QUIRK, LAWLER & MATUSKY ENGINEERS

cc: HP 10/1
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SPAULDING FIBRE COMPANY, INCORPORATED TONAWANDA, NEW YORK

Memorandum Report Summarizing Mill Effluent Loadings

October 1968

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October 9, 1968

Mr. Richard A. Preibisch
Technical Director
Industrial Plastics Division
SPAULDING FIBRE COMPANY, INC.
310 Wheeler Street
Tonawanda, New York 10452

Dear Mr. Preibisch:

In accordance with your request, we are pleased to submit our analysis of the mill's effluent loadings.

Statistical analyses and summary tabulations of analytical data supplied by the mill are presented.

For your convenience, a summary of findings, conclusions and recommendations prefaces the memorandum.

Very truly yours,

Leonard J. Eder

Leonard J. Eder

LJE/kj

Enclosure

Summary of Findings, Conclusions and Recommendations

1. The Spaulding Fibre Company at Tonawanda, New York produces approximately 22 tons of paper board per day. Board production is continuous, three shifts per day, seven days per week.

2. Rags, which provide the product raw material, are batch processed at the rate of 33 raw tons per day. Rags are processed on an average of 5.4 days per week.

3. The paper board is sent to the fibre mill for a zinc leaching process, which gives the board the insulative quality associated with the plant's final product. Fibre mill processes are both batch and continuous. Process effluents contain metal salts.

4. A survey of the plant's industrial waste effluents was undertaken from May through July, 1968. QL&M Engineers designed the effluent sampling installations and recommended technical procedures. Spaulding Fibre technical personnel conducted the survey and performed all laboratory analyses. Survey data were sent to QL&M Engineers for statistical interpretation.

5. The plant's effluent loading may be summarized as follows:

Source	Flow (million gals/day)	BOD (lbs/day)	Suspended Solids (lbs/day)	Zinc (lbs/day)
Paper mill (incl. rag processing)	2.07	10,000	8,300	--
Fibre mill	.32	---	---	93
Total	2.39	10,000	8,300	93

6. Statistical analyses have shown that variations of up to ±66% of mean daily paper mill effluent loadings may be experienced during any normal production week.

7. Mean paper mill effluent loadings per ton of product are summarized as follows:

Source	Flow (gals/ton)	BOD (lbs/ton)	Suspended Solids (lbs/ton)
Beater room & machine room sewers [Basis: per ton of paper production]	98,000	300	400
Rag cooker effluents [Basis: per ton of rags processed]	690	101	5

Unit loadings are considered approximate since production records and sampling periods were not exactly coincident.

8. BOD equivalent of effluent suspended solids ranged from an average of 0.53# BOD/# SS in the beater room sewer to 3.2#/# in the rag cooker effluents. These values are somewhat higher than normal industry experience. The use of high effluent BOD/SS equivalents could erroneously indicate that high BOD removals could be anticipated from primary treatment by plain sedimentation or coagulation. Hence, it is recommended that these values be checked by independent analysis at the QL&M laboratories.

9. Effluent loading data has been forwarded to engineers representing the City of Tonawanda. Preliminary costs of municipal treatment of the Spaulding effluent should be available shortly.

10. The evaluation of the least cost approach for the treatment of the Spaulding effluent will require laboratory process studies for the development of preliminary design criteria for an independent treatment facility, as well as the development of the cost-benefit ratios of various degrees of pretreatment prior to discharge to a municipal system.

11. The submittal of a report to the New York State Department of Health detailing the Spaulding pollution abatement plan is required in the first quarter of 1969. In order that preliminary cost data for the various treatment alternatives be available prior to the submittal of the report, it is recommended that the laboratory process studies be undertaken as soon as possible, and also that in-plant close-up and sludge reuse studies should be initiated to dovetail with the laboratory investigations.

I. Introduction

The Spaulding Fibre Company produces an average of 22 tons of insulative paper board per day. Rags furnish the main product raw material.

Effluents having significant BOD and suspended solids loads are discharged from rag cooking and paper board production processes. Additional waste streams containing metal salts are also discharged.

Spaulding Fibre is required to submit a report outlining pollution abatement plans to the New York State Department of Health in early 1969.

Present treatment alternatives available to the Spaulding Fibre Company are:

1. Pretreatment of certain effluents for removal of metals and similar components.

2. Collection and treatment of mill effluent in an independent treatment system with independent discharge of treated effluent to receiving waters.

3. Collection and pretreatment of mill effluent to varying degrees with subsequent discharge of pretreated effluent to a regional sewage treatment plant. The extent of pretreatment will depend upon the comparative costs and administrative requirements of independent versus combined treatment. Alternatives are anticipated to include the following:

    a. Pretreatment of selected effluent streams for BOD reduction with discharge of waste sludges to the regional plant in combination with untreated effluent.

    b. Pretreatment of total effluent for BOD and solids reduction with discharge of treatment plant sludge to the regional plant.

4. Collection and discharge of untreated mill effluent to the regional treatment plant.

Evaluation of alternatives will be based upon the following: municipal treatment costs; laboratory process design criteria for independent treatment facilities; in-mill close-up and sludge reuse studies.

An industrial effluent survey was initiated as the first phase of the pollution abatement plan in order to provide an effluent loading model to be used as the basis of treatment plant design.

The survey included participation of both QL&M and Spaulding Fibre Company personnel. QL&M Engineers designed the effluent sampling installations and recommended technical procedures. Spaulding technical personnel collected the effluent samples and performed analyses. Survey data was sent to QL&M for interpretation.

The body of this memorandum summarizes the results of this survey.

II. Effluent Survey - Technical Aspects

A survey of the Spaulding Fibre Company waste discharges was undertaken from May through July, 1968. The following is a brief summary of the sampling installations, operational procedures and analytical techniques employed during that survey.

A. Fibre Mill Discharges

Fibre mill discharges, while containing insignificant amounts of BOD and SS, do contain possibly objectionable concentrations of zinc.

Fibre mill discharges were not measured during this survey. Effluent loading data were based on a 1966 survey and anticipated process alterations.

