Report No. 9075-044-001

Contract No. 68-01-2942
Task Order No. 014

February 19, 1976

A SURVEY OF THE USE OF INNOVATIVE TECHNOLOGY IN MUNICIPAL WASTEWATER TREATMENT

Office of Research and Development
Environmental Protection Agency
Waterside Mall, RD-682
401 M Street, S.W.
Washington, D.C. 20460

Attention: Mr. James Basilico

BOOZ · ALLEN & HAMILTON Inc

Management Consultants

4733 BETHESDA AVENUE
BETHESDA, MARYLAND 20014
656-2200
AREA CODE 301

TABLE OF CONTENTS

	Page Number
INTRODUCTION	
I. SUMMARY OF FINDINGS AND CONCLUSIONS	I-1
1. A Survey of 13 States Indicates That. Conservatism Dominates the Technology Selection Process in Municipal Wastewater Treatment	I-1
2. Critical Needs Are Becoming Evident in Municipal Wastewater Treatment That Are Not Being Addressed Within the Present Framework of the Construction Grant Program	I-2
3. Significant Barriers Exist to the Timely Introduction of New Wastewater Treatment Technologies	I-3
4. Tracking of Projects Utilizing New Technology and the Dissemination of Information to Potential Users Are Necessary Prerequisites to Any Attempt to Streamline the Development Process	I-5
5. Alternatives Must Be Considered to Encourage the Development of Potentially Cost-Effective New Technologies for Use in Municipal Treatment Systems	I-6
II. EMERGING PROBLEMS IN MUNICIPAL WASTEWATER TREATMENT	II-1
1. Ultimate Disposal of Sludge	II-1
2. Wastewater Renovation	II-3
3. Alternative Methods of Disinfection	II-3
4. Small Community Treatment Needs	II-3
5. Resource Recovery	II-4
6. Energy Usage	II-4

	Page Number
III. BARRIERS TO THE IMPLEMENTATION OF INNOVATIVE TECHNOLOGY	III-1
1. Equipment Manufacturers	III-1
2. Consulting Engineering Firms	III-8
3. Municipalities	III-10
4. State Regulatory Agencies	III-11
5. EPA Construction Grant Program	III-12
IV. DATA COLLECTION AND DISSEMINATION	IV-1
V. ALTERNATIVES TO ENCOURAGE THE INTRODUCTION OF INNOVATIVE TECHNOLOGIES IN MUNICIPAL WASTEWATER TREATMENT	V-1
1. Increased Level of Funding for the EPA Demonstration Grant Program	V-1
2. Establishment of a Federally Funded, State-Run Technology Development Program	V-2
3. Privately Financed Demonstrations of New Technology	V-2
4. Modification of Existing Legislation to Fund the Demonstration Grant Program From Construction Grant Funds	V-3
5. Expansion of the Existing Construction Grant Program	V-3

INTRODUCTION

This report summarizes the results of a study performed for the Office of Research and Development of the Environmental Protection Agency. The purpose of the study is to determine whether or not innovative technologies are being used in municipal wastewater treatment projects funded under the Construction Grant Program and to identify the reasons why such technologies are or are not being employed.

During the seven-week study, interviews were conducted with EPA regional personnel, state regulatory personnel, municipal representatives, consulting engineers, and equipment manufacturers. The survey concentrated on 13 states within EPA Regions IV, V, and IX. The states surveyed were:

- Region IV:
  - Alabama
  - Mississippi
  - Georgia
  - Florida
  - Kentucky
  - Tennessee
  - North Carolina
  - South Carolina
- Region V:
  - Illinois
  - Wisconsin
  - Michigan
  - Ohio
- Region IX:
  - California.

Additional contacts were made with EPA personnel in Regions III, VIII, and X.

Regions IV, V, and IX were selected for the survey largely because of their diversity in climate, geography, and population distribution. This selection provided a broad cross-section of municipal treatment and disposal

practices and problems for inclusion in the study. Participants in the study were selected for their general familiarity with wastewater treatment practices and needs in their area.

Participants were asked to identify any wastewater treatment projects that had considered certain innovative processes and to indicate whether the process had been selected/rejected and why/why not. An innovative technology was defined to be one not in common use about the country. Sixteen treatment technologies were selected as a basis for discussion, although each respondent was encouraged to add to the list as appropriate. The 16 technologies selected for discussion were:

- Regional septage treatment. A regional septic tank pumpout, treatment, and disposal system was the basis of discussion.

- Landspreading of sludge. Application of sludge to land in either solid or liquid form as fertilizer was discussed. Treatment of sludge by overland flow was also included.

- Attached growth media for biological nitrification. Technologies considered here included rotating biological discs (RBDs), rotating biological contactors (RBCs), redwood media tower, stacked plastic media tower, and dumped plastic media tower.

- Advanced sludge dewatering techniques. Of interest here was the use of slow-speed centrifuges and filter presses.

- Steam gasification of sewage sludge. The described system uses pyrolytic activity to convert organic materials into fuel gas and inorganic materials into ash. The fuel gas is then burned to produce electricity.

- Composting. Subjects were questioned as to their familiarity with this process and their perceptions of its suitability for widespread use.

- Ozone disinfection. Perceptions regarding the use of ozone as an alternative to chlorine for disinfection of wastewater were examined.

- Alternatives for upgrading lagoons to meet secondary standards. Sand, rock and mixed media filters were the principal methods discussed.

- Treatment alternatives for reuse of wastewater. Wastewater uses were examined ranging from deep well injection to prevent salt water intrusion to primary contact. Feasibility of wastewater renovation to meet drinking water standards was also discussed. State-of-the-art of treatment technologies necessary to allow the various uses was also addressed.

- Sludge pyrolysis. Chemical conversion of organic material by pyrolysis in multiple hearth furnaces was the principal method discussed.

- Open-tank oxygenation. Oxygenation of wastewater in closed tanks was considered to be already developed; subjects were questioned to determine their familiarity with the open tank oxygenation systems presently under development.

- Single-stage nitrification-denitrification. The process discussed employs alternating periods of aerobic and anaerobic operating conditions in a single activated sludge reactor to produce nitrogen removal without methanol addition.

- Physical/chemical treatment. The principal method discussed was the addition of lime for coagulation followed by activated carbon filtration.

- Deep oxidation ditch. A biological treatment system was described that uses mechanical aerators for producing secondary treatment with the potential for moderate removal of total nitrogen.

- Fluidized oxygen reactor for biological secondary treatment. The system under discussion was to achieve carbonaceous oxidation-nitrification using fluidized oxygen bed, fixed-film technology in biological reactors.

- Nitrogen recovery from wastewater and reuse as fertilizer. A system using pure oxygen biological treatment followed by two-stage lime clarification, filtration, ammonia removal and recovery, chlorination, and dechlorination formed the basis of discussion.

The technologies listed above were selected because they showed a potential for being cost-effective, were not in common use across the country, and in a number of cases had not been demonstrated full-scale yet.

In order to provide the framework for the interview, each respondent was questioned as to his familiarity with EPA's Technology Transfer Program. Each participant was asked if he regularly used any of Technology Transfer's Process Design Manual's on the following topics:

- Phosphorus removal
- Carbon adsorption
- Suspended solids removal
- Upgrading existing water treatment plants
- Sulfide control in sanitary sewage systems
- Sludge treatment and disposal
- Nitrogen control.

In general, the Technology Transfer Program enjoyed a high degree of recognition among those contacted. The Process Design Manuals put out by the group were known virtually to all contacted and seemed to be widely employed. In addition, the Technology Transfer seminars were consistently described as useful in identifying new developments in municipal wastewater treatment.

I. SUMMARY OF FINDINGS AND CONCLUSIONS

I. SUMMARY OF FINDINGS AND CONCLUSIONS

1. A SURVEY OF 13 STATES INDICATES THAT CONSERVATISM DOMINATES THE TECHNOLOGY SELECTION PROCESS IN MUNICIPAL WASTEWATER TREATMENT

Interviews with equipment manufacturers, consulting engineers, municipal representatives, and state and Federal regulatory personnel have established that there exists considerable resistance to the introduction of potentially cost-effective, innovative technologies in municipal wastewater treatment. Reluctance to adopt innovative processes stems largely from doubts about process reliability and uncertainty over costs of construction, operation, and maintenance. In the majority of states surveyed, the lack of familiarity with new processes is responsible for the relatively small number of construction grant applications proposing innovative technologies.

The ability of individual states to encourage adoption of more progressive approaches in wastewater treatment seems directly related to the financial commitment made by the state in its water management programs. States with strong water resource management programs, such as California, Illinois, and Michigan, are more aggressive in implementing innovative solutions to water quality problems. States lacking the necessary financial commitment are content to employ more conservative solutions for the present and wait for others to develop the newer technologies.

In California, for example, the State Water Resource Control Board has implemented a progressive construction grant program funded under guidelines as restrictive as EPA's and staffed with sufficient personnel to provide in-depth technical review of each project. The state commonly implements new technology as a pilot project recommended for Step 1 funding under the Construction Grant Program. Illinois and Michigan may also be considered fairly progressive in this respect due to active state involvement in water programs.

In the other states surveyed, conservatism generally dominates the technology selection and review process to such extent that only the most developed technologies are recommended for Federal funding. However, some large municipalities, such as the Metropolitan Sanitary District of

Greater Chicago and the Los Angeles County Sanitation District, are able to implement new technologies quickly and efficiently, largely as a result of their funding autonomy. A state-by-state breakdown of survey results is presented in the appendix.

2. CRITICAL NEEDS ARE BECOMING EVIDENT IN MUNICIPAL WASTEWATER TREATMENT THAT ARE NOT BEING ADDRESSED WITHIN THE PRESENT FRAMEWORK OF THE CONSTRUCTION GRANT PROGRAM

Although an energetic program is underway to implement the provisions of PL 92-500 in a timely fashion, certain needs in wastewater treatment are likely to become more critical in the near future and will require the application of technologies not currently in common use. Among the areas needing greater development are:

- Ultimate disposal of sludge. As treatment standards become more restrictive, sludge handling and disposal problems multiply. Proven alternatives are too limited to satisfy current needs, much less future demands. Dewatering techniques, composting, pyrolysis, landspreading, and steam gasification of sludge are considered candidates for more intensive study and development.

- Wastewater reuse. Many water-short areas of the country are facing the prospect of wastewater reuse on a large scale within the next 10-15 years. Other areas of the country which enjoy a superabundance of water are concerned with indirect reuse because of the increased potential for contact between effluent flows and potable supplies. Public resistance to the concept of reuse is strong and represents an obstacle to the demonstration of new technologies.

- Treatment needs of small communities. Until recently, state and Federal funding priorities were slanted toward the needs of the major metropolitan centers in an effort to get the greatest benefit from each dollar. This operated to the detriment of small communities, especially those on water quality-limited streams. Although priorities have been adjusted somewhat, more needs to be done to demonstrate economical means of meeting tightened standards. Delay could intensify both groundwater and surface water pollution problems.

- Energy consumption. The recent escalation of energy costs pointed up the need for development of technologies less extravagant in energy usage. Such processes would find ready applications to conventional, as well as advanced treatment needs.

3. SIGNIFICANT BARRIERS EXIST TO THE TIMELY INTRODUCTION OF NEW WASTEWATER TREATMENT TECHNOLOGIES

Factors inhibiting the implementation of new technology are common to all elements of the development process, comprising equipment manufacturers, consulting engineers, municipalities, and state and Federal regulatory bodies.

(1) Equipment Manufacturers

Equipment manufacturers are limited financially in their ability to develop a new process to the point where it is ready for widespread application to municipal systems. The primary reasons for this are:

- The size of the market for municipal wastewater equipment is a small although growing portion of total costs of treatment plants.
- The structure of the industry has not been conducive to product innovation.
- Economic conditions beyond the control of the industry have resulted in limited prospects for introducing new technology.
- Generally low industry-wide rates of return on investment have seriously limited the capability of the industry to develop innovative products.
- There are significant barriers to the demonstration of innovative products by the industry.
- The "Nonrestrictive Specification" clause of PL 92-500 is not well understood. Uncertainty over the interpretation of the clause has adversely affected the introduction of new technology.

