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Biological Treatment of Wastes From the Corn Wet Milling Industry

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May 1978

BIOLOGICAL TREATMENT OF WASTES FROM THE CORN WET MILLING INDUSTRY

by

Donald R. Brown
Gretchen L. Van Meer
Argo, Illinois 60501

Grant No. 12060 DPE

Project Officer

Max W. Cochrane
Industrial Pollution Control Division
Industrial Environmental Research Laboratory
Cincinnati, Ohio 45268

INDUSTRIAL ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

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FOREWORD

When energy and material resources are extracted, processed, converted, and used, the related pollutional impacts on our environment and even on our health often require that new and increasingly more efficient pollution control methods be used. The Industrial Environmental Research Laboratory - Cincinnati (IERL-Ci) assists in developing and demonstrating new and improved methodologies that will meet these needs both efficiently and economically.

"Biological Treatment of Wastes from the Corn Wet Milling Industry" was a part of the Industrial Pollution Control Division's program to develop and demonstrate new technology for the treatment of industrial wastes. A full-scale completely mixed activated sludge system was constructed to process 0.9 MGD of corn wet milling process wastewater. In order to assure a functional biological system modifications to both the equalization basin and sludge thickening were required. Although the waste is amenable to aerobic biological degradation, problems were encountered in consistently maintaining an effluent BOD and suspended solids that met design effluent standards.

For further information contact the Food and Wood Products Branch of the Industrial Environmental Research Laboratory - Cincinnati.

David G. Stephan
Director
Industrial Environmental Research Laboratory
Cincinnati

ABSTRACT

The Pekin, Illinois plant of CPC International Inc. is treating 0.9 mgd of corn wet milling process wastes with a completely mixed activated sludge system. Laboratory studies had shown that this treatment method would produce a satisfactory effluent; in addition, a simultaneous pilot plant study had shown that an aerated lagoon would also provide satisfactory treatment for either the process wastes alone or combined with the plant's 18 mgd of cooling water. Economic factors dictated the selection of the activated sludge plant.

Problems encountered during initial stages of operation of the waste treatment facility included the splitting of the rubber liners in the equalization and aeration tanks, and odor problems that developed in the thickener and the equalization tank. The rubber liners were replaced with concrete. The thickener was converted to an aerated biomass storage tank. The equalization tank design was modified and aeration was increased.

The major problem with the Pekin activated sludge waste treatment plant has been its failure to consistently meet effluent suspended solids criteria. Efforts to reduce effluent suspended solids levels have included nutrient analyses; examination of the effects of the food-to-microorganism ratio (F/M), pH, and hydraulic loading; and the use of a cationic polymer as a flocculating agent in the clarifier overflow. Although these efforts have resulted in considerable improvement in performance compared with initial operation, the effluent still does not consistently meet the design effluent standards.

This report was submitted in fulfillment of Grant Number 12060DPE under the partial sponsorship of the Office of Research and Monitoring, Environmental Protection Agency.

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The guidance of Clifford Risley, Jr., EPA Office of Research and Monitoring, Region V, and Project Officer Max Cochrane, are acknowledged with sincere thanks.

SECTION I

CONCLUSIONS

1. Corn wet milling wastes are readily biodegradable in a completely mixed activated sludge process. However, incomplete suspended biological solids removal has resulted in failure to meet the expected effluent quality at the Pekin, Illinois plant of CPC International Inc.

2. Aerated lagoon treatment was studied in a pilot plant and a laboratory study was made of completely mixed activated sludge treatment. The aerated lagoon study of corn wet milling wastes indicated good soluble chemical oxygen demand (COD) removal when treating either a dilute mixture of combined process waste and cooling water or the concentrated stream of process wastes alone. The activated sludge study resulted in data for rate of biochemical oxygen demand (BOD) removal, oxygen uptake, and biomass yield for design of a full-scale treatment plant for treating the concentrated process wastes. Economic factors dictated the selection of the activated sludge system. The total waste flow of 13-25 million gallons per day (mgd) from the plant included process wastes, cooling water, and sanitary wastes. The sanitary wastes were isolated and sent to the Pekin municipal treatment plant, and the cooling water did not require treatment. The activated sludge plant was therefore designed to treat the 0.9 mgd of process wastes.

3. The waste treatment plant as designed and modified often removes 90% or more of incoming BOD. Removal of organic solubles is usually satisfactory. However, to meet the design effluent criteria of 40 milligrams per liter (mg/l) BOD, BOD removal must be on the order of 97 to 99%. High effluent suspended biological solids concentrations prevent meeting both the suspended solids and BOD criteria for more than a few days at a time. The influent BOD fluctuations are

considerable, largely due to the variability in both the raw material and the factory production schedule. Deterioration of effluent quality can nearly always be traced to a shock load of 2 to 5 times the normal load of BOD, which results in poor separation of biomass in the clarifier and flotation cell. The result is failure to meet both the effluent suspended solids and effluent BOD criteria. The suspended solids are unflocculated bacteria, formed during the biological reaction. The BOD in the effluent is almost entirely due to these suspended bacteria.

4. Increase in biomass recycle rates, from 25-35% to 75-100% of the supply, and reaeration of the recycled biomass resulted in some improvement in solids separation. Also, under some conditions, addition of 10 mg/l of a cationic polymer to the clarifier overflow, followed by the dissolved air flotation, resulted in a satisfactory effluent quality of less than 25 mg/l suspended solids. Addition of nutrients to produce a BOD:N:P ratio near the recommended minimum ratio of 100:5:1 resulted in an improved population of suitable microorganisms, thereby improving the quality of treatment. As of this writing, an effluent suspended solids level of 35 mg/l or less is being achieved about 25 per cent of the time.

5. It appears that the major problems encountered in the treatment of corn wet milling wastes are: (a) dealing with the variations in waste that are the inevitable result of using a natural product subject to variations in composition and quality, and (b) reduction of suspended solids in the final effluent. As of this writing, no method of adequately reducing the effluent suspended solids to meet water quality standards has been found with any treatment method or combination of treatment methods tried with the existing treatment plant.

SECTION II

RECOMMENDATIONS

For the treatment of corn wet milling wastes by a completely mixed activated sludge system it is recommended that:

1. process wastes be isolated from cooling water and sanitary wastes for the most economical and efficient treatment.

2. equalization be used to reduce shock loads to aeration tanks, and to minimize the variability that results from using a natural product such as corn, and having a variable production schedule.

3. odor prevention methods be used, including aerating equalization tanks and avoiding the use of large thickeners or other equipment where biomass is held without oxygen for long periods.

4. nutrient analyses be made to determine any need for additions of nitrogen, phosphorus, and trace elements to provide a complete growth medium for appropriate microorganisms.

5. the use of flocculating chemicals, together with solids removal equipment such as flotation cells, or other effluent polishing devices be included in waste treatment plant design for corn wet milling wastes, to help reduce effluent suspended solids.

6. additional studies be made to determine the best method of obtaining lower effluent suspended solids concentrations.

SECTION III

INTRODUCTION

PURPOSE OF PROJECT

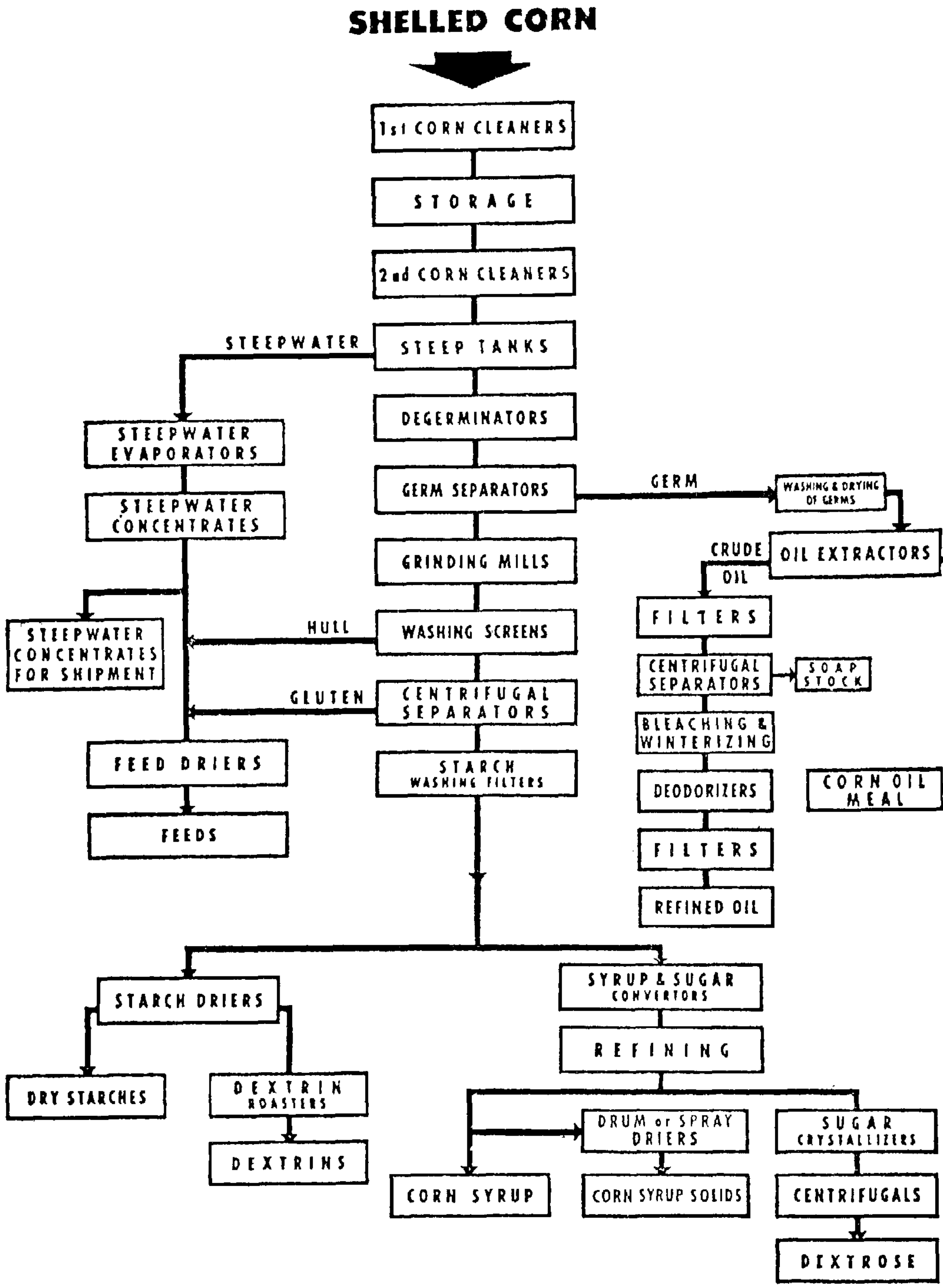
The corn wet milling industry, also called the corn refining industry, gets its name because large quantities of water are used to separate and refine the constituent parts of the corn kernel. For every bushel of corn processed, 12 to 15 gallons of water are used in direct contact with the corn or its components. A simplified flow chart of the process is shown in Figure 1.

The industry is comprised of 12 companies with 17 domestic plants. The converted products in the industry are worth over $700 million annually. The 500 different products include adhesives, food ingredients, animal feed, and consumer products, serving 60 industries in the food, chemical and heavy industry areas.

The over-all efficiency of the corn wet milling process is high, utilizing close to 100% of the input material. However, trace amounts of end products such as syrups, sugar, and starch are found in the waste process water. Up until the present study was done, no information was available on specific guidelines and operating parameters for the treatment of wet milling wastes. For this reason, a Federal EPA research and demonstration grant was awarded to CPC International Inc. with the objective of utilizing laboratory reactor data to design a full-scale treatment facility at the Pekin, Illinois plant. A one-year demonstration period was included to determine if the laboratory data resulted in an adequate design. It was believed that this information, while directly applicable only to the special circumstances of the Pekin plant

FIGURE 1

THE CORN REFINING PROCESS



of CPC International Inc., would prove useful in the selection and design of waste treatment systems for other corn wet milling plants, and possibly for the cane and beet sugar, and the potato, wheat and rice starch industries.

The scope of the grant included biological treatment and biomass separation, but did not include methods for excess biomass disposal, which are not discussed in this report.

The only water-borne waste from the actual milling of corn and separation into its components is the condensate resulting from the evaporation of steepwater. The condensate contains volatile substances which are formed during the steeping process and vaporized during evaporation, and some entrained steepwater solids.

In-plant sources of other liquid wastes vary, depending on the products made and the processes used. Possible sources include filtrates from the preparation of modified starches, with associated dissolved chemicals used for modification if any, and some soluble carbohydrate formed during the process. Other possible sources result from the refining of corn syrups and dextrose.

CPC International Inc. operates four wet milling plants in the United States. Two of these pay for treatment of their wastes in municipal treatment plants. In the past, the other two discharged waste directly to the waterways. As awareness of the environmental effects of this discharge increased, it became evident that this practice could not continue. Hence, a program was undertaken at the Pekin plant of CPC International Inc. to determine the most economical waste treatment method to meet the effluent standards then in existence.

Since the waste products from the wet milling process are primarily biodegradable carbohydrates, biological treatment was the method of choice for the treatment of the concentrated waste stream.

BIOLOGICAL TREATMENT: COMPLETELY MIXED ACTIVATED SLUDGE

Biological wastewater treatment consists of a combination of interrelated operations, beginning with the transfer of impurities from the wastewater to film, floc, or other forms of biomass by interfacial contact and associated absorptions and adsorptions. This process is fast and effective if the interface between the liquid and the biomass is large, if the concentration gradient of the substances to be removed from one phase to the other is steep, and if obstructive liquid films and concentrations of interfering substances do not build up on the interface. Quality, therefore, as well as extent of contact is important.

Second and equally important is the preservation of this quality of contact, accomplished primarily by the biological oxidation of organic matter and synthesis of new cells. Contact quality is maintained because of the tendency of dissolved matter to change in concentration so as to decrease surface tension in the biotic film or floc. Substances concentrating at surfaces are adsorbed, then decomposed by the accumulating enzymes of living cells. New cells are then synthesized, and the end products of decomposition are washed into the waters or escape to the atmosphere. Finally, conversion of the biomass into settleable or otherwise removable solids proceeds as a function of the quality of contact, and determines the over-all effectiveness of the process[1].

In the activated sludge system, air is provided continuously to keep the units aerobic, in spite of heavy concentrations of living organisms.

In order to operate the process on a continuous basis, the solids generated must be separated for recycle to the aeration tank, with the excess sludge from the system being withdrawn for disposal[2].

In the completely mixed activated sludge system, influent waste and the recycled sludge are immediately and uniformly mixed in the aeration tank. This allows for uniform oxygen demand throughout the aeration tank, and adds some operational stability when treating shock loads of industrial waste. However, when there are unusually large variations in waste, equalization must be used to smooth out some of the variation prior to aeration.

BACKGROUND

Because of both the nature of the raw product and the nature of the production schedule of most plants, wastes in the corn wet milling industry are subject to unusually large variations. The raw product, corn, is a natural product, subject to significant variations as a result of weather and other factors. The production schedule is unique in that it is more economical to run the various portions of the plant at full production capacity for a number of days each week, shutting down and starting up a major portion of the plant each weekend. Some products have seasonal cycles, while others have relatively stable demands. In addition, finished product inventories are kept to a minimum because natural products have a limited storage life.

Waste sources in the Pekin plant consist of process water, cooling water, and sanitary wastes, with a total flow of 13-25 mgd. The pollution abatement program began with several major in-plant changes for the purpose of reducing the waste load to be treated.

BOD was reduced by about half by isolating sanitary wastes and diverting them to the Pekin municipal treatment plant; by installation of new process control instruments in critical areas; by operator and supervisor training regarding process losses, supported by an extensive waste stream monitoring system; and by discontinuing an intermittently operated process which generated a large, difficult to treat waste load.

When these changes were made, process wastes and cooling water were combined in a single effluent. During the treatability studies described later in this report, economic studies showed that it was more economical to isolate the process wastes for treatment, as the cooling water discharge met the effluent water quality standards in effect at the time. Separating the cooling water flow of 18 mgd left the process water, which averaged 0.9 mgd, to be treated. This process water is referred to as the concentrated waste stream.

It was estimated that prior to the waste reduction program, process and sanitary waste flows totalled 1.6 mgd, so the program resulted in reducing the flow to be treated by about 45%. Much of the flow reduction was due to the abandoned process (0.29 mgd) and the sanitary wastes (0.1 mgd). Cooling water flow rates were not affected by the waste reduction program.

At the Pekin plant, the major waste sources are from production to dextrose, corn syrup, steepwater, and starch. The contribution of each of the waste sources varies considerably on a time basis, but the general composition indicates that the concentrated raw waste stream is made up of about 35% from the corn syrup channel, 25% from volatiles in the steepwater channel, 20% from the dry starch channel, 15% from the steepwater entrainment, and 5% from the dextrose channel. Treatment of the concentrated process waste stream is the subject of this report.

SECTION IV

LABORATORY AND PILOT PLANT DEVELOPMENT STUDIES

Two methods of waste treatment were considered for the Pekin plant: a completely mixed, activated sludge process operating on a concentrated waste stream, and a simple aeration lagoon and quiescent pond process which could operate on the dilute plant waste stream, consisting of a combination of process wastes and cooling water. Two parallel process investigations were undertaken to determine the feasibility and economics of each method. The dilute waste lagooning process was studied in a pilot plant, to determine the effects of summer and winter operation, and to obtain effluent quality data on the system for year-around operation. Simultaneously, a laboratory investigation of a completely mixed activated sludge process was implemented using concentrated waste.

The studies showed both methods to be suitable for obtaining satisfactory effluent quality. However, the completely mixed activated sludge process was more economical than the aerated lagoon settling pond process.

Results from the laboratory tests provided information on rate of COD removal, rate of oxygen utilization, biomass growth rate, and characteristics of microbial cultures grown in corn wet milling wastes.

Parameters measured included BOD, total COD, soluble COD, total biological oxygen demand (T_bOD), dissolved oxygen (DO), nitrogen, phosphorus, and mixed liquor suspended solids (MLSS). The use of soluble COD, MLSS, and T_bOD to calculate the unit rate of removal (lb soluble COD/lb MLSS-day) is detailed in Appendix A.

PILOT PLANT: AERATION POND-SETTLING POND SYSTEM

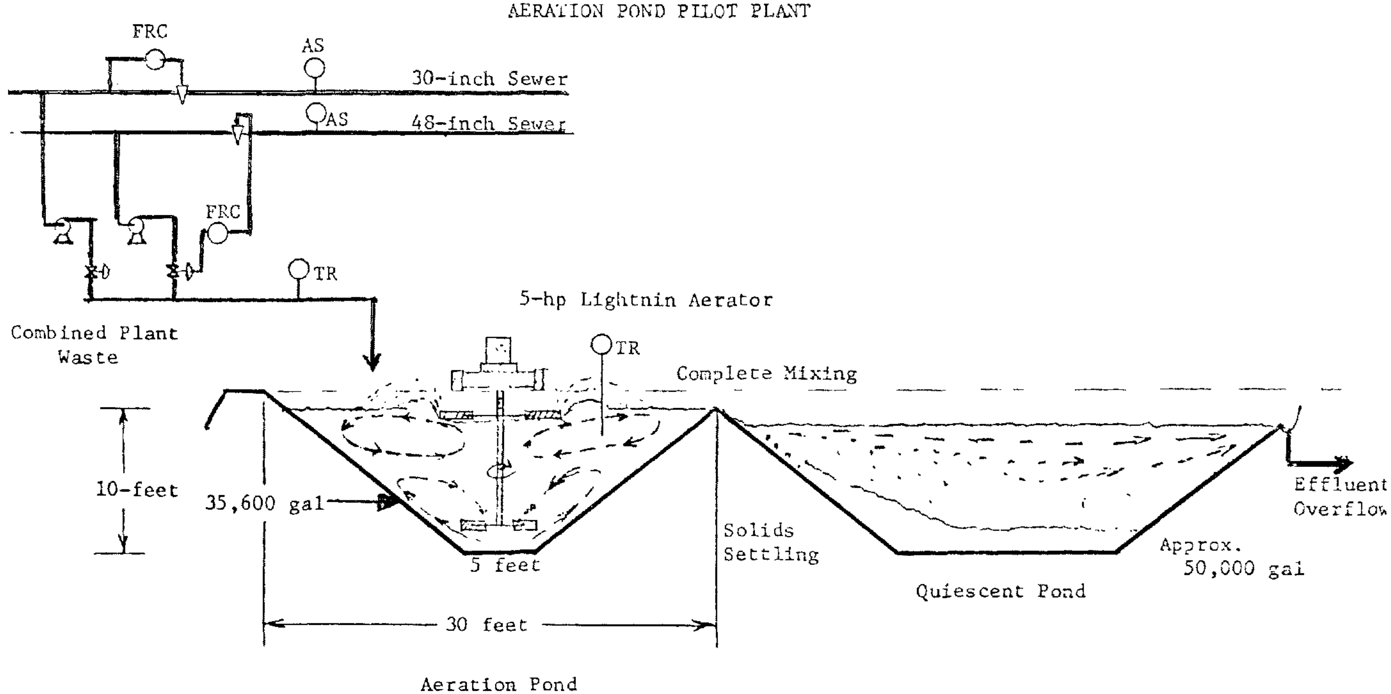
The aeration pond-settling pond system is suitable where large areas of low cost land are available. It is a simple, relatively inexpensive procedure, requiring a minimum of operator attention, but using many acres of land. Oxygen and nutrients are added in the aeration pond so that the waste undergoes bioconversion to suspended solids. This mixture then passes into the settling pond where the solids are allowed to settle to the bottom and the effluent flows into the receiving stream. The settled solids continue to biodegrade anaerobically, but with adequate surface area the upper part of the settling pond remains aerobic so that odors should not be a problem. Periodically the accumulated solids must be removed, with intervals varying from several months to years, depending on the concentration of the waste.

A schematic diagram of the pilot plant is shown in Figure 2. Flow was taken from the 30-inch and 48-inch sewers in proportion to the flow rates in the respective sewers. The waste flowed into the aeration chamber, and overflowed into the settling chamber where the solids settled to the bottom. The aeration pond was operated over the range of 10 to 96 hours retention time. Combined holding time with the settling chamber ranged from 1 to 10 days. No nutrients were added to the system when it was operating with dilute waste.

Evaluation of dilute effluent treatment was not pursued in depth, because economic studies soon showed that treatment of concentrated waste would be less costly. However, the results while operating with the dilute waste indicated that an average effluent soluble COD concentration of 40 mg/l was obtained in both cold and warm seasons (February through April 1967). Soluble COD in the raw waste ranged from 75 to 175 mg/l, averaging about 100 mg/l. While this is only about 60% removal of soluble COD, batch tests showed the waste contained about

Figure 2

AERATION POND PILOT PLANT



FRC - Flow Recorder and Proportional Flow Control
AS - Automatic Sampler
TR - Temperature Recorder

25 mg/l of non-biodegradable COD, so 40 mg/l COD in the effluent was considered satisfactory for a continuous reactor.

Floating solids in the settling chamber often led to high total COD in the effluent. When settling was good, effluent total COD was in the range of 50 to 75 mg/l. When floating solids were present, the value was usually 125 to 175 mg/l. Optimization of the settling chamber design, and provisions for skimming floating solids from the surface, would probably result in a satisfactory effluent.

A major change in pilot plant procedure came as a result of a decision, based on economic factors, to split the concentrated plate waste streams out of the 30-inch and 48-inch sewers for separate treatment. This would reduce the flow of waste to be treated from about 20 mgd to about 1 mgd. When this decision was reached, pilot plant operation on a synthetic waste concentrate, with characteristics which would be typical of the new concentrated waste stream, was begun. This procedure was used from approximately spring of 1967 through October 1967. As soon as the concentrated plant wastes were separated from the cooling water stream, the pilot plant was operated on the actual concentrated plant waste stream.

The pilot plant was operated as a washout reactor, since no equipment for biomass recycle had been installed. It was found that with a retention time of 4 days in the aeration tank, effluent soluble COD of 60 to 100 mg/l was obtained, with a supply concentration of about 1000 mg/l. The non-biodegradable COD in the concentrated waste was usually about 40 mg/l, as determined by batch tests. This procedure is described in Appendix A.

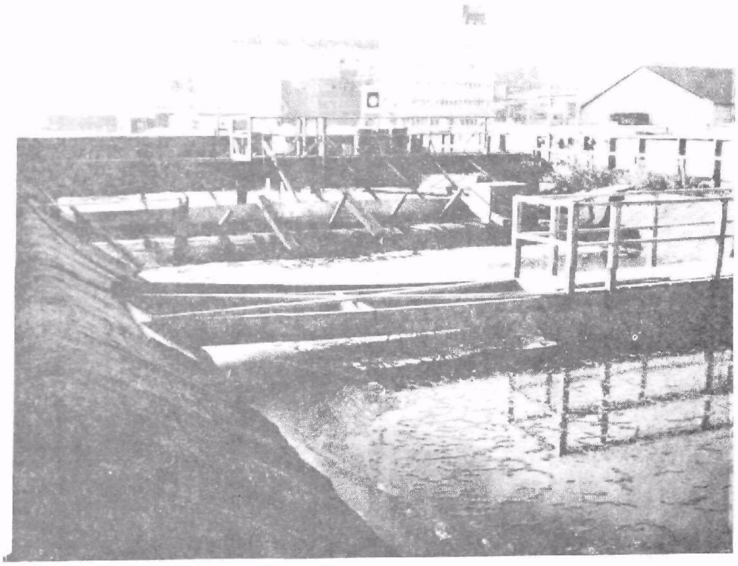
No evaluation of solids separation was made while operating with concentrated waste, because by this time it had become apparent that an activated sludge system with recycle would be selected for final design for economic reasons.

Figure 3 shows the aeration pond in normal operation. A foaming condition which occasionally occurred is shown in Figure 4a. This illustration shows a particularly severe case, probably caused by a COD shock load. The foam was several feet high and interfered with the oxygen transfer capabilities of the aeration equipment. The problem was solved by the use of an anti-foam agent (Nalco G613), the results of which can be seen in Figure 4b.

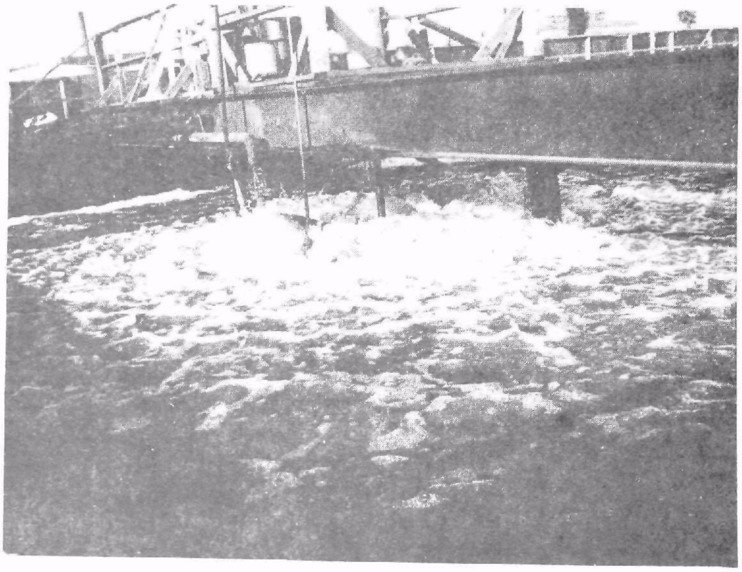
Figure 5a shows bubbles and foam on the surface of the settling pond which resulted from the anaerobic decomposition of solids on the bottom of the pond. The resultant gases percolate up through the solids and liquid to the surface of the pond, occasionally carrying large clumps of floating material with them, and causing a mildly offensive odor. Furthermore, the floating solids caused unacceptably high suspended solids levels in the effluent. This problem occurred most often in summer, when increased temperatures accelerate the rate of anaerobic decomposition and simultaneously reduce the capacity of water to hold dissolved oxygen. The solution in a full-scale plant is to provide a settling pond of adequate size for the expected waste load. Figures 5b and 6 also show the aeration pond in winter. In spite of the ice accumulation the aerator continued to provide adequate dissolved oxygen.

When the aeration pond operated on the dilute waste stream, no nutrients were added. With the change to concentrated supply, there was a noticeable increase in effluent soluble COD in the effluent ranging from 250 to 500 mg/l. The addition of nitrogen and phosphorus in the ratio COD:N:P = 100:5:1 produced the results shown in Figure 7, with effluent soluble COD dropping to an acceptable 100 mg/l. These results showed clearly that nutrient addition should be incorporated into the full-scale plant.

FIGURE 3
PILOT PLANT AERATION POND

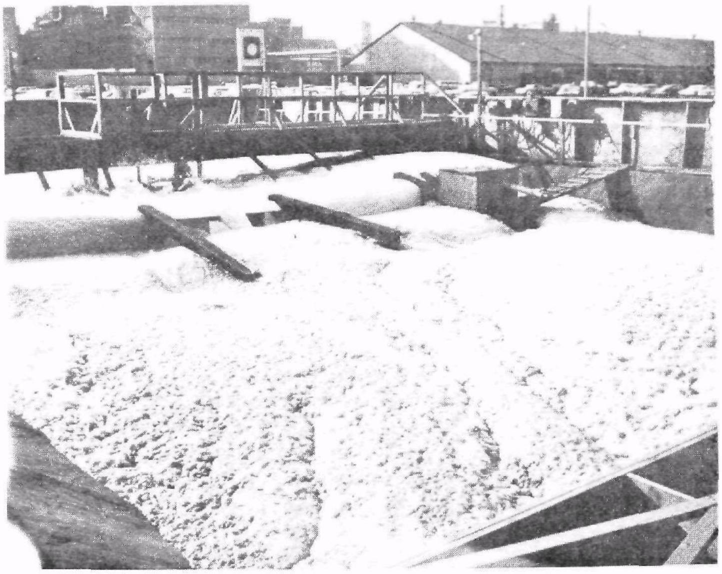


3a. Aeration pond (background) and settling pond (foreground).



3b. Aeration pond with aerator in operation.

FIGURE 4
FOAMING PROBLEM IN PILOT PLANT

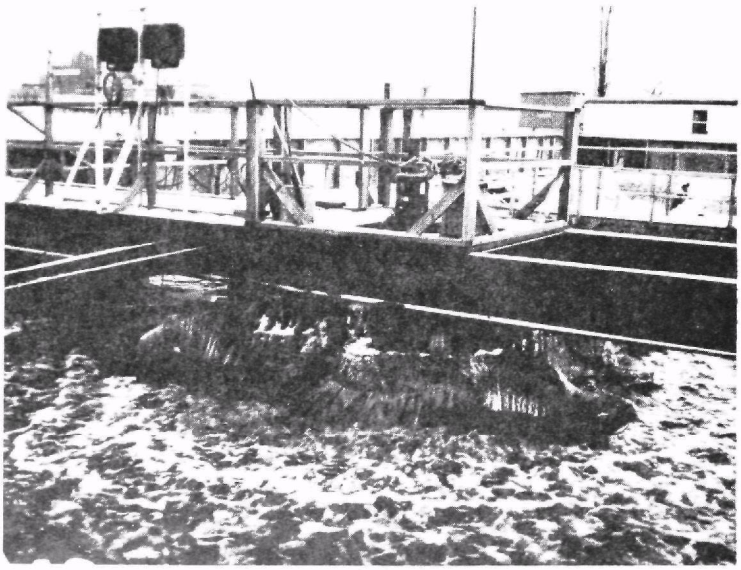


4a. Foam coming over baffle in the aeration pond.

4b. After using an antifoam agent, 45 minutes elapsed time.

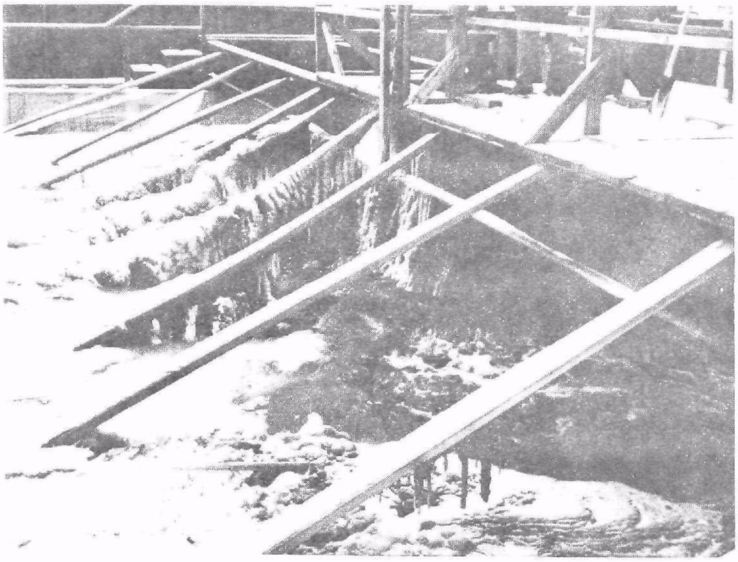
FIGURE 5
PILOT PLANT SETTLING POND AND AERATION POND

5a. Overflow system at the end of the settling pond (summer), showing bubbles and foam on the surface of the pond.



5b. Aerator (winter), which continued to provide adequate dissolved oxygen in spite of ice accumulation.

FIGURE 6
FROZEN PILOT PLANT AERATION POND

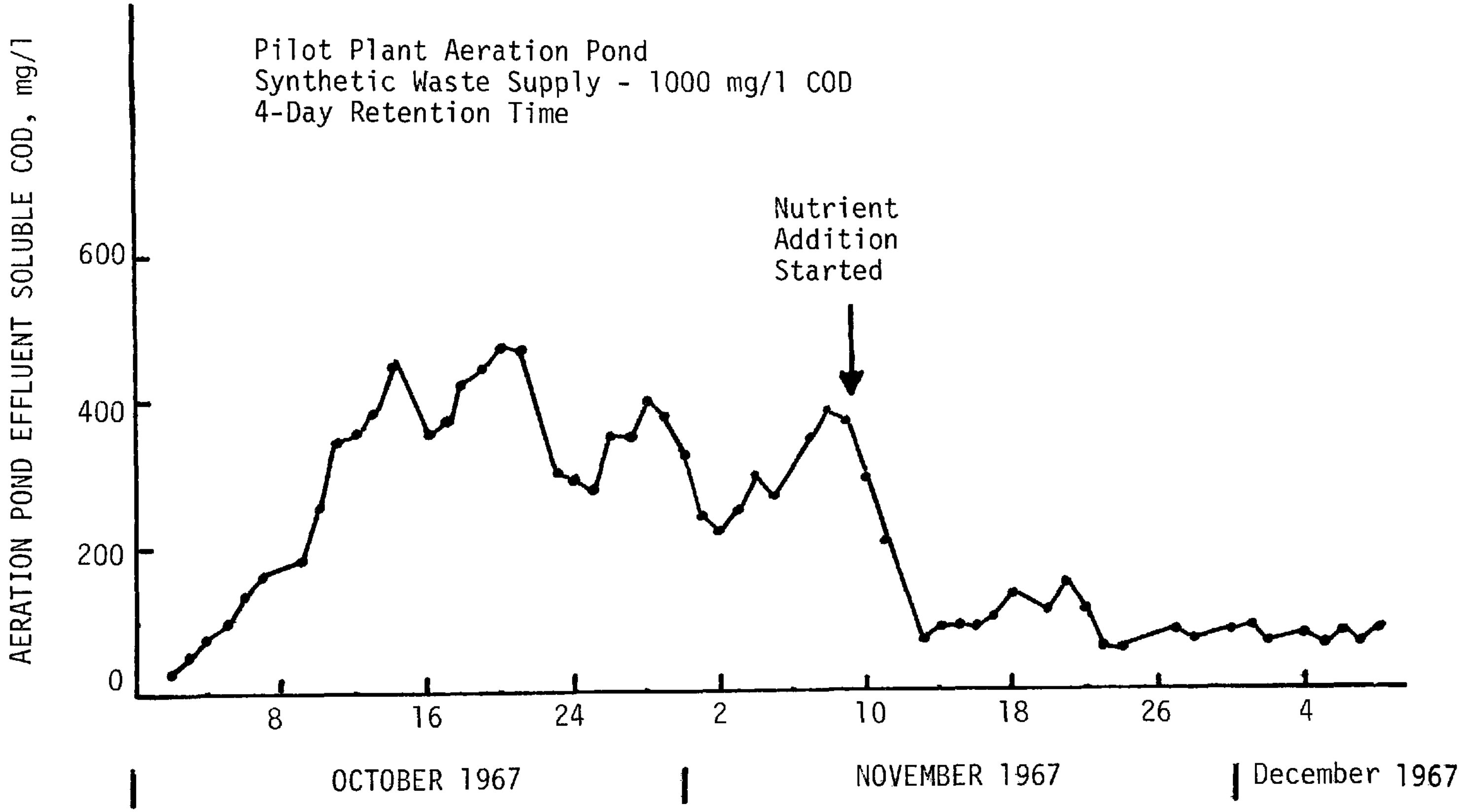


6a. Aeration pond (winter), showing that only a small portion of the aeration zone was free water during the coldest part of the winter.

6b. Frozen foam accumulation

FIGURE 7

EFFECT OF NITROGEN AND PHOSPHOROUS
NUTRIENTS ON EFFLUENT SOLUBLE COD



Because biological waste treatment consists essentially of the care and feeding of microorganisms, the process of the growth of microbial cultures is shown in Figures 8 and 9. The biomass showed good growth characteristics with appropriate settling tendencies. The conclusion of the pilot plant study was that the method was feasible for adequate waste treatment. However, economics dictated the construction of an activated sludge waste treatment facility.

LABORATORY STUDIES

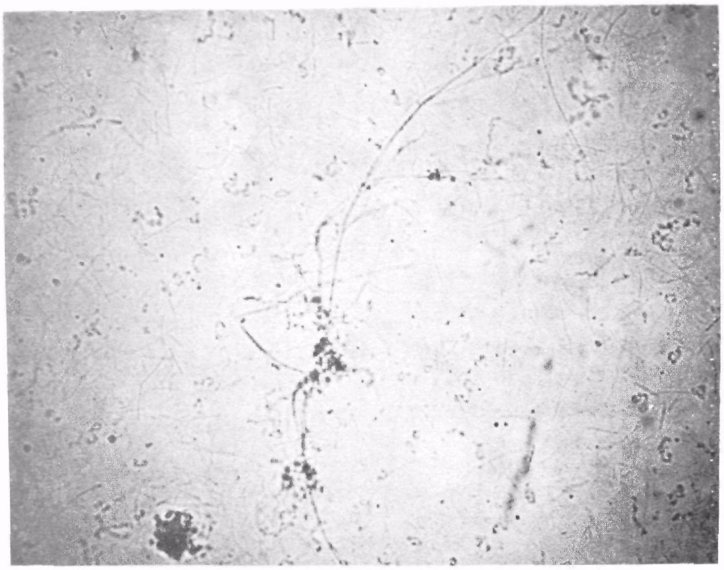
Completely Mixed Activated Sludge

The activated sludge process is a compact, versatile and efficient method, widely used in waste treatment. The effluent from the aeration tank is continuously separated into settleable solids and liquid effluent in a clarifier, with most of the biomass being recycled to the aeration tank. Because of the continuous nature of the activated sludge process, it is important in a laboratory situation to develop the biological culture in a continuous mode of operation[3], so as to simulate the actual environment encountered in the treatment plant as closely as possible.

The activated sludge process was studied on a laboratory scale, using continuous flow reactors of about 5 liters capacity. A schematic of the apparatus is shown in Figure 10. Supply to the reactors was taken from a cooled storage vessel, containing 2 days supply. The effluent was drawn off through a siphon arrangement into a bottle calibrated to show the quantity of substrate used per day.

Raw waste supply was collected periodically from the plant concentrated waste discharge. The waste was diluted to 1000 mg/l COD concentration. The pH was usually in the range of 5.5 to 7.0, but if the pH was below 5.5, it

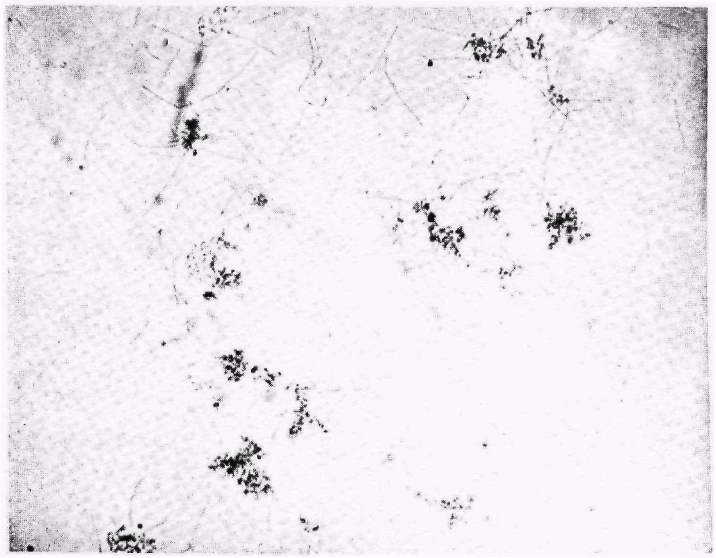
FIGURE 8
EARLY AERATION POND CULTURES



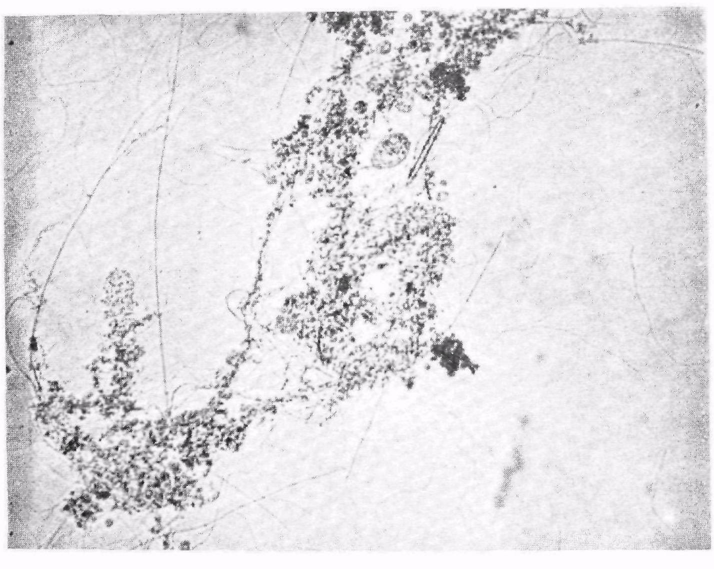
8a. Initial operation, dispersed growth with numerous small clumps.

8b. After two weeks of operation, with some increase in size of clumps.

FIGURE 9
LATER AERATION POND CULTURES



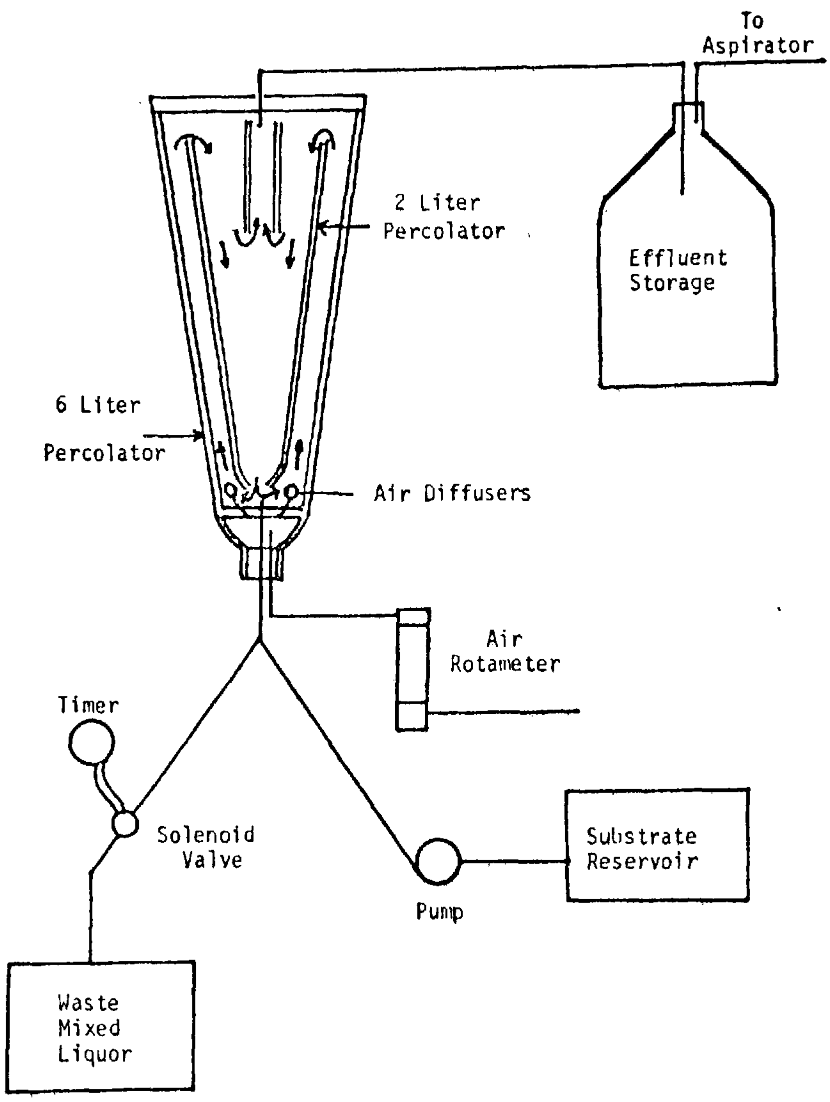
9a. After one month of operation, some filamentours organisms present.



9b. After two months of operation, showing some higher life forms.

FIGURE 10

SCHEMATIC DRAWING OF LABORATORY
ACTIVATED SLUDGE REACTOR



was adjusted to 6.0. Nitrogen and phosphorus were added in the ratio of COD:N:P = 100:5:1 . The laboratory reactor studies were conducted at ambient temperatures (73°-77°F).

In retrospect, this method of supply preparation contributed to the failure of the laboratory reactors to simulate performance of the full-scale plant. Since the laboratory reactor raw waste supply was nearly constant in concentration and pH, none of the problems later encountered with varying supply conditions in the full-scale plant were recognized in the laboratory.

The laboratory reactor operation was begun in June 1967 to develop bacterial cultures acclimated to the concentrated Pekin waste stream. The development of acclimated biological cultures with good settling characteristics was the primary objective for the first few months of continuous laboratory reactor operation. For this period, the reactors were operated on a flow-through basis without use of the settling chamber for the reactor effluent and without any recycle of biological solids from the effluent stream. In this way, an acclimated culture was developed.

The next phase was simulation of normal operation with the separation of solids from the effluent, and the recycle of a portion of the settled biomass. Four reactors were run at different supply rates and MLSS concentrations to investigate a broad range of F/M ratios. The food rate for a given reactor was controlled by varying the supply volumetric rate, since the supply COD concentration was kept constant at about 1000 mg/l. The concentration of MLSS in a given reactor was controlled by adjusting the amount of settled biomass recycled back to the reactor and the biomass waste rate.

Material balance data and analytical data were obtained for each of the continuous reactors throughout the experimental investigation. Periodic tests were run for BOD, COD, MLSS, phosphorus, nitrogen, and dissolved oxygen, using standard laboratory techniques[4]. The steady-state material balance data for the continuous laboratory reactors at various operating conditions are summarized in Table 1. The data were analyzed with the computer program which performed a material balance for COD and suspended solids over a period of days. Usually the period chosen was 10 days. The major operating parameters were then calculated and reported.

All four reactors were operated on a flow-through basis without recycle for the first 4 months in order to develop suitable cultures. During this period, the MLSS concentration in the reactors was low, mostly in the range of 200 to 400 mg/l.

The results in Table 1 show that soluble COD removal was 90% or more at nearly all conditions. Generally, the effluent suspended solids concentration from the settling chamber was high, although at times low concentrations were obtained. It was the opinion of our consultant that the hydraulics of the laboratory scale settling chambers did not reflect conditions that would exist in a full-scale plant. Since good solids separation was obtained at times in the laboratory reactors, he felt that by designing the full-scale plant on the basis of soluble COD removal as determined by batch tests, satisfactory solids separation would be obtained. It will be seen that this conclusion was not borne out in the results of the full-scale plant.