B. Paper Mill Discharges

1. Machine Room Effluent - Flow measurement in the machine room effluent flume was accomplished by installation of a prismatic weir and a water level recorder. The chart of continuous measurement of static head on the weir was translated into flow by means of a weir calibration curve corrected for velocity of approach.

   Sampling of the flow was accomplished by installation of an automatic sampler that collected a sample proportional to the prevailing flow. The frequency of sampling was once in every five minutes. The discharge from the sampler was collected in a plastic refuse can to provide a 24-hour composite sample.

2. Beater Room Effluent - Flow measurement in the fume collecting effluent from the beater room was measured using the existing 12-inch Parshall flume. Continuous level recorders were installed in the float wells of the Parshall flume to provide for flow estimation from a stage-discharge curve. Sampling of the flow was accomplished by installation of an automatic sampler that collected a sample proportioned to the prevailing flow. The frequency of sampling was once every five minutes. The discharge from the sampler was collected in a plastic refuse can to provide a 24-hour composite sample.

3. Rag Cooker Effluents - The magnitude of the discharge from the rag cookers was estimated from knowledge of the volume of charge to a cooker and the number of batch cooks per day. The waste drainage from a single cook was estimated as 5,000 gallons.

All samples were analyzed for total BOD and COD, dissolved BOD and COD, suspended solids, volatile suspended solids and pH.

Waste analyses were performed in accordance with procedures described in Standard Methods for the Examination of Water and Wastewater, twelfth edition, 1965.

III. Effluent Loading Analysis

Effluent survey data was sent to QL&M Engineers for the development of an effluent loading model to be used as the basis of treatment plant design.

Waste loading data obtained during the survey exhibited a high degree of fluctuation. This variation in the data obviated the use of a logical loading model based on unit process production. A computer program was developed to determine an applicable statistical model for the data. The use of a statistical model was required because such a model allows predictions to be based upon the best estimate of the actual distribution which would result if an infinite number of samples were available.

All waste surveys contain inherent errors due to sampling fluctuations, the nature of the laboratory analyses and the inclusion of non-representative production days during which process upsets may have occurred. The uncertainty of predictions based upon the arithmetic average of a small set of data of this type are decreased when the data are described by a smooth distribution indicated by the major portion of the data.

The computer program compares survey data to a number of standard distributions and mathematically chooses the most applicable format. This analysis showed that the Spaulding effluent data generally followed a log-normal distribution.

Summaries of pertinent statistical parameters as well as graphical representations of the various distributions indicated by computer selection are presented.

A. Fibre Mill Loadings

Waste discharges from the fibre mill were not sampled during the recent survey. Loadings based upon a 1966 survey and anticipated process alterations were supplied by Spaulding Fibre for inclusion in this memorandum. These effluent loadings are summarized in Table 1.

Future fibre mill effluent loadings will be used as the basis of design, since process changes affecting these loadings will be completed prior to the start-up of treatment facilities.

B. Paper Mill Effluents

There are three waste streams leaving the paper mill. These are the beater room sewer, the machine room sewer and the rag cooker discharges.

Graphical representations of the distributions of paper mill effluent flow, BOD and suspended solids loadings chosen by the computer are presented in Figures 1, 2 and 3.

SPAULDING FIBRE COMPANY, INCORPORATED

TONAWANDA, NEW YORK

Table 1

Fibre Mill Effluent Loadings*

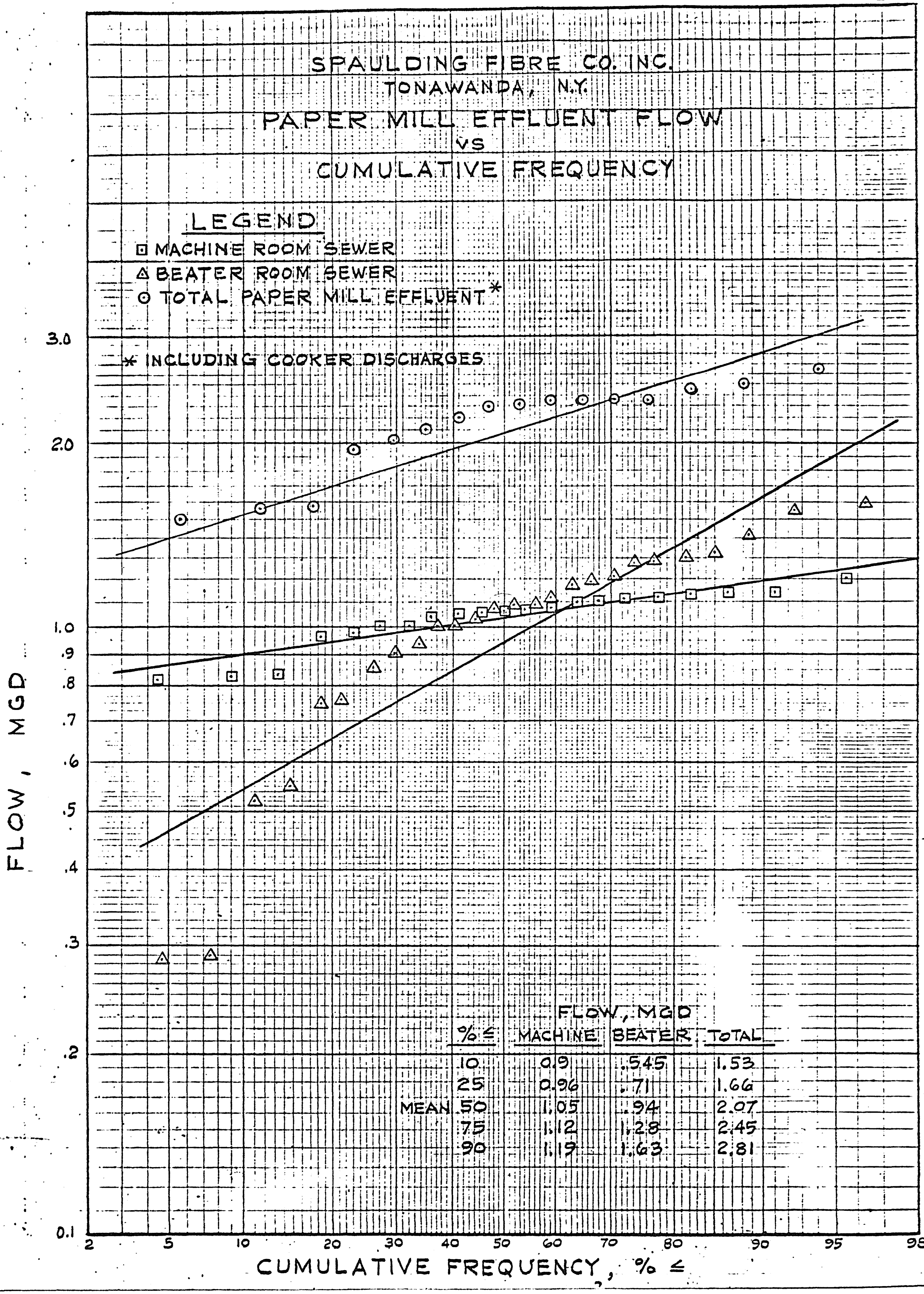
	Period	Flow (gpd)	BOD (#/day)	Zinc (#/day)
1.	1966 Survey	1,078,000	20	1,000
2.	Present	646,000	20	200
3.	Future	~~315,000~~ 86,400 (ONLY COOLING H_2O FOR TANKS)	~~20~~	~~93~~