(2) The Consulting Engineer

The consulting engineer is often reluctant to recommend the use of innovative technology because:

- His first priority is to provide the municipality with the most reliable system available to do the job.
- Adequate data for evaluation of innovative technologies is frequently lacking.
- The constraints on the consulting engineer's time from the many municipalities seeking EPA Construction Grants militates against the thorough evaluation of innovative technologies.
- The true cost-effectiveness of a new technology can usually be evaluated only after very detailed study.
- Required operator skill levels are often higher than those available to the municipal client.

(3) Municipalities

Municipalities tend to be fairly conservative with regard to selection of treatment technologies. Two major considerations tending to limit the adoption of new technology by municipalities are:

- Uncertainties in O&M costs of innovative technologies, and
- The need to upgrade operator skill levels and operating staff levels.

(4) State Regulatory Agencies

State regulatory agencies are constrained in their adoption of new technologies by the need to commit allocated Federal funds in a timely fashion lest they revert to the government. Thus, the amount of time a state can allot for implementing a new process is closely circumscribed by the need for decisive funding action.

Complicating the approval process further, are the following factors:

- State offices charged with the review of facilities plans and specs have varying degrees of familiarity with innovative technology and tend to be conservative in their selection.

- Most states do not have research budgets or funds for demonstration programs.

- State regulatory agencies sometimes overzealously interpret suggested EPA guidelines as mandated regulations.

(5) EPA's Construction Grant Program

EPA's Construction Grant Program has as a top priority, getting treatment systems "into the ground" in time to meet the deadlines set by PL 92-500. As a result, those technologies furthest along in development are picked up most readily, while those processes lagging for lack of adequate demonstration are adopted slowly, if at all. Although the official EPA guidelines will allow implementation of technologies that are less than fully proven, the ruling of itself is unlikely to have a significant effect upon the development of new technologies.

4. TRACKING OF PROJECTS UTILIZING NEW TECHNOLOGY AND THE DISSEMINATION OF INFORMATION TO POTENTIAL USERS ARE NECESSARY PREREQUISITES TO ANY ATTEMPT TO STREAMLINE THE DEVELOPMENT PROCESS

Design and operating data from plants employing new technology will need to be collected and analyzed before a strategy for speeding the development of selected technologies can be chosen. Dissemination of relevant data will also be an integral part of any such program.

It is recommended that an information system be established and maintained to track proposed and on-going projects using new technology and to disseminate information on the design and operation of such facilities to potential users.

5. ALTERNATIVES MUST BE CONSIDERED TO ENCOURAGE THE DEVELOPMENT OF POTENTIALLY COST-EFFECTIVE NEW TECHNOLOGIES FOR USE IN MUNICIPAL TREATMENT SYSTEMS

Alternatives for speeding the development of new technologies include:

- Funding the existing Demonstration Grant Program at a higher level with financial incentives to encourage new technology demonstration
- Providing Federal demonstration money to the states to encourage full-scale demonstrations oriented toward state needs
- Privately financed demonstrations of new technology — performed by EPA and paid for by industry
- Changing existing legislation to allow some percentage of construction grant funds to be spent for new technology development under the Demonstration Grant Program
- Reordering of priorities of existing Construction Grant Program to encourage development of new technologies.

These and other alternatives will need more detailed study before an appropriate course of action can be selected.

II. EMERGING PROBLEMS IN MUNICIPAL WASTEWATER TREATMENT

II. EMERGING PROBLEMS IN MUNICIPAL WASTEWATER TREATMENT

The results of the survey of 13 states, presented in the Appendix, bring out the fact that there are certain emerging treatment needs that are common to a large number of the states surveyed. The consistency with which these problem areas were singled out, points up the need for planning beyond the immediate requirements of PL 92-500. The urgency of the Construction Grant Program's efforts to get proven technology "into the ground" in time to meet the legislated deadlines leaves little time for formulating approaches to emerging problems. Although the "now" orientation of the program is appropriate to its goal of meeting the 1977 deadline, the approach, nevertheless, lends little guidance to communities attempting to plan beyond immediate needs.

An example of the Construction Grant Program's inability to address emerging needs in a cost-effective fashion is provided by the problems encountered in Decatur, Illinois. Discharge from a Decatur treatment plant often constitutes the only flow in the Sangamon River. Since the flow passes through Allerton Park, a biological preserve, strict controls are maintained over the quality of the plant effluent. Nevertheless, in order to meet the standards imposed for the Sangamon, the plant's discharge will have to either eliminated or diluted. Because zero discharge systems are considered unproved technology, the Construction Grant Program cannot fund their addition to the plant. However, zero discharge technology would be a strong candidate for a demonstration grant, were one available. Now, in order to achieve the necessary dilution of effluent, a dam upstream of the treatment plant has been proposed as the only means for meeting water quality standards along that portion of the Sangamon. The dam will cost many times the price of a grant to demonstrate zero discharge technology and will have a much more severe effect upon the environment. A demonstration grant would be a cost-effective method of getting beyond the impasse caused by the lack of flexibility in the Construction Grant Program.

Innovative technologies will be needed to address many of the most commonly cited problem areas simply because

conventional processes can't. Examples of emerging needs that will require the demonstration of cost-effective, innovative technology in the near future include:

- Ultimate disposal of sludge
- Wastewater renovation
- Alternate methods of disinfection
- Small community treatment needs
- Resource recovery
- Energy usage.

New technology needs for these emerging problem areas are discussed in the following sections.

1. ULTIMATE DISPOSAL OF SLUDGE

The dilemma faced in this area is that while ocean disposal of sludge is to be phased out, land disposal options are not yet fully proven. In particular:

- Landspreading of sludge needs more full-scale work on control of heavy metals and viruses, as well as techniques for application to the soil.

- Landfill disposal of sludge is of limited use in high watertable areas, such as those common over the Southeastern U.S.

- Incineration of sludge creates air pollution problems unless emissions are controlled by expensive stack gas treatment systems.

- Composting faces serious public acceptance problems, as well as some technical difficulties.

- Pyrolysis is a process whose uses and advantages are poorly understood; it will need more demonstration before finding widespread acceptance.

- Steam gasification of sludge to generate electricity is virtually unknown, although it promises energy self-sufficiency in sludge disposal; the process will need full-scale demonstration prior to general use.

In sum, the range of proven alternatives in sludge disposal is simply too narrow to address even current problems adequately, much less future needs.

2. WASTEWATER RENOVATION

Many water-short areas of the country, including parts of Florida and California, are facing the prospect of wastewater reuse on a large scale within the next 10-15 years. Other areas of the country which enjoy a superabundance of water are concerned over indirect reuse because of the increased potential for contact between effluent discharges and potable supplies. Public resistance to the concept of wastewater reuse is strong and represents an obstacle to the implementation of recycling programs.

Much work needs to be done in the areas of chlorination-dechlorination, ozonation for disinfection, and nitrification-denitrification. Too few technological alternatives have been developed sufficiently to allow the necessary comparison testing of different approaches to renovation.

3. ALTERNATIVE METHODS OF DISINFECTION

Potentially adverse effects of chlorine compounds in treated effluent are becoming more of a concern. The high cost of dechlorination is resulting in increased emphasis on alternative disinfection methods. Ozone is the most developed replacement in sight, but its use is questioned in some areas, most notably in California, on technical grounds. More work is needed to determine if problems with turbidity and coliform survival can be resolved. Other technologies, such as UV-light and radiation, are far from full-scale application.

4. SMALL COMMUNITY TREATMENT NEEDS

In an effort to obtain the greatest benefit from each dollar spent, both state and Federal funding priorities for wastewater treatment have been directed toward the needs of the major metropolitan centers. Priorities have recently been revised somewhat to allow the funding of projects in the smaller towns but much more needs to be done before their needs will be met adequately.

The major problem is that conventional treatment systems are so expensive that many small towns cannot even raise their local share of the cost (25 percent). Secondly, most small communities can't afford to hire the type of qualified plant operator that most complex treatment systems require.

Thus, there is a real need for the development of simple and inexpensive treatment alternatives for small communities, especially if they lie along water quality-limited streams.

5. RESOURCE RECOVERY

Resource recovery techniques have the potential to turn costly waste disposal operations into sources of income for the large municipalities. Although some unit processes are available, i.e., the "Puretec" wet oxidation process for metals recovery, what is lacking is a systems approach to the generation of profit from waste. Waste processing for resource recovery will require not only new technology, but also a multidisciplinary approach to waste handling.

6. ENERGY USAGE

The recent, sharp increases in the price of energy have accentuated the need for development of treatment technologies that avoid energy-intensive steps. Given the sensitivity of municipalities to operating and maintenance costs, technologies which can demonstrate savings in energy usage are likely to find applications in conventional, as well as advanced waste treatment systems.

III. BARRIERS TO THE IMPLEMENTATION OF INNOVATIVE TECHNOLOGY

III. BARRIERS TO THE IMPLEMENTATION OF INNOVATIVE TECHNOLOGY

This chapter examines obstacles to the development and adoption of innovative technologies in municipal wastewater treatment. The various elements of the selection process under which new technologies are implemented are discussed and the economic factors affecting each segment's view of new technology are described.

The selection process consists primarily of the following elements:

- Equipment manufacturers
- Consulting engineering firms
- Municipalities
- State regulatory agencies
- EPA Construction Grant Program.

The role and the limitations of each of these groups in implementing new technology is discussed in the following sections.

1. EQUIPMENT MANUFACTURERS

The pollution control equipment industry historically has been buffeted by a variety of factors important among which were:

- Excessive competition among manufacturers
- Divergent regulatory positions of government agencies
- A smaller market than was originally expected
- Unfavorable contracts with equipment buyers
- Low rates of return on investment.

The stormy climate within the industry led to some shaking out of marginal firms and the development of fairly strong marketing and technological expertise among the more successful firms. The transition years of the industry, from the

late 1960's to the present, however, took their toll in terms of research and development reinvestment by manufacturers. There just weren't sufficient earnings, if any, to channel into R&D except among a few relatively profitable firms. Other firms either were forced to make private debt placements to fund R&D or simply to forego R&D completely. The high cost of private borrowing made prospects for new R&D even worse.

At present, prospects for reinvestment by manufacturers in R&D have improved somewhat, but serious barriers to the research, development, and marketing of innovative technologies by manufacturers still exist and are likely to continue in the future. Existing barriers to the adoption of innovative, potentially cost-effective technologies are discussed below in terms of the size of the municipal equipment market, the structure and performance of the industry, consequences of poor rates of return, and several key marketing problems.

(1) The Size of the Market for Municipal Wastewater Equipment is a Small but Growing Portion of the Cost of Treatment Plants

Most published information on the pollution control industry cites tremendous amounts of Federal funds being allocated to municipal waste treatment and tends to imply a grossly exaggerated market for municipal wastewater control equipment. A careful analysis reveals that only about 13 to 28 percent of the total cost of a treatment plant goes toward process and process control equipment.* The reason is simple: treatment plant construction is labor intensive. For example, a typical 15 MGD secondary treatment plant might have the following allocation of costs:

Cost Allocation, 15 MGD Plant

. HVAC	13%
. Total labor	39
. Wastewater equipment and sludge incineration	16
. Site preparation, piping, concrete and structures, miscellaneous	32
	100%

* Source of information: "The Environmental Control Industry," Council on Environmental Quality, December 1975, Kenneth Leung and Jeffrey A. Klein.

The size of the market for municipal wastewater equipment has been estimated and is shown below:

Expenditures for Municipal Wastewater Equipment and Treatment Plants, 1960-1970 and Projections to 1980

Year	Equipment Costs (Millions of Dollars)	Treatment Plant Costs (Millions of Dollars)	Percent of Total
1960	34.0	261.7	12.9%
1961	32.9	251.2	13.1%
1962	40.0	303.0	13.2%
1963	50.0	375.9	13.3%
1964	66.4	494.5	13.4%
1965	53.4	430.0	12.4%
1966	61.9	476.8	13.0%
1967	52.9	391.9	13.5%
1968	78.3	570.0	13.7%
1969	70.0	496.5	14.1%
1970	89.6	586.0	15.3%
1971*	115.0	735.0	15.6%
1972*	140.0	864.0	16.2%
1975*	233.0	1,164.0	20.0%
1980*	502.0	1,860.0	27.0%

* Estimated in 1971 dollars.

