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Multibillion Dollar Construction Grant Program: Are Controls Over Federal Funds Adequate? CED-77-113; B-166506. September 12, 1977. 41 pp. + 3 appendices (19 pp.).

Report to the Congress; by Elmer B. Staats, Comptroller General.

Issue Area: Environmental Protection Programs: Federal Controls Over Wastewater Treatment Construction Grant Funds (2202).
Contact: Community and Economic Development Div.
Budget Function: Natural Resources, Environment, and Energy: Pollution Control and Abatement (304).
Organization Concerned: Environmental Protection Agency.
Congressional Relevance: House Committee on Public Works and Transportation; Senate Committee on Environment and Public Works; Congress.
Authority: Federal Water Pollution Control Act Amendments of 1956 (P.L. 84-660). Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500). P.L. 94-447. P.L. 95-26.

Although the Environmental Protection Agency (EPA) is providing billions of dollars in grants each year to build publicly owned wastewater treatment facilities, the Congress does not have assurance that these are properly planned, designed, and constructed. Grantees, usually municipalities contributing from 5% to 25% of project funding, are expected to provide such assurance, but generally they rely on consulting engineers to develop accurate, complete, and cost effective designs. They rely also on the engineer and construction contractor to assure that construction complies with detailed plans and specifications. Findings/Conclusions: Because EPA lacks criteria on Federal funding of aesthetic features in waste treatment plants, plants have been constructed with a wide variety of architectural features ranging from relatively austere buildings to plants with elaborate and costly aesthetic features. Of 24 operational waste treatment plants reviewed, 5 could not meet design criteria because of design deficiencies. Seventeen of the 48 projects reviewed experienced delays, increased costs, and inferior workmanship as a result of ineffective controls during the construction phase. If properly enforced, recently promulgated EPA regulations that establish criteria for determining whether a contractor is responsible should help to assure selection of qualified contractors. Recommendations: The Administrator, EPA, should establish criteria restricting Federal grant participation in the cost of ornamental or aesthetic features of waste treatment projects. The Administrator should: amend EPA regulations to require that as a grant condition the grantee shall be subject to EPA approval of the selected engineer; disapprove Federal funding for future construction projects intended to correct problems resulting from design deficiencies; provide technical assistance to grantees to identify the reasons waste treatment facilities

do not meet design criteria and encourage grantees to hold the responsible party accountable for damages; develop a clear definition of the resident engineer's duties and responsibilities; and insure that consulting engineers are held responsible for the poor performance of their resident engineers. (Author/SW)

REPORT TO THE CONGRESS

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

Multibillion Dollar Construction Grant Program: Are Controls Over Federal Funds Adequate?

Environmental Protection Agency

Grantees--usually municipalities--are expected to assure that waste treatment facility projects, financed largely with Federal funds, are properly planned, designed, and constructed. GAO's review of 48 projects showed that:

--Lack of Agency criteria has resulted in waste treatment plants with a variety of architecture including elaborate and costly aesthetic features.

--Facilities have been constructed with design deficiencies which, if left uncorrected, prevent facilities from providing adequate treatment and/or create operation and maintenance problems.

--Despite Agency safeguards intended to reduce construction problems, many projects experienced delays, increased costs, and inferior workmanship.

CED-77-113

SEPTEMBER 12, 1977

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

B-166506

To the President of the Senate and the
Speaker of the House of Representatives

This report discusses the adequacy of controls over the design and construction of municipal waste treatment facilities assisted with Environmental Protection Agency grants.

We made this review because the Agency provides several billions of dollars in Federal grant funds each year to build waste treatment facilities. The grantees are usually municipalities which are expected to insure that the facilities are properly planned, designed, and constructed.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53) and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget; the Chairman of the Council on Environmental Quality; and the Administrator, Environmental Protection Agency.

Elmer B. Staats
Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

MULTIBILLION DOLLAR CONSTRUCTION GRANT PROGRAM: ARE CONTROLS OVER FEDERAL FUNDS ADEQUATE?
Environmental Protection Agency

D I G E S T

Although the Environmental Protection Agency is providing billions in grants each year to build publicly owned wastewater treatment facilities, the Congress does not have assurance that these are properly planned, designed, and constructed.

Grantees--usually municipalities contributing from 5 to 25 percent of project funding--are expected to provide such assurance, but generally they rely on consulting engineers to develop accurate, complete, and cost-effective designs. They rely also on the engineer and construction contractor to assure that construction complies with detailed plans and specifications. (See pp. 3 to 4.)

AESTHETIC FEATURES IN TREATMENT PLANTS

Lack of criteria by the Environmental Protection Agency has resulted in the Federal funding of waste treatment plants with a variety of architectural features, ranging from relatively austere buildings to plants with costly aesthetic features.

Expensive and unnecessary aesthetic features in plants should not have been eligible for Federal money, such as

--stucco exterior, red tile roof, and decorative arches;

--reflecting pool; and,

--mosaic tile fountain. (See pp. 6 to 12.)

Recommendation

The Administrator, Environmental Protection Agency, should establish criteria restricting Federal grant participation in the cost of ornamental or aesthetic features of waste treatment plants that do not contribute to the functional use of the facility. (See p. 12.)

CONTROLS DURING DESIGN PHASE

Since the Agency's program controls do not assure that project designs are complete and accurate or that plants, when constructed, will provide expected levels of pollution treatment, waste treatment facilities have been constructed with design deficiencies. If uncorrected, they prevent facilities from providing adequate treatment and/or create operation and maintenance problems. Of 24 operational waste treatment plants GAO reviewed, 5 could not meet design criteria because of design deficiencies. Those deficiencies noted during GAO's review included:

--Lack of grit chambers in one plant servicing a combined sewer system. The plant became inoperative because of large quantities of grit flowing into the plant.

--Three years after completion a plant became overloaded and was unable to meet secondary treatment standards because of inadequate design.

--An unreliable sludge-handling and disposal system contributed to poor plant performance, and the capacity of a trickling filter was reduced because of an error in an engineer's drawings.

The quality of a design depends primarily on the experience, skill, and capability of the consulting engineer; however, until recently the Agency provided no guidance concerning engineer selection. It left this decision to grantees, several of whom selected engineering firms with little regard to their qualifications. When deficiencies are corrected, it is usually done with Federal or local funds rather than at the expense of the party responsible for the deficiency. (See 13 to 27.)

RECOMMENDATIONS

The Administrator, Environmental Protection Agency, should:

--Amend Agency regulations to provide that as a grant condition the (1) grantee shall document and submit to the Agency the selected consulting engineers' qualifications and (2) Agency will have the right to disapprove the selection.

--Disapprove Federal funding for future construction grant projects that are intended to correct problems resulting from design deficiencies unless the grantee has taken all reasonable measures to hold the consulting engineer accountable for damages.

--Provide technical assistance to grantees in identifying the reasons waste treatment facilities do not meet design criteria and encourage grantees to hold the consulting engineer accountable for damages resulting from his work. (See p.27.)

CONTROLS DURING CONSTRUCTION

The Agency has instituted several safeguards to reduce construction problems. It requires that grantees award construction contracts to the low responsive, responsible bidder; the successful bidder must be bonded; and grantees must provide supervision to insure construction conforms with Agency- and State-approved plans and specifications. The States and the Agency also inspect projects during construction.

These safeguards, however, are often ineffective. Grantees award construction contracts despite doubts about contractor qualifications; grantees seldom look to bonding companies for relief in instances of poor contractor performance; engineering supervision does not assure that the contractor complies with plans and specifications; and State and Agency site visits generally are infrequent.

Seventeen of the 48 projects included in GAO's review experienced delays, increased costs, and inferior workmanship as a result of ineffective controls during the construction phase. On most of the 17 projects there were indications before contract award that the construction contractor might perform poorly or indications that more effective engineering supervision during construction could have prevented or alleviated problems that occurred during construction.

If properly enforced, recently promulgated Agency regulations that establish criteria for determining whether a contractor is responsible should help to assure selection of qualified contractors and thereby reduce the incidence of construction problems. (See pp. 29 to 40.)

Recommendations

The Administrator, Environmental Protection Agency, should:

--Disapprove Federal funding for future construction grant projects that are intended to correct problems resulting from negligent performance of construction contractors unless the grantee has taken all reasonable measures to hold the contractor responsible for damages.

--Provide technical assistance to grantees to find out why construction problems exist and to encourage grantees to hold the responsible party accountable for damages.

--Develop a clear definition of the resident engineer's duties and responsibilities, including the authority to interpret plans and specifications and to determine acceptability of all work, and the obligation to suspend work when necessary to protect the grantee. Include this definition in grantee contracts for resident engineering services and construction contracts.

--Insure that consulting engineers are held responsible for the poor performance of their resident engineers. (See p. 41.)

AGENCY COMMENTS NOT FURNISHED

GAO requested written Agency comments in a letter dated January 14, 1977. Although several meetings were subsequently held with Agency officials to discuss the report findings and recommendations, the Agency has not submitted written comments. To avoid further delay, GAO is issuing the report without an official Agency expression of position.

Contents

ABBREVIATIONS

BOD	biochemical oxygen demand
EPA	Environmental Protection Agency
GAO	General Accounting Office
mgd	million gallons per day
VE	value engineering

GLOSSARY

Advanced waste treatment	Wastewater treatment beyond the secondary or biological stage that includes removal of nutrients, such as phosphorus and nitrogen, and a high percentage of suspended solids. (Also called tertiary treatment.)
Biochemical Oxygen Demand (BOD)	A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. Large amounts of organic waste use up large amounts of dissolved oxygen, thus the greater the degree of pollution, the greater the BOD
Combined sewers	A sewerage system that carries both sanitary sewage and storm water runoff.
Digester	In a wastewater treatment plant, a tank that decreases the volume of solids and stabilizes raw sludge by bacterial action.
Effluent	The liquid that comes out of a treatment plant after completion of the treatment process.
Force main	A pipeline on the discharge side of a water or sewage pumping station, usually under pressure.
Grit chamber	In a waste treatment plant, a tank where sand, grit, cinders, and small stones are allowed to settle to the bottom and are then disposed of.
Municipality	A city, town, borough, county, parish, district, association, or other public

	body or Indian tribal organization having jurisdiction over disposal of sewage, industrial wastes, or other wastes.
Primary treatment	The first stage in wastewater treatment in which substantially all floating or settleable solids are mechanically removed by screening and sedimentation.
Resident engineering	Used in this report to denote construction supervision. The individual performing this function may not in fact be an engineer and may be called a resident inspector, resident representative, resident engineer, or some similar term.
Secondary treatment	As generally defined by EPA, secondary treatment will remove at least 85 percent of the biochemical oxygen demand in municipal sewage.
Sludge	Solid matter removed from sewage during wastewater treatment.
Suspended solids	Small particles of solid pollutants in sewage that resist separation from the water by conventional means.
Vacuum filter	A sludge-dewatering device consisting of a cylindrical drum covered with filtering material, such as cotton, felt, or nylon. The drum revolves, partially submerged in the liquid sludge, and a vacuum is maintained under the cloth to extract moisture. The sludge cake is scraped off continuously.

CHAPTER 1

INTRODUCTION

The Federal Water Pollution Control Act Amendments of 1956 (Public Law 84-660) created the waste treatment construction grant program. The act authorized grants for constructing waste treatment facilities to prevent untreated or inadequately treated sewage or other waste discharges into waterways. The grant recipient--usually a municipality--received Federal assistance of 30 percent of the project costs. Subsequent amendments to the act increased the Federal share of project costs up to a maximum of 55 percent, and the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) established the Federal share at a flat 75 percent of allowable project costs.

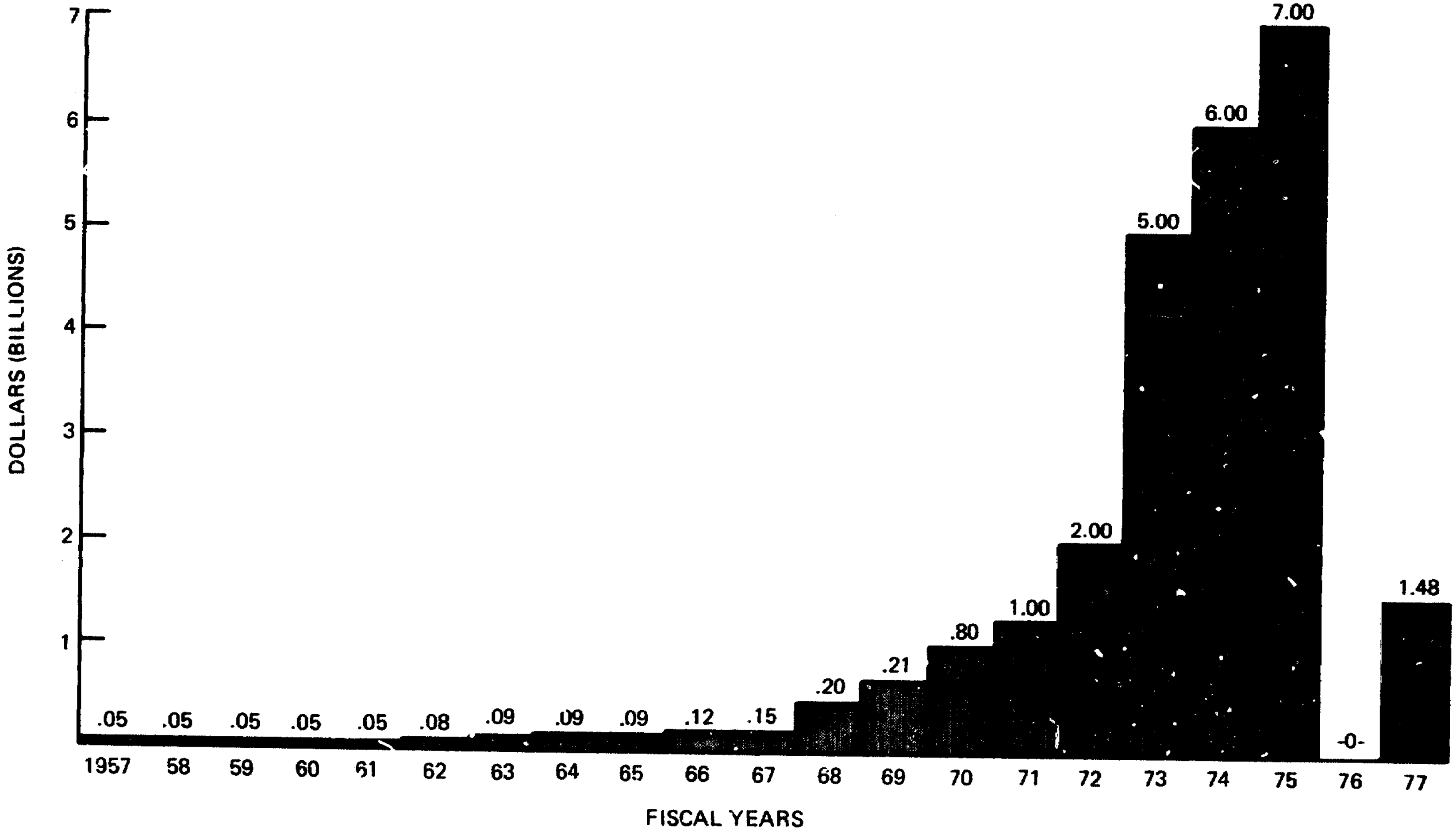
The 1972 amendments established a national goal of eliminating the discharge of pollutants into navigable waters by 1985 and an interim goal of providing water quality sufficient for the protection of fish, shellfish, wildlife, and recreation by 1983.

