United States
Environmental Protection
Agency

Office of Water
Program Operations (WH-595)
Washington D C 20460

September 1981
430/9-81-004

EPA

Technical Report

Operation and Maintenance Costs for Municipal Wastewater Facilities

[redacted]

TECHNICAL REPORT

OPERATION & MAINTENANCE COSTS FOR MUNICIPAL WASTEWATER FACILITIES

SEPTEMBER 1981

Prepared For

U. S. ENVIRONMENTAL PROTECTION AGENCY
FACILITY REQUIREMENTS DIVISION
WASHINGTON, D. C. 20460

Project Officer: Dr. Wen H. Huang

y

U.S. Environmental Protection Agency

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (Concluded)

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Concluded)

ACKNOWLEDGEMENTS

This report was prepared by Sage Murphy & Associates, Inc., Denver, Colorado, under the direction of Dr. Wen H. Huang of EPA Headquarters, Facility Requirements Division.

Sincere appreciation is extended to EPA Construction Grants personnel in each of the ten Regions and to the many State and local officials who contributed their experience, advice, and counsel to this task. A special thanks is extended to the municipal wastewater control facility personnel--more than a thousand of them--who took the time to provide the data and information on which this report is based.

Inquiries concerning this report should be directed to:

Dr. Wen H. Huang
Facility Requirements Division
U.S. Environmental Protection Agency
401 M Street, S.W. (WH-595)
Washington, D.C. 20460
(202) 426-4443

EXECUTIVE SUMMARY

Successful operation and maintenance (O&M) of wastewater control facilities is essential to the attainment of this nation's clean water goals. It is also an expensive undertaking, equal in magnitude over the life of the facility, to the cost of its construction. For these reasons EPA's Construction Grants Program examines and, if appropriate, approves the projected O&M costs for proposed wastewater control facilities. To facilitate this determination EPA continually collects and maintains data on O&M costs for municipal wastewater treatment works. Currently data on the O&M costs for separate sewer systems, and for secondary, advanced secondary, and advanced wastewater treatment plants served by separate sewer systems are of special concern. This report presents the results of the latest and most comprehensive effort to obtain and analyze O&M costs for these kinds of facilities. It summarizes O&M data from more than 900 treatment plants and almost 500 conveyance systems throughout 41 of the 48 contiguous United States--including all ten EPA Regions. Included is information on administrative costs, sludge handling costs, and staffing.

The basic information for this report was obtained from visits to selected sites and from earlier studies. It was combined into a single data base, and examined for relationships between O&M costs and common facility design and operating parameters. These relationships were determined for the general national case and, where possible, for smaller geographic units. Where appropriate in analyzing the data, total O&M costs were reduced to their major components such as personnel, utilities, chemicals, materials, equipment, and contractual.

Among the more significant findings are:

- O&M cost recordkeeping procedures are less than adequate for many facilities. For example, complete O&M cost data were available for only 60 percent of the sites actually visited.

- Estimates of administrative costs attributable to O&M indicate that this is a significant fraction of the total O&M investment--often as much as ten percent and sometimes larger. Moreover, little accurate documented information exists on these administrative costs.

- "Normal" operation of wastewater facilities, i.e., plants operating for at least a year in a continuous mode at a consistent treatment level without major upset or failure and having good records of such operation, appear to be the exception rather than the rule.

- Analysis of O&M costs is hampered, especially for advanced secondary and advanced wastewater treatment plants, by the lack of adequate numbers of such facilities with a record of normal operation.

- Little difference in annual O&M costs was observed between secondary, advanced secondary, and advanced wastewater treatment facilities.

- Few wastewater treatment plants--approximately 15 percent of the total--were found to operate near their design flow. Most--74 percent--were underloaded. Seventy-seven of the 88 advanced wastewater treatment plants studied were underloaded; five were overloaded.

- Personnel costs constitute the largest component of annual O&M costs for both treatment plants (almost 50 percent of the total) and conveyance systems (60 percent of the total).

- Information on O&M staff needs for both plants and conveyance systems is inadequate. Many authorities use contractors for O&M tasks rather than employing resident staff. However, accurate records are not maintained on equivalent staff hours procured through contracts.

- Accurate O&M costs are difficult to obtain for wastewater conveyance systems, especially those in small municipalities. Many such authorities have a unified public works budget and do not keep separate records of costs for operating and maintaining their sewer system.

1.0 INTRODUCTION

BACKGROUND

Effective, efficient operation and maintenance of facilities can mean the difference between success and failure in water pollution control efforts (1). Inadequately or improperly operated collection and treatment works--no mater how well designed, sited, or constructed--are unlikely to produce desired results. But O&M is not inexpensive; it is often a significant portion of the total costs of wastewater collection and treatment. In fact, it has been reported that more will be expended for O&M over the lifetime of most facilities than initially invested in capital costs (2). It is essential then that O&M costs be carefully considered as the facility is being planned to assure adequate funding for these purposes once it is constructed.

Despite the efforts of EPA's Construction Grants Program to insure that O&M costs are given full consideration during facilities planning, following construction many facilities often are allotted prohibitively small O&M budgets by their owner authorities. There are two aspects of this problem. One is the human proclivity for being more concerned with today's costs than with tommorrow's. The other is that realistic estimates of such costs are extremely difficult to obtain because of the inadequacy of data linking O&M costs to the size and/or efficiency of operation of various facilities. Improved information on O&M costs can help mitigate both aspects of this problem.

Recognizing this, EPA initiated efforts in 1976 to collect and analyze information on O&M costs for municipal wastewater treatment and conveyance systems. Cost data on selected facilities were systematically obtained for the period from late 1972 to early 1977 and presented in a 1978 report (2). Until now this report has been the only general tool available for estimating probable O&M costs for future systems.

Rapid changes in parameters affecting costs--inflation and interest rates, energy, chemical, and labor costs, to name a few--make it necessary to update and expand O&M cost information periodically. For this reason EPA entered into a contract in 1979 to obtain additional data on specific kinds and sizes of municipal wastewater control facilities, to update the data obtained earlier, and to re-analyze all of this information to produce more current, comprehensive estimates of annual O&M costs. This report presents the results of that effort.

As used here the term "O&M costs" refers to those expenditures related to daily operation and maintenance of a wastewater treatment plant or conveyance system. Specifically not included in this definition are replacement costs beyond routine repair and/or replacement of equipment, and the costs for debt service and/or amortization.

PURPOSE

To be eligible for funding under the Construction Grants Program, each proposed wastewater control facility must undergo a cost effectiveness analysis. An integral part of this analysis is the examination of projected O&M costs and the determination that such projections are reasonable and appropriate.

The purpose of the effort being reported here is to provide EPA with improved information on which to base such funding decisions. Specifically, the effort was designed to provide for the continuation, enhancement, and, as appropriate, redirection of O&M cost estimating acitivities that have been carried out by EPA since 1976.

OBJECTIVES

Specific objectives adopted in support of this overall purpose include:

- Collection of O&M information on certain specific sizes and kinds of facilities.
- Development of consistent, uniform O&M data for such facilities representative of the U.S. at large.
- Preparation of these data for inclusion into the automatic data processing files of EPA.
- Examination of the effect of geographical distribution on these data.
- Presentation of these data in terms of their more significant components.
- Analysis of the data base to investigate possible relationships between O&M costs and certain accepted parameters of facility size, type, and efficiency.
- Recommendations regarding the need for additional study or research on O&M costs.

APPROACH

Operation and maintenance data contained in a 1978 EPA report (2) served as the starting point for the present effort. This data base consisted of information on more than 300 individual wastewater treatment plants and more than 150 sewer systems across the U.S. These data, and information from other rports in the technical literature, were reviewed to determine their usefulness for the current study. Part of this information was used in preparing this report.

The criteria used in making this selection included data reliability, geographical distribution, and type of treatment system. These same criteria were used to select additional plants and facilities for study during the present effort.

The 1978 Needs Survey provided a listing of the number of municipally owned treatment plants and collection systems in existence and potentially available for inclusion in the study (3). Preliminary decisions were made about facilities to be visited. EPA Regional and State agency people were asked for advice about the suitability of such facilities for this purpose. Contact was made with personnel responsible for those treatment works which seemed to present the opportunity for successful data collection efforts. The results of this contact served as the final test of which plants and facilities would be visited.

Data on the facility and its operation and maintenance costs were obtained from the selected sites. These raw cost data were updated to a common dollar base using approved indexes and standard updating techniques. Then the data were subjected to bivariate analysis to investigate the possibility of predictable relationships between O&M costs and certain standard parameters of facility size, function, or efficiency. The results of such analyses were reduced to statistical parameters, mathematical relationships, and graphical plots which are presented and discussed in the body of this report.

SCOPE

Data for this study were obtained from 916 treatment facilities and 482 conveyance systems located in 41 of the 48 contiguous United States.

These data represent costs incurred during the period 1973 to 1981. Only facilities with secondary or higher levels of treatment receiving wastes from separate sewer systems were selected for this effort. All lagoon systems were excluded, as were systems with combined sewers. A further requirement for inclusion in this study was a recent, full year of records for normal operating conditions.

Data analyses were performed for three levels of treatment, three levels of performance as measured by plant loading and by pollutant removal, and for different levels of plant complexity.

Illustrative examples are presented at several points in this report for guidance in the use of the data and results of the study.

2.0 DEFINITIONS AND PROCEDURES

INTRODUCTION

This effort followed and took direction from an earlier and similar effort by EPA to obtain and present information on O&M costs for municipal wastewater control facilities (2). The present study addressed objectives and dealt with questions not convered before. It required the collection, analyses, and presentation of new information on certain types of facilities, and the integration of this information with previously published data on similar systems. Thus, decisions were required as to definition of terms; type, location, and number of facilities to be investigated; type, precision, and accuracy of the information to be obtained from each facility; procedures for data handling and analysis; and the manner of data presentation and discussion.

This section gives the basic definitions used in this study. It also describes the procedures employed in this effort: how the facilities were selected for study, how the data were collected, and how the data were analyzed and presented. This description is meant to provide a general overview of the investigation. Specific points of procedure and methodology are discussed, as appropriate, in subsequent sections of this report.

DEFINITION OF TERMS

Following is a listing of terms frequently used in this report, arranged alphabetically according to functional groups of definitions. Many of these terms have a variety of definitions and interpretations within the sanitary engineering community; however, the definitions given below are applied consistently and uniformly throughout this report. The definitions apply to this report only and are not necessarily the same as used in other times and places by EPA or by others involved with water pollution control.

ABC Classification

The Association of Boards of Certification for Operating Personnel in Water and Wastewater Utilities (ABC) classification system is a method for determining the relative complexity of treatment facilities. The system assigns points to treatment plants based on numerous factors such as population served, receiving stream sensitivity, variation in loading, treatment processes in use, and laboratory testing methods utilized. These points are then summed to indicate a complexity of operation relative to other facilities.

Collection Systems

Collection systems are defined in this report as the agglomerate of gravity collector sewers, interceptors, lift stations, and associated force mains necessary to collect and transport municipal and industrial wastewater to a treatment facility. Systems transporting stormwater in any appreciable extent were excluded from this study.

Combined Sewer System. A combined sewer system is one which carries stormwaters in addition to sanitary and/or industrial wastewater.

Separate Sewer System. A separate sewer system, or sanitary sewer, is a system intended to carry only sanitary and/or industrial wastewater from residences, commercial buildings, industrial plants, and institutions.

Cost Information

All cost information given in this report is expressed as 1st Quarter 1981 dollars unless specifically noted otherwise. Several types of costs are discussed as follows.

Administrative Costs. Costs for administrative and support activities related to the daily operation and maintenance of the wastewater control facility are defined as administrative costs. These costs are associated with functions such as supervising a central office, purchasing, billing and other financial activities, legal assistance, and clerical duties. In this report administrative costs are not included in the total operation and maintenance costs but are presented separately.

Component Costs. Component costs are general budgetary categories which collectively make up the total O&M costs. Several components, itemized below, are analyzed in this report.

- Personnel - This component includes wages and fringe benefits.
- Utilities - All expenditures for electrical power, natural gas, telephone, fuel, and water are included in this component.
- Chemicals - This component includes costs for all process chemicals including disinfectants, coagulants, and sludge conditioners. Laboratory chemicals are considered supplies as a part of the equipment and materials component.
- Equipment and Materials - Expenditures for minor machinery, routine replacement of parts, laboratory equipment and supplies, tools, and routinely consumable supplies are part of this component. The supplies included are for process, building, grounds and vehicle maintenance, laboratory work, and office management.

- Contractual Services and Other - This component includes any contracted function and costs which are not accounted for in other components. Examples of services which are often contracted are sludge handling, sludge disposal, laboratory work, contract maintenance, and engineering consultation. Some items in the "Other" category are travel, transportation, training, vehicle and equipment insurance, and magazine subscriptions.

- Replacement Costs. Replacement costs are the costs for replacing or repairing major equipment items or for the replacement, reconstruction, expansion, upgrading, or betterment of the entire facility. They represent the decline in worth of operating assets because of day-to-day consumption in providing services. They are not included in the total operation and maintenance costs presented in this report.

- Sludge Handling Costs. Sludge handling costs represent that portion of the total plant expenditures necessary for sludge treatment process O&M and ultimate sludge disposal. Sludge handling costs, both on-site and contracted sludge treatment and disposal costs, are included in total operation and maintenance costs in this report.

- Total Operation and Maintenance Costs. All expenditures for the daily operation and maintenance of a wastewater treatment plant or sewer system are termed total operation and maintenance costs. Components which make up total O&M costs include personnel, utilities, chemicals, equipment and materials--including the cost of minor equipment repair and replacement--and contracted services. Sludge treatment and disposal costs and laboratory costs are also part of the total operation and maintenance costs, regardless of whether they are on-site activities or contracted. Specifically not included are administrative costs, replacement costs beyond routine repair and/or replacement of equipment, and the costs for debt service and/or amortization.

Hydraulic Loading

Design Loaded. Treatment facilities with average annual hydraulic loadings in the range of 90 to 110 percent of design flow are referred to as design loaded.

Overloaded. Treatment facilities with average annual hydraulic loadings greater than 110 percent of the design flow are defined as overloaded.

Underloaded. Treatment facilities with average annual hydraulic loadings of less than 90 percent of design flow are defined as underloaded.

Sludge Handling

Complex Sludge Handling. Complex sludge handling is a term used to categorize those treatment facilities where the sludge treatment scheme includes at least one of the following processes: heat treatment, wet air oxidation, incineration, or pyrolysis.

Moderate Sludge Handling. Moderate sludge handling is a term used to categorize those treatment facilities where the sludge treatment scheme includes dewatering (centrifuge, vacuum filter, or filter press), but excludes more complex processes such as heat treatment, wet air oxidation, incineration, or pyrolysis.

Simple Sludge Handling. A simple sludge handling scheme includes, as its most sophisticated process, one of the following unit processes: aerobic digestion, anaerobic digestion, sludge lagooning, composting, gravity thickening, or sludge flotation.

Staff Size

Staff size represents equivalent full time staff utilized for operation and maintenance of the treatment facility or sewer system. Equivalent full time staff is based on a 40 hour work week and is calculated from reported average weekly staff hours at the facility.

Treatment Levels

Secondary Treatment. Secondary treatment facilities are defined as those facilities, regardless of treatment process, designed to reduce the five day Biochemical Oxygen Demand (BOD) effluent concentration to between 25 and 30 mg/l, inclusive. No data were collected from lagoon systems or other so-called secondary facilities having design effluents greater than 30 mg/l.

Advanced Secondary Treatment. Advanced secondary treatment (AST) facilities are defined as those facilities designed to reduce the five day BOD effluent concentration to a value in the range of 11 to 24 mg/l, inclusive. This definition makes no distinction between types of treatment processes or whether or not there is any requirement for nutrient removal.

Advanced Wastewater Treatment. The advanced wastewater treatment (AWT) category includes facilities designed to reduce the five day BOD effluent concentration to 10 mg/l or less, without regard to nutrient removal.

Treatment System Type

Attached Growth Systems. Attached growth systems are those whose liquid treatment scheme includes trickling filters and/or rotating biological contactors.

Suspended Growth Systems. Suspended growth systems are those whose liquid treatment scheme utilizes some form of activated sludge process including extended aeration, oxidation ditch systems, and pure oxygen.

DATA COLLECTION PROCEDURES

Generation of a comprehensive, statistically valid base on total annual O&M costs and staffing requirements for wastewater control facilities was a major objective of this project. A further concern was that this data base provide consistent, uniform information representative of the entire U.S. and permit delineation of the variations in costs and staffing between geographical areas. Thus, the initial step in the process was the judicious selection of facilities from which to collect the needed data.

The selection was accomplished through repeated screenings of the 1978 Needs Survey (3) and through questioning of knowledgeable persons in EPA's Regional offices and in State water quality control offices. Final selection was based on actual questioning of personnel from prospective facilities.

An initial decision was to limit the effort to treatment systems producing secondary or higher levels of treatment which are served by collection systems that carry municipal and industrial wastes only. Collection systems carrying stormwater were ruled out, as were lagoon type treatment systems regardless of their performance level.

The decision to link collection systems to treatment facilities in the data gathering efforts was based on the assumption that communities with good cost records for treatment plants likely would maintain good records on their sewer systems--an assumption that proved to be untrue in many cases.

Following these decisions, the 1978 Needs Survey was examined to determine the number of treatment plants and conveyance systems in existence and potentially available for inclusion in the data base. Decisions were then made regarding the total number of facilities needed for the data base and their distribution with respect to EPA Regions. It was decided to select a certain minimum number of plants of each performance level (secondary, advanced secondary, and advanced wastewater treatment) and of each hydraulic loading condition (underloaded, design loaded, and overloaded) for each Region.

Information on plants and facilities contained in the 1978 report, Analysis of Operation & Maintenance Costs for Municipal Costs for Municipal Wastewater Treatment Systems, MCD-39 (2) was screened to determine the availability of necessary data from this source. This led to a determination of the number of additional data sources needed in each Region. The final facility selection criteria are listed below.

Secondary Treatment: A base of 50 plants per Region was required. At least 30 new plant visits were made in each Region with approximately 30 additional visits for those Regions with more than 600 secondary facilities.

Advanced Secondary Treatment: A base of 15 plants per Region was included in the combined data base. At least ten new plant visits were made in each Region.

Advanced Wastewater Treatment: A slightly different approach was used to create the sample for AWT facilities. For those Regions with less than 100 such facilities, a base of seven plants per Region was included in the combined data base. Regions having 100 to 300 AWT facilities provided ten plants per Region, while 12 plants each were selected in those Regions with more than 300 AWT facilities.

Following the determination of the number of facilities needed for the study in each Region, the 1978 Needs Survey again was consulted in order to select specific facilities capable of meeting the following criteria:

- Representing the full range of treatment levels (secondary to AWT).
- Being served by separate sewers.
- Representing the full range of hydraulic loading (underloaded, design loaded, and overloaded).

Additional criteria were introduced at this point. Facilities selected were required to have at least one full year of "normal" operation and a history of good recordkeeping. Normal was defined as continuous operation at a consistent treatment level. These criteria were utilized to eliminate facilities which had experienced recent major plant upset or failure, natural disaster, expansion, and/or upgrading.

Representatives of Regional EPA offices and State water pollution control regulatory agencies, using their knowledge of specific plant operating characteristics, assisted in selecting the proposed list of plants to be visited in each State. Each proposed facility was contacted. Information about the project was provided, the need for a site visit was explained, and cooperation was solicited. This contact was the final step in selecting facilities for this study. If the facility did indeed meet all the criteria and if the owner/operator appeared cooperative, the facility was chosen.

Contractor personnel visited most of the sites and collected information on total annual O&M costs, staffing, performance, and other facility characteristics. Data for a few of the sites were obtained by telephone or written requests. A summary of the data items collected is presented in Table 2.1 and Table 2.2 for the treatment plants and sewer systems, respectively.

TABLE 2.1

SUMMARY OF TREATMENT PLANT INFORMATION ITEMS

Facility Identification: Facility name, name of operating authority, City or town, county, State, zip code, EPA Region, authority/facility number (from the Needs Survey), facility architectural/engineering firm, and service population.

Information Dates: The month, day, and year defining the end of the fiscal year from which were taken actual or budgeted costs and operating information. Also, the year in which the last major modification was completed.

Permit Information: The National Pollution Discharge Elimination System (NPDES) number, and maximum values based on a 30 day average for influent flow (mgd) and effluent concentrations (mg/l) of BOD, Suspended Solids (SS), and any applicable nutrient.

Wastewater Characteristics: Actual average daily concentrations (mg/l) of BOD, SS, and any applicable nutrient in influent and effluent; actual average daily flow (mgd); peak daily flow (mgd) for the year being reviewed; and average daily industrial flow (mgd).

Facility Design Parameters: Influent and effluent average daily concentrations (mg/l) of BOD, SS, and any applicable nutrient for which facility was designed.

Staffing Information: Number of employees at facility, average number of hours per week for superintendents, supervisors, operators, maintenance staff, chemists, laboratory technicians, laborers, and others. Also, percentage of overall hours devoted to supervision, upkeep, liquid line, and sludge line.

Cost Information: Total annual O&M costs, either budgeted or actual, in terms of power, total utilities, personnel, chlorine, total chemicals, equipment, materials, contractual and other, and administrative costs (for offsite facility management). When possible, costs associated strictly with sludge handling and laboratory work were segregated.

Yearly totals for replacement/capital improvement costs for major facility work were retrieved. These costs were not reflective of plant expansion, nor for any work not fully financed by the operating authority. Several years' information was collected.

General Facility Information: Type of sewer system serving the plant, i.e., sewers carrying domestic/industrial flow only, or sewers carrying combined domestic/industrial and stormwater flows.

Treatment level, i.e., design effluent concentrations (mg/l) for BOD and any applicable nutrient.

TABLE 2.1 (Concluded)

Percentage value of average daily flow attributed to infiltration/inflow (I/I) and comment if I/I presented a problem.

Unit processes in operation at facility (i.e., bar screen, primary clarification, chlorination).

Daily amount of dry solids (lbs./day) removed from the facility.

Plant classification based on the ABC method.

TABLE 2.2

SUMMARY OF SEWER SYSTEM INFORMATION ITEMS

Total miles of gravity sewer pipe in the system and diameter range (inches) of the pipe.

Total miles of force main in the system and diameter range (inches) of the pipe.

Number of lift stations in operation in the system, the design pumping capacity (mgd) of each, and the motor horsepower of each.

Number of service connections to the collection system.

Number of collection system employees and average hours per week in areas of supervision, foreman, maintenance, equipment operation, laborer, and other.

Total annual O&M costs, either budgeted or actual, in terms of personnel, power, equipment and materials, contractual and other, and administrative costs (for administration and management of collection system).

Yearly totals of replacement/capital improvement costs for the collection system. These costs were not reflective of system expansion, nor for any work not fully financed by the operating authority. Several years' information was collected.

Records of actual expenditures were the prime source of cost information. Where actual cost records were not available, budget information from the last complete fiscal year of operation or estimates by the facility personnel were utilized.

While in the field, project personnel recorded the required information on specially designed forms. A manual quality assurance check was made of these forms prior to entering the data into the computerized data file. After data entry, every data item was screened by computer to verify that it fell within a prescribed range of values. Any data item not passing the computer screen was examined manually by inspection of the data collection form and the written record of the site visit. Data items which remained outside of the prescribed range of values after this review were checked further with the respective municipal operating personnel. Only data items passing these screenings were retained in the data base.

Data collected for this study were added to EPA's existing O&M data base. The combined data base represents costs from 41 States and all ten EPA Regions. Table 2.3 shows the distribution of plants and sewer systems for which data were obtained. Some 100,000 data items from 916 treatment facilities and 482 sewer systems are contained in the data base. Because of various necessary exclusions and screenings, only 723 treatment facilities and 419 sewer systems were used in the analyses presented here.

COST UPDATING PROCEDURES

Cost data collected during this study were for the period from 1972 to 1981. To enable comparable analyses, these costs were updated to 1st Quarter 1981.

The EPA developed Quarterly Indexes of Direct Cost for Operation, Maintenance and Repair (OM&R)[1] were used to update the raw cost data. These indexes are prepared quarterly by the Facility Requirements Division of EPA to reflect changes in O&M costs for wastewater treatment facilities and conveyance systems. The base year for the Treatment Facilities Index is 1967; for the Conveyance System Index, 1973. The indexes were published annually from 1967 to 1973 and on a quarterly basis thereafter.

Updating Wastewater Treatment Facility Costs

The EPA developed OM&R Indexes for treatment plants are based on categorical cost estimates for operating and maintaining a 5.0 mgd activated

[1] Although EPA uses this terminology for these indexes, a more common definition of OM&R is Operation, Maintenance and Replacement which, in general, is the context in which O&M is used in this report.

TABLE 2.3

DISTRIBUTION OF PLANTS AND SEWERS BY EPA REGION AND LEVEL OF TREATMENT

	Secondary Plants		AST Plants		AWT Plants		Sewer Systems	
EPA Region	Number Available*	Number in Data Base**	Number Available*	Number in Data Base**	Number Available*	Number in Data Base**	Number Available*	Number in Data Base**
01	282	21	32	5	7	3	549	21
02	306	63	146	17	15	12	1,049	38
03	471	32	313	28	103	12	2,445	36
04	1,736	54	182	32	118	16	3,765	59
05	1,172	55	859	20	318	7	3,764	63
06	554	42	450	49	22	10	3,123	47
07	874	53	7	14	2	8	2,959	41
08	613	51	30	12	17	6	1,450	47
09	271	26	46	20	26	8	1,207	36
10	243	22	85	18	12	7	828	31
TOTALS	6,522	419	2,150	215	640	89	21,139	419

* Source: 1978 Needs Survey (3) for number of existing facilities.

** The number of facilities included in the data base includes those investigated under this contract, as well as those investigated and reported under an earlier contract.(2).

sludge facility. Eleven O&M cost categories are considered including labor, power, utilities, chemicals, and administration. A composite index was developed from the categorical indexes to form an average O&M Escalation Index.

In collecting data for this report, total O&M costs for wastewater treatment facilities were separated into several components. Table 2.4 lists these components and presents the indexes applied to update each of them.

Updating Wastewater Conveyance Systems Costs

The EPA developed OM&R Indexes for updating wastewater conveyance O&M costs use separate indexes for gravity sewers and for those having lift stations. The Lift Station Index is based on a national average cost for the operation, maintenance, and repair of a 1.0 mgd average flow rate raw wastewater lift station. The Gravity Sewer Index is based on a national average cost per mile for the operation, maintenance, and repair of municipal sewer lines excluding the cost of lift stations. Table 2.5 outlines the appropriate indexes applied to update the specific cost components for sewer systems.

Cost Updating Formula

Raw data were updated to 1st Quarter 1981 dollars using the following formula:

$$\text{O\&M Item Specific Cost from Data Base as Collected} \times \frac{\text{EPA O\&M Item Specific Cost Index (1st Qtr 1981)}}{\text{Appropriate Qtr EPA O\&M Item Specific Cost Index}} = \text{O\&M Item Specific Cost 1st Qtr 1981}$$

DATA ANALYSIS AND PRESENTATION

Most data analysis for this report took the familiar form of using one parameter as the sole predictor of a second parameter. The method employed was bivariate analysis using a linear regression technique; a convenient, widely accepted way of analyzing both large and small data sets for relationships.

The least-squares method was used for the linear regression analysis. This method yields a linear regression equation--expressing one variable in terms of another--and certain kinds of statistical information about this equation and the relationship it expresses.

The large sample sizes encountered in this study precluded, in most cases, the display or presentation of individual data points. Because of this, a general rule was adopted that no data points be used in the graphical presentations. Rather the information usually is presented as

TABLE 2.4

WASTEWATER TREATMENT FACILITY O&M COST UPDATING INDEXES

Cost Category from Data Base	EPA Developed OM&R Index Used for Update*
Total O&M Costs	Total of All Cost Categories or Average OM&R Escalation Index if only Total Costs Available
Personnel	Labor Index
Power	Power Index
Total Utilities	Power Index
Chlorine	Chlorine Index
Total Chemicals	Overall Chemical Index
Equipment	Maintenance Index
Materials	Wholesale Price Index for Industrial Commodities
Contractual	Labor Index
Other	Other Costs Index
Replacement Items	Maintenance Index
Administrative	Administration Index

* Available through the Priorities & Needs Assessment Branch, Facility Requirements Division, U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, D. C. 20460.

TABLE 2.5

WASTEWATER CONVEYANCE SYSTEM O&M COST UPDATING INDEXES

Cost Category from Data Base	EPA Developed OM&R Index Used for Update*
Total O&M Costs (Sewer Systems without Lift Stations)	Total of All Cost Categories or Average Sewer OM&R Index without Lift Stations
Total O&M Costs (Sewer Systems with Lift Stations)	Total of All Cost Categories or Average Sewer OM&R Index with Lift Stations
Personnel	Labor Index
Power	Power Index
Equipment and Materials	Equal Weighted Composite of Subindexes for Cleaning, Testing, and Maintenance of Sewer Lines
Contractual	Labor Index
Other	Composite of Subindexes

* Available through the Priorities & Needs Assessment Branch, Facility Requirements Division, U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, D. C. 20460.

the log-log plot of the linear regression equation together with appropriate statistical information about the data used. Some information is presented in tabular form. Unless otherwise indicated, the data are presented in 1st Quarter 1981 dollars and are representative of the entire nationwide data set for the particular system or systems being discussed.

Further explanation of this approach is provided in subsequent sections of this report, together with examples of the use and interpretation of the information presented.

3.0 FINDINGS

INTRODUCTION

This chapter presents the most current, comprehensive information available on annual O&M costs for municipal wastewater control systems. Total O&M costs reflecting the general national situation were obtained by collecting appropriate data from throughout the U.S. In the case of secondary treatment facilities, information descriptive of conditions in each of the ten EPA Regions was segregated from the larger data base and is presented separately. Data on administrative costs, sludge handling costs, staffing and personnel costs, power costs, and lift station costs associated with municipal sewerage works also are presented. Where appropriate, total O&M costs are reduced to their principal components, i.e., personnel, utilities, chemicals, materials and equipment, contractual and other.

Costs presented are those annual costs required to maintain design capacity and performance over the life of the facility. They include only those replacement costs which apply to the routine replacement of minor equipment, accessories, and appurtenances. They do not include costs for replacement of major equipment items or of entire facilities. Neither do they include costs for debt service or amortization.

All costs are presented in 1st Quarter 1981 dollars and are reported and compared on the basis of such system variables as design flow, actual flow, degree and method of treatment, method of sludge handling, population served, and length of collection system.

The data reported here were collected and analyzed by commonly accepted techniques. However, certain limitations relative to both data collection and analyses should be recognized before attempting to apply these results to specific cases. These data generally reflect well operated plants and systems, functioning under normal conditions, and having good operating records. Nevertheless, some O&M component cost data were not available for some of the sites visited. Complete cost data were available for only about 60 percent of the sites with data from the remaining facilities consisting of a combination of actual and budgeted or estimated costs. In addition, the data have not been normalized to account for cost differences inherent to various parts of the country, such as might be found among identical plants treating identical wastewater, but located in different geographical areas.

The method of data analysis used in this report--bivariate analysis using linear regression--is widely accepted in the sanitary engineering community as a way of analyzing and expressing data. However, in interpreting the results of such analysis, it is important to keep in mind certain aspects of the method. For example, the technique always yields an equation--the regression equation--which can be plotted as a straight line--the regression line--on log-log paper, regardless of the true relationship between one parameter and the other. Thus, strong relationships between parameters often are assumed, even when they do not exist, because of the equation or graph generated. This can result in the placing of more confidence in the relationship expressed by the graph or equation than is merited.

The bivariate, linear regression approach was used because it is both a convenient means of expressing large numbers of data points and a useful analytical tool. In this report large sample sizes preclude display of individual data points in many cases, thus it was decided not to plot individual data points on any of the graphs. Rather, the data were used to develop the regression equation which was then plotted to illustrate general trends. For this reason statistical information is included with each graph to help in defining the significance of the relationship.

In general, large sample sizes (n) and high values of the squared correlation coefficient (r^2) imply more statistically sound relationships. To provide an indication of data scatter, most of the graphs--regardless of the associated number of data points--include a shaded band about the plotted regression line. The shaded region is an indication of data scatter--the "goodness of fit" of the data points to the plotted line. The wider the bands the greater the degree of scatter in observed data and the less reliable the equation of the plotted line as a measure of the true relationship(s) between one variable and the other. Examples are used to illustrate the application of these graphs.

Despite such limitations this report represents the most comprehensive information currently available on the O&M costs of U.S. water pollution control systems. Used with good engineering judgment and normal engineering estimating procedures, it should be helpful in providing more definitive preliminary estimates of O&M costs for several kinds of wastewater control processes and facilities.

TREATMENT PLANTS

Administrative Costs

Cost for administrative and support activities related to the daily operation and maintenance of wastewater control facilities are defined here as administrative costs. Such costs might include those for supervising a central office, purchasing, financial management, legal assistance, general computer usage, and routine clerical support. These services often are provided at locations separate from the wastewater control facility and by an authority of which the wastewater system is but one subunit. This study found that such authorities seldom maintain records sufficient for segregating administrative costs for each of its subunits. Because of this, much of the information collected on administrative costs is an approximation obtained at the site, according to "best available estimates," but likely having less reliability than the data on other O&M cost components. For this reason, it was decided to exclude administrative costs from other O&M costs in this report and to present the available administrative cost information separately.

Administrative cost data were collected for secondary, advanced secondary, and advanced wastewater treatment plants. These data were analyzed to examine their relationships to design flow, and the three regression lines resulting from the analyses are shown in Figure 3.1.

It should be noted that these are administrative costs associated with the plants only. Insufficient information was collected to permit a meaningful analysis of sewer system administrative costs. Figure 3.1 represents data from 385 plants from all Regions of the contiguous United States. The number (n) of each type facility is shown on the figure and in each case is sufficiently large to assure reliability of the information.

The regression lines--or the regression equations--of Figure 3.1 show that, as expected, administrative costs generally increase as design flow (Q_D) increases. However, caution must be used in interpreting the information presented here. First, it should be noted that the square of the correlation coefficient (r^2) is low in all three cases. An r^2 of 1.0 would indicate a perfect fit between the data and the regression line, i.e., all the real data actually fall on the line. Thus, the lower values of r^2 contained in Figure 3.1--0.357, 0.282, and 0.382, respectively--indicate that the relationships between administrative costs and design flow depicted by the regression line plots are questionable. This is logical as there is a "fixed" nature to many of the components of administrative costs and the relationship between such costs and design flow might more accurately be represented, on an arithmetic plot, by some kind of step function.

Statistically there is little distinguishable difference in administrative costs between the three types of systems studied. The bulk of administrative costs are probably fixed costs having little relationship to degrees of treatment. Given the nature of the data, the conclusion is that there are no measurable differences between administrative costs for the three levels of treatment investigated.

Considering the above, the administrative cost data from all three levels of treatment were analyzed as one data set. This result is shown in Figure 3.2 which can be used to estimate the administrative costs associated with either of the three treatment levels considered. However, caution is again urged in the use of this information. There is a large scatter of data about the regression line of Figure 3.2. This is illustrated by the shaded band shown on the figure, which is of a width to contain most (approximately 95 percent) of the actual data points. The regression line itself expresses the most probable location of the actual data points. However, as the shaded band becomes larger the regression line becomes less accurate as an expression of the probable location of the actual data.

Administrative cost data were collected for secondary, advanced secondary, and advanced wastewater treatment plants. These data were analyzed to examine their relationships to design flow, and the three regression lines resulting from the analyses are shown in Figure 3.1.

It should be noted that these are administrative costs associated with the plants only. Insufficient information was collected to permit a meaningful analysis of sewer system administrative costs. Figure 3.1 represents data from 385 plants from all Regions of the contiguous United States. The number (n) of each type facility is shown on the figure and in each case is sufficiently large to assure reliability of the information.

The regression lines--or the regression equations--of Figure 3.1 show that, as expected, administrative costs generally increase as design flow (Q_D) increases. However, caution must be used in interpreting the information presented here. First, it should be noted that the square of the correlation coefficient (r^2) is low in all three cases. An r^2 of 1.0 would indicate a perfect fit between the data and the regression line, i.e., all the real data actually fall on the line. Thus, the lower values of r^2 contained in Figure 3.1--0.357, 0.282, and 0.382, respectively--indicate that the relationships between administrative costs and design flow depicted by the regression line plots are questionable. This is logical as there is a "fixed" nature to many of the components of administrative costs and the relationship between such costs and design flow might more accurately be represented, on an arithmetic plot, by some kind of step function.

Statistically there is little distinguishable difference in administrative costs between the three types of systems studied. The bulk of administrative costs are probably fixed costs having little relationship to degrees of treatment. Given the nature of the data, the conclusion is that there are no measurable differences between administrative costs for the three levels of treatment investigated.

Considering the above, the administrative cost data from all three levels of treatment were analyzed as one data set. This result is shown in Figure 3.2 which can be used to estimate the administrative costs associated with either of the three treatment levels considered. However, caution is again urged in the use of this information. There is a large scatter of data about the regression line of Figure 3.2. This is illustrated by the shaded band shown on the figure, which is of a width to contain most (approximately 95 percent) of the actual data points. The regression line itself expresses the most probable location of the actual data points. However, as the shaded band becomes larger the regression line becomes less accurate as an expression of the probable location of the actual data.

ADMINISTRATIVE COSTS vs DESIGN FLOW
COMPARISON: TREATMENT LEVELS
SECONDARY, ADVANCED SECONDARY,
AND ADVANCED WASTEWATER TREATMENT PLANTS

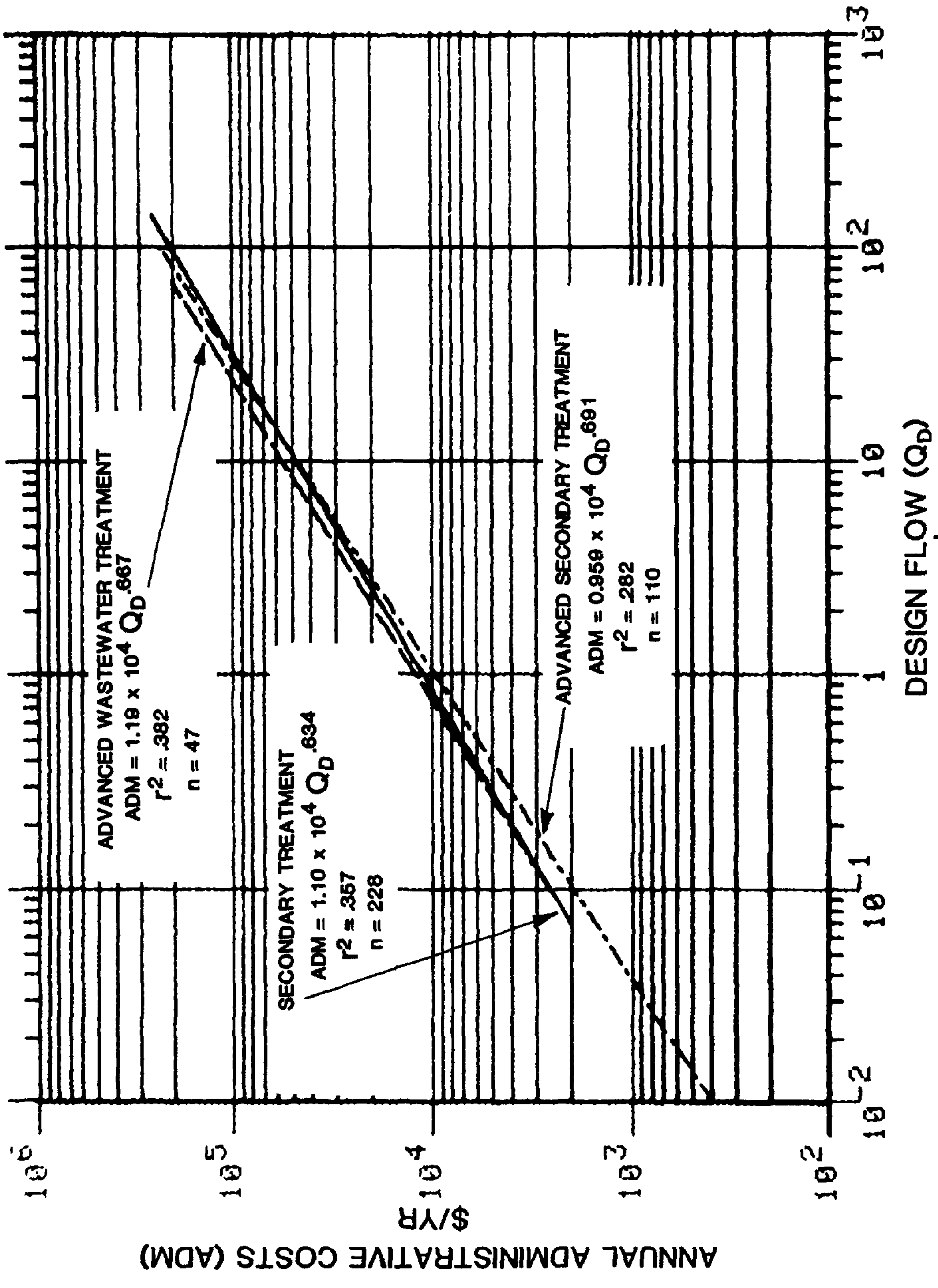
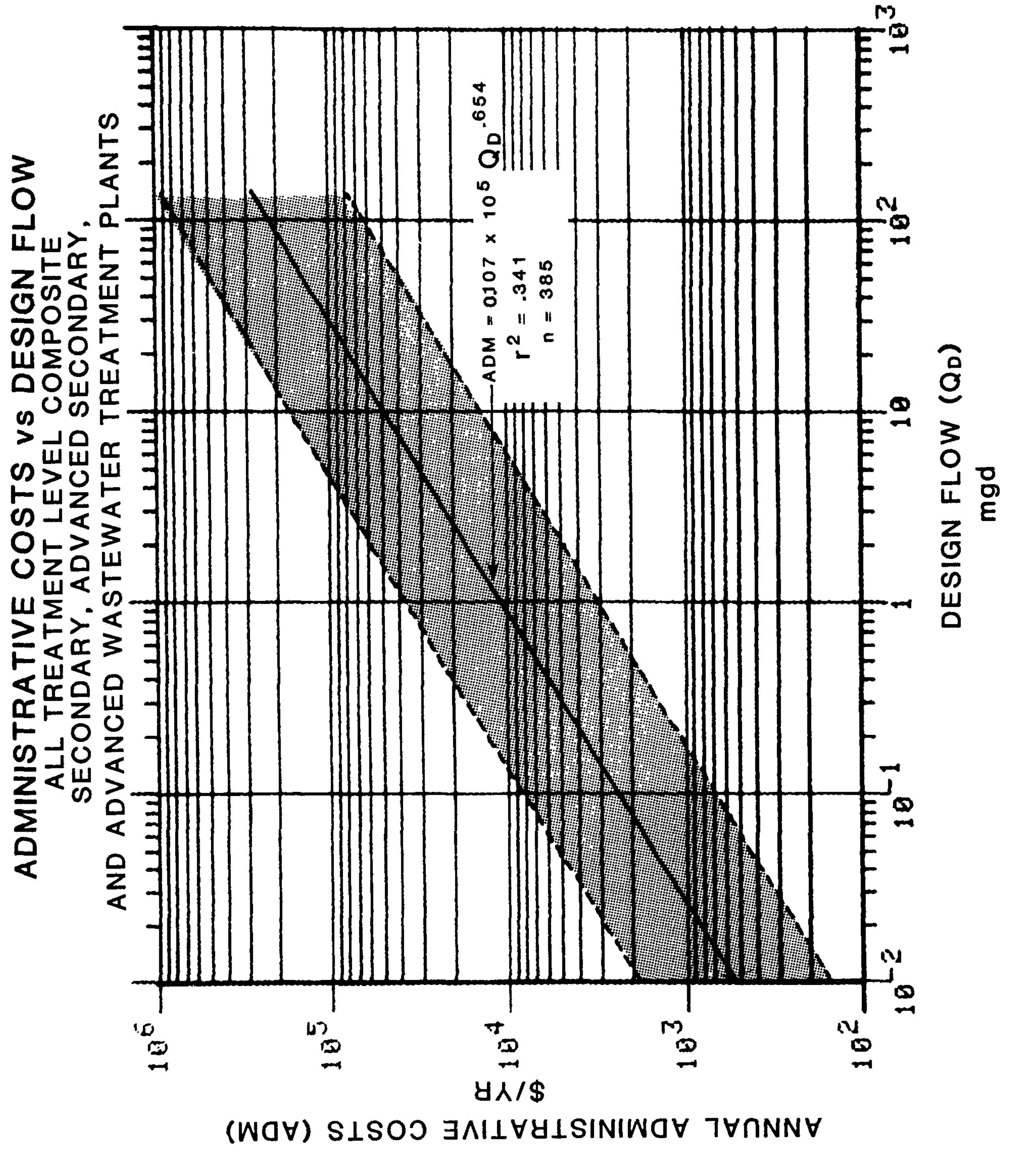


FIGURE 3.1



ADMINISTRATIVE COSTS vs DESIGN FLOW
ALL TREATMENT LEVEL COMPOSITE
SECONDARY, ADVANCED SECONDARY,
AND ADVANCED WASTEWATER TREATMENT PLANTS
ADM = 0107 x 10^5 Q_D^.654
r^2 = .341
n = 385
ANNUAL ADMINISTRATIVE COSTS (ADM)
$/YR
10^6
10^5
10^4
10^3
10^2
10^-2
10^-1
1
10
10^2
10^3
DESIGN FLOW (Q_D)
mgd

FIGURE 3.2

An example calculation based on Figure 3.2 will serve to illustrate both the use of such plots and some of the problems inherent in their use.

Example Problem: Estimate administrative costs for a secondary wastewater treatment facility having a design flow (Q_D) of 5.0 mgd.

Solution: From the regression line[1] of Figure 3.2 and for a Q_D of 5.0 mgd, the most probable annual administrative cost is (reading from the graph at the design flow rate):

Secondary Administrative Costs = $30,000

However, the range of cost values which could be expected to contain most of the data (about 95 percent) should also be determined, and can be as follows:

From Figure 3.2, using the upper and lower boundaries of the shaded band and reading from the graph at the 5.0 mgd design flow rate, the range and the most probable values of administrative costs for the 5.0 mgd secondary facility are:

Lowest Probable Value	:	$ 9,000
Most Probable Value	:	$ 30,000
Highest Probable Value	:	$100,000

This tabulation shows the very large uncertainty inherent in these data which must be considered when using them. The reason for this extreme range of values for administrative costs is not clear; perhaps some plants simply spend more on such costs than others; perhaps many plants do not really know what they spend--because of poor recordkeeping or because such costs are borne elsewhere. At any rate, these data should only be used for first cut approximations of such costs.

These data also were analyzed to evaluate possible relationships between administrative costs and design flow in situations where flow is equal to or less than 1.0 mgd and greater than 1.0 mgd. It was reasoned that the general relationship between administrative costs and design flow might differ for small plants as opposed to larger ones.

