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91st Congress
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COMMITTEE PRINT

OPERATION AND MAINTENANCE OF MUNICIPAL WASTE TREATMENT PLANTS

REPORT

TO THE

SUBCOMMITTEE ON AIR AND WATER POLLUTION

OF THE

COMMITTEE ON PUBLIC WORKS
UNITED STATES SENATE

BY THE

COMPTROLLER GENERAL OF THE UNITED STATES

AT THE REQUEST OF

SENATOR EDMUND S. MUSKIE

NOVEMBER 1969

Printed for the use of the Committee on Public Works

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LETTER OF TRANSMITTAL

Hon. JENNINGS RANDOLPH,
Chairman, Committee on Public Works,
U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: As you know, in November of 1968 I requested the Comptroller General to prepare a report on the operation and maintenance of completed waste treatment plants constructed in part with grants awarded by the Federal Water Pollution Control Administration, Department of the Interior.

This committee has long been interested in the water pollution control program and has been a leader in the effort to improve the quality of the Nation's waters. In this regard, the GAO report has been of great interest to the members of the subcommittee and will be of substantial benefit to the subcommittee in its deliberations concerning water pollution control legislation early next year.

The subcommittee expresses its appreciation to Comptroller Staats and his assistants in the General Accounting Office for the outstanding job they did in performing this review for the subcommittee.

Sincerely,

EDMUND S. MUSKIE, U.S. Senator,
Chairman, Subcommittee on Air and Water Pollution.

LETTER OF SUBMITTAL

COMPTROLLER GENERAL OF THE UNITED STATES,
Washington, D.C.

DEAR MR. CHAIRMAN: The accompanying report presents the results of our review of certain aspects of the operation and maintenance of municipal waste treatment plants approved under the construction grants program of the Federal Water Pollution Control Administration (FWPCA), Department of the Interior. The review was undertaken as a result of your request of November 19, 1968, and this is the second of three reports necessary to comply with that request.

As requested by the committee staff, we did not obtain the formal comments of the Department of the Interior on the matters discussed in this report. These matters were, however, discussed with officials of FWPCA as our review progressed.

We plan to made no further distribution of this report unless copies are specifically requested, and then we shall make distribution only after your agreement has been obtained or public announcement has been made by you concerning the contents of this report.

Sincerely yours,

ELMER B. STAATS,
Comptroller General of the United States.

DIGEST

Why the Review Was Made

The chairman of the Senate Subcommittee on Air and Water Pollution, Committee on Public Works, in a letter dated November 19, 1968, requested that the General Accounting Office (GAO) provide to the committee factual information on the operation and maintenance (O. & M.) of completed waste treatment facilities. The review involved six States and three Federal Water Pollution Control Administration (FWPCA) regions.

Findings and Conclusions

GAO's review showed that FWPCA and State requirements for insuring proper and efficient O. & M. of waste treatment plants were, in comparison with the procedures followed after the project was placed in operation, rather limited at the time a construction grant application was being considered.

FWPCA has not established guidelines which set forth specific O. & M. requirements that are to be met before an applicant receives a construction grant. Rather, FWPCA headquarters officials rely upon regional office officials to evaluate each application on its own merits after having given due consideration to the screening of applications by responsible State agencies.

GAO found that, before a grant was made, FWPCA regional officials usually approved an application if the applicant (1) certified that he would properly and efficiently operate and maintain the completed plant and (2) furnished certain general information on labor and funding.

With regard to the six States included in the GAO review, none require an applicant to specify the provisions he has made or plans to make for insuring proper and efficient O. & M.

Once a plant has been constructed, FWPCA's principal procedure for insuring proper and efficient operation is to conduct an inspection about 1 year after the plant is placed in operation. These inspections are usually completed within half a day.

The six States follow a number of procedures for insuring proper and efficient O. & M., including issuing waste discharge permits, inspecting plants, requiring plant operating reports, and providing operator training and certification programs.

Three fundamental requirements for the proper operation of waste treatment plants are personnel, laboratory controls, and records. Guidelines developed by a conference of State sanitary engineers and distributed by FWPCA to its regional offices, States, and consulting engineering firms contain recommendations for minimum personnel, laboratory controls, and records for various sizes and types of municipal waste treatment plants. These guidelines are generally considered

to be adequate minimum criteria. GAO examined into whether the recommended minimum criteria had been provided at 69 plants in the six States and found that at 59 plants one or more of the recommendations had not been met.

FWPCA and State officials recognize that many plants are not operating effectively. They generally attribute O. & M. problems to such causes as lack of qualified operators and inadequate control over industrial sources of pollution.

GAO visited two plants in each of the six States to review O. & M. problems. Instances of operating difficulties existed in 11 of the 12 plants. For example, operating difficulties were so serious in one plant that its abandonment had been recommended. Poor maintenance practices caused a second plant to deteriorate "virtually to the point of destruction." Concerning a third plant, a qualified operator was not available and raw sewage was bypassing the plant. For a detailed discussion of our findings on each of the 12 plants, see pages 17 to 23 of this report.

Agency Actions and Unresolved Issues

As requested by the committee staff, GAO did not obtain the formal comments of the Department of the Interior on the matters discussed in this report. These matters were, however, discussed with FWPCA officials as GAO's review progressed.

GAO found that FWPCA and the six States were taking or considering certain actions to improve plant O. & M. FWPCA (1) is considering proposed policies and procedures for improving the O. & M. program, (2) has issued to its regional offices instructions that provide that all applicants for construction grant funds require consulting engineers who design the waste treatment plants to furnish operating manuals and on-the-job training for plant employees, and (3) has increased its efforts related to the training of plant operators. The six States are also taking action to increase their training and inspection programs.

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ABBREVIATIONS

BOD—biochemical oxygen demand.
CAMPS—Cooperative Area Manpower Planning System.
Conference—Conference of State Sanitary Engineers.
FWPCA—Federal Water Pollution Control Administration.
GAO—General Accounting Office.
HEW—Department of Health, Education, and Welfare.
MDTA—Manpower Development and Training Act.
MGD—millions of gallons a day.
NW—Northwest.
O&M—operation and maintenance.
OB—Ohio Basin.
PHS—Public Health Service.
SE—Southeast.

OPERATION AND MAINTENANCE OF MUNICIPAL WASTE TREATMENT PLANTS

INTRODUCTION

On October 24, 1968, representatives of the General Accounting Office met with staff members of the Senate Committee on Public Works to inform them of the results of our survey of the activities of the Federal Water Pollution Control Administration and to ascertain what specific areas were of interest to the committee. Subsequently, by letter dated November 19, 1968, the chairman of the Senate Subcommittee on Air and Water Pollution, Committee on Public Works, requested our Office to provide factual information on several matters. (See app. I.)

On April 11, 1969, we issued the first report in response to the November 19, 1968, request—"Personnel, Staffing, and Administration of the Federal Water Pollution Control Administration" (B–166506). The subject matter of this report is the operation and maintenance of completed waste treatment facilities approved under FWPCA's construction grants program. We plan to examine further into plant O. & M. and to issue a report to the Congress on the results of the examination.

The scope of our review is described on page 27.

Construction Grants Program

The Federal Water Pollution Control Act of 1956, as amended (33 U.S.C. 466), authorizes grants to State, interstate, municipal, and intermunicipal agencies for the construction of necessary treatment works to prevent the discharge of untreated or inadequately treated sewage or other waste into any waters. The act limits the extent of Federal financial assistance to an amount not to exceed from 30 to 55 percent of project cost, the percentage being dependent upon the fulfillment of certain conditions specified in the act.

Municipal waste discharged directly into water or carried by natural runoff into water historically has received much of the attention devoted to water pollution control. From 1957 to June 30 1968, FWPCA, through its construction grants program approved, grants of about $1 billion for the construction of more than 8,000 waste treatments projects.

Waste Treatment Processes

The conventional waste treatment process is usually considered to consist of two steps—primary treatment and secondary treatment. Primary treatment involves (1) the removal of suspended and settleable solids by flotation and sedimentation and (2) chlorination of the effluent. Primary treatment plants normally reduce the biochemical

oxygen demand (BOD)[1] by about 35 percent, through removal of about 50 percent of the suspended solids and of about 90 percent of the settleable solids. Where the flow of the receiving stream is high in relation to the quantity of sewage contributed, the primary treatment process is sometimes sufficient to safeguard public health and to prevent the development of nuisance conditions. However, additional treatment beyond primary treatment is often required, especially in instances where the receiving streamflow may be low or where pollution loads are exceptionally high.

Secondary treatment involves the aerobic decomposition,[2] of the greater portion of the organic matter left in the effluent after the primary treatment process. Generally, where secondary treatment is required, the main function is to furnish oxygen to support aerobic stabilization of the organic matter which cannot be removed by sedimentation. Secondary plants without high industrial waste concentrations will normally remove from 80 to 95 percent of the total BOD, and approximately 85 percent of the suspended solids. The presence of industrial wastes can be expected to reduce these removals if the plant is not properly designed and careful control is not continually maintained over the treatment process.

Under its "Guidelines for Establishing Water Quality Standards for Interstate Waters," FWPCA provides that all wastes, prior to discharge into any interstate water, receive the best practical treatment or control unless it can be demonstrated that a lesser degree of treatment or control will provide for water quality enhancement commensurate with proposed present and future water uses.

Waste Treatment Plant Operation and Maintenance Costs

The basic cost elements to operate and maintain waste treatment plants are labor, power, spare parts, and chemicals, labor generally accounting for 50 to 60 percent of the cost. However, the composition of these elements of O. & M. costs depends on such factors as wasteload, degree of treatment, method of treatment, and age and size of plant.

FWPCA estimates that units of local government in the United States are currently spending between $150 million and $200 million a year to operate and maintain waste treatment plants. On a per capita basis, the cost amounts to about $1.40 for every man, woman, and child being served by waste treatment plants. A comparison of estimated annual O. & M. costs between various types and sizes of waste treatment plants is shown in the following table.

---

[1] BOD is a measure of the strength of sewage in terms of the amount of oxygen required to sustain decomposition of the waste by bacteria.

[2] Aerobic decomposition is the breakdown of organic matter in sewage by bacteria which grow only in an aquatic environment containing dissolved oxygen.

COMPARISON OF ESTIMATED ANNUAL O. & M. COSTS BETWEEN VARIOUS TYPES AND SIZES OF WASTE TREATMENT PLANTS

Size (flow in millions of gallons per day)	Type [1] and estimated annual O. & M. costs [2]		Ratio of annual O. & M. costs
	Primary treatment	Activated sludge	
0.1	$5,930	$6,360	1 to 1.1
1.0	22,900	34,100	1 to 1.5
10.0	88,400	183,000	1 to 2.1
100.0	357,000	983,000	1 to 2.8
	High-rate trickling filter	Activated sludge	
0.1	$5,360	$6,360	1 to 1.2
1.0	21,400	34,100	1 to 1.6
10.0	93,700	183,000	1 to 2.0
	Primary treatment	High-rate trickling filter	
0.1	$5,930	$5,360	1 to 0.90
1.0	22,900	21,400	1 to 0.94
10.0	88,400	93,700	1 to 1.06

[1] Activated sludge and high-rate trickling filter are secondary treatment processes. The high-rate trickling filter has capacity limitations.