The Congress authorized $18 billion for fiscal years 1973 through 1975 for constructing waste treatment facilities. As of April 30, 1977, about $4.8 billion was still available. Public Law 94-447, dated October 1, 1976, and Public Law 95-26, dated May 4, 1977, provided additional construction grant funds of $480 million and $1 billion, respectively.

From fiscal year 1957 to March 31, 1977, Federal funds totaling about $19.9 billion had been obligated under the waste treatment construction grant program.

Before 1973, Federal appropriations for waste treatment facilities were relatively small (see graph on following page)--particularly compared to cost estimates of the goals of the 1972 amendments. In a February 1977 report to the Congress, the Environmental Protection Agency (EPA) estimated that it would cost $95.9 billion to control pollution from municipal sources excluding storm water runoff. The fiscal year 1978 budget recommended a 10-year funding plan of $4.5 billion a year for the construction grant program.

CONSTRUCTION GRANTS FOR MUNICIPAL WASTE WATER TREATMENT WORKS APPROPRIATIONS OR CONTRACTING AUTHORITY[1]



FUNDS ILLEGALLY IMPOUNDED IN FY 1973-1975 WERE RELEASED FOR USE IN FY 1976 BUT WERE ACTUALLY AUTHORIZED IN PREVIOUS YEARS.

[1] THE 1972 AMENDMENTS CHANGED FUNDING METHOD FOR FISCAL YEARS 1973-75 FROM APPROPRIATIONS TO CONTRACT AUTHORITY.

THE CONSTRUCTION GRANT PROGRAM

EPA administers the construction grant program and awards grants from funds allotted to each State on the basis of need. The States, within parameters established by the 1972 amendments and EPA, determine how the funds will be distributed to municipalities. Twenty-eight States supplement the Federal grant with State funds ranging from 5 to 20 percent of eligible project costs. (See appendix I for listing of State assistance programs.)

Although EPA and States may jointly bear up to 95 percent of the cost of waste treatment facilities, municipalities are responsible for executing the grant program. Construction of a waste treatment facility is, however, generally a large, complex project requiring procurement and technical expertise. Consequently, most municipalities rely totally on consulting engineers for planning, designing, and supervising construction of treatment facilities.

Prior to the 1972 amendments, EPA's first involvement in a project was to review the final detailed design of the proposed treatment facility. A preliminary engineering report, which included cost comparisons of several alternate processes, usually accompanied the design submittal. A single grant was awarded for the construction of the treatment facility including costs already incurred for planning and design.

With passage of the 1972 amendments, EPA structured the program to award grants in three successive steps--preparing facility plans, preparing detailed designs and specifications, and constructing the facility. Each step requires a separate or amended grant application and EPA and State approval.

The facilities plan--an expanded and more formalized document than its predecessor preliminary engineering report--includes an analysis of alternative solutions to a particular pollution problem with a recommendation of the most cost-effective and environmentally sound approach. For example, alternatives for an existing facility to meet higher treatment levels might include improving existing operation and maintenance procedures, upgrading the existing facility, building a new facility, or combining several plants into a regional facility. The grantee (usually through a contractual relationship with its consulting engineer) develops anticipated costs for the various alternatives, considers environmental and social impacts, and holds public hearings. Alternatives are then ranked and a preliminary design is prepared for the recommended solution.

After the States and EPA approve the facilities plan, the grantee's consulting engineer usually develops detailed drawings and specifications.

Once the detailed design is approved by the State and EPA, the project is formally advertised, bids evaluated, and a construction contract awarded by the grantee to the lowest responsive, responsible bidder. The grantee must also provide engineering supervision to insure that construction complies with the approved plans and specifications. Usually the grantee's consulting engineer performs this service for a fee.

The following table shows the progression of a typical project through the construction grant cycle.

	STEP I	STEP II	STEP III
Preapplication stage	Facilities planning stage	Design stage	Construction stage
1. State places project on priority list. 2. Applicant selects consultant. 3. Applicant and consultant have preapplication conference with State and EPA.	1. Application for Step I grant submitted to State and EPA for review and approval. 2. Consultant prepares facilities plan. 3. EPA and State review and approve facilities plan. 4. EPA prepares environmental impact statement, if necessary, or declares none is needed.	1. Consultant generally prepares materials for Step 2 grant agreement; submits it to State and EPA for approval. 2. Consultant prepares plans and specifications. 3. EPA and State review and approve project plans and specifications.	1. Consultant generally prepares materials for Step 3 grant agreement; submits it to State and EPA for approval. 2. Grantee advertises for construction bids, selects responsive low bidder, submits all bids in tabular form to State and EPA for approval, and upon approval awards contract. 3. Project is constructed. 4. EPA and State conduct final inspection. 5. EPA conducts final audit and makes final payment.

Environmental Protection Agency, "Review of the Municipal Waste Treatment Works Program," November 30, 1974

SCOPE OF REVIEW

We reviewed the extent of managerial controls to assure that waste treatment facilities are adequately planned, designed, and constructed. We examined 48 projects in California, Kansas, Massachusetts, Missouri, Nevada, New Hampshire, Rhode Island, and Vermont. Project selection was limited, with two exceptions, to grant awards made no earlier than fiscal year 1970 and included grants made under the 1972 amendments as well as preceding legislation.

We reviewed construction grant program administration in the eight States and at EPA headquarters and EPA Regions I (Boston, Mass.), VII (Kansas City, Mo.), and IX (San Francisco, Calif.). We examined EPA, State, municipal, and consulting engineer records and documents. We interviewed officials of municipalities and consulting engineering firms responsible for project design and construction monitoring. We also met with EPA officials on several occasions, at their request, to discuss action necessary for greater control over the construction grant program.

We were assisted by Dr. Richard I. Dick, Professor, Department of Civil Engineering, University of Delaware and the staff of Gale Engineering Company, Inc., Braintree, Massachusetts.

On January 14, 1977, we forwarded a draft of this report to EPA and requested written comments within 30 days. Although we met several times with Agency officials to discuss the report findings and recommendations, the Agency has not submitted written comments. To avoid further delay, we are issuing the report without an official Agency position.

CHAPTER 2

ARE AESTHETIC FEATURES IN WASTE TREATMENT PLANTS NECESSARY?

EPA has funded waste treatment plants with a wide variety of architectural designs ranging from relatively austere buildings to plants with elaborate, costly aesthetic features which do not contribute to the functional use of the plant. Construction plans and specifications prepared by the grantee should be reviewed to insure that waste treatment plants are designed at lowest cost.

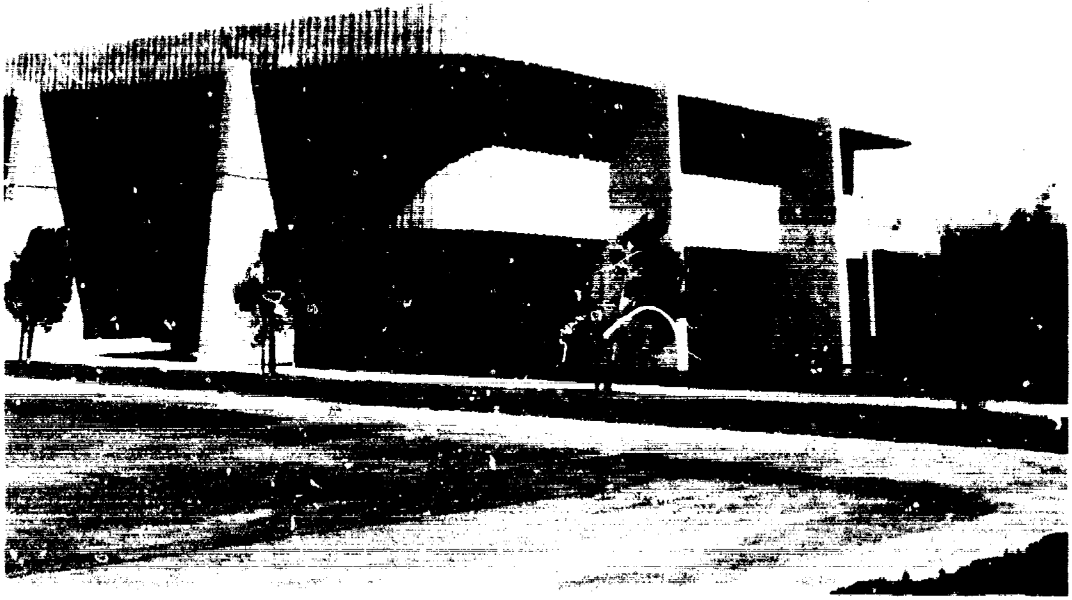
LACK OF CRITERIA FOR AESTHETIC FEATURES

EPA's regulations specify that its regional offices shall determine that the design, size, and capacity of a treatment works are cost-effective and relate directly to the needs served by the works. EPA has issued guidance on the eligibility of certain miscellaneous project costs, such as facility site-related costs; equipment, tools, and parts; and indirect grantee costs. However, EPA has not established criteria on using Federal grant moneys for ornamental or aesthetic architectural features and has relied on grantees to design the most cost-effective facility.

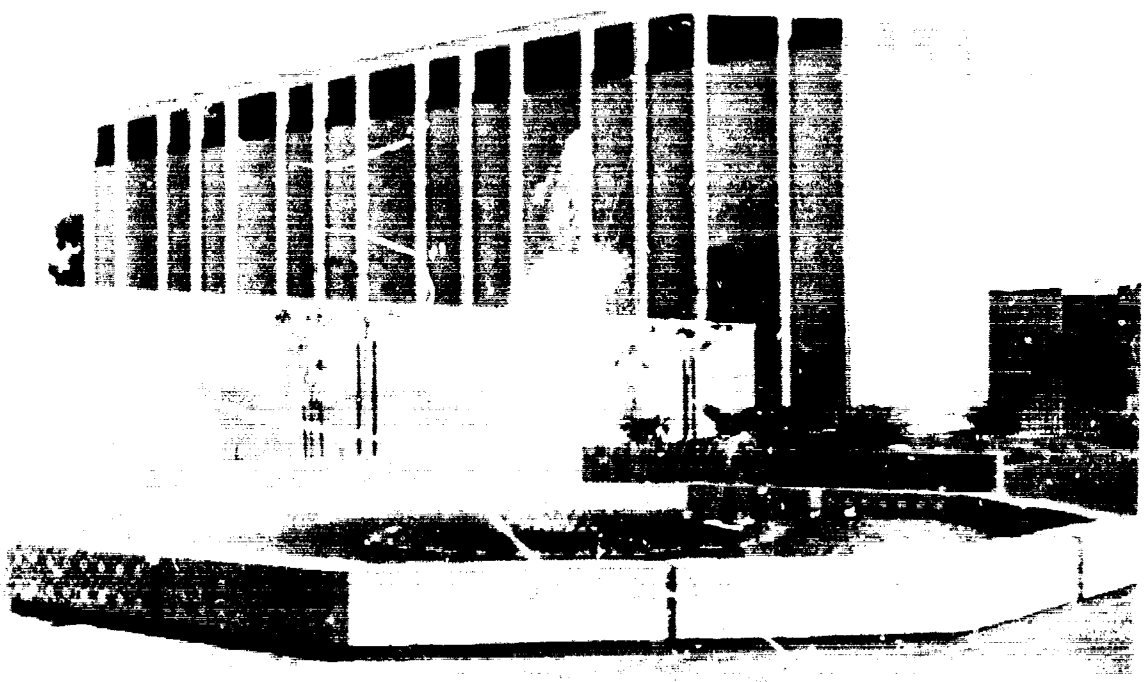
In Region VII, the treatment plants included in our review were factory-like facilities and relatively austere. In contrast to the treatment plants in Regions IX and I, the buildings were of basic rectangular design and were constructed of painted concrete block, concrete block with brick veneer, or preengineered steel. (See contrasting photographs, pages 7, 8, and 9.)

In contrast, EPA Region IX had a treatment facility overlooking the Pacific Ocean that looked like an old Spanish mission with its stucco exterior, red tile roof, decorative arches, and open wood-beamed ceilings. (See photograph.) The entire facility is surrounded by a 15-foot stucco wall capped with red tile. The wall alone cost $200,000. Most of the surrounding structures are small, older houses of no destinctive architecture. The municipality's consulting engineer advised us that the plant was "the best-looking building in town." A city official said that the municipality was relatively poor and was not satisfied with merely constructing a plant whose design was compatible with existing surroundings; it wanted the facility to serve as a catalyst for upgrading the area.

