of use.

At the southern end of the state, where water generally is higher priced, SCS workers find that farmers are more willing to talk about efficiency and to install systems that allow efficient use of water. Where water is low in price, farmers are less willing to practice efficiency.

Now, often in this state, when a person starts talking about the need for water conservation by agriculture, the complaint is made that systems which allow for better water control are expensive and that the farmer should not have to bear the burden of such expense.

This argument, which I do not intend to get into today, overlooks the point that there is much over-irrigation taking place in California today which could be prevented by simple management practices and which would not require the purchase, installation, and operation of expensive systems.

For example, significant amounts of water could be saved by more accurate determination by farmers of actual crop needs, rooting depth of the crop, and the amount of moisture the soil will hold and when the soil should be irrigated. The

Soil Conservation Service has approximately 60 offices throughout California that would be happy to develop this kind of information -- at no charge.

Through the above methods, the SCS estimates, in some areas great amounts of water could be saved. This takes into account the fact that in some places large amounts of applied water are needed to leach salts.

Clearly a change in approach is needed -- not only by agricultural but by M&I users as well.

I was interested in an article that appeared recently in the Sacramento Bee describing the effort of north Lake Tahoe utilities to solve their recent problems with waste disposal at the Cinder Cone Disposal Area.

The utilities dispatched teams of Cub Scouts, Boy Scouts, Little Leaguers and others -- I hope some Girl Scouts as well -- armed with bricks to be sold to north shore residents. The residents were asked to place the bricks in toilet tanks in an effort to cut down the amount of water flushed into the system. (That children's brigade is not what I was referring to when I entitled my remarks today "The Tread of Mighty Armies.")

Water conservation, as we are all aware, means more than bricks in toilets, but just how much more is often open to debate. There is a need for some sort of consensus.

Our Department supports Assembly Bill 1395, which requires low-flush toilets in new buildings after January 1, 1978.

Information developed by the authors of the bill estimates that by the year 2000 (assuming D-100 growth rate) use of low-flush toilets in new residential construction could result in a statewide savings of about 75,000 acre-feet (9,200 hectare meters) of water per year.

In addition to supporting new legislation, we also will take steps to implement our existing statutory authority to take necessary actions to prevent waste, unreasonable use, and method of use of water.

To help bring about the needed conservation consensus I was talking about, our Department is presently preparing a report on water conservation which is targeted for completion in August of this year.

The report will describe methods of conservation, discuss pros and cons, identify cost ranges, estimate water savings, and discuss relative effects on water supply, water quality, the environment, and the economy.

Our objective is to develop a report that can be used both by water agencies and the general public. We will also use the information in our revision of the Water Management Element of the California Water Plan.

In the past few weeks, I have discussed this particular planning effort throughout the state, and I hope that most of you here today are aware of the program by now.

The main thrust of our program is to restore some order to the water management aspects of the California Water Plan.

Over the years the Plan has just sort of become a big pile of reports. Most water activities of the state are supposed to be compatible with the Plan, but someone once pointed out that it almost legally and morally impossible to find anything not compatible with the Plan. It is sort of planning run amok.

For example, the water quality element of the Plan, which is the responsibility of the State Water Resources Control Board, has not been integrated with the Department of Water Resources' California Water Plan efforts.

Our new planning program will be fully coordinated with the State Board's basin planning process. Together we hope to produce a California Water Plan which reflects today's expanded resources goals and objectives.

In our planning effort, we will focus in on specific water problems and will allocate water by defining both the water needs in specific areas and sources to meet those needs. We will be taking a new look at old assumptions. We will be evaluating "crisis" claims and many other factors in order to provide a meaningful look at just where we are today in terms of water resources.

We do not intend to do all this single-handed. Rather, the Department hopes to be the catalyst in bringing together opposing viewpoints on California's water future. We would like to free developers and environmentalists and others from "locked in" positions, and we hope we can provide a forum where this process can take place and accommodations can occur.

We need everyone's input if we are to plan for water resources management in California in an orderly and thoughtful way, particularly those agencies and individuals who make up WATERCARE.

With your support and the support of all those who are interested in the wise and balanced management of all our water resources for all the people, we can surely put together a force that really is greater than the tread of mighty armies -- for wise water use truly is an idea whose time has come!

FOOTNOTES

1/ "A Study of the Proposed Requirement for Mandatory Water Metering for Municipalities or for Community Domestic Water Systems," Arthur D. Little, Inc., San Francisco.

2/ "Amendment to the Final Environmental Statement and Supplement on Auburn-Folsom South Unit, American River Division, Central Valley Project - California," Department of the Interior, Bureau of Reclamation.

3/ "Water Policies for the Future," Final Report to the President and to the Congress of the United States by the National Water Commission.

4/ "Water Rates: An Assessment of Current Issues," American Water Works Association JOURNAL, May, 1975.

5/ "The Costs of Sprawl," Prepared for the Council on Environmental Quality, et al, by Real Estate Research Corporation.

6/ "Water and Food and Fiber (Panel Two)," Issue Paper, National Conference on Water.

Jean Auer

Member
California Water Resources Control Board

IMPLEMENTING REUSE OF WASTEWATER FOR GROUNDWATER RECHARGE IN CALIFORNIA

IMPLEMENTING REUSE OF WASTEWATER FOR GROUNDWATER RECHARGE IN CALIFORNIA

By
Jean Auer, Member
State Water Resources Control Board

It's good to be here with you in Marin County at a conference which is discussing two of my favorite topics. I noted the typographical error in your program which had me a member of the State Water Regional Control Board; but I don't mind at all being associated with Regional Water Quality Control Boards and particularly here. My experience in this field prior to being appointed to the State Water Resources Control Board was serving for one year as a member of the San Francisco Bay Regional Water Quality Control Board after having served a year on the Central Coast Regional Water Quality Control Board.

Actually, what impressed me more in looking at your program for yesterday and today was the talent that was assembled here to discuss reclamation and water conservation. You have already heard from a distinguished group of people to whom I gladly look as experts in the specific topics that they have covered. My remarks, coming as they do at the end of your program, make me feel a little like the frosting on the cake. I bring less technical expertise to the subject, but a citizen's viewpoint.

As a matter of fact, Mr. Fowler, your assignment of the topic of my remarks has turned out to be too technical for me. If my good friend, Ron Robie, can be eloquent and "mod" with his "Tread of Mighty Armies", this citizen-appointee is entitled to equal imagination. Therefore, I have chosen to retitle my remarks, even as I begin them--and here it is: "On the Teeter-Totter Scale: Health and Happiness". Think I'll claim victory on imagination.

Presented to California Association of Reclamation Entities of Water, Annual Conference, June 25, 1975, San Rafael.

Moving on to the real world we are discussing, it is advantageous to look at our present available water supplies and the current level of use. Groundwater provides about forty percent of California's applied water needs. This equals about 15 million acre-feet, of which one-third (5.2 million acre-feet) is supplied from natural replenishment of the groundwater basins. One-half of the total pumping comprises reuse of deep percolating irrigation water and of losses from canals and distribution systems serving urban and agricultural areas. The remaining portion is overdraft, about 2.2 million acre-feet a year.

The overdraft is depleting our water bank. It is borrowing from the future. Although this depletion in some water deficient areas has provided those areas with an inexpensive interim supply, it is necessary for us to recognize that overdraft is just that--an interim program. It must be followed by a permanent operation which balances our underground bank account either by reducing our withdrawals or by increasing our deposits. Implementing a program to reuse treated wastewater for groundwater recharge is a means of increasing our deposits.

In some areas of the State, particularly the northern regions, water supply exceeds demand and is exported to deficient basins. In other areas, such as the south coastal region, overdrafting of the underground basin began early in California's history. Local water requirements, and the need to replenish the basins, generated importation projects such as those from Owens Valley, from the Colorado River, and from the Feather River.

San Francisco is another example where a water shortage has been alleviated by importing water from the Sierras.

The end result has been that water-short areas have resolved their water needs by moving surplus supplies from naturally water-rich areas. But while doing so, many have continued to deplete their underground reservoirs.

Only a few have attempted to balance their groundwater bank account. We are reaching the point where surface water surpluses are more difficult to identify, more expensive to transport to areas of need, and are subject to new and proper environmental considerations as to their availability.

As we look to the future, the Department of Water Resources has projected that the gap between Statewide needs and Statewide supply will range between 1.6 to 3.8 million acre-feet a year by 1990 and from 2.6 to 9.6 million acre-feet annually by 2020. Reasons for the varying estimates include a reflection of differing forecasts of population growth, questions as to the growth of irrigated agriculture in California during future years, and a smaller but significant variance depending upon inland or coastal location of thermal power plants. Urban water demand growth due to population increase and added acreage for agriculture are the two primary reasons for higher demand forecasts.

Past experience has shown that regions finding themselves water-short will have to rely more and more upon efficient use of their existing supplies, recycling after cleanup, and on an increased volume of imports (but to a much lesser extent than before). Water-rich areas now are finding the need to make full use of those waters which have in the past been surplus to their needs. As population increases, areas of deficiency will be pressed to meet maximum potential demands from existing facilities because areas of surplus will have less available for diversion to meet Statewide needs.

With this situation, we must encourage wastewater reclamation and specifically plan for large-scale charging of our groundwater basins with treated wastewater. Unanswered questions relating to health considerations are limitations on immediate and broad implementation of groundwater recharge with wastewater effluent. But we can begin to plan now. We should not wait until trapped by circumstances to develop the means to implement large-scale reuse of treated wastewater through percolation into our underground reservoirs. We can begin now.

Actually, wastewater reclamation for groundwater recharge, of course, is not a new concept in California. Our State presently has six groundwater recharge projects in operation.

The major projects are:

- Whittier Narrows, which began in 1962 the recharge of about 14 mgd of reclaimed effluent from the Whittier Narrows secondary treatment plant.

- San Jose Creek, operated the past few years by the Los Angeles County Sanitation District.

- Orange County Water District's Water Factory 21, where an equal blend of de-salted sea water and reclaimed wastewater will be injected to provide a sea water intrusion barrier and to recharge the groundwater.

The State Water Resources Control Board has a dual function in this area of wastewater reclamation for groundwater recharge:

1. The Porter-Cologne Water Quality Control Act states that all possible steps are to be taken to encourage development of water reclamation facilities so that reclaimed water may be made available to help meet the growing water requirements of the State, and directs the State Board to give added consideration to water quality control facilities which will provide water reclamation and reuse.
2. Also, the Federal Water Pollution Control Act Amendment of 1972 encourages wastewater management which results in construction of revenue-producing facilities for wastewater reclamation. However, speaking parenthetically, the findings of a study panel of the National Research Council on water reuse, prepared as background for the National Commission on Water Quality for that commission's report to Congress later this year on implementation of PL 92-500 are worthy of fully noting. The NRC panel found that although some sections of PL 92-500 are aimed at stimulating development of reuse projects, as

I previously mentioned, the law itself has a number of constraints that act to inhibit such projects. Among the most important constraints listed by the panel are provisions such as the requirement that reuse projects produce revenue, the priority system used in the federal construction grant system, and regulations on groundwater or agricultural drain water. It should be noted that these factors will seem less restrictive as reclamation gathers momentum.

3. Both the state and federal legislation require protection of groundwaters from pollution. Unless reclaimed water meets established criteria for groundwater recharge, pollution may result. In case of recharge of aquifers which serve as source of domestic water supply, reuse criteria have not been established.

We can see the need for expanding our use of reclaimed wastewater, but we must recognize that there are major problems which will delay us in implementing large scale wastewater reclamamtion for groundwater recharge. The complex problems to be overcome involve costs (economic and environmental), institutional, and social questions. Independently they pose significant questions which must be answered before we proceed. Collectively their interrelationships further complicate our attempts to find necessary solutions to the questions that are posed.

COSTS (ECONOMIC AND ENVIRONMENTAL)

In order to recognize the impact that costs can play upon our decisions as to when to implement groundwater recharge of treated wastewater the following conditions must exist if the project is to have economic and environmental feasibility:

- There must be a demonstrated need for reclaimed wastewater
- The new water supply must be economically competitive, on a long term basis, with other potential water supply sources

in the area. In comparing the cost of reclaimed wastewater with an alternative fresh water source, it is essential that both costs include environmental effects and energy use. This means total costs, regardless of who pays for wastewater reclamation or other alternatives. Economic considerations should include broad Statewide and nationwide benefits. The method of scoping the cost estimate can lead to erroneous conclusions. The cost of the reclaimed wastewater should properly include the fact that collection and treatment costs including the secondary treatment level, are mandated just to dispose of the effluent to surface waters.

- Federal and State financing of reclamation projects for water supply should be considered on the same planes as other types of water supply projects. If we are to truly consider statewide and national benefits, we must find a means to negate the impact of additional local costs made necessary by these broader benefits.

I don't want to suggest how we might accomplish this. But it isn't fair to toss you the problem without at least a brainstorming. How about a requirement within the Central Valley Project that the Bureau of Reclamation construct reclamation plants to produce a water supply equal to that supplied for domestic purposes and that such a produced supply be made available to new domestic customers at the melded rate of CVP deliveries. Interestingly, Director Robie of the Department of Water Resources is suggesting something parallel to this in his action on the San Felipe Project. Robie has advised the districts involved, as well as State legislators and Congressmen from the project service area, that he will recommend that Governor Brown oppose the federal appropriation for the San Felipe Division for the coming fiscal year and transition quarter unless three specific points are resolved. One of those points would require:

> "Reduction of project deliveries and development of contractual assurances that water reclamation and water conservation will also be utilized to meet service area needs throughout the life of the project."

We all must begin exploring these types of things. In my opinion we should not wait until the cost of new importation schemes becomes intolerable. We should recycle before that time arrives.

INSTITUTIONAL

The institutional obstacle should be overcome so as to increase use of wastewater reclamation. Traditionally, the water supply and waste treatment agencies have been separate from each other. However, the practice of reclamation involves both treatment and the supply of that treated water to users who will contract for it. This is going to require institutional arrangements between waste treatment and water supply agencies to overcome the lack of a single agency responsible for both reclamation and supply. A good example of solving the institutional problem has been demonstrated by the agreement between Central Contra Costa Sanitary District and Contra Costa County Water District. Construction there will allow treatment and delivery of 50 million gallons per day of reclaimed wastewater.

The interaction among agencies involved in water programs needs new perspectives and working forms. For example, it is conceivable that the State Board could condition new water rights for a surface storage and long distance diversion on a positive showing that the development of the potential for reclamation and reuse within the proposed service area has been reasonably accomplished, or that plans will be implemented to do so.

SOCIAL CONCERNS

Generally our social concerns with relation to recharge of groundwater with treated wastewater has revolved around the question of public acceptance primarily due to aesthetics and health hazards. I believe public support for reclamation is here and it is growing.

There is an increasing public awareness of wastewater reuse as a potential source to increase water supply. It is obvious that more people today would accept reuse than would have done so several years ago. However, there is still great resistance to use of reclaimed wastewater for household purposes. Generally you find a lot of people are in favor of wastewater reclamation as long as they are not the recipients.

The plateau of public opinion today might be categorized as one of reluctance. But we who are involved in governmental agencies with a responsibility to plan for efficient use of our water resources must not allow that reluctance to act as a brake on our efforts to expand the amount of water we reclaim by recharge. We need to have and use good public information programs. As our reclamation programs and products are being developed we need public groups that are informed so that they can participate in the decisions which must be made as our knowledge in this area increases. Informed, they can lead us toward implementation of our plans as they gradually determine through study and knowledge that there is no further need for reluctance. Perhaps it is presumptuous to believe our technology will enable us to meet our reclamation goals. I hope not.

To discover public attitudes toward reclaimed water use Brunveld and Ward in 1971 surveyed several of California's communities. They found that only 3.8% of the respondents opposed the use of reclaimed water for toilet flushing, whereas 38.7% opposed it for bathing in the home, and 56.4% opposed it as a drinking water supply.

More recently, and with a more directly worded set of questions, the Marin Municipal Water District held a public opinion survey which showed that 65% of the people had no concern using reclaimed water for non-consumptive uses and 25% stated that they would have no problem accepting reclaimed water as a source for domestic and drinking purposes.

These were small samplings of opinions and cannot be cited as general sources of blanket approval.

Regardless of polls, public health problems must be resolved beyond question if we are to expect to be successful in implementing a program of recharge of treated effluent.

HEALTH CONCERNS

The lack of information on health effects that may be associated with the use of reclaimed wastewater for groundwater recharge is a major obstacle to implementing proposed recharge projects where reclaimed wastewater would constitute a significant percentage of the total water in the recharge area. Of greatest concern are the potential (unknown) effects of stable organics which are not completely removed by presently used treatment processes and which may pose a hazard to public health.

Before any large-scale groundwater recharge projects involving domestic water supplies can be implemented, reuse criteria must be developed to assure the protection of public health. The problem is not one of known hazards, but one of unknowns.

The State Board is sponsoring, with the Department of Water Resources and the Department of Health, a panel of health and water experts which is designed to focus upon the health aspects of wastewater reclamation for groundwater recharge. The panel, which held its first meeting in April, will assist the state agencies by recommending a research program aimed directly at the area of the unknowns. Included will be demonstration projects to provide the necessary information to allow decisions to be made regarding reuse. Such information is particularly necessary in cases where groundwaters are used for domestic water supply. It is in this area the panel's recommendations are expected to assist the Department of Health to establish reclamation criteria for groundwater recharge to augment domestic water supply.

Following their first meeting, the panel members have begun a review and evaluation of current knowledge including the types and sources of biological contaminants found in municipal wastewaters which may affect public health and treatment plant processes which are able to remove the contaminants from wastewaters which have received secondary treatment. While the panel's work will be done in September, that will be but the start of the research efforts.

It is unlikely that sufficient information to establish reuse criteria will be available for at least five years. In the meantime, we ought to leave as many options open as possible. At this time funding of wastewater reclamation projects associated with recharged wastewater can only proceed on a case by case basis, and then only if the quantity of wastewater represents a relatively small amount of the total aquifer volume.

INTERRELATIONSHIPS

In reviewing the problems of economics and institutions, and of public acceptance and health hazards, I purposely held health aspects last. Each of the problems interrelates with others, but none has such impact in the complex meshing as does our concern for public health.

Our economic feasibility teeters, depending upon limitations of use which are prescribed by health considerations. The viability of institutional vehicles we choose to implement reclamation totters, depending upon the restrictions which adherence to necessary health requirements places upon those institutions and their staffs. Public acceptance of reclamation is intimately related to the successful solution of our health questions. And if there is to be a brake on expansion of our wastewater reclamation program, we responsible representatives of our governmental agencies must be sure it is nothing less important than a requirement that all necessary health requirements are met.

SUMMARY

Although we seem to be restricted by health considerations, by institutional dilemmas, by a wary public, and by limited economic feasibility, none the less we are proceeding to encourage wastewater reclamation in California. As mentioned previously, the State Water Resources Control Board will initiate research needed to establish reuse criteria.

The statewide Comprehensive Water Quality Control Plan effort being carried on by the State Board and its nine Regional Boards is looking ahead as far as the year 2000 in the management of California's water resources.

The federal and state programs for grants for construction of municipal wastewater treatment plants provide 87-1/2 percent of the cost for combined wastewater treatment-reclamation facilities, provided contractual use of the reclaimed water can be shown.

Added consideration is given to grant applicants for wastewater treatment facilities which will provide water reclamation and reuse. Procedures for developing a treatment works project report require that at least one alternative involving reclamation be thoroughly evaluated. Thus, every municipality which applies for a grant msut evaluate the efficacy of reclamation. The most cost-effective alternative is generally selected. However, the State Board may fund a reclamation project even though other treatment and disposal alternatives may be less expensive.

CONCLUSION

The problems facing us in implementing water reuse for groundwater recharge are substantial. Priorities must be established and problems must be attacked systematically and in a well coordinated program, which includes federal, state, and local agencies and citizens. Foremost, a well informed citizenry is essential for implementing recharge projects.

Now, it is up to government, industry, and water agencies to seek the goal of the implementation of wastewater effluent reuse as a supply for groundwater recharge development. It is time that we started to lay the foundation for balancing our bank account. We need to deposit to our underground water bank those resources that we can reclaim and reuse. The sooner we begin, the better our future water bank account will read. There are numerous basins in California with the capacity to store our savings.

Implementation is a task large enough for all of us--you, me, the State Water Resources Control Board, and the people. It is a task that we need to get at. I congratulate you for holding this successful two day conference which is concerned with the conservation of the water assets we have and the restoration to reserves status of a supply that we have used and can reuse again. But I urge you to consider this conference but a step along a path we must travel together. We need your assistance in focusing upon those problems which require additional research, or upon public education needs or upon political adeptness. In all of these areas you can be sure that your efforts can be important if we are soon to meet our goals of conservation and reclamation.

John De Vito

General Manager
Contra Costa County Water District

CONTRA COSTA COUNTY WATER DISTRICT
RECLAIMED WATER PROJECT (Fact Sheet)

CONTRA COSTA COUNTY WATER DISTRICT

RECLAIMED WATER PROJECT

FACT SHEET

Water Use: Industrial Cooling Towers
Scheduled Operation: Summer 77
Capacity: 30 MGD
Initial Delivery: 12-15 MGD

Water Users:
Phillips Petroleum - Avon Refinery
Shell Oil - Martinez Refinery
Stauffer Chemical - Martinez
Monsanto Chemical - Avon
P.G. & E. - Avon
P.G. & E. - Martinez

Agencies:
Contra Costa Water (CCCWD)
Central Contra Costa Sanitary District (CCCSD)

Consulting Engineers:
James M. Montgomery (CCCWD)
Brown & Caldwell (CCCSD)
Bechtel (CCCSD)

Institutional Arrangement: Contract (CCCWD - CCCSD)

Major Contract Items:

1. CCCSD produces reclaimed water in accordance with contract quality requirements (30 MGD CCCSD Water Reclamation Facility now under construction).

2. CCCWD purchases reclaimed water from CCCSD and distributes to user industries. Price to industry is not specified in contract.

3. Term of contract through June 30, 2006.

4. Price of reclaimed water to CCCWD is $3.50 per acre-foot for reclaimed water meeting the contractual quality limits. Contract provides for increase or decrease in price contingent on quality.

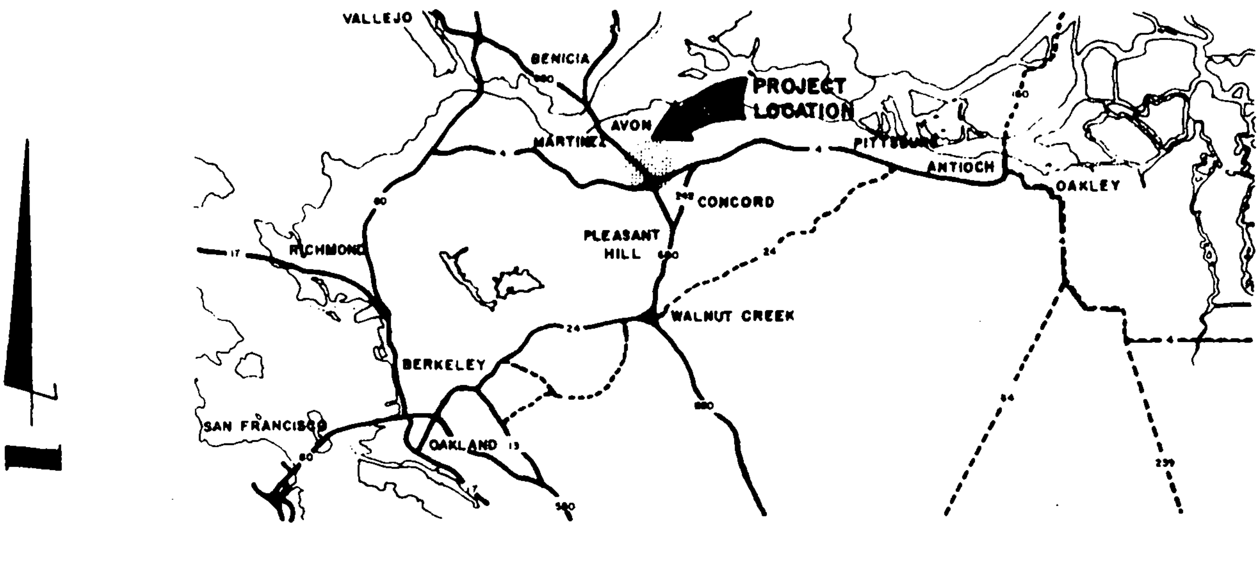
Upon completion of the total project in 1976-77, this joint CCCWD/CCCSD project will supply about 15 MGD peak demand of reclaimed water to six industrial customers, located between Martinez and Port Chicago, for use as industrial cooling water. The six industrial users presently receive about 30 MGD of raw water from CCCWD for their total industrial needs which include cooling, low and high pressure boiler, process, wash-down, and fire protection. The reclaimed water will replace 15 MGD peak demand of the cooling water use. The project is designed to meet 30 MGD of future demand by industrial users.

The CCCWD project facilities consist of a split process strong acid-sodium ion exchange (SANAX) unit (15 MGD), two 3-mg storage tanks and appurtenances (with provision for a third tank), conversion of various pipelines to reclaimed water use and construction of new pipelines and pump stations.

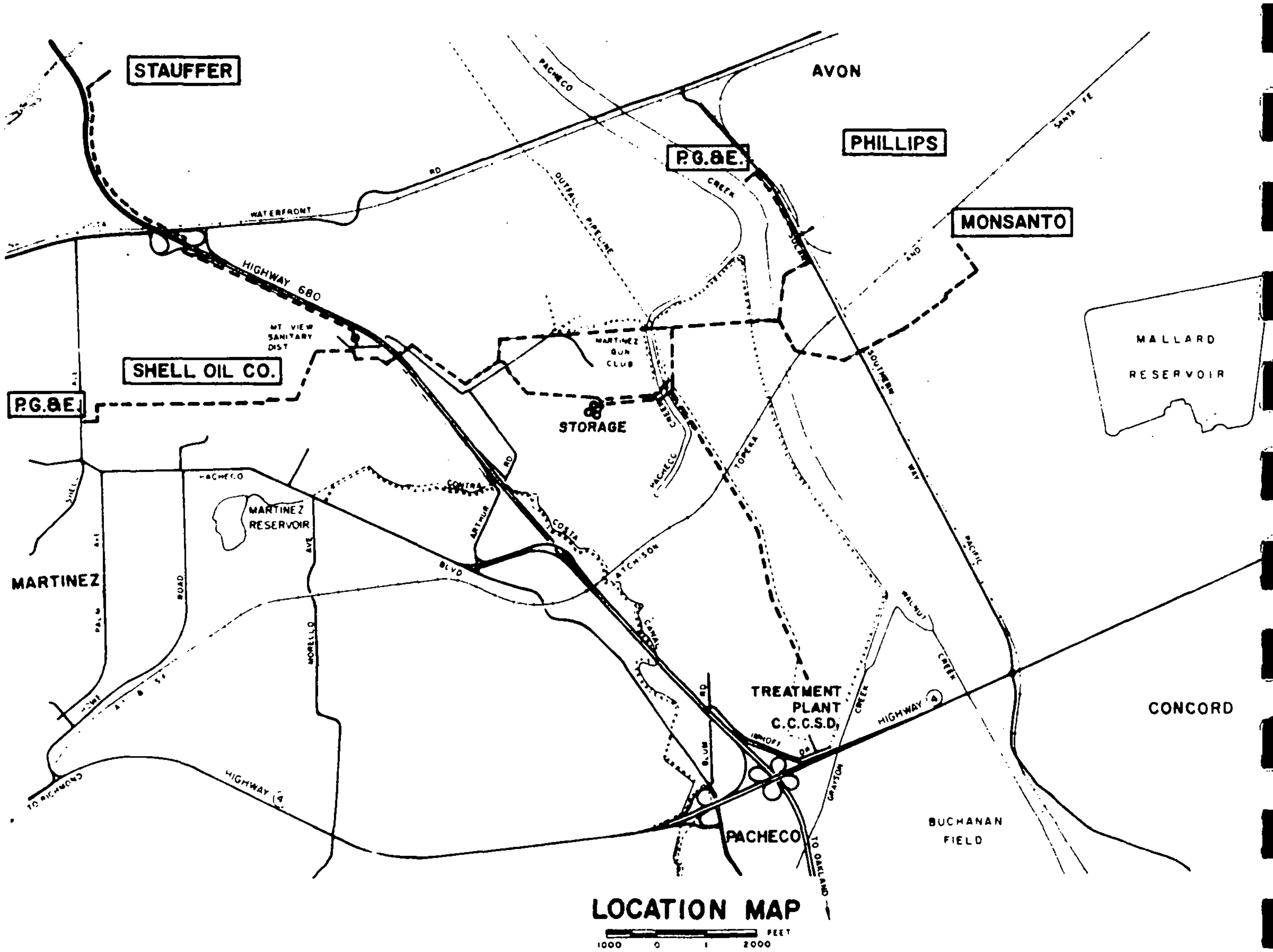
Following completion of the CCCWD project, the quality of the reclaimed water will be suitable for cooling tower uses and generally of better quality than the raw water now utilized. In addition, the SANAX-type treatment produces a water of sufficiently high quality that it may be used for other industrial purposes.