The data sets for each level of treatment--secondary, advanced secondary, and advanced wastewater treatment--were used for these split analyses. In each case the results of such analyses showed that most of the plants in the data set have design flows greater than 1.0 mgd. Plants having flows equal to or less than 1.0 mgd represent only 23, 16, and 17 percent of all plants for secondary, advanced secondary, and advanced wastewater treatment plants, respectively.

---

[1]This value could also be determined from the regression equation given on the figure.

The analyses of the split data sets agreed, in general, with those obtained from analyses of the total data sets. For each level of treatment, the regression equations produced from analyses of the data subsets were not significantly different from those derived using the full data sets. Neither the accuracy (r^2) nor the precision (shaded band width) of the regression equation as an expression of the actual data points were improved by the separate analyses. In fact, in all cases the r^2 was smaller for the split data--in some cases, dramatically smaller--than for the full data set. Because they revealed nothing of value, the plots of these split analyses are not included in this report.

The relative magnitude of administrative costs compared to total O&M costs for the same kinds of systems is also of significance. This calculation is shown in Table 3.1. Here, annual administrative costs are seen to be on the order of six to ten percent of annual total O&M costs. In many instances this represents a considerable sum, worthy of more careful accounting than is generally being applied at present.

Total Annual O&M Costs

Operation and maintenance costs for the treatment systems studied--exclusive of administrative costs, major replacement costs, and debt service--are presented here. These costs are expressed in terms of plant type, size, and complexity. Information is also given on staff size for these facilities.

Secondary Treatment Facilities:

Nationwide - More than 900 wastewater treatment plants were investigated for this study. Of these, 723 produced data of sufficient quantity and quality to permit their use in this report. Information on 376 of these--all secondary treatment facilities--is shown in Figure 3.3. The plants included here are those which produce a five day BOD effluent concentration of 25 to 30 mg/l. The plot is a generalization of the data obtained on these facilities and thus represents current, national average total annual O&M costs. The data were obtained from widely distributed geographical locations around the U.S. and the number of data entries is sufficient for good statistical generalization.

For comparative purposes, the information presented in Figure 3.3 is shown in Figure 3.4 along with plots of O&M cost information obtained from the technical literature (5, 6, 7). It was not possible to determine if the O&M costs reported in the literature include or exclude administrative costs. However, much of this information fits that obtained by this effort--most of it falling within the shaded band width (approximately 95 percent of the data) for plants with design flows ranging from 0.1 mgd to 60 mgd. In fact, the New York data (5) coincides almost precisely with the regression line from Figure 3.3 over the entire range studied. It should be noted, however, that the data on

TABLE 3.1

COMPARISON OF ANNUAL ADMINISTRATIVE COSTS TO ANNUAL TOTAL O&M COSTS FOR WASTEWATER TREATMENT PLANTS

Design Flow (mgd)	Type of Facility		
	Secondary	AST	AWT
1.0	9%	10%	7%
5.0	8%	8%	7%
10.0	7%	7%	6%
25.0	7%	6%	6%
50.0	6%	5%	5%
100.0	6%	5%	5%

Note: Percentages were computed from Most Probable Values, determined by substituting the appropriate design flow value in the regression equations from Figures 3.2, 3.3, 3.17, and 3.20.

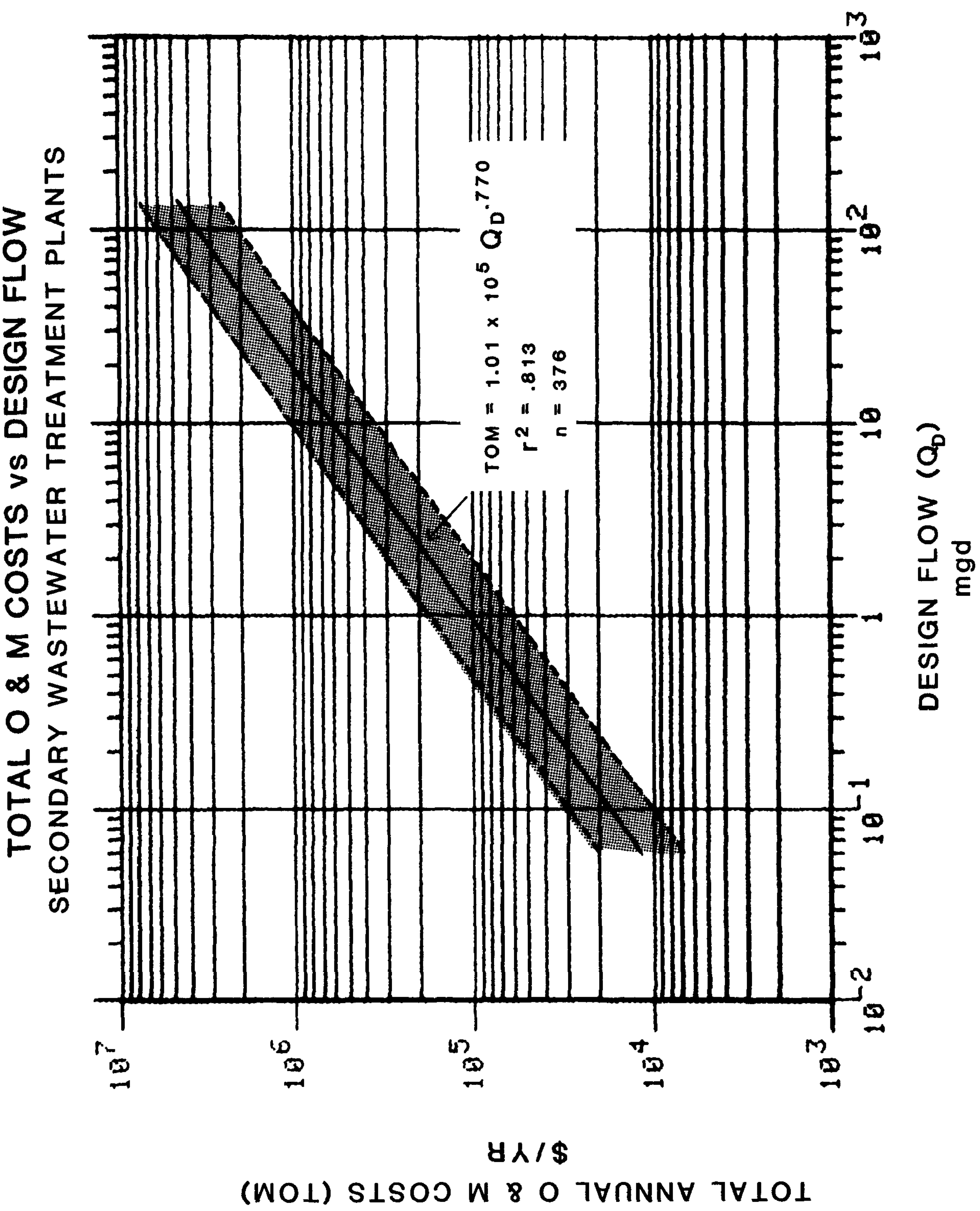
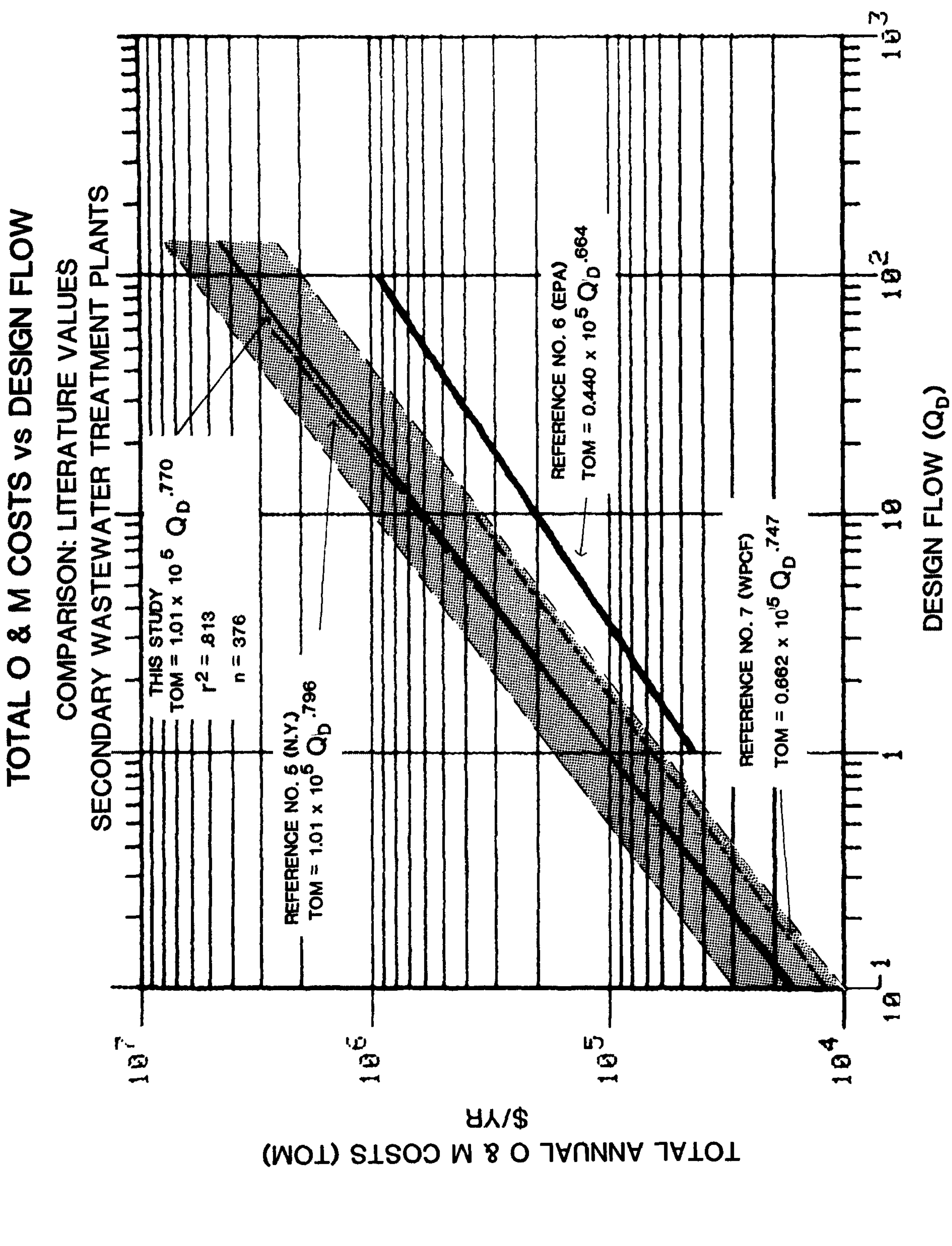

TOTAL O & M COSTS vs DESIGN FLOW
SECONDARY WASTEWATER TREATMENT PLANTS
TOM = 1.01 x 10^5 Q_D^.770
r^2 = .813
n = 376
DESIGN FLOW (Q_D)
mgd
TOTAL ANNUAL O & M COSTS (TOM)
$/YR
10^7
10^6
10^5
10^4
10^3
10^-2
10^-1
1
10
10^2
10^3

FIGURE 3.3



TOTAL O & M COSTS vs DESIGN FLOW
COMPARISON: LITERATURE VALUES
SECONDARY WASTEWATER TREATMENT PLANTS
THIS STUDY
TOM = 1.01 x 10^5 Q_D^.770
r^2 = .813
n = 376
REFERENCE NO. 5 (N.Y.)
TOM = 1.01 x 10^5 Q_D^.796
REFERENCE NO. 6 (EPA)
TOM = 0.440 x 10^5 Q_D^.664
REFERENCE NO. 7 (WPCF)
TOM = 0.662 x 10^5 Q_D^.747
TOTAL ANNUAL O & M COSTS (TOM)
$/YR
10^7
10^6
10^5
10^4
10^-1
1
10
10^2
10^3
DESIGN FLOW (Q_D)
mgd

FIGURE 3.4

secondary plants obtained for this study show total O&M costs to be appreciably higher than those computed from the methods in an earlier EPA report (6).

Total O&M costs for secondary plants were generated by the Computer Assisted Procedure for the Design and Evaluation of Wastewater Treatment Plants (CAPDET) program (8). These costs were developed for several typical configurations of both activated sludge plants and trickling filter plants with design flows ranging from 0.5 mgd to 25 mgd. These results are shown in Figure 3.5 and compared with the nationwide data on secondary treatment plants obtained during this study. The CAPDET estimates for trickling filters adequately approximate the location of most of the collected data over the range studied. These results, however, do raise questions about CAPDET O&M cost approximations for activated sludge systems. As Figure 3.5 clearly shows, CAPDET activated sludge O&M costs are significantly higher over the entire range studied than those obtained by this study.

In light of these observations and considering the relatively wide scatter in the data, caution must be exercised in the application of these plots for O&M cost estimating. For example, on Figure 3.3 the square of the correlation coefficient (r^2) is 0.813; fairly good, but still far enough below a perfect 1.000 to indicate a less than perfect relationship between costs and design flow. The shaded band width also is indicative of this imperfection and can be useful in setting the limits of believability in the use of the data.

Although the results are not shown here, these data also were split several ways and each subset analyzed separately. The total data set contained information on 376 plants. There were 97 plants with flows equal to or less than 1.0 mgd, 212 plants with flows greater than 1.0 mgd but equal to or less than 10.0 mgd, and 67 plants greater than 10.0 mgd. Each of these three subsets were analyzed separately and the results compared to those for the total data set. No significant points emerged from this analysis. The regression equation for each subset compared favorably with that of the full set. But as expected, the r^2 for each subset was less than that in the full set.

Most of the collected data are for facilities on the lower end of the flow scale (309 of 376 are equal to or less than 10.0 mgd). There simply are not very many large plants in existence. This suggests that the bulk of the relationship shown in Figure 3.3 is contributed by the smaller facilities. However, r^2 for the smaller plant data set is less than for the complete secondary facility data set. This could indicate that total O&M costs vary more widely for the small facilities than for the large. It might also mean, however, that the larger plants keep better records of O&M costs. This brings up a second point. In terms of logic, Figure 3.3 compares apples and oranges. That is, the data have not been normalized to make possible comparison between identical plants treating identical wastes, but located in different

TOTAL O & M COSTS vs DESIGN FLOW

COMPARISON: CAPDET VALUES

SECONDARY WASTEWATER TREATMENT PLANTS

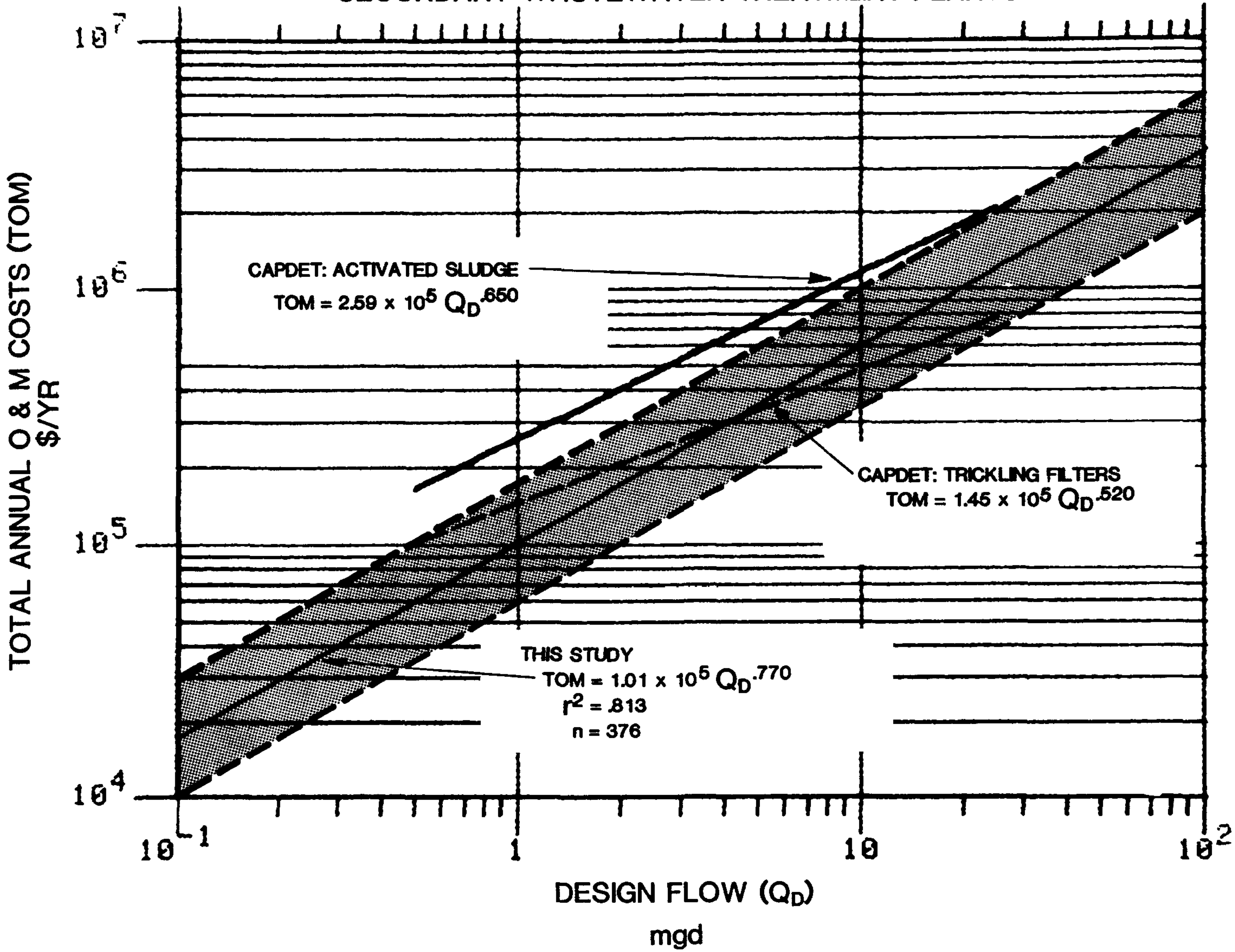


FIGURE 3.5

parts of the country. Thus, the observation made above regarding possible differences between large and small plants might arise from unspecified geographical differences.

The following example serves to illustrate the use of these data.

Example Problem: To determine total annual O&M costs for a 5.0 mgd secondary treatment plant.

Solution: From Figure 3.3 obtain the most probable value of the total O&M cost by reading from the plotted regression line at the 5.0 mgd design flow rate.

Most Probable Total Annual O&M Costs = $350,000

An expected range of total O&M cost values which would contain approximately 95 percent of all observed values is determined by reading from the upper and lower limits of the shaded band for the 5.0 mgd design flow. The range and the most probable values of total annual O&M costs for a 5.0 mgd secondary treatment plant are:

Lowest Probable Value : $200,000

Most Probable Value : $350,000

Highest Probable Value: $600,000

Figure 3.6 presents nationwide total annual O&M data on two types of secondary treatment in combination with three sludge handling methods. For this presentation suspended growth systems, regardless of type, are compared with attached growth systems, regardless of stage or type. Systems are further distinguished by the complexity of sludge handling employed as shown in Table 3.2.

The difficulty of generalizing from these data is emphasized by Figure 3.6. Over most of the design flow range studied, attached growth systems require less total O&M expenditures than suspended growth systems. This is in agreement with the estimate of O&M costs made by CAPDET for activated sludge and trickling filter systems and shown earlier. Furthermore, O&M costs generally increase for both types of systems as sludge handling complexity increases. However, given the fact that there is wide scatter in these data, it is presumptuous to claim that there are distinguishable differences in O&M costs for the various combinations studied even though the regression lines are, in fact, different. The conclusion is that more analysis and/or more information is needed.

Regional - Information on total O&M costs within each of the ten EPA Regions is presented in Figures 3.7 through 3.16. In terms of r^2 and shaded band width (data scatter), these plots demonstrate a better fit

TOTAL O & M COSTS vs DESIGN FLOW
COMPARISON: SLUDGE HANDLING COMPLEXITY
SECONDARY WASTEWATER TREATMENT PLANTS

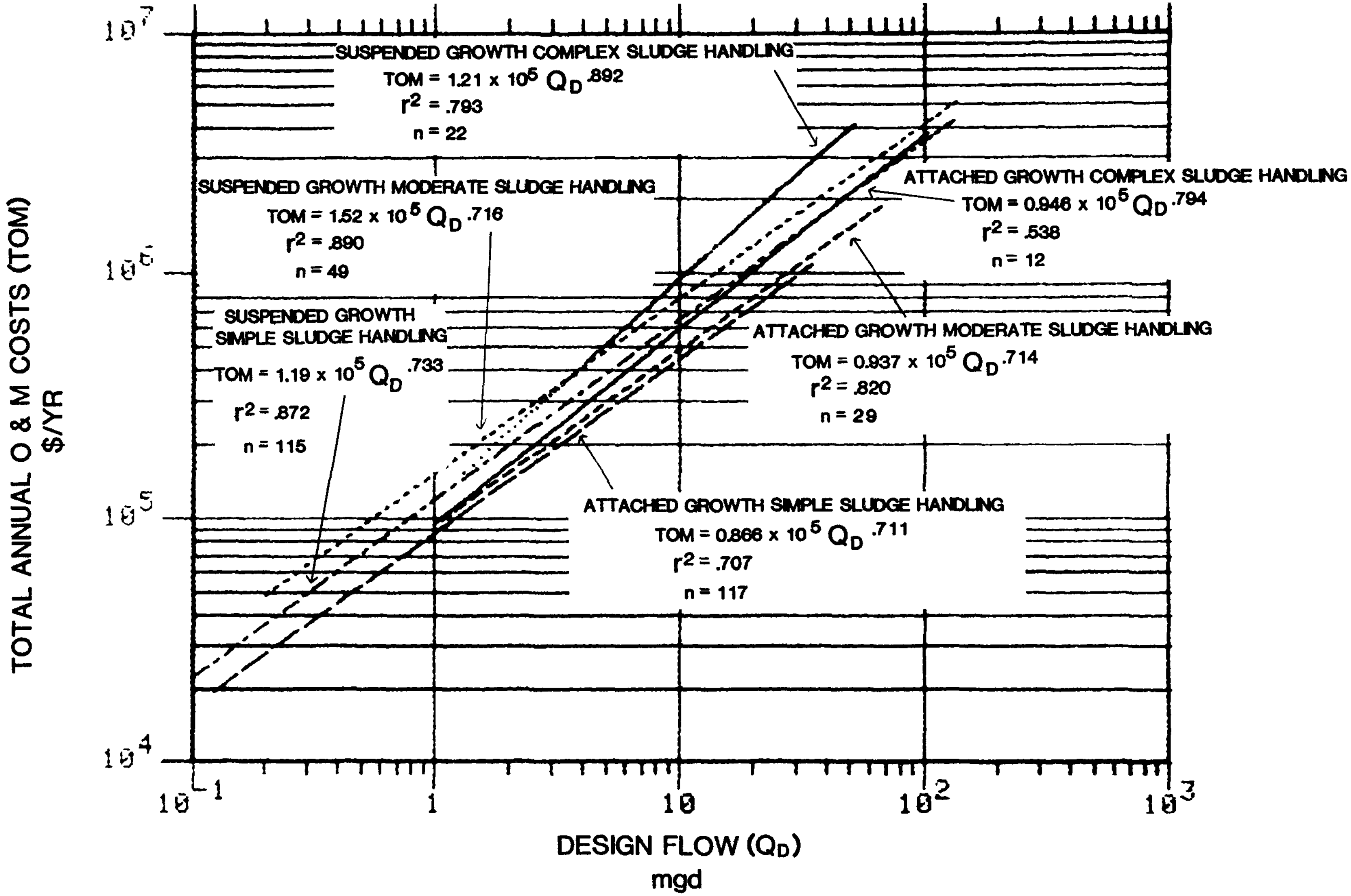
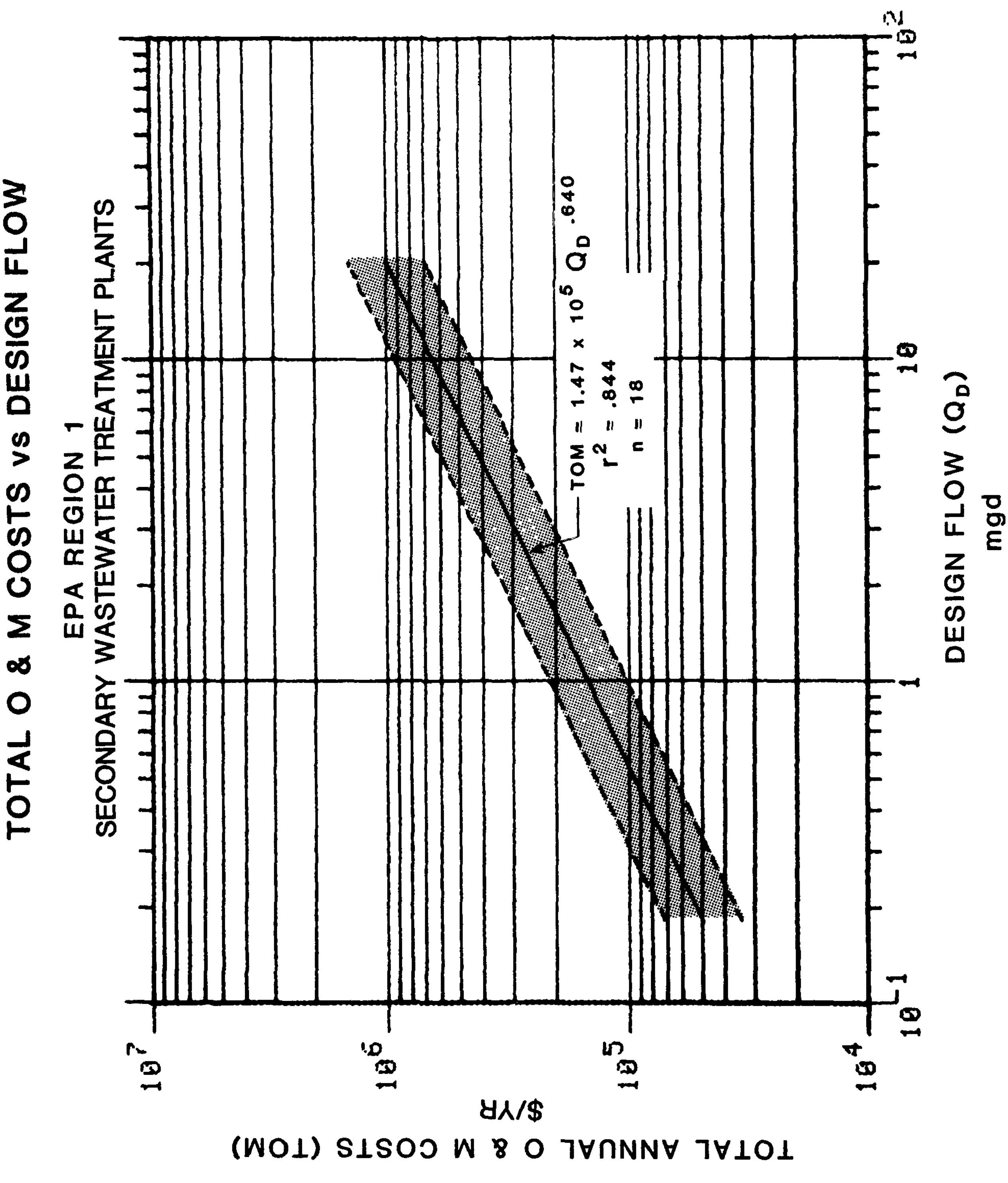


FIGURE 3.6

TABLE 3.2

SECONDARY TREATMENT SLUDGE HANDLING METHODS

Treatment Method	Sludge Handling Method		
	Simple	Moderate	Complex
Attached Growth Systems:			
Trickling Filters Rotating Biological Contactors	No Heat Treatment, No Dewatering	No Heat Treatment, Dewatering	Heat Treatment, Dewatering
n = 158	n = 117	n = 29	n = 12
Suspended Growth Systems:			
Activated Sludge			
n = 186	n = 115	n = 49	n = 22



TOTAL O & M COSTS vs DESIGN FLOW
EPA REGION 1
SECONDARY WASTEWATER TREATMENT PLANTS
TOM = 1.47 x 10^5 Q_D^.640
r^2 = .844
n = 18
TOTAL ANNUAL O & M COSTS (TOM)
$/YR
10^7
10^6
10^5
10^4
10^-1
1
10
10^2
DESIGN FLOW (Q_D)
mgd

FIGURE 3.7

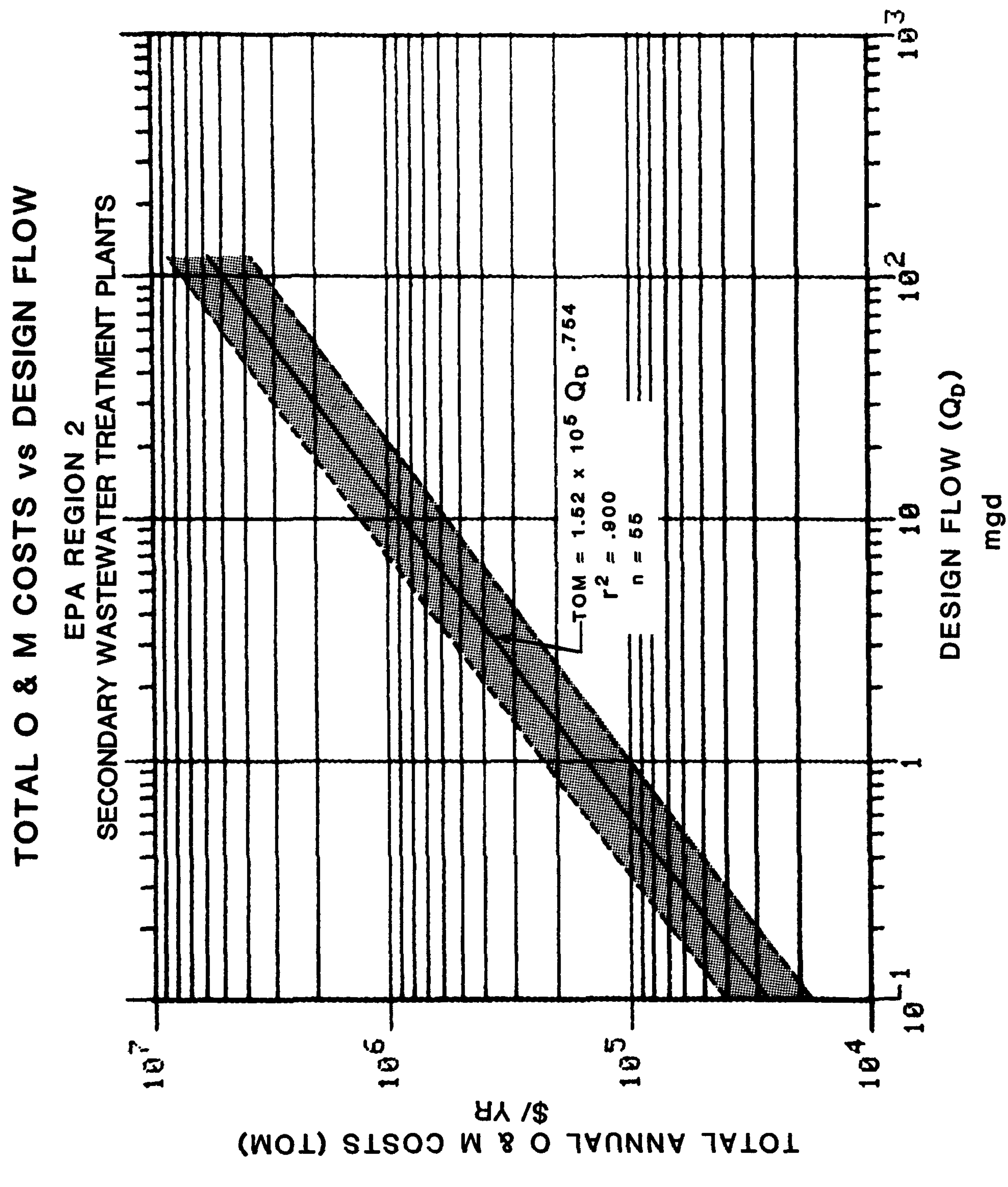

TOTAL O & M COSTS vs DESIGN FLOW
EPA REGION 2
SECONDARY WASTEWATER TREATMENT PLANTS
TOM = 1.52 x 10^5 Q_D^.754
r^2 = .900
n = 55
TOTAL ANNUAL O & M COSTS (TOM)
$/ YR
10^4
10^5
10^6
10^7
10^-1
1
10
10^2
10^3
DESIGN FLOW (Q_D)
mgd

FIGURE 3.8

TOTAL O & M COSTS vs DESIGN FLOW

EPA REGION 3

SECONDARY WASTEWATER TREATMENT PLANTS

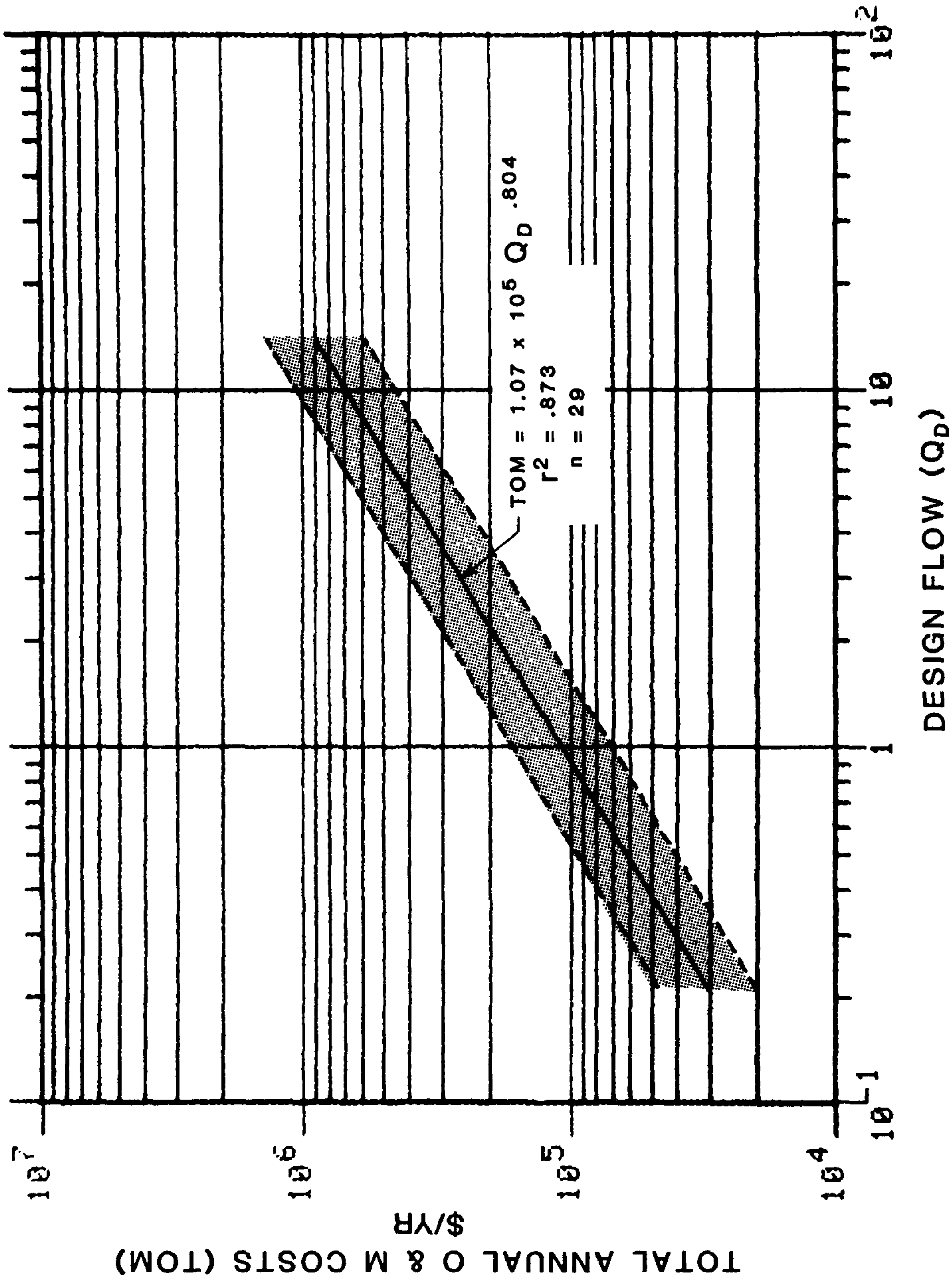
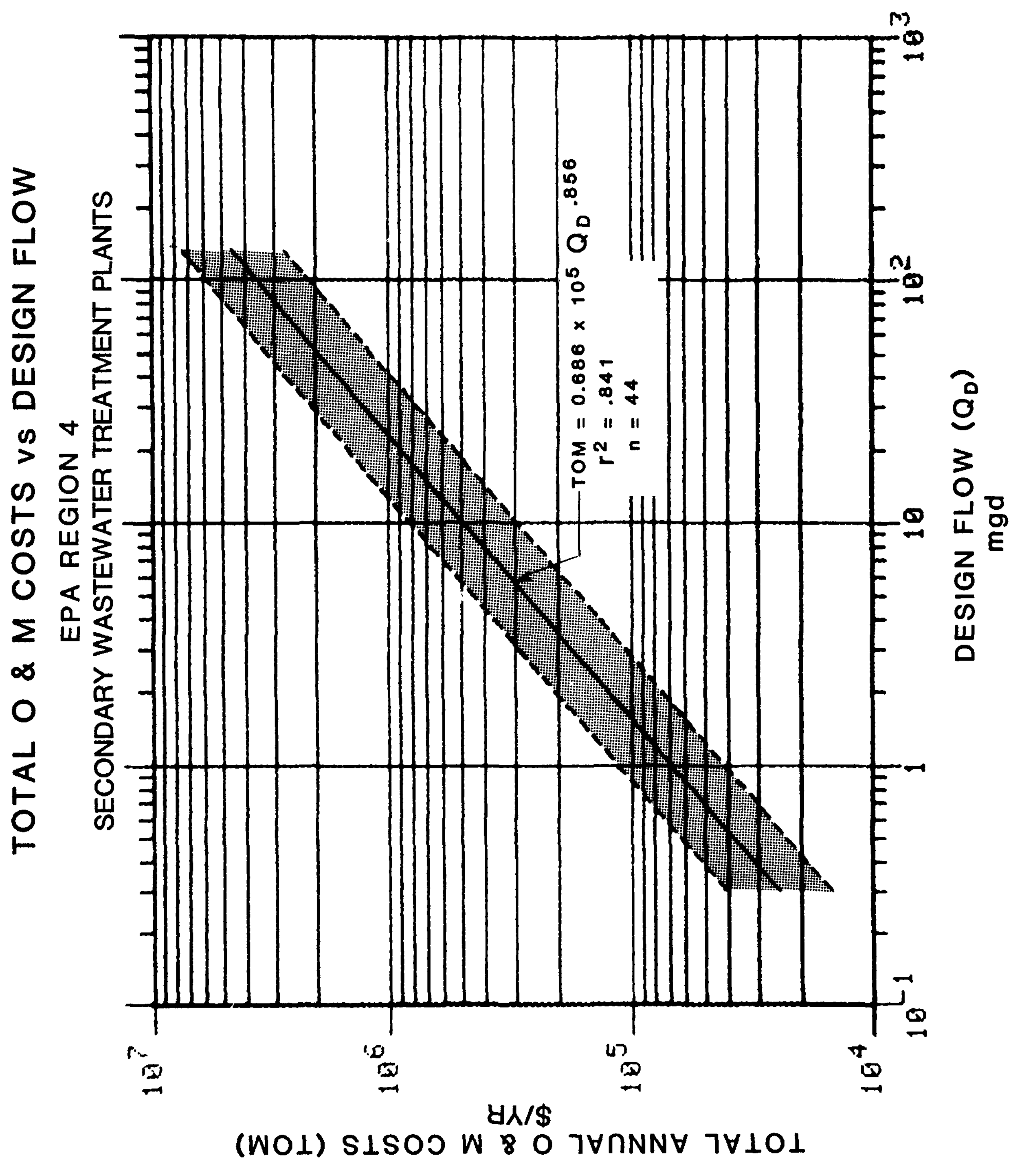


FIGURE 3.9



TOTAL O & M COSTS vs DESIGN FLOW
EPA REGION 4
SECONDARY WASTEWATER TREATMENT PLANTS
TOM = 0.686 x 10^5 Q_D^.856
r^2 = .841
n = 44
TOTAL ANNUAL O & M COSTS (TOM)
$/YR
10^7
10^6
10^5
10^4
10^-1
1
10
10^2
10^3
DESIGN FLOW (Q_D)
mgd

FIGURE 3.10

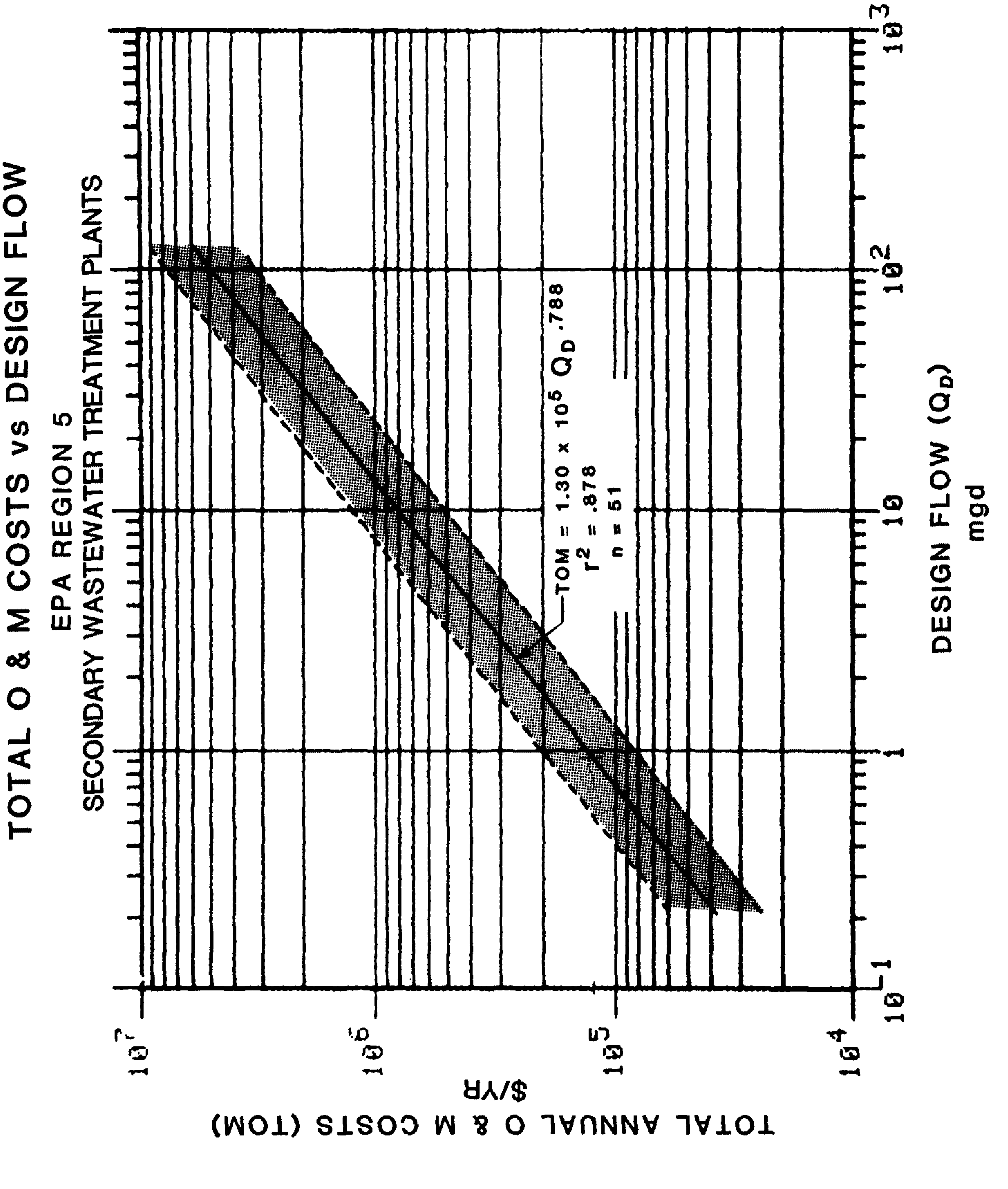
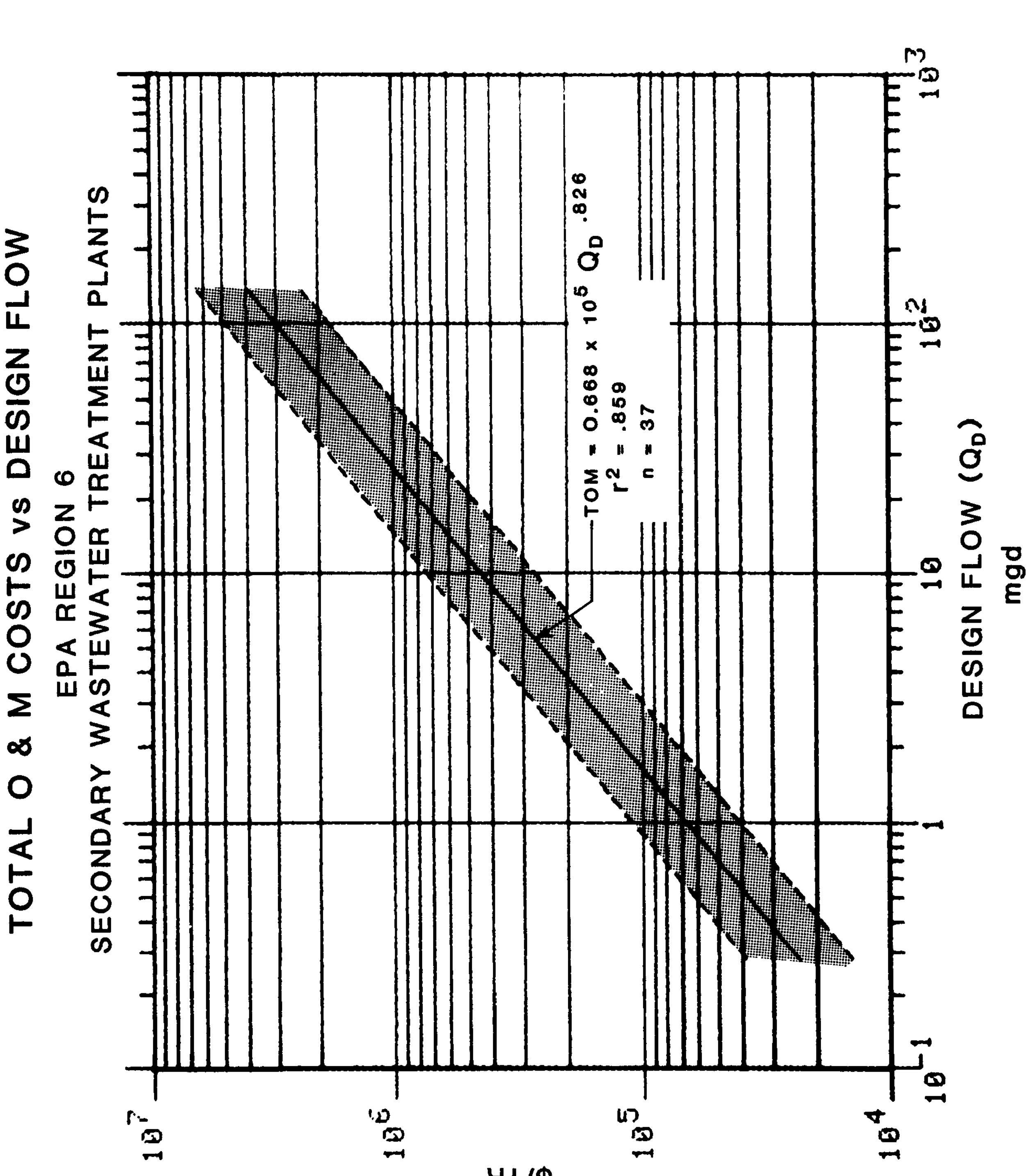