[2] Costs expressed in 1968 dollars. These estimates represent the results of an FWPCA study of data submitted by 1,600 plants between 1965 and 1968. The study did not exclude poorly operated plants, make allowances for regional cost differences, or ascertain the reliability of the data furnished.

FWPCA estimates that Federal participation in the funding of waste treatment works construction will require about $3.6 billion for the 5-year period beginning with fiscal year 1969. It can be expected that, as a result of future construction of additional waste treatment plants, total annual O. & M. costs will increase. A comparison of estimated construction costs with estimated total O. & M. costs over the life of the plants by various types and sizes of waste treatment plants, is shown in the following table. The O. & M. costs represent our projection of estimated annual O. & M. costs over the average estimated useful life—25 years—of waste treatment plants.

COMPARISON OF ESTIMATED CONSTRUCTION COSTS WITH ESTIMATED TOTAL O. & M. COSTS OVER THE LIFE OF THE PLANTS BY VARIOUS TYPES AND SIZES OF WASTE TREATMENT PLANTS [1]

Type [2]	Size (flow in million gallons per day)	Estimated construction costs [3]	Estimated total O. & M. costs over life of plant [4]	Ratio of construction costs to O. & M. costs
Waste stabilization ponds	0.1	$45,000	$25,750	1 to 0.6
	1.0	112,000	92,250	1 to 0.8
Primary treatment	.1	72,000	148,250	1 to 2.1
	1.0	341,000	572,500	1 to 1.7
	10.0	1,610,000	2,210,000	1 to 1.4
	100.0	7,560,000	8,925,000	1 to 1.2
High-rate trickling filter	.1	79,400	134,000	1 to 1.7
	1.0	380,000	535,000	1 to 1.4
	10.0	1,820,000	2,342,500	1 to 1.3
Activated sludge	.1	81,400	159,000	1 to 2.0
	1.0	428,000	852,500	1 to 2.0
	10.0	2,260,000	4,575,000	1 to 2.0
	100.0	11,900,000	24,575,000	1 to 2.1

[1] Costs expressed in 1968 dollars.

[2] Waste stabilization ponds, high-rate trickling filter, and activated sludge are secondary treatment processes. The waste stabilization ponds and the high-rate trickling filter have capacity limitations.

[3] Based on daily design flow. These estimates do not include the cost of land. Data is from an FWPCA study of about 2,500 FWPCA-assisted projects completed or under construction as of December 1966.

[4] Based on average daily flow. These estimated O. & M. costs were based on an FWPCA study of data reported by 1,600 plants between 1965 and 1968 and on an average estimated useful plant life of 25 years but do not allow for inflationary influences on O. & M. costs over the 25-year period. The FWPCA study did not exclude poorly operated plants, make allowances for regional cost differences, or ascertain the reliability of the data.

INFORMATION OBTAINED ON OPERATION AND MAINTENANCE OF WASTE TREATMENT PLANTS

FWPCA, in a cooperative Federal-State-local effort to control water pollution, is authorized to award grants to municipalities for the construction of waste treatment plants. The municipalities have the responsibility for the proper and efficient O. & M. of these plants. In this regard, the Federal Water Pollution Control Act provides that:

> No grant shall be made for any project * * * until the applicant has made provision satisfactory to the Secretary (of the Interior) for assuring proper and efficient operation and maintenance of the treatment works after completion of the construction thereof.

The act provides also that:

> In determining the desirability of projects for treatment works and of approving Federal financial aid in connection therewith, consideration shall be given by the Secretary to * * * the adequacy of the provisions made or proposed by the applicant for such Federal financial aid for assuring proper and efficient operation and maintenance of the treatment works after completion of the construction thereof.

The following sections of this report discuss the procedures of FWPCA and the States for insuring proper and efficient O. & M. of plants, personnel, and controls provided at selected plants, major problems identified with regard to plant operation, and actions being taken by FWPCA and the States to improve plant O. & M.

FWPCA Procedures for Assuring Proper and Efficient Plant Operation and Maintenance

Our review showed that FWPCA's requirements for assuring proper and efficient O. & M. of a waste treatment plant were, in comparison with the procedures followed after the plant had been placed in operation, rather limited at the time an application for a construction grant was being considered. We found that, before construction grants were awarded, FWPCA obtained and reviewed certain forms of assurances that the plant would be properly and efficiently operated and maintained and that, after plants had been constructed, FWPCA conducted inspections about 1 year after the plants became operational, and participated in training programs for plant operators.

REQUIREMENTS BEFORE A GRANT IS AWARDED

FWPCA requires that applications for Federal construction grants be submitted through State water pollution control agencies. An application is usually accompanied by an engineering report, which describes alternative projects considered and recommends that the preferred project be constructed. After FWPCA approval of the application, the FWPCA regional office makes a written offer to the applicant, which is conditional upon the applicant's agreement to comply with various

assurances stated or referred to in the offer and acceptance form, including an assurance that the applicant will properly and efficiently operate and maintain the completed plant. Upon acceptance of FWPCA's offer, the applicant is required to submit detailed project plans and specifications to FWPCA for review and approval.

The Director, Division of State and Local Programs, FWPCA, advised us that FWPCA had not established guidelines that set forth specific O. & M. requirements to be met before an applicant received a construction grant. He advised us further that FWPCA relied upon its regional office officials to evaluate each case on its own merits, after having given due consideration to the screening of applications by responsible State agencies.

We found that FWPCA regional office requirements regarding application for construction grants were usually satisfied if the applicant (1) certified that the completed plant would be properly and efficiently operated and maintained and (2) furnished certain general information on labor and funding for O. & M. Prior to January 1966, applicants for construction grants were required to furnish information in their applications on the annual funds to be used for labor, chemicals, utilities, and supplies. Since that date it has been required that applications include also a breakdown of the number and types of employees to be hired. The certification and other information mentioned above have been incorporated in the grant agreements by reference to them in the offer and acceptance form.

In examining into whether applicants had been providing the information mentioned above we reviewed the applications available for 67 of 69 selected plants approved for Federal grants in three FWPCA regions—Northwest (NW) region, Ohio Basin (OB) region, and Southeast (SE) region. These plants had been inspected between January 1, 1967, and December 31, 1968. Our sample included plants in six States—Montana and Oregon in the Northwest region, Indiana and Kentucky in the Ohio Basin region, and Georgia and Tennessee in the southeast region. To the extent possible, we selected projects representative of the various sizes and types for which construction grants had been made.

Our review of the 67 applications showed that 54 contained the required data. The remaining 13 applications did not contain the required detail.

Regional office officials advised us that, in their opinion, the certification regarding O. & M. contained in an application and the offer and acceptance was sufficient. However, they stated that, although the certification was legally enforceable, it would be necessary to initiate court action and prove damages in order to obtain reimbursement from a grantee for not properly operating and maintaining a waste treatment plant. There is no provision in the Federal Water Pollution Control Act to enable the Government to obtain reimbursement from grantees other than by resorting to legal action.

PROCEDURES AFTER A GRANT IS AWARDED

Inspections

The FWPCA Handbook of Procedures—Construction Grants Program requires that an inspection be made about 1 year after plants have been placed in operation. The purpose of these inspections is to determine whether plants are providing the service for which Federal

assistance was granted. FWPCA officials stated that inspection of plants is the principal procedure followed to insure proper O. & M. of completed plants.

Generally, O. & M. inspections are one-time visits. In some cases a followup inspection is performed after 3 years. We were told that the municipalities were informed in advance that the inspections would be made, and usually were notified of the date of the inspection. In addition, a copy of the FWPCA inspection form (sewage treatment plant operation and maintenance practices questionnaire) is usually forwarded to the municipality with instructions that it be completed, to the extent possible, prior to the inspector's visit.

The inspections may be made by a representative of either FWPCA or the State. For about 25 percent of those cases where the inspections are made by State officials, cognizant FWPCA regional office officials accompany the State officials on the inspections. Although the FWPCA Ohio Basin regional office requires that the States in its region make the inspections, we found that one State had not performed any of the required inspections since 1965. According to regional officials, the Ohio Basin regional office plans to make the required inspections in that State and will be accompanied by a State inspector.

FWPCA officials informed us that most inspections of plants were completed within half a day and that FWPCA inspectors did not make laboratory tests when performing the inspections but relied on the States' and the plants' test results and records in evaluating plant effectiveness. (See p. 15 regarding the reliability of these tests.) Northwest regional office officials stated that, if no test results were available, the inspectors relied on visual observation of the equipment, operating records and procedures, housekeeping, influent, sewage as it passed through the plant, effluent, and receiving waters.

After the O. & M. inspection of a plant has been completed, copies of the report are normally sent to the municipality or other governing body of the plant. In those cases where FWPCA performs the inspection, the report is routed through the State water pollution control agency. The States are to use the reports to call potential or existing problems to the attention of the municipalities. We found, however, that FWPCA had not established formal procedures to insure correction of deficiencies noted in the inspection reports. Northwest regional office officials informed us that, where major problems were observed, they asked the States to advise them of corrective action taken but that oftentimes the States did not furnish the requested information.

Training

Traditionally, FWPCA has viewed the training of waste treatment plant operators as being primarily a State responsibility. FWPCA awards grants to States and to interstate agencies to assist them in meeting the costs of establishing and maintaining adequate measures for the prevention and control of water pollution, including the training of personnel of public agencies.

Also, FWPCA supports the operator training programs of the States through technical consultations in the planning and development of operator training courses, guest appearances of FWPCA instructors, and provision of instructional material and training aids.

Recently, however, FWPCA has assumed a more active role in the training of waste treatment plant operators. (See pp. 9 and 25.)

State Procedures for Assuring Proper and Efficient Plant Operation and Maintenance

Our review showed that the procedures followed by certain States to insure the proper and efficient O. & M. of waste treatment plants, like the procedures followed by FWPCA, were, in comparison with the procedures followed after the project had been placed in operation, rather limited at the time a construction grant application was being considered. Responsibility for matters relating to the control and prevention of water pollution in the six States in which we made our review is placed with the State health agencies. We obtained, from officials of these agencies, the following information regarding the procedures followed to insure proper and efficient plant O. & M.

The six States require that, prior to awards of construction grants, applicants certify that they will properly and efficiently operate and maintain the completed plants. The States, however, do not require that applicants specify the provisions that they have made or plan to make for insuring proper O. & M.

We found that the six States generally employed similar procedures after completion of construction of a plant but that the manner in which they implemented them varied. The principal procedures employed by each of the six States are shown in the following table.

State	Waste discharge permits	Plant O. & M. inspections	Plant operating reports	Operator training	Operator certification
Oregon	Permit system established.	Annual	Required monthly.	An annual 3-day school; and a 1-night-a-week course for 9 months.	Voluntary.
Montana	do	do	Requested monthly (annually for lagoons).	An annual 5-day school	Mandatory.
Indiana	No permit system established.	At least quarterly.	Required monthly.	An annual 3- or 4-day school and six 1-day schools annually.	Do.
Kentucky	Permit system established.	As needed	do	An annual 4-day school; 3 area courses; and two 1-night-a-week schools for 9 weeks.	Do.
Georgia	do	do	Submitted voluntarily by a few plants.	A semiannual 4-day school; a 1-night course every other week for 3½ months; and a 2-year college course.	Voluntary.
Tennessee	do	do	Required monthly.	Two annual 5-day schools	Do.

