DOCUMENT RESUME

07678 - [C3186280] (Restricted) Released 11-27-78

Reuse of Municipal Wastewater and Development of New Technology: Emphasis and Direction Needed. CED-78-177; B-166506. November 13, 1978. 35 pp. + 2 appendices (4 pp.).

Report to Rep. Don H. Clausen, Ranking Minority Member, House Committee on Public Works and Transportation: Water Resources Subcommittee; by Elmer B. Staats, Comptroller General.

Issue Area: Environmental Protection Programs: Federal Controls Over Wastewater Treatment Construction Grant Funds (2202); Science and Technology: Applying Science and Technology to State and Local Government Problems (2006).
Contact: Community and Economic Development Div.
Budget Function: Natural Resources, Environment, and Energy: Pollution Control and Abatement (304).
Organization Concerned: Environmental Protection Agency.
Congressional Relevance: House Committee on Public Works and Transportation: Water Resources Subcommittee. Rep. Don H. Clausen.
Authority: Federal Water Pollution Control Act, as amended (33 U.S.C. 1251). Federal Water Pollution Control Act Amendments of 1956 (P.L. 84-660). Federal Water Pollution Control Act Amendments [of] 1972 (P.L. 92-500). Clean Water Act of 1977 (P.L. 95-217). Clean Water Act Amendments [of] 1977. P.L. 94-447. P.L. 95-26. P.L. 95-240.

The Clean Water Act of 1977 requires that alternative wastewater treatment methods, including land application, must be evaluated during facilities planning before an agency grant is made for a wastewater treatment plant. Findings/Conclusions: Even though new technologies for the treatment and reuse of wastewater are available, they have not been used extensively because: they provide treatment levels higher than needed to meet requirements; some are more costly than conventional methods; and program participants are unwilling to risk failure. Land application could provide benefits such as eliminating point discharges to surface waters, higher levels of treatment than provided by conventional secondary methods, and replenishment of groundwater. However, it has not been widely used because of stringent State pretreatment requirements, limited technical and health effects information, and unavailability of suitable land. Recycled wastewater may be used for several industrial, municipal, and recreational purposes. However, only a few wastewater reuse projects have been funded because the use of reclaimed wastewater is generally not cost effective and concerns over recycled wastewater discourage potential users. There is no clear Environmental Protection agency (EPA) policy on the funding of wastewater reclamation. Recommendations: The EPA should promote the acceptance and use of newly developed technologies in wastewater treatment projects. The Administrator, EPA, should: designate a central

group within his agency to analyze long-term wastewater treatment research needs and to receive, review, and coordinate the approval of evaluation grant awards; and identify the types of plants and municipalities where new technology could be utilized effectively. (Author/BTS)

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REPORT BY THE

Comptroller General

OF THE UNITED STATES

Reuse Of Municipal Wastewater And Development Of New Technology-- Emphasis And Direction Needed

released 11-27-78

Several new or alternative wastewater treatment technologies exist which provide additional benefits to wastewater recycling and reuse. However, few techniques have been used on construction grant projects because

--they often provide unnecessary treatment levels,

--they are not cost effective in comparison to conventional secondary technologies,

--stringent State pretreatment requirements create additional costs,

--limited information on health effects exists,

--suitable land is not available, and

--program participants are unwilling to risk failure.

The Environmental Protection Agency should encourage the acceptance and use of new or alternative technologies and designate a central group to analyze long-term wastewater treatment research needs. The Environmental Protection Agency should also receive, review, and coordinate the approval of evaluation grant awards.

CED-78-177

NOVEMBER 13, 1978

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-166506

The Honorable Don H. Clausen
Ranking Minority Member
Subcommittee on Water Resources
Committee on Public Works and
Transportation
House of Representatives

Dear Mr. Clausen:

As you requested on March 7, 1977, we are reporting on the use of new technology and reuse of reclaimed municipal wastewater in projects funded under the Federal Water Pollution Control Act, which is administered by the Environmental Protection Agency.

At the request of your office, we did not take the additional time to obtain written agency comments. The matters covered in the enclosed report, however, were discussed with appropriate agency officials, who stated that the report presents an accurate assessment of the overall problems associated with the acceptance and use of new technology and reuse of reclaimed municipal wastewater.

Agency officials also stated that many of the problems recognized in our report will be rectified through policy and regulation changes as a result of the passage of the 1977 amendments to the Federal Water Pollution Control Act.

As agreed to by your office, we will make a general distribution of this report in 14 days including a copy to the Administrator, Environmental Protection Agency.

Sincerely yours,

Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT TO THE HONORABLE DON H. CLAUSEN HOUSE OF REPRESENTATIVES

REUSE OF MUNICIPAL WASTEWATER AND DEVELOPMENT OF NEW TECHNOLOGY--MORE EMPHASIS AND DIRECTION NEEDED

D I G E S T

Even though new technologies for, the treatment and reuse of wastewater are available, they have not been used to any great extent because:

--They provide treatment levels higher than needed to meet existing requirements. For example, some municipalities do not use ion exchange or reverse osmosis processes because there is no need to remove salt or other minerals.

--Some of them, such as ozonation, ultra -violet light and bromine chloride, alternative disinfectants to chlorination, are not always the least expensive when compared to the conventional methods available.

--As was stated by various witnesses during 1976 congressional research hearings, programs participants are unwilling to risk failure.

Although the Clean Water Act of 1977 provides incentives for greater use of new technology, the Environmental Protection Agency needs to promote the acceptance and use of newly developed technologies in wastewater treatment projects and find ways of assisting in demonstrating promising equipment and processes.

GAO recommends that the Administrator, Environmental Protection Agency:

--Designate a central group within his Agency to analyze long-term wastewater treatment research needs and to

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receive, review, and coordinate the approval of evaluation grant awards.

--Identify the types of plants and municipalities where new technology could be utilized effectively. This would show its potential and spread the information to consultants, equipment manufacturers and others.

(See pp. 6 through 14.)

GREATER USE OF LAND APPLICATION IS NEEDED

Land application as an alternative wastewater treatment technique, if well designed and maintained, provides various benefits such as (1) eliminating point discharges to surface waters, (2) higher levels of treatment than generally provided by conventional secondary methods and (3) replenishment of groundwaters.

The use of land application techniques, as with other new or alternative technologies have not been widely used because

--stringent State pretreatment requirements have caused these techniques to compare unfavorably with conventional treatment alternatives,

--limited technical and health effects information is available, and

--suitable land may not be available.

The Clean Water Act of 1977 requires that alternative wastewater treatment methods, including land application, must be thoroughly evaluated during facilities planning before an agency grant is made.

(See pp. 15 through 23.)

OBSTACLES TO RECLAMATION OF WASTEWATER

Recycled wastewater may be used for several industrial, municipal (domestic) and recreational purposes, such as for cooling, washing, toilet flushing, lawn watering, and boating or fishing purposes.

GAO found that only a few Federal Water Pollution Control Act projects have been funded for industrial, municipal, or recreational wastewater reuse because

--The use of reclaimed wastewater is generally not cost effective. High treatment levels are required to protect public health and industrial processes.

--Transportation costs further reduce their cost effectiveness.

--Concerns over recycled wastewater quality discourages potential users.

GAO found that there is no clear EPA policy on the funding of wastewater reclamation/reuse of wastewater. The Environmental Protection Agency has a mandate to submit a report to the Congress by December 1979 recommending legislation on a program to require coordination between water supply and wastewater control plans as a condition to grants for construction of treatment works. (See pp. 24 through 33.)

GAO did not obtain written comments from EPA. However, EPA officials orally agreed with GAO's conclusions and recommendations. They believe that new provisions of the Clean Water Act Amendments of 1977 will further encourage the use of new wastewater treatment technologies.

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APPENDIX

ABBREVIATIONS

BAH	Booz-Allen & Hamilton, Inc.
BOD	biochemical oxygen demand
BPWTT	best practicable waste treatment technology
EPA	Environmental Protection Agency
GAO	General Accounting Office
mg/l	million gallons per litre
OMB	Office of Management and Budget
TDS	total dissolved solids

GLOSSARY

Activated sludge process	A biological wastewater treatment process in which a mixture of wastewater and activated sludge is agitated and aerated. The activated sludge is subsequently separated from the treated wastewater (mixed liquor) by sedimentation and wasted or returned to the process as needed.
Advanced waste treatment	Wastewater treatment beyond the secondary or biological stage that includes removal of nutrients (such as phosphorous and nitrogen), and a high percentage of suspended solids. (Also called tertiary treatment.)
Biochemical oxygen demand (BOD)	A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. Large amounts of organic waste use up large amounts of dissolved oxygen, thus the greater the BOD.
Carbon absorption	An advanced treatment method using activated carbon to remove soluble organics that are not removed by conventional secondary treatment.
Conventional secondary treatment	The activated sludge or trickling filter process to attain secondary treatment.
Lagoon (wastewater treatment pond)	A shallow pond where sunlight, algae and oxygen interact to purify wastewater.
Primary treatment	The first stage in wastewater treatment in which most floating or settleable solids are mechanically removed by screening and sedimentation.