CONTRA COSTA COUNTY WATER DISTRICT

RECLAIMED WATER PROJECT



VICINITY MAP



LOCATION MAP

William Kortum

Member
Sonoma County Board of Supervisors

TRIPLE USE PLAN

TRIPLE USE PLAN

One of the best ways government organizations can beat present inflation rates as high as 14% annually is to cut costs--of luxeries we have fallen into the habit of calling necessities, and the unnecessary costs of what modern expertise has told us is absolutely necessary in order to perpetuate technology.

A classic example of this is sewage treatment, known euphemistically as wastewater treatment. In recent years a simple and obvious solution to the wastewater treatment problem has emerged. This solution lends itself especially to communities that are surrounded by large agricultural areas, as in Sonoma and Marin counties.

It is a solution of startling simplicity: Use treated wastewater as irrigation for forage crops. In Sonoma and Marin counties, this solution will (1) satisfy the pressing need of our cities for wastewater disposal, (2) prevent the discharge of wastewater into our streams and rivers, (3) prevent the out migration of our dairy industry by meeting the dairy producers' need for local forage, (4) generate a new industry and jobs in the form of forage-crop production, and (5) provide a means of establishing much-needed greenbelts around our cities, by making the greenbelts part of our utility system.

Let's consider these concepts one by one.

The Need for Wastewater Disposal

Modern sewage treatment comprises three basic steps. (1) primary treatment, which consists essentially of screening, sedimentation, and filtration to remove particulate matter, (2) secondary treatment, involving chlorination or other chemical means of rendering the wastewater relatively free of bacteria and most other microorganisms, and (3) tertiary treatment, which removes the nitrates and phosphates from effluent already sanitized by secondary treatment. These latter nutrients, if not removed by tertiary treatment, create growth of algae downstream from sewer plants under out present disposal techniques.

Discharge of Wastewater into Streams and Rivers

One of the hallowed traditions of America is to dump its sewage into its streams and rivers. In keeping with this tradition, the disposal of wastewater from the sewer treatment plants of Sonoma and Marin counties has become a major problem. As a case in point, the cities and towns in the Russian River basin will soon contribute almost 35% of the summertime flow in the form of wastewater, albeit most of it being secondary-treated. People swim in this. People eat fish they catch in this. As a consequence, the State Department of Public Health prefers to keep all wastewater out of our streams.

Further, and for obvious reasons, the Water Quality Control Boards of the Bay Area and the North Coast (who are concerned with drinking water) have mandated that no wastewater, unless it is tertiary- treated, is to be dumped in our streams and rivers during the months of low rainfall.

Reclamation of Wastewater

A great deal of public discussion in recent years has been devoted to the possibility of large cities recycling their wastewater by some means-- usually an extremely expensive one, such as the tertiary treatment employed by the South Lake Tahoe plant. The use of secondary treated wastewater as a means of furnishing irrigation for forage crops would appear to be a sensible and relatively inexpensive approach.

Economically, such water reclamation is attractive: it is an expandable system that can easily accomodate the wintertime overages of secondary treatment plants, it calls for only a fraction of the energy requirements of a tertiary plant, it has no built-in obsolescence, and there is no chance of river or bay contamination.

Wastewater reclamation on land is thus patently superior to tertiary treatment in the North Bay area. The job remains to guarantee the water-quality control requirement that enough land will remain available in the future for the wastewater reclamation needs of projected populations.

Preventing Exodus of Dairy Industry

The dairy industry is the largest cash-producing industry in Sonoma County. The combined dairy industries in Sonoma and Marin counties bring $60 million per year into the area, which generates $300 million of economic activity. It should be kept in mind also that the dairy industry generates, many times over, the property tax that it receives in county and school services.

But the county's dairy industry is in jeopardy. Because local roughage production (hay, silage, and green-crop forage) has been mainly limited to a one-crop, dry-land agriculture, dairymen have traditionally had to import most of their hay from the Central Valley. Years ago this was a satisfactory arrangement, but presently competition by other crops for the Central Valley lands owing to worldwide demand for American farm products has created prohibitively high prices for alfalfa hay. In fact, Earl Holtz, Sonoma County dairy extension specialist, confirms that the only economic sector where dairymen in this area cannot compete against Valley producers is in our high cost for hay. Unless local forage crops can be substituted for the increasingly expensive imported hay, our dairymen will be forced to move to the Central Valley, where efficient growing of forage crops is feasible, or go out of business.

The dairy producers of the North Bay are the largest holders of open space in these two counties; in Sonoma County alone this amounts to more than 100,000 acres. But the dairymen need two things in order to exist: (1) freedom from the pressure of urbanization in the form of land taxation and nuisance complaints, and (2) water to irrigate crop lands in order to promote the development of an in-county forage industry. The availability of cheap water would allow this land to produce two crops a year instead of one. The economics of urban water impounded by a project such as Warm Springs Dam produces water too expensive for agriculture.

Creation of New Industry

Not only would the availability of cheap water save the dairy industry in this area, it would also create a new industry; a two-crop agriculture would attract farming contractors to establish year-round commercial silage operations. It is estimated that such an industry could generate at least 300 new permanent jobs.

Avoiding the Costs of Tertiary Treatment

Enormous capital expenditures are required for tertiary treatment facilities. Amortization of these costs by the sewer rates of the homeowners would almost triple their monthly sewer charge. Capital costs for tertiary treatment plants or for shipment of sewage to regional plants could well cost the cities of the two counties $150 million or more. Further, avoiding tertiary treatment will save large amounts of electrical energy, which will continue to become increasingly expensive.

Creation of Greenbelts around Cities

The esthetic, taxation, and social need for greenbelts around our cities is obvious. Establishing such buffer areas free of developmental pressure will allow new market values to be established on land outside the greenbelts at agricultural values rather than developers' values and thereby remove the taxing pressures that otherwise force these lands to be sold for development. By thus confining urban sprawl, taxing pressures are also relieved on the agricultural lands lying beyond the greenbelts. This relief of higher land values and hence higher assessments in the agricultural areas would be the best guarantee to the urban dweller that open space in private hands will not disappear.

Beyond the above advantages there are even others. The greenbelts and the agricultural lands beyond them become available for wastewater reclamation and forage-crop production. Agricultural dedication of these lands also gives the cities--which are beset with the growth problems of providing adequate school and municipal services--a reasonable form of growth control, which is in itself the leading problem in the north bay counties because these cities have available land and a desirable climate close to the metropolitan bay area.

In an attempt to solve this very problem, voters throughout the state are beginning to pass measures to limit their urban boundaries and create greenbelts around their cities. Here in Sonoma County the city council of Petaluma recently passed such a measure. This was known as the Petaluma Environmental Plan, and it was subsequently endorsed by the voters of Petaluma by a margin of 6 to 1. Nearby Rohnert Park has set a policy of defining the City's boundary, and is looking for a means to buy open space just outside that boundary. Rohnert Park has also endorsed what is known as the college Environs Plan, which calls for a greenbelt around Sonoma State College.

But such plans will only act as a temporary holding action unless some means are found to purchase the land for the greenbelt. Certainly the costs of buying such land cannot be covered by property tax revenue alone. This land must serve a triple function and be financed by these functions.

In fact, the essence of this plan is that it will provide greenbelts that do <u>not</u> depend on tax money alone.

How, then, can this be done?

The Solution

The means available are several. In the first place, Federal funding of water quality programs allows the purchase of land for wastewater disposal or reclamation. This is on a basis competitive with using these same funds to build tertiary treatment plants--which utilization of wastewater for forage crops would obviate.

A second part of the solution is that Federal funding can be used to deliver wastewater to these lands. Although a delivery system would represent a sizeable investment, it would nowhere near approach the cost of tertiary treatment plants.

A third part of the solution is that, once these lands are purchased, commercial forage operators can be encouraged to lease back these lands and develop a two-crop, year-round silage industry that can continuously deliver silage from centralized storage facilities, from which a steady, dependable flow of silage to the dairies can be maintained. The lease-back fees would produce significant income because the free water delivery allowing a two-crop system would make this attractive to commercial agriculture. This income function should represent about 25% of the money necessary to amortize the land purchase.

Beyond the above three sources of funds that can be combined to amortize purchase of this land there are yet others. For instance, a possessory tax will be charged the commercial operators who lease back this land. Estimates are that this would generate the same property tax revenue that these lands would return if they were assessed at agricultural value.

Further, since the alternative of tertiary treatment would necessitate the tripling of sewer fees to meet the increased cost of this form of treatment, increasing the sewer fees to buy land for open space and water reclamation would be politically more palatable--especially greenbelt lands that would be highly visible to the people who would be paying for them, through their sewer fees.

Additional Advantages

There are yet other advantages to this solution. For instance, no bureaucracy would be required to maintain these lands because the land would be leased to private enterprise as productive open space, similar to the greenbelts around London. Inasmuch as it would involve private enterprise, such leasing could be on competitive bids to further enhance the income

Also, the fact that the cities are separated from one another, and pretty well scattered throughout the dairyland countryside, places the silage-producing greenbelts surrounding the cities within a very feasible 10-15/mile transportation radius of the dairy producer.

It should also be pointed out that the potential greenbelt lands are exactly those that are of greatest interest to the land speculator, whose continued and increasing exploitation has been the source of most of the pressure upon these cities to expand beyond their fiscal capabilities. In fact, in this light it can be said that the whole problem is essentially an urban one, rather than being a simple matter of water reclamation.

Part of such lands could also be used for recreation, which has become a big problem for cities. Parks and trails for public use could be provided along the borders of these greenbelts.

Since the dairy industry is the largest holder of open space in the North Bay counties, and the largest cash-producing industry in Sonoma County, it should be encouraged to remain here. This solution would utilize the nitrates and phosphates already present in wastewater to enhance crop production, putting tax dollars into land use instead of tertiary treatment plants. Further, the ultimate goal of the plan is important: although the maintenance and operation charges of a tertiary treatment plant go on forever, multiple use of the land is self-liquidating.

How to Get Started

In the two counties there are 48,000 acres of flat land (less than 5% slope) lying between San Pablo Bay and Santa Rosa Creek that is not yet urbanized. Of this, some 6,000-8,000 acres should be acquired to handle the present wastewater needs of the counties by agricultural irrigation; this would provide 50% of all the roughage needs of the local dairy industry. The project would require a total of 12,000 acres by the year 2000 to reclaim the summertime flows of urban wastewater.

Potential greenbelt land is not a bargain. Indeed, much if it represents one of the most expensive kinds of land left on the valley floor. But we are not looking for the cheapest available land--we're looking for land that can solve the problem of wastewater reclamation. Even at an average purchase price of $3,000-$4,000 per acre, which is about what it would cost, it would still offer a cheaper solution than would tertiary treatment. Total purchase costs of the 6,000-8,000 acres presently needed would probably come to around $25 million.

The County should purchase this quantity of land and establish an irrigation district that would utilize the secondary-treated wastewater, which would be delivered to the greenbelts by pipeline from the cities' treatment plants. Excess wastewater during the winter months could be piped to a storage area, such as Tolay Reservoir southeast of Petaluma, for subsequent use during the summer months.

Even at the present rate of growth, by the year 2000 all the summertime wastewater from the two counties could be reclaimed on 12,000 acres of productive agriculture.

The solution would require a wastewater pipeline from Santa Rosa's Llano treatment plant and the Petaluma plant to Tolay Reservoir. The reservoir will act as a failsafe system to collect all flows from these plants year-round. Backflow in summer, supplemented by pumping from the treatment plants, will provide water for irrigating lands surrounding the 17-mile length of the pipeline. A separate connecting line to collect wastewater in north Marin County could be added at any time. A line from the Sonoma Valley plant could also connect to Tolay and become part of the system.

Financing

The solution calls for Federal and State financing of the wastewater line, the pumps, the reservoir, and the land; 87½% financing could be expected for all but the land. The level of financing for land would be for the acreage that would be needed for non-crop disposal only, which is 50% of the land requirements for waste water reclamation and crop growing.

The remianing 12½% financing would come from local sources--mainly increased monthly household sewer charges, and lease-back of lands to agriculture, which would generate about $80-$100/acre per year. Low maintenance cost on these greenbelt lands would be assured by the lease-back to forage contractors, who would keep these lands productive throughout the year.

The large expenditure by the Federal and State grant agencies, plus the local expenditure represented by doubling or tripling the monthly sewer rates, are necessary to fund and maintain a system of effluent treatment that will meet 1984 Federal guidelines.

Continued public acceptance of this plan would be essential to its success. A large, multimillion-dollar expenditure in the form of tertiary treatment facilities and discharge of the effluent into the Russian and Petaluma river systems would never be seen or appreciated. Perhaps it would not even be tolerated. However, the public could readily appreciate the agricultural greenbelts created by this plan, which would serve as a daily reminder of where their sewer fees are being invested.

As a beginning, Sonoma County must explore the following ways to provide the necessary acreage:

1. Develop a two-county, joint-powers wastewater irrigation district covering this land.
2. Propose new legislation to set aside such land.
3. Explore purchase of development rights.
4. Explore other methods of immediate financing to be amortized by later increased sewer fees, lease fees, etc.
5. Develop format of a contract with property owners who do not want to sell but will use the water.
6. Encourage the State of California to use Sonoma County as a pilot project for wastewater reclamation.

Will it Work?

This system, with some modifications, is already working in other countries and in other communities in the U.S. (e.g., London, Bakersfield, San Diego). A pilot project of 8 acres along Highway 101 between Cotati and Santa Rosa shows every promise of success.

What are We Waiting For?

It seems unreasonable to delay this concept any longer. It offers a unique, opportunity and economical solution to a host of problems that beset us. It solves the wastewater disposal problem. It stops the discharge of wastewater into our bays and rivers, enabling them to remain clean for recreational use. It recycles excess water for agricultural use. It utilizes the nutrients of phosphates and nitrates in wastewater. It enables us to keep our dairy industry strong. It creates a new agricultural industry and more jobs. It obviates the extreme expense of tertiary treatment of wastewater, and saves a vast amount of energy. It stops urban sprawl. It allows us to create greenbelts--open space--around our cities.

In other words, it enables us to do what we want to do.

And at minimum expense.

Donald C. Tillman

City Engineer
Los Angeles

Stanley S. Naydo

Engineer
Wastewater Division, Los Angeles

SEPULVEDA WATER RECLAMATION PLANT AND GROUNDWATER RECHARGE

SEPULVEDA WATER RECLAMATION PLANT
AND GROUNDWATER RECHARGE

Southern Californians are beginning to ask themselves: "Why use water only once?" We have long depended on imported supplies from the North to supplement the inadequate and capricious natural supplies of our semi-arid region. But the water supply from the Owens Valley is limited, and new sources from Northern California are going to cost us dearly. We observe also that costly and energy consuming processes for desalting seawater are being implemented, even though wastewater is far less saline. And finally, new stringent discharge requirements have spawned all sorts of technologies capable of renovating wastewater to just about any quality desired. Any quality for a price, I grant you, but the economic and technical feasibility of wastewater reclamation is not so much the problem any longer, as is the psychological barrier.

WASTEWATER RECLAMATION POTENTIAL

The City's Department of Recreation and Parks was interested in Sepulveda water from the start, when the concept of inland plants in Los Angeles was first being discussed. Their support led to relinquishing 86 acres of their valuable leasehold within the Sepulveda Flood Control Basin as a site for Sepulveda. By locating the Sepulveda plant amid the nearly 1650 acres of landscaped parklands, Sepulveda water represented an inexpensive source of irrigation water, and water for recreational and ornamental lakes. Recent accelerated development by

Recreation and Parks of this immense complex of parkland and golf courses seems to have coincided with the decision in the late sixties to design and construct the Sepulveda plant.

Tangible proof of the practicality of reclaiming wastewater will probably be no more dramatically evident than on the west boundary of the plant, where an authentic Japanese Garden will be sited. The Sepulveda Plant Administration Building will overlook one and one-half acres of breathtaking landscaping, ornamental lake and meandering streams, all sustained by water reclaimed just a few hundred feet away.

During the mid sixties, the City's Department of Water and Power launched a water reclamation feasibility study cooperatively with the Department of Public Works, including both the Bureaus of Engineering and Sanitation. The study culminated in a 1968 report which strongly indicated wastewater reclamation would work in Los Angeles, and supported steps toward a positive reclamation program. Water and Power's own first step was to convert the San Fernando Valley Settling Basin to a pilot activated sludge plant providing irrigation water for local use in Griffith Park. This pilot study was so successful, Water and Power began a long range research program, now in progress, at both the Headworks Spreading Grounds in the San Fernando Valley, and at the Hyperion Treatment Plant in Playa del Rey. No one can yet say what the long-term effects on our groundwaters will be from large-scale replenishment with reclaimed water and such a study is vital. Ample land has been reserved on the 86-acre Sepulveda site for possible advanced treatment facilities which may be required by Water and Power prior to spreading operations, or perhaps for other uses such as industrial process water.

INLAND TREATMENT PLANT CONCEPT

Water reclamation briefly aside, I would like to explain why the inland treatment plant concept figures heavily in our system plans. The parallel benefits to other metropolitan areas appear fairly obvious. To our City, the tangible benefits from a program of reclaiming our imported water are many, but the primary benefit of Sepulveda is economic. The location of the Sepulveda Plant within the flood control basin is particularly significant. The site is adjacent to the major outfall sewer from the western San Fernando Valley, where most of our growth flows have been generated. We'll manage to greatly reduce additional influent sewers and pumping costs compared with other potential sites. Intercepting and treating wastewater at inland locations has been proven in economic studies made by us and by others to be a far better alternative to constructing larger and longer sewer lines to our coastal plant, Hyperion. A nine-mile tunnel through the Santa Monica Mountains would be needed if Sepulveda were not built. Inland plants also lend extraordinary flexibility to Los Angeles' system. One only has to reflect on the drastic revisions in population forecasts in the past five years -- the forecasts upon which most wastewater system planning is based -- to see why planning for adequate hydraulic and treatment capacity over the normal economic design periods is done with justificable apprehension. In the past, Los Angeles, as with just about every other municipality, has relied on expanding its network of pipes to serve the growing volumes of wastewater. But when our upstream plant in Glendale is completed, and with Sepulveda on line, we are afforded the economic and least disruptive alternative of adding modules to these plants -- especially when population trends don't happen according to plan.

PURITY OF WATER SUPPLY

The major portion of the domestic water supplied to the area tributary to the Sepulveda Plant comes from the Owens Valley via the Los Angeles Aqueduct. The balance is supplied from local groundwater extraction. Owens Valley water, like Feather River water from Northern California, is High Sierra snow melt which is very low in total dissolved solids, or TDS. Its TDS is so low, in fact, that even after domestic use it contains less TDS than most of the San Fernando Valley groundwater. Colorado River water, by comparison, is very saline and must be filtered and diluted with other freshwater before it's tolerable for direct domestic use. TDS reduction, if required, would mean costly demineralization, and thereby render groundwater replenishment with reclaimed wastewater impractical. SWRP's location is further advantageous in that industrial contribution is less than ten percent of the tributary wastewater flow. Thus, wastewater entering SWRP is nearly all clean domestic flow, of a uniform organic and inorganic content, and virtually free of toxic constituents associated with industrial waste discharges. This fortunate circumstances of geography was recognized at the outset of water reclamation studies, and accounts for the early support of other City departments who are potential users.

CLOSE PROXIMITY TO SPREADING BASINS

When SWRP water is made available, it can be destined for a number of locations. The Bureau of Engineering and the Department of Water and Power concur in their studies that there exist three prime locations for surface spreading of reclaimed water.

The simplest scheme calls for utilization of the Headworks Spreading Grounds at the Los Angeles Narrows. Transporting the water can be accomplished by discharging to the Los Angeles River from the Sepulveda Plant effluent line and recapturing that flow downstream at the Headworks Spreading Grounds. By taking advantage of the topography in this way we can sizably reduce total pumping costs. The loss of flow in transit from percolation through short unlined reaches of the Los Angeles River, and from evaporation to the atmosphere would be minimal. The Headworks Spreading Ground has a maximum percolation capacity of 30 mgd.

The Tujunga Spreading Grounds further north has a potential spreading capacity of 40 mgd. The Tujunga and the Pacoima Spreading Ground (mentioned later) are the two major facilities in the San Fernando Valley being utilized today for capturing rainfall runoff in the wet seasons, and for spreading surplus imported water whenever practical. This practice has been essential due to historic overdraws of the San Fernando Valley aquifers, which would allow adjacent aquifers of inferior quality (potable but high in TDS) to encroach on them if unchecked. SWRP reclaimed water will be low in TDS and will be available throughout the year without interruption, so optimum use can be made of the spreading basins. Pipeline routes have been tentatively established to the

Tujunga site, and the overall economics favor reclaimed water over imported supplies.

The third facility, the Los Angeles County Flood Control District's Pacoima Spreading Grounds, could be provided with reclaimed water from SWRP via a relatively short extension of the pipeline to Tujunga. The capacity there is about 40 mgd also, giving the City of Los Angeles a potential spreading capacity of 110 mgd for the three sites. Since SWRP reclaimed water is low in TDS, none of this capacity need be consumed by diluting with other freshwater. Large-scale groundwater replenishment in the San Fernando Valley could conceivably draw all the water produced at Sepulveda for about three 40 mgd modules.

DESIGN FEATURES ENSURING A RECLAIMABLE EFFLUENT

In our effort to meet governmental mandates for purer water by efficient and complete treatment, we have at the same time incorporated design features in the Sepulveda plant which add markedly to the water reclamation potential of its effluent.

The nucleus of efficient plant performance will be the direct computer control. Sepulveda will be unique among wastewater treatment plants in that control commands, or outputs, will derive from digital control logic in the dual minicomputer system. All inputs and outputs to the process control will be multiplexed remotely in the field and transmitted in serial digital form to the computer center over a common cable. Controlling the flow of aeration process air, for example, will be based on a complex computer program, taking into account the raw sewage flow, the BOD in the primary effluent, the dissolved oxygen level in the aeration tank, and the predicted diurnal variation of the plant flow. Computer flexibility will be stressed to give us a variety of operator-oriented control and monitoring functions. Instead of indicating meters, strip charts, alarm light panels and other conventional displays, the central control room will feature an impressive variety of video screen displays of the status and performance of the entire plant.

Two interesting aspects of automated control are worthy of mention. First, as a means of protecting the biological process against upsets, the plant influent system will be provided with automatic return capability in the event that upstream sensing devices detect toxic wastes. Toxic slugs will be sent downstream to Hyperion, which by virtue of its much greater treatment capacity, can more easily absorb them. The City's policing of all industrial wastes discharged into the sewer system upstream of the Sepulveda plant makes toxic discharges unlikely, but we can't risk having the activated sludge process knocked out for several weeks or months. Another automated control feature is the operation of the plant in a constant flow, or steady state, mode. Constant flow mode will allow the plant to achieve a state of equilibrium where the activated sludge will exist under optimum conditions. Treatment plants which handle the extreme variations in plant flow through the course of a day are essentially compromise designs -- geared to overtreat during minimum and average flows, and to undertreat during peak flows.

We owe our confidence in producing a consistently high quality water at Sepulveda for other reasons as well. The aeration system, for example, has the capability of partial nitrification which is essential for limiting nutrient levels. Our engineers were able to provide this feature with only a modest increase in process air capacity over that needed for the activated sludge process. Following secondary treatment, the effluent will be purified through dual media filters. This tertiary step was added to assure that Sepulveda effluent would meet any future discharge requirements for fine particulate matter, but further analysis indicated it would also contribute significantly to process flexibility and reliability because it complements both the secondary system upstream and the chlorination system downstream. Another departure from conventional design can be found in the chlorination system. After turbulent mixing the flow must travel through the chlorine contact tanks for an extremely long two-hour detention period. This design was based on anticipated limitations for chlorine residual levels, which have since materialized.

The Sepulveda Water Reclamation Plant is aptly named. We believe this plant, to the extent possible, has been conceived with the maximum potential for reuse of its final effluent. In building this potential into the plant, the City has made Sepulveda into what most experts express to be one of the most modern treatment plants of its kind in the world. It will have the capability and flexibility to be operated in optimum condition and is designed to be an extension of the water supply system. Part of the site has even been assigned to the Los Angeles Water System for their eventual future use in a tertiary or fourth stage treatment following the dual media filtration scheduled at the Sepulveda Plant.

One may argue that since our groundwater extractions do not constitute a very large percentage of the total domestic supply, that there is little dependence, to speak of, on our underground supplies. But this overlooks our City's need for a diversified water supply system to capitalize on all of our resources -- which is what good groundwater management is all about.

Jerome B. Gilbert

President
J. B. Gilbert & Associates, Sacramento

THE SACRAMENTO REGIONAL WASTEWATER PROGRAM - RECYCLING TO THE DELTA POOL

THE SACRAMENTO REGIONAL WASTEWATER PROGRAM
RECYCLING TO THE DELTA POOL*

In recent months, in water conferences and in the planning of projects throughout the State, the discussion of wastewater reclamation options has continued to increase. The desire to reuse wastewater is a direct outgrowth of the conservation movement and of most everyone's natural desire (conservationists' viewpoints notwithstanding) to be frugal. Many have come to consider the water resource similar to such resources as oil or gas which are difficult to recover once they have been consumed. Since water is a constantly replenishing resource, our desire for its conservation stems primarily from one of, or a combination of, the following:

- The need to limit financial investments in basic water supply facilities, particularly as cheap supplies are exhausted.
- The increasing desire to avoid <u>any</u> environmental detriments associated with water development projects.
- The desire to avoid creating basic support facilities that will make undesirable growth possible.