Information regarding the States' use of the above procedures and examples of State enforcement authority provisions are discusssed in the following paragraphs.

WASTE DISCHARGE PERMITS

Of the six States, each of five has a waste discharge permit system to help insure proper O. & M. of plants. The requirements stated in the waste discharge permit are generally based upon the plant's capability to meet the State's standards of waste removal.

Four of the five States issue permits that require compliance with the standards to plants that are capable of meeting State standards.

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These four States issue also some type of conditional permit to those plants that cannot meet State standards. The conditional permits generally allow the plants a specified period of time to upgrade their capability in order to meet the standards. The fifth State, Kentucky, issues permits to plants after they have been placed in operation, and such permits signify that the plants were constructed in accordance with the approved plan and thus are capable of achieving the required waste removal.

Permits issued to plants by the State of Oregon specify the types and frequencies of laboratory tests to be made at the plants, the records to be maintained and the reports to be submitted to the State agency. Permits issued by the other four States do not contain such requirements. None of the five States have established standards regarding the number of personnel needed to operate a plant. See pages 10 and 11 regarding the significance of personnel, laboratory tests, and records.

OPERATION AND MAINTENANCE INSPECTIONS

Each of the six States conduct plant O. & M. inspections. These inspections are in addition to any O. & M. inspections that the States may perform for FWPCA.

As shown in the table on page 7, one State inspects each plant quarterly, two States inspect plants annually, and the remaining three make inspections on an "as needed" basis. For example, periodic inspections are not made in Kentucky because of personnel limitations. Inspections in Kentucky are made on an "as needed" basis and may result from an analysis of monthly operating reports, complaints by citizens, or requests from municipalities.

In addition to making inspections, four of the States conduct independent laboratory tests to determine the quality of plant effluent. Oregon and Indiana perform such tests at selected plants on a regular basis, and Tennessee performs such tests to the extent that time permits. Georgia usually makes such tests only when a specific need arises to obtain the information.

PLANT OPERATING REPORTS

Four of the six States require plant operators to submit periodic reports of plant operations. The report format, established by the State agencies, usually provides for the reporting of results of laboratory tests, weather and flow data, cost data, and operator comments regarding matters affecting plant O. & M.

We were advised by State officials that the State agencies may use the reports for such purposes as (1) analyzing stream data, (2) evaluating the advisability of approving requests for a tiein to a sewer system, and (3) identifying actual or potential problems in plant operation. The results of laboratory tests, for example, may indicate whether proper control is being maintained over plant operations and whether the plant is removing the required quantity of waste.

Although four States require that operators of all plants submit monthly operating reports, we found that the required reports were not always submitted. Georgia and Montana did not require plant operating reports. Georgia officials stated that, at that time, staff shortages prevented them from making use of such reports. They stated also that some plants did submit operating reports and the reports

were scanned to determine if significant problems existed. Montana officials told us that they requested periodic operating reports from selected types of plants. They stated, however, that they did not check the validity of the data shown in the reports submitted.

TRAINING

Each of the six States conducts an annual or semiannual training course for plant operators. The courses usually last from 3 to 5 days and generally consist of a series of lectures covering both water and waste treatment plant operations. The following table shows the estimated number of plant operators attending the courses during calendar year 1968.

State:	*Number of operators attending*
Oregon	130
Montana	50
Indiana	(1)
Kentucky	200
Georgia	87
Tennessee	212

[1] Data not available.

The diversity of subjects covered during a course is illustrated by those included in Montana's 1968 training course. It covered mathematics, chemistry, electricity, first aid, theory and operation of anaerobic digestion, electrical instrumentation, bateriological tests, chemical tests, primary treatment, and the operation of activated sludge and trickling filter plants.

In addition to conducting annual training courses, four of the States either conduct or participate in limited training programs for groups of operators in selected areas of the States. In Oregon, for example, a group of about 30 plant operators in the Portland, Oreg., area meet for 3 hours a week for 9 months of the year at the State's laboratory to discuss current problems and to receive instructions from State officials.

Kentucky holds area schools throughout the State for the primary purpose of qualifying operators in laboratory techniques. Information furnished to us by a Kentucky official showed that three area schools had held sessions in 1968 and that 19 operators had received from 1 to 5 days of instruction.

A Georgia official informed us that special courses were held from time to time, one of which was the training course for wastewater treatment plant operators in northeast Georgia. The course was held one night every other week during the period July 15 through October 28, 1968, and had an average attendance of 19 at these sessions.

Indiana conducts 1-day laboratory training sessions for waste treatment plant operators. State records indicated that during 1968 there had been six of these sessions which had been attended by a total of 44 plant operators.

OPERATOR CERTIFICATION

Each of the six States has an operator certification program, and certification is mandatory in three of the States. With the exception

of Montana, the States generally require applicants to meet certain education and experience requirements and to pass a written examination in order to become certified. Montana's only requirement for certification is that an applicant pass a written examination.

State laws for the three States having mandatory certification programs permitted that certain operators become certified automatically under a grandfather clause. The clause applied to those individuals who had been employed as waste treatment plant operators for a period of at least 1 year as of the effective date of the mandatory certification law. We found, for example, that this clause was the basis for certification of 188 of the 307 certified plant operators in Indiana.

In general, individuals are certified to operate a plant under one of several classifications based principally on the size of the population served by the plant. Operation certification requirements become more stringent as the size of the plant increases.

ENFORCEMENT AUTHORITY

State enforcement authority for the abatement and prevention of water pollution is provided by State legislation for each of the six States. The following are examples of State enforcement authority provisions:

1. Preventing new connections to municipal sewer systems by restricting the issuance of building permits.
2. Requiring the plant to operate at maximum efficiency, such as having an operator at the plant 24 hours a day.
3. Requiring the owner to upgrade the plant so that it will meet the standards set by the State.
4. Requiring that industrial customers' facilities be disconnected.
5. Holding court hearings, and issuing fines and/or injunctions.
6. Revoking permits.
7. Revoking operator certificates.

Although we did not make an evaluation of either the extent or the effectiveness of State enforcement actions, our review indicated that enforcement was not one of the principal procedures used by the States to insure proper and efficient plant O. & M.

Personnel and Controls Provided for Plant Operation and Maintenance

Waste treatment facilities are expensive and complex and must be properly designed, constructed, operated, and maintained in order to serve the purposes for which they are intended and to protect the public health, as well as the investment of local, State, and Federal funds. Proper and efficient O. & M. of these facilities requires certain personnel and controls.

In 1963 the conference of State sanitary engineers (Conference), in cooperation with FWPCA's predecessor organization in the Public Health Service (PHS), Department of Health, Education, and Welfare (HEW) concluded that three fundamental components were required in the proper operation of waste treatment plants—personnel, laboratory control, and records. Guidelines relating to these matters were contained in a 1963 report of the conference entitled "Recommenda-

tions for Minimum Personnel, Laboratory Control, and Records for Municipal Waste Treatment Works." (See app. II.)

The report was reprinted by FWPCA in January 1966 and was included in a 1968 FWPCA training manual. Copies of the report have been distributed to various States, consulting engineering firms, and FWPCA regional offices.

The report stated that the recommendations had been developed to provide a minimum framework, of control procedures to assist all communities with new or existing treatment facilities toward a better understanding and execution of their responsibilities. The report included the quantitative needs as to personnel, laboratory tests, and records but not such qualitative factors as plant personnel qualifications. A participant in the study that led to the formulation of the recommendations informed us that the Division of Water Supply and Pollution Control, PHS, had wanted guidelines to use in evaluating the O. & M. of waste treatment plants and, to gain State acceptance, it has developed the recommendations in cooperation with the 1963 conference.

The conference report stated that a plant must be staffed with certain personnel who are trained to carry out the functions necessary to obtain the degree of treatment provided by the design of the plant and to maintain and protect the community's investment in the physical plant. The report states also that adequacy of laboratory control is the only satisfactory and sure measurement of the degree of treatment being obtained by a plant. The report states further that accurate and readily understandable records are necessary for (1) supervising by local and State officials, (2) guiding the operating personnel toward locating and solving operating problems, (3) providing evidence of proof of performance, and (4) justifying decisions, expenditures, and recommendations.

The conference report contains recommendations for the minimum personnel, laboratory controls, and records for various sizes and types of municipal waste treatment plants. The plant sizes for which recommendations were developed were those having flow capacities of 0.25, 0.5, 1.0, 5.0, and 10.0 millions of gallons a day (m.g.d.), which, on the basis of an assumed daily contribution of 100 gallons per person, would be adequate for populations of 2,500, 5,000, 10,000, 50,000, and 100,000, respectively.

Knowledgeable officials whom we contacted in the field of water pollution control generally agreed that the conference recommendations represented acceptable minimum criteria; however, some of them expressed exceptions. For example, some officials stated that the recommendations were somewhat high, especially with respect to the number of personnel. Some stated that factors, such as quality and productivity of operators, should also be considered. Others stated that the recommended requirements for laboratory controls were too low in some respects. A participant in the initial study said that the recommended personnel requirements were below a realistic minimum but represented a compromise between the desirable minimum and what could be financed by the community. Many officials advised us that they were not aware of any better overall guidelines.

The Director, Division of State and Local Programs, FWPCA, stated that the minimum recommendations were intended to be the basis for a program in the area of operation and maintenance but that

increased responsibility and insufficient staff had prevented the Division from doing as much as originally had been intended. He stated that he realized that a great deal more had to be done in this area and that the Division was attempting to accomplish as much as possible with the resources available.

Our review indicated that none of the FWPCA regions or the six States where we made our review had followed the conference recommendations, either before or after award of the grant, in evaluating the adequacy of provisions made for insuring proper and efficient plant O. & M., even though FWPCA's inspection report forms are designed to obtain information on the personnel, laboratory controls, and records being provided at waste treatment plants.

We examined into whether the minimum personnel and controls recommended in the conference report were being provided at the 69 selected plants. (See p. 5.) Our examination showed that one or more of the conference's recommendations had not been met at 59 of the 69 plants as summarized below:

	Number of plants	Plants not fully meeting conference recommendations
Northwest region:		
Oregon	13	10
Montana	7	7
Ohio Basin region:		
Indiana	15	13
Kentucky	15	13
Southeast region:		
Georgia	9	8
Tennessee	10	8
Total	69	59

As shown in the following table, we identified 158 instances in which operation of the 59 plants was not in accordance with the conference's recommendations for minimum (1) personnel, (2) laboratory controls, or (3) records.

	Number of instances
Personnel:	
Insufficient number	18
Insufficient work hours	30
Laboratory controls:	
Certain tests not performed	45
Tests not frequent enough	30
Records:	
Incomplete records of operations	18
Incomplete records of laboratory tests	17
Total	158

Specific examples of problems involving inadequate personnel and controls and problems encountered in operating waste treatment plants are discussed in the following section of this report.

Problems Identified in Plant Operation and Maintenance

Both FWPCA and the States have established procedures to insure that waste treatment facilities serve the purposes for which intended.

