Western Consortium for Public Health

CITY OF SAN DIEGO TOTAL RESOURCE RECOVERY PROJECT:

HEALTH EFFECTS STUDY

Project Summary

Spring 1993

POTABLE REUSE OF RECLAIMED WATER

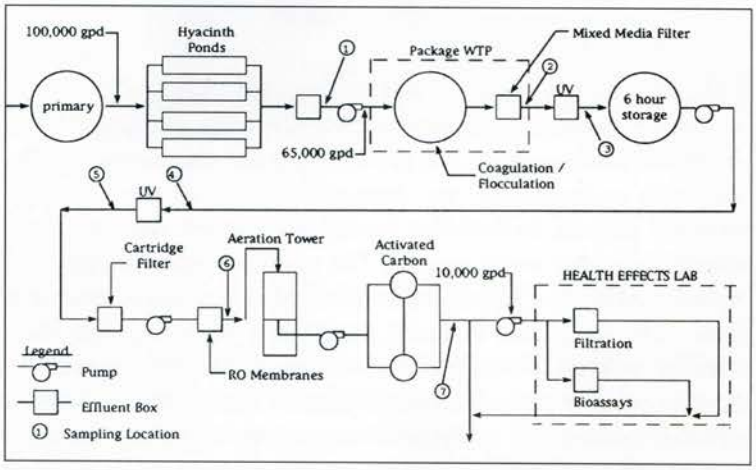
The City of San Diego, California imports virtually all of its water supply from other parts of the state. The City is projecting a need for additional water within the next decade. New sources of imported water are not readily available, and the City is actively investigating advanced water treatment technologies for utilization of potential resources that may already exist locally. Municipal wastewater, which is presently discharged to the Pacific Ocean, is among the potential local water resources that are being investigated.

The City of San Diego received Federal and State funding to build and operate a 1.0 million gallons per day (Mgal/day) water hyacinth secondary treatment facility with 0.5 Mgal/day Advanced Wastewater Treatment (AWT) facilities; and for constructing facilities at the Mission Valley site that included 0.5 Mgal/day water hyacinth secondary treatment facilities and 0.05 Mgal/day AWT facilities. The testing of this water reclamation system included a substantial research effort to estimate the risk associated with potential potable use of the treated water. The study included comparison of the potential health risk relative to that associated with the City's present water supply. The monitoring components of the study have been underway since July 1987.

HEALTH EFFECT STUDY OBJECTIVES AND ORGANIZATION

The program was designed to test the feasibility and determine possible health risks associated with reuse of reclaimed wastewater. Public health jurisdictions have not accepted such direct reuse because of the following concerns:

- the "raw" water supply, wastewater in this instance, can be expected to contain infectious and toxic materials;
- the uncertainty as to the quality requirements for a safe drinking water regardless of the source; and,
- the recognition that public health authorities have worked for decades to provide "pure and safe" drinking water sources and the deliberate reuse of wastewater runs counter to traditional patterns of water use.



Plant Schematic of Aqua II

The Western Consortium for Public Health entered into a contract with the City of San Diego in July of 1985 to conduct a Five Year Heath Effects Study (HES) for the City of San Diego to investigate whether the proposed wastewater treatment scheme can reliably reduce contaminants of concern to levels such that the health risks to the population would be no greater than those associated with the present water supply.

Since 1981, the City of San Diego has been experimenting with an innovative aquatic system for the secondary treatment of wastewater. In the mid 1980's, a Technical Advisory Committee (TAC) and a Health Advisory Committee (HAC) were established to investigate the feasibility and associated health risks of the project. Both the TAC and HAC consist of representatives from the California Department of Health Services, the University of California at Berkeley, San Francisco, Davis, and Los Angeles, the San Diego County Department of Health Services, and the California Water Resources Control Board.