SOURCE: K.L. Kollar and W.G. Youngwirth, "The Market for Water and Wastewater Equipment," Construction Review, October/November 1971.

These estimates were obtained from surveys performed by the Department of Commerce in 1965, 1968, and 1970. Values shown for the years 1971 through 1980 are based on trend line projections in 1971 dollars. As is seen from the table outlays for wastewater equipment as a percentage of treatment plant cost are expected to increase by 67 percent over the 8 years from 1972 to 1980. Part of the increase can be attributed to the growing importance of advanced treatment systems which consume a higher percentage of total new plant cost and to the need for improved sludge handling and disposal equipment. In the transition years of the industry, 1968-

1974, manufacturers and investors typically overestimated the size of this market segment because of uncertainty about the rate of Federal expenditures. As a consequence, the industry attained an undeserved "glamour," and many firms were attracted to the marketplace.

(2) The Structure of the Industry Has Not Been Conducive to Product Innovation

In the transition years, manufacturers gradually shifted attention from existing product lines to new and diversified products which were tailored more to meeting emerging treatment needs. Thus, it has been only recently that manufacturers have aggressively started to define their markets and to market effectively. The following structural elements of the industry have constrained profitability, return on investments, and technology innovation:

- High number of firms in the industry. The industry developed from a base comprised of numerous participants mostly small in size but including several divisions of large firms. About 600 firms currently market municipal wastewater treatment products. Many firms are not well financed and have very limited or no R&D capabilities.

- Excessive competition. The sheer numbers of participants in the market combined with hectic efforts to carve out niches in the market in the face of overestimated market size has led to stress on price as the competitive marketing edge rather than value. Manufacturers have been preoccupied with cutting costs on existing product lines in lieu of identifying new markets and developing innovative products for them.

- Expensive marketing requirements for innovative products. Innovative products require a much greater commitment to marketing, because the buyer is a "process" rather than a person. In contrast to the industrial pollution control equipment buyer who is a profits-oriented production manager, the buyer of municipal equipment is actually several people

in both private industry and government agencies engaged in the EPA construction grant process. The "buyer" includes the consulting engineer, the municipality, the state regulatory body, and EPA. To some extent, the public at large is part of the "buyer," because the manufacturer's innovative product must be acceptable to the public, particularly in environmental protection areas.

Because a particular manufacturer has prospects for only a small market share, he must market to as many buyers as possible. That means going to a great number of people just to introduce the new technology. The corresponding costs are high and cannot be met by firms that are not well financed. Thus, the more profitable firms and firms able to assume more risk are the only ones who can really afford to develop innovative products. The number of firms in this position is small relative to the total number in the industry.

- Unfavorable sales contract structure. The sales contract between the equipment manufacturer and the municipality is regulated by the EPA, who funds the bulk of the project cost. In the past, two restrictions have contributed significantly to the poor profitability of equipment sales:

  - Payment on installation with no progress payments allowed

  - Fixed price contracts

  Both of these regulatory restrictions are in the process of being amended by the EPA. Some form of progress payments and inflation coverage would greatly improve the industry's profitability prospects and ease the serious cash flow problems.

(3) Economic Conditions Beyond the Control of the Industry Have Resulted in Limited Prospects for Introducing New Technology

The availability of capital has been a restrictive factor during an important part of the industry's growth, the early 1970's. The increased cost of capital has hindered the introduction of new technologies by increasing certain operating expenses such as marketing and by making the cost of R&D higher to firms with limited reinvestment opportunities. Most firms in the industry were adversely affected.

The period 1973 to 1975 was a tremendously difficult period for the industry, because cost escalations, materials shortages, and some labor problems eroded already slim profit margins. Poor profits, coupled with the high cost of capital, set R&D back severely. Manufacturers were forced to concentrate on keeping a lid on prices of existing products, instead of developing new ones. The industry also had some difficulty in retaining enough environmental engineers to satisfy its total needs, and individual manufacturers were plagued somewhat by job switching among key people. Together, these factors undermined profitability, and increased project lead times substantially, further discouraging development of new technologies.

(4) Generally Low Industry-Wide Rates of Return on Investment Have Seriously Limited the Capability of the Industry To Develop Innovative Products

Poor performance of firms in the industry, in terms of low rates of return, has led management to take three courses of action which restrict the research, development, and marketing of innovative municipal waste treatment equipment:

- Restrict commitments to additional manufacturing capacity. This action precludes much of the potential for the commercialization of any innovative projects by limiting opportunities for unit cost reduction and product exposure.

- Restrict availability of internal financing for innovative product marketing. When borrowed funds are necessary to market new

products, the prospects for profitability of these products are further reduced.

- Limit funding of R&D. This action defers innovation to years of better company performance and forces the firm to allocate resources among existing products and priority research projects.

(5) There Are Significant Barriers to the Demonstration of Innovative Products by the Industry

It was noted earlier that the buyer of municipal wastewater equipment is really a number of people engaged in the process of designing a treatment plant and obtaining EPA approval. The manufacturer must convince everyone in the process that his innovative equipment will not only do the job but will also produce cost savings. To do this, the manufacturer must supply adequate proof of his claims. More often than not, the only convincing proof is full-scale operating data on a process or piece of equipment. The manufacturer's key to getting this data is arranging with municipalities for incorporation of the innovative equipment into a proposed plant on a pilot basis. This usually requires that the equipment have only a minor effect on the reliability of the whole plant and that it be specified as only part of the new plant's treatment process. An optional approach is to arrange with the municipality to add innovative equipment in parallel to existing equipment at a municipal plant. This option is financed usually by the manufacturer either entirely or with some support from state or EPA funds. Thus, the means for full-scale demonstration of innovative technologies are limited and expensive for the manufacturer. When costs become too high because of poor profitability of the firm or the high cost of capital, demonstration becomes a difficult or impossible burden for the firm to bear. It can either shift resources to more proven technologies or try to market innovative equipment using the operating results of pilot-scale tests. As will be discussed later, such results are much less convincing to the municipal equipment buyers.

Complicating the manufacturer's demonstration problems is the reluctance of most municipalities to engage in arrangements with manufacturers for full-

scale demonstrations. It is usually very difficult for a manufacturer to find the right combination of factors to enable a meaningful one-time demonstration of his equipment. On the other hand, it becomes prohibitively costly for one firm to conduct such demonstrations in more than one area of the country at one time. The manufacturer can rarely, if ever, finance his own full-scale demonstration plant. Likewise, a manufacturer can almost surely not finance a comparison demonstration on a full-scale basis in which his equipment is tested against a competitor's or against a different process.

(6) The "Nonrestrictive Specification" Clause of PL 92-500 is Not Well Understood. Uncertainty Over Interpretation of the Clause Has Adversely Affected the Introduction of New Technology.

The "Nonrestrictive Specification" clause, known to many manufacturers and consulting engineers as the "brand name or equal" clause, requires that specifications for equipment for EPA grant-eligible treatment plants be structured so that no manufacturers are arbitrarily excluded. Where manufacturers or brand names are used in the specification, at least three names, all included as equals, must be given. The regulation can be expected to cause manufacturers to stress price instead of value in their products since the lowest cost product which satisfies the specs must be chosen. Such very real values as reliability of the manufacturer in providing satisfactory units on time, his ability to honor warranties, his reputation for and ability to provide service on equipment, and his reputation for reliable equipment in general are usually not appraised in determining equality between products and can be written into specifications only with difficulty.

Another concern of the manufacturer is that the "Nonrestrictive Specification" clause will cost him at least some of the business of his most established customers since they can no longer routinely specify his proven products.

2. CONSULTING ENGINEERING FIRMS

Consulting engineers are virtually at the center of the design/approval process for EPA grant-eligible treatment

plants. They evaluate innovative technologies against more conventional ones before arriving at design recommendations, but at the same time, they are sensitive to the preferences of their clients — the municipalities — and to the acceptability of innovative designs to the state and EPA reviewers. In addition, equipment manufacturers recognize the key position of consulting engineers and inundate them with claims of varying credibility on innovative equipment and processes.

This overview of the role of the consulting engineer in the design/approval process is expanded below with attention to constraints on his recommendation of innovative technology in POTW design.

(1) The Consulting Engineer Tends To Be Conservative Because His First Priority is To Provide the Municipality With a Workable, Reliable System

Municipalities generally prefer the reliability provided by proven technology to the risk associated with innovative technologies, even if some cost savings are possible with innovation. The consulting engineer seeks to minimize the risk to the municipality by recommending technologies for which full-scale operating data are available from plants in a region similar to his client's. When other requirements become overriding, the consulting engineer will evaluate innovative alternative technologies very thoroughly.

(2) Adequate Data for Evaluation of Innovative Technologies is Frequently Lacking

Consulting engineers are plagued with data of varying reliability from manufacturers and process innovators. Claims of potential cost savings are made based on experiments ranging from bench-scale tests to full-scale demonstrations. Respondents in the study consistently reported the need for more data on existing innovative pilot and full-scale plants. The major data deficiencies cited included reliability indicators and O&M costs.

(3) The Constraints on the Consulting Engineer's Time From the Many Municipalities Seeking EPA Construction Grants Militates Against the Thorough Evaluation of Innovative Technologies

The push by municipalities to obtain early EPA commitment to the funding of a proposed treatment plant design has placed severe time constraints on the consulting engineer's ability to evaluate innovative designs. In the face of pressing deadlines, consulting engineers are often unable to provide the in-depth evaluation required for new process designs. Without the proper engineering analysis, an innovative technology stands little chance of being selected over more conventional technologies.

(4) Innovative Technologies Are Often Excluded From Serious Consideration by Superficiality of Cost-Effectiveness Analysis

Cost effectiveness analyses in plans submitted under the EPA Construction Grant Program vary from token computations to computerized analyses of a wide range of alternatives. Innovative technologies tend to fare worse when the evaluation is cursory. It is all too easy to write off many innovations as having inadequate data to determine reliability, costs, or any other parameter.

(5) Low Skill Levels of Available Treatment Plant Operators Have Seriously Limited the Recommendations of Many Innovative Technologies

Almost every respondent in the study pointed to low operator skills as a major constraint in design. Clearly, if operation and maintenance quality is likely to be questionable, there is little point in recommending the technology in the design. The problem applies to all sizes of plants, from upgraded lagoons to plants of large metropolitan areas.

3. MUNICIPALITIES

As mentioned earlier, municipalities tend to be fairly conservative with regard to selection of treatment technologies.

Two factors tending to limit the application of new technology are identified here:

- Uncertainties in O&M costs
- Operator skill requirements.

(1) Uncertainties in O&M Costs of Innovative Technologies Limit Their Applicability

Municipalities are very concerned with O&M costs of new plants or plant expansions. Generally, O&M cost data for innovative technologies is lacking and the designer cannot present well documented estimates to the municipality in his evaluation. The municipality is, generally, willing to pay a small premium for risk minimization by sticking to technologies of proven O&M costs.

(2) Often a Municipality Will Specify That New Plants or Additions Require Minimal Need for Upgrading of Operator Skill Level and Operating Staff Levels

Such specifications to the designer can seriously limit the range of innovative technologies available. Clearly, where uniformity in operation is a design objective, innovative technologies become less competitive with conventional ones.

4. STATE REGULATORY AGENCIES

All states do have one common response to the EPA Construction Grant Program: move projects in order to use up all of the state's allocation. This reponse generally does not really promote careful evaluation of innovative alternatives against conventional technologies. The general similarity between states ends here. There are differences in their handling of innovative technology as discussed below.

(1) State Offices Charged With the Review of Facilities Plans and Specs Have Varying Degrees of Familiarity With Innovative Technology and Tend To Be Conservative

State offices appear to reach much more favorably toward innovative plans based on full-scale operating

data than to plans based on anything else. Increased manpower would probably enable the states to be more involved in innovation.

(2) Most States Do Not Have Research Budgets or Funds for Demonstration Programs

Those that do clearly have a greater impact on the introduction of innovative technology. Such states include California and Illinois.