FWPCA recognizes, however, that many municipal waste treatment plants are not operating effectively. Our review of various reports, studies, and records, and discussions with knowledgeable officials in the field of water pollution control, indicated that ineffective operations were caused by many factors, including a lack of qualified operators and inadequate control over industrial sources of pollution. Our visits to 12 selected waste treatment plants confirmed that operating difficulties existed and that these difficulties were due to factors such as those mentioned above.

FWPCA REPORTS

We noted that there had been two FWPCA studies that had dealt specifically with the O. & M. of municipal waste treatment plants. One of these, "Report on Operation and Maintenance of Municipal Waste Treatment Plants," was performed nationwide and published in March 1969. The other study, "Waste Treatment Plant Survey," dated January 1969, was conducted by FWPCA's Northwest region, and included treatment plants in selected river basins in the States of Idaho, Oregon, and Washington.

The report concerned with the nationwide study on O. & M. summarized and analyzed the findings of 1,500 inspections conducted during the period July 1, 1962, through December 31, 1964. The principal problems reported were (1) operational, mechanical, and structural difficulties at about 40 percent of the plants inspected, (2) odor complaints at about 19 percent of the plants inspected, and (3) bypassing of untreated sewage at about 38 percent of the plants inspected. In addition, the report stated that more than 30 percent of the approximately 970 plants reviewed failed to maintain operating and/or laboratory records and less than 10 percent of the approximately 530 stabilization ponds reviewed maintained records.

The FWPCA Northwest region's survey report on O. & M. was based on plant operating reports, State survey records, and discussions with State personnel in late 1968. Ninety-five plants were included in this survey. The O. & M. problems identified included (1) inadequate operational data for determining plant efficiency, (2) failure to conduct plant surveys in one State for over 3 years, (3) failure to establish a testing schedule for treatment plants in one State, and (4) inefficient operation or overloading at some plants.

According to the report, all plants reviewed in Oregon had submitted operational data of some type to the State but only 66 percent of the plants surveyed in Washington and 27 percent of the plants surveyed in Idaho had submitted data. The report stated that, of the 95 plants surveyed, 42 had inadequate data to determine their efficiency, 44 were attaining efficient operation, two were not attaining efficient operation, and seven were overloaded. Northwest regional officials informed us that in the survey, data had been used that was available at State offices, such as the results of BOD and suspended solids tests, and that additional data would have to be obtained from plant visits if a complete evaluation were to be made.

In addition to the above reports, other documents indicated that O. & M. problems existed. A draft of a program developed by FWPCA headquarters to improve O. & M. of waste treatment plants stated

that reports on plant operation indicated that "* * * too many facilities are operated at efficiency levels below design optima."

FWPCA's report entitled, "The Cost of Clean Water," dated January 10, 1968, stated that many existing waste treatment plants were not being operated effectively and, therefore, were achieving a lesser degree of waste removal than they were capable of attaining. The report attributed low waste removal efficiency in many cases to inadequate operation by the plant operator or understaffing of treatment plants.

INSPECTION AND OPERATING REPORTS

Our review of current FWPCA inspection reports showed that O. & M. problems, similar to those identified in FWPCA's nationwide report, still existed. The nationwide study (see p. 13) analyzed reports of inspections performed from July 1, 1962, through December 31, 1964. We examined reports of inspections conducted in 1967 and 1968 for 54 of the 69 plants selected for our review of applications; inspections were not made for the remaining 15 plants. As summarized in the following table, the 54 available inspection reports identified O. & M. problems similar to those shown in the FWPCA nationwide report.

Type of problem	Number of inspection reports		
	Reviewed	Disclosing problems	Number of problems
Operational, mechanical, or structural problems	54	36	60
Odor complaints	54	20	20
Bypass of untreated sewage	54	28	28
Total			108

Also, other types of O. & M. problems were reported, such as deficiencies in laboratory controls and plants' not meeting State standards or requirements.

Generally, however, the inspection reports did not contain a conclusion as to whether the plants were operating so as to attain the degree of treatment provided by the design of the plant. In this regard, a Northwest regional office official told us that most inspections had been completed within half a day even though as much as 3 weeks could be required to determine whether the plants were operating effectively.

The 1963 conference report (see p. 10) states that the only satisfactory and sure measurement of the degree of treatment being obtained by a plant is adequate laboratory control. FWPCA officials informed us that the BOD test was frequently used in measuring the operational effectiveness of waste treatment plants. Therefore, for the 69 selected plants, we compared available test results recorded in plant operating reports with engineering data on plant design capabilities for BOD removal. Our comparison was for a 5-month period which was, generally, the low or critical streamflow period. The results of our comparison are shown in the following table:

	Number of plants			
	Selected for review	Design or test results not available	Not operating effectively	Operating effectively
Northwest region	20	13	5	2
Southeast region	19	14	3	2
Ohio Basin region	30	24	3	3
Total	69	51	11	7

For the 18 treatment plants for which both design criteria and test results were available, our comparison showed that 11 were not operating effectively because the levels of BOD removal did not meet design standards for all or part of the 5-month period, and that seven plants were operating effectively.

We did not test the reliability of the test results data for any of the 69 plants. However, State and consulting firm officials and treatment plant operators informed us that laboratory control data developed by some plant operators was not reliable. Officials of two consulting firms estimated that about 75 percent of the plants they reviewed did not have reliable test results. One of these officials explained that many operators were not adequately trained to make the complex tests required and municipal budgets were frequently inadequate to finance the needed laboratory equipment. An official of another consulting firm informed us that in his opinion only about 50 percent of the operating reports that he had reviewed in the past 2 to 3 years were reliable.

Also, State officials told us that some of the laboratory test results reported by treatment plants had been unreliable, however, some of these officials estimated that as few as 10 to 20 percent of the test results reported had been unreliable. For example, they cited one plant where the operator had been entering flow data on the report even though the flowmeter had been inoperative and another plant where the operator had admitted to falsifying the test result report after the State inspector had observed dust on all laboratory equipment.

Some plant operating personnel told us that the test results were not always correctly recorded. One plant supervisor said that inaccuracies were reported especially when the plant started to experience O. & M. difficulties. Another treatment plant supervisor, with 33 years of treatment plant experience, informed us that probably about three out of five plants reported invalid laboratory test results to the State.

LACK OF QUALIFIED OPERATORS

We discussed with many individuals, knowledgeable in the field of water pollution, the qualifications required of waste treatment plant operators and the lack of sufficient numbers of qualified operators. These individuals informed us that:

> The qualifications required of waste treatment plant operators varied depending upon the size and type of treatment plant. (For example, educational requirements considered desirable varied from a high school education to a college degree in sanitary engineering.)

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Generally, operators should have a basic knowledge in the fields of chemistry, biology, microbiology, bacteriology, physics, and mathematics in order to accurately perform laboratory tests and interpret the results.

Operators should have a knowledge of sanitation procedures and should be capable of recording data accurately and in a usable form for their benefit and for the benefit of others.

Operators should be able to effectively meet and deal with those who may be interested in or concerned with the operation of the plants—such as the public—and those whose activities affect the plants' operation—such as industrial officials.

Because of such factors as the lack of effective certification programs for plant operators, difficulties in acquiring training, public indifference, and low salaries, there is an insufficient number of operators having the qualifications necessary to satisfactorily operate and maintain waste treatment plants.

A need exists to provide training for operators at more locations in the States.

Some operators are unable to attend training courses because they live far from the training location, funds are not made available by the municipality to defray their expenses while attending the training, or their attendance at the courses would leave the plant without an operator.

Some municipalities do not recognize either the importance of waste treatment or the complexity of plant operation.

Waste treatment plant operators lack social status in the community, and the salaries offered are often not sufficient to encourage competent individuals to enter the waste treatment field.

In small communities the O. & M. of the waste treatment plant is usually a part-time job, and the individual responsibile for this function often performs other duties for the municipality.

Higher salaries are necessary in order to obtain a sufficient number of qualified personnel.

INADEQUATE CONTROL OVER INDUSTRIAL SOURCES OF POLLUTION

Our discussions with knowledgeable officials and our review of records showed that controls over industrial sources of pollution have not always been adequate to insure effective plant O. & M. as follows:

Industrial wastes may result in overloading of plants in several ways. The volume of waste contributed by industry may create loads in excess of a plant's capacity and may decrease the detention time in the treatment units, especially in sedimentation basins where the more rapid flow may not permit adequate settling. Settleable solids from industrial wastes may result in overloading various treatment plant components, such as the screens, grit chambers, settling tanks, and sludge-handling mechanisms. Such coarse and floating solids as hair, feathers, and rags occur in certain industrial waste and cannot be handled by conventional sewage processing equipment. Oils and greases are troublesome because they cause sludges and floating scums that do not settle, drain, or dry properly.

Many industrial wastes carry a higher organic load, as measured by BOD tests, than domestic sewage. Unless such industrial wastes are pretreated before entering the municipal waste treatment plant,

overloading of the plant equipment may result. The usual effect of such overloading is inadequately treated effluent. In addition, the biological and bacterial action of treatment plant processes may be retarded or stopped entirely by the presence of certain toxic industrial wastes, such as heavy-metal salts, cyanides, phenols, formaldehyde, and other chemicals.

During our review, we noted several instances where industrial wastes had adversely affected plant operations. In one instance, the waste discharged from a meat industry clogged a treatment plant. In another, feathers and grease from a poultry plant disrupted treatment plant operations and caused the operator to bypass the raw waste to the receiving stream. In still another, milk processing and other wastes present in a treatment plant caused an excessive organic load. A similar effect occurred in another instance where blood was discharged from a meatpacking plant-slaughterhouse into a treatment plant.

In our review we also found instances at several treatment plants where toxic industrial wastes killed the bacteria essential to the secondary treatment process. We were informed that one plant was shut down for a period of 9 months in 1968 because toxic wastes had stopped the operation of the sludge digester.

Our discussions with State and municipal officials indicated that either the lack of sewer ordinances relating to industrial wastes or the lack of enforcement of such ordinances was the cause for many of the above problems. Several community officials told us that industrial waste ordinances were not enforced because of the concern over losing the industry.

OPERATION AND MAINTENANCE PROBLEMS IDENTIFIED AT SELECTED PLANTS

Of the 69 waste treatment plants included in our review, we selected in each of the six States two plants which appeared to warrant the most attention and examined into specific O. & M. problems. We visited the 12 plants and found that 11 had experienced operating difficulties because of such factors as insufficient or unqualified personnel, industrial sources of pollution, and design or equipment deficiencies. A lack of records prevented us from determining whether the other plant was operating effectively.

At one plant, operating difficulties were so serious that plant abandonment had been recommended; at a second plant, poor maintenance practices had deteriorated the plant "virtually to the point of destruction," which resulted in poorly treated sewage and caused oxygen depletion and discoloration of the receiving stream; and at a third plant, where a qualified operator was not available, raw sewage was bypassing the plant.

Our findings at each of the 12 plants are discussed below under headings of the States in which the plants are located, along with the total amounts of the Federal construction grants.

Georgia, $75,929

This secondary treatment plant, with an estimated flow of about 0.5 million gallons per day, was inspected by FWPCA about September 1968. The 1963 conference's recommendations (see app. II) for a plant of this size are, as a minimum, one full-time operator and a

half-time laborer, six tests for laboratory control, a diary-type log of operating information, and a record of laboratory control results.