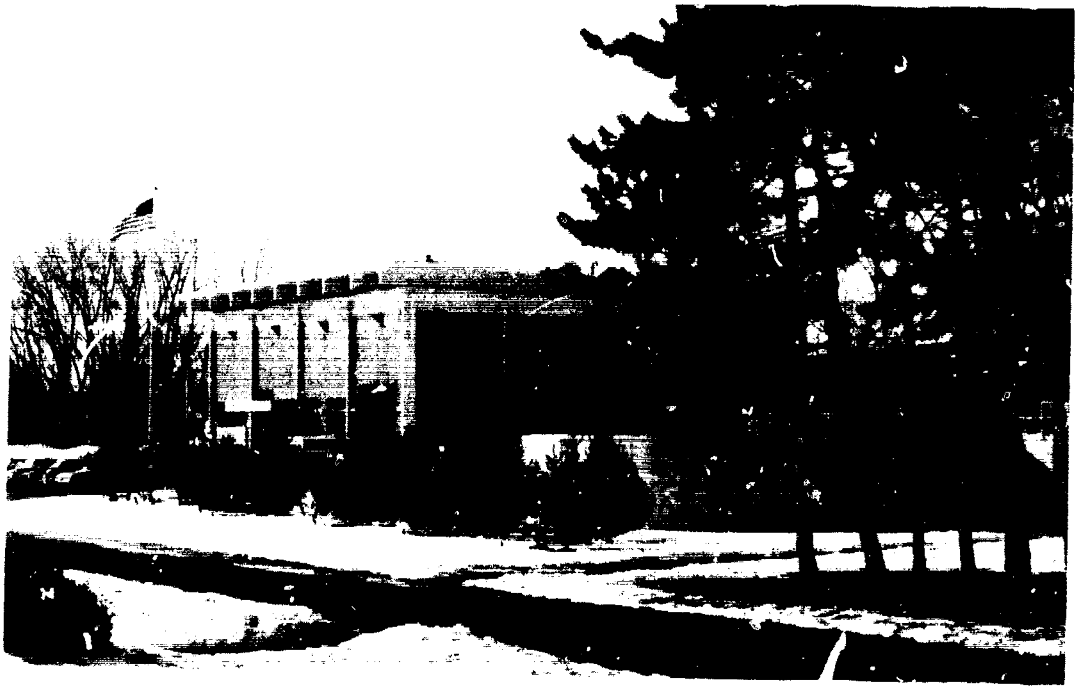
EPA Region IX-Primary Waste Treatment Facility (6.0 mgd) Designed in the Style of a Spanish Mission.



EPA Region IX
Secondary Waste Treatment Facility (35 mgd) with $80,000 Reflecting Pool.



EPA Region IX
Mosaic Tile Fountain At An Advanced Waste Treatment Facility (15 mgd) Used to Display Effluent Quality.



EPA Region I
Operations/Administration building for a 3.2 mgd secondary treatment facility. Exterior facing is glazed brick and precast concrete.

EPA Region VII
Operations/Administration building for a 5 mgd secondary treatment facility. Exterior facing is red brick.

In the same region a $30,000 mosaic tile fountain was constructed solely to display the quality of the effluent of an advanced waste treatment plant. EPA paid 55 percent of the cost. (See photograph, p. 8.)

Another Region IX grantee insisted that the design of its treatment plant be compatible with the proposed parkland area on which the plant was constructed. As such, the consulting engineer had to use the architect responsible for the park master plan. He included an $80,000 reflecting pool surrounding the operations building (see photograph, p. 8), curved tinted glass windows, and other expensive aesthetic features, for which EPA paid 55 percent of the cost. We question whether these features can be justified for Federal grant participation on the basis of compatibility with the parkland. The treatment plant is not near other buildings in the development and in fact overlooks land which the municipality was using as a refuse disposal area. A grantee official said that someday a golf course may be built on this land.

Comparative cost study--Region I

To determine if existing interior and exterior architectural plant designs are cost effective, we contracted with Gale Engineering Company, Inc., to review three projects of our selection in Region I. None of the projects are adjacent to residential areas. The specific items studied included exterior siding, interior walls, flooring, windows, and doors as designed compared to less costly alternatives. The study did not include a review of basic structural design concepts, such as preengineered buildings instead of brick and block construction, and the alternatives identified could have been readily substituted with no effect on the basic design.

The following schedule shows the money that could have been saved by substituting less costly alternatives. The figures reflect major maintenance costs, such as repainting, but not routine maintenance. (See app. II for complete study.)

	As designed	Proposed	Savings	Percent
Plant A	$ 72,722	$ 31,437	$ 41,285	57
Plant B	113,520	59,506	54,014	48
Plant C	154,985	95,273	59,712	39
Total	$341,227	$186,216	$155,011	45

On one of the projects, relatively simple design changes could have reduced exterior costs by 56 percent. Reductions on specific items ranged from 50 percent by substituting concrete block for the exterior siding to 89 percent by changing the design of the entrance stairs. By replacing various grades of brick veneer with concrete face block on the two other projects, the cost of the exterior siding could have been reduced by 48 percent and 38 percent. Some aesthetics would be lost, but in both cases Gale Engineering pointed out that concrete block retains heat better than the design brick veneer.

Of the three plants reviewed, two had glazed structural tile rather than epoxy-painted interior walls. By replacing the tile with epoxy-painted concrete walls and a glazed structural tile base for ease in cleaning, interior wall costs could have been reduced by $40,277, or 47 percent, at one plant and by $33,239, or 37 percent, at the other. The study showed that the cost of flooring could have been reduced by 70 percent in all areas where resilient tile was substituted for terrazzo flooring.

VALUE ENGINEERING

As a result of our report 1/ EPA has developed a value analysis or value engineering (VE) program. VE is a systematic, organized approach designed to optimize the value of each dollar spent. It involves identification and analysis of high-cost items in a project and development of less costly alternatives without sacrificing essential requirements. We stated in our report that value analysis showed potential for greatly reducing waste treatment plant costs. For example, a value analysis study of a $4.1 million waste treatment plant identified an estimated potential initial capital cost savings of $1.2 million and operation, maintenance, and replacement cost savings of $1.4 million projected over the estimated life of the plant.

Effective October 26, 1976, EPA amended the regulations applicable to the construction grant program to require value engineering on all projects/with eligible construction costs of $10 million or more excluding the cost of sewers.

In proposing this rule change EPA stated:

1/ Potential of Value Analysis for Reducing Waste Treatment Plant Costs (RED-75-367, May 8, 1975).

"The results from all of the completed projects subjected to VE in the EPA voluntary VE program confirm GAO's findings that the present Step 2 grant process does not always ensure that the most economical design is specified. Additionally, the results of the voluntary program show that when the VE program is properly managed, an average saving of 10 percent of the total construction cost is possible and project delays can be avoided."

The value engineering requirements would apparently apply, however, to a relatively small percentage of federally funded waste treatment facility projects. An EPA analysis indicated that as of April 15, 1976, only 251--or 14 percent--of 1,850 projects had estimated eligible project costs exceeding $10 million.

CONCLUSIONS

Billions of taxpayers' dollars will be needed to construct and operate municipal waste treatment facilities to clean upon the Nation's waterways. Therefore, the most cost-effective use of Federal funds is essential, especially in view of the Nation's inflation and economic problems.

Because EPA lacks criteria on Federal funding of aesthetic features in waste treatment plants, plants have been constructed with a wide variety of architectural features ranging from relatively austere buildings to plants with elaborate and costly aesthetic features.

Although EPA's recently established value engineering program should insure the construction of cost-effective facilities relative to larger waste treatment plants, most plants will be excluded from the program. We beleive that results of value engineering analyses should be widely disseminated and used to identify minimum design features beyond which Federal funds will not be available. In addition, specific criteria on the eligibility of aesthetic features is needed to guide all municipalities--large and small--in the early stages of designing waste treatment facilities.

RECOMMENDATION

We recommend that the Administrator, EPA, should establish criteria restricting Federal grant participation in the cost of ornamental or aesthetic features of waste treatment projects that do not contribute to the functional use of the facility.

CHAPTER 3

DO PROGRAM CONTROLS ASSURE PROJECTS ARE ADEQUATELY DESIGNED?

EPA's program controls do not assure that project designs are complete and accurate or that plants, when constructed, will provide expected levels of pollution treatment. As a result, waste treatment facilities have been constructed with design deficiencies. Left uncorrected, they prevent facilities from providng adequate treatment and/or create operation and maintenance problems.

Although the quality of a project design depends primarily on the consulting engineer, until recently EPA provided no guidance on selection but left this decision to grantees. Grantees, on several projects reviewed, selected engineering firms with little regard for their qualifications. In addition, State and EPA design reviews are limited in scope and have not identified numerous design deficiencies.

When design problems are corrected, it is usually done with Federal or local funds rather than at the expense of the party responsible for the deficiency. Although grantees can take legal action based on contractual relationships with their engineers, they seldom do. EPA recently required that grantees' contracts with consulting engineers provide for establishing the engineer's (1) responsibility for the technical accuracy and completeness of project designs and (2) liability for any damages caused by negligent performance.

EXTENT OF INADEQUATE DESIGN

Half of the 48 projects we reviewed were either under construction, recently placed in operation, or involved sewer lines or pumping stations. The remaining projects were fully operational waste treatment plants. We compared the actual performance of these 24 plants to their design criteria to determine whether the plants were satisfactorily removing biochemical oxygen demand (BOD) and suspended solids--two of the more common indicators of plant performance. The following shows the results of our analysis.

	EPA Regions			
Waste treatment plant projects	I	VII	IX	Total
Meeting design criteria	4	3	1	8

Not meeting design criteria because of design deficiencies	4	1	-	5
Not meeting design criteria because of inadequate operation and maintenance or reasons not readily identifiable.	4	4	3	11
				24

As the schedule shows, five plants could not meet their design criteria at the time of our review because of design deficiencies. One of these plants was inoperable, and the average performance at the other four for the periods we analyzed ranged from 73 percent to 96 percent of their design criteria for BOD removal and from 61 percent to 79 percent of their design criteria for the removal of suspended solids. In addition, one Region VII treatment plant could not initially meet its design criteria due to a design problem which has been corrected. The existence of design deficiencies was substantiated by the design engineers, independent engineers, and/or by the fact that in some instances plant performance improved when the design engineer had additional equipment installed.

Although none of the plants we reviewed in Region IX failed to meet design criteria for BOD and suspended solids removal because of design deficiencies, officials of the California water pollution control agency gave us a listing of nine plants which they stated were not operating properly because of design deficiencies.

Design problems are not restricted to the three regions included in our review. For example, in an April 1976 report on EPA and State programs relating to munici, ' waste treatment facilities, the EPA National Enforcement Investigations Center staff commented on the results of inspections at 22 waste treatment facilities in four regions--II (New York, N.Y.), VI (Dallas, Tex.), VIII (Denver, Colo.), and IX (San Francisco, Calif.). The staff reported that (1) consulting engineers had made many wrong choices for equipment in their designs, (2) process control flexibility was generally lacking, (3) instrumentation was incomplete so that it was often impossible to determine critical process variables, (4) units were designed without drains so that the only way to empty a unit for maintenance was to use a portable pump, (5) in several instances, final clarifiers were poorly designed, and (6) in several instances, newer plants were being designed with excess treatment capacities.

The staff also stated in the April 1976 report that

"The more flagrant design errors appear to be associated with the smaller plants. In general, it was found that these plants are designed by small local consulting firms. These firms generally do adequate architectural, mechanical, electrical, etc., work but have evidently not had enough waste water treatment experience to truly understand the fine points of plant systems design and operation."

CONTROLS FOR ASSURING THAT PROJECTS ARE ADEQUATELY DESIGNED

To help assure that waste treatment facilities are adequately designed, it is essential that consulting engineers are technically competent and familar with the design requirements of such facilities. In addition, EPA and/or the States must perform adequate reviews of project plans and specifications before EPA approval to minimize the possibility of operating problems stemming from design deficiencies.

Consulting engineer selection

Although grantees are responsible for developing complete and accurate plans and specifications, they generally lack this capability and rely totally on their consulting engineers. The American Society of Civil Engineers, in its manual entitled "Consulting Engineering," states:

> "In the development of any engineering project, no decision is more important to the Client than the selection of the Consulting Engineer. Upon the experience, skill, integrity, and judgment of the Engineer rests the cost, suitability and structural soundness of the proposed work for its intended function. The Engineer's decisions based on these factors affect costs that influence the economic feasibility of the entire undertaking.
>
> "No two engineering firms have equal training, experience, skills, capabilities, personnel, work loads, and particular abilities. Selection of the firm for a specific project can mean the difference between a well-planned, low cost, successful project, or a mediocre and costly one."

Despite the importance of engineer selection, EPA has left it entirely to the grantee and until recently provided no guidance in this area. Municipalities frequently selected engineers they had employed previously--in some instances with little consideration of the firm's sanitary engineering experience.

One firm, for example, was selected to design major renovations to a treatment plant on the basis of its performance on a recently completed traffic control study. The city official who recommended the firm acknowledged he was unaware of its sanitary engineering experience, but felt the quality shown on the traffic control study would extend to the firm's sanitary engineering ability. The project later encountered numerous design-related problems, such as flooding in the room housing equipment that removes silt from the influent whenever the equipment was used because the floor was not sloped and had no drains.

In another case, EPA awarded a $6.5 million grant for upgrading a municipal treatment plant from primary to secondary treatment. Although the upgrading was a large ($12 million), complex project, the municipal officials selected a local firm that specialized in bridge and highway design. Since the principals of the firm had never designed a treatment plant, the local firm entered into a joint venture with an out-of-State firm before contract award to obtain the necessary sanitary engineering expertise.