(3) Part of the States' Conservatism Might Be Related to Their Interpretation of EPA Regulations

The regulations covering the construction grant approval process appear to allow for more discretion by the states in approving processes than has historically been exercised. The regulations do allow for state and EPA approval of innovative processes for which successful demonstration on less than full-scale has been shown. Thus, it appears that the states' tendency to rely on full-scale operating data for approving plans is based on their choice than EPA regulations.

5. EPA CONSTRUCTION GRANT PROGRAM

Much of the facilities plan approval process has been turned over to the states, but EPA regional offices still have formal review authority for many states. The involvement of the regional office in innovative technology introduction is more pronounced for states having formal review authority. Constraints to the introduction of innovative technology are discussed below.

(1) Pressure by EPA to Obligate Construction Grant Funds Quickly Has Somewhat Hindered the Evaluation of Innovative Technologies Against Conventional Ones in Facilities Plans

As can be inferred from the earlier findings of this study, the pressure by and on the EPA to obligate funds constitutes a major constraint on the introduction of innovative technology.

(2) The Limited Availability of Data on Innovative Technologies and the Overextension of Manpower Resources in the Regional Offices Restricts the Involvement of EPA in Introducing Innovative Technologies

The general lack of adequate data and the inadequate mechanisms for disseminating existing data on innovative technologies constrains EPA involvement as much as it does that of the designers and state regulatory agencies. In addition, Construction Grant Program personnel are so inundated with grant applications that they have little time and even less incentive to encourage the consideration of innovative alternatives in proposed projects.

IV. DATA COLLECTION AND DISSEMINATION

IV. DATA COLLECTION AND DISSEMINATION

Attempts to streamline the technology development process should be preceded by improvements in the transmission of data from existing projects utilizing innovative technologies. A fact universally deplored was that the Federal Construction Grant Program does not provide funding to gather the data needed for designers to improve upon subsequent systems. Current efforts to generate this type of feedback depend largely on the determination of the state regulatory body to get the information out to others within the state. The transmittal of such information from state to state is much less direct. Unfortunately, EPA's Construction Grant Program is unlikely to be able to take on any additional responsibility for developing an information system. In each regional office visited, the construction grant personnel were hard pressed just to "get the money out" for new projects.

An information service to provide design and operating data from plants using innovative technology is vitally needed. In California and throughout Region IV, the lack of such a capability was causing delays in supplying needed funds. For example, the State of California was placed in the awkward position of having to commit funds to projects without having the type of information normally preferred or face the possibility of losing uncommitted funds. The ready availability of information on new technologies from projects across the Nation would greatly enhance the ability of each state to develop needed technologies in a timely fashion. Therefore, it is recommended that an information system be established and maintained to track proposed and on-going projects using innovative technologies and to disseminate design and operating data from plants employing such processes.

V. ALTERNATIVES TO ENCOURAGE THE INTRODUCTION OF INNOVATIVE TECHNOLOGIES IN MUNICIPAL WASTEWATER TREATMENT

V. ALTERNATIVES TO ENCOURAGE THE INTRODUCTION OF INNOVATIVE TECHNOLOGIES IN MUNICIPAL WASTEWATER TREATMENT

Numerous problem areas in wastewater treatment have been discussed in previous chapters that could benefit substantially from the timely introduction of certain cost-effective technologies. Furthermore, since many communities across the country are unlikely to be in compliance with the directives of PL 92-500 until several years beyond the 1977 deadline, the results of a technology demonstration program could be applied to currently identified needs as well as future concerns.

The identification and recommendation of alternatives for the development of new technologies are properly the subject of a more detailed study. However, certain options can be presented for tentative consideration; they include:

- Funding the existing Demonstration Grant Program at a higher level
- Establishment of a federally funded technology development program run by the states
- Privately financed demonstrations of new technology
- Modification of existing legislation to allow the expenditure of construction grant money by the Demonstration Grant Program
- Reordering of Construction Grant Program priorities to encourage the demonstration of new technologies.

These alternatives are discussed briefly in the following sections.

1. INCREASED LEVEL OF FUNDING FOR THE EPA DEMONSTRATION GRANT PROGRAM

Increased funding for the EPA Demonstration Grant Program represents a logical and direct method for establishing national priorities for new technology development and for performing meaningful, full-scale demonstrations of new

technology. The concept of the demonstration grant enjoys wide recognition already so that a minimal effort would be needed in implementing it. In addition, enough is known about the operation of the previous Demonstration Grant Program to improve its performance significantly.

In order to encourage municipalities to participate in new technology demonstrations, it is likely that some financial incentive will be needed, for example, raising the ceiling on the Federal share of project costs from 75 percent to 90 percent.

2. ESTABLISHMENT OF A FEDERALLY FUNDED, STATE-RUN TECHNOLOGY DEVELOPMENT PROGRAM

Under this proposal, Federal funds would be provided to the states outside of the Construction Grant Program to encourage development of new processes oriented toward a state's needs. This suggestion has a certain logic to it since the technical review function for proposed projects resides largely with the states. Thus, Federal funds for technology development could be injected at the level where the competence of a proposed design would be evaluated. Also, this type of approach would allow the states to address their priority needs directly. Development programs of regional interest could be handled on a cooperative basis by the interested states. The question of the degree of Federal control over demonstration funds and the possibility of unnecessary duplication of effort by the states will need to be addressed here.

3. PRIVATELY FINANCED DEMONSTRATIONS OF NEW TECHNOLOGY

Demonstration projects would be funded by private industry but conducted by EPA under this option. The success of this attempt to lend objectivity to the demonstration of a manufacturer's equipment or process will depend heavily on EPA's technical credibility and the willingness of the manufacturer to disseminate negative results, should they be obtained.

4. MODIFICATION OF EXISTING LEGISLATION TO FUND THE DEMONSTRATION GRANT PROGRAM FROM CONSTRUCTION GRANT FUNDS

This alternative calls for a certain small percentage of construction grant funds, probably less than one percent, to be given to the Demonstration Grant Program to finance new technology demonstrations. Existing legislation regulating the expenditure of construction grant funds would have to be amended to allow use of the funds for this purpose. It may be necessary to take measures to ensure that the states do not perceive this reallocation of construction grant funds as a net loss of Federal money promised to them.

5. EXPANSION OF THE EXISTING CONSTRUCTION GRANT PROGRAM

This alternative involves reordering the priorities of the Construction Grant Program to encourage the demonstration of new technologies. The function of the construction grant group would have to be modified from what is essentially the review of funding proposals to include the promotion of new, cost-effective processes. In addition, this reorientation would need to be carried out in a way that would not hinder the flow of construction funds. Some incentive for selecting a new technology would probably be necessary.

* * * *

The alternatives identified above as well as others yet to be suggested will require more thorough analysis before an efficient technology development program can be proposed. Certainly a high priority should be assigned to any assessment of programmatic options in this area.

APPENDIX

SURVEY OF INNOVATIVE TECHNOLOGY IN 13 STATES

This chapter presents the results of a series of interviews held in EPA Regions IV, V, and IX with equipment manufacturers, consulting engineers, municipal representatives, and state and Federal regulatory personnel. The interviews concentrated on the following topics:

- Experience with past demonstration grant programs
- State and Federal approval process for implementing technology
- Identification of projects using innovative technology
  - Reasons why technology was/was not proposed
  - Reasons for acceptance/rejection of technology
- Emerging problem areas in wastewater treatment.

The discussion is presented by individual state, and identifies important features of the state approval process, innovative technologies recently introduced or under consideration, and the major treatment needs perceived within each state. Contacts were queried as to the use of the following technologies within their area:

- Regional septage treatment: A regional septic tank pumpout, treatment and disposal system
- Landspreading of sludge: Application of sludge to land in either solid or liquid form as fertilizer. Treatment of sludge by overland flow was also included
- Attached growth media for biological nitrification: Technologies considered here included rotating biological discs (RBDs), rotating biological contactors (RBCs), redwood media tower, stacked plastic media tower and dumped plastic media tower

- Advanced sludge dewatering techniques: Of interest here was the use of slow-speed centrifuges and filter presses

- Steam gasification of sewage sludge: A system using pyrolytic activity to convert organic materials into fuel gas and inorganic materials into ash. The fuel gas is then burned to produce electricity

- Composting: Subjects were questioned as to their familiarity with this process and their perception of its suitability for widespread use

- Ozone disinfection: Perceptions regarding the use of ozone as an alternative to chlorine for disinfection of wastewater

- Alternatives for upgrading lagoons to meet secondary standards: Sand, rock and mixed media filters were the principal methods discussed

- Treatment alternatives for reuse of wastewater: Wastewater uses were examined ranging from deep well injection to prevent salt water intrusion to primary contact. Feasibility of wastewater renovation to meet drinking water standards was also discussed. State of the art of treatment technologies necessary to allow the various uses was also addressed

- Sludge pyrolysis: Chemical conversion of organic material by pyrolysis in multiple hearth furnaces was the principal method discussed

- Open tank oxygenation: Oxygenation of wastewater in closed tanks was considered to be already developed; subjects were questioned to determine their familiarity with the open tank oxygenation systems presently under development

- Single-stage nitrification-denitrification: A process employing alternating periods of aerobic and anaerobic operating conditions in a single activated sludge reactor to produce nitrogen removal without methanol addition.

- Physical/chemical treatment: The principal method discussed was the addition of lime for coagulation followed by activated carbon filtration

- Deep oxidation ditch: A biological treatment system using mechanical aerators for producing secondary treatment with the potential for moderate removal of total nitrogen

- Fluidized oxygen reactor for biological secondary treatment: System for carbonaceous oxidation-nitrification using fluidized oxygen bed, fixed-film technology in biological reactor

- Nitrogen recovery from wastewater and reuse as fertilizer: System using pure oxygen biological treatment followed by two-stage lime clarification, filtration, ammonia removal and recovery, chlorination, and dechlorination.

Innovative technologies and emerging needs identified in the survey are summarized in Tables 1 and 2.

1. CALIFORNIA

California has a variety of physical and demographic characteristics that influence its approach to wastewater management. The northern half of the state is typified by a cool, wet climate providing a superabundance of water. The terrain ranges from the lowest point, Death Valley, to the highest point in the contiguous United States, Mt. Whitney, in less than one hundred miles.

In contrast, the southland with its hot, dry desert climate is largely a water-poor area with rainfall averaging somewhat less than ten inches per year. As a consequence, the water needs of its large metropolitan centers must be met by importing water from relatively distant water-rich areas. The change in relief over southern California in going from the sea to the mountains is not as great as in the north, and the soil quality is definitely poorer over broad areas.

Certain important similarities that exist between the northern and southern portions of the state tend to blur the sharp distinctions made above. For example, the population of both sections is concentrated in a fairly narrow band along the seacoast and the nearby inland valleys. Accordingly, the two major metropolitan areas, San Francisco-Oakland in the north and Los Angeles-San Diego in the south and their surrounding broad belt of communities, are the focus of the main thrust of municipal water pollution control efforts within the state.

The following sections discuss new technology implementation in municipal wastewater treatment. Specific aspects discussed include the approval process for implementing technology, a survey of new technologies being adopted, and emergent water treatment needs within the state.