* Loadings include contributions from the following processes:

1. Continuous and reel leaching
2. Cutdown leaching
3. Fibre tube and roving can leaching
4. Evaporator cooling water
5. Extension leaching

Suspended solids contributions are assumed negligible.

FIGURE 1



SPAULDING FIBRE CO. INC.
TONAWANDA, N.Y.
PAPER MILL EFFLUENT FLOW
VS
CUMULATIVE FREQUENCY
LEGEND
⊡ MACHINE ROOM SEWER
△ BEATER ROOM SEWER
⊙ TOTAL PAPER MILL EFFLUENT*
* INCLUDING COOKER DISCHARGES
FLOW, MGD
% ≤ MACHINE BEATER TOTAL
10 0.9 .545 1.53
25 0.96 .71 1.66
MEAN 50 1.05 .94 2.07
75 1.12 1.28 2.45
90 1.19 1.63 2.81
FLOW, MGD
3.0
2.0
1.0
.9
.8
.7
.6
.5
.4
.3
.2
0.1
2 5 10 20 30 40 50 60 70 80 90 95 98
CUMULATIVE FREQUENCY, % ≤

FIGURE 2

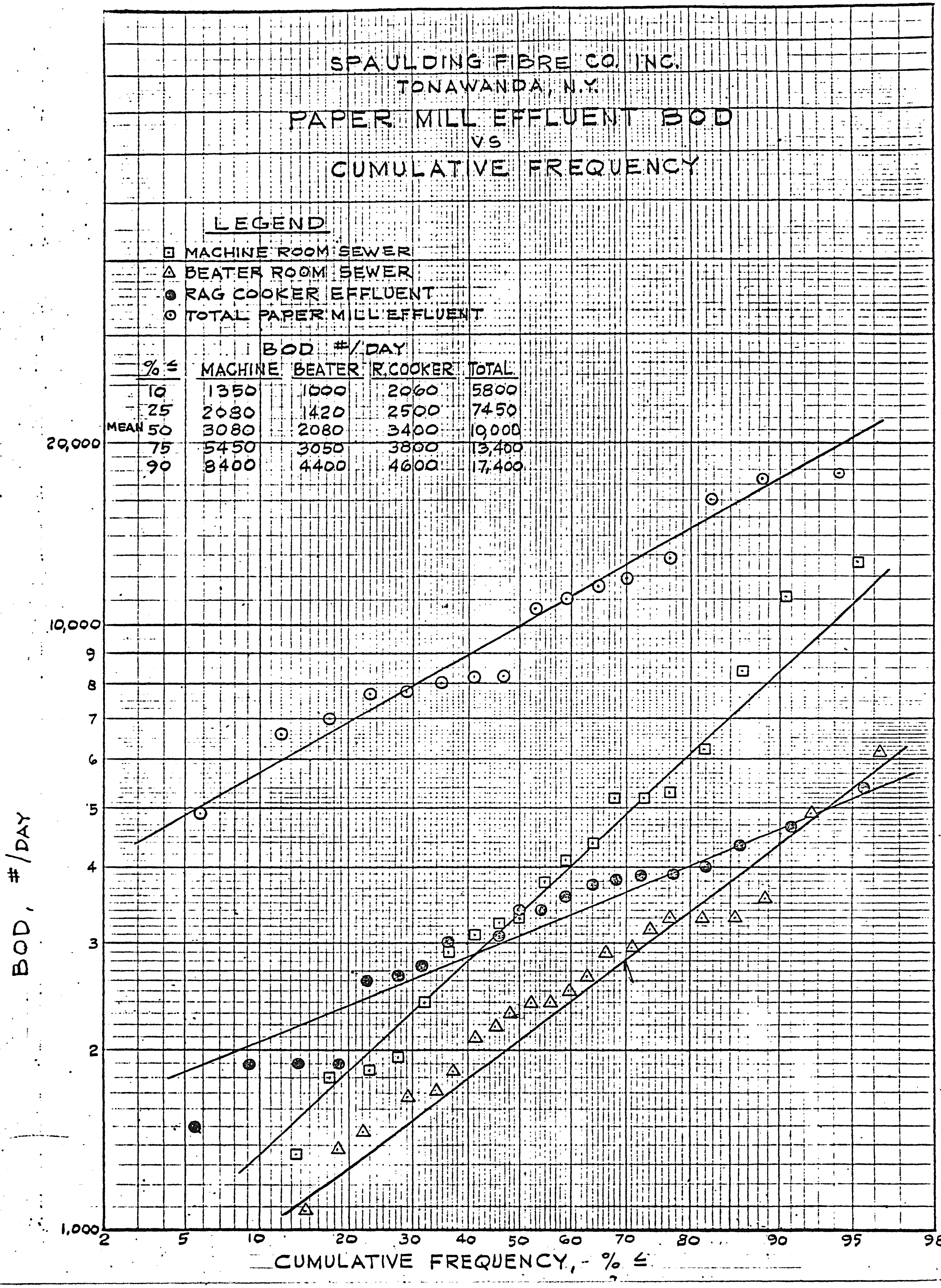
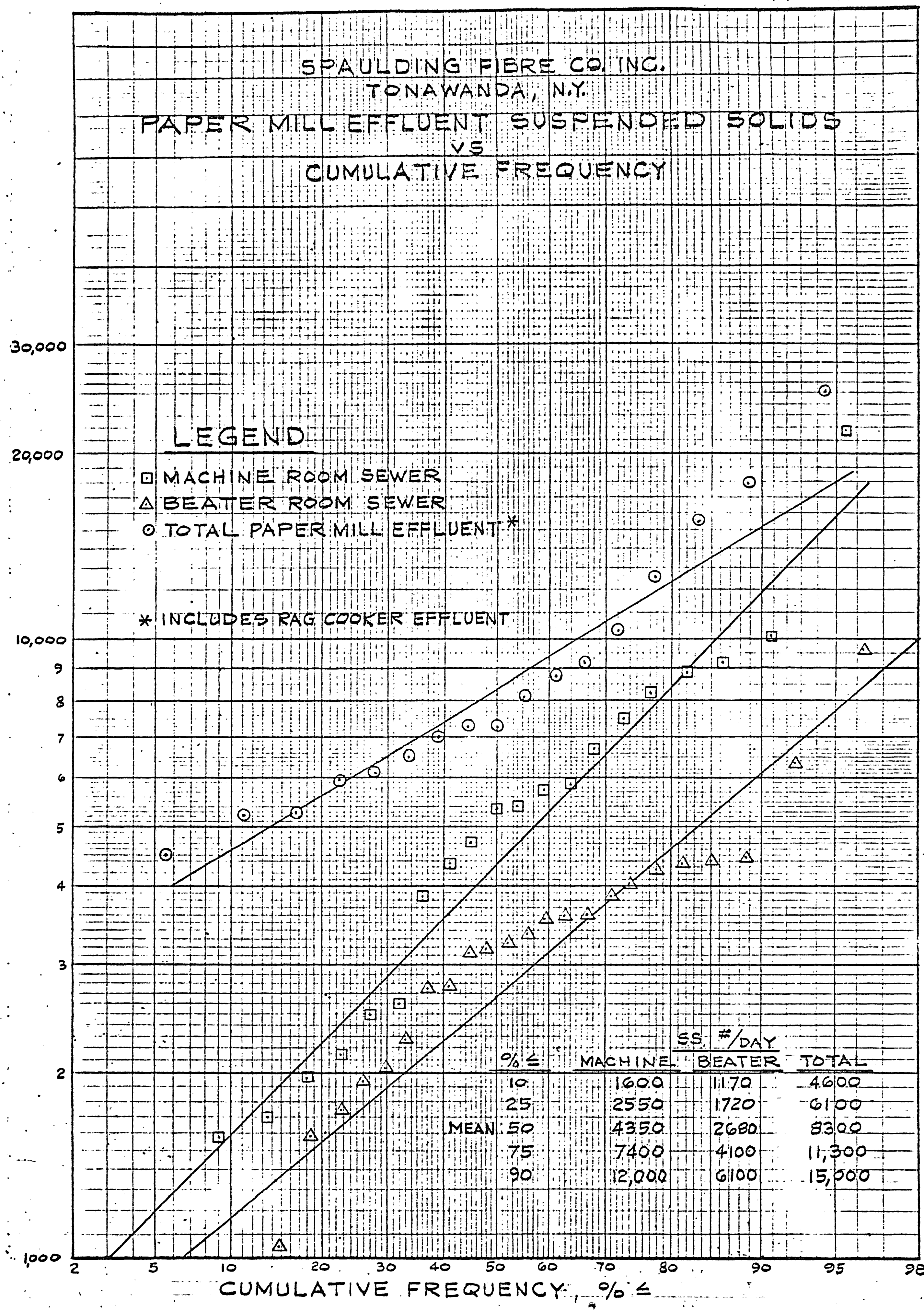

SPAULDING FIBRE CO. INC.
TONAWANDA, N.Y.
PAPER MILL EFFLUENT BOD
VS
CUMULATIVE FREQUENCY
LEGEND
□ MACHINE ROOM SEWER
△ BEATER ROOM SEWER
● RAG COOKER EFFLUENT
⊙ TOTAL PAPER MILL EFFLUENT
BOD #/DAY
% ≤ MACHINE BEATER R.COOKER TOTAL
10 1350 1000 2060 5800
25 2080 1420 2500 7450
MEAN 50 3080 2080 3400 10,000
75 5450 3050 3800 13,400
90 8400 4400 4600 17,400
20,000
10,000
9
8
7
6
5
4
3
2
1,000
BOD, #/DAY
2 5 10 20 30 40 50 60 70 80 90 95 98
CUMULATIVE FREQUENCY, - % ≤

FIGURE 3



SPAULDING FIBRE CO. INC.
TONAWANDA, N.Y.
PAPER MILL EFFLUENT SUSPENDED SOLIDS
VS