Secondary treatment	Biochemical treatment of wastewater after the primary stage, using bacteria to consume the organic wastes. Use of trickling filters or the activated sludge process removes floating and settleable solids and about 90 percent of oxygen-demanding substances and suspended solids. Disinfection with chlorine is the final stage of secondary treatment.
Suspended solids	Small particles of solid pollutants in sewage.
Tertiary treatment	See advanced treatment.
Trickling filter	A device for secondary treatment of wastewater consisting of a bed of rocks or stones that support bacterial growth. Sewage is trickled over the bed, enabling the bacteria to break down organic wastes.
Water quality criteria	Specific concentrations of water pollutants which, if not exceeded, are expected to allow a body of water to be suitable for its designated use.
Water quality standards	A plan for water quality management specifying the use (recreation, fish and wildlife propagation, drinking water, industrial, or agricultural) to be made of the water; criteria to measure and protect these uses; implementation and enforcement plans; and an anti-degradation statement to protect existing water quality.

CHAPTER 1

INTRODUCTION

On March 7, 1977, the Ranking Minority Member of the Subcommittee on Water Resources, House Committee on Public Works and Transportation, requested that we review the apparent absence of new and innovative technologies in waste treatment projects being constructed under the Environmental Protection Agency (EPA) construction grants program. We were asked to concentrate on the greater use of land application of wastewater and wastewater reuse and suggest ways of overcoming any obstacles which inhibit the use of these two approaches.

On October 20, 1977, we briefed staff representatives from both the House and Senate Committees on Public Works. The meeting was requested in order to provide timely input, based on this report's review effort, to the appropriate congressional committees regarding the proposed Clean Water Act of 1977 (Public Law 95-217). The input provided by our staff was used by the committees and resulted either in changes to the legislation or a clearer expression of congressional intent on specific provisions in the legislation.

WATER POLLUTION CONTROL GOALS AND REQUIREMENTS

The Federal Water Pollution Control Act, as amended (33 USC 1251 et seq), is to restore and maintain the chemical, physical, and biological integrity of the Nation's water. To accomplish this, the act states that "***it is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985." The act also states "***wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983***"

In setting the 1983 goal, the act requires that publicly owned treatment works provide for the application of the best practicable waste treatment technology (BPWTT) while requiring municipalities to provide at least secondary treatment by 1977, except that under certain circumstances EPA may extend the 1977 compliance date to no later than July 1, 1983.

Emphasis on land application and recycling

Section 201 of the act also requires EPA to encourage waste treatment management which includes open space and recreational considerations. Section 201 (g) states that:

> The Administrator shall not make grants to any State, municipality, or intermunicipal, or interstate agency for construction of treatment works unless the grant applicant has satisfactorily demonstrated that innovative and alternative wastewater treatment processes (including recycling techniques and land treatment) have been fully studied and evaluated.

Use of reclaimed wastewater for irrigation, industrial use, or other suitable purposes leaves high quality water available for potable needs and can thereby help alleviate water shortages which already exist in some parts of the country and are expected to become more widespread. Applying wastewater to the land is generally beneficial in that it contains nutrients (such as nitrogen and phosphorus), conditions the soil, and aids the growth of revenue-producing crops. On the other hand, wastewater discharged into a waterway may promote excessive algae growth.

EPA CONSTRUCTION GRANT PROGRAM

The Federal Water Pollution Control Act Amendments of 1956 (Public Law 84-660) created the wastewater treatment construction grant program. The act authorized grants for constructing publicly owned treatment facilities to prevent untreated or inadequately treated sewage or other waste discharges into waterways. The grant recipient--usually a municipality--received Federal assistance of 30 percent of eligible project costs. Subsequent amendments to the act increased the Federal share of project costs up to a maximum of 55 percent. During this period, Office of Research and Development (ORD) demonstration project grants were authorized at 75 percent of eligible costs, thus providing a financial incentive for applying new or improved technology at field scale.

The 1972 Federal Water Pollution Control Act Amendments (Public Law 92-500) established the Federal share for construction grants at 75 percent of eligible costs. The Clean Water Act of 1977 (Public Law 95-217) increased the Federal share at 85 percent of construction costs for grants made during fiscal years 1979-81 for projects using innovative or

alternative wastewater treatment processes and techniques. However, ORD demonstration grant funding remained at 75 percent of eligible project costs.

The 1972 amendments provided $18 billion for constructing waste treatment facilities. Public Law 94-447, (Oct. 1, 1976), and Public Law 95-26, (May 4, 1977) provided additional construction grant funds of $480 million and $1 billion, respectively. The Clean Water Act of 1977 authorized construction grant fundings of $4.5 billion for fiscal year 1978 which was appropriated by the Congress in March 1978 (Public Law 95-240) and $5 billion annually for fiscal years 1979-82.

From fiscal year 1957 to November 30, 1977, Federal funds totaling about $25.4 billion had been obligated under the waste treatment construction grant program. With passage of the 1972 amendments, EPA structured the program to award grants in three successive steps--preparing facility plans (step 1) preparing detailed designs and specifications (step 2), and constructing the facility (step 3). Each step requires a separate or amended grant application with EPA and State approval. The Clean Water Act of 1977, however, authorized EPA to award a combined step 2 and step 3 grant in the case of a treatment facility expected to cost not more than $2 million--or $3 million in a State with unusually high construction costs--and which will serve a population of not more than 25,000.

During the facilities planning stage, basic decisions are made about the best solution to a municipality's pollution problem. The decision to reuse wastewater or use land treatment or other new technologies is included in facilities planning. EPA regulations require that to the extent deemed appropriate by regional administrators, facility plans initiated after April 30, 1974, must include a cost-effectiveness analysis of alternatives on which selection of the treatment system is to be based. The analysis must identify and provide for applying the best practicable waste treatment technology based on an evaluation of alternative methods of treatment and discharge to receiving waters, treatment and reuse, and land application. To further encourage the use of innovative and alternative wastewater treatment technologies, the Clean Water Act of 1977 provides that:

--EPA shall not make any construction grants from funds authorized for fiscal year 1979 or later unless the grant applicant shows that it has fully

studied and evaluated innovative and alternative wastewater treatment processes and techniques which provide for the reclaiming and reuse of water, otherwise eliminate the discharge of pollutants, and use recycling techniques, land treatment, new or improved waste treatment management techniques and the confined disposal of pollutants;

--EPA may make construction grants for treatment facilities by using innovative and alternative technologies if determined by EPA to be in the public interest interest and if the life cycle cost of the treatment works for which the grants are to be made does not exceed the life cycle cost of the most cost-effective alternative by more than 15 percent;

--EPA may make a grant to fund all costs of modifying or replacing any facility constructed with an 85 percent Federal grant, if the facility fails to meet design performance specifications;

--two percent of the construction grant funds allotted to a State for fiscal years 1979-80 and three percent of a State's fiscal year 1981 allotment shall be set aside to increase grants from 75 percent to 85 percent for constructing treatment facilities by using innovative and alternative processes and techniques. Of those funds set aside at least 0.5 percent of a State's allotment must be spent for innovative processes and techniques;

--under section 105 EPA may make a grant to pay up to 100 percent of the costs of technically evaluating the operation of a facility constructed with an 85 percent construction grant, the costs of training persons (other than employees of the grantee) and the costs of disseminating technical information on the facility's operation; and

--land use for storing treated wastewater in land treatment systems prior to land application is included in the definition of treatment works (and therefore is a grant-eligible construction cost component).

SCOPE

We concentrated on land treatment and wastewater reuse, relying primarily on previous studies and congressional hearings for information on new technology.