The biomass growth rate expressed as pounds of MLSS produced per pound of MLSS under aeration per day as a function of the F/M ratio[3] is shown in Figure 11. These data were obtained from 10-day material balance

TABLE 1

LABORATORY REACTOR STUDIES

Steady State Material Balance Summaries

Dates	Reactor	Retention Time, days	Recycle, % of Feed	Wastage, % of Feed	F/M,[a] lb COD/ lb MLSS-day	Reactor MLSS, mg/liter + 0.45 μ	Reactor[a] COD, mg/liter - 0.45 μ	Effluent MLSS, mg/liter + 0.45 μ	Growth Rate Produced, lb MLSS/ lb Aeration MLSS-day	Yield, lb MLSS Produced/ lb Soluble COD Removed	Soluble COD Removal Efficiency, %
1/3-1/12, 1968	1	2	100	0	0.455	1031	59.7	257	0.081	0.190	94.1
1/3-1/12, 1968	2	2	50	0	0.901	521	56.9	246	0.214	0.251	94.3
1/3-1/12, 1968	3	1	100	0	0.291	2573	44.4	70	0.035	0.127	95.6
1/3-1/12, 1968	4	1	0	0	2.641	387	52.2	391	1.012	0.404	94.8
2/19-2/28, 1968	1	2	100	0	0.204	2454	36.8	99	0.036	0.186	96.3
2/19-2/28, 1968	2	2	100	0	0.222	1907	42.8	133	0.076	0.358	95.7
2/19-2/28, 1968	3	1	90	10	0.461	1872	43.0	139	0.131	0.297	95.7
2/19-2/28, 1968	4	0.5	100	0	0.821	2252	59.4	129	0.189	0.244	94.1
3/28-4/6, 1968	1	1	50	50	0.668	1854	66.7	46	0.208	0.333	93.6
3/28-4/6, 1968	2	1	75	25	0.915	1202	70.5	36	0.311	0.364	93.2
3/28-4/6, 1968	3	1	90	10	0.633	1739	71.5	127	0.208	0.353	93.1
3/28-4/6, 1968	4	0.25	100	0	0.806	5133	58.3	270	0.227	0.298	94.4
5/14-5/23, 1968	1	0.5	50	50	2.662	749	43.5	148	1.335	0.523	95.7
5/14-5/23, 1968	2	1	75	25	1.735	619	46.3	327	1.735	0.459	95.4
5/14-5/23, 1968	3	1	90	10	0.500	2028	48.4	57	0.159	0.335	95.2
5/14-5/23, 1968	4	0.25	90	10	2.142	1887	69.0	302	0.863	0.432	93.2
6/18-6/27, 1968	1	0.5	50	50	2.818	692	103.8	153	0.999	0.395	89.6
6/18-6/27, 1968	2	1	75	25	0.806	977	61.8	188	0.337	0.446	93.7
6/18-6/27, 1968	3	1	90	10	0.788	1345	79.4	68	0.196	0.270	92.1
6/18-6/27, 1968	4	0.5	75	25	3.933	476	104.5	285	1.247	0.354	89.6
7/30-8/8, 1968	4	0.5	100	0	1.155	1621	42.1	284	0.364	0.329	95.7

a) COD values are soluble.

TABLE 1 (Continued)

LABORATORY REACTOR STUDIES

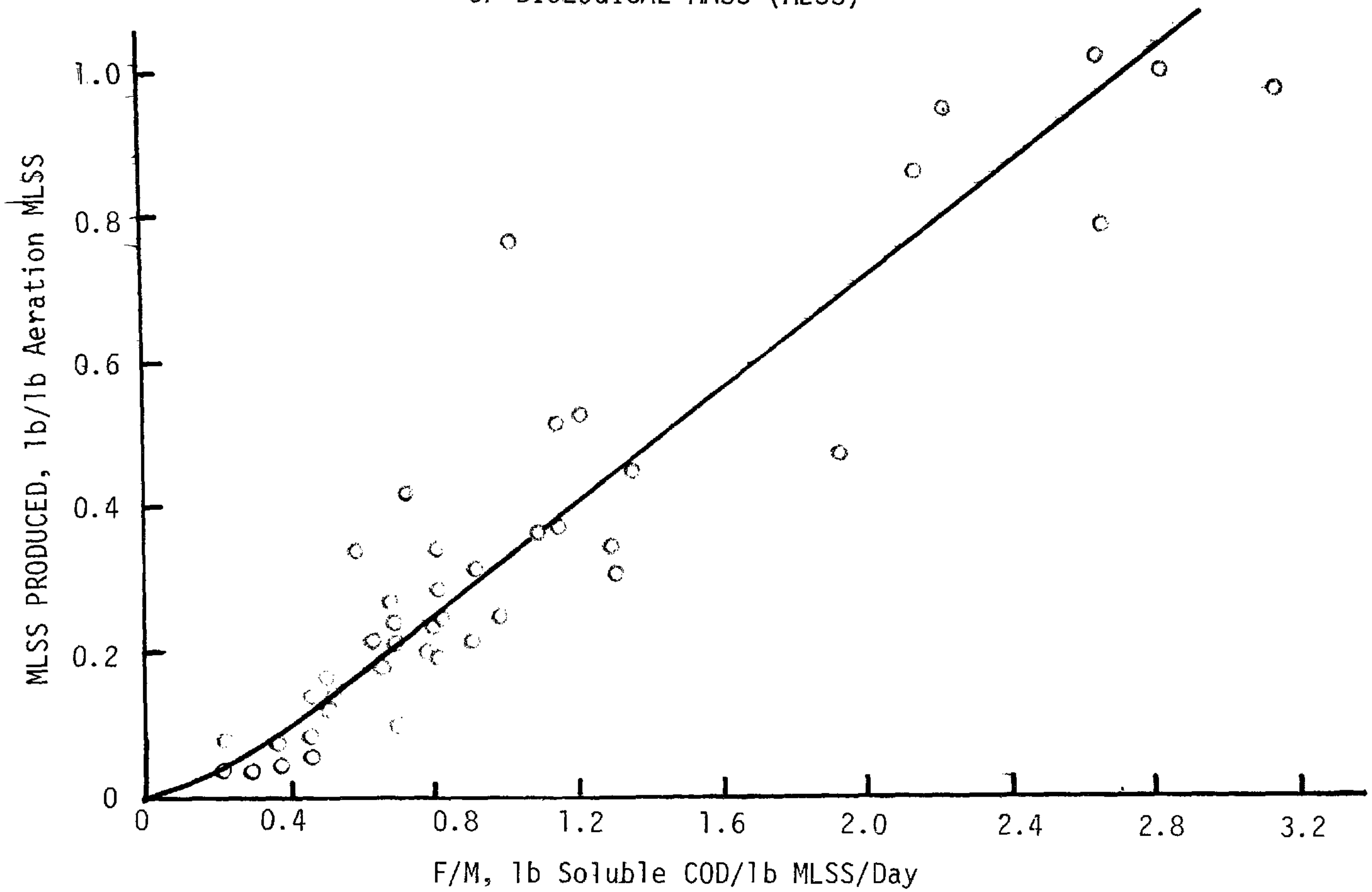
Steady State Material Balance Summaries

Dates	Reactor	Retention Time, days	Recycle, % of Feed	Wastage, % of Feed	F/M,[a)] lb COD/ lb MLSS-day	Reactor MLSS, mg/liter + 0.45 μ	Reactor COD,[a)] mg/liter − 0.45 μ	Effluent MLSS, mg/liter + 0.45 μ	Growth Rate Produced, lb MLSS/ lb Aeration MLSS-day	Yield, lb MLSS Produced/ lb Soluble COD Removed	Soluble COD Removal Efficiency, %
6/4-6/13, 1967	1	4	0	0	0.830	291	53.3	289	0.238	0.304	94.2
6/4-6/13, 1967	2	6	0	0	0.513	289	46.9	289	0.118	0.243	94.9
6/4-6/13, 1967	3	8	0	0	0.370	296	44.4	295	0.075	0.214	95.2
6/4-6/13, 1967	4	10	0	0	0.429	199	61.0	198	0.046	0.116	93.4
7/1-7/9, 1967	1	4	0	0	0.623	277	64.2	278	0.177	0.303	93.7
7/1-7/9, 1967	2	6	0	0	0.652	211	72.5	213	0.174	0.288	92.9
7/1-7/9, 1967	3	8	0	0	0.519	197	77.3	201	0.132	0.275	92.4
7/1-7/9, 1967	4	10	0	0	0.374	196	89.9	193	0.037	0.110	91.1
8/11-8/20, 1967	1	4	0	0	1.609	142	68.8	142	0.163	0.109	92.7
8/11-8/20, 1967	2	3	0	0	0.590	513	69.2	512	0.333	0.608	92.7
8/11-8/20, 1967	3	2	0	0	0.719	644	63.4	638	0.415	0.619	93.3
8/11-8/20, 1967	4	1	0	0	1.017	750	44.6	725	0.763	0.787	95.2
9/21-9/30, 1967	1	4	0	0	0.984	227	77.4	227	0.244	0.269	92.4
9/17-9/26, 1967	2	3	0	0	1.313	233	69.8	233	0.303	0.248	93.2
9/21-9/30, 1967	3	2	0	0	1.927	256	64.1	257	0.466	0.258	93.7
9/19-9/28, 1967	4	1	0	0	2.659	308	76.4	308	0.787	0.320	92.4
10/9-10/18, 1967	1	4	0	0	0.692	318	55.8	335	0.238	0.365	94.2
10/9-10/18, 1967	2	3	0	0	1.094	305	121.9	310	0.362	0.377	87.7
10/9-10/18, 1967	3	2	0	0	1.222	423	109.1	416	0.529	0.487	89.0
10/9-10/18, 1967	4	1	0	0	2.207	427	107.3	422	0.942	0.478	89.2
10/23-11/1, 1967	1	4	0	0	0.680	366	47.8	366	0.262	0.404	95.1
10/23-11/1, 1967	2	2	0	0	0.820	366	41.1	362	0.282	0.359	95.8
10/23-11/1, 1967	3	2	0	0	1.154	431	34.9	433	0.511	0.459	96.4
10/23-11/1, 1967	4	1	0	0	2.040	482	32.4	483	1.011	0.512	96.7
12/6-12/15, 1967	1	2	100	0	1.297	358	33.0	263	0.344	0.274	96.8
12/6-12/15, 1967	2	2	50	0	1.358	341	46.2	330	0.445	0.343	95.5
12/6-12/15, 1967	3	1	100	0	0.702	1475	41.6	148	0.093	0.139	95.9
12/6-12/15, 1967	4	1	0	0	3.144	329	60.8	330	0.977	0.330	94.1

a) COD values are soluble.

FIGURE 11

EFFECT OF F/M ON GROWTH RATE
OF BIOLOGICAL MASS (MLSS)



calculations, and may be used to estimate the quantity of sludge that will be produced in a treatment process. The same data, expressed as yield of MLSS per unit of soluble COD removal, are shown in Figure 12.

Table 2 summarizes oxygen uptake rate data from the continuous laboratory reactors. At steady-state this rate should be a constant[3]. The unit oxygen uptake rate is plotted in Figure 13.

<u>Batch Tests</u>

The purpose of a batch test is to obtain the unit rate of reaction (removal of soluble COD) for a given culture as a function of the concentration of substrate available for reaction (BOD). The BOD was estimated by calculating the difference between total COD and non-biodegradable COD[5]. The batch test procedure[5] was to mix measured amounts of culture from the continuous reactor and substrate to be tested in the prescribed proportion. The mixed liquor was then placed into the batch test vessel under adequate aeration. Samples were withdrawn at half-hour intervals for the first 4 or 6 hours with a final sample taken after 8 or 12 hours.

The soluble COD data for a given batch test were plotted as a function of time, and the rate of removal was determined at various values of the soluble COD remaining in the mixed liquor solution. The results are shown in Figure 14.

Effluent standards issued by regulatory agencies usually specify acceptable levels of BOD. The use of BOD analysis is not practical for laboratory studies, where great numbers of analyses are required; therefore the COD analysis was used for all of the experiments. Correlations were developed between BOD and COD, so that test results could be related

FIGURE 12

EFFECT OF F/M ON CONVERSION
YIELD OF BIOLOGICAL MASS (MLSS)

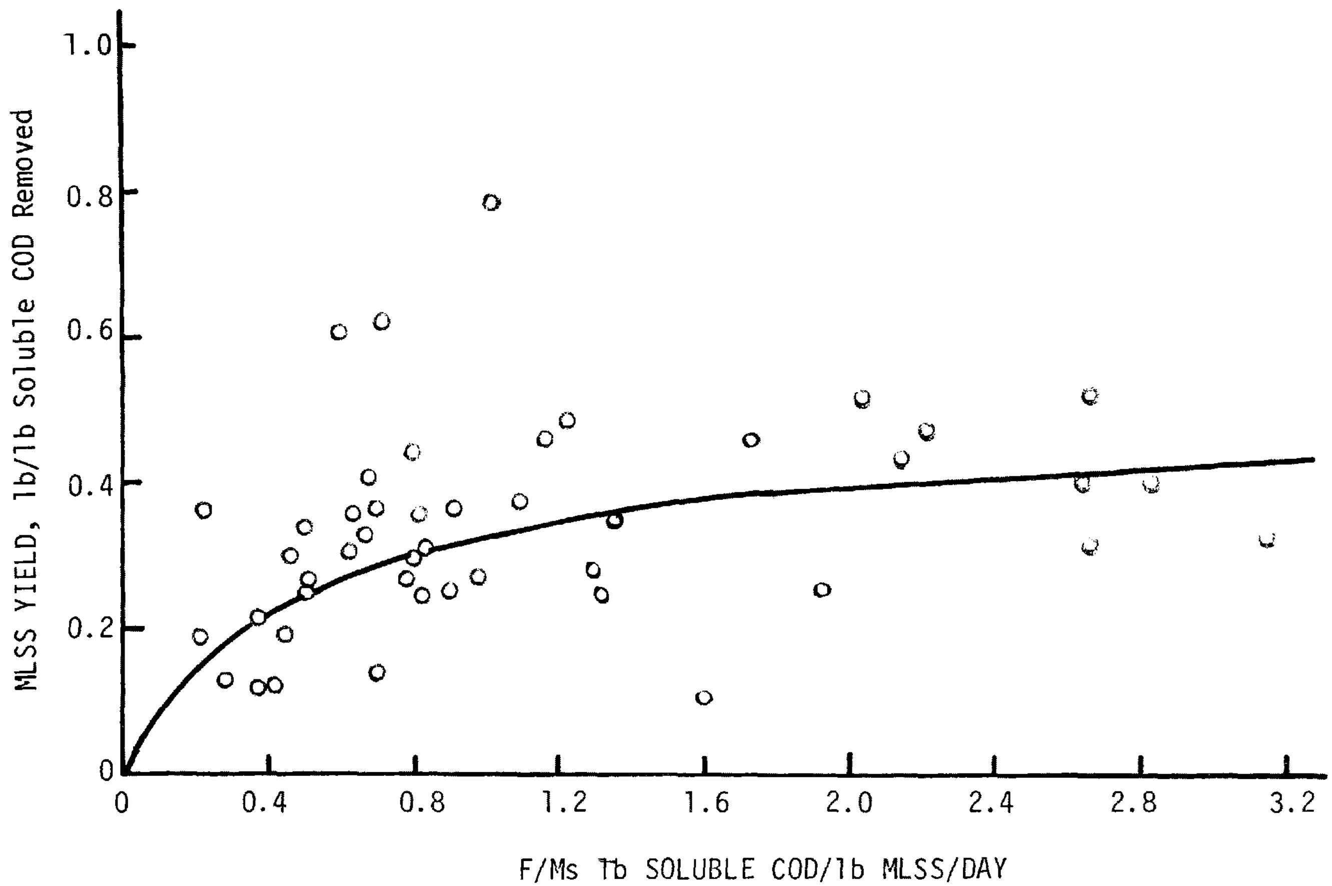


Table 2

CONTINUOUS LABORATORY REACTOR OXYGEN UPTAKE ANALYSES SUMMARY

Date	Reactor	Reactor MLSS, mg/liter	F/M, lb Soluble COD/ lb MLSS-day	Oxygen Uptake, mg/liter-minute	Unit Oxygen Uptake, lb O_2/ lb MLSS-hr
3/15/68	1	1820	0.24	0.215	0.0071
3/15/68	2	1970	0.25	0.205	0.0063
3/15/68	3	1470	0.62	0.325	0.0133
3/15/68	4	2160	0.89	0.65	0.0180
3/19/68	1	2830	0.18	0.23	0.0049
3/19/68	2	2350	0.24	0.22	0.0056
3/19/68	3	2000	0.47	0.33	0.0099
3/19/68	4	1910	1.01	0.59	0.0185
3/27/68	4	3210	1.56	2.00	0.0374
4/4/68	1	1916	0.45	0.41	0.0128
4/4/68	2	1032	1.12	0.59	0.0229
4/4/68	3	1840	0.48	0.75	0.0150
4/4/68	4	5110	0.71	1.75	0.0205
7/9/68	4	336	6.65	0.80	0.1429
7/17/68	4	688	3.39	0.40	0.0349
5/1/68	1	1840	0.48	0.41	0.0134
5/1/68	2	720	1.37	0.32	0.0267
5/1/68	3	1930	0.50	0.42	0.0131
5/1/68	4	3290	1.21	1.43	0.0261
	4	1396	1.30	0.845	0.0363

FIGURE 13

EFFECT OF F/M ON OXYGEN UPTAKE RATE

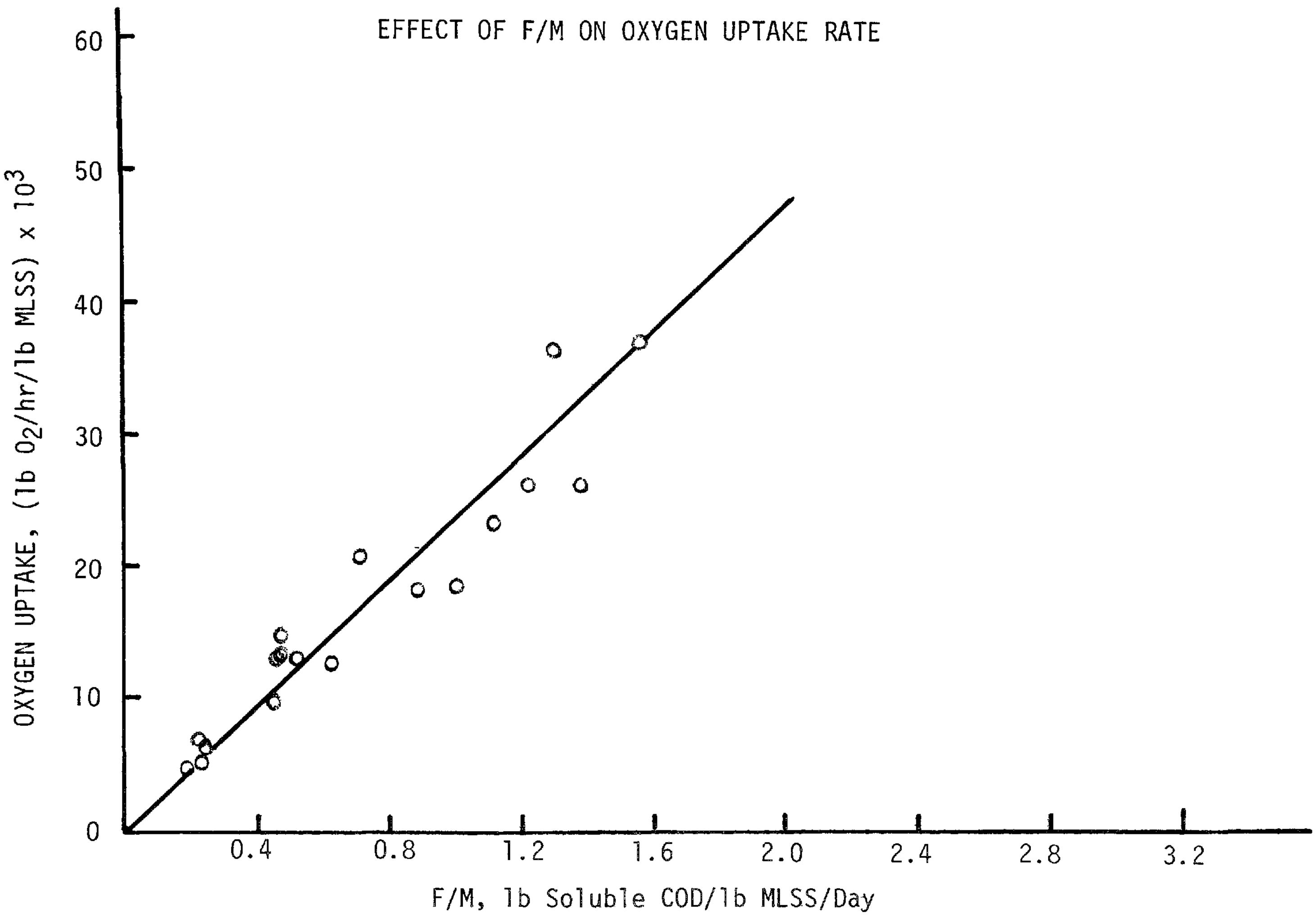
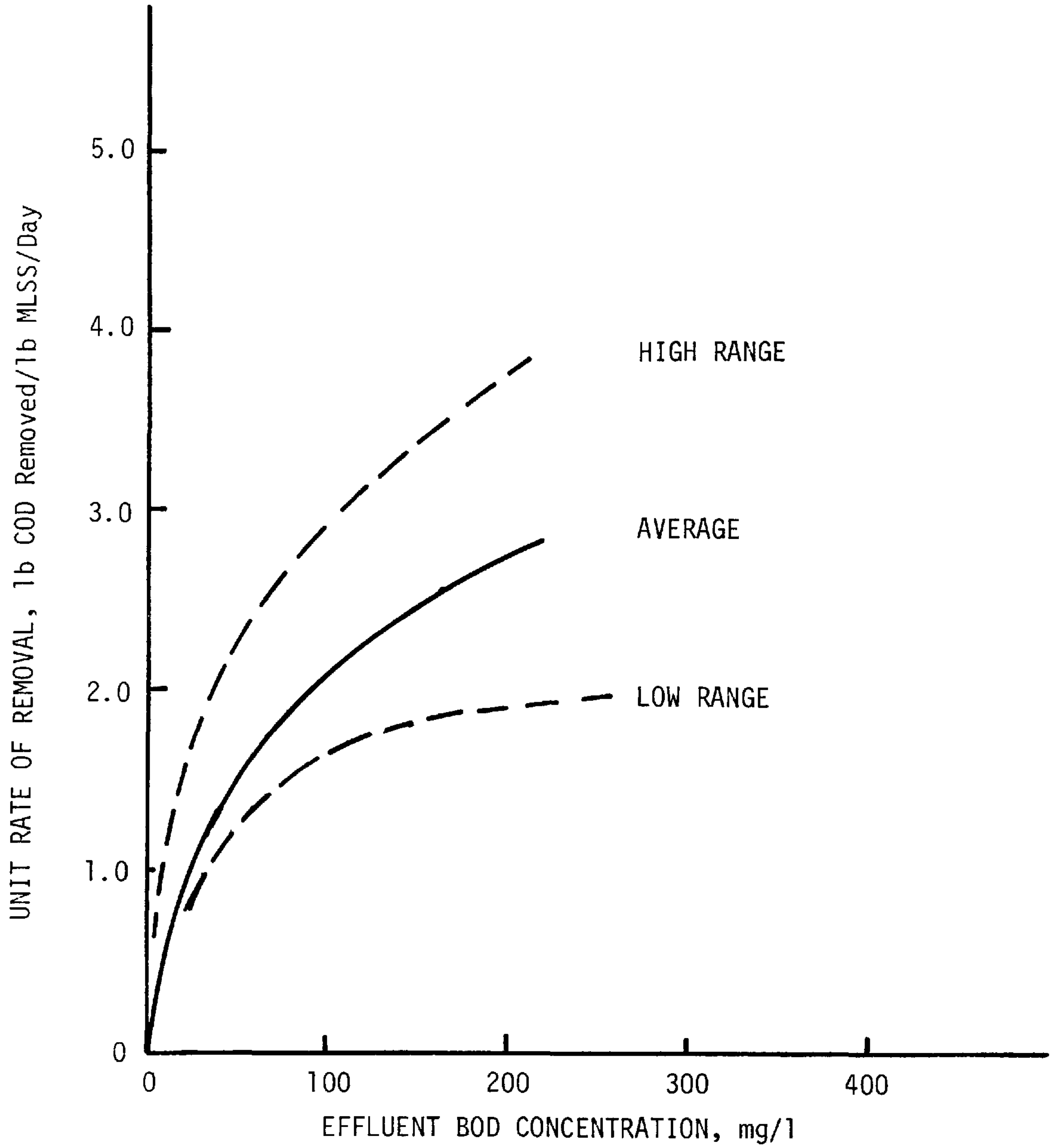


FIGURE 14

UNIT RATE OF REMOVAL FOR
CULTURES DEVELOPED IN CORN
WET MILLING WASTE WATER
LABORATORY BIOLOGICAL REACTORS



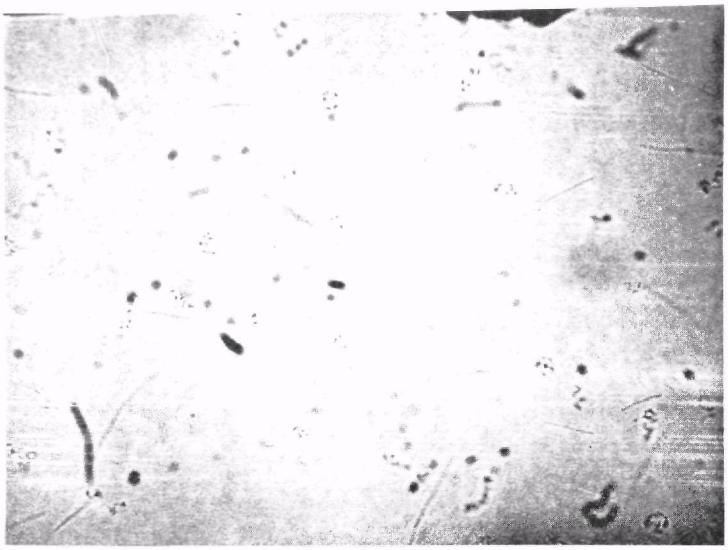
to effluent standards for BOD. The data indicate that the BOD is 25% to 30% of the COD for treated wastes. Calculations are shown in Appendix A.

Because of the importance of microorganisms in waste treatment[6], several photomicrographs are shown in Figures 15 and 16 to illustrate the biological cultures in the laboratory reactors. Figure 15a is taken from a reactor which was operating as a wash-out process. Because the biomass was not recycled, bacterial clumps failed to develop.

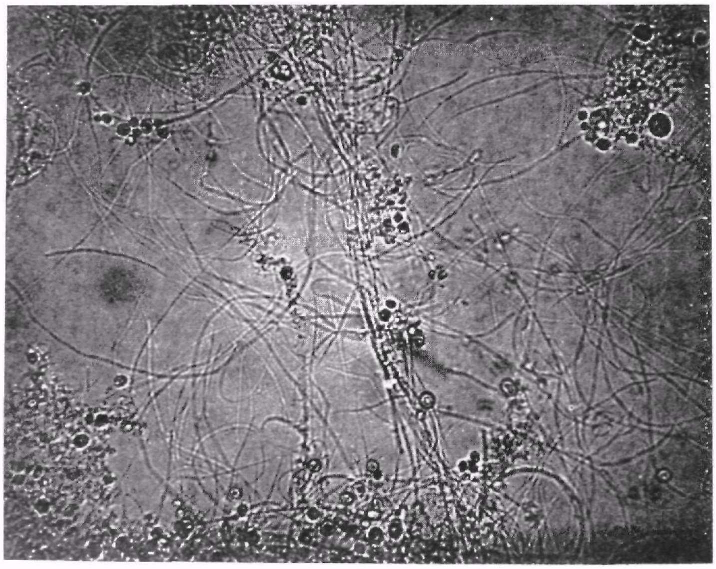
Filamentous organisms[1,4] sometimes appeared in the reactors, resulting in a culture with poor settling characteristics. An example of this is given in Figure 15b.

Cultures developed in reactors operating with recycle showed the best settling characteristics. Rotifers in particular are shown in Figure 16a, while Figure 16b shows a large variety of biological forms. Both pictures show excellent clumping.

FIGURE 15
REACTOR CULTURES: UNDESIRABLE GROWTH



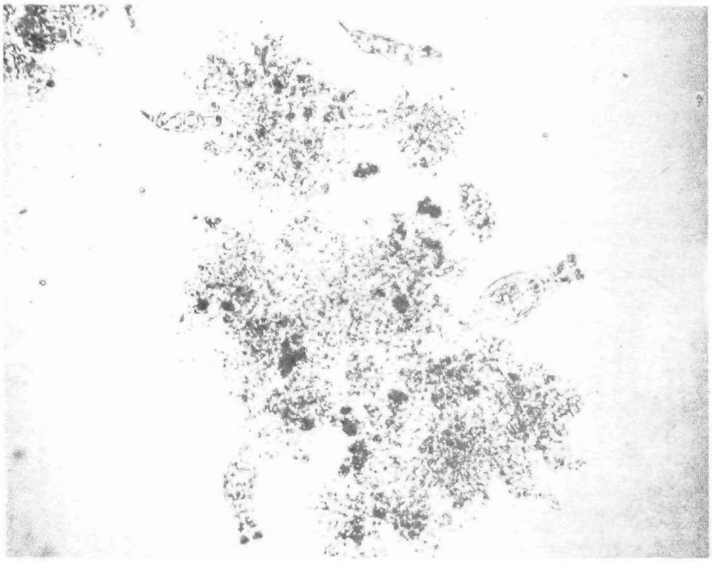
15a. Culture from a reactor which was operating as a wash-out process.



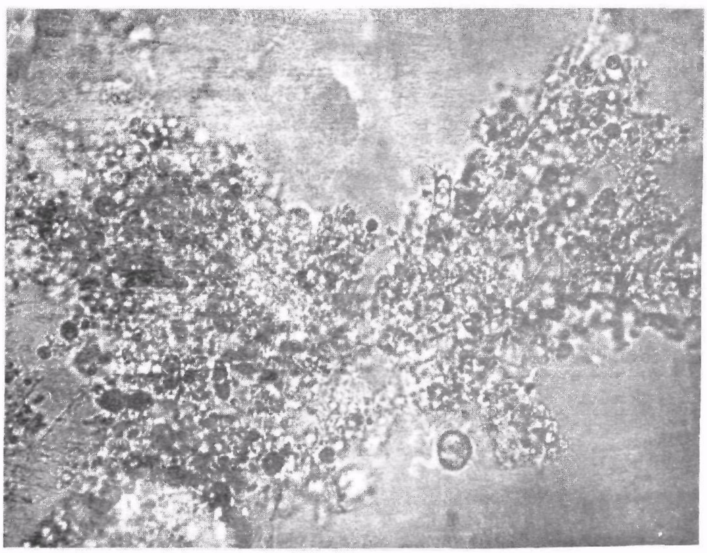
15b. Filamentous organisms, which sometimes appeared in the reactors.

FIGURE 16

REACTOR CULTURES: IMPROVED GROWTH



16a. Culture from a reactor operating at 100% recycle.



16b. Culture from a reactor operating at 90% recycle.

SECTION V

DESIGN BASIS

As a result of the laboratory work and some additional solids separation studies, the following process steps were decided upon for treating the waste.

1. Equalization
2. Cooling
3. Aeration
4. Clarification
5. Dissolved Air Flotation
6. Solids Thickening
7. Final Effluent Reaeration

A schematic of this system is shown in Figure 17. Some of the equipment is shown in Figures 18 and 19. The following description is of the equipment as originally installed. Many modifications, described later, have since been made.

EQUALIZATION

As is the case with many industrial wastes, the raw waste suspended solids concentrations are not great enough to require initial clarification. The first phase of the completely mixed activated sludge process is usually aeration. However, in this study all waste load data were based on 24-hour composite samples. It was known that product changes and batch operations in the manufacturing area could cause wide variations in BOD concentration and pH within a 24-hour period. Therefore, it was decided to install an equalization tank with 24 hours retention at normal flow, or 900,000 gallons. It was also necessary to provide some volume for accumulation of waste so that the treatment plant could be shut down for maintenance without shutting down the manufacturing plant. Essentially all maintenance requirements could be accomplished within 8 hours. Allowing for

Figure 17

PEKIN WASTE TREATMENT PLANT

FLOW DIAGRAM

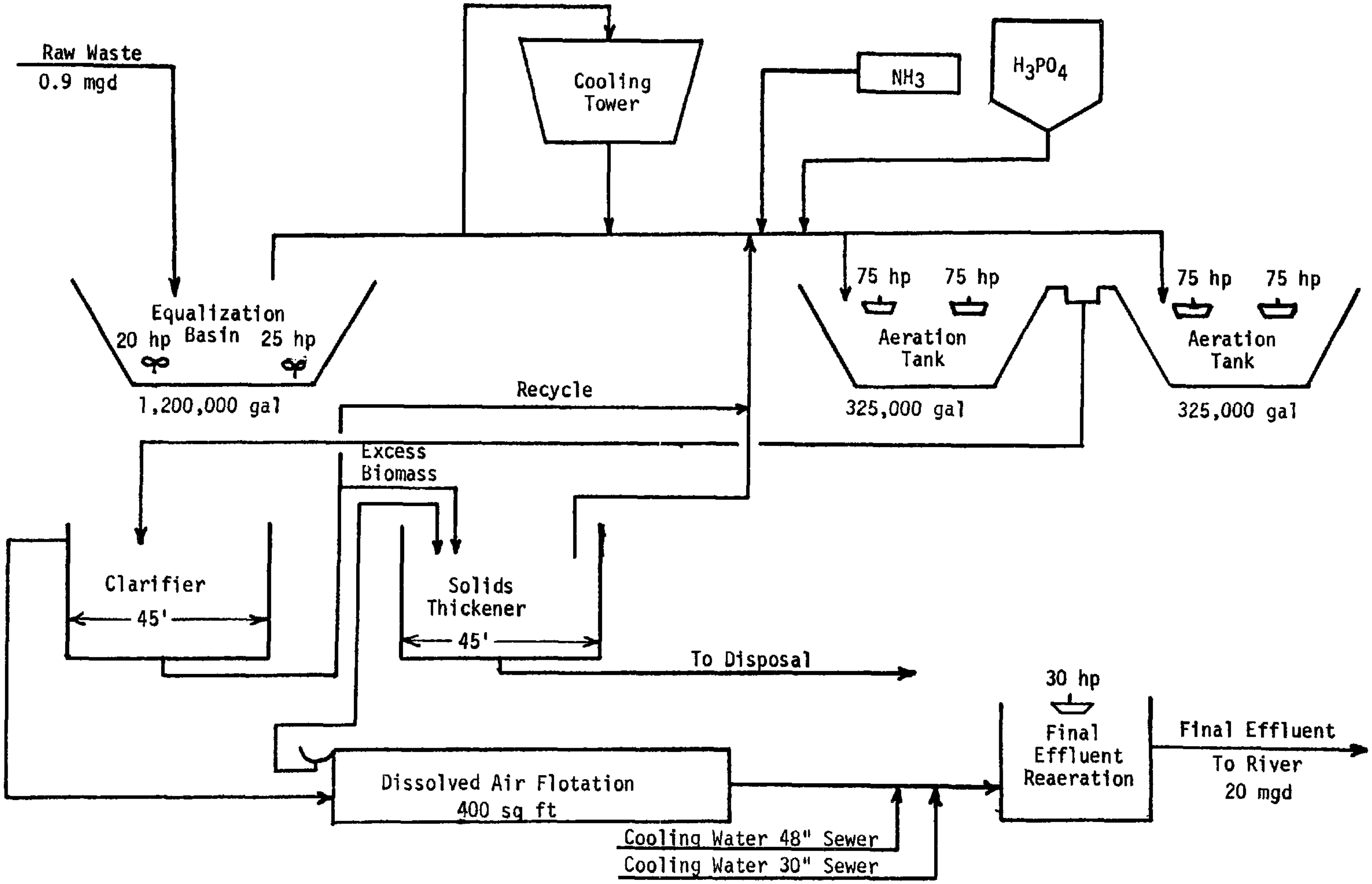
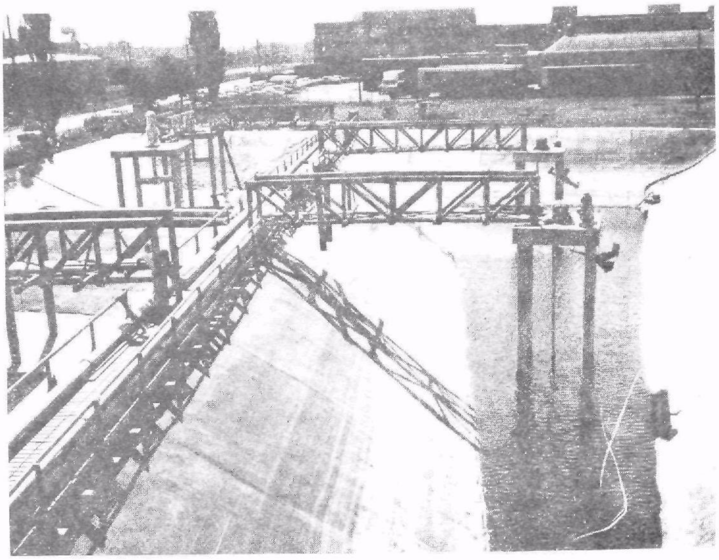
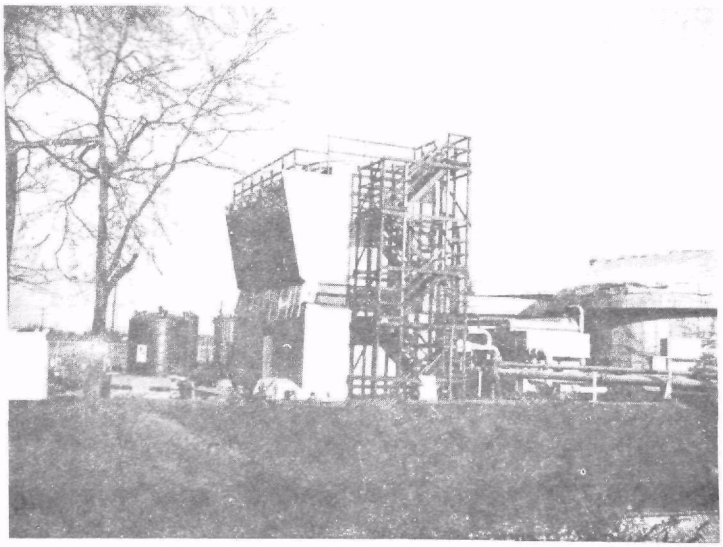


FIGURE 18
PEKIN WASTE TREATMENT FACILITIES

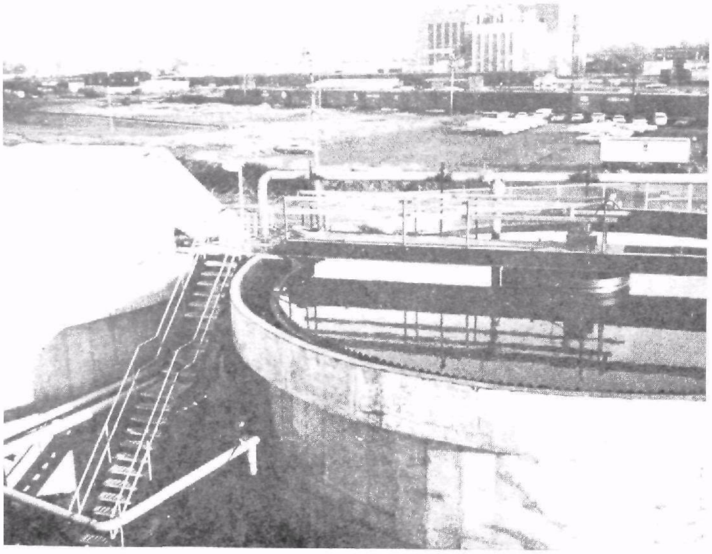


18a. Equalization basin, foreground, with adjacent aeration tanks on left.

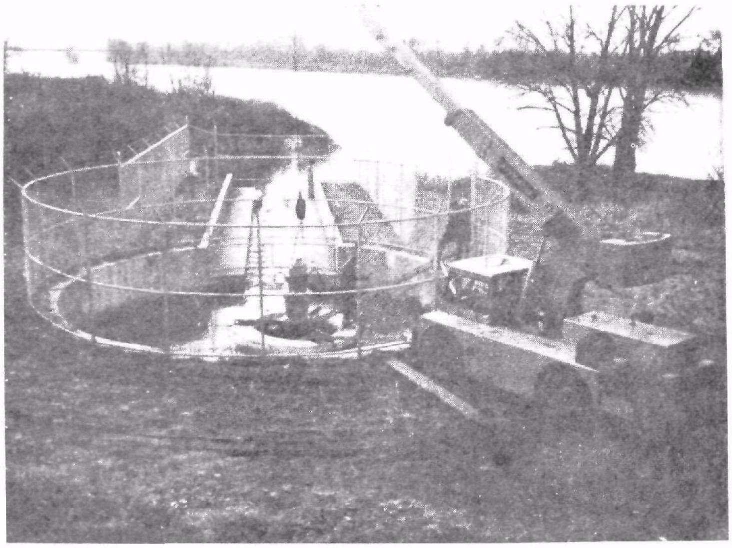


18b. Cooling tower, with clarifier in background.

FIGURE 19
PEKIN WASTE TREATMENT FACILITIES



19a. Clarifier (right) and thickener (left).



19b. Floating aerator being lowered into reaeration basin, with Illinois River in background.

a normal equalization basin operating volume of 900,000 gallons and an 8-hour accumulation of an additional 300,000 gallons in case of repair and maintenance, the total design volume was 1.2 million gallons. An additional benefit of this design was to provide an adequate supply to the aeration tanks on weekends, when the waste flow from the manufacturing plant was greatly reduced.

Because of the shape and size of the available land area, the equalization basin is of irregular shape, and was constructed with an interior 1/16-inch thick rubber lining over sloping compacted earth and gravel walls. As will be seen, this was not a satisfactory design. Two turbine agitators mix the contents. The unit in the larger end was 25 hp and the one in the smaller end was 20 hp. These agitators were sized by the manufacturer to meet the specifications of maintaining a suspension of up to 1700 mg/l of starch granules, and of blending the basin contents uniformly within 30 minutes. The 25-hp agitator had a 102-inch impeller operating at 37 rpm, and the 20-hp unit had an 84-inch impeller operating at 45 rpm. As will be seen later, these turned out to be inadequate for the job.

Waste is pumped from the equalization basin, with a level recorder provided to aid in adjustment of the flow rate. Alarms indicate pump or agitator motor failure.

COOLING

The waste stream temperature averages 120°F, occasionally reaching 150°F. In order to maintain a temperature range of 75°-90°F in the aeration basin in summer, some of the waste stream must be cooled. A spray-type cooling tower is provided for this purpose.

The tower was sized to cool the concentrated waste stream to an average of not more than 90°F over a 24-hour period at the most severe conditions of temperature and relative humidity. Meterological data from the U.S. Weather Bureau for the Peoria, Illinois area during several recent years were used to determine these conditions.

The temperature in one aeration tank is recorded. The temperature control element is located in the combined supply and recycle line to the aeration basin. Temperature control is obtained by automatically passing a suitable volume of the supply stream through the cooling tower.

AERATION

The purpose of the aeration tank is to provide an environment suitable for the growth of the appropriate microorganisms. An extensive laboratory program was conducted at the Pekin plant to determine the rate of COD removal, oxygen requirements, and biomass growth rate for the completely mixed activated sludge process, using cultures developed in the environment of corn wet milling wastes. As a result of these tests, unit rate of removal curves were determined for a wide range of laboratory operating conditions, described in Appendix A. Most of the data fell within the range of the dotted lines shown in Figure 14. The solid curve represents the approximate average. These curves show the quantity of COD that can be removed per day per pound of MLSS under aeration, at different BOD values.

The effluent BOD standard for discharge into the Illinois River when the treatment process was designed was 40 mg/l. Another constraint on the operation of the aeration process, determined during the development work, is that the system should be maintained at less than 100 mg/l soluble COD, to minimize the chance of growth of filamentous bacteria. In the laboratory studies, the COD:BOD relationship for the treated effluent had been found to be approximately 100:30 (COD:BOD correlations are given in Appendix A). Therefore, 100 mg/l COD was used for design. An MLSS concentration of 3000 mg/l was selected, based on laboratory tests which showed that operation at this level generally resulted in a culture with good settling characteristics. The concentration can be increased if necessary for treating unusually high waste loads or if lower rates of removal are experienced during winter operation. This level is controlled by varying the biomass recycle and wastage rates.

The raw waste flow is approximately 900,000 gallons per day (gpd) with a COD concentration of 2,500 mg/l. The calculations for sizing the aeration basins are summarized below.

(1)	Raw Waste Volume. gal/day	900,000
(2)	COD Concentration, mg/l	2,500
(3)	COD in Waste, lb/day	18,800
(4)	Effluent COD, mg/l	100
(5)	Effluent COD, lb/day	750
(6)	COD Removed, lb/day (3) - (5)	18,050
(7)	Effluent BOD, mg/l	30-40
(8)	Unit Rate of Removal at 40 mg/l BOD (from Figure 14), lb COD/lb MLSS/day (using low range of data)	1.1
(9)	MLSS Required, lb (6) ÷ (8)	16,200
(10)	MLSS Concentration, mg/l	3,000
(11)	Aeration Tank Volume Required, gallons	650,000

Oxygen requirements for the completely mixed activated sludge process were determined by laboratory tests and are summarized in Table 2. The maximum load expected was 30,000 lb COD per day. The unit oxygen uptake rate is a function of the F/M ratio, as shown in Figure 13. The oxygen requirement calculations are as follows.

(1)	Maximum Waste Load, lb COD/day	30,000
(2)	Normal MLSS in Aeration Tanks, lb	16,200
(3)	Maximum F/M (1) ÷ (2)	1.85
(4)	Unit Oxygen Rate, lb O_2/hr/lb MLSS (Figure 13)	0.041
(5)	Oxygen Required, lb/hr (4) x (2)	665

The calculations showed that 665 lb/hr of oxygen transfer was required. Surface aeration was selected for the Pekin process due to its relatively high oxygen transfer efficiency, and good liquid mixing characteristics for the completely mixed process. The α and β values, factors relating oxygen transfer rate and oxygen saturation in the mixed liquor, respectively, to the values for water, were determined to be 0.85 and 0.95. The oxygen requirements and other data were sent to several aerator suppliers for bids. The selected supplier (as well as others) found that four 75 hp surface aerators were required.

The aeration station was designed to consist of two excavated, rubber-lined basins, each with a capacity of 325,000 gallons. Oxygen is provided by two 75 hp surface aerators in each tank. Fixed-mount aerators were selected because of lower cost in comparison with floating mount for this size unit. Depth of submersion is critical for proper operation of surface aerators. Level control is obtained by overflowing a weir at one end of each tank. The weir was designed to hold the level within one inch of nominal over the expected range of flows, so that optimum aerator submergence could be obtained.

Waste is pumped from the equalization basin to the aeration tanks through a flow recorder-controller. The flow rate is set according to the level in the equalization tank. The supply stream is automatically sampled, and split equally between the two aeration tanks. This is accomplished by using symmetrical piping, and flow distribution nozzles on the outlet to each tank. In addition to the waste, the supply stream contained added nutrients, recycled biomass from the clarifier, and thickener overflow.

Nutrient addition is necessary to maintain the ratio COD:N:P = 100:5:1. Nitrogen is added in the form of ammonia, with a flow control station for controlling the rate of addition. Phosphorus is added in the form of phosphoric acid, which is stored in a 3000-gallon tank. The concentration of acid in the tank is maintained at 65% to 70% to prevent freezing, as the freezing point is below 0°F at these concentrations.

CLARIFICATION

The mixed liquor from the aeration tank is pumped to a clarifier for the purpose of separating the suspended solids from water by gravity settling. The clarifier supply rate, supply solids concentration, overflow rate, and desired overflow concentration were given to four clarifier manufacturers. Each recommended a 45-foot diameter unit, corresponding to an overflow rate of about 550 to 650 gallons per day per square foot over the expected range of flows.

A suction-type clarifier was selected, which uses a rotating, perforated tube for collecting solids across the entire bottom, to a collecting well. The construction of the unit is concrete, with the interior coated. The suction arm is galvanized steel, and the remaining steel is painted.

Clarifier overflow goes to the dissolved air flotation tank. The settled biomass collected from the clarifier was expected to have a concentration of 8,000 to 10,000 mg/l solids. Most of this stream is recycled to the aeration tank.

Settled biomass which is not needed to maintain the culture in the aeration tank must be removed. This excess biomass went to the thickener. Flow controls were provided for the biomass recycle stream and for the excess biomass stream.

DISSOLVED AIR FLOTATION

Since laboratory studies had indicated that the waste was susceptible to the growth of filamentous organisms, resulting in an effluent with poor settling characteristics, and since filamentous organisms can be removed from suspension by dissolved air flotation, a dissolved air flotation station was included in the process design.

Overflow from the clarifier flows by gravity to the flotation cell. Some of the effluent from the flotation cell is recycled through a pump to a pressure tank, where it is contacted with air at 60 to 70 psi. The air-saturated water then returns to the flotation cell. When the pressure is released from the recycle stream, the air that had been dissolved at the higher pressure comes out of solution as very small bubbles. The air bubbles rise to the surface, carrying suspended particles with them. These floated solids are removed by paddles suspended from a moving chain. The solids are raked onto a beach plate, and then dropped into the foam collecting tank where it mixes with the settled solids from the thickener. The clarified water from the flotation cell flows by gravity to the reaeration tank.

The supplier selected a 400-square foot unit, based on specifications of an average supply stream of 625 gallons per minute containing 500 mg/l suspended solids, to produce an effluent of less than 45 mg/l suspended solids.

SOLIDS THICKENING

The purpose of the thickener was to increase the concentration of the clarifier underflow in order to reduce the volume of excess biomass to be processed. In order to determine the necessary thickener size, data from the continuous laboratory reactors was used to estimate the quantity of excess biomass production in the aeration tanks. Figure 11 shows the biomass growth rate as a function of F/M. The excess biomass handling system was sized for average F/M as follows.

(1)	COD in Waste, lb/day	18,800
(2)	MLSS in Aeration Tanks, lb	16,200
(3)	F/M, lb COD/lb MLSS/day (1) ÷ (2)	1.1
(4)	Growth Rate, lb MLSS/day/lb MLSS in Aeration Tanks (from Figure 11)	0.41
(5)	Excess Solids Produced, lb/day (4) x (2)	6,700

The anticipated flow rate and concentration of the biomass stream were given to several thickener manufacturers who were asked to give their recommendations for the diameter of the unit. Recommendations varied from 30 to 45 feet in diameter.