DESCRIPTION OF WASTEWATER TREATMENT SYSTEM

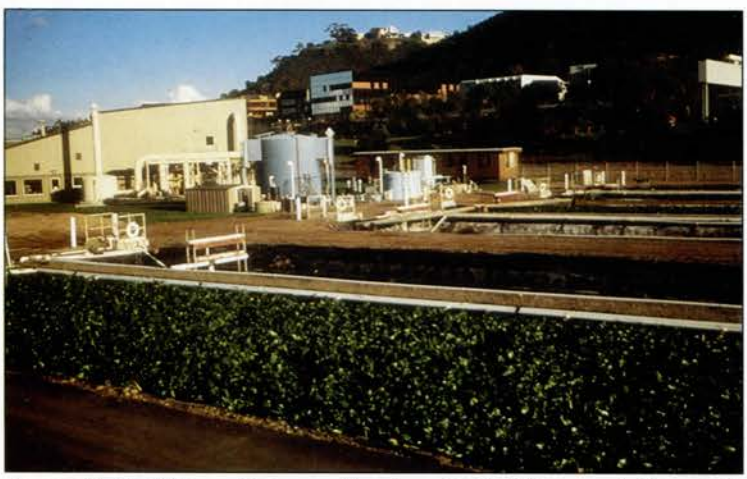
The wastewater treatment system that was studied in San Diego is a unique and innovative system, utilizing channels containing

water hyacinths for secondary treatment, followed by an Advanced Wastewater Treatment (AWT) system to upgrade the secondary effluent water to a quality that should be sufficient to serve as raw water for potable reuse.

The AWT plant contains a full range of advanced wastewater and water treatment unit processes, including coagulation, filtration, reverse osmosis, air stripping, carbon absorption, and final disinfection. The effluent from the advanced wastewater treatment system represents a potential raw water supply for the City of San Diego and has been compared to the City's present raw water supply.

HEALTH EFFECT STUDY ELEMENTS

The health risk evaluation was a five year effort. The study included elements for identifying, characterizing, and quantifying infectious disease agents and potentially-toxic chemicals, and for screening mutagenicity and bioaccumulation of the chemical mixtures present, in both the treated wastewater and the City's untreated potable water supply. The untreated water supply was represented by raw water entering the Miramar water treatment plant. The study also included a reliability analysis, using data from the technical performance evaluation of unit processes in the demonstration water reclamation plant. Lastly, the evaluation included conducting an epidemiology study to collect baseline data of the San Diego population and developing chemical and biological risk assessments.



Aqua II Facility - Primary Treatment Building and Hyacinth Ponds

INFECTIOUS DISEASE AGENTS

The treated effluent from the AWT plant was monitored for the presence and number of pathogens and indicator organisms. Representative samples of San Diego's raw water supply were also monitored for the same organisms. The data were collected over a two and one-half year monitoring program. Results of the monitoring program indicated that the microbiology of the AWT water, without disinfection, meets all microbiological criteria for recreational waters (fresh and marine) and raw drinking water source requirements.

CHEMICAL AGENTS

The chemical agents element of the project is organized into the five sub-tasks described below.

HES Laboratory - Virus Sampling

Chemical Screening and Monitoring

The objective of the screening phase was twofold; one, to determine which chemicals are present and their concentrations in the AWT water, the Miramar water, and the raw wastewater (RWW); and two, to identify which of these chemicals are known to be of concern to human health. Data generated during the chemical screening phase were used to design the monitoring phase of the Chemical Agents study element. The objective of the monitoring phase was to characterize the variability of concentrations, and relative concentrations, of a sub-set of chemicals selected on the basis of their public health importance and their representation of larger classes of chemicals. The monitoring results indicate that most constituent levels in the reclaimed water were extremely low; well below conventional detection limits.