We performed our review at EPA Headquarters, Washington, D.C., EPA regional offices in Boston (region I) and San Francisco (region IX) and at EPA's Environmental Research Center in Cincinnati, Ohio. We also contacted officials at EPA's Ada, Oklahoma, research facility. Our review included State water pollution control agencies in Massachusetts, Rhode Island, Connecticut, Vermont, New Hampshire, Maine, California, Arizona, and Nevada. We discussed obstacles to wastewater reuse, land application, and other new technologies with representatives of consulting engineering firms which had designed construction grant projects. We also contacted representatives of water-using industries to ascertain their position on using reclaimed water; equipment manufacturers to discuss obstacles to new technology development; and an environmental interest group which encourages land application. We also reviewed project files, technical publications, and other pertinent documents.

CHAPTER 2

LIMITED USE MADE OF NEW OR INNOVATIVE TECHNOLOGIES

Although a variety of individual new technologies exist, few have been used to any great extent on construction grant projects. The limited use results from the fact that available technologies are often either not needed to meet existing treatment requirements or are not cost effective when compared to conventional technologies which serve the same purposes.

The development of new technologies by the private sector has been inhibited because the deemphasis of EPA's research and development program has restrained the development and demonstration of new or innovative technologies for the control and treatment of municipal wastewater. The problem is compounded by a general unwillingness to accept the risks of utilization of a new technology and the uncertainty of equipment manufacturers regarding the market potential for new processes.

These and other obstacles discussed in subsequent sections of this report are significant, and unless some reasonable solution is developed there is little prospect that improvement in the use of new or innovative technologies will occur.

WHAT IS NEW OR INNOVATIVE TECHNOLOGY?

The terms "new technology" and "innovative technology" mean different things to different people. When the consulting firm of Booz-Allen and Hamilton (BAH) surveyed innovative technology for EPA, (see p. 7) it defined an innovative technology as one not in common use around the United States. In congressional hearings, however, the term "new technology" was used to describe alternatives to biological secondary treatment--primarily land treatment.

When EPA surveyed the use of new technology in March 1977 it classified technologies as either conventional or new. Conventional technology was defined as systems which have been widely used for at least 20 years to treat municipal wastewater or sludge (trickling filters, activated sludge, anaerobic digestion, vacuum filters, etc.). Any other technology or modification, whether

proven or unproven, was classified as new, as long as it would be available for online use within 10 years. For the purposes of this study we generally accepted EPA's definition of new technology and used the terms "new technology" and "innovative technology" interchangeably.

EXTENT TO WHICH NEW TECHNOLOGY HAS BEEN USED

EPA studies have shown that although a variety of individual new technologies have been used on construction grant projects most have not been used extensively.

In response to the September 1976 water quality research hearings by the Subcommittee on the Environment and the Atmosphere, House Committee on Science and Technology, EPA attempted to determine what new technologies were being used in the construction grant program. Each regional office was asked to report the number of its Water Pollution Control Act projects using new technologies. Based on the regional responses, EPA reported that 697 projects out of approximately 2,500 step 2 and 3 grants for treatment plants--or 28 percent--are using one or more new technologies. EPA also noted that this figure was understated because time and budgetary constraints prevented the identification of all projects using new technologies.

As part of the innovative technology survey BAH performed for EPA, it attempted to determine to what extent innovative technologies were being used in the construction grant program. BAH selected 16 technologies which were not commonly used, showed a potential for being cost effective, and had not been demonstrated full-scale. BAH then contacted program participants in 13 States to discuss the use of these technologies and others considered innovative by the participants. In a report published in February 1976 BAH concluded that a relatively small number of construction grant applications proposed the use of innovative technologies.

Our review of EPA regions I and IX confirmed that, except for land application, none of the new technologies have been used extensively. The following table shows the various types of new technologies identified by EPA and the number of times each occurred in region I.

New technology	Number of times used
Wastewater	Per EPA region I
Oxygen-activated sludge -------	4
Rotating biological contactors-	4
Oxidation ditch ----------	9
Activated biofilter ----------	0
Plastic media trickling filter	0
Lagoon upgrading ----------	1
Land application (slow rate, rapid infiltration or overland flow) ----------	4
Carbon adsorption ----------	2
Carbon regeneration ----------	0
Lime treatment ----------	1
Recarbonation ----------	0
Ion exchange ----------	0
Reverse osmosis ----------	0
Ammonia stripping ----------	0
Tube settlers ----------	0
Micro screens ----------	0
Nitrification ----------	3
Denitrification ----------	0
Combined nitrification-denitrification ----------	0
Wastewater reuse (groundwater recharge, recreation, industry, other) ----------	1
Utilization of solar energy ---	2
New disinfection technology (ozone, ultra-violet light, bromine chloride or other) --	0
Dechlorination ----------	2
Storm and combined sewer overflow treatment ----------	4
Non-sewered treatment ---------	0

New technology	Number of times used Per EPA region I
Sludge	
Co-incineration	1
Co-pyrolysis	0
Pyrolysis	0
Regional treatment of septage	3
Sludge composting	3
Lime conditioning	1
Utilization of incinerator ash for sludge conditioning	0
Chemical fixation of sludge	2
Commercial soil conditioners/ fertilizer products	0
Digestor gas driven internal combustion engines	0
New sludge dewatering techniques (heat treatment, filter press, belt filters, utilization of waste heat)	5
Computerized process control	0

OBSTACLES CONTRIBUTING TO LIMITED USE OF NEW TECHNOLOGY

The limited use of new technologies results from the fact that some provide a higher than necessary level or type of treatment while others are not cost effective when compared to conventional technologies. Another significant factor is a general unwillingness among the participats to accept the risks and uncertainties associated with new processes.

Treatment levels may not require use of a new technology

Municipalities are generally required to provide only secondary treatment for their wastewater--85 percent removal of BOD and suspended solids with a maximum of 30 million gallons per litre (mg/l) of BOD and suspended solids in the effluent (suspended solids requirements for lagoons have been relaxed). Even though the law also requires effluent limitations more stringent than secondary if necessary to meet water quality standards, only about half of the Nation's treatment facilities discharge to waters

with such water quality limitations. An EPA official estimated that only 45 of region I's 169 municipalities with step 2 or 3 construction grants must provide more than secondary treatment before discharge to surface waters.

Some new technologies provide treatment well beyond that required. For example, denitrification removes nitrogen from wastewater, carbon adsorption and lime treatment after secondary remove organic materials, and ion exchange and reverse osmosis remove minerals.

In region I nine municipalities provided nitrogen treatment generally because of discharges to a lake or stream where dissolved oxygen was a problem or because nitrogen is a nutrient which causes algae growth. In contrast, no region I municipality used ion exchange or reverse osmosis processes because there was no need to remove salt or other minerals.

New technologies are not always cost effective

State officials and consulting engineers stated that new technologies are often not cost effective. Oxygen-activated sludge, for example, can treat the same flow as conventional activated sludge in smaller aeration tanks, and may therefore be the best alternative when a treatment plant site has limited space. However, it is more expensive to operate than conventional activated sludge because of the energy needed to convert air to oxygen. The new disinfection technologies--ozone, ultraviolet light, and bromine chloride--have been cited as more expensive than chlorination--the conventional means of disinfection. Like oxygen-activated sludge, an ozone system is expensive to operate because of the energy needed to manufacture the ozone.

Unwillingness to accept risks

After interviewing municipal officials, BAH reported that reluctance to adopt innovative processes stems largely from doubts about process reliability and uncertainty over costs of construction, operation, and maintenance. Some new technologies require a high degree of sophistication to operate, whereas we reported on April 11, 1977, 1/ there is already an insufficient number of qualified treatment plant operators. Therefore, expensive operator retraining

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1/"Continuing Need for Improved Operation and Maintenance of Municipal Waste Treatment Plants," CED-77-46, Apr. 11, 1977.

would be necessary. One consulting engineer added that municipalities have much to lose and little to gain by innovation, and therefore, tend to hire conservative consultants with good past performance records, so that if problems occur they cannot be severely criticized.

A consulting engineer testifying at the 1976 research hearings explained the profession's reluctance to use new technology by raising several questions. He said that "Anytime we talk about being innovative with other people's money, we have to think, is it going to work, can we afford a failure***who is going to pay for innovative failures***"

Consultants feel strongly that their reputation depends on successful projects. According to BAH, its consultants primary concern is providing municipalities with reliable systems, and adequate data for evaluating new technologies is frequently lacking. Another consultant stated at the 1976 research hearings that consultants are increasingly sensitive to the risks associated with new technology because of increased lawsuits attempting to hold them responsible for their designs.