Our review of the FWPCA inspection report for this plant showed that the plant did not have the recommended full-time operator but did employ a full-time laborer and a plant supervisor who devoted 6 hours a week to the plant, that laboratory tests were not being performed, and that operating records were not being maintained.

The plant facilities consist of a primary treatment plant and a 20-acre stabilization pond for secondary treatment. A memorandum in the FWPCA files, dated October 4, 1968, noted that the plant was severely overloaded, which resulted in poor removal of solids, and that the problem appeared to be caused by a meatpacking plant-slaughterhouse which released blood and large, unusable portions of slaughter into the sewage system.

During our February 1969 visit, we observed a large quantity of blood in the influent, grease scum floating on the primary clarifier, and some grease on the surface of the stabilization pond. We also noted that dried sludge was deposited along the outsides of the beds.

Georgia, $60,870

This secondary treatment plant, with an estimated flow of about 1 million gallons per day, was inspected by FWPCA on September 9, 1968.

The FWPCA inspection report stated that an estimate of plant efficiency would be a very poor guess because of the lack of records. The inspection report also noted that the trickling filter was ponding [1] over 25 percent of its surface and that the secondary clarifier appeared to be passing a large quantity of solids.

A State inspection memorandum, dated February 12, 1969, showed that the plant did not have chlorination facilities. The memorandum recommended that the plant operating permit be withheld until disinfection facilities were added.

In February 1969, we visited the plant which had no operator. The city's superintendent of water and sewage operations stated that he devoted about 15 hours a week to the plant and that the equivalent of 2½ plant laborers were employed. He stated also that the city was trying to hire an operator at a salary of $350 a month. We found that laboratory tests were not being made and that neither laboratory control records nor any other operating records were being maintained. We also observed that surface drainage was poor, resulting in erosion, and that the trickling filter was ponding over about 10 percent of its surface.

Indiana, $230,702

This secondary treatment plant, with an average flow of about 1.8 million gallons per day, was placed in operation in September 1966 and was inspected by the State, for FWPCA, in December 1967.

Our review of the State inspection report submitted to FWPCA showed that all the recommendations of the 1963 conference had been met, except the making of a dissolved oxygen test in the receiving waters. The inspection report noted, however, that the extent of BOD and solids removal was not considered adequate and that the plant would be required to install advanced equipment to provide for low-flow augmentation within 10 years.

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[1] Ponding is the formation of pools of sewage on the surface of filters caused by surface clogging.

During our visit to the plant in March 1969, the plant operator told us that the plant had not operated effectively since its construction because of the high concentration of industrial waste and that infiltration from rainwater contributes to the problem by overloading the plant and causing bypassing. We also noted that plant laboratory records were not current. The plant superintendent told us that he had been busy training a new operator and did not have time to perform all the laboratory tests.

Correspondence in State files indicated that industrial wastes, high in chrome content, may eventually cause damage to the plant if they are not pretreated. Also, plant operating reports in the State files showed that the plant was not meeting State standards for BOD removal.

Indiana, $74,199

This secondary treatment plant has an average daily flow of 16.9 million gallons per day. The plant was placed in operation in 1967 and was inspected by the State for FWPCA on December 18, 1968.

Our review of the inspection report showed that the plant met all the recommendations of the 1963 conference with the exception that four of the nine required tests were not performed at the recommended frequency.

Our review of plant operating reports submitted to the State showed that the plant had not met State standards during any month of the 5-month test period selected for review. A State letter to the plant, dated December 26, 1968, commented that there was a need for improvement in BOD and suspended solids removal.

A preliminary engineering report estimated that 40 percent of the plant's influent would be from industrial sources. The assistant plant superintendent told us that the plant was experiencing problems from large amounts of chrome and other plating wastes. The plant superintendent advised us that, although the municipality had an industrial waste ordinance, it had never been enforced "because the city depends on industry for survival."

Kentucky, $121,920

This secondary treatment plant has an average daily flow of 1.0 m.g.d. We were told that FWPCA did not make the required inspection of this plant. For this size plant, the 1963 conference recommended a minimum of 6 hours of administrative supervision, two operators, and one laborer.

During our visit to the plant in February 1969, the plant superintendent told us that the plant had one supervisor and two operators but no laborer. He stated also that records of laboratory tests were not maintained.

A State inspection report dated November 26, 1968, stated:

> During the past 18 months the quality of the effluent discharged from the * * * plant has progressively worsened to the point that * * * the receiving stream has presented an unsightly appearance for the past 5 months. Recently this office has received complaints of this unsightly appearance * * * which means that this condition prevails through the entire 15.1 mile stretch of [the receiving] creek from the sewage treatment plant to the * * * river and, after being greatly diluted, is still noticeable in this 4.6 mile stretch of the * * * river. * * *
>
> During the past year, the city has made progress in rehabilitating the plant units and grounds. Through the years a lack of operational knowledge, together with negligent maintenance practices, the plant had deteriorated virtually to the

point of destruction. In spite of the efforts thus far exerted, the efficiency of the sewage treatment plant, based on the writer's observations and excepting the few brief periods when industrial wastes were being withheld from the plant, appears to be rapidly diminishing and will very soon, if not now, reach the point at which it will be of no practical value toward fulfilling its intended purpose.

During our visit to the plant, we observed that, for about 100 yards downstream from the outflow pipe, the receiving stream was covered with 4 to 6 inches of foam and that the effluent was red in color and changed to black downstream. The plant superintendent told us that the unsightly appearance was the result of tannery wastes being discharged to the treatment plant.

Kentucky, $118,429

This plant, a 0.35 m.g.d. trickling filter facility (secondary treatment), was completed on March 11, 1966, but was not inspected by FWPCA until 1968.

The memorandum of the FWPCA visit to this plant noted that the effluent appeared untreated and that the plant was in extremely poor operating condition, to the point of generally being rendered ineffective. The memorandum also stated that "the operator, who was aware that we were to be in town, made himself unavailable" at the time of FWPCA's visit.

A State inspection report, dated November 4, 1968, stated that the operator was not present, the flowmeter was not working, all units were black in color and odorous, gas was forming in the chlorine contact chamber, and the effluent was cloudy and odorous.

During our visit to the plant in February 1969, a State official told us that, although the plant experiences some difficulty from infiltration, the major problem was that a qualified operator was not available. We observed that total bypassing of raw sewage was occurring and that the effluent was being channeled through the chlorine chamber and into the receiving stream.

We found that this plant was staffed with one operator who contributes about 5 hours a week to plant operations and that no time was spent performing tests or maintaining records. The 1963 conference recommendations for a plant in the 0.25 m.g.d. category provide for a half-time operator to contribute 5 hours a week to laboratory testing and records. No operator was on duty at the time of our visit.

Montana, $51,820

This plant, which is a primary treatment plant with a lagoon for secondary treatment, was placed in operation in 1966. The average daily summer flow is about 0.39 m.g.d.

We noted that the minimum recommendations for a plant of this size provide for three tests to be performed. However, the plant operator stated that he did not know how to perform more than two tests. Because reports of laboratory test results were not prepared by the operator, we were unable to determine whether the plant was operating effectively.

A July 1968 FWPAC inspection report on the plant disclosed that a comminutor for grinding incoming sewage and sight glasses for monitoring sewage flow in sludge pump lines had not been provided when the plant was built. The report stated that rags and stringy materials were causing ineffective operation of the sludge pumps and

that the efficiency of the pumps could not be monitored because of the lack of sight glasses.

At the time of our visit to the plant in February 1969, the plant operator informed us that the comminutor and sight glasses had not yet been ordered. The plant operator informed us also that the plant effluent is discharged into a lagoon designed to overflow into moats which allow the effluent to evaporate and percolate into the ground. He stated, however, that during periods of heavy rainfall the algae growth in the lagoon overflowed into the moats and sealed them, and thereby caused the moats to overflow into the surrounding area. The plant operator stated also that this problem had occurred in August 1968 and that an additional moat had been constructed to help correct the situation.

Montana, $13,500

This plant, a lagoon, was placed in operation in September 1966 and was inspected by FWPCA on July 1, 1968. It has a reported peak flow of 0.036 m.g.d.

The smallest size plant covered in the Conference recommendations is a plant in the 0.25 m.g.d. category. For that size plant, the Conference recommended that three tests be performed and that 5 hours a week be spent on recordkeeping.

The operator of the plant told us that he was not aware of and major O. & M. problems at the plant. He stated also that he (1) hay never been to a sewage treatment school, (2) did not perform laboratory tests, and (3) did not maintain detailed records of operations. Because of the lack of laboratory tests and operating records, we were unable to determine whether the plant was operating effectively.

Oregon, $72,133

Additions and modifications to this secondary treatment plant, now designed for a capacity of 0.1 m.g.d., were completed in March 1967 and were inspected by FWPCA in September 1968.

According to the 1963 Conference's recommendations, the minimum personnel required for a plant of 0.25 m.g.d. is at least a half-time operator. The plant supervisor told us that about 9 hours each week are spent operating the plant.

State records showed that the plant had not met design standards of operating effectiveness for 4 months of a 5-month test period and that records of laboratory test results had not been provided to the State for 1 month of the test period. The plant supervisor informed us that he did not have enough trained personnel available to keep the plant operating efficiently.

The FWPCA inspection report, dated September 1968, stated that the type of rock used as a filter media in the trickling filter of the plant caused flooding over about 40 percent of the filter area. The report noted that the plant was not providing the degree of treatment required by the State. The report also stated that the waste discharge permit for the plant required that the plant be either abandoned or upgraded. A State official informed us that the State recommended abandonment because the plant was overloaded and the receiving stream was too small.

The plant supervisor informed us, during our January 1969 visit, that the above situation still existed and that the poor filter media was

a factor contributing to the plant's inability to meet State requirements. At the time of our visit, the secondary treatment portion of the plant was not operating because a distributor arm on the trickling filter was broken. We were informed that the arm had been broken since January 1, 1969.

Oregon, $61,901

This tertiary[1] treatment plant was placed in operation in 1966. An FWPCA inspection, performed on June 14, 1968, showed that the plant had an average daily flow of 1.4 m.g.d.

The 1963 Conference report did not cover minimum personnel requirements for tertiary plants. But, for a lower level secondary treatment plant, equivalent in capacity, the report recommended a minimum of 6 hours of administrative supervision, two operators, and one fulltime laborer.

The FWPCA inspection report showed that the city had provided no administrative supervision, only one operator and no laborer. In the area of laboratory controls, the report indicated that only four of seven recommended tests were being performed and only two of the tests were performed at the recommended frequency. The report noted that arrangements had been made to have testing done at another waste treatment plant in the vicinity and that the operator kept weekly instead of daily laboratory records.

State records of the plant's operations showed that, for the 5-month period selected for our examination, the plant failed to operate to design standards for 2 months and that laboratory test information necessary to determine operational effectiveness was not reported for another 2 months.

At the time of our visit to the plant in January 1969, the plant operator told us that, because he had no help, he often had to forgo testing and preventive maintenance to make repairs.

