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DEVELOPMENT DOCUMENT FOR PROPOSED EFFLUENT LIMITATIONS GUIDELINES, NEW SOURCE PERFORMANCE STANDARDS AND PRETREATMENT STANDARDS

FOR THE

PHARMACEUTICAL MANUFACTURING
POINT SOURCE CATEGORY

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ABSTRACT

This document presents the findings of a study of the Pharmaceutical Manufacturing Point Source Category for the purpose of developing effluent limitations guidelines for existing and new point sources and to establish pretreatment standards for existing and new dischargers to publicly owned treatment works to implement Sections 301, 304, 306, 307, 308, and 501 of the Clean Water act (the Federal Water Pollution Control Act Amendments of 1972, 33 USC 1251 et. seq., as amended by the Clean Water Act of 1977, P.L. 95-217 (the "Act")). This document was also prepared in response to the Settlement Agreement in Natural Resources Defense Council, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976), modified 12 ERC 1833 (D.D.C. 1979).

The information presented supports regulations proposed in February 1982, to improve and restate standards (originally promulgated in 1976) for best practicable control technology currently available (BPT) and to institute new source performance standards (NSPS) and pretreatment standards for new and existing sources (PSNS and PSES) for the Pharmaceutical Manufacturing Point Source Category. The report presents and discusses data gathering efforts, consideration of subcategorization, characterization of wastewaters, selection of pollutant parameters, review of treatment technology, cost and nonwater quality considerations and development of regulatory options and effluent limitations.

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SECTION I

EXECUTIVE SUMMARY

A. SUMMARY AND CONCLUSION

This document presents the technical data to support effluent limitations for the pharmaceutical manufacturing point source category as required by the Clean Water Act (The Act) and related settlement agreements. It also presents the technologies to achieve limitations as defined by an amended best practicable control technology currently available (BPT), best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT), and standards as defined by new source performance standards (NSPS), and pretreatment standards for new and existing sources (PSNS and PSES).

The focus of the effort in developing these limitations and standards was a complex development program utilizing industry data obtained under Section 308 of the Act, supplemented by additional data collection programs for selected portions of the industry.

The pharmaceutical manufacturing point source category manufactureres biological products, medicinal chemicals, botanical products and pharmaceutical products covered by Standard Industrial Classification Code (SIC) Numbers 2831, 2833, and 2834, and other commodities described within this report.

The industry is characterized by diversity of product, process, plant size, and process stream complexity. Subcategories based on process characteristics were defined for purposes of technical evaluation. Although these subcategories were also considered for regulatory purposes, such separation was not found to be appropriate for this industry. This is largely because of the predominance, particularly among larger plants, of multi-subcategory operations as well as the diversity within each defined subcategory.

Sections III through VIII of this document describe the technical data and engineering analyses used to develop the regulatory technology options. The rationales by which the Agency selected the technology options for each of the proposed effluent limitations are presented in Sections X through XIV. Effluent limitations guidelines based on the application of BPT, BAT and BCT are to be achieved by direct dischargers. New source performance standards (NSPS) based on best available demonstrated

technology are to be achieved by new facilities. Pretreatment standards for both existing sources (PSES) and new sources (PSNS) are to be achieved by indirect dischargers for those pollutants which are incompatible with or not susceptible to treatment in a publicly owned treatment works (POTW). These effluent limitations and standards are required by Sections 301, 304, and 307 of the Clean Water Act of 1977 (P.L. 95-217).

B. EFFLUENT LIMITATIONS GUIDELINES

1. BPT Limitations

Proposed BPT limitations* are summarized below:

Parameter	Maximum 30-Day Average	Daily Maximum
TSS (mg/l)	217	
Cyanide (µg/l)	375	643

The existing BPT limitations for BOD5, COD and pH remain unchanged. However, alternative 30-day average maximum concentrations are proposed for BOD5 and COD so that the existing BPT limitations may not, in some cases, be more stringent than the BCT and BAT concentration limitations. The 30-day concentration limitations are equal to the proposed BOD5 and COD limitations for BCT and BAT. In all cases, the less stringent of the limitations will apply. The existing TSS limitations, which apply to 3 out of 5 subcategories, will be replaced by a new less stringent TSS limitation applicable to all 5 subcategories.

2. BAT limitations

Proposed BAT limitations are summarized below:

Parameter	Maximum 30-Day Average	Daily Maximum
COD (mg/l)	570	1024
Cyanide (µg/l)	375	643

3. BCT limitations

Proposed BCT limitations are summarized below:

Parameter	Maximum 30-Day Average	Daily Maximum
BOD (mg/l)	113	252
TSS (mg/l)	110	291

4. NSPS limitations

Proposed NSPS limitations are summarized below:

Parameter	Maximum 30-Day Average	Daily Maximum
BOD_5 (mg/l)	51	126
COD (mg/l)	449	853
TSS (mg/l)	72	195
Cyanide (μg/l)	375	643

5. PSES and PSNS

Proposed PSES and PSNS are summarized below:

Parameter	30 Day Average Maximum	Daily Maximum
Cyanide (ug/l)	375	643

C. IMPACT OF REGULATION

1. BPT Regulation

Proposed BPT effluent limitations for cyanide will prevent the discharge of 17,000 lbs of cyanide per year to surface waters. The total annual and investment costs that may be incurred are estimated to be $628,000 and $1,740,000, respectively. Increases in energy consumption costs as a result of these limitations are expected to be negligible when compared with the other wastewater treatment energy costs of this proposed regulation. The information used to develop these estimates was taken from 308 survey and sampling program results.

No overall decrease in the discharge of TSS is expected as a result of the revised BPT TSS limitations. Although limitations are being established for the first time for subcategory A and C plants, any reduction of TSS achieved by these plants would be offset by the relaxation of the TSS limitations for subcategory B, D, and E plants. No implementation costs are attributable to this revised limitation because the costs are either attributable to compliance with the current BPT BOD5 and COD limitations or are not necessary because this limitation can be met by improvements in treatment system operation.

2. BCT Regulations

Proposed BCT effluent limitations will reduce the discharge of BOD5 by an estimated 6,500 lbs/day (1200 tons/yr) and TSS by

4,425 lbs/day (807 tons/yr). These values are based on the available data for direct discharges as reported in 308 responses and long term daily data submissions with adjustment estimates to reflect all industry direct dischargers. Incremental sludge generation due to the proposed limitations is estimated to be 6395 lbs/day (1167 tons/yr). Sludge estimates are based on a ratio of sludge to BOD removal of 0.3 and a sludge to TSS removal ratio of 1.0.
Costs to implement BCT were estimated on a conservative basis at $7.72 million for total annual costs and $19.4 million for investment costs (1980 dollars). These costs are likely to be somewhat overstated in that they do not reflect site-specific opportunities for modification (as opposed to adding new treatment units.

The incremental energy cost impact of the proposed BCT is approximately $900,000 per year for about 22 M M KWH/yr of electricity. This power can be generated by approximately 37,000 BBL of fuel oil. This energy cost when added to the estimated $2.2 M M (for 56 M M KWH/yr) currently being expended for wastewater treatment energy consumption results in a new energy consumption cost for wastewater treatment of $3.1 M M (for 78 M M KWH/yr). Since the total energy consumption costs of the pharmaceutical industry are about $50 M M to $80 M M, the increment is less than 2 percent bringing the total energy costs devoted to wastewater treatment to about 4 - 6 percent of the industry total.

3. BAT Regulation

Proposed BAT regulations will prevent the discharge of approximately 4.4 million pounds per year of COD (beyond what is removed by the BPT regulation) to the nation's surface waters. There are no costs for incremental energy requirements attributable to this regulation.

4. PSES and PSNS Regulations

Proposed pretreatment standards for existing sources (PSES) control the discharge of cyanide to POTWs. It is estimated that these standards will prevent the discharge of 5900 lbs per year of cyanide to the Nation's POTWs. Total annual and investment costs that may be incurred in complying with these standards are $323,000 and $880,000, respectively. Energy use increases as a result of these standards are expected to be negligible when compared with the total energy use of the industry.

5. NSPS Regulation

The NSPS standards will require the average new source direct discharger to reduce its discharge of BOD5, TSS and COD by 30,000, 15,000 and 83,000 pounds per year, respectively, more than that required of an average existing source direct discharger. The average annual costs for a new source are expected to be 38% above those incurred by a existing source and sludge generation is expected to be 18% higher. Energy consumption costs for wastewater treatment are expected to be 20% higher than those for an average existing source.

SECTION II

INTRODUCTION

A. PURPOSE AND LEGAL AUTHORITY

The Federal Water Pollution Control Act Amendments of 1972 established a comprehensive program to restore and maintain the chemical, physical, and biological integrity of the Nation's waters [Section 101(a)]. By July 1, 1977, existing industrial direct dischargers were required to achieve effluent limitations requiring the application of the best practicable control technology currently available (BPT) [Section 301(b)(1)(A)]. By July 1, 1983, these dischargers were required to achieve effluent limitations requiring the application of the best available technology economically achievable (BAT) which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants [Section 301(b)(2)(A)]. New industrial direct dischargers were required to comply with Section 306 new source performance standards (NSPS) based on best available demonstrated technology. New and existing dischargers to publicly owned treatment works (POTW) were subject to pretreatment standards under Sections 307(b) and (c) of the Act. The requirements for direct dischargers were to be incorporated into National Pollutant Discharge Elimination System (NPDES) permits issued under Section 402 of the Act. Pretreatment standards were made enforceable directly against dischargers to POTWs (indirect dischargers).

Although Section 402(a)(1) of the 1972 Act authorized local authorities to set requirements for direct dischargers on a case-by-case basis, Congress intended that for the most part control requirements would be based on regulations promulgated by the EPA Administrator. Section 304(b) of the Act required the Administrator to promulgate regulatory guidelines for direct discharger effluent limitations setting forth the degree of effluent reduction attainable through the application of best practicable control technology (BPT) and best available technology economically achievable (BAT). Moreover, Sections 304(c) and 306 of the Act required promulgation of regulations for NSPS, and Sections 304(f), 307(b), and 307(c) required promulgation of regulations for pretreatment standards. In addition to these regulations for designated industry categories, Section 307(a) of the Act required the Administrator to promulgate effluent standards applicable to all dischargers of toxic pollutants. Finally, Section 501(a) of the Act authorized the Administrator to prescribe any additional regulations necessary to carry out his or her functions under the Act.

The EPA was unable to promulgate many of these regulations by the dates contained in the Act. In 1976 EPA was sued by several environmental groups; in settlement of this lawsuit, EPA and the plaintiffs executed a settlement agreement, which was approved by the Court. This agreement required EPA to develop a program and adhere to a schedule for promulgating for 21 major industries BAT effluent limitations guidelines, pretreatment standards, and new source performance standards for 65 "toxic" pollutants and classes of pollutants. (40)

On December 27, 1977, the President signed into law the Clean Water Act of 1977. Although this law makes several important changes in the federal water pollution control program, its most significant feature is its incorporating into the Act several of the basic elements of the settlement agreement program for toxic pollution control. Sections 301(b)(2)(A) and 301(b)(2)(C) of the Act now require the achievement by July 1, 1984, of effluent limitations requiring application of BAT for toxic pollutants, including the 65 priority pollutants and classes of pollutants which Congress declared toxic under Section 307(a) of the Act. Likewise, EPA's programs for new source performance standards and pretreatment standards are now aimed principally at toxic pollutant controls. Moreover, to strengthen the toxics control program, Congress added Section 304(e) to the Act, authorizing the Administrator to prescribe best management practices (BMPs) to prevent the release of toxic and hazardous pollutants from plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw material storage associated with or ancillary to the manufacturing or treatment process.

In keeping with its emphasis on toxic pollutants, the Clean Water Act of 1977 also revised the control program for "conventional" pollutants (including biochemical oxygen demand, suspended solids, fecal coliform, oil and grease, and pH) identified under Section 304(a)(4). Instead of BAT for conventional pollutants, the new Section 301(b)(2)(E) requires by July 1, 1984 achievement of effluent limitations requiring the application of the best conventional pollutant control technology (BCT). The factors considered in assessing BCT include the reasonableness of the relationship between the costs of attaining a reduction in effluents and the effluent reduction benefits derived, and the comparison of the cost and level of reduction for an industrial discharge with the cost and level of reduction of similar parameters for a typical POTW [Section 304(b)(4)(B)]. For nontoxic, nonconventional pollutants, Sections 301(b)(2)(A) and 301(b)(2)(F) require achievement of BAT effluent limitations within three years after their establishment or after July 1, 1984 (whichever is later), but not later than July 1, 1987.

This document presents the technical bases for the application of revised BPT, and new BAT, BCT, new source performance standards (NSPS), pretreatment standards for existing sources (PSES), and pretreatment standards for new sources (PSNS) for the pharmaceutical manufacturing point source category.

B. PRIOR EPA REGULATIONS

On November 17, 1976, the EPA promulgated interim final BPT regulations for the pharmaceutical manufacturing point source category at 41 Federal Register 50676, 40 CFR Part 439, Subparts A-E. (27). The BPT regulations set monthly limitations for BOD5 and COD based on percent removals for all subcategories. No daily maximums were established for these two parameters. The pH was set as within the range of 6.0 to 9.0 standard units. The rulemaking also set an average of daily TSS values for any calendar month for subcategories B, D, and E. No TSS limits were established for categories A and C. Subpart A (the section applicable to the fermentation operations subcategory) was amended on February 4, 1977 (42 FR 6814), to improve the language referring to separable mycelia and solvent recovery and to allow the inclusion of spent beers (broths) in the calculation of raw waste loads for subcategory A in those instances where the spent beer is actually treated in the wastewater treatment system. These regulations were never challenged and are presently in effect. The technical basis for these regulations was provided in EPA 440/1-75/060, published in December 1976. This report, which formed the technical basis for BPT is henceforth referred to as the 1976 Development Document. (55) These BPT regulations were never challenged, and are still in effect.

C. SCOPE OF THIS RULEMAKING

In EPA's initial rulemaking (August 1973 thru November 1976), emphasis was placed on the achievement of BPT based on the control of familiar, primarily conventional pollutants, such as BOD, TSS and pH and non-conventional pollutants, such as COD. By contrast, in this round of rulemaking, EPA's efforts are directed toward amending existing BPT limitations and instituting BAT and BCT effluent limitations and new source performance standards, PSES and PSNS, with added attention given to toxic pollutants.

D. DEFINITION OF THE INDUSTRY

The pharmaceutical manufacturing point source category is defined as those manufacturing plants producing or utilizing the following products, processes, and activities:

(1) Biological products covered by Standard Industrial Classification (SIC) Code No. 2831.

(2) Medicinal chemicals and botanical products covered by SIC Code No. 2833.

(3) Pharmaceutical products covered by SIC Code No. 2834.

(4) All fermentation, biological and natural extraction, chemical synthesis, and formulation products which are considered as pharmaceutically active ingredients by the Food and Drug Administration, but which are not covered by SIC Code Nos. 2831, 2833, or 2834. (Products of these types which may not contain pharmaceutically active ingredients will be included if they are manufactured by processes, and result in wastewaters, which closely correspond to those of a pharmaceutical product. Examples of ingredients which fall into this category are citric acid, benzoic acid, gluconic acid, fumaric acid, and caffeine.)

(5) Cosmetic preparations covered by SIC Code No. 2844 which function as a skin treatment. (This would exclude lipsticks, eyeshadows, mascaras, rouges, perfumes, and colognes which enhance appearance or provide a pleasing odor, but do not provide skin care. In general, this would also exclude deodorants, manicure preparations, and shaving preparations which do not primarily function as a skin treatment.)

(6) The portion of a product with multiple end uses which is attributable to pharmaceutical manufacturing either as a final pharmaceutical product, component of a pharmaceutical formulation or a pharmaceutical intermediate. (Products with pharmaceutical and nonpharmaceutical end uses will be entirely covered under this point source category if the products are used primarily as pharmaceuticals.

(7) Pharmaceutical research which includes biological, microbiological, and chemical research, product development, clinical and pilot plant activities. (This includes animal farms at which pharmaceutical research is conducted or at which pharmaceutically active ingredients are tested on the farm animals. This does not include farms which breed, raise, and/or hold animals for research at another site. Also excluded are ordinary feedlot or farm operations using feed which contains pharmaceutically active ingredients since the wastewater generated from these operations is not characteristic of pharmaceutical wastewater).

Products or activities specifically excluded from the pharmaceutical manufacturing category are:

(1) Surgical and medical instruments and apparatus covered by SIC Code No. 3841.

(2) Orthopedic, prosthetic, and surgical appliances and supplies covered by SIC Code No. 3842.

(3) Dental equipment and supplies covered by SIC Code No. 3843.

(4) Medical laboratories covered by SIC Code No. 8071.

(5) Dental laboratories covered by SIC Code No. 8072.

(6) Outpatient care facilities covered by SIC Code No. 8081.

(7) Health and allied services, not elsewhere classified, covered by SIC Code No. 8091.

(8) Diagnostic devices not covered by SIC Code No. 3841.

(9) Animal feeds which include pharmaceutically active ingredients such as vitamins and antibiotics. (The major portion of the product is nonpharmaceutical and the wastewater which results from the manufacture of feed is not characteristic of pharmaceutical manufacturing.)

(10) Foods and beverages which are fortified with vitamins or other pharmaceutically active ingredients. (The major portion of the product is nonpharmaceutical and the wastewater which results from the manufacture of these products is not characteristic of pharmaceutical manufacturing.)

In the previous regulation based on BPT, the pharmaceutical manufacturing point source category was grouped into five product or activity areas. This subcategorization was based on distinct differences in manufacturing processes, raw materials, products, and wastewater characteristics and treatability. The five subcategories that were selected are:

(1) Subcategory A - Fermentation Products.
(2) Subcategory B - Biological and Natural Extraction Products.
(3) Subcategory C - Chemical Synthesis Products.
(4) Subcategory D - Formulation Products.
(5) Subcategory E - Pharmaceutical Research.

For the purposes of the 1977-82 study, EPA decided to de-emphasize pharmaceutical research (Subcategory E). Pharmaceutical research does not fall within the SIC Code Nos. 2831, 2833, and 2834, which were identified in the Consent Decree, and does not appear to be a significant part of the

industry from the point of view of effluent. In addition, this activity does not involve production and wastewater generation on a regular basis. However, in cases where the pharmaceutical research activity does involve the production of active ingredients by processes generating wastewater which are similar to those in the current study, the information contained in the proposed development document may be used by permit writers and other interested parties.

The subcategory breakdown utilized for the current study was used for evaluative purposes only. In terms of analyzing raw waste characteristics, wastewater flow, treatment technology alternatives, etc., a breakdown of the industry by product/process (i.e., subcategories) was the most practical. However, as explained in more detail below, separate subcategories were not considered necessary for regulatory purposes, because one set of limits could be met by all pharmaceutical plants. Therefore, the limitations proposed will be applicable across the industry irrespective of the process source of the waste.

E. SUMMARY OF METHODOLOGY

As explained in more detail in Section II. E EPA first gathered technical and descriptive data about the industry, from which the Agency proceeded to develop the proposed regulations. EPA used four basic sources in acquiring data to support these new regulations. These sources included:

(1) Data acquired from industry under Section 308 of the Act. Using this approach, 308 Portfolio questionnaires were distributed to a representative sample of the industry. This was followed by a sampling and verification program from candidate plants chosen from the first group. This program used the analytical protocol for pollutant detection and measurement developed under section 304(h).

(2) Data acquired through open literature search using documents from or relevant to the pharmaceutical industry.

(3) Data acquired from EPA regional offices, state and other government offices, and pharmaceutical plant visits.

(4) The Administrative Record from the 1976 rulemaking for the pharmaceutical industry, including the 1976 Development Document.

EPA then studied the pharmaceutical industry to determine whether differences in such factors as raw materials, final products, manufacturing processes, equipment, water use, wastewater

constituents, and age and size of the manufacturing facilities required the development of separate effluent limitations and standards for different segments of the industry. This study required the identification of raw waste and treated effluent characteristics, including: (1) the water sources and volume used, (2) the manufacturing processes employed, (3) the location of pollutant and wastewater sources within the plant, and (4) the wastewater constituents including toxic pollutants. After tentatively designating subcategories, EPA then identified the constituents of wastewaters which should be considered for effluent limitations and standards.

Next, the EPA identified several distinct control and treatment technologies, including both in-plant and end-of-process technologies, which currently are in use or capable of being used to control or treat pharmaceutical industry wastewater. The Agency compiled and analyzed historical and newly acquired effluent data utilizing these various technologies. Long-term performance, operational limitations, and reliability for each treatment and control technology were also considered and statistical analyses of long term data performed in order to derive performance standards and variability factors. Additionally, the EPA evaluated the non-water environmental impact of these technologies on air quality, solid waste generation, and energy requirements.

The EPA developed base cases representative of each subcategory (based on waste load characteristics) to derive treatment processes and capital and operating costs for each technology. These costs were presented as curve functions of waste loading and flow. The technologies evaluated included biological end-of-pipe processes (e.g., biological enhancement), as well as in-plant priority pollutant treatments (cyanide destruction and steam stripping). The annual unit costs (including capital amortization) were totaled at varying flows and waste loads for each of the four subcategories. The agency then evaluated the economic impact of these costs on the industry as a whole. Costs and economic impacts are discussed more fully in "Economic Impact Analysis of Proposed Effluent Limitations Guidelines, New Source Performance Standards and Pretreatment Standards for the Pharmaceutical Manufacturing Point Source Category."

EPA identified various control and treatment technologies as BPT, BAT, BCT, NSPS, PSES, and PSNS. The proposed regulations, however, do not require the installation of any particular technology. Rather, they require achievement of effluent limitations representative of the proper application of these technologies or equivalent technologies. A pharmaceutical plant's existing controls should be fully evaluated, and existing

treatment systems fully optimized before commitment to any new or additional end-of-pipe treatment technology.

F. DATA AND INFORMATION GATHERING PROGRAM

EPA used a number of sources in acquiring data to support regulations for the pharmaceutical manufacturing point source category. These sources are identified and discussed below in the 9 following subsections:

(1) Preliminary data was obtained from the five sources described below. This information was used to direct the other data gathering efforts.

(a) Data acquired from 22 plants which served as the supportive data base for the BPT regulations issued in November, 1976.

(b) Data acquired from PEDCo, RTP and RSKERL/Ada studies (discussed in Section V).

(c) Information acquired through an open literature search. (A major portion of this effort has been performed by The Research Corporation of New England (TRC). Some of the important literature sources were documents prepared by the Pharmaceutical Manufacturers Association (PMA); the Executive Directory of U.S. Pharmaceutical Industry, Third Edition, Chemical Economics Services, Princeton, New Jersey; (51) and the Directory of Chemical Producers - U.S.A., Medicinals, Stanford Research Institute, Menlo Park, California. (50))

(d) Data acquired from EPA regional offices, state and other government offices, and pharmaceutical plant visits.

(e) The administrative record relating to previous EPA regulations included the original Development Document (EPA-440/1-75/060, December 1976) and its appendices. This record was very useful in obtaining general information on the pharmacutical manufacturing industry. We reviewed this document for information on use or suspected presence of toxic and nonconventional pollutants, applicable production process controls, and available effluent treatment techniques. The administrative record also included the original economic impact analysis documents.

(2) Data acquired from the industry under Section 308 of the Act. (This approach included (a) the distribution of 308 Portfolios to members of the industry population which we identified and (b) wastewater sampling of candidate plants which were selected in accordance with the criteria discussed in

Section V.) The objectives of the 308 Portfolio for Pharmaceutical Manufacturing were:

(1) To obtain information for the construction of a comprehensive industry profile.

(2) To obtain information on production, wastewater generation, and wastewater treatment at existing facilities to expand the data base for guidelines development.

(3) To ascertain industry-specific problems which need to be considered in guidelines development.

(4) To develop a list of candidate plants for priority pollutant sampling.

The 308 request also was used to solicit information from the industry which it felt would be relevant to this rulemaking effort and to develop individual plant contacts to lay the foundations for future inquiry.

The 308 Portfolio for Pharmaceutical Manufacturing presented in Appendix B, was developed by EPA and Burns and Roe Industrial Service Corp. (BRISC) with the cooperation of the PMA Environmental Task Force during the spring and summer of 1977. During the same period, a distribution mailing list was formulated. The 308 Portfolios initially were sent only to PMA member firms and to nonmember plants included in previous EPA guidelines work. This decision was based on the following assumptions and facts:

(1) PMA members were considered more likely to provide quality responses to the 308 Portfolio.

(2) Development and distribution of the 308 Portfolio could in part be assisted and coordinated by the PMA.

(3) Many of the essential contacts had already been established with the PMA.

(4) The Agency felt that the 308 Portfolio need cover only a statistically representative sample of pharmaceutical plants in the United States. The PMA has members which range from small one-plant firms to firms with as many as 25 plants, some of which are large manufacturing complexes. The PMA members are principally manufacturers of prescription pharmaceuticals, medical devices, and diagnostics. However, PMA member firms also produce a significant portion of the over-the-counter drugs on the market. These members account for approximately 90 to 95 percent of the U.S. sales of prescription products and about 50

percent of the free world's total output of ethical pharmaceuticals. For the purpose of the 308 Portfolio, the PMA member firms were judged to provide a statistically representative distribution.

The PMA List of Administrative Officers of the Member Firms Associates, October 1976 Edition, which contains 130 member firms, was used as a basis for the mailing list. Many of the 130 members are subsidiaries or divisions of common member or non-member parent firms. Table II-1 summarizes the Original 308 Portfolio distribution and response. Of the 442 portfolios that were mailed in 1977, a total of 431 were returned. One hundred five of these were from nonpharmaceutical/nonmanufacturing plants, while another 50 were duplicates of plants already covered. For purposes of this study, EPA decide to exclude exclusively Subcategory E plant as explained earlier. The 32 plants that had only Subcategory E operations were dropped from the survey. Thus, a total of 244 pharmaceutical manufacturing plants are presently included in the original 308 data base. They are listed in Appendix C.

(3) Supplemental 308 Portfolio

Since 1977, EPA has identified more than 500 additional facilities that may be part of this industry. The open literature file developed by TRC identified a total of 990 possible pharmaceutical sites in the United States. The data file was reviewed by BRISC and PEDCo, an EPA contractor with process design and construction experience in the pharmaceutical industry. This led to a revised listing of more than 540 plant sites of approximately 400 companies which were not included in the original 308 Portfolio distribution, but which were possible producers of pharmaceutically active ingredients.

Although EPA knew that this segment of the industry (principally comprised of non-PMA-member companies) accounts for only a small fraction of sales (5-10 percent), the total wastewater volume was unknown. The Agency also expected that these plants are small producers upon whom new regulations could have a major impact. In an effort to define the entire pharmaceutical population, obtain a more complete profile of the industry, and confirm the assumption that the PMA member firms included in the initial survey do indeed represent the industry, a Supplemental 308 Portfolio for Pharmaceutical Manufacturing was developed during the fall of 1978. This questionnaire, presented in Appendix D, is an abbreviated form of the original 308 Portfolio and was distributed to 540 possible pharmaceutical sites in April 1979. Table II-1 presents a summary of the Supplemental 308 Portfolio distribution program. Of the 540 supplemental portfolios, 355 were returned. After accounting for the 128

nonpharmaceutical/nonmanufacturing plants, 4 duplicate portfolios, and 3 Subcategory E-only plants, 220 plants were identified as pharmaceutical manufacturers. They are listed in Appendix E.

The end result of the two questionnaire mailings was a comprehensive pharmaceutical industry data base containing 464 manufacturing plants. Throughout later sections of this report, references to 308 Portfolio data are to the comprehensive data base of 464 plants. Table II-1 summarizes distribution and response return counts for the entire 308 Portfolio program.

There are some differences in the information requested by first and second 308 questionnaires. Both versions contained a general information section requesting company name, number of employees, etc. The original 308 requested information on research and development facilities which was dropped from the supplemental form. Products manufactured and method of production were covered by both the original and supplemental portfolios.

The most significant difference between the two mailings was in the wastewater data section. The original 308 was very detailed in this area. Water source, water use, wastewater source and wastewater disposal information was requested. The original questionnaire contained questions concerning solid wastes, changes in treatment operation, and operating costs all of which were dropped from the Supplemental 308. In the supplemental form wastewater data was requested only if end-of-pipe treatment was practiced. Both forms of the portfolio requested data relating to priority pollutant occurrence in raw materials and wastewater. The supplemental portfolio was shortened because the second group of plants to whom this portfolio was sent were considered to be smaller and less complex on average and to have less data and response resources.

(4) Plant Visits and Direct Contacts

During the screening/verification phase of this project, we also gathered information on production capacity, manufacturing process, waste flows, water reuse, wastewater treatment systems and performance, and best management practices (BMP). The visits also provided an opportunity to update and clarify information from the 308 Portfolio responses.

An additional plant visit was made to a selected pharmaceutical manufacturing site for the purposes of the precision and accuracy (P/A) analysis. This visit is discussed in Section V which reviews th analytical sampling results.

We also telephoned plant personnel to clarify 308 and long term data responses.

(5) Screening Program

a. Background

EPA focused its sampling and analysis on the toxic pollutants designed in the Act. However, we also sampled and analyzed conventional and nonconventional pollutants. We have explained our analysis methods for toxic organic pollutants in the preamble to the proposed regulation for the leather Tanning point source category (44 FR 38749, July 2, 1974). Before proceeding to analyze industrial wastes, we had to isolate specific toxic pollutants for analysis. The list of 65 pollutants and classes of pollutants potentially includes thousands of specific pollutants; analyses for all of them would overwhelm private and government resources. To make the task more manageable, therefore, EPA selected 129 specific toxic pollutants for study in this and other industry rulemakings. The criteria for choosing these pollutants included the frequency of their occurrence in water, their chemical stability and structure, the amount of the chemical produced, and the availability of chemical standards for measurement.

The screening program for the pharmaceutical manufacturing industry was developed to obtain data indicating the presence of priority pollutants and the extent of their presence in the industry's wastewater. The resulting plant-by-plant priority pollutant concentrations are included in the screening/verification data base.

b. Selection of Screening Plant Candidates

In order to prepare a list of pharmaceutical manufacturing plants for the screening program, specific criteria were developed which served as the basis for the selection process. Each candidate plant was subjected to these criteria to determine its acceptability as a screening candidate. The object of the selection process was to prepare an optimal list of candidates which was representative of the pharmaceutical industry in terms of production methods, product lines, wastewater characteristics, treatment technology, and other characteristics, and yet would result in sampling at the smallest number of sites. Brief discussions of each criterion used in the selection process are presented in the paragraphs that follow.

One of the major criteria for selecting candidate plants for the screening program was the pharmaceutical plant's subcategory or type of production operation. Four different types of production

operations are utilized in the making of pharmaceutical products. They are fermentation, biological/ natural extraction, chemical synthesis, and mixing/compounding/ formulation (see fuller discussion in section III). Because of the distinct characteristics of each operation, the properties of a plant's wastewater will be influenced by the operation(s) employed at the site. Since the major portion of wastewater flow is generated by pharmaceutical manufacturing plants employing more than one type of production operation at a particular site, the goal of the selection process was to choose plants that would not only cover the above four categories, but that would also provide a satisfactory production operation mix (i.e., provide various combinations of the above four subcategories). Also, past experience indicated that Subcategories A and C were more likely to have priority pollutants in their discharge than Subcategories B and D. Therefore, the selection process concentrated on obtaining plants with these production operations. The end result was that the screening list had proportionately more Subcategory A and C plants than the pharmaceutical industry as a whole.

Another important criterion of the selection process dealt with the type of treatment at the plant, since the final effluent quality of any wastewater discharge will be dependent upon the treatment used. For the screening program, the goal was to try to select those plants that had significant treatment. In this analysis, significant treatment was defined as treatment beyond equalization, neutralization, and primary sedimentation, namely, biological, physical/chemical, or other secondary treatment. Therefore, the end result was that the screening list reflected a relatively higher degree of treatment than the pharmaceutical industry as a whole.

As stated previously, the purpose of the screening program was to determine the nature and extent of priority pollutants in the pharmaceutical industry's wastewaters. Probably the most important factor affecting the presence of these pollutants in a plant's effluent is their use as raw materials in the production operation. Thus, to optimize the screening program, the selection process concentrated on selecting those plants that used a large number of different priority pollutants in their operations.

Some pharmaceutical plants indicated that they had performed their own wastewater sampling over a period of time. Information of this kind was thought to be important, since it could provide background information on the plant's effluent quality and assist in the analyses of the sampling data gathered during the screening program. Therefore, consideration was given to those facilities known to have historical sampling data.

The amount of wastewater discharged by a particular pharmaceutical manufacturing plant is dependent upon many factors. Some of the more important factors are type of production operation, product line, plant size, treatment costs, etc. For the screening program, it was thought to be desirable to select plants which discharged varying quantities of wastewater. In this way, the screening could ascertain the effect of small and large flows on priority pollutant levels and also be relatively representative of the pharmaceutical industry as a whole. However, since it was necessary for a plant to have a measurable wastewater flow in order to be sampled, plants having zero (or very low) wastewater flows were omitted.

Another criterion for selecting plant candidates had to do with company ownership of the particular manufacturing plant. The goal was to minimize, wherever possible, the number of plants operated by a single company. First, this would avoid "biasing" the screening data because of a particular company's operating procedures. Second, it would minimize the resource impact (personnel, time, costs, etc.) sampling would have on an individual company.

Although they were not as significant as the above criteria in the selection of plant candidates, each manufacturing plant's geographic location, age, number of employees, etc. were also considered. For plant location and age, the selection process tried to obtain a good variety of facilities reflecting the total pharmaceutical manufacturing industry.

In order to satisfy the more important criteria, the selection process regarding plant employment tended to emphasize larger facilities since past experience indicated that the larger plants generally had more complex operations. Thus, the screening list would tend to contain more of the larger manufacturing plants than the pharmaceutical industry as a whole would.

The development of the final list of pharmaceutical plants to comprise the screening program was accomplished in a step-wise fashion. For each plant, the BPT data file, 308 Portfolio, federal and state government documents, and other available information were reviewed in order to prepare a preliminary screening list. This list was frequently reviewed and revised on the basis of the aforementioned criteria in an attempt to develop an optimal final list. The goal was to ensure that the final list of screening plants maximized the specified criteria, yet comprised a minimum number of plants to be sampled.

The end result of the selection process was that 26 pharmaceutical manufacturing plants comprised the final screening list. Pertinent data on the selected plants are shown in Table II-2.

c. Screening Protocol

Following the final selection of the 26 screening plants, preparations were made for the actual sampling activities. The sampling protocol developed by EPA and discussed in "Sampling and Analysis Procedures for Screening of Industrial Effluent for Priority Pollutants" (60) served as the basis for the collection and analysis of screening samples at the subject pharmaceutical manufacturing sites. An overview of the screening methods is discussed below.

The general rule was to obtain 24-hour samples wherever possible. In some instances, this was altered to accommodate a particular aspect of the plant to be screened. Certain facilities had batch operations and/or did not operate "around-the-clock." For these situations, samples of less than 24 hours, generally 8 hours, were collected. On the other hand, some facilities had varying operations which showed fluctuating characteristics over a period longer than 24 hours. Here a longer sampling time was warranted, generally on the order of 48 hours. In most cases, however, 24 hour samples were collected. To cover certain unique situations, the sample period was increased or decreased as necessary. No significant impact was expected from these modifications, since the major goal of the screening program was only to identify the presence and typical levels of priority pollutants in the wastewaters of the pharmaceutical manufacturing industry.

The types of samples collected during the screening program were based upon the sampling protocol developed by EPA. To identify these priority pollutants, classified as acid or base/neutral extractables and metals, composite samples were obtained. For the volatile organics and phenols portion of the priority pollutants, grab samples were taken. Samples were analyzed in accordance with the analytical techniques outlined in "Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants" (60).

Two sampling locations of specific interest were the influent and effluent of the plants' wastewater treatment systems. The influent to the treatment system was important in the analyses to determine the levels of priority pollutants generated by the various pharmaceutical manufacturing operations. The effluent from the treatment system was critical in determining the effect of the various treatment systems on the removal of priority pollutants and the resultant levels reaching the receiving waters.

Samples were also usually collected at other locations throughout a particular facility. This was done to obtain supplementary information on a specific operation or treatment step or to

ensure that certain characteristics unique to a certain plant were adequately covered. Some examples of these sample locations are intake water, specific production wastewaters, holding tanks, cooling water, etc. The end result was that more detailed information for each screening plant was made available for the analyses of the fate of priority pollutants in pharmaceutical wastewaters.

(6) Verification Program

As previously mentioned, the screening program was developed to obtain data which could be used to indicate the presence of priority pollutants and to characterize their nature and extent in the pharmaceutical industry's wastewaters. Having obtained these data, the EPA then selected five of the screening plants for the verification program that used the assortment of major priority pollutants as raw materials for the manufacture of pharmaceuticals. The purpose of the verification program was to confirm the data obtained during the screening program and to more accurately quantify the concentrations, loadings, and percent reductions of those pollutants found at significant levels during the screening program.

a. Selection of Verification Plant Candidates

The final list of pharmaceutical plants to comprise the verification study is given in Table II-3. EPA developed this list by selecting those plants that satisfied one or more of the following criteria:

- Those plants with BPT-type treatment systems.
- Those plants that use cyanide as a raw material.
- Those plants with in-plant control measures such as cyanide destruction, steam stripping, and solvent recovery.

In addition, EPA selected plants that would not only cover the four subcategories, but that would also provide a satisfactory production operation mix (i.e., provide various combinations of subcategories at particular plants).

b. Verification Protocol

Prior to verification sampling, preliminary grab samples were collected from the verification sampling locations to determine the applicability of the planned analytical methods. However, the data obtained from these grab samples were not used to

quantify effluent levels or to calculate percent removals achieved by the treatment systems.

The results of analyzing the screening visit samples were usually discussed with operating personnel to determine if priority pollutants found were used by the plant as either raw, intermediate, or final products. These results and the data obtained from the aforementioned grab samples were used to determine the final verification sampling locations and to define the priority pollutant verification analyses to be performed.

For a detailed discussion of the sampling methods employed in the verification program, the reader is referred to "Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants" (60). With respect to sampling time, the verification program was directed toward gathering three days of 24-hour samples. Where automatic composite samples were not feasible, manual composite samples were obtained for analysis of acid and base/neutral extractables, metals, and conventional and non-conventional pollutants. Grab samples were taken for analysis of volatile organics, phenols, and cyanides. Some wastewater streams were grab sampled once for analysis of all parameters. Samples for the verification phase were analyzed in accordance with the 304(h) approved methods found in "Analytical Methods for the Verification Phase of the BAT Review" (129).

The analysis of verification samples was performed under a detailed quality-assurance/quality-control procedure. The procedure required analyses of duplicate extractions for samples collected on the first day of verification sampling. Samples taken on the second and third days of verification sampling were extracted and analyzed, spiked with appropriate amounts of pollutants, and reanalyzed. Spike recoveries were calculated from the data generated during these analyses. The spiking and reanalysis requirement was deleted if the original pollutant concentration was below the detectable limit. Another requirement was that samples not analyzed, spiked, and re-extracted within 72 hours of sample collection were subjected to an additional spiking, holding, and analysis. This requirement was designed to determine whether the pollutants degrade during storage.

As in the previous case of the sampling programs, the two sampling locations of specific interest were the influent and effluent of each plant's wastewater treatment systems. The treatment system's influent was important in the analyses to determine the levels of priority pollutants generated by the various pharmaceutical manufacturing operations. The treatment system's effluent was critical in determining the effect of the various treatment systems on the removal of priority pollutants and the resultant levels reaching the receiving waters.

In addition to the above, samples were usually collected at other locations throughout a particular facility. This was done to obtain supplementary information on a specific operation or treatment step or to ensure that certain characteristics unique to a plant were adequately covered. Examples of these sampling locations are intake water, cooling water, specific production wastewaters, etc. The end result was a more detailed analysis of the fate of priority pollutants for each verification plant. Since a goal of the verification program was to quantify those pollutants found during the screening program, the same sampling locations were generally used for the two programs.

(7) Long-Term Data Program

In addition to 308 and Screening/Verification data, the Agency was interested in obtaining data which would reveal traditional pollutant raw waste loads and their day-to-day variability. This required obtaining data, collected over a consecutive time period, which reflected fluctuations in process effluent. Therefore, the Agency decided to identify those plants which had collected data through self-monitoring. The Agency was particularly interested in data for the conventional parameters Biochemical Oxygen Demand (BOD), and Total Suspended Solids (TSS), the non-conventional parameter Chemical Oxygen Demand (COD), and cyanide (CN).

As in the Screening and Verification programs, specific criteria were developed which served as the basis for the selection process. The controlling factor for assembling a list of candidate plants was whether the plant in question had been conducting a self-monitoring program. Once a list of candidate plants had been developed, they were subjected to criteria similar to those for the screening program.

One of the major points of concern for selecting long-term plants was the subcategory or type of production operation. The prime objective was to select plants that would encompass the four subcategories and combinations of subcategories. This was done to provide a representative cross section of production processes and the consequent wastewater effluents found within the industry. An equally important criterion for selection was the type of wastewater treatment used by the candidate plant. It was also desirable to include not only plants that had exemplary "BPT type" but also plants with typical "BPT type" treatment. If possible more than one type of treatment system was included.

Also important as a selection criterion was the amount of wastewater discharged. Again an attempt was made to cover a range of wastewater flows that was representative of the industry.

Another criterion for selection involved company ownership. An attempt was made to select plants operated by different companies. This was done for two reasons. This would avoid biasing the data because of a particular company's operation circumstances and policy. Also, it would reduce the resource burden that sampling would be for an individual company. However, for comparative purposes it was desirable to have some plants common to both the Screening/Verification data base and the Long-Term data base.

Other criteria considered but not as significant were geographic location of each plant, plant age, and number of employees.

Using the criteria outlined above, thirty-five (35) plants were selected as long-term data candidates. Questionnaires were sent to these plants and responses were received from 22 plants. The respondents represented a good cross section of the industry as indicated by the statistics which follow:

SUBCATEGORY CLASSIFICATION

SINGLE SUBCATEGORY PLANTS	13
Subcategory A only	2
Subcategory B only	1
Subcategory C only	3
Subcategory D only	7
MIXED SUBCATEGORY PLANTS	9

WASTEWATER FLOW

Less than 0.1 MGD	6	plants
0.1 to 1.0 MGD	11	plants
1.0 to 10.0 MGD	4	plants

DISCHARGE TYPE

Direct	17
Indirect	5

The responses were carefully reviewed to see that the treatment systems and data were suitable. One plant (#12123) was eliminated from traditional pollutant consideration because data were available for cyanide removal only. Five more plants were eliminated because they were indirect dischargers whose treatment systems were in place to avoid sewer use charges rather than to achieve a permit-specified performance. The data base contained 17 plants with reasonable treatment schemes at this point of the review. The remaining plants were scrutinized to determine the

level of performance of their waste treatment facilities. Four of the remaining plants were eliminated due to poor performance of their facilities, which made their data unsuitable as a basis for limitations reflecting good technology as required for BCT, BAT, and NSPS. The performance of the remaining plants was averaged and served as the basis for BCT and BAT regulations. Three plants classified as marginal performers were eliminated from the data base before averaging for NSPS purposes. Details on the exact plant selection process are provided in Section X.

Table II-4 presents the total list of Long-Term Data Plants with selected characteristics.

Table II-5 presents a comparison of the screening plants and long-term plants versus the total pharmaceutical manufacturing population.

(8) PCS Data

Another source of data was the current PCS (Permit Compliance Schedule) for pharmaceutical manufacturers possessing NPDES permits. These permits contain the limitations under which the individual plants are currently being regulated. A comparison of the permit limitations versus 1976 BPT limitations is presented in Section III.

G. Processing of Data and Information

Stanford Research Institute (SRI) was contracted to do a two-part statistical analysis of the pharmaceutical industry data base. Long-term effluent data were evaluated to determine variability of pollutant removal resulting from long-term operation. The analysis centered on effluent data yielding daily and monthly variability factors for each pollutant. Alternative methods for calculating variability factors were developed, permitting the recommendation of a meaningful and useful variability allowance for regulatory purposes.

In the second part of the analysis, screening and verification data were evaluated to determine the frequency of occurrence of each priority pollutant occurring in the manufacture of pharmaceuticals. A frequency ranking was prepared for groups of priority pollutants and is discussed in Section V. In addition, the statistical pattern of concentrations of each pollutant present was analyzed. Frequency of occurrence and concentration information were two criteria on which the selection of specific priority pollutants for regulation was based. In addition, we considered whether treatment required by other regulations would control these pollutants. Section VI contains a detailed

discussion of this selection process in light of the criteria for exclusion in paragraph 8 of the Consent Agreement.

TABLE II-1

PHARMACEUTICAL SUMMARY

SUMMARY OF 308 PORTFOLIO MAILING

	Original 308's	Supplemental 308's	Comprehensive Data Base
Portfolios Distributed:	442	540	982
Plants in the Initial Mailing	396	523	919
"Additional" Plants Included in Survey	46	17	63
Portfolios Not Returned:	-11	-185	-196
Portfolio Processing:	-187	-135	-322
Duplicate Portfolios	-50	-4	-54
Non-Mfg. (Non-Pharm.) Portfolios	-105	-128	-233
Exclusively Research (Subcategory E) Portfolios	-32	-3	-35
Manufacturing Portfolios:	244a	220b	464

(a) These plants are listed in Appendix C.
(b) These plants are listed in Appendix E.

TABLE II-2

PHARMACEUTICAL INDUSTRY

CHARACTERISTICS OF THE 26 PLANTS SELECTED FOR SCREENING

Plant No.	Subcategory	EOP Treatment*	Wastewater Flow (MDG)	EPA Region	Startup Year
12015	D	AS,AC	0.101	III	1960
12022	A C	AS,TF	1.300	III	1951
12026	C	AS,AL	0.101	II	1950
12036	A	AS,TF,AL	1.128	V	1948
12038	A B C D	AS,AL	0.855	V	1954
12044	A D	Primary Treatment Only	2.97	V	1938
12066	B C D	AS,AL	0.26	V	1953
12097	C D	AS	0.035	V	1951
12108	A C D	Primary Treatment Only	-	II	N/A
12119	A D	AS	0.032	II	1977
12132	A C	AS,TF	1.000	III	1941
12161	A C D	AS	1.332	II	1969
12204	A B C D	AS	0.850	II	1907
12210	B C	AL	0.002	IV	1973
12231	A D	AL	0.50	II	1968
12236	C	AS	0.810	IV	1952
12248	D	AS	0.035	III	1961
12256	A B C D	Primary Treatment Only	30.00	I	1948
12257	A B C D	AS	.600	V	1965
12342	A C D	None	0.701	II	N/A
12411	B C D	AL	0.30	IV	1970
12420	B D	AS	1.33	V	1973
12439	C D	AS,AL	0.01	II	1974
12447	A B C D	Primary Treatment Only	1.50	V	N/A
12462	A	AS,AL	0.170	VII	1972
12999**	C D	Primary Treatment Only	0.45	VII	N/A

Subcategory Totals: A = 15 Legend: AC = activated carbon AS = activated
AL = aerated lagoon TF = trickling

* See Appendix M for in-plant and end-of -pipe treatment
** 308 Portfolio was not received from this plant.

TABLE II-3

PHARMACEUTICAL INDUSTRY

CHARACTERISTICS OF THE FIVE PLANTS SELECTED FOR VERIFICATION

PLANT CODE	SUBCATEGORY	MAJOR TREATMENT	COMMENTS
12026	C	Activated Sludge Aerated Lagoon Polishing Pond	Has Solvent Recovery
12038	ABCD	Activated Carbon Activated Sludge Aerated Lagoon Physical-Chemical Thermal Oxidation	Uses Cyanide; Has Steam Stripping; Has Solvent Recovery
12097	CD	Activated Sludge Physical-Chemical	Uses Cyanide; Has Solvent Recovery
12236	C	Activated Sludge	Uses Cyanide; Has Solvent Recovery
12411	BCD	Aerated Lagoon	On-Site Incineration of Solvents

TABLE II - 4

PHARMACEUTICAL INDUSTRY

CHARACTERISTICS OF 23 PLANTS SELECTED FOR LONG TERM STUDY

Plant No.	Subcategory	EOP Treatment*	Wastewater Flow (MGD)	EPA Region	Startup Year	Employment
12015	D	AS, AC	0.101	III	1960	300 - 400
12022	A C	AS, TF	1.448	III	1951	100 - 200
12026	C	AS, AL	0.161	II	1950	0 - 100
12036	A	AS, TF, AL	5.156**	V	1948	100 - 200
12097	C D	AS	0.064	V	1951	100 - 200
12098	D	AS	0.006	II	1975	0 - 100
12117	B D	AS	0.101	III	1882	400 - 500
12123	C D	Primary Treatment Only	0.932	II	1937	200 - 300
12160	D	AS	0.029	II	1974	200 - 300
12161	A C D	AS	1.653	II	1969	800 - 900
12186	C D	AS, AL	0.037	II	1976	0 - 100
12187	C	TF	1.065	I	1949	0 - 100
12235	C	Primary Treatment Only	No Data	II	1971	0 - 100
12236	C	AS	0.816	IV	1952	200 - 300
12248	D	AS	0.110	III	1961	700 - 800
12257	A B C D	AS	0.755	V	1922	4000 - 4500
12294	C D	AS	0.118	II	1969	300 - 400
12307	D	AS, AL	0.002	II	1975	100 - 200
12317	D	AS	0.740	IV	1972	2000 - 2500
12420	B D	AS	0.164	V	1973	100 - 200
12439	C D	AS, AL	No Data	II	1974	0 - 100
12459	D	AL	0.049	II	1977	Not Reported
12462	A	AS, AL	0.209	VII	1972	0 - 25

Subcategory Totals: A = 5
B = 3
C = 12
D = 16

Legend: AC = Activated Carbon
AL = Aerated Lagoon
AS = Activated Sludge
TF = Trickling Filter

* See Appendix L for in-plant and end-of-pipe treatment
** Includes non-process flows.

TABLE II - 5

PHARMACEUTICAL INDUSTRY

COMPARISON OF SCREENING PLANTS AND LONG TERM PLANTS VERSUS TOTAL PHARMACEUTICAL MANUFACTURING POPULATION

Item	Screening Plants	Long Term Plants		Total Pharm. Mfr's.
		All	Single Subcat. Only	
Total Number of Plants	26	23	13	464
Subcategory				
A	57.7%	22.7%	15.4%	8.0%
B	34.6	13.0	0.0	17.2
C	69.2	52.2	30.8	28.7
D	73.1	69.6	53.8	80.2
Wastewater Quantity				
Less than 0.1 Mgal/d	23.1%	28.6%	33.3%	80.0%
0.1 to 1.0 Mgal/d	46.2	52.4	50.0	15.1
1.0 to 10.0 Mgal/d	26.9	19.0	16.7	4.3
Greater than 10.0 Mgal/d	3.8	0.0	0.0	0.6
EPA Region				
I	3.7%	4.3%	8.3%	3.7%
II	14.8	17.4	16.7	26.1
PR	14.8	30.4	33.3	9.5
III	14.8	17.4	16.7	9.5
IV	11.1	8.7	16.7	10.6
V	33.3	17.4	8.3	20.0
VI	0.0	0.0	0.0	3.4
VII	7.4	4.3	8.3	6.0
VIII	0.0	0.0	0.0	1.3
IX	0.0	0.0	0.0	8.6
X	0.0	0.0	0.0	1.3
Plant Age (1978 Basis)				
Less than 5 years	18.2%	17.4%	23.0%	16.2% (*)
5 to 10 years	18.2	34.8	30.8	22.7 (*)
10 to 25 years	22.7	8.7	15.4	27.8 (*)
25 to 50 years	36.4	30.4	30.7	19.9 (*)
50 to 100 years	4.5	8.7	0.0	12.0 (*)
Greater than 100 years	0.0	0.0	0.0	1.4 (*)
Employment				
Less than 100	8.4%	31.8%	41.7%	36.9%
100 to 500	45.8	50.0	41.7	41.0
500 to 1000	20.8	9.0	8.3	10.8
Greater than 1000	25.0	9.0	8.3	11.3

*Only (original) 308 Portfolio plants had these data and, thus, were used to calculate these figures.

SECTION III

DESCRIPTION OF THE INDUSTRY

A. INTRODUCTION

In order to establish an industry data base upon which proposed regulations can be developed and promulgated, a comprehensive profile was developed from survey, sampling and existing data sources.

This section presents information assembled to describe, in a quantitative and specific manner, the pharmaceutical manufacturing industry. The data comes from responses to requests provided by companies in the industry as well as information obtained from open literature and other sources. Processes, production, plant size, age, geographical location, employment, and current wastewater discharge performance are discussed and tabularly presented.

B. DETAILED INDUSTRY PROFILE

The objectives of the 308 Questionnaire were to obtain information from pharmaceutical manufacturing facilities and to develop an industry profile that includes plant size, age, location, and production activities. Appendix F lists each of the 464 manufacturing plants contained in the comprehensive EPA data base by plant code number (assigned for identification purposes), applicable manufacturing subcategories, manufacturing employment, and year of operational startup. Plants with code numbers in the 12000 series are from the original 308 Portfolio survey; those with 20000 series numbers are from the Supplemental 308 Portfolio survey.

Table III-1 shows the geographical distribution of the industry and the number of manufacturing plants by state and EPA region. Also shown are the average number of manufacturing employees per plant and the average plant startup year.

Most of the pharmaceutical industry is located in the eastern half of the United States (See Figure III-1.) Of the 464 manufacturing plants in the comprehensive data base, almost 80 percent are in the East. New Jersey (with about 16 percent) and Region II (with approximately 36 percent) is the largest pharmaceutical manufacturing state and EPA region, respectively. The data show that Regions II, III, V, and VII (the Northeast and Midwest) have generally older plants than Regions IV, VI, VIII, and IX (the South and West). This is due to the recent trend toward building plants in the "Sun Belt" of the United States.

Puerto Rico has close to 10 percent of the industry and is becoming a major pharmaceutical manufacturing center.

Table III-2 breaks down the industry by manufacturing subcategory. These process-based subcategories were used for a review of the industry, although these distinctions were not carried through for purposes of developing the newly proposed regulations. Subcategory D (formulating/mixing/ compounding) is the most prevalent pharmaceutical manufacturing operation, with 80 percent of the plants in the industry engaged in this activity. Fifty-eight percent of the plants have operations in only Subcategory D. The remainder also have operations in other subcategories.

Table III-3 summarizes the total number of batch, continuous, and semi-continuous manufacturing operations by subcategory for the entire pharmaceutical industry. Batch-type production is the most common type of manufacturing technique for each of the four subcategories.

C. MANUFACTURING PROCESSES

One of the most important generalizations which can be made about the wastewaters produced and discharged by the pharmaceutical industry is their extreme diversity. Products, processes, and the materials to which wastewater is exposed vary greatly. With the goal of relating those discharges with some common characteristics, subcategories based on unit manufacturing processes were defined. The broad manufacturing processing areas considered were (a) fermentation, (b) biological and natural extraction, (c) chemical synthesis, and (d) formulation.

One characteristic of processing in this industry is that the ratio of finished product to the quantity of raw materials, solvents, and other processing materials is generally very low. This is most apparent in natural extraction (Subcategory B), followed by fermentation (A), synthesis (C), and formulation (D), respectively.

1. Fermentation

Fermentation is the usual method for producing most antibiotics and steroids. The fermentation process involves three basic steps: inoculum and seed preparation, fermentation, and product recovery.

Production of a fermentation pharmaceutical begins with spores from the plant master stock. The spores are activated with water, nutrients, and warmth; they are then propagated through

the use of agar plates, test tubes, and flasks until enough mass is produced for transfer to the seed tank. In less critical fermentations, a single seed tank may serve several fermenters. In this type of operation, the seed tank is never emptied completely, so the seed remaining will serve as the inoculum for the next seed batch. The seed tank may be sterilized and inoculated only when contamination occurs.

Fermentation is conventionally a large-scale batch process. A fermentation cycle begins with a water wash and steam sterilization of the fermenter vessel. Sterilized nutrient raw materials in water are then charged to the fermenter. Microorganisms are transferred to the fermenter from the seed tank and fermentation begins. During fermentation, air is sparged into the batch and temperature is carefully controlled. After a fermentation period of from twelve hours to a week, the fermenter batch whole broth is ready for filtration. Filtration removes mycelia (remains of the microorganisms), leaving the filtered aqueous broth containing product and residual nutrients ready to enter the product recovery phase.

There are three common methods of product recovery: solvent extraction, direct precipitation, and ion exchange or adsorption. Solvent extraction is a recovery process in which an organic solvent is used to remove the pharmaceutical product from the aqueous broth and form a more concentrated solution. With subsequent extractions, the product is separated from any contaminants. Further removal of the product from the solvent can be done by either precipitation, solvent evaporation, or further extraction processes. Normally, solvents used for product recovery are recovered and reused. However, small portions left in the aqueous phase during the solvent "cut" can appear in the plant's wastewater stream. The typical processing solvents used in fermentation operations are benzene, chloroform, 1,1-dichloroethylene, and 1,2-trans-dichloroethylene. (42)

Direct precipitation consists of first precipitating the product from the aqueous broth, then filtering the broth, and finally extracting the product from the solid residues. Priority pollutants known to be used in the precipitation process are copper and zinc. (42)

Ion exchange or adsorption involves the removal of the product from the broth, using such solid materials as ion exchange resin, adsorptive resin, or activated carbon. The product is recovered from the solid phase with the use of a solvent; it is then recovered from the solvent.

Steam is used as the major sterilizing medium for most equipment. However, to the extent that chemical disinfectants may be used,

they can contribute to priority pollutant waste loads. Phenol is a commonly used disinfectant.

Sometimes a fermentation batch can become infested with a phage, a virus that attacks microorganisms. Although phage infestation is rare in a well-operated plant, when it occurs, very large wastewater discharges may be necessary in a short period of time. Usually the batch is discharged early and its nutrient pollutant concentration is higher than that of spent broth.

Another fermentation wastewater source is the control equipment that is sometimes installed to clean fermentation waste off-gas. The air and gas vented from the fermenters usually contain odoriferous substances and large quantities of carbon dioxide. Treatment is often necessary to deodorize the gas before its release to the atmosphere. Some plants employ incineration methods; others use liquid scrubbers. The blowdown from scrubbers may contain absorption chemicals, light soluble organic compounds, and heavier insoluble organic oils and waxes. However, wastewater from this source is unlikely to contain priority pollutants.

The pollution contribution of the spent beer arises from the fact that the beer contains substantial food materials such as sugars, starches, protein, nitrogen, phosphate, and other nutrients. Methods for treating the fermentation wastes are generally biological in nature. Although the spent beers, even in a highly concentrated form, can be satisfactorily handled by biological treatment systems, it is less likely to upset the system if the wastes are first diluted to some degree. Dilution normally results from the equalization of fermentation wastes with the other waste streams. As a result, a satisfactory biological reduction of the contaminants can be achieved.

The 308 data shows generally that wastewaters from Subcategory A plants generally are characterized by high BOD, COD, and TSS concentrations, large flows, and a pH range of about 4.0 to 8.0.

2. Biological and Natural Extraction

Many materials used as pharmaceuticals are derived from such natural sources as the roots and leaves of plants, animal glands, and parasitic fungi. These products have numerous and diverse pharmaceutical applications ranging from tranquilizers and allergy relief medications to insulin and morphine. Also included in this group is blood fractionation, which involves the production of plasma and its derivatives.

Despite their diversity, all extractive pharmaceuticals have a common characteristic: they are too complex to synthesize commercially. They are either very large molecules and/or the synthesis results in the production of several steroisomers only one of which has pharmacological value. Extraction is an expensive manufacturing process since it requires the collection and processing of very large volumes of specialized plant or animal matter to produce very small quantities of products.

The extraction process consists of a series of operating steps. In almost every step, the volume of material being handled is reduced significantly. In some processes, the reductions may be in orders of magnitude and the complex final purification operations may be conducted on quantities of materials only a few thousandths of the material handled in earlier steps. Neither continuous processing methods nor conventional batch methods are suitable for extraction processing. Therefore, a unique assembly-line, small-scale batch processing method has been developed. Material is transported in portable containers through the plant in batches of 75 to 100 gallons. A continuous line of these containers is sent past a series of operating stations. At each station, operators perform specific tasks on each batch in turn. As the volume of material being handled decreases, individual batches are continually combined to maintain reasonable operating volumes and the line moves more slowly. When the volume is reduced to a very small quantity, the containers used also become smaller, with laboratory-size equipment used in many cases.

An extraction plant may produce one product for a few weeks; then, by changing the logistical movement of pots and redefining the tasks to be conducted at each station, a plant can convert to the manufacture of a different product.

Residual wastes from an extraction plant essentially will be equal to the weight of raw material, since the active ingredients extracted are generally present at very low levels. Solid wastes will represent the largest pollutant load; however, solvents used in the processing steps will cause both air and water pollution.

The nature of the products of the pharmaceutical industry dictates that any manufacturing facility maintain a standard of cleanliness higher than that required for most industrial operations. Since most of these plants are cleaned frequently, detergents and disinfectants are normally found in the wastewater.

As in the fermentation process, a small number of priority pollutants were identified as being used in the manufacturing of extractive pharmaceuticals. (41) The cations of lead and zinc are

known to be used as precipitating agents. Phenol was identified as an equipment sterlizing chemical as well as an active ingredient. Otherwise, priority pollutants are found to be used only as processing solvents. Some identified as solvents were benzene, chloroform, and 1,2 dichloroethane.

Solvents are used in two ways in extraction operations. First, they are used to remove fats and oils that would contaminate the products. These "defatting" extractions use an organic liquid that dissolves the fat but not the product material. Solvents are also used to extract the product itself. Plant alkaloids, when treated with an alkali, become soluble in such selected organic solvents as benzene, chloroform, or 1,2 dichloroethane.

Ammonia is used in many extraction operations since it is necessary to control the pH of water solutions from both animal and plant sources to achieve separation of valuable components from waste materials. Ammonium salts are used as buffering chemicals and aqueous or anhydrous ammonia is used as an alkalizing reagent. The high degree of water solubility of ammonium salts prevents unwanted precipitation of salt; also, ammonia does not react chemically with animal or plant tissue. Such basic materials as hydroxides and carbonates of alkali metals do not have these advantages.

The principal sources of wastewater from biological/natural extraction operations are (a) spent raw materals (waste plasma fractions, spent eggs, spent media broth, plant residues, etc.); (b) floor and equipment washwaters; (c) chemical wastes (spent solvents and the like); and (d) spills.

In general, the bulk of the spent raw materials is collected and sent to an incinerator or landfill. Likewise, the nonrecoverable portions of the spent solvents are incinerated or landfilled. However, in both cases, portions of the residual materials find their way into a plant's wastewater. Floor and equipment washings and spills also contribute to the ordinary waste discharge.

Although pollutant information for the biological/natural extraction operations in the pharmaceutical data base was limited, that which was available lent itself to a preliminary analysis. Generally, wastewaters from Subcategory B plants are characterized by low BOD, COD, and TSS concentrations; small flows; and pH values of approximately 6.0 to 8.0.

3. Chemical Synthesis

Most of the compounds used as drugs today are prepared by chemical synthesis (generally by a batch process). The basic

major equipment item is the conventional batch reaction vessel, one of the most standardized equipment designs in industry.

Generally, the vessel is equipped with a motor-driven agitator and an internal baffle. It is made of either stainless steel or glass-lined carbon-steel and contains a carbon-steel outer shell suitable for either cooling water or steam. Vessels of this type are made in many different sizes, with capacities ranging from 0.02 to 11.0 m^3 or more.

The basic vessels may be fitted with many different attachments. Baffles usually contain temperature sensors to measure the temperature of the reactor contents. An entire reactor may be mounted on load cells to weigh accurately the reactor contents. Dip tubes are available to introduce into the vessels reagents below the liquid surface. One of the top nozzles may be fitted with a floodlight and another with a glass cover to enable an operator to observe the reactor contents. Agitators may be powered by two-speed motors or by variable-speed motor drives. Typically, batch reactors are installed with only the top heads extending above the operating floor of the plant in order to provide the operator with easy access for loading and cleaning.

With other suitable accessories, these vessels can be used in many different ways. Solutions can be mixed, boiled, and chilled in them. By addition of reflux condensation, complete reflux operations are possible. By application of a vacuum, the vessels become vacuum evaporators. Solvent extraction operations can be conducted in them, and, by operating the agitator at slow speed, they serve as crystallizers.

Synthetic pharmaceutical manufacture consists of using one or more of these vessels to perform in a step-by-step fashion the various operations necessary to make the product. Following a definite recipe, the operator (or, increasingly, a programmed computer) adds reagents; increases or decreases the flow rate of cooling water, chilled water, or steam; and starts and stops pumps to transfer the reactor contents into another similar vessel. At appropriate steps in the process, solutions are pumped through filters or centrifuges or are pumped into solvent recovery headers or waste sewers.

The vessels with an assembly of auxiliary equipment are usually arranged into independent process units; a large pharmaceutical plant may contain many such units. Each unit may be suitable for the complete or partial manufacture of many different pharmaceutical compounds. Only with the highest volume products is the equipment "dedicated" or modified to be suitable for only one process.

Each pharmaceutical is usually manufactured in a "campaign" in which one or more process unit is employed for a few weeks or months to manufacture enough compound to satisfy its projected sales demand. Campaigns are usually tightly scheduled, with detailed coordination extending from procurement of raw materials to packaging and labeling of the product. For a variable period of time, therefore, a process unit actively manufactures a specific compound. At the end of this campaign, another is scheduled to follow. The same equipment and operating personnel are used to make a completely different product, utilizing different raw materials, executing a different recipe, and creating different wastes.

The synthetic pharmaceuticals industry uses a wide variety of priority pollutants as reaction and purification solvents (43). Water was reported to be used more often than would be expected in an industry whose products are organic chemicals. However, benzene and toluene were the most widely used organic solvents since they are stable compounds that do not easily take part in chemical reactions. Similar ring-type compounds (xylene, cyclohexane, pyridine, etc.) also were reported as being used in the manufacture of synthesized pharmaceuticals or resulting from unwanted side reactions.

Solvents serve several functions in a chemical synthesis. They dissolve gaseous, solid, or viscous reactants to bring all reactants into close molecular proximity. They serve to transmit heat to or from the reacting molecules. By physically separating molecules from each other, they slow down some reactions that would otherwise take place too rapidly and that would result in excessive temperature increases and unwanted side reactions.

There are other less obvious uses of solvents, however. One of these is the use of a solvent in the control of reaction temperature. It is common practice in a batch-type synthesis to select a solvent whose boiling point is the same as the desired reaction temperature and which is compatible with the reaction. Heat is then applied to the reaction mass at a rate sufficient to keep the mixture continuously boiling. Vapors that rise from the reaction vessel are condensed and the liquefied solvent is allowed to drain back into the reaction vessel. Such refluxing prevents both overheating and overcooling of the reactor contents and can automatically compensate for variations in the rate of release or absorption of chemical energy.

Essentially all production plants operate solvent recovery facilities that purify contaminated solvent for reuse. These facilities usually contain distillation columns and may also include extraction facilities where still another solvent is used to separate impurities. Many of the wastes from the synthetic

pharmaceutical industry will be discharged from these solvent recovery facilities. Aqueous wastes which may result from such operations include residues saturated with the solvents recovered.

Another cause of solvent loss is storage practices. Bulk storage is usually in an unpressurized tank that is only partially filled. The level of the liquid in the tank rises and falls as liquid is added to or removed from the tank. The vapor in the tank above the surface of the liquid is therefore exhausted when the liquid level is rising; as the level falls, fresh air (or nitrogen from a padding system) is introduced. Even if no liquid is added or removed, the tank "breathes" as a result of temperature and barometric pressure changes. Each time a tank "exhales," the released vapor is saturated with solvent vapor; rather large quantities of solvent can be lost to the atmosphere through this mechanism.

Chemical synthesis operations also produce large quantities of pollutants normally measured as BOD and COD. Wastewater is generally produced with each chemical modification that requires the filling and emptying of the batch reactors. These wastewaters can contain the unreacted raw materials as well as some solvents.

The effluent from chemical synthesis operations is the most complex to treat because of the many types of operations and chemical reactions (nitration, amination, halogenation, sulfonation, alkylation, etc.). The production steps may generate acids, bases, cyanides, metals, and many other pollutants. In some instances, process solutions and vessel wash waters may also contain residual solvents. Sometimes, this wastewater is incompatible with biological treatment systems. Although it is possible to acclimate the bacteria to the various substances, there may be instances where certain chemical wastes are too concentrated or too toxic to make this feasible. Thus, it may be necessary to equalize and/or chemically pretreat a process wastewater prior to conventional treatment.

Primary sources of wastewater from chemical synthesis operations are (a) such process wastes as spent solvents, filtrates, concentrates, etc.; (b) floor and equipment wash waters; (c) pump seal waters; (d) wet scrubber spent waters; and (e) spills. Wastewaters from Subcategory C plant can be characterized as having high BOD, COD, and TSS concentrations; large flows; and extremely variable pH, ranging from 1.0 to 11.0.

4. Formulation

Although pharmaceutically active ingredients are produced in bulk form, they must be prepared in dosage form for use by the consumer. Pharmaceutical compounds can be formulated into tablets, capsules, liquids, or ointments.

Tablets are formed in a tablet press machine by blending the active ingredient, filler, and binder. Some tablets are coated by tumbling with a coating material and drying. The filler (usually starch, sugar, etc.) is required to dilute the active medicinal to the proper concentration, a binder (such as corn syrup or starch) is necessary to bind the tablet particles together. A lubricant (such as magnesium stearate) may be added for proper tablet machine operation. The dust generated during the mixing and tableting operation is collected and is usually recycled directly to the same batch. Broken tablets are generally collected and recycled to the granulation operation in a subsequent lot. After the tablets have been coated and dried, they are bottled and packaged.

Capsules are produced by first forming the hard gelatine shell. These shells are produced by machines that dip rows of rounded metal dowels into a molten gelatine solution and then strip the capsules from the dowels after the capsules have cooled and solidified. Imperfect empty capsules are remelted and reused, if possible, or sold for glue manufacture. Most pharmaceutical companies purchase empty capsules from a few specialist producers.

The active ingredient and any filler are mixed before being poured by machine into the empty gelatine capsules. The filled capsules are bottled and packaged. As in the case of tablet production, some dust is generated. Although this is recycled, small amounts of waste dust must be disposed of. Some glass and packaging waste from broken bottles and cartons also result from this operation.

Liquid preparations can be formulated for injection or oral use. In either case, the liquid is first weighed and then dissolved in water. Injectable solutions are bulk sterilized by heat or filtration and then poured into sterilized bottles. Oral liquid preparations may be bottled directly without the sterilization steps.

Wastewaters are generated by general cleanup operations, spills, and breakage. Bad batches may create a solid waste disposal problem.

The primary objective of mixing/compounding/formulation operations is to convert the manufactured products into a final, usable form. The necessary production steps have typically small

wastewater flows because very few of the unit operations use water in a way that would cause wastewater generation. The primary use of water in the actual formulating process is for cooling water in the chilling units and for equipment and floor wash.

Sources of wastewater from mixing/compounding/formulation operations are (a) floor and equipment wash waters, (b) wet scrubbers, (c) spills, and (d) laboratory wastes. The use of water to clean out mixing tanks can flush materials of unusual quantity and concentration into the plant sewer system. The washouts from recipe kettles may be used to prepare the master batches of the pharmaceutical compounds and may contain inorganic salts, sugars, syrup, etc. Other sources of contaminated wastewater are dust and fumes from scrubbers either in building ventilation systems or on specific equipment. In general, these wastewaters are readily treatable by biological treatment systems.

An analysis of the pollutant information in the pharmaceutical data base shows that wastewaters from Subcategory D plants normally have low BOD, COD, and TSS concentrations; relatively small flows; and pH values of 6.0 to 8.0.

D. RAW MATERIALS AND PRODUCTS

The pharmaceutical industry utilizes a vast array of raw materials and processing agents. The diversity of feedstock is attributable to the variety of products and the number of process variations common to the industry. This review describes a number of materials that can be used as feedstocks and processing agents.

Fermentation operations use large quantities of nutrient materials such as carbohydrates and proteins. Examples of some raw materials are meat extractions and distillers extract. Materials classified as priority pollutants which enter fermentation operations are mainly metals, as reaction modifiers and processing agents in the fermenter, and organic solvents, which are employed as extractive agents for product separation and purification. The residues from the organic starting materials plus mycelia contribute heavily to conventional BOD loadings.

Biological and natural extraction processes can have a wide variety of feedstocks including roots, leaves of plants, animal glands or parasite fungi. These substances contribute to BOD loadings; priority pollutant loadings are primarily due to solvents used for extraction. These solvents can be any number

of organic compounds with benzene and chloroform being among the most widely used.

Chemical synthesis presents the broadest spectrum of starting materials. Feedstocks can range from oxbile to dextrose. Given the appropriate starting material there are many common synthetic processes (as many as several hundred) by which the starting material is transformed to the product. A number of solvents and additives are required to complete the synthesis. Solvents are usually inexpensive relative to the product and are used liberally for this reason. These solvents are almost exclusively organic and may be priority pollutants. Additives are used to control reactions and many contain metals that are priority pollutants.

Product recovery and purification from most of the processes used to produce pharmaceuticals expose a variety of solvents and extractive agents to the wastewater. These include hydrocarbons and other organic compounds such as methylene chloride, benzene, carbon tetrachloride, and chloroform. Reaction control, and in some cases reactant requirements, call for the use of many metal compounds listed as priority pollutants.

Many of the 126 priority pollutants appear in the industry's wastewater. Most of them have their source in the raw materials and processing agents employed. The organic solvent and metal pollutants are almost completely accounted for by plant material inputs.

In summary, chemical materials utilized and produced in the pharmaceutical industry are numerous and diverse. They are used as reactants, extractive solvents, catalysts, inhibitors, diluents, and other purposes. In addition, other chemical compunds may be identified as intermediates, products, and by-products. Many of these materials are among those listed as priority pollutants. In fact, the vast majority of the 126 priority pollutants listed are present somewhere in the industry although not necessarily in wastewater. Appendix H summarizes the usage and occurrence of priority pollutants as indicated by 308 responses.

E. CURRENT DIRECT DISCHARGER PERFORMANCE

1. BPT Compliance

Direct discharger wastewater effluents in the pharmaceutical industry are currently subject to 1976 BPT performance standards. A plant-by-plant analysis of 308 data for direct dischargers indicates that although many plants are well within BPT limits, a substantial number are not meeting the BPT level of 90 percent

BOD removal and 74 percent COD removal. These performance rankings are shown in Table III-4.

2. Current Performance Compliance with Proposed BPT

Current performance of some plants already meets the approximate BCT limitations (see Table III-5) for BOD, COD, and TSS of 40, 360, and 40 mg/l, respectively. Tables III-6 through III-8 show a ranking by effluent concentration and indicate a projected compatibility with the projected design criteria for BCT and BAT limitations.

Tables III-9 and III-10 compare performance as judged by concentration criteria and by percent removal for BOD and COD. The ranking derived for plants using either criterion are similar.

F. Comparison of Current Permits with 1976 BPT

Table III-11 presents the results of a comparison of current permit limitations for direct dischargers with 1976 BPT limitations for BOD, COD and TSS. Permit limitations (expressed in lbs/day) were compared to a lbs/day value calculated from 308 data, using 1976 BPT design criteria (BOD 90%, COD 74%, TSS 52 mg/l), for each plant. The comparison shows that in general the majority of current permit limitations for BOD and COD are more stringent than, or at least equivalent to, the 1976 BPT limitations. However, the majority of current permit limitations for TSS are less stringent than 1976 BPT limitations.

TABLE III-1

PHARMACEUTICAL INDUSTRY
GEOGRAPHICAL DISTRIBUTION

Location	Number of Plants	Percent of Total Plants	Average Number Employees Per Plant	Average Plant Start-up Year(1)
EASTERN U.S.	368	79.2	268	1952
Connecticut	8	1.7	195	1963
Maine	0	0.0	-	-
Massachusetts	7	1.5	77	1961
New Hampshire	0	0.0	-	-
Rhode Island	1	0.2	(2)	(2)
Vermont	1	0.2	(2)	(2)
REGION 1 Total	17	3.6	161	1960
New Jersey	76	16.4	346	1950
New York	43	9.3	211	1943
Puerto Rico	44	9.5	216	1970
Virgin Islands	2	0.4	13	-
REGION 2 Total	165	35.6	239	1956
Delaware	2	0.4	121	1965
Maryland	7	1.5	65	1938
Pennsylvania	26	5.6	370	1949
Virginia	7	1.5	138	1950
West Virginia	2	0.4	151	-
District of Columbia	0	0.0	-	-
REGION 3 Total	44	9.4	267	1950
Alabama	3	0.6	15	1958
Georgia	6	1.3	189	1956
Florida	8	1.7	95	1967
Mississippi	2	0.4	759	1949
North Carolina	12	2.6	456	1971
South Carolina	3	0.6	87	1968
Tennessee	10	2.2	301	1940
Kentucky	5	1.1	12	-
REGION 4 Total	49	10.5	250	1962
Illinois	38	8.2	305	1951

Indiana	18	3.9	664	1944
Ohio	14	3.0	203	1929
Michigan	15	3.2	423	1933
Wisconsin	4	0.9	54	1957
Minnesota	4	0.9	41	-
REGION 5 Total	93	20.1	351	1943
WESTERN U.S.	96	20.8	152	1962
Arkansas	2	0.4	1558	1970
Louisiana	2	0.4	9	-
Oklahoma	0	0.0	-	-
Texas	12	2.6	127	1967
New Mexico	0	0.0	-	-
REGION 6 Total	16	3.4	129	1968
Iowa	3	0.6	77	1963
Kansas	4	0.9	123	1954
Missouri	17	3.7	108	1943
Nebraska	4	0.9	201	1962
REGION 7 Total	28	6.1	117	1951
Colorado	5	1.1	96	1967
Utah	1	0.2	(2)	(2)
Wyoming	0	0.0	-	-
Montana	0	0.0	-	-
North Dakota	0	0.0	-	-
South Dakota	0	0.0	-	-
REGION 8 Total	6	1.3	162	1968
Arizona	1	0.2	(2)	(2)
California	38	8.2	139	1967
Neva	1	0.2	(2)	(2)
Hawaii	0	0.0	-	-
REGION 9 Total	40	8.6	137	1967
Alaska	0	0.0	-	-
Idaho	0	0.0	-	-
Oregon	2	0.4	25	-
Washington	4	0.9	33	-
REGION 10 Total	6	1.3	30	1955

(1) Since data concerning plant start-up year were not solicited

from the Supplemental 308 plants, the figures were calculated using only the original 308 plants responses.

(2) Employment and start-up year figures are not presented to avoid disclosing individual plant data.

TABLE III-2

SUBCATEGORY BREAKDOWN

Manufacturing Subcategory Combination	Number of Plants	Percent of Total Plants
A only	4	0.9
A B	1	0.2
A B C	2	0.4
A B C D	8	1.7
A B D	4	0.9
A C	3	0.6
A C D	10	2.2
A D	5	1.1
B only	21	4.5
B C	12	2.6
B C D	9	1.9
B D	23	5.0
C only	47	10.1
C D	42	9.1
D only	271	58.4
Not Available	2	0.4
Total Plants	464	100.0

Individual Manufacturing Subcategory	Number of Plants in Subcategory	Percent of Totals
A	37	6.0
B	80	12.8
C	133	21.3
D	372	59.6
Not Available	2	0.3

Total number of subcategories 624*

* This represents the total number of subcategories covered by the 464 manufacturing plants.

TABLE III-3

PRODUCTION OPERATION BREAKDOWN

Type of Operation	Number of Operations in Subcategory A	B	C	D	Total	Percent of Total Oper.
Batch	32	76	129	359	596	87.0
Continuous	3	0	14	16	33	4.8
Semi-continuous	11	9	19	17	56	8.2
Total Number of Operations	46	85	162	392	685*	100.0
Percent of Total Operations	6.7	12.4	23.6	57.2	100.0	
Percent of Subcategory Which is Batch	69.6	89.4	79.6	91.6	87.0	

* Since each individual subcategory within a plant may be comprised of more than one type of operation, this figure will be greater than the total number of subcategories.

NOTE: The above data apply to 462 manufacturing plants. For two plants no information was available on their subcategories and types of production operations.

TABLE III-4

DIRECT DISCHARGERS: COMPARISON OF PLANT PERFORMANCE
vs. 1976 BPT PERCENT REMOVAL "DESIGN" CRITERIA (BOD @ 90% & COD @ 74%)
(BASED ON 308 DATA)

Summary of Comparison

Meets design criteria, both parameters		7
Meets design criteria, but data incomplete		4
Does not meet criteria	13	
Data lacking	36	
Total Direct Dischargers	60	

Plant Number	308 Long Term Avg. BOD % Removal	BOD Rank	308 Long Term Avg. COD % Removal	COD Rank
Plants meeting design criteria:				
12306	99.0	2	92.1	5
12307	97.5	3	96.5	1
12353	96.5	4	94.4	4
12038*	96.1	5	87.9	7
12248	95.9	6	87.0	8
12317	95.8	7	89.9	6
12026	95.0	8	77.7	13
Partially meeting design criteria, but lacking one data item:				
12160	99.1	1		
12463	94.1	9		
12022	93.2	10		
20297	94.7	8		
Plants poorer than design criteria in one or more items:				
12161	92.6	12	36.56	17
12015	92.5	14	69.72	
20245	88.7	14	94.5	3
12132	87.2	15	95.77	2
12236	86.7	16	79.32	11
12104	85.9	17	74.52	15
12294	85.2	18	79.89	10
12338	85.0	19	-	-
20165	84.0	20	79.11	12
12239	81.9	21	81.97	9
12038*	80.1	22	-	-

12471	72.0	23	-	-
20257	70.5	24	75.78	14
12407	16.7	25	-	-

Plants without % removal data:

12001	12085	12119	12256	12287	12462
12006	12089	12261	12298	20037	12014
12095	12189	12264	12308	20201	12030
12097	12194	12267	12339	20246	12057
12098	12205	12281	12406	20298	12073
12117	12283	12459	20319	20370	20402

Note: Underline indicates performance not meeting design criteria.

TABLE III-5

DIRECT DISCHARGERS: COMPARISON OF PLANT PERFORMANCE
vs. PROPOSED BCT and BAT CONCENTRATION DESIGN CRITERIA (BOD @ 40 MG/L, COD @ 360 MG/L and TSS @ 40 MG/L)
(BASED ON 308 DATA)

Summary of Comparison

Meets design criteria, both parameters	9
Meets design criteria, but data incomplete	9
Does not meet design criteria	23
Data lacking	19
Total Direct Dischargers	60

Plant Number	308 Long Term Avg. Effluent BOD mg/l	BOD Rank	308 Long Term Avg. Effluent COD mg/l	COD Rank	308 Long Term Avg. Effluent TSS mg/l	TSS Rank
Plants meeting design criteria:						
12463	6	2	29	1	9	4
20201	1	2	50	4	4	2
12053	8	5	67	7	2	1
12248	10	6	63	6	35	19
12104	12	7	40	2	22	10
20246	13	10	128	13	33	18
12097	28	19	289	16	29	14
12132	29	20	203	15	29	14
20165	32	22	113	12	24	11
Partially meeting design criteria, but lacking one or more items						
12089	13	9	-	-	13	7
12298	15	11	-	-	26	11
20319	15	12	-	-	9	4
20297	20	16	-	-	36	20
12001	21	18	-	-	-	-
12338	30	21	-	-	30	15
12407	54	25	-	-	17	9
12095	-	-	-	-	6	2
12406	-	-	-	-	10	4
Plants poorer than design criteria in one or more items:						
12160	5	1	-	-	43	23
12119	7	5	40	2	70	29
12036	13	8	197	14	44	24

12471	14	11	-	-	59	28
12307	18	14	83	10	90	30
12015	19	15	489	-	146	-
20037	20	16	-	-	47	25
12317	32	22	107	11	50	26
12283	35	24	-	-	50	26
12287	56	26	51	5	13	7
20245	56	26	74	8	32	17
12205	60	28	81	9	40	22
12161	72	29	944	22	196	34
12026	93	30	946	23	326	36
12022	105	31	-	-	38	21
20257	143	32	329	19	-	-
12462	145	33	297	18	97	32
12236	149	34	553	20	90	30
12294	208	35	658	21	28	13
12038*	244	36	1453	24	306	35
12239	284	37	290	17	174	33
12098	693	38	2886	26	336	37

Plants poorer than design criteria in one or more items:

12038**	1140	39	4470	27	457	38
12261	-	-	9880	28	565	39

Plants with no effluent data:

12006	12073	12187	12264	12339	20402
12014	12085	12194	12267	12459	12030
12117	12281	20298	12057	12256	12308
20370					

* Fermentation Wastes Only
** Chemical Wastes Only

TABLE III-6

RANKING OF DIRECT DISCHARGERS BY EFFLUENT BOD CONCENTRATION
(DATA BASE: 308)

Plant No.	308 Long Term Avg. Effluent BOD5 mg/l	Rank by BOD5 Effluent Conc.	Rank by % Removal	% Removal
12160	5	1	1	99.1
12463	6	2	10	94.1
20201	6	2	-	-
12119	7	4	-	-
12053	8	5	4	96.5
12248	10	6	6	95.9
12104	12	7	16	85.9
12036	13	8	2	99.0
12089	13	8	-	-
20246	13	10	-	-
12471	14	11	22	72.0
12298	15	12	-	-
20319	15	12	-	-
12307	18	14	3	97.5
12015	19	15	13	92.6
20037	20	16	-	-
20297	20	16	9	94.7
12001	21	18	-	-
12097	28	19	-	-
12132	29	20	15	87.2
12338	30	21	19	85.0
12317	32	22	7	95.8
20165	32	22	20	84.0
12283	35	24	-	-
Design criterion of 40 mg/l.....				
12407	45	25	25	16.7
12287	56	26	-	-
20245	56	26	14	88.7
12205	60	28	-	-
12161	72	29	12	92.7
12026	93	30	8	95.0
12022	105	31	11	93.2
20257	143	32	24	70.5
12462	145	33	-	-
12236	149	34	16	86.7
12294	208	35	18	85.2
12038*	244	36	5	96.1
12239	284	37	21	81.9
12098	693	38	-	-

12038**	1140	39	23	80.1

Plants with no BOD data:

12006	12073	12187	12264	12308	20298
12014	12085	12194	12281	12339	20370
12030	12095	12256	12281	12459	20402
12057	12117	12261	12298		

* Fermentation Wastes Only
** Chemical Wastes Only
(Ranked as two separate plants, but counted as one.)

TABLE III-7

RANKING OF DIRECT DISCHARGERS BY EFFLUENT COD CONCENTRATION
(DATA BASE: 308)

Plant No.	308 Long Term Avg. Effluent COD mg/l	Rank by COD Effluent Conc.	Rank by % Removal	% Removal
12463	29	1	-	-
12104	40	2	16	74.52
12119	40	2	-	-
20201	50	4	-	-
12287	51	5	-	-
12015	54	6	7	88.96
12248	63	7	9	87.04
12053	67	8	4	94.44
20245	74	9	3	94.52
12205	81	10	-	-
12307	83	11	1	96.53
12317	107	12	6	89.94
20165	112	13	13	79.11
20246	128	14	-	-
12036	197	15	5	92.19
12132	203	16	2	95.77
12097	289	17	-	-
12239	290	18	10	81.97
12462	297	19	-	-
20257	329	20	15	75.78
Design criterion of 360 mg/l.....				
12236	553	21	12	79.32
12294	568	22	11	79.89
12161	944	23	17	68.30
12026	946	24	14	77.69
12038*	1453	25	8	87.91
12339	2370	16	-	-
12098	2886	27	-	-
12038**	4470	28	-	-
12261	9880	29	18	36.56

Plants with no COD effluent data:

12001	12014	12006	12022	12030	12057
12073	12085	12089	12095	12117	12160
12187	12194	12256	12264	12267	12281
12283	12298	12308	12338	12406	12407
12459	12471	20037	20297	20298	20319
20370	20402				

* Fermentation Waste Only
** Chemical Waste Only

TABLE III-8

RANKING OF DIRECT DISCHARGERS BY EFFLUENT TSS CONCENTRATION
(DATA BASE: 308)

Plant No.	308 Long Term Avg. Effluent TSS mg/l	Rank by TSS Effluent Conc. mg/l	Rank by % Removal	% Removal
12053	2	1	1	99.5
20201	4	2	-	-
12095	6	3	4	96.5
20319	9	4	-	-
12463	9	4	-	-
12406	10	6	3	97.0
12287	13	7	-	-
12089	13	7	-	-
12015	15	9	7	89.7
12407	17	10	14	43.3
12104	22	11	-	-
70165	24	12	13	48.9
12298	26	13	-	-
12294	28	14	-	-
12132	29	15	-	-
12097	29	15	-	-
12338	30	17	8	85.0
20245	32	18	-	-
20246	33	19	-	-
12248	35	20	-	-
20297	36	21	11	75.5
12022	38	22	-	-
12205	40	23	-	-
Design criterion of 40 mg/l.....				
12160	43	24	2	99.0
12036	44	25	5	93.7
20037	47	26	-	-
12283	50	27	-	-
12317	50	27	-	-
12471	59	29	15	36.6
12119	70	30	-	-
12236	90	31	-	-
12307	90	31	-	-
12462	97	33	-	-
12239	174	34	-	-
12161	196	35	12	50.8
12038*	306	36	8	86.5
12026	326	37	-	-
12098	336	38	16	5.1

12038**	457	39	6	89.8
12261	567	40	10	81.6

Plants with no TSS data:

12001	12057	12256	12308	20298	12006
12073	12187	12339	20370	12014	12985
12194	12267	12459	20402	12030	12117
12281	20257				

* Fermentation Waste Only
** Chemical Waste Only

TABLE III-9

RANKING OF DIRECT DISCHARGERS BY BOD PERCENT REMOVAL
(DATA BASE: 308)

Plant No.	308 Long Term Avg. Effluent BOD mg/l	Rank by BOD Effluent Conc.	Rank by % Removal	% Removal
12160	5	1	1	99.1
12036	13	8	2	99.0
12037	18	14	3	97.5
12053	8	5	4	96.5
12038*	244	36	5	96.1
12248	10	6	6	95.9
12317	32	22	7	95.8
12026	93	30	8	95.0
20297	20	17	9	94.7
12463	6	2	10	94.1
12022	105	31	11	93.2
12161	72	29	12	92.7
12015	19	15	13	92.6
Design criteria of 90% removal				
20245	56	27	14	88.7
12132	29	20	15	87.2
12236	149	34	16	86.7
12104	12	7	17	85.9
12294	208	35	18	85.2
12338	30	21	19	85.0
20165	32	23	20	84.0
12239	284	37	21	81.9
12038*	1140	39	22	80.1
12471	14	11	23	80.1
20257	143	32	24	70.5
12407	45	25	25	16.7

* Fermentation Wastes Only
** Chemical Wastes Only

TABLE III-10

RANKING OF PLANTS BY COD PERCENT REMOVAL
(DATA BASE: 308)

Plant No.	308 Long Term Avg. Effluent COD mg/l	Rank by Effluent Conc.	Rank by % Removal	% Removal
12307	83	11	1	96.53
12132	203	16	2	95.77
20245	74	9	3	94.52
12053	67	8	4	94.44
12036	197	15	5	92.19
12317	107	12	6	89.94
12915	54	6	7	88.96
12038*	1453	25	8	87.91
12248	63	7	9	87.04
12239	290	18	10	81.97
12294	658	22	11	79.89
12236	553	21	12	79.32
20165	113	13	13	79.11
12026	946	24	14	77.69
20257	329	20	15	75.78
12104	40	2	16	74.52
Design Criteria of 74% removal.....				
12161	944	23	17	68.30
12261	9880	29	18	36.56

*Fermentation Wastes Only

TABLE III-11

Comparison of Current Permits with 1976 BPT

Plant No.	BOD_5 Permit Levels			COD Permit Levels			TSS Permit Levels		
	<BPT	=BPT	>BPT	<BPT	=BPT	>BPT	<BPT	=BPT	>BPT
12015			x			x			x
12022		x					x		
12026		x			x		x		
12036		x					x		
12038			x			x			x
12053	x				x		x		
12085			x			x		x	
12097	x						x		
12104							x		
12117			x			x			x
12132			x		x		x		
12161			x		x			x	
12187							x		
12205								x	
12236		x				x	x		
12248								x	
12256								x	
12261				x			x		
12294			x			x		x	
12307			x			x			
12317			x			x		x	
12339					x		x		
12406									x
12459	x							x	
12462							x		
12471			x				x		

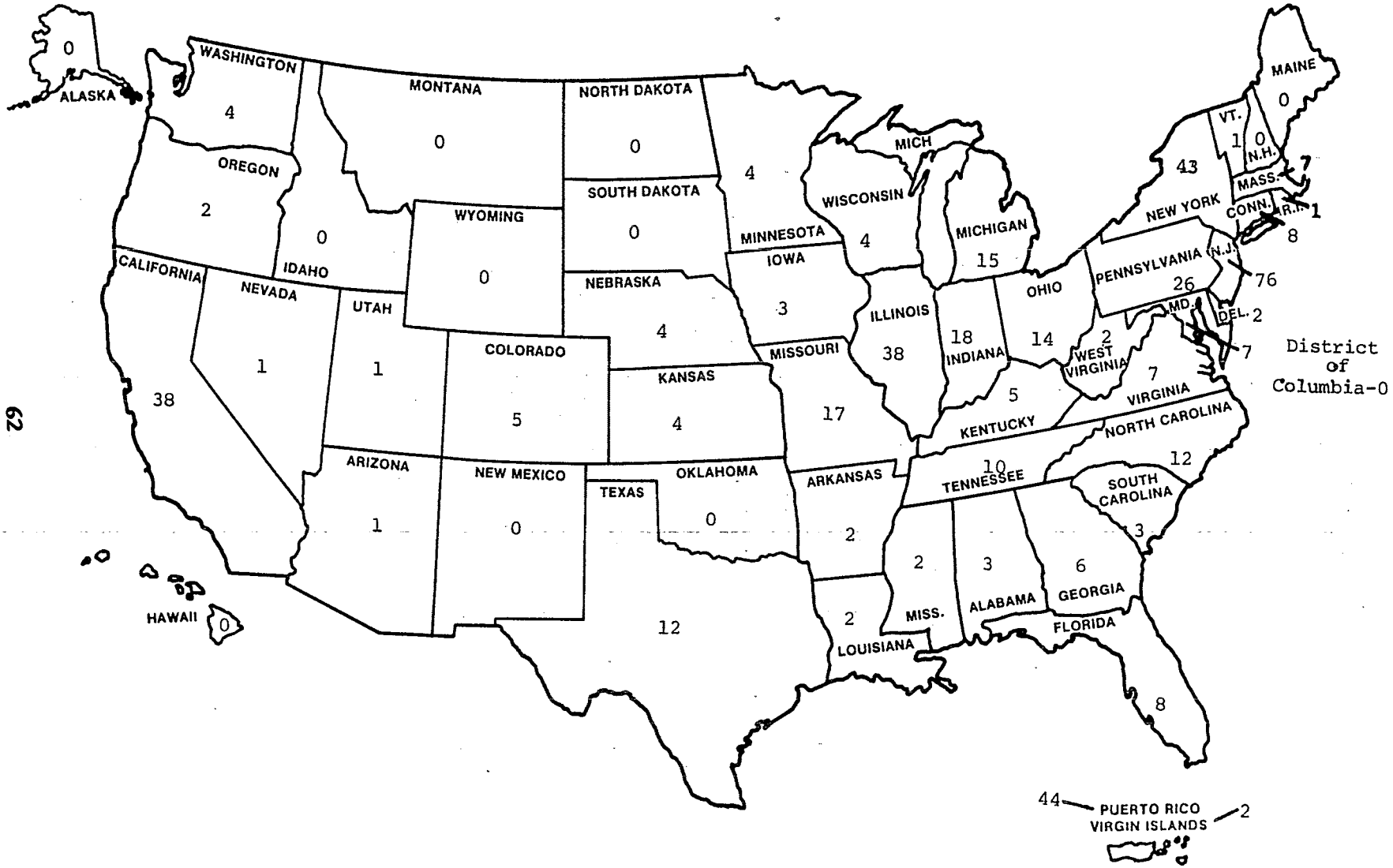
Note: <BPT: permit less stringent than BPT
=BPT: permit equivalent to BPT
>BPT: permit more stringent than BPT

Totals:
BOD permits less stringent than BPT = 3
BOD permits equivalent to BPT = 4
BOD permits more stringent than BPT 9

COD permits less stringent than BPT 1
COD permits equivalent to BPT 4
COD permits more stringent than BPT 8

TSS permits less stringent than BPT 13
TSS permits equivalent to BPT 7
TSS permits more stringent than BPT 4

FIGURE III-1
PHARMACEUTICAL INDUSTRY
GEOGRAPHICAL DISTRIBUTION



SECTION IV

INDUSTRY SUBCATEGORIZATION

A. INTRODUCTION

This section defines the subcategories selected for evaluative analysis and presents the rationale for their selection. The subcategory breakdown utilized in this study was developed for evaluative purposes. This method was found to be the most practical means of analyzing raw waste characteristics, wastewater flow, and treatment technology alternatives. However, at the end of the analysis, we determined that subcategories were not necessary for regulatory purposes because the calculated limits would not vary significantly between subcategories.

B. BASIS FOR SUBCATEGORIZATION

The existing BPT regulation divides the pharmaceutical industry into subcategories based on the general type of manufacturing process. Process method is an easily definable basis for subcategorization and is well understood by those knowledgeable about the industry. Characteristically only one process is used for a given product or class of products although there are sequential processing exceptions. Subcategorization based on process therefore provides effective subcategorization by product type as well.

Both plant size and wastewater flow relate to process methods in the sense that some processing methods (e.g., fermentation and synthesis) are undertaken only in large-scale or highly complex facilities. More direct product-oriented methods, such as biological extraction or product formulation generally involve small and less complex manufacturing facilities and less water use.

The wastewater generated by most plants in the industry results from more than one kind of process. Nonetheless, the existence of single subcategory plants does permit wastewater characterization according to process method. Process methods are often distinct from one another in their effect on wastewater characteristics (pollutant identities and loads and flow) because of differences in the production modes involved and the use of the campaign operation. Production mode may be batch or continuous and in some cases semi-continuous, that is, with part of the process being carried out on a batch basis (e.g. chemical synthesis) and the other part of the process being carried out

continuously (e.g. product purification). The use of campaign operation involves the use of the same equipment train to produce different products. Both approaches to production are employed where possible to reduce unit operating costs and the number of certification analyses.

Fermentation and chemical synthesis processes are generally conducted on a batch basis. Fermentation usually involves large batches, while the batch size tends to vary considerably for chemical synthesis processes. Chemical synthesis involving several steps is usually conducted using the campaign operation method. Biological extraction and product mixing and formulation processes are generally carried out continuously.

The effect of differing uses of production approaches not only affects wastewater characteristics on a plant to plant basis but also affect the wastewater characteristics of individual plants on a day to day basis. The effect of this induced variability on wastewater characteristics and the resulting treatment inefficiency can be ameliorated to some extent by flow equalization prior to treatment.

C. SELECTED SUBCATEGORIES

The pharmaceutical industry subcategories selected and established for data analysis are:

Subcategory A - Fermentation
Subcategory B - Biological Extraction
Subcategory C - Chemical Synthesis
Subcategory D - Mixing, Compounding, and Formulation

An additional subcategory (Subcategory E - Research) was identified earlier. However, since research does not fall within SIC Codes 2831, 2833, or 2834 designated by the Consent Decree and does not have wastewater characteristics warranting a national regulation, it is not included in this study.

D. SUBCATEGORY CHARACTERISTICS

There are discernable differences among the subcategories when viewed in terms of effluent concentration averages or ranges and wastewater flow rates. However, diversity within each subcategory is often greater than between subcategories. As explained below, this is a major reason for not subcategorizing for regulatory purposes.

1. Fermentation is the basic processing method used in the production of most antibiotics and steroids. The steps employed are (a) preparation of a seed, (b) innoculation of the nutrient

batch, (c) fermentation of the nutrient raw materials, and (d) recovery of the product by such means as extraction, precipitation, or ion exchange.

Fermentation processes are typically very large water users. Spent beers are the major source of characteristically high BOD, COD, and suspended solids levels in the wastewater.

2. Biological or natural extraction is the extractive removal of therapeutic products from such natural sources as plant parts (e.g., roots or leaves) animal parts (e.g., glands), or parasytic fungi (e.g., molds).

In contrast to fermentation, biological extraction processes are normally small-volume water users with lower BOD, COD, and suspended solids levels.

3. Chemical synthesis is utilized widely in the manufacture of many drugs in use today. Most production is in batch reactors which can be used for a wide variety of process steps (heating, cooling, mixing, evaporation, condensation, crystallization, and extraction). Generally, these vessels are constructed of glass-lined or stainless steel. Their versatility permits multiple functions to produce many different compounds.

Chemical synthesis processes are characterized as relatively large water users with high pollutant loadings. Also, a wide variety of chemical pollutants can be expected.

4. In formulation (mixing, compounding, and formulation), pharmaceuticals are prepared in such useable forms as tablets, capsules, liquids, and ointments. Active ingredients are physically mixed with filler, formed into dosage quantities, and packaged for distribution.

Formulation is normally a low-level water user (in many cases a dry operation) with low pollutant levels.

5. Because most plants in the pharmaceutical industry include operations in two or more subcategories and because common treatment systems are used to treat combined wastes, raw waste characteristics or treatment effectiveness often cannot be differentiated by subcategory. For these reasons, much of the data analysis is limited to that portion of the data base which describes the performance of single subcategory plants; the remainder discusses the performance of mixed subcategory plants.

6. Variations in process routes employed by different producers are common in the pharmaceutical industry. Process variations in chemical synthesis plants manufacturing the same product occur

because different starting materials and reaction dequences are used. Two plants making the same product but using different starting materials may use different reaction sequences. It is possible that once a common intermediate compound is derived, that the remaining processing steps will mirror each other. Even if the same starting material is used by different plants, it is possible, due to the complexity of a synthesis, that several feasible routes to an end product exist. The decision as to which route will be employed can depend on economics, patent coverage, corporate history or even personal preferences.

In fermentation and material extraction processes the major differences between processes will occur in the extraction method. In many cases, extractions can be accomplished by any number of solvents. Choice of a solvent will depend on environmental impact, company history, economics, patents and other factors. Due to the number of variables involved it is not surprising that such processes vary widely between companies.

E. DECISION NOT TO SUBCATEGORIZE FOR REGULATORY PURPOSES

Although the industry was analyzed considering these process-based subcategories, such distinctions were determined to be unnecessary for the statement of limitations since:

(1) Most of the industry (in terms of total wastewater flow) is composed of plants with operations in more than one process subcategory, which combine the wastewater from all process subcategories before it is treated for conventional and nonconventional pollutants. In addition, the relative volumes of wastewater from the different subcategory operations are subject to considerable variation. Thus, wastewater in most plants is not normally distinguishable by process origin. Under these circumstances it is difficult to apply different limitations to different subcategories.

(2) The broad product/process diversity within each subcategory studied tends to exceed and obscure distinctions characteristic of each subcategory. Differences in pollutant loadings for plants within a subcategory may be greater than for plants from different subcategories. Subcategorization schemes along different product/process lines were considered but were rejected as being too complex and not necessarily more accurate.

(3) The treatability of the wastewater from plants within each subcategory is not characteristically related to the subcategory. The conventional pollutant loadings for BOD and TSS are generally amenable to reduction by biological treatment and associated operations (clarification) regardless of their subcategory source. It has also been demonstrated that reduction

to identical pollutant levels is achievable for wastewater from each of the different subcategories. Pollutant loadings may vary within each subcategory and across subcategories but such differences may be addressed by design and operating modifications to the biological systems. The current BPT regulation establishes identical limitations for each subcategory covered.

(4) The existing subcategorization scheme is irrelevant to the regulation of toxic pollutants for this industry. The occurrence of toxic pollutants in a plant's wastewater is not dependent on its process subcategory designation but on the particular mix of individual product/processes it engages in.