It was decided to use a 45-foot diameter unit, the same as the clarifier, since this simplified the design and construction of the concrete tanks somewhat. In addition, the larger unit provided adequate volume for biomass accumulation during times when the excess biomass disposal process is not operating. The thickener was similar to the clarifier in design and construction, except that the settled solids were discharged by a rotating rake mechanism, rather than by a suction tube.

According to the manufacturer, a thickener of this capacity should increase the concentration of the biomass to about 3% solids. The thickener underflow was removed for disposal, a process not covered by this report. The thickener overflow was returned to the aeration tanks.

FINAL EFFLUENT REAERATION

The treated effluent is combined in the reaeration tank with the cooling water from the 30-inch and 48-inch sewers, creating a single outfall for sampling and measuring. The 25 hp floating aerator is sized to increase the dissolved oxygen content of the effluent to 4 mg/l, at an average flow of 20 mgd.

SECTION VI

PLANT STARTUP AND OPERATION: NOVEMBER 1970-SEPTEMBER 1971

Plant operation began in November 1970, utilizing the equalization basin and aeration tanks. Development of the biological culture was started by using clarifier underflow from another corn wet milling activated sludge plant as seed. Initially, 5,000 gallons of seed, 100,000 gallons of concentrated waste and 200,000 gallons of city water were placed in each tank. A fill-and-draw procedure was used for the first 6 days of operation, until the MLSS concentration was built up to about 1500 mg/l. For the next two weeks, the aeration tanks were operated on a washout basis, treating about 25% of the plant waste. Because no recycled biomass was available, the MLSS dropped to 900 mg/l in the aeration tanks.

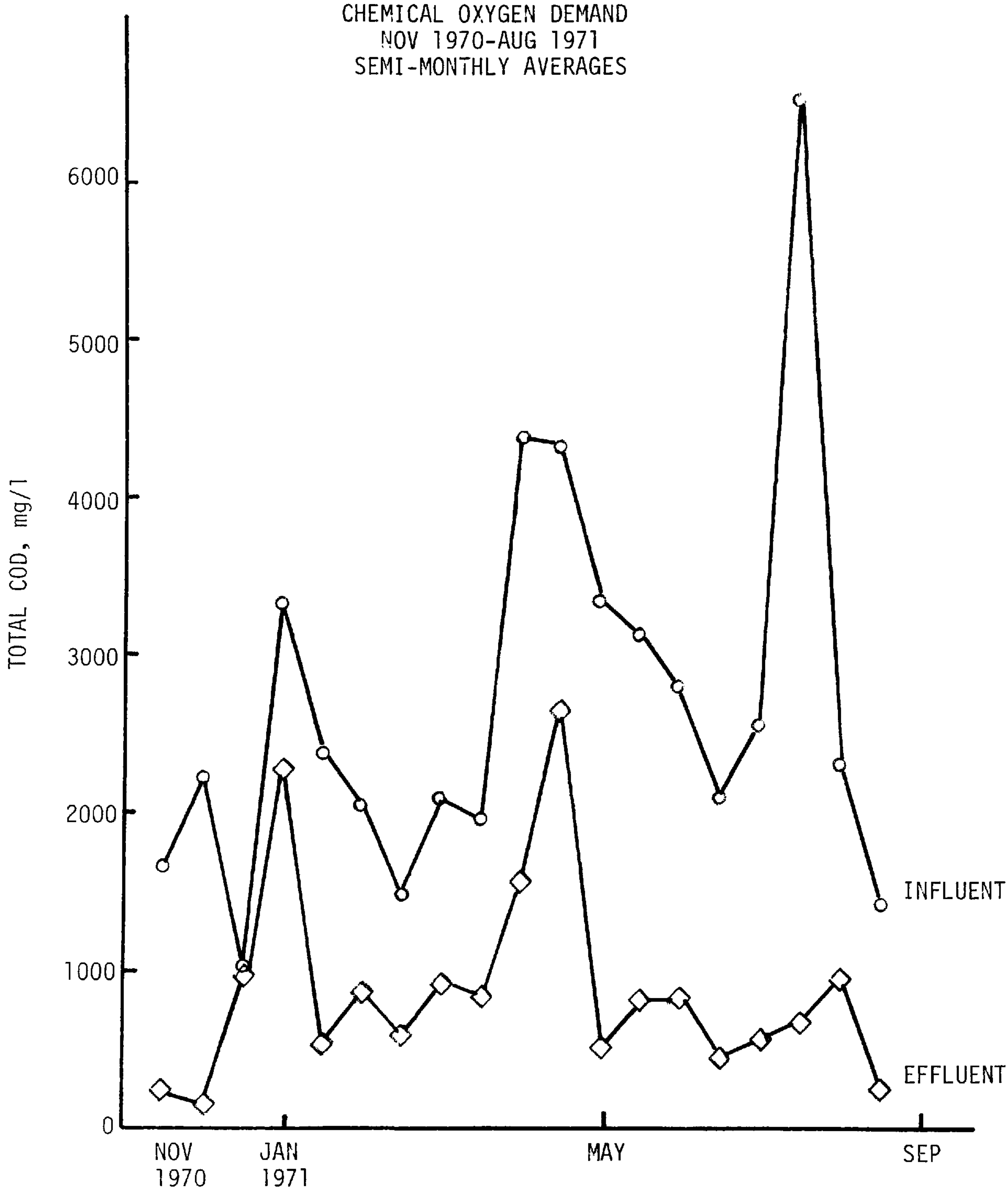
The clarifier was put into operation December 1970. Initial operation on the total plant waste flow produced an effluent with a soluble COD concentration of less than 100 mg/l, with a suspended solids concentration in the aeration tanks of 2000 to 3000 mg/l. Clarifier underflow had a suspended solids concentration of 10,000 to 20,000 mg/l; overflow, 100 to 150 mg/l.

The remaining equipment for the waste treatment plant was placed in service by the end of January 1971. However, the smooth operation observed during this period was to be the last that would be seen for nearly a year. A combination of mechanical failures and unforeseen operational problems demanded a great deal of time, attention, and money.

Figure 20 gives the semimonthly average total COD concentration for influent and effluent, calculated by computer. Monthly averages were

FIGURE 20

CHEMICAL OXYGEN DEMAND
NOV 1970-AUG 1971
SEMI-MONTHLY AVERAGES



not used because of the relatively short time period involved. Semimonthly averages were chosen rather than biweekly averages in order to facilitate computer programming. The original data are given in Appendix C.

Figures 21 and 22 give the probability of occurrence of influent and effluent COD concentrations, respectively. These figures are based on computer-generated distributions of the daily data, given in Appendix C along with computer-generated histograms of these distributions.

Figure 23 shows the semimonthly averages for effluent suspended solids, calculated by computer in the same manner as the COD data. Figure 24 gives the probability of occurrence for effluent suspended solids concentrations, developed from a computer-generated distribution. The original data, the distribution, and a computer-generated histogram of this distribution are also given in Appendix B.

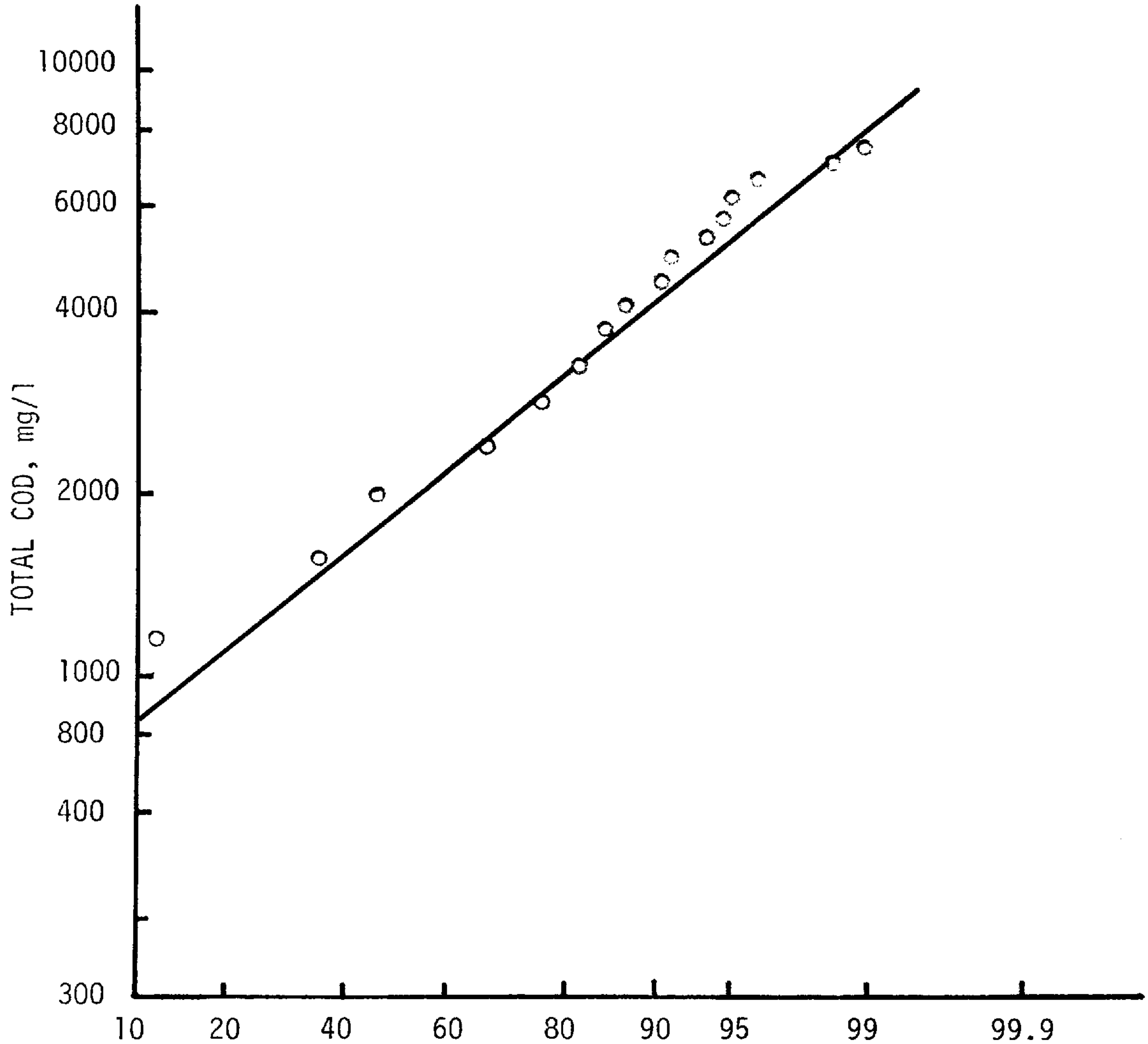
Of the problems encountered during this period, the most serious were the splitting of the rubber liners in the equalization and aeration tanks, and odor problems that developed in the equalization tank and thickener.

RUBBER LINER PROBLEMS

On December 14, 1970, it was noticed that a seam in the equalization basin was open for a distance of about 30 feet, as shown in Figure 25a. As recommended by consultants, based on soil boring tests, the equalization and aeration tanks were constructed with sloping sides, with the slope ratio 1.5:1. This turned out to be sufficiently close to the angle of repose of the soil that the wave action due to the agitators and aerators caused the soil to come loose under the liner and fall to

FIGURE 21

INFLUENT TOTAL CHEMICAL OXYGEN DEMAND
NOVEMBER 1970-AUGUST 1971



PROBABILITY OF OCCURENCE:

PERCENT OF DAYS COD WAS LESS
THAN OR EQUAL TO INDICATED CONCENTRATION

FIGURE 22

EFFLUENT TOTAL CHEMICAL OXYGEN DEMAND
NOVEMBER 1970-AUGUST 1971

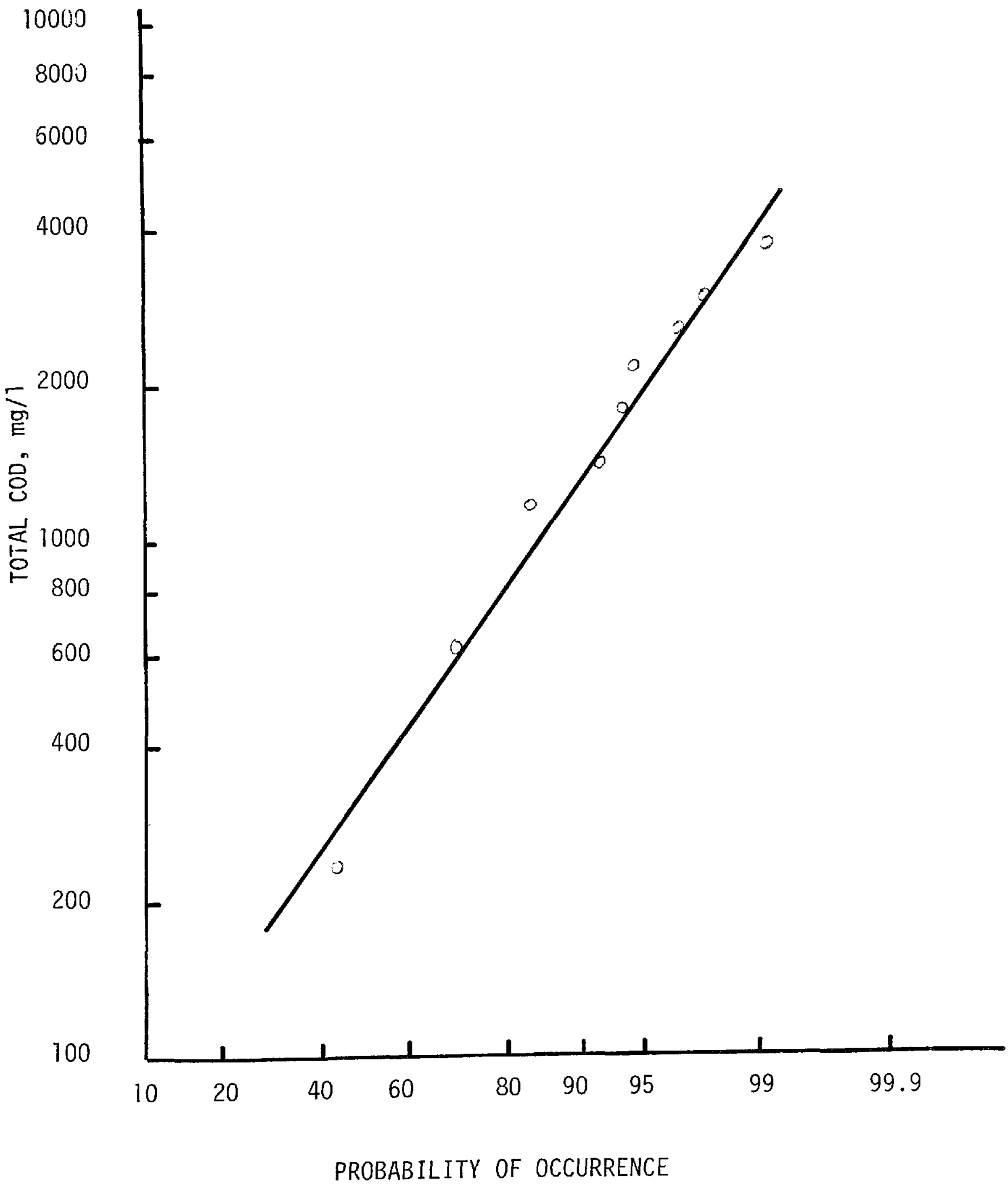


FIGURE 23

EFFLUENT SUSPENDED SOLIDS CONCENTRATION
NOVEMBER 1970-AUGUST 1971
SEMIMONTHLY AVERAGES

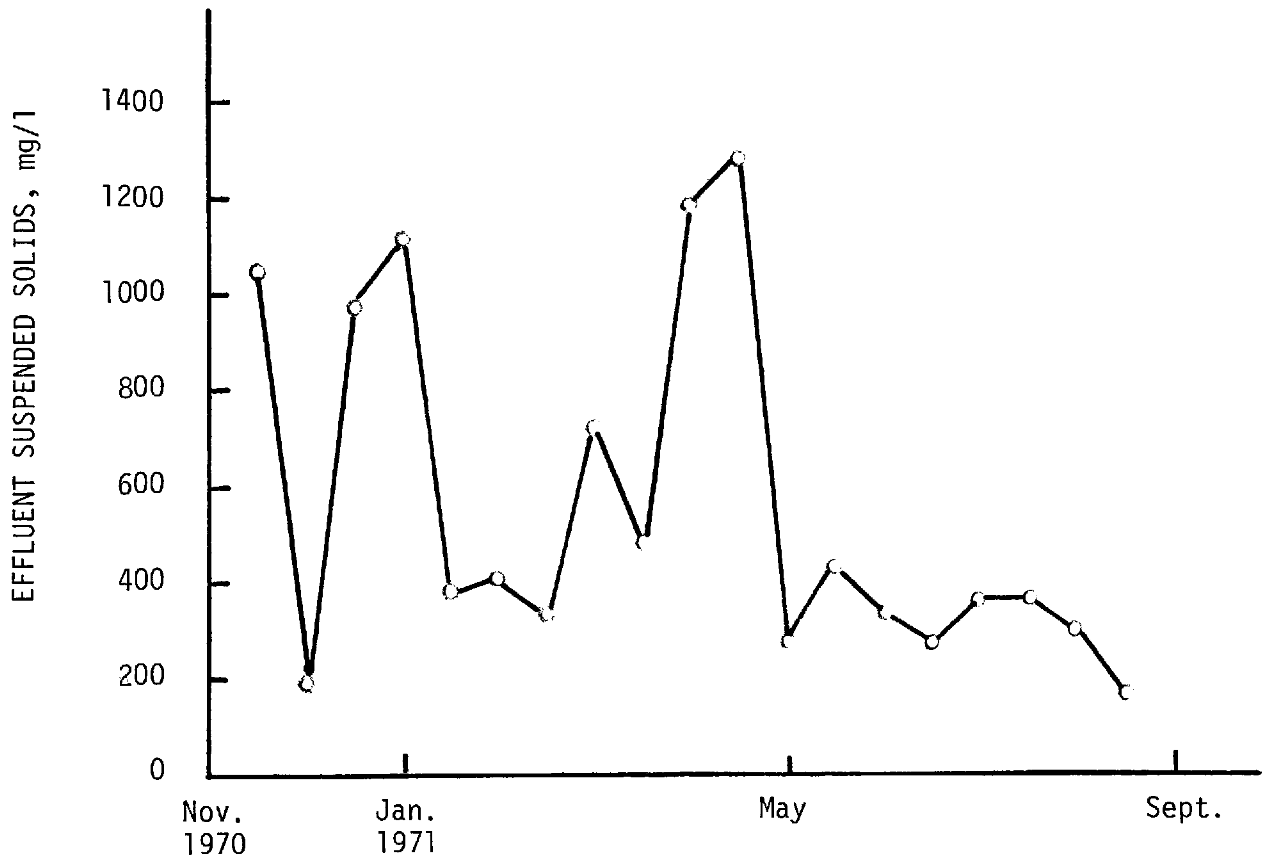


FIGURE 24

EFFLUENT SUSPENDED SOLIDS
NOVEMBER 1970-AUGUST 1971

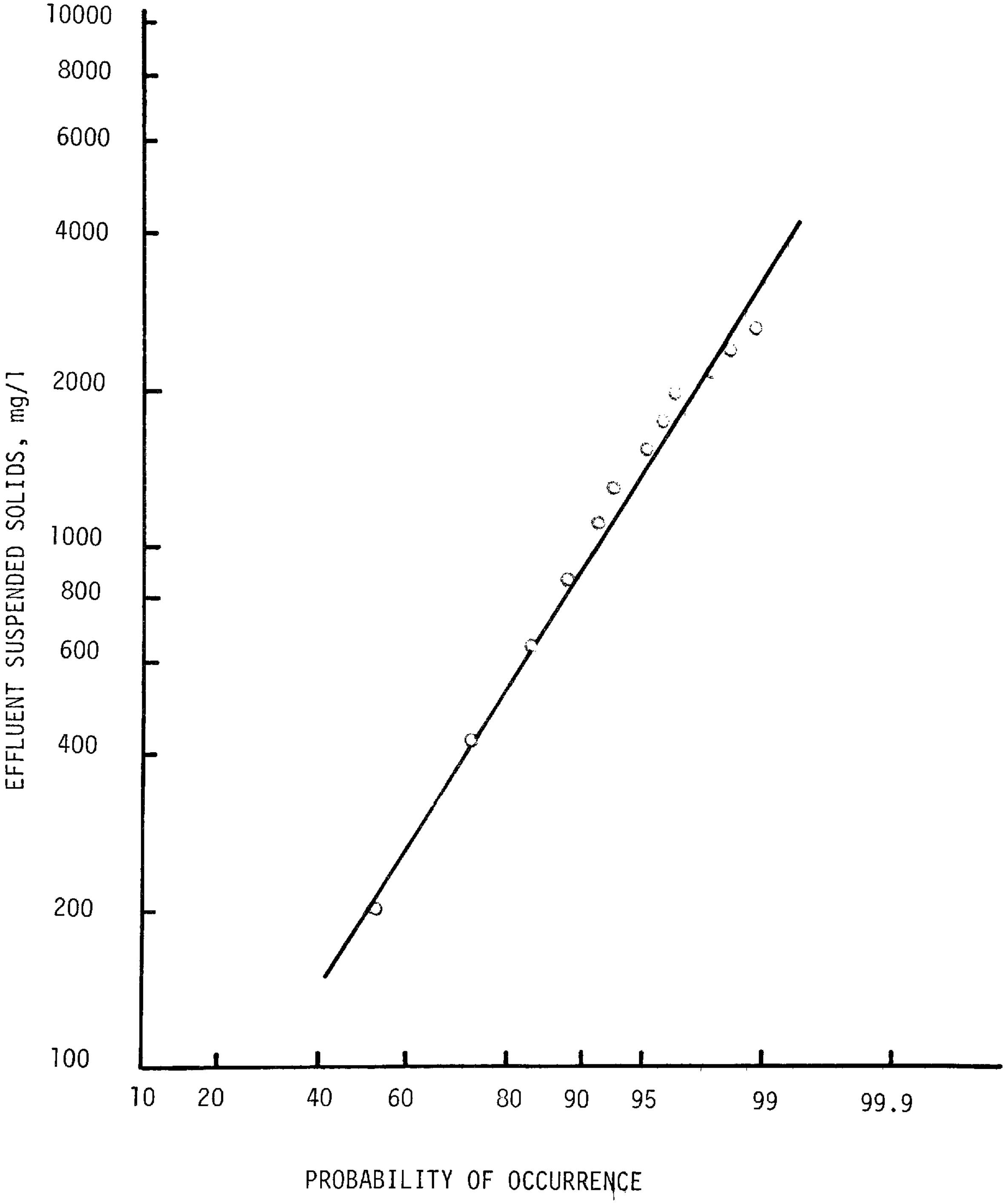
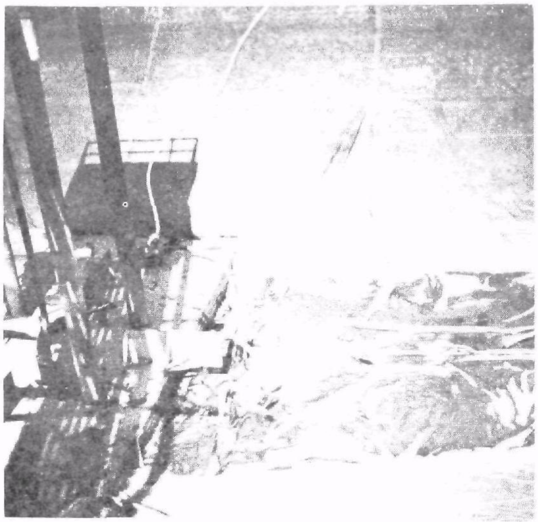
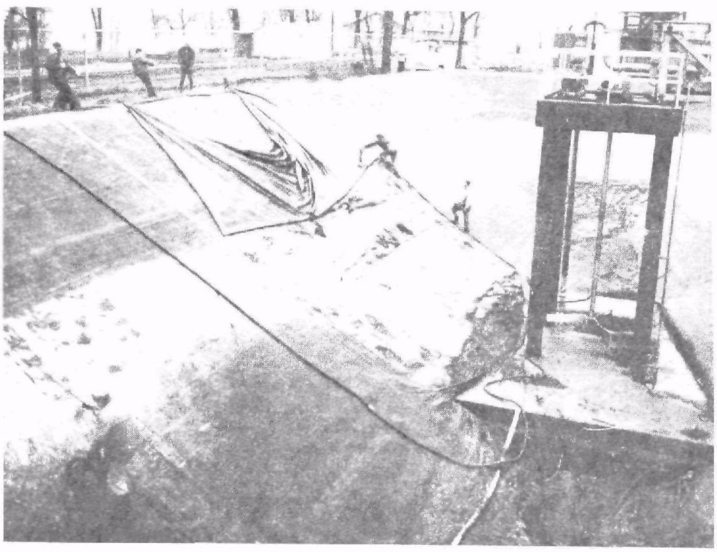


FIGURE 25
EQUALIZATION BASIN LINER PROBLEMS



25a. Split seam in the rubber lining of the equalization basin.



25b. Repair work on the lining of the equalization basin.

the bottom. The resultant tension applied to the rubber lining caused the seam to split.

Repair work involved draining and cleaning the tank, cutting away the lining, replacing the fallen material, and adding cement to create a soil cement with a 1 to 6 mixture. Figure 25b shows the repair work in progress.

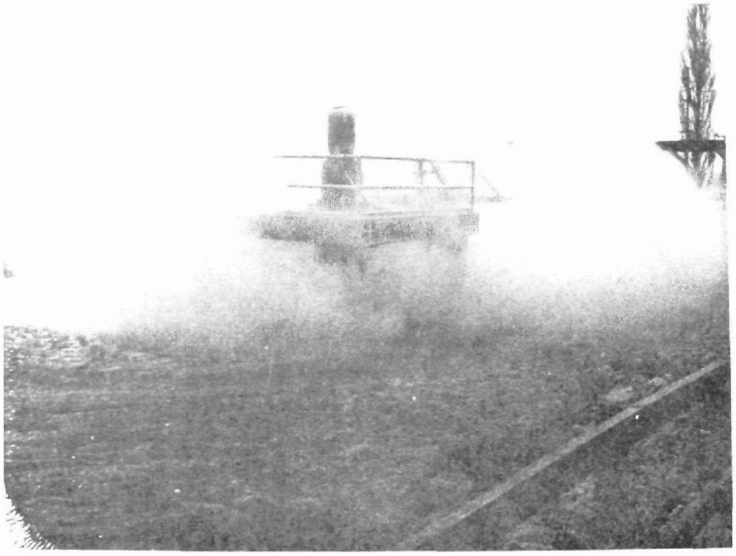
During this time, piping was installed to allow pumping the waste directly to the aeration tanks. The lining was repaired, but the repaired areas failed again immediately upon being put back in service.

Supplying raw waste directly to the aeration tanks resulted in severe foaming problems, illustrated in Figure 26a. This problem disappeared when the equalization basin was returned to service after being repaired the second time.

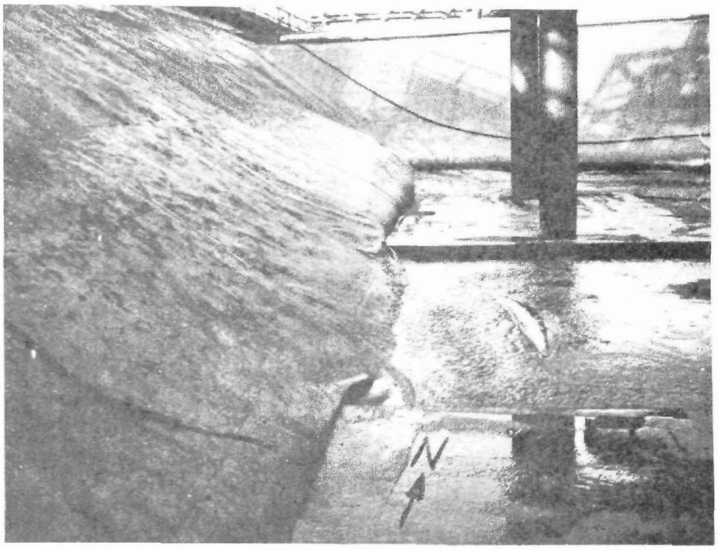
In February 1971 the south aeration tank developed the same problem as had occurred in the equalization tank, shown in Figure 26b. It was decided to remove the rubber liner, pour a 4-inch concrete pad on the sides of the tank, and cover the concrete with rubber liner, shown in Figure 27a. This was completed in April 1971. However, the rubber did not adhere to the concrete, and so was removed completely. The concrete surface was covered with 3 coats of epoxy tar coating.

Plant performance during this time was not improved by the failure of two more seams in the equalization basin. For two weeks in April, while the equalization basin was being repaired, the plant was operating on one aeration basin only. As can be seen from Figures 20 and 23, effluent COD and suspended solids reached their highest concentrations during this time.

FIGURE 26
AERATION TANK PROBLEMS

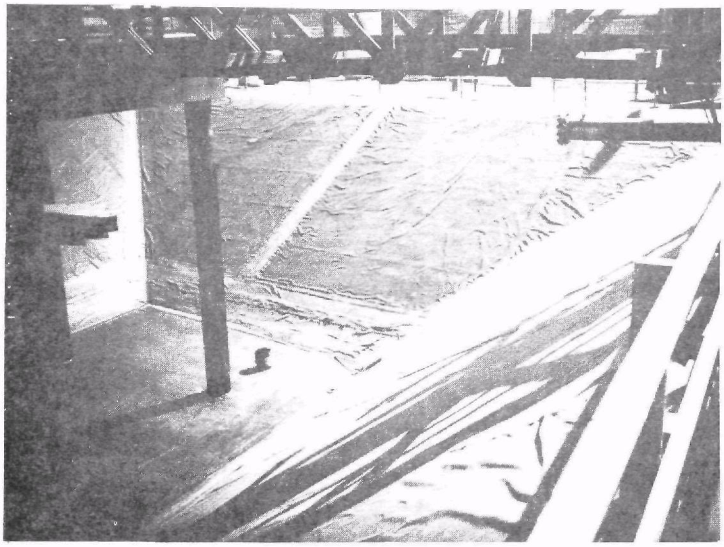


26a. Foaming in the aeration tank during shutdown of the equalization basin.

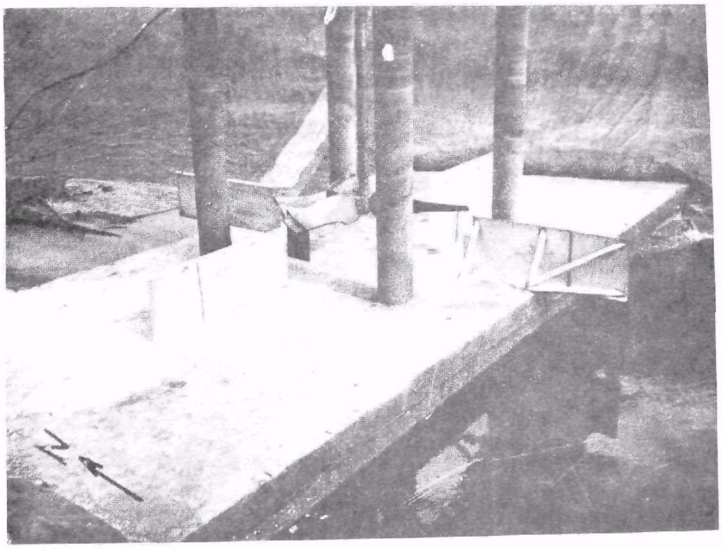


26b. Tension and breakage of the rubber lining in the south aeration basin due to soil accumulation.

FIGURE 27
REPAIR WORK IN AERATION TANK AND EQUALIZATION BASIN



27a. Concreted and relined aeration basin.



27b. New baffles in equalization basin.

Because of the time required to cure the concrete and the coating, the south aeration basin was not ready for service until the end of April 1971. The north aeration basin was then renovated by installing concrete slabs over the reconditioned soil sides, with the rubber lining under the concrete. This was completed by June 1971, and similar work on the equalization basin was completed by August 1971. All concrete surfaces were coated with epoxy tar. No further problems have been encountered with the tank linings.

EQUALIZATION TANK AND THICKENER ODOR PROBLEMS

In April 1971, complaints of odors were received from a nearby industry. The equalization tank and thickener were identified as contributors to the odors.

Odors in waste treatment facilities are generally caused by a depletion in the oxygen supply. This results in anaerobic activity on the part of faculative and anaerobic bacteria[2], which use oxygen contained in chemical compounds, creating odorous gases as a byproduct of their decomposition activity.

Odors were not the only concern centering on the thickener at this time. Additional storage was needed for the biomass. Both problems were solved simultaneously by converting the thickener to an aerated storage tank. The inside sweep mechanism was removed, and 600 cubic feet per minute (cfm) of air dispersed by a 15 hp agitator maintained the biomass in an aerobic condition.

The odor problem in the equalization basin appeared to be caused by solid materials settling out and undergoing anaerobic decomposition. Part of the problem was due to the concrete agitator supports being higher than the basin bottom, creating dead spaces unaffected by the agitation. This problem was attacked by installing a smooth concrete bottom in the equalization basin, and adding baffles for both agitators, shown in Figure 27b. This was done when the rubber liner was being replaced with concrete, and the tank was returned to service in August 1971.

The odor problem, it turned out, was not yet solved. It was decided to increase agitation, and add aeration. A second impeller was added to each agitator. The 25 hp north agitator was replaced with a 50 hp one, and the 20 hp south agitator was replaced by a 30 hp one with the agitator shaft speed increased from 45 to 68 rpm. A 1000 cfm air blower was installed, with the air being dispersed by the agitators.

This equipment was put into operation September 1971, and there has been no recurrence of the odor problem since.

SECTION VII

PLANT OPERATION: OCTOBER 1971-JANUARY 1973

After the initial equipment and operation problems of the plant were solved, efforts were concentrated on optimization of the waste treatment process. Of primary concern was meeting the Illinois EPA effluent quality standards for BOD and for suspended solids. At the time the Pekin facility was designed, the criteria in effect for allowable effluent concentrations were 40 mg/l BOD and 45 mg/l suspended solids. These criteria have since been reduced to 30 and 35 mg/l, and beginning in 1975 will be 20 mg/l BOD and 25 mg/l suspended solids.

It was found that the treatment plant effluent seldom met the effluent criteria. The problem was nearly always due to poor separation of biomass in the clarifier and flotation cell. High suspended solids in the effluent resulted in failure to meet both the suspended solids and BOD criteria.

Several process modifications were made which improved treatment plant performance. The most significant changes, described in detail later in this section, were:

1. Ammonia nitrogen concentration of the waste stream was reduced.

2. The biomass recycle rate was increased from the conventional rate of 25% to 35% of the supply to 75% to 100% of the supply.

3. Recycled biomass was aerated before being returned to the aeration tank.

4. The use of chemical flocculating agents was tested.

These modifications were made over a short time period, and the individual effects could not be determined. The over-all effect can be seen by comparing operating results during the period July 1972 to January 1973, after the changes had been made, with those discussed in earlier sections. Some dramatic improvements in treatment plant performance can be seen, although the anticipated effluent quality was still not consistently attained. For example, during the time period October 1971 through June 1972, 90% of the effluent BOD values were below 540 mg/l; during the time period July 1972 through January 1973 the 90% occurrence had been reduced to 205 mg/l (see Figure 32). Also, during the earlier period, effluent suspended solids concentrations were below 795 mg/l 90% of the time; during the later period this was reduced to 330 mg/l (see Figure 37). Detailed descriptions of the changes that brought about these improvements are given below.

Throughout the reporting period, waste flow fell within or below the maximum design flow of 1.2 mgd maximum. The average flow was 0.763 mgd. Flow data are given in Appendix C. Computer-generated distributions were made for each of the time periods under consideration, and are also shown in Appendix C. However, the difference in flow for these two periods is insignificant, and the data were combined to give the distribution shown in Figure 28.

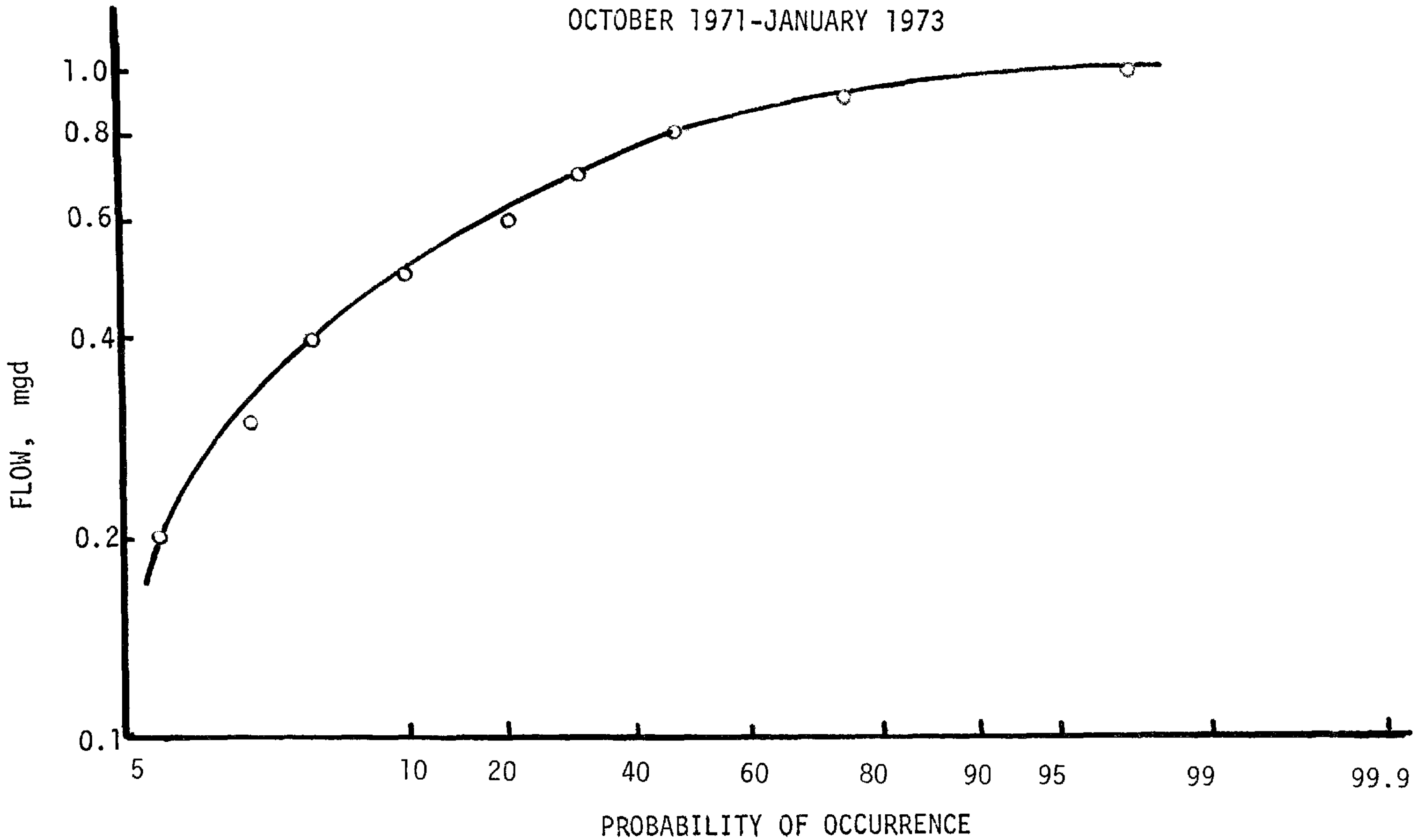
BIOCHEMICAL OXYGEN DEMAND (BOD)

The BOD constitutes an empirical test in which standard laboratory procedures are used to determine the relative oxygen requirements of waste waters and effluents for the stabilization of oxidizable organic matter present. The procedure is described in Standard Methods[4]. The test has its widest application in measuring the waste loadings to treatment

FIGURE 28

CONCENTRATED WASTE FLOW

OCTOBER 1971-JANUARY 1973



PROBABILITY OF OCCURRENCE

plants and in evaluating the efficiency (BOD removal) of such treatment systems. Furthermore, effluent water quality standards frequently include BOD levels. Since complete stabilization of a waste may require an incubation period too long for practical purposes, the 5-day period at 20°C has been accepted as standard. The Pekin waste treatment facility was originally designed to meet the then existing effluent 5-day BOD criterion of 40 mg/l.

Because of the length of time required for the BOD test, it is often easier to use the COD test, which measures the oxygen equivalent of matter in a sample that is susceptible to oxidation by a strong chemical oxidant, whether or not it it biodegradable. For a given waste, there is usually a relatively constant relationship between BOD and the COD[7]. The correlation coefficients were calculated by computer for BOD as a function of COD for both influent and effluent. Separate calculations were done for each of the two time periods under consideration. Although there is considerable scatter in the data, good correlation coefficients were obtained for both time periods, and are given in Table 3.

TABLE 3

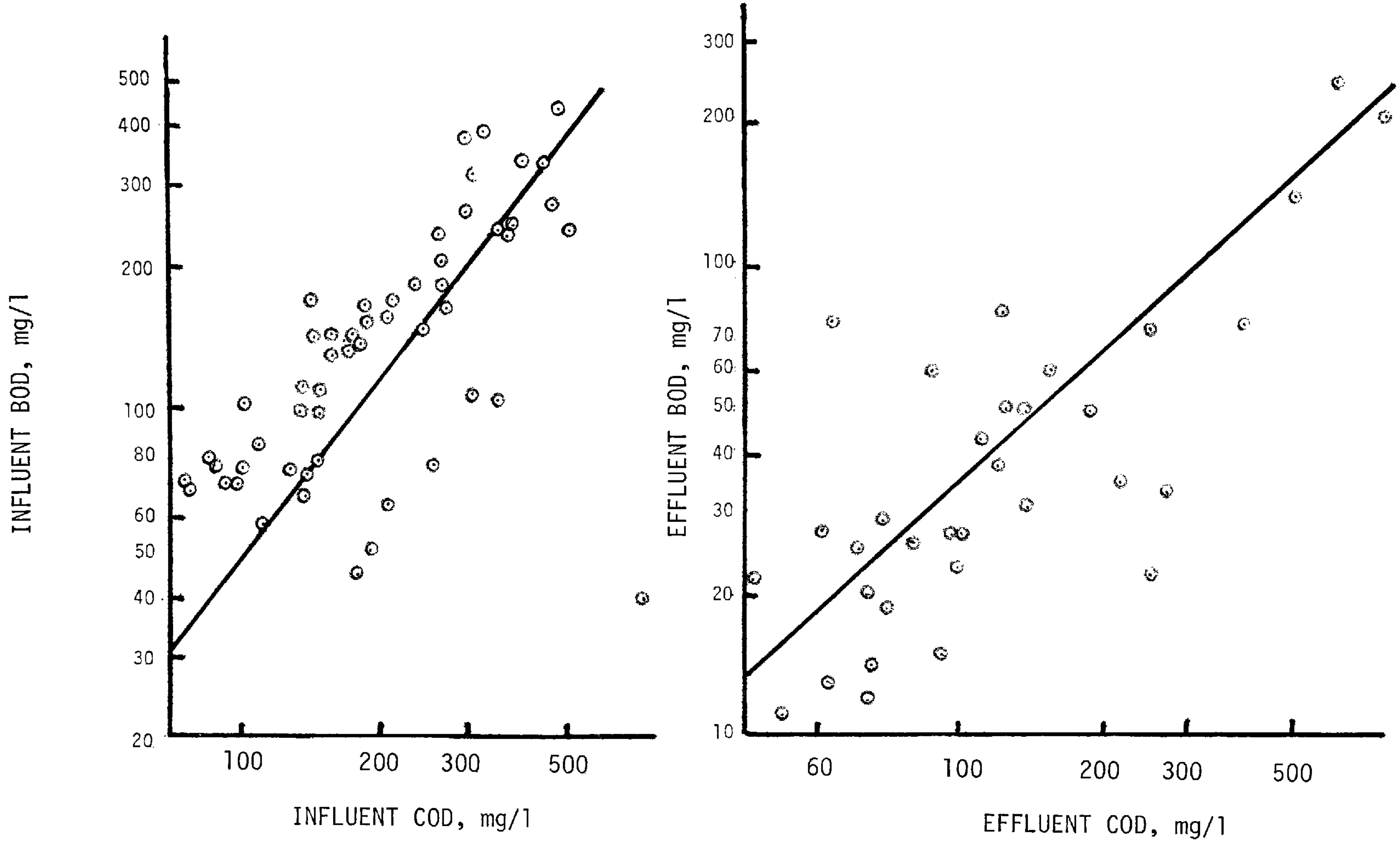
CORRELATION COEFFICIENTS, BOD AS A FUNCTION OF COD

October 1971-June 1973		July 1972-January 1973	
Influent	0.89	Influent	0.82
Effluent	0.98	Effluent	0.81

The data for these calculations are given in Appendix C. The relationship for the second time period only are shown graphically in Figure 29. The COD test was used for determining the daily operating conditions in the treatment plant. However, treatment plant performance described in this section was calculated from 5-day BOD tests.

FIGURE 29

BOD AS A FUNCTION OF COD



Throughout this report, BOD and COD removals and loadings, and influent BOD and COD values, are based on samples of the stream from the equalization tank to the aeration tanks. Effluent samples were taken from the discharge of the flotation cell. Both samples were collected in continuous, refrigerated samplers. It has been observed that significant soluble COD reduction occurs in the equalization tank; about 1/3 at times. Thus the influent BOD and COD values in this report reflect the loading to the aeration tanks, but do not represent the total raw waste load from the manufacturing process.

The semimonthly average influent and effluent BOD concentrations are shown in Figure 30 for October 1971 through January 1973. The data, shown in Appendix C were averaged by computer. As can be seen, the fluctuations are considerable. This is due largely to the variability in both the raw material and the production schedule, discussed previously. The lower effluent BOD levels in the second half of the time sequence are due partly to the lower influent BOD levels and partly to improvements in managing the waste treatment plant. As can be seen from Figure 31, the per cent reduction of BOD was improved significantly during this period. During the period September 1971 through June 1972 the per cent BOD reduction was below 90% forty-five per cent of the time, but from July 1972 through January 1973 it was below 90% only ten per cent of the time. These calculations are based on computer-generated distributions, given in Appendix C.

In spite of this relatively high level of efficiency, effluent criteria were difficult to meet. As can be seen in Figure 32, based on computer-generated distributions also given in Appendix C, during the period October 1971 through June 1972 the design BOD standard of 40 mg/l was rarely met. During the period July 1972 through January 1973 this standard was met nearly 60% of the time. While still not completely satisfactory, this represents a substantial improvement.