APPENDIX (3a)

Table 1
Status of the Use of Innovative Technology in 13 States

STATE	INNOVATIVE TECHNOLOGY															
	Nitrogen Recovery for Fertilizer	Fluidized O2 Reactor	Deep Oxidation Ditch	Physical/Chemical Treatment	Single-Stage Nit.-Denit.	Pure O2 in Open Tanks	Pyrolysis	Wastewater Reuse	Lagoon Upgrading Techniques	Ozone Disinfection	Composting	Steam Gasification of Sludge	Advanced Sludge Dewatering Techniques	Attached Growth Media	Landspreading of Sludge	Regional Septage
CALIFORNIA			LU	PR			FS	FS	UC	NTA	PR		FS	FS	LU	PR
ALABAMA			PR												LU	
MISSISSIPPI									FS						PS	
GEORGIA				PR	UC				UC			UC	PS		FS	
FLORIDA								FS							FS	PR
KENTUCKY			PRO											PRO		
TENNESSEE						UC			FS	NEA		UC	UC			
NORTH CAROLINA				PRO										PRO	UC	
SOUTH CAROLINA			PRO	FS	UC									PR	FS	
ILLINOIS			PRO					UC	FS	NEA			UC	PR	FS	PRO
WISCONSIN			PR	PS					PRO					PR	PR	
MICHIGAN				FS	FS				FS	PRO			PR	PR	FS	
OHIO				FS					UC					PR	FS	PRO

KEY:
- UC = Under consideration, being researched
- PRO = Currently proposed
- LU = In limited use
- PS = Pilot-scale testing
- FS = Full scale testing
- PR = Considered to be proven reliable
- NEA = Not economically acceptable
- NTA = Not technically acceptable

Table 2
Problem Areas in Wastewater Treatment Identified in Survey of States

Area of Concern	CALIFORNIA	ALABAMA	MISSISSIPPI	GEORGIA	FLORIDA	KENTUCKY	TENNESSEE	NORTH CAROLINA	SOUTH CAROLINA	ILLINOIS	WISCONSIN	MICHIGAN	OHIO
Resource Recovery Techniques	●										●		
Smaller Land Requirements											●		
Detection of Carcinogens													●
Regionalization											●		
Instream Aeration										●			
Process Control										●			
O&M Cost Reduction										●			
Alternative Disinfection Methods	●					●			●				●
Lagoon Upgrading Alternatives	●		●						●	●		●	
Nutrient Removal Techniques								●	●				
Improved C-E Analysis						●							
Operator Skill Levels					●		●						
CSO Control Technology				●								●	●
Urban Runoff Controls				●									
Intermittent Discharge Alternatives		●											
Inflow/Infiltration Calculations		●				●	●						
Small Community Needs	●	●		●				●			●	●	
Energy Conservation	●					●			●			●	
Wastewater Reuse Technology	●	●		●	●		●						●
Ultimate Disposal of Sludge	●				●		●	●		●	●	●	●

(1) Approval Process

Control over the construction of new wastewater treatment projects within California lies with the State's Water Resource Control Board. Through the Clean Water Grant Program of the Control Board, the State of California funds the construction of new projects to a level of 12.5 percent of the total cost of the treatment facilities. This is the largest share borne by any of the states surveyed for EPA grant-eligible projects. Eligibility criteria for the Clean Water Grant are at least as restrictive as those for an EPA Construction Grant. With a technical review staff several times larger than EPA's, the Control Board is able to perform a detailed analysis of each proposed project.

Although the board is receptive to proposals involving new technology, its top priority within the municipal grant program is to ensure the reliable treatment of wastes, not to implement innovative technology. A widely stated position is that a process has to be ready to "go into the ground" to be funded by the grant program. The burden of proof as to the efficacy of a new technology is, thus, upon the applicant and his consultant.

In proposing a new technology, the consulting engineer must be able to present sufficient data, preferably from a full-scale operating plant, to convince the board that the process will meet relevant standards. Proposed innovative technologies are closely scrutinized by the board and approved projects are then recommended to EPA for funding under a Step 1 grant as a pilot plant. In this way, certain new technologies can be introduced to municipal treatment systems under the Construction Grant Program. The risks associated with the new technologies are reduced by the detailed review provided by the state's technical staff and by limiting the plant's size in most cases to pilot scale. However, except in instances of pressing need, new technologies picked up this way are those farthest along in development, (i. e., those technologies that have had the benefit of previous demonstration). For example, an early project of the Tahoe-Truckee Sanitation Agency using demonstration grant funds, developed information on physical/chemical treatment that is now being used in a number of large treatment plants throughout California (see following section).

One problem that has developed with this approach is that under the crush of applications for funding as Step 1 pilot projects that is occurring in California, little can be done to incorporate the experience gained in one such project in time to affect the design of the next one. This has led to an undesirable duplication of effort in some instances. Compounding this difficulty is the lack of money under Step 1 to allow the collection and dissemination of data from pilot plant operation.

(2) Innovative Technologies

The aggressive attitude of the State of California Water Resource Control Board has led to the implementation of a variety of innovative technologies, many of which promise enhanced cost-effectiveness over conventional processes and some of which represent the sole solution to a particular treatment problem. Within California the following innovative technologies have been identified:

- Regional septage. Process is most useful in mountainous or very hilly areas. Mostly small projects are being funded under Construction Grant Program:
  - Orange County Sanitation District
  - Las Virgines Water Treatment Plant, City of Los Angeles
  - City of Santa Cruz
  - Humboldt Bay
- Landspreading. Concept is generally accepted for use in landscaping but not for application to crop lands. Use is limited in southern California by soil alkalinity problems.
  - L. A. County - Orange County Sludge Study performed under a Step 1 grant
  - East Bay Municipal Utility District studying use of sludge from 136 Mgd plant on agricultural land. Being done under 201 planning.

- Attached growth media for biological nitrification. A few full-scale systems are in use based on results of pilot plant studies.

  - Rotating biological discs (RBDs) being used at South Bayside System Authority

  - Nitrification towers in use at Sunnyvale plant near San Francisco

  - RBD's being considered in Palo Alto AWT plant.

- Sludge dewatering techniques. Slow-speed centrifuges are being adopted but filter presses are not being proposed anywhere. BEST system and Carver-Greenfield process are considered to be of unproven reliability.

  - Los Angeles County Sanitation District is presently using 30 small centrifuges in modular approach-scale up in numbers rather than size

  - East Bay Municipal Utility District has plans to use centrifuges as well as vacuum dewatering units.

- Composting. Proven technology; adoption depends largely on economics of transportation.

  - Los Angeles County Sanitation District is composting one hundred tons per day of sludge from Joint Water Pollution Control Plant to avoid ocean disposal.

- Ozone for disinfection. Ozone is not currently approved for use in the state as a primary disinfectant because of the lack of demonstrated ability to remove coliform bacteria and because of turbidity problems. However, as concern increases over potentially adverse health effects associated with chlorination, the need for a demonstrated alternative method of disinfectation will become more pressing. Two projects using ozone were identified:

  - Los Angeles County Sanitation District pilot plant

- Chino Municipal Utility District in San Bernardino County is using ozone more as a conditioning agent for filtration than as a disinfectant. Conventional disinfectation is achieved at this plant using chlorine.

. Lagoon upgrading techniques. Too few alternatives are currently available, especially for use in small communities.

  - Sunnyvale plant near San Francisco will use microscreening to remove algae.

. Wastewater reuse. This is becoming more of a priority in both the water-rich northern part of California (related to contact recreation) and the water-poor southern portion. Among the plants currently using or planning to use advanced waste treatment to meet reuse needs are:

  - Sepulveda plant, City of Los Angeles, now using Harding mixed-media filters

  - Orange County Water System No. 21

  - Tahoe-Truckee Sanitation Agency with ammonium sulfate recovery

  - Chino Municipal Utility District

  - City of San Francisco, using sulfur dioxide to dechlorinate effluent

  - Santa Clara Flood Control and Water Conservation District, injection of filtered effluent from a 1 Mgd plant to counter salt water intrusion in Palo Alto area

  - Los Angeles County Sanitation District: Reclaimed water being used for irrigation of crops and golf courses and in freeway landscaping. Spreading of secondarily treated effluent for groundwater recharge is being done at Whittier Narrows plant and San Jose Creek plant (230 Mgd). An artificial lake near

Lancaster is filled solely with reclaimed water. Fishing is allowed but not swimming.

- Pyrolysis. Two projects have been funded under Step 1 grants, both experimental in nature:

  - Contra Costa County treatment plant will pyrolyze sludge and solid waste to generate electricity on pilot scale

  - Orange County in conjunction with the Jet Propulsion Labs of NASA will pyrolyze sludge, producing activated carbon for use in effluent filtration.

- Physical/chemical treatment. Technology is developed and understood but may not be able to guarantee meeting secondary standards economically. New plants have used information gained from Tahoe-Truckee Sanitation Agency demonstration project.

  - Vallejo plant, 10 Mgd

  - Ontario treatment plant, 10-15 Mgd

  - Chino Municipal Utility District, 10 Mgd

  - Napa plant, 5 Mgd

  - Fairchild Plant, 20 Mgd; effluent is discharged to marshy wildlife area along California Flyway

  - Central Contra Costa County Sanitation District, 230 Mgd

  - Orange County Sanitation District, pilot plant doesn't meet secondary treatment standards

  - City of San Francisco, study shows that the number of stages needed to reach secondary treatment level are too costly to implement.

- Deep oxidation ditch. Technology considered proven but use has been limited to small communities thus far. Potential for savings not widely known.

(3) Problem Areas

California is energetically addressing its most pressing wastewater treatment needs through the use of Federal and state construction grants. In fact, because of the active role assumed by the State Water Resource Control Board, California has been able to develop new technologies as pilot projects under Step 1 Construction Grants. Nevertheless, some current problems in wastewater treatment are likely to become increasingly more critical over the next ten years unless more attention is accorded them now. The major areas of concern are:

- Ultimate disposal of sludge. Existing range of proven alternatives is too limited to address near-term problems. Both pilot- and full-scale studies are needed. Pyrolysis and landspreading are top priorities.

- Reuse of wastewater. This is a major issue in Los Angeles where effluent discharge from treatment plants is often the only flow in the concrete-lined Los Angeles River. Although the channel is fenced off to prevent contact, children often play in it. The State Health Department is requiring advanced treatment to produce a well oxidized, coagulated and filtered effluent which must meet bacterial standards as well. Work is being done on different processes under a Step 1 grant but full-scale demonstration is needed to show the comparative advantages of various processes. It was widely felt that the necessary technology was not likely to be implemented under the Construction Grant Program.

- Treatment needs of small communities. Not adequately addressed under existing state and Federal funding priorities. Technologies available for meeting relevant standards in an affordable fashion are not yet developed.

- Energy consumption. In the face of sharp increases in energy costs, less energy-intensive processes need to be demonstrated.

2. ALABAMA

In this state, there are great differences between the municipal treatment problems of small towns and those of the larger cities. Many of the smaller towns are located on ridges of the headwaters of streams and treatment requirements are difficult to meet. Larger towns, on the other hand, can usually meet water quality standards through secondary treatment. The activated sludge process is common for such towns. Wet weather flows generally present a problem in the state.

The following discussion describes the extent to which innovative design is used in Alabama, and points to emerging design problems.

(1) The Approval Process

The Alabama Water Improvement Commission is the state agency which receives facilities plans from designers for state-level review. The commission does not have full official responsibility for the review of plans and specifications but appears to give close scrutiny to proposed plans. The approach of both the state and EPA Region IV to project review is generally conservative. For example, the state recently favored a design for a new Birmingham plant which was similar to that of two existing plants in Birmingham. The state's objective was to promote uniformity in operation and maintenance of the three plants. Many towns in the state haven't started new facility planning yet, and the state is pushing for acceleration of their efforts.

(2) Examples of Innovative Technologies

Several of the technologies on which this study focuses have been implemented in Alabama. The reported plants are:

- Landspreading of sludge. At several locations, landspreading of dried sludge is done for

agricultural use as well as for use on municipal golf courses.

- Reuse of wastewater. Indirect reuse currently occurs at Birmingham because the input to the city's potable water works contains an appreciable amount of treatment plant effluent.

- Nitrification. At Birmingham, an activated sludge plant uses nitrification and third stage aeration.

- Pure oxygen systems. At Mobile, a 29 Mgd pure oxygen closed tank system is in the construction award stage.

- Deep oxidation ditch. This technology is used at several locations in the state.

The state is engaged in a research and development program which is examining the feasibility of upgrading lagoons with slow- and rapid-sand filters and rock filters. The state also maintains a laboratory for sampling, testing, and performing treatability studies for existing plants throughout the state. Responding to the need for innovation in collector system design, several manufacturers have been promoting vacuum systems, pressure systems, and lightweight collector pipe.

(3) Problem Areas

- Treatment needs of small communities. Most of Alabama's emerging problems focus on the small town. There are hundreds of lagoon systems in the state with a concentration in the southern part of the state. So much add-on material and equipment is needed to upgrade lagoons in many cases, that the costs exceed those for a new package-type plant. Soils in many areas require the use of vinyl or concrete liners, and add-on sand filters tend to be expensive. State sponsored research aims at developing a system for small towns which is relatively inexpensive to own and operate.