TOTAL O & M COSTS vs DESIGN FLOW
EPA REGION 5
SECONDARY WASTEWATER TREATMENT PLANTS
TOM = 1.30 x 10^5 Q_D^.788
r^2 = .878
n = 51
TOTAL ANNUAL O & M COSTS (TOM)
$/YR
DESIGN FLOW (Q_D)
mgd
10^-1
1
10
10^2
10^3
10^4
10^5
10^6
10^7

FIGURE 3.11



TOTAL O & M COSTS vs DESIGN FLOW
EPA REGION 6
SECONDARY WASTEWATER TREATMENT PLANTS
TOM = 0.668 x 10^5 Q_D^.826
r^2 = .859
n = 37
DESIGN FLOW (Q_D)
mgd
TOTAL ANNUAL O & M COSTS (TOM)
$/YR
10^-1
1
10
10^2
10^3
10^4
10^5
10^6
10^7

FIGURE 3.12

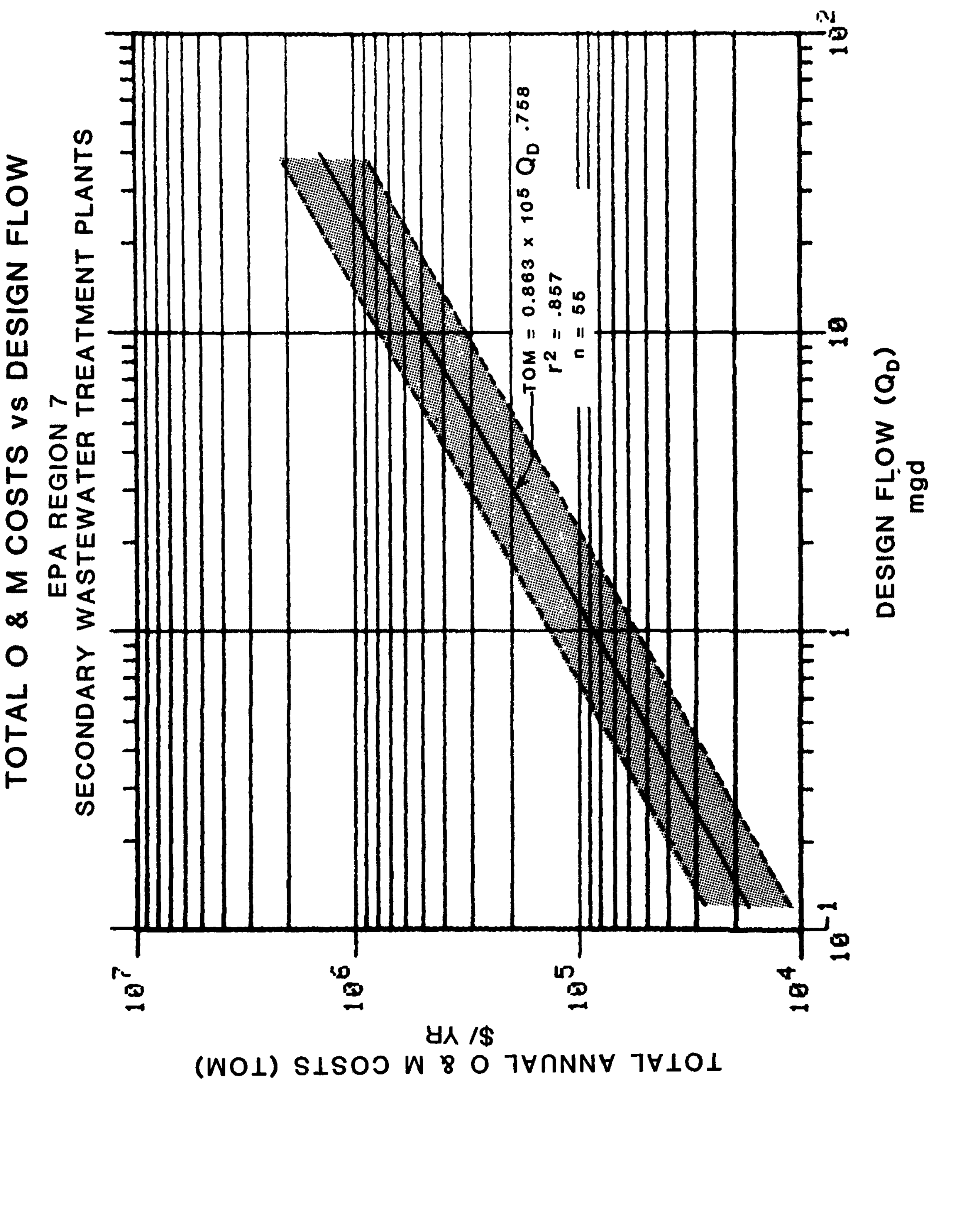

TOTAL O & M COSTS vs DESIGN FLOW
EPA REGION 7
SECONDARY WASTEWATER TREATMENT PLANTS
TOM = 0.863 x 10^5 Q_D .758
r2 = .857
n = 55
TOTAL ANNUAL O & M COSTS (TOM)
$/ YR
10^7
10^6
10^5
10^4
10^-1
1
10
10^2
DESIGN FLOW (Q_D)
mgd

FIGURE 3.13

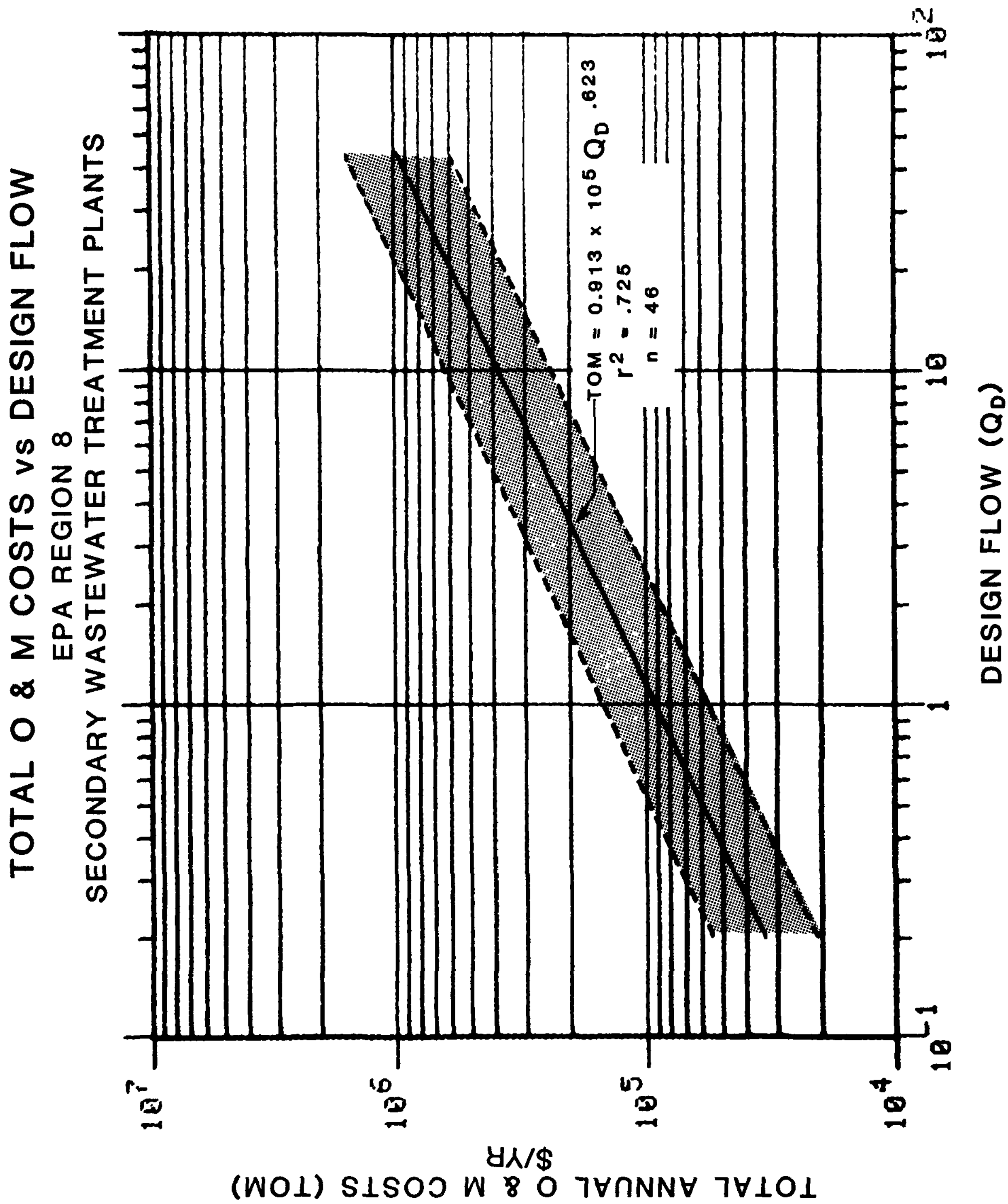

TOTAL O & M COSTS vs DESIGN FLOW
EPA REGION 8
SECONDARY WASTEWATER TREATMENT PLANTS
TOM = 0.913 x 10^5 Q_D^.623
r^2 = .725
n = 46
DESIGN FLOW (Q_D)
mgd
TOTAL ANNUAL O & M COSTS (TOM)
$/YR
10^-1
1
10
10^2
10^4
10^5
10^6
10^7

FIGURE 3.14

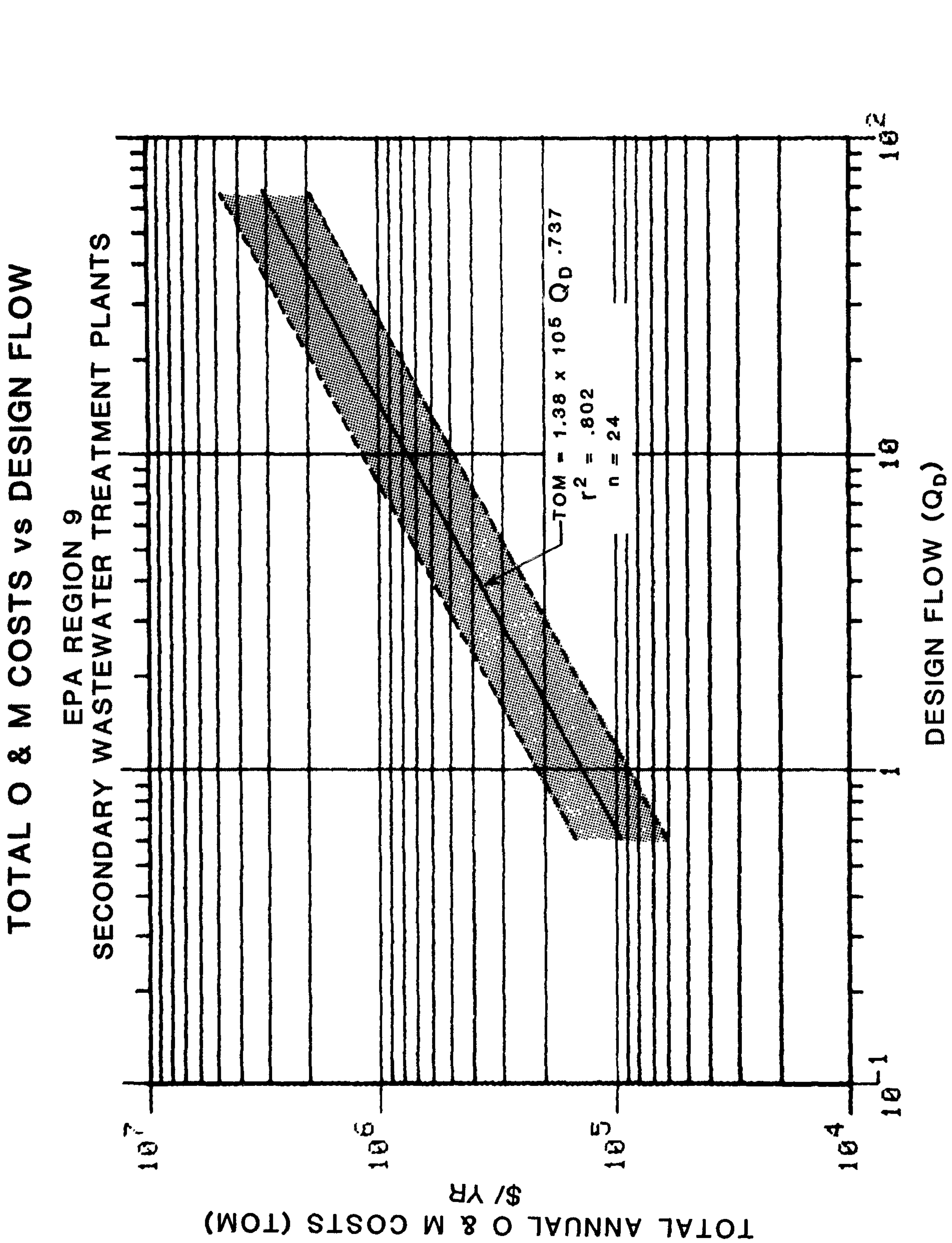
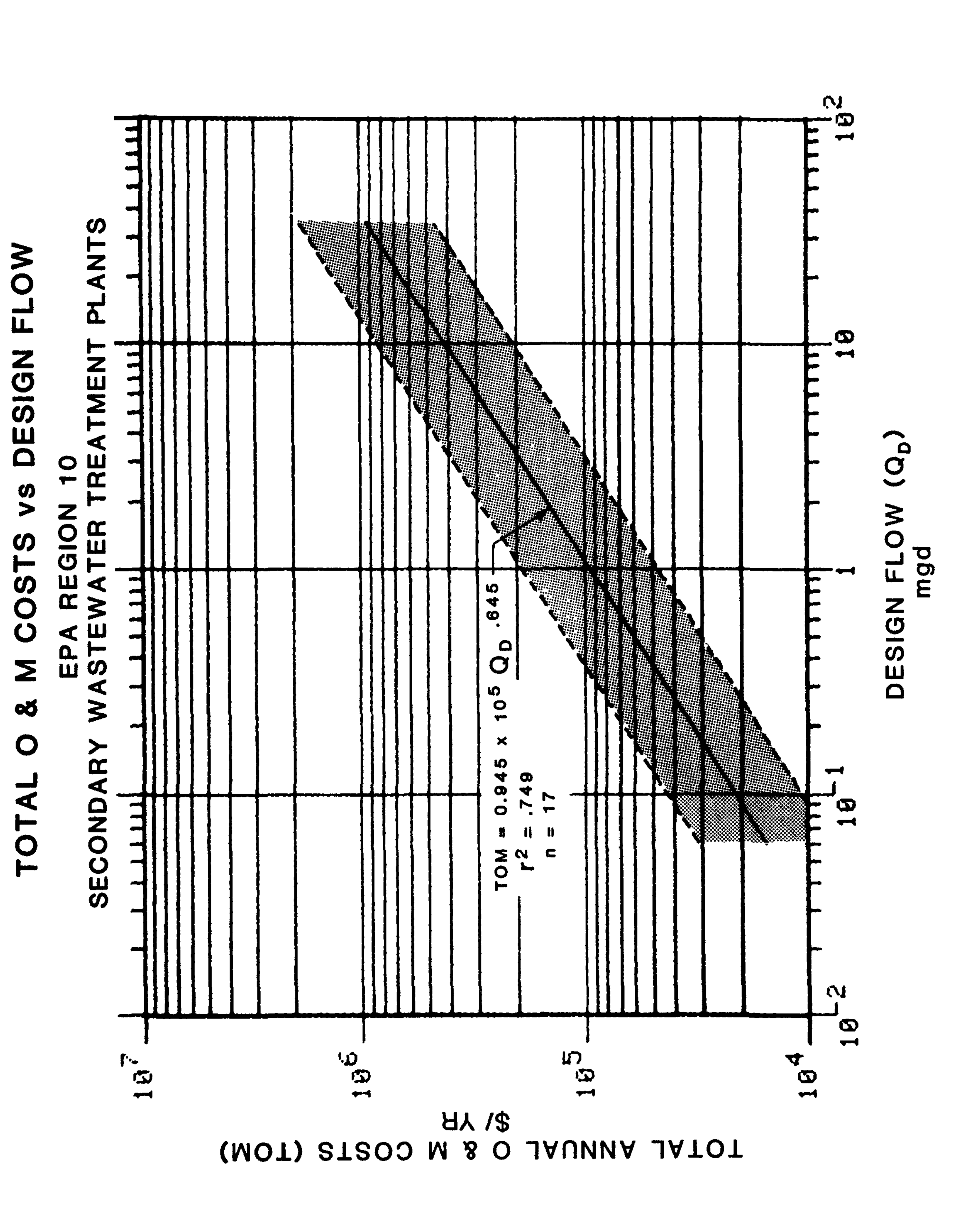

TOTAL O & M COSTS vs DESIGN FLOW
EPA REGION 9
SECONDARY WASTEWATER TREATMENT PLANTS
TOM = 1.38 x 105 QD .737
r2 = .802
n = 24
DESIGN FLOW (QD)
mgd
TOTAL ANNUAL O & M COSTS (TOM)
$/ YR
10^-1
1
10
10^2
10^4
10^5
10^6
10^7

FIGURE 3.15



TOTAL O & M COSTS vs DESIGN FLOW
EPA REGION 10
SECONDARY WASTEWATER TREATMENT PLANTS
TOM = 0.945 x 10^5 Q_D .645
r^2 = .749
n = 17
TOTAL ANNUAL O & M COSTS (TOM)
$/ YR
10^7
10^6
10^5
10^4
10^-2
10^-1
1
10
10^2
DESIGN FLOW (Q_D)
mgd

FIGURE 3.16

between observed values and the regression plots than did the nationwide data set. This is understandable as analysis of the data by Region should tend to minimize inaccuracies or distortions in the national data presentation caused by factors which are dependent on geographical location. Because of this, the Regional data plots are preferred for estimating the O&M costs of future facilities. Unfortunately, as can be seen by the shaded band width on each Regional plot, the data scatter is such that it is not possible to determine accurately the effect of geographical location on these costs.

These Regional data sets also were split into two subsets of design flow equal to or less than 1.0 mgd and greater than 1.0 mgd and examined by regression analysis. The plots of these analyses are not shown, but did re-emphasize a point made earlier; the data on total O&M costs versus design flow for all Regions show a much higher scatter for those plants with flows equal to or less than 1.0 mgd than for the larger facilities.

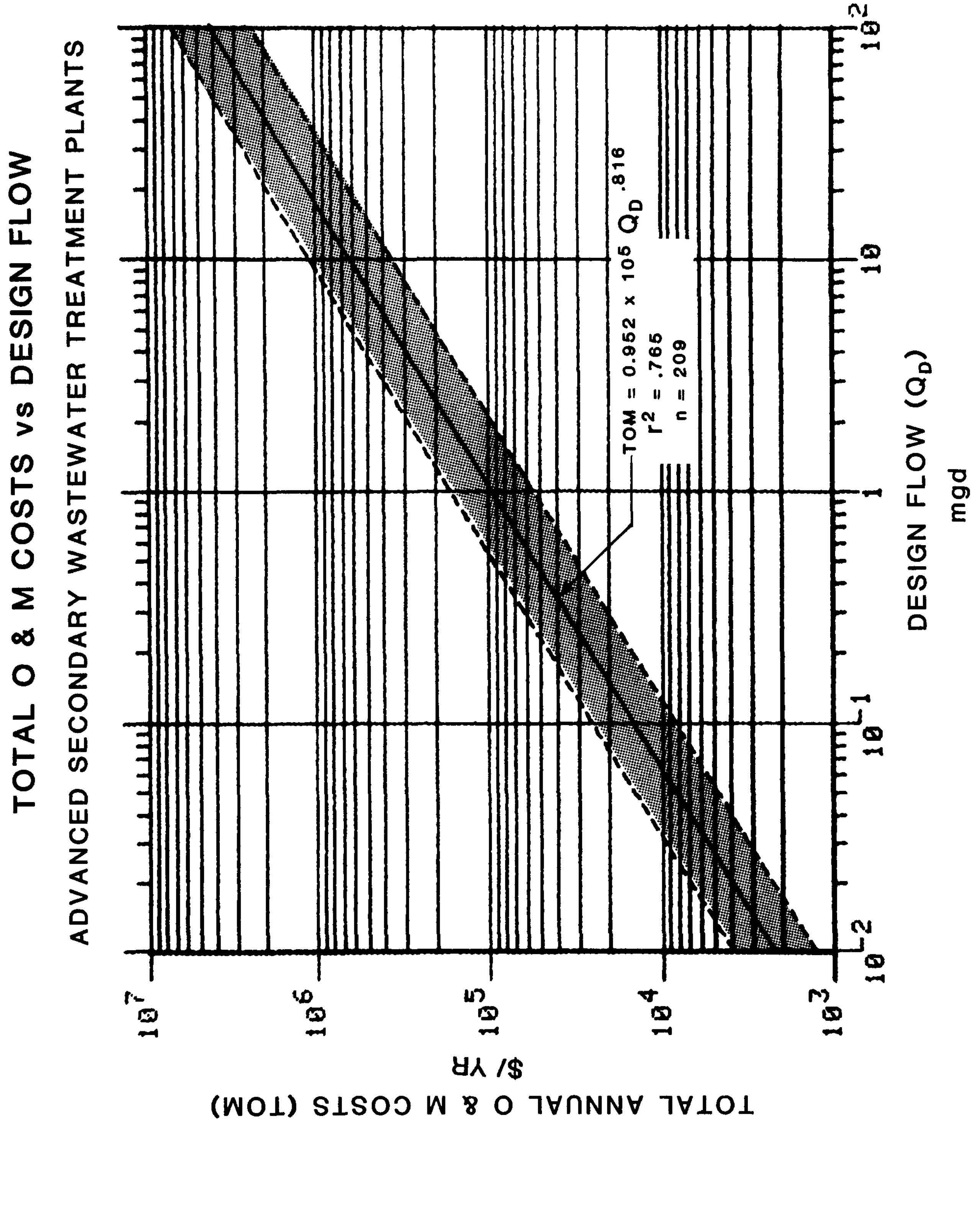
Advanced Secondary Treatment Facilities: This study included 209 treatment facilities defined as advanced secondary, i.e., producing a five day BOD effluent concentration of 11 to 24 mg/l. The number of these type facilities proved to be inadequate for analyses distinguishing between Regions; thus, only nationwide information is presented. Figure 3.17 presents the linear regression analysis of these data.

This plot is sufficient to deduce a useful relationship between costs and design flow. However, the data scatter is large as shown by the width of the shaded band and must be given consideration when attempting to predict O&M costs from this graph.

No data were found in the literature with which to compare this plot. However, comparison of the information of Figure 3.17 with that obtained from the CAPDET program (8) is shown in Figure 3.18. The CAPDET program estimates of total annual O&M costs are somewhat higher than those found by this study. Perhaps the default data used in CAPDET are on the conservative side for advanced secondary systems, i.e., yield higher costs values.

Figure 3.19 presents total annual O&M costs as a function of design flow by type of sludge handling for advanced secondary facilities. No segregation of treatment methods was attempted because few trickling filter plants reported BOD effluent concentrations of less than 24 mg/l. Thus, the data reflect primarily activated sludge systems with sludge handling as shown in Table 3.3.

Total annual O&M costs might logically be expected to increase with increasing complexity of sludge handling. The regression line plots for the three types of sludge handling shown on Figure 3.19 demonstrate this over the range studied.



TOTAL O & M COSTS vs DESIGN FLOW
ADVANCED SECONDARY WASTEWATER TREATMENT PLANTS
TOM = 0.952 x 10^5 Q_D^.816
r^2 = .765
n = 209
10^-2
10^-1
1
10
10^2
DESIGN FLOW (Q_D)
mgd
10^3
10^4
10^5
10^6
10^7
TOTAL ANNUAL O & M COSTS (TOM)
$/ YR

FIGURE 3.17

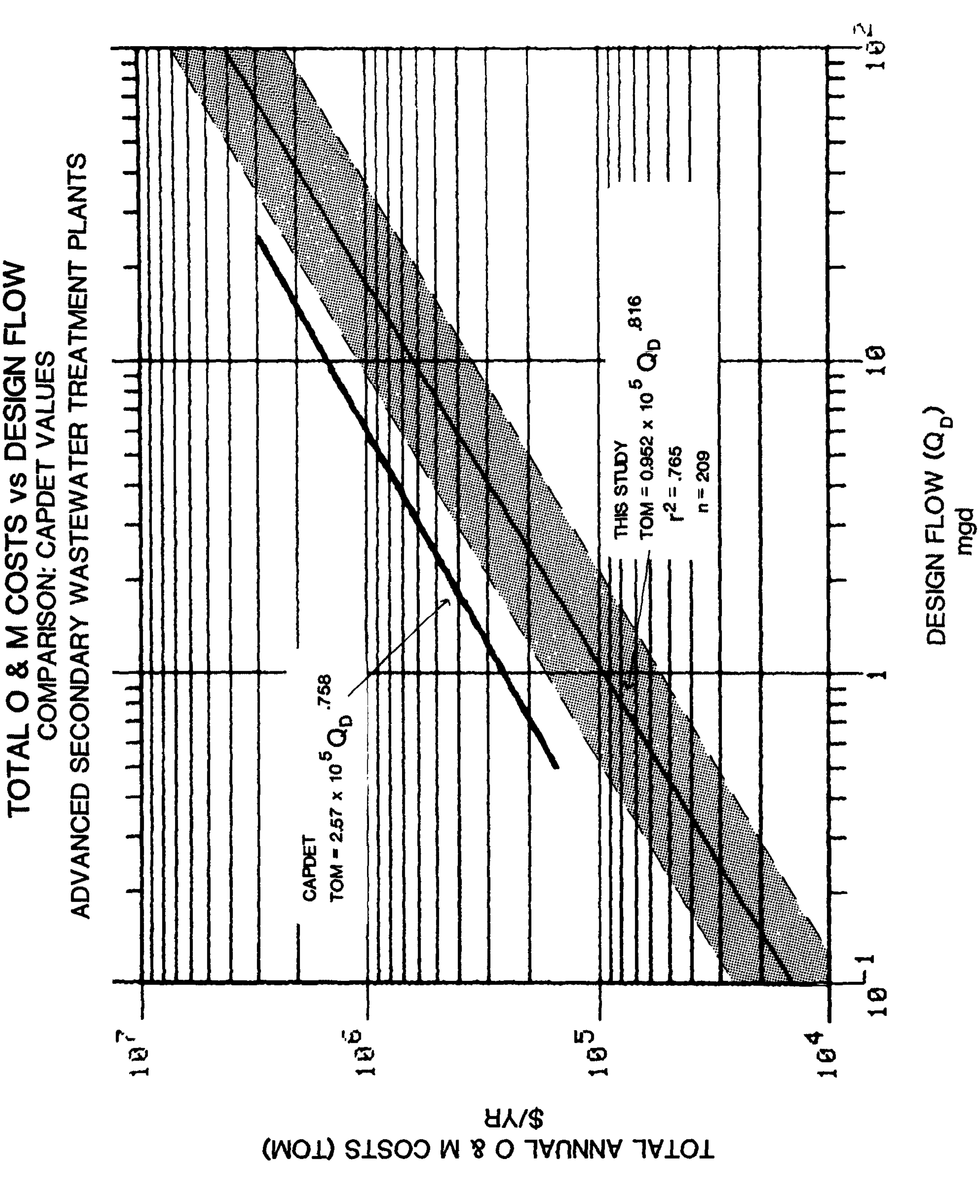

TOTAL O & M COSTS vs DESIGN FLOW
COMPARISON: CAPDET VALUES
ADVANCED SECONDARY WASTEWATER TREATMENT PLANTS
CAPDET
TOM = 2.57 x 10^5 Q_D^.758
THIS STUDY
TOM = 0.952 x 10^5 Q_D^.816
r^2 = .765
n = 209
TOTAL ANNUAL O & M COSTS (TOM)
$/YR
DESIGN FLOW (Q_D)
mgd
10^-1
1
10
10^2
10^4
10^5
10^6
10^7

FIGURE 3.18

TOTAL O & M COSTS vs DESIGN FLOW

COMPARISON: SLUDGE HANDLING COMPLEXITY
ADVANCED SECONDARY WASTEWATER TREATMENT PLANTS

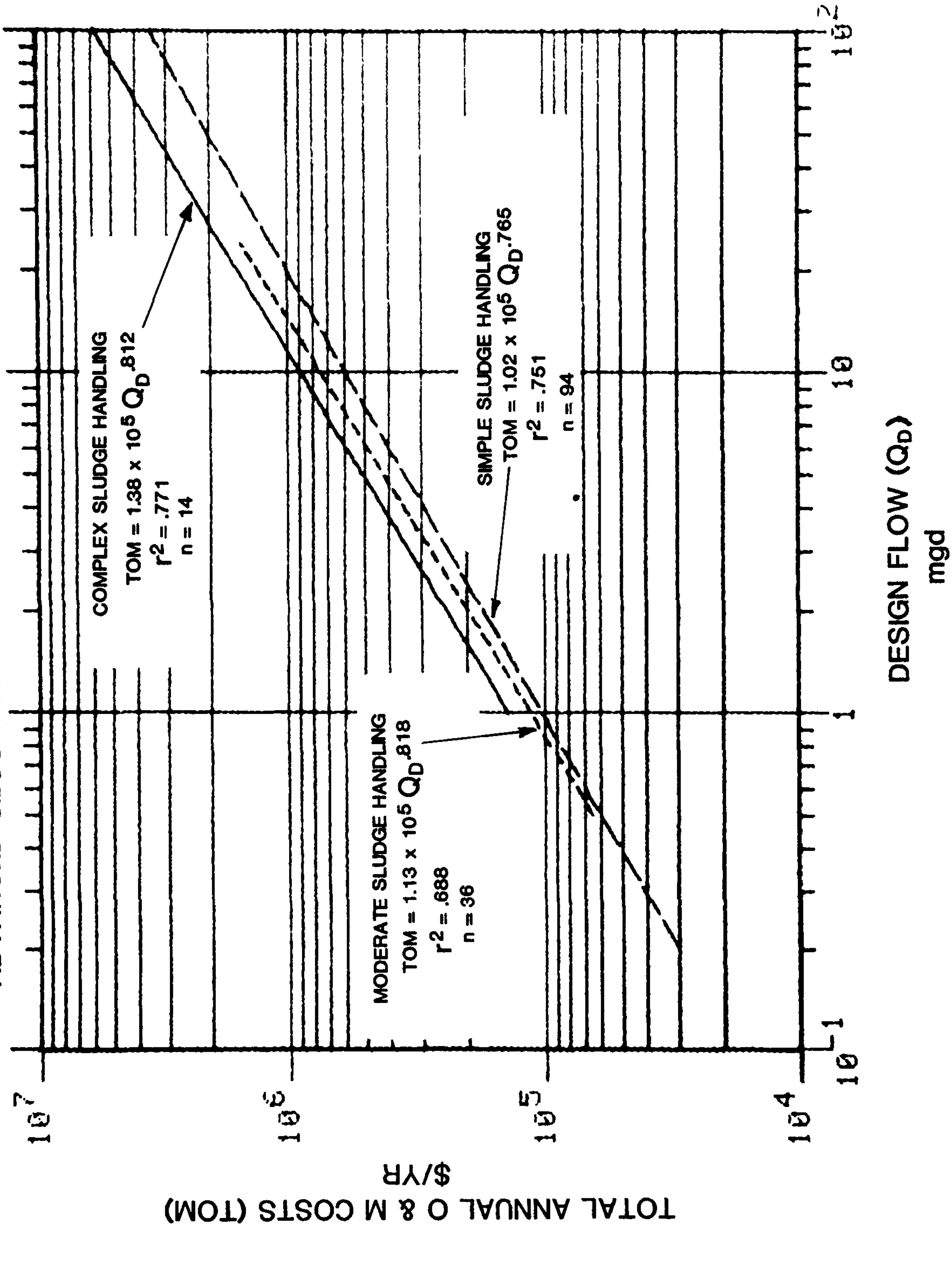


FIGURE 3.19

TABLE 3.3

ADVANCED SECONDARY TREATMENT
SLUDGE HANDLING METHODS

Simple	Moderate	Complex
No Heat Treatment, No Dewatering	No Heat Treatment, Dewatering	Heat Treatment, Dewatering
n = 94	n = 36	n = 14

The full data set on O&M costs versus design flow for advanced secondary facilities also was examined for plants with flows equal to or less than 1.0 mgd and greater than 1.0 mgd. Most of the facilities--169 out of 209--were of a design flow size greater than 1.0 mgd. The r^2 value was better for the full data set (r^2 = 0.765) than for either of the subsets, suggesting that something other than plant size introduces a significant amount of the uncertainty inherent in these data. For example, such things as variation in the costs of labor, power, and chemicals resulting from geographical differences might well impact these O&M costs significantly.

Advanced Wastewater Treatment Facilities: Figure 3.20 is a presentation of total annual O&M costs for the 86 plants studied which are categorized as advanced wastewater treatment facilities, i.e., producing five day BOD effluent concentrations of 10 mg/l or less. The observed data fit the regression line produced from them moderately well and should serve as an adequate guide for estimating the O&M costs for such facilities when used with caution and judgment. No Regionalized analyses were done for these high performance systems because of the small number of them in each Region.

As with the other types of facilities, the data set on O&M costs as a function of design flow for advanced facilities was analyzed for the two subsets of plants with flows equal to or less than 1.0 mgd and greater than 1.0 mgd. No new information was derived from this exercise. About two-thirds (57 of 86) of these plants had design flows greater than 1.0 mgd. Again, the r^2 values for both subsets were less than for the full data set, suggesting the importance of factors other than design flow in the determination of O&M costs.

A comparison of the linear regression plot from Figure 3.20 with O&M costs produced by the CAPDET program (8) is shown in Figure 3.21. This comparison shows the O&M costs for the advanced wastewater treatment facilities of this study to be generally lower than predicted by CAPDET. As noted for advanced secondary systems, no explanation of this observation is apparent. However, it could be that the generalized cost data used by CAPDET produce conservative (higher) estimates of total O&M costs for advanced wastewater treatment plants. This is not illogical as CAPDET was developed before there were many operative AWT plants from which to collect O&M data.

Figure 3.22 isolates the O&M cost data obtained from several advanced wastewater treatment facilities in terms of the way their sludges are handled, as described in Table 3.4.

Over the range of design flows studied--and apparently for a considerable distance outside this range--the data match logic; total O&M costs are directly related to the complexity of the sludge handling procedure. This observation fits that encountered for advanced secondary systems and, in general, for secondary systems.

TOTAL O & M COSTS vs DESIGN FLOW

ADVANCED WASTEWATER TREATMENT PLANTS

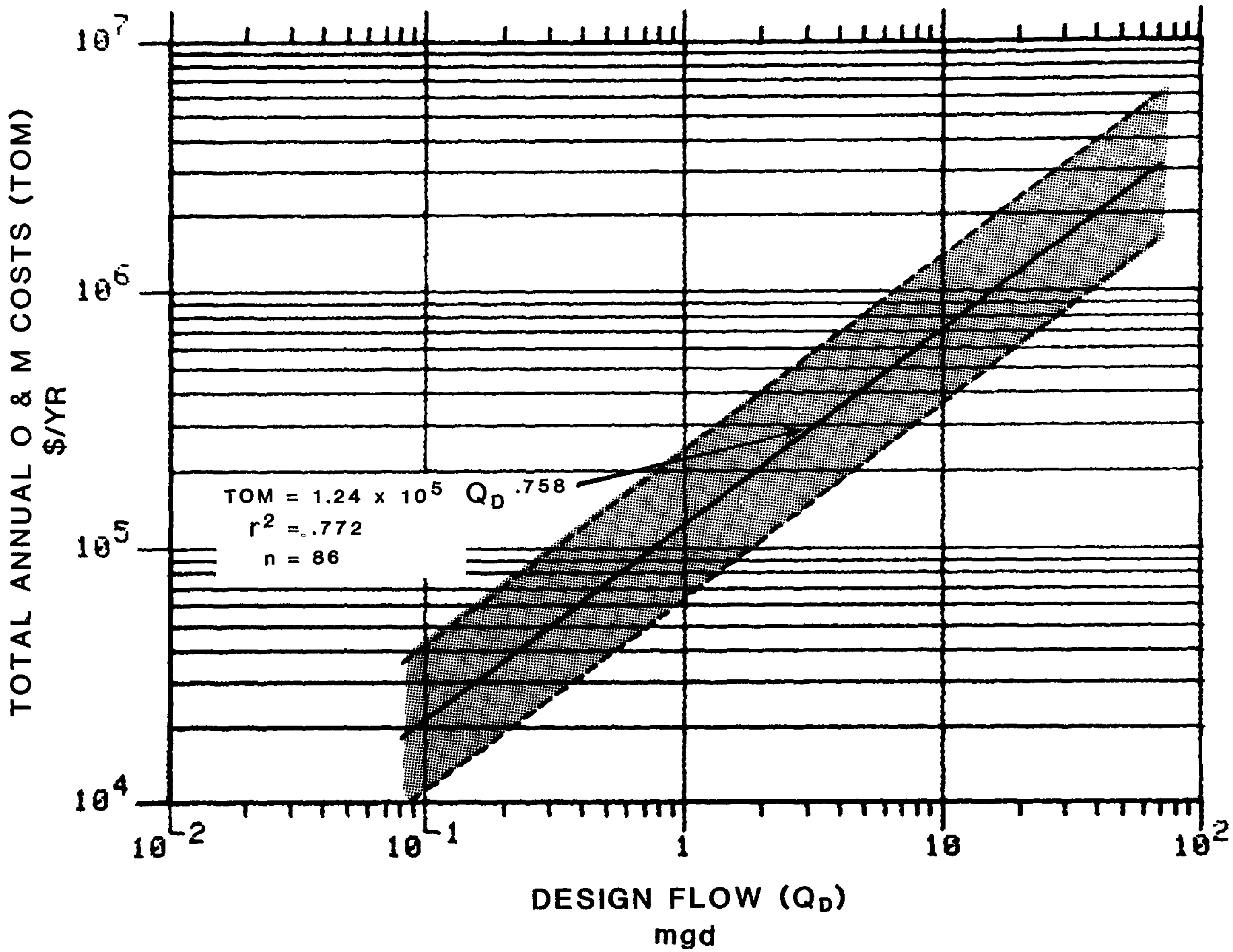


FIGURE 3.20

TOTAL O & M COSTS vs DESIGN FLOW
COMPARISON: CAPDET VALUES
ADVANCED WASTEWATER TREATMENT PLANTS

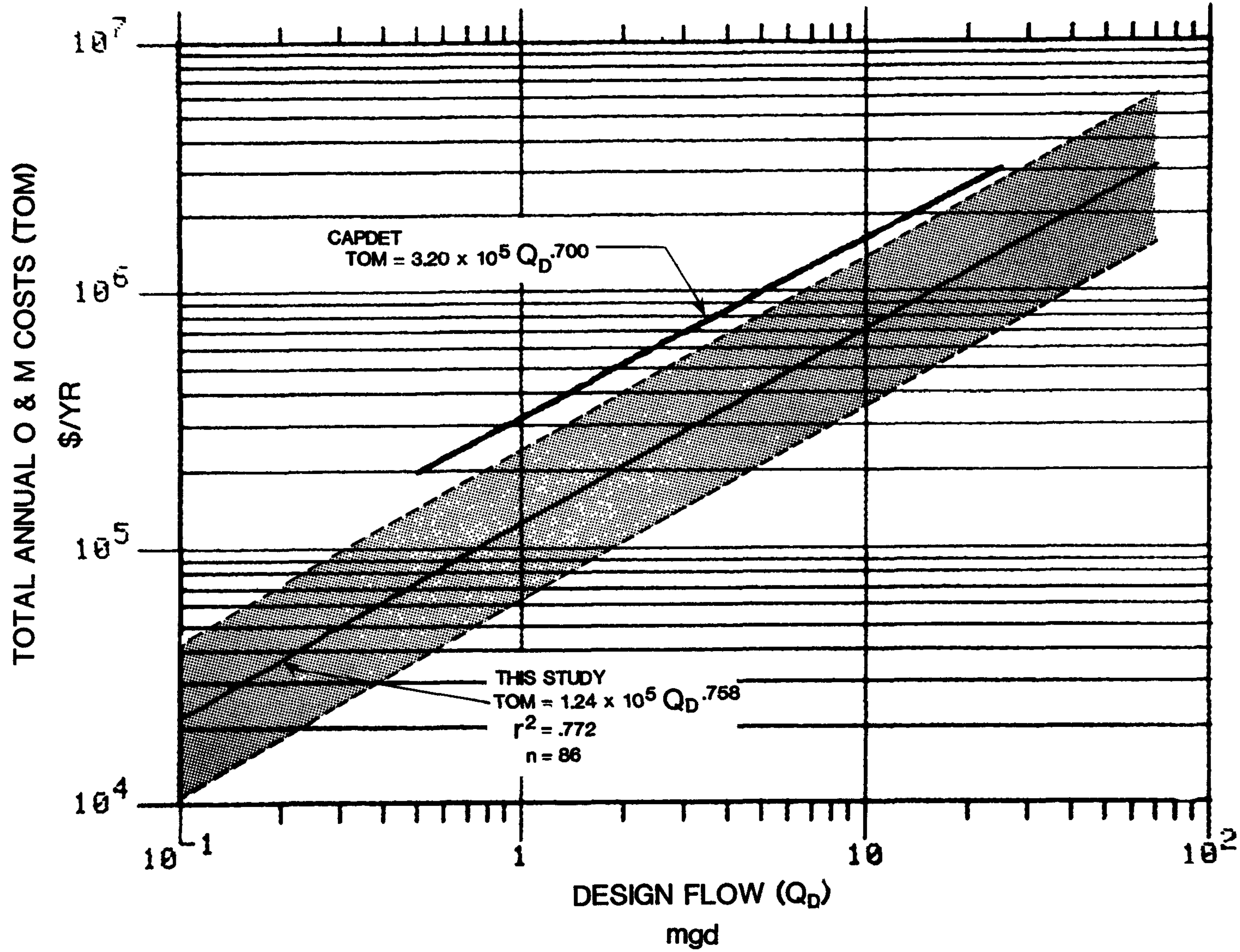
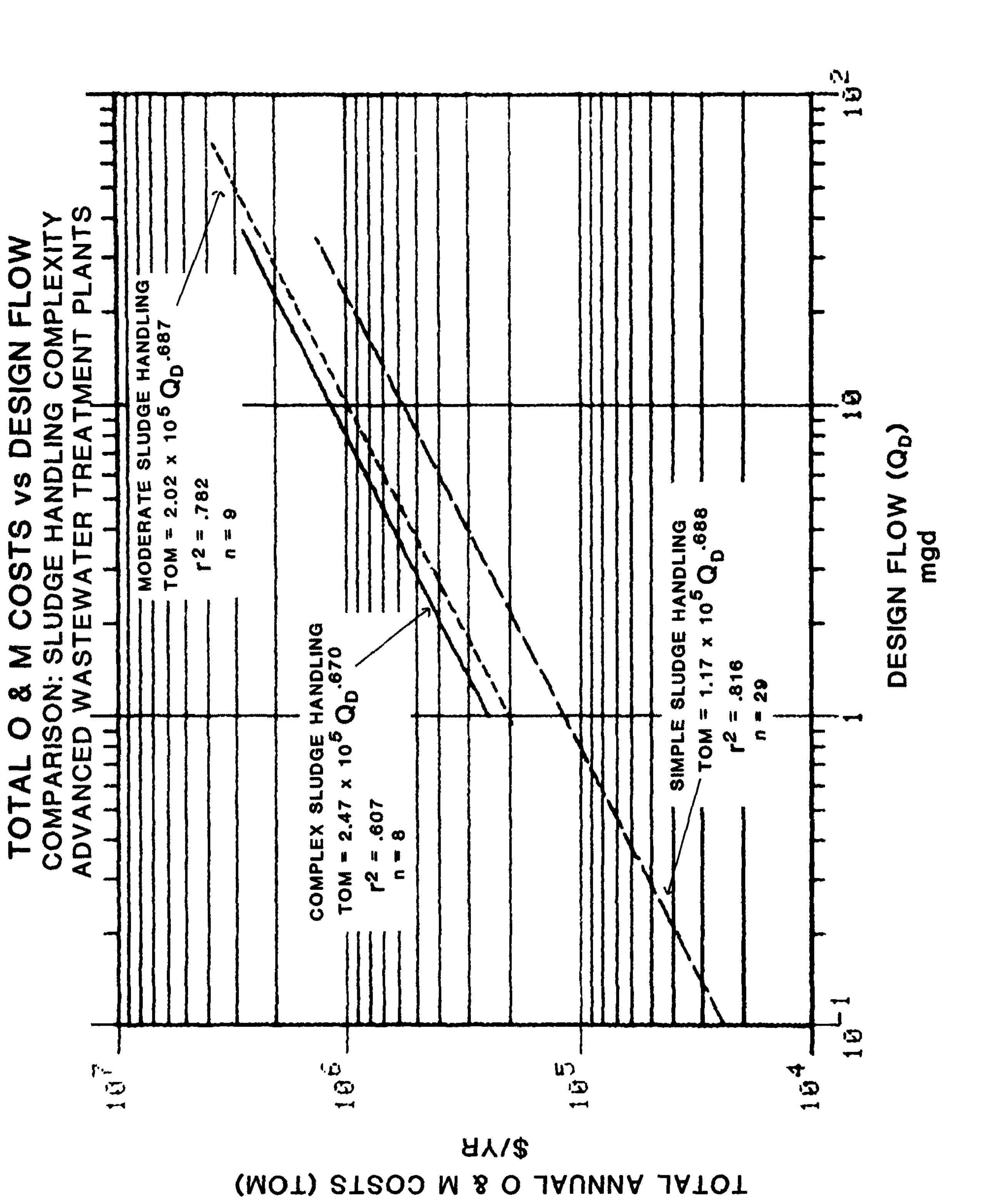


FIGURE 3.21



TOTAL O & M COSTS vs DESIGN FLOW
COMPARISON: SLUDGE HANDLING COMPLEXITY
ADVANCED WASTEWATER TREATMENT PLANTS
MODERATE SLUDGE HANDLING
TOM = 2.02 x 10^5 Q_D^.687
r^2 = .782
n = 9
COMPLEX SLUDGE HANDLING
TOM = 2.47 x 10^5 Q_D^.670
r^2 = .607
n = 8
SIMPLE SLUDGE HANDLING
TOM = 1.17 x 10^5 Q_D^.688
r^2 = .816
n = 29
DESIGN FLOW (Q_D)
mgd
TOTAL ANNUAL O & M COSTS (TOM)
$/YR

FIGURE 3.22

TABLE 3.4

ADVANCED WASTEWATER TREATMENT
SLUDGE HANDLING METHODS

Simple	Moderate	Complex
No Heat Treatment, No Dewatering	No Heat Treatment, Dewatering	Heat Treatment, Dewatering
n = 29	n = 9	n = 8

Summary and Comparison - Total Annual O&M Costs for Treatment Plants: The regression equations obtained from the nationwide data sets of total annual O&M costs for secondary, advanced secondary, and advanced wastewater treatment facilities were compared against one another. The plot of these equations is contained in Figure 3.23. Figures 3.24 and 3.25 also show similar plots for the two data subsets of plants with design flow equal to or less than 1.0 mgd and greater than 1.0 mgd, respectively. This comparison suggests that advanced wastewater treatment is somewhat more costly of O&M dollars than the lower degrees of treatment over the range of plant size investigated. In Figure 3.24 the ordering of O&M costs (highest to lowest) to treatment level is AWT, secondary, and advanced secondary. In Figure 3.25 this ordering is from AWT to advanced secondary to secondary. However, when data scatter previously noted for the three individual cases is considered, it must be concluded that there are no significant differences in the total O&M costs reported for the three levels of treatment.