The project was completed in 1973 but the plant cannot achieve secondary treatment and is experiencing numerous operation and maintenance problems. A principal in the out-of-State firm blamed the municipality and construction contractor for these problems. During fiscal year 1975, however, EPA and an experienced sanitary engineering firm engaged by the municipality to study the plant's problems, found several major design deficiences.

For example, the out-of-State firm had specified pumps normally used for clear water as sludge-return pumps, and grit and other solids in the sludge subsequently caused excessive wear on the pump bearings. Within 16 months of initial operation, all four sludge-return pumps had to be removed from service and rebuilt at the municipality's expense. Moreover, the pumps ran at constant speed, making it difficult for the operators to control the amount of sludge returned to the aeration tanks. In addition, controls over the rate at which sewage passes through the various treatment steps were inadequate. This resulted in a varying water level in the primary settling tank, making scum removal ineffective.

The engineering firm that studied the plant's problems estimated that it will cost between $2 million and $3 million to correct design deficiencies before the plant can treat waste satisfactorily and operate reliably. Rather than take legal action against the original design engineers, the municipality requested additional EPA funding. EPA has awarded a grant increase of $126,566 to the municipality which will partially finance the corrective work and as of January 1977 planned to fund 75 percent of the additional costs necessary to bring the plant into compliance with required treatment levels.

By leaving consulting engineer selection to the grantees, EPA does not have the opportunity to bar engineers from the program for poor performance. Officials of several State water pollution control agencies told us that they are aware of the poorly performing engineering firms, but because of ethical or legal considerations will not reject a firm selected by a grantee. California officials pointed out that when a municipality selects a poorly qualified engineer, invariably the designs have to be returned to the engineer for repeated revisions.

Recent EPA actions

EPA regulations, effective March 1, 1976, require grantees with populations over 25,000 to make public announcements requesting architect-engineer qualifications or to use an updated prequalified listing developed on the basis of public announcement procedures for all contracts over $25,000. The public notice requirement is to insure that grantees have an opportunity to consider the qualifications of all architect-engineers interested in working under the construction grant program. This requirement is not applicable to engineering services for facility design or facility construction if the grantee wants to continue using the engineer engaged for initial facility planning.

The regulations also require the grantee to request professional service proposals from at least three candidates who either responded to the announcement or were selected from the prequalified list. Mandatory criteria are provided for evaluating the three finalists. A selection panel is to be established and will have technical expertise to the extent practicable.

The mandatory evaluation criteria set forth in the regulations for evaluation of the three finalists include:

--Specialized experience and technical competence of the candidate in connection with the type of services required and the complexity of the project.

--Record of past performance on contracts including such factors as control of costs, quality of work, and ability to meet schedules.

--Capacity of the candidate to perform the work (including any specialized services) within the time limitations, taking into consideration its current and planned workload.

--Familiarity of the candidate with types of problems applicable to the project.

The grantee is also required to evaluate the candidate's proposed method to accomplish the work required, including demonstrated capability to develop innovative or advanced techniques and design where appropriate.

Although the foregoing procedures should aid in selecting qualified engineering firms for participation in the construction grant program, the exemptions eliminate the vast majority of grantees from compliance. EPA reported that as of December 31, 1976, 81 percent of the 9,301 construction grant awards under the 1972 amendments to the act had been made to communities with census populations of 25,000 or less. In addition, EPA believes the majority of grantees that select an engineer for the initial facility planning process will probably use the same engineer for facility design and construction.

For engineering services contracts expected to exceed $100,000, the grantee is required to submit for review by the EPA project officer (1) documentation of the public notice, selection procedures, and negotiation methodology used, (2) cost and pricing data submitted by the selected engineer, (3) certification of review and acceptance of the selected engineer's cost or price, and (4) a copy of the proposed contract document. The EPA project officer is to approve the grantee's compliance with procedural requirements before award of the contract.

The final selection of the engineering firm is still made by the municipality. EPA stated that it is not intended for the project officer to "second guess" grantee actions or veto the grantee's choice of an engineer.

State and EPA design reviews

The primary purpose of State and EPA design reviews is to assure compliance with minimum sanitary engineering requirements. These include Federal guidelines for design, EPA technical bulletins, various State and interstate standards, and the American Society of Civil Engineer/ Water Pollution Control Federation manuals of practice.

The design standards or guidelines range from state-of-the-art studies issued as early as 1959 to recently issued detailed technical criteria. Certain of these standards mandate the use of specific types of facilities in designing treatment plants--such as the use of grit chambers in plants serving combined sewer systems. Others describe the general objectives of process control and leave the choice of specific facilities to design engineers. For example, some standards do not mandate the use of grit chambers, but point out the items design engineers should consider in deciding whether a grit chamber is necessary.

In the case of waste treatment plant designs, the States and EPA generally review only the process and in a limited manner. They satisfy themselves that components are properly sized to adequately treat anticipated flows. They do not critically review the electrical or mechanical aspects of a design, its structural soundness, or the quality of materials used. EPA believes that the structural, electrical, and mechanical design details are the engineer's responsibility.

State and EPA reviews in several cases have not assured compliance with minimal sanitary engineering requirements or treatment processes that provided adequate treatment. For example: During the designing of one project, the State changed the design standards for the specific treatment process. When notified of this change, the consulting engineer advised the State and EPA that the change would reduce the proposed plant's capacity as initially designed. Despite this fact, EPA and the State, in reviewing the plans and specifications for the facility, failed to require redesign to conform with the new State standards. As a result, the Federal and State governments expended about $240,000 to construct a sewage treatment facility that was overloaded 3 years after completion and unable to meet secondary treatment standards.

An EPA investigations group has also commented on inadequate design reviews. As previously noted in this chapter, in an April 1976 report the EPA National Enforcement Investigations Center staff described design errors and poor equipment choices disclosed in its review of 22 waste treatment facilities. The staff concluded that many of the design errors and poor equipment choices should have been caught in the review/approval process. The staff recommended that EPA and/or State procedures for review of plans and specifications be tightened to minimize these problems.

CORRECTING DESIGN DEFICIENCIES

Many design deficiencies are discovered during construction and corrected by change orders. Associated costs are generally borne by those participating in the project--the grantee, EPA, and possibly the State. However, the State and EPA sometimes refuse to participate in change orders if the incorrect design had already been constructed and would require removal and reconstruction to correct. In such cases, the grantee must bear the entire cost.

Major design deficiencies often do not surface until a treatment plant is placed in operation and it is too late to correct the deficiencies through change orders. In such cases, the municipality can

--seek additional EPA or State funding,

--make corrections at its own expense, or

--initiate legal action against the designer on the basis of failure to comply with contract terms.

New funding

Municipalities sometimes seek and receive additional EPA funds to correct design problems, thus diverting funds from other pollution abatement projects. For example, a municipality was awarded a $1 million EPA grant in April 1971 to expand and upgrade its treatment plant. Construction on this project was completed in December 1972, but according to consulting engineers and municipal officials that plant is now plagued with serious operational problems due in part to design deficiencies. The sludge-handling and disposal system is unreliable--the sludge beds are inadequate and cannot be used during the winter--and contributes to poor plant performance. Further, the capacity of one trickling filter was reduced because of an error in the consulting engineer's drawings.

EPA regional officials were unaware of these problems and expressed little concern when we brought them to their attention. The officials merely commented that trickling filters have a history of poor performance, and that other treatment plants also have difficulty handling sludge. Rather than seeking corrective action, EPA recently awarded a $51,000 facilities planning grant which in part will evaluate alternative ways of correcting the design deficiencies.

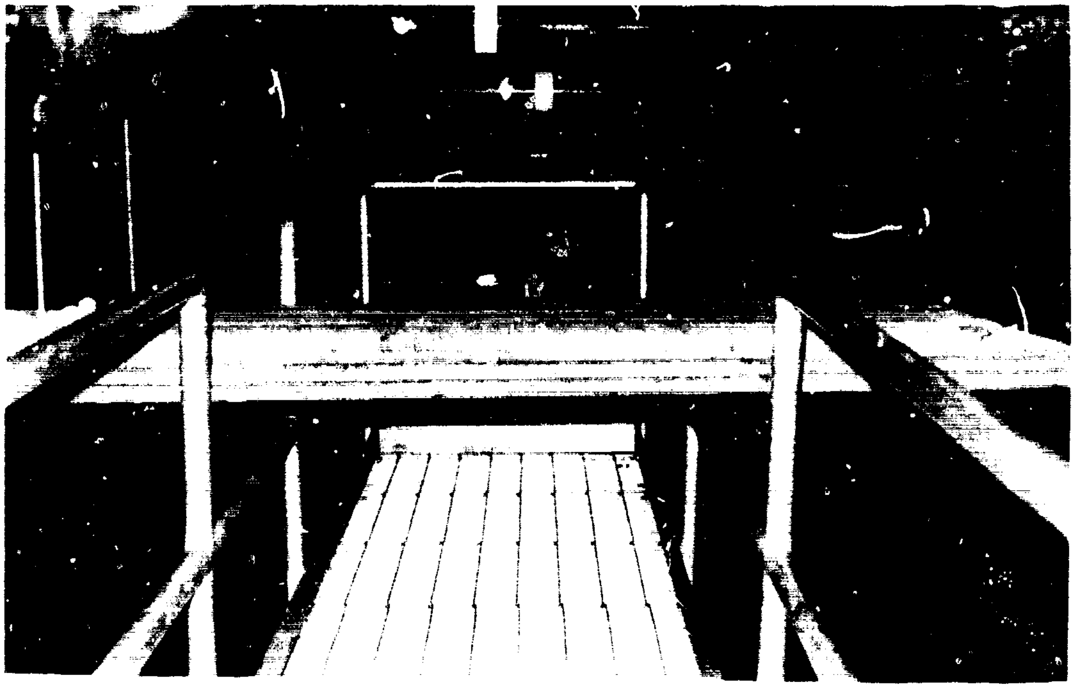
California, unlike other States, has a policy of denying funds to municipalities for improvements needed to meet treatment levels specified in original grants. A California grantee that receives funds for a secondary treatment plant receives no additional funds to correct design problems that prevent the plant from achieving secondary treatment. The municipality must assume the entire cost of the needed corrective work.

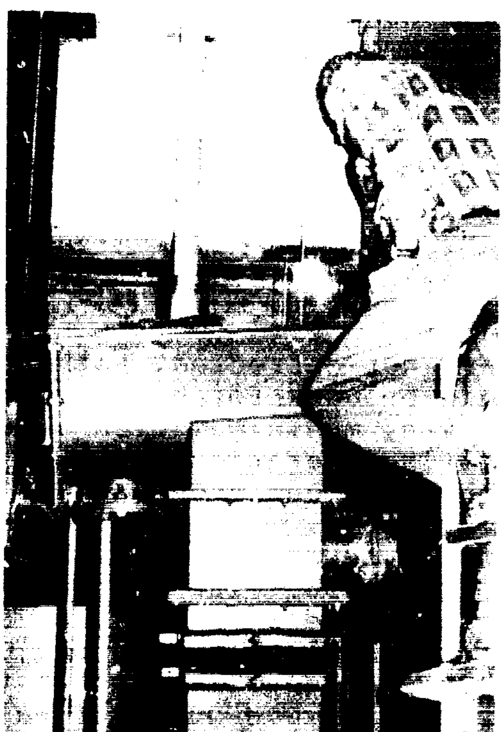
Municipality corrects problem

In many situations, grantees have corrected design deficiencies at their own expense. Generally, these deficiencies were relatively minor and did not require any degree of sanitary engineering expertise. For example, sludge in the aerobic digesters at one municipal treatment facility froze during the winter. A municipal official attributed the problem to inadequate consideration of weather conditions on the part of the designer. To correct the situation, the municipality built wood and fiberglass housings over the digesters at a cost of $5,000. The engineer said he did not include digester covers in his design for economic reasons. If the digester covers had been included in the approved plans and specifications, their cost would have been eligible for Federal grant participation and the municipality's share of construction cost would have been reduced. (See photographs, p. 22.)

A State engineer told us that municipalities "traditionally" pay for correction of engineers' errors; we found this to be true even when the engineer admits his error. For example, a catwalk at one plant was designed to permit inspection and cleaning of the equipment used to transport sludge. Not only was the catwalk too short, requiring plant personnel to lean out over the end to inspect and clean the equipment, but the inspector had to either crawl over or under a series of pipes that pass directly across the catwalk. The design firm admitted the error, saying it failed to properly coordinate the information on different construction drawings. Nevertheless, the municipality plans to spend $2,000 to partially correct the situation, which it considers a safety hazard. (See photographs, p. 23.)

Aerobic digesters were covered by the municipality to prevent freezing during the winter.





The catwalk at this plant is obstructed by a series of electrical conduits passing directly across it. In addition, it is too short, requiring plant personnel to lean over the end to inspect and clean the beginning of a worm drive used to transport sludge.

In some cases, grantees were unable to easily correct design errors or omissions and had to seek technical assistance from independent consulting engineers. For example, a municipality received $4 million from EPA to build a 30-million gallons per day (mgd) primary treatment plant which was inoperable as designed. The consulting engineer included four grit chambers in the preliminary design, but eliminated them from the final design to reduce costs. This was contrary to applicable engineering standards which require grit chambers be installed in treatment plants receiving flows from a combined sewer system, as was the case in this instance. Nevertheless, the State and EPA approved the design without grit chambers.

The plant was placed in operation in April 1973, but was soon inoperative because of large quantities of grit flowing into the plant. While some equipment was repaired under warranties, the city paid $22,000 to repair other damaged equipment. For the next 2 years the plant discharged 25 million gallons of raw sewage daily into the adjoining bay, and the city paid interest charges exceeding $128,000 on borrowed capital needed to reimburse contractors as final EPA and State grant payments were withheld pending resolution of the problem. The city incurred costs of $325,000 to clean the interceptor line and construct a temporary grit chamber, which the waste treatment plant operator stated completely resolved the grit problem at the plant. The city's present consultant estimated that it will cost $820,000 to construct a permanent grit chamber--a cost EPA will not participate in unless the feature is included in a design to upgrade the facility to secondary treatment. The original consultant maintains that the problem was strictly one of operation and maintenance rather than any deficiency in the design.