<u>Conservation Hydrology</u>

In the planning for management of wastewaters from the Sacramento urban area, the largest urban area in the Central Valley, one geographic fact is fundamental. When wastewater is discharged to the freshwater system of the Central Valley consisting of both ground and surface waters, except for evaporative losses, it will be reused--regardless of the point at which it is discharged. When wastewater is discharged to the estuarine or marine environment, it is lost.

<u>Conservation Technology</u>

There are many ways to make more efficient use of water. On the supply side, most water supply systems still have large leakage factors, large unaccounted for uses, and significant reservoir

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*Presented by Jerome B. Gilbert, President, J. B. Gilbert & Associates at the Watercare Annual Conference, June 24, 1974, San Rafael, California.

evaporation losses. Improved distribution systems, better control of reuse, and continued research on evaporation suppression may effectively increase system yields.

During actual use, many new approaches can be used to save water. The North Marin program, with which you are familiar, is a major start in this direction. Another approach to use management would be to develop a policy of planned shortage. That is, many communities if given the opportunity might elect to take shortages in nonessential uses during dry years as part of a planned program to reduce water supply commitments.

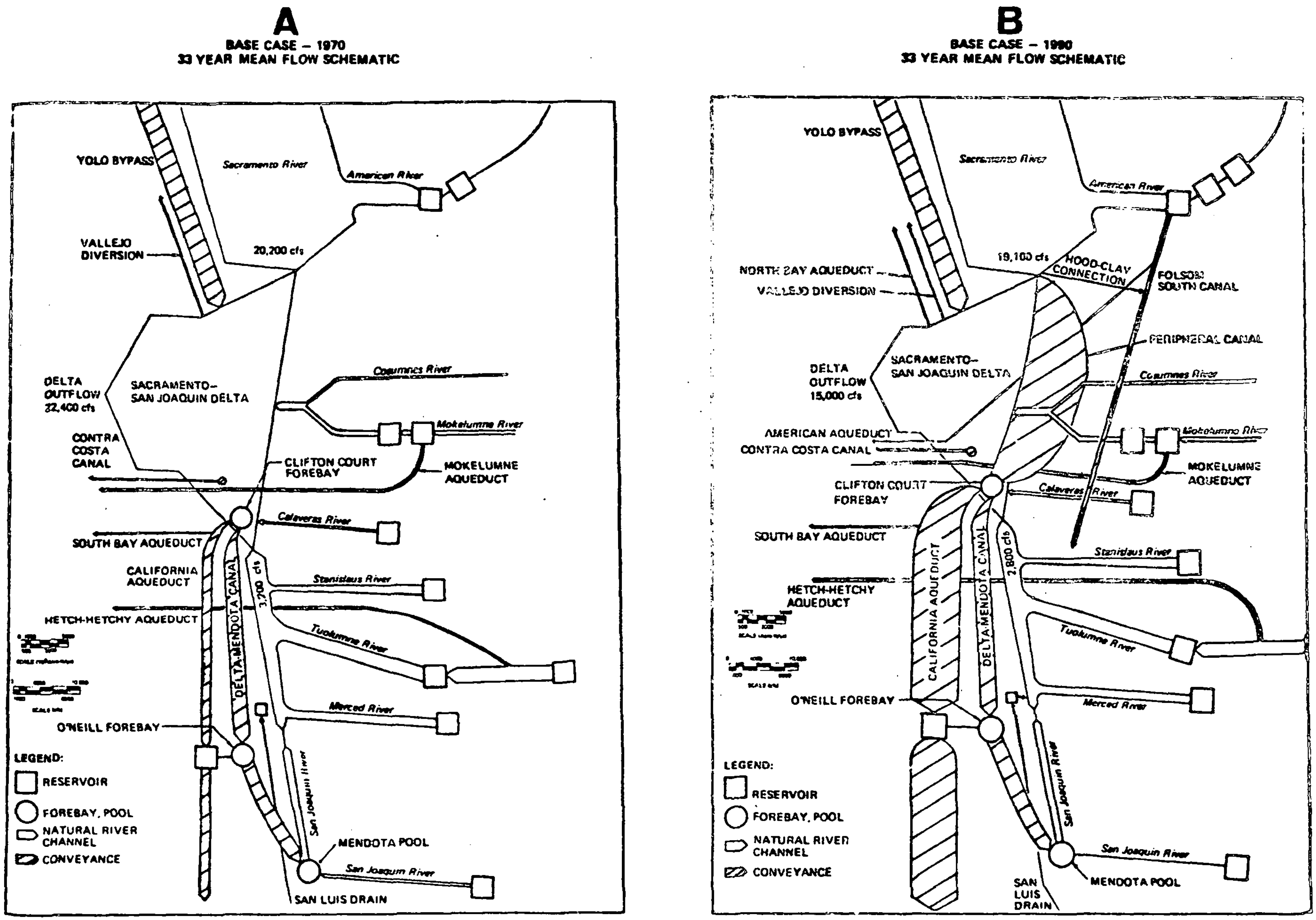
Finally, water can be reused by diverting wastewater effluents through additional treatment as required for a wide variety of uses, leaving only concentrated pollutants or residuals to manage.

Irrigation Return Flow

Even though most of some 42 million acre-feet of water that is used each year in California is used by agriculture, much of this water is used many times before it flows from the Central Valley. This sequential use contributes to salt accumulation problems in the lower parts of the Valley; and when combined with exports, the net result is that during dry years the amount of outflow from the entire Valley will be increasingly limited. (Figure 1) In fact, during dry years, so limited that it is inadequate to meet criteria necessary to assure supply to users in the Western Delta and to assure a viable migratory fishery resource. This has resulted in the requirements for minimum outflow which are quite controversial and which are the subject of litigation between the State and Federal agencies. During most years, at least now, there is plenty of water in the Central Valley. During dry years, the yield of Central Valley reservoirs will be used to assure minimum Delta outflow and to supply users. As the amount of irrigated acreage increases in the Central Valley and more efficient irrigation systems are required, it will be necessary to find ways of removing salts and total dissolved solids from farm soils, particularly in poorly drained areas. Eventually, they will be collected on a regional basis and discharged through such proposed projects as the San Luis Drain and others that may be necessary in the Central Valley. There are increasing demands for more efficient use of water by farmers, but that efficiency may be offset in detriment to soil productivity unless the farm control practices are a part of a regional program which recognizes both the quantity and quality considerations.

FIGURE 1 WATER FLOWAGE IN DELTA AND SAN JOAQUIN VALLEY

Source: State Water Resources Control Board. Water quality control plan report, Central Valley Region 5. May 1975.



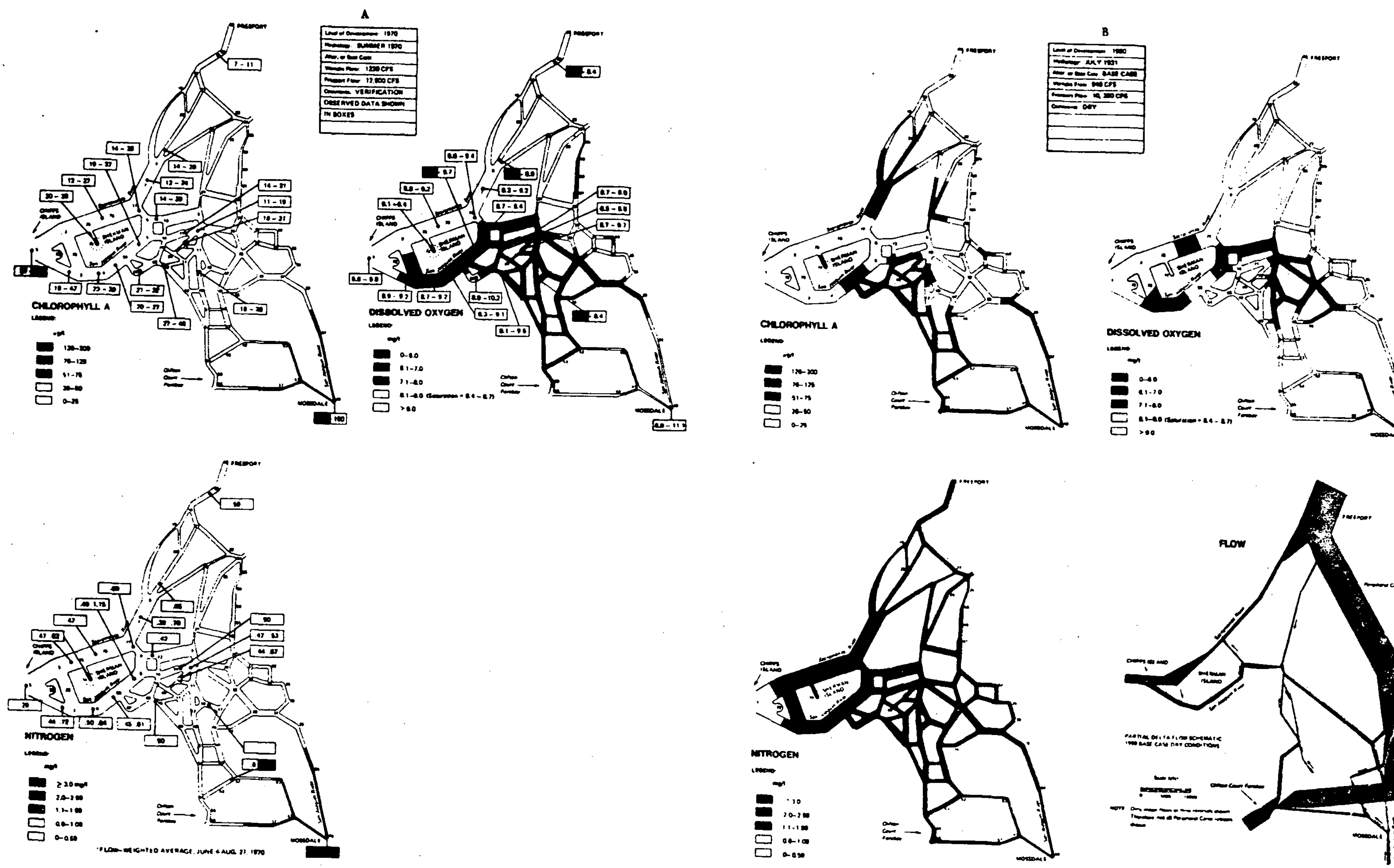


FIGURE III-10 DELTA EUTROPHICATION MODEL OUTPUT

You may wonder what this general discussion of the problem of irrigated agriculture has to do with reclaimed wastewater. First, let us review the goals we discussed at the outset with particular reference to the Sacramento region.

On an average, the region is currently discharging approximately 150 cfs of wastewater to the Sacramento River system. This compares with the proposed capacity of the Peripheral Canal of 18,000 cfs and a proposed minimum Delta outflow of 1,800 cfs under certain circumstances. It is estimated that the region's wastewater flows might reach 450 cfs after the turn of the century. The amount of water used by irrigated agriculture in any of Sacramento, Yolo, Solano, or San Joaquin Counties far exceeds this amount. Local water supplies include ground and surface water sources that range in cost from $5 to $20 per acre-foot, and at the moment they are ample. The State Water Resources Control Board in Decision 1400 has required under normal conditions a minimum flow of 1,500 cfs in the American River with a dry year condition that would reduce flows as low as 800 cfs. The estimated range of 1990 monthly average flows in the Sacramento River is expected to vary from a minimum of 7,000 cfs under full State Water Project operation to a maximum of 100,000 cfs at flood stage.

Two diagrams (Figure 2) illustrate the general magnitude of the flows in the area downstream from the Sacramento waste discharge with and without the Peripheral Canal in operation.

General Use Criteria

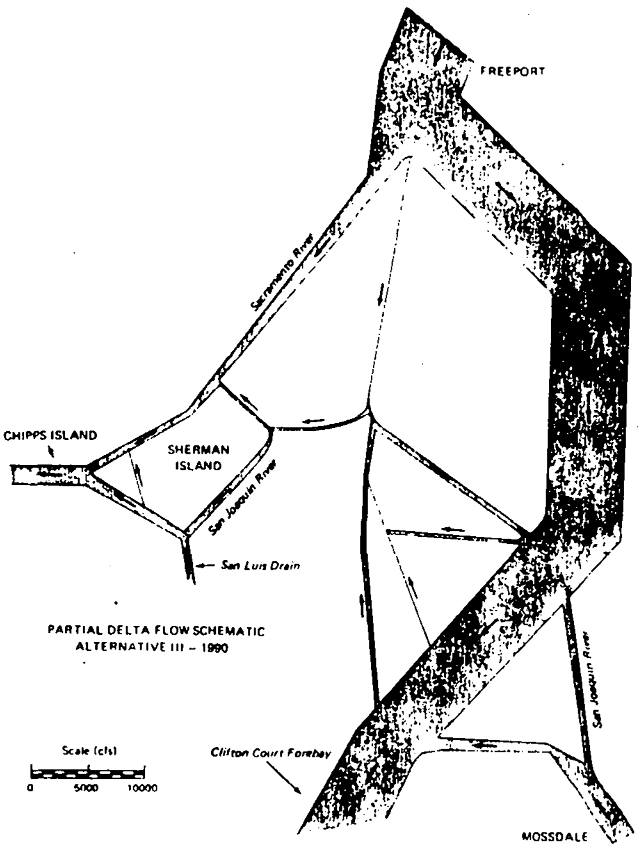
Since wastewater is part of our available water resources, it is important to consider certain desired features of water for various uses.

Irrigation

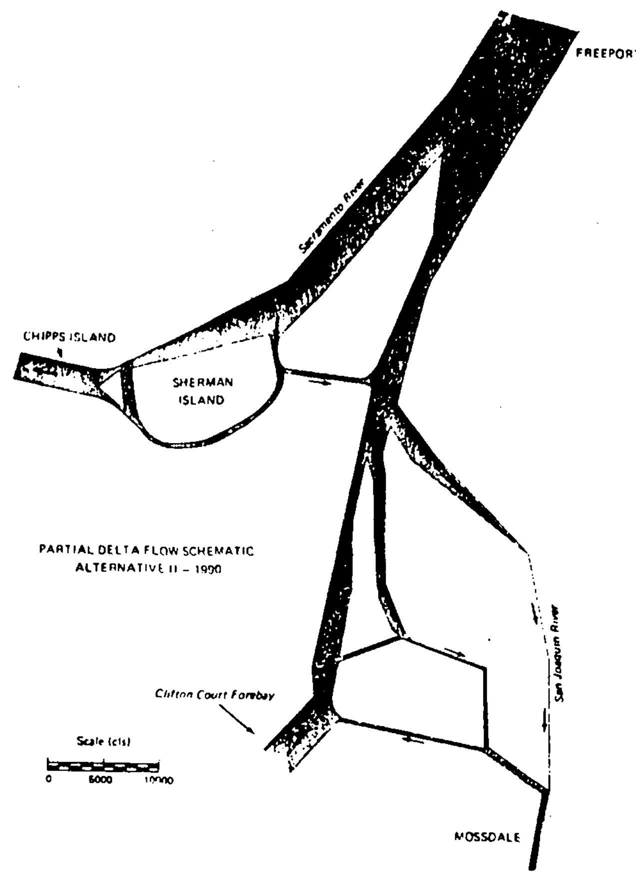
- Low total dissolved solids, the lower the better, but generally below 500 ppm.
- Reliability for delivery primarily at critical irrigation times.
- Seasonal requirements primarily for about six months.
- Any reused water must meet public health criteria which depend on crops.

FIGURE 2

DELTA EUTROPHICATION MODEL OUTPUT



Level of Development:	1990
Hydrology:	JULY 1931
Alter. or Base Case:	ALT III
Vernalis Flow:	4140 CFS
Freeport Flow:	11,820 CFS
Comments:	DRY



Level of Development:	1990
Hydrology:	JULY 1931
Alter. or Base Case:	ALT II
Vernalis Flow:	940 CFS
Freeport Flow:	12,050 CFS
Comments:	DRY

Municipal Supply

- High reliability, but for some uses more than others.

- Total dissolved solids 500 ppm or less with supplies in the range of 100 ppm clearly preferable.

- Any source must be fully treated with sources originating beyond man's influence preferred.

- Where this is not possible, wastewater blends are likely to be acceptable providing full municipal intake treatment is provided and the percentage of blend is extremely low, say less than 5 percent.

Industrial

- Industrial uses vary widely but the primary one considered for application of reuse of wastewaters is cooling which in turn requires low nutrient levels and as low total dissolved solids as possible to reduce the cost of in-plant water recycling.

Delta Outflow

- Here I am tempted to say--any liquid that pushes salt water out is good. However, salinity repulsion isn't the only criteria for location of effluent discharges in the Sacramento-San Joaquin Delta. Up to and including the Western Delta, there are both municipal and irrigation users that could be affected, primarily due to public health aspects, by a relatively high concentration of wastewaters. For example, if Sacramento effluent some 40 years from now were discharged below Hood under the present criteria for minimum Delta outflow, the wastewater would represent on an average 25 percent or more of the total stream at the discharge point and during certain diurnal periods, perhaps more.

These constraints are obviously oversimplified, but they serve as sort of a yardstick considering the place of reclaimed wastewater in the scheme of things.

What Water Goes Where

I was impressed with a study that was done by the Bechtel Corporation for San Diego in the 1960's. The study identified sources of imported water, sources of reclaimed wastewater, potential sites for demineralization facilities, and projected water demands. Economic factors were applied and the model identified desalter, reclamation plant, and imported pipeline locations to provide the optimum solution. This was a theoretical exercise but it illustrated an important principle that should be considered in planning reclamation in the Central Valley. Since as we previously said, all water is reused time and time again and no water is "wasted," the real management needs are:

- To provide the most economical water supply for a particular use.

- To provide water of the quality best suited for the particular use.

- To provide water for uses in accordance with the most efficient seasonal and reliability factors related to the use.

- To apply all waters to various uses in a way that will minimize encroaching on the threshold of public health risk.

Delta Outflow Needs

Sacramento wastewater now contributes to Delta outflow, but constitutes less than 1 percent of current minimum flow passing Chipps Island. If the current discharge location is maintained and the Peripheral Canal is built, the future maximum effluent concentration in flows passing Chipps Island would be further reduced.

If the Peripheral Canal is built, it would be possible to divert most of the wastewater from its intake by extending the outfall downstream on the Sacramento River. This would result in wastewater concentrations ranging from 20 to 30 percent at the point of discharge and the concentration of effluent in water passing Chipps Island would rise to above 2 percent. While significantly contributing to the low flow quantity in the Sacramento River, quality problems would include:

- Requirement for relocation of Cache and Lindsey Slough water diversions.

- Possible impacts on direct agricultural diversion from the River reach.

- Possible impact on westerly Delta municipal users.

- Even if all municipal and agricultural users were terminated west of Hood, the reduced flow, increased light penetration, and nitrogen levels could cause serious adverse increases in productivity.

Delta outflow needs are generally critical only in the late fall or late spring to protect fishery and municipal uses.

The question arises "what would we do with Sacramento's wastewaters during the period it wasn't needed for outflow." It still could be discharged to the system and if it is discharged as proposed at Freeport it automatically becomes part of the export supply and the Department's supply calculations have included the effluent as part of the project yield.

Water Rights

Some have claimed that there is a possible water rights problem in that downstream users including the Department and the Bureau have relied on the availability of effluent for their uses and diversions for other purposes including flow augmentation and this may not be appropriate. Since the California Constitution and legislation requires "reasonable use," it would be hard to claim that wastewater that was put to a reasonable use (i.e., appropriate considering quality and economic factors) must be returned to the stream to satisfy downstream rights.

Nutrients

The nitrogen in wastewater does no good to the Delta. How bad it is we don't know yet, but the thought of removing nitrogen from the region's wastewaters to reduce the adverse effects if the primary use is low flow augmentation seems counterproductive.

Other Uses

There are and will be possible uses for wastewaters that may be preferable to total supply augmentation and are certainly preferable to low flow augmentation in the Lower Sacramento River.

In a hypothetical case developed by Bill Dendy in the Davis workshop on wastewater reclamation, the possibility of the use of wastewater for irrigation in Yolo County was thoroughly explored. In fact that possibility has been so thoroughly explored by the Corps of Engineers, the State Water Resources Control Board, and in the Sacramento program that it is hard to believe there is much left in it. There is no doubt that with the exception of the nitrate sensitive sugar beets certain type of crops can be irrigated with reclaimed wastewaters; but the cost, primarily for transportation, of such reuse ranges from $35 to $120 per acre foot and present local supplies are available at $6 per acre foot. While that gap will narrow, it is unlikely that all of the problems associated with reclaimed water reuse will encourage farmers to substitute it for the very high quality supplies available in the channels and groundwaters in the vicinity of Sacramento.

The use of reclaimed wastewater for industrial or power plant cooling purposes requires a year-round supply and is the subject of increasingly serious study by power utilities despite cost and quality problems.

Summary

To summarize the Sacramento situation, and in fact this applies to the managing of waters in the Valley, the best water we have (i.e., the freshwaters flowing in those streams or conserved in reservoirs in the Valley Uplands where irrigation return flows are relatively limited) can best be applied first to domestic uses where the quality considerations are most significant, and second to irrigation uses. As water is further degraded through irrigation use or domestic use, it might be available for cooling in facilities designed specifically for its use or additional irrigation where the shortage of high quality water has become a problem. It will become a problem and I predict that large quantities of wastewater will be used for irrigation of crops in the Central Valley in the not-too-distant future. As for Delta outflow, it can best be provided by high quality waters (with low municipal wastewater percentages) since the Delta streams are still used for domestic water supplies. The Department of Health is strongly in support of ultimate land disposal of wastewaters, but I doubt whether year-round confinement of wastewaters to land and the 15,000 acres that this is estimated to require by 1990 will be sufficiently beneficial considering the very low risk associated with the proposed discharge.

The State has increasingly supported wastewater reclamation programs. The Contra Costa program of wastewater use for industrial cooling, the many land disposal programs for small communities in the Central Valley, groundwater recharge programs in Southern California all indicate that on a case-by-case basis reclamation may prove desirable. There may be considerations, other than economics and water conservation, that will result in increased reuse, such as the possibilities of open space preservation and marsh enhancement.

When unusual treatment projects have been presented, the State Water Resources Control Board has shown a willingness to give special consideration for grant funding.

Where fresh wastewaters are discharged to the marine environment, the most valuable reuse is that which offsets the need for new supplies for consumptive use. Unfortunately, at least for a while, industrial uses provide the only opportunity.

Reclamation can offer the opportunity to reduce environmental damages, and in some areas of the State actually reduce the cost of providing additional water supplies.

Our goal should not be to reclaim as an end in itself as some seem to advocate. It should be rather to provide a limited amount of the highest quality water appropriate to each particular use, to avoid waste, to minimize environmental damage, and to do all these things at the least cost to society. The use of reclaimed wastewater from the Central Valley specifically to augment Delta outflow does not meet this test. The potential use of Bay area wastewater may. In urban areas until we can achieve some better understanding of the impacts of direct or even partial recycling we need far more emphasis on water conservation and wise use.

Hugo H. Sephton

University of California
Sea Water Conversion Laboratory

INCREASED EFFICIENCIES IN THE DISTILLATION PROCESS BY THE USE OF FOAMING AGENT ADDITIVES

Presented at the Annual Watercare Conference, June 24, 1975.

INCREASED EFFICIENCIES IN THE DISTILLATION PROCESS BY THE USE OF FOAMING AGENT ADDITIVES

by Hugo H. Sephton

University of California Sea Water Conversion Laboratory

SUMMARY

Desalination of seawater and wastewaters increasingly provides a source of high quality water for potable and industrial use. Recent developments indicating the potential of vertical tube evaporation (VTE) for wastewater renovation-recycle and freshwater production are the startup of the Orange County facility (Water Factory 21), several seawater desalting plants in the Caribbean, the industrial use of vertical tube evaporation for concentration of effluents notably from pulp and paper mills and cooling towers, and the startup of a State- and Utility-sponsored project to test the use of irrigation drainage for power plant cooling in the San Joaquin Valley.

This paper presents a novel method of operating vertical tube evaporators (VTE) that provides an approximately 100 percent increase in their rates of distilled water production. This mode of VTE operation, termed interface enhancement, relies on the addition to the saline feed of a few parts per million of a selected, biodegradable surfactant (detergent) followed by induced foamy two-phase vapor-liquid flow of the feed over the heat transfer surfaces, under otherwise conventional process conditions.

Typical test data, obtained with a 10,000 gallon per day pilot plant under process conditions that closely simulate those pertaining to large plant installations utilizing the most advanced distillation technology, will be presented, showing heat transfer performance data with and without the

interface-enhanced procedure. A method for recycle of the foaming agent additive, by foam fractionation, was also developed as shown.

Applications for the interface-enhanced VTE technology will be discussed, including seawater desalting, wastewater renovation and its proposed use in novel power plant cooling cycles designed to utilize wastewater and waste heat.

# # # # #

Recent papers published on this work:

1) "Desalination by Upflow Vertical Tube Evaporation with Interface Enhancement," Proceedings of the International Desalination & Environmental Association Conference, Puerto Rico, April 1975.

2) "Recycle of Power Plant Cooling Tower Blowdown by Vertical Tube Evaporation with Interface Enhancement, Utilizing Waste Heat," Second National Conference on Complete WateReuse, Chicago, May 1975.

Gordon Culp

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AMMONIA STRIPPING
AND HIGH RATE FILTRATION

I. AMMONIA STRIPPING

The only nitrogen-removal process that actually has been used on a plant scale in wastewater treatment is ammonia stripping. This process has been in use for ammonia nitrogen at the South Lake Tahoe plant for about 6 years.[2] Both the advantages and limitations of this process have been clearly demonstrated.

The ammonia-stripping process itself consists of

- Raising the pH of the water to values in the range of 10.8 to 11.5, generally with the lime used for phosphorus removal
- Formation and re-formation of water droplets in a stripping tower
- Providing air-water contact and droplet agitation by circulation of large quantities of air through the tower

The towers used for ammonia stripping closely resemble conventional cooling towers.

Questions are sometimes raised concerning the fate of ammonia discharged to the atmosphere. Are we merely converting a water-pollution problem to an air-pollution problem? Does the ammonia stripped from the wastewater cause an air-pollution problem or find its way back to the receiving stream owing to scavenging by precipitation?

The concentration of ammonia in the stripping-tower discharge is only about 6 mg/m^3 for domestic wastewaters (at an air flow of 500 ft^3/gal and at an ammonia concentration of 23 mg/l in the tower influent). As the odor threshold of ammonia is 35 mg/m^3, the process does not present a pollution problem in this respect. The ammonia discharged to the atmosphere is a stable material that is not oxidized to nitrogen oxides in the atmosphere. The natural production and release of ammonia as part of the natural nitrogen cycle is about 50 billion tons per year. Roughly 99.9 percent of the atmosphere's ammonia concentration is produced by natural biological processes.[1] There is a large turnover of ammonia in the atmosphere, with the total ammonia content being displaced once a week on the average. Ammonia is returned to the earth through gaseous deposition (60 percent), aerosol deposition (22 percent), and precipitation (18 percent). Ammonia is not considered an air pollutant because there are no known public health implications, and because it is a natural constituent of the atmosphere derived almost entirely from natural sources. For example, a single cow releases as much nitrogen to the atmosphere in feces and urine as 12 people would contribute if all of their ammonia production were stripped to the atmosphere.