A consulting engineer stated at the 1976 research hearings that regulatory agencies involved in the construction grant program have a protective philosophy about the expenditure of public funds. A regional EPA official, who would like to see more new technology used, said that grant personnel considered attempts to fund unproven technologies with construction grants as a "raid on the funds in their trust." The official added that grant personnel contend that each municipality has one chance at construction grant funds, and they want to make sure their system will work.

Deemphasis of EPA's demonstration program has discouraged development of new technologies

An EPA official testifying at the 1976 research hearings stated that Public Law 92-500 caused a change in priorities within EPA's research program. EPA decided that its primary responsibility was to research health and ecological processes to set sound effluent standards, as required by Public Law 92-500, while the private sector bore the primary burden of developing technologies needed to meet the standards. He stated that as a result reduced funding "essentially terminated the [EPA] demonstration program."

There seems to be general agreement that the lack of an EPA demonstration program is a major obstacle to the use of new technology. An EPA official testifying at the 1976 research hearings listed 22 technologies which he said

were developed and awaiting demonstration. Other witnesses agreed that a demonstration program is necessary to help overcome the reluctance of program participants to depart from proven technology.

As stated above and reported by BAH, the decline in funding of EPA's demonstration program has also discouraged the development of new technology. Equipment manufacturers realize that marketing a new technology is very difficult if it has not been demonstrated. BAH points out that many manufacturers cannot afford the expense of a demonstration and, knowing that EPA assistance will not be available, they are unwilling to research and develop equipment which may not be accepted.

One equipment manufacturer said he believed equipment manufacturers in general are reluctant to invest in research and development because they don't know whether existing or future markets will allow them to recoup their investment. Another stated that his firm no longer develops municipal treatment technologies because of the lack of a market. Existing technology can meet current water quality requirements and equipment manufacturers don't know what future treatment requirements will be or what capabilities new equipment should have.

In addition to the uncertainty of future requirements, BAH noted in its 1977 report that requirements for advanced treatment depend to a great extent on the States and appear somewhat arbitrary. This situation makes it difficult for equipment manufacturers, as well as EPA, to evaluate the potential market for advanced technologies. BAH believes EPA should assess, as accurately as possible, the market for any new technology when deciding how to allocate research and development funds.

Under the 1977 Clean Water Act Amendments (sections 104 and 214) the Congress has required EPA to establish a clearinghouse for alternative treatment information, and a public information program on recycling and reuse of wastewater respectively. We believe that this requirement will contribute to the broader dissemination of technological information regarding alternative (nonconventional) treatment systems, thereby making the evaluation and selection of equipment and processes less arbitrary.

The 1977 amendments also address the uncertainty about the future eligibility and funding of alternative technologies. As we have already discussed on page 3, the

1977 amendments (section 201) authorized setting aside of construction grant funds to encourage innovative and alternative technology utilization. The 1977 Amendments' 15 percent credit allowed to innovative or alternative technologies over the most cost-effective conventional alternative (section 201); 100 percent cost guarantees for modification or replacement of innovative facilities (section 202); and the requirement that all applicants must satisfactorily demonstrate to EPA that innovative and alternative wastewater treatment processes and techniques have been fully studied and evaluated by the applicant (section 201) should reduce or eliminate much of the uncertainty about the future market for innovative and alternative technologies under EPA's wastewater construction grant program.

CONCLUSIONS

New technologies have not been used more extensively under Public Law 92-500 because (1) they may provide unnecessary levels of treatment, (2) they are not always cost effective compared to conventional technology, and (3) program participants are unwilling to risk failure. By phasing out its demonstration program, EPA eliminated an important means of reducing such risks.

Major obstacles to the development of new technologies are (1) equipment manufacturers' uncertainty as to their market potential and (2) the lack of EPA demonstration assistance.

EPA officials commenting on the provisions of the 1977 act acknowledged that under section 105 EPA will pay 100 percent of the costs for technical evaluation and dissemination of information for projects incorporating innovative or alternative treatment process (discussed on page 4). They stated that these evaluation grants will become EPA's primary vehicle (replacing the EPA demonstration program which pays only 75 percent of the costs for evaluation and dissemination) for promoting new technology. The evaluation grants will be awarded through EPA's regional offices.

RECOMMENDATIONS

We recommend that the Administrator, EPA in order to promote the greater acceptance and widespread use of newly developed technologies in construction grant projects:

--Designate a central group within EPA to analyze long-term wastewater treatment research needs and would also receive, review, and coordinate the approval of evaluation grant awards.

--Identify the types of plants and municipalities where new technology could be utilized effectively to show the potential scope of application and disseminate the information to consultants, equipment manufacturers and others in order to facilitate the adoption of these new processes.

AGENCY COMMENTS

Commenting on our report, EPA officials generally agreed with our conclusions and recommendations. They believe that many of the new provisions of the Clean Water Act Amendments of 1977 will further encourage the use and acceptance of new wastewater treatment technologies.

CHAPTER 3

GREATER USE OF LAND APPLICATION IS NEEDED

EPA headquarters officials stated that EPA policy regarding land application of municipal wastewater has been modified in order to increase the emphasis on the use of land application methods. However, we found that concern over the possible adverse health and environmental effects associated with new treatment processes is an obstacle to the wider acceptance of new technologies. Concern over adverse health effects has been a major obstacle to land application of municipal wastewater for treatment purposes. States have established stringent pretreatment requirements for land application which may not be necessary in many cases. Stringent pretreatment requirements make land application expensive compared to conventional treatment facilities and discharge to surface waters. The absence of thorough land application evaluations and suitable land create additional obstacles as well.

LAND APPLICATION TECHNIQUES PROVIDE ENVIRONMENTAL BENEFITS

Land application systems are capable of removing large amounts of pollutants, nutrients, trace elements and microorganisms. Well-designed and maintained systems provide a higher level of treatment than conventional secondary treatment. Land application eliminates or reduces discharges to surface waters and therefore is consistent with the Federal Water Pollution Control Act goal of eliminating polluting discharges to the Nation's waters by 1985. Land application of wastewater also contributes to the replenishment of groundwaters.

The three major land application techniques are discussed below. Additional information on these techniques is contained in appendix II.

Slow rate

In slow rate systems, vegetation is an important part of the treatment process. Wastewater is applied to the soil by spraying, flooding the land, or feeding it into a system of furrows. The wastewater is treated as it moves through the soil. Phosphorous and other elements are held by the soil; the remaining water drains to the groundwater. In

cold climates, wastewater storage is needed during winter months. Slow rate systems are well suited for crop irrigation.

Rapid infiltration

Rapid inflitration involves applying wastewater to highly permeable, sandy type soils. The wastewater is treated as it travels vertically through the soil and eventually reaches the groundwater. The principal objective of rapid infiltration is wastewater treatment. Crop irrigation potential is poor, but this system is well suited for groundwater recharge and recharge of surface streams.

Overland flow

In overland flow systems, wastewater is applied to clay-type soils with little or no absorption capacity. The main objective of overland flow is to provide treatment, although growth of forage grasses may be achieved in the process. The water flows across sloped surfaces planted with vegetation to control runoff and erosion. The soil acts to remove bacteria and nutrients and the treated water, which is collected at the bottom of the slope, can be either reused or discharged to surface water. In cold climates, wastewater storage is needed during winter months. Groundwater recharge potential is minimal.

Subsurface and wetlands discharge is not discussed because (1) literature on land application refers only to slow rate, rapid infiltration and overland flow and (2) these types of treatment systems are generally less adaptable on a large scale basis.

LAND APPLICATION TECHNIQUES HAVE NOT BEEN WIDELY USED

The Federal Water Pollution Control Act states that EPA shall not award grants from funds authorized for any fiscal year beginning after June 30, 1974, unless the applicant has studied alternative waste management techniques. Although land treatment is such an alternative, it has been chosen by relatively few municipalities.

Region IX EPA and State officials stated that Arizona, California, and Nevada have only a few projects they consider for land application treatment. California officials knew of only three construction grant projects in which wastewater is applied to the land primarily for treatment purposes.

EPA region IX officials reported during our review that there were 414 step 2 and 3 wastewater construction grant projects being funded under the 1972 amendments. Of these, 81 projects were identified as land application systems. 1/

We identified 169 municipalities in EPA region I which had received step 2 or 3 construction grants under the 1972 amendments for funding treatment facilities. Only 11 of these grants involved land application systems. 1/

OBSTACLES TO LAND APPLICATION FOR TREATMENT

Obstacles to more frequent use of land application for treatment include (1) stringent State pretreatment requirements based on health effects concerns often cause land application to be more expensive than conventional secondary treatment and discharge, (2) absence of technical and demonstration information restricts the thorough evaluation of land treatment systems, and (3) lack of suitable land.