Some design deficiencies are not corrected. Rather than seek correction by the engineer, ask for help from EPA, or pay repair costs themselves, municipalities sometimes decide to accept the resulting operation and maintenance problems. For example, on one project a grit chamber washdown system used raw sewage. When placed in operation, grease and solids in the sewage clogged the nozzles, trapping the sewage in the pipe. The sewage froze when winter arrived and cracked the pipe's control valves. The design engineer presently responsible for this project stated that the design should have included a strainer to remove solids from the sewage before it was used for washdown. However, the firm has failed to accept responsibility for repairs. Since the washdown system is unuseable, the plant operator uses a high-pressure hose to wash down the tank after each storm. (See photograph, p. 26.)

At another plant no provision was made to transfer sludge from dewatering equipment to a dump truck for transport to a landfill site. The sludge drops 15 feet and splatters the garage ceiling which must be cleaned daily. (See photograph, p. 26.)

Legal action

Municipal officials and an assistant EPA regional counsel told us that municipalities do not favor initiating legal action against designers of waste treatment facilities. They are reluctant to undertake what is likely to be an extended court conflict over contractual terms that are generally vague. In this regard, only 8 of 51 contracts applicable to the 48 projects we reviewed assigned the engineers responsibility for damages resulting from their "acts or failures to act" in performance of the contract.

Further, litigation often involves significant legal and other costs plus possible damage claims against the municipality in the event of an unfavorable judgment. None of these costs are eligible for reimbursement under EPA's construction grant program.

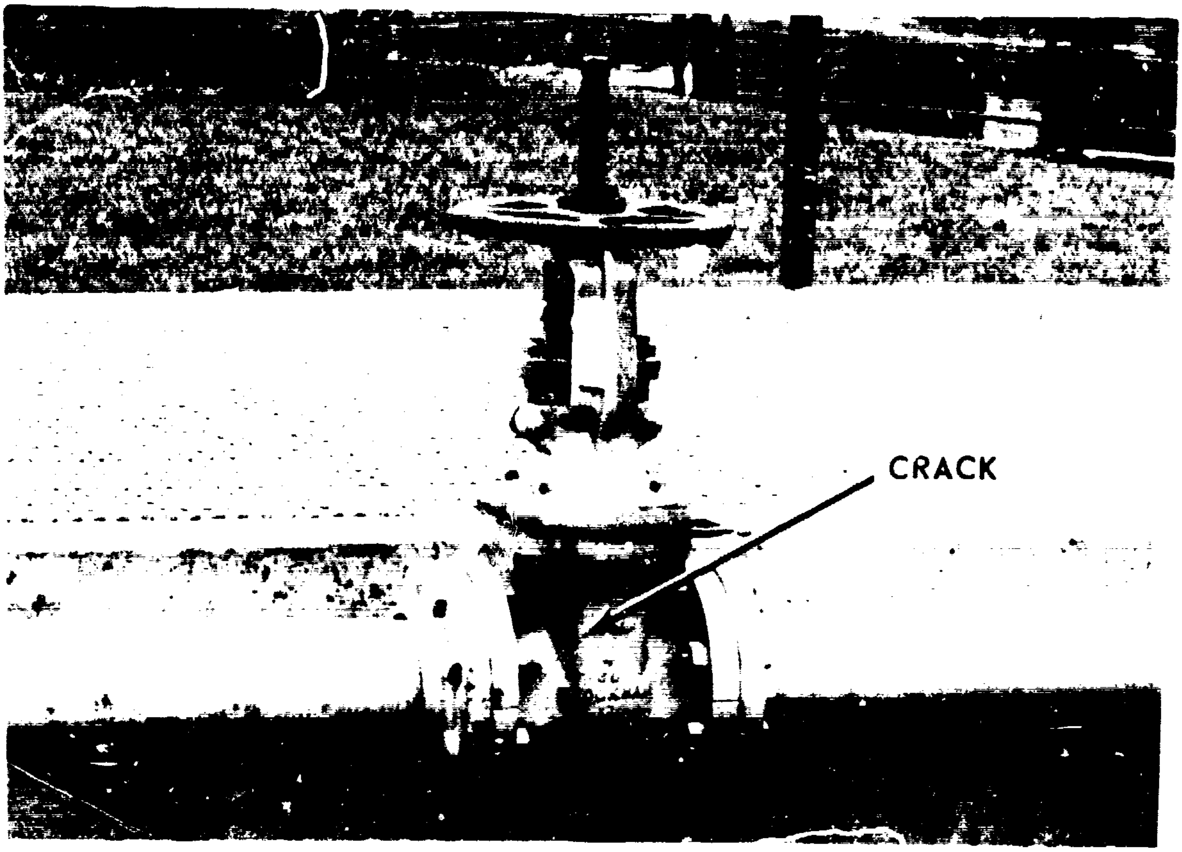
Recent EPA actions

On March 4, 1976, EPA issued regulations that require certain standard contract clauses to be made a part of contractual agreements between a municipality and its consulting engineers. These clauses assign responsibility for the technical accuracy and completeness of design to the consulting engineers and provide for damages resulting from design deficiencies if negligence is involved.

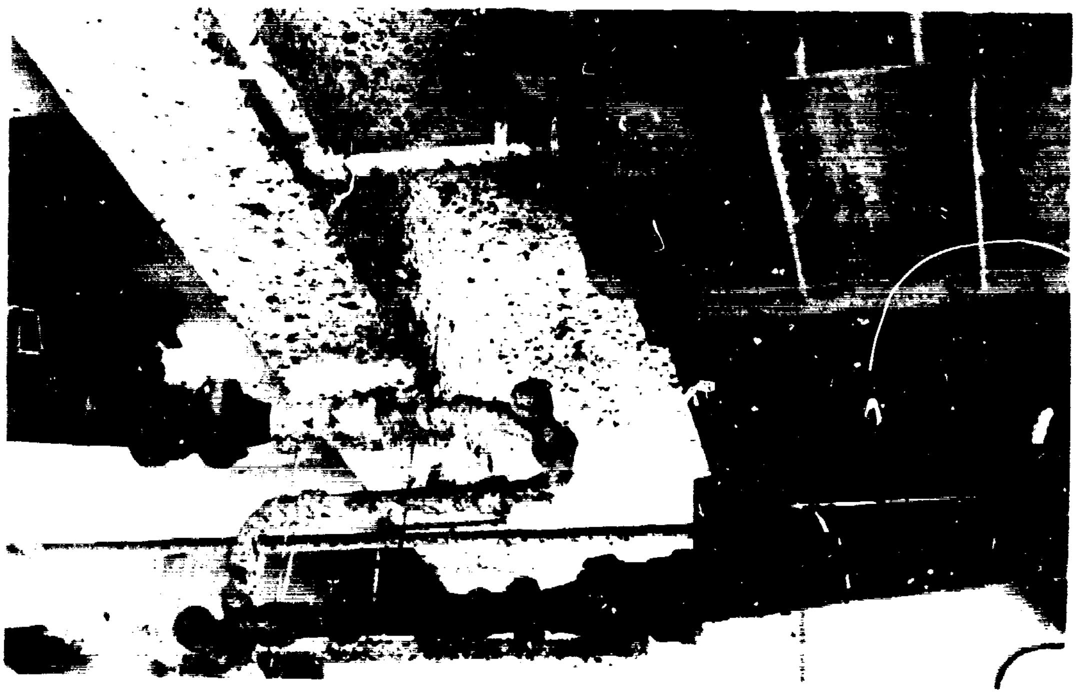
These new regulations should provide a basis for EPA and local officials to hold engineers responsible for damages resulting from design deficiencies.

CONCLUSIONS

Although the quality of a design depends primarily on the experience, skill, and capability of the consulting engineer, grantees on several projects we reviewed selected engineers with little consideration of their qualifications. EPA's March 1976 regulations, if properly implemented, could help improve engineer selection and the quality of designs on future projects. To protect the Federal



Control valves all cracked from freezing on this washdown system.



Sludge splattered on ceiling of garage area.

financial interest in all waste treatment projects, we believe that EPA should have as a grant condition the right to disapprove of any engineer selected by a municipality. This is especially true for the majority of municipalities that are exempted from the advertising and evaluation of qualification requirements and are not required to document the selected engineer's qualifications.

However, selection of well-qualified engineers, by itself, will not assure well-designed facilities. State and EPA reviews of plans and specifications prepared by consulting engineers have been limited and have overlooked many design deficiencies. While expanded reviews might reduce the incidence of design deficiencies on grant projects, they would also increase the burden on the States and EPA.

Primary responsibility for complete and accurate designs rests with the consulting engineers and we believe they should be held accountable for damages resulting from design deficiencies. Municipalities, however, are reluctant to take legal action against their engineers primarily because of the questionable cost effectiveness of such a decision. Extended court conflicts involving vague contractual responsibilities can result in significant legal costs--none of which are grant eligible. We recognize also that there are limits to engineer liabilities both in the amount of liability insurance coverage they are able to obtain and, in any specific case, court judgments.

EPA's recent regulations requiring that grantees' contracts with consulting engineers provide for the engineer's liability for any damages caused by negligent performance will provide a basis for holding engineers accountable for design deficiencies. We believe that EPA should assist local officials in identifying the reasons waste treatment facilities do not meet design criteria and encourage them to hold consulting engineers accountable for damages resulting from design deficiencies.

RECOMMENDATIONS

We recommend that the Administrator, EPA:

--Amend EPA's regulations to provide that as a grant condition the grantee shall document and submit to EPA the selected consulting engineer's qualifications. EPA will have the right to disapprove the selection.

--Disapprove Federal funding for future construction grant projects that are intended to correct problems resulting from design deficiencies unless the grantee has taken all reasonable measures to hold the consulting engineer accountable for damages.

--Provide technical assistance to grantees in indentifying why waste treatment facilities do not meet design criteria and encourage grantees to hold the consulting engineer accountable for damages resulting from his work.

CHAPTER 4

DO PROGRAM CONTROLS MINIMIZE CONSTRUCTION PROBLEMS?

The construction grant program has several safeguards to minimize construction problems. EPA regulations require that (1) grantees must award construction contracts to the low responsive, responsible bidder, (2) the successful bidder must be bonded, and (3) grantees must provide engineering supervision to assure construction conforms with EPA- and State- approved plans and specifications. The States and EPA also inspect the projects during construction.

These safeguards, however, are often ineffective. Grantees award construction contracts despite doubts about contractor qualifications; grantees seldom look to the bonding companies for relief in instances of poor contractor performance; engineering supervision does not assure that the contractor complies with plans and specifications; and State and EPA site visits generally are infrequent.

THE EXTENT OF CONSTRUCTION PROBLEMS

Seventeen of the 48 projects included in our review experienced delays, increased costs, and inferior workmanship as a result of ineffective controls during the construction phase. These problems were identified during our review of project files and visits to the projects in the company of municipal officials, State inspectors, or representatives from the consulting engineering firms employed by the municipality.

	EPA Region			
	I	VII	IX	Total
Projects reviewed	28	11	9	48
Projects with construction problems	13	1	3	17

On most of the 17 projects, there were indications before contract award that the construction contractor could be expected to perform poorly or indications that more effective engineering supervision during construction could have prevented or alleviated problems during construction.

EPA's Office of Audit has also identified instances of inadequate construction. For example, in February 1975 it reported on a situation where telescoping weirs on one project could not be raised or lowered because the contractor did not build them according to specifications. The city may have to correct the problem at its own expense.

USE OF BONDING AS A CONTROL DURING CONSTRUCTION

After contract award the construction contractor must furnish 100 percent performance and payment bonds. A performance bond is insurance against a contractor's failure to perform in accordance with contract documents including the plans and specifications. A payment bond is insurance against the contractor not paying for labor and materials used in the project. Bonding involves a three-party relationship in which a surety (an individual or corporation) becomes obligated to an owner (in this case the grantee-municipality) for a construction contractor's performance.

Construction contracts specifically state the reasons a city can terminate a contract as well as the procedures for termination and "calling" a bond. A typical contract states that if the contractor becomes insolvent or

> "if at any time the Engineer shall...certify in writing, that the conditions herein specified as to rate of progress are not being complied with, or that the work...is being unnecessarily or unreasonably delayed, or that the Contractor has violated or is in default under any of the provisions of the Contract...."

the city may instruct the contractor, in writing, to stop work, and send a copy of the letter to the bonding company. The contractor and its surety would be liable for the cost to complete the work. Many contracts give the surety 10 days to take over the work before the city can take action to complete the project.

Although such contract clauses appear to provide adequate insurance against poor contractor performance, calling a bond invariably results in project delays and protracted litigation if the contractor disputes the contention that he violated the contract. Municipalities generally can not afford these costs; consequently, they rarely call a performance bond even in those cases of substantial problems with the contractor's performance. In some instances, possible costs were not the major factor in the municipality's decision not to call the bond.

For example, EPA awarded a $298,500 grant in December 1970 to a municipality for the renovation of an existing pump station and construction of a sewer line. The pump station contract was awarded to the low bidder at EPA's insistence, although the municipality had reservations about the contractor's ability. The municipality was unable, however, to demonstrate that the contractor had previously performed incompetently.

During construction the contractor's temporary pumping facilities failed continually, causing flooding and work delays. At one point city officials declared the site a health hazard because it was covered with raw sewage.

The pumps, motor mounts, and motors arrived from the manufacturer as matched sets. The contractor, however, disassembled the units and mismatched the motor mounts and pumps during reassembly. City officials said he sledge hammered some parts into place. When the pumps were activated, they vibrated violently and operation stopped.

The consulting engineer later approved a substitute pump motor control system proposed by the contractor with the understanding that the contractor would insure equipment compatibility. Although the contractor failed to demonstr te compatibility, the resident engineer--employed by the consulting engineer--allowed the substitute pump motor control to be installed and recommended that the contractor be paid. When the municipality operated the motors and they overheated, it was apparent that the substitute control system was incompatible. Later, it was also determined that the overheating had damaged the motors.