(5) The available performance data from which the regulations are devised as well as the screening and verification program results for toxic pollutants suggest that the industry can be equitably regulated by a single set of limits.

SECTION V

WASTE CHARACTERIZATION

A. INTRODUCTION

The Agency, through an extensive data gathering effort, has studied qualitatively and quantitatively the wastewaters of the pharmaceutical industry. This effort provided the baseline data necessary for determining the significant pollutants present in the wastewaters of the pharmaceutical industry and subsequently the regulatory scope for the pharmaceutical point source category.

As a result of earlier studies, particularly the 1976 Development Document, the EPA had available a limited amount of data which characterized the wastewater discharges of the pharmaceutical manufacturing industry. However, not only were some of these data old, but for the most part they were related only to such "traditional" pollutant parameters as BOD, COD, and TSS. Information on the 126 toxic pollutants or classes of toxic pollutants was almost nonexistent. In order to fill this void, the Agency instituted a number of programs aimed at gathering from the pharmaceutical industry the necessary data on both toxic and traditional pollutants.

Wastewater characterization has been addressed considering the following:

(1) Traditional pollutants
(2) Priority pollutants
(3) Wastewater flow

This section reviews the sources of data and describes the results which provide the basis for the limitations and standards.

B. TRADITIONAL POLLUTANTS

Traditional pollutants considered for regulation are BOD_5 COD, TSS, and pH. The reasoning behind their selection and the omission of others is reviewed in Section VI. Three of these, BOD, TSS, and pH are listed as conventional pollutant parameters and one, COD, is listed as non-conventional.

1. Sources of Data

a. Previous studies - The 1976 Development Document, which was part of the Rulemaking Package for the 1976 BPT, comprises the main source of previously developed information.

b. 308 Survey - During 1978 the pharmaceutical industry was surveyed to obtain wastewater data and related plant information in support of this new rulemaking effort. The first 308 questionnaire was sent to member companies of the Pharmaceutical Manufacturers Association (PMA). The content of this questionnaire appears as Appendix B. The second phase of this survey was aimed at the remainder of the industry, and the questionnaire employed is in Appendix D. Substantial differences in both the form and question content of these forms result from shifts of program emphasis between the times of their distribution. Recipients are listed in Appendices C and E. Survey/response statistics are reviewed in Section II. Traditional pollutant (BOD, COD, and TSS) levels, as indicated in the 308 Portfolio data, are summarized in Appendix I, and flows in Appendix J.

c. Long term data - A list of plants was selected for further survey of long-term plant log data on end-of-pipe treatment influents and effluents, with respect to BOD, COD, and TSS. The development of a long-term data base, covering at least a full year's data for each plant, was necessary to permit establishment of a performance average for a representative group of industry treatment plants in terms of both pollutant level and effluent variability. A summary of long-term data is presented in Table V-1.

A summary of plants covered by the long-term data program follows. Some, but not all, of the plants also appear in the screening/verification plant list, subsequently used in priority pollutant analysis.

The flow values presented herein are long-term daily averages developed from the log data submitted by each plant. These may differ from flows reported in the 308 portfolio due to the different time periods in which they were established and/or different modes of operation during those time periods.

Plant 12015 is a Subcategory D plant which appears in both the screening plants and the long-term data plants. Activated sludge and activated carbon are used to treat 0.101 MGD of wastewater from pharmaceutical manufacture.

Plant 12022 is a Subcategory A and C plant which is one of the screening plants in addition to being a long-term data plant. Plant 12022 discharges 1.45 MGD of wastewater from its treatment

facilities which include activated sludge, trickling filters, equalization, neutralization, and primary clarification.

Plant 12026 is a Subcategory C plant which is a screening plant, a long-term data plant, and a verification plant. This plant discharges 0.161 MGD of pharmaceutical process wastewater after treatment with equalization, neutralization, activated sludge, and a polishing pond.

Plant 12036 is a Subcategory A plant which is both a screening plant and a long-term data plant. This plant discharges 0.855 MGD of wastewater from pharmaceutical manufacture, which is treated with activated sludge, trickling filters, an aerated lagoon, and a final stabilization lagoon.

Plant 12097 is a Subcategory C and D plant which is a screening plant as well as a long-term data plant. The chemical waste treatment unit consists of equalization, neutralization, physical-chemical treatment, filtration, and chemical stabilization. This plant discharges 0.640 MGD of wastewater from pharmaceutical processes.

Plant 12098 is a Subcategory D plant. Activated sludge is used to treat pharmaceutical process wastewaters which amount to 0.005 MGD.

Plant 12117 is a Subcategory B and D plant. Activated sludge is used in the wastewater treatment system to treat 0.101 MGD of pharmaceutical process wastewater.

Plant 12123 is a Subcategory C and D plant which uses only primary treatment to treat 0.932 MGD of wastewater from pharmaceutical manufacture.

Plant 12160 is a Subcategory D plant. Pharmaceutical process wastewater is treated with activated sludge. The flow of wastewater is 0.029 MGD.

Plant 12161 is an Subcategory A, C, and D plant which appears as both a screening plant and a long term data plant. Pharmaceutical process wastewaters are treated by neutralization, primary clarification, equalization, activated sludge, and polishing ponds. The amount of wastewater discharged 1.65 MGD.

Plant 12186 is a Subcategory C and D plant. Activated sludge and an aerated lagoon are used to treat 0.370 MGD of pharmaceutical process wastewaters.

Plant 12187 is a Subcategory C plant. The 1.07 MGD of pharmaceutical process wastewaters is treated with a trickling filter.

Plant 12235 is a Subcategory C plant. Primary treatment is the only treatment used for pharmaceutical process wastewater. (This plant was excluded from the variability analysis since it is not a direct discharger).

Plant 12236 is a Subcategory C plant. This plant appears in the screening plants, the verification plants, and the long-term data plants. The 0.816 MGD of pharmaceutical process wastewaters is treated with equalization, neutralization, primary sedimentation, and activated sludge.

Plant 12248 is a Subcategory D plant. Activated sludge is used to treat the 0.110 MGD of pharmaceutical process wastewater.

Plant 12257 is a Subcategory A, B, C, and D plant. This plant is in both the screening plants and the long-term data plants. The treatment system components are equalization, neutralization, and activated sludge. The amount of pharmaceutical process wastewater discharged is 0.755 MGD.

Plant 12294 is a Subcategory C and D plant. Activated sludge is used to treat the 0.118 MGD of pharmaceutical process wastewater.

Plant 12307 is a Subcategory D plant. Two biological treatments, activated sludge and aerated lagoon, are used to treat the 0.002 MGD of pharmaceutical process wastewater.

Plant 12317 is a Subcategory D plant. Activated sludge is used to treat the 0.740 MGD of pharmaceutical process wastewater.

Plant 12420 is a Subcategory B and D plant. This plant is included in both the screening plants and the long-term data plants. Activated sludge is used to treat the 0.164 MGD of pharmaceutical process wastewater.

Plant 12439 is a Subcategory C and D plant. Plant 12439 is in both a screening and long-term data plant. Process wastewaters are treated with equalization, neutralization, primary sedimentation, activated sludge, and an aerated lagoon. Long-term flow data was not available.

Plant 12459 is a Subcategory D plant with a long-term data flow of 0.049 MGD. The only method of wastewater treatment utilized is an aerated lagoon.

Plant 12462 is a Subcategory A plant with an average flow of 0.209 MGD. The wastewater treatment employed includes activated sludge and aerated lagoon.

2. Results and Bases for Limits

Raw waste loads for plants reporting data under the 308 survey are tabulated in Appendix I. These raw waste loads were compared to 1976 BPT and proposed BCT, and were ranked according to (1) effluent concentration and (2) percent removal for BOD, COD, and TSS. These ranking tabulations are included earlier in Section III as Tables III-4 through III-10.

Averages of the raw waste concentrations of BOD and TSS were developed for each subcategory as base case figures for the calculation of cost estimates. However, these averages are not intended to convey any significance other than as a calculation tool (for further discussion, refer to Section VIII). They do indicate relative average levels among the subcategories, but are not used directly in establishing limits.

The development of plant-by-plant costs to accomplish proposed BCT levels used 308 reported concentrations as the flag indicating which plants are likely to require additional treatment and to what extent. This is discussed in detail in Section VIII.

Table V-1 presents a summary of long term data. Among the direct dischargers, 13 plants are identifiable as having reasonable removal performances (equal to or better than that required by the existing regulation). These are summarized in Table V-2 with a notation of performance in terms of percent removal and of long-term average effluent concentrations for BOD, COD, and TSS. The average performance of these plants serves as the basis for developing statements of limits for BCT, BAT, NSPS, PSES and PSNS as discussed in Sections XI, XII, XIII, and XIV. The development of the statement of limits for the new TSS limitation is presented in Section X.

Similarly, a further selection of long-term data plants was made to serve as the basis for NSPS, which is discussed in Section XIII. This was accomplished by exclusion of data from 3 additional plants whose performance was judged to be marginal as indicated by percent removal of BOD. Table V-3 lists this further group of selected plants and their data.

Statistical studies of this data were conducted to develop variability factors reflecting changes in performance occurring from day to day and through the measured period of performance.

The bases, methodology, and results of these variability analyses are reviewed in Section IX.

C. Priority Pollutants

The Consent Agreement list of priority pollutants and classes of priority pollutants potentially includes thousands of specific compounds. However, for purposes of rulemaking, the Agency has selected 129 specific pollutants for limited consideration. These are listed in Table V-4.

Thirty-three priority pollutants are present in the wastewater of at least one of the plants sampled. However, few of the priority pollutants are individually widespread in their occurrence or high in concentration. The significance of these facts as they affect the choice of pollutants to be regulated is discussed in Section VI.

1. Sources of Data

a. 308 Portfolio Survey - The 308 Portfolio Survey was an invaluable source of information for developing profiles of the pharmaceutical manufacturing industry. Similarly, this survey proved to be a major source of data for waste characterization purposes. Not only did it provide more recent and detailed information on traditional pollutant parameters and wastewater flow characteristics, but the 308 Portfolio was the first major source of data on the use and/or generation of priority pollutants by this industry.

One purpose of the 308 survey was directed at quantifying the nature and extent of priority pollutants in the pharmaceutical industry. Of the 464 pharmaceutical manufacturing plants in the comprehensive 308 Portfolio Data Base, 212 responded to the questions concerning priority pollutants. Of the 115 different priority pollutants identified, chloroform, methylene chloride, phenol, toluene, and zinc were reported as being the most frequently used as raw materials for manufacturing operations. None of the priority pollutants were reported by even as many as ten respondents as being intermediate or final products. Some priority pollutants (primarily such pesticide-related compounds as endrin and heptachlor) were reported as being analyzed in the effluents of the manufacturing plants (most probably due to the mixing of pharmaceutical and nonpharmaceutical wastewaters), but not as being a raw material or a final product.

The 308 data base indicates that although the pharmaceutical manufacturing industry uses and therefore might discharge a large number of priority pollutants, broad occurrence of specific chemical compounds is limited. Priority pollutant information

submitted by the pharmaceutical manufacturing plants is presented in Appendix H.

b. PEDCo Reports - Concurrent with the efforts to profile the pharmaceutical manufacturing industry using the 308 Portfolio survey, PEDCo Environmental, Inc. undertook a study to detail the various manufacturing processes/steps that are used in the production of fermentation, extractive, and synthesized pharmaceuticals.

In their studies, PEDCo examined recent industry data and selected those products that comprise the major areas of production for each of the three manufacturing subcategories (i.e., A, B, and C). With these major product lines as a base, they then consulted all available literature describing the step-by-step procedures to be used in the production of each substance. As a result, PEDCo was able to identify certain priority pollutants that were known to be used by the pharmaceutical industry. These pollutants are listed in Table V-5.

Because of the size and complexity of the industry and the myriad of products manufactured, it was not practical for a study of this kind to identify every priority pollutant that could be used. The competitive nature of the industry and the fact that many products are produced under closely held processes make much of the necessary data unavailable.

c. RTP Study - In December 1978, EPA's Office of Air Quality Planning and Standards at Research Triangle Park published a document (70) providing guidance on air pollution control techniques for limiting emissions of volatile organic compounds from the chemical formulation subcategory of the pharmaceutical industry.

As part of this study, the Pharmaceutical Manufacturers Association (PMA) surveyed selected pharmaceutical plants to determine estimates of the ten largest volume volatile organic compounds that each company purchased and the mechanism by which they leave the plant (i.e., sold as product, sent to the sewer, or emitted as an air pollutant).

Table V-6 presents a compilation of the results of this survey. Of the twenty-six reporting companies, 25 indicated that their ten largest volume volatile organics accounted for 80 to 100 percent of their total plant usage. (The other company stated that the ten highest volume compounds only accounted for 50 percent of its total plant usage.) These 26 companies accounted for 53 percent of the domestic sales of ethical pharmaceuticals in 1975.

Included in the list of 46 compounds presented in Table V-6 are seven priority pollutants. These compounds are methylene chloride, toluene, chloroform, benzene, carbon tetrachloride, 1,1,1-trichloroethane, and 1,2-dichlorobenzene.

Table V-7 presents a summary and analysis of the data outlined in Table V-6. Priority pollutants represent approximately 27 percent of the total volatile organic usage in the segment of the industry analyzed. However, priority pollutants represent only 13 percent of the total mass discharge of volatile organics to the plant sewers. This indicates a tighter control of the discharge of toxic materials than of other organic materials.

Table V-7 also indicates that of the total quantity of all volatile organic compounds discharged, only a fraction (16.7 percent) is discharged via wastewater. The priority pollutants volatile organics are discharged with the wastewater in an even lower proportion (9.7 percent).

In summary, the RTP report indicates that although the pharmaceutical industry has a large involvement with volatile organic materials, including some toxic compounds, there is presently tight control over their discharge to the environment via plant sewers.

d. RSKERL/ADA Study - The Robert S. Kerr Environmental Research Laboratory at Ada, Oklahoma (RSKERL/ADA) conducted for the Effluent Guidelines Division (EGD) an applied research study entitled "Industry Fate Study." (90) The purpose of this report was to determine the fate of specific priority pollutants as they pass through a biological treatment system. In the course of this study, priority pollutants associated with the manufacture of pharmaceuticals at two industrial facilities were identified. The results of these wastewater analysis are reported in Appendix K. These priority pollutants are listed in Table V-8 with similar data from the RTP Study, Pedco Reports, and Screening/Verification Programs. RSKERL/ADA data are limited since they are from only two plants. However, they do serve to supplement the other data in Table V-8.

e. Wastewater Sampling Programs - Information on priority pollutants from the aforementioned reports and surveys was largely qualitative, although the 308 Portfolio did contain some quantitative data. Moreover, those reports did not always distinguish between pollutants used by a plant and pollutants in the final effluent. To expand the data base the EPA initiated the Screening/Verification Sampling Program under which a number of plants representing the pharmaceutical manufacturing industry were sampled for priority pollutants and for the traditional pollutants (BOD_5, COD, and TSS) in a two phase program. The

first phase, called the screening phase, involved 26 plants and covered a broad cross-section of the industry. This was followed by a verification phase which limited the sampling to only five carefully selected plants. Augmentation of the existing data base with the analytical results of the Screening/Verification Program along with the qualitative information from the other studies provided the Agency with sufficient information with which to characterize the industry's wastewaters.

The screening program was conducted to determine the presence or absence of important priority pollutants in the wastewaters of a number of pharmaceutical plants and to provide a quantitative estimate of those present. The information was then used to limit the search to specific priority pollutants for the verification program and to identify plants likely to provide information to accurately characterize the industry wastewaters.

Major processing areas and subcategory coverage, range of wastewater flows, and an assortment of both in-plant and end-of-pipe treatment technology/techniques were used as selection criteria for the screening plants. Multiple subcategory plants, as well as plants within only one subcategory, were deliberately sought. Similarly, special effort was made to include plants with wastewater flows less than 1000 GPD and more than 2.5 MGD. Descriptions of the plants and of the sampling points are presented in Appendix O.

Included in the screening group were nine direct dischargers, seven indirect dischargers, three zero dischargers and seven plants which utilized more than one mode of discharge. In the latter group there were three plants that were both indirect and zero dischargers, three plants that were both direct and zero dischargers and one plant that utilized all three modes of discharge.

Plant ID No.	Subcategory	Plant ID No.	Subcategory
12015	D	12210	BC
12022	AC	12231	AD
12026	C	12236	C
12036	A	12248	D
12038	ABCD	12256	ABCD
12044	AD	12257	ABCD
12066	BCD	12342	ACD
12097	CD	12411	BCD
12108	ACD	12420	BD
12119	AB	12439	CD
12132	AC	12447	ABCD
12161	ACD	12462	A

The verification program was developed to confirm the presence of the priority pollutants that were tentatively identified by the screening program and to provide qualitative pollutant data with a known precision and accuracy. The analytical results from these episodes serve as a basis for technology selection and for use in rulemaking.

Selection of the five plants for the verification program was based in part on general criteria presented in Section II. A criterion mentioned earlier and which weighed heavily in the final selection process was the assortment of major priority pollutants that were being used as raw materials for the manufacture of pharmaceuticals. Table VI-1 lists the priority pollutants which appear in the waste streams of each of the screening plants. Other plant specific characteristics that were considered in the final selection process are summarized below on a plant-by-plant basis.

Plant No. 12411. Plant 12411 was found to have in its waste streams three of the common priority pollutants for the industry -- methylene chloride, chloroform, and toluene. The presence of these pollutants, a process area involving three subcategories, utilization of a solvent recovery system, and pretreatment of wastewater followed by aerated lagoon justified this plant for verification sampling.

Plant No. 12038. This plant was selected for sampling in the verification program because of its use of potential BAT technology including activated carbon, aerobic biological treatment, and thermal oxidation. The known presence of several priority pollutants, including nitrosamines; the existence of a large historical data base relating to nitrosamines; and the inclusion of both pesticides and pharmaceuticals in the manufacturing operations at the plant were also considered in the selection process.

Plant No. 12236. Limitation to one subcategory, reported flows of about 0.81 MGD, use of cyanide as raw material, and treatment of its wastewaters by activated sludge process qualified this plant for the verification program. Also of interest were its cyanide destruction and solvent recovery in-plant treatment processes.

Plant No. 12026. A treatment train consisting of activated sludge, aerated lagoon, and polishing pond after in-plant treatment for solvent recovery were the reasons this plant was

selected for verification sampling. It has a reported flow of 0.101 MGD and belongs in Subcategory C.

Plant No. 12097. Plant 12097 is a multiple subcategory (C, D) plant with a reported flow of 0.035 MGD. Its use of cyanide in production and a treatment system consisting of in-plant solvent recovery, activated sludge, and physical-chemical treatment were considered in selecting this plant.

2. Results of Screening/Verification Program

A plant-by-plant summary of the analytical results from the program is presented in Appendix G.

Table V-9 lists the traditional and priority pollutants that were found in this program and the frequency at which they were found to be present in the waste streams. Although a number of the priority pollutants appeared in the waste stream, only a few of them were sufficiently repetitive to cause concern. Pesticides and PCBs were detected in one of the plants but were not due to pharmaceutical-related activity.

Wastewater entering and leaving the end-of-pipe wastewater treatment train were among the points in the waste stream that were sampled in this program. Concentration levels for many of the priority pollutants in the final effluent are relatively low. The reasons for this are: (1) in-plant treatment and process controls to minimize specific wastewater pollution (2) dilution of concentrated process wastewater with other less concentrated wastewaters and (3) incidental removal of some specific chemical pollutants by end-of6pipe treatment.

D. Wastewater Flow Characteristics

In order to characterize the waste from plants in the pharmaceutical industry, a determination was made from 308 data of the total industry wastewater flow rate and its component process subcategory flows for direct and indirect dischargers. Total flow from plants with data is compared in Table V-10 with the flows estimated for the subcategories. These are based on single-subcategory plant total flow adjusted for the number of occurrences for each subcategory. The averages of these flows are also useful as base-case flows for cost analysis.

Approximately 70 percent of the direct and indirect dischargers (not including zero dischargers) within the 308 Data Base reported wastewater flows totaling about 80 MGD. Of this, about 45 MGD is from the plants reporting direct discharges. A major factor in both of these flow totals is the inclusion of Plant

12256 which, due to a mixed discharge of large quantities of once-through river water, reported a flow of 30 MGD.

Using the reported single-subcategory plant flows as a means of estimating flow attributable to each subcategory, the plants not reporting flow are estimated to add another 13 MGD (93 MGD total estimated discharge flow for the plants in the data base). Table V-10 summarizes reported and estimated wastewater flows for the industry as represented by the 308 Data Base; this information is more comprehensively covered in Appendix J.

E. Precision and Accuracy Program

The Precision and Accuracy (P/A) Study is a fundamental, continuing program to insure the reliability and validity of analytical laboratory techniques. The P/A program is not utilized as a separate data base in support of the proposed limitations, but is used primarily to substantiate the data illustrated in Table V-11.

Precision refers to the reproducibility among replicate observations. In an Analytical Quality Control Program, precision is determined not on reference standards, but by the use of actual wastewater samples which cover a wide range of concentrations and a variety of interfering materials usually encountered by the analyst.

Accuracy refers to a degree of difference between observed and actual values. Accuracy should also be determined on actual wastewater samples routinely analyzed and, preferably, on the same series as those used in the precision determinations.

Through this process, data obtained by analysis of multiple samples were compared to demonstrate that (a) they present clearcut evidence that the analyst is indeed capable of analyzing the samples for that particular parameter (i.e., he has the standard method under control, and is capable of generating valid data) and (b) the data can be used in the evaluation of daily performance in reference to replicate samples, spiked samples, and in the preparation of quality control charts.

This type of quality assurance program is applicable to and can be adapted for all types of analytical procedures.

TRW and Radian performed on a split-sample basis for EPA a P/A study on a series of 24-hour composite influent and effluent samples collected from a single pharmaceutical manufacturing plant (12236) representing Subcategory C (chemical synthesis). Extraction of the non-volatile organic (NVO) sample for the basic recovery study was performed using continuous liquid/liquid

extractors. Volatile Organics (VOA) were analyzed using the purge-and-trap procedure adopted for this study. Standard spiking levels were used by both laboratories as specified by EPA. The extract volumes were selected depending upon expected concentration of the priority pollutants in the sample and the established linear response range of the GC/MS instruments. All pollutants detected in the samples are summarized in Table V-11.

The values reported by the two laboratories for priority pollutants are well within the detection limits of GC/MS analysis, with the exceptions of methylene chloride, toluene, and chloromethane. The values from the two laboratories are also moderately close to each other. In some cases, methylene chloride, toluene, and chloromethane were present in such high concentrations that although reasonable recovery and quantitation could be obtained, the results are not meaningful due to instrument saturation. The high levels present for these compounds apparently did interfere with the analysis of other priority pollutants. Recoveries of 2,4-dimethylphenol, benzidine, and the phthalates were low and erratic.

The detection of some of the priority pollutants could be the result of contamination by sources in the field or laboratory. It is common practice to equip automatic composite samplers with polyvinyl chloride (tygon) tubing. Phthalates are widely used as plasticizers to ensure that the tubing remains soft and flexible. These compounds have a tendency to migrate to the surface of the tubing and leach out into water passing through the sample tubing. Results of analysis shown in Table V-11 indicate the phthalates vary between laboratories. Sample contamination is possible and therefore, some of the results cannot be conclusively attributed to the wastewater.

TABLE V - 1

SUMMARY OF LONG TERM DATA

PLANT	SUBCAT	FLOWKGD	INBOD	EFBOD	INBODLB	EFBODLB	INCOD	EFCOD	INCODLB	EFCODLB	INTSS	EFTSS	INTSSLB	EFTSSLB	EFCN	EFCNLB
12015	D	100.93	232.64	9.70	192.84	7.81	552.68	43.98	462.49	35.44	123.76	10.76	102.56	8.67	.	.
12022	A C	1448.1	2141.6	110.24	25880	1308.3	.	.	.	.	.	84.85	.	990.99	.	.
12026	C	160.58	3670	108.14	4869.7	135.42	7334.7	1221.8	9700.6	1644.7	87.94	283.68	113.45	377.83	.	.
12036	A	1092.1	1570.8	33.06	14490	293.61	3542.3	444.49	32358	3919.7	1059.1	78.14	9812.4	720.71	.	.
12097	CD	63.99	1577.3	49.39	844.33	30.64	1804.8	37.61	984.73	20.42	.	18.11	.	10.50	0.03	0.02
12098	D	5.52	.	409.88	.	12.81	.	.	.	.	.	392.08	.	16.16	.	.
12117	B	100.86	34.50	1.94	26.48	1.73	95.41	24.49	76.59	20.34	.	16.00	.	12.81	.	.
12123	CD	931.82	.	.	.	.	.	.	.	.	.	.	.	.	0.02	0.15
12160	D	29.35	490.19	166.85	77.97	41.80	2160.4	516.69	449.56	137.51	1615.2	115.41	282.17	20.27	.	.
12161	A CD	1653.3	1538.9	19.78	21142	276.37	4332.6	850.24	59231	11727	795.94	31.55	10680	436.72	.	.
12186	CD	37.49	.	77.01	.	27.05	.	447.54	.	150.19	.	119.25	.	40.19	.	.
12187	C	1065	.	707.25	.	6380.9	.	.	.	.	.	60.50	.	538.05	.	.
12236	C	816.12	741.97	126.17	5149.6	886.26	2009.7	501.90	13277	3451.8	.	61.96	.	431.04	0.25	1.72
12248	D	109.55	294.44	26.00	281.31	25.47	473.90	95.85	455.16	90.90	.	60.42	.	59.12	.	.
12257	ABCD	754.50	2961.7	228.38	18750	1439.5	.	.	.	.	1009.4	715.27	6306.4	4403.8	.	.
12294	CD	117.55	1584.3	44.68	1537.6	43.86	3429.6	232.29	3332.3	228.94	.	59.21	.	60.53	.	.
12307	D	2.10	.	11.35	.	0.21	.	106.39	.	2.13	.	32.30	.	0.60	.	.
12317	D	739.83	1003.7	7.85	5985.6	43.65	1102.3	42.34	6887.7	254.80	41.35	9.84	247.66	59.53	.	.
12420	B D	164.23	.	786.80	.	1097.2	.	.	.	.	.	966.40	.	1328.7	.	.
12439	CD	.	.	495.36	.	.	.	971.20	.	.	.	.	.	.	.	.
12459	D	49.08	69.50	3.82	18.05	1.58	298.86	112.79	91.93	48.31	58.57	16.74	23.71	6.74	.	.
12462	A	208.54	1805	726.81	3074.8	1272.6	5168.2	2499.3	8866.5	4247	2012.9	2020.4	3308.7	3391.8	.	.

Note: Influents & effluents in mg/L, LB = LB/DAY.
Period (.) indicates no data reported.

TABLE V-2

LONG TERM DATA PLANTS SELECTED FOR BCT AND BAT

Plant No.	Type of Treatment	BOD% Removal	Long Term Avg. Effluent Conc. (mg/l) BOD	COD	TSS
12015	Biological	95.8	9.7	44.0	10.8
12022	Biological	94.9	110.2	N/A	84.9
12026	Biological	97.1	108.1	1222.0	283.7
12036	Biological	97.9	33.1	444.5	78.1
12097	Biological	96.9	49.4	37.6	18.1
12117	Biological	94.4	1.9	24.5	16.0
12161	Biological	98.7	19.8	850.1	31.6
12236	Biological	83.0	126.2	501.9	62.0
12248	Biological	91.2	26	95.9	60.4
12294	Biological	97.2	44.7	232.3	59.2
12307	Biological	ND	11.4	106.4	32.3
12317	Biological	99.2	7.8	42.3	9.8
12459	Biological	94.5	3.8	112.8	16.7

N/A = Not available

ND = Not determined

TABLE V-3

LONG TERM DATA PLANTS SELECTED FOR NSPS

Plant No.	Type of Treatment	BOD% Removal	Long Term Avg. Effluent Conc. (mg/l) BOD	COD	TSS
12015	Biological	95.8	9.7	44.0	10.8
12036	Biological	97.9	33.1	444.5	78.1
12097	Biological	96.9	49.4	37.6	18.1
12117	Biological	94.4	1.9	24.5	16.0
12161	Biological	98.7	19.8	850.1	31.6
12248	Biological	91.2	26.0	95.9	60.4
12294	Biological	97.2	44.7	232.3	59.2
12307	Biological	ND	11.4	106.4	32.3
12317	Biological	99.2	7.8	42.3	9.8
12459	Biological	94.5	3.8	112.8	16.7

ND = Not determined

TABLE V-4

LIST OF EPA-DESIGNATED PRIORITY POLLUTANTS

*No.	Compound	No.	Compound
1B	acenaphthene	70B	diethyl phthalate
2V	acrolein	71B	dimethyl phthalate
3V	acrylonitrile	72B	benzo(a)anthracene
4V	benzene	73B	benzo(a)pyrene
5B	benzidine	74B	3,4-benzofluoranthene
6V	carbon tetrachloride	75B	benzo(k)fluoranthane
7V	chlorobenzene	76B	chrysene
8B	1,2,4-trichlorobenzene	77B	acenaphthylene
9B	hexachlorobenzene	78B	anthracene
10V	1,2-dichloroethane	79B	benzo(ghi)perylene
11V	1,1,1-trichloroethane	80B	fluorene
12B	hexachloroethane	81B	phenanthrene
13V	1,1-dichloroethane	82B	dibenzo(a,h)anthracene
14V	1,1,2-trichloroethane	83B	indeno(1,2,3-C,D)pyrene
15V	1,1,2,2-tetrachloroethane	84B	pyrene
16V	chloroethane	85V	tetrachlorethylene
17B	bis(chloromethyl) ether**	86V	toluene
18B	bis(2-chloroethyl) ether	87V	trichloroethylene
19V	2-chloroethylvinyl ether	88V	vinyl chloride
20B	2-chloronaphthalene	89P	aldrin
21A	2,4,6-trichlorophenol	90P	dieldrin
22A	parachlorometa cresol	91P	chlordane
23V	chloroform	92P	4,4'-DDT
24A	2-chlorophenol	93P	4,4'-DDE
25B	1,2-dichlorobenzene	94P	4,4'-DDD
26B	1,3-dichlorobenzene	95P	alpha-endosulfan
27B	1,4-dichlorobenzene	96P	beta-endosulfan
28B	3,3'-dichlorobenzidine	97P	endosulfan sulfate
29V	1,1-dichloroethylene	98P	endrin
30V	1,2-trans-dichloroethylene	99P	endrin aldehyde
31A	2,4-dichlorophenol	100P	heptachlor
32V	1,2-dichloropropane	101P	heptachlor epoxide
33V	1,3-dichloropropylene	102P	alpha-BHC
34A	2,4-dimethylphenol	103P	beta-BHC
35B	2,4-dinitrotoluene	104P	gamma-BHC (lindane)
36B	2,6-dinitrotoluene	105P	delta-BHC
37B	1,2-diphenylhydrazine	106P	PCB-1242
38V	ethylbenzene	107P	PCB-1254
39B	fluoranthene	108P	PCB-1221
40B	4-chlorophenyl phenyl ether	109P	PCB-1232
41B	4-bromophenyl phenyl ether	110P	PCB-1248
42B	bis(2-chloroisopropyl) ether	111P	PCB-1260
43B	bis(2-chloroethoxy) methane	112P	PCB-1016
44V	methylene chloride	113P	toxaphene

45V	methyl chloride	114M	antimony (total)
46V	methyl bromide	115M	arsenic (total)
47V	bromoform	116	asbestos (fibrous)
48V	dichlorobromomethane	117M	beryllium (total)
49V	trichlorofluoromethane**	118M	cadmium (total)
50V	dichlorodifluoromethane**	119M	chromium (total)
51V	chlorodibromomethane	120M	copper (total)
52B	hexachlorobutadiene	121	cyanide (total)
53B	hexachlorocyclopentadiene	122M	lead (total)
54B	isophorone	123M	mercury (total)
55B	naphthalene	124M	nickel (total)
56B	nitrobenzene	125M	selenium (total)
57A	2-nitrophenol	126M	silver (total)
58A	4-nitrophenol	127M	thallium (total)
59A	2,4-dinitrophenol	128M	zinc (total)
60A	4,6-dinitro-o-cresol	129B	2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD)
61B	N-nitrosodimethylamine		
62B	N-nitrosodiphenylamine		
63B	N-nitrosodi-n-propylamine		
64A	pentachlorophenol		
65A	phenol		
66B	bis(2-ethylhexyl) phthalate		
67B	butyl benzyl phthalate		
68B	di-n-butyl phthalate		
69B	di-n-octyl phthalate		

* V - volatile organics
A - acid extractables
B - base/neutral extractables
P - pesticides
M - metals

** Deleted from the list of priority pollutants as per 46 FR 2264.

TABLE V-5
SUMMARY OF PRIORITY POLLUTANT INFORMATION: PEDCo REPORTS

Priority Pollutants Identified As Used In:

Subcategory A1

benzene
chloroform
1,1-dichloroethylene
1,2-trans-dichloroethylene
phenol
copper
zinc

Subcategory B2

benzene
carbon tetrachloride
1,2-dichloroethane
chloroform
methylene chloride
phenol
toluene
cyanide
lead
mercury
nickel
zinc

Subcategory C3

benzene
carbon tetrachloride
chlorobenzene
chloroethane
chloroform
1,1-dichloroethylene
1,2-trans-dichloroethylene
methylene chloride
methyl chloride
methyl bromide
nitrobenzene
2-nitrophenol
4-nitrophenol
phenol
toluene
chromium
copper
cyanide
lead
zinc

Total No. of Pollutants: 23

1 Reference No. 42
2 Reference No. 41
3 Reference No. 43

TABLE V-6

COMPILATION OF DATA SUBMITTED BY THE PMA FROM 26 MANUFACTURERS OF ETHICAL DRUGS: RTP STUDY

Type of Volatile Organic Compound	Annual Disposition (metric tons)							
	Annual Purchase	Air Emissions	Sewer	Incineration	Contract Haul	Disposal*	Product	Solvent Recovery
Methylene Chloride	10,000	5,310	455	2,060	2,180	-	5	73,400
Skelly Solvent B	1,410	410	23	980	-	-	-	90
Methanol	7,960	2,480	3,550	1,120	410	30	340	-
Toluene+	6,010	1,910	835	1,590	1,800	-	-	23,850
Acetone+	12,040	1,560	2,580	4,300	770	-	2,210	40,760
Dimethyl Formamide+	1,630	1,350	60	380	120	-	-	5,100
Ethanol	13,230	1,250	785	915	200	-	10,000	7,570
Isopropanol+	3,850	1,000	1,130	1,150	470	25	3,090	3,880
Amyl Alcohol+	1,430	775	-	-	0	-	9	76,900
Ethyl Acetate	2,380	710	1,110	480	80	-	-	715
Chloroform	500	280	23	-	175	17	-	1,210
Benzene+	1,010	270	350	150	80	-	90	20,500
Ethyl Ether	280	240	12	-	30	-	-	110,800
Methyl Isobutyl Ketone+	260	260	-	-	-	-	65	6,160
Carbon Tetrachloride	1,850	210	120	1,510	-	-	-	-
Xylene+	3,090	170	510	1,910	140	-	3	9,400
Methyl Ethyl Ketone	260	170	30	60	-	-	-	6,460
Trichloroethane	135	135	-	-	-	-	-	-
Hexane	530	120	-	100	475	-	-	25,670
Amyl Acetate	285	120	165	-	-	-	-	3,510
Isopropyl Acetate	480	105	45	230	-	-	-	1,840
Methyl Cellosolve	195	90	100	-	-	-	-	360
Butanol+	320	85	30	5	130	-	110	1,040
Isobutyraldehyde	85	40	40	-	-	-	-	145
Acetonitrile	35	30	6	-	-	-	-	125
Tetrahydrofuran	4	-	-	4	-	-	-	-
Isopropyl Ether	25	12	12	-	-	-	-	12
Acetic Acid	930	12	770	-	-	-	160	1,040
Acetic Anhydride	1,265	8	550	-	-	-	410	300

TABLE V-6
(Cont'd)

Type of Volatile Organic Compound	Annual Disposition (metric tons)							
	Annual Purchase	Air Emissions	Sewer	Incineration	Contract Haul	Disposal*	Product	Solvent Recovery
Dimethylacetamide	95	7	-	-	90	-	-	-
Formaldehyde	30	5	20	-	-	-	1	-
Dimethylsulfoxide	750	4	210	535	-	-	-	4,760
1,4-Dioxane	43	2	-	-	41	-	-	-
o-Dichlorobenzene	60	1	60	-	-	-	-	7,060
Diethyl Carbonate	30	1	20	-	-	-	7	-
Blenda (Amoco)	530	-	-	-	-	-	530	-
Ethyl Bromide	45	-	45	-	-	-	-	7,170
Cyclohexylamine	3,930	-	-	-	-	-	3,930	-
Methyl Formate	415	-	310	-	50	-	60	1,130
Formamide	440	-	290	-	110	-	30	-
Ethylene Glycol	60	-	60	-	-	-	-	60
Diethylamine	50	50	3	-	-	-	-	300
Freons	7,150	6	-	-	-	-	7,145	-
Diethyl-ortho Formate	54	-	21	-	-	-	33	-
Pyridine	3	-	3	-	-	-	-	-
Polyethylene Glycol 600	3	-	-	-	-	-	3	-
TOTALS	85,170	19,190	14,880	17,480	7,350	72	27,700	441,320

Source - 26 member companies of the Pharmaceutical Manufacturers Association (PMA) reported these data which they feel represent 85 percent of the volatile organic compounds used in their operations; these reporting companies caccount for approximately 53 percent of the 1975 domestic sales of ethical pharmaceuticals.

*Deepwell or landfill.

+Annual disposition does not closely approximate annual purchase.

TABLE V-7

SUMMARY OF VOLATILE ORGANIC COMPOUND EMISSION DATA: RTP STUDY

Item:	Amount: Total Compounds (total of 46)	Priority Pollutants (total of 7)
Amount purchased (metric tons)	85,170	19,565
Amount discharged (metric tons)	86,142	19,595
Amount recovered within the plant (metric tons)	441,320	126,020
Total amount used in plant (sum of items 1 and 3) (metric tons)	526,490	145,585
Percent recovered	83.8%	86.6%
Percent of total used that is discharged	16%	13.5%
Percent of total used that is discharged to sewer	2.7%	1.3%
Percent of total discharged that is discharged to sewer	16.7%	9.7%

TABLE V-8
SUMMARY OF MAJOR* PRIORITY POLLUTANTS IDENTIFIED
FROM MULTIPLE SOURCES OF INFORMATION

Priority Pollutant	RTP Study	PEDCo Reports	RSKERL/ ADA	308 Portfolio	Screening & Verification Sampling Program
Acid Extractables					
65 Phenol		X	X	X	X
Base Extractables					
25 1,2-Dichlorobenzene	X				
Volatile Organics					
4 Benzene	X	X	X	X	X
6 Carbon Tetrachloride	X	X		X	
11 1,1,1 - Trichloroethane	X				
23 Chloroform	X	X		X	X
29 1,1-Dichloroethylene		X			
30 1,2-Trans-Dichloroethylene		X			
38 Ethylbenzene			X		X
44 Methylene Chloride	X	X		X	X
86 Toluene	X	X		X	X
Metals					
119 Chromium			X	X	X
120 Copper		X	X	X	X
122 Lead		X	X	X	X
123 Mercury			X	X	X
124 Nickel				X	X
128 Zinc		X	X	X	X
Others					
121 Cyanide		X	X	X	X

* For this table toxic compounds were defined as "major" priority pollutants in accordance with the following criteria for each data source:

RTP - The pollutant was reported by at least one plant (26 plants reporting)
PEDCo - The pollutant was found in two or more subcategories (130 plants studied).
RSKERL/ADA - The pollutant was reported by at least one plant (2 plant study).
308 - The pollutant was identified by 25 or more plants (464 plants surveyed).
Screening/Verification - The pollutant was detected at ten or more plants (26 plants sampled).

TABLE V-9

ANALYSIS OF PRIORITY POLLUTANT CONCENTRATIONS (ug/l)
Screening/Verification Data Base

Influent

Based on Values Equal to or Greater than (10 ug/l)

	Priority Pollutant	Number of Plants	Number of Observations	Minimum	Maximum	Median	Mean	Standard Deviation
Acid Extractables								
21	2,4,6-trichlorophenol	1	1	20	20	20	20	.
24	2-chlorophenol	1	1	50	50	50	50	.
31	2,4-dichlorophenol	1	1	10	10	10	10	.
34	2,4-dimethylphenol	1	1	62	62	62	62	.
57	2-nitrophenol	2	2	23	119	71	71	68
58	4-nitrophenol	2	2	181	1600	891	891	1003
60	4,6-dinitro-o-cresol	1	1	15	15	15	15	.
64	pentachlorophenol	2	2	42	62	52	52	14
65	phenol	20	36	12	51,000		7529	15,499
Base Neutrals								
1	acenaphthene	2	2	35	92	64	64	40
25	1,2-dichlorobenzene	2	2	12	20	16	16	6
27	1,4-dichlorobenzene	1	1	90	90	90	90	.
35	2,4-dinitrotoluene	1	1	68	68	68	68	.
42	bis(2-chloroisopropyl) ether	2	2	300	448	374	374	150
54	isophorone	2	2	11	1014	513	513	709
62	N-nitrosodiphenylamine	1	1	12	12	12	12	.
66	bis(2-ethylhexyl)	8	10	10	760	105	157	222

67	butyl benzyl phthalate	3	3	12	719	18	250	406
68	di-n-butyl phthalate	4	4	18	20	20	19	1
70	diethyl phthalate	1	1	61	61	61	61	.
78	anthracene	1	1	14	14	14	14	.
80	fluorene	1	1	27	27	27	27	.
81	phenanthrene	1	1	14	14	14	14	.
Volatile Organics								
4	benzene	11	19	15	10,300	120	1586	3186
6	carbon tetrachloride	3	5	12	300	18	81	124
7	chlorobenzene	4	6	11	123,000	3206	36,405	55,025
10	1,2-dichloroethane	8	17	12	14,000	62	2516	4944
11	1,1,1-trichloroethane	8	11	17	1,300	22	169	383
14	1,1,2-trichloroethane	2	2	19	20	20	20	1
15	1,1,2,2-tetrachloro-ethane	1	1	20	20	20	20	.
23	chloroform	14	22	26	1620	170	396	470
29	1,1-dichloroethylene	1	1	230	230	230		.
33	1,3-dichloropropylene	1	1	100	100	100	100	.
38	ethylbenzene	9	18	11	42,000	24	3237	10,020
44	methylene chloride	18	31	16	200,000		11,356	37,952
45	methyl chloride	2	4	59	13,000	8,600	7,565	5,439
47	bromoform	1	2	12	12	1.2	12	.
49	trichlorofluoromethane	1	1	970	970	970	970	.
85	tetrachloroethylene	8	4	14	36	31	28	10
86	toluene	14	29	50	227,000	310	21,075	50,223
87	trichloroethylene	2	2	11	124	68	68	80

88	vinyl chloride	1	1	14	14	14	14	-
Metals								
114	antimony	8	9	12	210	27	45	62
115	arsenic	4	4	13	43	31	29	12
118	cadmium	4	5	10	40	32	25	14
119	chromium	18	30	13	650	39	117	155
120	copper	21	39	14	7030		571	1689
122	lead	9	13	14	500	63	119	139
*123	mercury	16	31	0.1	0.1		3.9	9.6
124	nickel	11	19	15	630	39	103	146
125	selenium	4	5	16	60	28	31	17
126	silver	2	2	24	40	32	32	11
127	thallium	2	3	18	43	40	34	14
128	zinc	20	37	29	2070		363	475
Other								
121	cyanide	8	16	18	540	140	153	135
130	BOD (mg/l)	18	33	98	11,300	1,090	2,183	2,688
131	COD (mg/l)	18	33	128	25,900	2,641	3,994	4,868
132	TSS (mg/l)	15	31	10	3,480	218	649	837

Effluent

Priority Pollutant		Number of Plants	Number of Observations	Minimum	Maximum	Median	Mean	Standards Deviation
Acid Extractables								
34	2,4-dimethylphenol	1	1	15	15	15	15	.
58	4-nitrophenol	1	1	15	15	15	15	.
65	phenol	9	12	10	126	23	47	46
Base Neutral								
42	bis(2-chloroisopropyl) ether	1	1	181	181	181	181	.
66	bis(2-ethylhexyl) phthalate	6	9	10	68	30	36	21
68	di-n-butyl phthalate	2	2	10	15	13	13	4
70	diethyl phthalate	2	2	10	20	15	15	7
80	fluorene	1	1	10	10	10	10	.
Volatile Organics								
2	acrolein	1	1	100	100	100	100	.
4	benzene	1	1	120	120	120	120	.
6	carbon tetrachloride	2	2	16	61	39	39	32
10	1,2-dichloroethane	5	9	22	500	62	158	169
11	1,1,1-trichloroethane	4	6	10	33	20	21	11
23	chloroform	6	7	14	150	90	79	55
29	1,1-dichloroetyhlene	1	1	180	180	180	180	.
38	ethylbenzene	3	3	14	22	17	18	4
44	methylene chloride	14	21	12	8100	120	863	1852
45	methyl chloride	2	4	100	410	310	283	139

49	trichlorofluoromethane	1	1	420	420	420	420	-
85	tetrachloroethylene	1	1	18	18	18	18	-
86	toluene	4	4	100	315	185	196	89
87	trichloroethylene	1	1	14	14	14	14	-
Metals								
114	antimony	2	5	20	51	31	34	15
115	arsenic	3	6	10	20	12	13	4
118	cadmium	1	1	40	40	40	40	-
119	chromium	13	21	10	304	27	77	94
120	copper	13	25	14	106	31	38	24
122	lead	9	14	13	400	33	64	100
*123	mercury	11	19	0.1	1.3	0.7	0.7	0.5
124	nickel	8	16	19	300	51	83	81
125	selenium	2	5	12	56	45	42	18
126	silver	1	1	40	40	40	40	-
127	thallium	2	5	10	129	11	37	52
128	zinc	17	32	13	2009	118	240	378
Other								
121	cyanide	6	11	30	7700	100	827	2282
**130	BOD	13	25	10	1090	84	155	211
**131	COD	13	30	216	3293	528	911	921
**132	TSS	13	29	0.1	1200	88	237	338

*All non-remarked data considered

**Expressed in mg/l

TABLE V-10

ANALYSIS OF WASTEWATER FLOW CHARACTERISTICS
(BASIS: 308 DATA)

Direct Discharger Flow (All plants reporting data) (Without Inclusion of Plant 12256)		45 MGD (15)
Indirect Discharge Reporting Flow (178 plants)		35
Total Flow Reported		80 MGD
Total Single Subcategory Flow/No. plants (with data)		
Subcat. A	1.30/3 = 0.435	
Subcat. B	0.67/15 = 0.045	
Subcat. C	8.80/34 = 0.260	
Subcat. D	9.80/131 = 0.075	
Indirect Discharger Estimated Flow for Non-Reporting Plants		
Subcat. A	0.435 X 5 occurrences = 2.175 MGD	
Subcat. B	0.045 x 16 occurrences = 0.72	
Subcat. C	0.260 x 14 occurrences = 3.64	
Subcat. D	0.075 x 90 occurrences = 6.75	
Estimated Unreported Flow		13
Total Discharge Flow Estimated for Data Base (Without Inclusion of Plant 12256)		93 MGD (63)

TABLE V - 11

COMPARISON OF PRECISION & ACCURACY (P&A) DATA - PLANT 12236

Priority Pollutants (ug/l)	P&A Sample Analyses				Comparison of Other Data Sources				
	Radian		TRW		Screening		Verification		308
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
Volatile Organics									
44V Methylene Chloride	916,000	-	22,000	-	40,000	200	14,000-80,000	15,000-8,100	
86V Toluene	24,000	-	36,000	-	33,000	1350	56,000-71,000	10	reported as used
45V Methyl chloride	33,000	-	18,000	-	1,300	-	8,000-13,000	100,410	
23V Chloroform	24-29	-	17-21	2-3	30	-	10	10	
4V Benzene	7-9	-	4	T	40	-	10-27	10	reported as used
10V 1,2-Dichloroethane	57-83	-	51-56	13	-	-	68-650	62-300	
30V Trans-1,2-Dichloroethylene	4-6	-	2	T					
38V Ethylbenzene	19-25	-	12-13	T	12	-	10-12	10	
49V Trichlorofluoromethane	ND	-	7	ND					
29V 1,1-Dichloroethylene	ND	-	9-12	ND	190	-	10-16	10	
13V 1,1-Dichloroethane	ND	-	1	ND					
Acid Extractables									
65A Phenol	6-7	ND	9-10	T-1					
24A 2-Chlorophenol	ND	ND	ND-2	T					
57A 2-Nitrophenol	ND	ND	ND	T-1					
34A 2,4-Dimethylphenol	ND	ND	ND	ND-1					
21A 2,4,6-Trichlorophenol	ND	ND	T	1					
64A Pentachlorophenol	ND	ND	T-1	T					
Base/Neutral Extractables									
42B Bis(2-chloroisopropyl)ether	ND	ND	ND	ND-1					
36B 2,6-Dinitrotoluene	ND	ND	1-4	T					
56B Nitrobenzene	ND	ND	ND-T	3					
35B 2,4-Dinitrotoluene	ND	ND	ND	2					
70B Diethyl phthalate	-	-	ND	1					
68B Di-N-Butyl phthalate	1	1	12-13	13-25					
67B Butyl benzyl phthalate	ND	ND	ND	1					

ND = not detected
T = trace or less than 1
- = no data

SECTION VI

SELECTION OF POLLUTANT PARAMETERS

A. INTRODUCTION

The priority (toxic) and traditional (conventional and nonconventional) pollutants characterized in Section V are discussed in this section in light of their occurrence in pharmaceutical industry wastewaters and their effects on the environment.

B. TRADITIONAL POLLUTANTS

The Clean Water Act of 1977 (P.L. 95-217) requires the Administrator to establish effluent limitations and standards for traditional pollutants. Among these, the conventional parameters of biochemical oxygen demand (BOD), total suspended solids (TSS), pH, and oil and grease and the nonconventional parameters of chemical oxygen demand (COD), total organic carbon (TOC), color, ammonia, nitrogen, and phosphorus were considered. Those chosen as representative of specific and persistent pollution problems across the industry were BOD, TSS, COD and pH.

These pollutant parameters were identified in 100 percent of the plants for which data were obtained. Pollutant levels in treatment influent and untreated effluent streams are frequently high, particularly in Subcategories A and C (fermentation and synthesis, respectively).

Other conventional parameters subject to regulation under the Administrator's discretion are oil and grease, pH, and fecal coliform. Although they do appear as problems in some plant process wastewater, oil and grease is not sufficiently widespread nor severe enough to justify regulation. Fecal coliform is not of significance in the industrial wastewater effluents of this industry. Similarly, the nonconventional parameters of color, phosphorus and various forms of nitrogen are not judged to present a frequent enough problem to justify regulation. TOC is considered to be so closely related to BOD and COD that separate attention is not necessary. The BPT pH range (6.0 - 9.0) will be continued in all other direct discharge regulations.

1. Biochemical Oxygen Demand

BOD is the quantity of oxygen required for the biological and chemical oxidation of waterborne substances under ambient or test conditions. Substances that may contribute to the BOD include carbonaceous organic materials usable as a food source by aerobic organisms; oxidizable nitrogen derived from nitrites, ammonia,

and organic nitrogen compounds that serve as food for specific bacteria; and such chemically oxidizable materials as ferrous iron, sulfides, sulfite, and similar reduced-state inorganics that will react with dissolved oxygen or that are metabolized by bacteria.

The BOD of a waste adversely affects the dissolved oxygen resources of a body of water by reducing the oxygen available to fish, plant life, and other aquatic species. Total exhaustion of the dissolved oxygen in water results in anaerobic conditions and the production of such undesirable gases as hydrogen sulfide and methane. The reduction of dissolved oxygen can be detrimental to fish populations, fish growth rate, and organisms used as fish food. A total lack of oxygen due to excessive BOD can result in the death of all aerobic aquatic inhabitants in the affected area.

Water with a high BOD indicates the presence of decomposing organic matter and associated increased bacterial concentrations that may degrade water quality and minimize potential uses of the water. This organic material promoting a high BOD can also increase algal concentrations and cause blooms.

The BOD_5 (5-day BOD) test is widely used to estimate the oxygen requirements of domestic and industrial wastes and to evaluate the performance of waste treatment facilities. To test for BOD, complete biochemical oxidation of a given waste may require a period of incubation too long for practical analytical test purposes. For this reason, the 5-day period has been accepted as standard and the test results have been designated as BOD_5. Despite its relative complexity, this test is widely accepted for measuring potential pollution because it is the best available method for evaluating the deoxygenation effect of a waste on a receiving water body.

The BOD test measures the weight of dissolved oxygen utilized by microorganisms as they oxidize or transform the gross mixture of chemical compounds in the wastewater. The degree of biochemical reaction involved in the oxidation of carbon compounds is related to the period of incubation. BOD_5 normally measures only 60 to 80 percent of the total carbonaceous biochemical oxygen demand of the sample, but, for most purposes, this is a reasonable estimate of ultimate BOD.

When measuring BOD either by the Winkler dissolved oxygen titration method or by the dissolved oxygen probe determination, measured BOD at lower levels of approximately 2 mg/l give a deviation of about ±33 percent even under the most careful laboratory conditions. At higher concentrations (above 100 mg/l, for example), the deviation is about ±15 percent.

2. Total Suspended Solids

Suspended solids in wastewater are normally measured as total suspended solids. They can include both organic and inorganic materials. The inorganic materials may include sand, silt, clay, and, possibly, toxic metal compounds. The organic fraction may include such materials as grease, oils, animal and vegetable waste products, fibers, microorganisms (algae, for example), and many other dispersed insoluble organic compounds. These solids may settle rapidly and form bottom deposits that are often a mixture of both organic and inorganic solids.

Solids may be suspended in water for a time and then settle to the bed of the stream or lake. They may be inert; they may be slowly biodegradable materials; or they may be rapidly decomposable substances. While in suspension, they increase the turbidity of the water, reduce light penetration, and thereby impair the photosynthetic activity of aquatic plants. After settling to the stream or lake bed, the solids can form sludge banks which, if largely organic, create localized dead areas in the water body and result in anaerobic and undesirable benthic conditions. Aside from any toxic effect attributable to substances leached out by water, suspended solids may kill fish and shellfish by causing abrasive injuries, by clogging gills and respiratory passages, by screening light, and by promoting and maintaining the development of noxious conditions through oxygen depletion. Suspended solids also reduce the recreational value of the water.

The precision of the TSS determination varies directly with the concentration of suspended matter in the sample. At 15 mg/l, the deviation is shown to be ±33 percent; at 242 mg/l, the deviation is ±10 percent; and at 1707 mg/l, the deviation is ±0.76 percent. There is no satisfactory procedure for determining the accuracy of the TSS method on wastewater samples since the true initial concentration cannot be determined.

3. Chemical Oxygen Demand

COD is a chemical oxidation test devised as an alternate method of estimating the total oxygen demand of a wastewater. Since the method relies on the oxidation-reduction system of chemical analyses rather than on biological factors, it is more precise, accurate, and rapid than the BOD_5 test. The COD test is widely used to estimate the total oxygen demand (ultimate rather than 5-day BOD) required to oxidize the compounds in a wastewater. It is based on the fact that with the assistance of certain inorganic catalysts, strong chemical oxidizing agents under acid conditions can oxidize most organic compounds.

The COD test measures organic matter that exerts an oxygen demand and that may affect public health. It is a useful analytical tool for pollution control activities. Most pollutants measured by the BOD_5 test can be measured by the COD test. In addition, pollutants more resistant to biochemical oxidation can also be measured as COD. COD is a more inclusive measure of oxygen demand than BOD_5 and results in higher oxygen demand values than BOD_5.

The COD of a wastewater normally exceeds BOD_5 since it is usually constituted of those materials contributing to the BOD level plus those more resistant to biochemical oxidation. Joint consideration of COD and BOD measurements can indicate the relatively biodegradability of the pollutants and the levels of the chemical pollutants not easily bio-oxydized. The correlation between the COD and BOD concentrations in a specific plant waste resulting from a particular operation is applicable only to that waste. Furthermore, the level of organic pollutants as indicated by COD do not correlate with the level of individual priority pollutants.

Compounds more resistant to biochemical oxidation are of great concern because of their slow, continuous oxygen demand on the receiving water and also because of their potentially harmful effects on the health of humans and aquatic life. Many of these compounds result from industrial discharges; some of the compounds have been found to have carcinogenic, mutagenic, and similar adverse effects. Concern about these compounds has increased as a result of demonstrations that their long life in receiving waters (the result of a low biochemical oxidation rate) allows them to contaminate downstream water intakes. The commonly used systems of water purification are not effective in removing these types of materials and such disinfection as chlorination may convert them into even more hazardous materials.

The COD test when performed by the dichromate reflux procedure will account for 95 to 100 percent of the theoretical values for most organic compounds. However, there are some compounds of the aromatic family (benzene, toluene, and pyridine, for example) that are not oxidized by this procedure.

C. PRIORITY POLLUTANTS

The frequency and level of priority pollutant occurrence in the wastewaters of the industry were considered in order to determine the manner in which these pollutants might be regulated. The diversity of process and materials employed by the industry brings about a broad presence, with virtually every toxic pollutant compound listed in the modified comprehensive settlement agreement present in at least one plant. However,

none are present in the effluent in all or even a predominant part of the industry.

Under the provisions of Paragraph 8 of the Settlement Agreement in Natural Resources Defense Council, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976), modified 12 ERC 1833 (D.D.C. 1979) (1)(2), guidance is provided to the Agency on exclusion of specific priority pollutants, subcategories, or categories from regulations under the effluent limitations guidelines, standards of performance and pretreatment standards. This paragraph is excerpted below:

> "8(a) The Administrator may exclude from regulation under the effluent limitations and guidelines, standards of performance, and/or pretreatment standards contemplated by this Agreement a specific pollutant or category or subcategory of point sources for any of the following reasons, based upon information available to him:
>
> (i) For a specific pollutant or a subcategory or category, equally or more stringent protection is already provided by an effluent, new source performance, or pretreatment standard or by an effluent limitation and guideline promulgated pursuant to Section(s) 301, 304, 306, 307(a), 307(b) or 307(c) of the Act;
>
> (ii) For a specific pollutant, except for pretreatment standards, the specific pollutant is present in the effluent discharge solely as a result of its presence in intake waters taken from the same body of water into which it is discharged and, for pretreatment standards, the specific pollutant is present in the effluent which is introduced into treatment works (as defined in Section 212 of the Act) which are publicly owned solely as a result of its presence in the point source's intake waters, provided however, that such point source may be subject to an appropriate effluent limitation for such pollutant pursuant to the requirements of Section 307;
>
> (iii) For a specific pollutant, the pollutant is not detectable (with the use of analytical methods approved pursuant to 304(h) of the Act, or in instances where approved methods do not exist, with the use of analytical methods which represent state-of-the-art capability) in the direct discharges or in the effluents which are introduced into publicly-owned treatment works from sources within the subcategory or category; or is detectable in the effluent from only a small number of sources within the subcategory and the pollutant is uniquely related to only those sources; or the pollutant is present only in trace amounts and is

neither causing nor likely to cause toxic effects; or is present in amounts too small to be effectively reduced by technologies known to the Administrator; or the pollutant will be effectively controlled by the technologies upon which are based other effluent limitations and guidelines, standards of performance, or pretreatment standards; or

(iv) For a category or subcategory, the amount and the toxicity of each pollutant in the discharge does not justify developing national regulations in accordance with the schedule contained in Paragraph 7(b).

(b) The Administrator may exclude from regulation under the pretreatment standards contemplated by this Agreement all point sources within a point source category or point source subcategory:

(i) If 95 percent or more of all point sources in the point source category or subcategory introduce into treatment works (as defined in Section 212 of the Act) which are publicly owned only pollutants which are susceptible to treatment by such treatment works and which do not interfere with, do not pass through, or are not otherwise incompatible with such treatment works; or

(ii) If the toxicity and amount of the incompatible pollutants (taken together) introduced by such point sources into treatment works (as defined in Section 212 of the Act) that are publicly owned is so insignificant as not to justify developing a pretreatment regulation..."

a. Pollutants Excluded from Direct Discharger Regulations

Table VI-1 lists the occurrence, frequencies and levels found in the screening plant data for the priority pollutants addressed by the Consent Decree. The priority pollutant data provided in the 308 data base was used to help develop the group of plants which were then screened for priority pollutants. However, these data were not used to support Paragraph 8 exclusion of priority pollutants found in the S/V study because many of the 308 priority pollutant responses were incomplete or of a non-quantitative nature. This was due in part to the fact that many plants have not performed a priority pollutant scan of their wastewater. The 308 priority pollutant data were used to exclude those which were uniquely related to individual sources or occur as the result of non-pharmaceutical operations.

Compounds numbered 17B, 49V, and 50V have been deleted by 46 FR 10723 and 46 FR 2266. The remaining list of priority pollutants was considered under the individual subparagraphs of Paragraph 8.

The compounds that can be excluded under each provision are tabulated in Tables VI-2 through VI-5, with those which can be excluded by more than one provision being noted by an asterisk (*). In addition a few pollutant compounds can be excluded by combinations of provisions (Table VI-5).

Table VI-2 lists compounds whose incidental removal is likely to be brought about by technologies instituted to meet other limitations. A significant example is phenol whose biodegradability makes it likely that substantial removal will be accomplished by activated sludge, aerated lagoons, or other biological treatment systems targeted for BOD removal. Air strippable volatiles are also likely to be removed by the passage of aeration air and high surface atmospheric exposure.

Table VI-3 lists pollutants with levels of occurrence insufficient to justify regulation. Some are present at no more than trace amounts (at or below the detection limits) and others at levels below or essentially the same as removal capabilities of applicable technologies. Those compounds with sufficient volatility and low solubility to be effectively steam stripped can be removed to no better than about 50-100 micrograms per liter ($\mu g/l$). Earlier consideration by the Agency (98) of the treatability of a number of the more significant priority pollutants indicates the following typical treatability criteria, expressed on a 5-day maximum basis:

		$\mu g/l$
8B	1,2,4-Trichlorobenzene	50-100
11V	1,1,1-Trichloroethane	500-600
13V	1,1-Dichloroethane	500-600
23V	Chloroform	500-600
25B	1,2-Dichlorobenzene	400-500
26B	1,3-Dichlorobenzene	400-500
27B	1,4-Dichlorobenzene	400-500
44V	Methylene Chloride	500
55B	Naphthalene	400-500
86V	Toluene	400
4V	Benzene	400
69B	Di-n-Octyl Phthalate	100

Metals removal effectiveness is indicated in Table VII-2. Table VI-3 shows the priority pollutants which were excluded based on a comparison of these treatability levels with the screening verification effluent data in Appendix G.

Also included in Table VI-3 are a number of phthalates whose presence is likely the result of sample contamination by sampling equipment.

Table VI-4 considers the frequency of occurrence in the Screening/Verification plant data. Those occurring infrequently, even though at significant levels, are excluded where a review of process wastewater from all of the Screening/Verification plants indicates that such occurrence is mainly related to those limited sources. Some priority pollutants analyzed in the effluent wastewater of one or more Screening/Verification plants are clearly not the result of pharmaceutical operations. For example, one plant is known to also produce pesticides and consequently exhibits pesticides in the mixed wastewater.

Table VI-5 lists those pollutants which are present in amounts too small to be effectively reduced by the technologies known to the Administrator. The most prevalent of these pollutants, methylene chloride, occurs in most (15 of 20) of the Screening/Verification plant effluents. However, only two of these plants exhibit an average effluent concentration higher than 500 micrograms per liter (the treatability criterion set out above). Chloroform and zinc were not found in effluent of any plants at treatable levels.

The one priority pollutant detected at sufficient levels and frequency control by direct dischargers is cyanide.

b. Pollutants Excluded from Regulation under Pretreatment Standards

Paragraph 8(b) (ii) of the Settlement Agreement allows for the exclusion of those pollutants whose toxicity and amounts (taken together) are so insignificant as not justify regulation under pretreatment standards. These pollutants which were found in the wastewater of 11 indirect discharger screening plants are listed in table VI-6 and include toxic metals, phenols, methyl chloride and various phthalates. (The presence of the last group of pollutants cannot be attributed with certainty to pharmaceutical manufacturing operations.) These pollutants were found infrequently and at low concentrations and therefore are not required to be controlled by pretreatment standards. Eighteen other pollutants (toxic solvents) which are listed in table VI-7 may be controlled by pretreatment standards. The remaining toxic pollutants were not detected in the wastewater of indirect discharging pharmaceutical plants.

TABLE VI-1

SUMMARY OF PRIORITY POLLUTANT OCCURRENCE

SCREENING PLANT DATA

No.*	Compound	No. of Occurrences Detected Influent (25)**	No. of Occurrences Detected Effluent (20)**	No. of Occurrences Above 500 ug/L in Effluent (20)**	Max. Effluent Level ug/L
1B	acenaphthene	4 (16%)			
2V	acrolein				
3V	acrylonitrile				
4V	benzene	15 (60%)	3 (15%)		120
5B	benzidine	1 (4%)			
6V	carbon tetrachloride	3 (12%)	1 (5%)		16
7V	chlorobenzene	5 (20%)			
8B	1,2,4-trichlorobenzene				
9B	hexachlorobenzene				
10V	1,2-dichloroethane	5 (20%)	4 (20%)	1	500
11V	1,1,1-trichloroethane	8 (32%)	4 (20%)		33
12B	hexachloroethane				
13V	1,1-dichloroethane	4 (16%)			
14V	1,1,2-trichloroethane	4 (16%)	1 (5%)		14
15V	1,1,2,2-tetrachloroethane				
16V	chloroethane	2 (8%)			
17B***	bis(chloromethyl) ether				
18B	bis(2-chloroethyl) ether	1 (4%)	1 (5%)		20
19V	2-chloroethylvinyl ether				
20B	2-chloronaphthalene				
21A	2,4,6-trichlorophenol	1 (4%)			
22A	parachlorometa cresol				
23V	chloroform	16 (64%)	9 (45%)		110
24A	2-chlorophenol	1 (4%)			
25B	1,2-dichlorobenzene	2 (8%)			
26B	1,3-dichlorobenzene				
27B	1,4-dichlorobenzene	1 (4%)			
28B	3,3'-dichlorobenzidine				
29V	1,1-dichloroethylene	5 (20%)	2 (10%)		180
30V	1-2-trans-dichloroethylene	1 (4%)			
31A	2,4-dichlorophenol				
32V	1,2-dichloropropane				
33V	1,3-dichloropropylene				
34A	2,4-dimethylphenol	1 (4%)	1 (5%)		15
35B	2,4-dinitrotoluene	2 (8%)	1 (5%)		14
36B	2,6-dinitrotoluene	1 (4%)			
37B	1,2-diphenylhydrazine	1 (4%)			
38V	ethylbenzene	12 (48%)	2 (10%)		160
39B	fluoranthene	1 (4%)			

TABLE VI-1 (continued)

No.*	Compound	No. of Occurrences Detected Influent (25)**	Detected Effluent (20)**	Above 500 ug/L in Effluent (20)**	Max. Effluent Level ug/L
40B	4-chlorophenyl phenyl ether				
41B	4-bromophenyl phenyl ether				
42B	bis(2-chloroisopropyl) ether	3 (12%)	2(100%)		
43B	bis(2-chloroethoxy) methane				
44V	methylene chloride	17 (68%)	15 (75%)	2	2600
45V	methyl chloride	1 (4%)			
46V	methyl bromide	1 (4%)			
47V	bromoform	1 (4%)	1 (5%)		44
48V	dichlorobromomethane				
49V***	trichlorofluoromethane				
50V***	dichlorodifluoromethane				
51V	chlorodibromomethane				
52B	hexachlorobutadiene				
53B	hexachlorocyclopentadiene				
54B	isophorone	2 (8%)			
55B	naphthalene	1 (4%)			
56B	nitrobenzene	1 (4%)			
57A	2-nitrophenol	3 (12%)			
58A	4-nitrophenol	3 (12%)	1 (5%)		15
59A	2,4-dinitrophenol				
60A	4,6-dinitro-o-cresol		1 (5%)		15
61B	N-nitrosodimethylamine				
62B	N-nitrosodiphenylamine	1 (4%)			
63B	N-nitrosodi-n-propylamine				
64A	pentachlorophenol	2 (8%)			
65A	phenol	14 (56%)	4 (20%)		120
66B	bis(2-ethylhexyl) phthalate	10 (40%)	8 (40%)		68
67B	butyl benzyl phthalate	2 (8%)			
68B	di-n-butyl phthalate	3 (12%)	4 (20%)		15
69B	di-n-octyl phthalate				
70B	diethyl phthalate	1 (4%)	1 (5%)		20
71B	dimethyl phthalate				
72B	benzo(a) anthracene				
73B	benzo(a) pyrene				
74B	3,4-benzofluoranthene				
75B	benzo(k) fluoranthane				
76B	chrysene				
77B	acenaphthylene				
78B	anthracene	2 (8%)			
79B	benzo(ghi) perylene				
80B	fluorene	1 (4%)			
81B	phenanthrene	1 (4%)			
82B	dibenzo(a,h) anthracene				

TABLE VI-1 (continued)

No.*	Compound	No. of Occurrences Detected Influent (25)**	Detected Effluent (20)**	Above 500 ug/L in Effluent (20)**	Max. Effluent Level ug/L
83B	indeno(1,2,3-C,D)pyrene				
84B	pyrene				
85V	tetrachloroethylene	4 (16%)	2 (10%)		18
86V	toluene	16 (64%)	5 (25%)	1	1350
87V	trichloroethylene	3 12%)	2 (10%)		11
88V	vinyl chloride				
89P	aldrin				
90P	dieldrin				
91P	chlordane				
92P	4,4'-DDT				
93P	4,4'-DDE				
94P	4,4'-DDD				
95P	alpha-endosulfan				
96P	beta-endosulfan				
97P	endosulfan sulfate				
98P	endrin				
99P	endrin aldehyde				
100P	heptachlor				
101P	heptachlor epoxide				
102P	alpha-BHC				
103P	beta-BHC				
104P	gamma-BHC (lindane)				
105P	delta-BHC				
106P	PCB-1242				
107P	PCB-1254				
108P	PCB-1221				
109P	PCB-1232				
110P	PCB-1248				
111P	PCB-1260				
112P	PCB-1016				
113P	toxaphene				
114M	antimony (total)	10 (40%)	3 (15%)		90
115M	arsenic (total)	5 (20%)	3 (15%)		30
116	asbestos (fibrous)				
117M	beryllium (total)	4 (16%)	2 (10%)		2.0
118M	cadmium (total)	8 (32%)	5 (25%)		40
119M	chromium (total)	23 (92%)	15 (75%)		304
120M	copper (total)	24 (96%)	16 (80%)		63
121	cyanide (total)	11 (44%)	10 (50%)		7700
122M	lead (total)	13 (52%)	9 (45%)		400
123M	mercury (total)	16 (64%)	12 (60%)		1.58
124M	nickel (total)	14 (56%)	9 (45%)		310
125M	selenium (total)	7 (28%)	3 (15%)		56

TABLE VI-1 (continued)

No.*	Compound	No. of Occurrences Detected Influent (25)**	Detected Effluent (20)**	Above 500 ug/L in Effluent (20)**	Max. Effluent Level ug/L
126M	silver (total)	7 (28%)	3 (15%)		40
127M	thallium (total)	5 (20%)	4 (20%)		29
128M	zinc (total)	21 (84%)	17 (85%)		403
129B	2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD)				

* V - volatile organics
A - acid extractables
B - base/neutral extractables
P - pesticides
M - metals

** Indicates number of plant streams.

*** Deleted from further consideration by 46 FR 10723 and 46 FR 2266.

TABLE VI-2

PRIORITY POLLUTANTS EXCLUDED FROM DIRECT DISCHARGER REGULATIONS BASED ON CONTROL BY OTHER LIMITATION TECHNOLOGIES

Paragraph 8 (a) (i) "For a specific pollutant effectively controlled by the technology upon which are based upon other effluent limitations and guidelines, standards of performance, or pretreatment standards . . ."

4V	benzene	(Air stripping and/or biodegradation)
11V*	1,1,1-trichloroethane	(Air stripping)
13V*	1,1-dichloroethane	(Air stripping)
85V	tetrachloroethylene	(Air stripping)
86V	toluene	(Air stripping and/or biodegradation)
87V*	trichloroethylene	(Air stripping)
57A*	2-nitrophenol	(Biodegradation)
58A*	4-nitrophenol	(Biodegradation)
59A*	2,4-dinitrophenol	(Biodegradation)
65A	phenol	(Biodegradation)
25B*	1,2-dichlorobenzene	(Biodegradation)
26B*	1,3-dichlorobenzene	(Biodegradation)
27B*	1,4-dichlorobenzene	(Biodegradation)
55B*	naphthalene	(Biodegradation)

* Indicates exclusion under two or more separate provisions of Paragraph 8.

V - Volatile organics

A - Acid extractables

B - Base/neutral extractables

P - Pesticides

M - Metals

TABLE VI-3

PRIORITY POLLUTANTS EXCLUDED FROM DIRECT DISCHARGER REGULATIONS BASED ON LOW-LEVEL PRESENCE

Paragraph 8 (a) (iii) "For a specific pollutant...present only in trace amounts and is neither causing nor likely to cause toxic affects; or is present in amounts too small to be effectively reduced by technologies known to the Administrator..."

6V*	carbon tetrachloride
7V	chlorobenzene
11V*	1,1,1-trichloroethane
13V*	1,1-dichloroethane
14V*	1,1,2-trichloroethane
15V*	1,1,2,2-tetrachloroethane
16V*	chloroethane
19V*	2-chloroethylvinyl ether
30V*	1,2-trans-dichloroethylene
32V*	1,2-dichloropropane
33V*	1,3-dichloropropylene
38V*	ethylbenzene
46V*	methyl bromide
47V*	bromoform
48V*	dichlorobromomethane
51V*	chlorodibromomethane
85V*	tetrachloroethylene
87V*	trichloroethylene
88V*	vinyl chloride
21A*	2,4,6-trichlorophenol
22A*	parachlorometa cresol
24A*	2-chlorophenol
31A*	2,4-dichlorophenol
34A*	2,4-dimethylphenol
37A*	1,2-diphenylhydrazine
57A*	2-nitrophenol
58A	4-nitrophenol
59A*	2,4-dinitrophenol
64A*	pentachlorophenol
65A	phenol
1B*	acenaphthene
5B*	benzidine
8B*	1,2,4-trichlorobenzene
9B*	hexachlorobenzene
12B*	hexachloroethane
18B*	bis(2-chloroethyl) ether
20B*	2-chloronaphthalene
25B*	1,2-dichlorobenzene
26B*	1,3-dichlorobenzene
27B*	1,4-dichlorobenzene
28B*	3,3-dichlorobenzidine
35B*	2,4-dinitrotoluene
36B*	2,6-dinitrotoluene
39B*	fluoranthene
40B*	4-chlorophenyl phenyl ether
41B*	4-bromophenyl phenyl ether
43B*	bis(2-chloroethoxy) methane
52B*	hexachlorobutadiene
53B*	hexachlorocyclopentadiene
54B*	isophorone
55B*	naphthalene
56B*	nitrobenzene
61B*	N-nitrosodimethylamine
62B*	N-nitrosodiphenylamine
63B*	N-nitrosodi-n-propylamine
66B**	bis(2-ethylhexyl) phthalate
67B**	butyl benzyl phthalate
68B**	di-n-butyl phthalate
69B**	di-n-octyl phthalate
70B**	diethyl phthalate
71B**	dimethyl phthalate
72B*	benzo(a)anthracene
73B*	benzo(a)pyrene
74B*	3,4-benzofluoranthene
75B*	benzo(k)fluoranthane
76B*	chrysene
77B*	acenaphthylene
78B*	anthracene
79B*	benzo(ghi)perylene
80B*	fluorene
81B*	phenanthrene
82B*	dibenzo(a,h)anthracene
83B*	indeno(1,2,3-C,D)pyrene
84B*	pyrene
129B*	2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD)
114M	antimony (Total)
115M	arsenic (Total)

TABLE VI-3 (CONT'D.)

PRIORITY POLLUTANTS EXCLUDED FROM DIRECT DISCHARGER REGULATIONS BASED ON LOW-LEVEL PRESENCE

117M*	beryllium (Total)
118M*	cadmium (Total)
119M	chromium (Total)
120M	copper (Total)
122M	lead (Total)
123M	mercury (Total)
124M	nickel (Total)
125M*	selenium (Total)
126M*	silver (Total)
127M	thallium (Total)

* Indicates exclusion under two or more separate provisions of Paragraph 8.

** Phthalates likely resulting from sample contamination.

V - Volatile organics

A - Acid extractables

B - Base neutral extractables

P - Pesticides

M - Metals

TABLE VI-4

PRIORITY POLLUTANTS EXCLUDED FROM DIRECT DISCHARGER REGULATIONS BASED ON INFREQUENT OCCURRENCE

Paragraph 8 (a) (iii) "For a specific pollutant...detectable in the effluent from only a small number of sources within the subcategory and the pollutant is uniquely related to only those sources..."

2V	acrolein
3V	acrylonitrile
6V*	carbon tetrachloride (tetrachloromethane)
7V*	chlorobenzene
10V*	1,2-dichloroethane
13V*	1,1-dichloroethane
14V*	1,1,2-trichloroethane
15V*	1,1,2,2-tetrachloroethane
16V*	chloroethane
19V*	2-chloroethyl vinyl (mixed)
29V	1,1-dichloroethylene
30V*	1,2-trans-dichloroethylene
32V*	1,2-dichloropropane
33V*	1,3-dichloropropylene (1,3-dichloropropene)
38V*	ethylbenzene
45V	methyl chloride (chloromethane)
46V*	methyl bromide (bromomethane)
47V*	bromoform (tribromomethane)
48V*	dichlorobromomethane
51V*	chlorodibromomethane
85V*	tetrachloroethylene
87V*	trichloroethylene
88V*	vinyl chloride (chloroethylene)
21A*	2,4,6-trichlorophenol
22A*	parachlorometa cresol
24A*	2-chlorophenol
31A*	2,4-dichlorophenol
34A*	2,4-dimethylphenol
37A*	1,2-diphenylhydrazine
58A*	4-nitrophenol
59A*	2,4-dinitrophenol
60A	4,6-dinitro-o-cresol
64A*	pentachlorophenol
1B*	acenaphthene
5B*	benzidine
8B*	1,2,4-trichlorobenzene
9B*	hexachlorobenzene
12B*	hexachloroethane
18B*	bis(2-chloroethyl) ether
20B*	2-chloronaphthalene
25B*	1,2-dichlorobenzene
26B*	1,3-dichlorobenzene
27B*	1,4-dichlorobenzene
28B*	3,3-dichlorobenzidine
35B*	2,4-dinitrotoluene
36B*	2,6-dinitrotoluene
39B*	fluoranthene
40B*	4-chlorophenyl phenyl ether
41B*	4-bromophenyl phenyl ether
42B	bis(2-chloroisopropyl) ether
43B*	bis(2-chloroethoxy) methane
52B*	hexachlorobutadiene
53B*	hexachlorocyclopentadiene
54B*	isophorone
55B*	naphthalene
56B*	nitrobenzene
61B*	N-nitrosodimethylamine
62B*	N-nitrosodiphenylamine
63B*	N-nitrosodi-n-propylamine
72B*	benzo(a)anthracene
73B*	benzo(a)pyrene
74B*	3,4-benzofluoranthene
75B*	benzo(k)fluoranthene
76B*	chrysene
77B*	acenaphthylene
78B*	anthracene
79B*	anthracene
80B*	fluorene
81B*	phenanthrene

TABLE VI-4 (CONT'D.)

PRIORITY POLLUTANTS EXCLUDED FROM DIRECT DISCHARGER REGULATIONS
BASED ON
INFREQUENT OCCURRENCE

82B*	dibenzo(a,h) anthracene
83B*	indeno(1,2,3-C,D)pyrene
84B*	pyrene
129B*	2,3,7,8-tetrachloro-dibenzo-p-dioxin(TCDD)
89P**	aldrin
90P**	dieldrin
91P**	chlordane
92P**	4,4'-DDT
93P**	4,4'-DDE
94P**	4,4'-DDD
95P**	alpha-endosulfan
96P**	beta-endosulfan
97P**	endosulfan sulfate
98P**	endrin
99P**	endrin aldehyde
100P**	heptachlor
101P**	heptachlor epoxide
102P**	alpha-BHC
103P**	beta-bhc
104P**	gamma-BHC (lindane)
105P**	delta-BHC
106P**	PCB-1242
107P**	PCB-1254
108P**	PCB-1221
109P**	PCB-1232
110P**	PCB-1248
111P**	PCB-1260
112P**	PCB-1016
113P**	toxaphene
117M*	beryllium (Total)
118M*	cadmium (Total)
125M*	selenium (Total)
126M*	silver (Total)

* Indicates exclusion under two or more separate provisions of Paragraph 8.

** Infrequent presence due to operations on site other than pharmaceutical.

V - Volatile organics

A - Acid extractables

B - Base neutral extractables

P - Pesticides

M - Metals

TABLE VI-5

PRIORITY POLLUTANTS EXCLUDED FROM DIRECT DISCHARGER REGULATIONS BASED ON PRESENCE IN AMOUNTS TOO SMALL TO BE EFFECTIVELY REDUCED BY TECHNOLOGIES KNOWN TO THE ADMINISTRATOR

23V	chloroform
44V	methylene chloride
128M	zinc (Total)

M - Metals

V - Volatile organics

TABLE VI-6

POLLUTANTS EXCLUDED FROM PRETREATMENT STANDARDS

No.	Compound	No. of Occurrences in Indirect Wastewaters	Max. Indirect Wastewater Concentration	Basis For Exclusion
14V	1,1,2-trichloroethane	0		Infrequent
15V	1,1,2,2-tetrachloroethane	0		"
16V	chloroethane	0		"
19V	2-chloroethylvinyl ether	0		"
32V	1,2-dichloropropane	0		"
33V	1,3-dichloropropylene	0		"
48V	dichlorobromomethane	0		"
51V	chlorodibromomethane	0		"
88V	vinyl chloride	0		"
1B	acenaphthene	0		"
5B	benzidine	0		"
8B	1,2,4-trichlorobenzene	0		"
9B	hexachlorobenzene	0		"
12B	hexachloroethane	0		"
18B	bis(2-chloroethyl) ether	0		"
20B	2-chloronaphthalene	0		"
25B	1,2-dichlorobenzene	1	12	" & low level
26B	1,3-dichlorobenzene	0		"
27B	1,4-dichlorobenzene	0		"
28B	3,3'-dichlorobenzidine	0		"
35B	2,4-dinitrotoluene	0		"
36B	2,6-dinitrotoluene	0		"
37B	1,2-diphenylhydrazine	0		"
39B	fluoranthene	0		"
40B	4-chlorophenyl phenyl ether	0		"
41B	4-bromophenyl phenyl ether	0		"
42B	bis(2-chloroisopropyl) ether	0		"
43B	bis(2-chloroethoxy) methane	0		"
52B	hexachlorobutadiene	0		"
53B	hexachlorocyclopentadiene	0		"
54B	isophorone	0		"
55B	naphthalene	0		"
56B	nitrobenzene	0		"
61B	N-nitrosodimethylamine	0		"
62B	N-nitrosodiphenylamine	1	12	" & low level
63B	N-nitrosodi-n-propylamine	0		"
66B	bis(2-ethylhexyl) phthalate	5*	2700*	"
67B	butyl benzyl phthalate	0		"
68B	di-n-butyl phthalate	0		"

* Phthalate occurrence likely the result of sample contamination by sample tubing.

TABLE VI-6 (Continued)

No.	Compound	No. of Occurrences in Indirect Wastewaters	Max. Indirect Wastewater Concentration	Basis For Exclusion
69B	di-n-octyl phthalate	0		Infrequent
70B	diethyl phthalate	0		"
71B	dimethyl phthalate	0		"
73B	benzo(a) pyrene	0		"
74B	3,4-benzofluoranthene	0		"
75B	benzo(k) fluoranthane	0		"
76B	chrysene	0		"
77B	acenaphthylene	0		"
78B	anthracene	0		"
79B	benzo(ghi) perylene	0		"
80B	fluorene	0		"
81B	phenanthrene	0		"
82B	dibenzo(a,h) anthracene	0		"
83B	indeno(1,2,3-C,D) pyrene	0		"
84B	pyrene	0		"
129B	2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD)	0		"
89P	aldrin	0		"
90P	dieldrin	0		"
91P	chlordane	0		"
92P	4,4'-DDT	0		"
93P	4,4'-DDE	0		"
94P	4,4'-DDD	0		"
95P	alpha-endosulfan	0		"
96P	beta-endosulfan	0		"
97P	endosulfan sulfate	0		"
98P	endrin	0		"
99P	endrin aldehyde	0		"
100P	heptachlor	0		"
101P	heptachlor epoxide	0		"
102P	alpha-BHC	0		"
103P	beta-BHC	0		"
104P	gamma-BHC (lindane)	0		"
105P	delta-BHC	0		"
106P	PCB-1242	0		"
107P	PCB-1254	0		"
108P	PCB-1221	0		"
109P	PCB-1232	0		"
110P	PCB-1248	0		"
111P	PCB-1260	0		"
112P	PCB-1016	0		"
113P	toxaphene	0		"
114M	antimony (total)	7	210	treatable level
115M	arsenic (total)	3	43	" " "
117M	beryllium (total	2	2	" " "
118M	cadmium (total)	3	32	" " "
119M	chromium (total)	11	650	" " "

TABLE VI-6 (Continued)

No.	Compound	No. of Occurrences in Indirect Wastewaters	Max. Indirect Wastewater Concentration	Basis For Exclusion
120M	copper (total)	11	150	treatable level
122M	lead (total)	8	286	" " "
123M	mercury (total)	7	50	" " "
124M	nickel (total)	8	630	" " "
125M	selenium (total)	3	30	" " "
126M	silver (total)	4	24	" " "
127M	thallium (total)	2	43	" " "
128M	zinc (total)	10	522	
116		--		

TABLE VI-7

POLLUTANTS CONSIDERED FOR PRETREATMENT STANDARDS

No.	Compound	No. of Occurrences in Wastewaters	Max. Wastewater Concentration Level (ug/L)
121	cyanide	5	590
	Volatile Organics:		
2V	acrolein	2	100
3V	acrylonitrile	1	100
4V	benzene	6	580
6V	carbon tetrachloride	1	300
7V	chlorobenzene	2	11
10V	1,2-dichloroethane	2	290
11V	1,1,1-trichloroethane	4	360,000
13V	1,1-dichloroethane	3	27
23V	chloroform	6	1,350
29V	1,1-dichloroethylene	2	10
30V	1,2-trans-dichloroethylene	1	550
38V	ethylbenzene	3	21
44V	methylene chloride	9	890,000
47V	bromoform	1	12
85V	tetrachloroethylene	1	2
86V	toluene	6	1,050
87V	trichloroethylene	1	7

SECTION VII

CONTROL AND TREATMENT TECHNOLOGY

A. INTRODUCTION

This section addresses the technologies currently used or available to remove or reduce wastewater pollutants generated by the pharmaceutical manufacturing industry. Although wastewater flow and raw waste load will vary from plant to plant, they are expected to be treatable by the techniques presented herein. Many possible combinations of in-plant and EOP systems exist that are capable of achieving the pollutant reduction levels anticipated. However, each individual plant must make the final decision concerning the specific combination of pollution control measures best suited to its particular situation.

In identifying appropriate control and treatment technologies, the Agency assumed that each manufacturing plant had installed or would install the equipment necessary to comply with limitations based on BPT. Those treatment technologies currently in place in the industry, as reported in 308 responses, are presented by plant in Appendix L. Thus, the technologies described below are those which can further reduce the discharge of pollutants into navigable waters or POTW systems. They are divided into two broad classes: in-plant and end-of-pipe (EOP) technologies.

Since the ultimate receiving point of a plant's wastewater can be critical in determining the overall treatment effort required, information on ultimate discharge is also supplied.

B. IN-PLANT SOURCE CONTROL

The intent of in-plant source control is to reduce or eliminate the hydraulic and/or pollutant loads generated by specific sources within the overall manufacturing process. By implementing controls at the source, the impact on and requirements of subsequent downstream treatment systems can be minimized.

Many of the newer pharmaceutical manufacturing plants are designed with the reduction of water use and subsequent minimization of contamination as part of the overall planning and plant design criteria. Improvements also have been made in existing plants to better control their manufacturing processes and other activities and the consequent environmental effects. Some examples of in-plant source controls that have been effective in reducing pollution loads are as follows:

(1) Production processes have been modified or combined and reaction mixtures have been concentrated to reduce waste loads as well as increase yields. Processes have also been reviewed and revised to reduce the number of toxic substances used.

(2) Efforts are made to concentrate and segregate wastes at their source to minimize or eliminate wastes where possible. New process equipment is designed to produce effluents requiring no further treatment.

(3) Several techniques have been employed to reduce the volume of fermentation wastes discharged to end-of-pipe treatment systems. One approach involves concentrating "spent beer" wastes by evaporation and then dewatering and drying waste mycelia. The resulting dry product in some instances has sufficient economic value as an animal feed supplement to offset part of the drying cost.

(4) Several plants have installed automatic TOC-monitoring instrumentation or both pH and TOC monitoring to permit early detection of process upsets that may result in excessive discharges to sewers.

(5) The recovery of waste solvents is a common practice among plants using solvents in their manufacturing processes. However, to further reduce the amount of waste solvent discharge, plants have instituted such measures as (a) incineration of solvents that cannot be recovered economically, (b) incineration of "bottoms" from solvent recovery units, and (c) design and construction of solvent recovery columns to strip solvents beyond the economical recovery point.

(6) The use of barometric condensers can result in significant water contamination, depending upon the nature of the materials entering the discharge water stream. In addition, barometric condenser use very high quantities of water, which results in substantial increases in the total amount of process-exposed wastewater. An outstanding example of this is plant 12256 which utilizes more than 20 MGD of once-through barometric condenser water. As an alternative, several plants are using surface condensers to reduce hydraulic or organic loads.

(7) Several plants are using a recirculation system as a means of greatly reducing the amount of contaminated water being discharged from water-sealed vacuum pumps.

(8) Reduction of once-through cooling water by recycling through cooling towers is used in numerous plants and results in decreased total volume of discharge.

(9) Separation of manufacturing area stormwater is practiced throughout the industry and often facilitates the isolation and treatment of contaminated runoff.

(10) Spill prevention is recognized in the industry as a critical aspect of pollution control. In addition to careful management of materials and methods, such preventive steps as impoundment basins are utilized in many cases.

(11) Wash waters can be reduced or eliminated in many situations by use of dry cleanup methods. Containment control and removal of either liquid or solid dry process wastes can often be accomplished using little or no water. This particular approach can possibly completely eliminate wastewater discharge, especially in Subcategory D (Formulation) plants, where washwater is often the only wastewater source.

C. IN-PLANT TREATMENT

Besides implementing source controls to reduce or eliminate the waste loads generated within the manufacturing process, plants may also employ in-plant treatment directed at removing certain pollutants before they are combined with the plant's overall wastewaters and thus diluted.

This concept of in-plant treatment of a segregated stream is of major importance. First, treatment technologies can be directed specifically toward a particular pollutant. Also, since wastewater treatment and pollutant removal costs are strongly influenced by the volume of water to be treated, the costs involved in treating a segregated stream are considerably less than they would be in treating combined wastewater.

Additionally, chemicals other than those being treated are less likely to interfere with the treatment technology if treatment occurs before commingling. Further, lower EOP effluent levels can be attained due to dilution of the treated segregated stream.

In-plant treatment processes can be visualized as end-of-pipe treatment for a particular production process or stage within the plant itself, designed to treat specific waste streams. Although in-plant technologies can remove a variety of pollutants, their principal applications are for the treatment of toxic or priority pollutants. In the pharmaceutical manufacturing industry, three

classes of priority pollutants are of particular importance. As indicated in Section V, the major priority pollutants are solvents, metals, and cyanide. Thus, the discussions presented below on in-plant technologies concern the treatment of these three classes of pollutants.

The 308 Portfolio data base was the principal source of information relating to the use of in-plant treatment in the pharmaceutical industry. Most of this information came from the Supplemental 308 Portfolio responses. In addition, while not specifically requested in the original 308 Portfolio, some in-plant treatment information was obtained from the original 308 Portfolio plants. It was gathered via three mechanisms: a) some plants provided on the questionnaire "additional" data or comments relative to in-plant treatment; b) a small amount of information was gathered by direct contact with plant personnel; and c) the wastewater sampling programs discussed in Section II identified the use of a few in-plant technologies. (At the time of the original 308 mailing, data on in-plant treatment was not thought to be a critical item. This philosophy was changed prior to the Supplemental 308 mailing.)

Table VII-1 presents a summary of in-plant treatment technologies identified from the various data bases along with the number of plants that employ each process. A listing of each plant's treatment system, including in-plant treatment, is presented in Appendix L.

1. Cyanide Destruction Technologies

Cyanide destruction is employed in the pharmaceutical industry, as noted by the 308 responses (table VII-1), by limited direct inquiry, and by information from the S/V program.

Present cyanide treatment processes demonstrated to be effective are based upon two fundamental approaches, chemical oxidation and high pressure and temperature techniques. Chemical oxidation is a reaction in which one or more electrons are transferred from the chemical being oxidized to the chemical initiating the transfer (oxidizing agent); as a result of the valence change, the oxidized substance can then react to form a more desirable compound. The latter treatment is the application of high temperature and pressure to break down chemical bonds; the end result is that more tolerable substances are formed (e.g. CO_2 and NO_2). Under some circumstances, cyanide ions may combine with several metals to form inert complexes which may interfere with removal of both the cyanide and the metal. Of the commonly encountered metals, chromium, manganese, and iron form inert complexes, while nickel and mercury form labile complexes:

Cyanide Complexes

Inert	Labile
$Cr(CN)_6^{-4}$	$Ni(CN)_4^{-2}$
$Mn(CN)_6^{-3}$	$Hg(CN)_4^{-2}$
$Fe(CN)_6^{-3}$	

Although they are classified as inert, cyanide will be released from the inert complexes over an extended period of time. However, this time period may exceed the residence time in the cyanide destruct unit and cyanide from these complexes would not be destroyed. The labile complexes will present no interference in cyanide removal.

An evaluation of cyanide limitations practically achievable by the various technologies must consider the following:

(1) Theoretical reaction equilibrium limits. These are generally extreme and therefore not a controlling factor.

(2) Conditions under which cyanate reversion can occur.

(3) Competitive reactions resulting in increased oxidant consumption.

(4) Chemical interferences such as iron complexing and the processing alternatives necessary to avoid them.

(5) Physical interferences which might hamper reactant availability and design methods to overcome them.

(6) The extent to which equalization dilution after treatment lowers cyanide in the final effluent. In most plant situations this results in a substantial concentration reduction allowing limitation levels at end-of-pipe which might be difficult to reach directly.

a. Chlorination

Destruction of cyanide by oxidation either with chlorine gas under alkaline conditions or with sodium hypochlorite is a very common method of treating industrial wastewaters containing cyanide. Although more costly, sodium hypochlorite is less hazardous and is simpler to handle. Oxidation can be approximated by the following two-step chemical reaction:

$$Cl_2 + NaCN + 2\ NaOH = NaOCN + 2\ NaCl + H_2O$$

$$3Cl_2 + 6NaOH + 2NaOCN = 2\ NaHCO_3 + N_2 + 6\ NaCl + 2\ H_2O$$

Cyanide is oxidized to cyanate completely and rapidly at a pH of about 9.5 to 10.0. Usually 30 minutes are required to insure a complete reaction. The oxidation of cyanide to cyanate is accompanied by a marked reduction in volatility and a thousandfold reduction in toxicity.

However, since cyanate may revert to cyanide under some conditions, additional chlorine is provided to oxidize cyanate to carbon dioxide/bicarbonate. At pH levels around 9.5 to 10.0, several hours are required for the complete oxidation of the cyanate, but only one hour is necessary at a pH between 8.0 and 8.5. Also, excess chlorine must be provided to break down cyanogen chloride, a highly toxic intermediate compound formed during the oxidation of cyanate.

Although stoichiometric oxidation of one part of cyanide to cyanate requires only 2.73 parts of chlorine, in practice 3 to 4 parts of chlorine are used. Complete oxidation of one part cyanide to carbon dioxide and nitrogen gas theoretically requires 6.82 parts of chlorine, but nearly 8 parts are normally necessary in practice. The chlorine required in practice is higher than the theoretical amount because other substances in the wastewater compete for the chlorine.

Soluble iron interferes seriously with the alkaline chlorination of cyanide wastes. Iron and cyanide form a stable complex which is impervious to chlorine oxidation. Similar difficulties result from formation of nickel cyanides. Ferrocyanides are reported treatable by alkaline chlorination at temperatures of 71 C (160 F) and at a pH of about 12.0.

Ammonia also interferes with the chlorine oxidation process since the chlorine demand is increased by the formation of chloramines. When cyanide is only being oxidized to cyanate, it is usually not economical to remove the ammonia by breakpoint chlorination, which requires almost 10 parts of chlorine per part of ammonia. Complete cyanate formation can be accomplished by allowing an extra 15 minutes contact time. When complete oxidation of the cyanide is to be accomplished, the ammonia must be removed by breakpoint chlorination so a free chlorine residual can be maintained to break down the cyanogen chloride.

An example of a cyanide destruction system using chlorination is shown in Figure VII-1.

Because of some of the advantages of the chlorination process, this technology has received widespread application in the chemical industry as a whole. First, it is a relatively low cost

system and does not require complicated equipment. It also fits well into the flow scheme of a wastewater treatment facility. The process will operate effectively at ambient conditions and is well suited for automatic operation, thus minimizing labor requirements. This technique is used by pharmaceutical processes manufacturers who use cyanide in chemical synthesis.

The chlorination process, however, does have limitations and disadvantages. For example, toxic, volatile intermediate-reaction products can be formed. Thus, it is essential to properly control the pH to ensure that all reactions are carried to their end point. Also, for waste streams containing other oxidizable matter, the chlorine may be consumed in oxidizing these materials and may interfere with the treatment of the cyanide. Finally, for those systems using gaseous chlorine, a potentially hazardous situation exists when it is stored and handled.

The oxidation of cyanide-bearing wastewaters by using chlorine under basic conditions is a classic technology. However, its use by the pharmaceutical industry is limited to a few plants. From the EPA's Effluent Guidelines Division's study to develop BAT regulations for the electroplating industry (109), it was found that cyanide levels around 40 µg/l are achievable by in-plant chlorination processes, as long as reaction interferences are not present. The presence of interfering substances in pharmaceutical manufacturing wastewater may, in fact, prevent the attainment of these levels using the alkaline chlorination method.

In addition, the Draft Development Document for the Inorganic Chemicals Industry (71) indicates that the free cyanide level after chemical oxidation treatment is generally below 100 ug/l. An important consideration relative to the reported attainable effluent level and the variety of pharmaceutical wastewaters encountered is the presence of constituents which interfere by complexing or competing for the chlorine oxidizing agent. The extent to which the various materials found in pharmaceutical wastewater may interfere with chlorine oxidation is not known.

Chemical oxidation of cyanide is currently the most prevalent technique used by pharmaceutical plants to destroy cyanide. However, the available data from plants using this method does not permit an adequate evaluation of the cyanide destruction capability of this technique as applied to pharmaceutical wastewater.

b. Ozonation

Ozone (allotropic form of oxygen) is a good oxidizing agent and can be used to treat process wastewaters that contain cyanide.

In fact, ozone oxidizes many cyanide complexes (for instance, iron and nickel complexes) that are not broken down by chlorine. Ozonation is primarily used to oxidize cyanide to cyanate.

With traces of copper and manganese as catalysts, cyanide is reduced to very low levels, independent of starting concentrations and form of the complex. The oxidation of cyanide by ozone to cyanate occurs in about 15 minutes at a pH of 9.0 to 10.0, but the reaction is almost instantaneous in the presence of traces of copper. The pH of the cyanide waste is often raised to 12.0 in order that complete oxidation occurs before the pH drops to 8.0 in the process.

Oxidation of cyanate to the final end products, nitrogen and bicarbonate, is a much slower and more difficult process unless catalysts are present. Therefore, since ozonation will not readily effect further oxidation of cyanate, it is often coupled with such independent processes as dialysis or bio-oxidation.

The ozonation treatment process is beginning to receive more and more usage. Its initial applications in treating metal finishing wastewater have shown it to be quite effective for cyanide removal. Like chlorination, the ozonation process is well suited to automatic control and will operate effectively at ambient conditions. Also, the reaction product (oxygen) is beneficial to the treated wastewater. Since the ozone is generated onsite, procurement, storage, and handling problems are eliminated.

The ozonation process does have drawbacks. It has higher capital and operating costs than chlorination and similar toxicity problems; also, as with chlorination, increased ozone demand is possible if other oxidizable matter is present in the waste stream. Finally, in most cases the cyanide is not effectively oxidized beyond the cyanate level.

c. Alkaline Hydrolysis

Removal of cyanide from process wastewaters can be accomplished without the use of strong oxidizing chemicals. For the alkaline hydrolysis system, the principal treatment action is based upon the application of heat and pressure. In this process, a caustic solution is added to the cyanide-bearing wastewaters to raise the pH to between 9.0 and 12.0. Next, the wastewater is transferred to a continuous reactor where it is subjected to temperatures of about 165°C to 185°C (329°F to 365°F) and pressured from approximately 90 to 110 psia. The breakdown of cyanide in the reactor is generally accomplished with a residence time of about 1.5 hours.

An example of an alkaline hydrolysis system for treating cyanide-bearing wastewaters is shown in Figure VII-2.

The absence of specific chemical reactants in this process eliminates procurement, storage, and handling problems. As with other cyanide processes, alkaline hydrolysis is well suited to automatic control.

In the pharmaceutical industry, wastewaters with large amounts of cyanide content are more likely to be treated by alkaline hydrolysis, for economic reasons.

As in the case of chlorination, only a limited amount of data is available regarding the pharmaceutical industry's use of alkaline hydrolysis for cyanide treatment. The data available from these plants, however, indicated that the cyanide levels reached by this technology are similar to those achieved by the chlorination process. Long term performance data has been submitted by one plant (12236) which uses this method to destroy cyanide in its wastewater. The available data indicate that an average effluent value of 200 ug/l is achievable for cyanide. It should be emphasized that this is an achievable effluent level and not necessarily what is achievable directly as result of the treatment of pharmaceutical wastewater by the alkaline hydrolysis technique.

2. Metals Removal Technologies

This discussion of metals removal technologies is presented even though the Agency is not proposing effluent guidelines limitations for metals. It is intended to aid permit writers and others who may, at some point, have an interest in the performance of these technologies. Metals removal technologies are reported to be in place by the 308 responses.

Proven metals treatment technologies are based upon precipitation and filtration. Based on the solubility products (Ksp) quoted for insoluble metal salts (113), the concentration of metal ions in a saturated solution can be calculated. This concentration represents the theoretically achievable levels.

Compound	Ksp	µg/l
Cu S	6×10^{-36}	1×10^{-10}
Ni S	2×10^{-25}	8×10^{-6}
Zn S	1.6×10^{-25}	2×10^{-5}
Hg S	3.5×10^{-52}	3×10^{-18}
$Cu(OH)_2$	3.5×10^{-19}	25
$Ni(OH)_2$	1.5×10^{-15}	400

$Zn(OH)_2$	1.8×10^{-14}	1×10^{-3}
$Cr(OH)_3$	6.7×10^{-31}	6×10^{-1}

Comparison of theoretically achievable treatment levels of metal priority pollutants to the other proposed regulation levels (i.e., metal finishing) shows that sulfide precipitation is theoretically capable of removing the metals to levels several orders of magnitude lower than the levels that are practically achieved. Hydroxide precipitation can result in the theoretical levels of metals which are lower then the levels generally achievable by hydroxide precipitation as practiced.