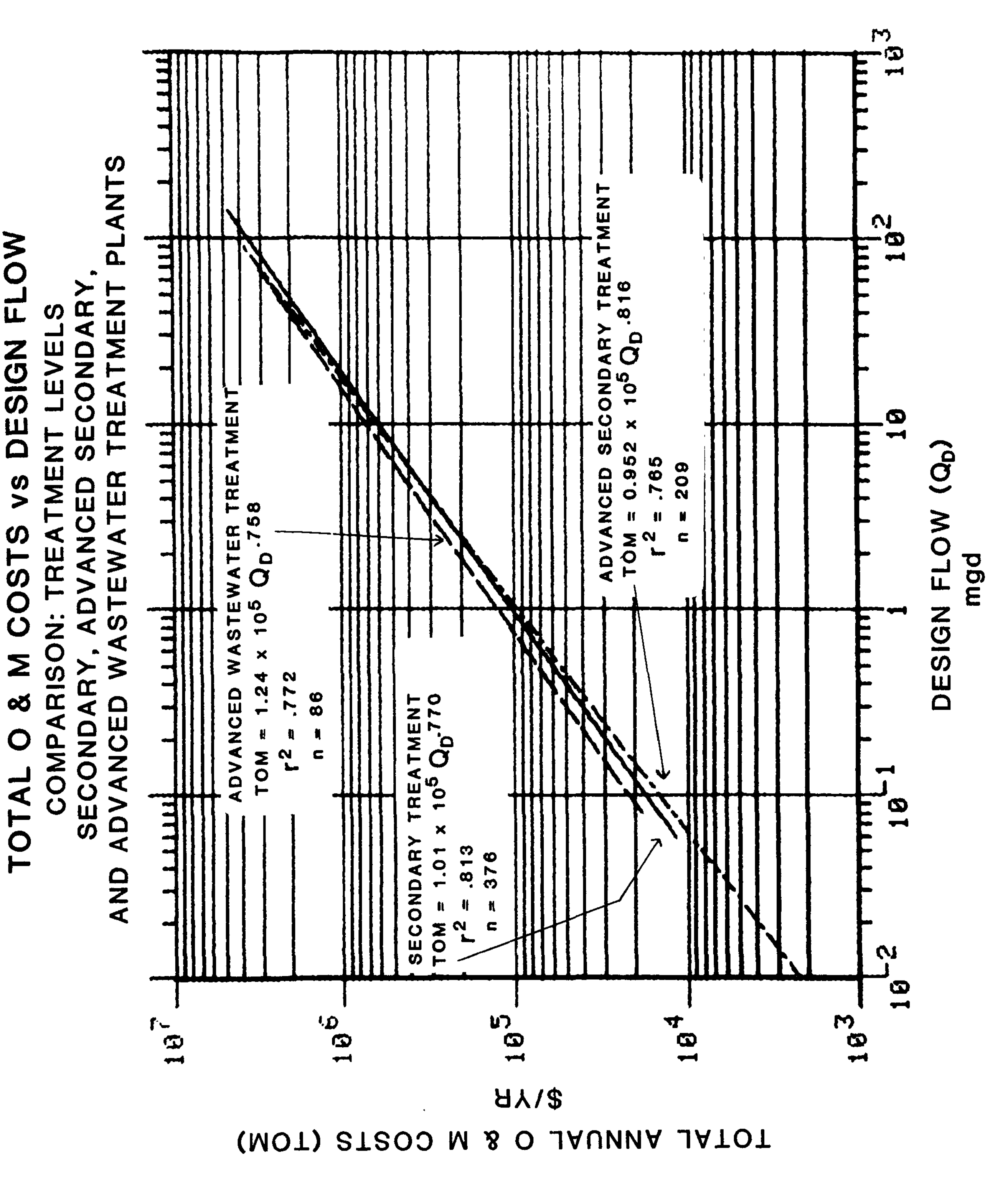
Because of this conclusion, the data from plants of all three treatment levels were treated as a single data set and analyzed. This regression, as shown in Figure 3.26, supports the conclusion of no significant differences in the total annual O&M costs between secondary, advanced secondary, and advanced wastewater treatment plants. As shown in Table 3.5, regression equations, r^2 values, and shaded band widths are comparable for each of the individual levels of treatment and for the composite of treatment levels. Thus, Figure 3.26 is as adequate as Figures 3.3, 3.17, or 3.20 for determining the estimated total O&M costs for either of the three levels of treatment.

Sludge Handling Costs

Earlier information (2) indicated that expenditures for solids handling might be a significant part of the total O&M costs of treatment facilities--perhaps 20 to 30 percent of the total. However, there is little information to substantiate or refute this point. Thus, it seemed useful in this effort to examine the O&M cost attributable to the handling and disposing of sludge.

As used here, the term sludge handling O&M costs refers to all O&M costs incurred in handling, treating, dewatering, and/or disposing of the sludge once it leaves the clarifiers of the systems under study. These costs, of course, were included in the total treatment facility O&M costs reported earlier, but are dealt with here separately.

Sludge handling O&M costs are reported as a function of actual plant flow and as a function of dry solids production. All of the plants studied were municipal facilities. It was assumed that their waste strength and composition would be roughly comparable, making flow and dry solids production reasonable bases for comparing sludge handling O&M costs.



TOTAL O & M COSTS vs DESIGN FLOW
COMPARISON: TREATMENT LEVELS
SECONDARY, ADVANCED SECONDARY,
AND ADVANCED WASTEWATER TREATMENT PLANTS
ADVANCED WASTEWATER TREATMENT
TOM = 1.24 x 10^5 Q_D^.758
r^2 = .772
n = 86
SECONDARY TREATMENT
TOM = 1.01 x 10^5 Q_D^.770
r^2 = .813
n = 376
ADVANCED SECONDARY TREATMENT
TOM = 0.952 x 10^5 Q_D^.816
r^2 = .765
n = 209
DESIGN FLOW (Q_D)
mgd
TOTAL ANNUAL O & M COSTS (TOM)
$/YR
10^-2
10^-1
1
10
10^2
10^3
10^7
10^6
10^5
10^4

FIGURE 3.23

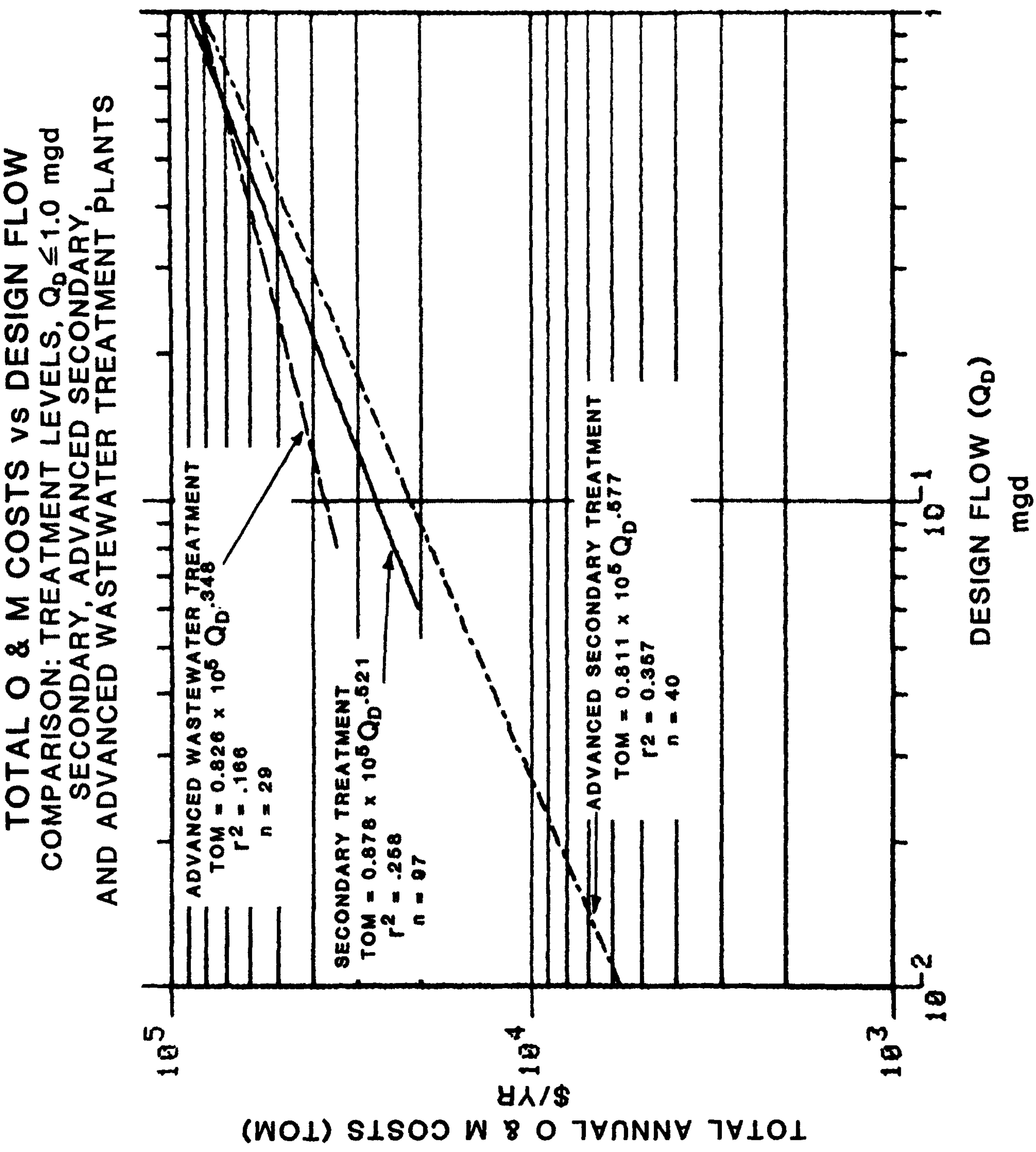

TOTAL O & M COSTS vs DESIGN FLOW
COMPARISON: TREATMENT LEVELS, $Q_D \leq 1.0$ mgd
SECONDARY, ADVANCED SECONDARY,
AND ADVANCED WASTEWATER TREATMENT PLANTS
ADVANCED WASTEWATER TREATMENT
TOM = $0.826 \times 10^5 Q_D^{.348}$
r^2 = .166
n = 29
SECONDARY TREATMENT
TOM = $0.878 \times 10^5 Q_D^{.521}$
r^2 = .258
n = 97
ADVANCED SECONDARY TREATMENT
TOM = $0.811 \times 10^5 Q_D^{.577}$
r^2 = 0.357
n = 40
TOTAL ANNUAL O & M COSTS (TOM)
$/YR
10^5
10^4
10^3
10^{-2}
10^{-1}
1
DESIGN FLOW (Q_D)
mgd

FIGURE 3.24

TOTAL O & M COSTS vs DESIGN FLOW

COMPARISON: TREATMENT LEVELS, $Q_D > 1.0$ mgd
SECONDARY, ADVANCED SECONDARY,
AND ADVANCED WASTEWATER TREATMENT PLANTS

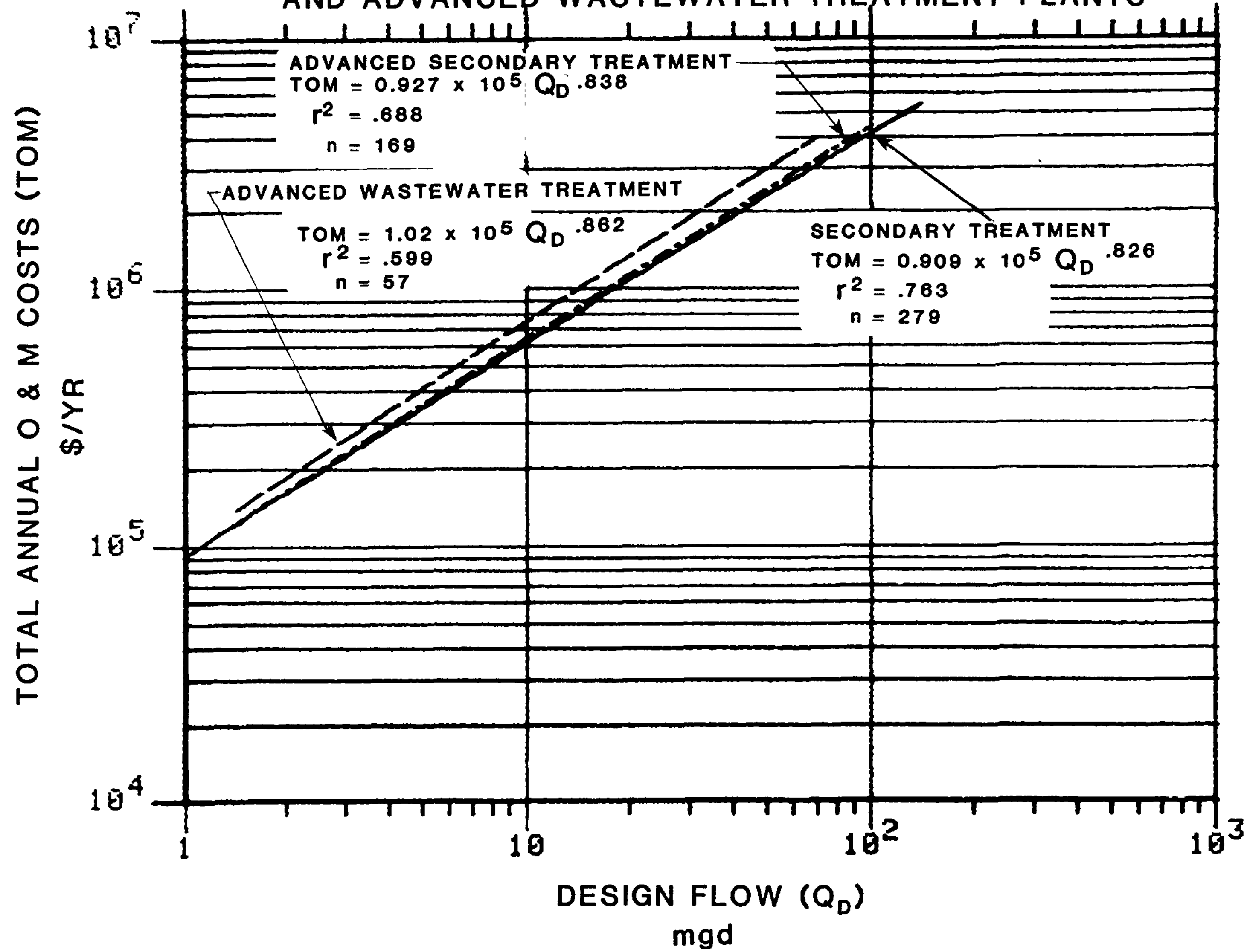
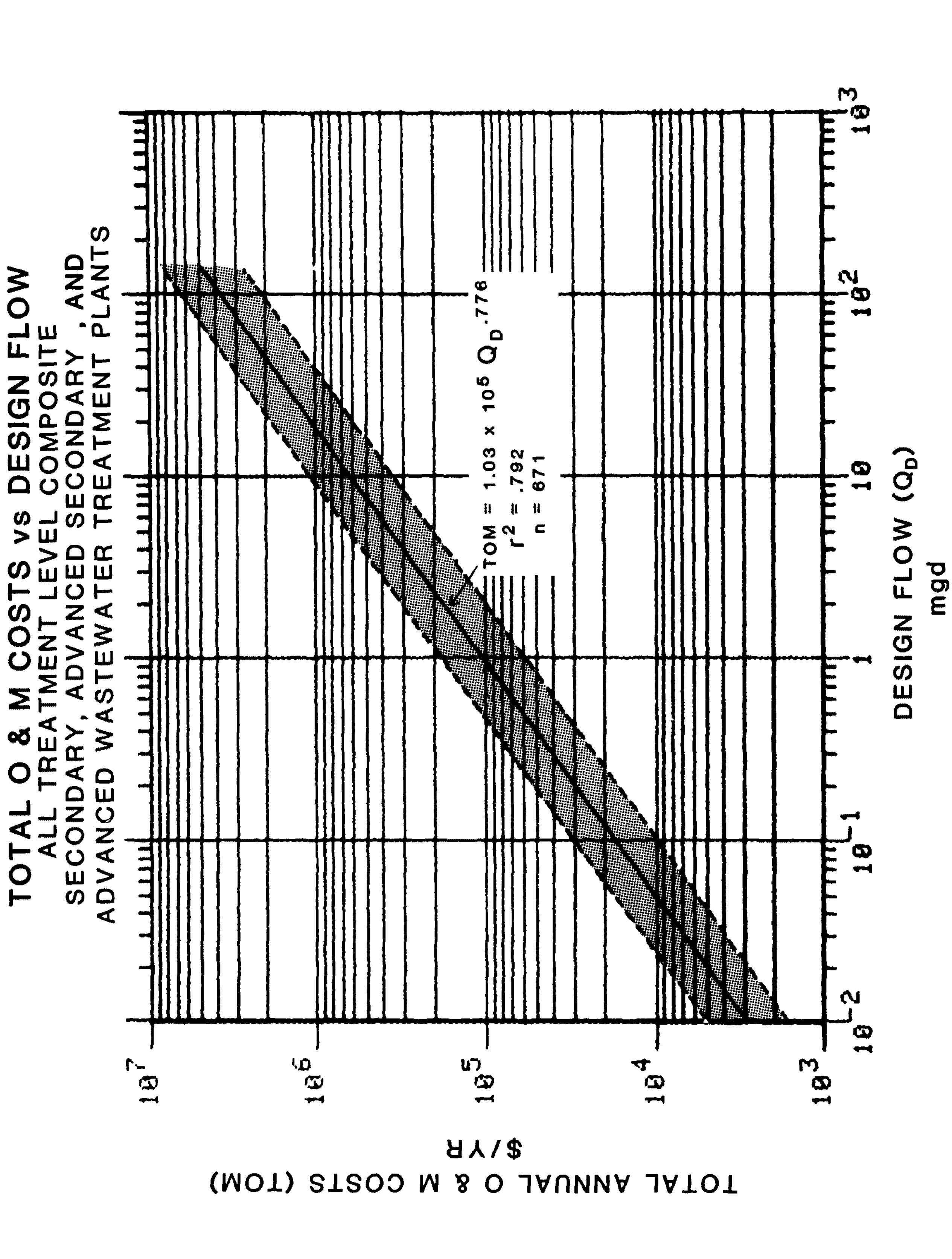


FIGURE 3.25



TOTAL O & M COSTS vs DESIGN FLOW
ALL TREATMENT LEVEL COMPOSITE
SECONDARY, ADVANCED SECONDARY, AND
ADVANCED WASTEWATER TREATMENT PLANTS
TOM = 1.03 x 10^5 Q_D^.776
r^2 = .792
n = 671
TOTAL ANNUAL O & M COSTS (TOM)
$/YR
10^7
10^6
10^5
10^4
10^3
10^-2
10^-1
1
10
10^2
10^3
DESIGN FLOW (Q_D)
mgd

FIGURE 3.26

TABLE 3.5

COMPARISON OF STATISTICAL INFORMATION FROM SECONDARY, ADVANCED SECONDARY, AND ADVANCED WASTEWATER TREATMENT PLANT DATA

Level of Treatment	Regression Equation	r^2	Shaded Band Width @ 1.0 mgd (1,000)
Secondary (Figure 3.3)	$\$ = 1.01 \times 10^5\ Q_D^{\ 0.770}$	.813	120
Advanced Secondary (Figure 3.17)	$\$ = 0.95 \times 10^5\ Q_D^{\ 0.816}$	.765	125
Advanced Wastewater Treatment (Figure 3.20)	$\$ = 1.24 \times 10^5\ Q_D^{\ 0.758}$	.772	180
Summary: All Treatment Levels (Figure 3.23)	$\$ = 1.03 \times 10^5\ Q_D^{\ 0.776}$	.792	140

Linear regression analyses were performed for sludge handling costs as a function of actual plant flow for secondary, advanced secondary, and advanced wastewater treatment systems. These analyses showed little significant difference in sludge handling costs between the three levels of treatment over the range of plant sizes studied. For this reason, a regression of sludge handling costs as a function of actual plant flow for all treatment levels was done and is shown in Figure 3.27.

The statistical information on this plot is not good. The r^2 is quite low (.406) and the data scatter is large. However, this plot is as significant statistically as those obtained from the regression analysis of each treatment level. Consideration of Figure 3.27 suggests that other factors, for example individual plant sludge handling procedures, may be a more important determinant of O&M costs for sludge handling than the actual plant flow.

Regression analysis also was performed on sludge handling costs as a function of dry solids production for each of the three levels of treatment. These analyses provide little in the way of confidence about the relationship between the two parameters; thus, their results are not shown. Statistically there was little difference in the relationship of sludge handling costs and solids production between the three treatment levels. Because of this a single plot of sludge handling annual costs as a function of solids production, using the data from all three levels of treatment, was developed and is presented in Figure 3.28. This plot may be used as the general expression of sludge handling costs versus solids production.

Components of O&M Costs

Earlier work (2) established five major components of total annual O&M costs, e.g., personnel, utilities, chemicals, equipment and materials, contractual and other. Table 3.6 presents information on the national average cost of each of these five components. It also compares these values with similar values taken from the literature (2) and updated to 1st Quarter 1981.

In evaluating the information in Table 3.6, it should be noted that the component size given for "this study" is the sum of the ratio between the individual component costs and the total O&M costs for a particular wastewater treatment plant, divided by the available data points for that particular component cost, expressed as a percentage. The equation is shown below.

SLUDGE HANDLING COSTS vs ACTUAL PLANT FLOW
ALL TREATMENT LEVEL COMPOSITE
SECONDARY, ADVANCED SECONDARY, AND
ADVANCED WASTEWATER TREATMENT PLANTS

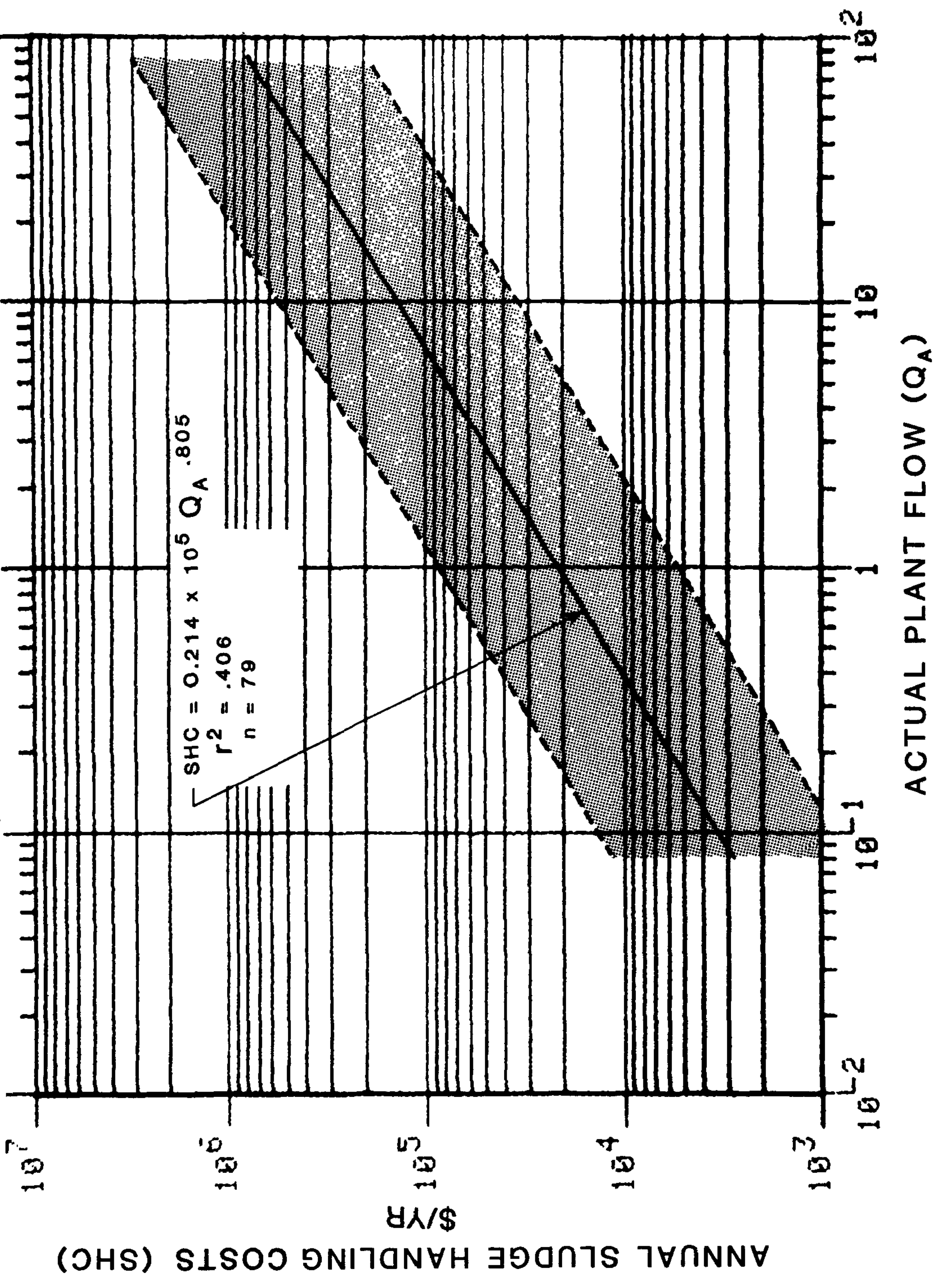


FIGURE 3.27

SLUDGE HANDLING COSTS vs SOLIDS PRODUCTION
ALL TREATMENT LEVEL COMPOSITE
SECONDARY, ADVANCED SECONDARY,
AND ADVANCED WASTEWATER TREATMENT PLANTS

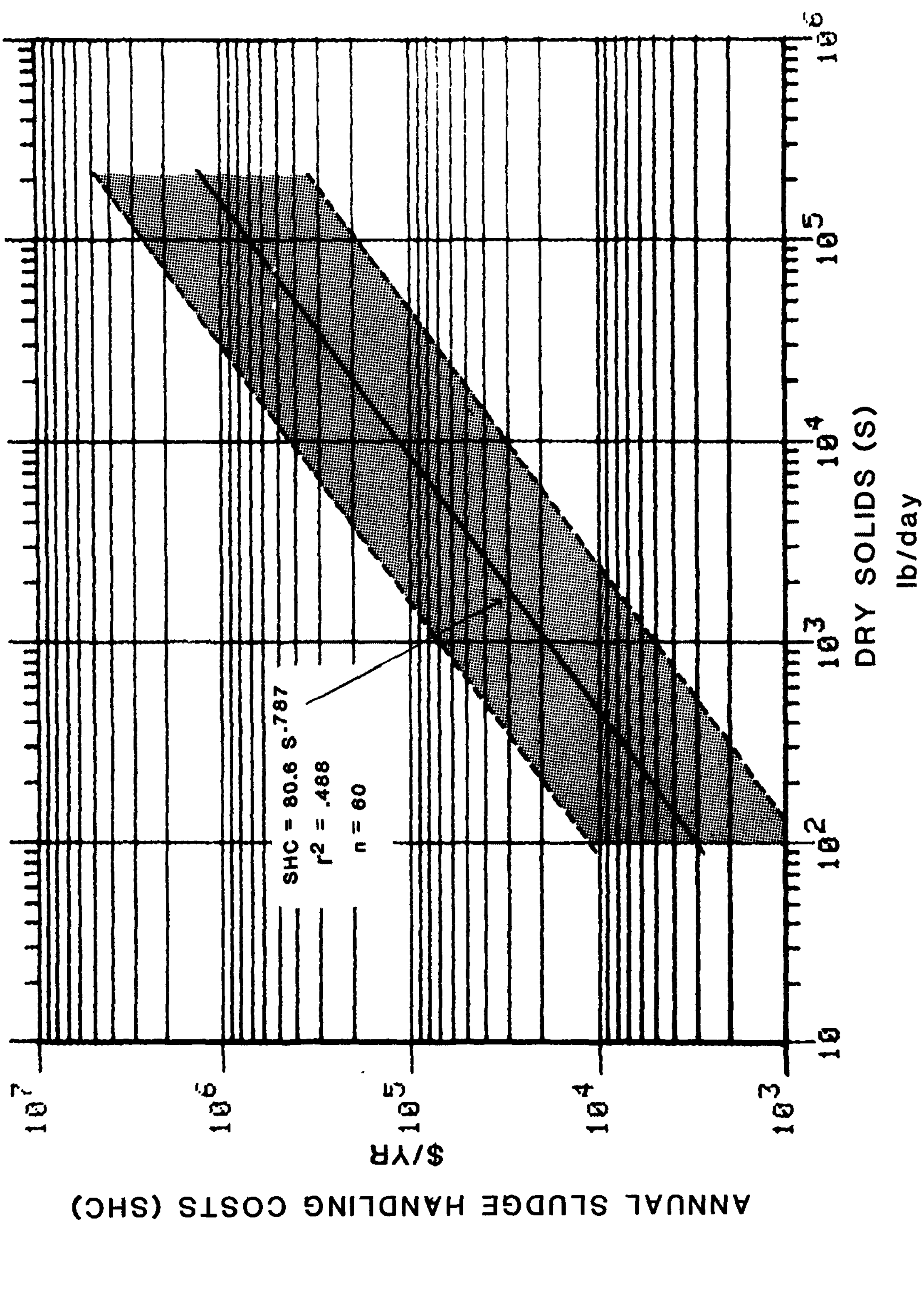


FIGURE 3.28

TABLE 3.6

MAJOR COMPONENT COSTS AS A PERCENTAGE OF TOTAL O&M COSTS

	Components				
Secondary Treatment	Personnel	Utilities	Chemicals	Equipment & Materials	Constructual & Other
This Study	48%	26%	7%	14%	12%
Trickling Filters:					
EPA	55%	28%	8%	12%	7%
AMSA	57%	13%	12%	9%	9%
Activated Sludge:					
EPA	49%	26%	6%	11%	7%
AMSA	41%	26%	19%	8%	7%
Advanced Secondary Treatment					
This Study	48%	26%	7%	7%	11%
Advanced Wastewater Treatment					
This Study	45%	30%	7%	13%	10%
EPA	44%	25%	11%	9%	11%
AMSA	39%	22%	22%	7%	10%

Note: All information for EPA and AMSA percentages obtained from Tables 4.8 and 4.9, respectively, of Reference 2. The associated costs were updated to 1st Quarter 1981.

$$\% = \sum_{i}^{n} (c/t \times 100) \times 1/n$$

Where: n = Number of plants having a particular component cost

c = Cost of a given type of component for a particular facility

t = Total O&M costs for the facility

There were differing amounts of data available on each of these component costs. Thus, the percentage of component costs expressed in each type of treatment system will not total to one hundred. In this sense, they are not strictly comparable with the literature reported values or, indeed, one with another. However, such comparisons are useful in determining relative magnitudes of the various components. Table 3.6 demonstrates that the five components chosen for study as described above are, indeed, the major O&M cost components. Furthermore, their ranking and their value agree with earlier reported data (2) on this subject.

Comparison of the percentage of costs represented by each component shows no significant differences among the three levels of treatment studied. For example, personnel costs make up about half of the total annual O&M costs for secondary, advanced secondary, and advanced wastewater treatment facilities. Similar observations can be made with respect to treatment level for the other components of costs. This result is surprising, but may derive from the fact that only biological plants were studied, only a few AWT plants were studied, and all the data were compared on a nationwide basis without regard for cost differences that might arise from geographical location.

Staffing

As noted in the previous section, personnel costs are a large part of total O&M costs for wastewater control facilities. As little information on this subject is available, treatment plant staffing was made a part of this investigation. The average weekly staff hour report of each facility served as the basis for information on staff size. Unfortunately, this approach does not give a complete picture of personnel needs as many plants use contractors rather than resident staff for such items as laboratory analysis and sludge disposal. Weekly staff hour reports do not reflect this additional manpower, and it is not considered here.

Secondary Treatment Facilities: Figure 3.29 illustrates the data obtained on staff size for 264 secondary treatment facilities with design flows ranging from 0.1 to 120 mgd.

STAFF SIZE vs DESIGN FLOW

SECONDARY WASTEWATER TREATMENT PLANTS WITH LITERATURE COMPARISONS

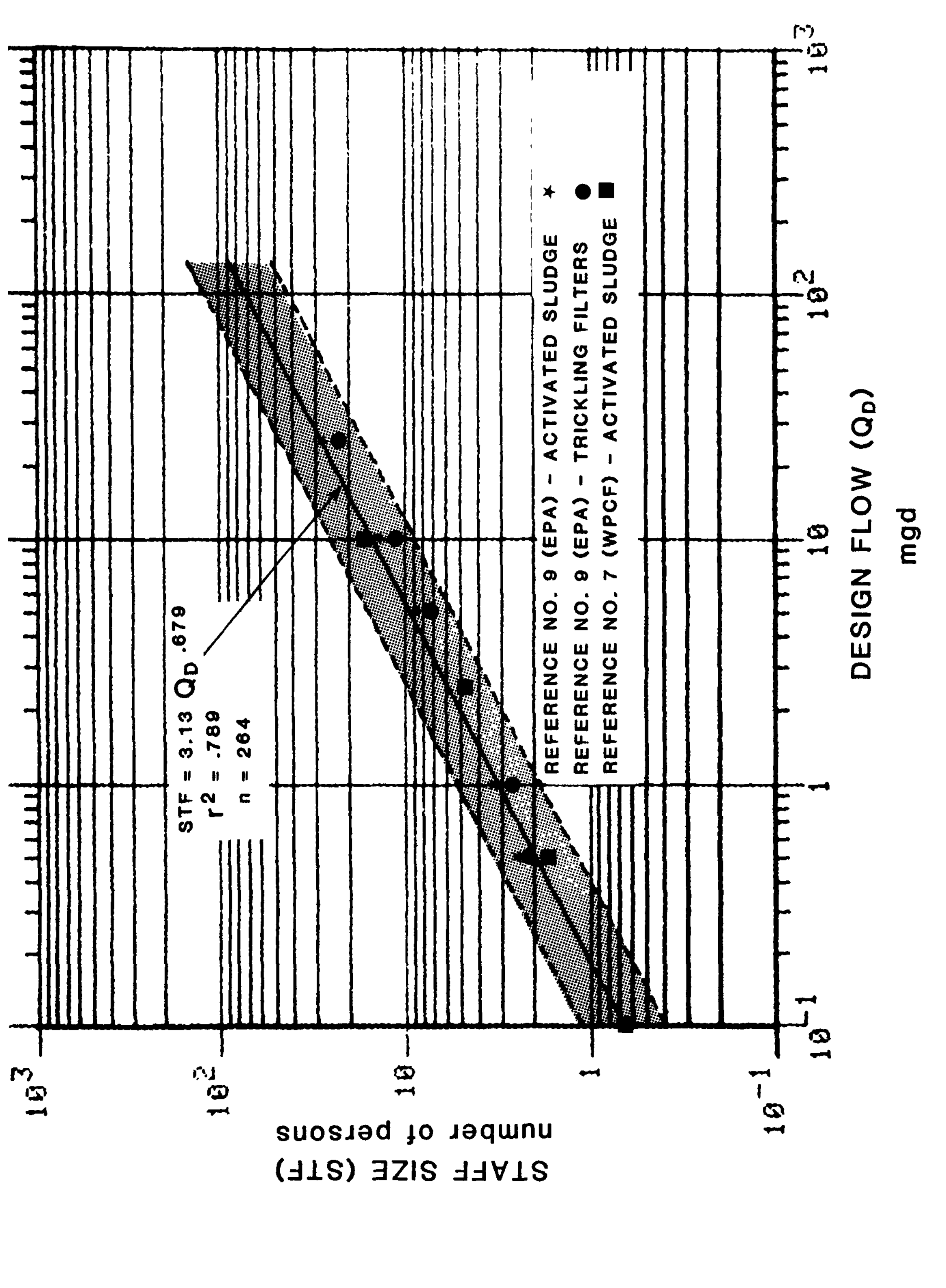


FIGURE 3.29

The regression analysis plotted on Figure 3.29 shows a relatively good relationship between plant size and staff size. Staff size, as a function of plant size, probably should be envisioned as a step function rather than as a curvilinear or linear function. A certain minimum number of staff is required for a plant of a given size. However, this same number of people also might be adequate for plants with considerably larger flows, up to some point, where additional staff would have to be added.

This observation is supported by data obtained from the literature (7, 9) and plotted on Figure 3.29. This literature information fits well with the field information obtained during this investigation. One to three persons, on the average, are required to staff plants ranging in size from 0.1 to more than 1.0 mgd. After that size is reached, additional people must be added.

These data also were used to examine the effect of treatment system type and sludge handling complexity on staff size. Two types of systems were studied--suspended growth and attached growth systems--each having three levels of sludge handling as discussed and described earlier in Table 3.2. This analysis suggested that more complex sludge handling generally results in the need for more staff, although this might depend to some degree on plant size. While this observation seems reasonable, the statistical reliability of the analysis did not permit definitive conclusions on these or other points. Thus, their results are not shown.

Advanced Secondary Treatment Facilities: The data on staff sizes from 95 advanced secondary treatment facilities, with design flows ranging from 0.2 to 100 mgd, produced the regression plot shown in Figure 3.30. Data from the literature (9) are added to this plot for comparative purposes. In general, this plot agrees with observations made earlier about staffing in secondary systems.

The regression line for Figure 3.30 is quite similar to that of Figure 3.29, and they are such that staff sizes for advanced secondary facilities are comparable to those in secondary systems for sizes up to 10 mgd. Above that value staff needs appear to increase more sharply for the advanced secondary plants than for the secondary plants.

Data on staff size versus design flow for advanced secondary plants were segregated and analyzed according to type of sludge handling as described in Table 3.3. Simple sludge handling appeared to be less demanding of staff, but there was no discernible difference in staff needs for plants smaller than 10 mgd. Furthermore, no significant difference in staff requirements was noted between moderate and complex sludge handling. Because of the doubtful significance of these analyses, their results are not presented.

STAFF SIZE vs DESIGN FLOW

ADVANCED SECONDARY WASTEWATER TREATMENT PLANTS WITH LITERATURE COMPARISONS

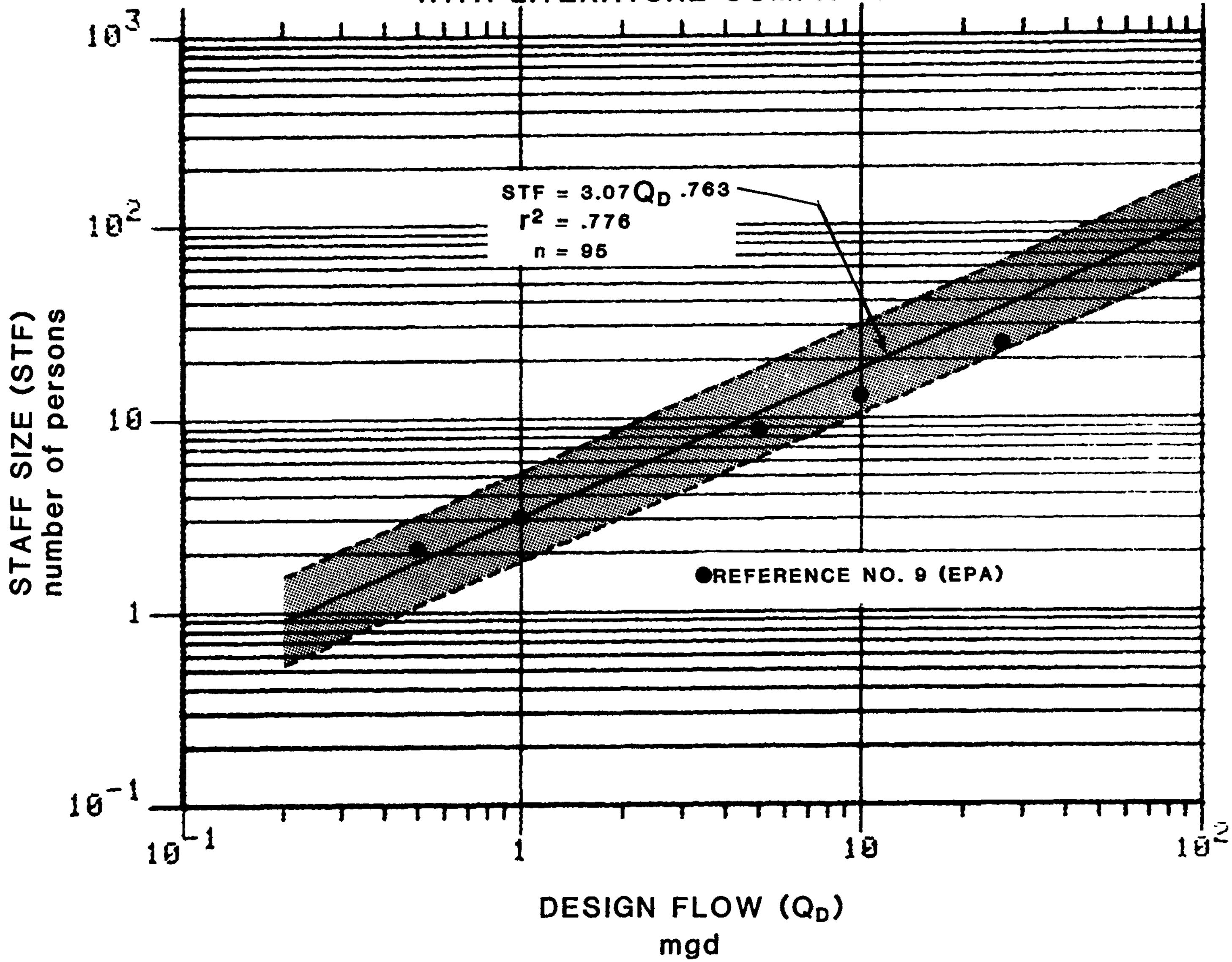


FIGURE 3.30

Advanced Wastewater Treatment Facilities: The plot of staff size versus design flow shown in Figure 3.31 was obtained from data on 39 advanced wastewater treatment facilities having design flow rates up to 70 mgd. As with secondary and advanced secondary systems, data from the literature (9) fit observed data well. Also for sizes up to 10 mgd, advanced wastewater treatment seems to require no more staff than secondary or advanced secondary treatment.

The data on advanced wastewater treatment facilities were segregated and analyzed according to complexity of sludge handling as described earlier in Table 3.4. Simple sludge treatment appeared to be less demanding of staff than moderate or complex handling. Further, the analyses for the latter two cases suggested that for flows smaller than 20 mgd, adding heat treatment to the sludge handling process significantly increases the need for staff. Above the 20 mgd design flow, staff size needs appear to have little relationship to sludge handling complexity. However, the number of plants on which these analyses were based was quite small, and the statistical parameters produced indicated very doubtful relationships. For these reasons, the plots of these analyses are not presented.

Summary and Comparison - Staff Size: Figure 3.32 presents the regression lines produced by the data on staff size versus treatment level for all plants studied. These lines verify that there is little difference in staff needs between the various treatment levels in plants with design flows less than 10 mgd. As design flow increases above 10 mgd, there is a slowly increasing need for more staff in the plants producing higher levels of treatment. More data are needed to see if this relationship holds at design flows above 100 mgd.

All the data on staff size versus design flow were analyzed together and the regression line of this effort is shown in Figure 3.33. This line is quite similar to the regression lines produced from the data on each of the three individual treatment levels and could be used as the general expression for staff size versus design flow.

Performance

Wastewater treatment plant performance is influenced by many factors. One of the more important is the hydraulic loading--whether or not the facility is overloaded, underloaded, or design loaded with respect to flow. Design loaded facilities are those with average annual hydraulic loadings in the range of 90 to 110 percent of design capacity. Underloaded facilities are those which receive less than 90 percent of their design flow, and overloaded plants are those with actual flows of more than 110 percent of design capacity.

Figures 3.34, 3.35, and 3.36 present information on total annual O&M costs as a function of hydraulic loading for secondary, advanced secondary, and advanced wastewater treatment facilities.