There are no standards in the United States for ammonia concentrations in the atmosphere. Some foreign standards[1] have been established.

- Czechoslovakia, 100 mg/m^3 (24 hours)
- U.S.S.R., 200 mg/m^3 (24 hours)
- Ontario, Canada, 3,500 mg/m^3 (30 minutes)

All of these standards are far above the 6 mg/m^3 that will occur right at the tower discharge. The process cannot be dismissed from consideration because of air pollution.

A remaining question is the fate of the ammonia discharge to the air. Is it likely to find its way into the receiving stream by being scavenged from the atmosphere by precipitation?

Ammonia may be washed from air by rainfall, but not by snowfall. The natural background concentration of ammonia in the atmosphere is 5-7 ppb. In rainfall the natural background ranges from 0.01 to 1 mg/l, with the most frequently reported values of 0.1 to 0.2 mg/l. The amount of ammonia in rainfall is related directly to the concentration of ammonia in the atmosphere. Thus, an increase in the ammonia in rainfall wuuld occur only in that area where the stripping-tower discharge increases the natural background ammonia concentration in the atmosphere.

Calculations for the ammonia washout in a rainfall rate of 3 mm/h (0.12 in./h) have been made for the Orange County, Calif., project. The ammonia concentrations of ammonia in the rainfall would approach natural background levels within 16,000 feet of the tower. Of course, the ammonia discharge during dry periods diffuses into the atmosphere quickly so that the background concentration and resulting washout rate of ammonia at greater distances from the tower are not affected during a subsequent storm. The ultimate fate of the ammonia that is washed out by rainfall within the 16,000-foot downwind distance depends on the nature of the surface upon which it falls. Most soils will retain the ammonia. That portion which lands on paved areas or directly on a stream surface will appear in the runoff from that area. Even though a portion of the ammonia washed out by precipitation will find its way into surface runoff, the net discharge of ammonia to the aquatic environment in the vicinity of the plant would be very substantially reduced.

One of the great advantages of this method of nitrogen removal is its extreme simplicity. Water is merely pumped to the top of the tower at a high pH, air is drawn through the fill, and the ammonia is stripped from the water droplets. The only control required is the proper pH in the influent water. This simplicity of operation also enhances the reliability of the process.

Several factors affect the efficiency of the ammonia-stripping process.

- Type of stripping unit
- pH
- Temperature
- Loading rate
- Scale of deposition

There are three basic types of stripping units now being used in full-scale applications.

- Countercurrent towers
- Crossflow towers
- Stripping ponds

Countercurrent towers (the entire airflow enters at the bottom of the tower while the water enters the top of the tower and falls to the bottom) have been found to be the most efficient. In the crossflow towers, the air is pulled into the tower through its sides throughout the height of the packing. This type of tower has been found to be more prone to scaling problems. The stripping-pond approach will be discussed in more detail later.

The pH of the water has a major effect on the efficiency of the process. The pH must be raised to the point that all of the ammonium ion is converted to ammonia gas. The pH required varies somewhat with temperature,[2] but is generally about 11.0.

Another critical factor is the air temperature. The water temperature has less effect on performance because the water temperature reaches equilibrium with the air temperature in the top few inches of the stripping tower. The efficiency of the process decreases as the temperature decreases. For example, at 20° C 90 percent removal of ammonia is typically achieved. At 10° C, the maximum removal efficiency drops to about 75 percent. When air temperatures reach freezing, the tower operation must generally be shut down owing to icing problems.

The hydraulic loading rate of the tower is also an important factor. This rate typically is expressed in terms of gallons per minute applied to each square foot of the plan area of the tower packing. When the hydraulic loading rates become too high, good droplet formation is disrupted and the water begins to flow in sheets. Tower loading rates of 2 gal/min/ft^2 have been shown to be compatible with optimum tower performance.[2] It is critical that the water and air be uniformly distributed over the tower area.

Another factor that may have an adverse effect on tower efficiency is scaling of the tower packing resulting from deposition of calcium carbonate from the unstable, high-pH water flowing through the tower. The original crossflow tower at the South Lake Tahoe plant has suffered a severe scaling problem. The severity of the scaling problem was not anticipated from the pilot studies in which a countercurrent tower was used. As a result, the full-scale crossflow-tower packing was not designed with access for scale removal in mind. Thus, portions of the tower packing are inaccessible for cleaning. Those portions that were accessible were readily cleaned by high-pressure hosing. The potential scaling problem must be recognized in design. The use of countercurrent towers and design of the packing with access for cleaning can adequately combat this problem.

An example of design for scale control is the 15-mgd tower now under construction at the Orange County, Calif., Water District plant (fig. I-1). There the tower packing has been designed to be readily removable for cleaning as a precaution against scaling problems, although no significant scaling problem has been observed in several months of pilot tests at Orange County.[3] Scaling has also been reported not to be a significant problem at the Windhoek, South Africa, plant where only a soft, easily removed scale was encountered.[4] On the other hand, tests at the Blue Plains pilot plant encountered a hard scale that was extremely difficult to remove.[5] The hardness of the scale at Blue Plains was affected by operating pH, with a harder scale forming at pH 11.5 than at pH 10.8.

Typical design criteria are

- Hydraulic loading, 1 to 3 gal/min/ft^2
- Air-to-water ratio, 300 to 500 ft^3/min per gal/min
- Air-pressure drop, 0.5 to 1.25 inches water
- Fan-tip speed, 9,000 to 12,000 ft/min
- Fan-motor speed, 1 or 2 speed
- Packing depth, 20 to 25 feet

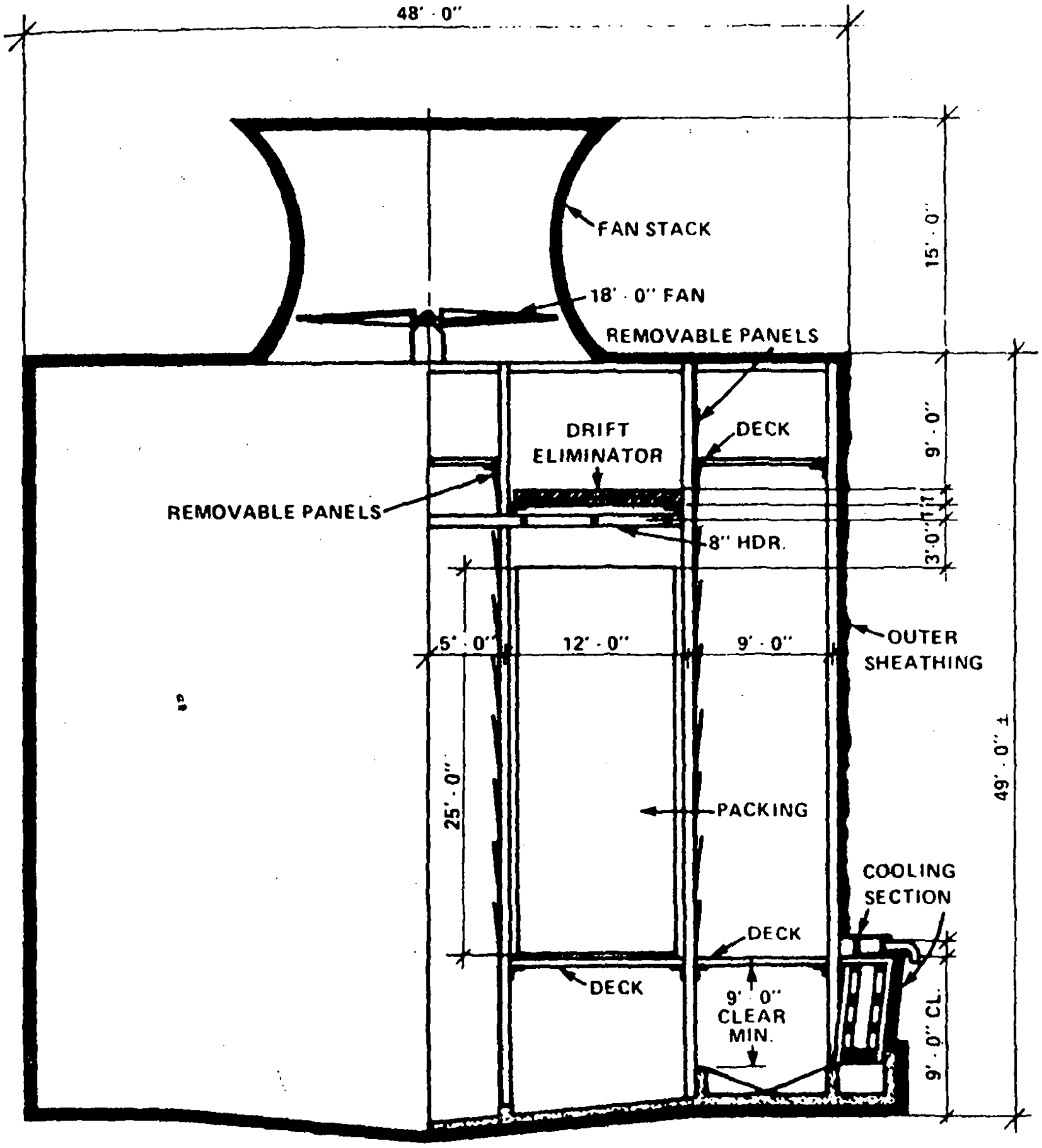

Figure I-1. Ammonia-stripping tower design, Orange County, Calif.

- Packing spacing, 2 to 4 inches horizontal and vertical
- Packing material, wood, plastic (½-in. PVC pipe being used at Orange County)

A curve for estimating the costs of the ammonia-stripping process for various-size plants is presented in figure I-2. This curve is based on a loading rate of 2 gal/min/ft^2. Because some applications may require ammonia removal only during warm weather months, operating costs are shown for both 6-month and 12-month operation.

The South Tahoe system is being modified to reduce the impact of temperature and scaling limitations encountered at this plant.[6] Basically, the modified process will consist of three steps (see figs. I-3, I-4, and I-5).

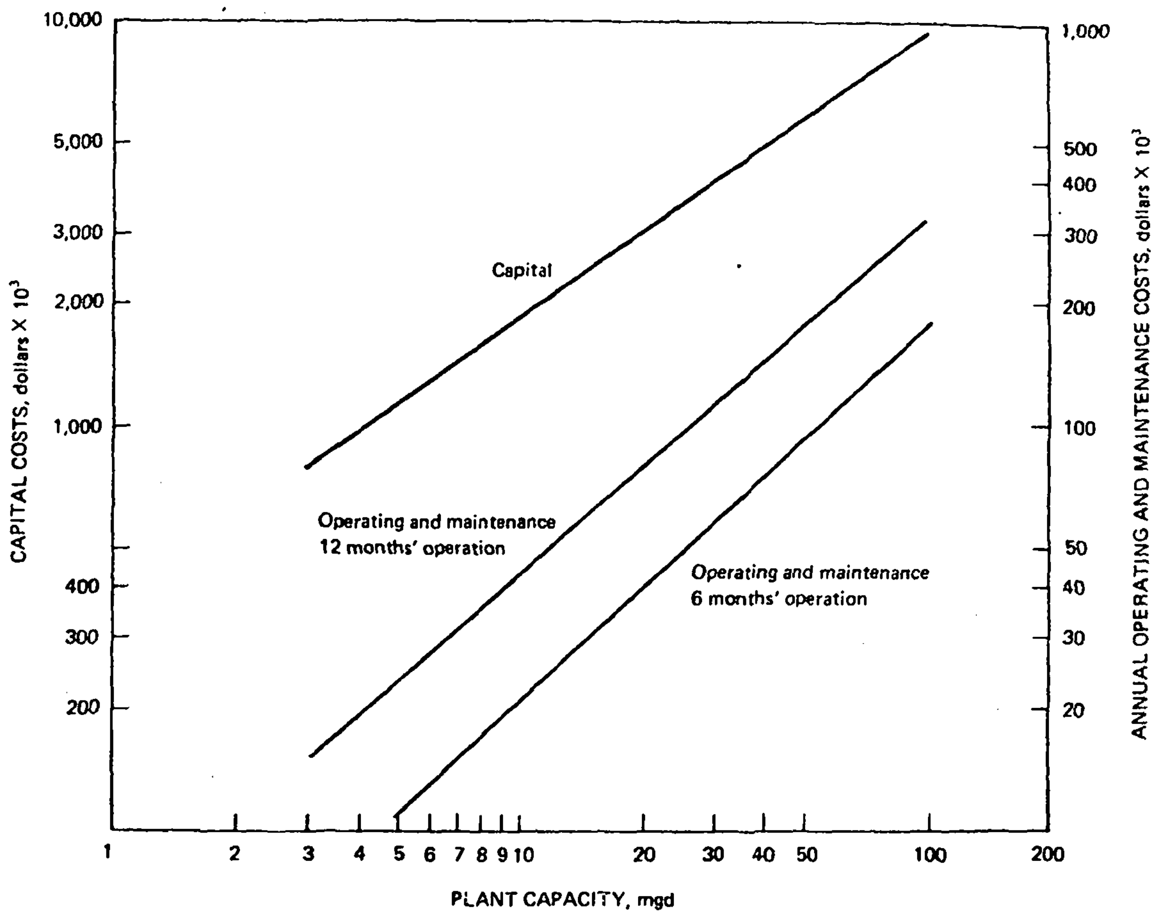

Figure I-2. Ammonia-stripping costs. (EPA STP Index = 200; includes engineering, legal, administrative, construction financing, and contingencies.)

- Holding in high-pH, surface-agitated ponds
- Stripping in a modified, crossflow forced-draft tower through air sprays installed in the tower
- Breakpoint chlorination

This system was inspired by observations in Israel of ammonia nitrogen losses from high-pH holding ponds.[7]

Pilot tests at South Tahoe indicated that the release of ammonia from high-pH ponds could be accelerated by agitation of the pond surface. In the modified Tahoe system, the high-pH effluent from the lime clarification process will flow to holding ponds. Holding pond detention times of 7-18 hours will be used in the modified South Tahoe plant. The pond contents will be agitated and recycled 4-13 times by pumping the pond contents through vertical spray nozzles into the air above the ponds. At least 37 percent ammonia removal is aniticipated, even in cold weather conditions, in the ponds. The pond contents then will be sprayed into the forced-draft tower. The packing will be removed from the tower and the entire area of the tower will be equipped with water sprays. At least 42 percent removal of the ammonia in the pond effluent is anticipated, based on pilot tests, from this added spraying in cold weather, which will include recycling of the pond effluent through the tower to achieve 2-5 spraying cycles. The ammonia escaping this process then

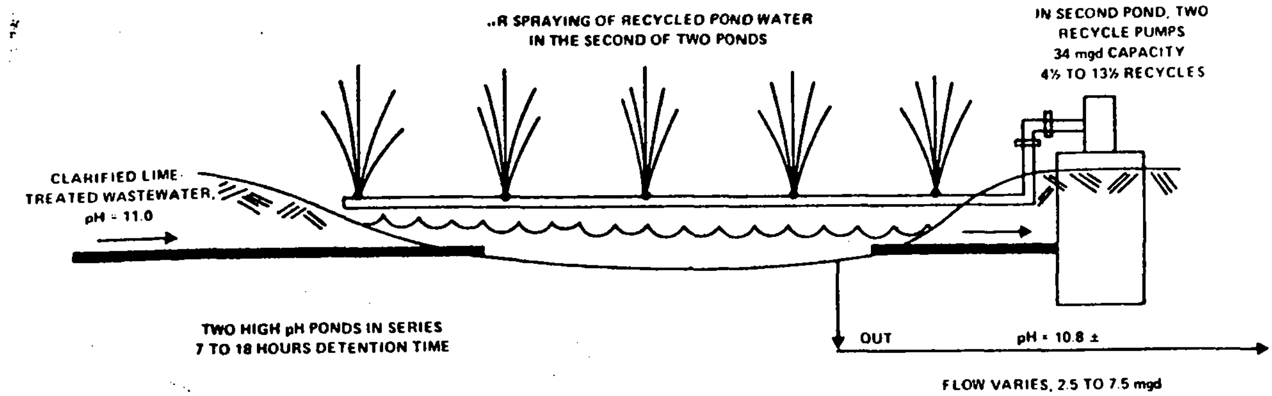

Figure I-3. Proposed new and modified ammonia nitrogen removal processes, South Lake Tahoe: New high-pH flow-equalization ponds.

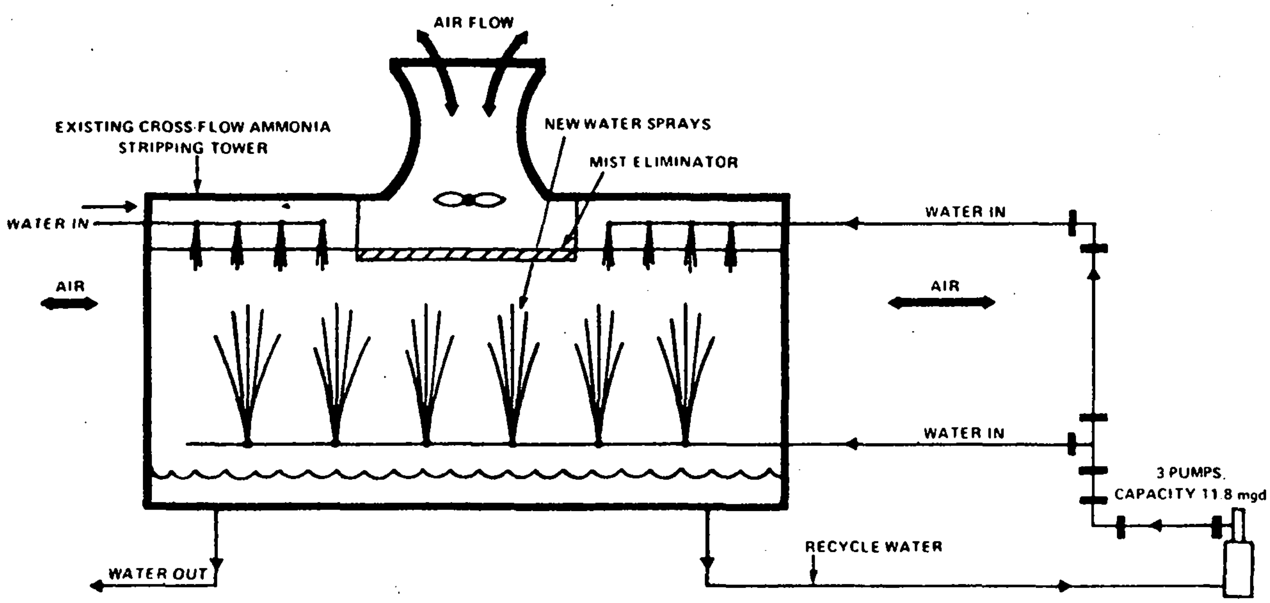

Figure I-4. Proposed new and modified ammonia nitrogen removal processes, South Lake Tahoe: Existing stripping tower modified with new sprays.

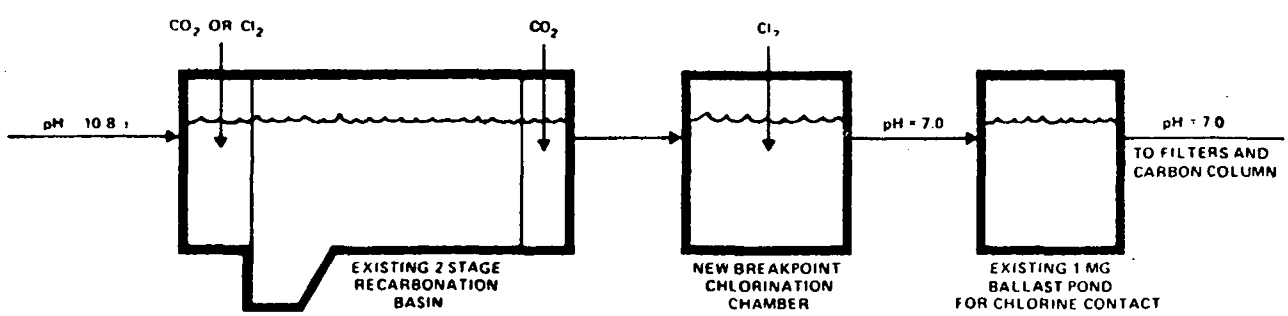

Figure I-5. Proposed new and modified ammonia nitrogen removal processes, South Lake Tahoe: Breakpoint chlorination (new).

will be removed by downstream breakpoint chlorination. The quantity of ammonia to be removed by breakpoint chlorination will vary from 5 to 16 mg/l, depending on the plant flow and temperatures.

Another approach to overcoming the limitations of the stripping process has been developed by CH2M/HILL Consulting Engineers.[8] Although the process is only in its initial stages of development, preliminary tests indicate it may be a significant advance in the state of the art of nitrogen removal. It appears that the new process overcomes most of the foregoing limitations and has the advantage of recovery of ammonia as a byproduct.

The improved process, shown diagrammatically in figure I-6, includes an ammonia-stripping unit and an ammonia-absorption unit. Both of these units are essentially sealed from the outside air but are connected by appropriate ducting. The stripping gas, which initially is air, is maintained in a closed cycle. The stripping unit operates essentially in the same manner that is now being or has been used in a number of systems, except that this system recycles the gas stream rather than using single-pass outside air.

Most of the ammonia discharged to the gas stream from the stripping unit is removed in the absorption unit. The absorbing liquid is maintained at a low pH to convert absorbed and dissolved ammonia gas to ammonium ion. This technique effectively traps the ammonia and also has the effect of maintaining the full driving force for absorbing the ammonia, since dissolved ammonia

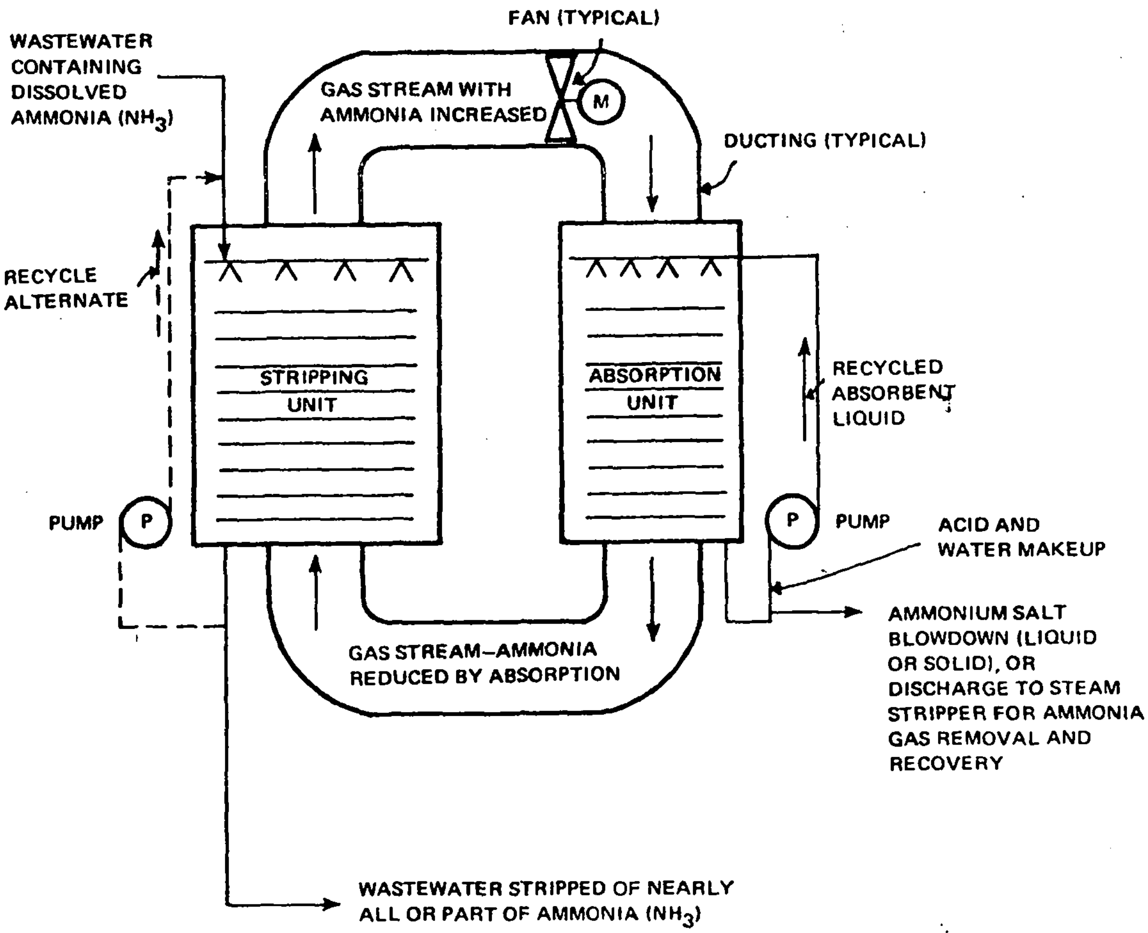

Figure I-6. Process for ammonia removal and recovery.

gas does not build up in the absorbent liquid. The absorption unit can be a slat tower, packed tower, or sprays similar to the stripping unit, but will usually be smaller owing to kinetics of the absorption process.

The absorbent liquid initially is water with acid added to obtain low pH, usually below 7.0. In the simplest case, as ammonia gas is dissolved in the absorbent and converted to ammonium ions, acid is added to maintain the desired pH. If sulfuric acid is added, for example, an ammonium sulfate salt solution is formed. This salt solution continues to build up in concentration and the ammonia is finally discharged from the absorption device as a liquid or solid (precipitate) blowdown of the absorbent. With current shortages of ammonia-based fertilizers, a salable byproduct may result.

Other methods of removal of the ammonia from the absorbent may also be applicable, depending on the acid used and the desired byproduct. Ammonia gas or aqua ammonia could be produced, for example, by steam stripping the absorbent. In this case, acid makeup would be unnecessary.

It is believed that the usual scaling problem associated with ammonia-stripping towers will be eliminated by the improved process, since the carbon dioxide which normally reacts with the calcium and hydroxide ions in the water to form the calcium carbonate scale is eliminated from the stripping air during the first few passes. The freezing problem is eliminated owing to the exclusion of nearly all outside air. The treatment system will normally operate at the temperature of the wastewater.

REFERENCES

[1]S. Miner, "Preliminary Air Pollution Survey of Ammonia," U.S. Public Health Service, Contract No. PH22-68-25, Oct. 1969.

[2]A. F. Slechta and G. L. Culp, "Water Reclamation Studies at the South Tahoe Public Utility District," *J. Water Pollut. Cont. Fed.*, *39*, 787, May 1967.

[3]G. M. Wesner and R. L. Culp, "Wastewater Reclamation and Seawater Desalination," *J. Water Pollut. Cont. Fed.*, *44*, 1932, Oct. 1972.