Thus, in most cases, the solubility level will not be the controlling factor in establishing minimum levels. Practical limits of removal are set by other circumstances, many of which are peculiar to particular treatment processes. The efficiency of physical removal of precipitate solids by such means as filtration or clarification is limited by such particle characteristics as particle size and stability, which are functions of pH and other chemicals present. Many metal cations are subject to chemical complexing that transforms them into an unprecipitable species, causing interference with their removal.

Treatment system performance under industrial operating conditions is indicated in Table VII-2. The levels shown are estimates of practical attainable long-term average effluent concentrations for priority pollutant metals. Of the six metals of special interest in this study, copper, chromium, lead, and nickel are generally amenable to reductions to approximately 500 µg/l at the point of metals treatment. Although zinc reductions to about 500 µg/l are reported, 1,200 µg/l may be a more realistic limit for the zinc content of wastewater since a higher final concentration is also reported for all three treatment methods. Mercury concentration, though not treatable by alkaline precipitation, may be reduced to around 50 ug/l after sulfide precipitation and filtration.

a. Chemical Reduction

Chromium and some other metals must be reduced from their high valence states before they can be precipitated. This is accomplished by chemical reduction, a reaction in which one or more electrons are transferred from the chemical initiating the transfer (reducing agent) to the chemical being reduced.

The main application of chemical reduction in the treatment of industrial wastewater is in the reduction of hexavalent chromium to trivalent chromium. Chromium is a common metal contaminant in the industry is wastewaters and its chemical reduction is employed as an in-plant treatment by the industry. The reduction

enables the trivalent chromium in conjunction with other metal salts to be separated from solution by precipitation. Sulfur dioxide, sodium bisulfite, sodium metabisulfite, and ferrous sulfate are strong reducing agents in aqueous solution and are therefore useful in industrial waste treatment facilities for the reduction of hexavalent chromium to trivalent chromium.

The chemical reduction of chromium wastes by sulfur dioxide is a well-known and widely accepted treatment technology in numerous plants employing chromium or other high valence ions in their manufacturing operations. An example of how this system treats process wastewaters containing chromates is presented in Figure VII-3. The reactions involved may be illustrated as follows:

$$3SO_2 + 3H_2O = 3H_2SO_3$$

$$3H_2SO_3 + 2H_2CrO_4 = Cr_2(SO_4)_3 + 5H_2O$$

This reaction is favored by a low pH;, a value of 2.0 to 3.0 is normally required for situations requiring complete reduction. At pH levels above 5.0, the reduction rate is slow. Such oxidizing agents as dissolved oxygen and ferric iron interfere with the reduction process by consuming the reducing agent. The sulfate precipitate can be removed by filtration or clarification.

Chemical reduction has been used quite successfully to treat large concentrations of hexavalent chromium (e.g. from metal finishing operations). This method is well suited to automatic control and may be used when conditions are ambient.

Chemical reduction, however, is not without some limitations. Careful pH control is required for effective reduction. In addition, when waste streams contain other reducible matter, the reducing agent may be consumed, depleting that available for treatment of the metals. Also, for those systems using sulfur dioxide, a potentially hazardous situation exists when it is stored and handled. Data indicate that chromium levels below 500 µg/l can be achieved from in-plant chromium reduction processes. (109)

b. Alkaline Precipitation

The solubility of metal hydroxides, in most cases, is a function of pH and therefore the success of metal hydroxide precipitation treatment is heavily dependent on the pH level of the solution. In order to achieve optimum formation of solid metal hydroxides the pH of the wastewater must be adjusted to the range (usually moderately alkaline) found to be most effective for the metal(s)

involved. This is accomplished by measured addition of lime to the wastewater with concurrent pH monitoring.

Following the attainment of optimum pH conditions the solid metal hydroxides are coagulated (using coagulating agents) in a clarifier and deposited as sludge. Proper clarifier design and good coagulation are important prerequisites for efficient metals removal by alkaline precipitation.

If substantial sulfur compounds are present in the wastewater, caustic soda (sodium hydroxide) may be used instead of lime to prevent calcium sulfate formation which would increase sludge volume. Treatment chemicals for adjusting pH prior to clarification may be added to a rapid mix tank, to a mix box, or directly to the clarifier, especially in batch clarification. If such metals as cadmium and nickel are in the wastewater, a pH in excess of 10.0 is required for effective precipitation. This pH, however, is unacceptable for discharged wastewater; therefore, the pH must be reduced by adding acid. The acid is usually added as the treated wastewater flows through a small neutralization tank prior to discharge.

An example of a metals removals system using alkaline precipitation is shown in Figure VII-4.

There are several advantages to the use of alkaline precipitation. In the first place, it is well demonstrated wastewater treatment technology. It is well suited to automatic control and will operate at ambient conditions. Also, in many instances, preceding treatment steps adjust the waste (especially pH) to aid the alkaline precipitation process. The end result is that the costs associated with this technology may be substantially lower than those for other processes. However, this method is subject to interference when mixed wastes are treated. In addition, this process generates relatively high quantities of sludge that also require disposal.

Alkaline precipitation is a classic technology being used by many industries, although its use by the pharmaceutical industry has been limited. The EPA study to develop BPT regulations for the electroplating industry (109) indicated that the alkaline precipitation process is capable of achieving the following approximate levels: 300 ug/l for chromium and zinc, 200 ug/l for copper, 100 ug/l for lead, and 500 ug/l for nickel.

c. Sulfide Precipitation

In this process, heavy metals are removed as a sulfide precipitate. Sulfide is supplied by adding a very slightly soluble metal sulfide that has a solubility somewhat greater than

that of the sulfide of the metal to be removed. Normally, ferrous sulfide is used. It is fed into a precipitator where excess sulfide is retained in a sludge blanket that acts both as a reservoir of available sulfide and as a medium to capture colloidal particles.

The process is applicable for treatment of all heavy metals. The process equipment requirement required includes a pH adjustment tank, a precipitator, a filter, and pumps to transport the wastewater. The filter is optional and may be a standard, dual-media pressure filter.

A variation of the process utilizes sulfide for reducing hexavalent chromium. Ferrous sulfide at a pH of 8.0 to 9.0 acts as an agent to reduce the hexavalent chromium and then precipitates it as a hydroxide in one step. Hexavalent chromium wastes do not have to be isolated and pretreated by reduction to the trivalent form.

With respect to the generated sludge, sulfide sludges have been found to be less subject to leaching than hydroxide sludges. However, sulfide precipitation produces sludge in greater volumes (requiring more available storage space) and requires greater expenditures for chemicals than does alkaline precipitation. Pollutant levels after treatment with sulfide precipitation are very similar to the pollutant levels after alkaline precipitation.

3. Solvent Recovery and Removal

Solvents are used extensively in the pharmaceutical manufacturing industry. Because such materials are expensive, most manufacturers try to recover them in order to purify them for reuse whenever possible. Solvent recovery operations typically employ such techniques as decantation, evaporation, distillation, and extraction. The feasibility and extent of recovery purification are governed largely by the quantities involved and by the complexity of solvent mixtures to be separated. If recovery is not economically practicable, the used solvents may have to be disposed of by means of incineration, landfilling, deep-well injection, or contract disposal.

Even when an effort is made to recover solvents, some wastewater contamination can be expected. Removal of small quantities of organic solvents from the segregated wastewater can be accomplished by such techniques as steam stripping or carbon adsorption. Further removal of solvents from combined end-of-pipe wastewater may result from biological treatment or from surface evaporation in the treatment system.

a. Steam Stripping

Steam stripping is a variation of distillation in which steam is used as both the heating medium and the driving force for the removal of volatile materials. Steam is added at the bottom of a tower and the wastewater being treated is fed either at the middle or near the top of the unit. As the steam passes through the wastewater, volatile materials are vaporized and removed with the steam exiting from the top of the tower.

Some steam stripping processes employ columns packed with materials that are inert and corrosion resistant. Packing materials have shapes that maximize the surface area for a given volume. Materials of construction for packing include steel, porcelain, stoneware, and plastic. In tray towers, the column contains a series of trays that contain bubble caps or sieve perforations to allow for liquid-vapor contact.

The tower bottoms contain only trace quantities of volatile materials. Tower overheads contain the volatile materials removed along with steam. Subsequent condensation results in an immiscible organic layer that is recovered and an aqueous layer that is returned to the column. If more than one compound has been removed, further separation possibly may be desired for recovery. Separation techniques include selective condensation, extraction, and distillation. If the organic distillate removed is not recovered, it may be disposed of by such methods as incineration, landfilling, deep-well injection, or contract disposal.

An example of a steam stripping unit for removing solvents from process wastewaters is shown in Figure VII-5.

Steam stripping of organic-bearing wastewaters has been used in pharmaceutical manufacturing and in other industries. A preliminary study (72) by the EPA's Organic Chemical Branch has shown that steam stripping used as an in-plant technology can produce very low pollutant levels for benzene, 1,2-dichloroethane, chloroform, methylene chloride, toluene, and many other similar compounds. The starting concentration does not strongly influence either the cost of treating a given quantity of water or the achievable effluent concentrations. A level of about 50 μg/l can be reached for the volatile organic solvents used in commercial practice.

Steam stripping technology is known to be in-place at a number of pharmaceutical plants. However, adequate data has not yet been received which would confirm the Agency's estimates of the pollutant reduction capability of this technology.

b. Activated Carbon Adsorption

Adsorption is defined as the adhesion of dissolved molecules to the surface of solid bodies with which they are in contact. Granular activated carbon particles have two properties that make them effective and economical adsorbents. First, they have a high surface area per unit volume which results in faster, more complete adsorption. Second, they have a high hardness value which lends itself to reactivation and repeated use.

The adsorption process typically is preceded by preliminary filtration or clarification to remove insolubles. Next, the wastewaters are placed in contact with carbon so adsorption can take place. Normally, two or more beds are used so that adsorption can continue while a depleted bed is reactivated. Reactivation is accomplished by heating the carbon between 870°C to 980°C (1600°F to 1800°F) to volatize and oxidize the adsorbed contaminants. Oxygen in the furnace is normally controlled at less than 1 percent to avoid loss of carbon by combustion. Contaminants may be burned in an afterburner.

Carbon adsorption is primarily designed to remove dissolved organic material from wastewater although it can, to some extent remove chromium, mercury and cyanide. A discussion of the technical and economic feasibility of activated carbon adsorption technology may be found in "Treatability of Priority Pollutants in Wastewater by Activated Carbon" by S. T. Hwang and P. Fahrenthold, EPA report, 1979.

The potential use for this technology by the Pharmaceutical Industry is limited. Concentrations of most of the toxic pollutants (metals, volatile organics and cyanide) characteristic of pharmaceutical wastewater are all reduced more effectively and with less cost by the previously discussed technologies than by activated carbon adsorption. Phenols, the other group of pollutants found in pharmaceutical wastewater are biodegradable and their concentrations can be reduced by improved biological treatment. Carbon adsorption is particularly applicable in situations where organic material in low concentrations not amenable to treatment by other technologies must be removed from wastewater.

The equipment necessary for an activated carbon adsorption treatment system consists of a preliminary clarification and/or filtration unit to remove the bulk of the solids, two or three columns packed with activated carbon, and pumps and piping. When on-site regeneration is employed, a furnace, quench tanks, a spent carbon tank, and a reactivated carbon tank are generally required. Contract regeneration at a central location is frequent commercial practice.

An example of an activated carbon adsorption unit is shown in Figure VII-6.

Carbon adsorption systems are compact, will tolerate variation in influent concentrations and flow rates and can be thermally desorbed to recover the carbon for reuse. Economic application of carbon adsorption is limited to the removal of low pollutant concentrations. Competititive adsorption of non-target constituents, as well as blinding by suspended solids, can cause interference.

D. END-OF-PIPE TREATMENT

In-plant treatment processes are used to treat specific pollutants in segregated waste streams; end-of-pipe (EOP) technologies usually are designed to treat a number of pollutants in a plant's overall wastewater discharge. The types and/or stages of EOP treatment are primary treatment, secondary treatment, and tertiary treatment. Depending on the nature of the pollutants to be removed and the degree of removal required, combinations of the available technologies are used.

As in the case of in-plant treatment, the 308 Portfolio Data Base was the principal source of information for identifying the use of EOP treatment by the pharmaceutical industry. This information was requested by both 308 Portfolio mailings. As a cross-check for accuracy and completeness, the 308 Portfolio responses were compared with information available from the other data bases.

Table VII-3 presents a summary of the EOP technologies identified by the various data bases, along with the number of plants that employ each process. A listing of each plant's end-of-pipe treatment system is presented in Appendix L.

1. Primary Treatment

Primary (physical/chemical) treatment refers to those processes that are nonbiological in nature. Primary treatment involves (a) the screening of the influent stream to remove large solids and (b) gravity separation to remove settleable solids and floating materials. Commonly used primary treatment technologies in the pharmaceutical industry are coarse solids removal, primary sedimentation, primary chemical flocculation/clarification, and dissolved air flotation.

In selecting EOP treatment processes for consideration as BAT, BCT, NSPS, PSES, and PSNS technologies, only those that would follow primary treatment were examined.

2. Secondary and Tertiary Treatments

Secondary (biological) treatment is the principal method by which many pharmaceutical manufacturing plants are now meeting existing BPT regulations. This is one of the first steps toward compliance with future BAT, BCT, and NSPS guidelines. Biological treatment could also be an important technology in meeting future PSES and PSNS guidelines.

Although it is discussed as a single EOP treatment alternative, biological treatment actually encompasses a variety of specific technologies such as aerated lagoons, activated sludge, trickling filters, and rotating biological contactors. Since there are numerous publications available that describe all aspects of the operations (advantages, limitations, and other pertinent facts), discussions of these specific treatment processes will be presented only in moderate detail in this report. Although each has its own unique characteristics, they are all based on one fundamental principle: the reliance on aerobic and/or anaerobic biological microorganisms for the removal of oxygen-demanding compounds.

An aerated lagoon is one example of a treatment facility which utilizes aerobic biological processes. It is essentially a stabilization basin to which air is added either through diffusion or mechanical agitation. The air provides the oxygen required for aerobic biodegradation of the organic waste. If properly designed, the air addition will provide sufficient mixing to maintain the biological solids in suspension so that they can be removed in a secondary sedimentation tank. After settling, sludge may be recycled to the head of the lagoon to ensure the presence of a properly acclimated seed. When operated in this manner, the aerated lagoon is analogous to the activated sludge process. The viable biological solids level in an aerated lagoon is low when compared to that of an activated sludge unit. The aerated lagoon relies primarily on detention time for the breakdown and removal of organic matter; aeration periods of 3 to 8 days are common.

The activated sludge process is also an aerobic biological process. The basic process components include an aerated biological reactor, a clarifier for separation of biomass, and a piping arrangement to return separated biomass to the biological reactor. The aeration requirements are similar to those of an aerated lagoon in that aeration provides the necessary oxygen for aerobic biodegradation and mixing to maintain the biological solids in suspension. The available activated sludge processes that are used in the treatment of wastewaters include conventional, step-aeration, tapered-aeration, modified-aeration, contact-stabilization, complete-mix and extended-aeration.

A trickling filter is a fixed-growth biological system where a thin-film biological slime develops and coats the surfaces of the supporting medium as wastewater makes contact. The film consists primarily of bacteria, protozoa, and fungi that feed on the waste. Organic matter and dissolved oxygen are extracted and the metabolic end products are released. Although very thin, the biological slime layer is anaerobic at the bottom so hydrogen sulfide, methane, and organic acids are generated.

These materials cause the slime to periodically separate (slough off) from the supporting medium and be carried through the system with the hydraulic flow. The sloughed biomass must be removed in a clarifier. Trickling filters are classified by hydraulic or organic loading as "low rate" or "high rate." Low-rate filters generally have a hydraulic loading rate of 1 to 4 million gal./acre/day (or an organic loading rate of 300 to 1,000 lb. BOD_5/acre-ft./day), a depth of 6 to 10 feet, and no recirculation. High-rate filters have a hydraulic loading rate of 10 to 40 million gal./acre/day, an organic loading rate of 1,000 to 5,000 lb. BOD_5/acre-ft./day, a depth of 3 to 10 feet, and a recirculation rate of 0.5 to 4.0. High-rate filters can be single or two stage. The medium material used in trickling filters must be strong and durable. The most suitable medium in both the low-and high-rate filters is crushed stone or gravel graded to a uniform size.

The rotating biological contactor (RBC) process consists of a series of disks constructed of corrugated plastic plates and mounted on a horizontal shaft. These disks are placed in a tank with contour bottom and immersed to approximately 40 percent of the diameter. The disks rotate as wastewater passes through the tank and a fixed-film biological growth similar to that on trickling filter media adheres to the surface. Alternating exposure to the wastewater and the oxygen in the air results in biological oxidation of the organics in the wastes. Biomass sloughs off (as in the trickling filter) and is carried out in the effluent for gravity separation. Direct recirculation is not generally practiced with the rotating biological disks.

There are a few other biological treatment techniques not specifically mentioned in this section which utilize either aerobic or anaerobic biodegradation or both. These are stabilization ponds, anaerobic lagoons and facultative lagoons. In facultative lagoons, the bacterial reactions include both aerobic and anaerobic decomposition.

Besides the direct utilization of these treatment processes, biological treatment also encompasses two other approaches; in this report, they are referred to as biological enhancement and biological augmentation. Generally, these variations are

accomplished by (a) modifications made in the conventional biological treatment itself or (b) conventional processes combined into a multistage system. Examples of biological enhancement are pure oxygen activated sludge and biological treatment with powdered activated carbon. Biological augmentation could be trickling filter/activated sludge, activated sludge/ rotating biological contactor, aerated lagoon/polishing pond, or any combination of two or more conventional biological treatment processes.

The differences in performance inherent in differences in number of stages rest on the applicability of plug-flow/back-mix effects. A true plug-flow system, such as a narrow channel lagoon, approaches equivalence to an infinity of stages if the food/microorganism (F/M) ratio is maintained. This tends to beneficially maximize the availability of nutrients, a function of the concentration of biodegradable pollutants. A fully back-mixed system (as an activated sludge unit tends to be) operates throughout at its exit concentration. It is thus a distinct, finite stage incremental with any stage before it or after it.

In practice, these distinctions are not clearcut. Since there is some back-mixing even in a channelled lagoon, separations of units or even of cells within one unit may be beneficial. Also, in most mixed systems, the concentration gradient established is sufficient for some increase in the effective nutrient concentration and consequently the optimum microorganism concentration.

In many systems, design factors other than the concentration-induced driving force may overshadow the concentration gradient and prevent simple performance correlation.

Comprehensive consideration of the criteria affecting bio-reaction performance suggests the following to be significant:

(1) Influent concentration of pollutants.

(2) Resistive characteristics of the BOD pollutants and the resultant K value (i.e., how easily the BOD is biodegraded).

(3) Presence of potential interfering pollutants (e.g., constituents toxic to the microorganisms).

(4) Bio-reaction characteristics and concentration of the microorganisms present.

(5) Dissolved oxygen content and distribution at least to the point of adequate O_2 availability.

(6) Sludge recycle as it may affect microorganism availability and character as represented by the F/M ratio.

(7) Contact efficiency of pollutants and microorganisms, as may be induced by agitation, flow pattern, and MLVSS.

(8) Availability and balance of nutrients, including nitrogen and phosphate.

(9) Required target effluent.

(10) Temperature (e.g., seasonal effects)

The proper design of biological systems in addition to developing optimum operating criteria, must also take into account how much of the system's potential capacity will be used so that an optimum modification approach will be available. The most economical approach may be simple adjustments of operating variables to exploit existing capacity fully. The adjustments may require such minor changes as increasing agitation, power input, or sludge recycle rate or, at the extreme, may require the addition of an independently functioning system. In many cases the optimum upgrade may be a combination of existing component units integrated with balanced new units. This is likely to result in a system complex dictated in part by performance requirements and in part by equipment already in place.

Some examples of typical augmented biological configurations are shown in Figure VII-7.

Tertiary treatment usually means any treatment following the biological or other secondary treatment system. The treatment technologies are quite varied and are normally applied for the removal of such pollutants as a specific priority pollutant class, nitrogen, color, and so forth. Some tertiary treatment processes are also applicable to in-plant or primary treatment schemes. The location in the overall treatment concept determines whether the operation is a tertiary treatment.

Biological treatment systems are mainly intended to reduce the level of the traditional pollutants BOD and COD. Some priority pollutants may be removed incidentally, even though not targeted by the treatments.

Biological treatment removal efficiency is a function of treatment intensity, detention time, and such system characteristics as bioreaction rate constant, biomass concentration (as represented by food/microorganism ratio), and biomass contact efficiency. The configuration of the system is

important since it affects these factors, but the effectiveness is not necessarily benefitted by splitting the bioreaction into a number of steps. In a plug-flow (non-backmixed) system there is a continuation of reaction and little inherent effect of staging as in certain separation techniques and driving force systems. There may be reaction rate advantages in a back-mixed system which might accrue from staging but these must be evaluated for a specific system considering microorganism availability, contact efficiency and other factors.

Economic concerns often dictate a design which uses (a) one biotechnique in preference to others (b) more than one technique as the reaction progresses (e.g., activated sludge and trickling filter) or (b) various arrangement configurations. However, these design choices are highly site and waste specific, and generalizations should be avoided in the comparison of systems and in the choice a particular treatment configuration.

One of the Agency's data-gathering programs requested long-term traditional pollutant data from the industry. As opposed to the screening/verification data obtained by a few days of sampling and the annualized 308 Portfolio data, the long-term data consisted of raw daily or weekly influent and effluent data that covered a period of one year and was obtained from 22 plants having some type of biological treatment. Therefore, for purposes of predicting what the industry can achieve in the way of traditional pollutant control by biological enhancement, the long-term data selected were the best available. Summaries of the long-term data are presented in Table V-1.

The thirteen plants chosen from among the 22 plants (see section IX for explanation of plant selection) that submitted raw daily or weekly data indicate what existing sources can achieve in the way of traditional pollutant control. These plants have achieved performance in almost all cases which is greater than that required by the existing regulation for BOD_5 and COD. Total suspended solids performance was better than the average performance of all plants with biological treatment systems.

3. Solids Removal

Removal of solids from EOP wastewater can occur at several points in the treatment sequence. Grit removal by screening, filtration, or sedimentation is often necessary as a preliminary step in primary treatment. After secondary biological treatment, it is generally necessary to complete the removal of sludge and other solids by means of clarification, filtration, or a special operation such as flotation.

Further solids removal occurs in tertiary treatment stages, e.g., incidentally by retention of wastewater in polishing ponds.

a. Clarification

Clarification is a method of removing suspended or colloidal solids by means of gravity sedimentation. Since the settling rate of suspended solids is dependent on particle size and density (the smaller the particle size and the closer the density to that of water, the slower the settling rate), flocculant or coagulant aids sometimes must be added to promote bridging between particles and to render them more settleable. A slow settling rate and the stability of colloidal mixtures make chemical destabilization and agglomeration of colloids/suspensions necessary.

Clarifiers are usually large containment vessels that have a continuous water throughput. A conventional clarification system utilizes a rapid mix tank to mix chemicals with the entering water; the wastewater is then subjected to slow agitation. Provision for the removal of settled solids is also a necessary part of the system.

Typical clarifiers are shown in Figure VII-8.

b. Filtration

Filtration is a basic solids removal technology in water and wastewater treatment. Silica sand, anthracite coal, garnet, and similar granular inert materials are among the most common media used in this technology, with gravel serving as a support material. These media may be used separately or in various combinations. Multimedia filters may be arranged in relatively distinct layers by balancing the forces of gravity, flow, and buoyancy of the individual particles. This is accomplished by selecting appropriate filter flow rates, media grain size, and media densities.

The most common filtration system is the conventional gravity filter. It normally consists of a deep bed of granular media in an open-top tank. The direction of flow through the filter is downward and the flow rate is dependent solely on the hydrostatic pressure of the water above the filter bed. Another type of filter is the pressure filter. In this case, the basic approach is the same as a gravity filter, except the tank is enclosed and pressurized.

As wastewater is processed through the filter bed, the solids collect in the spaces between the filter particles. Periodically, the filter media must be cleaned. This is

accomplished by backwashing the filter (reversing the flow through the filter bed). The flow rate for backwashing is adjusted in such a way that the bed is expanded by lifting the media particles a given amount. This expansion and subsequent motion provides a scouring action which effectively dislodges the entrapped solids from the media grain surfaces. The backwash water fills the tank up to the level of a trough below the top lip of the tank wall. The backwash is collected in the trough, fed to a storage tank, and recycled into the waste treatment stream. The backwash flow is continued until the filter is clean.

An example of a filtration unit is shown in Figure VII-9.

c. Flotation

Flotation is an optional method of clarification utilized to treat some industrial waste in which the suspended solids have densities less than that of water. Air-assisted flotation may be applied to some systems with solids slightly heavier than water. As with conventional clarifiers, flocculants are frequently employed to enhance the efficiency of flotation.

E. ULTIMATE DISPOSAL

In any evaluation of control and treatment technologies, one of the most important considerations is the ultimate disposal methods used by the industry. Whether a plant is a direct discharger to surface waters, an indirect discharger to POTW's, or a zero discharger can be a critical factor in determining what technologies are most appropriate for controlling its waste discharge. Table VII-4 summarizes the methods used by the pharmaceutical manufacturing industry for the ultimate disposal of its process wastewaters. This table was prepared from a listing of each plant's individual disposal methods (See Appendix M).

Approximately 13 percent of the 464 manufacturing plants have direct discharges. Seven of these plants also have indirect discharges, while another nine use zero discharge methods for some of their smaller waste streams. The majority of the industry are indirect dischargers. Almost 63 percent of the plants in the 308 Portfolio Data Base discharge to POTW's. Seven of these plants also have direct discharges, but another 25 use zero discharge techniques for some of their smaller waste streams. Over 25 percent of the manufacturing plants use only such zero discharge methods as contract disposal, evaporation, ocean dumping, recycling, and so forth. Seventy-five percent of the zero dischargers were classified as such because they generated no process wastewaters requiring disposal.

TABLE VII-1

SUMMARY OF IN-PLANT TREATMENT PROCESSES

In-Plant Technology	Number of Plants
Cyanide Destruction	6
Chromium Reduction	1
Metals Precipitation	3
Solvent Recovery	29
Steam Stripping	7
Other Technologies	19
Evaporation	9
Neutralization	5

TABLE VII-2

ESTIMATED ACHIEVABLE LONG-TERM AVERAGE EFFLUENT CONCENTRATIONS FOR THE PRIORITY POLLUTANT METALS

Final Concentration ($\mu g/l$)*

Metal	Lime Settling	Lime Filter	Sulfide Filter	References
Antimony	800-1500	400-800	-	116
Arsenic	500-1000	500-1000	50-100	118, 120, 121
Beryllium	100-500	10-100	-	116
Cadmium	100-500	50-100	10-100	117, 118, 123, 124, 125
Copper	500-1000	400-700	50-500	117, 118, 119, 121, 123, 124, 125
Chromium III	100-500	50-500	-	113, 115, 118, 119, 120, 121, 126
Lead	300-1600	50-600	50-400	118, 120, 121, 122, 124
Mercury	-	-	10-50	120, 121, 128
Nickel	200-1500	100-500	50-500	118, 123, 124
Silver	400-800	100-400	50-200	120, 121, 126
Selenium	200-1000	100-500	-	116
Thallium	200-1000	100-500	-	116
Zinc	500-1500	400-1200	20-1200	114, 118, 123, 124

*Estimated achievable levels reported in the Inorganic Chemicals Manufacturing Development Document (Ref. 127) based on additional references cited.

TABLE VII-3

SUMMARY OF-END-OF-PIPE TREATMENT PROCESSES
(Data Base: 308)

End-of-Pipe Technology	Number of Plants
Equalization	60
Neutralization	79
Primary Treatment	61
Coarse Settleable Solids Removal	41
Primary Sedimentation	37
Primary Chemical Flocculation/Clarification	11
Dissolved Air Flotation	3
Biological Treatment	74
Activated Sludge	51
Pure Oxygen	1
Powdered Activated Carbon	2
Trickling Filter	9
Aerated Lagoon	23
Waste Stabilization Pond	9
Rotating Biological Contactor	1
Other Biological Treatment	1
Physical/Chemical Treatment	17
Thermal Oxidation	3
Evaporation	5
Additional Treatment	40
Polishing Ponds	10
Filtration	16
Multimedia	7
Activated Carbon	2
Sand	5
Other Polishing	17
Secondary Chemical Flocculation/Clarification	5
Secondary Neutralization	4
Chlorination	10

Note: Subtotals may not add to totals because: 1) some plants employ more than one treatment process; 2) minor treatment processes were not listed separately; 3) details for some treatment processes were not available.

TABLE VII-4

SUMMARY OF WASTEWATER DISCHARGES

Method of Discharge	Number of Plants in the Industry	Number of Plants by Subcategories		
		A	B	C
Direct Only	44	6	4	14
Direct with minor Zero Discharge	9	3	4	7
Total Direct Dischargers	53	9	8	21
Indirect Only	251	17	53	68
Indirect with minor Zero Discharge	21	7	8	15
Total Indirect Dischargers	272	24	61	83
Combined Direct/Indirect Dischargers	7	2	2	3
SUBTOTAL	332	35	71	107
Zero Dischargers	132	2	9	27
TOTAL	464	37	80	134

NOTE: Subcategory counts will not equal industry totals because of multiple subcategory plants.

FATE OF WASTEWATERS AT ZERO DISCHARGE PLANTS (TOTAL INDUSTRY)

Discharge Method	Zero Dischargers	Direct w/Zero	Indirect w/Zero
No process Wastewater	98	0	0
Contract Disposal	7	3	7
Deep Well Injection	0	1	2
Evaporation	7	1	3
Land Application	6	3	5
Ocean Dumping	2	1	2
Recycle/Re-use	2	0	1
Septic System	6	0	2
Subsurface Discharge	4	0	3
Total	132	9	25

FIGURE **VII-1**

CYANIDE DESTRUCTION SYSTEM - CHLORINATION

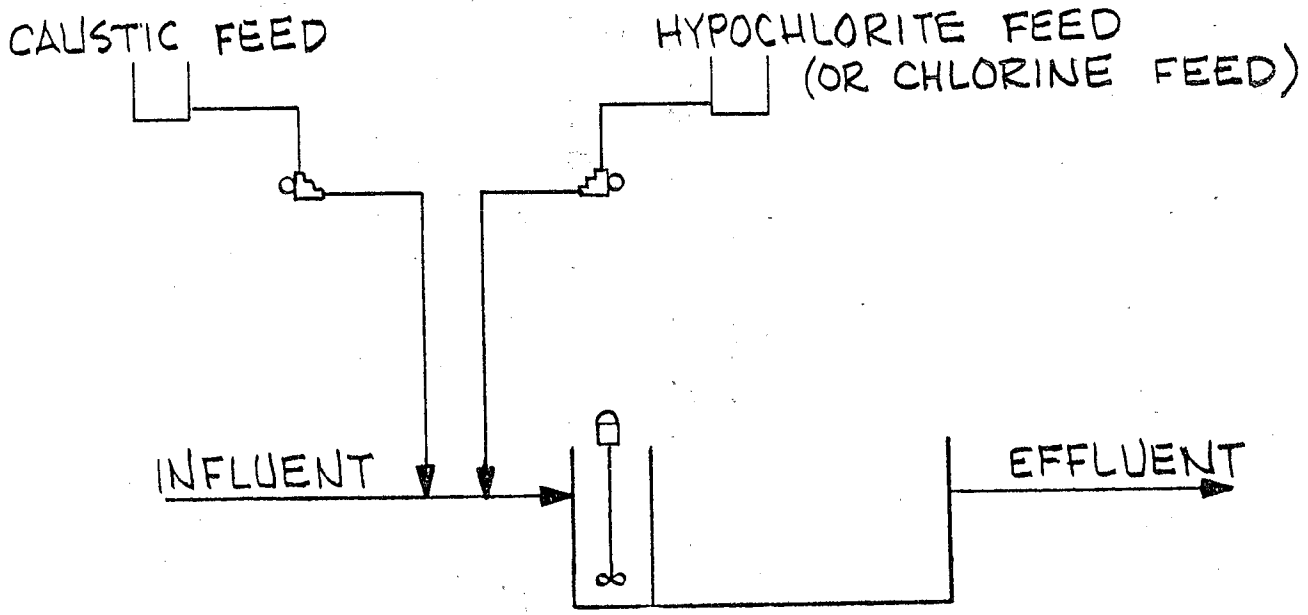


FIGURE VII-2

CYANIDE DESTRUCTION SYSTEM - ALKALINE HYDROLYSIS

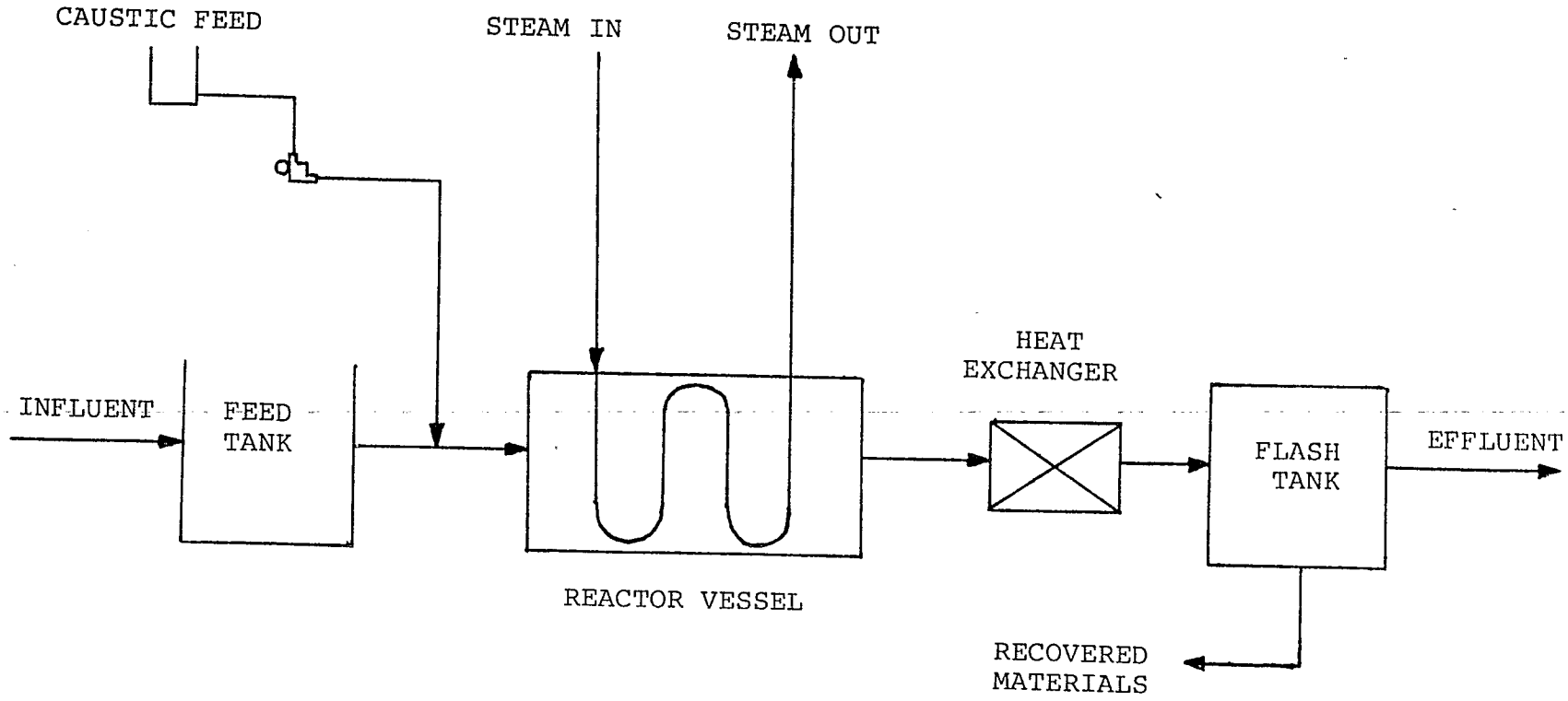


FIGURE **VII-3**

CHROMIUM REDUCTION SYSTEM

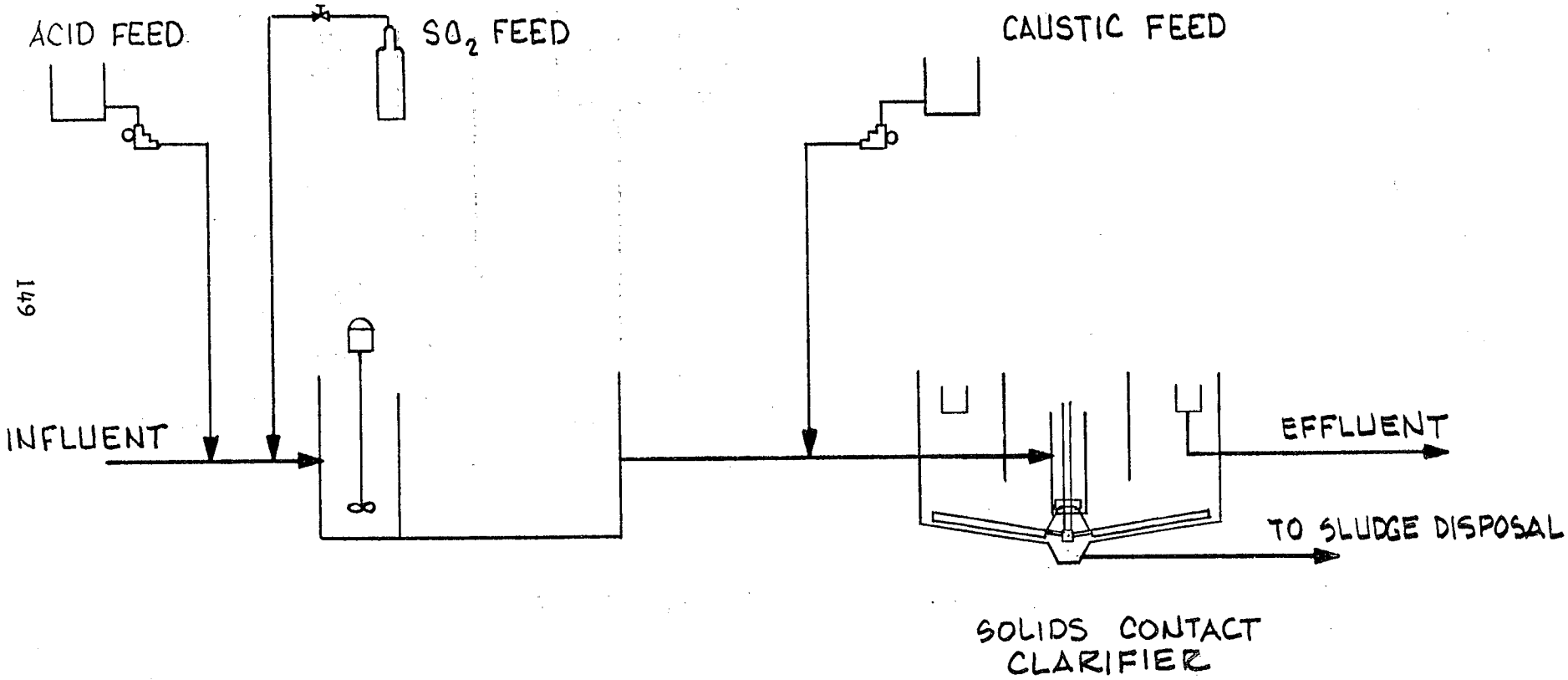
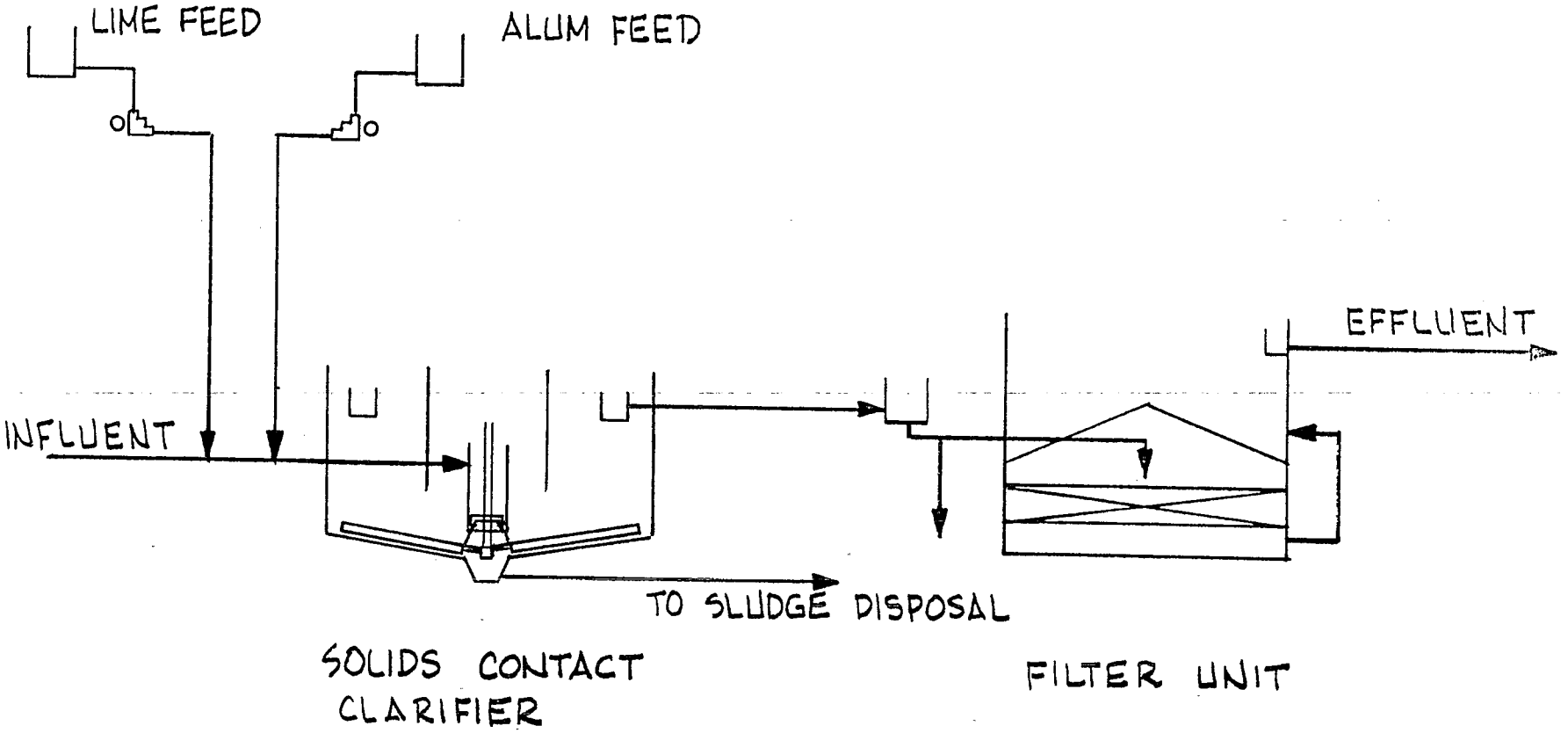


FIGURE VII-4

METALS REMOVAL SYSTEM -ALKALINE PRECIPITATION



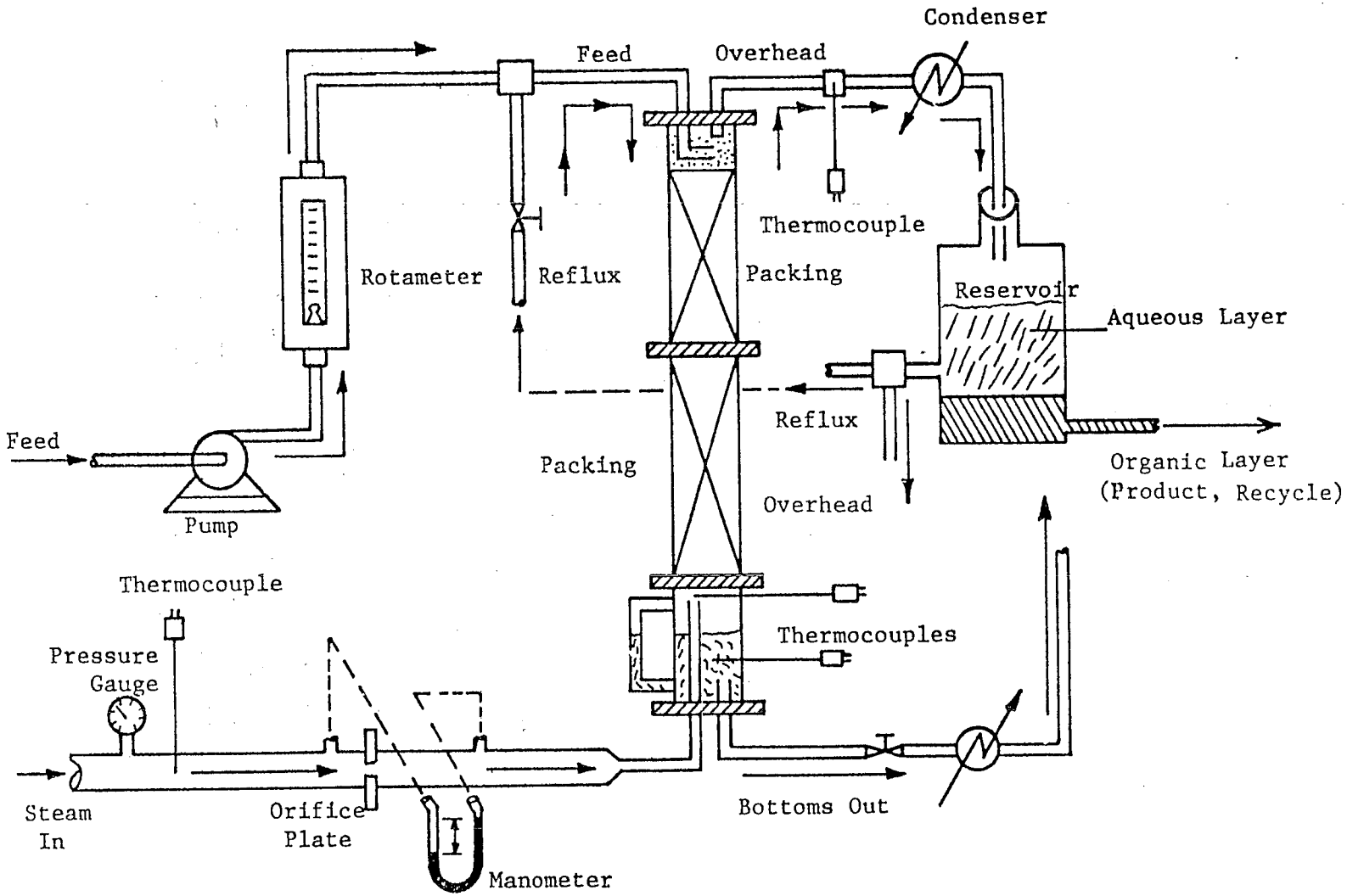


FIGURE VII-5

STEAM STRIPPING UNIT

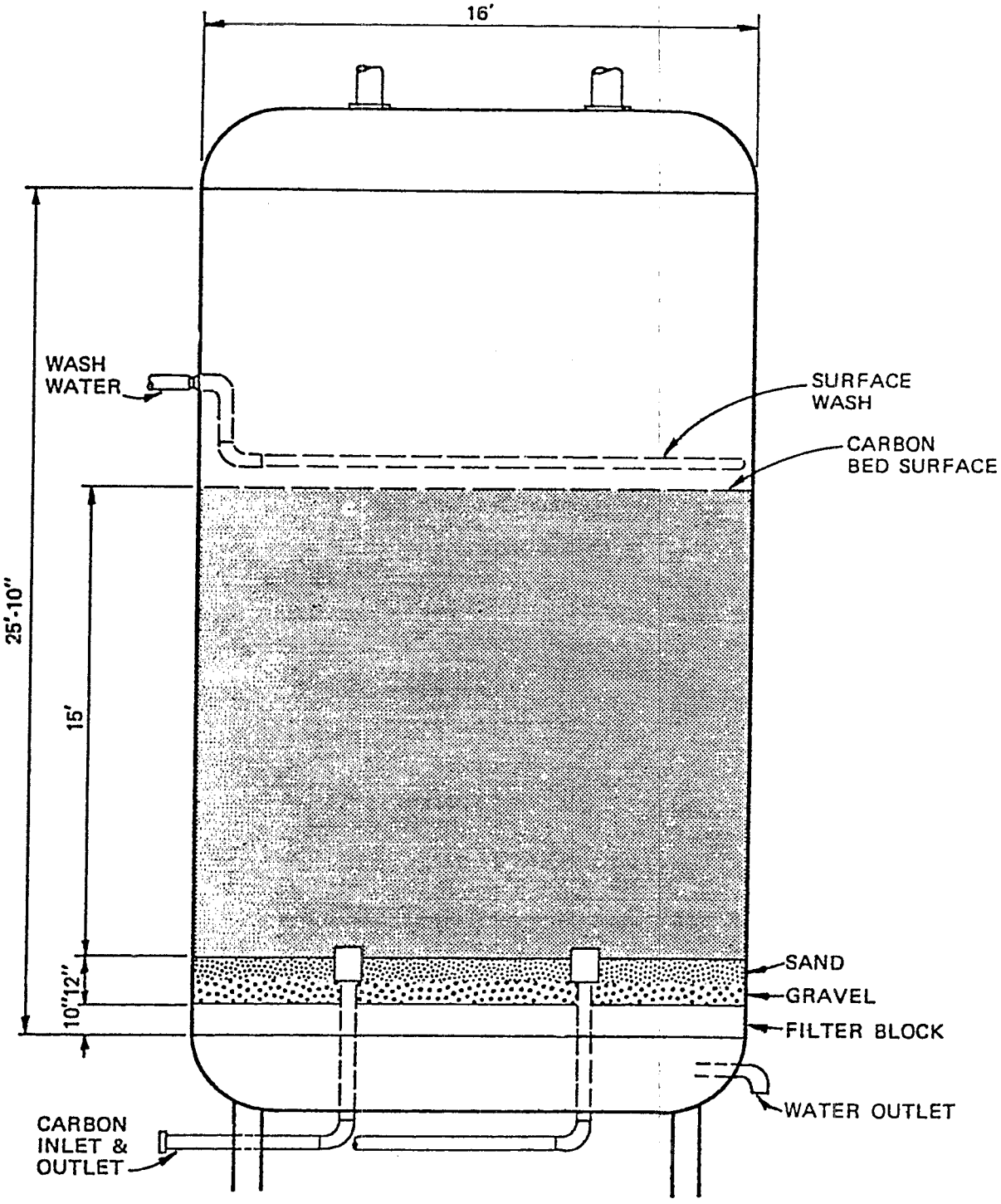
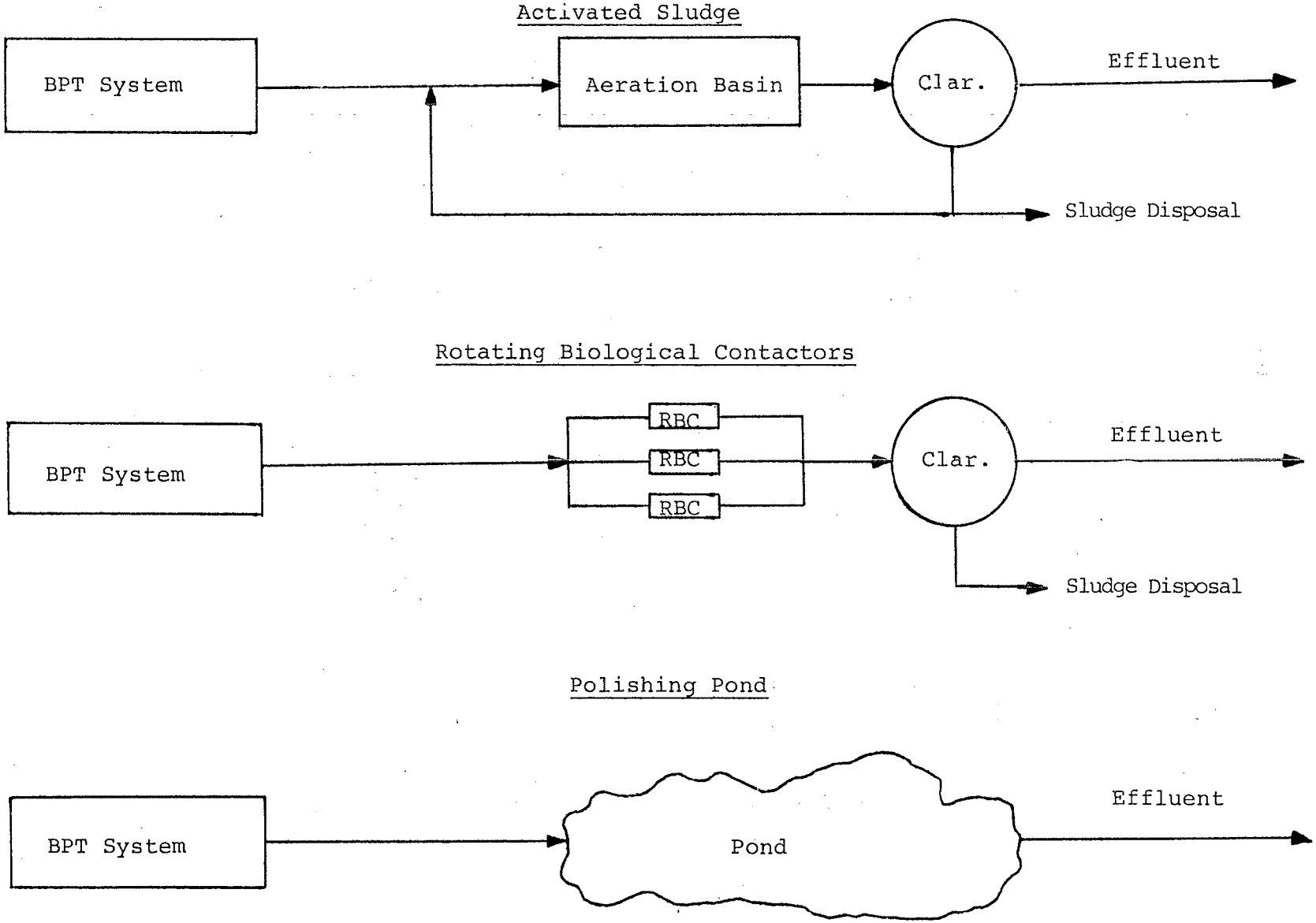


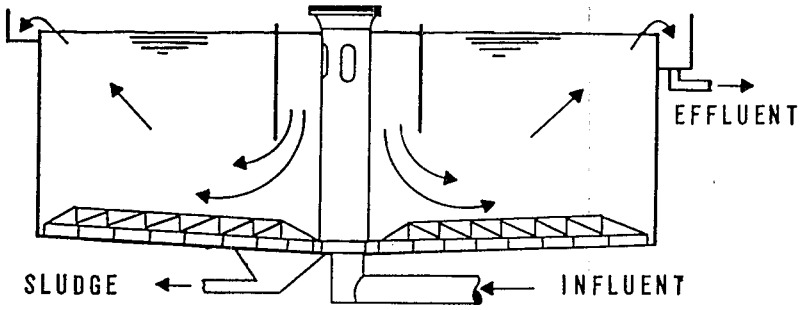
FIGURE **VII-6**

ACTIVATED CARBON ADSORPTION UNIT

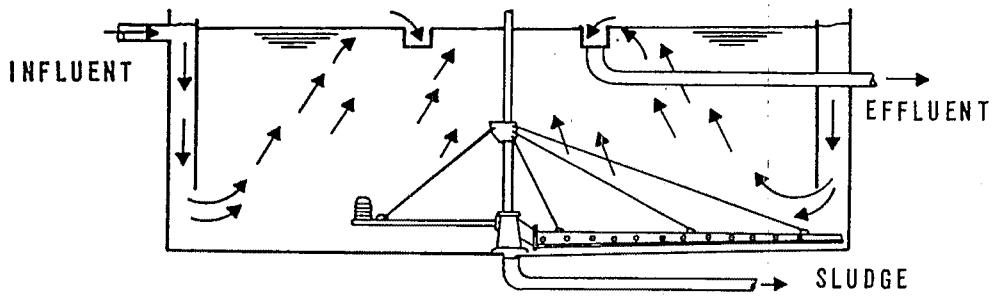
FIGURE **VII-7**

EXAMPLES OF AUGMENTED BIOLOGICAL SYSTEMS

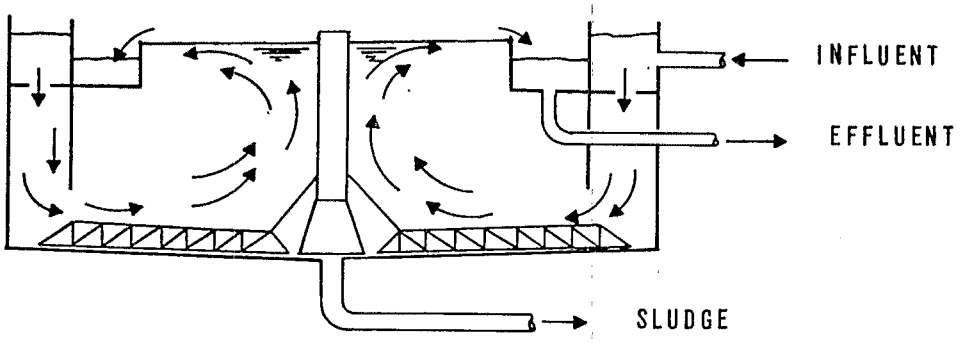




(a) CIRCULAR CENTER-FEED CLARIFIER WITH A SCRAPER SLUDGE REMOVAL SYSTEM



(b) CIRCULAR RIM-FEED, CENTER TAKE-OFF CLARIFIER WITH A HYDRAULIC SUCTION SLUDGE REMOVAL SYSTEM



(c) CIRCULAR RIM-FEED, RIM TAKE-OFF CLARIFIER

FIGURE **VII-8**

TYPICAL CLARIFIER CONFIGURATIONS

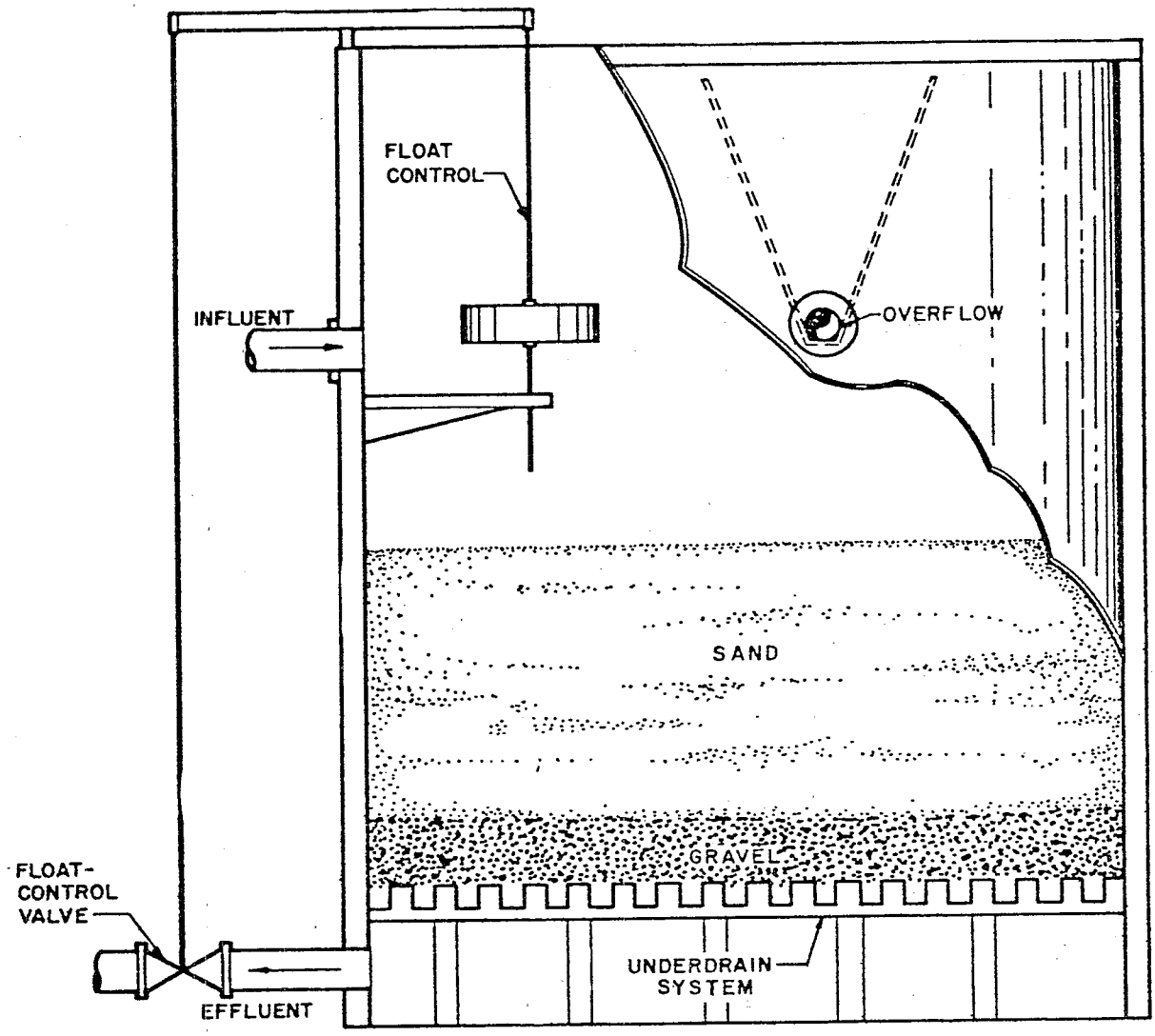


FIGURE **VII-9**

FILTRATION UNIT

SECTION VIII

COST, ENERGY, AND NON-WATER QUALITY ASPECTS

A. INTRODUCTION

This section addresses the costs, energy requirements, and non-water quality environmental impacts associated with the control and treatment technologies.

There is substantial variability within the industry and within each subcategory as to products, process methods, plant size, wastewater flow, raw waste characteristics, and waste treatment methods employed. Therefore, it is appropriate to evaluate the impact of limitations on an individual plant basis.

Treatment costs are largely a function of wastewater flow rate and pollutant loadings. Choice of treatment methods is also of importance and is dependent on wastewater quality, effluent target, and site considerations. In-plant treatments are, of course, largely dictated by which specific pollutants are to be removed.

It is not feasible to develop exact individual requirements for every plant because of the lack of data on site specific considerations and bioreaction treatability (K rates). Instead, an approach has been taken which assumes conservative (high side) valuation of these considerations across the board.

Capital, operating, and maintenance costs were developed and applied to each of the processing subcategories for a variety of in-plant treatment and end-of-pipe (EOP) systems. The resultant annualized costs were then generalized to variations in wastewater flow, raw wasteload, and effluent limitation levels. Cost "sensitivity" curves show the effect of these variables on annualized costs and investments; tabulations of individual plant costs indicate specific cost details.

The costs considered are those costs likely to be required over and above the capital and operating costs associated with BPT guidelines technology. In other words, the costs noted are those incremental to what is necessary to meet current BPT requirements. Since all plants within the industry are not precisely in compliance with BPT (many being significantly better or worse), an alternative statement of costs was considered in the plant-by-plant analysis projecting actual upgrade requirements relative to performance capabilities indicated at the time of the 308 questionnaire (1977). A series of six cases

reflecting the various target level options as well as starting bases (BPT or actual) were developed.

B. COST DEVELOPMENT

1. Approach

Treatment costs were developed for the direct and indirect dischargers in the 308 Data Base. Raw waste loads and flow rates were reviewed to determine the required treatments for in-plant streams, wastewater effluents to surface waters, and flows to various POTW's. Average flows and raw waste loads were estimated for each subcategory to serve as bases for cost development. Individual plant costs were then determined by adjustment of base costs for flow and RWL, allowing for economies of scale. Adjustment of investment components in proportion to an exponential ratio is generally acknowledged to best reflect economies of scale. Cost extensions were applied directly to plants with sufficient flow and concentration data,. For plants with insufficient data costs were indirectly applied by assuming requirements similar to plants with data.

Investment and operating costs for individual plants were developed by adjustment of applicable subcategory model plants to account for specific wastewater flow and concentrations of the subject plants. Mixed subcategory plants containing A and/or C were evaluated based only on those subcategories since their flows were judged to predominate. If both A and C process were used, an average of the cost models was used. If B and/or D processes were employed, their cost models were employed, either individually or averaged. It should be noted that the sensitivity of an individual plant cost to the choice of subcategory model is not great since the models are substantially similar on comparable flow and loading bases.

The base costs to meet proposed design requirements for limitations were developed for average conditions for each subcategory as presented in Table VIII-1. This was done by establishing representative values for wastewater flow rates and traditional pollutant loadings for subcategories A, B, C, and D; costs were then determined for each of the end-of-pipe and in-plant treatment alternatives for these representative flows and loadings. Since these base costs are not used directly but only as calculation bases for adjustment to specific plant situations, the base values of flow and concentration are not critical.

Investment and operating costs were developed by means of the Catalytic Treatment Model. It applies end-of-pipe and in-plant treatment alternatives to influent, effluent, and flow conditions

stated for each case. Because of distinctive processing techniques and materials employed, not all priority pollutants are likely to be associated with all subcategories (e.g., reactant and catalyst chemicals are not likely to be found in Subcategory D wastewaters). However, they tend to appear in the same range of concentrations in those subcategories in which they do occur. Paragraph B.2. (Case Definition) summarizes the judgment made as to subcategory occurrences of priority of pollutants. Cost development is limited to those instances of likely occurrence.

As indicated in Section V, the priority pollutant loadings for the individual subcategories are effectively represented by the median values from all plants in the Screening/Verification data base. These concentrations of priority pollutants were not found to vary markedly among subcategories, due in part to the necessity of relying on unsegregated stream data. For the total industry, raw waste concentrations of 13 of the most commonly found priority pollutants are presented in Table VIII-2.

Following the development of the base costs for the various flow/loading levels, each of the plants was analyzed for flow and concentration data, end-of-pipe and in-plant treatment requirements, and incremental cost impacts. Of the direct dischargers, 18 plants lacked sufficient data to directly apply the treatment costs. The indirect dischargers include 33 plants with sufficient data, 144 plants with flow data only, and 105 plants with insufficient flow and concentration data. Additionally, the available concentration data for the indirect dischargers was normally presented for the total flow to the POTW, which includes process, sanitary, noncontact cooling, and other wastewaters. Further calculations were required to determine the concentration in process wastewater prior to mixing and the consequent estimate of treatment cost if applied to this segregated stream only.

For plants with sufficient data, the current effluent concentration was compared to a target level, and further percent removal was calculated. The percent removal was related to an incremental number of "treatment stages" and a cost/capacity extension of the treatment costs was applied. Initially, the cost for one stage was extended from the appropriate base case; that cost was then adjusted to reflect any incremental stages required.

A similar approach was applied to the plants with only flow data. The incremental stage requirement, however, was calculated as a constant based on the plants with sufficient data. Average additional percent removals, average flows, and probabilities of r;t);tequired treatment) were incorporated into the base cases.

Exponential ratio cost adjustments were made based on the ratio of plant flow to base flow. The costs for these plants can be combined to provide part of the total industry cost estimate.

The costs for plants with insufficient flow and concentration data were calculated and applied in a similar fashion with two exceptions. First, the average flow was calculated for all plants with flow data (including plants with flow data only and plants with sufficient data on flow and concentrations). Second, costs were determined for this average set of conditions. Without any individual capacity adjustment, these costs were applied as a constant to all plants with insufficent data. These costs are applicable to an average plant situation and the sum of these average plant costs is included in the total industry cost estimate.

The probabilities of treatment being required for the direct and indirect dischargers were calculated from the plants with sufficient data. These probabilities reflect the percentage of total plants not meeting specified targets. The probabilities of required treatment (both end-of-pipe and in-plant) for the direct and indirect dischargers were calculated from the plants with sufficient concentration data. These probabilities reflect the percentage of total plants not meeting specified targets as defined for each case.

Direct discharge plants with flows of 3,000 gallons per day or less were assigned costs for hauling to an off-site centralized contract treatment plant rather than on-site treatment costs. Hauling for such flows was found to be a more economical alternative. This is illustrated by Figure VIII-24, which shows that the cost curves with flow variation cross at about this level.

For situations where a plant was classified as a direct and an indirect discharger, costs were applied to each waste treatment segment. The total plant costs were derived from the summation of direct, indirect, and in-plant treatment costs. Zero dischargers are not affected by this proposal. Therefore, no costs are developed for these plants.

2. Assumptions, Bases, and Limitations

This section describes assumptions regarding current performance levels and design criteria which were used in developing cost cases. These cost cases were then used to estimate the loss that would be incurred by plants in complying with the anticipated regulations.

a. Case Definition

BCT target levels for two levels of concentration and one level of percent removal were considered for direct dischargers. Two comparison starting levels are covered, one equivalent to BPT (90 percent removal) and the other reported actual performance at the time of the 308 responses. One level of pretreatment of indirect discharge (200 mg/l of BOD) was considered. A single set of limits for priority pollutants was considered for both direct and indirect discharges. Thus we developed six distinct cost cases each comprehensively covering the cost impacts for all plants.

Case variations studied cover three potential BCT effluent design criteria limitations for direct discharge:

(1). 40 mg/l BOD, 40 mg/l TSS

(2). 20 mg/l BOD, 30 mg/l TSS

(3). 95 percent removal BOD, 40 mg/l TSS

Upgrade costs for direct dischargers were developed from two starting bases. BPT performance and actual performance. BPT performance of 90 percent removal of BOD was not fully achieved at the time of the 1977 308 questionnaire. Some plants met and even exceeded that level, but many more did not.

Cost cases are set forth as follows for direct dischargers:

OPTION CASES BASED ON EOP DESIGN CRITERIA LIMITS	UPGRADE FROM BPT	UPGRADE FROM ACTUAL REPORTED
40 mg/l BOD 40 mg/l TSS	Case I	Case IV
20 mg/l BOD 30 mg/l TSS	Case II	Case V
95% Removal BOD 40 mg/l TSS	Case III	Case VI

The costs of each treatment case were developed for all direct dischargers using the data supplied by the plants (flows and influent and effluent concentration values). In cases where concentration data was not supplied, average values were used for influent and effluent concentrations and the costs were derived in the same manner as the costs based on known influent and effluent concentrations. The technology options chosen as the control bases for the traditional pollutants (to be regulated by BCT, BAT, and NSPS) do not equate exactly to any of the six option cases described because they require the attainment of different effluent target levels for BOD_5, COD, and TSS than

specified above. However, the overall technology bases (varying degrees of biological enhancement or augmentation as required) of these regulations are only different in that they involve slightly different design requirements to accommodate the different target concentration levels. Plant-by-plant costs for the chosen BCT/BAT option were developed by allowing for necessary design modifications to Option Case IV. The costs were then calculated for all direct dischargers requiring treatment upgrading based on data submissions. New source costs were estimated for an average new source direct discharger using an adjustment of Option Case V. In addition, pretreatment costs were estimated for indirect dischargers assuming plants would discharge effluent containing 200 mg/l or less of BOD_5 to POTWs. All costs are included in the technical record of this rulemaking.

In-plant treatment requirements developed to meet revised BPT, PSES, and PSNS for the treatment most probably applicable to each process subcategory in each plant are:

Subcategory	Steam Stripping of Volatiles	Cyanide Destruction
A Fermentation	Yes	No
B Biological Extraction	Yes	No
C Chemical Synthesis	Yes	Yes
D Formulation	No	No

There are exceptions to the exclusions set forth in this listing (e.g., the use of cyanide-related materials in the Vitamin-B_{12} manufacture via fermentation) (42); however, for purpose of cost approximation, treatment for removal of priority pollutants is considered whenever actual effluent data reported for a given plant exceeds the following values:

	EOP Value
All volatile organics	1200
Cyanide	200

(all values in micrograms/liter)

Removal methods for priority pollutants for which specific processing costs were developed include steam stripping for volatile organics, alkaline precipitation for most metals, chromium reduction, and oxidative destruction of cyanide. Other priority pollutants can be removed by methods which are generally cost equivalent to the methods which have been costed. These pollutants include phenol, mercury, and other metals. The techniques which might be employed, although not analyzed here for cost detail, might include ion exchange, sulfide precipitation, and thermal oxidation.

Costs for in-plant treatment of toxic volatile organics and cyanide were developed for individual plants when a comparison of the data submitted with the above effluent target values indicated that treatment for cyanide and/or toxic volatile organics was required. Costs were also estimated for plants that did not supply effluent priority pollutant data by assuming that the above target values and average raw waste values were applicable to these plants. Although the Agency will not develop limitations on metals in this rulemaking, costs for metals precipitation and chromium reduction (developed on a basis similar to that used the cyanide destruction and steam stripping cost development) are included in the technical record. The components of all in-plant costs are discussed in the ensuing subsections.

b. Cost Factors

The following major capital and operating cost factors were used throughout the costing effort:

(1) Land - The cost estimates presented do not include land costs. The cost of land is variable and site dependent and cannot be estimated on a national basis. For in-plant systems, the necessary equipment usually can be placed in existing structures near the source stream being treated. For end-of-pipe systems, the total area required is indicated.

(2) Piping and Pumps - Where required, piping and pumps are assumed to be 20 percent of basic equipment costs.

(3) Delivery and Installation - These costs are assumed to be 50 percent of total equipment costs.

(4) Engineering and Contingency - These costs are assumed to be 30 percent of total installed costs.

(5) Energy - Electricity costs are assumed to be $0.04 per KWh. Annual power costs for mixing and pumping are computed as

(Total horsepower) x (8760 hr/yr) x (0.746 KW/hp) x ($0.04/KWh).

(6) Operating Labor - A rate of $10/hr including taxes and fringe benefits is assumed.

(7) Maintenance - Maintenance costs are assumed to be 3 percent of total capital costs.

(8) Sludge Disposal - This cost (including transportation) is assumed to be $0.30 per gallon.

(9) Capital Amortization - This figure is estimated at 10 percent at 10 years.

(10) Escalation Indices - All cost data presented in this section are expressed in January, 1978 dollars. (The Engineering News Record Construction Index number was 2670 and the Chemical Engineering Plant Cost Index number was 210.6. See Appendix N for tabulation of these indices.) Capital costs for such major equipment items as tanks, clarifiers, filters, mixers, sludge thickeners, and vacuum filters were obtained from equipment manufacturers and from a wastewater treatment cost data base Catalytic, Inc. developed for the Effluent Guidelines Division (131, 132).

c. Cost Sensitivity Bases

Additional assumptions and bases necessary for derivation of the cost variations are:

(1) Investment costs vary with the 0.7 exponential power of wastewater throughput.

(2) Break points or discontinuities in equipment sizes (as they vary with flow or performance) are not considered since they are likely to be plant specific and potentially misleading. A smoothed transition form of capacity and investment data is preferred and used.

(3) Sludge-dewatering equipment size or disposal volume is directly proportional to quantity of sludge generated. Disposal costs are constant per unit of sludge handled.

(4) Within the ranges considered, labor cost is considered to be constant and independent of equipment size or throughput.

(5) Treatments requiring the addition of pH-adjustment chemicals utilize such chemicals in proportion only to the amount of water treated.

(6) Treatments based on chemical reaction of pollutants are considered to require reactant-treatment chemicals in direct proportion to the amount of pollutant removed.

(7) Cost Factors applied to investment, labor, and other costs remain valid within the range of data and results presented.

d. Plant-by-Plant Cost Bases

The bases on which the plant-by-plant costs were developed are:

(1) Treatment Stages - Treatment systems costs are estimated in relation to the base costs determined by BRISC/Catalytic. The extent of treatment is defined as a stage of biotreatment and is assumed to be equivalent to be approximately 85 percent BOD removal.

(2) Treatment Choice - Activated sludge is used as a cost basis for biological treatment. Although it is not expected to be the treatment selected for every case, it is the most broadly applicable technology and should be a conservative cost representation of other treatment methods (e.g., aerated lagoons, trickling filters, etc.).

(3) Bio-reaction Kinetics - The degree of biological treatment is developed as a function of percent BOD removal required to meet target performance. The bio-reaction is considered to be first order, with a constant K value equal to the conservative value of 1 used in the base study.

(4) Extent of Treatment - Since detention time and the consequent holdup volume of the system is directly proportional to the number of "stages", system investment cost also can be related. The counting of "stages" is an artificial calculation convenience used to compare extent of treatment by comparison to an arbitrary standard treatment extent, chosen at about 85 percent BOD_5 removal for the purposes of these calculations. Investment was taken to vary as the 0.7 exponent both of the system throughput rate and of the number of stages. For the sake of simplicity, those system parts (pumps, piping, instrumentation, and the like) not varying with holdup are not estimated separately.

(5) Throughput Effect - Wastewater flow rate is also considered to influence system capacity proportionately and therefore is also scaled by 0.7 exponent.

(6) Low-Flow Alternative - A few plants among the direct dischargers indicate flows to be low enough to require exhorbitant additional treatment cost per unit of volume.

In such cases, the alternative of hauling the small volumes of wastewater to a POTW or to a neighboring industrial treatment facility is substituted. The break point between these methods is approximately 3,000 GPD.

(7) TSS Removal - Costs developed for biological treatment systems include secondary TSS removal. However, there are a few direct dischargers for which biotreatment is not needed but TSS treatment is. A separate TSS removal is estimated and included in such cases. Because of the small magnitude of these costs and the uncertainty of applicability, no estimates of supplemental TSS costs were made for the plants with insufficient data.

(8) Direct Discharge Data Projection - Flow data are reported for most direct discharge plants. However, performance data in terms of influent and effluent BOD concentrations are not available in the 308 data for a substantial number of plants. If either influent or effluent data (not both) are missing, current BPT compliance performance at 90 percent removal is assumed. If both are missing, an average level of treatment based on known treatment plants and a probability of biotreatment being required are used to estimate a probability-weighted cost for each plant.

(9) Indirect Discharge Data Reported Projection - Data reported for indirect discharge plants are not as complete as the data for direct dischargers. Flow data as well as BOD concentrations are lacking for many plants. Where concentration only is missing, treatment requirements and costs are scaled to individual volumes based on a "representatively average" plant that supplied complete data. Where flow also is not known, an average plant is developed from those with data, and its costs are used to estimate an average set of costs applied to all of the plants without data.

(10) In-Plant Data Projection - In-plant treatment data are subject to considerable uncertainty since wastewater flows and concentrations are reported on an end-of-pipe or a combined influent basis. Thus flows and local priority pollutant concentrations before combination and equalization are not available. Based on reasonable processing mix, an estimate was made that, for a typical plant, 10 percent of the total process wastewater is subject to each of the in-plant treatments applicable. It is to be expected that actual plants will vary substantially above and below this proportion. Average treatment costs are developed based on those plants with data. These averages are factored by the probability of a treatment being required for plants without

data and the resultant costs have been developed for these plants.

The application of a probability of treatment as well as the estimated wastewater proportion prevents reliance on the accuracy of individual plant costs so calculated. These cost effects should be relied on only as an estimate of cumulative effects for the plants without data.

3. In-Plant Treatment Costs

In-plant treatment is directed at removing certain pollutants from specific waste streams before the water is combined with other wastewaters. The costs of in-plant treatment alternatives allocated to any pharmaceutical plant must be based upon the flow of the process wastewater stream bearing the specific pollutant or pollutants of interest. To prepare costs for the subcategory base cases, the flow rate of the process waste stream to be treated by in-plant treatment systems was assumed to be 10 percent of a plant's total wastewater flow since in-plant flows are seldom reported individually. In addition, it was assumed that the entire mass loading for each case of the subject pollutant (calculated from the data in Table VIII-2) was contained in the process waste stream. The major priority pollutants found in pharmaceutical wastewaters were cyanide, metals, and solvents. Therefore, cost estimates were developed for treating these three classes of pollutants.

a. Cyanide Destruction

Cyanide has been identified in the wastewaters of a number of pharmaceutical plants. Table VIII-3 contains the equipment cost bases and energy requirements for oxidation with hypochlorite in an alkaline environment.

Capital cost items are presented in Table VIII-4 and include detention tanks, mixers, piping and pumps, and automatic chemical feed systems. The annual operating costs for base conditions and variations are shown in Tables VIII-5 and VIII-6. To estimate the annual cost of chemicals, it was assumed that 1.2 lbs of hypochlorite ($0.60/lb) and 1.4 lbs of caustic ($0.12/lb) were added to each 1000 gallons of wastewater treated.

b. Chromium Reduction

Chromium in wastewaters can occur in either a hexavalent or a trivalent state. Hexavalent chromium is extremely soluble while trivalent chromium forms an insoluble hydroxide. Therefore, the first step in the treatment of chromium is the reduction of the hexavalent ions to the trivalent state. This usually is

accomplished with sulfur dioxide at low pH values; however, other reducing agents can be used.

The pH of the wastewater containing the trivalent chromium is adjusted to the range (8 to 10) where chromium hydroxide is precipitated and removed by clarification. The procedure generally is performed on a batch basis for systems below 15 gallons per minute and on a continuous basis for larger systems. Table VIII-7 presents the equipment cost bases and energy requirements for chromium reduction systems. Adjustment of pH and clarification are included as part of the systems cost.

Tables VIII-8 through VIII-11 present the capital and operating costs for base conditions and variations. Chemical requirements for the systems presented include 0.45 lbs of sulfur dioxide ($0.15/lb), 0.45 lbs of sulfuric acid ($0.06/lb), and 2 lbs of caustic ($0.12/lb) for each 1000 gallons of wastewater treated.

c. Metal Precipitation

Metal removal generally is accomplished by pH adjustment in the range of 8 to 10. After, the metal hydroxide precipitates formed by the pH adjustment are removed by clarification. There are a variety of chemicals that can be used to aid in the precipitation and clarification process; however, the data presented in Tables VIII-12 and VIII-13 are based upon lime and alum addition since they are commonly used. Sulfide precipitation, similar in cost, is also frequently employed.

Table VIII-12 presents the design bases and energy requirements for metal precipitation. Solids-contact-type clarifiers were used for costing purposes. These units include a flash mix zone, a flocculation zone, and a settling zone in one unit.

Since metals removal by precipitation requires very little head loss, most systems will be operated by the head already available in the wastewater effluent line. The miscellaneous energy requirements shown in Table VIII-12 include those for chemical addition and sludge removal.

Table VIII-13 presents the capital cost items for the base case for the systems outlined, while Tables VIII-14 through VIII-16 show the annual operating costs for base conditions and variations. Capital amortization (capital recovery plus interest) is the largest portion of annual cost.

d. Steam Stripping

A study (72) conducted by EPA on the applicability of steam stripping for treating wastewaters containing organic priority

pollutants shows that this technology is a feasible in-plant treatment method for the pharmaceutical manufacturing industry and is in fact currently in use.

Since no other specific cost data were available, the preliminary figures reported in that study are used in this document. Table VIII-17 presents capital and annual operating costs for steam stripping. As work continues in this area, more detailed cost information can be developed and incorporated into the analysis.

4. End-of-Pipe Treatment Costs

Biological treatment was found to be the principal end-of-pipe method in use by the majority of pharmaceutical manufacturing plants now seeking to meet existing BPT limitations guidelines. This treatment alternative consists of such specific technologies as activated sludge systems, trickling filters, rotating biological contactors, lagoons, etc. In addition, variations in the application of these specific technologies can improve biological treatment. Modifications and combinations of conventional biological treatment processes are referred to as biological enhancement and augmentation.

a. Biological Treatment

For the purpose of developing costs, combinations of biological treatment processes were considered for biological treatment. The assumption was made that a conventional biological process would be added to a BPT system already in place. For costing purposes, those plants lacking effluent data were assumed to be meeting the existing BPT (90 percent removal) limitations.

Data analyses conducted during this study indicate a significant number of plants utilizing biological treatment can achieve effluent levels of 40 mg/l BOD and 40 mg/l TSS (an improvement over BPT systems in many cases).

Table VIII-18 presents equipment cost bases and energy requirements for activated sludge systems designed for four subcategory base levels developed for cost calculation purposes. Capital cost items are presented in Table VIII-19 and include typically such auxillary equipment as aeration basins, aerators, nutrient-addition equipment, clarifiers, and sludge-handling facilities. The total annual costs for base conditions and variations are shown in Table VIII-20.

Rotating biological contactors (RBC's) were another type of biological treatment considered. RBC systems were sized for each of the base conditions and were based upon the data in Table

VIII-21. The major capital and operating costs for base conditions and variations are presented in Table VIII-22.

Enhanced biological treatment can also be accomplished with the use of polishing ponds. Costs were developed based on the data shown in Table VIII-23 for each set of base conditions. A pond was sized for a depth of 10 feet and for the detention time shown. Capital cost items and annual operating costs for base conditions and variations are presented in Table VIII-24 and include excavation, grading, compaction, an impervious liner, and piping; sludge disposal costs were not included in the annual costs since cleanout should not be required for many years and the present value of such costs is judged to be negligible.

For plant-by-plant cost evaluation, activated sludge treatment was considered to be representative of the various biological treatment systems which might be employed to meet new limitations. For consistency, costs were developed assuming that an activated sludge unit designed to achieve the required upgrade was installed in each plant where needed. No allowance was made for achieving some or all of the desired removal through internal modification of existing systems, although undoubtedly feasible in many cases, because site-specific knowledge of each plant was not available.

b. Biological Treatment and Filtration

Filtration can be used as a polishing step following biological treatment for increased solids removal. Analyses indicate that effluent concentrations of 20 mg/l BOD and 30 mg/l TSS are achievable with biological treatment and filtration of pharmaceutical wastewaters.

Table VIII-25 presents equipment cost bases and energy requirements for activated sludge systems followed by dual-media filters. Aeration basins were sized for longer detention times than those noted in Table VIII-18. The two filters provided for each model plant are dual-media, gravity-flow units with automatic backwashing. Capital and total annual costs for base conditions and variations are presented in Tables VIII-26 and VIII-27.

Cost estimates were also prepared for filtration units following RBC systems. The RBC units were sized for the desired effluent quality, increasing the total RBC surface area above those shown in Table VIII-21. The same dual media filters as those provided with activated sludge systems are specified in Table VIII-28. Capital and total annual costs for base conditions and variations are given in Table VIII-29.

c. Low-Volume Wastewater Hauling

The manufacturing operations making up the pharmaceutical industry include a large number of plants with small volume wastewater discharges. Many of these flows are so small that the cost of conventional treatment, expressed as cost per unit of wastewater flow, would be comparatively quite large. Most low-volume plants are indirect dischargers to a POTW and have no indigenous wastewater treatment. However, a few may be located such that this is not practical. In such situations, it may be advantageous to find a means of consolidating such small volumes into some larger volume system (e.g., hauling the wastewater to a POTW or other combined treatment system).

An analysis of wastewater hauling costs is presented in Figure VIII-24 and is supported by Table VIII-30. A range of hauling distance represented by parameters of round-trip hauls of 50 miles and 200 miles are considered. Investment for wastewater hauling is included, as is destination cost of treatment. The current criterion of $.36 per pound of pollutant (1980) is taken as a reasonable approximation of a combined system treatment cost.

In many cases, moderately small flows of wastewater might be accommodated by intermediate-scale methods, such as small package-type treatment units or evaporation ponds. Since these approaches are expected to be intermediate in cost and in many cases involve site-specific circumstances, they are not individually analyzed. Hauling costs are considered to set an upper, conservative limit for small volumes.

Wastewater hauling as opposed to a standard treatment such as activated sludge, becomes advantageous at about 3,000 gallons per day.

5. Cost Sensitivities

The variations of treatment cost with wastewater flow, raw waste load (RWL), and effluent concentration level are recognized by means of the cost sensitivity curves shown in Figures VIII-1 through VIII-24. Subcategories are presented as parametrically distinct curves. The cost axes are stated as annual cost of treatment or as cost per thousand gallons of wastewater treated. Flow rate must be considered because of its effects on treatment plant investment and annual costs.

Biological treatment systems are directed toward removal of BOD and, in a related manner, COD, also with supplemental solids removal.

In-plant treatment is directed primarily toward reduction of priority pollutants. Cost sensitivities developed for treatment systems in both areas cover the following:

(1) Activated Sludge, Annual Treatment Cost vs. Wastewater Flow.

(2) Activated Sludge With Supplemental Treatment, Annual Treatment Cost vs. Wastewater Flow.

(3) RBC System, Annual Treatment Cost vs. Wastewater Flow.

(4) RBC System With Supplemental Treatment, Annual Treatment Cost vs. Wastewater Flow.

(5) Polishing Pond, Annual Treatment Cost vs. Wastewater Flow.

(6) Cyanide Destruction, Annual Treatment Cost vs. Wastewater Flow.

(7) Cyanide Destruction, Annual Treatment Cost vs. Influent CN Concentration.

(8) Cyanide Destruction, Unit Treatment Cost vs. Wastewater Flow.

(9) Cyanide Destruction, Unit Treatment Cost vs. Influent CN Concentration.

(10) Chromium Reduction, Annual Treatment Cost vs. Wastewater Flow.

(11) Chromium Reduction, Unit Treatment Cost vs. Wastewater Flow.

(12) Chromium Reduction, Annual Treatment Cost vs. Influent Cr Concentration.

(13) Chromium Reduction, Unit Treatment Cost vs. Influent Cr Concentration.

(14) Chromium Reduction, Annual Treatment Cost vs. Effluent Cr Concentration.

(15) Chromium Reduction, Unit Treatment Cost vs. Effluent Cr Concentration.

(16) Metals Precipitation, Annual Treatment Cost vs. Wastewater Flow.

(17) Metals Precipitation, Unit Treatment Cost vs. Wastewater Flow.

(18) Metals Precipitation, Annual Treatment Cost vs. Influent Metals Concentration.

(19) Metals Precipitation, Unit Treatment Cost vs. Influent Concentration.

(20) Metals Precipitation, Annual Treatment Cost vs. Effluent Metals Concentration.

(21) Metals Precipitation, Unit Treatment Cost vs. Effluent Metals Concentration.

(22) Steam Stripping, Annual Cost vs. Flow Rate and Steam Cost.

(23) Steam Stripping, Unit Cost vs. Flow Rate and Steam Cost.

(24) Wastewater Hauling Costs vs. Wastewater Flow.

C. ANALYTICAL COSTS FOR MONITORING PRIORITY POLLUTANTS

In addition to the cost of treatment facilities to remove priority pollutants, the cost of monitoring the priority pollutants discharged must be considered. An estimate of these costs is shown in Table VIII-31.

The basis for these costs assumes a typical slate of eleven priority pollutants to be monitored by the example plant: five volatiles (including acid extractables), five metals, and cyanide. This slate cannot cover all plant situations, for purpose of costing; but it is judged to be representative of the priority pollutants most commonly found in the industry's wastewater.

Several methods of analysis are available for each category of pollutant. For volatiles and extractables, the methods are gas chromatography (GC), high-pressure liquid chromatography (HPLC), and gas chromatography with mass spectroscopy (GC/MS). Of these methods, GC and HPLC were judged to be appropriate for routine use, as they are considerably less expensive than GC/MS. A GC/MS run would be made at intervals for confirmation of the GC or HPLC results and for identification of any unexpected priority pollutants. An interval of one GC/MS for every ten samples was selected as reasonable. Which method, GC or HPLC, might be used for routine analysis would depend on the specific pollutants present and established analytical capabilities. However, the

costs are very similar. Extractables would be analyzed using the same methods employed for volatile organics, but preceded by appropriate extraction.

A colorimetric test was selected for cyanide analysis. Two tests were considered for metals analysis: Inductively Coupled Plasma (ICP) and Atomic Absorption (AA). A cost range for each element analyzed was established covering these methods.

Costs of the applicable analyses are expected to vary with a number of site-and location-specific factors. For example, the cost of analysis would vary with the cost-of-living if the area where the plant is located. The cost of analysis would also vary from lab to lab, since each lab sets its own prices. The number of pollutants analyzed would also be a factor. For this reason, a range of costs is presented along with a weighted average. The costs given are based on quotations from labs in Baton Rouge, Louisiana, and U.S. Bureau of Labor Statistics for various U.S. cities.

Once the total cost per analysis has been calculated, the required frequency of analysis is established. Factors to be considered in setting frequency include the volume of outflow, the compliance history of the plant, the variability history, the nature of the product/processes and priority pollutants of the plant, and the equalization pattern of the plant's treatment system. The frequencies selected for study were daily, weekly, monthly, and a three-day series once per month. Costs based on each of these patterns are included in Table VIII-31.

Finally, another monitoring cost determinant is the number of outfall analyses which must be covered. Some outfalls may be combined if waste characteristics are similar and if a high level of priority pollutants is not likely to cause individual monitoring concern. The cost presented is per individual sample, be it from an individual outfall or a composite.

D. ENERGY CONSIDERATIONS

The energy consumption impact of further limitation on wastewater quality in the pharmaceutical industry is largely limited to power requirements for additional pumps, agitators, and so forth. One exception is the substantial steam requirement (relative to pollutant removed) for steam stripping removal of volatile organics or other solvent recovery technologies based on volatilization.

Incremental energy consumption is reflected within the additional costs noted for each plant. Availability of power or steam where

needed is not judged to be a prevalent problem, largely because of the relatively modest demand.

To the extent that regulatory limits on priority pollutants may encourage changes in manufacturing techniques, there may be some specific changes in energy utilization. These are expected to be minor. Examples are recycle and reuse of process contact water and substitution of techniques other than direct contact barometric legs for vacuum systems.

E. NON-WATER QUALITY ASPECTS

Although these proposed limitations cover effluent wastewater quality from the pharmaceutical industry, the effect such regulations might have on other aspects of environmental quality must be considered. These include RCRA wastes ("solid wastes") and air emissions.

1. RCRA Wastes

RCRA wastes generated by the pharmaceutical industry fall into four general categories: sludges, waste solvents, infectious wastes, and returned rejected goods. (129)

a. Sludges

Sludges are generated by in-plant and end-of-pipe technologies and range from the relatively innocuous sludge of aerated lagoons and activated sludge units to sludge cakes of high metal content (the amount of which will not be affected by these regulations). Sludge from biological treatment and general process waste (e.g., mycelia from fermentation) is usually landfilled. A current trend in the industry is to reprocess waste mycelia and market it as an animal feed supplement.

Sludge production rates for base-case plants are shown for each treatment process in the cost bases tables. The amount of sludge produced by pharmaceutical plants will vary markedly from site to site. However, these estimates are high and are expected to be equal to or higher than the actual amounts experienced by any given production site. Based upon these factors, it is expected that any additional sludge production will be minimal, especially when compared to the large quantities of sludge produced by the basic in-place technology.

b. Waste Solvents

Waste solvents, such as toluene, methylene chloride, benzene, and carbon tetrachloride, are a substantial part of RCRA wastes from the pharmaceutical industry. Solvents which might be separated

from wastewater by steam stripping would contribute a modest increment to such wastes. For the most part, waste solvents are disposed in approved hazardous waste disposal sites. However, because of RCRA considerations this method will more than likely decline. Another and more attractive form of disposal for waste solvents is incineration, either direct or by incorporation into a fuel system. These systems are designed to completely oxidize organic solvents and eliminate the need for landfill.

Changes in process in the pharmaceutical industry generally require FDA approval. Because of potential process contamination, solvent recovery would normally fall into such a change category, effectively restricting recycle, at least into pharmaceutical processing.

The latest estimates available (1980) show the pharmaceutical industry already generates approximately 52,000 dry U.S. tons per year of waste solvents(43). A toxic solvent limitation (PSES) would have the effect of increasing the quantity of waste solvents subject to RCRA disposal. The Agency estimates that if a toxic solvent pretreatment standard were promulgated, an increase of about 9300 tons/yr of waste solvents requiring RCRA disposal would result, assuming no recycle.

c. Infectious Wastes, Returned and Rejected Goods

This category covers a wide spectrum of solid waste materials. Because of their infectious nature, the wastes must undergo treatment that will insure destruction of pathogenic agents. The two methods most commonly used in the pharmaceutical industry for the treatment of infectious waste are autoclaving and incineration.

Returned and rejected goods from formulation, test animal carcasses, bedding, and other disposable materials are incinerated and/or landfilled, depending upon whether they are suspected of carrying infectious agents.

Any new effluent limitations will have no effect on the disposal of infectious agents and other solid wastes since these wastes are not generaged by wastewater treatment.

2. Air Emissions

The various types of air emissions which may emanate from a pharmaceutical manufacturing site include solvents, particulates, combustion gases, and odors. However, these regulations will only affect the emissions of wastewater-borne solvents to air, and hence only the effect of these emissions has been considered.

The technology options likely to be selected for controlling traditional pollutants and cyanide beyond existing BPT may, in some cases, increase to a small extent the air emissions of wastewater-borne volatile solvents. In particular, plants which may choose to use aerated biological treatment systems, such as aerated lagoons, may have some increase in emission via incidental air stripping.

This may or may not result in local air pollution problems depending on the nature and amount of volatile organics in the untreated wastewater. However, no significant direct effect on air quality is anticipated as a result of any effluent guidelines limitations and standards that may be proposed in this rulemaking.

TABLE VIII-1

RAW WASTE LOADS FOR SUBCATEGORY BASE CASES

TRADITIONAL POLLUTANTS

Traditional Pollutant	Subcategory Base Cases A	B	C	D
BOD, mg/l	2,440	1,270	2,190	1,630
lbs/day	8,850	480	4,750	1,020
COD, mg/l	5,180	2,050	5,160	2,780
lbs/day	18,800	770	11,200	1,740
TSS, mg/l	1,030	520	740	370
lbs/day	3,740	200	1,600	230
Wastewater Flow				
Mean Plant Flow, gal/day	435,000	45,000	260,000	75,000

Notes:

1. Wastewater concentrations (mg/l) were developed using the results of the screening and verification programs. Twenty-six individual plants comprise this data base with subcategory breakdown as noted in Table II-2.

2. BOD, COD, and TSS concentrations are the mean of the results in the screening and verification data base for each of the three pollutants. The mean concentrations are based on the data from all plants that had that particular type of operation (Example: data from an ABC plant were used in the A, the B, and the C determinations).

3. The averages tabulated above include mixed subcategory data.

TABLE VIII-2

TYPICAL PRIORITY POLLUTANT CONCENTRATIONS USED FOR BASE CASE IN-PlANT COSTS*

Pollutant	µg/l
Acid Extractables	
Phenol	180
Volatile Organics	
Benzene	100
Chloroform	150
Ethylbenzene	20
Methylene Chloride	320
Toluene	515
Metals	
Chromium	45
Copper	85
Lead	50
Mercury	8
Nickel	50
Zinc	250
Other	
Cyanide	280

*Concentration values are based on earlier analysis and do not duplicate medians of Table V-6 but are used only as a typical, hypothetical calculation base and introduce no discrepancy since cost variation with concentration is accounted for in individual plant costs, based on 308 data for each plant.