FIGURE 30

BIOCHEMICAL OXYGEN DEMAND
SEMI-MONTHLY AVERAGES

OCTOBER 1971 - JANUARY 1973

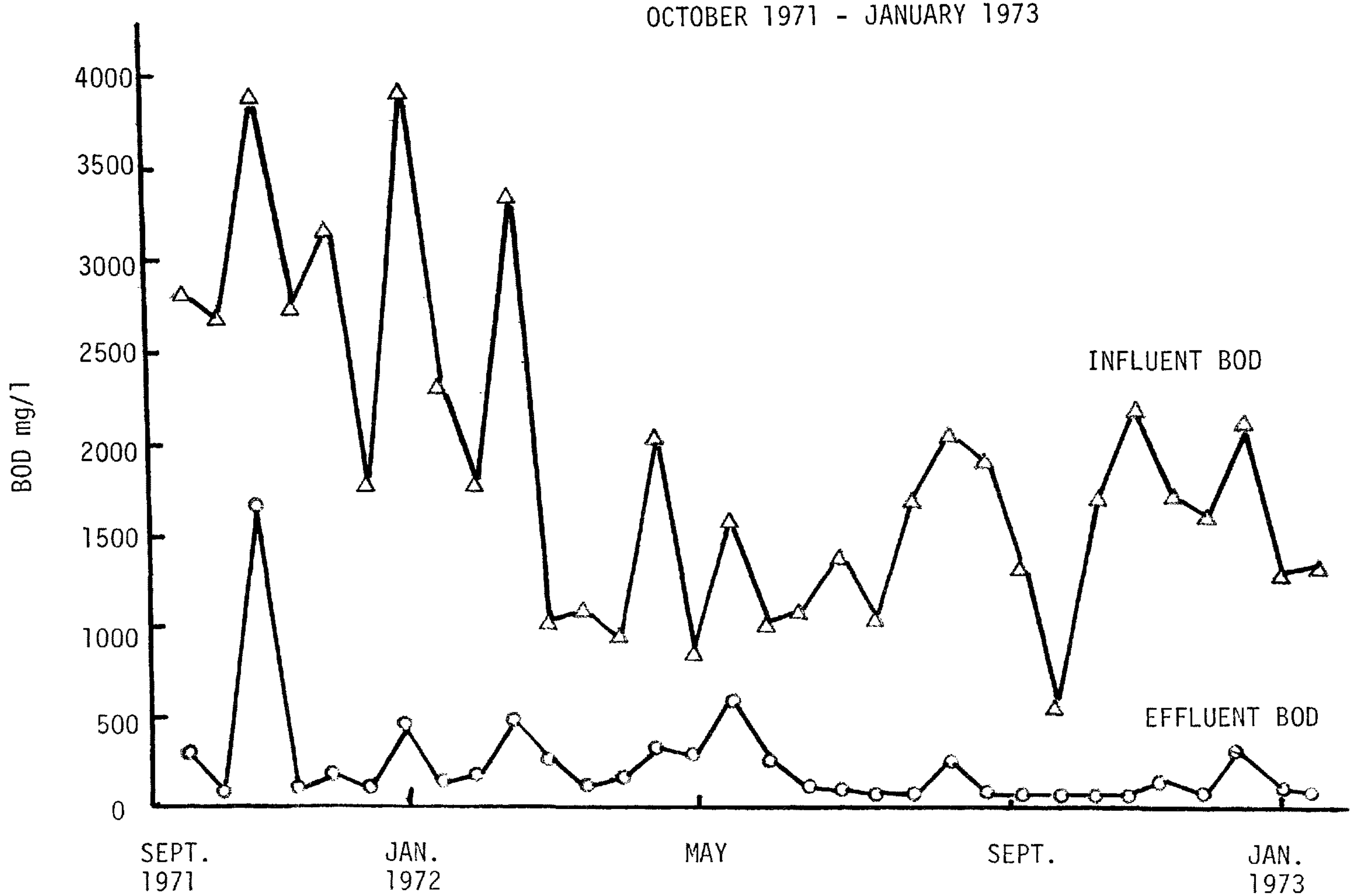


FIGURE 31
BIOCHEMICAL OXYGEN DEMAND, PERCENT REMOVED
OCTOBER 1971 - JANUARY 1973

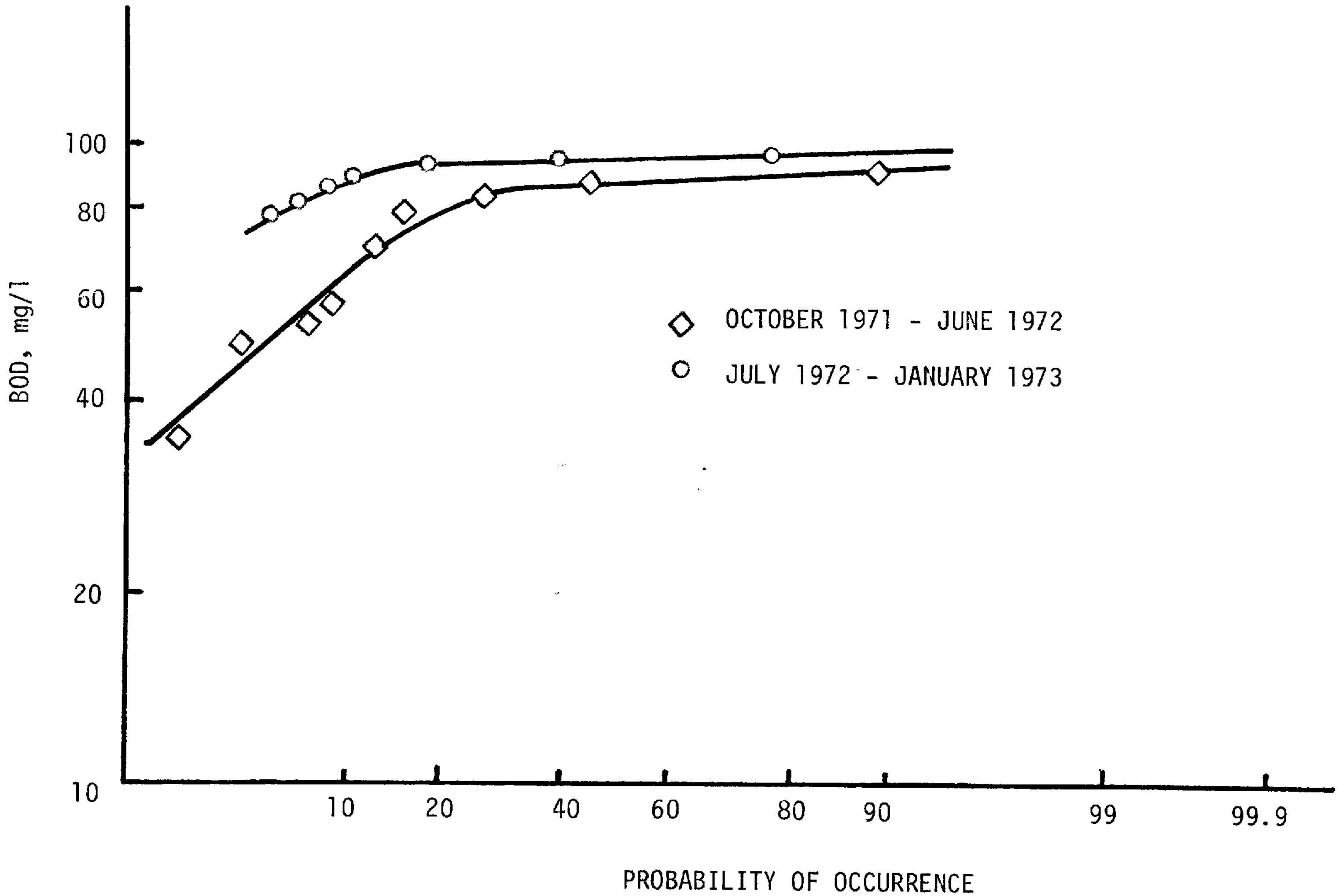
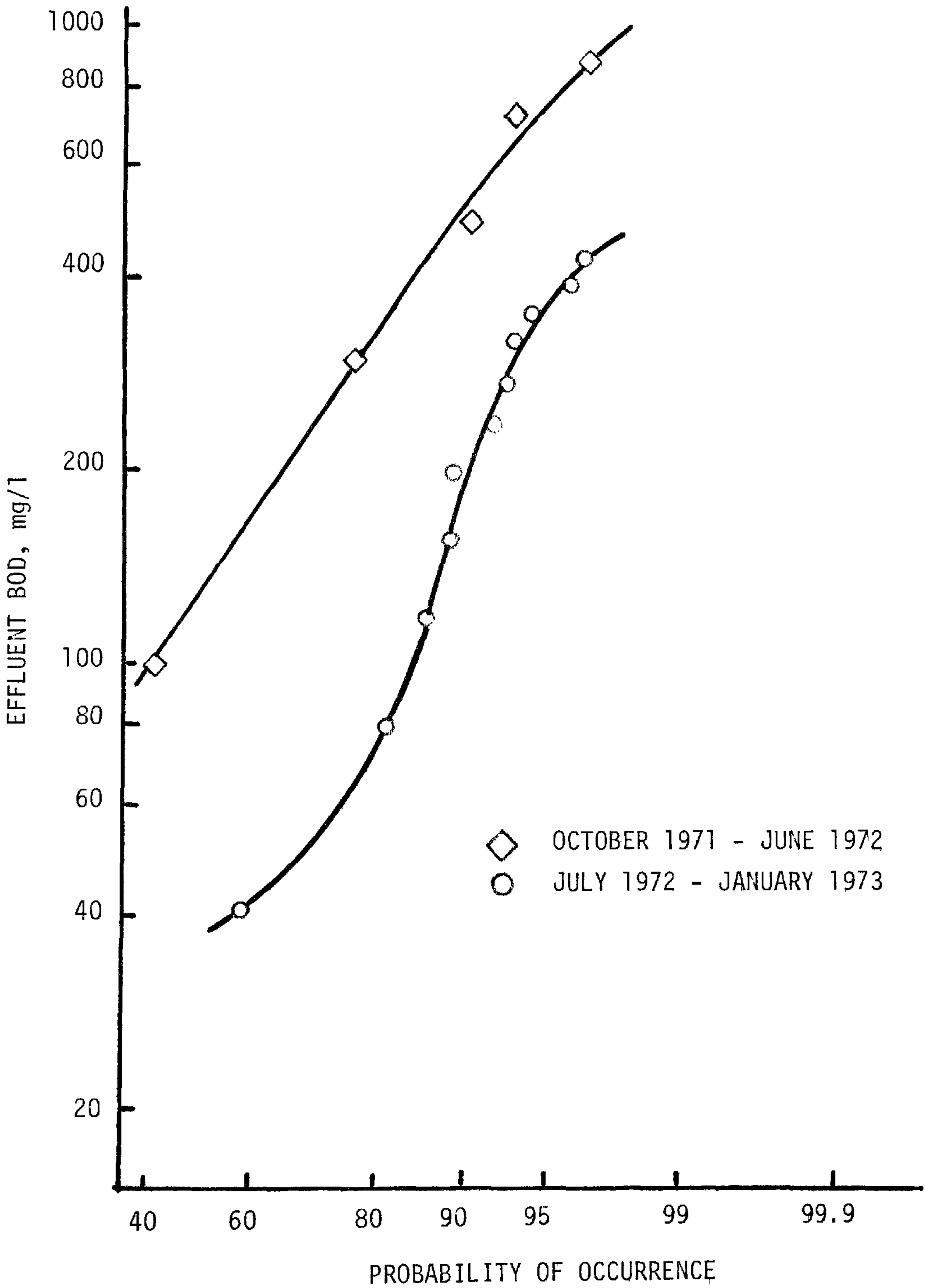


FIGURE 32
EFFLUENT BOD



One of the changes in operating procedure during this period was to increase the biomass recycle rate from the clarifier to the aeration tanks from 25% to 35% of the supply rate to 75% to 100%. The reason for this change was to decrease the time that the biomass was held in the clarifier without oxygen. At times, gas bubbles had been observed rising to the clarifier surface, resulting in carryover of floc to the effluent. The effect on BOD removal is shown in Figure 33, using computer calculated semimonthly averages. The original data are given in Appendix C. As can be seen, at the lower recycle rates results were sometimes adequate; at the higher recycle rates BOD removal was nearly always 90% or better. Figure 33 can be compared with Figure 31, which is based on a distribution of daily data, to give a better idea of the results.

In addition to the higher recycle rates, at this time it was also decided to aerate the biomass prior to recycling it to the aeration tanks. The thickener, which had been modified due to odor problems (described in Section II), was utilized for this purpose. Pilot scale tests had indicated some improvement in flocculation with additional time under aeration. At normal recycle flow rates, the biomass underwent about 5 hours retention time in the thickener.

The F/M ratio is described in a later section; however, the relationship between BOD removal and F/M is shown in Figure 34. Computer calculated semimonthly averages are used, based on the original data given in Appendix C. The curve represents best results. The scatter indicates other factors besides F/M affecting the BOD removal.

The clarifier was designed to operate at an overflow rate of 550 to 650 gallons per day per square foot over the expected range of flow. The characteristics of the biomass are such that this overflow rate usually results in a high sludge blanket level in the clarifier. At times, even

FIGURE 33

BOD REMOVAL AS A FUNCTION OF RECYCLE RATE, SEMIMONTHLY AVERAGES

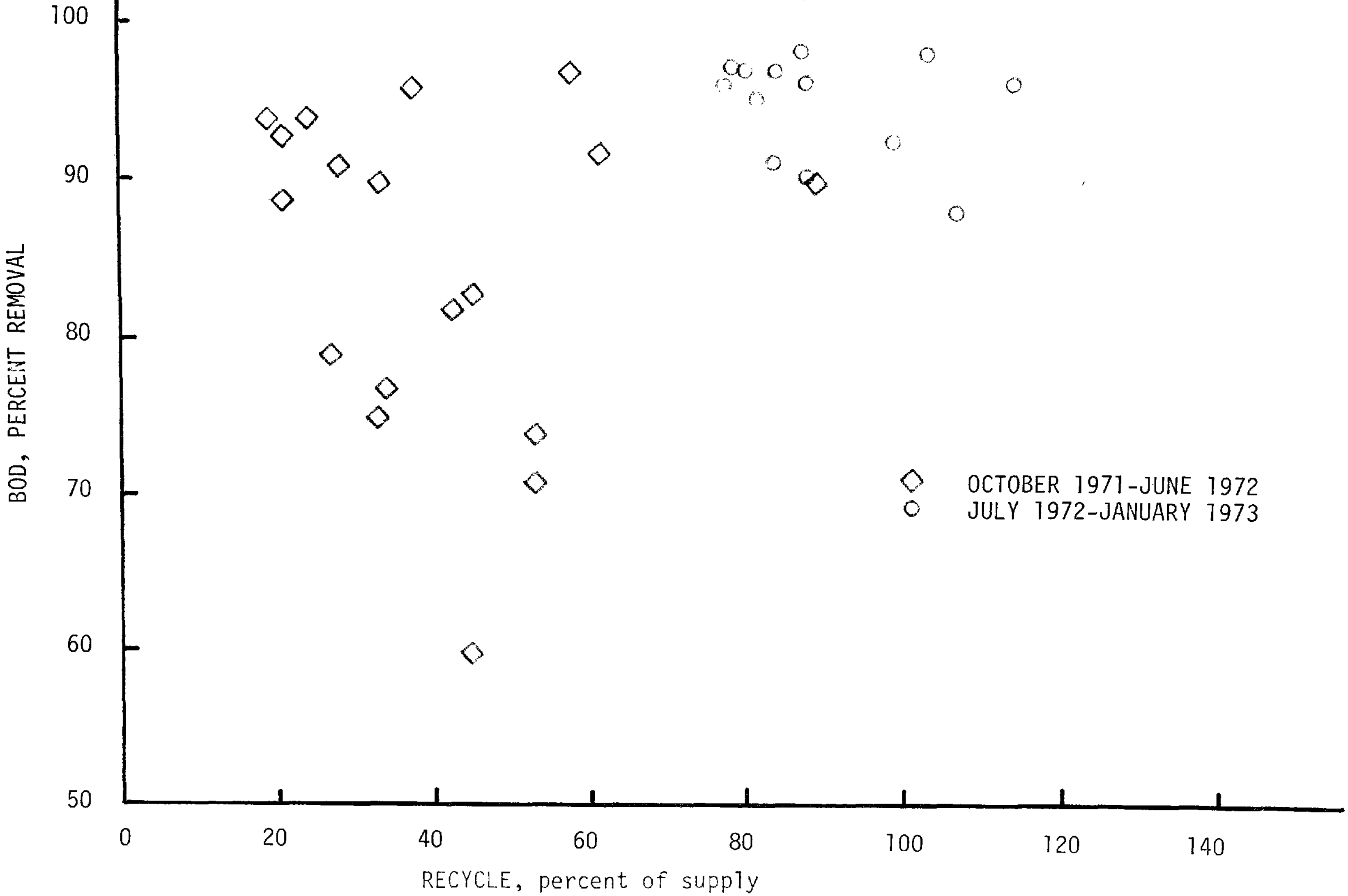
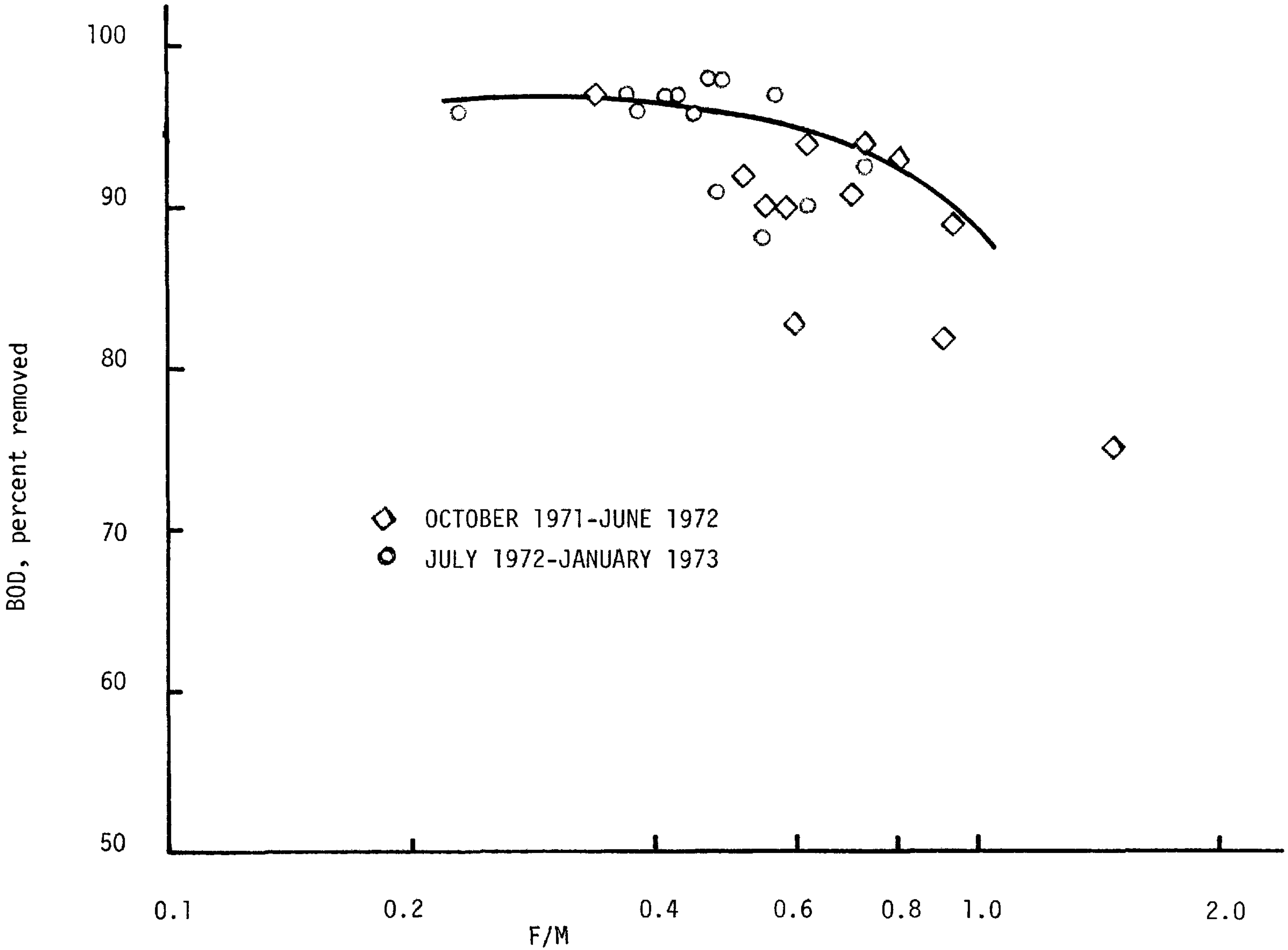


FIGURE 34
BOD REMOVED AS A FUNCTION OF F/M SEMIMONTHLY AVERAGES



when laboratory settling tests show that settling should occur, floc is carried over the top of the clarifier. A lower overflow rate should result in a lower sludge blanket, and less frequent floc carryover.

It should be noted, however, that while carryover of floc has occurred often, the primary cause of failure to meet suspended solids criteria is the presence of unflocculated bacteria which do not settle even in a static settling test. Lower clarifier loading alone will not overcome this problem.

SUSPENDED SOLIDS

One of the factors essential to the performance of the activated sludge process is effective flocculation of the sludge, with subsequent rapid settling and compaction of the floc[7]. Inadequate flocculation and settling will result in an unacceptably high level of suspendes solids in the effluent.

Several factors were examined for their effect on the suspended solids level in the effluent. These include nutrient levels, hydraulic loading, food-to-microorganism ratios, and the use of chemical flocculating agents.

Nutrient Addition

In the highly complex microorganism population of an activated sludge system, good settling characteristics are associated with the presence of protozoa, stalked ciliates, rotifers and other higher microbial life forms. Developing a suitable microorganism population depends largely on nutrient balance. With the exception of nitrogen and phosphorus, most of the minerals entering into the growth of these populations are normally available from water supplies used for the transport of waste substances[1]. Minimum requirements for nitrogen and phosphorus are placed at ratios of BOD:N:P = 150:5:1 and requirements for maximum N and P content of sludge at 90:5:1[8].

In the Pekin plant, phosphorus levels in the waste were below minimum levels, and provision for the addition of phosphoric acid was included in the plant design. The ammonia nitrogen level in the waste, however, was unusually high because of its use in one of the manufacturing processes. BOD:N ratios, prior to January 1972, averaged around 65:5, significantly outside the normal range for optimum operation. Since the microorganism population was low in protozoa, stalked ciliates, rotifers, and other higher life forms, and since the plant effluent had poor settling characteristics, an effort was made to reduce the level of ammonia nitrogen to the waste, and studies were undertaken to try to improve the types of microorganisms in the activated sludge.

A study on the growth of rotifers in activated sludge systems, undertaken by the Technical Service Department of CPC International Inc., indicated that ammonium toxicity was the only factor to have an appreciable effect on the establishment of higher life forms in the Pekin waste. The study examined the effects of mineral addition, pH and shear, as well as ammonium nitrogen toxicity. The results of this study are summarized in Table 4.

For the mineral study, rotifer growth in Pekin's clarifier overflow water was compared with growth in a control medium known to support rotifers. It was found that mineral additions to the overflow water appeared to stimulate the rotifer growth rate and support a higher density of rotifers than the control system. The source of water in the concentrated waste stream at the Pekin plant is primarily condensed water vapor from evaporators. It was suspected that some trace elements required for optimum microbial growth might be lacking. Analyses of

TABLE 4

ROTIFER GROWTH IN ACTIVATED SLUDGE SYSTEMS

Per cent increase in numbers of rotifers in Pekin clarifier overflow (C.O.) and in a control broth at pH 7.0

	% Increase in 24 hr	Doubling Time of Population, hr
C.O.	28	85.6
Control Broth	31	77.2
C.O. plus 5 mg/l Mg	25.3	95.7
C.O. plus 15 mg/l Fe	39	67.7
C.O. plus 5 mg/l Mg and 15 mg/l Fe	57.5	41.8

Ammonium nitrogen toxicity on rotifers

	% Increase in 24 hr
Control Broth	+ 31
+ 100 mg/l NH_4	+ 26
+ 200 mg/l NH_4	- 32
+ 300 mg/l NH_4	- 61

Effect of pH on rotifers

pH	% Increase in 24 hr
4	- 2.0
5	+ 3.76
6	+ 2.44
7	+ 9.5
8	+ 3.75
9	- 5.37

Effect of shear on rotifers

Waring Blender, rpm	Blade Tip Speed, fpm	Rotifer Density
0	0	21.1
840	550	19.2
2700	1775	16.8
3500	2290	19.8
4200	2750	19.2

The tip speed of the agitators in the Pekin Aeration Pond is 1100 fpm.

the waste stream showed that concentrations of iron, nitrate, potassium, zinc and cobalt might be below required levels. Based on the results of this study, ions were added to the Pekin system as follows.

Fe^{+++}	5 ppm
NO_3^-	5 ppm
K^+	1 ppm
Zn^{++}	1 ppm
Co^{+++}	1 ppm

Shortly after this mineral addition, higher forms of microorganisms such as stalked ciliates and rotifers appeared in the system. However, the mineral addition was discontinued after a period of two months, and the life forms remained. It was concluded that mineral deficiency was not a significant factor in propogation of higher forms.

The pH studies indicated that the rotifers were able to tolerate a relatively wide range with little effect on growth, from approximately pH 4.0 to pH 9.0. Also, shear does not appear to be particularly damaging to rotifers. Laboratory tests with rotifers in a Waring Blender for five minutes with a blade tip speed of 2750 feet per minute (fpm) showed no adverse effects. The tip speed of the aerators in the Pekin waste treatment system is 1100 fpm.

Tests on ammonium toxicity indicated that this was the major problem. The study showed that the growth of rotifers began to be inhibited at 100 ppm ammonium concentration and continued to be further depressed as the concentration increased. Ammonium concentrations in the Pekin waste had ranged from 150 to 200 ppm.

In February 1972, the use of ammonia in manufacturing was stopped completely, and nitrogen in the form of ammonia was added to the waste in appropriate quantities along with the phosphoric acid. Suspended solids in the effluent dropped to significantly lower levels following this change.

Hydraulic Loading

Although the wastewater flow rate to the waste treatment plant was reasonably consistent, the relationship between the hydraulic loading and effluent suspended solids was examined. For the first time period, October 1971 through June 1972, the correlation coefficient was found to be - 0.0002, showing no relationship between the two parameters. The correlation coefficient for the second time period, July 1972 through January 1973, was somewhat higher at 0.13, but still not high enough to indicate a significant relationship. The graph in Figure 35 of a representative sample of data points shows the randomness of the relationship. Therefore, other factors were examined for their effect on effluent suspended solids. Original data used to calculate the correlation coefficients are given in Appendix C.

Food-to-Microorganism Ratio (F/M)

The most difficult parameter to control has been the F/M ratio.

Figure 36 shows that there is a limited, but significant correlation between effluent suspended solids and average F/M. The correlation coefficient for both the time period October 1971 through June 1972 and for July 1972 through January 1973 is 0.3, showing a low, but definite relationship[9]. However, the nearly identical slopes of the two regression lines indicate that other factors may be of greater significance in reducing the effluent suspended solids levels.

One of the most significant factors affecting effluent quality has been

FIGURE 35

EFFLUENT SUSPENDED SOLIDS AS A FUNCTION OF HYDRAULIC LOADING

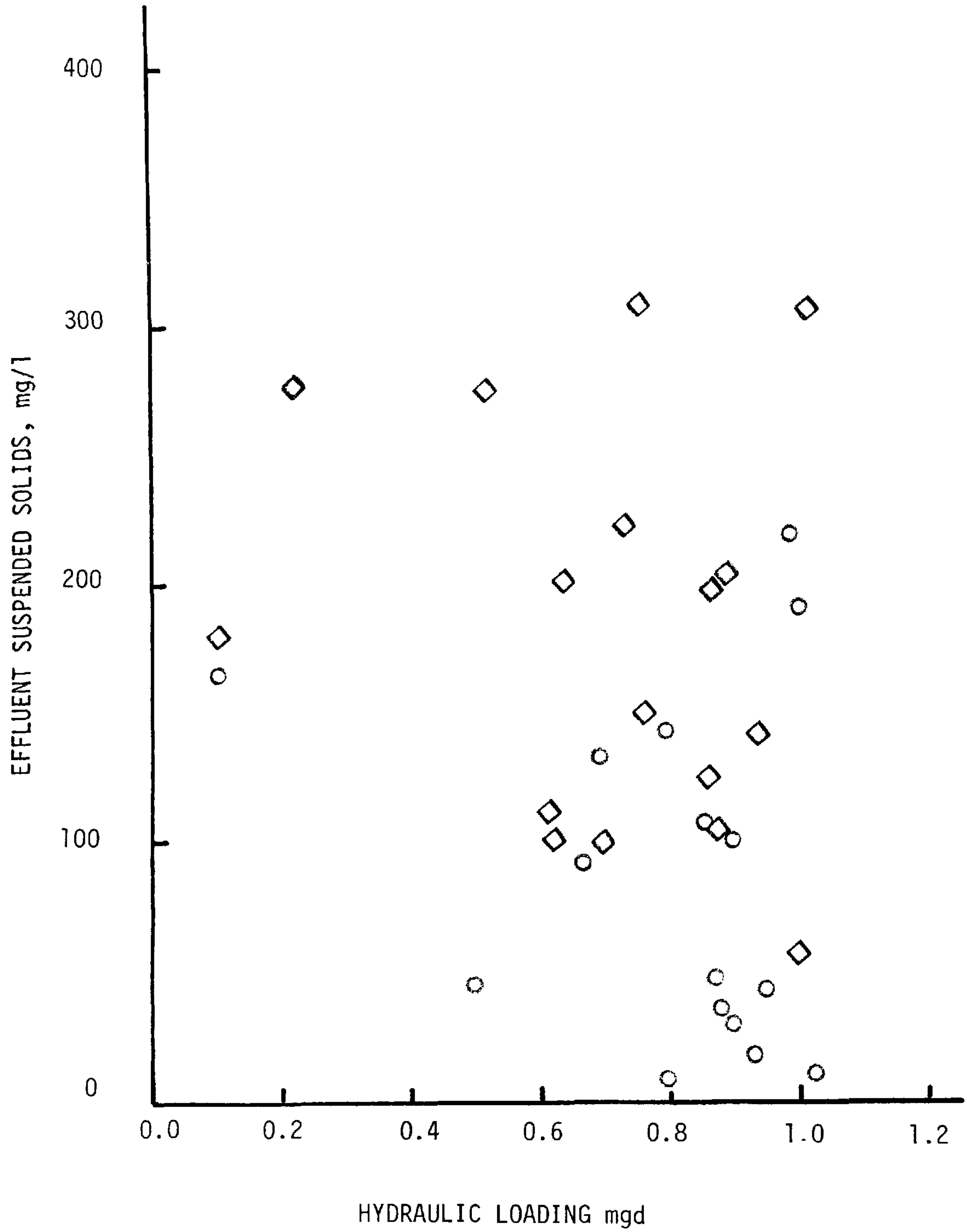
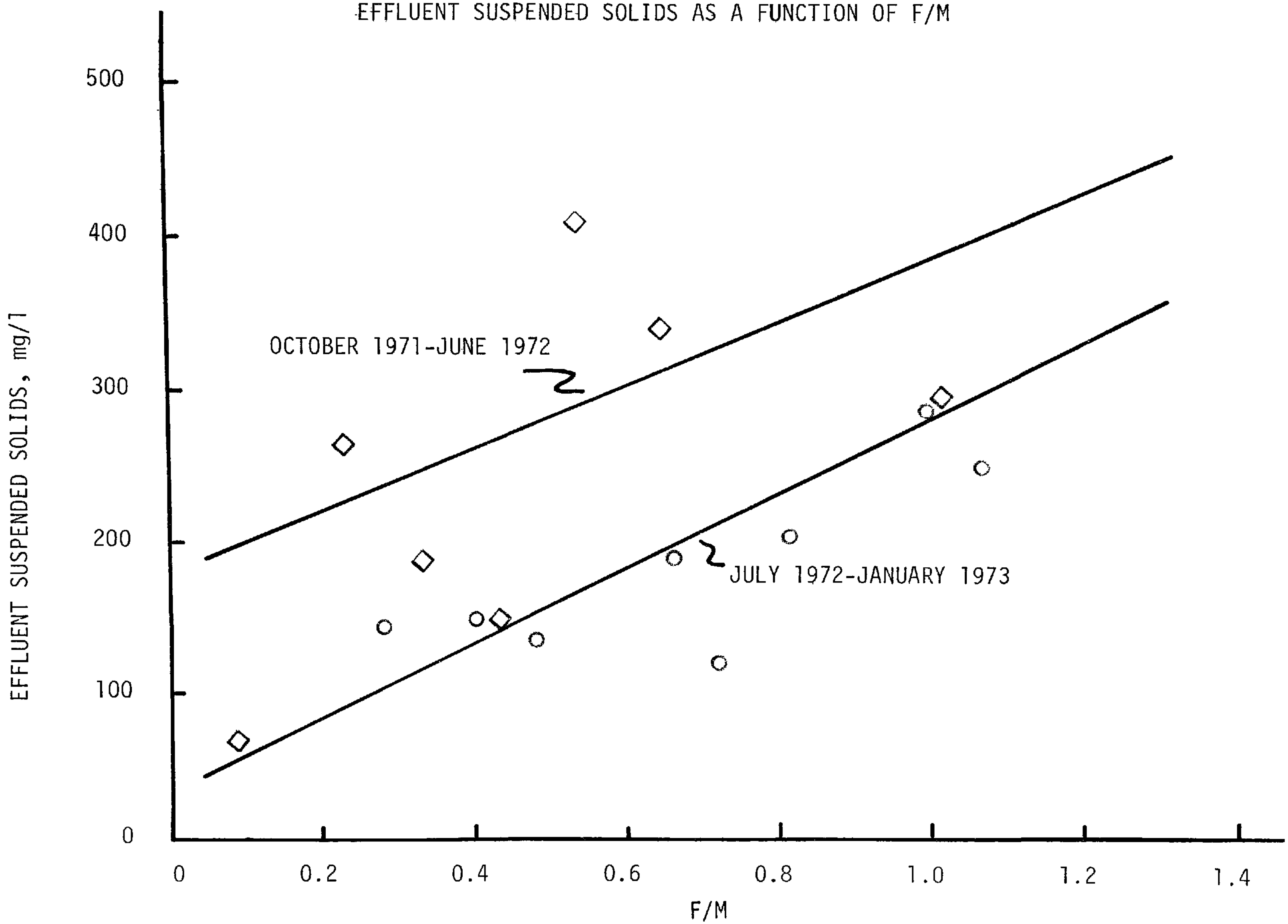


FIGURE 36

EFFLUENT SUSPENDED SOLIDS AS A FUNCTION OF F/M



observed to be shock changes in the raw waste load. Even with the 24-hour retention time equalization tank, changes in COD concentration to the aeration tanks of as much as 5:1 have been observed, and changes of 2:1 are common.

Depending on the severity of the shock, the effect can vary from the growth of individual bacteria or tiny flocs which do not settle, to formation of a bulking sludge which does not settle at all. The flotation cell generally does not have the capacity to remove the large amounts of suspended solids resulting from these upsets. Recovery from an upset requires from several days, to as much as 3 or 4 weeks for a very large shock.

Examples of the effect of a moderate and a severe shock COD load are shown below:

	Nov. 13, 1972 Moderate Shock	Dec. 4-5, 1972 Severe Shock
Aeration Tank Supply COD Day before shock, mg/l	865 (Nov. 12)	1451 (Dec. 3)
Aeration Tank Supply COD Day of shock, mg/l	1497 (Nov. 13)	5588 (Dec. 5)
Average Effluent BOD for 3 days before shock, mg/l	36 (Nov. 10-12)	8 (Dec. 2-4)
Average Effluent BOD for 3 days after shock, mg/l	51 (Nov. 13-15)	240 (Dec. 6-8)

	Nov. 13, 1972 Moderate Shock	Dec. 4-5, 1972 Severe Shock
Average Effluent Suspended Solids for 3 days before shock, mg/l	68 (Nov. 10-12)	19 (Dec. 2-4)
Average Effluent Suspended Solids for 3 days after shock, mg/l	184 (Nov. 13-15)	577 (Dec. 6-8)

These changes in waste load, and the resulting changes in F/M, are considered to be the most significant factor in failure to consistently meet the effluent standards.

Chemical Flocculants

The suspended solids in the clarifier overflow generally consisted of individual bacteria or very small clumps. The particle size of the solids was too small for removal in the dissolved air flotation cell. Successful flotation requires particle sizes large enough for air bubbles coming out to solution to become attached and float them to the surface.

In order to overcome this problem, an attempt was made to treat the clarifier overflow with a flocculating agent, increasing the particle size of the solids, and improving solids removal in the flotation unit. Several chemical suppliers tested numerous flocculating agents in the laboratory. Four products showed some promise in laboratory tests and were further tested full scale in the treatment plant. The products and manufacturers were:

Calgon Corp.	Alum + WT3000 polymer
American Chemicals Co.	CN51 polymer
Nalco Chemical Co.	634 polymer + 650 clay
CPC International	C-300 polymer

Using the available mixing, dosing, and blending equipment in the treatment process, only C-300 showed full scale results that confirmed laboratory tests. C-300 polymer is an experimental product made by CPC International, and is not commercially available.

Results of some of the early full scale tests with C-300 are shown in Table 5. The polymer dose was 10 mg/l. The results indicate that when the clarifier overflow suspended solids concentration was about 100 mg/l, flotation effluent was in the range of the design basis of 45 mg/l. Lower values of solids in the clarifier overflow resulted in even better effluent quality.

TABLE 5

ANALYSIS OF PEKIN FINAL EFFLUENT DURING C-300 TEST

Date	Suspended Solids (mg/l) of Final Effluent 24-hr Composite Samples	Suspended Solids of Air Flotation Influent Grab Sample Taken at 7:30 A.M.
July 28, 1972	6	33
July 29	26	59
July 30, 31	40[a]	101
August 1	14	34
August 2	24	46
August 3	18	22

a) 48-hour composite sample.

However, with continued operation, it was found that the polymer was not always effective. When suspended solids in the clarifier overflow was above about 150 mg/l, flocculation was not complete. Even at lower concentrations, there were periods when effective flocculation was not obtained. The reason is not fully understood. Tests are still in progress to find a commercially available flocculant that is effective at all conditions.

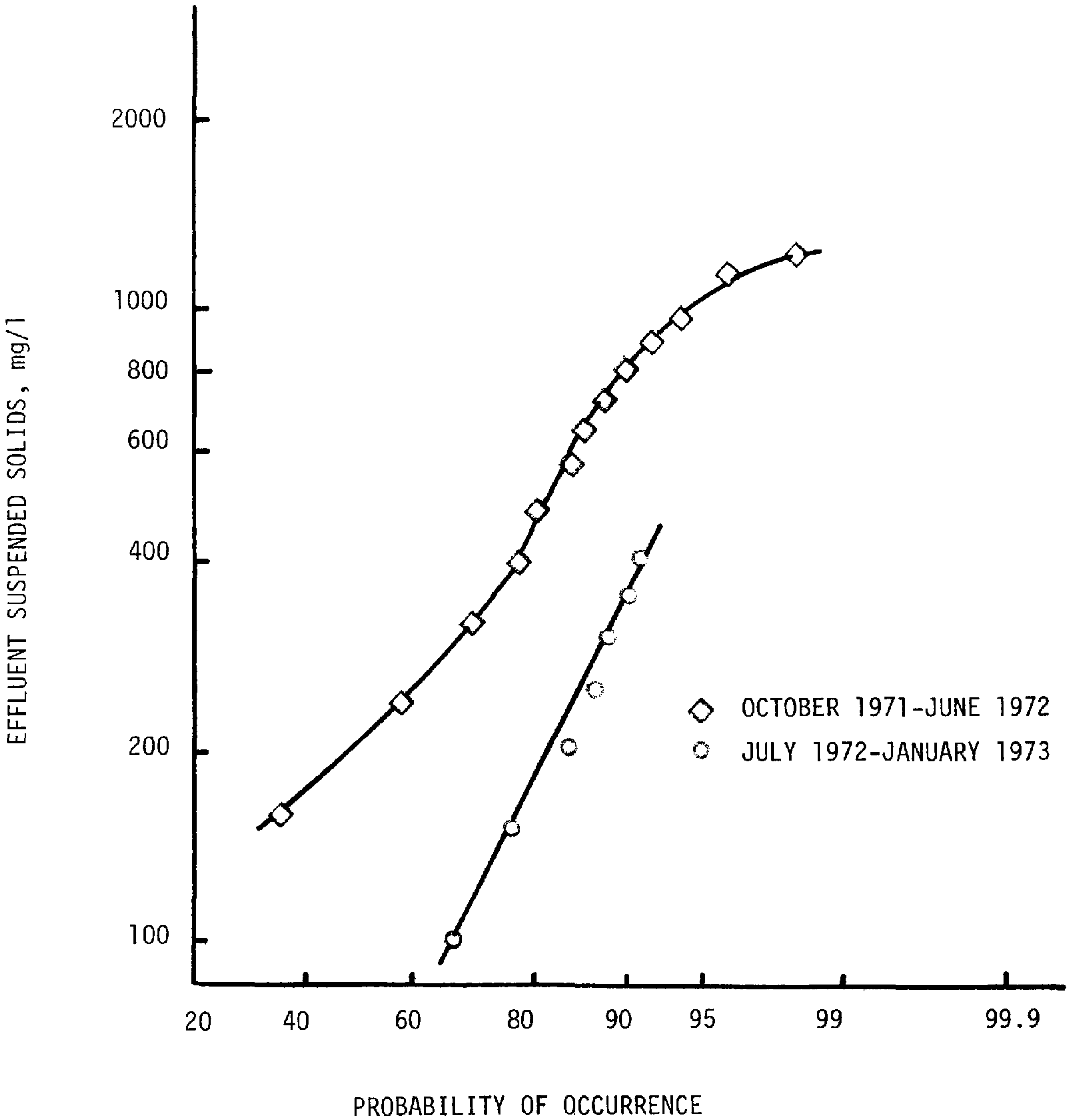
Figure 37 shows the range of suspended solids levels in the treatment plant effluent for the period October 1971 through June 1972, and for July 1972 through January 1973. The computer-generated distribution is given in Appendix C. Substantial improvement can be seen as a result of the combined factors of higher biomass recycle rates, aeration of recycled biomass, control of nutrients, and intermittent use of the cationic polymer. During the earlier period, the effluent suspended solids concentration was rarely below 100 mg/l; during the later period it was below this level 67% of the time. However, this is still above water quality standards, and continuing efforts are being made to correct this deficiency.

EFFECT OF pH

Corn wet milling wastes tend to be low in pH. Both high and low pH streams are discharged, but when combined and equalized, the pH is usually about 6.0. Certain production schedules and product mixes result in pH values below 5.5. When this occurs, pH is adjusted by adding sodium hydroxide to the stream entering the equalization tank.

FIGURE 37

EFFLUENT SUSPENDED SOLIDS
OCTOBER 1971-JANUARY 1973



The aeration tanks are highly buffered. If the equalization tank pH is above 5.5, the aeration tank pH nearly always falls between 7.0 and 7.5.

There have been occasional process upsets caused by extreme pH due to accidental discharge of materials, or failure of the pH control on the stream supplying the equalization tank. Aeration pH control has not been a major problem in operation of the process as long as the equalized waste pH is between 5.5 and 8.5.

BIOMASS YIELD

The excess biomass wasted averaged 0.41 lb per lb total COD removed during the period of October 1971 to July 1972. This figure was determined by calculating the total biomass wasted and total COD removed over 6-day intervals throughout the period. The range of values was 0.16 to 0.64 lb excess biomass per lb total COD removed, but most of the values fell between 0.3 and 0.5. Because of the extreme variations of F/M ratio within the 6-day intervals used to calculate the yield, no correlation could be found between F/M and biomass yield.

The average yield of 0.41 is higher than predicted from the laboratory data (0.3 to 0.35). However, the actual yield includes some insoluble material in the raw waste (such as powdered carbon), which was not present in the laboratory tests.

EFFECT OF DISSOLVED OXYGEN

The aerators have maintained a positive dissolved oxygen under all conditions. Although it is possible that extreme shock loads might have caused oxygen deficiencies for short periods, whenever oxygen concentration was measured, a positive value was obtained. Oxygen supply was not considered to be a cause of any of the problems encountered with the treatment process.

COSTS

The Total cost of the project discussed in this report was approximately $2,000,000. This cost is described in more detail in Appendix F. An additional $1,000,000 was spent for excess biomass disposal facilities.

Average treatment plant operating costs for the period July 1972-January 1973 are listed below.

	$/mo	$/1000 gal treated
Operator and supervisor salaries	4,522	0.19
Laboratory salaries	2,040	0.09
Maintenance	6,334	0.27
Chemicals and other supplies	3,378	0.14
Electric power	6,543	0.28
Overhead	1,574	0.07
Total	24,391	1.04

The cost per 1000 gallons is based on the actual flow treated during the period. The BOD removal averaged 9571 lb/day (based on the average of monthly averages) for the period, and the operating cost was $0.085/lb BOD removed on this basis, excluding biomass disposal costs.

SUMMARY

Although the waste treatment plant as designed and modified often removes 90% or more of the incoming BOD, and under normal circumstances reaches a soluble BOD that would meet present and future criteria, the nature of the waste is such that suspended solids, and therefore total BOD criteria are seldom met for more than a few days at a time. Deterioration of effluent quality can nearly always be traced to a shock load of COD, which causes an increase in effluent suspended solids, and a corresponding increase in BOD. The BOD in the effluent is primarily due to the suspended solids. Figure 38 shows the relationship between effluent BOD and suspended solids, based on computer calculated monthly averages for 1972. Original data are given in Appendix C.

Further improvement in effluent quality will require stabilization of the waste load, and improved suspended solids removal.

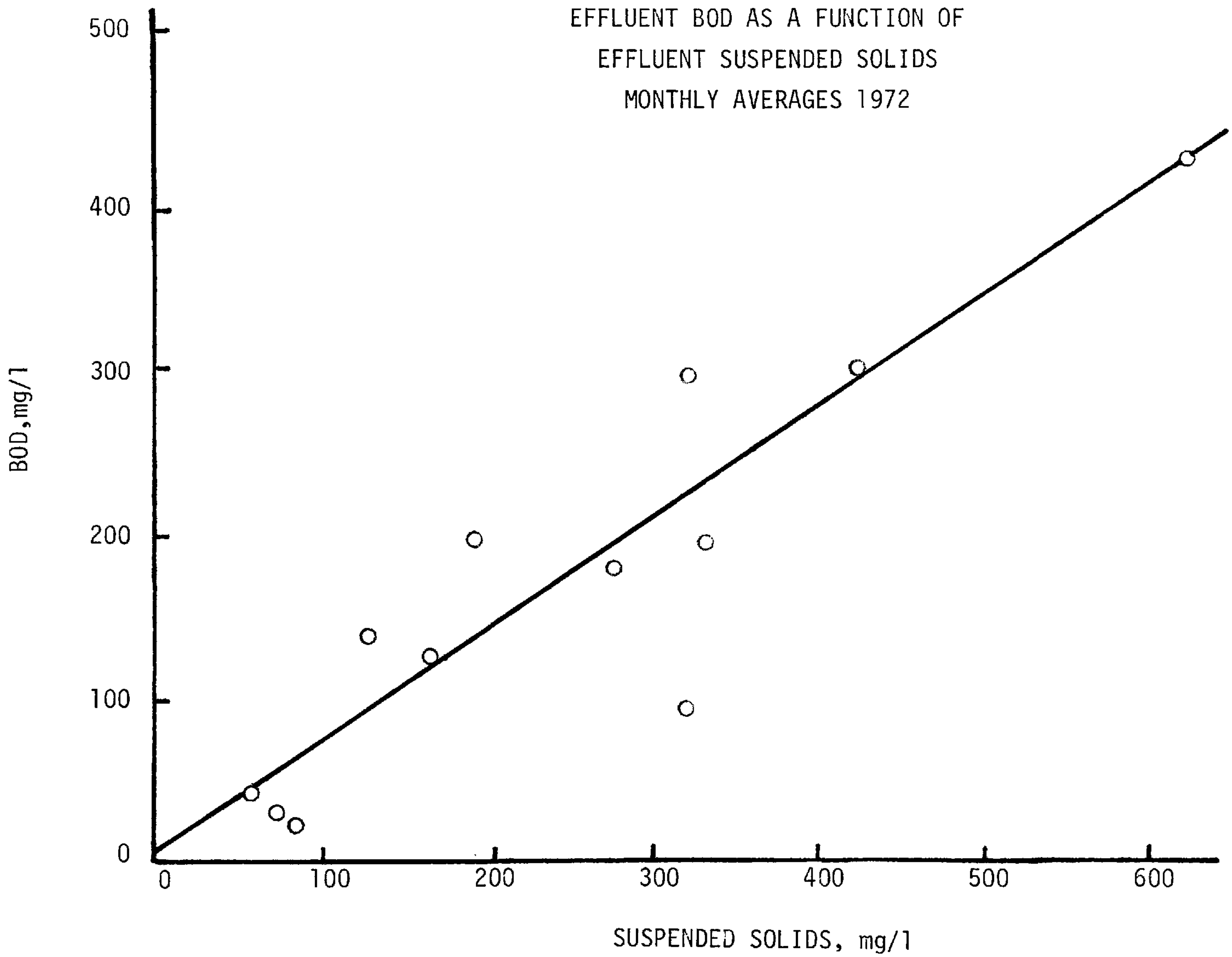


FIGURE 38
EFFLUENT BOD AS A FUNCTION OF
EFFLUENT SUSPENDED SOLIDS
MONTHLY AVERAGES 1972

SECTION VIII
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SECTION IX

PUBLICATIONS

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Bensing, H. O., Brown, D. R., and Watson, S. A., Waste Utilization and Pollution Control in Wet Milling, Cereal Science Today, Vol. 17, No. 10, October, 1972.

SECTION X

GLOSSARY OF TERMS AND ABBREVIATIONS

Activated Sludge - Biological waste treatment process which uses microorganisms in suspension to oxidize soluble and colloidal organics to CO_2 and H_2O in the presence of molecular oxygen.

Aerobic - Pertaining to an oxygen-dependent form of respiration.

Anaerobic - Pertaining to an oxygen-independent form of respiration.

Biochemical Oxygen Demand (BOD) - An empirical test to determine the relative oxygen requirements of wastewaters, effluents and polluted waters. Water quality standards are based on the 5-day 20°C BOD.

cfm - Cubic feet per minute.

Chemical Oxygen Demand (COD) - A measure of the oxygen equivalent of that portion of the organic matter in a sample that is susceptible to oxidation by a strogn chemical oxidant.

Correlation Coefficient - Statistic ranging from -1 to +1. The absolute value gives the magnitude of the correlation; the sign tells whether the relationship is direct or inverse.

DO - Dissolved oxygen.

Filamentous Organisms - Microorganisms such as the bacteria Sphaerotilus and Beggiatoa which may cause bulking in activated sludge.

Floc - Aggregation of suspended particles in water or wastewater.

Food-to-Microorganism Ratio (F/M) - Lbs. COD per lbs. MLSS per day.

fpm - Feet per minute.

gpd - Gallons per day.

hp - Horsepower.

mgd - Million gallons per day.

Milligrams per Liter (mg/l) - In water and wastewater, approximately equivalent to parts per million.

Mixed Liquor Suspended Solids (MLSS) - Solids in suspension in a waste treatment liquor.

ppm - Parts per million.

psi - Pounds per square inch.

rpm - Revolutions per minute.

Suspended Solids - Insoluble substances in water or wastewater.

Total Biological Oxygen Demand (T_bOD) - A relatively quick method of measuring the oxygen demand of the biodegradable fraction of a sample, described by Hiser and Busch[5].

APPENDIX A

LABORATORY AND PILOT PLANT ANALYTICAL METHODS

Tests for biochemical oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen (DO), nitrogen (N), and phosphorus (P) used the procedure described in Standard Methods[4]. The total biological oxygen demand (T_bOD) test and the mixed liquor suspended solids (MLSS) test are described in an article by Hiser and Busch[5].