States' pretreatment requirements may be too conservative

Pretreatment requirements prior to land application vary among the States. Region IX EPA and State officials stated that when no crop is harvested a minimum of primary treatment is required to prevent the soil from clogging. Secondary treatment may be required, depending on the risk of human contact and the ultimate disposition of the effluent.

Region I State officials cited the following pretreatment requirements for land application of wastewater for treatment purposes:

--Connecticut: No written pretreatment requirements exist. Pretreatment requirements would be decided on a case-by-case basis if a land application project were proposed.

--Maine: At least 70 percent BOD removal (achievable by lagoons) and wastewater disinfection.

1/Includes land application projects (applying wastewater to the land as an integral part of the treatment process) and land disposal (wastewater applied to the land not necessarily, as part of the treatment process), in California, Arizona, Nevada, and Hawaii.

--Massachusetts: No written pretreatment requirements, but policy dictates secondary treatment before land application.

--New Hampshire: Secondary treatment and wastewater disinfection are required before spraying wastewater onto the land. The State will accept lagoon pretreatment.

--Rhode Island: Secondary treatment is required before land application.

--Vermont: Secondary treatment and disinfection are required before spraying wastewater onto the land. Tertiary treatment is required before infiltration.

State officials generally cited potential adverse health effects to support their pretreatment requirements.

Several EPA and State officials as well as consulting engineers interested in land application believe that the amount of pretreatment needed should be determined on a case-by-case basis. In some cases primary pretreatment may be adequate. Factors to be considered are the type of soil, land area, water table, amount of wastewater to be applied, climate, and location of population relevant to the treatment site.

In cost comparisons between land treatment and conventional treatment with discharge to surface waters, land treatment is at a disadvantage. While secondary treatment is usually adequate for discharge, State requirements for treatment prior to land application often approach secondary treatment. EPA and State officials in region I stated that whenever secondary treatment is adequate for discharge land application is not likely to be cost-effective because once a municipality provides the secondary treatment needed for land application it will find it easier and less expensive simply to discharge the effluent to the surface waters rather than invest in piping, pumping, and land costs associated with land application. Even when a State accepts lagoon treatment prior to land application, EPA officials believe a municipality that builds a lagoon can usually make adjustments or additions to the lagoon process which results in an effluent suitable for discharge to surface water.

We selected nine small rural region I communities which appeared to be suitable for land application and

reviewed their facilities plans to determine why land application was rejected. In one case, suitable land was not available. In the other eight cases it was eliminated because it was not the lowest cost alternative. Most of the plans described nonmonetary benefits associated with land application, but they were not considered of sufficient significance to justify selecting other than the lowest cost alternative. For example, the Concord, New Hampshire, facility plan states that a rapid infiltration system is workable and would provide excellent recharge of the groundwater table, but it is not cost effective. The plan states that "land disposal and re-use of the treated effluent are not considered feasible unless future guidelines require significantly higher levels of treatment."

The following example illustrates the effect of blanket pretreatment requirements:

Nantucket, Massachusetts, a sparsely-populated island south of Cape Cod, has been applying raw sewage to sand filter beds--a type of rapid infiltration system--at two locations for about fifty years. A facility plan completed in 1976 proposed upgrading the existing collection facilities. To comply with State pretreatment requirements, it also proposed constructing two secondary treatment plants which would discharge onto the existing sand filters.

In an October 1977 letter to EPA region I, Nantucket's Board of Selectmen stated that it

> "had been led to believe that the Town would have to build two secondary treatment plants because the EPA regulations require that any plant built must meet what they call best practical treatment and this has been defined as secondary treatment...While it is true the State requires secondary treatment for all communities in the Commonwealth, it has become apparent that EPA cannot only approve and fund less than secondary land application systems when ground water quality standards can be met, but according to a recent project review memo now requires that EPA be shown that secondary treatment is needed on a case-by-case basis. The Division of Water Pollution Control's blanket requirement that all communities in the Commonwealth shall build secondary treatment facilities may no longer be applicable."

In accordance with OMB Circular A-95, several State and regional groups reviewed the facility plan. They were unanimously critical of it. The Massachusetts Office of Coastal Zone Management (CZM) noted that the facility plan offered no documentation of either present or future pollution problems resulting from domestic waste disposal and concluded that the need for secondary treatment has not been established. CZM stated that

> "***although adequate information on the status of the groundwater aquifer is not available, what information is available shows no degradation***CZM believes, then, that the integrity of the environment could be maintained if only primary treatment were provided before sand application." CZM recommended that primary pretreatment be studied."

A regional planning commission stated that it could not concur with the proposed project until it is shown that the existing treatment facilities do not meet BPWTT requirements for land application systems and a cost-effectiveness analysis of land application with primary treatment is conducted.

The Director of the Massachusetts Division of Water Pollution Control replied, in a letter to the planning commission:

"...it would be poor engineering judgment to allow the limited ground water resources on the Island to be degraded before upgrading the existing treatment plants. In this Division's engineering judgment and in consultation with the Department of Environmental Quality Engineering, secondary treatment is the minimum level of pollutant reduction necessary in order to satisfactorily protect the groundwater...thus, secondary treatment alternatives are the only ones which we consider to be environmentally sound and thus approvable by this Division. It should also be noted that EPA cannot fund a project unless it is approved by the State."

Nantucket is seeking supplemental funding to evaluate alternatives to the proposed conventional secondary treatment facilities. An EPA official stated that EPA would fund a study of land application after primary treatment.

The EPA Administrator questioned State pretreatment requirements in an October 3, 1977, memorandum to the regional offices. The memorandum states:

> "***imposition of stringent wastewater treatment requirements prior to land application has quite often nullified the cost-effectiveness of land treatment processes in the past. We must ensure that***regulations are not used in a manner that may arbitrarily block land treatment projects. Whenever States insist upon placing unnecessarily stringent preapplication treatment requirements upon land treatment, such as requiring EPA secondary effluent quality in all cases prior to application on the land, the unnecessary wastewater treatment facilities will not be funded by EPA***"

The memorandum, however, does not explain how the regional offices are to determine whether a pretreatment requirement is unnecessarily stringent. A California official doubts that EPA has developed enough data to show definitively what pretreatment is unnecessary. EPA region I has not formulated any policy to implement this directive; rather, region I is waiting for guidelines from EPA headquarters.

Nantucket's experience supports the EPA official's statement. Originally, the Nantucket Board of Selectmen supported their consultant's plan to provide secondary treatment even though, according to a Nantucket planning official, operation and maintenance costs would increase from $3,000 annually to $158,000. Information presented at a public hearing on the facility plan caused the Board of Selectmen to start questioning the project.

Sufficient technical information is not available

Several obstacles restrict consulting engineers from thoroughly evaluating land treatment during facilities planning. Sanitary engineers are well versed in conventional treatment processes, but designing a good land treatment system may require expertise in geology, groundwater, soils, and agronomy. Representatives of a large sanitary engineering firm in region I stated that they can can obtain the expertise, but it increases the cost of facilities planning and they are reluctant to incur such an expense on small projects. In addition, as previously

noted land treatment alternatives are often limited by State pretreatment requirements. Nantucket's consulting engineer, for example, did not evaluate land treatment with only primary pretreatment because the State would not approve such a project.

An EPA official, in a draft memorandum to the EPA Administrator, pointed out that decisionmakers for most communities are laymen who rely on consultants or State agencies for technical assistance. They generally lack sufficient knowledge to know if consultants' comparisons of alternatives are adequate, and as a result they can and have been led to more costly in-plant treatment alternatives.

An EPA research official in Ada, Oklahoma, believes that more research is needed on the technical aspects of overland flow and rapid infiltration systems, including pretreatment needed for them to work well. He also believes that slow rate systems have been proven to be workable. During October 1977 EPA issued a process design manual regarding land treatment of municipal wastewater. The manual presents procedures for the design of slow rate, rapid infiltration, and overland flow processes.

The Ada research official and a land application consultant stated that many more full scale demonstrations of land application systems are needed to show that land application is a viable wastewater treatment alternative. They pointed out that regardless of the amount of research done, Government officials and the public will not accept land application until they have been shown the systems do work.

Suitable land may not be available

According to EPA region I and State officials, geological factors also restrict the use of land application. Many locations have unsuitable land conditions (such as poor soil ledge near the surface) which prohibit sufficient filtering action by the soil and a high water table.