The municipality eventually stopped paying the contractor and hired another to complete the project. The contractor brought legal action against the municipality for nonpayment and the municipality countersued for liquidated damages and inadequate performance.

The city paid an additional $43,000 to purchase and install the originally specified motor control system, $4,000 to repair damage caused by the overheating, and about $14,000 for proper pump installation. Moreover, the consulting engineer billed the municipality $35,000 in additional resident inspection fees, more than doubling anticipated inspection costs for the pump station. The municipality has refused to pay.

The pump station renovation was finally completed in April 1975--over 40 months behind schedule. Although municipal officials believe the delay was due primarily to the contractor's poor performance, they made no attempt to hold the contractor's bonding company responsible. Municipal officials stated they did not take such action because they felt the bonding company would use the same contractor to complete the project--a course the unicality considered totally unacceptable. As of January 1977 case had not been settled.

The only instances we found where a surety took over a project were those in which the contractor was unable to complete the work because of financial difficulties. In two cases the contractor went bankrupt and in the third the contractor was unable to pay its suppliers and subcontractors, which resulted in a work stoppage. In none of the 17 projects with construction problems was a surety called in because the quality of a contractor's work was unsatisfactory.

Bonding used to determine whether a contractor is responsible

EPA requires municipalities to award contracts to the lowest responsive, responsible bidder. Rather than accept the lowest bid, a municipality may reject all bids; or, if it considers the low bidder nonresponsible, select the next lowest bid. In this event, however, EPA regulations require that the municipality must be able to establish and substantiate the basis for its determination and must establish that such determination has been made in good faith. After the contract has been awarded, the contractor must provide evidence of meeting the bonding requirements.

Despite these regulations, grantees rely heavily and sometimes exclusively on a contractor's ability to obtain bonding as evidence that the contractor is responsible. A bond, however, provides little such evidence and does not prevent inexperienced contractors or those with a history of poor performance from working on construction grant projects.

For example, one grantee awarded a contract to the low bidder who was able to obtain bonding despite poor performance on many past projects. The project involved major renovations to an existing treatment plant. The contractor, deciding that it was the most efficient method of completing his work, dismantled the entire existing sludge-handling and disposal system and failed to reassemble it. As a result, the sludge accumulated--to a depth of 15 feet in one tank--causing a serious health hazard. The municipality, at its own expense, had to reassemble the sludge-handling equipment and remove accumulated sludge. The contractor also contributed to numerous other problems, and disputes eventually had to be settled through arbitration.

Another municipality awarded a contract to a low bidder who had a record of slow payment to suppliers. The contractor was able to obtain bonding and begin work. Completion of the treatment plant was delayed over 2 years by work stoppages and litigation resulting from the general contractor's failure to pay subcontractors. About 20 months after the scheduled completion date the municipality, with the concurrence of the bonding company, hired another construction contractor to complete the work.

Recent EPA action

EPA regulations, effective March 1, 1976, set forth criteria to be used by grantees to determine whether a construction contractor is responsible. Before contract award, contractors must demonstrate they have

--adequate financial resources and necessary experience and technical qualifications;

--ability to comply with the proposed or required completion schedule; and

--satisfactory record of integrity, judgment, and performance especially past performance on grants and contracts from the Federal Government.

Grantees are responsible for assuring these criteria are met, and EPA is responsible for reviewing grantee compliance.

The new regulations, if properly implemented, should provide a basis for insuring that municipalities select qualified construction contractors.

RESIDENT ENGINEERING

EPA requires grantees to provide competent and adequate engineering supervision on all projects to insure that construction conforms with the approved plans and specifications. Most municipalities do not have the resources to perform the resident engineering function and accordingly rely on consulting engineers to provide this service. However, EPA has not defined the specific duties and responsibilities of resident engineers including what actions to take if the contractor is reluctant or unwilling to comply.

Not only has EPA failed to define the duties and responsibilities of a resident engineer, but we were unable to obtain a generally accepted definition from other sources. Representatives of EPA, State agencies, municipalities, and consulting engineers expressed different understandings of resident engineers' responsibilities. While some stated they should withhold payment and stop work if necessary to obtain compliance with plans and specifications, others said they are merely the "eyes and ears" of the municipality to which they should report problems.

Agreements between engineers and grantees do not always address this issue. For example, in New Hampshire, where engineering agreements are standardized by the State, The resident engineer's function is to:

> "* * * assist the ENGINEER in the work of General Administration and in controlling construction activity only insofar as to assure complete compliance with the contract and with the plans and specifications and any associated change orders."

New Hampshire contracts, however, do not specify what action a resident engineeer should take when work does not comply with the plans and specifications.

Other agreements for resident engineer services do not even state that resident engineers are to assure compliance. Some specifically assign them the role of a powerless observer:

> "* * * observe the materials furnished and the construction work and * * * report to the (municipality) relative thereto, and also * * * report whether the end product, as furnished and installed substantially meets the requirements of the contract documents."

Other contractual definitions of a resident engineer's function are so vague, it is impossible to determine his responsibilities:

> "The ENGINEER agrees to furnish a competent resident engineer and such assistants as required for * * * inspection of construction * * * under the general direction and instruction of the ENGINEER."

> "* * * supervision shall be limited to (1) so much of the Engineer's own personal services as are necessary

in reporting and making recommendations relative to the progress of the work, and endeavoring to guard the Owner against defects and deficiencies in the work of the Contractors (without in any way guaranteeing such work); * * *"

Contracts between construction contractors and grantees generally provide that the resident engineer has authority to 1) determine the acceptability of work to be paid for under the contract and 2) interpret plans and specifications where they are obscure or in dispute. Some construction contracts also give the authority to stop work if such action seems necessary to prevent improper execution of the work. The engineer, however, is not a signatory to the onstruction contract and these duties are not included in the engineering agreement.

Because of the vague and inconsistent descriptions of a resident engineer's function, it is difficult to evaluate a resident engineer's performance. We did note, however, several cases where resident engineering failed to either assure contractor compliance with plans and specifications or alleviate problems that occurred during construction.

For example, completion of a treatment plant was delayed and litigation resulted when leaks were discovered in newly installed pipelines. The consulting engineer agreed that some that some piping was installed incorrectly, adding that his resident engineer often failed to make simple tests to assure gaskets were properly seated. The consulting engineer believes that the resident, who was eventually fired, is now working for the contractor. He also expects his firm to be sued by the city for its part in the faulty pipe installation. The engineering agreement, which was vague in this case, stated that the engineer would "observe and approve" work for conformity to the plans and specifications, and "Make field tests where necessary...."

In several cases where resident engineering was ineffective, the consultants failed to accept responsibility for the results, and grantees did not attempt to hold them accountable. For example,

An old force main passed through the site where a new treatment plant was to be constructed. The force main, which discharged raw sewage into the ocean, was to remain in place and be used for discharging treated waste when the plant was completed. The construction drawings stated:

"The existing 18-inch cast iron force main is laid on wood piles with wood pile caps. The contractor shall use extreme caution not to disturb those parts which are to remain." (Emphasis added.)

Despite this warning, the contractor piled excavated fill and drove a bulldozer over the force main. The resident engineer warned the contractor of the danger, but the contractor did not remove the excavated material. A section of the main soon collapsed, creating a public health emergency and closing a nearby beach in the middle of summer.

The engineering firm maintains it had no authority over the contractor to prevent the force main collapse, and could only recommend various courses of action to the municipality. However, it made no such recommendations, and we found no evidence that the firm advised the municipality that the force main was in danger. This appears to be a violation of its agreement with the municipality which states:

"* * * A resident representative will * * * provide reports (* * * to the [municipality]) on progress of the work and on the contractor's compliance or noncompliance with the contract terms through on-site observation of the work."

Nevertheless, the engineering firm denied any responsibility for failing to prevent the force main collapse and billed the municipality $16,500 for services necessitated by the collapse. Total resident engineering fees paid exceeded $123,000. If the engineering firm had been held accountable for the terms of its contract, we believe that, at the least, the additional engineering costs incurred by the collapse would not have been eligible for grant participation.

Even in those situations where the contract terms specifically state that the resident engineer is to assure compliance with plans and specifications, no action may be taken against the engineer for failure to comply with the contract terms.

For example, the resident engineer on one treatment plant project failed to prevent the faulty installation of reinforcing steel for concrete and faulty vibration and curing of the concrete. State inspectors, visiting the site frequently, identified these deficiencies. The concrete cracked and failed to meet specifications. The consulting engineers agreed the concrete did not meet specifications, but they required repairs only at the insistence of State officials who feared that moisture would enter the cracks, freeze, and cause further damage. (See photographs, p. 38.)

The contractor also applied a coating to a concrete floor in the operations building. Although the resident engineer told him to prepare the concrete as the manufacturer advised, the contractor ignored him. When the flooring subsequently raised and cracked, the contractor claimed the material was defective. The consulting engineer then engaged an independent testing firm which determined that the material was not defective, but was installed improperly, as the resident engineer already knew. Although the contractor repaired the flooring, the municipality had to pay the testing firm $3,300. The consulting engineer not only failed to accept responsibility for this cost, but charged the municipality an additional $500 for engaging the testing firm.

Resident engineering fees on this project totaled over $186,000. Although the resident engineer clearly did not "assure complete compliance with the * * * plans and specifications" as required by the engineer's agreement with the municipality, no resident engineering fees were withheld.

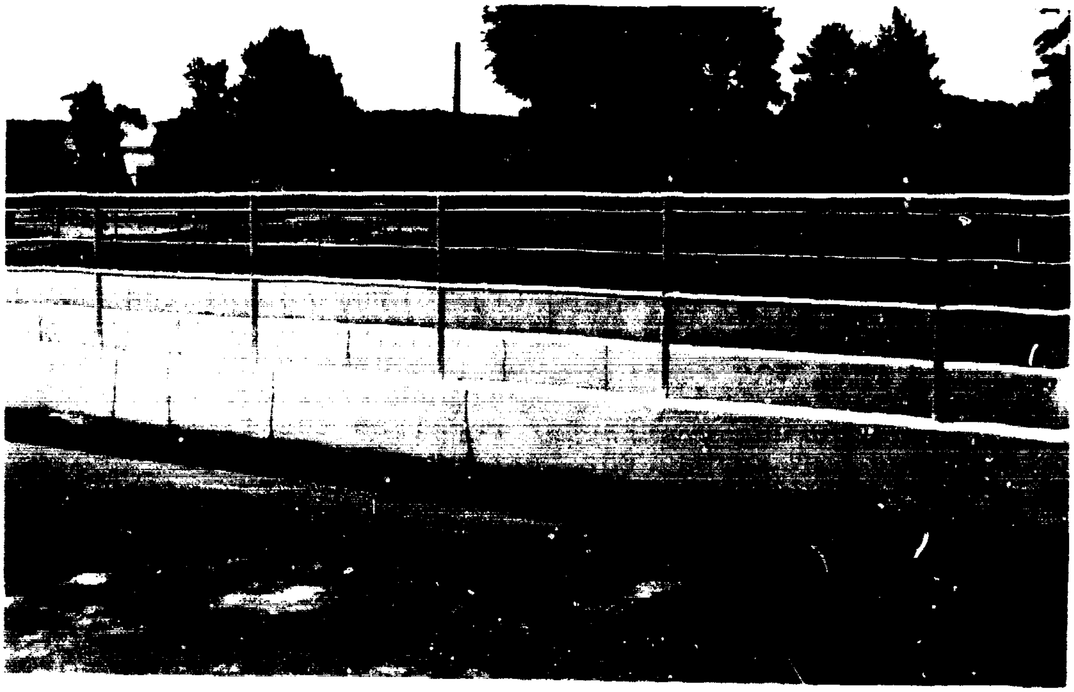
EPA AND STATE MONITORING

Monitoring by EPA and State staffs during construction has been inconsistent and in some cases nonexistent. We were not able, however, to establish any correlation between the extent of EPA/State monitoring and the extent of construction problems. Construction projects with extensive problems, as well as those with none, received the same number of inspections.

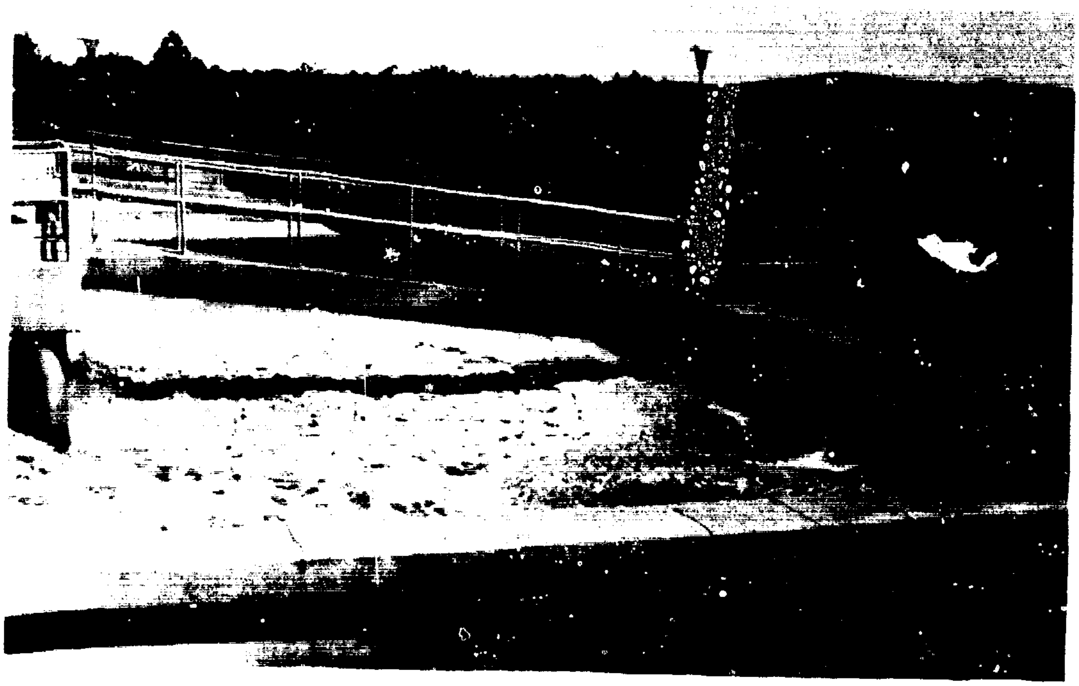
EPA inspections

EPA regulations require that before EPA makes final grant payment, all grant projects be given a final inspection to assure that construction is satisfactory. In Regions I and VII, EPA personnel make final inspection themselves. Region IX makes final inspections on California projects, but in 1975 contracted with the Army Corps of Engineers to perform this function for Nevada and Arizona projects.