The city engineer informed us that water infiltration in the old sewer system creates an overload problem at the plant and that during the winter months, because of the combined storm and sewer system, it was necessary to bypass up to three-fourths of the load directly to the receiving stream without treatment. In addition, he stated that the high volume of infiltration dilutes the sewage to a point where it is difficult to keep the aerobic bacteria on the filter media alive, which results in reduced plant efficiency.

Tennessee, $250,000

This primary treatment plant, with an average daily flow of 1.5 million gallons per day, was placed in operation in 1960.

An October 1968 FWPCA inspection report showed that the plant met the 1963 Conference's personnel recommendations but that three of the seven recommended tests were not made and another test was not made at the required frequency. Our review of plant reports submitted to the State disclosed, however, that the plant bypassed sewage several hours each month during 1967 and 1968. State correspondence revealed that complaints had been received concerning chicken feathers and entrails floating on a lake and that the source of the waste had been traced to the plant.

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[1] Advanced waste treatment which removes more contaminants from waste water than is possible by secondary treatment alone.

During our visit to the plant in February 1969, the plant operator told us that feathers from a poultry processing facility clogged up the plant's clarifier. A State official advised us that the operator's solution to the problem was to periodically flood the wet-well to wash the waste directly to the receiving stream.

In July 1968, the State revoked the plant's 5-year permit and issued a 1-year permit with the recommendation that the city adopt and enforce a sewer ordinance to protect the plant and prevent stream pollution.

Tennessee, $92,502

This secondary treatment facility, with an average daily flow of 0.70 m.g.d., was placed in operation in 1965. A plant performance audit was conducted by the State, for FWPCA, in September 1968. The performance audit report showed that the plant did not employ a half-time laborer and did not perform one of the tests recommended by the 1963 conference.

A State official told us that, shortly after the plant began operation, the need to heat the digester became apparent. He told us also that a heat exchanger and a recirculation pump were added to the plant but that the pump had not functioned properly. According to plant officials, the pump would not pass solid matter through the heat exchanger and back to the digester. Therefore, a constant temperature could not be maintained in order to allow the bacteria to perform its proper function. The operator told us that, since the digester was not working properly, no digester tests were performed and no data were available for preparing monthly operating reports.

Information in State correspondence files indicated that odor had been a serious problem at the plant since July 1966.

A State official told us that the plant was bypassed for about 2 months during the latter part of 1967 because coal had stopped up the clarifier.

FWPCA and State Actions To Improve Plant Operation and Maintenance

Both FWPCA and the States are taking or considering certain actions to improve the O. & M. of municipal waste treatment plants. These matters are discussed below.

ACTIONS BY FWPCA

Engineering operations section

Pursuant to the FPWCA reorganization in October 1968, the Engineering Operations Section was established within the Division of State and Local Programs of FWPCA. This section is presently staffed by a supervisory sanitary engineer. An FWPCA official advised us that staffing for this section will be increased as personnel limitations permit. The functions of this section include the evaluation of current criteria and practices for the design, operation, and maintenance of waste treatment plants and the development or promotion of new and improved criteria and practices where needed.

Proposed O. & M. program

On November 27, 1968, the Director, Division of State and Local Programs, FWPCA, sent a proposed O. & M. program to all regional

directors for their review and comment. In April 1969, subsequent to the receipt of regional comments, a revised preliminary draft of the program was prepared. The revised draft recommended the following measures for improving the O. & M. program.

1. Increase the effectiveness of waste treatment plant inspections by—

(*a*) requiring State water pollution control agencies to strengthen their waste treatment plant inspection and evaluation programs,

(*b*) developing a waste treatment plant inspection and performance manual to establish uniform methodology for evaluating plant operations,

(*c*) assigning at least one man in each region to the fulltime task of inspecting federally supported projects, including both new plants and those suspected of having poor operations, and

(*d*) establishing a reporting system whereby FWPCA is alerted by the State to significant O. & M. problems.

2. Expand training and operator certification efforts by—

(*a*) Developing new and/or specialized training programs in waste treatment operations for the professional sanitary engineer responsible for the management and operation of waste treatment plants,

(*b*) Being alert to opportunities for encouraging and developing State operator certification legislation, and

(*c*) Exploring the advisability of requiring a State mandatory operator certification requirement to qualify for Federal construction grant assistance.

3. Upgrade waste treatment plant design criteria by—

(*a*) Initiating a "Technical Bulletin" service to advise FWPCA regions, States, and design engineers on new policy, technology as it affects sewage interceptors and waste treatment plants, and design criteria, and

(*b*) Preparing an FWPCA treatment works design manual through an FWPCA-sponsored effort involving State and/or local agencies, design engineers, construction contractors, and others who can contribute to this effort.

4. Increase technical assistance by establishing a technical assistance program capable of providing expert advice on ways to improve treatment plant performace.

5. Increase research and development to improve sewer and waste treatment plant designs, including equipment and controls for automation.

6. Establish incentives to upgrade the O. & M. of waste treatment plants, such as—

(*a*) Establishing an awards program that recognizes excellence in waste treatment plant design, operation, and maintenance, and

(*b*) Exploring the establishment of a Federal grant program to assist in meeting costs and encouraging the establishment of similar programs by the States.

7. Upgrade eligibility requirements for Federal grants by reviewing grant eligibility regulations periodically and making revisions as required to improve O. & M.

Requirement for plant operating manual

On March 17, 1969, the Department of the Interior Solicitor's Office, in response to a request from FWPCA, issued an opinion which stipulated that a grant for the construction of a waste treatment project could be awarded subject to the condition that the grantee require its consulting engineer to supply an operating manual and on-the-job training for plant employees. Subsequently, on March 28, 1969, the Acting Chief, Construction Grants and Engineering Branch, FWPCA, sent a memorandum concerning the above opinion to all regional directors. The memorandum stated in part:

Therefore, eligibility for Federal grants for the construction of sewage treatment works under section 8 of the Federal Water Pollution Control Act, hereafter shall be predicated on the requirement that the consulting engineer provide a plant operating manual. The manual shall be designed to describe the purpose, functions, and controls for each process in the specific plant, plus all physical and laboratory controls, maintenance functions, and personnel requirements necessary to operate the entire facility at maximum effectiveness. Normally, the basic manual will be available when plant operations commence. In addition, provisions will be made to have the manual amended by the consulting engineer as necessary, during the first year of operations to include all changes or refinements, and thus describing substantially current plant operations.

The community, sanitary district, or other responsible public entity, must endorse and agree to fulfilling the tasks described in the manual. This will be considered minimum assurance that the treatment facility will be appropriately operated to achieve the applicable water quality objectives in the receiving waters.

Training

FWPCA's current efforts at training waste treatment plant operators consist primarily of encouraging and assisting State and local water pollution control agencies to conduct training programs to be funded under the Manpower Development and Training Act (MDTA).

FWPCA is cooperating with other Federal agencies, especially HEW and the Department of Labor, in utilizing existing Federal programs for the training of plant operators. One such program is the cooperative area manpower planning system (CAMPS) program. This program involves State programs for training people for a large variety of occupations utilizing MDTA funds.

FWPCA is involved in this program at the national and regional levels. The FWPCA role is to encourage and help the States formulate operator training projects and arrange for their funding under the CAMPS program. FWPCA also provides assistance on curriculums and teaching materials. These projects provide for both skill upgrading and the introduction of new people into the operator category. Commitments have been obtained for projects expected to involve over 1,200 trainees at a cost of $1.5 million.

On April 1, 1969, FWPCA entered into a contract with the Department of Labor and HEW for $1,031,775 in MDTA funds to be used for programs designed to improve the skills of 720 existing operators and to train 80 new operators. This program had the same objectives as the CAMPS program, except that FWPCA serves as the prime contractor and will subcontract with municipalities or waste treatment districts for the actual training.

The first effort at direct training of waste treatment plant operators by FWPCA was a course on "Basic Principles of Wastewater Treatment Operation." The course was conducted from November 4 to 8, 1968, at the FWPCA facility at Corvallis, Oreg., and 23 trainees attended the course.

A course entitled "Operator Instructor Training," offered by FWPCA for the first time during fiscal year 1969, is designed for those persons having responsibility for designing, managing, and teaching various types of short courses for waste treatment plant operators. The course will review current teaching methods and the preparation and management of short-term, operator-training courses.

ACTIONS BY THE STATES

Our review showed that five of the six States have initiated or are considering various actions for improving the O. & M. of municipal waste treatment plants. These actions include training, inspections, and other matters which are discussed below.

Training

Indiana, Oregon, Georgia, and Tennessee have made plans as follows to provide additional training for plant operators.

Indiana plans to provide 3- to 4-day training courses sponsored by universities; establish six to eight courses consisting of one night of training a week for 12 to 15 weeks, if a pilot course is successful; and provide a 44-week school for 40 plant operators, to be financed with a Federal grant under CAMPS.

The State of Oregon is applying for a Federal grant of $60,000 under the MDTA to set up either (1) night classes in waste treatment plant operation at each of the State's 10 community colleges or (2) a mobile laboratory for on-the-job site training of operators. The mobile laboratory could also be utilized in reviewing plant operations and solving plant problems.

Georgia has entered into a contract with the U.S. Department of Labor to provide on-the-job training for plant operators. Tennessee has also entered into such a contract and is considering adding a chemist to its staff for the purpose of traveling throughout the State and providing operators with individual instruction in laboratory procedures.

Inspections

Oregon, Georgia, Montana, and Tennessee have made plans to increase the number of plant O. & M. inspections. As a means of performing additional inspections, Oregon has delegated part of the inspection responsibility to its district office personnel. Georgia, Montana, and Tennessee plan to increase such inspections as soon as they are able to hire additional staff.

Other actions

Oregon, Georgia, and Tennessee currently have only voluntary operator certification programs, but they have introduced legislation for making these programs mandatory.

Oregon plans to use automatic data processing equipment to accumulate and process information from waste discharge permits, monthly plant operating reports, and inspection reports to assist in identifying plants having problems and in following up on correction of the problems.

Tennessee is considering the establishment of a regional office in the western area of the State similar to one located in the eastern area to monitor operations of plants.

SCOPE OF REVIEW

Our review was directed primarily to obtaining information regarding (1) the manner in which FWPCA complies with requirements of the Federal Water Pollution Control Act to obtain and consider applicants' provisions for insuring proper and efficient plant O. & M. and (2) the existence, nature, extent, and causes of plant O. & M. problems.

We reviewed pertinent legislation and FWPCA instructions; examined pertinent documents, reports, records, and files at FWPCA headquarters and regional offices and at State offices. We interviewed responsible FWPCA headquarters and regional officials, State and municipal officials, plant operators, and other individuals knowledgeable in the field of waste treatment.

Our review was conducted at FWPCA headquarters in Washington, D.C.; FWPCA regional offices in Atlanta, Ga., Cincinnati, Ohio, and Portland, Oreg.; State water pollution control agencies in Georgia, Tennessee, Indiana, Kentucky, Montana, and Oregon; and selected municipalities in each of the six States.

APPENDIXES

Appendix I

U.S. Senate,
Committee on Public Works,
Washington, D.C., November 19, 1968.

Hon. Elmer B. Staats,
Comptroller General of the United States,
General Accounting Office,
Washington, D.C.