STAFF SIZE vs DESIGN FLOW
ADVANCED WASTEWATER TREATMENT PLANTS WITH LITERATURE COMPARISONS

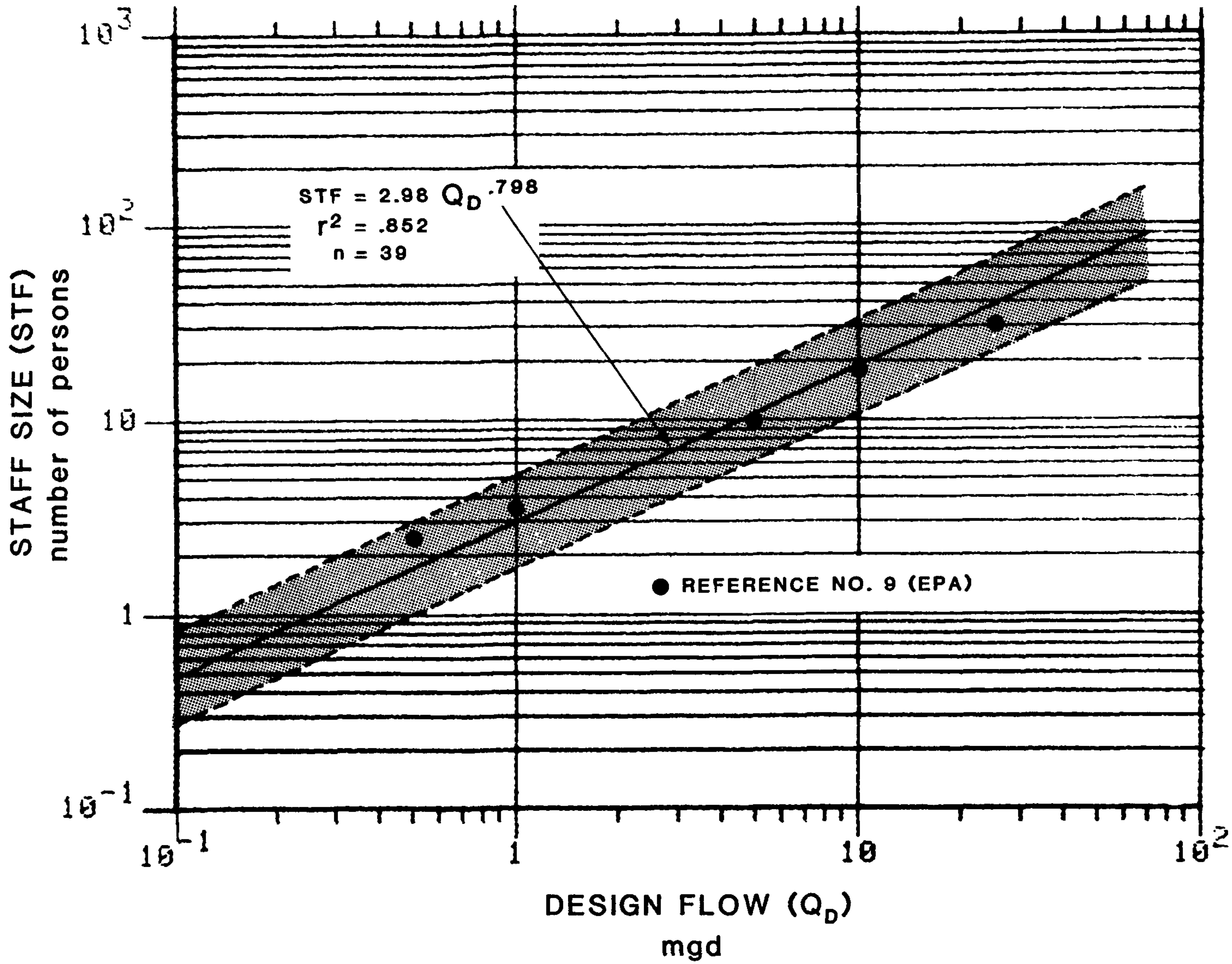


FIGURE 3.31

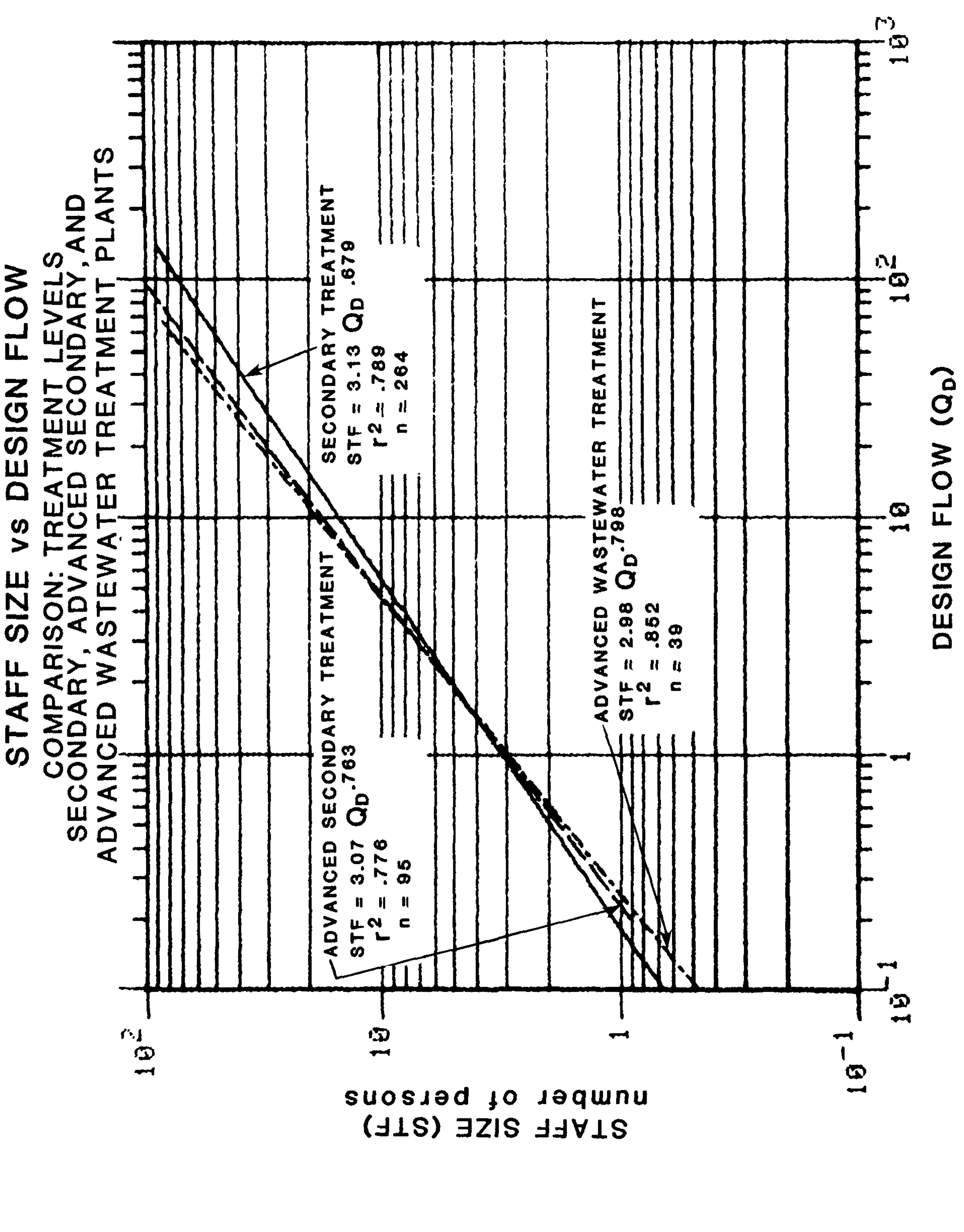

STAFF SIZE vs DESIGN FLOW
COMPARISON: TREATMENT LEVELS
SECONDARY, ADVANCED SECONDARY, AND
ADVANCED WASTEWATER TREATMENT PLANTS
SECONDARY TREATMENT
STF = 3.13 QD .679
r2 = .789
n = 264
ADVANCED SECONDARY TREATMENT
STF = 3.07 QD .763
r2 = .776
n = 95
ADVANCED WASTEWATER TREATMENT
STF = 2.98 QD .798
r2 = .852
n = 39
STAFF SIZE (STF)
number of persons
DESIGN FLOW (QD)
mgd
10
1

FIGURE 3.32

STAFF SIZE vs DESIGN FLOW

ALL TREATMENT LEVEL COMPOSITE
SECONDARY, ADVANCED SECONDARY, AND
ADVANCED WASTEWATER TREATMENT PLANTS

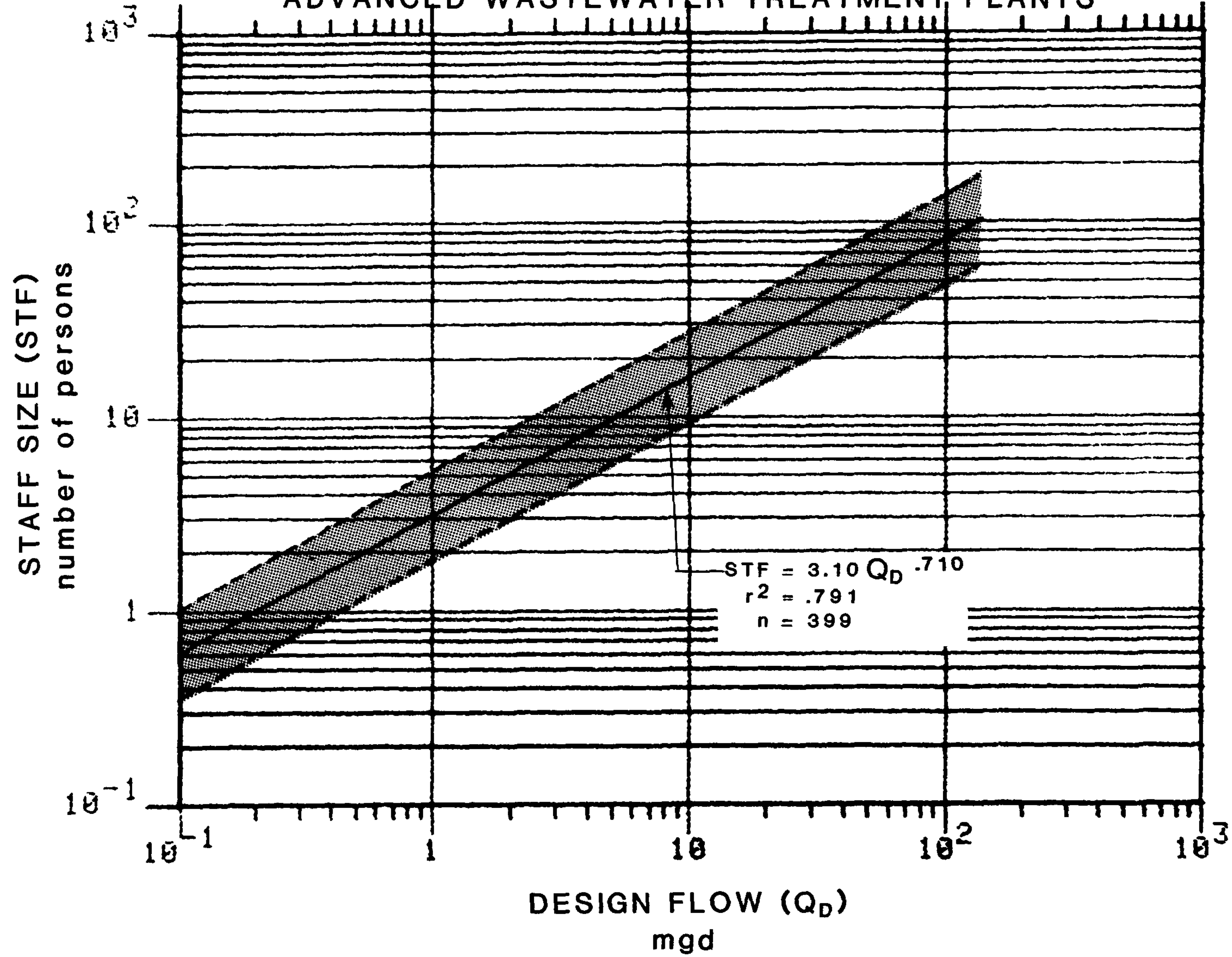


FIGURE 3.33

TOTAL O & M COSTS vs DESIGN FLOW
COMPARISON : HYDRAULIC LOADING RANGES
SECONDARY WASTEWATER TREATMENT PLANTS

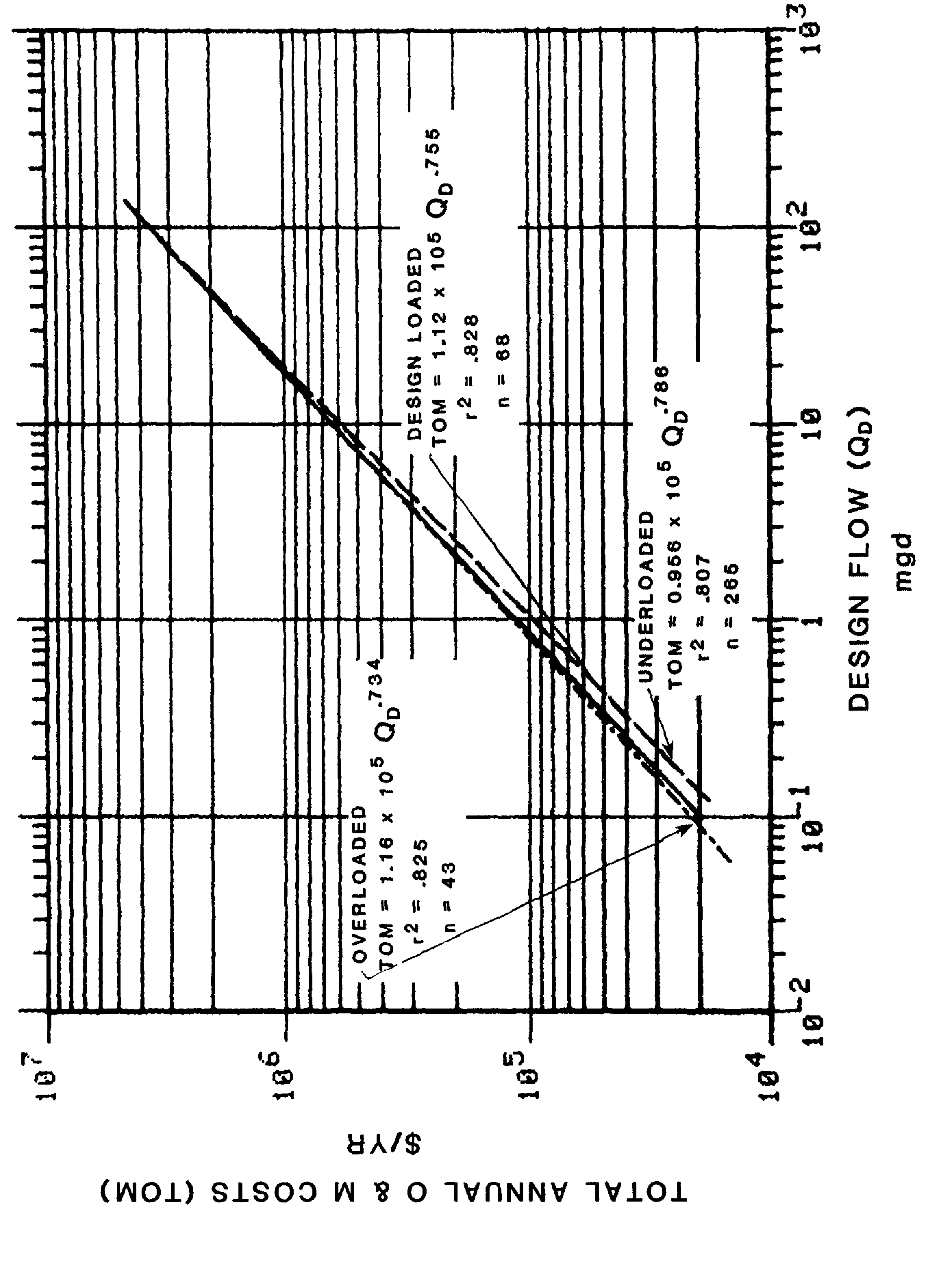


FIGURE 3.34

TOTAL O & M COSTS vs DESIGN FLOW
COMPARISON : HYDRAULIC LOADING RANGES
ADVANCED SECONDARY WASTEWATER TREATMENT PLANTS

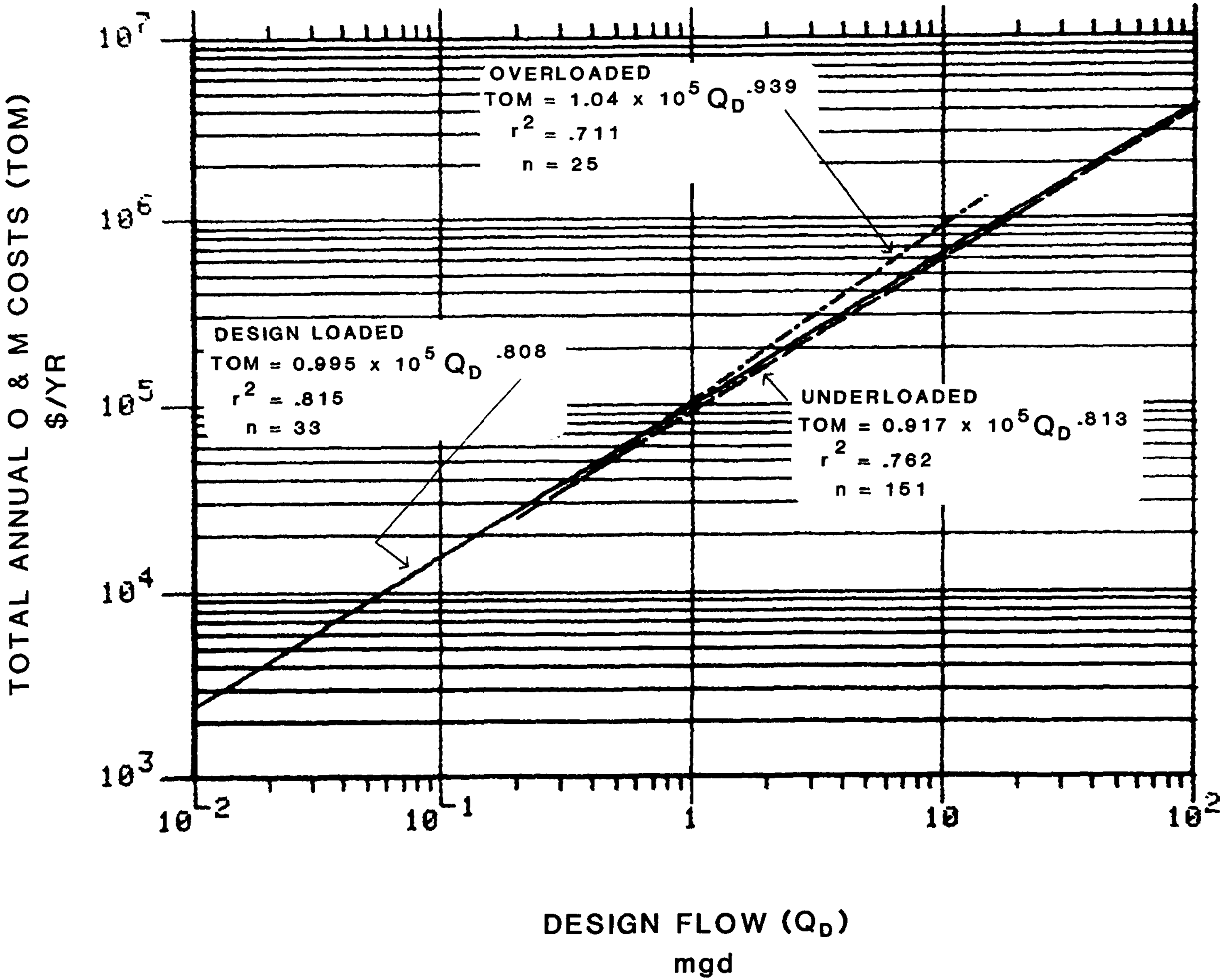


FIGURE 3.35

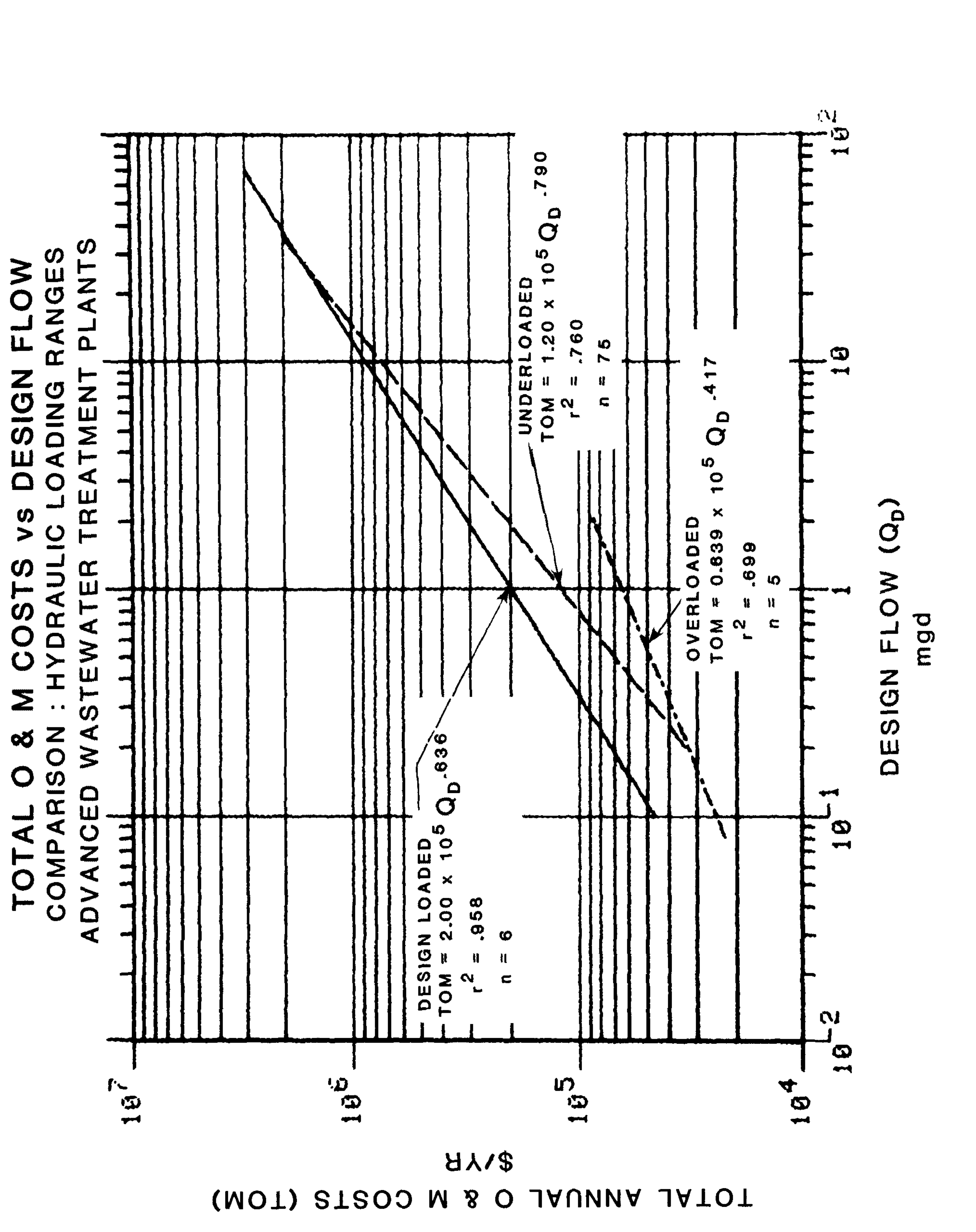

TOTAL O & M COSTS vs DESIGN FLOW
COMPARISON : HYDRAULIC LOADING RANGES
ADVANCED WASTEWATER TREATMENT PLANTS
DESIGN LOADED
TOM = 2.00 x 10^5 Q_D^.636
r^2 = .958
n = 6
UNDERLOADED
TOM = 1.20 x 10^5 Q_D^.790
r^2 = .760
n = 75
OVERLOADED
TOM = 0.639 x 10^5 Q_D^.417
r^2 = .699
n = 5
DESIGN FLOW (Q_D)
mgd
TOTAL ANNUAL O & M COSTS (TOM)
$/YR
10^7
10^6
10^5
10^4
10^-2
10^-1
1
10
10^2

FIGURE 3.36

Most of the plants studied in all three categories are either underloaded or overloaded. The data on these three figures represent 671 plants. Of these, only about 15 percent (107) were hydraulically loaded in the range of 90 to 110 percent of their design capacity. In fact, only six of the 86 advanced wastewater treatment plants studied were design loaded hydraulically. Considering all three types of facilities, a total of 491 were underloaded with 73 overloaded.

Data on each loading range within each treatment level were analyzed separately. Also, each loading range and treatment level was examined for relationships using the applicable full data set and the applicable split data sets for design flows equal to or less than 1.0 mgd and greater than 1.0 mgd. Nothing useful was observed from these analyses.

As shown in Figures 3.34 and 3.35 there is little difference in total annual O&M costs as a function of hydraulic loading between secondary and advanced secondary wastewater treatment plants. In fact, there is little difference in O&M costs between either level, regardless of hydraulic loading.

However, the information on advanced wastewater treatment plants shown in Figure 3.36 presents a different situation. Here O&M costs are less, over most of the range studied, for both the underloaded and overloaded systems as compared to the design loaded ones. This seems unreasonable and probably reflects the need for additional investigation more than anything else, as only six of the 86 AWT plants studied were loaded according to their design.

The data were further screened to select those plants having sufficient information on loading and removal of BOD and suspended solids to permit the use of these parameters in measuring performance. The characterization of these facilities by type and hydraulic loading is shown in Table 3.7.

For each loading range in this sample, average annual five day BOD and suspended solids were computed for both the influent and effluent. These values are shown in Tables 3.8 and 3.9.

It is unfortunate that more data on design loaded AWT and advanced secondary wastewater treatment facilities were not available. For secondary facilities, overloading generally decreases BOD and suspended solids removals, as is well known and further demonstrated here. The data suggest that the same effect occurs with advanced secondary plants, but the small number of plants and the small increase in average effluent BOD noted for the overloaded case make it difficult to determine the relative importance of overloading to these plants. However, it should be noted that the data on suspended solids removal for advanced secondary plants does support the contention that overloading these facilities causes a deterioration in effluent quality.

TABLE 3.7

NUMBER OF FACILITIES ACCORDING TO HYDRAULIC LOADING

Treatment Level	Underloaded	Design Loaded	Overloaded
Secondary	281	40	45
Advanced Secondary	157	33	25
Advanced Wastewater Treatment	77	6	5
Totals	515	108	75

TABLE 3.8

BOD REMOVAL (mg/l) ACCORDING TO HYDRAULIC LOADING

Treatment Level	Underloaded		Design Loaded		Overloaded	
	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.
Secondary	227	21	205	30	178	37
Advanced Secondary	217	13	174	20	161	22
Advanced Wastewater Treatment	194	9	133	7	105	4

TABLE 3.9

SUSPENDED SOLIDS REMOVAL (mg/l)
ACCORDING TO HYDRAULIC LOADING

Treatment Level	Underloaded		Design Loaded		Overloaded	
	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.
Secondary	209	24	205	29	181	36
Advanced Secondary	210	16	183	23	171	31
Advanced Wastewater Treatment	196	11	133	11	125	9

Advanced wastewater treatment facilities, on the other hand, seem to produce improved effluent quality--BOD and SS--as they go from underloaded to overloaded. Again, the small number of AWT plants investigated requires that great caution be used in making such a generalization.

Table 3.10 shows that O&M costs per unit volume treated rise for secondary and advanced secondary facilities as they go from underloaded through design flow to overloaded conditions. Why this should be so is not clear. Perhaps more sludge handling costs are encountered at the higher hydraulic loadings, or more operating and/or maintenance problems may be encountered at the higher loading levels.

On the other hand, O&M costs per unit volume treated seem to decline for AWT plants on either side of the design loading. However, the small number of facilities in this data set again makes the drawing of firm conclusions on this point quite risky.

In terms of O&M costs per unit of BOD or suspended solids removed, underloaded facilities should be more costly to operate and maintain than design loaded facilities. This observation is confirmed in general for secondary and advanced secondary plants by the values given in Tables 3.11 and 3.12 which present total O&M costs per pound of BOD and SS removed, respectively. In fact, as shown here, costs per pound of BOD or suspended solids removed increase as the secondary and advanced secondary systems become either underloaded or overloaded. Thus, it appears that design hydraulic loading gives the best return on O&M dollars, as far as BOD and suspended solids removal are concerned, for secondary and advanced secondary plants.

Unfortunately, the data do not show that this is true also for advanced wastewater treatment plants which appear to be more costly to operate at design load than at under or over design. It could be that not enough data are available to permit such generalization for AWT plants. However, it also could be that AWT facilities are being designed with imperfect loading criteria.

Operating Problems

As part of this study's data collection efforts, plant personnel were questioned on the most difficult problems encountered in operating and maintaining wastewater control facilities. Their responses are tabulated and shown in Table 3.13 according to the frequency of appearance of a particular response. These responses, though far from definitive, are interesting. More than 1,000 responses were recorded. Of these, more than 700 can be interpreted as relating to design/engineering, i.e., the categories listed as fluctuation in loadings, climatological factors, inadequate controls, pilot plant problems, and sludge disposal problems. About 20 percent of the problems reported were equipment

TABLE 3.10

TOTAL ANNUAL O&M COSTS/MILLION GALLONS
ACCORDING TO HYDRAULIC LOADING

Treatment Level	Underloaded	Design Loaded	Overloaded
Secondary	$262	$305	$317
Advanced Secondary	251	272	285
Advanced Wastewater Treatment	322	546	175

TABLE 3.11

TOTAL ANNUAL O&M COSTS/POUND OF BOD REMOVED
ACCORDING TO HYDRAULIC LOADING

Treatment Level	Underloaded	Design Loaded	Overloaded
Secondary	$0.32	$0.21	$0.27
Advanced Secondary	0.35	0.21	0.30
Advanced Wastewater Treatment	0.51	0.74	0.22

TABLE 3.12

TOTAL ANNUAL O&M COSTS/POUND OF SS REMOVED
ACCORDING TO HYDRAULIC LOADING

Treatment Level	Underloaded	Design Loaded	Overloaded
Secondary	$0.35	$0.22	$0.31
Advanced Secondary	0.37	0.23	0.30
Advanced Wastewater Treatment	0.47	0.75	0.22

TABLE 3.13

MOST FREQUENTLY REPORTED WASTEWATER TREATMENT O&M PROBLEMS

Factor	Number of Times Reported
Fluctuation in Flows	210
Design Deficiencies	184
Equipment Failures	181
Fluctuation in Loadings	94
Inadequate Capacity	97
Understaffing	89
Climatic Factors	83
Inadequate Process Controls or Control Plans	29
Inhibiting Industrial Wastes	24
Severe Operating Problems Requiring Process Shutdowns or Major Disruptions	6
Pilot Plant Associated Problems	2
Sludge Disposal Problems	2
TOTAL RESPONSES	1,006

failures and about ten percent of the responses are related to inadequate staffing--either in numbers of staff or poorly trained staff.

It follows that almost all of the most commonly observed problems with wastewater treatment plant operation and maintenance are preventable through better design criteria, better design/engineering, and improved operator training and/or staffing.

Complexity

The Association of Boards of Certification for Operating Personnel in Water and Wastewater Utilities (ABC), with funding from EPA, has developed a standard system for classifying the relative complexity of wastewater facilities (10).

This system provides a means of comparing facilities and is based on such items as population served, design flow, discharge limitations, variations in loading, number and type of treatment processes, and laboratory control. Points are assigned to each of these items and others, and the total number of points are summed to produce a plant rating which reflects the relative complexity of plant operation. Figure 3.37 shows the rating form used for this classification system, and Figure 3.38 offers further explanatory material on it.

These forms and instructions were used to prepare an ABC rating for 671 of the treatment facilities from which data were collected during this study. That rating is presented as part of the listing of plants contained in Appendix A. These ratings also were used to further investigate the relationship between total annual O&M costs, staffing levels, and plant complexity as shown in Figures 3.39 and 3.40. Because the ABC classification reflects more than effluent quality, plants classified for this study as secondary, advanced secondary, and advanced wastewater treatment were found throughout the range of ABC scores.

Figure 3.39 presents total annual O&M costs as a function of the ABC rating score using nationwide data for all levels of treatment. The analysis shown does not provide much confidence regarding the relationship between O&M costs and ABC rating. On the other hand, there is little reason to suspect that a strong relationship exists between the ABC rating and total O&M costs. General plant complexity probably has less effect on total O&M costs than specific factors such as energy use in the plant, use of process chemicals, or method of sludge disposal.

Similar observations apply to Figure 3.40 which shows the regression analysis of ABC rating versus plant staffing size using nationwide data for all treatment levels.

ABC CLASSIFICATION OF WASTEWATER TREATMENT PLANTS (WWT)

FACILITY-CLASS	I.	II.	III.	IV.
RANGE OF POINTS	30 and Less	31-55	56-75	76 and Greater

Assign points for every item that applies:

Item	Points		
Size			
Maximum population equivalent (P.E.) served, peak day	1 pt. per 10,000 P.E. or part	______	Max. 10 Points
Design flow (avg. day) or peak month's flow, (avg. day), whichever is larger	1 pt. per MGD or part	______	Max. 10 Points
Effluent Discharge			
Receiving stream (sensitivity)	0-6*	______	
Land disposal - evaporation	2	______	
Subsurface disposal	4	______	
Variation in Raw Wastes (slight to extreme)	0-6*	______	
Pretreatment			
Screening, comminution	3	______	
Grit removal	3	______	
Plant pumping of main flow	3	______	
Primary Treatment			
Primary clarifiers	5	______	
Combined sedimentation/digestion	5	______	
Chemical addition (except chlor., enz.)	4	______	
Secondary Treatment			
Trickling filter w/sec. clarifiers	10	______	
Activated sludge w/sec. clarifiers (including ext. aeration and oxidation ditches)	15	______	
Stabilization ponds without aeration	5	______	
Aerated lagoon	8	______	
Advanced Waste Treatment			
Polishing pond	2	______	
Chemical/physical - without secondary	15	______	
Chemical/physical - following secondary	10	______	
Biological or chemical/biological	12	______	
Ion exchange	10	______	
Reverse osmosis, electrodialysis	15	______	
Chemical recovery, carbon regeneration	4	______	
Solids Handling			
Thickening	5	______	
Anaerobic digestion	10	______	
Aerobic digestion	6	______	
Evaporative sludge drying	2	______	
Mechanical dewatering	8	______	
Solids reduction (incineration, wet oxidation)	12	______	
Disinfection			
Chlorination or comparable	5	______	
On-site generation of disinfectant	5	______	
Laboratory Control by Plant Personnel			
Bacteriological (complexity)	0-10*	______	
Chemical/physical (complexity)	0-10*	______	
TOTAL**		______	

***SEE FIGURE 3.38**

**If unique treatment plant conditions distort the point total, the certification board should adjust the facility classification

FIGURE 3.37

ABC WASTEWATER TREATMENT PLANT CLASSIFICATION
VARIABLE POINT GUIDE

Effluent Discharge

Receiving stream sensitivity .... **2 - 6***

The key concept is the degree of dilution provided under low flow conditions. Suggested point values are:

- "Effluent limited segment" in EPA terminology; secondary treatment is adequate. - 1
- More than secondary treatment is required. - 2
- "Water quality limited segment" in EPA terminology; stream conditions are very critical (dry run, for example) and a very high degree of treatment is required. - 3
- Effluent used in a direct recycle and reuse system. - 6

Variation in Raw Wastes (slight to extreme) .... **0 - 6***

The key concept is frequency and/or intensity of deviation or excessive variation from normal or typical fluctuations; such deviation can be in terms of strength, toxicity, shock loads, I/I, etc. Suggested point values are:

- Variations do not exceed those normally or typically expected. - 0
- Recurring deviations or excessive variations of 100 to 200 percent in strength and/or flow. - 2
- Recurring deviations or excessive variations of more than 200 percent in strength and/or flow. - 4
- Raw wastes subject to toxic waste discharges. - 6

Laboratory Control by Plant Personnel

Bacteriological/biological (complexity) .... **0 - 10***

The key concept is to credit bacti/bio lab work done on-site by plant personnel. Suggested point values are:

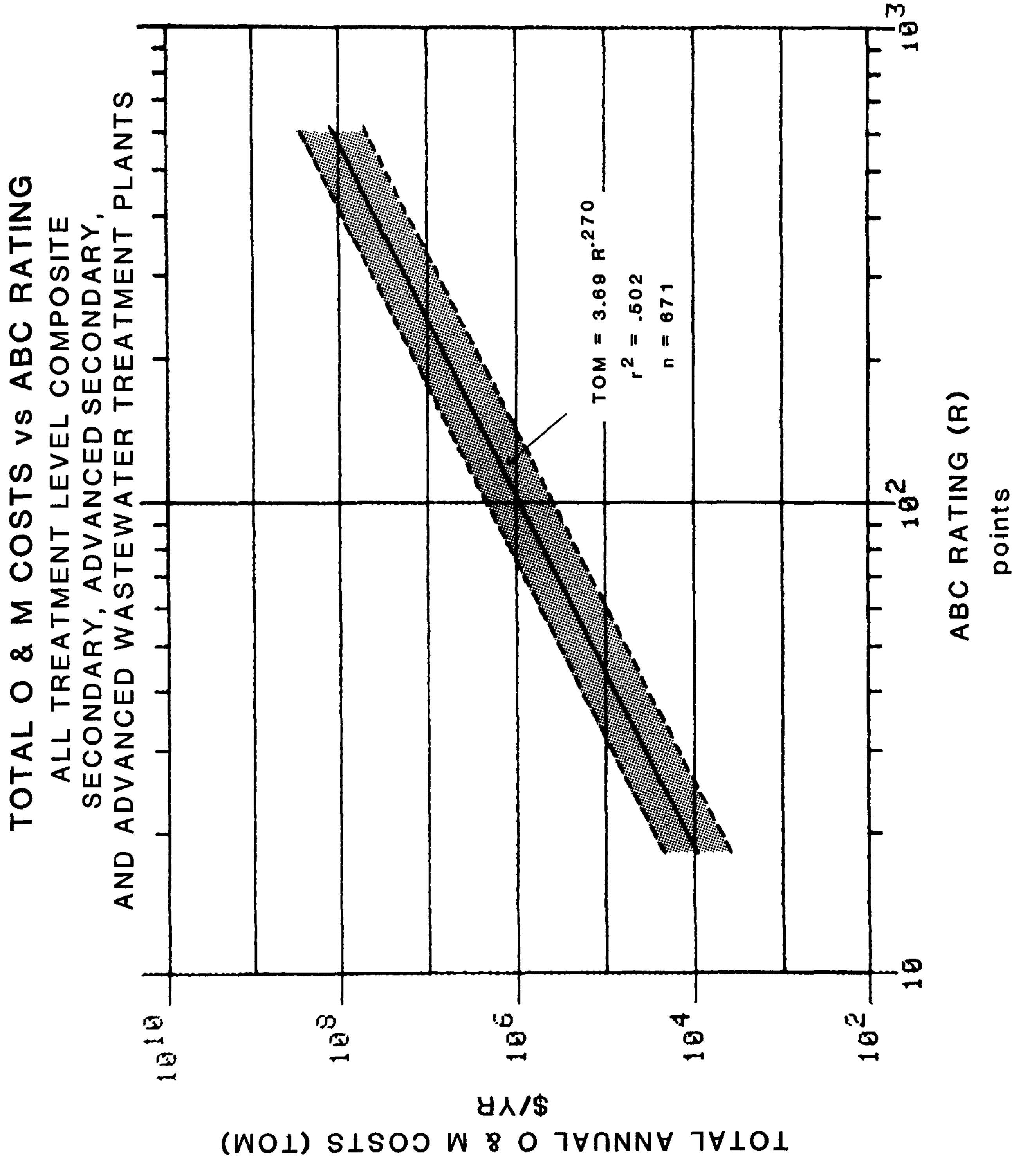
- Lab work done outside the plant. - 0
- Membrane filter procedures. - 3
- Use of fermentation tubes or any dilution method; fecal coliform determination. - 5
- Biological identification. - 7
- Virus studies or similarly complex work conducted on-site. - 10

Chemical/physical (complexity) .... **0 - 10***

The key concept is to credit chemical/physical lab work done on-site by plant personnel. Suggested point values are:

- Lab work done outside the plant. - 0
- Push-button or visual methods for simple tests such as pH, settleable solids—up to - 3
- Additional procedures such as DO, COD, BOD, gas analysis, titrations, solids, volatile content—up to - 5
- More advanced determinations such as specific constituents: nutrients, total oils, phenols, etc.—up to- 7
- Highly sophisticated instrumentation such as atomic absorption and gas chromatography. - 10

FIGURE 3.38



TOTAL O & M COSTS vs ABC RATING
ALL TREATMENT LEVEL COMPOSITE
SECONDARY, ADVANCED SECONDARY,
AND ADVANCED WASTEWATER TREATMENT PLANTS
TOM = 3.69 R.270
r2 = .502
n = 671
TOTAL ANNUAL O & M COSTS (TOM)
$/YR
ABC RATING (R)
points

FIGURE 3.39

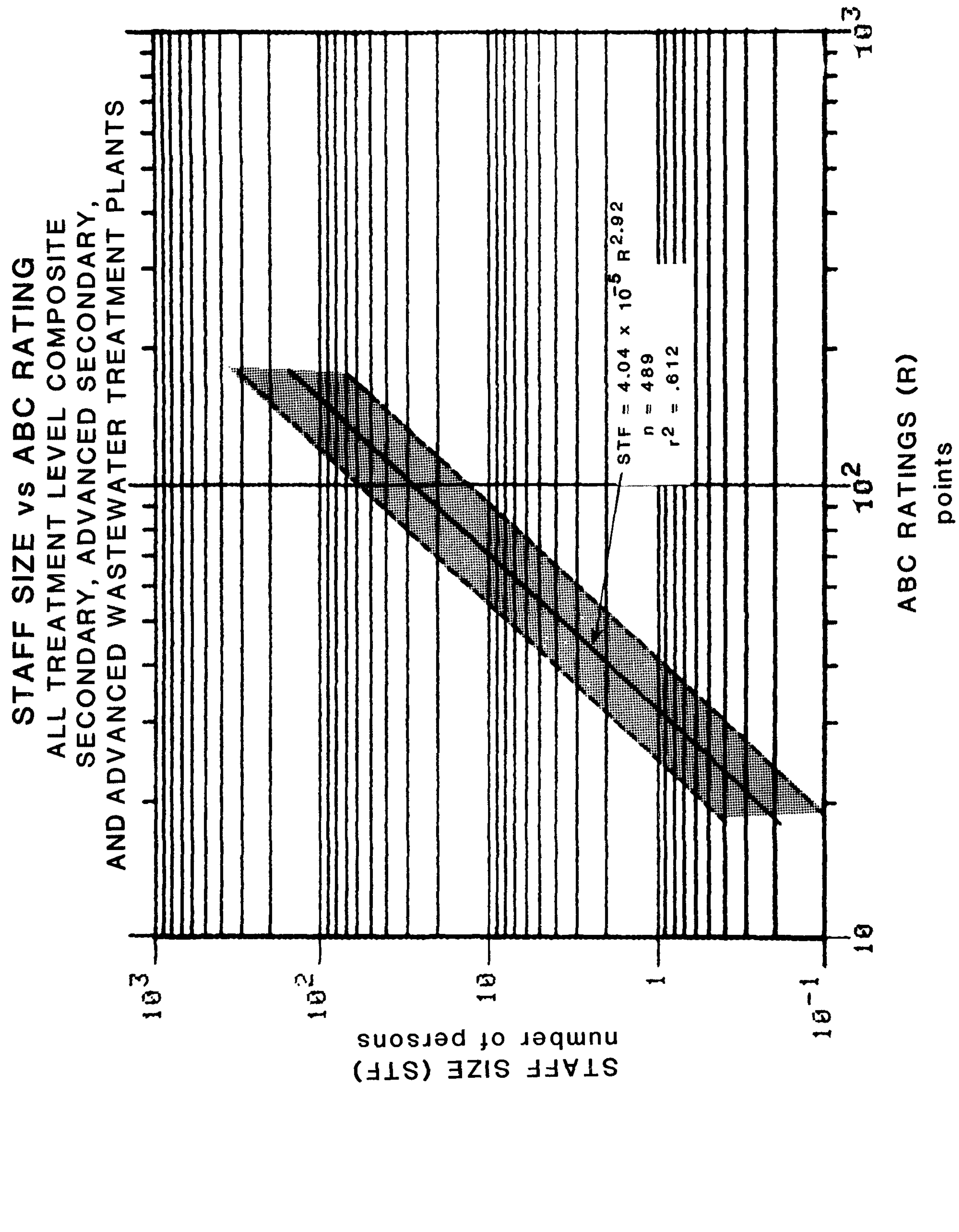

STAFF SIZE vs ABC RATING
ALL TREATMENT LEVEL COMPOSITE
SECONDARY, ADVANCED SECONDARY,
AND ADVANCED WASTEWATER TREATMENT PLANTS
STF = 4.04 x 10^{-5} $R^{2.92}$
n = 489
r^2 = .612
STAFF SIZE (STF)
number of persons
10^3
10^2
10
1
10^{-1}
10
10^2
10^3
ABC RATINGS (R)
points

FIGURE 3.40

CONVEYANCE SYSTEMS

This section presents total annual O&M costs and staffing levels for separate municipal wastewater conveyance systems--those systems intended to carry sanitary and industrial wastes only. More than 480 such systems were investigated. The results are expressed in terms of service population, length of system, and whether the system operates with lift stations or without. Component costs--personnel, power, equipment, materials, and miscellaneous costs--were examined where possible. Only information descriptive of the general national situation is presented. The data were insufficient to produce satisfactory Regional analysis of costs.

Accurate O&M cost data for wastewater conveyance systems are difficult to obtain. This is especially true for the small and medium sized municipalities. Many municipal entities have unified budgets and staff for general public works and separate records of O&M costs for the wastewater conveyance systems frequently are not kept. As a general rule, only total O&M, power costs, personnel costs, and total staff hours are available.