[4]R. B. Dean, ed., *Nitrogen Removal from Wastewaters*, Federal Water Quality Administration Division of Research and Development, Advanced Waste Treatment Research Laboratory, Cincinnati, Ohio, May 1970.

[5]T. P. O'Farrell et al., "Nitrogen Removal by Ammonia Stripping," *J. Water Pollut. Cont. Fed.*, *44*, No. 8, 1527, Aug. 1972.

[6]J. G. Gonzales and R. L. Culp, "New Developments in Ammonia Stripping," *Pub. Works*, May and June 1973.

[7]Y. Folkman and A. M. Wachs, "Nitrogen Removal Through Ammonia Release from Ponds," *Proceedings, 6th Annual International Water Pollution Research Conference*, 1972.

[8]L. G. Kepple, "New Ammonia Removal and Recovery Process," *Water Waste*, in press, 1974.

II. HIGH RATE FILTRATION WITH THE MIXED-MEDIA CONCEPT

INTRODUCTION

Filtration of water which contains relatively small amounts of suspended solids through granular filter media is one of the key process steps in present water treatment and tertiary sewage treatment practice. Because of the large number of variables involved, filtration practice varies widely.

A current trend in the water treatment industry is higher filtration rates and improved filtered water clarity. This trend has caused the widespread use of filters made from materials of differing specific gravities such as anthracite coal, silica sand, garnet, and ilmenite. Many possible mechanisms of particle removal by granular filters have been presented in the recent technical literature (Ives and Gregory, 1967; Mintz, D. M., 1966; O'Melia and Stumm, 1967). A recent paper (Conley and Hsiung, 1968) summarized filtration theory and the theoretical basis of the mixed-media concept. Various formulations for optimizing a mixed-media design were presented. The purpose of this paper is to present a practical discussion of the factors affecting mixed-media design and the practical applications.

MECHANISMS INVOLVED IN FILTRATION

There are two principal mechanisms involved in filtration of dilute suspensions through porous media. The most important mechanism is adhesion of the suspended matter to the grains of the filter media and to previously deposited material. The second and less important mechanism is straining of the suspended matter much as peas are retained in a kitchen sieve. The intent of good filter design is to prevent straining because straining leads to very rapid headloss increase. This is true because straining leads to cake formation with the deposited material acting as the filter. The filter becomes steadily finer as material deposits and headloss increase exponentially. This situation can be prevented by making sure that the filter media grain size is too large to permit straining to occur. Removal in this situation is by chance adhesion of the relatively small suspended particle onto the relatively large surface of the filter media or previously deposited material.

The suspended matter to be filtered will usually be a chemical floc containing turbidity and color from the raw water. This floc will readily adhere to surfaces of filter media or to previously deposited floc. The adhesion is so pronounced that particles too small to be seen with the unaided eye are readily removed by filtration through relatively coarse filter media. When this floc is removed by backwashing, the average particle size is found to be greatly increased. Based on this observation, it has been argued that a filter is a superior flocculator and that the adhesion is in reality flocculation upon the filter media grains. The argument is largely one of semantics.

VARIABLES AFFECTING FILTRATION

Flow Rate

The flow rate through the filter is a critical variable because the water tends to drag the particles of floc past the filter grains. As more particles accumulate, the flow cross section is reduced and the velocity of the water increases. Finally, equilibrium is reached so that the dragging action of the water balances the adhesive force and no further deposition occurs. Stated another way, the higher the flow rate, the more difficult it will be to cause particles to stick in a filter made of granular materials. For a given suspension and given filter, there will be a flow rate which will result in most of the suspended matter appearing in the effluent. In effect, there will be gross filtration failure at some flow rate.

Applied Suspended Solids

Both the kind and amount of suspended solids applied to the filter have a major effect on filtration performance. For a given kind of suspended solids, an increase in applied load will cause an increase in rate of headloss and a possible degradation of effluent quality. Suspended solids vary widely in filtration characteristics. An order of magnitude variation in rate of headloss increase for the same concentration of different materials may occur. Two orders of magnitude variation can be obtained by variation of polyacrylamide feed. Penetration of filters by different kinds of suspended solids also varies widely. At present, the only reliable way to predict the filtration characteristics of suspended solids is to run careful pilot filtration tests.

Desired Effluent Quality

The desired effluent quality is an important variable in filtration. Quality can be measured by running a suspended solids or turbidity determination, backed up by infrequent specialized tests for iron, aluminum, coliform organisms, algae, etc. The trubidity measurement is the most practical method and, properly used, is a highly satisfactory method of control. The best turbidimeters are highly sensitive and can readily and continuously detect subtle variations in effluent quality that would otherwise be missed.

If it is desired to have an effluent quality containing less than 0.1 standard turbidity unit, the filter design will be quite different from that needed to produce an effluent turbidity of 1.0 standard unit, or 10 standard units.

Water Temperature

Water temperature is a major variable in filtration. The effects are complex and quantitative estimates of these effects are uncertain. However, a given water is always more difficult to filter when cold than when warm, because floc penetration into and through the filter is greater. Because of the greater floc penetration for cold water, the rate of headloss increase is not necessarily greater than for warm water although the viscosity of water is 44 percent greater at 0 degrees C than at 20 degrees C.

Depth of Filter

A thin layer of granular filter media will remove a certain percentage of the applied suspended solids. It follows that the depth of filter media required is a function of the applied load and the desired quality. If a three-inch layer of a given size media will reduce the suspended solids from 10 to 5, a second 3-inch layer would reduce the solids from 5 to 2-1/2 and a third layer would reduce the 2-1/2 to 1-1/4. In order to reduce the suspended solids below 0.1 ppm, seven layers would be required. The foregoing is based on the assumption that all layers are exactly alike and that the filter is not run long enough to significantly alter the porosity of the media, and that the suspension is uniform in all significant filtration properties.

As the filter run continues, floc will accumulate in the media voids and the percentage removal of each layer will change. The top layer voids will be filled more quickly than the bottom layer and there will be a gradual shift of suspended solids deeper into the filter. The top part of the filter becomes less useful with time and the bottom part becomes more useful. It follows that the deeper the filter, the longer it can be run before floc penetrates through it.

Media Size

Small sand grains remove a higher percentage of the applied suspended matter than large sand grains. This can be explained in two ways. First, the surface area of the smaller grains is greater per a given unit volume than the area of the larger grains. This greater surface area presents more opportunity for floc particles to accumulate. Second, the opportunity for bridging between grains is greater for the smaller grains. The rate of headloss increase is greater for small media particles than it is for large media particles. It is generally agreed by workers in the field of filtration that headloss decreases and floc penetration into a filter increases as a function of the media grain size.

THE SAND FILTER

The sand filter has been used successfully for many years to filter water containing small amounts of suspended matter and is in use in a majority of the water filter plants in the United States. Upon back-washing the sand filter, there is a selective movement of the finer grains toward the top and of the larger grains toward the bottom. Figure 1 is an idealized illustration of a sand filter. A typical sand filter will have a variation of about a factor of 3 in diameter of sand grains (smallest 10% to largest 10%). Because most of the smaller grains are near the top of the filter and most of the larger grains are near the bottom, there will be a significant difference in filtration performance from top to bottom in the filter. The headloss effect is magnified because the smallest grains near the top of the filter are exposed to the maximum concentration of suspended solids. Headloss would be less if the larger grains were associated with the higher concentration of suspended solids. This is not possible with a filter made from a single material of uniform specific gravity unless flow is upward through the filter. Upflow introduces problems which have not been satisfactorily solved on a plant scale, such as uplift of the media as headloss develops and the cross connection inherent with upflow.

One approach to improve the grain size distribution illustrated in Figure 1 is to make the sand as uniform as possible. Unfortunately, in practice, it is economically prohibitive to obtain sand that is much more uniform than the 3 to 1 variation mentioned in the foregoing part of this paragraph.

Anthracite coal can be used rather than the sand in a single media filter. Coal does not stratify as uniformly as sand because of slight differences in particle specific gravity and odd shapes of the individual particles. The porosity of the coal is also lower. Because of these factors, headloss increase in coal is less than in sand of the same nominal size.

The designer of a sand filter is faced with a dilemma. From a quality standpoint, the sand grains should be small but from a headloss standpoint, they should be large. The dilemma is easily resolved if the filter is to be operated at low rates, but at some critical flow rate, it is not possible to resolve it. For example, for most water supplies a sand filter of 0.4 mm effective size can be expected to produce a good effluent and reasonable length filter runs at 2 gpm per square foot. The same filter at 5 gpm per square foot will have unacceptable length filter runs, although the effluent will be acceptable. If the effective size is increased to 0.8 mm, the headloss will be acceptable at 5 gpm per square foot but the effluent quality will be unacceptable.

One alternative is to use coarser media and increased filter depth. However, a more practical approach is to use materials of different specific gravity and sizes in the same filter.

THE DUAL MEDIA FILTER

After settling following backwash, filter media grains are positioned in the filter according to specific gravity and grain size. Anthracite coal with a specific gravity of 1.6 and a grain size of 1.0 mm will be above silica sand with a specific gravity of 2.6 and a grain size of 0.5 mm. However, silica grain less than 0.3 mm will be above the 1.0 mm coal or mixed with it due to the relationship of the particle diameters. Similarly, coal grains larger than about 2 mm will be below 0.5 mm sand or will be mixed with the sand. By correct relative sizing of coal and sand, one can obtain a filter which in effect is a coarse filter on top of a fine filter, as illustrated in Figure 2. A typical design is 20 inches of 0.8 to 2 mm coal on top of 10 inches of 0.4 to 1 mm sand. This filter is a partial solution to the dilemma posed by the sand filter. The dual media filter can be operated at high rate with low headloss and good effluent. The permissible upper flow limit depends on water temperature, kind and amount of suspended matter being filtered, depth of filter, and media grain size.

It will be noted that the coal-sand filter gives increased length of filter run at reasonably high filtration rates because of the relatively coarse coal at the top of the filter, while the effluent turbidity remains fairly good because of the relatively fine sand at the bottom of the filter. However, this arrangement can lead to problems with floc breakthrough, especially when filtering cold water at rates above 3 gpm per square foot. The total surface area of the filter particles is less in a bed of the type shown in Figure 1. The upper, fine sand is replaced with a coarser coal with a net effect of creating an overall coarser filter. Floc breakthrough can be prevented by using sand and coal of smaller sizes. There are limitations as noted in the foregoing paragraph concerning the ratio of sizes that can be used. The coal grains must not be larger than approximately three times the size of the sand grains to avoid sand being on top of the coal following backwash.

Experience has shown that it is not feasible to use silica sand smaller than about 0.4 mm because smaller sand would require smaller coal which would result in unacceptably high headloss at rates above about 3 gpm per square foot.

It will be seen that although the coal-sand filter can be operated satisfactorily at a higher rate than a sand filter, at some flow rates the filter will give short filter runs. If headloss is limiting, the coal size can be increased but only to the point compatible with the size sand that is required to maintain water quality. Similarly, if water quality is limiting, the sand size can be decreased but only to the point compatible with the size coal that is required to maintain a reasonable headloss increase. The point is finally reached where it is not possible to produce both the required quality and required length of run without using some alternative method. One method is the use of a third material of smaller size but greater specific gravity than sand.

THE MIXED, THREE MEDIA FILTER

Garnet with a specific gravity of about 4 and ilmenite with a specific gravity of about 4.5 are relatively inexpensive materials that are suitable for use in multimedia filters. It is possible to use garnet or ilmenite particle sizes that are about half those of silica sand and yet keep the small grains near the bottom of the filter where the filtration duty is relatively light. A typical multimedia design is 4 inches of 0.2 to 0.4 mm garnet, 8 inches of 0.5 to 1.0 mm sand and 18 inches of 1 to 2 mm coal. This filter has about 25 percent more filter particle surface area than a typical dual media filter but the rate of headloss increase somewhat less than the typical coal-sand filter because the three media filter has coarser materials near the top of the filter. The addition of the third filter media is justified under conditions where there is floc penetration of the filter bed. This condition ordinarily occurs when filtering water that is very cold or when operating at high filtration rates. The presence of the fine garnet or ilmenite in the filter bed makes high-rate filtration safer than with dual media because of the overall greater available filter particle surface area.

Careful selection of coal, sand, and garnet will give a filter that consists of almost pure coal at the top surface but with varying mixtures of sand and garnet at deeper levels in the bed and with an almost pure layer of garnet at the very bottom of the bed.

Proper particle sizing permits controlled intermixing of the filter materials to eliminate the undesirable effects of the stratified layers shown in Figure 2. It is possible, with proper intermixing to closely approach the ideal filter configuration shown in Figure 3. The efficiency of filtration, then, will steadily increase from the top of the bed to the bottom. Most of the material will be filtered out in the upper, relatively coarse filter media where the headloss will be low. The final polishing, however, will be done deeper in the bed where, because of the small amount of floc, the headloss will not be very high. The characteristics of such a filter approach the low headloss characteristics of a filter made of coal, but produce a filtered water quality as good or better than that from a filter made of fine sand operating at lower rates.

A rough approximation of the performance of a filter in terms of the ability to remove flocculated material at high filtration rates can be made by computing the total grain surface area in the filter. Either a decrease in grain diameter or increase in filter depth will increase the ability of the filter to retain floc particles. This means that 4-1/2 inches of garnet with an average size of 0.2 mm has about the same removal efficiency as 36 inches of coal with an average size of 1.6 mm. The ability to retain floc varies with other factors than size, such as grain shape and kind of suspended matter being filtered. For this reason, the computed surface area should be used as a rough guide only. For more exact computations, it is necessary to run filtration tests with the material to be filtered and the filter grains to be used in the filter. A recent paper (Conley and Hsiung, 1968) presented, in detail, testing techniques and formulations for optimizing a mixed-media design for any given water.

A rough approximation of headloss increase can also be obtained from a knowledge of total grain surface area. Here, however, another factor must be taken into account, and that is the size of the filter grains in relationship to their position in the filter bed. Two filters with equal surface area may differ by a factor of over three in headloss increase because of differences in the way the grains are positioned in the filter. For example, a filter made of 30 inches of 0.5 mm sand may show a rate of headloss increase of 0.3 ft/hr when operated in the down flow direction while the same filter may have a headloss increase of only 0.1 ft/hr when operated in the upflow direction. Similarly, filters made of coal, sand, and garnet, with the coal on top, sand mostly below the coal and garnet mostly below the sand will show a headloss increase of about 1/3 that of a sand filter of equal surface area.

A given quantity of suspended solids will produce less headloss when stored in a given volume of large grained filter media than when stored in an equal volume of small grained filter media. It follows that if the grain size in a given filter gradually decreases in the direction of flow that minimum rate of headloss will be obtained as compared to any other arrangement of the grains in this filter. If the suspended matter to be filtered is of such a nature as to be retained by the top surface of the filter, the rate of headloss increase will be very rapid because only the top surface of the bed is used to any extent. This often happens with water containing paper fiber or similar material. A similar situation can occur when large numbers of algae are present or when large amounts of coagulant aids are fed. The remedy for surface clogging is to increase the size of the filter media so that floc penetration will occur. By careful testing, it is possible to adjust the size of coal, sand, and garnet so that floc will penetrate enough to give low headloss but not so deep as to cause a poor quality effluent.

In order to get maximum surface area with the average grain size decreasing in the direction of flow, it is necessary to use as many different specific gravity materials as is feasible. Two materials are better than one, three are better than two and four are better than three, etc. There must be a significant difference in specific gravity to allow significant particle size differences. Other requirements are that the materials used must be relatively inexpensive and durable under filter conditions. As far as is known, commercial installations have been limited to three media filters because of the foregoing practical limitation. The authors' company has over 200 operating, high rate filter installations using the three media design.

USE OF POLYMERS TO AID FILTRATION

The nature of the floc in a given water treatment plant will vary seasonally. It is common for the floc to stick near the top of the filter in summer causing high headloss but giving good quality. In the winter, the floc usually penetrates deeply and the problem is not headloss but poor water quality. Polyacrylamides and activated silica can be used to control floc penetration. The ideal situation is to design the filter so that polymers are not required during the summer but are required during the winter. This means that a larger average grain size can be used than would be possible without the use of polymers.

The use of floc strengthening agents is considered to be almost essential for successful high-rate filtration. It is the exceptional case where successful high-rate filtration can be accomplished without the use of floc strengthening agents. These materials for maximum effectiveness should be added directly to the filter and not in the flocculator or in the settling basin. The action of the chemical is to bind the floc particles to one another and to the filter grains. This use of these chemicals is well proven. The turbidity of the plant filters is measured continuously and the feed of floc strengthening chemicals is adjusted to avoid filter breakthrough. Filter breakthrough is defined as the appearance of properly coagulated floc in the filter effluent. That is, the floc is there because of a filtration failure and not because of a coagulation failure. There are a number of ways that one can tell the difference between a coagulation failure and a filtration failure. One way is to measure the turbidity coming from a number of plant filters that have been washed at different periods of time. If the freshly washed filters are not passing floc and the old filters are passing floc, there is an obvious filtration failure and the floc strengthening chemicals should be increased.

A typical feed rate is 0.01-0.02 mg/l of polyacrylamide for each 3 mg/l of average quality alum floc. For very coarse filter media or very weak alum floc, it may be necessary to feed as much as 0.05 mg/l for each 3 mg/l of floc.

PRACTICAL APPLICATIONS OF MIXED MEDIA

As indicated previously, mixed-media technology has been applied in numerous cases and to a variety of conditions (Conley, 1965). At this writing, about 200 water treatment plants throughout the United States and Canada utilize mixed, three-media filtration technology in achieving a high clarity water at filter rates of 4 to 8 gpm per square foot. These plants vary in size from 10 gpm to 60 MGD. Many of these plants were originally existing rapid-sand treatment plants. They have been of the traditional design incorporating mixing of the coagulating chemicals, flocculation of the coagulated particles to promote optimum settling, settling of the majority of the floc particles in horizontal or upflow basins normally with 2 to 4 hours detention time and filtration at rates normally of 2 to 2.5 gpm per square foot. By applying mixed-media technology and assuring proper chemical control, these treatment plants have been more than doubled in capacity without changing the physical area of the plant.

An example of this is the Winnetka, Illinois treatment plant owned and operated by the Village of Winnetka (Sedore, 1968). This 6 MGD plant was of traditional design, utilizing flocculation, settling, and 8 rapid-sand filters to provide clarification of Lake Michigan water for municipal use. Early in 1967, four of these filters were converted to mixed (coal-sand-garnet) media to expand the capacity of the plant to 11 MGD.

Larger filter rate of flow controllers were also installed. No other changes in plant equipment were required. The rapid-sand filters were nominally rated at 2 gpm per square foot by the hydraulic changes and the installation of mixed-media beds. The Winnetka plant reports a 50 percent savings in backwash water with the mixed-media filters. The expansion of this plant from 6 to 11 MGD was accomplished at a cost less than $90,000 as compared to $650,000 for the installation of a conventional treatment system for the same additional capacity.

Because the mixed-media filter is capable of tolerating applied turbidities as high as 100 standard units while still maintaining economically long filter runs and producing an excellent effluent turbidity it has been found that pretreatment preceding mixed-media filtration can be eliminated in certain cases. Although not normally advocated unless raw water conditions are favorable, the economy provided by such a system is significant. Several plants, primarily for industrial clients, in operation in the size range of 15 to 50 MGD capacity, feature direct filtration of waters with relatively low turbidity and/or color concentrations.

One of the largest direct filtration plants serves the Crown Zellerbach Corporation at Wauna, Oregon. This 50 MGD plant obtains its raw water from the Columbia River. Raw water turbidities are normally 2 to 15 units although rare peaks of 100 units or more occur. The presence of industrial wastes makes coagulation difficult. There are no pre-treatment facilities for flocculation or settling. The raw water is treated with chemicals (10-50 mg/l alum, 0-0.2 mg/l polyacrylamide), passed through a flash mixer, and is applied directly to the filters operating at 5 gpm/per square foot. The media consists of 3 inches of -40 +80 garnet, 9 inches of -20 +40 sand, and 24 inches of -10 +20 coal. Filter effluent turbidities are 0.2-0.4. The operation of this plant has been reported previously in some detail (Moulton, Bede, Guthrie, 1968).

Another interesting example is the water treatment plant serving Champion Paper Company at Pasadena, Texas. A filter made from 2 inches of -40 +80 garnet (U.S. sieves) 7 inches of -20 +40 sand, and 16 inches of -10 +20 anthracite, was installed along side existing rapid sand filters. Nominal operating rate of the filters is 3.5 gpm per square foot for the sand filters and 6.0 gpm per square foot for the 3 media filter. The raw water for the plant is treated with about 50 mg/l of aluminum chloride and flocculated and settled in a conventional clarifier. Filter runs on the 3 media filter are routinely in the range from 30 to 70 hours and approximately equal the length of run of the sand filters which are running at about half of the rate of the 3 media filter. Polyacrylamide is fed from time to time to the 3 media filter at rates usually below 0.01 mg/l. Effluent quality of the 3 media filter is better than that from the sand filters. Data for a 2-day period are shown in Table 1.

In 1965, four of the ten filters at the Knoxville, Tennessee Water Treatment Plant were converted from sand to 3 media filters. The 3 media filters consist of 3 inches of -40 +80 garnet, 9 inches of -20 +40 sand and 18 inches of -10 +20 anthracite. The sand filters and 3 media filters were run in parallel for over a year. Alum is added for coagulation and the plant has conventional flocculation and settling equipment. During the year of trial operation, it was demonstrated that the 3 media filter could be operated successfully at 6 gpm per square foot or almost three times the design rate for the rapid sand beds. Following the test period, the remaining sand filters were converted to 3 media. Both water quality and length of filter run of the plant have been very good. Filter runs vary from 20-30 hours at 6 gpm per square foot to 200 hours at 3 gpm per square foot. Filtrate turbidity is typically 0.2 units.

Principles of mixed-media technology apply not only to removal of color and turbidity, but also to iron, manganese and even sewage filtration. Groundwaters containing iron and manganese can in many cases be handled directly on the mixed-media beds and pressure vessels can be utilized to minimize pumping cost. Several plants in the central states area are handling raw water iron concentrations of 1 to 2 ppm and manganese concentrations of less than 1 ppm by direct filtration, and at filtration rates of 7 to 8 gpm per square foot of filter bed area.

As mentioned previously, mixed-media filtration is being used in waste treatment (Culp and Hansen, 1967). The high efficiency of the mixed-media filter is utilized to provide polishing of the effluent from secondary sewage treatment plants. Depending on the degree of effluent clarity required to meet state standards, simple straining through the mixed-media beds can be utilized or chemical coagulation followed by flocculation, settling and filtration, may be necessary. Essentially complete removal of BOD, suspended solids, coliform bacteria, and phosphates can be provided. Additional applications are also being found in industrial wastes.

(continued)

The key to the reliable performance and continuous operation of the advanced wastewater treatment plant at South Tahoe is the successful development of the mixed media filter. It is a unit process which is vital to the proper functioning of the plant as a whole. The beds will accept heavy shock loads of suspended solids from upsets in biological or chemical pretreatment without interruption in service or deterioration in effluent quality. They remove all suspended solids, and produce excellent water clarity (turbidity = 0.01–1.0 JU). They remove significant amounts of colloidal and dissolved phosphorus from the wastewater. They protect the granular carbon treatment which follows from prolonged interruptions in service, and serious loss of efficiency which would occur in the absence of the filters due to poor applied water quality.

For the design flow of 7.5 mgd, there are 3 pairs of pressure beds in series, each 10 ft in diameter by 38 ft long. The design filter rate is 5 gpm/ft^2, but rates as high as 8 gpm/ft^2 have been employed at full treatment efficiency. The backwash rate is 15 gpm/ft^2. Each pair of beds is washed as a unit in series. The surface wash consists of four 7-ft-diameter rotary filter agitators per bed. Each bed consists of 3 ft of mixed media (as supplied by Neptune Microfloc), supported on 3 in. of coarse garnet and 2 ft, 4 in. of graded gravel. The underdrains are perforated plastic pipe. The influent rate-of-flow controller consists of a Dall flow tube and a rubber-seated butterfly valve. Loss of head across each bed is continuously measured and recorded. Turbidity of separation bed effluent is continuously measured by a Hach CR Turbidimeter to tenths of a Jackson unit and recorded. All filter operations are fully automatic. Backwash is initiated by time clock, high head loss, high turbidity, or manually. The beds are backwashed, filtered to waste, and restored on line automatically by a program timer. The filters are backwashed with filter influent water by means of a pump. There is a pressure booster pump for surface wash supply. Waste wash water discharges into an 80,000 gal steel tank (which holds the water from two backwashes.) The water from this tank is returned to the treatment process slowly over a period of about 2 hr. One pair of these beds has been in service for 5 years, and the other two pairs have been in use for 2 years at this writing (1970).

All except one end of each bed is installed out-of-doors. An allowance was made in the design for the formation of 4 in. of ice inside the steel filter shell. This ice then insulates the tank against further freezing under conditions of normal water flow through the bed.

The performance of these beds and the control system has been excellent. The length of filter runs varies from 4 hr under very bad conditions to about 60 hr under good. They have been used with alum as the primary coagulant in pretreatment, and with Calgon ST-270 or Purifloc N-11 (0.1–0.8 mg/l) as a filter aid. They have also been used with lime as the primary coagulant in pretreatment and either alum (1–20 mg/l) or ST-270 or N-11 (0.01–0.10 mg/l) as a filter aid applied directly to the filter influent. Normally the beds are backwashed when the head loss through each bed is about 8 ft (16 ft total). However, they have been backwashed successfully after head losses through the two beds totaled as much as 40 ft. This high head loss would be excessive for continuous operation. The table below indicates typical removals of several materials by the separation beds.

Typical Removals by Tahoe Mixed-Media Filters.

Substance	Typical Concentrations (mg/l) Influent	Effluent	Range (% removal)
Phosphorus, total	0.65	0.05	70–95
Phosphorus, dissolved	0.45	0.05	65–90
Phosphorus, particulate	0.20	0.00	100
COD	23	15	20–45
BOD	9	5	40–70
SS	15	0	100
Turbidity, JU	7.0	0.3	60–95

SUMMARY

Mixed-media filtration technology evolved in treatment plants to fit the need for the production of high clarity water at filtration rates substantially higher than used previously, in order to reduce both capital and operating costs. The configuration of the mixed-media bed is such that more particles can be stored before backwashing is required and the finely sized media used provides increased safety as well as improved filtration efficiency. Mixed-media technology has allowed significant increases in the capacity of existing plants without changing their physical area. It has also allowed reduction in size and capital cost of new plants.

Table 1

Comparison, Effluent Turbidity

Sand Filter Operating at 3.5 gpm per square foot versus

Three Media Filter Operating at 6.0 gpm per square foot

Turbidity - Standard Units

Time	3-Media	Sand	Applied to Filters
8 am	0.23	0.17	1.3
12 noon	0.25	0.26	1.1
4 pm	0.27	0.68	1.2
8 pm*	1.3	5.5	3.5
12 midnight	0.01	0.74	2.2
4 am	0.01	0.30	1.0
8 am	0.04	0.29	1.0
12 noon	0.07	0.91	1.5
4 pm	0.01	1.2	1.2
8 pm	0.02	1.2	1.5
12 midnight	0.05	0.65	1.0
4 am	0.03	0.46	1.1

*At 8 p.m., the 3 media filter was washed, accounting for the decrease in turbidity from 1.3 to 0.01. The sand filter was not washed during this period but had been washed the day before. Minimum turbidity observed after washing the sand filter was 0.14 units.