CUMULATIVE FREQUENCY
LEGEND
□ MACHINE ROOM SEWER
△ BEATER ROOM SEWER
⊙ TOTAL PAPER MILL EFFLUENT *
* INCLUDES RAG COOKER EFFLUENT
S.S. #/DAY
%≤ | MACHINE | BEATER | TOTAL
10 | 1600 | 1170 | 4600
25 | 2550 | 1720 | 6100
MEAN 50 | 4350 | 2680 | 8300
75 | 7400 | 4100 | 11,300
90 | 12,000 | 6100 | 15,000
30,000
20,000
10,000
9
8
7
6
5
4
3
2
1,000
S.S., #/DAY
2
5
10
20
30
40
50
60
70
80
90
95
98
CUMULATIVE FREQUENCY, % ≤

The cumulative frequency indicated in the figures refers to the percent of the time an effluent loading will be equal to or less than the value shown. Various paper mill processes function under separate time tables. Rags are batch processed and stored in mill chests; beater room operations also involve some degree of material storage. Board production, however, is continuous. A separate statistical analysis of the total daily load was required since the statistical distributions of the total paper mill effluent under these conditions may differ from the arithmetic sum of the distributions of the individual processes. Essentially, it must be recognized that just as neither the highest nor lowest loads of all the component streams can be expected to occur simultaneously, neither will the separate averages occur simultaneously. Hence, the distributions of the total loads will show less variation than the arithmetic sums of the component parts.