Total Annual O&M Costs

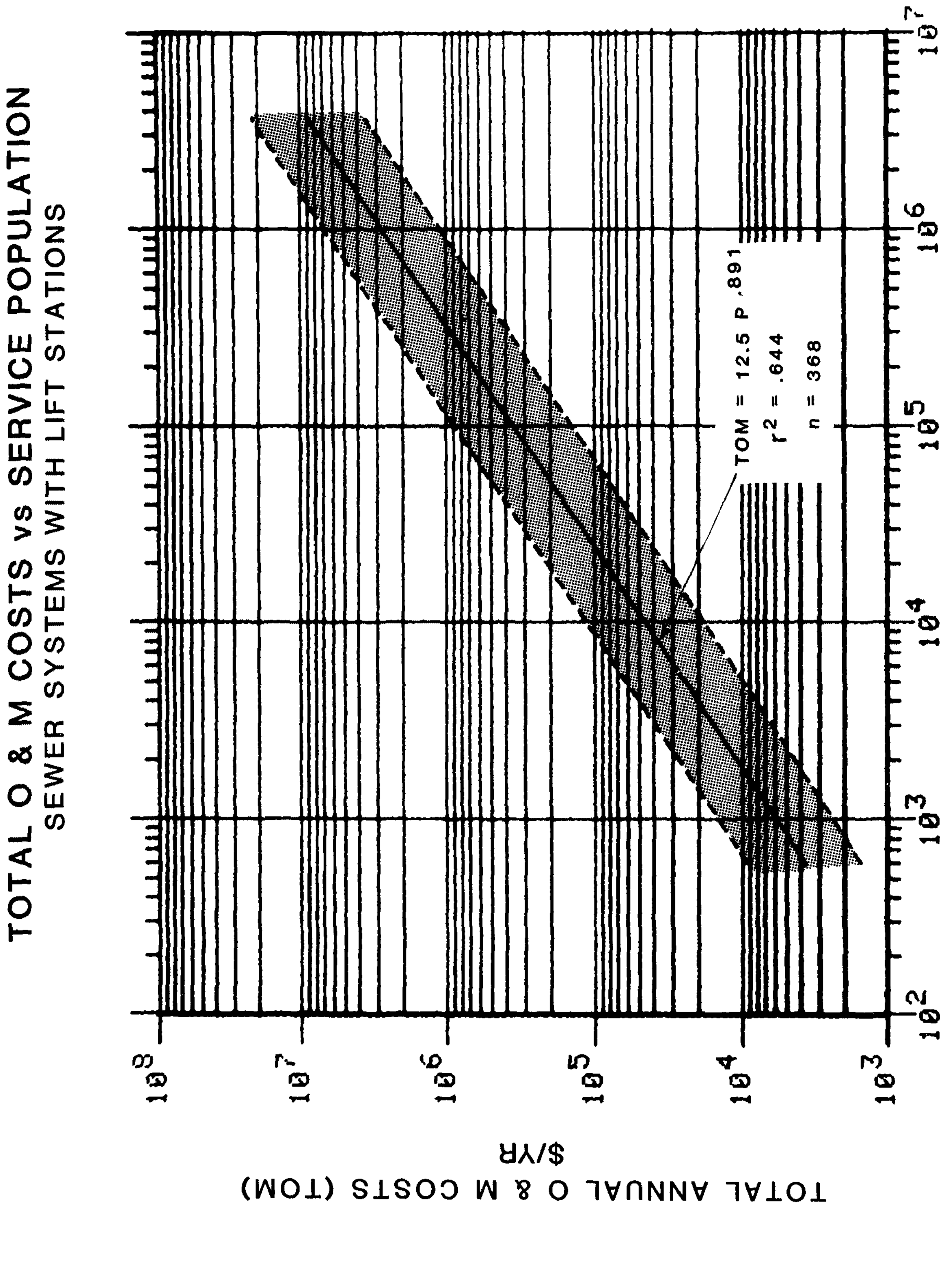
Service Population: Figures 3.41 and 3.42 present information on total annual O&M costs as a function of service population for systems with and without lift stations. More than 400 conveyance systems are represented on these plots. Comparison of these figures shows that in the smaller systems--less than 2,000 service population--there is no discernible difference in O&M costs between systems with lift stations and those having none. Such systems probably are so small that only a minimal number of lift stations are ever present--causing little impact on total O&M cost.

As the service population increases above 2,000, however, nongravity systems become ever more costly, comparatively, to operate and maintain. This is only logical as increasing system size will require an increasing number of lift stations with corresponding increases in O&M costs.

Length of System: Figures 3.43 and 3.44 illustrate the total O&M costs as a function of system length for conveyance systems with and without lift stations. Again, comparison shows that additional O&M costs for systems with lift stations are minimal for the smaller systems but increase continuously throughout the range studied as system size increases.

Components of O&M Costs

The total annual O&M costs for conveyance systems were divided into four basic components, i.e., personnel, power, equipment and materials, and



TOTAL O & M COSTS vs SERVICE POPULATION
SEWER SYSTEMS WITH LIFT STATIONS
TOM = 12.5 P .891
r2 = .644
n = 368
10^3
10^4
10^5
10^6
10^7
10^8
10^2
SERVICE POPULATION (P)
TOTAL ANNUAL O & M COSTS (TOM)
$/YR

FIGURE 3.41

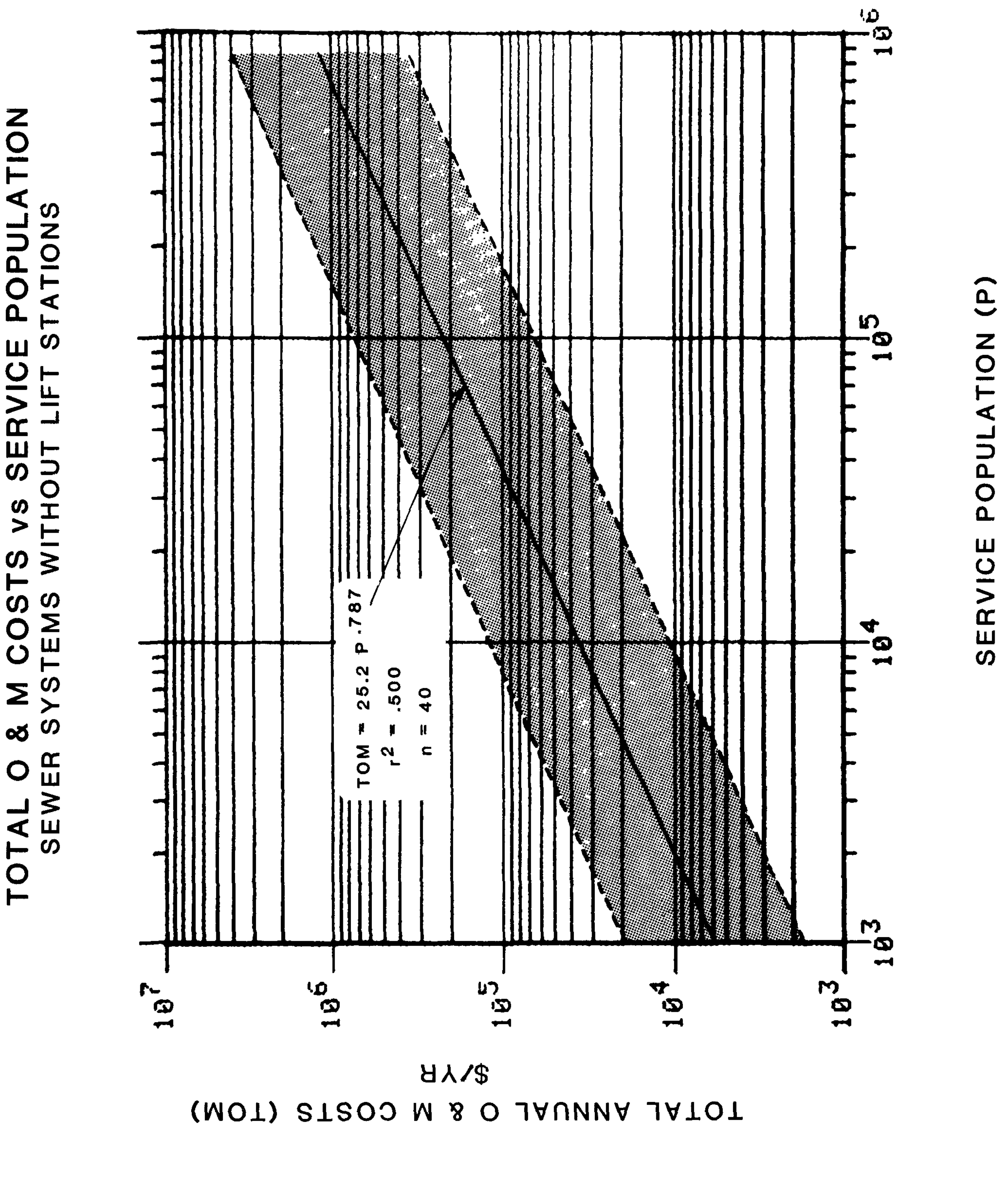
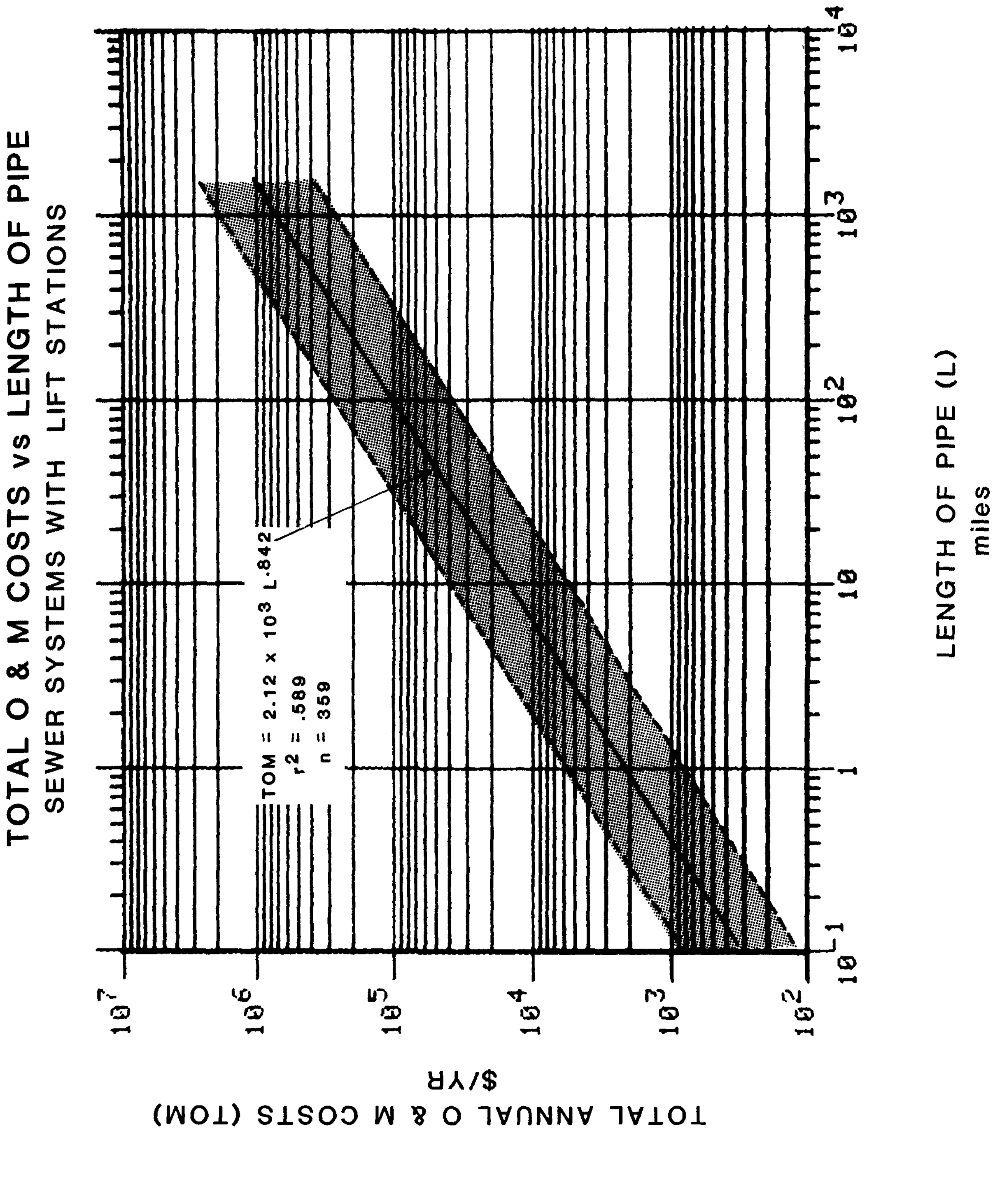

TOTAL O & M COSTS vs SERVICE POPULATION
SEWER SYSTEMS WITHOUT LIFT STATIONS
TOM = 25.2 P.787
r2 = .500
n = 40
TOTAL ANNUAL O & M COSTS (TOM)
$/YR
SERVICE POPULATION (P)
10^3
10^4
10^5
10^6
10^7

FIGURE 3.42



TOTAL O & M COSTS vs LENGTH OF PIPE
SEWER SYSTEMS WITH LIFT STATIONS
TOM = 2.12 x 10^3 L^.842
r^2 = .589
n = 359
LENGTH OF PIPE (L)
miles
TOTAL ANNUAL O & M COSTS (TOM)
$/YR
10^-1
1
10
10^2
10^3
10^4
10^2
10^3
10^4
10^5
10^6
10^7

FIGURE 3.43

TOTAL O & M COSTS vs LENGTH OF PIPE
SEWER SYSTEMS WITHOUT LIFT STATIONS

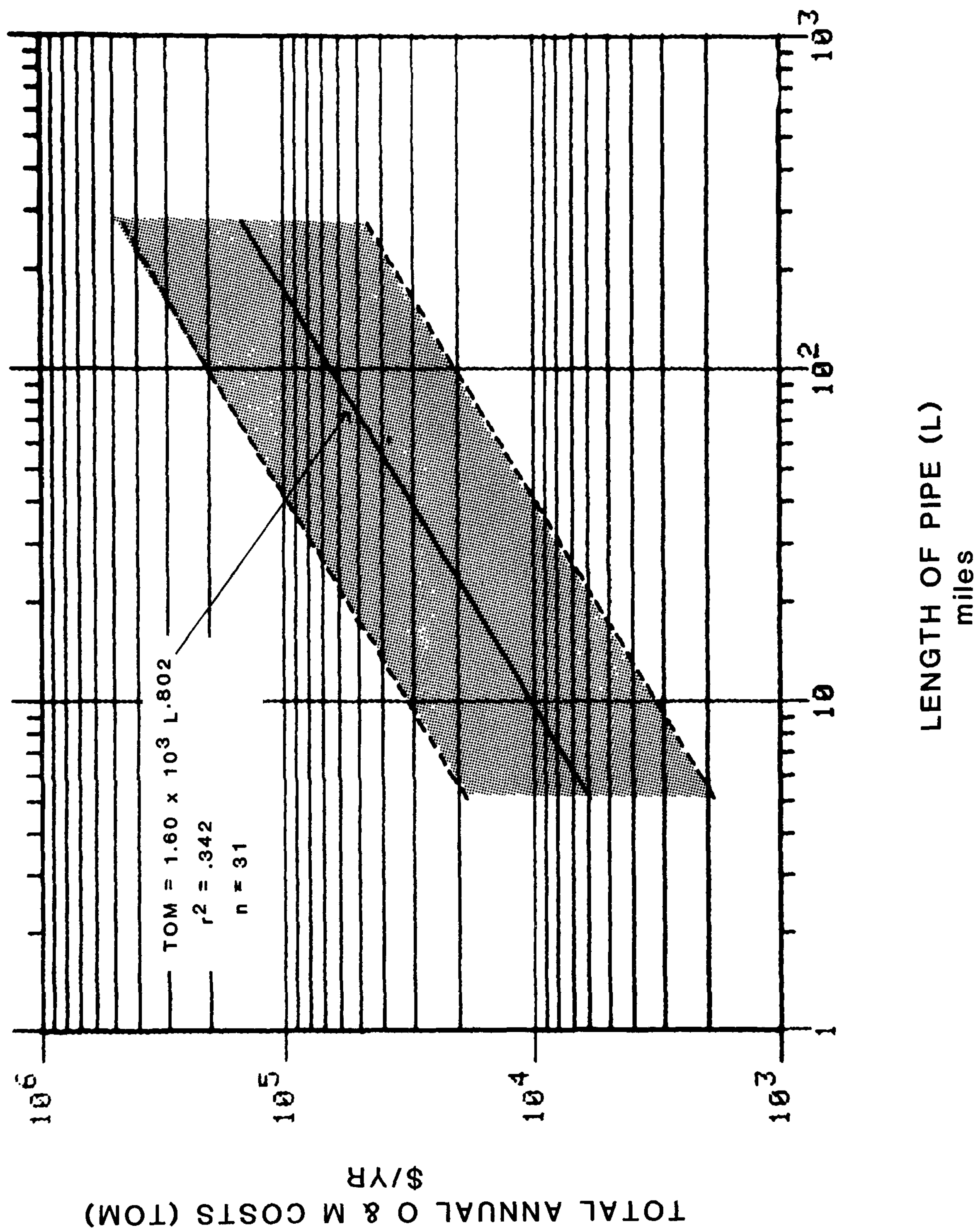


FIGURE 3.44

other. Table 3.14 presents the cost of each of these components expressed as a percentage of the total O&M costs. The component cost percentages were computed from average component costs, as expressed in the following equation:

$$\% = \sum_{i}^{n} (c/t \times 100) \times 1/n$$

Where: n = Number of systems having a particular component cost

c = Cost of a given type of component for a particular system

t = Total O&M cost for the system

The sample size used to calculate this percentage varied, as all components were not available for every system; therefore, the component percentages do not total 100.

The major discernible difference in component costs between gravity and power pumped systems is for power, as would be expected, with the other three components being essentially equal for both types of systems. The largest component of conveyance system O&M costs is for personnel.

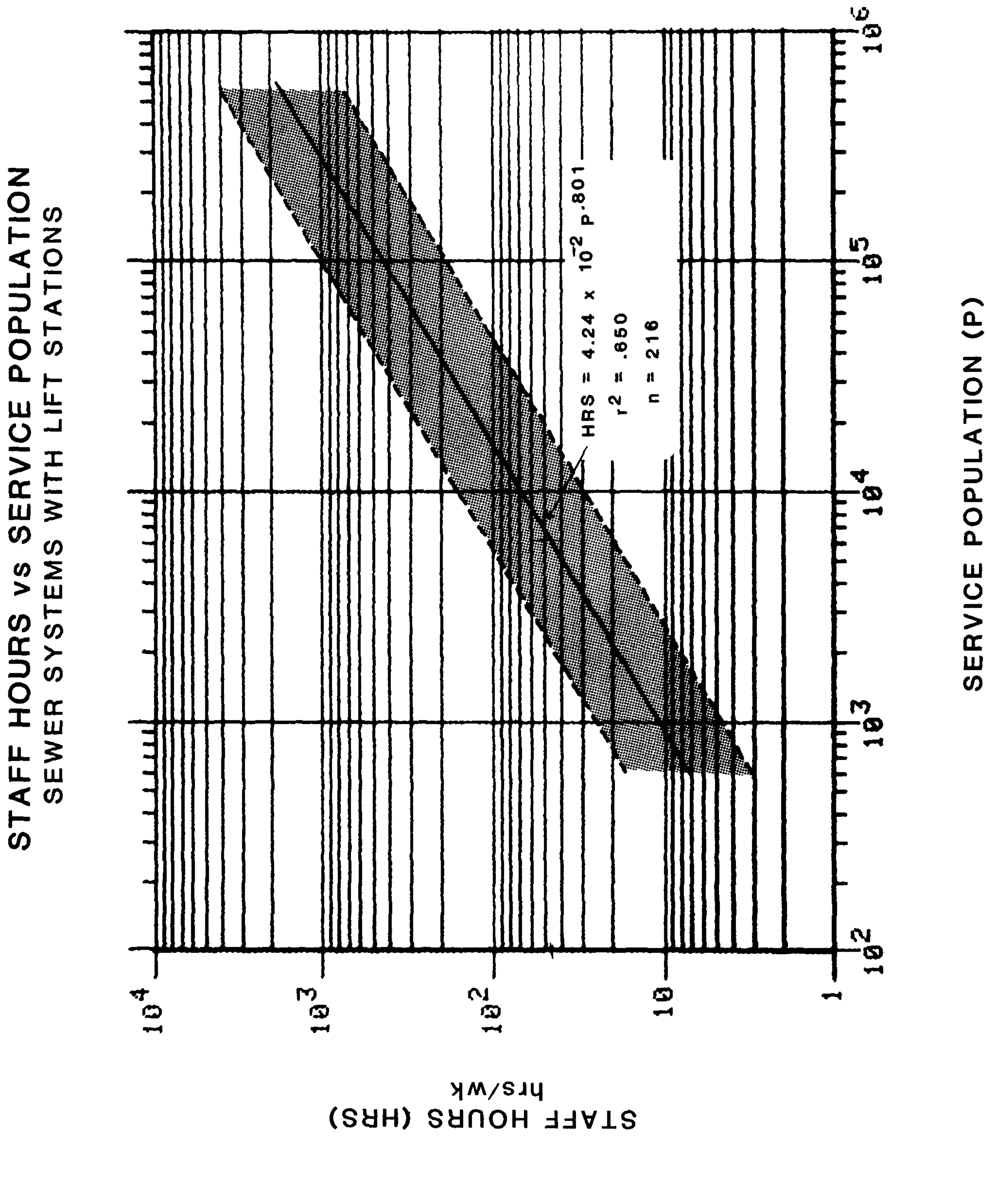
Staffing

Figures 3.45 and 3.46 show staff hours as a function of the service population for conveyance systems with and without lift stations, respectively. Regrettably, the sample size upon which Figure 3.46 is based is very small, thus the validity of the relationship it illustrates may be suspect. Further, as discussed for treatment systems, staff hours should more logically be considered as a stepwise function of system size.

TABLE 3.14

COMPONENT COSTS AS A PERCENTAGE
OF TOTAL O&M COSTS FOR CONVEYANCE SYSTEMS

Components	Systems With Lift Stations	Systems Without Lift Stations
Personnel	60%	63%
Power	18%	0%
Equipment and Materials	18%	18%
Other	17%	25%



STAFF HOURS vs SERVICE POPULATION
SEWER SYSTEMS WITH LIFT STATIONS
HRS = 4.24 x 10-2 P.801
r2 = .650
n = 216
STAFF HOURS (HRS)
hrs/wk
SERVICE POPULATION (P)
1
10
102
103
104
102
103
104
105
106

FIGURE 3.45

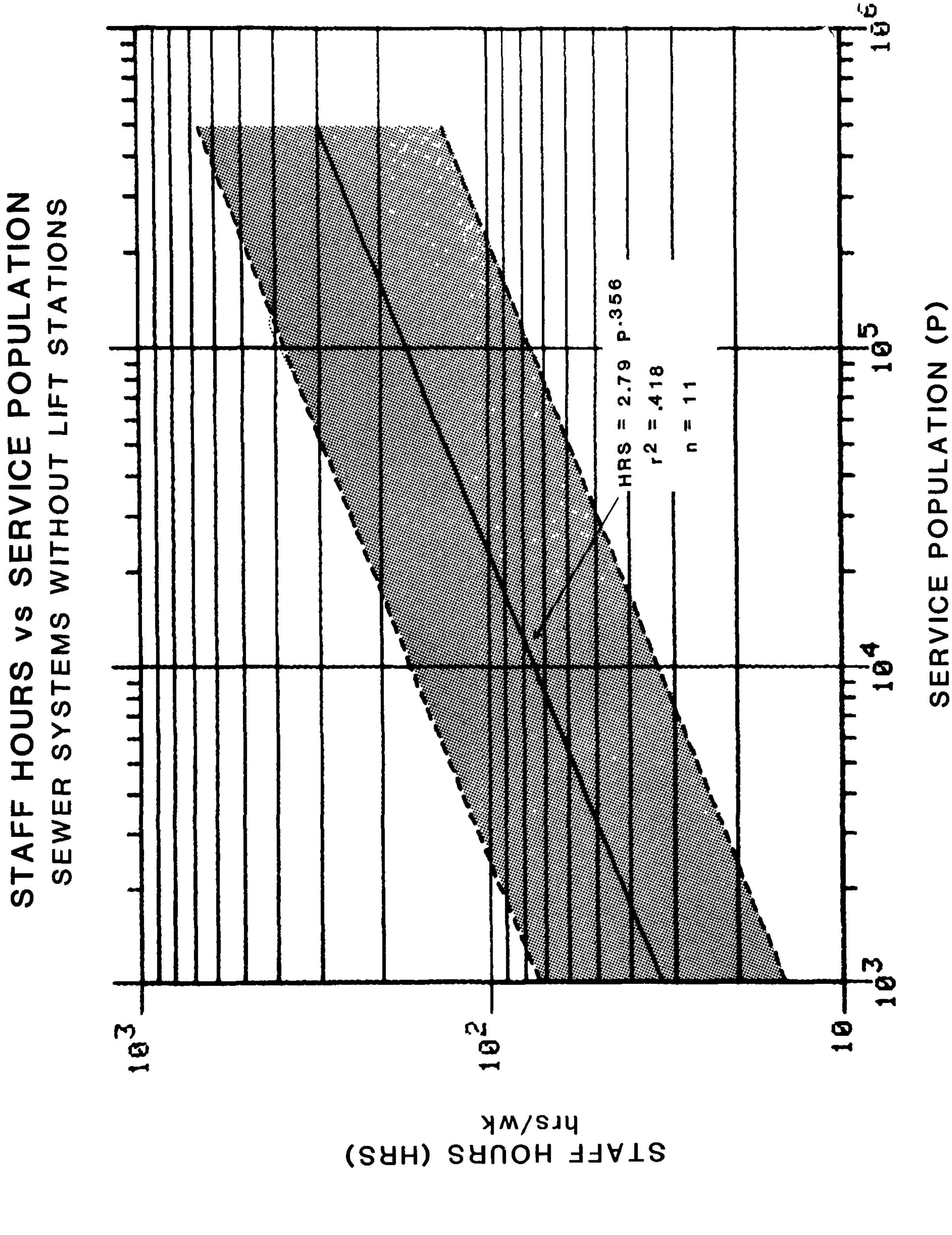

STAFF HOURS vs SERVICE POPULATION
SEWER SYSTEMS WITHOUT LIFT STATIONS
HRS = 2.79 P.356
r2 = .418
n = 11
SERVICE POPULATION (P)
STAFF HOURS (HRS)
hrs/wk
10
102
103
104
105
106

FIGURE 3.46

4.0 DATA UTILIZATION

INTRODUCTION

The use of O&M cost relationships developed in previous sections is illustrated here in an example problem. In the example, values are obtained from the figures to provide an estimate of O&M costs for what may be considered an average system. In actual application the cost estimates obtained should be adjusted to reflect any overriding local conditions. The statistical parameters presented with each graph should be useful for this adjustment process.

EXAMPLE PROBLEM

Midway through the facility planning process for a new treatment plant, local planning officials desire an estimate of O&M costs for a proposed treatment system. The following information is available:

Design Population	:	25,000
Existing per Capita Wastewater Flow	:	110 gpcd
Design Flow $\frac{(25,000 \times 110)}{1,000,000}$	:	2.75 mgd
Existing Sewer System	:	75 Miles of Pipe 2 Lift Stations
Proposed Effluent Limit	:	30 mg/l, five day BOD
Proposed Treatment Process	:	Rotating Biological Contactors
Proposed Sludge Handling	:	Thickening and Dewatering

The effluent limitation of 30 mg/l BOD indicates secondary treatment as defined earlier. The proposed treatment plant is an attached growth system with moderate sludge handling facilities. The cost data presented previously for secondary treatment plants may be used to estimate total O&M costs for this facility.

Several different figures in this report may be used to obtain an estimate of these O&M costs. Administrative costs are obtained from Figure 3.2. For this example, plant O&M costs are obtained from Figure 3.3 or from Figure 3.26--they yield the same values--which are based on nationwide data. For a specific case, the graph applicable to the appropriate Region (Figures 3.7 through 3.16) could be used.

O&M cost values may be obtained directly from the appropriate graphs and should include the most probable and the highest and lowest probable costs. These upper and lower values illustrate the expected range of costs. Total estimated costs to the community for operation and maintenance of the proposed plant include the administrative costs, as well as plant O&M costs.

Figure 3.6 also may be used to obtain O&M costs for an attached growth/moderate sludge handling plant. This approach yields O&M costs comparable to those obtained from Figure 3.3, with the latter being somewhat more conservative.

An indication of sludge handling costs, using the design flow rate in lieu of an actual flow, is obtained from Figure 3.27. Plant staffing requirements are estimated using Figure 3.29 or Figure 3.33, which yield the same values. Table 4.1 presents the O&M cost and staffing requirements for the example treatment plant obtained from the referenced figures.

Table 4.1 provides annual O&M costs and staff estimates for the plant only. The conveyance system also must be considered. Again, several different figures may be consulted to obtain estimates of conveyance system O&M costs and staffing requirements. For the example, O&M costs based on a service population of 25,000 are obtained from Figure 3.41. For a conveyance system with 75 miles of sewer, Figure 3.43 provides another O&M estimate. The two values obtained this way are different and judgment must be used in selecting the one to be used for planning purposes. In this example, the more conservative estimate is used.

Staffing requirements for the example sewer system are obtained from Figure 3.45. Table 4.2 lists the various conveyance system O&M costs for the example problem.

Table 4.3 summarizes the planning level estimates of O&M costs and staffing requirements for the example system. Debt service or amortization costs would need to be added to these totals to determine the total annual cost to the community.

The earlier section on plant performance should also be considered as part of the planning level O&M cost estimation. Specifically, the plant performance data, presented in terms of efficiency in removing BOD and suspended solids, are important if the influent is projected to be stronger or weaker than average. Data also are presented that reflect the variation in O&M costs as the hydraulic loading increases toward and through the design flow range. Such information might be useful in adjusting average annual O&M estimates over the first several years of the system's operations to more accurately reflect variation in costs resulting from variation in flow or loading during this period.

COST UPDATING

The O&M costs contained in this report are expressed in 1st Quarter 1981 dollars. All planning level cost estimates, such as those presented in this example, should be updated from 1st Quarter 1981 to the time of their use. EPA Quarterly Indexes of Direct Cost for Operation, Maintenance, and Repair as described earlier should be used for this. These indexes are published quarterly by EPA and also are printed in the Journal Water Pollution Control Federation.

TABLE 4.1

EXAMPLE
WASTEWATER TREATMENT FACILITY ANNUAL O&M ESTIMATES

Item	Figure No.	Lower Probable Value	Highest Probable Value	Most Probable Value	Planning Estimate
Administration	3.2	$ 6,000	$ 70,000	$ 20,000	$ 20,000
Total O&M - All Secondary Plants	3.3, 3.26	$120,000	$370,000	$205,000	$205,000
Total O&M - Attached Growth/ Moderate Sludge Handling	3.6	---	---	$180,000	---
O&M - Sludge Handling Treatment	3.27	$ 11,000	$195,000	$ 56,000	$ 56,000
Staff Size	3.29, 3.33	4	10	6	6

TABLE 4.2

EXAMPLE
CONVEYANCE SYSTEM ANNUAL O&M ESTIMATES

Item	Figure No.	Lower Probable Value	Highest Probable Value	Most Probable Value	Planning Estimate
Total O&M - Population	3.41	$45,000	$280,000	$100,000	$100,000
Total O&M - Length of Pipe	3.43	$30,000	$200,000	$ 80,000	---
Staff	3.45	60 hrs.	320 hrs.	150 hrs.	4 persons

* (1 Person = 40 hours)

TABLE 4.3

EXAMPLE
TOTAL ANNUAL O&M COST AND STAFFING ESTIMATES

Cost or Staffing Item	Total O&M Costs	Staffing (Persons)
Administration	$ 20,000	---
Total O&M - Plant	205,000	6
Total O&M - Sewer	100,000	4
Totals	$325,000	10

Average Per Capita O&M Costs

The treatment facility and conveyance system used in this example has an estimated total annual O&M cost of $325,000. For the assumed population of 25,000 this would result in a $13.00 per capita annual cost for total O&M of the wastewater system.

Assuming an occupancy of three persons in the typical residence, a cost of $13.00 x 3 = $39.00 annually is indicated, or $3.25 per month attributed to O&M for the wastewater control facilities. The costs of debt service and replacement should be added to these costs to estimate the total annual OM&R costs of wastewater conveyance and treatment.

The Construction Grants Program generally provides 75 percent of the funding necessary for the construction of new or improved treatment facilities. Thus, in computing the annual cost of wastewater treatment and conveyance debt service, costs should be based only on the local share of construction costs.

Table 4.4 compares the average annual residential wastewater service charge obtained from this example to those of eight metropolitan cities in the U.S. Charges for these cities were obtained from Inner City Studies prepared for EPA under Contract No. 68-01-5890. The assumption was made that an average residential unit consisted of three persons with a water usage of 330 gallons per day.

Data presented in this report should be used for planning level estimates. For analysis of cost effectiveness as required by 201 facilities plans, the CAPDET method as accepted by EPA or other more comprehensive analyses are necessary.

TABLE 4.4

WASTEWATER CHARGES FOR SELECT CITIES

Description	Total Annual Charge Per Residence
Example Problem	$ 39.00*
Atlanta, Georgia	150.00***
Baltimore, Maryland	80.00
Boston, Massachusetts	73.00
Denver, Colorado	
Flat Rate	30.00
Metered	67.00
Los Angeles, California	41.00
Memphis, Tennessee	26.00
San Diego, California	60.00**
Seattle, Washington	109.00***

*Includes total O&M costs only. No allowance for debt service, major replacement, or surcharges to commercial and industrial users.

**Flat rate charge.

***Rate for combined sewer system.

Note: All charges are in 1st Quarter 1981 dollars.

REFERENCES

1. Costly Wastewater Treatment Plants Fail to Perform as Expected, CED-81-9, General Accounting Office, U.S. Government Printing Office, Washington, D.C., November 14, 1980.

2. Analysis of Operations & Maintenance Costs for Municipal Wastewater Treatment Systems, MCD-39, U.S. Environmental Protection Agency, 430/9-77-015, Washington, D.C., February, 1978.

3. 1978 Needs Survey, Conveyance and Treatment of Municipal Wastewater, Summaries of Technical Data, FRD-2, U.S. Environmental Protection Agency, 430/9-79-002, Washington, D.C., February, 1978.

4. Construction Costs for Municipal Wastewater Treatment Plants: 1973-1978, FRD-11, U.S. Environmental Protection Agency, 430/9-80-003, Washington, D.C., April, 1980.

5. Stevens, K. B., Performance and Operation and Maintenance Costs of POTW's in New York State, New York State Department of Environmental Conservation, Albany, N.Y., December 31, 1979.

6. A Guide to the Selection of Cost-Effective Wastewater Treatment Systems, U.S. Environmental Protection Agency, 430/9-75-002, Washington, D.C., July, 1978.

7. "Costs and Manpower for Municipal Wastewater Treatment Plant Operation and Maintenance, 1965-1968," Journal Water Pollution Control Federation, Vol. 42, November, 1970.

8. Design of Wastewater Treatment Facilities, CAPDET, Program Users Guide, U.S. Department of the Army, Engineer Manual No. 1110-2-501, Washington, D.C., July 31, 1980.

9. Estimating Staffing for Municipal Wastewater Treatment Facilities, U.S. Environmental Protection Agency, 68/01-0328, Washington, D.C., March 1973.

10. Administrative Review of the ABC Certification System, Project Report, Grant No. T900589010, U.S. Environmental Protection Agency, Washington, D.C., August, 1977.

APPENDIX A

LIST OF WASTEWATER CONTROL FACILITIES IN THE DATA BASE

The following pages contain a listing of the wastewater treatment facilities and conveyance systems which were used to obtain the data base for this report. The listing is presented in two sections. Treatment plants are listed first, followed by conveyance systems. All are listed alphabetically by State and by city within the State. Included for both listings are the facility name and service population. For treatment facilities, the design flow and ABC rating score are shown also. The total length of gravity sewers and force main is given for the conveyance systems.

TABLE A.1

LIST OF WASTEWATER TREATMENT PLANTS

CITY	STATE	FACILITY NAME	SERVICE POPULATION	DESIGN FLOW IN M.G.D.	ABC RATING
ALBERTVILLE	ALABAMA	WESTSIDE TP	9000	2.00	44
ALBERTVILLE	ALABAMA	EASTSIDE STP	6000	6.00	52
FLORENCE	ALABAMA	CYPRESS CK WWTP	32000	10.00	62
GADSDEN	ALABAMA	WEST RIVER STP	46589	6.50	62
HUNTSVILLE	ALABAMA	HUNTSVILLE WTP 1A	150000	20.00	65
HUNTSVILLE	ALABAMA	HUNTSVILLE WTP 1	150000	10.00	70
JASPER	ALABAMA	TOWN CREEK STP	10000	3.05	53
MONROVILLE	ALABAMA	DOUBLE BRANCH TP	1750	2.00	48
MONROVILLE	ALABAMA	HUDSON BRANCH TP	3500	2.80	48
OXFORD	ALABAMA	CHOCCOLOCCO CREEK	60000	8.00	67
OZARK	ALABAMA	OZARK WTP A	7500	1.00	43
PHENIX CITY	ALABAMA	PHENIX CITY WTP	26490	4.50	64
TALLEDEGA	ALABAMA	MAIN STP	13600	4.50	53
FAYETTEVILLE	ARKANSAS	FAYETTEVILLE WWTP	35000	10.00	78
FORT SMITH	ARKANSAS	P STREET WPCP	22800	10.00	0
HARRISON	ARKANSAS	HARRISON WWTP	7000	3.00	52
HOT SPRINGS	ARKANSAS	HOT SPRINGS WWTP	31500	12.00	103
HUNTSVILLE	ARKANSAS	HUNTSVILLE WWTP	1300	0.28	57
PRAIRIE GROVE	ARKANSAS	PRAIRIE GROVE WWTP	1687	0.50	57
ROGERS	ARKANSAS	ROGERS WWTP	12000	4.00	77
RUSSELVILLE	ARKANSAS	RUSSELVILLE WWTP	14000	4.22	59
SPRINGDALE	ARKANSAS	SPRINGDALE WWTP	25000	16.00	77
WEST FORK	ARKANSAS	WEST FORK WWTP	1000	0.10	55
YELLEVILLE	ARKANSAS	YELLEVILLE WWTP	1031	0.30	38
ANDERSON	CALIFORNIA	ANDERSON WPCP	6500	1.00	48
BANNING	CALIFORNIA	BANNING STP	13500	1.31	43
BARSTOW	CALIFORNIA	BARSTOW STP	17590	5.10	50
BURBANK	CALIFORNIA	BURBANK WRP	83781	9.00	63
CALABASAS	CALIFORNIA	TAPIA WRF	45000	8.00	70
CAMARILLO	CALIFORNIA	CAMARILLO W.REC.PL	27000	4.80	80
CARMEL	CALIFORNIA	CARMEL STP	19950	2.40	66
CHICO	CALIFORNIA	CHICO WPCP	28000	5.00	69
CORONA	CALIFORNIA	CORONA WRF	58000	5.50	67
CRESCENT CITY	CALIFORNIA	CRESCENT CITY WPQF	3000	1.89	58
DALY CITY	CALIFORNIA	N SAN MATEO C SD	80000	8.00	80
EL MONTE	CALIFORNIA	WHITTIER NARROWS T	140000	15.00	73
ESCONDIDO	CALIFORNIA	ESCONDIDO STP	100000	11.00	82
FREMONT	CALIFORNIA	IRVINGTON WPCP	66468	10.00	69
HEALDSBURG	CALIFORNIA	HEALDSBURG TRT. FA	6000	1.00	39
INDIO	CALIFORNIA	VALLEY STP	44765	5.00	73
LIVERMORE	CALIFORNIA	LIVERMORE WWTP	50000	5.00	85
MERCED	CALIFORNIA	MERCED STP	35000	10.00	84
MILL VALLEY	CALIFORNIA	MILL VALLEY WWTP	19500	1.50	80
MILLBRAE	CALIFORNIA	MILLBRAE WWTP	21000	3.00	71
NEWARK	CALIFORNIA	NEWARK WPCP	93813	7.00	69
NORTH HIGHLANDS	CALIFORNIA	DIST. NO. 6 TP	30000	3.00	32
NOVATO	CALIFORNIA	IGNACIO PLANT	17400	1.20	67
NOVATO	CALIFORNIA	NOVATO PLANT	17400	3.00	52
OROVILLE	CALIFORNIA	OROVILLE WWTP	25000	5.30	61
PINOLE	CALIFORNIA	PINOLE WWTP	15000	2.00	83

CITY	STATE	FACILITY NAME	SERVICE POPULATION	DESIGN FLOW IN M.G.D.	ABC RATING
PLACERVILLE	CALIFORNIA	PLACERVILLE WWTP	6736	1.60	75
PLEASANTON	CALIFORNIA	PLEASANTON STP	17000	1.70	78
POMONA	CALIFORNIA	POMONA STP	74000	10.00	63
RED BLUFF	CALIFORNIA	RED BLUFF W RECL P	9200	1.90	66
RICHMOND	CALIFORNIA	MUNICIPAL SD #1	65000	16.00	90
RIO DELL	CALIFORNIA	RIO DELL WWTP	2800	0.33	58
RIO LINDA	CALIFORNIA	RIO LINDA TP	5600	0.60	55
S SAN FRANCISCO	CALIFORNIA	S SAN FRANCISCO ST	82000	13.00	90
SAN BERNARDINO	CALIFORNIA	SAN BERNARDINO STP	172200	28.00	75
SAN LORENZO	CALIFORNIA	ORO LOMA WWTP	140000	20.00	103
SAN RAFAEL	CALIFORNIA	SAN RAFAEL MAIN TP	32000	5.00	75
SANTA BARBARA	CALIFORNIA	SANTA BARBARA STP	85000	11.00	79
SANTA PAULA	CALIFORNIA	SANTA PAULA WW R F	18600	2.40	53
SAUGUS (D. 26)	CALIFORNIA	SAUGUS-NEWHALL WRP	40500	5.00	76
STOCKTON	CALIFORNIA	STOCKTON WWCF	138000	67.00	149
SUNNYVALE	CALIFORNIA	SUNNYVALE STP	106400	22.50	109
THOUSAND OAKS	CALIFORNIA	HILL CANYON STP	82000	10.00	93
THOUSAND OAKS	CALIFORNIA	HILL CANYON TP	69500	10.00	73
TURLOCK	CALIFORNIA	TURLOCK WQCF	400000	15.50	131
UKIAH	CALIFORNIA	UKIAH STP	14500	2.50	58
UNION CITY	CALIFORNIA	ALVARADO WPCP	50006	4.50	74
VALENCIA	CALIFORNIA	VALENCIA STP	38500	6.00	86
VENTURA	CALIFORNIA	VENTURA WATER RENO	69700	14.00	101
VENTURA	CALIFORNIA	OAK VIEW STP	16000	3.00	71
WEST SACRAMENTO	CALIFORNIA	W SACRAMENT WWTP	25000	5.00	70
WHITTIER	CALIFORNIA	SAUGUS STP	40000	5.00	64
WHITTIER	CALIFORNIA	LOS COYOTES STP	190000	37.50	73
WINDSOR	CALIFORNIA	WINDSOR WWTP	5200	0.75	40
ARVADA	COLORADO	CLEAR CREEK VAL. S	10000	2.10	68
ASPEN	COLORADO	ASPEN METRO WWTP	3500	2.00	53
ASPEN	COLORADO	ASPEN WWTP	1430	0.50	50
AVON	COLORADO	AVON STP	15000	2.00	46
BERTHOUD	COLORADO	BERTHOUD STP	3100	0.90	40
BOULDER	COLORADO	75TH ST WWTP	57904	15.60	70
BRIGHTON	COLORADO	BRIGHTON WPCP	16000	1.80	51
CANON CITY	COLORADO	CANON CITY METRO T	10000	2.50	46
CARBONDALE	COLORADO	CARBONDALE WWTP	2800	0.50	46
COLORADO SPRING	COLORADO	COLORADO SPRINGS T	220000	30.00	105
COMMERCE CITY	COLORADO	SOUTH ADAMS CO STP	27000	3.00	40
CORTEZ	COLORADO	CORTEZ NORTH WWTP	1875	0.42	41
DENVER	COLORADO	S. LAKEWOOD STP	17000	2.30	46
DILLON	COLORADO	BLUE RIVER STP	4000	2.00	60
DURANGO	COLORADO	DURANGO STP	12000	2.50	55
EATON	COLORADO	EATON WWTP	2200	0.34	40
ENGLEWOOD	COLORADO	ENGLEWOOD/LITTLETO	180000	20.00	82
ESTES PARK	COLORADO	UPPER THOMPSON SD	12000	1.50	87
ESTES PARK	COLORADO	ESTES PARK STP	2500	0.80	43
EVERGREEN	COLORADO	EVERGREEN WWTP	4550	1.00	65
FRISCO	COLORADO	FRISCO SD WWTP	2000	0.75	53
FT. COLLINS	COLORADO	WWTP #2	35000	4.80	63

CITY	STATE	FACILITY NAME	SERVICE POPULATION	DESIGN FLOW IN M.G.D.	ABC RATING
FT. COLLINS	COLORADO	WWTP #1	35000	4.60	59
GLENWOOD SPRING	COLORADO	GLENWOOD SPRINGS	7350	1.20	48
IDAHO SPRINGS	COLORADO	IDAHO SPRINGS WWTP	3000	0.35	50
LAFAYETTE	COLORADO	LAFAYETTE STP	9500	0.36	48
LONGMONT	COLORADO	LONGMONT STP	45000	8.30	97
LONGMONT	COLORADO	LONGMONT STP	37000	5.30	66
LOUISVILLE	COLORADO	LOUISVILLE STP	5700	1.00	41
LOVELAND	COLORADO	LOVELAND WWTP#1	35000	7.70	83
MEEKER	COLORADO	MEEKER SD	2350	0.40	57
MONTROSE	COLORADO	MONTROSE WWTP	8500	0.85	54
MORRISON	COLORADO	MORRISON STP	413	0.07	27
PUEBLO	COLORADO	PUEBLO STP	104000	17.00	75
SALIDA	COLORADO	SALIDA STP	6000	0.80	50
TRINIDAD	COLORADO	TRINIDAD STP	10000	1.80	51
WESTMINSTER	COLORADO	BIG DRY CK STP	10000	1.40	74
ENFIELD	CONNECTICUT	ENFIELD WPCP	48000	10.00	72
FAIRFIELD	CONNECTICUT	FAIRFIELD WPCF	46000	9.00	79
GROTON	CONNECTICUT	CITY OF GROTON PAF	15000	3.10	68
LITCHFIELD	CONNECTICUT	TWN OF LITCHFIELD	5700	0.80	57
MANCHESTER	CONNECTICUT	MANCHESTER STP	46600	6.75	78
NAUGATUK	CONNECTICUT	NAUGATUK TRMT CO.	30000	10.30	71
SALISBURY	CONNECTICUT	TWN SALISBURY WWTF	2400	0.68	45
SEYMOUR	CONNECTICUT	SEYMOUR WPCF	10000	1.00	68
STAMFORD	CONNECTICUT	STAMFORD WPCF	90000	20.00	104
TORRINGTON	CONNECTICUT	TORRINGTON WPCF	28500	7.00	88
WAREHOUSE PT	CONNECTICUT	EAST WINDSOR WPCA	2400	0.80	75
WEST HAVEN	CONNECTICUT	WEST HAVEN WPCP	52000	12.50	91
WILLIMANTIC	CONNECTICUT	WILLIMANTIC WWTP	20000	5.50	70
DELAWARE CITY	DELAWARE	DELAWARE CITY WWTP	2600	0.50	62
GEORGETOWN	DELAWARE	GEORGETOWN STP	3000	0.27	34
HARRINGTON	DELAWARE	HARRINGTON STP	2500	0.60	40
MIDDLETOWN	DELAWARE	MIDDLETOWN STP	2900	0.40	53
BOCA RATON	FLORIDA	BOCA RATON STP	35000	10.00	56
COCOA	FLORIDA	COCOA STP	15025	2.00	55
DAYTONA	FLORIDA	BETHUNE STP	100000	10.00	70
FT.PIERCE	FLORIDA	FT.PIERCE CITY WWT	33000	5.00	61
GOULDS	FLORIDA	GOULDS STP	20000	6.00	65
HOLLY HILL	FLORIDA	HOLLY HILL STP	10000	1.30	55
HOMESTEAD	FLORIDA	HOMESTEAD STP	10000	2.30	74
JACKSON. BEACH	FLORIDA	JACKSON. BEACH STP	17700	3.00	42
KISSIMMEE	FLORIDA	KISSIMMEE 192 STP	12000	1.70	57
KISSIMMEE	FLORIDA	KISS.MILL SLOUGH W	5000	1.00	44
MELBOURNE	FLORIDA	GRANT ST STP	21225	2.50	65
MIAMI	FLORIDA	VIRGINIA KEYS STP	400000	70.00	65
PENSACOLA	FLORIDA	MONTCLAIR PLANT ST	8586	1.10	54
ST. AUGUSTINE	FLORIDA	ST. AUGUSTINE PL.#	15700	3.00	53
ST.PETERSBURG	FLORIDA	NORTHEAST STP #2	44700	8.00	75
TALLAHASSEE	FLORIDA	SOUTHWEST STP	80000	8.80	93
TARPON SPRINGS	FLORIDA	TARPON SPRINGS STP	15000	1.30	59
TITUSVILLE	FLORIDA	SOUTH STP	10000	2.00	39