TABLE VIII-3

CYANIDE DESTRUCTION

EQUIPMENT COST BASES AND ENERGY REQUIREMENTS

Subcategory C - 26,000 GPD Base Case

Description	
Mean flow, gal/day	26,000
Type of Operation	Continuous
Detention Tank(s), gal	One, 600
Mixer(s), hp	One, 0.25
Mixing Req., kWh/yr	1,600
Hypochlorite Feed Rate, lb/yr	11,500
Caustic Feed Rate, lb/yr	13,300
Pumping Req., kWh/yr	2,000
Manpower Req., h/yr	500

TABLE VIII-4

CYANIDE DESTRUCTION

CAPITAL COSTS
(dollars)

Subcategory C - 26,000 GPD Base Case

Description	
Detention Tank(s)	$ 2,000
Mixer(s)	800
Hypochlorite Feed System	9,500
Caustic Feed System	9,500
pH and ORP Control Systems	10,000
Equipment Cost	38,200
Installation	19,100
Engineering	8,800
Contingency	8,900
Total Capital Cost	$75,000

TABLE VIII-5

CYANIDE DESTRUCTION

TOTAL ANNUAL COSTS
(Dollars/Year)

VARIATION WITH FLOW

Subcategory C - 26,000 GPD Base Case

Description			
Flow Variation	X 1/2	26,000 GPD	x 2
Chemicals			
Hypochlorite	$ 3,500	$ 6,900	$13,800
Caustic	800	1,600	3,200
Energy	100	200	400
Labor	5,000	5,000	5,000
Maintenance	1,500	2,300	3,600
Capital Amortization	7,650	12,000	18,800
Total Annual Cost	$18,500	$28,000	$44,800
$/1,000 Gal.	$ 3.90	$ 2.95	$ 2.36

TABLE VIII-6

CYANIDE DESTRUCTION

TOTAL ANNUAL COSTS
(Dollars/Year)

VARIATION WITH INFLUENT CN CONCENTRATION

Subcategory C - 26,000 GPD Base Case
Effluent Concentration = 40 ug/l

Description			
Influent Concentration (ug/l)	161	Base 322	644
Chemicals			
Hypochlorite	$ 3,500	$ 6,900	$13,800
Caustic	1,600	1,600	1,600
Energy	200	200	200
Labor	5,000	5,000	5,000
Maintenance	2,300	2,300	2,300
Capital Recovery plus Return	12,080	12,000	12,000
Total Annual Cost	$24,600	$28,000	$34,900
$/1,000 Gal.	$ 2.59	$ 2.95	$ 3.68

TABLE VIII-7

CHROMIUM REDUCTION

EQUIPMENT COST BASES AND ENERGY REQUIREMENTS

Subcategory C

	26,000 GPD Base Case
Mean flow, gal/day	26,000
Type of Operation	Continuous
Detention Tank(s), gal	One, 1,200 2 sections
Mixers, hp	One, 0.5 One, 0.25
Mixing Req., kWh/yr	4,800
Clarifier Dia., ft	8
SO2 Feed Rate, lb/yr	4,300
Acid Feed Rate, lb/yr	4,300
Caustic Feed Rate, lb/yr	19,000
Pumping Req., kWh/yr	2,000
Manpower Req., h/yr	500
Sludge Produced, lb/yr dry solids	4,800

TABLE VIII-8

CHROMIUM REDUCTION

CAPITAL COSTS
(Dollars)

Subcategory C

Description	26,000 GPD Base Case
Detention Tank(s)	$ 4,500
Mixers	2,500
Acid and SO_2 Feed Systems	19,000
pH and ORP Control Systems	10,000
Caustic Feed System	9,500
Clarifier	27,000
Piping and Pumps	13,500
Equipment Cost	86,000
Installation	43,000
Engineering	19,500
Contingency	19,500
Total Capital Cost	$168,000

TABLE VIII-9

CHROMIUM REDUCTION

TOTAL ANNUAL COSTS
(Dollars/Year)

VARIATION WITH FLOW

Subcategory C - 26,000 GPD Base Case

Flow (GPD)	13,000	Base Case	52,000
Chemicals			
SO_2	$ 325	$ 650	$ 1,300
Acid	125	250	500
Caustic	1,150	2,300	4,600
Energy	150	300	600
Labor	5,000	5,000	5,000
Maintenance	3,250	5,100	8,000
Sludge Disposal	1,750	3,500	7,000
Capital Recovery plus Return	17,780	27,900	43,800
Total Annual Cost	$29,530	$45,000	$70,800
$/1,000 Gal.	$ 6.22	$ 4.74	$ 3.73

TABLE VIII-10

CHROMIUM REDUCTION

TOTAL ANNUAL COSTS
(Dollars/Year)

VARIATION WITH FLOW

Subcategory C - 26,000 GPD Base Case
Effluent Concentration = 300 ug/l

Influent Conc. (mg/l)	0.90	1.1	1.35
Chemicals			
SO_2	$ 650	$ 650	$ 650
Acid	250	250	250
Caustic	2,300	2,300	2,300
Energy	300	300	300
Labor	5,000	5,000	5,000
Sludge Disposal	3,500	14,000	24,500
Capital Recovery plus Return	27,900	27,900	27,900
Total Annual Cost	$45,000	$55,500	$66,000
$/1,000 Gal.	4.74	5.85	6.95

TABLE VIII-11

CHROMIUM REDUCTION

TOTAL ANNUAL COSTS
(Dollars/Year)

VARIATION WITH EFFLUENT CONCENTRATION

Subcategory C - 26,000 GPD Base Case
Influent Concentration = 450 ug/l

Effluent Conc. (ug/l)	100	200	300
Chemicals			
SO_2	$ 650	$ 650	$ 650
Acid	250	250	250
Caustic	2,300	2,300	2,300
Energy	300	300	300
Labor	5,000	5,000	5,000
Maintenance	5,100	5,100	5,100
Sludge Disposal	8,200	5,800	3,500
Capital Recovery plus Return	27,900	27,000	27,900
Total Annual Cost	$49,700	$47,300	$45,000
$/1,000 Gal.	$ 5.24	$ 4.98	$ 4.74

TABLE VIII-12

METAL PRECIPITATION

EQUIPMENT COST BASES AND ENERGY REQUIREMENTS

Description	Subcategory A	Subcategory C
Mean flow, gal/day	43,500	26,000
Type of Operation	Continuous	Continuous
Clarifier Dia., ft	10	8
Filters Dia., ft	Two, 3	Two, 3
Lime Feed Rate, lb/yr	13,200	7,900
Alum Feed Rate, lb/yr	2,600	1,600
Misc. Energy Req., kWh/yr	500	300
Manpower Req., h/yr	500	500
Sludge Produced, lb/yr dry solids	15,900	9,500

TABLE VIII-13

METAL PRECIPITATION

CAPITAL COSTS
(Dollars)

Description	Subcategory A	Subcategory C
Clarifier, Solids Contact Type	32,000	27,000
Lime and Alum Feed Systems	22,000	19,000
Filtration Units	20,000	30,000
Piping	8,400	7,600
Equipment Cost	$ 92,400	$ 83,600
Installation	$ 46,000	$ 41,000
Engineering	20,700	18,000
Contingency	20,700	18,000
Total Capital Cost	$180,000	$163,000

TABLE VIII-14

METAL PRECIPITATION

TOTAL ANNUAL COSTS
(dollars/year)

VARIATION WITH FLOW

Subcategories A & C

	A			C		
Flow (GPD)	21,750	43,500	87,000	13,000	26,000	52,00
Chemicals						
Lime	$ 275	$ 550	$ 1,100	$ 175	$ 350	$ 70
Alum	100	200	400	50	100	20
Energy	25	50	100	25	50	10
Labor	5,000	5,000	5,000	5,000	5,000	5,00
Maintenance	3,450	5,400	8,500	3,150	4,900	7,70
Sludge Disposal	5,750	11,500	23,000	3,400	6,800	13,60
Capital Recovery Plus Return	18,700	29,300	46,000	17,100	26,800	42,00
Total Annual Cost	$33,300	$52,000	$84,100	$28,900	$44,000	$69,30
$/1,000 Gal.	$ 4.19	$ 3.27	$ 2.65	$ 6.09	$ 4.64	$ 3.65

TABLE VIII-15

METAL PRECIPITATION

TOTAL ANNUAL COSTS
(dollars/year)

VARIATION WITH INFLUENT CONCENTRATION
Effluent Conc. = 1.1 mg/l

Subcategories A & C

	A			C		
Influent Conc. (mg/l)	3.0	4.36	7.00	3.0	4.36	7.0
Chemicals Lime	$ 550	$ 550	$ 550	$ 350	$ 350	$ 350
Alum	200	200	200	50	100	100
Energy	50	50	50	50	50	50
Labor	5,000	5,000	5,000	5,000	5,000	5,000
Maintenance	5,400	5,400	5,400	4,900	4,900	4,900
Sludge Disposal	6,700	11,500	20,800	4,000	6,800	12,300
Capital Recovery Plus Return	29,300	29,300	29,300	26,800	26,800	26,800
Total Annual Cost	$47,200	$52,000	$61,300	$42,200	$44,000	$49,500
$/1,000 Gal.	$ 2.97	$ 3.27	$ 3.86	$ 4.45	$ 4.64	$ 5.22

TABLE VIII-16

METAL PRECIPITATION

TOTAL ANNUAL COSTS
(dollars/year)

VARIATION WITH EFFLUENT CONCENTRATION
Influent Conc. = 4.36 mg/l

Subcategories A & C

	A			C		
Effluent Conc. (mg/l)	0.5	1.1	2.0	0.5	1.1	2.0
Chemicals						
Lime	$ 550	$ 550	$ 550	$ 350	$ 350	$ 350
Alum	200	200	200	50	100	100
Energy	50	50	50	50	50	50
Labor	5,000	5,000	5,000	5,000	5,000	5,000
Maintenance	5,400	5,400	5,400	4,900	4,900	4,900
Sludge Disposal	13,600	11,500	8,300	8,100	6,800	4,900
Capital Recovery Plus Return	29,300	29,300	29,300	26,800	26,800	26,800
Total Annual Cost	$54,100	$52,000	$48,800	$45,300	$44,000	$42,100
$/1,000 Gal.	$ 3.41	$ 3.27	$ 3.07	$ 4.47	$ 4.64	$ 4.44

TABLE VIII - 17

STEAM STRIPPING

COST DATA

Description	Capital Cost, Dollars (57,600 GPD) Base x 0.1	(288,000 GPD) Base x 0.5	(576,000 GPD) Base Flow	1,152,000 GPD Base x 2.0
Process Equipment Steam Stripper with 20 trays, 4 ft. I.D. Feed rate = 200,000 lbs/hr (400 gpm)	$ 22,000	$ 63,000	$ 98,000	$ 154,000
Physical Plant 207% of equipment cost	46,000	130,000	203,000	318,000
Engineering and Construction 30% of the total equipment cost	20,000	58,000	90,000	142,000
Direct Plant Cost	88,000	251,000	391,000	614,000
Fixed Capital 120% of direct plant cost	106,000	301,000	469,000	737,000
Working Capital 15% of fixed capital	16,000	45,000	71,000	111,000
Total Capital Cost	$122,000	$346,000	$ 540,000	$ 848,000
	Annual Cost, Dollars/1,000 gal			
Steam $3/1,000 lbs. steam 0.1 lbs steam/lb feed	$ 2.50	$ 2.50	$ 2.50	$ 2.50
Steam for Feed Heating 70 °C to 100 °C 0.056 lbs steam/lb feed	1.40	1.40	1.40	1.40
Electricity $0.04/kwh	0.33	0.33	0.33	0.33
Labor $10/hr. Operating time = 8,000 hr/yr	4.20	0.84	0.42	0.21
Maintenance 3% of capital cost	0.18	0.10	0.08	0.06
Capital Recovery plus Return 16.3% of capital cost	1.05	0.60	0.47	0.37
Total Cost, $/1,000 GAL	$ 9.66/ 1,000 GAL	$ 5.77/ 1,000 GAL	$ 5.20/ 1,000 GAL	$ 4.87/ 1,000 GAL
$/Yr.	$203,000/Yr.	$607,000/Yr.	$1,093,000/Yr.	$2,048,000/Yr.

Note: Costs have been adjusted to January 1978 dollars.

Ref.: Contractor's Engineering Report Pharmaceutical Industry.

TABLE VIII-18

ACTIVATED SLUDGE SYSTEM

EQUIPMENT COST BASES AND ENERGY REQUIREMENTS

Description	Subcategory Base Case			
	A	B	C	D
Mean flow, gal/day	435,000	45,000	260,000	75,000
Detention Time, days	2.2	0.2	1.2	0.3
Aerators, hp	Four, 60	Two, 5	Four, 30	Two, 5
Nutrient Addition, lbs/day				
Ammonia	32	1.4	16	1.4
Phosphorous	6	0.3	3	0.3
Lime	30	-	17	-
Ferric Chloride	8	-	4.5	-
Clarifiers, Dia., ft	Two, 30	Two, 10	Two, 24	Two, 12
Sludge THickener Surface Area, ft2	28	-	20	-
Vacuum Filter Area, ft2	19	-	10	-
Energy Req., kwh/yr	1,625,000	104,000	845,000	111,000
Sludge Produced, lbs/day dry solids	130	6	85	8
Area Req., ft2	61,000	13,000	35,000	13,000

TABLE VIII-19

ACTIVATED SLUDGE SYSTEM

CAPITAL COSTS

Description	Cost, Dollars, for Subcategory Base Cases A	B	C	D
Activated Sludge Unit	$ 420,000	$ 12,000	$ 290,000	$ 34,000
Aeration	218,000	40,000	154,000	40,000
Nutrient Addition	13,000	1,000	7,000	1,000
Clarification	180,000	75,000	120,000	96,000
Sludge Thickening	33,000	-	24,000	-
Vacuum Filtration	142,000	-	132,000	-
Sludge Storage	-	18,000	-	18,000
Piping (installed)	151,000	22,000	108,000	28,000
Installed Cost	1,157,000	168,000	835,000	217,000
Engineering	174,000	25,000	125,000	33,000
Contingency	174,000	25,000	125,000	33,000
Total Capital Cost	$ 1,505,000	$ 218,000	$ 1,085,000	$ 283,000

TABLE VIII-20

ACTIVATED SLUDGE SYSTEM

TOTAL ANNUAL COSTS

Description	Cost, Dollars, for Subcategory Base Cases			
	A	B	C	D
Chemicals	$ 2,600	$ 200	$ 1,400	$ 200
Energy	65,000	4,200	33,800	4,400
Labor	110,000	80,000	110,000	80,000
Maintenance	45,200	6,500	32,600	8,500
Sludge Disposal	5,700	7,900	3,700	10,500
Capital Amortization	246,500	35,200	176,500	46,400
Total Annual Cost	$ 475,000	$ 134,000	$ 358,000	$ 150,000

TABLE VIII-21

ROTATING BIOLOGICAL CONTACTOR (RBC) SYSTEM

EQUIPMENT COST BASES AND ENERGY REQUIREMENTS

	Subcategory Base Cases			
Description	A	B	C	D
Mean Flow, gal/day	435,000	45,000	260,000	75,000
Number of RBC Units	Four	One	Three	One
Shaft Lengths, ft	20	10	20	20
Total RBC Surface Area, ft2	304,000	24,000	228,000	65,000
Energy Req., kwh/hr	130,000	13,000	98,000	33,000
Clarifiers, Dia., ft	Two, 30	Two, 10	Two, 24	Two, 12
Manpower Req., h/yr	2,000	2,000	2,000	2,000
Sludge Produced, lbs/day dry solids	220	20	130	40
Sludge Dewatering	Yes	No	Yes	No
Manpower Req., h/yr	1500	-	1500	-
Energy Req., kwh/yr	195,000	-	115,000	-
Area Req., ft2	30,000	2,500	20,000	4,000

TABLE VIII-22

ROTATING BIOLOGICAL CONTACTOR (RBC) SYSTEM

CAPITAL AND TOTAL ANNUAL COSTS

Description	Capital Costs ($) Subcategory Base Cases A	B	C	D
RBC Units, Steel Tankage, Insulated Covers	$ 205,000	$ 40,000	$ 155,000	$ 50,000
Clarifiers	120,000	50,000	80,000	64,000
Sludge Dewatering	96,000	-	84,000	-
Sludge Storage	-	8,000	-	12,000
Piping	42,000	10,000	32,000	13,000
Equipment Cost	463,000	108,000	351,000	139,000
Installation	232,000	54,000	176,000	70,000
Engineering	104,000	24,000	79,000	31,000
Total Capital Cost	$ 903,000	$ 210,000	$ 685,000	$ 271,000
	Annual Costs ($/yr)			
Energy	$ 13,000	$ 600	$ 8,500	$ 1,400
Labor	35,000	20,000	35,000	20,000
Maintenance	27,100	6,300	20,600	8,100
Sludge Disposal	9,600	5,300	5,700	10,500
Capital Amortization	147,300	34,800	112,200	44,000
Total Annual Cost	$ 232,000	$ 67,000	$ 182,000	$ 84,000

TABLE VIII-23

POLISHING POND

COST BASES

Description	Subcategory Base Cases A	B	C	D
Mean Flow, gal/day	435,000	45,000	260,000	75,000
Detention Time, days	5.5	3.3	5.0	4.0
Excavated Volume, yd3	15,000	1,000	8,000	2,000
Lined Area, ft²	40,000	3,300	22,000	5,700
Basin Width at Top, ft Square basin, 1:3 slope Freeboard = 1 ft Water depth = 8 ft Sludge depth = 1 ft	230	80	175	100
Manpower Req., h/yr	200	200	200	200
Area Req., ft²	62,000	10,000	40,000	14,000

TABLE VIII-24

POLISHING POND

CAPITAL AND TOTAL ANNUAL COSTS

Description	Capital Costs ($) Subcategory Base Cases A	B	C	D
Excavation, Grading, Compaction	$ 135,000	$ 9,000	$ 72,000	$ 18,000
Impervious Liner (installed)	26,000	2,200	14,300	3,700
Piping (installed)	24,000	1,700	12,900	3,300
Installed Cost	185,000	12,900	99,200	25,000
Engineering	28,000	2,000	14,900	4,000
Contingency	28,000	2,100	14,900	4,000
Total Capital Cost	$ 241,000	$ 17,000	$ 129,000	$ 33,000
	Annual Costs ($/yr)			
Labor	$ 2,000	$ 2,000	$ 2,000	$ 2,000
Maintenance	7,200	500	3,900	1,000
Capital Amortization	38,800	2,500	21,100	5,000
Total Annual Cost	$ 48,000	$ 5,000	$ 27,000	$ 8,000

TABLE VIII-25

ACTIVATED SLUDGE SYSTEM

WITH FILTRATION

EQUIPMENT COST BASES AND ENERGY REQUIREMENTS

Description	Subcategory Base Cases A	B	C	D
Mean Flow, gal/day	435,000	45,000	260,000	75,000
Detention Time, days	8	1	5.5	1
Aerators, hp	Six, 125	Two, 7.5	Four, 75	Two, 7.5
Nutrient Addition, lbs/day				
Ammonia	32	1.4	16	1.4
Phosphorous	6	0.3	3	0.3
Lime		-		-
Ferric Chloride		-		-
Clarifiers, Dia., ft	Two, 30	Two, 10	Two, 24	Two, 12
Number of Dual Media Filtration Units	Two	Two	Two	Two
Filter Diameters, ft	10	3	8	4
Sludge THickener Surface Area, ft ^{2}	20	-	20	-
Vacuum Filter Area, ft2	10	-	10	-
Energy Req., kwh/yr	5,600,000	130,000	2,340,000	140,000
Sludge Produced, lbs/day dry solids	90	20	60	20
Area Req., ft^2	165,000	17,000	74,000	17,000

TABLE VIII-26

ACTIVATED SLUDGE SYSTEM

WITH FILTRATION

CAPITAL COSTS

Description	Cost, Dollars, for Subcategory Base Cases			
	A	B	C	D
Activated Sludge Unit	$ 778,000	$ 63,000	$ 508,000	$ 86,000
Aeration	465,000	44,000	245,000	44,000
Nutrient Addition	13,000	1,000	7,000	1,000
Clarification	180,000	75,000	120,000	96,000
Dual Media Filtration	180,000	54,000	120,000	63,000
Sludge Thickening	24,000	-	24,000	-
Vacuum Filtration	132,000	-	132,000	-
Sludge Storage	-	44,000	-	44,000
Piping (installed)	266,000	43,000	174,000	50,000
Installed Cost	2,038,000	324,000	1,330,000	384,000
Engineering	306,000	48,000	200,000	58,000
Contingency	306,000	48,000	200,000	58,000
Total Capital Cost	$ 2,650,000	$ 420,000	$ 1,730,000	$ 500,000

TABLE VIII-27

ACTIVATED SLUDGE SYSTEM

WITH FILTRATION

TOTAL ANNUAL COSTS

Description	Cost, Dollars, for Subcategory Base Cases			
	A	B	C	D
Chemicals	$ 2,500	$ 200	$ 1,200	$ 200
Energy	224,000	5,200	93,600	5,600
Labor	130,000	100,000	130,000	100,000
Maintenance	79,500	12,600	51,900	15,000
Sludge Disposal	4,000	26,300	2,600	26,300
Capital Recovery plus Return	432,000	68,700	280,700	81,900
Total Annual Cost	$ 872,000	$ 213,000	$ 560,000	$ 229,000

TABLE VIII-28

ROTATING BIOLOGICAL CONTACTOR (RBC) SYSTEM

WITH FILTRATION

EQUIPMENT COST BASES AND ENERGY REQUIREMENTS

	Subcategory Base Cases			
Description	A	B	C	D
Mean Flow, gal/day	435,000	45,000	260,000	75,000
Number of RBC Units	Four	One	Four	One
Shaft Lengths, ft	25	20	20	20
Total RBC Surface Area, ft²	442,000	65,000	364,000	65,000
Energy Req., kwh/hr	260,000	33,000	195,000	33,000
Clarifiers, Dia., ft	Two, 30	Two, 10	Two, 24	Two, 12
Number of Dual Media Filtration Units	Two	Two	Two	Two
Filter Diameters, ft	10	3	8	4
Manpower Req., h/yr	4,500	4,500	4,500	4,500
Sludge Produced, lbs/day dry solids	300	30	180	50
Sludge Dewatering	Yes	No	Yes	No
Manpower Req., h/yr	1500	-	1500	-
Energy Req., kwh/yr	265,000	-	160,000	-
Area Req., ft²	31,000	3,000	21,000	4,500

TABLE VIII-29

ROTATING BIOLOGICAL CONTACTOR (REC) SYSTEM
WITH FILTRATION

CAPITAL AND TOTAL ANNUAL COSTS

Description	Capital Costs ($) Subcategory Base Cases A	B	C	D
RBC Units, Steel Tankage, Insulated Covers	$ 235,000	$ 50,000	$ 205,000	$ 50,000
Clarifiers	120,000	50,000	80,000	64,000
Filtration Units	120,000	36,000	80,000	42,000
Sludge Dewatering	108,000	-	92,000	-
Sludge Storage	-	12,000	-	18,000
Equipment Cost	641,000	163,000	503,000	191,000
Installation	321,000	82,000	251,000	96,000
Engineering	144,000	37,000	113,000	43,000
Total Capital Cost	$ 1,250,000	$ 319,000	$ 980,000	$ 373,000
	Annual Costs ($/yr)			
Energy	$ 21,000	$ 1,400	$ 14,200	$ 1,400
Labor	60,000	45,000	60,000	45,000
Maintenance	37,400	9,600	29,400	11,200
Sludge Disposal	13,100	7,900	7,900	13,100
Capital Amortization	203,500	52,100	159,500	61,300
Total Annual Cost	$ 335,000	$ 116,000	$ 271,000	$ 132,000
Number of				

TABLE VIII-30

WASTEWATER HAULING/TREATMENT COSTS

Description	Annual Cost, $					
	50 Miles Round Trip			200 Miles Round Trip		
	1000GPD	2000GPD	3000GPD	1000GPD	2000GPD	3000GPD
Tank Trailer Lease(1)	9,000	9,000	9,000	9,000	9,000	9,000
Hauling Charges(2)	17,000	35,000	52,000	29,000	57,000	86,000
Extra Hauling Charges(3)	5,000	8,000	11,000	5,000	8,000	11,000
Annual Hauling Cost	31,000	52,000	72,000	43,000	74,000	106,000
Capital Amortization(4)	5,000	5,000	5,000	5,000	5,000	5,000
Total Annual Hauling Cost	36,000	57,000	77,000	48,000	79,000	111,000
Treatment Cost(5)	5,000	10,000	15,000	5,000	10,000	15,000
Total Annual Cost	41,000	67,000	92,000	53,000	89,000	126,000
$/1,000 Gal	112	92	84	145	122	115

(1) Long Term lease for 6,000 gallon trailer with insulation and heating facilities.

(2) Based on New Jersey hauling rates weighted for inter- and intrastate, 50 mi. round trip - $.57/100 lb. and 200 mi. round trip - $.94/100 lb.

(3) Extra charges for dead head loads, truck pump rental, driver detention time, and other misc. charges.

(4) 20 year and 15% amortization of loading facilities and tank capital cost of $25,000.

(5) Based on average D subcategory loading and POTW treatment cost at $1.00-1.50/lb of BOD removed.

TABLE VIII-31
ANALYTICAL COSTS FOR MONITORING PRIORITY POLLUTANTS

	METHOD	COST PER ANALYSIS* - RANGE $	COST PER ANALYSIS* WEIGHTED AVG. $	COST PER SAMPLE MONITORED** $	ANNUAL COSTS PER OUTFALL OR OUTFALL/COMPOSITE: DAILY SAMPLE $/YR	WEEKLY SAMPLE $/YR	3-DAY SERIES EACH MONTH $/YR	MONTHLY SAMPLE $/Yr
VOA (5)	GC or HPLC	75-105	90	90				
	GC/MS	125-185	160	16				
Cyanide	Colormetric	25-50	27	37				
Sub-total				143	52,200	7,400	5,100	1,700
Metals (5)	ICP	10-19 (per element)	11	55				
	AA	15-25 (per element)	17	—				
Total with Metals				198	72,300	10,300	7,100	2,400

* Costs from contracting laboratory contacts, adjusted for geographical distribution of industry.

** Bases
- Assumes one screening/confirmation GC/MS required for every ten samples.
- Typical for five organics and five metals.

*** If outfalls are composited each composite counts as one outfall analysis.

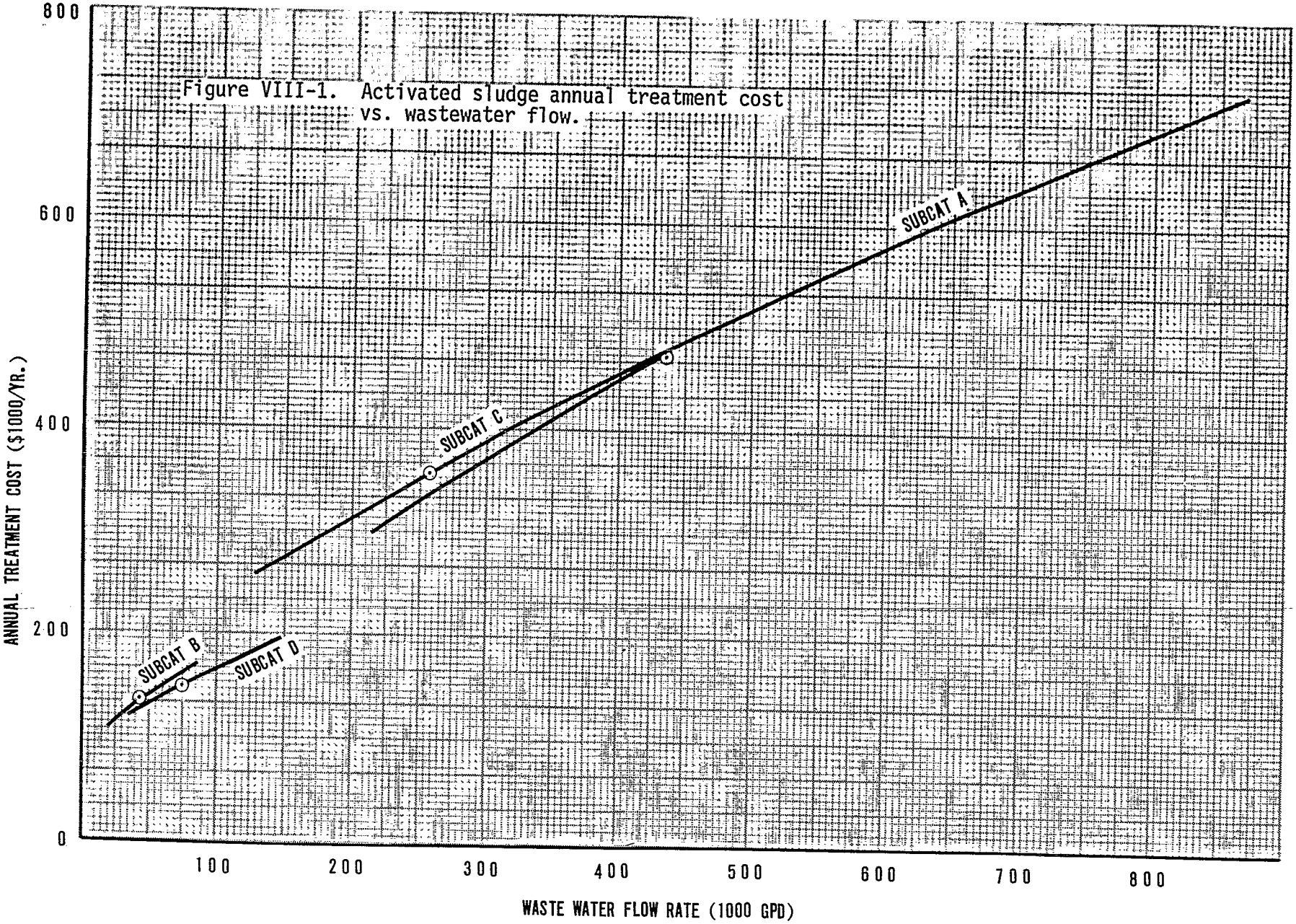


Figure VIII-1. Activated sludge annual treatment cost vs. wastewater flow.

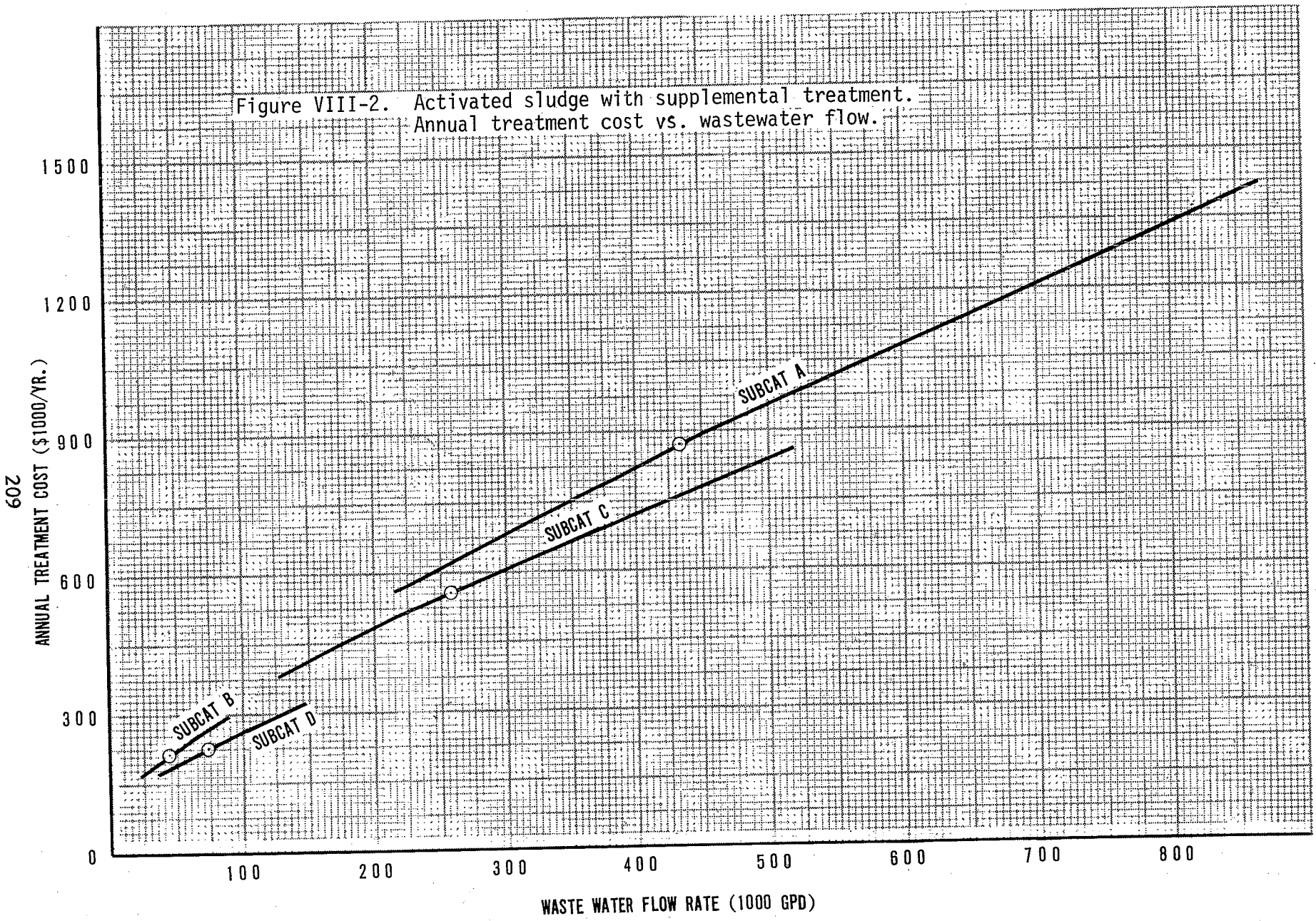
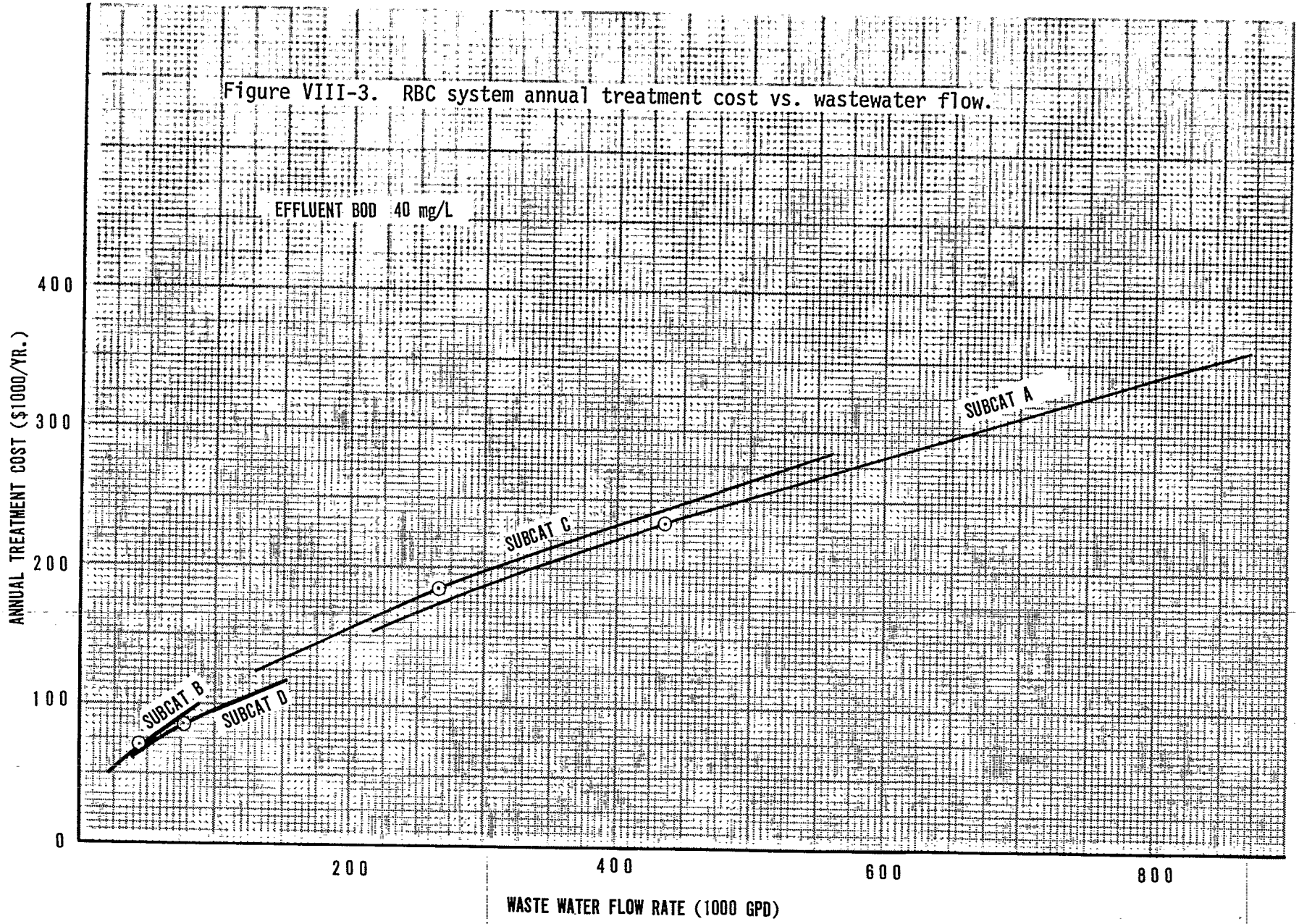


Figure VIII-2. Activated sludge with supplemental treatment.
Annual treatment cost vs. wastewater flow.
ANNUAL TREATMENT COST ($1000/YR.)
1500
1200
900
600
300
0
100
200
300
400
500
600
700
800
WASTE WATER FLOW RATE (1000 GPD)
SUBCAT A
SUBCAT C
SUBCAT B
SUBCAT D

Figure VIII-3. RBC system annual treatment cost vs. wastewater flow.



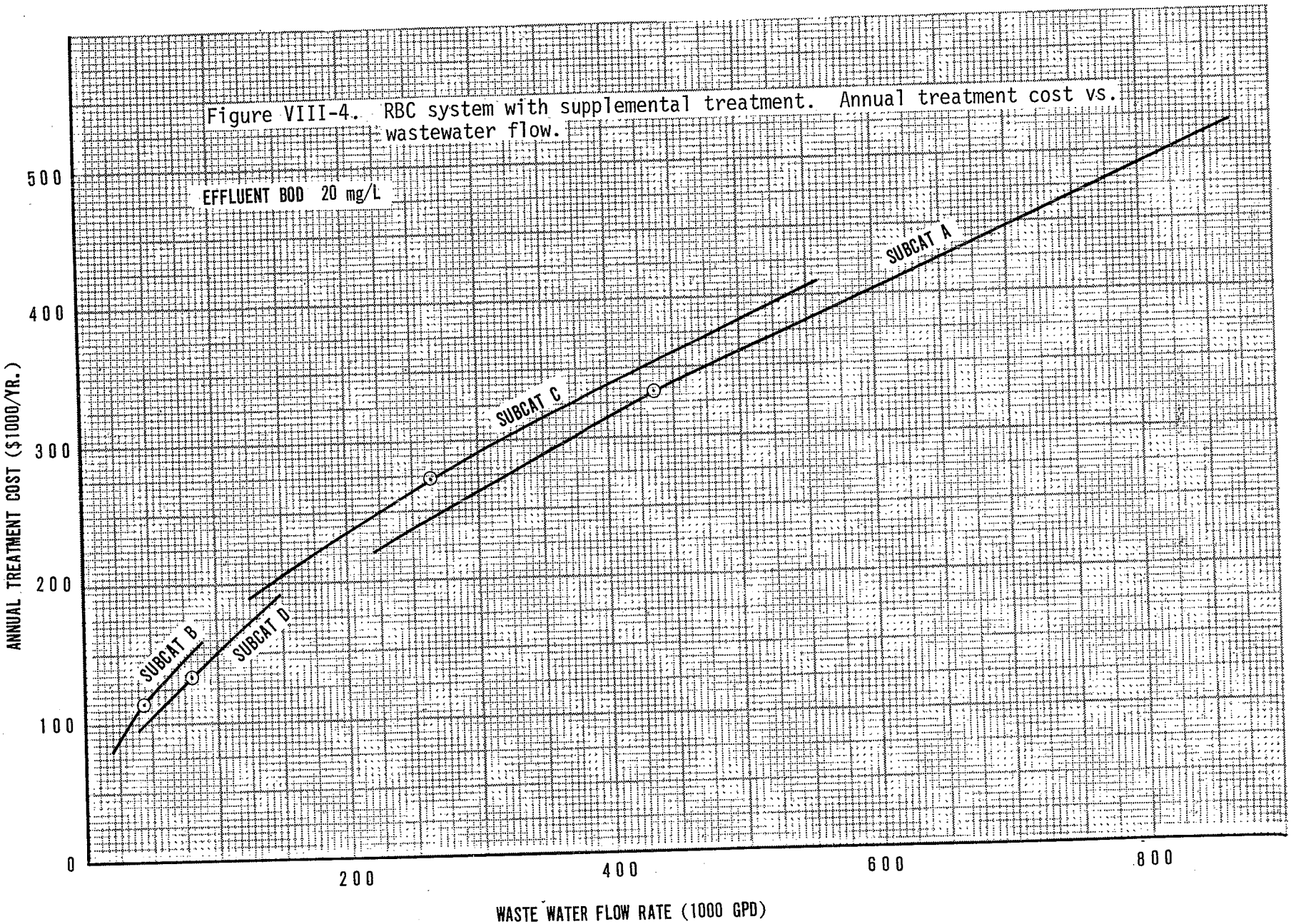


Figure VIII-4. RBC system with supplemental treatment. Annual treatment cost vs. wastewater flow.

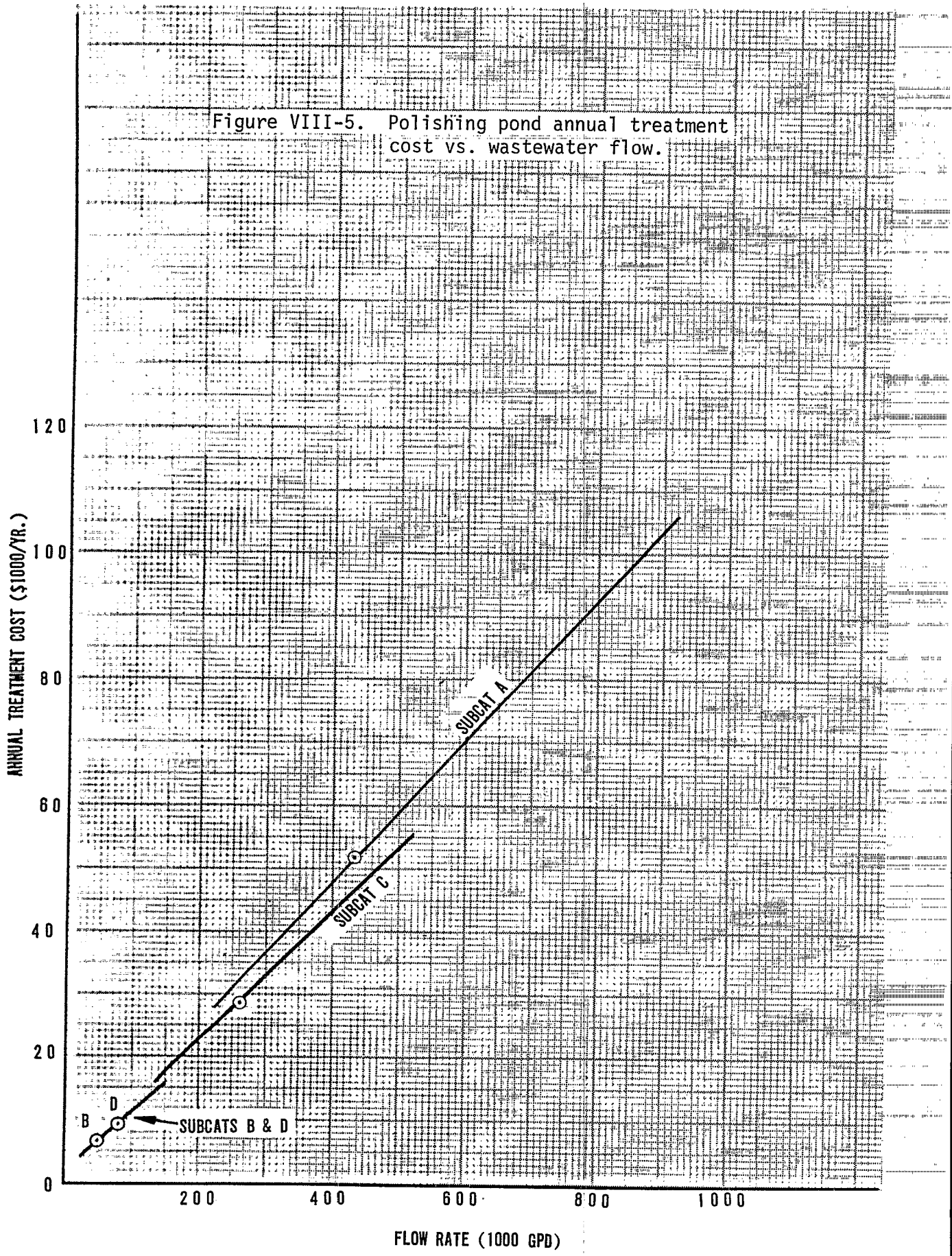


Figure VIII-5. Polishing pond annual treatment cost vs. wastewater flow.

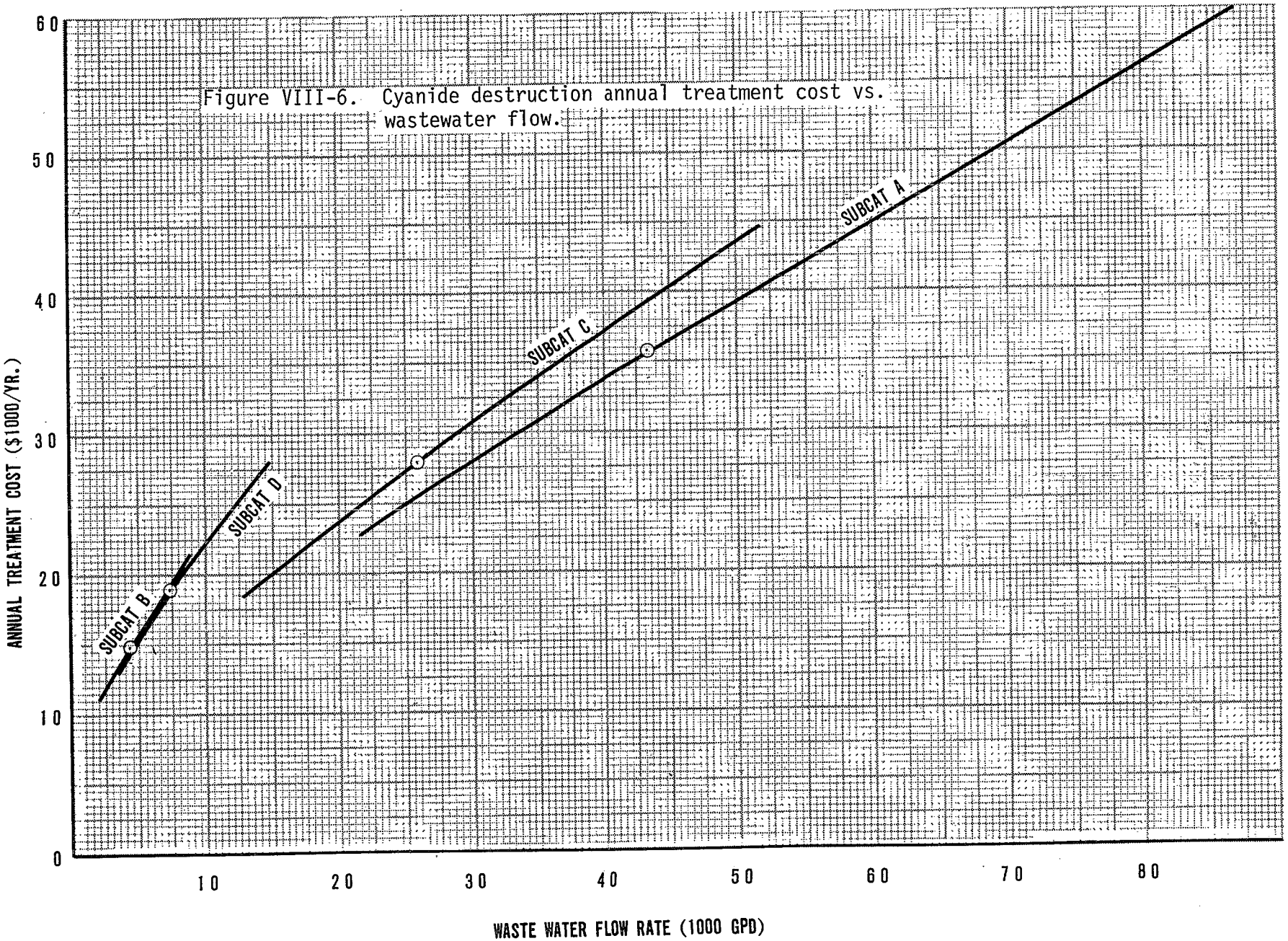


Figure VIII-6. Cyanide destruction annual treatment cost vs. wastewater flow.

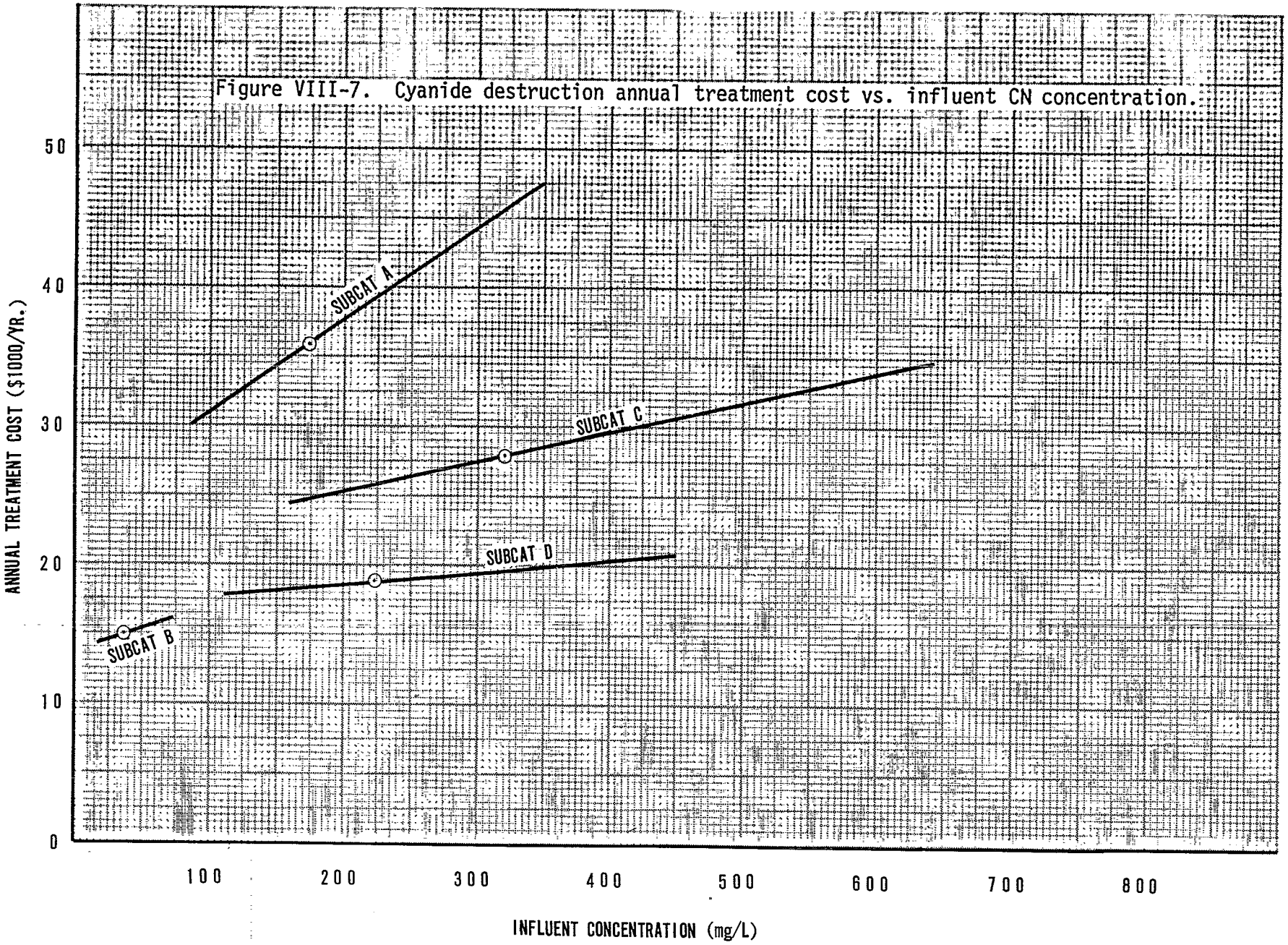


Figure VIII-7. Cyanide destruction annual treatment cost vs. influent CN concentration.

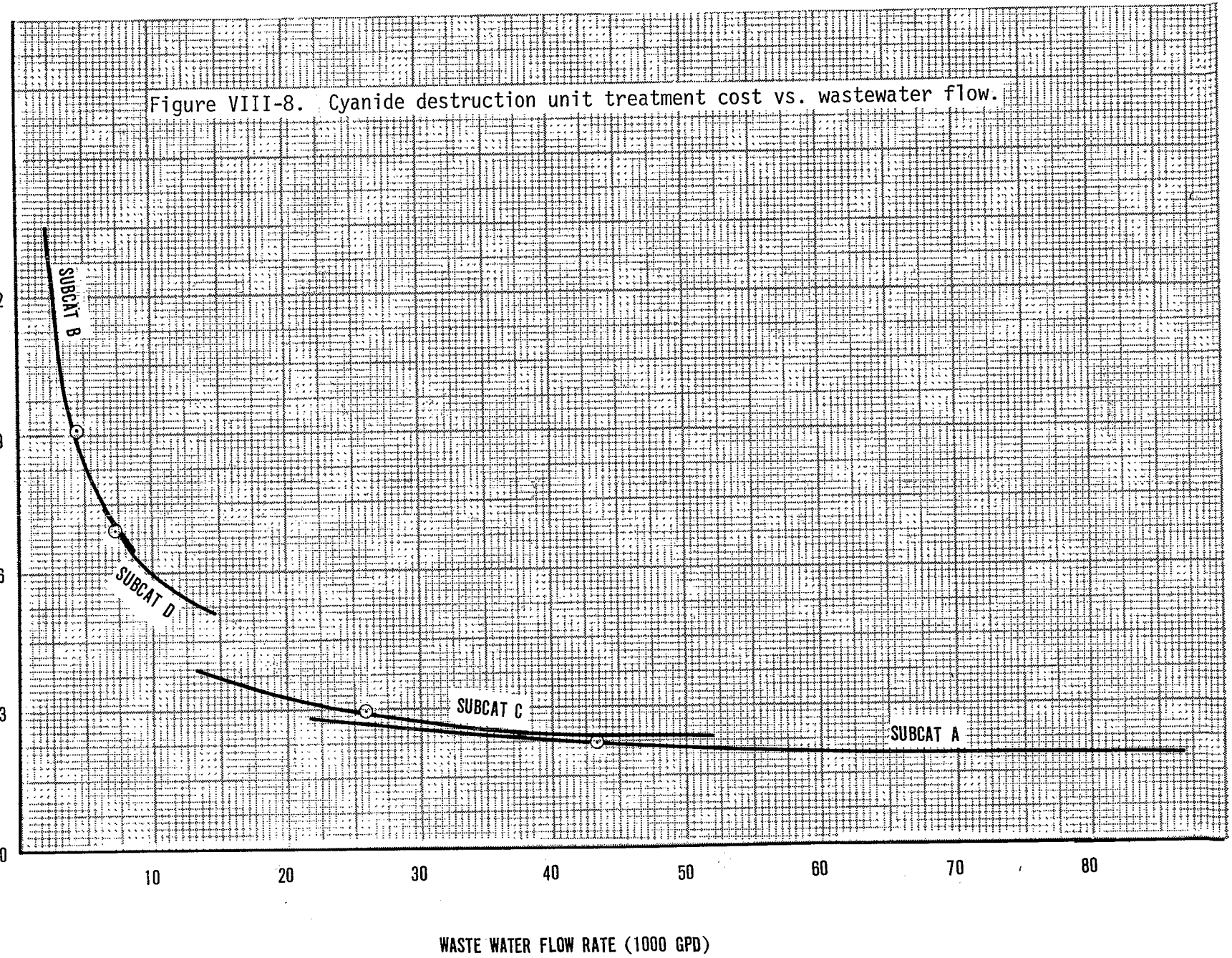


Figure VIII-8. Cyanide destruction unit treatment cost vs. wastewater flow.
UNIT TREATMENT COST (DOLLARS/1000 GAL.)
15
12
9
6
3
0
SUBCAT B
SUBCAT D
SUBCAT C
SUBCAT A
10
20
30
40
50
60
70
80
WASTE WATER FLOW RATE (1000 GPD)

Figure VIII-9. Cyanide destruction unit treatment cost vs. influent CN concentration.

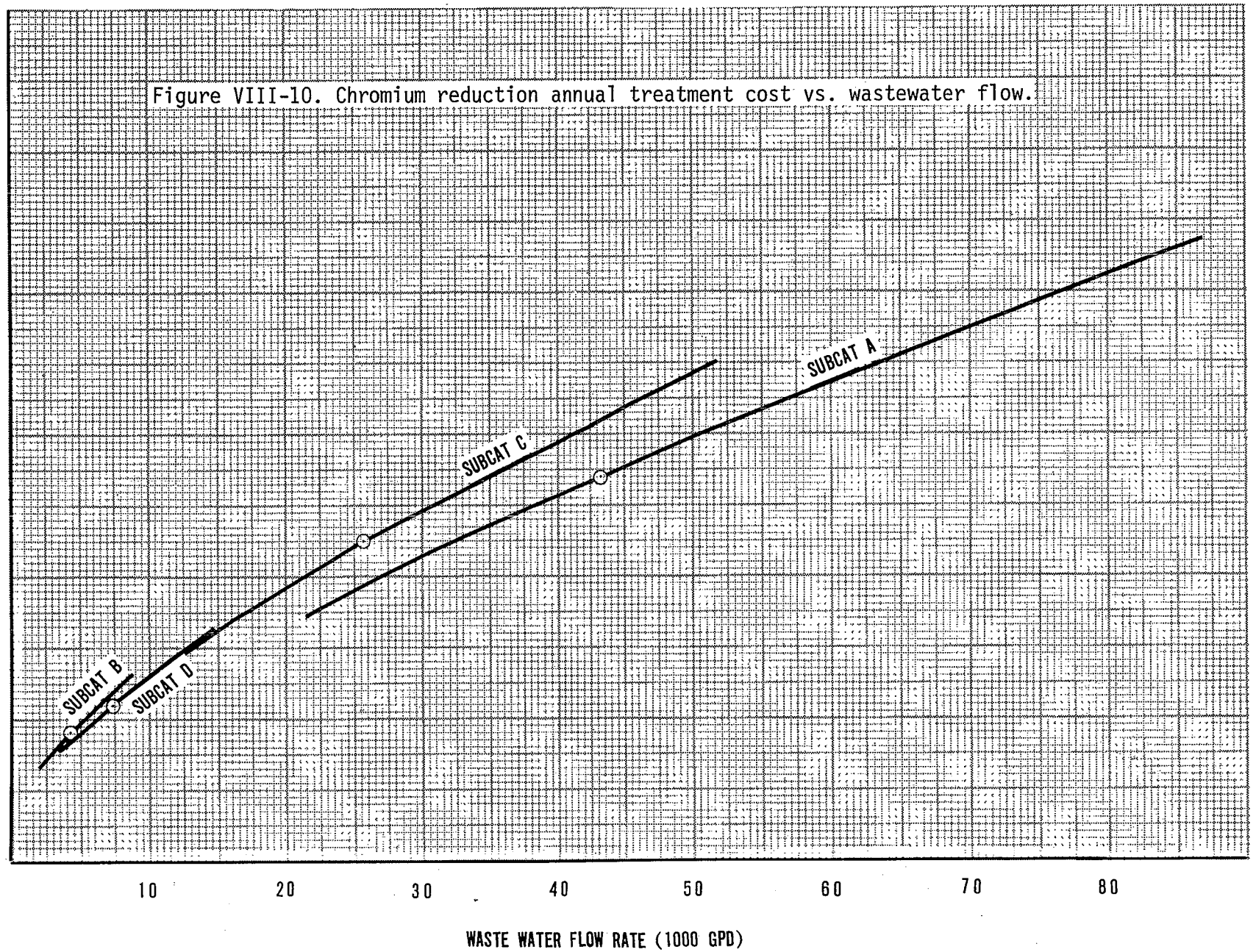


Figure VIII-10. Chromium reduction annual treatment cost vs. wastewater flow.

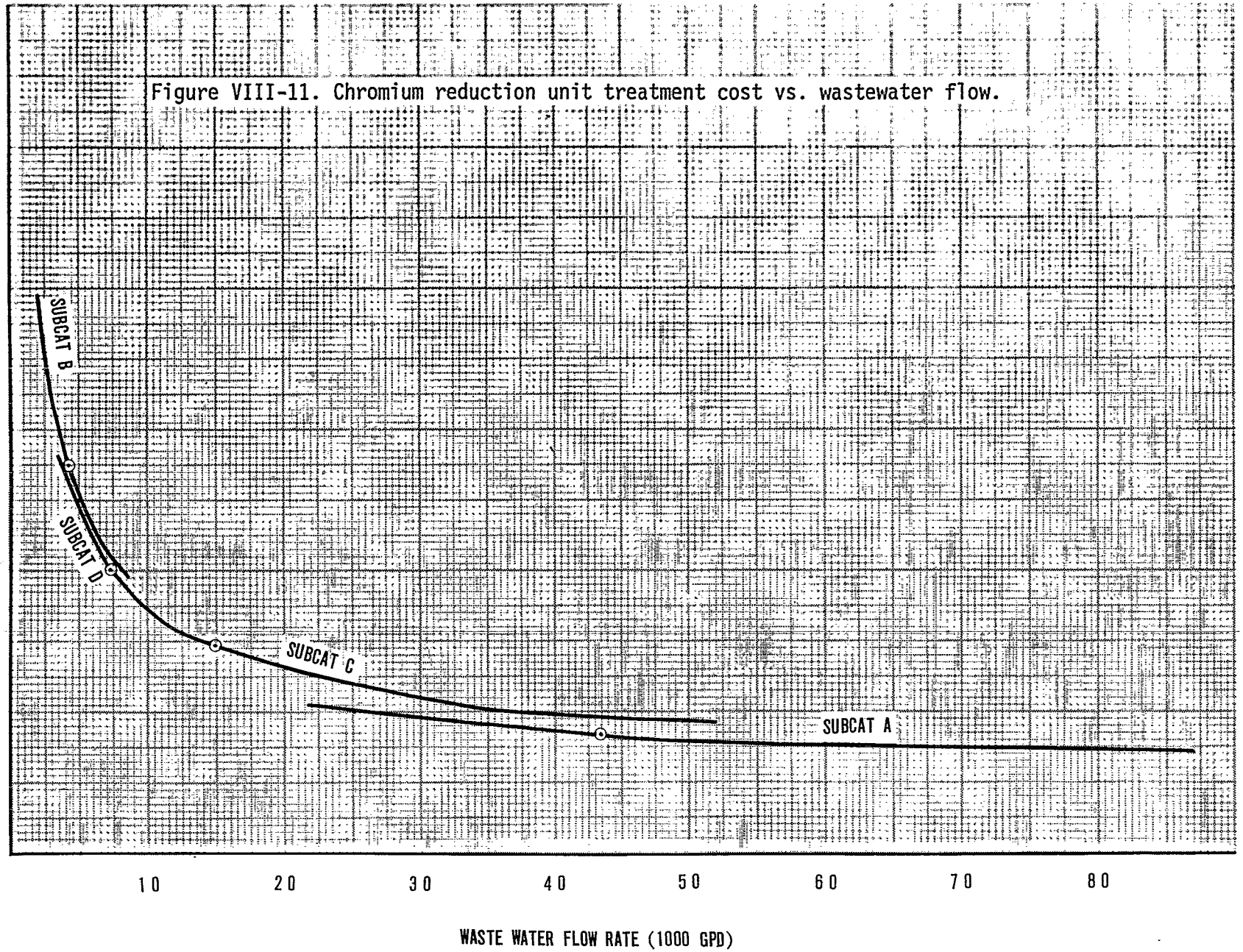


Figure VIII-11. Chromium reduction unit treatment cost vs. wastewater flow.

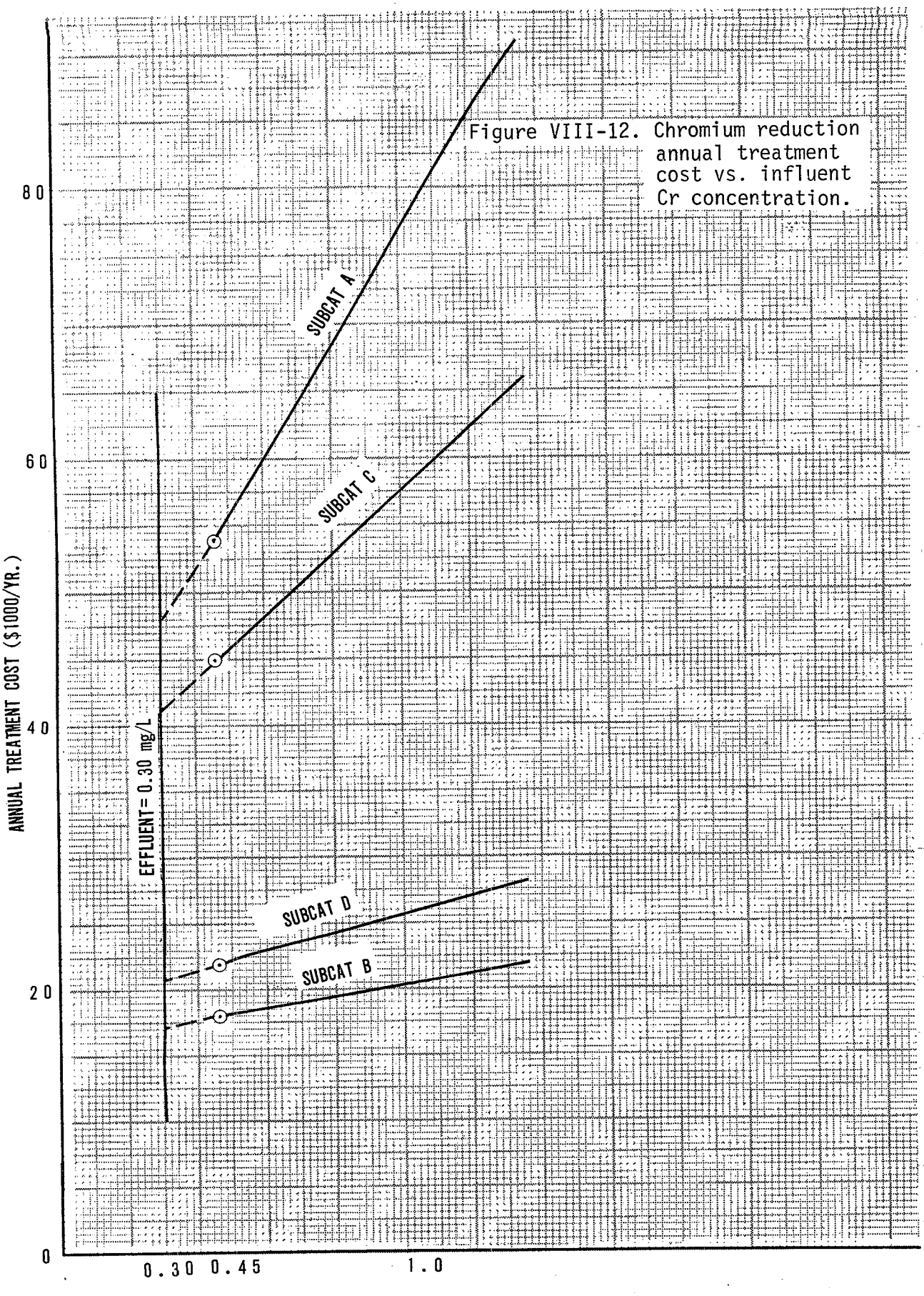


Figure VIII-12. Chromium reduction annual treatment cost vs. influent Cr concentration.

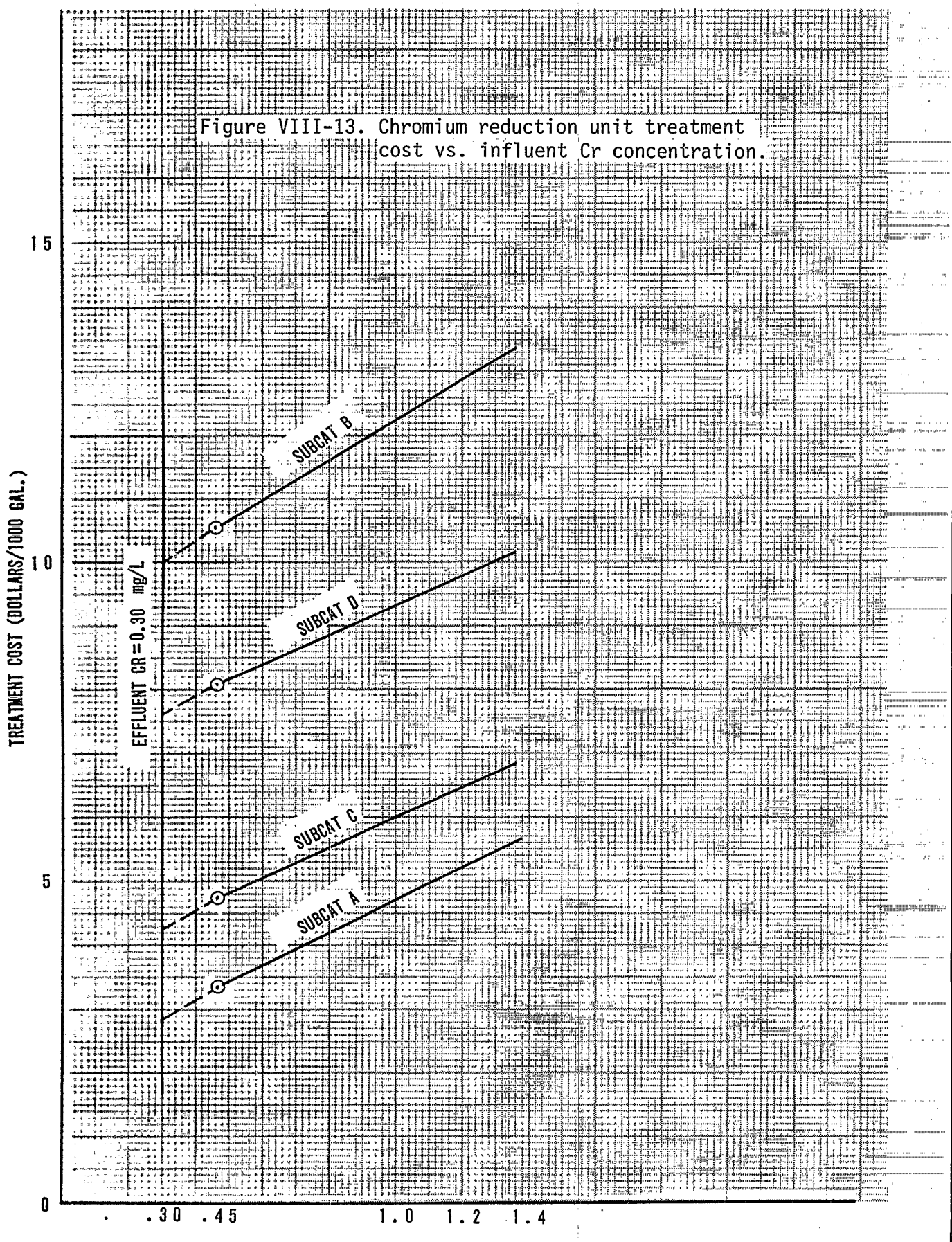


Figure VIII-13. Chromium reduction unit treatment cost vs. influent Cr concentration.

Figure VIII-14. Chromium reduction annual treatment cost vs. effluent Cr concentration.

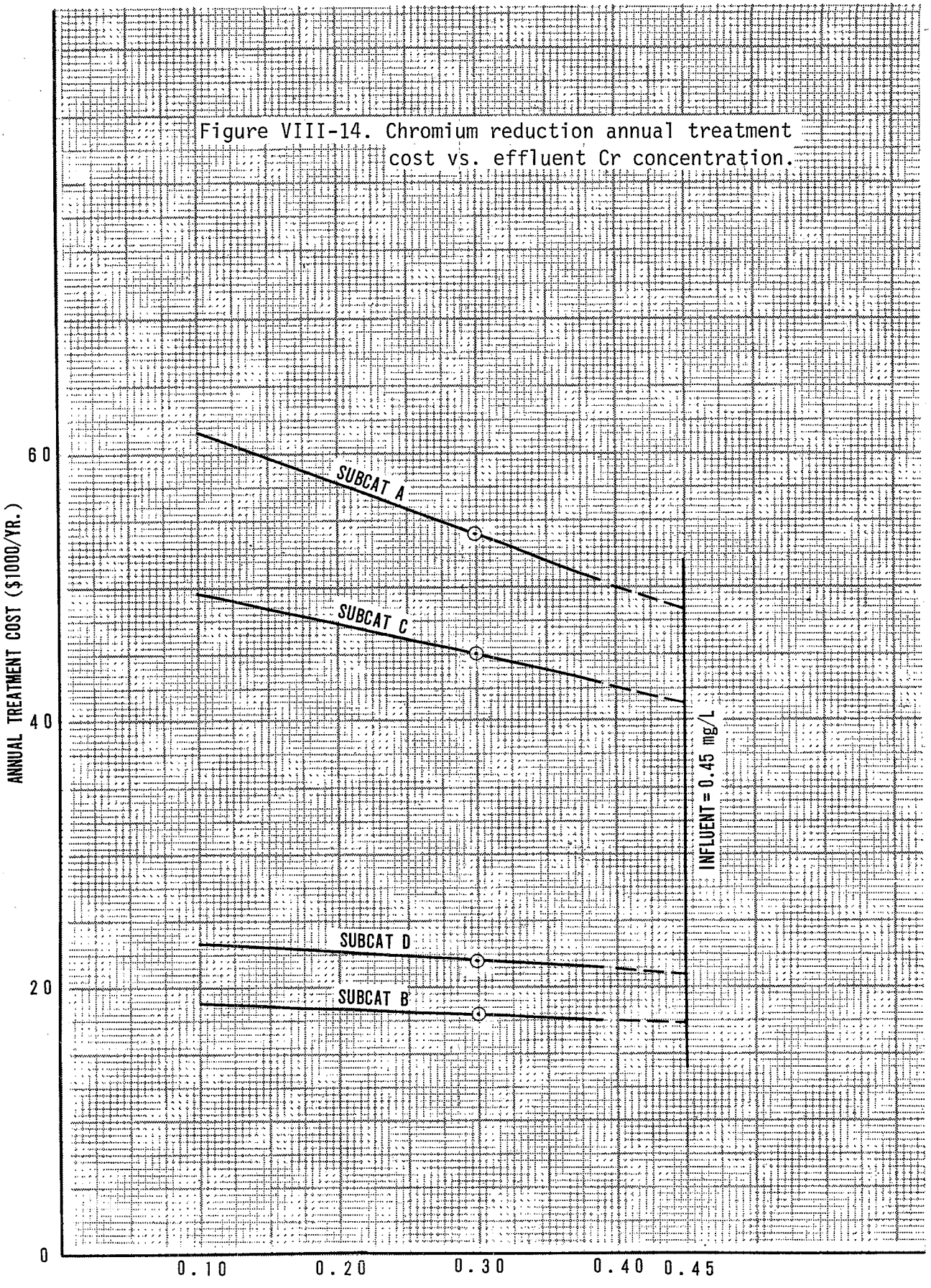
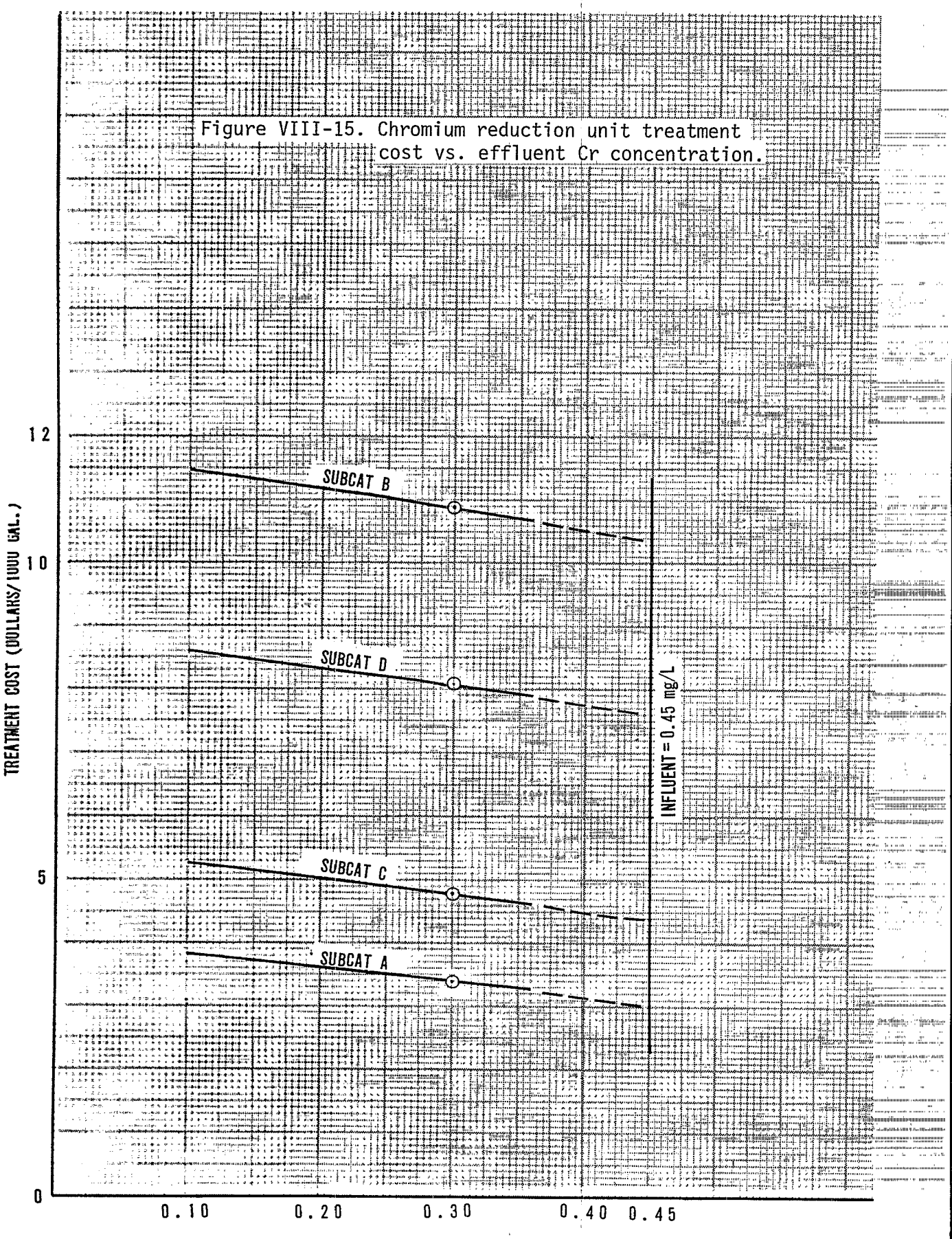


Figure VIII-15. Chromium reduction unit treatment cost vs. effluent Cr concentration.



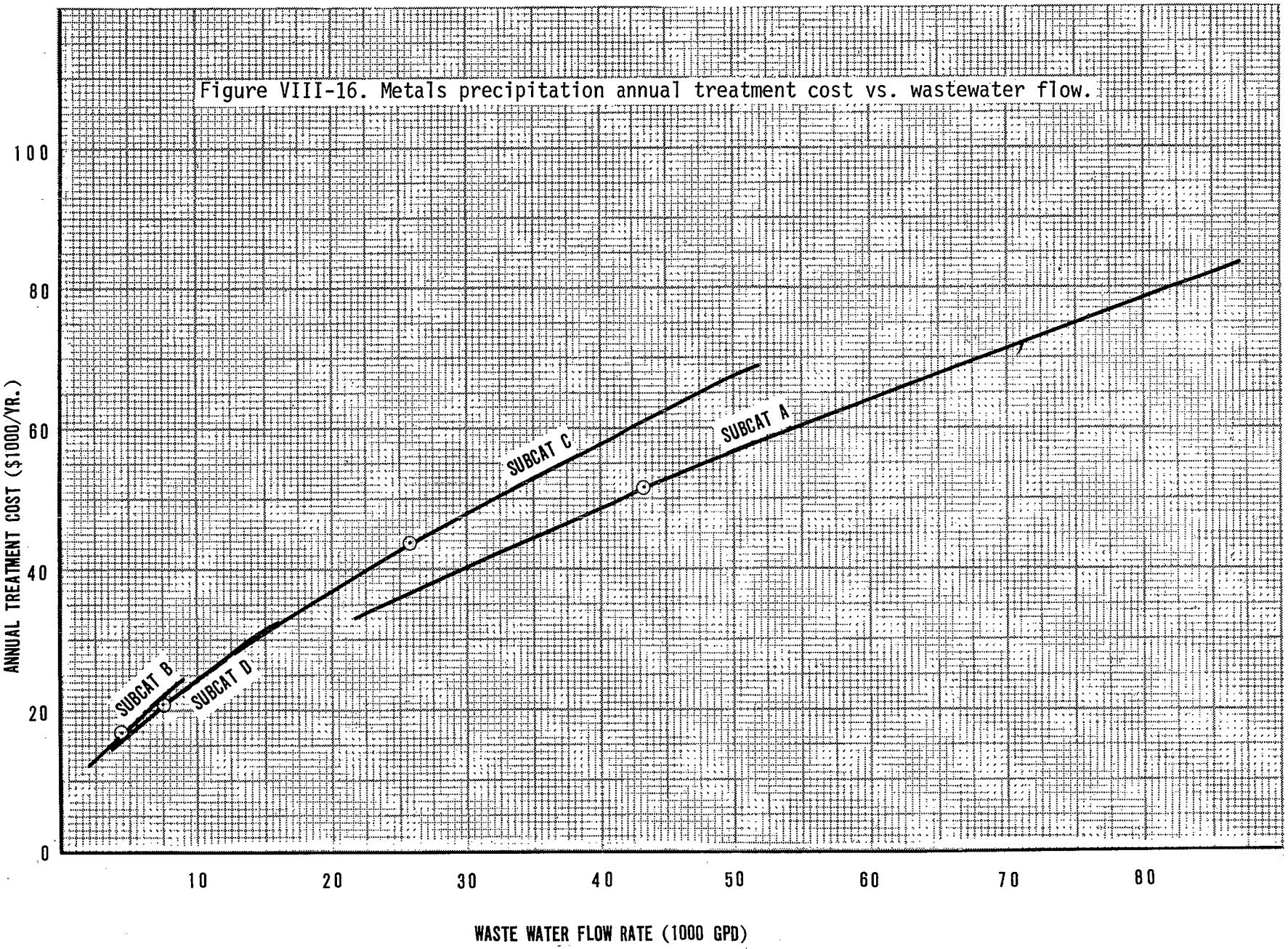


Figure VIII-16. Metals precipitation annual treatment cost vs. wastewater flow.

Figure VIII-17. Metals precipitation unit treatment cost vs. wastewater flow.

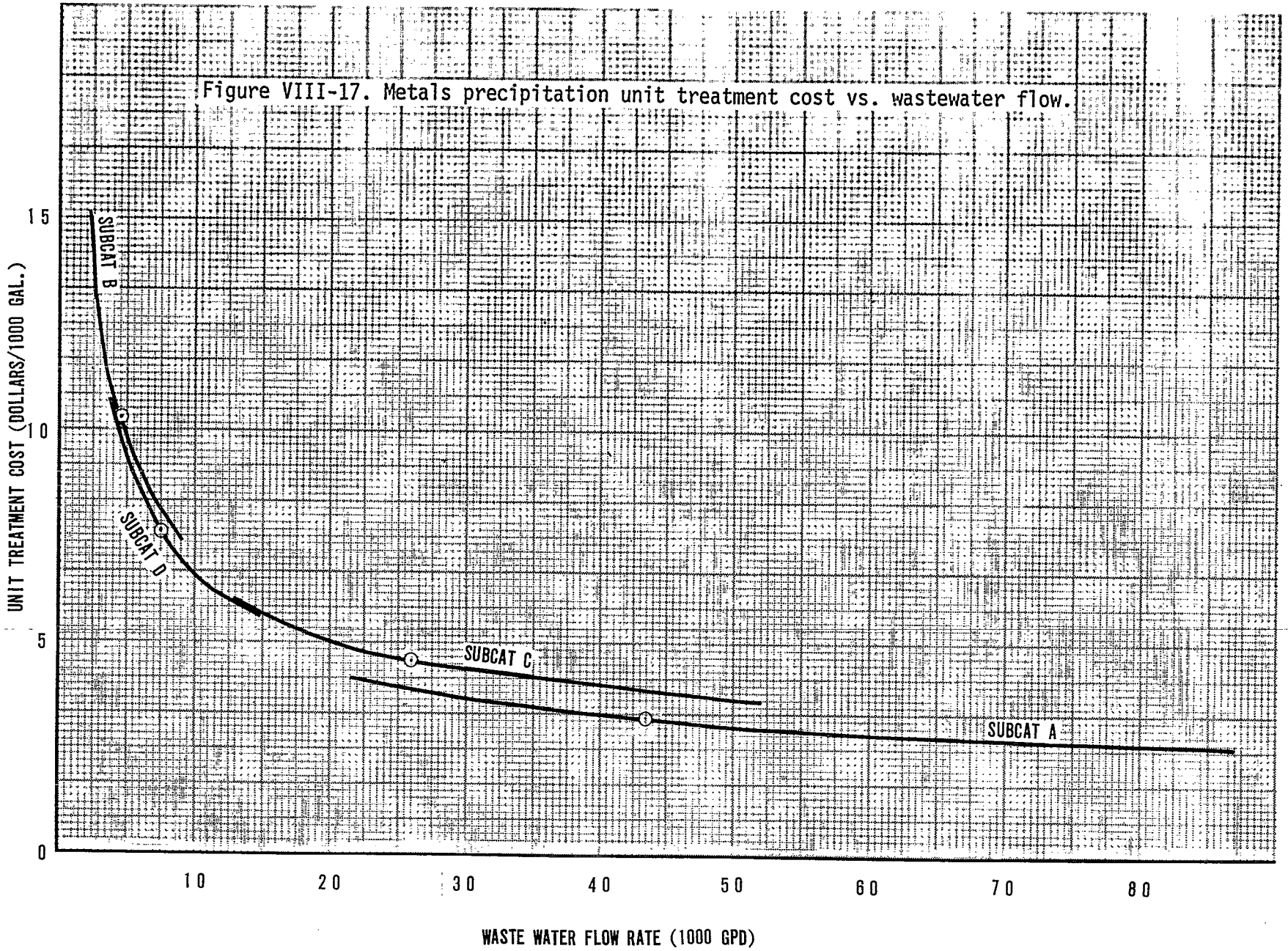


Figure VIII-18. Metals precipitation annual treatment cost vs. influent metals concentration.

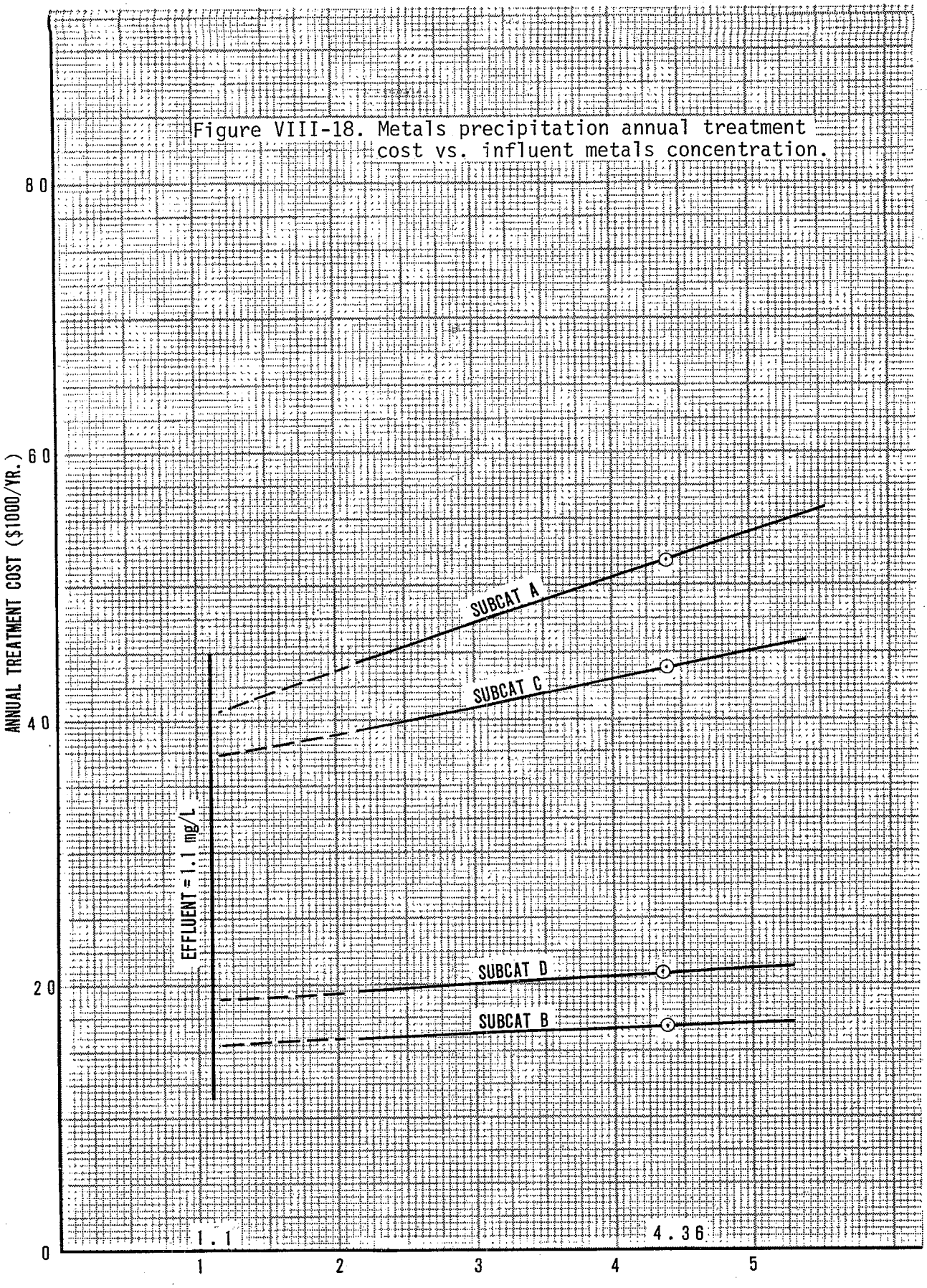


Figure VIII-19. Metals precipitation unit treatment cost vs. influent concentration.

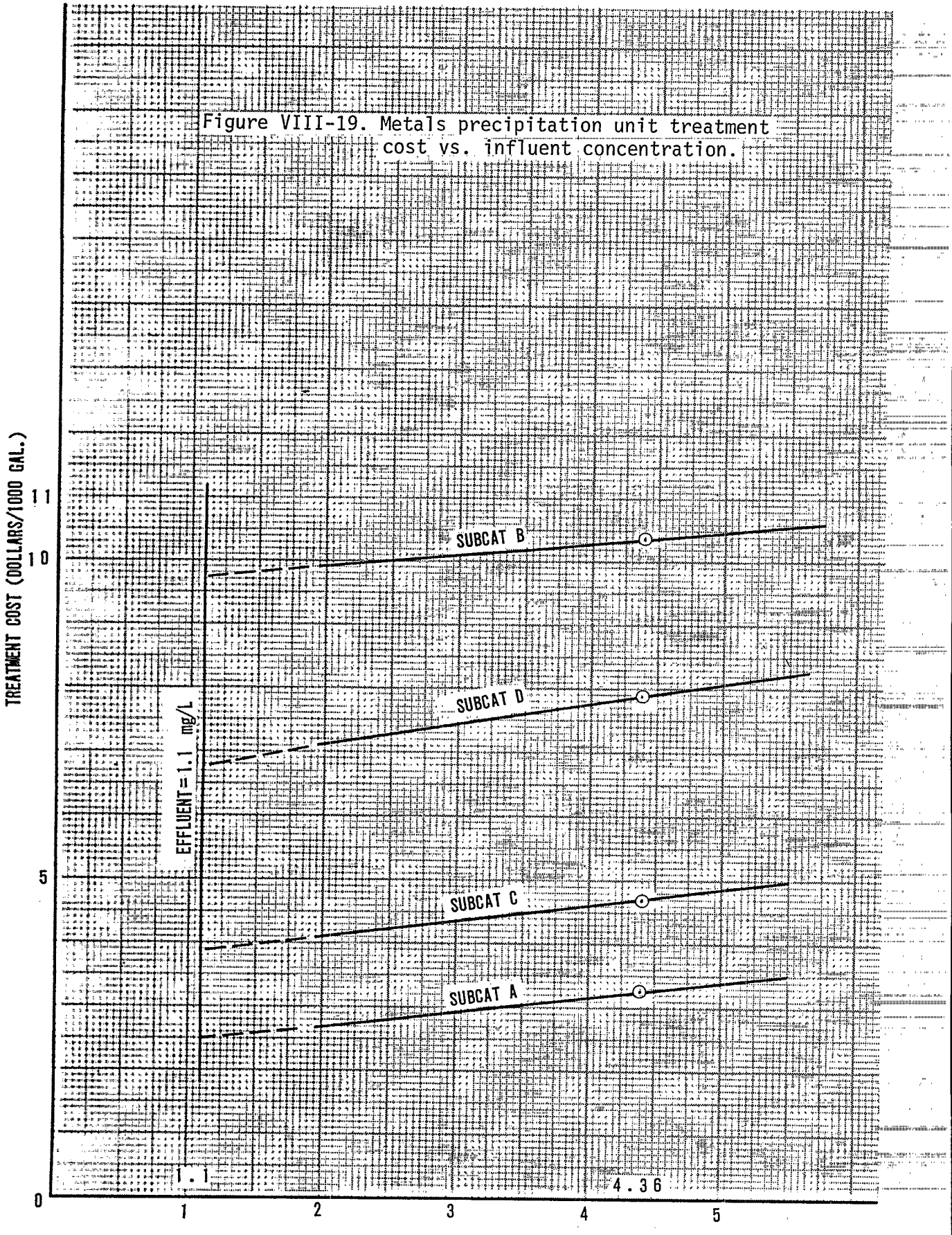


Figure VIII-20. Metals precipitation annual treatment cost vs. effluent metals concentration.

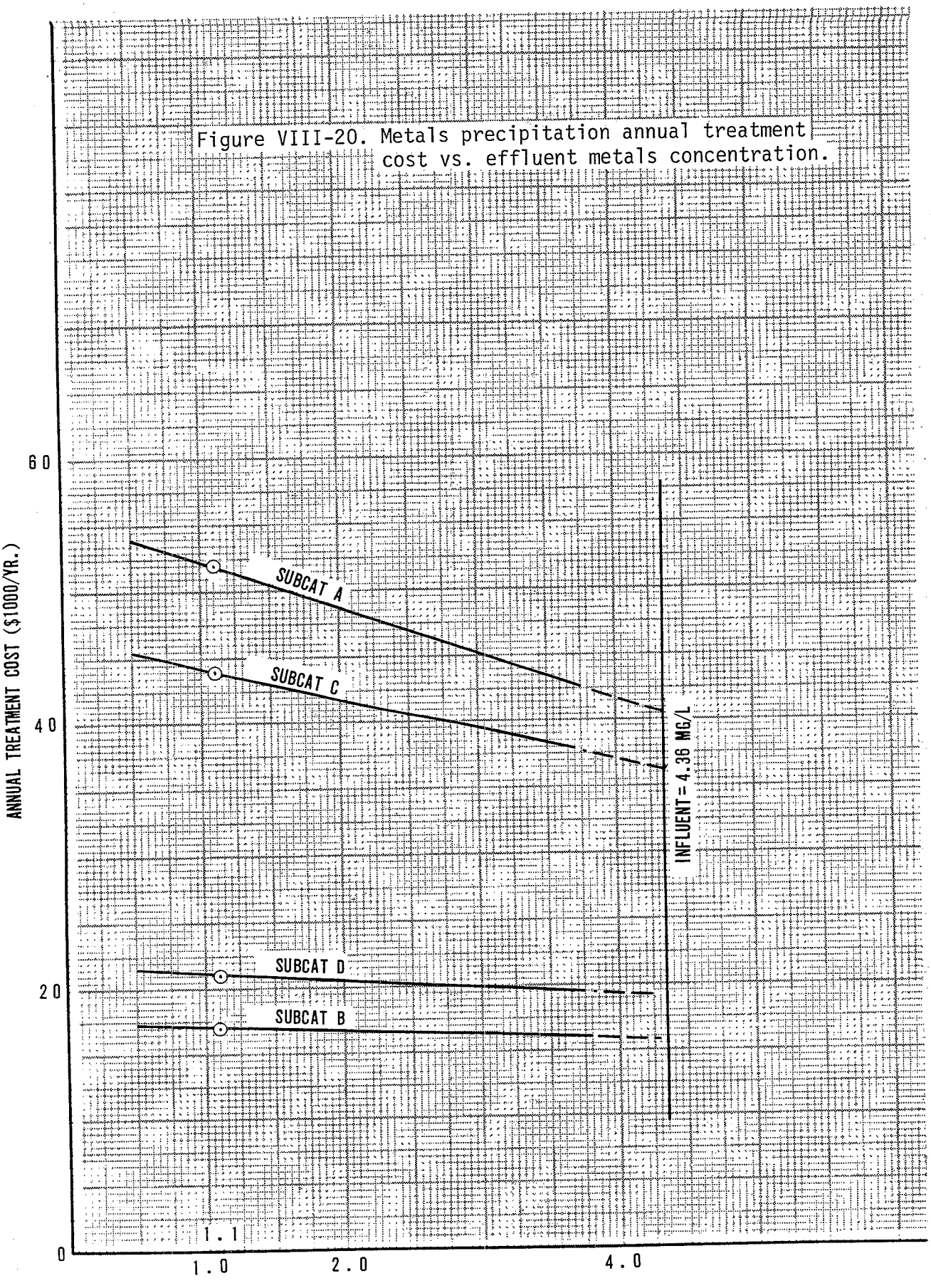


Figure VIII-21. Metals precipitation unit treatment cost vs. effluent metals concentration.

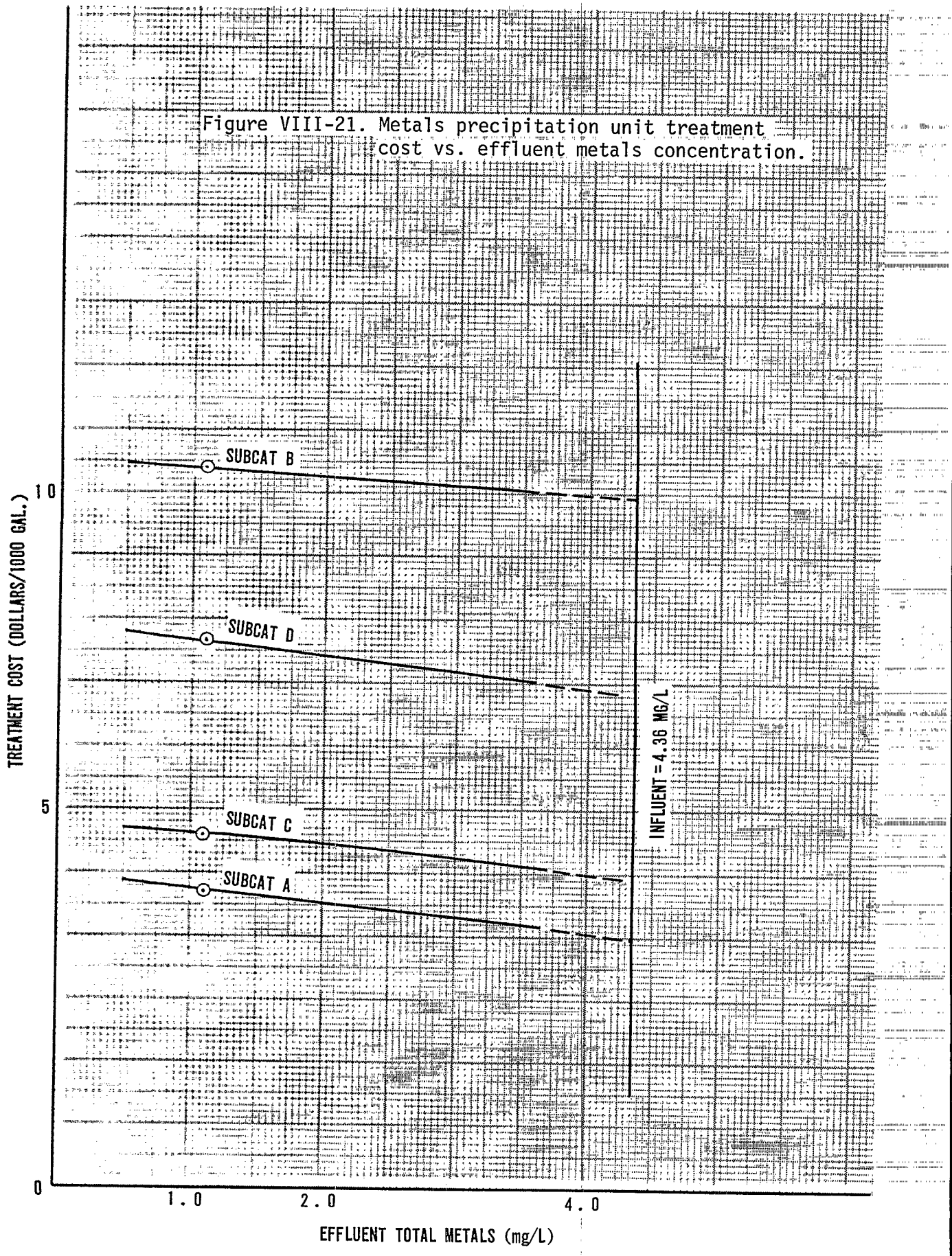
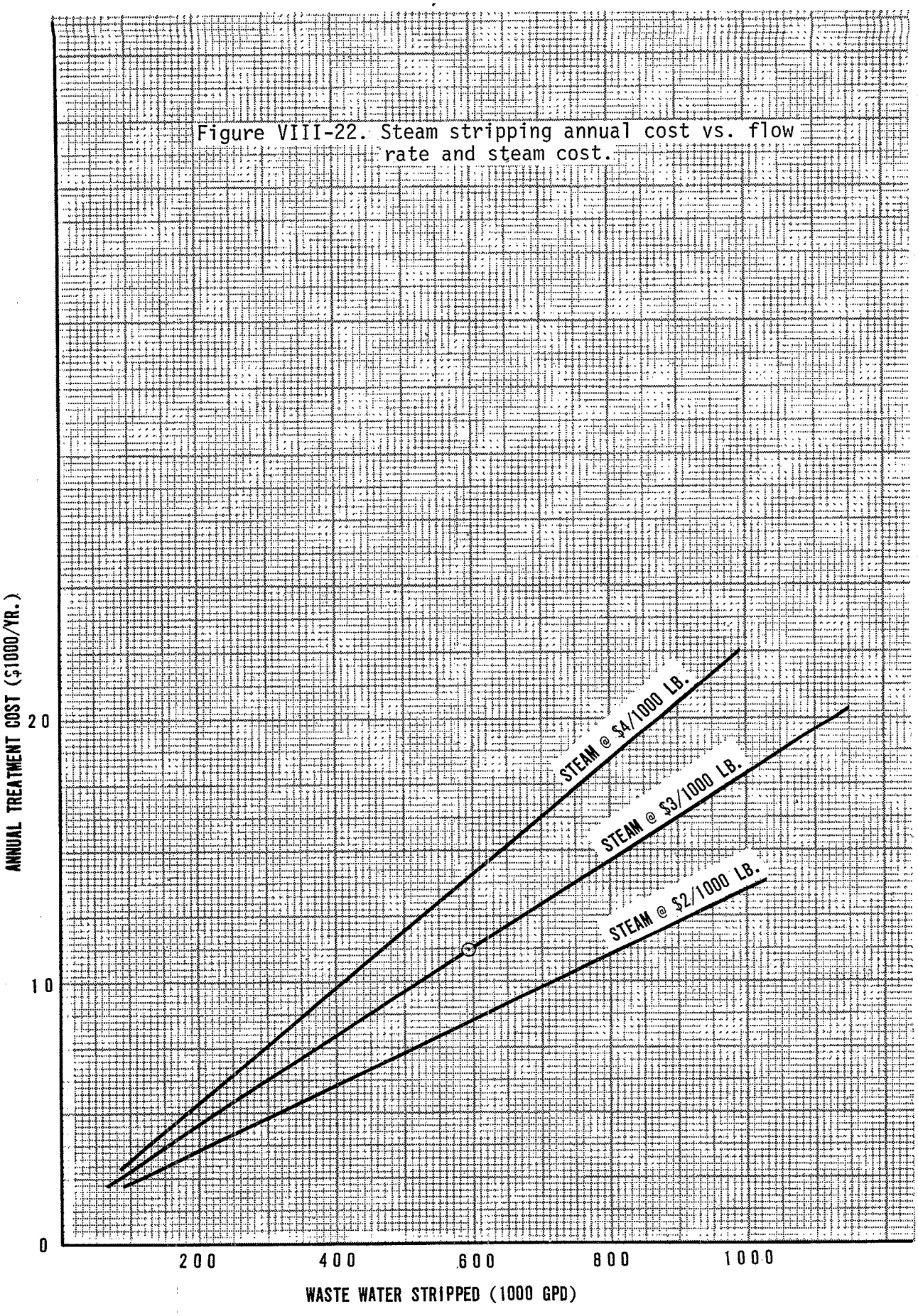


Figure VIII-22. Steam stripping annual cost vs. flow rate and steam cost.