The flow and suspended solids contributions of the rag cooker discharges were included in the total load distributions, but since they are small by comparison to the beater and machine room loadings, their separate distributions were not shown.

Table 2 summarizes the mean paper mill effluent loadings. Data fluctuations were significant. Table 3 summarizes the range of loadings experienced during the survey and the statistical variation in daily loads which may be expected during any normal production week.

A total variation of about 26% may be expected from the mean daily flow, while BOD loadings would vary 58% and suspended solid loadings would vary 66% from mean values during a normal production week.

C. Total Effluent Loadings

Total plant effluent loadings from all sources are summarized in Table 4. Mean values are presented.

D. Unit Effluent Loadings

The distribution of unit effluent loadings based upon daily production records are shown in Figures 4, 5 and 6.

Unit loadings have been divided into two groups, machine room plus beater room effluents unitized per ton of board produced and cooker effluents unitized per ton of rags processed.

Table 5 summarizes the mean and normal weekly variation expected in the paper mill unit loadings.

These unit loadings are approximate, since sample periods and production records are not exactly coincident.

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Table 2

Mean Paper Mill Effluent Loadings

	Source	Flow (mgd)	BOD (#/day)	SS (#/day)
1.	Machine room sewer	1.05	3,080	4,350
2.	Beater room sewer	.94	2,080	2,680
3.	Rag cooker effluent	.022	3,400	250
4.	Total*	2.07	10,000	8,300

* Non-additive, developed through independent statistical analyses.

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TONAWANDA, NEW YORK

Table 3

Paper Mill Effluent Load Variations

Loading	Range Observed During Survey	Variation Expected During A Normal Production Week
1. Machine room sewer		
Flow, mgd	0.82 - 1.20	0.92 - 1.15
BOD, #/day	950 - 12,800	1,580 - 7,200
SS, #/day	610 - 21,500	1,880 - 10,000
2. Beater room sewer		
Flow, mgd	0.285 - 1.60	0.60 - 1.48
BOD, #/day	470 - 6,200	1,130 - 3,800
SS, #/day	600 - 9,500	1,350 - 5,300
3. Rag cooker effluent		
Flow, gpd	15,000 - 25,000	15,000 - 25,000
BOD, #/day	1,500 - 5,200	2,350 - 4,100
SS, #/day	12 - 1,080	62 - 350
4. Total paper mill effluent		
Flow, mgd	1.5 - 2.65	1.6 - 2.60
BOD, #/day	4,900 - 17,800	6,300 - 15,800
SS, #/day	4,500 - 25,000	5,200 - 13,500

* As indicated by statistical analyses.

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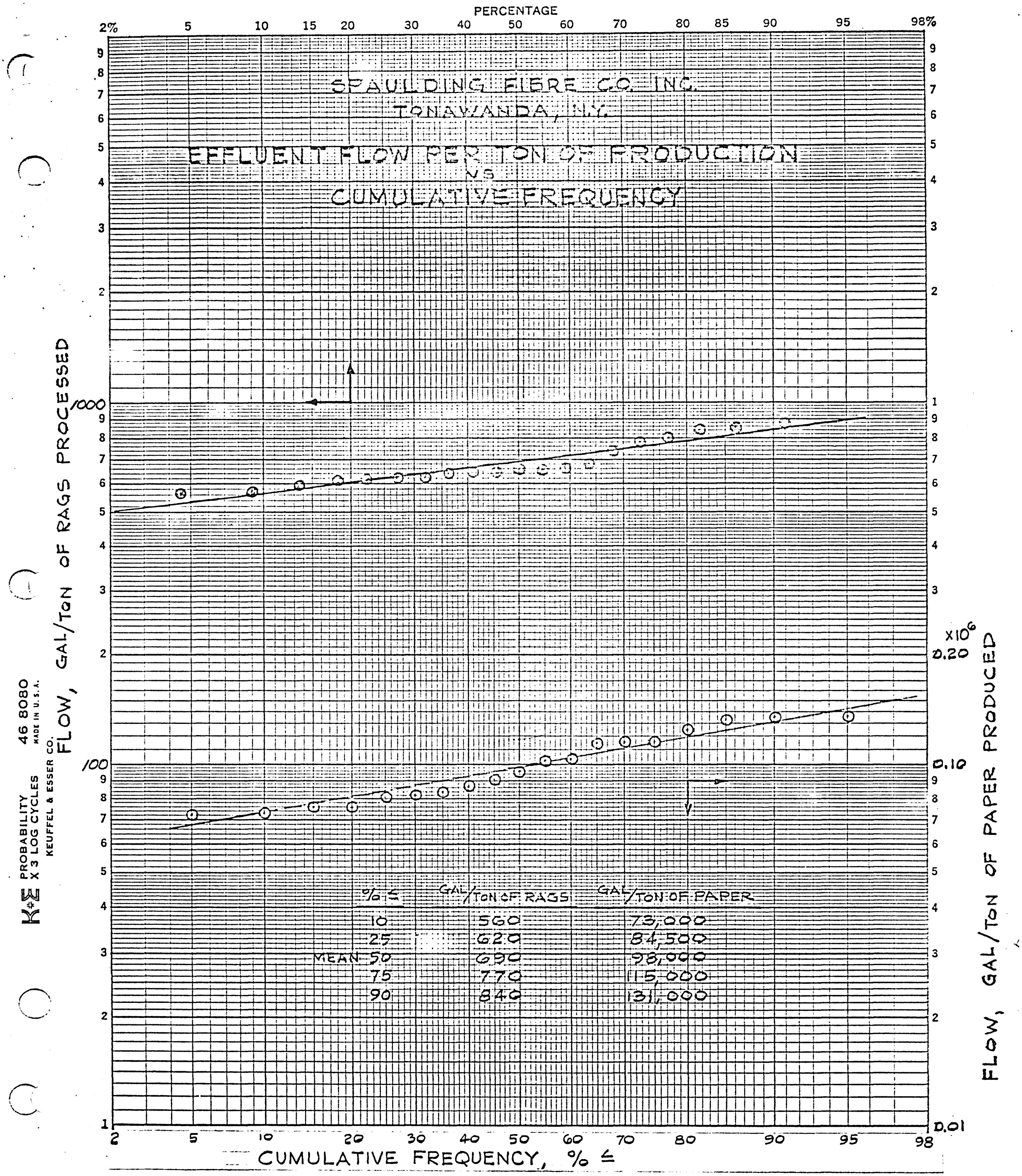
Table 4