CITY	STATE	FACILITY NAME	SERVICE POPULATION	DESIGN FLOW IN M.G.D.	ABC RATING
AMERICUS	GEORGIA	MUCKALEE CREEK WPC	13500	2.00	53
ATHENS	GEORGIA	NORTH OCONEE WPC 1	0	5.00	70
ATHENS	GEORGIA	NORTH OCONEE WPC 2	0	2.00	62
BRUNSWICK	GEORGIA	BRUNSWICK WPCP	35000	10.00	71
CARROLLTON	GEORGIA	CARROLLTON WWTP	0	5.00	69
CHICKAMAUGA	GEORGIA	CHICKAMAUGA WW PLT	760	5.20	47
COLLEGE PARK	GEORGIA	FLINT RIVER WPC	0	6.00	73
COLLEGE PARK	GEORGIA	SOUTHEAST WPC PLAN	3138	1.20	47
COVINGTON	GEORGIA	COVINGTON WWTP	10000	3.00	43
DOUGLAS	GEORGIA	DOUGLAS WPCP SE	10500	5.00	46
LAGRANGE	GEORGIA	BLUE JOHN MUNICIPA	15000	3.50	56
LILBURN	GEORGIA	JACKSON CREEK WPC	0	2.40	61
ST. SIMONS ISLA	GEORGIA	ST. SIMONS ISLAND	8700	1.00	56
SUMMERVILLE	GEORGIA	SUMMERVILLE WWTP	1363	2.00	50
THOMASVILLE	GEORGIA	THOMASVILLE WPCP	19095	4.00	57
ABERDEEN	IDAHO	ABERDEEN STP	1640	0.60	54
BOISE	IDAHO	BOISE WEST STP	26830	5.00	55
BOISE	IDAHO	LANDER STREET STP	78880	15.00	90
IDAHO FALLS	IDAHO	IDAHO FALLS STP	50000	14.00	83
JEROME	IDAHO	JEROME WWTP	6800	0.72	57
MERIDIAN	IDAHO	MERIDIAN STP	6654	2.82	65
SODA SPRINGS	IDAHO	SODA SPRINGS WWTP	4051	1.50	63
TWIN FALLS	IDAHO	TWIN FALLS STP	25000	8.00	88
MILLEDGEVILLE	ILLINOIS	MILLEDGEVILLE STP	6500	0.50	58
MT.CARROLL	ILLINOIS	MT.CARROLL STP	2100	0.31	44
VIRDEN	ILLINOIS	VIRDEN NORTH STP	1750	0.20	46
WHEATON	ILLINOIS	WHEATON WWTF	53000	8.90	87
YORKVILLE	ILLINOIS	YORKVILLE-BRISTOL	4000	2.10	65
AKRON	IOWA	AKRON WWTP	1400	0.15	47
ANKENY	IOWA	WESTWOOD PLANT #4	4590	0.46	28
ANKENY	IOWA	WEST PLANT #2	10000	0.28	26
ANKENY	IOWA	SOUTHEAST PLANT #3	12000	1.20	48
BEDFORD	IOWA	BEDFORD STP	1700	0.40	31
CAMANCHE	IOWA	CAMANCHE WWTP	4200	0.60	43
CEDAR FALLS	IOWA	CEDAR FALLS WWTP	35472	4.86	55
CHEROKEE	IOWA	CHEROKEE WWTP	7500	0.94	54
CORALVILLE	IOWA	CORALVILLE WWTP	6928	1.75	51
EMMETSBURG	IOWA	EMMETSBURG STP	4450	0.72	67
ESTHERVILLE	IOWA	ESTHERVILLE WWTP	8108	3.20	72
FORT DODGE	IOWA	FORT DODGE WPCP	28000	4.50	59
GRIMES	IOWA	GRIMES WWTP	1985	0.35	62
GRINNELL	IOWA	GRINNELL WWTP	8600	1.10	44
HOPKINTON	IOWA	HOPKINTON WWTP	800	0.20	46
INDIANOLA	IOWA	INDIANOLA N. WWTP	8000	1.50	75
INDIANOLA	IOWA	INDIANOLA S. WWTP	3000	0.65	59
IOWA CITY	IOWA	IOWA CITY WPCP	50000	8.00	47
MARSHALLTOWN	IOWA	MARSHALLTOWN WPCP	26000	5.50	60
MARSHALLTOWN	IOWA	MARSHALLTOWN WPCP	26000	5.50	76
NEWTON	IOWA	NEWTON NW WWTP	3141	0.22	28
NEWTON	IOWA	NEWTON SOUTH WWTP	6898	3.10	37

CITY	STATE	FACILITY NAME	SERVICE POPULATION	DESIGN FLOW IN M.G.D.	ABC RATING
NEWTON	IOWA	NEWTON SW WWTP	4145	0.50	18
OSKALOOSA	IOWA	OSKALOOSA SW WWTP	11000	0.81	47
REINBECK	IOWA	REINBECK WWTP	1711	0.27	41
REINBECK	IOWA	REINBECK WWTP	1800	0.28	37
WATERLOO	IOWA	WATERLOO WPCP	75000	20.35	96
ANTHONY	KANSAS	ANTHONY WWTP	2771	1.00	31
COLWICH	KANSAS	COLWICH STP	1000	0.12	42
DE SOTO	KANSAS	DE SOTO WWTP	2000	0.40	26
EMPORIA	KANSAS	EMPORIA WWTP	30000	4.00	48
LAWRENCE	KANSAS	LAWRENCE WWTP	54000	9.00	67
LAWRENCE	KANSAS	LAWRENCE WWTP	50000	9.00	85
LENEXA	KANSAS	LENEXA WWTP	10000	2.00	29
MANHATTAN	KANSAS	MANHATTAN WWTP	40000	6.20	56
NEWTON	KANSAS	NEWTON WWTP	17000	2.82	42
TOPEKA	KANSAS	OAKLAND WWTP	150000	20.00	66
WICHITA	KANSAS	WICHITA WWTP 1&2	300000	40.00	65
CADIZ	KENTUCKY	CADIZ STP	2200	0.32	53
GLASGOW	KENTUCKY	GLASGOW MSTP	12000	4.00	110
HOPKINSVILLE	KENTUCKY	HOPKINSVILLE N STP	29000	1.74	68
LEBANON	KENTUCKY	LEBANON MSTP	6350	1.00	58
LEXINGTON	KENTUCKY	TOWN BRANCH STP	79750	18.00	115
LOUISVILLE	KENTUCKY	OKOLONA STP	21700	2.60	52
LOUISVILLE	KENTUCKY	HITE CREEK WWTP	3504	2.19	69
MAYFIELD	KENTUCKY	MAYFIELD WWTP	11356	2.30	56
MT WASHINGTON	KENTUCKY	MT WASHINGTON WPCF	3080	0.40	41
MURRAY	KENTUCKY	MURRAY WWTP	19040	2.50	66
NICHOLASVILLE	KENTUCKY	W HICKMAN STP	36841	8.75	84
NICHOLASVILLE	KENTUCKY	W HICKMAN WWTP	36841	8.75	84
RUSSELLVILLE	KENTUCKY	RUSSELLVILLE STP	9394	1.20	60
ALEXANDRIA	LOUISIANA	ALEXANDRIA WWTF	53000	14.00	53
BOGALUSA	LOUISIANA	BOGALUSA WWTP	18412	6.00	69
BUNKIE	LOUISIANA	BUNKIE WWTP	5500	1.00	43
KENNER	LOUISIANA	PLANT 1 BIOFILTER	19000	2.50	51
KENNER	LOUISIANA	PLANT 1 ACT.SLUDGE	9500	1.25	47
KENNER	LOUISIANA	PLANT 2	38000	5.00	54
LAFAYETTE	LOUISIANA	LAFAYETTE SOUTH ST	66051	5.22	65
LAFAYETTE	LOUISIANA	LAFAYETTE EAST WWT	23638	2.03	63
NEW ORLEANS	LOUISIANA	WEST BANK STP	52340	10.00	77
PORT ALLEN	LOUISIANA	PORT ALLEN STP	8000	1.00	34
RUSTON	LOUISIANA	NORTHSIDE STP	15000	4.00	49
SHREVEPORT	LOUISIANA	LUCAS WWTP	215000	24.00	91
ACCOKEEK	MARYLAND	PISCATAWAY WWTP	104000	15.00	96
ANNAPOLIS	MARYLAND	BROADNECK WWTP	16500	4.00	59
ANNAPOLIS	MARYLAND	ANNAPOLIS WWTP	50000	10.00	77
ANNAPOLIS	MARYLAND	BROADCREEK WWTP	567	0.75	35
BOWIE	MARYLAND	BOWIE-BELAIR WWTP	32500	2.65	73
CAMBRIDGE	MARYLAND	CAMBRIDGE WWTP	13000	8.10	91
CHURCHTOWN	MARYLAND	BROADWATER WWTP	0	2.00	58
CROFTON	MARYLAND	PUTUXENT WWTP	25000	4.00	53
HAGERSTOWN	MARYLAND	HAGERSTOWN	35800	8.00	87

CITY	STATE	FACILITY NAME	SERVICE POPULATION	DESIGN FLOW IN M.G.D.	ABC RATING
LAUREL	MARYLAND	PARKWAY WWTP	33800	7.50	93
MANCHESTER	MARYLAND	MANCHESTER STP	1500	0.25	48
MARYLAND CITY	MARYLAND	MARYLAND CITY	3960	0.75	44
MAYO	MARYLAND	WOODLAND BEACH WWT	5580	0.75	34
RIVA	MARYLAND	SYLVAN SHORES WWTP	1000	0.25	32
RIVIERA BEACH	MARYLAND	COX CREEK WWTP	65000	8.50	72
THURMONT	MARYLAND	THURMONT STP	3000	0.50	39
UPPER MARLBORO	MARYLAND	WESTERN BRANCH WWT	75400	15.00	111
ADAMS	MASSACHUSETTS	ADAMS WWTP	11000	10.20	69
AMESBURY	MASSACHUSETTS	AMESBURY WWTP	12500	1.90	56
BELLERICA	MASSACHUSETTS	BELLERICA WWTP	12000	1.60	49
EAST DOUGLAS	MASSACHUSETTS	DOUGLAS WWTP	2100	0.18	42
FITCHBURG	MASSACHUSETTS	EAST FITCHBURG WWT	40000	12.40	110
GREAT BARRINGTO	MASSACHUSETTS	GREAT BARRINGTON T	7500	3.20	58
MANCHESTER	MASSACHUSETTS	MANCHESTER WWTP	3500	0.67	43
MEDFIELD	MASSACHUSETTS	MEDFIELD WWTP	2000	1.50	57
MILLBURY	MASSACHUSETTS	MILLBURY WPC PLANT	6000	0.90	62
ROCKPORT	MASSACHUSETTS	ROCKPORT WWTP	4500	0.80	37
SHREWSBURY	MASSACHUSETTS	SHREWSBURY WPCP	11630	1.30	44
WAREHAM	MASSACHUSETTS	WAREHAM WWTF	3500	1.80	65
WESTBOROUGH	MASSACHUSETTS	WESTBOROUGH WWTF	7500	1.10	60
FLINT	MICHIGAN	ANTHONY RAGNONE WT	200000	20.00	119
FRANKENMUTH	MICHIGAN	FRANKENMUTH WWTP	3800	1.21	79
GRANDVILLE	MICHIGAN	GRANDVILLE WWTP	18000	3.20	70
HASTINGS	MICHIGAN	HASTINGS WWTP	6500	1.00	68
IONIA	MICHIGAN	IONIA WWTP	12000	4.00	74
PETERSBURG	MICHIGAN	PETERSBURG WWTP	1200	0.21	36
PINCONNING	MICHIGAN	PINCONNING WWTP	1500	1.00	68
PORT HURON	MICHIGAN	PORT HURON WWTP	55000	20.00	113
TRAVERSE CITY	MICHIGAN	TRAVERSECITY WWTP	21000	8.50	73
TRENTON	MICHIGAN	TRENTON WWTP	25000	5.50	97
WARREN	MICHIGAN	WARREN WWTP	167000	36.00	117
WYOMING	MICHIGAN	WYOMING WWTP	100000	19.00	83
ZEELAND	MICHIGAN	ZEELAND WWTP	5200	1.10	61
ALEXANDRIA	MINNESOTA	ALEXANDRIA WWTP	12000	2.55	64
AUSTIN	MINNESOTA	AUSTIN WWTP	26000	6.90	83
DETROIT LAKES	MINNESOTA	DETROIT LAKES WWTP	7500	1.44	77
EAGAN	MINNESOTA	SENECA WWTP	135000	24.00	93
ELK RIVER	MINNESOTA	ELK RIVER WWTP	2400	1.04	49
FARIBAULT	MINNESOTA	FARIBAULT WPCP	16000	3.50	69
MANKATO	MINNESOTA	MANKATO WWTP	45000	10.00	68
MOORHEAD	MINNESOTA	MOORHEAD WWTP	5000	4.50	79
NORTHFIELD	MINNESOTA	NORTHFIELD MUN WWT	12783	1.65	65
ROCHESTER	MINNESOTA	ROCHESTER STP	70000	12.50	80
SHAKOPEE	MINNESOTA	BLUE LAKE WWTP	120000	20.00	61
TWO HARBORS	MINNESOTA	TWO HARBORS WWTP	4437	1.20	80
WILLMAR	MINNESOTA	WILLMAR WWTP	20000	2.50	66
WINONA	MINNESOTA	WINONA WWCP	25000	6.50	58
CLARKSDALE	MISSISSIPPI	CLARKSDALE STP	21500	4.50	54
GREENVILLE	MISSISSIPPI	GREENVILLE STP	55000	20.00	64

CITY	STATE	FACILITY NAME	SERVICE POPULATION	DESIGN FLOW IN M.G.D.	ABC RATING
OXFORD	MISSISSIPPI	OXFORD STP	30000	3.50	58
PICAYUNE	MISSISSIPPI	PICAYUNE STP	12000	3.00	62
VICKSBURG	MISSISSIPPI	VICKSBURG WWTP	30000	7.50	67
BELTON	MISSOURI	BELTON WWTP	5250	1.00	52
BOLIVAR	MISSOURI	BOLIVAR WWTP	6200	0.98	39
CAPE GIRARDEAU	MISSOURI	CAPE GIRARDEAU STP	30000	7.00	52
COLUMBIA	MISSOURI	PLANT #1	11000	2.00	49
FLORISSANT	MISSOURI	COLDWATER CREEK ST	185000	25.00	80
KANSAS CITY	MISSOURI	BIRMINGHAM WWTP	50000	4.00	43
KANSAS CITY	MISSOURI	TODD CK. STP	6000	2.00	43
KANSAS CITY	MISSOURI	PLATTE CO. STP	7000	1.00	44
KIRKSVILLE	MISSOURI	KIRKSVILLE WWTP	17000	5.00	75
LICKING	MISSOURI	NORTHWEST STP	1900	0.25	49
MARSHALL	MISSOURI	SOUTHEAST WWTP	12799	3.88	47
MARSHALL	MISSOURI	SOUTHEAST STP	15000	3.90	55
MARSHFIELD	MISSOURI	MARSHFIELD WWTF	3800	1.00	31
MARSHFIELD	MISSOURI	MARSHFIELD WWTP	4200	1.00	40
MEXICO	MISSOURI	MEXICO STP	11500	1.90	49
MEXICO	MISSOURI	MEXICO STP	13000	2.40	51
MOBERLY	MISSOURI	EAST STP	10000	1.70	49
SAINT CHARLES	MISSOURI	MISSISSIPPI RIVER	40000	5.50	80
SALEM	MISSOURI	SALEM STP	4300	0.80	32
SEDALIA	MISSOURI	SEDALIA STP	24000	2.50	53
SPRINGFIELD	MISSOURI	N.W. STP	15000	3.50	58
ST CHARLES	MISSOURI	MISS.RIVER PLANT	30000	5.50	93
ST. CHARLES	MISSOURI	MISSISSIPPI R. STP	29000	5.50	84
ST. LOUIS	MISSOURI	COLDWATER CK. STP	225000	25.00	80
COLUMBIA FALLS	MONTANA	COLUMBIA FALLS WWT	2100	0.50	53
HELENA	MONTANA	HELENA WWTP	23800	6.00	67
BELLEVUE	NEBRASKA	BELLEVUE WWTP	10500	1.90	64
COLUMBUS	NEBRASKA	COLUMBUS WWTP	18000	2.60	39
CRETE	NEBRASKA	CRETE WWTP	4500	1.05	60
FALLS CITY	NEBRASKA	FALLS CITY WWTP	5440	1.00	33
FREMONT	NEBRASKA	FREMONT WWTP	26000	10.50	73
GIBBON	NEBRASKA	GIBBON WWTP	1500	1.14	47
GRAND ISLAND	NEBRASKA	GRAND ISLAND WPCP	32000	5.80	60
HASTINGS	NEBRASKA	HASTINGS WPCP	25000	3.00	47
KEARNEY	NEBRASKA	KEARNEY WWTP	30000	3.00	43
LINCOLN	NEBRASKA	THERESA ST WWTR	180000	30.00	88
NEWMAN GROVE	NEBRASKA	NEWMAN GROVE WWTP	863	0.14	44
SUPERIOR	NEBRASKA	SUPERIOR WWTP	3512	1.57	58
WEST POINT	NEBRASKA	WEST POINT WWTP	3600	0.58	43
YORK	NEBRASKA	YORK WWTP	7500	3.00	69
BELFORD	NEW JERSEY	TWP MIDDLETON WWTP	65000	6.50	71
BIRMINGHAM	NEW JERSEY	PEMBERTON TWP WWTP	14000	2.50	75
BRICK TOWN	NEW JERSEY	NORTHERN WPCF	126973	28.00	86
BRIDGEPORT	NEW JERSEY	LOGAN TWP WWTP	2300	1.00	47
BRIDGEWATER	NEW JERSEY	SOM BAR VAL WWTP	80000	10.00	97
EAST WINDSOR	NEW JERSEY	E WINDSOR MUA WWTP	22000	2.23	72
ELIZABETH	NEW JERSEY	JOINT MEETING WWTF	500000	75.00	76

CITY	STATE	FACILITY NAME	SERVICE POPULATION	DESIGN FLOW IN M.G.D.	ABC RATING
HACKETTSTOWN	NEW JERSEY	HACKETTSTOWN MUA W	13600	1.65	53
LAMBERTVILLE	NEW JERSEY	LAMBERTVILLE STP	7000	0.65	57
LARENCEVILLE	NEW JERSEY	EWING-LAWRENCE WWT	65000	9.00	86
LONG BRANCH	NEW JERSEY	LONG BRANCH WWTP	34000	5.40	84
LONG VALLEY	NEW JERSEY	SCHOOLEYS MTN WWTP	2412	0.50	45
MARLTON	NEW JERSEY	WOODSTREAM WTP	10000	1.25	38
MARLTON	NEW JERSEY	ELMWOOD WTP	10000	1.50	46
MATAWAN	NEW JERSEY	STRATHMOORE STP	10020	0.80	34
MATAWAN	NEW JERSEY	CLIFFWOOD BEACH ST	6000	0.75	37
MATAWAN	NEW JERSEY	RIVER GARDENS STP	1400	0.10	36
MEDFORD	NEW JERSEY	MEDFORD TWP WWTP	15500	1.30	59
NEPTUNE	NEW JERSEY	TWP OF NEPTUNE WWT	85000	8.50	62
OAKHURST	NEW JERSEY	TWP OF OCEAN WWTP	35000	3.60	71
ORTLEY BEACH	NEW JERSEY	ORTLEY BEACH PLANT	60000	12.00	72
RAHWAY	NEW JERSEY	RAHWAY VALLY WWTP	215000	35.00	88
SAYREVILLE	NEW JERSEY	MIDDLESEX CO WWTP	600000	120.00	85
WEST CREEK	NEW JERSEY	SOUTHERN WPCF	88550	20.00	74
WILLINGBORO	NEW JERSEY	WILLINGBORO MUN PL	56450	4.20	74
LAS VEGAS	NEW MEXICO	LAS VEGAS EAST STP	8000	0.85	46
LAS VEGAS	NEW MEXICO	LAS VEGAS WEST STP	6000	0.35	46
RATON	NEW MEXICO	RATON STP	9000	1.20	49
SANTA FE	NEW MEXICO	SILER ROAD STP	14850	2.70	45
SANTA FE	NEW MEXICO	AIRPORT ROAD STP	29700	3.00	53
TAOS	NEW MEXICO	TAOS STP	3000	0.40	46
HARRIMAN-MONROE	NEW YORK	ORANGE CO SD 1 STP	9200	2.00	67
MANLIUS	NEW YORK	MEADOWBROOK-LIMEST	32192	7.00	64
ORANGEBURG	NEW YORK	ROCKLAND COUNTY ST	145000	10.00	98
ALFRED	NEW YORK	ALFRED WWTP	8500	1.00	57
APALACHIN	NEW YORK	OWEGO WPCP # 2	7500	2.00	58
AVON	NEW YORK	AVON WWTP	11410	2.75	57
BATAVIA	NEW YORK	BATAVIA WPCP	19500	2.50	61
BATH	NEW YORK	BATH WWTP	6530	1.00	51
BAY PARK	NEW YORK	NASSAU COUNTY SD#2	556000	60.00	178
BEACON	NEW YORK	BEACON STP	13800	6.00	87
CANISTEO	NEW YORK	CANISTEO STP	2772	0.40	44
CANTON	NEW YORK	CANTON WPCP	10000	2.00	66
CAPE VINCENT	NEW YORK	CAPE VINCENT STP	1500	0.14	46
CARMEL	NEW YORK	CARMEL STP	3000	0.35	33
CAYUGA HEIGHTS	NEW YORK	CAYUGA HTS WWTP	11000	2.00	72
CAYUGA HGTS	NEW YORK	CAYUGA HGTS WPCP	8000	2.00	63
CEDAR HILL	NEW YORK	BETHLEHEM WWTP	18000	4.90	59
CEDARHURST	NEW YORK	CEDARHURST WPCP	8200	1.00	52
CHEEKTOWAGA	NEW YORK	CHEEKTOWAGA SD #5	80000	7.50	67
E.ROCKAWAY	NEW YORK	BAY PARK STP	558400	60.00	70
ELMIRA	NEW YORK	CHEMUNG CO SD #1	4970	4.80	60
ENDICOTT	NEW YORK	ENDICOTT STP	49000	10.00	77
FLORIDA	NEW YORK	FLORIDA WWTP	2000	0.30	49
FREEPORT	NEW YORK	FREEPORT STP	42000	4.00	61
GOSHEN	NEW YORK	GOSHEN STP	8000	1.50	53
GREAT NECK	NEW YORK	BELGRAVE WWTP	13000	1.50	51

CITY	STATE	FACILITY NAME	SERVICE POPULATION	DESIGN FLOW IN M.G.D.	ABC RATING
GREECE	NEW YORK	GREECE NW QUAD WWT	132000	15.00	92
HALFMOON	NEW YORK	SARATOGA CO 1 WWTP	54263	13.00	84
HOLCOMB	NEW YORK	HOLCOMB STP	1421	0.23	62
LIVONIA	NEW YORK	CONESUS LAKE SD	4800	1.27	65
LONG BEACH	NEW YORK	LONG BEACH WPCP	35000	6.36	62
LYONS	NEW YORK	LYONS STP	4300	0.75	62
MANLIUS	NEW YORK	MEADOWBROOKLIMESTO	25900	7.00	55
NEWBURGH	NEW YORK	GIDNEYTOWN STP	1200	0.12	56
NEWBURGH	NEW YORK	GOLDEN PARK STP	615	0.20	44
NEWBURGH	NEW YORK	MEADOWHILL NORTH S	1500	0.20	43
NEWFANE	NEW YORK	NEWFANE STP	4875	1.60	60
NIAGARA FALLS	NEW YORK	NIAGARA SD #1	2000	999.99	81
NORTHPORT	NEW YORK	NORTHPORT STP	2500	0.30	44
ORANGEBURG	NEW YORK	ORANGETOWN STP	70000	8.50	76
ORANGETOWN	NEW YORK	ORANGETOWN WWTP	52000	8.50	61
OYSTER BAY	NEW YORK	OYSTER BAY STP	7500	1.20	60
PENN YAN	NEW YORK	PENN YAN WWTP	5200	1.50	57
PLATTSBURGH	NEW YORK	PLATTSBURGH STP	40000	16.00	74
POLAND (TN OF)	NEW YORK	JAMESTOWN STP	40000	8.00	64
PORT WASHINGTON	NEW YORK	PORT WASHINGTON ST	30000	3.00	59
POUGHKEEPSIE	NEW YORK	ARLINGTON STP	23000	4.00	73
ROCHESTER	NEW YORK	GATES CHILI OGDEN	85800	15.00	112
SAG HARBOR	NEW YORK	SAG HARBOR WWTP	2400	0.10	47
SARANAC LAKE	NEW YORK	SARANAC LAKE WPCP	10000	3.00	66
SARANAC LAKE	NEW YORK	SARANAC LAKE STP	15300	2.00	57
SOUTH FALLSBURG	NEW YORK	SOUTH FALLSBURG ST	2500	1.20	53
SPENCERPORT	NEW YORK	SPENCERPORT WWTP	6600	1.00	50
STONY POINT	NEW YORK	STONY POINT STP	9000	1.00	46
TONAWANDA	NEW YORK	TWO MILE CREEK STP	129000	30.00	104
TRUMANSBURG	NEW YORK	TRUMANSBURG WWTP	2000	0.25	49
TULLY	NEW YORK	TULLY WPCP	1100	0.25	48
VIL OF FISHKILL	NEW YORK	FISHKILL STP	1400	0.40	47
WANTAGH	NEW YORK	CEDAR CREEK WPCP	235000	45.00	79
WAPPINGER FALLS	NEW YORK	OAKWOOD KNOLLS STP	407	0.20	46
WASHINGTONVILLE	NEW YORK	WASHINGTONVILLE ST	2000	0.40	53
WEBSTER	NEW YORK	WEBSTER WWTP	7500	2.50	52
WEST LONG BEACH	NEW YORK	WEST LONG BEACH ST	4000	1.50	51
YORKTOWN	NEW YORK	YORKTOWN HEIGHTS T	13000	1.50	86
YORKTOWN	NEW YORK	YORKTOWN,OSCEOLA S	2388	0.20	46
ORANGEBURG	NEW YORK	ROCKLAND CO SD #1	40000	10.00	78
ALBMEARLE	NORTH CAROLINA	LONG CREEK WWTP	14000	16.00	79
GASTONIA	NORTH CAROLINA	CATABA CREEK WTP	50000	9.00	67
GASTONIA	NORTH CAROLINA	LONG CREEK WTP	14000	9.00	64
GREENSBORO	NORTH CAROLINA	NORTH BUFFALO WTP	196000	18.00	99
GREENVILLE	NORTH CAROLINA	GREENVILLE WWTP	33000	8.00	60
GRIFTON	NORTH CAROLINA	CONTENTNEA M S D	8390	4.73	52
LENOIR	NORTH CAROLINA	GRANT CREEK WTP	15000	6.00	42
MAXTON	NORTH CAROLINA	MAXTON WWTP	2500	0.30	37
NEW BERN	NORTH CAROLINA	NEW BERN WWTP	18000	4.00	53
PEMBROKE	NORTH CAROLINA	PEMBROKE WWTP	4000	0.50	43

CITY	STATE	FACILITY NAME	SERVICE POPULATION	DESIGN FLOW IN M.G.D.	ABC RATING
RALEIGH	NORTH CAROLINA	NEUSE RIVER WTP	188335	30.00	96
ROCKINGHAM	NORTH CAROLINA	ROCKINGHAM WTP	10100	6.00	53
SALISBURY	NORTH CAROLINA	GRANT CREEK WWTP	10200	5.00	91
SALISBURY	NORTH CAROLINA	TOWN CREEK WWTP	10500	5.00	91
WASHINGTON	NORTH CAROLINA	WASHINGTON MUN WTP	8900	2.20	58
ATHENS	OHIO	ATHENS WWTP	32000	4.80	66
BARBERTON	OHIO	BARBERTON STP	35300	8.00	58
BEDFORD	OHIO	BEDFORD STP	16500	3.20	56
BOARDMAN	OHIO	BOARDMAN WWTP	12000	5.00	61
CLEVELAND	OHIO	EASTERLY WWTP	540000	123.00	620
COLUMBUS	OHIO	SOUTHERLY WWTP	340000	100.00	77
COLUMBUS	OHIO	JACKSON PIKE WWTP	515000	100.00	107
DAYTON	OHIO	DAYTON WWTP	317000	60.00	74
FAIRBORN	OHIO	FAIRBORN WWTP	36000	5.50	71
GREENVILLE	OHIO	GREENVILLE WWTP	13500	3.00	37
HAMILTON	OHIO	HAMILTON WWTP	21274	25.00	73
HEATH	OHIO	HEATH WWTP	8020	2.00	56
LOGAN	OHIO	LOGAN WWTP	6000	1.20	57
MIAMISBURG	OHIO	MIAMISBURG STP	18200	2.20	67
NEWARK	OHIO	NEWARK WWTP	37000	12.00	74
RAVENNA	OHIO	RAVENNA STP	12000	1.90	80
SIDNEY	OHIO	SIDNEY WWTP	17000	2.50	42
SIDNEY	OHIO	SIDNEY WWTP	18000	4.00	70
SOLON	OHIO	SOLON CENTRAL STP	11500	2.40	72
SOLON	OHIO	SOLON NE STP	4000	0.80	43
TROY	OHIO	TROY WWTP	18000	6.20	71
VANDALIA	OHIO	VANDALIA WWTP	12400	1.20	47
WATERVILLE	OHIO	MAUMEE RIVER STP	20000	6.00	88
XENIA	OHIO	FORD ROAD WWTP	28500	3.00	54
ARDMORE	OKLAHOMA	SOUTHWEST STP	14000	2.50	51
ARDMORE	OKLAHOMA	NORTHEAST STP	12000	2.50	51
BLACKWELL	OKLAHOMA	BLACKWELL STP	8645	2.20	47
BROKEN BOW	OKLAHOMA	BROKEN BOW WPCP	4000	0.75	57
HENRYETTA	OKLAHOMA	HENRYETTA WPCP	7500	0.90	46
IDABEL	OKLAHOMA	IDABEL WPCF	12000	2.50	44
MUSKOGEE	OKLAHOMA	MUSKOGEE WWTP	40000	12.00	67
NORMAN	OKLAHOMA	NORMAN STP	63000	10.00	107
OKLAHOMA	OKLAHOMA	CHISHOLM CREEK AWT	50000	5.00	69
OKLAHOMA CITY	OKLAHOMA	NORTHSIDE WWTP	150000	10.00	61
OKLAHOMA CITY	OKLAHOMA	SOUTHSIDE WWTP	300000	25.00	60
OKMULGEE	OKLAHOMA	OKMULGEE WWTP	20000	5.00	76
PONCA CITY	OKLAHOMA	PONCA CITY WWTP	30000	4.00	58
TULSA	OKLAHOMA	FLATROCK STP	57874	6.20	61
TULSA	OKLAHOMA	COAL CREEK STP	31946	4.00	46
TULSA	OKLAHOMA	NORTHSIDE STP	91251	19.00	100
TULSA	OKLAHOMA	SOUTHSIDE STP	200000	31.50	116
CLATSKANIE	OREGON	CLATSKANIE STP	1700	0.50	52
COTTAGE GROVE	OREGON	COTTAGE GROVE STP	7500	1.50	60
DALLAS	OREGON	DALLAS STP	9000	2.00	45
DEPOE BAY	OREGON	DEPOE BAY STP	1650	0.80	46

CITY	STATE	FACILITY NAME	SERVICE POPULATION	DESIGN FLOW IN M.G.D.	ABC RATING
EUGENE	OREGON	EUGENE WWTP	106000	17.10	71
EUGENE	OREGON	EUGENE STP	90000	17.10	70
FOREST GROVE	OREGON	FOREST GROVE WWTP	19347	5.00	81
GASTON	OREGON	GASTON STP	642	0.06	39
GLENEDON BEACH	OREGON	SILETZ KEYS STP	25	0.01	30
HILLSBORO	OREGON	HILLSBORO WEST STP	7765	2.00	71
HILLSBORO	OREGON	ROCK CREEK STP	100747	15.00	99
HOOD RIVER	OREGON	HOOD RIVER STP	4500	3.50	87
OTTER ROCK	OREGON	OTTER CREST INN ST	600	0.13	35
PORTLAND	OREGON	TRYON CREEK STP	39208	8.34	74
PORTLAND	OREGON	INVERNESS STP	10829	2.00	45
SALEM	OREGON	WILLOW LAKE STP	135000	35.00	88
SPRINGFIELD	OREGON	SPRINGFIELD STP	39350	6.90	62
THE DALLES	OREGON	THE DALLES STP	16075	4.15	62
TIGARD	OREGON	DURHAM ADV.WWTP	120000	20.00	117
TILLAMOOK	OREGON	TILLAMOOK STP	4300	1.06	48
WEST SALEM	OREGON	WALLACE ROAD STP	3500	0.40	41
WILSONVILLE	OREGON	DAMASCH ST HOSP ST	1000	0.30	46
ALLENTOWN	PENNSYLVANIA	KLINE'S ISLAND WWT	179000	40.00	101
AMBLER	PENNSYLVANIA	AMBLER SOUTH WWTP	32300	3.26	53
BADEN	PENNSYLVANIA	BADEN STP	7000	0.50	53
BETHLEHEM	PENNSYLVANIA	BETHLEHEM WWTP	100000	12.50	79
BLOOMSBURG	PENNSYLVANIA	BLOOMSBURG STP	15000	4.30	60
CENTER VALLEY	PENNSYLVANIA	UPPER SAUCON TWP W	9000	0.60	62
CHAMBERSBURG	PENNSYLVANIA	CHAMBERSBURG WWTP	17000	3.00	53
CHINCHILLA	PENNSYLVANIA	CLARKS-SUMMITTS. A	10000	1.20	41
CONSHOHOCKEN	PENNSYLVANIA	CONSHOHOCKEN WPCP	17500	1.30	57
DUNCANSVILLE	PENNSYLVANIA	DUNCANSVILLE WWTP	7000	0.25	35
DURYEA	PENNSYLVANIA	L LACKAWANNA V STP	28749	6.00	85
FOLCROFT	PENNSYLVANIA	MUCKINPATES WWTP	78000	6.00	55
GROVE CITY	PENNSYLVANIA	GROVE CITY STP	8300	1.50	54
HARLEYSVILLE	PENNSYLVANIA	LOWER SALFORD TWP	2900	0.30	50
HASTINGS	PENNSYLVANIA	HASTINGS WWTP	2100	0.21	33
HATFIELD	PENNSYLVANIA	HATFIELD TWP AUT	10000	3.60	86
HERSHEY	PENNSYLVANIA	DERRY TOWNSHIP WPC	20000	5.00	80
KINGSTON TWP	PENNSYLVANIA	DALLAS AREA MUN. A	22000	2.20	49
LEBANON	PENNSYLVANIA	LEBANON STP	32300	6.80	86
LEMOYNE	PENNSYLVANIA	LEMOYNE BORO JT. A	16500	2.10	57
LITITZ	PENNSYLVANIA	LITITZ STP	7600	1.20	45
MCCANDLESS	PENNSYLVANIA	PINECREEK STP	8500	3.00	69
MECHANICSBURG	PENNSYLVANIA	MECHANICSBURG STP	9500	1.20	54
NEW HOLLAND	PENNSYLVANIA	NEW HOLLAND STP	4500	1.00	54
OAKMONT	PENNSYLVANIA	OAKMONT STP	8300	1.20	69
PLEASANT HILLS	PENNSYLVANIA	PLEASANT HILLS	22000	3.00	79
POTTSTOWN	PENNSYLVANIA	POTTSTOWN WWTP	33000	7.40	86
READING	PENNSYLVANIA	FRITZ ISLAND WWTP	102000	13.50	86
ROBESONIA	PENNSYLVANIA	ROBESONIA-WERNERSV	3300	0.60	48
SHARON HILL	PENNSYLVANIA	DARBY CREEK WWTP	98921	10.00	69
SINKING SPRING	PENNSYLVANIA	SINKING SPRING WWT	3200	0.35	45
SPRINGETTSBURY	PENNSYLVANIA	SPRINGETTSBURY TWP	48000	8.00	74

CITY	STATE	FACILITY NAME	SERVICE POPULATION	DESIGN FLOW IN M.G.D.	ABC RATING
WEST READING	PENNSYLVANIA	WYOMISSING VAL STP	20000	3.00	64
WILLOW GROVE	PENNSYLVANIA	U MORELAND-HATBORO	30000	6.00	80
EAST GREENWICH	RHODE ISLAND	EAST GREENWICH STP	3000	0.51	47
EAST PROVIDENCE	RHODE ISLAND	EAST PROVIDENCEWPC	40000	10.40	77
WARWICK	RHODE ISLAND	WARWICK SATP	13500	5.00	69
BATESBURG	SOUTH CAROLINA	BATESBURG STP	4500	1.30	43
COLUMBIA	SOUTH CAROLINA	COLUMBIA METRO STP	200000	20.00	103
LANCASTER	SOUTH CAROLINA	LANCASTER STP	18000	3.00	50
MARION	SOUTH CAROLINA	WITHLACOOCHEE STP	3300	1.00	50
ROCK HILL	SOUTH CAROLINA	MANCHESTER CREEK S	27185	12.00	69
ROCK HILL	SOUTH CAROLINA	WILDCAT STP	4942	0.50	49
UNION	SOUTH CAROLINA	MENGS CREEK STP	2500	1.00	42
UNION	SOUTH CAROLINA	TOSHES CREEK STP	5000	6.00	45
CUSTER	SOUTH DAKOTA	CUSTER WPCP	2200	0.56	45
DEADWOOD	SOUTH DAKOTA	LEAD DEADWOOD STP	8000	2.33	69
RAPID CITY	SOUTH DAKOTA	RAPID CITY WPCP	60000	13.50	61
RAPID CITY	SOUTH DAKOTA	RAPID CITY STP	50000	13.50	69
YANKTON	SOUTH DAKOTA	YANKTON WWTP	15000	1.80	56
CENTERVILLE	TENNESSEE	CENTERVILLE WWTP #	2495	0.30	43
CLEVELAND	TENNESSEE	CLEVELAND WWTP	30000	12.00	69
DICKSON	TENNESSEE	PINEY RIVER WWTP	3500	0.65	60
DICKSON	TENNESSEE	JONES CREEK WWTP	5500	0.90	53
FAYETTEVILLE	TENNESSEE	FAYETTEVILLE WWTP	8500	2.00	63
FRANKLIN	TENNESSEE	FRANKLIN WWTP	10500	2.50	66
KNOXVILLE	TENNESSEE	HALLSDALE POWEL ST	16750	2.10	83
KNOXVILLE	TENNESSEE	FOURTH CREEK WWTP	63794	7.72	81
LAVERGNE	TENNESSEE	LAVERGNE WWTP	476	0.08	50
MARYVILLE	TENNESSEE	MARYVILLE REG WWTP	15000	7.50	90
MEMPHIS	TENNESSEE	NORTH WWTP	350000	135.00	79
MEMPHIS	TENNESSEE	T.E. MAXSON WWTP	325000	80.00	85
NASHVILLE	TENNESSEE	DRY CREEK WWTP	25000	6.00	65
NASHVILLE	TENNESSEE	CENTRAL WWTP	323957	55.00	98
NASHVILLE	TENNESSEE	WHITES CREEK WWTP	50000	25.00	80
SOUTH PITTSBURG	TENNESSEE	SOUTH PITTSBURG ST	4200	1.07	47
ATHENS	TEXAS	ATHENS NORTH STP	4000	0.90	38
ATHENS	TEXAS	ATHENS WEST STP	9200	0.92	34
AUSTIN	TEXAS	GOVALLE STP	159000	26.00	59
AUSTIN	TEXAS	WALNUT CREEK STP	148000	25.00	74
AUSTIN	TEXAS	WALNUT CK WWTP	148000	18.00	68
AUSTIN	TEXAS	GOVALLE WWTP	159000	40.00	58
BAYTOWN	TEXAS	EAST DISTRICT STP	24000	3.00	59
BAYTOWN	TEXAS	CENTRAL DIST. STP	24450	4.70	54
BAYTOWN	TEXAS	LAKEWOOD STP	6672	0.70	50
BAYTOWN	TEXAS	W MAIN STP	26500	4.70	67
BAYTOWN	TEXAS	E DIST STP	18000	3.00	45
BROWNSVILLE	TEXAS	S.PLANT (MAIN PLAN	70000	7.50	72
CONROE	TEXAS	SOUTHEAST STP	10000	4.00	41
CONROE	TEXAS	SOUTHWEST STP	20000	2.00	51
CORPUS CHRISTI	TEXAS	BROADWAY STP	18600	10.00	63
CORPUS CHRISTI	TEXAS	BROADWAY STP	57800	12.00	72

CITY	STATE	FACILITY NAME	SERVICE POPULATION	DESIGN FLOW IN M.G.D.	ABC RATING
CORPUS CHRISTI	TEXAS	ALLISON STP	8900	2.00	58
CORPUS CHRISTI	TEXAS	WESTSIDE STP	16500	3.00	34
CORSICANA	TEXAS	CORSICANA #2	14000	1.50	60
CORSICANA	TEXAS	CORSICANA #1	7000	1.00	55
DICKENSON	TEXAS	WCID STP #1	13800	4.20	63
FLOWER MOUND	TEXAS	FLOWER MOUND MUD 1	1500	1.50	54
FT WORTH	TEXAS	VILLAGE CREEK STP	363612	45.00	78
GALVESTON	TEXAS	MAIN PLANT	54000	10.00	78
GALVESTON	TEXAS	AIRPORT STP	9000	1.00	46
GEORGETOWN	TEXAS	GEORGETOWN WWTP	10000	1.00	35
HITCHCOCK	TEXAS	HITCHCOCK WWTP	5700	0.74	38
HOUSTON	TEXAS	N. SIDE STP	465000	138.00	64
HOUSTON	TEXAS	CLINTON PARK STP	5500	0.80	43
HOUSTON	TEXAS	CHOCOLATE BAYOU ST	15000	1.60	49
HUNTSVILLE	TEXAS	S STP	6000	0.80	43
HUNTSVILLE	TEXAS	SOUTH WWTP	8000	1.60	42
HUNTSVILLE	TEXAS	NORTH WWTP	15000	2.10	54
LEWISVILLE	TEXAS	LEWISVILLE WTP	30000	6.00	70
LEWISVILLE	TEXAS	LEWISVILLE WWTP	23000	6.00	97
MEXIA	TEXAS	MEXIA STP	6200	1.50	55
NACOGDOCHES	TEXAS	PLANT # 2-A	26000	2.80	47
NACOGDOCHES	TEXAS	PLANT # 1	8165	2.00	56
PALESTINE	TEXAS	WELLS CREEK STP	9300	1.50	39
PALESTINE	TEXAS	TOWN CREEK STP	5200	1.80	52
PASEDENA	TEXAS	DEEPWATER STP	29000	4.00	60
PASEDENA	TEXAS	VINCE BAYOU STP A&	30000	7.00	69
PORT ARTHUR	TEXAS	MAIN WWTP	69000	8.00	65
PORT LAVACA	TEXAS	LYNN'S BAYOU STP	10000	1.00	45
PORT LAVACA	TEXAS	BLARDONE WWTP	3000	0.50	32
SAN ANTONIO	TEXAS	BILLING ROAD WWTP	933000	100.00	105
SAN ANTONIO	TEXAS	LEON CREEK WWTP	81400	24.00	96
TEMPLE	TEXAS	DOSIER FARM WWTP	23000	5.00	59
TEXAS CITY	TEXAS	TEXAS CITY STP	43000	4.40	62
TEXAS CITY	TEXAS	STP #1	70000	4.50	71
TEXAS CITY	TEXAS	STP #2	8000	0.80	62
WACO	TEXAS	TEMPLE-BELTON STP	40000	5.00	65
WACO	TEXAS	#2 WACO BRA	20000	2.80	62
WACO	TEXAS	WACO METRO REG SS	33000	5.00	57
WACO	TEXAS	WACO METRO REG SS	100000	18.50	72
COTTONWOOD	UTAH	COTTONWOOD STP	80000	8.00	56
GRANGER	UTAH	GRANGER-HUNTER STP	68000	12.50	72
HYRUM	UTAH	HYRUM WWTP	3800	1.00	55
MAGNA	UTAH	MAGNA WWTP	14000	1.30	43
MORONI	UTAH	MORONI WWTP	1358	1.50	60
MURRAY	UTAH	MURRAY STP	32000	4.00	59
OGDEN	UTAH	CENTRAL WEBER STP	132000	44.50	70
PROVO	UTAH	PROVO WWTP	60000	21.00	108
SALT LAKE CITY	UTAH	SALT LK CITY RCL P	189000	45.00	69
SALT LAKE CITY	UTAH	SLC SUBURBAN #1	155000	16.00	62
SANDY	UTAH	SANDY CREEK STP	7800	1.30	41