Connecticut, Rhode Island, and Massachusetts have limited land available to treat wastewater. For example, Connecticut has had to replace several old land application systems with conventional systems as the State developed because an increasing population caused a decrease in the amount of land available.

CONCLUSIONS

Stringent State pretreatment requirements have caused land application for treatment to compare unfavorably with conventional treatment alternatives. The EPA Administrator recognized in his policy statement of October 3, 1977, that State pretreatment requirements may be overly stringent and must be evaluated.

Land treatment also appears to have been limited by a lack of technical and health effects information. Rapid infiltration and overland flow systems seem to be especially unfamiliar to program participants.

In addition, several factors have discouraged consulting engineers from thoroughly evaluating land treatment during facilities planning. However, the Clean Water Act of 1977, section 201(g)(2), states that alternative methods of treatment must be fully studied before EPA shall make any grant for construction of treatment facilities.

EPA officials acknowledge the current development of program guidance intended to encourage the States to determine and adopt pretreatment land application standards based on the latest technical and health effects information available.

CHAPTER 4

RECLAIMED WASTEWATER PROVIDES ADDITIONAL BENEFITS--HOWEVER, OBSTACLES EXIST

The use of new wastewater treatment process technologies may provide additional benefits not normally expected with the use of conventional wastewater treatment methods. Land application projects for reclamation/reuse of wastewater offers such benefits. EPA policy, as stated in the Administrators October 1977 memorandum, clearly encourages alternative waste treatment alternatives. The EPA Administrators address to his regional administrators states

> "Each of you must exert maximum effort to ensure that the actions of your staffs reflect clearly visible encouragement of wastewater reclamation and recycling through land treatment processes".

Reclaimed wastewater may be reused for industrial, municipal (domestic), and recreational purposes. Industries could reuse municipal wastewater for several purposes--cooling, boiler feed, washing, transportation of materials, and as an ingredient in goods produced. Municipalities could reuse wastewater to supplement their potable supply by indirect methods, or to serve nonpotable purposes such as toilet flushing and lawn watering. Also, wastewater could be reused for recreational purposes such as boating or fishing; however, only a few such projects have been funded under the Federal Water Pollution Control Act Amendments of 1972.

Industrial, municipal, and recreational reuse of wastewater is far less common than reuse for irrigation. EPA region I has not funded any municipal, industrial, or recreational reuse projects with 1972 Federal Water Pollution Control Act funds. Region IX has not funded any municipal reuse projects; however, eight industrial and 3 recreational projects have been.

The Clean Water Act of 1977 (section 516(e)) amended the Federal Water Pollution Control Act by adding that "The Administrator***shall submit to Congress***(by December 1979) a report with recommendations for legislation on a program to require coordination between water supply and wastewater control plans as a condition to grants for construction of treatment works***."

LAND APPLICATION TECHNIQUES FOR RECLAMATION/REUSE PURPOSE

Historically, most projects applying wastewater to land are doing so to conserve water through reclamation/reuse for beneficial purposes because of existing or potential water shortages. These projects are for the most part located in the warmer, water-short areas of the United States where irrigation of crops and landscaping as well as replenishing groundwater aquifers are viable options for wastewater reuse much of the year. A direct correlation seems to exist between the potential for water shortages and the development of Federal Water Pollution Control Act projects proposing reclamation/reuse of wastewater.

OBSTACLES LIMITING LAND APPLICATION FOR RECLAMATION/REUSE PURPOSES

Wastewater reclamation/reuse faces many of the same obstacles as land application for treatment and, in some cases, additional obstacles as well. Under the 1972 amendments reuse has generally not been costeffective. Secondary treatment is often adequate to meet existing water quality standards, whereas States may require secondary or advanced treatment for irrigation and groundwater recharge. In addition, the low cost of alternate water supplies, unsuitability of reclaimed water for industrial uses, fear of public opposition, and concern over inadequate research limit reuse opportunities.

States pretreatment requirements make land application for reclamation/reuse expensive

Although secondary treatment is often adequate for surface water disposal, States often require additional treatment for irrigation and groundwater recharge. State pretreatment requirements vary according to the use of the wastewater. For example, Arizona accepts lagoon treatment for irrigation of golf courses and many food crops but requires tertiary treatment and disinfection for irrigation of (1) food crops which may be eaten raw, and (2) school grounds, playgrounds, and parks, where children are expected to congregate.

California accepts primary treatment for irrigating animal fodder and, in some cases, orchards and vineyards, but requires secondary treatment and disinfection for irrigation of food crops. California also requires advanced treatment and disinfection for spray irrigation of food

crops. Nevada determines the level of pretreatment on a case-by-case basis.

None of the States in region I have written pretreatment requirements specifically for crop irrigation; requirements are determined on a case-by-case basis as projects are proposed.

In addition to the pretreatment requirements described above, some States in region IX require wastewater mineral removal. High salinity is a common problem which makes the wastewater unsuitable for irrigation. For example, California has established guidelines for the amount of total dissolved solids (TDS), chlorides, sodium, and boron in water used for irrigation. Generally, as the amount of TDS in irrigation water increase crop yields are reduced until plants can no longer tolerate the salinity and die. Most tree crops are sensitive to sodium and chloride while annual crops are not. When spray irrigation is practiced, sodium or chloride can cause leaf burn under certain conditions. Minerals can be removed from wastewater by expensive advanced treatment processes such as reverse omosis and ion exchange.

Several region IX projects have been prevented from reusing wastewater at least in part by the wastewater's high mineral content. For example:

--Effluent from the Aliso, California, treatment facility was considered for irrigation and highway and golf course landscaping but it contained high levels of TDS, which would have been too costly to remove.

--Wastewater from the Santa Paula, California, treatment plant receives secondary treatment before discharge into the Santa Clara River. To assure reliable operation to comply with updated discharge requirements, several alternatives were evaluated. One involved discharging effluent to an irrigation company's agriculture line for 7 months each year. The company, however, refused to accept the reclaimed water, stating that the mineral quality of its current irrigation water was already marginal, most notably with regard to boron. A State official explained that irrigation water is currently drawn from the ground. Since Santa Paula, located about 15 miles from the ocean, is experiencing salt water intrusion into its groundwater, its irrigation water has a high TDS content. The wastewater contains an even higher TDS concentra-

tion. Rather than treat the wastewater with reverse osmosis, the plan to use it for irrigation was dropped.

Stringent State pretreatment requirements are based on health effects concerns

Stringent California pretreatment requirements are a result of concern over health effects, according to State officials. California justifies its stringent requirements by pointing to the lack of knowledge about health effects associated with land application for reuse. State officials are concerned that even highly treated wastewater may contain toxic metals, organic chemical pollutants, viruses, and bacteria, which could affect the public health over a period of time.

Reclamation for crop irrigation was considered as part of a Monterey Peninsula construction grant project, but was eliminated, at least for the present, because of several related problems:

--Advanced treatment required by the State Health Department is very costly.

--Health officials are concerned over the safety of using reclaimed water to irrigate nonprocessed food crops, even if published pretreatment requirements are met.

--Additional questions exist about farmworker safety, product quality, and long-term impact on the soil.

Although much is known about the effects of using reclaimed wastewater, the impact of the reuse of treated wastewater on crops and groundwater is in need of further research and demonstration if land application is to become a viable and treated method of water conservation. EPA has only recently started studying the health effects of irrigating crops with wastewater. In 1977 EPA spent $661,000 studying health effects of irrigation out of a total water quality research budget of $44.2 million. An EPA official stated that health effects of irrigation will receive about $600,000 of the $54.5 million budgeted for 1978. EPA does not expect to publish its research findings relating to land application of wastewater and sludge for agricultural purposes until 1981.

Low cost of alternative water supplies limits reuse opportunities

Potential users of reclaimed water may not want it if they can obtain fresh water at less cost or if they fear a public reaction to crops irrigated with wastewater.

Availability of lower cost water supplies

There is relatively little need to irrigate in region I, since the area gets approximately 40 inches of of rainfall annually. When irrigation becomes necessary, as it does in the potato-growing area of Maine, natural or manmade ponds provide a nearby, inexpensive source of water. In contrast, wastewater would be very expensive. Because of the short growing season, generally adequate rainfall and relatively small size of New England farms, a farmer would not need enough wastewater to justify the cost of the transportation facilities. A Rhode Island official added that farming is done primarily in areas remote from treatment plants. Treated wastewater, therefore, would have to be transported great distances.