The T_bOD test is a relatively quick method of measuring the oxygen demand of the biodegradable fraction of a sample. The procedure is to measure the COD on a filtered portion of the original sample. Then another portion of the sample is mixed with a biological culture and aerated. Samples are taken periodically over a period of 8 hours, and the COD of each sample measured after filtering through a membrane filter. A graph of the COD plotted against time will show a plateau COD, indicating that all the biodegradable material has been removed. The T_bOD is the difference between the original COD and the plateau COD. The plateau COD is a measure of the nonbiodegradable fraction of the waste.

T_bOD was used for preparation of unit rate of removal curves. The most important part of these curves, when used for design, is at low values of residual COD. Here, even small variations in plateau COD are important, so T_bOD is used as the parameter for unit rate of removal curves.

Batch Test

The batch test is an important analytical method for determining the unit rate of removal characteristic of a biological culture[3]. The batch test procedure is similar to the procedure for the T_bOD test. A sample of the culture to be characterized is mixed with a sample of the raw waste to be treated. The mixture is aerated for 8 hours. Samples are withdrawn at 30 to 60-minute intervals, and each sample is analyzed for MLSS and soluble COD.

Soluble COD and MLSS values are plotted against time, as shown in Figure 39. The slope of the COD curve is calculated at several points. The slope is divided by the corresponding MLSS value from the MLSS curve, and multiplied by 24 to obtain a basis of 1 day. The resulting curve shows the unit rate of removal, with the units of pounds of COD removed per day per pound MLSS under aeration.

Unit rate of removal is calculated for a number of values of COD over the range of the batch test. The unit rate of removal is then plotted against the corresponding T_bOD values (soluble COD minus plateau COD) as shown in Figure 40. Sample data are shown in Table 6. Sample calculations are shown below.

In order to determine the effect of T_bOD on the unit rate of COD removal, the rate of change of soluble COD must be calculated. For example, at 0.5 hour, dc/dt = 176 mg/l COD removal/hr. The unit rate of COD removal is the lb COD removed/lb MLSS-day. The MLSS at 0.5 hour is 859 mg/l. Therefore:

$$\frac{dc}{dt} \times \frac{24}{M} = \frac{176 \text{ mg/l COD removed}}{\text{hour}} \times \frac{1}{859 \text{ mg/l}} \times \frac{24 \text{ hours}}{\text{day}}$$

$$\frac{dc}{dt} \times \frac{24}{M} = \frac{4.92 \text{ lb COD removed}}{\text{lb MLSS-day}} \qquad T_bOD = 305 - 100 = 205 \text{ mg/l}$$

This unit rate of removal occurs at a T_bOD of 205 mg/l. The remaining data in Table 6 were calculated in like manner and are shown in Figure 40.

FIGURE 39

SAMPLE BATCH TEST DATA

BATCH TEST NO. 336

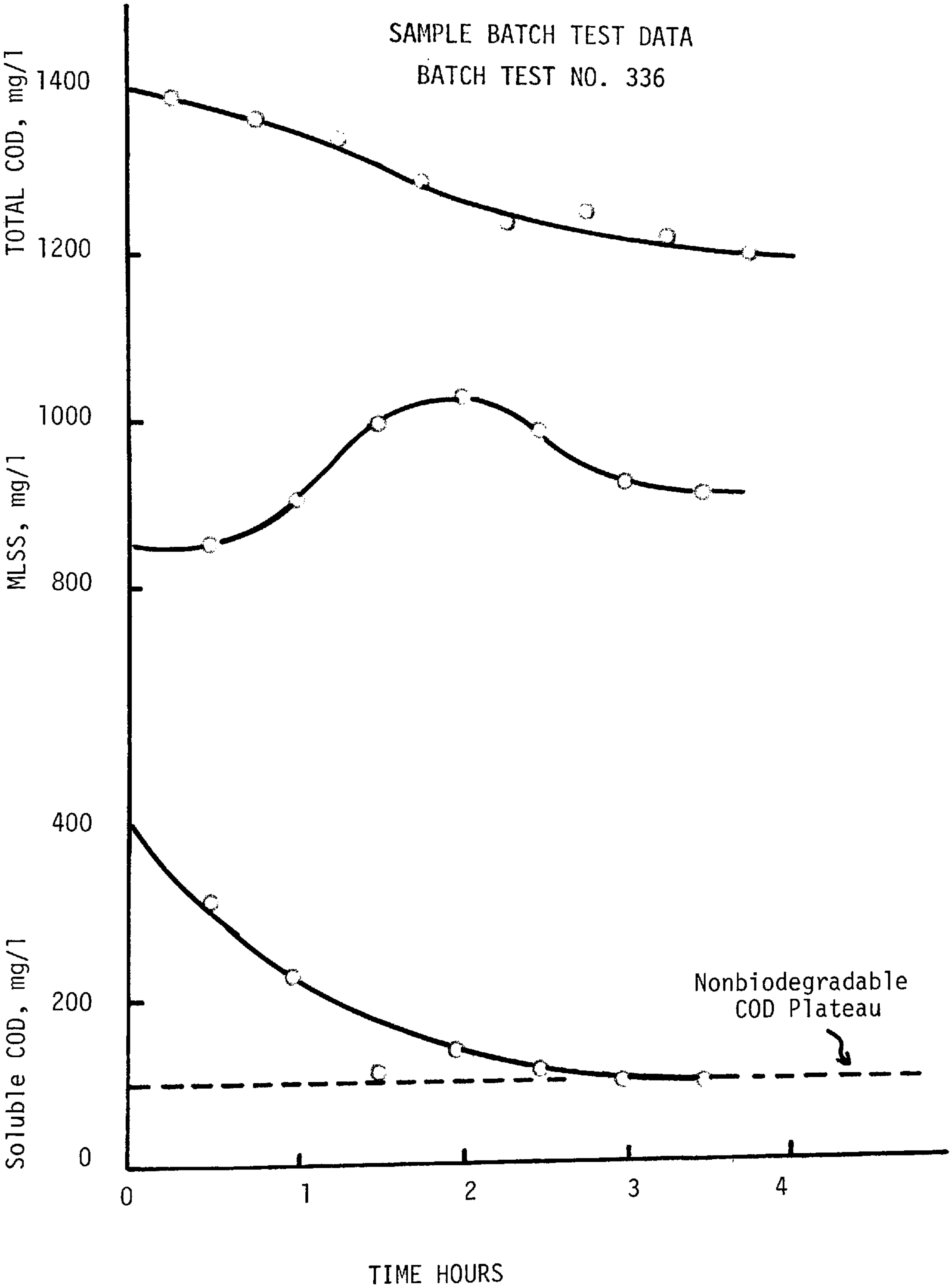


TABLE 6

SAMPLE DATA. BATCH TEST NO. 336

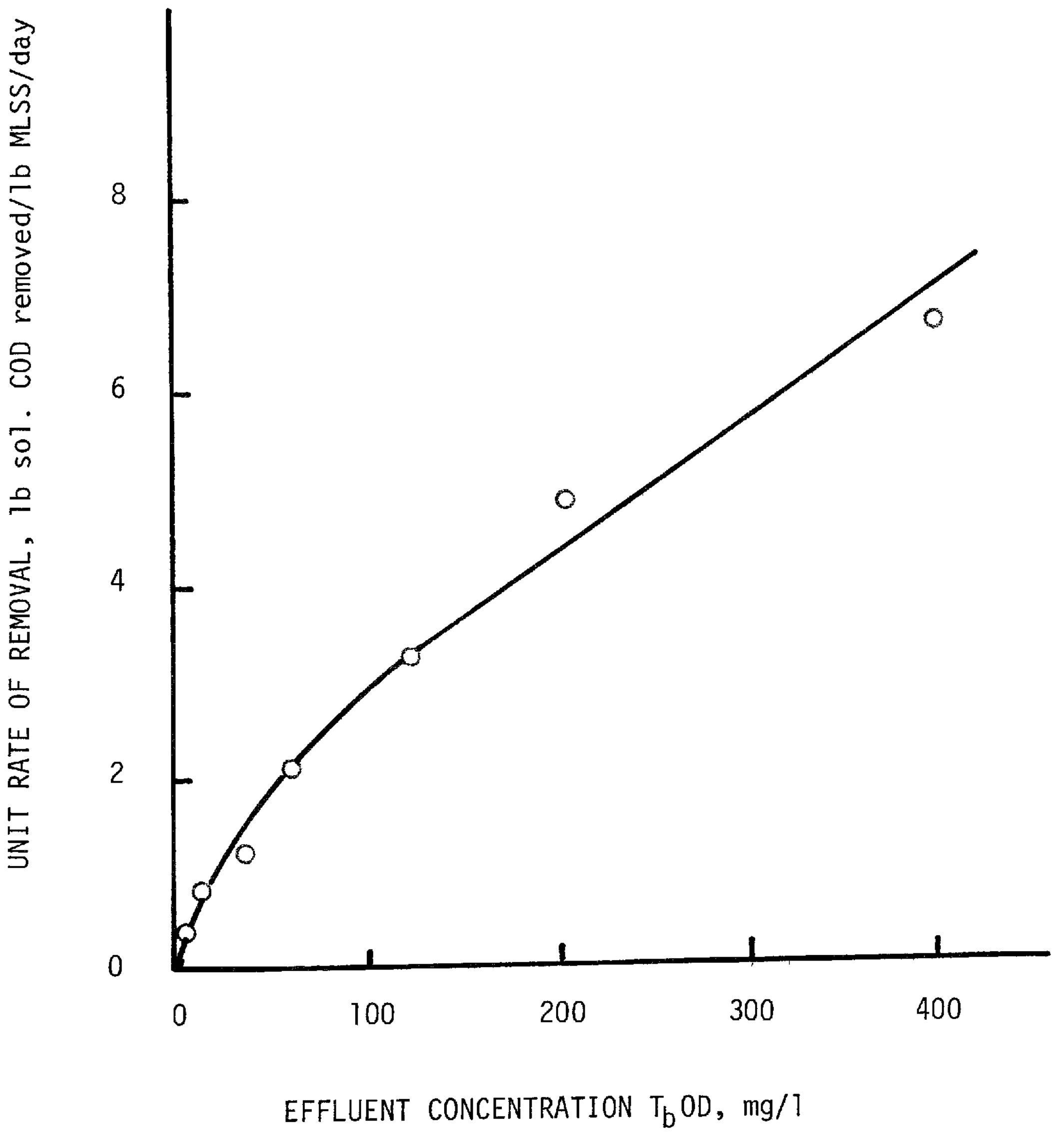
Time	Total COD, mg/l	M MLSS, mg/l (+ 0.45 μ)	C Soluble COD, mg/l (- 0.45 μ)	dc/dt, Rate of Change of Soluble COD, mg/l-hr	dc/Mdt, Unit Rate of Removal, lb COD/ lb MLSS-day	T_bOD, mg/l
1005		856	419	24.4	6.84	398
1015	1389					
1030		858	319	17.6	4.92	203
1045	1368					
1100		905	228	12.2	3.24	124
1115	1347					
1130		1000	112	8.5	2.03	62
1145	1285					
1200		1032	141	4.7	1.10	36
1215	1244					
1230		992	116	3.3	0.80	13
1245	1265					
1300		936	104	15	0.38	2
1315	1233					
1330		918	104	0	0	0
1345	1213					

Starting Time = 1000
Initial COD = 402
Initial MLSS = 856

Initial F/M = 0.47
Batch Test Temperature = 90°F

FIGURE 40

UNIT RATE OF REMOVAL
BATCH TEST NO. 336



The unit rate of removal curve characterizes the ability of a culture to remove soluble COD from the waste at various effluent T_bOD concentrations. Figure 40 shows that this particular culture could remove 2.75 pounds of COD per day per pound of MLSS, at an effluent T_bOD concentration of 100 mg/l.

APPENDIX B

ORIGINAL DATA FROM THE PEKIN WASTE TREATMENT PLANT OF CPC INTERNATIONAL INC., NOVEMBER 1970-AUGUST 1971

These data were taken during the startup period described in Section VI, and include the influent total COD (column 2), influent suspended solids (column 3), effluent total COD (column 4, and effluent suspended solids (column 5). The data are given in chronological order for each day that data were available from November 18, 1970 through August 26, 1971.

PEKIN WASTE TREATMENT PLANT

DATE	TOTAL COD INF MG/L	TSS INF MG/L	TOTAL COD EFF MG/L	TSS EFF MG/L
11/18/70	1340.	460.	82.	4110.
11/19/70	1436.	30.	164.	910.
11/20/70	1682.	40.	133.	660.
11/21/70	1650.	1.	103.	1130.
11/22/70	1681.	30.	93.	700.
11/23/70	2000.	490.	226.	770.
11/24/70	1866.	290.	632.	730.
11/25/70	1456.	153.	708.	580.
11/26/70	1650.	250.	629.	690.
11/27/70	1827.	390.	82.	800.
11/28/70	1674.	110.	112.	680.
11/29/70	1856.	230.	103.	740.
11/30/70	1500.	220.	92.	1110.
12/01/70	1735.	420.	102.	180.
12/02/70	1523.	220.	77.	230.
12/03/70	1579.	250.	86.	160.
12/04/70	1617.	360.	124.	96.
12/05/70	2020.	720.	115.	140.
12/07/70	1446.	190.	250.	246.
12/08/70	1907.	230.	82.	300.
12/09/70	1617.	290.	75.	124.
12/10/70	1897.	420.	135.	200.
12/11/70	1897.	320.	70.	164.
12/12/70	6887.	370.	313.	172.
12/14/70	2456.	1140.	1096.	360.
12/21/70	1026.	2820.	902.	1760.
12/22/70			435.	820.
12/28/70			1493.	240.
12/29/70			1057.	940.
12/30/70			300.	1165.
12/31/70			1804.	920.
1/12/71	2548.	330.		
1/13/71	1990.	1050.		
1/14/71	5073.	300.		2040.
1/15/71	3681.	1460.	7650.	2170.
1/03/71			2470.	1080.
1/04/71			1430.	2140.
1/05/71			1482.	470.
1/06/71			871.	330.
1/07/71			891.	850.
1/11/71			1025.	370.

PEKIN WASTE TREATMENT PLANT

DATE	TOTAL COD INF MG/L	TSS INF MG/L	TOTAL COD EFF MG/L	TSS EFF MG/L
1/08/71				530.
1/16/71	3670.	480.	526.	1560.
1/18/71	2340.	400.	687.	230.
1/19/71	2492.	170.	1068.	488.
1/20/71	2342.	130.	1371.	700.
1/22/71	1928.	790.	757.	200.
1/24/71	2083.	1430.	320.	152.
1/26/71	1815.	908.	326.	230.
1/27/71	1577.	208.	186.	360.
1/28/71	1918.	220.	175.	44.
1/29/71	2072.	212.	302.	140.
1/30/71	2612.	484.	549.	140.
1/25/71	2083.	752.	300.	
1/21/71	4660.	352.		
1/31/71	1835.			
2/01/71	2591.	376.	1361.	540.
2/02/71	3410.	992.	3027.	1292.
2/03/71	3400.	772.	1223.	164.
2/04/71	2177.	400.	379.	140.
2/05/71	1631.	268.	280.	120.
2/06/71	1596.	810.	320.	80.
2/08/71	1794.	556.	454.	230.
2/09/71	1619.	590.	580.	292.
2/10/71	1306.	328.	342.	140.
2/11/71	1721.	130.	570.	288.
2/12/71	2021.	1184.	453.	290.
2/13/71	1897.	290.	320.	136.
2/15/71	1361.	400.	1984.	1490.
2/16/71	1702.	520.	2830.	1840.
2/17/71	705.	350.	715.	350.
2/18/71	1596.	260.	663.	90.
2/19/71	1762.	1280.	523.	330.
2/20/71	1354.	800.	456.	280.
2/22/71	1928.	510.	268.	108.
2/23/71	1938.	620.	165.	220.
2/24/71	1309.	1670.	152.	88.
2/25/71	1261.	540.	152.	88.
2/26/71	1213.	350.	170.	112.
2/27/71	1513.	430.	207.	168.
3/01/71	2061.	650.	335.	200.
3/02/71	4664.	380.	983.	228.

PEKIN WASTE TREATMENT PLANT

DATE	TOTAL COD INF MG/L	TSS INF MG/L	TOTAL COD EFF MG/L	TSS EFF MG/L
3/03/71	2975.	170.	3638.	2710.
3/04/71	1793.	390.	1938.	1640.
3/05/71	1202.	240.	1244.	910.
3/06/71	1072.	230.	866.	850.
3/07/71	1620.	320.	995.	730.
3/08/71	1565.	380.	1379.	1270.
3/09/71	1244.	210.	249.	310.
3/10/71	1340.	110.	196.	160.
3/11/71	2464.	560.	217.	230.
3/12/71	2423.	1000.	309.	420.
3/14/71	2093.	490.	247.	250.
3/15/71	2633.	580.	404.	260.
3/16/71	2767.	440.	614.	392.
3/17/71	1610.	340.	640.	364.
3/18/71	1441.	40.	518.	500.
3/19/71	1052.	180.	1217.	720.
3/21/71	1210.	2780.	328.	180.
3/24/71	2712.	3520.	1062.	700.
3/30/71	2280.	420.	299.	60.
3/31/71	2536.	660.	338.	228.
3/22/71			2425.	1630.
3/23/71			2196.	476.
3/25/71			1037.	740.
3/26/71			533.	500.
3/28/71			398.	180.
3/29/71			280.	80.
4/01/71	2820.	770.	498.	516.
4/02/71	4297.	240.	532.	284.
4/04/71	2804.	390.	1194.	460.
4/05/71	6837.	720.	1347.	510.
4/14/71	4519.	770.	784.	450.
4/15/71	5093.	1110.	3939.	2500.
4/06/71			1171.	480.
4/07/71			2639.	2140.
4/08/71			3928.	5280.
4/09/71			757.	150.
4/13/71			622.	400.
4/25/71			972.	430.
4/16/71	7382.	570.	20620.	10330.
4/18/71	5485.	1140.	747.	500.
4/19/71	1042.	420.	620.	410.

PEKIN WASTE TREATMENT PLANT

DATE	TOTAL COD INF MG/L	TSS INF MG/L	TOTAL COD EFF MG/L	TSS EFF MG/L
4/22/71	2578.	230.	522.	350.
4/23/71	2967.	820.	473.	370.
4/24/71	5488.	550.	944.	400.
4/26/71	5515.	670.	1177.	610.
4/27/71	7018.	320.	1441.	330.
4/28/71	6343.	390.	1090.	170.
4/29/71	5730.	530.	705.	320.
4/30/71	3545.	720.		
4/20/71	1413.	310.		
4/21/71	1944.	260.		
5/02/71	2726.	450.	384.	290.
5/03/71	2342.	480.	281.	200.
5/04/71	1968.	430.	249.	170.
5/05/71	2177.	410.	177.	90.
5/06/71	2854.	440.	276.	180.
5/07/71	2900.	360.	389.	130.
5/11/71	4241.	870.	610.	790.
5/12/71	6695.	490.	519.	240.
5/13/71	3394.	630.	703.	70.
5/14/71	4154.	650.	705.	480.
5/09/71		3380.	639.	210.
5/10/71		1720.	1290.	430.
5/16/71	3957.	410.	726.	1040.
5/17/71	4478.	260.	431.	490.
5/20/71	3055.	1212.	544.	530.
5/21/71	2590.	310.	289.	340.
5/22/71	2136.	360.	1370.	240.
5/24/71	2610.	530.	265.	192.
5/25/71	2674.	730.	462.	76.
5/26/71	1687.	230.	448.	272.
5/27/71	1696.	220.	1029.	268.
5/28/71	6270.	990.	952.	288.
5/29/71	3172.	310.	2460.	1220.
5/19/71		1210.	706.	170.
6/02/71	5348.	430.	2460.	1220.
6/03/71	2894.	100.	455.	204.
6/04/71	3192.	1100.	421.	120.
6/05/71	3118.	720.	1328.	404.
6/07/71	3769.	1060.	1811.	700.
6/08/71	1957.	160.	1109.	260.
6/09/71	2489.	380.	622.	370.

PEKIN WASTE TREATMENT PLANT

DATE	TOTAL COD INF MG/L	TSS INF MG/L	TOTAL COD EFF MG/L	TSS EFF MG/L
6/10/71	2260.	500.	385.	130.
6/11/71	2197.	500.	295.	140.
6/12/71	1967.	760.	303.	100.
6/14/71	1540.	410.	321.	160.
6/15/71	2709.	370.	452.	188.
6/16/71	3538.	370.	324.	184.
6/17/71	2462.	240.	466.	200.
6/18/71	2236.	210.	490.	280.
6/19/71	2152.	60.	478.	210.
6/21/71	1804.	150.	439.	208.
6/22/71	1476.	330.	475.	292.
6/23/71	1696.	440.	557.	364.
6/24/71	1674.	440.	617.	396.
6/25/71	1871.	700.	318.	140.
6/26/71	2718.	1420.	313.	420.
6/28/71	1418.	760.	301.	156.
6/29/71	2125.	1010.	400.	256.
6/30/71	1914.	1100.	864.	520.
7/02/71	5081.	16440.	724.	280.
7/05/71	2789.	5420.	1003.	736.
7/06/71	1032.	350.	249.	116.
7/07/71	1262.	560.	180.	68.
7/08/71	1849.	970.	232.	104.
7/09/71	3401.	1100.	294.	700.
7/11/71	4188.	2050.	318.	120.
7/12/71	2532.	590.	2064.	1540.
7/13/71	1412.	120.	505.	172.
7/14/71	1155.	230.	471.	164.
7/15/71	3264.	1580.	383.	152.
7/16/71	1979.	660.	323.	164.
7/18/71	2298.	8030.	153.	88.
7/19/71	6796.	5490.	1130.	680.
7/20/71	4359.	1620.	1352.	548.
7/21/71	12555.	6670.	1926.	1360.
7/22/71	11097.	9050.	303.	208.
7/25/71		1850.	1245.	460.
7/26/71		1970.	975.	550.
7/27/71		4370.	462.	196.
7/28/71		1000.	345.	160.
7/29/71		2040.	105.	36.
7/30/71		16310.	72.	20.

PEKIN WASTE TREATMENT PLANT

DATE	TOTAL COD INF MG/L	TSS INF MG/L	TOTAL COD EFF MG/L	TSS EFF MG/L
8/01/71	3215.	2100.	120.	12.
8/02/71	1222.	830.	200.	140.
8/03/71	1717.	890.	196.	96.
8/04/71	1935.	580.	513.	260.
8/05/71	1275.	160.	1363.	608.
8/06/71	1873.	610.	532.	240.
8/08/71	2386.	440.	206.	60.
8/09/71	4110.	1990.	233.	263.
8/10/71	2696.	1530.	739.	144.
8/11/71	3629.	2170.	1278.	856.
8/12/71	2520.	490.	1104.	512.
8/13/71	1577.	320.	309.	132.
8/15/71	1939.	340.	546.	590.
8/16/71	1472.	450.	514.	300.
8/17/71	1277.	70.	339.	244.
8/18/71	1524.	570.	377.	244.
8/19/71	1665.	610.	293.	320.
8/20/71	1233.	360.	294.	164.
8/22/71	1812.	790.	237.	148.
8/23/71	1320.	490.	266.	188.
8/24/71	1389.	410.	124.	44.
8/25/71	1437.	580.	121.	28.
8/26/71	1156.	240.	121.	16.

APPENDIX C

ORIGINAL DATA FROM THE PEKIN WASTE TREATMENT PLANT OF CPC INTERNATIONAL INC., OCTOBER 1971-JANUARY 1973

Columns headed "influent" represent the stream from the equalization tank to the aeration tanks, and not the raw waste from the manufacturing plant. Effluent samples were taken from the effluent of the dissolved air flotation tank. Both of these samples were 24-hour composites. All others were grab samples. The composite samples were time proportioned. However, because of the equalization tank it was seldom necessary to change the flow rate through the treatment plant more than once each day, so the samples in effect are also flow proportioned.

The first section of this appendix lists all of the treatment plant data during the operating period discussed in Section VII (October 1971-January 1973). Semimonthly averages of these data were used to prepare Figures 30, 33 and 34. Monthly averages were used for Figure 38. Representative data points were used for Figures 29, 35 and 37.

The probability curves in Figures 28, 31, 32 and 37 were developed from computer generated distributions.

DATE	FLOW MGD	INFLUENT TOTAL COD MG/L	INFLUENT SOLUBLE COD MG/L	INFLUENT BOD MG/L	INFLUENT PH	INFLUENT AMMONIA N MG/L	INFLUENT INORGANIC P MG/L
OCT 1 1971	0.8140	1821.	1281.		6.9	291.0	123.0
OCT 3 1971	0.6180	1476.	1016.		6.4	272.0	105.0
OCT 4 1971	0.7460	1708.	1125.	1310.	5.4	260.0	33.0
OCT 5 1971	0.8430	1423.	1000.	1610.	5.1	213.0	75.0
OCT 6 1971	0.7440	3258.	1485.	2570.	5.0	232.0	87.0
OCT 7 1971	0.6950	2588.	1876.	2370.	4.8	260.0	97.0
OCT 8 1971	0.7060	3700.	3555.			235.0	48.0
OCT 10 1971	0.5820	2526.	2041.		5.3	249.0	39.0
OCT 11 1971	0.6780	1897.	1067.	1400.	6.2	263.0	43.0
OCT 12 1971	0.7300	3011.	1897.	4400.	5.3	174.0	32.0
OCT 13 1971	0.6670	4916.	4312.	6800.	4.7	185.0	43.0
OCT 14 1971	0.6460	3155.	2516.	2150.	6.3	221.0	70.0
OCT 15 1971	0.7010	3711.	1316.		6.4	218.0	61.0
OCT 17 1971	0.9420	3701.	1897.		5.7	272.0	67.0
OCT 18 1971	0.7260	3650.	2258.	3635.	5.3	283.0	56.0
OCT 19 1971	0.7220	3722.	1536.	3585.	5.9	252.0	0.1
OCT 20 1971	0.7510	1866.	1037.	3145.	6.8	238.0	18.0
OCT 21 1971	0.7990	2030.	1015.	1895.	6.2	202.0	19.0
OCT 22 1971	0.7550	3068.	2405.			263.0	15.0
OCT 24 1971	0.8310	1760.	1239.		6.2	263.0	11.0
OCT 25 1971	0.6090	2114.	1237.	1650.	6.4	207.0	39.0
OCT 26 1971	0.7790	3701.	2742.	3050.	4.0	230.0	12.7
OCT 27 1971	0.6260	3696.	1853.	2650.	5.8	188.0	42.0
OCT 28 1971	0.8490	2739.	1500.	2025.		174.0	31.0
OCT 29 1971	0.8020	1467.	928.			216.0	17.0
OCT 31 1971	0.7170	1784.	1619.		6.1	294.0	11.0
NOV 1 1971	0.2630	10103.	8042.	6140.	4.1	238.0	10.0
NOV 2 1971	0.5770	2322.	1814.	3470.	5.5	370.0	9.0
NOV 3 1971	0.6450	2114.	1866.	1820.	5.2	297.0	11.0
NOV 4 1971	0.8760	2578.	2052.	1970.	4.5	204.0	12.0
NOV 5 1971	0.8300	2208.	1731.		4.2	241.0	10.0
NOV 7 1971	0.3840	5311.	2312.			311.0	11.0
NOV 8 1971	0.4320	3671.	2625.	3000.	6.6	507.0	18.0
NOV 9 1971	0.4152	6784.	3753.	6800.	4.5	101.0	27.0
NOV 10 1971	0.5532	3980.	3361.	4330.		305.0	10.0
NOV 11 1971	0.8761	3567.	2928.	4230.	4.3	263.0	10.0
NOV 12 1971	0.8690	6758.	2529.		4.2	291.0	23.0
NOV 14 1971	0.4572	7774.	2309.		4.5	11.0	83.0
NOV 15 1971	0.5000	3692.	2543.	3510.	5.7	140.0	15.0
NOV 16 1971	0.7665	2742.	1897.	2155.	4.9	106.0	12.0
NOV 17 1971	0.8300	3569.	2851.	2930.	5.2	381.0	11.0
NOV 18 1971	0.8368	4081.	3487.	4330.	8.5	666.0	83.0
NOV 19 1971	0.8346	2887.	1959.		6.9	104.0	
NOV 21 1971	0.6808	2807.	1837.		6.5	336.0	37.0
NOV 22 1971	0.8720	2330.	1382.	1535.	7.1	302.0	36.0

DATE	AERATION PH	AERATION TEMP DEG F	AERATION D.O. MG/L	SETTLING ML/L	EFFLUENT TOTAL COD MG/L	EFFLUENT SOLUBLE COD MG/L	EFFLUENT SS MG/L	EFFLUENT BOD MG/L
OCT 1 1971	6.7	80.	1.6		1211.	144.	856.	
OCT 3 1971	6.6	72.			247.	159.	112.	
OCT 4 1971	6.9	72.	4.1		262.	146.	112.	142.
OCT 5 1971	6.3	70.	4.9		351.	128.	248.	105.
OCT 6 1971	6.6	70.	6.1		907.	173.	848.	408.
OCT 7 1971	6.8	72.	5.7		627.	194.	1140.	408.
OCT 8 1971	6.1	66.	5.5	130.	489.	315.	208.	
OCT 10 1971	5.6	60.		210.	285.	132.	24.	
OCT 11 1971	6.5	60.	4.3	210.	213.	123.	144.	65.
OCT 12 1971	5.7	65.	5.2	140.	276.	153.	176.	90.
OCT 13 1971	4.7	60.	4.7	230.	1083.	754.	224.	400.
OCT 14 1971	7.3	61.	1.8	640.	561.	231.	348.	50.
OCT 15 1971	7.2	64.	3.6	450.	390.	174.	264.	
OCT 17 1971	7.2	72.		280.	243.	136.	152.	
OCT 18 1971	7.0	64.	3.1	320.	301.	148.	88.	167.
OCT 19 1971	7.2	71.	5.5	290.	268.	190.	124.	147.
OCT 20 1971	6.8	71.	2.7	280.	182.	116.	104.	110.
OCT 21 1971	6.6	71.		220.	135.	94.	56.	63.
OCT 22 1971	6.5	72.	5.7	280.	124.	79.	48.	
OCT 24 1971	6.6	68.		230.	121.	79.	60.	
OCT 25 1971	6.4	62.	4.1	210.	113.	87.	50.	24.
OCT 26 1971	5.3	66.		250.	146.	76.	82.	26.
OCT 27 1971	6.6	65.		300.	193.	126.	102.	43.
OCT 28 1971	6.4	70.	3.2	280.	175.	121.	122.	38.
OCT 29 1971	6.6	72.	1.5	190.	172.	82.	116.	
OCT 31 1971	8.9	60.		350.				
NOV 1 1971	3.8	62.	3.6	350.	10413.	9073.	488.	7340.
NOV 2 1971	3.9	62.	2.8	270.	7152.	5867.	1200.	6140.
NOV 3 1971	5.2	68.	4.2	360.	1485.	730.	720.	788.
NOV 4 1971	6.3	70.	5.3	510.	503.	285.	196.	174.
NOV 5 1971	6.6	69.		530.	381.	207.	136.	
NOV 7 1971	6.5	48.		620.	329.	137.	208.	
NOV 8 1971	6.9	51.		710.	357.	127.	228.	125.
NOV 9 1971	6.7	60.		500.	344.	132.	256.	150.
NOV 10 1971		64.	4.0	540.	384.	132.	228.	163.
NOV 11 1971	7.2	72.	2.2	220.	313.	136.	268.	123.
NOV 12 1971	6.7	72.	1.2	230.	232.	104.	120.	
NOV 14 1971	6.3	68.		320.	239.	111.	108.	
NOV 15 1971	7.0	72.		250.	332.	187.	100.	76.
NOV 16 1971	7.4	72.		220.	359.	190.	152.	66.
NOV 17 1971	7.4			310.	254.	119.	180.	103.
NOV 18 1971	7.9	70.		340.	332.	74.	180.	163.
NOV 19 1971	7.9	70.	1.7	490.	289.	190.	124.	
NOV 21 1971	7.5	60.		290.	202.	161.	92.	
NOV 22 1971	7.5	64.	6.1	310.	227.	123.	120.	52.

DATE	EFFLUENT AMMONIA N MG/L	EFFLUENT INORGANIC P MG/L	RECYCLE RATE GPM	RECYCLE SS MG/L	EXCESS BIOMASS WASTE LB/DAY	AERATION MLSS MG/L	F/M LB SOL COD/LB MLSS DAY
OCT 1 1971	154.0	120.0	300.	10370.	7439.	3150.	0.43
OCT 3 1971	176.0	86.0	300.	9160.	6570.	3590.	0.34
OCT 4 1971	196.0	40.0	300.	5800.	3485.	3710.	0.32
OCT 5 1971	232.0	67.0	300.	7270.	3515.	2710.	0.37
OCT 6 1971	216.0	72.0	300.	6800.	3289.	3320.	0.51
OCT 7 1971	202.0	88.0	300.	9480.	4588.	3440.	0.67
OCT 8 1971	190.0	92.0	300.	10020.	4843.	2740.	0.96
OCT 10 1971	185.0	52.0	300.	13650.	6600.	5110.	0.54
OCT 11 1971	196.0	22.0	300.	12480.	6038.	3310.	0.28
OCT 12 1971	185.0	3.0	300.	9350.	6708.	3660.	0.55
OCT 13 1971	148.0	53.0	300.	7620.	5438.	5010.	0.93
OCT 14 1971	118.0	55.0	300.	10790.	7826.	5070.	0.51
OCT 15 1971	126.0	41.0	300.	11210.	8041.	4380.	0.36
OCT 17 1971	182.0	47.0	300.	16830.	8143.	6390.	0.40
OCT 18 1971	213.0	13.0	300.	17390.	8410.	7850.	0.31
OCT 19 1971	210.0	0.1	300.	17220.	12350.	6930.	0.26
OCT 20 1971	190.0	11.0	300.	12650.	11394.	7030.	0.20
OCT 21 1971	154.0	14.0	300.	25990.		5220.	0.24
OCT 22 1971	165.0	11.0	300.	11520.	6919.	5800.	0.53
OCT 24 1971	151.0	3.0	300.	10720.	7688.	4360.	0.38
OCT 25 1971	179.0	3.0	300.	8840.	6388.	4250.	0.28
OCT 26 1971	146.0	3.0	300.	28170.		5750.	0.59
OCT 27 1971	151.0	2.7	300.	12540.	6067.	7040.	0.29
OCT 28 1971	115.0	1.8	300.	17090.		5790.	0.36
OCT 29 1971	137.0	10.0	300.	8950.	14180.	4430.	0.27
OCT 31 1971			300.	14780.		6720.	0.27
NOV 1 1971	342.0	16.0	300.	15440.	7419.		
NOV 2 1971	319.0	21.0	300.	8650.	6229.	3765.	
NOV 3 1971	260.0	7.0	300.	10450.	7534.	4875.	
NOV 4 1971	174.0	5.0	300.	10460.	7534.	4535.	
NOV 5 1971	185.0	3.0	300.	7920.	7603.	3625.	
NOV 7 1971	176.0	3.0	240.	10790.	3888.	6230.	
NOV 8 1971	193.0	2.0	200.	16970.	3665.	6060.	
NOV 9 1971	266.0	3.0	100.	13190.	4752.	5830.	
NOV 10 1971	230.0	3.0	100.	16620.	13970.	4880.	
NOV 11 1971	213.0	2.0	75.	19100.	16057.	4790.	
NOV 12 1971	193.0	2.0	100.	19460.	16360.	4365.	
NOV 14 1971	45.0	2.0	45.	23260.	8381.	4240.	
NOV 15 1971	193.0	1.0	40.	11030.	3974.	3495.	
NOV 16 1971	302.0	3.0	80.	9800.	8824.	3430.	
NOV 17 1971	302.0	4.0	200.	10770.	9052.	4290.	
NOV 18 1971	353.0	3.0	230.	10820.	9092.	5015.	
NOV 19 1971	140.0		300.	8980.	8628.	4705.	
NOV 21 1971	325.0	32.0	200.	10620.	7017.	4390.	
NOV 22 1971	283.0	35.0	200.	12730.	8411.	4310.	

DATE	FLOW MGD	INFLUENT TOTAL COD MG/L	INFLUENT SOLUBLE COD MG/L	INFLUENT BOD MG/L	INFLUENT PH	INFLUENT AMMONIA N MG/L	INFLUENT INORGANIC P MG/L
NOV 23 1971	0.9482	1876.	1196.	1586.	7.0	274.0	18.0
NOV 24 1971	0.6290						
NOV 25 1971	0.2600	3999.	2953.	4100.	4.5		18.0
NOV 26 1971	0.2980						36.0
NOV 28 1971	0.2220	7609.	4081.		6.2	232.0	
NOV 29 1971	0.2540	4969.	3918.		7.6	246.0	21.0
NOV 30 1971	0.6790	4697.	2953.		5.0	255.0	19.0
DEC 1 1971	0.8500	3856.	2195.			84.0	11.0
DEC 2 1971	0.8830	1920.	1410.	1620.	6.8	272.0	9.0
DEC 3 1971	0.9340	2913.	1361.		7.1	260.0	19.0
DEC 5 1971	0.4430	3569.	2789.		5.9	297.0	8.0
DEC 6 1971	0.4850	6537.	4846.	4060.	6.6	308.0	22.0
DEC 7 1971	0.7550	4743.	3361.	5960.	4.8	325.0	15.0
DEC 8 1971	0.9500	3429.	2021.	2680.	5.9	308.0	9.0
DEC 9 1971	0.9590	2928.	2062.	2880.	5.2	249.0	8.0
DEC 10 1971	1.0320	3134.	2351.			171.0	11.0
DEC 12 1971	0.5150	3835.	2451.		4.8	316.0	9.0
DEC 13 1971	0.7730	7815.	1845.	4330.	5.1	328.0	39.0
DEC 14 1971	0.7430	4266.	1784.	2365.	5.3	286.0	24.0
DEC 15 1971	0.7610	2666.	1538.	1800.	6.5	266.0	12.0
DEC 16 1971	0.8520	1835.	1175.	1700.	6.2	258.0	6.0
DEC 17 1971	0.8550	1856.	1258.		5.4	213.0	11.0
DEC 19 1971	0.7210	2091.	1360.		5.7	269.0	12.0
DEC 20 1971	0.7140	1897.	1360.	1325.	6.9	260.0	15.0
DEC 21 1971	0.7080	1320.	1010.	1090.	7.5	249.0	15.0
DEC 22 1971	0.8640	1340.	887.		6.0	216.0	
DEC 23 1971	0.3040		969.				
DEC 24 1971	0.2890						
DEC 26 1971	0.2930	1938.	1113.		5.2		7.0
DEC 27 1971	0.4990	2543.	1989.	2380.	5.5	358.0	13.0
DEC 28 1971	0.7440	2449.	1990.	2130.	4.9	274.0	33.0
DEC 29 1971	0.7940	1939.	1704.	1835.	5.1	232.0	18.0
DEC 30 1971	0.8410	2010.	1723.	2085.	4.6		10.0
DEC 31 1971							
JAN 2 1972	0.4310	3414.	2475.		4.8		10.0
JAN 3 1972	0.5456	11998.	7753.	10100.	4.3	314.0	9.0
JAN 4 1972	0.6485	7526.	7485.	6500.	4.5	235.0	16.0
JAN 5 1972	0.9368	3364.	2912.	3145.	4.8	210.0	3.0
JAN 6 1972	0.9294	4040.	2051.	3995.	6.0	244.0	24.0
JAN 7 1972	0.8821	3021.	1674.		6.7	230.0	18.0
JAN 9 1972	0.2854	2276.	2031.		5.5	235.0	11.0
JAN 10 1972	0.5270	2206.	1598.	2325.	6.7	92.0	11.0
JAN 11 1972	0.8030	1743.	1261.	2025.	6.3	252.0	12.0
JAN 12 1972	0.9950	1856.	1436.	1725.	5.5	216.0	11.0
JAN 13 1972	1.0030	1897.	1713.	2425.	4.6	182.0	18.0

DATE	AERATION PH	AERATION TEMP DEG F	AERATION D.O. MG/L	SETTLING ML/L	EFFLUENT TOTAL COD MG/L	EFFLUENT SOLUBLE COD MG/L	EFFLUENT SS MG/L	EFFLUENT BOD MG/L
NOV 23 1971	7.6	69.	4.7	250.	285.	169.	148.	46.
NOV 24 1971			6.2					
NOV 25 1971	7.3	52.		200.		139.	432.	210.
NOV 26 1971								
NOV 28 1971	7.8	49.		280.	624.	148.	280.	
NOV 29 1971	7.7	56.	8.7	260.	495.	239.	312.	
NOV 30 1971	7.4	66.	6.6	730.	377.	197.	196.	
DEC 1 1971		66.	4.4	650.	279.	164.	128.	
DEC 2 1971	7.5	67.	5.9	590.	124.	58.	136.	63.
DEC 3 1971	7.5	67.	6.0	410.	197.	101.	72.	
DEC 5 1971	6.8	67.		300.	484.	336.	172.	
DEC 6 1971	7.1	62.	7.0	500.	499.	239.	288.	372.
DEC 7 1971	7.4	66.	5.0	910.	404.	173.	260.	183.
DEC 8 1971	7.6	72.	3.4	860.	261.	131.	140.	108.
DEC 9 1971	7.3	74.	1.8	390.	264.	140.	168.	128.
DEC 10 1971	7.0	74.	1.9	460.	107.	49.	132.	
DEC 12 1971	7.4			250.	281.	57.	152.	
DEC 13 1971	7.4	56.	9.0	190.	427.	187.	288.	217.
DEC 14 1971	7.4	62.	5.8	200.	525.	148.	44.	243.
DEC 15 1971	7.4	68.	5.3	270.	254.	144.	310.	95.
DEC 16 1971	7.4	64.	5.6	220.	202.	111.	550.	90.
DEC 17 1971	7.4	61.	6.0	190.	285.	120.	76.	
DEC 19 1971	7.6			120.	235.	110.	176.	
DEC 20 1971	7.6	62.	6.9	160.	282.	103.	148.	68.
DEC 21 1971	7.6	61.	7.1	160.	194.	99.	200.	78.
DEC 22 1971	7.3	65.	7.7	170.	190.	107.	96.	57.
DEC 23 1971								
DEC 24 1971								
DEC 26 1971	7.6			380.				
DEC 27 1971	7.5	59.	8.8	300.	279.	152.	172.	280.
DEC 28 1971	7.5	58.	6.8	250.	359.	176.	224.	86.
DEC 29 1971	7.3	67.	6.0	350.	257.	131.	268.	167.
DEC 30 1971	6.9	70.	4.7	430.	197.	115.	270.	87.
DEC 31 1971								
JAN 2 1972	6.7			910.	206.	97.	64.	
JAN 3 1972	6.3	61.	6.9	890.	529.	406.	112.	253.
JAN 4 1972	6.5	60.	3.9	440.	1563.	1555.	204.	1675.
JAN 5 1972	6.8	62.	2.3	340.	738.	525.	164.	498.
JAN 6 1972	7.4	70.	3.8	290.	505.	250.	248.	240.
JAN 7 1972	7.5	73.	4.2	340.	502.	216.	284.	
JAN 9 1972	7.4	68.		290.	404.	143.	320.	
JAN 10 1972	7.4	56.	8.0	200.	532.	177.	344.	205.
JAN 11 1972	7.4	62.	7.6	260.	476.	172.	296.	305.
JAN 12 1972	7.0	68.	5.3	290.	373.	135.	168.	158.
JAN 13 1972	7.0	64.	4.6	330.	443.	164.	88.	165.

DATE	EFFLUENT AMMONIA N MG/L	EFFLUENT INORGANIC P MG/L	RECYCLE RATE GPM	RECYCLE SS MG/L	EXCESS BIOMASS WASTE LB/DAY	AERATION MLSS MG/L	F/M LB SOL COD/LB MLSS DAY
NOV 23 1971	269.0	27.0	200.	6430.	3859.	3685.	
NOV 24 1971			425.				
NOV 25 1971		26.0	80.	22670.	5446.	3525.	
NOV 26 1971		16.0	30.				
NOV 28 1971	140.0		60.	21460.	4869.	4780.	
NOV 29 1971	112.0	14.0	30.	13410.		3915.	
NOV 30 1971	143.0	9.0	42.	13980.	10028.	4215.	
DEC 1 1971	168.0	3.0	160.	10800.	9343.	4800.	0.69
DEC 2 1971	232.0	2.0	240.	10890.	8108.	4070.	0.56
DEC 3 1971	227.0	1.0	220.	11400.	8492.	3680.	0.61
DEC 5 1971	218.0	6.0	130.	32820.	14588.	4490.	0.58
DEC 6 1971	165.0	4.0	40.	18390.	3973.	5680.	1.09
DEC 7 1971	151.0	2.0	80.	12810.	7690.	5560.	0.97
DEC 8 1971	218.0	2.0	260.	15330.	10224.	5400.	0.60
DEC 9 1971	227.0	3.0	240.	17420.	13397.	5060.	0.80
DEC 10 1971	81.0	3.0	140.	12190.	9377.	5970.	0.60
DEC 12 1971	224.0	2.0	40.	33600.	16140.	3700.	0.81
DEC 13 1971	230.0	7.0	20.	24200.	12794.	4490.	0.62
DEC 14 1971	266.0	5.0	70.	28860.	10398.	3040.	0.97
DEC 15 1971	251.0	6.0	30.	27680.	16617.	3820.	0.71
DEC 16 1971	249.0	4.0	50.			3050.	0.62
DEC 17 1971	204.0	5.0	50.	9720.	3378.	2320.	0.81
DEC 19 1971	224.0	7.0	75.	21520.	10339.	1740.	0.96
DEC 20 1971	221.0	9.0	75.	10390.	4988.	2470.	0.66
DEC 21 1971	218.0	13.0	105.	6320.	4174.	2380.	0.49
DEC 22 1971	199.0		198.	14920.	5374.	2500.	0.64
DEC 23 1971			144.				
DEC 24 1971							
DEC 26 1971		12.0	95.	9110.	2515.	3170.	0.20
DEC 27 1971	165.0	10.0	50.	9740.	5846.	2940.	0.72
DEC 28 1971	199.0	16.0	46.	8460.	6100.	2840.	2.11
DEC 29 1971	196.0	17.0	121.	3690.	6384.	2990.	0.85
DEC 30 1971		13.0	112.	12080.	7012.	3190.	0.90
DEC 31 1971			108.	10440.			
JAN 2 1972		5.0	112.	12140.	2044.	4000.	0.47
JAN 3 1972	146.0	2.0	85.	13820.	1993.	5060.	1.51
JAN 4 1972	140.0	7.0	74.	18900.	15665.	4710.	1.69
JAN 5 1972	109.0	3.0	70.	16200.	15564.	3950.	1.33
JAN 6 1972	129.0	6.0	72.	11720.	11118.	2820.	1.06
JAN 7 1972	171.0	4.0	90.	8940.	6445.	2380.	0.99
JAN 9 1972	190.0	18.0	88.	5660.	2039.	3290.	0.32
JAN 10 1972	202.0	27.0	170.	7640.	2752.	3010.	0.53
JAN 11 1972	235.0	19.0	145.	7480.	4131.	2530.	0.71
JAN 12 1972	216.0	15.0	150.	9340.	5048.	2640.	1.02
JAN 13 1972	165.0	13.0	130.	12580.	7857.	2820.	0.91

DATE	FLOW MGD	INFLUENT TOTAL COD MG/L	INFLUENT SOLUBLE COD MG/L	INFLUENT BOD MG/L	INFLUENT PH	INFLUENT AMMONIA N MG/L	INFLUENT INORGANIC P MG/L
JAN 14 1972	0.8970	1918.	1340.		5.9	17.0	16.0
JAN 16 1972	0.5640	2195.	1692.		4.7	109.0	17.0
JAN 17 1972	0.6770	2629.	1691.	2060.	7.4	311.0	18.0
JAN 18 1972	0.7170	7836.	2103.	4420.	4.8	179.0	50.0
JAN 19 1972	0.7630	3155.	1804.	2300.	7.1	196.0	27.0
JAN 20 1972	0.8420	2165.	1217.	1750.	6.7	196.0	9.0
JAN 21 1972	0.8780	1665.	995.		7.1	224.0	16.0
JAN 23 1972	0.5000	7794.	1825.		4.9	101.0	39.0
JAN 24 1972	0.7150	2174.	1836.	1925.	7.0	56.0	12.0
JAN 25 1972	0.7350	2125.	1786.	1775.	5.4	17.0	9.0
JAN 26 1972	0.6620	2701.	1907.		5.6	232.0	15.0
JAN 27 1972	0.6700	2789.	2051.		4.6	196.0	10.0
JAN 28 1972	0.8130	2359.	1620.		5.6	230.0	16.0
JAN 30 1972	0.6410	2144.	1309.		5.8	193.0	13.0
JAN 31 1972	0.4330	1567.	1443.		7.5	238.0	
FEB 1 1972	0.7190	1919.	1459.	1385.	6.5	193.0	11.0
FEB 2 1972	0.9410	2392.	1928.	1335.	5.2	185.0	11.0
FEB 3 1972	0.5940	2625.	1887.	1635.	7.0	84.0	17.0
FEB 4 1972	0.6240	2092.	1374.			196.0	16.0
FEB 6 1972	0.5940	1856.	1423.		5.3	168.0	10.0
FEB 7 1972	0.7000	3165.	1835.	2135.	4.4	87.0	14.0
FEB 8 1972	0.4250	3102.	2643.	2085.	4.8	204.0	9.0
FEB 9 1972	0.5200	2371.	1608.	1690.	5.5	216.0	10.0
FEB 10 1972	0.7380	2680.	1845.	2290.	4.6	196.0	13.0
FEB 11 1972	0.9810	3175.	2598.		4.3	160.0	13.0
FEB 13 1972	0.8720	2716.	2032.		4.5	92.0	11.0
FEB 14 1972	0.9440	3402.	2258.		4.6	0.1	11.0
FEB 15 1972	0.8530	2072.	2072.		4.0	11.0	9.0
FEB 16 1972	0.8740	3604.	2562.	4270.	5.7	0.1	19.0
FEB 17 1972	0.8820	3110.	2684.	3670.	3.8	0.1	11.0
FEB 18 1972	0.8420	2377.	1639.		3.5	0.1	
FEB 20 1972	0.5760	5901.	3887.			0.1	24.0
FEB 21 1972	0.4200	5114.	3196.		4.5	3.0	23.0
FEB 22 1972		4371.	1887.			3.0	50.0
FEB 23 1972		2804.	1815.	2230.	0.2	0.1	29.0
FEB 24 1972		4892.	1347.	3460.	2.3		30.0
FEB 25 1972	0.4260	1691.	1258.		10.0	40.1	
FEB 27 1972	0.4710	1660.	1474.		6.4	0.1	6.0
FEB 28 1972	0.5850	2510.	1194.		4.2	13.0	12.0
FEB 29 1972	0.6590	1876.	1362.		4.7	1.0	7.0
MAR 1 1972	0.7040	1464.	1227.	1084.	7.5	0.1	
MAR 2 1972	0.6620	2351.	2124.	1210.		28.0	
MAR 3 1972	0.5940	1592.	1470.		6.0	0.1	
MAR 5 1972	0.5760	1959.	1041.		5.2	0.1	
MAR 6 1972	0.6170	1743.	1231.		5.8	0.1	

DATE	AERATION PH	AERATION TEMP DEG F	AERATION D.O. MG/L	SETTLING ML/L	EFFLUENT TOTAL COD MG/L	EFFLUENT SOLUBLE COD MG/L	EFFLUENT SS MG/L	EFFLUENT BOD MG/L
JAN 14 1972	7.2	64.	5.6	360.	280.	132.	212.	
JAN 16 1972	6.5			400.	492.	226.	200.	
JAN 17 1972	6.5	49.	9.3	850.	309.	132.	184.	142.
JAN 18 1972	6.9	67.	4.5	340.	412.	181.	240.	152.
JAN 19 1972	7.4	70.	5.7	310.	318.	132.	192.	170.
JAN 20 1972	7.3	74.	4.2	340.	210.	78.	92.	83.
JAN 21 1972	7.5	72.	5.1	390.	183.	142.	112.	
JAN 23 1972	6.8			960.	363.	148.	294.	
JAN 24 1972	7.3	62.	3.2	550.	295.	144.	104.	115.
JAN 25 1972	7.3	60.	6.2	410.	286.	114.	180.	113.
JAN 26 1972	6.9	64.	5.6	400.	309.	107.	200.	129.
JAN 27 1972	6.7	63.		760.	328.	119.	120.	167.
JAN 28 1972	7.0	66.	5.7	980.	357.	123.	192.	
JAN 30 1972	7.3			970.	330.	111.	180.	
JAN 31 1972	7.3	56.	7.9	970.	169.	91.	160.	
FEB 1 1972	7.2	60.	7.6	410.	282.	131.	172.	88.
FEB 2 1972	7.0	72.	4.0	410.	330.	144.	196.	67.
FEB 3 1972	7.6	72.	3.6	600.	418.	197.	236.	154.
FEB 4 1972	7.3	56.	4.4	730.	566.	238.	152.	
FEB 6 1972	6.9	56.		700.	392.	165.	272.	
FEB 7 1972	5.9	56.	5.5	950.	507.	289.	328.	267.
FEB 8 1972	5.8	57.	6.5	530.	714.	331.	336.	327.
FEB 9 1972	5.9		6.4	970.	516.	227.	276.	179.
FEB 10 1972	6.7	61.	5.1	950.	342.	173.	184.	149.
FEB 11 1972	6.6	61.	5.0	960.	470.	214.	216.	
FEB 13 1972	6.6			920.	775.	240.	456.	
FEB 14 1972	6.3	76.	2.3	900.	722.	313.	344.	
FEB 15 1972	6.6	77.	2.3	910.	488.	176.	296.	
FEB 16 1972	7.1	72.	1.2	850.	454.	237.	204.	199.
FEB 17 1972	6.5	77.	2.0	830.	485.	187.	216.	297.
FEB 18 1972	5.3	77.	1.7	820.	289.	140.	84.	
FEB 20 1972	5.7		0.8	860.	1084.	345.	800.	
FEB 21 1972	5.0	81.	0.6	220.	949.	441.	443.	
FEB 22 1972	6.1	74.	1.2	670.	668.	445.	232.	
FEB 23 1972	2.1	74.			1571.	652.	928.	972.
FEB 24 1972	2.4	76.			593.	257.	308.	396.
FEB 25 1972	7.2	75.						
FEB 27 1972	6.8			670.	234.	136.	228.	
FEB 28 1972	6.1	70.	6.5	800.	314.	114.	108.	
FEB 29 1972	7.1	71.	5.8	820.	124.	83.	8.	
MAR 1 1972	7.0	78.	5.1	880.	140.	58.	100.	81.
MAR 2 1972	7.2	64.	5.0	910.	157.	74.	112.	74.
MAR 3 1972	6.9	60.	6.4	920.	184.	102.	96.	
MAR 5 1972	6.8			930.	746.	231.	404.	
MAR 6 1972	6.4	56.	6.7	850.	1091.	328.	1212.	