- Inflow/infiltration problems plague many municipal systems. The repair of existing

collection systems is expensive for smaller towns, but it is cheaper than constructing new systems.

- Alternatives for intermittent discharge to streams from municipal plants appears to warrant further study in the state.

3. MISSISSIPPI

Mississippi is very conservative in its approach to wastewater treatment, preferring to see a new process adopted elsewhere before it is tried in the state. There are nearly three hundred lagoon treatment facilities in the state, about 75 percent of which serve towns of less than 9,000 people. Emphasis is being placed on lagoon upgrading, overland flow, and land application of treated effluent.

The discussion below describes the treatment of innovative technology in the facilities plan approval process, gives examples of innovative technologies in use and examples of emerging wastewater treatment problems.

(1) The Approval Process

The state and EPA facilities plan reviewers consider the introduction of more types of innovative technology to be greatly needed. However, several important constraints prevail:

- The need for full-scale operating data on innovative plants
- Operator skill limitations
- Cost limits.

The state and EPA regional office are watching pilots, demonstrations, and new innovative projects in other states to gain data for guiding approval decisions in Mississippi. It appears that adequate data on innovative technologies with applicability in the state is lacking. As a consequence, needed innovations may have to be approved without the benefit of full-scale demonstration.

(2) Examples of Innovative Technologies

- Overland flow. Mississippi State University is researching overland flow at Faulkner, Mississippi. High-rate overland flow was proposed for the Town of Water Valley, but inadequate demonstration of the technology is preventing approval of the plan.

- Spray Irrigation. The facilities plan for Oakland incorporates this technique, and it is now under review.

- Lagoon upgrading. The Construction Grant Program has provided $100,000 for full-scale upgrading of a lagoon system by installation of sonic microstrainers.

(3) Problem Areas

Two major needs were identified:

- Improvement of availability and quality of data on innovative plants

- Development of lagoon upgrading alternatives which require minimal operating skill.

4. GEORGIA

This state generally has high stream capacity at most sites used for treated municipal wastewater discharge. Suitable land is available for sludge disposal by landfilling except near some of the larger cities. The terrain of the state varies from mountainous in the north to fairly flat in the southern areas near the ocean, and causes few serious impediments to the use of septic systems. Ocean discharges are prohibited.

The following discussion describes the general constraints to the introduction of innovative technology in the facilities plan approval process. It also provides examples of proposed and constructed innovative plants and examples of emerging wastewater treatment needs in the state.

(1) The Approval Process

The approval of facilities plans eligible for EPA grants is influenced greatly by the conservatism of all parties in the process: designers, municipalities, and state and EPA plan reviewers. Each party tends to be very cost conscious and usually insists on full-scale operating data from innovative technologies before they are recommended for use. While relatively few innovative processes have been proposed and built in the state, the attitude of state reviewers toward potentially cost-effective innovations is generally positive. One of the more serious constraints to the incorporation of innovative technology in design is the lack of familiarity of designers with the more innovative technologies. The low availability of data on such technologies contributes to this lack of familiarity. Another important constraint is operator skill levels. Designs must reflect the necessity to keep skill requirements low.

(2) Examples of Innovative Design

- Advanced dewatering techniques. Some plants use filter presses or slow-speed centrifuges.* Advanced techniques would be used more if operator skill requirements were not increased as a result.

- Steam gasification of sewage sludge and solid waste. This technology was proposed for a site in De Kalb County. Certain institutional questions could not be adequately addressed, and the project was dropped.

- Lagoon upgrading. At Adel, existing lagoons will be upgraded by dividing the lagoons into cells, adding mechanical floating aerators, and adding sand filters as a final stage. Mixed media filters have also been used in upgrading.

---

* Filter presses are used at a plant in De Camp County, at the South River plant in Atlanta, and at a plant in Savannah.

- Land application of treated effluent. Plants at Brazelton and Unicoy State Park are using this technique, but it is generally not well received.

- Single-stage nitrification-denitrification. Several designs have been made using this technology, but no plants have been built yet.

- Pure oxygen systems. This technology was demonstrated at Brunswick, Georgia.

- Physical/chemical treatment. In the Atlanta area, physical/chemical treatment is used to treat combined sewer overflows in an automated system. At a plant in De Kalb County, lime will be used as a coagulant and buffer.

(3) Problem Areas

The following needs were identified as growing in importance:

- Small community treatment needs. Upgrading alternatives for lagoons which keep operator skill levels to a minimum are needed.

- Urban runoff control and combined sewer overflow technology. Some alternative methods of controlling runoff and combined sewer overflow have been tested, but much more work needs to be done.

- AWT for wastewater reuse. Reuse may become a real need in the Atlanta area within ten years. In other areas of the state, reuse is not generally regarded to be economically justifiable for the next 25 years.

5. FLORIDA

Physical parameters important in wastewater treatment and handling, such as rainfall, stream flow, and soil type, vary widely across the state making it difficult to characterize Florida simply. However, one factor which overrides these other variables in determining the state's approach

to wastewater treatment is the extreme degree of politicization of the planning process. For example, Dade County is divided into so many small 401 districts that the implementation of regional approaches is effectively precluded.

(1) Approval Process

The State Department of Environmental Regulation in general, exercises a conservative approach to the use of new technologies. Usually state regulators need to see a new process operating somewhere on a waste flow comparable in size to that of the proposed project.

The Department of Environmental Regulation also prohibits the use of lagoons.

(2) Examples of Innovative Technologies

- Regional septage treatment. A plant is in operation in Brevard County.

- Landspreading of sludge. As an interim measure until an incinerator can be constructed, the City of Jacksonville is spreading its sludge over strip-mined land in an attempt at reclamation. Landspreading is not always a feasible alternative due to the high water table in many parts of the state and the possibility of leaching out heavy metals.

- Sludge dewatering techniques. Centrifuges for dewatering sludge were not seriously considered by the City of Jacksonville for its combined Sewer District Number 2 and Buckman Street Plant because of a lack of information on their performance and reliability.

- Wastewater reuse.

  - Spray irrigation is being used by the City of Tallahassee and at Bel Air and Lynn Haven although public resistance is being encountered.

- Injection of secondarily treated and disinfected effluent is being used to control salt water intrusion in West Palm Beach. Secondarily treated and disinfected effluent is injected in the Orlando area to protect local rivers and lakes and to recharge groundwater aquifers of the area.

- In Tampa a large AWT project has been completed using a three-stage sludge process.

(3) Problem Areas

Among the emerging wastewater treatment problems of Florida are:

- Ultimate disposal of sludge. Too few proven alternatives are available. Work is needed on making land disposal sites impervious to groundwater leaching of heavy metals.

- Operator skill levels. Skill levels are high in Dade County, for example, but are much lower in smaller communities. Either more skilled operators must be supplied or technologies must be greatly simplified.

- AWT for wastewater reuse. The need for advanced treatment is likely to become significant in such water short areas as Gainesville.

6. KENTUCKY

In this state, most of the larger cities are on the Ohio River, and secondary treatment is sufficient for meeting water quality criteria. Many smaller communities, however, are located on small streams where tertiary treatment is required to meet water quality standards. Such towns are hard pressed to find treatment systems which they can afford. The following discussion illustrates the extent to which innovative technologies are used to meet both big- and small-town treatment requirements. It also indicates emerging treatment problems.

(1) The Approval Process

The review of EPA grant-eligible POTW projects concentrated on the points of view of the EPA Region IV office and the consulting engineer. Both designer and Federal reviewers appear to be generally conservative in their approaches to design technology.

Consulting engineering firms practicing in Kentucky tended to exercise limited consideration of alternative technologies and their cost-effectiveness. The joint state — EPA Region IV approval process has resulted in the rejection of certain innovative proposed projects. Examples of such rejected projects were chemical conditioning of sewage using mine effluent and sludge, low flow stream augmentation, and discharge of waste activated sludge into a biologically inactive receiving stream.

The approval of certain innovative technologies, such as attached growth biological systems, for Step 2 Grants can be accelerated because design data is thought to be adequate and easily accessible.

In sum, conventional technologies predominate because of the conservative approaches to both design and approval.

(2) Examples of Innovative Technologies

Of the sixteen technologies considered in this study, two were reported to be in use: attached growth biological systems and deep oxidation ditches. The reported plants are:

- Attached growth media for biological nitrification. Rotating bio-disc-type plants have been proposed for towns in Scott County and for Bowling Green. At Clark County a bio-disc system with a hydrosieve was proposed.

- Deep oxidation ditch. This technology has been proposed in Louisville and Campbellsville.

(3) Problem Areas

The following important problems were stressed by the consulting engineers interviewed:

- Improved Inflow/Infiltration calculation procedures.
- Improved cost-effectiveness analysis techniques, such as computerized programs for use by both designers and EPA reviewers.
- Low-cost, low-energy treatment systems in smaller communities. Existing lagoon upgrading techniques are not thought capable of meeting relevant standards, and their use is discouraged by the regional office. Clearly, more work is needed in this area.
- Better understanding of the public health risks of chlorination and ozonation.
- Improved data base for innovative technologies.

7. TENNESSEE

Certain hydrologic and geologic characteristics are creating unique wastewater treatment needs in Tennessee. The large number of dams and impoundments on the TVA system have maintained the water table at such a high level that the state is largely water quality-limited. The possibility of effluent contact with drinking water supplies has led to a requirement to meet health standards through use of tertiary treatment of wastewater. The height of the water table can also lead to contamination of groundwater by leachate from sludge lagoons and landfills.

In many areas of the state, bedrock is only three to five feet below the surface. This effectively precludes the use of septic systems over a broad area.

Tennessee has four major population centers; Memphis, Nashville, Chatanooga and Knoxville, with the rest of the population generally scattered in rural communities of less than 20,000 people.

(1) Approval Process

Technical review of plans and specifications has been delegated to the state by EPA. Both agencies tend to be conservative in their funding of projects and

seem to have adopted a "wait and see" attitude toward new technology.

(2) Examples of Innovative Technologies

- Sludge dewatering techniques. Combination of filter presses and centrifuges is being considered for Chattanooga (decision pending).

- Sludge combustion. Memphis is considering mixing sludge with solid wastes and burning the slurry solution in a TVA power plant.

- Ozone. Earlier demonstration project at Murfreesborough used ozone as primary disinfectant with chlorine backup. Demonstration has not led to wide application because of economics. Project may get a second look if dechlorination becomes an issue.

- Lagoon upgrading. Rock filtration to meet secondary standards is being used at two towns, Halls and Gates.

- Use of pure oxygen. Pure oxygen in both open and closed tanks is being considered in Murfreesborough.

(3) Problem Areas

- Ultimate sludge disposal. Landfill and landspreading are not feasible in many areas of the state because of the high water table. Lagoons may escape this problem if impermeable liners are used to prevent leaching. Pyrolysis has not yet been proposed largely because of economics. Too few alternatives have been demonstrated at present.

- Advanced treatment for wastewater reuse. Problem of inadvertent contact between effluent discharges and drinking water supplies needs to be addressed. Possible alternatives need to be proved out to determine cost-effective solution.

- Operator skill levels. Even in the large cities the skill level of treatment plant operators is not sufficient for conventional system operation much less for advanced systems.

- Infiltration/inflow. Information is needed on techniques for controlling infiltration. Problem is causing an overtaxing of existing facilities.

8. NORTH CAROLINA

This state is in some ways more sophisticated than some of the other Southeastern States in that proposed treatment plant designs reflect increasing innovation, and skilled plant operators can be found when needed. The state has many textile plants which discharge to municipal systems, and extended aeration has been a popular way of handling the mix of textile and municipal wastes. The following discussion provides examples of the role of the state and EPA Region IV in the approval process for construction grants, identifies innovative technologies proposed and built, and points up emerging problems in POTW design in North Carolina.

(1) The Approval Process

Generally, the state, through its Department of Natural and Economic Resources, has adequate resources to review innovative proposed designs and has exercised control over the designs. For example, the state concluded that there was insufficient data to evaluate properly a proposed full-scale rotating bio-disc plant for the City of Charlotte. Consequently, the proposal was withdrawn, and plans for a pilot rotating-disc plant were drawn up and submitted.