Total Plant - Mean Effluent Loadings

	Source	Flow (mgd)	BOD (#/day)	SS (#/day)	Zinc (#/day)
1.	Paper mill	2.07	10,000	8,300	--
2.	Fibre mill* (future conditions)	.32	---	---	93
3.	Total effluent	2.39	10,000	8,300	93

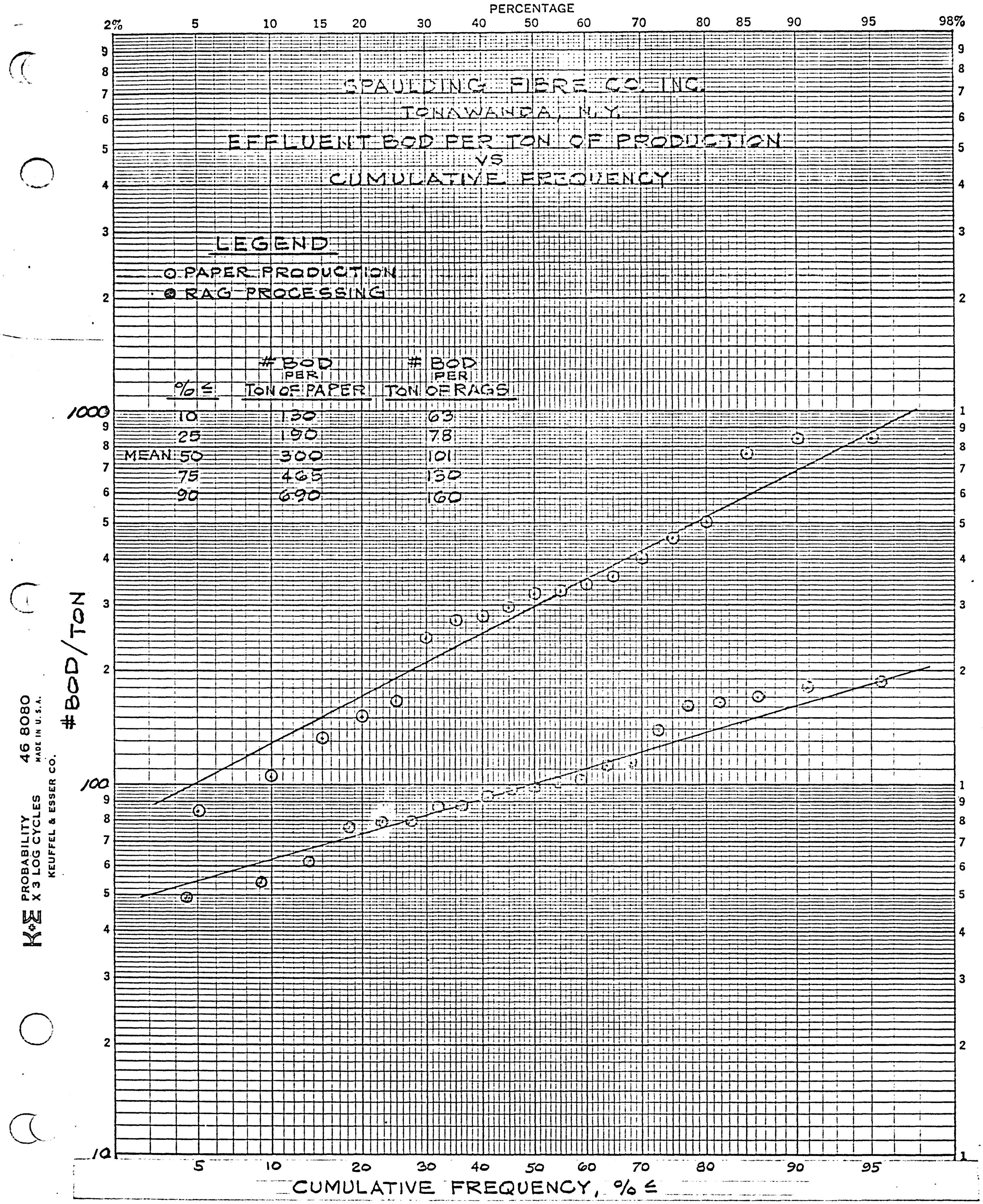
* BOD and SS contributions are negligible.