Part II.

REFERENCES

Conley, W. R., "Integration of the Clarification Process," AWWA Journal (October, 1965), page 1333.

Conley, W. R. and Hsiung, K., "Design and Application of Multi-Media Filters." Presented at the AWWA Conference, Cleveland, Ohio, 1968.

Culp, G. L., and Hansen, S.P., "How to Clean Wastewater for Reuse." American City (June 1967), page 96.

Ives, K. J., and Gregory, J., "Basic Concepts of Filtration." J. Proc. Soc. Water Treatment Exam (1967), page 147.

Mintz, D. M., Report to International Water Supply Association, 7th Congress, Barcelona, Spain, 1966.

Moulton, F., Bede, C., and Guthrie, J. L. "Mixed-Media Filters Clean 50 MGD Without Clarifiers." (March 1968), Chemical Processing.

O'Melia, C. R., and Stumm, W., "Theory of Water Filtration." AWWA Journal (1967), page 1383.

Sedore, J. K., "We Converted to High Rate Filtration." American City (April 1968).

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TRACE ORGANICS IN THE ENVIRONMENT--
CURRENT STATUS OF EPA INVESTIGATIONS

TRACE ORGANICS IN THE ENVIRONMENT-- CURRENT STATUS OF EPA INVESTIGATIONS

The Environmental Protection Agency first became aware that there was probably an organics contamination problem from a sampling program that started in 1969 and concluded in 1970 at the largest water-treatment plant in New Orleans. During this initial study, 36 organic chemicals were identified, and others were found, but could not be identified. Seemingly, the 1970 Survey may be just the tip of the iceberg. Extensive information on contamination was available only for the chlorinated hydrocarbon pesticides such as dieldrin and DDT. Thus, to better define this new problem, most of the research to about 1974 had to be directed toward the development of analytical methods for organics in water in trace amounts and to the establishment of the profile of organics in water.

A survey from July to November 1974 concentrated on the treatment plants serving the residents in New Orleans, water supplies in Cincinnati, and a few other areas. By the end of this survey in November, EPA had identified 162 organic compounds in these public water supplies. The last updating (March 1975) showed a total of 187 compounds identified.

The Safe Drinking Water Act of 1974 was signed into law on December 16, 1974 by the President as PL 93-523. Section 1442(a) (9) of this act requires the Administrator of EPA to "conduct a comprehensive study of public water supplies and drinking water sources to determine the nature, extent, sources of and means of control of contamination by chemicals or other substances suspected of being carcinogenic. Not later than six months after the date of enactment of this title, he shall transmit to Congress the initial results of such study, together with such recommendations for further review and corrective action as he deems appropriate."

Therefore, early this year (1975) we started a nation-wide program by sampling water supplies at 80 cities. All samples were analyzed for six volatile organics: chloroform, bromodichloromethane, dibromochloromethane, bromoform, carbon tetrachloride, and 1, 2 dichloroethane. Ten of these cities will more intensely studied for pesticides, and the organics that can be absorbed on carbon. This investigation is to be completed by December 1975.

Another nation-wide study for aldrin, dieldrin, and DDT in drinking water in several hundred communities has just had the sampling phase completed.

In addition, we have a contract with Versar, Inc., to assemble and maintain a comprehensive list of all known organics found in drinking water. This is to be a continuing program.

Analytical techniques are always under research. Emphasis is currently being placed on developing methods for detecting polar non-volatile organics and macro-organic molecules.

The EPA Science Advisory Board has received and published a report from its Ad Hoc study group on the "Assessment of Health Risk from Organics in Drinking Water". This report discusses the possible human health risks associated with low concentrations of organic chemicals in drinking water. Other possible carcinogenic contaminants of drinking water such as pesticides, asbestos, and inorganic chemicals were excluded. This Study concluded that there may be some cancer risk associated with consumption of chloroform in drinking water. The level of risk, estimated from consideration of the worst case.... and from the expected cancer site for chlorofrom (the liver), might be extrapolated to account for up to 40 percent observed liver cancer incidence rate. However, the more reasonable assumption based upon current water quality data which show much lower levels of chloroform than the worst case in the majority of the US drinking water supplies would place the risk of hepatic cancer much lower and possibly nill. It should be emphasized that both the experimental carcinogenicity data and the mathematical and biological extrapolation principles being used to arrive at the upper estimate of risk are extremely tenuous. Epidemiologic studies do not, thus far, support the conclusion of increased risk of liver cancer, although hypothesis formulating studies in southern Louisiana suggest the possibility of an association with contaminated water and overall incidence.

A major report to Congress with be made in the near future. It will include the results of progress reports of EPA studies in the following health project areas:

1. Delination of toxicological activity of the concentrated organic fraction obtained from drinking water (both for toxicity and carcinogencity).

2. Determination of the carcinogenic activity of ozonated and chlorinated humic materials.

3. Development of data on the mutagenic activity of 20 organics and haloethers found in drinking water.

4. Determination of the mutagenic activity of ozonated drinking waters.

5. Development of data on a teratogenic activity of chlorinated methanes.

6. Development of data on the chronic toxicity of halobenzene and haloethers.

In the area of control of organics in drinking water supplies, we have recently released one report on activated carbon as a means of removing organic contaminants from water. Much research in this area remains to be done. Other studies currently under way are:

1. Development of information on operational problems of water treatment plants associated with specific treatment technologies (by-products, interferences, loading potential, etc.).

2. Bench scale verification of promising methods for treating drinking water.

3. In cooperation with the Corps of Engineers, conduct a pilot or field investigation of new treatment techniques for the purification of potable water drawn from intensive industrial or agricultural areas.

It is of interest that of all compounds found in drinking water and recognized or suspected of being carcinogenic, only chloroform has been identified in a municiple waste treatment plant effluent. It should be pointed out, however, that the effluent containing chloroform was from a waste treatment plant receiving both domestic and industrial waste. Thus, chloroform should not be characteristic of waste treatment plant systems receiving only domestic wastes. In fact, of all the organic compounds which have been identified to date in public water supplies, none appears to be characteristic of domestic waste treatment plants.

EPA has a few studies in progress to identify sources of organics in drinking water. In particular, to determine the type and amounts of organics found in "point source" discharges. At least one similar study for "non-point sources" is being done. Associated with this work are investigations to determine the identity and quantity of selected organics produced by the municiple waste treatment process.

Preliminary results of studies on advanced-waste-treatment plant effluents indicate that the total non-volatile organic carbon is about 2 ppm in Cincinnati and New Orleans drinking water. One sample from Dallas showed 1 ppm but others had more, from example, Tahoe 5-9, Blue Plains 5, and Pomona 3 ppm.

Our volatile organic analysis technique has permitted us to identify 14 to 18 compounds in waste treatment plant effluents compared to 17 reported for New Orleans drinking water. Preliminary judgement would be that the advanced-waste-treatment plant effluents have more organic contaminants than some, if not most, drinking waters. Thus, given the seemingly ubiquity of volatile organics currently in public drinking water supplies and the continuing improvements on waste treatment technology, it can be suggested that a water-short area in the near future may be able to produce a water from waste of equal or better quality than it often may be able to import from some neighboring area. But we expect that it will take some time before there will be enough research completed to allow certification of such water for potable purposes.

If it develops for certain water reuse situations that only acute effects need to be considered, than it should be possible to reuse water derived from wastewater sooner. But when chronic toxicities must be considered, then there must be intensive research on many aspects for the problem at very low concentrations of contaminants. Thus, much of the research of health effects of reuseable water from wastewater and the research on the quality of todays drinking water supplies and standards become one and the same program.

Henry J. Ongerth

State Sanitary Engineer
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A PUBLIC HEALTH OVERVIEW OF REUSE

A PUBLIC HEALTH OVERVIEW OF REUSE

The U.S. has the most affluent and profligate society the world has ever known: two chickens in every pot, two color T.V.'s in every home, two gas-guzzlers in every garage. We are using up the world's resources at a shameful rate: This country is using 44% of the world consumption of coal, 42% of aluminum, 63% of natural gas, 33% of the world consumption of petroleum. Last night on KQED Kenneth Clark used the expression "greedy expansion and exploitation." This applies to our society, it seems appropriate to mention at this point.

We establish the world's richest agricultural economy in a semi-arid area and dam up every one of the area's streams to irrigate the crops. We build a megalopolis in the desert and convey water over 500 miles to serve it. Water that for strictly domestic purposes is used at the rate of over 100 (up to 200 or 300) gallons per capita per day - over twice the rate of 25 years ago - a rate which has been increasing by about 4% per year. Water that is so readily available that a utility that has only 10% unaccounted for water (the difference between production and metered delivery to the customer) is managing its system better than average! I agree completely with Ron Robie's remarks. We <u>must</u> effectively conserve water. Efforts in this direction, up to now, have been miniscule. We must do better. High credit to John Nelson and Dietrich Stroeh for the efforts their Districts are making in this respect.

Net California water consumption, according to DWR's latest publication, Bulletin 160-74, is 31 million acre ft/year, 5 million of this for domestic use. In the face of all our affluence, of our wasteful use of

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Presented by H. J. Ongerth, State Sanitary Engineer, California Department of Health, at the WATERCARE Conference, San Rafael, California, June 24, 1975.

resources - including water - an increasing number of engineers and laymen are advocating recycling sewage to meet future water needs, particularly domestic. Such recycling has the potential of adding something less than 1.7 million acre ft/year to our net water resources. In addition to domestic purposes, this recycled water could be used as you've heard to irrigate agriculture, for industrial purposes, for low flow augmentation, for green belt irrigation and for other less significant purposes.

This department has been supporting reuse for all but domestic purposes for many years. California leads the world in reuse. We lead the world in establishing public health standards for such reuse. California has regulations for crop and landscape irrigation and recreational use. California does not have regulations either for direct reuse or groundwater augmentation for indirect reuse for potable purposes. The overriding reason is that it is not possible to assure the public that prolonged consumption of such water will not lead to significant harmful effects to the users. Instead, there is increasing reason to believe that such reuse is unsafe. Ever since CCE was added to the list of constituents in the 1963 Drinking Water Standards (on the basis of work done starting in the mid-50's), there has been concern about the organics in water supply; about the possibility that long-term exposure to some of the unidentified compounds present will lead ultimately to adverse physiological effects on the users. The most recent information is obtained in the report of an Ad Hoc Study Group of the EPA Science Advisory Board. This report, titled "Assessment of Health Risk from Organics in Drinking Water", in part, has two conclusions: first, that the chemicals which have been measured account for only a few percent of the total organic content of drinking water. "Thus, attempts to evaluate the health risk of contamination may be mistakenly directed toward identified, potentially toxic compounds, while other groups of compounds perhaps of equal or greater toxicologic significance go undetected." Second (with regard to one of the organics identified, chloroform), "that there may be some cancer risk associated with consumption of chloroform in drinking water. The level of risk, estimated from consideration of the worst case and for the expected cancer site for chloroform (the liver), might be extrapolated to account for up to 40% of the observed liver cancer incidence rate. A more reasonable assumption, based upon current water quality data which show much lower levels than the worst case in the majority of U.S. drinking water supplies, would place the risk of hepatic cancer much lower and possibly nil."

Before California can proceed, in a responsible way, to plan for reuse for potable purposes, we must be able to set standards for organics. This, in turn, requires knowledge of the constituents likely to be present, information on the toxicology of the substances, establishment of standards for safe limits, and development of engineering data on treatment and removal of such substances. Armed with such information, engineers can plan water resource projects incorporating reuse for potable purposes. Until then we should energetically pursue water conservation measures for all types of water use (we must stretch our water as far as we can), and we should plan water management schemes making the best quality water available for domestic purposes and using poorer quality water for less demanding purposes. Finally, to deal with organics in existing water sources and to understand the possibility of reuse for potable purposes in the future, we must energetically promote and support appropriate research work on these organic substances. In conclusion, I would like to quote from Jerry Gilbert's paper just presented in which he quotes from a study done by the Bechtel Corporation for San Diego in the 1960's. He quoted that report as saying the real management needs are (among other things) "to apply all waters to various uses in a way that will minimize encroaching on the public health risks." This expresses the public health view.

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THE EFFECT OF PEAK-LOAD PRICING ON WATER CONSUMPTION AND REVENUES

THE EFFECT OF PEAK-LOAD PRICING ON WATER CONSUMPTION AND REVENUES

Despite extensive study (much of it of a theoretical nature) of the use of pricing techniques to moderate water consumption (and/or peak demand), adoption of these techniques by the water utility industry has, in general, been extremely slow. Because many of the proposed pricing techniques have been based on limited data regarding the effect of price on consumption, and because many of these proposals involve significant departures from conventional rate making practice, most utilities have taken a "wait and see" attitude, hoping others would institute these various pricing techniques first and thus provide valuable data as to their effect on both consumption and revenues. It is the purpose of this paper to analyze the effects of the application of one particular pricing technique, peak-load pricing, on consumption and revenues and to illustrate that the results of such an application are fairly predictable (at least within a limited range). The risk in adopting such a pricing policy is minimal, and accordingly,the hesitancy on the part of water utilities appears unwarranted.

Peak-Load Pricing

In general, municipal water demand is characterized by two types of temporal variations, a daily use cycle and a seasonal use cycle. In order to reduce daily peaks, it would be necessary to install demand meters (at considerable cost) and assess higher quantity charges during peak periods. It is doubtful that such an endeavor would have a significant effect on total average daily water consumption, since demand would shift from the peak hours to non-peak hours. In addition, insofar as facility costs are concerned, the daily cycle is generally provided for by storage in the various distribution areas. This storage capacity (and associated distribution system) is usually governed by fire flow requirements rather than demand fluctuations, and very little cost can be attributed to the daily cycles in demand.

The variation in seasonal demand, however, is due primarily to summer lawn irrigation. Since most facilities (transmission lines, treatment plant, pumping requirements, major storage, etc.) must be designed to meet maximum day requirements, capacity costs (at least in part) associated with these facilities can be attributed to summer season demand (irrigation use). As a consequence, it can be justified (on an economic basis) to charge a higher price for peak seasonal (summer) use over and above the average off-peak (winter) level of use. The quantity charge applicable to irrigation use could, for example, be designed to recover that portion of fixed charges, such as debt service and pay-as-you-go replacement costs, related to the extra capacity necessary to meet this peak seasonal demand.

Consumption and Revenue Model

Whatever the peak-load pricing philosophy, it is necessary to know its effect on both metered water consumption and metered water sales revenues. In order to estimate this effect, the following data is required: (1) the price elasticity of peak use, over and above off-peak use, (2) the peak-load period (and conversely the off-peak period), (3) the price increase to be applied to the average peak use over and above the average off-peak use, (4) the percentage of the average peak use over the average off-peak use to which the price increase is to be applied and (5) the average peak month and off-peak month consumption levels. With the exception of the price elasticity of peak demand, all of the above required information can usually be obtained from the water utility's records.

Elasticity of Demand. There has been a considerable amount of work in recent years (mostly of an empirical nature) relating changes in water demand with changes in water price. The most comprehensive treatment is The Impact Of Price on Residential Water Demand and Its Relation to System Design and Price Structure, (Howe and Linaweaver, 1967). In this reference, basic data as presented in Data Report of the Residential Water Use Research Project, (Linaweaver et al, 1966) was used to determine empirical relationships relating domestic residential water consumption, maximum day sprinkling water consumption, and peak hour sprinkling consumption with such relevant parameters as market value of dwelling unit, irrigable area per dwelling unit, summer potential evapotranspiration, summer precipitation, and commodity charge. This basic data was gathered from 39 study areas ranging in size from 34 to 2,373 dwelling units which were served by 16 water utilities, and it covered the period of time from October 1961 to June 1966. The 39 study areas experience the entire spectrum of climatic conditions encountered in the continental United States and fall into five basic categories:

1. Ten study areas with metered water and public sewer service in the Western United States (Oakland, Los Angeles, and San Diego metropolitan areas).
2. Eleven study areas with metered water and public sewer service in the Eastern United States (Des Moines, Fort Worth, Little Rock, Washington, D.C., Baltimore and Philadelphia metropolitan areas).
3. Five study areas with metered water sales and septic tanks (Des Moines, Baltimore and Philadelphia suburban areas).
4. Eight study areas with flat rate water service and sewers (Sacramento, Great Fall and Denver).
5. Five study areas composed of apartment buildings with metered water service (San Diego, Denver, and Washington, D.C. metropolitan areas).

The relevant conclusions concerning the relationships between domestic residential demand and summer sprinkling demand with price are expressed in formulae as follows:

(1) Domestic Resident Demand, Qd, (gallons per customer per day) for metered service with public sewer can be expressed as:

$$Q_d = 206 + 3.47v - 1.30\ p_w \qquad (1)$$

where v is dwelling valuation in thousands of dollars and p_w is sum of water and sewer charges that vary with water use evaluated at the block rate applicable to the average domestic (off-peak) use.

(2) Summer Sprinkling Demand, Q_s, for

(a) Metered service with public sewer, west

$$Q_s = Ap_s^{-0.703} \qquad (2)$$

and

(b) Metered service with public sewer, east

$$Q_s = Bp_s^{-1.57} \qquad (3)$$

where A and B are the products of parameters which are independent of price, and p_s is the marginal charge applicable to the average (peak) summer rate of use.

As can be seen from equations (2) and (3), the elasticity of sprinkling demand with respect to price varies from -0.703 in the west to -1.57 in the east. It should also be noted that the above relationships are best fit regression relationships based on all the data in the respective categories; and price elasticity is expected to vary between water service areas, even within the same geographical area.

The relevant conclusions that can be drawn from the above relationships are that (1) *sprinkling (irrigation or average peak season use* over and above average off-peak season use) is relatively elastic with respect to price, the elasticity being a function of geographical location, and (2) non-sprinkling demand (average off-peak use) is essentially inelastic with respect to price.

Consumption and Revenues. Given the exponential form empirically derived in the above cited references, assuming a constant elasticity within the price range under consideration, then the percentage decrease in consumption subjected to a price increase can be expressed as:

$$\text{Percent decrease in peak consumption} = 100\,(1 - A^{\eta}) \qquad (4)$$

where:

A is the ratio of the price after increase to the price prior to increase, and η is the price elasticity.

This relationship was used to construct a matrix which relates the percentage decreases in consumption to both η and A, shown in Table 1.

Table 1. Percent Decrease in Water Consumption Subjected to Price Increase as a Function of Price Increase, A, and Price Elasticity, η

η \ A	25 percent	50 percent	75 percent	100 percent
-0.70	14.5	24.7	31.4	38.4
-0.90	18.2	30.6	39.6	46.4
-1.10	21.8	36.0	46.0	53.3
-1.30	25.2	41.0	51.7	59.4
-1.50	28.4	45.6	56.8	64.6
-1.57	29.6	47.1	58.5	66.3

Although the total decrease in average peak use over and above average off-peak use (irrigation demand) as a function of price elasticity can be determined from Table 1, for rate making purposes it is necessary to know several additional facts. These are the decrease in both total annual consumption and total annual revenues from quantity charges as a function of A, η, and the percentage of the summer use differential upon which a price increase is applied. As a result, generalized relationships were derived which can be used to determine both the total water consumption and revenues from quantity charges for each customer class, or for the service areas as a whole, after the application of a peak-load pricing structure. These relationships are presented below:

$$\text{Total water consumption} = 12C + (12-W)XC\left(1-M\left[1-A^{\eta}\right]\right) \quad (5)$$

$$\text{Total revenues from quantity charges} = 12Cp + (12-W)XC\left[1+(A-1)M\right]p\left(1-M\left[1-A^{\eta}\right]\right) \quad (6)$$

where:

C is the average off-peak period monthly consumption,

X is the ratio of the average peak period monthly consumption to the average off-peak period monthly consumption minus one,

W is number of months in the defined off-peak period,

M is the fraction of the average peak period monthly consumption over and above the average off-peak period monthly consumption to which the price increase is applied, and

p is the quantity charge prior to increase.

<u>Illustrative Example</u>

To illustrate the use of equations (5) and (6) in calculating the percentage change in both water consumption and revenue from quantity rates, consider a service area with the following characteristics: (1) an off-peak period (W) of 7 months, and (2) a ratio of average peak period monthly consumption to average off-peak period monthly consumption of 2 (x=1). Thus both consumption and revenues from quantity charges, prior to and after the application of a peak-load pricing structure, can be expressed as:

Total water consumption prior to the application of a peak-load pricing structure	$=17C$	(7)
Total water revenues from quantity charges prior to the application of a peak-load pricing structure	$=17Cp$	(8)
Total water consumption after the application of a peak-load pricing structure	$=12C+5C\left[1-M\left(1-A^{\eta}\right)\right]$	(9)
Total water revenues from quantity charges after the application of a peak-load pricing structure	$=12Cp+5Cp\left[1+(A-1)M\right]\left[1-M\left(1-A^{\eta}\right)\right]$	(10)

Consequently the percentage change in both water consumption and revenues from quantity rates can be expressed as :

Percentage change in consumption
$$=\frac{5M\left(1-A^{\eta}\right)}{17} \qquad (11)$$

Percentage change in revenues from quantity rates
$$=\frac{5}{17}\left\{1-\left[1+(A-1)M\right]\left[1-M\left(1-A^{\eta}\right)\right]\right\} \qquad (12)$$

Tables 2, 3, and 4 below illustrate quantitatively the effect of the application of a peak-load pricing rate structure to quantity rates on both consumption and revenues.

Table 2. Percent Decrease in Consumption and Increase (Decrease) in Total Revenues as a Function of η = -0.7

M \ A	0	25	50	75	100
0	0	0	0	0	0
25	0	1.06 0.71	1.82 1.65	2.41 2.68	2.82 3.80
50	0	2.11 1.28	3.65 2.82	4.76 4.48	5.65 6.20
75	0	3.18 1.73	5.47 3.53	7.18 5.37	8.47 7.3
100	0	4.24 2.04	7.29 3.82	9.53 5.38	11.29 6.8

Table 3. Percent Decrease in Consumption and Increase (Decrease) in Total Revenues as a Function of A and M for η = -1.0

M \ A	1	1.25	1.5	1.75	2.0
0	0	0	0	0	0
0.25	0	1.47 0.28	2.45 0.92	3.15 1.77	3.76 2.75
0.50	0	2.94 0.37	4.90 1.23	6.30 2.36	7.35 3.68
0.75	0	4.41 0.28	7.35 0.92	9.45 1.77	10.29 2.75
1.00	0	5.88 0	9.80 0	12.61 0	14.71 0

Table 4. Percent Decrease in Consumption and Increase (Decrease) in Total Revenues as a Function of A and M for η = -1.2

M \ A	1	1.25	1.5	1.75	2.0
0	0	0	0	0	0
0.25	0	1.73 0	2.83 0.49	3.60 1.24	4.15 2.16
0.50	0	3.46 (0.21)	5.67 0.27	7.19 1.14	8.30 2.25
0.75	0	5.18 (0.64)	8.50 (0.36)	10.79 (0.31)	12.46 (1.28)
1.00	0	6.91 (1.28)	11.33 (2.29)	14.38 (3.11)	16.6 (3.81)

Conclusions

One can surmise from examination of the results of Tables 2, 3, and 4 that the risk (in reduced revenues) associated with the adoption of a peak-load pricing rate structure is minimal. As can be seen in the case of greatest elasticity (η = -1.2, A=2, and M=1; Table 4), revenues from quantity rates decrease by only 3.8 percent. Since the typical water utility derives approximately 70 percent of its revenues from quantity rates (the remainder from minimum or service charges), the 3.8 percent decrease in revenues from quantity rates corresponds to a 2.7 percent decrease in total revenues. This decrease in revenues, however, is accompanied by 16.6 percent decrease in consumption, and thus such variable operating and maintenance expenses as pumping (power) costs and treatment (chemical) costs, which vary directly with consumption, can be expected to decrease a like amount. It is estimated that for the typical water utility, costs that vary directly with consumption approximate 20 percent of total operating and maintenance costs, and total operating and maintenance costs approximate 60 percent of revenues. Accordingly, the 16.6 percent decrease in consumption will be accompanied by a 2 percent decrease in operating and maintenance expense, resulting in only a 0.7 percent decrease in net revenues (income).

As can be deduced from the above, even if average peak season demand over and above average off-peak season is relatively elastic with respect to price ($\eta \leqq -1.2$), the risk of reduced net revenues associated with the adoption of a peak-load pricing policy can virtually be eliminated simply by accompanying the adoption with a 1 or 2 percent rate increase. This ensures receiving the full benefits resulting from the elimination of additional capacity costs.

It can be concluded, therefore, that because it is justified on an economic basis to charge a higher price for peak seasonal use over and above the average off-peak level of use, and that because this particular use is relatively elastic with respect to price, the adoption of a peak-load pricing rate structure will result in a significant reduction in water consumption with little risk of a decrease in net revenue , while remaining consistent with the rate making precepts of fairness and equitability. The hesitancy, on the part of the water utility industry to adopt such rates has been unwarranted. Therefore, it is recommended that water utilities operating at or near the limits of their source of supply and/or facility capacity consider the adoption of a peak-load pricing structure.

James E. Lattie

Director of Public Information
East Bay Municipal Utility District

PUBLIC EDUCATION CAMPAIGNS TO CUT WATER USE

PUBLIC EDUCATION CAMPAIGNS TO CUT WATER USE

James E. Lattie, Director of Public Information
East Bay Municipal Utility District

Water conservation has been with us for thousands of years. Water has always meant life, and throughout the history of man, communities have always had to move it around and use it carefully in order to maintain an optimum quality of life.

In recent years, thanks largely to the often unheralded efforts of the water industry in this country, we have come to take generous amounts of pleasant, healthful water largely for granted. Yet those responsible for delivering water for urban use can see that the ready availability of this resource, like our others, is not as limitless as it once seemed. In this time of expanding environmental awareness, water conservation is a logical step in the face of growing population and per capita consumption. It offers hope for relief from the economic strain of building systems to deliver ever-increasing amounts of water.

Once again, water conservation becomes a means of protecting our future water supply -- a way of assuring that there'll be enough to go around. It can almost be considered a supplemental source of water. At the East Bay Municipal Utility District, water conservation is considered a logical, necessary and wholly proper part of our overall water management plan to guarantee adequate supplies for the future. To us, good water management concepts must be extended to encourage efficient use of the resource, as well as efficient production and distribution.

The differences between conserving water and rationing water are important and should be noted: You conserve water in a time of plenty, ration it in a time of shortage. Conserving is voluntary, rationing is mandatory. And water conservation should result in happy, satisfied customers, while rationing may result only in customers who feel de-watered and deprived.

A water conservation public education program should have none of the negative connotations of a rationing program; the aim of a water conservation program is not to make people use less water than they want, but to lead them into wanting less water than they now use. The customer should understand water conservation as a positive concept, the opposite of waste and misuse of a valuable resource. Secondly, it should be recognized that misuse is the only alternative to conservation -- there is not some broad, "safe" area in between where the water-consuming public can take refuge along with its past practices. The public education program is aimed at changing established habits; it's based on the assumption that savings can be realized through a change of these habits, while at the same time enabling the water consumer to be just as happy with his new level of consumption as he was before.