EPA also makes interim inspections during construction, but infrequently. Region I is the only region that made somewhat regular inspections, generally one or two on each



Repaired cracks in chlorine chamber walls.



Repaired cracks in aeration tank walls.

project. Region VII performed interim inspections as time allowed on projects with eligible costs exceeding $1 million. Only 3 of 10 Region VII projects we reviewed with costs exceeding $1 million received an interim inspection. Region IX made no interim visits. Instead, it relied on the State to perform this function in California, and on the Corps of Engineers in Nevada and Arizona.

Besides being infrequent, EPA's interim inspections were usually announced in advance and were primarily concerned with administrative requirements, construction progress, and readily observable deficiencies.

EPA recently took action to expand its monitoring of construction projects. On March 18, 1976, EPA announced that:

> "EPA has concluded an agreement with the Corps of Engineers and the General Services Administration to assist in expansion of Federal monitoring of projects under construction. The efforts will focus on the quality of supervision provided by the grantee and the resident inspector. The Agency will continue to rely to a large extent on the grantee to insure proper, speedy completion of construction."

State inspections

State monitoring of projects included in our review was inconsistent. In five States (California, Kansas, Missouri, Nevada, and Rhode Island), monitoring was practically nonexistent, and in Massachusetts it was generally limited to one interim visit. California and Rhode Island recently expanded their monitoring activities.

New Hampshire and Vermont conducted more frequent inspections--each project at least monthly. In Vermont we reviewed two projects, one of which experienced delays. The State inspector said he plans to take action to recover damages from the construction contractor because he believes that contractor is responsible for part of the delay. Four of the seven projects reviewed in New Hampshire experienced construction problems. State inspections had disclosed most of the problems, and attempts were made to obtain contractor compliance with the plans and specifications. In one instance, however, where the resident engineer's performance was obviously not meeting contract requirements, no attempt was made to hold the consulting engineer accountable or to withhold payment.

CONCLUSIONS

Many construction problems we identified could have been avoided if grantees relied less on a construction contractor's ability to obtain bonding and more on professional qualifications. If properly enforced, criteria recently established by EPA for determining if a contractor is responsible should help to select well-qualified contractors and thus reduce the incidence of construction problems.

We believe that construction contractors should be held accountable for damages resulting from their negligent performance, and EPA should not provide funds to correct such construction problems. We recognize, however, that the grantee's ability to fully recover damages may be limited by factors such as court judgments.

Resident engineering, however, still needs improvement. The practical difficulties of calling a contractor's performance bond make it especially important that competent resident engineers oversee construction to assure that it complies with plans and specifications. Many construction problems identified during our review could have been alleviated or even prevented by better resident engineering.

It is difficult to determine the causes of poor resident engineering. In several cases the individual engineer seemed to lack technical knowledge or was reluctant to confront the contractor. There also seems to be some concern among consulting engineers of legal action by construction contractors. It is also possible that resident engineers do not clearly understand what they are expected to do, because of vague contractual agreements, when a contractor violates the plans and specifications.

Not only are resident engineers sometimes ineffective, but the consulting engineers for whom they work do not accept responsibility for damages resulting from poor performance, nor do grantees attempt to hold them accountable. Contracts among grantees, engineers, and contractors, if properly written and enforced, should minimize construction problems. Construction contractors are required by their contracts to conform to plans and specifications, and resident engineers are expected to assure that they do.

RECOMMENDATIONS

We recommend that the Administrator, EPA:

--Disapprove Federal funding for future construction grant projects that are intended to correct problems resulting from the negligent performance of construction contractors unless the grantee has taken all reasonable measures to hold the contractor responsible for damages.

--Provide technical assistance to grantees in identifying the reasons for construction problems and encourage grantees to hold the responsible party accountable for damages.

--Develop for insertion in grantee contracts for resident engineering services and construction contracts a clear definition of the resident engineer's duties and responsibilities, including the authority to interpret plans and specifications, determine acceptability of all work, and the obligation to suspend work when necessary to protect the grantee;

--Insure that consulting engineers are held responsible for the poor performance of their resident engineers.

STATE PARTICIPATION IN ELIGIBLE PROJECTS COSTS

REGION I	
Connecticut	15%
Maine	15
Massachusetts	15
New Hampshire	20
Rhode Island	15*
Vermont	15
REGION II	
New Jersey	15%
New York	12.5
Puerto Rico	25**
Virgin Islands	25**
REGION III	
Delaware	10%
Maryland	12.5
Pennsylvania	None
Virginia	5-15***
West Virginia	None
Dist. of Columbia	25**
REGION IV	
Alabama	None
Florida	None
Georgia	None
Kentucky	None
Mississippi	12.5%
North Carolina	12.5
South Carolina	None
Tennessee	25%(loan)
REGION V	
Illinois	None
Indiana	10%
Michigan	5
Minnesota	15
Ohio	None
Wisconsin	5-15***
REGION VI	
Arkansas	None
Louisiana	None
New Mexico	12.5%
Oklahoma	None
Texas	None
REGION VII	
Iowa	None
Kansas	None
Missouri	15%
Nebraska	12.5
REGION VIII	
Colorado	5%
Montana	None
North Dakota	None
South Dakota	5
Utah	None
Wyoming	None
REGION IX	
Arizona	5%
California	12.5
Hawaii	10
Nevada	None
American Samoa	25**
Tr.Terr.of Pac.Islds.	25**
Guam	25**
REGION X	
Alaska	12.5
Idaho	15
Oregon	None
Washington	15

* May decrease due to lack of funds
** Applicant same as State
*** Variable

SOURCE: Environmental Protection Agency

 APPENDIX II

COMPARATIVE COST STUDIES OF ARCHITECTURAL TREATMENT

IN THREE WASTEWATER TREATMENT PLANTS

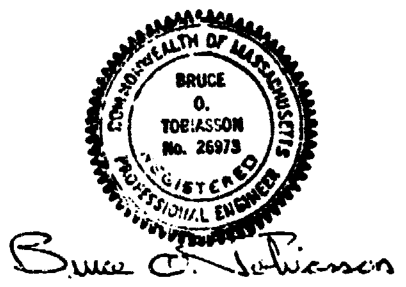
Prepared for the GENERAL ACCOUNTING OFFICE

DECEMBER 1975

by

GALE ENGINEERING COMPANY, INC.

8 Washington Place, Braintree, Mass.



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REPORT TO THE GENERAL ACCOUNTING OFFICE

Comparative Cost Studies of Architectural Treatment in
Three Wastewater Treatment Plants

Studies were performed to determine the comparative cost of alternative architectural treatment in three wastewater treatment plants. The specific items studied include exterior siding, interior walls, flooring, windows and doors as designed compared to less costly alternatives. The plans and specifications for each plant were briefly reviewed and a site visit made to each facility. This study does not address itself to alternatives for basic structural design philosophy such as pre-engineered steel building in lieu of brick and block construction, nor is it a detailed investigation of all items under study. It does, however, present a reasonable comparison of existing building features to our determination of a less costly alternative.

As a basis for comparison, this study considers the following items as the less costly alternatives consistent with the anticipated service. Exterior siding as a minimum would consist of cavity wall sections of 4" x 8" x 16" plain concrete face block and 6" x 8" x 16" plain concrete back-up block epoxy painted on the interior exposed face. Exterior face block would be silicone sealed to retard moisture absorption but would retain the natural color of block and mortar. Interior partition walls would be 6" & 8" lightweight concrete block epoxy painted on all exposed surfaces and with glazed structural tile base course for ease of cleaning. Flooring would be resilient tile in the main entrance and corridor, office spaces, lunch rooms, laboratory and control rooms. It is felt these areas require underfoot comfort for plant personnel and ease of cleaning capability. Toilet rooms, showers and locker rooms would have ceramic tile or equivalent flooring. Work spaces

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containing equipment such as vacuum filters or centrifuges would have surface treated concrete floors to allow washing and cleaning. Chemical storage, general storage, workshops, truck wells and other areas where sanitation is not affected would have plain concrete floors. The less costly alternative for doors would be hollow metal doors with steel frames appropriately painted for interior use and aluminum doors for exterior use. Windows would be aluminum frame with single glass thickness. All three plants studied conform to the less costly alternative for doors and windows and therefore this category has not been itemized in the cost breakdown for each plant.

Life cycle costs as presented in this report are defined as those costs associated with minimum maintenance providing continued use of the item under consideration for a life cycle time frame of 20 years. Life cycle costs do not consider routine operations and maintenance items such as washing of windows and walls, and waxing floors since these items would be constant whether the less costly alternative or existing construction is utilized, nor does it include potential costs due to vandalism. Costs considered would include such items as resealing of exterior concrete block walls to prevent moisture absorption, resealing of translucent panels and repainting of interior masonry walls after the first 10 years of occupation.

As requested by the G. A. O., the costs associated with each treatment plant have been related to a specific time frame ranging from April 1972 to March 1974. In general, for each item commented upon the costs were developed directly from area suppliers of each product for the appropriate time frame. This data was

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then verified and geographicaly adjusted utilizing several construction cost guides including Masonry Cost Index 1973, published by Mason Contractors Assoc. of Massachusetts; Building Construction Cost Data, 1972, 1973, 1974, published by Robert Snow Means Company, Inc.; Building Cost File, 1973, published by Construction Publishing Co., Inc.; and Dodge Manual for Building Construction Pricing and Scheduling, published by McGraw Hill Information Systems Co. Other sources included review of bid prices for similar types of construction projects within the designated time frames.

All of the unit prices presented reflect our best judgment as to appropriate costs after rationalizing geographic location, quantity of work involved, and time frame.

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WASTEWATER TREATMENT PLANT "A"

Comparative Cost Related to February 1973

1. EXTERIOR SIDING:

Existing: Siding consists of colored split rib face block; precast concrete fascia panels; and architectural metal curtain walls (translucent panels)

a. Split rib face block	3290 s.f.	@ $3.02/s.f.	=	$ 9,936
b. Precast conc. panels	1936 s.f.	@ $8.80/s.f.	=	17,037
Base	318 l.f.	@ $5.00/l.f.	=	1,590
Belt course	384 l.f.	@ $5.00/l.f.	=	1,920
c. Architectural metal curtain wall				
Curtain wall panels	2098 s.f.	@ $9.00/s.f.	=	18,882
Fastening hardware	250 l.f.	@$28.00/l.f.	=	7,000
		Sub Total	=	$ 56,365
Life cycle costs (seal translucent panel in 10 years)	2098 s.f.	@ $0.20	=	420
				$ 56,785

Alternative: Substitute 4" concrete block for split rib block, precast fascia panels, base & belt course. Replace translucent panels with 500 s. f. of aluminum frame windows and the remainder with 4" concrete face blocks and 6" concrete back up blocks.

a. 4" concrete block	3290 s.f.	@ $2.45/s.f.	=	$ 8,060
b. 4" concrete block	2286 s.f.	@ $2.45/s.f.	=	5,600
c. Window units - sash and glass	500 s.f.	@ $7.13/s.f.	=	3,565
Steel Lintels	120 l.f.	@ $3.60/l.f.	=	432
4" concrete block	1598 s.f.	@ $2.45/s.f.	=	3,915
6" concrete block	1598 s.f.	@ $2.57/s.f.	=	4,107
Paint	1598 s.f.	@ $0.30/s.f.		479
		Sub Total	=	$ 26,158
Life cycle costs (reseal exterior 4" block siding in 10 yrs.)	7174 s.f.	@ $0.20/s.f.	=	$ 1,435
(repaint interior 6" block wall)	1598 s.f.	@ $0.30/s.f.	=	480
		Total	=	$ 28,073
		Net Savings	=	$ 28,712

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Comments: The less costly alternative as indicated would suffice for shelter and protection. It would improve heat retention capability in areas of translucent panel replacement but reduce exterior light transmission in those areas. The proposed alternative would reduce esthetics.

2. INTERIOR WALLS:

Existing: Interior walls are generally 6" concrete block, painted and with glazed structural tile base course for ease of cleaning. These walls represent the less costly alternative while suited to the intended service.

One exception is glass partition wall between sludge treatment room and truck area.

a. Glass partition wall	290 s.f. @ $14.00/s.f.	=	$ 4,060
Life cycle costs		=	0
	Total	=	$ 4,060

Alternative:

6" concrete block partition wall, painted one side with observation glass:

6" concrete block	250 s.f. @ $2.57/s.f.	=	$ 643
Paint	250 s.f. @ $0.30/s.f.	=	75
Sash & glass	40 s.f. @ $8.00/s.f.	=	320
	Total	=	$ 1,038
Life cycle costs (repaint in 10 years)	250 s.f. @ $0.30/s.f.	=	75
	Total	=	$ 1,113
	Net Savings	=	$ 2,947

Comments: By selecting the alternative construction, visibility between the sludge treatment room and the truck area is sacrificed as well as light transmission between the areas, however heat transmission is reduced. A reduction in esthetics for this area would not be meaningful.

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3. FLOORING:

Existing: Flooring consists of painted and unpainted concrete in work areas and resilient tile in entry, administration and laboratory areas. We believe this construction to be the less costly alternative for the intended service.