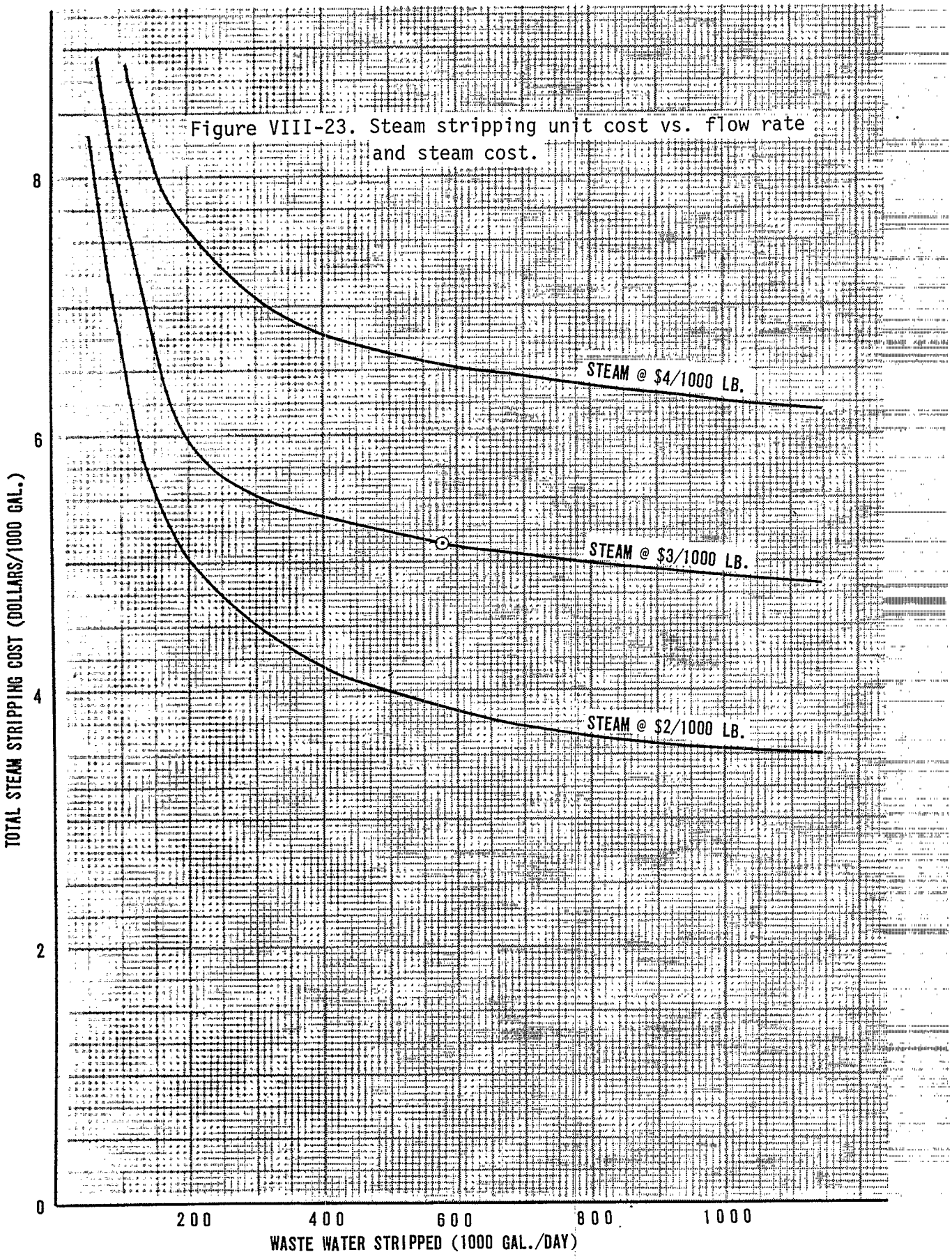
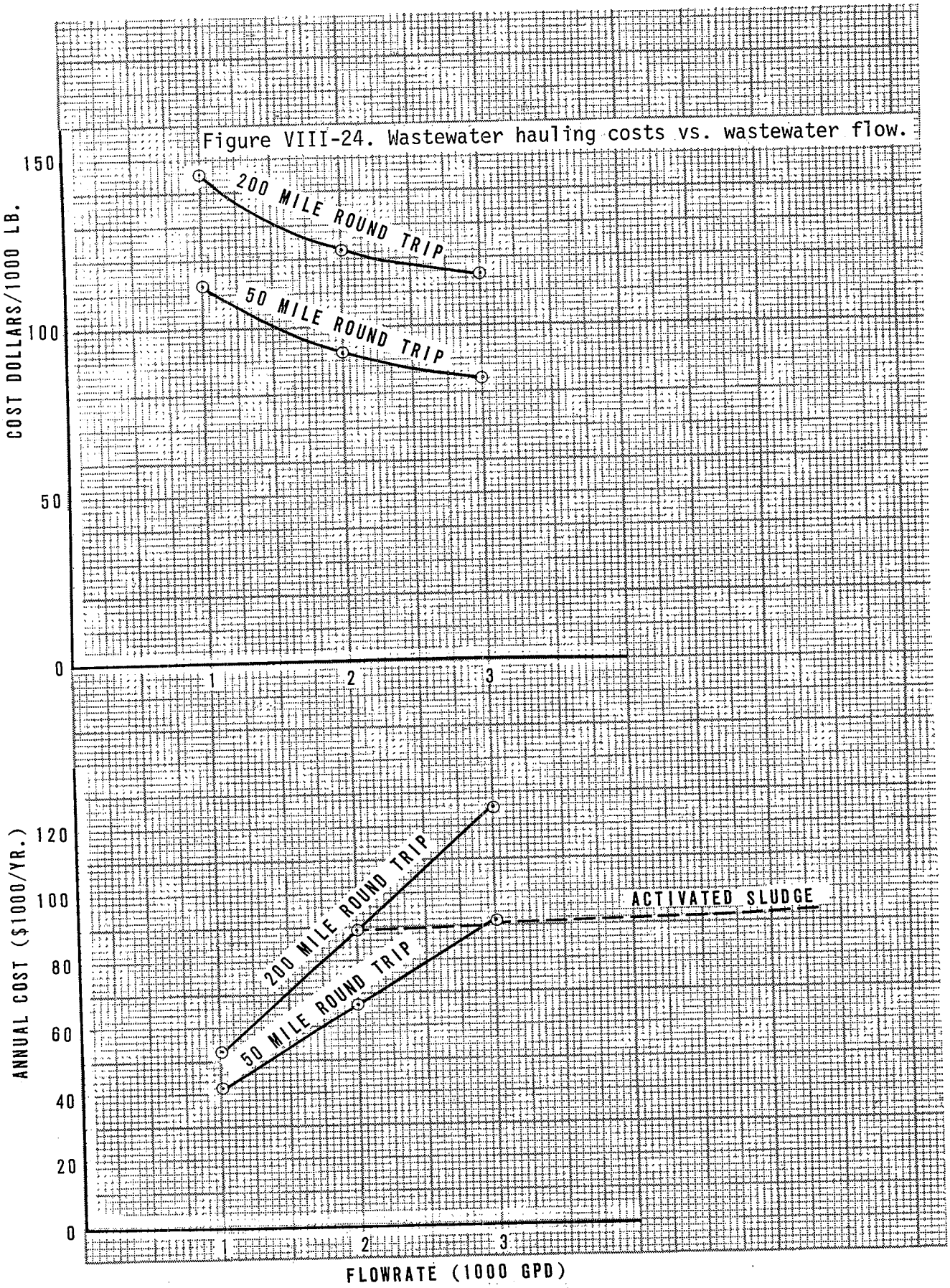


Figure VIII-23. Steam stripping unit cost vs. flow rate and steam cost.

Figure VIII-24. Wastewater hauling costs vs. wastewater flow.



SECTION IX

ANALYSIS OF LONG TERM DATA FOR POLLUTANTS OF CONCERN

This section describes the analysis of long term BOD5, COD, TSS and cyanide data submitted to EPA by pharmaceutical plants utilizing biological treatment systems and in-plant cyanide destruction. The first part of this section details which plant data were used to develop the suggested limitations and discusses reasons for the deletion of some of the submitted data. Data verification procedures are described as well as the contents of the limitations data base. The second part of this section describes the statistical methodology used to calculate the daily maximum and 30-day average maximum variability factors.

A. Description of Data

EPA conducted statistical analyses of long term effluent monitoring data from the pharmaceutical industry to establish revised BPT and new BCT, BAT and NSPS effluent limitations guidelines and pretreatment standards (PSES and PSNS). These guidelines are in the form of daily maximum and 30-day average maximum effluent limitations for the conventional pollutants TSS and BOD5, the nonconventional pollutant COD and the toxic pollutant cyanide.

The major objectives of the study were to quantify the day-to-day variability of treated process effluent and to provide appropriate variability factors to be used in conjunction with appropriate long term performance averages to construct new limitations guidelines. The specific methodologies for calculation of these variability factors are presented in the statistical appendices of the report Pharmaceutical Effluent Data Analysis conducted by SRI International, EPA Contract 68-01-6062, Task 1.

1. Plant Data Used in Limitations Development

Long term self-monitoring daily data were submitted to EPA by 22 pharmaceutical manufacturing plants. Information concerning the data collection is contained in the report entitled "Contractor's Engineering Report for the Development of Effluent Limitations Guidelines and Standards for the Pharmaceutical Manufacturing Industry Point Source Category" prepared for the Effluent Guidelines Division of the U.S. EPA by the Burns and Roe Industrial Service Corporation (1980).

In order to preserve source confidentiality, each plant was assigned the five digit identification number assigned in the

Section 308 Portfolio Survey. In conjunction with the plant identification numbers are listed the manufacturing subcategory designations where coded for each plant. The four subcategory designations used are part of the five original manufacturing subcategories established in the 1976 "Development Document" for the purpose of BPT regulation. In several cases, a single plant engaged in manufacturing processes characteristic of more than one subcategory. In such cases all major subcategories of activity were indicated. The plant identifiers and subcategories are shown in Table IX-1.

All but one of the 22 plants included in the study employ BPT treatment systems (i.e. biological systems). The lone exception is plant 12123, which is an indirect discharger.

Data from nine of the 22 plants were not used to develop the various limitations and associated variability factors. Data from five of these plants (12123, 12186, 12257, 12420 and 12439) was deleted because these plants are indirect dischargers. Since the main purpose of the treatment in-place in these plants was to avoid sewer use charges, data from these systems were not deemed representative of BCT (BAT) treatment. In addition data from four other direct discharging plants (12098, 12160, 12187 and 12462) were not used. These data were judged not to be representative of a properly designed and operated biological system. These omissions are explained as follows:

Plant 12098 The data from this plant did not include influent concentrations for BOD5, COD and TSS as well as effluent COD concentrations; therefore, long term average percent removal for these parameters could not be determined. The data available show relatively high effluent long term average BOD5 and TSS concentrations (409.9 and 392.1 mg/l) and low average flow (5,500 gpd) which indicates either adequate reduction from extremely high raw waste levels or inadequate reduction from normal raw waste levels. Since this plant is within the formulations mixing and compounding subcategory, a subcategory which produces characteristically low raw waste loads, the latter explanation for the high effluent concentrations has been assumed. The difficulties encountered by plants with low wastewater flows in equalizing wasteloads flowing into biological systems could explain the less than BCT level of performance by this plant.

Plant 12187

This plant did not provide influent data for BOD5, COD and TSS as well as effluent COD data. The high effluent average BOD5 concentration (707.3 mg/l) indicates that, in order for the plant's treatment system to be properly designed and operated, an average influent BOD5 concentration several times greater than

that observed in any other Subcategory C plant must have existed, a highly unlikely possibility. Therefore, in the absence of any other data this high average effluent BOD_5 value can only be explained by either improper design or inadequate operation of the treatment system.

Plants 12160 and 12462

These plants show poor long term average percent reduction for both BOD and COD (68 percent and 67 percent, respectively, for BOD and 60 percent and 52 percent, respectively, for COD). The current BPT regulation requires a 90 percent reduction in BOD and a 74 percent reduction in COD from raw waste levels. In addition both plants show high long term average effluent TSS levels. These long term performance data are not representative of proper BCT treatment.

The remaining 13 plant data sets were used to derive BCT and BAT limitations and variability factors. One plant (12236), which achieved a less than 90 percent average reduction for BOD (83 percent), was still included in the BCT-BAT data set because it was a significantly better overall performer than the four deleted plants.) For purposes of calculating NSPS standards and variability factors, we further eliminated 3 of the 13 plant data sets. The performance of three plants (12022, 12026 and 12236) was judged to be demonstrably inferior to that of the other ten plants and therefore these plant data sets were excluded from the NSPS data set group. While two of the three plants (12022 and 12026) have average long term BOD removal percentages greater than 90 percent, their performance regarding COD and TSS was considerably inferior to that of the NSPS plants. The performance of the third plant, 12236, was considerably below that of the other ten plants from the standpoints of percent reduction and final effluent concentration. Although one plant in the NSPS data set (12307) did not provide influent data, it was retained because its effluent pollutant levels were deemed acceptable. Finally, only plant 12236 provided acceptable long term cyanide destruction performance data, and this data was used to develop BPT (BAT) cyanide limitations and variability factors.

2. Data Verification Procedure

In order to identify values that may have been coding errors or that possibly reflected physical breakdown of the plant treatment system, graphic displays of daily pollutant values versus date of sample were generated. Data values found to deviate greatly from neighboring values were listed as possible transcription errors or observations reflecting physical breakdown of the plant treatment system. As a result of this procedure, some values were corrected and others were deleted because they reflected

apparent breakdowns in the plant treatment systems or other excursions beyond the scope of ordinary treatment plant operation. The methodology used in this data verification process and the actions taken on individual values are described in Statistical Appendix B of the report cited for EPA contract 68-01-6062, Task 1.

3. Contents of the Pharmaceutical Long Term Data Base

In addition to implementing corrections as warranted, influent and effluent pollutant loadings in mass discharge units (lbs/day) were computed from the daily flow (MGD) and the pollutant concentrations (mg/l or ug/l) by multiplying the flow rate by the concentration and then applying the appropriate unit conversion factor(s). The data base contains the following information:

(1) Plant: The five digit plant identifier code.

(2) SUBCAT: The plant subcategory (EPA classification based on specific nature of plant activity).

(3) DATE: The date on which each observation was taken.

(4) FLOW MGD: The flow in million gallons per day through the plant treatment facility.

(5) INBOD: Influent biological oxygen demand to the treatment plant (mg/l).

(6) EFBOD: Effluent biological oxygen demand from the plant (mg/l).

(7) INCOD: Influent chemical oxygen demand (mg/l).

(8) EFCOD: Effluent chemical oxygen demand (mg/l).

(9) INTSS: Influent total suspended solids (mg/l).

(10) EFTSS: Effluent total suspended solids (mg/l).

(11) EFCN: Effluent cyanide (ug/l).

Also, for analysis purposes, the following variables were computed:

(1) FLOWKGD: Flow in thousand gallons per day.

(2) INBODLB: Influent biological oxygen demand (lb/day).

(3) EFBODLB: Effluent biological oxygen demand (lb/day).

(4) INCODLB: Influent chemical oxygen demand (lb/day).

(5) EFCODLB: Effluent chemical oxygen demand (lb/day).

(6) INTSSLB: Influent total suspended solids (lb/day).

(7) EFTSSLB: Effluent total suspended solids (lb/day).

(8) EFCNLB: Effluent cyanide (.001 lb/day).

A complete listing of the data base used in determining the pollutant specific variability factors is available in Statistical Appendix A of the report cited for EPA contract 68-01-6062, Task 1.

B. Definition and Use of Variability Factors

The pollutant effluent level from a physical treatment process is subject to a certain degree of inherent day-to-day fluctuation. Limitations should account for this variability while at the same time incorporate an acceptable level of treatment performance. Consequently, achievable effluent limitations are determined as the product of the long term average performance and a factor accounting for daily effluent variability.

The term variability factor is defined as the ratio of the estimated 99th percentile of the distribution of pollutant values to the estimated mean value of the distribution. The mean used is the arithmetic average of all the daily values for a specific pollutant which were not deleted on the basis of being erroneous or descriptive of aberrant performance.

Pollutant-specific variability factors were calculated using statistical methods on the long term data available from individual plants. These pollutant-specific variability factors were then combined across plants to obtain an overall variability factor for a given pollutant. The concentration variability factor, calculated from the reported daily effluent concentration data, was used to derive limitations on effluent concentrations. The mass discharge variability factors were calculated from the reported daily flow volume and the daily concentration measurements.

The two (daily and 30 day average maximum) variability factors used in limitations development are discussed in the ensuing subsections.

a. Daily Variability Factors. Several approaches were used to estimate the 99th percentile distribution of daily values. One approach fits a parametric distribution to the data set and then estimates the 99th percentile using the fitted distribution. Three distributions were examined in this study: the normal distribution, the two parameter lognormal distribution and the three parameter lognormal distribution. The normal (or Gaussian) distribution has a symmetric bell shape and is characterized by two parameters, its mean and its standard deviation. The two parameter lognormal distributions in the distribution of a variable whose logarithm has a normal distribution; it is characterized by the same two parameters. This distribution was examined because it corresponds closely to the observable skewed behavior of the variables in this data set, (i.e., the occurrence of a large "tail" of observations toward the higher pollutant values). The three parameter lognormal distribution is similar to the two parameter distribution but it contains an additional parameter which allows a constant shift to be applied to all the values of the distribution. Due to the difficulty in estimating the three parameter lognormal distribution, two different methods of fitting this distribution to the data were used. The methods are called Modified Maximum Likelihood Estimation (MMLE) and Method of Moments Estimation (MME). For details on the method used in fitting the distributions to the data set, see Statistical Appendix C of the report cited for EPA Contract 68-01-6062, Task 1.

Another approach investigated for estimation of the 99th percentile of the daily pollutant values assumes no parametric distribution and hence is referred to as "nonparametric." The estimate is referred to as a 50 percent tolerance level estimate of the 99th percentile. For calculation procedures, see Statistical Appendix D of the report cited for EPA contract 68-01-6062, task 1. In order to calculate nonparametric tolerance estimates, a minimum number of data values are required. Specifically, a 50 percent tolerance estimate of the 99th percentile can be calculated only if 69 or more data values are available.

The final approach considered is a combination of parametric and nonparametric methodologies. The data values above the 90th percentile (upper 10 percent) were assumed to follow an exponential distribution. The fitted exponential distribution was then used to estimate the 99th percentile of daily pollutant values. This estimate is referred to as the "tail-exponential" assumption and was suggested by the skewness exhibited by the data. Since the variance associated with the "tail-exponential" 99th percentile estimate can be shown to be less than the variance of the nonparametric estimate for a given sample size, this estimate was calculated only if 69 or more samples were

available. (See Statistical Appendices E & G of the earlier cited SRI report for procedures and references).

In order to compare and assess the fits of the assumed distributions to the plant-specific pollutant data sets, statistical goodness-of-fit tests were applied. Two general tests, the Kolmogorov-Smirov and the Anderson-Darling were used to test each distribution: normal two and three parameter lognormal, and tail exponential. A specific test of normality, the D'Agostiro test, was also used to test the fit of the data to the normal and lognormal distributions. The Watson test of exponentiality was applied to test the tail-exponential fit. Overall comparisons of the goodness-of-fit of each distribution to the data for each variable were made by combining the tests at each plant via Fisher's combined test of significance. The results and procedures are described in Statistical Appendix F of the earlier cited SRI report. In summary, the following conclusions are evident from the overall assessment of distribution fit:

(1) In most cases, the normal distribution does not fit the observed data.

(2) The lognormal (2- and 3-parameter) distributions fit the data moderately well, and considerably better than the normal distributions. Of these, the 3-parameter lognormal, fitted by the MMLE method provided the best overall fit.

(3) The tail-exponential distribution, providing a sufficient number of observations is available, fits the data acceptably and certainly more effectively than the other distributions. The instances of apparent lack of fit can reasonably be attributed to statistical fluctuation.

Since the nonparametric estimate assumes no distributional form, the question of goodness of fit is not at issue.

Many of the plants did not provide sufficient information to calculate either the tail-exponential or the nonparametric estimate (i.e. sample sizes were less than 69). Because it was important to utilized as much plant-specific information as possible a variability factor was calculated for each plant/variable combination according to the best procedure consistent with the amount of data available.

For each variable at each plant, the best procedure is defined as follows:

(1) If 69 or more pollutant values are available, then utilize the tail-exponential estimate unless goodness-of-fit tests

reject tail-exponentiality. Otherwise use the nonparametric estimate.

(2) If 69 or more pollutant values are not available, use the 3-parameter lognormal MMLE fitting procedure.

For each pollutant the average of the selected variability factors (weighted by the number of observations at each plant) was computed (See Statistical Appendix H of the earlier cited SRI report for formulas). These average daily maximum variability factors (concentration and mass based), along with minimum and maximum factors plant variability and the number of plants used in the calculation of the average factors is found in Table IX-2.

b. Monthly Variability Factors

A 30-day average variability factor is defined as the ratio of the estimated 99th percentile of the distribution of 30-day averages of daily pollutant values to the estimated long term mean value. A 30-day average is the arithmetic mean of 30 daily measurements; the sets of measurements used in determining each monthly average are assumed to be distinct. The long term mean is the long term arithmetic mean of 30 day averages and is the same as the long term mean of the daily pollutant values.

The 30-day variability factors were developed on the basis of a statistical result known as the Central Limit Theorem. The Theorem states that, under general and nonrestrictive assumptions, the distribution of a sum of a number of random variables, say n, is approximated by the normal distribution. The approximation improves as the number of variables, n, increases. The Theorem is quite general in that no particular distributional form is assumed for the distribution of the individual variables. In most applications (as in determining the 30-day limitations) the Theorem is used to approximate the distribution of the average of n observations of a random variable. The result is important because it makes it possible to compute approximate probability statements about the average in a wide range of cases. For instance, it is possible to compute a value below which a specified percentage (e.g. 95 or 99 percent) of the averages of n observations are likely to fall. Most textbooks state that 25 or 30 observations are sufficient for the approximation to be valid although in many cases 10 or 15 are adequate. In applying the Theorem to the determination of 30-day limitations, we approximate the distribution of the average of 30 observations drawn from the distribution of daily measurements.

Various forms of this Theorem exist and are applicable for different situations. A key assumption in the most familiar form of the Central Limit Theorem is that the individual measurements are independent. That is, it is assumed that measurements made on successive days or any fixed number of days apart are statistically independent or not related. This assumption of independence is rarely satisfied in an absolute sense in effluent data. In many cases, however, the assumption is satisfied to a degree sufficient to yield a suitable result. In the case of the pharmaceutical data, there is evidence of dependency in the data that should be incorporated into the determination of limitations. The Central Limit Theorem can still be used in developing variability factors in the case of dependent data but some of the necessary calculations must be modified to account for the dependency and more samples (i.e. larger n) may be required for the approximation to be adequate. In the case of positive dependence (the usual situation with effluent data) the modifications will result in a larger variance of the mean than would be obtained if independence is assumed. This in turn results in a larger limitation for the mean than would be obtained if independence is assumed. The technical details of the Central Limit Theorem including computational formulae and results obtained for the pharmaceutical data are described in Chapter V and Statistical Appendix I of the earlier cited SRI report. The average 30-day variability factors (weighted by the number of observations at the plant) was computed and these values, along with minimum and maximum variability factors and the number of plants used in the calculating of the average factors, are presented in Table IX-3. Both concentration and mass based variability factors are shown.

c. Applicability of Variability Factors at New Performance Levels of Plant Operation

In order to evaluate the applicability of the calculated variability factors when applied to plants operating at generally lower levels of pollutant concentration, the plant-specific daily variability factors and the 30-day variability factors for each variable were plotted versus the mean concentration of the pollutant for each plant (see Figures VI-1-1 through VI-2-8 of the cited SRI Task 1 report). contractor's report). Similarly, in order to evaluate the applicability of the calculated variability factors to plants operating at higher pollutant reduction percentages, plant-specific variability factors were plotted versus the average percentage reduction of the pollutant at each plant (see Figures VI-3-1 through VI-4-8 of the cited SRI report). No trends are generally observable in either set of plots, except for the somewhat greater scatter of the daily factors based on smaller numbers of observations.

As a further check, the Spearman rank correlation, a measure of monotonic (not necessarily linear) association, was computed in each case. The Spearman correlations are shown in Tables VI-1 and VI-2 of the above cited report. Spearman correlations were not calculated for cyanide since cyanide values were used from one plant. Based on these analysis, there exists little or no association of variability factors with the mean pollutant level or percent reduction. As long as similar control technologies are employed this result suggests that the computed variability factors are indeed appropriate for plants operating at different performance levels.

d. Regulatory Limitations

For each pollutant, concentration and mass discharge effluent limitations were determined by multiplying a pollutant's across-plant or average variability factor by its across-plant long term average. As with the across-plant variability factor, the across-plant long term average was determined by weighting the individual plant's long term average by their pollutant specific sample sizes. Daily maximum and 30-day average maximum concentration limitations (in concentration and mass discharge units) along with the across-plant long term averages and variability factors are shown for all the pollutants to be regulated in Table IX-4. The respective type of limitation or standard to which the long term averages and variability factors apply is also indicated.

Table IX-1

PLANT IDENTIFIERS AND SUBCATEGORIES
IN THE PHARMACEUTICAL LONG-TERM DATA BASE

PLANT CODE NO.	SUBCATEGORIES
12015	D
12022	AC
12026	C
12036	A
12097	CD
12098	A
12117	B
12123	CD
12160	D
12161	ACD
12186	CD
12187	C
12236	C
12248	C
12257	ABCD
12294	CD
12307	D
12317	D
12420	BD
12439	CD
12459	D
12462	A

Table IX-2

DAILY VARIABILITY FACTORS

Pollutant	Concentration Data: Number of Plants	Concentration Data: Weighted Average VF	Concentration Data: Min VF	Concentration Data: Max VF	Mass Discharge Da: Number of Plants	Mass Discharge Da: Weighted Average VF	Mass Discharge Da: Mi VF
BCT and BAT Plants							
BOD	13	4.53	2.58	16.25	13	4.65	2.
COD	12	3.03	1.92	6.95	12	3.30	2.
TSS	13	5.07	2.35	7.60	13	5.15	2.
NSPS Plants							
BOD	10	4.43	2.58	16.25	10	4.64	2.
COD	10	3.43	2.20	6.95	10	3.55	2.
TSS	10	5.60	2.56	7.60	10	5.74	2.
Cyanide	1	3.1			1	3.34	

Note: VF = variability factor

Table IX-3

30-DAY VARIABILITY FACTORS

Pollutant	Concentration Data: Number of Plants	Concentration Data: Weighted Average VF	Concentration Data: Min VF	Concentration Data: Max VF	Mass Discharge Da: Number of Plants	Mass Discharge Da: Weighted Average VF	Mass Discharge Da: Mi VF
BCT and BAT Plants							
BOD	4	2.04	1.56	2.59	4	2.04	1.
COD	5	1.96	1.48	2.25	5	1.77	1.
TSS	6	2.04	1.71	2.70	6	2.09	1.
NSPS Plants							
BOD	3	2.78	1.56	2.04	3	1.80	1.
COD	4	1.70	1.48	2.25	4	1.79	1.
TSS	5	2.07	1.71	2.70	5	2.16	1.
Cyanide	1	1.81			1	2.0	

Note: VF = variability factor

Table IX-4

LONG TERM AVERAGE CONCENTRATIONS, VARIABILITY FACTORS AND LIMITATIONS

Regulation	Pollutant	Mean Pollutant Level (mg/l)	Daily Variability Factor	Daily Limitation Value (mg/l)	Var Fa
BCT	BOD	55.48	4.53	252	
BAT	COD	338.0	3.03	1024	
BCT	TSS	50.94	5.07	258	
NSPS	BOD	28.51	4.43	126	
NSPS	COD	263.7	3.23	853	
NSPS	TSS	34.73	5.60	195	
BPT, BAT and NSPS	Cyanide	.207	3.1	.643	

SECTION X

BPT

A. Summary

1. General

The factors considered in defining best practicable control technology currently available (BPT) include: (1) the total cost of applying the technology relative to the effluent reductions that result, (2) the age of equipment and facilities involved, (3) the processes used, (4) engineering aspects of the control technology, (5) process changes, (6) nonwater quality environmental impacts (including energy requirements), and (7) other factors, as the Administrator considers appropriate. In general, the BPT level represents the average of the best existing performances of plants within the industry of various ages, sizes, processes, or other common characteristics. When existing performance is uniformly inadequate, BPT may be transferred in from a different subcategory or category. BPT focuses on end-of-process treatment rather than process changes or internal controls, except when these technologies are common industry practice.

The existing BPT regulation requires all subcategory plants to reduce their raw waste BOD5 loading by 90 percent and their raw waste COD loading by 74 percent. It also requires subcategory B, D, and E plants to achieve a monthly maximum average of no more than 52 mg/l for TSS. The latter requirement has been found to be an overly stringent one for the technology basis of BPT. Amended limitations are proposed based on additional data. Reflecting what is actually achievable by that technology. EPA is also proposing new cyanide limitations based on the use of cyanide destruction technology currently by the industry.

Three sets of limitations are being proposed. The first set, the TSS limitations, are to replace the existing TSS limitations for subcategory B, D, and E plants with limitations which will apply to subcategory A - E plants. The second set of limitations are new and will apply to all A, B, C, D, and all mixed subcategory plants but not to E only plants. In addition, current BPT limitations for BOD5 and COD Based on a percent reduction calculation are revised to allow dischargers the option of meeting specific BCT and BAT concentration based limitations, whichever is less stringent.

2. Limitations

BPT limitations are summarized in Table X-1 below.

TABLE X-1

BPT EFFLUENT LIMITATIONS

Pollutant	30-Day Average Maximum	Daily Maximum
TSS mg/l	217	---
Cyanide ug/l	375	643
BOD5 mg/l	113 or existing BPT	-
COD mg/l	570 or existing BPT	-

No changes are being made in the existing BPT Limitations for BOD5, COD and pH (codified at 40 CFR 439).

B. IDENTIFICATION OF BPT

1. Prior Regulations

BPT was originally promulgated for the pharmaceutical manufacturing industry as an interim final regulation in November of 1976. The regulation divides the industry into five subcategories: fermentation (A), biological extraction (B), chemical synthesis (C), formulation (D), and research (E). It limits BOD and COD by percent reduction limitation of 90 percent and 74 percent, respectively, in all subcategories and TSS to 52 mg/l as a maximum monthly average in subcategories B, D, and E. The allowable range for pH is 6.0 to 9.0. The TSS numbers were developed from a limited data base and they reflect the same technology relied on for the BOD5 and COD numbers. Based on performance data, these limits have been found to be relatively lenient with respect to BOD5 and COD but quite stringent with respect to TSS.

2. Regulated Pollutants

The Agency will amend and extend the coverage of the existing TSS limitations and propose new cyanide limitations and propose new cyanide limitations in this rulemaking. The available data from the group of plants whose TSS preformance averages were used to compute the long term average basis for the revised TSS limitations did not include daily data and it is therefore not possible to develop a statistically reliable daily maximum limitation. Hence, only a 30-day maximum average limitation will be proposed for TSS while both 30-day and daily maximum limitations will be proposed for cyanide.

Limitations on the discharge of cyanide are necessary not only to control the effluent discharge of cyanide, a toxic pollutant, to surface waters but also to prevent interference with the operation of in-plant biological treatment systems.

3. Methodology Used

a. TSS Limitation

An analysis of th current treatment performance of direct discharging plants serves as the basis for the modification and extension of the existing TSS limitation. The TSS Limitation for subcategories B, D, and E in the existing regulation stipulate a 30 day maximum average of 52 mg/l based on a long term average of 18 mg/l. The NPDES permits issued, before that regulation was issued as well as the available 308 and long term daily data, indicate this level is overly stringent.

Compliance with this limitation is generally achieved mostly by plants that generate low raw waste levels of TSS (mostly formulation (D) only plants). For the industry as a whole, compliance with the TSS level could in fact force BOD5 and COD removal in excess of that required under the 1976 regulation. Therefore the 1976 TSS limitation is not reasonable as a performance criterion for BPT.

Accordingly, the Agency has decided to propose a less stringent limitation which will apply to all plants covered by the existing regulation. This limitation will be a more in keeping with the demonstrated performance of BPT systems.

This amended limitation is derived from data submitted by direct discharging plants in the 308 and long term daily data surveys. The long term average performance with respect to TSS Of 41 plants which have in-place some type of biological treatment provides the immediate data base for the limitation. This group of performance values has been specifically chosen because the group of plants submitting them is most representative of all direct discharging pharmaceutical plants in terms of manufacturing processes and treatment employed. Table IX-1 lists the TSS average values used to compute the new long term average, the identification numbers of plants submitting them, their process wastewater flows, their manufacturing subcategory(s) and the actual source of the value. Table IX-2 compares the subcategory breakdown of the plants in the new TSS limitation group with that of the entire direct discharger population.

When both long term daily and 308 data were available, long term daily average value was used in preference to the 308 value for TSS because the long term daily value for the TSS was supported

by a significant number of observations which make possible a more accurate judgement about the solids removal achieved by the plant's treatment system. The one notable exception was in the case of data from plant 12462. This plant submitted average TSS values of 97 and 2022 mg/l in the 308 and long term daily surveys, respectively. The value of 2022 mg/l was not used because it reflects negative removal of TSS by the treatment system. In all other cases, the 308 value did not differ significantly from the long term daily average value. The TSS value of 97 is also a long term average value since the 308 survey participants were requested to supply annual averages.

The new long term average concentration for TSS Is 75 mg/l. When multiplied by the appropriate variability factor, this results in the amended 30 day average maximum limitation. The variability factor (2.89) used is identical to the one used in the development of the existing TSS limitation. This factor was used in preference to the one calculated from the long term data since most of the averages (25 of 41) used to compute the TSS limitation base average were from 308 submissions. These dtata submissions are not supported by daily or weekly values and, therefore, it was not possible to calculate a 30-day average maximum variability factor from the available data that would be representative of the average of performance of all 41 plants. In addition, all 41 data submissions describe the performance of treatment systems that were installed in response to or coincidentally with the development of the existing regulation. The TSS variability factor calculated for the original limitation is therefore considered appropriate for use in setting the amended BPT TSS limitation.

b. Cyanide Limitations

About 7 to 10 percent of all pharmaceutical plants may use and generate waterborne cyanide waste on a regular or intermittent basis. Cyanide destruction units are in-place in several plants and long term data was requested which describes the performance of these units. Two plants provided data on the performance of cyanide control technology. However, one plant was an indirect discharger that provided much less extensive data and therefore data from this plant was not used in developing cyanide limitation for direct dischargers.

The 30-day and daily maximum limitations are derived from data submitted by plant 12236 on the performance of its alkaline pyrolysis cyanide destruction unit. The concentration results submitted are final effluent values and do account for dilution by other non-cyanide process wastewater. These limitations make no distinction as to the form of the cyanide in the effluent (complexed or noncomplexed). The Agency will request additional

data on the performance of cyanide destruction technology in this rulemaking.

The statistical treatment of the daily cyanide data was discussed in Section IX.

c. Alternative BPT, BOD5 and COD Concentration-based Limitations

The revised alternative concentration-based limitations for BOD5 and COD are proposed to d to revise the existing BPT regulation to allow plants with low raw waste loads the option of meeting the concentration-based limitations proposed BCT and BAT limitations. This proposal will eliminate the possibility that for any plant BPT could be more stringent than BCT and/or BAT. These proposed limitations are stated in terms of 30-day average maximums as were the original BPT percent reduction limitations.

4. Engineering Aspects of BPT

A technical review and evaluation of the treatment technologies employed in the industry presented in Section VII Indicates that the industry makes use of a variety of in-plant and end-of-pipe technologies. In-plant controls consist of solvent recovery, steam stripping, metals precipitation and cyanide destruction. Filtration of mycelia from fermentation wastewater (required by the existing BPT regulation) will reduce the nutrient BOD5 loading before combination with other wastewater. In some cases, the mycelia are a recoverable by-product. The end-of-pipe treatment technologies employed in the industry include primary clarification, neutralization and neutralization and equalization followed by secondary biological treatments such as activated sludge, aerated lagoons and trickling filters and finally by tertiary treatments such as polishing ponds.

Generally, the industry engages in the processing of organic material and wastes which are strongly acid or alkaline are not generated. However, some neutralization of equalized influent is often necessary before secondary treatment. The secondary biotreatment technologies used include activated sludge, aerated lagoons, and trickling filters, bollowed by clarification or filtration.

5. Cost in Relation to Benefits

The implementation costs for the amended BPT regulations will be incurred by plants which must install cyanide destruction equipment. No implementation costs or lbs of TSS removed can be attributed to the new TSS limitation for two reasons. First, as to subcategories B, D, and E the regulation does not require any

new treatment. Second, the costs for subcategories A and C plants are either attributable to compliance with the current BOD5 and COD percent reduction limitations or are not required because the limitations can be met by changes in treatment system operation.

On the basis of the information available from the 308 survey and the S/V program, 6 plants will incur a total of $628,000 in annual costs and $1,740,000 in investment costs (1980 dollars). We estimate that these regulations will result in the removal of 17,000 lbs/year of cyanide from the effluent of pharmaceutical plants.

6. Nonwater Quality Environmental Impact

The four general categories of RCRA wastes generated by the pharmaceutical industry are sludges, waste solvents, infectious wastes and returned goods. None of these is expected to be increased significantly as a result of this amended regulation.

Sludge from biological treatment can mostly be landfilled as can separable solid process waste such as mycelia from fermentation.

Implementation of BPT in-plant cyanide destruction is not expected to affect air emissions.

The energy consumption and energy costs of BPT implementation are expected to be small. The increases in energy needs are largely limited to additional power requirements for pumps and agitators needed for cyanide destruction systems. These requirements tend to be very small in scale.

TABLE X-1

EFFLUENT TSS PERFORMANCE OF DIRECT DISCHARGERS
(308 & Long-Term Data)

PLANT NO.	SUBCATEGORY	DATA SOURCE	FLOW (MGD)	AVERAGE EFFLUENT TSS (mg/L)
12053	D	308	0.004	2
12463	BD	308	0.057	9
20319	D	308	0.003	9
12406	C	308	0.370	10
12317	D	L.T.	0.740	10
12015	D	L.T.	0.101	11
12089	BD	308	0.155	13
12287	D	308	0.131	13
20201	D	308	0.002	14
12117	BD	L.T.	0.101	16
12407	C	308	0.731	17
12459	D	L.T.	0.049	17
12097	CD	L.T.	0.064	18
12104	D	308	0.367	22
20165	BC	308	0.004	24
12298	D	308	0.003	26
12132	AC	308	1.000	29
12338	D	308	0.001	30
20245	AC	308	0.500	32
12307	D	L.T.	0.002	32
12161	ACD	L.T.	1.653	32
20246	C	308	1.250	33
20297	C	308	0.001	36
12205	D	308	0.030	40
12036	A	308	1.128	44
20037	D	308	0.043	47
12283	D	308	0.013	50
12294	CD	L.T.	0.118	59
12294	CD	L.T.	0.118	59
12471	B	308	0.043	59
12248	D	L.T.	0.110	60
12187	C	L.T.	1.065	61
12236	C	L.T.	0.816	62
12119	AC	308	0.032	70
12022	AC	L.T.	1.300	85
12462	A	308	0.170	97
12160	D	L.T.	0.006	115
12239	D	308	0.002	174
12026	C	L.T.	0.161	284
12038*	ABCD	308	0.855	340
12098	D	L.T.	0.006	392

12261	C	308	0.051	567

Total Flow = 13.237 MGD
Plant Avg. Flow = 0.323 MGD
Flow-Weighted TSS Avg. = 65 mg/l
Plant Avg. TSS = 75 mg/l

Plants lacking effluent TSS data:

12001	12073	12264	20257
12006	12085	12267	20298
12014	12194	12281	20370
12030	12235	12308	20370
12057	12256	12339	20402

Plant with TSS data but without biotreatment:

12095

*Provable process flows only; incinerator scrubber water and other diluting flows not included.

TABLE X-3

SUBCATEGORY BRACKDOWN OF TSS GROUP PLANTS COMPARED TO ALL DIRECT DISCHARGES.

% Subcategory Plants	TSS Group	All Direct Dischargers
A	4.9	3.2
B	2.4	1.6
C	19.5	19.7
D	43.9	45.9
Mixed	26.3	29.5

SECTION XI

BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY CURRENTLY AVAILABLE

A. Summary

1. GENERAL

The 1977 Amendments added Section 301(b)(2)(E) to the Act establishing "best conventional pollutant control technology" (BCT) for discharges of conventional pollutants from existing industrial point sources. Conventional pollutants are those defined in Section 304(a)(4) [biological oxygen demanding pollutants (BOD_5), total suspended solids (TSS), fecal coliform, and pH], and any additional pollutants defined by the Administrator as "conventional" [oil and grease, 44 FR 44501, July 30, 1979].

BCT is not an additional limitation but replaces BAT for the control of conventional pollutants. In addition to other factors specified in section 304(b)(4)(B), the Act requires that BCT limitations be assessed in light of a two part "cost-reasonableness" test. American Paper Institute v. EPA, 660 F.2d 954 (4th Cir. 1981). The first test compares the cost for private industry to reduce its conventional pollutants with the costs to publicly owned treatment works for similar levels of reduction in their discharge of these pollutants. The second test examines the cost-effectiveness of additional industrial treatment beyond BPT. EPA must find that limitations are "reasonable" under both tests before establishing them as BCT. In no case may BCT be less stringent than BPT.

2. LIMITATIONS

BCT limitations are summarized in Table XI-1 below:

TABLE XI-1

Pollutant	Range	30-Day Average Maximum	Daily Maximum
BOD (mg/l)	---	113	252
TSS (mg/l)	---	110	291
pH	6.0 - 9.0	---	---

B. Identification of BCT

1. Methodology BCT limitations which are more stringent than existing BPT limitations for a given industrial category or subcategory must satisfy a two part "cost reasonableness test." The first part of the test involves a comparison of the average annual removal cost incurred by direct discharging plants in upgrading from existing BPT to BCT level performance regarding the treatment of conventional pollutants with an analogous POTW removal cost figure. The latter figure, $0.42/lb in 1980 dollars, is an estimate of the incremental removal costs incurred by an average POTW which has upgraded from secondary to advanced secondary treatment. If the average industry category or subcategory removal cost is less than this figure, the more stringent BCT limitations meet the requirement of the first part of the test. The second part of the test entails calculation of the ratio of the removal cost incurred in upgrading from BPT to BCT to the removal cost incurred in upgrading from a raw waste or treatment in-place (at the time of BPT promulgation) status to existing BPT. The choice of status depends on the reliability of the data available. (The raw waste status was used in this rulemaking, based on that criterion). This ratio is then compared to an incremental cost ratio 1.43 (which has been obtained by dividing the average annual removal costs incurred by a POTW in upgrading from a secondary to an advanced secondary treatment level by the average annual removal costs incurred in upgrading from a primary to a secondary treatment level.) If an industry category or subcategory meets the requirement of the first part of the test and the calculated incremental ratio is less than 1.43, then the cost of the BCT limitations are considered reasonable. If the calculated figures are greater than the benchmark figures in either case, BCT limitations must be raised until the calculated figures are less than the benchmark figures in both cases.

2. Costs

The plant-by-plant incremental annual costs for upgrading from BPT to BCT performance levels were assigned using an incremental treatment stage approach. First, the average effluent BOD concentration from the plant's 308 as long term data submission was compared to the anticipated BCT long term data average for BOD_5 55 mg/l. Then an estimate was made of the number of treatment stages which had to be added to a plant's existing biological treatment system to produce a long term effluent BOD of 55 mg/l. These treatment stages are equivalent to increases in unit capacities within the system (greater equalization, aerated lagoon or clarifier capacity). All cost increments assume an activated sludge type of treatment, the most expensive of the three types considered (the others being RBC's and ponds). Costs for plants discharging less than 3000 gpd were based on the assumption that they would haul their concentrated wastewater

(see Table VIII-30) to comply with the limitations rather than upgrade existing biological treatment, an extremely cost ineffective solution at these low flow rates. All costs were computed in 1980 dollars. These estimates are conservative, because many plants may be able to improve removal by adjusting the operation of existing treatment stages, thus saving costs.

An updated (1980) version of a graph of annual treatment costs versus flow (see original document (55)) was used to estimate annual costs for BPT (biological treatment) systems. This graph was obtained by plotting subcategory model plant annual costs versus flow. This technique was considered appropriate in view of the number of mixed subcategory plants.

3. Pollutant Loading Reduction Calculations

The annual conventional (BOD and TSS) pollutant loading reductions to be achieved upon upgrading from existing BPT to BCT level performance were calculated in following manner. The average long term BOD and TSS concentrations submitted in the 308 or long term data surveys were multiplied by the respective variability factors in the existing BPT regulation, 3.0 and 2.89, to obtain the 30-day maximum average concentrations. (Generally, long term data average concentrations were used when available because they were derived from data which were readily verifiable). Thirty-day average maximum concentrations were used because the POTW benchmark figures were calculated using this type of concentration limitation. Thereafter, the 30 day average maximum concentrations (mg/l) were multiplied successively by the average process wastewater flow (MGD), 365 days per year, and a conversion factor (8.34) to give the annual BOD_5 and TSS load from the plant's BPT system. In a similar manner the plant's BCT annual loading was calculated using the long term averages and 30 day variability factors derived from the BCT plant data set (13 sets of long term data) in Section IX. The plant's BCT loading was then subtracted from the existing BPT loading to determine the incremental removal obtainable by upgrading from BPT to BCT level performance. The individual incremental loads for all plants in the test group were summed to give the aggregate incremental removal for all plants tested. This aggregate was used for both parts of the cost test.

The other number required for the second part of the cost test, cost of BPT removal, was calculated using raw waste and effluent annual averages from 308 and long term data. (A variability factor of 1.0 was assumed and applied to the average raw waste concentrations to generate 30 day average maximum concentrations). When 308 and long term data average concentrations were not available, average raw waste concentrations characteristic of the plant's manufacturing

activities (in the case of TSS) or raw waste concentrations derived by assuming BPT compliance (e.g. 90 percent method in the case of BOD5) were used. The calculations were performed in the same manner as the previously described calculations. Individual BPT loadings for plants were subtracted from the raw waste loadings. The results were summed to give the total removal by BPT technology for all plants tested.

4. Test Criteria Results

EPA performed the BCT cost test using data from 28 of the 60 known direct dischargers in the pharmaceutical industry. Thirty-two plants submitted data which indicate that they are currently in compliance with the proposed BCT limitations for BOD5 and TSS. (Therefore, no costs as pollutant reductions are attributable to these plants). If the 28 plants pass the BCT cost test, the industry passes. The tests were performed using the submitted concentration and flow data except in cases where insufficient data were available as in the case of 18 plants. In these instances the calculations were performed using industry average effluent concentrations for BOD5 and TSS and plant-by-plant estimated upgrade costs based on these industry average effluent concentrations.

Before discussing the results, one exception to the above procedure requires explanation. One plant, 12256, indicated that it had an effluent flow rate of 30 MGD. This flow was composed of both treated process effluent and once-through stream water which is used for barametric condensation. Since it was not possible to determine the actual flow rate of the treated effluent from actual manufacturing operations, it was assumed that ten percent of the 30 MGD flow is from manufacturing and the costs and pollutant reductions were calculated accordingly. This flow (3.0 MGD) is equivalent to that of the average large plant in the industry. A set of criteria was also calculated for the group of 27 plants that did not include plant 12256. This procedure was employed so as not to bias the results of the BCT test for the whole industry. Costs and removals calculated for a 30 MGD plant are highly cost effective since this flow is over twice that of the reported total flow from all the remaining 27 plants.

Initially, two sets of BCT criteria were calculated. The calculation of one set of criteria assume that all 18 plants in the insufficient data group will incur costs and achieve pollutant reduction as a result of the BCT limitations. The calculations for the other set assume only 24 percent of the plants or 35 percent of the flow in this group will incur costs and achieve pollutant reductions as a result of the new limitations. These percentages reflect the segment of plants who

have submitted data which are not in compliance with the proposed BCT limitations. The two sets of criteria were calculated to be $0.38/lb. and 0.87 and $0.37/lb and 0.86, respectively. EPA considers the latter set of criteria, $0.37/lb. and 0.86 (the one obtained using the percentage estimate for costs and removals) as the more reliable indicator because many of the 18 plants in the insufficient data group are small formulating facilities which are not likely to require additional treatment.

Thereafter, four additional sets of criteria were calculated. One set of criteria was calculated for the 28 plant group (including plant 12256) and another set was calculated for the 27 plant group (without plant 12256). These two sets of calculations assumed the aforementioned percent non-compliance. The results for each set were $0.37/lb. and 0.86 and $0.38 and 0.82, respectively. Finally, two sets of criteria were calculated for the 28 and 27 plant groups assuming 100% non-compliance with proposed BCT. These results were $0.38/lb. and 0.84 and $0.40/lb. and 0.83 for the 28 and 27 plant groups, respectively.

Based on the comparison of these calculated criteria to the BCT cost test benchmark figures ($0.42/lb. and 1.43), the proposed BCT limitations meet the requirements of the BCT "cost reasonableness test" regardless of which set of criteria are used as the comparison criteria. A subsequent analysis and discussion of the test as applied confirm this conclusion.

As part of its confirmatory analysis EPA presents the BPT and BCT costs and removals as well as the criteria results for 10 plants who have submitted data which indicate that they are not currently achieving BCT level performance. Table XI-2 lists the identification numbers of these plants along with the calculated incremental removals achieved by BPT and to be achieved by BCT and the estimated costs of these loading reductions. Table XI-3 lists the plant identification numbers, their manufacturing subcategory classification(s), the test criteria on a plant by plant basis and the overall results. The 10 plants in this test group were specifically chosen further analysis because they submitted data which could be used to calculate actual BCT cost test criteria (estimations had to be made in a few cases) and their data indicated that they were below the anticipated BCT performance requirements. The average industry criteria calculated for this plant group are $0.36/lb and 0.81. These values confirm the overall result for the industry.

The above analysis uses existing BPT performance as the measure of BPT removal. Because not all plants are exactly at the levels required by the existing BPT regulation, we also considered whether the BCT cost test results would be different using the

existing BPT regulation, as opposed to actual performance data. The existing BPT regulation requires that all direct dischargers achieve a 90% reduction from BOD5 levels and that subcategory B, D and E plants comply with a maximum monthly average of 52 mg/l for TSS. In order to calculate BCT cost criteria using the existing BPT regulation (as opposed to existing BPT performance) as a base point, some changes had to be made in the in the identity of the plants in the test group. Two plants (12098 and 12187) were dropped because raw waste BOD5 data was not provided, and a third (12160) was dropped because a 90 percent BPT reduction of its BOD5 raw waste concentration would bring it into compliance with the BCT limitation. Five other plants (12132, 12161, 12294, 12307 and 12317) were added because 90% BOD reduction costs and concentrations can be estimated with the data they submitted.

The calculation of BCT criteria for this group of 12 plants involves significant difficulties. In the first place, it is not possible to establish effluent TSS concentrations that exist after a 90% reduction in raw waste BOD and therefore average values must be used for plants that do not have a TSS limitation (9 plants). Consequently, the BCT criteria derived for this plant group will be based to a large extent on artificial performance. Secondly, the BPT TSS limitation in effect for some plants in the test group (3) is more stringent than the anticipated amended BPT and BCT limitations. Attributing costs and removals to meeting this soon-to-be deleted limitation is not reasonable nor is it necessarily consistent with the intent of the Clean Water Act concerning BCT. Finally, this exercise would require that the costs incurred by the 3 plants to meet their existing BPT TSS limitation be separated from the costs required to meet BCT BOD5 limits. This is not feasible, however, since the upgrading costs are developed based on average effluent BOD5 concentrations and not effluent TSS concentrations. Biological treatment systems are designed to meet a target BOD5 effluent level and if the system is operated properly roughly equivalent effluent levels of TSS will result. The data from plants already meeting the anticipated BCT limits show this to be the case.

Nonetheless, BCT criteria for this 12 plant group using the existing BPT regulation as a base point were calculated by assuming TSS average concentrations of 18 mg/l and 178 mg/l (the non-regulated subcategory average), respectively, for plants with and without a TSS limitation. No attempt was made to separate the costs of BPT/TSS compliance from the BCT upgrade costs. The criteria results, $0.38/lb and 0.49, should be interpreted in light of the approximations used to obtain them.

Finally, since we are proposing to amend the existing BPT regulation, we considered whether those changes could alter the

results of the BCT cost test. The planned amended BPT regulation will be the same as the existing BPT regulation except that the current mg/l TSS limitation for B, D and E subcategory plants will be replaced by a limitation based on a long term average concentration of 75 mg/l which will apply to all plants and all operations in subcategories A - E.

The calculation of the test criteria is similar to the calculation just described except that all 12 plants were assigned a TSS concentration of 75 mg/l. The criteria results $0.54 and 0.76 are of questionable validity because the plant by plant removal calculations are based on contrived BPT performance for TSS.

The results obtained from these exercises support the Agency's conclusion concerning the BCT cost test for the pharmaceutical industry. These results also support the Agency's contention that the procedure used to calculate the BCT criteria for comparison to the BCT benchmark figures represents the most effective use of the data available.

4. Technology Basis for BCT

The treatment technologies employed by the industry were evaluated to determine the pattern for technology addition. Primary clarification, neutralization and equalization may be followed by secondary biological treatments such as activated sludge, aerated lagoons or trickling filters and finally by tertiary treatment such as polishing ponds. After consideration of these various technologies, the Agency decided that the technology basis for the BCT limitations will be add-on activated sludge. Activated sludge is both commonly used and effective, and any requirement to achieve improved effluent quality as measured by the conventional pollutant parameters BOD and TSS may be accommodated by either increasing the capacity of existing activated sludge units or by adding new units. The adoption of add-on activated sludge technology as the basis for BCT limitations does not, of course, preclude the use of other technologies to achieve the requisite effluent quality.

Effluent limitations based on the performance of these technologies may be either on a percentage basis or a concentration basis. The reasoning behind the use of a concentration basis for effluent limits is as follows:

a. Markedly higher loadings do not inherently indicate proportionately more difficult treatment. In fact, removal of a pound of BOD equivalent, for example, is generally much easier at higher concentrations than at lower concentrations.

b. A greater removal of pounds of pollutant per dollar expended will generally be accomplished by further treatment of higher concentration streams, an approach not encouraged by percent removal limitations but consistent with concentration limits.

c. Other industry regulations are based on concentration limits and implementation of the regulation would be facilitated by this approach.

d. Dilution in order to meet concentration limits can be avoided by permit recognition of applicable flows.

EPA also considered two other technology options as the basis for BCT. Option (2) for advanced biological treatment entails the addition of specific design units (activated sludge, RBC's or polishing ponds) to existing biological treatment systems. Biological systems employing these additional units can achieve long term effluent performance levels of 20 mg/l BOD_5 and 30 mg/l TSS with appropriate treatment system design and operation. The other option considered (3) was advanced biological treatment that could produce long term average effluent concentrations of 28 mg/l BOD_5 and 36 mg/l TSS. Similarly, this treatment performance can be achieved by the addition of activated sludge digestors, rotating biological contactor units or polishing ponds to existing biological systems. Option 3 is a lower cost option than option 2 because of its less stringent design requirements.

Both options were evaluated using the BCT "cost reasonableness" test as required by the Clean Water Act in the same manner as the selected option was evaluated. The results for the POTW benchmark criterion were $.54/lb. and $.53/lb., respectively, for options 2 and 3. These values are both greater than the $.42/lb. benchmark criterion stipulated for the first part of the test and therefore the Agency has rejected these options for BCT on the basis of the "cost reasonableness" statutory requirement. The failure of these options to pass the cost test is due to the fact that a significant number of plants are achieving effluent quality in terms of BOD_5 and TSS that is close to that required by these options and further upgrading would be relatively cost ineffective for these plants.

5. Regulated Pollutants

Conventional pollutants to be regulated by BCT are BOD_5, TSS and pH. These pollutants were also regulated under the 1976 BPT. No other conventional pollutants were found to present significant problems in the wastewaters of the industry. A more detailed review of the selection of pollutant parameters for regulation is presented in Section VI.

6. Profile of Industry Facilities

An in-depth profile of the Pharmaceutical Industry is provided in Section III of this document. In this section the major manufacturing operations are evaluated in terms of wastewater generating characteristics and priority pollutant usage. While there is significant operational diversity within each manufacturing subcategory and from one subcategory to the next, and while the raw waste loads generated may differ with respect to the composition and concentration of pollutants, the waste load generated by pharmaceutical plants are nonetheless consistently amenable to treatment by biological systems. This is evidenced by the large number of mixed subcategory which employ one biological system to treat wastes from all their manufacturing operations. Moreover, the methods of treatment employed by single subcategory plants do not vary markedly from subcategory to subcategory. The 308 and long term daily data submitted provide adequate justification for proposing one set of limitations for all plants covered by this study.

7. Engineering Aspects of BCT

A technical review and evaluation of treatment technologies employed in the industry, presented in Section VII indicates use of a variety of treatment technologies, both in-plant and end-of-pipe. Filtration of mycelia from fermentation wastewater offers an opportunity for a major reduction in nutrient BOD loading before combination with other wastewaters and also, in some cases, a recoverable by-product.

Since the manufacturing operations entail the handling of mostly organic materials, waste loads which are decidedly acid or alkaline are usually not encountered. However, some neutralization of equalized influent before secondary treatment is often necessary. The secondary biotreatment systems used include activated sludge, aerated lagoons, and trickling filters, with clarification or filtration following.

8. Variability

The variability of wastewater effluent in the industry is a result of variations in three general factors. The first is in raw waste loads and concentrations, resulting from process variation and from phasing of batch and campaign production. The second is in wastewater flow, resulting from variations in production rate and operating techniques. The third is in treatment efficiency which is affected by seasonal ambient conditions and operating variations.

EPA conducted statistical analyses of long-term effluent monitoring data to determine BAT, BCT, and NSPS limitations in the form of daily maximum effluent limitations and 30-day average maximum effluent limitations for traditional pollutants (conventional pollutants TSS and BOD5 and the nonconventional pollutant, COD) and the toxic pollutant, cyanide. In addition, allowable mass-based variability factors were also determined.

The specific methodologies for calculation of these variability factors are discussed in Chapter IX. Variability factors are calculated for each pollutant in terms of both daily and 30-day average levels.

As mentioned above, the 1976 "Development Document" established five manufacturing subcategories of pharmaceutical products and activities for regulatory purposes A through E. The statistical analyses presented are herein for the set of all pharmaceutical plants. As stated earlier, plants operating solely in subcategory E (Research) were not studied as part of the investigation. The contribution of research activities to the effluent of plants also engaged in activities in the first four subcategories was deemed to be negligible.

9. Cost in Relation to Benefits

The cost of BCT implementation is considered to be the cumulative implementation costs for those plants not already meeting the new limits (including estimated costs for plants that supplied insufficient data) at the time of the data surveys. These costs (investment and operating) were developed on a conservative basis for treatment module units wherever reported performance did not meet average long term performance of 55 mg/l for BOD and 51 mg/l for TSS. Estimates based on the average costs for plants not meeting the new limitations were projected for plants submitting insufficient data, assuming that the rate of compliance (76%) found for the plants who submitted complete data applies to these plants. The total annual and investment costs may amount to $7.72 million and $19.4 million, respectively, for direct dischargers. Actual expenditures are expected to be substantially less due to site specific opportunities for improvement of wastewater treatment operations.

BOD discharge by industry direct dischargers will be reduced by an estimated 4,727,000 lb. per year and TSS discharge by an estimated 1,756,000 lb. per year. These discharge reductions were calculated on a long term average concentration basis and include an estimated contribution from plants from whom insufficient data was received. These discharge reductions reflect reductions achievable from actual performance levels as reported in the 308 and long term data surveys.

10. Nonwater Quality Environmental Impact

The four general categories for RCRA wastes generated by the pharmaceutical industry are sludges, waste solvents, infectious wastes, and returned and rejected goods. Only one of these, sludges, is expected to be significantly increased by technologies expected to be employed under BCT.

Sludge from biological treatment can mostly be land-filled, as would separable solid process waste such as mycelia from fermentation.

Implementation of BCT level technology is not expected to affect air emissions significantly.

The energy consumption and cost effect of BCT implementation are slight. Increases in energy needs are largely limited to additional power requirements for pumps, agitators, etc., and are not generally a large requirement. Costs of incremental energy needs are included in the cost studies.

11. Guidance to Enforcement Personnel

The regulatory limits set forth earlier in this section are expressed in terms of concentration. In stating permit limits, it is anticipated limits will be set based both on concentration and on loading, e.g., pounds per day. The conversion requires consideration of flow and unit conversion according to:

$$\text{Maximum Loading (lb/day)} = \text{Maximum Day Concentration (mg/l)} \times \text{Maximum Applicable Flow (MGD)} \times 8.34 \frac{\text{lb} \times \text{liters}}{\text{mg} \times \text{MG}}$$

TABLE XI-2

Incremental BPT and BCT Annual Costs and Removals

Plant #	BPT Cost ($)	BPT Removal (lbs)	BCT Cost ($)	BCT Removal (lbs
12022	6,400,000	9,954,000	1,044,000	581,000
12026	1,400,000	1,641,000	275,000	455,000
12038	4,500,000	22,881,000	1,243,000	5,407,000
12098	200,000	52,000	156,000	39,000
12160	400,000	113,000	203,000	54,000
12187	5,200,000	17,721,000	1,539,000	6,747,000
12236	4,400,000	2,176,000	715,000	845,000
12239	150,000	6,000	89,000	7,000
12462	1,500,000	698,000	387,000	1,080,000
20257	300,000	22,000	171,000	22,000
	24,450,000	55,264,000	5,822,000	16,237,000

TABLE XI-3

BCT Cost Test Criteria

Plant #	Subcategory(s)	BCT Cost ($/lb)	BCT/BPT Ratio
12022	AC	0.66	1.03
12026	C	0.60	0.71
12038	ABCD	0.23	1.17
12098	D	3.98	1.04
12160	D	3.73	1.06
12187	C	0.23	0.78
12236	C	0.85	0.42
12239	C	12.84	0.47
12462	A	0.36	0.17
20257	C	7.93	0.54
		Overall Ave. = 0.36*	Overall Ave. 0.81*

*Calculated from totals in Table XI-2.

SECTION XII

Best Available Technology Economically achievable

A. Summary

1. GENERAL

As a result of the Clean Water Act of 1977, the achievement of BAT has become the principal national means of controlling wastewater discharges of toxic pollutants. The factors considered in establishing the best available technology economically achievable (BAT) level of control include the costs of applying the control technology, the age of process equipment and facilities, the process employed, process changes, the engineering aspects of applying various types of control techniques, and non-water quality environmental considerations such as energy consumption, solid waste, generation, and air pollution (Section 304(b)(2)(B)). In general, the BAT technology level represents, at a minimum, the best economically achievable performance of plants of shared characteristics. Where existing performance is uniformly inadequate, BAT technology may be transferred from a different subcategory or industrial category. BAT may include process changes or internal controls, even when not common industry practice.

The statutory assessment of BAT "considers" costs, but does not require a balancing of costs against effluent reduction benefits (see Weyerhaeuser v. Costle, 11 ERC 2149 (D.C. Cir. 1978)). However, in assessing the proposed BAT, EPA has given substantial weight to the reasonableness of costs. The Agency has considered the volume and the nature of discharges, the volume and nature of discharges expected after application of BAT, the general environmental effects of the pollutants, and the costs and economic impacts of the required pollution control levels. Despite this expanded consideration of costs, the primary determinant of BAT is effluent reduction capability using economically achievable technology.

2. Limitations

BAT limitations are summarized in Table X-1 below.

Table X-1
BAT LIMITATIONS

Pollutant	30-Day Average	Maximum	Daily Maximum

COD (mg/l)	570	1024
Cyanide (mg/l)	0.375	.643

B. Identification of BAT

1. Prior Regulations

The Agency has not previously proposed or promulgated BAT effluent limitation guidelines for the pharmaceutical manufacturing industry. Suggested limitations were published in the 1976 Development Document for information purposes.

2. Regulated Pollutants

The only priority pollutant sufficiently evident in the industry and requiring BAT limitation was cyanide. The nonconventional pollutant COD will also be regulated.

3. Methodology Used

The first part of EPA's priority pollutant study of the pharmaceutical industry involved a review of the priority pollutant information provided in the 308 portfolio responses concerning the manufacturing use and wastewater discharge of priority pollutants. This information was evaluated to determine what priority pollutants were commonly discharged as a result of pharmaceutical manufacturing operations. Those priority pollutants known to be present in wastewater as a result of non-pharmaceutical manufacturing operations (e.g., pesticide manufacturing) or which were present in only one instance (as a result of unique site-specific operations) were rejected as candidates for regulation at that point. After developing a group of commonly discharged priority pollutants (cyanide, toxic solvents, metals, and phenols), the Agency then selected as group of plants for sampling in the S/Y program. The purposes of this program were to determine the levels of these pollutants discharged and the degree to which the raw waste levels of these pollutants were reduced by treatment in-place.

EPA found 34 toxic pollutants in the wastewater of pharmaceutical plants who were in the S/V program. 33 of these pollutants have been excluded from direct discharger regulations by the provisions of paragraph 8 of the Consent Decree. A detailed discussion of the rationale for these exclusions and the exclusions of the pollutants not found in the S/V program is contained in Section VI of this document. The remaining toxic pollutant, cyanide, was found at levels and frequencies requiring regulatory control (see Section X).

A. Cyanide

Where toxics are present at levels and frequencies requiring regulation, but insufficient technological justification exists for levels more stringent than BPT, BAT levels should be set at BPT levels for such toxics. In regard to the BAT control of cyanide in the pharmaceutical industry, EPA has concluded that further reduction of cyanide from the BPT level has not been adequately demonstrated by technologies for cyanide destruction. Therefore, the Agency is proposing BAT limitations to control cyanide which are equal to the BPT limitations.

B. COD

In addition to controlling toxic pollutants, BAT may be appropriate for the control of nonconventional pollutant parameters. One such parameter, COD, has been found at high concentrations in the raw waste of direct discharging pharmaceutical plants. This pollutant parameter is a measure of the non-biodegradable or slowly biodegradable organics in wastewater. The discharge of COD is currently being controlled by percent reduction limitation of the existing BPT regulation.

In its analysis of the 13 plant BCT data set discussed in Section IX, the Agency was able to derive a long term average concentration of COD based on data submitted from 12 of the 13 plants. This average performance together with the daily and 30-day average variability factors (see Section IX for methods of calculation) were combined to provide COD daily maximum and 30-day maximum average limitations. This performance is characteristic of what is achievable by BCT biotreatment systems in regard to the control of COD. These systems are also judged to be the "best available and economically achievable."

4. Technology Basis for BAT

The technology basis for BAT is a combination of cyanide destruction (part of the technology basis for BPT) and add-on activated sludge (the technology basis for the BCT limitations). While most plants will be able to meet the COD limitations by proper operation of adequately designed and operated biological treatment to which any required activated sludge capacity has been added, some plants because of their heavy use of certain refractory organic materials (e.g., solvents and some synthetic starting materials) may be required to carefully control the amounts of these substances that enter their wastewater in order to meet these limitations. In some instances this may require appropriate stream segregation and treatment or disposal or changes in process operations.

EPA also considered other technology options for the control of COD. Specifically, EPA considered the two advanced biological treatment options that were also considered for BCT (See Section XI). These options were rejected for BAT control of COD after an evaluation of the available treatment in terms of the processes which generate COD in the pharmaceutical industry indicated that these technology options would require a level of COD reduction which is not achievable generally achievable by existing direct dischargers.

5. Costs and BMP Considerations

Cost considerations relating to COD limitations are intimately involved with the costs for BOD5 and TSS removal addressed by the BCT cost analysis, as the same technology which achieves BCT limits will achieve the COD limits under BAT. A discussion of the BCT costs may be found in Section XI. Therefore, there are no incremental costs for COD control attributable to BAT. In addition, no costs are expected as a result of the BAT limitations on cyanide discharge since any costs to be incurred are attributable to the BPT regulation.

No BMPs (Best Management Practices) beyond those required by the existing BPT regulation are proposed in this rulemaking.

6. Guidance to Enforcement Personnel

Although cyanide is the only priority pollutant to be limited by this regulation, enforcement personnel are urged to limit other priority pollutants at specific plants where they are identified as discharged in treatable quantities. Permit writers should study the product/process mix employed by each facility to determine whether toxic pollutants may be discharged in manufacturing operations. The priority pollutants used in various pharmaceutical manufacturing operations are presented in the PEDCo reports (41, 42, 43). Raw materials and process materials are the two key areas of priority pollutant usage. A good understanding of these areas as they pertain to a given facility is necessary before any decision can be made about imposing additional controls on toxic pollutants not controlled by BAT.

Referring to screening and verification data will also provide the permiters with information on priority pollutant levels in a plant's discharge. Careful note should be made of both influent and effluent concentrations of toxic compounds so that the process and non-process dilution effects can properly be accounted for.

Although the most efficient removals of toxic pollutants are performed at the in-plant treatment level, end-of-pipe technologies are effective in removing substantial amounts of priority pollutants as well. In-plant treatment for the removal of toxic metals and solvents (metal precipitation and steam stripping) has been found to be very effective when applied to streams containing high concentrations of these pollutants (see Section VII). The performance capabilities of these technologies should be carefully considered when site-specific limitations are to be imposed.

A review of permit limits may be required if changes in the materials or processes occur. Such changes may require that limitations on toxics discharge be eased or made more stringent or completely eliminated. In some cases, new limitations may be necessary. Any changes in operations reported by the permit holder should alert the permit writer to the possibility of new limitations.

SECTION XIII

NEW SOURCE PERFORMANCE STANDARDS

A. Summary

1. General

The basis for new source performance standards (NSPS) under Section 306 of the Act is the best available demonstrated technology. At new plants, the opportunity exists to design the best and most efficient production processes and wastewater treatment facilities. Therefore, Congress directed EPA to consider the best demonstrated process changes, in-plant controls, and end-of-pipe treatment technologies that reduce pollution to the maximum extent feasible.

2. Limitations

NSPS limitations are summarized in Table XII-1, below:

Table XIII-1
NEW SOURCE PERFORMANCE STANDARDS

Pollutant	Range	30-Day Average Max	Daily Maximum
BOD5 (mg/l)	-	51	126
COD (mg/l)	-	449	853
TSS (mg/l)	-	72	195
Cyanide (mg/l)	-	0.375	0.643
pH	6.0 - 9.0		

B. Identification of NSPS

1. Methodology Used

a. BOD5, COD and TSS

NSPS for BOD, COD and TSS were derived from the data of a more select group of plants than that group whose data was used to develop BCT and BAT limitations. This more select group was established by deleting data from three plants. The performance of these plants (12022, 12026 and 12236) was considered significantly inferior to that of the other 10 plants in the BCT (BAT) group from the standpoint of both removal efficiency and final effluent concentration (see discussion in Section IX) and therefore inappropriate in light of the statutory requirements

for NSPS. The effluent data points from the remaining 10 plants were used to develop a long term average for each pollutant parameter. 30-day average maximum and daily maximum variability factors for each pollutant parameter were derived from the data from these 10 plants as described in Section IX. These factors multiplied by the long term average values for the individual pollutant parameters equal the 30-day maximum average and daily maximum limitations.

b. Cyanide

The cyanide NSPS are identical to those derived for the BPT, BAT and PSES regulations. Data is not yet available to the Agency which indicates that more stringent levels of cyanide control can be achieved by new sources.

2. Regulated Pollutants

Pollutants regulated for NSPS are those also regulated under BPT guidelines. These are the conventionals BOD5, TSS, and pH, the nonconventional pollutant COD, and the toxic pollutant cyanide. A more detailed review of the selection of pollutant parameters for regulation is presented in Section VI.

3. Engineering Aspects

End-of-pipe treatment systems can be designed to attain the long term average concentrations for BOD, COD and TSS which form the bases of NSPS for these pollutant parameters. Several plants in the long term and 308 data bases have provided data along with descriptions of their end-of-pipe systems that demonstrate that these standards are achievable. Biological treatment systems which have capacities that allow for sufficient aeration and retention time and which employ equalization of waste loads prior to biotreatment are quite capable of producing effluent which meets these standards. The fact that different wastes from various manufacturing operations may have different K factors (biodigradability constants) associated with them has been and can be accounted for by on-site treatment system design and does not necessitate separate standards for different subcategories of plants.

EPA also considered two other technology options as the basis for NSPS. One option was identical to the technology option chosen for BAT (namely enhanced biological treatment and in-plant cyanide control). After a review of the technology available to treat wastewater from pharmaceutical manufacturing operations, the Agency concluded that this option did not provide sufficiantly stringent control of traditional pollutants (BOD5, COD and TSS) in terms of the demonstrated performance of

available treatment systems in the industry and new sources could achieve a more stringent levels of control with proper treatment system design. The second option considered (also considered for BAT) involved specified design treatment levels (20 mg/l BOD5, 30 mg/l TSS and 270 mg/l COD) for enhanced biological treatment. After review of the best demonstrated available technology in the industry, the Agency concluded that this technology option was insufficiently demonstrated in the industry to warrant its selection.

In addition to being able to design better performing end-of-pipe treatment systems, new sources may also design manufacturing operations and install appropriate in-plant controls in such a way as to limit the amount of waste that must be treated end-of-pipe. Provision may also be made for the recycle and reuse of water, solvent recovery and reuse and other resource and materials conserving practices by incorporation of these functions into the design of the plant. The ability to practice resource recovery and reuse is not always available to existing sources because of on-site structural limitations.

EPA considered the feasibility of attaining the new source performance standards at new sites from the standpoint of the technology basis (i.e., enhanced biological treatment). The Agency concluded that these standards would not impose any unachievable technological requirements on new sources beyond those already met by existing sources. We also considered the effect of the NSPS technological basis on existing sources who might expand on-site pharmaceutical operations or start new ones. The Agency concluded that the new source standards applicable to these new pharmaceutical operations at existing sites would also not impose technological requirements that are not currently being satisfied by existing source direct dischargers.

4. Total Capital and Annual Costs and Incremental Pollutant Reduction

The total capital and annual costs of new source wastewater treatment technology for an average mixed subcategory pharmaceutical source are estimated to be $3.9 million and $1.5 million, respectively. These costs for an average new source are estimated to be 38 percent greater than the costs incurred by the average existing source in meeting BCT/BAT. Average pollutant reductions for BOD5, TSS and COD by an new source will be 18% greater than that achieved by an existing source.

SECTION XIV

PRETREATMENT STANDARDS FOR NEW AND EXISTING SOURCES

A. Summary

1. General

Section 307(b) of the Act requires EPA to promulgate pretreatment standards for existing sources (PSES) that must be achieved by a data specified by EPA which is not later than three years from promulgation. PSES are designed to prevent the discharge from presently operating facilities of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of POTWs.

Section 307(c) of the Act requires EPA to promulgate pretreatment standards for new sources (PSNS) at the same time that it promulgates NSPS. New indirect dischargers, like new direct dischargers, have the opportunity to incorporate the best available demonstrated technologies including process changes, in-plant control measures, and end-of-pipe treatment and to use plant site selection to ensure adequate treatment system installation. PSNS are designed to prevent the discharge from new facilities of pollutants that pass-through, interfere with, or are otherwise incompatible with the operation of POTWs.

The Clean Water Act of 1977 states that pretreatment is required for pollutants, such as heavy metals, that pass through POTWs in amounts that would violate direct discharger effluent limitations or limit POTWs' sludge management alternatives, including the beneficial use of sludges on agricultural lands. The legislative history of the 1977 Act indicates that pretreatment standards are to be technology-based, analogous to the best available technology for removal of toxic pollutants. The general pretreatment regulations (40 CFR Part 403) which serve as the framework for these proposed pretreatment regulations can be found in 40 FR 27736 (June 26, 1978).

2. Standards

Standards controlling cyanide discharge will be proposed. These standards are shown below in Table XIV-1 and are identical for existing and new sources.

Table XIV-1
PRETREATMENT STANDARDS FOR NEW AND EXISTING SOURCES

Pollutant	30 Day Maximum Average	Daily Maximum

Cyanide (mg/l)	0.375	0.643

Additional standards for total volatile organics (TTVO) are being considered and are also discussed below.

B. Identification of Pretreatment Standards

1.. Methodology Used

a. Cyanide

308 submissions indicate that 31 of the 278 indirect dischargers use cyanide in their manufacturing operations (batch and continuous). S/V data indicate that pharmaceutical plants wastewater may contain high concentrations of cyanide as a result of process operations. High concentrations of cyanide will interfere with the operation of biological treatment systems which are utilized by POTWs and various ranges of cyanide concentrations have been shown to pass through the treatment systems of municipal plants (117). High concentrations of cyanide in the POTW sludge will also limit the alternatives available for its management. Consequently, PSES and PSNS for the control of cyanide discharge are deemed appropriate. The cyanide destruction technology and data which form the basis for BPT and BAT cyanide limitations may also be used to prevent pass-through, etc. by indirect sources and therefore is used as the basis for PSES and PSNS.

b. TTVO (Total Toxic Volatile organics)

Although a Paragraph 8 exclusion of direct discharges from limitations controlling the discharge of toxic volatile organics has been recommended for BAT and NSPS, such an exclusion from regulation is not appropriate for indirect dischargers. Information from the 308 data base shows that 155 indirect discharging plants use priority pollutant solvents in their manufacturing operation. An extropolation of the S/V flow weighted mean TTVO raw waste concentration (232 mg/l) to these plants results in a TTVO loading of 19.5 million pounds per year. This loading is significant in that only 12 plants have indicated having treatment in-place which can reduce raw waste concentrations of these pollutants, e.g., steam stripping and aerated equalization.

Generally, POTWs with secondary treatment do reduce their influent concentration of volatile organics to some extent. Data from the 40 plant POTW study (133) indicate that POTWs may remove 68.5% (mass based) of the raw waste TTVO found in the S/V program. However, the biological treatment systems of direct

dischargers in the S/V program were able to achieve an overall mass based average removal rate of 96.1% for a very similar mix of solvents. It was also found that the POTW removal rates of individual commonly found toxic solvents were less in most cases than the direct discharger removal rates of the same solvents. A comparison of these removal rates along with the percent by weight of the various solvents found in the S/V sampling program is presented in Table XIV-2.

The Agency's interpretation of the pass-through provision of 307(b) of the Act assumes that pass through at POTWs occurs as a result of a pollutant discharge from an industrial category when the percent removal of that pollutant achieved by the BAT treatment systems is greater than that achieved by POTWs. The available data viewed in light of this interpretation suggest that pretreatment standards controlling the discharge of toxic solvent pollutants may be required to prevent pass through of these substances at POTWs.

The recommended technology for reducing the concentration of volatile organics in wastewater is steam stripping. The performance capability of steam stripping technology has been discussed in Section VII of this document. The employment of this technology on a selected in-plant basis would drastically reduce the current discharge of toxic solvents from indirect dischargers. Although a few plants (6) have indicated that they have steam strippers in-place, data has not been made available which would allow derivation of standards for TTVO. When such performance data is received a decision on how the discharge of toxic solvents by indirect dischargers can be regulated will be made. Therefore, pretreatment standards controlling the discharge of TTVO are not specified in this rulemaking. However, if during this rulemaking we obtain appropriate data concerning the performance of steam-stripping to derive standards, we will include a TTVO standard in the final regulation.

c. Other Toxics

EPA also considered the effect that other toxic pollutants, which were found in significant concentrations in the wastewater of pharmaceutical plants, would have on the operation of POTWs. One group of pollutants, phenol and the various phenol type pollutants, is adequately biodegraded by the biological treatment systems of direct dischargers and the evidence available from the 40-plant POTW study (117) indicates that the concentrations of these pollutants as discharged by pharmaceutical plants can be adequately reduced by the secondary treatment works of POTWs. The concentrations of toxic metals discharged by indirect discharging pharmaceutical plants are low enough that no pass-through or interference problems result from this discharge at

POTWs. Therefore, no pretreatment standards are required to control the discharge of toxic metals, phenol and phenol related pollutants from pharmaceutical plants.

1. Regulated Pollutants

Only cyanide will be controlled by pretreatment standards in this rulemaking. These standards will apply to end-of-pipe discharges and will limit total cyanide (complexed and free).

2. Engineering Aspects

Cyanide can be controlled on an in-plant basis by the cyanide destruction systems discussed in Section VII. Process streams containing high cyanide concentrations can be selectively treated for cyanide and the effluent from cyanide destruction can then be combined with other wastewater streams.

4. Variability

The cyanide effluent standards to be proposed for indirect dischargers are 30-day maximum average and daily maximum standards. These standards are identical to the BPT and BAT limitations as well as the new source standards (NSPS) for cyanide and account for variations in raw waste loads and flows.

5. Cost and Nonwater Quality Aspects

The annual and investment costs to indirect dischargers for meeting the cyanide standards are $880,000 and $323,000, respectively. Increases in energy use as a result of these standards are expected to be very small and no increase in wastes to be disposed of under RCRA is anticipated.

6. Guidance to Enforcement Personnel

Enforcement personnel are referred to Sections VI, IX and X and an earlier part of this section for information concerning the development of these standards.

TABLE XIV-2

COMPARISON OF POTW AND DIRECT DISCHARGER REMOVAL RATES FOR SOLVENTS

Toxic Solvent	% by Wgt. in Raw Waste of S/V Plants	POTW Removal Rate, %	Direct Discha Removal Rate,
Methylene chloride	59.3	58	92
1,1,1-trichloro-ethane	23.0	87	**
Toluene	8.9	90	98
Chlorobenzene	4.2	67	100
Chloroform	1.8	61	94
Ethylbenzene	1.2	84	85
1,2-Dichloro-ethane	0.9	91	95
Benzene	0.3	71	69
Methyl chloride	0.3	92	100
Others	0.1	-	-

*Other solvents found at least once include tetrachloroethylene, 1,1-dichloroethane, 1,1-dichloroethylene, carbon tetrachloride, trichloroethylene, chloroethane, 1,2-trans-dichloroethylene, 1,1,2-trichloroethane and bromoform.

**Influent concentrations are to low to make accurate removal rate estimates.

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SECTION XVII

LEGEND OF ABBREVIATIONS

AA	atomic absorption
A.C.	activated carbon
AE	Acid extractables
atm	atmosphere
avg.	average
BADCT	Best Available Demonstrated Control Technology
BAT (BATEA)	Best Available Technology Economically Achievable
bbl.	barrel
BCT	Best Conventional Control Technology
B-N	Base - Neutral Extractables
BOD_5	Biochemical Oxygen Demand, five day
BPT (BPCTA)	Best Practicable Control Technology Currently Available
Btu	British Thermal Unit
^oC	degrees Centigrade
C.A.	carbon adsorption
cal.	calorie
cc	cubic centimeter
cfm	cubic feet per minute
cfs	cubic feet per second
cm	centimeter
CN	cyanide
COD	Chemical Oxygen Demand
conc.	concentration
cu.m.	cubic meter
deg.	degree
DO	dissolved oxygen
E.Col.	Escherichia coli - coliform bacteria
Eq.	equation
^oF	degrees Fahrenheit
Fig.	Figure
F/M	Food to microorganisms ratio (lbs BOD/lbs MLSS)
fpm	feet per minute
fps	feet per second
ft	foot
g	gram
gal.	gallon
GC	Gas chromatography
GC/MS	Gas chromatography/Mass Spectrophotometry
gpd	gallon per day
gpm	gallon per minute

hp	horsepower
hp-hr	horsepower-hour
HPLC	High Pressure Liquid Chromatography
hr	hour
in	inch
kg	kilogram
KW	kilowatt
KWh	kilowatt hour
l	liter
l/kkg	liters per 1000 kilograms
lb	pound
m	meter
M	thousand
mg	milligram
MGD	million gallons per day
mg/l	milligrams per liter
min	minute
ml	milliliter
MLSS	mixed liquor suspended solids
MLVSS	mixed liquor volatile suspended solids
mm	millimeter
MM	million
mole	gram molecular weight
mph	mile per hour
MPN	most
mu	millimicron
NH_3-N	ammonia nitrogen
NO_3-N	nitrate nitrogen
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standards
O_2	Oxygen
PO_4	phosphate
p.	page
pH	potential hydrogen or hydrogen-ion index (negative logrithm of the hydrogen-ion concentration)
POTW	Publicly Owned Treatment Works
pp.	pages
ppb	parts per billion
ppm	parts per million
PSES	Pretreatment Standards for Existing Sources
psf	pounds per square foot
psi	pounds per square inch
PSNS	Pretreatment Standards for New Sources
RBC	Rotating Biological Contactor
R.O.	reverse osmosis
rpm	revolution per minute

RWL	raw waste load
sec.	second
Sec.	Section
SIC	Standard Industrial Classification
SOx	Oxides of Sulfur (e.g. sulfate)
sq.	square
sq. ft.	square foot
SS	suspended solids
STP	standard temperature and pressure
SRWL	standard raw waste load
TDS	total dissolved solids
TKN	total Kjedahl nitrogen
TLM	median tolerance limit
TOC	total organic carbon
TOD	total oxygen demand
TSS	total suspended solids
VOA	Volatile Organic Analysis
vol	volume
wt	weight
yd	yard
u	micron
ug	microgram
ug/l	microgram per liter

note: symbols for chemical elements and compounds are in accordance with IUPAC and standard chemical nomenclature.

SECTION XVI

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APPENDIX A

Glossary

APPENDIX A

GLOSSARY

Abatement. The measures taken to reduce or eliminate pollution.

Absorption. A process in which one material (the absorbent) takes up and retains another (the absorbate) with the formation of a homogeneous mixture having the attributes of a solution. Chemical reaction may accompany or follow absorption.

Acclimation. The ability of an organism to adapt to changes in its immediate environment.

Acid. A substance which dissolves in water with the formation of hydrogen ions.

Acidulate. To make somewhat acidic.

Act. Clean Water Act of 1977, PL 95-217.

Activated Carbon. Carbon which is treated by high temperature heating with steam or carbon dioxide producing an internal porous particle structure.

Activated Sludge Process. A wastewater purification process in which microorganisms absorb dissolved or suspended organic matter and secrete enzyme to digest and utilize this matter. The term "activated sludge" applies to the flocculant growths formed as the microorganisms grow and reproduce.

Active Ingredient. The chemical constituent in a medicine which is responsible for its activity.

Adsorption. A method of treating wastes in which a material (designated "adsorbent") chemicals or organic matter not necessarily responsive to clarification or biological treatment by adherence on the surface of solid bodies.

Advanced Waste Treatment. Any treatment method or process employed following biological treatment to increase the removal of pollution load, to remove substances that may be deleterious to receiving waters or the environment or to produce a high-quality effluent suitable for reuse in any specific manner or for discharge under critical conditions. The term tertiary treatment is commonly used to denote advanced waste treatment methods.

Aeration. (1) The bringing about of intimate contact between air and a liquid by one of the following methods: spraying the

liquid in the air, bubbling air through the liquid, or agitation of the liquid to promote surface absorption of air. (2) The process or state of being supplied or impregnated with air; in waste treatment, a process in which liquid from the primary clarifier is mixed with compressed air and with biologically active sludge.

Aerobic. Ability to live, grow, or take place only where free oxygen is present.

Algae. Unicellular or multicellular autotrophic, photosynthetic protists. They are a food for fish and small aquatic animals and, like all plants, put oxygen into the water.

Algicide. Chemical agent added to water to destroy algae. Copper sulfate is commonly used in large water systems.

Alkali. A water-soluble metallic hydroxide that ionizes strongly.

Alkalinity. The presence of salts of alkali metals. The hydroxides, carbonates, and bicarbonates of calcium, sodium and magnesium are common impurities that cause alkalinity. A quantitative measure of the capacity of liquids or suspensions to neutralize strong acids or to resist the establishment of acidic conditions. Alkalinity results from the presence of bicarbonates, carbonates, hydroxides, alkaline salts and occasionally borates and is usually expressed in terms of the amount of calcium carbonate that would have an equivalent capacity to neutralize strong acids.

Alkaloids. Basic (alkaline) nitrogenous botanical products which produce a marked physiological action when administered to animals or humans.

Alkylation. The addition of a aliphatic group to another molecule. The media in which this reaction is accomplished can be vapor or liquid phase, as well as aqueous or non-aqueous.

Ammonia Nitrogen. A substance produced by the microbiological decay of plant and animal protein. When ammonia nitrogen is found in waters, it is indicative of incomplete treatment.

Ampules. A small glass container that can be seated and its contents sterilized. Ampoules are used to hold hypodermic solutions.

Anaerobic. Ability to live, grow, or take place where there is no air or free oxygen present.

Anion. Ion with a negative charge.

Antagonistic Effect. The simultaneous action of separate agents mutually opposing each other.

Antibiotic. A substance produced by a microorganism which has the power, in dilute solution, to inhibit or destroy other organisms, especially bacteria.

Aqueous Solution. One containing water or watery in nature.

Arithmetic Mean. The arithmetic mean of a number of items is obtained by adding all the items together and dividing the total by the number of items. It is frequently called the average. It is greatly affected by extreme values.

Autoclave. A heavy vessel with thick walls for conducting chemical reactions under high pressure. Also an apparatus using steam under pressure for sterilization.

Azeotrope. A liquid mixture that is characterized by a constant minimum or maximum boiling point which is lower or higher than that of any of the components and that distills without change in composition.

Bacteria. Unicellular protists having round, rodlike, spiral, or filamentous bodies and often aggregated into colonies or mobile by means of flagella. They exist in soil, water, organic matter, and in the bodies of plants and animals. Nutritionally, they are autotrophic, saprophytic, or parasitic. Temperature and pH play an important role in the life cycle of bacteria. A few are capable of performing photosynthesis. Any water supply contaminated by sewage is certain to contain a bacterial group called "coliform."

Bacteriophage. A submicroscopic, usually viral, organism that destroys bacteria. Also called "phage."

BADCT. Limitations for new sources which are based on the application of the Best Available Demonstrated Control Technology.

Base. A substance that in aqueous solution turns red litmus blue, furnishes hydroxyl ions and reacts with an acid to form a salt and water only.

BAT Effluent Limitations. Limitations for point sources, other than publicly owned treatment works, which are based on the application of the Best Available Technology Economically Achievable. These limitations must be achieved by July 1, 1983.

Batch Process. A process which has an intermittent flow of raw materials into the the process and a resultant intermittent flow of product from the process.

BCT. Best Conventional Pollutant Control Technology.

Bioassay. An assessment which is made by using living organisms as the sensors.

Biochemical Oxygen Demand (BOD). A measure of the oxygen required to oxidize the organic material in a sample of wastewater by natural biological process under standard conditions. This test is presently universally accepted as the yardstick of pollution and is utilized as a means to determine the degree of treatment in a waste treatment process. Usually given in mg/l(or ppm) units), meaning milligrams of oxygen required per liter of wastewater, it can also be expressed in pounds of total oxygen required per wastewater or sludge batch. The standard BOD test is run for five days at 20 degrees C.

Biota. The flora and fauna (plant and animal life) of a stream or other water body.

Biological Products. In the pharmaceutical industry, medicinal products derived from animals or humans, such as vaccines, toxoids, antisera and human blood fractions.

Biological Treatment System. A system that uses microoganisms to remove organic pollutant material from a wastewater.

Blood Fractionation. The separation of human blood into its various protein fractions.

Blowdown. (1) Water intentionally discharged from a cooling or heating system to maintain the dissolved solids concentration of the circulating water below a specific critical level. The removal of a portion of any process flow to maintain the constituents of the flow within desired levels. Process may be intermittent or continuous. (2) The water discharged from a boiler or cooling tower to dispose of accumulated salts.

BOD5. Biochemical oxygen demand (BOD) is the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic conditions. The BOD test has been developed on the basis of a 5-day incubation period (i.e. BOD5).

Botanicals. Drugs made from a part of a plant, such as roots, bark, or leaves.

BPT Effluent Limitations. Limitations for point sources, other than publicly owned treatment works, which are based on the application of the Best Practicable Control Technology Currently Available. These Limitations must be achieved by July 1,1977.

Brine. Water saturated with a salt.

Buffer. A solution containing either a weak acid and its salt or a weak base and its salt which thereby resists changes in acidity or basicity (pH).

Capsules. A gelatinous shell used to contain medicinal chemicals and as a dosage form for administering medicine.

Carbohydrate. A compound of carbon, hydrogen and oxygen, usually having hydrogen and oxygen in the proportion of two to one.

Carbonaceous. Containing or composed of carbon.

Catalyst. A substance which changes the rate of a chemical reaction but undergoes no permanent chemical change itself.

Cation. The ion in an electrolyte which carries the positive charge and which migrates toward the cathode under the influence of a potential difference.

Cellulose. The fibrous constituent of trees which is the principal raw material of paper and paperboard. Commonly thought of as a fibrous material of vegetable origin.

Chemical Oxygen Demand (COD). A measure of oxygen-consuming capacity of organic and inorganic matter present in water or wastewater. It is expressed as the amount of oxygen consumed from a chemical oxidant in a specific test. It does not differentiate between stable and unstable organic matter and thus does not correlate with biochemical oxygen demand.

Chemical Synthesis. The processes of chemically combining two or more constituent substances into a single substance.

Chlorination. The application of chlorine to water, sewage or industrial wastes, generally for the purpose of disinfection but frequently for accomplishing other biological or chemical results.

Coagulation. The clumping together of solids to make them settle out of the sewage faster. Coagulation of solids is brought about with the use of certain chemicals, such as lime, alum or polyelectrolytes.

Combined Sewer. One which carries both sewage and storm water run-off.

Composite Sample. A combination of individual samples of wastes taken at selected intervals, generally hourly for 24 hours, to minimize the effect of the variations in individual samples. Individual samples making up the composite may be of equal volume or be roughly apportioned to the volume of flow of liquid at the time of sampling.

Comprehensive Pharmaceutical Data Base. Combined data base formed by the first 308 survey of PMA-member companies plus the second, or Supplemental 308 survey.

Concentration. The total mass of the suspended or dissolved particles contained in a unit volume at a given temperature and pressure.

Conductivity. A reliable measurement of electrolyte concentration in a water sample. The conductivity measurement can be related to the concentration of dissolved solids and is almost directly proportional to the ionic concentration of the total electrolytes.

Contact Process Wastewaters. These are process-generated wastewaters which have come in direct or indirect contact with the reactants used in the process. These include such streams as contact cooling water, filtrates, centrates, wash waters, etc.

Continuous Process. A process which has a constant flow of raw materials into the process and resultant constant flow of product from the process.

Contract Disposal. Disposal of waste products through an outside party for a fee.

Crustaceae. These are small animals ranging in size form 0.2 to 0.3 millimeters long which move very rapidly through the water in search of food. They have recognizable head and posterior sections. They form a principal source of food for small fish and are found largely in relatively fresh natural water.

Crystallization. The formation of solid particles within a homogeneous phase. Formation of crystals separates a solute from a solution and generally leaves impurities behind in the mother liquid.

Culture. A mass of microorganisms growing in a media.

Cyanide, Total. Total cyanide as determined by the test prodecure specified in 40 CFR Part 136 (Federal Register, Vol. 38, no. 199, October 16,1973).

Cyanide A. Cyanides amenable to chlorination as described in "1972 Annual Book of ASTM Standards" 1972: Standard 2036-72, Method B, p. 553.

Derivative. A substance extracted from another body or substance.

Desorption. The opposite of adsorption. A phenomenon where an adsorbed molecule leaves the surface of the adsorbent.

Diluent. A diluting agent.

Direct Discharge. The discharge of process wastewaters to navigable waters such as rivers, streams and lakes.

Disinfectant. A chemical agent which kills bacteria.

Disinfection. The process of killing the larger portion (but not necessarily all) of the harmful and objectionable microorganisms in or on a medium.

Dissolved Oxygen (DO). The oxygen dissolved in sewage, water or other liquids, usually expressed either in milligrams per liter or percent of saturation. It is the test used in BOD determination.

Distillation. The separation, by vaporization, of a liquid miscible and volatile mixture into individual components, or, in some cases, into groups of components. The process of raising the temperature of a liquid to the boiling point and condensing the resultant vapor to liquid form by cooling. It is used to remove substances from a liquid or to obtain a pure liquid from one which contains impurities or which is a mixture of several liquids having different boiling temperatures. Used in the treatment of fermentation products, yeast, etc., and other wastes to remove recoverable products.

Effluent. A liquid which leaves a unit operation or process. Sewage, water or other liquids, partially or completely treated or in their natural states, flowing out of a reservoir basin, treatment plant or any other unit operation. An influent is the incoming stream.

Elution. (1) The process of washing out, or removing with the use of a solvent. (2) In an ion exchange process it is defined as the stripping of adsorbed ions from an ion exchange resin by

passing through the resin solutions containing other ions in relatively high concentrations.

Emulsion. A suspension of fine droplets of one liquid in another.

Equalization Basin. A holding basin in which variations in flow and composition of a liquid are averaged. Such basins are used to provide a flow of reasonably uniform volume and composition to a treatment unit.

Esterification. This generally involves the combination of an alcohol and an organic acid to produce an ester and water. The reaction is carried out in the liquid phase, with aqueous sulfuric acid as a catalyst. The use of sulfuric acid has, in the past, caused this type ofonation.

Ethical Products. Pharmaceuticals promoted by advertising to the medical, dental and veterinary professions.

Fatty Acids. An organic acid obtained by the hydrolysis (saponification) of natural fats and oils, e.g., stearic and palmitic acids. These acids are monobasic and may or may not contain some double bonds. They usually contain sixteen or more carbon atoms.

Fauna. The animal life adapted for living in a specified environment.

Fermentation. Oxidative decomposition of organic substances through the action of enzymes produced by microorganisms.

Fermentor Broth. A slurry of microorganisms in water containing nutrients (carbohydrates, nitrogen) necessary for the microorganisms' growth.

Filter Cakes. Wet solids generated by the filtration of solids from a liquid. This filter cake may be a pure material (product) or a waste material containing additional fine solids (i.e., diatomaceous earth) that have been added to aid in the filtration.

Fines. Crushed solids sufficiently fine to pass through a screen, etc.

Flocculants. Those water-soluble organic polyelectrolytes that are used alone or in conjunction with inorganic coagulants such as lime, alum or ferric chloride or coagulant aids to agglomerate solids suspended in aqueous systems or both; the large dense

flocs resulting from this process permit more rapid and more efficient solids-liquid separations.

Flora. The plant life characteristic of a region.

Flotation. A method of raising suspended matter as scum to the surface of the liquid in a tank by aeration, vacuum, evolution of gas, chemicals, electrolysis, heat or bacterial decomposition and the subsequent removel of the scum by skimming.

Fractionation (or Fractional Distillation). The separation of constituents, or groups of constituents, of a liquid mixture of miscible and volatile mixtures by vaporization and recondensation over specific boiling point ranges.

Fungus. Any of a plant-like group of organisms that does not produce chlorophyll; they derive their food either by decomposing organic matter from dead plants and animals or by parasitic attachment to living organisms, thus often causing infections and disease. Examples of fungi are molds, mildews, mushrooms, and the rusts and smuts that infect grain and other plants. They grow best in a moist environment at temperatures of about 25°C, little or no light being required. In sanitary engineering, fungi are considered to be multicellular, nonphotosynthetic, heterotrophic protists.

Gland. A device utilizing a soft wear-resistant material used to minimize leakage between a rotating shaft and the stationary portion of a vessel such as a pump.

Gland Water. Water used to lubricate a gland. Sometimes called "packing water."

Grab Sample. (1) Instantaneous sampling. (2) A sample taken at a random place in space and time.

Grease. In sewage, grease includes fats, waxes, free fatty acids, calcium and magnesium soaps, mineral oils and other non-fatty materials. The type of solvent to be used for its extraction should be stated.

Hardness. A measure of the capacity of water for precipitating soap. It is reported as the hardness that would be produced if a certain amount of CaCo3 were dissolved in water. More than one ion contributes to water hardness. The "Glossary of Water and Wastewater Control Engineering" defines hardness as: A characteristic of water imparted by salts of calcium, magnesium and iron, such as bicarbonates, carbonates, sulfates, chlorides and nitrates, that causes curdling of soap, deposition of scale in boilers, damage in some industrial processes, and sometimes

objectionable taste. Calcium and magnesium are the most significant constituents.

Hormone. Any of a number of substances formed in the body which activate specifically receptive organs when transported to them by the body fluids. A material secreted by ductless glands (endocrine glands). Most hormones as well as synthetic analogues have in common the cyclopentanophenanthrene nucleus.

Indirect Discharge. The discharge of (process) wastewaters to publicly owned treatment works (POTW).

Injectables. Medicinals prepared in a sterile (buffered) form suitable for administration by injection.

Mycelia. The filamentous material which makes up the vegetative body of a fungus.

New Source. Any facility from which there is or may be a discharge of pollutants, the construction of which is commenced after the publication of proposed regulations prescribing a standard of performance under section 306 of the Act.

Non-contact Cooling Water. Water used for cooling that does not come into direct contact with any raw material, intermediate product, waste product or finished product.

Non-contact Process Wastewaters. Wastewaters generated by a manufacturing process which have not come in direct contact with the reactants used in the process. These include such streams as noncontact cooling water, cooling tower blowdown, boiler blowdown, etc.

NSPS. New Source Performance Standards.

NPDES. National Pollution Discharge Elimination System. A federal program requiring industry to obtain permits to discharge plant effluents to the nation's water courses.

Nutrient. Any substance assimilated by an organism which promotes growth and replacement of cellular constituents.

Operation and Maintenance. Costs required to operate and maintain pollution abatement equipment including labor, material, insurance, taxes, solid waste disposal, etc.

Organic Loading. In the activated sludge process,the food to microorganisms (F/M) ratio defined as the amount of biodegradable material available to a given amount of microorganisms per unit of time.

Oxidation. A process in which an atom or group of atoms loses electrons; the combination of a substance with oxygen, accompanied with the release of energy. The oxidized atom usually becomes less positive while the oxidizing agent becomes more negative (in chlorination, for example).

Oxidation Reduction (OR). A class of chemical reactions in which one of the reacting species gives up electrons (oxidation) while another species in the reaction accepts electrons (reductions). At one time, the term oxidation was restricted to reactions involving hydrogen. Current chemical technology has broadened the scope of these terms to include all reactions where electrons are given up and taken on by reacting species; in fact, the donating and accepting of electrons must take place simultaneously.

Oxidation Reduction Potential (ORP). A measurement that indicates the activity ratio of the oxidizing and reducing species present.

Oxygen, Available. The quantity of atmospheric oxygen dissolved in the water of a stream; the quantity of dissolved oxygen available for the oxidation of organic matter in sewage.

Oxygen, Dissolved. The oxygen (usually designated as DO) dissolved in sewage, water or another liquid and usually expressed in mg/l, parts per million, or percent of saturation.

Parts Per Million (ppm). Parts by weight in sewage analysis;ppm by weight is equal to milligrams per liter divided by the specific gravity. It should be noted that in water analysis, ppm is always understood to imply a weight/weight ratio, even though in practice volume may be measured instead of a weight.

Pathogenic. Disease producing.

pH. The negative logarithm of the hydrogen ion concentration or activity in a solution. The number 7 indicates neutrality, numbers less than 7 indicate increasing acidity and numbers greater than 7 indicate increasing alkalinity.

Photosynthesis. The mechanism by which chlorophyll-bearing plants utilize light energy to produce carbohydrate and oxygen from carbon dioxide and water(the reverse of respiration.).

Physical/Chemical Treatment System. A system that utilizes physical (i.e., sedimentation, filtration, centrifugation, activated carbon, reverse osmosis, etc.) and/or chemical means (i.e. coagulation, oxidation, precipitation, etc.) to treat wastewaters.

Plasma. The fluid part of blood, lymph, or intramuscular fluid in which cells are suspended.

PMA. Pharmaceutical Manufacturers Association.

Point Source. Any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.

Potable Water. Drinking water sufficiently pure for human use.

Potash. Potassium compounds used in agriculture and industry. Potassium carbonate can be obtained from wood ashes. The mineral potash is usually a muriate (chloride). Caustic potash is its hydrated form.

Preaeration. A preparatory treatment of sewage, consisting of aeration to remove gases and add oxygen or to promote the flotation of grease and aid coagulation.

Precipitation. The phenomenon which occurs when a substance held in solution passes out of that solution into solid form. The adjustment of pH can reduce solubility and cause precipitation. Alum and lime are frequently used chemicals in such operations as water softening or alkalinity reduction.

Pretreatment. Any wastewater treatment process used to partially reduce the pollution load before the wastewater is introduced into a main sewer system or delivered to a treatment plant for substantial reduction of the pollution load.

Process Waste Water. Any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, by-product, or waste product.

Process Water. Any water(solid, liquid or vapor) which, during the manufacturing process, comes into direct contact with any raw material, intermediate product, by-product, waste product, or finished product.

Proprietary Products. Pharmaceuticals promoted by advertising directly to the consumer.

PSES. Pretreatment Standards for Existing Sources.

PSNS. Pretreatment Standards for New Sources.

Raw Waste Load (RWL). The quantity (kg) of pollutant being discharged in a plant's wastewater measured in terms of some common denominator (i.e., kkg of production or m2 of floor area).

Receiving Waters. Rivers, lakes, oceans or other courses that receive treated or untreated wastewaters.

Reduction. A process in which an atom (or group of atoms) gains electrons. Such a process always requires the input of energy.

Refractory Organics. Organic materials that are only partially biodegradable in biological waste treatment processes. Refractory organics include detergents, pesticides, color- and odor-causing agents, tannins, lignins, ethers, olefins, alcohols, amines, aldehydes, ketones, etc.

Residual Chlorine. The amount of chlorine left in the treated water that is available to oxidize contaminants if they enter the stream. It is usually in the form of hypochlorous acid of hypochlorite ion or of one of the chloramines. Hypochlorite concentration alone is called "free chlorine residual" while together with the chloramine concentration their sum is called "combined chlorine residual."

Retort. A vessel, commonly a glass bulb with a long neck bent downward,used for distilling or decomposing substances by heat.

Sanitary Sewers. In a separate system, pipes in a city that carry only domestic wastewater. The storm water runoff is handled by a separate system of pipes.

Saprophytic Organism. One that lives on dead or decaying organic matter.

Secondary Treatment. The second step in most waste treatment systems in which bacteria consume the organic part of the wastes. This is accomplished by bringing the sewage and bacteria together either in trickling filters or in the activated sludge process.

Seed. To introduce microorganisms into a culture medium.