DATE	EFFLUENT AMMONIA N MG/L	EFFLUENT INORGANIC P MG/L	RECYCLE RATE GPM	RECYCLE SS MG/L	EXCESS BIOMASS WASTE LB/DAY	AERATION MLSS MG/L	F/M LB SOL COD/LB MLSS DAY
JAN 14 1972	76.0	16.0	100.	10700.	6681.	2680.	0.83
JAN 16 1972	106.0	17.0	100.	15280.	5504.	3290.	0.47
JAN 17 1972	151.0	6.0	60.	13360.	6417.	3530.	0.59
JAN 18 1972	179.0	7.0	68.	9460.	6138.	2550.	0.71
JAN 19 1972	123.0	11.0	70.	7540.	6340.	2240.	0.99
JAN 20 1972	140.0	11.0	105.	7120.	5560.	2000.	0.83
JAN 21 1972	168.0	9.0	130.	9640.	5210.	2410.	0.62
JAN 23 1972	90.0	4.0	60.	12650.	3354.	3890.	0.41
JAN 24 1972	101.0	4.0	100.	13180.	791.	3110.	0.70
JAN 25 1972	129.0	6.0	80.	12720.	6016.	2480.	0.70
JAN 26 1972	188.0	11.0	70.	10660.	6401.	2420.	0.69
JAN 27 1972	143.0	8.0	70.	6260.	3350.	3130.	0.72
JAN 28 1972	162.0	11.0	200.	13620.	7361.	3640.	0.66
JAN 30 1972	146.0	11.0	60.	12080.	3627.	3300.	0.45
JAN 31 1972	165.0				2331.	2940.	0.33
FEB 1 1972	207.0	13.0	60.	12720.	4123.	2230.	0.79
FEB 2 1972	196.0	10.0	50.	10260.	3481.	2410.	1.59
FEB 3 1972	188.0	10.0	104.	1940.	4008.	2810.	0.71
FEB 4 1972	204.0	14.0	140.	27480.	7286.	3080.	0.56
FEB 6 1972	193.0	13.0	125.	7000.	2704.	2700.	0.52
FEB 7 1972	106.0	11.0	130.	11600.	3481.	3770.	0.64
FEB 8 1972	760.0	14.0	105.	6960.	4008.	3240.	0.56
FEB 9 1972	168.0	8.0	220.	12140.	7286.	3820.	0.35
FEB 10 1972	140.0	6.0	110.	11260.	2704.	3900.	0.58
FEB 11 1972	120.0	8.0	180.	11260.	5409.	3470.	1.01
FEB 13 1972	64.0	9.0	250.	14200.	5967.	4620.	0.74
FEB 14 1972	0.1	8.0	180.	15820.	3799.	5400.	0.78
FEB 15 1972	0.1	6.0	180.	12900.	7284.	4620.	0.40
FEB 16 1972	25.0	8.0	165.	12700.	12200.	5490.	0.81
FEB 17 1972	8.0	5.0	200.	11940.	8605.	5060.	0.77
FEB 18 1972	0.1		300.	11920.	10020.	4960.	0.44
FEB 20 1972	7.0	12.0	128.	24460.	11738.	8940.	1.50
FEB 21 1972	0.1	7.0	150.	17360.	8340.	3160.	0.47
FEB 22 1972	0.1	5.0	150.	16700.	18053.	5400.	
FEB 23 1972	10.0	28.0	150.	4890.	5275.	1920.	
FEB 24 1972	3.0	8.0	150.	2700.	1296.	3200.	
FEB 25 1972			300.	9040.	867.	3790.	0.30
FEB 27 1972	0.1	5.0	300.	11380.	1917.	5060.	0.31
FEB 28 1972	21.0	6.0	200.	13040.	1882.	7440.	0.49
FEB 29 1972	8.0	4.0	210.	14800.	2838.	4570.	0.37
MAR 1 1972	4.0	1.0	168.	11080.		4610.	0.37
MAR 2 1972	3.0	2.0	290.	10740.		5530.	0.51
MAR 3 1972	28.0		310.	11050.	3405.	5600.	0.30
MAR 5 1972	45.0	9.0	290.	7800.	2793.	5090.	0.22
MAR 6 1972		10.0	290.	5860.	2098.	3190.	0.36

DATE	FLOW MGD	INFLUENT TOTAL COD MG/L	INFLUENT SOLUBLE COD MG/L	INFLUENT BOD MG/L	INFLUENT PH	INFLUENT AMMONIA N MG/L	INFLUENT INORGANIC P MG/L
MAR 7 1972	0.6280	1732.	1196.		3.1	0.1	1.0
MAR 8 1972	0.7360	1380.	9740.	1050.	6.9	0.1	3.0
MAR 9 1972	0.7240	1629.	1464.	1350.	6.4	0.1	5.0
MAR 10 1972	0.7470	1300.	1072.		4.0	0.1	
MAR 12 1972	0.8580	1388.	1184.		5.2	0.1	2.0
MAR 13 1972	0.5410	2881.	1918.		8.3	6.0	11.0
MAR 14 1972	0.6150	1886.	1575.		9.6	4.0	1.0
MAR 15 1972	0.7840	1313.	1005.	686.	6.3	0.1	0.2
MAR 16 1972	0.9270	1026.	861.	806.	5.1	0.1	0.3
MAR 17 1972	0.9500	958.	771.		6.7	0.1	1.0
MAR 19 1972	0.8090	1093.	845.		6.3	0.1	0.3
MAR 20 1972	0.8650	1897.	1608.		5.0	0.1	3.0
MAR 21 1972	0.7970	2083.	1739.		5.8	1.0	2.0
MAR 22 1972	0.8400	1534.	1285.	1180.	7.6	0.1	1.0
MAR 23 1972	0.9980	1629.	1443.	1300.	8.5	0.1	1.0
MAR 24 1972	0.9220	1072.	887.		7.3	0.1	2.0
MAR 26 1972	0.7940	1460.	1230.		7.0	0.1	1.0
MAR 27 1972	0.7870	2578.	1897.		5.9	0.1	4.0
MAR 28 1972	0.7190	1989.	1610.		5.8	0.2	3.0
MAR 29 1972	0.8430	1429.	1388.	1158.	5.3	0.1	2.0
MAR 30 1972	0.8630	1583.	1347.	1195.	5.6	1.0	1.0
MAR 31 1972	0.8770	1638.	1347.		7.0	0.1	
APR 2 1972							
APR 3 1972	0.8590	2021.	1949.		7.0	0.1	
APR 4 1972	0.8610	1546.	1477.		7.0	0.1	1.0
APR 5 1972	0.9100	1493.	1233.	1244.	7.2	0.1	0.3
APR 6 1972	1.0020	1072.	907.	672.	8.2	0.1	1.0
APR 7 1972	1.0190	1354.	1067.		7.5	0.1	0.2
APR 9 1972	0.9420	1701.	928.		7.4	0.1	1.0
APR 10 1972	0.8950	2186.	1340.		8.6	0.1	1.0
APR 11 1972	0.8380	2144.	1351.		6.6	0.1	3.0
APR 12 1972	0.8470	1443.	1175.	524.	7.1	0.1	2.0
APR 13 1972	0.9160	1866.	1562.	1324.	7.1	0.1	2.0
APR 14 1972	0.8490	1700.	1202.		7.2	1.0	2.0
APR 16 1972	0.7260	3774.	3671.		5.3	0.1	3.0
APR 17 1972	0.5290	3587.	3275.	3865.	4.4	0.1	2.0
APR 18 1972	0.7780	3031.	1918.		5.1	0.1	1.0
APR 19 1972	0.9510	2371.	1907.		4.7	0.1	1.0
APR 20 1972	1.0170	2441.	1856.	1890.	5.1	0.1	0.4
APR 21 1972	1.0140	1526.	1113.		6.0	0.2	2.0
APR 23 1972	0.5620	2021.	1526.		5.7	2.0	2.0
APR 24 1972	0.8070	2062.	2062.	1518.	5.3	0.1	2.0
APR 25 1972	1.0460	1653.	1653.		5.5	0.1	2.0
APR 26 1972	1.0190	1368.	1368.		6.5	7.0	2.0
APR 27 1972	0.9540	1265.	1265.	1026.	6.7	2.0	4.0

DATE	AERATION PH	AERATION TEMP DEG F	AERATION D.O. MG/L	SETTLING ML/L	EFFLUENT TOTAL COD MG/L	EFFLUENT SOLUBLE COD MG/L	EFFLUENT SS MG/L	EFFLUENT BOD MG/L
MAR 7 1972	6.8	65.	4.2	940.	1468.	206.	1060.	
MAR 8 1972	7.1	60.	8.3	660.	1039.	173.	980.	500.
MAR 9 1972	6.8	66.	8.2	600.	685.	124.	550.	380.
MAR 10 1972	6.6	70.	6.0	460.	544.	82.	390.	
MAR 12 1972	5.9	68.		970.	220.	69.	124.	
MAR 13 1972	7.1	62.	8.0	980.	489.	133.	224.	
MAR 14 1972	7.5	67.		980.	941.	112.	856.	
MAR 15 1972	7.4	74.	5.5	930.	755.	103.	696.	366.
MAR 16 1972	7.0	74.	7.5	320.	279.	53.	192.	113.
MAR 17 1972	7.1		6.5	190.	175.	58.	60.	
MAR 19 1972	6.4	70.		860.	91.	58.	112.	
MAR 20 1972	6.4	80.	7.6	760.	487.	99.	460.	
MAR 21 1972	7.3	74.		425.	400.	62.	360.	
MAR 22 1972	7.2	70.		475.	166.	66.	160.	106.
MAR 23 1972	7.1	72.		480.	132.	54.	68.	53.
MAR 24 1972	7.5	74.		490.	260.	33.	52.	
MAR 26 1972	7.2	68.		485.	92.	36.		
MAR 27 1972	6.7	72.	2.7	490.	148.	45.	92.	
MAR 28 1972	7.5	70.	2.4	485.	742.	53.	964.	
MAR 29 1972	7.4	70.	2.8	485.	506.	49.	372.	219.
MAR 30 1972	7.8	73.	4.0	460.	182.	50.	180.	60.
MAR 31 1972	7.5	73.		455.	431.	50.	300.	
APR 2 1972								
APR 3 1972	6.9	73.		495.	363.	115.	92.	
APR 4 1972	7.0	74.	2.5	495.	767.	82.	544.	
APR 5 1972	6.8	78.	5.6	305.	551.	87.	136.	
APR 6 1972	7.5	74.	4.9	260.	478.	49.	124.	282.
APR 7 1972	7.4	74.	8.0	300.	254.		216.	
APR 9 1972	7.4	77.		280.	227.	62.	140.	
APR 10 1972	7.5	75.	4.8	450.	194.	66.	80.	
APR 11 1972	7.3	80.	4.6	400.	194.	49.	188.	
APR 12 1972	7.4	66.	4.8	425.	239.	82.	88.	101.
APR 13 1972	7.2	73.		485.	212.	67.	208.	116.
APR 14 1972	8.0	72.	5.5	475.	199.	75.	164.	127.
APR 16 1972	6.5	71.		450.	133.	94.	128.	116.
APR 17 1972	7.2	77.	2.5	500.	775.	182.	1036.	543.
APR 18 1972	7.3	74.	2.0	500.	1089.	95.	1608.	478.
APR 19 1972	7.5	72.	2.6	495.	1225.	66.	1732.	516.
APR 20 1972	7.7	70.	3.3	500.	1563.	86.	1590.	790.
APR 21 1972	7.4	70.	5.5	500.	421.	74.	308.	199.
APR 23 1972	7.6	70.			107.	45.	10.	32.
APR 24 1972	7.6	70.	6.3	475.	470.	58.	356.	169.
APR 25 1972	7.6	70.	5.2	495.	547.	89.	292.	410.
APR 26 1972	7.8	70.	5.8		294.	79.	252.	221.
APR 27 1972	7.6	70.	6.9	500.	373.	33.	316.	153.

DATE	EFFLUENT AMMONIA N MG/L	EFFLUENT INORGANIC P MG/L	RECYCLE RATE GPM	RECYCLE SS MG/L	EXCESS BIOMASS WASTE LB/DAY	AERATION MLSS MG/L	F/M LB SOL COD/LB MLSS DAY
MAR 7 1972	25.0	1.0	330.	4440.	518.	3170.	0.42
MAR 8 1972	29.0	0.3	400.	8020.	935.	2980.	0.44
MAR 9 1972	15.0	0.1	200.	8120.	947.	3120.	0.72
MAR 10 1972	0.1		200.	8620.	1005.	3110.	0.50
MAR 12 1972	11.0	6.0	240.	9740.	1136.	3510.	0.58
MAR 13 1972	0.1	9.0	172.	11200.	2705.	4740.	0.52
MAR 14 1972	6.0	8.0	200.	9740.	2353.	3940.	0.53
MAR 15 1972	17.0	4.0	125.	10820.	3876.	3860.	0.46
MAR 16 1972	10.0	1.0	120.	10580.	4373.	2430.	0.52
MAR 17 1972	3.0	4.0	150.	10500.	2536.	3110.	0.51
MAR 19 1972	1.0	5.0	170.	20080.	4850.	3350.	0.42
MAR 20 1972	8.0	0.1	180.	10880.	2435.	3840.	0.77
MAR 21 1972	6.0	0.1	225.	9700.	3474.	3770.	0.75
MAR 22 1972	7.0	4.0	225.	10500.	3760.	3670.	0.61
MAR 23 1972	0.1	4.0	230.	11620.	4839.	3690.	0.75
MAR 24 1972	0.1		250.	10680.	4448.	4030.	0.40
MAR 26 1972	0.1	0.6	250.	11220.	3364.	6920.	0.38
MAR 27 1972	0.2	0.1	245.	12180.	5884.	5830.	0.50
MAR 28 1972	0.2	0.5	200.	11460.	6595.	6760.	0.38
MAR 29 1972	15.0	6.0	170.	12280.	6649.	2820.	0.53
MAR 30 1972	19.0	6.0	180.	11140.	5832.	4450.	0.68
MAR 31 1972	10.0			8420.	5050.	3560.	0.58
APR 2 1972			220.				
APR 3 1972	0.1		220.	14320.	4294.	4850.	0.74
APR 4 1972	0.1	0.1	250.	8940.	5362.	4780.	0.49
APR 5 1972	0.1	0.1	200.	11360.	5488.	4160.	0.48
APR 6 1972	3.0	0.2	200.	10500.	3149.	3220.	0.48
APR 7 1972	0.1		200.	12960.	3130.	4290.	0.59
APR 9 1972	8.0	4.0	240.	12420.	3724.	4470.	0.42
APR 10 1972	0.1	3.0	220.	14340.	4300.	4670.	0.50
APR 11 1972	0.1	0.1	220.	13200.	5498.	4950.	0.46
APR 12 1972	0.1	0.1	210.	11600.	4831.	4330.	0.42
APR 13 1972	0.1	0.1	200.	10320.	5588.	4200.	0.67
APR 14 1972	8.0	9.0	200.	10160.	6093.	3670.	0.52
APR 16 1972	1.0	5.0	200.	12100.	5040.	5770.	1.13
APR 17 1972	0.1	0.1	200.	9620.	5770.	4670.	0.60
APR 18 1972	0.1	0.1	400.	7440.	4462.	4100.	0.63
APR 19 1972	0.1	0.1	350.	7080.	4246.	3280.	0.92
APR 20 1972	0.1	0.1	400.	4860.	1457.	2180.	1.26
APR 21 1972	4.0	6.0	200.	7280.	5215.	2270.	0.92
APR 23 1972	16.0	4.0	300.	8960.	4851.	3280.	0.78
APR 24 1972	3.0	1.0	250.	7420.	4450.	2720.	0.94
APR 25 1972	8.0	1.0	200.	7580.	6692.	2530.	1.23
APR 26 1972	10.0	2.0	200.	7560.	4156.	2700.	0.87
APR 27 1972	24.0	5.0	200.	10340.	5684.	5690.	0.58

DATE	FLOW MGD	INFLUENT TOTAL COD MG/L	INFLUENT SOLUBLE COD MG/L	INFLUENT BOD MG/L	INFLUENT PH	INFLUENT AMMONIA N MG/L	INFLUENT INORGANIC P MG/L
APR 28 1972	0.8850	1196.	1196.		6.5	0.1	2.0
APR 30 1972	0.7310	3470.	3470.		5.1	0.1	3.0
MAY 1 1972							1.0
MAY 2 1972	0.8160	1859.	1427.		5.2	0.1	1.0
MAY 3 1972	0.8060	1875.	1350.		6.2	0.1	1.0
MAY 4 1972	0.6460	1850.	1325.	1105.	10.4	0.1	1.0
MAY 5 1972	0.9920	1119.	964.		7.1	0.1	1.0
MAY 7 1972	0.8340	953.	766.		7.3	0.1	2.0
MAY 8 1972	0.7540	990.	887.	721.	8.2	0.1	1.0
MAY 9 1972	1.0500	1026.	820.		6.5	0.1	2.0
MAY 10 1972	0.9480	1042.	802.		7.8	0.1	2.0
MAY 11 1972	0.9900	1072.	856.	824.	8.3	0.1	2.0
MAY 12 1972	0.8090	1052.	763.		8.0	0.1	4.0
MAY 14 1972	0.2020	1794.	1248.		7.9	0.1	3.0
MAY 15 1972							2.0
MAY 16 1972	0.6370	1897.	1052.		6.3	0.1	1.0
MAY 17 1972	0.7800	2032.	1420.		6.9	0.1	2.0
MAY 18 1972	0.8430	2195.	1856.	2150.	5.9	0.1	1.0
MAY 19 1972	0.9120	1646.	1469.		5.9	0.1	1.0
MAY 21 1972	0.8640	1237.	1083.		9.2	0.1	1.0
MAY 22 1972	0.9500	928.	784.	978.	7.2	0.1	2.0
MAY 23 1972	0.8940	2646.	2297.		6.9	0.4	1.0
MAY 24 1972	1.0220	2041.	1656.		6.8	0.4	2.0
MAY 25 1972	1.0270	2104.	1843.	1695.	7.2	0.9	1.0
MAY 26 1972	0.5910	18288.	17219.		4.4	0.4	2.0
MAY 29 1972						0.1	1.0
MAY 30 1972	0.5580	3166.	1479.		6.0	0.1	1.0
MAY 31 1972	0.9130	1281.	1156.		7.2	0.6	3.0
JUN 1 1972	1.0280	1118.	860.	720.	8.4	2.0	0.2
JUN 2 1972	1.0170	1010.	794.		6.7	7.0	0.2
JUN 4 1972	0.8670	953.	806.		6.9	3.0	0.3
JUN 5 1972	0.7240	989.	812.	691.	7.0	7.0	1.0
JUN 6 1972	0.9740	1323.	1010.		6.2	1.0	1.0
JUN 7 1972	0.8910	1332.	1175.		5.8	5.0	1.0
JUN 8 1972	0.8920	1646.	1312.	1382.	5.8	3.0	1.0
JUN 9 1972	0.7520	2041.	1770.		8.5	0.1	1.0
JUN 11 1972	0.8580	1479.	1250.		7.4	2.0	2.0
JUN 12 1972	0.8480	1093.	711.	885.	7.3	4.0	2.0
JUN 13 1972	0.8410	1037.	757.		7.1	5.0	1.0
JUN 14 1972	0.8170	2062.	1489.		6.5	28.0	3.0
JUN 15 1972	0.8110	1265.	1026.	1310.	7.1	13.0	2.0
JUN 16 1972	0.7080	2197.	1772.		7.1	9.0	2.0
JUN 18 1972	0.7890	1794.	1588.		6.2	3.0	1.0
JUN 19 1972	0.7540	1313.	954.	1096.	7.0	1.0	5.0
JUN 20 1972	0.9390	1233.	985.		6.0	1.0	1.0

DATE	AERATION PH	AERATION TEMP DEG F	AERATION D.O. MG/L	SETTLING ML/L	EFFLUENT TOTAL COD MG/L	EFFLUENT SOLUBLE COD MG/L	EFFLUENT SS MG/L	EFFLUENT BOD MG/L
APR 28 1972	7.8	70.	6.2	500.	383.	58.	200.	116.
APR 30 1972	7.2	75.		500.	990.	73.	448.	772.
MAY 1 1972	7.1	70.	3.2	500.				
MAY 2 1972	7.2	70.	6.5	495.	1635.	31.	1900.	905.
MAY 3 1972	7.3	69.	7.0	475.	760.	60.	388.	422.
MAY 4 1972	8.0	72.	5.8	425.	250.	50.	240.	101.
MAY 5 1972	7.5	68.	7.3	475.	249.	52.	220.	76.
MAY 7 1972	7.5	66.		365.	332.	41.	324.	111.
MAY 8 1972	7.5	66.	5.8	325.	598.	41.	644.	151.
MAY 9 1972	6.3	70.	7.0	275.	706.	49.	636.	204.
MAY 10 1972	7.6	70.	6.6	300.	450.	62.	380.	141.
MAY 11 1972	7.9	70.	7.5	450.	635.	50.	616.	264.
MAY 12 1972	7.7	66.	7.0	495.	730.	45.	392.	438.
MAY 14 1972	7.8	70.		495.	691.	58.	492.	319.
MAY 15 1972	7.3	74.	6.9	360.				
MAY 16 1972	7.4	76.	6.3	460.	528.	124.	490.	260.
MAY 17 1972	7.6	77.	4.2	460.	301.	21.	260.	220.
MAY 18 1972	7.5	77.	3.1	500.	954.	21.	1050.	680.
MAY 19 1972	7.5	77.	2.9	480.	750.	31.	820.	509.
MAY 21 1972	8.3	77.		400.	804.	21.	780.	349.
MAY 22 1972	7.7	78.	4.8	300.	722.	52.	560.	269.
MAY 23 1972	7.0	80.	3.2	500.	1132.	53.	1148.	489.
MAY 24 1972	6.9	80.	1.0	460.	1066.	121.	920.	718.
MAY 25 1972	5.8	80.		450.	887.	87.	1092.	269.
MAY 26 1972	4.0	80.	2.0	485.	3722.	3358.	732.	2510.
MAY 29 1972	5.6	70.						
MAY 30 1972	7.2	70.			1521.		360.	760.
MAY 31 1972	7.6	70.	5.5		575.	146.	296.	210.
JUN 1 1972	7.9	70.	6.7	175.	303.	52.	72.	125.
JUN 2 1972	7.8	76.	6.0	180.	202.	87.	108.	151.
JUN 4 1972	7.6	74.		450.	117.	80.	100.	44.
JUN 5 1972	7.9	80.		450.	258.	58.	280.	371.
JUN 6 1972	7.6	80.	6.0	370.	1021.	42.	952.	371.
JUN 7 1972	6.8	82.	5.2	670.	639.	49.	716.	291.
JUN 8 1972	6.9	87.	3.5	780.	579.	62.	528.	641.
JUN 9 1972	7.5	72.	4.0	950.	225.	58.	168.	117.
JUN 11 1972	8.1	75.		720.	675.	92.	652.	335.
JUN 12 1972	7.7	83.	3.3	650.	210.	54.	152.	77.
JUN 13 1972	7.8	82.	1.9	870.	91.	25.	28.	56.
JUN 14 1972	7.9	82.	2.9	950.	550.	71.	512.	584.
JUN 15 1972	7.6	82.	2.9		211.	66.	128.	81.
JUN 16 1972	7.6	75.	5.6		95.	66.	20.	38.
JUN 18 1972	7.6	78.			107.	70.	60.	32.
JUN 19 1972	7.9	84.	2.9		172.	70.	140.	59.
JUN 20 1972	7.5	82.	2.8	980.	692.	58.	680.	300.

DATE	EFFLUENT AMMONIA N MG/L	EFFLUENT INORGANIC P MG/L	RECYCLE RATE GPM	RECYCLE SS MG/L	EXCESS BIOMASS WASTE LB/DAY	AERATION MLSS MG/L	F/M LB SOL COD/LB MLSS DAY
APR 28 1972	8.0	5.0	150.	11080.	3968.	3040.	0.53
APR 30 1972	0.1	0.1	200.	9700.	4040.	4990.	1.56
MAY 1 1972	0.1	0.1	180.	6380.	4464.	3170.	
MAY 2 1972	0.1	0.2	180.	6240.	2910.	2620.	0.75
MAY 3 1972	0.1	0.8	190.	8640.	1223.	2100.	0.88
MAY 4 1972	6.0	3.0	110.	7860.	1898.	2230.	0.77
MAY 5 1972	9.0	4.0	150.	8480.	2542.	2090.	0.86
MAY 7 1972	12.0	3.0	150.	9020.	3230.	1920.	
MAY 8 1972	17.0	2.0	100.	6720.	1623.	2060.	0.64
MAY 9 1972	15.0	1.0	150.	6480.	1565.	1990.	0.83
MAY 10 1972	16.0	1.0	150.	6860.	1319.	1840.	0.75
MAY 11 1972	10.0	2.0	150.	6400.	2033.	2360.	0.82
MAY 12 1972	14.0	17.0	150.	6060.	3150.	1840.	0.58
MAY 14 1972	8.0	6.0	150.	4820.	4470.	2300.	0.46
MAY 15 1972	10.0	1.0	150.	7200.	1096.	2400.	
MAY 16 1972	9.0	0.1	200.	7180.	541.	2870.	0.45
MAY 17 1972	3.0	0.3	200.	6520.	555.	2880.	0.73
MAY 18 1972	0.1	0.7	150.	6240.	647.	2840.	1.14
MAY 19 1972	6.0	6.0	150.	4540.		1830.	1.16
MAY 21 1972	13.0	7.0	200.	2240.		1350.	1.06
MAY 22 1972	9.0	7.0	200.	2300.		1040.	1.09
MAY 23 1972	6.0	1.0	150.	2680.		1770.	2.49
MAY 24 1972	1.0	1.0	150.	4840.		1880.	1.72
MAY 25 1972	6.0	2.0	300.	3120.		2270.	1.66
MAY 26 1972	6.0	6.0	300.	6620.		5300.	4.76
MAY 29 1972	5.0	0.3	150.	2760.		1390.	
MAY 30 1972	0.1	0.1	150.	5080.		1980.	0.95
MAY 31 1972	13.0	9.0	150.	9160.		3830.	0.74
JUN 1 1972	15.0	6.0	150.	8240.	1990.	1900.	0.58
JUN 2 1972	36.0	9.0	150.	8980.	3216.	2630.	0.62
JUN 4 1972	23.0	8.0	150.	6500.	2003.	2250.	0.58
JUN 5 1972	16.0	2.0	400.	4660.	854.	2040.	0.54
JUN 6 1972	8.0	0.1	200.	2780.	509.	1770.	1.06
JUN 7 1972	0.1	0.1	200.	3760.	438.	1790.	2.46
JUN 8 1972	10.0	0.1	400.	5560.	1065.	2430.	2.25
JUN 9 1972	0.1	0.6	400.	4880.	1179.	2700.	1.02
JUN 11 1972	9.0	2.0	400.	3800.	918.	2130.	0.81
JUN 12 1972	25.0	9.0	400.	5060.	1222.	2500.	0.49
JUN 13 1972	24.0	7.0	400.	4600.	1762.	2750.	0.45
JUN 14 1972	25.0	8.0	400.	4520.	2183.	2510.	0.87
JUN 15 1972	10.0	8.0	500.	4720.	1965.	2680.	0.60
JUN 16 1972	2.0	6.0	520.	5720.	3430.	3680.	0.72
JUN 18 1972	3.0	3.0	500.	7520.	5387.	4100.	0.60
JUN 19 1972	10.0	3.0	520.	7260.	2419.	4150.	0.33
JUN 20 1972	7.0	2.0	500.	6180.	1853.	3110.	0.98

DATE	FLOW MGD	INFLUENT TOTAL COD MG/L	INFLUENT SOLUBLE COD MG/L	INFLUENT BOD MG/L	INFLUENT PH	INFLUENT AMMONIA N MG/L	INFLUENT INORGANIC P MG/L
JUN 21 1972	0.9520	1358.	964.		6.8	6.0	8.0
JUN 22 1972	0.9320	1784.	1258.	1100.	5.4	7.0	0.5
JUN 23 1972	0.6880	1052.	917.		7.2	1.0	0.1
JUN 25 1972	0.7180	1793.	1451.		6.1	3.0	0.3
JUN 26 1972	0.7210	1629.	1155.	1210.	4.9	1.0	0.4
JUN 27 1972	0.7410	1330.	1062.		5.2	1.0	1.0
JUN 28 1972	0.7920	840.	1161.	1036.	5.3	2.0	2.0
JUN 29 1972	0.5400	2804.	2351.		4.7	1.0	2.0
JUN 30 1972			5640.		4.4		
JUL 2 1972							
JUL 3 1972							
JUL 4 1972	0.5540	1113.	1113.		7.1		2.0
JUL 5 1972	0.7910	1700.	1700.		8.0		3.0
JUL 6 1972	0.9110	1608.	1608.	1450.	6.8	4.0	1.0
JUL 7 1972	0.8700	2031.	2031.		5.1	0.1	3.0
JUL 9 1972	0.8640	1783.	1783.		4.9	5.0	1.0
JUL 10 1972	0.9370	1844.	1544.	1382.	6.5	1.0	1.0
JUL 11 1972	0.9600	1794.	1670.		5.6	2.0	2.0
JUL 12 1972	0.9870	2227.	1897.		6.4	1.0	1.0
JUL 13 1972	0.5910	1723.	1200.	1370.	7.9	0.4	2.0
JUL 14 1972	0.6000	1648.	1544.		7.5	0.2	3.0
JUL 16 1972	0.2240	1202.	881.		7.3	0.6	3.0
JUL 17 1972	0.5450	1382.	598.	660.	7.2	1.0	2.0
JUL 18 1972	0.8950	1078.	498.		7.4	0.7	1.0
JUL 19 1972	0.9020	1493.	1099.		6.7	5.0	0.5
JUL 20 1972	0.6170	1441.	1140.	1730.	4.0	1.0	0.3
JUL 21 1972	0.5200	1057.	881.		7.0	1.0	1.0
JUL 23 1972	0.5840	1155.	804.		7.2	1.0	2.0
JUL 24 1972	0.3820	773.	516.	706.	7.3		1.0
JUL 25 1972	0.5770	1026.	697.		8.2	1.0	1.0
JUL 26 1972	0.7140	1037.	653.		7.5	3.0	0.6
JUL 27 1972	0.7320	1026.	518.	1044.	7.0	4.0	2.0
JUL 28 1972	0.4910	1332.	670.		7.9	0.1	0.4
JUL 30 1972	0.4380	881.	782.		6.7	2.0	0.3
JUL 31 1972	0.4330	1382.	940.	1000.	6.9	4.0	0.8
AUG 1 1972	0.7450	2239.	1604.		7.3	2.0	0.4
AUG 2 1972	0.7860	1588.	1031.		7.2	1.0	1.0
AUG 3 1972	0.7220	1384.	861.	1135.	8.5	1.0	12.0
AUG 4 1972	0.8000	1103.	722.		7.8	0.2	2.0
AUG 6 1972	0.8000	1202.	746.		7.7	1.0	3.0
AUG 7 1972	0.6720	1021.	619.	702.	8.1	0.4	2.0
AUG 8 1972	0.6440	1507.	1046.		7.2	3.0	2.0
AUG 9 1972	0.8600	1268.	1567.		7.9	2.0	2.0
AUG 10 1972	0.8730	1855.	1140.	1680.	7.4	0.4	2.0
AUG 11 1972	0.8470	861.	677.		7.3	0.1	2.0

DATE	AERATION PH	AERATION TEMP DEG F	AERATION D.O. MG/L	SETTLING ML/L	EFFLUENT TOTAL COD MG/L	EFFLUENT SOLUBLE COD MG/L	EFFLUENT SS MG/L	EFFLUENT BOD MG/L
JUN 21 1972	7.5	82.	3.2		850.	54.	772.	300.
JUN 22 1972	7.6	77.	3.6	980.	495.	66.	396.	160.
JUN 23 1972	7.8	75.	4.4	980.	192.	54.	172.	114.
JUN 25 1972	7.4	80.		850.	124.	50.	120.	73.
JUN 26 1972	7.0	82.	1.6	850.	140.	49.	54.	85.
JUN 27 1972	7.3	80.	2.8	480.	132.	41.	136.	87.
JUN 28 1972	7.0	80.	2.0	500.	174.	54.	132.	129.
JUN 29 1972	7.1	80.	2.1	870.	177.	66.	132.	
JUN 30 1972	7.1					62.		
JUL 2 1972	7.7	67.		950.				
JUL 3 1972								
JUL 4 1972	7.1	74.		850.	123.	54.	110.	80.
JUL 5 1972	7.4	76.		790.	128.	82.	92.	70.
JUL 6 1972	7.4	78.	1.6	840.	130.	66.	128.	63.
JUL 7 1972	7.4	80.	1.5	750.	120.	49.	48.	78.
JUL 9 1972	7.4	78.		720.	70.	53.	64.	92.
JUL 10 1972	7.6		4.9	310.	87.	50.	64.	60.
JUL 11 1972	7.5			610.	86.	25.	80.	52.
JUL 12 1972	7.3			540.	128.	29.	116.	71.
JUL 13 1972	7.8			650.	123.	53.	96.	59.
JUL 14 1972	7.5			650.	100.	46.	32.	28.
JUL 16 1972	7.0			700.	112.	33.	92.	43.
JUL 17 1972	6.9			620.	120.	66.	80.	26.
JUL 18 1972	7.4		2.8	550.	145.	62.	60.	72.
JUL 19 1972	7.1		4.5	550.	91.	62.	32.	59.
JUL 20 1972	6.7		4.2	700.	41.	31.	22.	26.
JUL 21 1972	6.3		5.5	590.	52.	35.	36.	28.
JUL 23 1972	6.4			410.	74.	23.	34.	23.
JUL 24 1972	6.7			550.	74.	49.	46.	49.
JUL 25 1972	7.0		7.1	550.	49.	43.	26.	30.
JUL 26 1972	7.2		4.9	520.	46.	35.	22.	22.
JUL 27 1972	7.1		6.5	550.	37.	33.	38.	22.
JUL 28 1972	6.9		2.6	600.	49.	33.	6.	15.
JUL 30 1972	6.5			520.	23.	18.	26.	8.
JUL 31 1972	7.2		6.1	470.	101.	96.	40.	34.
AUG 1 1972	7.1		7.0	590.	62.	60.	14.	17.
AUG 2 1972	7.3		4.0	740.	43.	39.	24.	11.
AUG 3 1972	7.4		4.9	800.	31.	25.	18.	7.
AUG 4 1972	7.5		4.1	950.	43.	29.	26.	21.
AUG 6 1972	7.4			900.	50.	29.	16.	17.
AUG 7 1972	7.3			900.	58.	29.	14.	18.
AUG 8 1972	7.1		5.0	980.	72.	25.	30.	19.
AUG 9 1972	7.3			990.	118.	35.	52.	25.
AUG 10 1972	7.5		2.7	940.	116.	50.	80.	33.
AUG 11 1972	7.4		3.6		98.	37.	18.	22.

DATE	EFFLUENT AMMONIA N MG/L	EFFLUENT INORGANIC P MG/L	RECYCLE RATE GPM	RECYCLE SS MG/L	EXCESS BIOMASS WASTE LB/DAY	AERATION MLSS MG/L	F/M LB SOL COD/LB MLSS DAY
JUN 21 1972	8.0	2.0	500.	4200.	1014.	2820.	1.22
JUN 22 1972	3.0	2.0	500.	5140.	985.	2790.	0.58
JUN 23 1972	3.0	6.0	400.	6000.	1099.	3150.	0.42
JUN 25 1972	3.0	0.2	400.	7980.	1462.	4240.	0.55
JUN 26 1972	1.0	3.0	500.	6740.	3256.	4170.	0.38
JUN 27 1972	0.6	5.0	500.	7500.	2686.	3890.	0.37
JUN 28 1972	1.0	4.0	500.	6320.	1526.	3910.	0.44
JUN 29 1972	0.7	1.0	400.	5840.	3502.	4760.	0.51
JUN 30 1972			300.				
JUL 2 1972			300.	5540.		5240.	
JUL 3 1972			400.				
JUL 4 1972	1.0	0.1	400.	7560.	3652.	4650.	0.15
JUL 5 1972	7.0	0.1	450.	8620.	5169.	4550.	0.42
JUL 6 1972	3.0	0.8	450.	10000.	4165.	4820.	0.45
JUL 7 1972	1.0	5.0	450.	9800.	4082.	5260.	0.48
JUL 9 1972	3.0	2.0	450.	9700.	4686.	5130.	0.46
JUL 10 1972	4.0	2.0	400.	5780.		2900.	0.55
JUL 11 1972	0.4	1.0	500.	10460.		4750.	0.77
JUL 12 1972	0.1	0.2	500.	10700.		5370.	0.68
JUL 13 1972	0.4	0.1	500.	10220.		5880.	0.23
JUL 14 1972	0.4	1.0	400.	9120.		4950.	0.32
JUL 16 1972	0.7	4.0	400.	7800.		2020.	0.19
JUL 17 1972	2.0	2.0	400.	9800.		4890.	0.35
JUL 18 1972	1.0	2.0	500.	5780.		3830.	0.20
JUL 19 1972	0.7	1.0	500.	8620.		4630.	0.45
JUL 20 1972	0.9	2.0	500.	7420.		4680.	0.29
JUL 21 1972	3.0	4.0	500.	6780.		5150.	0.19
JUL 23 1972	1.0	5.0	400.	6000.		3530.	0.21
JUL 24 1972	3.0	6.0	400.	5760.		3820.	0.10
JUL 25 1972	2.0	4.0	500.	5600.		3170.	0.22
JUL 26 1972	1.0	3.0	500.	6880.		3880.	0.26
JUL 27 1972	1.0	5.0	500.	7940.		4050.	0.19
JUL 28 1972	0.1	5.0	400.	6680.		4560.	0.14
JUL 30 1972	2.0	5.0	400.	6060.		3580.	0.17
JUL 31 1972	11.0	7.0	400.	6740.		3820.	0.21
AUG 1 1972	2.0	0.4	500.	9120.		4020.	0.53
AUG 2 1972	1.0	1.0	500.	8900.		4380.	0.32
AUG 3 1972	1.0	6.0	550.	8080.		3450.	0.29
AUG 4 1972	0.1	12.0	550.	6980.		3630.	0.27
AUG 6 1972	0.7	7.0	500.	6660.		3840.	0.28
AUG 7 1972	0.2	3.0	450.	6880.		3720.	0.21
AUG 8 1972	0.6	2.0	500.	6120.		4150.	0.32
AUG 9 1972	0.4	0.2	500.	7880.		4410.	0.48
AUG 10 1972	0.6	0.1	650.	8080.		4410.	0.47
AUG 11 1972	0.0	0.3	690.	6920.		4240.	0.27

DATE	FLOW MGD	INFLUENT TOTAL COD MG/L	INFLUENT SOLUBLE COD MG/L	INFLUENT BOD MG/L	INFLUENT PH	INFLUENT AMMONIA N MG/L	INFLUENT INORGANIC P MG/L
AUG 13 1972	0.9480	1051.	647.		8.1	0.7	1.0
AUG 14 1972	0.8900	4105.	2985.	3340.	6.9	2.0	2.0
AUG 15 1972	0.8340	7235.	5742.		6.8	2.0	3.0
AUG 16 1972	0.4590	5728.	4969.		4.8	1.0	0.1
AUG 17 1972	0.4330	4851.	3794.	4320.	4.4	1.0	1.0
AUG 18 1972	0.4880	2695.	2457.		4.5	1.0	0.4
AUG 20 1972	0.8680	1547.	1072.		5.0	1.0	0.2
AUG 21 1972	0.8560	2766.	1710.	2035.	4.7	1.0	0.1
AUG 22 1972	0.9330	1732.	1309.		4.7	0.7	1.0
AUG 23 1972	0.9360	1248.	979.		6.0	1.0	0.1
AUG 24 1972	0.8240	1425.	1200.	1372.	7.3	1.0	0.6
AUG 25 1972	0.6520	1555.	1213.		5.0	1.0	0.1
AUG 27 1972	0.5160	1261.	892.		5.8	2.0	0.1
AUG 28 1972	0.6340	1866.	1138.	1569.	8.8	1.0	0.4
AUG 29 1972	0.7950	4882.	1566.		5.2	1.0	2.0
AUG 30 1972	0.8080	2072.	1742.		4.7	2.0	0.4
AUG 31 1972	0.8060	3172.	3172.	1096.	4.9	8.0	0.1
SEP 1 1972	0.6100	4598.	4330.	2712.	4.4	5.0	0.4
SEP 3 1972							
SEP 4 1972	0.9360	5081.	4552.	2410.	7.2	9.0	2.0
SEP 5 1972	0.9370	1804.	1368.		5.8	1.0	2.0
SEP 6 1972	0.9320	1588.	1289.		5.8	2.0	0.3
SEP 7 1972	0.9650	3130.	2446.	2660.	4.9	1.0	1.0
SEP 8 1972	0.4790	5701.	4913.		4.6	0.1	0.4
SEP 10 1972	0.6460	3784.	3516.		4.5	0.7	
SEP 11 1972	0.1950	871.	715.	800.	9.1	3.0	0.3
SEP 12 1972	0.5760	1436.	1179.		9.4	3.0	0.1
SEP 13 1972	0.8130	1441.	1202.		8.9	3.0	1.0
SEP 14 1972	0.8970	1513.	1005.	1120.	6.8	1.0	35.0
SEP 15 1972	0.7750	1237.	938.		7.4	0.1	1.0
SEP 17 1972	0.8070	1497.	1067.		7.0	0.4	0.8
SEP 18 1972	0.7950	2819.	1835.	1650.	8.0	0.4	0.3
SEP 19 1972	0.8310	1949.	1223.		7.4	0.2	0.1
SEP 20 1972	0.8270	1361.	845.		8.0	0.4	0.1
SEP 21 1972	0.8680	1072.	701.	858.	7.7	0.2	0.1
SEP 22 1972	0.9490	1097.	746.		7.5	0.7	0.1
SEP 24 1972	0.9470	954.	622.		7.4	2.0	0.1
SEP 25 1972	0.9550	1814.	1237.	1485.	7.6	0.7	1.5
SEP 26 1972	0.8250	1381.	783.		7.0	1.1	0.2
SEP 27 1972	0.8920	1208.	812.		7.0	0.7	0.1
SEP 28 1972	0.9200	2135.	705.		7.1	0.7	0.4
SEP 29 1972	1.0430	990.	619.		7.3	0.7	1.0
OCT 1 1972	1.0360	878.	663.		7.1	0.4	
OCT 2 1972	0.9160	2104.	1614.	628.	5.4	1.0	0.7
OCT 3 1972	0.9560	1916.	1437.		5.0	1.0	1.0

DATE	AERATION PH	AERATION TEMP DEG F	AERATION D.O. MG/L	SETTLING ML/L	EFFLUENT TOTAL COD MG/L	EFFLUENT SOLUBLE COD MG/L	EFFLUENT SS MG/L	EFFLUENT BOD MG/L
AUG 13 1972	7.2			950.	67.	37.	62.	25.
AUG 14 1972	6.7		3.6	940.	132.	46.	196.	49.
AUG 15 1972	5.5		1.0	910.	315.	226.	142.	206.
AUG 16 1972	5.6		1.1	980.	342.	239.	148.	196.
AUG 17 1972	6.3		2.0	990.	309.	286.	124.	113.
AUG 18 1972	6.8		0.5		653.	104.	396.	357.
AUG 20 1972	7.1			990.	136.	52.	90.	571.
AUG 21 1972	7.4		1.2	990.	168.	37.	112.	745.
AUG 22 1972	7.3		1.1	940.	738.	35.	642.	376.
AUG 23 1972	7.4			960.	744.	45.	624.	366.
AUG 24 1972	7.4		4.2	960.	558.	45.	484.	208.
AUG 25 1972	7.4		3.9	975.	155.	35.	80.	60.
AUG 27 1972	7.0			950.	250.	31.	200.	47.
AUG 28 1972	7.3			920.	150.	31.	124.	25.
AUG 29 1972	7.2			950.	266.	39.	48.	63.
AUG 30 1972	7.3		2.1	990.	74.	47.	32.	30.
AUG 31 1972	7.0		1.6	204.	62.	33.	18.	25.
SEP 1 1972	7.0		0.7	172.	62.	37.	22.	14.
SEP 3 1972								
SEP 4 1972	7.5			251.	216.	64.	230.	45.
SEP 5 1972	7.8			266.	83.	66.	70.	14.
SEP 6 1972	7.7		3.0	269.	62.	45.	20.	24.
SEP 7 1972	6.5		1.0	183.	66.	46.	16.	14.
SEP 8 1972	7.2		0.3	158.	178.	133.	84.	72.
SEP 10 1972	6.8			131.	97.	74.	26.	6.
SEP 11 1972	7.1		4.2	158.	220.	50.	180.	133.
SEP 12 1972	7.2			191.	205.	78.	140.	48.
SEP 13 1972	7.1			216.	139.	60.	56.	50.
SEP 14 1972	7.2		2.9	240.	220.	39.	144.	86.
SEP 15 1972	7.5		2.6	291.	151.	64.	82.	20.
SEP 17 1972	7.0			202.	74.	66.	26.	18.
SEP 18 1972	7.2			199.	222.	166.	66.	40.
SEP 19 1972	7.2			231.	251.	211.	70.	72.
SEP 20 1972	7.3		3.3	208.	231.	124.	84.	136.
SEP 21 1972	7.5		4.0	260.	153.	66.	60.	41.
SEP 22 1972	7.6		5.6	204.	58.	25.	44.	8.
SEP 24 1972	7.5			120.	41.	29.	20.	8.
SEP 25 1972	7.3			115.	70.	43.	46.	29.
SEP 26 1972	7.5			177.	78.	58.	40.	13.
SEP 27 1972	7.2		5.7	151.	65.	42.	46.	18.
SEP 28 1972	7.2			124.	100.	81.	38.	25.
SEP 29 1972	7.3		6.3	122.	72.	49.	28.	15.
OCT 1 1972	7.4			530.	53.	41.	8.	13.
OCT 2 1972	6.2		6.0	720.	69.	52.	56.	17.
OCT 3 1972	7.5			510.	83.	54.	32.	27.