Alternative: None recommended

Comments: The selection of floor surfaces in this plant is consistent with the defined less costly alternative for floor surface construction

4. OTHER:

A. MAIN ENTRANCE:

Existing: The main entrance has a glass curtain wall to each side and above the entrance doors.

a. Glass curtain wall	170 s.f. @ $14.00/s.f.	=	$ 2,380
Life cycle costs			0
	Total	=	$ 2,380

Alternatives:

a. 4" concrete face block wall	170 s.f. @ $2.45/s.f.	=	$ 417
6" concrete back up block	170 s.f. @ $2.57/s.f.	=	437
Paint (interior face)	170 s.f. @ $0.30/s.f.	=	51
Life cycle costs (reseal in 10 years)	170 s.f. @ $0.20/s.f.	=	34
(repaint interior wall in 10 years)	170 s.f. @ $0.30/s.f.	=	51
	Total	=	$ 990
	Net Savings	=	1,390

Comments: Selection of the less costly alternative will result in a reduction in esthetics and a reduction in light transmission into the lobby, however increased heat retention capability will be gained.

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B. ENTRANCE STAIRS:

Exsiting: Black slate stair treads, risers and platform on cast-in-place concrete

4 treads, 1' x 19' =	76 s.f. @ $15.00/s.f.	=	$	1,140
5 risers, 6" x 19' =	48 s.f. @ $10.00/s.f.	=		480
walking surface	185 s.f. @ $10.00/s.f.	=		1,850
	Sub Total	=	$	3,470
Life cycle costs (repoint in 10 years)				
	309 s.f. @ $1.62/s.f.	=		500
	Total		$	3,970

Alternative: Plain concrete with stair nosing of abrasive aluminum

4 treads, plain conc. w/nosing & finish	@ $4.50/s.f.	=	$	342
5 risers, plain conc. (rubbed)	@ $1.00/s.f.	=		48
walking surface (rubbed)	@ $0.25/s.f.	=		47
	Sub Total	=	$	437
Life cycle costs		=		0
	Total	=	$	437
	Net Savings	=	$	3,533

Comments: The black slate stair treads, risers and platform serve no useful purpose for the intended service and only add to the esthetics of the main entrance. Nothing else would be sacrificed in selecting the alternative indicated

C. PLASTIC SKYDOMES:

Existing: On the roof of this building are 17 plastic skydomes allowing daylight into the work areas beneath

Total plastic skydomes	317 s. f. @ $10.71/s.f.	=	$	3,395
308 l. f. curbing	@ $4.00/l.f.			1,232
250 l.f. steel beam W6x12	@ $3.60/l.f.			900
	Sub Total	=	$	5,527
Life cycle costs		=		0
	Total	=	$	5,527

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Alternative: Eliminate skydomes and continue metal roof deck and roofing over all areas.

Metal deck	317 s. f. @ $0.60/s.f.	=	$	190
Roofing and insulation	317 s. f. @ $2.00/s.f.	=		634
	Sub Total	=	$	824
Life cycle costs				0
	Total	=	$	824
	Net Savings	=	$	4,703

Comments: The existing skydomes allow light transmission during daylight hours thereby reducing usage of interior artificial lighting with a resulting saving of electrical consumption. The magnitude of the saving in initial construction costs by using the alternative would appear to far outweigh the savings in power consumption.

Total anticipated savings Plant "A" utilizing the less costly alternatives. = $41,285

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WASTEWATER TREATMENT PLANT "B"

Comparative Cost Related to April 1972

1. EXTERIOR SIDING:

Existing: Siding consists of 4" face brick veneer (dense quality)

4" face brick veneer	4900 s.f. @ $5.00/s.f.	=	$ 24,500
Life cycle costs		=	0
	Total	=	$ 24,500

Alternative: Substitute 4" concrete block, sealed

	4900 s.f. @ $2.40/s.f.	=	11,760
Life cycle costs (reseal in 10 years)	4900 s.f. @ $0.20/s.f.	=	980
	Total	=	$ 12,740
	Net Savings	=	$ 11,760

Comments: The alternative concrete block facing would provide the same degree of shelter as brick, it has a "U" factor of .33 versus a "U" factor of .45 for brick indicating less heat loss through the concrete block. The concrete block would require a silicone resealing at 10 year intervals to retard moisture absorption, whereas the face brick veneer would be maintenance free for up to 35 years. Some esthetics would be lost by using the concrete block.

2. INTERIOR WALLS:

Existing: Back up blocks for exterior brick veneer and interior partition walls glazed structural tile.

a. Exterior back up blocks 8" x 8" x 16" glazed structural tile	4900 s.f. @ $5.20/s.f.	=	$ 25,480
b. Interior partition walls-glazed structural tile			
4" x 8" x 16"	7900 s.f. @ $4.00/s.f.	=	31,600
2" x 8" x 16"	7900 s.f. @ $3.60/s.f.	=	28,440
	Sub Total	=	$ 85,520
Life cycle costs		=	0
	Total	=	$ 85,520

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Alternative: Substitute 6" x 8" x 16" concrete block for exterior back up blocks and 6" x 8" x 16" concrete block for interior partition walls. All exposed faces to be painted.

a. Exterior back up blocks - 6" x 8" x 16"			
concrete	4560 s.f. @ $2.50/s.f.	=	$ 11,400
paint	4560 s.f. @ $0.30/s.f.	=	1,368
glazed structural base	340 s.f. @ $4.56/s.f.	=	1,550
b. Interior partition walls - 6" x 8" x 16"			
concrete block	7520 s.f. @ $2.50/s.f.	=	18,800
paint	15040 s.f. @ $0.30/s.f.	=	4,512
glazed structural base	380 s.f. @ $4.56/s.f.	=	1,733
	Sub Total	=	$ 39,363
Life cycle costs (repaint walls in 10 years)	19600 s.f. @ $0.30/s.f.	=	5,880
	Total	=	$ 45,243
	Net Savings	=	$ 40,277

Comments: The glazed structural tile, although providing an excellent maintenance free surface, appears overused in this facility. A properly painted concrete block would be adequate for the intended service for all areas where glazed structural tile has been used. The only sacrifice in using concrete block is a required repainting after 10 years of service.

3. FLOORING:

Existing: The first floor level of this building has a total of approximately 1400 square feet of ¼" thick polyester terrazzo flooring in administration, toilet, laboratory, lunch and entrance areas. The second floor level has 1/8" thick polyester ceramic chip coating which we feel is consistent with the intended service for this area.

1/4" polyester terrazzo	1400 s.f. @ $2.50/s.f.	=	$ 3,500
Life cycle costs		=	0
	Total	=	$ 3,500

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Alternative: Substitute resilient tile for all first floor polyester errazzo except toilet and locker rooms.

Tile 1400 s.f. - 270 s.f. = 1130 s.f. @ $0.75		=	$ 848
1/4" polyester terrazzo 270 s.f. @ $2.50/s.f.		=	675
	Total	=	$ 1,523
Life cycle costs		=	0
	Total	=	$ 1,523
	Net Savings	=	$ 1,977

Comments: The polyester terrazzo flooring, being a monolithic coating would be somewhat easier to maintain and would have a greater endurance capability over the building life cycle.

4. OTHER:

Fenestration at underside of precast roof tees:

Acrylic plastic panels between concrete bond beam & precast tees not considered since any closure would be of comparable cost.

Total anticipated savings Plant "B" utilizing the less costly alternatives. = $54,014

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WASTEWATER TREATMENT PLANT "C"

Comparative Cost Related March 1974

1. EXTERIOR SIDING:

Existing: Siding consists of 4" face brick veneer (standard quality)

4" face brick veneer	12450 s.f. @ $4.80/s.f.	=	$ 59,760
Life cycle costs		=	0
	Total	=	$ 59,760

Alternative: Substitute 4" concrete block, sealed

	12450 s.f. @ $2.75/s.f.	=	$ 34,238
Life cycle costs (reseal in 10 years)	12450 s.f. @ $0.20/s.f.	=	$ 2,490
	Total	=	$ 36,728
	Net Savings	=	$ 23,032

Comments: Concrete block would provide the same degree of shelter as brick and it has better heat retention properties. The concrete block would require silicone resealing at 10 year intervals to retard moisture absorption, whereas the face brick veneer would be maintenance free for up to 35 years.

2. INTERIOR WALLS:

Existing: Back up blocks for exterior brick veneer and interior partition walls are varying sizes and combinations of concrete masonry units and glazed structural tile. The concrete masonry units are in accordance with the less costly alternative and therefore only the glazed structural tile will be considered.

a. Exterior back up blocks:

8" x 8" x 16" glazed structural tile	3477 s.f. @ $6.30/s.f.	=	$ 21,905

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a. Exterior back up blocks: (Cont'd)

8" x 8" x 16" acoustic glazed structural tile
2363 s.f. @ $8.00/s.f. = $ 18,904
(made up from 4" concrete + 4" Tile)

6" x 8" x 16" glazed structural tile
580 s.f. @ $5.05/s.f. = 2,929

b. Interior partition walls:

2" x 8" x 16" glazed structural tile
1794 s.f. @ $4.10/s.f. = 7,355

4" x 8" x 16" glazed structural tile
7548 s.f. @ $4.40/s.f. = 33,211

6" x 8" x 16" glazed structural tile
1006 s.f. @ $5.05/s.f. = 5,080

Sub Total = $ 89,384

Life cycle costs = 0

Total = $ 89,384

Alternative: Substitute appropriate size concrete block for all areas of glazed structural tile. Exposed concrete block surfaces to be painted.

a. Exterior back up blocks:

6" x 8" x 16" concrete block
6280 s.f. @ $2.65/s.f. = $ 16,642

Paint
6280 s.f. @ $0.30/s.f. = 1,884

6" x 8" x 16" glazed structural tile base
140 s.f. @ $5.05/s.f. = 707

b. Interior partition walls:

2" x 8" x 16" concrete block
1764 s.f. @ $2.50/s.f. = $ 4,410

2" x 8" x 16" glazed structural tile base
30 s.f. @ $4.10/s.f. = 123

4" x 8" x 16" concrete block
7238 s.f. @ $2.55/s.f. = $ 18,457

4" x 8" x 16" glazed structural tile base
310 s.f. @ $4.40/s.f. = 1,364

6" x 8" x 16" concrete block
940 s.f. @ $2.65/s.f. = 2,491

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b. Interior partition walls: (cont'd)

6" x 8" x 16" glazed structural tile base 66 s.f. @ $5.05/s.f.	=	$	333
Paint - concrete block 16222 s.f. @ $0.30/s.f.	=		4,867
Sub Total	=	$	51,278
Life cycle costs (repaint concrete block in 10 years) 16222 s.f. @ $0.30/s.f.	=		4,867
Total	=	$	56,145
Net Savings	=	$	33,239

Comments: The glazed structural tile, although providing an excellent maintenance free surface, appears greatly overused in this facility. A properly painted concrete block would be adequate for the intended service for all areas where glazed structural tile has been used. The only sacrifice in using concrete block is a required repainting after 10 years of service. The acoustic glazed structural tile found in the centrifuge room of this building, although reducing any equipment noise generated, has a potential for attracting particulate matter which may lead to bacteria development and therefore may offset the benefit of the glazed surface. It was noted that the chemical storage and truck way areas in the primary plant have a glazed wall coating; however the specified coating compares favorably with the cost of a painted surface and therefore alternative cost was not considered.

3. FLOORING:

Existing: Polyester ceramic chip coating 1/8" thick occurs in electric, chlorine, chlorine scale, centrifuge and janitors' rooms. This coating is in accordance with the less costly alternative and therefore has not been considered. Polyester terrazzo surface 1/4" thick occurs in office, corridor #1, corridor #2, men's toilet and locker room. women's toilet and laboratory. All other floor surfaces are conventionally treated concrete and have not been considered.

1/4" polyester terrazzo 2124 s.f. @ $2.75/s.f.	=	$	5,841
Life cycle costs			0
Total	-	$	5,841

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3. FLOORING: (cont'd)

Alternative: Substitute resilient tile for all areas of polyester terrazzo except toilet areas.

resilient tile 1700 s.f. - 400 = 1300 s.f. @ $1.00/s.f.		$	1,300
1/4" polyester terrazzo 400 s.f. @ $2.75/s.f.	=		1,100
Sub Total	=	$	2,400
Life cycle costs			0
Total	=	$	2,400
Net Savings:	=	$	3,441

Comments: The polyester terrazzo flooring, being a monolithic coating would be somewhat easier to maintain and would have a greater endurance capability over the building life cycle.

Total anticipated savings Plant "C" utilizing the less costly alternatives. $ 59,712

APPENDIX III

PRINCIPAL ENVIRONMENTAL PROTECTION AGENCY OFFICIALS RESPONSIBLE FOR ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
ADMINISTRATOR:		
Douglas M. Costle	Mar. 1977	Present
John R. Quarles, Jr. (acting)	Jan. 1977	Mar. 1977
Russell E. Train	Sept. 1973	Jan. 1977
John R. Quarles, Jr. (acting)	Aug. 1973	Sept. 1973
Robert W. Fri (acting)	Apr. 1973	Aug. 1973
William D. Ruckelshaus	Dec. 1970	Apr. 1973
ASSISTANT ADMINISTRATOR FOR WATER AND HAZARDOUS MATERIALS:		
Thomas C. Jorling	June 1977	Present
Dr. Andrew Breidenbach	Sept. 1975	June 1977
James L. Agee	Apr. 1974	Sept. 1975
Roger Strelow (acting) (note a)	Feb. 1974	Apr. 1974
Robert L. Sansom (note a)	Apr. 1972	Feb. 1974
DEPUTY ASSISTANT ADMINISTRATOR FOR WATER PROGRAM OPERATIONS:		
John R. Rhett	Mar. 1973	Present
Louis De Camp (acting)	Sept. 1972	Mar. 1973
Eugene T. Jensen	June 1971	Sept. 1972

a/ Before April 22, 1974, the title of this position was Assistant Administrator for Air and Water Programs.