FIGURE 4



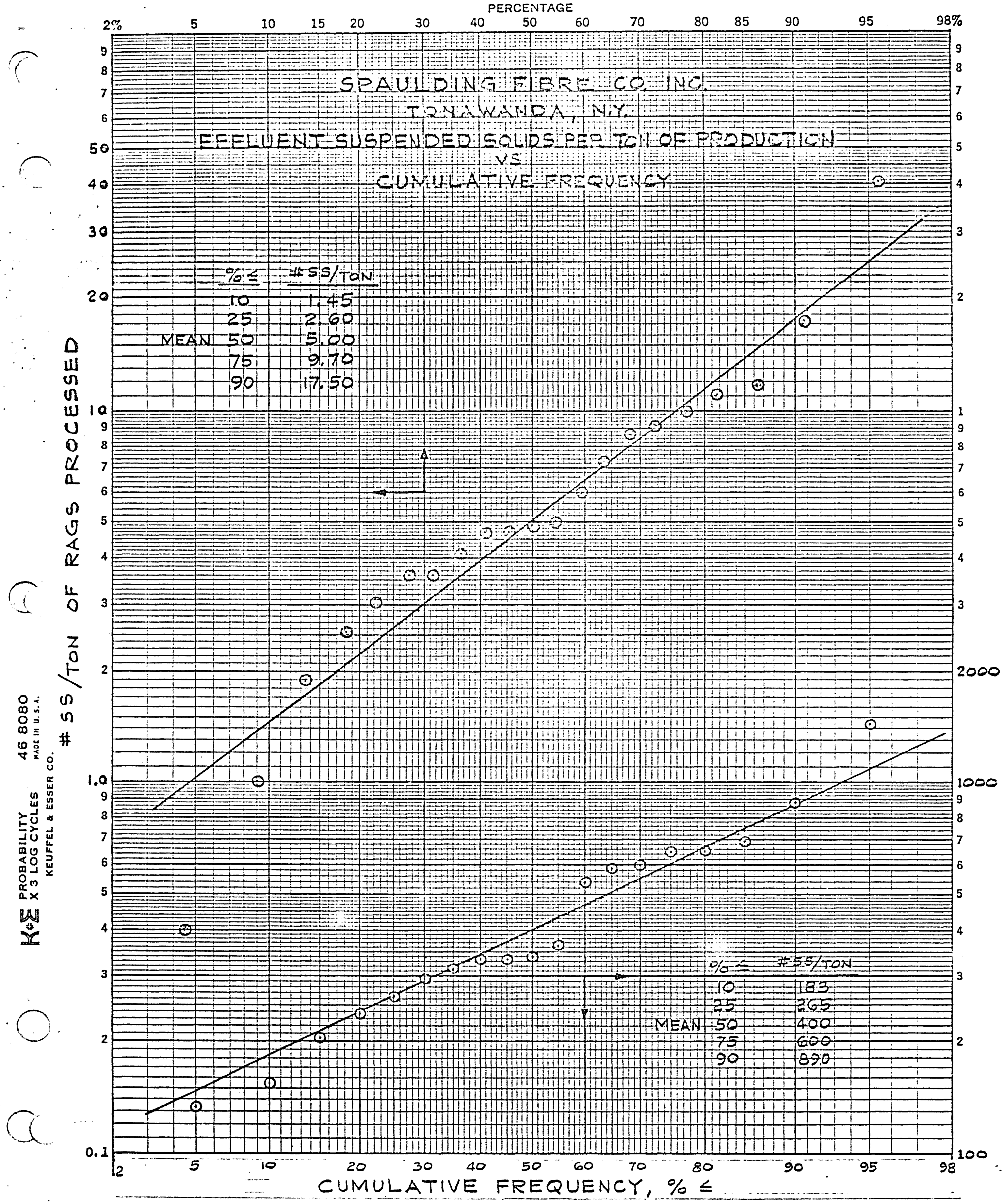
SPAULDING FIBRE CO. INC.
TONAWANDA, N.Y.
EFFLUENT FLOW PER TON OF PRODUCTION
VS
CUMULATIVE FREQUENCY
PERCENTAGE
FLOW, GAL/TON OF RAGS PROCESSED
FLOW, GAL/TON OF PAPER PRODUCED
x10^6
CUMULATIVE FREQUENCY, % ≤
% ≤ | GAL/TON OF RAGS | GAL/TON OF PAPER
10 | 560 | 73,000
25 | 620 | 84,500
MEAN 50 | 690 | 98,000
75 | 770 | 115,000
90 | 840 | 131,000
K+E PROBABILITY X 3 LOG CYCLES 46 8080 KEUFFEL & ESSER CO. MADE IN U.S.A.

FIGURE 5



% ≤	# BOD PER TON OF PAPER	# BOD PER TON OF RAGS
10	130	63
25	190	78
MEAN 50	300	101
75	465	130
90	690	160

FIGURE 6



PERCENTAGE
SPAULDING FIBRE CO. INC.
TONAWANDA, N.Y.
EFFLUENT SUSPENDED SOLIDS PER TON OF PRODUCTION
VS
CUMULATIVE FREQUENCY
% ≤ | #SS/TON
10 | 1.45
25 | 2.60
MEAN 50 | 5.00
75 | 9.70
90 | 17.50
% ≤ | #SS/TON
10 | 183
25 | 265
MEAN 50 | 400
75 | 600
90 | 890
SS/TON OF RAGS PROCESSED
SS/TON OF PAPER PRODUCED
CUMULATIVE FREQUENCY, % ≤
K+E PROBABILITY X 3 LOG CYCLES 46 8080
KEUFFEL & ESSER CO. MADE IN U.S.A.

SPAULDING FIBRE COMPANY, INCORPORATED

TONAWANDA, NEW YORK

Table 5

Paper Mill Effluent Loadings

Per Ton of Production

Loading	Mean Value	Variation Expected During A Normal Production Week
1. Machine and beater room effluents		
Flow, gals/ton of paper produced	98,000	77,000 - 125,000
BOD, #/ton of paper produced	300	148 - 600
SS, #/ton of paper produced	400	210 - 750
2. Rag cooker effluents		
Flow, gals/ton of rags processed	690	600 - 790
BOD, #/ton of rags processed	101	72 - 130
SS, #/ton of rags processed	5	2.1 - 12

E. BOD Equivalent of Effluent Suspended Solids

Distributions describing the variations in the BOD equivalent of mill effluent suspended solids are shown in Figure 7. The equivalence is obtained through the following relationship:

$$\frac{\text{Total BOD - Dissolved BOD}}{\text{Suspended Solids}} = \frac{\#\text{BOD}}{\#\text{SS}}$$

Table 6 summarizes the distribution means and the range of values encompassed by 1 standard deviation ($\pm$34.1%) about the mean.