Serum. A fluid which is extracted from an animal rendered immune against a pathogenic organism and injected into a patient with the disease resulting from the same organism.

Settleable Solids. Suspended solids which will settle out of a liquid waste in a given period of time.

Sewage, Storm. The liquid flowing in sewers during or following a period of heavy rainfall.

Sewerage. A comprehensive term which includes facilities for collecting, pumping, treating and disposing of sewage; the sewerage system and the sewage treatment works.

SIC Codes. Standard Industrial Classification. Numbers used by the U.S. Department of Commerce to denote segments of industry.

Sludge, Activated. Sludge floc produced in raw or settled sewage by the growth of zoogleal bacteria and other organisms in the presence of dissolved oxygen and accumulated in sufficient concentration by returning the floc previously formed.

Sludge, Age. The ratio of the weight of volatile solids in the digester to the weight of volatile solids added per day. There is a maximum sludge age beyond which no significant reduction in the concentration of volatile solids will occur.

Sludge, Digested. Sludge digested under anaerobic conditions until the volatile content has been reduced, usually by approximately 50 percent or more.

Solution. A homogeneous mixture of two or more substances of dissimilar molecular structure. In a solution, there is a dissolving medium, solvent, and a dissolved substance, solute.

Solvent Extraction. The treatment of a mixture of two or more components by a solvent that preferentially dissolves one or more of the components in the mixture. The solvent in the extract leaving the extractor is usually recovered and reused.

Steam Distillation. Fractionation in which steam is introduced as one of the vapors or in which steam is injected to provide the heat of the system.

Sterilization. The complete destruction of all living organisms in or on a medium; heat to 121 C at 5 psig for 15 minutes.

Steroid. Term applied to any one of a large group of substances chemically related to various alcohols found in plants and animals.

Still Bottom. The residue remaining after distillation of a material. Varies from a watery slurry to a thick tar which may turn hard when cool.

Stillwell. A pipe, chamber, or compartment with comparatively small inlet or inlets communicating with a main body of water. Its purpose is to dampen waves or surges while permitting the water level within the well to rise and fall with the major

fluctuations of the main body of water. It is used with water-measuring devices to improve accuracy of measurement.

Stoichiometric. Characterized by being a proportion of substances exactly right for a specific chemical reaction with no excess of any reactant or product.

Stripper. A device in which relatively volatile components are removed from a mixture by distillation or by passage of steam through the mixture.

Supernatant. Floating above or on the surface.

Surge Tank. A tank for absorbing and dampening the wavelike motion of a volume of liquid; an in-process storage tank that acts as a flow buffer between process tanks.

Suspended Solids. The wastes that will not sink or settle in sewage. The quantity of material deposited on a filter when a liquid is drawn through a Gooch crucible.

Synergistic. An effect produced by a group of contributors which is greater than the sume of the individual contributors acting individually.

Tablet. A small, disc-like mass of medicinal powder used as a dosage form for administering medicine.

Tertiary Treatment. A process to remove practically all solids and organic matter from wastewater. Granular activated carbon filtration is a tertiary treatment process. Phosphate removal by chemical coagulation is also regarded as a step in tertiary treatment.

Thermal Oxidation. The combustion of organic materials through the application of heat in the presence of oxygen.

Total Organic Carbon (TOC). A measure of the amount of carbon in a sample originating from organic matter only. The test is run by burning the sample and measuring the carbon dioxide produced.

Total Solids. The total amount of solids in a wastewater both in solution and suspension.

Toxoid. Toxin treated so as to destroy its toxicity, but still capable of inducing formation of antibodies.

Vaccine. A killed or modified live virus or bacteria prepared in suspension for inoculation to prevent or treat certain infectious diseases.

Viruses. (1) An obligate intracellular parasitic microorganism smaller than bacteria. Most can pass through filters that retain bacteria. (2) The smallest (10-300 um in diameter) form capable of producing infection and diseases in man or other large species. Occurring in a variety of shapes, viruses consist of a nucleic acid core surrounded by an outer shell (capsid) which consists of numerous protein subunits (capsomeres). Some of the larger viruses contain additional chemical substances. The true viruses are insensitive to antibiotics. They multiply only in living cells where they are assembled as complex macromolecules utilizing the cells' biochemical systems. They do not multiply by division as do intracellular bacteria.

Volatile Suspended Solids (VSS). The quantity of suspended solids lost after the ignition of total suspended solids.

Water Quality Criteria. Those specific values of water quality associated with an identified beneficial use of the water under consideration.

Zero Discharge. Plants that do not discharge wastewaters to either publicly owned treatment works or to navigable waters. Plants that use evaporation ponds or deep well sites, for example, are considered zero dischargers.

APPENDIX B

308 Portfolio for Pharmaceutical Manufacturing

308 PORTFOLIO
FOR
PHARMACEUTICAL MANUFACTURING

INSTRUCTIONS AND DEFINITIONS

Instructions

1. Please complete this portfolio for each pharmaceutical manufacturing site in your company which manufactures Fermentation Products (Subcategory A), Biological and Natural Extraction Products (Subcategory B), Chemical Synthesis Products (Subcategory C) and Formulation Products (Subcategory D). This portfolio is also to be completed for each pharmaceutical research facility (Subcategory E) in your company. If this copy has been received by or for a non-manufacturing site (i.e. main office, warehouse, sales office, etc.) or by or for a non-manufacturing site which also does not conduct pharmaceutical research, please follow the procedure below:

   A. Please check the carbon copies list attached to Mr. Schaffer's letter to see if each of your company's manufacturing locations has received a separate portfolio. If any of your manufacturing locations has not received a portfolio, please request additional copies as indicated in (C) below. Please ensure that the requested information is provided for each site where your company manufactures pharmaceutical products or conducts pharmaceutical research.

   B. Please complete Part I, questions 1 through 5 of the portfolio only, write "not a manufacturing site" and return the portfolio in the enclosed envelope. Portfolios have been sent to company headquarters as notification that each manufacturing site will receive and should complete a separate portfolio. You may reproduce this document and maintain a copy in your files for future reference.

   C. Extra copies of the portfolio may be obtained by contacting Mr. J. S. Vitalis at 202-426-2497. Since each copy of this portfolio is coded, it is necessary to obtain additional copies from Mr. Vitalis.

2. Please read all definitions which follow these instructions carefully before completing this portfolio. It is preferred that the individuals who respond to this portfolio be familiar with the manufacturing processes and the wastewater treatment systems and operations at this site.

3. Please check the appropriate box or boxes in each question where they appear throughout this portfolio. (More than one box may be checked for some questions, where appropriate.) Please complete all questions which require written responses by printing or typing in the spaces provided. If separate sheets or attachments are used to clarify or answer a question, please make certain that the code number for this portfolio, which appears at the top right hand corner of each page, is also placed at the top right hand corner of each page of the attachments.

4. Please indicate which information in your responses is confidential so that it may be treated properly.

5. Please answer all items. Also, please provide a separate set of responses for each plant. The purpose of this request is to gather all available, pertinent information and is not designed to create an undue burden of sampling requirements on your plant personnel. If a question is not applicable to a particular facility, indicate by writing "N/A". If an item is not known, indicate unknown and explain why such information is not available. If an item seems ambiguous, complete as best as possible and state your assumptions in clarifying the apparent ambiguity.

6. The U.S. Environmental Protection Agency will review the information submitted and may, at a later date, request your cooperation for site visits and additional sampling in order to complete the data base. Please retain a copy of the completed portfolio in case future contact is necessary to verify your responses.

7. Use the Merck Index, Ninth Edition, 1976, to specify the Merck Index Identification Numbers (Merck Index Number) in Part II of this questionnaire. Many of the Chemical Abstract Service Registry Numbers (CAS Numbers) may be found in the Merck Index beginning on page REG-1 for use in completing Part II of this portfolio.

8. Please use the enclosed, pre-addressed envelope to return the completed portfolio and appropriate attachments. If you are sending supplemental information that will not fit into the return envelope provided, please send it under separate cover to:

   Mr. Robert B. Schaffer, Director
   Effluent Guidelines Division
   U.S. EPA (WH-552)
   401 M. Street, S.W.
   Washington, D.C. 20460

   Attention: J.S. Vitalis

9. If you have any questions, please telephone Mr. J.S. Vitalis at 202-426-2497

Definitions

Subcategory A - Fermentation Products-Pharmaceutical products derived from fermentation processes.

Subcategory B - Biological and Natural Extraction Products-Pharmaceutical products which include blood fractions; vaccines; serums; animal bile derivatives; endocrine products; and isolation of medicinal products, such as alkaloids, from botanical drugs and herbs.

Subcategory C - Chemical Synthesis Products-Pharmaceutical products which result from chemical synthesis.

Subcategory D - Mixing/Compounding and Formulation Products- Pharmaceutical products from plants which blend, mix, compound, and formulate pharmaceutical ingredients and includes pharmaceutical preparations for human and veterinary use such as ampules, tablets, capsules, vials, ointments, medicinal powders, and solutions.

Subcategory E - Research - Products or services which result from pharmaceutical research, which includes micro-biological, biological and chemical operations.

POTW - Publicly Owned Treatment Works - Municipal sewage treatment plant

NPDES - National Pollutant Discharge Elimination System

BOD - Biochemical Oxygen Demand

COD - Chemical Oxygen Demand

TSS - Total Suspended Solids

TOC - Total Organic Carbon

308 PORTFOLIO FOR
Pharmaceutical Manufacturing

For multiple plant companies, please complete one portfolio for each manufacturing and research site, and return within 60 days of receipt to:

Robert B. Schaffer, Director
Effluent Guidelines Division
U.S. EPA (WH-552)
401 M Street, S.W.
Washington, D.C. 20460

Attention: J. S. Vitalis

PART I

GENERAL INFORMATION

1. Name of Firm _____

2. Address of Firm Headquarters:

_____
Street City State Zip

3. Name of Plant _____

4. Address of Plant:

_____
Street City State Zip

5. Name(s) of firm personnel to be contacted for information pertaining to this data collection portfolio:

Name	Title	(Area Code) Telephone

6. Number of Manufacturing Employees in 1976: Minimum_____ Maximum_____ Average_____

7. Year of operational startup_____

8. Type of production operation within this site for each subcategory:

	Subcategory			
	A	B	C	D
Batch	☐	☐	☐	☐
Continuous	☐	☐	☐	☐
Semicontinuous	☐	☐	☐	☐

9.a. Indicate below the type of research and development activities conducted at this site and, for each activity checked, provide the total laboratory square footage in column A, the number of employees in column B and, if applicable, the animal capacity in column C.

Activities	A Total Laboratory Square Footage	B Number of Employees	C Animal Capacity
☐ Microbiological			
☐ Biological			
☐ Chemical			
☐ Clinical			
☐ Development			
☐ Pilot Plant			

b. If animals are used in the above research activities, list their type below:

_____

_____

10. Does this plant have a National Pollutant Discharge Elimination System Permit (NPDES)? Yes ☐ No ☐

11. Has plant submitted NPDES permit application? Yes ☐ No ☐

12. Permit or application number_____

13. Date of permit expiration_____

14. Does this plant have wastewater treatment facilities on site? Yes ☐ No ☐

15. Name and address of publicly owned treatment works (POTW) receiving plant wastewater, if any:

Name_____

Address_____

_____

16. Type of wastewater discharge to POTW: Process ☐ Sanitary ☐ Cooling ☐

17. Level of treatment provided by POTW: Primary ☐ Secondary ☐ Tertiary ☐

18. Is there a user charge for discharge to the POTW? Yes ☐ No ☐

If yes, provide the net annual charge below and indicate which parameters listed below serve as a basis for this charge.

Net Annual Charge_____

Basis for Charge

☐ Flow

☐ BOD_5

☐ COD

☐ TSS

☐ TOC

☐ Other (Specify)_____

19. Is the plant under the requirements of a municipal sewer use ordinance or other ordinance regulating sewer use?

Yes ☐ No ☐

20. Has an industrial wastewater survey report been submitted to the State and/or U.S. EPA Regional Office in compliance with a municipal NPDES Permit compliance schedule for industrial discharge to POTW?

Yes ☐ No ☐

If yes, attach copy of survey report.

PART II

PRODUCTS AND PRODUCTION PROCESSES

1. A. For products which are produced at this site, list the Fermentation Products (Subcategory A) in Table II A, the Biological and Natural Extraction Products (Subcategory B) in Table II B, and the Chemical Synthesis Products (Subcategory C) in Table II C. In each table, indicate for each product the number of production steps (chemical processes and physical operations) which result in wastewater generation in column A and the annual production as kilograms in column B. For the Chemical Synthesis Products (Subcategory C), list only the products which are produced in quantities of 100 kilograms per year or greater. For each of the Fermentation Products (in Subcategory A) that you list in Table II A provide a separate list of raw materials and solvents, along with quantities used in kilograms per day. Fermentation Products, which constitute less than 5% of the active ingredient production by weight, may be grouped together and submitted as a composite annual production number; however, each production product comprising such a grouping, should be identified and listed in Table II A. Provide the above information for the period January 1, 1975 to December 31, 1976 or for the exact period of production if less than this two year period. For each product listed, provide the Merck Index Identification Number (Merck Index Number) and the Chemical Abstracts Service Registry Number (CAS Number) in the columns provided, if these numbers exist for the product. If these numbers do not exist for the particular product, please note NA in the appropriate space. The production data should match with the wastewater data tables in Part III. Please photocopy each table prior to filling in the requested information to allow for adequate space to cover the products produced at this plant.

   B. List in Table II D Chemical Synthesis Products not in Table II C if they account for an unusually high pollution load either in terms of pounds discharged per 1,000 pounds of production (Raw Waste Load) or if they present difficult treatment problems.

2. Indicate which of the following are sources of wastewater:

- ☐ Floor, Equipment, Tanks, etc. - Washwater
- ☐ Waste Plasma, Blood and Blood Fractions
- ☐ Spent media broth from vaccine production
- ☐ Wet Scrubber spent waters
- ☐ Spent Beer
- ☐ Noncontact cooling water
- ☐ Pump seal water
- ☐ Research laboratory waste other than solvents
- ☐ Bad batches of production seed and/or final product
- ☐ Inorganic Solids - Diatomaceous earth - Filter cake washdown
- ☐ Chemical wastes - organic and inorganic, process waste solvents, cleanup waste solvents
- ☐ Barometric condenser water
- ☐ Process chemical synthesis liquids
- ☐ Spills, leakage from processes
- ☐ Solvents from research laboratories
- ☐ Ejector condensate
- ☐ Stormwater
- ☐ Sanitary wastewater
- ☐ Other (Specify)_____

3. Describe any production process changes made to date for the primary purpose of pollution control. Also describe other process changes which have resulted in an increase or decrease of raw waste load indicating the change accordingly.

TABLE II A

List below Fermentation Products (Subcategory A).

For each of the Fermentation Products (in Subcategory A) that you list in Table IIA provide a separate list of raw materials and solvents, along with quantities used in kilograms per day. Fermentation Products, which constitute less than 5% of the active ingredient production by weight, may be grouped together and submitted as a composite annual production number; however, each production product comprising such a grouping, should be identified and listed in Table IIA.

Abbreviations:

Merck Index Number - Merck Index Identification Number
CAS Number - Chemical Abstracts Service Registry Number

Photocopy this table before filling out

CAS Number	Merck Index Number	Product	A No. of Production Steps which result in wastewater Generation	B Annual Production Kilograms

TABLE II B

List below Biological and Natural Extraction Products (Subcategory B).

Abbreviations:

Merck Index Number - Merck Index Identification Number
CAS Number - Chemical Abstracts Service Registry Number

Photocopy this table before filling out

CAS Number	Merck Index Number	Product	A No. of Production Steps which result in wastewater Generation	B Annual Production (Kilograms)

TABLE II C

List below Chemical Synthesis Products (Subcategory C).

Abbreviations:

Merck Index Number - Merck Index Identification Number
CAS Number - Chemical Abstracts Service Registry Number

Photocopy this table before filling out.

CAS Number	Merck Index Number	Product	A No. of Production Steps which result in wastewater Generation	B Annual Production (Kilograms)

TABLE II D

List below Chemical Synthesis Products not in Table II C if they account for an unusually high pollution load either in terms of pounds discharged per 1,000 pounds of production (Raw Waste Load) or if they present difficult treatment problems.

PART III

WATER USE, REUSE AND DISCHARGE

1. Water Use, Total Plant Needs During the Period January 1, 1975 to December 31, 1976

List below for your plant, the sources and quantities of water used and describe the disposition of waste waters. If a time period of less than January 1, 1975 to December 31, 1976 is used, state the reason that the values are representative of that period. Check appropriate boxes.

A. Water Source	Average Flow (Million gallons per day)	Time Period of Calculation
☐ Municipal		
☐ Surface		
☐ Ground		
☐ Recycle Process		
☐ Other		

Specify other_____

B. Water Uses	Average Flow (Million gallons per day)	Time Period of Calculation
☐ Non-contact cooling		
☐ Direct process contact (as diluent, solvent carrier, reactant, by-product, cooling, etc.)		
☐ Indirect process contact (pumps, seals, etc.)		
☐ Non-contact ancillary uses (boilers, utilities, etc.)		
☐ Maintenance, equipment cleaning and work area washdown		
☐ Air pollution control		
☐ Sanitary and potable		
☐ Other		

Specify other_____

C. Sources of Wastewater Flows	Average Flow (Million gallons per day)	Time Period of Calculation
☐ Non-contact cooling		
☐ Direct process contact		
☐ Indirect process contact		
☐ Non-contact ancillary uses		
☐ Maintenance, equipment cleaning and work area washdown		
☐ Air pollution control		
☐ Sanitary/Potable water		
☐ Storm water (collected in treatment system)		
☐ Other		

Specify other_____

D. Method of Disposal of Process Wastewater (exclude non-contact cooling water)

	Treated		Untreated	
	Average Flow (Million gallons per day)	Time Period of Calculation	Average Flow (Million gallons per day)	Time Period of Calculation
☐ Surface Water				
☐ Subsurface				
☐ Deep Well				
☐ Publicly Owned Treatment Works				
☐ Land Application				
☐ Recycle/Reuse				
☐ Other				

Specify other_____

E. Method of disposal of non-contact cooling water

	Average Flow (Million gallons per day)	Time Period of Calculation
☐ Surface Water		
☐ Subsurface		
☐ Deep Well		
☐ Publicly Owned Treatment Works		
☐ Land Application		
☐ Recycle/Reuse		
☐ Other		

Specify other_____

2. Quality of Water Discharged

For the period January 1, 1975 to December 31, 1976, summarize your influent, effluent and raw waste loads in Tables III A, III B, III C, and III D. For plants discharging directly to publicly owned waste treatment plants, summarize the effluent and raw waste load. Information for combined waste streams should be furnished which represents the greatest degree of detail available. The tables are located at the end of this section.

Instructions for Completing Tables III A, III B, III C and III D

For Tables III A, III B, III C and III D, use the following definitions and notes. The period covered should correspond with that used for Part II.

A. Flow - Do not include rainfall runoff, unless it is collected in the treatment system. If collected, estimate the percent of total flow which is attributed to this source in Tables III B, III C and III D.

B. Maximum Monthly Average Quantity - The value for the highest 30 consecutive day average over the period January 1, 1975 to December 31, 1976 or over the actual period of analysis if less than this two year period. The 30 consecutive day period may be a calendar month or any other 30 consecutive day period for values which are computed on a monthly basis.

C. Maximum Daily Average Quantity - The highest average of any day's samples if samples are taken daily or more frequently or the highest value if samples are taken less frequently than daily, over the period January 1, 1975 to December 31, 1976 or over the actual period of analysis if less than this two year period.

D. Annual Average Quantity - The highest twelve consecutive month average over the period January 1, 1975 to December 31, 1976 or over the actual period of analysis if less than this two year period. If the period of analysis is less than one year, provide the average for the entire period of analysis.

E. Type of Sample - Insert a number from the following list in Tables III A, III B, III C, and III D to indicate the type of samples collected.

Type of Sample	Number
Flow composite	1
Time composite	2
Grab	3
Continuous	4
Other	5

F. Frequency of Sample - Insert a number from the following list in Tables III A, III B, III C and III D to indicate the frequncy of samples collected.

Frequency	Number
Continuously	1
Hourly	2
Daily	3
Weekly	4
Monthly	5
Less than once per month	6
One time sample	7
Other	8

G. Use the blank lines at the end of each table to list additional pollutants not specifically listed, which are introduced into the wastewater as the result of materials used or products produced, for which you have test data. (Exclude the chemicals listed in Table V A of Part V of this portfolio.)

H. Identify all data which results from abnormal operating or other conditions.

I. If use of a different time period (a portion of the time period January 1, 1975 to December 31, 1976) results in more adequate representation of the pollution loads, you may do so if the time period is not less than six months. You should specify the time period and explain why that period is more representative in an attachment to this portfolio.

J. Tables

Table III A - Complete a separate Table III A for each plant intake water source at this site.

Table III B - Complete a separate Table III B for each untreated waste discharge point from this site (to publicly owned treatment works, surface waters, deep wells, land application, etc.).

Table III C - Complete a separate Table III C for the combined influent to each treatment facility on this site. Not applicable to plants that have not yet installed waste treatment facilities. This section is not restricted by type or level of treatment.

Table III D - Complete a separate Table III D for the treated effluent from each treatment facility on this site. Not applicable to plants that have not yet installed waste treatment facilities. This section is not restricted by type or level of treatment.

So that you may have sufficient tables to report the requested information, please photocopy each of Tables III A, III B, III C and III D before filling in. A separate table is required for each plant intake water source, each untreated wastewater discharge from this site, and the influent to and the effluent from each wastewater treatment facility on this site.

TABLE III A

INTAKE WATER

With the available information, complete, to the best of your ability, a separate Table III A for each plant intake water source.

Abbreviations:

mgd - million gallons per day
mg/l - milligrams per liter
lb/day - pounds per day

Photocopy this table before filling in the requested information

Parameter	Maximum Monthly Average Quantity	Maximum Daily Average Quantity	Annual Average Quantity	Time Period of Analysis	Type of Sample	Frequency of Sample
Flow (mgd)						
BOD 5 (mg/l)						
BOD 5 (lb/day)						
COD (mg/l)						
COD (lb/day)						
TSS (mg/l)						
TSS (lb/day)						
TOC (mg/l)						
TOC (lb/day)						
NH_3-N (mg/l)						
NH_3-N (lb/day)						
pH						
Sulfides (mg/l)						
Oil and Grease (mg/l)						
Chromium (mg/l)						
Alkalinity (mg/l as $CaCO_3$)						
Hardness (mg/l as $CaCO_3$)						

TABLE III B

UNTREATED WASTE DISCHARGE

With the available information, complete a separate Table III B for each untreated waste discharge point from this site (to publicly owned treatment works, surface waters, deep wells, land application, etc.)

Abbreviations:

mgd - million gallons per day
mg/l - milligrams per liter
lb/day - pounds per day

Photocopy this table before filling in the requested information

Percent Storm Water_____

Parameter	Maximum Monthly Average Quantity	Maximum Daily Average Quantity	Annual Average Quantity	Time Period of Analysis	Type of Sample	Frequency of Sample
Flow (mgd)						
BOD 5 (mg/l)						
BOD 5 (lb/day)						
COD (mg/l)						
COD (lb/day)						
TSS (mg/l)						
TSS (lb/day)						
TOC (mg/l)						
TOC (lb/day)						
NH_3N (mg/l)						
NH_3N (lb/day)						
pH						
Sulfides (mg/l)						
Oil and Grease (mg/l)						
Chromium (mg/l)						

TABLE III C

COMBINED INFLUENT

With the available information, complete a separate Table III C for the combined influent to each treatment facility on this site. Not applicable to plants that have not yet installed waste treatment facilities. This section is not restricted by type or level of treatment.

Abbreviations:

mgd - million gallons per day
mg/l - milligrams per liter
lb/day - pounds per day

Photocopy this table before filling in the requested information.

Percent Storm Water_____

Parameter	Maximum Monthly Average Quantity	Maximum Daily Average Quantity	Annual Average Quantity	Time Period of Analysis	Type of Sample	Frequency of Sample
Flow (mgd)						
BOD 5 (mg/l)						
BOD 5 (lb/day)						
COD (mg/l)						
COD (lb/day)						
TSS (mg/l)						
TSS (lb/day)						
TOC (mg/l)						
TOC (lb/day)						
NH_3N (mg/l)						
NH_3N (lb/day)						
pH						
Sulfides (mg/l)						
Oil and Grease (mg/l)						
Chromium (mg/l)						

TABLE III D

TREATED EFFLUENT

With the available information, complete a separate Table III D for the treated effluent from each treatment facility on this site. Not applicable to plants that have not yet installed waste treatment facilities. This section is not restricted by type or level of treatment.

Abbreviations:

mgd - million gallons per day
mg/l - milligrams per liter
lb/day - pounds per day

Photocopy this table before filling in the requested information.

Percent Storm Water_____

Parameter	Maximum Monthly Average Quantity	Maximum Daily Average Quantity	Annual Average Quantity	Time Period of Analysis	Type of Sample	Frequency of Sample
Flow (mgd)						
BOD 5 (mg/l)						
BOD 5 (lb/day)						
COD (mg/l)						
COD (lb/day)						
TSS (mg/l)						
TSS (lb/day)						
TOC (mg/l)						
TOC (lb/day)						
NH_3-N (mg/l)						
NH_3-N (lb/day)						
pH						
Sulfides (mg/l)						
Oil and Grease (mg/l)						
Chromium (mg/l)						

3. Indicate all parameters listed in Part III, Tables III A through III D, which were not measured by EPA approved methods.

Has the seed used in the BOD 5 test been acclimated to the waste waters that have been treated?

Yes ☐ No ☐

If yes, what is the source of the seed?

☐ Sewage treatment plant

☐ Plant treatment facility

☐ Laboratory acclimation

☐ Other

Explain

PART IV

A. Do you have a treatment system(s) at this plant? Yes ☐ No ☐

If yes, attach a separate flow sheet for each distinct treatment facility indicating waste streams treated, unit sizes of treatment equipment, detention times, recycle rates, effluent concentration or design criteria and other pertinent engineering information for operation of the treatment facility. Include treatment of storm runoff, where applicable. Indicate the process lines for which any portion of the waste water flow is diverted to separate treatment, pretreatment or disposal (e.g., deep well, solvent recovery, incineration, etc.). Which portions are so diverted and which portions are combined for joint treatment?

For each treatment facility complete the following:

Name of Facility_____

Source(s) of Waste Water_____

_____

1. Check which of the treatment processes listed below are employed at this plant:

☐ Equalization

☐ Neutralization

☐ Coarse Settleable Solids Removal

Primary Separation

☐ Primary Sedimentation

☐ Primary Chemical Flocculation/Clarification

☐ Other

Specify Other_____

Biological Treatment

☐ Activated Sludge

☐ Trickling Filter

☐ Aerated Lagoon

☐ Waste Stabilization Ponds

☐ Bio-Discs

☐ Intermittent Sand Filtration

☐ Other

Specify Other_____

☐ Physical/Chemical Treatment

Polishing

☐ Pond

☐ Multi-media Filtration

☐ Activated Carbon

☐ Other

Specify Other_____

Sludge Handling

Thickening

☐ Mechanical

☐ Flotation

☐ Centrifugation

Stabilization

☐ Anaerobic Digestion

☐ Chemical

☐ Heat

☐ Composting

☐ Other

Specify Other_____

Conditioning

- ☐ Heat
- ☐ Chemical
- ☐ Elutriation

Dewatering

- ☐ Vacuum Filtration
- ☐ Centrifugation
- ☐ Drying Beds
- ☐ Other

Specify Other _____

Reduction

- ☐ Incineration
- ☐ Wet Air Oxidation
- ☐ Pyrolysis

Final Disposal

- ☐ Landfill
- ☐ Cropland Use
- ☐ Ocean
- ☐ Other

Specify Other _____

Design Conditions for overall treatment facility

Flow (million gallons per day) _____

BOD (milligrams per liter) _____

BOD (pounds per day) _____

TSS (milligrams per liter) _____

TSS (pounds per day) _____

		Year	Cost (1976 dollars)
2. a.	Original installation (treatment only)	____	_____
b.	Other costs (include collection system, piping, pumping, etc.)	____	_____
3.	Estimated replacement cost	____	_____
4.	Estimated total capital expenditure for this facility to date	____	_____
5.	Annual cost of operation and maintenance (exclude depreciation and debt service cost).	____	_____

6. List major modifications or additions since original installation and state the purpose of the modification or addition.

Modification-Addition	Treatment Facility	Year	Cost (1976 Dollars)	Purpose of Modification

7. List future scheduled modifications or additions and estimated date of completion and state the purpose of the modification or addition.

Modification-Addition	Treatment Facility	Year	Cost (1976 Dollars)	Purpose of Modification

8. Is nutrient addition practiced? Yes ☐ No ☐

9. How many employees (equivalent man-years/year) are primarily engaged as operators of the waste water treatment facility? (exclude maintenance)

How many employees (equivalent man-years/year) are engaged as support personnel for the waste water treatment facility?

10. Is an operator always present? Yes ☐ No ☐

11. Quantity of wastewater treatment facility solid wastes disposed of at present (dry basis).

_____ pounds per day

12. Moisture content of waste solids disposed of at present.

_____ percent moisture.

13. Present disposition of solids

14. Estimated annual cost of solids handling and disposal (1976 dollars).

_____ dollars per ton dry basis

15. Planned future disposition of solids:

16. What are the total annual energy requirements for the treatment facility?

Electrical _____ kilowatt-hours

Other (e.g., Heat) _____ British thermal units

B. Carbon Adsorption Technology

	Yes	No
Have you determined carbon adsorption isotherms on your waste waters?	☐	☐
Have carbon adsorption isotherms been determined for waste waters from your plant(s) by a person(s) other than company personnel?	☐	☐
Have you or anyone else evaluated carbon columns on waste waters from this plant?	☐	☐
Do you have carbon adsorption data from your plant(s) on:	☐	☐
raw wastes	☐	☐
biologically treated wastes	☐	☐
individual process lines	☐	☐
combined process lines	☐	☐
pilot plant studies	☐	☐
contractor evaluations	☐	☐
cost evaluations	☐	☐
plant scale evaluations	☐	☐
operational units	☐	☐

For each question above which was answered affirmatively, give a brief description of the data (source and types of wastes, period of time covered, plant involved, extent of data base and contact personnel suggested) in the space below.

C. Filtration

Have you done filtration studies on your wastewaters (sand, multi-media, etc.) beyond what was described in Section A, Part IV?

Yes ☐ No ☐

If yes, give a brief description of the data (source and types of wastes, period of time covered, process stream involved, extent of data base and contact personnel suggested) in the space below.

D. Biological Treatment

Have biological treatability studies been conducted on your wastewaters beyond what was described in Section A, Part IV?

Yes ☐ No ☐

If yes, give a brief description of the data and results (source and types of wastes treated, duration of the study, extent of data base, conclusions of study, and contact personnel suggested) in the space below:

E. Have other treatability studies, beyond what was described in Section A, Part IV, employing treatment processes such as sedimentation, neutralization, hydrolysis, precipitation, oxidation/reduction, ion exchange, phenol recovery, etc., been run on any of the process wastewater streams from the plant?

Yes ☐ No ☐

If yes, list below those product/process streams on which such treatability studies were conducted.

Note: Use the Engineering News-Record (ENR) Index to project costs to December 1976 Dollars where requested in this portfolio. ENR Indices for January 1964 through December 1976 are shown on page IV-6 of this portfolio.

PART V

PRIORITY POLLUTANTS

A. Please provide the information requested in Table V A, concerning the chemicals which are considered as priority pollutants and which are listed in Table V A, in conformance with the following instructions:

1. In column A, place a check mark to indicate all of the listed chemicals which are used as raw or intermediate material.

2. In column B, place a check mark to indicate all of the listed chemicals which are manufactured at this plant as a final or intermediate material.

3. In column C, place a check mark to indicate all of the listed chemicals for which you have analyzed in your wastewater.

4. In column D, insert a number from the following list to indicate the frequency that the influent (I) and effluent (E) in your wastewater is analyzed for the presence of the listed chemicals.

Frequency	Number
Continuously	1
Hourly	2
Daily	3
Weekly	4
Monthly	5
Less than once per month	6
One time sample	7
Other	8

5. In column E, insert a number from the following list to indicate the type of sample used to analyze the influent (I) and effluent (E) in your wastewater for the presence of the listed chemicals.

Type of Sample	Number
Flow Composite	1
Time Composite	2
Grab	3
Continuous	4
Other	5

6. In columns F, G, and H, insert a value to indicate the average loading per day as pounds per day (lb/day), average flow as million gallons per day (mgd), and the average concentration as micrograms per liter (µg/l) respectively, for influent (I) and effluent (E) over a period January 1, 1975 to December 31, 1976, or over the actual period of analysis if shorter than this two year period, for all the listed chemicals for which you have analyzed in your wastewater.

B. If there is an indication in column C that an analysis is performed on your wastewater for a listed chemical, please describe in an attachment to this portfolio which analytical method(s) and specialized equipment are used for that substance.

C. If there is an indication in column C that an analysis is performed on your wastewater for a listed chemical, please provide the following information in an attachment to this portfolio:

1. If available, please provide plant data which correlate the removal of any of the chemicals in Table V A with the removal of BOD, TOC, COD and any other pollutants.

2. If available, please provide data from any treatability study which shows the effectiveness of carbon adsorption, filtration, biological treatment and other treatment technology for removal of any of the chemicals in Table V A.

3. If available, please provide any data which indicate how any of the chemicals in Table V A are removed by the treatment units at this site.

D. If there is an indication in column C that an analysis is performed on your wastewater for a listed chemical, and if there is an indication that a listed chemical is removed to any degree by the treatment units at this site, please attach a separate flow sheet for each of those treatment facilities, which indicates waste streams treated, unit sizes of treatment equipment, detention times, recycle rates, effluent concentration or design criteria and other pertinent engineering information for operation of the treatment facility. Please note that the above flow sheets may be identical to those provided in response to Part IV, Question A of the portfolio but the flow sheets should indicate clearly which chemicals are removed and which treatment equipment is used for the removal.

TABLE V A

PROCESSING OF CHEMICALS CONSIDERED AS PRIORITY POLLUTANTS

	CAS Number	Merck Index Number	Chemical	A Raw or Intermediate Material	B Final or Intermediate Material	C Analyzed in Wastewater	D Frequency Analyzed I*	D Frequency Analyzed E**	E Type Sample I *	E Type Sample E**	F Loading (lb/day) I *	F Loading (lb/day) E**	G Flow Million Gallons /Day I *	G Flow Million Gallons /Day E**	H Concentration (µg/l) I *	H Concentration (µg/l) E**
1.	83-32-9	19	acenaphthene													
2.	107-02-8	123	acrolein													
3.	107-13-1	127	acrylonitrile													
4.	71-43-2	1069	benzene													
5.	92-87-5	1083	benzidine													
6.	56-23-5	1821	carbon tetrachloride (tetrachloromethane)													
7.	108-90-7	2095	chlorobenzene													
8.	120-82-1	9310	1,2,4-trichlorobenzene													
9.	118-74-1	4544	hexachlorobenzene													
10.	107-06-2	3733	1,2-dichloroethane													
11.	71-55-6	9316	1,1,1-trichloroethane													
12.	67-72-1	4545	hexachloroethane													
13.	75-34-3	3750	1,1-dichloroethane													
14.	79-00-5	9317	1,1,2,-trichloroethane													
15.	79-34-5	8906	1,1,2,2-tetrachloroethane													
16.	75-00-3	3713	chloroethane													
17.	542-88-1	3046	bis(chloromethyl) ether													
18.	111-44-4	3040	bis(2-chloroethyl) ether													
19.	110-75-8	2119	2-chloroethyl vinyl ether (mixed)													
20.	91-58-7	2127	2-chloronaphthalene													
21.	88-06-2	9323	2,4,6-trichlorophenol													
22.	59-50-7	2108	parachlorometa cresol													
23.	67-66-3	2120	chloroform (trichloromethane)													
24.	95-57-8	2134	2-chlorophenol													
25.	95-50-1	3029	1,2-dichlorobenzene													
26.	541-73-1	3028	1,3-dichlorobenzene													
27.	106-46-7	3030	1,4-dichlorobenzene													
28.	91-94-1	3032	3,3'-dichlorobenzidine													
29.	75-35-4	9647	1,1-dichloroethylene													
30.	540-59-0	85	1,2- trans-dichloroethylene													

* I = Influent
** E = Effluent

TABLE V A

PROCESSING OF CHEMICALS CONSIDERED AS PRIORITY POLLUTANTS

	CAS Number	Merck Index Number	Chemical	A Raw or Intermediate Material	B Final or Intermediate Material	C Analyzed in Wastewater	D Frequency Analyzed I*	D Frequency Analyzed E**	E Type Sample I*	E Type Sample E**	F Loading (lb/day) I*	F Loading (lb/day) E**	G Flow Million Gallons /Day I*	G Flow Million Gallons /Day E**	H Concentration (ug/l) I*	H Concentration (ug/l) E**
31.		----	2,4-dichlorophenol													
32.	78-87-5	7643	1,2-dichloropropane													
33.	542-75-6	3051	1,3-dichloropropylene (1,3-dichloropropene)													
34.	1300-71-6	9744	2,4-dimethylphenol													
35.		----	2,4-dinitrotoluene													
36.		----	2,6-dinitrotoluene													
37.		----	1,2-diphenylhydrazine													
38.	100-41-4	3695	ethylbenzene													
39.		----	fluoranthene													
40.		----	4-chlorophenyl phenyl ether													
41.		----	4-bromophenyl phenyl ether													
42.		----	bis(2-chloroisopropyl) ether													
43.		----	bis(2-chloroethyoxy) methane													
44.	75-09-2	5932	methylene chloride (dichloromethane)													
45.	74-87-3	5916	methyl chloride (chloromethane)													
46.	74-83-9	5904	methyl bromide (bromomethane)													
47.	75-25-2	1418	bromoform (tribromomethane)													
48.		----	dichlorobromomethane													
49.	75-69-4	9320	trichlorofluoromethane													
50.	75-71-8	3038	dichlorodifluoromethane													
51.		----	chlorodibromomethane													
52.		----	hexachlorobutadiene													
53.		----	hexachlorocyclopentadiene													
54.		----	isophorone													
55.	91-20-3	6194	naphthalene													
56.	98-95-3	6409	nitrobenzene													
57.	88-75-5	6442	2-nitrophenol													
58.	100-02-7	6443	4-nitrophenol													
59.	51-28-5	3277	2,4-dinitrophenol													
60.	534-52-1	3275	4,6-dinitro-o-cresol													

* I = Influent

** E = Effluent

TABLE V A

PROCESSING OF CHEMICALS CONSIDERED AS PRIORITY POLLUTANTS

	CAS Number	Merck Index Number	Chemical	A	B	C	D		E		F		G		H	
				Raw or Intermediate Material	Final or Intermediate Material	Analyzed in Wastewater	Frequency Analyzed		Type Sample		Loading (lb/day)		Flow Million Gallons /Day		Concentration (µg/l)	
							I*	E**	I*	E**	I*	E**	I*	E**	I*	E**
61.	62-75-9	6458	N-nitrosodimethylamine													
62.		----	N-nitrosodiphenylamine													
63.		----	N-nitrosodi-n-propylamine													
64.	87-86-5	6901	pentachlorophenol													
65.	108-95-2	7038	phenol													
66.	117-81-7	1270	bis(2-ethylhexyl) phthalate													
67.		----	butyl benzyl phthalate													
68.	84-74-2	1575	di-n-butyl phthalate													
69.			di-n-octyl phthalate													
70.	84-66-2	3783	diethyl phthalate													
71.	131-11-3	3244	dimethyl phthalate													
72.	56-55-3	1063	1,2-benzanthracene													
73.	50-32-8	1113	benzo (a)pyrene (3,4-benzopyrene)													
74.		----	3,4-benzofluoranthene													
75.		----	11,12-benzofluoranthene													
76.	218-01-9	2252	chrysene													
77.		----	acenaphthylene													
78.	120-12-7	718	anthracene													
79.		----	1,12-benzoperylene													
80.	86-73-7	4037	fluorene													
81.	85-01-8	6996	phenanthrene													
82.	53-70-3	2971	1,2:5,6-dibenzanthracene													
83.		----	indeno(1,2,3-C,D) pyrene													
84.	129-00-0	7746	pyrene													
85.	127-18-4	8907	tetrachloroethylene													
86.	108-88-3	9225	toluene													
87.	79-01-6	9319	trichloroethylene													
88.	75-01-4	9645	vinyl chloride (chloroethylene)													
89.	309-00-2	220	aldrin													
90.	60-57-1	3075	dieldrin													

* I = Influent
** E = Effluent

TABLE V A

PROCESSING OF CHEMICALS CONSIDERED AS PRIORITY POLLUTANTS

	CAS Number	Merck Index Number	Chemical	A Raw or Intermediate Material	B Final or Intermediate Material	C Analyzed in Wastewater	D Frequency Analyzed I*	D Frequency Analyzed E**	E Type Sample I*	E Type Sample E**	F Loading (lb/day) I*	F Loading (lb/day) E**	G Flow Million Gallons /day I*	G Flow Million Gallons /day E**	H Concentration (µg/l) I*	H Concentration (µg/l) E**
91.	57-74-9	2051	chlordane (technical mixture and metabolites)													
92.	50-29-3	2822	4,4'-DDT													
93.		----	4,4'-DDE (p,p'-DDX)													
94.	6088-51-3	2821	4,4'-DDD (p,p'-TDE)													
95.	115-29-7	3519	alpha-endosulfan													
96.	115-29-7	3519	beta-endosulfan													
97.		----	endosulfan sulfate													
98.	72-20-8	3522	endrin													
99.		----	endrin aldehyde													
100.	76-44-8	4514	heptachlor													
101.		----	heptachlor epoxide													
102.	58-89-9	5341	alpha-BHC													
103.	58-89-9	5341	beta-BHC													
104.	58-89-9	5341	gamma-BHC (lindane)													
105.	58-89-9	5341	delta-BHC													
106.		----	PCB-1242 (Arochlor 1242)													
107.		----	PCB-1254 (Arochlor 1254)													
108.		----	PCB-1221 (Arochlor 1221)													
109.		----	PCB-1232 (Arochlor 1232)													
110.		----	PCB-1248 (Arochlor 1248)													
111.		----	PCB-1260 (Arochlor 1260)													
112.		----	PCB-1016 (Arochlor 1016)													
113.	8001-35-2	9252	Toxaphene													
114.	7440-36-0	729	Antimony (Total)													
115.	7440-38-2	820	Arsenic (Total)													
116.		850	Asbestos (Fibrous)													
117.	7440-41-7	1184	Beryllium (Total)													
118.	7440-43-9	1600	Cadmium (Total)													
119.	7440-47-3	2229	Chromium (Total)													
120.	7440-50-8	2496	Copper (Total)													

* I = Influent
** E = Effluent

TABLE V A

PROCESSING OF CHEMICALS CONSIDERED AS PRIORITY POLLUTANTS

	CAS Number	Merck Index Number	Chemical	A Raw or Intermediate Material	B Final or Intermediate Material	C Analyzed in Wastewater	D Frequency Analyzed I*	D Frequency Analyzed E**	E Type Sample I*	E Type Sample E**	F Loading (lb/day) I*	F Loading (lb/day) E**	G Flow Million Gallons /Day I*	G Flow Million Gallons /Day E**	H Concentration (ug/l) I*	H Concentration (ug/l) E*
121.	420-05-3	2694	Cyanide (Total)													
122.	7439-92-1	5242	Lead (Total)													
123.	7439-97-6	5742	Mercury (Total)													
124.		6312	Nickel (Total)													
125.	7782-49-2	8179	Selenium (Total)													
126.	7440-22-4	8244	Silver (Total													
127.	7440-28-0	8970	Thallium (Total)													
128.	7440-66-6	9782	Zinc (Total)													
129.		----	2,3,7,8 - tetrachlorodibenzo-p-dioxin (TCDD)													

* I = Influent
** E = Effluent

ENGINEERING NEWS - RECORD (ENR) INDICES *

YEAR	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANNUAL INDEX
1964	917.94	920.40	922.41	926.27	929.74	935.42	944.97	947.92	947.36	947.74	948.25	948.12	936.38
1965	947.56	957.43	957.70	957.43	957.92	969.34	977.08	984.16	986.29	986.18	985.83	987.74	971.22
1966	987.94	997.43	998.32	1006.06	1014.03	1028.65	1030.56	1033.37	1033.72	1032.40	1032.71	1033.71	1019.08
1967	1039.05	1040.67	1043.31	1043.54	1059.20	1067.88	1078.45	1089.14	1092.22	1096.22	1096.74	1098.39	1070.40
1968	1107.37	1113.63	1117.15	1123.73	1140.31	1152.78	1159.04	1169.68	1184.20	1189.08	1190.73	1200.82	1154.04
1969	1216.13	1229.56	1238.14	1248.85	1258.33	1284.96	1282.77	1292.20	1285.29	1299.31	1305.23	1304.76	1270.46
1970	1308.61	1310.90	1314.45	1329.21	1345.36	1368.66	1413.91	1418.44	1422.54	1433.64	1445.13	1445.08	1379.66
1971	1465.07	1466.85	1494.06	1511.49	1542.95	1575.05	1597.80	1614.78	1639.64	1642.59	1644.06	1654.75	1570.57
1972	1685.72	1690.76	1696.68	1706.89	1735.15	1760.78	1771.56	1776.80	1785.29	1793.75	1807.60	1815.86	1752.23
1973	1837.87	1849.70	1858.96	1873.62	1880.26	1896.21	1901.24	1920.79	1929.03	1933.19	1934.85	1938.84	1896.74
1974	1939.47	1939.74	1940.19	1961.25	1960.88	1993.47	2041.36	2075.49	2088.82	2094.74	2094.06	2098.26	2019.31
1975	2103.00	2127.72	2127.65	2135.03	2163.72	2205.00	2247.65	2274.30	2275.34	2293.03	2291.65	2297.15	2211.77
1976	2300.42	2309.97	2317.14	2327.33	2356.76	2409.51	2413.60	2444.94	2468.38	2478.22	2486.32	2489.66	2399.94

* CONSTRUCTION COST INDEX - BASE YEAR 1913=100

APPENDIX C

Pharmaceutical Manufacturing Plants in the Original 308 Data Base

APPENDIX C

PHARMACEUTICAL MANUFACTURING PLANTS
IN THE
ORIGINAL 308 DATA BASE

NAME	LOCATION	
A. H. ROBINS COMPANY	RICHMOND	VA
A. H. ROBINS MANUFACTURING COMPANY	BARCELONETA	PR
ABBOTT LABORATORIES	BARCELONETA	PR
ABBOTT LABORATORIES	NORTH CHICAGO	IL
ABBOTT LABORATORIES - N. CHICAGO	NORTH CHICAGO	IL
ABBOTT: HOSPITAL PRODUCTS DIVISION	ROCKY MOUNT	NC
ABBOTT: MURINE COMPANY	CHICAGO	IL
ABBOTT: SCIENTIFIC PRODUCTS DIVISION	LOS ANGELES	CA
AHSC: DADE DIVISION	MIAMI	FL
AHSC: HARLECO DIVISION	GIBBSTOWN	NJ
ALCON LABORATORIES (P.R.). INC.	HUMACAO	PR
ALCON LABORATORIES - OPHTHALMIC	FORT WORTH	TX
ALCON: CENTER LABORATORIES, INC.	PORT WASHINGTON	NY
ALCON: OWEN LABORATORIES, INC.	ADDISON	TX
ALZA CORPORATION	PALO ALTO	CA
ALZA CORPORATION - BUILDING A	PALO ALTO	CA
ALZA CORPORATION - BUILDING J	PALO ALTO	CA
AMERICAN CYANAMID COMPANY	HANNIBAL	MO
AMES COMPANY	SOUTH BEND	IN
AMES IMMUNOLOGY MANUFACTURING DIV.	ELKHART	IN
ARBROOK, INC.	ARLINGTON	TX
ARMOUR PHARMACEUTICAL COMPANY	KANKAKEE	IL
ARNAR-STONE LABORATORIES, INC.	MT. PROSPECT	IL
ARNAR-STONE, INC.	AGUADILLA	PR
ASTRA PHARMACEUTICAL PRODUCTS, INC.	WORCESTER	MA
AYERST LABORATORIES, INC.	ROUSES POINT	NY
BARNES-HIND DIAGNOSTICS, INC.	CANOVANAS	PR
BARNES-HIND PHARMACEUTICALS, INC.	SUNNYVALE	CA
BARRY LABORATORIES, INC.	POMPANO BEACH	FL
BEECHAM LABORATORIES	BRISTOL	TN
BEECHAM PHARMACEUTICALS	PISCATAWAY	NJ
BIO-REAGENTS AND DIAGNOSTICS, INC.	IRVINE	CA
BLOCK DRUG COMPANY, INC.	JERSEY CITY	NJ
BLOCK DRUG COMPANY, INC.	MEMPHIS	TN
BOWMAN PHARMACEUTICALS, INC.	CANTON	OH
BRISTOL ALPHA AND BRISCHEM	BARCELONETA	PR
BRISTOL LABORATORIES CORP.	MAYAGUEZ	PR
BRISTOL-MYERS PRODUCTS	HILLSIDE	NJ
BRISTOL-MYERS PRODUCTS	ST. LOUIS	MO
BRISTOL-MYERS: IND. & BRISTOL LABS.	EAST SYRACUSE	NY

BURDICK & JACKSON LABORATORIES, INC.	MUSKEGON	MI
BURROUGHS WELLCOME COMPANY	GREENVILLE	NC
BURROUGHS WELLCOME: VACCINE DIVISION	DENVER	CO
BYK-GULDEN, INC.	HICKSVILLE	NY
BYK-GULDEN: DAY-BALDWIN DIVISION	HILLSIDE	NJ
CARTER-WALLACE, INC.	CRANBURY	NJ
CARTER-WALLACE: DENV. CHEM. (P.R.)	HUMACAO	PR
CENTRAL PHARMACAL COMPANY	SEYMOUR	IN
CERTIFIED LABORATORIES, INC.	WARRINGTON	PA
CIBA-GEIGY CORPORATION	CRANSTON	RI
CIBA-GEIGY CORPORATION	SUFFERN	NY
CIBA-GEIGY CORPORATION	SUMMIT	NJ
CONNAUGHT LABORATORIES, INC.	SWIFTWATER	PA
COOPER LABORATORIES (P.R.), INC.	SAN GERMAN	PR
COOPER LABORATORIES (P.R.): SMP DIV.	PALO ALTO	CA
COOPER LABORATORIES: WAYNE OLD DIV.	WAYNE	NJ
CUTTER LABORATORIES, INC.	BERKELEY	CA
CUTTER LABORATORIES, INC.	CHATTANOOGA	TN
CUTTER LABORATORIES, INC.	CLAYTON	NC
CUTTER LABORATORIES, INC.	OGDEN	UT
CUTTER LABORATORIES: BAYVET DIVISION	SHAWNEE	KS
DADE DIAGNOSTICS, INC.	AGUADA	PR
DAVIS AND GECK, INC.	MANATI	PR
DENTCO, INC.	HUMACAO	PR
DOME LABORATORIES DIVISION	WEST HAVEN	CT
DORSEY LABORATORIES DIVISION	LINCOLN	NE
DOW PHARMACEUTICALS	INDIANAPOLIS	IN
E. R. SQUIBB AND SONS, INC.	NEW BRUNSWICK	NJ
E. R. SQUIBB MANUFACTURING, INC.	HUMACAO	PR
EATON LABORATORIES, INC.	MANATI	PR
ELI LILLY - CLINTON LABS.	CLINTON	IN
ELI LILLY - INDUSTRIAL CIR. 1200	INDIANAPOLIS	IN
ELI LILLY - OMAHA LABS	OMAHA	NE
ELI LILLY - PARK FLETCHER	INDIANAPOLIS	IN
ELI LILLY - TIPPECANOE LABS.	LAFAYETTE	IN
ELI LILLY AND COMPANY	CAROLINA	PR
ELI LILLY AND COMPANY	GREENFIELD	IN
ELI LILLY AND COMPANY	INDIANAPOLIS	IN
ELI LILLY AND COMPANY	MAYAGUEZ	PR
ELI LILLY INDUSTRIES	CAROLINA	PR
ENDO LABORATORIES, INC.	GARDEN CITY	NY
ENDO, INC.	MANATI	PR
FERNDALE LABORATORIES, INC.	FERNDALE	MI
FIRST TEXAS PHARMACEUTICALS, INC.	DALLAS	TX
HILTON DAVIS CHEMICAL COMPANY	CINCINNATI	OH
HOECHST-ROUSSEL PHARMACEUTICALS, INC.	SOMERVILLE	NJ
HOFFMANN-LA ROCHE - AG. DIVISION	FORT WORTH	TX
HOFFMANN-LA ROCHE, INC.	AMES	IA
HOFFMANN-LA ROCHE, INC.	BELVIDERE	NJ
HOFFMANN-LA ROCHE, INC.	FRESNO	CA

HOFFMANN-LA ROCHE, INC.	NUTLEY	NJ
HOFFMANN-LA ROCHE, INC.	SALISBURY	MD
HOFFMANN-LA ROCHE, INC.	TOTOWA	NJ
HOLLISTER-STIER LABORATORIES	SPOKANE	WA
HYNSON, WESTCOTT, & DUNNING DIVISION	BALTIMORE	MD
ICI AMERICAS, INC.	DIGHTON	MA
IMC, INC.	TERRE HAUTE	IN
INOLEX CORPORATION: PHARM. DIVISION	PARK FOREST SOUTH	IL
IVERS-LEE DIVISION	NEWARK	NJ
IVERS-LEE DIVISION	SHIPSHEWANA	IN
IVERS-LEE DIVISION	WEST CALDWELL	NJ
J. T. BAKER CHEMICAL COMPANY	PHILLIPSBURG	NJ
J. T. CLARK COMPANY	GENEVA	IL
JELCO LABORATORIES, INC.	RARITAN	NJ
JELCO LABORATORIES, INC.	RIVIERA BEACH	FL
JENSEN-SALSBERY LABORATORIES	KANSAS CITY	KS
JENSEN-SALSBERY LABORATORIES	KANSAS CITY	MO
JOHNSON AND JOHNSON	NORTH BRUNSWICK	NJ
JOHNSON AND JOHNSON - EAST. SURG. DR.	NORTH BRUNSWICK	NJ
JOHNSON AND JOHNSON - MIDWEST SUR. DR.	CHICAGO	IL
JOHNSON AND JOHNSON - SW. SURG. DRESS.	SHERMAN	TX
JOHNSON AND JOHNSON D.O.C., INC.	GURABO	PR
KNOLL PHARMACEUTICAL COMPANY	WHIPPANY	NJ
KREMERS-URBAN COMPANY	MEQUON	WI
LEDERLE LABORATORIES DIVISION	PEARL RIVER	NY
LEHN AND FINK PRODUCTS COMPANY	LINCOLN	IL
MALLINCKRODT, INC.	DECATUR	IL
MALLINCKRODT, INC.	ST. LOUIS	MO
MALLINCKRODT, INC. - BULK LYSATE	BEAUFORT	NC
MALLINCKRODT, INC. - NUCLEAR	MARYLAND HEIGHTS	MO
MALLINCKRODT, INC. - RALEIGH CHEMICAL	RALEIGH	NC
MALLINCKRODT, INC. - RALEIGH PARENT.	RALEIGH	NC
MALLINCKRODT, INC. - RALEIGH PLASTICS	RALEIGH	NC
MARION HEALTH AND SAFETY, INC.	ROCKFORD	IL
MARION LABORATORIES, INC.	KANSAS CITY	MO
MCGRAW LABORATORIES	IRVINE	CA
MCGRAW LABORATORIES	IRVINE	CA
MCGRAW LABORATORIES	MILLEDGEVILLE	GA
MCGRAW LABORATORIES	SABANA GRANDE	PR
MCNEIL LABORATORIES, INC.	DORADO	PR
MCNEIL LABORATORIES, INC.	FORT WASHINGTON	PA
MEAD JOHNSON AND COMPANY	EVANSVILLE	IN
MEDIPHYSICS, INC.	EMERYVILLE	CA
MEDIPHYSICS, INC.	GLENDALE	CA
MEDIPHYSICS, INC.	MIAMI LAKES	FL
MEDIPHYSICS, INC.	ROSEMONT	IL
MEDIPHYSICS, INC.	SOUTH PLAINFIELD	NJ
MERCK AND CO., INC.	RAHWAY	NJ
MERCK AND CO., INC. - CHEROKEE	DANVILLE	PA
MERCK AND CO., INC. - FLINT RIVER	ALBANY	GA

MERCK AND CO., INC. - STONEWALL	ELKTON	VA
MERCK SHARP AND DOHME, INC.	WEST POINT	PA
MERCK SHARP AND DOHME (P.R.), INC.	BARCELONETA	PR
MERRELL-NATIONAL LABORATORIES, INC.	CAYEY	PR
MERRELL-NATIONAL LABORATORIES, INC.	CINCINNATI	OH
MILES LABORATORIES, INC.	ELKHART	IN
NORWICH-EATON PHARM. DIV. - NORWICH	NORWICH	NY
NORWICH-EATON PHARM. DIV. - W'DS CORNER	NORWICH	NY
NORWICH-EATON PHARM. DIVISION	GREENVILLE	SC
ORGANON, INC.	WEST ORANGE	NJ
ORTHO DIAGNOSTICS, INC.	ARLINGTON	TX
ORTHO DIAGNOSITCS, INC.	RARITAN	NJ
ORTHO PHARMACEUTICALS, INC.	DORADO	PR
PARKE-DAVIS AND COMPANY	DETROIT	MI
PARKE-DAVIS AND COMPANY	GREENWOOD	SC
PARKE-DAVIS AND COMPANY	HOLLAND	MI
PARKE-DAVIS AND COMPANY	ROCHESTER	MI
PARKE-DAVIS LABORATORIES	FAJARDO	PR
PENNWALT CORPORATION	ROCHESTER	NY
PFIZER PHARMACEUTICALS, INC.	BARCELONETA	PR
PFIZER, INC.	BROOKLYN	NY
PFIZER, INC.	GROTON	CT
PFIZER, INC. - MAYW'D CANCER RES'RCH	MAYWOOD	NJ
PFIZER, INC. - VIGO	TERRE HAUTE	IN
PHARMASEAL LABORATORIES	IRWINDALE	CA
PHILIPS ROXANE LABORATORIES, INC.	COLUMBUS	OH
PLOUGH, INC.	MEMPHIS	TN
PURDUE FREDERICK LABORATORIES, INC.	TOTOWA	NJ
R. P. SCHERER (MIDWEST) CORP.	DETROIT	MI
R. P. SCHERER (SOUTHEAST) CORP.	MONROE	NC
REEDCO, INC.	HUMACAO	PR
REHEIS CHEMICAL COMPANY	BERKELEY HEIGHTS	NJ
RIKER LABORATORIES, INC.	NORTHRIDGE	CA
ROSS LABORATORIES	ALTAVISTA	VA
ROSS LABORATORIES	COLUMBUS	OH
S. B. PENICK AND COMPANY	LYNDHURST	NJ
S. B. PENICK AND COMPANY	MONTVILLE	NJ
S. B. PENICK AND COMPANY	NEWARK	NJ
S. B. PENICK AND COMPANY	VANCOUVER	WA
S. B. PENICK AND COMPANY	WALLINGFORD	CT
SANDOZ, INC.	EAST HANOVER	NJ
SCHERING (P.R.) CORPORATION	MANATI	PR
SCHERING CORPORATION	UNION	NJ
SCHERING-PLOUGH CORPORATION	KENILWORTH	NJ
SCHERING: AMERICAN SCIENTIFIC LABS.	MADISON	WI
SEARLE AND COMPANY	CAGUAS	PR
SEARLE LABORATORIES	SKOKIE	IL
SMITHKLINE AND FRENCH COMPANY	CAROLINA	PR
SMITHKLINE AND FRENCH LABORATORIES	PHILADELPHIA	PA
SMITHKLINE AND FRENCH LABORATORIES	SWEDELAND	PA

SMITHKLINE CORPORATION	LOWELL	AR
SMITHKLINE: NORDEN LABORATORIES	LINCOLN	NE
SMITHKLINE: SEA AND SKI CORP.	RENO	NV
STERLING DRUG, INC.	GULFPORT	MS
STERLING DRUG, INC.	MONTICELLO	IL
STERLING DRUG, INC.	MYERSTOWN	PA
STERLING DRUG, INC.	MYERSTOWN	PA
STERLING DRUG, INC.	RENSSELAER	NY
STERLING DRUG, INC.	TRENTON	NJ
STERLING DRUG, INC. - EAST GREENBUSH	RENSSELAER	NY
STERLING DRUG, INC.	MCPHERSON	KS
STERWIN LABORATORIES, INC.	MILLSBORO	DE
STERWIN LABORATORIES, INC.	OPELIKA	AL
STUART PHARMACEUTICALS DIVISION	NEWARK	DE
STUART PHARMACEUTICALS DIVISION	PASADENA	CA
SYNTEX (F.P.), INC.	HUMACAO	PR
SYNTEX AGRIBUSINESS, INC.	DES MOINES	IA
SYNTEX LABORATORIES, INC.	PALO ALTO	CA
TENNECO CHEMICALS, INC.	GARFIELD	NJ
TRAVENOL LABORATORIES, INC.	CAROLINA	PR
TRAVENOL LABORATORIES, INC.	CLEVELAND	MS
TRAVENOL LABORATORIES, INC.	COSTA MESA	CA
TRAVENOL LABORATORIES, INC.	JAYUYA	PR
TRAVENOL LABORATORIES, INC.	MARICAO	PR
TRAVENOL LABORATORIES, INC.	MARION	NC
TRAVENOL LABORATORIES, INC.	MORTON GROVE	IL
TRAVENOL LABORATORIES, INC.	MOUNTAIN HOME	AR
TRAVENOL: CLINICAL ASSAYS	CAMBRIDGE	MA
TRAVENOL: DAYTON FLEXIBLE PROD. DIV.	KINGSTREE	SC
TRAVENOL: HYLAND DIVISION	GLENDALE	CA
TRAVENOL: HYLAND DIVISION	LOS ANGELES	CA
TRAVENOL: HYLAND DIVISION	ROUND LAKE	IL
UPJOHN COMPANY	ARECIBO	PR
UPJOHN COMPANY	KALAMAZOO	MI
UPJOHN COMPANY	KALAMAZOO	MI
USV LABORATORIES	MANATI	PR
USV PHARMACEUTICAL CORP.	TUCKAHOE	NY
VICKS HEALTH CARE DIVISION	GREENSBORO	NC
VICKS HEALTH CARE DIVISION	HATBORO	PA
VICKS RESEARCH AND DEVELOPMENT DIV.	MT. VERNON	NY
WARNER-CHILCOTT DIVISION	MORRIS PLAINS	NJ
WARNER-CHILCOTT LABORATORIES	CAROLINA	PR
WARNER-CHILCOTT PHARMACEUTICAL CO.	VEGA BAJA	PR
WARREN-TEED LABORATORIES, INC.	COLUMBUS	OH
WARREN-TEED, INC.	HUMACAO	PR
WESTWOOD PHARMACEUTICALS, INC.	BUFFALO	NY
WILLIAM H. RORER, INC.	FORT WASHINGTON	PA
WILLIAM H. RORER, INC.	SAN LEANDRO	CA
WILLIAM P. POYTHRESS AND CO., INC.	RICHMOND	VA
WINTHROP LABORATORIES, INC.	BARCELONETA	PR

WYETH LABORATORIES, INC.	MARIETTA	PA
WYETH LABORATORIES, INC.	SKOKIE	IL
WYETH LABORATORIES, INC.	WEST CHESTER	PA
WYETH LABORATORIES, INC. - GR. VALLEY	MALVERN	PA

TOTAL NUMBER OF MFG. PLANTS IN THE ORIGINAL 308 DATA BASE: 244

APPENDIX D

Supplemental 308 Portfolio for the Pharmaceutical Manufacturing Industry

SUPPLEMENTAL 308 PORTFOLIO
FOR THE
PHARMACEUTICAL MANUFACTURING INDUSTRY

Instructions

1. Please complete the following portfolio and return within 30 days of receipt to:

   Mr. Robert B. Schaffer, Director
   Effluent Guidelines Division
   U.S. EPA (WH-552)
   401 M. Street, S.W.
   Washington, D.C. 20460

   Attention: J. S. Vitalis

2. Please read all instructions and questions carefully before completing this portfolio. It is preferred that the individual(s) who responds to this portfolio be familiar with manufacturing processes and wastewater treatment operations at the plant.

3. Please check the appropriate box or boxes in each question where they appear throughout this portfolio. (More than one box may be checked for some questions, where appropriate.) Please complete all questions which require written responses by printing or typing in the spaces provided.

4. Please indicate which information in your responses is confidential so that it may be treated properly.

5. The U.S. Environmental Protection Agency will review the information submitted and may, at a later date, request your cooperation for site visits and additional sampling in order to complete the data base. Please retain a copy of the completed portfolio in case future contact is necessary to verify your responses.

6. If you have any questions, please telephone Mr. J. S. Vitalis at 202-426-2497.

FORM APPROVED
OMB No. 158-R0160

PLANT CODE NO._____
(For EPA Use Only)

PART I

GENERAL INFORMATION

1. Name of Plant_____

2. Address of Plant:

_____
Street City State Zip

3. Name of Parent Firm_____

4. Address of Parent Firm Headquarters:

_____
Street City State Zip

5. Name(s) of plant personnel to be contacted for information pertaining to this data collection portfolio:

Name	Title	(Area Code) Telephone

PART II

PLANT DATA

1. a. Does this plant manufacture or formulate pharmaceutical active ingredients? (Research and development activities should not be considered.) Yes ☐ No ☐

b. If the answer to (a) is no, please describe the operations at this facility, but do not complete the remainder of this portfolio.

c. If the answer to (a) is yes, please complete the remainder of this portfolio.

2. Type of production operation(s) at this facility (check all items that are appropriate):

	Batch	Continuous	Semicontinuous
a. Fermentation	☐	☐	☐
b. Biological and Natural Extraction	☐	☐	☐
c. Chemical Synthesis	☐	☐	☐
d. Mixing/Compounding and Formulation	☐	☐	☐

3. Number of manufacturing or formulating employees in 1978: Average____ Minimum____ Maximum____

PLANT CODE NO._____

4. Please list in Table 1 all products manufactured at this plant site by the following production subcategories during 1978: (A) Fermentation, (B) Biological and Natural Extraction, and/or (C) Chemical Synthesis. Place an A, B, or C in the appropriate column to indicate the type of production subcategory used. Use the Merck Index, Ninth Edition, 1976, to specify the Merck Index Identification Numbers (Merck Index Number). Many of the Chemical Abstract Service Registry Numbers (CAS Numbers) may be found in the Merck Index beginning on page REG-1.

Note: Make as many photocopies of this sheet as necessary before filling in the requested information.

TABLE 1

CAS NUMBER	MERCK INDEX NO.	PRODUCT NAME	PRODUCTION SUBCATEGORY	ANNUAL PRODUCTION (kg/yr)
Examples:				
87081	6890	Penicillin V	A	10,000
-	-	Allergenic extracts	B	300
103902	36	Acetaminophen	C	5,000

PLANT CODE NO._____

PART III

WASTEWATER DATA

1. a. Does this plant site generate process wastewaters? Yes ☐ No ☐

Note: Process wastewater is any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, by-product, or waste product. This does not include sanitary wastewaters, non-contact cooling waters, nor stormwater.

b. Average daily quantity of process wastewaters generated during 1978, in gallons per day _____

2. a. Does this plant have a National Pollutant Discharge Elimination System permit (NPDES) for the discharge of process wastewaters? Yes ☐ No ☐

b. Permit or application number_____

c. Average daily flow rate of permitted discharge during 1978, in gallons per day _____

3. a. Does this plant discharge process wastewaters to a municipal sewage treatment plant? Yes ☐ No ☐

b. Average daily flow rate of discharge to municipal sewage treatment plant during 1978, in gallons per day _____

4. List other methods used for process wastewater disposal (e.g., incineration, evaporation, deep well disposal, etc.)

Method	Average daily flow rate during 1978, gallons per day

Note: Flow rates presented in Questions 2.c., 3.b. and 4. should total the flow rate given in Question 1.b.

5. Are there wastewater treatment facilities on site? Yes ☐ Complete Question III.6.
No ☐ Go to Part IV.

6. Check which of the treatment processes listed below are employed at this plant:

a. In-plant

- ☐ Cyanide Destruction
- ☐ Metal Precipitation
- ☐ Chromium Reduction
- ☐ Steam Stripping
- ☐ Solvent Recovery
- ☐ Other, Specify_____

b. End-of-Pipe

- ☐ Equalization
- ☐ Neutralization
- ☐ Coarse Settleable Solids Removal

Primary Separation

- ☐ Primary Sedimentation
- ☐ Primary Chemical Flocculation/Clarification
- ☐ Other, Specify_____

Biological Treatment

- ☐ Activated Sludge
- ☐ Trickling Filter
- ☐ Aerated Lagoon
- ☐ Waste Stabilization Ponds
- ☐ Rotating Biological Contactor

☐ Powdered Activated Carbon

☐ Other, Specify_____

☐ Physical/Chemical Treatment

Polishing

☐ Pond

☐ Multi-media Filtration

☐ Activated Carbon

☐ Other, Specify_____

c. Sludge Disposal

☐ Landfill

☐ Cropland Use

☐ Ocean

☐ Other, Specify_____

7. If this plant operates an end-of-pipe treatment system and one or more boxes in Question 6.b were checked, then please provide available data on the performance of that system by completing Table 2. Data used to compute long term average flow rates and concentrations should be for the time period from July 1, 1977 to December 31, 1978. If data is not available for the entire 1-1/2 year period, then please provide data that is available and indicate the actual time period used to compute long term average values. Do not include data obtained before July 1, 1977. In addition, please indicate the frequency of sampling that occurred for the subject parameter during the indicated time period. In Table 2, please insert a number from the following list that corresponds to that frequency.

Frequency	Number
One time sample	1
Less than one sample per month	2
One sample per month to less than one sample per week	3
One sample per week to one sample per day	4
More than one sample per day	5

Note: gal/d = gallons per day
mg/l = milligrams per liter

TABLE 2

Parameter	Long Term Average Value: Influent to End-of-Pipe System	Long Term Average Value: Effluent from End-of-Pipe System	Time Period over which average conc. occurred	Frequency of sampling during the indicated time period
Flow (gal/d)				
BOD_5 (mg/l)				
COD (mg/l)				
TSS (mg/l)				
Cyanide (mg/l)				
Phenol (mg/l)				

PART IV

PRIORITY POLLUTANTS

Please provide the information requested in Table 3 concerning the chemicals which are considered as priority pollutants and which are listed in Table 3 in conformance with the following instructions:

1. In column A, place a check mark to indicate all of the listed chemicals which were used as raw or intermediate material during 1978.

2. In column B, place a check mark to indicate all of the listed chemicals which were manufactured at this plant as a final or intermediate material during 1978.

3. In column C, place a check mark to indicate all of the listed chemicals for which you have analyzed in your raw (untreated) process wastewater (R) and/or treated effluent (E), and for which analytical data are available.

4. If one or more check marks have been placed in column C, then please attach a copy of the analytical results. However, if the results are voluminous, the data may be summarized on a separate sheet of paper by computing an average concentration and flow rate and stating minimum and maximum concentrations and flow rates for each pollutant. In addition, please indicate the time period over which this data was collected and the frequency of sampling that occurred during that time period.

TABLE 3

PRIORITY POLLUTANTS

PLANT CODE NO._____

	CAS Number	Merck Index Number	Chemical	A Raw or Intermediate Material	B Final or Intermediate Material	C Analyzed in Wastewater R	C Analyzed in Wastewater E
1.	83-32-9	19	acenaphthene				
2.	107-02-8	123	acrolein				
3.	107-13-1	127	acrylonitrile				
4.	71-43-2	1069	benzene				
5.	92-87-5	1083	benzidine				
6.	56-23-5	1821	carbon tetrachloride (tetrachloromethane)				
7.	108-90-7	2095	chlorobenzene				
8.	120-82-1	9310	1,2,4-trichlorobenzene				
9.	118-74-1	4544	hexachlorobenzene				
10.	107-06-2	3733	1,2-dichloroethane				
11.	71-55-6	9316	1,1,1-trichloroethane				
12.	67-72-1	4545	hexachloroethane				
13.	75-34-3	3750	1,1-dichloroethane				
14.	79-00-5	9317	1,1,2,-trichloroethane				
15.	79-34-5	8906	1,1,2,2-tetrachloroethane				
16.	75-00-3	3713	chloroethane				
17.	542-88-1	3046	bis(chloromethyl) ether				
18.	111-44-4	3040	bis(2-chloroethyl) ether				
19.	110-75-8	2119	2-chloroethyl vinyl ether (mixed)				
20.	91-58-7	2127	2-chloronaphthalene				
21.	88-06-2	9323	2,4,6-trichlorophenol				
22.	59-50-7	2108	parachlorometa cresol				
23.	67-66-3	2120	chloroform (trichloromethane)				
24.	95-57-8	2134	2-chlorophenol				
25.	95-50-1	3029	1,2-dichlorobenzene				
26.	541-73-1	3028	1,3-dichlorobenzene				
27.	106-46-7	3030	1,4-dichlorobenzene				
28.	91-94-1	3032	3,3'-dichlorobenzidine				
29.	75-35-4	9647	1,1-dichloroethylene				
30.	540-59-0	85	1,2- trans-dichloroethylene				
31.		----	2,4-dichlorophenol				
32.	78-87-5	7643	1,2-dichloropropane				
33.	542-75-6	3051	1,3-dichloropropylene (1,3-dichloropropene)				
34.	1300-71-6	9744	2,4-dimethylphenol				
35.		----	2,4-dinitrotoluene				
36.		----	2,6-dinitrotoluene				
37.		----	1,2-diphenylhydrazine				
38.	100-41-4	3695	ethylbenzene				
39.		----	fluoranthene				
40.		----	4-chlorophenyl phenyl ether				
41.		----	4-bromophenyl phenyl ether				
42.		----	bis(2-chloroisopropyl) ether				
43.		----	bis(2-chloroethyoxy) methane				

TABLE 3

PRIORITY POLLUTANTS

PLANT CODE NO._____

	CAS Number	Merck Index Number	Chemical	A Raw or Intermediate Material	B Final or Intermediate Material	C Analyzed in Wastewater R	C Analyzed in Wastewater E
44.	75-09-2	5932	methylene chloride (dichloromethane)				
45.	74-87-3	5916	methyl chloride (chloromethane)				
46.	74-83-9	5904	methyl bromide (bromomethane)				
47.	75-25-2	1418	bromoform (tribromomethane)				
48.		----	dichlorobromomethane				
49.	75-69-4	9320	trichlorofluoromethane				
50.	75-71-8	3038	dichlorodifluoromethane				
51.		----	chlorodibromomethane				
52.		----	hexachlorobutadiene				
53.		----	hexachlorocyclopentadiene				
54.		----	isophorone				
55.	91-20-3	6194	naphthalene				
56.	98-95-3	6409	nitrobenzene				
57.	88-75-5	6442	2-nitrophenol				
58.	100-02-7	6443	4-nitrophenol				
59.	51-28-5	3277	2,4-dinitrophenol				
60.	534-52-1	3275	4,6-dinitro-o-cresol				
61.	62-75-9	6458	N-nitrosodimethylamine				
62.		----	N-nitrosodiphenylamine				
63.		----	N-nitrosodi-n-propylamine				
64.	87-86-5	6901	pentachlorophenol				
65.	108-95-2	7038	phenol				
66.	117-81-7	1270	bis(2-ethylhexyl) phthalate				
67.		----	butyl benzyl phthalate				
68.	84-74-2	1575	di-n-butyl phthalate				
69.			di-n-octyl phthalate				
70.	84-66-2	3783	diethyl phthalate				
71.	131 -11-3	3244	dimethyl phthalate				
72.	56-55-3	1063	1,2-benzanthracene				
73.	50-32-8	1113	benzo (a)pyrene (3,4-benzopyrene)				
74.		----	3,4-benzofluoranthene				
75.		----	11,12-benzofluoranthene				
76.	218-01-9	2252	chrysene				
77.		----	acenaphthylene				
78.	120-12-7	718	anthracene				
79.		----	1,12-benzoperylene				
80.	86-73-7	4037	fluorene				
81.	85-01-8	6996	phenanthrene				
82.	53-70-3	2971	1,2:5,6-dibenzanthracene				
83.		----	indeno(1,2,3-C,D) pyrene				
84.	129-00-0	7746	pyrene				
85.	127-18-4	8907	tetrachloroethylene				
86.	108-88-3	9225	toluene				

TABLE 3

PRIORITY POLLUTANTS

PLANT CODE NO._____

	CAS Number	Merck Index Number	Chemical	A Raw or Intermediate Material	B Final or Intermediate Material	C Analyzed in Wastewater R	C Analyzed in Wastewater E
87.	79-01-6	9319	trichloroethylene				
88.	75-01-4	9645	vinyl chloride (chloroethylene)				
89.	309-00-2	220	aldrin				
90.	60-57-1	3075	dieldrin				
91.	57-74-9	2051	chlordane (technical mixture and metabolites)				
92.	50-29-3	2822	4,4'-DDT				
93.		----	4,4'-DDE (p,p'-DDX)				
94.	6088-51-3	2821	4,4'-DDD (p,p'-TDE)				
95.	115-29-7	3519	alpha-endosulfan				
96.	115-29-7	3519	beta-endosulfan				
97.		----	endosulfan sulfate				
98.	72-20-8	3522	endrin				
99.		----	endrin aldehyde				
100.	76-44-8	4514	heptachlor				
101.		----	heptachlor epoxide				
102.	58-89-9	5341	alpha-BHC				
103.	58-89-9	5341	beta-BHC				
104.	58-89-9	5341	gamma-BHC (lindane)				
105.	58-89-9	5341	delta-BHC				
106.		----	PCB-1242 (Arochlor 1242)				
107.		----	PCB-1254 (Arochlor 1254)				
108.		----	PCB-1221 (Arochlor 1221)				
109.		----	PCB-1232 (Arochlor 1232)				
110.		----	PCB-1248 (Arochlor 1248)				
111.		----	PCB-1260 (Arochlor 1260)				
112.		----	PCB-1016 (Arochlor 1016)				
113.	8001-35-2	9252	Toxaphene				
114.	7440-36-0	729	Antimony (Total)				
115.	7440-38-2	820	Arsenic (Total)				
116.		850	Asbestos (Fibrous)				
117.	7440-41-7	1184	Beryllium (Total)				
118.	7440-43-9	1600	Cadmium (Total)				
119.	7440-47-3	2229	Chromium (Total)				
120.	7440-50-8	2496	Copper (Total)				
121.	420-05-3	2694	Cyanide (Total)				
122.	7439-92-1	5242	Lead (Total)				
123.	7439-97-6	5742	Mercury (Total)				
124.		6312	Nickel (Total)				
125.	7782-49-2	8179	Selenium (Total)				
126.	7440-22-4	8244	Silver (Total				
127.	7440-28-0	8970	Thallium (Total)				
128.	7440-66-6	9782	Zinc (Total)				
129.		----	2,3,7,8 - tetrachlorodibenzo-p-dioxin (TCDD)				

APPENDIX E

Pharmaceutical Manufacturing Plants in the Supplemental 308 Data Base

APPENDIX E

PHARMACEUTICAL MANUFACTURING PLANTS IN THE SUPPLEMENTAL 308 DATA BASE

NAME	LOCATION	
A. E. STALEY MANUFACTURING COMPANY	DECATUR	IL
AJAY CHEMICALS, INC.	POWDER SPRINGS	GA
ALLIED CHEMICAL COMPANY	CHICAGO	IL
AMERCHOL, INC.	EDISON	NJ
AMERICAN AGAR AND CHEMICAL COMPANY	SAN DIEGO	CA
AMERICAN APOTHECARIES COMPANY	LONG ISLAND CITY	NY
AMERICAN CYANAMID CO. - FINE CHEM.	BOUND BROOK	NJ
AMERICAN CYANAMID CO. - FINE CHEM.	WILLOW ISLAND	WV
AMERICAN LABORATORIES, INC.	OMAHA	NE
ANABOLIC, INC.	IRVINE	CA
ANDERSON DEVELOPMENT COMPANY	ARDIAN	MI
ARAPAHOE CHEMICALS, INC.	BOULDER	CO
ARAPAHOE CHEMICALS, INC.	NEWPORT	TN
ARENOL CHEMICAL CORPORATION	LONG ISLAND CITY	NY
ASH STEVENS, INC. (PILOT PLT.)	DETROIT	MI
ATLAS POWDER COMPANY	TAMAQUA	PA
BANNER GELATIN PRODUCTS CORPORATION	CHATSWORTH	CA
BARR LABORATORIES	NORTHVALE	NJ
BAYLOR LABORATORIES, INC.	HURST	TX
BEIERSDORF, INC.	SOUTH NORWALK	CT
BELPORT COMPANY, INC.	CAMARILLO	CA
BEN VENUE LABORATORIES, INC.	BEDFORD	OH
BIOCRAFT LABORATORIES, INC.	ELMWOOD PARK	NJ
BIOCRAFT LABORATORIES, INC.	ELMWOOD PARK	NJ
BIOCRAFT LABORATORIES, INC.	WALDWICK	NJ
BLISTEX, INC.	OAK BROOK	IL
BOLAR PHARMACEUTICAL COMPANY, INC.	COPTAGUE	NY
BOOTS PHARMACEUTICALS, INC.	SHREVEPORT	LA
BRIOSCHI, INC.	FAIR LAWN	NJ
C AND M PHARMACAL, INC.	HAZEL PARK	MI
C. M. BUNDY COMPANY	ERLANGER	KY
CAMPANA CORPORATION	BATAVIA	IL
CARSON CHEMCIALS, INC.	NEW CASTLE	IN
CARTER-GLOGAU LABORATORIES	GLENDALE	AZ
CARTER-GLOGAU LABORATORIES	MELROSE PARK	IL
CENTURY PHARMACEUTICALS, INC.	INDIANAPOLIS	IN
CHAP STICK COMPANY	LYNCHBURG	VA
CHASE CHEMICAL COMPANY	NEWARK	NJ
CHATTEM CHEMICALS DIVISION	CHATTANOOGA	TN
CHATTEM LABORATORIES DIVISION	CHATTANOOGA	TN

CHROMALLOY LABORATORIES	LOS ANGELES	CA
COHELFRED LABORATORIES, INC.	CHICAGO	IL
CORD LABORATORIES, INC.	BROOMFIELD	CO
CORWOOD LABORATORIES, INC.	HAUPPAUGE	NY
CREOMULSTON COMPANY	ATLANTA	GA
CUMBERLAND MANUFACTURING COMPANY	NASHVILLE	TN
D. M. GRAHAM LABORATORIES, INC.	HOBART	NY
DANBURY PHARMACAL, INC.	DANBURY	CT
DEL LABORATORIES, INC.	FARMINGDALE	NY
DEL-RAY LABORATORY, INC.	BIRMINGHAM	AL
DELL LABORATORIES, INC.	TEANECK	NJ
DEPREE COMPANY	HOLLAND	MI
DEVLIN PHARMACEUTICALS, INC.	EL SEGUNDO	CA
DEWEY PRODUCTS COMPANY	GRAND RAPIDS	MI
DIAMOND SHAMROCK CORPORATION	LOUISVILLE	KY
DON HALL LABORATORIES	PORTLAND	OR
DORASOL LABORATORIES	HATO REY	PR
DR. G. H. TICHENOR ANTISEPTIC CO.	NEW ORLEANS	LA
DR. MADIS LABORATORIES, INC.	SOUTH HACKENSACK	NJ
DR. ROSE, INC.	MADISON	CT
DRUGS, INC.	ELIZABETH	NJ
E. E. DICKINSON COMPANY, INC.	ESSEX	CT
E-Z-EM COMPANY	WESTBURY	NY
EASTMAN KODAK CO. - KODAK PARK	ROCHESTER	NY
ELKINS-SINN, INC.	CHERRY HILL	NJ
EMERSON LABORATORIES	DALLAS	TX
ENZYME PROCESS COMPANY, INC.	NORTHRIDGE	CA
EX-LAX, INC.	HUMACAO	PR
FERMCO BIOCHEMICS, INC.	ELK GROVE VILLAGE	IL
FLEMING AND COMPANY	FENTON	MO
FOREST/INWOOD LABORATORIES, INC.	INWOOD, L.I.	NY
FORT DODGE LABORATORIES	FORT DODGE	IA
FRANKLIN LABORATORIES, INC.	AMARILLO	TX
FRESH LABORATORIES, INC.	WARREN	MI
FROMM LABORATORIES, INC.	GRAFTON	WI
G AND W LABORATORIES, INC.	SOUTH PLAINFIELD	NJ
G. E. LABORATORIES, INC.	SHAMOKIN	PA
GANES CHEMICALS, INC.	CARLSTADT	NE
GANES CHEMICALS, INC.	PENNSVILLE	NJ
GEBAUER CHEMICAL COMPANY	CLEVELAND	OH
GENERIC PHARMACEUTICAL CORPORATION	PALISADES PARK	NJ
GIBO/INVENEX DIVISION	GRAND ISLAND	NY
GOODY'S MANUFACTURING COMPANY	WINSTON-SALEM	NC
GORDON LABORATORIES	UPPER DARBY	PA
GRANDPA BRANDS COMPANY	CINCINNATI	OH
GUARDIAN CHEMICAL CORPORATION	HAUPPAUGE	NY
H. CLAY GLOVER COMPANY, INC.	TOMS RIVER	NJ
HALSEY DRUG COMPANY, INC.	BROOKLYN	NY
HEATHER DRUG COMPANY, INC.	CHERRY HILL	NJ
HENKEL CORPORATION	KANKAKEE	IL

HEUN/NORWOOD LABORATORIES	ST. LOUIS	MO
HEXAGON LABORATORIES, INC.	BRONX	NY
HEXCEL SPECIALTY CHEMICALS	LODI	NJ
HIGH CHEMICAL COMPANY	PHILADELPHIA	PA
HOBART LABORATORIES, INC.	CHICAGO	IL
HOLLAND-RANTOS COMPANY, INC.	TRENTON	NJ
HOPPE PHARMACAL CORPORTION	GRAND HAVEN	MI
HUMPHREYS PHARMACAL, INC.	RUTHERFORD	NJ
ICN PHARMACEUTICALS: COVINA DIVISION	COVINA	CA
INFRACORP, LTD.	PETERSBURG	VA
INTERNATIONAL HORMONES, INC.	FORT MITCHELL	KY
J. H. GUILD COMPANY, INC.	RUPERT	VT
JOHN D. COPANOS COMPANY, INC.	BALTIMORE	MD
KALLESTAD LABORATORIES, INC.	CHASKA	MN
KENDALL COMPANY	AUGUSTA	GA
KENDALL COMPANY	FRANKLIN	KY
KEY PHARMACEUTICALS, INC.	MIAMI	FL
KOPPERS COMPANY, INC.	PETROLIA	PA
L. T. YORK COMPANY	BROOKFIELD	MD
LANNETT COMPANY, INC.	PHILADELPHIA	PA
LARSON LABORATORIES, INC.	ERIE	PA
LEE PHARMACEUTICALS	SOUTH EL MONTE	CA
LEWIS/HOWE COMPANY	ST. LOUIS	MO
LIBBY LABORATORIES, INC.	BERKELEY	CA
LILY WHITE SALES COMPANY, INC.	ORISKANY FALLS	NY
LORVIC CORPORATION	ST. LOUIS	MO
LYNE LABORATORIES, INC.	NEEDHAM HEIGHTS	MA
LYPHO-MED, INC.	CHICAGO	IL
M. K. LABORATORIES, INC.	FAIRFIELD	CT
MANHATTAN DRUG COMPANY	HILLSIDE	NJ
MANN CHEMICAL CORPORATION	LOUISVILLE	KY
MARSHALL PHARMACAL CORPORATION	SOUTH HACKENSACK	NJ
MAURRY BIOLOGICAL COMPANY, INC.	LOS ANGELES	CA
MBH CHEMICAL CORPORATION	ORANGE	NJ
McCONNON AND COMPANY	WINONA	MN
MENTHOLAIUM COMPANY	BUFFALO	NY
MERICON INDUSTRIES, INC.	PEORIA	IL
MERRICK MEDICINE COMPANY	WACO	TX
MERRILL-NATIONAL LABORATORIES	MILWAUKEE	WI
MICROBIOLOGICAL ASSOCIATES	WALKERSVILLE	MD
MILEX PRODUCTS, INC.	CHICAGO	IL
MILLER-MORTON COMPANY	RICHMOND	VA
MILROY LABORATORIES	SARASOTA	FL
MONSANTO CO. - JOHN F. QUEENY PLT.	ST. LOUIS	MO
MORTON PHARMACEUTICALS, INC.	MEMPHIS	TN
MOYCO INDUSTRIES, INC.	PHILADELPHIA	PA
MYLAN PHARMACEUTICALS, INC.	MORGANTOWN	WV
N.E.N. - MEDICAL DIAGNOSTIC DIVISION	NORTH BILLERICA	MA
NAPP CHEMICALS, INC.	LODI	NJ
NATCON CHEMICAL COMPANY, INC.	PLAINVIEW	NY

NATIONAL PHARMACEUTICAL MFG. COMPANY	BALTIMORE	MD
NELCO LABORATORIES, INC.	DEER PARK	NY
NEPERA CHEMICAL COMPANY, INC.	HARRIMAN	NY
NORTH AMERICAN BIOLOGICALS, INC.	MIAMI	FL
NUTRILITE PRODUCTS, INC.	BUENA PARK	CA
O'NEAL, JONES, AND FELDMAN, INC.	ST. LOUIS	MO
O'NEAL, JONES, AND FELDMAN, INC.	CINCINNATI	OH
ORGANICS, INC.	CHICAGO	IL
ORMONT DRUG AND CHEMICAL CO., INC.	ENGLEWOOD	NJ
OTIS CLAPP AND SONS	CAMBRIDGE	MA
OTTAWA CHEMICAL DIVISION	TOLEDO	OH
PASCAL COMPANY, INC.	BELLEVUE	WA
PAUL B. ELDER COMPANY	BRYAN	OH
PETERSON OINTMENT COMPANY	BUFFALO	NY
PFANSTIEHL LABORATORIES, INC.	WAUKEGAN	IL
PHARMACARE, INC.	LARGO	FL
PHARMACIA, INC.	PISCATAWAY	NJ
PHILIPS ROXANNE, INC.	ST. JOSEPH	MO
PIERCE CHEMICAL COMPANY	ROCKFORD	IL
PITMAN-MOORE, INC.	WASHINGTON CROSSING	NJ
PRALEX CORPORATION	ST. CROIX	VI
PREMO PHARMACEUTICAL LABS., INC.	SOUTH HACKENSACK	NJ
PRIVATE FORMULATIONS, INC.	EDISON	NJ
RACHELLE LABORATORIES, INC.	LONG BEACH	CA
RECSEI LABORATORIES	GOLETA	CA
REED AND CARNRICK, INC.	KENILWORTH	NJ
REID-PROVIDENT LABORATORIES, INC.	ATLANTA	GA
REXALL DRUG COMPANY	ST. LOUIS	MO
REXAR PHARMACAL CORPORATION	VALLEY STREAM	NY
RHONE-POULENC, INC.	NEW BRUNSWICK	NJ
RHONE-POULENC: HESS AND CLARK DIV.	ASHLAND	OH
RIKER LABORATORIES, INC.	NORTHRIDGE	CA
ROEHR CHEMICALS COMPANY	LONG ISLAND CITY	NY
RUETGERS-NEASE CHEMICAL COMPANY	STATE COLLEGE	PA
RYSTAN COMPANY, INC.	LITTLE FALLS	NJ
SCHOLL, INC.	CHICAGO	IL
SCHUYLKILL CHEMICAL COMPANY	PHILADELPHIA	PA
SEIN/MENDEZ LABORATORIES	RIO PIEDRAS	PR
SHELL CHEMICAL COMPANY	DENVER	CO
SHERWOOD LABORATORIES, INC.	EASTLAKE	OH
SINCLAIR PHARMACAL COMPANY, INC.	FISHERS ISLAND	NY
SOUTHLAND CORPORATION	GREAT MEADOWS	NJ
STANBACK COMPANY, LTD.	SALISBURY	NC
STANLABS PHARMACEUTICAL COMPANY	PORTLAND	OR
STIEFEL LABORATORIES, INC.	OAK HILL	NY
SUPPOSITORIA LABORATORIES, INC.	FARMINGDALE	NY
SYNTEX AGRI-BUSINESS, INC.	SPRINGFIELD	MO
SYNTEX AGRI-BUSINESS, INC.	VERONA	MO
SYNTEX (F.P.), INC.	HUMACAO	PR
TABLICAPS, INC.	FRANKLINVILLE	NJ

TAYLOR PHARMACAL COMPANY	DECATUR	IL
TENNESSEE EASTMAN COMPANY	KINGSPORT	TN
THOMPSON-HAYWARD CHEMICALS	KANSAS CITY	KS
TRUETT LABORATORIES	DALLAS	TX
UPSHER SMITH LABORATORIES	MINNEAPOLIS	MN
V. K. BHAT	EVERETT	WA
VALE CHEMICAL COMPANY, INC.	ALLENTOWN	PA
VINELAND LABORATORIES, INC.	VINELAND	NJ
VINELAND/EVSCO, INC.	BUENA	NJ
VIOBIN CORPORATION	MONTICELLO	IL
VISTA LABORATORIES, INC.	ST. CROIX	VI
VITA-FORE PRODUCTS COMPANY	OZONE PARK	NY
VITAMINS, INC.	CHICAGO	IL
VITARINE COMPANY, INC.	SPRINGFIELD GARDENS	NY
W. F. YOUNG, INC.	SPRINGFIELD	MA
WALGREEN LABORATORIES, INC.	CHICAGO	IL
WATKINS,INC	WINONA	MN
WEST ARGO-CHEMICALS, INC.	EIGHTY FOUR	PA
WEST ARGO-CHEMICALS, INC.	KANSAS CITY	MO
WEST-WARD, INC.	EATONTOWN	NJ
WESTERN RESEARCH LABORATORIES	DENVER	CO
WESTWOOD PHARMACEUTICALS, INC.	BUFFALO	NY
WHITEHALL LABORATORIES	ELKHART	IN
WHITEWORTH, INC.	GARDENA	CA
WHORTON PHARMACEUTICALS, INC.	FAIRFIELD	AL
WILLIAM T. THOMPSON COMPANY	CARSON	CA
WORTHINGTON DIAGNOSTICS	FREEHOLD	NJ
XTTRIUM LABORATORIES, INC.	CHICAGO	IL
YAGER DRUG COMPANY	BALTIMORE	MD
ZENITH LABORATORIES, INC.	NORTHVALE	NJ

TOTAL NUMBER OF MFG. PLANTS IN THE SUPPLEMENTAL 308 DATA BASE: 220

APPENDIX F

Pharmaceutical Industry General Plant Information
(308 Data,

APPENDIX F

GENERAL PLANT INFORMATION

Plant Code No.	Subcategories	Average Employment(1)	Start-Up Year(2)
12000	D	2200	1965
12001	D	380	1959
12003	A C D	5930	1931
12004	C D	72	1972
12005	B	10	1971
12006	D	54	1963
12007	D	1710	1933
12011	A B D	224	1968
12012	B D	3540	1947
12014	B	N/A	1977
12015	D	365	1960
12016	D	132	1968
12018	A C D	210	1916
12019	D	850	1960
12021	D	39	1973
12022	A C	176	1951
12023	D	442	1967
12024	D	1240	1920
12026	C	30	1950
12030	D	200	1966
12031	D	60	1897
12035	D	208	1972
12036	A	184	1948
12037	C D	1118	1937
12038	A B C D	1053	1954
12040	B D	433	1967
12042	A B D	183	1974
12043	C	14	1973
12044	A D	873	1938
12048	C D	425	1951
12051	D	19	1963
12052	C D	503	1971
12053	D	250	1963
12054	D	350	1958
12055	D	100	1956
12056	D	200	1971
12057	C D	750	1934
12058	D	100	1955
12060	D	546	1962
12061	B	152	1967
12062	C D	300	1950
12063	N/A	313	1974
12065	D	980	1960

12066	B C D	666	1953
12068	D	17	1934
12069	D	176	1964
12073	C	6	1961
12074	D	220	1897
12076	D	50	1972
12077	C D	493	1970
12078	D	N/A	1977
12080	D	1640	1948
12083	D	190	1972
12084	B C D	275	1958
12085	D	74	N/A
12087	C	90	1957
12088	D	250	1950
12089	B D	32	1914
12093	C D	560	1948
12094	D	135	1967
12095	C D	102	1947
12097	C D	160	1951
12098	D	54	1975
12099	D	75	1970
12100	C D	17	N/A
12102	C D	265	N/A
12104	D	1415	1951
12107	B D	105	1923
12108	A C D	372	1974
12110	D	10	1974
12111	B D	444	1949
12112	C	12	1959
12113	D	922	1962
12115	A B D	271	1963
12117	B D	455	1882
12118	D	280	1972
12119	A D	N/A	1977
12120	D	22	1974
12122	D	6	1937
12123	C D	277	1937
12125	D	32	1974
12128	D	24	N/A
12129	D	615	1975
12131	D	32	1970
12132	A C	383	1941
12133	D	10	1969
12135	B C D	875	1896
12141	D	112	1971
12143	D	175	1924
12144	D	20	1972
12145	D	18	1972
12147	D	231	1965
12155	C D	1668	1849

12157	D	8	1973
12159	C D	356	1942
12160	D	215	1974
12161	A C D	905	1969
12166	D	90	1974
12168	A B C D	250	1938
12171	B C D	70	1970
12172	D	34	1974
12173	B	3	1940
12174	D	75	1939
12175	D	66	1975
12177	D	70	1960
12178	B D	40	1962
12183	B	270	1903
12185	B C	26	1941
12186	C D	051	1976
12187	C	0632	1949
12191	A B C	450	N/A
12194	D	20	1973
12195	C	N/A	1975
12198	B D	70	1949
12199	A C D	2061	1946
12201	D	N/A	N/A
12204	A B C D	2000	1907
12205	D	300	1968
12206	D	220	1971
12207	D	55	1962
12210	B C	190	1973
12211	C	22	1976
12212	D	212	1976
12217	D	140	1975
12219	D	544	1964
12224	D	1333	1915
12225	D	22	1972
12226	B	124	1973
12227	D	25	1963
12230	B	20	1969
12231	A D	685	1968
12233	D	341	1895
12235	C	84	1971
12236	C	250	1952
12238	D	42	1976
12239	D	46	1973
12240	C D	53	1972
12243	D	70	1973
12244	C	224	1947
12245	A B C	230	1951
12246	C D	716	1948
12247	C	6	1969
12248	D	810	1961

12249	D	115	1968
12250	D	259	1940
12251	D	53	1968
12252	A C D	1400	1939
12254	A D	444	1971
12256	A B C D	1239	1948
12257	A B C D	4600	1922
12260	D	176	1943
12261	C	128	1966
12263	D	28	1973
12264	A B D	4450	1910
12265	B D	65	1965
12267	D	122	1969
12268	D	112	1974
12269	D	135	1957
12273	D	14	1975
12275	B C	1297	1925
12277	D	15	1965
12281	D	303	1957
12282	B C D	85	1900
12283	D	37	1972
12287	D	3112	1964
12289	D	31	N/A
12290	D	59	1975
12294	C D	332	1969
12295	B D	8	1925
12296	D	685	N/A
12297	D	70	1972
12298	D	88	1962
12300	B	410	1953
12302	C	144	1901
12305	D	174	1971
12306	D	4	1976
12307	D	151	1975
12308	D	1052	N/A
12309	B C	30	1967
12310	C D	170	1970
12311	A B C D	1008	1953
12312	B D	693	1873
12317	D	2387	1972
12318	D	210	1960
12322	D	98	1969
12326	D	60	1975
12330	A B C D	2438	1906
12331	D	374	1967
12332	C	N/A	N/A
12333	C D	198	1970
12338	D	150	1974
12339	A C D	555	1970
12340	D	1595	1957

12342	A	C	D	377	1944
12343	A	C	D	166	1967
12345			D	389	1963
12375		B		91	1953
12384		B		35	1970
12385			D	60	1966
12392			D	110	1959
12401	A		D	1324	1968
12405		C	D	85	1964
12406		C		163	1948
12407		C		67	1904
12409			D	18	1920
12411		B	C D	750	1970
12414			D	627	1951
12415			D	450	1968
12417			D	10	1950
12419		B	D	123	1969
12420		B	D	160	1973
12427			D	579	1958
12429			D	51	1886
12433			D	180	1953
12438			D	560	1964
12439		C	D	115	1974
12440			D	235	1965
12441		C		1108	1923
12444			D	78	1977
12447	A	B	C D	4095	1948
12454		B	D	710	1947
12458		C	D	120	1968
12459			D	4	1977
12460		B	D	70	1975
12462	A			25	1972
12463		B	D	224	1926
12464			D	4	N/A
12465			D	315	1967
12466		B		18	1958
12467		B		67	1959
12468			D	628	1947
12470	A			14	1967
12471		B		328	1972
12472		B	C	44	1971
12473		B	C	242	1947
12474			D	64	1969
12475		C		153	1966
12476			D	55	1967
12477		B	C	298	1867
12479		B		5	1977
12481			D	N/A	1918
12482		N/A		N/A	N/A
12495			D	130	1959

12499		D	1150
20006		D	2
20008	B	D	20
20012	C		4
20014		D	210
20015		D	45
20016		D	4
20017		D	13
20020		D	68
20026		D	3
20030	C	D	1
20032	B	D	79
20033	C	D	38
20034		D	14
20035	C		25
20037		D	1
20038		D	81
20040	B		12
20041		D	20
20045		D	12
20048		D	10
20049		D	31
20050	A B		31
20051		D	6
20052		D	30
20054		D	21
20055		D	4
20057		D	30
20058		D	15
20062		D	35
20064		D	16
20070		D	150
20073		D	2
20075		D	4
20078		D	1
20080		D	35
20081		D	14
20082	C	D	6
20084		D	75
20087		D	10
20089		D	55
20090		D	40
20093		D	3
20094		D	2
20099		D	5
20100		D	34
20103		D	3
20106		D	3
20108		D	62
20115		D	7

1961

20117	D	127
20120	D	14
20125	D	50
20126	D	12
20134	C D	6
20139	C D	40
20141	D	6
20142	D	70
20147	D	15
20148	D	15
20151	B C D	6
20153	D	10
20155	D	20
20159	B C	22
20165	B C	10
20169	D	30
20173	C	3
20174	D	6
20176	D	2
20177	C	5
20178	D	12
20187	D	10
20188	D	200
20195	D	100
20197	D	3
20201	D	8
20203	C	93
20204	C D	84
20205	C	37
20206	C	49
20208	D	2
20209	D	12
20210	D	3
20215	D	13
20216	D	6
20218	C	15
20220	D	20
20224	D	6
20225	D	65
20226	D	22
20228	D	2
20229	D	86
20231	D	20
20234	C	N/A
20235	D	7
20236	D	120
20237	B	28
20240	C	20
20241	D	31
20242	C D	10

20244			C		1
20245	A		C		59
20246			C		171
20247		B			25
20249			C		3
20254			C		3
20256				D	90
20257			C		60
20258			C	D	20
20261				D	15
20263				D	2
20264				D	11
20266				D	13
20267				D	116
20269				D	10
20270				D	6
20271				D	6
20273				D	70
20282				D	2
20288				D	38
20294		B			9
20295				D	53
20297			C		10
20298			C		N/A
20300				D	40
20303		B			1
20305				D	19
20307		B			29
20308				D	3
20310			C		15
20311			C		15
20312		B	C	D	44
20316				D	60
20319				D	272
20321				D	100
20325				D	5
20328				D	10
20331			C		60
20332			C		24
20333				D	3
20338				D	130
20339				D	4
20340			C		4
20342			C		35
20346		B	C		60
20347				D	1
20349			C		50
20350			C	D	20
20353		B	C		35
20355			C		25

20356			C	D
20359		B		D
20361	A			
20362			C	D
20363	A		C	D
20364		B		D
20366		B	C	D
20370		B	C	
20371				D
20373			C	
20376				D
20377			C	D
20385				D
20387			C	
20389			C	
20390				D
20394		B		D
20396			C	D
20397			C	D
20400				D
20402				D
20405				D
20413				D
20416				D
20421				D
20423				D
20424			C	D
20425				D
20435			C	D
20436				D
20439				D
20440				D
20441				D
20443		B		D
20444				D
20446				D
20448				D
20450				D
20452				D
20453				D
20456				D
20460				D
20462				D
20464				D
20465				D
20466				D
20467		B		D
20470				D
20473		B		
20476				D

2	
16	
N/A	
4	
N/A	
9	
315	
45	
3	
N/A	
15	
3	
240	
7	
40	
40	
4	
4	
18	
N/A	
65	
21	
3	
25	
2	
85	
60	
2	
2	
80	
200	
11	
25	
3	
5	
3	
6	
15	
7	
20	
6	
4	
2	
4	
240	
110	
3	
1	
150	
50	

20483	D	2
20485	D	30
20486	D	5
20490	D	250
20492	C D	3
20494	D	65
20496	D	12
20498	D	2
20500	D	31
20502	D	3
20503	D	1
20504	D	2
20507	D	3
20509	D	33
20511	D	8
20518	D	5
20519	D	13
20522	D	6
20526	C D	18
20527	D	24
20529	D	2

(1) Average employment for orignal 308 (12000 series) plants is for 1976; for Supplemental 308 (20000 series) plants it is 1978.