Likewise, the EPA regional office has taken firm positions on the design of new plants. For the proposed pure oxygen system for Concord, it recommended significant changes in process train design as a condition for grant approval.

(2) Examples of Innovative Technology

Types of innovative plants used in North Carolina are described below along with the rationale for their use where possible.

- Landspreading of sludge. A trial study is in progress at the University of North Carolina, Raleigh.

- Sludge drying with nutrient addition for fertilizer use. This technique has been proposed for Winston-Salem.

- Attached growth media for biological nitrification. A proposed full-scale installation was rejected by the state, but a pilot plant has now been proposed.

- Pure oxygen systems. For Concord, a 24 Mgd plant has been proposed which incorporates lime treatment in the primary stage. The pure oxygen technology was proposed in order to meet nitrification and color removal requirements resulting from the high concentration of industrial wastes. Ozonation is also proposed for the plant because of its compatibility with the pure oxygen system.

  Another pure oxygen system 16 Mgd, has also been proposed for Fayetteville to replace existing trickling filters.

- Physical/chemical treatment. In Newton, North Carolina, a plant was proposed to meet color removal requirements. It incorporates lime treatment and nitrification.

- Advanced filtration. An airlock type filtration system was used in the 6 Mgd Albemarle extended aeration plant in order to meet stream limitations. The Fayetteville 16 Mgd pure oxygen system also uses this type of filter. The filter achieves some reaeration and has the advantage of reducing operation and maintenance costs.

(3) Problem Areas

- Treatment needs of small communities. Like many states, North Carolina needs treatment systems for small towns which can meet fairly strict effluent requirements while remaining simple enough to require only low-skill operators. A town with a population of 2,000 and a TKN requirements of 3 mg/l is a typical case.

- Nutrient removal. The state is also starting to face the problem of phosphorous removal. No limits have been set yet, but enforcement problems are already anticipated. The prevalence of textile plants in the state makes color removal technology a high priority.

- Sludge handling and disposal. Area of growing concern.

9. SOUTH CAROLINA

South Carolina, with its generally rural character, is very concerned with meeting standards on water quality-limited streams and rivers. Recently imposed requirements for nutrient removal from all discharges into lakes are expected to place heavy demands on the treatment facilities of small and large communities alike. The state has already completed a study to determine which water bodies are most susceptible to eutrophication from high nutrient levels. The state's revised emphasis on nutrient removal is expected to be reflected in the yet-to-be-completed facility plans for Charleston and Columbia, the state's most populous metropolitan areas. The impact of the nutrient removal requirement is likely to affect the smaller rural areas as well. For example, while some of the smaller cities, such as Florence, Georgetown and Spartanburg, use trickling filters or activated sludge systems, most of the state still employs lagoons.

The discussion which follows highlights some of the more important aspects of the approval process for EPA construction grants and provides examples of plants using innovative technology, and of emerging treatment problems.

(1) The Approval Process

The state, through its Department of Health and Environmental Control (DHEC), has the responsibility for certifying plans and specifications for EPA construction grant-eligible projects. DHEC has adequate resources for evaluating innovative project proposals, and, in some cases, it approves pilot plant testing for proposed projects prior to full-scale use. For example, a pilot plant at Sumpter, built in 1973, evaluated nitrification in an activated sludge process. The state is involved in several studies of innovative technologies. One is a joint project with Clemson University to explore lagoon upgrading alternatives. Another involves the study of overland flow treatment alternatives under an EPA grant. The results of these studies will be important in evaluating future facilities plans. For a developing lagoon upgrading technology, DHEC is starting to explore the availability of EPA funds for evaluation. The technology involves planting a unique grass in a shallow lagoon and managing the crop so that there is no discharge. The crop would be routinely harvested. Uses for the crop are currently being evaluated by at least one private firm.

(2) Examples of Innovative Technologies

Where possible, the rationale behind the selection of the reported innovative plants is given.

- Land treatment with effluent. At a community in Hilton Head in the Sea Pines Public Service District, spray irrigation of effluent on golf courses is in practice. This technology is proposed in the facilities plan for the Grand Strand area.

- Landspreading of sludge. Dried sludge use at golf courses is proposed in the facilities plan for the Grand Strand area. The facilities plan is currently the subject of an environmental impact statement. Dried sludge has been used on golf courses and municipal gardens at various locations with positive results in the state.

- Attached growth media for biological nitrification. Several plants using this technology have been built.

- Pure oxygen systems. A closed tank 4 Mgd system for Greenville is funded at the EPA Step 2 level. Open-tank oxygenation is not being used.

- Singe-stage nitrification. A pilot plant built at Sumpter in 1973 evaluated this technique in an activated sludge process. Applicability is currently under review in light of nutrient removal requirements.

- Steam conditioning of sludge. In Aiken County, some industrial and municipal waste streams now discharging to Horse Creek, will consolidate into a regional 20 Mgd system and discharge to the Savannah River. The technique of steam conditioning is aimed partially at reduction of high coliform counts. Also considered in reclamation of spent sand and gravel pits with sludge.

- Physical/chemical treatment. At Sumpter, a 6 Mgd plant, which receives heavy industrial loads, will receive chemical addition at the final clarifier to reduce suspended solids in the effluent.

- Deep oxidation ditch. This technology has been considered in several plans and proposed in at least one. Application to needs of rural communities is unknown.

(3) Problem Areas

Problems perceived in the near-term include those outlined below:

- General. The causes of lake eutrophication will need to be better understood as the state's nutrient removal requirements are implemented. In many cases, low cost innovations for nutrient removal could ease the financial burden of the affected communities.

- Lagoon upgrading alternatives. Becoming increasingly important, and might emerge as the state's highest priority.

- Energy consumption. Less energy-intensive systems essential.

- Alternate disinfection methods. Likely to emerge as a high priority item because of the need to protect the state's valuable shellfish resources and recreational fishing.

10. ILLINOIS

In this state there are about 2,600 municipal sewage treatment facilities. Although small town lagoons predominate, the state contains some of the largest plants in the U.S. Among the larger cities, Chicago has the most extensive waste treatment system, which is managed by the Metropolitan Sanitary District of Greater Chicago, MSDGC. Treatment plants in the district have been meeting secondary standards for about 25 years, so that most of its new projects are aimed at expansion of capacity and upgrading of treatment levels.

The State of Illinois Construction Grant Program funds 75 percent of the cost of plants not eligible for Federal funds. This program has been used to fund such projects as in-stream aeration of canals carrying large wastewater loads.

The following discussion addresses the role of MSDGC, the state, and EPA Region IV in the construction grant approval process. It also gives examples of innovative POTW projects in Illinois and of emerging problems in waste treatment. Discussions of the Chicago area are separated from those of the remainder of the state.

(1) The Approval Process

In the Chicago metropolitan area, MSDGC exercises firm control over the treatment technologies and plant design implemented. Overall, technology and design selection is heavily influenced by project cost, because the projects tend to be very large. MSDGC takes a hard look at alternatives available and implements

low risk, proven technology. Those innovations which might be significantly delayed in subsequent review by EPA Region V are not as favorably received by MSDGC as those which will clear the approval process expeditiously. MSDGC favors processes that lend themselves to retrofitting to its existing plants; technologies which might result in piecemeal approaches to areawide problems are quickly weeded out in the approval process. MSDGC also rigorously evaluates the cost-effectiveness of alternative technologies. For example, excessive pumping of sewage or process flows is closely examined for nonessential hardware. Projects which would result in relatively high O&M costs also are not favored. Since many of the more innovative technologies tend toward relatively high O&M costs compared to capital costs, they tend to be screened more closely than conventional methods. Lack of reasonably predictable O&M costs can seriously limit a process's chances of adoption. In sum, an innovative technology proposed to MSDGC must have wide applicability to the area, have relatively high potential for cost savings over conventional systems and have a record of proven large-scale performance.

In other areas of the state, municipalities and their consulting engineers are hard pressed to meet EPA's deadline of September 30, 1977, for secondary treatment. Facilities plans of many towns submitted to EPA are very similar to those of other towns. Although there are some indications of change, this practice of assembly line design has impeded the adoption of innovative processes. Projects approved by the state usually receive EPA approval.

(2) Examples of Innovative Technologies

The examples for the area served by the MSDGC are listed first, followed by examples of innovative POTW projects for the remainder of the state. Where possible, the rationale for the selection of the technology or design concept is discussed.

Projects in the MSDGC Service Area:

- Underground Conveyance of Combined Sewer Overflow. The Tunnel and Reservoir Plan (TARP) will use tunnels to convey overflow from a system of collectors to surface

storage reservoirs for treatment by existing and new plants.

- Landspreading of sludge. At a 10,000 acre site in Fulton County in Southern Illinois, land, including strip mined areas, is reclaimed using sludge in the fill material. Lagoons are used for storing sludge during winter months. At a plant on Chicago's North Side, sludge is also spread on 140 acres of crop land. Heavy metal ion uptake by various crops has been monitored.

- Dewatering of sludge. Using its own funds, alternative methods were evaluated by MSDGC including filter presses and high- and low-speed centrifuges. Results are currently under evaluation.

- Ozonation. At a former pilot plant at Hanover Park, MSDGC tested ozone as a disinfectant. While the economics of ozonation vs. chlorination proved unfavorable, the process will be more competitive if the need for dechlorination becomes pronounced.

- Single-stage nitrification. Favorable pilot plant studies led to the adoption of this technology by MSDGC.

- Attached growth media for biological nitrification. At the Village of Fox Lake, a 6 Mgd bio-disc plant is under construction.

- Wastewater distillation for potable reuse. A feasibility study of this technique is underway at Bensonville.

- In-stream aeration. MSDGC maintains that potentially significant cost savings can be effected by this technique to prevent downstream "DO" sag. State funds are being used to test it in certain canals.

- Pure oxygen systems. At Addison, Illinois, a 2 Mgd plant will operate in parallel with a 1 Mgd plant. Both plants will use the pure oxygen aeration system in closed tanks. EPA Step 2 approval has been secured.

Other Projects in Illinois

- Landspreading of sludge. At Galesburg, Illinois, one hundred acres will receive sludge treatment under an EPA Step 2 project.

- Lagoon upgrading. At various locations, this technique will utilize combinations of slow sand filters, rock filters, reaeration, and mechanical clarifiers to remove algae. Illinois specifies year-round discharge for lagoons.

- Attached growth media for biological nitrification. Four or five plants using this technology are operating or under construction. Manufacturers of related equipment have marketed extensively in the state, and proposals using the technique are submitted to the state almost daily.

- Advanced treatment for meeting drinking water standards. This technology has been considered in numerous facilities plans because of phosphorous standards, but no proposals have emerged because of public resistance..

- Pure oxygen systems. A 29 Mgd closed tank plant at Decatur, Illinois, has been built. Its experimental permit designation requires monitoring, and valuable data has been acquired. Open tank systems are regarded as experimental.

- Deep oxidation ditch. This technology has been proposed for several locations, where it competed favorably with lagoon upgrading.

  Potential problems are perceived from the lack of operating data and a reported potential for icing up in severe weather.

- Regional septage treatment. In the vicinity of Wheaton, DuPage County, 35,000 gallons of septic tank sludge will be treated by a wet air oxidation process.

(3) Problem Areas

For the larger metropolitan areas, especially Chicago, five major areas of concern have been identified.

- Sludge handling and disposal is becoming more difficult to manage on a large scale. For example, a suit has been filed to challenge the reclamation project in Fulton County. An environmental impact statement is being prepared as a result. Because of the large scale of sludge disposal, any savings in energy from innovations would be a boon to existing and projected operations.

- O&M costs. The high cost and intensity of labor in operation of complex POTW's presents a challenge to innovation in the form of labor reduction.

- Process control. Improved plant monitoring, control, and operation in general have the potential for both saving money and eliminating the need for some new treatment capacity.

- In-stream aeration of sewage and other "before-the-plant" technologies also have the potential for addressing one of the biggest emerging problems — scarcity of money resources — by reducing costs.

- Lagoon upgrading. In the remainder of the state, lagoon upgrading techniques appear to have the most widespread potential for providing smaller communities with low cost treatment facilities.