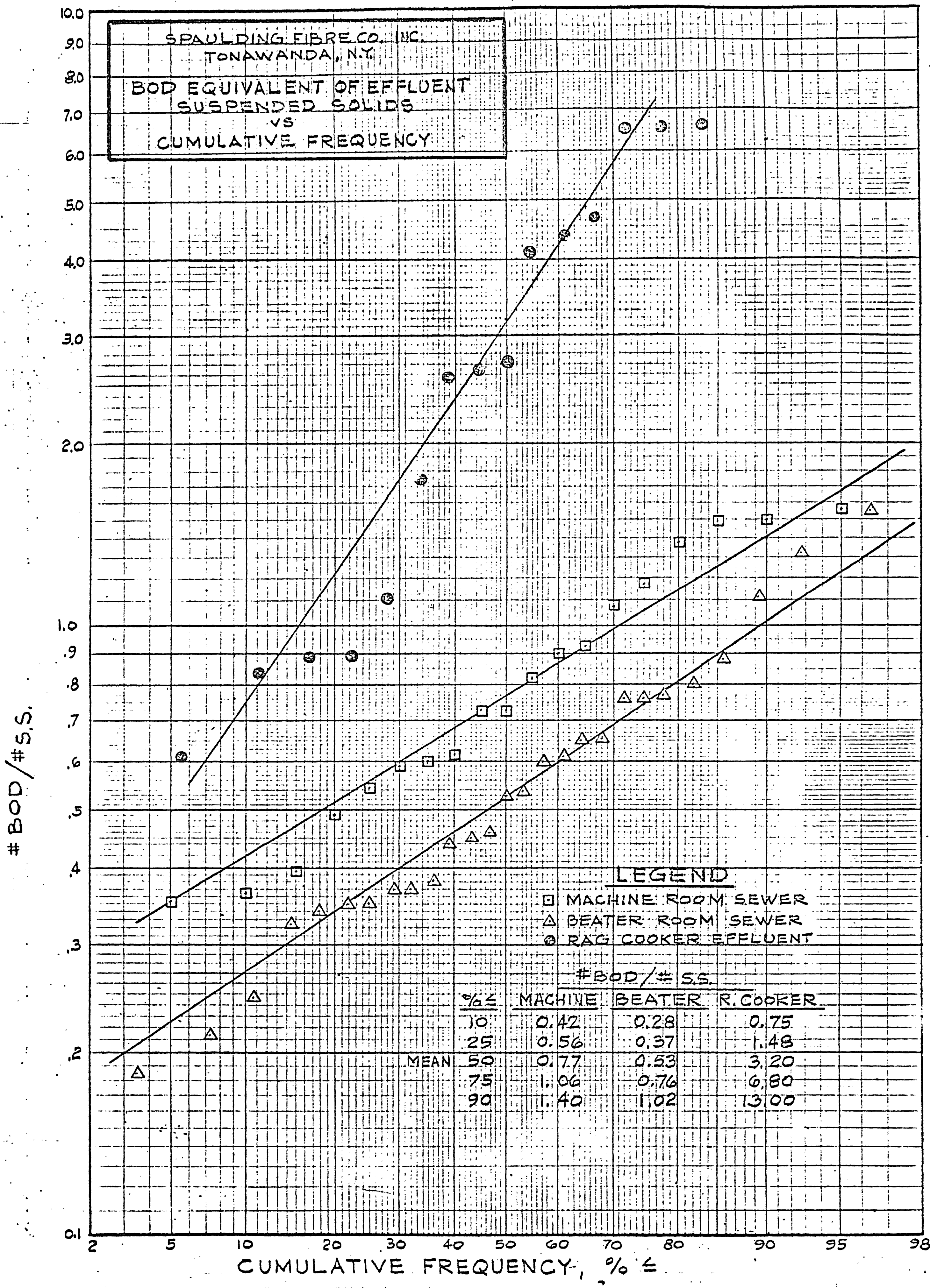
The survey values are an order of magnitude higher than those normally encountered in the paper industry.

High BOD-suspended solids equivalents indicate that a high BOD removal can be obtained by plain sedimentation or coagulation. Erroneous estimates of BOD removals attainable via primary treatment would significantly affect preliminary selection of a treatment scheme for the mill. Hence, it is recommended that these values be checked through a series of independent analyses at the QL&M laboratories.

F. Additional Effluent Characteristics

Table 7 summarizes the average values of additional effluent waste characteristics investigated during the survey.

FIGURE 7



SPAULDING FIBRE CO. INC.
TONAWANDA, N.Y.
BOD EQUIVALENT OF EFFLUENT SUSPENDED SOLIDS
VS
CUMULATIVE FREQUENCY
LEGEND
MACHINE ROOM SEWER
BEATER ROOM SEWER
RAG COOKER EFFLUENT
#BOD/#S.S.
%≤ MACHINE BEATER R.COOKER
10 0.42 0.28 0.75
25 0.56 0.37 1.48
MEAN 50 0.77 0.53 3.20
75 1.06 0.76 6.80
90 1.40 1.02 13.00
#BOD/#S.S.
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
.9
.8
.7
.6
.5
.4
.3
.2
0.1
2
5
10
20
30
40
50
60
70
80
90
95
98
CUMULATIVE FREQUENCY, % ≤

SPAULDING FIBRE COMPANY, INCORPORATED

TONAWANDA, NEW YORK

Table 6

BOD Equivalent of Effluent

Suspended Solids

	Source	Mean Value	Range of Values 1 Standard Deviation About the Mean
1.	Machine room sewer	0.77	.48 - 1.28
2.	Beater room sewer	0.53	.315 - .92
3.	Rag cooker effluent	3.20	1.04 - 10.0

SPAULDING FIBRE COMPANY, INCORPORATED

TONAWANDA, NEW YORK

Table 7

Additional Effluent Characteristics

	Characteristics	Machine Room Sewer	Beater Room Sewer	Rag Cooker Effluents
1.	Total COD, ppm	730	555	38,200
2.	Dissolved COD, ppm	27	186	32,000
3.	Average total BOD/COD ratio	0.67	0.53	0.49
4.	% Volatile suspended solids	93	77	86
5.	pH	7.4	7.8	11.7