DATE	EFFLUENT AMMONIA N MG/L	EFFLUENT INORGANIC P MG/L	RECYCLE RATE GPM	RECYCLE SS MG/L	EXCESS BIOMASS WASTE LB/DAY	AERATION MLSS MG/L	F/M LB SOL COD/LB MLSS DAY
AUG 13 1972	0.6	2.0	700.	6200.		3370.	0.30
AUG 14 1972	0.7	0.1	650.	8560.		4730.	1.16
AUG 15 1972	0.9	0.1	600.	11620.		6830.	1.42
AUG 16 1972	0.6	0.0	620.	10160.		7910.	0.54
AUG 17 1972	0.6	0.0	610.	10700.		7640.	0.38
AUG 18 1972	1.7	0.1	610.	8920.		6390.	0.31
AUG 20 1972	3.2	0.1	550.	6680.		4350.	0.31
AUG 21 1972	5.0	0.0	530.	5160.		3720.	0.64
AUG 22 1972	3.0	0.1	430.	11620.		3650.	0.63
AUG 23 1972	16.0	2.0	510.	3060.		4110.	0.46
AUG 24 1972	19.0	0.2	480.	4200.		2600.	0.55
AUG 25 1972	12.0		480.	4060.		2500.	0.56
AUG 27 1972	8.0	7.4	480.	3700.		2810.	0.38
AUG 28 1972	1.0	0.1	500.	6720.		2900.	0.50
AUG 29 1972	0.2	0.1	510.	5620.		3260.	0.75
AUG 30 1972	4.0	0.0	510.	6180.		3730.	0.72
AUG 31 1972	1.0	0.2	520.	8620.		4260.	1.02
SEP 1 1972	0.1	0.1	500.	9020.		6550.	0.86
SEP 3 1972			500.				
SEP 4 1972	0.6	0.1	500.	6640.		4410.	1.12
SEP 5 1972	3.0	0.1	500.	7180.		3840.	0.57
SEP 6 1972	7.0	0.1	500.	6360.		3300.	0.61
SEP 7 1972	1.0	0.1	500.	9580.		5050.	1.02
SEP 8 1972	1.0	0.3	500.	8260.		6690.	0.72
SEP 10 1972	0.4	0.1	500.	10100.		9960.	0.56
SEP 11 1972	0.4	0.1	500.	8180.		6630.	0.03
SEP 12 1972	0.9	0.1	500.	11960.		5170.	0.21
SEP 13 1972	0.4	0.6	500.	7800.		4370.	0.38
SEP 14 1972	1.0	0.8	500.	6960.		4250.	0.39
SEP 15 1972	0.4	8.0	500.	5040.		3910.	0.33
SEP 17 1972	6.0	8.0	500.	7860.		5070.	0.37
SEP 18 1972	0.4	7.0	500.	8280.		5160.	0.53
SEP 19 1972	0.6	4.0	500.	7400.		4650.	0.39
SEP 20 1972	0.2	5.0	500.	6340.		4460.	0.30
SEP 21 1972	0.6	5.0	500.	13080.		3770.	0.28
SEP 22 1972	1.0		500.	6560.		3940.	0.36
SEP 24 1972	1.0	4.0	490.	5820.		3830.	0.32
SEP 25 1972	0.4	0.4	500.	9140.		4360.	0.62
SEP 26 1972	1.0	1.0	400.	6560.		4230.	0.31
SEP 27 1972	1.0	3.0	475.	5900.		4200.	0.33
SEP 28 1972	1.0	4.0	500.	6140.		3800.	0.31
SEP 29 1972	1.0	9.0	500.	5860.		3530.	0.35
OCT 1 1972	0.4		480.	8020.		4030.	0.35
OCT 2 1972	0.4	7.0	490.	9420.		4850.	0.65
OCT 3 1972	0.4	8.0	490.	11900.		4420.	0.58

DATE	FLOW MGD	INFLUENT TOTAL COD MG/L	INFLUENT SOLUBLE COD MG/L	INFLUENT BOD MG/L	INFLUENT PH	INFLUENT AMMONIA N MG/L	INFLUENT INORGANIC P MG/L
OCT 4 1972	0.8970	1389.	1202.		5.7	2.0	1.0
OCT 5 1972	0.9080	1031.	660.	752.	7.8	1.0	0.3
OCT 6 1972	0.9330	1016.	808.		7.3	0.1	0.5
OCT 8 1972	1.0160	536.	237.		7.2	0.6	0.9
OCT 9 1972	0.5950	1916.	670.	503.	7.4	0.6	2.0
OCT 10 1972	0.9360	1072.	907.		6.9	0.4	0.1
OCT 11 1972	1.0120	1104.	708.		6.2	0.4	0.3
OCT 12 1972	1.0170	1790.	716.	464.	7.5	0.6	0.4
OCT 13 1972	1.0170	906.	583.		7.3	0.4	0.4
OCT 15 1972	0.8800	299.	198.		6.8	0.6	0.3
OCT 16 1972	0.6480	2114.	1385.	1560.	8.7	0.7	2.0
OCT 17 1972	1.0250	1421.	1011.		7.4	0.4	2.0
OCT 18 1972	1.0780	1186.	763.		7.7	0.4	1.0
OCT 19 1972	0.9870	1739.	1208.	1402.	7.1	0.2	0.2
OCT 20 1972	0.8550	1518.	943.		7.9	0.4	0.3
OCT 22 1972	0.7970	1816.	1551.		8.1	2.6	2.0
OCT 23 1972	0.8770	1837.	1480.	1398.	7.4	0.2	2.0
OCT 24 1972	0.8870	1360.	690.		6.5	0.6	0.3
OCT 25 1972	0.9370	1067.	574.		7.0	0.9	2.0
OCT 26 1972	0.8210	959.	561.	698.	7.3	0.2	3.0
OCT 27 1972	0.5920	2928.	2598.		6.9	0.4	1.0
OCT 29 1972	0.4900	3423.	2897.		6.7	0.7	0.7
OCT 30 1972	0.3310	4519.	3762.	3340.	10.2	2.1	2.0
OCT 31 1972	0.7320	2408.	1878.		5.4	0.7	
NOV 1 1972		3753.	3031.		4.8	0.1	0.1
NOV 2 1972		3360.	2701.	3900.	4.9	1.0	0.3
NOV 3 1972		2103.	1804.		5.4	2.0	0.1
NOV 5 1972		3258.	1949.		4.6	8.0	1.0
NOV 6 1972		3645.	2729.	2410.	4.7	4.0	0.4
NOV 7 1972		5348.	3568.		4.6	0.7	5.0
NOV 8 1972		3093.	1918.		4.6	0.4	6.0
NOV 9 1972		1402.	1144.	728.	5.2	5.0	1.0
NOV 10 1972		1223.	871.		6.4	0.4	12.0
NOV 12 1972		1425.	861.		6.4	0.6	28.0
NOV 13 1972		2154.	1497.	1726.	6.9	5.0	7.0
NOV 14 1972		1721.	1410.		10.1	3.0	0.8
NOV 15 1972		3172.	1503.		7.3	7.0	0.1
NOV 16 1972		3133.	2041.	3790.	6.1	63.0	23.0
NOV 17 1972		3715.	3266.		6.6	86.0	35.0
NOV 19 1972		2063.	1347.		6.8	10.0	16.0
NOV 20 1972							
NOV 21 1972	0.6670	1354.	841.		7.0	6.0	2.0
NOV 22 1972	0.8640	1695.	1095.		6.7	1.0	
NOV 23 1972	0.8450	1695.	1095.		6.7	1.0	2.0
NOV 24 1972	0.7800	1250.	864.	746.	0.4	0.7	0.8

DATE	AERATION PH	AERATION TEMP DEG F	AERATION D.O. MG/L	SETTLING ML/L	EFFLUENT TOTAL COD MG/L	EFFLUENT SOLUBLE COD MG/L	EFFLUENT SS MG/L	EFFLUENT BOD MG/L
OCT 4 1972	7.2			380.	269.	56.	316.	72.
OCT 5 1972	7.3		3.2	350.	177.	107.	100.	39.
OCT 6 1972	7.3			350.	187.	146.	80.	47.
OCT 8 1972	7.2			360.	116.	54.	178.	27.
OCT 9 1972	7.4		10.7	350.	105.	52.	152.	24.
OCT 10 1972	7.3			350.	115.	58.	16.	21.
OCT 11 1972	7.1			300.	96.	60.	22.	15.
OCT 12 1972	7.4			270.	93.	65.	32.	15.
OCT 13 1972	7.2		5.5	250.	106.	69.	56.	18.
OCT 15 1972	7.0			290.	78.	53.	68.	20.
OCT 16 1972	7.5			750.	127.	37.	370.	29.
OCT 17 1972	7.3			550.	51.	27.	58.	25.
OCT 18 1972	7.4			480.	21.	4.	24.	20.
OCT 19 1972	7.5		5.1	710.	15.	2.	6.	19.
OCT 20 1972	7.5			700.	135.	49.	64.	30.
OCT 22 1972	7.4			680.	90.	20.	160.	15.
OCT 23 1972	7.2		5.1	500.	73.	45.	44.	14.
OCT 24 1972	7.4		5.5	550.	61.	14.	108.	9.
OCT 25 1972	7.3			460.	66.	43.	84.	12.
OCT 26 1972	7.3		6.2	440.	29.	20.	76.	15.
OCT 27 1972	7.0			450.	49.	37.	40.	7.
OCT 29 1972	6.7			580.	120.	89.	34.	19.
OCT 30 1972	7.1		3.0	650.	226.	158.	52.	52.
OCT 31 1972	6.9			450.	252.	113.	50.	22.
NOV 1 1972	6.0			390.	307.	206.	110.	34.
NOV 2 1972	6.9		1.4	400.	386.	338.	154.	35.
NOV 3 1972	7.3			340.	217.	128.	82.	26.
NOV 5 1972	7.2			400.	208.	138.	120.	30.
NOV 6 1972	7.0			480.	273.	181.	78.	33.
NOV 7 1972	7.1			550.	371.	203.	208.	66.
NOV 8 1972	7.5		2.6	630.	315.	195.	146.	66.
NOV 9 1972	7.8			410.	157.	87.	52.	25.
NOV 10 1972	7.8			370.	122.	83.	76.	34.
NOV 12 1972	7.2			380.	121.	72.	60.	38.
NOV 13 1972	7.1			420.	254.	117.	116.	56.
NOV 14 1972	7.6			410.	290.	112.	248.	55.
NOV 15 1972	7.6			480.	220.	75.	188.	42.
NOV 16 1972	7.6			710.	433.	169.	340.	190.
NOV 17 1972	7.7			830.	494.	204.	292.	139.
NOV 19 1972	8.0			940.	713.	112.	630.	75.
NOV 20 1972	8.0			920.		111.		
NOV 21 1972	7.5			820.	176.	94.	90.	23.
NOV 22 1972	7.3			940.	103.	51.	72.	9.
NOV 23 1972	7.3			940.	103.	51.	72.	9.
NOV 24 1972	7.2			980.	221.	54.	224.	35.

DATE	EFFLUENT AMMONIA N MG/L	EFFLUENT INORGANIC P MG/L	RECYCLE RATE GPM	RECYCLE SS MG/L	EXCESS BIOMASS WASTE LB/DAY	AERATION MLSS MG/L	F/M LB SOL COD/LB MLSS DAY
OCT 4 1972	0.6	9.0	490.	6060.		4070.	0.49
OCT 5 1972	0.9	8.0	500.	7340.		3750.	0.31
OCT 6 1972	0.4	10.0	500.	6300.		4100.	0.41
OCT 8 1972	0.7	9.0	500.	7240.		3690.	0.13
OCT 9 1972	0.9	9.0	500.	5360.		3480.	0.24
OCT 10 1972	0.4	5.0	500.	6300.		3530.	0.48
OCT 11 1972	0.6	4.0	500.	6940.		3230.	0.41
OCT 12 1972	1.0	5.0	500.	6760.		3200.	0.42
OCT 13 1972	1.0	6.0	500.	7420.		3300.	0.33
OCT 15 1972	0.6	0.1	450.	8560.		4430.	0.09
OCT 16 1972	0.2	0.7	350.	7740.		5300.	0.36
OCT 17 1972	0.2	0.2	500.	7420.		4890.	0.40
OCT 18 1972	0.7	0.3	480.	6340.		4030.	0.37
OCT 19 1972	0.4	0.1	500.	9400.		5120.	0.51
OCT 20 1972	0.4	3.0	500.	8860.		5780.	0.29
OCT 22 1972	0.2	0.2	500.	9400.		5500.	0.42
OCT 23 1972	0.2	0.1	500.	8180.		5030.	0.44
OCT 24 1972	0.2	0.1	500.	7900.		4920.	0.22
OCT 25 1972	1.0	6.0	500.	8260.		3820.	0.23
OCT 26 1972	1.0	9.0	500.	6680.		4100.	0.22
OCT 27 1972	0.4	10.0	500.	7520.		5250.	0.93
OCT 29 1972	1.0	1.0	400.	7280.		5240.	0.73
OCT 30 1972	0.4	0.5	200.	7220.		5760.	0.43
OCT 31 1972	0.2		450.	8710.			0.45
NOV 1 1972	0.2	0.4	500.	11800.		6190.	0.90
NOV 2 1972	0.2	2.0	500.	9380.		5810.	0.68
NOV 3 1972	0.6	8.0	500.	9500.		5670.	0.48
NOV 5 1972	0.4	7.0	500.	10400.		6220.	0.56
NOV 6 1972	8.0	7.0	500.	9660.		7130.	0.64
NOV 7 1972	0.7	7.0	500.	14060.		8170.	0.72
NOV 8 1972	0.6	3.0	500.	11760.		7200.	0.43
NOV 9 1972	14.0	8.0	500.	10640.		6230.	0.26
NOV 10 1972	19.0	10.0	500.	10700.		5650.	0.26
NOV 12 1972	4.0	10.0	500.	11470.		4330.	0.32
NOV 13 1972	0.2	10.0	300.	10038.		5270.	0.27
NOV 14 1972	2.0	9.0	400.	6740.		5110.	0.30
NOV 15 1972	0.7	6.0	400.	7060.		4600.	0.35
NOV 16 1972	56.0	9.0	500.	8020.		4950.	0.64
NOV 17 1972	53.0	10.0	500.	8820.		5660.	1.01
NOV 19 1972	18.0	10.0	500.	3720.		8730.	0.26
NOV 20 1972		10.0	200.	8040.		5590.	
NOV 21 1972	38.0	10.0	500.	7440.		5100.	0.21
NOV 22 1972	3.0		500.			5180.	0.38
NOV 23 1972	3.0	5.0	500.			5180.	0.38
NOV 24 1972	0.7	5.0	500.	5760.		4040.	0.29

DATE	FLOW MGD	INFLUENT TOTAL COD MG/L	INFLUENT SOLUBLE COD MG/L	INFLUENT BOD MG/L	INFLUENT PH	INFLUENT AMMONIA N MG/L	INFLUENT INORGANIC P MG/L
NOV 26 1972	0.8600	1641.	1231.		7.1	0.1	0.7
NOV 27 1972	0.5380	2490.	1398.	1490.	5.0	0.2	5.0
NOV 28 1972	0.7500	1513.	1099.		5.8	0.1	7.0
NOV 29 1972	0.8750	1182.	871.		9.7	1.0	3.0
NOV 30 1972	0.8970	928.	722.	820.	6.9	0.4	0.9
DEC 1 1972	0.8980	969.	701.		7.2	0.4	0.4
DEC 3 1972	0.7200	1451.	922.		5.1	0.1	0.5
DEC 4 1972	0.2900	3588.	2742.	1055.	4.8	0.1	13.0
DEC 5 1972	0.4360	5588.	4268.		4.6	0.1	3.0
DEC 6 1972	0.6220	4881.	3323.		4.4	0.1	10.0
DEC 7 1972	0.6810	2757.	1876.	1880.	5.4	0.1	4.0
DEC 8 1972	1.0500	2520.	1916.		5.4	19.0	7.0
DEC 10 1972	0.5930	2051.	1169.		5.1	0.1	0.1
DEC 11 1972	0.5250	3845.	2011.	2425.	7.1	3.0	3.0
DEC 12 1972	0.7600	1783.	1068.		6.5	1.0	3.0
DEC 13 1972	0.9020	1753.	969.		6.0	0.6	4.0
DEC 14 1972	0.9560	1470.	990.	974.	5.9	0.7	0.5
DEC 15 1972	0.9420	1854.	948.		5.3	2.0	0.1
DEC 17 1972	0.8240	2186.	1732.		5.9	6.0	2.0
DEC 18 1972	0.8890	2413.	1670.	1855.	5.3	14.0	7.0
DEC 19 1972	0.9990	2225.	1653.		5.2	0.1	22.0
DEC 20 1972	1.0090	1895.	1485.	1755.	5.0	7.0	9.0
DEC 21 1972	0.8770	1937.	1625.	1755.	4.7	1.0	3.0
DEC 22 1972							
DEC 24 1972							
DEC 25 1972	0.4320	2061.	1521.		5.0	0.1	0.8
DEC 26 1972	0.3320	7552.	6395.		7.6	0.1	2.0
DEC 27 1972	0.7530	3192.	2342.	3185.	5.3	0.1	2.0
DEC 28 1972	0.9560	2557.	2186.		5.1	29.0	19.0
DEC 29 1972							
DEC 31 1972							
JAN 1 1973	0.5770	1357.	969.			5.2	5.0
JAN 2 1973	0.7080	1510.	918.	788.	5.2	0.2	2.0
JAN 3 1973	0.9130	1316.	827.		6.9	62.0	5.0
JAN 4 1973	0.9430	2605.	1456.	774.	6.5	12.0	2.0
JAN 5 1973	0.9400	2516.	1887.		5.2	0.1	2.0
JAN 7 1973	0.9490	1237.	876.		7.4	0.2	6.0
JAN 8 1973	0.9250	1587.	1010.	1282.		0.7	7.0
JAN 9 1973	0.8550	3320.	1639.			4.0	17.0
JAN 10 1973	0.9250	1937.	1323.		5.4	4.0	19.0
JAN 11 1973	0.9640	1588.	1043.	1223.	6.0	1.0	8.0
JAN 12 1973	0.8760	1161.	964.		6.2	1.0	2.0
JAN 14 1973	0.4980	1433.	814.		6.0	0.6	0.1
JAN 15 1973	0.5630	2701.	835.	2385.	6.7	4.0	2.0
JAN 16 1973	0.9470	2184.	1480.		4.8	0.1	13.0

DATE	AERATION PH	AERATION TEMP DEG F	AERATION D.O. MG/L	SETTLING ML/L	EFFLUENT TOTAL COD MG/L	EFFLUENT SOLUBLE COD MG/L	EFFLUENT SS MG/L	EFFLUENT BOD MG/L
NOV 26 1972	7.3			980.	779.	51.	1260.	446.
NOV 27 1972	7.2			920.	780.	82.	1120.	378.
NOV 28 1972	7.3			930.	750.	83.	870.	300.
NOV 29 1972	8.0			950.	713.	52.	620.	120.
NOV 30 1972	7.6			940.	101.	37.	60.	23.
DEC 1 1972	7.4			850.	56.	33.	30.	8.
DEC 3 1972	7.2			910.	35.	33.	4.	7.
DEC 4 1972	7.0		8.6	970.	74.	45.	34.	8.
DEC 5 1972	7.1			970.	101.	52.	68.	25.
DEC 6 1972	7.1			950.	1036.	115.	720.	416.
DEC 7 1972	7.5			960.	771.	52.	820.	208.
DEC 8 1972	7.6			930.	265.	37.	190.	95.
DEC 10 1972	7.3			950.	139.	41.	92.	26.
DEC 11 1972	7.2			900.	104.	62.	54.	17.
DEC 12 1972	7.2			860.	104.	73.	54.	27.
DEC 13 1972	7.1			890.	93.	58.	26.	13.
DEC 14 1972	6.9			850.	94.	49.	44.	18.
DEC 15 1972	7.1			800.	142.	40.	78.	33.
DEC 17 1972	7.3			920.	78.	52.	60.	39.
DEC 18 1972	7.6			690.	54.		820.	76.
DEC 19 1972	7.7			750.	300.	57.	220.	216.
DEC 20 1972	7.5			580.	164.	51.	134.	91.
DEC 21 1972	7.7			560.	62.	46.	60.	85.
DEC 22 1972								
DEC 24 1972								
DEC 25 1972	7.0			380.	63.	43.	32.	21.
DEC 26 1972	6.8			320.	1531.	1502.	108.	994.
DEC 27 1972	6.9		7.4	510.	1045.	738.	296.	814.
DEC 28 1972	7.4			320.	2248.	340.	1008.	908.
DEC 29 1972								
DEC 31 1972								
JAN 1 1973	7.7			340.	129.	80.	78.	48.
JAN 2 1973	7.3			300.	73.	39.	52.	13.
JAN 3 1973	7.7		9.4	360.	96.	73.	20.	27.
JAN 4 1973	7.5			220.	96.	51.	42.	25.
JAN 5 1973	7.6			410.	120.	58.	40.	52.
JAN 7 1973	7.6			500.	101.	29.	44.	34.
JAN 8 1973	7.0			550.	103.	52.	68.	37.
JAN 9 1973	7.0				598.	78.	668.	242.
JAN 10 1973	6.9			450.	240.	79.	174.	112.
JAN 11 1973	7.3			500.	227.	62.	188.	86.
JAN 12 1973	7.5			590.	162.	56.	104.	35.
JAN 14 1973	7.5			500.	200.	54.	136.	51.
JAN 15 1973	7.3			800.	140.	43.	78.	31.
JAN 16 1973	6.9			840.	86.	49.	48.	57.

DATE	EFFLUENT AMMONIA N MG/L	EFFLUENT INORGANIC P MG/L	RECYCLE RATE GP''	RECYCLE SS MG/L	EXCESS BIOMASS WASTE LB/DAY	AERATION MLSS MG/L	F/M LB SOL COD/LB MLSS DAY
NOV 26 1972		6.0	500.	3520.		2830.	0.54
NOV 27 1972	0.1	5.0	300.	4440.		2810.	0.48
NOV 28 1972	1.0	7.0	400.	4260.		2790.	0.55
NOV 29 1972	5.0	5.0	500.	4860.		2840.	0.53
NOV 30 1972	9.0	2.0	510.	4920.		2830.	0.44
DEC 1 1972	2.0	0.3	510.	5540.		2740.	0.42
DEC 3 1972	0.2	1.0	425.	8540.		4030.	0.42
DEC 4 1972	4.0	4.0	200.	6760.		4920.	0.34
DEC 5 1972	1.0	0.1	200.	8120.		5250.	0.69
DEC 6 1972	1.0	0.3	450.	6920.		4870.	0.78
DEC 7 1972	22.0	0.2	500.	6800.		5240.	0.50
DEC 8 1972	0.6	0.1	500.	7700.		4450.	0.80
DEC 10 1972		0.1	500.	8720.		5830.	0.31
DEC 11 1972	0.9	8.0	400.	8940.		5640.	0.34
DEC 12 1972	2.0	9.0	500.	7980.		5200.	0.28
DEC 13 1972	0.2	7.0	500.	9220.		4570.	0.33
DEC 14 1972	0.1	5.0	500.	7480.		4890.	0.36
DEC 15 1972	1.0	7.0	500.	6300.		4500.	0.34
DEC 17 1972	0.1	2.0	500.	7200.		4960.	0.52
DEC 18 1972	4.0	8.0	500.	8320.		4840.	0.58
DEC 19 1972	30.0	10.0	500.	8360.		4550.	0.67
DEC 20 1972	27.0	10.0	510.	7380.		4340.	0.64
DEC 21 1972	13.0	10.0	510.	7140.		4270.	0.64
DEC 22 1972			510.				
DEC 24 1972			500.				
DEC 25 1972	0.4	5.0	400.	6640.		5040.	0.54
DEC 26 1972	0.1	2.0	300.	7180.		5330.	0.75
DEC 27 1972	0.1	0.1	500.	8640.		5580.	0.59
DEC 28 1972	0.9	4.0	600.	5160.		4790.	0.74
DEC 29 1972			500.				
DEC 31 1972			350.				
JAN 1 1973	15.0	6.0	350.	6160.			0.36
JAN 2 1973	13.0	3.0	400.	6630.		3070.	0.37
JAN 3 1973	29.0	6.0	500.	6830.		3180.	0.48
JAN 4 1973	31.0	5.0	500.	6360.		3310.	0.80
JAN 5 1973	0.1	5.0	500.	7600.		4190.	0.86
JAN 7 1973	0.2	7.0	500.	7420.		3900.	0.36
JAN 8 1973	0.7	5.0	500.	10160.		5780.	0.38
JAN 9 1973	4.0	10.0	500.	11340.		6450.	0.52
JAN 10 1973	4.0	10.0	500.	10840.		5730.	0.37
JAN 11 1973	1.0	8.0	500.	8900.		6030.	0.33
JAN 12 1973	1.0	8.0	500.	10060.		5490.	0.34
JAN 14 1973	0.6	3.0	250.	8860.		6610.	0.18
JAN 15 1973	4.0	.0.6	250.	8940.		5400.	0.16
JAN 16 1973	0.1	8.0	500.	10280.		5180.	0.55

DATE	FLOW MGD	INFLUENT TOTAL COD MG/L	INFLUENT SOLUBLE COD MG/L	INFLUENT BOD MG/L	INFLUENT PH	INFLUENT AMMONIA N MG/L	INFLUENT INORGANIC P MG/L
JAN 17 1973	0.9580	2094.	1648.		5.2	0.1	7.0
JAN 18 1973	0.8810	1575.	1254.	1676.	5.1	4.0	1.0
JAN 19 1973	0.7260	1572.	1367.		5.1	2.0	0.6
JAN 21 1973	0.7680	796.	571.	693.	5.1	25.0	0.1
JAN 22 1973	0.8350	808.	415.		6.5	22.0	0.1
JAN 23 1973	0.8700	1118.	708.		6.7	29.0	0.4
JAN 24 1973	0.8800	1650.	1010.		5.4	10.0	0.4
JAN 25 1973	0.8730	3791.	3281.	2441.	4.4	0.2	0.6
JAN 26 1973	0.9430	3156.	2895.		4.8	6.0	0.9
JAN 28 1973	0.9360	539.	1120.		6.6	11.0	0.1
JAN 29 1973	0.8060	1130.	736.	567.	7.3	17.0	0.1
JAN 30 1973	1.0120	1472.	1005.		7.1	17.0	1.0
JAN 31 1973		1316.	871.		7.2	12.0	4.0

DATE	AERATION PH	AERATION TEMP DEG F	AERATION D.O. MG/L	SETTLING ML/L	EFFLUENT TOTAL COD MG/L	EFFLUENT SOLUBLE COD MG/L	EFFLUENT SS MG/L	EFFLUENT BOD MG/L
JAN 17 1973	7.1		2.3	910.	89.	58.	44.	59.
JAN 18 1973	7.0			870.	97.	41.	68.	58.
JAN 19 1973	7.3			830.	90.	35.	80.	31.
JAN 21 1973	6.0			480.	80.	24.	48.	26.
JAN 22 1973	5.3			440.	31.	23.	70.	20.
JAN 23 1973	7.0		7.2	650.	153.	57.	32.	62.
JAN 24 1973	7.6		7.2	750.	120.	55.	66.	23.
JAN 25 1973	7.2		4.3	830.	231.	104.	180.	55.
JAN 26 1973	7.1			960.	396.	96.	340.	75.
JAN 28 1973	8.0				126.	63.	112.	22.
JAN 29 1973	8.1		7.7	260.	93.	62.	920.	49.
JAN 30 1973	7.7			440.	286.	83.	810.	
JAN 31 1973	7.8			600.	240.	52.	200.	

DATE	EFFLUENT AMMONIA N MG/L	EFFLUENT INORGANIC P MG/L	RECYCLE RATE GPM	RECYCLE SS MG/L	EXCESS BIOMASS WASTE LB/DAY	AERATION MLSS MG/L	F/M LB SOL COD/LB MLSS DAY
JAN 17 1973	0.1	4.0	500.	10140.		5490.	0.58
JAN 18 1973	4.0	2.0	500.	8540.		5040.	0.42
JAN 19 1973	2.0	6.0	400.	8560.		4630.	0.41
JAN 21 1973	25.0	3.0	500.	4400.		3390.	0.22
JAN 22 1973	22.0	3.0	500.	5520.		2790.	0.24
JAN 23 1973	29.0	1.0	500.	5580.		2990.	0.39
JAN 24 1973	10.0	1.0	500.	6140.		3180.	0.52
JAN 25 1973	0.1	0.7	500.	7880.		4870.	1.31
JAN 26 1973	6.5	1.0	500.	9700.		5630.	0.97
JAN 28 1973	11.0	0.1	500.	1540.		1320.	0.61
JAN 29 1973	17.0	1.0	500.	2820.		1020.	1.10
JAN 30 1973	17.0	6.0	500.	3640.		1370.	2.18
JAN 31 1973	12.0	2.0	500.	5800.		2150.	

APPENDIX D

TREATMENT PLANT PERFORMANCE JANUARY 1973 - SEPTEMBER 1975

Monthly average operating results for the treatment plant for the period of January 1973 to September 1975 are as shown on the following pages. It can be seen that effluent suspended solids and BOD continued to be high and extremely variable, similar to the results discussed in the body of this report. Major equipment additions and changes in process configuration were started after September 1975 in an effort to improve performance.

DATE		FLOW, MGD	INFLUENT TOTAL COD MG/L	INFLUENT SOLUBLE COD MG/L	INFLUENT BOD MG/L	INFLUENT PH	INFLUENT AMMONIA N MG/L	INFLUENT INORGANIC P MG/L
JAN	1973	0.8440	1795.	1219.	1314.	6.0	9.3	3.9
FEB	1973	0.8780	1346.	963.	1064.	6.1	5.4	4.3
MAR	1973	0.9200	1150.	872.	850.	6.2	1.3	6.5
APR	1973	0.4500	1555.	1252.	1074.	5.0	1.9	6.2
MAY	1973	0.6360	1729.	1322.	1292.	5.8	0.9	10.2
JUN	1973	0.7930	1626.	1217.	1229.	6.0	0.3	6.1
JUL	1973	0.7200	2942.	2210.	2672.	6.3	4.2	5.4
AUG	1973	0.6550	1874.	1461.	1536.	6.6	160.0	9.7
SEP	1973	0.7150	1452.	897.	1007.	6.5	144.0	8.7
OCT	1973	0.6140	2342.	1635.	1948.	6.8	87.0	7.9
NOV	1973	0.6850	1820.	1382.	1481.	6.0	97.0	6.6
DEC	1973	0.7090	1691.	1266.	1530.	6.3	111.0	12.3
JAN	1974	0.7470	2883.	1860.	1567.	7.3	118.0	6.2
FEB	1974	0.7690	2170.	1435.	1284.	6.3	143.0	4.9
MAR	1974	0.7590	2048.	1399.	1502.	6.9	107.0	8.2
APR	1974	0.8060	1734.	1375.	1318.	7.5	169.0	5.4
MAY	1974	0.8370	1650.	1050.	1152.	7.3	60.0	6.2
JAN	1975	0.5120	7057.	6002.	4887.	6.4	40.0	17.8
FEB	1975	0.7840	3424.	3215.	2447.	6.5	38.0	2.4
MAR	1975	0.7100	2124.	1552.	1517.	7.5	46.0	2.1
APR	1975	0.6470	4791.	3889.	3166.	7.5	65.0	7.8
MAY	1975	0.7480	1902.	1358.	1546.	7.9	51.0	2.1
JUN	1975	0.6150	4097.	2861.	2326.	8.3	37.0	5.5
JUL	1975	0.6180	2630.	1667.	1613.	10.2	46.0	2.9
AUG	1975	0.6240	2458.	2006.	1799.	10.6	31.0	2.7
SEP	1975	0.5830	2404.	2093.	1581.	10.9	38.0	3.6

DATE		AERATION MLSS MG/L	F/M LB SOL COD/LB MLSS/ DAY	AERATION PH	SETTLING ML/L	EFFLUENT TOTAL COD MG/L	EFFLUENT SOLUBLE COD MG/L
JAN	1973	4011.	0.58	7.3	551.	137.	58.
FEB	1973	3139.	0.55	7.4	933.	415.	50.
MAR	1973	2675.	0.64	7.5	895.	502.	55.
APR	1973	1136.	1.60	7.5	940.	498.	86.
MAY	1973	2450.	0.94	7.4	624.	616.	254.
JUN	1973	4260.	0.40	7.3	788.	320.	106.
JUL	1973	5760.	0.53	7.4	830.	209.	85.
AUG	1973	4037.	0.46	7.1	868.	184.	78.
SEP	1973	2550.	0.81	6.8	394.	341.	187.
OCT	1973	6356.	0.30	7.4	560.	168.	126.
NOV	1973	5355.	0.32	7.2	684.	157.	62.
DEC	1973	3993.	0.48	7.4	770.	410.	63.
JAN	1974	5190.	0.41	7.6	707.	540.	150.
FEB	1974	5186.	0.39	6.8	615.	631.	180.
MAR	1974	5680.	0.38	7.5	620.	378.	73.
APR	1974	5496.	0.36	7.3	470.	252.	90.
MAY	1974	4937.	0.32	7.4	567.	117.	67.
JAN	1975	2110.	5.50	6.0	196.	5283.	4570.
FEB	1975	2130.	3.30	7.0	770.	2366.	1381.
MAR	1975	3877.	0.51	7.7	730.	662.	193.
APR	1975	4598.	1.10	7.4	441.	2578.	1819.
MAY	1975	4225.	0.50	7.5	297.	665.	506.
JUN	1975	5298.	0.83	7.6	455.	1620.	1125.
JUL	1975	4875.	0.49	8.1	517.	447.	216.
AUG	1975	4700.	0.44	8.2	342.	547.	387.
SEP	1975	5154.	0.29	8.3	847.	529.	177.

DATE		EFFLUENT SS MG/L	EFFLUENT BOD MG/L	EFFLUENT AMMONIA N MG/L	EFFLUENT INORGANIC P MG/L	RECYCLE RATE GPM	RECYCLE SS MG/L
JAN	1973	178.	56.	8.4	4.2	473.	7399.
FEB	1973	423.	136.	3.6	5.2	480.	5236.
MAR	1973	411.	145.	5.2	6.2	305.	5341.
APR	1973	364.	123.	8.6	7.2	205.	2615.
MAY	1973	295.	232.	8.0	4.4	322.	4114.
JUN	1973	157.	181.	7.4	4.9	395.	8488.
JUL	1973	117.	106.	3.2	4.5	327.	10986.
AUG	1973	101.	68.	44.0	9.2	316.	7459.
SEP	1973	178.	153.	48.0	10.0	340.	4860.
OCT	1973	60.	93.	33.0	6.1	384.	10931.
NOV	1973	96.	43.	11.0	4.3	347.	933.
DEC	1973	312.	150.	56.0	4.9	416.	6654.
JAN	1974	389.	186.	82.0	4.7	342.	9980.
FEB	1974	347.	203.	95.0	5.6	304.	10193.
MAR	1974	337.	79.	47.0	5.3	265.	12860.
APR	1974	149.	86.	69.0	4.3	302.	9813.
MAY	1974	70.	36.	14.0	4.8	310.	9500.
JAN	1975	840.	4048.	15.0	7.8	202.	3938.
FEB	1975	1212.	1418.	24.0	2.5	250.	3915.
MAR	1975	490.	221.	36.0	0.1	200.	10464.
APR	1975	530.	1518.	52.0	7.7	200.	10986.
MAY	1975	192.	457.	37.0	3.6	200.	12180.
JUN	1975	588.	1062.	16.0	7.2	207.	11104.
JUL	1975	288.	154.	17.0	1.4	200.	12006.
AUG	1975	254.	169.	24.0	1.8	383.	9230.
SEP	1975	114.	417.	38.0	3.3	432.	9493.

APPENDIX E

TABLE 7

METRIC CONVERSION FACTORS FOR ENGLISH UNITS USED IN THIS REPORT

ENGLISH UNIT	MULTIPLY BY	METRIC UNIT
Horsepower	0.74557	Kilowatt
	2.54	Millimeter
MGD	0.0438	Cu Meters/sec
Pound	0.4536	Kilogram
Pounds per Sq.In.	703.1	Kg/Sq. meter
Square inch	6.452	Square Centimeter
Square foot	0.0929	Square Meter
U.S.Gallons	3.785	Liters
U.S.Gallons	0.003785	Cubic Meters

$^{o}C = 0.5555\ (^{o}F - 32)$

APPENDIX F

ADDITIONAL PROJECT COST DATA

The total cost of the portion of the waste treatment process discussed in this report was $1,948,155, as detailed below:

Cooling Tower	$ 24,859
Aeration Equipment	463,442
Tanks	119,657
Agitators	29,887
Blowers and Compressors	14,917
Process Equipment	124,509
Instruments	88,827
Pumps	24,843
Piping	71,172
Power Wiring	90,136
Machinery Supports	117,001
Miscellaneous Construction	104,563
Laboratory Facilities	25,869
Plant Maintenance Expense	648,473
TOTAL	$1,948,155

An additional cost of $952,000 was required for biomass disposal facilities.

APPENDIX G

ADDITIONAL STATISTICAL STUDIES

After this report had been completed, some additional statistical studies of treatment plant performance were performed. Since the time periods used and the method of calculation of the probabilities were different than those in the body of the report, the results are presented as an appendix.

Non-parametric statistical methods were used; that is, it was not assumed that the distribution of the data was "normal". Analyses were performed for daily values, and also for 30-day averages. A moving average was used to generate many more 30-day averages than would be obtained by using only calendar monthly averages. However, only non-missing data were used for the averages. For example, if a 30-day period had 5 missing daily values, the average was calculated from the 25 non-missing values.

Probability curves are given for the year of 1972, and also for July-December 1972 (the period of best operation). Graphs are presented for flow, BOD, and total suspended solids for the treatment plant effluent. The term WCPE appearing on the graphs is a designation used internally for the treatment plant effluent, to distinguish it from the total plant effluent, which includes cooling water. BOD and suspended solids data are presented in terms of concentration, pounds per day, and pounds per 1000 bushels, which relates the discharge to production rate. A bushel of corn is defined as 56 lb at 17% moisture.

FIGURE 41

CPC INTERNATIONAL, INC.
PEKIN PLANT

FLOW WCPE, mgd
JANUARY 1972 - DECEMBER 1972

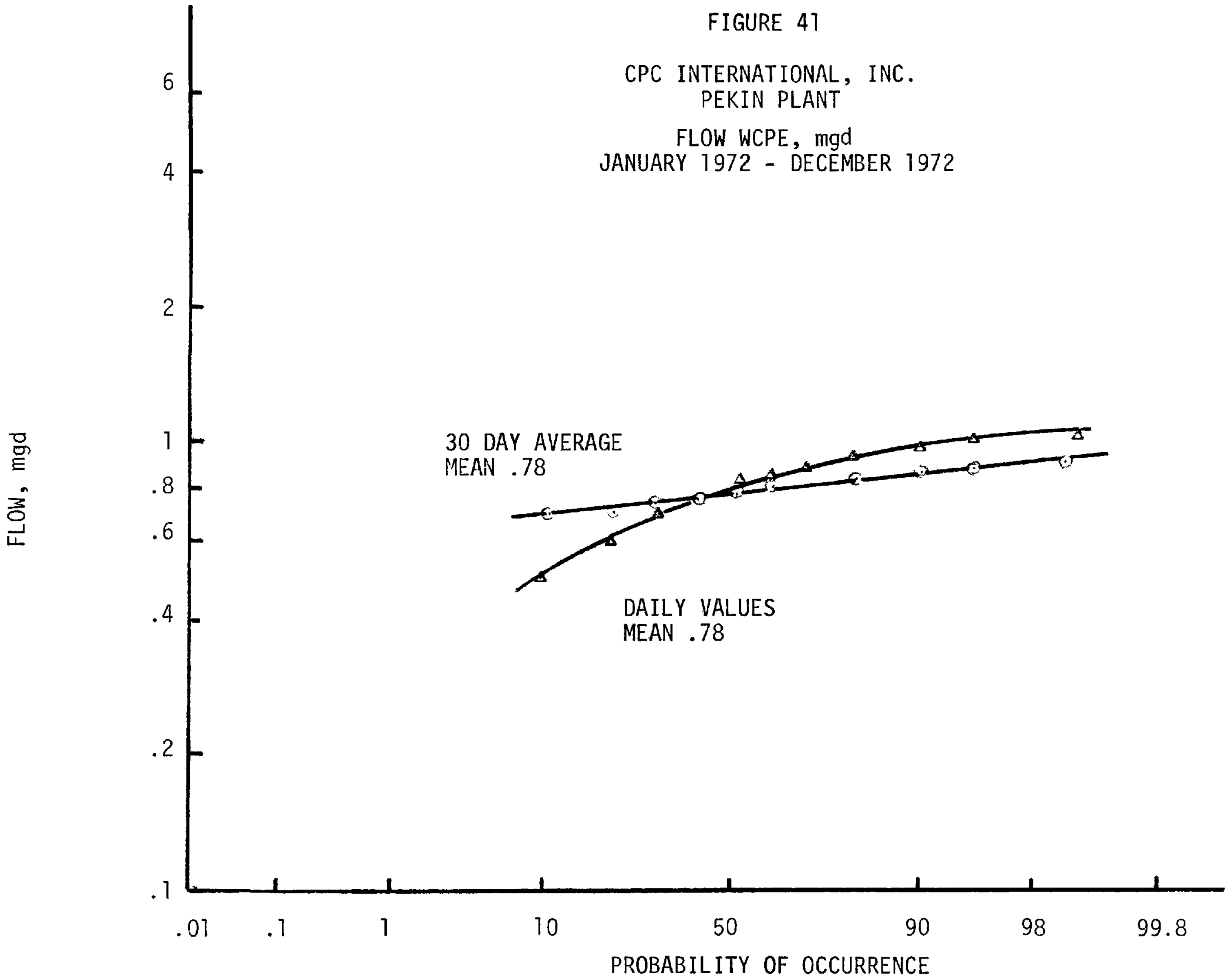


FIGURE 42

CPC INTERNATIONAL, INC.
PEKIN PLANT

BOD WCPE, mg/l
JANUARY 1972 - DECEMBER 1972

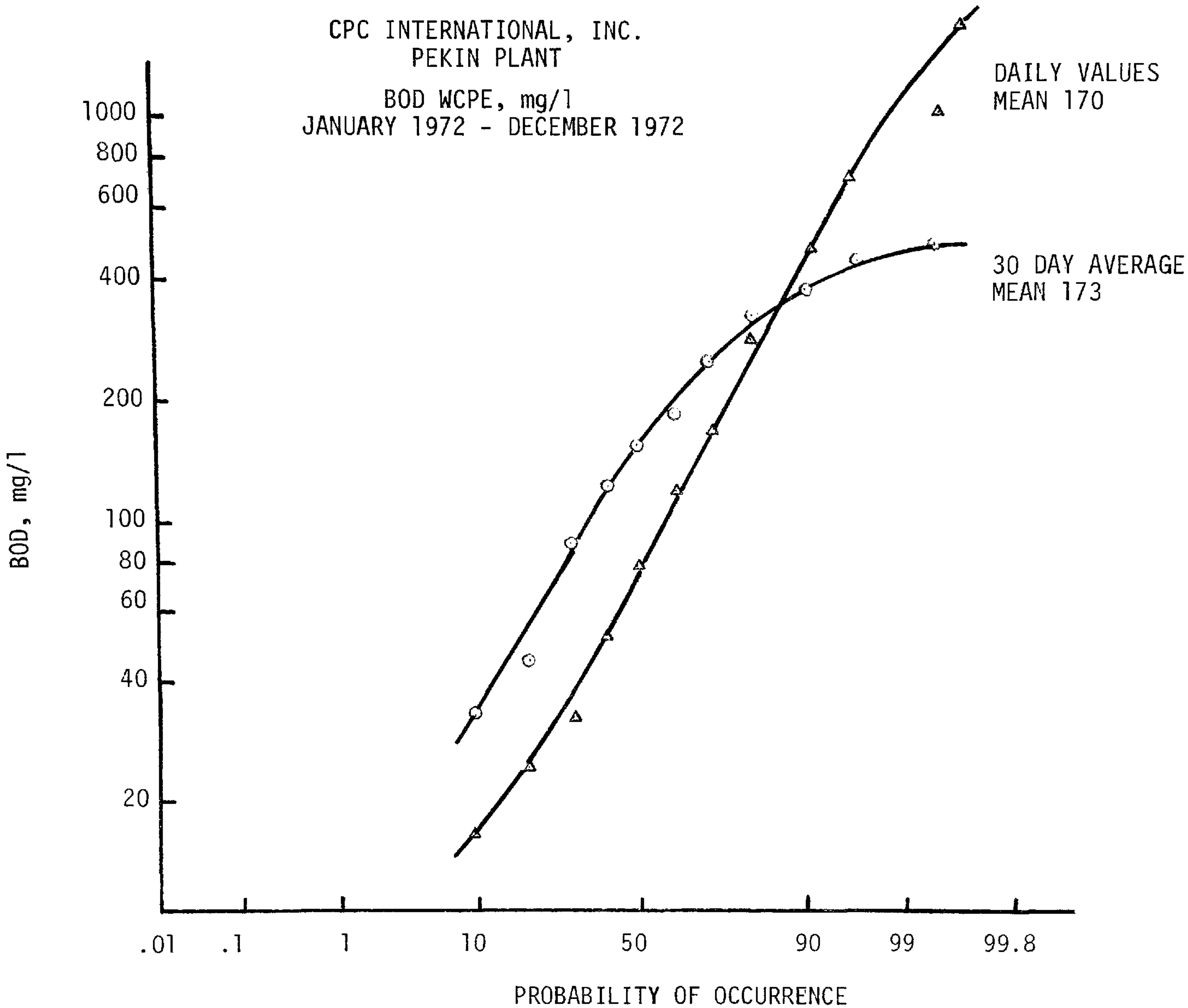
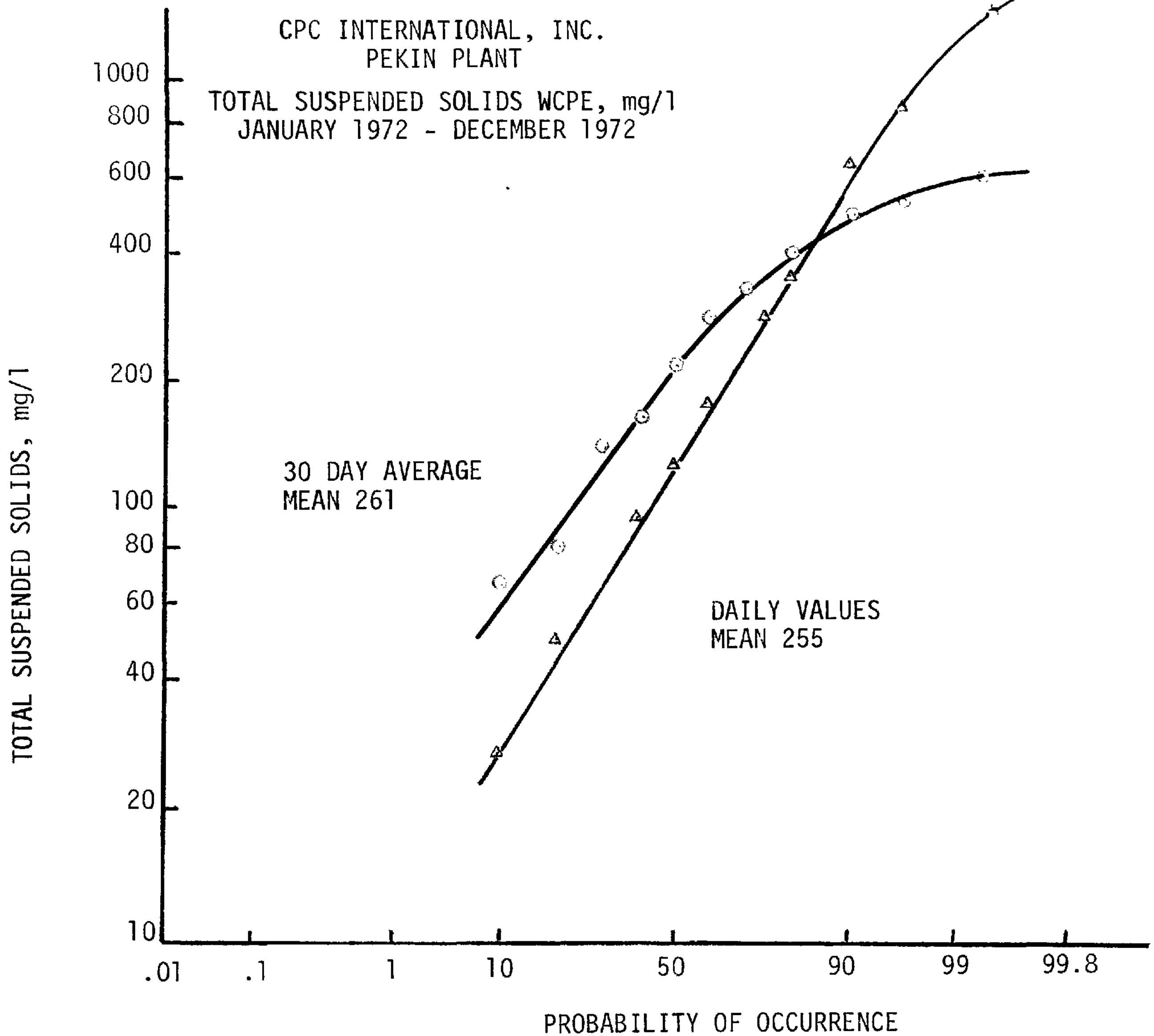