Such a program is a logical continuation of our work. If we, as water industry professionals, have managed to solve well the problems of supply and distribution, we should encourage, expect and maybe even require the guy at the other end of the pipe to use equally well the product of our efforts.

For many years we have urged our customers to not waste water, to look for leaks, to be careful. In the past three years, the East Bay Municipal Utility District has gone beyond that, urging a more active role on the part of the consumer, encouraging him to change his water way of life. The biggest problem of this accelerated program is the low level of "water awareness" of most of our customers -- an unfortunately large percentage of them have no idea, really, where their water comes from nor what we have to do to transport it and make it suitable for them to use. They turn on their faucet and they get as much as they want. They lack what we call a "water conscience" -- since they seldom want, they often waste. They have little knowledge of the proper use of water, and even less understanding of what the consequences are -- particularly in the future -- of misuse or excessive use of water.

A second major problem, encountered early in our campaign, is the self image of individual customers. We quickly learned that everybody knows a water-waster, but that nobody is one. It's always the other guy. There is an obvious need for an approach that will make each consumer stop and think long enough to recognize that he, like everybody else, is probably wasting water in at least two or three ways that he could easily correct.

With these concepts and problems in mind, we designed a public education program with three phases: First, to increase the appreciation of water as a resource; second, to clearly establish the concept of water conservation; and third, to give the customer specific means of conserving water in his own home or business. All three phases are concurrent and continuing.

Our first major effort was a vegetable dye pill for detecting leaks in toilet tanks. It was offered in a bill insert that went out to all of our customers. We received requests from more than four percent of them -- a response that is good, considering our past history at direct-mail offerings. We chose this as a first step partially because it was an easy one, and partially because some 90 percent of the high bill complaints received by our business offices seemed to be due to leaky toilets. Since the initial offering we have continued to make pills available by mail, through our business offices, and with the help of Camp Fire Girls. More than 100,000 pills have been distributed -- enough for nearly one-third of our customers. The program has been successful, but it illustrates one of the problems with any voluntary public education program: You only reach a minority of the customers with any single approach. We assume that the people who bothered to get leak detector kits probably already had a high level of maintenance awareness; but the ones we did not hear from probably need the most assistance in detecting leaks and learning other ways of conserving water.

To partially solve this problem we distributed a sixteen-page water conservation handbook to each of our 300,000 customers with the water bills. Another 150,000 were prepared for distribution to renters through landlords and property managers. The handbook covers a wide range of nuts and bolts solutions to water conservation problems -- things the homeowner can do himself. We included tips on simple plumbing repairs, because we found that some people, when they detected a leak, would call in a plumber because they did not know how to handle the repair themselves. The inevitable result was a bill, and in a few cases, a backlash against our water conservation program.

Our other public information efforts are aimed at creating general water conservation awareness and involvement on the part of the public. We've used a variety of posters -- for classroom walls, buses, and even sidewalk trash containers -- which have been very popular and effective covering such subjects as leaks, water misuse and just general reminders to the public that water conservation is a good idea. Again our Camp Fire friends have been very helpful in distributing posters and buttons throughout the community.

Incidentally, volunteers are a very important asset to any water conservation program. Youth groups such as Camp Fire Girls and Boy Scouts are particularly helpful. They have a lot of energy, they will dedicate it to conservation ideas and they add the manpower that most water agencies don't have. The Camp Fire Girls have been particularly helpful to us. There are more than 5,000 of them in our area -- a sizable volunteer army by any standard -- and they help us on a continuing basis by distributing posters and other things. Last year they sponsored a "water awareness year" ending in a day-long "Water Faire" complete with a model filter plant and dozens of exhibits, skits and other presentations with water appreciation and conservation themes.

The materials we have available for distribution -- whether through volunteer groups, at our own business offices, at community meetings where staff members speak, or in response to requests from schools or other sources -- range from brochures to matchbooks and key chains. The key chains show the amount of water that can be lost through small leaks. Our business offices have found these very useful in explaining to customers -- unhappy with a sudden increase in their bill -- how they could lose an awful lot of water with a little leak.

A similar design has also been used on matchbooks, in conjunction with an emblem which was specially designed for our water conservation program. We have used this emblem on litter bags and all other materials we produce. In addition, Mayfair Markets used it on their grocery bags as a voluntary advertising contribution to the water conservation effort.

Another kind of free advertising that has been effective is the large poster which is mounted on the backs of buses. There has been no charge to us for this service, other than the production cost of the poster and a nominal mounting fee. The transit district that serves our area donated the space on 50 buses for a month for each of the three posters we have produced in the last two years.

In a similar vein of community support, radio and television stations in the Bay Area have donated public service time for radio tapes and short television public service announcements that we prepared on water and energy conservation. Unfortunately, the high production costs of good quality television announcements can make this approach a very expensive one, even with free air time.

In effort to solve this problem, EBMUD has been joined by two other San Francisco Bay Area agencies -- the Marin Municipal Water District and the Santa Clara Valley Water District -- to share the production costs of our latest series of announcements. They will be distributed to a dozen broadcast and cable television stations watched by some five million residents of the greater bay area.

Perhaps one of our best public information tools is our bill insert program. The bill inserts are well received -- about 40 percent of our customers read them -- and they give us a means of getting a regular water conservation message directly to each of our customers, something that no other medium can guarantee. The inserts are varied. Most are short folders, but one recent departure was a single sheet of pressure adhesive slogan labels. Soon after they were in the mail they started showing up on youngsters' jackets and in other unanticipated locations; but the fact that they were noticed and used is more important than where they were used.

Our biggest bill insert to date was the previously mentioned 16-page brochure. It was primarily focused on indoor opportunities for water conservation, so we are looking ahead to another one about gardening.

A more personal type of contact is available through our Speakers Bureau, a professionally trained group of 60 management and non-management utility district personnel prepared to show films and slide shows and give speeches on all aspects of our operation. Topics range from recreation on watershed lands to the technical aspects of the distribution system, but we manage to work in a word about water conservation in all of them, whether the audience is a community organization or an elementary school class.

We have produced a half hour film, a shorter version of it, and a programmed slide show which deal with the problems of water supply in general, and water conservation in particular. The two films have been distributed to all our school districts for classroom use. The slide show, using photographs and cartoons with recorded narration and music, is an especially good length for luncheon meetings and service clubs.

Most of these materials and programs are directed toward the homeowner and specifically toward the inside of the house, but we haven't forgotten the garden and the need for brochures and films describing good water use methods there. We hope to be able to develop a demonstration garden that would encourage the use of plants native to a California-type climate, which don't require as much water as broad expanses of green grass or many of the traditional eastern or sub-tropical plants now popular. Many materials are available for this purpose, but most people know very little about native plants, and even when they do go to a nursery seeking plants that don't use much water, they'll probably find a pretty limited selection. We've been searching for a site on our watershed where we could establish a demonstration garden. If we're successful in getting such a garden going, it should produce both technical information and a site where the public could come and see how low-water-consumption plants and water conserving irrigation techniques can be used effectively in home landscaping. If the project works, it could mean a very major reduction in the amount of irrigation water that's used around homes, in parks, and in other types of landscaping.

Another program looking toward the future will provide educational materials for schools. This project has been greeted by teachers with almost overwhelmingly enthusiastic acceptance. We had hoped for strong interest on the part of the educational community, but it has been so strong that we have had some difficulty in meeting the demand for just the preliminary materials. East Bay M.U.D. is now mid-way through a two-year project to develop water conservation curriculum materials for all pre-college grade levels. When completed, we will have a program enabling teachers to bring various water-conserving concepts into the whole range of classroom subjects, from history to mathematics, as well as the natural sciences. This will be done through a variety of means, such as videotapes, films, and filmstrips with teaching guides. Publications will include student workbooks, such as one for the upper elementary grade levels combining the cartoon adventures of Captain Hydro with water conservation lessons in mathematics, science, social science, and humanities and the arts. The 10-minute film, "My World -- Water," deals with water supply and conservation, and is distributed nationally through Churchill Films in Los Angeles. The Captain Hydro workbook and teacher's manual will be available through our educational newsletter, "Currents," for classroom use this fall. We feel that our educational program is perhaps the most interesting and exciting of our water conservation programs to date, and the one that may, in the long run, be the most effective. Youngsters are not set in their habits, are environmentally aware, and are quick to take home the things that they learn in school. They are our best hope for the future.

WATER CONSERVATION MATERIAL COSTS*

Printed Materials	Design	Printing
Bill Inserts	$ 400 - 700	$ 6 - 10/1000
Stickers	400 - 700	16 - 20/1000
Buttons	100 - 400	70 - 100/1000
Truck Decals	100 - 400	1 - 1.30 ea.
Key Chains	100 - 400	130 - 200/1000
Leak Detector Kits	300 - 600	20 - 30/1000
Litter Bags	100 - 400	50 - 55/1000
Shopping Bags	100 - 400	None
Matchbooks	100 - 400	13 - 16/1000
Posters	300 - 700	80 - 100/1000
Bus Posters	300 - 700	7 - 10 ea.
Trash Can Posters	100 - 400	75 - 80/100
Plastic Wallet Cards	50 - 200	90 - 100/1000
Water Conservation Brochure (16 pages)	500 - 2000	35 - 60/1000

Broadcast Materials	Production	Per Print
Television Public Service Announcement/30 seconds	$ 400 - 15,000	$ 8 - 12
Radio Public Service Announcement/30 seconds	0 - 200	1.50
Motion Picture/10 minutes	5000 - 25,000	50 - 100

* These are intended to be only general estimates. Breadth of the ranges reflects differences that may be due to variations in local design and production costs, in acceptable quality standards from community to community, and in the availability of utility staff, rather than outside agencies, to provide design and production services.

The obvious first questions about any water conservation program have got to be, "What does it cost, and does it work?" Unfortunately, the answers are not easy. Costs can vary widely depending on such factors as the quality level required, the diversity of the program, prevailing design and production costs in individual communities, the number of customers involved, whether or not the water utility has staff capable of handling some or all of the program or must seek the help of consultants, and -- of course -- the degree to which the utility is committed to a water conservation program. Although generalities are difficult, a utility serving a community of 25,000 residents probably should expect to spend at least $5,000 annually, not counting such major expenditures as motion picture films and special projects.

Effectiveness of a public education program based entirely on voluntary responses from the customers is always difficult to measure. In our case, we feel it is a little too early to be sure. In the three years that our program has been in effect, both per capita and average daily consumption have dropped about five percent; however, we have had some cool summers and wet winters, and the economic trends of the past two years may have played a factor in the lower consumption. On the other hand we are certainly not willing to say that none of the decline in consumption can be attributed to the water conservation program. We are sure that some of it has been, we're just not sure how much.

Regardless of how well we can measure the effectiveness of the program, we are convinced that water conservation is worthwhile and that it should be pursued. The reception by the public, whether expressed in schools, community groups, or letters, has been almost universally good and encouraging. Clearly if a water conservation public education program does nothing more than create appreciation for the problems faced by a water utility, an appreciation of water as a resource, it has done enough to justify its existence. Looking ahead, it can also be expected to be helpful at that time in the future -- if it is reached -- when water supplies are indeed limited and when more stringent, mandatory methods must be adopted.

We feel that water conservation in some form is here to stay -- it's a fact of life today; tomorrow it must be a way of life.

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John Olaf Nelson

General Manager
North Marin County Water District

WATER CONSERVATION IN NEW RESIDENTIAL DEVELOPMENT

WATER CONSERVATION IN NEW RESIDENTIAL DEVELOPMENT

INTRODUCTION

Water is a precious resource.

The purpose of this paper is to shed light on one element of water resource management getting increasingly and deservedly more attention in recent years, namely, water conservation in new residential development.

DOMESTIC WATER USE IN PERSPECTIVE

To place the domestic component of water use in proper perspective, note that water withdrawn in the United States from our oceans, rivers, lakes and the underground is used as follows:

• cooling (power plants)	45%
• agriculture	34%
• industry	13%
• municipal/domestic	8%
	100%

In 1970, it was estimated[1] that total withdrawals amounted to 378 billion gallons each day.

Although, from these figures we can see that domestic water use is less than 10% of all use, in terms of proportional impact on the environment and the economy, it is much more significant since it represents a consolidated use which normally requires sophisticated transport systems and high levels of treatment and (as it relates to the household component) is collected and returned back to the resource pool as a concentrated point discharge again requiring substantial treatment to render it harmless.

DOMESTIC WATER USE CHARACTERISTICS

Domestic use includes water used for household purposes - the bath, toilet, sinks, laundry, cleaning, cooking and drinking and water used on property outside of the house - irrigation of lawns and gardens, car washing, wash-down, pools, etc. Per capita use requirements vary widely from place to place depending principally on climatic conditions, especially rainfall, and most especially, when the rain falls. Other factors such as whether the water is metered or unmetered, whether the home is served by sewers or a septic tank, household population, median income, price of water, are also important but except for metering practice and method of sewering are generally not of overriding significance.

California, where semi-arid conditions prevail throughout much of the state, per capita use in metered communities averages 185 gpcpd varying from a low of 153 gpcpd in the North Coastal area to a high of 410 gpcpd in the Colorado Desert.[2] FHA studies[3] in the Western United States indicated that outside (irrigation) requirements amount to 57% of total residential requirements. Others[4] have shown that the outside irrigation component, though varying widely, averages from 30% to 50% in the Western United States. Using 50% to approximate the outside irrigation component and distributing the remaining household component according to factors determined by Howe and others[5] we find that a fair approximation of typical household use in metered, sewered communities in the North Coastal area of California is:

• water closet	45%	34 gpcpd
• bathing	30%	23
• laundry & dishes	20%	15
• drinking & cooking	5%	4
	100%	76 gpcpd

Some typical examples of the amount of the water required by various appliances and fixtures found in the home are:[6, 7]

water closets	5 to 6 gallons per flush
shower	5 to 10 gallons per minute
automatic clothes washers ...	20 to 33 gallons per load
automatic dishwashers	6 to 19 gallons per load

Note from the foregoing the relative importance of the water closet in household use, making up almost 1/2 of the total.

A WATER CONSERVATION PROGRAM FOR NEW GROWTH

At North Marin County Water District we have chosen to concentrate on devices suitable for installation in new growth. We are trying just such a program in a large integrated residential development called

Pacheco Valle and located in southern portion of Novato, California, which by buildout will involve 360 townhouse/condominium (T/C) units, 290 apartment (Apt.) units, 50 single family (s.f.) units and 30 commercial establishments - 730 dwelling units and establishments in all. The developer is Realty Venture Associates, Inc., 2700 Wilshire Blvd., Los Angeles, California. Although the masterplan for the entire project has been approved, precise development plans have thus far been approved only for Phase 1 which consists of 174 T/C. and 15 s.f. units. Construction of the T/C units of Phase 1 are, as of this writing, just about complete and first move-ins will occur this month. All 174 T/C units of Phase 1 are expected to be occupied by fall of this year. Landscaping for Phase 1 contains:

grassy areas	11.2 acres
ground cover areas	0.9 acres
	12.1 acres

or approximately 3020 square feet per unit. A significant portion of the grassy area will consist of a fescue-wildflower mix which will not be mowed. Occupancy of the T/C units is expected to average 3.0 persons per unit.

The key elements of the program fall into two categories - the irrigation plan and the household plan. All elements employ utilization of existing technology and equipment readily available to the typical developer.

<u>The Irrigation Plan</u> The objective of the irrigation plan is to optimize water consumption hence minimizing run-off and waste. Happy byproducts are reduced leaching of nutrients, reduced pollution from urban run-off, healthier and more attractive lawns and reduced landscape maintenance costs.

- Soil Preparation: The soils of the area are clays and have stood undisturbed for generations being used only to support dry-land grazing activity. Preliminary test data indicated they were deficient in nitrogen, potassium and magnesium and exhibited a pH slightly higher than optimum. All landscaped areas were filled and specifications called for blending in four yards of nitrogen-stabilized rice hulls as a soil amendment and approximately one yard of nitro-humus as a bacteria booster per 1000 square feet. The cost for Phase 1 for soil preparation for the T/C units was $11,368 or $65.33 per unit.

- Sprinkler System Design: All landscaped areas are covered by a sprinkler system utilizing impact (or impulse) type heads in the few flat broad areas and slow rate, low-pressure stream spray heads in all other zones. The latter emit finger-like sprays and apply water quite slowly. They are especially well suited for slope areas and clayey soils which have low infiltration capacities. The landscaped area is covered by 18 controllers with each controlling from 3 to 12 stations. The basic aim of the sprinkler system layout is to provide maximum opportunity to achieve slow application rates. Cost of the system is believed essentially equal to the type of system normally installed in such a development.

- Moisture Sensors: Tensiometers (think of them as false soil roots) measure moisture conditions throughout the landscaped area. Forty-nine sets are used in all. Each set consists of two probes, one installed shallow (3 inches for turf areas) and one installed deep (8 inches for turf areas). Each set is located below ground level in a vandal proof box similar to a 5/8-inch meter box and each is connected to the section of controller it controls by low-voltage D.C. wire. The tensiometers override the controllers and permit the controller to carry out its pre-set irrigation cycle only if one or both of the probes is registering soil moisture conditions below the optimum range. The irrigation cycles are pre-set to achieve application rates in balance with the water infiltration capacity of the various soil zones and to come on only during early morning hours thus avoiding periods of high evaporation and interference with turf use by residents. Cost of the tensiometers installed including vandal proof boxes and wiring was $210 per set which figures out at $59.14 per unit.

<u>The Household Plan</u> Relatively simple, the household conservation plan relies on use of low-flush toilets, flow-control inserts in shower heads and other devices such as faucet aerators and temperature mix valves

which although contributing to water conservation were not credited to the conservation program because they would have been installed anyway.

- Low-Flush Water Closets: Although only about one percent of all flush water closets now sold in the United States are of the low-flush variety, these are nevertheless available to developers. The shallow trap water closet is the most popular water saver model and is available at a premium of approximately $8 to $15 over the cost of a standard water closet. The standard water closet uses about 5 to 6 gallons per flush whereas the low-flush model uses 3-1/2 gallons per flush (a 30 to 40 percent savings). Figuring two water closets per unit, the additional cost to the Pacheco Valle T/C units was $25.06 per unit.

- Shower Controllers: A shower control insert is mounted just behind each shower head. This orifice type device simply reduces flow rates from the typical level of 5 to 10 gallons per minute to 3 gallons per minute. Cost of the plastic insert installed was $1.48 per T/C unit.

- Instant Hot Water: Although the achieving of "instant" hot water by insulating hot water runs was dropped in the Pacheco Valle program due to high costs estimated at greater than $1 per foot for field applied wrapping, the element is nevertheless included here based on the recent availability of foam tubes which come in 3-foot lengths and because they are slit longitudely along one side appear to make hot water pipe insulation feasible. It is estimated this new type of installation, even assuming a retail purchase price, can be installed for less than 50¢ per foot. If used in Phase 1, the cost of this element of the program would have been about $25 per unit since the hot water runs in each unit averaged 50 feet.

<u>Water Savings and Cost</u> Preliminary estimates of water savings that will be realized by implementing the described plan are:

	Reductions in T/C Use in gpcpd	
	Avg. Annual	Peak Month
irrigation plan	19	50
low-flush water closets	12	12
shower controllers	6	8
"instant" hot water	8	8
	45	78
corresponding use for T/C type unit in 1971	100	209
Percent Reduction	45%	37%

With occupancy of the units now occuring, North Marin plans to monitor actual savings realized and initial figures should be available by the fall of 1976.

A summary of costs for the 174 T/C units of Phase 1 of the development is:

	Cost per T/C Unit
irrigation plan	$124.47
low-flush water closets	25.06
shower controllers	1.48
"instant" hot water (estimate) ..	25
	$176.01

Cost/Effectiveness Using initial cost per gallon of water saved per year for each T/C unit as an indicator of cost-effectiveness and ranking the elements in ascending order, the result is:

	Initial Cost	Annual Water Savings	Initial Cost per Gallon Saved per Year
shower controllers	$ 1.48	6,570 gal.	0.02¢/gal.
low-flush water closets	25.06	13,140	0.19
"instant" hot water	25	8,750	0.29
irrigation plan	124.47	20,805	0.60

Some Benefits of Domestic Water Conservation The impact and principal benefit of domestic water conservation is mainly related to the ability to defer (or possibly avoid entirely) construction of additional costly water development projects such as dams, canals, transmission lines, holding reservoirs, etc. These facilities, although absolutely necessary to the continued integrity of urban areas in our semi-arid state, should definitely be optimized so that their number can be minimized for such facilities are not only extremely costly from an economic point of view but also invariably involve significant environmental consequences and tradeoffs.

Other benefits from domestic water conservation are:

a. increased in-stream flows (where surface waters make up the supply) and resultant higher flows available for enhancement of downstream fisheries,

b. greater concentration of domestic sewerage reaching sewerage treatment plants hence increased utility of existing or planned new capacity and some reductions in direct operation and maintenance expense, and

c. reductions in urban runoff pollution loads due to reduced nutrient leaching from landscaping areas and reduced pesticide use both of which result if efficient irrigation is practiced.

To sum up then, domestic water conservation is just one area of effort which will contribute to optimizing the utility function of our water resource systems and in so doing bring about a more harmonious balance between a given population and the water supply system necessary to support that population.

REFERENCES

1 Estimated Use of Water in 1970, Geological Survey Circular 676, U. S. Geological Survey, Washington, D. C.

2 Municipal and Industrial Water Use, California Department of Water Resources, Bul. No. 166-I (1968)

3 A Study of Residential Water Use, Federal Housing Administration, U. S. Dept. of Housing and Urban Development (1967)

4 Linaweaver, F. P. Jr.; Geyer, J. C.; and Wolve, J. B. Report V, Phase Two, Residential Water Use Research Project, Johns Hopkins University, Baltimore, Md. (1963)

5 Howe, C. W.; Russell, C. S.; and Young, R. A. Future Water Demands: The Impact of Technological Change, Public Policies and Changing Market Conditions on Water Use Patterns of Selected Sections of the U. S. Economy, National Water Commission (1970)

6 Bailey, J. R.; Benoit, R. F.; Dodson, J. L.; Robb, J. M.; Wallman, H. A Study of Flow Reduction and Treatment of Wastewater from Households, Gen. Dynamics, Electric Boat Div. for Federal Water Quality Administration, Dept. of Interior (1969)

7 Cohen, S.; Wallman, H. Demonstration of Waste Flow Reduction From Households, Gen. Dynamics, Electric Board Div. for Environmental Protection Agency (1974)

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LEGAL ASPECTS OF WATER CONSERVATION

LEGAL ASPECTS OF
WATER CONSERVATION

by

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Basically my message to you today is that much can be done legally in the field of water conservation and what doubt there is is on the way to being clarified.

First of all the basic policy of the State of California is conservation of water. The California Constitution, Article XIV, Section 3 and Water Code Section 100 provide that "the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such water is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare."

Bob Goodwin had planned to tell you a little about the Ordinance they passed in the Goleta County Water District effective July 1, 1974, which basically requires approved water conservation devices in all new construction, alterations, or additions for which a building permit is required. The District has specified a long list of approved water conservation devices in seven different categories, including such areas as toilet devices, shower head devices, and hot water installation requirements. The legal authority for this action was based upon something that you won't all have because Goleta is under a moratorium as we are here in Marin and in that situation the legal authority is very clear. For instance, take Water Code Section 353 which applies to all water districts. Where you have a water shortage emergency condition you are empowered to adopt regulations which restrict delivery of water and consumption within the area of water supply for public use and you are also entitled under Section 354 to establish priorities for use of water--allocation, distribution and delivery of water. There are also specific provisions in County Water District laws (Water Code Section 31026) and in municipal water districts we have an identical section (Water Code 71640). These sections permit restrictions on use of district water, prohibition of water wastage, prohibition of water use for "nonessential" purposes, and even prohibition of use of water for any purposes other than household. So there is very ample authority for those districts in water shortage situations to impose pretty much any type of water conservation requirements and in fact these codes allow a moratorium. In Goleta there are two ways of enforcing their ordinance: (1) they won't give them any water, and (2) it is a misdemeanor punishable by a maximum of 30 days in jail or a $200 fine. Now Goleta back in 1973 also adopted a limited water conservation measure of allowing watering only from 10:00 to 4:00, and banned washing sidewalks, driveways and so forth with hoses and also motor vehicles, trailers, boats, more than once a month, so there are several kinds of things that can be done. In Marin, we were using a little different approach. When our water shortage arose, our Ordinance No. 122 was proposed, which was very similar to the 1973 Goleta Ordinance. I think our proposal banned watering from 10:00 to 6:00 and we added airplanes to the list of washing no-noes. Basically, it was pretty much the same thing. Our Board backed off from the idea of calling it a misdemeanor because they felt they would get quite an outcry from the public and we felt that a voluntary program would be more successful, at least here in Marin. So instead of passing an ordinance and making it a misdemeanor, our Board did it by resolution. They called upon the public to volunteer to do these things: limit watering hours, not use the hose to wash off their sidewalks, wash cars with a bucket, things of this kind and this information was sent out with our customer billings. We have had I think a very good response. We have had a drop in our per capita consumption from 170 gallons per day per person down to 148 gallons per day per person. Of course, this isn't all due to any one thing. There are a number of factors and a broad conservation program is underway in the district. We do feel that this had an effect and our Board felt that doing it on a voluntary basis rather than making it a crime would be more successful in this area. Now, of course, this raises the question: Suppose you don't have a water shortage situation and you want to propose water conservation requirements in your area; I think you can do it, and I think you can do it under the well-established rule that water districts may always impose reasonable rules and conditions on service. While it is true there are no appellate cases in California upholding rules and regulations of this particular kind (requiring water conservation devices), I think it is well within the meaning of prior court decisions. The California Supreme Court as long ago as 1936 in Schultz v. Lakeport (5 C.2d 377) said that the right to impose reasonable rules and regulations as a condition of water service was "generally recognized and may not be disputed." So the right is there, but the problem might arise and someone might say "in this particular case, this rule is not reasonable." Maybe the required water conservation devices will cost a lot more money than might be saved, and it is conceivable that a court would say "well, that is unreasonable." I think the concept is pretty broad. In order to clarify the law in this area, we have a bill which is in the Assembly, AB 2114, which specifically authorizes municipal water districts to undertake water conservation programs and to require as a condition of service reasonable water-saving devices and water reclamation devices. We still have that word "reasonable," but "reasonable" is a pretty broad word. I think the Board's discretion is quite broad, and I think the water conservation requirements that are being talked about are realistic, so I don't think we are going to have a problem. AB 2114 passed the Assembly 73-0 and we don't anticipate any problem getting it through. Of course, you never know what will happen in Sacramento, but so far, there hasn't been any opposition to it.* I am sure if this bill passes it won't be very long before there will follow bills expanding its coverage to all kinds of water districts. There is also the approach that John Nelson mentioned; that is, trying to approach the problem on a statewide basis. On his bill AB 1395, I have some good news for John. The bill is on third reading in the Assembly, and it is expected to pass momentarily. However, the Legislature is expected to recess shortly for about a month. If it doesn't pass before the recess it will be early August before it can be sent to the Senate. There is one thing that I might call to your attention which really doesn't relate to public water districts but certainly does indirectly and that is the opinion rendered by the Public Utilities Commission last week in the case of the California-American Water Company which serves the Monterey, Carmel Valley area. (Decision No. 84527 issued June 10, 1975). In effect the PUC imposed a water moratorium in that area because the annual consumption was exceeding the net safe yield by

* – AB 2114 was voted out of the Senate Agriculture & Water Committee with a "do pass" recommendation on August 19, 1975, by a 5-1 vote after it was amended to limit the right to condition water services to "new" services.

about 10%. The interesting point, I think, for our purposes here today, is that the water company had a water conservation program initiated in early 1974 in which they contacted large users on the need to conserve water, sent a letter with all their customer billings urging water conservation, revised their billings to show useage in gallons, made special efforts to work with golf courses to reduce their use, and ran water conservation newspaper ads. It is interesting to see PUC's attitude. The decision called these conservation efforts "rudimentary" and criticized the company for making no effort to promote low water using appliances and low water requirement landscaping and making no effort to obtain building code changes.