Dear Mr. Staats: I want to express my appreciation for the briefing given on October 24, 1968, to the Public Works Committee staff by members of your Office regarding the GAO survey and plans for audit in the water pollution area for development of reports to the Congress.

As discussed by the staff members with your representatives, the subcommittee is concerned with the effectiveness and the progress of the program to control, abate, and prevent water pollution. In this regard, the subcommittee plans to hold hearings concerning the water pollution program early in the next session of Congress.

Accordingly, I would like you to furnish the subcommittee certain factual information on the following matters which, I am informed, are being examined during the course of your reviews of the activities of the Federal Water Pollution Control Administration (FWPCA).

1. Personnel, staffing, and administration of the water pollution program by FWPCA—target date for submission of information is February 1969.
2. State plans for controlling water pollution and State priority systems for awarding construction grants to communities—target date for submission of information is March 1969.
3. Operation and maintenance of completed waste treatment facilities—target date for submission of information is April 1969.

I understand that the details relating to these areas of interest were discussed with your representatives during the briefing session and at a subsequent meeting. Please do not hesitate to call on us if we can be of further assistance.

Sincerely,

Edmund S. Muskie,
Chairman, Subcommittee on Air and Water Pollution.

Appendix II

Recommendations for Minimum Personnel, Laboratory Control, and Records for Municipal Waste Treatment Works

(By the Conference of State Sanitary Engineers in cooperation with U.S. Department of Health, Education, and Welfare, Public Health Service)

INTRODUCTION

Experience has demonstrated the need for improved operation of domestic wastewater treatment plants. This need has been demonstrated throughout the full range of plant sizes although the tendency in general is more evident as the plant decreases in size.

Concurrent with the large number of new treatment plants placed in service since the inception of the Federal construction grants program in 1956 has been the increased awareness of these needs. In many locations this construction program has brought to communities for the first time the responsibility of operating and maintaining a wastewater plant. For others it has increased capacity or provided for a higher degree of treatment.

Increasing concentration of population in urban areas has caused changing needs for all services in most communities. Increasing demands on streams for water supply, recreation, and other uses have stepped up the requirements for wastewater treatment efficiency. In many instances these requirements have increased without full realization by the communities.

Therefore, to assist all communities with new or existing treatment facilities toward a better understanding and execution of their responsibilities, a minimum framework of control procedures was developed. These procedures provide a fundamental basis on which to begin. They also establish a basis on which to build toward further improvement. It is important to understand that these recommendations are *minimum* at this time because the demand for higher degrees of treatment will increase as the population increases and urbanization trends continue.

Three fundamental components required in the consideration of sound operating techniques for any waste treatment plant are: (1) personnel, (2) laboratory control, and (3) records.

A plant must be staffed with certain personnel who are trained to carry out the functions necessary to (1) obtain the degree of treatment provided by the plant design, and (2) maintain and protect the community's investment in the physical plant. Even the simplest treatment plant will not operate continuously or for long without supervision. As would be expected, the needs for more personnel and personnel with more complex training increase with the size of the facility as well as the degree of treatment for which the plant has been designed.

The only stisfactory and sure way to measure the degree of treatment being obtained is by adequate laboratory control. There are many procedures used to measure plant performance. They range from quite simple tests requiring only limited equipment and instructions to complex examinations requiring elaborate equipment and considerable training to perform the tests and interpret the results. The procedures recommended here are intended to be consistent with the personnel recommended for the various sizes of treatment facilities and are intended to fit the minimum requirements found necessary for the control of these works.

The third operating component discussed in detail here is the keeping of records. The need for accurate and readily understandable records is necessary for local and State supervision. They also are valuable in guiding the operating personnel toward locating and solving operating problems. They comprise the only proof of performance and serve to justify decisions, expenditures, and recommendations. They provide valuable information for release to customers and the public and are critical documents in the event of any legal action. Training, experience, and consultation with others will further emphasize the value of well-kept records.

Certain assumptions necessarily were used as guides in developing these recommendations. All recommendations are basic minimum proposals and should be adjusted or expanded as the needs dictate. In the laboratory procedures the suggested tests are intended to deal with a normal domestic wastewater treatment plant with no unusual industrial waste or raw wastewater pumping problems. A wastewater contribution of 100 gallons per capita per day was chosen to establish a relationship between plant capacity and population. In addition to the standard tests, several techniques used by operators as aids to plant control are also described.

Consideration was given to the amount of time operating personnel can be allowed for making the tests and for operating and maintaining the treatment plant. This is necessary to prevent an undue economic burden on a community. The suggestions on time required for operation of the various size plants are based on studies of existing practice. The number of operators or laborers may need to be increased because of local conditions or other requirements.

To outline these minimum recommendations, it was necessary to select several kinds and sizes of plants to represent the most prevalent conditions of the size of the community being served. These were arbitrarily selected and represent a cross section of the majority of plants now in operation or expected to be placed in operation. The capacities selected were 0.25, 0.5, 1.0, 5.0, and 10.0 m.g.d., and based on the assumed per capita wastewater contribution, correspond to populations of 2,500, 5,000, 10,000, 50,000, and 100,000, respectively. For communities having populations and/or design conditions between the selected sizes (for example, a 0.75 m.g.d plant), qualified interpolation of the recommendations will be necessary. Qualified in this instance means that the exact requirements should be somewhere within but not necessarily precisely proportionate to the recommendations for the plants immediately larger and smaller. Where judgment is necessary, a tendency toward the recommendations for the larger plant is desirable.

Recommendations for personnel, laboratory control, and records follow for each plant size selected.

PLANT CAPACITY 0.25 MILLION GALLONS PER DAY

Personnel

Very small communities seldom can afford more than a half-time or, at best, a single full-time operator at the plant during the normal 5-day workweek. A minimum of 1 to 2 hours should be provided on Saturdays, Sundays, and holidays for sludge pumping, equipment inspection, and minimum operational attendance. Much of the operator's time will be required for routine operation of the treatment works and equipment maintenance. Time should be available, however, to perform minimum tests and keep necessary records. Two hours per week should be sufficient for the tests and recordkeeping at primary plants. An estimated 5 hours a week will be required at secondary treatment plants.

Laboratory control

In a plant of this size, the operator should conduct the following tests:

(1) Settleable solids (Imhoff Cone) once or twice a week using grab samples. The grab samples should be taken at a time of representative flow and should reflect varying days of the week and hours of the day.

(2) Relative stability (methylene blue) daily, Monday through Friday.

(3) Chlorine residual of effluent daily, Monday through Friday; twice daily when stream conditions require.

(4) For activated sludge plants, in addition to the above tests, sludge index tests daily and a colorimetric dissolved oxygen test weekly.

Records

Usually personnel and time limitations will permit the keeping of only minimal records. However, two types of records should be kept: (1) a diary-type log showing a necessarily wide variety of useful and important information such as unusual maintenance work, failure of a piece of equipment, accidents, unusual weather, flooding, bypassing, complaints, visitors, etc.; and (2) a tabular record showing the observation or results of each laboratory test made and other available measured data such as plant flow, volume of sludge, or time sludge pumped. Emphasis is placed here on the need for the operator to record the data available to him with strict regularity and in a form best suited to his schedule.

PLANT CAPACITY 0.5 M.G.D.

Personnel

A community of this size should be able to provide at least one full-time operator and one half-time laborer. With an activated sludge plant, the laborer should

be full time. A plant of this size (other than activated sludge) probably will require about 5 hours a week to keep records and carry on the laboratory control procedures. In an activated sludge treatment plant, the time required would increase to 8 hours a week.

Laboratory control

For a plant other than activated sludge the following tests should be conducted:

(1) Settleable solids (Imhoff Cone) daily, Monday through Friday. Tests should be made at varying hours during the day.

(2) Relative stability (methylene blue) daily, Monday through Friday. Tests should be made at varying hours during the day.

(3) Colorimetric pH of raw waste water occasionally.

(4) Chlorine residual of effluent daily; twice daily when stream conditions require.

(5) Total solids of digested sludge occasionally and when the sludge is drawn to the drying beds.

(6) pH of digested sludge occasionally and when the sludge is drawn to the drying beds.

For an activated sludge plant the following tests should be conducted:

(1) Settleable solids (Imhoff Cone) daily.

(2) Relative stability (methylene blue) daily.

(3) Sludge index daily.

(4) Mixed liquor dissolved oxygen (colorimetrically) daily.

(5) Sludge depth measurements in primary and secondary settling tanks daily.

(6) pH of digested sludge when sludge is drawn.

(7) Total solids of digested sludge when sludge is drawn.

Records

A diary should be kept similar to the 0.25 m.g.d. plant, but with a full-time operator it should be more comprehensive. Regularity is emphasized.

The laboratory control record also is slightly more detailed because of the additional tests specified and with a full-time operator should be maintained with ease. Consultation with State regulatory agency representatives, university personnel, and/or other experienced personnel, and attendance at short courses in his State will assist the operator to establish and maintain suitable records. These records should be accurate and complete for the items specified. Time and funds should be made available to allow the operator to attend short schools, operator meetings, and to obtain necessary books and periodicals. Membership in organizations concerned with wastewater treatment problems should be encouraged.

PLANT CAPACITY 1.0 M.G.D.

Personnel

A 1.0 m.g.d. plant should have 6 hours per week of administrative supervision, two operators, and one laborer.

For primary and trickling filter plants approximately 15 hours a week will be needed for recordkeeping and laboratory tests. For activated sludge plants the time required for recordkeeping and testing will increase to approximately 20 hours per week so that sufficient time is allowed for the added control procedures.

Laboratory control

For primary and trickling filter plants the following tests are specified:

(1) Settleable solids (Imhoff Cone) daily.

(2) Relative stability (methylene blue) daily.

(3) BOD's of raw waste, final effluent, and of such other components as possible once a week and preferably twice a week. Samples should be 3-hour composites taken at 11 a.m., 12 noon, and 1 p.m.

(4) Suspended solids of raw waste, final effluent and of such other components as possible once a week and preferably twice a week. Samples should be 3-hour composites taken at 11 a.m., 12 noon, and 1 pm.

(5) pH of digested sludge when drawn or when operating difficulties are experienced or anticipated.

(6) Total solids of digested sludge when drawn or when operating difficulties are experience or anticipated.

(7) DO of receiving stream at least twice a week above and below the plant discharge.

(8) Chlorine residuals of effluent daily; twice daily, when stream conditions require.

For activated sludge plants the following tests are specified:

(1) Settleable solids (Imhoff Cone) daily.

(2) Relative stability (methylene blue) daily.

(3) BOD's of raw waste, final effluent, and of such other components as possible twice a week. Samples should be 3-hour composites taken at 11 a.m., 12 noon, and 1 p.m.

(4) Suspended solids of raw waste, mixed liquor, and final effluent once a week. Samples should be 3-hour composites taken at 11 a.m., 12 noon, and 1 p.m.

(5) pH of digested sludge when drawn or when operating difficulties are experienced or anticipated.

(6) Total solids of digested sludge when drawn or when operating difficulties are experienced or anticipated.

(7) Depth of sludge in primary and final settling tanks daily.

(8) Sludge index daily.

(9) Dissolved oxygen (colorimetric) of mixed liquor daily.