Bioassay (Genetic Toxicity Testing)

Genetic toxicity testing (Ames assay) was used as a relatively cost-effective bioassay for screening the relative toxicity of the two waters being investigated. Data from the short-term bioassay results for both AWT and Miramar water indicate that water from the AWT facility appears to exhibit less genotoxic or mutagenic activity than the low levels observed in water

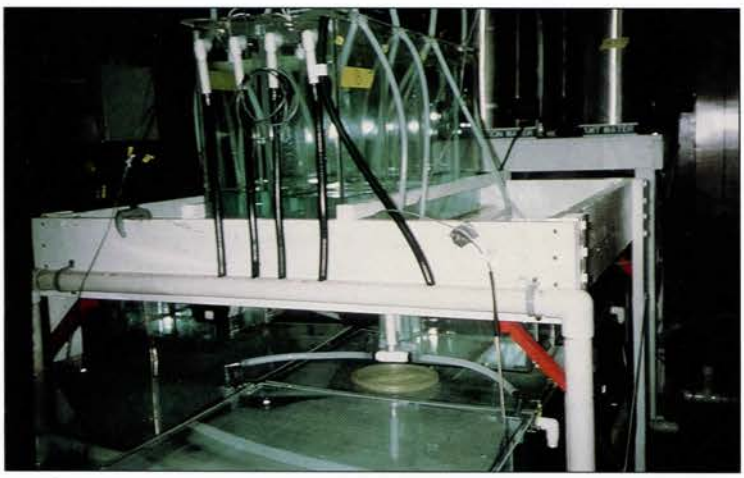
from the Miramar reservoir, a current raw drinking water source for the City of San Diego.

Biomonitoring

Three 28-day bioaccumulation experiments were completed at each site under standardized conditions following EPA and ASTM bioconcentration guidelines. In addition, swim speed and optomotor (eye reflex) response tests were conducted. Chemical analysis of fish tissue and water in the 28-day bioconcentration experiments revealed no statistically significant differences. The fish displayed no significant difference in survival, growth, or swim speed after up to 28 days of continuous whole body exposure to either Aqua II or Miramar water under test conditions.

Toxicological Literature Review

The toxicological literature review was used to identify and review studies on toxic chemicals in drinking water and provide the basis and support for the chemical risk assessment.



Fish Biomonitoring Aquaria

Quantitative Risk Assessment for Chemical Agents

The quantitative chemical risk assessment was performed for carcinogenic and noncarcinogenic substances using the Environmental Protection Agency's linearized multistage model to develop estimates of human health risk. In addition, recent research findings addressing uncertainty were incorporated into the risk assessment methodology.

Data collected during the monitoring phase of the Total Resource Recovery Project were evaluated to determine which chemicals to include in the risk assessment. In general, the cancer risk posed by the AWT water, after a lifetime of exposure, is less than one cancer per million people. Results of the noncarcinogenic risk assessment indicated that long term ingestion of AWT water would not be anticipated to result in any significant health risk.

Advanced Wastewater Treatment - Filtration, Reverse Osmosis, and Activated Carbon Pilot Facility

PLANT RELIABILITY

Evaluating the risk associated with the AWT plant effluent includes considering the ability of the treatment system to consistently achieve the level of treatment that was used as the basis for the health risk assessment. Therefore, the overall reliability of the San Diego Aqua II Pilot Plant has been expressed in terms of its ability to achieve a consistent effluent. The levels of treatment obtained at the Aqua II plant were consistent and sufficient to meet all existing drinking water standards for all of the data reviewed in this study. Results of the plant reliability analysis revealed that observed equipment failures do not cause a significant interruption in operation of the plant and that critical equipment are operational nearly 100 percent of the time.

EPIDEMIOLOGY

The epidemiological component provided baseline data to facilitate monitoring for actual health effects if the city decides to proceed with potable reuse of the type of effluent studied in this project.

CONCLUSION

Based on the above research, the overall conclusion reached by the Health Advisory Committee was that the health risk associated with the use of the Aqua II (AWT water) as a raw water supply is less than or equal to that of the use of the existing City raw water supply as represented by water entering the Miramar water treatment plant.

Place Label Here

FOR ADDITIONAL INFORMATION PLEASE CONTACT:

Mr. Paul Gagliardo
City of San Diego
5540 Kiowa Drive
La Mesa, CA 91942
(619) 533-5101

TO PURCHASE COPIES OF TECHNICAL PROJECT REPORTS PLEASE CONTACT:

Ms. Denise Nilsson
Western Consortium for Public Health
2001 Addison Street, Suite 200
Berkeley, CA 94704-1103
(510) 644-9300