Transportation costs

The cost of reclaimed wastewater can be prohibitive simply because of the transportation facilities. Region I textile and paper manufacturers are generally located along rivers or lakes, which provide suitable water without pretreatment. Powerplants are often located on the ocean which provides a vast supply of cooling water that does not need pretreatment. Since the industries pipe directly from the river or ocean into their plants, there is little chance for wastewater to be competitive. Region IX will fund distribution facilities in some cases based on California's more liberal cost-effectiveness criteria. According to State officials and consulting engineers, however, transportation costs can be so expensive as to make reuse non-cost-effective even under California's guidelines.

According to State officials and consulting engineers, transportation costs to a reuse site are frequently so expensive as to eliminate reuse as the most cost-effective alternative. For example, Encina, California, received a step 1 construction grant to upgrade its primary treatment plant to secondary. Several reuse alternatives were considered. Under one alternative, secondary effluent would have been used to irrigate a 150-acre tomato field about 1 mile from the treatment plant. During periods of reduced demand, wastewater would be discharged to the ocean. Even though this alternative was obviously more

expensive than discharging secondary effluent to the ocean year round, it would have been cost-effective if the transportation and distribution facilities could have supplied reclaimed water at a lower cost than alternate sources. Preliminary calculations, however, showed that reclaimed water would cost $111 per acre-foot (based on capital costs of $350,000 and annual costs of $50,000) while Colorado River water was available for irrigation at $23 per acre-foot.

The use of Encina's wastewater for these alternatives and others was considered uneconomical. Each user would have applied relatively small amounts of wastewater and, therefore, the unit cost of delivering reclaimed water would not have been competitive with other sources.

Reclaimed water is more likely to be priced competitively in region IX than it is in region I, but obstacles remain. Even though reclamation is shown to be a more cost-effective alternative than treatment and discharge, it may be difficult to find a user because the lowest price a municipality is willing to charge for the reclaimed water exceeds the price of alternate water sources. The same factors which tend to make reclamation not cost effective from EPA's point of view--a high level of treatment necessary for reuse and transportation costs--make it difficult for a municipality to offer farmers reclaimed water at a competitive price.

Under the Federal Water Pollution Control Act, EPA and the State of California will contribute 92.5 percent of construction costs, leaving the municipality to fund the remaining 7.5 percent. A municipality will ordinarily want to recover as much of its contribution as possible by selling the reclaimed water to avoid local tax increases. Thus, as treatment and transportation costs increase a municipality's contribution will increase--and the price of reclaimed water is likely to increase.

While treatment and transportation costs increase the price of reclaimed water, subsidies keep the price of fresh irrigation water relatively low. A major source of California's water supply is the Central Valley Project, funded through the United States Bureau of Reclamation. According to a Bureau official, the Bureau is authorized to fund construction of multipurpose projects in the western States. The Central Valley Project includes flood control, power generation, irrigation water, municipal-industrial service, recreation, navigation, and more. Under Federal law, project costs are allocated to each function and repayment provisions vary, depending on the function. Costs allocated to irrigation must be repaid, but no

a surplus basis--municipal, industrial, and domestic interest is charged. In addition, irrigation costs beyond the farmers' ability to repay can be paid from revenue the project earns from selling power.

A representative of the Metropolitan Water District of Southern California stated that irrigation water is sold on needs must be met first. As a result, the price of irrigation water is relatively low.

Unsuitability of Reclaimed Wastewater for Industrial Uses

An official of EPA's Environmental Research Center in Cincinnati, Ohio, stated that industry is a major potential user of reclaimed wastewater. We found, however, that industry is often unwilling to use wastewater. The quality of wastewater which has been adequately treated for disposal is frequently inadequate for industrial use, and additional treatment necessary to make it suitable is very costly. In contrast, water-using industries generally have ready access to other suitable and less-expensive water supplies.

In region I, the major water-using industries are textiles, pulp and paper, and utilities. The textile industry uses water for dyeing, cooling, rinsing of starches, and finishing. An industry representative stated that secondary effluent would not be suitable for any purpose. He said physical/chemical treatment would probably be needed for the first two purposes and chlorides would have to be removed by a process such as ion exchange before using the wastewater for bleaching.

In a Glendale, California, project, the effluent will receive secondary treatment, filtration, and phosphate removal before being used for industrial cooling purposes. The Central Contra Costa reuse project's reclaimed wastewater will receive secondary treatment, denitrification, filtration, and demineralization before being delivered to industries for several different uses. If the wastewater were discharged to San Francisco Bay, filtration and demineralization would not be necessary.

Industries also fear the unknown effects of wastewater reuse. Forced to reduce their fresh water usage, many industries would recycle water within the plant rather than switch to municipal wastewater because they don't know what it contains or how the quality might vary. A California oil refinery, for example, is currently changing its operating process to include recycling because it expects an increase in the price of fresh water and because it fears being forced to switch to wastewater. EPA and State officials

in region IX stated that food processing industries would be reluctant to use municipal wastewater, even with department of health approval.

Public opposition

Officials in region IX try to maximize the use of wastewater because of water-short conditions. In some cases, grantees sell reclaimed water for irrigation of privately-owned land. Grantees may also own or lease the land application site.

Either way, it is necessary, and sometimes difficult, to find someone who wants wastewater.

A State official stated that the agricultural community has reservations about irrigating with wastewater because of its unknown effects on the soil over a period of time on crops and human beings through the food chain. A consulting engineer added that fear of adverse publicity can also make farmers reluctant to use reclaimed water. He stated that a group of Monterey, California, lettuce growers who ship nationwide are opposed to using wastewater for fear their competitors or the newspapers would destroy their livelihood if they found out that the growers used wastewater for irrigation.

An EPA official testifying at 1976 hearings before the House Committee on Science and Technology cited public opposition as a major obstacle to land application systems. Aerosols 1/ and odors resulting from wastewater irrigation of food crops were cited as the specific issues limiting public acceptance. However, a 1976 study by the University of California found that, although most respondents opposed using wastewater for drinking and food preparation, less then 15 percent opposed the use of wastewater for irrigation, even irrigation of food crops. A State official involved with reclamation agreed that California residents generally accept wastewater reuse unless they are personally going to reuse it. He believes that public opposition is primarily directed at its cost. However, he also believes the Monterey lettuce growers were legitimately concerned about an unfavorable reaction to lettuce irrigated with reclaimed

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1/ The concern over aerosols centers around the possible spread of bacteria and viruses contained in aerosol droplets emitted into the air during spray irrigation. See EPA process design manual "Land Treatment of Municipal Wastewater," Oct. 1977, p. D-22.

wastewater because lettuce irrigated with fresh water is readily available and wastewater irrigation health effects research is incomplete.

Opposition to reuse may decrease as the public becomes more aware of the need for reuse and its benefits. EPA and State officials note that attitudes vary among different parts of the State. In northern California, like region I, water is plentiful and interest in reclamation is minimal. In central California, where the demand for water is increasing, and in water-short southern California, interest is greater. A Nevada official said that public opinion was a strong obstacle to reuse until 5 or 6 years ago, but as a result of public meetings, presentations, and publicity from successful reuse projects such as South Tahoe, public opinion has become more favorable. The University of California report also concluded that public acceptance of reclaimed water could be gained through highly visible, well publicized demonstrations using reclaimed water for low-contact purposes. Such demonstrations, the report said, would provide evidence to technical experts, health officials, and the public that modern technology can produce high quality reclaimed water.

Recreational reuse opportunities are limited

Wastewater reuse for recreation usually means creating lakes for boating, fishing and swimming. In region I, the primary obstacles to recreational reuse is the high degree of treatment required and the cost associated with such treatment. A region I official stated that no facilities plans have recommended recreational reuse. If it was recommended region I would not approve it unless it was the least-cost alternative to comply with BPWTT. The abundant surface waters in region I substantially negate any incentive for States and municipalities to fund the costs that EPA considers ineligible for grant participation.

Concern over inadequate reclaimed wastewater research for potable reuse

In 1973 the American Water Works Association issued a statement discouraging the direct potable reuse of wastewater until research has shown it will not affect the public health. An Association official stated that basic position still holds true; however, he stated that it is now considered reasonably safe to use wastewater for potable purposes in short-term emergency situations, assuming proper treatment is provided.

An EPA official said that State public health officials will not approve potable reuse because they will not risk the unknown health hazards as long as "good" water is available. Public opinion is also opposed to direct potable reuse, according to a June 1976 University of California study.