11. WISCONSIN

In this state, small communities are hard pressed to get treatment systems which they can afford. At the same time, they do not desire to assume the risk of trying new systems. Bigger cities typically use activated sludge processes, but they are being forced to consider innovative

technologies because of combined sewer overflow problems, permit requirements, and the scarcity of land needed for expansion of treatment capacity. The larger cities appear to have much room for improvement of operation and maintenance on older plants. The discussion which follows describes the role of innovative technology in the approval process for construction grants, gives examples of innovative treatment plants, and points out emerging waste treatment problems.

(1) The Approval Process

The merits of innovative projects submitted to the state and EPA Region V for review are considered on a case by case basis. Adequate operating data on full-scale systems greatly increases the chance of a project's approval. Implementation is recommended when real cost savings are likely to result. The rate at which innovative technologies are being proposed in facility plans is increasing.

In addition to its role as a reviewer of facility plans and specifications for EPA construction grant projects, the state has its own grants program. This program is being revamped in order to channel state funds to projects more in accordance with its priorities.

(2) Examples of Innovative Technologies

For the technologies discussed below, the rationale behind the selection of a technology is provided where possible.

- Landspreading of sludge. A high percentage, perhaps 80 - 90 percent of all communities in the state, use this method for disposal of sludge. Sludge containment is required in the winter months. Madison is considering landspreading in detail for a proposed 60 Mgd plant. Milwaukee has a milorganite production facility.

- Attached growth media for biological nitrification. This technology is readily accepted for towns of 10 - 30,000 population.

A number of plants are built, in construction, or in design, and more are proposed. An EPA demonstration plant for the technology was built in 1970 at Pewaukee. The state encourages the technology and finds that for adequate nitrification a two-stage sludge system appears necessary.

- Deep oxidation ditch. Several facilities have been built and more are proposed. A plant built at Beloit in 1968 and one built at Jaynesville in 1970 have produced favorable results.

- Lagoon upgrading. Many existing lagoons have been upgraded with aeration. Numerous proposals for lagoon upgrading are being made, and the state encourages the practice.

- Pure oxygen systems. At Fondulac, a plant using closed-tank technology is under construction. At Kaukauna, a similar plant is in the design phase. For one of these plants, ozonation was considered but costs were too high. Open-tank oxygenation is not being proposed.

- Physical/chemical treatment. A few installations have used this technology, usually smaller plants of large municipal treatment systems aiming at specific problems such as industrial waste loads.

- Land application of treated effluent. About 80 to 85 communities are using this technology, and some large cities are considering it.

(3) Problem Areas

- Ultimate disposal of sludge. Sludge handling and disposal is becoming more expensive as energy costs go up. Plants built in the 1970's are already looking at alternative methods.

- Treatment needs of small communities. Most small communities will start facilities

planning during 1976. Timely data on low cost innovations, including lagoon upgrading technologies is needed. EPA is funding some collection and treatment systems in economically depressed areas, and this practice should help meet the great need for low cost systems for small communities.

- Population and industrial growth are potential problems, because growth will make it more difficult to preserve any water quality gains which have been made. Overcoming the current resistance to regionalization of treatment in some areas might prove to be a boon to both cost effectiveness and innovation in design.

- The scarcity of land for plant expansion and big city sludge disposal and the demand for alternative use of lands used by older treatment works are problems of increasing importance.

- Recovery of resources from raw wastewater and from treatment processes can be expected to grow in importance as can attention to technologies for reuse of treated wastewater.

12. MICHIGAN

The wastewater treatment needs of the smaller communities in the state are receiving more attention than in the past because of the recent budget allocation in EPA construction grant funds to small communities. About 90 percent of the state's stream-miles are effluent-limited, but small communities on the remaining ten percent of stream-miles which are water quality-limited, tend to have difficulties in meeting treatment requirements. Towns of less than 500 people generally use lagoons for sewage treatment, and there are hundreds of such lagoons. Towns of more than 500 people generally employ some variation of the activated sludge process. The largest cities, including Lansing and Detroit, have large-scale treatment systems with chronic problems such as combined sewer overflows and increasing operating and maintenance costs.

The following sections discuss the approval process for proposed plants which are eligible for EPA construction grants, examples of innovative plants which are proposed or built, and problems in waste treatment which are gaining in importance.

(1) The Approval Process

In Michigan, the Department of Natural Resources has the responsibility of reviewing proposed plans for EPA grant-eligible plants. It will shortly be granted full formal responsibility by the EPA for the review of plans and specifications for such plants. The department is relatively young and is generally considered to be aggressive and forward looking, and capable of evaluating and recommending new municipal wastewater treatment technologies. Full-scale operating data is preferred by the Department as the basis for proposed innovative plants. Communities are aided in meeting their share of EPA-funded plant costs by a five percent contribution by the state. As more innovative plants are proposed and built, the state faces the problem of getting adequate data and results of operation out to those who demand it, particularly consulting engineers.

EPA Region V expects proven technologies to be proposed, and generally there is little interchange between the state and EPA on developments in innovative technology. Region V has experienced on several occasions, suits by manufacturers of wastewater treatment equipment who claim inadequate evaluation of their products in facilities plans approved by EPA. A short-term goal of Region V is to promote the use of value engineering in the engineering of facilities plans.

(2) Examples of Innovative Technology

In the following discussion of innovative treatment plants, the rationale for the selection of the chosen technology will be given when possible:

- Landspreading. This technique was proposed at three locations: Lake Linden, Manistique, and Clinton. It has been used in a major project at Muskegan, but most sludge is incinerated or landfilled. Preventing the

more widespread use of this technique are the problems of heavy metals and virus control.

- Attached growth media for biological nitrification. Bio-disc-type units have been proposed at Cheboygan, Jonia, and Clinton. Under construction is a 2 Mgd plant at Cadillac.

- Advanced dewatering techniques. At Holland, Michigan, centrifuges will be used at a 3 Mgd plant. At Selene, a 1 Mgd plant will use filter presses. Plants at Big Rapids and Luce County will also use advanced techniques.

- Ozonation. A pilot plant at Wyoming, Michigan, was built under an EPA R&D grant. Full scale plants have been proposed for Grand Rapids and Grosse Ile. In general, solids problems tend to inhibit the use of ozonation in the state.

- Lagoon upgrading. There are hundreds of lagoons in the state, and attempts to upgrade many of them have been made. Secondary treatment can usually be achieved with the usual exception of not satisfying solids removal requirements. A typical problem in upgrading is that the addition of such equipment as sand filters or mixed media filters tends to raise operator skill requirements significantly. Some lagoons are aerated and used for treatment prior to land application. Discharges from lagoons are limited to three months of the year, during spring and fall. Upgrading was proposed recently at Elk Rapids.

- Pure oxygen systems. Based on a scale-up from a pilot plant, a 450 Mgd closed-tank system is being designed for Detroit.

- Single-stage nitrification-denitrification. A plant approved for Owosso is the only example of the technology in the state.

- Physical/chemical treatment. A plant at Owosso has been approved using this

technology. Physical/chemical treatment has been considered in several instances but its high cost and high resource commitment erode its competitiveness.

(3) Problem Areas

The following problems were identified as growing in importance in the state:

- Small community treatment needs. Many current porposals for upgrading lagoons involve additions which are too expensive for many samll towns. They tend to require substantially higher operator skills as well. Compounding the problem is that many towns seek the services of some of the smaller consulting engineering firms who have only limited experience with upgrading techniques. Moreover, lagoon upgrading has only recently gained attention, and relatively few upgrading techniques are known.

- Control of combined sewer overflows. In some of the larger cities, such as Lansing, combined sewer overflows negate the benefits achieved most of the year with tertiary treatment. Some solutions have been tested and some costs determined, but more alternatives need exploring.

- Energy consumption. Some existing disposal methods such as incineration of sludge consume large amounts of increasingly costly natural gas. Many treatments processes, as well are energy intensive, such as those which use pumping, and will warrant increased attention to the potential for energy reduction.

- Ultimate disposal of sludge. Among the areas of waste treatment design, sludge disposal is perhaps the most conservative. Existing alternatives need to be proven out for full-scale application.

13. OHIO

While the treatment problems of large metropolitan areas in Ohio are significant, the need to meet sewage treatment requirements is especially pressing for the smaller cities and towns. This is because most streams are water quality-limited as are most discharges to Lake Erie.

The following discussion describes in a general way the state's role in approving innovative technologies for EPA construction grants, gives examples of innovative plants which have been proposed or built, and points to emerging problems in municipal waste treatment.

(1) The Approval Process

The Ohio EPA has the responsibility for reviewing proposed facilities plans for treatment plants eligible for Federal EPA construction grants. In dealing with proposed projects of an innovative nature, the state agency prefers designs based on full-scale operating data for proven technologies. The agency tends to work closely with the designers of innovative plants, but maintains a conservative posture. Each innovative technology is reviewed on a case by case basis as projects using that particular technology are submitted. In contrast to other states, treatment plant construction is financed through loans made by the Ohio Water Development Administration, rather than through construction grants.

(2) Examples of Innovative Technologies

For the following innovative treatment plants, the rationale behind the selection of the technology is given where possible:

- Regional septage treatment. A plant designed to handle septic tank waste sludge, as well as normal domestic sewage has been proposed for a community in Geauga County.

- Landspreading of sludge. At a 1,000 acre site in Montgomery County, landspreading of sludge is being practiced. The technique

has been proposed at Lucas County and at Lima. Landspreading is not feasible in many areas of the state because of scarcity of suitable land and the potential for contamination of soil with heavy metals and nitrate leaching.

- Attached growth media for biological nitrification. Bio-disc type units have been proposed for the Fish Creek project in Summit County and for a 1 Mgd plant in Ashley, Ohio. In Batter County, a plant has EPA Step 2 approval. Among designers and state reviewers, the technology is generally considered to be well developed and suitable for installation by small- to medium-sized communities.

- Lagoon upgrading technologies. A recently proposed project was the addition of aerating equipment to a lagoon in Tuscarawas County. Other techniques for upgrading which have been considered are the addition of sand filters, mixed-media filters, and microstainers. A few consulting engineering firms are investigating the feasibility of automating the operation of upgraded lagoons to reduce the skill level required for operation.

- Physical/chemical treatment. This technique was recently proposed for a plant at Paynesville, Ohio. At Cleveland's 50 Mgd Westerly plant, chemical addition in the primary stage is used for coagulation, and carbon adsorption is used in later stages. These techniques were chosen to meet the strict water quality criteria for discharge to Lake Erie. Cleveland's Rocky River plant, 10 - 15 Mgd, uses similar physical/chemical processes.

(3) Emerging Needs in Wastewater Treatment

Five major problem areas which are growing in importance were identified:

- Combined sewer overflow. This problem plagues many cities along the Great Lakes.

Many of the alternative solutions considered require large commitments of land and money. A greater number of alternatives need to be identified.

- AWT for wastewater reuse. No real need for reuse of wastewater exists in the state at the present time. For the foreseeable future, only indirect reuse for potable supplies will be implemented.

- Detection of carcinogens. As the interest of the public and regulators grows as to the presence of potentially carcinogenic agents in potable water, the discharges of treated wastewaters containing such agents will need to be monitored as accurately as possible. Work will be needed as well to establish the limits to the monitoring of carcinogens in waste streams, prior to the adoption of regulations on the discharges.

- Alternative methods for disinfection. The problems of high chlorine residuals and difficulties in removing coliforms have spurred the need to consider dechlorination. The costs of adapting plants for dechlorination and operating costs are increasing and provide stimulus to the consideration of alternatives such as ozonation.

- Ultimate disposal of sludge. The most common methods of sludge disposal in the state, incineration and landfilling, are yielding to consideration of alternative methods as the costs of fuel and air quality controls increase and as suitable landfill sites became more scarce. At present, landspreading meets with public resistance even where suitable land is available. Composting has severe limitations in the state because of the apparent lack of market for the compost product and because of the state's climate. Steam gasification of sludge and sludge combined with solid waste is gaining in general acceptance as a workable technology, but no proposals for its implementation are being submitted. Pyrolysis is generally regarded as requiring more research and development.