CITY	STATE	FACILITY NAME	SERVICE POPULATION	DESIGN FLOW IN M.G.D.	ABC RATING
SOUTH SALT LAKE	UTAH	SOUTH SALT LAKE ST	7810	4.60	51
SPRINGVILLE	UTAH	SPRINGVILLE WWTP	13000	4.00	40
SYRACUSE	UTAH	NORTH DAVIS CO STP	77000	19.00	55
WOODS CROSS	UTAH	S DAVIS CO SD N ST	35000	5.35	55
WOODS CROSS	UTAH	S DAVIS CO SD S PL	13125	2.84	46
CHARLOTTESVILLE	VIRGINIA	MEADOW CREEK WWTP	32597	4.16	67
CHARLOTTESVILLE	VIRGINIA	MOORES CREEK STP	25000	3.30	57
CHESTERFIELD	VIRGINIA	FALLING CREEK STP	49000	6.00	70
CHESTERFIELD	VIRGINIA	FALLING CREEK STP	60000	6.00	74
DANVILLE	VIRGINIA	DANVILLE NORTHSIDE	108000	24.00	77
FAIRFAX	VIRGINIA	WESTGATE STP	140000	14.00	71
FREDERICKSBURG	VIRGINIA	FREDERICKSBURG STP	28000	3.50	68
LEXINGTON	VIRGINIA	LEXINGTON STP	7600	2.00	71
MANASSAS PARK	VIRGINIA	UPPER OCCOQUAN WWT	70000	15.00	130
NEWPORT NEWS	VIRGINIA	BOAT HARBOR WWTP	300000	22.00	67
PETERSBERG	VIRGINIA	PETERSBERG WWTP	76000	15.00	79
RICHMOND	VIRGINIA	RICHMOND WWTP	233000	70.00	95
RIDGEWAY	VIRGINIA	MARTINSVILLE WPCP	22000	6.00	65
ROANOKE	VIRGINIA	ROANOKE WPCP	170000	35.00	119
WILLIAMSBURG	VIRGINIA	WILLIAMSBURG WWTP	45000	9.60	92
BLAINE	WASHINGTON	WHATCOM CTY DIST #	10000	0.50	57
BURLINGTON	WASHINGTON	BURLINGTON WWTP	3500	1.60	49
CHEHALIS	WASHINGTON	CHEHALIS TP	5900	7.50	89
E WENATCHEE	WASHINGTON	DOUGLAS CO STP #1	6000	2.30	64
EAST WENATCHEE	WASHINGTON	EAST WENATCHEE WWT	8500	1.60	59
LONGVIEW	WASHINGTON	COWLITZ WPCP	45000	10.00	77
MCCLEARY	WASHINGTON	MCCLEARY STP	1313	0.30	42
NACHES	WASHINGTON	NACHES WWTP	646	0.17	39
OMAK	WASHINGTON	CITY OF OMAK STP	4081	1.90	43
PASCO	WASHINGTON	PASCO WPCP	17000	4.25	54
SEDRO WOOLLEY	WASHINGTON	SEDRO WOOLLEY WWTP	4000	1.90	51
SELAH	WASHINGTON	SELAH WWTP	4300	4.60	56
TOPPENISH	WASHINGTON	TOPPENISH WWTP	6000	1.30	51
VANCOUVER	WASHINGTON	SALMON CREEK STP	13000	2.00	46
VANCOUVER	WASHINGTON	WESTSIDE STP	69000	12.00	94
WAPATO	WASHINGTON	WAPATO WWTP	3100	1.00	46
WESTPORT	WASHINGTON	WESTPORT WWTP	1560	1.00	49
ATHENS	WEST VIRGINIA	ATHENS WWTP	2700	0.25	35
BECKLEY	WEST VIRGINIA	N BECKLEY PUB SERV	5000	0.56	31
BELLE	WEST VIRGINIA	BELLE WWTP	3000	0.30	33
BELOIT	WISCONSIN	BELOIT STP	36000	9.50	81
BROOKFIELD	WISCONSIN	FOX RIVER WPCP	18000	5.00	84
GERMANTOWN	WISCONSIN	GERMANTOWN WWTP	6819	1.00	56
GRAFTON	WISCONSIN	GRAFTON STP	8434	1.00	65
GREEN BAY	WISCONSIN	GREEN BAY METRO ST	130000	52.50	100
LACROSSE	WISCONSIN	LACROSSE WWTP	68428	20.00	82
MADISON	WISCONSIN	NINE SPRINGS WWTP	225000	57.00	84
MADISON	WISCONSIN	NINE SPRINGS WWTP	240000	27.50	88
MANITOWOC	WISCONSIN	MANITOWOC WWTP	34000	15.50	82
MENASHA	WISCONSIN	NEENAH-MENASHA STP	39000	18.00	68

CITY	STATE	FACILITY NAME	SERVICE POPULATION	DESIGN FLOW IN M.G.D.	ABC RATING
MENOMONIE	WISCONSIN	MENOMONIE WWTP	15000	2.88	74
MERRILL	WISCONSIN	MERRILL WWTP	9500	2.10	66
MILWAUKEE	WISCONSIN	SOUTH SHORE WWTP	212100	120.00	81
OSHKOSH	WISCONSIN	OSHKOSH WWTP	54100	20.00	86
RACINE	WISCONSIN	NORTH PARK STP	10000	1.90	59
RICHLAND CENTER	WISCONSIN	RICHLAND CENTER ST	5100	1.60	47
ROTHSCHILD	WISCONSIN	ROTHSCHILD STP	5000	1.30	86
SO MILWAUKEE	WISCONSIN	SOUTH MILWAUKEE ST	23487	6.00	67
STURGEON BAY	WISCONSIN	STURGEON BAY WWTP	7000	1.20	72
TOMAH	WISCONSIN	TOMAH STP	5700	1.50	70
WATERTOWN	WISCONSIN	WATERTOWN STP	16000	2.50	540
WAUKESHA	WISCONSIN	WAUKESHA STP	49500	8.50	69
WAUKESHA	WISCONSIN	WAUKESHA STP	50000	8.50	66
WAUSAU	WISCONSIN	WAUSAU STP	40000	9.20	97
CASPER	WYOMING	CASPER BPU WWTP	51000	6.50	68
CHEYENNE	WYOMING	DRY CREEK WWTP	26000	4.50	70
EVANSTON	WYOMING	EVANSTON WWTP	7000	1.80	44
JACKSON	WYOMING	JACKSON WWTP	6000	0.80	38
KEMMERER	WYOMING	KEMMERER WWD	3700	0.50	23
RIVERTON	WYOMING	RIVERTON WWTP	12000	1.50	51
ROCK SPRINGS	WYOMING	ROCK SPRINGS WWTP	25950	2.00	69
TETON VILLAGE	WYOMING	TETON VILLAGE STP	1212	0.20	43
THERMOPOLIS	WYOMING	THERMOPOLIS STP	6300	0.60	54

TABLE A.2

LIST OF CONVEYANCE SYSTEMS

CITY	STATE	FACILITY NAME	SERVICE POPULATION	TOTAL LENGTH OF GRAVITY SEWERS (MI)	TOTAL LENGTH OF FORCE MAIN (MI)
ALBERTVILLE	ALABAMA	ALBERTVILLE SS	15000	7.0	0.0
FOLEY	ALABAMA	FOLEY SS	4000	2.0	2.0
GADSDEN	ALABAMA	GADSDEN SS	46589	27.0	7.0
HUNTSVILLE	ALABAMA	HUNTSVILLE SS	300000	21.0	2.0
JASPER	ALABAMA	JASPER SS	10000	1.0	1.0
MONROEVILLE	ALABAMA	MONROEVILLE SS	5200	99999.0	10.0
OXFORD	ALABAMA	OXFORD SS	60000	3.0	2.0
OZARRK	ALABAMA	OZARK SS	7500	1.7	1.6
PHENIX CITY	ALABAMA	PHENIX CITY SS	26490	60.0	90.0
FORT SMITH	ARKANSAS	P STREET SS	22800	77.0	13.0
GREENBRIAR	ARKANSAS	GREENBRIAR SS	1400	1.9	1.1
HARRISON	ARKANSAS	HARRISON SS	7000	0.6	0.0
HOT SPRINGS	ARKANSAS	HOT SPRINGS SS	31500	21.0	4.8
HUNTSVILLE	ARKANSAS	HUNTSVILLE SS	1300	0.5	1.0
JACKSONVILLE	ARKANSAS	JACKSONVILLE SS	25000	7.0	14.5
PRAIRIE GROVE	ARKANSAS	PRAIRIE GROVE SS	1687	0.6	0.2
ROGERS	ARKANSAS	ROGERS SS	12000	2.0	1.3
RUSSELLVILLE	ARKANSAS	RUSSELLVILLE SS	14000	27.0	4.0
SPRINGDALE	ARKANSAS	SPRINGDALE SS	25000	5.6	3.0
WEST FORK	ARKANSAS	WEST FORK SS	1000	0.0	0.0
YELLEVILLE	ARKANSAS	YELLEVILLE SS	1031	0.7	0.6
ANDERSON	CALIFORNIA	ANDERSON SS	6500	2.3	0.1
BANNING	CALIFORNIA	BANNING SS	13500	0.0	0.4
BARSTOW	CALIFORNIA	BARSTOW SS	17590	0.0	0.0
BURBANK	CALIFORNIA	BURBANK SS	83781	0.0	3.0
CALABASAS	CALIFORNIA	CALABASAS SS	45000	11.0	3.0
CAMARILLO	CALIFORNIA	CAMARILLO SEWER SY	27000	21.0	0.0
CARMEL	CALIFORNIA	CARMEL SS	19950	54.0	6.0
CHICO	CALIFORNIA	CHICO SS	28000	1.4	0.4
CORONA	CALIFORNIA	CORONA SS	58000	99999.0	0.3
CRESCENT CITY	CALIFORNIA	CRESCENT CITY SS	3000	2.0	0.1
DALY CITY	CALIFORNIA	N SAN MATEO C SD S	80000	99999.0	2.0
FREMONT	CALIFORNIA	FREMONT SS	210287	7.0	0.0
INDIO	CALIFORNIA	INDIO SS	44765	0.4	0.5
LIVERMORE	CALIFORNIA	LIVERMORE SS	50000	3.5	0.9
LOS ANGELES	CALIFORNIA	LOS ANGELES CO SS	3800000	99999.0	99999.0
LOS BANOS	CALIFORNIA	LOS BANOS SS	10000	2.0	0.0
MODESTO	CALIFORNIA	MODESTO SS	101000	37.7	1.6
OROVILLE	CALIFORNIA	OROVILLE SS	25000	3.5	2.7
OXNARD	CALIFORNIA	OXNARD SEWER SYSTE	93000	0.0	0.0
PLACERVILLE	CALIFORNIA	PLACERVILLE SS	6736	0.5	0.1
RED BLUFF	CALIFORNIA	RED BLUFF SS	9200	99999.0	0.0
RICHMOND	CALIFORNIA	RICHMOND SS	65000	99999.0	0.0
RIO DELL	CALIFORNIA	RIO DELL SS	2800	99999.0	0.3
S SAN FRANCISCO	CALIFORNIA	S SAN FRANCISCO SS	82000	18.0	2.0
SAN BERNARDINO	CALIFORNIA	SAN BERNARDINO SS	172200	99999.0	99999.0
SAN LORENZO	CALIFORNIA	SAN LORENZO SS	140000	20.0	2.0
SANTA PAULA	CALIFORNIA	SANTA PAULA SEWER	18600	0.0	0.0
STOCKTON	CALIFORNIA	STOCKTON SS	138000	62.0	12.0
THOUSAND OAKS	CALIFORNIA	THOUSAND OAKS SS	82000	0.0	0.0

CITY	STATE	FACILITY NAME	SERVICE POPULATION	TOTAL LENGTH OF GRAVITY SEWERS (MI)	TOTAL LENGTH OF FORCE MAIN (MI)
THOUSAND OAKS	CALIFORNIA	HILL CANYON TRIBUT	69500	1.8	0.0
TURLOCK	CALIFORNIA	TURLOCK SS	400000	99999.0	0.0
UKIAH	CALIFORNIA	UKIAH SS	14500	0.1	0.4
VALLEJO	CALIFORNIA	VALLEJO SS	85000	99999.0	3.7
VENTURA	CALIFORNIA	VENTURA SEWER SYST	69700	21.0	0.0
WEST SACRAMENTO	CALIFORNIA	WEST SACRAMENTO SS	25000	0.0	12.0
WINDSOR	CALIFORNIA	WINDSOR SS	5200	99999.0	0.2
ARVADA	COLORADO	CLEAR CREEK VAL. S	10000	0.0	0.0
ASPEN	COLORADO	ASPEN METRO SS	3500	0.0	0.0
ASPEN	COLORADO	ASPEN SD SS	1430	0.0	0.0
AVON	COLORADO	AVON SS	15000	1.5	0.5
BOULDER	COLORADO	BOULDER COLLECTION	57904	0.0	0.0
BRIGHTON	COLORADO	BRIGHTON COLL. SYS	16000	1.8	0.0
CARBONDALE	COLORADO	CARBONDALF WWTP	2800	0.0	0.0
COLORADO SPRING	COLORADO	COLORADO SPRINGS S	150000	0.0	0.0
CORTEZ	COLORADO	CORTEZ SS	7500	0.4	0.0
DELTA	COLORADO	DELTA SD	4600	0.0	0.0
DENVER	COLORADO	S. LAKEWOOD COLL.	17000	0.0	0.0
DENVER	COLORADO	N. TABLE MTN. SS	4500	0.0	0.0
DURANGO	COLORADO	DURANGO SS	12000	99999.0	99999.0
ENGLEWOOD	COLORADO	ENGLEWOOD SS	40000	0.0	0.0
ESTES PARK	COLORADO	UPPER THOMPSON SD	12000	3.2	0.2
ESTES PARK	COLORADO	ESTES PARK COLLECT	2500	0.0	0.0
EVANS	COLORADO	EVANS SAN.DIST.SS	6000	1.3	0.0
EVERGREEN	COLORADO	EVERGREEN SS	4550	99999.0	0.0
FRISCO	COLORADO	FRISCO SAN DIST SS	2000	0.9	0.2
GLENWOOD SPRING	COLORADO	GLENWOOD SPRINGS S	7350	1.1	0.0
IDAHO SPRINGS	COLORADO	IDAHO SPRINGS SS	3000	0.2	0.0
LONGMONT	COLORADO	LONGMONT SS	45000	0.0	0.0
LOUISVILLE	COLORADO	LOUISVILLE SD	5700	1.7	3.4
LOVELAND	COLORADO	LOVELAND	35000	1.4	2.4
MEEKER	COLORADO	MEEKER SD	2350	0.0	0.0
MONTROSE	COLORADO	MONTROSE SS	8500	99999.0	0.0
NEDERLAND	COLORADO	NEDERLAND SD	8500	0.0	0.0
PAGOSA SPRINGS	COLORADO	PAGOSA SPRINGS SS	1500	0.1	0.0
RIFLE	COLORADO	RIFLE SD	3000	0.0	0.0
SALIDA	COLORADO	SALIDA SS	6000	0.0	0.0
TRINIDAD	COLORADO	TRINIDAD SS	10000	1.4	0.2
VAIL	COLORADO	VAIL COLL.	2500	0.0	0.0
WESTMINSTER	COLORADO	WESTMINSTER COLL.	32000	7.1	0.0
WINDSOR	COLORADO	WINDSOR COLLECTION	5000	0.0	0.0
ENFIELD	CONNECTICUT	ENFIELD WPCP	48000	13.9	5.0
FAIRFIELD	CONNECTICUT	FAIRFIELD SS	46000	4.5	0.8
GROTON	CONNECTICUT	GROTON SS	15000	6.9	3.8
LITCHFIELD	CONNECTICUT	LITCHFIELD SS	5700	0.0	0.0
MANCHESTER	CONNECTICUT	MANCHESTER SS	46600	0.6	99999.0
SALISBURY	CONNECTICUT	TWN OF SALISBURY S	2400	1.1	1.2
SEYMOUR	CONNECTICUT	SEYMOUR SS	10000	2.7	0.7
STAMFORD	CONNECTICUT	STAMFORD WPCF	90000	15.2	99999.0
TORRINGTON	CONNECTICUT	TORRINGTON WPCF	28500	4.3	3.2

CITY	STATE	FACILITY NAME	SERVICE POPULATION	TOTAL LENGTH OF GRAVITY SEWERS (MI)	TOTAL LENGTH OF FORCE MAIN (MI)
VERNON	CONNECTICUT	VERNON SS	25000	4.9	5.0
WAREHOUSE PT	CONNECTICUT	EAST WINDSOR SS	2400	2.3	0.7
WEST HAVEN	CONNECTICUT	WEST HAVEN SS	52000	56.4	5.4
WILLIMANTIC	CONNECTICUT	WILLIMANTIC SS	20000	0.1	0.1
GEORGETOWN	DELAWARE	GEORGETOWN SS	3000	3.5	3.0
HARRINGTON	DELAWARE	HARRINGTON SS	2500	2.9	1.5
MIDDLETOWN	DELAWARE	MIDDLETOWN SS	2900	1.8	0.5
SHELBYVILLE	DELAWARE	SHELBYVILLE SS	1400	0.7	1.1
BARTOW	FLORIDA	LAKELAND SS (BARTO	23000	6.5	0.0
BOCA RATON	FLORIDA	BOCA RATON SEWERS	35000	54.4	73.0
FT.PIERCE	FLORIDA	FT.PIERCE CITY OF	33000	67.0	16.0
GOULDS	FLORIDA	GOULDS COLL.	20000	22.0	0.0
HOLLY HILL	FLORIDA	HOLLY HILL SS	10000	0.0	3.0
JACKSON.BEACH	FLORIDA	JACKSONVILLE BEACH	17700	7.0	10.0
KISSIMMEE	FLORIDA	KISSIMMEE 192 STP	2000	6.0	0.0
LAKELAND	FLORIDA	LAKELAND SS	63000	0.0	0.0
MIAMI	FLORIDA	VIRGINIA KEYS COLL	400000	51.6	250.0
OCALA	FLORIDA	OCALA STP #1 SS	13500	0.0	25.0
PENSACOLA	FLORIDA	PENSACOLA SS	25000	0.0	0.0
PINELLAS PARK	FLORIDA	PINELLAS PARK SS	0	12.5	0.0
SARASOTA	FLORIDA	SARASOTA SS	54000	15.0	48.0
ST. PETERBURG	FLORIDA	ST.PETERSBURG SS	236140	57.0	0.0
ST.AUGUSTINE	FLORIDA	ST.AUGUSTINE SS	21200	28.0	12.0
TALLAHASSEE	FLORIDA	TALLAHASSEE SS	85000	128.0	0.0
TARPON SPRINGS	FLORIDA	TARPON SPRINGS SS	15000	7.0	0.0
TITUSVILLE	FLORIDA	SOUTH STP SS	10000	54.0	113.0
BRUNSWICK	GEORGIA	BRUNSWICK SS	35000	0.0	10.0
THOMASVILLE	GEORGIA	THOMASVILLE WPCP	19095	4.3	0.0
ABERDEEN	IDAHO	ABERDEEN SS	1640	99999.0	0.1
BOISE	IDAHO	BOISE SS	108079	8.0	99999.0
IDAHO FALLS	IDAHO	IDAHO FALLS SS	50000	99999.9	0.3
MERIDIAN	IDAHO	MERIDIAN SS	6654	0.5	3.8
SODA SPRINGS	IDAHO	SODA SPRINGS SS	4051	3.0	0.3
TWIN FALLS	IDAHO	TWIN FALLS SS	25000	7.3	0.5
MT CARROLL	ILLINOIS	MT CARROLL SS	2100	0.5	0.1
WHEATON	ILLINOIS	WHEATON SS	53000	0.9	0.2
ANKENY	IOWA	WESTWOOD PLANT #4S	4590	0.3	0.0
ANKENY	IOWA	WEST PLANT #2 SS	10000	0.3	0.0
ANKENY	IOWA	SE PLANT #3 SS	12000	1.6	0.0
CAMANCHE	IOWA	CAMANCHE SS	4200	1.3	0.6
CEDAR FALLS	IOWA	CEDAR FALLS SS	35472	10.7	3.8
CORALVILLE	IOWA	CORALVILLE SS	6928	3.8	5.0
EMMETSBURG	IOWA	EMMETSBURG SS	4450	99999.0	0.8
ESTHERVILLE	IOWA	ESTHERVILLE SS	8108	5.3	3.0
FORT DODGE	IOWA	FORT DODGE SS	28000	7.9	2.0
GRIMES	IOWA	GRIMES SS	1985	0.0	0.0
INDIANOLA	IOWA	INDIANOLA N. SS	8000	1.3	2.0
INDIANOLA	IOWA	INDIANOLA S. SS	3000	0.4	0.6
IOWA CITY	IOWA	IOWA CITY SS	50000	10.0	99999.0
NEWTON	IOWA	NEWTON SOUTHWEST S	4145	0.0	0.0

CITY	STATE	FACILITY NAME	SERVICE POPULATION	TOTAL LENGTH OF GRAVITY SEWERS (MI)	TOTAL LENGTH OF FORCE MAIN (MI)
NEWTON	IOWA	NEWTON NORTHWEST S	3141	0.0	0.0
NEWTON	IOWA	NEWTON SOUTH SS	6898	1.5	0.7
OSKALOOSA	IOWA	OSKALOOSA SS	11000	1.7	3.0
REINBECK	IOWA	REINBECK SS	1711	0.2	0.1
WATERLOO	IOWA	WATERLOO SS	75000	99999.0	99999.0
ANTHONY	KANSAS	ANTHONY SS	2771	0.7	0.3
DE SOTO	KANSAS	DE SOTO SS	2000	0.6	0.5
EMPORIA	KANSAS	EMPORIA SS	30000	7.1	4.9
LENEXA	KANSAS	LENEXA SS	10000	1.2	0.4
MANHATTAN	KANSAS	MANHATTAN SS	40000	7.1	1.5
NEWTON	KANSAS	NEWTON SS	17000	0.4	0.1
TOPEKA	KANSAS	TOPEKA SS	150000	99999.0	2.0
WICHITA	KANSAS	WICHITA SS	300000	14.8	3.0
BOWLING GREEN	KENTUCKY	BOWLING GREEN SS	53000	3.5	4.0
CADIZ	KENTUCKY	CADIZ SS	2200	1.5	0.0
HOPKINSVILLE	KENTUCKY	HOPKINSVILLE SS	29000	4.0	11.0
MT WASHINGTON	KENTUCKY	MT WASHINGTON SS	3080	1.5	3.0
RUSSELLVILLE	KENTUCKY	RUSSELLVILLE SS	9394	0.1	5.0
ALEXANDRIA	LOUISIANA	ALEXANDRIA SS	53000	99999.0	25.0
BOGALUSA	LOUISIANA	BOGALUSA SS	18412	16.0	2.0
KENNER	LOUISIANA	KENNER SS	66500	99999.0	35.0
LAFAYETTE	LOUISIANA	LAFAYETTE SS	89689	63.0	28.0
SHREVEPORT	LOUISIANA	SHREVEPORT SS	215000	100.0	28.0
BRUNSWICK	MAINE	BRUNSWICK SS	13000	0.0	0.0
ACCOKEEK	MARYLAND	PISCATAWAY	104000	33.5	1.9
BOWIE	MARYLAND	BOWIE-BELAIR SS	32500	0.0	2.5
EASTON	MARYLAND	EASTON SS	8000	12.9	7.6
HAGERSTOWN	MARYLAND	HAGERSTOWN SS	35800	0.0	0.0
LAUREL	MARYLAND	PARKWAY BASIN SS	33800	8.0	0.8
MANCHESTER	MARYLAND	MANCHESTER SS	1500	0.0	0.6
THURMONT	MARYLAND	THURMONT SS	3000	0.0	1.0
UPPER MARLBORO	MARYLAND	WESTERN BRANCH WWT	75400	0.3	0.5
AMESBURY	MASSACHUSETTS	AMESBURY SS	12500	2.9	8.0
BELLERICA	MASSACHUSETTS	BELLERICA SS	12000	0.0	14.0
DOUGLAS	MASSACHUSETTS	DOUGLAS SS	2100	0.1	0.5
MANCHESTER	MASSACHUSETTS	MANCHESTER SS	3500	0.0	0.8
ROCKPORT	MASSACHUSETTS	ROCKPORT SS	4500	7.8	4.0
FLINT	MICHIGAN	GENESSE COUNTY SS	200000	18.0	3.0
FRANKENMUTH	MICHIGAN	FRANKENMUTH SS	3800	0.4	1.0
GRANDVILLE	MICHIGAN	GRANDVILLE SS	18000	1.0	0.0
HARBOR SPRINGS	MICHIGAN	HARBOR SPRINGS SS	5500	10.0	11.0
HASTINGS	MICHIGAN	HASTINGS S S	6500	0.0	0.1
IONIA	MICHIGAN	IONIA SS	12000	4.0	0.5
PETERSBURG	MICHIGAN	PETERSBURG WWTP	1200	2.0	2.0
PINCONNING	MICHIGAN	PINCONNING SS	1500	0.8	0.0
PORT HURON	MICHIGAN	PORT HURON SS	55000	88.0	1.0
TRAVERSE CITY	MICHIGAN	TRAVERSE	21000	8.0	4.0
TRENTON	MICHIGAN	TRENTON SS	25000	31.0	4.0
WARREN	MICHIGAN	WARREN SS	167000	48.0	0.0
WYOMING	MICHIGAN	WYOMING SS	100000	4.0	1.0

CITY	STATE	FACILITY NAME	SERVICE POPULATION	TOTAL LENGTH OF GRAVITY SEWERS (MI)	TOTAL LENGTH OF FORCE MAIN (MI)
ZEELAND	MICHIGAN	ZEELAND SS	5200	2.0	4.0
ALEXANDRIA	MINNESOTA	ALEXANDRIA SS	12000	99999.0	29.0
AUSTIN	MINNESOTA	AUSTIN SS	26000	14.6	4.0
DETROIT LAKES	MINNESOTA	DETROIT LAKES SS	7500	5.3	99999.0
ELK RIVER	MINNESOTA	ELK RIVER SS	2400	1.6	0.3
FARIBAULT	MINNESOTA	FARIBAULT SS	16000	6.6	0.6
MANKATO	MINNESOTA	MANKATO SS	45000	7.5	1.5
MOORHEAD	MINNESOTA	MOORHEAD SS	35000	19.6	5.0
NORTHFIELD	MINNESOTA	NORTHFIELD SS	12783	1.5	0.2
ROCHESTER	MINNESOTA	ROCHESTER SS	70000	3.7	1.4
TWO HARBORS	MINNESOTA	TWO HARBORS SS	4437	99999.0	99999.0
WILLMAR	MINNESOTA	WILLMAR SS	20000	9.9	1.0
WINONA	MINNESOTA	WINONA SS	25000	24.0	3.5
GREENVILLE	MISSISSIPPI	GREENVILLE SS	55000	0.0	0.0
HATTIESBURG	MISSISSIPPI	HATTIESBURG SS	45000	0.0	1.0
PICAYUNE	MISSISSIPPI	PICAYNE SS	12000	0.0	0.0
COLUMBIA	MISSOURI	COLUMBIA COLLECTOR	59850	2.3	0.0
MEXICO	MISSOURI	MEXICO COLL.	13000	1.4	0.0
BELLEVUE	NEBRASKA	BELLEVUE SS	10500	9.9	2.5
COLUMBUS	NEBRASKA	COLUMBUS	18000	2.7	2.0
FALLS CITY	NEBRASKA	FALLS CITY SS	5440	0.5	0.9
FREMONT	NEBRASKA	FREMONT SS	26000	0.0	0.0
GIBBON	NEBRASKA	GIBBON SS	1500	0.3	0.0
GRAND ISLAND	NEBRASKA	GRAND ISLAND SS	32000	8.5	3.3
HASTINGS	NEBRASKA	HASTINGS SS	25000	99999.0	0.0
KEARNEY	NEBRASKA	KEARNEY SS	30000	1.2	0.8
LINCOLN	NEBRASKA	LINCOLN SS	180000	10.3	0.0
NEWMAN GROVE	NEBRASKA	NEWMAN GROVE SS	863	0.0	0.0
SUPERIOR	NEBRASKA	SUPERIOR SS	3512	4.7	0.3
YORK	NEBRASKA	YORK SS	7500	0.4	0.1
BAYVILLE	NEW JERSEY	OCEAN COUNTY SS	240273	0.0	40.0
BELFORD	NEW JERSEY	TWP MIDDLETOWN SS	65000	3.0	6.0
BIRMINGHAM	NEW JERSEY	PEMBERTON TWP SS	14000	24.0	6.0
BRIDGEPORT	NEW JERSEY	LOGAN TWP SS	2300	0.0	10.0
EAST WINDSOR	NEW JERSEY	E WINDSOR MUA SS	22000	1.5	6.0
ELIZABETH	NEW JERSEY	JOINT MEETING SS	500000	0.0	0.0
HACKETTSTOWN	NEW JERSEY	HACKETTSTOWN SS	13600	0.0	0.0
LAMBERTVILLE	NEW JERSEY	LAMBERTVILLE SS	7000	0.9	0.7
LAWRENCEVILLE	NEW JERSEY	EWING-LAWRENCE SS	65000	21.0	20.0
LONG BRANCH	NEW JERSEY	LONG BRANCH SS	34000	12.0	1.0
LONGVVALLEY	NEW JERSEY	WASHINGTON TWP SS	2412	0.4	2.0
MARTON	NEW JERSEY	EVESTROM TWP SS	20000	4.0	2.0
MATAWAN	NEW JERSEY	ABERDEEN TWP SS	17420	5.0	2.0
MEDFORD	NEW JERSEY	MEDFORD TWP SS	15500	3.0	7.0
OAKHURST	NEW JERSEY	TWP OF OCEAN SS	35000	9.0	3.0
SAYREVILLE	NEW JERSEY	MIDDLESEX CO SS	600000	120.0	4.0
TOMS RIVER	NEW JERSEY	DOVER SEW AUTH SS	60000	8.0	18.0
WILLINGBORO	NEW JERSEY	WILLINGBORO SS	56450	5.0	2.0
LAS VEGAS	NEW MEXICO	LAS VEGAS SS	14000	0.0	0.2
RATON	NEW MEXICO	RATON SS	9000	0.7	0.4

CITY	STATE	FACILITY NAME	SERVICE POPULATION	TOTAL LENGTH OF GRAVITY SEWERS (MI)	TOTAL LENGTH OF FORCE MAIN (MI)
TAOS	NEW MEXICO	TAOS SS	3000	0.0	0.0
AMHERST	NEW YORK	AMHERST S.S.	60000	25.0	0.0
APALACHIN	NEW YORK	OWEGO # 2 S.S.	7500	10.0	1.5
BATAVIA	NEW YORK	BATAVIA S.S.	19500	12.0	0.0
BATH	NEW YORK	BATH S.S.	6530	0.1	0.0
CANTON	NEW YORK	CANTON SEW SYS	10000	1.2	0.0
CAYUGA HGTS	NEW YORK	CAYUGA HGTS S.S.	7200	0.0	0.0
DELMAR	NEW YORK	BETHLEHEM S.S.	18000	23.6	11.0
E.ROCKAWAY	NEW YORK	SEWAGE DIS.DIST NO	558400	47.0	2.5
ELMIRA	NEW YORK	CHEMUNG CO SD #1 S	16090	2.2	0.3
JAMESTOWN	NEW YORK	JAMESTOWN S.S.	40000	43.0	1.0
LOWVILLE	NEW YORK	LOWVILLE SEW.SYS	3800	1.0	0.0
ORANGEBURG	NEW YORK	ORANGETOWN SEW SYS	70000	25.0	0.0
OYSTER BAY	NEW YORK	OYSTER BAY S.S.	7500	1.6	0.0
PENN YAN	NEW YORK	PENN YAN S.S	5200	0.5	0.0
POUGHKEEPSIE	NEW YORK	ARLINGTON SEW SYS	23000	11.0	0.0
SARANAC LAKE	NEW YORK	SARANAC LAKE SEW S	10000	12.0	0.0
SPENCERPORT	NEW YORK	SPENCERPORT S.S.	5000	0.0	0.0
STONY POINT	NEW YORK	STONY POINT SEW SY	9000	1.0	0.0
SUFFERN	NEW YORK	SEWER SYSTEM	11000	2.2	0.0
WEBSTER	NEW YORK	WEBSTER S.S.	7000	0.0	0.0
ALBEMARLE	NORTH CAROLINA	LONG CREEK SS	14000	0.5	1.0
GREENSBORO	NORTH CAROLINA	GREENSBORO SS	196000	23.0	14.0
GREENVILLE	NORTH CAROLINA	GREENVILLE WWTP	33000	99999.0	3.2
MAXTON	NORTH CAROLINA	MAXTON WWTP	2500	99999.0	0.0
PEMBROKE	NORTH CAROLINA	PEMBROKE WWTP	4000	0.0	0.7
RALEIGH	NORTH CAROLINA	RALEIGH SS	188334	45.0	0.0
ROCKINGHAM	NORTH CAROLINA	ROCKINGHAM SS	10100	17.2	3.4
WASHINGTON	NORTH CAROLINA	WASHINGTON MUM WTP	8900	2.5	7.0
BARBERTON	OHIO	BARBERTON SS	35300	0.0	0.0
BEDFORD	OHIO	BEDFORD SS	16500	0.0	0.0
BELLEFONTAINE	OHIO	BELLEFONTAINE SS	13000	0.8	1.1
COLUMBUS	OHIO	COLUMBUS SEWERAGE	865000	0.0	0.0
DAYTON	OHIO	DAYTON SEWERS	317000	0.0	0.0
HEATH	OHIO	HEATH SS	8020	2.5	3.1
LOGAN	OHIO	LOGAN SS	6000	1.2	2.0
NEWARK	OHIO	NEWARK SEWERS	43000	0.0	0.0
RAVENNA	OHIO	RAVENNA SS	12000	0.0	0.0
SIDNEY	OHIO	SIDNEY SEWERAGE SY	17000	5.9	0.0
SIDNEY	OHIO	SIDNEY SS	18000	6.4	1.0
TROY	OHIO	TROY SS	18000	11.6	1.0
BLACKWELL	OKLAHOMA	BLACKWELL SS	8645	0.2	0.0
HENRYETTA	OKLAHOMA	HENRYETTA SS	7500	99999.0	0.4
IDABEL	OKLAHOMA	IDABEL SS	12000	2.0	11.0
MUSKOGEE	OKLAHOMA	MUSKOGEE SS	40000	26.5	1.6
NORMAN	OKLAHOMA	NORMAN SS	63000	2.0	8.0
OKLAHOMA CITY	OKLAHOMA	OKLAHOMA CITY SS	500000	6.0	2.0
OKMULGEE	OKLAHOMA	OKMULGEE SS	20000	2.8	2.0
PONCA CITY	OKLAHOMA	PONCA CITY SS	30000	3.3	0.5
TULSA	OKLAHOMA	TULSA SS	380071	162.0	3.0

CITY	STATE	FACILITY NAME	SERVICE POPULATION	TOTAL LENGTH OF GRAVITY SEWERS (MI)	TOTAL LENGTH OF FORCE MAIN (MI)
CLATSKANIE	OREGON	CLATSKANIE SS	1700	0.0	0.6
COTTAGE GROVE	OREGON	COTTAGE GROVE SS	7500	2.1	0.5
DALLAS	OREGON	DALLAS SS	9000	3.2	2.0
DEPOE BAY	OREGON	DEPOE BAY SS	1650	8.9	0.3
EUGENE	OREGON	EUGENE SS	106000	99999.0	0.0
FOREST GROVE	OREGON	FOREST GROVE SS	19347	6.6	0.5
HILLSBORO	OREGON	HILLSBORO WEST SS	7765	0.0	0.0
HILLSBORO	OREGON	HILLSBORO SS	100747	99999.0	99999.0
OTTER ROCK	OREGON	OTTER CREST INN SS	600	0.5	0.3
PORTLAND	OREGON	INVERNESS SS	10829	14.0	99999.0
SALEM	OREGON	SALEM SS	138500	0.0	99999.0
THE DALLES	OREGON	THE DALLES SS	16075	1.1	2.0
TIGARD	OREGON	TIGARD SS	120000	99999.0	99999.0
TILLAMOOK	OREGON	TILLAMOOK SS	4300	4.2	1.3
ALLENTOWN	PENNSYLVANIA	KLINE'S ISLAND WWT	179000	0.0	0.0
BETHLEHEM	PENNSYLVANIA	BETHLEHEM WWTP	100000	0.0	0.0
CENTER VALLEY	PENNSYLVANIA	UPPER SAUCON TWP W	9000	1.0	1.4
CHAMBERSBURG	PENNSYLVANIA	CHAMBERSBURG WWTP	17000	0.8	0.8
HATFIELD	PENNSYLVANIA	HATFIELD TWP AWT	10000	0.0	1.0
HERSHEY	PENNSYLVANIA	DERRY TOWNSHIP SS	20000	4.1	2.9
LEBANON	PENNSYLVANIA	LEBANON SS	32300	0.6	0.2
LEMOYNE	PENNSYLVANIA	LEMOYNE BORO JT. A	16500	4.3	3.0
LITITZ	PENNSYLVANIA	LITITZ STP	7600	0.0	0.0
MECHANICSBURG	PENNSYLVANIA	MECHANICSBURG STP	9500	2.6	3.0
POTTSTOWN	PENNSYLVANIA	POTTSTOWN SS	33000	3.1	2.7
SPRINGETTSBURY	PENNSYLVANIA	SPRINGETTSBURY TWP	48000	7.4	0.3
WILLOW GROVE	PENNSYLVANIA	U MORELAND-HATBORO	30000	1.0	2.5
EAST PROVIDENCE	RHODE ISLAND	EAST PROVIDENCE SS	40000	13.8	10.0
WARWICK	RHODE ISLAND	WARWICK SS	13500	0.0	4.5
BATESBURG	SOUTH CAROLINA	BATESBURG SS	4500	99999.0	4.5
COLUMBIA	SOUTH CAROLINA	COLUMBIA SS	200000	30.0	10.0
ROCK HILL	SOUTH CAROLINA	ROCK HILL SS	32127	19.8	5.0
UNION	SOUTH CAROLINA	UNION SS	11000	0.7	1.2
CUSTER	SOUTH DAKOTA	CUSTER SS	2200	0.0	0.0
RAPID CITY	SOUTH DAKOTA	RAPID CITY SS	60000	1.2	1.4
YANKTON	SOUTH DAKOTA	YANKTON SS	15000	5.8	1.3
CENTERVILLE	TENNESSEE	CENTERVILLE SS	2495	1.6	0.6
CLEVELAND	TENNESSEE	CLEVELAND SS	30000	1.8	2.6
DICKSON	TENNESSEE	DICKSON COLL SYS	9000	2.2	1.3
FAYETTEVILLE	TENNESSEE	FAYETTEVILLE SS	8500	2.1	3.2
FRANKIN	TENNESSEE	FRANKLIN SS	10500	5.0	4.0
HUNTINGDON	TENNESSEE	HUNTINGDON SS	4500	1.0	0.0
KNOXVILLE	TENNESSEE	KNOXVILLE SS	163794	42.5	20.0
MARYVILLE	TENNESSEE	MARYVILLE SS	5008	0.0	2.5
NASHVILLE	TENNESSEE	WHITES CREEK SS	50000	31.6	12.0
NASHVILLE	TENNESSEE	DRY CREEK SS	25000	4.3	11.0
ATHENS	TEXAS	ATHENS N COLL SYS	4000	0.9	0.1
ATHENS	TEXAS	ATHENS W COLL SYS	9200	2.3	1.7
ATHENS	TEXAS	ATHENS WEST SS	9200	2.3	1.7
ATHENS	TEXAS	ATHENS NORTH SS	4000	0.4	0.1

CITY	STATE	FACILITY NAME	SERVICE POPULATION	TOTAL LENGTH OF GRAVITY SEWERS (MI)	TOTAL LENGTH OF FORCE MAIN (MI)
BAYTOWN	TEXAS	EAST DISTRICT SS	24000	87.0	99999.0
BAYTOWN	TEXAS	CENTRAL DIST SS	24450	205.0	99999.0
BROWNSVILLE	TEXAS	BROWNSVILLE COLL S	48135	0.0	0.0
CONROE	TEXAS	CONROE SS	30000	99999.0	10.0
COPPELL	TEXAS	SEWAGE COLLECTORS	825	0.0	0.0
EVLESS	TEXAS	EVLESS W&S SYSTEM	27000	3.0	0.0
GALVESTON	TEXAS	SEWAGE COLLECTION	60000	21.0	0.0
GEORGETOWN	TEXAS	GEORGETOWN WWTP	10000	0.8	4.0
HITCHCOCK	TEXAS	HITCHCOCK SS	5700	0.5	2.0
HUNTSVILLE	TEXAS	HUNTSVILLE SS	23000	99999.0	8.0
IRVING	TEXAS	IRVING COLLECTION	115244	5.0	0.0
LEWISVILLE	TEXAS	WW COLLECTION SYS	23000	6.0	5.0
PORT ARTHUR	TEXAS	PORT ARTHUR SS	69000	44.0	9.0
TEXAS CITY	TEXAS	TEXAS CITY SS	43000	99999.0	0.5
COTTONWOOD	UTAH	COTTONWOOD SS	80000	0.2	0.3
PROVO	UTAH	PROVO SS	60000	0.0	0.0
SALT LAKE CITY	UTAH	SLC SUBURBAN SS	151000	1.7	1.0
CHESTERFIELD	VIRGINIA	CHESTERFIELD CO SS	60000	10.5	14.0
DANVILLE	VIRGINIA	DANVILLE SEW SYS	108000	99999.0	3.0
FREDERICKSBURG	VIRGINIA	FREDERICKSBURG SS	28000	0.0	35.0
LEXINGTON	VIRGINIA	LEXINGTON SS	7600	0.5	0.3
MANASSAS PARK	VIRGINIA	UPPER OCCOQUAN SD	70000	0.0	6.0
PETERSBERG	VIRGINIA	PETERSBERG SS	76000	34.0	10.0
PORTSMOUTH	VIRGINIA	PINNER'S POINT SS	92393	199.0	0.0
RIDGEWAY	VIRGINIA	MARTINSVILLE SD	22000	0.0	0.0
BELLEVUE	WASHINGTON	BELLEVUE COLL SYS	18228	0.0	0.0
BLAINE	WASHINGTON	WHATCOM CTY DIST #	10000	13.2	1.5
BOTHELL	WASHINGTON	BOTHELL COLL SYS	5120	0.0	0.0
BURLINGTON	WASHINGTON	BURLINGTON SS	3500	12.0	3.0
EAST WENATCHEE	WASHINGTON	EAST WENATCHEE SS	8500	0.0	0.0
OMAK	WASHINGTON	CITY OF OMAK SS	4081	0.5	0.0
PASCO	WASHINGTON	PASCO SS	17000	7.1	1.0
SEDRO WOOLLEY	WASHINGTON	SEDRO WOOLLEY SS	4000	0.2	0.5
SELAH	WASHINGTON	SELAH SS	4300	2.8	1.5
TUKWILA	WASHINGTON	TUKWILA COLL SYS	3000	0.0	0.0
WESTPORT	WASHINGTON	WESTPORT SS	1560	9.8	8.8
BECKLEY	WEST VIRGINIA	N BECKLEY PUB SERV	5000	99999.0	1.6
BELLE	WEST VIRGINIA	BELLE SD	3000	99999.0	4.0
GLENVILLE	WEST VIRGINIA	GLENVILLE SD	2900	99999.0	0.5
BROOKFIELD	WISCONSIN	FOX RIVER SS	18000	99999.0	99999.0
GERMANTOWN	WISCONSIN	GERMANTOWN SS	6819	3.3	4.0
GRAFTON	WISCONSIN	GRAFTON SEWERS	8434	4.5	0.0
JANESVILLE	WISCONSIN	JANESVILLE SS	50000	0.0	0.0
LACROSSE	WISCONSIN	LACROSSE SS	68428	99999.0	5.0
MADISON	WISCONSIN	MADISON SS	225000	208.0	22.0
MANITOWOC	WISCONSIN	MANITOWOC SS	34000	1.8	0.7
MENOMONIE	WISCONSIN	MENOMONIE SS	15000	2.9	0.5
MERRILL	WISCONSIN	MERRILL SS	9500	0.0	0.0
MILWAUKEE	WISCONSIN	SOUTH SHORE SS	212100	37.5	0.7
OSHKOSH	WISCONSIN	OSHKOSH SS	54100	17.0	4.6

CITY	STATE	FACILITY NAME	SERVICE POPULATION	TOTAL LENGTH OF GRAVITY SEWERS (MI)	TOTAL LENGTH OF FORCE MAIN (MI)
RACINE	WISCONSIN	NORTH PARK SS	10000	8.2	4.0
RICHLAND CENTER	WISCONSIN	RICHLAND CENTER SE	5100	4.0	1.0
ROTHSCHILD	WISCONSIN	ROTHSCHILD SS	5000	0.0	0.0
SO MILWAUKEE	WISCONSIN	SO MILWAUKEE SS	23487	4.9	0.6
STURGEON BAY	WISCONSIN	STURGEON BAY SS	7000	0.0	0.0
SUPERIOR	WISCONSIN	SUPERIOR SS	32000	0.0	0.0
TOMAH	WISCONSIN	TOMAH SS	5700	2.0	0.0
WATERTOWN	WISCONSIN	WATERTOWN SEWERS	16000	4.0	0.0
WAUKESHA	WISCONSIN	WAUKESHA SEWERS	49500	27.0	0.0
WAUKESHA	WISCONSIN	WAUKESHA SS	50000	14.4	9.0
WAUSAU	WISCONSIN	WAUSAU SS	40000	3.0	2.0
WISCONSIN DELLS	WISCONSIN	WISCONSIN DELLS SS	3000	6.0	2.0
CASPER	WYOMING	CASPER SS	51000	2.8	0.4
JACKSON	WYOMING	JACKSON SS	6000	4.3	0.0
KEMMERER	WYOMING	KEMMERER SS	3700	99999.0	0.0
RIVERTON	WYOMING	RIVERTON SS	12000	0.0	0.0
ROCK SPRINGS	WYOMING	ROCK SPRINGS SS	25950	99999.0	0.6
TETON VILLAGE	WYOMING	TETON VILLAGE SS	1212	0.5	0.2
THERMOPOLIS	WYOMING	THERMOPOLIS SS	6300	99999.0	0.2

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA 430/9-81-004		

4. TITLE AND SUBTITLE	5. REPORT DATE
Operation and Maintenance Costs for Municipal Wastewater Facilities Technical Report	September 1981
	6. PERFORMING ORGANIZATION CODE U.S. EPA/OW/OWPO/FRD/PNAB
7. AUTHOR(S) Dr. R. Sage Murphy Dr. Millard W. Hall Dr. Wen H. Huang	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Sage Murphy & Associates, Inc. 910 16th Street, Ste 420 Denver, Colorado 80202	10. PROGRAM ELEMENT NO. B54B2G 11. CONTRACT/GRANT NO. 68-01-5107
12. SPONSORING AGENCY NAME AND ADDRESS U. S. Environmental Protection Agency 401 M Street, S.W. Washington, D.C. 20460	13. TYPE OF REPORT AND PERIOD COVERED Final Report 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This report presents the results of the latest and most comprehensive effort to obtain and analyze O&M costs for wastewater treatment works. It summarizes data from more than 900 treatment plants and almost 500 conveyance systems throughout 40 of the 48 contiguous United States, including all ten EPA regions. Included is information on administrative costs, sludge handling costs, and staffing.

The basic information for this report was obtained from visits to selected sites, and from earlier studies. This basic information was combined into a simple data base, and examined for relationships between total O&M costs, facility design parameters and plant operation parameters. These relationships were developed for the general national level and, where possible, for smaller geographic units. Where appropriate in analyzing the data, total O&M costs were reduced to their major components.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
	non-sensitive	
	20. SECURITY CLASS *(This page)*	22. PRICE
	non-sensitive	

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

☆ U. S. GOVERNMENT PRINTING OFFICE 1981 - 777-002/1103 Reg. 8