(10) DO of receiving stream at least twice a week above and below the plant discharge.

(11) Chlorine residual of effluent daily; twice daily, when stream conditions require.

Records

For a plant of this size considerable care and technical competence is required in assembling and recording the data. Included in the supervision should be the understanding and patience needed to interpret the control procedure carried on. To establish and maintain adequate records, some guidance will be needed from State regulatory agency representatives, unviersity personnel, and/or other experienced individuals. Time and funds should be made available to allow the operator to attend short schools, operator meetings, and to obtain necessary books and periodicals. Membership in organizations concerned with wastewater treatment problems should be encouraged.

PLANT CAPACITY 5.0 M.G.D.

Personnel

A 5.0 m.g.d. plant should have 24-hour attendance with a superintendent, 4 operators, 1 maintenance man, and 1 laborer. Approximately 40 hours per week should be devoted to records and laboratory control. For activated sludge plants it would be well so add 1 chemist and 1 additional laborer to the staff.

Laboratory control

Following are recommended test procedures for plants other than activated sludge:

(1) Settleable solids daily.

(2) Relative stability daily.

(3) Dissolved oxygen of raw waste, effluent and receiving stream above and below the plant dlscharge 5 days per week.

(4) pH of raw waste and effiuent 5 days per week.

(5) BOD's of raw waste and effluents 3 times per week on 24-hour composite samples.

(6) Suspended solids of raw waste and effluents 3 times per week on 24-hour composite samples.

(7) pH of digested sludge when drawn or as necessary to control digester operation.

(8) Total and volatile solids of digested sludge when drawn or as necessary to control digester operation.

(9) Volatile acids of digested sludge when drawn or as necessary to control digester operation.

(10) Chlorine residual of effluent daily, twice daily when stream conditions require.

For activated sludge plants the recommended test procedures are as follows:

(1) Settleable solids daily.

(2) Relative stability or nitrates 5 days per week on 24-hour composite samples.

(3) Dissolved oxygen of raw waste, effluent and receiving stream above and below discharge 5 days per week.

(4) pH of raw waste and final effluent daily.

(5) BOD's of raw waste and effluents 5 days per week, on 24-hour composites.
(6) Suspended solids of raw waste and effluents 5 days per week on composite samples.
(7) Sludge index daily on each shift.
(8) Mixed liquor DO (colorimetric) daily on each shift.
(9) Sludge depth in primary and final settling tanks daily on each shift.
(10) pH of digested sludge when drawn or as needed to control digester operation.
(11) Total and volatile solids of digested sludge when drawn or as needed to control digester operation.
(12) Volatile acids of digested sludge when drawn or as needed to control digester operation.
(13) Chlorine residual of effluent daily, twice daily when stream conditions require.

Records

The size of this plant makes it desirable to keep daily records of all operations—many of them on a shift basis. With a full-time superintendent and a staff of trained men, including a chemist in an activated sludge plant, there should be no difficulty in maintaining the records in a highly competent manner. The specified personnel should assure the interpretation and use of the control information in such a way as to obtain the maximum treatment efficiency.

Since this falls in the large plant category there may be considerable flexibility in the form of records and various control procedures. In addition to the recorded laboratory control and diary-type log information, this plant may need to record a number of other determinations. Some of these might include alkalinity, ORP, heavy metals, or certain components indicative of particular industrial waste problems.

Time and funds should be made available to allow the superintendent and operators to attend short schools, operator meetings, and to obtain necessary books and periodicals. Memberships in organizations concerned with wastewater treatment problems are desirable.

There are frequent needs to record other information which contributes markedly to the control procedure. Some of these data include the following:

(1) Weather and wind direction in the event of odor problems.
(2) In addition to the raw waste flow, a record of bypassing.
(3) Amount of course solids handled; i.e., grit screening, dried sludge hauled from beds, or sludge removal from digesters.
(4) Primary and secondary settling tank cleanup—hours of hosing or skimming and/or maintenance, etc.
(5) Trickling filter maintenance—nozzle cleaning, dosing or recirculating pump operation, humus sludge pumping to primary tanks, etc.
(6) Activated sludge operation—air volume and blower operation, volume of sludge return and waste, replacement or cleaning diffusers, etc.
(7) Sludge handling—in addition to volume of sludge pumped and time, such information as amount of recirculation or transfer of digested sludge, gas mixing, supernatant withdrawal, final sludge to drying beds or filters disposal of sludge from beds, conditioning chemicals for filters, incineration, etc.

Records of the above operations may be kept in a form most convenient to the superintendent. Because of the wide variation in plants of this size and individual needs, the way these records are kept will vary considerably.

PLANT CAPACITY 10.0 M.G.D.

Personnel

A 10.0 m.g.d. plant should have a superintendent, a chemist, 6 operators, a maintenance man, and 2 laborers. A plant of this size should be completely staffed and conduct all tests needed for operation and industrial wastes studies.

Laboratory control

Required test procedures for plants other than activated sludge are:

(1) Settleable solids daily.
(2) Relative stability daily.
(3) Dissolved oxygen of raw waste, effluent and receiving stream above and below discharge 5 days per week.
(4) pH of raw waste and effluent daily.
(5) BOD's of raw waste and effluents daily, Monday through Friday, based on 24-hour composite samples.

(6) Suspended solids of raw waste and effluents daily, Monday through Friday, based on 24-hour composite samples.

(7) pH of digested sludge when drawn or as needed to control digester operation.

(8) Total and volatile solids of digested sludge when drawn or as needed to control digester operation.

(9) Volatile acids of digested sludge when drawn or as needed to control digester operation.

(10) Chlorine residuals of effluent daily, twice daily when stream conditions require.

For an activated sludge plant the required test procedures are:

(1) Settleable solids daily.

(2) Relative stability or nitrates daily on 24-hour composite samples.

(3) Dissolved oxygen of raw waste, final effluent and receiving stream above and below discharge 5 days per week.

(4) pH of raw waste and final effluent daily.

(5) BOD's of raw waste and effluents daily, Monday through Friday, on 24-hour composite samples.

(6) Suspended solids of raw waste and final effluents daily, Monday through Friday, on 24-hour composite samples.

(7) Sludge index daily on each shift. Solids should be determined in conjunction with the BOD and suspended solids determinations.

(8) Mixed liquor DO (colorimetric) daily on each shift.

(9) Sludge depth in primary and final settling tanks daily on each shift.

(10) pH of digested sludge when drawn or as needed to control digester operation.

(11) Total and volatile solids of digested sludge when drawn or as needed to control digester operation.

(12) Volatile acids of digested sludge when drawn or as needed to control digester operation.

(13) Chlorine residual of effluent daily, twice daily when stream conditions require.

Records

The comments on records for the 5.0 m.g.d. plant also apply to the 10.0 m.g.d. plant. The administrative personnel should select the record style best suited to their specific needs. Many more items of control data also may be desirable, based on the superintendent's judgment and on special conditions.

With a larger staff the 10.0 m.g.d. plant may be able to carry on special projects beyond that possible in the smaller plants. Such projects may include special studies on industrial wastes or operational research projects. These projects may result in published information which can be valuable to many others with similar problems.

A plant of this size normally is expected to produce an annual operating report containing comprehensive records of the year's activities and performance. This procedure enables the superintendent to transform the daily records into summary and unusual information which is quite helpful to others.

DISCUSSION

Laboratory control and personnel

It is emphasized that all recommendations for laboratory analyses and personnel are minimum. When special problems such as industrial wastes exist, where the availability of trained personnel permits, or when special treatment standards are required, it may be advisable or necessary to amend the recommendations toward more detailed control. Consultation with the responsible State agency or other applicable control agency will determine the extent of these requirements.

The same controlling factors will determine personnel needs in excess of those recommended. There may be instances where local conditions, special pumping requirements or special treatment problems will make it necessary to increase the staff, by utilizing additional operators, chemists, and/or laborers.

In addition to consultation with individuals and use of available published information, the superintendent and/or operator will find the short courses offered in his State of great benefit. From these courses come much of the fundamental information and detailed assistance most valuable to the operator in carrying out his daily job. Membership in and attendance at meetings of organizations concerned with wastewater treatment problems also are integral to the operating personnel's best performance. Regular use of comprehensive guides for operating

practice is strongly recommended. By using such references the operator may take advantage of the experiences of many others with similar problems.

There are several general comments on laboratory control which are considered both explanatory and pertinent to the sound application of the minimum recommendations. These include:

(1) The settleable solids test using the Imhoff Cone is the basic control test and in many respects is the most valuable of all. Its simplicity and ease of interpretation make it suitable for the smallest plant. By a visual indication a ready comparative evaluation of a plant's performance may be obtained. Daily use is highly desirable where possible.

(2) The relative stability test using methylene blue is recommended for trickling filters and even for activated sludge because of its simplicity and its indication of nitrates in the final effluent. The relative degree of stabilization of the wastewater is thus apparent.

(3) Where sludge digester capacity is limited, pH, volatile acids, and alkalinity should be determined as often as necessary to control digester operation.

(4) Because of the time involved in conducting the tests, the frequency of determining BOD's and suspended solids of the raw waste, settled waste, and final effluent is limited to the recommendations of once or twice a week for the 1.0 m.g.d. plant to 5 days a week for the 10.0 m.g.d. plant. More frequent determinations for the smaller plant are desirable if possible.

(5) For activated sludge control there should be frequent tests for depths of sludge blanket, not only in final settling tanks, but also in primary tanks, because of the importance of solids control in the aeration tanks. These measurements also may be used with equal success to control sludge pumping from primary tanks or return and wasting of sludge from activated sludge final settling tanks.

(6) For controlling dissolved oxygen in the mixed liquor, the operator may collect the sample (fixed by copper sulfate solution), settle and siphon off a clear sample into a 4-oz. bottle, add manganous sulfate, alkali, and acid, and compare the yellow iodine color with color standards made with $K_2C_2O_7$ and $CdCl_2$; 0.5, 1.0, 4.0, and 6.0 mg/l. This is a control test—not a precise laboratory titration, but is valuable for rapid control.

(7) When making the mixed liquor settling test, the volume settled at both 5-minute and the 30-minute interval should be recorded. If the sludge volume index is 100 or less the solids level at the 5-minute time will be about twice the level at 30-min. settling. As the sludge volume index rises above 100 the 5-minute settling will show a level considerably more than twice the 30-minute level. By this means a rough approximation of an index above 100 indicates the approach of operating difficulty.

Records

The need for regular and accurate records is outlined earlier in the recommendations. The records outlined here also are minimum recommendations. Obviously, the smallest plant cannot be expected to keep an elaborate set of records; however, it is far more useful to have excess information than none.

The operator should learn to record the observations and data available to him in the most orderly manner possible. Many of the smaller plants record all information in a log book, others on tabular sheets. As the size and complexity of the plants increase many find it desirable to organize the records into separate sheets for treatment components, such as preliminary and primary treatment, trickling filters, activated sludge units, final settling, sludge handling, laboratory records, and so forth. Experience and guidance from State regulatory agencies, university personnel, published information, and other indivuduals and organizations will assist the operator in adopting the physical type of records best suited to his particular needs. Above all he should be faithful in recording the information available to him.

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