(2) Data on year of operational start-up was not requested of the Supplemental 308 (20000 series) plants.

APPENDIX G

Screening/Verification Plant Data

APPENDIX G

SCREENING/VERIFICATION PLANT DATA

Abbreviations:

GT-greater than
J-approximate value
LT-less than
LTDL-less than detection limit
NAI-not able to analyze due to interference
ND-not detected
NQ-not quantifiable due to instrument saturation

Notes:

(1) numbers in parenthesis indicate number of data points.

(2) when more than one data point was available a range (min-max.) is given.

(3) pollutants not listed were not detected, below detection limit, or not analyzed for.

SCREENING PROGRAM—SUMMARY OF PLANT 12015

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
Pentachlorophenol	62 (1)	ND (1)
Phenol	8 (1)	ND (1)
Phenols (4AAP)	249 (1)	26 (1)
Base/Neutral Extractables		
Bis (2-ethylhexyl) phthalate	170 (1)	30 (1)
Di-n-butyl phthalate	20 (1)	3 (1)
Volatile Organics		
Benzene	79 (1)	ND (1)
1,2 Dichloroethane	19 (1)	ND (1)
Chloroform	100GT (1)	14 (1)
Ethylbenzene	11 (1)	ND (1)
Methylene chloride	100GT (1)	12 (1)
Tetrachloroethylene	36 (1)	ND (1)
Toluene	100GT (1)	3 (1)
Trichloroethylene	6 (1)	ND (1)
Metals		
Beryllium	1LT (1)	1LT (1)
Cadmium	6 (1)	7 (1)
Chromium	30 (1)	10 (1)
Copper	50 (1)	30 (1)
Lead	20LT (1)	20LT (1)
Mercury	0.7 (1)	0.1 (1)
Nickel	5LT (1)	5LT (1)
Zinc	300 (1)	200 (1)
All other metals	--	--
Cyanide	25LT (1)	25LT (1)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Equalization
Primary Sedimentation
Activated Sludge with Powdered Activated Carbon
Secondary Chemical Flocculation/Clarification
Gravity Dewatering
Aerobic Digestion
Landfill

PLANT CHARACTERISTICS

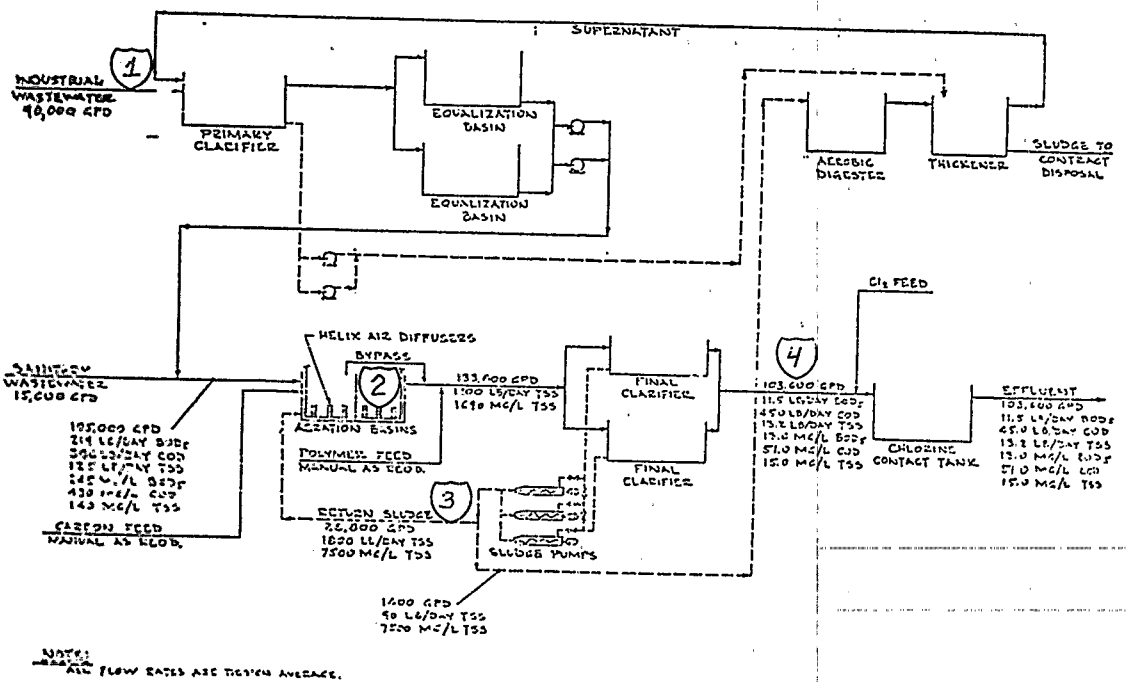
Subcategory	Wastewater Quantity (MGD)	Employment
D	.07	300-400

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
---	---	---	---	---	0 (2)*

* Data supplied by plant

WASTEWATER TREATMENT PLANT FLOW DIAGRAM



NOTE: ALL FLOW RATES ARE THIRTY AVERAGE.

SAMPLING PROGRAM

Sample Location	No. of Samples
1. Influent to primary clarifier	4
2. XAD-2 resin	4
2. Tenax column	4
3. Return sludge	4
4. Clarifier effluent	4

SCREENING PROGRAM—SUMMARY OF PLANT 12022

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
2,4,6-Trichlorophenol	20 (1)	LTDL (1)
2-Chorophenol	50 (1)	ND (1)
Phenol	1400 (1)	ND (1)
Phenols (4AAP)	1367 (1)	867 (1)
Base/Neutral Extractables		
1,2-Dichlorobenzene	20 (1)	ND (1)
1,4-Dichlorobenzene	90 (1)	ND (1)
Volatile Organics		
Benzene	120 (1)	ND (1)
Chlorobenzene	6400 (1)	ND (1)
1,2-Dichloroethane	11000 (1)	500 (1)
Chloroform	80 (1)	LTDL (1)
Ethylbenzene	20 (1)	ND (1)
Methylene chloride	170 (1)	LTDL (1)
Toluene	11000 (1)	ND (1)
Metals (Data supplied by plant)		
Antimony	50LT (1)	50LT (1)
Arsenic	50LT (1)	50LT (1)
Beryllium	10LT (1)	10LT (1)
Cadmium	2.6 (1)	1.2 (1)
Chromium	125 (1)	75 (1)
Copper	70 (1)	20 (1)
Lead	20LT (1)	20LT (1)
Mercury	1.4 (1)	1.0 (1)
Nickel	510 (1)	310 (1)
Selenium	50LT (1)	50LT (1)
Silver	3 (1)	1.6 (1)
Thallium	50LT (1)	50LT (1)
Zinc	480 (1)	100 (1)
Cyanide	168 (1)	400GT (1)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Equalization
Neutralization
Coarse Setteable Solids Removal
Primary Sedimentation
Activated Sludge
Trickling Filter
Mechanical Thickening
Chemical Conditioning
Vacuum Dewatering
Incineration
Landfill

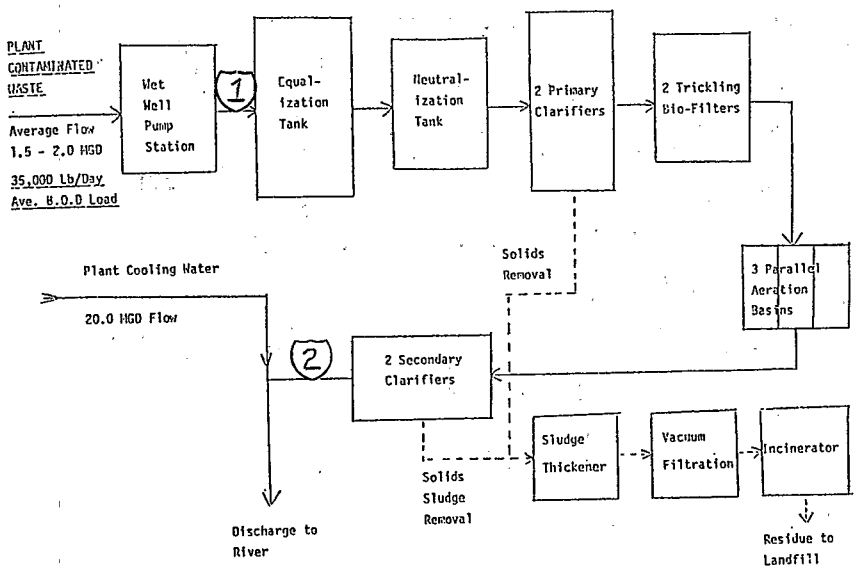
PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
A,C	1.30	100-200

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
2630	680	4619	1701	---	---

WASTEWATER TREATMENT PLANT FLOW DIAGRAM



SAMPLING PROGRAM

Sample Location	No. of Samples
1. Influent to biological treatment	2
2. Final effluent before dilution	2
Potable water	1

SCREENING PROGRAM—SUMMARY OF PLANT 12026

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
Phenol	64 (1)	5.8 (1)
Base/Neutral Extractables		
Acenaphthene	1.9 (1)	0.10LT (1)
Fluoranthene	0.2 (1)	0.10LT (1)
Naphthalene	9.8 (1)	0.10LT (1)
Bis(2-ethylhexyl) phthalate	10.7 (1)	14.6 (1)
Anthracene	0.4 (1)	0.10LT (1)
Volatile Organics		
Benzene	7 (1)	0.01LT (1)
Carbon Tetrachloride	11000 (1)	0.01LT (1)
1,2-Dichloroethane	17 (1)	0.01LT (1)
Chloroethane	1.6 (1)	0.01LT (1)
Chloroform	3170 (1)	8.1 (1)
Ethylbenzene	130 (1)	0.01LT (1)
Toluene	470 (1)	0.01LT (1)
Acrolein	100LT (1)	100LT (1)
Acrylonitrile	100LT (1)	100LT (1)
Metals		
Atimony	3 (1)	5LT (1)
Arsenic	20LT (1)	20LT (1)
Beryllium	3J (1)	0.8J (1)
Cadmium	1LT (1)	1LT (1)
Chromium	11 (1)	4J (1)
Copper	41J (1)	8J (1)
Lead	10LT (1)	10LT (1)
Mercury	0.79 (1)	0.20 (1)
Nickel	4LT (1)	4LT (1)
Selenium	20LT (1)	20LT (1)
Silver	3LT (1)	3LT (1)
Thallium	8LT (1)	8LT (1)
Zinc	120 (1)	71 (1)
Cyanide	1980	63

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Equalization
Neutralization
Activated Sludge
Aerated Lagoon
Polishing Pond
Anaerobic Digestion

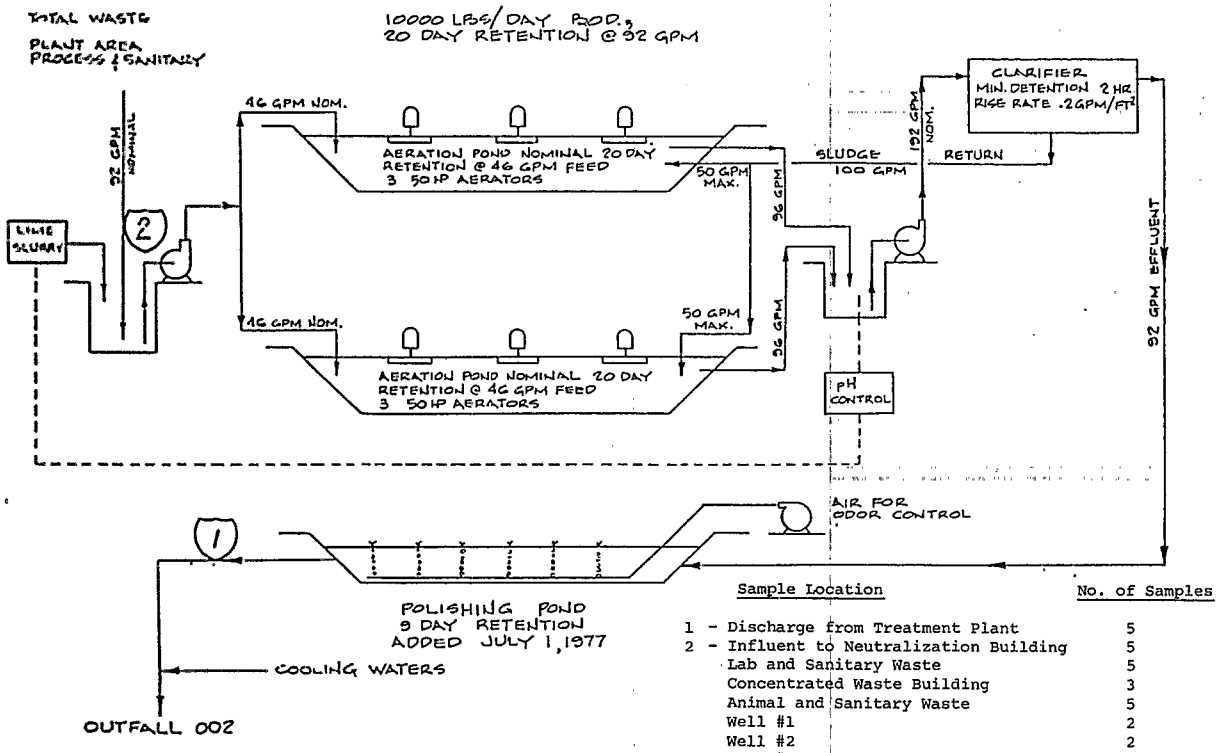
PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
C	.101	0-100

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
1418	348.4	2375	159.7	621	117.6

WASTEWATER TREATMENT PLANT FLOW DIAGRAM



Sample Location	No. of Samples
1 - Discharge from Treatment Plant	5
2 - Influent to Neutralization Building	5
Lab and Sanitary Waste	5
Concentrated Waste Building	3
Animal and Sanitary Waste	5
Well #1	2
Well #2	2
Well #3	2

Appendix F
Verification Program
Analytical Results
Plant 12026

Priority Pollutants (ug/l)	Day 1		Day 2		Day 3	
	Influent	Effluent	Influent	Effluent	Influent	Effluent
Volatile Organics						
Carbon Tetrachloride	15	1LT	12	1LT	59	1LT
1,2 Dichlorethane	1.1	1LT	1	1LT	1LT	1LT
Chloroform	1620	1LT	554	1LT	1100	1LT
Ethylbenzene	61	1LT	25	1LT	22	1LT
Toluene	122	1LT	78	1LT	193	1LT
Bromodichloromethane	1	1LT	1	1LT	1LT	1LT
Acid Extractables						
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND
Phenol	515-750	ND-3	99	3	450	ND
*Base/Neutral Extractables						
*Metals						
*Pesticides						
Cyanides (mg/l)	0.45	0.35	.06	.53	2.0	0.49
Asbestos (verification program did not analyze for this compound)						
Conventionals (mg/l)						
BOD_5	328	216.7	3479	98	4537	135
TSS	110	98	55	110	1600	104
Non-Conventionals (mg/l)						
COD	7310	970	6650	900	7700	903

*NOTE: All analytical fractions were not analyzed for samples taken for this plant.

SCREENING PROGRAM—SUMMARY OF PLANT 12036

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
Phenol	56-80 (2)	ND (3)
Base/Neutral Extractables		
Acenaphthene	ND-35 (3)	ND (3)
Bis (2-ethylhexyl) phthalate	ND-180 (2)	38-68 (3)
Di-n-butyl phthalate	ND (2)	ND-15 (3)
Diethyl phthalate	ND (2)	ND-20 (3)
Volatile Organics		
Benzene	260 (1)	120 (1)
Carbon Tetrachloride	18 (1)	16 (1)
1,1,1-Trichloroethane	22 (1)	11 (1)
Chloroform	180 (1)	110 (1)
1,1-Dichloroethylene	230 (1)	180 (1)
Ethyl benzene	18 (1)	22 (1)
Methylene chloride	6200 (1)	2600 (1)
Trichlorofluoromethane	970 (1)	420 (1)
Tetrachloroethylene	14 (1)	18 (1)
Toluene	310 (1)	180 (1)
Metals		
Antimony	20LT (2)	10-20LT (3)
Arsenic	10-50LT (2)	10-11 (3)
Chromium	16 (1)	20LT (3)
Beryllium	1LT (2)	1LT (3)
Cadmium	1LT (2)	1LT (3)
Copper	50-73 (2)	5LT-9 (3)
Lead	5LT (2)	5LT (3)
Mercury	0.5-1.2 (2)	0.2-0.7 (3)
Nickel	10LT (2)	10LT (3)
Selenium	20-200LT (2)	20LT (3)
Thallium	8-18 (2)	10-11 (3)
Zinc	149-251 (2)	60-100 (3)
Cyanide	100-280 (2)	28-30 (3)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Activated Sludge
Trickling Filter
Aerated Lagoon
Waste Stabilization Pond
Polishing Pond
Aerobic Digestion
Cropland Use

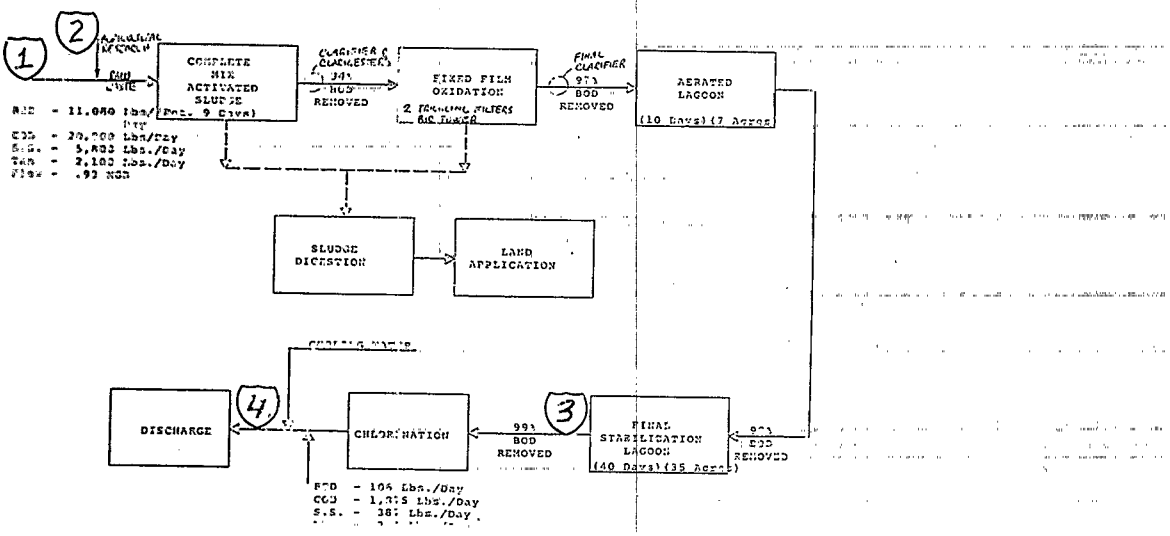
PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
A	1.13	100-200

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
1326-1900 (2)	24-35 (3)	2800-4210 (2)	227-262 (3)	700-840 (2)	44-49 (3)

WASTEWATER TREATMENT PLANT FLOW DIAGRAM



SAMPLING PROGRAM

Sample Location	No. of Samples
1 - Influent to Wastewater Treatment System at Manhole M-5	1
2 - Agricultural Research Farm Discharge to the WTP	3
3 - Pond 4 Effluent Before Chlorination	6
4 - 001 Discharge	3
Raw Water Supply	1
Process Waste Discharge from Penicillin Packaging Operation-Manhole 12A	3
Combined Process Wastestream at Manhole M-7	3

SCREENING PROGRAM—SUMMARY OF PLANT 12038

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent*	Effluent
Acid Extractables		
Phenols (Tot.)	---	16-17 (2)
Volatile Organics		
Benzene	---	10LT-44 (2)
1,2-Dichloroethane	---	15-65 (2)
Chloroform	---	32-56 (2)
1,1-Dichloroethylene	---	62-90 (2)
Ethylbenzene	---	57-160 (2)
Trichlorofluoromethane	---	180-280 (2)
Toluene	---	120-NQ (2)
Methylene chloride	---	NQ (2)
Metals		
Antimony	---	20LT (2)
Arsenic	---	14.5-50LT (2)
Beryllium	---	1.0LT (2)
Cadmium	---	1.0LT (2)
Chromium	---	20LT-26 (2)
Copper	---	44-63 (2)
Lead	---	5LT (2)
Mercury	---	0.2-0.4 (2)
Nickel	---	10LT (2)
Selenium	---	20LT (2)
Silver	---	1.0LT (2)
Thallium	---	10LT (2)
Zinc	---	55-63 (2)
Cyanide	---	300 (2)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Fermentation Waste Treatment System
Equalization
Neutralization
Coarse Settleable Solids Removal
Primary Sedimentation
Activated Sludge
Centrifugal Dewatering
Anaerobic Digestion
Landfill

Thermal Oxidation System
Equalication
Neutralization
Thermal Oxidation

Chem. Waste Treatment System
Equalization
Neutralization
Coarse Settleable Solids Removal
Primary Sedimentation
Primary Chemical Flocculation/ Clarification
Aerated Lagoon
Centrifugal Dewatering
Anaerobic Digestion
Landfill

Pretreatment System
In-Plant Treatment
Heat Conditioning

PLANT CHARACTERISTICS

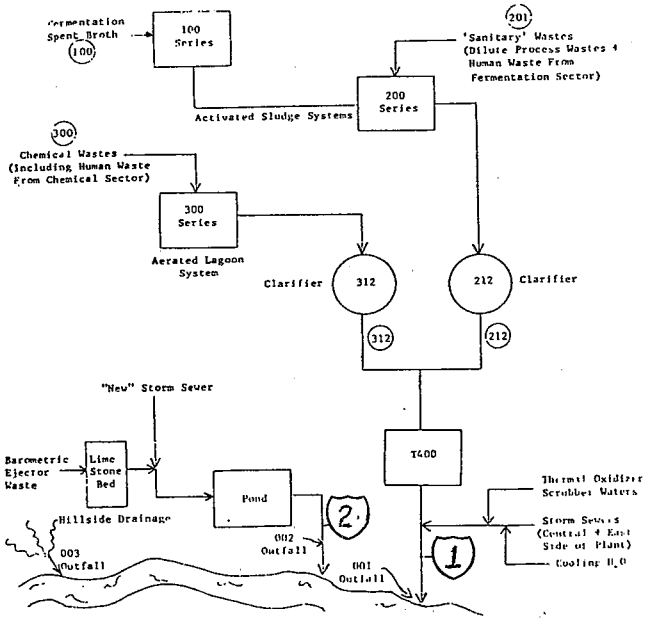
Subcategory	Wastewater Quantity (MGD)	Employment
A,B,C,D	2.60	1000-1100

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
---	26-30 (2)	---	192-219 (2)	---	20-24 (2)

* Complex arrangement of multiple raw waste streams prevents simple definition of influent.

WASTEWATER TREATMENT PLANT FLOW DIAGRAM

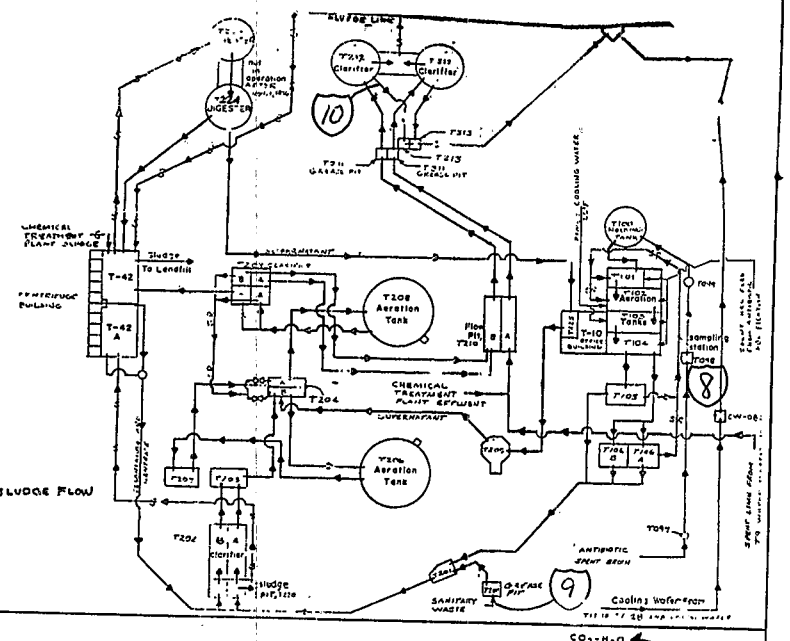


* See the following page for detailed flow diagrams and sampling information.

SAMPLING PROGRAM

Sample Location	No. of Samples
1. 001 Discharge	4
2. Combined effluent from limestone bed and hillside storm sewer	3
3. Building T-17 process waste discharge	3
4. Chemical synthesis influent, T302 to T303	3
5. Treflan influent to T307B (clarifier)	1
6. Treflan process waste line feeding lagoon T-310 from Building T-66	1
7. Clarifier T-312 effluent	3
8. Concentrated antibiotic waste - influent to biological treatment	1
9. Dilute antibiotic waste influent to T201	3
10. Clarifier T-212 effluent	
Storm sewer	3
Combined raw water supply	1

FERMENTATION WASTE TREATMENT SYSTEM



VERIFICATION PROGRAM
ANALYTICAL RESULTS
PLANT 12038

	INFLUENT								EFFLUENT	
	From Other Operations		From Chemical Operations		From Fermentation Operations					
					Spent Beer		Dilute Wastes			
	Apparent Concentration (ug/Liter)	Pollutant Loading (kg/Day)	Apparent Concentration (ug/Liter)	Pollutant Loading (kg/Day)	Apparent Concentration (ug/Liter)	Pollutant Loading (kg/Day)	Apparent Concentration (ug/Liter)	Pollutant Loading (kg/Day)	Apparent Concentration (ug/Liter)	Pollutant Loading (kg/Day)
Priority Pollutants										
Volatile Organics										
Benzene									10	.275
1,2-Dichloroethane	10	.001- .0027	100-10,300	.09-9.74					22-44	.605-1.21
Chloroform	10-30	.001- .0079	3,500-14,000	3.31-13.2					10	.275
1,1-Dichloroethylene	10	.001- .0027	160-690	.151-.653					10	.275
1,2-Trans-Dichloroethylene	10	.001- .0027	10-20	.009					10	.275
Ethylbenzene	10-105	.001- .011	10	.009					10	.275
Methylene Chloride	10	.001- .0027	5,600-42,000	5.30-39.7					16-26	.44-.715
Toluene	10-560	.001- .148	6,400-16,000	6.05-15.1					10	.275
Monochlorobenzene	10	.001- .0027	26,000-227,000	24.6-215					10	.275
			100-123,000	.09-116						
Acid Extractables										
Phenol	10-50	.0023-.0068	3,500-6,400	3.31-6.05						
2-Chlorophenol	10-50	.0023-.0056	10-25	.009-.024						
Pentachlorophenol	10	.0027							20-23	.55-.63
Phenol (4 AAP)	81-279	.009-.075	21,500-48,500	20.3-45.9						
Base/Neutral Extractables										
Pesticides										
Product X	13,000-17,000	3.03-4.49	1	.0009					1-1.9	.028-.05
Dipropylnitrosoamine	170-5,500	.04-1.5	5	.0047					1- 2	.028-.05
Metals										
Chromium	49-180	.0067-.019	37-126	.035-.119					60-81	1.65-2.23
Copper	40-115	.004-.018	5,170-6,670	4.89-6.65					57-61	1.65-1.68
Mercury	1	.0001-.0002	1-15	.0009-.0142					1	.0275
Zinc	50-202	.006-.055	313-2,690	.296-2.54					68-82	1.87-2.26
Cyanide	104,00-135,000	11.1-15			32-136	.036-.159	10-32	.011-.031	56-85	1.54-2.34
Asbestos	(Verification program did not analyze for this compound)									
Conventionals										
BOD_5 (Concentration in MG/L)			3,790-9,300	3,590-8,800	9,900-10,500	11,600-11,900	674-1,210	745-946	21-46	578-1,270
TSS (Concentration in MG/L)			892-2,140	844-2,020	1,210-1,430	1,410-1,730	548-1,100	524-1,070	28-46	770-1,270
Non-Conventionals										
COD (Concentration in MG/L)	4,390-7,130	696-1,640	9,800-21,000	9,440-19,800	17,100-20,300	20,700-22,900	1,520-2,200	1,450-1,840	216-274	5,940-7,540
NH_3-N (Concentration in MG/L)					78-128	91.3-145	2.3-21.8	2.24-24.1	23.7-25	652-688

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
4,6-Dinitro-o-cresol	ND (1)	15 (1)
Phenol	45 (1)	ND (1)
Base/Neutral Extractables		
1,2-Dichlorobenzene	12 (1)	ND (1)
N-nitrosodiphenylamine	12 (1)	ND (1)
Bis (2-ethylhexyl) phthalate	130 (1)	44 (1)
Volatile Organics		
Chloroform	51 (1)	ND (1)
Methylene chloride	35 (1)	31 (1)
Metals		
Antimony	28 (1)	9 (1)
Arsenic	20LT (1)	30 (1)
Cadmium	7 (1)	9 (1)
Chromium	136 (1)	166 (1)
Copper	22 (1)	41 (1)
Mercury	0.9 (1)	0.5 (1)
Selenium	16 (1)	30 (1)
Zinc	191 (1)	254 (1)
Beryllium	1LT (1)	1LT (1)
Nickel	5LT (1)	5LT (1)
Thallium	50LT (1)	50LT (1)
Cyanide	5LT (1)	5LT (1)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Neutralization
Activated Sludge
Aerated Lagoon
Mechanical Thickening
Sludge to POTW

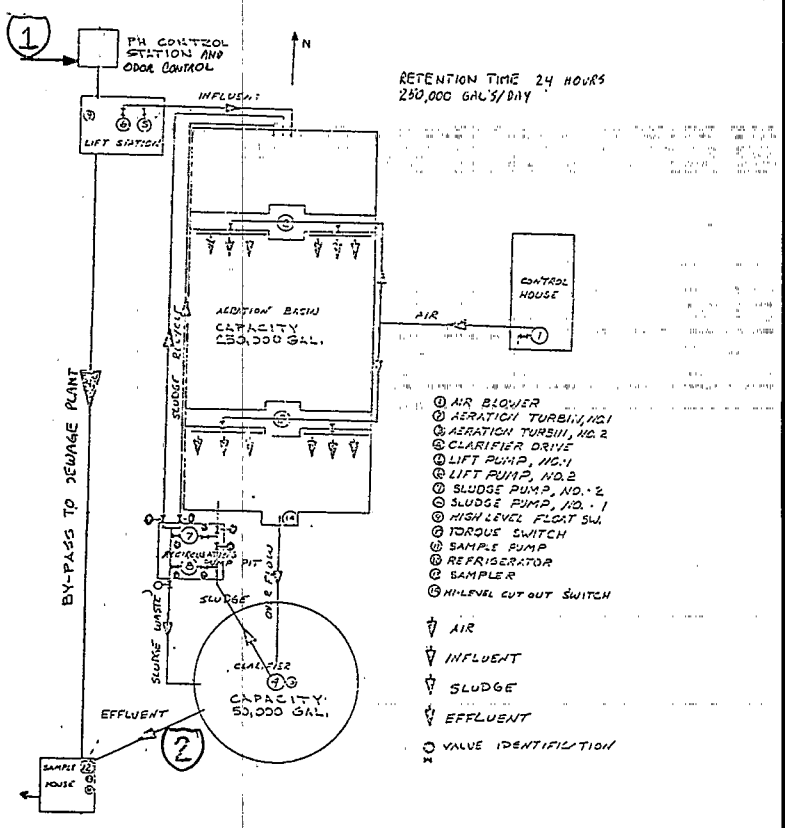
PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
B,C,D	0.259 MGD	600-700

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
500	98	757	687	---	---

WASTEWATER TREATMENT PLANT FLOW DIAGRAM



Sample Location	No. of Samples
1. Influent to Pretreatment Facility	5
2. Effluent from Pretreatment Facility	5

SCREENING PROGRAM—SUMMARY OF PLANT 12097

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
Phenol	19	ND
Base/Neutral Extractables		
Acenaphthene	135	ND
Benzidine	27	ND
2,4-Dinitrotoluene	32	14
2,6-Dinitrotoluene	19	ND
Bis (2-chloroisopropyl) ether	38	48
Volatile Organics		
Benzene	92	80
Chlorobenzene	139	LTDL
1,1,1-Trichloroethane	LTDL	20
Chloroform	LTDL	13
Ethylbenzene	445	LTDL
Methylene chloride	87	397
Bromoform	ND	44
Toluene	617	LTDL
Metals		
Antimony	2000LT	2LT
Aisenic	2000LT	2LT
Beryllium	1LT	1LT
Cadmium	6	2LT
Chromium	55	8
Copper	154	13
Lead	119	20LT
Mercury	1.8	0.1LT
Nickel	31	5LT
Selenium	2000LT	2LT
Silver	1LT	1LT
Thallium	2000LT	2LT
Zinc	458	60LT
Cyanide	25	48

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Chemical Waste Treatment System
Equalization
Neutralization
Physical-Chemical Treatment
Filtration/Presses
Chemical Stabilization
Chemical Conditioning
Vacuum Dewatering
Landfill

Floor Wash Treatment System
Coarse Settleable Solids Removal
Activated Sludge with Powdered Activated Carbon
Physical-Chemical Treatment
Secondary Chemical Flocculation/Clarification
Chemical Stabilization
Chemical Conditioning
Vacuum Dewatering
Landfill

PLANT CHARACTERISTICS

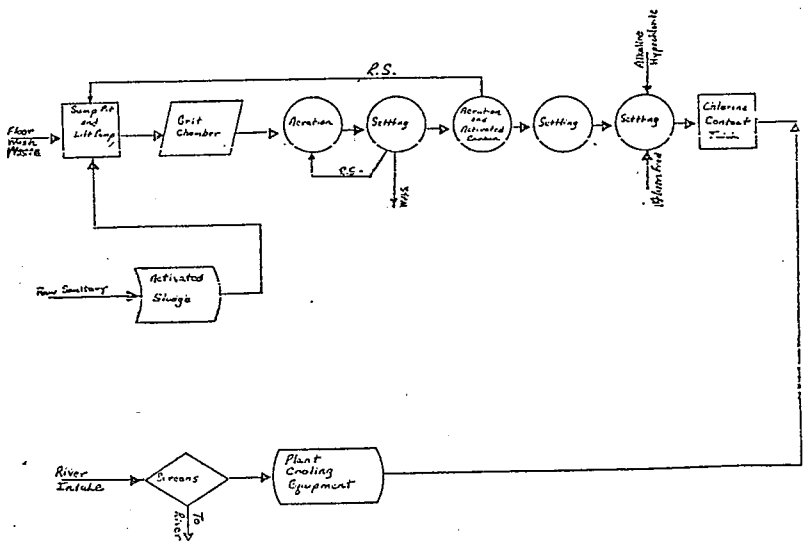
Subcategory	Wastewater Quantity (MGD)	Employment
C,D	0.035	100-200

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
---	---	---	---	262	5LT

Note: Weak chemical waste reported only. Strong chemical waste is deep well injected.

WASTEWATER TREATMENT PLANT FLOW DIAGRAM



Sample Location	No. of Samples
Raw Waste for Deep Well	2
Treated Waste for Deep Well	2
Raw Waste from Floor Drains	2
Treated Waste from Floor Drains	2
River Intake	2
Cooling Water Discharge	2
Well Water	1

VERIFICATION PROGRAM
ANALYTICAL RESULTS
PLANT 12097

Priority Pollutants	TAP WATER Concentration (ug/l)	WEAK CHEMICAL WASTE CONCENTRATION (ug/l) Influent	WEAK CHEMICAL WASTE CONCENTRATION (ug/l) Effluent	WEAK CHEMICAL WASTE POLLUTANT LOADING (kg/day) Influent	WEAK CHEMICAL WASTE POLLUTANT LOADING (kg/day) Effluent	STRONG CHEMICAL WASTE (Deep Well) CONCENTRATION (ug/l) Influent	STRONG CHEMICAL WASTE (Deep Well) CONCENTRATION (ug/l) Effluent	STRONG CHEMICAL WASTE (Deep Well) POLLUTANT LOADING (kg/day) Influent	STRONG CHEMICAL WASTE (Deep Well) POLLUTANT LOADING (kg/day) Effluent
Volatile Organics									
Benzene	4	15-180	3-6			15000-87000	1100-10000		
Toluene	3	90-6600	7-49			1400-130000	720-75000		
Acid Extractables									
Phenol	12	24-58	3-5			44-5700	140-4600		
Base/Neutral Extractables	---	---	---			---	---		
Pesticides	---	---	---			---	---		
Metals									
Antimony	1	2	1-2			1-2	1-2		
Arsenic	1	3-4	1			1-10	1-3		
Beryllium	1	1	1			1	1		
Cadimum	2	6-11	2			7-23	6-19		
Chromium	2	1-13	2			2-222	2-155		
Copper	3	244-336	3-22			431-922	562-665		
Lead	45	91-206	40-44			93-409	67-291		
Mercury	1	1	1			1-30	1-22		
Nickel	6	15-36	6			91-447	94-378		
Selenium	1	1-2	1-2			3-12	1-11		
Silver	1	1	1			1	1		
Thallium	1	1	1			1	1		
Zinc	1	134-397	1-154			254-540	308-687		
Cyanides		31-154	3			220-1090	69-5900		
Asbestos	(Verification program did not analyze for this compound)								
Conventionals (concentrations in mg/l)									
Oil and Grease	---	---	---			---	---		
BOD	---	1000-3973	186-240			16427-72320	37760-54400		
TSS^5	---	85-109	3.5-16			118-354	9-22		
Ph	---	7.1-7.3	7.1-7.6			5.0-6.7	4.6-6.6		
Non-Conventionals (concentrations in mg/l)									
TVSS		39-43	2-5			79-216	6-20		
TS	612	798-1234	1380-1662			19742-31148	20652-30364		
TVS	308	350-750	176-392			1596-3736	2068-3616		
TDS	609	689-1148	1377-1646			19624-30794	20634-30355		
TVDS	307	309-710	174-387			1517-3520	2582-3610		
SS		.25-7.5				.3-130	.1-.4		
COD		1762-4685	304-508			40000-92928	20200-78731		
TOC		511-665	80-150			13000-18000	14500-20200		
NH_3-N		1.18-4.31	.8-1.1			252-455	297-435		

SCREENING PROGRAM—SUMMARY OF PLANT 12108

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent*	Effluent
Acid Extractables		
Phenols (4AAP)	925 (1)	---
Volatile Organics		
Benzene	390 (1)	---
Carbon tetrachloride	300 (1)	---
1,1,1-Trichloroethane	1300 (1)	---
1,1-Dichloroethane	0.1 (1)	---
Chloroform	1350 (1)	---
Methylene chloride	200000 (1)	---
Toluene	53 (1)	---
Metals		
Antimony	NAI	---
Arsenic	NAI	---
Beryllium	10LT (1)	---
Cadmium	32 (1)	---
Chromium	107 (1)	---
Copper	116 (1)	---
Lead	286 (1)	---
Mercury	50 (1)	---
Nickel	137 (1)	---
Silver	24 (1)	---
Zinc	522 (1)	---
Selenium	NAI	---
Thallium	NAI	---
Cyanide	2LT	---

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Neutralization

* Plant 12108 is a zero discharger. Influent sample was taken from a tank truck holding waste to be trucked off site.

PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
A,C.D	---	300-400

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
11300	---	25900	---	2640	---

WASTEWATER TREATMENT PLANT FLOW DIAGRAM

NOT APPLICABLE

SAMPLING PROGRAM

Sample Location	No. of Samples
Raw Process Wastewater	1

SCREENING PROGRAM—SUMMARY OF PLANT 12119

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
4-Nitrophenol	ND (1)	15 (1)
Pentachlorophenol	42 (1)	10LT (1)
Phenols (4AAP)	190 (2)	5LT (1)
Base/Neutral Extractables		
Bis (2-chloroisopropyl) ether	448 (1)	ND (1)
Isophorone	11 (1)	ND (1)
Butyl benzyl phthalate	18 (1)	ND (1)
Volatile Organics		
1,1,1-Trichloroethane	10LT (1)	10 (1)
Methylene chloride	23 (1)	349 (1)
Metals		
Antimony	40 (1)	NAI
Arsenic	10LT (1)	NAI
Beryllium	10LT (1)	10LT (1)
Chromium	57 (1)	19 (1)
Copper	93 (1)	39 (1)
Lead	75 (1)	89 (1)
Mercury	5.5 (1)	0.5 (1)
Nickel	112 (1)	50 (1)
Selenium	28 (1)	NAI
Thallium	NAI	2LT (1)
Zinc	1395 (1)	403 (1)
Cyanide	2LT (1)	2LT (1)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Equalization
Neutralization
Coarse Settleable Solids Removal
Primary Sedimentation
Activated Sludge
Phys./Chem. Evaporation
Anaerobic Digestion
Drying Beds
Sludge to POTW

PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
A,D	.032	N/A

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
833	10	1410	232	475	10

WASTEWATER TREATMENT PLANT FLOW DIAGRAM

Not available.

SAMPLING PROGRAM

Sample Location	No. of Samples
Raw process water	1
Process wastewater	1
Stripped wastewater	1
Influent to treatment	3
Effluent from treatment	3

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
2-Nitrophenol	119 (1)	ND (1)
4-Nitrophenol	181 (1)	ND (1)
Phenols (Tot.)	188 (1)	126 (1)
Base/Neutral Extractables		
Bis (2-ethylhexyl) phthalate	ND (1)	6 (1)
Di-n-butyl phthalate	ND (1)	3 (1)
Volatile Organics		
Benzene	100GT (1)	ND (1)
1,1,1-Trichloroethane	19 (1)	ND (1)
1,1-Dichloroethane	5 (1)	ND (1)
Chloroform	100GT (1)	ND (1)
Ethylbenzene	100GT (1)	ND (1)
Methylene chloride	100GT (1)	100GT (1)
Toluene	50 (1)	ND (1)
Metals		
Beryllium	10LT (1)	---
Cadmium	20GT (1)	---
Chromium	200 (1)	---
Copper	200 (1)	---
Lead	200LT (1)	---
Mercury	0.7 (1)	---
Nickel	50LT (1)	---
Silver	10LT (1)	---
Zinc	600LT (1)	---
Cyanide	1485 (1)	400 GT (1)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Equalization
Neutralization
Coarse Settleable Solids Removal
Primary Sedimentation
Primary Chemical Flocculation/Clarification
Activated Sludge
Trickling Filter
Waste Stablization Ponds
Flotation Thickening
Centrifugal Thickening
Centrifugal Dewatering
Incineration
Landfill

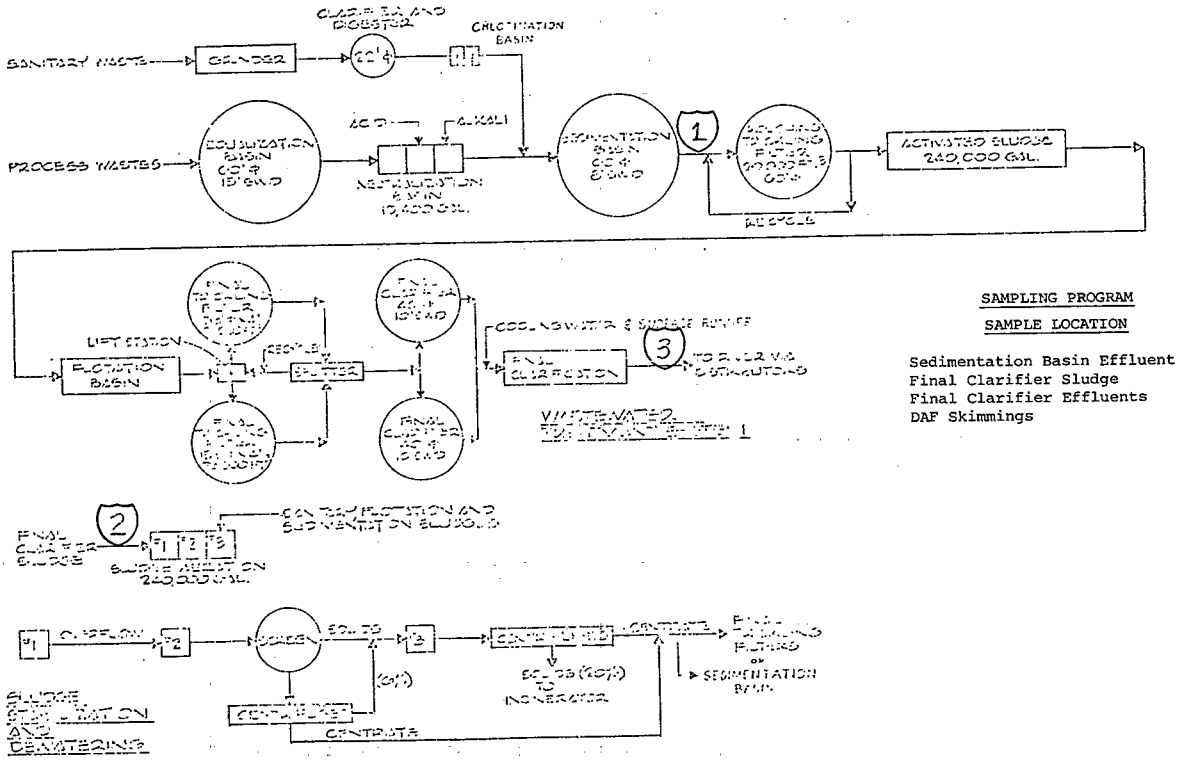
PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
A,C	1.02	300-400

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
420	246	5512	1803	---	---

WASTEWATER TREATMENT PLANT FLOW DIAGRAM



SAMPLING PROGRAM

SAMPLE LOCATION

Sedimentation Basin Effluent
Final Clarifier Sludge
Final Clarifier Effluents
DAF Skimmings

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
Phenolics	57-204 (2)	8-16 (2)
Base/Neutral Extractables		
Bis (2-ethylhexyl) phthalate	39 (1)	0.10LT (1)
Volatile Organics		
Benzene	48 (1)	0.01LT (1)
1,1,2-Trichloroethane	0.9 (1)	0.01LT (1)
Chloroethane	6.1 (1)	0.01LT (1)
Chloroform	1050 (1)	2.8 (1)
Ethylbenzene	7.5 (1)	0.01LT (1)
Methylene chloride	2.2 (1)	1.7 (1)
Toluene	10400 (1)	0.01LT (1)
Metals		
Antimony	24 (1)	0.17 (1)
Arsenic	20LT (1)	20LT (1)
Beryllium	1.6 (1)	0.20LT (1)
Cadmium	32 (1)	1.0LT (1)
Chromium	14 (1)	2.0LT (1)
Copper	27 (1)	0.2LT (1)
Lead	46 (1)	10LT (1)
Nickel	89 (1)	56 (1)
Silver	4 (1)	3LT (1)
Zinc	250 (1)	14 (1)
Cyanide	40LT (2)	40LT (2)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Equalization
Neutralization
Coarse Settleable Solids Removal
Primary Sedimentation
Primary Chemical Flocculation/Clarification
Activated Sludge
Polishing Ponds
Gravity Thickening
Aerobic Digestion
Compositing
Landfill
Cropland Use

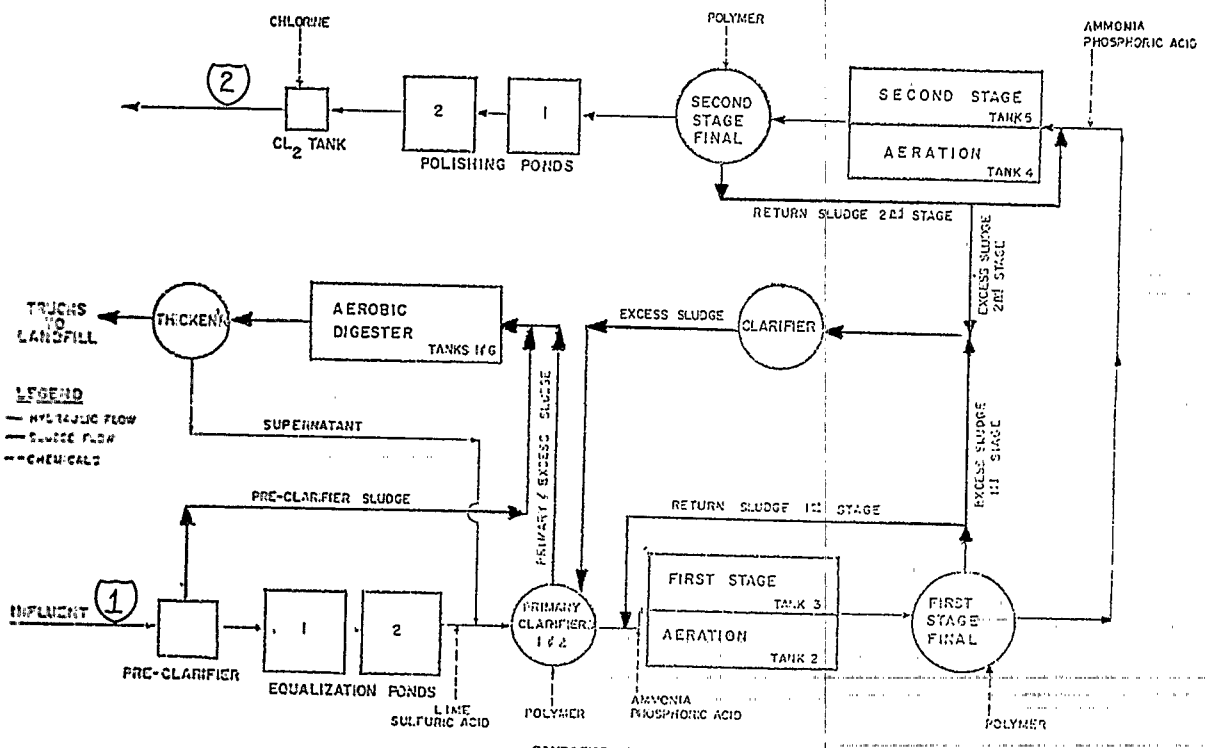
PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
A,C,D	1.33	900-1000

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
748-1043 (2)	34-61 (2)	1800-3000 (3)	600-780 (3)	150-398 (3)	60-88 (3)

WASTEWATER TREATMENT PLANT FLOW DIAGRAM



SAMPLING PROGRAM

Sample Location	No. of Samples
1. Raw waste (combined) to WWTP	5
2. Discharge 001 - Treated from WWTP	5
Raw waste - Plant A	4
Raw waste - Plant B	4
Raw waste - Plant C	4

SCREENING PROGRAM—SUMMARY OF PLANT 12204

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
2,4 Dimethylphenol	62 (1)	0.10LT (1)
Phenol	38 (1)	3.8 (1)
Phenolics	134 (1)	17 (1)
Base/Neutral Extractables		
Bis (2-ethylhexyl) phthalate	0.10LT (1)	25 (1)
Volatile Organics		
Acrolein	100LT (1)	100LT (1)
Acrylonitrile	100LT (1)	100LT (1)
Benzene	6.5 (1)	0.10LT (1)
Chlorobenzene	1.9 (1)	0.10LT (1)
1,2-Dichloroethane	28 (1)	0.10LT (1)
1,1,1-Trichloroethane	27 (1)	33 (1)
Chloroform	150 (1)	90 (1)
1,1-Dichloroethylene	2.1 (1)	0.01LT (1)
Ethylbenzene	14 (1)	0.01LT (1)
Methylene chloride	1400 (1)	0.01LT (1)
Trichlorofluoromethane	0.9 (1)	0.01LT (1)
Tetrachloroethylene	1.9 (1)	1.4 (1)
Toluene	190 (1)	0.01LT (1)
Trichloroethylene	6.6 (1)	0.8 (1)
Metals		
Antimony	20J (1)	8J (1)
Arsenic	20LT (1)	20LT (1)
Beryllium	0.2LT (1)	0.2LT (1)
Cadmium	4J (1)	1LT (1)
Chromium	23 (1)	19 (1)
Copper	88J (1)	16 (1)
Lead	63J (1)	20 (1)
Mercury	1.3 (1)	1.3 (1)
Nickel	28 (1)	37 (1)
Silver	6J (1)	3 (1)
Thallium	7LT (1)	7LT (1)
Zinc	500J (1)	300J (1)
Cyanide	40LT (1)	40LT (1)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Neutralization
Coarse Settleable Solids Removal
Primary Chemical Flocculation/Clarification
Activated Sludge with Pure Oxygen
Mechanical Thickening
Chemical Conditioning
Vacuum Dewatering
Compositing

PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
A,B,C,D	0.85	2000-2100

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
690-1090 (3)	15-75 (3)	1215-1815 (3)	243-303 (3)	900-1200 (3)	90-120 (3)

Traditional data supplied by plant.

WASTEWATER TREATMENT PLANT FLOW DIAGRAM

Not available.

SAMPLING PROGRAM

Sample Location	No. of Samples
Municipal water	4
Well water	4
Combined influent	5
Final effluent	5
Building "A" process wastewaters	5

SCREENING PROGRAM—SUMMARY OF PLANT 12210

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
4-Nitrophenol	10LT (1)	---
Pentachlorophenol	10LT (1)	---
Phenol	10LT (1)	---
Phenols (4AAP)	420 (1)	---
Base/Neutral Extractables		
Bis (2-ethylhexyl) phthalate	2700 (1)	---
Diethyl phthalate	10LT (1)	---
Fluorene	10LT (1)	---
N-nitrosodiphenylamine	10LT (1)	---
Volatile Organics		
Benzene	7.7 (1)	---
Chloroform	5LT (1)	---
Ethylbenzene	5LT (1)	---
Methylene chloride	150 (1)	---
Tetrachloroethylene	5LT (1)	---
Toluene	5LT (1)	---
1,1,1-Trichloroethane	5LT (1)	---
Metals		
Antimony	10LT (1)	---
Arsenic	10LT (1)	---
Beryllium	10LT (1)	---
Cadmium	10LT (1)	---
Chromium	56 (1)	---
Copper	147 (1)	---
Lead	NAI	---
Mercury	0.48 (1)	---
Nickel	96 (1)	---
Selenium	10LT (1)	---
Silver	10LT (1)	---
Thallium	10LT (1)	---
Zinc	503 (1)	---
Cyanide	4 (1)	---

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Aerated Lagoon (Receives only sanitary waste)

Plant 12210 is a zero discharger. All process wastewater is disposed of off site.

PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
B,C	.002	100-200

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
---	---	---	---	480	---

WASTEWATER TREATMENT PLANT FLOW DIAGRAM

Not available

SAMPLING PROGRAM

Sample Location	No. of Samples
Process wastewater at waste storage tanks	2
Influent to pretreatment system for sanitary wastewater	1
Effluent from pretreatment system for sanitary wastewater	1

SCREENING PROGRAM—SUMMARY OF PLANT 12231

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
Phenols (4AAP)	180 (1)	20 (1)
Volatile Organics		
Methylene chloride	—	72 (1)
Metals		
Antimony	20LT (1)	20LT (1)
Arsenic	10LT (1)	10LT (1)
Beryllium	10LT (1)	10LT (1)
Cadmium	10LT (1)	10LT (1)
Chromium	57 (1)	51 (1)
Copper	150 (1)	59 (1)
Lead	18 (1)	89 (1)
Mercury	0.72 (1)	0.5 (1)
Nickel	10LT (1)	22 (1)
Selenium	10LT (1)	10LT (1)
Thallium	NAI	5 (1)
Zinc	208 (1)	48 (1)
Cyanide	2LT (1)	2LT (1)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Equalization
Neutralization
Coarse Settleable Solids Removal
Primary Sedimentation
Aerated Lagoon
Waste Stabilization Ponds
Anaerobic Digestion
Landfill

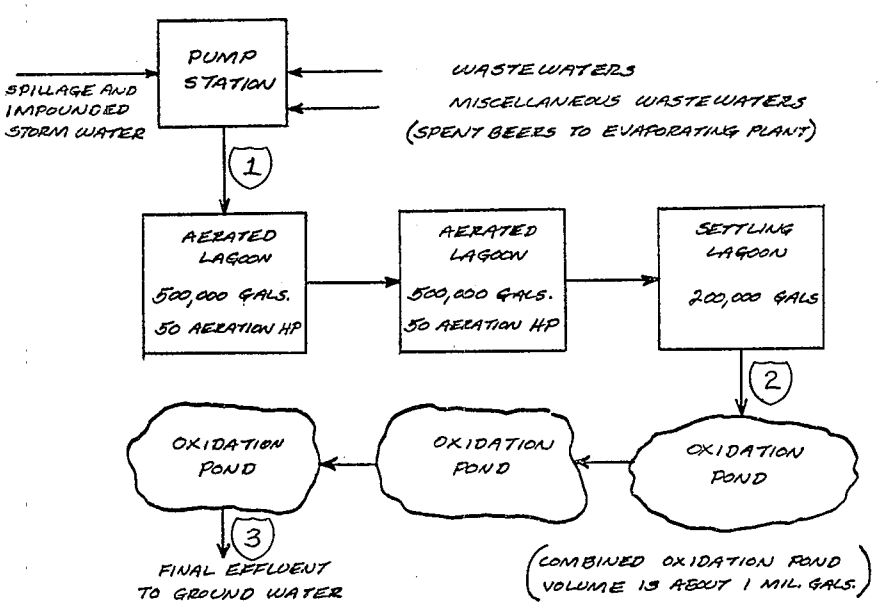
PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
A,D	0.50	600-700

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
3200	147	2160	436	113	12

WASTEWATER TREATMENT PLANT FLOW DIAGRAM



SAMPLING PROGRAM

Sample Location	No. of Samples
1. Influent - raw waste to treatment	2
2. Intermediate WWTP point	2
3. Final effluent	2
Raw process water	1

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
Phenols (4AAP)	780 (1)	580 (1)
Base/Neutral Extractables		
Bis (2-chloroethyl) ether	10 (1)	20 (1)
1,2-Diphenyl hydrazine	20 (1)	ND (1)
Volatile Organics		
Benzene	40 (1)	---
Chloroform	30 (1)	---
Methylene chloride	40000 (1)	200 (1)
Ethyl benzene	12 (1)	---
Toluene	33000 (1)	1350 (1)
1,1-Dichloroethylene	190 (1)	---
Methyl chloride	1300 (1)	---
Bromomethane	30 (1)	---
Metals		
Antimony	NAI	NAI
Arsenic	NAI	NAI
Beryllium	10LT (1)	10LT (1)
Cadmium	10LT (1)	10LT (1)
Chromium	34 (1)	10LT (1)
Copper	16 (1)	10LT (1)
Lead	NAI (1)	96 (1)
Mercury	0.2LT (1)	0.80 (1)
Nickel	63 (1)	63 (1)
Selenium	NAI	NAI
Silver	10LT (1)	10LT (1)
Thallium	30 (1)	NAI
Zinc	191 (1)	34 (1)
Cyanide	560 (1)	220 (1)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Equalization
Neutralization
Primary Sedimentation
Activated Sludge
Flotation Thickening
Chemical Conditioning
Vacuum Dewatering
Landfill

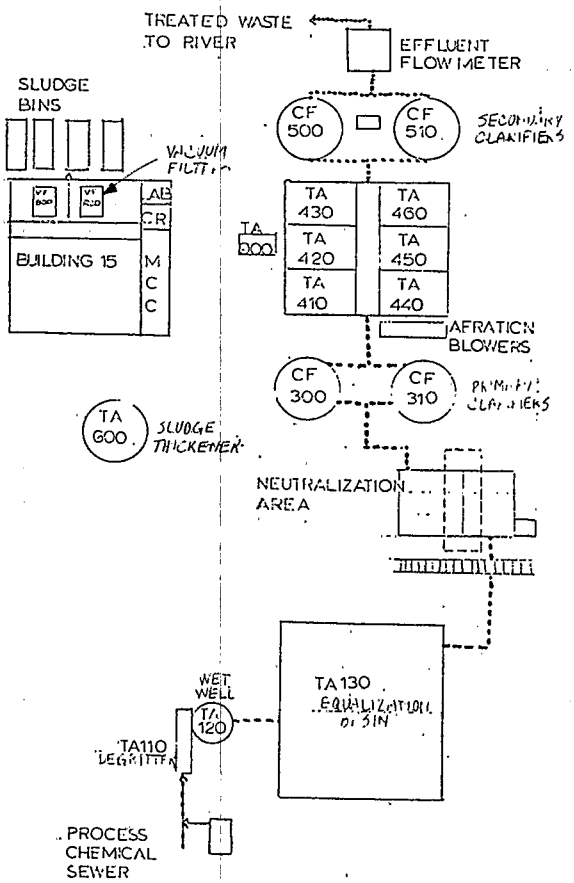
PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
C	.810	200-300

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
1200GT	300	3500	1370	188	94

WASTEWATER TREATMENT PLANT FLOW DIAGRAM



SAMPLING PROGRAM

Sample location	No. of Samples
1. Influent to wastewater treatment system	3
2. Effluent from wastewater treatment system	3
Non-contact cooling water discharge	3

VERIFICATION PROGRAM
ANALYTICAL RESULTS
PLANT 12236

	Adjusted Concentration		Pollutant Loading	
	Influent (ug/Liter)	Effluent (ug/Liter)	Influent (kg/day)	Effluent (kg/day)
Priority Pollutants				
Volatile Organics				
Toluene	56,000-71,000	10	170-210	.032
Methylene Chloride	14,000-80,000	1500-8100	42-2403	4.8-26
Chloroform	10	10	.030	.032
1,1-Dichloroethylene	10-16	10	.030-.048	.032
1,2-Dichloroethane	68-560	62-300	.2-1.7	.2-.96
Benzene	10-27	10	.030-.081	.032
Ethylbenzene	10-12	10	.030-.036	.032
Chloromethane	8,000-13,000	100-410	24-39	.32-1.3
Acid Extractables				
Base/Neutral Extractables				
Pesticides				
Metals				
Berylium	10	10	.030	.030
Cadmium	10	10	.030	.030
Chromium	42-152	10-16	.126-.456	.03-.048
Copper	14-16	10	.042-.048	.030
Lead	40	25	.12	.075
Mercury	0.62-0.69	0.2-0.56	.002	.0006-.0017
Nickel	26-39	21-30	.078-.117	.063-.09
Selenium	40	40	.12	.12
Silver	10	10	.030	.030
Zinc	69-159	13-173	.2-.477	.039-.52
Cyanides	20-270	9-228	.06-.81	.027-.684
Phenol (4AAP)	940-1900	55-455	2.82-5.7	.16-1.4
Asbestos	(Verification program did not analyze for this compound)			
Conventional				
BOD	1023-1266	130-140	3070-3800	390-420
Non-Conventional				
COD	1904-2641	633-640	5712-7923	1900-1920

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (µg/l) Influent	Effluent
Acid Extractables		
Phenols (Tot.)	694 (1)	ND (1)
Base/Neutral Extractables		
Bis (2-ethylhexyl) phthalate	50 (1)	10 (1)
Di-n-butyl phthalate	20 (1)	4 (1)
Volatile Organics		
1,2-Dichloroethane	15 (1)	ND (1)
1,1,1-Trichloroethane	17 (1)	ND (1)
Chloroform	100GT (1)	ND (1)
Methylene chloride	100GT (1)	100GT (1)
Toluene	2 (1)	ND (1)
Metals		
Beryllium	1LT (1)	1LT (1)
Cadmium	2LT (1)	4 (1)
Chromium	30 (1)	10 (1)
Copper	80 (1)	20 (1)
Lead	20LT (1)	20LT (1)
Nickel	5LT (1)	5LT (1)
Silver	1LT (1)	1LT (1)
Zinc	60LT (1)	100 (1)
Cyanide	25LT (1)	25LT (1)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Equalization
Coarse Settleable Solids Removal
Activated Sludge
Mechanical Thickening
Aerobic Digestion
Gravity Dewatering
Landfill

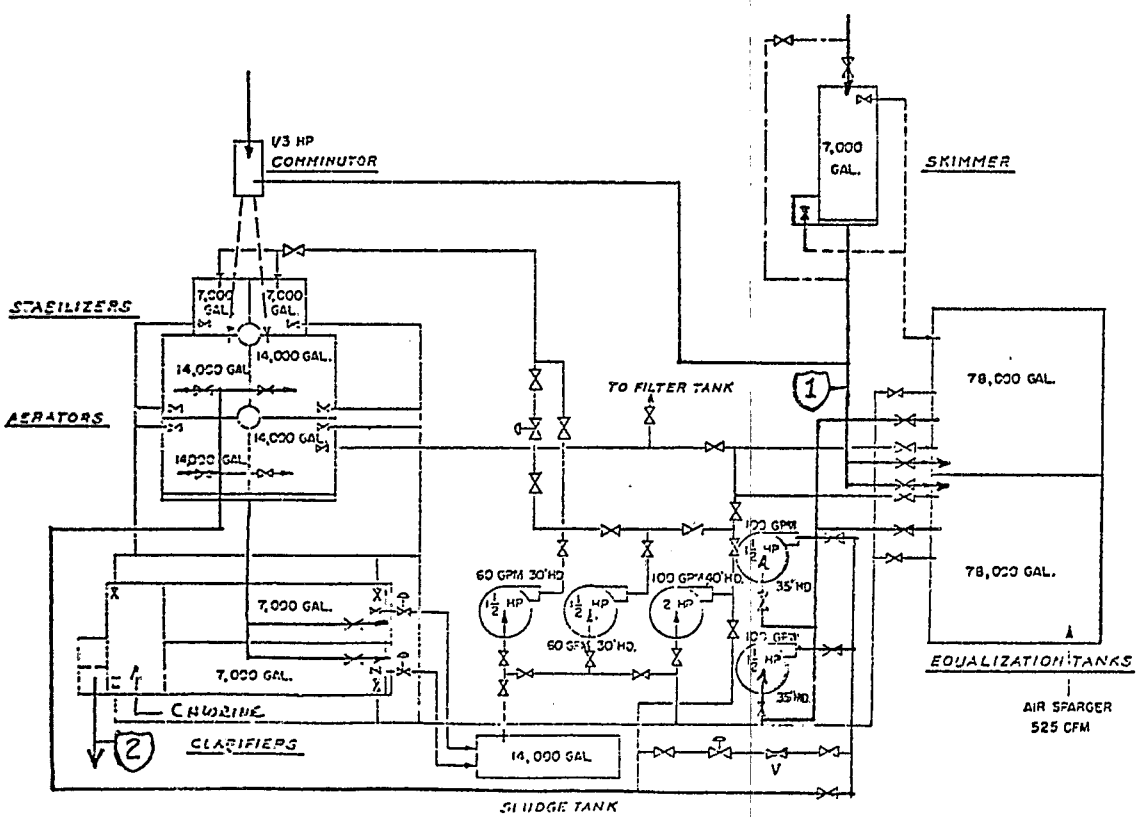
PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
D	.035	800-900

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
---	---	---	---	---	---

WASTEWATER TREATMENT PLANT FLOW DIAGRAM



SAMPLING PROGRAM

Sample Location

1. Influent To WWTP
2. Effluent from WWTP

SCREENING PROGRAM—SUMMARY OF PLANT 12256

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
Phenol	10 (1)*	33 (1)*
Volatile Organics		
Chloroform	40 (1)	40 (1)
Methylene chloride	300LT (1)	300LT (1)
Toulene	100J (1)	100J (1)
Metals		
Antimony	400LT-1000LT (2)	400LT-1000LT (2)
Arsenic	5LT-13 (2)	5LT-14 (2)
Beryllium	10LT (2)	10LT (2)
Cadmium	10LT-40 (2)	10LT-40 (2)
Chromium	50LT (2)	50LT (2)
Copper	100LT (2)	100LT (2)
Lead	100LT-500 (2)	100LT-400 (2)
Mercury	0.2-1J (2)	0.2-0.7J (2)
Nickel	100LT-300 (2)	100LT-300 (2)
Selenium	5LT-21 (2)	5LT-12 (2)
Silver	5LT-40 (2)	5LT-40 (2)
Thallium	100LT (2)	100LT (2)
Zinc	50LT-310 (2)	50LT-230 (2)

* Influent and effluent samples believed to be interchanged when labeled.

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Equalization
Neutralization
Coarse Settleable Solids Removal
Primary Sedimentation w/Skimming

PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
A,B,C,D	30.0	1200-1300

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
---	177-242 (3)	---	300-420 (3)	---	29-42 (3)

Traditional data supplied by plant.

WASTEWATER TREATMENT PLANT FLOW DIAGRAM

NOT AVAILABLE

SAMPLING PROGRAM

Sample Location

Well Area before Discharge Through Outfall #001
Split Manhole Discharging To Outfall #002
Manhole Prior to Discharge To Outfall #003
Skimming Basin Which Discharges To Outfall #008
Collection Basin Discharge to the Skimming Basin
Municipal Sewers Pumping Station
Raw Freshwater Supply
Saltwater Supply At Intake Structures

NOTE: ALL REPORTED CONCENTRATION VALUES HAVE NOT BEEN CLEARLY ASSOCIATED WITH PROCESS FLOW STREAMS. THEREFORE DATA FROM THIS SAMPLING EFFORT WILL NOT BE USED IN S/V DATA ANALYSIS.

SCREENING PROGRAM—SUMMARY OF PLANT 12257

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
Phenol (Tot.)	320LT-4700 (2)	50LT-540LT(3)
Volatile Organics		
1,2-Dichloroethane	---	13-290(3)
Methylene chloride	---	30-67(3)
Metals		
Antimony	12-100LT (2)	10LT(3)
Arsenic	10LT-43 (2)	10LT-20(3)
Beryllium	1 (2)	1LT(3)
Cadmium	1.0LT (3)	1.0LT(3)
Chromium	630-650 (2)	160-190(3)
Copper	97-110 (2)	21-31(3)
Lead	5LT-14 (2)	20-24(3)
Mercury	0.20LT (2)	.20LT(3)
Nickel	56-630 (2)	160-190(3)
Selenium	10LT (2)	10LT(3)
Silver	2LT-4LT (3)	2LT(3)
Thallium	40-43 (2)	10LT-29(3)
Zinc	289-319 (2)	113-163(3)
Cyanide	440-580 (2)	70-7700(3)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Equalization
Neutralization
Activated Sludge
Centrifugel Dewatering
Cropland Use

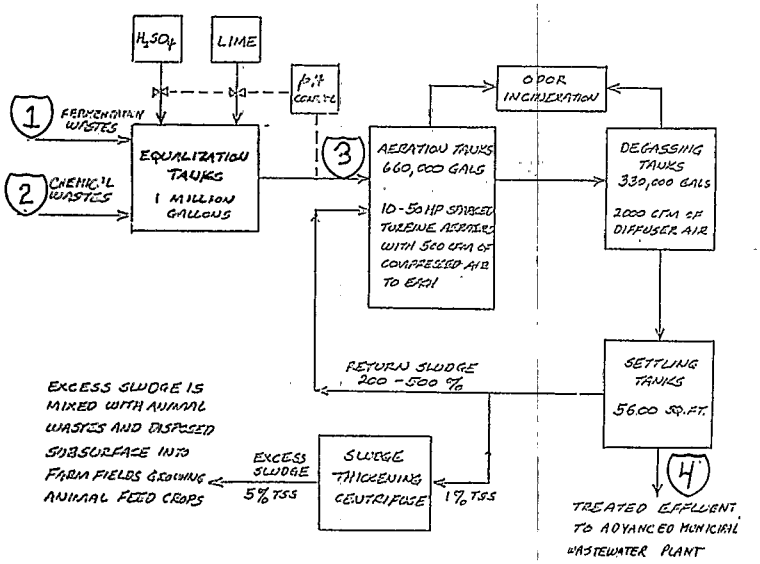
PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
A,B,C,D	.600	2100-2200

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
3100-4500 (2)	36-56 (3)	4610-6430 (2)	482-626 (3)	876-968 (2)	94-144 (3)

WASTEWATER TREATMENT PLANT FLOW DIAGRAM



SAMPLING PROGRAM

Sample Location	No. of Samples
1. Raw fermentation process wastes	6
2. Raw chemical synthesis process wastes	5
3. Combined plant process wastes after neutralization	4
4. Treated effluent to WWTP	6
Cooling water discharge at bypass line	1
Municipal water supply	2

SCREENING PROGRAM—SUMMARY OF PLANT 12342

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent *	Effluent
Acid Extractables		
Phenol	14000 (1)	---
Base/Neutral Extractables		
Bis (2-ethylhexyl) phthalate	760 (1)	---
Volatile Organics		
Chloroform	2 (1)	---
Toluene	2 (1)	---
1,1-Dichloroethane	2 (1)	---
Ethylbenzene	1 (1)	---
Acrolein	100LT (1)	---
Metals		
Antimony	27 (1)	---
Arsenic	20LT (1)	---
Cadmium	1LT (1)	---
Chromium	20 (1)	---
Copper	130 (1)	---
Lead	10LT (1)	---
Nickel	22 (1)	---
Selenium	20LT (1)	---
Silver	3LT (1)	---
Thallium	8LT (1)	---
Cyanide	40LT (1)	---

* Plant 12342 is an indirect discharger and the influent is an influent to a POTW.

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

NO TREATMENT PROVIDED

PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
A,C,D	.701	300-400

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
5810	---	12840	---	3480	---

WASTEWATER TREATMENT PLANT FLOW DIAGRAM

NOT APPLICABLE

SAMPLING PROGRAM

Sample Location	No. of Samples
Discharge from Manhole No. 1	3
Discharge from Manhole No. 5	3
Discharge from Manhole No. 6	3
Discharge from Manhole No. 7	3
Potable Water - Building 28	1
Potable Water - Building 1	1
Potable Water - Building 5	1
Potable Water - Building 20A	1

SCREENING PROGRAM—SUMMARY OF PLANT 12411

SUMMARY OF SCREENING DATA

Priority Pollutants	Influent (ug/l)	Effluent (ug/l)
Acid Extractables		
Phenol	34 (1)	10LT (1)
Phenols (4AAP)	NAI	70 (1)
Base/Neutral Extractables		
Bis (2-ethylhexyl) phthalate	38 (1)	28 (1)
Volatile Organics		
Benzene	6.7 (1)	ND (1)
Chloroform	860 (1)	5LT (1)
Ethylbenzene	5LT (1)	ND (1)
Tetrachloroethylene	5LT (1)	ND (1)
Toluene	290 (1)	5LT (1)
Methylene chloride	11000 (1)	32 (1)
Metals		
Antimony	68 (1)	NAI
Arsenic	32 (1)	NAI
Beryllium	10LT (1)	10LT (1)
Cadmium	10LT (1)	10LT (1)
Chromium	16 (1)	16 (1)
Copper	35 (1)	26 (1)
Lead	80 (1)	NAI
Mercury	NAI (1)	1.58 (1)
Nickel	20 (1)	40 (1)
Selenium	30 (1)	NAI
Silver	10LT (1)	10LT (1)
Thallium	5 (1)	7 (1)
Zinc	146 (1)	99 (1)
Cyanide	590 (1)	52 (1)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Equalization
Neutralization
Aerated Lagoon
Incineration

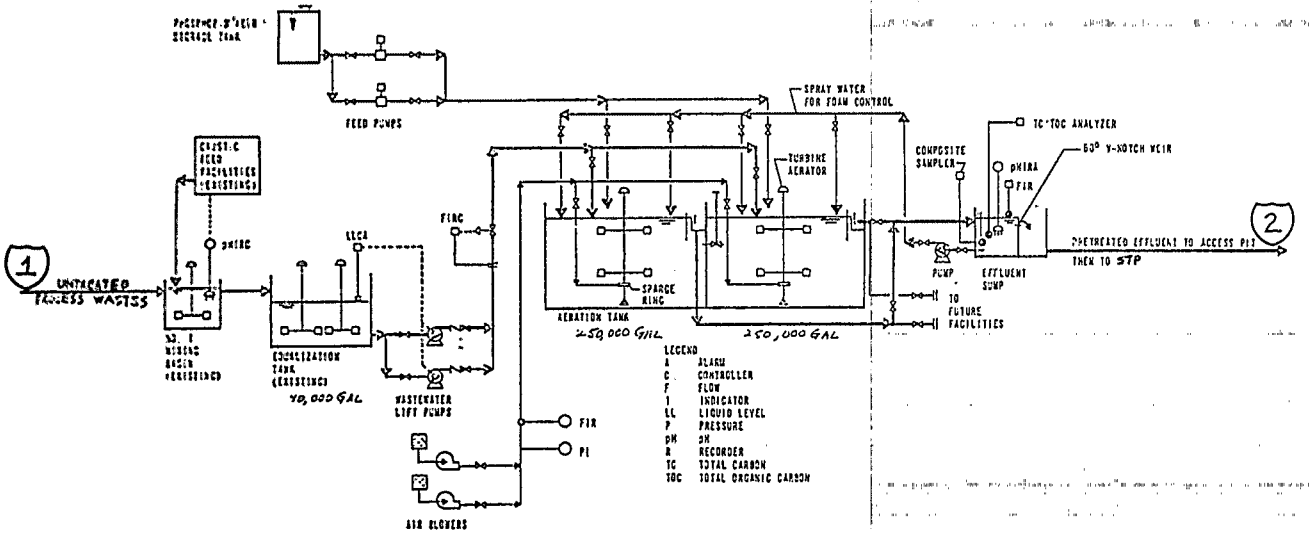
PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
B,C,D	0.35	700-800

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
167GT	167GT	---	---	316	585

WASTEWATER TREATMENT PLANT FLOW DIAGRAM



SAMPLING PROGRAM

Sample Location	No. of Samples
1. Influent to pretreatment system	3
2. Effluent from pretreatment system	3
Combined sanitary cooling water and pretreated process wastewater at access pit	3

VERIFICATION PROGRAM
ANALYTICAL RESULTS
PLANT 12411

	Concentration		Pollutant Loading	
	Influent (ug/Liter)	Effluent (ug/Liter)	Influent (kg/day)	Effluent (kg/day)
Priority Pollutants				
Volatile Organics				
Toluene	10	10	.0086-.011	.0086-.011
Methylene Chloride	110-380	10	.095-.33	.0086-.011
Chloroform	11000-280,000	10-170	9.5-310	.0086-.19
Acid Extractables				
2-Chlorophenol	10	10	.01	.011
2-Nitrophenol	14	10	.015	.011
Phenol	10	10	.011	.011
2,4-Dimethylphenol	10	10	.011	.011
2,4-Dichlorophenol	10	10	.011	.011
2,4,6-Trichloro Phenol	10	10	.011	.011
4-Chloro-3-Methylphenol	10	10	.011	.011
2,4-Dinitro-2-Methylphenol	10	48	.011	.053
Pentachlorophenol	10	114	.011	.13
4-Nitrophenol	10	10	.011	.011
Base/Neutral Extractables				
Pesticides				
Metals				
Berylium	10	10	.009	.009
Cadmium	10	10	.009	.009
Chromium	35-89	27-40	.03-.095	.036
Copper	20-30	19-21	.018-.03	.02
Nickel	126-130	51-85	.113-.136	.055-.07
Lead	25	25	.027	.27
Selenium	40	40	.04	.04
Zinc	111-388	110-2009	.12-.39	.12-1.7
Mercury	1-310	.74-.96	0-.0045	0
Cyanides	96-268	144-254	106-260	160-246
Asbestos	(Verification program did not analyze for this compound)			
Conventional				
BOD	1470	294	1270	254
Non-Conventional				
COD	4400-5750	2900-3300	4830-5600	2770-3610

SCREENING PROGRAM—SUMMARY OF PLANT 12420

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
2-Nitrophenol	23 (1)	ND (1)
Phenol	240-51000 (2)	ND-120 (2)
Volatile Organics		
Benzene	580 (1)	ND (1)
Toluene	1050 (1)	LTDL (1)
Metals		
Beryllium	1LT (1)	1LT (1)
Cadmium	2LT (1)	2LT (1)
Chromium	212 (1)	304 (1)
Copper	106 (1)	14 (1)
Lead	27 (1)	42 (1)
Mercury	0.4 (1)	0.1 (1)
Nickel	5LT (1)	5LT (1)
Zinc	151 (1)	83 (1)
Cyanide	5LT (1)	5LT (1)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Activated Sludge
Chemical Conditioning
Centrifugal Dewatering
Landfill

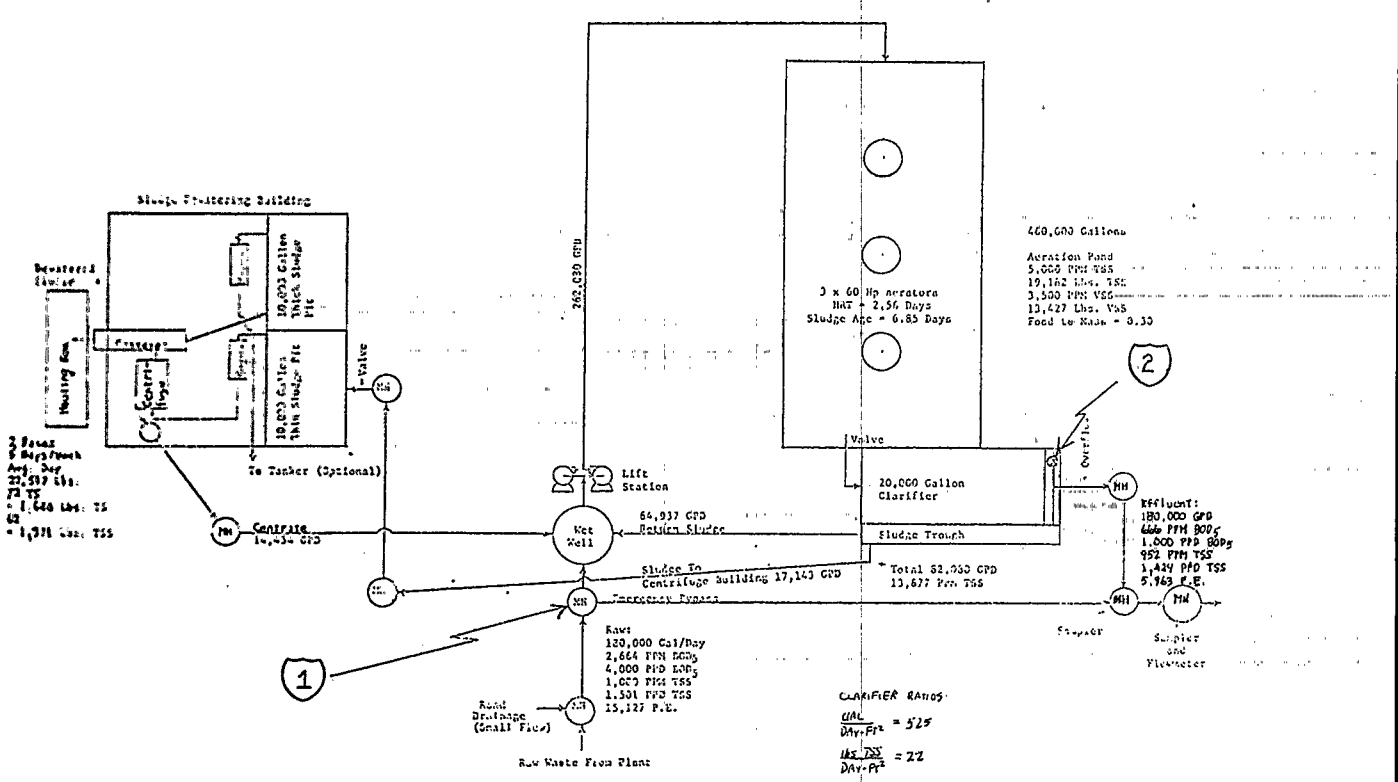
PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
B,D	---	100-200

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
3250	195	355	638	---	490

WASTEWATER TREATMENT PLANT FLOW DIAGRAM



SAMPLING PROGRAM

Sample Location	No. of Samples
1. Influent to pretreatment system	3
2. Effluent from pretreatment system	3
Rescreening: 1. Influent to pretreatment	2
2. Effluent from pretreatment	4

SCREENING PROGRAM—SUMMARY OF PLANT 12439

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
2,4-Dimethyl phenol	10LT (1)	15 (1)
Phenols (4AAP)	42 (1)	36 (1)
Base/Neutral Extractables		
Acenaphthene	92 (1)	ND (1)
2,4-Dinitrotoluene	65 (1)	10LT (1)
Bis (2-Chlorosopropyl) ether	300 (1)	181 (1)
Isophrone	1014 (1)	10LT (1)
Butyl benzyl phthalate	719 (1)	ND (1)
Di-n-butyl phthalate	19 (1)	10LT (1)
Diethyl phthalate	61 (1)	ND (1)
Anthracene	14 (1)	10LT (1)
Fluorene	27 (1)	10LT (1)
Phenanthrene	14 (1)	10LT (1)
Volatile Organics		
Benzene	73 (1)	10LT (1)
Chlorobenzene	12 (1)	ND (1)
1,1,1-Trichloroethane	261 (1)	10LT (1)
1,1,2-Trichloroethane	19 (1)	ND (1)
Chloroform	26 (1)	16 (1)
Ethylbenzene	82 (1)	10LT (1)
Methylene chloride	640 (1)	108 (1)
Tetrachloroethylene	26 (1)	ND (1)
Toluene	342 (1)	270 (1)
Trichloroethylene	124 (1)	11 (1)
Metals		
Antimony	20LT (1)	20LT (1)
Arsenic	10LT (1)	10LT (1)
Beryllium	10LT (1)	10LT (1)
Cadmium	10LT (1)	10LT (1)
Chromium	9 (1)	15 (1)
Copper	32 (1)	32 (1)
Lead	10LT (0)	14 (1)
Mercury	0.67 (1)	0.76 (1)
Nickel	10LT (1)	10LT (1)
Silver	10LT (1)	10LT (1)
Thallium	5 (1)	8 (1)
Zinc	29 (1)	153 (1)
Cyanide	2LT (1)	2LT (1)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Equalization
Neutralization
Primary Sedimentation
Activated Sludge
Aerated Lagoon
Landfill

PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
C,D	0.01	100-200

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
---	---	6841	2297	10	125

WASTEWATER TREATMENT PLANT FLOW DIAGRAM

Raw Waste------➤Neutralization-----➤Primary Sedimentation-------➤Aeration Units (activated sludge)----➤Lagooning.

Design Considerations

Detention time of Aerators--2 hrs
Detention time of lagoons--- 60 days
Treatment Plant Capacity---30,000 gpd

Solvent Wastes---➤recovery

SAMPLING PROGRAM

Sample Location	No. of Samples
Industrial Stream Influent	2
Secondary Clarifier Effluent	

SCREENING PROGRAM—SUMMARY OF PLANT 12044

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
Phenols (4AAP)	5 (1)	---
Base/Neutral Extractables		
Bis (2-ethylhexyl) phthalate	10 (1)	---
Volatile Organics		
Chlorobenzene	11 (1)	---
1,1,1-Trichloroethane	22 (1)	---
Ethylbenzene	21 (1)	---
Methylene chloride	16 (1)	---
Bromoform	12 (1)	---
Metals		
Antimony	210 (1)	---
Beryllium	2 (1)	---
Chromium	102 (1)	---
Copper	148 (1)	---
Lead	30 (1)	---
Mercury	0.1 (1)	---
Nickel	23 (1)	---
Silver	4 (1)	---
Zinc	254 (1)	---
Arsenic	20LT (1)	---
Cadmium	2LT (1)	---
Selenium	2LT (1)	---
Thallium	100LT (1)	---
Cyanide	7 (1)	---

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Neutralization

Note: The arrangement of the wastewater streams was such that a representative sample of untreated influent could not be obtained. The influent samples analyzed were taken at MH-81 through wich 90 percent of the process wastewater flows.

PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
A,D	2.97 MGD	800-900

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
1425	---	3390	---	---	---

* Influent is influent to POTW.

WASTEWATER TREATMENT PLANT FLOW DIAGRAM

NOT APPLICABLE

SAMPLING PROGRAM

Sample Location	No. of Samples
Citric Acid Effluent After Lime Neutralization-#81 Manhole	5
Effluent At #83 Manhole	4
Effluent At #37A Manhole	4
Effluent At #6 Manhole	4
Effluent At #74 Manhole	4

SCREENING PROGRAM—SUMMARY OF PLANT 12447

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) * Influent	** Influent
Acid Extractables		
Phenol	280 (1)	ND (1)
Phenols (Tot.)	129 (1)	54 (1)
Volatile Organics		
Benzene	100 (1)	500 (1)
1,1,1-Trichloroethane	12 (1)	720000 (1)
1,1-Dichloroethane	ND (1)	54 (1)
Chloroform	460 (1)	900 (1)
1,1-Dichloroethylene	ND (1)	20 (1)
1,2-Trans-dichloroethylene	ND (1)	1100 (1)
Methylene chloride	1700000 (1)	80000 (1)
Toluene	700 (1)	40 (1)
Metals		
Antimony	57 (1)	10 (1)
Arsenic	20LT (1)	9 (1)
Beryllium	1LT (1)	1LT (1)
Cadmium	2LT (1)	2LT (1)
Chromium	91 (1)	20 (1)
Copper	86 (1)	181 (1)
Lead	21 (1)	96 (1)
Mercyr	0.7 (1)	0.1 (1)
Nickel	50 (1)	5LT (1)
Selenium	48 (1)	2LT (1)
Silver	4 (1)	4 (1)
Thallium	100LT (1)	2.9 (1)
Zinc	311 (1)	154 (1)
Cyanide	19 (1)	38 (1)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Plant 12447 is an indirect/zero discharger. Strong chemical wastes are deep well injected. With no pretreatment, these two streams are discharged to a POTW.

* Fermentation and fine chemicals process wastewaters.

** Formulation process wastewaters.

PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)		Employment
A,B,C,D	*1.0	**1.0	4000-4100

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
*Influent	**Influent	*Influent	**Influent	*Influent	**Influent
2600	45	7400	139	---	---

WASTEWATER TREATMENT PLANT FLOW DIAGRAM

NOT AVAILABLE

SAMPLING PROGRAM

Sample Location	No. of Samples
Process Wastes From Building 197	5
Process Wastes From Building 42	5
Process Wastes To Injection Wells	4
Non-Contact Cooling Water to Outfall 001	5
Non-Contact Cooling Water to 85 Acre Pond	5

SCREENING PROGRAM—SUMMARY OF PLANT 12462

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
4-Nitrophenol	1600 (1)	400LT (1)
Phenol	70 (1)	20LT (1)
Phenols (Tot.)	1200 (1)	70LT-540LT (3)
Volatile Organics		
Methylene chloride	---	70 (1)
Metals		
Antimony	10LT (1)	21-51 (3)
Arsenic	10LT (1)	10LT-20LT (3)
Beryllium	1LT (1)	1LT-2.4 (3)
Cadmium	1LT (1)	1LT (3)
Chromium	10LT (1)	10LT-17 (3)
Copper	48 (1)	36-48 (3)
Lead	31 (1)	5LT-6 (3)
Mercury	0.60 (1)	0.4-1.3 (3)
Nickel	50LT (1)	60LT (3)
Selenium	22 (1)	43-56 (3)
Silver	1LT (1)	1LT (3)
Thallium	100LT (1)	100LT (3)
Zinc	76 (1)	57-122 (3)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Activated Sludge
Aerated Lagoon
Sludge Hauling

PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
A	.170	0-100

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
2090	84-156 (3)	2690	548-1300 (3)	150	372-1000 (3)

WASTEWATER TREATMENT PLANT FLOW DIAGRAM

Not available.

SAMPLING PROGRAM

Sample Location	No. of Samples
Raw water supply	1
Existing backwash lagoon effluent	1
Biological waste treatment system effluent	6
Process wastes influent line to the biological treatment system	3
Combined influent to the biological wastewater treatment system	2
Effluent from final clarifier	4

SCREENING PROGRAM—SUMMARY OF PLANT 12999

SUMMARY OF SCREENING DATA

Priority Pollutants	CONCENTRATION (ug/l) Influent	Effluent
Acid Extractables		
2-Nitrophenol	---	4100 (1)
4-Nitrophenol	---	1100 (1)
Phenol	---	16500 (1)
Base/Neutral Extractables		
Nitrobenzene	---	30 (1)
Volatile Organics		
1,1-Dichloroethylene	---	370 (1)
1,2-Dichloroethane	---	20 (1)
1,1,2-Trichloroethane	---	6650 (1)
Metals		
Antimony	---	35-90 (3)
Arsenic	---	5700-7200 (3)
Cadmium	---	1LT (3)
Chromium	---	5LT-9 (3)
Copper	---	19-35 (3)
Lead	---	5LT (3)
Nickel	---	50LT (3)
Selenium	---	210-310 (3)
Silver	---	2LT (3)
Thallium	---	5LT-10LT (3)
Zinc	---	49-70 (3)

WASTEWATER TREATMENT PLANT UNIT OPERATIONS

Equalization
Neutralization
Primary Chemical Flocculation/Clarification
Detention Pond

PLANT CHARACTERISTICS

Subcategory	Wastewater Quantity (MGD)	Employment
C,D	0.45	Unknown

PERFORMANCE OF TREATMENT SYSTEM

BOD (mg/l)		COD (mg/l)		TSS (mg/l)	
Influent	Effluent	Influent	Effluent	Influent	Effluent
---	310-675 (3)	---	680-1380 (3)	---	3-31 (3)

WASTEWATER TREATMENT PLANT FLOW DIAGRAM

NOT AVAILABLE

SAMPLING PROGRAM

Sample Location	No. of Samples
Detention Pond Effluent	3
Raw Waste Feed for Bench Scale Treatment Units	2
Activated Sludge Effluent	1
Powdered Activated Carbon Treatment (PACT) Effluent	1

APPENDIX H

Priority Pollutant Occurrence as Reported in Original 308 Portfolio Data

APPENDIX H

PRIORITY POLLUTANT OCURRENCE
AS REPORTED IN ORIGINAL 308 PORTFOLIO DATA

Priority Pollutants by Plant		Concentrations (ug/l) Influent	Effluent
Plant 12003:	**A CD N***		
	Copper		10
	Nickel		80
	Zinc		5
Plant 12018:	**A CD N***		
	Zinc	100	
Plant 12037:	**CD N***		
	Methylene Chloride		12
	Chromium		930
	Copper		190
	Lead		50
	Mercury		0.3
	Nickel		100
	Zinc		40
	Cyanide		89
Plant 12038:	**ABCD AS, AL, PC***		
	Phenol		102
	Chromium		20
	Lead		100
	Mercury		0.6
	Cyanide		30
Plant 12052:	**CD AS***		
	Phenol		1100
	Chromium		21
	Copper		45
	Lead		100
	Mercury		10
	Nickel		100
	Zinc		92
	Cyanide		100
Plant 12056:	**D AC***		
	Chromium		5
	Zinc		17900

Plant 12057:	**CD**	**N***	
Toluene			780
Plant 12062:	**CD**	**N***	
Zinc			200
Plant 12065:	**D**	**N***	
Cyanide			1000
Plant 12089:	**B D**	**TF, AS, PP***	
Mercury			0.3
Plant 12102:	**CD**	**N***	
Phenol			8000
Chromium			100
Copper			500
Lead			100
Mercury			1.0
Nickel			500
Zinc			1000
Cyanide			1000
Plant 12107:	**B D**	**N***	
Phenol			290
Chromium			290
Lead			90
Plant 12123:	**CD**	**N***	
Benzene			6
Carbon Tetrachloride			50
Chloroform			50
Methylene Chloride			15
Toluene			67
Chromium			108
Copper			73
Lead			13
Mercury			35.0
Nickel			50
Zinc			368
Cyanide			110
Phenol			30
Chromium			50
Zinc			370
Plant 12161:	**A CD**	**As, PP***	
Phenol			14
Benzene		800	250

Chloroform			11000	6
Toluene			9100	17
Chromium				10
Copper				80
Lead				70
Mercury				2.0
Nickel				2100
Zinc				137
Plant 12186:	**CD**	**AS, AL***		
Copper				240
Plant 12195:	**C**	**N***		
Chromium				200
Copper				200
Lead				200
Mercury				0.1
Nickel				300
Zinc				400
Cyanide				10
Plant 12204:	**ABCD**	**AS***		
Chromium			9	15
Plant 12224:	**D**	**N***		
Copper				97
Zinc				177
Plant 12235:	**C**	**N***		
Cyanide			34	14
Plant 12236:	**C**	**AS***		
Cyanide			120	290
Plant 12244:	**C**	**N***		
Chromium				500
Mercury				0.5
Plant 12245:	**ABC**	**N***		
Toluene			290000	14000
Plant 12252:	**A CD**	**P***		
Chromium				70
Plant 12257:	**ABCD**	**AS***		
Phenol				30
Chromium				100
Copper				50
Lead				50
Mercury				0.1

	Nickel			1300
	Zinc			250
	Cyanide			10
Plant 12282:		BCD	SF*	
	Mercury			80.0
Plant 12287:		D	AL*	
	Phenol		31	10
	Chromium		100	100
	Zinc		80	80
	Cyanide			20
Plant 12289:		D	N*	
	Chromium			300
	Copper			540
	Lead			680
	Mercury			7.0
	Nickel			200
	Zinc			2050
	Cyanide			15
Plant 12302:		C	N*	
	Toluene			9
Plant 12339:		A CD	AS, PC*	
	Phenol			79
	Chloroform			9
	Methylene Chloride		22000000	742
	Chromium			85
	Copper			541
	Lead		117	117
	Mercury			4.0
	Zinc		120000	983
	Cyanide			2100
Plant 12342:		A CD	N*	
	Phenol			210
	Methylene Chloride			9300
Plant 12407:		C	AS, PC, PP*	
	Chromium			70
	Copper			23
	Lead			90
	Mercury			10.0
	Zinc			21
	Cyanide			2300
Plant 12411:		BCD	AL*	
	Phenol			106

Chloroform			3990
Methylene Chloride			1650
Plant 12414:	**D**	**N***	
Chromium			4
Copper			49
Lead			4
Nickel			7
Zinc			130
Plant 12420:	**B D**	**AS***	
Phenol		168	160
Toluene		174	174
Copper			300
Lead			170
Nickel			260
Zinc			600
Cyanide			3
Plant 12440:	**D**	**N***	
Phenol			750
Chloroform			300
Methylene Chloride			1000
Chromium			11
Copper			70
Lead			70
Mercury			0.1
Nickel			26
Zinc			80
Cyanide			200
Plant 12458:	**CD**	**N***	
Phenol			192
Plant 12468:	**D**	**N***	
Copper			140
Lead			24
Mercury			0.2
Nickel			100
Zinc			180
Plant 12475:	**C**	**AS***	
Phenol		10	10
Plant 12477:	**BC**	**N***	
Phenol			50
Chromium			2000
Copper			300
Lead			50
Mercury			5.0

	Nickel			500
	Zinc			5600
	Cyanide			760
Plant 20033:	CD	P*		
	Phenol			
	Chromium		200	200
	Copper			250
	Mercury			110
	Nickel			0.2
	Zinc			200
				250
Plant 20037:	D	AS, AL, PP*		
	Phenol			8
Plant 20245:	A C	AS*		
	Phenol		130	34
	Benzene		130	2
	Chloroform		72	42
	Methylene Chloride		4	2
	Toluene		40000	1
	Chromium		1700	86
	Copper		37	23
	Lead		8400	41
	Mercury		0.6	0.1
	Nickel		490	6
	Zinc		37000	3500
	Cyanide		1500	40
Plant 20246	C	AS, MF*		
	Phenol			172
	Benzene			3
	Chloroform			8
	Methylene Chloride			6
	Toluene			1
	Chromium			19
	Copper			55
	Lead			2
	Mercury			0.2
	Nickel			2
	Zinc			88
	Cyanide			36
Plant 20254:	C	AL, PP*		
	Phenol			65
	Cyanide			70
Plant 20297:	C	TF, AS, PC*		
	Phenol		1800	60
	Cyanide		200	110

Plant 20321:	D	N*		
Copper				300
Zinc				2000
Plant 20342:	C	P*		
Phenol			21	12
Chloroform				20
Toluene				8
Chromium				50
Copper				50
Mercury				0.2
Nickel				50

*End-of-Pipe Treatment Abbreviations:

N = No Treatment
P = Primary
TF = Trickling Filter
AS = Activated Sludge
AL = Aerated Lagoon
PP = Polishing Pond
PC = Physical/Chemical
AC = Activated Carbon
MF = Multimedia Filter
SF = Sand Filtration

APPENDIX I

308 Portfolio
(Traditional Pollutant Data)

APPENDIX I

308 PORTFOLIO TRADITIONAL POLLUTANT DATA

Plant Code	Sub-Category	Major End-of-Pipe Treatment*	BOD(mg/l) Inf.	BOD(mg/l) Eff.	COD(mg/l) Inf.	COD(mg/l) Eff.	TSS(mg/l) Inf.	TSS(mg/l) Eff.
12000	D	N	80				80	
12001	D	AL		21				
12012	B D	P	611		916		273	
12015	D	AS, AC, OP	259	19	489	54	146	15
12016	D	N	1210				135	
12018	A CD	N	33		76		11	
12022	A C	TF, AS	1551	105				38
12023	D	N	4597				512	
12026	C	AS, AL, PP	1865	93	4240	946	84	326
12031	D	N	344				222	
12036	A	TF, AS, AL, PP	1340	13	2521	197	705	44
12037	CD	N	1811		6893		775	
12038	ABCD	Fermentation Wastes AS, PC	6210	244	12023	1453	2264	306
		Chemical Wastes AL, PC	5717	1140	1741		4483	457
12040	B D	N	210		800		280	
12053	D	TF, AS, SF	2 9	8	1205	67	383	2
12062	CD	N	2600		2924		49	
12066	BCD	AS, AL	1195	331			116	251
12069	D	N	320		450		30	
12084	BCD	N	5772		10450		1465	
12087	C	P	27416		56902		2501	
12089	B D	TF, AS, PP		13				13
12095	CD	PC, OP					193	6
12097	CD	ASw/PAC, OP		28		289		29
12098	D	AS	465	693	2556	2886	354	336
12102	CD	N	2705		5124		143	
12104	D	SP	85	12	157	40	19	22
12119	A D	AS, PC		7		40		70
12125	D	PC		218	256	456	53	88
12132	A C	TF, AS, SP	2330	29	4800	203		29
12135	BCD	P	200		400		200	
12141	D	AS		4				12
12143	D	N	93		358		143	
12159	CD	N	79					
12160	D	AS, PC, MF	530	5			4128	43

APPENDIX I (cont.)