Now on the subject of rates. Sometime ago our district was thinking of going into a reverse rate structure. In checking up on its legality, I found California Supreme Court case from 1927, Willard V. Glenn-Colusa Irrigation District (201 C. 776) where a very steep reverse rate schedule was in effect for agricultural use. The first two acre-feet cost 37-1/2 cents per acre-foot and the next acre-foot went to 66 cents and the next $1.00 and by the eighth acre-foot you were up to $4.00 per acre-foot. The court stated in upholding this that it was "obvious that such a rule would tend to encourage the economical water use by the landowners of the district." The fact that there was ample water available for the district was not an excuse for the excessive use or waste of water. The court further held the district had a duty to adopt all reasonable measures to prevent the excessive use or waste of water. They also indicated that it was a widespread type of rate at that time, at least for agricultural districts, and that no court had ever struck such rates down as illegal.

There is one other thing I want to call to your attention in this area and that is the case of <u>Environmental Defense Fund v. East Bay Municipal Utility District</u>. The case arose in 1972 when the Environmental Defense Fund, Oceanic Society, Save the American River Association, and four individuals sued East Bay MUD on their decision to seek a new water supply from the American River. This case revolves around that California Constitutional provision which I read to you earlier requiring that water be put to beneficial use to which it is capable and requiring that waste and unreasonable use or unreasonable methods of use be prevented. It was alleged in that suit that East Bay MUD violated the requirement of reasonable use by (1) not recycling their waste waters before seeking a new water supply, and (2) that by taking water at a point where they planned to take it, they were interferring with proper use and that they could take the same amount of water at a lower point downstream. This caused cries of outrage from East Bay MUD because they felt that (1) they were in fact doing a lot of recycling and (2) they would obtain a much higher quality of water upstream. The trial court threw the case out for two reasons. First of all, since the East Bay MUD contract for water is with the United States, the judge felt that state law did not apply, and secondly, all prior cases interpreting the California constitutional provision involved disputes and problems between water users, not third parties. The case is now on appeal and everyone is getting into the act. The County of Sacramento, the Attorney General, the Goleta County Water District, and the Department of Water Resources have lined up with the Environmental Defense Fund, and the Association of California Water Agencies has filed a brief supporting East Bay MUD. ¶ I would like to just venture a guess or a semi-prediction on the outcome of this case.

Many water districts fear a decision against East Bay MUD might cause a lot of hassle from people challenging whatever project you were involved in on the basis that you didn't consider reclamation and recycling, of that you didn't consider it enough. I think the court is probably going to find that "yes, you do have to look at reclamation and recycling and all beneficial uses of water." You can't just go out and get a virgin water supply without at least considering other alternatives. I am not saying that East Bay MUD hasn't considered recycling and reclamation, but only that I think the court will find that this is a triable question of fact to be decided at trial. I do think this will be the ultimate result when the case hits the California Supreme Court, and I think it would be a very helpful decision if it will make the Districts consider and look at reclamation, look at recycling, look at conservation and do it seriously. I know you people here today are looking at it seriously, but I know there are a lot of water district people in California who are not looking at this yet or are not looking at it seriously. There are 200 people here today; maybe next year there will be 500 and 1,000 the year after. Let's hope so.

QUESTIONS AND ANSWERS

Q: This is on residence swimming pools - Should a pool be filled to capacity at all times and does it need a lot of water if only one or two people use that facility?

A: I have heard it stated that a swimming pool doesn't need any more water than a lawn of comparable size. You must keep it filled to a certain level in order for the water to recirculate and be filtered. Otherwise it becomes a health hazard. You can't ask people to fill their pool only half way because it would not be filtered.

Q. This business of reversed rate - By any chance is that Supreme Court case limited to agricultural use, or would it be broader than that?

A. Certainly it could be argued that it is limited only to agricultural use, but the language is so broad that I believe, and I am confident that it would be applied to other uses as well.

Q. Linda Phillips - Director, Goleta County Water District - Another thing I would like to say is that the 1973 Ordinance you mentioned was adopted at a time when the Board felt it necessary at that time to appease the users with a moratorium without rationing. It was not an effective ordinance. I think it was known at the time it would not be and there was another ordinance adopted at that time, and we have a couple of copies here which provides (1) it prohibits the water for service except where it is necessary for health and safety and the other is it prevents (it doesn't prevent, unfortunately), it prohibits over-watering to the extent that you have a lot of runoff. We have not had a full cooperation on this, and we have just sent our first case on it to the District Attorney, so we have to see what happens.

J. D. Stroeh

General Manager
Marin Municipal Water District

TOTAL APPROACH TO DOMESTIC WATER CONSERVATION

TOTAL APPROACH TO DOMESTIC WATER CONSERVATION

I think Marin Municipal Water District (MMWD) is a little ahead of most. As far as we are concerned we do have a total approach to domestic water conservation. As a background, I think it might be appropriate to tell you how we got there or where we are today. Back about the late 1960's, we were working on a new supply program for our district in conjunction with North Marin County Water District and Sonoma County Water District to bring water in from the Russian River. In 1970, we went to a bond issue for the first leg of that. That was passed in November of 1970. In 1971, we went back to the elecorate to contract with Sonoma County which was defeated by 9-1. During that period there were a lot of questions raised about water supply; where you get it; what are you doing. This is when we started getting into the whole issue of water supply. We went through a series of meetings and soul searching trying to determine exactly which way to approach water supply, which resulted in an election in November of 1973 of a smaller Russian River project. This was defeated by 2-1. Then we really had to take a hard look at ourselves and many of the questions that had been raised by people in Marin County i.e. are you looking at recycling or reclamation; what are you doing in the water conservation area; how much are the rates (by the way we went into a rate restructuring in 1972)-- all of these areas. Last year we spent a full year working out what we call "The Total Supply Management Program" and last fall we submitted to the Board a program which they subsequently adopted. This program includes water conservation, reclamation and a new source of some sort in the county. This brings up another question that was raised by a lot of people. They want to stay local. They want us to stay local and stay within the County. So, we did just that. To give you some idea of where we are, we have a demand of around 32,500 acre feet a year and a reservoir system here in the county of 26,00 acre feet. We have been lucky. We have had some wet winters. We are waiting for the dry period when we are going to get caught. We have a deficit of 6,500 acre feet and that caused us a moratorium. We turned to the local Master Plan which is what we call a Countywide Plan which indicated that we needed an additional 16,000 acre feet by 1995 to eliminate our deficit and also to give us the needed supply to serve the increasing population. We took a look at the whole supply program. With water conservation we thought we could do some work here. Water conservation is part of the answer and we actually cranked this into our whole program as an amount of water--the negative amount of water we don't have to develop to get that 16,000 acre feet. We think we can drop that amount by 5,000 acre feet in 20 years. Wastewater reclamation--we have isolated areas within our District we think we can use reclaimed wastewater for irrigation purposes. We have no industry so it has to be for irrigation uses. 80% or 85% usage. We think we can save 2,000 acre feet for domestic supply out of reclaimed wastewater. That brings us down to approximately 9,000 acre feet of water required. The 1970 bond issue passed a project that could bring in 4,000 acre feet from the Russian River so that leaves us 5,000 acre feet for a project from some place here in the County. There are some projects in the County where we can develop on that basis. We are looking at a number of them and we think that through the old departmental system that one or more of them that we could possibly use will be a winner. So you can see how water conservation comes into departmental cases and what is going through a lot of your minds is well, what happens if one portion of that fails. That's a good question. If it does fail, we have to go to Plan B, or C or D or something else. Right now this is the direction we are working on and working on very hard. It has to work together. The water conservation and water reclamation elements have to work. I just learned yesterday that we have received the bids on the project and that project will be constructed and will be completed next year. As mentioned already, our per capita consumption was 170 gallons per day per person. It has gone down to about 150. We do feel that there has been some effect due to conservation. We have two types of development--one is condominiums, this type of thing. This is happening of course all over but this too has affected our per capita consumption. Now the areas that we are looking at will fill the conservation needs the greatest are existing consumption, use of reclamation systems which I will get into in a second, new development which John Nelson talked about, and public education. All of these have to be tied together. One by itself will not work. You talked about rates earlier and what happens after five years within the rate structures. Well, you may be right back where you are. You have got to keep pounding away on an educational program that we have got to conserve water. I am not going to get into any detail on rates because you have heard what we are going to be getting or at least what the consultants are working on for our District. I am not going to make any editorial comments at this point because I haven't seen the full text but it is an approach that we are looking at. It would, in fact, as mentioned earlier, probably save somewhere around 10%. Studying percentage usage--in other words, your whole budget is set up on a basis of 90%. Anything over that will pay maybe 10%, 20%, but anyway our consultants are working on that and we will see how that comes out. As it is now, there should be about a 10% saving. We will see if, in fact, that does happen. Public education is very similar to East Bay MUD, in fact, we have stolen a little bit of their material; they are now stealing a bit of our material and that is the way it is I think. It is great to have material back and forth. We will have a film here after I finish of 7-9 minutes in length which I think has on it the TV spots that we worked out with East Bay MUD, Santa Clara and ourselves which are basically on water conservation. One other thing, that I would like to mention that we are working on, in fact, we are putting into effect which has been done worldwide--that is, working with the local restaurants. It may sound a little silly but you have all been to resturuants and gotten a glass of water and sometimes you drink it and sometimes you don't. You waste water, but also the washing of that glass and the whole works, so we are working on restaurants locally and we have gotten some good response that will go into effect some time in the next month, where we are working with them where basically we will have a program where there will be on each table a little tent type of thing which will say "if you want a glass of water, please ask" and, of course, there will be an explanation of it. This is done here; this is done in New York; this is done in various other areas where they don't even tell you about it. Another thing we are working on which was dedicated last Saturday is what we call a Water Conserving Garden and this has been established at our County Civic Center. It is an acre and a half plot and this has been established with various plants that will survive in Marin County and its different climates and different soils situations. We hope that this particular water conserving garden will be used by not only public spirited groups but educators, planners, and developers. This is another portion of this whole program and we have also put out a Water Conserving Garden booklet which includes a number of plants which are planted here, the way they are planted, John Nelson's work up north, the lawn situation. We think this will be effective and can be helpful to our community. As far as suggesting consumers, this is a definite problem area because of that fact--a couple of reasons--its response, getting your existing consumers to work with you. I am speaking now of record systems or where you get into the old toilet tank bit or dams or . . .

PACHECO VALLE

THE PACHECO VALLE WATER STORY

"Water and life are two threads woven intrinsically together."
Quote from *Living Water* by David Cavagnaro

. . . and so it is at Pacheco Valle.

Pacheco Valle has enlisted the talents of many professional disciplines to cooperate with North Marin County Water District in designing a community which conserves one of our most precious resources . . .water. The Water District estimates overall water savings of 37 percent will be realized with the added bonus that homeowners will in fact enjoy greener, healthy lawns, reduced landscape maintenance costs and, of course, reduced water costs.

LANDSCAPING

Settlers in this charming valley will occupy dwellings surrounded by lush green grasses blending into the natural woods of native oak and buckeye. The free flowing design of green areas, while giving the visual impression of abundance is actually comprised of less lawn area than found in the more traditional development. Hence landscape irrigation and maintenance costs are reduced.

Special attention has been given to build up the natural top soils by adding organic, chemical and bacteria soil amendments to provide a fertile, well drained and balanced environment for the grasses they support. This extra effort will pay continuing dividends in healthier, more attractive lawns with reduced water and maintenance costs.

Sprinkler systems have been designed to apply water gently and slowly — thus reducing run-off and deep perculation losses below the root zone. In addition to automatic timer devices called "controllers", which periodically irrigate each zone in the low evaporation morning hours when people are not about, other devices called "tensiometers" are set in the ground at representative sites. The tensiometer (think of it as a false root) constantly measures moisture concentrations in the root zone and feeds back information to the controller via low voltage D.C. circuits. This information is automatically used by the controller to achieve optimum water application. The result is healthier, greener lawns which are deeper rooted and less susceptible to disease and which require less water and fertilizer due to increased irrigation efficiency.

THE HOUSEHOLD

Proven technology has also subtly been put to work in each home to reduce water consumption.

First and most important is the water closet which, although costing more than units commonly found in modern subdivisions, saves about two gallons of water per flush. The design concept of these low-flush units is identical to traditional units except that the air trap, separating bowl water from the sewer, is lower in elevation. This, together with more efficient bowl cleansing, results in less water needed to displace wastes from the bowl. The low profile design of the unit is attractive and in many situations permits extension of the lavatory vanity over the toilet tank, thus achieving a pleasant integrated bathroom design.

Behind each shower head, specially designed inserts control delivery rate to three gallons per minute. Most people enjoy this flow rate, but for the hearty individual who prefers an especially prickly shower, the shower head easily comes off exposing the insert, which can then readily be removed.

Shower/bath and kitchen sink are also fitted with temperature mix faucets which reduce "hunting" for that most desired temperature and which are safer and more convenient to use.

Interior faucets are also equipped with aerators which reduce splash, increase wetability and hence cleansing efficiency while at the same time improving the taste of tap water and reducing demand.

Water heaters are located to minimize the length of hot water pipe runs. This not only saves water by reducing "waiting time" at the taps but it also reduces heat loss and hence energy costs.

WATER STORAGE

Lastly, but certainly not least, is the massive 5 million gallon concrete water tank built by Pacheco Valle, which will serve peak demands and provide standby fire protection for the area. Partially buried so as to nestle unobtrusively into the woods abounding on the hills to the north of the development, the reservoir has been attractively color treated so that the portions visible to the passer-by complement the natural landscape. Furthermore, the surface of the reservoir is designed to permit, at some future date, the development of four tennis courts or some other type of recreational use. The City of Novato would be responsible for such a development and has no current plans for same, but the option exists.

In summary, water and life at Pacheco Valle are indeed woven intrinsically together, and those who come to abide here can be proud that efficient use of water permits them to enjoy all or more water related amenities than most homeowners, with the added rewards of reduced landscape maintenance costs and reduced water costs.

PACHECO VALLE

Text approved by
North Marin County
Water District.

MINUTES OF 25 JUNE 1975
WATERCARE
BUSINESS MEETING

MINUTES OF ANNUAL MEETING OF MEMBERS
OF
CALIFORNIA ASSOCIATION OF RECLAMATION ENTITIES OF WATER
a California Corporation

June 25, 1975, San Rafael, California

Following the Second Annual Conference of the California Association of Reclamation Entities of Water held June 24 and 25, 1975 at the Dominican College in San Rafael, California, President Fowler called the Annual Business Meeting of the general membership to order at 3:45 p.m., June 25, 1975, in Gusman Hall, Dominican College. There were present at said meeting the following Representatives and Alternate Representatives of members of the Corporation:

H. W. Stokes, Representative, Las Virgenes Municipal Water District
John Olaf Nelson, Representative, North Marin County Water District
Neil M. Cline, Representative, Orange County Water District
Howard Bensen, Representative, City of Santa Barbara Public Works Department
Lloyd C. Fowler, Representative, Santa Clara Valley Water District
George W. Adrian, Representative, City of Los Angeles Department of Water and Power
Joseph V. Reynolds, Representative, Napa County Flood Control and Water Conservation District
J. Dietrich Stroeh, Representative, Marin Municipal Water District
Eugene Bowers, Alternate Representative, The Metropolitan Water District of Southern California
Polly O. Smith, Alternate Representative, Marin Municipal Water District
Orrin H. Harder, Alternate Representative, East Bay Municipal Utility District
Dave Perkins, Alternate Representative, East Bay Municipal Utility District
Nereus L. Richardson, Orange County Water District
Dr. Linda K. Phillips, Representative, Goleta County Water District

Associate Members present included:

William R. Seeger, Kennedy Engineers
William E. Warne, Consultant, Associate Director
Joan B. Kerns, Director, Montecito County Water District

Representing Associate Member:

Bob Whiting, Charlie Kleine, and W. B. Mitchell, California Department of Water Resources

Representing member agencies in an unofficial capacity were:

Courtney R. Chandler, President, Orange County Water District
Robert L. Clark, Director, Orange County Water District

Guests present at the meeting included:

James Crook, California State Department of Health
Janet Beymer, Ventura County Environmental Coalition
Elroy F. Spitzer, AWWA Research Foundation

Also present was Barbara Barber, Orange County Water District, Recording Secretary.

Following introductions, President Fowler reviewed the agenda for the meeting and the acceptance of new members was agreed to be the first item of business to be considered.

MOTION NO. 75-6-84 — Upon motion by Mr. Neil Cline, seconded by Mr. H. W. Stokes, and carried, the Goleta County Water District is hereby accepted as a member agency of the California Association of Reclamation Entities of Water.

MOTION NO. 75-6-85 — Upon motion by Mr. William E. Warne, seconded by Mr. Neil M. Cline and carried, applicants for Associate Membership in WATERCARE to date are hereby accepted:

Mr. George E. Wilson
Mr. John R. Teerink
Mr. W. Edward Nute
Mr. Allan W. Kitchen
Miss Kathleen D'Arezzo
Mr. Ross A. Morrison
Mr. Carl Harris
Mrs. Janet Beymer

It is hereby further agreed that all applications for Associate Membership received during the Second Annual Conference are hereby approved.

APPROVAL OF MINUTES

MOTION NO. 75-6-86 — Upon motion by Mr. John O. Nelson, duly seconded and carried, the Minutes of the First Annual Meeting of WATERCARE, held July 17 and 18, 1974, in Newport Beach, California, are hereby approved by the General Membership and Associate Members.

MOTION NO. 75-6-87 — Upon motion by Mr. H. W. Stokes, duly seconded and carried, the Minutes of the meeting of the Board of Directors of WATERCARE held April 25, 1975 in Playa del Rey, are hereby approved.

TREASURER'S REPORT

MOTION NO. 75-6-88 — Upon motion by Mr. Neil M. Cline, seconded by Mr. J. Dietrich Stroeh and carried, the Treasurer's Report of the California Association of Reclamation Entities of Water dated April 30, 1975 is hereby approved and accepted.

1975-76 BUDGET

MOTION NO. 75-6-89 — Upon motion by Mr. John O. Nelson, seconded by Mr. H. W. Stokes and carried, the proposed Budget for WATERCARE for the fiscal year 1975-76 is hereby approved with the provision that the $355 Contingency item be modified to reflect actual Cash on Hand as of June 30, 1975.

AUDITOR'S REPORT

Mr. Dave Perkins, East Bay Municipal Utility District, elected at the 1974 Annual Meeting of WATERCARE as Auditor to audit the Corporation's books for the year ended June 30, 1975, requested that the audit report be submitted for approval at the next meeting of the Board of Directors, in order that the audit could be performed after the closing of the books at the end of the fiscal year.

MOTION NO. 75-6-90 — Upon motion by Mr. J. Dietrich Stroeh, seconded by Mr. John O. Nelson and carried, it is hereby agreed that the audit report for the year 1974-75 be deferred to the next meeting of the Board of Directors of WATERCARE.

1975-76 ELECTIONS

1. <u>Election of Directors</u>

The recommendation of the Nominating Committee, submitted to members by mail prior to the meeting, was that Directors Lloyd C. Fowler, J. Dietrich Stroeh, and Howard Bensen, whose terms expire at the 1975 Annual Meeting, be retained in office. The following action occurred:

MOTION NO. 75-6-91 — Upon motion by Mr. H. W. Stokes, seconded by Mr. John O. Nelson, and carried, the report of the Nominating Committee is hereby accepted and, there being no further nominations from the floor, the nominations are hereby closed and Directors Lloyd C. Fowler, J. Dietrich Stroeh, and Howard Bensen are hereby unanimously reelected to three-year terms as Directors of the California Association of Reclamation Entities of Water.

2. Election of Associate Director

MOTION NO. 75-6-92 — Upon motion by Associate Member Joan B. Kerns, duly seconded and carried unanimously, Mr. William E. Warne is hereby nominated to serve as Associate Director of WATERCARE during the 1975-1976 fiscal year.

MOTION NO. 75-6-93 — Upon motion by Associate Member William R. Seeger, duly seconded and carried unanimously, there being no further nominations from the floor, nominations for Associate Director are hereby closed and Mr. William E. Warne is hereby reelected Associate Director of WATERCARE.

3. Election of Auditor

MOTION NO. 75-6-94 — Upon motion by Mr. John O. Nelson, seconded by Mr. J. Dietrich Stroeh, and carried, Mr. Dave Perkins, East Bay Municipal Utility District, is hereby nominated to serve as Auditor of the California Association of Reclamation Entities of Water to audit the books of the Corporation for the fiscal year ended June 30, 1976.

MOTION NO. 75-6-95 — There being no further nominations, upon motion by Mr. John O. Nelson, seconded by Mr. J. Dietrich Stroeh and carried unanimously, nominations for WATERCARE Auditor for the fiscal year to end June 30, 1976, are hereby closed and Mr. Dave Perkins is hereby reelected Auditor.

COMMITTEE REPORTS

Program Evaluation Committee

1. Committee objectives; revisions to Committee structure

Program Evaluation Committee Interim Chairman H. W. Stokes reviewed the proposal for reorganization of the Committee's work and organization submitted to the membership by mail prior to the meeting. Following discussion, action was taken that:

MOTION NO. 75-6-96 Upon motion by Mr. Neil Cline, seconded by Mr. Howard Bensen, and carried, it is hereby agreed that the recommendations for reorganization of the composition and objectives of the Program Evaluation Committee be discussed further at the next meeting of the Board of Directors, and that members of the organization study the proposals in the interim for comment at that time.

2. Seminar of virologists, U.C.L.A.

Mr. Stokes noted that a meeting of experts in the field of virology would be held June 26, 1975 at the University of California, Los Angeles. Following discussion of the impact of this meeting, Mr. Stokes was requested to represent WATERCARE at the meeting and to furnish a report on the meeting if possible, either prior to or at the next meeting of the Board.

Legislative Committee

1. Safe Drinking Water Act

Mr. William E. Warne had mailed to WATERCARE members prior to the meeting a memorandum containing notes regarding the Safe Drinking Water Act of 1974. Following further discussion of this legislation, Mr. Warne commented that he would attempt to furnish a follow-up report prior to the next meeting of the Board if at all possible.

2. AB 1395

Mr. John O. Nelson distributed copies of AB-1395 related to low-flush toilets, together with a fact sheet on the bill, and urged member agency boards to support this legislation.

AWWA RESEARCH FOUNDATION WATER RECLAMATION RESEARCH PROJECT

By action taken at the April 25, 1975 meeting of the Board of Directors, WATERCARE had agreed to participate in a water reclamation research project with the American Water Works

Association Research Foundation, under which the Foundation will receive, review and summarize reports to be submitted from ten utilities active in water reclamation participating in the project. Mr. Elroy Spitzer, Director of the AWWA Research Foundation was present at the meeting and further reported on the program, budgeted at $50,000 for the first year. Mr. Spitzer stated that, including the $10,000 budgeted by WATERCARE for participation in the project, presently $35,000 is committed for the study with another $5,000 tentatively forthcoming. Eight other utilities which have been invited to participate have not yet responded. Participants committed to date are: WATERCARE; the cities of Denver, Dallas, and Los Angeles; Fairfax County, Virginia; and the EPA by purchase of copies of reports submitted. Since WATERCARE as an organization and its member agencies are vitally interested in this project, it will be a continuing item for report and discussion at future meetings of the Board.

WATERCARE VIRUS STUDY RESEARCH PROJECT

Mr. Eugene Bowers, Chairman of the WATERCARE ad hoc committee formed to study the feasibility of a joint study of virus by California water agencies, reported that, in discussing the project with EPA officials, the question had been raised of which virus would be studied, since they had discovered that no one virus would make itself known in a constant manner. Mr. Bowers noted also that Dr. Rhodes Trussell and Mr. Gordon Culp had indicated at the WATERCARE conference a priority need for research of hepatitis virus. While Mr. Bowers had no further report at this time, he stressed that, if WATERCARE proceeds with the virus studies, the project will have to be of a size and scope and involve enough experts to obtain the relevant data needed. He also suggested that the agency consider researching stable organics.

As Interim Chairman of the Program Evaluation Committee and in order to officially represent WATERCARE's ad hoc virus study committee at the virologists meeting to be held June 26 at U.C.L.A., Mr. Fowler appointed Mr. Stokes to this committee.

WATERCARE SECOND ANNUAL CONFERENCE

In recognition of the efforts of the Marin Municipal Water District and the North Marin County Water District resulting in the tremendous success of the Second Annual Conference of WATERCARE, the following action was taken:

MOTION NO. 75-6-97 — Upon motion by Mr. H. W. Stokes, duly seconded and carried unanimously, Resolution No. 12 commending North Marin County Water District and Marin Municipal Water District for their work in arranging the Second Annual Conference of WATERCARE, is hereby adopted.

RESOLUTION NO. 12

RESOLUTION OF THE
CALIFORNIA ASSOCIATION OF RECLAMATION ENTITIES OF WATER
IN APPRECIATION OF THE EFFORTS OF THE
NORTH MARIN COUNTY WATER DISTRICT
AND THE
MARIN MUNICIPAL WATER DISTRICT
FOR THE ASSOCIATION'S SECOND ANNUAL MEETING

The Second Annual Meeting of WATERCARE, held June 24-25, 1975, at Dominican College in San Rafael, was declared by all to be an outstanding success. The program for the meeting was excellent, the setting was eminently conducive to the success of the meeting, and the luncheons were superior.

This meeting was developed and conducted by the MARIN MUNICIPAL WATER DISTRICT and the NORTH MARIN COUNTY WATER DISTRICT as co-hosts. It was because of the superior efforts of these agencies and their staffs that the Second Annual Meeting of WATERCARE was so successful.

IT IS THEREFORE RESOLVED by the Board of Directors and membership of WATERCARE that the deep sense of gratitude of the Association be expressed to the MARIN MUNICIPAL WATER DISTRICT and to the NORTH MARIN COUNTY WATER DISTRICT for their activities on behalf of the California Association of Reclamation Entities of Water.

ADJOURNMENT

There being no further business to come before the meeting, the Annual Business Meeting of the membership of the California Association of Reclamation Entities of Water was adjourned at 5:30 p.m. A business and organizational meeting of the Board of Directors will be held at a time and place to be noticed by President Fowler.

Lloyd C. Fowler, President

Neil M. Cline, Secretary