The study focused on five California communities where reclaimed water had actually been used and five other similar communities where reclaimed water was not used. The 10 communities surveyed were selected to be representative not only of geography, but also of the population and water reclamation projects in California. The study produced consistent results: more than 50 percent of those sampled were opposed to the use of reclaimed water for the highest contact purposes (drinking, food preparation, canning vegetables, and so on).

CALIFORNIA PROGRAM RAISES MAJOR ISSUE ON GRANT ELIGIBILITY OF RECLAMATION COSTS

California, concerned with its water shortage problem, liberally interpreted EPA's cost-effectiveness guidelines in its January 1977 "Policy and Action Plan for Water Reclamation in California." Simply stated, California will fund a reclamation project if it is more cost-effective than two single purpose projects--one being for water pollution control and the other for water supply. To make such a determination municipalities are instructed to compare the incremental costs of reclamation (over and above costs necessary for disposal) with the cost of alternative or future water supplies that may be necessary to meet demand. According to a region IX official, if reclamation is shown to be the most cost-effective alternative, region IX will fund additional treatment or transportation facilities as necessary for reuse.

California is giving high priority to reuse projects. The State groups its projects into four basic purposes--groups I, II, and III (which are needed to meet water pollution control requirements while perhaps creating additonal water supplies), and group IV projects (which are not needed to meet water pollution control requirements, but would create additional water supply sources). If an existing secondary treatment plant is adequately meeting water quality requirements, any additional filters and transportation facilities necessary to irrigate a crop with the wastewater would be considered a group IV project.

According to a State agency official, the major question is whether reclamation projects *per se* will be

grant eligible. He said that California is waiting to see what happens to 22 strictly reclamation (group IV) projects that have been moved into the top funding category on the fiscal year 1978 priority list. The trend toward reclamation projects in water-short areas as a substitute water supply based on conservation raises a serious question as to the future of construction grant expenditures. In cases where States consider water supply of greater priority than water pollution control, construction grant funds could become utilized primarily for water supply purposes as long as they were keyed to wastewater reuse.

EPA has recognized the need for better guidance in determining the eligibility of reclamation costs. An ad hoc task force comprised of EPA and California officials is currently studying the issue. In this regard, EPA contracted with a private firm to perform several tasks, including

--identifying alternative approaches for funding reclamation projects,

--assessing the potential demand for reclamation projects,

--assessing the Federal costs of implementing alternative funding policies, and

--assessing Federal subsidy implications of water supply augmentation through Federal Water Pollution Control Act funding of reclamation projects.

The task force report, "Evaluation of Alternative Funding Policies for Municipal Wastewater Treatment and Reuse (Reclamation) Projects," was issued in March 1978.

The popularity of land application of wastewater in recent years under the 1972 Water Pollution Control Act Amendments has been in those areas such as the Southwest where water shortages and need for conservation of water have prompted the reclamation of wastewater and reuse for crop irrigation and groundwater recharge. These projects are directed primarily toward creating additional water supplies and not toward water pollution control--which, in many cases, is less costly than reclamation. They do, however, represent a method of land application which may have wider application than those specifically for treatment.

In region IX California has placed projects on its priority list for fiscal year 1978 that are primarily for

reclamation of treated wastewaters that already meet water pollution control requirements. Should these projects be approved by EPA as eligible for grant funding, significant amounts of construction grant allocations may be expended to provide for new or additonal water supplies in watershort areas.

CONCLUSIONS

Few projects have been funded under Public Law 92-500 for industrial, municipal, or recreational wastewater reuse. The use of reclaimed wastewater for such purposes has generally not been cost effective because of the need for high levels of treatment required to protect public health or make the wastewater usable in industrial processes. Transportation costs to get the wastewater to the user further reduced their costeffectiveness. Also, liberal cost-effective guidelines, such as those established by California, would do little to make industrial, municipal, and recreational reuse costeffective in region I because of the low cost of alternative water supplies. In addition to the transportation costs of using reclaimed wastewater, concern over its quality discourages potential users.

In region IX, California has placed projects on its priority list for fiscal year 1978 that are primarily for reclamation of treated wastewaters that already meet water pollution control requirements. Should these projects be approved by EPA as eligible for grant funding, significant amounts of construction grant allocations may be expended to provide for new or additional water supplies in water-short areas.

EPA has recognized the need for funding guidance of reclamation projects. On April 25, 1978, EPA issued proposed rules governing the grant eligibility of treatment works devices and systems for recycling and reclamation of municipal sewage. These proposed rules, when finalized will be effective until EPA has evaluated the task force report on alternative funding policies and developed its report (as required by section 516(e) of the Act) and a final Agency policy established.

Committee on Public Works and Transportation
NINETY-FIFTH CONGRESS
Congress of the United States
House of Representatives
Room 2165, Rayburn House Office Building
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HAROLD T. (BIZZ) JOHNSON, CHAIRMAN

March 7, 1977

The Honorable Elmer B. Staats
Comptroller General of the United States
General Accounting Office
441 G. Street, N.W.
Washington, D.C. 20548

Dear Mr. Staats:

The House Public Works and Transportation Committee, after its work on H.R. 3199, will be considering major changes to the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) during this congressional session.

I am concerned about the apparent absence of new technology being employed in Federally funded wastewater treatment projects, including those large mechanical treatment plants usually located in or near metropolitan areas and less sophisticated processes associated with smaller communities.

I ask that your office conduct a review of the Federal water pollution control construction grant program administered by the Environmental Protection Agency (EPA) and respond to the following questions raised by Committee members. They are:

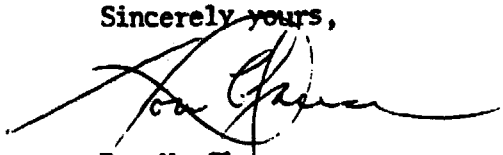
--Has new or advanced technology been developed in the water pollution control area? Has this technology been adequately incorporated into projects being funded under the 1972 Amendments? If not, what are the problems?

--If new or advanced technology is available but not being adequately utilized, what administrative and legislative incentives are needed at the Federal level to stimulate such interest?

--Are there disincentives to development and application of new or advanced technology created by the Environmental Protection Agency's wastewater construction grant process? How can this condition be reversed if it exists?

I would appreciate having your findings and conclusions regarding these matters by the end of the year.

Sincerely yours,



Don H. Clausen
Ranking Minority Member
Subcommittee on Water Resources

APPENDIX II

CHARACTERISTICS AND DESIGN FEATURES FOR LAND TREATMENT PROCESSES

Site characteristic	Slow rate	Rapid infiltration	Overland flow
Slope	Less than 20 percent on cultivated land; less than 40 percent on noncultivated land	Not critical; excessive slopes require much earthwork	Finish slopes 2 to 8 percent
Soil permeability	Moderately slow to moderately rapid	Rapid (sands, loamy sands)	Slow (clays, silts, and soils with impermeable barriers)
Depth to groundwater	2 to 3 feet (minimum)	10 feet (lesser depths are acceptable where underdrainage is provided)	Not critical
Climatic restrictions	Storage often needed for cold weather and precipitation	None (possibly modify operation in cold weather)	Storage often needed for cold weather
Design feature			
Application techniques	Sprinkler or surface a/	Usually surface	Sprinkler or surface
Annual application rate, feet	2 to 20 feet	20 to 560 feet	10 to 70 feet
Field area required, acres b/	56 to 560 acres	2 to 56 acres	16 to 110 acres

APPENDIX II

Site characteristic	Slow rate	Rapid infiltration	Overland flow
Typical weekly application rate, inches	0.5 to 4 inches	4 to 120 inches	2.5 to 6 inches c/ 6 to 16 inches d/
Minimum pre-application treatment provided in United States	Primary sedimentation e/	Primary sedimentation	Screening and grit removal
Disposition of applied wastewater	Evapotranspiration and percolation	Mainly percolation	Surface runoff and evapotranspiration with some percolation
Need for vegetation	Required	Optional	Required

a/ Includes ridge-and-furrow and border strip.

b/ Field area in acres not including buffer area, roads, or ditches for 1 million gallons per day (43.8 L/s) flow.

c/ Range for application of screened wastewater.

d/ Range for application of lagoon and secondary effluent.

e/ Depends on the use of the effluent and the type of crop.

Source: EPA "Process Design Manual for Land Treatment of Municipal Wastewater," Oct. 1977, pp 2-2, 2-3.

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