308 PORTFOLIO TRADITIONAL POLLUTANT DATA

Plant Code	Sub-Category	Major End-of-Pipe Treatment*	BOD(mg/l)		COD(mg/l)		TSS(mg/l)	
			Inf.	Eff.	Inf.	Eff.	Inf.	Eff.
12161	A CD	AS, PP	987	72	2978	944	398	196
12168	ABCD	N	1300		3300		500	
12183	B	N	4		10		3	
12185	BC	N	47		154		7	
12186	CD	AS, AL		129		683		328
12187	C	TF	653		1950		124	
12191	BCD	P			1352		92	
12195	C	N	215		584			
12199	A CD	N	2180				650	
12204	ABCD	AS	1220	146	2628	407	2000	320
12205	D	AS, SP		60		81		40
12231	D	AL, SP	2500	200		600	100	50
12235	C	N	12374		22250			
12236	C	AS	1117	149	2674	553		90
12239	D	AS	1573	284	1608	290		174
12240	CD	PC		3636		8481		286
12248	D	AS	244	10	486	63		35
12257	ABCD	AS	3000	120			950	500
12261	C	AL, PC			15574	9880	3089	567
12275	BC	P	366					
12283	D	AS		35				50
12287	D	AL	30	56	50	51	12	13
12294	CD	AS, MF	1404	208	3288	658		28
12298	D	AS		15				26
12307	D	AS, AL	732	18	2390	83	497	90
12308	D	AS	130		372		67	
12317	D	AS, PC, MF	760	32	1064	107	39	50
12338	D	AS, SF	200	30			200	30
12339	A CD	AS, PC			430	2370		
12343	A CD	P	636					
12406	C	PC, PP, OP					420	10
12407	C	AS, PC, PP	54	45			30	17
12411	BCD	AL	7100	869	15700		369	1793
12420	B D	AS	7520	4636	12032	7418	4923	4048
12454	B D	TF		288				
12462	A	AS, AL		143		297		97
12463	B D	AS, SP, PC, OP	102	6		29		9

APPENDIX I (cont.)

308 PORTFOLIO TRADITIONAL POLLUTANT DATA

Plant Code	Sub-Category	Major End-of-Pipe Treatment*	BOD(mg/l) Inf.	BOD(mg/l) Eff.	COD(mg/l) Inf.	COD(mg/l) Eff.	TSS(mg/l) Inf.	TSS(mg/l) Eff.
12471	B	AL, PP, OP	50	14	169		93	59
12475	C	AS	10670	1960	16140	6440		2340
12476	D	AS	10670	1960	16140	6440		2340
12477	BC	N	327		725			
20037	D	AS, AL, PP		20				47
20165	BC	AL	200	32	541	113	47	24
20201	D	AS		6		50		14
20204	CD	AL	1600	370	1370			
20206	C	AL	1600	5	12000	340		10
20245	A C	AS	497	56	1350	74		32
20246	C	AS, MF,		13		128		33
20257	C	AS	484	143	1358	329		
20297	C	TF, AS, PC	380	20			147	36
20312	BCD	AL	1500	150			500	150
20319	D	TF, SP		15				9
20342	C	P	609		870		32	
20363	A CD	P	8460		16748		1535	

* ABBREVIATIONS:

N = No Treatment
P = Primary
TF = Trickling Filter
AS = Activated Sludge (w/PAC = with Powdered Activated Carbon)
AL = Aerated Lagoon
SP = Stabilization Pond
PP = Polishing Pond
OP = Other Polishing
PC = Physical/Chemical
AC = Activated Carbon
MF = Multimedia Filter
SF = Sand Filtration

APPENDIX J

308 Portfolio
(Wastewater Flow Data)

APPENDIX J
308 PORTFOLIO
WASTEWATER FLOW DATA

DIRECT DISCHARGERS

Plant No.	Subcategory	Discharge Flow, MGD
12001	D	0.155
12006	D	0.125
12014	B	***
12015**	D	0.074
12022	A C	1.300
12026	C	0.101
12030	D	0.030
12036	A	1.128
12038**	A B C D	2.607
12053	D	0.004
12057*	C D	0.005
12073	C	0.015
12085	D	0.001
12089	B D	0.155
12095	C D	0.071
12097*	C D	0.035
12098	D	0.002
12104*	D	0.367
12117	B D	0.121
12119	A D	0.032
12132*	A C	0.460
12160	D	0.006
12161	A C D	1.332
12175	D	0.004
12187*	C	0.913
12194	D	0.002
12205	D	0.030
12236	C	0.810
12239	D	0.002
12248	D	0.035
12256*/**	A B C D	30.000
12261	C	0.051
12264*	A B D	0.044
12267	D	0.005
12281*	D	***
12283	D	0.013
12287*	D	0.131
12294**	C D	0.089
12298	D	0.003
12307	D	0.001
12308**	D	0.059
12317	D	0.390
12338	D	0.001
12339**	A C	1.600
12406	C	0.370
12407	C	0.731
12459	D	0.073
12462	A	0.170
12463**	B D	0.003
12471	B	0.043
20037	D	0.037
20165	B C	0.004
20201	D	0.002
20245	A C	0.500
20246	C	1.250
20257**	C	0.015
20297	C	***
20298	C	***
20319	D	0.003
20370	B C	0.014
20402	D	0.024

APPENDIX J
308 PORTFOLIO
WASTEWATER FLOW DATA

INDIRECT DISCHARGERS:

Plant No.	Subcategory	Discharge Flow, MGD
12000	D	0.140
12003	A C D	0.980
12004	C D	0.003
12005	B	0.001
12007	D	0.527
12011	A B D	0.031
12012	B D	0.340
12016	D	0.009
12018**	A C D	0.020
12019	D	****
12023	D	0.020
12024**	D	0.033
12031	D	0.001
12035	D	0.003
12037	C D	0.125
12040	B D	0.063
12042	A B D	****
12043**	C	0.001
12044**	A D	2.973
12048	C D	0.089
12051	D	0.009
12054	D	0.008
12055	D	0.002
12056	D	0.110
12057*	C D	0.080
12058	D	0.005
12060	D	0.104
12061	B	0.042
12062	C D	0.075
12065**	D	0.005
12066	B C D	0.259
12068	D	***
12069	D	0.017
12074	D	0.037
12076	D	0.001
12077	C D	0.022
12078	D	***
12080	D	0.090
12083	D	0.217
12084	B C D	0.008
12087	C	0.232
12088	D	0.002
12093	C D	0.004
12094	D	****
12100	C D	0.002
12104*	D	0.190
12107	B D	0.009
12108**	A C D	****
12110	D	****
12111	B D	****
12112	C	0.005
12113	D	0.380
12115	A B D	0.010
12118*	D	0.009
12120	D	0.001
12122	D	****
12123	C D	0.404
12125	D	****
12128	D	****
12129	D	****
12131	D	0.004
12135	B C D	1.650
12141	D	0.001
12143	D	0.037
12144	D	****
12145	D	0.001
12147	D	****
12155	C D	1.170
12157	D	****
12166	D	0.004
12168	A B C D	0.159
12171	B C D	0.001
12172	D	****
12177	D	****
12178	B	0.005
12183	B	0.090
12186	C D	0.052
12187*	C	0.078
12191	A B C D	****
12195	C	0.080
12198	B D	0.012
12199	A C D	0.500

APPENDIX J
308 PORTFOLIO
WASTEWATER FLOW DATA

INDIRECT DISCHARGERS (CONT'D.)

Plant No.	Subcategory	Discharge Flow, MGD	Plant No.	Subcategory	Discharge Flow, MGD
12204	A B C D	0.850	12305	D	0.034
12206	D	0.130	12309	B C	0.007
12207	D	****	12310	C D	0.018
12210	B C	0.002	12311	A B C D	0.240
12211	D	****	12312	B D	****
12212	D	0.040	12318	D	0.100
12217**	D	****	12322	D	0.010
12219	D	0.053	12330	A B C D	1.606
12224	D	****	12331	D	0.380
12226	B	0.040	12332	C	0.045
12230	B	0.001	12333	C D	0.017
12233	D	****	12340	D	0.034
12235**	C	0.295	12342	A C D	0.701
12238	D	0.010	12343	A C D	0.088
12240**	C D	0.013	12345	D	0.020
12243	C	****	12375	B	****
12244	C	0.042	12384	B	0.002
12245**	A B C	0.085	12385	D	****
12246**	C D	0.362	12392	D	****
12247	C	0.029	12401	A D	0.223
12249	D	0.002	12405	C D	****
12250	D	0.047	12409	D	****
12251	D	0.001	12411	B C D	0.300
12252	A C D	0.865	12414	D	0.464
12254**	A D	0.213	12415	D	0.080
12256*	A B C D	0.410	12417	D	****
12257**	A B C D	0.600	12419	B D	****
12260	D	0.125	12420**	B D	****
12264*	A B D	0.127	12427	D	0.011
12265	B D	0.003	12429	D	0.005
12268	D	****	12433	D	****
12273	D	****	12438	D	0.004
12275	B C	0.426	12440	D	****
12277	D	****	12441	C	1.300
12281	D	0.034	12444	D	0.076
12282	B C D	0.004	12454	B D	0.100
12287*	D	0.070	12458	C D	0.778
12289	D	0.003	12460	B D	****
12290	D	****	12464	D	****
12295	B D	****	12465	D	0.018
12296	D	0.016	12467	B	0.002
12300	B	0.160	12468	D	0.038
12302	C	1.028	12470	A	0.001

APPENDIX J
308 PORTFOLIO
WASTEWATER FLOW DATA

DIRECT DISCHARGERS (CONT'D.)

Plant No.	Subcategory	Discharge Flow, MGD
12472	B C	0.001
12473	B C	0.023
12474	D	0.003
12477	B C	2.400
12479	B	****
12481	D	****
12482	****	****
12495	D	****
12499	D	****
20012	C	****
20017	D	****
20026	D	****
20032	B D	****
20033	C D	0.200
20034	D	0.001
20050	A B	****
20052	D	****
20057	D	****
20058	D	****
20062	D	****
20064	D	0.001
20081	D	****
20089	D	****
20117	D	****
20120	D	****
20126	D	****
20139	C D	0.060
20142	D	0.001
20147	D	****
20153	D	****
20155	D	****
20169	D	0.026
20174	D	****
20177	C	0.001
20187	D	0.002
20188	D	0.008
20203**	C	0.034
20205	C	****
20216	D	0.001
20220	D	****
20224	D	****
20231	D	****
20234	C	****
20237	B	0.040
20240	C	0.002
20244	C	0.001
20247	B	0.059
20254	C	0.020
20258	C D	0.002
20261	D	****
20263	D	****
20264	D	****
20267	D	****
20269	D	****
20270	D	0.002
20273	D	****
20282	D	****
20288	D	0.037
20303	B	****
20307	B	****
20310	C	0.190
20311	C	0.034
20312	B C D	0.900
20321	D	0.008
20328	D	0.001
20331	C	0.107
20333	D	***
20339	D	0.500
20342	C	0.039
20346	B C	****
20349	C	0.018
20350	C D	0.003
20353	B C	0.006
20355	C	0.033
20356	C D	****
20359	B D	****
20361	A	****
20362	C D	****
20363	A C D	0.125
20364	B D	0.006
20366	B C D	0.010
20371	D	****
20377	C D	****
20385	D	****
20389	C	****
20400	D	****

APPENDIX J
308 PORTFOLIO
WASTEWATER FLOW DATA

INDIRECT DISCHARGERS (CONT'D.)

Plant No.	Subcategory		Discharge Flow, MGD
20405		D	****
20423		D	****
20439		D	****
20441		D	****
20443	B	D	0.023
20446		D	***
20450		D	****
20453		D	0.010
20456		D	****
20460		D	****
20465		D	****
20466		D	0.001
20473**	B		0.001
20476		D	****
20490		D	****
20492		D	****
20494		D	0.001
20503	C	D	****
20519		D	0.010
20527		D	0.001

APPENDIX J
308 PORTFOLIO
WASTEWATER FLOW DATA

ZERO DISCHARGERS (ONLY)

Plant No.	Plant No.	Plant No.	Plant No.	Plant No.	Plant No.
12021	12476	20084	20204	20308	20440
12052	20006	20087	20206	20316	20444
12063	20014	20090	20208	20325	20448
12099	20015	20093	20209	20332	20452
12102	20016	20094	20210	20338	20462
12133	20030	20099	20215	20340	20464
12159	20035	20100	20218	20347	20467
12173	20038	20103	20225	20373	20470
12174	20040	20106	20226	20376	20483
12175	20041	20108	20228	20387	20485
12185	20045	20115	20235	20390	20486
12225	20048	20125	20236	20394	20496
12231	20049	20134	20241	20396	20498
12263	20051	20141	20242	20397	20500
12269	20054	20148	20249	20413	20502
12297	20055	20151	20256	20416	20504
12306	20070	20159	20266	20421	20507
12326	20073	20173	20271	20424	20509
12439	20075	20176	20294	20425	20511
12447	20078	20178	20295	20435	20518
12466	20080	20195	20300	20436	20522
12475	20082	20197	20305	20440	20526
					20529

APPENDIX J
308 PORTFOLIO
WASTEWATER FLOW DATA

* These plants are combined direct/indirect dischargers. The value reported is for the appropriate portion of the total discharge.

** These plants also have some zero discharge operations. Zero discharge flow is not included.

*** Flow is negligibly small (less than 500 MGD).

**** Data unavailable.

Notes:

1. The above plants were the only ones to report flow data in the 308 Portfolio. For all others the discharge flows were unknown or negligible.

2. The discharge flows consist of wastewater from the following sources.
   - Direct process contact
   - Indirect process contact
   - Non-contact
   - Maintenance and equipment cleaning
   - Air pollution control

3. The discharge flows do not contain:
   - Non-contact cooling water
   - Sanitary/potable water
   - Storm water

APPENDIX K

RSKERL Data

ANALYTICAL DATA (PLANT 4)

Priority Pollutant	Influent (µg/l)	Return Sludge (µg/l)	Effluent (µg/l)
CLASSICAL			
TOTAL CYANIDES (mg/l)*	<.05 *	<.05*	<.05 *
TOTAL PHENOL	350	74	18
TOTAL METALS			
Arsenic	<10	<10	<10
Selenium	<10	33	<10
Cadmium	2	59	<1
Beryllium	3	<3	<3
Copper	120	8,300	29
Antimony	<10	<10	<10
Chromium	12	740	11
Nickel	<10	110	12
Zinc	620	7,700	260
Silver	<10	160	<10
Thallium	<10	<10	<10
Lead	12	810	<10
Mercury	<0.8	62	<0.5
ORGANICS (GAS CHROMATOGRAPHY)			
PURGEABLES			
1,2-Dichloroethane		N.A.	
Toluene	<10	N.A.	<10
Chloroform	<10	N.A.	<10
Methylene chloride	<10	N.A.	48
Benzene	<40	N.A.	<40
Ethylbenzene	<10	N.A.	<10
Tetrachloroethylene	10	N.A.	<10
Trichloroethylene	<10	N.A.	<10
PHENOLICS			
Phenol	17	9	19
Pentachlorophenol	18	38	26
PHALLATES			
Bis(2-ethylhexyl) phthallate			
Di-n-butyl phthallate			

*Note: Total Cyanides expressed in mg/l.
**Key: N.D. - Not Detectable, or less than detectable limits
N.A. - Not Applicable
N.S. - No Standard Available
N.P. - No Procedure "

ANALYTICAL DATA (PLANT 5)

Priority Pollutant	Influent (µg/l)	DAF Skimmings (µg/l)	Clarifier Effluent (µg/l)	Clarifier Sludge (µg/l)
CLASSICAL				
TOTAL CYANIDES (mg/l)*	.25*	.22*	.17*	.23*
TOTAL PHENOL	945	107	39	201
TOTAL METALS				
Arsenic	<10	16	<10	21
Selenium	<10	<10	<10	<10
Cadmium	<01	11	<1	16
Beryllium	3	<3	<3	<3
Copper	120.	1,900	34	2,800
Antimony	10.	<10	<10	<10
Chromium	12	1,500	34	2,100
Nickel	39	42	38	32
Zinc	41	5,600	9	7,800
Silver	<10	17	<10	72
Thallium	<10	<10	<10	56
Lead	22	12	<10	30
Mercury	<2.0	<10	<2.0	<10.0
ORGANICS (GAS CHROMATOGRAPHY)				
PURGEABLES				
Benzene	127	N.A.	<40	N.A.
Chloroform	<10	"	<10	"
Methylene chloride	47	"	<10	"
Toluene	<10	"	<10	"
Ethylbenzene	150	"	<10	"
1,1,1-trichloroethane	<10	"	<10	"
1,2-dichloroethane	<10	"	<10	"
PHENOLICS				
4-Nitrophenol	N.D.	381	N.D.	N.A.
2-Nitrophenol	123	387	21	N.A.
PHTHALLATE ESTERS				
Bis(2-ethylhexyl) phthallate				

*Note: Total Cyanides expressed in mg/l.

**Key: N.D. - Not Detectable, or less than detectable limits
N.A. - Not Applicable
N.S. - No Standard Available
N.P. - No Procedure Available

PLANT 4 (Continued)

Priority Pollutant	Sparged Air, XAD-2 μgrams per 1,755 ft^3	Sparged Air, Tenax μgrams per ft^3
POLYNUCLEAR AROMATICS		
Naphthalene	90	
2-Chloronaphthane	<10	
Acenaphthalene	<10	
Acenaphthene	<10	
Fluorene	<13	
Phenanthrene/Anthracene	<10	
Fluoranthene	<10	
Pyrene	<10	
1,2-Benzanthracene	<10	
Chrysene	<10	
3,4-Benzopyrene	<35	
1,2:5,6-Dibenzanthracene	N.D.	
PHENOLICS		
2-Chlorophenol	<25	
2-Nitrophenol	<25	
Phenol	<10	
2,4-Dimethylphenol	<25	
2,4-Dichlorophenol	80	
2,4,6-Trichlorophenol	<10	
4-Chloro-m-cresol	110	
2,4-Dinitrophenol	100	
4,6-Dinitro-o-cresol	<25	
Pentachlorophenol	<25	
4-Nitrophenol	<25	
PURGEABLES		
Methylene chloride		No results - sample lost. Analytical equipment malfunction.
1,1-Dichloroethane		
1,2-Trans-dichloroethylene		
Chloroform		
1,2-Dichloroethane		
1,1,1-Trichloroethane		
Carbon tetrachloride		
Dichlorobromomethane		
1,2-Dichloropropane		
Benzene		
Trichloroethylene		
Chlorodibromomethane		
1,1,2-Trichloroethane		
Methyl bromide		
Bromoform		
1,1,2,2-Tetrachloroethane		
Tetrachloroethylene		
Toluene		
Chlorobenzene		
Ethylbenzene		

PLANT F (Continued)

Priority Pollutant	Sparged Air, XAD-2 (µg)	Sparged Air, Tenax (µg)
POLYNUCLEAR AROMATICS		
Naphthalene	940	
2-Chloronaphthane	5,000	
Acenaphthalene	<60	
Acenaphthene	60	
Fluorene	<78	
Phenanthrene/Anthracene	150	
Fluoranthene	<60	
Pyrene	<60	
1,2-Benzanthracene	<60	
Chrysene	<60	
3,4-Benzopyrene	<210	
1,2:5,6-Dibenzanthracene	N.D.	
PHENOLICS		
2-Chlorophenol	<150	
2-Nitrophenol	<150	
Phenol	<60	
2,4-Dimethylphenol	<150	
2,4-Dichlorophenol	1,500	
2,4,6-Trichlorophenol	<10	
4-Chloro-m-cresol	1,800	
2,4-Dinitrophenol	<600	
4,6-Dinitro-o-cresol	600	
Pentachlorophenol	<150	
4-Nitrophenol	<150	
PURGEABLES		
Methylene chloride		Sample lost - Analytical apparatus malfunction.
1,1-Dichloroethane		
1,2-Trans-dichloroethylene		
Chloroform		
1,2-Dichloroethane		
1,1,1-Trichloroethane		
Carbon tetrachloride		
Dichlorobromomethane		
1,2-Dichloropropane		
Benzene		
Trichloroethylene		
Chlorodibromomethane		
1,1,2-Trichloroethane		
Methyl bromide		
Bromoform		
1,1,2,2-Tetrachloroethane		
Tetrachloroethylene		
Toluene		
Chlorobenzene		
Ethylbenzene		

APPENDIX L

Current In-Place Treatment Technologies

APPENDIX L

CURRENT IN-PLACE TREATMENT TECHNOLOGIES

Plant Code No.	Subcategories	Treatment System	BPT Treatment
12001	D	Industrial Wastes Equalization Primary Chemical Flocculation/ Clarification Aerated Lagoon Drying Beds Landfill	X
		Sanitary Wastes Activated Sludge Sand Filtration Mechanical Thickening Sludge to POTW	X
12003	A C D	Neutralization	
12007	D	Neutralization Sludge to Sewer System	
12011	A B D	Neutralization	
12012	B D	Equalization	
12014	B	Biological Treatment	X
12015	D	Equalization Primary Sedimentation Activated Sludge with Powdered Activated Carbon Secondary Chemical Flocculation/ Clarification Gravity Dewatering Aerobic Digestion Landfill	X
12022	A C	Cyanide Destruction Equalization Neutralization Coarse Settleable Solids Removal Primary Sedimentation Activated Sludge	X

		Trickling Filter Mechanical Thickening Chemical Conditioning Vacuum Dewatering Incineration Landfill	
12026	C	Equalization Neutralization Activated Sludge Aerated Lagoon Polishing Pond Anaerobic Digestion	X
12030	D	Retention for Radioactive Decay	
12036	A	Activated Sludge Trickling Filter Aerated Lagoon Waste Stabilization Pond Polishing Pond Aerobic Digestion Cropland Use	X
12038	A B C D	<u>Fermentation Wastes</u> Equalization Neutralization Coarse Setteable Solids Removal Primary Sedimentation Activated Sludge Tertiary Plant Centrifugal Dewatering Anaerobic Digestion Landfill	X
		<u>Chemical Wastes</u> Solvent Recovery Equalization Neutralization Coarse Settleable Solids Removal Primary Sedimentation Primary Chemical Flocculation/ Clarification Aerated Lagoon Tertiary Plant Centrifugal Dewatering Anaerobic Digestion Landfill	X
		<u>Pretreatment</u>	X

		Solvent Recovery In-Plant Evaporation Steam Stripping Tertiary Plant Heat Conditioning	
		<u>Thermal Oxidation</u> Equalization Neutralization P/C: Thermal Oxidation Tertiary Plant	
12042	A B D	Equalization Neutralization	
12043	C	Solvent Recovery Neutralization Coarse Settleable Solids Removal	
12044	A D	Neutralization	
12052	C D	Primary Sedimentation Activated Sludge	X
12053	D	Equalization Coarse Settleable Solids Removal Activated Sludge Trickling Filter Sand Filtration Mechanical Thickening Drying Beds Cropland Use	X
12056	D	De-Gasifier De-Mineralizer Neutralization Activated Carbon Filtration	
12066	B C D	Neutralization Activated Sludge Aerated Lagoon Mechanical Thickening Sludge to POTW	X
12077	C D	Equalization Neutralization Coarse Settleable Solids Removal Primary Sedimentation Dissolved Air Flotation Sludge to POTW	

12085	D	Activated Sludge Landfill	X
12087	C	Solvent Recovery Neutralization Coarse Settleable Solids Removal Dissolved Air Flotation Sludge Hauling	
12089	B D	Equalization Neutralization Coarse Settleable Solids Removal Primary Sedimentation Activated Sludge Trickling Filter Polishing Pond Mechanical Thickening Anaerobic Digestion Drying Beds Cropland Use	X
12093	C D	Equalization Aerated Equalization Tanks	
12095[2]	C D	Equalization Neutralization Coarse Settleable Solids Removal Primary Chemical Flocculation/ Clarification Physical/Chemical Treatment Secondary Neutralization Flotation Thickening Sludge Hauling	X
12097	C D	<u>Chemical Wastes</u> Equalization Neutralization Physical/Chemical Treatment Filtration/Presses Chemical Stabilization Chemical Conditioning Vacuum Dewatering Landfill	X
		<u>Floor Washes</u> Coarse Settleable Solids Removal Activated Sludge with Powdered Activated Carbon Physical/Chemical Treatment	X

		Secondary Chemical Flocculation/ Clarification Chemical Stabilization Chemical Conditioning Vacuum Dewatering Landfill	
12098	D	Activated Sludge Landfill	X
12102	C D	Equalization Neutralization	
12104	D	Equalization Neutralization Waste Stabilization Ponds Chemical Conditioning Mechanical Dewatering Landfill	X
12108	A C D	Neutralization	
12113	D	Equalization Neutralization	
12117	B D	Activated Sludge Chlorination Gravity Aerobic Digestion Dewatering	X
12119	A D	Equalization Neutralization Coarse Settleable Solids Removal Primary Sedimentation Activated Sludge P/C: Evaporation Anaerobic Digestion Drying Beds Sludge to POTW	X
12123	C D	Equalization Neutralization	
12125	D	Neutralization Physical/Chemical Treatment Secondary Neutralization	X
12132	A C	Solvent Recovery Equalization	X

		Neutralization Coarse Settleable Solids Removal Primary Sedimentation Primary Chemical Flocculation/ Clarification	
12132 (cont'd)	A C	Activated Sludge Trickling Filter Waste Stablization Ponds Flotation Thickening Centrifugal Thickening Centrifugal Dewatering Incineration Landfill	
12135	B C D	Cyanide Destruction Equalization Neutralization	
12141	D	Neutralization Primary Sedimentation Activated Sludge Sludge Hauling	X
12159	C D	Solvent Recovery Steam Stripping	
12160	D	Equalization Neutralization Coarse Settleable Solids Removal Primary Sedimentation Activated Sludge P/C: Evaporation Multi-Media Filtration Flotation Thickening Anaerobic Digestion Sludge Hauling	X
12161	A C D	Solvent Recovery Equalization Neutralization Coarse Settleable Solids Removal Primary Sedimentation Primary Chemical Flocculation/ Clarification Activated Sludge Polishing Pond Gravity Thickening Aerobic Digestion Composting	X

		Landfill Cropland Use	
12175	D	Equalization	
12186	C D	Neutralization Activated Sludge Aerated Lagoon Ozone Polishing	X
12187	C	Solvent Recovery Zinc Isolation Equalization Neutralization Coarse Settleable Solids Removal Dissolved Air Flotation Trickling Filter Gravity Thickening Sludge to POTW Vacuum Dewatering Landfill	X
12191	A B C	Neutralization	
12199	A C D	Solvent Recovery	
12204	A B C D	Solvent Recovery Mercury Collection Neutralization Coarse Settleable Solids Removal Primary Chemical Flocculation/ Clarification Activated Sludge with Pure Oxygen Mechanical Thickening Chemical Conditioning Vacuum Dewatering Composting	X
12205	D	Equalization Activated Sludge Sand Filtration Mechanical Thickening Aerobic Digestion Sludge to POTW	X
12210	B C	Aerated Lagoon	X
12231	A D	Equalization Neutralization Coarse Settleable Solids Removal	X

		Primary Sedimentation Aerated Lagoon Waste Stabilization Ponds Anaerobic Digestion Landfill	
12236	C	<u>Weak Wastes</u> Cyanide Destruction Solvent Recovery Equalization Neutralization Primary Oil/Solvent Skimming	
		<u>Strong Wastes</u> Cyanide Destruction Solvent Recovery Equalization Neutralization Primary Sedimentation Activated Sludge Flotation Thickening Chemical Conditioning Vacuum Filtration Landfill	X
12239	D	Activated Sludge Landfill	X
12240	C D	Equalization Neutralization Physical/Chemical Treatment Chlorination	X
12246	C D	Solvent Recovery In-Plant Evaporation	
12248	D	Equalization Coarse Settleable Solids Removal Activated Sludge Mechanical Thickening Gravity Dewatering Aerobic Digestion Dewatering Landfill	X
12252	A C D	Equalization Neutralization Coarse Settleable Solids Removal	
12254	A D	Equalization	

		Neutralization	
12256	A B C D	Solvent Recovery In-Plant Evaporation Equalization Neutralization Coarse Settleable Solids Removal Primary Sedimentation w/Skimming	
12257	A B C D	Equalization Neutralization Activated Sludge Centrifugal Dewatering Cropland Use	X
12261	C	Equalization Neutralization Coarse Settleable Solids Removal Primary Sedimentation Aerated Lagoon P/C: Thermal Oxidation Secondary Neutralization Chlorination Vacuum Dewatering Landfill	X
12275	B C	Equalization Neutralization	
12282	B C D	Neutralization Coarse Settleable Solids Removal Primary Sedimentation Primary Chemical Flocculation/ Clarification Sand Filtration Gravity Dewatering Sludge Storage	X
12283	D	Activated Sludge Landfill	X
12287	D	Coarse Settleable Solids Removal Primary Sedimentation Aerated Lagoon	X
12294	C D	Solvent Recovery Equalization Neutralization Activated Sludge Multi-Media Filtration	X

		Centrifugal Thickening Centrifugal Dewatering Incineration Landfill	
12298	D	Activated Sludge Landfill	X
12305	D	Equalization Neutralization	
12307	D	Primary Sedimentation Activated Sludge Aerated Lagoon Chlorination Mechanical Thickening Flotation Thickening	X
12308	D	Activated Sludge Chlorination Landfill	X
12311	A B C D	Activated Sludge Mechanical Thickening Centrifugal Thickening Landfill	X
12317	D	Equalization Neutralization Coarse Settleable Solids Removal Activated Sludge Physical/Chemical Treatment Multi-Media Filtration Mechanical Thickening Aerobic Digestion Cropland Use	X
12330	A B C D	Neutralization	
12332	C	Equalization Neutralization Waste Stabilization Pond	X
12333	C D	Solvent Recovery Coarse Settleable Solids Removal Primary Sedimentation Multi-Media Filtration Landfill	X
12338	D	Coarse Settleable Solids Removal	X

		Primary Sedimentation Activated Sludge Sand Filtration Mechanical Thickening Anaerobic Digestion Sludge Hauling	
12339	A C D	<u>Thermal Oxidation (3 Units)</u> Neutralization Coarse Settleable Solids Removal P/C: Thermal Oxidation Tertiary Plant	X
		<u>Oil Dehydration</u> Neutralization P/C: Evaporation Tertiary Plant Centrifugal Dewatering Pyrolysis Landfill	X
		<u>Sanitary Wastes</u> Primary Separation Activated Sludge Tertiary Plant Mechanical Thickening Evaporation Aerobic Digestion Dewatering Pyrolysis Landfill	X
		<u>Solvents</u> Solvent Recovery Steam Stripping Tertiary Plant	X
12343	A C D	Neutralization	
12392	D	Neutralization	
12406	C	Neutralization Physical/Chemical Treatment Secondary Chemical Flocculation/ Clarification Polishing Pond Sludge Dewatering Landfill	X
12407	C	Equalization	X

		Neutralization Coarse Settleable Solids Removal Primary Sedimentation Primary Chemical Flocculation/ Clarification Activated Sludge Physical/Chemical Treatment Polishing Pond Flotation Thickening Landfill	
12411	B C D	Solvent Recovery Equalization Neutralization Aerated Lagoon Incineration	X
12420	B D	Activated Sludge Chemical Conditioning Centrifugal Dewatering Landfill	X
12438	D	Aerated Equalization Tanks	
12439	C D	Equalization Neutralization Primary Sedimentation Activated Sludge Aerated Lagoon Landfill	X
12441	C	Equalization Neutralization Coarse Settleable Solids Removal Primary Sedimentation	
12447	A B C D	Deep Well Injection Equalization Neutralization Coarse Settleable Solids Removal Primary Sedimentation Physical/Chemical Treatment Diatomaceous-Earth Filtration	X
12454	B D	Primary Sedimentation Trickling Filter Anaerobic Digestion Landfill	X

12458	C D	Equalization Neutralization	
12459	D	Equalization Aerated Lagoon Polishing Pond Chlorination	X
12462	A	Activated Sludge Aerated Lagoon Sludge Hauling	X
12463	B D	Coarse Settleable Solids Removal Activated Sludge Waste Stabilization Pond Physical/Chemical Treatment Secondary Chemical Flocculation/ Clarification Flotation Thickening Sludge Hauling	X
12471	B	Coarse Settleable Solids Removal Aerated Lagoon Secondary Chemical Flocculation/ Clarification Polishing Pond Secondary Neutralization Chlorination Drying Beds Landfill	X
12475	C	Equalization Neutralization Activated Sludge Forest Land Use	X
12476	D	Equalization Neutralization Activated Sludge Forest Land Use	X
12477	B C	Equalization Neutralization	
20014	D	In-Plant Evaporation	
20017	D	Activated Carbon Filtration Landfill	X
20030	C D	In-Plant Evaporation	

20033	C D	Primary Sedimentation	
20037	D	Activated Sludge Aerated Lagoon Polishing Pond Landfill	X
20057	D	Primary Sedimentation Landfill	
20139	C D	Cyanide Destruction Solvent Recovery In-Plant Neutralization	
20153	D	Multi-Media Filtration	X
20165	B C	Aerated Lagoon	X
20177	C	Neutralization	
20195	D	P/C: Evaporation	X
20201	D	Solvent Recovery Activated Sludge	X
20203	C	Cyanide Destruction Chromium Reduction Metals Precipitation Solvent Recovery Equalization Neutralization Coarse Settleable Solids Removal Primary Chemical Flocculation/ Clarification Landfill	
20204	C D	Solvent Recovery In-Plant Neutralization Neutralization Aerated Lagoon Sludge Lagoon	X
20205	C	Solvent Recovery Neutralization Coarse Settleable Solids Removal Aerated Lagoon Landfill	X
20206	C	Solvent Recovery	X

		Equalization Aerated Lagoon Landfill	
20234	C	Solvent Recovery Neutralization Primary Sedimentation	
20236	D	Activated Sludge	X
20237	B	Solvent Recovery Steam Stripping Equalization	
20244	C	Solvent Recovery Equalization Neutralization Primary Chemical Flocculation/ Clarification Landfill	
20245	A C	Solvent Recovery Steam Stripping In-Plant Neutralization Equalization Neutralization Coarse Settleable Solids Removal Primary Chemical Flocculation/ Clarification Activated Sludge Landfill	X
20246	C	Equalization Neutralization Primary Sedimentation Activated Sludge Multi-Media Filtration Chlorination Vacuum Filtration Incineration	X
20254	C	Solvent Recovery Neutralization Primary Sedimentation Aerated Lagoon Polishing Pond	X
20257	C	Equalization Neutralization Coarse Settleable Solids Removal	X

		Primary Sedimentation Activated Sludge Sludge Lagoon	
20258	C D	Equalization Neutralization Activated Sludge	X
20263	D	Coarse Settleable Solids Removal	
20273	D	Coarse Settleable Solids Removal Sludge Hauling	
20297	C	Neutralization Coarse Settleable Solids Removal Primary Sedimentation Activated Sludge Trickling Filter P/C: Evaporation	X
20298	C	Metals Precipitation In-Plant Evaporation Neutralization Primary Sedimentation Activated Sludge Incineration Cropland Use	X
20310	C	Cyanide Destruction Solvent Recovery Steam Stripping Neutralization Coarse SEttleable Solids Removal	
20312	B C D	Aerated Lagoon Landfill	X
20319	D	Coarse Settleable Solids Removal P/C: Oxidation Trickling Filter Waste Stabilization Pond Sludge Hauling	X
20339	D	Waste Stabilization Pond	X
20342	C	In-Plant Neutralization Coarse Settleable Solids Removal Sludge Hauling	
20349	C	Neutralization	

20355		C		Neutralization	
20356		C	D	In-Plant Neutralization	
20363	A	C	D	Equalization Neutralization Primary Sedimentation	
20370		B C		Rotating Biological Contractor Chlorination Sludge Hauling	
20373		C		Steam Stripping In-Plant Evaporation Neutralization Primary Sedimentation w/Skimming	
20376			D	In-Plant Evaporation	
20389		C		Aerated Lagoon	X
20402			D	Primary Sedimentation Waste Stabilization Pond Multi-Media Filtration	X
20423			D	In-Plant Evaporation	
20456			D	Primary Sedimentation	
20476			D	Metals Precipitation Ultraviolet Sterilization Chlorination	

APPENDIX M

Pharmaceutical Industry Wastewater Discharge Methods

APPENDIX M

PHARMACEUTICAL INDUSTRY
WASTEWATER DISCHARGE METHODS

Plant Code No.	Indirect	Direct	Zero	Comment	POTW Treatment Level
12000	X				T
12001		X			
12003	X				P
12004	X				S
12005	X				S
12006		X			
12007	X				S
12011	X				S
12012	X				T
12014		X			
12015		X	X	Recycle/Reuse	
12016	X				S
12018	X			Land Application	S
12019	X				-
12021			X	No Process Wastewater	
12022		X			
12023	X				S
12024	X			Recycle/Reuse	-
12026		X			
12030		X		Private Treatment System	
12031	X				T
12035	X				T
12036		X			
12037	X				S
12038		X		Evaporation	
12040	X				S
12042	X				-
12043	X			Subsurface Discharge	S
12044	X			Subsurface Discharge	S
12048	X				S
12051	X				S
12052			X	Subsurface Discharge	
12053		X			
12054	X				-
12055	X				-
12056	X				S
12057	X	X			P
12058	X				S
12060	X				S

12061	X				S
12062	X				S
12063			X	Subsurface Discharge	
12065	X			Septic System	S
12066	X				T
12068	X				
12069	X				S
12073		X		Private Treatment System	
12074	X				T
12076	X				P
12077	X				P
12078	X				P
12080	X				S
12083	X				P
12084	X				T
12085		X			
12087	X			Contract Disposal	S
12088	X				P
12089		X			
12093	X				S
12094	X				T
12095		X			
12097		X		Deep Well Injection	
12098		X			
12099			X	Contract Disposal	
12100	X				-
12102			X	Ocean Discharge	
12104	X	X			P
12107	X				P
12108	X			Ocean Discharge	-
12110	X				P
12111	X				-
12112	X				T
12113	X				S
12115	X				S
12117		X		Private Treatment System	
12118	X			Subsurface Discharge	S
12119		X			
12120	X				S
12122	X				
12123	X				S
12125	X				-
12128	X				-
12129	X				-
12131	X				T
12132		X		Land Application	
12133			X	No Process Wastewater	
12135	X				S
12141	X				S
12143	X				S

12144	X				-
12145	X				T
12147	X				S
12155	X				S
12157	X				-
12159			X	Recycle/Reuse	
12160		X		Private Treatment System	
12161		X			
12166	X				-
12168	X			Evaporation	S
12171	X				S
12172	X				
12173			X	No Process Wastewater	
12174			X	Evaporation	
12175		X		Private Treatment System	
12177	X				-
12178	X				S
12183	X				S
12185			X	Ocean Discharge	
12186	X				S
12187	X	X		(Also Contract Disposal)	S
12191	X				S
12194		X		Private Treatment System	
12195	X				S
12198	X				S
12199	X				S
12201	X				S
12204	X				S
12205		X			
12206	X				S
12207	X				P
12210	X			Land Application	S
12211	X				-
12212	X				P
12217	X			Contract Disposal	S
12219	X				P
12224	X				S
12225			X	No Process Wastewater	
12226	X				-
12227	X				S
12230	X				-
12231			X	Subsurface Discharge	
12233	X				P
12235		X		Ocean Discharge	
12236		X			
12238	X				S
12239		X			
12240	X			Contract Disposal	S
12243	X				P
12244	X				T

12245	X			Evaporation	S
12246	X			Contract Disposal	P
12247	X				S
12248		X		Private Treatment System	
12249	X				S
12250	X				S
12251	X				S
12252	X				S
12254	X				S
12256	X	X		(Also Land Application)	S
12257	X			Land Application	T
12260	X				T
12261		X			
12263			X	Septic System	
12264	X	X			S
12265	X				S
12267		X			
12268	X				P
12269			X	Septic System	
12273	X				
12275	X				S
12277	X				
12281	X	X			P
12282	X				T
12283		X			
12287	X	X			S
12289	X				S
12290	X				-
12294		X			
12295	X				P
12296	X				S
12297			X	Contract Disposal	
12298		X			
12300	X				T
12302	X				S
12305	X				S
12306			X	Septic System	
12307		X			
12308		X			
12309	X				-
12310	X				P
12311	X				S
12312	X				S
12317		X			
12318	X				S
12322	X				P
12326			X	Septic System	
12330	X				P
12331	X				S
12332	X				S

12333	X				P
12338		X			
12339		X		Land Application	
12340	X				P
12342	X				S
12343	X				P
12345	X			Land Application	S
12375	X				S
12384	X				S
12385	X				T
12392	X				
12401	X				S
12405	X				-
12406		X			
12407		X			
12409	X				-
12411	X			Contract Disposal	S
12414	X				S
12415	X				T
12417	X				-
12419	X				T
12420	X				T
12427	X				S
12429	X				S
12433	X				S
12438	X				S
12439			X	Land Application	
12440	X				-
12441	X				S
12444	X				S
12447	X			Deep Well Injection	-
12454	X				S
12458	X				S
12459		X			
12460	X				-
12462		X			
12463		X		Land Application	
12464	X				-
12465	X				S
12466			X	Septic System	
12467	X				S
12468	X				S
12470	X				-
12471		X			
12472	X				P
12473	X				P
12474	X				S
12475			X	Land Application	
12476			X	Land Application	
12477	X				P

12479	X			Ocean Discharge	S
12481	X				P
12482	X				-
12495	X				S
12499	X				-
20006			X	No Process Wastewater	
20008	X				
20012	X				
20014			X	Evaporation	
20015			X	No Process Wastewater	
20016			X	No Process Wastewater	
20017	X				
20020	X				
20026	X				
20030			X	Evaporation	
20032	X				
20033	X				
20034	X				
20035			X	No Process Wastewater	
20037		X			
20038			X	No Process Wastewater	
20040			X	No Process Wastewater	
20041			X	No Process Wastewater	
20045			X	No Process Wastewater	
20048			X	No Process Wastewater	
20049			X	No Process Wastewater	
20050	X				
20051			X	No Process Wastewater	
20052	X			Septic System	
20054			X	Contract Disposal	
20055			X	No Process Wastewater	
20057	X				
20058	X				
20062	X				
20064	X				
20070			X	No Process Wastewater	
20073			X	No Process Wastewater	
20075			X	No Process Wastewater	
20078			X	No Process Wastewater	
20080			X	No Process Wastewater	
20081	X				
20082			X	No Process Wastewater	
20084			X	No Process Wastewater	
20087			X	No Process Wastewater	
20089	X				
20090			X	No Process Wastewater	
20093			X	No Process Wastewater	
20094			X	No Process Wastewater	
20099			X	No Process Wastewater	
20100			X	No Process Wastewater	

20103			X	No Process Wastewater
20106			X	No Process Wastewater
20108			X	Evaporation
20115			X	Septic System
20117	X			
20120	X			
20125			X	No Process Wastewater
20126	X			
20134			X	No Process Wastewater
20139	X			
20141			X	No Process Wastewater
20142	X			Contract Disposal
20147	X			
20148			X	No Process Wastewater
20151			X	No Process Wastewater
20153	X			
20155	X			
20159			X	No Process Wastewater
20165		X		Contract Disposal
20169	X			
20173			X	No Process Wastewater
20174	X			
20176			X	No Process Wastewater
20177	X			
20178			X	No Process Wastewater
20187	X			
20188	X			
20195			X	Evaporation
20197			X	No Process Wastewater
20201		X		
20203	X			Land Application
20204			X	Land Application
20205	X			
20206			X	Land Application
20208			X	No Process Wastewater
20209			X	No Process Wastewater
20210			X	No Process Wastewater
20215			X	No Process Wastewater
20216	X			
20218			X	No Process Wastewater
20220	X			
20224	X			
20225			X	No Process Wastewater
20226			X	No Process Wastewater
20228			X	No Process Wastewater
20229	X			
20231	X			
20234	X			
20235			X	No Process Wastewater
20236			X	Contract Disposal

20237	X			
20240	X			
20241			X	No Process Wastewater
20242			X	No Process Wastewater
20244	X			
20245		X		
20246		X		
20247	X			
20249			X	No Process Wastewater
20254	X			
20256			X	No Process Wastewater
20257		X		Contract Disposal
20258	X			
20261	X			
20263	X			
20264	X			
20266			X	No Process Wastewater
20267	X			
20269	X			
20270	X			
20271			X	No Process Wastewater
20273	X			
20282	X			
20288	X			
20294			X	No Process Wastewater
20295			X	No Process Wastewater
20297		X		
20298		X		
20300			X	No Process Wastewater
20303	X			
20305			X	No Process Wastewater
20307	X			
20308			X	No Process Wastewater
20310	X			Contract Disposal
20311	X			
20312	X			
20316			X	No Process Wastewater
20319		X		
20321	X			
20325			X	No Process Wastewater
20328	X			
20331	X			
20332			X	No Process Wastewater
20333	X			
20338			X	No Process Wastewater
20339	X			
20340			X	Evaporation
20342	X			
20346	X			
20347			X	No Process Wastewater

20349	X			
20350	X			
20353	X			
20355	X			
20356	X			
20359	X			
20361	X			
20362	X			
20363	X			
20364	X			
20366	X			
20370		X		Contract Disposal
20371	X			
20373			X	Land Application
20376			X	Evaporation
20377	X			
20385	X			
20387			X	Contract Disposal
20389	X			
20390			X	No Process Wastewater
20394			X	No Process Wastewater
20396			X	No Process Wastewater
20397			X	No Process Wastewater
20400	X			
20402		X		
20405	X			
20413			X	Contract Disposal
20416			X	No Process Wastewater
20421			X	No Process Wastewater
20423	X			Evaporation
20424			X	No Process Wastewater
20425			X	No Process Wastewater
20435			X	No Process Wastewater
20436			X	No Process Wastewater
20439	X			
20440			X	No Process Wastewater
20441	X			
20443	X			
20444			X	No Process Wastewater
20446	X			
20448			X	No Process Wastewater
20450	X			
20452			X	No Process Wastewater
20453	X			
20456	X			
20460	X			
20462			X	No Process Wastewater
20464			X	No Process Wastewater
20465	X			
20466	X			

20467		X	Subsurface Discharge
20470		X	No Process Wastewater
20473	X		Deep Well Injection
20476	X		
20483		X	No Process Wastewater
20485		X	No Process Wastewater
20486		X	No Process Wastewater
20490	X		
20492	X		
20494	X		
20496		X	No Process Wastewater
20498		X	No Process Wastewater
20500		X	No Process Wastewater
20502		X	No Process Wastewater
20503	X		
20504		X	No Process Wastewater
20507		X	No Process Wastewater
20509		X	No Process Wastewater
20511		X	No Process Wastewater
20518		X	No Process Wastewater
20519	X		
20522		X	No Process Wastewater
20526		X	Contract Disposal
20527	X		
20529		X	No Process Wastewater

[1]POTW Treatment Level Symbols:
P - Primary
S - Secondary
T - Tertiary

[2]Data on POTW treatment level was not requested from the Supplemental 308 (20000 series) plants

APPENDIX N

Cost of Treatment and Control Systems

APPENDIX N

COSTS OF TREATMENT AND CONTROL SYSTEMS

N-1 APPROACH (Also see Section VIII):

1. Define industry as represented by cost data.
2. Define subcategories.
3. Determine representative flow for each subcategory based on single subcategory plants from 308 data base.
4. Determine representative raw waste loads for each subcategory from screening/verification data base.
5. Estimate the respective treatment system investment costs (catalytic treatment cost model) and adjust to 1978 dollar basis which is the baseline year for all costs.
6. Estimate annual treatment costs for the various systems including operating, maintenance and annualized investment costs (catalytic treatment cost model).
7. Estimate costs for contract hauling and other low volume wastewater treatment systems.
8. Using costs estimated above for base case "model" conditions develop variations of cost with flow, RWL and effluent target as parameters for the various wastewater systems.
9. Plot these variations in the form of cost sensitivity curves.

N-2 CAPITAL COST INDICES

1. ENGINEERING NEWS RECORD (ENR) CONSTRUCTION COST INDICES
2. CHEMICAL ENGINEERING (CE) PLANT INDICES

APPENDIX N

ENGINEERING NEWS - RECORD (ENR) CONSTRUCTION COST INDICES *

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Index
1964	918	920	922	926	930	935	945	948	947	948	948	948	936
1965	948	957	958	957	958	969	977	984	986	986	986	988	971
1966	988	997	998	1006	1014	1029	1031	1033	1034	1032	1033	1034	1019
1967	1039	1041	1043	1044	1059	1068	1078	1089	1092	1096	1097	1098	1070
1968	1107	1114	1117	1124	1142	1154	1158	1171	1186	1190	1191	1201	1155
1969	1216	1229	1238	1249	1258	1270	1283	1292	1285	1299	1305	1305	1269
1970	1309	1311	1314	1329	1351	1375	1414	1418	1421	1434	1445	1445	1385
1971	1465	1467	1496	1513	1551	1589	1618	1629	1654	1657	1665	1672	1581
1972	1686	1691	1697	1707	1735	1761	1772	1777	1786	1794	1808	1816	1753
1973	1838	1850	1859	1874	1880	1896	1901	1902	1929	1933	1935	1939	1895
1974	1940	1940	1940	1961	1961	1993	2040	2076	2089	2100	2094	2101	2020
1975	2103	2128	2128	2135	2164	2205	2248	2274	2275	2293	2292	2297	2212
1976	2305	2314	2322	2327	2357	2410	2414	2445	2465	2478	2486	2490	2401
1977	2494	2505	2513	2514	2515	2541	2579	2611	2644	2675	2659	2660	2557
1978	2672	2681	2693	2698	2733	2753	2821	2829	2851	2851	2861	2869	2776
1979	2872	2877	2886	2886	2889	2984	3052	3071	3120	3122	3131	3140	3003
1980	3237												

* Construction Cost Index - Base Year 1913 = 100

APPENDIX N

CHEMICAL ENGINEERING (CE) PLANT COST INDICES*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Index
1972	136.5	136.0	137.0	137.1	137.1	136.5	136.5	137.0	137.8	138.2	138.4	139.1	137.2
1973	140.8	140.4	141.5	141.8	142.4	144.5	144.6	145.0	146.4	146.7	147.5	148.2	144.1
1974	150.0	150.7	153.8	156.7	161.4	164.7	168.8	172.2	174.8	176.0	177.4	177.8	165.4
1975	179.6	179.5	180.7	180.7	181.0	181.8	181.8	181.9	183.7	185.4	185.7	186.6	182.4
1976	187.1	187.5	188.4	188.9	190.2	191.1	192.0	193.9	195.6	196.3	196.4	197.4	192.1
1977	198.7	198.5	199.3	200.3	201.4	202.3	204.7	206.4	208.8	209.0	209.4	210.3	204.1
1978	210.6	213.1	214.1	215.7	216.9	217.7	219.2	221.6	221.6	223.5	224.7	225.9	218.8
1979	225.9	231.0	232.5	234.0	236.6	237.2	239.3	240.7	243.4	245.8	246.8	247.6	238.7
1980	249.9	255.1											

* CE Plant Cost Index - Base Year 1957-59 = 100

APPENDIX O

Screening/Verification Plant Descriptions and Sample Points

Screening Samples

Location	Lab No.	Sample Type
Discharge from Treatment Plant Sta #2		
Extractable (NVOA)	1935	Composite
Composite Sampler Blank Flush	1925	Grab
Metals Scan*, Phenols, Cyanides, purgeables (VOA)	1935, 1935A, 1935B	3 Grabs
TSS, COD, BOD_5	1935	Composite
Influent to Neutralization Bldg. Sta #1		
Extractables (NVOA)	1934	Composite
Composite Sampler Blank Flush	1924	
Metals Scan*, Phenols, Cyanides, purgeables (VOA)	1934, 1934A, 1934B	3 Grabs
TSS, COD, BOD_5	1934	Composite
Lab and Sanitary Waste Manhole Building #46, Sta #5		
Extractables (NVOA)	1933	Composite
Composite Sampler Blank Flush	1922	Grab
Metals Scan*, Phenols, Cyanides, purgeables (NOA)	1933, 1933A, 1933B	3 Grabs
TSS, BOD_5, COD	1933	
Concentrated Waste Bldg. Sta. #4		
Extractables (NVOA)	1932	Grab**
Metals Scan, Phenols, Cyanides, Purgeables (VOA)	1932B	Grab**
TSS, COD, BOD_5	1932	Grab**
Animal and Sanitary Waste near Bldg #74, Standpipe Sta #3		
Extractables (NVOA)	1931	Composite
Composite Sampler Blank Flush	1926	Grab
Metals Scan*, Phenols, Cyanides purgeables (VOA)	1931, 1931A, 1931B	3 Grabs
TSS, COD, BOD_5	1931	Composite
Super "O" Blank		

Extractables (NVOA)	1930	Grab
Purgeables (VOA)	1930	Grab
Well #1 - Bldg 44		
Extractables	1927	Grab***
Purgeables	1927	Grab
Well #2 - Bldg 34		
Extractables	1928	Grab***
Purgeables	1928	Grab
Well #3 - Bldg 49		
Extractables	1929	Grab***
Purgeables	1929	Grab

* Composited in Edison Lab
** Two Grab Samples Composited - All Samples Taken from Composite
*** Flow from three wells totals about 0.8 MGD

Plant 12026

Verification Samples

Sample Location	Sample Type	Pollutants Analyzed
Intake Water (Well #34)	Grab	Extractables, VOA Cyanides
	Blank	Extractables, VOA
Intake Water (Well #44)	Grab	Extractables, VOA, Cyanides
	Blank	Extractables, VOA
Intake Water (Well #49)	Grab	Extractables, VOA Cyanides
	Blank	Extractables, VOA
Return Sludge (Secondary Clarifier)	Grab	Extractables, VOA Cyanides
	Grab	Extractables, VOA Cyanides
	Grab	Extractables, VOA Cyanides
Treated Effluent (Day 1)	Blank	Extractables
	Blank	VOA, Extractables COD, BOD
	Composite	TSS
	Grab	VOA, Cyanides
Treated Effluent (Day 2)	Composite	BOD, TSS
	Grab	VOA, Cyanides
	Blank	VOA
Treated Effluent (Day 3)	Composite	BOD, TSS
	Grab	VOA, Cyanides
	Blank	VOA

4. Plant 12036

Plant 12036 is a Subcategory A plant which discharges 1.13 MGD of wastewater from pesticide manufacturing processes. This plant also manufactures synthetic organic chemicals.

The treatment system for this plant consists of activated sludge, trickling filters, secondary clarification, aerated lagoons (other than activated sludge), a stabilization lagoon, and chlorination. The sampling points and parameters sampled for follow:

001 Discharge

Date	Time	Temp °C	Parameters
8/31/77	0905	--	Organics (sampler blank)
8/31 - 9/1/77	0910 to 1010	--	Priority pollutants, pH, BOD5, COD, NFS, nutrients
9/1/77	1010	25	Volatile organics, phenolics, cyanide

Pond 4 Effluent Prior to Chlorination

Date	Time	Temp -C	Parameters
8/31/77	0930	--	Organics (sampler blank)
8/31 - 9/1/77	0930 to 0955	--	Priority pollutants, BOD5, pH, COD, nutrients, NFS
9/1/77	0955	24	Volatile organics, phenolic, cyanide
9/1 - 2/77	0955 to 0855	--	Priority pollutants, BOD5, pH, COD, NFS, nutrients
9/2/77	0855	--	Volatile organics, phenolics, cyanide
9/1/77	1120	--	Priority pollutants, BOD5, pH, COD, NFS, nutrients

Agricultural Research Farm Discharge to the Waste Treatment Plant

Date	Time	Parameters
9/1/77	1140	Organics (sampler blank)
9/1 - 2/77	1140 to 0955	Priority Pollutants
9/2/77	0955	Volatile organics, phenolics, cyanide

Process Waste Discharge from Packaging Operations

Date	Time	Parameters
9/1/77	0910	Organics (sampler blank)
9/1 - 2/77	0915 to 0930	Priority Pollutants
9/2/77	0930	Volatile organics, phenolics, cyanide

Combined Wastestreams from Organic Chemical Synthesis, Most of the Fermentation, the Offices and the Laboratories

Date	Time	Temp °C	Parameters
8/31/77	1000	--	Organics (sampler blank)
8/31 - 9/1/77	1015 to 0830	--	Priority pollutants
9/1/77	0830	44	Volatile organics, phenolics, cyanide

5. Plant 12038

Plant 12038 is a multiple-subcategory plant (A, B, C, D) with an annual average flow of 2.61 MGD. A brief description of the wastewater sampling points is as follows:

Screening Samples

Point 1 - Wastewater treatment plant effluent (001 Discharge). Four manual composite samples were taken here and analyzed for priority pollutants, BOD_5, COD, pH, nutrients, non-fillerable solids (NFS), and Al.

Point 2 - Combined effluent from limestone bed and hillside storm sewer. Three samples (one blank) were taken here and were analyzed for priority pollutants.

Point 3 - Building T-17 process waste discharge (pesticide). Three samples (one blank) were taken here and analyzed for priority pollutants.

Point 4 - Chemical synthesis influent T302 to T303. Three samples (1 blank) were taken here and analyzed for priority pollutants.

Point 5 - Influent to T307B clarifier. One sample was taken here and analyzed for priority pollutants.

Point 6 - Effluent line from carbon column train. One sample was taken here and analyzed for metals, BOD5, COD, pH, nutrients, and phenols

Points 7 and 10 - Adjacent points near T312 and T212 clarifier.

Point 8 - Concentrated antibiotic waste-influent to biological treatment. One sample was taken here and analyzed for priority pollutants.

Point 9 - Dilute antibiotic waste influent to T201. Three samples (one blank) were taken here and analyzed for priority pollutants.

Plant 12038 uses a number of wastewater treatment technologies which include equalization, neutralization, activated sludge, aerated lagoon, and in-plant treatments.

Plant 12038

Verification Samples

Sample Location	Sample Type	Pollutants Analyzed
T66 Influent (Pesticides)	Grab	Priority Pollutants, COD
T57 Effluent (Pesticides)	Grab	Priority Pollutants,
T66 Effluent (Pesticides)	Grab	Priority Pollutants, COD
307B Influent (Pesticides)	Grab	Priority Pollutants, BOD, COD, TSS
307B Effluent (Pesticides)	Grab	Priority Pollutants,
Tertiary Plant Effluent (All)	Grab	Priority Pollutants BOD, COD, TSS, NH_3-N
312 Effluent (Synthesis & Pesticides)	Grab	Priority Pollutants BOD, COD, TSS
300 Effluent (Synthesis) (302/306 Influent)	Grab	Priority Pollutants BOD, COD, TSS
212 Effluent (Fermentation)	Grab	Cyanide, BOD, COD, TSS, NH_3-N
Beer Storage Tank (Fermentation)	Grab	Cyanide, BOD, COD, TSS, NH_3-N
100 & 200 Influent (Fermentation)	Grab	Cyanide, BOD, COD TSS, NH_3-N
Thermal Oxidizer Waste (Pesticides)	Grab	Cyanide
Tertiary Plant Influent (All)		Priority Pollutants BOD, COD, TSS, NH_3-N

6. Plant 12044

Plant 12044 is a multiple subcategory (A, D) plant with an annual average flow of 2.97 MGD.

Seven sample points were identified; however, only five were actually sampled.

Screening Samples

Citric acid production effluent after neutralization with lime - Location 1, #81 manhole:

CDO Sample Number	Date	Time (Hours)	Parameters
23-05-CM13R03	8/1/78	1500	Quality control (QC) blank for extractable organics, metals and COD
23-05-CM13SO5	8/2/78	0822 8/2 to 0822 8/3	24-hour composite for extractable organics, metals, COD and BOD
23-05-CM13SO6	8/2/78	0749	Grab for VOA
23-05-CM13SO7	8/2/78	0735	Grab for phenol
23-05-CM13SO8	8/2/78	0735	Grab for cyanide

Effluent at Location 2, #83 manhole:

CDO Sample Number	Date	Time (Hours)	Parameters
23-05-CM13S11	8/2/78	0850 to 1445	Composite Comprising three 3-liter grabs for extractable organics, metals, BOD and COD
23-05-CM13S12	8/2/78	1003	Grab for VOA
23-05-CM13S13	8/2/78	1000	Grab for phenol
23-05-CM13S14	8/2/78	1000	Grab for cyanide

Effluent at Location 4, #37A manhole:

CDO Sample Number	Date	Time (Hours)	Parameter
23-05-CM13S21	8/2/78	0905 to 1455	Composite comprising three 3-liter grabs for extractable organics, metals, BOD and COD
23-05-CM13S22	8/2/78	1035	Grab for VOA
23-05-CM13S23	8/2/78	1033	Grab for phenol
23-05-CM13S24	8/2/78	1033	Grab for cyanide

Effluent at Location 6, #6 manhole:

CDO Sample Number	Date	Time (Hours)	Parameter
23-05-CM13S31	8/2/78	0926 to 1510	Composite comprising three 3-liter grabs for extractable organics, metals, BOD and COD
23-05-CM13S32	8/2/78	1115	Grab for VOA
23-05-CM13S33	8/2/78	1115	Grab for phenol
23-05-CM13S34	8/2/78	1115	Grab for cyanide

Effluent at Location 7, #74 manhole:

CDO Sample Number	Date	Time (Hours)	Parameter
23-05-CM13S36	8/2/78	0920 to 1415	Composite comprising three 3-liter grabs for extractable organics, metals, BOD and COD
23-05-CM13S37	8/2/78	1125	Grab for VOA
23-05-CM13S38	8/2/78	1125	Grab for phenol
23-05-CM13S39	8/2/79	1125	Grab for cyanide

The only method of wastewater treatment employed by plant 12044 is neutralization.

7. Plant 12066

Plant 12066 is predominately a Subcategory B manufacturer with a small percentage of activities under Subcategories C and D. The annual average flow is 0.26 MGD. Wastewater treatment technologies employed are neutralization, activated sludge, and aerated lagoon.

Screening Samples

Influent to Pretreatment Facility

An ISCO Model 1680 automatic sampler #104 was installed to pump equal volume aliquots from the wet well of the raw sample house. Grab samples were also obtained. The following samples were collected:

SAD Sample No.	Date	Time	Parameters
23-05-CMIISO2 (Blank)	6/27/78	1410	Quality Control (QC) Blank for extractable organics, metals and COD
23-05-CMIISO2	6/28/78 6/29/78	0825 0830	24 hr. composite for extractable organics, metals, COD, and BOD
23-05-CMIISO3	6/29/78	1015	Grab for VOA
23-05-CMIISO4	6/28/78	1515	Grab for phenols
23-05-CMIISO	6/28/78	1515	Grab for cyanide

Effluent from Pretreatment Facility

An ISCO Model 1680 automatic sampler #108 was installed to pump equal volume aliquots from the discharge flume of the final clarifier. Grab samples were also obtained. The following samples were collected:

SAD Sample No.	Date	Time	Parameters
23-05-CMIISOI (Blank)	6/27/78	1315	Quality Control (QC) Blank for organics, metals and COD
23-05-CMIISOI	6/28/78 6/29/78	0825 0835	24 hr. composite for organics, metals, COD and BOD
23-05-CMIISO6	6/29/78	0930	Grab for VOA
23-05-CMIISO7	6/28/78	1430	Grab for phenols
23-05-CMIISO8	6/28/78	1435	Grab for cyanide

8. PLant 12097

Plant 12097 is a multiple-subcategory plant (C, D) with an annual average flow of 0.10 MGD. The wastewater treatment technologies employed include equalization, neutralization, and activated sludge with powdered activated carbon.

Screening Samples

Well Water - Sample #2305EG16S13

A single grab sample was obtained directly from a tap in building #41.

River Intake - Sample #2305EG16S09-10

Composite samples were obtained by ISCO sampler through a grating covering the intake structure. Grab samples were obtained from the surface water below the grating. The intake was located in a small creek estuary of the Black River.

Cooling Water Discharge - Sample #2305EG16S11-12

Composite samples were obtained by ISCO sampler below the weir at the discharge point to Black River. Grab samples were obtained from the surface water of the cooling water discharge.

Treated Floor Drain - Sample #2305EG16SO7-78

Composite samples were obtained by ISCO sampler from a small sump receiving water from 90° V-notch weir. Grab samples were collected from the flow over the V-notch weir.

Raw Waste Floor Drain - Sample #2305EG16SO5-06

Composite samples were obtained by ISCO sampler from a small equilization tank prior to activated sludge aeration. Grab samples were obtained from the surface water of the equilization tank.

Treated Deep Well - Sample #2305EG16SO3-04

Composite samples were obtained by ISCO sampler from a metal bucket receiving water from a pipe inside the pump house, building #31. Grab samples were collected directly from the pipe flow.

Raw Waste Deep Well - Sample #2305EG16S01-02

Composite samples were obtained by ISCO sampler from a 2 1/2-gallon glass jar which receives water from a small pipe. Grab samples were obtained directly from the pipe.

Sample Types and Frequency

All sample sites, except the well-water sites, included a 24-hour composite sample and one grab sample. All composite samples were obtained by ISCO samplers programmed to collect aliquots every 30 minutes. Two samplers were used at each site to obtain sufficient sample volume to provide a split with the company. Composite sample types included general chemistry, nutrients, metals, and liquid extraction organics. One additional grab sample was collected at each composite site for phenols, cyanide, and volatile organic analyses. The sample types obtained from the well-water site were all grab samples for the same analyses as those collected at the composite sites.

Field parameters, pH and temperature, were determined for each grab sample, while pH was determined on each composite sample at the end of the survey. Flow data was obtained for the two treated waste streams and the cooling water discharge.

Plant 12097

Verification Samples

Sample Location	Sample Type	Pollutants Analyzed
Tap Water SP6	Grab	Phenol
Tap Water SP6	Grab	Cyanide
Tap Water SP6	Grab	BOD5 - TSS
Tap Water SP6	Grab	COD - TOC
River Water SP7	Grab	Phenol
River Water SP7	Grab	Cyanide
River Water SP7	Grab	BOD5 - TSS
River Water SP7	Grab	COD - TOC
Infl Floor SP1	Grab	Phenol
Infl Floor SP1	Grab	Cyanide
Infl Floor SP1	Grab	Phenol
Infl Floor SP1	Grab	Cyanide
Infl Floor SP1	Comp	BOD5 - TSS
Infl Floor SP1	Comp	COD - TOC
Effl Floor SP2	Grab	Phenol
Effl Floor SP2	Grab	Cyanide
Effl Floor SP2	Grab	Phenol
Effl Floor SP2	Grab	Cyanide
Effl Floor SP2	Comp	BOD5 - TSS
Effl Floor SP2	Comp	COD - TOC
Infl DP Well SP3	Grab	Phenol
Infl Dp Well SP3	Grab	Cyanide
Infl Dp Well SP3	Grab	BOD5 - TSS
Infl Dp Well SP3	Grab	COD - TOC
Effl Dp Well SP4	Grab	Phenol
Effl Dp Well SP4	Grab	Cyanide
Effl Dp Well SP4	Grab	Phenol
Effl Dp Well SP4	Grab	Cyanide
Effl Dp Well SP4	Comp	BOD5 - TSS
Effl Dp Well SP4	Comp	COD - TOC
Tap Water SP6	Grab	VOA
Tap Water SP6	Grab	VOA (Dup)
Tap Water SP6	Grab	VOA (Sup 2)
Tap Water SP6	Grab	Extractable
Tap Water SP6	Grab	Extrac (Dup)
River Water SP7	Grab	VOA
River Water SP7	Grab	VOA (Dup)
River Water SP7	Grab	VOA (Dup2)

Plant 12097

Verification Samples (Cont'd.)

Sample Location	Sample Type	Pollutants Analyzed
River Water SP7	Grab	Extractable
River Water SP7	Grab	Extrac (Dup)
Infl Floor SP1	Grab	VOA
Infl Floor SP1	Grab	VOA (Dup)
Infl Floor SP1	Grab	VOA (Dup2)
Infl Floor SP1	Grab	VOA
Infl Floor SP1	Grab	VOA (Dup)
Infl Floor SP1	Grab	VOA (Dup2)
InflFloor SP1	SB	Sampler Blnk
Infl Floor SP1	Comp	Extractable
Infl Floor SP1	Comp	Extrac (Dup)
Infl Floor SP1	TB	VOA
Infl Floor SP1	TB	VOA (Dup)
Effl Floor SP2	Grab	VOA (Pres)
Effl Floor SP2	Grab	VOA-DUP-PRES
Effl Floor SP2	Grab	VOA-DP2-PRES
EFfl floor SP2	Grab	VOA (Pres)
Effl Floor SP2	Grab	VOA-DUP-PRES
Effl Floor SP2	Grab	VOA-DP2-PRES
Effl Floor SP2	SB	Sampler Blnk
Effl Floor SP2	Comp	Extractable
Effl Floor SP2	Comp	Extrac (Dup)
Infl DP Well SP3	Grab	VOA
Infl Dp Well SP3	Grab	VOA (Dup)
Infl DP Well SP3	Grab	VOA (Dup2)
Infl Dp Well SP3	Grab	Extractable
Infl Dp Well SP3	Grab	Extrac (Dup)
Effl Dp Well SP4	Grab	VOA
Effl Dp Well SP4	Grab	VOA (Dup)
Effl Dp Well SP4	Grab	VOA (Dup2)
Effl Dp Well SP4	Grab	VOA
Effl Dp Well SP4	Grab	VOA (Dup)
Effl Dp Well SP4	Grab	VOA (Dup2)
Effl Dp Well SP4	SB	Sampler Blnk
Effl Dp Well SP4	Comp	Extractable
Effl Dp Well SP4	Comp	Extrac (Dup)
Tap Water SP6	Grab	Metals
River Water SP7	Grab	Metals
Infl Floor SP1	Comp	Metals
Effl Floor SP2	Comp	Metals
Infl Dp Well SP3	Grab	Metals
Effl Dp Well SP4	Comp	Metals

SB - Sampler Blank
TB - Trip Blank

9. Plant 12108

Plant 12108 is a multiple-subcategory (A, C, D) plant with an annual average flow of 0.14 MGD. The facility utilizes ocean disposal of their wastewater; they provide no treatment.

Screening Samples

Point 1 - sample set taken from tank truck loading from holding tanks.

Samples:

(1) One gallon for extractable organics

(2) Four 1/2-gallon samples for BOD's, metals, cyanides, COD, and TOC

(3) Two 1-pint samples for phenol and mercury

(4) Two 4-ounce vials for volatile organics

10. Plant 12119

Plant 12119 has fermentation (A) and formulation (B) subcategory operations. Wastewaters are collected in an equalization tank and then treated in an activated sludge system.

Screening Samples

Intake Water (EL-OOR) - A grab sample was collected from a tap on the city water distribution line.

SAD Sample No.	Date	Time	Parameter
23-04-78C-1783	7/27/78	0940	BOD, COD, TOC, TKN, NH_3-N, NO_2-NO_3, Total P, solid series, chlorides, pH, temperature, non-volatile organics, Hg, metals, CN, phenol, volatile organics

Fermentation Wastewater (EL-OOF)--A grab sample was collected at a tap on the waste broth tanks (C-135).

SAD Sample No.	Date	Time	Parameter
23-04-78C-1784	7/27/78	0925	BOD, COD, TOC, TKN, NH_3-N, Total P, solids series, pH, Hg, temperature, metals, non-volatile organics, phenol, CN, volatile organics

Ammonia Stripped Wastewater (EL-OON)--A grab sample was collected at a tap on the Ammonia Stripping line.

SAD Sample No.	Date	Time	Parameter
23-04-78C-1785	7/27/78	0910	BOD, COD, TOC, TKN, NH_3-N, NO_3-NO_2, Total P, solids series, metals, pH, Hg, CN, temperature, non-volatile organics, VOA, phenol

Influent to Treatment (EL-OOI)--A composite sample was collected at the flow equilization box upstream of any treatment, using an ISCO 1680 automatic sampler. The following samples were collected.

SAD Sample No.	Date	Time	Parameter
23-04-78C-1565	7/6/78	1505	QC Blank precollected at the SAD Lab, Athens, GA non-volatile organics, metals, mercury
23-04-78C-1786	7/26/78 7/27/78	1000/ 0830	BOD, COD, TOC, Total P, solids series, TKN, NH_3-N, NO_3-NO_2, nonvolatile organics, mercury, metals
23-04-78C-1786	7/27/78	0835	cyanide, phenol, pH, temperature, volatile organics

11. Plant 12132

Plant 12132 is a combination A and C plant with an annual average flow of 1.0 MGD. The wastewater treatment consists of equalization, neutralization, activated sludge and trickling filter.

Samples Collected

(1) Sedimentation Basin Effluent (Influent to Biotreatment) - Grab and composite samples taken and analyzed for priority pollutants.

(2) Final Clarifier Effluents - Grab and composite samples taken and analyzed for priority pollutants.

No analyses were run for traditional pollutants; however, the plant did supply these data. Two additional sample points were identified (final clarifier sludge and DAF skimmings), but were not sampled in the screening program.

12. Plant 12161

Plant 12161 is a multiple-subcategory (A, C, D) plant with an annual average flow of 1.0 MGD. The wastewater treatment employed includes equalization, neutralization, activated sludge and polishing ponds.

Screening Samples

	Lab No.	Sample Type	Flow (MGD)
Raw Waste-Vitamin C Plant			
Nonvolatile Organics, Metals	50689	Composite	1.45*
Phenols, Cyanides, Purgeables	50677	Grab	0.726*
Phenols, Cyanides, Purgeables	50682	Grab	0.726*
Composite Sampler Blank Rinse	50671	Grab	Blank
Raw Waste-Sulfa Plant			
Nonvolatile Organics, Metals	50690	Composite	0.018*
Phenols, Cyanides, Purgeables	50678	Grab	0.009*
Phenols, Cyanides, Purgeables	50683	Grab	0.009*
Composite Sampler Blank Rinse	50672	Grab	Blank
Raw Waste-Fermentation Plant			
Nonvolatile Organics, Metals	50691	Composite	0.062
Phenols, Cyanides, Purgeables	50679	Grab	0.028
Phenols, Cyanides, Purgeables	50684	Grab	0.035
Composite Sampler Blank Rinse	50673	Grab	Blank
Raw Waste (Combined) to WWTP			
Nonvolatile Organics, Metals	50688	Composite	3.74
Phenols, Cyanides, Purgeables	50676	Grab	1.73
Phenols, Cyanides, Purgeables	50681	Grab	2.01
BOD5, TSS, COD	50687	Composite	1.73
Composite Sampler Blank Rinse	50670	Grab	Blank
Discharge 001 - Treated from WWTP			
Nonvolatile Organics, Metals	50692	Composite	3.54
Phenols, Cyanides, Purgeables	50680	Grab	1.78
Phenols, Cyanides, Purgeables	50685	Grab	1.76
BOD5, TSS, COD	50693	Grab	1.76
composite Sampler Blank Rinse	50674	Grab	Blank

* Estimates

13. Plant 12204

Plant 12204 is a multiple-subcategory (A, B, C, D) plant with an annual average flow of 0.20 MGD. This plant employs primary treatment and pure-oxygen activated sludge for wastewater treatment.

Screening Samples

Sample Location	Sample Type	Pollutants Analyzed
Municipal Water	Grab	Non-volatile Organics, Metals
	Grab	Cyanides, Phenols
	Grab	Purgeable Organics
	Grab	Purgeable Blank
Well WAter	Grab	Non-Volatile Organics, Metals
	Grab	Cyanides, Phenols
	Grab	Purgeable Organics
	Grab	Purgeable Blank
Combined Treated Process Wastewaters	Composite	Non-Volatile Organics, Metals
	Grab	Composite Sampler Blank Rinse
	Grab	Cyanides, Phenols
	Grab	Purgeable Organics
	Grab	Purgeable Blank
Combined Raw Process Wastewaters	Composite	Non-volatile Organics, Metals
	Grab	Composite Sampler Blank Rinse
	Grab	Cyanides, Phenols
	Grab	Purgeable Organics
	Grab	Purgeable Blank
Fermentation Processing Area Discharge	Composite	Non-volatile Organics, Metals
	Grab	Composite Sampler Blank Rinse
	Grab	Cyanides, Phenols
	Grab	Purgeable Organics
	Grab	Purgeable Blank

No analyses were made for traditional pollutants; however, the plant provided data for these pollutants.

14. Plant 12210

Plant 12210 is a multiple-subcategory (B, C) plant with an annual average flow of 0.01 MGD. The only method of wastewater treatment utilized by Plant 12210 is an aerated lagoon.

Screening Samples

Volatile Organics Blank (CL-OOB) -- Samples of Mill6Q water from the Region IV laboratory were returned for analyses.

Sample Number*	Date	Time	Parameter
23-04-78C-1022	4/25/78	1015	Volatile Organics

Process Wastewater at Waste Storage Tanks (CL-OOP) --An ISCO Model 1580 automatic sampler was used to pump wastewater from each of the three wastewater storage tanks into a single composite jug. The following samples were collected.

Sample Number	Date	Time	Parameter
23-04-78C-1020	4/25/78	1025	Quality control blanks for non-volatile organics, metals, mercury
23-04-78C-1021	4/25/78	1030	Non-volatile organics, metals, mercury, TSS, volatile organics, cyanide, phenols

Influent to Pretreatment System for Sanitary Wastewater (CL-OOI) -- A single grab sample was collected at the influent to the aeration system.

Sample Number	Date	Time	Parameter
23-04-78C1024	4/25/78	1055	Non-volatile organics, metals, mercury, volatile organics, cyanides, phenols, Bod5, TSS

Effluent from Pretreatment System for Sanitary Wastewater (CL-00E) -- A single grab sample was collected at the effluent from the aeration system.

Sample Number	Date	Time	Parameter
23-04-78C-1023	4/25/78	1100	Non-volatile organics, metals, mercury, volatile organics, cyanide, phenols, BOD5, TSS

15. Plant 12231

Plant 12231 is a multiple-subcategory (A, D) plant with an annual average flow of 0.50 MGD. Primary (equalization and neutralization) and secondary (aerated lagoon) wastewater treatment are utilzied at this plant.

Screening Samples

Raw Process Water (AL600R)--A grab sample was collected from a tap on the well water pumps.

SAD Sample No.	Date	Time	Parameter
23-04-78C-1781	7/24/78	1400	BOD, COD, TOC, TKN, NH_3-N, NO_3-NO_2, total P, solids, chlorides, non-volatile organics, mercury, metals, volatile organics, cyanide, phenol, pH, temperature

Influent - Raw Waste to Treatment (AL-001I) - A series of grab samples were collected and composited at hourly intervals at the influent discharge pipe to the aeration pond. The following samples were collected.

SAD Sample No.	Date	Time	Parameter
23-04-78C-1775	7/24/78 7/25/78	1000/ 1500	BOD, COD, TOC, TKN, NH_3-N, NO_3-NO_2, total P, solids, chlorides, non-volatile organics, metals, mercury
23-04-78C-1776	7/24/78	1340	cyanide, phenol, volatile organics, pH, temperature

Intermediate WWTP Point (AL-00INT)--A series of grab samples were collected and composited at hourly intervals at a point between the settling basin and the lagoons. The following samples were collected.

SAD Sample No.	Date	Time	Parameter
23-04-78C-1777	7/24/78 7/24/78	1000/ 1500	BOD5, TOC, COD, TK NO_3-NO_2, total P, chlorides, non-v organics, mercur
23-04-78C-1778	7/24/78	1325	volatile organi cyanide, pH, t

Final Eflfuent (AL-001)--A series of grab samples were collected and composited at hourly intervals at the discharge pipe from the final lagoon. The following samples were collected.

SAD Sample No.	Date	Time	Parameter
23-04-78C-1779	7/24/78	1000/ 1500	BOD, COD, TOC, TKN, NH_3-N, NO_3-NO_2, total P, chlorides, non-volatile organics, metals, mercury
23-04-78C-1780	7/24/78	1310	volatile organics, phenols, cyanide, pH, temperature

16. Plant 12236

Plant 12236 is a single-subcategory (C) plant with an annual average flow of 0190 MGD. Wastewater treatment utilized includes neutrilization and activated sludge.

Screening Samples

atile Organics Blank (MA-00B)--Samples of Milli-Q water from Region IV laboratory were returned for analysis.

mple No.	Date	Time	Parameter
C-1141	5/9/78	0900	Volatile organics

o Wastewater Treatment System (MA-001)--An ISCO Model matic sampler was installed at the effluent from the n basin. The intake line was placed in the basin effluent stream. The following samples were

Date	Time	Parameter
5/9/78	0905	Quality control blank for non-volatile organics, metals, mercury
5/9/78	0930	pH
/10/78	0900	Non-volatile organics, metals, mercury, BOD5, TSS, TKN, COD
0/78	0900	Cyanide, phenols, volatile organics, pH

Effluent from Wastewater Treatment System (MA-OOE)--An ISCO Model 1680 automatic sampler was installed at the effluent from the final clarifiers. The intake line was placed in the wastewater stream. The following samples were collected.

SAD Sample No.	Date	Time	Parameter
23-04-78C-1142	5/9/78	0945	Quality control blank for non-volatile organics, metals, mercury
--	5/9/78	1000	pH
23-04-78C-1143	5/9/78 5/10/78	1000 0930	Non-volatile organics, metals, mercury, BOD5, TSS, TKN, COD
23-04-78C-1144	5/10/78	0930	Cyanide, phenols, volatile organic, pH

Non-contact Cooling Water Discharge (MA-OOC)--An ISCO Model 1580 automatic sampler was installed adjacent to the non-contact cooling water discharge ditch. The intake line was placed in the cooling water stream. The following samples were collected.

SAD Sample No.	Date	Time	Parameter
23-04-78C-1148	5/9/78	1030	Quality control blank for non-volatile organics, metals, mercury
23-04-78C-1149	5/9/78 5/10/78	1045/ 1030	non-volatile organics, metals, mercury
23-04-78C-1150	5/10/78	1015	Volatile organics, phenols, cyanide

Verification Samples

Volatile Organics Trip Blank - Preserved and unpreserved volatile organic trip blanks (one each) were prepared in Athens EPA Region IV laboratory prior to the sampling trip. The blanks were left exposed to ambient conditions and shipped with the organic samples to the contract laboratory.

SAD Sample No.	Date	Time	Parameter
Samples shipped to contract lab	6/21/79	1435	Volatile Organics

Raw Water Supply (MH-OOR) - Raw water was collected from the facility's well No. 6 at the discharge side of the well pump.

SAD Sample No.	Date	Time	Parameter
Samples shipped to contract lab	6/26/79	1100	volatile organics

Influent to the Waste Treatment System (MH-00I) - An ISCO Model 1680 automatic sampler was installed at the equalization basin discharge. The intake line was placed in the wastewater stream at the overflow ditch. The following samples were collected.

SAD Sample No.	Date	Time	Parameter
23-04-79C-1571	6/25/79	1540	Quality control blank for metals sample mercury
23-04-79C-1572	6/26/79 6/27/79	0830/ 0830	Metals, mercury
Samples shipped to contract lab	6/26/79	0930	pH, temp, volatile organics
Samples shipped to contract lab	6/26/79	1330	pH, temp, volatile organics
23-04-79C-1573	6/27/79	0825	pH, temp, phenols, cyanide, volatile organics
23-04-79C-1574	6/27/79 6/28/79	0845/ 0830	BOD, COD, Metals, TKN, TSS, mercury
Samples shipped to contract lab	6/27/79	1345	Volatile organics
23-04-79C-1575	6/28/79	0830	pH, temp, cyanide, phenols, volatile organics
23-04-79C-1625	6/28/79 6/29/79	0840/ 0815	BOD, COD, Metals, TKN, TSS, Mercury
Samples shipped to contract lab	6/28/79	1330	Volatile organics
23-04-79C-1626	6/29/79	0815	pH, temp, cyanide, phenols, volatile organics

Effluent from the Waste Treatment System (MH-OOE)--An ISCO Model 1680 automatic smapler was installed at the final effluent after secondary clarification. The intake line was placed in the waste stream at the facility's rectangular weir. The following samples were collected:

SAD Sample No.	Date	Time	Parameters
23-04-79C-1576	6/25/79	1600	Quality control blanks for metals, mercury
23-04-79C-1577	6/26/79 6/27/79	0840- 0845	Metals, mercury
Samples shipped to contract lab	6/26/79	0950	pH, temp, volatile organics
Samples shipped to contract lab	6/26/79	1400	pH, temp, volatile organics
23-04-79C-1578	6/27/79	0900	pH, temp, cyanide, phenols, volatile organics
23-04-79C-1579	6/27/79 6/28/79	0900- 0855	BOD, COD, Metals, TKN, TSS, mercury
Samples shipped to contract lab	6/27/79	1415	Volatile organics
23-04-79C-1580	6/28/79	0900	pH, temp, cyanide, phenols volatile organics
23-04-79C-1627	6/28/79 6/29/79	0900 0900	BOD, COD, metals, TKN, TSS, mercury
Samples shipped to contract lab	6/28/79	1400	Volatile organics
23-04-79C-1628	6/29/79	0900	Cyanide, phenols, volatile organics

Effluent from Sludge Thickener (MH-OOS) six grab samples were collected from the sludge thickener (before addition of polymers) at a discharge line leading from the bottom of the mix tank. The following samples were collected:

SAD Sample No.	Date	Time	Parameters
Samples shipped	6/26/79	1030	Volatile organics
Samples shipped to contract lab	6/26/79	1445	Volatile organics
23-04-79C-1569	6/27/79	1000	Cyanide, metals, volatile organics, mercury
Samples shipped	6/27/79	1515	Volatile organics
23-04-79C-1570	6/28/79	1000	Volatile organics, mercury, metals, cyanide
Samples shipped contract lab	6/28/79	1430	Volatile organics
23-04-79C-1629	6/29/79	0945	Volatile organics, metals, mercury

Effluent from the Cyanide Destruct Unit (MH-CN) - Grab samples were colelcted by facility personnel from a bleedoff value leading from the cyanide destruct unit effluent. The following samples were collected.

SAD Sample No.	Date	Time	Parameters
23-04-79C-1566	6/26/79	1600	Cyanide
23-04-79C-1567	6/27/79	1030	Cyanide
23-04-79C-1568	6/28/79	1030	Cyanide

In-line Process from Factory I (NH-IP) - In-line process samples were collected from the production of acrylonitrile by facility personnel. The following samples were collected.

SAD Sample No.	Date	Time	Parameters
23-04-79C-1565	6/27/79	1500	COD, cyanide, metals, TKN, extractable organics, phenols, TSS, volatile, organics, mercury

17. Plant 12248

Plant 12248 is a single subcategory (D) plant with an annual average flow of 0.04 MGD. Wastewater treatment employed includes equalization and activated sludge.

Screening Samples

(1) Equalization Basin (Influent to treatment) - All samples taken were 24-hour composites and were analyzed for priority pollutants.

(2) Final Clarifier (Effluent from treatment) - All samples taken were 24-hour composites and were analyzed for priority pollutants.

No traditional pollutant data were available for this plant.

18. Plant 12256

Plant 12256 is a multiple-subcateogry (A, B, C, D) plant with an annual average flow of 30 MGD. End-of-pipe treatment is limited to equalization, neutralization and solids removal.

Screening Samples

(1) Well area before discharge through outfall #001

(2) Split Manhole discharging to outfall #002

(3) Manhole prior to discharge to outfall #003

(4) Skimming basin discharging to outfall #008

(5) Collection basin discharge to skimming basin

(6) Municipal sewers pumping station

(7) Freshwater supply

(8) Saltwater supply

In general, composite samples (24 hour) were taken for priority pollutants other than phenols, cyanides, and volatile organics, for which grab samples were taken.

19. Plant 12257

Plant 12257 is an A, B, C, and D subcategories plant. A treatment system composed of neutralization, equalization, and

activated sludge is used to treat 0.5 MGD of wastewater prior to discharge to a POTW.

A summary of sample points and parameters analyzed for are presented below.

Screening Samples

Combined plant process wastes after neutralization and activated sludge treatment.

Date	Time	Description
10/24/77	0940	Tubing flush blank
10/25/77	0900	Set of grab samples for phenol, cyanide, volatile organics
10/25/77	0900	24-hour automatic composite
10/26/77	0820	Set of grab samples for phenol, cyanide, and volatile organics
10/26/77	0820	24-hour automatic composite
10/26/77	0923	Set of grab samples for phenol, cyanide, volatile organics, and a 2 1/2-gallon grab sample

Combined Plant Process Wastes After Neutralization

Date	Time	Description
10/24/77	0950	Tubing flush blank
10/25/77	0925	Set of grab samples for phenol, cyanide, volatile organics, and a 2 1/2-gallon grab sample
10/26/77	0830	Set of grab samples for phenol, cyanide, and volatile organics
10/26/77	0830	24-hour automatic composite

Raw Fermentation Process Wastes

Date	Time	Description
10/24/77	1005	Tubing flush blank
10/25/77	1110	Set of grab samples for phenol, cyanide, and volatile organics
10/25/77	1110	24-hour automatic composite
10/26/77	0855	Set of grab samples for phenol, cyanide, and volatile organics
10/26/77	0855	24-hour automatic composite
10/26/77	0940	Set of grab samples for phenol, cyanide, volatile organics, and a 2 1/2-gallon grab sample

Raw Chemical Synthesis Process Wastes

Date	Time	Description
10/24/77	1015	Tubing flush blank
10/25/77	1130	Set of grab samples for phenol, cyanide, volatile organics, and a 2 1/2-gallon grab sample
10/26/77	0905	Set of grab samples for phenol, cyanide, and volatile organics
10/26/77	0905	24-hour automatic composite
10/26/77	0910	Set of grab samples for phenol, cyanide, volatile organics, and a 2 1/2-gallon grab sample

Cooling Water Discharge at Bypass Line

Date	Time	Description
10/24/77	1040	Set of grab samples for phenol, cyanide, volatile organics, and a 2 1/2-gallon grab sample

Municipal Water Supply

Date	Time	Description
10/25/77	1500	Flow measurement
10/25/77	1500	Set of grab samples for phenol, cyanide, volatile organics, and a 2 1/2-gallon grab sample

Volatile Organics Blank

Date	Time	Description
10/25/77	1510	Volatile organics blank

Plant 12311

20. Plant 12342

Plant 12342 is an A, C, and D subcategories plant which discharges 1.06 MGD of process wastewater without pretreatment to a POTW. Below, is a table of sample points and sampled parameters for this plant.

Discharge from Manhole No. 1*	Sample Type
Extractables (NVOA)	Composite
Sampler Blank (flush)	Grab
Metals**, Phenols, Cyanides, purgeables (VOA)	3 Grabs
BOD, TSS, COD	Composite

Discharge from Manhole No. 5*	Sample Type
Extractables (NVOA)	Composite
Sampler Blank (flush)	Grab
Metals**, Phenols, cyanides, Purgeables (VOA)	3 Grabs
BOD, TSS, COD	Composite

Discharge from Manhole No. 5*	Sample Type
Extractables (NVOA)	Composite
Sampler Blank (flush)	Grab
Metals**, Phenols, cyanides, Purgeables (VOA)	3 Grabs
BOD, TSS, COD	Composite

Super "Q" Blank	Sample Type

Extractables (NVOA)		Grab
Purgeables (VOA)		Grab

Potable Water - Building 28	Sample Type
Extractables (NVOA)	Grab
Purgeables (VOA)	Grab

	Lab No	Sample Type
Potable Water - Building No. 1		
Extractables (NVOA)	2082	Grab
Purgeables (VOA)	2082	Grab
Potable Water - Building No. 5		
Extractables (NVOA)	2083	Grab
Purgeables (VOA)	2083	Grab
Potable Water - Building No. 20A		
Extractables (NVOA)	2084	Grab
Purgeables (VOA)	2084	Grab

21. Plant 12411

Plant 12411 is a B, C, and D subcategories plant. Wastewater from the process area is treated with neutralization, equalization, and aeration, then combined with sanitary waste and once-through cooling water, and then discharged to a sanitary sewer. The flow of process wastewater is 0.35 MGD.

The sample points and pollutants sampled for are presented below.

Screening Samples

Influent to Pretreatment System -- An ISCO Model 1680 automatic sampler was installed at the pretreatment system influent. The intake line was placed in the equalization basin. the following samples were collected.

Date	Time	Parameters
4/26/78	0945	Quality control blank for non-volatile organics, metals, mercury
4/26/78	1100	Temperature, pH
4/26/78 4/27/78	1045 0945	Non-volatile organics, metals, mercury, TSS BOD5, total phosphorus
4/27/78	0945	Volatile organics, cyanide, phenols, temperature, pH

Effluent from Pretreatment System--An ISCO Model 1680 automatic sampler was installed at the pretreatment system effluent. The intake line was placed in the mid-channel upstream fron the V-notch weir. The following samples were collected.

Date	Time	Parameters
4/26/78	1000	Quality control blank for non-volatile organics, metals, mercury
4/26/78 4/27/78	1045 0930	Non-volatile organics, metals, mercury, TSS, BOD5, total phosphorus
4/26/78	1100	Temperature, pH
4/27/78	0930	Volatile organics, cyanide, phenols, temperature, pH

Combined Sanitary Cooling Water and Pretreated Process Wastewater at Access Pit --An ISCO Model 1680 automatic sampler was installed at the "access pit." The intake line was places in the waste stream at the bottom of the pit. The following samples were collected.

Date	Time	Parameters
4/26/78	1010	Quality control blank for non-volatile organics, metals mercury
4/26/78 4/27/78	1100 1015	Non-volatile organics, metals, mercury, TSS, BOD5, total phosphorus

4/26/78	1100	Temperature, pH
4/27/78	1015	Volatile organics, cyanide, phenols, temperature, pH

Plant 12411

Verification Samples

Volatile Organic Blanks (VOA) -- A trip blank consisting of well water was placed in a preserved and unpreserved VOA bottle and carried into the field.

SAD Sample No	Date	Time	Parameters
79C-1502	6/7/79	0900	VOA

Effluent from Aeration Basins (BS-001E) -- An ISCO Model 1680 automatic sampler was installed at the discharge weir box from the aeration basins and collected the following samples:

SAD Sample No	Date	Time	Parameters
79C-1578	6/12/79	1130	Quality control blanks for non-volatile organics, metals, mercury
79C-1519	6/12/79 6/13/79	1200 1130	Non-volatile organics, metals, mercury, COD, TSS
79C-1520	6/13/79	1130	VOA, phenol, cyanide
79C-1521	6/13/79 6/14/79	1130 1100	Non-volatile organics, metals, mercury, COD, TSS
Sample sent to contract lab	6/13/79	1325	VOA
79C-1522	6/14/79	1100	VOA, phenol, cyanide
79C-1523	6/14/79 6/15/79	1100 1000	Non-volatile organics, metals, mercury, COD, BOD5, TSS
Sample sent to contract lab	6/14/79	1130	VOA
79C-1524	6/15/79	1000	VOA, phenol, cyanide

Influent to Aeration Basins Collected from Holding/Mix Basin (BW-001I) --An ISCO Model 1680 automatic sampler was installed in

the holding basin before aeration. The following samples were collected:

SAD Sample No	Date	Time	Parameters
79C-1504	6/12/79	1115	Quality control blanks for non-volatile organics, metals, mercury
79C-1505	6/12/79 6/13/79	1230 1015	Non-volatile organics, metals, mercury, COD, TSS
79C-1506	6/13/79	1015	VOA, phenol, cyanide
79C-1507	6/13/79 6/14/79	1100 1030	Non-volatile organics, metals, mercury, COD, TSS
Sample sent to contact lab	6/13/79	1335	VOA
79C-1508	6/14/79	1030	VOA, phenol, cyanide
79C-1509	6/14/79 6/15/79	1030 0920	Non-volatile organics, metals, mercury, COD, BOD5, TSS
Sample sent to contract lab	6/14/79	1145	VOA
79C-1510	6/15/79	0930	VOA, phenol, cyanide

Barometric Condenser Mix Basin (BW-002I) -- An ISCO Model 1680 automatec sampler was installed in the mix basin and collected the following samples:

SAD Sample No	Date	Time	Parameters
79C-1511	6/12/79	1145	Quality control blanks for non-volatile organics, metals, mercury
79C-1512	6/12/79 6/13/79	1215 1100	Non-volatile organics, metals, mercury, COD,TSS
79C-1513	6/13/79	1100	VOA, phenols, cyanide
79C-1514	6/13/79 6/14/79	1115 1000	Non-volatile organics, metals, mercury, COD, TSS
Sample sent to contract lab	6/13/79	1320	VOA
79C-1515	6/14/79	1000	VOA, phenol, cyanide
79C-1517	6/14/79 6/15/79	1000 0900	Non-volatile organics, metals, mercury, COD, BOD_5 TSS
Sample sent to contract lab	6/14/79	1140	VOA
79C-1517	6/15/79	0900	VOA, phenol, cyanide

Raw Water Sample (BS-RW) -- A grab sample was collected from the City of Greenville water supply from a tap in the wastewater treatment plant laboratory.

SAD Sample No	Date	Time	Parameters
79C-1503	6/12/79	1430	Non-volatile organics,* metals, mercury, phenol, VOA,* cyanide

*The VOA and non-volatile organics samples were shipped to the contract lab; the metals, COD, BOD_5 and TSS samples were taken to the Revion IV, US-EPA Laboratory, Athens, Georgia.

22. Plant 12420

Screening Samples

Plant 12420 is a subcategory B, D plant. The wastewater flow of 0.17 MGD from this plant is pretreated with an aeration pond followed by a secondary clarifier, then discharged to a private wastewater treatment facility.

The sample points and pollutants analyzed for are tabulated below.

	VOA	Pest.	Base Neut.	Acid
Effluent to pretreatment plant	x	x	x	x
Effluent from Sec. clarifier	x	x	x	x
Effluent at manhole	x	x	x	x
Intake water	x	x	x	x

23. Plant 12439

Screening Samples

Plant 12439 is a C and D subcategories plant. A flow of 0.01 MGD is reported for this plant/even though this plant is classified as a zero discharger. This flow arises from wastewater which is discharged to an irrigation system after neutralization, settling, activated sludge, and lagooning.

Two sampling points were used during the screening visit: the industrial stream influent and the secondary clarifier effluent. The secondary clarifier effluent contains treated wastewater from the industrial stream influent and sanitary wastewater. These two streams were sampled for priority and traditional pollutants.

24. Plant 12447

Screening Samples

Plant 12447 is an A, B, C, and D subcategories plant which discharges 1.5 MGD of wastewater. This plant produces non-pharmaceuticals. Wastewater is discharged without treatment to a POTW except for some very concentrated wastes which are deep welled.

The following table lists dates, times, and parameters sampled for at the various sampling sites.

	Time	Parameters
g 197		
	0810	24-hour composite for extractable organics, metals, BOD and COD
	0837	Grab for VOA
	1330	Grab for phenol
8	1330	Grab for cyanide pH and temperature measured 9.25 and 26°C
8/9/78	1330	Quality control (QC) blank for extractable organics, metals, BOD and COD pumped through sampler #108
8/9/78	1530	
8/8/78		

From Building 42

Date	Time	Parameters
	0903	24-hour composite for extractable organics, metals, BOD and COD
8/9/78 8/10/78	0900	Grab for VOA
		Grab for phenol
8/9/78	1620	Grab for cyanide pH and temperat measured 8.2 a
8/9/78	1620	QC blank fo organics, and COD sampler
8/9/78		
8/8/78	1600	

Waste to Injection Well #3

Date	Time	Parameters
8/9/78	1015 1515	A 3-grab composite for extractable organics, metals, BOD and COD
8/9/78	1412	Grab for VOA
8/9/78	1412	Grab for phenol
	1412	Grab for cyanide
		pH and temperature measured 4.7 and 26°C

Noncontact Cooling Waters:
To Outfall 001

Date	Time	Parameters
8/9/78 8/10/78	0944 0900	24-hour composite for extractable organics, metals, BOD and COD
8/9/78	1551	Grab for VOA
8/9/78	1551	Grab for phenol
	1551	Grab for cyanide
/8/78	1630	pH and temperature measured 7.2 and 22°C
Acre Pond		QC blank pumped through sampler #101 for extractable organics, metals, BOD, and COD

8/9/78	1105 1450	A 3-grab composite for extractable organics, metals, BOD, and COD
8/9/78	1437	Grab for VOA
8/9/78	1437	Grab for phenol
8/9/78	1437	Grab for cyanide pH and temperature measured 6.5 and 21°C
		Organic free water used in field to pump through samplers for sampler blanks. Also used direct for reagent blanks for phenol and cyanide and as VOA trip blanks

25. Plant 12462

Plant 12462 is a Subcategory A plant which discharges to an aerated lagoon 0.3 MGD from pharmaceutical manufacture. Non-pharmaceutical products are also produced at this plant.

Six sample sites were selected during the screening visit. Grab samples were taken from the intake water and backwash lagoon discharge. Composite samples were obtained of the phamaceutical manufacturing influent to the aerated lagoon the total influent to the aerated lagoon, the effluent from the final clarifier, and the final plant effluent. Pollutants analyzed for include the traditional pollutants and priority pollutants.

The table shown below gives a breakdown of the samples taken and pollutants sampled for:

Screening Samples

Date	Time	Flow (gallons)	Parameters
9/19/77	1510	--	Organics (sampler blank)
9/19/77 9/20/77	0850 1200	29,400	Priority pollutants, BOD, pH, COD, NFS, nutrients
9/20/77	1240	--	Volatile organics, phenolics, cyanide

Combined influent to aerated lagoon

Date	Time	Temp °C	Parameters
9/20/77 9/21/77	1230 1025	--	Priority pollutants, pH, BOD, COD, NFS, nutrients
9/21/77	1025	30	Volatile organics, phenolics, cyanide

Biological waste treatment system effluent

9/19/77	1540	--	Organics (sample blank)
9/19/77 9/20/77	1550 1145	--	Priority pollutants, pH, BOD5, COD, NFS, nutrients
9/20/77	1230	--	volatile organics, phenolics, cyanide
9/20/77 9/21/77	1200 1020	--	Priority pollutants, Ph, BOD5, COD, NFS, nutrients
9/21/77	1020	21	Volatile organics, phenolics, cyanide
9/21/77	1200	21	Priority pollutants, pH, BOD5, COD, NFS, Nutrients, phenolics, volatile organics, cyanide

Plant outfall

Date	Time	Temp °C	Parameters
9/19/77	1545	--	Organics (sampler blank)
9/19/77 9/20/77	1600 1150	--	Priority pollutants, pH BOD5, COD, NFS, nutrients
9/20/77	1230	--	Volatile organics, phenolics, cyanide
9/21/77	1015	25	Priority pollutants, pH, BOD5, COD, NFS, Nutrients volatile organics, phenolics, cyanide

26. Plant 12999

Screening Samples

Plant 12999 is a subcategories C and D plant which discharges 0.45 MGD of wastewater to a municipal treatment plant.

The Plant 12999 wastewater treatment facility currently consists of a primary clarifier and an equalization pond. However, the plant is performing bench scale treatability studies to determine the effectiveness of activated sludge and powdered activated carbon on its wastewater. The activated sludge unit effluents and the powdered activated carbon unit effluents were two of the sample points during the screening visit. The other two sample points were the raw waste feed to the bench scale units and the equalization pond effluent which is discharged to the POTW. The parameters sampled for were the traditional pollutants and priority pollutants.

APPENDIX P

English Units to Metric Units Conversion Table

APPENDIX P

ENGLISH UNITS TO METRIC UNITS CONVERSION TABLE

Multiply (English Units) English Unit		By Conversion	To Obtain (Metric Units) Metric Unit	
acre	ac	0.405	ha	hectares
acre-feet	ac ft	1233.5	cu m	cubic meters
British Thermal Unit	BTU	0.252	kg cal	Kilogram-calories
British Thermal Unit/pound	BTU/lb	0.555	kg cal/kg	kilogram calories per kilogram
cubic feet per minute	cfm	0.028	cu m/min	cubic meters per minute
cubic feet per second	cfs	1.7	cu m/min	cubic meters per minute
cubic feet	cu ft	0.028	cu m	cubic meters
cubic feet	cu ft	28.32	l	liters
cubic inches	cu in	16.39	cu cm	cubic centimeters
degree Farenheit	°F	0.555(F-32)*	°C	degree Centigrade
feet	ft	0.3048	m	meters
gallon	gal	3.785	l	liter
gallon per minute	gpm	0.0631	l/sec	liters per second
pounds per square inch	psi	0.06803	atm	atmospheres (absolute)

* Actual conversion, not a multiplier

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