FIGURE 43


CPC INTERNATIONAL, INC.
PEKIN PLANT
TOTAL SUSPENDED SOLIDS WCPE, mg/l
JANUARY 1972 - DECEMBER 1972
TOTAL SUSPENDED SOLIDS, mg/l
1000
800
600
400
200
100
80
60
40
20
10
30 DAY AVERAGE
MEAN 261
DAILY VALUES
MEAN 255
.01
.1
1
10
50
90
99
99.8
PROBABILITY OF OCCURRENCE

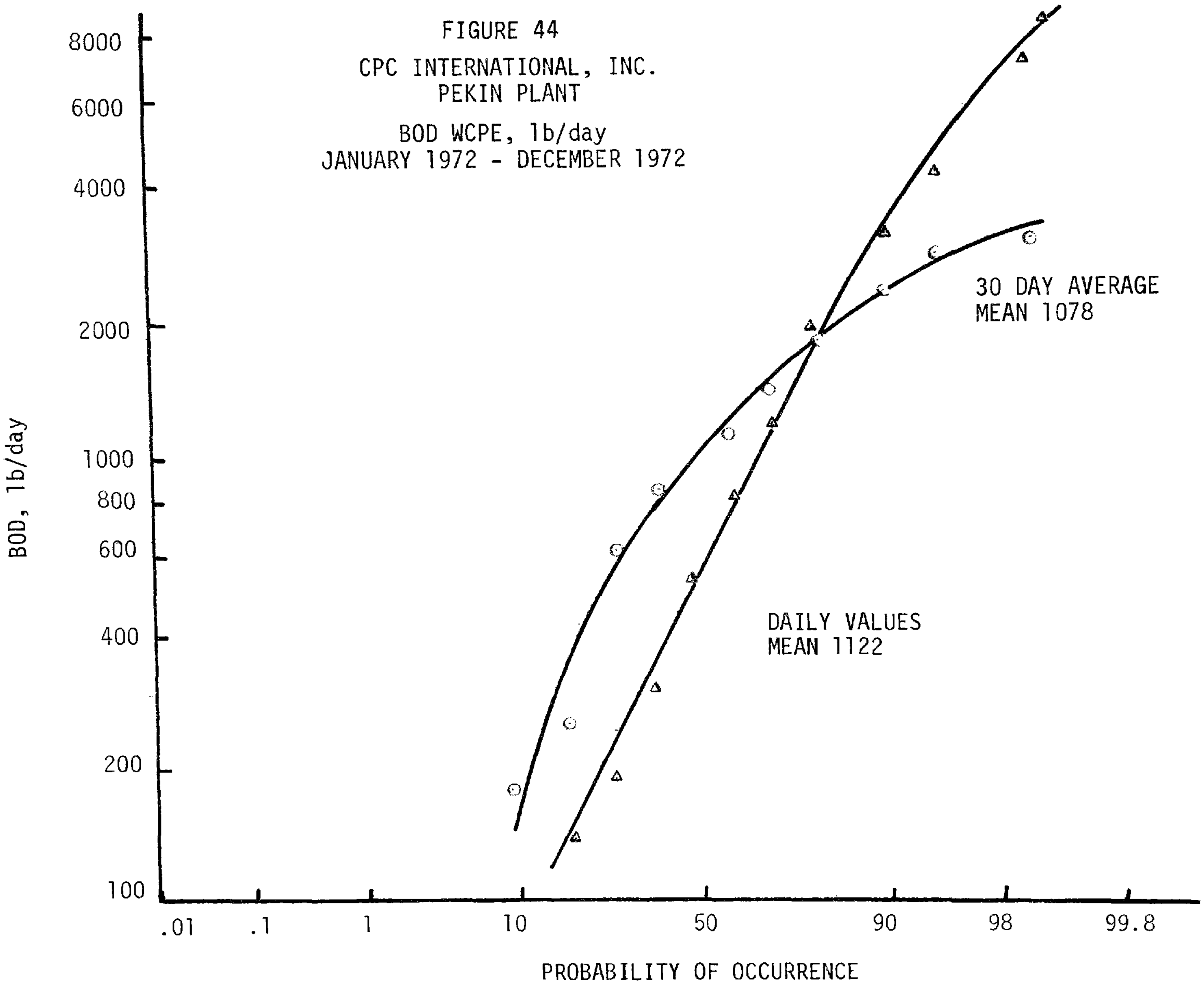


FIGURE 44

CPC INTERNATIONAL, INC.
PEKIN PLANT

BOD WCPE, lb/day
JANUARY 1972 - DECEMBER 1972

FIGURE 45

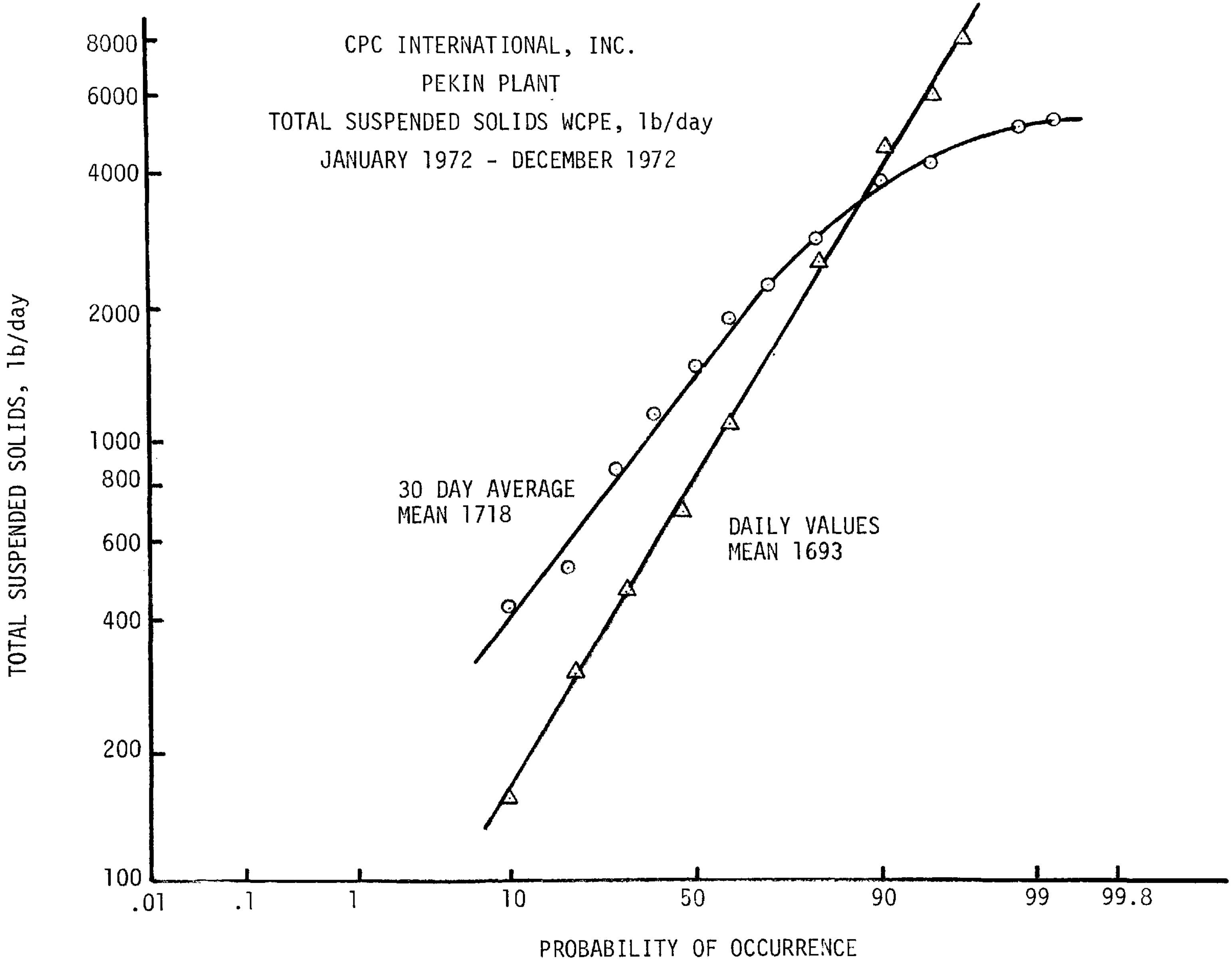
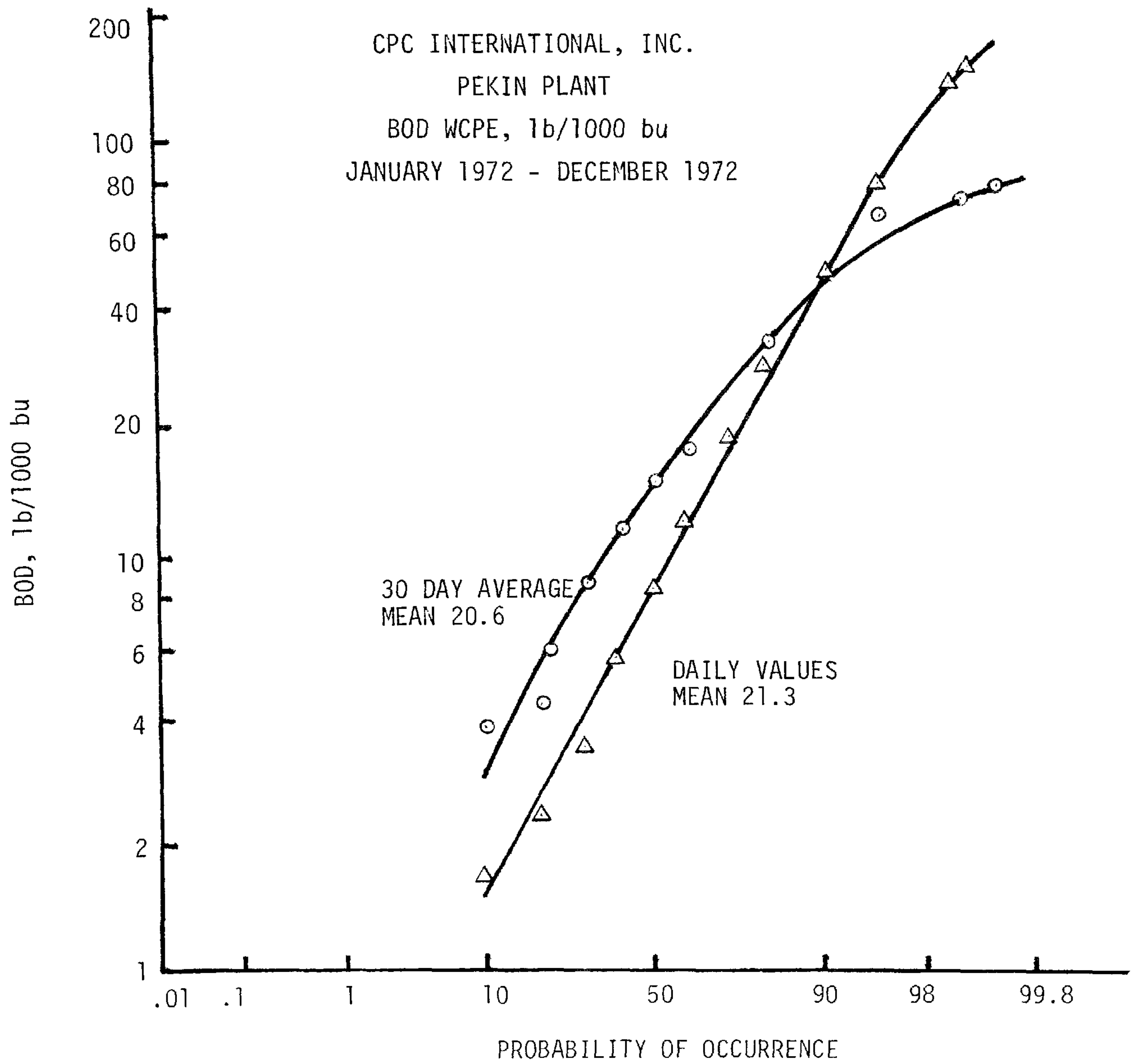

CPC INTERNATIONAL, INC.
PEKIN PLANT
TOTAL SUSPENDED SOLIDS WCPE, lb/day
JANUARY 1972 - DECEMBER 1972
TOTAL SUSPENDED SOLIDS, lb/day
8000
6000
4000
2000
1000
800
600
400
200
100
30 DAY AVERAGE
MEAN 1718
DAILY VALUES
MEAN 1693
.01
.1
1
10
50
90
99
99.8
PROBABILITY OF OCCURRENCE

FIGURE 46



CPC INTERNATIONAL, INC.
PEKIN PLANT
BOD WCPE, lb/1000 bu
JANUARY 1972 - DECEMBER 1972
BOD, lb/1000 bu
200
100
80
60
40
20
10
8
6
4
2
1
30 DAY AVERAGE
MEAN 20.6
DAILY VALUES
MEAN 21.3
.01
.1
1
10
50
90
98
99.8
PROBABILITY OF OCCURRENCE

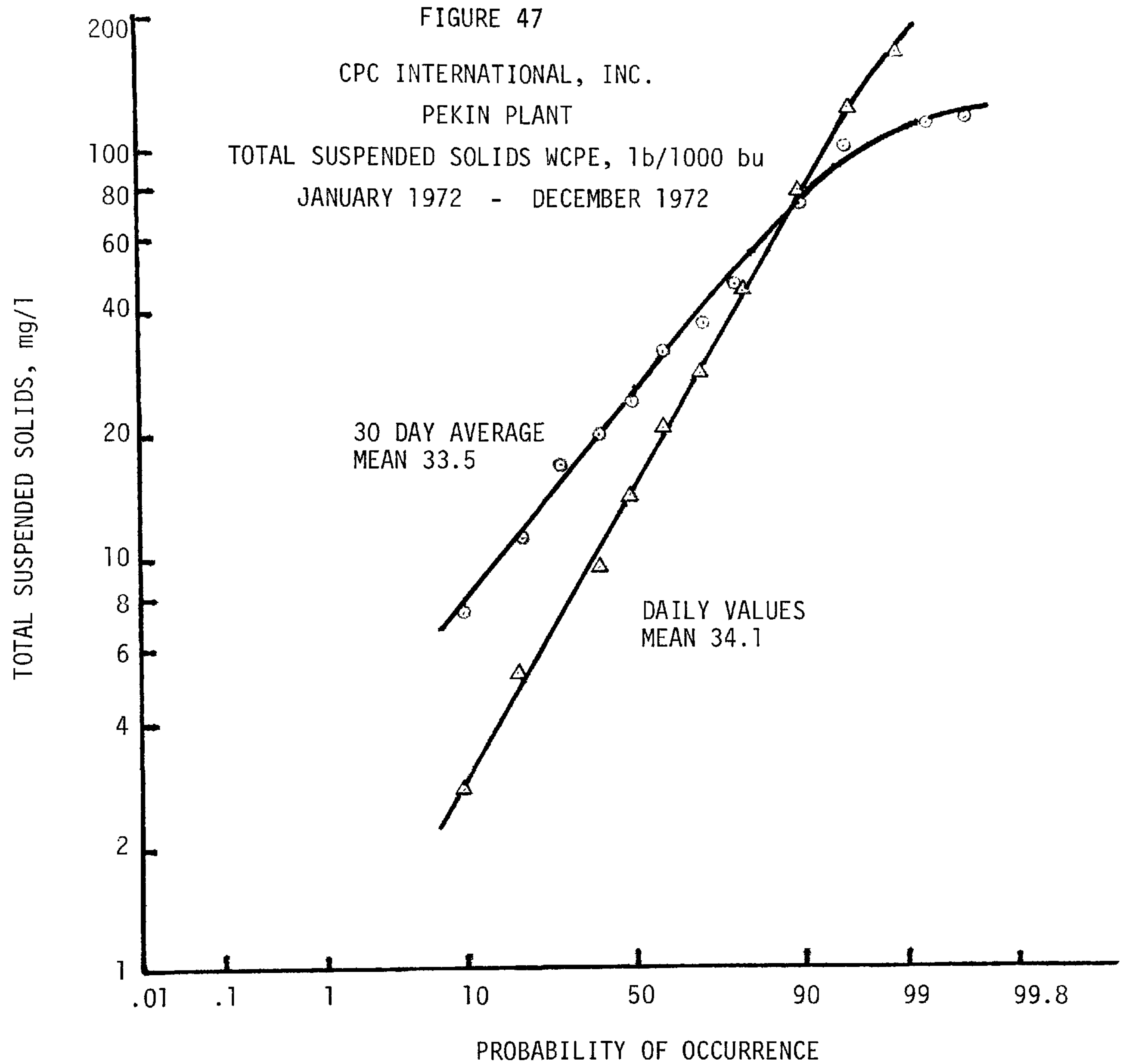
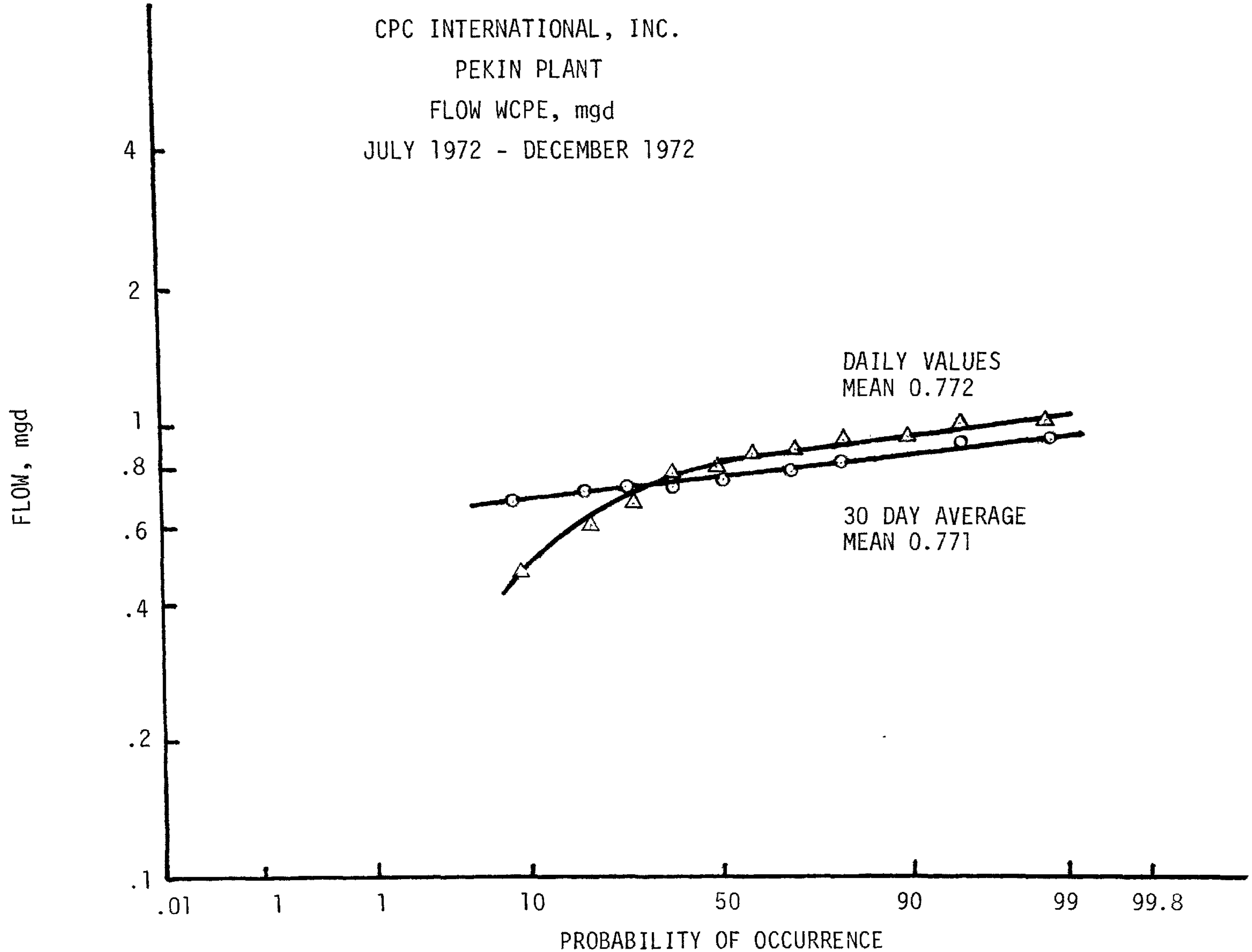


FIGURE 47
CPC INTERNATIONAL, INC.
PEKIN PLANT
TOTAL SUSPENDED SOLIDS WCPE, lb/1000 bu
JANUARY 1972 - DECEMBER 1972
TOTAL SUSPENDED SOLIDS, mg/l
200
100
80
60
40
20
10
8
6
4
2
1
.01
.1
1
10
50
90
99
99.8
PROBABILITY OF OCCURRENCE
30 DAY AVERAGE
MEAN 33.5
DAILY VALUES
MEAN 34.1

FIGURE 48


CPC INTERNATIONAL, INC.
PEKIN PLANT
FLOW WCPE, mgd
JULY 1972 - DECEMBER 1972
4
2
1
.8
.6
.4
.2
.1
FLOW, mgd
DAILY VALUES
MEAN 0.772
30 DAY AVERAGE
MEAN 0.771
.01
1
1
10
50
90
99
99.8
PROBABILITY OF OCCURRENCE

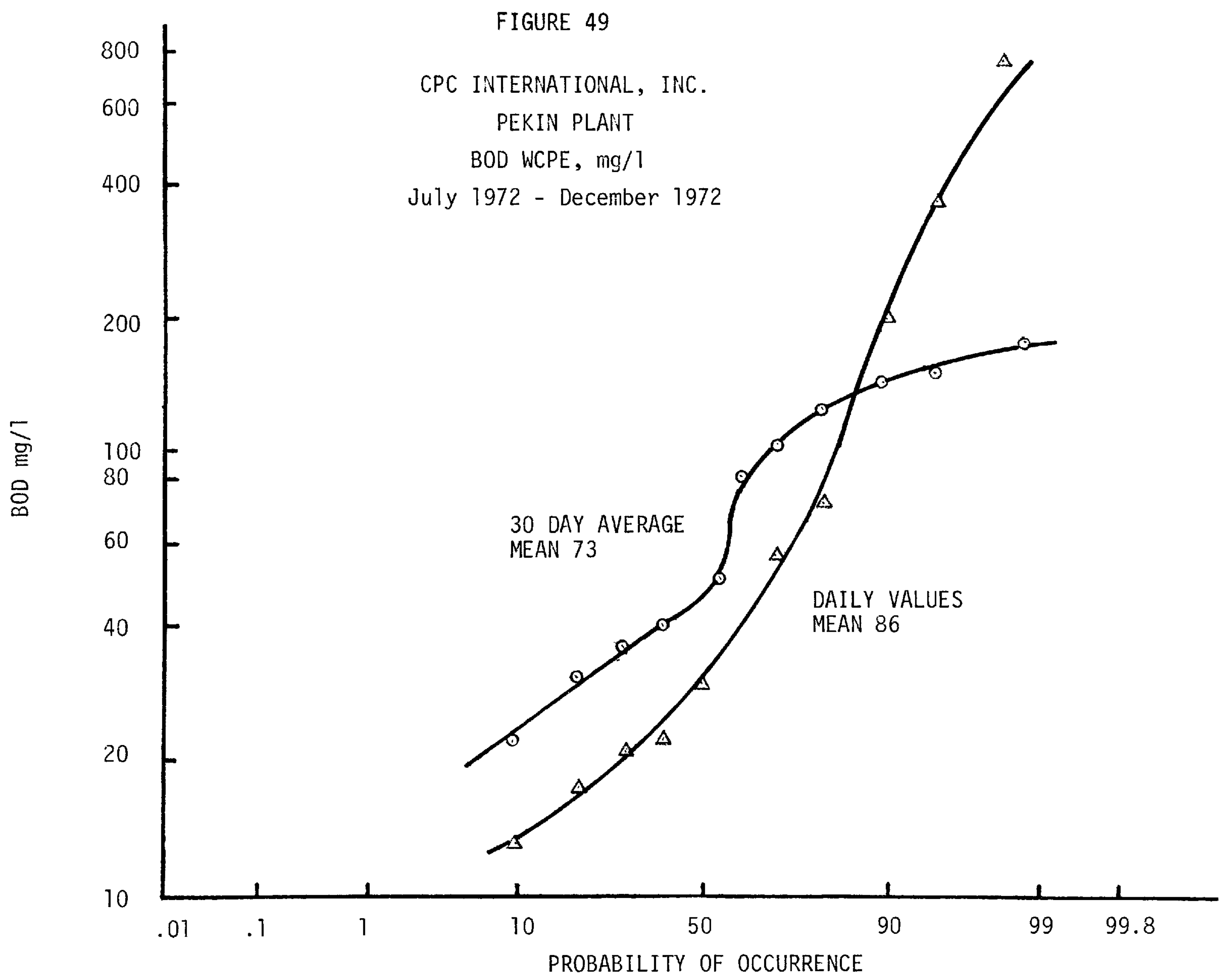
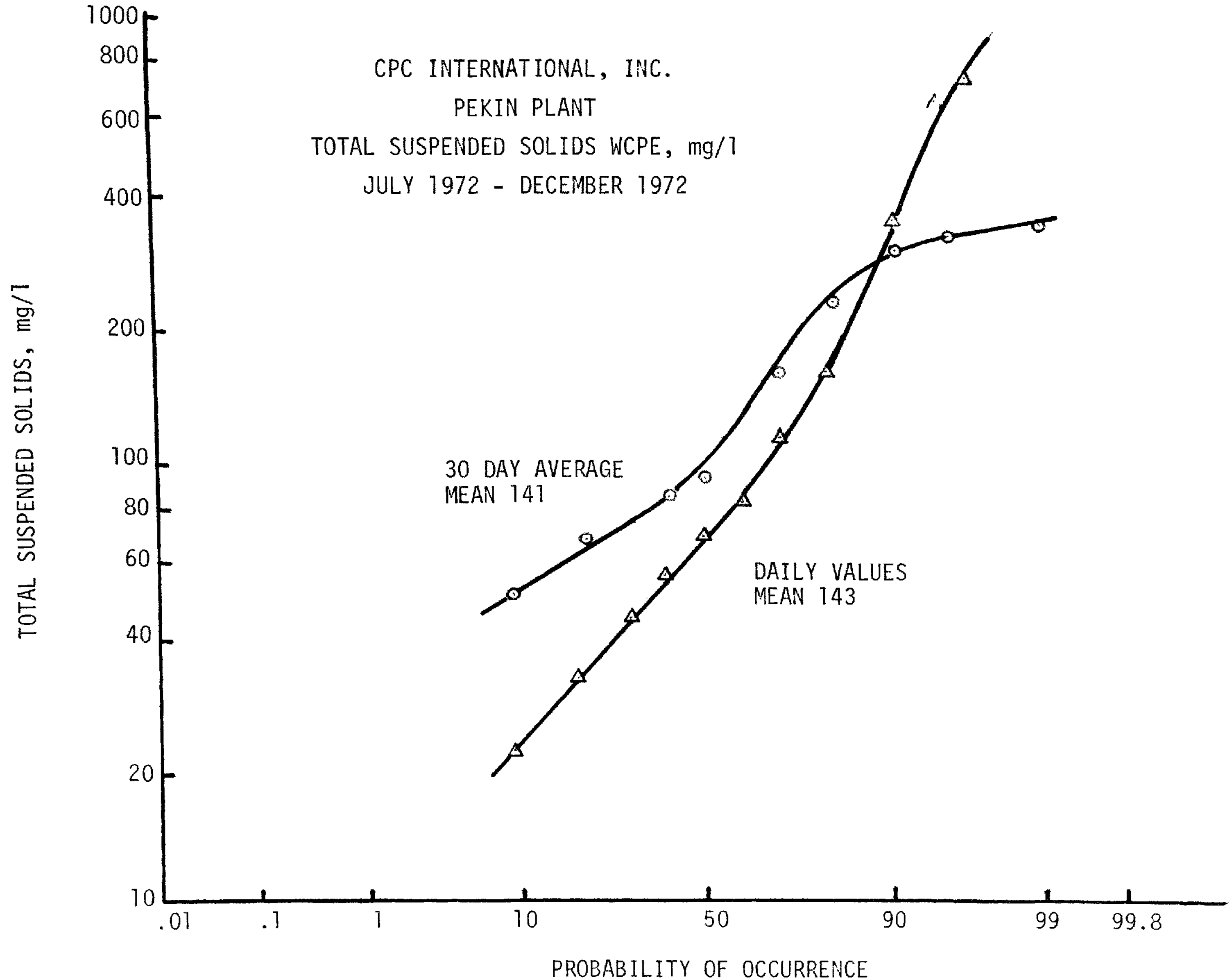


FIGURE 49
CPC INTERNATIONAL, INC.
PEKIN PLANT
BOD WCPE, mg/l
July 1972 - December 1972
BOD mg/l
800
600
400
200
100
80
60
40
20
10
30 DAY AVERAGE
MEAN 73
DAILY VALUES
MEAN 86
.01
.1
1
10
50
90
99
99.8
PROBABILITY OF OCCURRENCE

FIGURE 50



CPC INTERNATIONAL, INC.
PEKIN PLANT
TOTAL SUSPENDED SOLIDS WCPE, mg/l
JULY 1972 - DECEMBER 1972
TOTAL SUSPENDED SOLIDS, mg/l
1000
800
600
400
200
100
80
60
40
20
10
.01
.1
1
10
50
90
99
99.8
30 DAY AVERAGE
MEAN 141
DAILY VALUES
MEAN 143
PROBABILITY OF OCCURRENCE

FIGURE 51

CPC INTERNATIONAL, INC.
PEKIN PLANT
BOD WCPE, lb/day
JULY 1972 - DECEMBER 1972

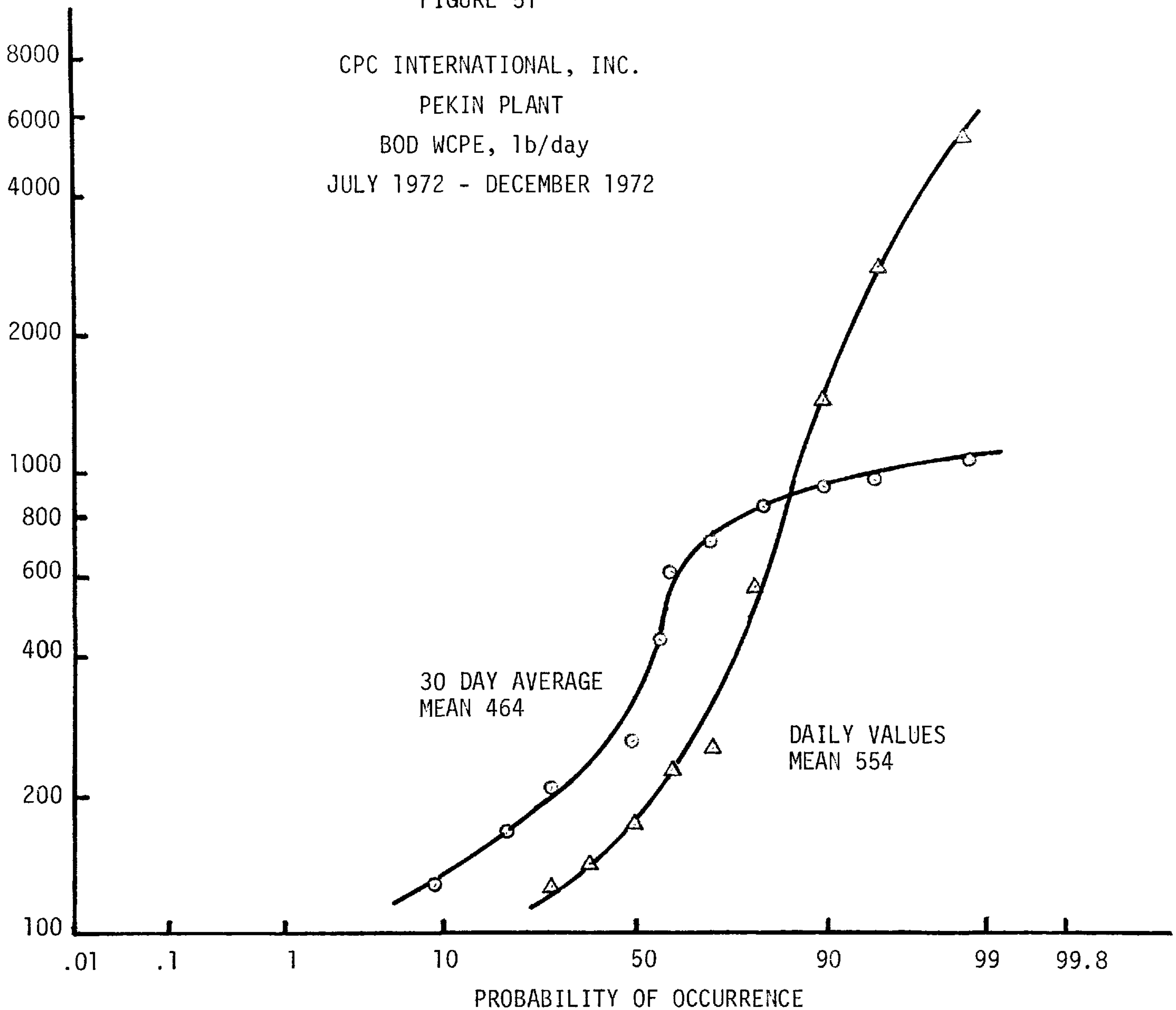
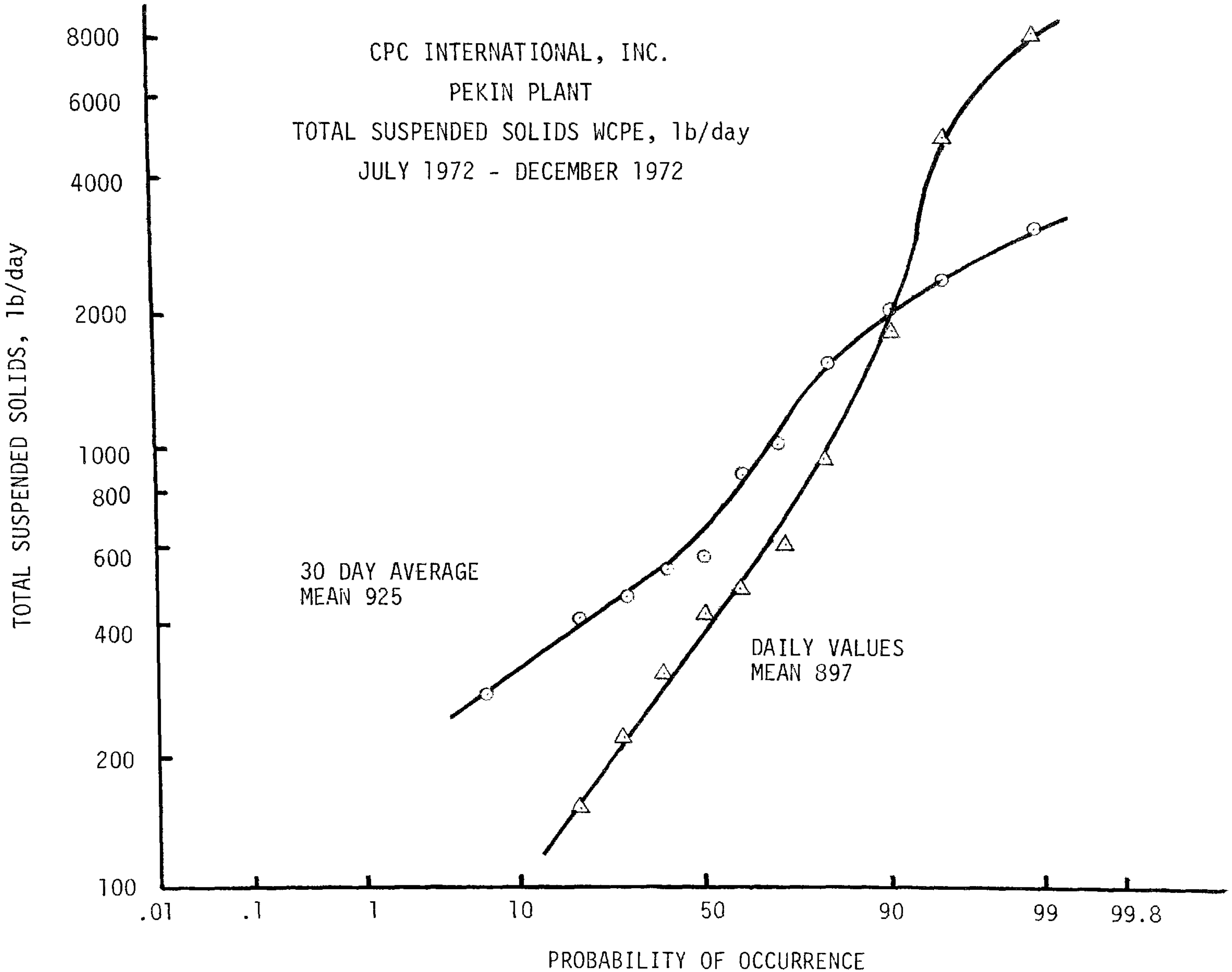


FIGURE 52



CPC INTERNATIONAL, INC.
PEKIN PLANT
TOTAL SUSPENDED SOLIDS WCPE, lb/day
JULY 1972 - DECEMBER 1972
TOTAL SUSPENDED SOLIDS, lb/day
8000
6000
4000
2000
1000
800
600
400
200
100
30 DAY AVERAGE
MEAN 925
DAILY VALUES
MEAN 897
.01
.1
1
10
50
90
99
99.8
PROBABILITY OF OCCURRENCE

FIGURE 53

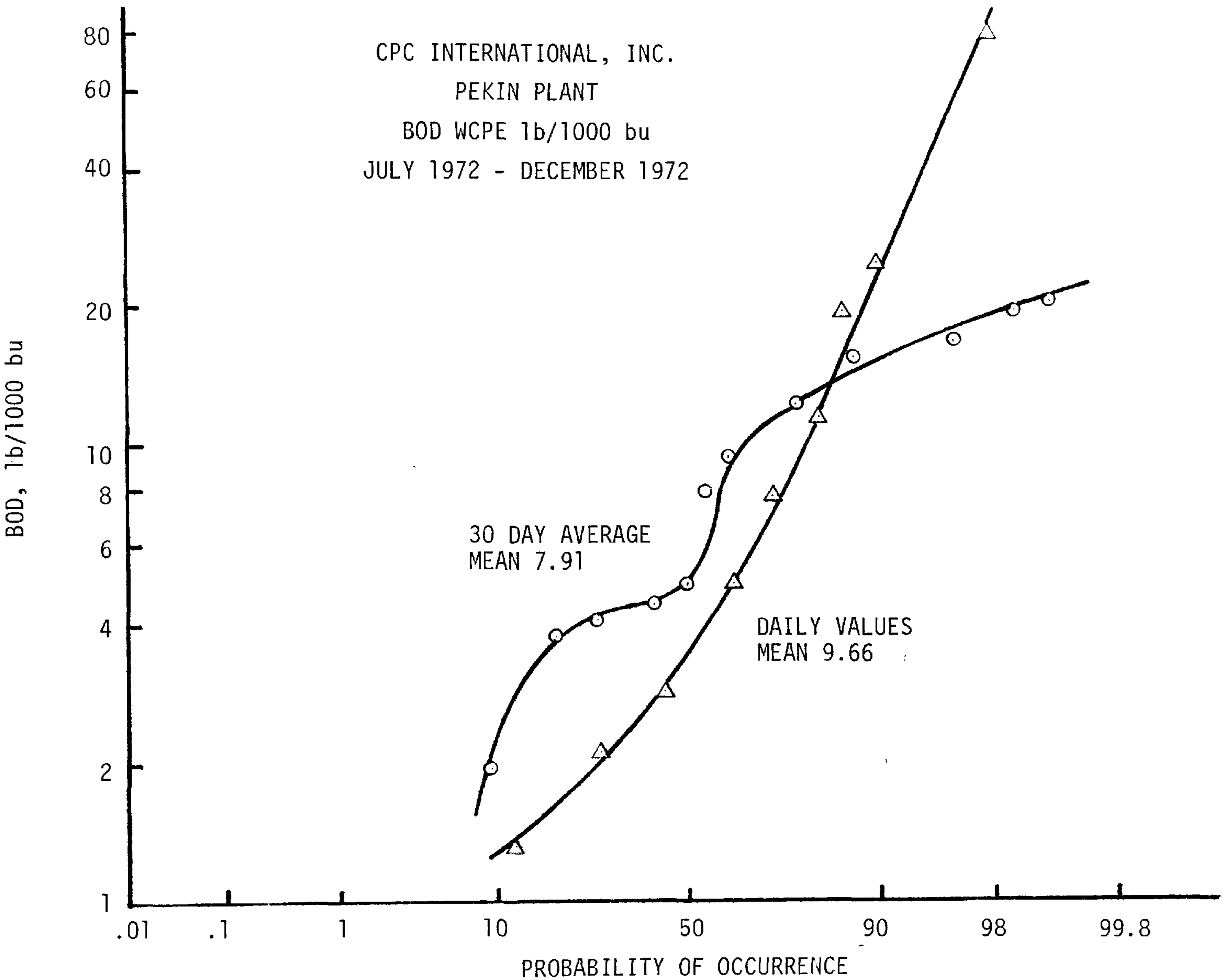
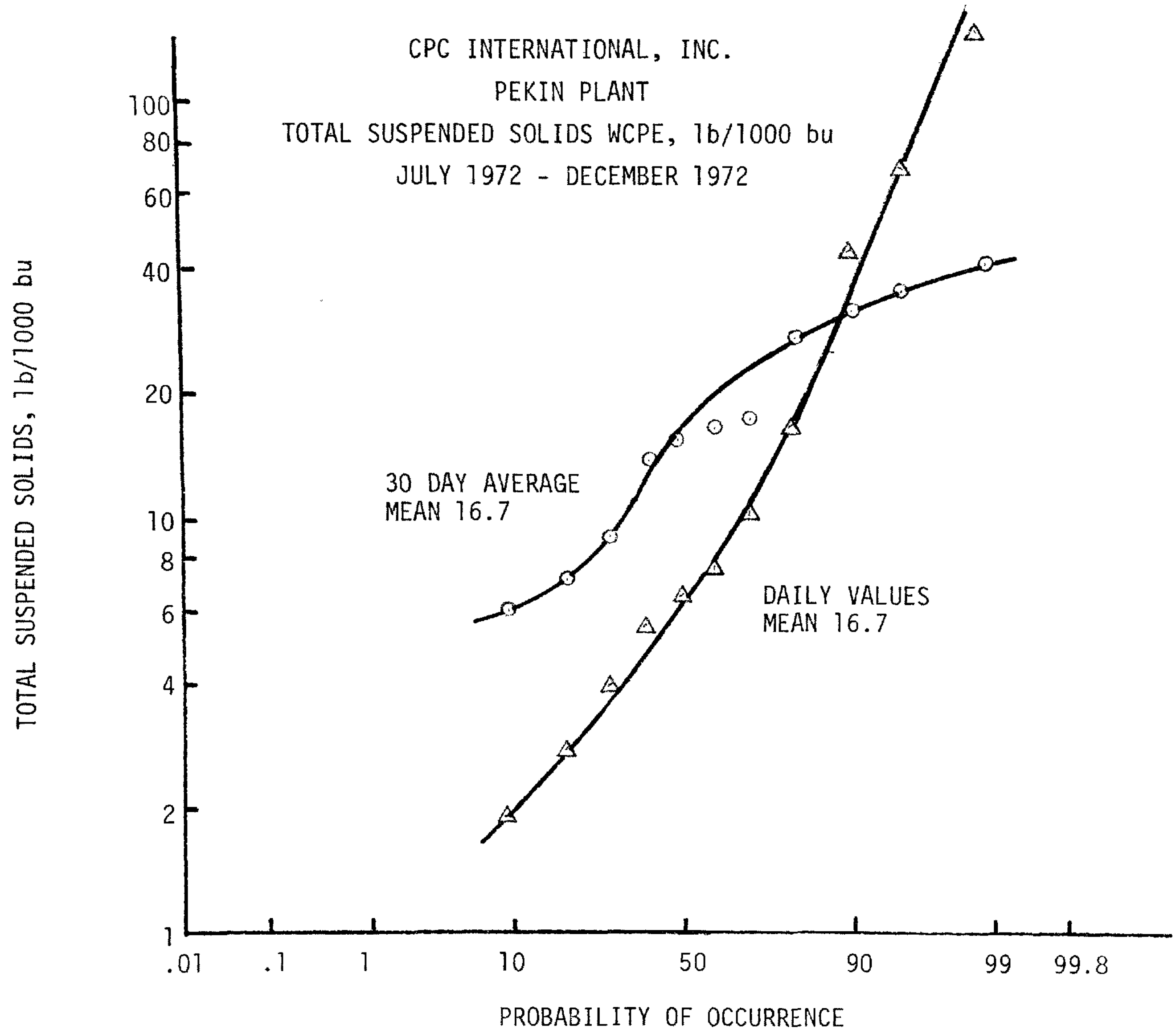

CPC INTERNATIONAL, INC.
PEKIN PLANT
BOD WCPE lb/1000 bu
JULY 1972 - DECEMBER 1972
BOD, lb/1000 bu
80
60
40
20
10
8
6
4
2
1
30 DAY AVERAGE
MEAN 7.91
DAILY VALUES
MEAN 9.66
.01
.1
1
10
50
90
98
99.8
PROBABILITY OF OCCURRENCE

FIGURE 54


CPC INTERNATIONAL, INC.
PEKIN PLANT
TOTAL SUSPENDED SOLIDS WCPE, lb/1000 bu
JULY 1972 - DECEMBER 1972
TOTAL SUSPENDED SOLIDS, lb/1000 bu
100
80
60
40
20
10
8
6
4
2
1
30 DAY AVERAGE
MEAN 16.7
DAILY VALUES
MEAN 16.7
.01
.1
1
10
50
90
99
99.8
PROBABILITY OF OCCURRENCE

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

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4. TITLE AND SUBTITLE Biological Treatment of Wastes From The Corn Wet Milling Industry.		5. REPORT DATE May 1978 issuing date 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Donald R. Brown Gretchen L. Van Meer		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS CPC International, Inc. Moffett Technical Center P.O. Box 345 Argo, Illinois 60501		10. PROGRAM ELEMENT NO. 1BB610 11. CONTRACT/GRANT NO. 12060 DPE
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15. SUPPLEMENTARY NOTES		

16. ABSTRACT

Pilot plant aerated lagoon and laboratory completely mixed activated sludge treatment studies of corn wet milling wastes showed that either process could produce a satisfactory effluent.

A full scale completely mixed activated sludge treatment plant was designed from laboratory reactor data. Soluble BOD removal performance has been about as predicted from the laboratory data. Although total BOD removal often exceeds 90%, the nature of the waste is such that the effluent BOD and suspended solids concentrations usually do not meet effluent criteria. The effluent suspended solids consist almost entirely of bacteria. The BOD is almost entirely due to the oxygen demand of these bacteria.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Corn, Wet mills, activated sludge process, Biochemical oxygen demand, pilot plants, equalizing, aeration, clarification, settling	corn wet milling wastes, treatment costs	68D

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